CZECH UNIVERSITY OF LIFE SCIENCES

Faculty of
Environmental Sciences

Diploma thesis

Methodology for the monitoring of birds in organic and conventional agricultural areas

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Prague, 2024

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Environmental Sciences

DIPLOMA THESIS ASSIGNMENT

B.Sc. Nerea Elorza Corrales

Nature Conservation

Thesis title

Methodology for the monitoring of birds in organic and conventional agricultural areas

Objectives of thesis

1.Does the observer's expertise and the number of visits affect the results of bird monitoring?
2.Are there differences between seasons of the year?
3.Are there differences at the level of estimating the number of species? Or the number of individuals?
4.Are there differences different between differently abundant or differently conspicuous species?

Methodology

This research was conducted in Suchdol, near Prague, focusing on two ecologically managed fields, MPPM_Su1 and MPPM_Su2, distinguished by vegetative buffers attracting various bird species. Additionally, two con- ventional fields, MPPM_Su1k and MPPM_Su2k, lacking such features, were chosen for comparison, with ef- forts made to match size and environmental characteristics. Data collection involved careful route planning covering all habitats, bird counting procedures, and considerations like weather and observer effects. Anal- ysis included examining bird populations across field management systems and seasons, utilizing a Nonlin- ear Mixed-Effects Model.

The proposed extent of the thesis

30-50 pp

Keywords

Biodiversity loss, agriculture, intensification, organic farming, avian biodiversity, ecological farming, begin-ner observers, experienced observers, species richness, Functional Biodiversity Index (FBI).

Recommended information sources

Batary, P., Matthiesen, T., & Tscharntke, T. (2010). Landscape-moderated importance of hedges in conserving farmland bird diversity of organic vs. conventional croplands and grasslands. BiologicalConservation, 143, 2020–2027.

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Expected date of thesis defence

2024/25 WS – FES

The Diploma Thesis Supervisor

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Electronic approval: 26. 3. 2024

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Electronic approval: 26. 3. 2024

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Dean

Prague on 26.03. 2024

Author´s declaration:

I hereby declare that I have independently elaborated the diploma thesis with the topic of "Methodology for the monitoring of birds in organic and conventional agricultural areas" and that I have cited all the information sources that I used in the thesis and that are also listed at the end of the thesis in the list of used information sources. I am aware that my diploma/final thesis is subject to Act No. 121/2000 Coll., on copyright, on rights related to copyright, and on amendment of some acts, as amended by later regulations, particularly the provisions of Section 35(·) of the act on the use of the thesis. I am aware that by submitting the diploma/final thesis, I agree with its publication under Act No. 111/1998 Coll., on universities and on the change and amendments of some acts, as amended, regardless of the result of its defense. With my own signature, I also declare that the electronic version is identical to the printed version, and the data stated in the thesis has been processed in relation to the GDPR. I declare that I have used AI tools in accordance with the university's internal regulations and principles of academic integrity and ethics.

Nerea Elorza Corrales

In Prague on the 26th of March 2024.

Acknowledgments

I would like to express my deepest gratitude to my supervisor, Dr. prof. Miroslav Šálek, for his invaluable patience and feedback, for supporting and motivating me throughout the whole thesis period.

I am also grateful to my colleagues and classmates for their help and support, especially to Claire Herlihy and Ana Ribadeneira.

Lastly, I would like to acknowledge the support of my partner and family. Their love and belief in me have kept my spirits and motivation high during the last two years and while conducting this research.

Abstract

Biodiversity loss, driven primarily by agricultural intensification, poses significant threats to ecosystems globally. This study investigates the impacts of agricultural practices on avian biodiversity within agricultural landscapes, focusing on focusing on how the characteristics of the observer can affect the results of field research and their interpretation from the point of view of assessing the impact of management on bird biodiversity. Utilizing data collected by both beginner and experienced observers over multiple years, our analysis reveals consistent patterns of increased avian abundance and species richness within ecologically managed fields, particularly during springtime. Despite methodological disparities and varying levels of observer experience, both datasets consistently highlight the ecological benefits of these habitats for avian populations.

Keywords: *Biodiversity loss, agriculture, intensification, organic farming, avian biodiversity, ecological farming, beginner observers, experienced observers, species richness, Functional Biodiversity Index (FBI).*

Abstrakt

Ztráta biodiverzity, zejména způsobená intenzifikací zemědělství, představuje významné hrozby pro ekosystémy globálně. Tato studie zkoumá, jak mohou vlastnosti pozorovatele ovlivnit výsledky terénního výzkumu a jejich interpretaci z hlediska posouzení dopadu zemědělského hospodaření na ptačí biodiverzitu.. Využívajíce dat sbíraných jak začínajícími, tak zkušenými pozorovateli po řadu let, naše analýza odhaluje konzistentní trend zvýšeného zastoupení ptáků a druhové bohatosti v ekologicky obhospodařovaných polích, zejména během jara. Navzdory metodologickým disparitám a různým úrovním zkušeností pozorovatelů oba soubory dat konzistentně zdůrazňují ekologické výhody tohoto přístupu pro ptačí populace.

Klíčová slova: *Ztráta biodiverzity, zemědělství, intenzifikace, ekologické zemědělství, biodiverzita ptáků, ekologické zemědělství, začínající pozorovatelé, zkušení pozorovatelé, druhová bohatost, Index funkční biodiverzity (FBI).*

Table of Contents

1. **Introduction**

Biodiversity faces threats on both global and regional scales (Sachs et al., 2009; Butchart et al., 2010). Over recent decades, agriculture has emerged as a primary driver behind this loss of biodiversity, influenced by the intensification of existing farmland and the conversion of natural land into cropland (Rudel et al., 2009; Balmford et al., 2012; Tscharntke et al., 2012). Fundamental changes in crop rotations occurred, including an increase in the share of cereals, as herbicides with varying chemical composition and selectivity were applied more and more frequently. Additionally, nitrogen fertilizers were being applied at higher rates (Chamberlain et al. 2000; Báldi et al. 2005) and thus invertebrates and field weeds suffered severe and detrimental effects. The diversity of herbal communities and the overall number of insects - which provide food for animals like birds that live in agricultural areas - were steadily declining as a result of the widespread use of pesticides (Wilson et al. 1999; Vickery et al. 2001).

The shift towards industrialized and highly intensive farming practices in recent decades, aimed at meeting the growing demand for food, has not only failed to achieve its goal but has also led to detrimental environmental impacts, including declines in farm bird populations (Bavec & Bavec, 2015) and marginalization of farms unable to keep pace, often forcing them to abandon their land, with equally devastating consequences for biodiversity (European Commission, 2011).

Heightened concerns about the environmental ramifications of intensive farming have motivated calls for more environmentally friendly agricultural production methods. Organic farming, in particular, has gathered attention from the public and policymakers due to its potential to deliver environmental, social, and economic benefits. There is a widespread acknowledgment that organic farming embodies many attributes of a sustainable farming system (Rossi and Nota, 2000; Stolze et al., 2000; Hansen et al., 2001; Rigby and Cáceres, 2001).

A growing number of farmers are switching to organic agricultural methods as their advantages become more widely acknowledged. Still, there aren't many empirical studies evaluating the effectiveness of sustainable agriculture management techniques. Monitoring bird populations is a promising way to assess the efficacy of ecological farming. This is especially true for species strongly linked to agricultural fields, like those identified by the Farmland Bird Indicator (FBI) (European Bird Census Council, 2014). As a useful indicator of the health of an ecosystem, the quantity of avian species indicates the presence of important food supplies, such as seeds and insects. Furthermore, the existence of avian predators is indicative of a healthy environment, which supports the ecosystem's general vitality. As a result, research on bird populations provides information about how ecologically sustainable agricultural methods are.

2. Literature review

2.1. Ecological farming/organic agriculture

2.1.1. How is it defined

Organic agriculture is a farming system that does not employ synthetic compounds, genetically modified organisms, or agrochemicals such as food additives; instead, it emphasizes on soil fertility by using local resources as efficiently as possible (Gomiero et al., 2011). It lessens environmental effect, promotes ecological cycles, and guarantees food of the highest caliber. By putting an emphasis on the health of the soil, water, plants, and animals, organic farming promotes biodiversity and sustainable management. In addition, it promotes social justice, animal welfare, and environmental preservation (Bavec et al., 2012). Health, ecology, justice, and management are the main tenets of organic farming (Toncea 2002; Roman et al., 2008). It also follows guidelines that guarantee biodiversity preservation, environmental protection, management of soil fertility, consumer health prioritization, recycling of on-farm materials, optimal yield approaches, adoption of appropriate technologies, and integrity in production and marketing (Davidescu & Davidescu, 1994; Toncea & Stoianov, 2002).

Organic farming systems are firmly based on a biological understanding of soil fertility and ecological interconnectedness, in addition to these guiding principles and regulations. In organic agricultural practices, soil humus, soil organisms, and plant roots are all important components that represent an ecological viewpoint that connects humans, animals, and plants. Organic farming stresses biological and ecological practices grown mostly on the farm itself, avoiding insecticides, herbicides, and inorganic fertilizers, whereas conventional farming often relies on chemical intensification methods (Tuck et al., 2014). In the past, organic farming has been linked to hopes for the betterment of society; this has evolved from independent gardeners supporting a natural way of life to more recent initiatives centered around sustainability and the preservation of dying rural customs (Geier et al., 2007).

According to Fuller et al. (2005), there are clear distinctions between organic and nonorganic farms concerning the size, makeup, and management techniques of their habitats. According to Smith et al. (2011), organic farms are generally located in more varied landscape types, which are typified by smaller field widths and wider, less fragmented hedgerows, all of which contribute to biodiversity. In order to preserve soil fertility, organic farmers utilize strategies such as crop rotation, mixed cropping, and the application of green manures. Furthermore, mixed livestock enterprises and the creation and maintenance of permanent pastures, grass leys, hedgerows, and beetle banks are common practices on organic farms. In general, organic management practices give sustainability and diversity precedence over intensification.

2.1.2. Origins

Though organic farming has been around for more than 70 years, politicians, consumers, environmentalists, and farmers in Europe didn't start paying it any attention until the mid-1980s. The EU didn't establish legislation, known as Regulation 2092/91, to formally define organic crop cultivation until 1991. Later, as part of the 1992 Common Agricultural Policy (CAP) reform, more extensive support for organic farming was added to the agri-environment program under Regulation 2078/92. There has been significant growth in the sector since the enactment of EC Regulation 2092/91 and the introduction of policies to support the switch to and continued practice of organic farming, with 70% of the expansion in land area taking place after 1993 (Lampkin et al., 2000).

2.1.3. Development of Organic Agriculture

The practice of organic agriculture has its origins in prehistoric times when farmers raised cattle and cultivated crops using natural means. Crop rotation, composting, and natural pest conventional techniques were all part of traditional farming practices that prioritized soil fertility. Early in the 20th century, worries about the detrimental effects of industrialized agriculture led to the emergence of the modern organic agricultural movement. Formal organic certification requirements were established in the middle of the 20th century as a result of worries about chemical inputs in agriculture. In several nations, organic agriculture received official government support by the 1980s and 1990s. To guarantee customer confidence in organic products and to standardize organic certification, regulatory frameworks were formed. Consumer interest in organic products has increased dramatically over the last few decades due to worries about food safety, sustainability of the environment, and health. The demand for organic vegetables, meat, dairy, and processed goods has surged, leading to a rapid growth in the organic sector. More growers are being encouraged to switch to organic practices as a result of this expansion, which has increased market opportunities for organic farmers. Regenerative agriculture, which goes beyond organic methods to improve and restore ecosystem health, is becoming more and more popular these days (Reganold & Wachter, 2016; Paull,2023).

2.1.4. Future of Organic Agriculture

As part of a land-sharing strategy, organic farming, which usually increases crop and landscape diversity, can provide larger ecological advantages like amenity and the conservation of culturally relevant species (Vandermeer & Perfecto, 2007; Gabriel et al., 2013). From this angle, precisely quantifying the unique benefits of organic farming is essential to guaranteeing the sustainability and effectiveness of this farming method going forward (Tuck et al., 2014).

2.1.5. International Federation of Organic Agriculture Movements (IFOAM)

With almost 750 member organizations spread across more than 100 countries, the International Federation of Organic Agriculture Movements (IFOAM) seeks to represent and unify the diverse organic movement worldwide. It creates common platforms, encourages knowledge sharing, facilitates information interchange, and represents organic agriculture's interests in international organizations. IFOAM was created in response to issues with soil fertility, industrialization, and monoculture in agriculture. After the organic movement became more diversified, it realized that there needed to be international coordination, which is how IFOAM was formed (Geier et al., 2007).

2.2. Economics

The diminishing cost advantage of organic farming emphasizes how important it is to close the yield gap and produce balanced yields in order to maintain profitability in the future. In this sense, it becomes imperative to prioritize knowledge-based technologies and decision-making procedures, with market conditions becoming less significant. Some farmers may have adopted alternate production practices due to this transition (Urfi et al., 2011). Subsidies for organic farming have the potential to contribute to biodiversity preservation; however, the current regulations are not detailed enough to address individual farms or landscapes, therefore programs for subsidies need to be flexible. Nevertheless, few thorough studies have been conducted at appropriate farm and landscape scales to examine these challenges (Bengtsson et al., 2005). According to a global meta-analysis (Crowder & Reganold, 2015), organic farming generates much higher economic profitability due to the premium prices of organic products, even when yields are lower (Ramesh et al., 2010). Improved access to organic markets and a decreased need for outside inputs are credited with this profitability (Giovannucci, 2006; Kilcher, 2007). Supportive policies can improve the benefits of organic farming and synergy in biodiversity. Agri-environmental payments should be in line with the demand from society for ecologically beneficial activities (Gómez et al., 2011). Farmers' ethical and social values about biodiversity imply that, in addition to financial incentives, soft policy tools can promote practices that are sensitive to biodiversity (Giovannucci, 2006). The adoption of organic farming is influenced by economic factors, but practical decisions about farm organization are limited by issues such as labor requirements, agronomics, and market limits (Schneeberger et al., 2002; Gómez et al., 2011).

2.3. Applications in different countries in Europe

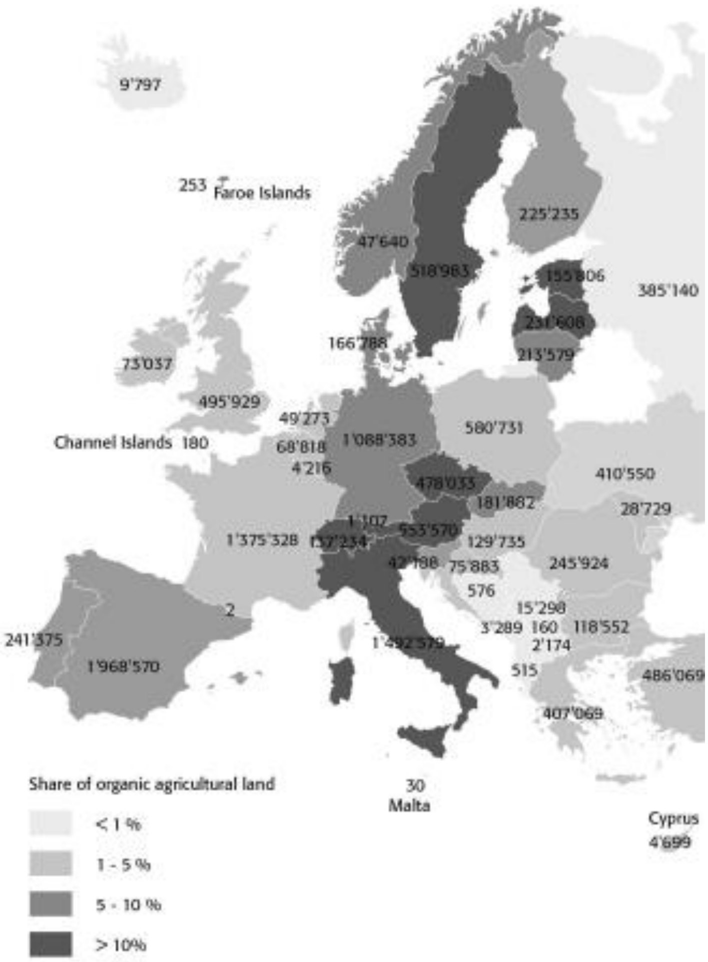

Figure 1*. Organic agricultural land in the countries of Europe 2015. Source: FiBL-AMI survey 2017; based on information from the private sector, certifiers, governments, Eurostat and the Mediterranean Organic Agriculture Network.*

In Europe, the organic food and farming industries have grown significantly during the last thirty years (Figure 1). Since 1985, the total amount of farmland in Europe devoted to organic farming has been rising significantly; by 2015, it had reached almost 13 million hectares, of which 11.2 million were located within the European Union (EU). Alongside this expansion, the European organic retail market has experienced substantial growth, with its total value nearly tripling from 11.8 billion euros in 2005 to roughly 29.8 billion euros in 2015 (27.1 billion euros within the EU).

The organic food and farming industry's ability to adapt to the needs of European consumers seeking high-quality food production and the expectations of policymakers for the sector to uphold environmental sustainability, animal welfare, and rural development is demonstrated by its sustained growth (Willer & Lernoud, 2017).

2.3.1. Austria-Czechia

There are several noticeable differences between the landscape patterns in the Czech Republic and Austria. The Czech Republic exhibits more homogeneity than Austria. There are notable differences in farming practices and agricultural intensity between the two countries, as evidenced by the cropland mean patch size, which is 5.6 times greater in the Czech Republic. The frequency of these sharp disparities along their common boundary indicates that broad-based political and economic reasons specific to each nation were the main forces for landscape evolution, rather than local environmental considerations. In addition, Austria's edge density is 1.9 times higher than the Czech Republic's, indicating more variability in the terrain overall as well as in farming patterns. Since the mid-1900s, the rural landscape patterns of the two countries have diverged significantly despite similar environmental conditions. This divergence can be attributed to different political and socioeconomic environments, which have influenced varying rates of transformation and differing directions (Atauri & de Lucio, 2001; Weibull, Östman, & Granqvist, 2003; Moudrý & Símová, 2013). The spatial landscape makeup of the Czech Republic and Austria differs significantly, as this study by Sklenicka et al. (2014) reveals. Austria's landscape patterns, which are noticeably more varied, generally have good effects on the environment. The benefits of farmland fragmentation, landscape variety, and the existence of near-natural habitats on species diversity and the occurrence of uncommon plant and animal species have been confirmed by a number of scientific studies.

2.4. Methods/approaches

2.4.1. Ways to measure

Direct and indirect observation are the two basic methods used in the study of effectiveness of organic farming. Measuring biodiversity indicators like earthworms, butterflies, or birds is part of the direct method (Smith et al., 2011). On the other hand, the indirect method examines aspects of the ecosystems associated with organic farming, like disease and pest management and nutrient flows. These findings show how the farming system's essential biodiversity is protected and preserved (Smith et al., 2011).

2.4.2. Problems with methodology

While most research supports the idea that biodiversity gains from organic farming, there are issues with establishing suitable comparison methodologies and comprehending the roles that biodiversity markers play in agricultural and natural ecosystems. Hector & Bagchi (2007) point out that an exclusive emphasis on specific processes undervalues the biodiversity required for ecosystems with many functions. It is unknown, nevertheless, how much organic farming contributes to biodiversity beyond food production (Smith et al., 2011). Significant problems also arise from disparities in research spatial scales, variances in organic farming requirements among nations and certification agencies, and the selection of appropriate conventions taking landscape factors into account. Research results are further complicated by the pairing of organic farms with conventional farms of a comparable size, restricted temporal replication of studies, and differences in biodiversity metrics between taxa (Paoletti, 1999; Purvis & Hector, 2000; Crowder et al., 2012). Furthermore, the high cost of fully capturing biodiversity and the mismatch between field-scale research and farmers' holistic management decisions make it difficult to assess the effects of farming systems on biodiversity. To fully understand how farming systems affect biodiversity, it is imperative that research be conducted at various scales (Bengtsson et al., 2005; Gabriel et al., 2006; Gabriel et al., 2010; Hodgson et al., 2010; Kleijn et al., 2011 Kelemen et al., 2013). Many studies that compare conventional with organic farming are poorly designed, having few replicates and ignoring variables other than agricultural systems, like farm history and landscape layout. Further research is needed to fully understand the effects of functional biodiversity on ecosystems, especially in places with substantial organic farming (Rahman, 2011; Bavec & Bavec, 2015).

2.5. Scope of Organic agriculture use

It is common to undervalue the critical role that farmers play in the field of farmland biodiversity studies. It is likely their personal views, not the particular farming method used, have the biggest impact on biodiversity at the farm level. The active participation of knowledgeable and driven farmers is necessary to enhance biodiversity in agricultural landscapes, and their efforts should be bolstered by a system of subsidies that encourage ecologically conscious management methods. For scientists to suggest and test strategies that work in actual environments, farmer collaboration is essential (Bengtsoon et al., 2005). Farmers' management choices and farming techniques have a substantial impact on biodiversity in agricultural settings. Their adoption of farming practices that promote biodiversity is influenced by their opinions about the value of biodiversity (Bavec & Bavec, 2015). Farmers' views on biodiversity, entwined with their quotidian farming practices, go beyond acknowledging the diversity of species and habitats to take into account the more intricate workings of ecological systems. Conventional farmers tend to be more uniform in their attitudes toward biodiversity, whereas organic farmers generally take a more nuanced and philosophical approach. Conventional farmers prioritize economic considerations, which influences their conduct, even if ethical and social values are important to all farmers (Kelemen et al., 2013). Organic farmers exhibit a greater inclination toward environmentally beneficial methods because they are usually more aware of environmental issues. More biodiversity is typically fostered on farms by those with more environmental knowledge and positive environmental attitudes. Although there may be some discrepancies between views and behaviors, organic farmers are generally more willing to use ecologically friendly farming methods. The connection between organic farming's beneficial effects on biodiversity and farmers' environmental attitudes and knowledge emphasizes how crucial farmer participation and well-informed decision-making are to promoting biodiversity (Power et al., 2013).

2.6. Effects

Reduced exposure to pesticides and inorganic fertilizers is a clear result of using organic agricultural methods (Rundlöf et al., 2016). On the other hand, indirect effects result from modified farming techniques brought about by limitations on the use of agrochemicals, such as the use of organic manure and adjustments to crop selection (Stockdale et al., 2001). On organic farms, this might improve the diversity of local habitats (Hardman et al., 2016). According to various studies (Bengtsson et al., 2005; Fuller et al., 2005; Bengtsson, Ahnstrom & Weibull, 2005; Batary et al., 2011; Winqvist et al., 2011; Winqvist, Ahnstrom & Bengtsson, 2012; Birkhofer et al., 2014a; Schneider et al., 2014; Tuck et al., 2014). Organic farming has varying effects on biodiversity, which is commonly measured in terms of species richness. Part of the reason for these differences is that organisms can move around, making it harder to find mobile species, particularly in tiny organically maintained regions (Fuller et al., 2005). Furthermore, the reaction to organic farming is contingent upon variables like crop selection and the decrease in pesticide use. Sedentary creatures like plants may be more impacted by local factors like agrochemical inputs, whereas mobile species are more impacted by landscape aspects like habitat availability. Research has demonstrated that the benefits of organic farming on biodiversity can differ depending on the features of the landscape. Because varied landscapes increase the availability of habitat, they are expected to promote similar levels of variety in both conventional and organic fields (Tscharntke et al., 2005). Furthermore, research indicates that organic farming may benefit other farms and landscapes in addition to the farm itself, thus expanding its advantages to biodiversity (Rundlöf et al., 2008; Gabriel et al., 2010; Hodgson et al., 2010). On the other hand, arable farming dominated, simple homogeneous landscapes might include intermediate species pools that benefit from better local habitat quality brought about by organic farming methods (Tscharntke et al., 2005).

In conclusion, when compared to conventional farming methods, organic farming, which is characterized by lower nitrogen inputs, fewer mechanical field operations, and lower pesticide applications, typically results in increased species richness and abundance across various organism groups (Schneider et al., 2014). According to Burns et al. (2013), organic farming is acknowledged as a tried-and-true technique for increasing biodiversity on farmlands, providing potential remedies for the reduction of common species in developed countries.

2.6.1. Disadvantages of Organic farming on biodiversity

Although organic farming often increases biodiversity (Tuck et al., 2014), it is unclear if this increased local biodiversity results in increased regional diversity (Schneider et al., 2014). Organic farming may not always prioritize biodiversity protection, and its implementation and design may not be best suited for such objectives. Organic farming may have a greater positive influence on biodiversity if its regulations are in line with the biological needs of the organisms it targets (Rundlöf et al., 2016). The need for more acreage to make up for reduced yields in organic systems limits the amount of land available for biodiversity protection, even though organic farming generally has a beneficial impact on biodiversity (Tuck et al., 2014; Ponisio et al., 2015). There have been claims that there may be no net advantage of organic farming due to this problem being exacerbated by the suggested increased diversity per unit production under conventional farming approaches (Hodgson et al., 2010).

Ecosystem services may benefit from organic farming's beneficial effects on biodiversity, such as increased pollinator diversity, yet it is still unclear how exactly organic farming affects these services. Although species-based biodiversity metrics have garnered a lot of interest, genetic and ecological variations have not gotten enough attention in relation to organic farming (Rundlöf et al., 2016). Additionally, several species that have been observed in some studies at lower densities on organic farms - such as parasitoids, ground and rove beetles, and pests - may respond negatively to organic farming (Fuller et al., 2005; Bengtsson et al., 2005; Clough et al., 2007a). Although organic farmers may benefit from lower pest numbers, differences in parasitoid responses are probably the result of intricate interactions with regional and environmental factors (Holzschuh et al., 2007). Despite the established advantages of organic farming on soil conditions and carbon content, favorable impacts on decomposers, namely soil fauna, have not been consistently demonstrated (Mäder et al., 2002; Gattinger et al., 2012). This disparity could be explained by the fact that soil organisms are more influenced by soil type and structure than by the farming method itself.

2.6.2. Benefits of Organic farming on biodiversity

2.6.2.1. Landscape

The amount of arable land in the terrain turns out to be the only important factor affecting overall variety. As the percentage of arable land increases, the diversity gap between conventional and organic farming generally widens; however, there is significant variance around this trend, which may be related to different reactions from different functional groups (Batary et al., 2011). Contrary to expectations for small-scale mosaic landscapes with a mixture of agricultural fields and non-cropped habitats, positive effects on species richness and diversity are expected from organic farming practices in intensively managed agricultural landscapes (Bengtsson et al., 2005). Small-scale studies that ignore the surrounding environment usually show a more noticeable distinction between conventional and organic farming. Bengtsson et al. (2005) propose that the variations in species richness and abundance within agricultural landscapes can be attributed to factors other than farming practices.

2.6.2.2. Plants

When comparing organic and conventional agricultural practices, plants always show stronger responses than other taxa (Bengtsson et al., 2005). Herbicide usage in traditional farming is largely to blame for this trend, as it directly reduces the diversity of non-crop plants in fields and nearby ecosystems (Roschewitz et al., 2005; Winqvist et al., 2011; Schneider et al., 2014). According to Bengtsson et al. (2005), our meta-analysis verifies that using organic farming practices typically results in a greater species richness of weeds as well as plants in field margins and other agricultural habitats. Weeds are predicted to be more common in systems without herbicides (Bengtsson et al., 2005).

2.6.2.3. Herbivores

Because most applied studies focus on how organic farming affects the abundances of specific pest species rather than doing community-level analyses, the effects of organic farming on the diversity of herbivores are still poorly understood (Tuck et al., 2014; Birkhofer et al., 2016). The scant literature suggests that the impact of regional farming methods on the richness of herbivore species varies greatly, and that landscape-scale intensification may have a greater effect on herbivore diversity than organic farming methods (Tuck et al., 2014).

2.6.2.4. Invertebrates

In comparison to their conventional counterparts, organism groups like ground beetles, spiders, wasps, and pollinating insects - such as butterflies and bees - generally show higher species richness on organic farmland (Feber et al., 1997; Rundlöf and Smith, 2006; Holzschuh et al., 2008; Rundlöf et al., 2008a, b; Andersson et al., 2013; Birkhofer et al., 2014a; Schneider et al., 2014). This variety is probably influenced by the profusion of blooming plants in and near organically maintained fields, which supply the nectar and/or pollen essential to these creatures (Gabriel & Tscharntke, 2007; Rundlöf et al., 2008b). Pollinators, which include both wild and cultivated plants, may benefit especially from the presence of a rich floral resource base in cropped regions and semi-natural habitats (Tuck et al.,2014).

2.6.2.5. Microbes

When compared to non-organic farming, organic farming usually leads to an increase in a variety of soil-borne organisms, including mycorrhizae (Oehl et al., 2004; Esperschütz et al., 2007). Enhanced root colonization and higher concentrations of arbuscular mycorrhizal spores have been reported in organic soils (Gosling et al., 2010; Verbruggen et al., 2010).

2.6.2.6. Birds

Although results vary among studies and bird species (Wilcox et al., 2014), organic farming practices generally benefit birds (Winqvist et al., 2011; Tuck et al., 2014). However, species richness may even be higher on conventional farms (Gabriel et al., 2010). There may be a reason for this disparity: organic farms often support ecosystems that are beneficial to corvids - which are important nest predators - making it difficult for some species to thrive, predominance of adjacent habitats, the time since the start of organic farming, field size; but also methodological aspects, such as the individual ability to detect some hidden birds in the field, insufficient monitoring (few visits) and weather during monitoring. Although there has been little research done to identify the exact elements that contribute to organic farming's advantages for birds, there are signs that reduced pesticide use and more accessible semi-natural habitats play a role, possibly increasing the availability of food (McKenzie & Whittingham, 2009).

Birds are undoubtedly good indicators of environmental health. Studies suggest that bird populations may begin to decline around six years after the onset of agricultural intensification. This decline could be attributed to indirect mechanisms like food reduction. This delayed response highlights the critical need to factor in long-term effects when forecasting the consequences of future agricultural changes (Chamberlain et al., 2000).

Both arable fields and meadows have positive effects on the richness of bird species (Batary et al., 2010). Moreover, in landscapes with low levels of semi-natural habitat, organic farming has a greater impact on the diversity of bird species (Smith et al., 2010a). Wintertime bird populations may benefit from organic farming as well, especially in simpler agricultural settings (Geiger et al., 2010b). All things considered, farm management techniques may not be as important in determining bird species richness as landscape layout (Gabriel et al., 2010).

The irregular variation in the magnitude of advantages can be attributed to species-specific responses. The extent of physical weed conventional on organic farms (Geiger et al., 2010) may account for part of this diversity, but bird size, movement, and habitat specialization may also play a role. On organic farms, generalist species and crow family members are typically more prevalent (Smith et al., 2011). For example, Kragten and de Snoo (2008) discovered that among field-breeding birds, skylark abundances were higher on organic farms. According to Watson et al. (2006), organic farms had considerably greater wintertime total bird numbers, especially for insectivores. The increased habitat diversity found in organic systems benefits species that rely on insects in particular by improving their foraging options (Smith et al., 2010).

Particularly when the sward is species-rich and structurally diverse, grass margins provide birds with important foraging habitats by offering seed and insect food supplies in both the winter and the summer (Vickery et al., 2001). These areas are preferred by foraging species such as yellowhammers and whitethroats (Bradbury et al., 2000; Morris et al., 2001; Stevens and Bradbury, 2006).

Summing up, it is crucial to emphasize the role of birds as bioindicators and their ease of detection. By leveraging birds as indicators, we can more effectively assess and monitor the effectiveness of organic farming practices in supporting biodiversity. Birds serve as reliable indicators of environmental health, responding swiftly to changes in their habitat. Thus, their presence or absence can provide valuable insights into the impact of organic farming on local ecosystems. Harnessing this aspect can enhance the ability to measure the success of organic farming initiatives in promoting biodiversity conservation.

3. Objectives of the study

The primary objective of this investigation was to assess the efficacy of ecological farming practices, as quantified by the population density of avian individuals and the diversity of avian species. Additionally, the study aims to examine the potential influence of the observer's experience and the temporal aspects of monitoring, specifically investigating how variations in monitoring personnel expertise and the seasonal timing of data collection may impact the gathered data. To address these objectives, several key questions were investigated:

1.Does the observer’s expertise and the number of visits affect the results of bird monitoring?

2.Are there differences between seasons of the year?

3.Are there differences at the level of estimating the number of species? Or the number of individuals?

4.Are there differences different between differently abundant or differently conspicuous species?

4.Methodology

4.1. Study region

This research was conducted in the geographical region of Suchdol, situated in the northwestern vicinity of Prague, proximate to the urban periphery (Figure 2). Two specifically ecologically managed fields were designated as primary sites for data collection, denominated as MPPM_Su1 (29,7ha) (see Figure 1 in annex) and MPPM_Su2 (5,98ha), respectively (see Figure 2 in annex). These fields were chosen by the farmers themselves due to their distinctive ecological attributes, notably the presence of vegetative buffers along their perimeters, which offer sanctuary and sustenance to smaller avian species and granivorous birds. In order to facilitate a comprehensive analysis of abundance data, two additional fields were selected for comparative purposes, but in this instance, they lacked the aforementioned ecological features. These conventional fields were designated as MPPM_Su1k (29,71ha) (see Figure 3 in annex) and MPPM_Su2k (6,14ha) (see Figure 4 in annex). Careful consideration was given to ensure that the selected fields were as closely matched as possible in terms of size and environmental characteristics. Nevertheless, it is important to note that each field exhibited variances, primarily in terms of the cultivated crop. MPPM_Su1 and MPPM_Su2 featured corn plantations (see Figure 5 in Annex), which are associated with ecological management practices due to their seed-bearing nature, making them particularly attractive to avian species. Conversely, MPPM_Su1k and MPPM_Su2k were characterized by distinct crop plantation, oilseed (see Figure 6 in Annex).

Figure 2. Map of the fields where the data collection was conducted.

4.2. Sampling design and data collection

4.2.1. Route Planning

Before commencing the census, the path of all the transects at each site were carefully sketched out. To guarantee thorough representation, this route adequately covered every habitat feature found in the site and the buffer zone that surrounds it. The integrity of the route will not be compromised during the census or in years to come, unless there are extraordinary circumstances, including problems with land accessibility. It will mostly travel around and along the borders of the property.

4.2.2. Actual counting

The observer slowly followed the predetermined path while carefully noting any bird sightings, including species and quantity. The location of the observer at the time of detection is plotted alongside these data. Either a modified LSD program or conventional paper maps is used for data entry. The following details are noted specifically: line (code, name), date, start and end of count (hh:mm), and observer's name.

4.2.3. Count procedure

During each visit, the sequence of checks within plot pairs (measured and conventional) will change. For example, the census will start on the measure plot on the first visit and then on the conventional plot that same day. On the following visit, this order will be reversed, and it will remain that way for all the following visits to give a more random factor to the data.

4.2.4. Counting time

The notes will explicitly state that counting will start at sunrise and end by 10 am. To maintain uniformity, the beginning time of every count should not vary by more than +/-30 minutes in the following years. This commitment to a set timetable helps to preserve data comparability and integrity throughout time.

4.2.5. Weather and Observer Considerations

In order to ensure data accuracy and observer safety, census activities will be discontinued during unfavorable weather circumstances such as strong winds, continuous heavy rain, or snow. Additionally, although it might not always be possible, efforts will be made to place constant observers along the same transect lines across time. As so, the possible observer effect will be appropriately taken into account while analyzing the data, especially in subsequent iterations.

4.2.6. Other variables

Other factors that will be noted in the field during the census include the crops that are there and their state (crop height, bloom, etc.) to determine how this may impact the appearance of birds in the area.

4.3. Data analysis

4.3.1. Summary of the data

The number of individuals observed for each species were arranged in an Excel spreadsheet. In addition to the number of species observed, the dataset also contained information about the observer, the season in which the observations were made, the site's designation, site number, and field management system classification, which differentiates between ecologically managed fields denoted as "E" and conventional fields denoted as "C." Null data points are those that have neither an individual nor a species recorded; although they are significant when compared to census data, they should be carefully considered and included in studies. RStudio was used to assess which field management system and which season has higher bird populations, and a Nonlinear Mixed-Effects Model was employed to evaluate the effects of the variables on the total data.

4.3.2. FBI indicators

The farmland bird indicator (FBI) is meant to serve as an alternative for additional instruments in evaluating Europe's agricultural landscapes' biodiversity. Because of their high position in the food chain, birds are regarded as reliable markers of the general health of biodiversity. The indicator, a composite index, evaluates how quickly the relative abundance of common bird species changes at particular locations. These species, which were picked from a list of commonly selected species at the EU level, are unable to thrive in other ecosystems and are dependent on farms for food and nesting. The species on the list represent the maximum number from which the nations choose the species that are significant to them (European Bird Census Council, 2014). For this research, the following species were counted for the FBI indicator: *Alauda arvensis, Carduelis cannabina, Emberiza citrinella, Falco tinnunculus, Passer montanus, Perdix perdix, Sturnus vulgaris* and *Hirundo rustica*.

4.3.3. Analysis featuring the observer and the same time frame (2023)

The impact of observers on the number of individuals and species was studied using RStudio, a statistical software tool. It was necessary to apply a Nonlinear Mixed-impacts Model because the data had fixed effects, number of individuals for example, and random effects, like the site. Also, this modeling approach fit the data the best as it works with small sample sizes and sparse data sets and are often used to make inferences on features underlying profiles of repeated measurements from a group of individuals from a population of interest. By incorporating both fixed and random effects, this analytical method allows for the evaluation of changes that can be attributed to different observers while taking potential correlations within the data structure into account.

4.3.4. Issues to consider

Larges flocks of *Columba livia f. domestica* were not taken into consideration for the data analysis. These observations may exaggerate the presence of the species; thus, care must be taken to avoid biasing the data. In order to ensure proper data collection, sightings involving up to three individuals were taken into account.

It is also necessary to mention that during the whole research, supervisor (Miroslav Šálek, who has been studying local bird communities for many years) is classified as the experienced observer in the data collecting procedure since he has more experience recognizing and documenting bird encounters. The author of the thesis, Nerea, on the other hand, is labeled the beginner observer.

For the FBI indicator of 2023 the Grey Partridge was left out as there was no data of it.

5. Results

5.1. Data summary

The combined dataset includes all the data that the experienced observer has gathered since 2020, as well as the data that the beginner observer gathered in 2023. Notably, the beginner observer made observations six times, and the experienced observer made contributions twelve times (see Table 1 in Anex). Overall, the experienced observer counted 436 individuals of 43 bird species while the beginner observer counted 365 individuals of 27 bird species.

5.1.1. Abundance of all individuals

Regarding the number of all the individuals in the fields, there is a statistically significant difference between the spring and winter seasons and the conventional and ecologically managed fields (Table 1). Spring shows a considerable increase of about 6 individuals on average compared to the winter. Furthermore, compared to conventional field treatments, ecologically managed fields exhibit a greater individual prevalence (Figure 3).

Table 1. Results from Nonlinear Mixed-Effects Model testing for factors season and treatment regarding individuals.

Factor	Estimate	Std.Error	Df	t-value	p
Intercept	10.9	4.21	1.4	2.602	0.165
Season (winter)	-6.4	2.70	67.3	-2.378	**0.020**
Treatment	5.3	2.64	67.0	2.017	**0.047**

Significant effects are in bold font.

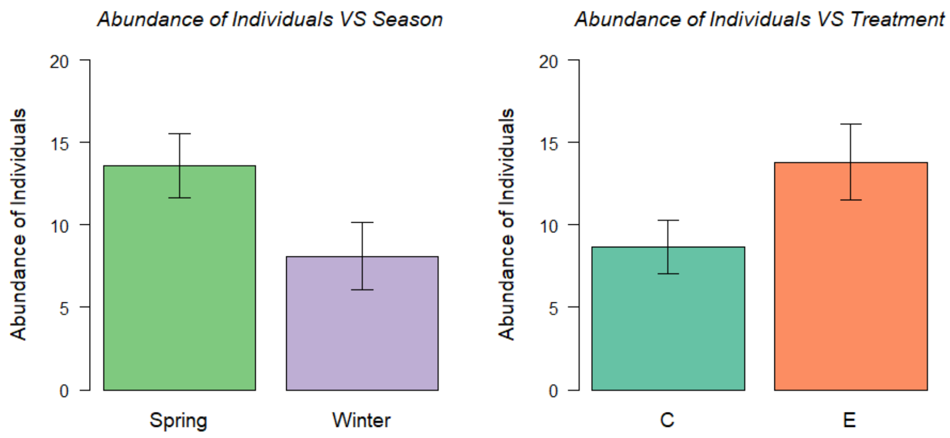

Figure 3. *The effect of season and treatment on the count of individuals being both factors significant. "C" stands for conventional fields and "E" for ecologically managed fields.*

5.1.2. Species richness

When comparing the winter and spring seasons, there is a statistically significant difference in the species richness showing higher richness in spring (Table 2). Moreover, the field management system does seem to have a significant effect on species richness, if not as much as it does on individual abundance. When compared to conventional management regimes, ecologically managed fields still show a higher species richness (Figure 4).

Table 2. Results from Nonlinear Mixed-Effects Model testing for factors season and treatment regarding species.

Factor	Estimate	Std.Error	Df	t-value	p
Intercept	5.0	2.95	1.0	1.723	0.323
Season (winter)	-3.7	0.81	67.0	-4.538	**<0.001**
Treatment (organic)	1.7	0.79	67.0	2.207	**0.030**

Significant effects are in bold font.

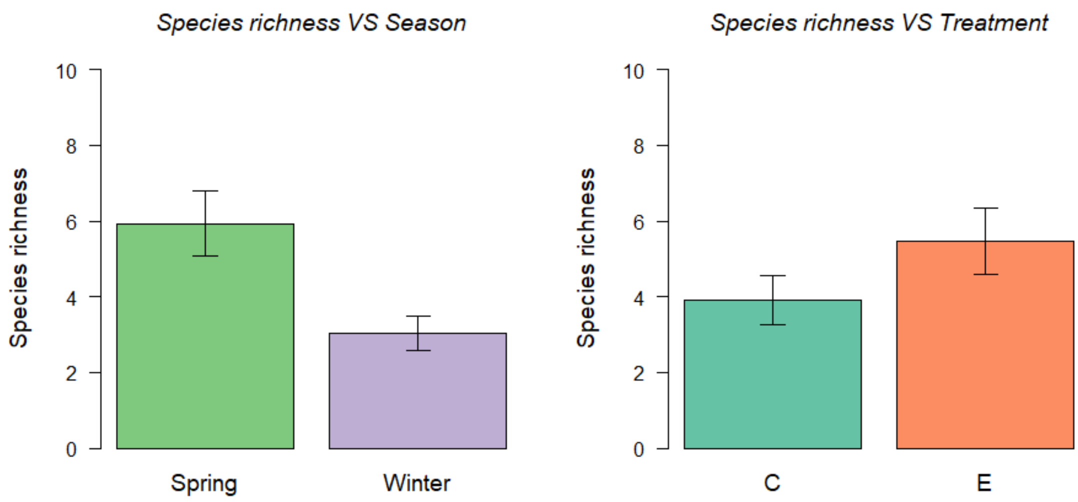

Figure 4. *The effect of season and treatment on the count of species being both factors significant. "C" stands for conventional fields and "E" for ecologically managed fields.*

5.2. FBI indicators

Of all the 70 species counted, 11.5% were FBI species. Among those FBI species, the majority of the individuals were Eurasian Skylarks (*Alauda arvensis*), followed by Yellowhammers (*Emberiza citrinella*). The least counted FBI species was the Grey Partridge (*Perdix perdix*) alongside the Barn Swallow (*Hirundo rustica*) (Figure 5).

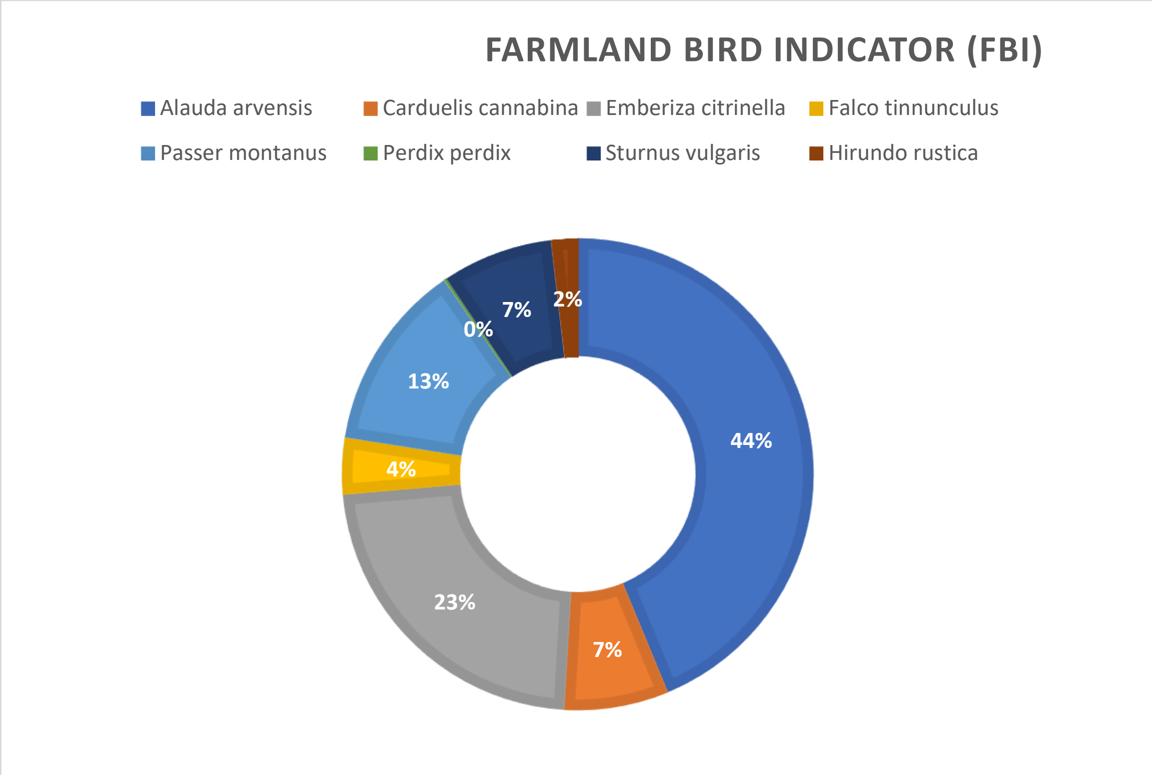

Figure 5. *Farmland bird indicator with percentages of abundance for each species.*

Regarding the observer, both saw all the species except for the Grey Partridge in the case of the beginner observer. Overall, the beginner observer saw more individuals, especially when it comes to the most common species (Skylark, Yellowhammer and the Eurasian tree Sparrow, *Passer montanus*) (Figure 6).

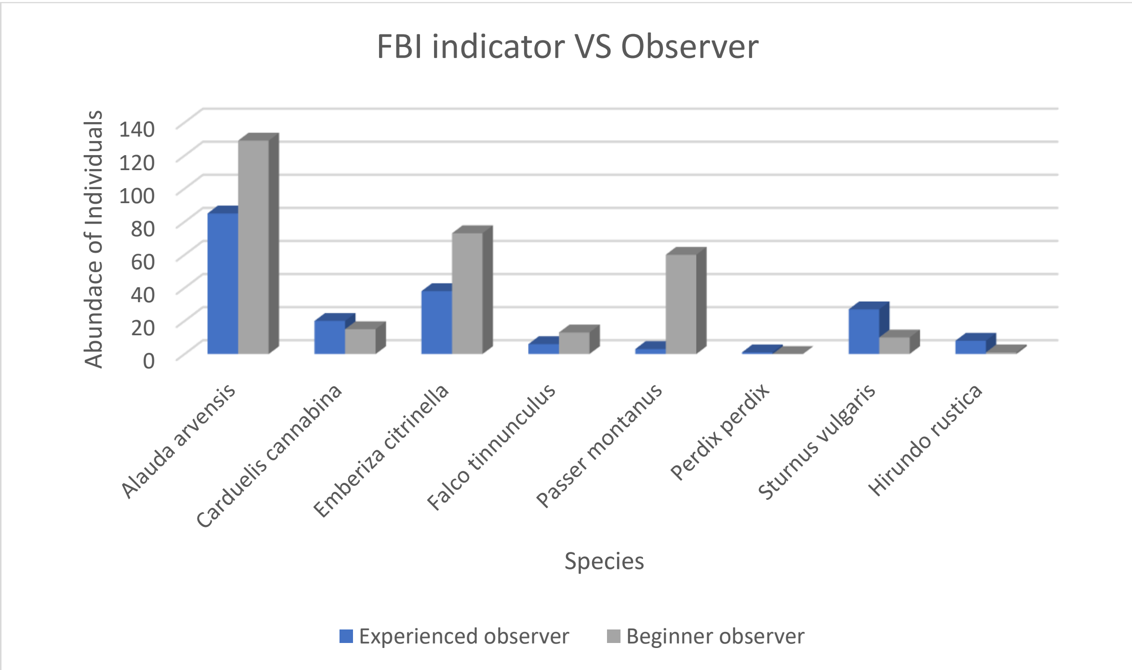

Figure 6. *Abundance of individuals regarding the person that collected the data.*

5.3. Analysis of the observer effect

5.3.1. Analysis of the individuals counted comparing data from the experienced observer and from the beginner observer

Overall, the beginner observer's observations consistently yielded a higher count of individuals compared to the experienced observer (Figure 7), spanning both winter and spring seasons (Figure 8). Notably, during winter, the difference in counts between the beginner observer and the experienced observer is less pronounced, aligning with previous data indicating lower individual presence of birds in winter. Furthermore, it is noteworthy that the management system employed in the fields exhibited no significant influence on the counts of individuals recorded by either the experienced observer or the beginner observer, meaning both of them found more individuals in ecologically managed fields (Table 3).

Table 3. Results from Nonlinear Mixed-Effects Model testing for factors who, season and treatment and their interactions regarding individuals.

Factor	Estimate	Std.Error	Df	t-value	p
Intercept	8.1	4.77	1.5	1.714	0.263
Who	11.1	4.67	64.0	2.393	**0.019**
Who (Experienced observer)*Season	-6.6	3.26	64.1	-2.048	**0.044**
Who (Beginner observer)*Season	-11.7	4.37	64.1	-2.692	**0.009**
Who (Experienced observer)*Treatment	5.4	3.07	64.0	1.783	0.079
Who (Beginner observer)*Treatment	5.4	4.29	64.0	1.261	0.211

Significant effects are in bold font.

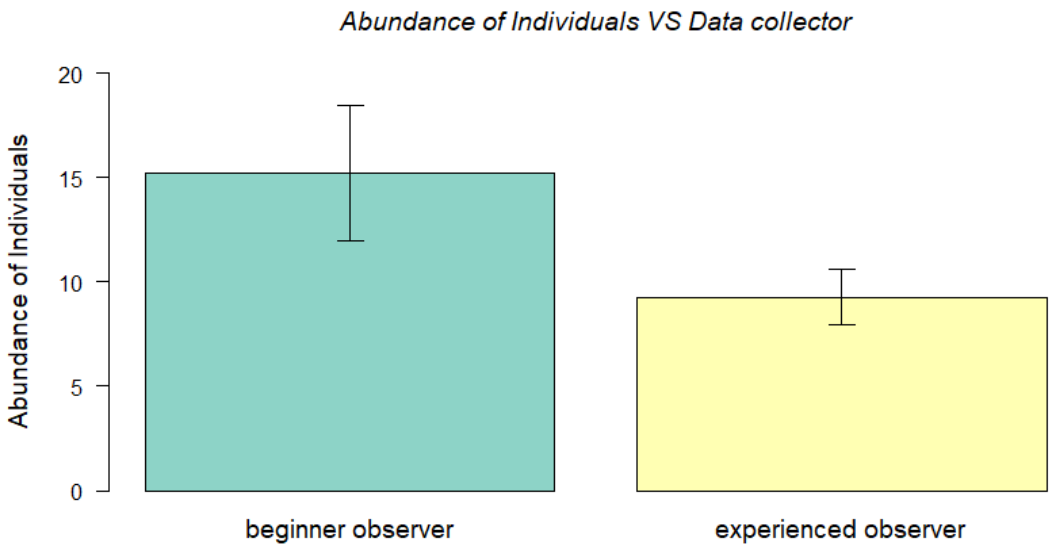

***Figure** 7. The overall number of individuals counted by the experienced observer and the beginner observer.*

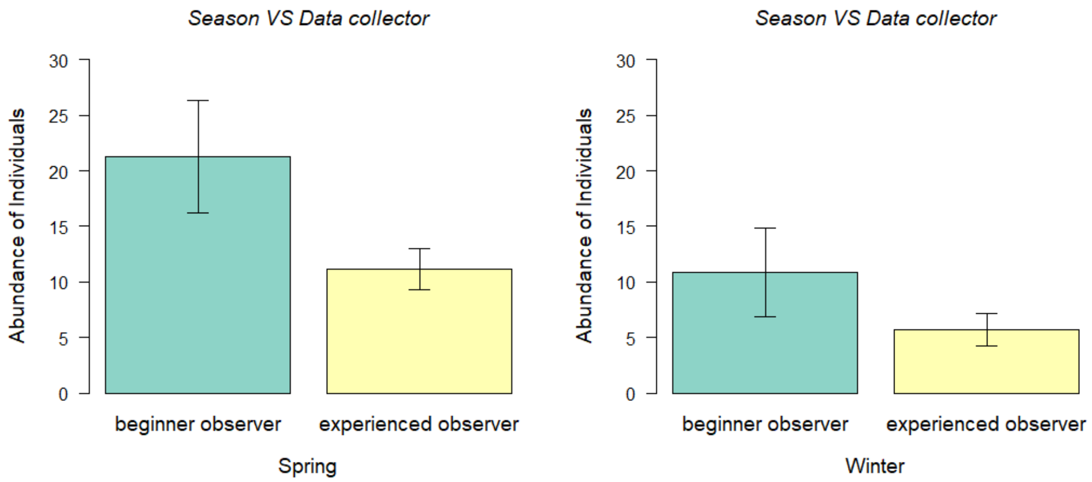

Figure 8. *Comparison between seasons in number of individuals featuring the observer.*

5.3.2. Analysis of the species counted comparing the experienced observer and the beginner observer

Overall, the experienced observer's species totals were higher than the beginner observer's (Figure 9). The experienced observer's species counts showed a statistically significant increase over the beginner observer's (Table 4), especially in the spring (Figure 10). Beginner observer's winter observations, on the other hand, produced a higher number of species (Figure 10). In terms of the difference between the number of species in the ecological and conventional fields, the experienced observer found significantly more species in the conventional fields than the beginner observer (Figure 11).

Table 4. Results from Nonlinear Mixed-Effects Model testing for factors who, season and treatment and their interactions regarding species.

Factor	Estimate	Std.Error	Df	t-value	p
Intercept	5.5	2.90	1.1	1.898	0.28953
Who	-2.0	1.43	64.0	-1.434	0.15631
Who (Experienced observer)*Season	-4.0	1.00	64.0	-4.053	**<0.001**
Who (Beginner observer)*Season	-1.7	1.34	64.0	-1.314	0.193
Who (Experienced observer)*Treatment	2.4	0.94	64.0	2.554	**0.013**
Who (Beginner observer)*Treatment	0.4	1.31	64.0	0.316	0.752

Significant effects are in bold font.

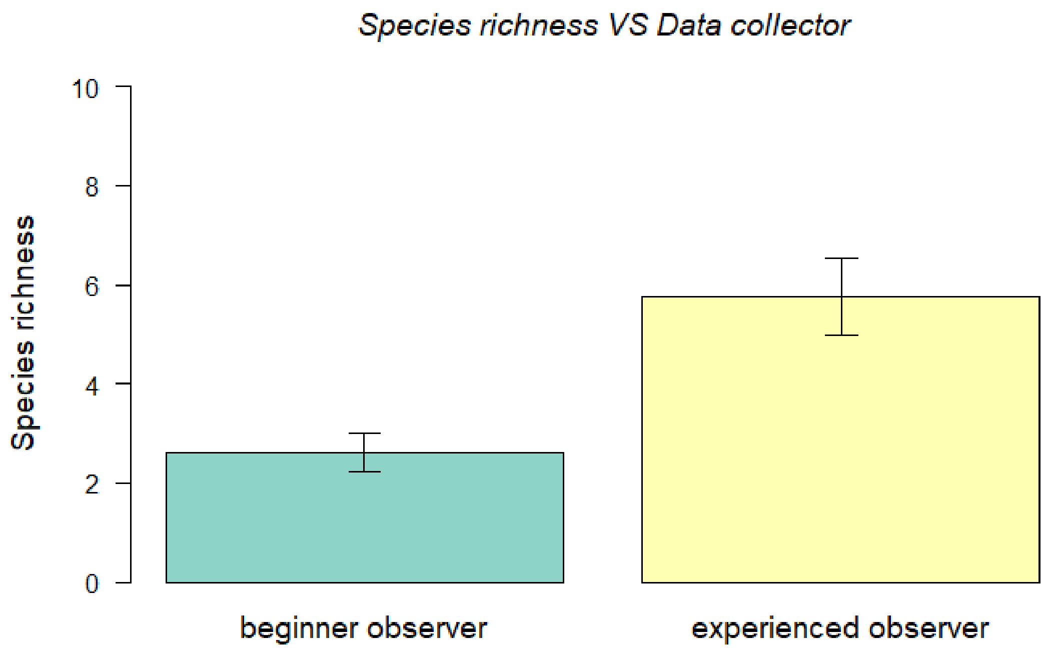

Figure 9. The overall number of species counted by the experienced observer and the beginner observer.

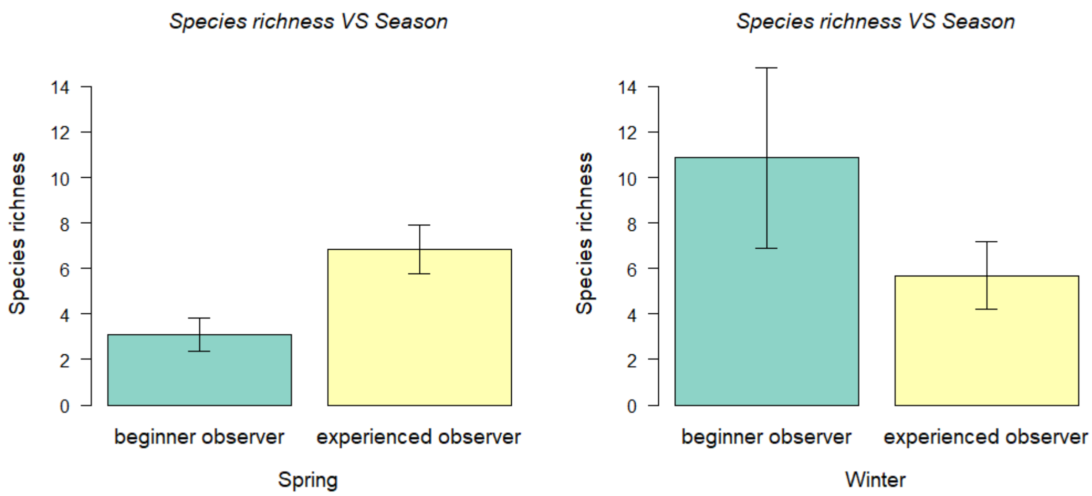

Figure 10. *Comparison between seasons in number of species featuring the observer.*

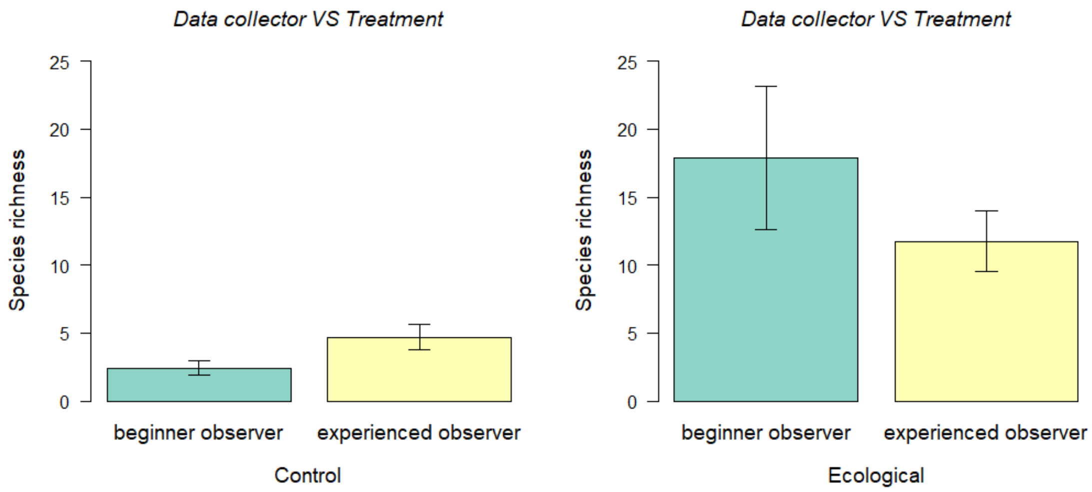

Figure 11. *Comparison between treatment in number of species featuring the observer.*

5.4. Data summary for the year 2023

5.4.1. Abundance of all individuals in 2023

During the spring season, there is a notable increase in the population density of organisms when compared to winter. Furthermore, ecologically managed fields exhibit a higher abundance of individuals in comparison to conventional fields (Figure 12).

Table 5. Results from Nonlinear Mixed-Effects Model testing for factors season and treatment regarding individuals in 2023.

Factor	Estimate	Std.Error	Df	t-value	p
Intercept	14.9	4.15	34.0	3.590	**0.001**
Season	-8.4	4.58	34.0	-1.838	0.07
Treatment	4.9	4.57	34.0	1.082	0.28

Significant effects are in bold font.

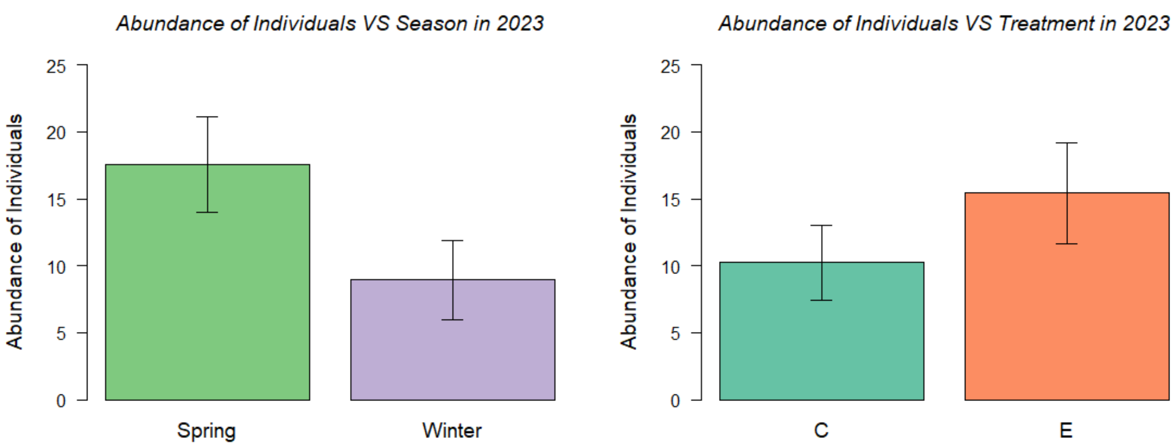

Figure 12. *Effect of season and treatment on the count of individuals in 2023. "C" stands for conventional fields and "E" for ecologically managed fields.*

5.4.2. Species richness in 2023

Species richness shows a statistically significant (Table 6) elevation during the spring season relative to winter. Moreover, ecologically managed fields share a greater diversity of species compared to conventional fields, although the disparity observed between ecological and conventional fields is less pronounced in species richness than in individual abundance (Figure 13).

Table 6. Results from Nonlinear Mixed-Effects Model testing for factors season and treatment regarding species in 2023.

Factor	Estimate	Std.Error	Df	t-value	p
Intercept	4.9	1.85	1.6	2.666	0.139
Season	-3.1	1.18	33.0	-2.689	**0.011**
Treatment	0.6	1.18	33.0	0.591	0.558

Significant effects are in bold font.

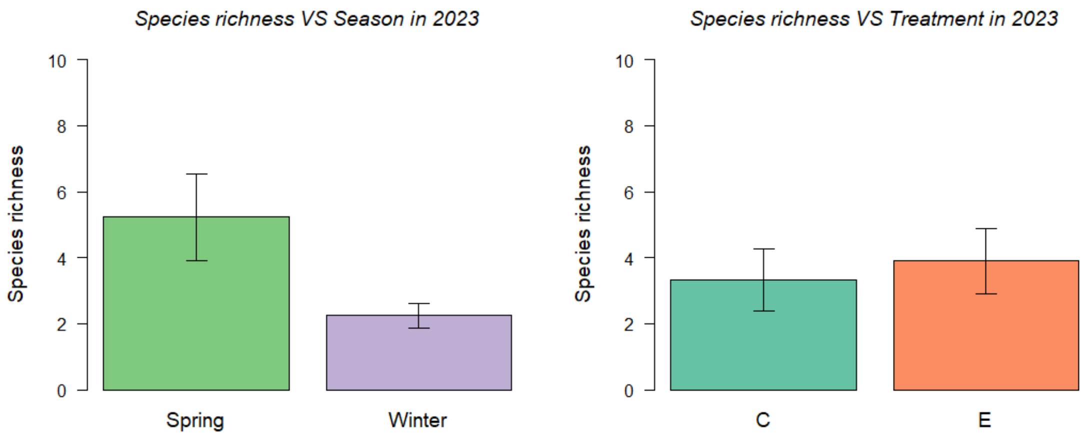

***Figure 13.** Effect of season and treatment on the count of species in 2023. "C" stands for conventional fields and "E" for ecologically managed fields.*

5.5. FBI indicators in 2023

12.3% of the 57 species counted in 2023 were FBI indicator species. The species with more observations were the Skylark and the Yellowhammer. The species with the least observations was the Barn Swallow (Figure 14).

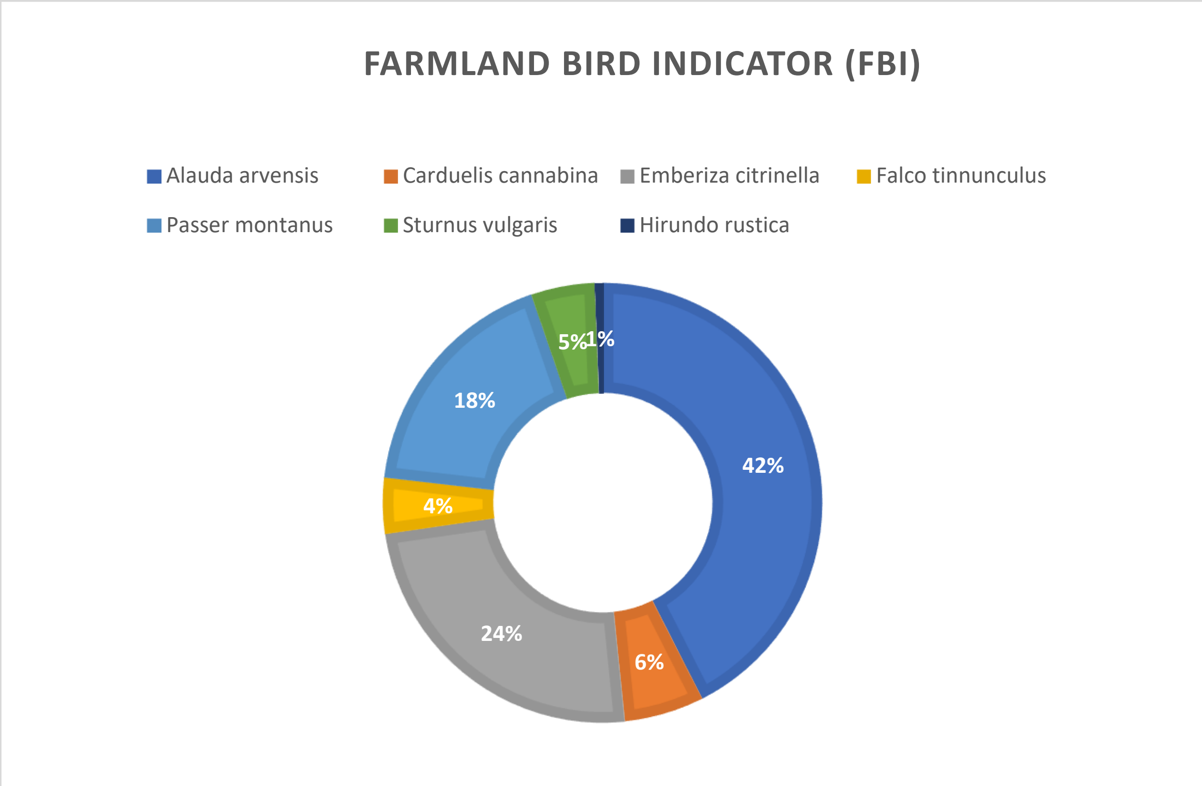

Figure 14. *Farmland bird indicator with percentages of abundance for each species in 2023.*

Concerning the observer, the beginner observer found more individuals of each species except of the Barn Swallow that both observers found the same amount (Figure 15).

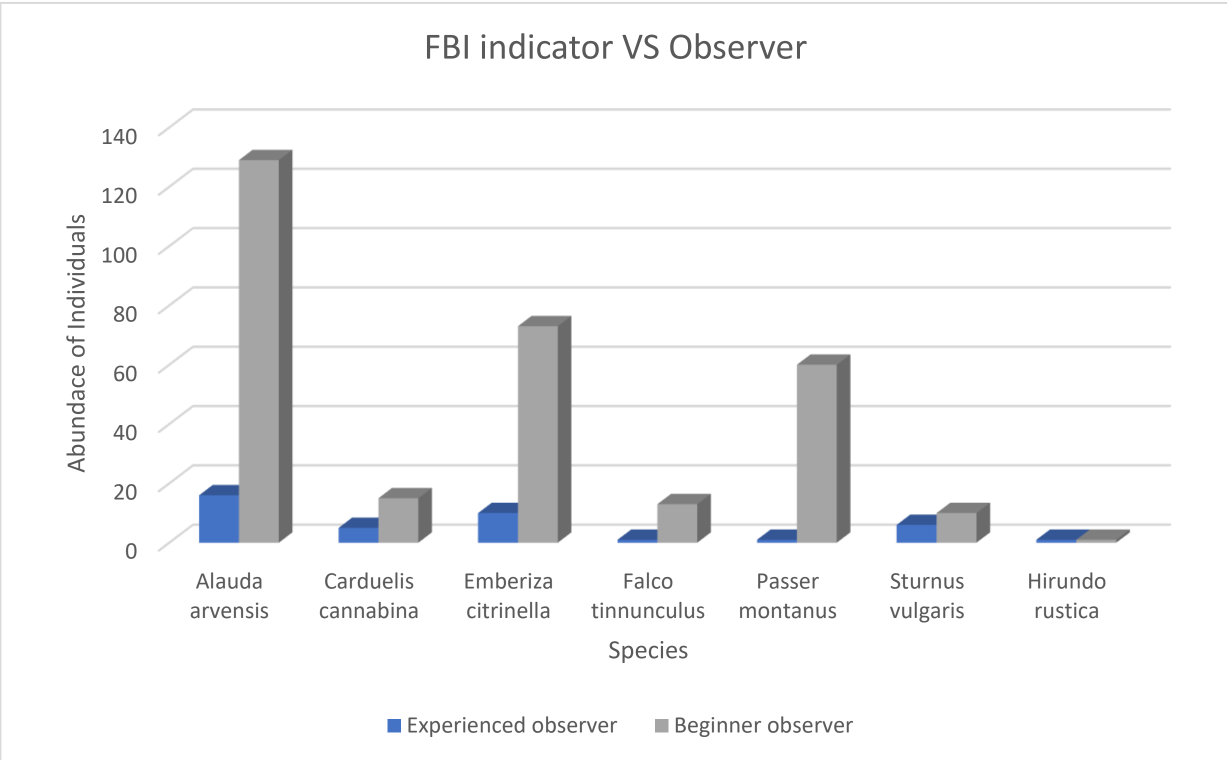

Figure 15. *Abundance of individuals regarding the person that collected the data.*

5.6. Analysis of the observer effect in 2023

5.6.1. Analysis of the individuals counted comparing data from the experienced observer and from the beginner observer in 2023

The beginner observer saw overall significantly more individuals in 2023 (Table 7). On average about 9 individuals more than the experienced observer (Figure 16).

Table 7. Results from Nonlinear Mixed-Effects Model testing for factors who, season and treatment and their interactions regarding individuals in 2023.

Factor	Estimate	Std.Error	Df	t-value	p
Intercept	18.5	5.25	31.0	3.451	**0.001**
Who (Experienced observer)	-9.2	8.66	31.0	-1-071	0.29
Who (Beginner observer)*Season	-10.4	5.77	31.0	-1.808	0.08
Who (Experienced observer)*Season	-7.2	7.78	31.0	-0.937	0.35
Who (Beginner observer)*Treatment	5.4	5.69	31.0	0.951	0.34
Who (Experienced observer)*Treatment	4.9	7.78	31.0	0.637	0.52

Significant effects are in bold font.

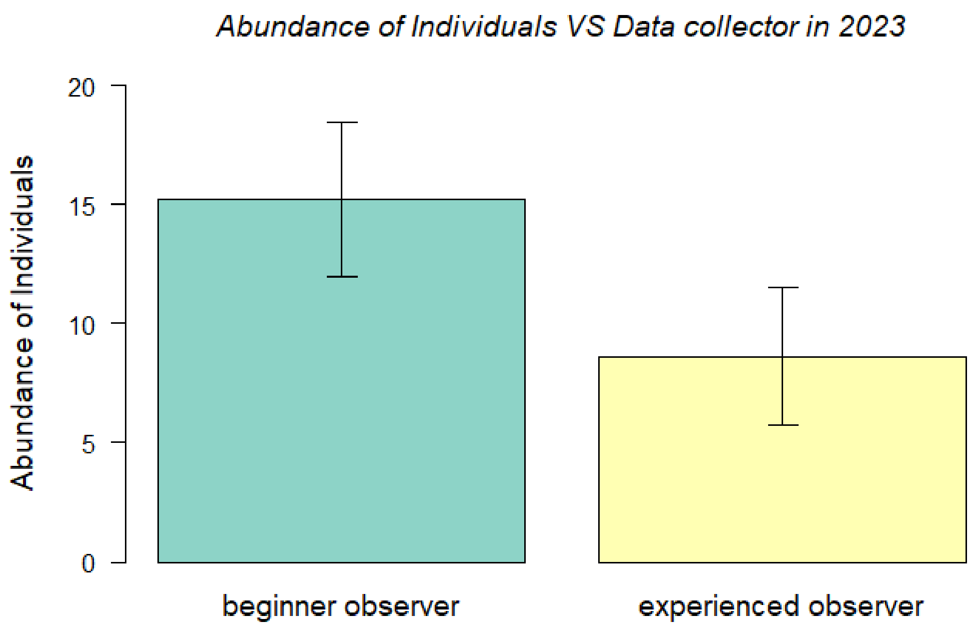

Figure 16. *Overall number of individuals counted by the experienced observer and the beginner observer in 2023.*

While there is no statistically significant difference in data collection between seasons, it is noteworthy that the confidence intervals for the experienced observer in 2023 are larger compared to previous analyses (Figure 17).

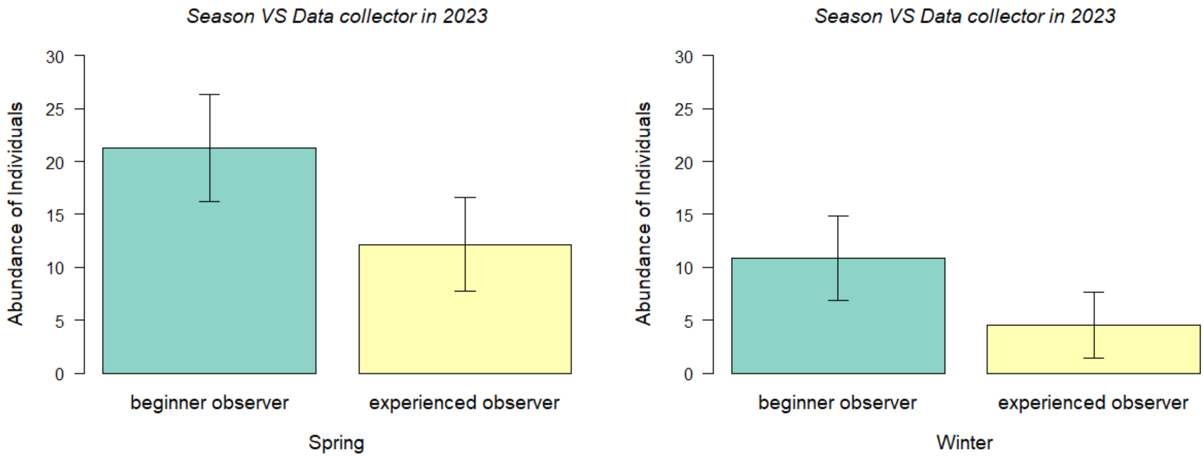

Figure 17. *Comparison between seasons in number of individuals featuring the observer in 2023.*

5.6.2. Analysis of the species counted comparing the experienced observer and the beginner observer in 2023

The experienced observer recorded a higher species count (Figure 18). Notably, the experienced observer exhibited a statistically significant increase in species sightings during the spring season (Table 8) compared to both the beginner observer and historical data (Figure 19). Conversely, species sightings decreased during the winter months for the experienced observer (Figure 19). The experienced observer notably recorded a higher species richness on conventional fields compared to the beginner observer, accompanied by wider confidence intervals (Figure 20). On the contrary, in ecologically managed fields, the mean species richness observed by the experienced observer was lower. However, the widened confidence intervals in ecologically managed fields, relative to previous years, suggest an increased observation of species by the experienced observer in these environments (Figure 20).

Table 8. Results from Nonlinear Mixed-Effects Model testing for factors who, season and treatment and their interactions regarding species in 2023.

Factor	Estimate	Std.Error	Df	t-value	p
Intercept	3.4	3.05	1.3	1.129	0.41
Who	2.0	1.43	64.0	1.434	0.15
Who (Beginner observer)*Season	-1.7	1.34	64.02	-1.314	0.19
Who (Experienced observer)*Season	-4.0	1.00	64.0	-4.053	**<0.001**
Who (Beginner observer)*Treatment	0.4	1.31	64.0	0.316	0.75
Who (Experienced observer)*Treatment	2.4	0.94	64.0	2.554	**0.013**

Significant effects are in bold font.

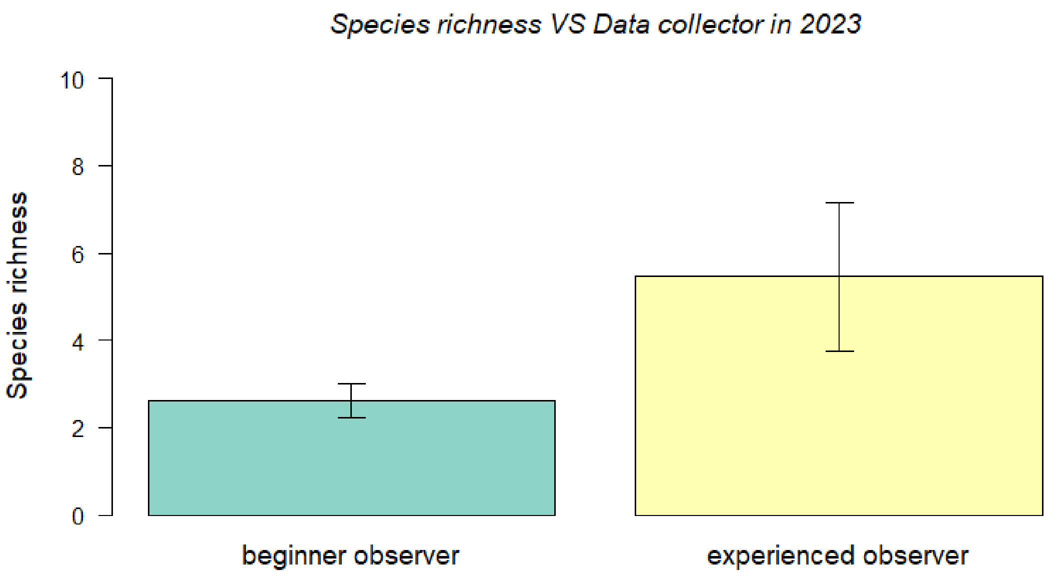

Figure 18. *Overall number of species counted by the experienced observer and the beginner observer in 2023.*

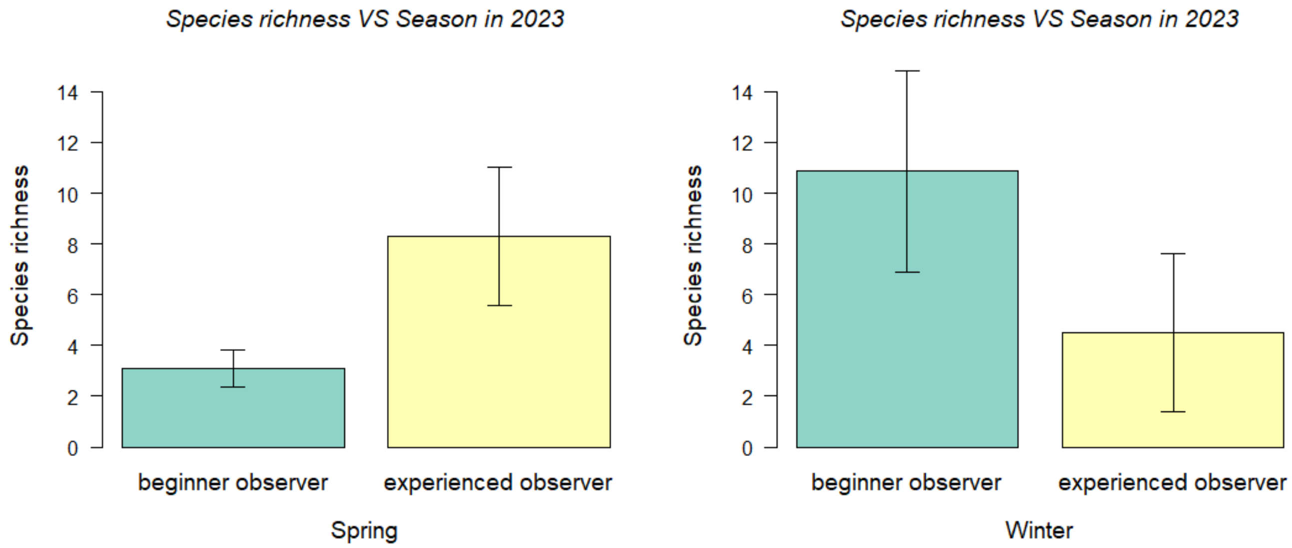

Figure 19. *Comparison between seasons in number of species featuring the observer in 2023.*

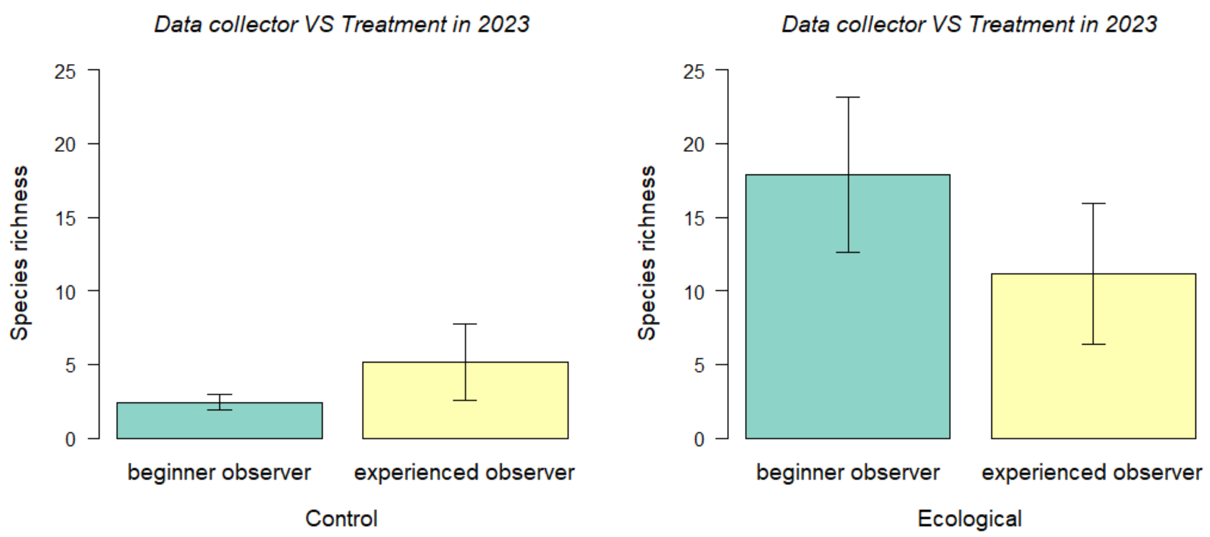

Figure 20. *Comparison between treatment in number of species featuring the observer in 2023.*

6. Discussion

6.1. Data Summary

Seasonal variations in individual counts reflect the interplay of climatic factors and resource availability, with spring exhibiting a notable surge attributed to favorable weather conditions and enhanced food availability. Conversely, winter presents a decline in individual counts, exacerbated by harsh weather conditions prevalent in certain years (Siriwardena, Calbrade, & Vickery, 2008; Moorcroft et al. 2002). The prevalence of individuals within ecologically managed fields during spring is attributed to the provision of abundant hiding spots and food resources (Rundlöf, Smith, & Birkhofer, 2016).

However, our study found little disparities in species richness between control and ecologically managed fields. Calvi *et al.* (2018) explained that a number of factors closely related to the management and structural characteristics of the ecological agricultural fields such as more contemporary and intense approaches could be the cause of this small difference in species abundance. It is significant, nonetheless, that the ecological areas chosen for our investigation had management practices that followed natural cycles and principles, as opposed to those highlighted in Calvi et al.'s (2018) study. It is also interesting that in contrast to the findings reported by Gabriel *et al.* (2010) in their study, our observations did not reveal a higher abundance of corvids within ecological fields. Consequently, there is no evidence to suggest a decline in species diversity attributable to predation by corvids in these environments.

Furthermore, contrary to the conclusions drawn by Calvi *et al.* (2018), which suggested a lack of discernible positive impacts on species richness within organic agricultural environments, our study shows an alignment of results across consecutive years underscoring the reproducibility of observed patterns, emphasizing the enduring influence of ecological agricultural management practices on avian biodiversity. Overall, the congruence of findings across datasets underscores the reliability of observed trends, reinforcing the importance of sustained ecological monitoring efforts in elucidating the complex interactions between agricultural practices and avian communities that various authors also highlighted (Winqvist et al., 2011; Tuck et al., 2014).

6.2. FBI Species

Comparisons across all species, with a particular emphasis on Functional Biodiversity Index (FBI) species, yield valuable insights given their significance as primary indicators of organic farming efficacy. Notably, the beginner observer's dataset exhibits a higher count of individuals among common FBI bird species, potentially attributed to their conspicuous nature and fortuitous survey days. Such occurrences may be especially prevalent during winter or autumn, wherein avian populations often adopt more nomadic behaviors, traversing expansive territories in sizable flocks like Atkinson *et al.*, (2006) mention in their study, thereby increasing the likelihood of chance encounters. Furthermore, the experienced observer's dataset boasts a greater representation of elusive species, evidence of his elevated expertise level. This observation underscores the importance of soliciting field assistants with a requisite level of experience, thereby mitigating biases inherent in data collection (Farmer, Leonard, & Horn, 2012). To cultivate proficiency among new recruits, strategic measures such as multiple pre-monitoring site visits accompanied by skilled guides offer an effective way of acclimatizing novices to the intricacies of field observation. These preparatory engagements serve to familiarize assistants with the specific environmental conditions conducive to observation, as well as acquainting them with species that exhibit cryptic behaviors or pose challenges in identification (Fitzpatrick et al. 2009).

Research projects can benefit from improved data quality and interpretative robustness by providing aspiring field assistants with fundamental training and experiential insights. This will further improve our comprehension of ecological dynamics within agricultural ecosystems. The absence of the Grey Partridge from the observed avian populations underscores the inherent challenges associated with its detection and quantification. The elusive nature of this species complicates both its visual identification and accurate enumeration thus making its detection and identification much more difficult (Farmer, Leonard, & Horn, 2012). Despite this challenge, it is noteworthy that the relative proportions of abundance remain relatively stable across years, reflecting a consistent presence within the avian community. This persistence is particularly significant given the ecological significance of the FBI species, which exhibits strong associations with agricultural landscapes, making its sustained presence a positive indicator of habitat health and functionality (Stjernman, et al. 2013).

Notably, the beginner observers' higher individual count can be attributed, at least in part, to her increased frequency of field visits, conducting six surveys compared to the experienced observers' four. This discrepancy in sampling effort underscores the importance of accounting for temporal variation in data collection when interpreting species abundance and distribution patterns. The augmented sampling intensity afforded to the beginner observer likely facilitated a more comprehensive assessment of avian populations within the study area, thereby yielding higher individual counts (Mac Nally, 1997). Despite methodological disparities in sampling effort, the consistent relative abundance percentages across years suggest a degree of stability in avian populations, reinforcing the robustness of observed trends. The maintenance of consistent abundance levels, particularly for species with ecological significance, foreshadows well for the ecological integrity of agricultural landscapes and underscores the resilience of avian communities in the face of environmental variability.

Moving forward, continued monitoring efforts should prioritize standardized methodologies and increased sampling intensity to enhance the accuracy and reliability of avian population assessments (Farmer, Leonard, & Horn, 2012). By mitigating methodological biases and accounting for temporal variation in data collection, researchers can obtain a more nuanced understanding of avian community dynamics and their ecological implications within agricultural ecosystems.

6.3. Observer Effect

When comparing individual counts between the experienced observer and the beginner observer, a consistent trend emerges wherein the beginner observer consistently records a higher number of individuals. Several factors may contribute to this discrepancy, including potential variations in the quality of the observation year, methodological disparities in bird counting techniques, or differences in estimating the distance from the field edge. However, Eglington *et al.*, (2010) found that 58% of the species they studied showed positive first-time observer effects, including many of the very common and easily identifiable species meaning that the observer's effect can be minimized regarding more common species.

The beginner observers' manual approach to bird counting may result in a broader estimation of distance from the field edge compared to the experienced observer's utilization of a mobile application, which strictly excludes individuals beyond a designated boundary. Consequently, the beginner observer may inadvertently include individuals situated farther from the field edge, potentially inflating her counts. Additionally, the beginner observers' relative lack of experience may predispose her to overcounting, as less experienced observers may inadvertently count the same individual's multiple times or fail to discern repetitive sightings within a single field (Walker & Taylor, 2017, 2020; Horns et al., 2018; Neate-Clegg et al., 2020). Conversely, the experienced observers' sharp expertise likely enables him to exercise greater caution in identifying and eliminating instances of potential duplication, thereby yielding more conservative counts (Farmer, Leonard, & Horn, 2012). Both observers register a higher count of individuals within ecologically managed fields, aligning with expectations based on prior data indicating that such habitats are more favorable for avian populations. Despite methodological disparities and potential differences in experience level, the overarching trend of increased individual counts within ecologically managed fields remains consistent across observers, affirming the robustness of this observation.

The variance in data collection length between the experienced observer dataset, spanning from 2020 to 2023, and the beginner observer dataset confined to 2023, suggests potential disparities in several dimensions. The extended period of observation granted to experienced observers allows for greater depth and increased sampling frequency, potentially resulting in the detection of a wider array of species. However, the experienced observers accumulated expertise and comprehensive sampling regimen may facilitate the identification of less conspicuous species, which could amplify discrepancies in species richness between organic and conventional agricultural settings (Cunningham et al., 1999).

7. Conclusion and next steps

In conclusion, the findings from the comprehensive analysis of avian populations within agricultural landscapes provide valuable insights into the complex dynamics shaping bird communities and their interactions with ecological management practices. Across multiple years, a consistent pattern emerges; in springtime, an ecologically managed field exhibits heightened abundance of both individuals and species, underscoring the importance of these habitats for avian biodiversity.

Notably, while there are discrepancies between datasets collected by beginner and experienced observers, the overarching trends remain robust. Beginner observers tend to detect a higher number of individuals, likely influenced by increased field visits, while experienced observers demonstrate greater proficiency in species identification, resulting in a wider diversity of recorded species. However, both observers consistently document higher counts of individuals within ecologically managed fields, highlighting the ecological benefits conferred by these habitats.

Furthermore, the use of Functional Biodiversity Index (FBI) species as indicators reveals the ecological significance of avian populations within agricultural landscapes. Despite methodological differences and varying levels of observer experience, the relative abundance percentages of FBI species remain stable across years, reflecting the resilience of these key indicator species.

The data also sheds light on the challenges associated with avian population monitoring, including the difficulty in detecting certain species and the potential for methodological biases. However, the consistent documentation of trends over time underscores the reliability and importance of sustained ecological monitoring efforts. However, it is imperative to continue refining monitoring methodologies and enhancing observer training to ensure the accuracy and reliability of avian population assessments. By doing so, researchers can further our understanding of avian ecology within agricultural ecosystems and inform conservation and management strategies aimed at preserving avian biodiversity.

The consistent trends observed in avian population dynamics underscore the reliability and importance of long-term monitoring efforts. Leveraging the assistance of volunteers as part of a citizen science initiative can significantly contribute to the continuity and expansion of data collection for this project and future efforts aimed at understanding ecological dynamics within agricultural landscapes.

Engaging volunteers in scientific research, often referred to as citizen science, offers several advantages. Firstly, it allows for the collection of large datasets across broad spatial and temporal scales, facilitating a comprehensive assessment of ecological trends. The involvement of volunteers enhances spatial coverage, enabling researchers to capture variations in avian populations across diverse habitats and regions.

Moreover, citizen science initiatives foster community engagement and environmental stewardship by involving members of the public in scientific research. This participatory approach promotes public awareness and understanding of local ecosystems, encouraging individuals to develop a deeper appreciation for biodiversity and conservation efforts. Volunteers can contribute to various aspects of the research process, including data collection, species identification, and data analysis. By providing volunteers with training and support, researchers can ensure the quality and reliability of collected data, while also empowering volunteers to develop scientific skills and knowledge.

Furthermore, citizen science initiatives promote collaboration between scientists, volunteers, and other stakeholders, fostering a collective effort to address complex environmental challenges. By mobilizing diverse expertise and resources, these collaborative endeavors can generate valuable insights and inform evidence-based decision-making.

Additionally, citizen science platforms and online databases provide a centralized repository for storing and sharing collected data, facilitating access for researchers, policymakers, and the public. These data repositories serve as valuable resources for conducting further analyses, generating scientific publications, and informing conservation actions.

Overall, incorporating volunteers as part of a citizen science initiative offers a cost-effective and scalable approach to long-term monitoring of avian populations. By harnessing the collective efforts of volunteers, researchers can enhance our understanding of ecological dynamics within agricultural landscapes and contribute to conservation efforts aimed at preserving avian biodiversity for future generations.

7.1. Next steps

As an idea for further analysis in the topic, the beginner observer also collected data in autumn (See Table 1 in Annex). This supplementary dataset represents a pivotal step towards enhancing our comprehension of avian ecological dynamics across diverse seasonal contexts within a given annual cycle.

The inclusion of autumn data offers a unique opportunity to investigate avian population dynamics throughout various phases of the annual calendar, thereby affording a more comprehensive understanding of seasonal fluctuations and ecological responses within avian communities. By extending observations beyond the confines of spring and winter, the study can clarify how avian populations adapt and respond to changing environmental conditions, resource availability, and migratory behaviors across different temporal contexts.

Autumn, characterized by transitions in weather patterns, resource availability, and migratory movements, presents a distinct ecological environment that influences avian behaviors and community composition. The autumn dataset provides valuable insights into how avian populations navigate these seasonal transitions, offering a different perspective on their ecological requirements and adaptive strategies.

Furthermore, the inclusion of autumn data facilitates temporal comparisons with spring and winter datasets, enabling researchers to discern temporal trends, seasonal variability, and phenological shifts within avian communities. Such comparative analyses can explain how avian populations respond to seasonal fluctuations in resource availability, habitat structure, and climatic conditions, thereby contributing to a more holistic understanding of avian ecology.

Moreover, the incorporation of autumn data enhances the robustness and completeness of the study, enabling researchers to capture a broader spectrum of avian behaviors and ecological interactions across the annual cycle. This comprehensive approach is essential for accurately characterizing avian population dynamics and informing effective conservation and management strategies aimed at preserving biodiversity and ecosystem integrity.

In summary, the inclusion of autumn data represents a critical advancement in the study's methodology, providing a multifaceted perspective on avian ecological dynamics throughout different seasons of the year. By leveraging this supplementary dataset, researchers can gain valuable insights into seasonal patterns, migratory behaviors, and ecological responses within avian communities, thereby advancing our understanding of avian ecology and informing evidence-based conservation efforts.

8. Bibliography

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9. Annex

9.1. Data summary

Table 1. *Summary of the raw data from the beginner observer and the experienced observer.*

All_Indis	All_species	who	Season	SiteName	Site	Treatment
1	1	Beginner observer	Winter	2k	2	C
45	2	Beginner observer	Winter	2	2	E
1	1	Beginner observer	Winter	1	1	E
0	0	Beginner observer	Winter	1k	1	C
39	5	Beginner observer	Winter	1	1	E
8	5	Beginner observer	Winter	1k	1	C
1	1	Beginner observer	Winter	2	2	E
2	2	Beginner observer	Winter	2k	2	C
7	2	Beginner observer	Winter	2	2	E
27	3	Beginner observer	Winter	2k	2	C
2	2	Beginner observer	Winter	1	1	E
5	3	Beginner observer	Winter	1k	1	C
6	1	Beginner observer	Winter	1k	1	C
8	4	Beginner observer	Winter	1	1	E
4	2	Beginner observer	Spring	2	2	E
5	2	Beginner observer	Spring	2k	2	C
11	2	Beginner observer	Spring	2	2	E
42	5	Beginner observer	Spring	2k	2	C
16	1	Beginner observer	Spring	1	1	E
14	5	Beginner observer	Spring	1k	1	C
31	4	Beginner observer	Spring	1	1	E
30	1	Beginner observer	Spring	1k	1	C

50	8	Beginner observer	Spring	2	2	E
10	1	Beginner observer	Spring	2k	2	C
19	12	Experienced observer	Spring	1k	1	C
14	5	Experienced observer	Spring	1k	1	C
8	7	Experienced observer	Spring	1k	1	C
19	12	Experienced observer	Spring	1k	1	C
14	8	Experienced observer	Spring	1k	1	C
11	7	Experienced observer	Spring	1k	1	C
10	8	Experienced observer	Spring	1k	1	C
18	17	Experienced observer	Spring	1k	1	C
19	12	Experienced observer	Spring	1	1	E
20	14	Experienced observer	Spring	1	1	E
32	17	Experienced observer	Spring	1	1	E
23	14	Experienced observer	Spring	1	1	E
20	14	Experienced observer	Spring	1	1	E
31	15	Experienced observer	Spring	1	1	E
18	11	Experienced observer	Spring	1	1	E
33	16	Experienced observer	Spring	1	1	E
1	1	Experienced observer	Winter	1k	1	C
2	2	Experienced observer	Winter	1k	1	C
9	8	Experienced observer	Winter	1k	1	C
6	4	Experienced observer	Winter	1k	1	C
1	1	Experienced observer	Winter	1k	1	C
3	3	Experienced observer	Winter	1k	1	C
7	6	Experienced observer	Winter	1	1	E

9	7	Experienced observer	Winter	1	1	E
11	8	Experienced observer	Winter	1	1	E
16	8	Experienced observer	Winter	1	1	E
20	6	Experienced observer	Winter	1	1	E
2	1	Experienced observer	Spring	2k	2	C
6	2	Experienced observer	Spring	2k	2	C
1	1	Experienced observer	Spring	2k	2	C
1	1	Experienced observer	Spring	2k	2	C
1	1	Experienced observer	Spring	2k	2	C
4	4	Experienced observer	Spring	2k	2	C
1	1	Experienced observer	Spring	2k	2	C
3	1	Experienced observer	Spring	2	2	E
2	1	Experienced observer	Spring	2	2	E
1	1	Experienced observer	Spring	2	2	E
3	1	Experienced observer	Spring	2	2	E
3	2	Experienced observer	Spring	2	2	E
3	3	Experienced observer	Spring	2	2	E
3	2	Experienced observer	Spring	2	2	E
2	1	Experienced observer	Spring	2	2	E
2	1	Experienced observer	Winter	2k	2	C
1	1	Experienced observer	Winter	2k	2	C
1	1	Experienced observer	Winter	2	2	E
1	1	Experienced observer	Winter	2	2	E
1	1	Experienced observer	Winter	2	2	E

9.2. Data collection sheets

MPPM_Su1

Suchdol 1

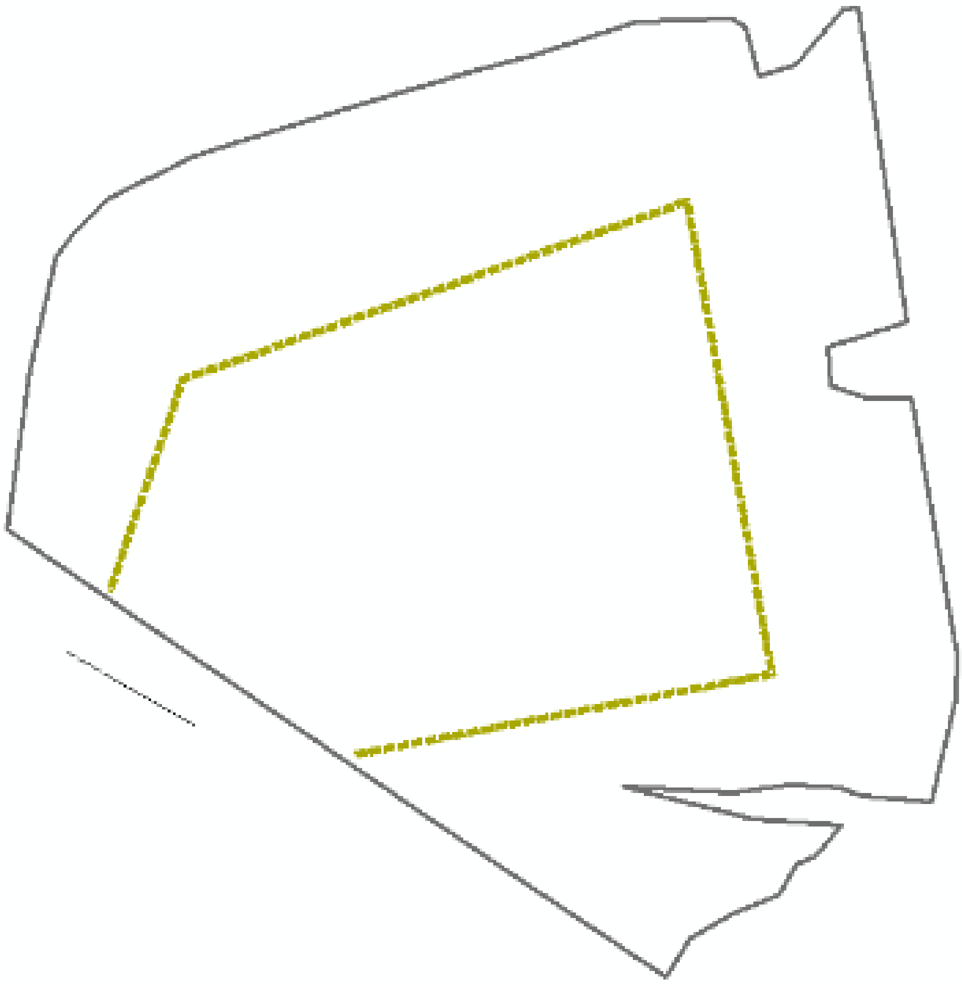


Figure 1. *Data collection sheet for the field MPPM_Su1; ecologically managed field.*

MPPM_Su1k

Suchdol 1k

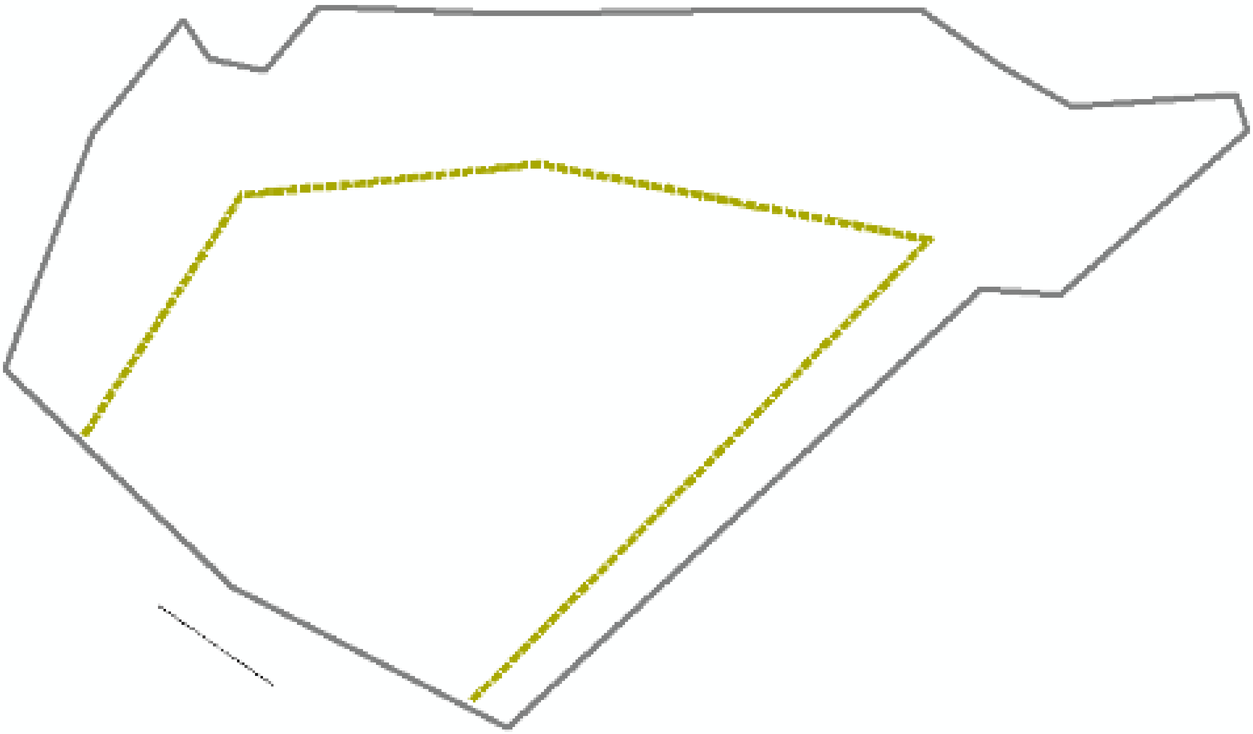


__Figure 2.__ Data collection sheet for the field MPPM_Su1k; conventionally managed field.

MPPM_Su2

Suchdol 2

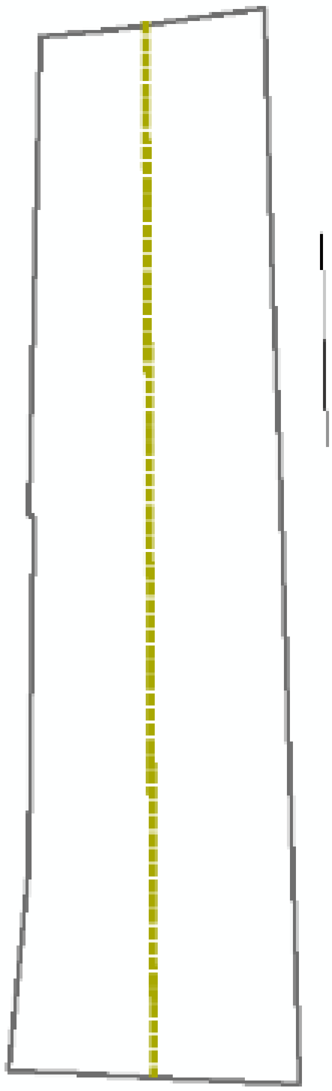
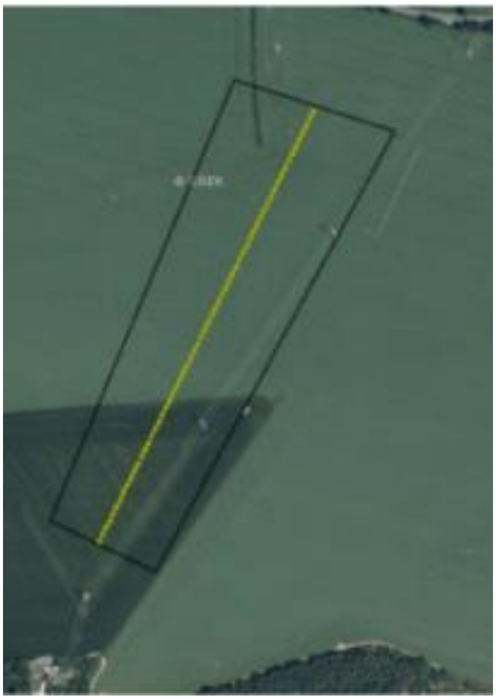


Figure 3. *Data collection sheet for the field MPPM_Su2; ecologically managed field.*

MPPM_Su2k

Suchdol 2k



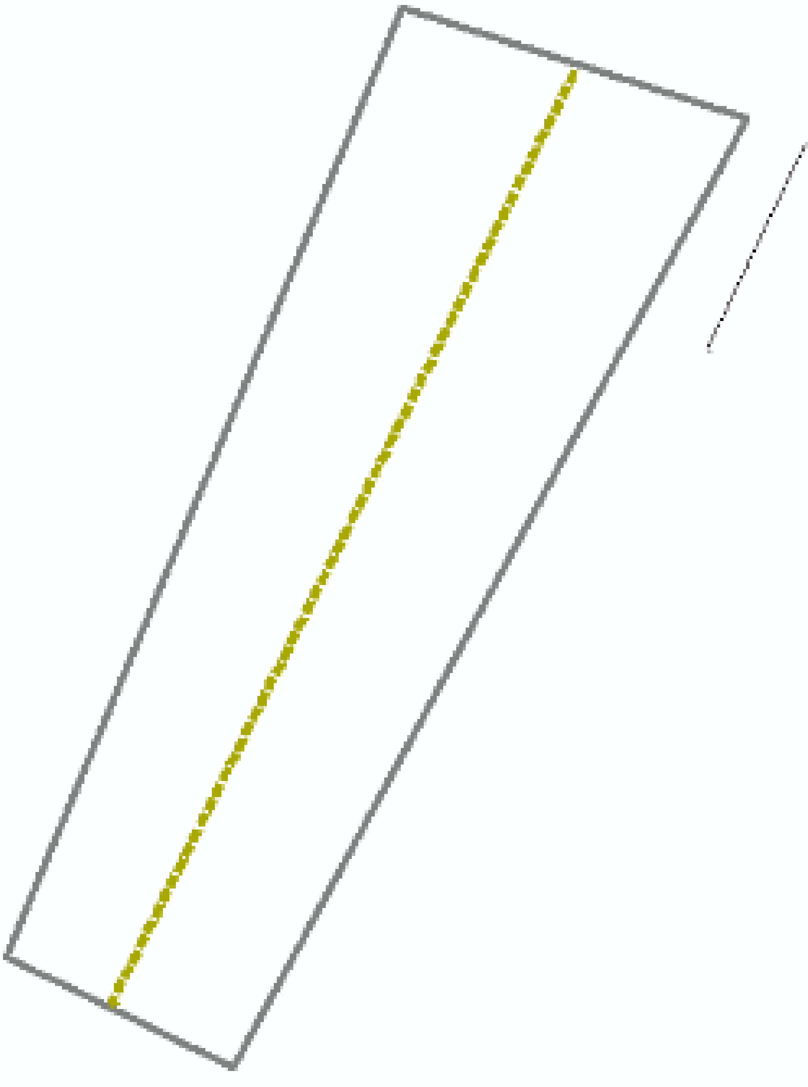


Figure 4. *Data collection sheet for the field MPPM_Su2k; conventionally managed field.*

9.3. Plantations on the fields

Figure 5. *Oilseed plantation in field MPPM_Suk.Source: author of the thesis.*

Figure 6. *Corn plantation in field MPPM_Su1. Source: author of the thesis.*

9.4. Data for next steps

Table 1. *Summary of data from autumn by the beginner observer.*

1	All_Indi	All_species	who	Season	SiteName	Site	Treatment
2	42	5	Beginner observer	Autumn	2	2	E
3	1	1	Beginner observer	Autumn	2k	2	C
4	0	0	Beginner observer	Autumn	1k	1	C
5	108	4	Beginner observer	Autumn	1	1	E
6	0	0	Beginner observer	Autumn	2k	2	C
7	63	4	Beginner observer	Autumn	2	2	E
8	4	1	Beginner observer	Autumn	1k	1	C
9	145	6	Beginner observer	Autumn	1	1	E