

Article

Evaluation of Citizen Science Project on Birdwatching in Germany: Advantages and Limits

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Abstract: Since 2005, The Nature and Biodiversity Conservation Union (NABU, Germany) has called upon people in Germany to count birds in their gardens during a defined time (Friday to Sunday) in May. This “Stunde der Gartenvögel” (hour of the garden birds) aims at obtaining a yearly overview of the birds in villages and towns. While this birdwatching action gives a broad overview due to the large number of gardens and parks involved (around 40,000 in the year 2024), several drawbacks must be mentioned that may impede the comparability of the counted bird numbers from one year to another. Here we give an overview of the chronological development of the overall numbers of species and specifically of the most frequent garden birds. We discuss correlations with external factors, such as weather and numbers of participants, and compare the results with ornithological studies in the same period as well as with the results of the yearly Birdrace in Germany, where ornithologically interested people count birds in a defined area on the full first Saturday in May. The main drawback of the citizen science project was found to be misidentifications of birds, especially evident in the case of the Tree Sparrow, combined with birds not being recorded because they could not be identified. The main advantage, on the other hand, is the large amount of data from the “Stunde der Gartenvögel”, which is important for measuring especially the trends of well-known, frequent species much better than the Birdrace. Ideally, all data taken in different ways should be combined, and misinterpretations should be reduced by showing male and female birds of species with strong gender dimorphism.



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1. Introduction

Several studies have shown changes in species distribution due to climate change as well as other environmental changes [1–3]. In many studies, especially rare species are monitored due to their high extinction risk and the corresponding danger to lose an irreplaceable function in the ecosystem [4–6], while others concentrated on the edges of distributions of more abundant plants or animals [7,8].

Amongst the monitored animals, birds are often taken into account as a biodiversity indicator [9]. Wintering waterbirds are known to be good indicator species for changing weather conditions [10,11], but their population will also be strongly influenced by the loss of their habitats, e.g., by the eutrophication of wetlands [12]. The decline in insect population, reported for many areas in Europe and other parts of the world [13–16], is a factor that may lead to a decline of insectivorous birds. Bowler et al. concluded from a

comparison of insectivores and seed-eaters that agricultural intensification and a loss of grassland were the main reasons for the decline in their populations [17]. Especially for common breeding birds in Germany, a long-term study from 1990 to 2018 based on data from the German Common Bird Monitoring scheme found that farmland birds declined strongly, while wetland birds increased strongly, and forest birds first declined and then recovered starting from around 2010 [18]. Declining trends were also reported for ground-nesting birds as well as granivorous and invertebrate-feeding birds, while insectivorous non-farmland birds were stable [18]. Interestingly, the authors of this study found more negative long-term trends for more common species. Especially for rarer species, they suggested developing robust monitoring schemes [18].

Generally, the way of monitoring birds can strongly influence the results of a study. Pomeroy and Gottschalk found that birds detected mainly by sound were often under-recorded, in addition to the problem that less common species were less often identified if they were only heard [19]. This is different in autonomous sound recording, which, in the case of sound recording with standardized detection ranges, did not show significant differences compared to point counts [20]. In citizen science bird monitoring projects, however, the risk of incorrect identification is also large when birds are seen, as a recent study among German adults showed, where on average only 6 of 15 common garden bird species were correctly identified from photographs [21]. To improve the precision of such citizen science data, Hertzog et al. suggested a model-based integration of these data and found that models integrating semi-structured data were comparable to those based on structured data only for 75% of the studied species [22]. On the other hand, monitoring by ornithologically skilled volunteers [23] and meta-studies combining different (national) indices [24] are being developed further.

This leads to the research question of how reliable citizen science in birdwatching is and whether it can add complementary information in addition to scientific studies as well as the data collections of ornithologically trained people, even if the citizen science data are potentially less reliable. To answer this question, we compare the results of different monitoring indices used in Germany to evaluate the data quality of a citizen science birdwatching project, identify potentials and obstacles, and give suggestions on how to further improve the reliability and comparability of the data gained by such citizen science projects. The choice of birds in our meta-study is explained in the next section.

2. Materials and Methods

The following data from freely available data sources related to birds in Germany were compared:

- Birds counted during the “Stunde der Gartenvögel” (German for “hour of the garden birds”) during a defined time (Friday to Sunday) in a one-hour period in May each year, organized by NABU (Germany) [25]
- Species counted during the “Birdrace” (only absence/presence of birds is monitored, no overall numbers of each species; organized by Dachverband Deutscher Avifaunisten (DDA) on the first Saturday in May) [26]
- Nesting bird pairs counted during “Monitoring häufiger Brutvögel” four times between 10 March and 20 June in 2637 defined areas (monitoring of frequent nesting birds, organized by DDA) [27].

The following species of garden birds were considered in our comparison:

- Frequent and well-known species:
 - o Common Blackbird (*Turdus merula*)
 - o Eurasian Magpie (*Pica pica*)

- Easy to confuse with each other:
 - o House Sparrow (*Passer domesticus*)
 - o Tree Sparrow (*Passer montanus*)
- Not frequent, but hard to confuse:
 - o Mallard (*Anas platyrhynchos*)
 - o Eurasian Blackcap (*Sylvia atricapilla*)
- Not frequent and easy to confuse with other corvids:
 - o Western Jackdaw (*Coloeus monedula*)

A special focus was laid on the Tree Sparrow, since recent studies suggest their strong decline in the northwest of Germany [28], while a preliminary check of the numbers of Tree Sparrows counted during the “Stunde der Gartenvögel” does not show this trend.

In our meta-study, the methods of the three compared data collections differ, as explained above (for further information, see [25–27]). This must be taken into account in the comparison of the results. It should also be mentioned that the data collections do not provide statistical analyses. The data are depicted by Origin 2023 (OriginLab Corporation, Northampton, MA, USA).

3. Results and Discussion

As a general overview, Figure 1a depicts the number of birds per garden counted during the “Stunde der Gartenvögel”, showing a decreasing trend. It must be mentioned that the number of overall gardens in which birds were counted was approximately doubled during the COVID-19 pandemic (2020/2021), which may explain the suddenly reduced number of birds per garden in 2020, when probably less experienced citizens counted birds for the first time, or less nature-friendly gardens were involved. However, the generally decreasing trend is obvious.

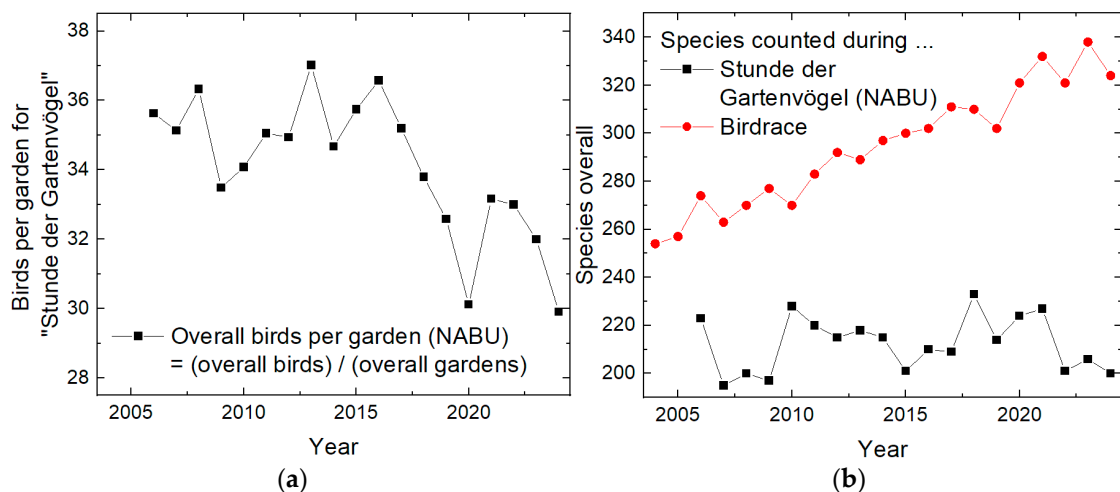


Figure 1. (a) Birds per garden counted during “Stunde der Gartenvögel”; (b) bird species counted during “Stunde der Gartenvögel” and Birdrace, respectively.

Contrary to Figure 1a, Figure 1b shows the overall species counted during the “Stunde der Gartenvögel” in comparison with the results of the Birdrace, independent from the number of birds per species. Here, the “Stunde der Gartenvögel” shows an approximately constant number of species found with an average of (212 ± 12) species per year. This finding is not contradictory to the decrease in birds per garden (Figure 1a), since here only the overall number of birds found all over Germany by all participants is given, where new and untrained participants are not expected to significantly influence the result.

This is different for the overall number of species found during the Birdrace, which increased from (264 ± 8) species in the first five years to (327 ± 8) species in the last five years. Here, more participants and increasing experience, regarding the most promising places to find rare birds, as well as fast availability of information about rare birds on specific websites can be expected to result in an increasing number of counted species.

To investigate the impact of the aforementioned number of participants in both data collections, Figure 2 shows the number of gardens attending the “Stunde der Gartenvögel” and the number of teams for the Birdrace per year. Both lines show a slightly increasing trend, with a sharp increase in the years 2020 and 2021. Only the number of Birdrace teams, however, stayed on a similar level as during the COVID-19 pandemic. This may be attributed to the possibility of building “virtual teams” for the Birdrace since 2020, i.e., teams of up to five people who can divide and may even count birds in different federal states of Germany, as opposed to the “classical teams” of 3–5 people who stay together in a group [29]. In contrast, the positive impact of the COVID-19 years on the number of gardens participating in the “Stunde der Gartenvögel” has not continued after the pandemic. The significant increase in the number of Birdrace teams, however, has not led to a correspondingly strong increase in observed bird species during the Birdrace (Figure 1b).

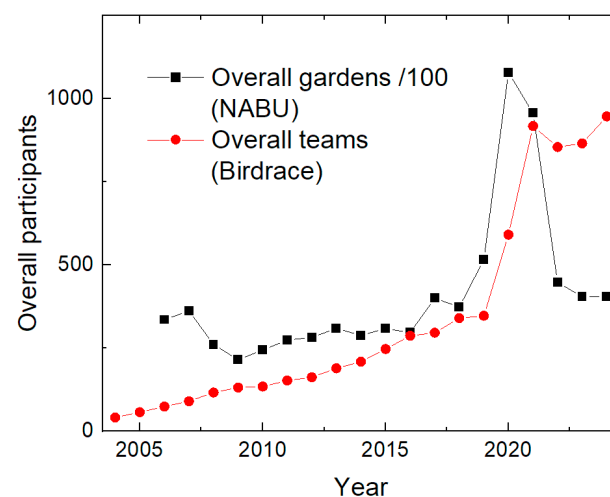


Figure 2. Number of gardens participating in “Stunde der Gartenvögel” (NABU) and number of teams participating in the Birdrace.

Independent from the increase in the number of Birdrace teams, it must be mentioned that the number of gardens participating in the “Stunde der Gartenvögel” is about two orders of magnitudes higher than the number of Birdracing teams, showing the potential of the citizen science data from the “Stunde der Gartenvögel” due to the large amount of collected data. On the other hand, these data stem from mostly not ornithologically trained participants, which may result in a higher error rate, as will be discussed in the next sub-sections.

3.1. Species-Related Results

The percentage of gardens in which a specific bird species is found during the “Stunde der Gartenvögel” is shown in Figure 3a. Generally, slightly decreasing trends can be observed for the Common Blackbird, Eurasian Magpie, House Sparrow, and Eurasian Blackcap (data are only available starting from 2010). These birds are easy to identify, similar to the Mallard (while the female Mallard can easily be confused with some other female ducks, no other ducks are usually expected to be found in gardens, so the risk of

counting any other duck as Mallard is very low) and the Western Jackdaw, which show approximately constant trends. For the Tree Sparrow, there is a remarkable sudden increase from 2014 to 2015, potentially due to confusion with the House Sparrow, which will be discussed in Section 3.2.

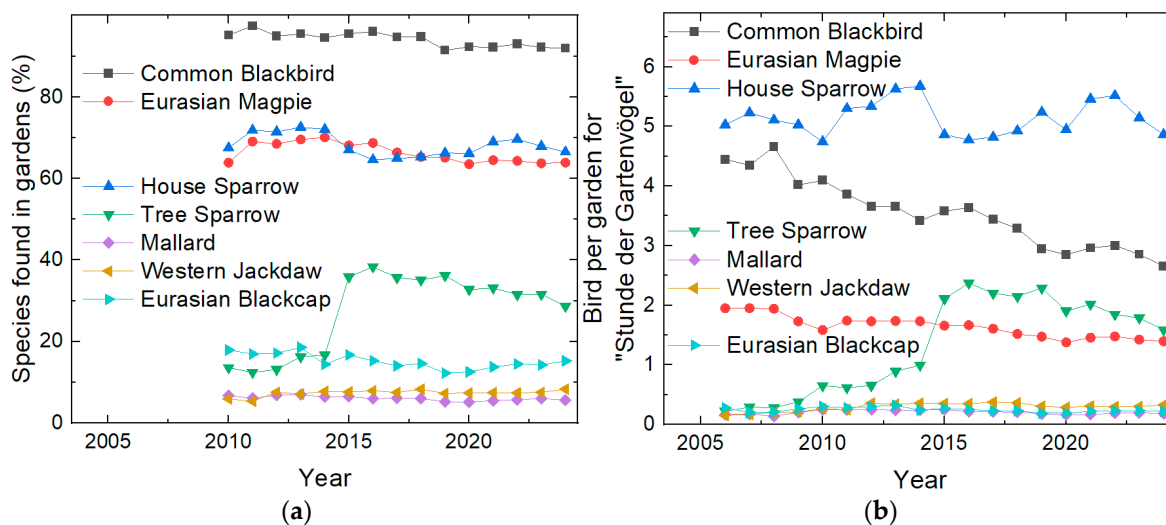


Figure 3. (a) Species found in percentage of gardens during “Stunde der Gartenvögel”; (b) birds counted during “Stunde der Gartenvögel”.

The number of birds per garden, depicted in Figure 3b, shows decreasing trends for the Common Blackbird and Eurasian Magpie and an approximately constant level for the Mallard, Western Jackdaw, and Eurasian Blackcap. The largest variations are visible for House Sparrows, possibly due to varying weather conditions, which make the identification difficult and thus impede counting them. Again, the sudden increase in the number of Tree Sparrows per garden from 2014 to 2015 is visible and needs an explanation (cf. Section 3.2).

As a comparison, Figure 4a depicts the percentage of Birdrace teams that found a specific bird species. For the most common birds (Common Blackbird, Mallard, House Sparrow), no trends are visible; they are usually found by all teams. Slightly decreasing trends are visible for the Eurasian Magpie and Blackcap and clearly decreasing trends for the Western Jackdaw and Tree Sparrow—which is contrary to the “Stunde der Gartenvögel” (Figure 3b).

This comparison shows, on one hand, the potential of the citizen science approach “Stunde der Gartenvögel” regarding common and easily identifiable birds, such as the Common Blackbird or House Sparrow—for such common species, only significantly reduced populations will be recognized by the Birdrace, as a small decrease will still result in nearly 100% of the teams finding the respective species. On the other hand, the significant decrease in teams finding Tree Sparrows during the last 10–15 years is contradictory to the apparent increase in this species reported by the “Stunde der Gartenvögel”.

The comparison with the development of the nesting bird pairs, counted by DDA (Figure 4b), shows increasing trends for the Western Jackdaw, House Sparrow, and Eurasian Blackcap, while the numbers for the other birds vary strongly. In particular, the development of the Western Jackdaw is contradictory to that observed during the Birdrace, which cannot be explained by errors of the observers, who are ornithologically skilled participants in both data collections. Instead, shifted territories may be a potential reason for these different results, not mainly due to a northward shift [1–3] but due to a change of habitat, such as from the woods or farmlands into the cities or generally toward areas where they are more visible during nesting, leading to an apparent increase in nesting pairs. On the other hand, the Birdrace teams may on average have changed their favored counting areas

to spots where rare species can be expected, in this way potentially finding less common birds, such as Western Jackdaws. Finally, it must be mentioned that the Birdrace does not count numbers of birds, but only the presence of a species, so that the Increase in nesting pairs and the decrease in teams finding the Western Jackdaw can also be explained by larger colonies, concentrating on smaller areas, so that a lower number of Birdrace teams finds them.

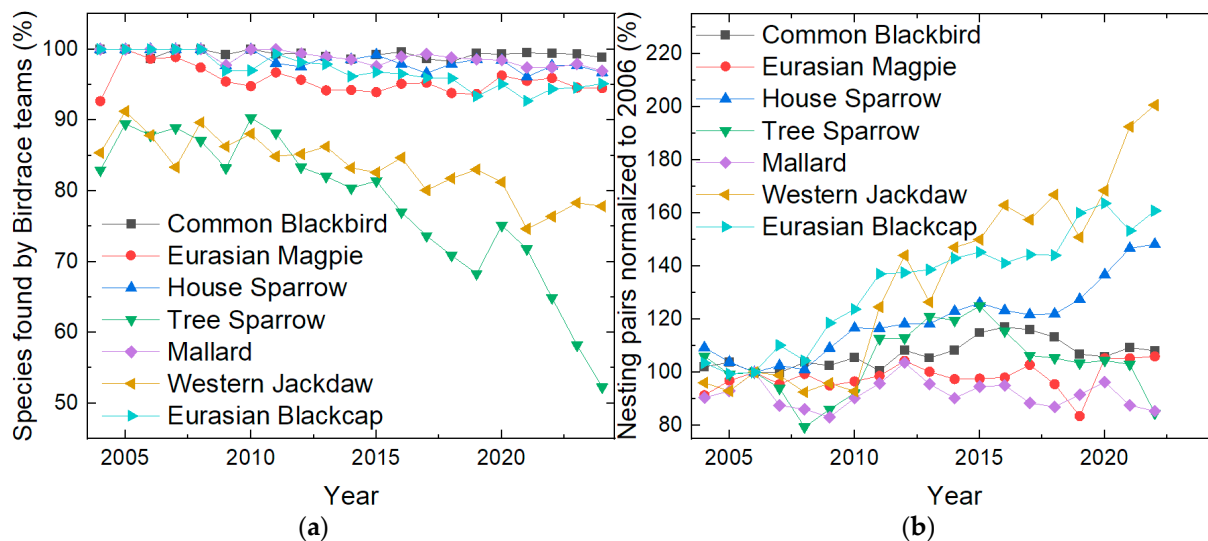


Figure 4. (a) Species found by percentage of Birdrace teams; (b) normalized number of nesting pairs according to “Monitoring häufiger Brutvögel” (DDA).

This comparison of a few common bird species shows that all studies complement each other, and especially the comparison of two or more of them may lead to further insights into changes of habitats, shifted territories, or other changes, which would not be recognized from a single data collection.

3.2. Increase in Tree Sparrow Counts from 2014 to 2015

As mentioned before, the development of the Tree Sparrow poses two questions: on one hand, an explanation for the sudden increase in Tree Sparrows from 2014 to 2015 in the “Stunde der Gartenvögel” is necessary; on the other hand, the decline of the Tree Sparrow according to the Birdrace and to Ref. [28] needs to be investigated (Section 3.3).

A potential indicator, independent from the number of participants in a data collection, is the ratio of House Sparrows to Tree Sparrows. The Red Lists for Germany give the ratios shown in Table 1. While no data for the years after 2016 are available, a relative constant ratio around 4–5 is found for the years 2005–2016 [30–32].

Table 1. Ratios of House Sparrows and Tree Sparrows according to the last Red Lists for Germany [30–32].

Red List	Valid for Years	Aver. Population House Sparrow	Aver. Population Tree Sparrow	Ratio House: Tree Sparrow
2007	(2000–)2005	8,300,000	1,300,000	6.38
2015	2005–2009	4,300,000	1,000,000	4.30
2020	2011–2016	5,050,000	1,045,000	4.83

Another possibility for estimating the ratio of House Sparrows to Tree Sparrows is by using the breeding bird ratio according to the DDA data [33,34]. This ratio is given in Figure 5, together with the ratios calculated from bird numbers and numbers of gardens

where they were found during the “Stunde der Gartenvögel” as well as the numbers of teams finding them during the Birdrace.

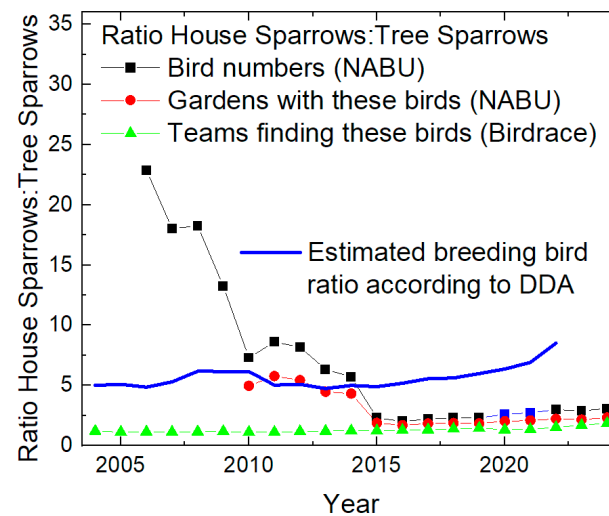


Figure 5. Ratio of House Sparrows to Tree Sparrows according to the “Stunde der Gartenvögel” (counting bird numbers, black dots; and counting gardens with these birds, red dots) and to the Birdrace (green dots). The blue line shows the estimated breeding bird ratio according to the DDA data [33,34].

Here, the ratio according to the numbers of birds found during the “Stunde der Gartenvögel” firstly declines until 2010, where it approximates the estimated breeding bird ratio according to DDA and stays on this level until 2014. Similarly, the ratio of gardens in which House and Tree Sparrows were found is around 5 from 2010 to 2014 (no earlier data available). The sudden decrease in both values from 2014 to 2015 corresponds to the sudden increase in the counted Tree Sparrows and decrease in counted House Sparrows (Figure 3). Starting from 2015, the ratios found during the “Stunde der Gartenvögel” and during the Birdrace are similar and slowly increase from approx. 1–2 in 2015 to approx. 2–3 in 2024. While this looks at first glance as if the values from the “Stunde der Gartenvögel” in the years 2015–2024 were more reliable than the previous ones, this is indeed not the case. During the Birdrace, the teams are explicitly searching for bird species during a full day, so that even after the significant decrease in Tree Sparrows (Figure 4a), more than 50% of the teams still found this species, leading to the relatively low ratio of House Sparrow to Tree Sparrow of around 2. On the other hand, House Sparrows should be more often found in gardens than Tree Sparrows, so that is actually even a higher ratio than approx. 5 (as derived from the Red Lists and the DDA data) can be expected.

It is thus necessary to have a deeper look for potential systematic changes in the “Stunde der Gartenvögel” from 2014 to 2015 to explain the increase in counted Tree Sparrows between these years. This can be done using the Wayback Machine, which enables the viewing of snapshots of specific websites at different times [35].

One possible explanation for this increase in the apparent number of Tree Sparrows is a change in the photographs of the respective species between the “Stunde der Gartenvögel” in 2014 and in 2015. Using the Wayback Machine, the photographs of the most common garden birds were shown to have indeed been changed, but between 7 September 2015 and 13 January 2016, i.e., after the occurrence of the yet unexplained increase in the counted Tree Sparrows.

Another hypothesis is a change in the “Zählhilfe” (counting aid) that participants can print out and use to identify birds during counting. In the recent version [36], 15 of the most common garden birds are shown with small photographs, amongst them the Tree Sparrow

and House Sparrow. The counting aid from 2015, retrieved by the Wayback Machine, is similar to that of 2024, with the Eurasian Collared Dove (*Streptopelia decaocto*) and Barn Swallow (*Hirundo rustica*) exchanged with the Black Redstart (*Phoenicurus ochruros*) and Carrion Crow (*Corvus corone*); in addition, the photographs were exchanged. The photographs of the Tree Sparrow are similar in both counting aids.

Going back to the counting aid of 2014, however, offers a reason for the strong increase in counted Tree Sparrows from 2014 to 2015: the 2014 counting aid does not show the Tree Sparrow at all. In addition, the Carrion Crow and Common Wood Pigeon (*Columba palumbus*) are missing in the 2014 counting aid, and the Black Redstart is depicted by a female bird in 2014, while it is represented by a male in 2015 and in 2013.

In order to evaluate the impact of adding the Carrion Crow and Common Wood Pigeon in the 2015 counting aid and depicting the Black Redstart as a female individual in 2014, the counts for these three species during the “Stunde der Gartenvögel” are shown in Figure 6, in addition to the numbers for the Tree Sparrow. While the Common Wood Pigeon shows a slightly increasing trend—with one outlier in 2015—and the numbers of Carrion Crows are approximately constant, the Black Redstart shows a slightly decreasing trend, with its number approximately halved from 2014 to 2015. While the latter cannot be explained by the change in the Black Redstart photograph only in 2014, the coincidence with the increase in Tree Sparrows suggests another interpretation. The Tree Sparrow and the female Black Redstart—as well as the female House Sparrow, female Common Chaffinch (*Fringilla coelebs*) and others—give the general impression of “small brown birds”. In the counting aids from 2015 to 2024, the species fitting best to this vague description is the Tree Sparrow.

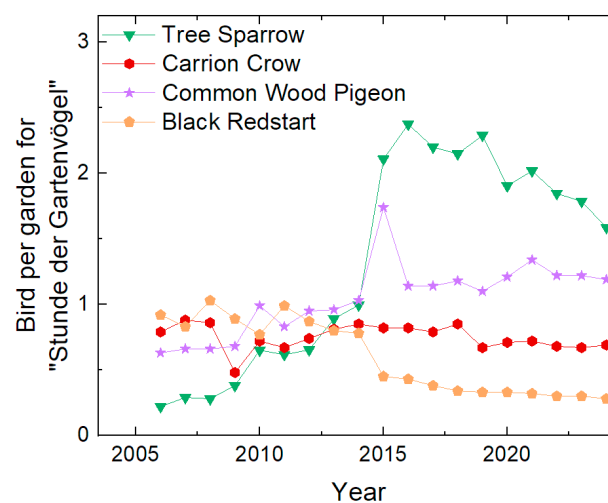


Figure 6. Birds per garden counted during “Stunde der Gartenvögel”.

This leads to the hypothesis that “small brown birds” are over-proportionally often counted as Tree Sparrows in the “Stunde der Gartenvögel”, mainly due to the fact that the female House Sparrow, female Common Chaffinch, female Black Redstart, and female European Greenfinch (*Chloris chloris*) are not shown in the photographs and thus not taken into account by less experienced participants who see a “small brown bird”. Even the Dunnock (*Prunella modularis*), seen from the back, may be misinterpreted as the Tree Sparrow.

To conclude, the apparent increase in Tree Sparrows counted during the “Stunde der Gartenvögel” can be attributed to the misidentification of diverse small brownish oscine birds other than Tree Sparrows, based on the fact that the female individuals of the birds with strong gender dimorphism as well as similar birds like the Dunnock are not shown in the counting aid.

3.3. Development of House and Tree Sparrow Population in Different Areas of Germany

In addition to the apparently problematic counting of Tree Sparrows during the “Stunde der Gartenvögel”, the difference between a more or less stable number of nesting pairs (Figure 4b) and the clear decrease in Tree Sparrows found during the Birdrace (Figure 4a) should be investigated. Ref. [28] suggests that the Tree Sparrow population may have changed its distribution in Germany, with a dramatic decline in the northwest of the country.

While the Birdrace data can be evaluated according to administrative districts, and the DDA evaluation of nesting pairs can be evaluated according to a fine raster across Germany only for a defined year [37,38], the data from the “Stunde der Gartenvögel” can be split according to federal states, enabling an overview over larger areas. This is why, in spite of the now well-understood problem regarding the years 2014–2015, these data are depicted in Figure 7 to enable a comparison of the Tree Sparrow distribution in different regions in Germany. The following relatively large federal states were chosen: Schleswig-Holstein (north), Lower Saxony (northwest), North Rhine-Westphalia (west), Baden-Württemberg (southwest), Bavaria (southeast), and Brandenburg (east).

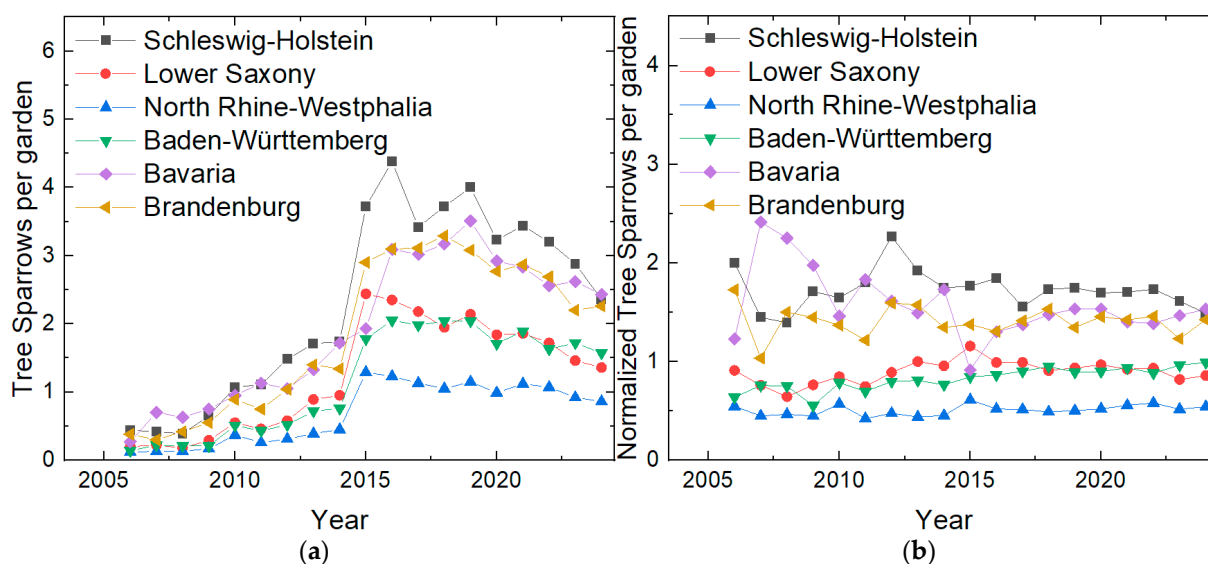


Figure 7. (a) Percentage of gardens with Tree Sparrows during “Stunde der Gartenvögel”, split according to different federal states; (b) percentage of gardens normalized to the overall values for Germany (from Figure 3a).

As Figure 7a shows, there are generally more Tree Sparrows counted in Schleswig-Holstein (north) and Bavaria (southeast) than in North Rhine-Westphalia. However, it is not easy to estimate a general trend here, whether the decrease in the Tree Sparrow population is stronger in one area than in another. This is why Figure 7b depicts the same values, normalized to the Tree Sparrows per garden counted all over Germany, as depicted in Figure 3a.

Here, especially Schleswig-Holstein and Bavaria show strong variations from year to year, while the values for North Rhine-Westphalia, Baden-Württemberg and Lower Saxony are approximately constant. This comparison indicates that there is no territorial shift of the Tree Sparrow from the south to the north of Germany or in another direction visible in this citizen science data collection. The inconsistency between the decreasing trend in the number of Tree Sparrows found during the “Stunde der Gartenvögel” (in addition to the sudden increase from 2014 to 2015), a decreasing trend in the presence of Tree Sparrows found during the Birdrace, and the approximately constant number of nesting

Tree Sparrow pairs counted by the DDA “Monitoring häufiger Brutvögel” apparently needs another explanation, such as a change of habitat. More research on this topic is necessary, potentially including scientific studies or more data from not freely available sources, to fully understand these apparently contradictory findings.

4. Conclusions

The citizen science project “Stunde der Gartenvögel”, counting garden birds in Germany each year in May, was compared with two other data collections by ornithologically skilled participants, the Birdrace and the “Monitoring häufiger Brutvögel”. The citizen science project has several well-known drawbacks, such as the weather and number of the counting people influencing the results, as well as erroneous identifications of birds or, in contrast, birds not recorded since they could not be identified. Nevertheless, the large amount of data from the “Stunde der Gartenvögel” complements the other data collections and is an important instrument to measure especially trends of well-known, frequent species much better than the Birdrace. This is especially visible for the Common Blackbird, whose steady decline was only recognized in the “Stunde der Gartenvögel” but is not evident from data from the Birdrace and “Monitoring häufiger Brutvögel”. Combining all these data collections and ideally more data from other sources gives more information than any of the data collections alone.

For the future, it is suggested to improve the identification of the different species by choosing adequate photographs or drawings of the birds, in cases of gender dimorphism showing both sexes, in typical situations (e.g., a Common House Martin (*Delichon urbicum*) in the air, not on the ground). It may be supportive to add brief descriptions of the most important differences between similar species to further reduce confusion of different species.

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

NABU The Nature and Biodiversity Conservation Union
DDA Dachverband Deutscher Avifaunisten

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