

Relative habitat use for wintering and breeding birds in Denmark

Daniel Palm Eskildsen, Nina Yasmin Ali, Thomas Vikstrøm

We calculated the relative habitat use (RHU) of birds in Denmark to study the use of nine different habitats as well as trends of habitat use between 1975 and 2021. We found that during the breeding season, habitat specialists were declining in all natural habitats. In contrast, most habitat categories showed positive trends in winter, which might arise from increasing numbers of winter guests that due to climate warming are able to spend the mild winters in Denmark.

The relative habitat use (RHU) is measured as the abundance of a species in a particular habitat, relative to the mean abundance of this species in all other habitats. The primary aim for applying such a measure of habitat use is to objectively select species that are representative of the particular habitat. Larsen et al. (2011) and Eskildsen et al. (2013) demonstrated how the RHU could be used to create habitat indicators for common Danish breeding birds. Using the same methodology, we here present preliminary updated habitat indicators for both the breeding and the winter season.

The objectives of the present study are (1) to calculate RHU scores for all Danish common breeding and wintering bird species in nine different habitats and three aggregated categories, and (2) to present overall trends of these indicators until the year 2021, starting from the beginning of the Danish point count census in 1975.

1. Methods

For analysis, we used data on those species surveyed in the Danish point count census that had at least 400 observations per species. The RHU was calculated for each species in each year, in each season and each habitat. Only years in which the species was observed in at least 10 sites were included. The final RHU for the species was then calculated as the mean RHU of those years. Three aggregated habitat categories were created as follows: Forest (deciduous and coniferous forest), Farmland (arable land and meadow), and wetland (lake and bog/marsh).

The RHU indicates the degree to which a habitat is preferred (RHU >2.0) or avoided (RHU <0.5) by a species, relative to other habitats. Species with RHU-values >2 are considered «high-use»-species, or specialists, in that habitat type.

The number of individuals found in a specific observation point was corrected with the proportion of the given habitat at that point. This correction of individual numbers was preferred over using only single-habitat points, because it enabled us to use a considerably larger dataset, because many points are associated with multiple habitats. The sum of the corrected number of individuals of each species in a particular habitat was then used to calculate a RHU value by applying the following equation:

$$\text{Relative habitat use} = \frac{n_i/p_i}{(N - n_i)/(P - p_i)}$$

where n_i is the number of individuals in the i^{th} habitat, p_i is the total number of i habitat points, N is the total number of individuals, and P is the total number of observation points. An RHU value of 2 can be interpreted as follows: the mean abundance of that species in that habitat is twice the mean abundance in all other habitats. Species with general habitat preferences will have RHU values ranging between 0.5 and 1.5 in most habitats, and values below 0.5 are interpreted as species avoiding those habitats.

To calculate trends and thus to get an indicator of the changes in bird diversity in each habitat, overall indices per habitat and season were calculated as the geometric mean of the yearly indices from the species. A linear regression was then performed based on all indices.

For more information on RHU, see Larsen et al. (2011), Eskildsen et al. (2013), and O'Reilly et al. (2022).

2. Results

Calculating RHU proved useful in categorizing each species by their habitat preferences in both seasons. As shown in Tables 1 and 2, the indicators included between 5 and 42 high-use (specialist) species, with the two forest types «deciduous forest» and «coniferous forest» during winter having the fewest high-use species (5) and «lake» during the breeding season having

the most high-use species (42). Arable land had only 6 high-use species during the breeding season, even though arable land is around two thirds of the Danish land area. This perhaps reflects the poor state of this habitat type in Denmark.

Most species scored RHU-values above 2 in more than one habitat, and thus were assigned high-use species in more than one indicator. Only very few species were not considered high-use species (specialists) in

Table 1. Trends for nine habitats and three aggregated habitat categories during the breeding seasons 1976–2021. Trends are based on linear regressions of geometric means of indices from the species included in each indicator.
Trends für neun Lebensräume und drei aggregierte Lebensraumkategorien während der Brutsaison 1976–2021. Die Trends basieren auf linearen Regressionen der geometrischen Mittelwerte der Indizes für die in jedem Indikator enthaltenen Arten.

Habitat	High-use species	Trend	Standard error	R ²	P
Coniferous forest	16	−0.52	0.05	0.72	<0.001
Deciduous forest	15	0.12	0.23	0.01	0.587
Arable land	6	−0.28	0.04	0.5	<0.001
Bog/marsh	24	−0.60	0.13	0.33	<0.001
Heath	15	−0.31	0.02	0.84	<0.001
Dunes/shores	32	−0.43	0.07	0.45	<0.001
Urban	11	0.83	0.16	0.39	<0.001
Lake	42	−0.57	0.09	0.48	<0.001
Meadow	40	−0.56	0.06	0.65	<0.001
Forest	28	−0.52	0.18	0.17	0.005
Farmland	18	−0.48	0.04	0.73	<0.001
Wetland	33	−0.62	0.11	0.45	<0.001

Table 2. Trends for nine habitats and three aggregated habitat categories during the winters 1975–2021. Trends are based on linear regressions of geometric means of indices from the species included in each indicator.
Trends für neun Lebensräume und drei aggregierte Lebensraumkategorien in den Wintern 1975–2021. Die Trends basieren auf linearen Regressionen der geometrischen Mittelwerte der Indizes für die in jedem Indikator enthaltenen Arten.

Habitat	High-use species	Trend	Standard error	R ²	P
Coniferous forest	5	−0.11	0.04	0.16	0.007
Deciduous forest	5	0.19	0.11	0.06	0.101
Arable land	18	0.06	0.04	0.06	0.120
Bog/marsh	7	0.05	0.01	0.19	0.003
Heath	7	0.03	0.02	0.04	0.172
Dunes/shores	31	0.19	0.03	0.56	<0.001
Urban	15	−0.23	0.06	0.27	<0.001
Lake	26	0.24	0.03	0.62	<0.001
Meadow	26	0.07	0.02	0.19	0.003
Forest	14	0.06	0.08	0.01	0.511
Farmland	24	0.08	0.03	0.15	0.008
Wetland	18	0.20	0.02	0.67	<0.001

any habitat (RHU < 2 in all habitats), e.g., Eurasian Sparrowhawk *Accipiter nisus* and Common Woodpigeon *Columba palumbus*.

In the breeding season (Table 1), negative trends around -0.5 were found for the breeding season indicators coniferous forest, bog/marsh, dunes/shore, lake, and meadow. Negative trends around -0.3 were found for the indicators arable land and heath. No clear trend was found for the indicator deciduous forest, and a positive trend about 0.8 was found for the urban indicator.

In contrast to the breeding season, most habitat categories showed positive trends in winter (Table 2), apart from the category «urban» that had a negative winter trend of -0.23.

As an example, the Hawfinch *Coccothraustes coccothraustes* is one of the few species with very different habitat preferences during the breeding season and winter. During the breeding season (Fig. 1a), it prefers forest, especially deciduous forest. During winter (Fig. 1b), it occurs mostly in urban areas.

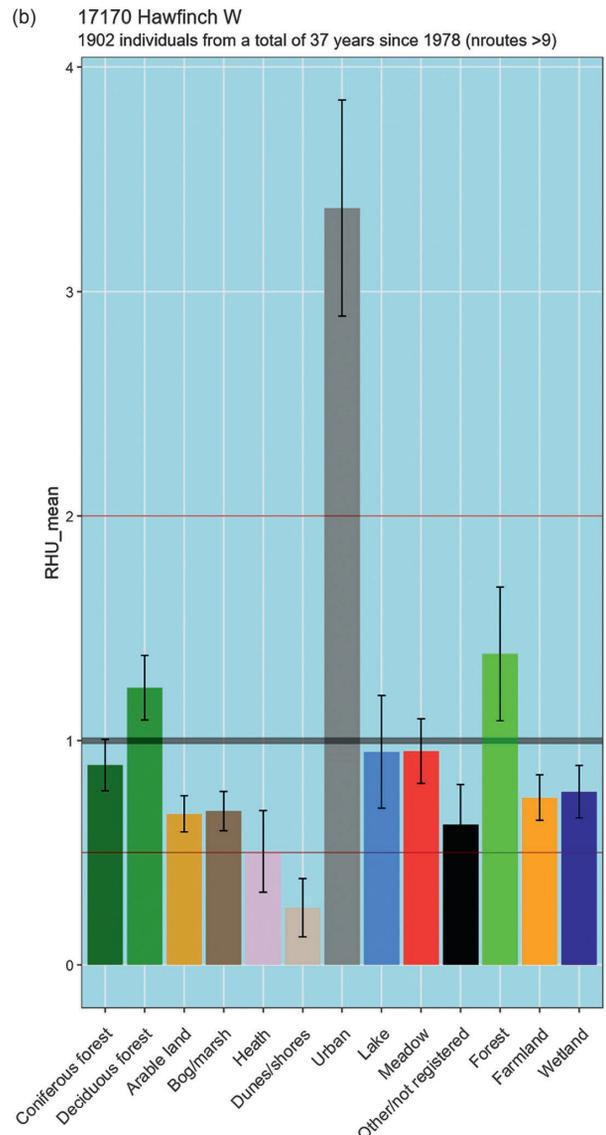
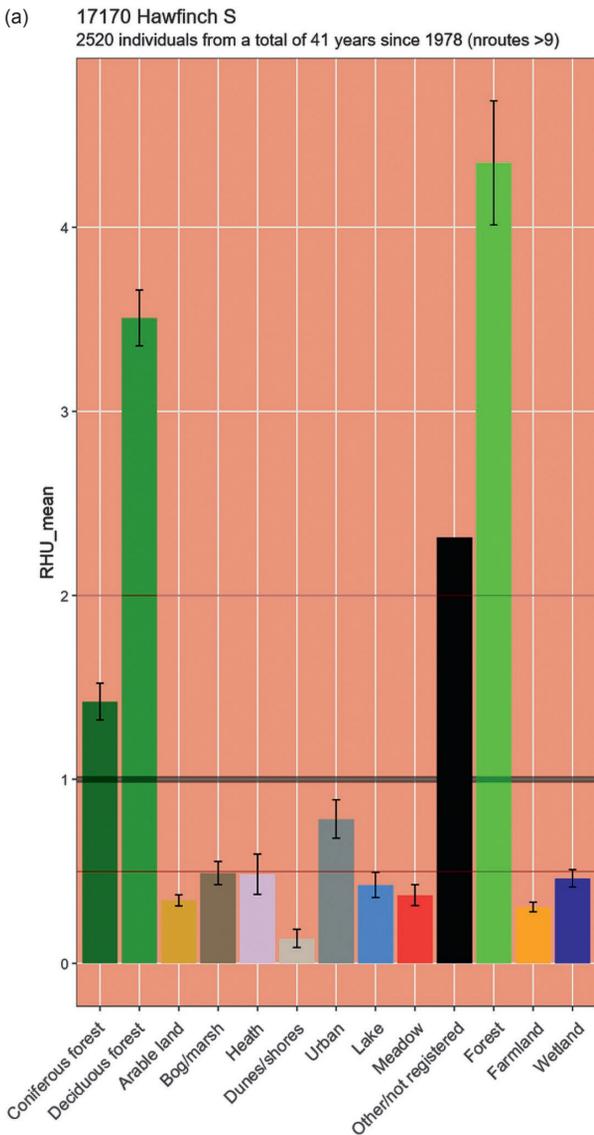


Figure 1. Relative habitat use (RHU) for the Hawfinch *Coccothraustes coccothraustes* in (a) the breeding season and (b) winter. The habitat category «other/not registered» contains old observations from habitat categories not used anymore. The combined habitat «forest» consists of «coniferous forest» and «deciduous forest». The combined habitat «farmland» consists of «arable land» and «meadow». The combined habitat «wetland» consists of «bog/marsh» and «lake.» The bars show standard errors.

Relative Lebensraumnutzung (RHU) für den Kernbeisser *Coccothraustes coccothraustes* (a) in der Brutzeit und (b) im Winter. Die Habitatkategorie «andere/nicht registriert» enthält alte Beobachtungen aus nicht mehr genutzten Habitatkategorien. Der kombinierte Lebensraum «Wald» besteht aus «Nadelwald» und «Laubwald». Der kombinierte Lebensraum «Kulturland» umfasst «Ackerland» und «Wiese». Der kombinierte Lebensraum «Feuchtgebiet» besteht aus «Moor/Sumpf» und «See». Die Balken zeigen Standardfehler.

3. Discussion

The trends of the presented indicators during the breeding season is a cause for alarm. Our findings suggest that during the breeding season, habitat specialists are declining in all natural habitats, likely as a result of the well-known threats to biodiversity, such as habitat degradation and climate change.

In contrast, the winter indicators for «bog/marsh», «dunes/shore», lake», «meadow», «farmland» and «wetland» showed positive trends, suggesting that these specialists are thriving and increasing in numbers in winter. Those positive trends might arise from increasing numbers of winter guests that due to climate warming are able to spend the mild winters in Denmark.

Acknowledgements

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Zusammenfassung

Eskildsen DP, Ali NY, Vikstrøm T (2022) Relative Lebensraumnutzung von überwinternden und brütenden Vogelarten in Dänemark. *Ornithologischer Beobachter* 119: 362–365.

Wir berechneten die Lebensraumnutzung (RHU) von Vögeln in Dänemark, um die Nutzung von neun verschiedenen Lebensräumen sowie die Trends der Lebensraumnutzung zwischen 1975 und 2021 zu untersuchen. Wir beobachteten, dass die Zahl der Habitatspezialisten während der Brutzeit in allen natürlichen Lebensräumen zurückging. Im Gegensatz dazu zeigten die meisten Habitatkategorien im Winter positive Trends, was auf die zunehmende Zahl von Wintergästen zurückzuführen sein könnte, die aufgrund der Klimaerwärmung die milden Winter in Dänemark verbringen.

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Authors

Daniel Palm Eskildsen studied ecology and evolutionary biology at the University of Copenhagen. Nina Yasmin Ali studied biology and specialized in ecology at the University of Copenhagen. They work at the Dansk Ornitologisk Forening (DOF)/BirdLife Denmark, and together with biologist Thomas Vikstrøm, they all three take care of the Danish Common Bird Census program, which since 1975 has monitored the population trends of the common Danish birds by counts carried out by DOF members.

Daniel Palm Eskildsen, Nina Yasmin Ali and Thomas Vikstrøm, Dansk Ornitologisk Forening (DOF)/BirdLife Denmark, Vesterbrogade 138-140, 1620 Copenhagen V, Denmark, e-mail thomas.vikstroem@dof.dk