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Thames Water Overwintering and Breeding Bird Indicators: Feasibility Study

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EXECUTIVE SUMMARY

1. With the aim of illustrating the conservation credentials of Thames Water, the feasibility of constructing wild bird indicators is assessed. These analyses are performed for Thames Water holdings supporting both overwintering waterbirds and terrestrial breeding birds.

2. Thames Water sites are matched, using GIS (ArcView v.3.3), to nearest wintering waterbird sites covered by the Wetland Bird Survey (WeBS). A similar procedure is followed to match Thames Water holdings to locations surveyed for national breeding bird schemes in which the BTO is involved, including the Breeding Bird Survey (BBS).

3. The conservation value of Thames Water sites for non-breeding waterbirds is investigated by comparing multi-species trends on selected sites with and without conservation enhancement. The international and national importance of these selected sites is outlined.

4. Breeding bird survey coverage is assessed for relevant Thames Water sites. The extent and periodicity of coverage are analysed, as is the species composition likely to feed into an indicator.

5. The wintering waterbird trend for 13 sites known to have received conservation enhancement shows an initial decline before stabilising and recently markedly increasing. It is unclear whether changes coincided with conservation action, although the same pattern is not repeated at non-enhanced sites.

6. 688 Thames Water sites (20% of total number of holdings) were found within 1 km of WeBS sites, and 16 waterbird species were counted on these sites. 921 Thames Water sites (27%) were discovered within 1 km of locations of the major breeding bird surveys, which monitored a minimum of 61 different bird species. Overall, 1,695 Thames Water sites were within 1 km of a bird survey; this represents 49% coverage of all Thames Water sites, with data for at least 77 different species of bird.

7. Thames Water site coverage by the various bird surveys in which the BTO is involved appears to be sufficiently comprehensive, consistent and species-inclusive to facilitate development of responsive, informative and accurate bird indicators. These could be used by Thames Water to highlight commitment to conservation.

8. It is suggested that indicators could be further refined if Thames Water site boundaries were digitised. This would allow more precise assessment of overlap between holdings and breeding or wintering bird survey locations, and could lead to enhanced responsiveness of potential indicators.

9. Preliminary results suggest that the construction of wild bird indicators for Thames Water sites is promising. Sites managed for conservation appear to show enhanced value for select species, although further development of indicators, including national and regional species trend comparisons, is proposed to confirm the extent of this pattern.

1. INTRODUCTION

Wild bird indicators, such as the government's 'headline indicator', are increasingly relied upon to inform the wider community about bird conservation issues. For example, the plight of many farmland and woodland bird species has been brought to public attention in this way (http://www.sustainable-development.gov.uk/indicators/headline/h13.htm). Underpinning these indicators are data from various bird surveys; predominantly, the BTO's Common Bird Census (CBC) and the BTO/JNCC/RSPB funded Breeding Bird Survey (BBS) for terrestrial birds, and the BTO/WWT/JNCC/RSPB Wetland Bird Survey (WeBS) for overwintering waterbird populations.

Wild bird indicators combine trends for individual species into a single multi-species trend. Such trends can indicate the underlying 'health' of the environment at a number of different spatial scales (*e.g.* regions, countrywide), habitats (*e.g.* woodland, farmland, urban), seasons, or community groups (*e.g.* woodland specialists, farmland generalists). These indicators are a useful way of summarising complex changes in wider bird populations and the general environment, and have gained resonance and popularity with both government and the public.

The United Kingdom has a special responsibility to monitor its birdlife, as it is crucial as a staging post or migratory refuge for vast numbers of waterbirds supported during the winter, whilst the diversity of habitat supports many species of breeding bird in the spring and summer. Internationally important (i.e. at least 1% of the flyway population) and nationally important (i.e. at least 1% of the number of birds wintering in Great Britain) numbers of waterbirds are reliant on sites such as those owned by Thames Water, and as the guardian of such locations, Thames Water has taken measures to safeguard the conservation value of several holdings. Similar techniques have been applied to many terrestrial site holdings, which are likely to benefit breeding birds.

Here we investigate the conservation value, in terms of species trends, of Thames Water sites using existing data from national breeding and non-breeding bird surveys. The potential coverage of Thames Water sites by bird surveys is also assessed. The ultimate goal is to assess the feasibility of producing wild bird indicators for Thames Water sites that will help them to quantify the value of the environmental resources that they manage, a resource that will help them establish green credentials at a time when these can be major drivers of consumer choice. Such indicators should also help identify the value of the conservation management techniques applied by Thames Water, although certain factors, such as climate change, may lead to changes in the distribution of birds and other fauna away from a site, irrespective of how well it is managed for its wildlife.

2. METHODS

An input file containing grid references, addresses, site names and site usage of 3,462 property holdings was supplied by Thames Water. This file was read into Arc View GIS v.3.3, so that all Thames Water sites could be plotted as spatially referenced centroid points. Unfortunately, digitised site boundaries were unavailable, and thus all distance measurements were made to the centre of each site location point. Therefore the distance measured to each site is likely to be an overestimation of the 'true' distance to the nearest edge of the site holding.

Bird data held by the BTO were similarly input to GIS for the various wintering and breeding bird surveys applicable. For breeding birds, surveys included the Breeding Bird Survey (BBS), the Breeding Waders of Wet Meadows survey (BWWM), the annual Heronries Census, the Waterways Bird Survey (WBS) and the related Waterways Breeding Bird Survey (WBBS). Depending on data type, sites were plotted at varying spatial resolutions. Thus, 1 km BBS squares were plotted as polygons, BWWM sites were digitised polygons at the site boundary level, locations of heronries were plotted as points, and straight polylines between known start and end grid references approximated WBS and WBBS stretches. These lines were always straight and therefore are unlikely to track exactly the course of canals and rivers included.

Wintering waterbirds are monitored by the Wetland Bird Survey (WeBS). Currently, not all of the sites surveyed are digitised, and therefore GIS operated on two data formats. Firstly, those sites where site boundaries have been digitised and added to the Count Unit Definition Inventory (CUDI) were plotted as polygons. Secondly, all WeBS sites were plotted as centroid points in the same manner as Thames Water sites. The spatial boundaries were therefore unknown, and measurements were made to the centre of the point. Detailed calculations were restricted to using centroids, for the sake of consistency.

Using nearest neighbour analysis, it was possible to ascertain all breeding and wintering survey sites within specified distances of Thames Water holdings. The nearest relevant bird survey site to each Thames Water site was calculated, to assess which Thames Water sites were likely to support birds monitored by a bird survey, and which Thames Water sites were too far away from survey sites to influence bird abundance there. Subsequently, a list of all relevant breeding and wintering bird survey sites within 1 km of Thames Water sites was generated. This distance was thought a reasonable approximation of the overlap between likely (unknown) spatial boundaries of holdings and the ranges of birds covered by the various surveys.

This distance parameter was considered to be the maximum for assessing overlap and many of the detailed calculations use a distance of 500 m. This distinction is important, as whilst this scoping study uses a distance parameter of 500 m between central points of Thames Water sites and bird survey sites, future work (for instance using digitised Thames Water site boundaries) may consider more of the sites within 1 km, as their respective edges may be found to be close or even overlap.

To illustrate the effects of conservation management at Thames Water sites, wintering waterbird sites owned by Thames Water and covered by WeBS were identified in the manner above. A sub-sample of 33 of these sites was selected to provide an example of the information conveyed by indicators. 13 of these sites were known to have undergone conservation management, whilst the remaining 20 received no dedicated conservation treatment (see Table 3.1.2.2 for site lists). The average trends of all waterbird species occurring on these sites were plotted as multi-species indicator trends, using smoothed General Additive Model techniques to allow for 'natural' fluctuation of bird populations (see Leech *et al.* 2002). The trends were compiled by factoring in a measurement of 'conservation value' of each species. A weighting was added based on the species' qualifying level (i.e. the British threshold for designation of national importance, Kershaw & Cranswick 2002). In this way an increase in the numbers of (for example) Shoveler contributed more to a rise in the trend than a similar increase in Mallard. These trends were plotted, along with a species composition list.

To assess the likely species coverage feasible for indicators, data were treated differently for breeding and wintering bird surveys. For wintering bird data, all WeBS sites within 500 m of a Thames Water site were identified. At this stage, time constraints prevented an exhaustive search of species recorded sufficiently on these sites for indicator inclusion. Instead, a suite of species from selected sites is presented and can be considered the minimum number of different species available for a wintering waterbird indicator. For breeding bird data, all BBS squares, Heronries, BWWM areas, WBS stretches and WBBS stretches found to be within 500 m of the centre of a Thames Water site were selected. This zone was considered an appropriate resolution to operate at, as the reasonable upper limit for detection of most species is likely to be around this distance. Therefore, from the edge of a 1 km BBS square for instance, breeding birds up to 500 m away would have a high chance of detection; where these distances coincide with the centres of Thames Water sites, the survey square is potentially viable for inclusion in multi-species indicators.

Data for each BBS square were extracted, producing tables of years of coverage and species recorded. Other breeding bird species identified were specific to the relevant survey (*e.g.* Grey Herons were covered by the Heronries Census).

3. RESULTS

3.1 Thames Water sites and wintering waterbirds

3.1.1 Coverage of Thames Water sites by The Wetland Bird Survey

All Thames Water sites within 1 km of the centroid point of a site covered by WeBS were identified using GIS. Some WeBS site boundaries were known, but centroids were considered as the standard spatial reference for consistency. The WeBS sites matched to these Thames Water sites are candidates for inclusion in future species indicators. 1 km was chosen as an arbitrary distance from the Thames Water sites, as none of the actual site boundaries of the water company holdings were known.

688 Thames Water sites were found within 1 km of the centroids of WeBS sites, whilst 2,774 were greater than 1 km from a WeBS site. Therefore 20% of Thames Water sites are candidates for coverage by WeBS. Of the 688, 238 (35%) were within 500 m, 66 were within 250 m, and 1 coincided exactly with the available grid references (note, however, that where WeBS site boundaries were known, this figure increased to 45). All sites within 500 m are displayed in Figure 3.1.1.

The list of Thames Water sites with matched WeBS sites is available in the documents supplied to Thames Water [survey by survey.xls] and [breeding & wintering.xls].

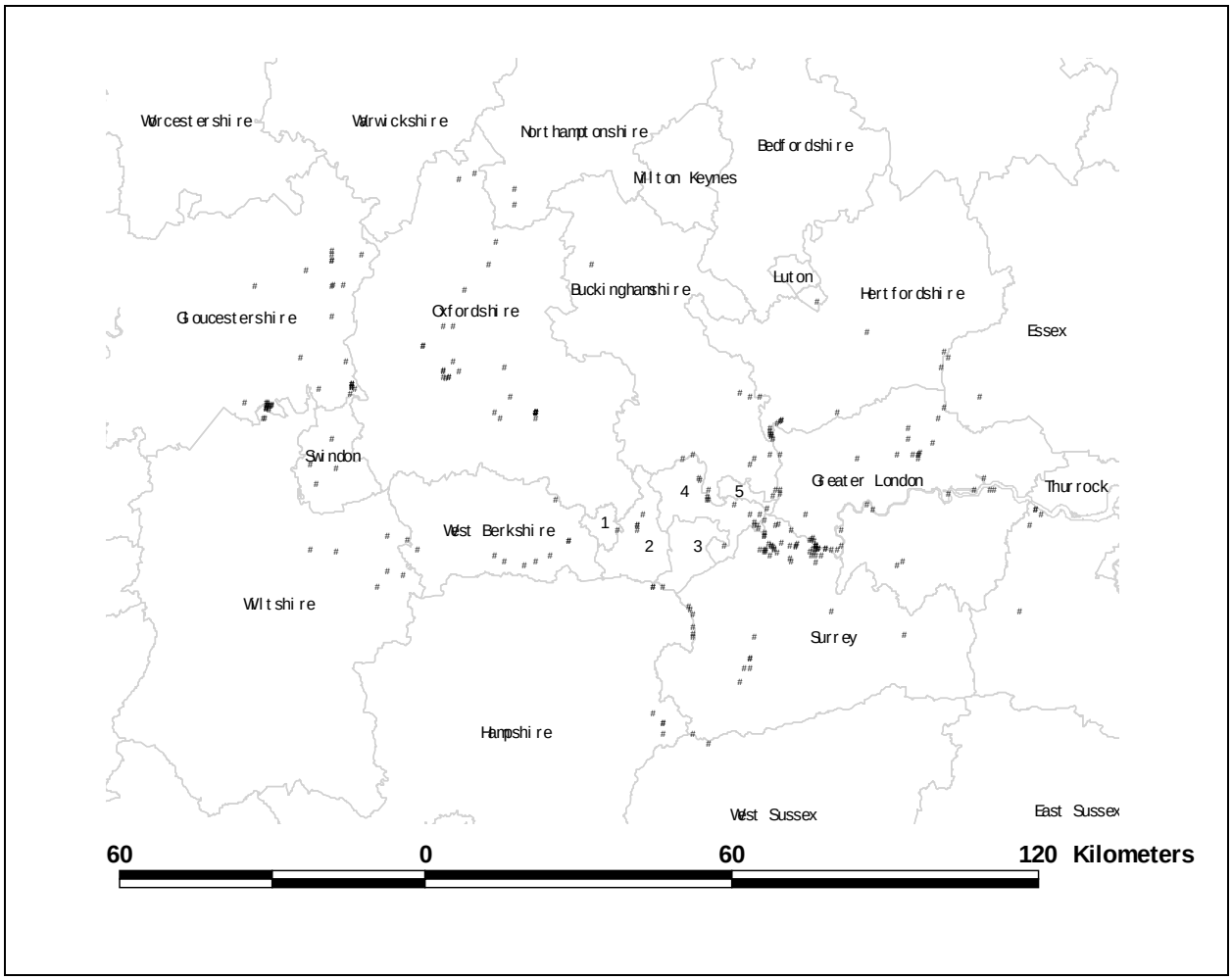

Figure 3.1.1 Wetland Bird Survey sites within 500 m of Thames Water sites. Key to numbered counties: 1 = Reading; 2 = Wokingham; 3 = Bracknell Forest; 4 = Windsor & Maidenhead; 5 = Slough.

A number of species are routinely monitored by WeBS, and as most Thames Water holdings are inland sites, most of the species involved are wildfowl. A list of these species appears below (Table 3.1.1), and the 16 species listed should be considered the minimum number available for producing indicators. Future, more extensive, searches of the WeBS database may bring to light further species that are recorded on a sufficiently large number of WeBS sites for inclusion in an indicator.

Species covered by WeBS	**Monitored since**
Cormorant *Phlacrocorax carbo*	1988/89
Coot *Fulica atra*	1984/85
Gadwall *Anas strepera*	1965/66
Great Crested Grebe *Podiceps cristatus*	1984/85
Goosander *Mergus merganser*	1965/66
Goldeneye *Bucephala clangula*	1965/66
Little Grebe *Tachybaptus ruficollis*	1987/88
Mallard *Anas platyrhynchos*	1965/66
Mute Swan *Cygnus olor*	1965/66
Pochard *Aythya ferina*	1965/66
Pintail *Anas acuta*	1965/66
Shelduck *Tadorna tadorna*	1965/66
Shoveler *Anas clypeata*	1965/66
Teal *Anas crecca*	1965/66
Tufted Duck *Aythya fuligula*	1965/66
Wigeon *Anas Penelope*	1965/66

Table 3.1.1. Alphabetical list of species covered by WeBS on Thames Water sites

3.2 Thames Water sites and breeding birds

3.2.1 Coverage of Thames Water sites by breeding bird surveys

All Thames Water sites within 1 km of BBS squares, BWWM sites, Heronries, WBS and WBBS stretches were identified. Table 3.2.1 shows the proportions of Thames Water sites potentially covered by the various surveys. The low match rate of WBS and WBBS sites within 0 m reflects the fact that the waterways sites are two dimensional (lines), and that without digitised boundaries, Thames Water sites are points, and hence unlikely to overlap. BBS sites are 1 km square polygons and hence overlap to a much greater extent.

Survey	**0 m**	**250 m**	**500 m**	**1000 m**
BBS	106	214	369	744
BWWM	48	210	359	639
Heronries	1	6	34	130
WBS	0	29	69	152
WBBS	0	29	68	148

Table 3.2.1 Numbers of different Thames Water sites within given distances of breeding bird survey sites.

A total of 1,385 different Thames Water sites (40%) fall within 1 km of the edge of a breeding bird survey site (note that one Thames Water site could be matched to >1 breeding bird survey site, as all available survey sites are candidates to indicate Thames Water site-level changes). Of this total number of 1,385, 65 sites (5%) have only a heronry within 1 km, and are therefore unsuitable for multi-species indicators. 375 (27%) further sites have only a Breeding Waders of Wet Meadows site within 1 km, and an additional 24 sites (2%) are within 1 km of both a heronry and a BWWM site, but

not a BBS, WBS or WBBS site. The suitability of these sites for inclusion in the indicators is outlined in the discussion.

The remainder of 921 Thames Water sites (66% of all sites within 1 km of a breeding bird survey location) fall within 1 km of a BBS, WBS or WBBS survey site. These sites are perhaps most suitable for indicators, as the surveys are regular and long running. A map of all breeding bird surveys sites within 500 m of Thames Water holdings appears in Figure 3.2.1.

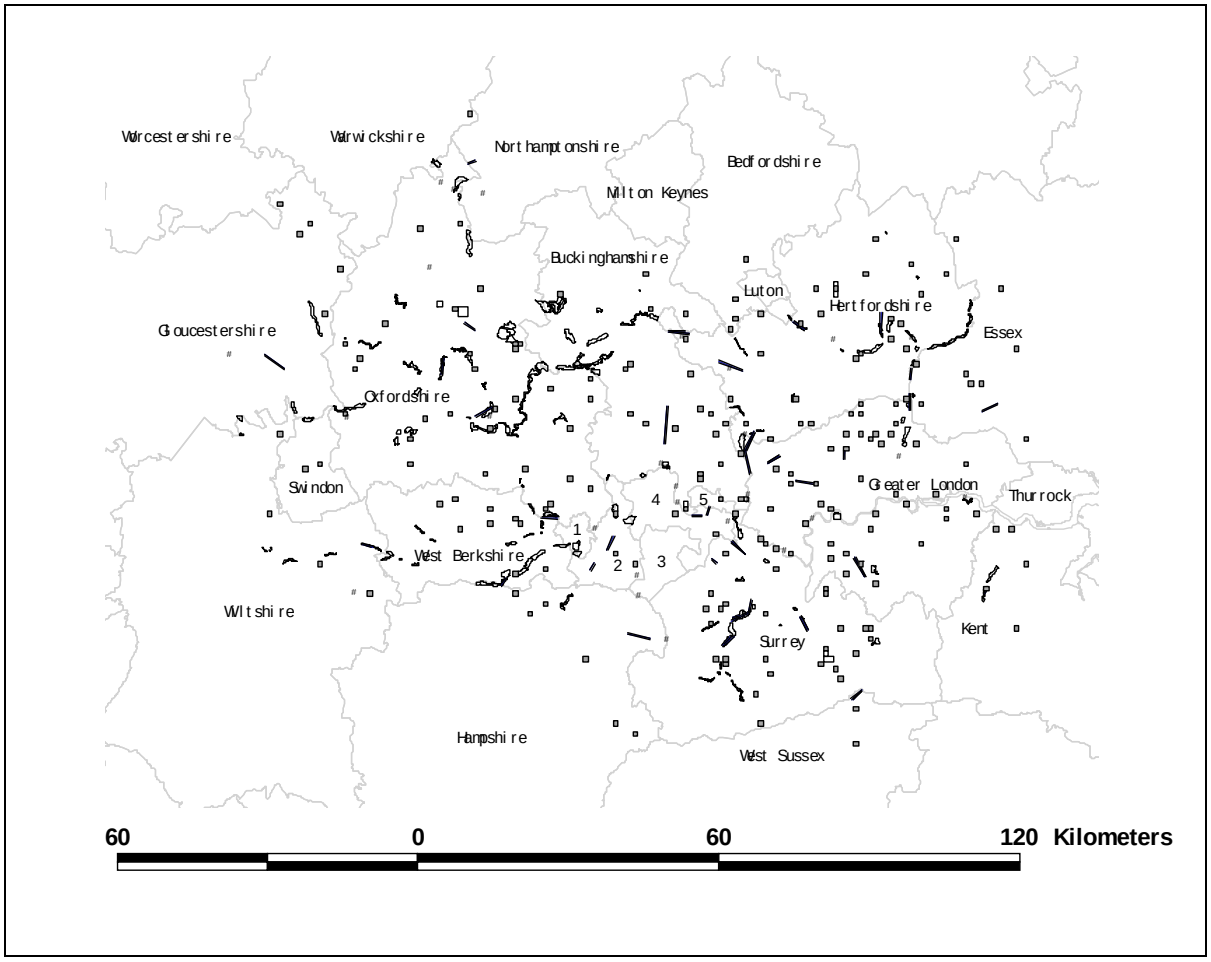

Figure 3.2.1 All sites with surveys of breeding birds within 500 m of Thames Water sites. Grey squares = BBS 1 km squares; Thick lines = WBS or WBBS stretches; Filled circles = Heronries Census; Open polygons = BWWM areas. Key to numbered counties: 1 = Reading; 2 = Wokingham; 3 = Bracknell Forest; 4 = Windsor & Maidenhead; 5 = Slough.

3.2.2 Extent, periodicity and species composition of breeding bird surveys

For each of the relevant breeding bird survey sites, it was possible to calculate the extent of survey coverage (i.e. how long the site has been monitored), the periodicity of monitoring and the species that have been counted.

3.2.2.1 Breeding Bird Survey

The BTO/JNCC/RSPB Breeding Bird Survey (BBS) is a volunteer-based survey of random 1 km squares organised by the BTO across the UK since 1994 (Raven *et al*. 2004). There were 199 different BBS squares within 500 m of Thames Water sites, and 22% of these (44 sites) were completely covered over the ten-year period 1994-2003. Two thirds of the sites (67%) had at least five counts during the ten-year period. The list of species covered appears in Table 3.2.2.1.

Species	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Blackbird *Turdus merula*	114	124	120	138	151	162	158	97	154	151
Blackcap *Sylvia atricapilla*	71	77	75	94	107	120	116	66	113	106
Blue Tit *Parus caeruleus*	113	123	119	135	149	161	155	94	154	150
Bullfinch *Pyrrhula pyrrhula*	33	38	37	39	39	49	46	22	42	40
Canada Goose *Branta canadensis*	21	23	25	35	35	40	44	24	42	43
Carrion Crow *Corvus corone*	107	116	110	126	147	155	149	90	146	146
Chaffinch *Fringilla coelebs*	99	115	103	116	129	144	144	82	137	136
Chiffchaff *Phylloscopus sibilatrix*	60	65	64	84	96	90	91	50	94	107
Coal Tit *Parus ater*	32	31	26	38	32	31	37	18	40	41
Collared Dove *Streptopelia decaocto*	82	88	87	100	107	118	120	70	113	107
Cuckoo *Cuculus canorus*	49	48	58	58	61	62	60	21	32	38
Dunnock *Prunella modularis*	90	106	103	113	123	139	138	78	129	134
Feral pigeon *Columba livia*	43	55	56	65	78	79	71	48	65	66
Garden Warbler *Sylvia borin*	20	29	25	27	27	28	33	16	28	23
Goldcrest *Regulus regulus*	37	36	30	35	38	52	49	23	53	63
Goldfinch *Carduelis carduelis*	63	66	64	68	76	81	82	46	73	88
Great Spotted Woodpecker *Dendrocopus major*	42	59	62	67	80	77	86	45	83	91
Great Tit *Parus major*	104	115	115	127	137	154	154	90	147	146
Green Woodpecker *Picus viridis*	45	51	57	70	81	99	98	51	92	81
Greenfinch *Carduelis chloris*	88	98	101	113	124	134	125	80	130	129
Grey Heron *Ardea cinerea*	25	27	27	30	39	46	47	34	45	47
House Martin *Delichon urbica*	47	57	54	50	61	53	56	32	46	56
House Sparrow *Passer domesticus*	88	98	97	106	120	127	116	73	111	113
Jackdaw *Corvus monedula*	61	70	67	85	95	95	92	52	104	98
Jay *Garrulus glandarius*	53	57	49	67	72	69	73	43	82	62
Kestrel *Falco tinnunculus*	39	40	32	41	37	45	38	26	38	44
Lapwing *Vanellus vanellus*	26	26	33	22	25	25	29	15	28	31
Linnet *Carduelis cannabina*	54	50	56	67	57	71	68	38	62	64
Long-tailed Tit *Aegithalos caudatus*	55	58	53	54	64	66	77	33	61	78
Magpie *Pica pica*	99	114	111	128	143	149	145	93	147	139
Mallard *Anas platyrhynchos*	50	52	63	64	73	87	78	47	84	86
Mistle Thrush *Turdus viscivorus*	67	79	72	77	85	93	87	53	76	78
Moorhen *Gallinula chloripus*	33	39	36	37	44	52	49	33	52	51
Nuthatch *Sitta europaea*	32	28	31	34	38	43	38	23	48	36

Table 3.2.2.1 Species coverage by BBS. Table shows number of squares (within 500 m of a Thames Water site) each species was observed on. Total number of squares covered each year in bold at foot of table. Table includes all species observed on an average of at least 20 squares per year.

Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pheasant *Phasianus colchicus*	72	77	72	78	92	97	98	49	103	98
Pied Wagtail *Motacilla alba*	38	51	45	46	55	69	58	38	61	71
Red-legged Partridge *Alectoris rufa*	18	19	27	23	27	26	24	14	27	23
Robin *Erithacus rubecula*	107	119	116	133	140	158	154	96	150	147
Rook *Corvus frugilegus*	48	61	57	60	63	70	57	33	60	57
Skylark *Alauda arvensis*	78	83	81	84	87	97	84	52	81	82
Song Thrush *Turdus philomelos*	87	107	101	100	115	121	122	80	122	130
Sparrowhawk *Accipiter nisus*	18	23	16	24	28	21	25	18	23	23
Starling *Sturnus vulgaris*	102	118	107	126	140	146	138	86	132	124
Stock Dove *Columba oenas*	38	46	27	44	48	65	57	28	47	55
Swallow *Hirundo rustica*	64	73	68	80	82	101	91	42	81	84
Swift *Apus apus*	71	70	80	71	97	85	91	58	87	91
Whitethroat *Sylvis communis*	52	59	73	72	87	84	88	48	86	81
Willow Warbler *Phylloscopus trochilus*	59	60	61	63	60	67	56	26	52	37
Woodpigeon *Columba palumbus*	114	124	121	138	151	161	158	97	153	150
Wren *Troglodytes troglodytes*	110	119	112	128	138	154	151	91	149	146
Yellowhammer *Emberiza citrinella*	62	71	64	72	76	82	69	37	67	68
Number of squares surveyed	**114**	**124**	**121**	**138**	**151**	**162**	**158**	**97**	**154**	**151**

Table 3.2.2.1 Continued.

3.2.2.2 Breeding Waders of Wet Meadows

Of 134 BWWM areas with edges less than 500 m from Thames Water sites, 12 sites (9%) had been covered on all three surveys (1982, 1989 and 2002). Another 69 sites were covered in more than one of the survey years, meaning that 60% of BWWM sites were surveyed in more than one year, allowing interpolation of data. 86 sites (64%) were monitored during the most recent survey of 2002. The list of species covered appears in Table 3.2.2.2.

Species covered by BWWM
Curlew *Numenius arquata*
Lapwing *Vanellus vanellus*
Oystercatcher *Haematopus ostralegus*
Redshank *Tringa totanus*
Snipe *Gallinago gallinago*

Table 3.2.2.2 Species coverage by BWWM

3.2.2.3 Heronries Survey

35 sites within 500 m of a Thames Water holding were observed as part of the BTO's Heronries Survey. Of these, 10 (29%) had been visited every year between 1994 and 2003. Over half of the total number of sites (63%) were visited in at least five of the past ten years. Traditionally, the Grey Heron *Ardea cinera* was the only species monitored by this survey; however, in recent years the Little Egret *Egretta garzetta* has also been included in surveys.

3.2.2.4 Waterways Bird Survey/Waterways Breeding Bird Survey

WBS and WBBS are similar surveys covering birds breeding along waterways such as rivers and canals. 21 sites covered by the former were found within 500 m of Thames Water sites. Six of these

were surveyed in 2003, whilst one riverine stretch on the River Lea was checked every year between 1994 and 2003. Another nine stretches of various waterways received coverage in five or more of the past ten years. Thirteen of 24 WBBS stretches were covered at least three times in the period 1998-2003, with stretches of the Rivers Roding and Thames/Isis, plus two stretches of the Grand Union Canal, counted in every year of that period. The list of principal species covered by the surveys appears in Table 3.2.2.4. In addition to these, some species covered by the BBS will also be monitored (*e.g.* Mallard). Of the WBS/WBBS sites selected to be within 500 m of a Thames Water site, only Grey Wagtail, Kingfisher, Mute Swan and Reed Warbler are likely to be sufficiently recorded for inclusion in an indicator.

Species covered by WBS/WBBS
Common Sandpiper *Actitis hypoleucos*
Dipper *Cinclus cinclus*
Goosander *Mergus merganser*
Grey Wagtail *Motacilla cinera*
Kingfisher *Alcedo atthis*
Little Grebe *Tachybaptus ruficollis*
Mute Swan *Cygnus olor*
Reed Warbler *Acrocephalus scirpaceus*
Sand Martin *Riperia riperia*

Table 3.2.2.4 Species coverage by WBS/WBBS

A spreadsheet, provided to Thames Water, contains all of the visit information for all of the relevant breeding bird survey sites and provides full details [survey by survey.xls].

3.3 Overall bird survey coverage of Thames Water sites

To illustrate the overall extent of coverage of Thames Water sites by wintering and breeding bird surveys, a map was plotted showing all Thames Water sites within 500 m of a bird survey site. It is clear that the spread of coverage is fairly uniform and not restricted to particular counties or cities (Figure 3.3).

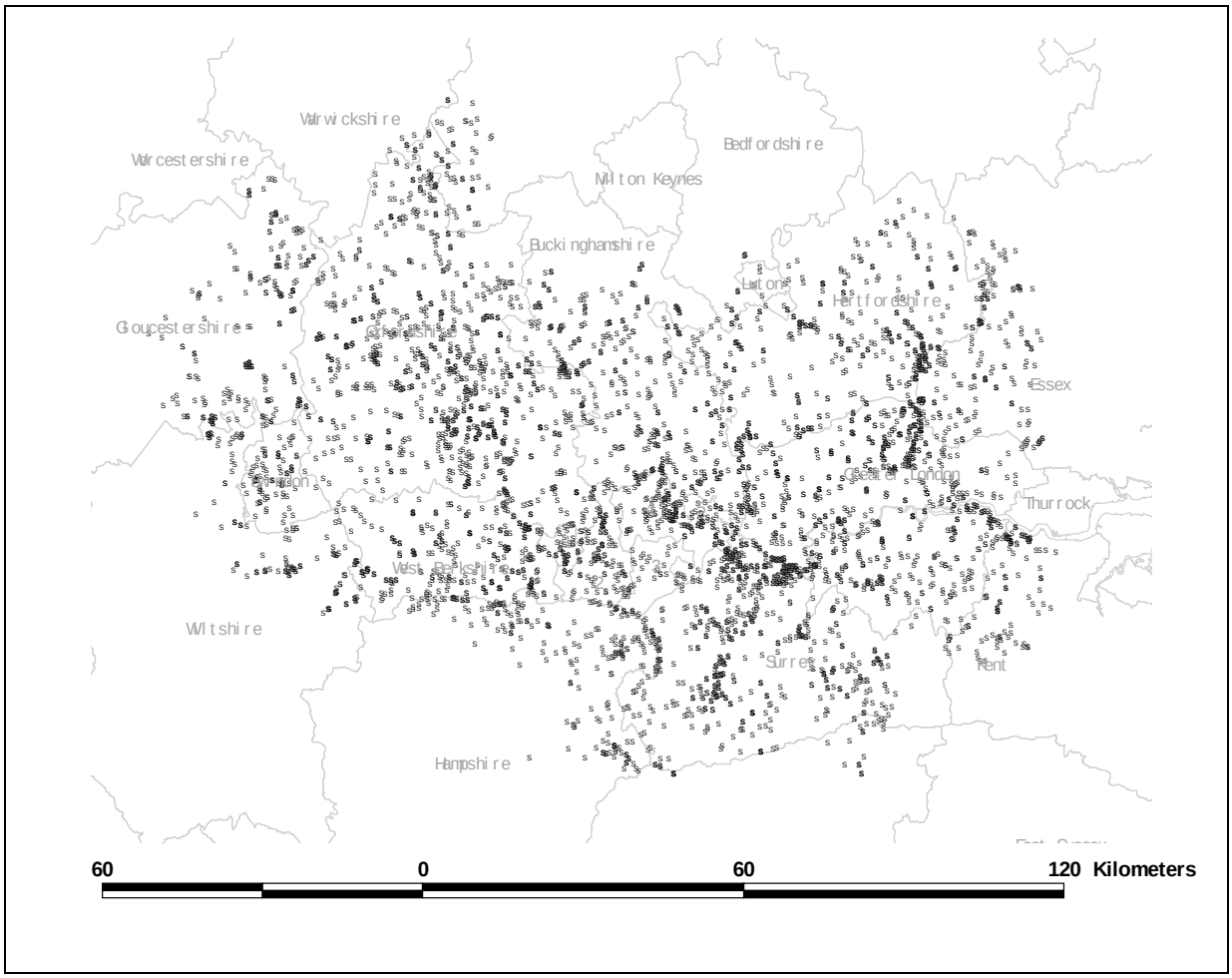

Figure 3.3 Complete coverage of Thames Water sites by bird surveys. Filled circles = Thames Water sites within 500 m of a bird survey site; open circles = Thames Water sites greater than 500 m from a bird survey site.

A total of 1,695 (49%) Thames Water sites were within 1 km of a bird survey site, whilst of these 925 (27%) were no further than 500 m away. The latter figure illustrates that a large number of Thames Water sites would be covered in one or more multi-species bird indicators, and therefore that potentially bird trends on almost a third of Thames Water holdings could be monitored. Furthermore, there is considerable potential to expand this figure still further once site boundaries- both of Thames Water sites and WBS/WBBS and WeBS sites- are elucidated.

3.4 Conservation value of Thames Water sites for wintering waterbirds

A number of waterbodies and associated treatment works provide important refuge for waterbirds overwintering in, or on passage through, the British Isles. Many of these fall under the jurisdiction of Thames Water, and as such have undergone management to enhance the conservation value of the sites.

Table 3.4.1 shows 14 important Thames Water sites, with the national or international importance for various species displayed. Most species are wildfowl (i.e. ducks, geese and swans), as the majority of relevant Thames Water sites are inland waterbodies. Of the selected sites, Lee Valley Gravel Pits are internationally important for Gadwall, and nationally important for seven other species (Coot, Cormorant, Great Crested Grebe, Little Grebe, Shoveler, Smew and Tufted Duck). Moorhen and Water Rail are additional species of note. Also significant are Staines Reservoirs, the tenth most important site in the country for Shoveler and the eleventh most important site for Tufted Duck, and

Walthamstow Reservoirs, which support the tenth largest site numbers of both Cormorant and Tufted Duck.

SPECIES	LVGP[1]	QMARYRES[2]	QEII[3]	WALTH[4]	QMOTHER[5]	WRAYSRES[6]	WGRES[7]	STAINES[8]	FARMOOR[9]	TRING[10]	KGVI[11]	K&B[12]	BEDDINGTON[13]	KGV[14]
Little Grebe	14													
Great Crested Grebe	18	7	39											
Cormorant	31	13	27	10	22	40	44	45	53					
Grey Heron				*1*										
Gadwall	**5**													
Mallard										*6*				
Shoveler	16			47		61		10			25	43	53	
Tufted Duck	13			10			21	11						20
Smew	3													
Water Rail	*11*													
Moorhen	*7*									*17*				
Coot	5													

Table 3.4.1 Selected Thames Water sites holding important numbers of wintering waterbirds, with site rank of (inter) national importance for various species (source: Pollitt *et al.* 2003). Bold type indicates international importance. Species in italics do not have established British thresholds, and ranking relates to arbitrary thresholds. Site Key: [1]Lee Valley Gravel Pits (including some TW holdings); [2]Queen Mary Reservoir; [3]Queen Elizabeth II Reservoir; [4]Walthamstow Reservoirs; [5]Queen Mother Reservoir; [6]Wraysbury Reservoir; [7]William Girling Reservoir; [8]Staines Reservoirs; [9]Farmoor Reservoir; [10]Tring Reservoirs; [11]King George VI Reservoir; [12]Knight & Bessborough Reservoirs; [13]Beddington STW; [14]King George V Reservoir.

3.4.1 Effectiveness of site conservation

To assess the impact of site management for conservation at Thames Water sites, a select number of sites were identified based on importance for waterbirds and extent of coverage by WeBS. Species routinely counted on WeBS sites are listed in Table 3.1.1 (note that introduced Canada Goose and re-established Greylag Goose have not been included, as these are not usually considered targets for conservation). Two indicator graphs, with wintering waterbird trends for conservation-enhanced Thames Water sites and those not specifically managed for conservation, were generated (Figures 3.4.1.1 and 3.4.1.2).

Figure 3.4.2.1 suggests that the smoothed multi-species trend appeared to dip in the early 1990s, with a subsequent recovery and increase beyond the 1989 index value. This would imply that the selected Thames Water sites (Table 3.4.1.1 for site list) have supported recent increases in species of conservation value. Thus, conservation techniques would appear to be successful in reversing apparent declines in various waterbird species.

Conservation enhanced sites	Sites not enhanced for conservation
Barn Elms NR	Ashford WTW
Beddington NR	Aylesbury STW
East Hyde STW	Farmoor Reservoir
Grimsbury WTW	Ham Island STW
Kempton NR	Hampton & Hydes Field WTW
Kings Mead & New River NR	Horton Kirby Service Reservoir
Maple Lodge NR	Island Barn Reservoir
Molesey	Kempton Park WTW
Rye Meads STW	King George V Reservoir
Shorncote NR	King George VI Reservoir
Swindon (Rodbourne) STW	Knight & Bessborough Reservoirs
Unsted NR	QEII Reservoir
Walthamstow Reservoir	Queen Mary Reservoir
	Queen Mother Reservoir
	Stain Hill
	Staines Reservoir
	Tring STW
	Walton WTW
	William Girling Reservoir
	Wraysbury Reservoir

Table 3.4.1.1 Thames Water sites known to be conservation-enhanced and those not known to have undergone dedicated management for bird conservation. NR = Nature Reserve; STW = Sewage Treatment Works; WTW = Water Treatment Works.

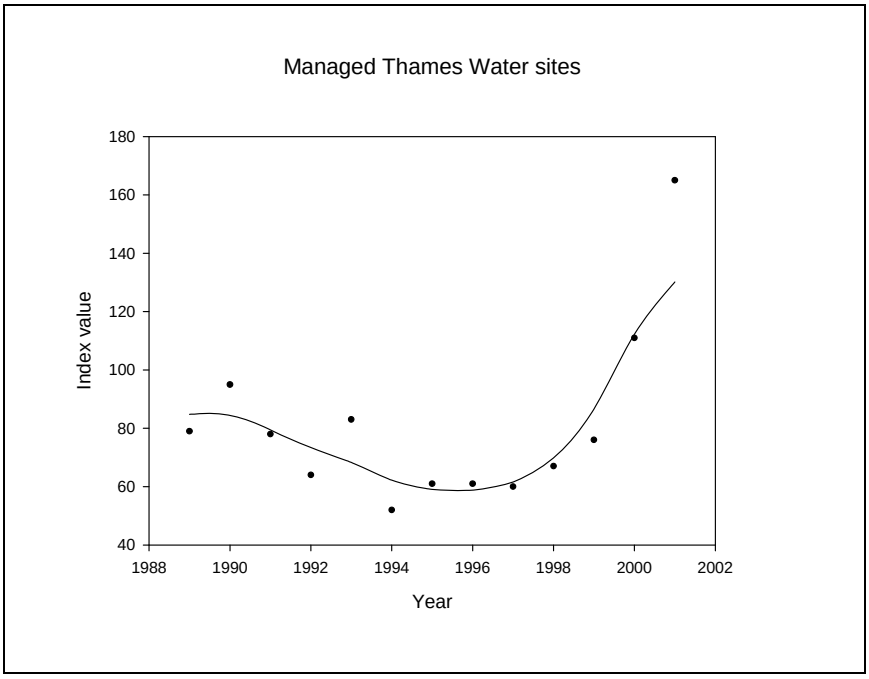

Figure 3.4.1.1 Weighted trend of wintering waterbirds on selected Thames Water sites managed for conservation.

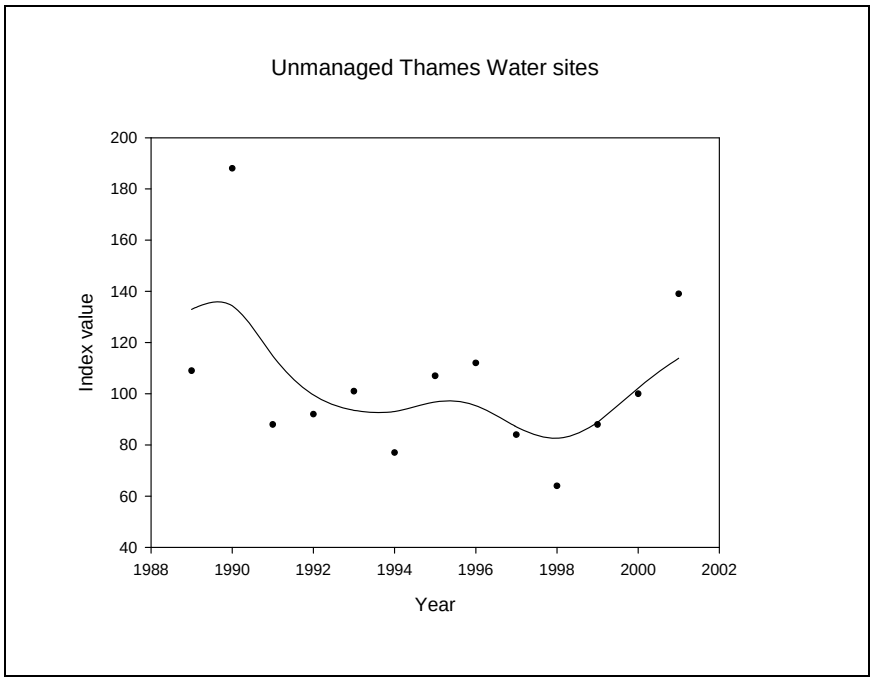

Figure 3.4.1.2 Weighted trend of wintering waterbirds on selected Thames Water sites not specifically managed for conservation.

The trend for the same group of species as featured in Figure 3.4.1.1 appears in Figure 3.4.1.2, for selected sites not managed for conservation. The general pattern is one of relative stability, with the index value in 2001 similar to that in 1989. However, the period of decline appears more prolonged and steeper than for managed sites, although there has also been recent increase. It is possible that various waterbirds filled the high quality conservation-managed sites first, creating a buffer effect (Brown 1969). In this case, increases would occur at conservation managed sites, whilst declines may be seen at unmanaged sites as birds are attracted elsewhere. The recent increase at both types of site is potentially explicable by wider increases in the British wintering populations of various species (*e.g.* Cormorant, Gadwall, Great Crested Grebe, Little Grebe: Austin *et al*. 2004).

4. CONCLUSIONS

4.1 Feasibility of indicator construction

Nearly half (49%) of all Thames Water sites were found within 1 km of a bird survey location. These surveys encompassed a minimum of 77 different bird species, and data are in most cases long-running and comprehensive. BBS data extends back to 1994, whereas WeBS data are in some cases available as far back as 1964. Interpolation techniques and methods of imputing to create smoothed indices are certainly advanced enough to contend with missing values. Therefore, even using existing levels of precision in site matching, it should be possible to generate bird indicators reflecting the 'health' of many Thames Water properties.

4.1.1 Wintering birds

Sixteen species were identified as receiving substantial coverage on Thames Water sites coincident with those monitored by the Wetland Bird Survey. These include four species in national decline under the WeBS Alerts system: Goosander, Mallard, Pochard and Pintail (Austin *et al*. 2004). Coverage of sites tends to vary between locations and years, but data can usually be interpolated where missing. The 'major' Thames Water sites (*e.g.* London area reservoirs) are likely to have received comprehensive monitoring.

WeBS data could therefore be applied in various ways for future construction of indicators. Some possibilities include:

- 'All sites' indicator (i.e. the trend of all species combined for all WeBS sites within a set distance of Thames Water sites).
- Conservation enhancement indicator (i.e. the bird trends of all specifically managed Thames Water sites *vs*. those not specifically managed for conservation).
- Declining species and 'conservationally valuable' species indicator (i.e. the trend of species on Thames Water sites identified to be in national or regional decline by the WeBS Alerts system).

4.1.2 Breeding birds

51 species of breeding bird were recorded on an average of at least 20 BBS squares within 500 m of Thames Water sites. This list includes a wide variety of bird groups, including corvids (Carrion Crow, Jackdaw, Rook), game birds (Pheasant, Red-legged Partridge), woodland specialists (Great Spotted Woodpecker, Jay, Nuthatch), raptors (Kestrel, Sparrowhawk), urban specialists (House Martin, House Sparrow, Swallow, Swift) and waterbirds (Canada Goose, Moorhen). This list is extensive enough to generate a robust indicator of widespread common bird species and could be broken down into constituent groups such as migrants and residents, or farmland and woodland species. However, waterbody and riparian specialists such as Tufted Duck, Mute Swan, Little Grebe, Great Crested Grebe, Kingfisher, Sedge Warbler, Reed Warbler, Sand Martin and Grey Wagtail occurred at too few BBS sites within the Thames catchment to be indexed, and a different approach to producing useable indices would have to be considered.

One possibility for bolstering the BBS list is to include data from the specialist surveys. These could potentially provide information for an additional 14 species for inclusion in the breeding bird indicators. However, coverage of some surveys, especially BWWM, is at periodic intervals of more than 10 years, rather than annually as for BBS. Considerable interpolation of data between years would be necessary, and it is therefore highly questionable whether data are comprehensive enough for inclusion in indicators, even though for Curlew, Oystercatcher, Redshank and Snipe this is likely to be the only source of breeding data.

WBS and WBBS are better candidates for increasing the number of species covered. Although only a limited number of species are monitored by these riverine surveys, they are likely to be birds of conservation value such as Grey Wagtail, Kingfisher and Reed Bunting. Combined with BBS plots, WBS/WBBS stretches could increase the number of different sites visited to above 20 a year, thus allowing trends of species such as Coot, Mute Swan and Reed Bunting to be included in any potential indicator. Although the BBS species alone would provide sufficient variety for sub-indicators, such as those listed below, it is worthwhile including trends from other long-running surveys wherever possible.

- 'All sites' indicator (i.e. the trend of all species combined for all breeding bird survey sites within a set distance of Thames Water sites).
- Species group indicators (i.e. the trends of species grouped into feeding or nesting preferences). If the BWWM 'wader'species are treated as a distinct subset then the indicator approach could be different, for example the percentage change between historical and recent BWWM. The same could be done using overall occurrence on BBS squares for the less frequently recorded species of waterbody and riparian specialists (*e.g.* grebes, kingfisher, etc).
- Conservation enhancement indicator (i.e. the bird trends of all specifically managed Thames Water sites *vs*. those not specifically managed for conservation).
- Declining species indicator (i.e. the trend of species on Thames Water sites identified to be in serious or medium national decline by Gregory *et al*. 2002).

4.2 Conservation value of Thames Water sites

This report has identified a minimum of 77 species that could be used in constructing indicators. Sixteen of these species would be covered by a wintering bird indicator, the remainder by one of the breeding bird indicators (Mallard would be covered by both wintering and breeding indicators). Of these species, the wintering populations of many are of national importance (i.e. representing at least 1% of British wintering numbers of the species) at Thames Water sites (*e.g.* Coot and Gadwall on the Lee Valley Gravel Pits), whereas six of the breeding species are red-listed as birds of conservation concern (House Sparrow, Linnet, Skylark, Song Thrush, Starling, and Yellowhammer; Gregory *et al*. 2002). Therefore, the Thames Water sites identified have a potentially large impact on the conservation status of the birds listed in Great Britain, particularly in terms of discrete sub-populations of wintering waterbirds.

The effectiveness of conservation management for birds on Thames Water sites is highlighted by the plots of multi-species trends for managed and unmanaged sites. Of the 33 Thames Water sites selected at this initial stage of analysis, 13 were known to have undergone site enhancement for conservation, whereas the remaining 20 were not thought to have received management specific to conservation objectives. Indicators produced for wintering waterbirds, and weighted to reflect changes in species of high 'conservation value', showed that declining site trends on enhanced sites began to stabilise in the mid 1990s, before reversing around 1998. The overall bird trend appears to have been upward in the years since, which has positive implications for the conservation techniques employed. It would be extremely beneficial to ascertain the timing of Thames Water's management actions, to see if these coincide with observed bird trend changes.

However, the trend compiled on selected sites not thought to have been subject to specific conservation management does show differences to the trend for managed sites. The overall trend is of a negative index, with recent increases after ten years of steady declines. It is impossible to infer that site-specific practices may have contributed to bird declines through the 1990s, especially if recent increases have occurred without changes in site stewardship. Nonetheless, as this group of sites includes many important waterbodies, such as those that are components of the South West London Waterbodies SPA, it would be worth investigating differences between management practices at the two groups of sites.

If further work confirmed that management practices appeared to influence bird trends on wintering waterbird sites, the conservation benefits of site enhancement to many important species would be underlined. Species known to be in national decline, such as those issued with WeBS 'Alerts' (Austin *et al*. 2004) could be targeted. Goosander, Mallard, Pochard and Pintail are all species identified to be on 'Medium Alert' (i.e. declining between 25% and 50% over a 5-, 10- or 25-year period). Species-specific indicators could be generated for Thames Water sites, to illustrate the effects of directly managing sites for birds of declining conservation status.

Thames Water sites that overlap or fall close to breeding bird survey sites could have similar indicators produced to those for wintering sites. Management at these sites would have to extend to terrestrial habitat conservation as well as issues concerning water levels, quality and pollution because the majority of species monitored are not associated particularly with water. Breeding birds require nest-building habitat, suitable trees, coverage or buildings for nest location, plus abundant sources of food and water. Those Thames Water sites managed as nature reserves could be used to investigate whether breeding bird trends improve with site management. Indicators of red-listed birds would show how the most threatened species react to such conservation enhancement.

4.3 Future directions and research

4.3.1. Comparisons with national and regional trends

A worthwhile next step would be to confirm that the preliminary indicators generated here, that seem to highlight differences in wintering waterbird trends at Thames Water sites enhanced for conservation, do reflect responses to site management. One signifier would be if trends at Thames Water sites did not reflect those at the wider scale. For example, it would be useful to check the trends for the relevant species at the regional and national levels. If multi-species indicators for Thames Water sites showed different trends to regional or national trends, effects of general changes in population trends could effectively be ruled out. In this way, site-specific factors could be focused on as drivers of change in bird indicators. Recent developments in methods for WeBS Alerts (Banks & Austin 2004) would allow straightforward approximation of site *vs*. regional and national trends.

4.3.2 Digitisation of site boundaries

The findings of this report illustrate the possibility for additionally varied and comprehensive coverage of many Thames Water sites by both wintering and breeding bird surveys. Whilst most of the potential sites for inclusion in potential indicators were based on a distance parameter of 500 m between bird survey site and Thames Water site, many more areas of overlap were found by increasing this to 1 km. It would be extremely useful to obtain digitised site boundaries of Thames Water sites, so that it is possible to ascertain how many more bird survey sites could feed into any proposed indicators, and to achieve greater precision in site matching (see Appendix).

For example, if a BBS square is currently measured to be 1.2 km from the central grid reference of a Thames Water site, it will not have been picked up by the GIS search. However, if it transpired that the site boundary of the Thames Water site passed within 500 m of the same BBS square, this site would then potentially be suitable for inclusion in an indicator, as part of the Thames Water property could be covered by the BBS transect.

Similarly, with the imminent completion of the CUDI (Count Unit Definition Inventory) system for WeBS, it will be possible to recalculate the numbers of Thames Water sites covered by WeBS counters. In this report, only centroid grid references were used for consistency, but the likelihood is that many more Thames Water and WeBS locations overlap than currently estimated.

BBS squares are already defined by a grid reference centred on the area of a 1 km square. Also, BWWM sites have been digitised by the BTO and the spatial boundaries are clarified. Regarding the Heronries Survey, as most heronries will be confined to small areas of wooded habitat, there is

probably little to be gained in increasing spatial precision from the current grid references. However, if practical, it would be an additional bonus to digitise WBS and WBBS stretches, as the current straight-line plots are only approximately accurate.

4.3.3 Timing/nature of conservation management

Future analysis of the effectiveness of conservation management at Thames Water holdings would greatly benefit from detailed information. Although changes in site management are unlikely to be universal in timing or implementation, interpretation of bird trends would be facilitated by knowledge of site action. Additionally, if Thames Water hold up-to-date and comprehensive lists of those sites specifically enhanced for conservation, then indicators designed to highlight green credentials would be greatly refined. The finer the scale of detail, the more flexibility indicators would be able to achieve.

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APPENDIX 1

Illustrating the increased precision of site matching with digitised site boundaries

Implementing the recommendation to digitise site boundaries would allow for much greater precision in matching Thames Water sites with bird survey sites. Not only is this likely to increase the candidate number of survey sites for input to indicators, it will also increase confidence that indicators are based on survey areas that fall under the jurisdiction of Thames Water. Currently, we can infer that proximate sites are likely to overlap in terms of home ranges or 'reasonable' expectations of bird movements, and that indicators have a high chance of reflecting changes at the target Thames Water sites. With greater precision of site matching, flexibility would be increased, and different indicators could be generated based on different parameters. For instance, an indicator based solely on survey data known to be collected within Thames Water site boundaries could be compared to one including survey data from sites at a given distance (but with biological relevance).

On a similar theme, the matching process does not discriminate presently between duplicate matches, so that more than one bird survey area can be matched to one Thames Water site. Although this may not affect an 'all sites' indicator, it would allow greater precision when analysing indicators for sub-groups (*e.g.* conservation enhancement indicator). Figure A.1 shows a hypothetical example of this scenario. One Thames Water site is matched to two WeBS sites based on a measured distance of less than 500 m. Currently, both WeBS sites would input data to an indicator. However, once the site boundaries of both sites are known, much greater accuracy can be placed on matching sites. In this example, WeBS 1 would reflect changes at TW 1; whether WeBS 2 did the same would become a subjective issue.

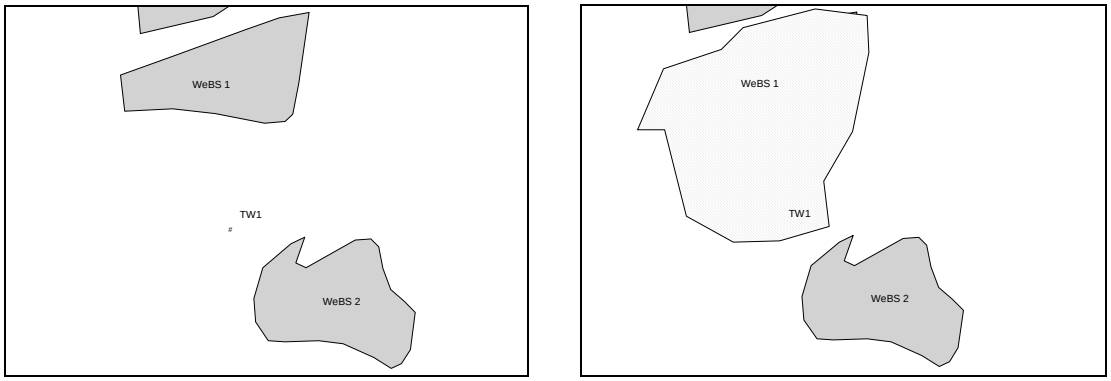

Figure A.1 Effect of site matching precision on hypothetical data. Left hand diagram shows current level of precision, with two digitised WeBS sectors matched to one Thames Water site (TW 1). Right hand diagram illustrates digitised Thames Water site boundaries that overlap WeBS 1 only.

On a related theme, more than one Thames Water site may also be covered by more than one BBS square, more than one WeBS site, or more than one survey. Figure A.2 shows a hypothetical situation where two Thames Water sites are matched to one WeBS site. Learning the spatial boundaries of both Thames Water sites and the WeBS sites shows that the WeBS site probably reflects bird trends of one Thames Water site only; if the second Thames Water site is particularly important for conservation, additional monitoring would be required for the site to contribute to indicators.

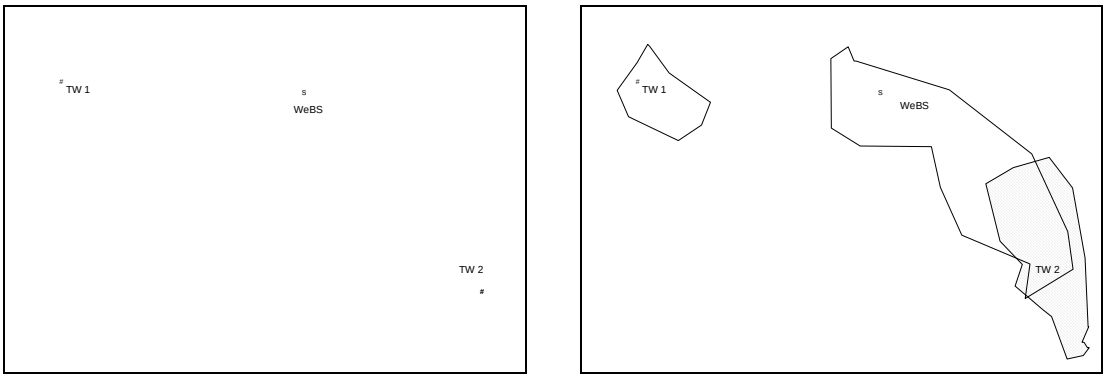

Figure A.2 Additional effect of site matching precision on hypothetical data. Left hand diagram shows current level of precision, with two Thames Water sites (TW 1 and TW 2) matched to one WeBS site. Right hand diagram illustrates effect of learning Thames Water site boundaries, where hatched area shows extent of TW 2.