Restoring inland shore-meadows for breeding birds

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In Sweden, as in other countries, inland shore meadows are a rapidly disappearing habitat. A restoration project was therefore undertaken at Lake Kävsjön in Store Mosse National Park, southern Sweden. The vegetation cover was removed from study plots to allow the recolonization of pioneer low grass/sedge communities suitable for breeding waders. This treatment, combined with grazing, led to positive effects on breeding waders and Yellow Wagtails, whereas only temporary effects were noted without grazing.

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INTRODUCTION

Lake Kävsjön in the Store Mosse National Park in southern Sweden (Figure 1) has been well-known for its birdlife for a long time, especially for the occurrence of breeding birds of both northern and southern origin, and for its rich populations of breeding waders and other waterbirds (Wibeck 1904, 1950; Nilsson *et al.* 1976, 1982). During the 1960s, many local bird watchers reported that the bird fauna of Lake Kävsjön had deteriorated, as it had in many other wetland areas in inland Sweden. Inspired by the lake-restoration projects started in Sweden in the late 1960s (Björck 1976), discussions were initiated concerning the possibilities of restoring the bird fauna of Lake Kävsjön. As a result of these discussions, extensive botanical, limnological and ornithological studies were undertaken in the area (Hamrin 1973, 1976; Larsson 1976; Larsson & Svensson 1972; Nilsson 1972, 1985; Nilsson *et al.* 1976, 1982).

After preliminary studies of the bird fauna and the lake vegetation, it was decided to initiate a project to try to restore the shore meadows to make them suitable for breeding waders and other shorebirds. In 1975, small study plots were treated to test the methods. The results were positive (Nilsson *et al.* 1982) and restoration work on larger areas of the shores at Kävsjön were undertaken in 1986. This paper reports the results of the restoration work at Kävsjön and the changes in the number of shore birds since the monitoring from when it started in 1973 until it ended in 1991, i.e. five years after the main restoration work.

STUDY AREA

Lake Kävsjön is situated in the Store Mosse National Park, a large area of elevated bogs in southern Sweden (Figure 1). In common with a large number of other bird sites in the region, it is a product of the nineteenth century attempts to increase the area of agricultural land by lowering the water level of the lake. Originally the lake covered an area of 9.5 km^2 of which 1.6 km^2 remained as a lake in the 1960s. During autumn and spring most of the former lake area was flooded. When the water level was lowered, large areas of organic bottom sediments were exposed in the southern part of the lake, whereas large expanses of sandy, mineral-rich bottom sediments were exposed on the northern shore. The organic bottom sediments were colonised by marshy plants forming a large area of floating vegetation dominated by various sedges *Carex spp.* During the early parts of the century, this floating mire vegetation was harvested for hay but this ceased some time during the 1930s.

The drier parts of the sandy shores were colonised by pine forest, whereas the lower-lying parts developed a vegetation zonation typical of oligotrophic lakes of the region. The area was invaded by low grasses e.g. *Agrostis canina* and sedges e.g. *Carex nigra* and formed excellent grazing areas. The vegetation was kept low by animals preventing invasion by *Myrica gale* from the forest and *Carex rostrata* from the lake. During the first decades of this century, these shore-meadows were important breeding habitats for various shorebirds, as has been documented by Wibeck (1904, 1950).

The grazing of the shore meadows at Lake Kävsjön decreased during the 1940s and 1950s and came to an end in the 1960s. The shores were colonised by *Myrica gale* from the forest side and high sedges *Carex rostrata,* from the lakeward side. By the 1970s, a large proportion of the sandy shores along Lake Kävsjön was covered by this vegetation, with a mosaic of the two dominant types in the mid-zone between the water's edge and the forest. In some parts of the area, smaller remnants of the former low plant community dominated by *Carex nigra* and *Agrostis canina* still existed (Larsson & Svensson 1972).

In the north-western part of Lake Kävsjön the sandy shores are wide, whereas they form a narrower fringe between the lake and the wood in other parts of the area. The wider part of the shore is divided into two areas separated by a

bay, both these areas (Store ö and Svänö), being of similar character and also being formerly important bird areas. These two areas were chosen for the restoration experiments (Figure 1). Initially, both areas were covered with *Carex rostrata* and *Myrica gale*, the dominant vegetation type of the shores of Lake Kävsjön, but both areas also included quite large areas containing fragments of the former low grass/sedge community (Figure 2). Both areas also had small groups of low trees and bushes. Taken together the two areas covered the majority of the wide, sandy shores at Lake Kävsjön. As the areas were of similar size and initially had similar vegetation and topography (as well as bird fauna) they were well suited as study areas for measuring the effects of different restoration treatments.

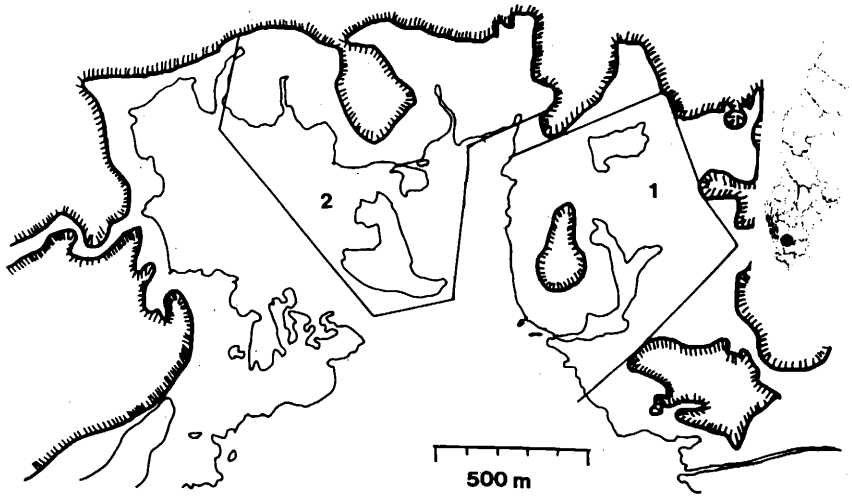

Figure 1. Map showing the location of Lake Kävsjön, and the two study areas : Svänö (1) and Store ö (2).

RESTORATION

The first step in the restoration project in 1975 was to cut the high sedges and bushes on the experimental plots (Figure 1) and to burn the plant remains. To evaluate the effect of grazing the Svänö plot was then grazed by cattle, whereas no grazing was undertaken at Store ö. By cutting and grazing the high vegetation, it was hoped to create a shorter sward and more suitable breeding conditions for waders and other shorebirds.

As the low grass/sedge community had invaded the sandy bottom sediments at Lake Kävsjön, when they were exposed after the lowering of the water level, it was decided to expose the sediments in small plots within the study areas to test the possibility of restoring this low grass/sedge community. Two small plots in the Svänö area (Figure 2) and one in the Store ö area were rotivated, to cut the root systems of the vegetation and to expose the sediments so that the short sedge-grass community could recolonize. The cut pieces later drifted to the shores with the next high water.

After the treatment, the study areas were monitored for a five year period to evaluate the effects on the vegetation and the breeding bird fauna. Originally it was planned to continue with further treatments after the five year period if the effect was positive, but for various reasons there was no immediate follow-up. In the meantime, the Svänö study area was grazed by cattle to keep the vegetation low, whereas the Store ö area was left ungrazed.

In the mid-eighties, funds were once more available for continuing the experiments. It was then decided to keep the Store ö study area as a control (the vegetation had very soon returned to the situation before the experiment, see below, except for a temporary effect on the bushes) and to concentrate the efforts on the Svänö study area. During the autumn of 1986, 14 ha of the 38 ha Svänö study area was rotivated, exposing the sediments and facilitating colonisation by the low sedge-grass community (Figure 2). It was decided not to graze the study area in the years immediately after the treatment as trampling would destroy the vegetation before a close sward had developed on the cultivated parts. Grazing was restarted later, but this did not happen until after the monitoring period.

VEGETATION DEVELOPMENT

Cutting had very little effect on the shore vegetation at Lake Kävsjön. In the Store ö area it was impossible to see any effects after two years except that the bushes were lower in a small area with birches. Both *Myrica gale* and *Carex rostrata* were back in full strength. In the Svänö area, cutting followed by grazing had very little effect on

the *Myrica* but in parts of the area, grazing kept the vegetation, especially the sedges, lower and more suitable for waders.

When the effects of the first experiments in 1975 were evaluated in 1980, the rotivated plots had been colonised by a low grass/sedge community forming a continuous vegetation cover. In the grazed plot at Svänö, the *Carex nigra / Agrostis canina* vegetation of the cultivated areas was still present when the studies ended in 1991. In the first years after the experiment in 1975, *Carex rostrata* colonised the wetter areas from the lakeward side, due to unusually high water levels in the lake, but this vegetation did not spread in the more normal seasons. In 1991, there was still almost no colonisation by *Myrica* in the treated plots.

After the second treatment in 1986, the cultivated parts of the Svänö study area were devoid of vegetation in the summer of 1987. In 1988, the treated areas still had no complete vegetation cover, but *Carex nigra* plants were found spread over the entire area. A further spread of the vegetation was noted in 1989 when smaller areas of low *Carex* / grass vegetation had developed. The spread of the vegetation continued in 1990 and 1991 but 1991 was quite a wet year with some water over parts of the treated areas.

When the vegetation development was monitored in 1991, most of the 1 m x 1 m squares surveyed had some vegetation cover, even if the total coverage was sparse. In the wettest area, *Juncus articulatus* was found in 86% of analysed squares, whereas *Carex nigra* was found in 76 - 100% of the squares in four separate sub-areas. In the sub-areas close to the former low grass/sedge areas, 81-85 % of the squares contained *Agrostis*, whereas it had reached a much lower frequency in the more distant parts of the study area.

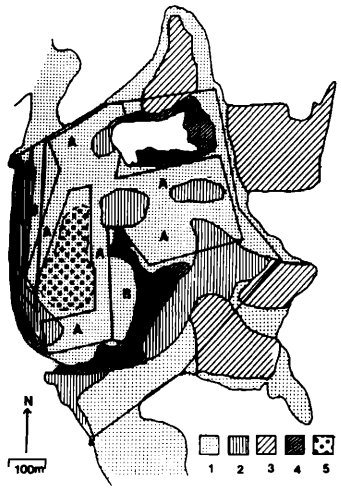

Figure 2 Vegetation map of the of the grazed area at Svänö, showing the areas rotivated in 1975 (B) and 1986 (A)
Key to habitats: 1. *Myrica gale/Carex panicea* - community; 2. *Carex nigra/Agrostis canina* - community; 3. carr vegetation of a relatively rich type for the region; 4. *Carex rostrata* - community; 5. an area with pines cut down in 1975 leaving an open area with grasses and low bushes

CHANGES IN THE BREEDING BIRD FAUNA

The breeding bird fauna of the study plots at Lake Kävsjön were surveyed during 1973 - 1980 and 1983 - 1991, i.e. for periods before and after the two treatments, using the same mapping technique as that used in the Swedish breeding bird monitoring programme and the Common Bird Census in Britain (Svensson 1978; Bibby *et al.* 1992). Each study area was surveyed on ten occasions spread over the breeding season plotting all relevant observations on large scale maps, one for each visit. The number of territories was later estimated according to standard procedures (Svensson 1978) based on species maps compiled over the ten visits.

The total estimated numbers of breeding waders and Yellow Wagtails *Motacilla flava* are shown in Figures 3 and 4. The data for each species for the two study areas are presented in Tables 1 and 2. In the Svänö area, an increase in the number of breeding pairs of waders and Yellow Wagtails was found after the treatment in 1975. The mean number of waders for 1973 - 1975 was 9 pairs compared to 12 pairs for 1976 - 1980. In particular, 2-4 pairs of Lapwings *Vanellus vanellus* and 2-3 pairs of Redshank *Tringa totanus* bred after the treatment, whereas only one pair of each was found in the years before the treatment. Both these species prefer shore meadows with low vegetation, whereas the Wood Sandpiper *Tringa glaerola* and Snipe *Capella gallinago* also breed in somewhat higher vegetation.

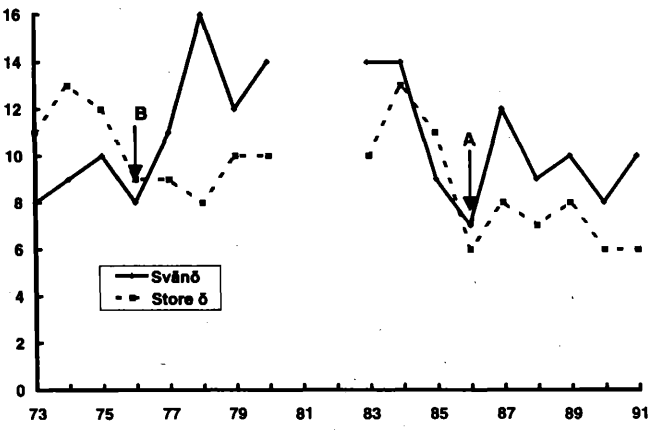

Figure 3. The number of breeding wader pairs in the two study areas.Arrows mark the treatments with rotoir cultivation of plots B and A, respectively.

The treatment did not affect the total number of passerines present (8 pairs, 1973 - 1975; 7 pairs, 1976 - 1980) but changed the species composition. Before the treatment, one pair of Yellow Wagtail bred annually in the study plot, but from 1976 onwards, the number of pairs began to increase and in 1980, 7 pairs were recorded but Whinchat *Saxicola rubetra* and the Meadow Pipit *Anthus pratensis,* which had been present previously, were absent.

In the Store ö area, the number of breeding wader pairs decreased from a mean of 12 pairs for 1973 - 1975 to 9

pairs for 1976 -1980. Store ö was the last area to be grazed before the restoration experiments started and still had some patches of low grass/sedge when the study started. The decrease in the number of waders over the years may be due to changes in the vegetation in the area as the low grass patches were invaded by bushes and higher vegetation. However, the number of breeding pairs of Yellow Wagtails increased here too, probably a temporary effect due to the cutting of the bushes and high vegetation. Later, when the bushes had grown high again, the Yellow Wagtail disappeared from this study plot.

In the second period of breeding bird surveys, the number of waders in the Svänö area was similar in 1983 and 1984 to that in 1978-80. However, a much lower number of waders was seen in 1985 and 1986 , e.g Lapwings and Redshanks were entirely absent and only 3 pairs of Snipe were found compared to 6 -7 pairs in most years. The decrease in the number of wader pairs from 1983-84 to 1986 was the same in both study areas and does probably reflect a general change in the lake area.

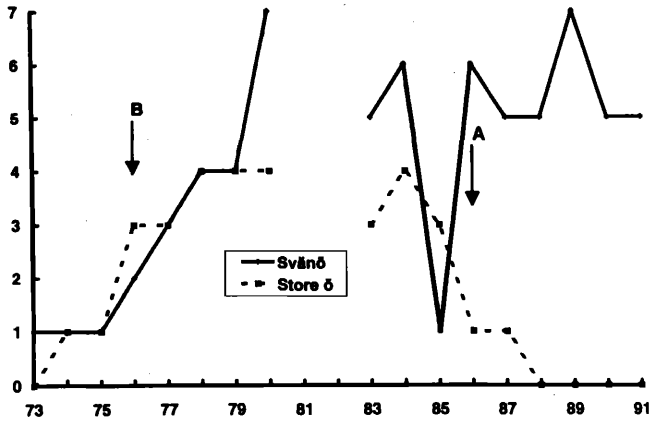

Fig.4. The number of breeding pairs of Yellow Wagtail *Motacilla flava* in the two study areas.

After the treatment in 1986, the mean number of breeding waders in the Svänö area was ten pairs. In the two years immediately before the treatment, the mean number recorded was eight pairs, but the mean for the periods 1978-1980 and 1983-1984 was 14 pairs. The mean number of waders before the first treatment in 1975 was nine pairs. Among the breeding pairs in 1987 -1991, 2 -3 pairs of Lapwings and 1 -3 Redshanks pairs were found annually. After the treatment in 1986 numbers again increased in the Svänö area, whereas they remained at a low level at Store ö.

Due to the disturbed sediments, the area available for breeding waders was considerably smaller than before the treatment, only a small part of the treated area having been colonised by the low grass/sedge vegetation considered suitable when the monitoring was terminated in 1991. Even if the treated areas were good for feeding waders they did not yet provide nesting opportunities, although there were some exceptions in 1991. The effective density of waders was thus 42 pairs/100 ha after treatment in 1986 compared to 36 pairs/100 ha after the first treatment in 1975.

In the Store ö area, where the vegetation did not show any signs of treatment by the late seventies, a decrease in the number of waders was found during the survey period 1983 - 1991. During 1984 - 1986, the number of waders were similar in the two plots, but when the numbers increased in the Svänö area after the treatment in the autumn of 1986, they remained at a low level in the Store ö area.

Among the passerines, only slight changes in the number of pairs of different species were found during the 1983 - 1991 period in the Svänö area. Overall the number of pairs was higher for this period than for the earlier period. During the earlier period, the number of Yellow Wagtails increased after the treatment to a total of 7 pairs in 1980. During 1983 - 1991 between 5 and 7 pairs were found annually with the exception of 1985, when there was only one breeding pair in the area.

During the latter period, relatively few passerines were found in the Store ö area. With the exception of 1984, which was an unusual year, between 7 and 8 pairs were found annually. In 1983 - 1985 3-4 pairs of Yellow Wagtails still bred in the area, but only 1 remained in 1986 and 1987, the species not being found in the plot during the last four seasons. The disappearance of the Yellow Wagtail from the plot can be related to the regrowth of bushes in the plot, which in turn led to an increase in the number of breeding Willow Warbler *Phylloscopus trochilus* and Chaffinch *Fringilla coelebs*.

DISCUSSION

The first series of experiments with the rotivator clearly showed that it was possible to restore the pioneer plant community of low grass/sedge by removing the higher vegetation and leaving the sediments free to be colonised. It should be noted however, that there were small remnants of the desired vegetation spread over the entire area. It was also clear from the first treatments, that it was necessary to graze the area with cattle to keep the vegetation as low as was desired. The studies in 1991 showed that the effects on the *Myrica* - vegetation remained, even after 16 years, only a very limited recolonisation being found in the grazed Svänö plot.

The second larger scale treatment in the Svänö plot showed that the method was also feasible for the treatment of larger areas. After the five year period of monitoring, the low sedge and grass species were well spread over the entire treated area even if the sediments were not fully covered with vegetation in some parts of the area. There was no regrowth of *Myrica* in the treated area even with the lack of grazing, however, it is clear that five

years is too short a period to follow the re-establishment of shore vegetation in these oligotrophic areas.

There was an immediate response in the number of breeding waders to the treatment in the Svänö area where grazing was introduced, whereas no such effect was found in the other, ungrazed area. The areas treated with the rotivator in 1975, although sufficient to test the effects of the treatment on the vegetation, were too small to be of importance for the bird fauna. The effect remained until 1984, but the low numbers in 1985 and 1986 were probably due to factors working outside the local area. After the second treatment, no marked increases were found, but it should be noted that the available area decreased markedly as the treated sediments did not settle in the first seasons and these areas were thus not available as breeding areas (but were used as feeding areas). Taking this into consideration, the density was higher after the second treatment than before. At Store ö (control), the number of waders were much lower in the later years than when the studies started, almost certainly due to the area being colonized by higher vegetation.

For the Yellow Wagtail the effect was clear, with a marked increase after the first treatment and much higher breeding numbers in the following years. In the Store ö area, a short-term effect of the cutting of high vegetation was noted (not seen in the waders) but the species later disappeared from the area as a response to colonisation by bushes.

Colonisation of the new habitats differed markedly between species. Whereas the Yellow Wagtail responded immediately with an increase in the number of pairs, the reaction was slower in the waders. In the past, the breeding bird fauna on the shore meadows included species such as Dunlin *Calidris alpina* , Ruff *Philomachus pugnax*, Redshank and Lapwing (Wibeck 1904; 1950). During the present study, the latter two species bred regularly in the study plots, whereas Ruff only bred in some years. Dunlin have not been found breeding in the Store Mosse area in recent years. Even if suitable breeding habitat for the species can be restored, success is dependent on nearby populations for colonisation.

In conclusion, the treatment of high vegetation with a rotivator is a workable method to help to re-establish a low shore vegetation in oligotrophic areas. However, to keep the treated areas free, they need to be grazed by cattle. It was also clear that a positive effect on breeding bird fauna could be achieved even if it is difficult to restore the old bird community because recruits have to find newly created areas.

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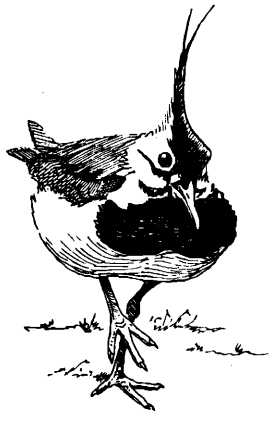

Table 1 Number of breeding pairs of different species in the Store ö study area (27 ha) at Lake Kävsjön, Store Mosse, 1973 - 1991

Species	1973	1974	1975	1976	1977	1978	1979	1980	1983	1984	1985	1986	1987	1988	1989	1990	1991
Vanellus vanellus	2	1	2	2	0	1	0	2	0	0	0	0	0	0	0	0	0
Gallinago gallinago	3	3	4	2	6	3	5	4	3	6	5	3	2	3	3	3	2
Tringa glaerola	2	3	2	3	1	2	3	2	6	6	5	3	5	4	4	3	3
Tringa totanus	3	1	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0
Philomachus pugnax	1	5	2	1	1	1	1	1	1	1	1	0	1	0	1	0	1
Total waders	11	13	12	9	9	8	10	10	10	13	11	6	8	7	8	6	6
Turdus pilaris	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saxicola rubetra	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthus pratensis	0	2	1	0	0	0	0	0	1	2	0	0	0	0	0	1	2
Motacilla flava	0	1	1	3	3	4	4	4	3	4	3	1	1	0	0	0	0
Emberiza schoeniclus	3	7	5	1	5	4	2	4	3	9	4	4	5	5	5	5	3
Fringilla coelebs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Phylloscopus trochilus	0	0	0	0	0	0	0	0	0	1	0	1	2	1	1	1	2
Acrocephalus schoenob.	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
Total passerines	3	11	8	4	8	8	6	8	7	17	8	7	8	7	7	8	8
OVERALL TOTAL	14	24	20	13	17	16	16	18	17	30	19	13	16	14	15	14	14

Table 2 Number of breeding pairs of different species in the Svänö study area (39 ha) at Lake Kävsjön, Store Mosse, 1973 - 1991

Species	1973	1974	1975	1976	1977	1978	1979	1980	1983	1984	1985	1986	1987	1988	1989	1990	1991
Vanellus vanellus	2	1	1	1	1	4	3	2	2	2	0	1	3	2	2	2	3
Gallinago gallinago	3	3	5	3	6	5	4	5	7	6	6	3	3	3	3	3	2
Lymnocryptes minimus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Tringa glaerola	2	2	2	2	2	2	2	3	4	2	3	3	4	2	4	2	3
Tringa nebularia	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tringa totanus	1	2	1	1	1	3	2	3	1	3	0	0	2	2	1	1	1
Philomachus pugnax	1	0	0	1	1	1	1	1	0	1	0	0	0	1	0	0	0
Total waders	8	9	10	8	11	16	12	14	14	14	9	7	12	10	10	8	10
Saxicola rubetra	1	1	1	0	0	0	0	0	0	0	0	2	1	0	2	2	1
Anthus trivialis	0	1	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0
Anthus pratensis	0	2	2	2	0	0	0	0	1	4	1	0	1	2	2	3	3
Motacilla flava	1	1	1	2	3	4	4	7	5	6	1	6	5	5	7	5	5
Motacilla alba	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Emberiza schoeniclus	3	5	5	2	4	3	3	3	5	8	3	4	3	4	3	4	3
Phylloscopus trochilus	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Acrocephalus schoenob.	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0
Total passerines	5	10	10	6	9	7	7	10	12	18	6	12	11	13	15	15	13
OVERALL TOTAL	13	19	20	14	20	23	19	24	26	32	15	19	23	23	25	23	23