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The winter bird community of river corridors in eastern England in relation to habitat variables

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Most river corridors have been highly modified and managed but they still support diverse assemblages of birds. To aid conservation it is important to know which river corridor habitats support the greatest diversity and numbers of bird species. All birds were counted on three occasions in winter along 50 one km stretches of lowland rivers in eastern England, and habitat variables were recorded. A total of 81 species was recorded. Species richness was greatest on tidal stretches of river, followed by urban/amenity sites, with lowest richness on rural stretches. Mute Swans, Mallards and Moorhens were significantly more numerous at urban/ amenity stretches and were scarce or absent in headwater reaches. Three terrestrial species also occurred in significantly greater numbers in urban/ amenity stretches. No species was significantly more numerous in rural stretches. TWINSPAN analysis separated out tidal and urban/amenity stretches, while bird species were separated into those associated with riparian trees and shrubs, and those of more open stretches, with further groups associated with wider rivers and the tidal stretches. A CANOCO analysis showed river width to be the most significant factor explaining bird distributions, followed by presence of floodbanks, riparian tree cover and amount of thick marginal vegetation. The rivers studied and their immediate floodplains have long been managed and modified from source and this has an overriding influence on habitat quality and on the species richness and numbers of birds utilizing any particular stretch.

1. Introduction

The river corridor provides important habitats for many species of resident and migrant birds. In the past, a natural river channel would have meandered through a forested landscape, with wetlands in the low-lying areas. However rivers have been intimately connected to the development of human society. Forests have been cleared for agriculture and rivers channels have been highly modified to improve land-drainage, to assist the transportation of goods, to provide water power for mills and other industries. The majority of our towns and cities have been built on the banks of rivers and we also use them extensively for recreation. The river of today is ecologically very different from its origins (Mason 2002).

Despite these modifications, river corridors have distinctive bird assemblages and it is important to determine those habitats which support the highest species diversity and abundance of birds. Rivers also provide important semi-natural habitat in towns and cities, which also provides a corridor through which species can pass in an otherwise often inhospitable habitat. There has been much recent interest in the use of urban habitats by birds (e.g. Jokimäki and Suhonen 1993, 1998, Mason in press), though the urban river has received little attention.

There have been few studies on the ecological correlates of bird distribution in river corridors. Rushton *et al.* (1994) analysed data from the Waterways Bird Survey (Carter 1989) and found that water quality was the most important factor influencing the abundance of bird territories. Buckton and Ormerod (1997) and Brewin *et al.* (1998) related bird distribution on upland Welsh rivers to habitat variables derived from the River Habitat Survey (Raven *et al.* 1997, 1998), with the distribution of some species influenced by channel features alone, other species being influenced by characteristics of both channel and riparian zone. Roché (1989) and Roché and Frochot (1993) examined the waterbird community in relation to river zonation, with zones for bird assemblages being analogous to those for fish described by Huet (1949). Other studies have related bird distribution to water quality (Ormerod *et al.* 1986, Rushton *et al.* 1994, Buckton *et al.* 1998, Sorace *et al.* 1999) and to land use and management (Raven 1986, Manel *et al.* 2000). Some studies of bird communities have considered the floodplain rather than the immediate river corridor (e.g. Strong and Bock 1990, Hubálek 1999). The only account of the bird community on rivers in winter in relation to features of habitat is that of Mason and Macdonald (2000), who found that river width had most influence on the numbers of birds present.

All of the above studies have considered mainly those species specifically associated with aquatic habitats. However, river corridors may be valuable to a range of other species, not restricted to the river/riparian zone, because river corridors often support a semi-natural habitat, such as trees, marginal and emergent vegetation in an agricultural landscape that is often poor in such features (Mason *et al.* 1984). These corridors may allow movement between patches of habitat for those species unwilling to fly over open spaces. Furthermore, emerging aquatic insects provide a supplementary food supply during much of the year (Iwata *et al.* 2003). The wetted edge of the river may become particularly important during cold weather when freezing conditions prevent access to other food sources.

With these considerations in mind, the present study describes the bird communities present in winter within the corridors of several lowland rivers in eastern England, with survey sites ranging from headwaters to the tidal reaches and including a number of stretches passing through towns and villages. It relates species distribution and numbers to habitat variables. The results are discussed in relation to the conservation of river corridor habitats for birds in highly managed rivers.

2. Methods

2.1. Study area

The study was carried out in the North Essex catchment (with an area size of 3,600 km^2) in eastern England, and comprising the rivers Stour, Colne, Blackwater and Chelmer. The total length of designated main rivers, excluding minor tributaries, was 573 km, the River Stour being the longest at 108 km. The human population of the catchment was 877,500 individuals and it contained five towns, with populations ranging from 6,820 (Hadleigh) to 154,400 (Colchester).

All rivers rise at altitudes of about 100 m and catchments are predominantly agricultural, much of it arable, especially in the upper and middle reaches. The lower reaches of the rivers are backed mainly by grassland. The natural channels have been modified from source over very many years, with a marked reduction in riparian tree cover (Mason and Macdonald 1990, Harper *et al.* 1997). The rivers are eutrophic, with low flows and with low oxygen concentrations frequent during summer (Parr and Mason 2003, 2004). The climate in both winters was mild, with no lying snow or periods of frost lasting for more than one week.

A total of 50 stretches of 1,000 m length were surveyed. For logistical reasons, the 25 stretches in

Table 1. Habitat variables measured at each stretch of river in eastern England.

Variable	CODE	Recorded as
Long-term average flow	FLOW	Classes 1 (< 0.31), 2 (0.31–0.62), 3 (0.62–1.25), 4 (1.25–2.5) m^3s^{-1}
Distance from tidal limit	DIST	Km
Width	WIDT	m, average of 10 estimates by eye
Depth	DEPT	recorded as shallow (bottom visible) or deep (bottom not visible)
Adjacent hinterland	ARAB	arable
	GRAS	pasture
	WOOD	woodland
	GARD	garden
	URBN	urban
		recorded on both banks, to a width of 50m, to a total of 20
Aspects of water flow	CANL	canal
	WEIR	weir
	RIFF	riffle
	RUN	run
	POOL	pool
	MILL	millpond
		recorded as present/absent each 100m, maximum score of 10 each
Island	ISLA	present/absent recorded at each 100m
Banks	VERT	vertical
	ARTI	artificial
	FLOO	floodbank
		presence recorded both sides every 100m
Marginal vegetation		vegetation with roots growing on substrate not covered with water; recorded on each bank as either
	MTHK	thick (>1 m wide) or
	MTHN	thin (<1m),
		with a score from 0 (absent) to 5 (continuous), assessing cover over 100m – maximum score 100
Emergent vegetation		vegetation clearly growing in water either
	ETHK	thick (> 1m wide) or
	ETHN	thin (<1m wide)
		recorded as for marginal vegetation
Floating vegetation	FLOA	recorded as present/absent, with a maximum score of 10
Scrub	SCRB	woody vegetation < 2m tall, recorded on a 0–5 scale, both banks, as above
Trees	TREE	recorded on a 0 (absent) – 5 (continuous cover) both banks – maximum score 100

the Stour catchment were surveyed in the winter of 2003–2004, the remainder in the winter of 2004–2005. With similar weather conditions in both winters, it was unlikely that sampling year would have significantly affected the results. The prime objective of the study was to compare species richness and numbers between habitat categories and relate bird distributions to habitat features; both survey years included the range of habitat categories and features.

From Ordnance Survey maps (scale 1:25,000) the river was categorised into four habitat types and the number of 1,000 m stretches in each determined. The habitat types were: Tidal, the river before it broadened out into the estuary, with narrow mudflats exposed at low tide. Urban, where the river ran largely through or immediately adjacent to the built environment of town or village. Amenity, typically a rural location where a car-park, picnic tables *etc*. were adjacent to the river, allowing ready access for the public, and rural (with none of the above). For analytical purposes, the urban and amenity categories were combined. Within these habitat categories, survey stretches were determined by a stratified random method related to the total number of stretches in each category. Three visits were made to each stretch: between mid-October to the end of November, between early December and mid-January and between early February and the end of the first week in March. One bank of the river was walked slowly and all birds observed within the river corridor (river and bank-side habitat to 5 m from the wetted perimeter) were recorded. Any new species noted on the return journey were counted and added to the list. All bird counts were conducted by two observers working together. On the first visit to each stretch a number of habitat features were assessed at intervals of 100 m by one observer (SMM). Table 1 provides details of these habitat features, which were based on those recorded in the River Habitat Survey (Raven *et al*. 1997), but modified to be relevant to the lowland rivers in this study.

2.2. Analysis of data

For purposes of analysis, the highest count of each bird species recorded on the three surveys was taken as the number present, included new species recorded on the return journey. The highest count was used because it was considered that this was closest to the carrying capacity of a stretch. During the winter, many bird species are mobile and counts at any one time likely to be variable, while disturbance immediately prior to a survey could result in a lowered count. The use of the maximum count also allowed for greater discrimination between sites. Abundances were log (n+1) transformed prior to analysis to normalise distributions. For those species occurring at ten or more stretches, and in at least two of the habitat categories, ANOVAs were used to examine differences in numbers between habitat categories. Differences in species richness between habitat categories were also tested by ANOVA.

Assemblages and sites were classified using TWINSPAN (Hill 1979), with pseudo-species cutoff levels based on abundances in the data (0, 0.2, 0.4, 0.6, 1.0), with equal weighting. The division was halted at level 4.

Canonical Correspondence Analysis (CCA, Canoco for Windows 4.5) was employed to relate the species abundance data to the environmental variables (ter Braak 1986). For these ordinations, the full species data set (pool of all replicates) and the measured environmental variables from each stretch were used initially. The number of environmental variables was then reduced using the automatic forward selection option in the Canoco programme. This allows for the step-wise building of a model for the species data, starting with the variable that explains most of the variance. Subsequent environmental variables were included only if they significantly improved the explained variance (based on Monte-Carlo permutation tests).

Plots are species-conditional, based on Hill's scaling ($L^a/1–L$)), that is the species scores were weighted averages of the sample scores, each species point in the ordination diagrams being at the centre of its niche. Intra-set correlation coefficients are reported. They represent the correlations between each environmental variable and the first two axes of the ordination. The higher the correlation coefficient the more important is the variable with respect to the variance explained by the specific axis. Correlation coefficients have the advantage of not being affected if environmental variables are mutually correlated, as is frequently the case in field data (ter Braak, 1995).

3. Results

3.1. Species recorded

A total of 81 species of birds was recorded during the study. A list of species, with species codes, scientific names, the number of sites at which species were recorded and the maximum count are given in Table 2. Some 15 species are primarily coastal in distribution and 19 species primarily wetland, though these categories are not mutually exclusive. The remaining species are terrestrial. The species richness at stretches ranged from 11 to 33 species. Differences in species richness between habitat categories were significant (Table 3), with tidal river stretches having more species than urban/ amenity stretches, which in turn had greater species richness than rural stretches.

Table 3 provides the results for species that showed significant differences in numbers between habitat categories. Little Grebes and Canada Geese were significantly more associated with tidal river stretches. Mute Swans were significantly associated with urban/amenity stretches,

Table 2. Bird species recorded at 50 stretches of river in eastern England.

Species	Code	No. Sites	Maximum Count
Little Grebe *Tachybaptus ruficollis*	LG	11	11
Cormorant *Phalacrocorax carbo*	CA	7	2
Little Egret *Egretta garzetta*	ET	6	4
Grey Heron *Ardea cinerea*	H.	15	2
Mute Swan *Cygnus olor*	MS	25	78
Greylag Goose *Anser anser*	GJ	7	31
Canada Goose *Branta canadensis*	CG	13	407
Barnacle Goose *Branta leucopsis*	BY	3	2
Egyptian Goose *Alopochen aegyptiacus*	EG	3	9
Shelduck *Tadorna tadorna*	SU	3	2
Muscovy Duck *Cairina moschata*	MY	3	12
Wigeon *Anas penelope*	WN	2	79
Teal *Anas crecca*	T.	6	79
Mallard *Anas platyrhynchos*	MA	33	267
Smew *Mergus albellus*	SY	1	1
Goosander *Mergus merganser*	GD	2	2
Sparrowhawk *Accipiter nisus*	SH	2	1
Kestrel *Falco tinnunculus*	K.	9	1
Red-legged Partridge *Alectoris rufa*	RL	1	3
Pheasant *Phasianus colchicus*	PH	10	6
Moorhen *Gallinula chloropus*	MH	46	28
Coot *Fulica atra*	CO	6	8
Oystercatcher *Haematopus ostralegus*	OC	1	1
Ringed Plover *Charadrius hiaticula*	RP	1	3
Grey Plover *Pluvialis squatarola*	GV	3	6
Lapwing *Vanellus vanellus*	L.	3	520
Dunlin *Calidris alpina*	DN	2	9
Snipe *Gallinago gallinago*	SN	7	3
Black-tailed Godwit *Limosa limosa*	BW	2	32
Spotted Redshank *Tringa erythropus*	DR	1	1
Redshank *Tringa totanus*	RK	4	36
Green Sandpiper *Tringa ochropus*	GE	4	1
Black-headed Gull *Larus ridibundus*	BH	13	109
Common Gull *Larus canus*	CM	7	32
Lesser Black-backed Gull *Larus fuscus*	LB	2	2
Herring Gull *Larus argentatus*	HG	1	1
Feral Pigeon *Columba livia*	FP	2	66
Stock Dove *Columba oenas*	SD	1	1
Woodpigeon *Columba palumbus*	WP	42	34
Collared Dove *Streptopelia decaocto*	CD	14	3
Little Owl *Athene noctua*	LO	1	1
Kingfisher *Alcedo atthis*	KF	25	2
Green Woodpecker *Picus viridis*	G.	4	1
Great Spotted Woodpecker *Dendrocopus major*	GS	8	2
Meadow Pipit *Anthus pratensis*	MP	5	6
Grey Wagtail *Motacilla cinerea*	GL	18	2
Pied Wagtail *Motacilla alba*	PW	14	11
Wren *Troglodytes troglodytes*	WR	47	7
Dunnock *Prunella modularis*	D.	36	4
Robin *Erithacus rubecula*	R.	47	6
Redstart *Phoenicurus phoenicurus*	RT	1	1
Stonechat *Saxicola torquata*	SC	2	2
Blackbird *Turdus merula*	B.	47	21
Fieldfare *Turdus pilaris*	FF	18	96

Table 2. Continued	Code	No. Sites	Maximum Count
Song Thrush *Turdus philomelos*	ST	38	3
Redwing *Turdus iliacus*	RE	13	47
Mistle Thrush *Turdus viscivorus*	M.	11	2
Chiffchaff *Phylloscopus collybita*	CC	5	2
Goldcrest *Regulus regulus*	GC	27	4
Long-tailed Tit *Aegithalos caudatus*	LT	33	13
Marsh Tit *Parus palustris*	MT	3	2
Coal Tit *Parus ater*	CT	4	3
Blue Tit *Parus caeruleus*	BT	45	12
Great Tit *Parus major*	GT	44	11
Tree Creeper	TC	9	2
Jay *Garrulus glandarius*	J.	15	3
Magpie *Pica pica*	MG	17	4
Jackdaw *Corvus monedula*	JD	2	6
Rook *Corvus frugilegus*	RO	5	24
Carrion Crow *Corvus corone*	C.	19	6
Starling *Sturnus vulgaris*	SG	15	20
House Sparrow *Passer domesticus*	HS	6	11
Chaffinch *Fringilla coelebs*	CH	42	15
Brambling *Fringilla montifringilla*	BL	1	1
Greenfinch *Carduelis chloris*	GR	21	9
Goldfinch *Carduelis carduelis*	GO	24	40
Siskin *Carduelis spinus*	SK	1	2
Linnet *Carduelis cannabina*	LI	1	1
Bullfinch *Pyrrhula pyrrhula*	BF	11	4
Yellowhammer *Emberiza citrinella*	Y.	9	12
Reed Bunting *Emberiza schoeniclus*	RB	2	3

with 85.7% of all swans found at these 19 stretches; no swans were found in headwater (flow class 1) stretches, though these comprised 26% of the total. Similarly, Mallards were strongly associated with urban/amenity stretches, with 91.2% of those counted occurring here; only 1% occurred in headwaters. Some 71% of Moorhens were also associated with urban/amenity stretches, while only 8.8% occurred in headwater streams. Black-headed Gulls occurred on urban/amenity and tidal river stretches with significantly fewer on rural rivers. Collared Dove, Great Tit and Goldfinch also occurred significantly more often at urban/amenity stretches compared with rural sites. No species occurred in significantly greater numbers at rural stretches.

Table 3. Mean species richness and maximum numbers (with ranges) of species showing significant differences between habitat categories. * P < 0.05; ** P < 0.01; *** P <0.001

Species	Tidal	Urban/Amenity	Rural	F
n	4	19	27	
Species Richness	28.5 (16–29)	22.1 (16–29)	18.3 (11–26)	12.97**
Little Grebe	6.3 (2–11)	0.4 (0–5)	0.2 (0–2)	30.7***
Mute Swan	1.3 (0–2)	6.9 (0–78)	0.6 (0–5)	8.0***
Canada Goose	195.8 (0–407)	14.1 (0–130)	8.2 (0–130)	5.4**
Mallard	5.3 (1–9)	47.3 (0–267)	2.4 (0–13)	19.0***
Moorhen	0.5 (0–1)	11.5 (1–28)	3.2 (0–14)	22.8***
Black-headed Gull	25.2 (6–64)	13.9 (0–109)	0.2 (0–4)	15.6***
Collared Dove	0	1.1 (0–3)	0.1 ((0–2)	20.7***
Great Tit	0	4.2 (0–9)	2.7 (0–11)	5.8*
Goldfinch	0	4.7 (0–40)	2.0 (0–15)	4.8*

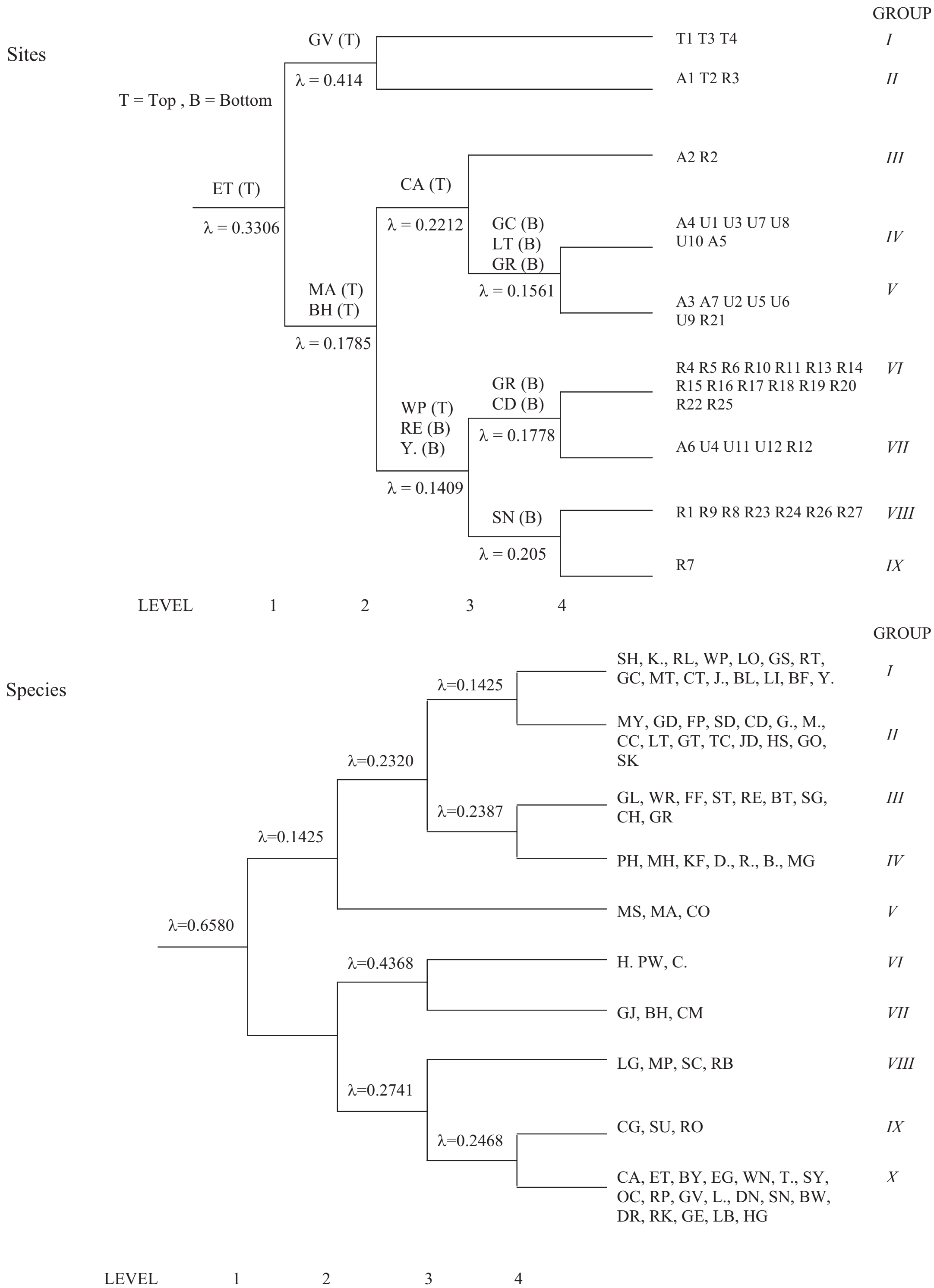

Fig. 1. Classification a) sites and b) species groups by TWINSPAN. Eigenvalues (λ) and indicator species are indicated for each dichotomy: T = Top, B = Bottom side of dichotomy. Sites codes: T = Tidal sites, A = Amenity sites, U = Urban sites, R = Rural sites (for bird codes, see Table 2).

Table 4. Intraset correlations of habitat variables with the first two axes of CCA of bird species data. The statistical significance of the effect of each variable was estimated by a Monte Carlo permutation test as each variable was added to the model (see Table 1 for abbreviations).

	Axis 1	Axis 2	F	P
WIDT	0.8117	–0.3207	8.32	<0.01
FLOO	0.7729	0.2800	3.35	<0.01
TREE	–0.4574	–0.3312	3.05	<0.01
MTHK	–0.1448	–0.3379	1.70	<0.05

3.2. Grouping analyses

TWINSPAN classification of stretches was concluded at level four with nine site groups produced (Figure 1a). Two groups (*I* and *II*) were separated out at the first division (indicator species: Little Egret), including the four tidal river stretches, with two additional stretches (Amenity A1, Rural R3) which had broad floodplains of grazing pasture. Urban/amenity stretches were separated out in groups *IV*, *V* and *VII*. Mallard and Black-headed Gull separated Groups *III*, *IV* and *V* at level 2. Group *V11* comprised largely small urban river stretches: Rural R12 in this group was flowing immediately downstream of a small town. Group *VII* was separated from rural group *VI* by indicator species Collared Dove and Greenfinch. Group *IX* consisted of a single stretch, a tributary of the River Stour receiving water from the Ely-Ouse transfer scheme and comprising a highly modified headwater channel with a series of weirs to oxygenate water discharging from a long tunnel. The majority of rural stretches fell into groups *VI* and *VIII*.

These two groups are separated at level 3 by Woodpigeon (group *VI*), Redwing and Yellowhammer (group *VIII*). As all three are mobile, flocking species during winter, not specifically associated with water, the division between the two is probably not biologically very meaningful. Both rural groups comprised headwater, middle and lower reaches of rivers.

TWINSPAN classification of species was concluded at level 4 with the production of 10 groups (Fig. 1b). Groups *I – IV* are largely associated with stretches of river with bankside trees and shrubs, while groups *VI – X* are birds associated with more open habitats, Group *X* being birds largely of the tidal river. The three species in group *V* (Mute Swan, Mallard and Coot) tend to be most numerous in the wider reaches of rivers.

In the CCA analysis, width (WIDT) was the most significant habitat factor explaining bird distribution patterns (Table 4), followed by presence of floodbanks (FLOO), tree-cover (TREE) and the amount of thick marginal vegetation (MTHK). Floodbanks were especially, but not exclusively, associated with the tidal reaches of the river, which are also wider, so both may be important for some species (such as wading birds and waterfowl), or may be surrogates for intertidal mud, a variable not specifically measured in this study. For species associated with floodbanks and width, tree cover and marginal vegetation were not important, these variables being more associated with primarily terrestrial species. A number of variables significantly associated with the axes of the ordination diagram when considered alone (flow class, distance from tidal limit, depth, number of riffles, amount of arable land in adjacent to river) were themselves correlated with width. The extracted gradients based on all canonical axes with reference to species weighted averages were significant (Monte Carlo permutation test, $F = 3.69$, $P < 0.01$). A number of species were therefore associated with wide stretches of river with floodbanks (Fig. 2), primarily coastal species of waders, wildfowl and gulls on the tidal river stretches. Some waterbird species are clearly associated with thick marginal vegetation on wider stretches of river (Mallard, Mute Swan, Coot and Goosander). A large number of primarily terrestrial species are associated with tree cover on narrower stretches of river, some being influenced also by the presence of thick marginal cover (e.g. Chiffchaff, Wren).

The tidal stretches cluster out along the floodbank and width gradient (Fig. 3). There is rather more overlapping than with the TWINSPAN clus-

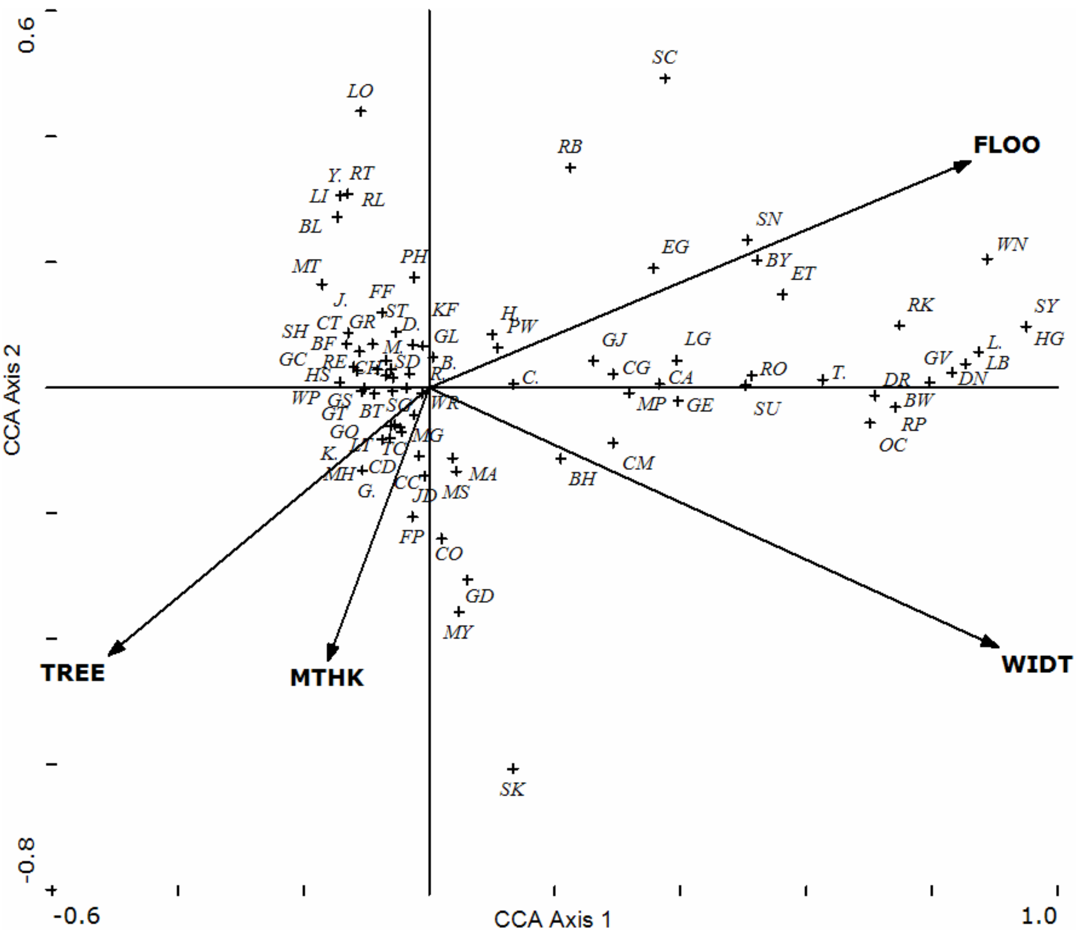

Fig. 2. Canonical Correspondence Analysis ordination diagram with bird species and habitat variables. For bird codes, see Table 2.

tering between rural, urban and amenity managed stretches. However, rural stretches are generally narrower with a lesser cover of trees and thick marginal vegetation. Urban stretches have on average more trees and amenity stretches are wider with more thick marginal vegetation.

4. Discussion

4.1. River birds in winter

All lowland rivers in England are extensively modified and managed, a situation typical of much of Europe. Nevertheless, this study has shown that they can support a diverse assemblage of birds, not only of species especially associated with water, but also of a range of terrestrial species utilizing the riparian zone.

The TWINSPAN analysis separated out tidal and rural/amenity stretches of river. Tidal stretches were found to have the highest species richness. These stretches not only held wading birds and wildfowl typical of the upper reaches of estuaries, but they also retained sufficient emergent vegetation and patches of scrub to support small numbers of terrestrial species.

Urban/amenity stretches were of intermediate species richness. Gilbert (1992) pointed out that urban river corridors have received scant attention from ecologists. It is of interest that the species richness of Odonata in this region was similarly higher in sites managed for amenity compared to agricultural landscapes, because these stretches

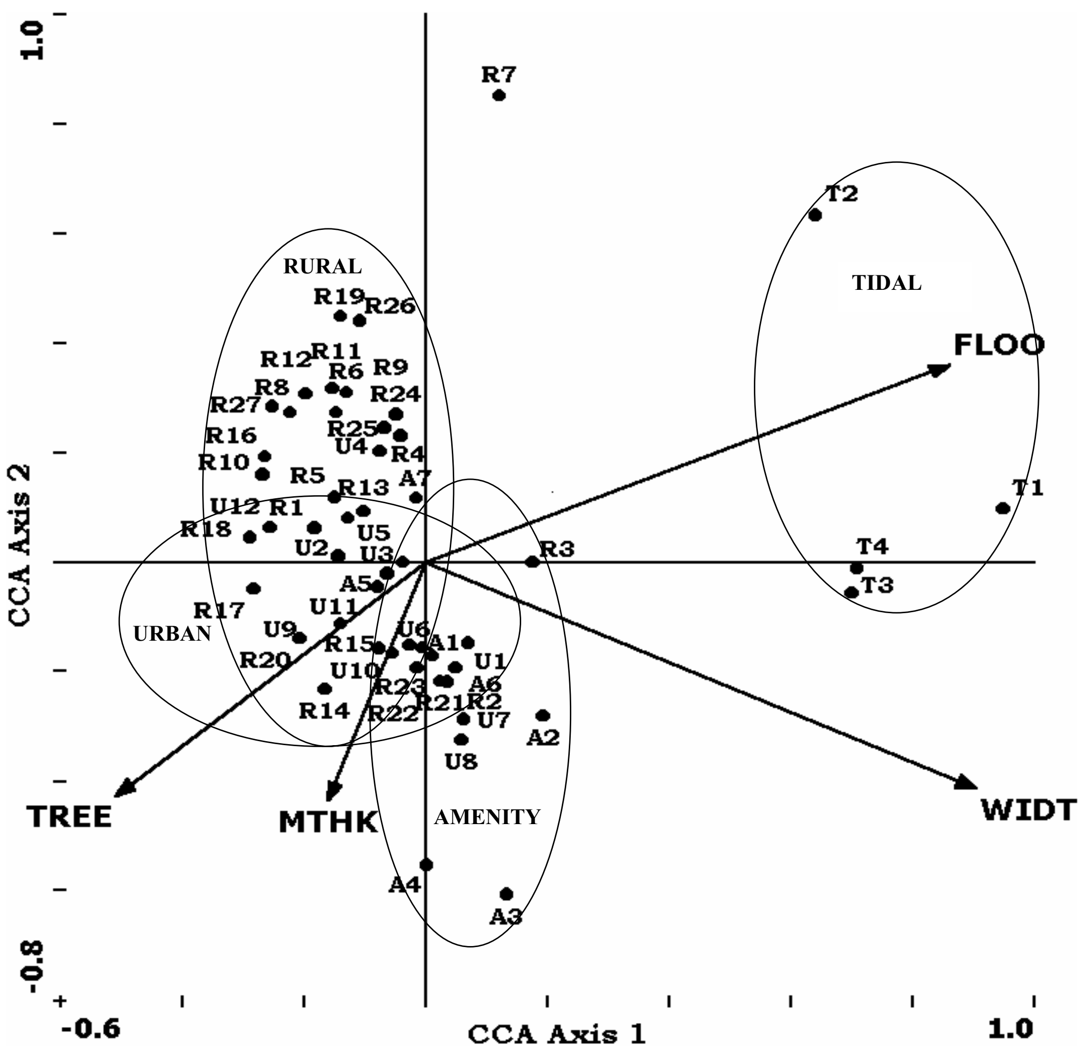

Fig. 3. Canonical Correspondence Analysis ordination diagram with sites and habitat variables. For site codes, see Fig. 1.

had greater structural diversity both within the river and the riparian zone (Hofmann and Mason 2005), features likely to be of importance also to the bird community. Of waterbirds, Mute Swan, Mallard, Moorhen and Black-headed Gull were all significantly more numerous in urban/amenity stretches, as found previously by Mason and Macdonald (2000). Clearly, these species are attracted to food supplied by the public and the cultural significance of these urban bird populations was discussed in Mason and Macdonald (2000). They are also likely to be more secure, especially so in the case of the Mallard, which is widely hunted in rural areas. Urban sites are also potentially less exposed to adverse weather in winter than in rural sites.

Very few waterbirds were found in the upper reaches of rivers, where riparian species, not specifically associated with water, predominated. No species occurred in significantly greater numbers along rural stretches of river. In the CANOCO analysis, river width was the most significant variable explaining bird distribution patterns. In the earlier, smaller-scale study of Mason and Macdonald (2000) width also correlated most strongly with the distribution of waterbirds, most occurring on the wider, lower reaches of rivers. The presence of floodbanks was also an important variable in the present study but these were largely restricted to the tidal reaches, with their distinctive assemblages of waders and wildfowl.

The other key habitat features to emerge were riparian tree cover and thick marginal vegetation. Well-developed, marginal vegetation has previously been shown to influence the distribution of Mallards in spring (Buckton and Ormerod 1997) and of both Mallards and Mute Swans in winter (Mason and Macdonald 2000). Many of the birds recorded in this study are essentially species of woodland or woodland edge. The riparian tree community is diverse (Mason *et al*. 1984) but management in eastern England has severely depleted tree numbers on riverbanks (Mason and Macdonald 1990). Nevertheless, alders (*Alnus glutinosa*) in particular provide a rich source of seed in winter, while the emergence of river insects such as the Chironomidae, even in mid-winter, provides a supplementary food for birds. The marginal herbaceous vegetation, utilized extensively by terrestrial species such as Wrens and Blue Tits, is likely to become more significant in hard winter weather when the marginal fringe generally remains unfrozen. Despite extensive modification, the riparian zone still contains overall a greater density of trees and a more diverse range of habitats than the farmed hinterland.

4.2. Conclusions

The rivers of eastern England support a varied assemblage of birds in winter, despite extensive modification and management along their entire courses. A sympathetic restoration of river corridors and their adjacent floodplains would significantly enhance their conservation value for birds and provide a range of other conservation benefits. Such measures should include the reversion of arable farmland to wet pasture within the immediate floodplain, and the redevelopment of wetlands and riparian woodlands, which have been almost entirely lost in the study area. Smaller measures could include the provision of buffer strips and the planting of bankside trees. Catchment restoration might appear expensive but its long-term benefits extend much further than wildlife conservation. Water would be retained for longer in the system, allowing for the replenishment of groundwaters, so important for this drought-prone region, while reducing the costly risk of flooding to property and life. New wetlands would retain and transform pollutants and nutrients, reducing both pollution and eutrophication to rivers, the latter costing some £75–114 million per annum in damage in England and Wales (Pretty *et al*. 2003). The re-establishment of riparian zones markedly reduces the costs of maintenance within the river (Fuglsang 1998). Finally the enhancement of landscape and wildlife will attract visitors, to the benefit of the local economy. Such floodplain restoration has been on a very small scale in the UK, but more ambitious projects are being developed elsewhere, such as the National Ecological Network in the Netherlands (van Rijen 1998).

Itä-Englannin jokikäytävien talvilintuyhteisö

Vaikka useimmat jokikäytävät (jokiuoma ja jokivarsien tulva-alueet) ovat ihmisen voimakkaasti muokkaamia, niissä asustaa monipuolinen linnusto. Suojelun helpottamiseksi on tärkeää tietää, mitkä jokikäytävän ympäristötyypit ovat tärkeimpiä lajiston monimuotoisuuden ja runsauden ylläpitäjiä. Tässä tutkimuksessa laskettiin itäenglantilaisten jokien kaikki lintulajit kolme kertaa talvessa 50 kilometrin matkalta. Laskentojen yhteydessä luokiteltiin jokikäytävän elinympäristötyypit.

Tutkimuksessa havaittiin 81 lajia. Eniten lajeja oli vuoroveden vaikutuspiirissä olevilla alueilla, toiseksi eniten kaupunki-/virkistysalueilla. Maaseutualueiden linnusto oli kaikkein köyhin. Kyhmyjoutsenet, heinäsorsat ja liejukanat olivat runsaampia kaupunki-/virkistysalueilla kuin joen yläjuoksulla. Kolme maalintulajiakin esiintyi runsaimmillaan kaupunki-/virkistysalueilla. Mikään laji ei esiintynyt runsaimmillaan maaseutualueilla.

Aineiston tilastollisessa analyysissä (TWINSPAN, CANOCO) vuorovesi- ja kaupunki-/virkistyslueet erottuivat selvästi omiksi ryhmikseen. Lintulajit ryhmittyivät jokivarren puustoisia ja pensaikkoisia jaksoja suosiviin ja sellaisiin, jotka viihtyivät paremmin avoimemmissa ympäristöissä. Omiksi ryhmikseen hahmottuivat myös leveiden jokien ja vuorovesialueiden lajit. Jokiuoman leveys oli tärkein lintujen esiintymistä selittävä tekijä. Myös tulvarantojen sekä uomaa reunustavien puiden ja tiheän rantakasvillisuuden merkitys oli suuri. Ihminen on muokannut alueen jokivarsien ja tulva-alueiden elinympäristöjä jo kauan, joten ihmisellä on tärkeä vaikutus alueella talvehtivien lintujen elinolosuhteisiin sekä lajien lukumäärään ja runsauteen.

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