# MONITORING THE PINKHILL MEADOW WETLANDS: SUMMER 1990-SPRING 1991

## A PROGRESS REPORT FOR THE

## NATIONAL RIVERS AUTHORITY (THAMES REGION)

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POND ACTION
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## SUMMARY


### 1. Introduction

This progress report describes the results of monitoring of 4 ponds created in Phase I of the Pinkhill Meadow Wetland Enhancement Project. The work was undertaken by Pond Action between July 1990 and May 1991.

### 2. The Pinkhill Meadow ponds

Four ponds (known as Main Pond, Groundwater pond, Surfacewater pond and the Scrape) were created on Pinkhill Meadow, Farmoor, in summer 1990 to increase the variety of wetland habitats on the Farmoor site. The ponds were particularly designed to provide shallow water habitats, otherwise scarce on the site, for wading birds. The ponds were also designed to provide a variety of habitats for aquatic plants and invertebrates. Monitoring of the ponds has focused on water chemistry, colonisation by aquatic plants and macroinvertebrates and the use of the site by waders and other water birds.

### 3. Water chemistry

Chemical analysis of water quality began in April 1991. Results are currently being processed by the National Rivers Authority and have not been included in this report.

### 4. Wetland plants

By late spring/early summer 1991 28 aquatic and marginal wetland plant species had colonised the Pinkhill ponds. Most species colonised the site naturally although four were accidentally introduced to the site when the trial *Phragmites* bed was planted-up.

Differences in the colonisation of the four ponds were striking. The Main Pond currently (summer 1991) supports a well-developed stand of *Chara* sp., growing in deeper water throughout the pond. No aquatic plants have colonised the other ponds to the same extent.

Colonisation by marginal wetland plants largely depended on the nature of the substrate at the pond margins. In all but one area the margins of the ponds consist of nutrient-poor subsoil. In these areas colonisation has proceeded slowly, with extensive areas of bare sediment being retained. On part of the margin of the Scrape nutrient-rich topsoil was spread following the excavation of the pond and this area has been colonised much more rapidly. This area now supports a moderately dense stand of marginal wetland plants and ruderals.

### 5. Aquatic macroinvertebrates

The four ponds have been rapidly colonised by aquatic macroinvertebrates, three of the four ponds already support communities which are distinctively different from each other. Throughout the period described by this report the macroinvertebrate communities of the ponds have been dominated by flighted insects which are able colonise new sites relatively rapidly. Of these, water beetles were the most diverse group, followed by water bugs, mayflies, caddis flies and dragonflies. Flightless groups (water snails, leeches, flatworms, freshwater shrimps and flightless members of the insect groups) were very scarce throughout the survey period.

The invertebrate communities of the ponds are already of either high or very high nature conservation value. One species rare in Britain (the diving beetle *Coelambus nigrolineatus*), has colonised two of the ponds with a further 4 to 6 local species recorded so far in each of the ponds (a total of nine rare or local species for the site). Larvae of two species of dragonflies have been recorded (the black-tailed skimmer, *Orthetrum cancellatum*, and the ruddy darter, *Sympetrum sanguineum*).

There are few other ponds in Britain for which comparable data about early colonisation have been gathered. However, Pinkhill Main pond currently supports about three times as many macroinvertebrate species as a 3ha, 1-2 year old gravel-pit lake near Reading, surveyed by Pond Action. This suggests that the site is proving attractive, perhaps exceptionally so, to macroinvertebrates.

## 6. Water birds and waders

During April and May 1991 10 species of waders were recorded visiting the Pinkhill wetlands. Little-ringed plovers were regularly seen on the site during the spring but did not remain to breed (although mating was observed). The margins of the Main pond were significantly more attractive to little-ringed plovers than the reservoir margins. Greenshank, Temminck's stint, whimbrel and bar-tailed godwit also visited the Pinkhill wetlands, as did little and common terns. Surprisingly, the two most abundant waders at Farmoor, dunlin and common sandpiper, were not attracted to the site.

The shoreline of the Pinkhill Main Pond and Scrape attracted significantly more waders/100m of margin than the two reservoirs. Although representing only 8% of the total shoreline on the Farmoor site, Pinkhill accumulated 15% of the wader-days during the spring. This was largely due to the frequency with which little-ringed plovers visited the site. However, this suggests that the Pinkhill ponds are already slightly more attractive to waders than the rest of the Farmoor site, despite their small size.

Results of the known-effort surveys of water birds undertaken by Pond Action were compared with the non-systematic records listed by visiting birdwatchers in the Farmoor log-book. For waders, the records in the Farmoor log-book were generally closely correlated with known-effort observations. Counts of other water birds in the log-book, however, were generally poorly correlated with the results of the known-effort surveys.

This suggests that observations of waders made by visiting bird-watchers will be of value in assessing changes in the use of the Farmoor site following the creation of the Pinkhill wetlands. The size of changes in bird numbers which can be detected with log-book data has yet to be determined but analysis is currently in progress to address this question. Preliminary interpretation of the results of this work suggests that recording by birdwatchers is unlikely to detect changes in numbers of waders of less than 50% of the total number of birds now recorded.

# 1. INTRODUCTION

This progress report describes the results of monitoring of ponds created in Phase I of the Pinkhill Meadow Wetland Enhancement Project. The work was undertaken by Pond Action between July 1990 and May 1991.

Monitoring of the ponds has focused on water chemistry, colonisation of the ponds by aquatic plants and macroinvertebrates and use of the site by waders and other water birds.

# 2. WATER CHEMISTRY

## 2.1 METHODS

Water chemistry sampling started on 18 April 1991. Samples are currently being taken monthly (every four weeks) at mid-day.

Each set of samples is taken at the same location and depth, with sampling position judged in reference to markers. Sampling positions in each of the waterbodies are described in Table 1.

To minimise disturbance and contamination, most samples were taken using a remotely controlled device operated from the shore. In the scrape the very shallow water prohibited the use of this method and the sampling was done by hand.

One litre of water was collected on each occasion, in a clean plastic bottle, rinsed thoroughly with pond water before use. Bottles were sealed with no air inside the bottle, before being delivered to Denton House (NRA) and transported to the NRA chemical analysis laboratories in Reading for analysis next day.

The following determinands were measured:

pH
Total suspended solids
Conductivity
Nitrate
Nitrate
Ammonia
Soluble reactive phosphate
Biochemical Oxygen Demand

## 2.2 RESULTS

Samples have been collected in April, May and June 1991 (24 samples have been taken altogether). Results from the analysis of these samples are currently being processed by NRA Thames Region and have not been included in this report.

**TABLE 1. SITES IN THE PINKHILL MEADOW PONDS FROM WHICH WATER SAMPLES ARE COLLECTED FOR WATER QUALITY ANALYSES**

| SITE | SAMPLE TYPE | SAMPLING SITES | DEPTH |
|---|---|---|---|
| Main pond | Single | North and South | 100cm |
| Ground water pond | Duplicate | Middle | 50cm |
| Surface water pond | Duplicate | Middle | 50cm |
| Scrape | Single | North and South | Mid Column |

# 3. WETLAND PLANTS

## 3.1 INTRODUCTION

The aim of plant survey work has been to describe the development of the wetland plant community, providing estimates of the change in abundance of vegetation.

## 3.2 METHODS

Plants were surveyed using standard National Pond Survey methods in June 1991 (Biggs et.al. 1989). Abundance of all species was also recorded on the DAFOR (Dominant, Abundant, Frequent, Occasional, Rare) scale.

Critical specimens were returned to the laboratory for examination.

Occasional observations were also made on the vegetation in the ponds throughout the period of this report.

## 3.3 RESULTS

Species list for the four ponds and the *Phragmites* bed are given in Table 2

### 3.3.1 Aquatic plants

Only two species of aquatic plants were recorded in the Pinkhill ponds throughout the period described in this report. The most abundant and widespread of these was *Chara vulgaris* agg. with much smaller amounts of *Callitriche* sp..

In June 1991 *C.vulgaris* occurred in three of the ponds, but varied greatly in abundance. In the Main pond *Chara* covered approximately 60% of the bottom surface, avoiding only the very shallow areas. Chara was also found in the Scrape and the Groundwater pond but was rare in both. It was notable that although in June only very small stands were present in the Scrape, up to 15% of bottom had been covered by *C.vulgaris* in autumn 1990.

*C.vulgaris* also grew in dense stands in the trial *Phragmites* trench, covering approximately 65% of the trench bottom.

A small number of plants of *Callitriche* sp. were present in the Main Pond at the time of the survey. A single plant of *Ranunculus* sp., recorded earlier in the year, was not re-recorded during the summer survey.

### 3.3.2 Marginal plants

The upper banks of all four ponds wee colonised by ruderals and grasses growing down from the surrounding meadow. Most of the rest of the pond margins were little colonised, with vegetation giving cover of up to 20%.

The two exceptions to this were: (i) where topsoil had been relaid around part of the Scrape
(ii) in the *Phragmites* bed where topsoil was deposited in the trench.

In total 26 species of marginal wetland plant were recorded around the newly excavated pond margins. The most abundant were wetland grasses, particularly *Agrostis stolonifera* and *Alopecurus geniculatus*.

Approximately 50% of the wetland species recorded on the new pond margins were species already present in the meadow grassland around the ponds. Most of the others were species common along the banks of the Thames in the near vicinity of the Pinkhill site (Pond Action 1990).

The most diverse area of wetland vegetation was the *Phragmites* trench where the addition of topsoil both below and above water level gave a more organic and nutrient rich substrate. This encouraged the colonisation of wetland ruderals like *Alisma plantago-aquatica Veronica anagallis-aquatica* and *Ranunculus sceleratus.*

## 3.4 THE NATURE CONSERVATION VALUE OF THE WETLAND PLANT COMMUNITY

The wetland plant communities of the four ponds was of only moderate or low conservation value (see Table 3). Species-richness was moderate and no rare or local species were recorded.

## TABLE 2. WETLAND PLANTS RECORDED IN THE PINKHILL MEADOW PONDS

Abbreviations:

MP Main Pond
GW Groundwater Pond
SW Surfacewater Pond
S Scrape
PH Phragmites bed

A Abundant
O Occasional
R Rare
I Introduced species

| SPECIES NAME | COMMON NAME | MP | GW | SW | SC | PT |
|---|---|---|---|---|---|---|
| Agrostis stolonifera | Creeping Bent | R | R | R | R | R |
| Alisma plantago-aquatica | Water-plantain | - | - | - | R | |
| Alopecurus geniculatus | Marsh Foxtail | R | R | R | R | R |
| Angelica sylvestris | Wild Angelica | - | - | - | - | R |
| Callitriche sp. | Starwort | R | - | - | - | - |
| Carex riparia | Greater Pond-sedge | - | - | R | - | - |
| Cardamine pratensis | Cuckoo flower | R | - | - | R | R |
| Chara vulgaris | Stonewort | F | R | - | R | A |
| Deschampsia caespitosa | Tufted Hair-grass | R | R | R | R | R |
| Epilobium hirsutum | Great Willowherb | R | R | R | R | R |
| Filipendula ulmaria | Meadowsweet | R | R | R | R | R |
| Glyceria plicata | Plicata Sweet-grass | - | - | - | - | R |
| Glyceria maxima | Reed Sweet-grass | - | - | - | - | I/R |
| Hypericum tetrapterum | Sq.-stk'd St John's wort | - | R | - | - | - |
| Iris pseudacorus | Yellow Flag | - | - | - | - | I/R |
| Juncus articulatus | Jointed Rush | R | R | R | R | R |
| Juncus effusus | Soft Rush | - | - | - | - | R |
| Juncus inflexus | Hard Rush | R | R | R | R | R |
| Phragmites australis | Common Reed | - | - | - | - | I/R |
| Polygonum amphibium | Amphibious Bistort | R | - | - | - | - |
| Ranunculus sceleratus | Celery-leaved Buttercup | - | - | - | - | R |
| Rorippa palustris | Marsh Yellow-cress | R | R | R | R | R |
| Scrophularia auriculata | Water Figwort | R | R | - | R | R |
| Sparganium erectum | Branched Bur-reed | - | - | - | - | I/R |
| Stachys palustris | Marsh Woundwort | R | - | - | - | - |
| Veronica anagallis-aquatica | Blue Water-speedwell | R | R | - | R | R |
| Veronica beccabunga | Brooklime | R | R | R | R | R |
| Veronica catenata | Pink Water-speedwell | R | - | | R | R |
| Filamentous algae | | R | R | - | - | R |
| TOTALS | | 18 | 13 | 10 | 13 | 23* |

* 4 introduced during planting up with Phragmites

English equivalents from Dony et.al. (1986) (2nd ed).

**TABLE 3. PROVISIONAL SYSTEM FOR ASSESSING THE NATURE CONSERVATION VALUE OF WETLAND PLANT COMMUNITIES**

| CONSERVATION VALUE | DESCRIPTION OF TYPE OF COMMUNITY |
|---|---|
| VERY HIGH | Above average numbers of aquatic species for the community type present (Nature Conservancy Council, 1989). Rare and local species present. |
| HIGH | Above average numbers of aquatic species for the community type present (Nature Conservancy Council, 1989). Generally more than three or four local species present. No rare species. |
| INTERMEDIATE | Average numbers of aquatic species for the community type present (Nature Conservancy Council, 1989). Few or no local species present. No rare species. |
| LOW | Below average numbers of aquatic species for the community type present (Nature Conservancy Council, 1989). No rare or local species. |

# 4. AQUATIC MACROINVERTEBRATES

## 4.1 INTRODUCTION

The survey of aquatic macroinvertebrates had three main aims:

(i) to describe the colonisation of the ponds by macroinvertebrates.
(ii) to assess the nature conservation value of the Pinkhill macroinvertebrate communities.
(iii) to assess the relative importance of different microhabitats within the ponds for macroinvertebrates.

The colonisation of the ponds was described in terms of the numbers of species recorded in each pond and the relative abundance of the species recorded in each pond.

The current nature conservation value of the communities was assessed using Pond Action's provisional technique for assessing the conservation value of invertebrate communities (see Table 7).

An assessment of the value of the different microhabitats within each pond was made by comparing the number of species found in each microhabitat.

## 4.2 METHODS

### 4.2.1 Sampling methods in summer, autumn and winter

The sampling strategy followed the habitat dependent, time limited method developed by Pond Action for the National Pond Survey (Biggs et.al. 1989).

On each occasion, the number of microhabitats present in the pond was assessed. A microhabitat was defined as an area of distinctively different substrate or vegetation cover. This might include gravelly or muddy banks, stands of different marginal plants or stands of submerged plants.

A total sampling effort of 3 minutes of hand-netting was allotted to each pond and this time was divided equally between the microhabitats present. For a pond with four microhabitats each microhabitat would be hand-netted for 45 seconds whereas for a pond with 3 microhabitats each microhabitat would be hand-netted for 60 seconds.

In most of the ponds the microhabitats either covered large areas or were present in more than one part of the pond (e.g. extensive, apparently uniform gravel banks, large stands of charophytes, etc.). Because of this, the sampling time was usually further divided between several areas of each microhabitat (eg 6 x 10 second samples might be taken in different areas of a microhabitat in order to a produce a cumulative 45 second sample).

All microhabitat samples were pooled to give a single three minute sample.

Microhabitats were sampled by vigorous sweeping with a pondnet (GB Nets, 1mm square mesh). Samples were taken back to the laboratory where macroinvertebrates were removed from the samples, counted and identified. Samples were sorted live in large white trays and specimens preserved in 70% ethanol (except for leeches and flatworms which were identified from live material).

Macroinvertebrates were mainly identified to species level. Table 4 lists the taxa removed from the samples, and the taxonomic levels to which they were identified. Keys and guides used to identify species are given in Section 6 (References).

### 4.2.2 Sampling methods in spring

In spring the sampling method was made slightly more complex in order to provide information about the value of individual microhabitats in each pond. The pooled results from this sampling method also gave results comparable with those from other seasons.

For the spring sampling programme the total sampling time of 3 minutes was divided between 16 separate hand-nettings (11.25 seconds each). In practice, all four ponds could be represented by either two or four microhabitats. This allowed eight or four replicates (respectively) to be collected from each microhabitat.

Examples of the procedure adopted for sampling macroinvertebrates in the microhabitats are given in Table 5.

As with sampling at other times of the year, the total time for each sample was further broken down where necessary. e.g 2 x 5.6 seconds of netting to form a composite 11.25 second sample.

In contrast to the samples from other seasons each 11.25 second microhabitat sample was kept separate during laboratory sorting and analysis.

### 4.2.3 Statistical analysis using DECORANA

Macroinvertebrate species and abundance data, obtained from the spring microhabitat sampling, was analysed using the ordination technique Detrended Correspondence Analysis, running as the Fortran programme DECORANA. The data-set consisted of 64 samples from 4 sites.

DECORANA assesses the variation within a set of samples. The major source of variation in a sample set is described by the first axis of DECORANA. The second axis describes the major source of the variation not already described by the first axis. All axes of DECORANA are independent of each other. The amount of variation is represented in terms of units of standard deviation. Samples separated by 4 standard deviations have about 25% of their species in common (Hill, 1979b).

An ordination diagram showing the relationships of the macro- invertebrate communities of the ponds was plotted (using Axes 1 and 2 of DECORANA). The diagram was built-up from ordination plots of individual microhabitat samples from each pond. The polygons enclose the ordination co-ordinates of all the microhabitats within a single pond and illustrate the relationships between the macroinvertebrate communities of the ponds (see Figure 1).

**TABLE 4. MACROINVERTEBRATE TAXA COLLECTED AT PINKHILL MEADOW AND THE TAXONOMIC LEVELS TO WHICH THEY WERE IDENTIFIED**

**GROUPS IDENTIFIED TO SPECIES LEVEL**

| | |
|---|---|
| Tricladida | (Flatworms) |
| Hirudinea | (Leeches) |
| Gastropoda | (Snails and limpets) |
| Bivalvia (excluding *Pisidium* sp.) | (Bivalves) |
| Malacostraca | (Shrimps and slaters) |
| Ephemeroptera | (Mayflies) |
| Odonata | (Dragonflies and damselflies) |
| Plecoptera | (Stoneflies) |
| Heteroptera | (Water bugs) |
| Megaloptera | (Alderflies) |
| Trichoptera | (Caddis-flies) |
| *Coleoptera | (Water beetles) |

*Adults from the following families of Coleoptera were identified: Dryopidae, Elminthidae, Gyrinidae, Hygrobiidae, Haliplidae, Noteridae, Dytiscidae, Heteroceridae, Hydraenidae, Hydrophilidae.

N.B. Inclusion of groups in this list does not imply that species from these groups were recorded during these surveys.

**TABLE 5. EXAMPLES OF THE PROCEDURE ADOPTED FOR SPRING SAMPLING OF MACROINVERTERATES AT PINKHILL MEADOW**

**(i) For a pond with 4 microhabitats**

Four replicate samples of 11.25 seconds from each microhabitat

Total sampling time 16 x 11.25 seconds =180 seconds

**(ii) For a pond with 2 microhabitats**

Eight replicate samples of 11.25 seconds from each microhabitat

Total sampling time 16 x 11.25 seconds =180 seconds

**TABLE 6. TERMINOLOGY USED TO DESCRIBE THE DISTRIBUTION OF AQUATIC MACROINVERTEBRATES**

| | |
|---|---|
| Rare macroinvertebrate species | Applied to species listed in the Insect Red Data Book (Shirt 1987) or to be included in the non-insect invertebrate Red Data Book (NCC, in prep). |
| Local macroinvertebrate species | Applied to macroinvertebrate species which are generally described as local or locally common. |

The current status of all macroinvertebrate species regarded as rare or local was checked with NCC Invertebrate Site Register staff (J.Bratton, P.Kirby, pers. comm.).

**TABLE 7. PROVISIONAL SYSTEM FOR ASSESSING THE NATURE CONSERVATION VALUE OF AQUATIC MACROINVERTEBRATE COMMUNITIES**

| CONSERVATION VALUE | DESCRIPTION OF TYPE OF COMMUNITY |
|---|---|
| VERY HIGH | Supporting a rich community of macroinvertebrate species, including local and rare species. Note that some sites with rare species may be relatively species-poor. |
| HIGH | Supporting a rich community of common macroinvertebrate species. Generally more than three or four local species recorded. No rare species. |
| INTERMEDIATE | Supporting a moderately rich community of common macroinvertebrate species. Generally up to three local species recorded, but no rare species. |
| LOW | Supporting a species-poor community of common macroinvertebrates. No rare or local species. |

NOTE: When making an assessment of the species-richness of sites, account must be taken of the tendency for acid or base-poor sites to support fewer species of macroinvertebrates than neutral, alkaline or base-rich sites.

## 4.3 RESULTS

### 4.3.1 The number of species recorded in the ponds

The numbers of invertebrate species recorded from the four ponds increased from 5-7 in the first (summer) sample to 19-31 in the final (spring) sample. The cumulative total of species for the whole site increased from 12 in the first season to 63 after all four seasons.

All of the sites showed a reduction in the rate of accumulation of species in the winter (February) sample which was taken after a period of ice cover.

Numbers of species in the major groups of macroinvertebrates are summarised in Table 8. Full species lists for surveys of all four ponds in four seasons are give in Appendix 1.

### 4.3.2 Abundance of macroinvertebrates

The abundance of macroinvertebrates increased throughout the year, with some species (e.g. the mayflies *Cloeon dipterum* and *Caenis luctuosa* and the diving beetle *Hydroglyphus pusillus*) becoming particularly abundant. As with species diversity, the number of individuals also showed a tendency to decline during the winter. This was particularly marked in two mayfly species *Caenis luctuosa* and *Cloeon simile*. Note that abundance estimates are relative because of the hand-netting technique and cannot be used derive absolute estimates of the abundance of invertebrates in the ponds.

### 4.3.3 Composition of the macroinvertebrate communities of the ponds

The fauna of all the ponds was dominated by species which fly freely, particularly water bugs and beetles (14 and 31 spp. respectively). A relatively rich community of mayflies became established (only about 8 species of mayfly are typically found in lowland nutrient-rich lakes and ponds) with individual species present in abundance. The caddisfly fauna also started to develop well.

Few species from slow colonising groups were recorded. No snails, bivalves or flatworms have so far been recorded with the spring survey producing the first records of malacostracan crustaceans (shrimps and slaters) for the site. Single individuals of the water slater *Asellus aquaticus* and the freshwater shrimp *Crangonyx pseudogracilis* were recorded from the Main pond in this survey. Two leech species have been recorded (in both cases only single specimens being found): *Helobdella stagnalis* was found in the autumn sample from the Main pond and the avian ectoparasite *Theromyzon tessulatum* was recorded in the spring survey of the Main pond.

### 4.3.4 Species-richness in comparison with other sites

At this early stage in the colonisation of the Pinkhill Meadow ponds it is difficult to compare the rate of colonisation with other sites. This is mainly because there is little comparable information about invertebrate colonisation of new ponds in Britain.

However, a comparison can be made between the Main Pond at Pinkhill and the 3ha Dean's Farm East gravel-pit lake at Caversham, near Reading (see Appendix 2). At present we have no data with which to make comparisons of the colonisation rates in the smaller Pinkhill ponds.

Dean's Farm East Lake, recently surveyed by Pond Action (Pond Action, 1990), is 1-2 years old (a little older than the Pinkhill Main pond) and 3ha in area (about six times larger than the Main pond). The lake is steep-sided and deeper than Pinkhill Main pond (estimated maximum depth c. 5m) and has not been reprofiled to increase its nature conservation value.

About three times as many species were recorded in Pinkhill Main pond than in Dean's Farm East lake (42 species compared to 15 species), suggesting that features of the Pinkhill Main pond are encouraging the development of a relatively species-rich invertebrate community.

**TABLE 8. NUMBER OF SPECIES IN MAJOR GROUPS RECORDED IN SAMPLES FROM FOUR PONDS ON PINKHILL MEADOWS**

POND: MP = Main Pond; GW = Groundwater Pond; SW = Surfacewater Pond; SC = Scrape
SAMPLING DATE: a = July 1990; b = November 1990; c = February 1991; d = May 1991

| | MP | | | | GW | | | | SW | | | | SC | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | a | b | c | d | a | b | c | d | a | b | c | d |
| HIRUDINEA | - | 1 | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 season total | | | | 2 | | | | - | | | | - | | | | - |
| CRUSTACEA | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 season total | | | | 2 | | | | - | | | | - | | | | - |
| EPHEMEROPTERA | - | 2 | 2 | 3 | 1 | 4 | 2 | 4 | 1 | 3 | 2 | 4 | 1 | 4 | 2 | 4 |
| 4 season total | | | | 3 | | | | 4 | | | | 4 | | | | 4 |
| ODONATA | - | - | - | 1 | - | - | - | 1 | - | 1 | - | 1 | - | - | - | - |
| 4 season total | | | | 1 | | | | 1 | | | | 1 | | | | - |
| TRICHOPTERA | - | 1 | 3 | 2 | - | 1 | 2 | 1 | - | 2 | 1 | 2 | - | 1 | - | 4 |
| 4 season total | | | | 3 | | | | 3 | | | | 4 | | | | 4 |
| HEMIPTERA | 1 | 4 | 3 | 9 | 3 | 8 | 5 | 9 | - | 7 | 8 | 7 | 3 | 5 | 6 | 4 |
| 4 season total | | | | 9 | | | | 11 | | | | 12 | | | | 7 |
| COLEOPTERA | 3 | 6 | 3 | 17 | 3 | 4 | 4 | 11 | 5 | 8 | 11 | 17 | 3 | 2 | 3 | 7 |
| 4 season total | | | | 19 | | | | 14 | | | | 21 | | | | 10 |
| TOTAL SPECIES | 5 | 13 | 12 | 34 | 7 | 17 | 13 | 26 | 6 | 21 | 22 | 31 | 7 | 12 | 11 | 19 |
| **4 SEASON TOTAL SPECIES** | | | | **39** | | | | **33** | | | | **42** | | | | **25** |

### 4.3.5 Differences in the communities of the four ponds as demonstrated by DECORANA

Each polygon on the DECORANA diagram (see Figure 1, over page) encloses the ordination coordinates of all the microhabitats (not shown individually) from one pond. In this way polygons represents graphically the total range of variation in the macroinvertebrate community of that pond.

Three of the four ponds supported communities which could be recognised as distinctively different using DECORANA . Figure 1 shows that the Main pond, Scrape and Groundwater pond all supported distinctive communities, although all had at least 35% of their species in common.

Four microhabitats caused an elongation to the right of the polygon describing the Surfacewater pond. Otherwise, the DECORANA plot suggests that this pond supported communities very similar to the Groundwater Pond and Scrape.

Correlation analysis indicates that the major axis of variation of the DECORANA plot, Axis 1, reflects a transition from microhabitats rich in species of corixid water bugs (left) to microhabitats rich in water beetles (right). Water beetles were mainly associated with edge habitats (for example, marginal grass microhabitats) whereas corixids were more associated with open water. However, these trends seem to be present in all ponds and do not explain the separation of the ponds on the second DECORANA axis. The second axis of DECORANA is not obviously associated with the species-richness of any of the main invertebrate groups present in the ponds.

### 4.3.6 Environmental factors causing differences in the composition of the communities in the four ponds

Factors likely to be causing differences between the communities of the four ponds, particularly on Axis 2 of the DECORANA, are not yet clear. Further analysis will probably be required in subsequent seasons but trends may become clearer when the results of water chemistry are available.

## 4.4 THE NATURE CONSERVATION VALUE OF THE MACROINVERTEBRATE COMMUNITIES

### 4.4.1 Species-richness and the occurrence of rare and local species

The cumulative total of 63 species included one rare and eight local species. These uncommon species are listed, with descriptions of the their national distribution and occurrence on the Pinkhill site, in Appendices 3 and 4. The terms rare and local, as used in this report, are defined in Table 6. Table 7 gives criteria for assessing the nature conservation value of aquatic invertebrate communities).

Using the criteria outlined in Table 7 two of the ponds (Main pond and the Scrape) supported communities which were of very high value, with the rare species *Coelambus nigrolineatus,* and 4 and 5 other local species, respectively. The remaining ponds supported communities of high nature conservation value.

## 4.5 THE RELATIVE IMPORTANCE OF DIFFERENT MICROHABITATS FOR MACRO-INVERTEBRATES

The species-richness of each microhabitat is listed in Table 9. The range of microhabitats within the ponds is currently small mainly because of the sparseness of aquatic and marginal plants.

Species-richness varied from 11 (marginal grass microhabitat of the Scrape) to 22 (marginal grass/*Chara vulgaris* microhabitat of the Main pond).

Figure 1 DECORANA ordination of Microhabitat samples from Pinkhill Meadows

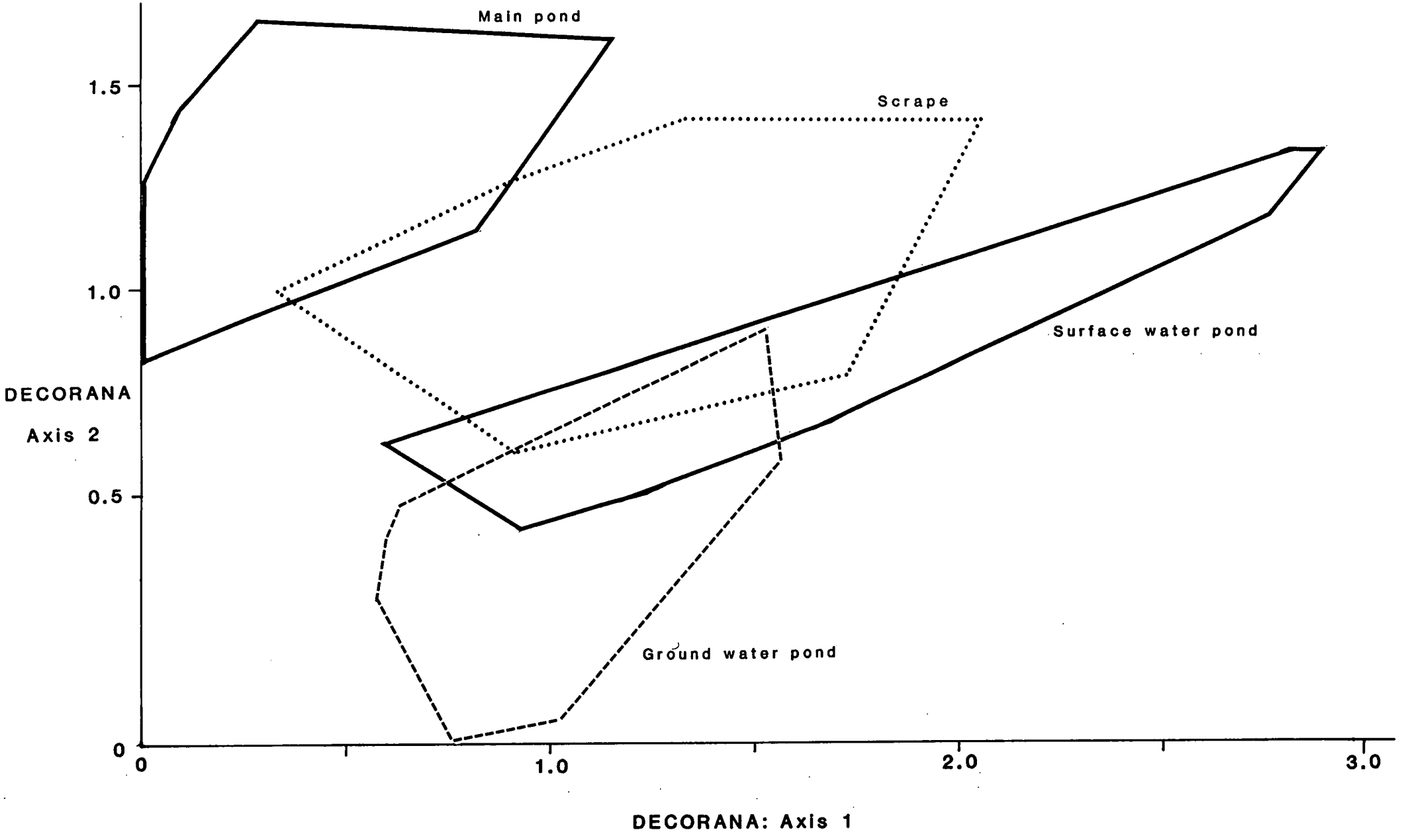

TABLE 9. NUMBERS OF SPECIES RECORDED IN EACH MICROHABITAT IN THE SPRING SURVEY

| SITE AND HABITAT | NO. OF SPECIES |
|---|---|
| **Main Pond** | |
| Marginal grasses & *Chara* sp. | 22 |
| Shingle | 19 |
| Open water over gravels | 17 |
| Sandy/muddy bank | 16 |
| **Groundwater Pond** | |
| Open water over gravels (deep) A | 20 |
| Open water over gravels and mud (shallow) A | 14 |
| Open water over gravels and mud (shallow) B | 13 |
| Open water over gravels (deep) B | 12 |
| **Surfacewater Pond** | |
| Marginal grasses | 17 |
| Open water over shallow ruts | 16 |
| Open water over deep ruts | 15 |
| Open water over smooth shallows | 12 |
| **Scrape** | |
| Open water | 13 |
| Shingle | 13 |
| Muddy bank | 12 |
| Marginal grasses | 11 |

# 5. BIRDS

## 5.1 INTRODUCTION

Monitoring of birds had two main objectives in the Pinkhill study.

(i) to record which species are using the new wetland habitats.

(ii) to determine whether or not any change in the use of the Farmoor site by wetland birds (especially waders) had occurred following the creation of the new wetlands.

### 5.1.2 The use of log-book data to describe changes in the bird population at Farmoor following the creation of the Pinkhill wetlands

Farmoor is visited very regularly by birdwatchers, with daily coverage during migration periods and much of the rest of the year. Ideally, monitoring of the new wetlands would make extensive use of the records gathered during these visits.

The frequency of visits to Farmoor by birdwatchers, and the interest that most people have in seeing species which are unusual in the county, ensures that a long list of species is recorded each year at Farmoor. However, changes in the use of the Farmoor site following the creation of the new wetlands may be subtle and may not be detected without more systematic recording.

For this reason the main emphasis of work described in this report has been to investigate the uses to which log-book data could be put. In particular:

(a) does the log-book data provide a good record of the number of species visiting the site?

(b) does the log-book provide an accurate assessment of the number of individuals of each species visiting the site?

(c) does the log-book give accurate information about the use of the new wetlands on Pinkhill Meadow?

### 5.1.3 Assessment of the use that may be made of log-book data

The assessment of the use to which the log-book data can be put is being undertaken by:

(a) Comparing log-book data gathered during migration periods with the results of known-effort survey work **undertaken at the same time**. So far results are available from the Spring 1991 migration period.

(b) Analysing log-book data gathered between 1982-1991 to determine how numbers of birds (especially waders) using the site vary from year to year. Work is still in progress on this analysis.

### 5.1.4 Conditions which will have to be fulfilled if the log-book data is to be of value in the monitoring of the Pinkhill wetlands

If the log-book data is to be used **at all** to assess the success of the new wetlands in objective terms it will be essential that:

(a) the data shows similar trends to those revealed in the results of random surveys.

(b) variations from year to year in the amount of effort used to gather log-book data can be estimated.

Assuming that these two conditions are fulfilled, the magnitude of changes in the use of the Farmoor site which can be detected with log-book data will depend on the size of annual fluctuations in bird numbers at Farmoor. If the numbers of birds, especially waders, visiting Farmoor are very variable it will be possible to detect only large changes in the use of the site.

Conversely, if the number of birds visiting Farmoor has been relatively constant during the 1980's, it will be possible to detect smaller changes in the use of the site.

## 5.2 METHODS

### 5.2.1 Sources of data

Data gathered for this study by Pond Action are referred to as 'known-effort data' throughout the report.

Data gathered by birdwatchers visiting Farmoor reservoir, and recorded in the Farmoor log-book, are referred to as 'log-book data'. No other casual records gathered by birdwatchers have been included in the analysis.

### 5.2.2 Survey methods for gathering known-effort data

#### Timing of daily counts

As only 10 days (c. 80hrs) was available for survey work it was necessary to determine how best to make use of this time. Preliminary work was undertaken to determine whether a reliable estimate of the birds present on any one day could be made with a relatively short visit (of 2-3 hrs) to the site.

#### Frequency of visits to the site

It was decided in advance to make 24 visits, on randomly selected days, to the site (approximately 12 each month). The adequacy of this sample size was tested at the end of the survey period for counts of all species combined, for all waders combined and for selected species. In all cases the sample size was large enough to make a reasonable estimate of the mean numbers of birds visiting the site. Waterfowl could be counted reliably with considerably fewer visits, but waders needed twenty or more visits for a reliable assessment of their abundance to be made.

#### Counting methods

Days for counts were chosen randomly with 14 visits made in April and 10 in May (see Table 13).

Birds were counted in the three areas of the Farmoor site twice on each of these days. Counts of the two halves of reservoir generally took 15-25 minutes each (occasionally longer if large numbers of birds were present). The reservoir was counted by driving right around the perimeter of the basin (to check for waders on the edges) and by scanning with telescope and binoculars. The Pinkhill Main Pond and Scrape were watched for 20 minutes.

Most recording was undertaken by Dr. J Biggs. On three days recording was undertaken by Dr. A Gosler.

### 5.2.3 Collection of 'log-book' data by birdwatchers

Birdwatchers visit Farmoor reservoir on most days of the year and dates of visits, together with birds seen, are recorded in the Farmoor log-book. Most people visiting the site do not record all birds seen systematically, concentrating on noting the more unusual visitors to the site.

Numbers of birds visiting the site daily were estimated from the log-book. On any one day the largest single number of each species recorded was counted as the total for that day. As visiting birdwatchers do not generally list counts for the three areas of the site separately the counts referred to the whole of the Farmoor site.

An estimate of the amount of time birdwatchers spent on the site was made by counting the number of visits recorded in the log-book and multiplying this by 1.5 hrs, a rough estimate of the time spent on the site by most people (see Table 10).

**TABLE 10. BIRD RECORDING AT FARMOOR RESERVOIR DURING APRIL AND MAY 1991: (a) NUMBER OF VISITS BY BIRDWATCHERS (b) DATES OF CONSTANT EFFORT RECORDING**

| APRIL | | | MAY | | |
|---|---|---|---|---|---|
| DAY | NUMBER OF BIRDWATCHER VISITS | KNOWN-EFFORT VISITS | DAY | NUMBER OF BIRDWATCHER VISITS | KNOWN-EFFORT VISITS |
| 1 | 1 | + | 1 | 5 | + |
| 2 | 1 | + | 2 | 3 | |
| 3 | 3 | | 3 | 2 | |
| 4 | 2 | | 4 | 4 | + |
| 5 | 4 | + | 5 | 6 | |
| 6 | 4 | | 6 | 4 | + |
| 7 | 6 | + | 7 | 3 | |
| 8 | 3 | + | 8 | 1 | |
| 9 | 4 | | 9 | 8 | |
| 10 | 4 | | 10 | 7 | |
| 11 | 2 | + | 11 | 3 | |
| 12 | 4 | | 12 | 3 | |
| 13 | 5 | + | 13 | 2 | |
| 14 | 1 | + | 14 | 1 | |
| 15 | 2 | | 15 | 2 | |
| 16 | 1 | + | 16 | 2 | + |
| 17 | 2 | + | 17 | 2 | + |
| 18 | 3 | + | 18 | 5 | + |
| 19 | 2 | | 19 | 2 | + |
| 20 | 3 | | 20 | 2 | |
| 21 | 4 | | 21 | 3 | |
| 22 | 5 | + | 22 | 2 | + |
| 23 | 3 | + | 23 | 4 | + |
| 24 | 4 | + | 24 | 2 | |
| 25 | 3 | | 25 | 3 | |
| 26 | 4 | | 26 | 1 | |
| 27 | 8 | | 27 | 4 | |
| 28 | 4 | | 28 | 3 | |
| 29 | 4 | | 29 | 3 | |
| 30 | 4 | | 30 | 4 | |
| | | | 31 | 2 | + |
| **TOTAL** | **98** | **14** | | **98** | **10** |

### 5.2.4 Analytical methods

#### Differences in the abundance of birds in the three areas of the site

The significance of differences in the numbers of waders using the three areas of the site was assessed with chi-square tests. In each case the hypothesis tested was that the number of birds observed was proportional to the length of shoreline. In other words birds would be expected in the ratio of roughly 8:39:53 on Pinkhill Meadow, Farmoor North and Farmoor South respectively, this being the percentage of total shoreline on the site in each of these three areas (see Appendix 6).

A preference for an area was suggested if the number of birds observed was significantly greater than expected with the chi-square test.

#### Comparison of known-effort data and log-book records

Preliminary inspection of both the known-effort data and the log-book data showed that it was not normally distributed. Because of this all comparisons were made using non-parametric statistics with ranked data.

To assess the reliability of the log-book data, comparisons were made between estimates of species abundance (in terms of bird-days) in the log-book and those obtained from known-effort counts for:

(i) the total number of individuals recorded of each species.
(ii) the total numbers of individuals recorded of each wader species.
(iv) the numbers of individual species.

#### The total number of individuals recorded of each species

The total number of bird-days for each species was calculated from the known effort data and from the log-book data. The totals were ranked and the Spearman's rank correlation between the two sets of ranked data calculated. The existence of a significant correlation between the two sets of data would indicate that log-book data was at least describing the general trend of species abundance correctly.

Comparisons were made in two ways:

(i) between the known-effort data and the log-book data for the same 24 days.

(ii) between the known-effort data from the 24 days and the log-book data for all 61 days of the two months.

#### The number of bird/days recorded for waders

The above procedure was repeated for waders alone as these appeared to be recorded more reliably than other species.

#### The abundance of individual species

The abundance of all species was compared individually using the same method. This was the most stringent test of the three comparisons.

## 5.3 RESULTS

### 5.3.1 Duration of surveys for log-book recording and known-effort recording

Table 10 shows the date of visits made for known-effort surveys and the number of birdwatchers visiting Farmoor during April and May. In both months just under 100 birdwatchers recorded observations in the log-book. If the duration of each visit by birdwatchers is roughly estimated as 1.5 hrs this suggests that the records in the Farmoor log-book are based on about 300 hrs of recording.

Counts for known-effort recording took about 2 hrs/day giving about 48 hours recording during the two months (excluding two all-day sessions).

### 5.3.2 Use of the Farmoor site, including the Pinkhill Meadow wetlands, by waders and water birds during April and May 1991

Appendix 5 lists all water birds recorded at Farmoor during April and May 1991. The table shows the total number of bird-days for each species, recorded by known-effort surveys and recorded in the log-book. Comparisons of the numbers of birds recorded by the two survey methods are described in Section 5.3.5.

57 species of water birds (including waders) were recorded using the whole of the Farmoor site during April and May 1991 (see Appendix 5). 20 of these species were recorded using the Pinkhill Meadow wetlands. 17 of the species recorded on Pinkhill were recorded during known-effort recording but only six species (three of which were not recorded during known-effort surveys) were reported in the log-book.

Appendix 6 shows the species recorded on Pinkhill Meadow during April and May 1991. Four other species (shelduck, dunlin, green sandpiper and snipe) which were recorded on Pinkhill outside the spring survey have not been included in these totals.

### 5.3.3 Use of Farmoor site, and the Pinkhill wetlands, by wading birds in April and May 1991

#### Numbers of species and abundance of waders at Farmoor

19 species of waders visited the Farmoor site during April and May 1991. The most abundant species on the site as a whole were dunlin, common sandpiper and little ringed plover. 8 of the species of wader recorded during the spring were present in very small numbers, with less than 10 individuals recorded (see Appendix 5).

9 of the 19 species were recorded at Pinkhill although, with the exception of little-ringed plover, the number of individual birds on the meadow was small.

#### Attractiveness of the three areas of the Farmoor site to waders

The three areas of the Farmoor site (Farmoor north, Farmoor south and Pinkhill) varied in their attractiveness to waders (see Appendix 7).

Numbers of species recorded in the three areas varied from 9 on Farmoor North to 6 on Pinkhill Meadow and 4 on Farmoor South. More bird-days were recorded on the two halves of the reservoir than on Pinkhill meadow (see Appendix 7).

### Abundance of waders in relation to shoreline length

Relative to the length of their margins, the Pinkhill meadow wetlands were the most attractive area of the site for waders. More wader-days were accumulated on the Pinkhill wetlands than would have been expected from the length of their margins alone, although this was mainly due to the frequent presence of little-ringed plovers on Pinkhill (see Appendices 7 and 8). Because of this, the Pinkhill wetlands (which have only about 8% of the total water edge on the site - see Appendices 7 and 8 ) accumulated 15% of the wader-days on the Farmoor site as a whole. Farmoor North was visited by roughly the number of waders that would be expected for its perimeter length. Farmoor South was visited by many fewer waders than would be expected for the length of its perimeter.

To give an indication of the relative attractiveness of the three areas of the site to waders, the number of bird-days/100m of shoreline for each of the three areas was calculated. Every 100m of shoreline on Pinkhill meadow supported about 3.5 wader-days during the two months, mainly because of the presence of little-ringed plovers. In contrast, Farmoor North and Farmoor South supported about 2.3 and 1.0 wader-days/100m shoreline, respectively.

## 5.3.4 The use of the three areas of the Farmoor site by little-ringed plovers, dunlin and common sandpipers

Amongst the three most frequent species using the site, preferences for different areas were apparent (see Appendices 7 and 8 ).

Little-ringed plovers were significantly more abundant on Pinkhill Meadow than would be expected for the length of shoreline. Dunlin had a very strong preference for Farmoor North (30 bird-days), with only 1 bird recorded (during known-effort recording) elsewhere on the site. Pinkhill Meadow wetlands do not yet provide an attractive habitat for this species. Common sandpipers, the second most frequent bird on the site as a whole, were probably distributed in direct proportion to the length of perimeter on the two halves of the reservoir (numbers on the Pinkhill wetlands were too low to be tested using chi-square). This suggests that they had no preference for any one area: at present the Pinkhill Meadow wetlands seem no more attractive to this species than the reservoir edges.

## 5.3.5 Use of the Pinkhill wetlands by other water birds

12 species of water birds other than waders (including several passerine species common beside water) were recorded using the Pinkhill wetlands in April and May (see Appendix 6 ). Mallard, pied wagtail and reed bunting were the most frequently recorded species.

## 5.3.6 The correlation between log-book counts and known-effort counts of birds visiting the Farmoor site

### All species

There are large differences between the numbers of bird-days recorded by known-effort sampling and the number of bird-days recorded in the log-book (see Appendix 9). If log-book counts made on the same day as known-effort counts are compared there is no significant correlation between the number of bird-days recorded when all species are compared. However, when log-book data for all 61 days of the month are compared with known-effort counts a highly significant correlation exists ( Appendix 9).

This reflects the fact that individual species are recorded with varying degrees of accuracy in the log-book. When counts of individual species made by the two methods are compared only 12 species show significant correlations. The species were: goldeneye, wood duck, turnstone, dunlin, sanderling, common sandpiper, whimbrel, bar-tailed godwit, common tern, little tern, black tern and yellow wagtail.

In general, the most abundant species during the survey period, mallard, tufted and cormorant were very irregularly recorded. The numbers reported in the log-book were not correlated with the numbers of birds present.

### Waders

Waders were generally well-recorded, reflecting the interest that visiting birdwatchers have in this group of species and the ease with which they can be recorded. There was a highly significant correlation between the number of bird-days for waders recorded in the log-book and the number of waders counted in known-effort surveys (see Appendix 9).

Half of the 12 species for which significant correlations were obtained were waders. However, it was notable that sightings of little-ringed plover (the third most abundant wader during the survey period) recorded in the log-book were not correlated with the number of little-ringed plovers actually present.

### All species (number of species-days/week)

It might be expected that counts of more species would be correlated if numbers of bird-days/week compared. Appendix 10 shows the results of these correlations.

This approach made little difference to the number of significant correlations. However, a significant correlation was found between numbers of all species data from the 24 known-effort survey days were compared.

Observations to investigate the timing of counts were made on 1 and 2 April and 18 May. Results of this work are summarised in Appendix 2.

The results showed that:

(i) counts of most waterfowl and other wetland birds (**excluding waders**) could be made at any time of day.

(ii) numbers of waders varied during the course of the day (mainly due to variations in the numbers flying over the site). Peaks of activity appeared to occur in both the morning and evening.

In the light of these results it was decided to count in the morning between about 0600 and 0900.

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## APPENDIX 1. MACROINVERTEBRATE SPECIES RECORDED IN FOUR PONDS ON PINKHILL MEADOW

MP = Main Pond; GW = Groundwater Pond; SW = Surfacewater Pond; SC = Scrape
a = July 1990; b = November 1990; c = February 1991; d = May 1991

Abundance Categories:
1 = 1 - 5
2 = 6 - 25
3 = 26 - 125
4 = 126 - 625
5 = 626 - 4000

| | MP | | | | GW | | | | SW | | | | SC | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | a | b | c | d | a | b | c | d | a | b | c | d |
| **HIRUDINEA** | | | | | | | | | | | | | | | | |
| Helobdella stagnalis | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Theromyzon tessulatum | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| **CRUSTACEA** | | | | | | | | | | | | | | | | |
| Asellus aquaticus | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Crangonyx pseudogracilis | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| **EPHEMEROPTERA** | | | | | | | | | | | | | | | | |
| Caenis horaria | - | - | - | - | - | - | - | - | - | - | 3 | - | 2 | - | 2 | |
| Caenis luctuosa | - | 3 | 1 | 5 | - | 5 | 4 | 5 | - | 4 | 2 | 4 | - | 4 | 2 | 5 |
| Cloeon dipterum | - | 3 | 3 | 3 | 1 | 5 | 3 | 5 | 1 | 5 | 5 | 4 | 3 | 3 | 2 | 3 |
| Cloeon simile | - | - | - | 3 | - | 3 | - | 1 | - | - | - | - | - | 3 | - | 2 |
| Ephemera vulgata | - | - | - | - | - | 1 | - | 3 | - | 1 | - | 1 | - | - | - | - |
| **ODONATA** | | | | | | | | | | | | | | | | |
| Orthetrum cancellatum | - | - | - | 1 | - | - | - | 2 | - | - | - | - | - | - | - | - |
| Sympetrum striolatum | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - | - | - |
| **TRICHOPTERA** | | | | | | | | | | | | | | | | |
| Agrypnia varia | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Anabolia nervosa | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Athripsodes cinereus | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Leptocerus tineiformis | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - |
| Limnephilus affinis/incisus | - | - | - | - | - | - | 1 | - | - | - | 1 | - | - | - | - | - |
| Mystacides longicornis | - | - | 1 | 2 | - | 1 | - | - | - | 1 | - | 1 | - | - | - | 1 |
| Oecetis ochracea | - | 1 | 1 | 3 | - | - | 1 | 2 | - | - | - | 2 | - | 1 | - | 1 |

**APPENDIX 1. (Continued)**

| | MP | | | | GW | | | | SW | | | | SC | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | a | b | c | d | a | b | c | d | a | b | c | d |
| **HEMIPTERA** | | | | | | | | | | | | | | | | |
| Arctocorisa germari | - | - | - | 2 | - | 1 | - | 2 | - | 1 | 1 | 1 | - | 1 | 1 | 1 |
| Callicorixa praeusta | - | 1 | 1 | 1 | 1 | 1 | 1 | - | - | - | 1 | - | 1 | 1 | 1 | - |
| Corixa panzeri | - | - | - | - | - | 1 | - | 1 | - | 1 | 1 | 1 | - | - | 1 | - |
| Corixa punctata | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - |
| Cymatia coleoptrata | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - |
| Microvelia reticulata | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - |
| Notonecta glauca | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - |
| Sigara concinna | - | 1 | - | 2 | - | - | - | 1 | - | 1 | 1 | 1 | - | 1 | - | 1 |
| Sigara distincta | - | - | - | 1 | - | 1 | 1 | - | - | - | 1 | 1 | - | - | - | - |
| Sigara dorsalis | - | - | - | 1 | - | 1 | - | 1 | - | - | - | - | - | - | - | - |
| Sigara falleni | - | - | 1 | 3 | - | 2 | 1 | 1 | - | - | 1 | - | - | - | 1 | - |
| Sigara fossarum | - | - | - | 1 | - | - | - | 1 | - | - | - | 1 | - | - | - | - |
| Sigara lateralis | 1 | 3 | 2 | 5 | 1 | 3 | 2 | 2 | - | 2 | 3 | 1 | 1 | 3 | 3 | 3 |
| Sigara nigrolineata | - | 1 | - | 1 | 1 | 3 | 1 | 2 | - | 1 | 1 | - | 1 | 1 | 1 | 1 |
| **COLEOPTERA** | | | | | | | | | | | | | | | | |
| Agabus bipustulatus | - | - | - | - | - | 1 | - | 1 | - | - | - | - | - | - | - | - |
| Agabus nebulosus | - | - | - | 1 | - | - | - | - | - | 1 | - | 1 | - | - | - | - |
| Coelambus confluens | - | 1 | - | 1 | - | - | - | - | - | 1 | - | - | 1 | - | - | - |
| Coelambus impressopunctatus | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Coelambus nigrolineatus | - | 1 | - | 2 | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Colymbetes fuscus | 1 | - | - | 1 | - | - | - | 1 | 1 | - | - | 1 | - | - | - | - |
| Dryops sp. (fem.) | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - |
| Elmis aenea | - | - | - | 1 | - | - | - | 1 | - | - | - | - | - | - | - | - |
| Gyrinus substriatus | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - |
| Haliplus confinis | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Haliplus flavicollis | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Haliplus fluviatilis | - | - | - | 1 | - | - | - | 1 | - | - | - | - | - | - | - | - |
| Helochares lividus | - | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - |
| Helophorus brevipalpis | - | - | - | 2 | 1 | - | - | 1 | 1 | 1 | 1 | 2 | - | - | 1 | - |
| Helophorus grandis | - | - | - | - | - | - | - | 1 | - | 1 | 2 | 2 | - | 1 | - | 1 |
| Helophorus granularis | - | - | - | - | - | - | - | - | - | - | 2 | 3 | - | - | - | 2 |
| Helophorus minutus | - | - | - | - | - | - | - | 1 | - | - | - | 2 | - | - | - | - |
| Helophorus obscurus | - | - | 1 | 1 | - | - | - | - | - | - | 2 | 2 | - | - | - | - |
| Heterocerus fenestratus | - | - | - | 1 | - | - | - | - | - | - | - | 2 | - | - | - | - |
| Hydrobius fuscipes | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - |
| Hydroglyphus pusillus | - | 2 | 2 | 3 | 1 | 2 | 2 | 4 | - | 3 | 3 | 3 | 1 | 1 | 1 | 3 |
| Hydroporus palustris | 1 | - | - | - | - | - | - | - | 1 | - | 1 | 1 | - | - | - | - |
| Hydroporus planus | - | - | - | - | - | - | 1 | - | 1 | 1 | 1 | - | - | - | 1 | - |
| Hydroporus pubescens | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Hygrotus inaequalis | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - |

(**Coleoptera** continued over page)

**APPENDIX 1. (Continued)**

| COLEOPTERA (continued) | MP a | MP b | MP c | MP d | GW a | GW b | GW c | GW d | SW a | SW b | SW c | SW d | SC a | SC b | SC c | SC d |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Laccobius minutus | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - |
| Laccobius striatulus | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | - | - | 1 | 3 | 1 | - | - | 2 |
| Laccophilus minutus | - | 1 | - | 1 | - | - | 1 | - | - | 1 | 3 | 2 | - | - | - | - |
| Ochthebius dilatatus | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Ochthebius minimus | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - |
| Oulimnius tuberculatus | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| Rhantus suturalis | - | - | - | 1 | - | 1 | - | - | - | - | 1 | 1 | - | - | - | - |

## APPENDIX 2. A COMPARISON OF THE MACROINVERTEBRATE SPECIES RECORDED IN PINKHILL MAIN POND AND DEAN'S FARM EAST LAKE, CAVERSHAM

MP = Main Pond, Pinkhill

DEFL = Dean's Farm East Lake, Caversham

a = summer 1990
b = autumn 1990
c = winter 1990
d = spring 1991

e = autumn 1990
f = spring 1991

| | MP | | | | DFEL | |
|---|---|---|---|---|---|---|
| | a | b | c | d | e | f |
| **HIRUDINEA** | | | | | | |
| Glossiphonia heteroclita | - | - | - | - | + | - |
| Helobdella stagnalis | - | + | - | - | - | - |
| Theromyzon tessulatum | - | - | - | + | - | + |
| **MOLLUSCA** | | | | | | |
| Bithynia tentaculata | - | - | - | - | - | + |
| Lymnaea peregra | - | - | - | - | + | + |
| Lymnaea truncatula | - | - | - | - | + | + |
| Physa (resembling acuta) | - | - | - | - | - | + |
| Planorbis carinatus | - | - | - | - | - | + |
| Theodoxus fluviatilis | - | - | - | - | - | + |
| **CRUSTACEA** | | | | | | |
| Asellus aquaticus | - | - | - | + | - | - |
| Crangonyx pseudogracilis | - | - | - | + | - | + |
| **EPHEMEROPTERA** | | | | | | |
| Caenis horaria | - | - | - | - | - | + |
| Caenis luctuosa | - | + | + | + | - | - |
| Cloeon dipterum | - | + | + | + | - | + |
| Cloeon simile | - | - | - | + | - | - |
| Ephemera vulgata | - | - | - | - | - | - |
| **ODONATA** | | | | | | |
| Orthetrum cancellatum | - | - | - | + | - | - |
| Sympetrum striolatum | - | - | - | - | - | - |
| **TRICHOPTERA** | | | | | | |
| Agraylea multipunctata | - | - | - | - | + | + |
| Agraylea sexmaculata | - | - | - | - | + | + |
| Agrypnia varia | - | - | + | - | - | - |
| Anabolia nervosa | - | - | - | - | - | - |
| Athripsodes cinereus | - | - | - | - | - | - |
| Halesus radiatus | - | - | - | - | - | + |
| Leptocerus tineiformis | - | - | - | - | - | - |
| Limnephilus affinis/incisus | - | - | - | - | - | - |
| Mystacides longicornis | - | - | + | + | - | - |
| Oecetis ochracea | - | + | + | + | - | - |

## APPENDIX 2. (CONTINUED)

MP = Main Pond, Pinkhill DEFL = Dean's Farm East Lake, Caversham

| | MP | | | | DFEL | |
|---|---|---|---|---|---|---|
| | a | b | c | d | e | f |
| **HEMIPTERA** | | | | | | |
| Arctocorisa germari | - | - | - | + | - | - |
| Callicorixa praeusta | - | + | + | + | - | - |
| Corixa panzeri | - | - | - | - | - | - |
| Corixa punctata | - | - | - | - | - | - |
| Cymatia coleoptrata | - | - | - | - | - | - |
| Microvelia reticulata | - | - | - | - | - | - |
| Notonecta glauca | - | - | - | - | - | - |
| Sigara concinna | - | + | - | + | - | - |
| Sigara distincta | - | - | - | + | - | - |
| Sigara dorsalis | - | - | - | + | - | - |
| Sigara falleni | - | - | + | + | - | + |
| Sigara fossarum | - | - | - | + | - | - |
| Sigara lateralis | + | + | + | + | - | - |
| Sigara nigrolineata | - | + | - | + | - | - |
| **COLEOPTERA** | | | | | | |
| Agabus bipustulatus | - | - | - | - | - | - |
| Agabus nebulosus | - | - | - | + | - | - |
| Coelambus confluens | - | + | - | + | - | - |
| Coelambus impressopunctatus | - | - | - | + | - | - |
| Coelambus nigrolineatus | - | + | - | + | - | - |
| Colymbetes fuscus | + | - | - | + | - | - |
| Dryops sp. (fem.) | - | - | - | - | - | - |
| Elmis aenea | - | - | - | + | - | - |
| Gyrinus substriatus | - | - | - | - | - | - |
| Haliplus confinis | - | - | - | + | - | - |
| Haliplus flavicollis | - | - | - | + | - | - |
| Haliplus fluviatilis | - | - | - | + | - | - |
| Haliplus lineatocollis | - | - | - | - | - | + |
| Helochares lividus | - | - | - | - | - | - |
| Helophorus brevipalpis | - | - | - | + | - | - |
| Helophorus grandis | - | - | - | - | - | - |
| Helophorus granularis | - | - | - | - | - | - |
| Helophorus minutus | - | - | - | - | - | - |
| Helophorus obscurus | - | - | + | + | - | - |
| Heterocerus fenestratus | - | - | - | + | - | - |
| Hydrobius fuscipes | - | - | - | - | - | - |
| Hydroglyphus pusillus | - | + | + | + | - | - |
| Hydroporus palustris | + | - | - | - | - | - |
| Hydroporus planus | - | - | - | - | - | - |
| Hydroporus pubescens | - | - | - | + | - | - |
| Hygrotus inaequalis | - | - | - | - | - | - |

(**Coleoptera** continued over page)

**APPENDIX 2. (CONTINUED)**

MP = Main Pond, Pinkhill DEFL = Dean's Farm East Lake, Caversham

| | MP | | | | DFEL | |
|---|---|---|---|---|---|---|
| | a | b | c | d | e | f |
| **COLEOPTERA** (continued) | | | | | | |
| Laccobius minutus | - | - | - | - | - | - |
| Laccobius striatulus | + | + | + | + | - | - |
| Laccophilus minutus | - | + | - | + | - | - |
| Ochthebius dilatatus | - | + | - | - | - | - |
| Ochthebius minimus | - | - | - | - | - | - |
| Oulimnius tuberculatus | - | - | - | - | - | - |
| Rhantus suturalis | - | - | - | + | - | - |

## APPENDIX 3. RARE AND LOCAL SPECIES RECORDED IN THE PINKHILL MEADOW PONDS

| | | |
|---|---|---|
| **Main Pond** | EPHEMEROPTERA | Cloeon simile |
| | ODONATA | Orthetrum cancellatum |
| | HEMIPTERA | Sigara concinna |
| | COLEOPTERA | Coelambus nigrolineatus<br>Hydroglyphus pusillus |
| **Groundwater Pond** | EPHEMEROPTERA | Cloeon simile |
| | HEMIPTERA | Corixa panzeri<br>Sigara concinna |
| **Surfacewater Pond** | HEMIPTERA | Corixa panzeri<br>Sigara concinna |
| | COLEOPTERA | Helochares lividus<br>Helophorus granularis |
| | TRICHOPTERA | Leptocerus tineiformis |
| **Scrape** | EPHEMEROPTERA | Cloeon simile |
| | HEMIPTERA | Corixa panzeri<br>Sigara concinna |
| | COLEOPTERA | Coelambus nigrolineatus<br>Hydroglyphus pusillus<br>Helophorus granularis |

## APPENDIX 4. RARE AND LOCAL SPECIES OF MACROINVERTEBRATE RECORDED FROM FOUR PONDS ON PINKHILL MEADOW

### RARE SPECIES

*Coelambus nigrolineatus*: (Dytiscidae: COLEOPTERA)

A diving beetle. The species is RDB3 *. The exact status of the species is not known. It appears to be a recent arrival from the continent and is likely to increase in range over the next few years. The most favourable habitat for the species is thought to be mature gravel pits. Determination by G.N.Foster.

The species was first recorded from the Main Pond in the autumn and is now present in the Main Pond (several specimens) and the Scrape.

### LOCAL SPECIES

*Cloeon simile*: (Baetidae: EPHEMEROPTERA)

The lake olive. Widespread but locally distributed. Favouring larger water bodies.

The species is recorded from all but the Surfacewater pond. It showed a dramatic decline (to no specimens recorded) after the winter, but is now present in large numbers in the Main pond and the Scrape.

*Orthetrum cancellatum*: (Libellulidae: ODONATA)

The black-tailed skimmer. Locally common in Southern England.

Recorded from the Main pond and the Groundwater pond in the spring sample. 7 specimens, the most mature being in, approximately, the antepenultimate instar were recorded from the Groundwater pond. The adults should be on the wing throughout the summer.

*Corixa panzeri*: (Corixidae: HETEROPTERA)

A lesser water boatman. A species local to South East England but rare elsewhere (P.Bratton, pers. comm.).

Recorded from all but the Main pond. Single specimens have been recorded in autumn, winter and spring samples from one or more of the ponds.

*Sigara concinna*: (Corixidae: HETEROPTERA)

A lesser water boatman. A local and scarce species often associated with new or disturbed sites. (P.Bratton pers. comm.; Pond Action, unpublished results).

The species was first recorded, casually, from the Surfacewater pond, two weeks after its construction. It is now present in all the ponds.

## LOCAL SPECIES

*Leptocerus tineiformis*: (Leptoceridae: TRICHOPTERA)

A caddis-fly. A locally common species in the South of Britain. In Oxfordshire the species is usually associated with wooded ponds. J.Bratton (pers. comm.); Pond Action, (unpublished results).

A single specimen was recorded in the autumn survey of the Surfacewater pond.

*Helochares lividus*: (Hydrophilidae: COLEOPTERA)

A water scavenger beetle. Locally common in South East England. The species is Nationally Notable B.

The species was recorded from the Surfacewater pond in the winter and spring samples.

*Helophorus granularis*: (Hydrophilidae: COLEOPTERA)

A widespread but local species, favouring grassy margins of standing water.

Several specimens were recorded from the Surfacewater pond in the winter and spring surveys and the Scrape in the spring survey.

*Hydroglyphus pusillus*: (Dytiscidae: COLEOPTERA)

A diving beetle. Found mainly in man-made silt ponds and often in new ponds. The species is Nationally Notable B (Foster, 1981).

The species was recorded from all four sites. Over the course of the year it has increased in numbers and is now very common in all sites and particularly so in the Groundwater pond (231 specimens in the spring sample).

*Hydroporus marginatus*: (Dytiscidae: COLEOPTERA)

A local species which has an association with interstitial water in gravels.

The species was recorded from the Surfacewater pond two weeks after its construction and has not been recorded since in any of the main survey ponds. It was, however recorded from the *Phragmites* pit prior to the spring planting. This particular specimen may have come from the population known to exist in the vicinity of Stanton Harcourt.

*Haliplus obliquus*: (Haliplidae: COLEOPTERA)

A crawling water beetle. A species with a widespread but local distribution. The species is usually associated with charophytes. The species is Nationally Notable B. (D.Bilton pers. comm.)

Not recorded from the main survey ponds, but recorded from the *Phragmites* trench prior to the spring planting.

## APPENDIX 5. COMPARISON OF TOTAL NUMBERS OF BIRDS (BIRD/DAYS) AT FARMOOR RESERVOIR ESTIMATED BY KNOWN-EFFORT SAMPLING AND FROM THE FARMOOR LOG-BOOK

| SPECIES | TOTAL BIRD/DAYS (KNOWN-EFFORT DATA) | TOTAL BIRD/DAYS (LOG-BOOK DATA) |
|---|---|---|
| Great crested grebe | 264 | 142 |
| Dabchick | 23 | 5 |
| Gannet | 0 | 1 |
| Cormorant | 464 | 176 |
| Heron | 6 | 7 |
| Mute swan | 38 | 0 |
| Greylag goose | 2 | 1 |
| Canada goose | 32 | 0 |
| Shelduck | 5 | 12 |
| Mallard | 830 | 92 |
| Wigeon | 1 | 2 |
| Teal | 7 | 0 |
| Garganey | 0 | 2 |
| Shoveler | 0 | 8 |
| Tufted duck | 999 | 244 |
| Goldeneye | 166 | 114 |
| Goosander | 1 | 1 |
| Ruddy duck | 0 | 1 |
| Wood duck | 3 | 1 |
| Moorhen | 2 | 0 |
| Oystercatcher | 0 | 4 |
| Little-ringed plover | 36 | 78 |
| Ringed plover | 6 | 35 |
| Golden plover | 52 | 0 |
| Grey plover | 1 | 1 |
| Turnstone | 4 | 18 |
| Lapwing | 7 | 6 |
| Dunlin | 44 | 114 |
| Temminck's stint | 0 | 1 |
| Knot | 0 | 3 |
| Sanderling | 4 | 35 |
| Redshank | 8 | 16 |
| Greenshank | 1 | 2 |
| Common sandpiper | 37 | 104 |
| Green sandpiper | 1 | 0 |
| Curlew 12 | 10 | |
| Whimbrel | 1 | 16 |
| Bar-tailed godwit | 17 | 15 |
| Black-tailed godwit | 0 | 9 |

Continued over page.

**APPENDIX 5. (CONTINUED)**

| SPECIES | TOTAL BIRD/DAYS (KNOWN EFFORT DATA) | TOTAL BIRD/DAYS (LOG-BOOK DATA) |
|---|---|---|
| Black-headed gull | 141 | 245 |
| Little gull | 0 | 17 |
| Mediterranean gull | 0 | 1 |
| Herring gull | 1 | 0 |
| L. black-backed gull | 9 | 41 |
| Imm. herring/L.b-bg | 2 | 0 |
| Common gull | 1 | 0 |
| Kittiwake | 0 | 2 |
| Common tern | 73 | 116 |
| Arctic tern | 13 | 185 |
| Little tern | 2 | 3 |
| Black tern | 19 | 158 |
| Kingfisher | 0 | 3 |
| Rock pipit | 3 | 2 |
| Pied wagtail | 126 | 182 |
| White wagtail | 28 | 50 |
| Grey wagtail | 0 | 3 |
| Yellow wagtail | 184 | 665 |
| Reed bunting | 23 | 19 |
| NUMBER OF SPECIES RECORDED | 45 | 49 |

TOTAL NUMBER OF SPECIES RECORDED = 57

## APPENDIX 6. WADERS AND WATER BIRDS RECORDED ON THE PINKHILL MEADOW WETLANDS DURING APRIL AND MAY 1991.

+ Species recorded at least once during April and May 1991.

| SPECIES | BIRD-DAYS: KNOWN-EFFORT OBSERVATION | | BIRD-DAYS: LOG-BOOK RECORDS | |
|---|---|---|---|---|
| Mute swan | + | - | - | - |
| Canada goose | - | + | - | - |
| Mallard | + | - | - | - |
| Tufted duck | - | + | - | - |
| Moorhen | - | + | - | - |
| Oystercatcher | - | - | + | - |
| Little-ringed plover | + | - | + | - |
| Ringed plover | - | - | - | + |
| Lapwing | - | + | - | - |
| Temminck's stint | - | - | + | - |
| Greenshank | - | + | - | - |
| Common sandpiper | + | - | + | - |
| Whimbrel | - | + | - | + |
| Bar-tailed godwit | + | - | - | - |
| Black-headed gull | + | - | - | - |
| Common tern | - | + | - | - |
| Little tern | - | + | - | - |
| Pied wagtail | - | + | - | - |
| Yellow wagtail | + | - | + | - |
| Reed bunting | + | - | - | - |

**NUMBER OF SPECIES OF WADERS RECORDED ON PINKHILL MEADOW** 9

**TOTAL NUMBER OF SPECIES OF WETLANDS BIRDS RECORDED ON PINKHILL MEADOW** 20

Four other species of wader have been recorded on Pinkhill Meadow outside the April/May survey period: shelduck, dunlin, green sandpiper and snipe.

Waders seen on or over the Farmoor site during April and May but not visiting Pinkhill: golden plover (flying over only), grey plover, turnstone, little stint, knot, sanderling, curlew, black-tailed godwit.

## APPENDIX 7. THE USE OF DIFFERENT AREAS OF THE FARMOOR SITE BY WADERS DURING APRIL AND MAY 1991

Results are derived only from Pond Action known-effort survey. Numbers in brackets indicate waders flying over each water body. Waders in flight have not been included in calculations of differences in use of each part of the site.

| SPECIES | BIRD-DAYS (KNOWN-EFFORT DATA) | | |
|---|---|---|---|
| | PINKHILL MEADOW | FARMOOR NORTH (I) | FARMOOR SOUTH (II) |
| Oystercatcher | Log-book records only | | |
| Little-ringed plover | 15(0) | 7(0) | 11(3) |
| Ringed plover | 0(1) | 2(2) | 0(1) |
| Golden plover | 0 | 0(52) | 0 |
| Grey plover | 0 | 1(0) | 0 |
| Turnstone | 0 | 1(3) | 0 |
| Lapwing | 1(0) | 0 | 0(6) |
| Dunlin | 0(5) | 30(1) | 1(7) |
| Temminck's stint | Log-book records only | | |
| Knot | Log-book records only | | |
| Sanderling | 0 | 4(0) | 0 |
| Redshank | 0 | 3(1) | 3(1) |
| Greenshank | 1(0) | 0 | 0 |
| Common sandpiper | 1(0) | 14(0) | 23(0) |
| Green sandpiper | 0 | 1(0) | 0 |
| Curlew | 0(12) | 0 | 0 |
| Whimbrel | 1(0) | 0 | 0 |
| Bar-tailed godwit | 2(4) | 0 | 0(11) |
| Black-tailed godwit | Log-book records only | | |
| **TOTAL BIRD-DAYS** | **21(22)** | **63(59)** | **38(29)** |
| **TOTAL SPECIES** | **6** | **9** | **4** |

## APPENDIX 8. STATISTICAL ANALYSIS OF RESULTS GIVEN IN APPENDIX 7

| | PINKHILL | FARMOOR NORTH | FARMOOR SOUTH |
|---|---|---|---|
| Perimeter of water-body (m) | 580 | 2700 | 3700 |
| Percentage of total (6980m) | 8.3 | 38.7 | 53.0 |

**HYPOTHESIS:** **THE NUMBER OF WADER-DAYS RECORDED ON EACH OF THE THREE WATER-BODIES IS PROPORTIONAL TO THE LENGTH OF THE PERIMETER OF EACH WATER-BODY.**

| | | | |
|---|---|---|---|
| Number of wader-days (total 138, excluding birds in flight) | 21 | 63 | 38 |
| Expected number of wader-days (138 x %age of perimeter) | 11.5 | 53.4 | 73.1 |
| (Observed-Expected)2 /Expected | 8.02 | 1.73 | 16.85 |
| Chi-square | 26.6**. n = 3, df = n-1. | | |

The hypothesis is rejected.

THE NUMBER OF WADER-DAYS ON EACH WATER-BODY IS NOT RELATED TO THE PERIMETER LENGTH.

On Pinkhill Meadow more wader-days were recorded then would be expected. On Farmoor South fewer wader-days were recorded than would be expected. The number of wader-days on Farmoor North appeared not to differ from expectation.

Continued over page.

**APPENDIX 8. (CONTINUED)**

**HYPOTHESIS:** **NUMBERS OF THREE COMMON WADERS (LITTLE-RINGED PLOVER, DUNLIN AND COMMON SANDPIPER) ON EACH WATER-BODY ARE PROPORTIONAL TO THE LENGTH OF THE PERIMETER OF EACH WATER-BODY.**

| | PINKHILL MEADOW | FARMOOR NORTH | FARMOOR SOUTH |
|---|---|---|---|
| Little-ringed plover | | | |
| number observed | 15.00 | 7.00 | 11.00 |
| number expected | 2.74 | 12.77 | 17.49 |
| $(Observed-Expected)^2$ /Expected | 54.90 | 2.61 | 2.41 |
| Chi-square | 59.9**. n = 3, df = n-1. | | |

The hypothesis is rejected.
THE NUMBER OF LITTLE-RINGED PLOVER WADER-DAYS ON EACH WATER-BODY IS NOT RELATED TO THE PERIMETER LENGTH.

| | | | |
|---|---|---|---|
| Dunlin | | | |
| number observed | 0 | 30.00 | 1.00 |
| number expected | 0 VALUES CANNOT BE TESTED. | | |
| $(Observed-Expected)^2$ /Expected | | | |
| Chi-square | Cannot be tested. However, dunlin were clearly almost completely confined to Farmoor North. | | |
| Common sandpiper | | | |
| number observed | 1 (excluded from test) | 14.00 | 23.00 |
| number expected | - | 14.7 | 20.10 |
| $(Observed-Expected)^2$ /Expected | - | 0.035 | 0.42 |
| Chi-square | **0.46 ns n=2, df=n-1** | | |

The hypothesis is accepted.
THE NUMBER OF COMMON SANDPIPER WADER-DAYS ON FARMOOR NORTH AND SOUTH IS RELATED TO THE PERIMETER LENGTH.

## APPENDIX 9. CORRELATIONS BETWEEN WADER BIRD-DAYS CALCULATED FROM KNOWN-EFFORT DATA AND LOG-BOOK DATA FOR APRIL AND MAY 1991

| NO. | CORRELATION | DATA SOURCES COMPARED | SPEARMAN'S RANK CORRELATION |
|---|---|---|---|
| (i) | All species (bird-days). | Log-book: 61 days<br>Known-effort: 24 days | 0.646*** (n=69) |
| (ii) | All species (bird-days). | Log-book: 24 days<br>Known-effort: 24 days | 0.012ns (n=69) |
| (iii) | Waders only (bird-days). | Log-book: 24 days<br>Known-effort: 24 days<br>(with golden plover) | 0.663*** (n=69) |
| | | Log-book: 24 days<br>Known-effort: 24 days<br>(without golden plover) | 0.857*** (n=69) |
| (iv) | Individual species | Log-book: 24 days<br>Known-effort: 24 days | |
| | Mallard | | -0.015ns (n=24) |
| | Tufted duck | | 0.114ns (n=24) |
| | Little ringed plover | | 0.177ns (n=24) |
| | Dunlin | | 0.777*** (n=24) |
| | Common sandpiper | | 0.430* (n=24) |
| | Sanderling | | 0.744*** (n=24) |

## APPENDIX 10. CORRELATIONS BETWEEN WADER SPECIES-DAYS/WEEK CALCULATED FROM KNOWN-EFFORT DATA AND LOG-BOOK DATA FOR APRIL AND MAY 1991

| NO. | CORRELATION | DATA SOURCES COMPARED | SPEARMAN'S RANK CORRELATION |
|---|---|---|---|
| (i) | All species (species-days/week) | Log-book 61 days<br>Known-effort 24 days | - |
| (ii) | All species (species-days/week) | Log-book 24 days<br>Known-effort 24 days | 0.806** (n=9) |
| (iii) | Waders only (species-days/week) | Log-book: 24 days<br>Known-effort: 24 days.<br>(with golden plover) | 0.663ns |
| | | Log-book: 24 days<br>Known-effort: 24 days<br>(without golden plover | 0.857**(n=9) |
| (iv) | Individual species | Log-book: 24 days<br>Known-effort: 24 days | |
| | Mallard | | 0.228ns (n=9) |
| | Tufted duck | | 0.604ns (n=9) |
| | Little ringed plover | | 0.319ns (n=9) |
| | Dunlin | | 0.851** (n=9) |
| | Common sandpiper | | 0.511ns (n=9) |
| | Sanderling | | 0.661ns (n=9) |