Suomen ympäristökeskuksen moniste

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Monitoring bumblebees and other pollinator insects

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Helsinki 1997
Finnish Environment Institute

PAINOPAIKKA:
Oy Edita Ab
Helsinki 1997

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1 PREFACE

Although species mapping has long traditions in Finland, there are few methods for the follow-up of population changes. Especially for the species rich group of insects - encompassing about 50% of all known biological species in this country - there are very few applicable monitoring methods. Still it is generally acknowledged, that the best indicators for biotope change are to be found in this group. The national Moth Monitoring Scheme, started in 1993, is so far the only significant scheme to monitor population change in an invertebrate group (Söderman et al. 1994, 1995).

Pollinator insects comprise a taxonomically heterogeneous group. These insects play a key role in the propagation of many flowering plants. They also have a central function in pollinating important cultivated flowering species like clover, fruit trees and wild berries. So far, only the honey bee (*Apis mellifera*) is bred for economic reasons.

The most important pollinators in northern Europe are bumblebees, bees, wasps (Hymenoptera, Aculeata) and flies (Diptera), especially hoverflies (Syrphidae). The highest species numbers of bumblebees are found in the Nemoral and Boreal regions (Pekkarinen and Teräs 1977). In the other groups the species number grows towards south. The species numbers in Finland are not very high: 35 species of bumblebees and cuckoo bees (Pekkarinen et al. 1981), about 180 bee species (Elfving 1968), about 40 wasp species (Pekkarinen 1982, Pekkarinen 1988, Pekkarinen and Hulden 1991, Pekkarinen & Hulden 1995) and about 280 species of hoverflies (Hackman 1980, Torp 1994). Most species of these groups are easily identified and there is good determination literature for all groups except the bees. Dr Antti Pekkarinen and Dr Ilkka Teräs kindly helped us with the determination of some aculeate Hymenoptera specimens, for which we are very thankful.

The systematics and taxonomy in this study follow in principle Vikberg (1986) and Torp (1994).

2 THREATS TO BUMBLEBEES AND OTHER POLLINATOR INSECTS

The relative number of threatened species of these pollinator insect groups is in Finland rather high in comparison to other groups of the same insect orders (Komiteanmietintö 1991). This is mainly due to the fact, that both intensive and extensive changes have occurred in Finnish land use during the last five decades. The most threatened species are associated with dead wood, i.e., saproxylophagous species that need old woods as breeding habitats. Natural or seminatural habitats for foraging and breeding have also diminished in many places as they have partly been taken into economic use through cultivating fields and partly become overgrown by forests. Species in these habitats are today more threatened further south, in Denmark (Torp 1994), Britain (Prys-Jones and Corbet 1991) and Germany (Hagen 1994). In these countries it has also been observed, although not through systematic recordings, that certain species visiting flowery meadows have severely declined in number, although they are not yet classified as threatened.

2.1 Threats to bumblebees

We recognise three main threat categories for the occurrence and population development of bumblebees: (1) loss of feeding habitats, (2) loss of breeding habitats, (3) increasing car traffic.

(1) Bumblebees forage on the nectar and pollen of flowers. Loss of feeding habitats may lead to declining status of bumblebees as meadows and road verge vegetation disappear in connection with more effective modern land use. The increasing cultivation of plants in monocultures has deprived large areas of natural flowering plants, in particular through the additional application of weed-killers. Despite that the use of insecticides and fungicides, which can be hazardous for bumblebees, has decreased in Finland, the use of weed-killers does not show any declining trend. The cutting of road verge vegetation, often in midsummer, leads also to the deprivation of feeding habitats for bumblebees. Even if there is a recognised loss of natural feeding habitats, man has, on the other hand, through garden plantations, forest clearings and extensive turnip rape and clover cultivation also created new foraging sites. The loss of potential feeding habitats is therefore not too severe in the summer. The critical time is the spring, when flowering willows provide the only food available for hibernated queen bumblebees. The increased cover and land draining have reduced willow stands at many places, and this has accentuated the loss of feeding sites for many bumblebee species. A special case is *Bombus consobrinus*, which only occurs in groves with *Aconitum* stands. Such specific habitats are found only in two places in Finland today, and as a consequence, this species has been classified as vulnerable.

(2) The Finnish bumblebee species can be divided into three groups according to their breeding habitats:

(a) species that predominantly build their nests in holes in the ground (*Bombus lucorum, B. terrestris, B. soroeensis, B. jonellus, B distinguendus, B. subterraneus* and all the *Bombus* species in Lapland). These species are dependent on existing vole holes and open ditches. Cover draining has severely lessened the possibility of finding such sites. Fields not under cultivation, grassy slopes and open forest glades are very suitable breeding biotopes for these species, because they are often impregnated by abandoned holes made by voles. After good vole years there is an abundance of available nesting sites, but the regional differences are often considerable.

(b) species that predominantly build their nest on the ground surface (*B. ruderarius, B. veteranus, B. sylvarum, B. muscorum, B. laevis*). These species are sensitive to mechanical disturbances of the ground and grass burning. Furthermore, these species usually have smaller colonies than those of the previous group, and they disappear faster from sites under disturbance. The majority of these species have declined considerably in Central Europe in recent years, and two species have been classified as rare and care-demanding in Finland.

(c) indifferent species that build their nest either on, or in, the ground depending on the local circumstances. These species (*B. hortorum, B. pascuorum, B. pratorum, B. lapidarius* and *B. hypnorum*), of which the last mentioned often nests in tree-hollows, prefer cultural habitats and adapt rather well to changes in the environment.

(d) cuckoo bees (*Psithyrus*) group according to their host species.

(3) Increasing traffic kills a lot of bumblebee individuals. To exemplify this, a count of dead bumblebees (predominantly *B. lapidarius* and *B. hortensis*) along a 100 m long road section at S.Möckleby (Öland, Sweden) was made daily during the week following the midsummer weekend of 1996. Between 80-135 dead specimens, mostly queens, were killed every day! Although traffic probably kills more bumblebees than any other single factor, there is no evidence of any effects on neither the occurrences nor the populations of bumblebees in countryside areas. We believe that it may be a contributing factor to declining populations and loss of species in densely populated areas, in cities and suburbs, where the paving of ground forces the bumblebees to seek for breeding sites along major roads. Once again, spring is the most sensitive season, when the hibernated queens look for suitable breeding grounds.

2.2 Threats to bees

Most wild bees build their nests in the ground, although species of some genera have specialised in building nest in woody material. For a large part the threat categories are the same as for bumblebees, but solitary bees are more specialised in their foraging, using only red, violet and blue flowers. Thereby the loss of feeding habitats might be equally important as the loss of breeding habitats. Bee communities would then be more sensitive to changes in flower diversity than the more generalist bumblebees.

2.3 Threats to wasps

Wasps are predominantly indifferent. Social wasps mainly feed their colonies with other invertebrates (often flies) and adult wasps visit flowers only for their individual nutritional need. The solitary wasp leaves a paralysed insect or spider in its small nest and afterwards leaves it. Adult solitary wasps visit flowers for their nutrition, but appear to be more selective in their flower choice than the social wasps. Solitary wasps, furthermore, seem to visit yellow flowers more seldom than white and violet ones.

2.4 Threats to hoverflies

The hoverfly species may be divided into three groups with respect to their ecology and threat categories:

(1) species whose larvae feed on aphids (predominantly the subfamily Syrphinae) and which are important in nature's own biological control. These species are mainly threatened by insecticides used for aphid pest control. No species of this group has yet been classified as threatened in Finland, but the knowledge of population changes of the species is very poor (Komiteanmietintö 1985, 1991). In Central Europe and Britain there are already many species belonging to this group that have become extinct or threatened (Torp 1994).

(2) species whose larvae develop in manure, sludge and small water ponds in the countryside (predominantly the subfamily Eristalinae) and are sapro- or coprophagous. These species are threatened by the decline of traditional cattle-breeding and pasturing and by the substitute use of mineral fertilisers. Neither in this group has any species

been classified as threatened in Finland. The knowledge is however quite poor in this case too, and we believe that at least some of the species have been more common in the 1930's and 1940's.

(3) species whose larvae live in decomposing wood or in small temporary water-pockets of tree-holes. Many of these species are threatened by the loss of old forests. Almost every species of this category has become rarer in Finland and many are classified as vulnerable or endangered (Komiteanmietintö 1991).

3 GOALS AND METHODS OF THE STUDY

3.1 Background

The idea for monitoring bumblebees and other insect pollinators arouse in the summer 1995, when during a study on the effectiveness of commercial moth pheromones, numerous other insects, in particular bumblebees, bees, wasps, and hoverflies were caught in these traps. We deduced the reason for this to be in the yellow and white colours of the trap, although the effect of pheromones could not be fully excluded. We decided to study the effect of the colour on the insect captures in more detail during the next summer, in 1996. The study was included in a methodological test framework for the development of a Nature Monitoring Scheme for the Nordic Council of Ministers.

3.2 Goals of the study

The following questions were set up:

1) Are yellow colour-traps suitable for monitoring bumblebees and other pollinator insects and what restrictions are connected to the technique?
2) How extensively can the species composition of the groups be covered by this method?
3) What kind of diversity calculations can be done on the basis of the captures?
4) If the colour-traps prove to be sufficient for monitoring purposes, what kind of a monitoring scheme will be needed?

3.3 Study methods

Scientific biodiversity calculations require both data on the number of species and the number of individuals (Woiwod & Riley, 1996). In literature no standard bumblebee monitoring techniques that could provide such data on long term are mentioned. Bumblebee counts based on flower visits and standardised observation routes have been described by Teräs (1985). Identification is to some extent difficult in the field, and almost impossible if other pollinators than bumblebees are to be included. Counts along observation routes (similar to Pollard walks for butterfly counting) will only give data on local species occurrence and to some extent frequency indexing can be used. One individual might however appear on several consecutive days and fly from one section to another during the counting period -- therefore numerical counts may be highly

biased. In Germany, small cups filled with fructose have been used for local species inventories of bumblebees (Hagen, 1994), but this point-counting technique tells equally little about the size of the colonies and populations in the area.

Trap sampling, provided that removal of individuals will not decisively affect the natural populations, gives a better basis for both identifying and counting the individuals of all groups. The conventional trapping technique has for long been the use of yellow water-pans (cf. Sahlén, 1994). This technique is based on the assumption that the yellow colour will attract the insects like flowers. The pan is filled with water and a surface tension diminishing fluid into which the individuals drown. Yellow waterpans (or yellow-coloured sticky paperboards) are frequently used in agricultural pest control, but the weakness of the method is in the openness of the pan. The use of waterpans will require repeated emptying of the pans if the specimens caught are to be not only killed but also transported for later identification and counting. The open pan is particularly unsuitable in rainy periods, when it will be filled to the rim and overflown with the consequence of loss of some of the captured specimens.

Commercially available traps (originally used as pheromone traps) are better designed for sampling. They come in many colours, and one version has a yellow upper part (collar) and a white lower part (sample container). It is equipped with a green-coloured roof that prevents rain from entering the trap. A strap of DDVP, placed in the sample container, acts as a killing agent. The DDVP strap is effective throughout the season. The sample of such a colour-trap will remain in good condition for later identification and counting, and the traps themselves do not need frequent maintenance nor frequent emptying.

The yellow collar acts as the attractant. Throughout the trapping season it simulates a succession of yellow flowering plant species (*Salix, Caltha, Trollius, Taraxacum, Ranunculus, Lathyrus, Melampyrum, Hieracium, Chrysanthemum vulgare, Solidago,* etc.). The weakest link in nature, within the Boreal region, is at the turn of June-July, when there are a few yellow flowering species but a lot of other coloured flowers for competition. Because the attraction of the traps is based only on the colour, they will not be very competitive with fragrant flowers of the later part of the summer.

3.4 Study sites

Of the 23 study sites 17 were situated in southern Finland (20 colour-traps) and 6 in Kainuu in eastern Finland (fig. 1, annex 1). The sites were chosen close to the sites of the Moth Monitoring Scheme, so that the sampling costs could be minimised. The traps were hung between 1-2 m above the ground. The traps were emptied weekly.

In southern Finland one trap per site was used, but in Kainuu 3 traps per site in order to measure the variation between the traps. The traps in southern Finland were active between the weeks 18 - 40 and in Kainuu between the weeks (21) 26-38.

At one site, in Sipoo Nikkilä, a comparatory study was made between captured species and species flying within a radius of 50 m from the trap. In this study all species and specimens were recorded *in situ* during the day the trap was emptied.

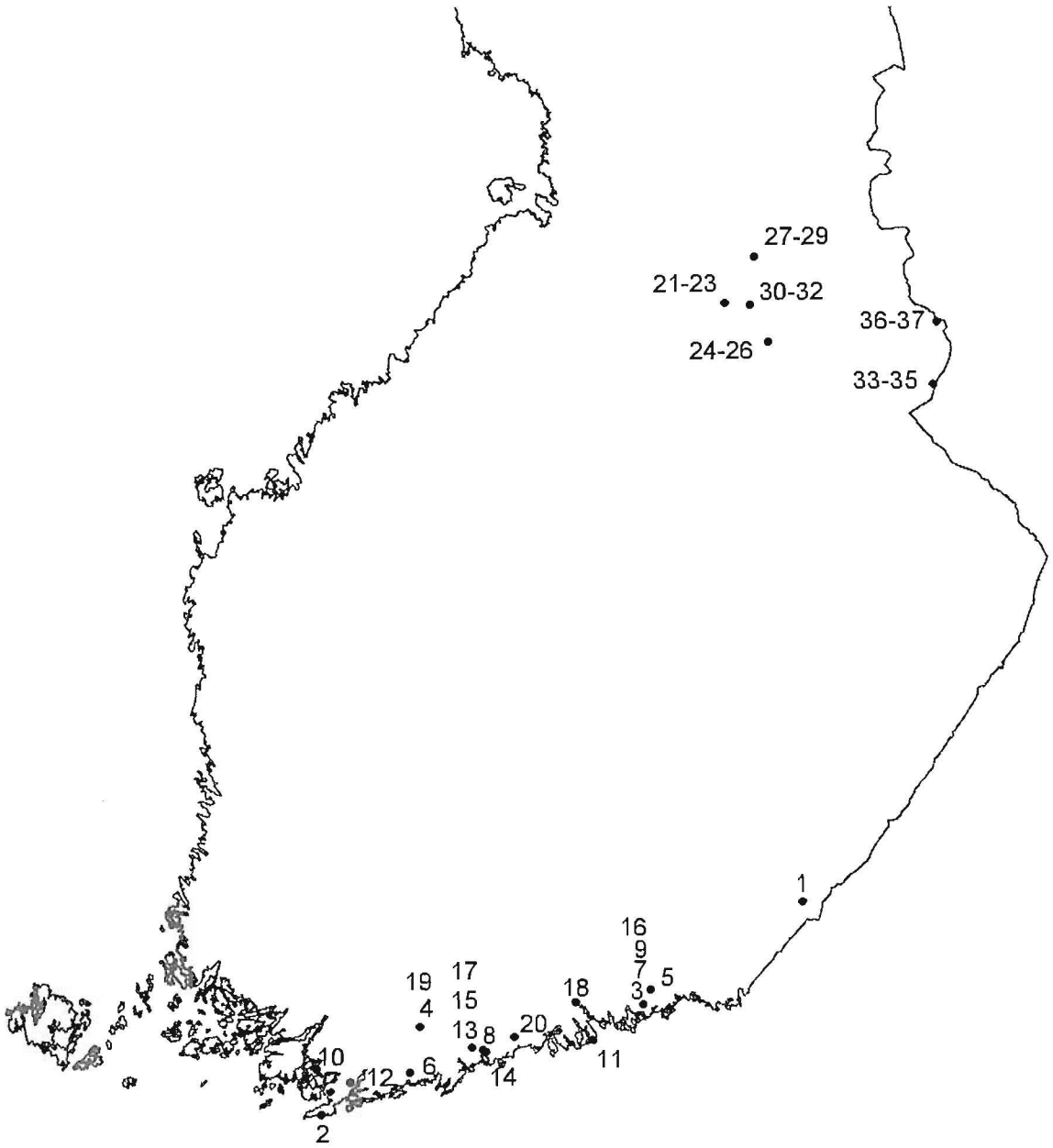


Fig. 1 Location of trap sites in the study

3.5 Weather conditions during the study period

The weather conditions during the study period were not too good. Early summer was much colder than on the average and also wetter (table 1). Different weather factors have different influence on the activity of the pollinator insects. Bumblebees are less demanding and well adapted to the boreal climate. They can fly at low temperatures and in cloudy weather (in Lapland even all day around), but they avoid rain. The number of rainy days therefore influences the possible captures. Social wasps can also be active during poor weather conditions but they do not prefer to fly actively on cool days. Wild bees require warm days to be very active and hoverflies are the most demanding

concerning weather. They require both warm and sunny days to be active, and although they can fly in a small breeze, most species prefer calm weather. During the summer 1996 there were at least two writings in the newspapers wishing for better weather for the pollinator insects, as the yields of both the turnip rape and wild berries were feared for - and they were in fact lower in 1996 than during previous years.

Table 1. Weather statistics for the study period

	May	June	July	Aug.	Sept.
Hki-Vantaa airport					
- mean temperature	+9.3	+13.5	+14.7	+17.6	+8.8
- dev.normal	-0.6	-1.4	-1.9	+2.6	-1.2
- rainy days	12	8	12	3	4
- % normal	248	117	207	11	60
Kajaani airport					
- mean temperature	+5.7	+12.2	+13.4	+15.3	+8.8
- dev.normal	-1.8	-1.1	-2.2	+2.2	-1.0
- rainy days	9	14	12	4	3
- % normal	118	178	138	28	15

4 RESULTS

4.1 Functionality of the technique and its restrictions

In connection with the study, we used 50 green coloured traps with moth pheromones in the vicinity of the yellow colour-traps. Bumblebee males extract pheromones that compose of fatty acid derivatives and terpene alcohols and esters as scent-marks when luring females. Since these compounds are close to those of moth pheromones, we checked if the moth pheromones had any effect on the captures of 1995. The results were negative. In 1250 capture weeks only 3 bumblebee males were found in the green traps.

The collar of one green trap was painted white. This trap was placed in the beginning of August in Pyhtää Länsikylä and it captured very few specimens, mostly wasps. Because many pollinator insects prefer white flowers we anticipated that the white colour would attract some species, but the result from the short period (and from only one trap) was not exclusive. Red colour was not tested because insects are red-colour blind, but we believe that blue colour should still be tested.

The colour tests showed that yellow-collared traps are effective. The effectiveness can perhaps be increased by changing the bright yellow colour towards more phosphorous yellow (cf. Sahlen 1994), or by adding a mixture of sugar and water (1:1 ratio) to replace the conventional pheromone liquid. We did not study this, because we regarded the captures from the yellow-traps to be large enough. We noted, however, that during weeks with large captures of bumblebees the killed specimens released a thin sticky film

of pollen and nectar on the bottom of the sample container. This may to some extent increase the attraction of the trap as the sticky film produces scent. The scent wares off rather quickly, and it was not observed to have a cumulative effect upon later captures.

Prys-Jones (1982) has demonstrated that different bumblebee species visit flowers of different structure depending of the direction of the corolla. *Bombus lapidarius* and *B. lucorum* prefer flowers opening upwards, *B. pascuorum* and *B. hortorum* flowers that are directed to the side, and *B. pratorum* visits flowers that open both upwards, to the side and downwards. The structural design of the colour-trap could then have some effect upon the relative capture of different species. The yellow collar of the trap is fairly well exposed to the sides and it curves gently inwards to the funnel. This means that bumblebees can land on the collar crest. The surface of the plastic is, however, so slippery that a landing probably leads to falling into the funnel and the sample container. The captures do not clearly indicate that the structure of the trap would have any significance to the relative capture of different species. On the other hand, as this study was based on passive trap sampling, only a limited number of observations were gained on how the bumblebees and other pollinator insects behaved when attracted to the colour. We often observed that many individuals flew away and did not react to the colour, whereas some stopped to "buzz" in front of the trap, before flying away. Active observations on the behaviour of different species can lead to a better understanding of the captures themselves.

The yellow colour-traps caught surprisingly many pollinator insects (table 2; Annex 2). As expected, the species composition was higher in southern Finland than in Kainuu, but the differences in bumblebees - and also in hoverflies - were quite small. Remarkably almost twice as many bumblebee individuals were captured in Kainuu as in southern Finland.

The weekly samples showed phenological differences between the pollinator groups (fig. 2). Bumblebees predominate in southern Finland in spring and early summer, the hoverflies are most numerous in midsummer, and in autumn social wasps and migrating hoverflies take over. Wild bees were recorded only in early summer. In Kainuu Finland bumblebees predominated throughout the study period, except for the last weeks, when migrating hoverflies became more common. The graphs show also that the trap sampling should have been started 1-2 weeks earlier.

Table 2. Captures in the two study areas

	southern Finland (20 traps)	Kainuu Finland (18 traps)
Bumblebees & Cuckoo bees		
species	15	11
individuals	1684	3082
Bees		
species	11	6
individuals	72	76
Wasps		
species	8	7
individuals	564	147
Hoverflies		
species	48	38
individuals	1809	648

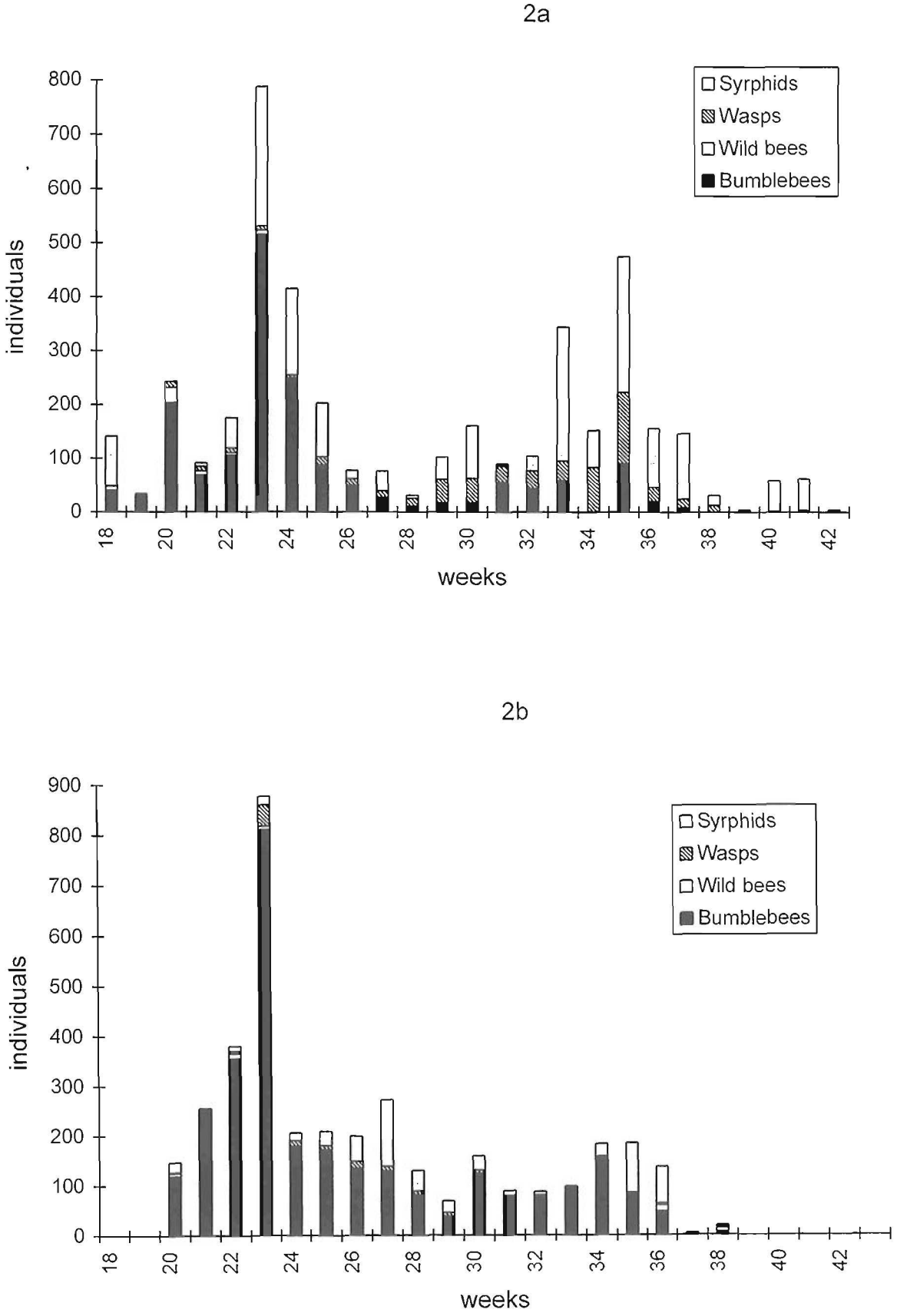


Fig.2 Phenology of different pollinator groups in Southern Finland (a) and Kainuu Finland (b).

4.2 Species coverage

4.2.1 Bumblebees and cuckoo bees

According to literature bumblebees are generalists and visit many different flowers. More than 75% of the Finnish species are known to visit yellow flowers. Less is known about the northern species, but they probably behave similarly. Apparently only one Finnish species, *B. consobrinus*, does not visit yellow flowers. Hence, the yellow collared traps are potentially well suited to monitor bumblebees. In the study 16 species were identified and of all possible species within the mentioned geographical ranges only the rarest and most local species (*B. subterraneus, B. terrestris, B. muscorum, B. laevis* and some *Psithyrus* species) were not captured.

The species that are indifferent as to their breeding habitats were most common in the captures. *Bombus pratorum* predominated along forest edges, particularly in Kainuu. *B. pascuorum* was most common close to cultivated fields. The hole nesting *B. hypnorum* belongs also to the most common species. *B. hortorum* was not common anywhere, but it was captured from many sites. This species usually has small colonies, which may explain the low number of captured individuals. The only indifferent species that appeared to be scarce was *B. lapidarius*. This, originally Mediterranean, species prefers stony and rich flowering meadows and is well adapted to densely populated areas. The reason for the low numbers might be, that it flies much higher than other species, several metres above the height of the colour-traps (Bringer 1973). *Bombus cingulatus* probably belongs to the indifferent group as well, but only one individual was captured in Kainuu. The species is northerly in its distribution and locally common, but it is on the southern limit of its distribution in Kainuu, which might explain its scarcity. The cuckoo bees of indifferent species are rare in Finland, and only *Psithyrus sylvestris* and *P. bohemicus* were captured.

Of the underground nesting species *Bombus lucorum, B. soroeensis* and *B. jonellus* were numerous in the study. *B. jonellus* was common only in the Kainuu study area. No records were made of the rare *B. subterraneus* and *B. terrestris,* but several individuals of the local *B. sporadicus* were captured in Kainuu and one female in Pyhtää. *Bombus distinguendus* was very local in the study -- only a single female was captured in Pyhtää. This species has smaller colonies than the other species of this group, which might explain its sparseness in the captures. All underground nesting species were captured in lower numbers than the indifferent species. Moreover, the regional differences were more pronounced in these species, which indicates that at least in some areas, in particular around the capital conurbation, they appear to have difficulties in finding suitable nesting habitats.

Of the species nesting on the ground only three species were captured and in very low numbers: only a few individuals of *Bombus veteranus* and only one worker of *B. sylvarum*. The third species, *B. ruderarius*, turned out to be rare and local too, although older studies claim it to be quite common and widespread in Finland. *B. muscorum* and *B. laevis* were not captured at all.

The results indicate that species that adapt more easily to changes in land use may maintain viable populations in spite of fast changes in the landscape. Also the relative

abundance of the bumblebee species tends to emphasise the importance of available nesting habitats.

4.2.2 Bees

About 70% of the Finnish bee fauna is known to visit yellow flowers. The study results, however, clearly indicate that the yellow colour-trap technique is not particularly suitable for the monitoring of this group -- only 13-14 species were captured. We find the following explanations plausible: (1) the visit of bees to different flowers is much more based upon the scent than mere colour of flowers, (2) wild bees prefer to visit other coloured flowers if present, (3) the bee fauna has been impoverished and the results reflect the actual species composition.

The social bee, *Apis mellifera*, was captured only in small numbers. This is to be regarded as good, because it shows that colour-traps will not affect the population of cultivated populations to a harmful degree. The social bee (the Nordic race) was most numerously captured in Paltamo, Melalahti, only ca. 1 km away from the closest beehives.

None of the species, except *Evylaeus fratellus*, can be considered to be numerously captured. Noticeable is, that of the few captured species 3 are inquilines (20%).

4.2.3 Wasps

The most common social wasp species recorded in the study were *Dolichovespula norwegica*, which was particularly common in the spring, and *Vespula vulgaris*, which was common in the late summer and autumn. Four other species were recorded, but none of the inquiline species. Social wasps are eurytopic and adapt quite well to environmental change. Although they can be monitored with this technique, they are not particularly good as indicator species. They may, however, serve as a reference group, since it is well known that they react with changes in distribution and colony size upon changes in annual weather conditions. Five solitary wasp species were caught in single number. Solitary wasps apparently only occasionally enter yellow colour-traps according to the study results.

4.2.4 Hoverflies

According to literature only some 20-25% of the Finnish species are known to visit yellow flowers. This reduces essentially the possibility to monitor this group as a whole with the colour-trap technique. In the study 64 species were captured, of which many were represented by only a single individual. Even if the number of species could be increased by several years of monitoring, still at least the saproxylophagous species, which are good indicators of old forests, will be missing, as they very seldom visit flowers. The species indicating changes in countryside activities were less captured than we expected. Several species of the subfamily Eristalinae are known to visit regularly yellow flowers in Sweden and Denmark, at least in spring, but they were very scarce in this study. There may be several reasons for this: (1) the species emerged later than usual because of the cold spring and were flying actively when there were ample amounts of other flowers competing with the colour-traps, (2) these species orientate themselves more by scent, (3) the fauna has been impoverished.

Most captured species belong to the subfamily Syrphinae. The most common syrphids in the study belonged to the genus *Syrphus*. *S. ribesii* and *S. vitripennis* occurred in two generations in southern Finland, whereas *S. torvus* was more common in Kainuu Finland. Some common syrphids can be attributed to migrations, such as *Episyrphus balteatus* and most probably also *Meliscaeva cinctella* in Kainuu Finland. Some rare species were encountered, i.a. all the *Pipiza* species in Kainuu Finland, of which *P. signata* has not earlier been reported from Finland. Notable is also the capture of all Finnish *Didea* species. These species have become extinct or highly threatened in western Europe (Torp 1994).

4.3 Site specific results

We studied the variation between traps in Kainuu Finland by using three traps per site. The differences proved to be considerable (tables 3 and 4). When using only one trap, little can be concluded about the local species composition and the annual populations. The comparison of the samples does not tell if a single trap would have captured more specimens than one of the three traps in the cluster. The big difference between the single trap sites in southern Finland may be explained by random sampling and by how well they were exposed to the flying insects. The use of 9 and 10 traps in Melalahti and Naapurivaara (Kainuu) during the weeks 23 and 24 did not give considerably larger samples. No "extra" species were caught compared with the weeks with 3 traps in a cluster. The only small differences were, that relatively more individuals of the common bumblebee species (*Bombus pratorum, B. pascuorum, B. jonellus*) were captured. Based on these results, at least 3 colour-traps need to be used at every site in order to evaluate the local species composition and their populations. Three traps close together form a more effective "flower-group" attractant and diminishes the risk of poor siting of an individual trap. The conclusion of the need to use at least 3 colour-traps per site, unfortunately also affects the credibility of the results from the southern Finnish sites in our study.

The study indicates rather big differences between individual sites (cf. Annex 2 A-D). The site differences are smaller in Kainuu than in southern Finland, which may be caused by the different number of traps/site used in these two regions. When looking at both the species composition and the number of captured individuals, the best southern sites were situated in the Pyhtää commune. This is pronounced in the bumblebees and hoverflies. There are much smaller differences between the southern sites when looking at the species composition alone (fig 3). The central part of Uusimaa is particularly species poor, which might be due to the higher density of the human population. The extremely poor result from the very sparsely habituated Noux National Park is even more striking. Social wasps were very common here, and it is possible, that bumblebees and wasps have difficulties to co-exist at the very same site (cf. also Teräs 1976).

In the Kainuu region the best site is not distinctly outstanding and it is situated close to the eastern border of Finland, viz. Viiksimo in the commune of Kuhmo (fig 4). At the two poorest sites (Mieslahti and Paljakka) the social wasps were not particularly abundant.

Table 3. Captures of the three colour-traps in Puolanka, Paljakka/Kainuu (weeks 26-38)

Species	trap 1	trap 2	trap 3
B. lucorum	4	6	1
B. jonellus	6	9	1
B. pascuorum	4	0	0
B. pratorum	18	12	6
B. hypnorum	12	11	2
B. hortorum	2	0	0
B. sporadicus	0	3	0
V. vulgaris	3	2	1
D. norvegica	3	0	0
D. pinastri	0	0	1
S. ribesii	1	0	1
S. vitripennis	8	0	0
S. torvus	3	1	3
P. viduata	1	0	0
M. cinctella	5	1	1
P. vittiger	1	1	0
C. *festivum*	0	0	1
Total:			
- species number	14	9	10
- individuals	71	46	18

Total species number = 17, of which common = 7 (41%) and only in one trap = 8 (47%)

Table 4. Captures of the three colour-traps in Paltamo, Melalahti/Kainuu (weeks 26-38)

Species	trap 1	trap 2	trap 3
B. lucorum	11	1	5
B. jonellus	3	1	3
B. pascuotum	2	2	1
B. pratorum	8	2	3
B. hypnorum	13	5	11
B. veteranus	0	0	1
B. sporadicus	2	0	0
P. sylvestris	0	0	2
A. mellifera	0	0	1
D. norvegica	0	1	1
S. bifasciatus	0	1	1
D. tricinctus	0	0	1
M. compositarum	0	1	2
S. ribesii	1	1	0
S. vitripennis	1	0	2
S. torvus	1	1	2
M. cinctella	1	1	3
P. signata	0	1	1
P. vittiger	0	1	0
L. lapponicus	0	1	0
P. viduata	0	1	0
Total:			
- species number	9	15	16
- individuals	43	21	40

Total species number = 21, of which common = 8 (38%) and only in one trap = 8 (38%).

The values of the alpha-index calculated from the number of captured species and individuals are low (fig. 5). This is a result of the small maximum number of possible species and the large size of populations of some trivial species. The alpha-index does not describe particularly well the pollinator insect diversity. Furthermore, the functionality of the ecosystem can be good even if only a few species have sustainable populations - if these species, like the bumblebees, can replace one another in the foraging process. Frequency values will give information only on the geographical distribution of species. The best "diversity" index appears to be the relation of captured species to that of potential species occurring in the area (cf. Pekkarinen et al. 1981).

4.4 Habitat preference

Due to the small number of sites in the study there is no strong evidence of habitat preference. Most of the traps were subjectively placed in ecotones, most often at a forest edge facing a pasture, a meadow or a cultivated field. The general picture we received was, that unsuitable biotopes for pollinator insects appear to be densely populated areas, cool and moist bogs, and sea shores. Traps situated some distance into the forest captured quite many insects. The overall best biotopes appear to be open-ditched fallow lands, that provide good foraging and nesting sites for bumblebees and a variety of different flowers for hoverflies. The data from Pyhtää Hirvivuolle indicate that river banks are good habitats, too.

There are factors that affect the results that can be explained by the choice of the microhabitat for the trap. The height of the traps was considered to be optimal although some high-flying species (*Bombus lapidarius* and *Epistrophe* species) probably are underrepresented in the samples. Some species that prefer to fly lower (species of the genera *Sphaerophoria, Neoascia* and *Chrysogaster*) were also underrepresented. The exposition of the traps did not make very much difference, because the best capturing traps were exposed in different directions (south, west and east). Exposition plays a role in early spring, when the traps situated on south facing slopes capture much better than those in other positions. The most important factor appears, however, to be the visibility of the trap. Therefore it must be checked during the summer, so that the developing foliage does not overcast the trap. In this respect, a coniferous branch is the best hanging place for a trap.

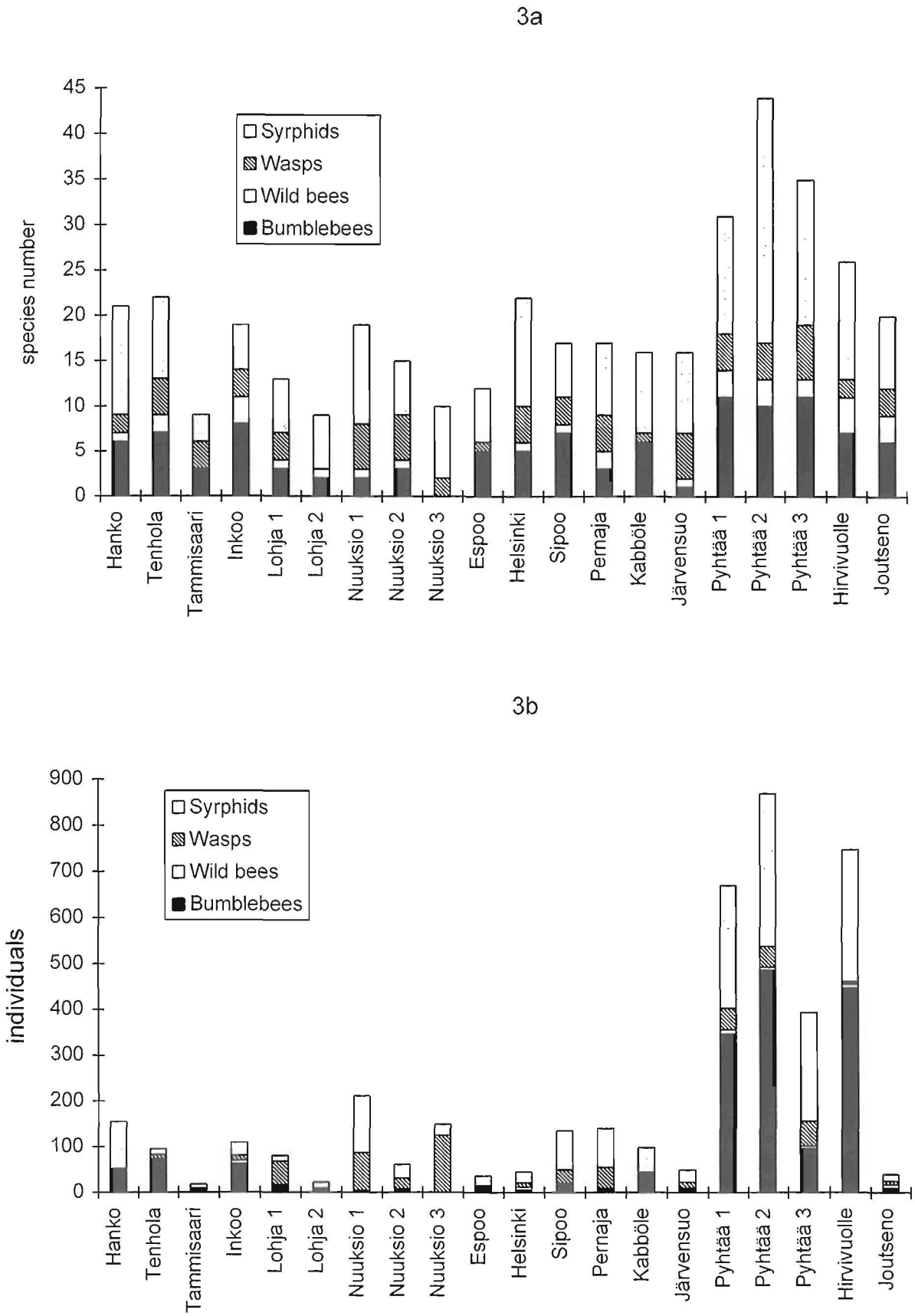
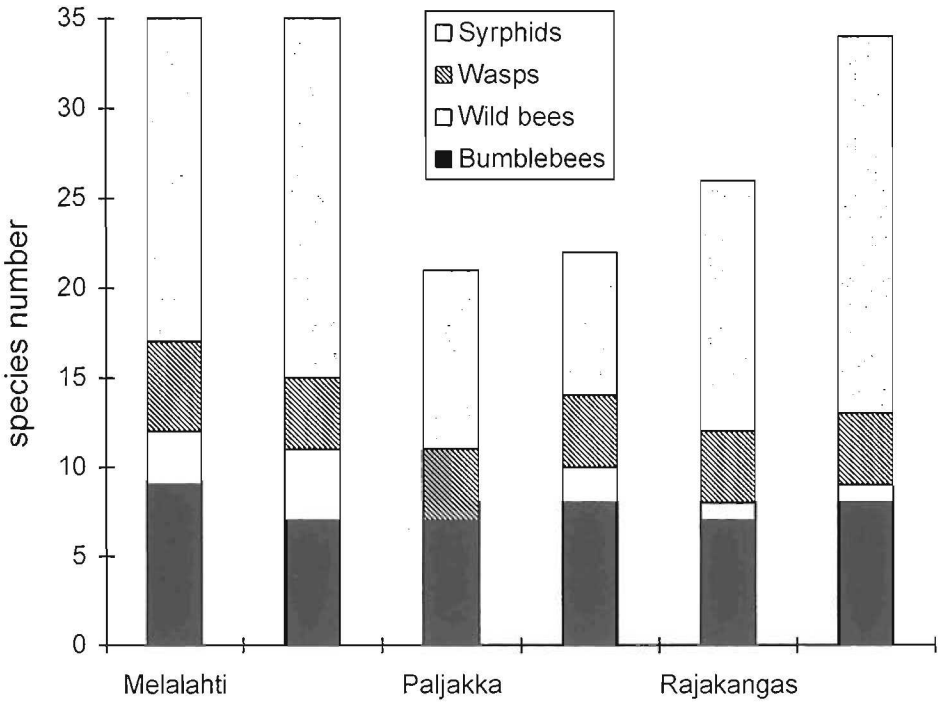


Fig.3 Capture of species (a) and individuals (b) in Southern Finland

4a



4b

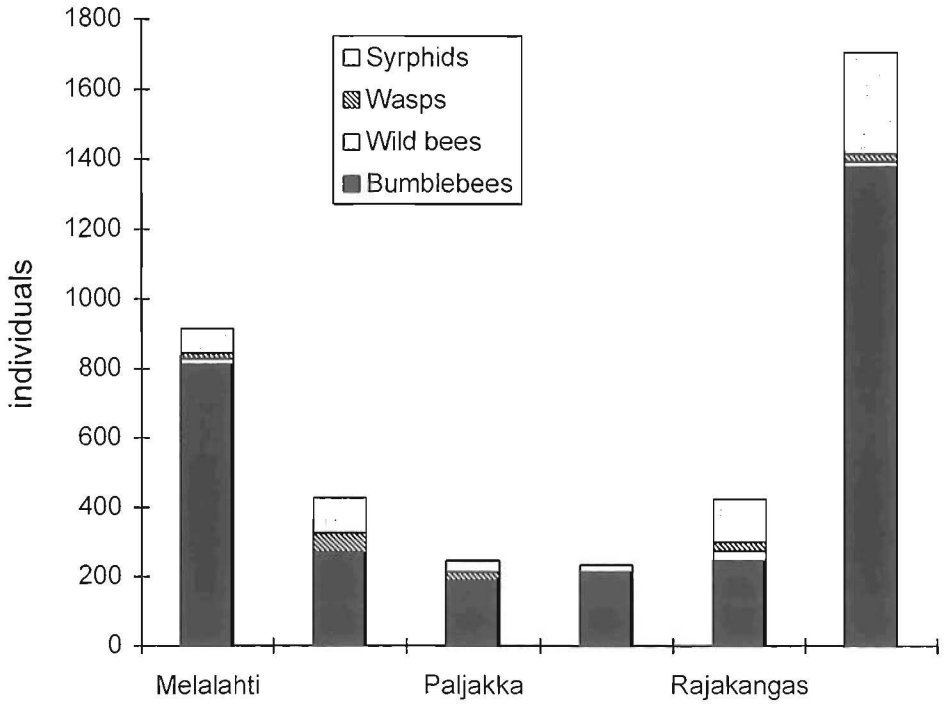


Fig.4 Capture of species (a) and individuals (b) in Kainuu Finland

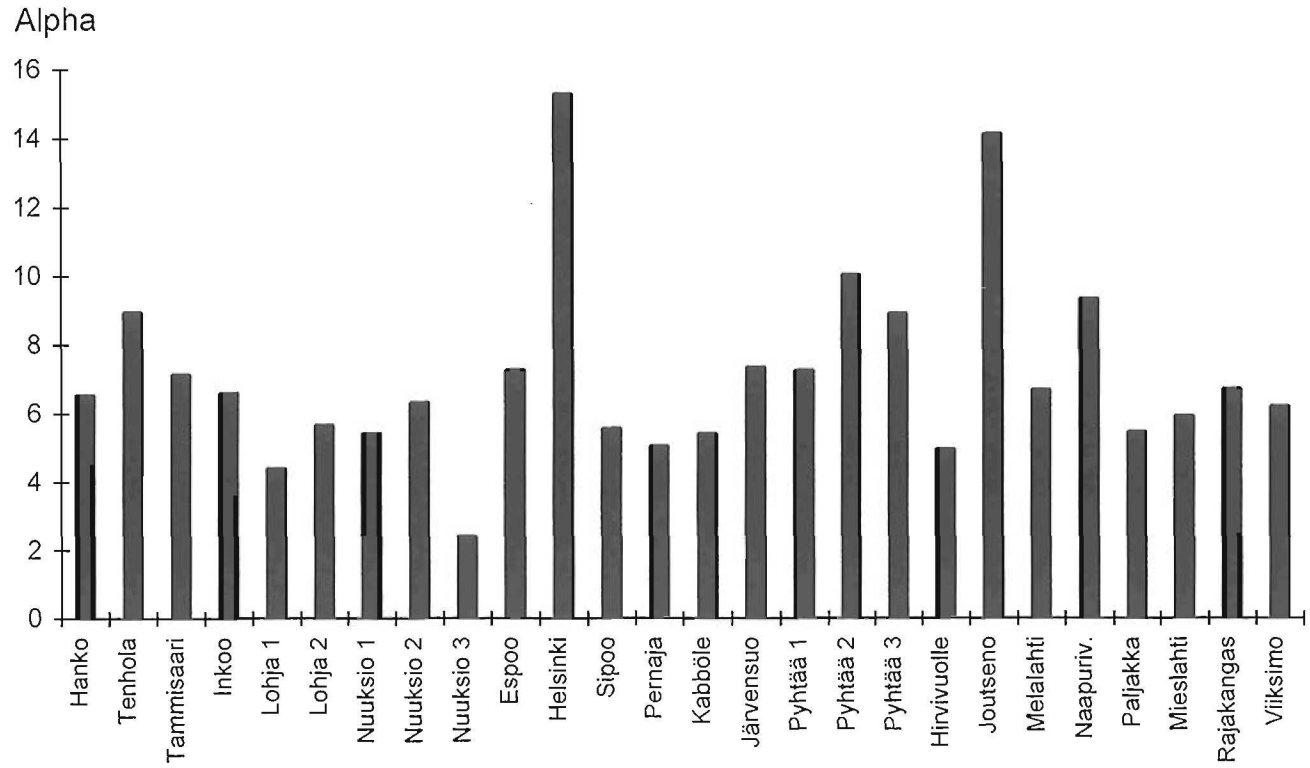


Fig. 5 Alpha-indicies for the captures in the study

4.5 Comparison of trap samples and field observations

The field observations in Sipoo showed that the trap samples rather poorly reflect the local overall species composition in the summer. The bumblebee species composition, however, reflected the local species composition rather well. Only one additional species (*Psithyrus bohemicus*) was recorded in the field: two males visiting white clover flowers in late summer. Bumblebee males are known to make quite long flights and can be recorded far from their colonies.

There were significant differences between the observed and captured number of individuals. In spring, about ten times as many bumblebee queens were seen than captured in the trap, but in summer, when the workers started to emerge, this relation sunk to 1:100 or less. Differences between different species were also observed, but to a lesser degree than anticipated (table 5). It may thus be concluded, that the yellow colour-trap is a rather inefficient sampling design. This can be regarded as good in the respect that the trapping does not considerably reduce the local populations. The monitoring technique can actually be defined as rather "environment-friendly", which is contradictory to what some nature conservationists claim (cf. Hagen 1994). It can also be concluded, that the trap sample forms a relatively good subset of the local species composition and populations. Therefore, the natural populations can be quite accurately estimated and monitored year after year.

Table 5. Captured and observed bumblebees in Sipoo, 1996

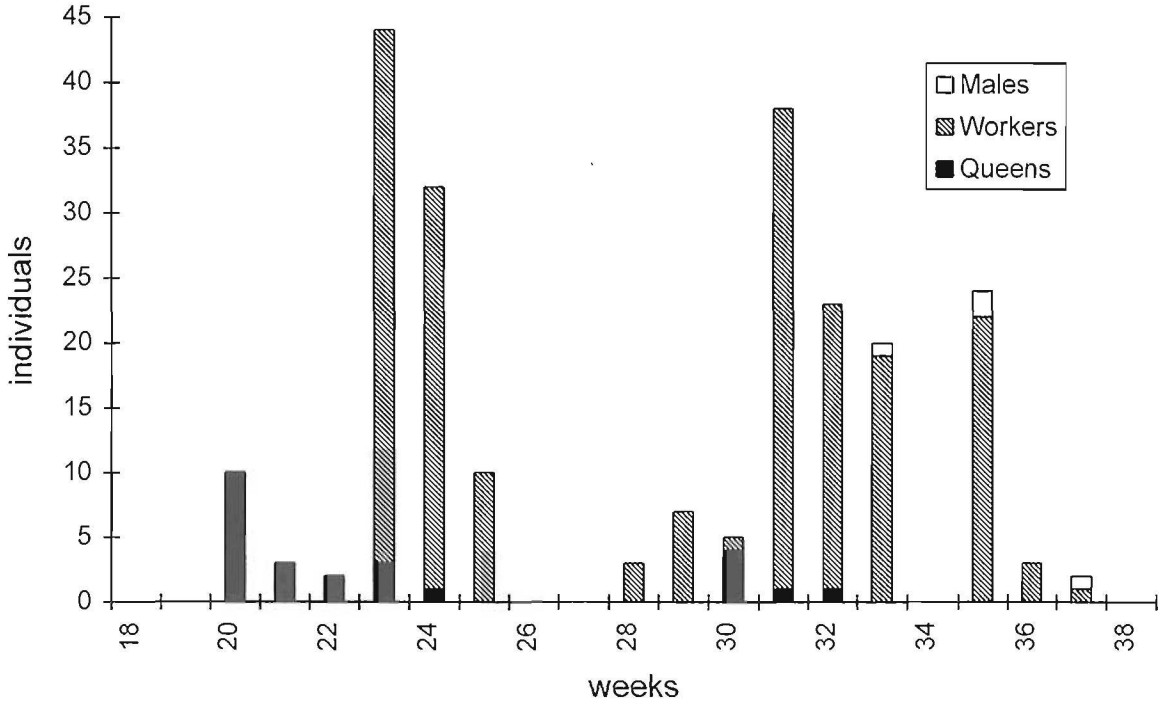
Species	Total capture	Observed max.number per day	Total observations	Captured portion (%)
B. ruderarius	3	3	37	8.1
B. lapidarius	1	2	16	6.3
B. pascuorum	6	28	605	1.0
B. pratorum	2	10	223	0.9
B. hortorum	2	3	95	2.1
B. lucorum	3	12	157	1.9
B. veteranus	1	22	145	0.7
P. bohemicus	0	2	2	0.0

The captures of different bumblebee castes do not reflect the natural ratio (figs 6 and 7). The proportion of hibernated queens is pronounced in spring, whereas the number of workers can be higher or lower than the number of queens. New queens and males are rare in the captures compared to their occurrence in the field. This imbalance can be attributed to the different behaviour of the three castes. The main task of the hibernated queen is to collect pollen and nectar for the next generation and she visits many flowers to do this. When workers emerge they help with the food collecting, but they visit flowers of other colours (for example *Trifolium* and *Chamaenerium*) much more often than the non-fragrant yellow ones. The males only visit flowers for their own need, and in many species the males choose entirely other flowers than the other castes (Prys-Jones and Corbet 1991). Males also fly more around during their patrolling of scent-marked routes. Apparently males visit white flowers more often than the queens and workers do, because they are much more commonly found in white-coloured light-trap designs than the other castes.

No conclusions can be drawn concerning the relation of captured bees and wasps to that in nature. In Sipoo only 2 species of these groups were trapped of altogether 4 observed. The number of social wasp individuals recorded in nature was many hundred times higher than the trapped numbers.

Of all observed 25 hoverfly species, only 5 species were trapped. Several of the species not captured do not visit flowers at all or have distinct preferences to white flowers. If only those species that are known to visit yellow flowers are compared with the capture, the relation changes to 10:5. The captured and observed numbers are presented in table 6.

6a



6b

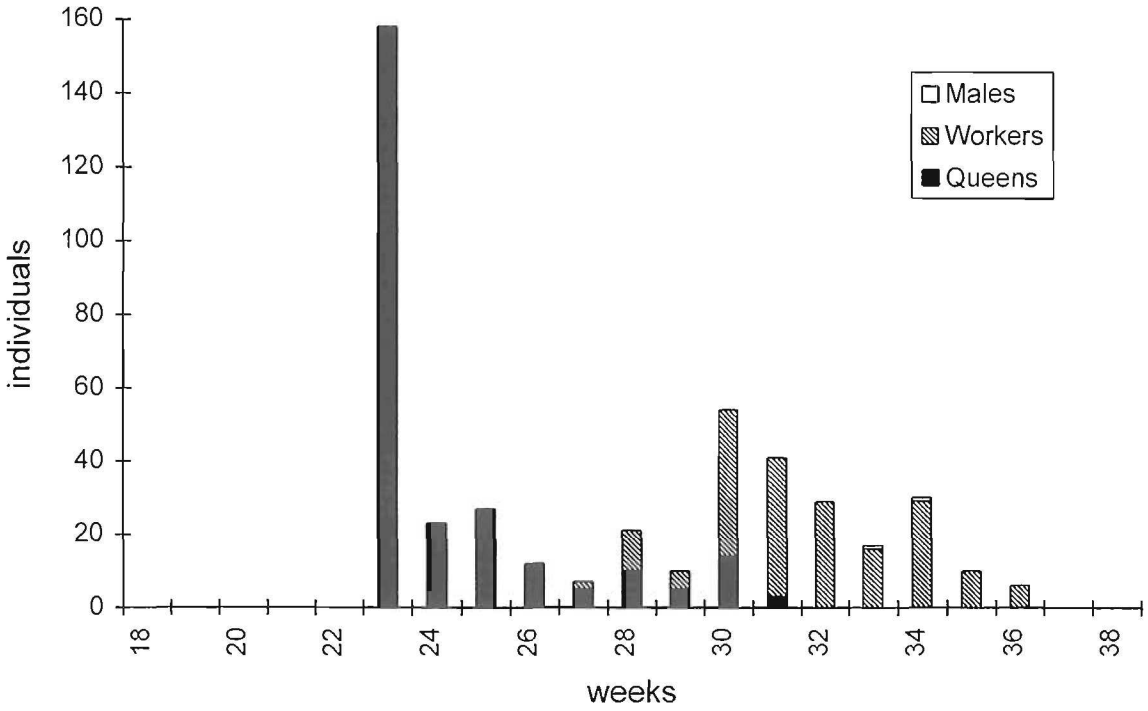
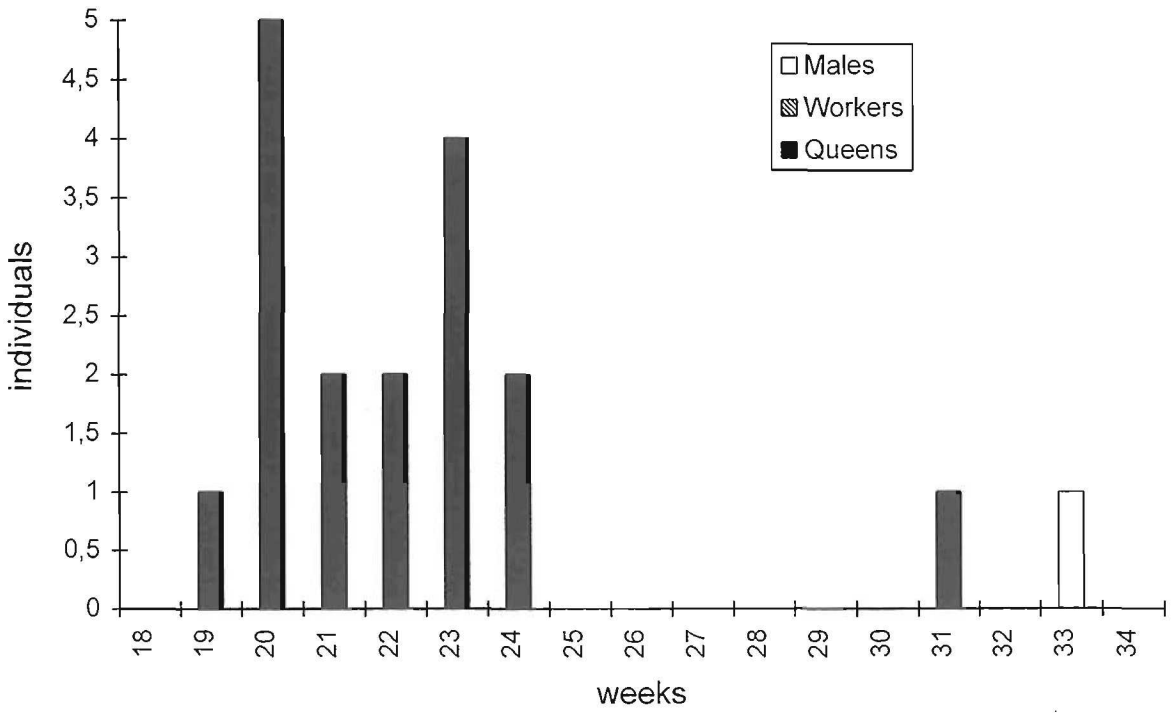


Fig. 6 Captures of different castes of *Bombus pratorum* in Pyhtää Länsikylä (a) and Kuhmo Viiksimo (b). In Pyhtää (traps 7,9,16) the species is *bivoltine*, in Kuhmo (traps 36,37,38) *univoltine*

7a



7b

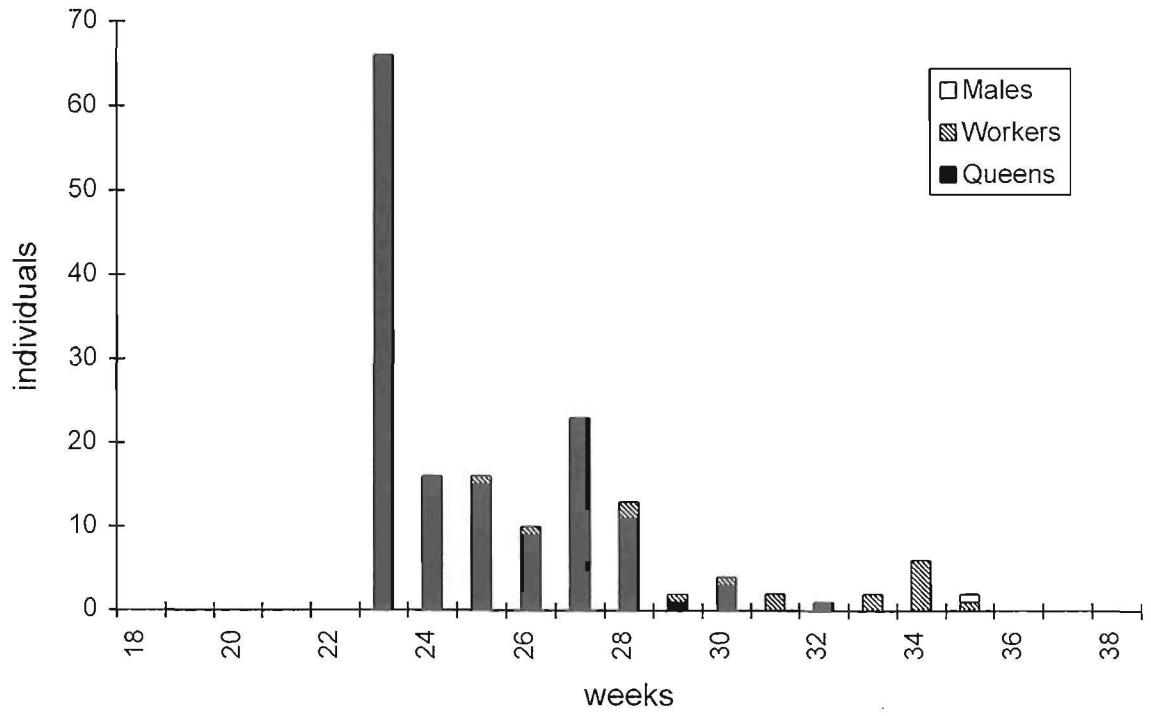


Fig.7 Captures of different castes of *Bombus hypnorum* in Pyhtää Länsikylä (a) and Kuhmo Viiksimo (b). In Pyhtää (traps 7,9,16) no workers were captured, in Viiksimo (traps 36,37,38) they were scarce in the captures.

Table 6. Captured and observed number of trapped hoverfly species in Sipoo, 1996.

Species	Total captured	Observed max.number per day	Total observed	Captured portion (%)
S. torvus	2	6	75	2.6
S. vitripennis	7	7	78	9.0
S. ribesii	2	8	154	1.3
E. balteatus	14	112	1224	1.1
O. nobilis	1	1	4	25.0

The captured portion varies considerably with species. Even if the material is small, the data indicate that the captured portion ranges between 1-10% of the observed numbers in the field, viz. rather congruent with the results for the bumblebees.

5 DISCUSSION AND RECOMMENDATIONS

When monitoring insects, irrespective of whether a group or a single species, the aim is to identify long-term changes. We recognise at least four different levels to be important:

I **Monitoring a faunistic group with a semiquantitative method to detect changes in species composition and the decrease/increase of different species populations.** This type of monitoring will give the first early-warnings of decline of some species or of alterations in the species composition, before any retardation of distribution can be detected.

II **Monitoring a faunistic group by analysing the change in the distribution pattern over time.** This monitoring can utilise collection material, which might be biased towards rarer species, and show retroperspective changes, but it is not economically feasible to carry out on a permanent inventory basis due to high field costs (and often lack of expertise).

III **Monitoring threatened species by repeated visits to sites where they have been recorded and noting absence/presence of the species.** This type of monitoring will secure if a species population is sustainable, but it will give no information on changes in the species composition and therefore has little biodiversity value.

IV **Analysing and forecasting trends in metapopulations of endangered species to assess the possible rate of extinction and to take conservation measures against this.** This encompasses a very focused population ecological study, with no additional information on changes in species composition and biodiversity.

Although all these levels will possibly be necessary in species monitoring, the methods focusing on change in biodiversity will only encounter level I, and to some extent, level II. We, therefore, recommend to monitor pollinator insects as a group on the level I, because they will functionally comprise a homogenous group.

The conclusions from this study are:

* The yellow colour-trap design worked well. Green coloured traps were not that effective.

* The capture of species is restricted to species visiting yellow flowers. Many pollinator insects do not visit yellow flowers and the monitoring of these pollinators can not be done with these traps. Certain species might require additional fragrance to be attracted to yellow flowers, and this further delimits the possible species number that can be monitored with these traps. Of the now investigated groups, bumblebees can best be monitored, because apparently only one species will not be captured. Social wasps also come in number to the traps, but the species have less indicator value than the bumblebees. Bees are poorly monitored because they are apparently attracted to other colours and, perhaps, to fragrance. Hoverflies can be monitored, but at least one important indicator group will lie outside the possible species composition.

* The trap samples were found to be quite representative subsamples of the local nature populations. Therefore the latter can be estimated.

* The variation between traps in a 3 trap cluster was found to be large. Therefore, a single trap will capture quite randomly and we recommend the use of 3 traps in a cluster for each site.

* Forest biotopes turned out to be quite good habitats, whereas bogs and marshes are quite poor habitats. River banks and lake shores are good sites, whereas cool seashores are not favoured habitats. It is recommended to place the traps in ecotones, for example forest/meadow and shore/open water. The best results can be achieved with traps with a south facing exposition, because hoverflies will prefer these microhabitats. The installation of the traps in the field must be done with care to avoid factors that can prohibit attraction to the yellow collar of the trap.

* From a cost-benefit point of view, the monitoring activity will not cause considerable extra costs if the colour-traps can be put near to other trapping devices (for example near moth monitoring light-traps). Then, however, compromises in the best available siting must be made. The identification and counting of the samples take fairly little time (one sample/5-15 minutes).

On the basis of these conclusions we recommend to start a pilot monitoring for the years 1997-1998. The targets for the pilot phase would be to:

(1) confirm the actual potential species composition that can be monitored (this study was geographically biased);
(2) test differently coloured traps (white and blue) for more optimal sampling;
(3) reduce randomness by using three traps per site;
(4) determine the actual potential size of the captures (this study was negatively affected by poor weather conditions)

After the 2-year pilot a more detailed analysis should be made to find out how the monitoring results can be used to support nature conservation and biodiversity maintaining measures.

APPENDIX 1. LIST OF SAMPLE SITES

Trap no	Commune	Site	X-coord.	Y-coord.	Biotope
1	Joutseno	Kähärilä	6773	3580	Cropland margin
2	Hanko	Täktom	6642	3281	Reed bed margin
3	Pyhtää	Järvensuo	6710	3480	Raised bog
4	Lohja	Mynterlä	6696	3341	Cropland margin to mixed forest
5	Pyhtää	Hirvivuolle	6719	3485	Garden by river bank
6	Inkoo	Tähtelä	6668	3335	Garden at cropland margin
7	Pyhtää	Länsikylä	6710	3480	Cropland margin to aspen stands
8	Espoo	Mäkkylä	6682	3380	Ornamental garden
9	Pyhtää	Länsikylä	6710	3480	Fallow land margin to young forest
10	Tenhola	Etelä Kuivasto	6670	3278	Mixed forest at sea shore
11	Pernaja	Kabböle	6688	3449	Cottage garden near sea shore
12	Tammisaari	Sköldargård	6662	3299	Orchard
13	Espoo	Nuuksio	6664	3376	Margin of implanted oak forest,
14	Helsinki	Tapaninkylä	6681	3382	Suburban ornamental garden
15	Espoo	Nuuksio	6664	3376	Implanted oak forest
16	Pyhtää	Länsikylä	6710	3480	Garden at cropland margin
17	Espoo	Nuuksio	6664	3376	Garden at meadow margin
18	Pernaja	Vanhakylä	6711	3438	Cropland margin to deciduous woodland
19	Lohja	Mynterlä	6696	3341	Garden in forest clearing
20	Sipoo	Nikkilä	6690	3400	Garden at cropland margin
21-23	Paltamo	Melalahti	7145	3532	Fallow land
24-26	Sotkamo	Naapurinvaara	7121	3560	Pasture
27-29	Puolanka	Paljakka	7174	3551	Supra-aquatic spruce forest
30-32	Paltamo	Mieslahti	7144	3548	Garden at alder forest margin
33-35	Kuhmo	Rajakangas	7094	3662	Pine heathland intermixed with spruce
36-37	Kuhmo	Viiksimo	7133	3664	Fallow land

ANNEX 2A: Captures of Bombus and Psithyrus

Trapnumber	C-2	C-10	C-12	C-6	C-19	C-4	C-13	C-15	C-17	C-8	C-14	C-20	C-18	C-11	C-3	C-7
Commune	Hanko	Tammis.	Tammis.	Inkoo	Lohja	Lohja	Nuuksio	Nuuksio	Nuuksio	Espoo	Helsinki	Sipoo	Pernaja	Pernaja	Pyhtää	Pyhtää
Site	Täktom	Et.Kuivasto	Sköldarg.	Tähtelä	Mynterlä	Mynterlä	Högbacka	Högbacka	Högbacka	Mäkkylä	Tapanila	Nikkilä	Vanhakylä	Kabböle	Järvensuo	Länsikylä
Biotope 1	53.1	43.X	83.X	83.X	83.X	82.2	43.5	43.5	83.X	83.X	83.X	83.2	82.2	83.X	51.1	82.2
Biotope 2	43.X	53.1		82.2	42.X	42.X	37.2		35.22		83.2	82.2	42.X	41.C3	44.A	41.D
first sample	4.May	4.May	26.May	4.May	13.May	13.May	26.May	26.May	26.May	19.May	14.May	22.May	11.May	11.May	5.May	5.May
last sample	11.Oct	29.Sep	29.Sep	29.Sep	29.Sep	11.Oct	11.Oct	11.Oct	28.Sep	12.Oct	29.Sep	29.Sep	12.Oct	1.Oct	1.Oct	1.Oct
Bombus jonellus																9
Bombus sylvarum																
Bombus veteranus													1			3
Bombus distinguendus																
Bombus hortorum		1		1		2		1			1	2	1			3
Bombus ruderarius											1	3				
Bombus pascuorum	14	16		13	12	5	1	4		2	1	6	2	15		73
Bombus lucorum	15	23		25			2			5	1	3		4	6	100
Bombus sporadicus																1
Bombus lapidarius				7						1	1	1				1
Bombus hypnorum	1	10	1	5						4				5		4
Bombus cingulatus																
Bombus pratorum	5	4	1	8	2			1		1		2		2		29
Bombus soroeensis	4	13	2	1	1								2	11		85
Psithyrus bohemicus	7			2										5		38
Psithyrus sylvestris		4														
BOMSUM	46	71	4	62	15	7	3	6	0	13	5	18	5	42	6	346
BOMSPEC	6	7	3	8	3	2	2	3	0	5	5	7	3	6	1	11

ANNEX 2A: Captures of Bombus and Psithyrus

Trapnumber	C-9	C-16	C-5	C-1	C-21-23	C-24-26	C-27-29	C-30-32	C-33-35	C-36-38	TOTAL	TOTAL
Commune	Pyhtää	Pyhtää	Pyhtää	Joutseno	Paltamo	Sotkamo	Puolanka	Paltamo	Kuhmo	Kuhmo		site freq.
Site	Länsikylä	Länsikylä	Hirvivuolle	Kähärilä	Melalahti	Naapuriv.	Paljakka	Mieslahti	Rajakang.	Viiksimo		max.26
Biotope 1	87.1	82.2	83.X	82.2	87.	83.X	42.C	83.X	44.A	87.	individuals	
Biotope 2	42.X	83.X	20.	83.X								
first sample	5.May	11.May	5.May	5.May	17.May	16.May	9.Jun	9.Jun	8.Jun	8.Jun		
last sample	11.Oct	1.Oct	11.Oct	11.Oct	19.Sep	19.Sep	19.Sep	19.Sep	20.Sep	20.Sep		
Bombus jonellus			1	2	101	19	31	22	58	268	511	9
Bombus sylvarum				1							1	1
Bombus veteranus	1	3			5			8			21	6
Bombus distinguendus	1										1	1
Bombus hortorum	7	1			4	2	6	4		18	54	15
Bombus ruderarius		2									6	3
Bombus pascuorum	40	33	52	2	249	39	4	59	28	206	876	23
Bombus lucorum	51	18	121		85	59	16	37	13	237	821	19
Bombus sporadicus					2		3			8	14	4
Bombus lapidarius		1		1							13	7
Bombus hypnorum	4	10	11	2	154	63	47	46	36	163	566	17
Bombus cingulatus									1		1	1
Bombus pratorum	181	15	32	1	199	82	78	17	100	450	1210	20
Bombus soroeensis	88	6	179								392	13
Psithyrus bohemicus	59	5	50			2			9	27	204	10
Psithyrus sylvestris	53	1			12			5			75	5
BOMSUM	485	95	446	9	811	266	185	198	245	1377	4766	
BOMSPEC	10	11	7	6	9	7	7	8	7	8		

ANNEX 2B: Capture of bees

Trapnumber	C-2	C-10	C-12	C-6	C-19	C-4	C-13	C-15	C-17	C-8	C-14	C-20	C-18	C-11	C-3	C-7
Commune	Hanko	Tammis.	Tammis.	Inkoo	Lohja	Lohja	Nuuksio	Nuuksio	Nuuksio	Espoo	Helsinki	Sipoo	Pernaja	Pernaja	Pyhtää	Pyhtää
Site	Täktom	Et.Kuivasto	Sköldarg.	Tähtelä	Mynterlä	Mynterlä	Högbacka	Högbacka	Högbacka	Mäkkylä	Tapanila	Nikkilä	Vanhakylä	Kabböle	Järvensuo	Länsikylä
Biotope 1	53.1	43.X	83.X	83.X	83.X	82.2	43.5	43.5	83.X	83.X	83.X	83.2	82.2	83.X	51.1	82.2
Biotope 2	43.X	53.1		82.2	42.X	42.X	37.2		35.22		83.2	82.2	42.X	41.C3	44.A	41.D
first sample	4.May	4.May	26.May	4.May	13.May	13.May	26.May	26.May	26.May	19.May	14.May	22.May	11.May	11.May	5.May	5.May
last sample	11.Oct	29.Sep	29.Sep	29.Sep	29.Sep	11.Oct	11.Oct	12.Oct	28.Sep	12.Oct	29.Sep	29.Sep	12.Oct	1.Oct	1.Oct	1.Oct
Apis mellifera				5									1			7
Osmia inermis																
Osmia uncinata													2		3	
Andrena lapponica																
Andrena fucata				2								2				
Andrena ruficrus																
Halictus sp.(prob.2 species)	1	1		1		1	1	1								
Hylaeus hyalinatus					1											
Seladonia tumulorum											7					2
Evylaeus fratellus																
Nomada obscura																
Nomada glabellum																1
Nomada leucophthalma		1														
BEESUM	1	2	0	8	1	1	1	1	0	0	7	2	3	0	3	10
BEESPEC	1	2	0	3	1	1	1	1	0	0	1	1	2	0	1	3

ANNEX 2B: Capture of bees

Trapnumber	C-9	C-16	C-5	C-1	C-21-23	C-24-26	C-27-29	C-30-32	C-33-35	C-36-38	TOTAL	TOTAL
Commune	Pyhtää	Pyhtää	Pyhtää	Joutseno	Paltamo	Sotkamo	Puolanka	Paltamo	Kuhmo	Kuhmo		site freq.
Site	Länsikylä	Länsikylä	Hirvivuolle	Kähärilä	Melalahti	Naapuriv.	Paljakka	Mieslahti	Rajakang.	Viiksimo		max.26
Biotope 1	87.1	82.2	83.X	82.2	87.	83.X	42.C	83.X	44.A	87.	individuals	
Biotope 2	42.X	83.X	20.	83.X								
first sample	5.May	11.May	5.May	5.May	17.May	16.May	9.Jun	9.Jun	8.Jun	8.Jun		
last sample	11.Oct	1.Oct	11.Oct	11.Oct	19.Sep	19.Sep	19.Sep	19.Sep	20.Sep	20.Sep		
Apis mellifera	1	4			15			1			34	7
Osmia inermis				1							1	1
Osmia uncinata											5	2
Andrena lapponica						1					1	1
Andrena fucata											4	2
Andrena ruficrus			5								5	1
Halictus sp.(prob.2 species)	3	2	1	7	1	4					24	12
Hylaeus hyalinatus											1	1
Seladonia tumulorum											9	2
Evylaeus fratellus								4	29	17	50	3
Nomada obscura			1			1					2	2
Nomada glabellum	3			1							5	3
Nomada leucophthalma			3		1	2					7	4
BEESUM	7	6	10	9	17	8	0	5	29	17	148	
BEESPEC	3	2	4	3	3	4	0	2	1	1		

ANNEX 2C: Capture of wasps

Trapnumber	C-2	C-10	C-12	C-6	C-19	C-4	C-13	C-15	C-17	C-8	C-14	C-20	C-18	C-11	C-3	C-7
Commune	Hanko	Tammis.	Tammis.	Inkoo	Lohja	Lohja	Nuuksio	Nuuksio	Nuuksio	Espoo	Helsinki	Sipoo	Pernaja	Pernaja	Pyhtää	Pyhtää
Site	Täktom	Et.Kuivasto	Sköldarg.	Tähtelä	Mynterlä	Mynterlä	Högbacka	Högbacka	Högbacka	Mäkkylä	Tapanila	Nikkilä	Vanhakylä	Kabböle	Järvensuo	Länsikylä
Biotope 1	53.1	43.X	83.X	83.X	83.X	82.2	43.5	43.5	83.X	83.X	83.X	83.2	82.2	83.X	51.1	82.2
Biotope 2	43.X	53.1		82.2	42.X	42.X	37.2		35.22		83.2	82.2	42.X	41.C3	44.A	41.D
first sample	4.May	4.May	26.May	4.May	13.May	13.May	26.May	26.May	26.May	19.May	14.May	22.May	11.May	11.May	5.May	5.May
last sample	11.Oct	29.Sep	29.Sep	29.Sep	29.Sep	11.Oct	11.Oct	11.Oct	28.Sep	12.Oct	29.Sep	29.Sep	12.Oct	17.Oct	17.Oct	17.Oct
Vespula vulgaris	1	1		2	39		53	15	106		3	24	32	1	3	27
Vespula rufa		4	2				7	2			1	3	2		3	
Dolichovespula sylvestris								1								
Dolichovespula saxonica		3	1	1	4		1				1		1		1	2
Dolichovespula norwegica	3	1		7	8		19	3	18		4	2	11		5	14
Dolichovespula media							2	2							1	4
Ancistrocerus trifasciatus																
Ancistrocerus parietinus																
Ancistrocerus scoticus																
Symmorphus bifasciatus			1													
Symmorphus crassicornis										1						
WASPSUM	4	9	4	10	51	0	82	23	124	1	9	29	46	1	13	47
WASPSPEC	2	4	3	3	3	0	5	5	2	1	4	3	4	1	5	4

ANNEX 2C: Capture of wasps

Trapnumber	C-9	C-16	C-5	C-1	C-21-23	C-24-26	C-27-29	C-30-32	C-33-35	C-36-38	TOTAL	TOTAL
Commune	Pyhtää	Pyhtää	Pyhtää	Joutseno	Paltamo	Sotkamo	Puolanka	Paltamo	Kuhmo	Kuhmo		site freq.
Site	Länsikylä	Länsikylä	Hirvivuolle	Kähärilä	Melalahti	Naapuriv.	Paljakka	Mieslahti	Rajakang.	Viiksimo		max.26
Biotope 1	87.1	82.2	83.X	82.2	87.	83.X	42.C	83.X	44.A	87.	individuals	
Biotope 2	42.X	83.X	20.	83.X								
first sample	5.May	11.May	5.May	5.May	17.May	16.May	9.Jun	9.Jun	8.Jun	8.Jun		
last sample	11.Oct	17.Oct	11.Oct	11.Oct	19.Sep	19.Sep	19.Sep	19.Sep	20.Sep	20.Sep		
Vespula vulgaris	20	30	2	2	1	27	6	1	1	3	400	23
Vespula rufa	3	5				1	1	1	1	2	38	15
Dolichovespula sylvestris		1		4							6	3
Dolichovespula saxonica	1	6				7	7	1	5	4	46	16
Dolichovespula norwegica	21	10	3	1	11	19	10	6	18	11	205	21
Dolichovespula media		2									11	5
Ancistrocerus trifasciatus					1						1	1
Ancistrocerus parietinus					1						1	1
Ancistrocerus scoticus					1						1	1
Symmorphus bifasciatus											1	1
Symmorphus crassicornis											1	1
WASPSUM	45	54	5	7	15	54	24	9	25	20	711	
WASPSPEC	4	6	2	3	5	4	4	4	4	4		

Trapnumber	C-2	C-10	C-12	C-6	C-19	C-4	C-13	C-15	C-17	C-8	C-14	C-20	C-18	C-11	C-3	C-7	C-9	C-16	C-5	C-1	C-21-23	C-24-26
Commune	Hanko	Tammis.	Tammis.	Inkoo	Lohja	Lohja	Nuuksio	Nuuksio	Nuuksio	Espoo	Helsinki	Sipoo	Pernaja	Pernaja	Pyhtää	Pyhtää	Pyhtää	Pyhtää	Pyhtää	Joutseno	Paltamo	Sotkamo
Site	Täktom	Et.Kuivast	Sköldarg.	Tähtelä	Mynterlä	Mynterlä	Högbacka	Högbacka	Högbacka	Mäkkylä	Tapanila	Nikkilä	Vanhakylä	Kabböle	Järvensuo	Länsikylä	Länsikylä	Länsikylä	Hirvivuolle	Kähärilä	Melalahti	Naapuriv.
Biotope 1	53.1	43.X	83.X	83.X	83.X	82.2	43.5	43.5	83.X	83.X	83.X	83.2	82.2	83.X	51.1	82.2	87.1	82.2	83.X	82.2	87.	83.X
Biotope 2	43.X	53.1		82.2	42.X	42.X	37.2		35.22		83.2	82.2	42.X	41.C3	44.A	41.D	42.X	83.X	20.	83.X		
first sample	4.May	4.May	26.May	4.May	13.May	13.May	26.May	26.May	26.May	19.May	14.May	22.May	11.May	11.May	5.May	5.May	5.May	11.May	5.May	5.May	17.May	16.May
last sample	11.Oct	29.Sep	29.Sep	29.Sep	29.Sep	11.Oct	11.Oct	11.Oct	28.Sep	12.Oct	29.Sep	29.Sep	12.Oct	17.Oct	17.Oct	17.Oct	11.Oct	17.Oct	11.Oct	11.Oct	19.Sep	19.Sep
Lapposyrphus lapponicus	1						1								1	2	4	1	65	3	4	17
Scaeva pyrastri	1																				1	
Cheilosia pagana											1					1						4
Cheilosia proxima									1													
Cheilosia praecox																						
Cheilosia vernalis	1																				11	1
Cheilosia variabilis						1																
Cheilosia grossa																	1					
Dasysyrphus venustus		1					1							2		2	3	3	3	2		4
Dasysyrphus tricinctus									1					1			2			1	1	1
Dasysyrphus hilaris		1					1										2					
Dasysyrphus pinastri																						1
Dasysyrphus albostriatus															1							1
Meliscaeva cinctella								8						1		2	10		3		6	3
Sphaerophoria scripta											2		1		1			1				1
Sphaerophoria rueppelli																	2					
Melanostoma scalare																						
Platycheirus cyaneus																					1	
Platycheirus discimanus											2											
Platycheirus scutatus																	1					
Platycheirus sticticus											1											
Platycheirus peltatus																					4	
Meligramma triangulifera									1		1						1					
Melangyna barbifrons									1										1		5	1
Melangyna lasiophthalma															1	3	20	2				
Melangyna umbellatarum										1				1		1	1	1				
Melangyna compositarum							1									3	9	3	2		1	
Orthonevra nobilis												1										
Pipiza signata																					3	
Pipiza lugubris																						1
Pipiza quadrimaculata																						
Pipizella viduata																					1	
Epistrophe nitidicollis															1							
Eupeodes nielseni		1												3			4	1	6			
Eupeodes lundbecki										2	1						1	1				1
Eupeodes corollae	1	1				2	1						4				3					

ANNEX 2D:Captures of Syrphidae

Trapnumber	C-2	C-10	C-12	C-6	C-19	C-4	C-13	C-15	C-17	C-8	C-14	C-20	C-18	C-11	C-3	C-7	C-9	C-16	C-5	C-1	C-21-23	C-24-26
Commune	Hanko	Tammis.	Tammis.	Inkoo	Lohja	Lohja	Nuuksio	Nuuksio	Nuuksio	Espoo	Helsinki	Sipoo	Pernaja	Pernaja	Pyhtää	Pyhtää	Pyhtää	Pyhtää	Pyhtää	Joutseno	Paltamo	Sotkamo
Site	Täktom	Et.Kuivast	Sköldarg.	Tähtelä	Mynterlä	Mynterlä	Högbacka	Högbacka	Högbacka	Mäkkylä	Tapanila	Nikkilä	Vanhakylä	Kabböle	Järvensuo	Länsikylä	Länsikylä	Länsikylä	Hirvivuolle	Kähärilä	Melalahti	Naapuriv.
Biotope 1	53.1	43.X	83.X	83.X	83.X	82.2	43.5	43.5	83.X	83.X	83.X	83.2	82.2	83.X	51.1	82.2	87.1	82.2	83.X	82.2	87.	83.X
Biotope 2	43.X	53.1		82.2	42.X	42.X	37.2		35.22		83.2	82.2	42.X	41.C3	44.A	41.D	42.X	83.X	20.	83.X		
first sample	4.May	4.May	26.May	4.May	13.May	13.May	26.May	26.May	26.May	19.May	14.May	22.May	11.May	11.May	5.May	5.May	5.May	11.May	5.May	5.May	17.May	16.May
last sample	11.Oct	29.Sep	29.Sep	29.Sep	29.Sep	11.Oct	11.Oct	11.Oct	28.Sep	12.Oct	29.Sep	29.Sep	12.Oct	17.Oct	17.Oct	17.Oct	11.Oct	17.Oct	11.Oct	11.Oct	19.Sep	19.Sep
Episyrphus balteatus	26	2	7	7	4	3	13	6	5	8	8	70	50		9	111	46	120	33	1		
Syrphus torvus	2	1		5	1	1	2	1	7	1		2		13		5	18	31	39	2	17	35
Syrphus vitripennis	17	1	2	7	4	5	47	7	4	7	2	7	4	27	9	41	91	39	82	1	10	21
Syrphus ribesii	51	4	1	10	2	2	56	8	5	3	3	5	23	6	3	95	93	30	46	5	2	2
Parasyrphus annulatus		1			1							1	2	1		2	2		1			
Parasyrphus malinellus																		1				
Parasyrphus vittiger	1																				1	1
Parasyrphus lineola	1				1		1						1				3	3	4		1	2
Parasyrphus nigritarsis	1																					
Parasyrphus tarsatus																					1	3
Parasyrphus relictus																						
Volucella pellucens																						
Myathropa florea							1															
Eristalis pertinax								1			1											
Eristalis arbustorum																				1		
Helophilus affinis											1											
Syritta pipiens											1											
Didea alneti																	1	1				1
Didea fasciata	1																					2
Didea intermedia													1		1							
Sericomyia lappona																	1					
Ischyrosyrphus glaucius																	7		3			
Ischyrosyrphus laternarius																1	3					
Chrysotoxium bicinctum				1													1	2			1	
Chrysotoxium festivum																						
Megasyrphus erraticus																	1					
SYRSUM	104	13	10	30	13	14	125	31	25	22	24	86	86	55	27	269	331	240	288	16	71	103
SYRSPEC	12	9	3	5	6	6	11	6	8	6	12	6	8	9	9	13	27	16	13	8	18	20

Trapnumber	C-27-29	C-30-32	C-33-35	C-36-38	TOTAL	TOTAL
Commune	Puolanka	Paltamo	Kuhmo	Kuhmo		site freq.
Site	Paljakka	Mieslahti	Rajakang.	Viiksimo		max.26
Biotope 1	42.C	83.X	44.A	87.	individuals	
Biotope 2						
first sample	9.Jun	9.Jun	8.Jun	8.Jun		
last sample	19.Sep	19.Sep	20.Sep	20.Sep		
Episyrphus balteatus		2		4	535	21
Syrphus torvus	9	11	46	57	306	22
Syrphus vitripennis	8	3	39	35	520	26
Syrphus ribesii	2		4	4	465	25
Parasyrphus annulatus		1		1	13	9
Parasyrphus malinellus	1		1		3	3
Parasyrphus vittiger				1	4	4
Parasyrphus lineola	1		1	9	28	12
Parasyrphus nigritarsis					1	1
Parasyrphus tarsatus	3	1	9	17	34	6
Parasyrphus relictus			2		2	1
Volucella pellucens				1	1	1
Myathropa florea					1	1
Eristalis pertinax					2	2
Eristalis arbustorum					1	1
Helophilus affinis				1	2	2
Syritta pipiens					1	1
Didea alneti					3	3
Didea fasciata					3	2
Didea intermedia					2	2
Sericomyia lappona					1	1
Ischyrosyrphus glaucius					10	2
Ischyrosyrphus laternarius					4	2
Chrysotoxium bicinctum					5	4
Chrysotoxium festivum	1				1	1
Megasyrphus erraticus					1	1
SYRSUM	35	23	125	291	2457	
SYRSPEC	10	8	14	21		

Trapnumber	C-27-29	C-30-32	C-33-35	C-36-38	TOTAL	TOTAL
Commune	Puolanka	Paltamo	Kuhmo	Kuhmo		site freq.
Site	Paljakka	Mieslahti	Rajakang.	Viiksimo		max.26
Biotope 1	42.C	83.X	44.A	87.	individuals	
Biotope 2						
first sample	9.Jun	9.Jun	8.Jun	8.Jun		
last sample	19.Sep	19.Sep	20.Sep	20.Sep		
Lapposyrphus lapponicus			5	5	109	12
Scaeva pyrastri				1	3	3
Cheilosia pagana				2	8	4
Cheilosia proxima					1	1
Cheilosia praecox		1			1	1
Cheilosia vernalis					13	3
Cheilosia variabilis					1	1
Cheilosia grossa					1	1
Dasysyrphus venustus			2	3	26	11
Dasysyrphus tricinctus				1	8	7
Dasysyrphus hilaris					4	3
Dasysyrphus pinastri	1		1		3	3
Dasysyrphus albostriatus					2	2
Meliscaeva cinctella	8	2	11	143	197	11
Sphaerophoria scripta				1	7	6
Sphaerophoria rueppelli					2	1
Melanostoma scalare			1	1	2	2
Platycheirus cyaneus					1	1
Platycheirus discimanus					2	1
Platycheirus scutatus					1	1
Platycheirus sticticus					1	1
Platycheirus peltatus			1		5	2
Meligramma trianguliferа					3	3
Melangyna barbifrons					8	4
Melangyna lasiophthalma					26	4
Melangyna umbellatarum		2			7	6
Melangyna compositarum			2	2	23	8
Orthonevra nobilis					1	1
Pipiza signata					3	1
Pipiza lugubris					1	1
Pipiza quadrimaculata				1	1	1
Pipizella viduata	1			1	3	3
Epistrophe nitidicollis					1	1
Eupeodes nielseni					15	5
Eupeodes lundbecki					6	5
Eupeodes corollae					12	6

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DOCUMENTATION PAGE

Published by
Finnish Environment Institute

Date of publication
January 1997

Author(s)
Söderman Guy, Leinonen Reima, Lundsten Karl-Erik

Title of publication
Monitoring bumblebees and other pollinator insects

Type of publication

Commissioned by

Parts of publication

Abstract
Invertebrate species monitoring is poorly developed in Finland. This study emphasizes a new technique in using yellow colour-traps for monitoring pollinator insects.

The tested yellow colour-traps collected efficiently bumblebees, waeps and hoverflies, and to a lesser extent also solitary bees. All collected species prefer to visit yellow flowers. Ninety-nine species and 8,082 individuals were collectedin this study..The composition of the samples reflected the local population well.

The study gave valuable information on the needed number of traps and suitable biotopes for monitoring purposes. Correct siting of the traps was found to be important for good results.

On the basis of the study results we recommend to start a nation wide 2 year pilot monitoring programme. The pilot monitoring programme should focuss on the species composition and changes in the populations. Three traps, close to one another, per site is recommended. Further research on the effect of other coloured traps should be continued.

A two-year pilot period is required to estimate the possible effect of various weather conditions from year to year.

Keywords
Polinator insects (bumblebees, solitary bees, wasps, hoverflies)
Monitoring method

Other information

Series (key title and no.)
Miniograph Series of Finnish Environment Institute no 58

ISBN

ISSN

Pages
43

Language
English

Price

Confidentiality
Public

Distributed by
Finnish Environment Institute
Client Service
Tel + 358 9 4030 0100
Fax + 358 9 4030 0190

Publisher
Finnish Environment Institute
BOX 140
FIN-00251 HELSINKI
Finland

KUVAILULEHTI

Julkaisija
Suomen ympäristökeskus

Julkaisun päivämäärä
Tammikuu 1997

Tekijä(t) (toimielimestä: nimi, puheenjohtaja, sihteeri)
Söderman Guy, Leinonen Reima, Lundsten Karl-Erik

Julkaisun nimi (myös ruotsinkielinen)
Kimalaisten ja muiden pölyttäjähyönteisten seuranta

Julkaisun laji | *Toimeksiantaja* | *Toimielimen asettamispvm*

Julkaisun osat

Tiivistelmä

Lajikohtaisista seurantamenetelmistä on Suomessa puutetta. Oheinen tutkimus selvittää uudenlaisten keltarysien käyttöä pölyttäjähyönteisten seurannassa.

Keltarysät keräsivät hyvin kimalaisia, ampiaisia, kukkakärpäsiä sekä jonkun verran mehiläisiä, eli keltaisilla kukilla käyviä pölyttäjähyönteisiä (yhteensä 99 lajia ja 8082 yksilöä). Näytteiden koostumus vastasi hyvin paikallisia kantoja.

Tarvittavien rysien määrästä sekä sopivista biotoopeista tutkimus antoi arvokasta tietoa. Rysien sijoittaminen näkyvästi oikeisiin maastokohtiin osoittautui tärkeäksi.

Tulokset olivat niin lupaavat, että päädyimme ehdottamaan 2 vuoden maanlaajuista pilottiseurantaa.Vuosittain toistuvalla seurannalla pyritään selvittämään lajistoa sekä muutoksia hyönteiskantojen koossa.

Sattumanvaraisuuden vähentämiseksi rysiä tulisi sijoittaa kolmen ryhmiin jokaiselle havaintopaikalle. Lisäksi tulisi vielä testata erivärisiä rysiä. Kahden vuoden aikana myös vaihtelevien säiden vaikutus tasoittuu.

Asiasanat (avainsanat)
Pölyttäjähyönteiset (kimalaiset, mehiläiset, ampiaiset, kukkakärpäset)
Seurantamenetelmä

Muut tiedot

Sarjan nimi ja numero
Suomen ympäristökeskuksen moniste 58

ISBN

ISSN

Kokonaissivumäärä
43

Kieli
Englanti

Hinta

Luottamuksellisuus
Julkinen

Jakaja
Suomen ympäristökeskus/asiakaspalvelu
Puh. 09-4030 0100
Fax 09-4030 0190

Kustantaja
Suomen ympäristökeskus
PL 140
00251 HELSINKI

PRESENTATIONSBLAD

Utgivare
Finlands miljöcentral

Utgivningsdatum
Januari 1997

Författare (uppgifter om organet: namn, ordförande, sekreterare
Söderman Guy, Leinonen Reima, Lundsten Karl-Erik

Publikation (även den finska titeln)
Övervakning av humlor och andra pollinerande insekter

Typ av publikation | *Uppdragsgivare* | *Datum för tillsättandet av organet*

Publikationens delar

Referat
Det råder brist på lämpliga metoder för övervakning av invertebrater i Finland. Denna undersökning redogör för användningen av en ny sorts gulfällor för övervakning av pollinerande insekter.

Gulfällorna samlade effektivt humlor, getingar, blomflugor samt ett mindre antal bin, dvs. insektgrupper som besöker gula blommor (tillsammans 99 arter och 8082 individer). Artsammansättninen motsvarade väl lokala populationer.

Undersökningen gav värdefull information om val av rätt biotop samt om antalet fällor som behövs för övervakningen. Det visade sig vara viktigt att fällorna upphängdes väl synliga i terrängen.

På basen av undersökningens resultat rekommenderar vi genomförandet av ett 2-årigt landsomfattande pilotövervakningsprogram. Övervakningsprogrammet bör inrikta sig på artsammansättning och populationsförändringar. Vi rekommenderar användning av tre fällor per plats. Olikfärgade fällors effekt bör undersökas vidare.

Under en två-års period är det möjligt att uppskatta inverkan av varierande väderleksförhållanden.

Sakord (nyckelord)
Pollinerande insekter (humlor, bin, getingar, blomflugor)
Övervakningsmetod

Övriga uppgifter

Seriens namn och nummer
Finlands mijöcentrals duplikat 58

ISBN | *ISSN*

Sidantal
43

Språk
Engelska

Pris

Sekretessgrad
Offentlig

Distribution
Finlands miljöcentral
kundservice
tel. 09-4030 0100
fax 09-4030 0190

Förlag
Finands miljöcentral
BP 140
00251 HELSINKI