Butterfly communities on field margins: Effects of changes in farming methods and adjacent forest cuttings (Lepidoptera: Hesperioidea, Papilionoidea)

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Between 1991 and 2000, butterflies were monitored once a week from early May to late September on a 2.7 km transect on agricultural land at Joutseno, SE Finland. During 213 counts a total of 56 species and 11 105 individuals were recorded. The effects of the shift from conventional farming to organic farming and adjacent pine forest cuttings on butterfly communities were compared in four field margin habitats. Between the two five-year periods, both beneficial and adverse impact on butterflies was recorded.

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Introduction

Agricultural environments provide various habitats for butterflies in southern and central Finland (Pitkänen *et al.* 2001). Although agricultural intensification turned the majority of diverse semi-natural grasslands into more productive arable land during the 20th century (Mukula & Ruuttunen 1969, Raatikainen 1986), butterflies have managed rather well in the present agricultural environments (Saarinen 2002a). Nowadays the most diversified butterfly fauna has become established in south-eastern Finland (Kuussaari *et al.* 2001, Marttila *et al.* 2001). There the local butterfly faunas consist of up to 60 species, some 40 of which can be found in a conventionally managed farmland site in an average season (Saarinen *et al.* 1998).

In an arable landscape, field margins are often the only suitable habitats for woodland and grassland butterfly species (e.g. Dover 1990). Species richness and diversity in the margins may be rather high and even comparable to sites with less intensive management (Saarinen 2002b), if there are enough food resources for adults and larvae. The number of nectar plants and the diversity of the vegetation, in particular, are among the most important factors affecting the occurrence and abundance of the species (Brakefield 1982, Dover 1989, Munguira & Thomas 1992, Holl 1995, Lörtscher *et al.* 1995, Sparks & Parish 1995, Gerell 1997, Peterson 1997, Smallidge & Leopold 1997, Fleishman *et al.* 1999).

Several studies have been focused on butterflies in agricultural habitats, field margins in particular, in relation to changes in agricultural practices, including pesticide use and spray drift (Rands & Sotherton 1986, Dover *et al.*1990, Davis *et al.* 1991, Cilgi & Jepson 1995, Longley & Sotherton 1997), organic versus conventional farming (Feber *et al.* 1997, Clausen *et al.* 1998, Weibull *et al.* 2000) and grazing or mowing management (Feber *et al.* 1994, Oates 1995, Feber *et al.* 1996, WallisDeVries & Raemakers 2001). Farmland butterflies have benefited from the reduced pesticide use. Because agrochemicals are prohibited on organic farms, it has been suggested that organic farming increases biodiversity (Paoletti 1995, Stopes *et al.* 1996), although the farming system may be less important for butterfly diversity and abundance than, for example, the variation in landscape heterogeneity (Smallidge & Leopold 1997, Weibull *et al.* 2000). Increasing the natural features of the field margins through management also improves butterfly communities. Besides management *in situ*, butterflies may be affected by activities in the surrounding landscapes (Pollard & Yates 1993, Hanski & Thomas 1994).

In this paper we attempt to assess the combined effects of changes in the farming method and adjacent forest cuttings on the butterfly communities in four field margin habitats. Using species richness and diversity, total butterfly abundance and the species composition, we tested whether the shift from conventional to organic farming had a positive effect on butterfly communities. On the other hand, the nearby loggings were presumed to adversely affect the butterfly community in one of the habitats.

Material and methods

The study area on open arable land was situated at Joutseno in SE Finland (61°10'N, 28°41'E). According to the results of canonical correspondence analysis of environmental variables and butterfly data over five years (Saarinen *et al.* 1998), the field boundary transect (2 740 m) represented three margin habitats for butterflies (Fig. 1): MH1 consisted of dry margins between arable field and pine forest (785 m), MH2 consisted of moist margins between arable field and aspen forest (560 m) and MH3 consisted of mesic margins between two arable fields (1 395 m). In this study, two parts of margin habitat 3 were treated as separate habitats (MH3a – 785 m, MH3b - 610 m) due to different farming practices.

Between 1991 and 1995, no changes in the management occurred. In the fields, however, cultivated plants varied from year to year from turnip rape, rye, oat and wheat to different forage plants. According to the land owner, approximately 550 kg of chemical fertilisers per hectare were used each year. Fields were sprayed annually with herbicides, mostly so-called MCPA-products, but insecticides were used in only one summer in the 1980s.

Between 1996 and 2000, two fundamental changes took place in the area. Firstly, the majority of conventionally managed fields along the transect were turned into organic fields in 1996. Since then herbicides have not been used and manure has been the only fertiliser in field sectors 1-3 (Fig. 1). The composition of crops, however, has remained the same, likewise the conventional management of the fields in sector 4. Secondly, pine forest lining the southern part of MH1 was logged in May 1996. In June 1998, the clearcut was completed in the northern part of the habitat. Due to logging, the wind force increased considerably in the habitat. In the other three habitats, some willows were removed from ditch banks in the autumn of 1995 and 1996.

During both five-year periods, butterflies were studied once a week from early May (week 18) to the end of September (week 39) using the transect count method (Pollard & Yates 1993). Individuals within a range of 2.5 m on both sides and 5 m in front of the recorder were noted. The transect was censused in the early afternoon in the best possible weather conditions. The temperature (°C) was measured, and the wind speed (1-6, Beaufort scale) and the sunshine percentage (0, 25, 50, 75, 100 %) were estimated during each census. The mean ($\pm S.D.$) values for weather variables were 18.4 ± 4.4°C for temperature, 2.4 ± 1.0 for wind speed and 85 ± 21 % for sunshine between 1991 and 1995, and 18.5 ± 4.6, 2.4 ± 1.0 and 92 ± 13 respectively between 1996 and 2000. The temperature and wind speed were not statistically different (*t*-test, $p > 0.05$), but the sunshine percentage was higher during

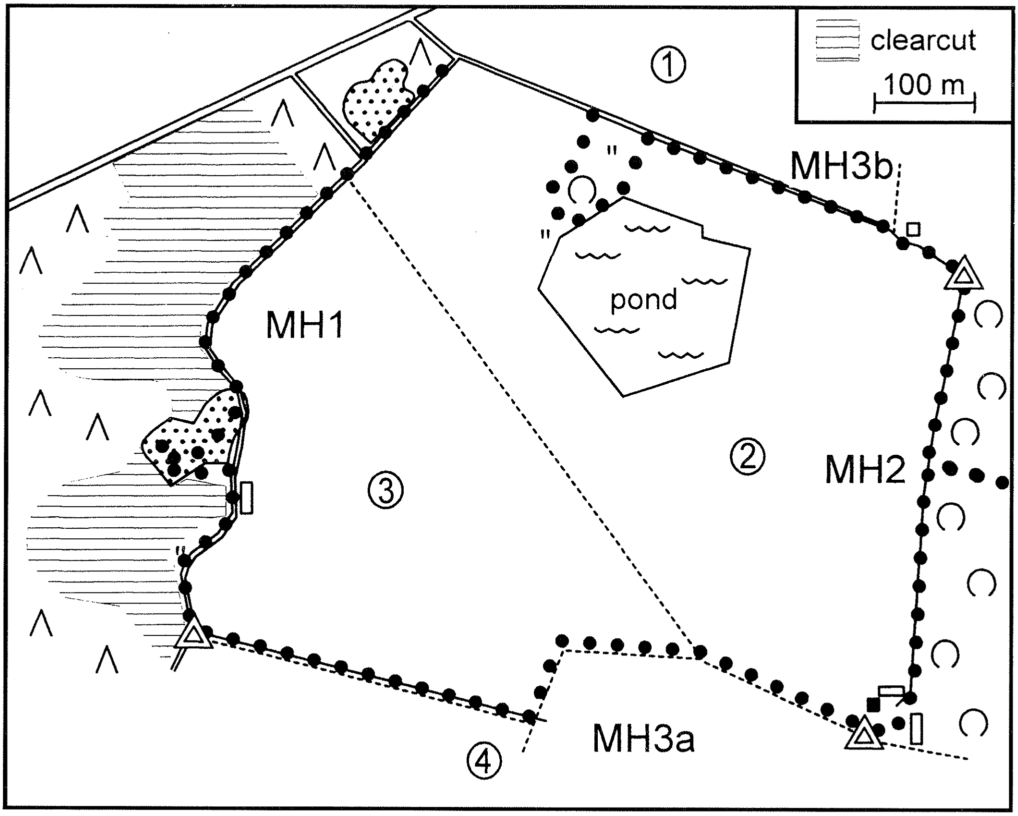

Fig. 1. The original division of the transect (black dots) into three field margin habitats. MH1= dry margins between arable field and pine forest (785 m), MH2= moist margins between arable field and aspen forest (560 m), MH3= mesic margins between two arable fields, divided into two sub-habitats MH3a (785 m) and MH3b (610 m). Double triangles indicate a shift from one habitat to another. Numbers 1-4 stand for the four field sectors.

the second period ($p < 0.01$). Variation in the number of annual censuses, i.e. 20 (1991-1992), 21 (1993-1994, 1997) and 22 (1995-1996, 1998-2000), totalling 213 counts, was due to unfavourable weather conditions.

Butterfly communities in four field margin habitats in the two five-year periods (1991-1995, 1996-2000) were compared using species richness and diversity, total abundance and species composition. Before any analyses were made, the annual abundance index (I) was calculated for each species in each habitat as $I = N^*(n^*l)^{-1}$, where N is the number of individuals, n is the number of censuses, and l is the length (km) of the habitat. Annual indices, expressed as individuals per km, were separately averaged to a total abundance index of the species for both periods.

The species richness was determined as the number of butterfly species (S) recorded in the habitat. The diversity measurements, calculated for each habitat and year, were the Shannon-Wiener index ($H' = -p_i \ln p_i$) and the Evenness index ($J = H'/(\log S)$), p_i is the proportion of species i (Magurran 1988). Annual values for species richness, diversity and total abundance, i.e. the sum of the abundance indices of all species in the habitat, for the two periods were compared using the Mann-Whitney U-test (Davis 1986).

Table 1. Butterfly communities in four field margin habitats (MH1, MH2, MH3a, MH3b) during the two five-year periods (A: 1991-1995, B: 1996-2000). *S.D.*= standard deviation.

	Number of species			Shannon-Wiener diversity index (*H'*)			Evenness index (*J*)			Total abundance (individuals per km)		
	mean	*S.D.*	*p*	mean	*S.D.*	*p*	mean	*S.D.*	*p*	mean	*S.D.*	*p*
MH1												
A	28.4	4.0	0.676	2.47	0.26	0.465	1.70	0.13	0.347	17.2	4.1	0.047*
B	27.4	4.8		2.55	0.19		1.78	0.08		12.0	2.8	
MH2												
A	25.0	4.0	0.047*	2.32	0.25	0.175	1.66	0.12	0.917	27.4	9.0	0.754
B	31.6	4.0		2.51	0.10		1.68	0.08		28.8	9.4	
MH3a												
A	23.0	3.4	0.754	2.13	0.29	0.917	1.56	0.15	0.917	24.7	10.1	0.076
B	24.0	5.0		2.15	0.17		1.57	0.06		16.2	3.8	
MH3b												
A	16.2	3.6	0.175	1.88	0.34	0.251	1.56	0.17	0.465	16.0	5.1	0.251
B	19.2	1.9		2.12	0.14		1.66	0.12		13.0	3.1	

Mann-Whitney *U*-test, * $p<0.05$.

Population trends and changes in species composition were evaluated using 42 species observed at a minimum level of ten individuals. In each habitat, species were classified into four categories according to a trend between the two five-year periods. A positive trend consisted of newcomers (recorded only in the second period) and increasing species, whereas a negative trend included decreasing and vanishing species (recorded only in the first period). The indicator species of the three original habitats (Saarinen *et al.* 1998) were of special interest.

Results

Butterfly data over ten years (1991-2000) consisted of 56 species and 11 105 individuals. The annual numbers varied from 35 (1994) to 48 (1999) species, and from 788 (1998) to 1 912 (1995) individuals. During the second period (1996-2000), the average number of species (42.2) was higher and the total abundance (16.9 individuals per km) lower compared to the first period (1991-1995: 38.4 and 21.3, respectively), but the differences were not statistically significant ($p=0.175$ for species, $p=0.210$ for individuals, Mann-Whitney *U*-test). A core of 21 species were observed in each year. The five most common butterflies accounted for 67% of the butterfly observations, while less than ten individuals were recorded for the following 14 species: *Limenitis populi* (8 individuals), *Pyrgus malvae* (7), *Lasiommata petropolitana* (7), *Thecla betulae* (5), *Pontia daplidice* (4), *Papilio machaon* (3), *Satyrium pruni* (3), *Glaucopsyche alexis* (3), *Argynnis niobe* (3), *Colias palaeno* (2), *Pyrgus alveus* (1), *Colias hyale* (1), *Nymphalis polychloros* (1) and *Pararge aegeria* (1).

In the four field margin habitats, the total number of species was 50 (MH1), 48 (MH2), 49 (MH3a) and 37 (MH3b). Between the two periods, the species richness significantly increased in MH2 ($p<0.05$) and the total abundance of butterflies decreased in MH1 ($p<0.05$). Although no significant changes were recorded in any diversity measurements, Shannon-Wiener and evenness indices slightly increased in all four habitats (Table 1).

Abundance indices of the species in four habitats are shown in Table 2. The classifications resulted in positive/negative trends for 14/

Table 2. Abundance indices (*I*) of butterfly species (14 species observed <10 individuals as one group) in four field margin habitats (MH1, MH2, MH3a, MH3b) in the two five-year periods (A: 1991-1995, B: 1996-2000). Indicators of a particular habitat group are marked increased (+) or decreased (-) between the two periods.

	Total number of individuals	MH1		MH2		MH3a		MH3b	
		I_A	I_B	I_A	I_B	I_A	I_B	I_A	I_B
Gonepteryx rhamni[1]	873	2.68	1.35-	2.10	2.69	1.29	0.56	1.11	0.46
Callophrys rubi[1]	277	1.89	1.05-	0.21	0.13	0.07	0	0.03	0.03
Erebia ligea[1]	244	0.76	0.68-	0.49	1.12	0.07	0.12	0.08	0.08
Lasiommata maera[1]	129	0.71	0.27-	0.26	0.34	0.10	0.06	0	0
Lycaena virgaureae[1]	87	0.41	0.32-	0.07	0.08	0.09	0.09	0.02	0.01
Euphydryas maturna[1]	55	0.47	0.13-	0.02	0.03	0.02	0.01	0	0
Polyommatus icarus[1]	43	0.07	0.04-	0.07	0.16	0.06	0.08	0.08	0.05
Lycaena phlaeas[1]	40	0.17	0.08-	0	0.02	0.11	0.07	0.03	0.02
Boloria euphrosyne[1]	38	0.11	0.26+	0.04	0.03	0.01	0.02	0	0
Melitaea athalia[1]	29	0.10	0.06-	0.05	0.18	0	0.02	0	0
Plebeius idas[1]	23	0.17	0.02-	0.02	0	0.05	0.02	0	0
Albulina optilete[1]	18	0.10	0.05-	0.02	0	0.05	0	0.02	0
Aphantopus hyperantus[2]	1981	1.58	1.55	5.27	8.53+	3.36	3.36	2.26	2.86
Pieris napi[2]	1783	3.06	2.36	5.32	3.60-	3.04	2.19	2.87	2.56
Brenthis ino[2]	675	0.08	0.02	2.92	1.83-	2.44	1.22	0.34	0.75
Polyommatus amandus[2]	337	0.38	0.20	1.13	0.97-	0.87	0.33	0.60	0.41
Nymphalis io[2]	133	0.06	0.06	0.31	0.80+	0.12	0.35	0.08	0.16
Nymphalis c-album[2]	100	0.13	0.14	0.42	0.25-	0.14	0.10	0.05	0.23
Boloria selene[2]	85	0.19	0.09	0.32	0.43+	0.04	0.08	0.06	0.04
Argynnis aglaja[2]	75	0.02	0.08	0.22	0.34+	0.22	0.08	0.05	0.06
Argynnis adippe[2]	65	0.18	0.13	0.25	0.08-	0.11	0.08	0	0.04
Leptidea sinapis[2]	48	0.06	0.06	0.22	0.34+	0	0.02	0	0.03
Pieris brassicae[2]	46	0.12	0.02	0.14	0.13-	0.11	0.01	0.07	0.04
Aricia eumedon[2]	44	0.01	0	0.36	0.26-	0.05	0.01	0	0.02
Nymphalis antiopa[2]	38	0.09	0.11	0.09	0.15+	0.05	0.01	0.03	0.02
Anthocharis cardamines[2]	16	0.06	0	0.09	0.10+	0	0	0	0
Thymelicus lineola[3]	1689	0.94	0.79	4.08	2.06	6.95	4.16-	2.48	1.43-
Nymphalis urticae[3]	1085	1.56	0.41	1.56	0.83	3.36	1.07-	3.83	2.41-
Ochlodes sylvanus[3]	350	0.30	0.45	0.47	1.27	0.58	0.99+	0.42	0.36-
Pieris rapae[3]	212	0.32	0.31	0.47	0.11	0.43	0.20-	1.06	0.12-
Polyommatus semiargus[3]	129	0.12	0.16	0.14	0.25	0.49	0.22-	0.13	0.24+
Coenonympha glycerion[3]	52	0.01	0.06	0.02	0.15	0.18	0.10-	0.06	0.12+
Vanessa cardui[3]	47	0.02	0.09	0.03	0.06	0.03	0.20+	0.06	0.10+
Lycaena hippothoe[3]	19	0.01	0.01	0.02	0.03	0.09	0.03-	0.03	0.03-
Celastrina argiolus	37	0.04	0.23	0	0.21	0	0.01	0	0
Aricia artaxerxes	31	0	0	0.04	0.36	0.01	0.05	0.01	0.01
Vanessa atalanta	29	0.05	0.05	0	0.06	0.01	0.05	0.02	0.16
Carterocephalus silvicola	28	0.01	0.02	0	0.31	0	0.01	0.03	0.05
Argynnis paphia	23	0	0	0	0.33	0	0.03	0	0
Plebeius argus	16	0.02	0.08	0	0.02	0.01	0.05	0	0.02
Coenonympha pamphilus	16	0.04	0.03	0.02	0.03	0.02	0.04	0.02	0.01
Aporia crataegi	11	0.01	0	0.05	0.06	0.02	0	0.02	0
(14 scarce species)	49	0.11	0.14	0.16	0.10	0.04	0.08	0.02	0.03

[1,2,3] Indicators of the three original habitats (MH1, MH2, MH3).

28 species in MH1, 28/14 species in MH2, 19/23 species in MH3a and 25/17 species in MH3b (Fig. 2). As far as indicator species were concerned, positive and negative trends were equally numerous in MH2 (7/7), whereas negative trends predominated in MH1 (1/11), MH3a (2/6) and MH3b (3/5). Between the two periods, a total of nine species exhibited a negative trend and three species a positive trend in each habitat group.

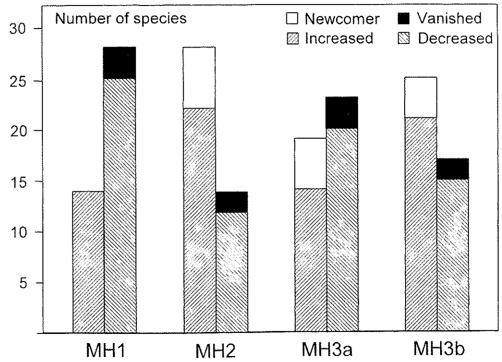

Fig. 2. Four classes of species in four field margin habitats (MH1, MH2, MH3a, MH3b). Newcomers and vanished species were recorded only in the second (1996-2000) or the first (1991-1995) period, respectively. Increased and decreased species were classified according to a change in total abundance between the periods.

Discussion

Butterfly populations fluctuate greatly for both natural reasons (e.g. weather, predators and parasites, diseases) and as a consequence of man-made changes in the environment. Unfortunately there was no reference transect where conventional farming management remained in the second period to provide a point of comparison for the relative population trends on conventional farmland between the two five-year periods at the study site. However, since populations tend to fluctuate in synchrony within large areas, suggesting a major impact of weather on butterfly numbers (e.g. Pollard 1991, Pollard *et al.* 1993, Sutcliffe *et al.* 1996), we assumed that a general trend in the study site at Joutseno was in line with the results of the national butterfly recording scheme (Marttila *et al.* 2001). Using the unpublished data collected in the biogeographical province *Sa* (1991-1995: 127 780 individuals, 39.3 per observation day, 1996-2000: 103 531 individuals, 28.5 per observation day), the total abundance of butterflies in SE Finland was 27% lower during the second period. In the transect, the reduction was somewhat smaller (21%). Although the sunshine percentage was higher in the second period, weather conditions during the censuses were satisfactory for both periods.

During the second period the annual species richness increased (+10%) despite the decreasing total abundance (-21%). However, patterns differed in four field margin habitats under different levels of environmental change. The relative change in the annual averages of the number of species was -4% in MH1, +26% in MH2, +4% in MH3a and +19% in MH3b. Correspondingly, changes in the total abundance were -30%, +5%, -34% and -19%, respectively. Thus, both values increased in the margins between arable field and aspen forest (MH2). A positive trend contrasting with that in the other habitats and with the regional trend intimated that a butterfly community may benefit from organic farming methods. On the other hand, the average species richness only slightly increased and the total abundance of butterflies decreased in margins between two arable fields (MH3a, MH3b). The trends were more severe in MH3a, where the possible beneficial effects of organic farming were most likely reduced by a continuation of conventional farming in field sector 4. Besides, the community in MH3a was probably challenged by nearby loggings because sheltering effects are present up to at least 10 times the height of the trees along MH1. Although various environmental benefits are associated with organic farming (Rands & Sotherton 1986, Feber *et al.* 1997), sometimes the effects on diversity may take a long time to manifest themselves (Younie & Armstrong 1996). In addition, butterfly communities in arable habitats with dissimilar natural features may simply respond differently towards changes in agricultural management.

Between the two five-year periods, margins between arable field and pine forest (MH1) suffered mostly in terms of the species richness and total butterfly abundance. Although no measurements were made, logging clearly increased the wind force in the habitat. According to Kuussaari *et al.* (2001), species richness among butterflies in agricultural landscapes decreases with increasing sensitivity to windiness. The increasing wind may also lead to a redistribution of butterfly species, in particular those with closed populations (Dover *et al.* 1997). During the second period, three woodland species, *Erebia ligea*, *Lasiommata maera* and *Melitaea athalia*, were discovered to have an increased attraction for MH2 instead of MH1. A fundamental change in MH1 was likely to cause more unstable microclimatic conditions, which poses a challenge for the whole butterfly community.

Trends in individual species were also based on different patterns in four margin habitats. The relationship between the number of species with a positive ("exploiters") or a negative trend ("sufferers") indicated the dominance of sufferers in MH1 and of exploiters in MH2, whereas both were rather equally numerous in MH3a and MH3b. In the previous paper we determined so-called preference species for three habitat groups (Saarinen *et al.* 1998). Adapted to specific conditions, these species may be used as the best indicators of the changes in the habitat concerned. Indicators of MH1 (12 species) included 11 sufferers, and the only exploiter (*Boloria euphrosyne*) is known to benefit from forest cuttings (Marttila *et al.* 1991). By contrast, indicators of MH2 (14) included seven exploiters and seven sufferers. The latter included three species which were reduced in all four habitats between the periods, thus indicating a regional population trend. Correspondingly, trends in indicators of MH3 (8) could be partly explained by the local and national trends of the species (Marttila *et al.* 2001). In both habitats, three decreased indicators (*Thymelicus lineola*, *Nymphalis urticae* and *Pieris rapae*) were reduced throughout the transect.

Since 1999, butterflies have been monitored nationally in Finnish agricultural landscapes by means of a network of some 40 transects. Based on the results of the first two years, Joutseno is ranked at the top according to the number of species observed in the sites (Kuussaari *et al.* 2001). During the ten-year period, we recorded all resident species living in SE Finland, except *Boloria aquilonaris*, *B. eunomia* and *Euphydryas aurinia*, along the transect. It is thus evident that, while the diversity of the fauna may not improve, the numbers may increase since fields now under an organic farming regime are likely to provide better circumstances for butterflies in the future.

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Selostus — Finnish summary

Suomen vakituisesta päiväperhoslajistosta kaksi kolmasosaa elää pääasiassa maatalouden luomissa ympäristötyypeissä, kuten niityillä, laitumilla ja pellonpientareilla. Viime vuosikymmeninä varsinkin pellonpientareiden merkitys on korostunut niittyjen ja muiden perinneympäristöjen voimakkaan vähenemisen myötä. Tässä työssä pellonpientareiden päiväperhosia tutkittiin linjalaskentamenetelmällä *Sa*: Joutsenossa vuosina 1991-2000. Peltoympäristöön sijoittuva 2.7 km linja (kuva 1) jakautui neljään elinympäristötyyppiin (MH1 = pellon ja mäntymetsän väliset pientareet, MH2 = pellon ja lehtimetsän väliset pientareet, MH3a ja MH3b = kahden pellon välissä olevat pientareet), joiden laji- ja yksilömäärän sekä lajiston monimuotoisuuden ja koostumuksen muutoksia arvioitiin kahden viisivuotisjakson välillä. Ensimmäisen jakson aikana (1991-1995) peltoviljelyssä ei tapahtunut muutoksia, mutta toisella jaksolla (1996-2000) suurin osa pelloista siirtyi luomuviljelyyn. Tämä erotti elinympäristöt MH3a (vain toinen puoli luomuviljelyssä) ja MH3b (molemmat puolet luomuviljelyssä). Metsänreunan pientareista MH2 säilyi toisella jaksolla ennallaan, mutta elinympäristöä MH1 suojaava mäntymetsä avohakattiin. Tavoitteena oli arvioida, vaikuttaako luomuviljely myönteisesti ja avohakkuu kielteisesti pellonpientareiden perhoslajistoon.

Viikoittaisissa linjalaskennoissa (n=213) havaittiin yhteensä 56 lajia ja 11 105 yksilöä. Toisella jaksolla (1996-2000) lajimäärän vuosikeskiarvo (42.2) oli suurempi, mutta yksilörunsaus (16.9 yksilöä laskentakilometriä kohti) pienempi kuin ensimmäisellä jaksolla (1991-1995: 38.4 ja 21.3). Yksilömäärän pieneneminen (-21%) johtui todennäköisesti yleisestä kehityssuunnasta Kaakkois-Suomessa, sillä valtakunnallisen päiväperhosseurannan aineistossa eliömaakunnan (*Sa*) kaikki yksilömäärätiedot (yhteensä 231 311 yksilöä) osoittivat 27% laskua samojen vuosijaksojen välillä.

Neljän elinympäristön kokonaislajimäärät olivat 50 (MH1), 48 (MH2), 49 (MH3a) ja 37 (MH3b). Kaikissa ympäristöissä havaittiin vuosijaksojen välillä vähäistä nousua lajiston monimuotoisuutta kuvaavissa muuttujissa, mutta vain lajimäärän kasvu ympäristössä MH2 ja yksilömäärän lasku ympäristössä MH1 oli tilastollisesti merkitsevä (taulukko 1). Laji- ja yksilömäärävertailut sekä lajiston rakenteen muutokset (taulukko 2) vahvistivat käsitystä ympäristömuutosten vaikutuksista pientareiden päiväperhosiin. Peltoalueen keskellä, jossa lajimäärät kasvoivat (MH3a +4%, MH3b +19%) ja yksilömäärät pienenivät (MH3a -34%, MH3b -19%), muutokset olivat myönteisempiä kokonaan luomuviljelyn piiriin kuuluvassa ympäristössä (MH3b). Ennallaan säilyneen lehtimetsän reunassa (MH2) sekä laji- (+26%) että yksilömäärä (+5%) nousi jälkimmäisellä jaksolla, kun taas avohakatun mäntymetsän reunassa (MH1) molemmat pienenivät (-4%, -30%).

Linjalla havaittiin kymmenen vuoden aikana vähintään kymmenen yksilöä 42 lajista, jotka luokiteltiin kussakin elinympäristössä hyötyjiksi (uustulokas tai runsastunut) tai häviäjiksi (vähentynyt tai kadonnut). Peltojen keskellä sijaitsevilla pientareilla näiden suhde oli parempi kokonaan luomuviljelyn piiriin kuuluvassa ympäristössä (MH3b). Vastaavasti metsänreunan pientareilla MH2:lla oli enemmän hyötyjiä ja MH1:llä häviäjiä (kuva 2). Avohakkuun haittavaikutukset korostuivat, kun muutoksia arvioitiin elinympäristön indikaattorilajien avulla (taulukko 2). Ympäristön MH1 indikaattoreista (12) peräti 11 lajia väheni toisella jaksolla. Näistä mm. metsänokiperhonen (*Erebia ligea*), tummapapurikko (*Lasiommata maera*) ja ratamoverkkoperhonen (*Melitaea athalia*) olivat toisella jaksolla runsaslukuisempia peltoalueen toisella puolella (MH2).

Valitettavasti tutkimuslinjalle ei ollut vertailulinjaa, jolla tavanomainen viljely olisi säilynyt myös toisella jaksolla. Vaikka tämä vaikeuttaa tulosten yleistämistä, havaitut muutokset neljässä eri elinympäristössä suhteutettuna alueelliseen kehityssuuntaan vihjaavat luomuviljelyn todennäköisesti hyödyttävän pientareiden päiväperhoslajistoa. Toisaalta metsänhakkuilla näyttäisi olevan kielteisiä vaikutuksia myös läheisten pellonpientareiden lajistoon.