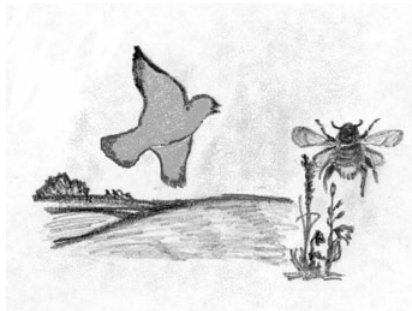


Ode to a Skylark:
Agricultural intensification and farmland birds
in the Baltic region



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Academic dissertation

To be presented with the permission of the Faculty of Agriculture and Forestry of the University of Helsinki, for public criticism in the Auditorium 2 in Infokeskus Corona (Viikinkaari 11), on February 24th, 2007 at 12 o'clock noon

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ISBN 978-952-10-3462-6 (paperback)
ISBN 978-952-10-3463-3 (PDF)
ISSN: 1457-8085

<http://ethesis.helsinki.fi>

Yliopistopaino
Helsinki 2007

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Agricultural intensification and farmland birds in the Baltic region

Irina Herzon

The thesis is based on the following articles, which are referred to in the text by their Roman numerals:

- I Herzon, I., and O'Hara, R.B. 2007. Effects of landscape complexity on farmland birds in the Baltic States. *Agriculture Ecosystems and Environment*. 118: 297–306.
- II Herzon, I., Auninš, A., Elts, J. and Preikša, Z. Intensity of agricultural land-use and farmland birds in the Baltic States. *Submitted manuscript*.
- III Herzon, I., Auninš, A., Elts, J. and Preikša, Z. 2006 Habitat associations of farmland birds across the East Baltic region. *Acta Zoologica Lituanica* 16: 249-260.
- IV Herzon, I and Mikk, M. 2007. Farmers' perceptions of biodiversity and their willingness to enhance it through agri-environment schemes: a comparative study from Estonia and Finland. *Journal for Nature Conservation* 15: 10-25.
- V Herzon, I., Elts, J. and Preikša, Z. 2002. Farmland birds and agricultural development in the Baltic region: results of the pilot project. *Aspects of Applied Biology* 67: 135-140.

Contributions

The following table shows the major contributions of authors to the original articles

	I	II	III	IV	V
Initial idea	IH	IH	IH	IH	IH
Logic of reasoning	IH, RO	IH, AA	IH	IH, MM	IH
Material	IH, AA, JE, ZP	IH, AA, JE, ZP	IH, AA, JE, ZP	IH, MM	IH, AA, JE, ZP
Analyses	IH, RO	IH	IH	IH	IH
Manuscript	IH, RO	IH, AA, JE, ZP	IH, AA, JE, ZP	IH, MM	IH, JE, ZP

AA = Ainars Auninš, JE = Jaanus Elts, IH = Irina Herzon, MM = Merit Mikk, RO = Robert O'Hara, ZP = Zydrunas Preikša

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Abstract

Intensification of agricultural land-use has been shown to be the key reason behind declines in wildlife species associated with farmland. Accession to the European Union is regarded as a potential threat to the farmland biota of its new member states. In my thesis I looked at scenarios of agricultural development across the Baltic states of Estonia, Latvia and Lithuania, and the ways they are seen to affect farmed environments as a habitat of farmland bird species. I assessed the role of spatial organisation of farmed habitats in different agricultural landscape types. Community characteristics as well as abundance of species were positively related to the number of non-cropped elements within farmland, the local mixture of annual crop and grass fields, and the variety of field types. I also looked at the effects of major farmed habitats to the species' species presence and abundance across the region. The variation reflected the geographical position and differences in the fragmentation level, soil types and vegetation development pattern. Finally, I evaluated the direction and magnitude of changes in bird communities following progression of farmland land-use from a relatively less intensive to the most intensive type within each country. There was a clear indication that the more intensively farmed areas across the region provided habitat for fewer bird species and individuals. Within large arable fields, intensification of field management was reflected in a tangible decrease in farmland bird abundance, especially in species in need of edge structures.

The second part of the thesis, based on interviews in Estonia and Finland, is devoted to farmers' interest in and knowledge of farmland wildlife, their understanding of the concept of biodiversity, and awareness of the potential causes behind declines of farmland birds. I examined the relationship between farmers' interest and their willingness to undertake practices favouring farmland wildlife. Many farmers viewed biodiversity from a narrow perspective. In Finland farmers expressed concern about the decline in common farmland species, but Estonian farmers did not, which might be related to the fact that these species are still very common. In both countries farmers rated intensification of agriculture as the major driving force behind farmland bird declines. The expressed interest in wildlife positively correlated with willingness to undertake wildlife-friendly measures. Only farmers with agri-environment contracts targeted specifically at biodiversity were more knowledgeable about practical on-farm activities favouring wildlife, and were more willing to employ them than the rest.

The results suggest that, by contributing to simplification of the farmland structure, homogenisation of crops, and increase in intensity of field use, EU agricultural policies will have a detrimental

effect on farmland bird populations in Eastern Europe. Farmers are on the whole positive to the idea of supporting wildlife on their farms, and are concerned about declines, but they require payments to offset their income loss and extra work. The agri-environment programme can be an effective awareness tool for farmers but only if biodiversity conservation integrated into it at all levels. I propose ways of further improving and better targeting of the agri-environment schemes in the region. I argue that with a foreseen tripling of cereal yields across the region, the EU Council's target of halting biodiversity decline in the EU by 2010 may not be realistic unless considerable improvements are made in conservation safeguards within the EU agricultural policy for the region.

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List of terms:

Agri-environment programme (AEP): A set of measures, designed on a national level, promoting adoption of environmentally-friendly farming techniques that go beyond usual good farming practice and cross-compliance. Farmers can voluntarily participate in AEP, for which they receive payments that compensate for additional costs and loss of income that arise as a result of altered farming practices.

Agri-environment schemes (AES): Sets of specific management prescriptions under the agri-environment programmes.

Central and East European Countries (CEEC): Post-socialist countries in Central and East Europe, eight of which were accepted into the EU in 2004.

Common Agricultural Policy (CAP): Policy overseeing and subsidising agricultural development in the EU member states. It can basically be divided into direct subsidies to farmers and additional volunteer payments under AEP, of which the latter comprise about 10% of the total budget.

Cross-compliance: Requirements concerning farming practices, which farmers are obliged to fulfil for getting the direct payments under CAP. The requirements include a minimum level of environmental standards, food safety, animal and plant health, and animal welfare standards.

EU-15: Member states of the EU before accession of new countries in 2004.

(Agricultural) Intensification: As used here, a large-scale phenomenon of land-use patterns, by which crop yields are being increased by use of high-yielding crop varieties, fertilization, pesticide applications, intensive mechanical working, improvement of less productive areas by irrigation and drainage, concentration of livestock into larger units and specialization in production, as well as conversion of marginal land into farmland, especially to arable crops.

(Management) Intensity: The rate of inputs to and frequency of disturbance of crops.

New Member States: Ten states - Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia - accepted to the EU on the 1st March 2004.

1. Introduction

1.1. Biodiversity conservation within agroecosystems in Europe

Nowhere do human endeavour and the survival of species interlock more closely than in agricultural systems, or agroecosystems. These are fundamentally natural systems artificially kept at early successional stages, so that a large proportion of the primary production can be harvested by Man. At the extreme end of agroecosystem modification is a modern intensively managed wheat field, an altogether novel type of ecosystem: an artificial monoculture force-fed on nutrients, with suppressed competitors and predators. The biodiversity of agroecosystems is often divided into "planned" and "associated" (Altieri 1999). The former refers to species directly manipulated by farmers, such as crops, and the latter comprises organisms that themselves colonised the fields and adapted to their specific disturbance regime.

At first glance farmland may seem a boring place, inhabited by just a few common species. In fact, at the European scale farmland encompasses a dazzling variety of habitat types as different as dry steppe grasslands and rice fields, vineyards and arable fields. Because of the very high proportion of land under agriculture in Europe - around 5 million square kilometres (FAOSTAT 2006) comprising nearly half the continent's total land area - and its long history of environmental modification, there are often no boundaries between food production areas, cultural landscapes and wildlife habitats. In fact, farmland has the highest overall species richness of birds of any habitat type in Europe (Tucker 1997).

The steppes of South-East Europe are regarded as the primary origin of the majority of species associated with farmland (Tucker 1997; Santos and Suárez 2005). These species reacted to the expansion of agriculture across Europe by significantly expanding their ranges and numbers. Recent theories suggest, however, that forest-steppe mosaics were more characteristic of Europe than previously assumed, because the post-Holocene megafauna created and maintained forest clearings (cited in Flade et al. 2006, p.278). Under such conditions many farmland specialist organisms would have thrived in Europe even before agricultural expansion. Other naturally open habitats such as floodplain meadows were also important sources of farmland species. Nowadays, some farmland species occur exclusively or nearly so in farmland as a substitute for their former natural habitats in Europe - e.g. great bustard (*Otis tarda*) and little bustard (*Tetrao tetrix*) (Tucker 1997). For another larger group of species farmland is now the predominant habitat of occurrence, even if they reach higher densities and possibly have higher reproduction success in natural habitats (e.g. skylark (*Alauda arvensis*) (Donald 2000) and yellowhammer (*Emberiza citrinella*) (Bradbury et al. 2000)). Finally, some species, for example curlew (*Numenius arquata*) and lapwing (*Vanellus vanellus*), readily colonise fields but suffer high mortality rates there, which makes farmland a vast sink habitat (Berg 1991).

Despite the importance of farmland in providing habitats for a diverse wildlife, the whole idea of biodiversity conservation within agroecosystems is relatively new (Robson 1997). In parts of the world where agriculture dominates land-use, such as Europe, this development was triggered by the unprecedented declines in species that began with modernisation of the food production industry.

Bird declines are particularly well documented (Gregory et al. 2005; Donald et al. 2001; Chamberlain et al. 2000). In the UK, populations of such typical farmland species as corn bunting (*Miliaria calandra*), partridge (*Perdix perdix*), and skylark have declined by as much as 60-80% (Gregory et al. 2005). A startling 66% of agricultural habitat bird species in Europe have an unfavourable conservation status – for example, their populations are in either rapid or long term steady decline - the highest proportion of any habitat (BirdLife International 2004). Research on other groups of organisms suggests that the conspicuous decline in bird populations represents just the tip of an iceberg of biodiversity collapse on farmland. Populations of many insects and plants, on which birds depend, have suffered drastic declines in numbers and distribution, and many formerly common species are now rare (Robinson and Sutherland 2002; Benton et al. 2002; Biesmeijer et al. 2006; Conrad et al. 2006). This mass disappearance of birds and other wildlife has been described as the Second Silent Spring (Krebs et al. 1999), taking a lead from Rachel Carson’s famous “Silent Spring” publication that documented the declines in birds in the 1960s caused by pesticides (Carson 2002).

1.2. Agricultural intensification

The Common Agricultural Policy (CAP) is one of the European Union’s few truly “common” policies, insofar as it is to a great extent regulated and financed at the central level rather than the level of individual Member States. The CAP’s original aims were to increase both agricultural productivity and the wealth of those engaged in food production within the EU. “The politicians, by choosing the route of increasing productivity as the means of increasing earnings, had implicitly adopted the strategy of intensification. The alternative, of restructuring agriculture and so allowing for more extensive farming, had thus been almost abandoned at the outset of the CAP” (Robson 1997). The result has been the most rapid intensification of farming ever seen, fuelled by as much as half of the EU budget –about 42 billion Euro annually allocated in 2006 (Europa 2006).

When commencing my research in the Baltic region in 2000, where intensification of agricultural land-use was only starting, I spent long hours thinking about what this potent and overwhelming process is really about. Some authors break the phenomenon of intensification into a long list of separate forces (Fuller 2000; Sanderson et al., 2006). The problem for the researcher is that most of them occur concurrently, are interdependent, happen on very different scales (from an individual field to the entire continent) and are not easy to measure in practice.

I came to understand that intensification¹ can generally be grouped into two main forces affecting associated biological diversity. One influences the farmed habitat structure and leads towards its simplification at all spatial scales, from within-field to the farm and landscape levels (review in Benton et al. 2003; but also Matson et al. 1997; Thenail 2002; Robinson and Sutherland 2002; Baessler and Klotz 2006). It manifests itself in removal of non-productive biotopes (such as hedges and ditches), segregation of arable and grassland production, expansion of monoculture fields, simplified rotations, and improvement of less productive parts of fields. The other force operates through intensified management of crop fields and grasslands themselves and manifests itself in a

¹ Hereafter “(agricultural) intensification” will refer to a large-scale phenomenon in land-use, while “intensity of (field) management” to the rate of inputs at the field level

considerable increase in chemical inputs of fertilisers and pesticides, and more frequent disturbance (tillage or mowing). The second of these forces increases the proportion of primary production appropriated for human use per crop unit, which is then unavailable to wildlife (Haberl et al. 2004). It critically shifts resource availability for birds and changes timing of disturbances relatively to their life cycles (Donald & Vickery 2000; Green et al. 1997). It also drives fine-scale homogenisation within a crop by levelling off soil properties (e.g. nutrient levels), microclimate (e.g. water level) and by creating evenly dense swards.

It is important to note that in practice the landscape simplification and intensity of field management often operate simultaneously in space and time: unproductive patches are removed to make big fields that can be efficiently machined, while applications of chemicals make it possible to simplify rotations. An example from Brittany in France illustrates how hedgerow density correlates with the farm's productivity and level of modernisation (Thenail 2002). However, such correlation is not always the case: a study from Germany showed that landscape complexity was related to several, but not all indicators of field management intensity (Roschewitz et al. 2005). Correlation between the two processes is unlikely to hold over a region comprising several countries with different traditions of land-use. A European-wide study confirmed that aggregation of indicators related to land-use intensity into a single index is of limited value (Herzog et al. 2006).

There remains an unresolved debate on the relative importance of these two characteristics of intensive farming: simplified farmland structure versus high intensity of field management. The question has high relevance in practice: to what extent can intensification in field management (e.g. increase in inputs) accelerate without major effects on wildlife if a high level of farmland heterogeneity is retained? Many studies compared conventional intensive farming systems to organic ones that lack some of the "intensive" features of the former (e.g. high chemical inputs and simplified crop rotations). The results were mixed and depended on the studied taxa and the research scale (reviews of Bengtsson et al. 2005; Hole et al. 2005; Fuller et al. 2005). A number of studies provided evidence that organic management is more benign to weeds, several groups of insects, birds and bats, among others (Freemark and Kirk 2001; Hyvönen and Salonen 2002; Shah et al. 2003, Wickramasinghe et al. 2003).

On the other hand, other researchers claim that the key reason for the higher species diversity in organic farms is an inherently higher level of heterogeneity because of crop rotations (Weibull 2003; BTO 1995; Roschewitz et al. 2005; Schmidt & Tschardtke 2005). Such field level complexity may compensate for biodiversity loss caused by local management intensity by providing non-cropped refugia, from which species, eliminated from the crop, can recolonise fields (Tschardtke et al. 2005). This, however, will hold only for mobile species. Finally, it has also been demonstrated that a higher level of insect diversity can be achieved within large fields under low intensity compared to smaller but intensively managed fields (review in Büchs 2003, p.66).

Research on the role of habitat heterogeneity at different scales for farmland birds is vast. It has been shown that agricultural landscape heterogeneity explains well the bird community patterns at the scale of kilometres (Atauri and Lucio 2001). A mixture of different habitat types in the landscape can provide habitats for species of different ecological profiles, and the presence of

certain habitat types particularly rich in resources is especially influential (Böhning-Gaese, 1997; Delgado and Moreira 2000; Heikkinen et al. 2004). Specialisation in farming has resulted in a prevalence of monocultures that do not provide resources through the whole life cycle of wild organisms. Some farmland birds rely on a combination of crop and grass through their breeding cycle. Curlew and lapwing both attain their highest densities in an open landscape, where crop fields are combined with grass patches of at least 35 ha. Cereal is a safer nesting habitat from both predators and mechanical operations, but fledged chicks are safer and better nourished in grassland (Berg 1991; Galbraith 1988). Many granivorous birds are dependant on stubbles rich in weed and crop seed for winter survival (Bradbury et al. 2000; Brickle et al. 2000; Evans 1997; Chamberlain et al. 2000), and declines in this habitat was shown to affect winter survival of a suite of species (Moorcroft et al. 2002).

Currently landscape homogenisation is not restricted to individual farms, but spreads over whole regions. Not only has the number of farms practicing mixed farming declined dramatically, but whole regions in several European countries specialise in either arable production or cattle rearing. For example, in eastern Britain farmers specialise in arable production, whereas in western and northern Britain they specialise in dairy production, which has been clearly implicated in the declines of a number of farmland bird species (Evans 1997; Robinson et al. 2001). In Finland, a similar polarisation into arable South and cattle rearing Centre was shown to drive starlings (*Sturnus vulgaris*) to extinction (Rintala and Tiainen, in press), and was listed as one of the major reasons for declines of many species of several taxa (Pitkänen and Tiainen 2001).

On the scale of patches of any single habitat, the number of species best relates to internal structure of the habitats, while abundance of species depends also on disturbance regimes and availability of resource (Arnold 1983; Wiens 1989; Parish et al. 1994). At the level of arable fields, combinations of crops can be crucial for ground-nesting birds, which require a specific crop sward structure to breed successfully. For example, skylarks prefer vegetation cover of 30-60%, the presence of bare patches, and a vegetation height of 15-60 cm (Wilson et al. 1997; Toepfer and Stubbe 2001). Schläpfer (1988, 2001) and Jenny (1990) demonstrated that skylarks used different crops for nesting only at certain stages of their development. In a monoculture field of winter wheat, a dominant crop over much of Europe, a skylark's territory contains a single habitat type, giving the birds no opportunity to nest in other crops once the cereal has become too dense. Territories either have to become far larger, reducing the number of pairs a given area can support, or the number of nesting attempts made by each pair is reduced (Chamberlain et al. 1999, 2000b; Chamberlain and Gregory 1999; Schläpfer 2001). Similarly, Wolff (2005) showed that little bustards feed on different crops closely following their development stage. Lack of a suitable foraging crop close to a nesting site also means longer foraging trips for breeding birds, which may be either impossible to make for a strictly territorial species, or be too costly energetically (Brickle et al. 2000; Morris et al. 2005).

Heterogeneity at the level of sward stands was demonstrated to be an important determinant of the value of crops and grassland as nesting and feeding habitat for birds (review of Wilson et al. 2005). Structural heterogeneity of herbaceous ground cover is more likely than uniform and dense cover to meet the needs of birds with differing food, anti-predator behaviours, microclimate preferences and lengths of breeding season. For nesting, most ground-nesting birds were shown to prefer patchy

vegetation cover with short and sparse spots surrounded by higher swards (Norris et al. 1997; Wilson et al. 1997; Baines et al. 2002). Under intensive management such structural sward variation is not available either in crops or grassland during the breeding period. Foraging is also more effective when food is accessible in sparse or heterogeneous swards of both arable crops and grasses (Moorcroft 2002; Atkinson et al. 2004; Barnett et al. 2004).

Homogenisation of farmland presents an additional threat to ground-nesting birds. There are indications that predation by natural predators becomes a serious problem to birds in fields once field area is simplified and crop structure homogenised (Evans 2004). For example, mammalian predators are more efficient in finding nests when only a few linear structures remain attractive for bird nesting. Overgrazed pasture does not provide enough cover to conceal nests from avian predators, while fertilised improved grassland has homogenously high sward, which does not allow adult birds to watch out for mammalian predators (review in Wilson et al. 2005).

Only very few species, such as skylark, meadow pipit (*Anthus pratensis*) or partridge, breed and feed exclusively within arable fields. The majority of farmland birds needs provision of some non-cropped elements, such as trees, bushes or patches of semi-natural vegetation, within farmland. The presence of such elements has been shown to be critical for a large number of farmland bird species (Fuller et al. 2001; Auninš and Priednieks 2003; Herzog et al. 2005; Laiolo 2005). Variation within any type of non-cropped habitat (hedge height and density, cut or non-cut margin) additionally enhances populations of different species (Arnolds 1983; Bradbury et al. 2000; Green et al. 1995; Parish et al. 1994; Walker et al. 2005). Most farmland bird species make extensive use of field margins (Aebischer et al. 1994); these serve as nesting habitat for yellowhammers (Stoate and Szczur 1994; Bradbury et al. 2000), as feeding areas rich in invertebrates for corn buntings (Brickle et al. 2000) and partridges (Rands 1997), and as safe habitat for corncrake chicks (Green 1996). In Finland skylarks attain higher densities in fields with open ditches and margins than in fields with subsurface drainage (Tiainen et al. 2001). However, it is still unclear to what extent non-cropped habitats can be sacrificed to land-use intensification and still support viable bird populations (review in Fuller et al. 2004). The local bird species abundance is also influenced by larger landscape characteristics, presumably through changes in habitat choice patterns and dispersal (Arnold 1983; Hinsley and Bellamy 2000; Söderström and Pärt 2000; Best et al. 2001).

Finally, there may be a temporal dimension to the phenomenon of intensification. Reviews of the factors affecting bird populations in the UK (Fuller 2000; Robinson and Sutherland 2002) suggested that habitat loss and decrease in landscape-level heterogeneity had a direct impact at the beginning of agricultural intensification there. Indirect effects of increased chemical inputs and mechanisation, which affect species' population dynamics by reducing breeding performance, and increasing adult and chick mortality during and outside of the breeding season, were the mechanisms further degrading farmland bird communities. Currently in Britain the majority of bird species are adversely affected by intensified management of crops as compared to the earlier decades, when changes in farmland structure, for example hedge removal, had a more drastic impact on bird communities (Newton 2004).

It seems therefore that heterogeneity as such can affect communities of birds in different ways depending on the scale at which the effect is studied, and the ecological characteristics of the species (reviews in Benton et al. 2003 and Bennett et al. 2006). These aspects were little explored outside the countries with already intensive agricultural land-use. For countries where large-scale agricultural intensification started only recently, questions remain concerning effects on birds of: a) farmland structure versus intensity of management of fields; b) heterogeneity of the farmland landscape overall as compared to heterogeneity of fields; and c) possible threshold values of non-cropped habitats within farmland. Answering these questions was deemed important because it was argued that, since the loss of ecological heterogeneity at multiple spatial and temporal scales is a universal consequence of agricultural intensification, developing cross-cutting policy frameworks and management for its restoration at all levels is the key to restoring and sustaining biodiversity in agricultural systems (Benton et al. 2003).

A wealth of research on specialised farmland bird species and their response to different aspects of landscape and field structure, as well as field management, has been conducted (reviews in Schifferli 2001; Vickery et al. 2004; Sanderson et al. 2006). Most of it comes from north-western Europe, where farming intensity is already high. Notable exceptions are studies in Spain and Portugal that include traditional agricultural land-use (Delgado and Moreira 2000; Suarez-Seoane et al. 2002a; Suarez-Seoane et al. 2002b), and from mountainous regions of Austria and Switzerland (Schifferli et al. 1999; Britschgi et al. 2006).

In recent years several studies from East European countries have been published, where intensification is an ongoing process. Bird communities in farmland areas differing in their intensity of management were compared in Latvia (Auninš and Priednieks 2003), Poland (F. Sanderson, pers.comm), and Hungary (Verhulst et al. 2004 and Báldi et al. 2005). These studies provided an indication of the scale of the potential impact of agricultural intensification on birds and underlined the varied response of species of different ecological profiles. For example, in Hungary bird species richness, abundance, and community diversity were significantly lower on intensively grazed and fertilised grassland than on extensively grazed grassland (Verhulst et al. 2004). Though the same species occurred in both grassland types, the bird densities were an order of magnitude lower: the density of yellow wagtail (*Motacilla flava*) and whinchat (*Saxicola rubetra*) was respectively 89% and 61% lower under intensive as compared to extensive management. Bird species richness and abundance were also highest in extensively used vineyards (Verhulst et al. 2004). Monitoring data from Latvia showed that in counties where agricultural production had intensified 1.6-2.8 times during 1995-2002 there were twice as many declining farmland species as in counties with stable farming intensity (Auninš and Priednieks 2003). In all of these studies farming intensity was approached as a holistic phenomenon affecting both habitat structure and field management, and no attempt was made to discriminate between the two.

1.3. The Central and East European Region: scenarios of agricultural development

Ten countries joined the EU in 2004, eight of which are Central and East European Countries (CEECs): Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia (Fig. 1). The conservation importance of the CEECs for farmland biodiversity in Europe is well documented (EEA 2004). Agriculture in former socialist states received less financial support than it did in the EU (OECD 2006), with state support aiming at maintaining rural employment rather than increasing productivity. As a result, agriculture was less intensive in eastern Europe than in western Europe, and agricultural intensity of production never reached EU levels (FAOSTAT 2006). Prior to their transition to market economies, the CEECs supported agriculture through state ownership and planning, but most farmland has now been privatised. During transition, the costs of variable inputs, such as fertilisers, increased at a higher rate than did wages, causing a fall in income amongst food-producers and a decline in agricultural intensity (Fig. 2). The region also retained a high proportion of extensively managed farmed habitats. For example, semi-natural grasslands represent half of all permanent pastures in the CEECs (EEA 2003). Populations of a number of farmland birds currently have their strongholds in the region (BirdLife International 2004), being both commoner and attaining densities several-fold higher than those in western Europe (Sanderson et al. 2006). The issue of reconciling production and other functions of agroecosystems is therefore particularly critical for these countries, because they are all likely to experience a dramatic increase in agricultural intensification under the EU's agricultural policy.

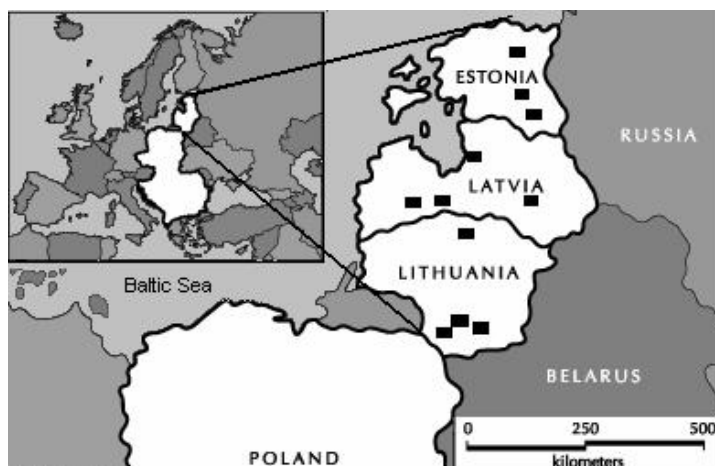
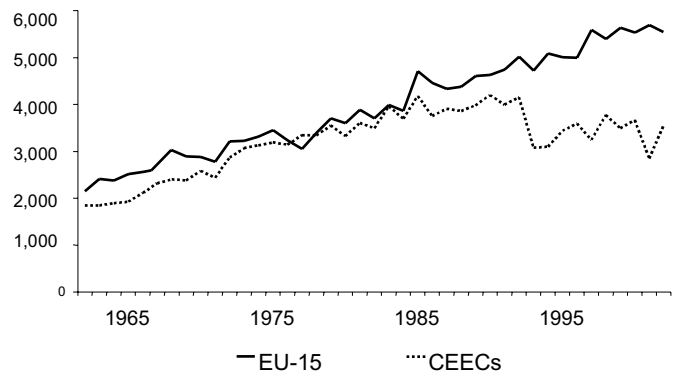


Figure 1. Map of Europe with the Central and East European region highlighted. Enlarged are three Baltic states, black rectangles are study plots.

For my thesis I developed a framework for studying the effects of intensification on bird communities in the Baltic region following a number of published assessments, as well as unpublished reports, of the possible impact of the EU enlargement on biodiversity in the new member states (Pain and Pienkowski 1997; Tucker and Evans 1997; Donald et al. 2002; Agra 2003; EEA 2003). These reports provided likely scenarios of the agricultural development in the CEECs. Several major changes in agricultural land-use in the region were envisaged in these reports. Below I summarise predicted changes in agricultural development, relevant for my research topic and the Baltic region, all of which are described in the above-mentioned reports.

Figure 2. Yield development in the EU member states before 2004 (EU-15) and Central and East European Countries (CEECs).
Source: FAOSTAT database of the UN Food and Agriculture Organization.



1.3.1. Total area of farmland

After the collapse of Soviet influence, a high proportion of the CEECs' agricultural land, as much as 30% in Estonia, was abandoned. It formed a so called "land reserve". It is envisaged that the total area of agricultural land currently in use will remain fairly stable (e.g. Estonia) or increase with additional land brought under production from the "land reserves" (e.g. Latvia). The remaining "land reserve" would likely be turned into forest either through natural succession or national afforestation programmes. This would result in a decrease in open landscape of up to 30%.

1.3.2. Areas of arable land and grasslands

An increase of arable area was predicted for the whole CEEC region, including Latvia and Lithuania. This is likely to happen at the expense of semi-natural grasslands, as new owners would pursue higher profits from cash-crop production, especially in regions with more fertile soils. Linked to this change was a predicted continuing decline in livestock numbers in the region. In spite of some possible growth in cattle numbers, the headage payment allocations decided at the EU level were seen as an additional economic limitation on keeping enough cattle to ensure adequate management of semi-natural grasslands. Especially in regions suitable for intensive cereal production, unprofitable farm operations such as livestock production were predicted to cease altogether.

1.3.3. Agricultural landscape structure

Although there were no statistics on valuable landscapes in the CEECs, threats to landscape diversity were reported from, above all, Latvia and the former East Germany (Aunins et al. 2001; Baessler and Klotz 2006). These included removal of landscape elements due to field enlargement, overgrowing by shrubs following land abandonment, and lack of maintenance of certain man-made landscape elements such as stone walls. Further simplification of the landscape was considered highly likely.

1.3.4. Changes in cropping patterns

At present, smallholding farms growing a variety of crops are still commonplace in the Baltics: the proportion of farms smaller than 20 hectares ranges from 60% in Estonia to 80% in Latvia and Lithuania (Salonen et al. 2001). Further specialisation was expected with enlargement of fields and areas under a single crop in regions suitable for intensive cereal production. Consequently, mixed cropping would likely decrease and only be maintained for a certain period due to the area payments available under the CAP and semi-subsistence aid.

1.3.5. Field management

The development of so called tramline agriculture in arable production - that is, highly mechanised high-input crop management, is expected. Arable production intensity is likely to increase, leading to higher yields per hectare and increased use of fertilisers and pesticides. Nevertheless, since intensification in the CEECs started from a low level, in most regions it seems unlikely to reach the levels found in the EU-15. Average cereal production per ha is expected to reach only 3.8 tons/ha by 2009 (as compared with 6 tons/ha in the EU-15 (FAOSTAT 2006)). However, this does not preclude strong increases in production intensity in the most fertile areas where the economic gain from outside inputs and high-yielding varieties is greatest. Most of the grasslands in use are likely to undergo transformation from extensive pastures and hay fields into a highly fertilised and frequently cut improved grassland type.

1.4. Incorporating conservation into production

In the last decade a new concept has entered the political discourse in Europe and beyond – multifunctional agriculture (OECD 2001). It is based on the idea of production within the natural limits of the environment (limiting pollution and use of resources such as fertile soil and water) for long-term sustainability, and on an appreciation of the other by-products of growing food such as a diverse agricultural landscape and biodiversity. In effect it means that “associated” species – e.g., flowers, butterflies and birds - are acknowledged a share of the primary productivity of the fields. Under this concept subsidies to farmers are justified on the grounds that farmers should be encouraged to produce other positive outputs to society, such as an open cultural landscape and the biodiversity associated with it. Up to now, however, this line of funding comprises but a small fraction – about 10% - of the overall direct subsidies to farmers under the CAP (Europa 2006)).

Since agricultural intensification aims at and leads to a rise in production, it has been suggested that, at least on a large scale, the yield level can be a good indicator of the land-use intensity; it is in fact explained as much as 30% of variation in bird declines across Europe (Donald et al., 2001). Yield can be seen as a measure of human appropriation of the agroecosystem primary productivity for human use. The whole process of intensification aims at increasing this share at a cost to other ecosystem components, such as associated species, as well as ecosystem services. A negative correlation between the current rate of human appropriation of primary productivity and farmland species diversity has been confirmed for Germany (Haberl et al. 2004).

Under the concept of multifunctional agriculture there is a need to enlarge the concept of “yield” so that it embraces production of wildlife and landscapes. Farmers should not be paid any longer for producing unwanted agricultural surpluses but rather for producing more wildlife and landscape (Sutherland 2004). Under such a system, skylarks, cornflowers and nature trails could be seen as being just as much a farm product as wheat (Musters *et al.* 2001). The introduction of the agri-environment policies and cross-compliance is a manifestation of this re-assessment.

In agriculture, “an industry in which political intervention is a virtually permanent state of affairs” (Robson 1997) conservation work will certainly not succeed unless political will is generated and social and economic systems are modified. Traditionally farmers were primary actors in food production, but nowadays their decision-making is largely dictated by government policies and restricted by other food sector actors such as retailers. The task of producing wildlife and landscape amenities is thus shared among several stakeholders. Farmers’ understanding and acceptance of agri-environment policies, and of ways to accommodate them into agronomic practices, are an important social aspect of the process. Since the whole reasoning behind conservation efforts is outside the purely biological domain, it is important that the conservation targets are understood within the existing socioeconomic and political context. An interdisciplinary approach can be expected to bring insights into the way conservation policy targets get translated into practice, and to facilitate this process (SoBio 2005; Mattison and Norris 2005). Research into the broad issue of biodiversity as it is experienced by farmers themselves, in the very specific context of birds dependant on farmland, and in the context of agricultural intensification, is a novel approach for the CEECs and an additional subject of this thesis.

2. Objectives of the study

The main aim of the thesis is to evaluate the current state of farmland bird communities across the Baltic region against expected changing patterns of land-use in the region, as well as the socio-political context of farmers’ attitudes to biodiversity and its conservation. This is hoped to facilitate predictions on the direction and scale of changes in numbers of farmland birds following agricultural intensification after the accession to the EU. I concentrated on two main aspects of agricultural intensification: changes in local habitat structure and heterogeneity across different agricultural landscape types (**I**), and changes in intensity of land-use on a regional (county) and local (field) levels within a similar landscape (**II**). In order to assess the likely influence of changes in cropping patterns I looked at the species’ associations with the main farmed habitat types across the region (**III**). Finally, I studied social opportunities and prerequisites for maintaining farmland as a wildlife habitat in Estonia based on farmers’ willingness to employ wildlife friendly management, and compared them to the situation in neighbouring Finland (**IV**). The research strategy and methods were developed and tested during the pilot year in 2001 (**V**).

3. Material and methods

Bird counts in farmland across the Baltic countries were used to relate farmland bird community characteristics and abundance of specialised species to the composition and structure of farmland,

and agricultural land-use intensity. The sociological part comprised interviews with farmers in one Baltic country (Estonia) and a neighbouring EU-15 country (Finland).

3.1. Study region

The research was carried out in the Baltic states of Estonia, Latvia, and Lithuania (Fig. 1). The region lies in the hemiboreal zone; it occupies 175,116 km², stretching for about 700 km in a North-South and 600 km in a West-East direction, representing a biogeographical continuum from forest-dominated Estonia (19.7% agricultural land) to the more open agricultural Lithuania (53.4% agricultural land) (Anonymous 2003).

3.2. Pilot study (V).

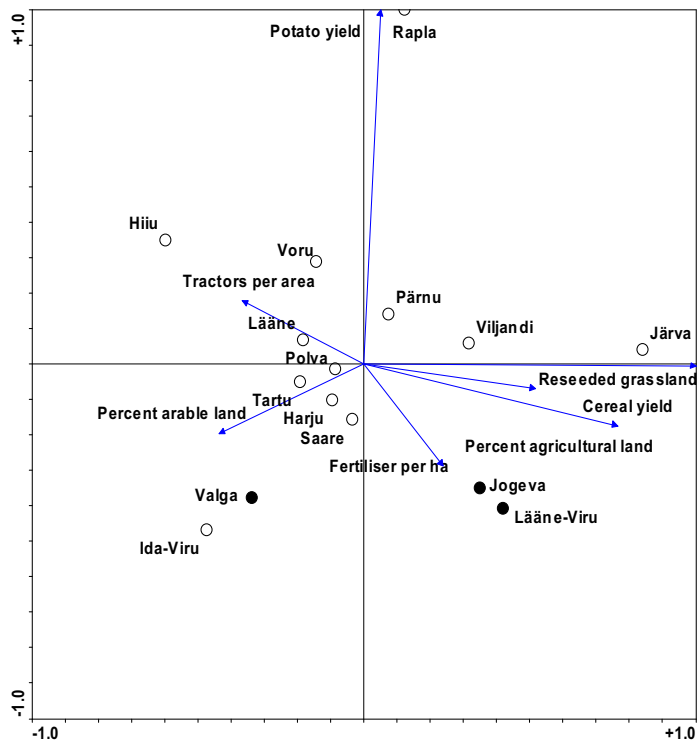
3.2.1. Design and methods

Prior to gathering field data we² conducted a pilot study in all three countries. Initial selection of the counties from each country was based on available agricultural records such as proportions of agricultural lands under arable and grassland fields, fertiliser inputs, machinery use per farmed area, and yields of the cereals and potatoes (Central Statistical Bureaux of Estonia, Latvia, and Lithuania). The statistics records were entered into the PCA analysis to grade the counties within each country according to the dominance of farmland and agricultural intensity (Fig. 3). Counties where farming was marginal with the lowest proportion of farmland and inputs/yields - that is, largely comprised of small subsistence plots embedded into a forest-dominated landscape - were excluded. They are not representative of commercial farming, and being small isolated farms within forest they do not support most of the typical farmland ground-nesting species. They are also not eligible for agri-environment support. We selected twelve counties across the Baltic states of three different landscape types and under two levels of land-use intensity (see below for details).

We tried out a randomised scheme of site selection by choosing a study area of 100km² within each county so that it represented the average proportion of farmland for a county. Then 1-km squares were selected at random from the grid. We employed three field methods commonly used in bird field counts: point counts, transect counts, and spot mapping (Tiainen et al. 1985; Bibby et al. 1992). All three were tried out in parallel by the same observers. We tested the practicalities of using these field methods on the required scale in farmland of the region with the same people who later carried out the main fieldwork. When deciding on the field method to be used we took into account such aspects as the region's farmland terrain, numbers of registrations of typical farmland bird species, convenience of describing habitat, time and costs of the work, and the experience of the observers. We also assessed the possibilities of collecting site-specific information on management practices from farm owners, and tried out a scheme of habitat description on different levels of detail and scale. The feedback from the observers was used as well.

² Hereafter under "we" I refer to joint efforts with my colleagues from the Baltic region

Figure 3. Results of the PCA analysis based on agricultural records for Estonia. Filled circles represent selected counties: Lääne-Viru, Jogeva and Valga.



3.2.2. Results

For the main survey we chose eleven counties out of twelve tested (due to financial constraints one was dropped as adding the least to the landscape and intensity types). Comparison of the data on farmland birds collected by the same observers during one day of work using point and transect methods did not produce any statistically significant difference. “Quick” mapping was a new method for the observers, which was probably the main cause of the generally low number of birds registered. A detailed analysis of the fieldwork costs with the applied design showed that the point counts were up to 15% more expensive to run because of the greater travel involved. An optimal placement of transects was a problem: in some cases it was seriously hindered because of difficult terrain and open ditches, and locating a transect the second time. According to all the participants transect counts were more demanding to execute because of the high vegetation in many field boundaries and grassland, and unfriendly farmers. In Estonia, point counts were carried out simultaneously by two fieldworkers through all the squares. Observer bias did not prove to be significant though one of the observers was less experienced in counts and had only the preceding training. The list of farmland species recorded - some 20-23 species of the farmland group - was very similar regardless of the counting method employed.

Based on the pilot results and a feedback from the counters, it was decided to use a point count method with unlimited distance (Bibby et al. 1992). Bird registrations were additionally marked on a field map to relate sightings to field type and the approximate distance from a point. Points were visited for five minutes twice a season at central dates around mid May and mid June. Counts were

started one hour after sunrise to avoid the dawn peak in bird activity under good weather conditions. The sequence with which points were visited was reversed between the visits. We decided to place four points in each square to reduce travel time.

Coverage of farming habitats within random squares was fairly representative if compared with the latest agricultural records on the proportion of farmland and crop types. Describing habitat at the scale of 200m around the points or along transects was three times more time demanding than for 100m, and in some cases, according to observers' feedback, impossible because of the difficult terrain. According to studies on the breeding biology of passerine farmland species, the majority of foraging trips by adult passerine birds while feeding nestlings are made within 100 m (Schifferli et al. 1999; Brickle et al. 2000; Morris et al. 2001; Biber 1993). In farmland of high habitat diversity and abundant resources - both are the case in the Baltic region - bird foraging trips tend to be shorter (Schifferli et al. 1999; Brickle et al. 2000; Britschgi et al. 2006). Though a detailed mapping of habitat was carried out for an area of 100m from a point, proximity to other major habitats other than farmland (forest, extensive scrub or settlements) for up to 200m was additionally estimated in the field and validated from topographic maps. Obtaining data on inputs and yields directly from the owners proved to be unrealistic due to unclear ownership and generally small holdings. Combined field estimates provided a crude general idea of the intensity of farming.

Interchanging observers is a straightforward solution to the potential problem of observer bias, but this was not a practical option in our case where work was carried out over a large area - familiarity with a particular area and the location of its recording sites is very important. The set of species in this study was restricted to those occurring in farmland, which are mainly common well-known species, and bias probably is less significant (Verner and Milne 1990). It was decided that in Latvia and Lithuania a separate observer would work in each study area. However, all areas were visited by a national co-ordinator, who also assisted with the habitat descriptions. All observers underwent training prior to counting and participated in the pilot study.

3.3. Study areas

The counties selected for the main survey represented three landscape types and two land-use intensity levels. The proportion of farmland in each county characterised the landscape type of a study area - ranging from generally open to fragmented by other habitat types, such as forest, extensive shrubbery, settlements, and bogs. The landscape type for each 100 km² study area was defined as open (over 80% agricultural land), semi-open (60 – 80%), and enclosed (40 - 60%) (**I**). When selecting in each country areas paired by intensity of agricultural land-use, the average cereal yield from commercial enterprises in each county for the five years preceding the field survey was used as an indication of farming intensity (Table 1). Within each country it positively related to the inputs of fertilisers and the number of tractors per agricultural area (**V**). The areas under less intensive production were characterised by a proportion of farmland and cereal yield that did not exceed the country's averages (**II**). A more intensively farmed region was chosen so that it was as similar as possible in overall landscape structure and proportion of farmland, but not further than 200 km from a respective less intensively farmed region. The latter restriction was used to ensure that differences in bird species composition and numbers were not caused by geographical factors.

The initial division of areas into more and less intensive land-use type was further confirmed by the evaluations of field management (II). Fields in the more intensively used areas had on average fewer weeds, and crops with a less dense structure.

Four points were placed in each square in a systematic way: at approximately equal distances from the corners with a minimum distance of 300 m between them. In Latvia, where the counts were performed as part of an existing monitoring scheme, two points per square were placed. However, the same principle of area selection was followed as in this study (Priednieks et al. 1999). Initially, an equal number of points were surveyed in each pair of regions within a country, but for the analysis of areas paired by agricultural intensity points within abandoned fields (wherever over 80% of a 100m circle area around a point was abandoned) as well as close to the farmland edge were excluded.

Table 1. Agricultural statistics used in the selection of regions in the Baltics of predominantly intensive and extensive farming types as compared to the countries' average, the main characteristics of the selected regions (mean value) and the number of survey points. Total $n = 274$ (adapted from paper II).

Region	Lithuania			Latvia			Estonia ^{a)}		
	Extensive Prienu	Intensive Sakai	Average	Extensive Skulte	Intensive Blidene	Average	Extensive Valga	Intensive Jõgeva	Average
Farmland, % of total	59	66	53	55	73	60	23	30	21
Arable, % of agricultural	82	93	84	30	58	36	84	53	84
Cereal yield, 100 kg/ha	24.9	33.4	24.5	16.6	25.9	21.5	19.1	22.3	19
Distance to the edge of fields, 200 m	141.3	204		149.7	181.5		181.5	189	
Index of field management intensity	0.8	1.3		-0.5	0.2		1.7	2	
Point number	60	60		37	30		39	48	

^{a)} yields between the countries can not be compared directly because of the climatic difference (e.g. yields in Estonia are low relative to land-use intensity; data from Central Statistical Bureaus of Estonia, Latvia, and Lithuania)

Because of the largely fragmented farmland, the many smallholdings in the region (Salonen et al. 2001), and the considerable variety of field types within each farm (II), it was difficult to satisfactorily account for the effect of habitat composition on bird communities as compared to the actual management intensity. In order to look at the effect of actual field management of arable fields in a more homogeneous landscape we additionally extracted a subset of data from the most farmland-dominated and agriculturally productive part of the Baltic region, in the neighbouring counties of Jelgava in Latvia and Pasvalys in Lithuania (II). These had about 90% of land under agricultural use, over half of which was annual crops. Average cereal yields were 25–30 hg/ha in 1998-2002, which was above the countries' average. Only points within open fields, that is with the distance to the field edge over 100m, and with over 80% of a 100-m radius area around the points being under an annual crop, were selected (total of 49 points).

3.4. Data and variables

The study's main fieldwork was conducted in spring-summer 2002 following well-established recommendations for bird counts (Bibby et al. 1992). For each point the maximum count of individual birds from two visits was used. There is a potential bias in bird detectability in habitats of different structural complexity, even in such generally simple habitats as fields (Henderson et al. 2000), which may impair accuracy of models of species habitat selection. Mapping of bird observations at various distances was not done by all the observers in a uniform way and we had to pool bird observations from all distances. This decision was justified because in this study we did not aim at accurate habitat models of bird species. Relation with the habitat structural arrangement (I) was less likely to be affected by this bias than habitat selection. Detectability of birds is potentially impaired in a more structurally complex habitat (such as semi-natural grasslands) and with a higher crop variety. Both these were characteristic of the least intensive areas. In the comparison of the relative occurrence of birds between regions of two land-use intensity levels (II), one would, based on detectability, expect lower number of observations in the least intensive areas. Our result was the reverse and so can be regarded as conservative.

We targeted analysis specifically at a group of birds defined as “farmland specialists” by an independent assessment for the whole of Europe (Tucker and Evans 1997), which we adapted to the region. Particular attention was paid to species shown to be in decline over most of their European range as a result of agricultural intensification (BirdLife International 2004). In order to assess a possible pattern of association of the farmland specialist species with the spatial organisation of habitat, the species were grouped by ecological characteristics similar to those used by Tiainen and Pakkala (2001) (Table 2).

Habitat variables were selected on the basis of their importance for the studied bird group based on similar studies elsewhere (cf. Petersen 1998; Auninš et al. 2001) (Table 2). The extent of each habitat was measured within a 100 m radius around the counting points. The distance to the nearest occurrence of major habitats other than farmland (forest, extensive scrub or settlements) was estimated in the field and validated from topographic maps for up to 200 m. The habitat types were sketched onto the field maps, and the percentage of their coverage was estimated from the field maps in LUPA software (LUPA 2002). The actual percentage of farmland in the areas of 100 km² was estimated from topographical maps in LUPA. For some analyses we calculated simple habitat structural indices pertaining to the surrounding farmland (Table 2) (see paper I for details). For some analysis habitat variables were pooled (e.g. grassland or types of grasslands) depending on the analysis' aims and occurrence of the habitat variables in the data sets.

For the purpose of assessing differential effects of farmed habitats on the bird community characteristics across the region (III) we subdivided the study region into four geographical belts of equal width. These belts differed not only in their geographical position but also in the farmland structure, crop type dominance, and land use intensity (Table 2).

Table 2. Explanatory variables describing habitat composition and its spatial arrangement, principles of the region division into geographical belts, bird community metrics, and description of ecological groups of farmland specialist species.

Name, units	Description
<i>Habitat composition</i>	
SPR_C, %	Spring cereal
WIN_C, %	Winter cereal
OTHCROP, %	Other crops (root vegetables, rape, peas or corn), and bare earth at the 2 nd count
SEEDGR, %	Improved grassland apparently treated with fertilisers and re-seeded, and grassland sown with grass and/or clover species
NATGR, %	Dry or wet grassland or meadow, usually grazed or regularly mown, containing a variety of herb species and/or looking neglected
ABAND, %	Abandoned, neglected for a number of years, usually with high vegetation, may be starting to overgrow with willow/birch
SCRUB, %	Area of any scrub
FOREST, %	Any forest type
OTHER, %	Ponds, bogs, orchards
D, m	Ditch with grassy banks
DITCHRIV, m	Vegetated ditches and small rivers
FENCE, m	Around pastures
ROAD, m	All road types
ETL, m	Electric and telephone line
TREEHEDG, m	Hedges, with or without trees, isolated trees or tree groups
STONE, %	Piled stones left after melioration works
FARMBUI, %	Farmsteads and farm buildings
<i>Habitat structural indices</i>	
DE, m	Distance to the field edge (settlements, forest, extensive shrubbery), up to 200
RH, number	Count of residual habitat element
VAR, num/ha	Count of all field types per area
MIX, yes/no	Combination of crop and grass fields
<i>Geographical belts</i>	
BELT 1	Fragmented farmland and a relatively low agricultural intensity, except in Sakiai in Lithuania (large field units, often interspersed by ditches, and intensive potato cultivation). Almost 40% of the counting area fell under dry grasslands used for extensive grazing or abandoned.
BELT 2	The most intensive cereal production zone with large open fields. Extensive dry grasslands were still common (20% of area).
BELT 3	The most fragmented forest-field mosaic. A third of the counting area was under crops, 30% under grasslands, mostly reseeded, and 20% was abandoned.
BELT 4	The fields, mainly spring cereal, oilseed rape, and seeded grasslands, tended to be large intensively managed units imbedded into forest. No abandoned fields.
<i>Community metrics</i>	
SR	Total number of bird species
SRF	Number of farmland specialist species
SRD	Number of declining species
SUM	Total abundance of all species
SUMF	Abundance of farmland specialist species
SUMD	Abundance of declining species
FSDIV	Diversity of farmland specialist species
<i>Ecological groups with typical species as an example</i>	
True field (15)	Breed and feed on fields and open margins (<i>Alauda arvensis</i>)
Edge (12)	Breed on field edges with high vegetation, reeds, bushes or low trees, or on similar vegetation patches within fields, and feed there or in open (<i>Saxicola rubetra</i>)

Table 2. continued

Tree/forest (14)	Breed in trees, also in forest and feed on fields (<i>Emberiza citrinella</i>)
Farmyard (10)	Utilise habitats provided on farms such as gardens, trees, bushes and buildings (<i>Sturnus vulgaris</i>)
Other species(51)	Territories near to the fields but both breeding and feeding elsewhere (<i>Turdus merula</i>)

3.5. Statistical analysis

In order to select the explanatory variables best related to the farmland bird community characteristics and abundance of species we used generalised linear modelling with Poisson error structure and logarithmic link function in S-Plus 6.1 (Insightful 2001). Variables were selected in a stepwise selection algorithm based on Akaike's information criteria (AIC) (Venables and Ripley 1999) corrected, wherever appropriate, for small sample sizes (Burnham and Anderson 2002). Working with models containing interactions, we used a rule of marginality, so that non-significant main effect variables were only removed if their interactions with a factor were not in the model. When comparing performance of the resulting optimal models for different model sets we assessed them with AICc (Venables and Ripley 1999).

In analysis of the whole dataset (**I, III**) I attempted to reduce the number of habitat variables and their intercorrelation by applying Principle Component Analysis (PCA, ter Braak and Šmilauer 1998). However, the proportion of explained variance by a few axes was low and decreased only slightly with each consequent axis. Based on this, the data reduction approach deemed to be unsuitable. In the analysis of a restricted dataset (**II**) it worked reasonably well.

We routinely examined the fit of each model with residual plots to detect heteroscedasticity. We did not transform the explanatory variables but systematically plotted residuals against each of them to detect strong non-linear responses. We checked the strength of non-linear responses through adding respective 2nd order terms. In cases where these were significant we retained them in the model but, for the sake of simplicity, omitted them if the significance level was marginal ($0.01 < p < 0.05$). We considered models with the dispersion parameter exceeding two as overdispersed. Where this was true – only in models for the abundance of all and farmland species - we corrected the estimates and confidence limits by the dispersion parameter (Crawley 1993). In exploring the pattern of species distribution within the region's farmland we employed canonical correspondence analysis (CCA) in CANOCO (ter Braak and Šmilauer 1998).

Recently there has been discussion on an inherent problem in the analysis of habitat associations based on stepwise regression, namely of a bias in results obtained when model selection proceeds at the same time as parameter inference (Miller 1990; Chatfield 1995; Whittingham et al. 2005). This was shown to lead to biases in parameters, overfitting and incorrect significance tests. A solution, which is increasingly recognized in ecological studies, is the use of multi-model inference and information theoretic approaches (Burnham and Anderson 2002). To avoid overfitting we did not include nearly significant terms into the final models (by using corrected AIC). Whenever possible

we looked closely at the effect size rather than associated levels of significance. This gave us better grounds to employ a traditional, and still widely used, method of model constructing.

3.6. Sociological data and analysis

For a study of farmer attitudes (**IV**), a semi-structured interview was chosen as the research methodology after a pilot questionnaire sent in 2003 to 100 randomly chosen farmers in Estonia. In Estonia the topic, birds vs. farming, was novel and not of a routine kind for farmers and some assistance from an interviewer was deemed necessary. The somewhat provocative theme of "birds suffering because of agriculture" was regarded as unlikely to evoke willingness to answer from farmers with a different outlook. The possibility to explore the diversity of views of farmers about biodiversity on their fields – a subject not studied in the region previously – was regarded as a useful by-product of an interview-based study. However, employing an entirely qualitative method based on open in-depth interviews simultaneously in two countries by two different people was regarded as prone to potential bias from the interviewer.

The data were collected in Estonia (autumn 2003, 27 interviews) and south-western Finland (spring 2004, 24 interviews). In both countries, the farmers were chosen randomly from those taking part in agri-environment schemes or, in Estonia, also applicants to them. In Estonia these included ten farmers from a county where a pilot agri-environment scheme has been running since 2001, and where farmers have received some training. Two other counties were selected because of the high uptake of agri-environment measures under the national programme. In Finland we randomly selected farms from a county in the South-West of the country. Six of the interviewed farmers in Finland were contracted to a more advanced-level support scheme (referred here as "special agri-environment agreements"). All except six of the farmers, all of whom we initially contacted by telephone, agreed to give an interview (lack of time was the reason for denial in both countries). All interviewed farmers owned their farms. The interviews were conducted in the local native languages by two different interviewers in Estonia and Finland. To ensure consistency, the interviews were based on exactly the same questions. The interviewer in Finland was trained to conduct the interviews in a way as similar as possible to that done earlier in Estonia. Answers were written down *verbatim*.

In addition to presenting data in the form of a frequency distribution, we used some quantitative analysis to detect associations between variables. The effects of such variables as the country, participation in a special support scheme in Finland or a pilot project in Estonia, farm size and farmers' plans for the future, as well as, wherever appropriate, the farmers' age and educational background, were analysed. Because of the use of ordinal scoring and a generally small sampling size, non-parametric tests with Dunn-Šidák adjustment of significance levels were used throughout the analysis (Sokal and Rolf 1995). Unfortunately, this restricted the ability to control for the effects of other possible variables than that of interest, so one needs to be aware of the danger of spurious significant correlations. Principal Component Analysis was used to rank the farmers according to their interest in wildlife, and their expressed willingness to take action favouring wildlife.

4. Results and discussion

Having carried out this comparative study, I acknowledge that it was challenging to separate the relative effects of farmland structure and management intensity. Management tended to be more intensive in areas with already simplified landscapes, which is a common situation in farming (Freemark and Kirk 2001; Roschewitz et al. 2005). In Latvia and Estonia the landscape structure and habitat composition were reasonably similar between the areas of contrasting intensity levels, but in Lithuania the “extensive” region was more heterogeneous (Table 2 in paper II). An experimental approach, under which farmland structure could be strictly controlled, is likely to be prohibitively expensive on a scale large enough for such mobile species as birds. Finally, intensified use of fields inevitably reduces heterogeneity on a within-crop level, resulting in a dense and more uniform crop structure, and fewer weeds. In this sense, total decoupling of “heterogeneity” and “intensity” is impossible. Having said this, it was possible to produce some qualitative and quantitative assessments of the likely changes in the farmland bird community in the Baltic region according to different scenarios of the agricultural development. I also succeeded in elucidating some aspects of farmers’ outlook on impacts of agricultural intensification on farmland wildlife and their attitude to potential species declines and reduction in habitat diversity.

4.1. Changes in the total area of farmland (I, II)

The bird species distribution within the Baltic region was relatively uniform. Most species were present across the whole region, and only some, mainly from a group of true field species, tended to associate mainly either with the northern or southern parts of the region (Table 3). Farmed habitats across the whole geographical region are therefore important in providing habitat to different farmland bird species. The first CCA gradient in species and site distribution strongly correlated with the geographical coordinates, and the second gradient with the presence of habitats other than farmland (Fig. 2 and Fig.3 in paper III). A high number of species were associated with the region’s open farmland (Fig. 2, left half in paper III). Importantly, several species of conservation priority in Europe, such as quail, partridge, wheatear (*Oenanthe oenanthe*), and ortolan bunting (*Emberiza hortulana*), were among them. Abandonment of farming is expected to happen especially in the least productive regions, which cover a large part of Estonia, North and East Latvia, and South and East Lithuania. Among farmland species characteristic of these regions are fieldfare (*Turdus pilaris*), ortolan bunting, and curlew, and therefore their numbers are likely to decline.

Displacement of farmland with other land-use types will result in a shift in the bird community from open country specialists to species associated with edge habitats (from left to right on Fig. 3; III). Most of the species associated with farmland edge and non-farmed habitats (on the right on Fig. 3; III) are generally common and widespread with no special adaptations to field habitats. Though maximisation of habitat heterogeneity on a landscape level by establishing various non-farmed habitats will increase total species richness within the landscape, the fragmentation of large fields, especially those managed at low intensity, will be detrimental to some specialised farmland species (as shown also for Hungary and Spain in Díaz et al. 1997; Suarez-Seoane et al. 2002a; Moreira et al. 2005; Báldi et al. 2005). It remains a controversial issue as to what degree the open field

Table 3. Occurrence of farmland specialist birds across the Baltic states (percent of squares with registrations/number of individuals) groups by ecological guilds, species in bold are declining in Europe.

	Lithuania n=60	Latvia n=40	Estonia n=36		Lithuania n=60	Latvia n=40	Estonia n=36
<u>True field species</u>				<u>Edge species</u>			
<i>Circus pygargus</i>	4/4	0	0	<i>Circus aeruginosus</i>	20/16	15/7	6/3
<i>Perdix perdix</i>	12/12	2/2	0	<i>Phasianus colchicus</i>	0	0	6/3
<i>Coturnix coturnix</i>	19/42	2/2	3/2	<i>Saxicola rubetra</i>	82/361	95/270	81/219
<i>Crex crex</i>	30/50	42/66	56/64	<i>Locustella naevia</i>	3/3	55/70	25/38
<i>Charadrius dubius</i>	0	5/3	3/2	<i>Acrocephalus palustris</i>	38/70	70/126	23/28
<i>Vanellus vanellus</i>	38/46	55/85	67/142	<i>A. schoenobaenus</i>	15/35	25/28	14/26
<i>Gallinago gallinago</i>	2/1	10/5	6/4	<i>A. dumetorum</i>	0	0	6/4
<i>Limosa limosa</i>	2/4	0	0	<i>Sylvia communis</i>	80/237	100/324	64/111
<i>Numenius arquata</i>	0	0	36/27	<i>Oenanthe oenanthe</i>	2/2	0	17/13
<i>Tringa totanus</i>	0	5/2	0	<i>Lanius collurio</i>	23/31	15/16	6/3
<i>Alauda arvensis</i>	100/1679	100/1426	100/4254	<i>Carpodacus erythrinus</i>	5/5	55/70	23/48
<i>Anthus pratensis</i>	67/133	75/86	38/41	<i>Emberiza schoeniclus</i>	8/8	25/20	3/2
<i>A. campestris</i>	7/10	0	0				
<i>Motacilla flava</i>	52/115	5/8	14/10				
<i>Emberiza hortulana</i>	0	2/2	11/14				
<u>Tree/forest species (14)</u>				<u>Farmyard species (10)</u>			
<i>Buteo buteo</i>	8/11	30/15	3/1	<i>Ciconia ciconia</i>	28/38	67/57	14/6
<i>Aquila pomarina</i>	2/1	7/3	0	<i>Columba livia</i>	12/33	10/14	3/2
<i>Falco tinnunculus</i>	0	2/1	6/2	<i>Apus apus</i>	5/6	0	0
<i>Columba palumbus</i>	18/26	52/	31/26	<i>Hirundo rustica</i>	63/147	70/95	31/33
<i>Streptopelia turtur</i>	2/2	2/2	3/2	<i>Delichon urbica</i>	12/4325/	295	0
<i>Lullula arborea</i>	7/10	0	6/3	<i>Motacilla alba</i>	12/9	24/22	19/12
<i>Turdus pilaris</i>	32/41	25/26	39/38	<i>Corvus monedula</i>	18/24	15/52	25/41
<i>Pica pica</i>	25/27	35/16	28/18	<i>Sturnus vulgaris</i>	65/257	87/266	62/54
<i>Corvus frugilegus</i>	23/356	2/1	17/58	<i>Passer domesticus</i>	2/2	2/8	6/4
<i>Corvus corone cornix</i>	58/76	82/192	64/82	<i>Passer montanus</i>	10/28	10/10	22/12
<i>Carduelis chloris</i>	12/21	15/5	9/14				
<i>Carduelis cannabina</i>	27/27	7/18	6/3				
<i>Carduelis carduelis</i>	27/31	15/7	0				
<i>Emberiza citrinella</i>	80/210	82/220	69/109				

specialists of steppe origin should be regarded as a conservation priority group in the boreal forest dominated part of Europe. While in the rest of eastern Europe a more continental climate may particularly favour species of steppe origin (Díaz et al. 1997; Báldi et al. 2005), the situation differs over most of the Baltic region. Only in parts of Lithuania might such species meet suitable conditions within large fields. In the overall biodiversity conservation context, much will depend on what habitat type will be promoted instead of the former farmland.

4.2. Expansion of arable crops (III)

With increase in the proportion of arable crops in a sample area, there was no substitution of species but rather a shift in relative dominance of species within the community. Part of the reason could be the considerable mixture of arable and grassland fields throughout the region (only 7% of squares had just one field type within the whole counting area (III)). Therefore we were unlikely to observe distinctive grassland or arable bird “communities” by carrying out a survey on randomly selected squares.

Our results indicate that the changes in abundance of individual species with increase of arable area may differ with geographical position and differences in the level of fragmentation, soil types and vegetation development patterns. The relationship of different field types with the bird community characteristics varied across the region, and was contrasting in different areas (Table 4). For example, the relation between spring cereals and farmland bird abundance was positive in the South, where grassland dominated, and negative in the region dominated by arable crop production. Similarly, natural grasslands positively related to the number of species in the Northern region, where arable production was intensive, but negatively in the South, where they were represented by dry grasslands with poorly developed vegetation. A similar variation existed also for the abundance of individual species.

Abandoned fields most frequently contributed to the abundance of species in otherwise open landscapes dominated by arable production. In the models for lapwing, whitethroat (*Sylvia communis*) and whinchat natural and seeded grasslands featured as either negative or positive predictors depending on the region’s geographical belt. In practical terms, this means that agri-environment prescriptions require regional targeting, and that habitat models produced in one region are unlikely to be accurate for another (see also Whittingham et al. 2007).

The presence of cereal and other crop fields featured as a negative predictor in models for species richness (Fig. 4a), and abundance of most of the individual bird species (III). However, it related to the higher abundance of the true field species (Fig. 4b) (cf. Moreira et al. 2005). The relationship of cereal fields with the latter group was asymptotically positive, and peaked when an extent of a cereal crop reached 50% (Fig. 4b). This pattern matches a similar relationship found in Poland (Tryjanowski 2000; Fiona Sanderson, pers. comm.). The models based on structural indices confirmed this conclusion (I). They indicated that a combination of annual crop fields was a strong positive predictor and perennial grassland (including recently abandoned fields) for numbers of farmland bird species and declining farmland species. Annual crops neighbouring perennial grass fields may be more important than any other combination of field types, as they contrast most strongly in vegetation development, resource base, and management (Evans 1997). In practical terms, it confirmed the importance for farmland birds of mixed farming, which is still common in the Baltic region.

An expansion of arable crops and replacement of grasslands will translate into impoverishment in farmland bird communities, but will benefit several bird species specifically adapted to crop fields (quail, partridge, and skylark). These species are likely to depend largely on the level of hetero-

Table 4. Contribution of habitat types to the farmland community characteristics over the whole Baltic region and only within a respective geographical belt: 1 – southern, 2 – cereal, 3 – mixed, and 4 – northern belt. The sign indicates the direction of the relationship. For a factor BELT the belt numbers are given in order of decrease in estimates. Pseudo r^2 refers to the ratio of explained deviance to the null deviance. Variable names are explained in the Table 2. (Adapted from **III**).

Variable	Final model	pseudo r^2
Farmland species richness	SEEDGR (-) WIN.C (-) OTHCROP (-) ABAND (-) OTHER (+) Belt 1: - NATGR Belt 2: - NATGR - SPR.C Belts 4: NATGR - SPR.C	0.25
Declining species richness	SPR.C (^+)* OTHER (+) BELT: (1 4) > 3 > 2	0.32
Farmland species abundance	OTHCROP (-) ABAND (-) FOREST (-) OTHER (+) Belt 1: SCRUB Belt 2: - NATGR- SEEDGR - SPR.C - WIN.C Belt 3: - SEEDGR - SPR.C - WIN.C - SCRUB Belts 4: - SEEDGR - SPR.C- WIN.C	0.20
Declining species abundance	WIN.C (-) OTHCROP (-) Belt 1: SEEDGR - SPR.C - FOREST Belt 2: - NATGR- SEEDGR - SPR.C Belt 3: - NATGR - SEEDGR – SCRUB - ABAND Belts 4: SEEDGR - SPR.C- WIN.C	0.30

* a predominant trend in curvilinear relationship

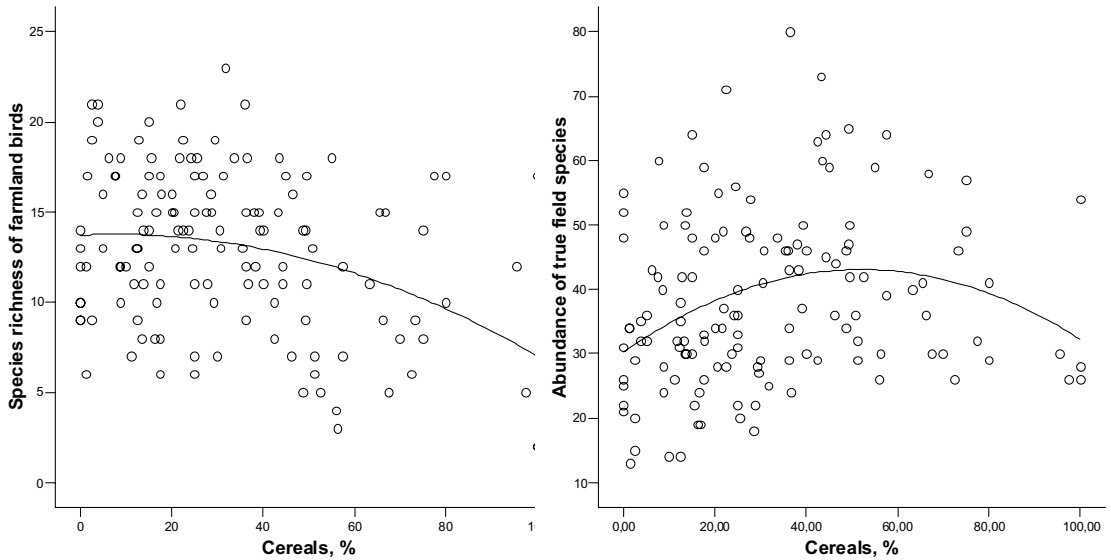
genity within the crop fields in terms of soil type and density of crops and weed plants. Many of these bird species are currently declining in Europe, and for them a further increase in management intensity of arable crops, leading to in-field homogenisation and reduced resource supply, is likely to be the decisive factor (see below). A decline in mixed farming coupled with regional specialisation in crop and grass production will have a detrimental effect on species such as lapwing in need of a combination of grassland and crops within their activity ranges (Berg 1991).

4.3. Importance of the diverse structure of farmland (I, II, III, IV)

The study demonstrated that structural characteristics of farmland, such as the number of residual non-cropped elements, the local mixture of annual crop and grass fields, and the variety of field types, all enhance the diversity of farmland bird communities (Table 5 in paper **I**). A simple index of the number of non-cropped habitat elements was the most significant positive predictor for the richness and abundance of farmland specialist birds, as well as for many individual species. In real terms, reduction of non-cropped habitat elements by half translated into a 25% decrease in the number of farmland species, and removal of all non-cropped elements led to a decrease of 60% (Fig. 5).

Birds of different ecological profiles showed a varied, sometimes contradictory, response to different types of non-cropped elements. For example, the number of trees, the length of hedges and tree alleys, and the area of farmsteads had predominantly negative correlation with the true field

Figure 4. The relationship between the extent of cereals and a) number farmland bird species, and b) abundance of true field species.



birds, but positive with several edge and forest species. The extent of ditches and small rivers had a consistently positive relationship in the case of abundance of many farmland species. The prominent positive role of ditches, as feeding and nesting patches in otherwise homogenous fields, has been shown in a number of studies from North-Eastern Europe (Auninš et al. 2001; Piha et al. 2003; Vepsäläinen et al. 2005). This particular non-cropped element is likely to be a keystone structure for farmland birds in the North of Europe (see Tews et al. 2004).

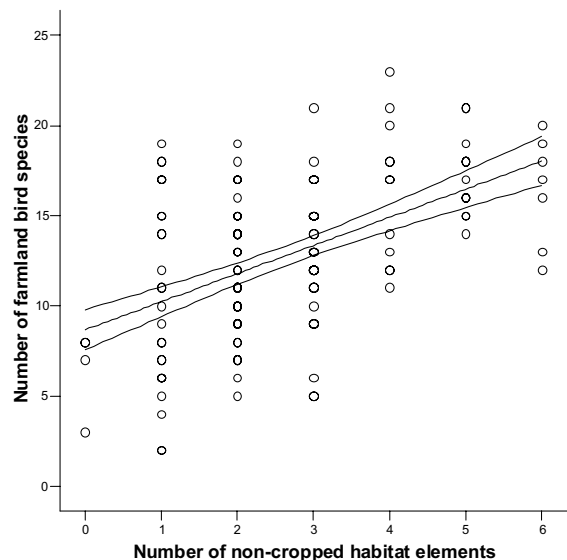


Figure 5. Relationship between number of farmland bird species (mean and CI of 95%) and number of different non-cropped elements within fields.

The presence of non-cropped habitats and habitat elements within farms as important areas for wildlife were also appreciated by farmers in both Estonia and Finland (IV). Farmers were more willing to preserve and enhance these elements on their farms rather than modify on-field practices. The majority regarded groups of trees and semi-natural grasslands as being especially valuable for wildlife (69% of farmers chose either or both), which generally reflects a good understanding of the habitat needs of many of the region's farmland species. The semi-natural grasslands enjoyed an especially high level of interest with the farmers from the pilot area in Estonia, where this type of habitat is relatively abundant and valued by rural people (Kaur et al. 2004). Farmers who regarded these habitats as valuable for wildlife were also willing to preserve or restore them on their farms more often than the other farmers (IV).

4.4. Landscape context (I, III)

Firstly, we showed that a large landscape type of 100 km² has a minor effect on the diversity of farmland bird communities. Structural complexity of habitat on a local level (within 200 m) had better explanatory power on the community characteristics, while different species favoured different landscapes (I). Secondly, enrichment of habitat with non-cropped elements had the greatest effects on the bird species and individual numbers in adjacent crop fields in simple landscapes as indicated by the highest slope of the parameter for the open landscape (Table 5 in paper I). Finally, the overall landscape affected the way species responded to the structural arrangement of farmland. A typical true field bird such as skylark avoided non-cropped structures only in the most enclosed landscape, and most strongly favoured diversity of fields in the open landscape. If landscape complexity can compensate for biodiversity loss caused by local management intensity, as was suggested by Tschardt et al. (2005), then the addition of various non-cropped refugia within large fields plays a crucial role in wildlife support. Retention of such elements as ditches and small rivers needs special attention across all landscapes since they did not impair true field species. Establishment of high vertical elements such as hedges should be tailored only to generally open landscapes.

4.5. Shift in crop types (III)

One would expect changes in abundance of some species according to their preference for either winter or spring-sown crops, because the development of these crops and resource availability within them differ. The skylark is a particularly interesting model species. It was shown that in most of Europe winter cropping results in worsening of breeding and wintering conditions for this species (Donald & Vickery 2000). Finland, because of its northern position, seems to be an exception to the above relationship (Tiainen et al. 2001). Skylarks were shown to generally prefer fields under vegetation in early spring, be it grassland or winter cereal (Piha et al. 2005). Winter cereals never grow so high and dense as to impair the species' second breeding. Also, spring cereal in Finland is sown so late into spring that all nests in them tend to be ruined during the operation. In this study we could not find evidence of the species' discrimination between the two crop types across the region, which corroborates the finding from Poland (Fiona Sanderson, pers. comm.) It is plausible that the intensity of management of winter crop fields in eastern Europe is still low relative to that of western Europe, and hence the structure of winter crops does not impair breeding of skylarks. We

also could not detect a difference of cropping type preference between the northern and southern parts of the region. The results may be inconclusive because already now rye cultivation (up to now the main winter crop in the North) is uncommon in Estonia, and there were too few rye or other winter cereal fields in our random sample.

4.6. Intensity of crop management (II)

Our results indicate that an increase in intensity of management of fields in the region will trigger marked declines in the abundance of farmland specialist birds (II). In the more intensively managed areas we observed only half the species and individuals of non-farmland birds, and nearly 20% fewer species and individuals of farmland specialists, as compared to less intensively farmed areas.

When the difference in species richness or abundance between two areas pared by intensity of land-use within each country existed, its direction was always consistently in favour of the less intensive area (Fig. 6). Intensity level remained a highly significant predictor in most of the models after habitat differences between the areas were controlled for by inclusion of habitat covariates. The initial difference in the number of species and individuals was the lowest for true field species (about 20%). However, this was the only ecological group for which, once the habitat was controlled for, the significance of the intensity level increased in the final model. Although true field species avoid edge habitats and scrub, both of which were more characteristic for the less intensive areas, they were nonetheless more abundant in these areas. Once the adverse effect of the habitat structure was removed statistically, the less intensive areas appeared even more attractive to species in this group. It is plausible that lower intensity of field management with associated higher crop variety and margin density were the main reasons for this.

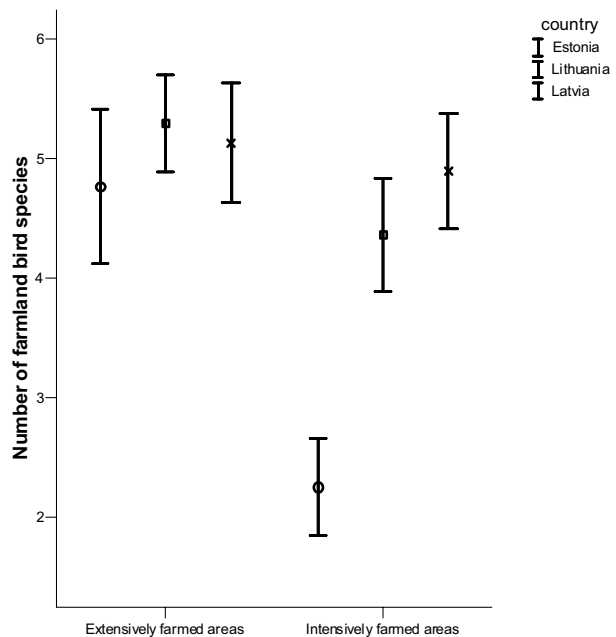


Figure 6. Abundance of farmland specialist birds (mean and SE) agricultural areas under extensive and intensive farming in the Baltic states of Estonia, Lithuania and Latvia.

To rule out the influence of habitat structure and composition on a field level, we studied arable fields within a structurally simple landscape. A tangible negative effect of intensity of field management on community characteristics, especially the abundance of birds, was also detected there (Fig. 7). In fields under more intensive management (with dense even crops, tramlines, and without weeds) we registered about 50% less individuals of farmland birds as compared to fields characterised by lack of regular management. Sampling points in the less intensively farmed fields were associated with a higher degree of field variety (mainly grasslands and abandoned fields) and with the presence of roads and ditches as field dividing borders - that is, higher in-field (crop variety) and in-crop (patchiness) heterogeneity. Edge bird species were most vulnerable to the increased “neatness” of fields and dominance of cereals. The effect size was the smallest for true field birds. The level of intensity in 2002 of even the most intensively managed fields may not have been high enough to greatly reduce abundance of this group.

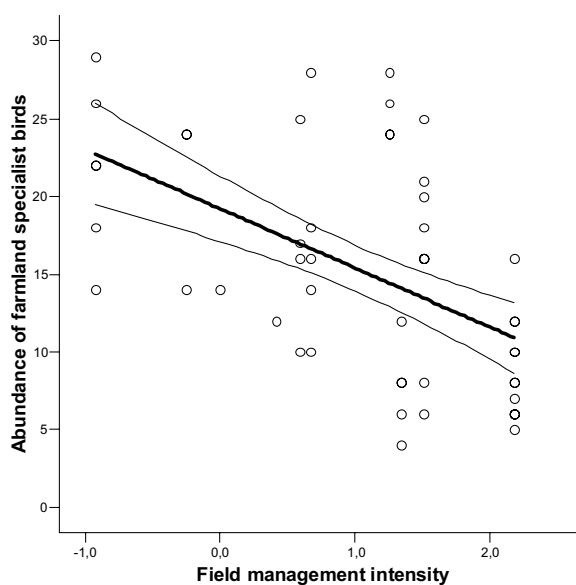


Figure 7. Relationship between abundance of farmland specialist birds (mean and CI of 95%) and the gradient of management intensity of arable fields based on field assessment of weed abundance, crop structure, and presence of tramlines.

4.7. Farmers’ awareness and attitudes (IV)

Over 20% of Estonian and Finnish farmers viewed biodiversity from a narrow perspective, limiting it to only the variety of crops and wild species outside the crops (Table 3 in paper IV). The perception of wild species diversity was most relevant to the farmers, while diversity of ecosystems and genes was less so. Nearly 70% of the farmers avoided explicit inclusion of pests and weeds into the “biodiversity” concept. This may impair acceptance of the agri-environment schemes having “biodiversity enhancement” as their main target.

When asked to name wild species whose disappearance from their farm they would feel as a “personal loss”, Finnish farmers expressed a higher level of concern about the decline in common farmland species than did Estonian ones. For Estonian farmers the question appeared difficult to answer and about 40% did not answer it at all. A further 20% of Estonians said no species would be

for them a personal loss, and only 40% disliked wildlife species disappearing in general and would miss some (examples named were: hare (*Lepus europeus*), moose (*Alces alces*), swallow (*Hirundo rustica*), skylark, starling, and black grouse (*Tetrao tetrix*). Contrasting with this, as many as 74% of the Finnish farmers felt strongly about the potential disappearance of wildlife species on their farms, while the rest did not answer the question. Only one Finnish farmer answered that "the world is changing all the time, and why should I worry". Most Finnish farmers could also provide examples of species they felt as particularly close to them; of these 64% were birds, 16% plants, 16% mammals, and 7% invertebrates. Starling, swallow, house martin (*Delichon urbica*), lapwing, curlew, and partridge dominated the answers. All of these are common farmland birds which have been strongly declining or have already disappeared from some of the Finnish countryside (Pitkänen and Tiainen 2001). Finnish farmers, being witnesses of current declines in formerly common birds, expressed personal attachment to many such species. The situation is quite different in Estonia, where most farmland birds are still common and abundant. The passive response of Estonian farmers does not necessarily indicate lack of interest (as results below demonstrate), but rather difficulty in apprehending the scale of potential losses driven by modern farming (see also below). Both the above mentioned points suggest that at least some agri-environment prescriptions may find higher uptake among farmers if, rather than promoting "biodiversity" in general, they are tailored to certain farmland species, about which farmers feel positive and are tailored the experience of farmers.

In both countries farmers rated intensification of agriculture as the major driving force behind farmland bird declines (Table 4 in paper IV). However, nearly 40% of farmers also looked for reasons elsewhere. Farmers in Finland rated afforestation, increase of predators, land abandonment, agricultural intensification, and loss of crop diversity as having a significantly stronger effect than did farmers in Estonia. There is an obvious need in awareness work in eastern Europe on likely wildlife declines caused by modernised farming practices.

All but three farmers expressed interest in preserving and enhancing habitat variety for wildlife on their farms. They were particularly willing to preserve and maintain wide margins, tree groups, old trees, areas of shrubs, and semi-natural grasslands. Most farmers were willing to continue without monetary compensation with such low-cost and, above all, traditional measures of supporting birdlife as winter feeding, putting up nestboxes, and also avoiding destruction of ground nests. However, farmers mostly required reimbursement for changes in the farm-area structure such as planting of hedges as well as modifications in customary farming practices such as reducing chemical applications. These measures also gained least interest in uptake.

Almost all farmers (over 90%) from both countries showed considerable interest in the wildlife on their farms, which positively correlated with their willingness to undertake wildlife-friendly measures. This result may seem contradictory with the passive response of Estonian farmers to provide examples of personally important species. However, it may also reinforce a conclusion that, while Estonian farmers are generally positive for wildlife, the issue of common farmland species disappearing is too abstract for them at times when these species are common and abundant.

Though about 80% of the interviewed farmers in both countries regarded conservation work as important on their farm, only 30% of them could clearly name some biodiversity-benign on-farm practices. They quoted almost exclusively management options supported under the countries' respective agri-environment programmes as ways to enhance biodiversity. Thus participation in agri-environment schemes targeted specifically at biodiversity enhancement is potentially an important learning tool about practical on-farm activities favouring wildlife. The fact that up to 94% of Finnish farmers are enrolled into the national agri-environment programme cannot be regarded as an indicator of the programme's efficiency in addressing conservation needs. We could not find indications that the programme, though in use since 1995, has added to farmers' understanding of farmland biodiversity or practical measures to enhance it, as compared to that of the farmers in Estonia. This is because only 12% of the funds was spent on schemes directly related to biodiversity enhancement (Kuussaari et al. 2004). A better incorporation of conservation-oriented options into the basic level schemes is clearly needed as suggested also by the programme evaluation (Kuussaari et al. 2004). The high willingness to enhance wildlife through agri-environment management showed by Estonian farmers is a good prerequisite for better incorporation of conservation measures into the recently established agri-environment programme. Currently, only about 6% of the agri-environment funding is allocated to the measures aimed at conservation and several schemes were discontinued in 2004 for lack of funds (Anonymous 2004, 2005).

5. Conclusions and recommendations

In this study the differences in crop yields between areas paired by land-use intensity were about 30%. In 2002, when the study was carried out, yields even in the most productive cereal zone were still one third of those possible by the standards of western European agriculture. The available statistical data show a further average increase for the Baltic countries of about half a tonne per hectare (or 25%) over the period 2003-2005 (FAOSTAT 2006). Further tripling of cereal yields across the region is possible if the respective yields for the EU-15 countries are to be reached: up to five tonnes on average in Estonia, and up to eight for Southern Latvia and Lithuania. Though high average yield levels are unlikely to be achieved over the whole region, this rate of increase is plausible for the most productive cereal growing areas, with which many typical true field species associate. Intensification of agricultural land-use in the Baltic region is likely to result in massive declines in farmland birds. This will undoubtedly impair the achievement of the Göteborg target of halting biodiversity decline in the EU by 2010 (Presidency Conclusions 2001).

Agricultural intensification affects bird communities by changing habitat composition (**III**) and structure (**I**), both leading to habitat simplification from landscape to in-crop levels, and by increasing intensity of crop management (**II**). An adverse impact of intensive management of crops is unlikely to be entirely mitigated by farmland complexity for all bird ecological groups (**II**), unless it is supported at all levels, from landscape to in-crop. Maximising heterogeneity of farmland at the landscape level with other habitats, such as forest, or high vertical elements such as hedges, will adversely affect specialised and often endangered field species, especially in already fragmented landscapes. At the same time, higher heterogeneity within farmland (low vertical structures such as grassy margins and ditches, variety of crops) and within crops (their patchiness, presence of weeds) will benefit all species. If similar factors operate in the Baltics as they do in western European

countries, both retention of farmland heterogeneity at all scales and maintenance of a network of extensively managed areas will be crucial aspects of farmland biodiversity preservation in the long run.

Based on this work, I suggest the following framework for securing the future of farmland bird populations in the region, to which several policy elements contribute (Table 5):

- i) Most importantly of all, an extensive network of the biologically particularly valuable semi-natural grasslands should be maintained across the whole Baltic region. Later restoration of such grasslands has proved difficult and uncertain (Kleijn et al. 2001). Conversion of such semi-natural grasslands into arable crops should be prohibited under cross-compliance, and sufficient management should be imposed to prevent their overgrowing under agri-environment support schemes. The latter should be targeted at the typical plant and bird communities, and endangered species, and their management should be explicitly tailored to the species needs, rather than be compromised by, for example, fodder quality.
- ii) A certain share of the currently abandoned fields should be maintained as conservation set-asides, especially in the most productive crop dominated parts of the region. This could be part of a cross-compliance regime similar to the EU set-aside requirement of 10%, which does not extend into the CEECs. Under the current conditions in the Baltic region even a higher and more ecologically plausible target of 20% is achievable. Other abandoned fields can be converted into forests, which are a characteristic habitat type of the Baltic region.
- iii) Agriculturally productive but biologically less valuable fields should be the subject of well-developed cross-compliance measures, and eligible for so-called shallow agri-environment schemes (AES). These will be particularly important for the enhancement of common species of birds and other wildlife, which are important for ecosystem services such as pollination and biological pest control. The cross-compliance policy should include above all requirements for retention of open ditches and small rivers with wide grassy buffer zones, as well as other non-cropped habitat elements, a minimum crop rotation, and a restriction on chemical inputs. The AES should include, for example, support to farmers who already achieve a high score of “crop heterogeneity”, “non-cropped habitat richness” or high length of grassy margins per hectare of their farmed land. Farmers whose fields fall far below the target scores should be encouraged to recreate it under cross-compliance. The above targets can be assigned regionally depending on landscape character - current and historical - and based on a “smallest economically justifiable size” of field allotment. A higher premium for keeping cattle in otherwise cereal-dominated regions is justified ecologically though may not be popular politically. Finally, AES should include possibilities for a voluntarily modified disturbance of fields (e.g. cutting dates or rates) to take into account needs of widespread vulnerable species.
- iv) Protection of whole rural landscapes of particularly high biological and aesthetic value, such as riverside valleys, should be targeted by the regional rural development plans as part of the EU’s Natura2000 network.

- v) More demanding conservation-oriented agri-environment schemes may work better if linked explicitly to the support of specific species, which farmers themselves know well and feel positive about, rather than to the abstract concept of “biodiversity”. Bird species, the decline of which was considered as a “personal loss” in our study, may become potential candidates for similar schemes in Finland and Estonia.

The agri-environment programmes aimed at conservation of wildlife on fields under ever increasing management intensity should not only provide a variety of management options that are most likely to deliver a conservation target, be attractive to farmers, and be tailored to regional priorities, but also need to be backed by sufficient funding. There are signs that most of the CEE countries are currently failing to achieving conservation targets through insufficient funding of national AEPs, selection of unsophisticated schemes of little benefit to birds and the environment, and lack of advisory services or political will to improve the situation (BirdLife International 2006).

A profound change in defining “yield” within the framework of “multifunctional agriculture” is needed in order for conservation policies of agricultural land to be successful. This study demonstrates that the farming community is highly interested in supporting wildlife (**IV**), especially well known and conspicuous species such as birds. However, there is a lack of understanding of biodiversity as a policy target and the ways to translate it into practice. The potentially severe impact of intensification is not appreciated. Finally, farmers will continue to resist changes in farming operations as long as yields are measured exclusively in tonnes of grain. This stresses the need for substantial awareness work on biodiversity aspects among farmers in the region. Though not researched here, I expect that similar shortfalls in understanding biodiversity as a policy target and as a legitimate part of an overall agricultural “yield” are characteristic also of policy-makers in the region.

Table 5. Directions of change in farmland bird communities following the scenarios of agricultural development in the Baltic states, and policy measures required in order to mitigate adverse impacts of intensification, as foreseen by this study. In bold are measures already in place in at least one of the Baltic country.

Development	Response in bird community	Necessary measures	Policy instruments
Reduction in farmland area	Decrease in true field species; Initial increase in edge species and species other than farmland; Succession to the forest community	Prevention of abandonment of the most biologically valuable semi-natural grasslands (all countries)	AES targeted at typical species, and communities within Natura 2000
Increase in arable farming and reduction in grasslands	Reduction in total and farmland bird species richness, especially in the region's part already dominated by cereal production; Some true field species will benefit, especially in the region's most southern and northern parts, until introduction of intensive crop production; Endangerment of species associated with semi-natural grasslands;	Retention of a minimum of 10-20% of abandoned fields as conservation set-asides, especially in cereal dominated areas; A set of measures designed for arable fields	Cross-compliance AES
Loss of non-cropped habitats	Decrease in numbers of farmland species benefiting from mixed farming, and of the edge ecogroup Decrease in species from all ecogroups except true field species	Requirements of wildlife will need to be explicitly incorporated into management prescriptions (e.g. mowing after 1 st August) Same as above for the most valuable sites Organic farming (all); Higher support for cattle rearing in the region's part dominated by cereal production; Retention and maintenance of the non-cropped habitats, including ditches (a volunteer measure under AEP, all) Subdivision of large cropping units (e.g. above 30 ha by mid-field grassy strips (only in Estonia) ;	Same as above AES AES, policy should be tailored to regional needs Cross-compliance Cross-compliance or AES, policy should be tailored

				to regional needs AES
			Retention of mid-field diversity in crop conditions (water-logged or dry patches); Grassy margins around fields (all)	Good Farming Practice
Shift in crop types	Inconclusive from our data			
Reduction in crop diversity species	Decrease in ecogroups of true field and tree/forest		Requirement of a minimum crop-rotation;	Cross-compliance
		Further encouragement of diverse crop rotations, including crop types specifically valuable for wildlife;		AES
Increase in intensity of crop management	Decrease in all farmland species, especially edge and true field birds	Restriction on inputs, esp. in ecologically sensitive areas (all under AEP) ;		Cross-compliance
		Further volunteer restriction on inputs		AES
		Retention of (a certain %) non intensively managed fields as conservation set-asides		Cross-compliance or AES

Acknowledgements

This work would not have materialised had fate not brought me all the way from the Black Sea coast of Ukraine to the Baltic coast of Finland. Having found myself on new ground I needed new challenges, so my husband – the “culprit” of my moving to Finland – suggested I pursue a doctorate degree.

It took six years. Six years of intensive learning and thinking, enjoyable meetings and discussions with people in the field, frustrations and small personal “Eureka”s. One of the main lessons I learnt on the way was that science these days is a communal process. I certainly would not have succeeded if not for the input of others who helped me with advice, assistance, encouragement, and direct collaboration. To these people a heartfelt thank-you! Jari Niemelä and Hannu Pietiäinen gave me the very first encouragement when I applied to the Department of (then) Population Ecology and Systematics, and more than once supported me with recommendations to funding bodies. The subject of my thesis was born in talks with our good Latvian friend and colleague Māris Strazds. Due to him I fell in complete love with the Latvian countryside, its nature and people. My interest and admiration later extended to the countryside of all Europe and indeed the World. This evolution in thinking and emotion has been happening with the constant support of my Finnish supervisors Juha Helenius (from my new “home” at the Department of Applied Biology) and Juha Tiainen (Finnish Game and Fisheries Research Institute), both of whom instilled in me their love for farmstead culture and environment. I was really lucky from the beginning to meet Paul Donald from the Royal Society for the Protection of Birds, UK. He kindly agreed to supervise my work, a generous decision considering Paul’s numerous projects all over the world. Perhaps Finland was an exotic addition to his working sites from Cape Verde to Kazakhstan and Myanmar!

I was not on my own when developing the research tasks, approaches and methods. Many people from several countries eagerly shared their experience with me: Rauno Yrjölä, Timo Pakkala, and Terho Hyvönen (Finland), Bo Petersen (Denmark), Ainārs Auninš and Jānis Priednieks (Latvia), Petras Kurlavičius and Zydrunas Preikša (Lithuania), Jaanus Elts (Estonia). I certainly would not have progressed much without generous financial support from the Maj and Tor Nessling Foundation, who paid for the fieldwork and my first scholarship. The Kemira Foundation (Finland) supported me on a later stage. The thorough work of fieldworkers across the Baltic countries was a prerequisite for a successful research outcome. I strongly relied on the organising help of Ainārs, Jaanus, and Zydrunas. Advice from Bob O’Hara - undoubtedly, the most generous statistician on earth – was invaluable at first stages of analysis and writing. Critical revisions of my manuscripts by Fiona Sanderson (UK) are also deeply appreciated. Comments from my research group Fabio (=Farmland Biodiversity) helped me to better concentrate on one task at a time, whether a piece of writing or a game of badminton. Thank you, Sanna, Ma, Jan-Peter, Sini, Reija, and Paul! Becoming a volunteer in BirdLife’s Agricultural Task Force may have delayed my graduation but was rewarding in other ways. Dedicated people from all round Europe working in it kept my research in perspective of real life conservation tasks.

No doubt the happiest hours of all the thesis work were spent in the field counting birds around Finnish, Estonian, and Latvian countryside³. A Finnish group of “farmland bird-boys” –Ville (Vepsäläinen), Markus (Piha), Jukka (Rintala), Jyrki (Holopainen), Jarmo (Piironen), Johan (Ekroos) - kept me amused and inspired with their utter devotion to flying creatures. Thank you for a many shared ice-creams at 2 am! When observing birds in fields I kept thinking about people who actually own and manage those fields, and make their living from them, that is, The Farmers. What did they have to say about skylarks? This thought led me

³ For those readers who study plants or do theoretical modelling: in Finland in June you start at 3 am and go on till 1 pm, or until you drop!

into the new world of sociology: new ways of thinking, perceiving and assessing information, and relating it to the real world. It was a most useful experience that helped me to realise how difficult it is to transfer conservation reasoning beyond ecology. For professional advice, encouragement, and practical help in this new field I thank Natalia de Lance-Holmes (UK), Minna Kaljonen and Kimmo Härjämäki (Finland), Merit Mikk and Argo Peepson (Estonia). The Ella and Georg Ehrnrooth Foundation helped me financially.

My dear friends in this far-away country – Asta, Irina, Traci, Sari, and Virpi - have been helping me to survive the twin frustrations of research and the northern winter. At times of “no-progress” Asta kept reminding me of my three other dissertations: my three sons. To them – without whose constant help and attention this thesis would have been made in half the time - I am grateful for reminding me of the simple pleasures of living for the moment. I would not have achieved what I have without the unwavering support of my family: my parents, my sister, my brother-in-law, and my mother-in-law. This thesis became a real family undertaking! And last but certainly not the least, I thank Marcus, my loyal partner-in-life, who supported me in every possible way: providing ideas and comments, working in the field and correcting manuscripts, encouraging and even, at times, leaving me well alone!

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