A comparative study of bird faunas in conventionally and organically farmed areas

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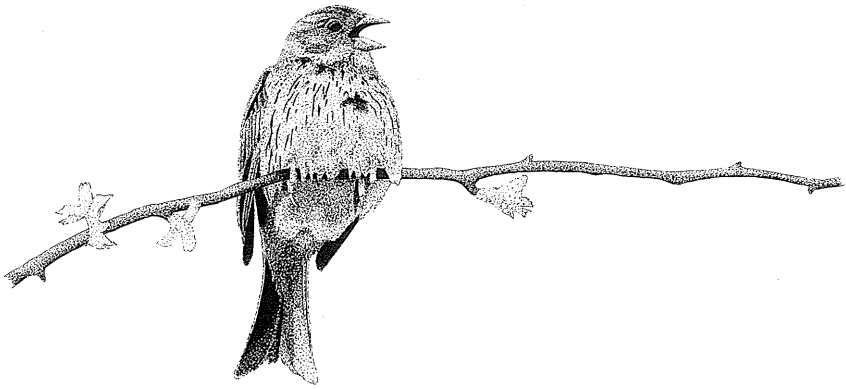

(Med et dansk resumé: Sammenlignende undersøgelser af fuglefaunaen på konventionelle og økologiske landbrug)

Introduction

The breeding populations of a number of bird species in the West European farmland have declined through the last decades (Marchant et al. 1990, Petersen & Nøhr 1991). This development is probably linked to the intensified agricultural practices. The major changes have been a general reduction in crop diversity, an increase in average field size, simplified rotational practices, cultivation of natural habitats, drainage, and increasing use of fertilizers and pesticides (O'Connor & Shrubb 1986).

In Denmark the pesticide-spraying frequencies more than doubled in the period 1975-1987 (Fig. 1). Pesticides may affect the bird fauna directly, increasing mortality or changing behaviour such as parental care or territorial defence (Grue et al. 1982, Busby et al. 1990). Pesticides may also have an indirect effect by reducing the food availability for birds (Potts 1986, Pascual & Perris 1992, Odderskær & Sell 1993).

In an attempt to distinguish between general changes in farmland ecosystems and more specific, field-related changes (e.g. the effect of pesticide use) as causes of the observed population declines, a four-year research programme was initiated in 1984 by the Danish Ministry of Environment. This paper summarizes the results of a study within the framework of this programme, carried out during 1984-87 for the Danish National Agency of Environmental Protection (Braae et al. 1988). The work is linked to an investigation by Hald & Reddersen (1990), dealing with the amount of available food in the same agricultural areas described in the present paper.

Material and methods

The bird faunas were investigated during four years, 1984-87, mainly by point count censuses. Two of the organic farms and their reference (conventional) farms were also investigated by territory mapping.

Study sites

A total of 31 organic farms distributed over most of Denmark were used in the investigation. The size of the farms varied between 10 and 96 ha (mean 31 ha). The minimum size of 10 ha was chosen to minimize the influence from surround-

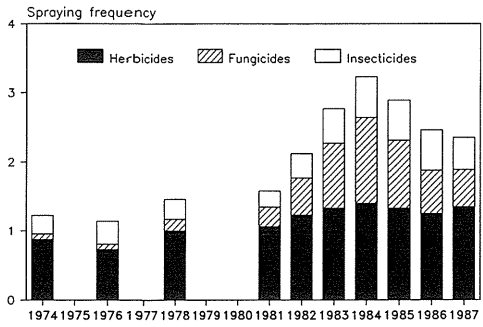

Fig. 1. Use of pesticides in the Danish farmland, 1974-1987. The spraying frequencies (number of sprayings per year) are estimated from the amounts sold and represent averages for all crops.
Behandlingshyppigheder med bekæmpelsesmidler, 1974-87.

ing conventionally treated areas. The selection of census points required that linear dimensions of the farmed areas were at least 200 m in any direction; generally, census points were at least 300 m apart, in order to minimize double observations of the same individuals.

For each census point in an organically farmed area a reference point in a conventionally farmed area was selected. To ensure uniformity in the geographical conditions, the reference point was placed as near as possible to the corresponding census point. However, to avoid registration of birds from the organically farmed areas, no reference points were placed nearer than 500 m from the organically farmed area. Ideally, the reference points should correspond closely to the organic census points in all respects, except for conditions directly deriving from the agricultural practice (organic vs conventional). The degree of point-to-point match in habitat structure was measured by use of 104 habitat factors recorded within a radius of 200 m from each census or reference point. Since complete uniformity in all habitat factors would obviously not be possible, the effort was directed towards getting uniformity in habitat factors believed to be particularly important for the distribution of birds:

- The amount of other habitats than agricultural areas (e.g. forests and bogs)
- Length and type of hedgerows
- Presence of buildings
- Crop composition, with special attention to the occurrence of winter green-fields and permanent grassland.

For each of the chosen habitat factors the differ-

Tab. 1. Proportion of point pairs (percentage of total) with a certain difference in occurrence of various habitats within 200 m (buildings: 500 m) of the organically farmed census points and their corresponding conventionally farmed census points.
Forskel i forekomst af forskellige biotoper på de økologiske punkter og deres referencepunkter (se også teksten).

Habitat	Habitat not present	Difference in occurrence (%)			
		0-10	11-25	26-50	>50
Farmland *Agerland*	0	77	12	7	4
Winter green fields *Vintergrønne marker*	2	25	17	34	22
Deciduous wood *Løvskov*	68	27	4	1	0
Meadow *Eng*	75	11	7	5	2
Coniferous wood *Nåleskov*	81	15	4	0	0
Lake *Sø*	83	13	3	1	0
Marsh *Mose*	85	11	3	1	0
Urban areas *Byområder*	91	9	0	0	0

		Difference in lenght (m)				
		0-50	51-100	101-200	201-500	>500
Hedgerows *Levende hegn*	15	27	16	20	17	5
		Difference in distance (m)				
		0-50	51-100	101-200	201-500	
Buildings *Bygninger*	50	34	3	10	3	

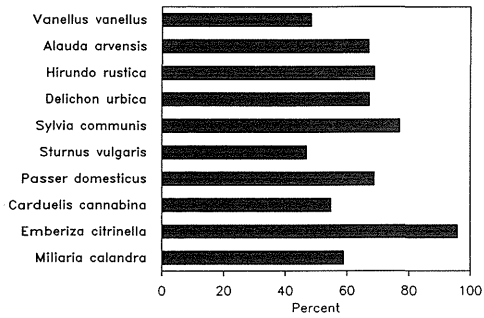

Fig. 2. Densities of 10 common Danish farmland species in conventionally farmed areas, expressed as percentages of the densities in organically farmed areas.
Tætheder (fugle pr punkt) af 10 almindelige danske agerlandsfugle i konventionelt dyrket agerland, udtrykt som procent af tætheden i økologisk dyrket agerland.

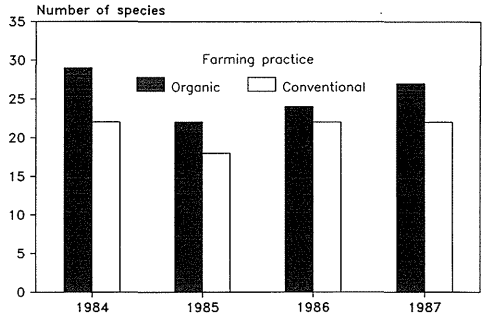

Fig. 3. Number of species found breeding during the mapping censuses on the organic farm Glimsholt and the corresponding conventional farm.
Antal arter fundet ynglende under kortlægningsoptællinger på det økologiske landbrug Glimsholt og på det tilsvarende konventionelt drevne landbrug.

ence in occurrence between the two members of a point pair was calculated (Tab. 1). An example will clarify the meaning of the table. For 68% of the point pairs deciduous forest did not occur within 200 m, neither around the organically nor the conventionally farmed census point. For the remaining 32% of the point pairs, deciduous forest did occur around one or both census points, covering proportions of the areas that differed by at most 10% in 27% of the point pairs, by 11-25% in 4% of the pairs, and by 26-50% in 1% of the pairs.

In the first year of investigation the census/reference point pairs were also chosen so as to exhibit a high degree of similarity in crop composition. However, due to crop rotation during the study years it was not possible to retain the same high degree of similarity during all four years. For practical reasons, however, it was decided to keep the same reference points throughout the study.

Point count censuses

On each farm up to eight censuses were carried out from 15 April to 15 June in each study year. The order in which the organically farmed points and the reference points were censused alternated from census to census. All bird species seen or heard from a census point during a period of 5 minutes were recorded as described by Blondel & Frochot (1970). The unit used for statistical analysis was the mean number recorded per census of each species, census point and year. The main analysis of data was a pairwise comparison between the number of birds found on corresponding organic and conventional census points. Test of significance was made using Wilcoxon matched-pairs signed-ranks test (e.g. Siegel 1956).

Territory mapping censuses

Territory mapping, based on Enemar (1959), was carried out on two organical farms (Glimsholt 40 km west of Copenhagen (55 ha), and Sjællands Odde in Northwest Zealand (61 ha)), and their respective reference census areas (56 ha and 64 ha, respectively). The farms were visited 5-8 times each year during the breeding season. All birds showing territorial behaviour were marked on field maps, and three or more records of a given species in the same territory and season were considered to indicate a breeding pair.

Results

A total of 145 bird species were recorded at the point count censuses during the four years of investigation; 92 of the species were recorded in numbers sufficient for a Wilcoxon matched pairs test to be carried out. The occurrence of 34 species differed significantly between organically and conventionally farmed areas (Tab. 2, Fig. 2). The majority (31 species) were more abundant in organically farmed land; only three species, Oystercatcher, Thrush Nightingale, and Reed Warbler were more abundant in conventionally farmed areas.

The results of the territory mapping censuses at Glimsholt – the most thoroughly studied organic farm – are shown in Tab. 3. The number of breeding species in the conventionally farmed areas during the four years were 76-92% (average 83%) of the number of species found in organically farmed areas (Fig. 3). The bird population densities (all species combined) in conventionally farmed land were only 38-52% (average 43%) of

Tab. 2. Occurrence of birds (point counts) in organic and conventional farmland, 1984-1987 (all species occurring at more than 10% of the count points, or showing significant differences between farmland types). Levels of significance (Wilcoxon test): * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.
Forekomster af fugle (punkttællinger) i økologiske og konventionelle landbrugsområder, 1984-87. De første to kolonner viser antallet af punkter med den pågældende art på konventionelle hhv. økologiske brug. De næste to kolonner viser tilsvarende antallet af individer.

	Number of points		Number of birds		
	conven.	organic	conven.	organic	
Grey Heron *Ardea cinera*	31	37	47	55	
Shelduck *Tadorna tadorna*	80	88	371	484	
Mallard *Anas platyrhynchos*	68	72	205	177	
Buzzard *Buteo buteo*	29	38	33	56	*
Kestrel *Falco tinnunculus*	16	30	22	45	*
Pheasant *Phasianus colchicus*	209	212	934	966	
Oystercatcher *Haematopus ostralegus*	83	70	307	211	**
Lapwing *Vanellus vanellus*	157	178	1229	2537	***
Common Snipe *Gallinago gallinago*	4	14	5	21	*
Black-headed Gull *Larus ridibundus*	202	232	3989	7049	***
Common Gull *L. canus*	129	141	1164	2129	***
Herring Gull *L. argentatus*	116	142	931	1155	**
Woodpigeon *Columba palumbus*	209	241	1357	2160	***
Collared Dove *Streptopelia decaocto*	27	29	49	35	
Cuckoo *Cuculus canorus*	145	174	325	341	
Swift *Apus apus*	44	50	242	172	
Skylark *Alauda arvensis*	267	267	5704	8508	***
Sand Martin *Riparia riparia*	27	39	111	158	
Swallow *Hirundo rustica*	226	233	1547	2243	***
House Martin *Delichon urbica*	80	96	540	802	
Tree Pipit *Anthus trivialis*	54	68	153	300	***
Meadow Pipit *A. pratensis*	89	114	611	907	*
Yellow Wagtail *Motacilla flava*	46	61	322	423	
White Wagtail *M. alba*	117	119	261	326	
Wren *Troglodytes troglodytes*	21	31	30	84	***
Dunnock *Prunella modularis*	60	59	124	108	
Thrush Nightingale *Luscinia luscinia*	51	52	128	86	*
Whinchat *Saxicola rubetra*	31	41	45	83	*
Blackbird *Turdus merula*	228	232	958	1082	*
Fieldfare *T. pilaris*	18	36	191	892	**
Song Thrush *T. philomelos*	64	78	143	216	**
Redwing *T. iliacus*	3	6	7	63	*
Marsh Warbler *Acrocephalus palustris*	26	40	40	62	
Reed Warbler *A. scirpaceus*	27	15	49	25	**
Icterine Warbler *Hippolais icterina*	51	60	81	104	
Lesser Whitethroat *Sylvia curruca*	55	56	91	116	
Whitethroat *S. communis*	202	214	692	898	***
Garden Warbler *S. borin*	58	81	96	151	**
Blackcap *S. atricapilla*	42	58	83	128	**
Willow Warbler *Phylloscopus trochilus*	127	127	443	505	
Pied Flycatcher *Ficedula hypoleuca*	5	13	5	16	*
Blue Tit *Parus caeruleus*	32	58	60	112	**
Great Tit *P. major*	149	161	413	530	**
Magpie *Pica pica*	106	104	278	304	
Jackdaw *Corvus monedula*	96	92	483	980	*
Rook *C. frugilegus*	101	98	2076	2278	
Crow *C. corone*	205	209	1191	1428	***
Starling *Sturnus vulgaris*	200	233	1974	4209	***
House Sparrow *Passer domesticus*	87	81	558	811	
Tree Sparrow *P. montanus*	96	95	504	653	
Chaffinch *Fringilla coelebs*	210	200	1511	1895	
Brambling *F. montifringilla*	7	19	13	396	***
Greenfinch *Carduelis chloris*	84	95	202	297	*
Linnet *C. cannabina*	148	161	608	1110	**
Yellowhammer *Emberiza citrinella*	178	164	1147	1197	
Reed Bunting *E. schoeniclus*	40	35	125	151	
Corn Bunting *Miliaria calandra*	89	113	315	535	***

the densities found in organically farmed land (Fig. 4, Tab. 3). Lower densities in conventional farmland were recorded in 14-18 species, while in six species there was an opposite tendency. However, all the species of the last mentioned group were uncommon, and none showed the same tendency through all four years. All the abundant species (more than one breeding pair per 10 ha) bred in lower densities in the conventionally farmed areas throughout the study period (Tab. 3). The dominant species, the Skylark, had a breeding density in conventionally farmed areas of only 33-50% of the density in organically farmed areas (Fig. 5).

Discussion

For most habitat parameters there was a fairly high degree of similarity between the organically farmed census point and its corresponding conventionally farmed reference point (Tab. 1). One obvious exception concerns the occurrence of winter-green fields, but this was inevitable, since winter green fields are especially characteristic of the organic farming practice.

The lower bird densities in conventionally farmed areas compared with organically farmed areas, as shown by the mapping census data, suggest a higher ecological carrying capacity in the or-

Tab. 3. Mean population densities (pairs/10 ha) found by territory mapping censuses of breeding birds in organically (55 ha) and conventionally (56 ha) farmed land at Glimsholt, 1984-1987.
Resultatet af kortlægningsoptællingerne: gennemsnitlige bestandstætheder (ynglepar pr 10 ha) i økologisk (55 ha) og konventionelt (56 ha) dyrket agerland på Glimsholt, 1984-87.

	Conventional	Organic
Mallard *Anas platyrhynchos*	0.1	0.1
Partridge *Perdix perdix*	0.5	0.6
Pheasant *Phasianus colchicus*	0.5	0.5
Moorhen *Gallinula cholopus*	0.0	0.1
Lapwing *Vanellus vanellus*	0.3	1.2
Woodpigeon *Columba palumbus*	0.3	0.8
Collared Dove *Streptopelia decaocto*	0.1	0.1
Skylark *Alauda arvensis*	2.7	6.7
Swallow *Hirundo rustica*	0.1	0.3
White Wagtail *Motacilla alba*	0.2	0.1
Wren *Troglodytes troglodytes*	0.1	0.1
Dunnock *Prunella modularis*	0.3	0.3
Robin *Erithacus rubecula*	0.2	0.2
Thrush Nightingale *Luscinia luscinia*	0.2	0.1
Redstart *Phoenicurus phoenicurus*	0.1	0.2
Whinchat *Saxicola rubetra*	0.0	0.1
Blackbird *Turdus merula*	0.5	0.7
Song Thrush *T. philomelos*	0.0	0.1
Marsh Warbler *Acrocephalus palustris*	0.2	0.3
Icterine Warbler *Hippolais icterina*	0.2	0.1
Lesser Whitethroat *Sylvia curruca*	0.1	0.0
Whitethroat *S. communis*	0.7	1.4
Garden Warbler *S. borin*	0.2	0.2
Blackcap *S. atricapilla*	0.2	0.3
Willow Warbler *Phylloscopus trochilus*	0.5	0.4
Blue Tit *Parus caeruleus*	0.1	0.1
Great Tit *P. major*	0,2	0.2
Magpie *Pica pica*	0.0	0.1
Jackdaw *Corvus monedula*	0.1	0.1
Rook *C. frugilegus*	0.0	4.3
Crow *C. corone*	0.1	0.2
House Sparrow *Passer domesticus*	>0.4	>1.0
Tree Sparrow *P. montanus*	0.0	0.6
Chaffinch *Fringilla coelebs*	0.6	0.5
Greenfinch *Carduelis chloris*	0.3	0.1
Linnet *C. cannabina*	0.0	0.1
Hawfinch *Coccothraustes coccothraustes*	0.0	0.1
Yellowhammer *Emberiza citrinella*	0.6	0.6
Corn Bunting *Miliaria calandra*	0.0	0.4
Total	9.9	22.8

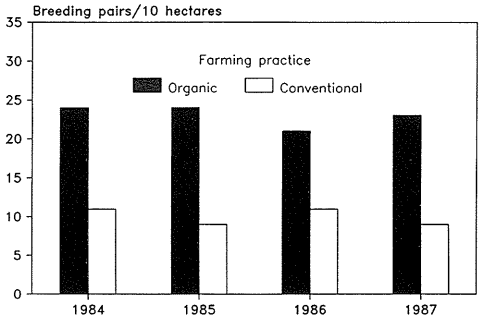

Fig. 4. Breeding densities (all species combined) recorded during the mapping censuses on the organical farm Glimsholt and the corresponding conventional farm.
Tætheder (ynglepar pr 10 ha) for alle arter under ét, registreret ved kortlægningsoptællinger på det økologisk drevne landbrug Glimsholt og det tilsvarende konventionelle landbrug.

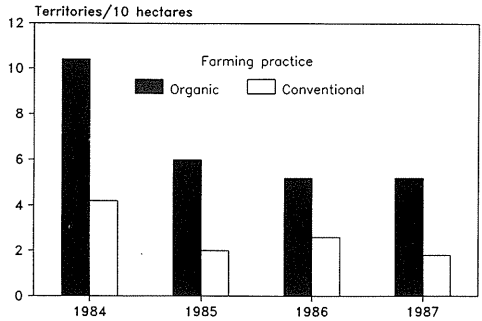

Fig. 5. Densities of Skylarks recorded during the mapping censuses on the organical farm Glimsholt and the corresponding conventional farm.
Tætheder (territorier pr 10 ha) af Sanglærker registreret ved kortlægningsoptællinger på det økologisk drevne landbrug Glimsholt og det tilsvarende konventionelle landbrug.

ganically farmed areas. The number of species, probably reflecting the diversity of ecological niches, was also lower in conventional farmland, but the difference was much less than the difference in density.

The results from the point count censuses were very clear: all common, characteristic farmland species (e.g., Lapwing, Skylark, Whitethroat, Corn Bunting) occurred with the highest frequencies in organically farmed areas, the difference between the two types of farmland often being statistically highly significant (Tab. 2). Species such as Fieldfare, Redwing, and Brambling, resting and feeding on the fields during their spring migration, also occurred with higher frequencies in the organically farmed areas.

The populations of most of the species displaying a higher abundance in the organically farmed areas have declined in Denmark during the years 1974-1987 (Jacobsen 1989): Buzzard,

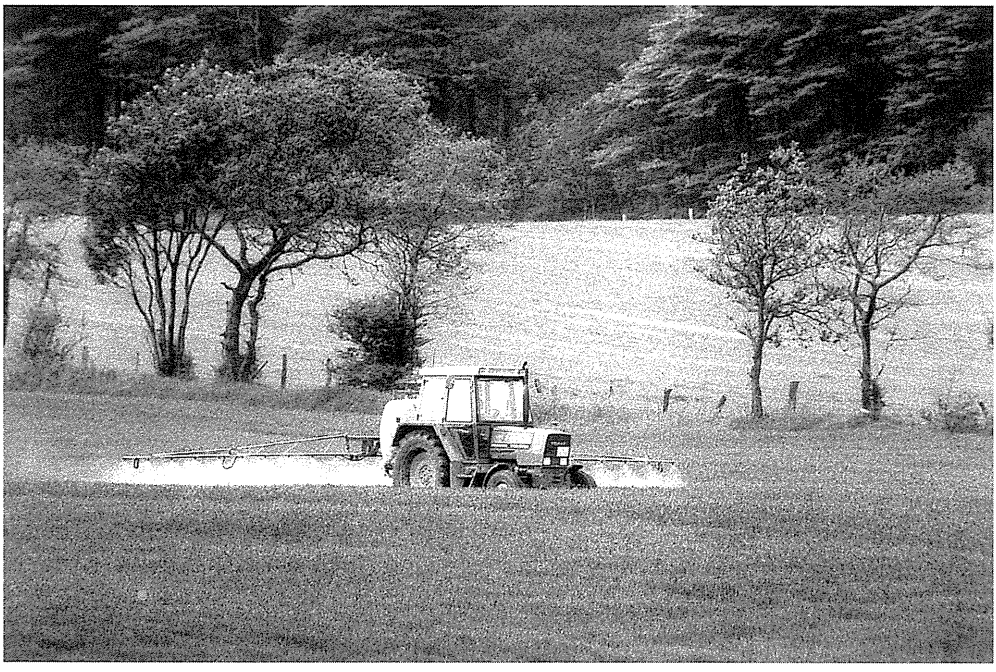

Foto: Lone Eg Nissen.

Kestrel, Lapwing, Common Gull, Herring Gull, Black-headed Gull, Skylark, Swallow, Reed Warbler, Icterine Warbler, Whitethroat, Dunnock, Starling, House Sparrow, Linnet, and Corn Bunting. On the other hand, most species occurring with similar frequencies in conventionally and organically farmed areas have increased during the same period: Mallard, Pheasant, Rook, Jackdaw, Magpie, Willow Warbler, White Wagtail, and Chaffinch. None of these can be characterized as typical farmland species.

Hald & Reddersen (1990) evaluated the food resources of some important arable land bird species. The study compared the flora and invertebrate fauna in organically vs conventionally farmed cereal fields, all of which were located on the larger of the farms already selected for the present study. By late June organic fields had 50-70% more species of wild plants than conventional fields, with significantly more weeds and higher biomass of wild plants. The differences increased markedly during the growth season due to herbicide treatments of the conventional areas. The average biomass of arthropods in the organic fields was significantly higher and more stable than in the conventional fields. The difference in predictability may be of greater importance to the birds than the difference in average biomass. These results, combined with the results of the present study, suggest that food availability is a key factor behind the reduced number of birds in the conventionally farmed areas, thereby supporting the assumption that the decline of several bird species in the Danish farmland is linked to the development of the modern, intensified farmland practice.

Other investigators have found a relationship between pesticide use and either a decrease in quality and amount of food available for birds in the conventionally farmed land (Green 1984, O'Connor & Shrubb 1986, Potts 1986, Rands 1986, Sotherton & Rands 1986), or a decreased breeding success of birds (Pascual & Perris 1992, Odderskær & Sell 1993).

Apart from such negative effects of pesticide use on the wild flora and fauna, farmland ecosystems will be influenced by other factors, such as change in field size, crop composition, rotational practice, and the use of fertilizers. However, more studies are needed before the effects of pesticides can be effectively separated from effects deriving from these additional changes in the arable land.

Resumé

Sammenlignende undersøgelser af fuglefaunaen på konventionelle og økologiske landbrug

En række fuglearter med særlig tilknytning til agerlandet har udvist markante bestandsnedgange siden midten af 1970erne, både i Danmark og i det meste af det øvrige

Foto: Lone Eg Nissen.

Vesteuropa. Det har været nærliggende at sætte disse bestandsnedgange i forbindelse med den stadig mere intensive udnyttelse af det dyrkede land.

I den foreliggende artikel refereres resultaterne fra en undersøgelse, Miljøstyrelsen i 1984-87 lod udføre som et led i en samlet udredning af den moderne landbrugsdrifts indflydelse på den vilde flora og fauna (Braae et al. 1988). Ved at sammenligne fuglefaunaen i økologisk og konventionelt dyrket agerland fokuseres der bl.a. på den indflydelse, anvendelsen af bekæmpelsesmidler (herbicider, fungicider, insekticider) har på fuglelivet.

En anden undersøgelse, foretaget på de samme landbrug, vurderede fødegrundlaget for fuglene, dvs. mængden af hvirvelløse dyr og vilde planter, i de to dyrkningssystemer (Hald & Reddersen 1990).

Som standardiseret optællingsmetode er anvendt punkttællingsmetoden. Til undersøgelsen udvalgtes 31 økologiske/biodynamiske landbrug over det meste af landet. For hvert optællingspunkt her blev der valgt et referencepunkt i et nærliggende konventionelt dyrket område, hvor landskabet inden for en radius af 200 meter så vidt muligt svarede til det økologiske optællingspunkts omgivelser med hensyn til f.eks. indslag af andre biotoper og forekomst af levende hegn (Tab. 1).

Punkttællingerne blev i to af områderne suppleret med kortlægningsoptællinger, hvor ynglebestandene på såvel det økologiske som det konventionelle brug blev registreret.

Der viste sig at være betydeligt flere fugle i økologisk dyrkede agerlandsområder end i konventionelle. I alt 34 arter havde signifikant forskellig forekomst i økologiske og konventionelle områder, og af disse var 31 hyppigst på de økologiske brug. De tre arter, der var hyppigst i konventionelle områder, var alle arter, hvis forekomst i agerlandet er sekundær.

Kortlægningsoptællingerne viste, at bestandstæthederne i de konventionelle områder kun var 38-52% af tæthederne i de tilsvarende økologiske områder, og illustrerer således tydeligt den større bæreevne i de økologisk dyrkede områder.

Disse resultater sandsynliggør, at brugen af bekæmpelsesmidler er en vigtig årsag til forskellene mellem de økologisk og konventionelt dyrkede områders fuglefauna. Bekæmpelsesmidlernes effekt ser især ud til at være en forringelse af fødegrundlaget, dvs. at det er miljøets bæreevne, der nedsættes. Det ses af Hald & Reddersens (1990) undersøgelse af 21 økologiske og 17 konventionelle landbrug, der viste, at der var over 50% flere plantearter på økologisk dyrkede marker, ligesom der var flere dyrearter her. Forskellen øgedes gennem sæsonen, formentlig som følge af brugen af bekæmpelsesmidler, og ydermere var fødegrundlaget på de konventionelt dyrkede marker mere ustabilt end på de økologiske marker.

De agerlandsfugle, der i årene 1974-1987 er gået tilbage i antal, forekom alle hyppigst på de økologiske landbrug. Disse arters bestandsnedgange hænger derfor med stor sandsynlighed sammen med den stadigt mere intensive udnyttelse af det dyrkede land. Undersøgelserne underbygger dermed behovet for en mere økologisk indfaldsvinkel til landbrugsdriften.

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