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Breeding avifauna in the heart of Europe: the Breeding Bird Atlas of Wallonia (Belgium) 2001-2007

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Abstract
More than 600 volunteers contributed to a seven-year inventory project of breeding birds in Wallonia (the Southern half of Belgium, covering about 16 844 km²). The resulting reference book presents in detail the distribution and abundance of the 175 breeding taxa. High-resolution relative density maps were built using spatial modelling on 1-km square sampling data. Comparison with the previous similar inventory, 30 years ago, offers interesting indications of changes in bird populations. Wetlands and forest species are globally showing a positive evolution, while farmland birds are rather declining. Altogether, species richness increased both at regional and local scale, while total number of birds probably slightly decreased.

Introduction

In the federal state of Belgium, bird population monitoring is organised at the regional level. After the publication of a breeding bird atlas for Flanders in 2004 (Vermeersch *et al.* 2004) and for Brussels in 2007 (Weiserbs & Jacob 2007), Wallonia was the last of the three federated regions without any breeding bird global inventory since the Breeding Bird Atlas of Belgium, whose fieldwork dated from the seventies (Devillers *et al.* 1988). Fieldwork started in spring 2001 and lasted till 2007. The main objectives were to list all breeding species (including exotics), to establish their distribution, to estimate their population, to highlight their variations in abundance and to analyse the observed changes since the last atlas work. This paper intends to summarize the methodology used in the field and in the subsequent analyses, and to present some of the main characteristics of present-day Wallonia breeding avifauna.

The study area: Wallonia

Wallonia covers 16 844 km², which is 55 % of Belgium (Figure 1a). Human density is 204 inhabitants/km², much lower than in neighbouring Flanders (439 inhabitants/km²) and the Netherlands (402 inhabitants/km²). Densely populated areas are concentrated in the historical industrial axes (from

Mons to Liège) and south of Brussels. This situation creates a strong gradient of largely urbanized areas or industrial farmland in the north, contrasting with mostly forested landscape or rural areas in the south. Variations in landscape (influenced both by man and abiotic conditions) define five “ecoregions” that were used in the analyses (Figure 1b). Wallonia is a low-lying country but altitudes increase according to a North-West / South-East axes up to 694 m at Eastern Ardennes.
Globally, main land-uses are agriculture (45.1 % - mostly very intensive practices), forestry (32.8 % - half semi-natural deciduous woodland, half coniferous plantations) and buildings (13.9 %). Very few natural habitat remains: only 250 ha of chalk grassland, less than 2 200 ha of mires and bogs, most of them in unfavourable conservation status (Dufrêne & Delescaille 2007). There is an extensive network of rivers but most ponds and lakes are of human origin.

Figure 1a: Belgium with Flanders in the north and Wallonia in the south (Brussels is the black spot), surrounded by France (F), Luxemburg (L), Germany (D) and The Netherlands (NL)

Methodology

The organization of the Atlas was entrusted to Aves within the framework of the program «Inventory and Surveillance of the Biodiversity», set up by the Walloon Region since 1989. This program includes diverse facets among

which a Common Bird Monitoring Scheme launched in 1990. The Atlas benefited from a wide participation of volunteer naturalists (more than 600 co-workers).

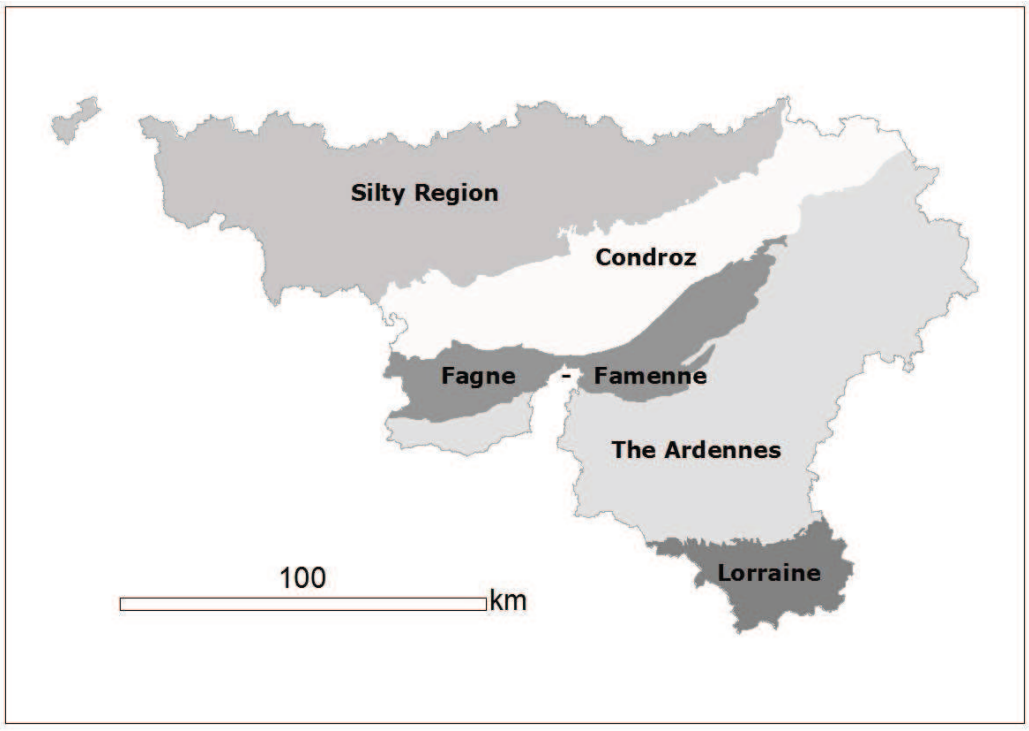


Figure 1b: The five Ecoregions in Wallonia

Field inventories

The chosen grid is based on the National Geographic Institute 1/10 000e topographic maps, this choice allowing direct comparison with the former Belgian Breeding Bird Atlas 1973-1977. Each of the 500 grid units covers 40 km² (8×5 km²). In each grid unit, all the bird species breeding in the wild (including allochtonous species) had to be listed (using the standard EBCC atlas code for assessing reproduction certainty (Hagemeijer & BLAIR 1997)) and their population estimated using a nine-class abundance scale.
In addition to the grid unit inventory, observers were also asked to sample 8 smaller squares of 1×1 km ("sampling square"), systematically delimited inside every 40 km² units. The sampling consisted in recording all birds seen or heard within the square limit, during two count periods of one hour, one early (25th of March to end-April) and a second one later in the season (mid-May to end of June). The sampling took place in the first 5 hours after sunrise. At the end of the fieldwork period, 2 800 squares were sampled, covering 17 % of Wallonia.
In addition to these standard atlas data, locations of approximate centre of bird territories were also collected at a precision of 100 m for a large number of the scarce breeders.

Map building

In the book, data are presented and commented by species regional experts under the form of two different maps for each species, and a third (the relative density map) for 77 of them.
The general map presents the field results at the 40 km² grid resolution. Two main information types are simultaneously shown: highest breeding evidence obtained for the grid unit and corresponding abundance class of the species.
The comparison map shows variation of occurrence and/or abundance of the species at the resolution of the former Belgian atlas grid (one unit of the 1973-1977 covers two units of the 2001-2007 atlas grid). The abundance classes of the present-day atlas were converted in the former atlas abundance classes. In this way, available information is degraded to allow direct comparison, unit per unit, with abundance estimation dating back from 30 years. This rationale was for example already successfully applied in the comparison of two successive atlases from the Netherlands (Van Turnhout *et al.* 2007).
The relative density map is based on the sampling square data, introduced in a spatial distribution modelling procedure taking into account 23 landscape, climatic and environmental variables calculated at the same resolution of 1 km². MaxEnt presence-only modelling tool (Phillips *et al.* 2006) was used to estimate a probability of presence score (for species where only occurrence data were used) or a relative density score (for species where the number of individuals recorded during the sampling was used) for the whole Wallonia at the resolution of the km².

Population estimates

Estimation of a population size at the regional level is a difficult but useful exercise, especially for very common species. In our case, estimates were given by the simple sum of abundance class limits for all occupied grid units (for rarer species) or by the sum of the abundance class central values (for commoner species). In this last case, population estimates have no more ambition than to give a very rough indication of the species abundance. For each species, population estimate is associated with a reliability score, based on expert judgment, in order to encourage readers to keep a critical look on the data presented.

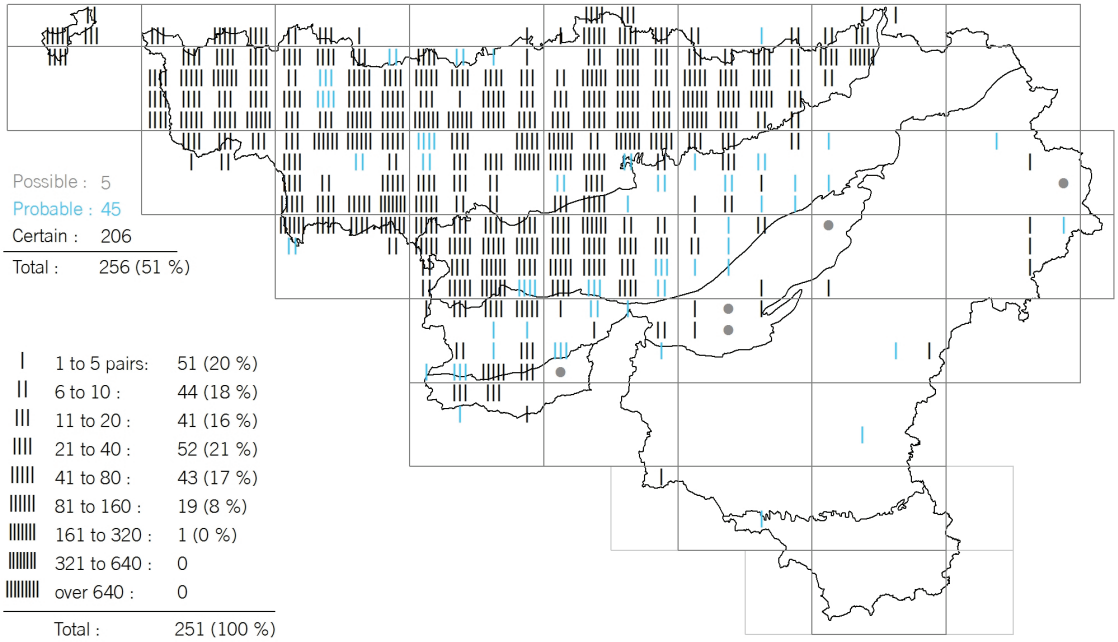
Results

The Walloon breeding avifauna

During the atlas period, 160 indigenous species (162 if *Motacilla f. flavissima* and *Motacilla a. yarrellii* are taken into account) have been breeding in Wallonia, most of them (90 %) on an annual basis. This total is close from those of neighbouring regions of similar size (for example 156 species in Rhineland, region of 13629 km² (Wink *et al.* 2005), 170 species in Flanders, region of about 14000 km² (Vermeersch *et al.* 2004)). About 15 species are unique to Wallonia in Belgium: mostly forest species (Hazel Grouse,

Wryneck) or birds linked to a continental context (Ring Ouzel). There are 13 species of allochtonous species breeding regularly in the wild in Wallonia: 9 Anatidae, 2 Pheasants, Feral Pigeon and Ring-Necked Parakeet. Most of them are recent breeders and all of these species are increasing, except the Common Pheasant. While being present in 80 % of the grid units, non-indigenous bird populations only represent 1.2 % of the estimated total of breeding pairs.
Together with the 13 wild-breeding exotic species, the distribution of 175 breeding taxa have been mapped at the grid-level. For 77 species, a high resolution relative density map has also been presented. Some examples are shown in Figure 2.

A)



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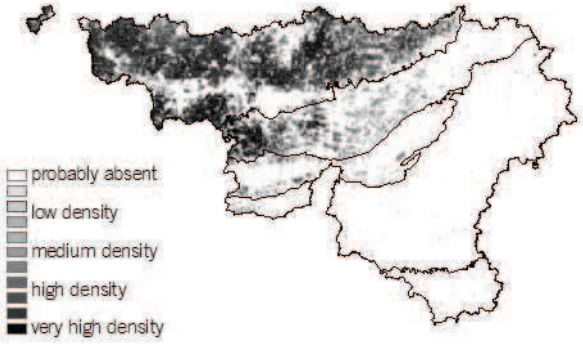

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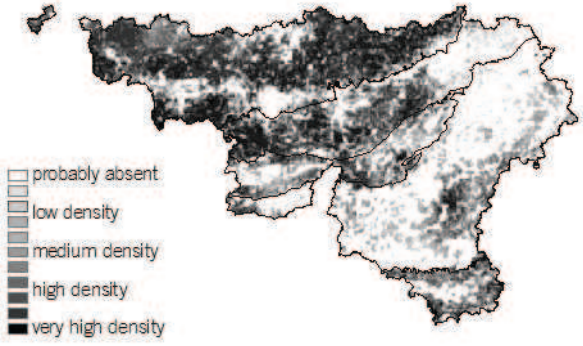

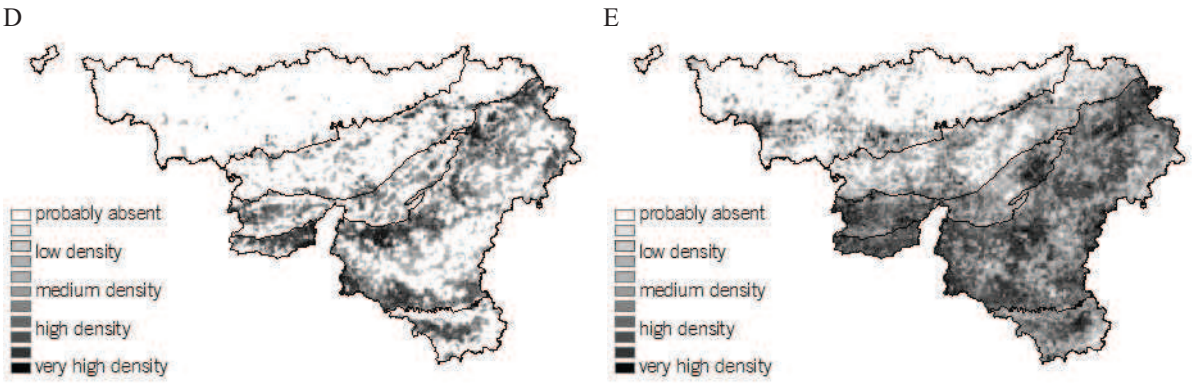

Figure 2 :Examples of maps. A: Result map at the 40-km² for the Yellow Wagtail. Dots stand for "possible" breeding cases, pales bars stand for "probable" and darkers bars for "certain". The number of bars correspond to the abundance class chosen by the observers. B to E are examples of relative density maps produced with the 1-km² sampling. The first two show typical distribution of farmland species (B: Yellow Wagtail, C : Skylark), D is the Wood Warbler and E the Willow Warbler.

Variation in species richness

Species richness per 40 km² grid unit averages 81.5 species, with seven 40-km² units hosting more than 100 species.

At the ecoregion scale, observed differences in species richness are low (Table 1). The longest breeding bird list is not found in the largest ecoregion (the Ardennes), but in the second largest (Silty Region), where several species-rich wetlands are located. However, at the grid unit scale, the picture is very different (Table 1). Average species richness is significantly higher (ANOVA, $p<0.001$) in the Lorraine and Fagne-Famenne ecoregion compared to Condroz and Ardennes, while Silty Region average species richness per unit is significantly lower than for the 4 other ecoregions. This is probably explained by a finer-grain mixing of better-quality habitats (deciduous forest, meadows and smaller-scale agriculture), typical of the two smallest ecoregions. Evidence of this can be found when comparing species richness of a subset of 1-km² sampling square dominated by farmland (meaning more than 75 % of land devoted to agriculture) : in farmland squares from Lorraine and Fagne-Famenne, species richness is on average about 30 % higher than in those sampled in the Silty Region.

Table 1: Comparison of breeding bird species richness, at the global and the grid unit scales, between the 5 ecoregions of Wallonia. All these figures are calculated without accounting for exotic species.

	Wallonia	Silty Region	Condroz	Fagne – Famenne	Ardennes	Lorraine
- Area (km²)	16 844	5 661	3 188	1 615	5 716	838
- Total number of breeding species	162	142	128	128	127	116
- Mean species richness by 40-km² grid unit	81.49	76.55	81.49	90.38	82.50	91.64
- Standard-deviation	8.56	8.95	6.94	7.01	6.02	7.39

Altogether, the shared set of species between ecoregion is rather high (100 species) and few birds are specific to only one ecoregion. The Ardennes, with its continental climate and its large cover of spruce plantations with relictual bogs and mires, is the ecoregion hosting the highest number of specific species (such as Black Grouse, Spotted Nutcracker…).

Abundances

Table 2 presents population estimates for all breeding species, associated with their reliability score. Common to very common species are probably greatly underestimated, but without more detailed data (like distance-sampling derived estimates), no better estimation can be made. Only 7 % of species are judged very common (more than 5 pairs / km²). Most species (76 %) are present in a density lower than 1 pair/km².

Table 2: List of the 175 breeding taxa in Wallonia, with the estimated population size and reliability of this estimation (A: reliable estimation given by a complete census; B : rather reliable estimation; C : poorly reliable estimation; D : under-estimated estimation, not reliable; E : very fluctant population, estimation not reliable). A star "*" indicates that the estimation was corrected by expert judgement from the raw data, "(E)" points to allochtonous species.

Species	Scientific name	Population size	ER
Black Swan	*Cygnus atratus*	0-3* pairs (E)	A
Mute Swan	*Cygnus olor*	140-180* pairs (E)	B
Greylag Goose	*Anser anser*	10-12* pairs (E)	B
Bar-headed Goose	*Anser indicus*	0-1* pair (E)	A
Barnacle Goose	*Branta leucopsis*	0-2* pair(s) (E)	A
Canada Goose	*Branta canadensis*	670-1 000 pairs (E)	B
Egyptian Goose	*Alopochen aegyptiaca*	330-590 pairs (E)	B
Common Shelduck	*Tadorna tadorna*	48-57 pairs	A
Wood Duck	*Aix sponsa*	0-2* pair(s) (E)	B
Mandarin Duck	*Aix galericulata*	53-71 pairs (E)	C
Eurasian Wigeon	*Anas penelope*	0-1 pair	A
Gadwall	*Anas strepera*	8-39* pairs	A
Eurasian Teal	*Anas crecca*	0-3* pair(s)	B
Mallard	*Anas platyrhynchos*	9 700 pairs	B
Garganey	*Anas querquedula*	1-5* pair(s)	B
Northern Shoveler	*Anas clypeata*	1-9* pair(s)	A
Red-crested Pochard	*Netta rufina*	0-3* pair(s)	A
Common Pochard	*Aythya ferina*	130-210* pairs	B
Ferruginous Duck	*Aythya nyroca*	0-1 pair	A
Tufted Duck	*Aythya fuligula*	200-260* pairs	B
Black Grouse	*Tetrao tetrix*	13-27* coqs	A
Hazel Grouse	*Bonasa bonasia*	48-140 pairs	E
Grey Partridge	*Perdix perdix*	3 900 pairs	B
Common Quail	*Coturnix coturnix*	2 300 territorial males	E
Reeve's Pheasant	*Syrmaticus reevesii*	84-140* cocks (E)	B
Common Pheasant	*Phasianus colchicus*	14 000 cocks (E)	B
Little Grebe	*Tachybaptus ruficollis*	610-860 pairs	B
Great Crested Grebe	*Podiceps cristatus*	410-490 pairs	A
Black-necked Grebe	*Podiceps nigricollis*	6-61* pairs	A
Great Cormorant	*Phalacrocorax carbo*	265-456* pairs	A
Eurasian Bittern	*Botaurus stellaris*	0-1* pair	A
Little Bittern	*Ixobrychus minutus*	1-4* pair(s)	A

Black-crowned Night Heron	*Nycticorax nycticorax*	0-2 pair(s)	A
Little Egret	*Egretta garzetta*	0-3 pair(s)	A
Grey Heron	*Ardea cinerea*	1 400-1 500 pairs	A
White Stork	*Ciconia ciconia*	0-1* pair	A
Black Stork	*Ciconia nigra*	75-95* pairs	B
European Honey-buzzard	*Pernis apivorus*	630-970 pairs	B
Red Kite	*Milvus milvus*	150-180* pairs	A
Black Kite	*Milvus migrans*	59-61* pairs	A
Western Marsh Harrier	*Circus aeruginosus*	1-7* pair(s)	A
Northern Harrier	*Circus cyaneus*	1-5* pair(s)	A
Montagu's Harrier	*Circus pygargus*	2-13* pairs	A
Eurasian Sparrowhawk	*Accipiter nisus*	2 700 pairs	B
Northern Goshawk	*Accipiter gentilis*	475-720 pairs	B
Common Buzzard	*Buteo buteo*	6 100 pairs	B
Common Kestrel	*Falco tinnunculus*	2 700 pairs	B
Eurasian Hobby	*Falco subbuteo*	340-380	B
Peregrine Falcon	*Falco peregrinus*	7-25* pairs	A
Water Rail	*Rallus aquaticus*	220-280 territorial males	C
Corn Crake	*Crex crex*	1-12* territorial males	E
Spotted Crake	*Porzana porzana*	0-1* territorial male	
Common Moorhen	*Gallinula chloropus*	6 000 pairs	B
Common Coot	*Fulica atra*	2 400 pairs	B
Eurasian Oystercatcher	*Haematopus ostralegus*	1-3* pair(s)	A
Pied Avocet	*Recurvirostra avosetta*	1-3* pair(s)	A
Northern Lapwing	*Vanellus vanellus*	6 100 pairs	B
European Golden Plover	*Pluvialis apricaria*	0-1 pair	A
Little Ringed Plover	*Charadrius dubius*	110-140* pairs	B
Eurasian Woodcock	*Scolopax rusticola*	3 000 territorial males	C
Common Snipe	*Gallinago gallinago*	1-4* territorial males	A
Mew Gull	*Larus canus*	82-94* pairs	A
Common Black-headed Gull	*Chroicocephalus ridibundus*	180-400* pairs	A
Common Tern	*Sterna hirundo*	0-1 pair	A
Feral Pigeon	*Columba livia*	19 000 pairs (E)	C
Stock Dove	*Columba oenas*	6 300 pairs	C
Common Wood Pigeon	*Columba palumbus*	100 000 pairs	D
European Turtle Dove	*Streptopelia turtur*	4 200 pairs	B
Eurasian Collared Dove	*Streptopelia decaocto*	43 000 pairs	C
Rose-ringed Parakeet	*Psittacula krameri*	45-60 pairs (E)	B
Common Cuckoo	*Cuculus canorus*	2 800 territorial males	B
Barn Owl	*Tyto alba*	1 400 pairs	B
Eagle Owl	*Bubo bubo*	80-85* pairs	A
Tawny Owl	*Strix aluco*	5 700 pairs	C
Little Owl	*Athene noctua*	3 700 pairs	B
Boreal Owl	*Aegolius funereus*	65-100* pairs	A
Long-eared Owl	*Asio otus*	2 300 pairs	C
Short-eared Owl	*Asio flammeus*	0-1 pair	
European Nightjar	*Caprimulgus europaeus*	50-60* pairs	A
Common Swift	*Apus apus*	23 000 pairs	C
Common Kingfisher	*Alcedo atthis*	450-650* pairs	B
European Bee-eater	*Merops apiaster*	0-3* pair(s)	
Eurasian Wryneck	*Jynx torquilla*	45-58 pairs	B
Lesser Spotted Woodpecker	*Dendrocopos minor*	2 000 pairs	C

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Middle Spotted Woodpecker	*Dendrocopos medius*	4 200 pairs	C
Great Spotted Woodpecker	*Dendrocopos major*	26 000 pairs	B
Black Woodpecker	*Dryocopus martius*	920-1 400 pairs	C
European Green Woodpecker	*Picus viridis*	5 900 pairs	B
Grey-headed Woodpecker	*Picus canus*	33-40* pairs	C
Wood Lark	*Lullula arborea*	200-220* pairs	A
Sky Lark	*Alauda arvensis*	23 000 pairs	B
Sand Martin	*Riparia riparia*	1 700-3 000* pairs	A
Barn Swallow	*Hirundo rustica*	36 000* pairs	C
Common House Martin	*Delichon urbicum*	32 000 pairs	C
White Wagtail	*Motacilla alba*	21 000 pairs	C
Pied Wagtail	*Motacilla alba yarrellii*	0-3* pairs	A
Yellow Wagtail	*Motacilla flava*	7 800 pairs	C
British Yellow Wagtail	*Motacilla flava flavissima*	3-6* pairs	A
Grey Wagtail	*Motacilla cinerea*	3 800 pairs	B
Tree Pipit	*Anthus trivialis*	11 000 pairs	B
Meadow Pipit	*Anthus pratensis*	3 800 pairs	B
White-throated Dipper	*Cinclus cinclus*	890 pairs	B
Winter Wren	*Troglodytes troglodytes*	160 000 pairs	D
Dunnock	*Prunella modularis*	76 000 pairs	D
European Robin	*Erithacus rubecula*	130 000 pairs	D
Common Nightingale	*Luscinia megarhynchos*	1 300 pairs	B
Bluethroat	*Luscinia svecica*	430-600 pairs	B
Black Redstart	*Phoenicurus ochruros*	18 000 pairs	C
Common Redstart	*Phoenicurus phoenicurus*	2 600 pairs	B
Whinchat	*Saxicola rubetra*	230-320 pairs	A
Eurasian Stonechat	*Saxicola torquatus*	2 700 pairs	B
Ring Ouzel	*Turdus torquatus*	9-13 pairs	C
Common Blackbird	*Turdus merula*	206 000* pairs	D
Fieldfare	*Turdus pilaris*	8 900 pairs	B
Song Thrush	*Turdus philomelos*	68 000 pairs	D
Mistle Thrush	*Turdus viscivorus*	19 000 pairs	C
Zitting Cisticola	*Cisticola juncidis*	0-1* pair	A
Cetti's Warbler	*Cettia cetti*	150-190 pairs	B
Common Grasshopper Warbler	*Locustella naevia*	1 900 pairs	C
Savi's Warbler	*Locustella luscinioides*	1-7* pair(s)	A
Sedge Warbler	*Acrocephalus schoenobaenus*	110-140 pairs	B
Eurasian Reed Warbler	*Acrocephalus scirpaceus*	1 500 pairs	B
Marsh Warbler	*Acrocephalus palustris*	7 800 pairs	C
Great Reed Warbler	*Acrocephalus arundinaceus*	0-2 pair(s)	A
Melodious Warbler	*Hippolais polyglotta*	2 100 pairs	B
Icterine Warbler	*Hippolais icterina*	1 100 pairs	B
Willow Warbler	*Phylloscopus trochilus*	38 000 pairs	C
Chiffchaff	*Phylloscopus collybita*	120 000 pairs	C
Wood Warbler	*Phylloscopus sibilatrix*	13 000 pairs	C
Eurasian Blackcap	*Sylvia atricapilla*	130 000 pairs	D
Garden Warbler	*Sylvia borin*	34 000 pairs	D
Common Whitethroat	*Sylvia communis*	29 000 pairs	D
Lesser Whitethroat	*Sylvia curruca*	7 100 pairs	C
Goldcrest	*Regulus regulus*	54 000 pairs	C
Firecrest	*Regulus ignicapilla*	51 000 pairs	C

Spotted Flycatcher	*Muscicapa striata*	3 500 pairs	C
Eurasian Pied Flycatcher	*Ficedula hypoleuca*	840 pairs	C
Bearded Reedling	*Panurus biarmicus*	0-1 pair	A
Long-tailed Bushtit	*Aegithalos caudatus*	12 000 pairs	C
Marsh Tit	*Poecile palustris*	22 000 pairs	C
Willow Tit	*Poecile montanus*	12 000 pairs	C
Coal Tit	*Periparus ater*	41 000 pairs	C
European Crested Tit	*Lophophanes cristatus*	19 000 pairs	C
Great Tit	*Parus major*	150 000 pairs	D
Blue Tit	*Cyanistes caeruleus*	86 000 pairs	D
Eurasian Nuthatch	*Sitta europaea*	39 000 pairs	C
Eurasian Treecreeper	*Certhia familiaris*	6 400 pairs	C
Short-toed Treecreeper	*Certhia brachydactyla*	31 000 pairs	C
Eurasian Golden Oriole	*Oriolus oriolus*	900 pairs	B
Red-backed Shrike	*Lanius collurio*	3 700 pairs	B
Great Grey Shrike	*Lanius excubitor*	270-330* pairs	A
Woodchat Shrike	*Lanius senator*	0-1* pair	A
Eurasian Jay	*Garrulus glandarius*	29 000 pairs	C
Eurasian Magpie	*Pica pica*	30 000 pairs	C
Spotted Nutcracker	*Nucifraga caryocatactes*	450 pairs	C
Western Jackdaw	*Corvus monedula*	15 000 pairs	C
Rook	*Corvus frugilegus*	15 000* pairs	A
Carrion Crow	*Corvus corone*	39 000 pairs	C
Northern Raven	*Corvus corax*	67-87* pairs	B
Common Starling	*Sturnus vulgaris*	88 000 pairs	C
House Sparrow	*Passer domesticus*	180 000 pairs	D
Eurasian Tree Sparrow	*Passer montanus*	12 000 pairs	C
Chaffinch	*Fringilla coelebs*	210 000 pairs	D
Red Crossbill	*Loxia curvirostra*	4 400 pairs	E
European Greenfinch	*Carduelis chloris*	25 000 pairs	C
Lesser Redpoll	*Carduelis flammea cabaret*	66-110 pairs	B
Eurasian Siskin	*Carduelis spinus*	520-1 000 pairs	E
European Goldfinch	*Carduelis carduelis*	6 600 pairs	C
Common Linnet	*Carduelis cannabina*	24 000 pairs	C
European Serin	*Serinus serinus*	1 300 pairs	C
Eurasian Bullfinch	*Pyrrhula pyrrhula*	9 800 pairs	C
Hawfinch	*Coccothraustes coccothraustes*	9 500 pairs	C
Yellowhammer	*Emberiza citrinella*	29 000 pairs	B
Common Reed Bunting	*Emberiza schoeniclus*	1 500 pairs	B
Corn Bunting	*Emberiza calandra*	1 400 pairs	B

When comparing density estimated in Wallonia with estimated density in Europe (using “Birds in Europe 2” for range and population size (BirdLife International 2004)), it appears that a panel of species are showing higher than average density in Wallonia (Table 3). Most of these species are forest-dwellers or raptors. In terms of international bird conservation concerns (Keller & Bollmann 2004), Wallonia shares a particular responsability in regards to these birds.

Table 3: Species showing an average density higher in Wallonia than in the rest of their European range. Bird Directive Annex I species are highlighted in bold.

English Name	Scientific Name	Density ratio (average density in Wallonia divided by average density in Europe)
Woodpigeon	*Columba palumbus*	2.8
Common Kestrel	*Falco tinnunculus*	2.6
Stockdove	*Columba oenas*	2.6
Eurasian Sparrowhawk	*Accipiter nisus*	2.5
Common Buzzard	*Buteo buteo*	2.1
Tawny Owl	*Strix aluco*	2.0
Winter Wren	*Troglodytes troglodytes*	1.7
Middle Spotted Woodpecker	***Dendrocopos medius***	1.6
Common Moorhen	*Gallinula chloropus*	1.5
Grey Heron	*Ardea cinerea*	1.4
Honey Buzzard	***Pernis apivorus***	1.4
Collared Dove	*Streptopelia decaocto*	1.4
Green Woodpecker	*Picus viridis*	1.4
Black Stork	***Ciconia nigra***	1.3
Blackbird	*Turdus merula*	1.2
Barn Owl	*Tyto alba*	1.1
Northern Goshawk	*Accipiter gentilis*	1.1
Eurasian Blackcap	*Sylvia atricapilla*	1.1
Carrion Crow	*Corvus corone*	1.1
Eurasian Hobby	*Falco subbuteo*	1.1

Observed changes in 30 years

Compared to the former atlas period 1973-1977, the list of breeding birds in Wallonia has increased by 16 species. Two species, already at the verge of extinction 30 years ago, disappeared (Crested Lark and Northern Wheatear) while 18 newcomers are now on the list. Most of them present very small or even irregular breeding population (Eurasian Wigeon, Red-Crested Pochard, Little Egret, Night Heron, Golden Plover, Eurasian Oystercatcher, Pied Avocet, Common Tern, Zitting Cisticola, and Bearded Tit). However, some of these newcomers developed long-lasting population, following either a recent expansion of their European range (Great Cormorant, Gadwall, Melodious Warbler) or a come-back after an extinction period: Black Stork, Montagu's Harrier, Peregrine, Eagle Owl and Raven (this last recovery originating from a successful local reintroduction program).

At the local scale, a clear increase of species richness is also observed: there are on average 12.9 more species for each 80-km² comparable grid units (+ 18 %). Moreover, this increase is calculated excluding exotic species. This phenomenon is probably partly explained by the better coverage of the recent Atlas, but not only. Compared frequency distribution of species richness (Figure 3) shows than, although the 2001-2007 distribution is more "bell-shaped", suggesting a better coverage, the median of species richness is

higher. Altogether, there is more species expanding their range than contracting. Excluding newcomers to Wallonia avifauna, 50 % of the species increased their range by at least 10 %, while only 9.5 % have lost more than 10 % of their range (range being calculated in that case by the number of occupied 80-km² units).

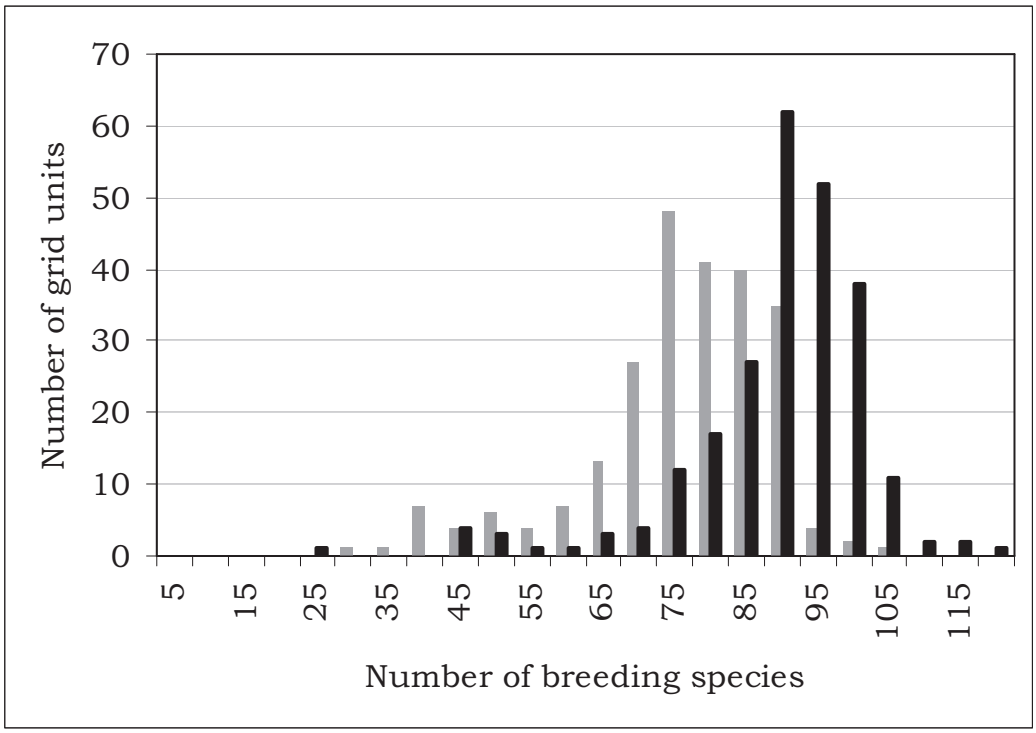

Figure 3: Compared distribution of species richness by 80-km² grid units between the 1973-1977 atlas (in grey) and the 2001-2007 atlas (in black).

Range expansion concerns a majority of species linked to wetlands (Figure 4). Most of the birds using wetlands, lakes and rivers are doing better than 30 years ago, for several reasons. Some of these waterbirds benefited from a diminution of traditional persecution (Great Crested Grebe, Grey Heron, Common Kingfisher), others from the creation of artificial ponds (Tufted Duck, Common Coot…). A few species also adapted to seemingly marginal habitats, like Bluethroat now commonly using ditches in-between intensive crops in Western Wallonia.

However, the landscape evolution having the strongest positive long-term influence on breeding birds in Wallonia probably concerns woodland (Figure 4). Several co-occurring phenomenon, dating back several dozens of years ago, are now reflected in woodland species range changes. These include: transformation of coppice-woodland to high-stand forests, aging of spruce-tree plantations, aging of planted parks and gardens, and legal protection for some species. These changes have in majority a positive effect on forest birds, but in some cases, some specialists are negatively affected, like for the Hazel Grouse, now a critically endangered species in Wallonia, following a long-term reduction of its traditional habitat, coppice-woodland. Very high density of ungulates also may concur to the threat on Hazel Grouse and other ground-nesting populations.

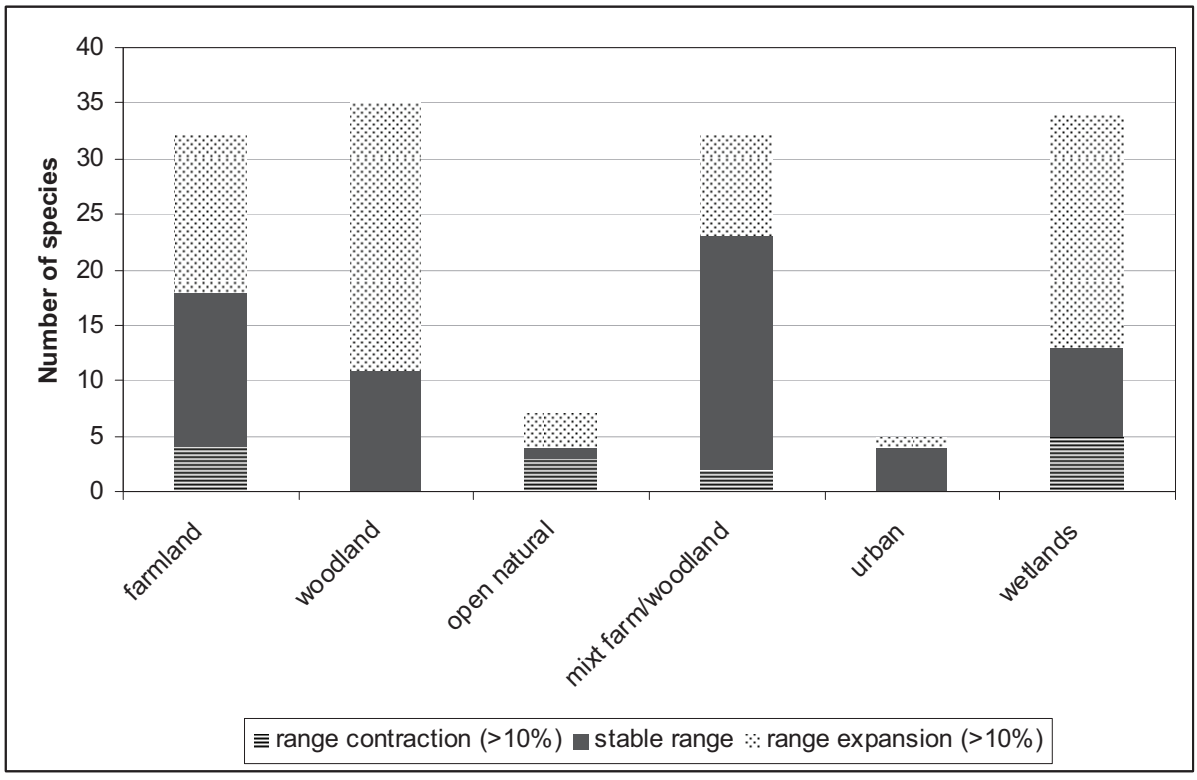

Figure 4: Number of species with increasing, stable or decreasing range, according to simple habitat types (only one habitat type for each species).

As everywhere in Europe (Donald *et al.* 2006), farmland birds are showing a much more negative evolution. Ranges of Whinchat, Grey Partridge and Corn Bunting shrunken dramatically, while a majority of farmland birds decreased in population without necessarily showing (yet ?) a range contraction at the 80-km² scale (Tree Sparrow, Common Linnet…). A few farmland species however benefited from reduction of persecution habits (Rook, farmland raptors…). Some also showed a contrasting pattern during the past 30 years: first a range expansion followed by a rapid range contraction (best examples are Lapwing and Fieldfare). Some unexpected phenomenons were also observed: Red-backed Shrike conquered 62 new grid units and its population was multiplied by 8 since 1973-1977. Yellow Wagtail shifted its breeding habitat, from wet meadows where the population is at the verge of extinction, to winter crop, with an expansion of the range to the South.

When looking at the population changes, a majority (65 %) of species are also increasing. Surprisingly, trends of commoner species tend to be more often negative, compared to the rarer species (Figure 5). As a result, there are more species but perhaps less birds than 30 years ago (an estimated decrease of 4.4 % in pair numbers, globally; however this figure must be taken with great care because of the uncertainties on common species population estimations).

Further investigation is required to test the hypothesis that this pattern is linked to an "homogenization" phenomenon, described for other parts of Europe (Van Turnhout *et al.* 2007; Devictor *et al.* 2008), where generalist species thrive and tend to occupy more and more space, while the specialists are in decrease.

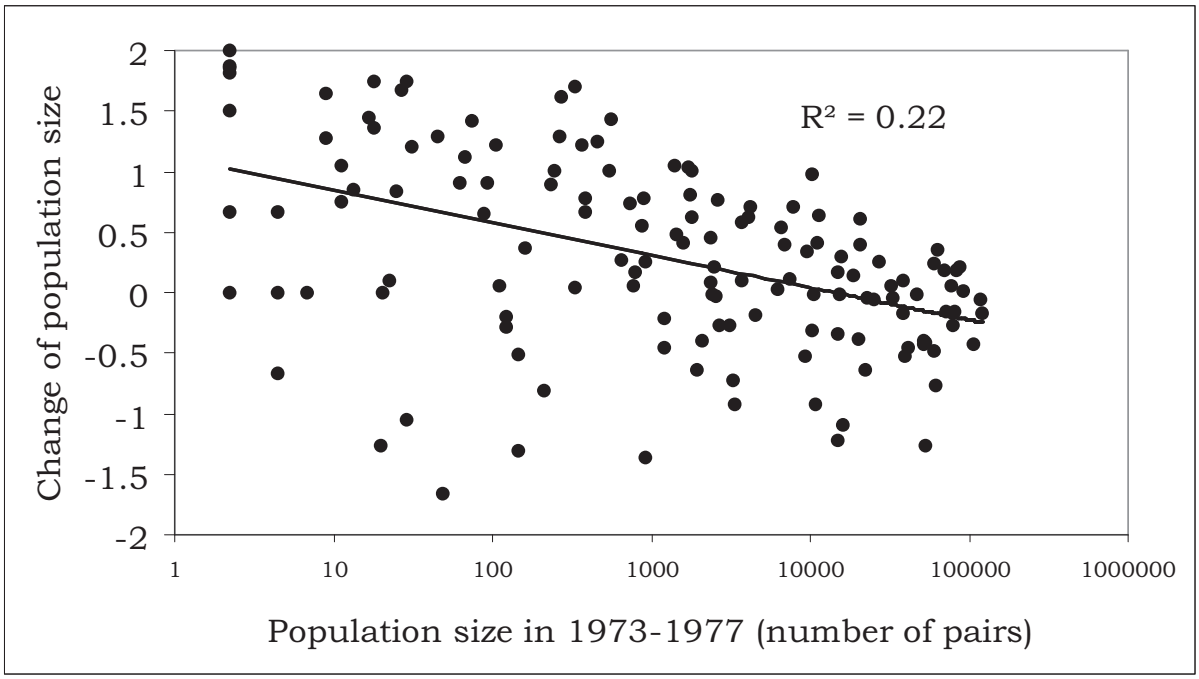

Figure 5: Relation between change in population between the two atlases and the initial population size (in 1973-1977). Change is calculated by the following formula: ($pop_{2001-2007} - pop_{1973-1977}$)/[($pop_{2001-2007} + pop_{1973-1977}$) / 2], which renders increases and decreases symmetrical, the maximum decline (extinction) being -2, and the maximum increase (colonization) being +2.

Conclusions

Thanks to an extensive collaboration with more than 600 volunteers and to the continuous support of the Walloon Region, this project succeeded in giving a thorough inventory of the breeding birds of Wallonia. Initiated at a crucial period where information technologies started changing the conduct of bird monitoring programs, the project did not took yet full advantages of now common online tools, but however took profit of new analysis methods, like relative density map building with spatial modelling.

Beside the reference book, numerous data are valuable for research and conservation, like more than 60 000 pointed locations of breeding territories of scarce species. Using this up-to-date and thorough information on bird distribution to fine-tune long-term bird monitoring scheme is also a challenging prospective. All in all, one of the ultimate goals of such an atlas is certainly to motivate the birdwatching community to pursue further fieldwork, hopefully focused on a better understanding of the described population evolutions.

Acknowledgements

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