Birds in the city - changes in species diversity along urban gradient and time in Krakow, Poland

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Introduction

Urban ecosystems:

- humans transform landscapes and replace natural habitats with anthropogenic ones
- some animals can adapt to these new environments, increasing their abundance and range of occurrence

Birds in the city:

- one of the best-studied urban groups of organisms
- used as bioindicators of landscape and environment quality
- studies became popular in the 1960s – growing interest

Marzluff et al. 2001
Chace & Walsh 2004

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Aim of the study

Evaluation of changes in bird species diversity along urban gradient and time.

Research questions

How does urban gradient affect the occurrence of different groups of birds?

How did bird communities change over the last 60 years in Krakow?

General method

A scientific review.

Keywords:
urban ecosystems; Krakow; diversity; birds; urbanisation

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Study area

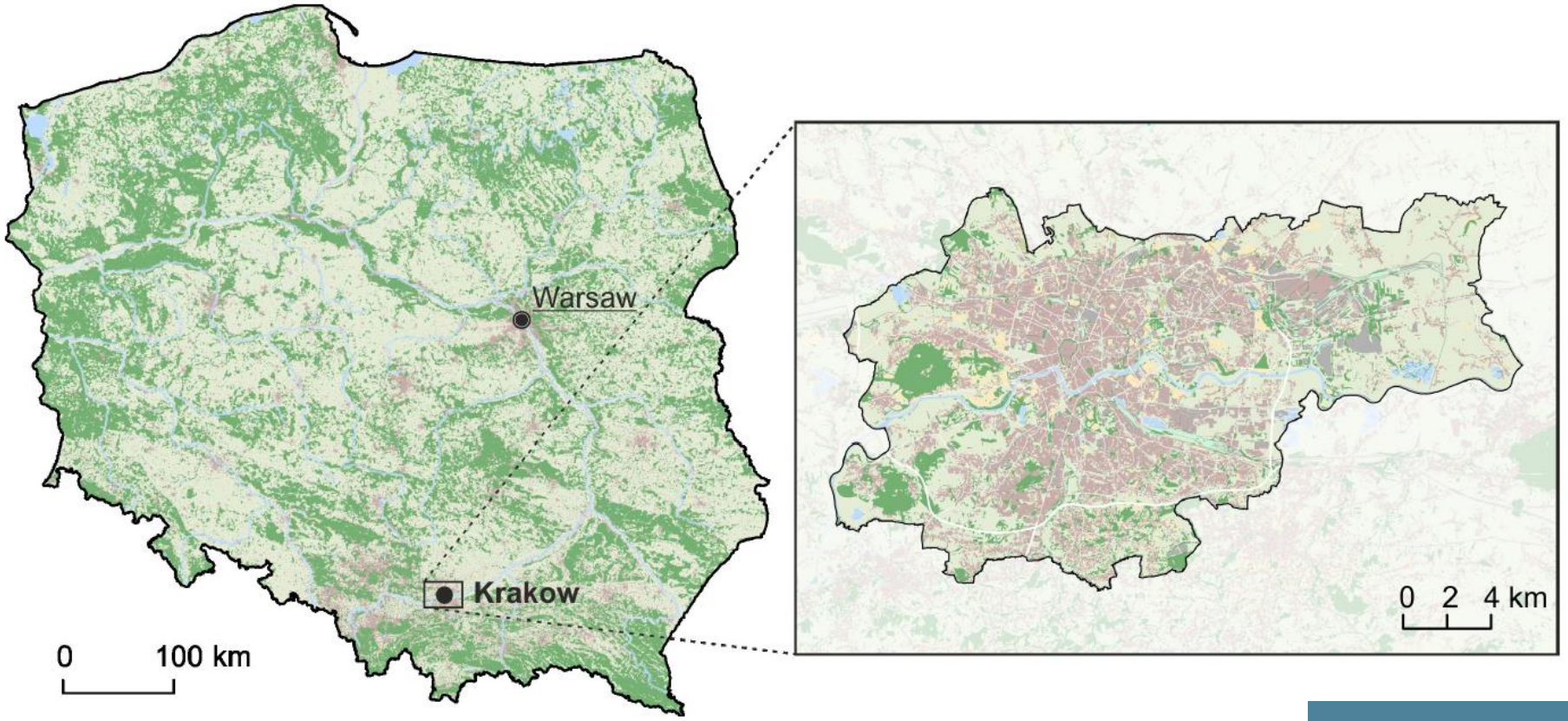

Figure 1. Location of the study area (Basak et al. 2020).

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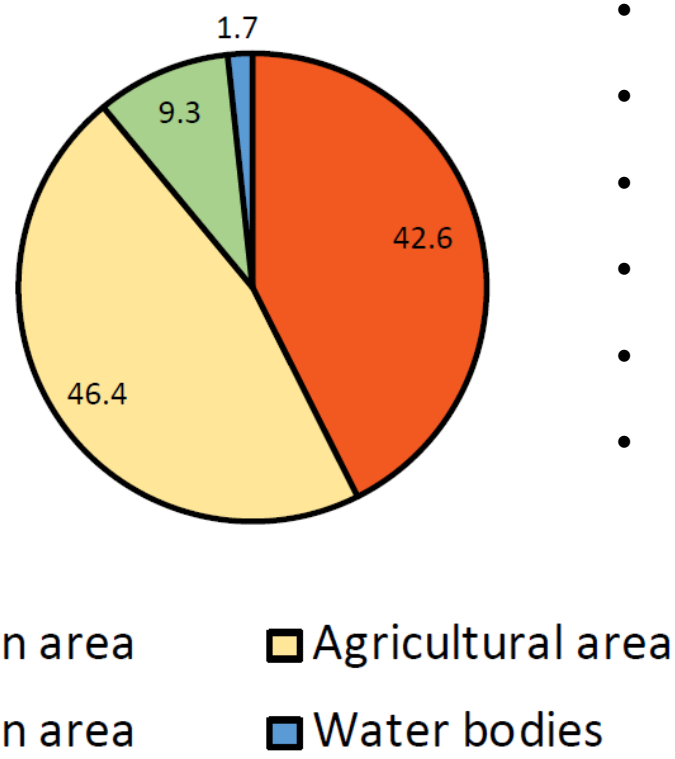
Study area



- second largest city in Poland
- population of 775,000
- population density of 2384/km^2
- area of 327 km^2
- diversified land cover
- Vistula river – natural migration corridor

Figure 2. Percentage of different types of landcover in Krakow (based on Chełstowska & Filip 2009, UMK. BIP – MK).

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Urząd Statystyczny w Krakowie

What was reviewed?

Over 140,000 scienific records, including:

academic theses
– about 750 observations

publications
– about 100 observations

an official online database Ornitho.pl
– about 139,700 observations

from the period of **1974-2020**.

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Types of a land use

Table 1. Landscape of settlement descriptors.

Term	Percentage built	Building density	Residential human density
Wildland	0-2	0	< 1 / ha
Exurban	5-20	< 2.5 / ha	1-10 / ha
Suburban	30-50	2.5-10 / ha	> 10 / ha
Urban	>50	> 10 / ha	> 10 / ha

Division based on Marzluff et al. 2008.

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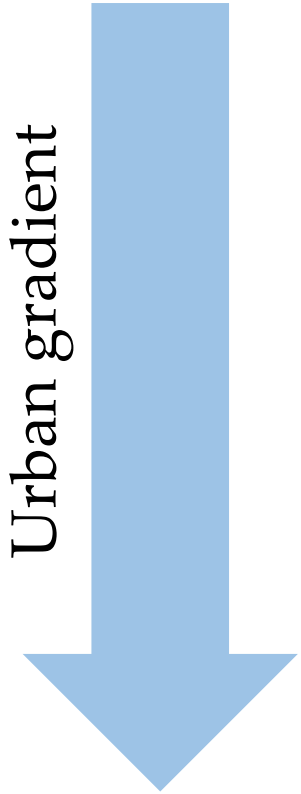
Urban wildlife categories



Avoiders
- highest densities in natural habitats

Adapters
- high densities in natural and suburban habitats, thrive in urban areas

Exploiters
- highest densities in urbanized areas, rare in natural habitats

Division based on the adaptive behavioural traits (Adams et al. 2006, Urban Wildlife Group 2012).

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Urban wildlife categories

Avoiders

- avoid people and urban areas
- sensitive to human-induced changes in the landscape
- visit cities occasionally, often during migration or winter season

Whooper swan (*Cygnus cygnus*) (photo MŚ).

Common crane (*Grus grus*) (MŚ).

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Urban wildlife categories

Adapters

- thrive in the cities
- prefer exurban and suburban areas, especially older, residential districts

White stork (*Ciconia ciconia*) (MŚ).

Common chaffinch (*Fringilla coelebs)* (photo MŚ).

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Urban wildlife categories

Exploiters

- achieve higher numbers and population densities in urban than natural areas
- often generalists, can utilize anthropogenic resources
- only a few species

Feral pigeon (*Columba livia f. urbana*) (Wikimedia CH).

House sparrow (*Passer domesticus*) (MŚ).

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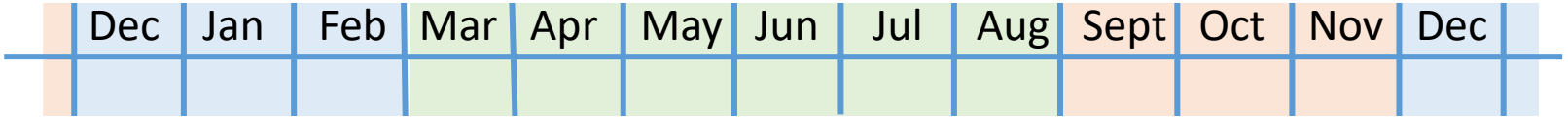
Seasons in the year

There are three main seasons in the year:



Winter

Breeding season
(spring and summer)

Migration
(autumn)

* there is also a spring migration, which happens between winter and breeding season, usually not distinguished in analyses.

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Results and Discussion

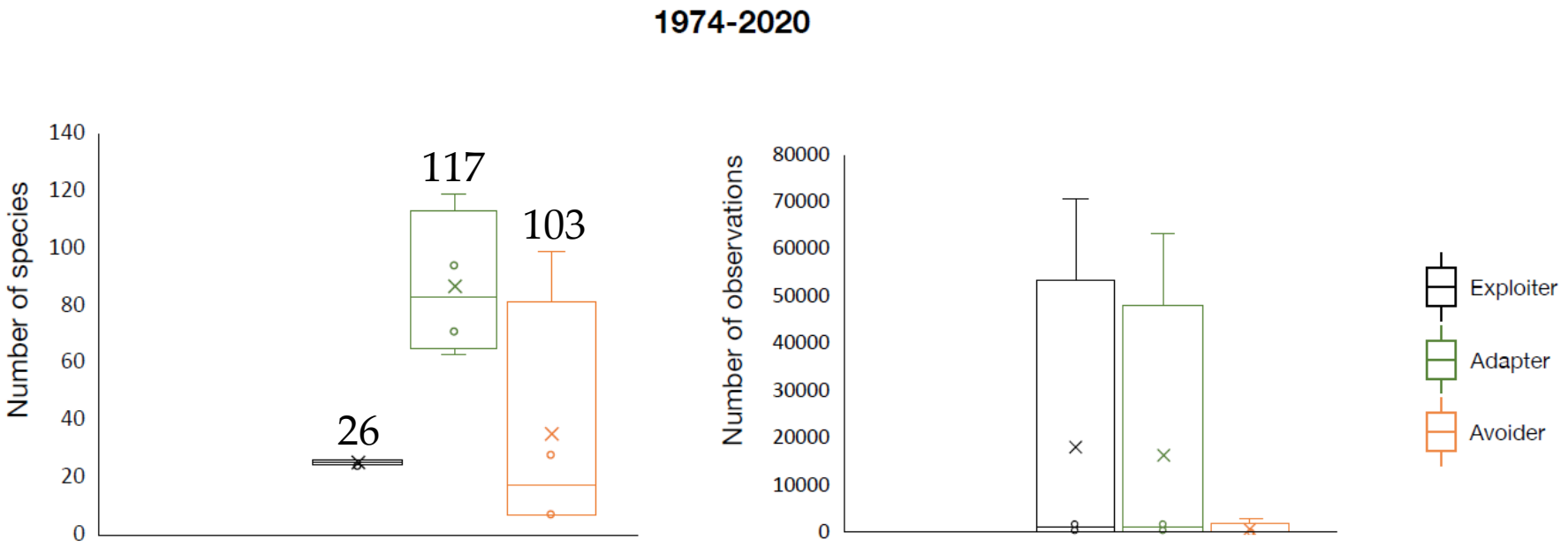

Figure 3. Number of species and observations in each bird category in 1974-2020 (mean and the total number).

In total **246** bird species, including 122 nesting ones.

The total number of species and observations was increasing over time.

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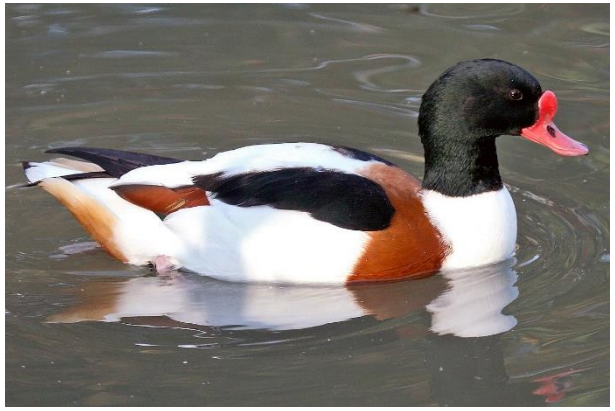
Results and Discussion

Avoiders in Krakow

Birds from different taxonomic groups.
Many of them observed only once or twice in the analysed time period.

Two of the most common species showed in photos.



Common shelduck (*Tadorna tadorna*) (Adrian Pingstone).

Corn crake (*Crex crex*) (Rachel Davies).

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Results and Discussion

Adapters in Krakow

Most diversified and species-rich group. Birds from different taxonomic groups, usually small passerines. Many water birds.

The three most common species showed in photos.

Great crested grebe (*Podiceps cristatus*) (MŚ).

Black-headed gull (*Chroicocephalus ridibundus*) (MŚ).

Fieldfare (*Turdus pilaris*) (hedera.baltica).

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Results and Discussion

Mute swan (*Cygnus olor*) (MŚ).

Common wood pigeon (*Columba palumbus*) (MŚ).

Exploiters in Krakow

Mainly representatives of three orders:

- Anseriformes (ducks, waterfowl)
- Columbiformes (pigeons and doves)
- Passeriformes (especially Corvidae)

The highest numbers of individuals.
The four most common species showed in the photos.

Rook (*Corvus frugilegus*) (MŚ).

Great tit (*Parus major*) (Sławomir Staszczuk).

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Results and Discussion

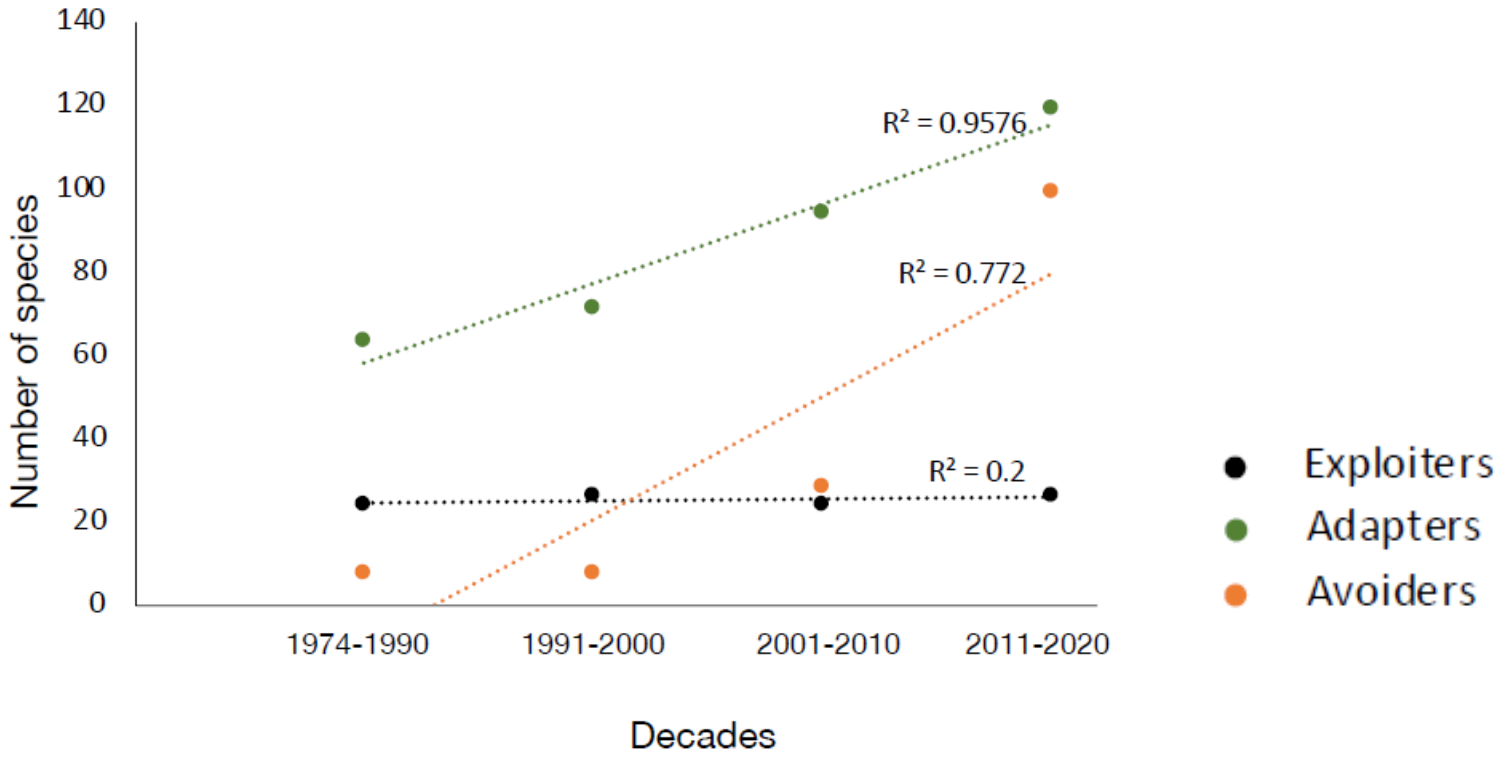

Figure 4. Number of species in each bird category over decades (the total number and linear regression).

An increase in the species diversity of adapters and avoiders. The number of species of exploiters remained constant.

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Results and Discussion

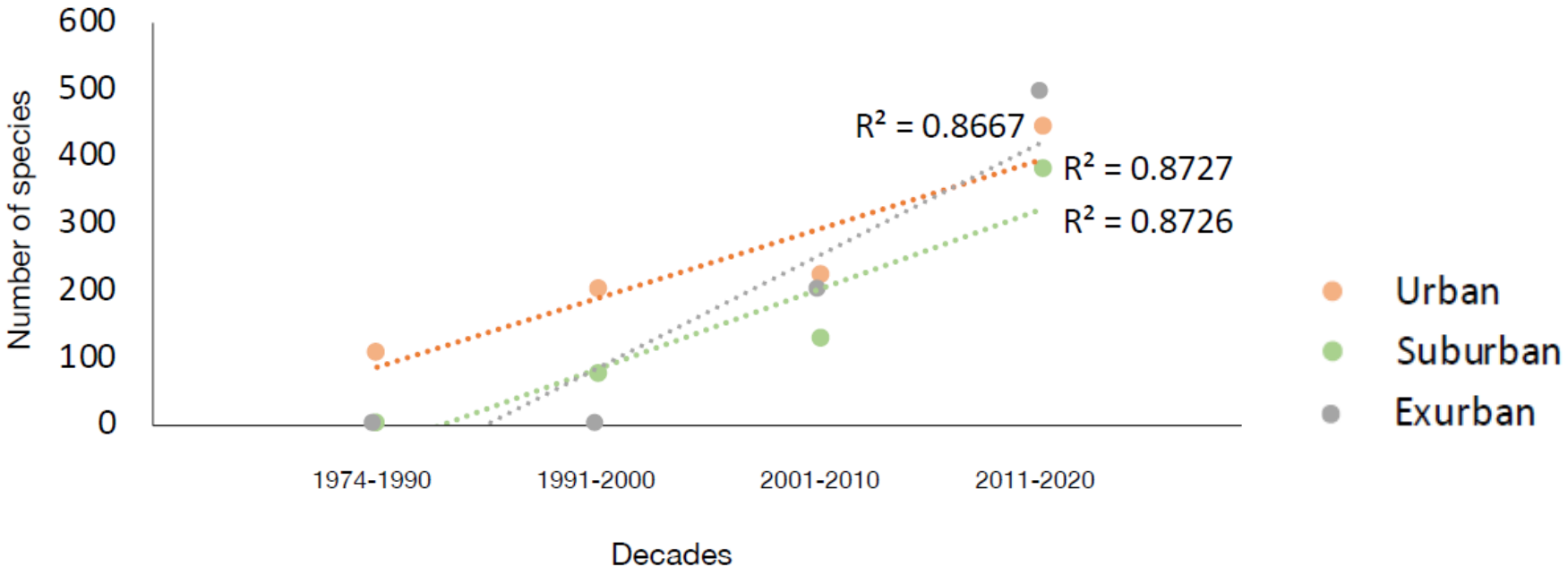

Figure 5. Number of species in each category of land use over decades (the total number and linear regression).

The number of species increased in all types of urbanised areas.

At the beginning of the study, the number of species was the highest in urban areas and then constantly grew. In the case of exurban and suburban areas, bird species numbers started to increase since the 1990s. This may be partly explained by the varying activity of observers in particular zones.

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Results and Discussion

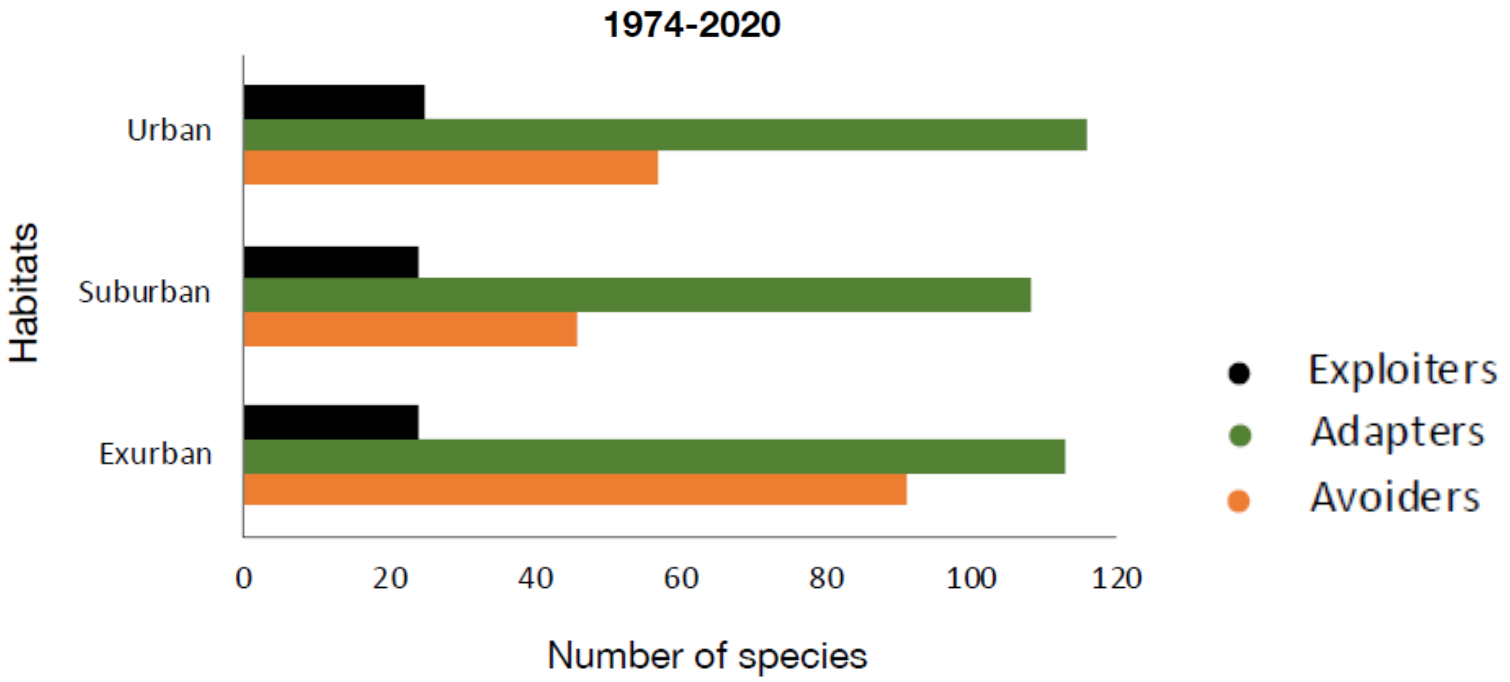

Figure 6. The total number of species in each bird category in different types of land use (habitat).

Much higher number of species of avoiders in an exurban area than in the other ones.

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Summary and conclusions

- number of species in Krakow is increasing over time
- high increase in the species diversity of avoiders and adapters, constant species composition of exploiters over decades
- exploiters are the most common birds observed in the city
- avoiders prefer exurban areas, other groups show no differences in choice of habitat

- small number of publications about urban avifauna in Poland
- online data bases are an important source of information about species abundance and occurrence in the 21st century
- significance of citizen science (online data bases)

- future data evaluation is planned

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ORNITHO.PL

European robin (*Erithacus rubecula*), a common adapter species (MŚ).

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