The Grey Partridge (Perdix perdix L.) - the Indicator of the Sustainable Agriculture

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Abstract
Agricultural intensification has played an important role in the decline of biodiversity in farmland ecosystems. Habitat degradation has resulted in reduced edge effects. This has led to species loss, soil degradation, deflation and drying of arable land. Much of Europe is farmland, which has a significant impact on the continent's climate. Although the previous conditions cannot be fully restored, beetle banks, grasslands and hedgerows can be well integrated into the agricultural policy of the European Union. How do linear habitats affect the microclimate, biosphere and crops? An endemic farmland bird, the grey partridge (Perdix perdix) is an indicator of healthy farmland ecosystems. Their population has declined drastically in recent decades across Europe.

Keywords: agriculture, field margin, grey partridge, hedgerows, indicator, sustainability,

1. Introduction

The grey partridge (Perdix perdix L.) used to be one of the most common farmland birds in Hungary and across Europe. Today the population declined to a few thousand individuals due to habitat degradation (Faragó, 1988). The common pheasant (Phasianus colchicus) has also suffered from changes in the agricultural environment, but the partridge has been even more sensitive to these changes [1]. Agricultural intensification has led to biodiversity loss and habitat degradation through the clearing of hedgerows, shrubs, forest belts and wildflower strips [2,3]. At the beginning of the last century, the grey partridge population numbered in the millions. After the First World War, however, it declined sharply. The mortality was high because of harsh winters around 1920. At the beginning of the following decade (1930-31) 893,000 individuals were harvested. By the mid-1930s, the population was estimated at one and a half million. There are no valuable data from after the Second World War. In the 1960s, the population was over 600,000, increasing until the mid-’70s (1976 - 878,000). After it began to decline rapidly. To slow down this trend, a partial hunting ban was imposed in 1978 [4]. The population continued to decline, demonstrating the failure of passive protection [5]. By 1985, the population had fallen below the critical level of 100,000,000 individuals [6,7,8]. Today, the estimated (wild) population is 10,885, and 11,237 partridges from captive breeding were released [9]. The data shows that around 1930 was the best period of the Hungarian grey partridge. Since the 1940s, agricultural intensification has led to habitat degradation and fragmentation. Brown Hares and pheasants have responded with significant population declines, but the situation is critical for partridges.

The partridges prefer hedgerows, grassy field margins, headlands with wildflowers and weedy edges of crops [10,11]. The problems are the homogeneous habitat conditions and big plots with low diversity. The removal of hedgerows

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caused damage to wildlife and agriculture also. Hedges are narrow boundary plants consisting of different shrubs, trees or herbaceous plants [12]. They separate arable land, pasture or other areas. The boundaries of different habitats overlap. Biodiversity is high in these zones. These buffer zones are habitats for typical local species, but some species are restricted to them [13]. This phenomenon is called the edge effect and the vegetation boundaries are called ecotones.

2. Materials and methods

This article examines the relationship between grey partridge and farmland habitats. We analyse publications. We look for correlations between habitat structure and population abundance. We have used the websites of Google Scholar, Sciencehub, Wiley and Elsevier to find the journals. We googled the following keywords: grey partridge, farmland, arable lands, crop fields, headlands, forest belt, hedgerows ecosystem services, field margins, microclimate, wildflower strip, grass bank, beetle bank, and game conservancy. We reviewed the ecological and climatic effects of hedgerows. We look for relationships between ecotone density, grey partridge population abundance, and farmland conditions. We think that:

1. Habitat limits the partridge population.
2. A high abundance of partridges means good habitat.
3. Good habitat (hedgerows, field margins) is also beneficial for agriculture.

3. Results and discussion

Habitat preference of the grey partridge

Grey partridges are typical farmland birds [14-16]. As we saw below, they prefer linear habitats in agri-environment. The grassy field margins, weedy ditches, headlands and wildflower strips are very important for reproduction and nutrition (Liukkonen-Anttila et al., 1999). Seeds and leaves of weeds are basic elements in adult partridge's diet. Chicks are zoophagous for the first month, eating only animal nutrition. The edges and margins are producing both, but intensive agriculture is destroying them. The partridge populations are highly dependent on marginal vegetation, but the characteristics of hedgerows are more important than the length [17]. Researchers have evidence that the quantity of dead grass and other herbaceous plant (for example common nettle (*Urtica dioica*) are the most determining factors for nesting [17]. According to Church (1980), the pairs after pairing do not move away from the edges. "For instance, [18] suggested that 'incomplete' hedges were the best type of nesting cover for grey partridges because of their ground vegetation characteristics. However, no previous studies have attempted to quantify hedgerow quality and relate it to partridge numbers." [17]. The ecological value of hedges can be enhanced with deadwood and herbaceous vegetation. Diverse ecotones provide habitat for multiple species [12, 19].

Ecological services of the hedgerows and edges

Hedges protect crops and livestock and provide a natural boundary. They also provide free fuel, timber and food. They play an important role in the landscape ecology. They are essential to the supply and quality of food and water [20]. They function as natural buffer zones. Hedgerows contribute to biodiversity conservation [21]. Their existence is threatened by agricultural intensification [22]. The loss of hedgerow length, the reduction of landscape continuity and the disruption of the spatial ecology of populations and communities are all factors that are under threat from agricultural intensification [23]. However, hedgerows are also important drivers of biodiversity: [24] found hedgerows of farms in northwest Europe, providing linear habitat for 10% of the total land area and 43% of wildlife habitat. Agri-environment schemes have been introduced to protect or restore hedgerows. Modern sustainable agriculture has recognised the importance of hedgerows and field margins. The benefits of urban hedgerows are also becoming increasingly important in horticulture. Hedgerows are difficult to classify. The only consistent hedge characteristic is a linear structure rising above the surrounding ground level. Their structure is characterised by the adjacent land use. Hedges and margins are often made up of native plants, but can also include invasive plants or just rocks. Hedgerows and associated features such as banks, ditches, borders and trees have similar or complementary functions [25]. The function of edges depends on their geographical location. Tropical hedgerows provide drought, flood and predator control. Temperate hedgerows provide biosecurity, crop protection, pollination and demarcation of land property [25]. The ecosystem services provided by uncultivated landscape elements are now diverse, but originally provided food, fuel and timber. Their size and structure depend on topography, climate, water conditions and the size of crop fields [25]. Their ecological value is determined by the proportion of native vegetation.

One of the most important effects of ecotones is crop protection. [25] say: “A model parameterized by published data suggested that 29% of crop production is lost within a distance of twice the hedge height but production then increases by 6% up to a distance of 20 times the hedge height into the field. Hedgerows intercept the cyclical flow of essential plant nutrients, causing reductions in components including surface nitrogen (69% reduction), sub-face nitrogen (34% reduction), and phosphorus (67% reduction). Nonproduction ESs may compensate for yield loss close to hedges [26]. At the field level, there is a trade-off between arable crop yield and regulating ESs that depend on field size, hedgerow width, and height [3]. Intercropping with a legume, such as Leucaena, can increase production stability or even lead to yields that exceed those in plots with fertilizer applications [27].

Hedgerows are ecological traps?

As we have seen, linear habitats (edges, hedgerows, field margins, forest belts, wildflower strips) are beneficial to both agriculture and wildlife. They improve the microclimate, protect crops and provide habitat. However, ecotones are narrow corridors where mortality can be high. Predation is a major limiting factor in ground-nesting birds’ reproduction. Ecotones provide nesting habitat but also attract predators. Hedges concentrate farmland birds in low biodiversity crop fields. [28] studied nest predation in different margins. After 21 days of exposure, the daily mean predation rate was 0.01 (± 0.012). 70% of the observed nests were caused by predators (red foxes and mustelids) and 17.5% by avian predators (corvids). The daily risk of predation was higher for nests close to the edge of the meadow and for nests with low vegetation cover. Predation risk increased later in the season. The previous year's land use had a significant effect on the predation risk of nests uncultivated plots had higher predation rates than mown plots. Unused pastures are likely to attract mammalian predators due to the large number of small rodents. [29] used 2 chicken eggs, 1 wax egg and 1 plasticine egg to study artificial nest predation in April and May in different edges in Hungary. They found the Red Fox (*Vulpes vulpes*) and the Wild Boar (*Sus scrofa*) were the most common predator species. The study also states, that: “in April the highest predation at the edges between the Alder forests and crop fields and the Alder forests and pastures and in May at inner micro edges of young afforestation, the differences were significant. The predation risk was also very high for artificial nests left at inner micro edges of young afforestation for 2 months, but the differences between the study periods were not significant.” [30] et al. set up 120 wildlife cameras on different edges in Germany. They found that nest predation was 9 times lower in wildflower strips than in hedgerows. The authors found correlations between predation, patch size and proximity to forests and settlements.

Habitat limits the partridge population.

Habitat is the most important factor in the dynamics of a population, but it is not enough to study it on its own. More accurate results can be obtained by analysing immigration and emigration, reproduction and mortality rates, and predation. However, it can be said: In the right habitat, these factors are in balance and density fluctuates less. For grey partridges, habitat is important, but not the only factor determining density. Another problem is the lack of food and the critical density. The grey partridges are monogamous, which further complicates the survival of the species. In general, the removal of the margins reduces the density, but there are also other components.

A high abundance of partridges means good habitat.

This statement is more certain than the previous one. High density means generally good habitat. This is particularly true for the partridge, which is an extremely vulnerable species [31]. However, other factors like food, climate, reproduction, mortality and human impact are also relevant. The partridge is sensitive to change, so we can assume that high density means good habitat. For these birds, this means grassy edges and field margins, beetle banks, low use of pesticides and increased control of predators. Hedgerows and forest belts with lots of dead grass and herbaceous plants are also suitable [19], but these microhabitats are also at higher predation risk [32,33]. Knowing the partridge's sensitivity to the environment, we can say that where they are abundant for long periods, the habitat is good and they are like indicators or “barometers of the countryside” [34,35].

Good habitat (hedgerows, field margins) is also beneficial for agriculture.

The benefits of hedgerows and field margins for wildlife and agriculture are clear. Agroecosystems have been severely damaged by the removal of linear habitats. These micro-habitats protect crops and soils and increase crop production [2] They also act as buffer zones. They support pollination and biodiversity. They mitigate climate change, wind erosion and other effects, as we saw see before. Perhaps agriculture needs marginal vegetation more than the grey partridge. Conserving edges is the cornerstone of sustainable agriculture. Nowadays we spend lots of money on soil conservation when we could do much more with some simple techniques. It is impossible to recreate the past, but protecting existing hedgerows and creating new ones is essential for sustainable farming.

4. Conclusions

In the previous chapters, we reviewed the population trends and habitat requirements of the grey partridge. We have analysed the main causes of the decline in the population. The positive effects of edges on wildlife and agroecosystems were discussed. We have also looked at the negative effects of the hedgerows. In the following, we briefly discuss the points posed in the introduction.

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