BTO Research Report 357

Waterways Breeding Bird Survey: progress report for 2002–03

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A report to the Environment Agency in respect of R&D project W1–071

April 2004

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Recommended citation: **Marchant, J.H., & R.H. Coombes. 2004. *Waterways Breeding Bird Survey: progress report for 2002–03.* Research Report 357. British Trust for Ornithology, Thetford.**

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EXECUTIVE SUMMARY

1 The Waterways Breeding Bird Survey (WBBS), which is operated by BTO and funded in collaboration with the Environment Agency's R&D Programme, began in 1998. Phases 1 and 2 of the project are already complete. This established the value of WBBS as a tool for assessing breeding birds for appraisal of 500-metre waterway sections, for example alongside the River Habitat Survey.

2 The present interim Phase 3 report covers the scheme's development during 2002–03, with emphasis on the results of the 2003 field season. Summary data from earlier years are included for comparison. Results are given also from the BTO's long-running Waterways Bird Survey (WBS).

3 WBBS coverage was due to be increased in 2001, as part of Phase 3 of the project. Owing to the access restrictions imposed by the outbreak of Foot & Mouth Disease (FMD) in 2001, efforts to increase the sample were postponed until spring 2002. A further 249 WBBS stretches were selected randomly for coverage, bringing the total number of random sites selected to 512. WBBS surveys were also requested on sites, selected by observers, that were already being covered by WBS mapping.

4 In 2002 and in 2003 an excellent response was received from volunteer observers in both the random and the WBS-linked WBBS samples. The number of WBBS surveys conducted in 2003 showed another substantial increase, to 261, of which 197 were random stretches and the remaining 64 WBS-linked. These 261 stretches comprised 1697 500-metre sections, with an average 6.5 sections per stretch.

5 Estimates of numbers of birds per unit waterway length in 2003 were mostly similar to those recorded for 1998–2002. Wood Pigeon was the most abundant species and Wren the most widespread. Dipper was found on 81 random stretches and Kingfisher on 51 and other waterbirds were also recorded in substantial numbers.

6 Population changes from WBBS and WBS in 2002–03 showed a preponderance of increases. On WBS, six changes were statistically significant: Redshank, Goosander, Grey Wagtail, Pied Wagtail and Moorhen increased, and Sand Martins decreased. Results were generally similar between WBS and WBBS, and between random and WBS-linked parts of the WBBS sample, although further analysis of these data is needed.

7 Mammal data were returned from 221 (85%) of the 261 WBBS stretches surveyed in 2003. There were 26 mammal species recorded, of which Rabbit and Mole were the most widespread, and Rabbit and Red Deer the most numerous. The value of WBBS mammal data is being explored through the JNCC's Tracking Mammals Partnership.

8 Increases in the number of random WBBS sites surveyed in 2003 brought more species over the threshold required for population monitoring. There were 22 waterbirds and 46 other bird species that had sample sizes of more than 40 plots. There is great potential, therefore, for WBBS to augment the UK's bird monitoring programme. Where sample sizes are too small from the random WBBS alone, there may be scope for combining them with the non-random sites, and/or with Breeding Bird Survey data, to provide a sufficient sample.

9 Further efforts have been made to increase the number of WBBS surveys to be conducted in spring 2004, which is the final year of the project's Phase 3.

1 INTRODUCTION

The 2003 breeding season had been planned to be the third and final one of Phase 3. The outbreak of Foot and Mouth Disease (FMD) in the UK in 2001, however, delayed the start of Phase 3 until 2002. In compensation for this lost fieldwork opportunity, fieldwork for Phase 3 will continue in the 2004 breeding season, with funding for the survey extended accordingly.

This report is therefore a further interim one from Phase 3 of the development of the Waterways Breeding Bird Survey (WBBS), rather than the final report that was originally planned. It covers WBBS results and developments, with emphasis on the 2003 breeding season, and with summary data for earlier years. Results from the BTO's Waterways Bird Survey (WBS: see below) are included for comparison. The final report from Phase 3 will now be produced in 2005.

The background of WBBS and the reasons for its introduction are summarised below.

1.1 The Waterways Bird Survey (WBS)

In the Waterways Bird Survey (WBS), which began in 1974, BTO volunteers conduct mapping censuses alongside linear waters, both rivers and canals, with the aim of monitoring bird population change in these important yet vulnerable habitats throughout the United Kingdom. These data can also be used to investigate, at a variety of spatial and temporal scales, the ways in which breeding birds use river and canal habitats. The primary role of the WBS has been to record population changes among species poorly represented in the BTO's other monitoring schemes, principally, in its first two decades, the Common Birds Census (CBC). Carter (1989), Marchant *et al.* (1990), Marchant & Balmer (1994) and Newson *et al.* (2003) have provided overviews of the WBS and its results.

The BTO/JNCC/RSPB Breeding Bird Survey (BBS) began in 1994 and is an ongoing programme that was introduced specifically to take over from CBC as the main way in which population changes of birds are measured in the wider countryside. After a seven-year overlap period between BBS and CBC, the CBC ceased to perform this function in 2000. WBS continues alongside BBS, supplying valuable extra data on a small number of specialist waterside bird species (Crick *et al.* 2004).

The WBS suffers the same disadvantages for bird population monitoring as the CBC did. Since observers can choose their own survey sites, the resulting data are non-random and potentially biased. Because the mapping method is labour-intensive, surveys are relatively few in number. In addition, WBS covers only a set list of waterside bird families and species, and so provides no information on more widespread bird species as they occur in the waterside environment. These drawbacks could all be addressed by applying BBS-style methods to waterside surveys (Marchant *et al.* 1996).

1.2 WBBS development during 1998–2003

With this background, the BTO has been developing a Waterways Breeding Bird Survey (WBBS) since 1998, in conjunction with the Environment Agency's R&D programme. The overall aims of the project are to develop a transect method suitable for collecting breeding bird survey data from random waterway sites, and test its implementation, to

- *supplement data from the BBS with counts from rivers and canals, thus maintaining or expanding the level of bird population monitoring currently available through BBS and the BTO's long-running WBS, and satisfying the needs of organisations with specific interests in ongoing long-term bird monitoring, such as JNCC and RSPB; and*
- *provide bird and bird–habitat data, relevant to nature conservation along waterways, that fulfil the requirements of the Environment Agency, and its sister organisations in Scotland and Northern Ireland, that have responsibilities specific to linear waters.*

In Phase 1 of the survey, methods of field survey and plot selection were tested, and a study was conducted of breeding bird numbers along canals in relation to the timing of the coarse fishing season. In Phase 2, the non-random canal sample was dropped, and WBS observers were invited to contribute to the WBBS as well as WBS. Also in Phase 2, WBBS bird data were compared with RHS habitat data that was collected from the same sites by Environment Agency contractors. Phase 3 continues the same protocol as Phase 2 but aims to increase the size of the annual sample from randomly selected sites.

It was intended that the 2001 breeding season should mark the beginning of Phase 3 of WBBS development. In practice, this was prevented by the outbreak of Foot & Mouth Disease (FMD) in February 2001. Owing to FMD, no additional fieldwork was requested from BTO volunteers in 2001. Many were prevented from repeating previous surveys; others were able only to make one of the two survey visits, after access restrictions to their stretches were lifted in mid season. Active promotion of WBBS, to increase the sample size, was postponed until 2002.

Previous reports from WBBS have covered progress in Phase 1 (Marchant & Gregory 1999, Marchant *et al.* 1999), Phase 2, to the end of the 2000 breeding season (Marchant & Noble 2000, Marchant *et al.* 2002a), 2001, the year in which Phase 3 had been scheduled to begin (Marchant *et al.* 2002b), and 2002, the first full season of Phase 3 (Marchant & Noble 2003). It is already clear from Phases 1 and 2 of WBBS that the method is valuable as a quick and easy way to assess bird populations in 500-metre river sections. Data gathered in this way can be of value at local or catchment scales, for example for pre- or post-project site appraisals, or for the identification of river or canal sections of special conservation value. Use of the method by the BTO's UK-wide network of volunteers allows large samples to be surveyed on a UK basis and enables assessments to be made of changes in breeding bird numbers in the waterside habitat.

A major innovation of WBBS is that it is designed to allow linkage to the Environment Agency's River Habitat Survey (RHS), with data for both schemes collected for 500-metre sections of waterway. Initial analyses of WBBS bird and RHS habitat data have been reported by Marchant & Gregory (1999) and Marchant *et al.* (2002a).

2 METHODS

2.1 Methods of the Waterways Bird Survey

2.1.1 WBS fieldwork methods

WBS procedures have been described in full by Taylor (1982) and Marchant (1994). The bird census method used is territory mapping, which produces an estimate of breeding numbers and a map of breeding territories for each species, stretch and year (see Figure 1). Details of the habitats available to the birds are also mapped. Plots are chosen by the observers themselves, under guidance from BTO staff, and are stretches typically 4–5 kilometres long that are of relatively easy access and of which at least one bank can be walked. Observers are asked to make nine visits to their site each breeding season. WBS coverage is restricted to waterside specialist birds such as grebes, ducks, geese, swans, waders, and reedbed passerines.

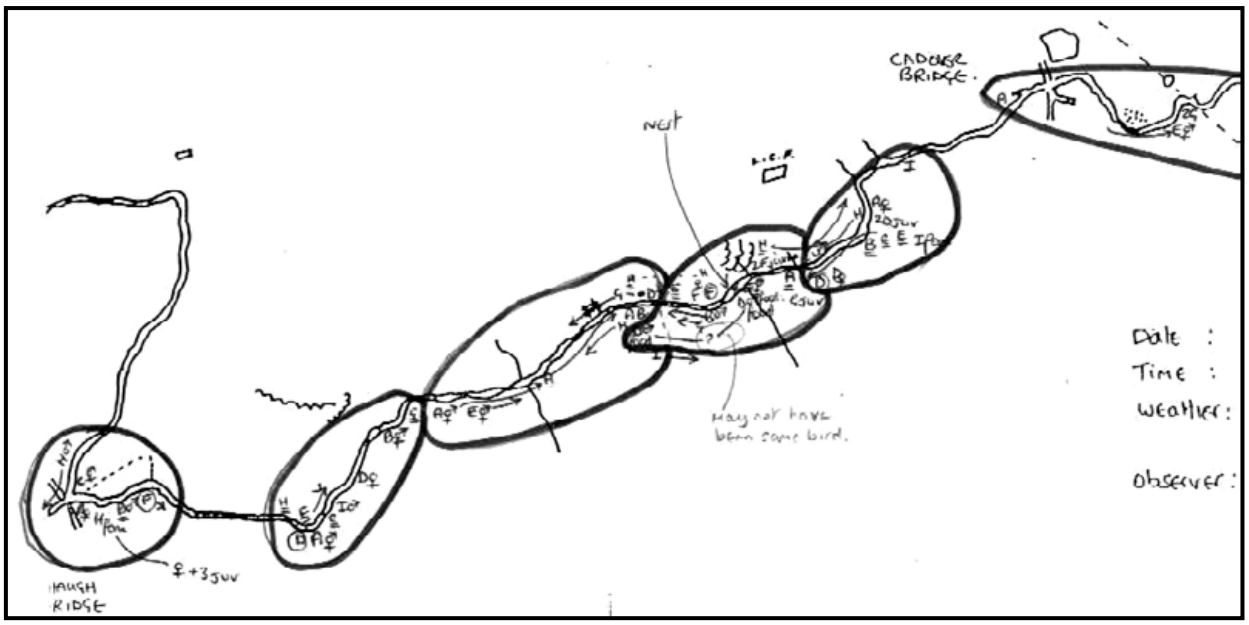

Figure 1 Example species map from the Waterways Bird Survey. The species is Grey Wagtail

By 2003, the WBS had completed 30 seasons of mapping fieldwork and recorded much very valuable information on population change and relationships between birds and habitat (e.g. Rushton *et al.* 1994, Marchant & Coombes 2003, Crick *et al.* 2004). Surveys continue in 2004.

2.1.2 Calculation of year-to-year population change from WBS data

The units of WBS mapping results are 'apparently occupied territories', whereas for WBBS and BBS they are the numbers of birds counted. Long-term monitoring from WBS data is possible for around 24 species that occur on at least 15 or so plots in each year, where number of territories can be modelled as a function of year and site (e.g. Newson *et al.* 2003). Year-to-year changes from WBS are typically presented using a simpler chain-index method that pairs the year-1 and year-2 data for those plots that were surveyed in both years (e.g. Marchant & Coombes 2003). This approach is taken here in considering population change between 2002

and 2003 – the advantages of modelling being hardly evident when only a single year-to-year change is being estimated.

Only those WBS plots where coverage was similar in 2002 and 2003 contributed to the calculations, and any individual counts that were not comparable between the two years were also excluded.

2.2 Methods of the Waterways Breeding Bird Survey

2.2.1 Selection of sites for coverage

A major innovation of WBBS is its use of random waterway sites for bird surveys. This sampling strategy allows WBBS results to be treated as representative of waterways generally, throughout the United Kingdom.

To select waterways randomly, we made a random selection of 2x2-km national grid squares, discarded those without a waterway running through them, and sought coverage of the waterway that ran through the selected square. The tetrad (2x2 km) was selected as the most appropriate grid-square size since, after a trial run, it emerged that too high a proportion of 1-km squares held no waterway. Larger squares (5x5 or 10x10 km) frequently held more than one waterway, and so raised questions about which to select from within the square. RHS reference sites have been chosen from 10-km squares, however, using the protocol of taking the stretch closest to a predetermined point within the square.

A clear definition was required of the water bodies that formed the population being sampled. The linear waters that were to be studied could have included rivers, canals, stretches that could be defined as both river and canal, and various kinds of ditches and drains. For rivers, a policy was needed on whether headwaters should be excluded and how this could be achieved, and also on whether broad or tidal stretches should be included. For the purpose of the WBBS, a waterway has been defined as any double blue line, with shaded in-fill, on the Ordnance Survey (OS) 1:25,000 Pathfinder/Explorer/Outdoor Leisure map series. Single blue lines, typically minor headwaters and drainage ditches, and all non-linear water features were ignored. Enquiries with OS revealed that double blue lines with 'water stipple' are used on this scale only for features that are 6.5 metres or more wide (W. Debeugny, pers. comm.). Rivers were considered to finish at the normal tidal limit as marked as 'NTL' on the OS maps; no width limit was applied.

Stratification, for example by waterway type, RHS data, water quality, waterbird density or observer density, has not been employed but could be applied to WBBS in the future, either to reduce the variance of selected results or to make best use of the available manpower. No stratification of the sample was required to meet the aims of survey's initial phases.

For each selected random waterway, a map was prepared showing the boundaries of the random tetrad and the selected waterway. The waterway was picked out with a highlighter, typically for several km from the tetrad boundary, in both directions. These maps were sorted by BTO region and sent to the relevant BTO Regional Representative (the RR), whose job it was to match each site with an observer.

Start and end points of the actual survey stretch within the highlighted length of waterway were not pre-set, but were left for the observer to determine with regard to:

- *the requested location;*
- *the requirement for a whole number of complete 500-metre transect sections;*
- *convenience of access;* and
- *the observer's preference for the number of sections to be covered (maximum ten).*

These concessions were designed to ensure that access problems could be overcome in the majority of cases, and a survey route set up that could be used on a long-term basis.

Aside from the random stretches, determined on the basis described above, the WBBS sample has also, since 1999, included a substantial number of non-random stretches that were chosen because there are WBS mapping data available for the same sites. The latter are referred to in this report as 'WBS-linked stretches' and are treated separately in most analyses. They differ from the random stretches in their geographical distribution, and may perhaps be biased towards places that are richer in breeding birds.

Surveys at sites falling into neither of these categories are no longer requested.

2.2.2 WBBS fieldwork methods

The BBS method had already proved to be enjoyable, popular with observers, and well suited to its purpose. It was their transfer to waterways that was being tested in the setting up of WBBS. Modifications to BBS procedures were therefore kept to a minimum.

BBS uses a transect method in which two visits are made, termed 'early' and 'late', one in the first and one in the second half of the breeding season, April–June (BTO 1998, Raven *et al.* 2003). The transect route is divided into up to ten sections of fixed length. During each visit, all birds seen or heard are counted, section by section, in each of three distance bands from the transect line (0–25 metres, 25–100 metres, and >100 metres, summing counts from both sides of the transect line); birds seen only in flight are recorded separately.

WBBS instructions and recording forms are based heavily on those designed for BBS. Some details of the design of forms were altered in minor ways between 1998 and 2000 but, once established, the field methods of WBBS have been kept constant. Forms for 1998–99 are each appended to the reports from WBBS for those seasons (Marchant & Gregory 1999, Marchant & Noble 2000). These contain full details of fieldwork methods and recording.

The methods for WBBS differ from those of BBS in that:

- *routes within sites follow the waterway, rather than a predetermined pattern based on the national grid;*
- *the sections composing each transect stretch are each 500 metres, to match RHS, whereas in BBS they are 200 metres;*
- *transects are not fixed at 2 km, as BBS transects are, but are of variable length, with a maximum of 5 km (ten 500-metre sections);* and
- *habitat recording is extended from the BBS standard to allow extra information to be recorded about the waterway itself.*

Other aspects of fieldwork and analysis are identical.

As on BBS, mammals and signs of mammals were noted on each counting visit. For each species of wild mammal detected, either presence or a pair of counts (one early in the season and one late) was recorded. Observers coded the main features of up to three habitat types per 500-m

section of canal, of which the first habitat was the canal itself and the other one or two were those considered by the observer to be the most important adjoining habitats. The system of habitat coding used was that devised by Crick (1992) and now used for all BTO monitoring surveys.

WBBS requires only two visits to count birds, compared to WBS's nine, and so is much quicker and simpler for observers. WBBS's transect data require relatively little processing and so there are efficiencies also for analysts in using this method. Importantly, its random sampling design ensures that the results are representative of the waterway habitat.

2.2.3 Application of WBBS methods in 2003

Sites designated for coverage in 2003 were the 512 sites randomly selected for Phase 3 of WBBS. These random stretches represent a sample drawn from the whole of the UK (Figure 2). They comprise the original selection of 201 sites in 1998, the 62 added in 1999, and the 249 sites added to the sample for Phase 3 in 2002.

Figure 2 shows the wide geographical scatter of the randomly selected plots, but also the absence of stretches in some parts of the UK. The pattern of their distribution follows from the area-based method of selection which, since the density of river courses in a catchment is greatest in the upper reaches, is more likely to score a hit with random tetrads that lie close to the watershed. Few stretches were selected in coastal regions and there were concentrations in some areas of higher ground, for example the Grampians, Southern Uplands and Welsh Marches. Eastern East Anglia, where river courses are few and well scattered, was barely represented in the sample since, by chance, just two of the tetrads selected there contained a waterway.

Within each region, each stretch was allocated a priority number (beginning at 1 for top priority), derived from the order of the random selection. BTO RRs then sought volunteer observers to cover as many of their selected sites as possible, beginning at priority 1 and working down the list. RRs distributed survey packs and collected completed forms for return to BTO HQ.

To promote the non-random, WBS-linked section of the sample, WBBS survey packs were distributed from BTO headquarters to all current WBS observers with a request to contribute to both surveys in 2003, as in 1999–2002.

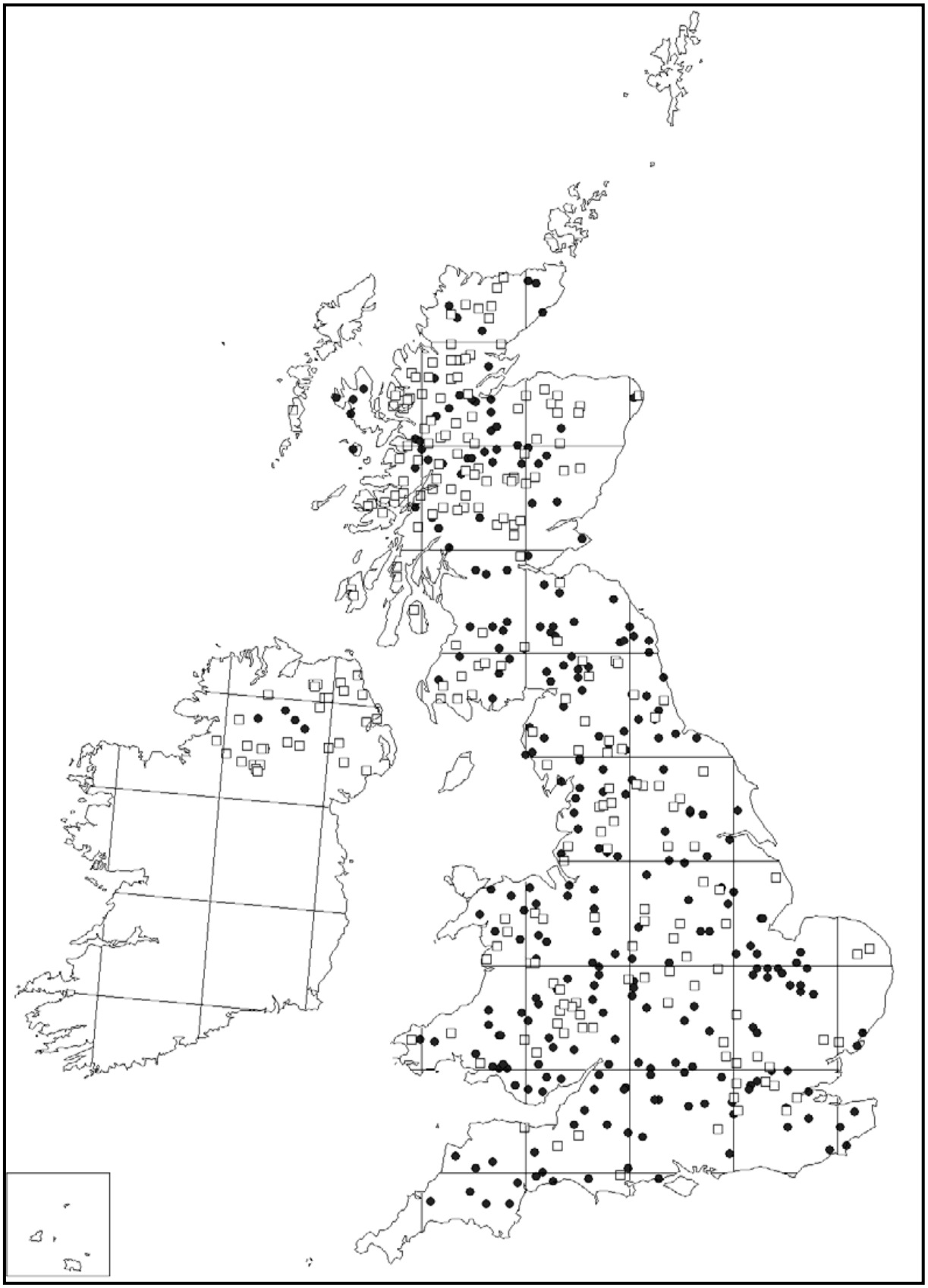

Figure 2 **Distribution of the 512 random WBBS stretches selected for coverage. Those surveyed at least once during 1998–2003 are shown as black spots, and those not surveyed as open squares.**

2.2.4 Calculation of year-to-year population change from WBBS data

This report contains estimates of population change between 2002 and 2003, derived from WBBS data for stretches covered in both years. For each year, species and stretch, a mean count was calculated by summing all the counts across 500-m sections and distance categories and dividing the total by the number of sections to give a mean value per 500-m section. The overall means of these values, across all stretches for which paired data were available for 2002 and 2003, were used to estimate year-to-year change for each species.

In taking a mean value across sections to find a figure for each species, stretch and year, WBBS differs from BBS, where the overall total across all sections enters the calculations of population change. This difference in the methods is designed to allow for the variability of WBBS stretches in the number of sections an observer can cover: BBS squares contain ten sections except where some of the square is water or below high-tide mark.

The two main parts of the WBBS sample – the random stretches, and the WBS-linked ones (non-random sites surveyed because of the existence of WBS mapping data for the same stretches) – were treated separately in this analysis.

3 RESULTS FROM WBBS AND WBS IN 2003

3.1 Coverage achieved by WBBS in 1998–2003

The numbers of stretches surveyed each year are shown in Table 1. Totals for 1999 and for 2002 are higher than those given in the previous report, because they include a few returns that were received well after the set deadlines. Any late data still to be submitted for 2003 or earlier years will be included in future summaries and analyses.

Table 1 Totals of WBBS stretches surveyed in 1998–2003.

Class of survey	1998	1999	2000	2001	2002	2003	Surveyed at least once
Random stretches (and as % of those requested)	108 (54%)	116 (44%)	109 (41%)	24 (9%)	162 (32%)	197 (38%)	275 (54%)
WBS-linked (non-random)	18	68	65	27	66	64	97
Other non-random stretches	42	1	1	0	0	0	43
TOTAL	**168**	**185**	**175**	**51**	**228**	**261**	**415**

The 1998 sample included a total of 60 canal stretches that had been chosen non-randomly on the basis of the fishing seasons in operation there. Some of these were also in the random sample or were also WBS plots. The 42 plots that did not also fall into either the random or the WBS category were dropped from the survey in subsequent seasons.

WBS observers were asked to contribute WBBS data also from their stretches, beginning in 1999 with Phase 2 of WBBS development. As part of the study of fishing seasons, 18 WBS sites had also been covered for WBBS in 1998, providing continuity in that part of the sample since 1998.

Of the 201 stretches that had been selected randomly for the first year of WBBS, 108 were surveyed (54%; Table 1). Despite an extra 62 stretches being made available, totals for 1999 and 2000 were only marginally higher, and percentage coverage fell. The likely reason for this is that the extra stretches were mostly in areas where the BTO RR had initially indicated unwillingness to take part. Only 24 random stretches were surveyed in 2001, when FMD imposed severe restrictions on access to the countryside. A further 249 waterway stretches were added to the random sample before the 2002 field season, bringing the total number of sites available for coverage to 512. Of these, 162 were surveyed in 2002 and 197 in 2003, by far the largest total achieved by WBBS so far.

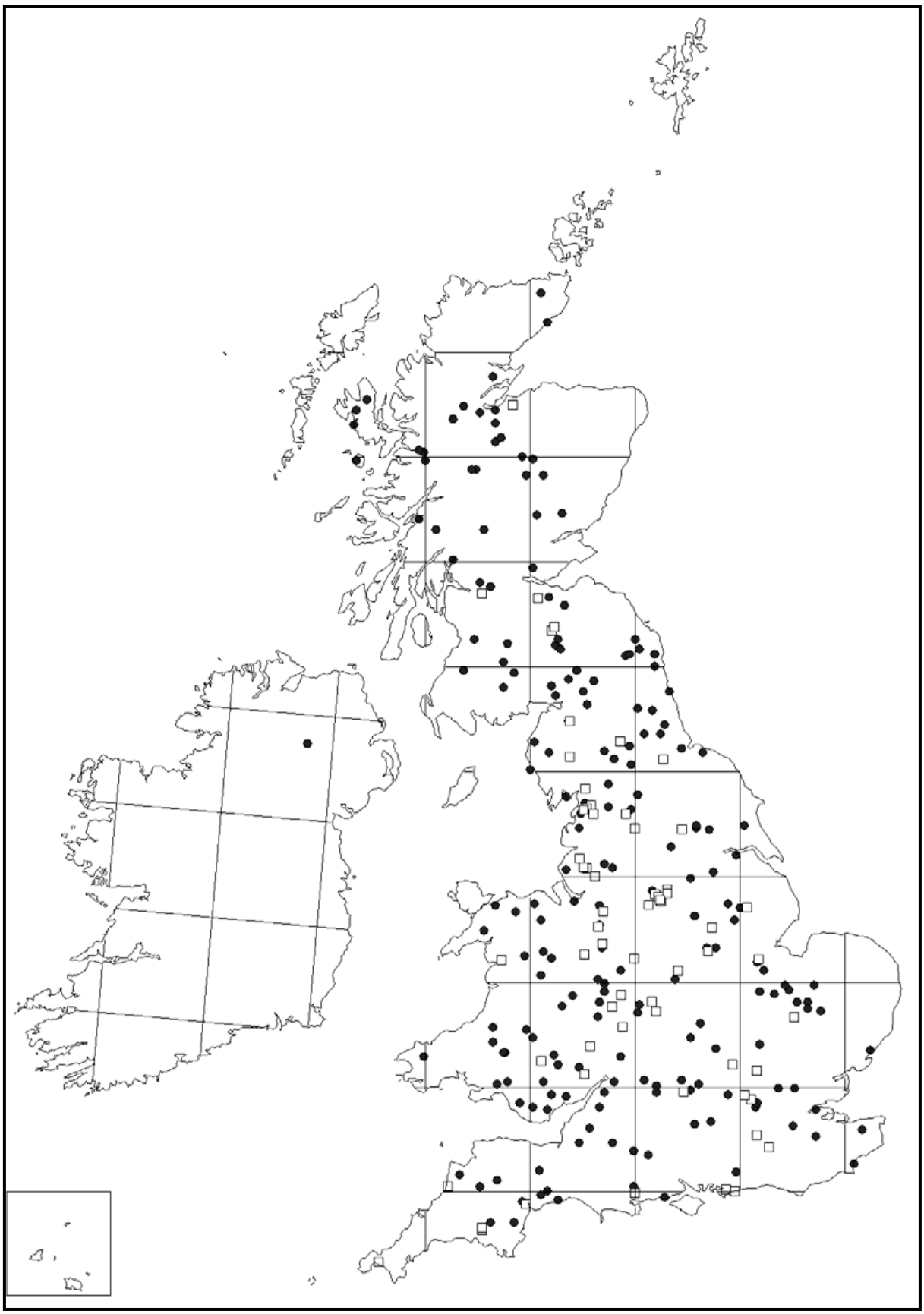

Figure 3 **The 261 sites at which WBBS fieldwork was conducted in 2003. Surveys at randomly chosen locations are shown as black spots, and those conducted at non-random WBS plots as open squares.**

In 2001, just 51 sites were surveyed in all, representing only 29% of the coverage in the previous year. These sites were concentrated in the English Midlands and the north of Scotland, these being areas where access generally was less restricted than elsewhere (Marchant *et al.* 2002b). The 2001 WBBS sample is thus rather different in character from the samples in other years.

In 2003, there were 58 stretches in the random selection that were covered for the first time, providing a further substantial boost to the WBBS sample. In addition, four WBS plots provided WBBS data for the first time. The grand total of 261 WBBS surveys in 2003 comprises 1697 500-metre sections of river and canal, at an average of 6.5 sections per stretch. The stretches covered in 2003 are mapped in Figure 3. Surveys in 2003 were well distributed around the UK but, compared with the overall distribution of random sites (Figure 2), it is notable that there were no surveys in northeast Scotland or far northwest Scotland, and only one in Northern Ireland.

The final column of Table 1 indicates the numbers of different stretches in each category that contribute to the annual totals. Most surveys since 1999 have been repeat surveys at stretches already covered, and can therefore contribute to models of population change.

A full list of stretches covered since the inception of WBBS is given in Appendix 1.

3.2 WBBS data collection for birds

Table 2 records the mean overall recording frequencies of bird species recorded on randomly selected WBBS stretches, for each year 1998–2002. The figures are the mean number of individuals recorded per 10 km of waterway. No estimate is tabulated where a species was found on fewer than six stretches. WBS-linked and other non-random sites are not included.

Zero values from stretches where the species was absent are included in the means, which are therefore comparable across species. Standard errors are not tabulated but were larger than the means in almost all cases. Differences between years in the mean figures reported for particular species result from chance effects and the effects of plot turnover as well as from population changes among the birds themselves.

The five most abundant species recorded on the random stretches in 2003 were Wood Pigeon (75.9 birds per 10 km), Mallard (54.7), Wren (49.1), Chaffinch (47.6) and Blackbird (43.5). Starling, previously among the top five species, was much less abundant in 2003. The most widespread species in 2003 on these stretches were Wren (found on 178 stretches), Chaffinch (177), Mallard (173), Robin (172) and Wood Pigeon (170).

Among waterside specialists, Dipper was found on 81 stretches and Kingfisher on 51. Sample sizes for Sand Martin, Common Sandpiper and Grey Wagtail were also above 50. Further waterbird species with samples greater than 30, and which are difficult to monitor by other existing schemes, included Tufted Duck, Goosander and Reed Warbler. The WBBS sample is already in double figures for Great Crested Grebe, Teal and Gadwall, for all of which there is currently almost no information on annual population change in the UK.

Table 2 **Birds recorded on randomly selected WBBS stretches in 1998–2003. Numbers of birds per 10 km are the means from all random stretches covered, including those where the species was not found. The number of occupied stretches is also given. No figures are presented where the sample size was fewer than six plots.**

Species	Birds per 10 km (number of stretches occupied)					
	1998 (n=108)	1999 (n=116)	2000 (n=109)	2001 (n=24)	2002 (n=162)	2003 (n=197)
Little Grebe	1.3 (12)	1.1 (12)	0.6 (8)	.	0.4 (9)	0.4 (9)
Great Crested Grebe	0.8 (6)	1.0 (9)	.	.	0.9 (14)	0.8 (14)
Cormorant	2.4 (27)	2.7 (29)	2.8 (25)	.	3.0 (34)	2.6 (47)
Grey Heron	5.3 (64)	4.9 (71)	5.3 (70)	3.8 (12)	5.1 (94)	5.7 (119)
Mute Swan	10.3 (41)	7.4 (45)	5.6 (38)	2.5 (8)	7.9 (48)	7.4 (66)
Greylag Goose	7.0 (14)	4.7 (11)	2.5 (12)	.	4.8 (17)	4.5 (25)
Canada Goose	7.6 (35)	7.9 (27)	10.1 (28)	.	8.6 (39)	11.0 (59)
Shelduck	13.4 (11)	9.2 (10)	15.4 (10)	.	6.2 (11)	5.6 (16)
Mandarin	.	.	.	.	.	0.5 (7)
Gadwall	1.3 (7)	0.9 (6)	1.5 (8)	.	1.1 (11)	1.3 (15)
Teal	0.5 (8)	0.4 (6)	0.8 (11)	.	0.5 (7)	1.1 (12)
Mallard	43.0 (92)	43.2 (98)	49.7 (90)	42.6 (16)	45.6 (130)	54.7 (173)
Tufted Duck	6.9 (17)	4.1 (17)	3.4 (17)	4.1 (6)	4.6 (28)	3.7 (30)
Goosander	1.4 (18)	1.2 (14)	1.1 (16)	.	1.6 (27)	1.7 (34)
Sparrowhawk	0.9 (20)	0.5 (16)	0.6 (11)	.	0.9 (24)	1.0 (44)
Buzzard	2.3 (31)	2.4 (43)	2.8 (38)	.	3.3 (62)	3.4 (86)
Kestrel	1.7 (36)	1.3 (28)	1.9 (25)	.	1.4 (46)	1.5 (62)
Red Grouse	.	.	0.3 (6)	.	0.4 (6)	.
Red-legged Partridge	2.2 (16)	2.5 (15)	2.1 (17)	.	1.4 (16)	1.7 (29)
Grey Partridge	1.0 (13)	0.4 (9)	0.9 (12)	.	0.4 (8)	0.4 (10)
Pheasant	8.7 (59)	11.4 (68)	11.2 (65)	10.7 (12)	9.0 (88)	12.5 (123)
Moorhen	9.6 (63)	10.3 (63)	11.3 (60)	12.8 (13)	7.5 (69)	10.0 (96)
Coot	5.8 (30)	7.2 (24)	5.3 (22)	10.9 (10)	5.0 (30)	5.8 (43)
Oystercatcher	7.8 (27)	8.7 (32)	8.1 (27)	8.7 (6)	8.5 (43)	9.7 (63)
Lapwing	21.0 (36)	8.2 (39)	9.1 (37)	20.3 (6)	11.3 (52)	10.5 (65)
Snipe	0.7 (10)	0.6 (12)	0.6 (11)	.	1.7 (20)	1.8 (21)
Curlew	4.4 (26)	5.0 (30)	4.3 (29)	.	4.9 (45)	3.9 (48)
Redshank	1.7 (8)	1.5 (7)	2.0 (12)	.	2.1 (11)	1.6 (17)
Common Sandpiper	5.2 (35)	3.6 (30)	4.1 (35)	3.6 (6)	4.9 (52)	4.2 (52)
Black-headed Gull	32.7 (35)	11.3 (32)	16.8 (37)	14.7 (8)	15.9 (50)	19.0 (59)
Common Gull	4.7 (15)	4.4 (14)	13.5 (14)	.	3.5 (20)	3.3 (25)
Lr Bl-backed Gull	8.8 (23)	5.1 (28)	5.7 (27)	4.3 (7)	3.7 (28)	3.9 (44)

Species	Birds per 10 km (number of stretches occupied)					
	1998 (n=108)	1999 (n=116)	2000 (n=109)	2001 (n=24)	2002 (n=162)	2003 (n=197)
Herring Gull	18.5 (28)	8.2 (28)	9.3 (25)	.	7.2 (37)	9.1 (47)
Gt Bl-backed Gull	.	.	0.9 (6)	.	0.6 (6)	0.5 (16)
Common Tern	1.0 (12)	1.1 (13)	.	.	1.5 (17)	1.6 (23)
Feral Pigeon	14.6 (23)	13.9 (21)	15.2 (24)	37.3 (6)	11.3 (36)	9.2 (39)
Stock Dove	5.4 (31)	8.5 (39)	6.3 (37)	4.4 (7)	3.6 (49)	3.6 (66)
Wood Pigeon	63.9 (90)	76.1 (94)	79.6 (93)	64.2 (16)	72.0 (132)	75.9 (170)
Collared Dove	5.4 (44)	5.8 (45)	7.3 (47)	5.7 (12)	7.6 (62)	5.0 (79)
Turtle Dove	1.2 (9)	1.9 (15)	1.3 (11)	.	1.1 (14)	0.8 (11)
Cuckoo	2.3 (41)	2.4 (37)	2.3 (45)	1.7 (6)	1.5 (43)	1.8 (56)
Barn Owl	.	.	.	.	.	0.2 (7)
Little Owl	0.3 (6)	.	.	.	.	.
Tawny Owl	.	0.2 (6)	0.2 (6)	.	0.1 (9)	0.2 (11)
Swift	30.1 (62)	21.3 (59)	21.6 (55)	13.4 (9)	20.1 (81)	16.9 (90)
Kingfisher	1.9 (30)	1.6 (37)	1.7 (30)	.	1.3 (41)	1.6 (51)
Green Woodpecker	1.9 (29)	1.8 (31)	2.2 (35)	.	1.6 (42)	2.0 (55)
Gt Sp Woodpecker	2.5 (38)	1.3 (32)	1.6 (36)	.	2.6 (64)	2.8 (77)
Skylark	11.3 (57)	10.2 (54)	9.2 (53)	11.8 (12)	7.6 (65)	8.5 (76)
Sand Martin	16.2 (29)	10.7 (32)	16.7 (31)	5.4 (6)	14.1 (46)	12.2 (57)
Swallow	15.7 (74)	18.4 (87)	19.6 (82)	11.7 (16)	18.2 (112)	24.7 (146)
House Martin	14.7 (49)	18.7 (53)	16.2 (52)	7.6 (9)	10.1 (60)	13.5 (101)
Tree Pipit	0.2 (6)	0.8 (11)	0.4 (10)	.	0.3 (9)	0.4 (13)
Meadow Pipit	19.5 (38)	18.8 (42)	19.5 (42)	28.4 (9)	15.5 (59)	17.6 (69)
Yellow Wagtail	2.3 (12)	1.6 (11)	1.9 (10)	.	0.9 (14)	0.9 (17)
Grey Wagtail	3.6 (42)	5.2 (63)	5.6 (57)	2.5 (7)	7.2 (91)	6.8 (114)
Pied Wagtail	6.2 (64)	6.4 (63)	6.4 (70)	4.8 (14)	6.2 (97)	7.9 (122)
Dipper	3.3 (39)	2.8 (42)	3.1 (44)	.	4.6 (63)	4.8 (81)
Wren	37.8 (88)	44.0 (101)	46.6 (95)	23.8 (17)	47.7 (138)	49.1 (178)
Dunnock	8.2 (64)	6.8 (71)	7.4 (68)	6.3 (12)	8.2 (91)	9.8 (130)
Robin	18.2 (78)	20.2 (93)	22.1 (92)	11.4 (17)	21.6 (129)	24.2 (172)
Redstart	1.0 (11)	1.0 (12)	0.9 (13)	.	1.1 (18)	1.2 (28)
Whinchat	0.7 (11)	0.8 (11)	1.2 (11)	.	0.6 (11)	0.2 (8)
Stonechat	.	0.4 (6)	1.0 (10)	.	1.4 (15)	0.9 (15)
Wheatear	2.3 (16)	1.9 (21)	1.6 (10)	.	1.4 (23)	1.8 (27)
Ring Ouzel	.	.	.	.	0.3 (6)	0.2 (6)
Blackbird	32.8 (86)	31.7 (95)	40.6 (91)	25.2 (17)	37.7 (129)	43.5 (169)
Fieldfare	.	.	.	.	.	6.2 (12)
Song Thrush	10.5 (74)	11.0 (80)	11.7 (84)	5.9 (14)	15.1 (122)	14.8 (155)

Species	Birds per 10 km (number of stretches occupied)					
	1998 (n=108)	1999 (n=116)	2000 (n=109)	2001 (n=24)	2002 (n=162)	2003 (n=197)
Mistle Thrush	4.9 (49)	5.3 (57)	4.8 (56)	4.8 (8)	4.7 (77)	4.7 (99)
Grasshopper Warbler	.	.	.	.	0.3 (10)	0.3 (11)
Sedge Warbler	6.6 (32)	7.4 (37)	9.8 (42)	13.5 (12)	8.7 (53)	7.7 (60)
Reed Warbler	7.3 (23)	8.8 (24)	9.0 (23)	12.9 (9)	6.2 (29)	6.0 (35)
Lesser Whitethroat	0.9 (12)	0.4 (7)	0.5 (8)	.	0.5 (14)	0.4 (16)
Whitethroat	7.5 (50)	7.7 (44)	8.0 (53)	10.1 (11)	8.8 (70)	8.6 (79)
Garden Warbler	2.7 (35)	2.8 (39)	2.6 (32)	.	2.0 (43)	2.4 (60)
Blackcap	10.8 (61)	8.8 (66)	9.8 (67)	4.1 (7)	10.1 (87)	9.2 (116)
Wood Warbler	.	.	0.5 (7)	.	0.6 (10)	0.4 (13)
Chiffchaff	8.1 (56)	4.9 (53)	6.1 (47)	.	7.3 (76)	10.5 (112)
Willow Warbler	16.0 (79)	15.4 (88)	14.1 (72)	12.5 (13)	15.2 (99)	15.0 (127)
Goldcrest	2.2 (30)	3.4 (36)	4.5 (44)	.	3.5 (47)	4.0 (79)
Spotted Flycatcher	1.4 (21)	1.6 (28)	2.1 (29)	.	1.3 (23)	2.5 (50)
Pied Flycatcher	.	.	.	.	0.6 (7)	0.9 (11)
Long-tailed Tit	6.6 (53)	8.2 (56)	7.7 (51)	1.7 (6)	7.1 (74)	9.3 (103)
Marsh Tit	0.5 (10)	0.5 (11)	0.7 (11)	.	0.3 (13)	0.5 (13)
Willow Tit	0.5 (9)	0.2 (6)	.	.	.	0.2 (7)
Coal Tit	2.4 (25)	3.4 (33)	2.5 (32)	.	4.5 (61)	4.7 (75)
Blue Tit	30.7 (85)	23.6 (91)	27.1 (88)	11.3 (13)	29.2 (125)	35.4 (165)
Great Tit	18.2 (83)	13.3 (87)	14.6 (86)	4.6 (10)	16.1 (117)	18.9 (155)
Nuthatch	0.9 (18)	1.7 (23)	1.5 (21)	.	1.2 (26)	2.6 (43)
Treecreeper	1.6 (29)	2.2 (39)	1.9 (30)	.	2.0 (54)	2.1 (57)
Jay	2.3 (28)	1.9 (32)	1.7 (30)	.	1.5 (29)	1.8 (54)
Magpie	11.1 (67)	12.1 (74)	10.5 (68)	9.3 (11)	11.4 (88)	10.9 (113)
Jackdaw	23.0 (57)	26.4 (60)	24.6 (64)	15.5 (9)	24.7 (87)	32.1 (117)
Rook	57.3 (57)	71.0 (59)	49.9 (53)	.	38.2 (69)	39.0 (93)
Carrion Crow	32.2 (89)	31.0 (92)	33.0 (89)	14.8 (16)	36.0 (132)	36.7 (167)
Hooded Crow	0.6 (8)	0.9 (12)	0.6 (9)	.	0.4 (14)	1.0 (13)
Raven	0.5 (9)	0.8 (13)	0.7 (16)	.	1.3 (20)	0.8 (20)
Starling	64.8 (66)	60.5 (72)	54.7 (75)	60.7 (14)	50.8 (96)	35.5 (114)
House Sparrow	10.7 (46)	11.0 (47)	14.0 (50)	20.0 (11)	12.2 (57)	16.6 (89)
Tree Sparrow	.	.	1.0 (6)	.	1.4 (12)	1.0 (11)
Chaffinch	38.8 (94)	39.7 (101)	41.2 (98)	21.5 (17)	41.8 (142)	47.6 (177)
Greenfinch	9.0 (59)	8.5 (61)	9.7 (60)	10.0 (13)	10.5 (93)	12.9 (113)
Goldfinch	9.4 (56)	8.4 (62)	10.1 (68)	8.7 (13)	9.4 (91)	11.7 (113)
Siskin	0.8 (10)	1.1 (10)	0.9 (11)	.	1.3 (16)	0.9 (19)
Linnet	6.9 (28)	8.8 (38)	7.1 (30)	7.2 (13)	6.3 (50)	6.2 (55)

Species	Birds per 10 km (number of stretches occupied)					
	1998 (n=108)	1999 (n=116)	2000 (n=109)	2001 (n=24)	2002 (n=162)	2003 (n=197)
Lesser Redpoll	0.4 (7)	.	0.3 (6)	.	1.1 (11)	0.8 (13)
Bullfinch	1.5 (24)	1.1 (22)	0.8 (18)	.	2.6 (46)	2.8 (61)
Yellowhammer	3.8 (36)	4.1 (38)	3.7 (38)	2.2 (8)	3.5 (40)	3.2 (54)
Reed Bunting	5.1 (45)	5.3 (42)	4.2 (40)	6.5 (11)	5.0 (52)	5.4 (66)
Corn Bunting	0.8 (7)	.	1.0 (7)	.	0.4 (6)	0.4 (8)

3.3 WBBS estimates of population change, 2002–03

The unexpectedly poor coverage in 2001, through FMD, reduced the samples available for estimating population changes between 2000 and 2001, and between 2001 and 2002, but a full sample is again available for the two most recent WBBS seasons. The data are presented in Table 3.

Results for random and WBS-linked stretches are tabulated separately, because of the differences between these two parts of the WBBS sample.

Mean counts per 500-m stretch have been multiplied by 20 and expressed as birds per 10 km. Means in Table 3 are designed to be comparable between years, within each paired sample, and not between species or between samples. These values tend to be higher than the overall figures in Table 2, because the means in Table 3 are drawn only from those stretches where the species was present in at least one of the two years, rather than from all stretches (including those where the species was absent), as in Table 2.

The random sites recorded 46 species that increased and 25 that decreased, and the WBS-related stretches recorded 24 that increased and 15 that decreased. These changes compound the general increase noted in 2001–02 (Marchant & Noble 2003), thus reversing the preponderance of decreases noted in the 2000–01 comparison (Marchant *et al.* 2002b). Relatively poor coverage in some surveys conducted in 2001 may be partly responsible for this pattern.

Table 3 **Percentage changes in population between 2002 and 2003 as estimated from WBBS data. Results from random stretches and WBS-linked stretches are shown separately. Mean counts are drawn only from sites paired between years, and do not include sites where the species was absent. No data are presented where the sample of sites providing data in both years was <30.**

Species	Mean count per 10 km (random sites)		2002–03 change (random sites)	Number of paired sites (random)	Mean count per 10 km (WBS-linked sites)		2002–03 change (WBS-linked sites)	Number of paired sites (WBS-linked)
	2002	2003			2002	2003		
Cormorant	11.2	8.8	-22%	43	.	.	.	.
Grey Heron	7.4	7.2	-3%	92	7.1	9.9	+40%	51
Mute Swan	25.0	23.5	-6%	44	14.5	12.0	-17%	35
Canada Goose	25.1	23.6	-6%	52	.	.	.	.
Mallard	52.9	55.4	+5%	118	74.9	83.0	+11%	56
Goosander	7.4	6.3	-16%	30	.	.	.	.
Sparrowhawk	2.5	3.0	+22%	40	.	.	.	.
Buzzard	5.3	6.3	+20%	66	.	.	.	.
Kestrel	3.1	3.4	+10%	58	.	.	.	.
Pheasant	14.2	19.4	+37%	89	10.1	12.6	+24%	43
Moorhen	14.9	18.8	+26%	73	20.7	22.0	+7%	48
Coot	21.9	23.9	+9%	33	.	.	.	.
Oystercatcher	24.4	31.0	+27%	43	.	.	.	.
Lapwing	27.0	29.1	+8%	56	.	.	.	.
Curlew	11.8	10.7	-10%	44	.	.	.	.
Common Sandpiper	12.7	11.4	-10%	47	.	.	.	.
Black-headed Gull	40.6	54.0	+33%	60	40.1	22.2	-45%	32
Lr Black-backed Gull	13.0	13.4	+3%	41	.	.	.	.
Herring Gull	24.4	19.3	-21%	43	.	.	.	.
Feral Pigeon	38.8	36.0	-7%	40	.	.	.	.
Stock Dove	8.4	9.0	+7%	61	.	.	.	.
Woodpigeon	89.6	91.6	+2%	111	70.9	72.2	+2%	55
Collared Dove	14.8	10.8	-27%	65	10.1	8.2	-19%	42
Cuckoo	3.9	5.0	+27%	50	.	.	.	.
Swift	37.4	34.4	-8%	81	34.0	24.5	-28%	38
Kingfisher	3.5	3.8	+11%	53	3.3	4.1	+23%	30
Green Woodpecker	4.7	6.4	+36%	48	.	.	.	.
Gt Sp Woodpecker	4.9	5.6	+14%	70	3.6	4.1	+13%	36
Skylark	17.0	19.5	+14%	61	.	.	.	.
Sand Martin	41.0	23.5	-43%	53	.	.	.	.
Swallow	22.8	24.1	+5%	105	20.8	18.6	-11%	47
House Martin	18.0	22.2	+23%	77	18.9	14.3	-25%	33
Meadow Pipit	35.9	41.8	+16%	55	.	.	.	.
Grey Wagtail	9.5	9.2	-3%	92	8.0	9.8	+22%	34

Species	Mean count per 10 km (random sites)		2002–03 change (random sites)	Number of paired sites (random)	Mean count per 10 km (WBS-linked sites)		2002–03 change (WBS-linked sites)	Number of paired sites (WBS-linked)
	2002	2003			2002	2003		
Pied Wagtail	8.5	9.5	+12%	99	5.6	9.0	+61%	42
Dipper	9.7	8.9	-9%	58	.	.	.	.
Wren	52.8	58.6	+11%	118	49.9	49.4	-1%	55
Dunnock	12.1	13.2	+9%	97	9.2	11.8	+29%	54
Robin	23.8	26.2	+10%	116	23.8	27.6	+16%	55
Blackbird	44.8	51.8	+16%	110	42.2	46.3	+10%	56
Song Thrush	18.6	17.2	-7%	111	11.0	12.0	+9%	53
Mistle Thrush	6.5	7.0	+7%	86	5.1	4.8	-6%	42
Sedge Warbler	24.2	21.8	-10%	46	19.3	17.9	-7%	31
Reed Warbler	32.3	29.5	-9%	30	.	.	.	.
Whitethroat	20.0	18.4	-8%	68	10.5	10.3	-2%	41
Garden Warbler	4.9	6.2	+28%	54	4.7	4.7	no change	32
Blackcap	14.3	13.8	-4%	93	11.9	10.9	-8%	47
Chiffchaff	13.2	18.5	+40%	77	9.6	13.6	+42%	44
Willow Warbler	21.4	19.6	-8%	91	13.8	13.3	-4%	46
Goldcrest	6.1	7.9	+30%	66	.	.	.	.
Spotted Flycatcher	3.5	8.1	+135%	41	.	.	.	.
Long-tailed Tit	12.3	13.0	+6%	81	8.3	9.0	+8%	45
Coal Tit	7.2	9.3	+29%	63	.	.	.	.
Blue Tit	33.7	42.4	+26%	111	29.2	37.1	+27%	56
Great Tit	20.8	23.0	+11%	106	20.3	20.2	-1%	56
Nuthatch	4.8	9.0	+89%	31	.	.	.	.
Treecreeper	4.6	5.1	+12%	55	.	.	.	.
Jay	4.2	4.4	+4%	48	.	.	.	.
Magpie	17.5	17.4	-1%	84	15.8	17.4	+10%	51
Jackdaw	37.2	47.4	+27%	85	35.9	37.1	+4%	49
Rook	70.2	65.4	-7%	77	39.9	113.1	+183%	37
Carrion Crow	41.0	41.8	+2%	114	34.2	42.2	+23%	55
Starling	80.7	55.9	-31%	89	38.5	30.3	-21%	48
House Sparrow	24.7	31.6	+28%	64	22.8	21.3	-7%	43
Chaffinch	46.9	52.7	+12%	118	41.6	45.0	+8%	56
Greenfinch	16.2	19.1	+18%	90	13.4	14.9	+11%	50
Goldfinch	13.7	16.0	+17%	92	11.8	12.5	+6%	46
Linnet	19.4	15.2	-21%	51	.	.	.	.
Bullfinch	6.4	7.6	+19%	56	.	.	.	.
Yellowhammer	12.2	7.5	-38%	45	.	.	.	.
Reed Bunting	10.6	11.6	+10%	55	8.6	12.5	+45%	34

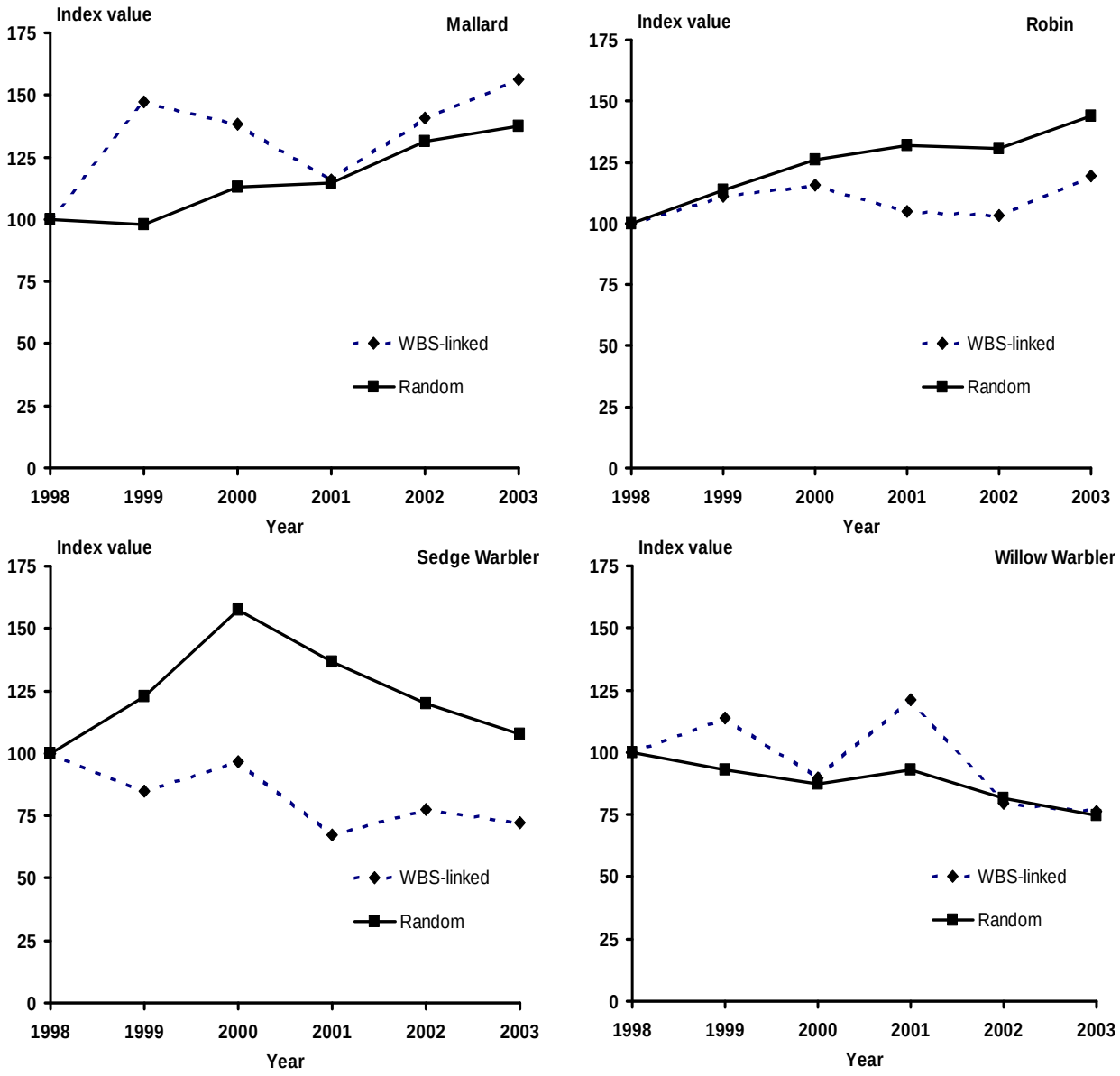

Figure 4 **Comparison of trends 1998–2003 for four species between random and WBS-linked WBBS samples, using a simple chain index.**

Individual estimates correspond relatively well between the two classes of stretches. Of the 40 species for which both estimates were calculated, estimates for only 13 species had different signs. Nineteen of the remaining 27 species showed increases on both samples of stretches, whereas eight species decreased on both.

Figure 4 shows comparisons of longer-term trends between samples for four selected species, as a preliminary exploration of long-term trends from WBBS. Chance fluctuations are to be expected in these indices because of measurement error, and variation between sites, and in a chain index these affect subsequent index values. Nevertheless, these trends show appreciable similarity between the two parts of the WBBS sample, and are in line with more rigorous trend calculations from CBC/BBS and WBS (Crick *et al.* 2004).

3.4 Data collection for mammals

The mammal data recorded by WBBS observers are always likely to be minimum figures, because mammal recording is secondary to the main tasks of recording birds and habitat, and in general is not systematic. Nevertheless, since mammals are generally an under-recorded group in the UK, any monitoring data, especially from random sites, are valuable.

Across the 261 WBBS returns for 2003, mammal forms were completed and returned for 221 (85%). Mammal recording was therefore well supported by WBBS volunteers, as in 1998–2002. Of these 221 returns, 19 reported that no mammals had been observed, leaving 202 sites from which mammals had been recorded.

In all, 30 mammal species were recorded (Table 4). Those found most frequently were diurnal species, such as Rabbit and Grey Squirrel, or ones that left obvious signs of presence, such as Mole. Half the sites recorded four or fewer species. Ten stretches recorded ten or more mammal species; the maximum was 14 at two sites. By far the most numerous mammals seen were Rabbit and Red Deer.

Of specialist waterway mammals, Otters were found on 14% of stretches in 2003 (15% in 1998, 11% in 1999, 13% in 2000, just 2% in 2001, and 15% in 2002), Water Vole on 7% (9% in 1998, 16% in 1999, 12% in 2000, 19% in 2001, 12% in 2002), and American Mink on 15% (8% in 1998, 21% in 1999 and 2000, 14% in 2001, 10% in 2002). None of these simple series shows any obvious trend.

A long-term WBBS data set would be needed to detect changes in numbers or distribution of mammals. It is not immediately clear whether any conclusions can be drawn from the data collected so far.

Table 4 **Mammals recorded on all WBBS stretches reporting mammal data in 2003 (n=221). Species are ranked according to the number of stretches they occupied. The number of animals counted is the sum of early and late counts across all occupied stretches.**

Species	Animals counted	Number of occupied stretches	% of stretches occupied
Rabbit	2355	149	67%
Mole	4	109	49%
Grey Squirrel	198	99	45%
Red Fox	17	88	40%
Brown Hare	162	62	28%
Roe Deer	72	52	24%
Feral/domestic cat	45	52	24%
Badger	0	41	19%
American Mink	0	33	15%
Hedgehog	3	31	14%
Stoat	5	31	14%
Otter	0	31	14%
Brown Rat	7	19	9%
Weasel	0	19	9%
Red Deer	873	18	8%
Water Vole	3	15	7%
Muntjac Deer	1	8	4%
Mountain Hare	2	7	3%
Red Squirrel	0	7	3%
Fallow Deer	9	6	3%
Common Shrew	2	5	2%
Water Shrew	0	2	1%
Wood Mouse	1	2	1%
Feral Goat	22	2	1%
Field Vole	0	1	0%
Pine Marten	0	1	0%

3.5 Coverage and results from WBS in 2003

In all 82 WBS mapping surveys were conducted in 2003 and returned to HQ in time for this analysis. This represents a continuation of the welcome return to fieldwork by the majority of observers after an enforced break for many in 2001 due to FMD. Even allowing for the expected arrival of a small number of late submissions, however, the 2003 total compares rather poorly with the 121 surveys for 1998, 105 for 1999, 97 for 2000, and 91 for 2002. A decrease in WBS participation could have been expected, following the launch of WBBS in 1998. Attempts are being made, however, to halt or reverse the slow decline in the WBS sample. An encouraging sign is that as many as 16 sites have been registered for new WBS coverage in 2004. Despite the fall in the WBS sample, the number of WBS-linked WBBS surveys has hardly changed since 1999 (Table 1).

Of the 82 WBS mapping surveys for which 2003 data were available, there were comparable data from 2002 for 73 plots (Table 5).

Table 5 A summary of the 73 WBS plots providing data on population change for 2002–03.

Category	No. of plots	Mean length (km)	Total length (km)
All paired plots	73	4.5	328.7
Changes since 2001–02 comparison			
Plots gained	46	4.6	210.2
Plots lost	6	4.2	25.2
Regional distribution			
Eastern England	11	4.7	51.6
Northern England	22	4.6	100.5
Southern England	11	4.4	48.3
Western England	18	4.4	78.5
Scotland	8	4.6	36.9
Wales	3	4.3	12.9
Distribution by waterway type			
Canal	22	4.3	94.8
Mixed canal/river	2	3.2	6.4
Slow river	27	4.5	121.7
Fast river	21	4.9	102.2
Other	1	3.6	3.6

Table 6 **WBS estimates of population change for 2002–03, drawn from 73 plots in total for which comparable data were received for both years. No estimates are given where the number of contributing plots was less than 10. An asterisk indicates percentage changes that were significant at the 95% level.**

Species	Territory total 2001	Territory total 2002	% change	Number of contributing plots
Little Grebe	9	8		5
Mute Swan	77	80	+4%	45
Greylag Goose	37	43	+16%	13
Canada Goose	133	146	+10%	34
Mallard	1802	1903	+6%	73
Tufted Duck	57	60	+5%	15
Goosander	51	61	+20%*	25
Moorhen	523	568	+9%*	64
Coot	200	205	+3%	33
Oystercatcher	232	218	-6%	24
Lapwing	181	195	+8%	33
Curlew	54	54	no change	17
Redshank	55	68	+24%*	10
Common Sandpiper	101	90	-11%	18
Kingfisher	49	43	-12%	38
Sand Martin	1734	1060	-39%*	17
Dipper	83	88	+6%	29
Reed Warbler	222	238	+7%	21
Sedge Warbler	302	274	-9%	35
Whitethroat	213	198	-7%	44
Pied Wagtail	163	186	+14%*	53
Grey Wagtail	132	159	+20%*	48
Yellow Wagtail	8	8		6
Reed Bunting	210	217	+3%	42

The 22 population changes presented in Table 6 include 15 increases and six decreases. Six changes were statistically significant: Redshank, Goosander, Grey Wagtail, Pied Wagtail and Moorhen increased, and Sand Martins decreased substantially. It should be noted that the information for Redshank is based on a very small sample of sites.

There is good agreement between the changes that were significant on WBS plots and those derived from WBBS (Table 3), although Goosander and Grey Wagtail both decreased in the random WBBS sample, and no population change data are provided for Redshank from WBBS.

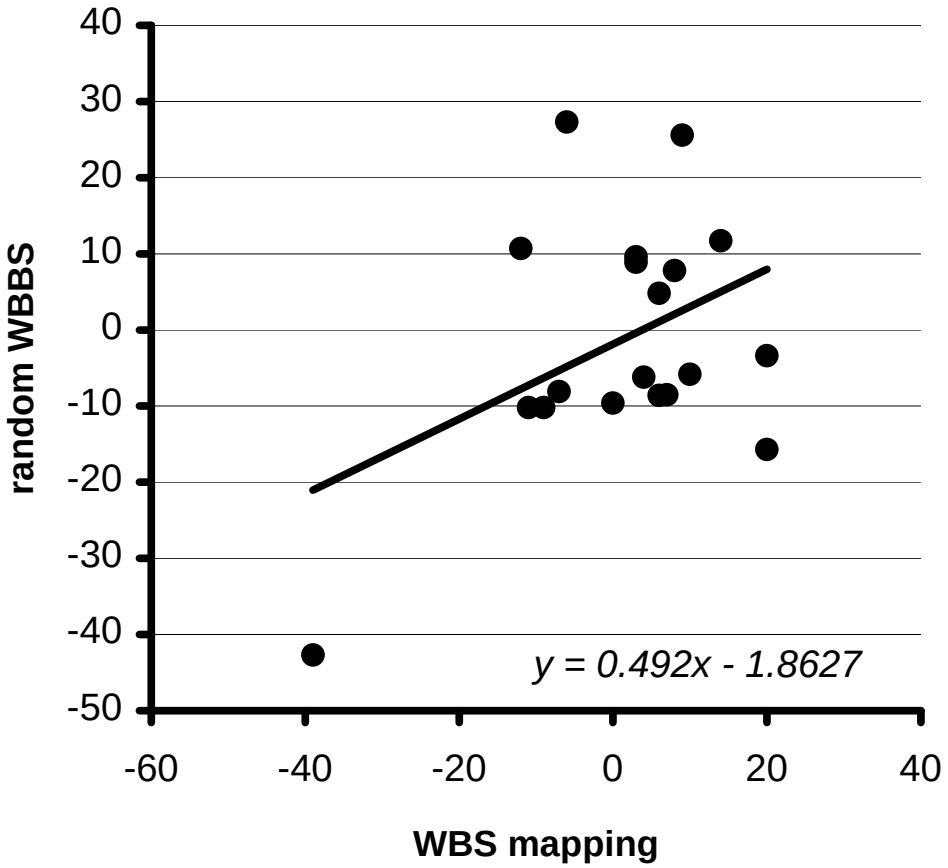

Figure 5

Scatter diagram of percentage changes for 2002–03 derived from random WBBS sites and from WBS mapping (n=19 waterbird species).

Taking all 19 species for which percentage change estimates for 2002–03 are available from both the random WBBS and WBS mapping, the scatter of points is centred close to the origin of the graph (Figure 5). A linear regression through the points shows a tiny intercept value, but a slope of around 0.5. Perfect agreement would have not only a small intercept but a slope close to unity.

Given that there is uncertainty about each the location of each point, and that only five of the points have WBS changes that are significantly different from zero (Table 6), the comparison is encouraging. It should be borne in mind that these two samples are completely independent, involving different survey methods, sites and observers. The slope as calculated depends heavily on the small number of species that showed a strong population change in 2003, notably Sand Martin which decreased by about 40% in both samples.

Comparison of longer-term trends from WBBS and WBS, ideally from an overlap period of more than seven years between the two schemes, will be more informative than considering a single pair of years in isolation.

4 DISCUSSION

4.1 Numbers of WBBS stretches surveyed

The main aim of Phase 3 of WBBS development has been to increase the number of stretches surveyed annually to around double that achieved during Phase 2. To facilitate this, a second batch of randomly selected sites was made available to observers in preparation for the 2002 field season. The successive increases in surveys in 2002 and 2003 (Table 1) show that BTO has been able to find new volunteers to become involved in WBBS surveying and to pursue that involvement long term. A projection of the rate of increase suggests that a total of surveys close to 300 should be achievable by 2004, the final season of Phase 3. This number would represent approximately a doubling of the number of random stretches surveyed in the peak year of Phase 2 (116 in 1999), augmented by a roughly stable sample of around 65 surveys from non-random, WBS-linked stretches.

The density of distribution of the randomly selected stretches offered to observers (Figure 2) is high in landscapes with a large number of watercourses and relatively low in lowland and coastal areas. This has arisen because of the use of grid squares rather than waterway lengths as the basic unit for site selection, and because no stratification was employed in designing the sample. The effect has been that many sites are located in remote areas of the UK, such as Northern Ireland and the northwest of Scotland, where potential volunteers are very few and mostly already fully occupied with other BTO surveys, and rather few in many parts of lowland England. In several English counties, the WBBS regional organiser has asked for more stretches to be added to the random sample, because there are more volunteers than stretches available, and making more selections would quickly lead to more surveys being conducted.

The present sampling design has therefore made the task of increasing the number of surveys more difficult than would be the case with a stratified sample. A redesign of the WBBS sample, to include more sites in lowland England and withdraw some unsurveyed sites from upland UK regions, would undoubtedly allow more observers to take part and increase the number of surveys annually. A further benefit might be to increase the proportion of the random sample for which observers can be found: at present, it has been difficult to achieve even 40% cover of these stretches, allowing some subjectivity among volunteers in choosing which among the random stretches are actually surveyed.

Ideally, the basis of site selection would be a linear database of UK waterways, thus avoiding the possibility of over-sampling in areas where there are many watercourses. Because of the lack of such a database, and because of the complications of adding to the sample at this stage, the sample of random stretches remains unchanged for the 2004 season. Further efforts are being made to increase the number of random sites to be covered in 2004.

4.2 Conclusions from fieldwork and results for 2003

There were 109 species for which density estimates were available from at least six sites (Table 2). For about 60% of these, the numbers of birds counted per 10 km in 2003 were within the ranges that had already been established in 1998–2002. For a substantial number of species (about 30%), however, the average density was somewhat higher than recorded previously. These species included Canada Goose, Mallard, Goosander, Buzzard, Great Spotted Woodpecker, Chiffchaff and Nuthatch, all of which have increased during recent years according to other monitoring data collated by BTO (Crick *et al.* 2004). The remaining species, for which

the 2003 density estimate was lower than recorded previously, included Turtle Dove and Starling which are known to have undergone widespread decline.

The tentative conclusion from the generally higher mean densities recorded is that birds were generally more abundant along waterways in 2003 than in recent years. The paired counts between 2002 and 2003 (Table 3) tend to confirm that most species were more abundant in 2003. Density figures are not a good indication of population change, however, owing to the changes in the constitution of the sample: in particular, there has been overall growth in the random section of the WBBS sample, and the number of surveys in 2001 was much reduced.

4.3 Potential of long-term monitoring data from WBBS

The analyses presented in this report, relating to average densities during 1998–2003 (Table 2) and to paired counts for 2002 and 2003 (Table 3) do not indicate the full potential of WBBS for population monitoring. A modelling approach, as is used to derive trends from BBS data (see Crick *et al.* 2004), would make the most efficient use of the data but has yet to be applied to WBBS.

A measure of the potential of WBBS for long-term monitoring of population changes for a bird species is the number of sites that hold that species. The larger the sample of sites, the narrower will be the confidence interval around the estimates of population change, although the width of the confidence interval will also be influenced heavily by the abundance of the species within sites and also by various features of its biology, such as its tendency to occur in flocks. A full appraisal of WBBS monitoring, including the calculation of confidence intervals, is not within the scope of the present report. This will be a part of the final report from Phase 3.

The sample sizes given in Table 2 indicate how the growth in the sample has increased the number of species for which WBBS is likely to be producing sufficient data for population monitoring. This aspect of the results is summarised in Table 7, for three example years. BBS experience indicates that, as a general rule, a minimum of 40 sites is likely to provide an acceptable confidence interval for monitoring purposes (Joys *et al.* 2003). The same rule is applied here to WBBS data. WBBS transects are on average about 63% greater in length than BBS transects, however, and run through a habitat generally richer in birds. Since Joys *et al.* (2003) found that an increase in the mean count of birds per site would increase the power for measuring change, it may be the case that fewer WBBS sites than BBS's 40 would provide adequate monitoring precision. Moreover, the fact that WBBS sites are all of similar habitat type should reduce the variance in the data, with respect to BBS sites, and so increase the power to detect population change.

Table 7 indicates that, at the higher level of coverage achieved in 2003, the random WBBS plots alone could provide adequate monitoring samples for at least 68 species in the waterside habitat, including 22 waterbirds. For non-waterbirds, the data collected are not likely to be representative of the UK population of that species as a whole but do represent population changes in WBBS habitats: comparison of WBBS population indices with BBS indices for other habitat groupings would be valuable, indicating whether populations are faring differently in different habitats.

Table 7 **Numbers of species in various categories of sample size on WBBS random sites in 2000, 2002 and 2003. Waterbirds are defined as those species included on WBS mapping surveys, including waterfowl, waders, gulls, Kingfisher, and various waterside passerines.**

Sample size (sites)	2000			2002			2003		
	Water-birds	Others	Total	Water-birds	Others	Total	Water-birds	Others	Total
26–40 sites	11	11	**22**	8	4	**12**	3	4	**7**
41–100 sites	8	31	**39**	16	31	**47**	18	24	**42**
>100 sites	0	0	**0**	1	10	**11**	4	22	**26**
Total species with >40 sites	8	31	**39**	17	41	**58**	22	46	**68**

Where sample sizes are not adequate for stand-alone WBBS monitoring, the potential exists for combining WBBS and BBS data to form joint indices designed to represent the UK population as a whole. This may be especially valuable for waterside specialist species for which WBBS samples are as large or larger than those available from BBS alone.

The sample sizes from random sites could be boosted substantially by the inclusion of the non-random WBS-linked sites. To assess whether monitoring data from the random and WBS-linked WBBS samples can be combined, and to compare monitoring results between the long-running WBS and WBBS, it would be ideal to have seven years of overlap between WBS and WBBS, as were available for comparing the BBS to the CBC (Freeman *et al.* 2002). The 2003 season was only the fourth such season, excluding 2001 when both surveys produced smaller and geographically limited sets of data.

The contribution WBBS could make to UK bird population monitoring is twofold. First, it would provide monitoring for a suite of waterside specialist species that are relatively infrequently encountered on BBS surveys. The wide range of species monitored by BBS could be supplemented by WBBS data for species such as Dipper, Kingfisher, Common Sandpiper, Sand Martin and Goosander, for which the WBBS sampling design is most effective. By adding extra species to the BBS list, or replacing BBS data with relatively poor precision, WBBS would contribute to monitoring of birds at UK and regional scales. Current outputs from such monitoring include the BTO's annual report on Birds of the Wider Countryside, distributed worldwide through the Internet (Crick *et al.* 2004), and the cross-species indicators that inform the government's biodiversity strategy. The data would also aid the next revision of UK bird conservation status, due in 2008 (Gregory *et al.* 2002). Second, WBBS could provide indices

specific to the waterside habitat for birds that are also found in other habitats. BBS is already able to provide separate indices for species such as Blackbird in various divisions of its habitat, such as classes of farmland and woodland. Addition of a WBBS index would provide a broader comparison of trends in different habitat types than is possible with BBS alone. Such indices are not possible through WBS, because that scheme monitors waterbirds only.

WBBS collected a substantial amount of mammal information in 2003 (Table 4), as in previous years. This may prove to be of value as local faunistic records, since these are much scarcer for mammals than for birds, or for mammal monitoring, perhaps in conjunction with other BTO schemes that collect mammal information. In this context, the WBBS data may be of particular value for waterside species such as Otter, Water Vole and American Mink. The potential for using WBBS data to help monitor UK mammal populations is being explored through JNCC's Tracking Mammals Partnership.

ACKNOWLEDGEMENTS

The launch of WBBS was funded in collaboration with the Environment Agency's R & D programme. We also acknowledge the financial support of Anglian Water, British Waterways, Northumbrian Water, Essex & Suffolk Water, Severn Trent Water, Thames Water and Welsh Water. BBS is funded jointly by the BTO, JNCC (on behalf of English Nature, Scottish Natural Heritage, the Countryside Council for Wales and the Environment and Heritage Service in Northern Ireland), and the RSPB.

The BTO's work relies heavily on volunteers. We are very grateful to all observers who have contributed WBBS or WBS data, and to the BTO's Regional Representatives and others who assisted with finding volunteers and forwarding paperwork.

We acknowledge the help of the following Environment Agency staff during the course of this project (since 1998): Geraldine Daly, Alastair Driver, Kevin Hall, Andrew Heaton, Marc Naura, Helena Parsons, Paul Raven, Martin Smalls, Adrian Taylor and Mark White. Steve Ormerod of the School of Biosciences at Cardiff University has also provided valuable advice and guidance. At BTO HQ in Thetford, Peter Beaven, Nick Carter, the late Jackie Coker, Steve Freeman, Richard Gregory, Vivien Hiom, Dave Leech, David Noble, Angela Rickard, Sam Rider, Fiona Sanderson, Susan Waghorn and Jane Waters have all assisted at various stages of the project. David Noble provided comments on the first draft of this report. Host Direct Ltd of Watford input the bulk of the WBBS data from the observers' field sheets.

Figures 2 & 3 were produced using the program DMAP, with thanks to Alan Morton.

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Appendix 1 Waterway stretches covered by WBBS 1998–2003, ordered by nominal 1-km grid square, together with the limiting grid references in the most recent survey, number of 500-metre sections covered in each year of coverage and the class of survey (random, WBS-linked, or other).

Nominal 1-km reference	Waterway name	Start and end grid references		Number of 500-m sections surveyed, 1998–2003					
Random sites				**98**	**99**	**00**	**01**	**02**	**03**
H3078	Fairy Water	H304800	H325780	–	–	–	–	6	–
H4050	Many Burns River	H381495	H504513	–	6	–	–	–	–
H5688	Glenlark River	H574871	H592889	–	6	6	–	6	–
H6680	Ballinderry River	unknown	unknown	–	3	–	–	–	–
H7672	Rock River	H765724	unknown	–	–	–	–	–	5
NC2634	Maldie Burn	NC252352	NC239340	4	4	4	–	4	–
NC3422	River Cassley	NC344225	NC368203	6	6	–	–	6	–
NC5810	Allt Chaiseagail	NC572106	NC582105	–	–	–	–	2	–
ND0258	Forss Water	ND033613	ND036595	–	–	–	–	3	–
ND1056	River Thurso	ND128586	ND118568	–	–	–	–	7	4
ND1628	Dunbeath Water	ND163296	ND143308	–	–	–	5	5	5
NG1846	Hamra River	NG187480	NG199463	–	4	4	–	–	–
NG3230	River Talisker/Sleadale Burn	NG324302	NG315305	–	–	–	–	–	2
NG3444	Allt Ruairidh/River Ose	NG345428	NG345456	–	–	–	–	–	5
NG4454	River Romesdal	NG440543	NG455547	–	–	10	–	–	5
NG9406	Allt Coire Sgoireadail	NG952068	NG974088	–	8	8	8	8	8
NG9804	Allt Coire nan Eiricheallach	NG998032	NG993055	5	5	5	5	5	5
NH1264	Abhainn Srath Chrombuill	NH142642	NH102642	–	–	–	8	–	–
NH1428	Allt a' Choire Dhomhain	NH144269	NH156302	6	–	–	–	–	–
NH2636	River Farrar	NH267376	NH239387	–	–	–	–	10	10
NH3648	Allt Cam Ban	NH362497	NH357500	2	1	1	–	1	2
NH4844	River Beauly	NH497442	NH468423	–	–	–	–	9	–
NH5242	River Beauly	NH517445	NH497442	–	–	–	–	9	9
NH6476	Strathrory River	NH660776	NH640773	–	–	–	–	–	4
NH6614	River Findhorn	NH705170	NH665140	10	10	10	–	10	10
NH6632	River Nairn	NH684340	NH674322	10	10	10	–	10	10
NH6644	River Ness (non-tidal part)	NH664444	NH642413	5	8	8	–	10	10
NH7218	River Findhorn	NH736200	NH705170	–	–	–	–	10	10
NH9200	Am Beanaidh	NH923039	NN917999	–	10	10	–	10	10
NJ3416	Water of Buchat	NJ323189	NJ393157	–	10	–	–	–	–
NK0446	South Ugie Water	NK015472	NK056485	–	9	–	–	–	–
NM3496	Abhainn Rangail	NM342954	NM374964	–	–	–	–	–	7
NM9440	Dearg Abhainn	NM955420	NM967404	–	–	–	–	–	3
NM9478	Dubh Lighe	NM966787	NM932799	–	6	9	–	9	–
NN0096	River Kingie	NN042978	NN000964	10	10	10	10	10	10
NN0686	Allt a' Cham Dhoire	NN040863	NN064873	6	–	–	–	–	–
NN1030	Allt Coire Chreachainn/Allt Mhoille	NN109317	NN105304	–	–	–	–	–	10
NN1620	Allt an Stacain	NN153213	NN162218	–	4	–	–	–	–

Nominal 1-km reference	Waterway name	Start and end grid references		Number of 500-m sections surveyed, 1998–2003					
NN2082	River Spean	NN183837	NN208814	9	9	–	–	–	–
NN2602	Croe Water	NN274019	NN242034	–	–	–	–	–	10
NN3872	Allt Feith Thuill	NN400731	NN372711	3	7	7	–	7	–
NN4488	Allt Coire Ardair	NN466887	NN440883	6	6	6	–	6	6
NN4888	Allt a' Chrannaig	NN484872	NN488885	3	3	3	–	3	3
NN5630	River Dochart	NN567321	NN537302	–	–	–	–	8	8
NN6094	River Spey	NN640941	NN596938	10	10	10	–	–	–
NN6884	Unnamed, feeds into aqueduct	NN687855	NN681870	3	–	–	–	–	–
NN7296	Milton Burn	NN744988	NN719956	10	10	10	–	10	–
NN9682	Bynack Burn	NN975844	NN960824	–	–	–	5	10	7
NO0298	Coire Etchachan Burn	NO034981	NO020987	–	–	–	6	6	3
NO0644	Buckny Burn/Lunan Burn	NO096455	NO060480	–	10	10	10	10	10
NO1282	Baddoch Burn	NO137834	NO129820	5	5	5	5	5	5
NO2090	River Dee	NO213920	NO201908	4	4	4	–	4	–
NO3046	Dean Water	NO340478	NO288458	–	7	7	–	7	10
NO5410	Kenly Water	NO538113	NO553122	4	4	–	–	–	–
NS4626	River Ayr	NS465261	NS454246	–	–	–	–	–	6
NS5280	Blane Water	NS518838	NS544804	–	–	–	–	–	10
NS6276	Glazert Water	NS608790	NS645768	–	–	–	–	–	10
NS6826	Rivr Ayr	NS682263	NS715281	–	–	10	–	–	–
NS7404	Scar Water	NS765025	NS727040	–	–	–	–	10	10
NS7822	Duneaton Water	NS828300	NS840319	10	10	10	–	10	10
NS8230	Douglas Water	NS840319	NS828300	5	5	5	–	5	–
NS8280	Bonny Water	NS823803	NS793789	8	8	8	–	8	–
NS9804	Crook Burn	NS973063	NS984039	6	6	6	–	–	–
NT0294	Black Devon	NT031942	NT034944	–	–	–	–	1	2
NT1426	Stanhope Burn	NT142260	NT150266	–	–	–	–	3	–
NT1866	Water of Leith	NT199686	NT173671	–	–	–	–	3	3
NT2420	Crosscleuch Burn	NT240202	NT245200	–	–	–	–	2	2
NT2626	Douglas Burn	NT279272	NT269281	–	–	–	–	3	3
NT2816	Ettrick Water	NT299164	NT290160	–	–	–	–	2	2
NT3258	River South Esk/Redside Burn	NT324600	NT320591	–	–	–	–	6	6
NT4630	Ettrick Water	NT474300	NT480314	–	–	–	–	3	–
NT8452	Blackadder Water	NT857543	NT825529	10	10	–	–	–	–
NT9010	River Alwin	NT925076	NT915105	7	–	–	–	7	6
NT9412	Shank Burn	NT973153	NT952137	6	6	6	–	6	6
NU0026	Wooler Water	NT995278	NT985248	–	–	–	–	–	10
NU0416	River Breamish	NU017164	NU044168	–	–	–	–	–	5
NU1800	River Coquet	NU184003	NU197009	–	–	–	–	–	3
NU1812	River Aln	NU186138	NU215125	9	9	9	–	9	9
NX1674	Cross Water of Luce	NX180772	NX192742	10	–	–	–	–	–
NX3696	River Stinchar	NX397956	NX371963	–	–	–	–	–	7
NX6856	Tarff Water	NX685579	NX682563	–	–	–	–	3	–

Nominal 1-km reference	Waterway name	Start and end grid references		Number of 500-m sections surveyed, 1998–2003					
NX7480	Urr Water	NX755802	NX753813	–	–	–	–	–	2
NX8494	Scar Water	NX884924	NX829945	–	–	–	–	–	10
NY0002	River Ehen	NY022033	NY008075	–	–	–	–	–	10
NY0428	Lostrigg Beck/River Marron	NY056282	NY062281	–	–	–	–	–	3
NY0604	River Bleng	NY077033	NY099032	4	4	–	–	–	–
NY1818	Mill Beck	NY168172	NY190188	–	–	–	–	–	6
NY2082	Water of Milk	NY200826	NY230835	–	–	–	–	4	7
NY2472	Kirtle Water	NY242740	NY240724	–	–	–	–	–	1
NY3648	River Caldew	NY371488	NY366450	–	–	–	–	–	10
NY3688	Ewes Water	NY368880	NY370900	–	–	–	–	4	4
NY4496	Hermitage Water (major source)	NY450964	NY460969	–	–	–	–	–	2
NY5076	Black Lyne	NY496733	NY499757	6	–	–	–	–	6
NY5084	Kershope Burn	NY483828	NY521848	10	10	10	–	–	–
NY5464	King Water	NY554668	NY525633	3	–	–	–	–	5
NY6086	Lewis Burn	NY631887	NY623874	–	4	4	–	4	4
NY7020	Hilton Beck	NY710200	NY719207	–	–	3	–	3	3
NY8012	River Belah	NY800124	NY819123	–	–	6	–	6	6
NY9424	River Tees/Hudeshope Beck	NY976243	NY934257	–	–	–	–	–	10
NY9606	Arkle Beck	NY970064	NY955074	–	–	–	–	–	5
NZ0260	River Tyne	NZ030620	NZ040616	–	–	–	–	2	2
NZ0836	River Wear	NZ055368	NZ083367	–	–	–	–	10	6
NZ1658	River Derwent	NZ180599	NZ152572	–	–	–	–	10	10
NZ2436	River Wear	NZ259374	NZ243361	2	4	4	–	4	4
NZ2818	River Skerne	NZ302193	NZ291207	6	6	6	–	–	–
NZ2844	River Wear	NZ284438	NZ302456	–	7	7	–	7	7
NZ3276	Holywell Dene	NZ336768	NZ336761	–	–	–	–	2	2
NZ4422	Billingham Beck	NZ446235	NZ457216	–	–	–	–	–	6
NZ6418	Skelton Beck	NZ659201	NZ668215	5	–	–	–	5	5
SD3406	Leeds & Liverpool Canal	SD365069	SD369092	–	–	6	6	6	6
SD3476	River Eea	SD350767	SD345765	–	–	–	–	–	1
SD4646	Lancaster Canal	SD481472	SD484453	10	–	–	–	–	6
SD4860	Lancaster Canal	SD474609	SD487635	–	–	–	–	–	7
SD5030	Lancaster Canal	unknown	unknown	–	–	–	–	2	–
SD5270	Lancaster Canal	SD521734	SD511707	–	–	–	–	–	10
SD5296	River Sprint	SD521977	SD521973	–	–	–	–	1	–
SD5298	River Kent	SD522996	SD524992	–	–	–	–	1	–
SD7012	Eagley Brook	SD712134	SD727123	4	4	4	–	4	4
SD7466	River Wenning	SD746673	SD714676	8	8	8	–	8	8
SD7488	Clough River	SD764902	SD718906	–	–	10	–	–	10
SD7808	Manchester, Bolton & Bury Canal	SD793095	SD779073	–	–	–	–	6	6
SD8804	Rochdale Canal	SD885079	SD893038	10	10	10	10	–	–
SD9664	River Wharfe	SD004633	SD981659	–	8	8	–	8	8
SE0278	River Cover	SE045808	SE023791	6	6	6	–	6	6

Nominal 1-km reference	Waterway name	Start and end grid references		Number of 500-m sections surveyed, 1998–2003					
SE3288	River Swale	SE320895	SE337880	8	8	8	–	8	–
SE3428	Aire & Calder Navigation/River Aire	SE383279	SE345301	–	–	–	–	10	10
SE3800	Dove & Dearne Navigation	SE411022	SE395012	4	4	4	–	–	–
SE5846	River Ouse	SE593445	SE600472	–	–	–	–	8	8
SE5848	River Ouse	SE602500	SE599467	–	–	–	–	8	8
SE7044	Pocklington Canal (The Beck)	unknown	unknown	–	–	–	–	–	10
SE7404	River Torne, and un-named drain	SE757067	SE740040	–	–	–	–	7	7
SE9620	New River Ancholme	SE972164	SE974209	–	–	9	–	9	9
SH5648	Afon Colwyn	SH592480	SH583516	–	–	–	–	10	10
SH6672	Afon Aber	SH659725	SH669700	–	–	–	–	6	6
SH7032	Afon Eden	SH703321	SH700328	–	–	2	–	–	–
SH8666	Afon Elwy	SH877675	SH870670	–	–	–	–	3	2
SH9424	Afon Eiddew	SH963244	SH947250	4	4	4	–	4	4
SH9852	Afon Alwen	SH976528	SH987519	–	–	–	–	2	–
SJ0474	Afon Clwyd	SJ048745	SJ041748	–	–	–	–	–	2
SJ1006	Afon Banwy neu Einion	SJ107068	SJ117078	3	–	–	–	–	3
SJ1058	Afon Clywedog	SJ087583	SJ107605	–	–	–	–	–	7
SJ1228	Afon Iwrch	SJ134266	SJ126300	7	7	7	–	7	7
SJ2022	Afon Tanat	SJ185240	SJ226240	10	10	10	–	10	10
SJ4066	Shropshire Union Canal	SJ415667	SJ399669	–	10	10	10	–	–
SJ4276	Manchester Ship Canal	SJ477777	SJ452773	5	5	5	–	5	5
SJ6402	River Severn	SJ672034	SJ634041	8	8	–	–	–	8
SJ6654	River Weaver	SJ650523	SJ662552	10	10	6	–	6	6
SJ6672	River Dane	SJ667716	SJ663733	–	–	–	–	–	10
SJ6832	Shropshire Union Canal	SJ691325	SJ682348	–	–	–	–	2	4
SJ8610	Shropshire Union Canal	SJ849142	SJ875102	10	10	10	–	10	10
SK0206	Cannock Extension Canal	SK021069	SK019045	5	–	–	–	–	–
SK0836	River Dove	SK102374	SK104346	–	–	10	–	10	–
SK1686	River Noe	SK168846	SK152864	8	7	7	–	7	7
SK3802	Ashby-de-la-Zouch Canal	SK384017	SK390037	–	–	–	–	–	4
SK5298	River Don	SK526400	SK522994	–	–	–	–	2	2
SK5662	River Maun	SK601649	SK569638	4	4	4	–	–	8
SK6832	Grantham Canal	SK676307	SK681331	–	–	–	–	7	7
SK7632	Grantham Canal	SK757333	SK776353	–	–	–	–	–	6
SK8874	Fossdyke Navigation	SK880745	SK909749	6	6	6	6	6	6
SK9458	River Brant	SK943600	SK940588	4	4	4	4	4	4
SM9828	Afon Anghof	SM971283	SM958266	–	–	–	–	–	4
SN1226	Eastern Cleddau (Cleddau-Ddu)	SN139278	SN127262	–	–	–	–	5	–
SN5214	Gwendraeth Fach	SN543163	SN532160	–	–	–	–	1	–
SN6442	Afon Twrch	SN652433	SN647414	–	–	–	–	4	4
SN6456	Afon Teifi	SN646561	SN660569	–	5	5	–	5	5
SN6802	Lower Clydach River	SN684026	SN687045	5	5	5	–	5	5
SN7400	River Clydach	SN740009	SS738972	9	9	9	–	10	–

Nominal 1-km reference	Waterway name	Start and end grid references		Number of 500-m sections surveyed, 1998–2003					
SN7432	Afon Tywi	SN762352	SN752326	–	–	–	–	5	6
SN7632	Afon Gwydderig	SN753327	SN759331	–	–	–	–	–	3
SN7804	Dulais River	SN781041	SN792057	–	–	–	–	4	4
SN8200	Melin Court Brook	SN818022	SN838004	–	–	–	–	6	–
SN9654	Chwefri	SN973558	SN984541	–	–	–	–	–	4
SO0246	Duhonw	SO000472	SO045487	–	–	–	–	–	6
SO1068	Afon Ieithon	SO104660	SO104703	–	–	–	–	10	–
SO1204	Afon Rhymni	SO120059	SO138040	–	10	10	10	10	10
SO1262	Mithil Brook	SO115630	SO144628	–	–	–	–	8	–
SO2230	Grwyne Fawr	SO253285	SO233307	–	6	–	–	–	6
SO2620	Grwyne Fawr	SO280207	SO279201	–	–	–	–	–	5
SO3076	River Redlake	SO317763	SO294767	–	–	–	–	–	5
SO4086	River Onny	SO408867	SO409869	–	–	–	–	–	1
SO4618	Afon Mynwy	SO478168	SO469202	–	10	10	–	8	8
SO6466	River Teme	SO629686	SO656691	7	7	7	–	7	7
SO6680	River Rea	SO662821	SO668787	9	9	9	–	9	9
SO7090	Mor Brook	SO729888	SO707905	–	–	–	–	–	7
SO7098	River Severn	SO722975	SJ707004	8	8	8	–	8	8
SO7454	River Teme	SO746563	SO758544	6	6	6	–	–	–
SO8004	River Frome	SO784057	SO808046	7	6	–	–	7	7
SO8628	River Severn	SO867304	SO844279	6	–	–	–	10	9
SP0270	Worcester & Birmingham Canal	SP020739	SP016706	–	–	–	–	8	8
SP0478	Worcester & Birmingham Canal	SP051810	SP047779	–	–	–	–	–	7
SP0484	Worcester & Birmingham Canal	SP044827	SP059867	–	–	–	–	10	–
SP0806	River Coln	SP085094	SP124066	–	–	–	–	–	8
SP1658	Stratford-upon-Avon Canal	SP183565	SP167604	–	–	–	–	10	–
SP2000	River Leach	SP225009	SP209031	–	–	–	–	–	5
SP4406	River Thames or Isis	SP442086	SP438055	–	–	–	–	10	10
SP5246	River Cherwell	SP505483	SP490476	–	–	–	–	3	3
SP6002	River Thame	SP612027	SP605017	4	4	4	–	4	4
SP6260	Grand Union Canal	SP630601	SP625621	4	4	4	–	–	4
SP7636	River Great Ouse	SP760373	SP773380	–	–	–	–	–	4
SS3216	River Torridge	SS339172	SS325177	–	–	–	–	5	4
SS5204	River Lew	SS535059	SS539043	–	4	4	–	4	4
SS6810	River Taw	SS680117	SS694102	5	5	5	–	5	5
SS9084	Ogmore River(Afon Ogwr)/Afon Garw	SS902838	SS906858	–	–	–	–	–	4
ST0280	Afon Elai	ST039811	ST034824	6	6	6	–	6	5
ST0820	River Tone	ST078202	ST084221	5	5	5	–	5	5
ST1600	River Otter	ST160012	ST170018	3	3	3	–	3	3
ST1678	River Taff (Afon Taf)	ST171780	ST162783	–	–	–	–	2	2
ST2092	Afon Ebwy	ST219921	ST218930	–	–	–	–	–	2
ST3490	Afon Lwyd	ST336924	ST342913	–	–	–	–	–	3
ST4646	River Axe	ST475475	ST452490	–	–	7	–	7	7

Nominal 1-km reference	Waterway name	Start and end grid references		Number of 500-m sections surveyed, 1998–2003					
ST5660	River Chew	ST572617	ST585631	5	5	5	–	–	5
ST6680	River Frome	ST645589	ST664814	–	–	–	–	–	7
ST7094	Little Avon River	ST728925	ST697947	–	–	–	–	9	9
ST7846	River Frome	ST784462	ST787476	5	5	–	–	5	5
ST9480	River Avon	ST953800	ST960805	2	2	–	–	–	–
ST9682	River Avon	ST960831	ST977820	6	6	–	–	–	–
ST9804	River Allen	ST996040	ST990060	4	4	4	–	4	2
ST9838	River Wylye	ST948399	ST972394	–	–	5	–	5	5
SU1234	River Avon	SU127354	SU129330	6	6	6	–	6	6
SU2094	River Cole	SU215960	SU216955	–	–	–	–	–	1
SU2470	River Kennet	SU240700	SU253703	–	3	–	–	–	–
SU2870	River Kennet	SU280715	SU299710	5	5	5	–	–	–
SU5296	River Thames/Isis	SU539989	SU505971	10	10	10	10	10	10
SU5664	River Enborne	SU567648	SU557633	4	4	4	–	4	4
SU7266	River Loddon	SU743677	SU734663	4	–	4	–	4	4
SU8892	River Wye	SU882916	SU888991	–	–	–	–	–	4
SU9618	River Rother	SU961197	SU980190	–	6	6	–	6	6
SU9868	Virginia Water (outflow)	SU977686	SU987678	3	–	–	–	–	–
SX0872	River Camel	SX082742	SX065715	–	10	10	–	10	–
SX4682	River Lyd	SX478835	SX454834	5	5	5	–	–	–
SX6270	River Swincombe	SX632718	SX647732	–	–	–	–	5	5
SX8470	River Lemon	SX833711	SX850709	–	–	–	–	4	4
SX9290	Exeter Canal	SX923917	SX940894	–	–	–	–	6	6
SY1096	River Otter	SY089920	SY094949	7	6	6	–	5	5
SY2692	River Axe	SY262955	SY260923	5	5	5	–	5	5
SY6094	River Frome	SY606960	SY617955	–	–	3	–	–	–
SZ2894	Avon Water	SZ298953	SZ292959	–	–	–	–	–	2
TA0448	Watton Beck	TA037491	TA063473	–	–	–	–	–	7
TF0070	River Witham/South Delph	TF014709	TF059714	–	–	–	–	–	9
TF0210	River Gwash	TF040107	TF028106	–	–	2	–	–	–
TF1618	River Glen	TF153185	TF168200	–	–	–	–	5	5
TF2210	River Welland	TF230105	TF237136	–	–	–	–	6	6
TF2644	North Forty Foot Drain	TF280448	TF262460	–	–	–	–	5	–
TF2844	North Forty Foot Bank	TF295447	TF280448	–	–	–	–	4	–
TF6002	Relief Channel	TF602038	TF601032	1	1	–	–	–	–
TF6412	River Nar	TF640133	TF663136	5	5	–	–	–	–
TL1840	River Ivel	TL182402	TL184429	5	–	–	–	5	5
TL1890	Yaxley Lode (Drain)	TL189920	TL213912	–	–	–	–	–	4
TL2234	River Ivel	TL222369	TL223377	2	2	2	–	–	–
TL2296	King’s Dike (Drain)	TL250965	TL222965	6	6	6	6	–	–
TL3288	Forty Foot or Vermuden’s Drain	TL345879	TL315880	6	6	6	–	–	6
TL3296	Twenty Foot River (Drain)	TL324969	TL352989	8	7	7	7	7	–
TL4296	River Nene	TL420966	TL445987	–	–	–	–	6	6

Nominal 1-km reference	Waterway name	Start and end grid references		Number of 500-m sections surveyed, 1998–2003					
TL4692	Sixteen Foot Drain	TL454924	TL468947	–	–	–	–	5	5
TL5480	River Great Ouse	TL544794	TL563807	–	–	–	–	–	5
TL6474	River Lark	TL666752	TL642764	–	–	–	–	6	6
TL6480	Mildenhall Drain	TL655813	TL650827	3	3	3	3	3	3
TL7096	Cut-off Channel	TL719964	TL705988	–	–	–	–	10	10
TL7672	River Lark	TL731739	TL762728	7	7	7	7	7	7
TM1822	Landermere	TM189239	TM197238	2	2	–	–	–	–
TM2434	Shotley Marshes	TM244361	TM251344	4	4	4	4	4	4
TQ0056	River Wey	TQ020569	TQ033571	5	5	5	–	–	–
TQ1480	River Brent	TQ146820	TQ146810	2	2	2	–	2	2
TQ1684	Grand Union Canal	TQ182836	TQ144843	10	10	10	10	10	10
TQ2288	River Brent	TQ240885	TQ241902	5	–	–	–	–	–
TQ3698	R Lee Navigation/Horsemill Stream	TQ372982	TL372016	–	–	–	–	7	7
TQ5062	River Darent	TQ521617	TQ527627	3	3	3	–	3	3
TQ5244	River Medway	TQ529437	TQ542437	4	4	4	–	4	–
TQ5298	River Roding	TQ547996	TQ517981	8	8	8	8	8	8
TQ7252	River Medway	TQ740539	TQ704529	9	9	9	–	9	9
TQ7278	Cliffe Fleet	TQ744782	TQ746792	4	4	4	–	4	4
TQ9222	River Rother (non-tidal part)	TQ927243	TQ923227	3	3	3	–	–	–
TR0244	Great Stour	TR038449	TR032430	4	4	–	–	–	–
TR0826	New Sewer	TR058264	TR090273	7	7	7	7	7	7
TR1658	Great Stour	TR155590	TR163598	3	3	3	–	3	3
WBS-linked sites (non-random)				**98**	**99**	**00**	**01**	**02**	**03**
NH8350	River Nairn	NH806483	NH832504	–	9	8	–	9	9
NJ5117	River Don	NJ528173	NJ496181	–	9	9	9	9	–
NS5370	Forth & Clyde Canal	NS531704	NS563690	–	–	8	8	8	8
NT2034	Manor Water	NT203324	NT218365	–	–	–	–	–	10
NT2238	Manor Water	NT218365	NT230395	–	–	–	–	–	10
NT5434	River Tweed	NT578346	NT528348	–	–	10	–	–	–
NY3714	Goldrill Beck	NY340125	NY393166	–	–	–	–	10	10
NY3748	River Caldew	NY371487	NY382516	–	7	7	–	7	7
NY8529	River Tees	NY857295	NY889283	–	10	10	–	10	10
NZ2612	River Tees	NZ259137	NZ273123	–	–	–	–	10	10
SD3710	Leeds & Liverpool Canal	unknown	SD402119	–	–	–	8	–	–
SD4610	Leeds & Liverpool Canal	SD494104	SD453112	10	10	10	–	–	–
SD4617	Leeds & Liverpool Canal	SD461149	SD458193	10	10	10	–	10	10
SD5009	Leeds & Liverpool Canal	SD524093	SD494104	–	7	7	–	7	7
SD5064	River Lune	SD522648	SD482631	–	10	10	–	10	10
SD5284	Lancaster Canal	SD537831	SD520854	7	7	7	–	7	7
SD5308	Leeds & Liverpool Canal	SD540073	SD525092	–	5	5	5	5	5
SD5365	River Lune	SD545653	SD523649	–	–	–	–	–	8
SD5465	River Lune	SD545653	SD558673	–	5	5	–	5	5
SD5768	Rivers Wenning & Lune	SD585684	SD558673	–	6	–	–	–	6

Nominal 1-km reference	Waterway name	Start and end grid references		Number of 500-m sections surveyed, 1998–2003					
SD5870	River Lune	SD592721	SD571683	–	–	5	–	5	–
SD5960	River Lune	SD592722	SD611574	–	–	–	–	8	8
SD6100	Leigh Branch Canal	SD602018	SJ630996	8	8	8	8	8	8
SD6177	River Lune	SD611790	SD609750	–	8	–	–	–	–
SD8025	River Limy	SD810237	SD807266	–	–	6	–	–	–
SD9060	River Aire	SD907581	SD901623	–	–	–	–	10	10
SD9946	River Aire	SD995468	SD986494	–	–	–	–	8	8
SE1222	River Calder/Calder & Hebble Canal	SE135228	SE128224	–	2	2	–	–	–
SE2796	River Swale	SE291965	SE257974	–	10	10	–	10	–
SE4445	River Wharfe	SE440453	SE472447	–	10	10	–	10	10
SH7220	River Mawddach	SH718193	SH735223	–	7	7	–	7	7
SJ0868	River Clwyd	SJ092659	SJ082687	–	9	10	–	10	–
SJ4070	Shropshire Union Canal	SJ394706	SJ418719	–	6	6	–	–	–
SJ5126	Shropshire Union Canal	SJ526603	SJ541603	–	–	–	3	3	3
SJ6452	Shropshire Union Canal	SJ629549	SJ638504	10	10	10	10	10	10
SJ6836	Shropshire Union Canal	SJ683347	SJ671389	–	–	9	–	9	9
SJ6967	Trent & Mersey Canal	SJ695672	SJ683689	5	5	5	5	5	5
SJ9279	Macclesfield Canal	SJ933779	SJ936814	8	8	–	–	–	–
SJ9586	Macclesfield Canal	SJ953860	SJ959880	–	5	5	–	–	–
SJ9785	Peak Forest Canal	SJ964882	SJ971859	–	5	5	–	–	–
SJ9786	River Goyt	SJ975867	SJ967883	–	5	5	–	–	–
SJ9822	Staffordshire & Worcs Canal	SJ995229	SJ971214	6	6	6	–	6	6
SK1273	River Wye	SK138732	SK103725	–	–	–	–	10	10
SK1883	River Noe	SK168846	SK204826	–	8	6	–	8	8
SK2181	River Derwent	SK205834	SK234806	–	10	10	–	10	10
SK2378	River Derwent	SK233806	SK244761	–	10	–	–	10	10
SK2476	River Derwent	SK244761	SK248727	–	8	8	–	8	8
SK3084	River Porter	SK302849	SK332857	–	–	–	8	8	8
SK3088	River Rivelin	SK322886	SK289871	–	7	7	7	7	7
SK4010	Erewash Canal	SK454471	SK469432	–	9	–	–	–	9
SK5715	River Soar	unknown	unknown	–	5	–	–	–	–
SK6236	Grantham Canal	SK639367	SK608368	8	8	8	8	–	–
SK6929	Grantham Canal	SK709292	SK676307	10	10	10	10	10	10
SK7351	River Trent	SK743515	SK767522	–	10	10	10	10	10
SO1024	River Usk	SO123234	SO095253	–	9	9	–	9	9
SO3780	River Clun	SO361805	SO382813	–	6	6	–	6	–
SO5112	River Monnow	SO495146	SO512122	–	10	10	–	10	10
SO5638	River Lugg	SO565372	SO556395	–	–	10	–	10	10
SO7776	Dowles Brook	SO779764	SO743762	–	–	–	–	9	9
SO8687	Staffordshire & Worcestershire Canal	SO864855	SO862887	–	9	9	–	9	9
SO8757	Worcester & Birmingham Canal	SO865576	SO889577	5	5	5	–	5	5
SP1581	Grand Union Canal	SP181804	SP144818	8	–	8	8	8	8
SP1869	Stratford-upon-Avon Canal	SP187711	SP189671	8	8	–	–	–	–

Nominal 1-km reference	Waterway name	Start and end grid references		Number of 500-m sections surveyed, 1998–2003					
SP1972	Grand Union Canal	SP192742	SP189706	–	–	–	–	8	8
SP4915	River Cherwell	SP484159	SP497153	–	3	3	–	–	–
SP7288	Grand Union Canal	SP727879	SP725901	10	10	10	10	–	–
SP9013	Grand Union Canal	SP933136	SP889140	–	10	10	10	–	–
SP9221	Grand Union Canal	SP929202	SP915230	8	8	8	8	8	8
SS2105	Bude Canal & River Neet	SS207063	SS218038	–	–	–	6	6	6
SU4595	River Ock	SU473959	SU432963	–	10	10	–	10	10
SU4930	River Itchen	SU488301	SU493314	–	–	–	–	3	–
SU8602	Chichester Canal	SU858036	SU842013	8	8	8	8	8	8
SU9400	Alding Bourne/Lidsey Rife	SZ945999	SU958027	–	8	8	8	8	8
SW5533	River Hayle	SW549351	SW566319	–	–	–	–	–	8
SX5363	River Plym	SX533637	SX569651	–	9	9	–	9	9
SX5365	River Meavy	SX527650	SX548669	–	10	10	–	10	10
SX9588	Exeter Canal	SX940894	SX963860	10	10	10	–	10	10
SY9999	River Stour	SZ004998	SY982994	–	6	6	6	6	6
TF0671	River Witham & South Delph	TF060715	TF090710	–	–	–	7	7	7
TF1721	River Glen	TF201245	TF173225	–	10	–	–	7	7
TL1210	River Ver	TL123103	TL128084	–	4	4	–	–	–
TL1515	River Lea	TL140160	TL162145	–	7	7	7	7	7
TL1550	River Ivel	TL156519	TL156508	–	5	5	–	5	–
TL3701	River Lea/Lee Navigation	TL371018	TL375026	–	10	–	–	–	–
TL4963	River Cam	TL502644	TL487621	–	6	6	6	–	–
TL5166	River Cam	TL502643	TL527682	–	–	–	–	–	10
TL8187	River Little Ouse	TL817879	TL786869	–	8	8	–	–	–
TM1150	River Gipping	TM125491	TM113527	–	10	10	–	–	–
TQ0370	River Thames	TQ044695	TQ018721	–	10	10	10	10	–
TQ0492	Grand Union Canal	TQ062940	TQ044902	10	10	10	10	10	10
TQ0558	River Wey Navigation	TQ050578	TQ055586	–	2	2	–	–	–
TQ1088	River Pinn	TQ112891	TQ088878	–	–	–	–	6	6
TQ1554	River Mole	TQ169543	TQ154570	–	–	–	–	8	8
TQ2742	River Mole	TQ276423	TQ259405	–	–	–	–	8	8
TQ2865	River Wandle	TQ282651	TQ261687	–	9	9	–	9	–
Other non-random sites				**98**	**99**	**00**	**01**	**02**	**03**
SD5913	Leeds & Liverpool Canal	SD596168	SD599124	10	–	–	–	–	–
SD8434	Leeds & Liverpool Canal	SD843365	SD845327	10	–	–	–	–	–
SD9012	Rochdale Canal	SD947182	SD917140	10	–	–	–	–	–
SD9702	Huddersfield Narrow Canal	SD984041	SD977025	4	–	–	–	–	–
SE0225	Rochdale Canal	SE015259	SE039245	7	–	–	–	–	–
SE0612	Huddersfield Narrow Canal	SE039119	SE079139	10	–	–	–	–	–
SE1138	Leeds & Liverpool Canal	SE107399	SE125384	5	–	–	–	–	–
SE2335	Leeds & Liverpool Canal	SE222368	SE238366	5	–	–	–	–	–
SE6029	Selby Canal	SE620320	SE585290	10	–	–	–	–	–
SE6416	New Junction Canal	SE634151	SE650184	7	–	–	–	–	–

Nominal 1-km reference	Waterway name	Start and end grid references		Number of 500-m sections surveyed, 1998–2003					
SE6518	Knottingley & Goole Canal	SE648187	SE667193	4	–	–	–	–	–
SJ3398	Leeds & Liverpool Canal	SJ350994	SJ341969	10	–	–	–	–	–
SJ3699	Leeds & Liverpool Canal	SJ387981	SJ350994	10	–	–	–	–	–
SJ5659	Shropshire Union Canal	SJ553599	SJ581588	6	–	–	–	–	–
SJ6153	Llangollen Branch Canal	SJ621551	SJ617524	6	–	–	–	–	–
SJ6386	Bridgewater Canal	SJ669871	SJ625864	10	–	–	–	–	–
SJ6575	Trent & Mersey Canal	SJ644753	SJ666759	6	–	–	–	–	–
SJ6764	Middlewich Branch Canal	SJ689658	SJ679632	6	–	–	–	–	–
SJ7992	Bridgewater Canal	SJ784912	SJ796937	6	–	–	–	–	–
SJ7995	Bridgewater Canal	SJ762986	SJ799945	10	–	–	–	–	–
SJ8842	Trent & Mersey Canal	SJ881442	SJ885393	10	–	–	–	–	–
SJ9273	Macclesfield Canal	SJ930744	SJ925716	6	–	–	–	–	–
SJ9396	Peak Forest Canal	SJ935984	SJ944951	8	–	–	–	–	–
SJ9398	Ashton Canal (derelict)	SJ925976	SJ948985	6	–	–	–	–	–
SK2525	Trent & Mersey Canal	SK273274	SK238241	10	–	–	–	–	–
SK4644	Erewash Canal	SK454471	SK469431	10	–	–	–	–	–
SK4799	Sheffield & South Yorkshire Canal	SK468997	SE504001	7	–	–	–	–	–
SK6279	Chesterfield Canal	SK649808	SK611788	10	–	–	–	–	–
SN7305	Swansea Canal	SN752065	SN724041	6	–	–	–	–	–
SO7407	Gloucester & Sharpness Canal	SO737049	SO758093	10	–	–	–	–	–
SO8762	Droitwich Canal	SO868611	SO884627	5	–	–	–	–	–
SO9387	Dudley Canal	SO932892	SO953883	10	–	–	–	–	–
SP1996	Birmingham & Fazeley Canal	SP202984	SP186938	10	–	–	–	–	–
SP4083	Oxford Canal	SP382831	SP421822	10	–	–	–	–	–
SP6791	Grand Union Canal	SP695916	SP664927	8	–	–	–	–	–
SP8737	Grand Union Canal	SP869398	SP877372	6	–	–	–	–	–
ST0213	Grand Western Canal	ST023134	SS999131	10	–	–	–	–	–
ST3134	Bridgwater & Taunton Canal	ST301365	ST322325	10	–	–	–	–	–
ST7666	Kennet & Avon Canal	ST782657	ST755642	10	–	–	–	–	–
SU2063	Kennet & Avon Canal	SU224635	SU179618	10	–	–	–	–	–
SU8953	Basingstoke Canal	SU809536	SU853527	9	–	–	–	–	–
TL8094	River Wissey	TL807945	TL774962	–	10	10	–	–	–
TQ9427	Royal Military Canal	TQ958292	TQ938248	10	–	–	–	–	–