Nota lepid. 22 (1): 17–34; 01.III.1999 ISSN 0342–7536

The national butterfly recording scheme in Finland: first seven-year period 1991–1997

Olli Marttila, Kimmo Saarinen & Juha Jantunen

South Karelia Allergy and Environment Institute, FIN-55330 Tiuruniemi, Finland e-mail: all.env@inst.inet.fi

Summary. The National Butterfly Recording Scheme in Finland (NAFI) conducted by the South Karelia Allergy and Environment Institute and the Lepidopterological Society of Finland, makes available, for the first time, quantitative information on the butterfly fauna for the whole country. The data, based on the Finnish uniform 27°E grid (10-km squares), numbers of individuals and numbers of observation days, are collected using a uniform questionnaire. During the first seven-year period (1991–1997) a total of 306 voluntary amateur and professional lepidopterists have participated in the scheme, providing data on 889,917 individuals representing all the Finnish resident species (95) and 8 non-resident species. Broadly speaking, the results are in line with earlier knowledge about Finnish butterflies, but not a single threatened or declining species has become more abundant or more widely distributed than was previously assessed. Parallel with this, there were decreases in annual frequencies (see methods) in 8 species, while only one exhibited of increase. As a prospective follow-up study, NAFI provides much needed quantitative on-line knowledge of possible changes in the distribution and abundance of butterflies for attempts to protect the Finnish butterfly fauna.

Zusammenfassung. Das Nationale Tagfalter-Überwachungs-Programm von Finnland (NAFI), gemeinschaftlich durchgeführt vom Südkarelischen Institut für Allergien und Umwelt und der Finnischen Lepidopterologischen Gesellschaft, liefert erstmalig quantitative Informationen zur Tagfalterfauna des ganzen Landes. Die Daten (Anzahl beobachteter Individuen bzw. Anzahl von Nachweisen pro Tag) werden auf der Kartierungsgrundlage des einheitlichen Finnischen Quadrantensystems (in 10-km²-Feldern) gesammelt. Während der ersten Siebenjahresperiode (1991–1997) haben 306 Lepidopterologen (Amateure und Berufsentomologen) insgesamt Daten zu 889,917 beobachteten Individuen geliefert, die alle 95 in Finnland heimischen sowie 8 nicht dauerhaft residente Arten repräsentieren. Insgesamt bestätigt dieser Datensatz bisherige Einschätzungen zur finnischen Tagfalterfauna. Keine einzige gefährdete oder bestandsrückläufige Art stellte sich demnach als häufiger oder weiter verbreitet heraus als zuvor angenommen. Acht weitere Arten scheinen in ihrer jährlichen Häufigkeit rückläufig zu sein (siehe "Methoden"), während nur bei einer Art Hinweise auf positive Bestandsentwicklung auftraten. NAFI stellt dringend benötigte quantitative Informationen in Zukunft auch on-line zur Verfügung, um mögliche Änderungen in der Verbreitung und Häufigkeit der finnischen Tagfalterfauna überwachen und Maßnahmen zum Schutz einleiten zu können.

Résumé. Le Programme National d'Inventarisation des Papillons Diurnes de Finlande (NAFI), conduit par l'Institut d'Allergie et de l'Environement de Carélie du Sud et la Société Lépidoptérologique de Finlande, rend disponible, pour la première fois, de l'information quantitative sur la faune des papillons diurnes du pays entier. Les données, basées sur le système de coordonnées 27° E finlandais uniformisé (carroyage 10 × 10 km), les nombres d'individus et les nombres de jours d'observation, sont assemblées au moyen d'un questionnaire uniforme. Durant la première période de sept ans (1991–1997), au total 306 lépidoptéristes volontaires, amateurs et professionnels, ont participé à l'inventarisation, fournissant des données sur quelques 889,917 spécimens représentant toutes les espèces autochtones (95) et 8 espèces non-résidentes. En règle générale, les résultats s'inscrivent dans la lignée de nos connaissances antérieures sur les papillons diurnes de Finlande, mais aucune espèce menacée ou en régression est devenue plus commune ou plus répandue qu'il n'était précédemment établi. Parallèlement à cela, il y eût une décroissance en fréquences annuelles (voir méthodes) chez 8 espèces, alors que seulement une seule espèce montrait un acroissement. En tant qu'étude prospective à poursuivre, NAFI fournit des données quantitatives actualisées sur des changements possibles affectant la distribution et l'abondance de papillons diurnes, d'une grande nécessité dans le cadre d'efforts de protection de la faune des papillons diurnes de Finlande.

K e y w o r d s: Lepidoptera, butterflies, fauna, monitoring, Finland.

Introduction

There are 114 butterfly species found in Finland. The fauna comprises 95 resident species, 14 of which live in Lapland in northernmost Finland (Marttila *et al.*, 1991).

Over the last few decades the decline of butterflies has been a general phenomenon in the country. One species has become extinct, four are endangered and six are considered vulnerable. Furthermore, there are 15 declining, insufficiently known and rare species in need of monitoring, making a total of 26 threatened butterfly species in Finland (Rassi *et al.*, 1992, Somerma, 1997). In addition, Marttila *et al.* (1991) evaluated that the status of another 15 species has been adversely affected during the last 20 years. Altogether, this makes 41 species that are declining, amounting to 43% of all the indigenous butterflies in Finland. At the same time only 8 species (8%) have become more abundant.

Decline of butterflies is mainly caused by changes in agricultural practices, the loss of meadows through the cessation of hay cutting and cattle grazing, indirect nitrogen fertilization of meadows by air pollution, heavy use of pesticides, herbicides and

fertilizers, a strong decline in natural pastures, the centralization of production, and depopulation of the countryside. The other main reason for the decline is changes in forestry, especially the drainage of peatlands and reforestation of open habitats (Marttila *et al.*, 1991, Rassi *et al.*, 1992, Väisänen, 1992, Somerma, 1997).

In spite of the alarming trends in the butterfly fauna of Finland, no permanent or large-scale follow-ups, based on quantitative data, have been carried out in the country. On the whole, there are only a few European countries where national monitoring of butterflies has been established. In Great Britain (Pollard *et al.*, 1986, Pollard & Yates, 1993) and The Netherlands (van Swaay *et al.*, 1997, van Strien *et al.*, 1997), the schemes are carried out using a network of transect counts. In Denmark, the monitoring scheme is based on observations by volunteers with transect counts and free observations (Stoltze, 1996), but today the scheme is continuing on a much smaller scale than previously (Peder Skou, pers. comm.).

In Finland, knowledge of population changes in butterflies has mostly been based on long-term collecting in the same locality, combined with thorough records, and surveys with queries and literature reviews. As a consequence, changes in the occurrence and abundance of butterflies, especially of common and non-threatened species, have been poorly known. The need for continuous countrywide butterfly monitoring has been obvious.

The South Karelia Allergy and Environment Institute and the Lepidopterological Society of Finland in 1991 organised a countrywide follow-up study, the National Butterfly Recording Scheme in Finland (NAFI), which is intended to create quantitative on-line knowledge for the attempts to monitor changes in the distribution and abundance of butterflies in Finland. We report here the methods and some results of the scheme application.

Methods

The monitoring scheme is directed to all voluntary amateur and professional lepidopterists and also naturalists interested in butterflies. All participants recorded their yearly observations on the form designed for the scheme. The data on each form includes the year, the Finnish uniform 27° E grid (10 km square), the

number of counted or estimated individuals of species observed, and the number of counted or estimated observation days. No advice on the use of zero, i.e. negative observation of species, is given. The recorder's name and address are also requested for correspondence purposes.

Forms are distributed by the Lepidopterological Society and South Karelia Allergy and Environment Institute. New forms and a franked, addressed envelope are mailed every April to the most active and other potential participants. Participants who are not members of the Society have also received a reprint of the previous year's survey results. Forms returned before the end of November have been included in the annual survey published in the *Bulletin of the Lepidopterological Society (Baptria)* (Marttila, 1992, 1993, 1994, Marttila & Saarinen, 1995, 1996a, 1997, Saarinen & Marttila, 1998). Forms mailed after the deadline were not ignored but retained for comparison in the next season's survey.

The forms are transformed and fed into a computer program designed for NAFI. The main tools of the program, which are needed on every form, are the 10 km square, the individual number of species observed, and the number of observation days. The data on each form is checked carefully. If necessary, questionable observations are verified by contacting the observer. Several checks have been made yearly, and assistance has also been given with filling in the form. Finally the computer data are read carefully and verified by a random selection of 5–10% of the new files. The data are collected and stored at the South Karelia Allergy and Environment Institute.

The program prints out the processed numerical data on each species as distribution maps. There are three kinds of maps. All of these show the result in terms of the 10 km squares: (1) *The accumulative map* of species shows the accumulative data for all years, (2) *The average map* shows the accumulative data as averages of certain years, and (3) *The relative map* shows the number of individuals related to observation days: $[(\Sigma n)/d$, where n is the number of individuals observed in any of 10 km square on any day and d is the number of days], being either accumulative or the average of certain years.

In many cases this map reveals the regional differences in abundance better than the total numbers of individuals.

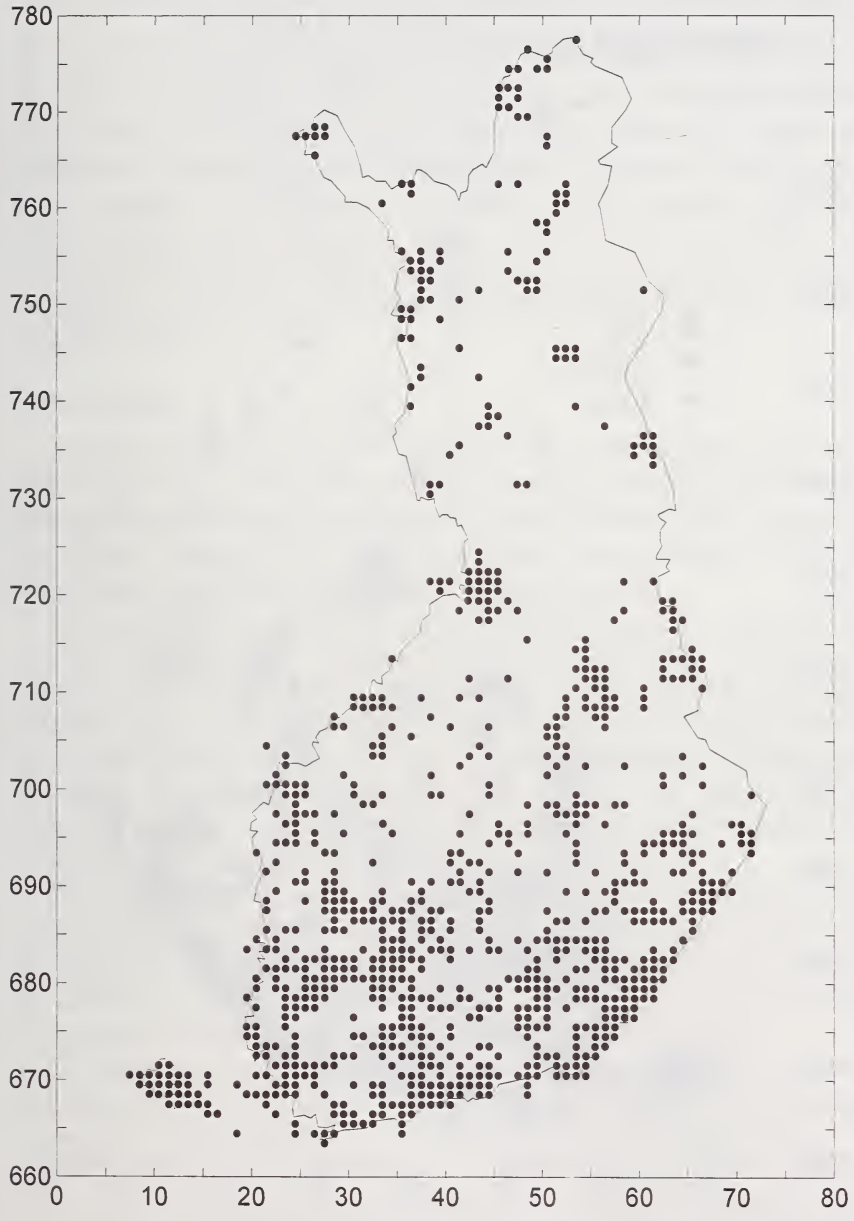


Fig. 1. The network of the National Butterfly Recording Scheme in Finland over the first seven-year period (1991–1997). The total number of positive 10 km squares (Finnish uniform 27° E grid) was 891.

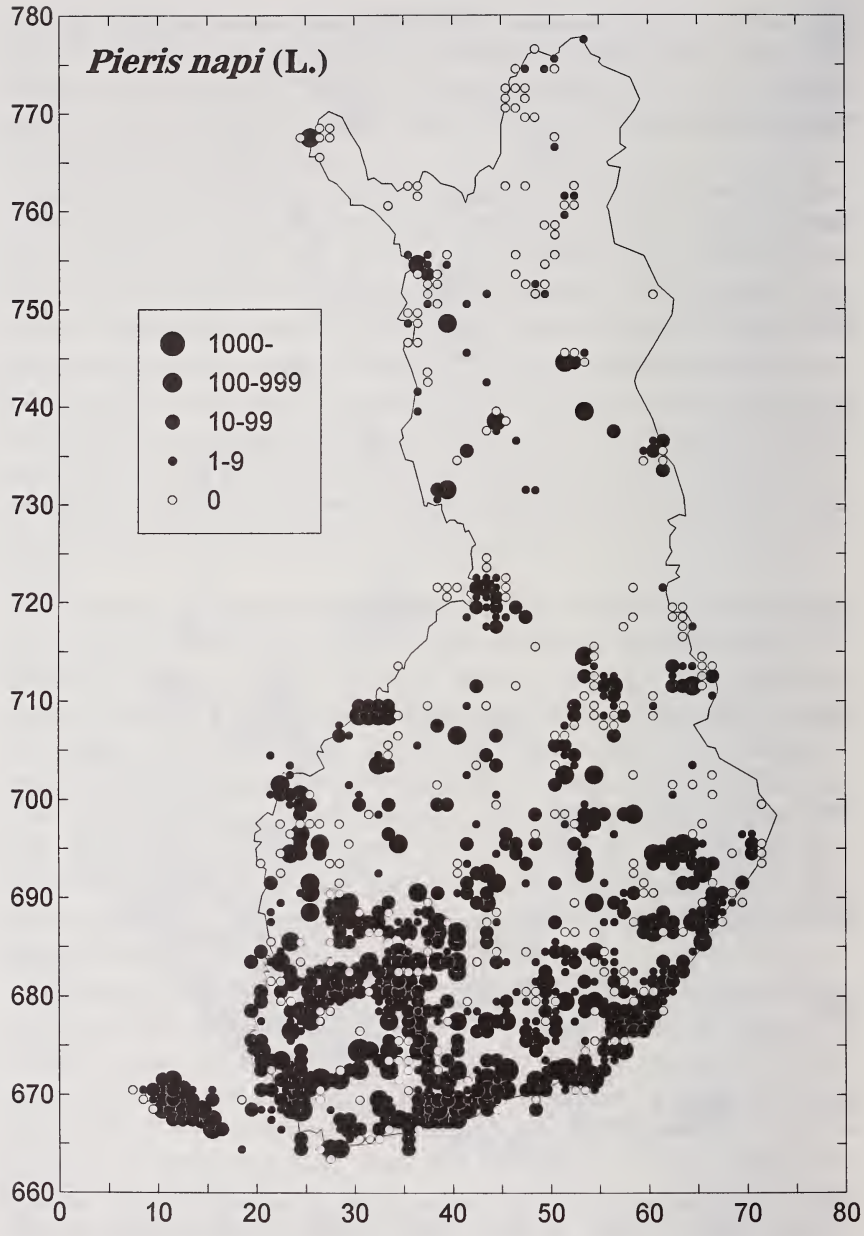


Fig. 2. The accumulative map of *Pieris napi* based on data from the first seven-year period (1991–1997). The species was the most numerous in the recording scheme during the period. The total number of individuals in each positive 10 km square is illustrated using proportionally-sized symbols.

The annual variation in the numbers of participants and observation days leads to the dilemma that a direct comparison of individual numbers of species between years is not really valid. To avoid this problem we have calculated annual frequencies for each species by dividing the positive 10 km squares (at least one individual observed) by the total number of squares in each year. For example, if the species is present in 250 squares and the total number of squares is 500, the frequency is 50%. To distinguish any trend in annual frequencies of the species during the seven-year period we used the linear regression (e.g. Sokal & Rohlf, 1981).

Some results

Altogether 306 persons have taken part in the scheme between 1991 and 1997. The seven-year data consists of 103 species and almost 890,000 butterfly individuals (Table 1 and 2). Fig. 1 depicts the NAFI network. In Figs. 2–4 there are examples of both accumulative and relative maps of certain species.

The proportion of the five most abundant species, *Pieris napi* (75,636 individuals), *Gonepteryx rhamni* (59,497), *Callophrys rubi* (56,506), *Aglais urticae* (55,467) and *Aphantopus hyperantus* (54,783), amounted to more than one third (34%) of all individuals. The most abundant migrant was *Vanessa atalanta* (7,986), and the most substantial migration events during the period were observed with *V. atalanta* (6,028) and *Vanessa cardui* (3,426) in 1994 and 1996, respectively (Table 2).

The year 1995 was the most favourable for butterflies. The total numbers of individuals on one average observation day for the whole country were as follows: 16 (1991), 28 (1992), 26 (1993), 26 (1994), 47 (1995), 28 (1996) and 23 (1997), the average of the whole seven-year period being 28 individuals in a day.

In terms of annual frequencies during the period there were increases in *Aricia nicias* ($r = 0.915^{**}$) and decreases in following 8 species: *Colias palaeno* ($r = -0.81^{*}$), *Lycaena hippothoe* ($r = -0.87^{*}$), *Boloria aquilonaris* ($r = -0.809^{*}$), *Euphydryas maturna* ($r = -0.796^{*}$), *Euphydryas aurinia* ($r = -0.895^{**}$), *Oeneis jutta* ($r = -0.998^{*}$), *Coenonympha pamphilus* ($r = -0.910^{**}$) and *C. tullia* ($r = -0.842^{*}$) (Table 2). Note that a periodical species *O. jutta* is in flight only in even years and the records available for the analysis were only of three years.

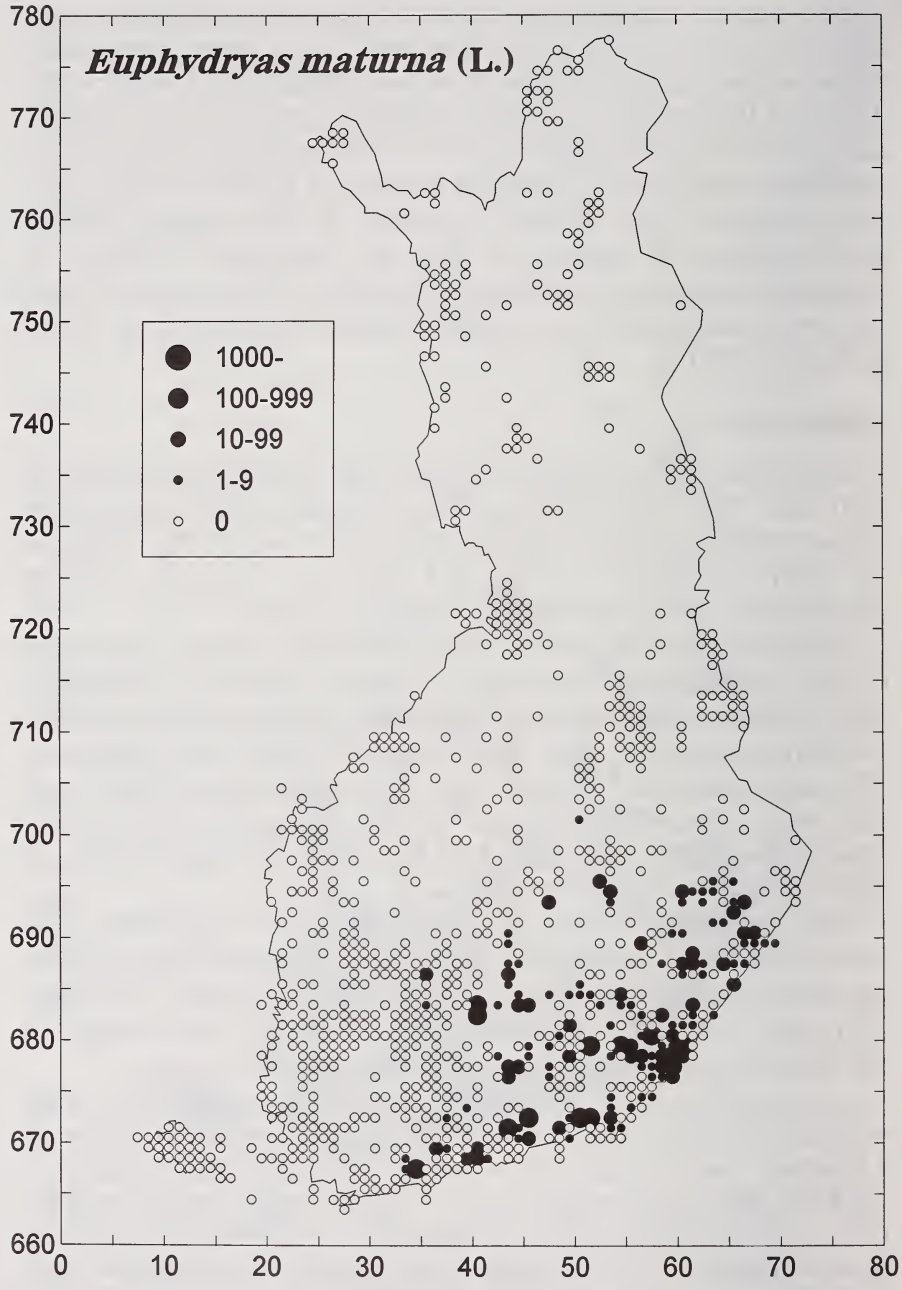


Fig. 3. The accumulative map of *Euphydryas maturna*. The map based on data from the first seven-year period (1991–1997) is an example of a species having a restricted distribution in the country. The total number of individuals in each positive 10 km square is illustrated using proportionally-sized symbols.

Table 1. The basic statistics of the National Butterfly Recording Scheme in Finland during the first seven-year period 1991–1997.

	1991	1992	1993	1994	1995	1996	1997	Total
Participants	42	90	117	151	168	176	168	306
Forms	91	255	338	565	610	571	521	2,951
10 km squares	79	204	259	376	401	433	418	891
Observation days	1,558	3,119	3,784	4,994	5,596	6,115	5,121	30,287
Species	71	83	96	98	96	96	93	103
Individuals	24,559	87,977	98,640	127,164	262,158	170,743	118,676	889,917

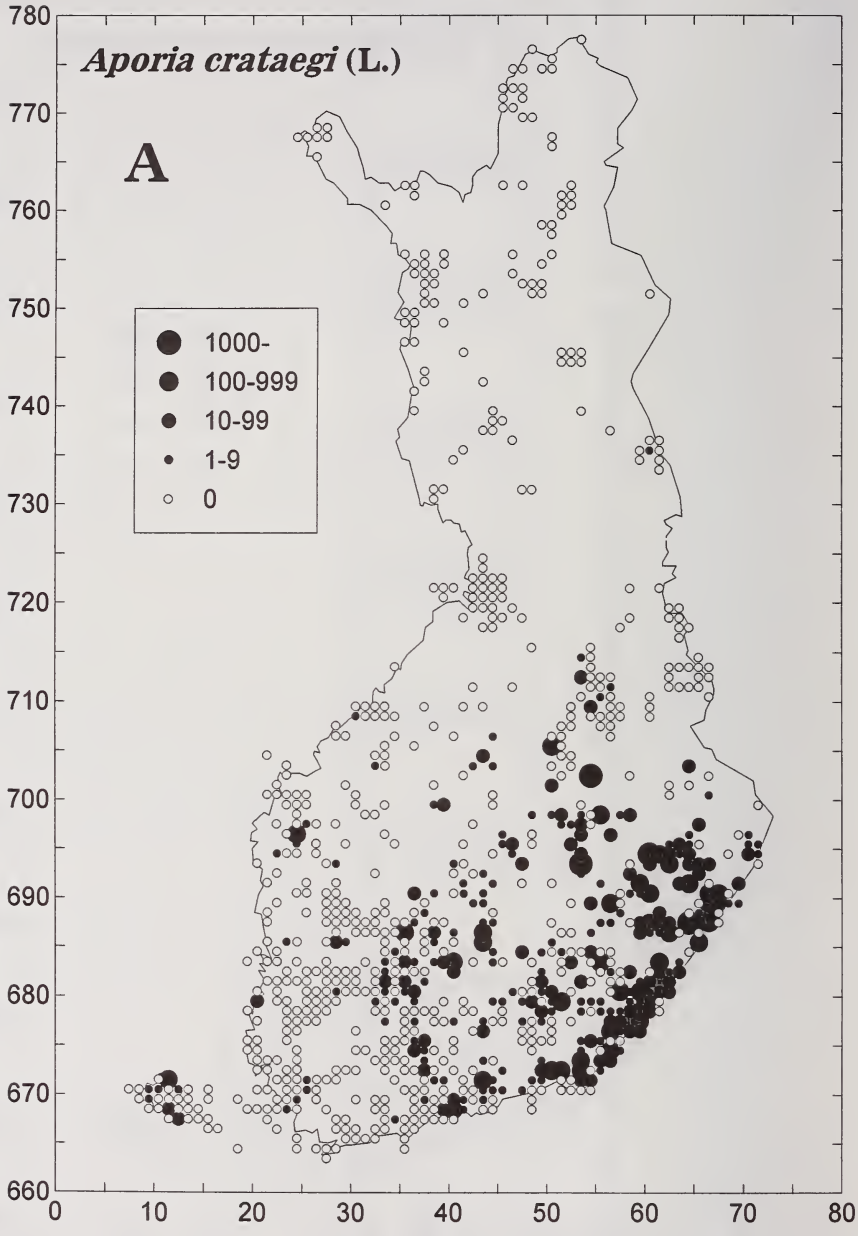
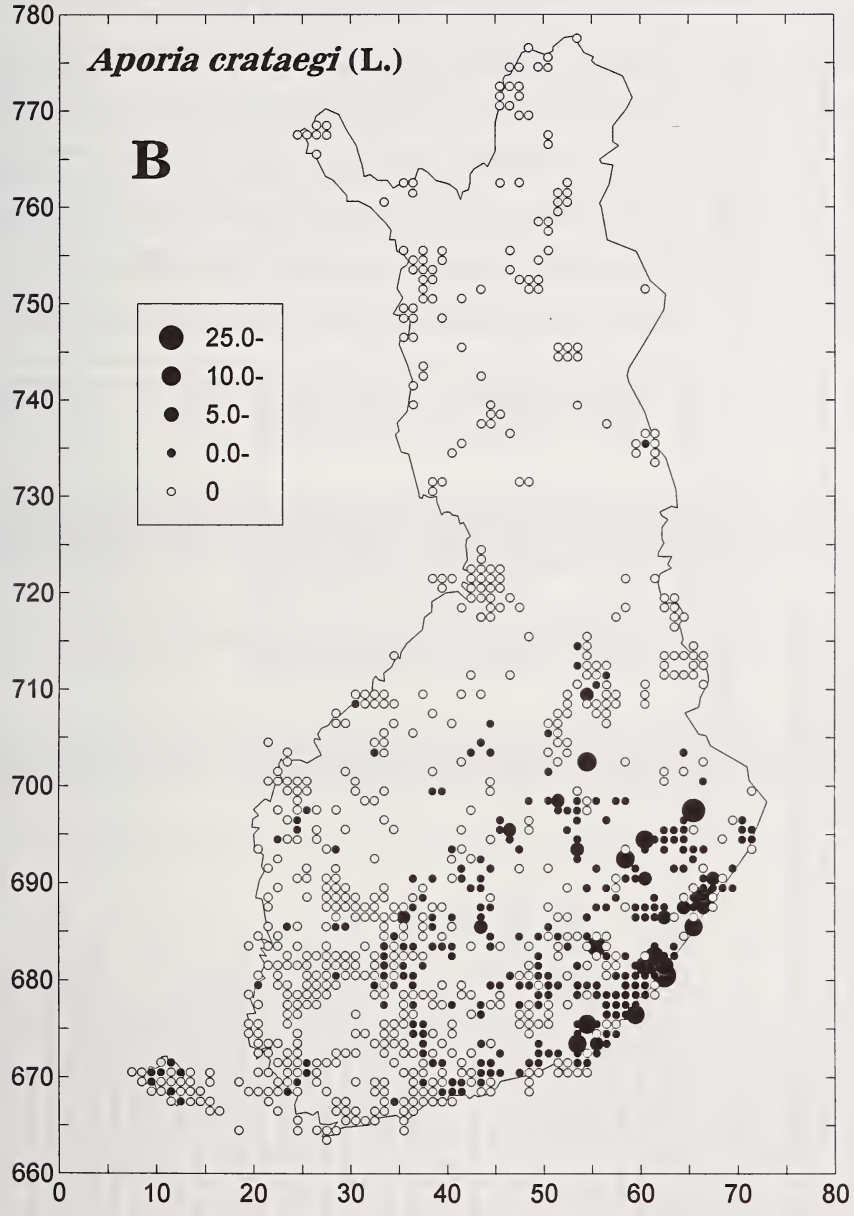


Fig. 4. The accumulative (A) and relative map (B) of *Aporia crataegi* based on data from the first seven-year period (1991–1997). The relative map shows the regional difference in abundance better than the accumulative map. On the accumulative map the total number of individuals in each positive 10 km square is illustrated using



proportionally-sized symbols, while on the relative map the spot shows the number of individuals [$(\Sigma n)/d$, where n is the number of individuals observed in any 10 km square on any day and d is the number of days].

Table 2. The comprehensive list of butterflies found in Finland and the numbers of individuals in the National Butterfly Recording Scheme in Finland during the first seven-year period 1991–1997. The nomenclature follows the checklist of Karsholt & Razowski (1996) with some minor amendments. Non-resident species are marked with an asterisk (*). For annual frequencies (%), see under **Methods** and **Some results**.

	Species	NUMBER OF INDIVIDUALS				FREQUENCY (%) 1991–1997						
		total	average	maximum	minimum							
1.	*Pyrgus andromedae* (Wallengren, 1853)	37	5	10 (94)	0	0	0	< 1	< 1	< 1	< 1	< 1
2.	*P. centaureae* (Rambur, [1839])	249	36	58 (94)	23 (92)	3	4	2	4	2	3	1
3.	*P. malvae* (Linnaeus, 1758)	4,026	575	1,517 (96)	259 (94)	30	26	25	15	20	28	17
4.	*P. alveus* (Hübner, [1803])	420	60	98 (92)	5 (91)	5	10	7	3	6	4	5
5.	**Heteropterus morpheus* (Pallas, 1771)	0	0	0	0	0	0	0	0	0	0	0
6.	*Carterocephalus palaemon* (Pallas, 1771)	990	141	197 (95)	45 (91)	10	10	10	4	6	5	9
7.	*C. silvicola* (Meigen, 1829)	3,661	523	825 (96)	210 (91)	32	38	40	17	21	26	23
8.	*Thymelicus lineola* (Ochsenheimer, 1808)	49,889	7,127	16,975 (95)	1,335 (91)	51	58	51	44	55	49	52
9.	*Hesperia comma* (Linnaeus, 1758)	208	30	56 (96)	7 (91)	4	2	3	2	1	1	2
10.	*Ochlodes venata* (Bremer & Gray, 1853)	16,424	2,346	4,569 (96)	662 (91)	58	53	45	31	45	48	41
11.	*Parnassius mnemosyne* (Linnaeus, 1758)	260	37	66 (93)	0	3	0	2	1	1	1	1
12.	*P. apollo* (Linnaeus, 1758)	678	97	233 (96)	0	0	2	1	1	2	2	1
13.	**Iphiclides podalirius* (Linnaeus, 1758)	0	0	0	0	0	0	0	0	0	0	0
14.	*Papilio machaon* (Linnaeus, 1758)	2,001	286	616 (96)	39 (91)	27	34	34	16	34	34	26
15.	*Leptidea sinapis* (Linnaeus, 1758)	10,519	1,503	2,798 (96)	320 (91)	44	48	45	34	38	42	39
16.	*Anthocharis cardamines* (Linnaeus, 1758)	12,923	1,846	3,660 (95)	532 (91)	49	53	49	35	49	47	29
17.	*Aporia crataegi* (Linnaeus, 1758)	21,332	3,047	11,046 (95)	129 (91)	28	37	22	16	31	23	23
18.	**Pieris brassicae* (Linnaeus, 1758)	3,677	525	2,462 (95)	73 (91)	18	28	19	7	37	15	11
19.	**P. rapae* (Linnaeus, 1758)	3,203	458	1,226 (92)	22 (91)	10	32	21	6	18	11	11
20.	*P. napi* (Linnaeus, 1758)	75,636	10,805	21,656 (95)	2,275 (91)	68	74	73	67	78	67	69
21.	**Pontia daplidice* (Linnaeus, 1758)	151	22	151 (95)	0	0	0	0	0	4	0	0
22.	**P. chloridice* (Hübner, [1813])	0	0	0	0	0	0	0	0	0	0	0
23.	*Colias nastes* (Boisduval, 1832)	70	10	45 (94)	0	0	0	< 1	< 1	< 1	< 1	0
24.	*C. palaeno* (Linnaeus, 1761)	5,726	818	1,777 (92)	196 (91)	34	49	38	25	33	20	14
25.	**C. croceus* (Fourcroy, 1785)	0	0	0	0	0	0	0	0	0	0	0
26.	*C. hecla* (Lefebvre, 1836)	253	36	155 (94)	0	0	0	1	1	< 1	0	1
27.	**C. hyale* (Linnaeus, 1758)	154	22	129 (95)	0	0	2	0	< 1	4	1	0
28.	*Gonepteryx rhamni* (Linnaeus, 1758)	59,497	8,490	17,608 (95)	1,602 (91)	67	62	61	50	62	61	56
29.	*Lycaena phlaeas* (Linnaeus, 1761)	2,870	410	674 (95)	118 (91)	28	24	23	27	28	25	21
30.	*L. helle* ([Denis & Schiffermüller], 1775)	46	7	27 (95)	0	0	1	< 1	< 1	< 1	< 1	< 1
31.	*L. dispar* ([Haworth], 1802)	6	1	5 (97)	0	0	0	0	0	0	< 1	< 1
32.	*L. virgaureae* (Linnaeus, 1758)	27,444	3,921	7,155 (95)	572 (91)	57	55	53	47	54	46	54

33.	*L. hippothoe* (Linnaeus, 1761)	2,697	385	804 (95)	94 (91)	34	23	21	18	22	16	13
34.	*Thecla betulae* (Linnaeus, 1758)	393	56	86 (95)	3 (91)	1	4	3	1	3	2	2
35.	*Neozephyrus quercus* (Linnaeus, 1758)	438	63	162 (95)	0	0	2	2	1	2	2	2
36.	*Callophrys rubi* (Linnaeus, 1758)	56,506	8,072	18,512 (96)	753 (91)	54	54	63	51	63	60	49
37.	*Satyrium w-album* (Knoch, 1782)	109	16	68 (96)	0	0	< 1	2	1	0	< 1	1
38.	*S. pruni* (Linnaeus, 1758)	398	57	159 (95)	19 (91)	9	8	4	3	4	3	3
39.	*Cupido minimus* (Fuessly, 1775)	750	107	396 (95)	0	1	0	2	1	1	1	1
40.	**C. argiades* (Pallas, 1771)	0	0	0	0	0	0	0	0	0	0	0
41.	*Celastrina argiolus* (Linnaeus, 1758)	11,869	1,696	5,494 (96)	59 (91)	27	30	45	36	43	51	37
42.	*Pseudophilotes vicrama* (Moore, 1865)	178	25	71 (94)	0	0	0	< 1	1	< 1	< 1	1
43.	*Scolitantides orion* (Pallas, 1771)	151	22	44 (95)	3 (93)	3	1	1	1	1	1	< 1
44.	*Glaucopsyche alexis* (Poda, 1761)	308	44	129 (95)	4 (91)	5	4	3	1	4	4	1
45.	*Maculinea arion* (Linnaeus, 1758)	77	11	24 (92)	0	0	1	1	< 1	1	1	0
46.	*Plebeius argus* (Linnaeus, 1758)	35,127	5,018	12,339 (95)	588 (91)	37	43	40	35	43	35	36
47.	*P. idas* (Linnaeus, 1761)	17,137	2,448	7,126 (95)	206 (91)	24	33	23	32	36	27	33
48.	*P. optilete* (Knoch, 1781)	10,217	1,460	2,471 (95)	322 (91)	32	43	32	34	32	31	36
49.	*P. glandon* (Prunner, 1798)	31	4	20 (96)	0	0	0	< 1	0	0	< 1	< 1
50.	*Aricia eumedon* (Esper, 1780)	7,760	1,109	2,653 (95)	73 (91)	15	20	23	20	23	18	15
51.	*A. artaxerxes* (Fabricius, 1793)	2,055	294	546 (95)	33 (91)	14	18	14	13	17	13	13
52.	*A. nicias* (Meigen, 1830)	2,236	319	1,214 (97)	0	0	2	2	3	4	3	5
53.	*Polyommatus semiargus* (Rottemburg, 1775)	9,289	1,327	2,468 (95)	338 (91)	43	51	36	26	39	33	35
54.	*P. amandus* (Schneider, 1792)	15,569	2,224	4,183 (95)	270 (91)	34	49	42	35	41	40	41
55.	*P. icarus* (Rottemburg, 1775)	7,963	1,138	2,203 (95)	338 (91)	28	37	29	27	34	32	33
56.	*Argynnis paphia* (Linnaeus, 1758)	2,409	344	983 (95)	48 (91)	5	5	5	4	5	5	5
57.	*A. aglaja* (Linnaeus, 1758)	15,140	2,163	6,210 (95)	246 (91)	38	50	37	37	48	36	38
58.	*A. adippe* ([Denis & Schiffermüller], 1775)	15,011	2,144	6,741 (95)	93 (91)	20	41	35	34	43	27	27
59.	*A. niobe* (Linnaeus, 1758)	1,992	285	665 (95)	17 (91)	4	10	9	8	11	6	6
60.	**A. laodice* (Pallas, 1771)	1	0	1 (94)	0	0	0	0	< 1	0	0	0
61.	*Issoria lathonia* (Linnaeus, 1758)	519	74	237 (95)	1 (97)	1	2	4	3	4	2	< 1
62.	*Brenthis ino* (Rottemburg, 1775)	28,268	4,038	11,762 (95)	372 (91)	43	54	45	42	52	43	44
63.	*Boloria eunomia* (Esper, [1799])	6,817	974	1,509 (96)	141 (91)	17	23	22	21	18	19	16
64.	*B. euphrosyne* (Linnaeus, 1758)	24,390	3,484	6,209 (96)	771 (91)	54	55	58	48	47	46	41
65.	*B. titania* (Esper, [1793])	1,016	145	336 (95)	0	0	2	1	< 1	1	1	1
66.	*B. selene* ([Denis & Schiffermüller], 1775)	25,045	3,578	6,469 (95)	691 (91)	54	57	51	42	51	49	45
67.	*B. chariclea* (Schneider, 1794)	433	62	314 (97)	0	0	0	< 1	1	1	0	2
68.	*B. freija* (Thunberg, 1791)	1,342	192	306 (96)	18 (91)	6	5	10	7	8	8	8
69.	*B. polaris* (Boisduval, 1828)	72	10	19 (97)	0	0	0	< 1	< 1	1	< 1	1
70.	*B. thore* (Hübner, [1803])	255	36	125 (95)	0	0	1	1	1	1	1	1
71.	*B. frigga* (Thunberg, 1791)	1,018	145	294 (92)	3 (91)	4	7	5	6	4	5	4
72.	*B. improba* (Butler, 1877)	12	2	12 (94)	0	0	0	0	< 1	0	0	0
73.	*B. napaea* (Hoffmansegg, 1804)	27	4	14 (94)	0	0	0	0	1	0	< 1	1
74.	*B. aquilonaris* (Stichel, 1908)	5,341	763	1,280 (95)	140 (91)	19	25	21	19	18	15	13
75.	**Vanessa atalanta* (Linnaeus, 1758)	7,986	1,141	6,028 (94)	25 (93)	19	22	4	31	32	22	9
76.	**V. cardui* (Linnaeus, 1758)	5,062	723	3,426 (96)	16 (97)	28	18	4	4	37	56	2

	Species	NUMBER OF INDIVIDUALS				FREQUENCY (%) 1991–1997						
		total	average	maximum	minimum							
77.	*Inachis io* (Linnaeus, 1758)	12,247	1,750	3,598 (95)	442 (91)	30	35	26	25	28	31	23
78.	*Aglais urticae* (Linnaeus, 1758)	55,467	7,924	20,516 (95)	1,660 (91)	72	67	62	61	68	63	44
79.	*Polygonia c-album* (Linnaeus, 1758)	12,173	1,739	3,233 (95)	167 (91)	42	46	46	36	46	44	38
80.	*Araschnia levana* (Linnaeus, 1758)	401	57	146 (97)	0	0	2	1	1	1	1	2
81.	*Nymphalis antiopa* (Linnaeus, 1758)	10,254	1,465	2,364 (97)	263 (91)	52	51	52	38	49	45	48
82.	**N. polychloros* (Linnaeus, 1758)	1	< 1	1 (95)	0	0	0	0	0	< 1	0	0
83.	**N. xanthomelas* (Esper, [1781])	0	0	0	0	0	0	0	0	0	0	0
84.	**N. vaualbum* ([Denis&Schiffermüller], 1775)	0	0	0	0	0	0	0	0	0	0	0
85.	*Euphydryas iduna* (Dalman, 1816)	15	2	6 (96)	0	0	0	1	1	< 1	1	< 1
86.	*E. maturna* (Linnaeus, 1758)	4,135	591	924 (96)	260 (91)	22	16	17	11	14	10	13
87.	*E. aurinia* (Rottemburg, 1775)	1,183	169	418 (96)	33 (92)	3	2	2	2	2	1	1
88.	*Melitaea cinxia* (Linnaeus, 1758)	4,047	578	1745 (91)	3 (97)	3	1	1	2	2	3	< 1
89.	*M. diamina* (Lang, 1789)	1,742	249	937 (95)	1 (91)	1	1	1	1	2	1	1
90.	*M. athalia* (Rottemburg, 1775)	11,129	1,590	4,342 (96)	347 (91)	38	37	38	23	32	37	30
91.	*Limenitis populi* (Linnaeus, 1758)	1,170	167	738 (95)	23 (94)	11	16	8	4	14	6	6
92.	*Apatura iris* (Linnaeus, 1758)	93	13	80 (96)	0	0	0	< 1	0	0	< 1	< 1
93.	*Pararge aegeria* (Linnaeus, 1758)	3,646	521	1,196 (96)	79 (91)	18	19	22	12	16	19	14
94.	**Lasiommata megera* (Linnaeus, 1767)	0	0	0	0	0	0	0	0	0	0	0
95.	*L. petropolitana* (Fabricius, 1787)	7,590	1,084	2,340 (96)	197 (91)	32	29	32	24	29	31	29
96.	*L. maera* (Linnaeus, 1758)	21,923	3,132	6,587 (95)	797 (91)	43	53	46	36	47	42	34
97.	*Lopinga achine* (Scopoli, 1763)	150	21	50 (94)	0	0	1	1	< 1	< 1	1	0
98.	*Coenonympha tullia* (Müller, 1764)	3,212	459	734 (92)	95 (91)	20	24	17	12	14	11	12
99.	*C. glycerion* (Borkhausen, 1788)	8,288	1,184	1,891 (95)	414 (91)	17	22	15	18	19	17	14
100.	**C. hero* (Linnaeus, 1761)	0	0	0	0	0	0	0	0	0	0	0
101.	*C. pamphilus* (Linnaeus, 1758)	6,829	976	1,384 (95)	480 (91)	33	32	24	22	22	22	19
102.	*Aphantopus hyperantus* (Linnaeus, 1758)	54,783	7,826	12,798 (95)	2,270 (91)	63	55	50	45	51	52	55
103.	*Maniola jurtina* (Linnaeus, 1758)	667	95	149 (92)	26 (97)	3	3	2	2	3	3	2
104.	**Hyponephele lycaon* (Rottemburg, 1775)	0	0	0	0	0	0	0	0	0	0	0
105.	*Erebia ligea* (Linnaeus, 1758)	34,658	4,951	12,849 (97)	808 (91)	56	32	47	25	50	32	54
106.	*E. embla* (Thunberg, 1791)	787	112	201 (94)	15 (91)	5	3	4	6	3	4	4
107.	*E. disa* (Thunberg, 1791)	413	59	162 (94)	0	0	1	< 1	2	1	2	0
108.	*E. polaris* (Staudinger, 1871)	542	77	283 (94)	0	0	0	1	1	2	0	1
109.	*E. pandrose* (Borkhausen, 1788)	966	138	538 (97)	0	0	1	2	3	2	1	2
110.	**Melanargia galathea* (Linnaeus, 1758)	0	0	0	0	0	0	0	0	0	0	0
111.	*Hipparchia semele* (Linnaeus, 1758)	1,551	222	427 (93)	121 (91)	4	5	6	4	3	4	2
112.	*Oeneis norna* (Thunberg, 1791)	133	19	47 (97)	0	0	0	1	2	1	1	< 1
113.	*O. bore* (Schneider, 1792)	64	9	28 (93)	0	0	0	1	1	1	< 1	1
114.	*O. jutta* (Hübner, [1806])	3,894	556	1,390 (94)	0	0	24	1	19	1	15	0

Discussion

The progress of NAFI mostly depends on the number of participants. During the seven-year period a total of 306 persons took part in the scheme. One fifth (188, 21%) of all members of the Lepidopterological Society (altogether about 900) have participated in NAFI for one year at least. Another 118 participants, comprising more than one third of the total (39%), have been naturalists but not members of the Society. We suggest that there are two main reasons for the positive progress. Firstly, the general interest in butterflies has grown in Finland during the 1990s, and secondly, NAFI has taken good care of the participants. They have been supplied with regular feedback of their work via the annual results published in the Society's bulletin, and most of the participants have personally received new forms with a covering letter every spring. In addition, five-year results (1991–1995) with accumulative maps of all 114 butterfly species have been published (Marttila & Saarinen, 1996b). Non-member participants have become acquainted with NAFI through reprints, the media and previous participants.

Validity of methods. The data on forms and in computer files is checked carefully as described under *Methods* above, but still the most serious question is how to ensure the reliability of the information sent in on forms. This problem is aggravated by the fact that all the participants are not registered members of the Lepidopterological Society. In order to minimize the risk of incorrect data, all questionable observations, whether provided by a member or not, have been checked by contacting the observer. There are some details which have made the authors dubious, such as the species being reported well outside of its known distribution area, or a periodical species being observed in a wrong year, or where a rare species inhabiting mires has been reported whereas no information on more common species living in similar environments has been given. If there still exists some doubt as to the authenticity of the observation after it has been followed up, it has not been computerized.

Broadly speaking, the maps based on the NAFI results are in line with earlier maps published in the handbook of Finnish butterflies (Marttila *et al.*, 1991). There is no reason to suspect that previous knowledge would not have been good enough to

show the essential distribution of any species living in Finland. Some similar species (*Plebeius argus*/*P. idas, Argynnis aglaja*/*A. adippe*), previously known to have different distributions, have provided a good control. The differences between these species have also been revealed in NAFI.

The observation network covers almost the whole country, except that a few regions in the northern part of Finland are poorly represented in comparison to the southern parts of the country. The poor network in the north causes an effect that the frequencies of 'northern' species tend to be underestimated. To avoid this possible bias the country could be divided into two subareas, a southern and a northern one, after which the frequencies of "northern" species could be assessed independently. However, even in "northern" species the distribution areas vary greatly from one species to another. That would cause a difficulty how to define the position of the line with no risk of underestimating or overestimating certain species occurring in the area concerned.

Something new already. The seven-year data applies to almost 890,000 butterfly individuals, representing all the Finnish resident species (95) and 8 of a total of 19 non-resident species. The NAFI results are largely parallel to previous knowledge of Finnish butterflies (Marttila *et al.*, 1991, Rassi *et al.*, 1992, Somerma, 1997), but the data also suggest some new trends.

The NAFI results point to the possibility of changes in the distributions of some species. When the distribution maps are compared to corresponding ones given in the handbook of Finnish butterflies (Marttila *et al.*, 1991), *Limenitis populi, Apatura iris* and *Argynnis paphia* show some expansion, while the ranges of *Lycaena helle, Glaucopsyche alexis, Issoria lathonia* and *Maniola jurtina* have decreased.

The trends in annual frequencies in nine species, almost all declining, *might* show — we say so, though the trends during the period were statistically significant — that the status of these species is undergoing a change.

The results for two species are alarming in particular. *Lycaena hippothoe* and *Glaucopsyche alexis* have had surprisingly low individual numbers, 2,697 and 308, respectively. In addition, there has been a significant fall-off in the annual frequencies of *L.*

hippothoe, while the range of *G. alexis* has strongly decreased in comparison to the distribution map given in the book of Finnish butterflies (Marttila *et al.*, 1991). The book classifies these species as fairly common and scarce, respectively, whereas the recent book on Finnish threatened Lepidoptera does not mention the species at all (Somerma, 1997).

The seven-year period of NAFI is not long enough to provide extensive conclusions about changes in the status of butterflies. Some changes observed during the period might form a part of natural long-term fluctuation, but some of them might also be cautionary, indicating an actual decline in adversely affected species. Most importantly, the scheme reveals the downward trend of these species earlier than could be detected previously. Thus, conservation projects, if needed, can also be launched earlier than before.

Acknowledgements

We wish to thank all those lepidopterists taking part in the scheme. We are grateful to Dr. Tapani Lahti for creating the computer program and to our secretary Seija Pohjalainen for helping with the computer work.

References

Karsholt, O. & Razowski, J. (eds.), 1996. The Lepidoptera of Europe. A distributional checklist. — Apollo Books, Stenstrup. 380 p.

Marttila, O., 1992. Päiväperhosseurannan vuoden 1991 tulokset. — *Baptria* 17: 17–21.

Marttila, O., 1993. Päiväperhosseurannan vuoden 1992 tulokset. — *Baptria* 18: 1–7.

Marttila, O., 1994. Päiväperhosseurannan vuoden 1993 tulokset. — *Baptria* 19: 41–51.

Marttila, O. & Saarinen, K., 1995. Päiväperhosseurannan vuoden 1994 tulokset. — *Baptria* 20: 35–46.

Marttila, O. & Saarinen, K., 1996a. Päiväperhosseurannan vuoden 1995 tulokset. — *Baptria* 21: 17–28.

Marttila, O. & Saarinen, K., 1996b. Valtakunnallinen päiväperhosseuranta. Ensimmäisen viisivuotisjakson (1991–1995) tulokset. *In*: Marttila O. & Saarinen K. (eds.). Perhostutkimus Suomessa. South Karelia Allergy and Environment Institute, Joutseno. p. 22–43.

Marttila, O. & Saarinen, K., 1997. Päiväperhosseurannan vuoden 1996 tulokset. — *Baptria* 22: 7–18.

Marttila, O., Haahtela, T., Aarnio, H. & Ojalainen, P., 1991. Suomen päiväperhoset, 2nd ed. — Kirjayhtymä, Helsinki. 370 p.

Pollard, E., Hall, M. L. & Bibby, T. J., 1986. Monitoring the abundance of butterflies 1976–1985. — Nature Conservancy Council, Peterborough. 280 p.

Pollard, E. & Yates T. J., 1993. Monitoring butterflies for Ecology and Conservation. — Chapman and Hall, London. 274 p.

Rassi, P., Kaipainen, H., Mannerkoski, I. & Ståhls, G., 1992. Report on the monitoring of threatened animals and plants in Finland. — Ministry of the Environment, Helsinki. 328 p. (In Finnish, English summary).

Saarinen, K. & Marttila, O., 1998. Valtakunnallisen päiväperhosseurannan vuoden 1997 tulokset. — *Baptria* 23: 27–37.

Sokal, R. R. & Rohlf, F. J., 1981. Biometry : The principles and practice of statistics in biological research. 2nd ed. — WH Freeman and Co., San Francisco. 859 p.

Somerma, P., 1997. Suomen uhanalaiset perhoset. — Suomen ympäristökeskus & Suomen Perhostutkijain Seura, Helsinki. 336 p.

Stoltze, M., 1996. Danske dagsommerfugle. — Gyllendal, Copenhagen. 383 p.

van Strien, A. J., van de Pavert, R., Moss, D., Yates, T. J., van Swaay, C. A. M. & Vos, P., 1997. The statistical power of two butterfly monitoring schemes to detect trends. — *J.appl.Ecol.* 34: 817–828.

van Swaay, C. A. M., Maes, D. & Plate, C., 1997. Monitoring butterflies in the Netherlands and Flanders: the first results. — *J. Insect Conservation* 1: 81–87.

Väisänen, R., 1992. Conservation of Lepidoptera in Finland: recent advances. — *Nota lepid.* 14: 332–347.