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Population trends in Swedish raptors demonstrated by migration counts at Falsterbo, Sweden 1942–97

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The autumn migration of raptors at Falsterbo, Sweden has been studied since the early 1940s, and from 1973 standardized counts were made. Here we present data for 15 species over a 39-year period from 1942–97. These are discussed in the context of available information on population trends in Sweden and neighbouring countries. Although annual numbers and concentration rate vary considerably between species, population changes are very well reflected in the migration figures from Falsterbo. Most raptors showed stable populations at a fairly high level during the 1940s, but a marked decline was already obvious in White-tailed Eagle Haliaeetus albicilla *and Peregrine Falcon* Falco peregrinus. *During the 1950s and 1960s, a more or less steep decline occurred in most species. Four species started to increase during the 1960s, but the real change came during the 1970s. At that time, decreased human persecution and a reduction in the effects from pesticides resulted in a general increase in Scandinavian raptors, with only Honey Buzzard* Pernis apivorus *continuing to decrease. The increases continued during the 1980s, but in the 1990s many raptors seem to have reached stable numbers or to have started to decline again. Two species, Marsh Harrier* Circus aeruginosus *and Montagu's Harrier* C. pygargus *show a positive trend through the study period. Numbers of Northern Harrier* Circus cyaneus, *Rough-legged Buzzard* Buteo lagopus *and Eurasian Kestrel* Falco tinnunculus *stabilized during the 1980s and show a clear decline since then, most probably due to a general lack of rodent peaks in Northern Scandinavia since 1982. Most species of raptors seem to be doing reasonably well at the moment, but a continuous decline in Honey Buzzard and Common Buzzard* Buteo buteo *is disturbing, and is possibly due to declining proportions of old deciduous forest and grazed meadows in Scandinavia. Since a general census programme of birds of prey does not exist in Sweden, the migration counts at Falsterbo is the best general method of monitoring population changes.*

The Falsterbo peninsula constitutes the southwesternmost point of Scandinavia (Fig. 1). Large numbers of migrants, especially those reluctant to cross large bodies of open water, concentrate here during autumn migration – making Falsterbo one of the best places in Europe to observe raptor migration. The migrants pass over the peninsula in a westerly to southwesterly direction towards Denmark (closest distance 25 km to Stevns klint). Counts of passing birds of prey began in the 1940s.[1] Later, a ten-year study covering the period 1949–60 was conducted.[2] Since 1973, annual standardized counts of migrants have been carried out from August 11 to November 20, financed by the National Environmental Protection Board.[3,4] The data covers 39 autumns over a period of more than 50 years, making it one of the longest series of migration counts on

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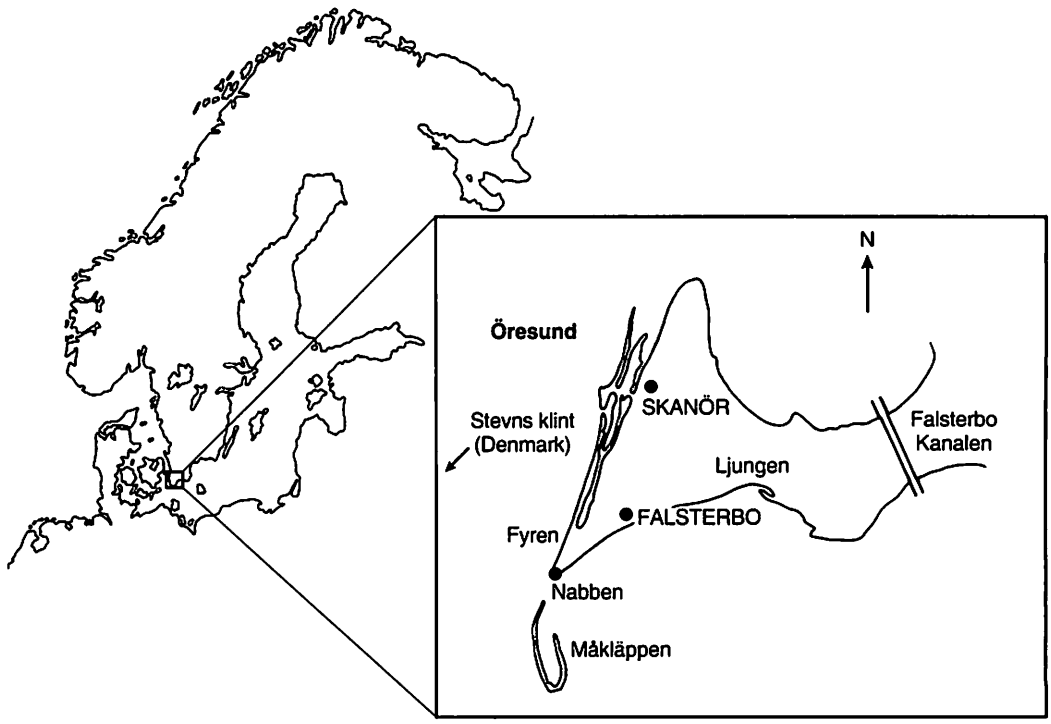

Figure 1. The study area on the Falsterbo peninsula, Sweden.

record, equalled only by the counts from Hawk Mountain, Pennsylvania.[5] Although the concentration rate of various raptor species varies a great deal at Falsterbo,[6] detailed censusing in a number of species indicates that the figures generally reflect the population trends very well.[7–11] Ringing recoveries indicate that most raptors originate from Sweden, with additional birds from Norway, Finland and possibly northwesternmost Russia.[12,13] There are, however, a few raptors, such as Eurasian Sparrowhawk *Accipiter nisus*, Rough-legged Buzzard *Buteo lagopus*, Northern Harrier *Circus cyaneus* and Peregrine Falcon *Falco peregrinus*, where a substantial proportion of the migrants at Falsterbo may be of Norwegian or Finnish origin. We describe the trends shown by the migration counts in the light of available information on population numbers.

METHODS

The three different count series (1, 1942–44; 2, 1949–60; and 3, 1973–97) are not completely comparable due to somewhat different routines. Count period, average daily observer activity and counting site are given in Table 1. In some years the counts started at the beginning of July, a time when raptor migration is very scarce. Most years in the first two series covered the whole of August, while the standardized counts from 1973 and onwards started on August 11. Also the termination date varied considerably in the first two series. Especially in the few years when the counts stopped before the end of October, this will affect the total in a number of migrants. This is most important in White-tailed Eagle *Haliaeetus albicilla*, Goshawk *Accipiter gentilis* and Eurasian Sparrowhawk where a considerable part of the migration pass as late as October–November.

1942–44

The counts were started 15–30 minutes before dawn and continued until migration activity had come to an end or was insignificant.[1] The average daily coverage varied between 8.5 and 9.4 hours (Table 1). Most of the counts were made from the southwesternmost point, Nabben (Fig. 1), with a smaller amount of time

Table 1. Coverage of migration counts at Falsterbo 1942–97.

Year	Period	Daily average (h)	Site
1942	13 Aug – 22 Oct	8.7	Nabben + Ljungen (10% of time)
1943	25 Jul– 1 Nov	8.5	Nabben + Ljungen (8% of time)
1944	1 Aug – 12 Nov	9.4	Nabben + Ljungen (7% of time)
1949	1 Aug – 17 Oct	9.3	Nabben (+ Fyren/Kolabacken)
1950	5 Aug – 28 Oct	10.6	Nabben (+ Fyren/Kolabacken)
1951	No observations		
1952	21 Jul – 31 Oct	5.9	Nabben (+ Fyren/Kolabacken)
1953	1 Aug – 31 Oct	7.8	Nabben (+ Fyren/Kolabacken)
1954	1 Aug – 1 Nov	7.1	Nabben (+ Fyren/Kolabacken)
1955	1 Jul – 17 Nov	7.8	Nabben (+ Fyren/Kolabacken)
1956	1 Jul – 15 Nov	8.5	Nabben (+ Fyren/Kolabacken)
1957	1 Jul – 17 Nov	10.9	Nabben (+ Fyren/Kolabacken)
1958	1 Jul – 17 Nov	9.7	Nabben (+ Fyren/Kolabacken)
1959	1 Jul – 15 Nov	10.8	Nabben (+ Fyren/Kolabacken)
1960	1 Aug – 17 Oct	6.8	Nabben (+ Fyren/Kolabacken)
1973–97	11 Aug – 20 Nov	8.4	Nabben

at Fyren (the Lighthouse), Kolabacken or Ljungen.

1949–60

In 1949, the Ornithological Society of Scania began an observation programme at Falsterbo running until 1960, excluding 1951. The routines were basically those used by Rudebeck.[2] The bulk of observations were made from Nabben. Most of the observation time there was only one observer, using binoculars, available. Data were recorded from 30 minutes before sunrise and continued until migratory activity had dropped to almost nil. However, if weather conditions led to migration later in the day, counts were resumed. During the 11 years, a number of different observers were involved for longer or shorter periods. This inevitably creates a problem when comparing single years. Knowledge, identification skill and visual acuity may vary to a greater or lesser extent between observers.

1973–97

In 1973, the National Environmental Protection Board initiated standardized counts at Nabben during the period August 11 to November 20.[3,4] These are included in a national monitoring programme and the dates were primarily selected to cover the whole raptor migration. A single observer counted from 30 minutes before sunrise until 13:00 hours GMT (14:00 hours local standard time). Apart from binoculars, a telescope is used only to identify distant birds. During the first two years, most work was done by Bengt Bengtsson but, since 1975, the great majority of counts have been conducted by the same observer (Gunnar Roos), only relieved on a few single days (Håkan Lindskog). The working routines since 1975 have been identical and the annual figures are highly comparable.

The great majority of raptors were identified to species. The only non-identified sample of importance is the category unidentified buzzards *Pernis/Buteo* (Table 2). In Rudebeck's series, the number of unidentified buzzards was moderate and does not significantly affect the totals.[1] However, in some years during the 1950s, the unidentified buzzards numbered several thousand (Table 2). In the standardized counts since 1973, the non-specified sample is generally of no importance. We have chosen to distribute the unidentified birds according to the percentage of identified individuals of Honey Buzzard, Common Buzzard and Rough-legged Buzzard in single years. Thus for example the 976 non-specified buzzards in 1942 were transformed to 182 Honey Buzzards, 786 Common Buzzards and eight Rough-legged

Table 2. Number of unidentified Buzzards *Pernis/Buteo* at Falsterbo in different years.

Year	Number	Year	Number
1942	976	1978	68
1943	785	1979	83
1944	381	1980	109
		1981	144
1949	1871	1982	0
1950	3914	1983	35
1952	611	1984	17
1953	968	1985	9
1954	1357	1986	254
1955	1610	1987	54
1956	4976	1988	73
1957	1386	1989	101
1958	1104	1990	44
1959	7117	1991	45
1960	4396	1992	26
		1993	0
1973	56	1994	2
1974	813	1995	0
1975	345	1996	4
1976	42	1997	0
1977	109		

Buzzards according to the identified sample. At most, the proportion of unidentified buzzards formed 22% in 1959, but in most years the percentage was very low (Table 2). Generally the unidentified sample does not raise the annual numbers of Rough-legged Buzzard much. The majority occurred in September when both Honey Buzzard and Common Buzzard migrate. In a few years during the 1950s the recorded number of migrating Honey Buzzards in late September to early October (when the migration is normally over) was surprisingly high and it is quite possible that some observers misidentified some Common Buzzards in those days. But even if the Honey Buzzard was somewhat over-represented in these few years, this does not affect the general picture.

The only other non-identified raptors were a few Steppe/Montagu's Harriers, with three birds in 1959–60 and a total of 13 birds 1973–97. Some of these were probably Montagu's Harriers, but since they were rather evenly distributed over the years they do not alter the increasing trend in this species. In spite of the reservations described above, we feel that the three data series give a very good picture of the general population trends in all species.

To test the synchrony of annual variation in numbers between the different species, a cluster analysis was performed. We used Spearman's and Pearson's correlation coefficients in a weighted pair group method with aritmethic mean (WPGMA).[14] This method combines a matrix of pairwise correlations of all species involved, resulting in a dendrogram grouping species according to their similarity in annual variation.

RESULTS

The annual figures as well as a running three-year mean are summarized for each species (Fig. 2). The population trend is discussed for each species below.

Varying weather conditions during the peak migration time may cause fairly large annual variations in the number of migrants in different species. For instance, during the last four years, prevailing stable high pressure conditions in August meant a comparatively low concentration of early migrants at Falsterbo. Thus the relatively low figures in species such as Honey Buzzard *Pernis apivorus*, Marsh Harrier *Circus aeruginosus*, Osprey *Pandion haliaetus* and Eurasian Kestrel *Falco tinnunculus* in some of these years are probably primarily a weather effect and not a sign of a population decrease. Therefore, long series are necessary in order to evaluate population development. The general trends in this material from a period of over 50 years are in many cases supported by breeding data but, especially in more common species, such information is often not available in Sweden.

Honey Buzzard *Pernis apivorus* (Fig. 2a)

The Honey Buzzard is the most common tropical migrant at Falsterbo. The majority are usually recorded on just a few peak days in late August to early September. It is less dependent on thermal migration than the Common Buzzard and the annual totals may vary considerably between single years. The numbers in the early 1940s and 1949–52 seem surprisingly low compared with the higher figures later in the 1950s (Fig. 2a). It is unlikely that Honey Buzzard populations have increased about four

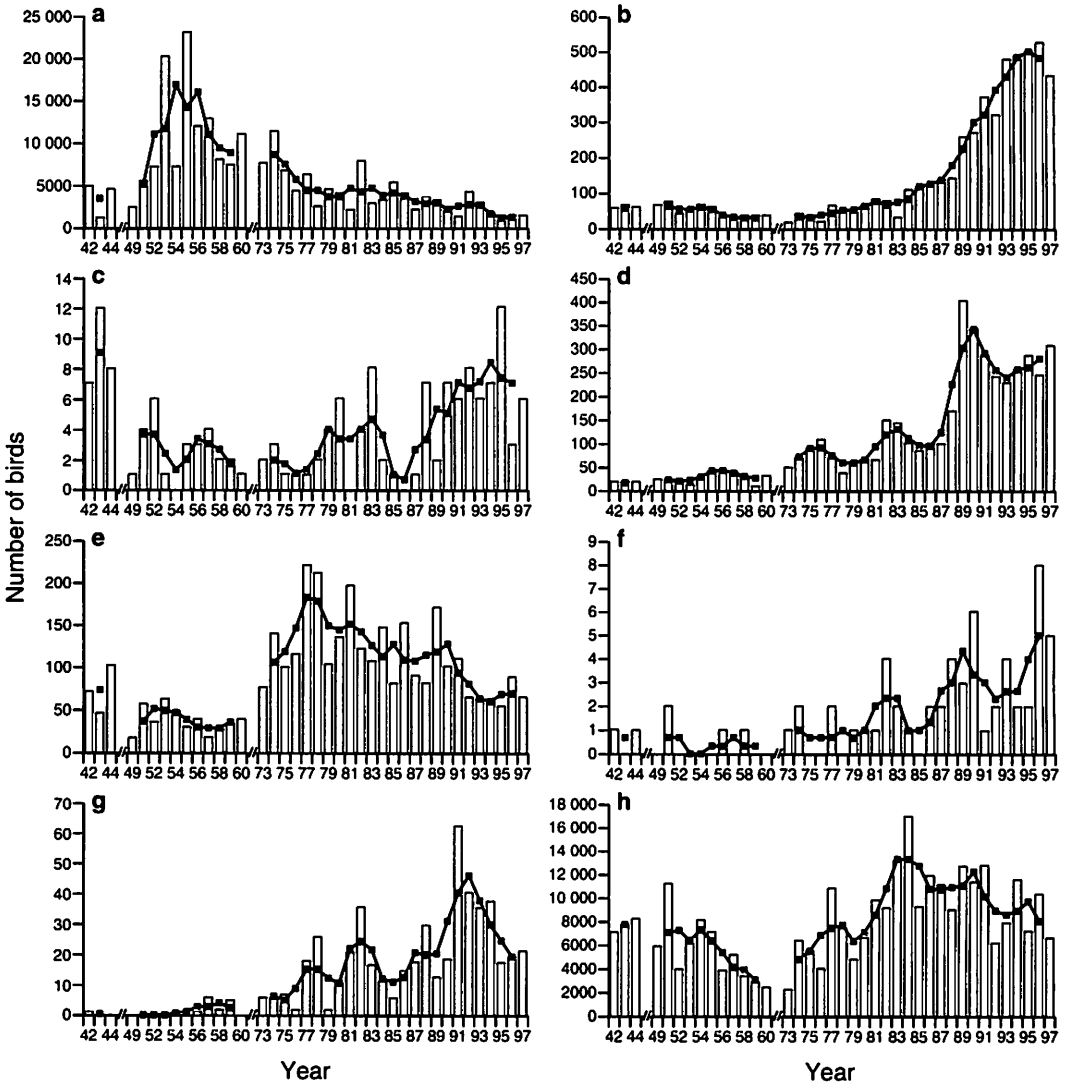

Figure 2. The number of different raptors counted on autumn migration at Falsterbo, Sweden, 1942–97. ■, Running three-year mean. a, Honey Buzzard; b, Red Kite; c, White-tailed Eagle; d, Marsh Harrier; e, Northern Harrier; f, Montagu's Harrier; g, Goshawk; h, Eurasian Sparrowhawk. *continued*

times in just a ten-year period.

The series from the 1950s is characterized by two extreme peak years (1953 and 1955). In these years, as well as in 1960, remarkably high numbers were recorded late in the season (when the migration passage at Falsterbo is normally completed). Although juveniles generally pass later, we feel that it is quite possible that a number of Common Buzzards were misidentified as Honey Buzzards in those years. The highest number of extremely late migrants occurred in 1955, at 18 000 [15,16], while a maximum of 1700 were misidentified in 1953. In the autumn of 1971, a total of 15 000 Honey Buzzards were seen on migration, with an impressive maximum of 9500 in one day.[17] In spite of large annual variations in numbers, a significant general decrease has been continuous from the early 1970s to the present (Fig. 2a). The percentage of juveniles recorded were as low as 9% 1975–97.[18,19] Only in 1986 was the proportion considerably higher at 37%.

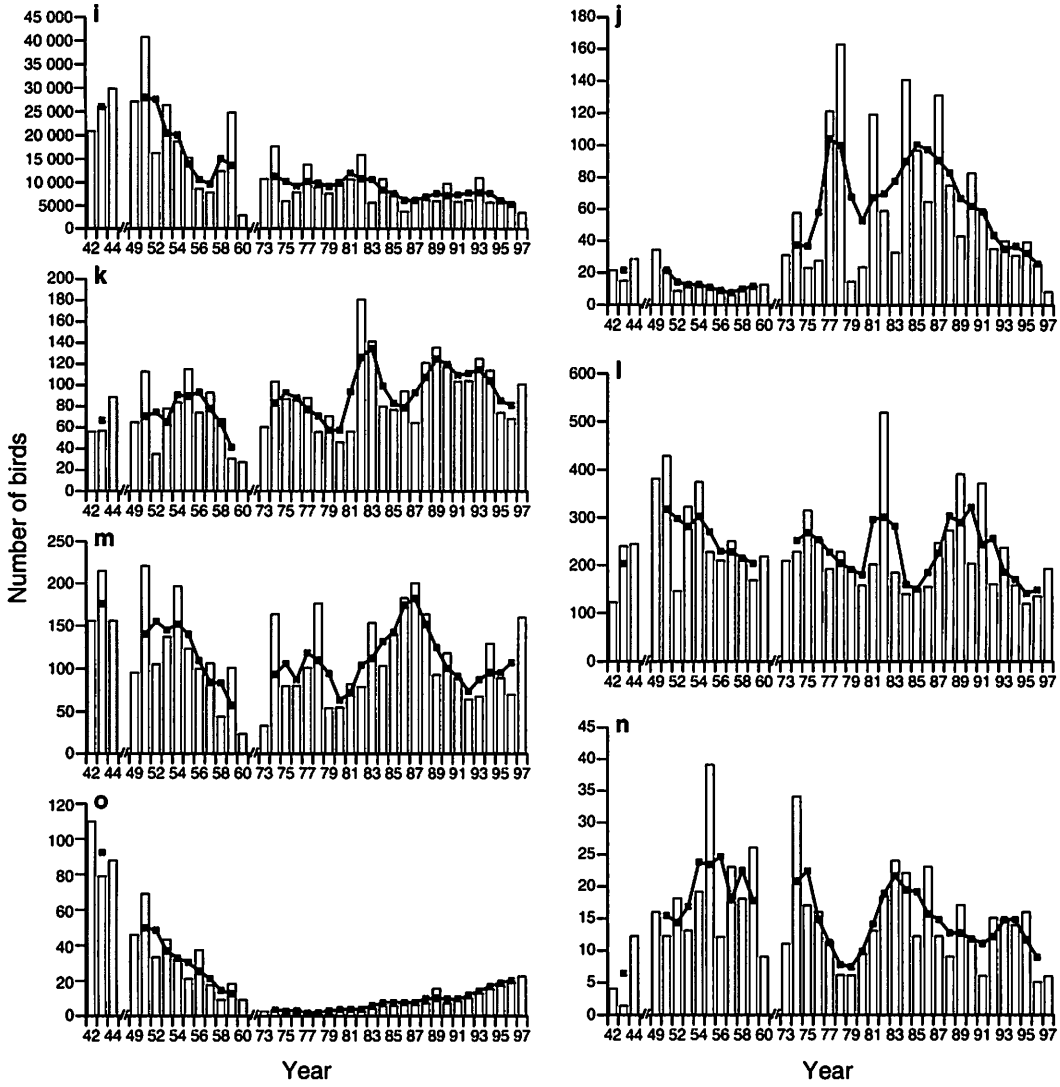

Figure 2 continued: i, Common Buzzard; j, Rough-legged Buzzard; k, Osprey; l, Eurasian Kestrel; m, Merlin; n, Hobby; o, Peregrine Falcon.

Red Kite *Milvus milvus* (Fig. 2b)

In the middle of last century, the Red Kite was a common breeder in the southern third of Sweden.[20] From this time, a steep decline, mainly caused by human persecution, occurred and by 1945 only about 100 pairs remained.[21,22] At this time, the figures at Falsterbo were stable at around 60 migrants annually (Fig. 2b). During the 1950s, decreasing numbers at Falsterbo indicate a further declining population. The bottom was probably reached during the 1960s, when the numbers may have fallen below 50 pairs. A national census in 1972 revealed approximately 50 breeding pairs concentrated to the southernmost county, Scania.[21,23] Since 1976, the species has been studied in a special project financed by WWF-Sweden. The Red Kite has made a remarkable recovery and the population was estimated at 800 pairs in 1998.[10] Increasing numbers of adult kites spend the winter in Scania nowadays, which most likely has led to a higher survival rate.[21] The development is mirrored extremely

well by the counts at Falsterbo (Fig. 2b). It has been estimated that about 50% of the adult and 69% of the juvenile Red Kites that leave Sweden migrate via Falsterbo.[10] This is the highest degree of concentration to Falsterbo among the raptors, primarily explained by the proximity of the breeding range.

White-tailed Eagle *Haliaeetus albicilla* (Fig. 2c)

After a general decline during the last century, the White-tailed Eagle now breeds primarily along the Swedish east coast and in the mountains of the north. Most birds spend the winter in Sweden and only small numbers of primarily juveniles and immatures reach Falsterbo. Annual censusing started in 1964, and since 1970 the White-tailed Eagle has been monitored in a special project – the population is now in the order of 200–260 pairs.[8,24]

In spite of annual totals of only between 0 and 12 birds, the counts at Falsterbo give a good reflection of the population development in Sweden (Fig. 2c). After comparatively high numbers in the early 1940s, an annual average of only two eagles were counted during the 1950s. However, the earlier completion of the counts in some of these years (Table 1) probably meant that a few birds escaped observation at the end of the season. The standardized counts since 1973 show large annual variation but the general trend is clearly positive.

Marsh Harrier *Circus aeruginosus* (Fig. 2d)

In Rudebeck's study,[1] the Marsh Harrier was a fairly rare migrant with an annual average of only 19 birds (Fig. 2d). The numbers were slightly higher during the 1950s with a mean of 31 migrants. When the new series was started in the early 1970s, numbers had more than doubled and since then a marked increase has occurred, especially during the late 1980s. Most likely the population increase is still continuing.

In the last century and the first half of the present the Marsh Harrier was a sparse breeder in the southern half of Sweden.[25] Four national censuses have been carried out by the Swedish Ornithological Society over 1958–95.[9,26–28] During the whole period, the observed proportion of the estimated autumn population recorded at Falsterbo remained at a similar level of 4–5%.[9]

Northern Harrier *Circus cyaneus* (Fig. 2e)

The Northern Harrier is a bird of the taiga zone of Northern Fennoscandia. It is highly dependent on the fluctuations in rodent numbers in this region [29,30], causing great annual variations in the breeding numbers. The Swedish population was estimated at 1000–2000 pairs in the late 1970s.[31]

An average of 47 Northern Harriers at Falsterbo in the early 1940s decreased to a mean of 38 migrants in the 1950s (Fig. 2e). It is quite surprising that the species was so much scarcer in those days compared with the standardized counts from the 1970s. The migration continues into November and a few birds may have been missed in the years when the counts ended earlier (Table 1), but this has only a marginal effect. That the species really was less common in the middle of the century is supported by figures from Ottenby, on the island Öland in the Baltic. During a complete coverage of the migration during July–October 1947–56, an average of only five Northern Harriers (and, on average, five *Circus* sp.) were counted at Ottenby[32] compared with 47 and 46 individuals during the two autumns 1989 and 1990.[33] There are no detailed rodent data available to explain the low numbers, but rough estimates of the number of lemmings and voles in the region show some peaks also in the period 1940–60.[34] Most Fennoscandian birds winter in Continental Europe and it is likely that the effects of human persecution and pesticides were more severe in that region before 1970.

The marked peaks in 1977–78 and 1981 correspond to peak rodent years in northern Sweden.[35,36] However, since 1982 there have not been any synchronized rodent peaks over large regions in northern Fennoscandia. This may be an important reason for the clearly decreasing numbers at Falsterbo during the last 15 years (Fig. 2e). The Swedish population may now be below 1000 pairs.

Montagu's Harrier *Circus pygargus* (Fig. 2f)

The first breeding in Sweden occurred as late as 1923.[25] During the 1940s, a small population

was established on the island Öland, enlarged to 45 pairs in 1996.[37] During the last 20 years, it has also increased on the mainland to roughly 25–30 pairs in 1996.[24] The small figures from Falsterbo mirror the situation quite well (Fig. 2f). During the period 1940–60 it was still a rare and not annual migrant. From the early 1970s, a gradual increase is evident. The concentration rate at Falsterbo is clearly lower than in Marsh Harrier[6], indicating migration on a generally broader front.

Goshawk *Accipiter gentilis* (Fig. 2g)

The Goshawk is a regular breeder over most of Fennoscandia but most of the birds spend the winter north of Falsterbo. The great majority migrating past Falsterbo are juveniles.[38] Population estimates from the last 20 years have varied between 3000 and 10000 pairs.[31,39–41] There has been some debate about population numbers and trends between hunters and ornithologists but the numbers have probably increased since the 1960s.[39]

The Goshawk is the latest migrant among the raptors, and the earlier ending of the counts in some years has certainly affected the numbers negatively (Table 1). It is, however, obvious that the numbers during the first two series were much lower than during the standardized counts (Fig. 2g). The species had been the subject of heavy human persecution and was not totally protected until 1979. Also, pesticides and modern forestry are assumed to have had negative effects on Goshawk numbers.[7,25,39] Even if only relatively small numbers reach Falsterbo, the clearly increasing figures between 1973 and 1991 probably reflect an increase in the population. Also migration counts from Ottenby, Öland, showed clearly increasing numbers during the period 1973–82.[42] Since 1991, the numbers at Falsterbo have dropped. This may be an occasional depression but a general breeding census in Finland shows a 20% decrease during the 1990s.[43]

Eurasian Sparrowhawk *Accipiter nisus* (Fig. 2h)

The Eurasian Sparrowhawk is a common breeder over much of Fennoscandia. The numbers at Falsterbo were in the order of 7000–8000 migrants from the early 1940s to the early 1950s (Fig. 2h). During the later part of the 1950s, the trend was a clear decrease and the bottom was probably reached in the following decade. Like many other raptors, the Eurasian Sparrowhawk was severely affected by pesticides at this time.[44,45] From the beginning of the 1970s, the curve changed and a fairly steep increase is indicated, making the Eurasian Sparrowhawk the most numerous raptor at Falsterbo at present. This is supported by a similar enhancement in the number of migrants at Ottenby.[42] After fairly stable figures in the late 1980s, the numbers at the moment seem to be falling.

Common Buzzard *Buteo buteo* (Fig. 2i)

The Common Buzzard was clearly the most common migrant in the early 1940s, with up to 30 000 birds in one autumn (Fig. 2i). The highest total so far is the 41 000 counted in 1950, but after that the numbers generally fell sharply during the rest of the 1950s. The Swedish population was estimated at 18 000–21 000 pairs in the late 1970s. [31,40] In contrast to many other raptors, the Common Buzzard has not really recovered since the 1960s. The standardized counts demonstrate a continuous slow decline since the early 1970s, although numbers have remained fairly stable for shorter periods during the series. After total protection in 1967, the Danish population increased to an estimated 6000 pairs in 1995.[46] In Finland, the breeding census shows a continuous slow decline in the period 1982–96.[43]

It has been suggested that modern plantation forestry is unfavourable to the Common Buzzard (P. Widén, pers. comm.). Another negative factor may be the continuous conversion of meadows to forest, causing losses of good hunting grounds. The proportion of juveniles at Falsterbo is generally much higher than in, for instance, Honey Buzzard and Rough-legged Buzzard,[6] indicating a good level of reproduction. During the 1940s and 1950s, the migration peak usually occurred in late September. In later years, however, most peak days have been in October. Since adults in general migrate ahead of juveniles,[38] this would indicate a higher proportion of juveniles nowadays.

While most Swedish Common Buzzards are migrants, wintering is regular in the southern-

most part (especially Scania). Thus it would be possible that decreasing numbers at Falsterbo could be an effect of more birds spending the winter in southern Sweden. However, winter censusing since 1975 does not show any clear increase in the number of Common Buzzards either in November, December or February.[47]

Rough-legged Buzzard *Buteo lagopus* (Fig. 2j)

Compared with the standardized counts, the figures from the first two series seem surprisingly low (Fig. 2j). Due to generally poorer binoculars in those days, it is possible that a larger proportion of Rough-legged Buzzards went undetected among the higher numbers of Common Buzzards, since peak days often overlap. However, this is certainly not enough to explain the very marked differences in numbers. Thus it seems likely that the Scandinavian population really was considerably lower in those days. This is further supported by similarly low migration counts at Ottenby, with an average of only 158 birds in the period 1947–56.[32] This does not seem to be associated with any general lack of rodents.[34] On the other hand, the similarity with the other northern rodent specialist, the Northern Harrier (Fig. 2e), is striking.

As with most other raptors, the numbers declined during the 1950s. This was followed by a steep increase during the 1970s. Large annual fluctuations in the standardized counts probably reflect changes in food supply. At least the peaks in 1974, 1977–78 and 1981 are correlated to high rodent numbers in Northern Scandinavia.[35,36] Also, at Ottenby, high number of migrants were recorded during the 1970s.[48] In particular, in 1978 unusually large numbers of migrating Rough-legged Buzzards were recorded in autumn at several places along the Swedish east coast.[49] Since 1982 no general peaks in either voles or lemmings have occurred in the Scandinavian breeding range, which may explain the steep decline in the number of migrating Rough-legged Buzzards at Falsterbo since then. The number in 1997 was back at the same low level as in the 1950s (Fig. 2j).

An estimated Swedish population of 7000 pairs in the late 1970s[31] is most certainly lower today. A generally low proportion of juveniles at Falsterbo since 1986 indicates a poor productivity.[6]

Osprey *Pandion haliaetus* (Fig. 2k)

At the beginning of this century the Osprey was fairly rare in Sweden, but numbers increased after the official protection at the end of the 1920s.[7,50]

The counts at Falsterbo indicate a fairly similar population at the beginning of the 1950s compared with the situation ten years earlier (Fig. 2k). After this, the numbers dropped and were probably comparatively low during the 1960s. At this time, the Osprey suffered from eggshell-thinning as a result of high levels of mercury and pesticides.[51,52] The situation improved during the 1970s and the number of migrants increased. Studies of local populations in central Sweden and the province Småland show an annual increase of 1% in the period 1973–93. In Finland, the growth rate during the last 25 years was between 1 and 1.5% annually.[50] With an estimated Swedish population of 3200 pairs at the end of the 1980s,[25] the concentration rate at Falsterbo is comparatively low.[6]

Eurasian Kestrel *Falco tinnunculus* (Fig. 2l)

The Eurasian Kestrel is a sparse breeder in southern Sweden, while higher densities inhabit the northern part of the country.[25] Comparatively low migration figures from the early 1940s (Fig. 2l) are most likely an effect of the cold winters during the second world war (G. Rudebeck, pers. comm.), since most birds winter in Western Europe. Declining numbers during the 1950s were probably caused by a deteriorating influence from pesticides, continuing into the next decade.

The Swedish population was estimated at 2000–3000 pairs in the middle of the 1970s.[31,53] During the standardized counts, the development has proceeded in waves with an overall slightly negative trend. It seems that the species has not fully recovered from the severe effects from mercury, especially in the southern part of the country.[7]

This may partly be an effect of more rational farming practices nowadays.[25] In particular, the northern breeding population is affected by fluctuating rodent numbers.[54] The peak at

Falsterbo in 1982 is linked to the latest general rodent peak in northern Scandinavia[36] and the falling numbers in later years are possibly a consequence of poor breeding results due to the lack of good vole years. In contrast, the breeding census in Finland shows a clear increase in the number of Eurasian Kestrels since 1982.[43] In Denmark, a general decrease occurred up until 1950. After this it has increased to at least 2500 pairs today.[46]

Merlin *Falco columbarius* (Fig. 2m)

The Merlin is a fairly common breeder in the northern mountains and the taiga zone. Not very much is known about fluctuations in the population, but 5000 pairs was estimated in Sweden in the late 1970s.[31] The counts at Falsterbo indicate a comparatively high population level in the 1940s (Fig. 2m). Like in most other raptors, the numbers declined during the next decade.

From the early 1970s until the late 1980s, the numbers seem to have recovered. Even though it mainly hunts birds, Merlin may also be affected by fluctuations in the northern rodent stock.[54] Falling numbers during most of the 1990s may at least partly be caused by poor rodent numbers in northern Scandinavia. Also, a breeding census in Finland registered a decline during this period.[43]

Hobby *Falco subbuteo* (Fig. 2n)

Especially in the eastern parts, the Hobby is a sparse breeder up to northern Sweden. Very little is known about any changes in breeding numbers during this century. It is a tropical migrant with a very low concentration at Falsterbo, where mainly juveniles are seen.[6]

Compared with most raptors, the numbers in the early 1940s were surprisingly low (Fig. 2n). There is really no reason to suspect that the Hobby was less common in those days, and also later prominent gaps in the migration curve exist. In contrast to most other species, numbers remained on a comparatively high level all through the 1950s. It is possible that this species, wintering in Africa, was affected by pesticides to a lower degree than most other raptors. On the other hand, numbers in the standardized counts, if anything, show a slight negative tendency.

Peregrine Falcon *Falco peregrinus* (Fig. 2o)

Until the middle of the century the Peregrine Falcon was a comparatively common Swedish breeder, with possibly 1000 pairs at the turn of the century.[55] In the early 1940s, numbers at Falsterbo were still at a fairly high level (Fig. 2o). Then, due to heavy human persecution and severe effects of mercury and pesticides the population rapidly crashed.

The Swedish population was estimated at 350 pairs in 1950, 35 pairs in 1965 and a low of only about 15 pairs were breeding in the middle of the 1970s.[7] Not until the 1980s did improved reproduction lead to an increase. This picture is reflected in the annual figures from Falsterbo – with a dramatic decline until the middle of the 1970s and a slow increase since the early 1980s (Fig. 2o). In 1996, a total of 60 breeding pairs were known in Sweden.[11] The stronger populations in Norway and Finland, most certainly contributing to the numbers at Falsterbo, also show a positive trend at the moment.

Overall trends

The comparisons above show that population changes in Swedish raptors are well reflected by the migration counts at Falsterbo. Using the figures, trends in different species during separate decades have been labelled decreasing (–), stable (0) or increasing (+) and are compiled in Table 3. Since no counts were performed during the 1960s, population trends during the decade are based on the change between figures in the late 1950s and the early 1970s. If a species shows an increase during the first part and a decrease during the last years (as Honey Buzzard during the 1950s), the trend during this decade was labelled stable (0). Most changes are not statistically significant during such short time periods but contribute to the general picture.

In the cluster analysis, we used Spearman's and Pearson's correlation coefficients resulting in two dendrograms (Fig. 3). With a few exceptions, both methods give a fairly similar result. A matrix showing the pairwise correlations of the figures from the whole series is given in the Appendix. In making a large number of comparisons, a few significant correlations on a low level may be the result of pure chance, but in

Table 3. Population trends in raptors migrating at Falsterbo during different decades 1942–97.

Species	1940s	1950s	1960s	1970s	1980s	1990s
Honey Buzzard	0	0	0	–	–	–
Red Kite	0	–	–	+	+	+
White-tailed Eagle	–	–	–	+	+	+
Marsh Harrier	0	0	+	+	+	0
Northern Harrier	–	–	+	+	0	–
Montagu's Harrier	0	0	0	+	+	+
Goshawk	0	+	+	+	+	–
Eurasian Sparrowhawk	0	–	0	+	+	–
Common Buzzard	0	–	0	0	–	–
Rough-legged Buzzard	0	0	+	+	0	–
Osprey	0	–	0	0	+	–
Eurasian Kestrel	0	–	0	0	0	–
Merlin	0	–	0	0	+	0
Hobby	+	0	0	0	0	–
Peregrine Falcon	–	–	–	0	+	+
Number of species						
Decreasing	3	9	3	1	2	9
Stable	11	5	8	6	4	2
Increasing	1	1	4	8	9	4

+, Increase; 0, no change; –, decrease.

this material most correlations are highly significant.

DISCUSSION

There are a few principal factors determining the population densities in raptors.[56,57] Direct human persecution in earlier decades kept many populations below carrying capacity.[58] The situation today is much better than 20 years ago, especially on the breeding grounds but also along the migration route. With the possible exception of adult Honey Buzzards on spring migration over the central Mediterranean region,[59] there are no indications that persecution seriously affects Scandinavian raptor numbers. Intense use of pesticides and mercury caused serious declines in most raptors in northern Europe, especially in the period 1950–70.[51,58] Since then, most populations have recovered and the effects of pesticides on the breeding grounds probably have no significant negative influence. Increased use of pesticides on the tropical wintering grounds in Africa may, however, cause problems in the future.

The availability of nesting sites is a factor that may be of importance to some raptors. In Sweden this is generally not a large problem[57] and only the two species of eagle may be locally limited by the number of available old nesting trees. The most important factor in Scandinavia today is probably the food supply. A clear connection between the available prey numbers and the breeding densities has been shown in several raptors.[54–57] Prey numbers are affected by land use. Increased efficiency and a change of routines in agriculture as well as forestry may result in a poorer food supply for some species. In particular, the effect of a general decrease in the proportion of land used for grazing is likely to be negative for many raptors.

The majority of raptors seem to show a stable population at a fairly high level during the 1940s, but a decrease is recorded in three species (Table 3). The marked decline in White-tailed Eagle and Peregrine Falcon is already obvious. Most raptors show a more or less steep decline in the 1950s, but five species are stable. In half of the declining species, the trend continues during the 1960s, while the others

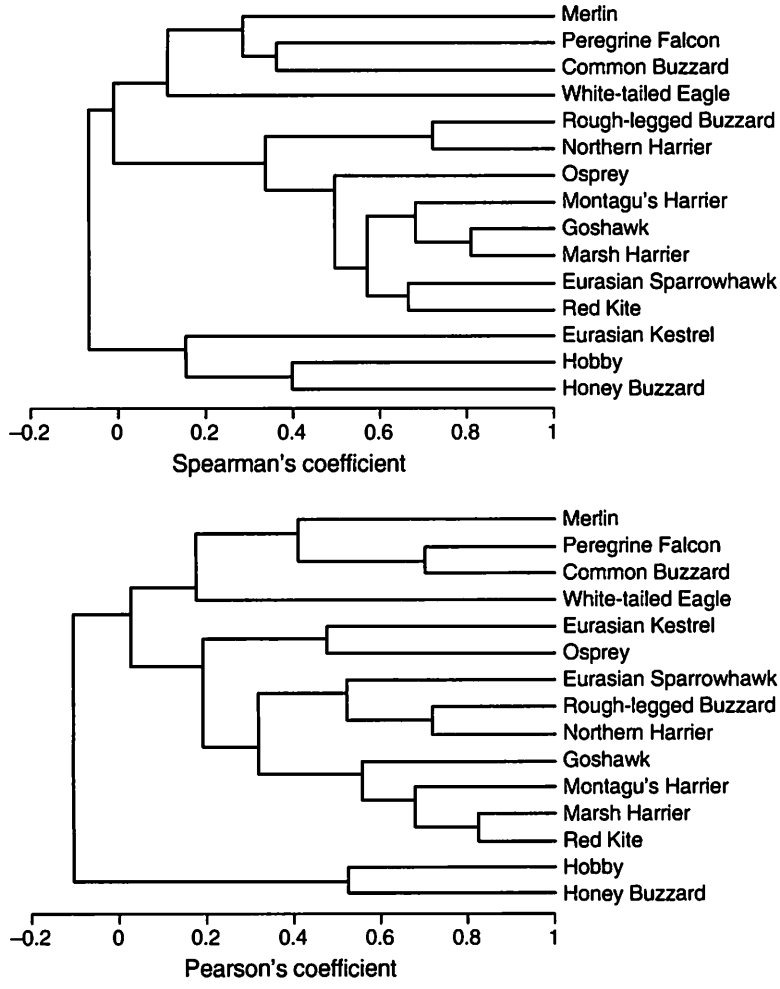

Figure 3. Dendrograms showing the synchrony of variation between autumn totals in different raptors at Falsterbo, Sweden, during 39 years in the period 1942–97, using Spearman's and Pearson's correlation coefficients.[14]

change to a stable trend. It may be noted that as many as four raptors are now on the increase. The real change, however, came during the 1970s, when decreased human persecution and less negative effects of mercury and pesticides resulted in a general increase in Scandinavian raptors. The only species continuing to decline at this time was the Honey Buzzard, indicating that other factors may be responsible. The positive development continued during the next decade with most raptor populations growing further. The lack of rodent peaks after 1982 is a likely explanation for the stabilizing numbers during the 1980s in the three rodent specialists: Northern Harrier, Rough-legged Buzzard and Eurasian Kestrel. This is changed to a decrease during the last seven years of the study, probably as a result of a continued poor food supply.[36] and *in litt.*

In four species, the clear increase continues into the 1990s. These have probably not yet reached the carrying capacity of the environment. Otherwise it is striking, and somewhat alarming, that a general increase has changed to a decline in a majority of raptors during the present decade. The fluctuations in the three northern rodent specialists mentioned above may be part of a long-term variation in rodent numbers. However, the general lack of rodent peaks in Northern Scandinavia since 1982 seems unusual and it has been suggested that an increased grazing pressure from reindeer

Rangifer tarandus may be at least partly responsible. The Goshawk increased sharply until 1991, most likely due to reduced human persecution. The decrease since then is supported by breeding numbers in the province Uppland (M. Tjernberg, pers. comm.) as well as in Finland.[43] Like in the Eurasian Sparrowhawk, the population may now have reached carrying capacity, and numbers are most likely regulated by prey densities and/or winter conditions. In Osprey, the migration figures from Falsterbo tend to vary in waves. The decline in the last seven years is at least partly the result of lower concentration due to prevailing weather during peak migration, and thus hardly any cause for great concern. Also, in the Hobby, comparatively large annual fluctuations may be due to weather factors, but the the long-term trend since the 1950s seems to be negative.

The general pattern thus at present seems fairly positive for most raptors. Two species, Marsh Harrier and Montagu's Harrier, show a more or less continuous increase over the whole period. However, the present long-term declines in Honey Buzzard and Common Buzzard are somewhat disturbing. The low productivity in Honey Buzzard is supported by studies of a breeding population in Uppland, Sweden, with 0.6 fledged young/territorial pair in 1986–91.[60] Based on recoveries, Tjernberg and Ryttman calculated that a reproductive rate of only 0.34 young/pair was enough to keep a stable population without hunting. The species prefers old forests with a high proportion of deciduous trees and high insect densities.[61] It has been suggested that habitat loss due to modern plantation forestry may be responsible for the decline.[7] Another factor that may affect the numbers negatively is the hunting pressure. With a low productivity, it is essential for the adults to be long-lived. Increased shooting of adults on spring migration over the central Mediterranean has been reported especially from Malta.[59] The apparent slight decrease in the number of Hobbies in the standardized counts may reflect a poorer food supply of insects. In Finland, most raptor populations have remained at the same general level during the 15 years until 1996, although microtine specialists have fluctuated widely from year to year.[43] In Denmark, heavy persecution until the 1970s generally resulted in lower raptor densities compared with Sweden. Since then, most species have shown a fast increase in numbers with some levelling in later years.[46,62–64]

A general breeding census programme of birds of prey, such as in Denmark[46] and Finland,[43] does not exist in Sweden.[57] Since raptors generally occur in densities too low to be followed by the Swedish breeding bird census programme,[65] the migration count at Falsterbo is, at the moment, the best method of monitoring population changes.

The dendrograms in Fig. 3 group the species after covariation in annual numbers, revealing some interesting patterns. The two tropical migrants, Hobby and Honey Buzzard, differ from all other species in showing comparatively low numbers in the 1940s, highest figures in the 1950s and a general decline since then. Honey Buzzard, in particular, shows a significantly negative correlation with many of the other raptors in the study (Appendix). Both species rely on insects to a higher degree than other raptors. Since they primarily winter in different parts of tropical Africa,[29] it seems likely that the similarity in their patterns of variation is related to food or other conditions on the breeding grounds, rather than in the winter area. A more obvious food connection is the similarity between Northern Harrier and Rough-legged Buzzard, both dependent on the fluctuating rodent numbers in northern Scandinavia. There is also a significant correlation in the annual proportion of juveniles of the two species recorded at Falsterbo in the period 1986–95.[18] It is also interesting to note that there is no close association between these two rodent specialists and the Eurasian Kestrel and especially Merlin, species also reported to be affected by fluctuations in northern rodent numbers.[54] Neither is there any similarity with the southern rodent specialist, the Common Buzzard. The Red Kite, Marsh Harrier, Montagu's Harrier and Goshawk are closely linked because of a general increase in numbers all through the study period, probably more linked to reduced human persecution than to similarities in food choice. Also, Eurasian Sparrowhawk and Osprey are strongly associated with this group and there is a somewhat weaker connection with the two northerly rodent specialists. The significant correlation between Common Buzzard and Peregrine is

rather surprising. Although both showed a clear decrease during the 1950s, the development since then has been an increase in Peregrine Falcon but a weak decrease in Common Buzzard. The association between Osprey and Eurasian Kestrel in long-term variations in numbers may be governed by effects of pesticides, possibly in combination with persecution. However at the moment they seem to diverge, probably due to a more negative food situation in the Eurasian Kestrel in later years.

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REFERENCES

1. Rudebeck, G. (1950) Studies on Bird Migration. *Vår Fågelvärld,* suppl. 1.
2. Ulfstrand, S., Roos, G., Alerstam, T. & österdahl, L. (1974) Visible Bird Migration at Falsterbo, Sweden. *Vår Fågelvärld,* suppl. 8.
3. Bernes, C., ed. (1990) *Monitor 1990. Environmental monitoring in Sweden.* Swedish Environmental Protection Agency.
4. Roos, G. (1996) Sträckräkningar vid Falsterbo hösten 1992 med en sammanfattning av långsiktiga förändringar i sträckets numerär under tjugo år. *Anser,* **35**, 163-188.
5. Bednarz, J.C., Klem, D. Jr, Goodrich, L.J. & Senner, S.E. (1990) Migration counts of raptors at Hawk Mountain, Pennsylvania, as indicators of population trends, 1934-1986. *Auk,* **107**, 96–109.
6. Kjellén, N. (1997) Importance of a bird migration hot spot: proportion of the Swedish population of various raptors seen on autumn migration at Falsterbo 1986–1995 and population changes reflected by the migration counts. *Ornis Svec.,* **7**, 21–34.
7. Ahlén, I. & Tjernberg, M., eds (1996) *Rödlistade ryggradsdjur i Sverige – Artfakta* [Swedish Red Data Book of Vertebrates 1996]. Artdatabanken, SLU, Uppsala.
8. Helander, B. (1997) Projekt Havsörn. *Vår Fågelvärld,* suppl. 27, 67–71.
9. Kjellén, N. (1996) Riksinventering av brun kärrhök 1995. *Vår Fågelvärld,* **55**, 6–15.
10. Kjellén, N. (1999) Projekt Glada – årsrapport 1998. *Anser,* **38**, 85–89.
11. Lindberg, P. (1997) Projekt Pilgrimsfalk 1996. *Vår Fågelvärld,* suppl. 27, 57–61.
12. Roos, G. (1984) Flyttning, övervintring och livslängd hos fåglar ringmärkta vid Falsterbo (1947–1980). *Anser,* suppl. 13.
13. Stolt, B.-O., Ekström, L., Fransson, T., Staav, R., Sällström, B. & Sällström, U.B. (1995) *Report on Swedish Bird Ringing for 1993.* Swedish Museum of Natural History, Bird Ringing Centre, Stockholm.
14. Kovach, W.L. (1998) *MVSP – a MultiVariate Statistical Package for Windows, ver. 3.0.* Kovach Computing Services, Pentraeth, Wales, UK.
15. Ulfstrand, S. (1958) Årtiga fluktuationer i sträcket av bivråk (*Pernis apivorus*) över Falsterbo. *Vår Fågelvärld,* **17**, 118–144.
16. Ulfstrand, S. (1959) Flyttfågelsträcket vid Falsterbo hösten 1955. *Vår Fågelvärld,* **18**, 131–162.
17. Roos, G. (1971) Falsterbonytt: augusti–oktober 1971. *Anser,* **10**, 84–86.
18. Kjellén, N. (1998) Annual variation in age and sex ratio among migrating raptors at Falsterbo, Sweden during 1986–1995. *J. Ornithol.,* **139**,157–171.
19. Søgaard, S. & Østerby, G. (1989) Höststräcket av bivråk *Pernis apivorus* vid Falsterbo 1977–86. *Vår Fågelvärld,* **48**, 191–201.
20. Nilsson, S. (1858) *Skandinavisk Fauna, Foglarna.* Gleerups, Lund.
21. Kjellén, N. (1994) Gladan i Sverige – Beståndsutveckling, flyttning och övervintring. *Vår Fågelvärld,* **53**, 6–19.
22. Österlöf, B. (1945) Gladans (*Milvus milvus*) förekomst i Sverige. *Vår Fågelvärld,* **4**, 101–136.
23. Svensson, S. (1974) Gladan *Milvus milvus* i Skåne 1972. *Anser,* **13**, 1–12.
24. Tyrberg, T. (1997) Fågelrapport för 1996. *Vår Fågelvärld,* suppl. 27, 73–123.
25. SOF. (1990) *Sveriges Fåglar,* 2nd edn. Sveriges Ornitologiska Förening, Stockholm.
26. Andersson, G.K.A. & Larsson, A. (1971) Bruna kärrhöken *Circus aeruginosus* i Sverige 1969. *Vår Fågelvärld,* **30**, 99–105.
27. Bylin, K. (1981) Bruna kärrhöken *Circus aeruginosus* i Sverige år 1979. *Vår Fågelvärld,* **40**, 455–460.
28. Enemar, A. (1959) Bruna kärrhöken *Circus aeruginosus* i Sverige 1958. *Vår Fågelvärld,* **18**, 42–49.
29. Alerstam, T. (1990) *Bird Migration.* Cambridge University Press, Cambridge.
30. Watson, D. (1977) *The Hen Harrier.* Poyser, Berkhamsted.
31. Nilsson, S. G. (1981) De svenska rovfågelbeståndens storlek. *Vår Fågelvärld,* **40**, 249–262.
32. Edelstam, C. (1972) The visible migration of birds at Ottenby, Sweden. *Vår Fågelvärld,* suppl. 7.
33. Kjellén, N. (1991) Ålders – och könsfördelning hos

sträckande rovfåglar över Falsterbohalvön hösten 1990. *Anser*, **30**, 77–100.
34. Curry-Lindahl, K. (1975) *Fjällämmel – en artmonografi.* Bonniers, Stockholm.
35. Angerbjörn, A., Tannerfeldt, M., Bjärvall, A., Ericson, M., From, J. & Norén, E. (1995) Dynamics of the arctic fox population in Sweden. *Ann. Zool. Fenn.*, **32**, 55–68.
36. Hörnfeldt, B. (1994) *Smådäggdjursinventeringar i PMK's referensområden – rapport från verksamheten 1992.* Report No. 4294, Naturvårdsverket.
37. Rodebrand, S. (1996) Ängshöken *Circus pygargus* på Öland. *Calidris*, **25**, 99–116.
38. Kjellén, N. (1992) Differential timing of autumn migration between sex and age groups in raptors at Falsterbo, Sweden. *Ornis Scand.*, **23**, 420–434.
39. Ryttman, H. (1985) Hur många duvhökar *Accipiter gentilis* häckar i Sverige. *Vår Fågelvärld*, **44**, 355–360.
40. Svensson, S. (1979) Svensk fågelatlas 1974–1978: halvtidsrapport. *Vår Fågelvärld*, **38**, 114–123.
41. Ulfstrand, S. & Högstedt, G. (1976) Hur många fåglar häckar i Sverige? *Anser*, **15**, 1–34.
42. Pettersson, J. (1983) Ottenby Fågelstation – rapport från hösten 1982. *Calidris*, **12**, 19–29.
43. Haapala, J., Korhonen, J. & Saurola, P. (1996) Petolintuvuosi 1996: Pohjalta on hyvä ponnistaa. *Linnut-Vuosikirja, 1996*, 41–53.
44. Kostrzewa, A. & Speer, G. (1995) *Greifvögel in Deutschland. Bestand, Situation, Schutz.* Aula-Verlag, Wiesbaden.
45. Newton, I. (1986) *The Sparrowhawk.* Poyser, Calton.
46. Jørgensen, H.-E. (1998) Status for de danske rovfuglebestande. *Dansk Ornithol. Foren. Tidsskr.* **92**, 299–306.
47. Svensson, S. (1998) Övervakning av fåglarnas populationsutveckling – årsrapport för 1997. Naturvårdsverket.
48. Lindström, Å. (1982) Fjällvråken *Buteo lagopus* vid Ottenby. *Calidris*, **11**, 121–134.
49. Lundgren, U. (1979) Fjällvråkens *Buteo lagopus* uppträdande i Sverige hösten 1978. *Vår Fågelvärld*, **38**, 95–100.
50. Saurola, P. (1997) The Osprey (*Pandion haliaetus*) and modern forestry: a review of population trends and their causes in Europe. *J. Raptor Res.*, **31**, 129–137.
51. Ahlgren, C-G. & Eriksson, M.O.G. (1984) Belastningen av kvicksilver och klorerade kolväten hos fiskgjuse *Pandion haliaetus* i sydöstra Sverige. *Vår Fågelvärld*, **43**, 299–305.
52. Odsjö, T. & Sondell, J. (1976) Reproductive success of Ospreys in southern and central Sweden. *Ornis Scand.*, **7**, 71–84.
53. Jessen, U. (1981) Tornfalken – numerär och giftstatus. *Fauna Flora*, **76**, 13–20.
54. Hagen, Y. (1952) *Rovfuglene og Viltpleien.* Gyldendal Norsk Forlag, Oslo.
55. Lindberg, P. (1975) *Pilgrimsfalken i Sverige.* Svenska Naturskyddsföreningen, Stockholm.
56. Newton, I. (1979) *Population Ecology of Raptors.* Poyser, Berkhamsted.
57. Widén, P. (1990) *Aktuella naturvårdsproblem hos våra rovfåglar.* Report 3687, Naturvårdsverket.
58. Bijleveld, M. (1974) *Birds of Prey in Europe.* Macmillan, London.
59. Fenech, N. (1992) *Fatal Flight.* Quiller Press, London.
60. Tjernberg, M. & Ryttman, H. (1994) Bivråkens *Pernis apivorus* överlevnad och beståndsutveckling i Sverige. *Ornis Svec.*, **4**, 133–139.
61. Amcoff, M., Tjernberg, M. & Berg, Å. (1994) Bivråkens *Pernis apivorus* boplatsval. *Ornis Svec.*, **4**, 145–158.
62. Bomholt, P. (1997) Bestanden af Rød Glente *Milvus milvus* i et censusområde i det sydøstligaste Jylland, 1980–1995. *Dansk Ornithol. Foren. Tidsskr.*, **91**, 53–58.
63. Jacobsen, E. M. (1997) Hvor mange fugle yngler i Danmark? *Dansk Ornithol. Foren. Tidsskr.*, **91**, 93–100.
64. Olsen, K. M. (1992) *Danmarks Fugle – en oversigt.* Dansk Ornitologisk Forening.
65. Svensson, S. (1997) Svenska häckfågeltaxeringen 1996. *Vår Fågelvärld*, suppl. 27, 11–19.

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APPENDIX

Matrix showing pairwise correlations between autumn totals in different raptors at Falsterbo, Sweden, during 39 years in the period 1942–97 using Spearman's and Pearson's correlation coefficients.*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

Spearman's	Hon. Buz.	Red Kite	W.-t. Eagle	Marsh Har.	N. Har.	Mont. Har.	Goshawk
Red Kite	–0.669***						
White-tailed Eagle	–0.316	0.251					
Marsh Harrier	–0.532***	0.654***	0.221				
Northern Harrier	–0.291	0.189	–0.153	0.435**			
Montagu's Harrier	–0.416**	0.638***	0.375*	0.718***	0.366*		
Goshawk	–0.522***	0.611***	0.222	0.808***	0.477**	0.639***	
Eurasian Sparrowhawk	–0.554***	0.664***	0.106	0.501**	0.526***	0.512***	0.472**
Common Buzzard	0.338*	–0.282	–0.013	–0.689***	–0.234	–0.310	–0.548***
Rough-legged Buzzard	–0.464**	0.460**	–0.104	0.475**	0.719***	0.382*	0.602***
Osprey	–0.047	0.392*	0.290	0.590***	0.208	0.561***	0.426**
Eurasian Kestrel	0.202	–0.135	–0.223	–0.125	–0.047	–0.133	–0.167
Merlin	–0.122	0.133	0.077	–0.196	0.013	0.010	–0.137
Hobby	0.398*	–0.210	–0.223	–0.016	–0.128	–0.132	–0.089
Peregrine Falcon	0.019	0.121	0.296	–0.390*	–0.679***	–0.140	–0.496**

Pearson's	Hon. Buz.	Red Kite	W.-t. Eagle	Marsh Har.	N. Har.	Mont. Har.	Goshawk
Red Kite	–0.463**						
White-tailed Eagle	–0.332*	0.406*					
Marsh Harrier	–0.464**	0.825***	0.339*				
Northern Harrier	–0.318*	–0.050	–0.249	0.175			
Montagu's Harrier	–0.379*	0.663***	0.240	0.692***	0.157		
Goshawk	–0.432**	0.651***	0.268	0.670***	0.303	0.452**	
Eurasian Sparrowhawk	–0.409**	0.348*	0.083	0.448**	0.485**	0.384*	0.456**
Common Buzzard	0.217	–0.369*	0.060	–0.523***	–0.239	–0.260	–0.445
Rough–legged Buzzard	–0.340*	0.010	–0.250	0.100	0.720***	0.104	0.369*
Osprey	–0.011	0.289	0.188	0.532***	0.154	0.472**	0.466**
Eurasian Kestrel	0.155	–0.179	–0.230	0.005	–0.019	–0.042	0.079
Merlin	–0.092	–0.091	0.142	–0.144	0.039	–0.017	–0.100
Hobby	0.522***	–0.237	–0.233	–0.137	–0.105	–0.209	–0.185
Peregrine Falcon	0.042	–0.121	0.358*	–0.325*	–0.375*	–0.162	–0.404*

APPENDIX continued

Spearman's	Eur. Sp.hawk	Com. Buz.	R-l. Buz.	Osprey	Eur. Kest.	Merlin	Hobby
Red Kite							
White-tailed Eagle							
Marsh Harrier							
Northern Harrier							
Montagu's Harrier							
Goshawk							
Eurasian Sparrowhawk							
Common Buzzard	–0.180						
Rough-legged Buzzard	0.635***	–0.151					
Osprey	0.511***	–0.197	0.224				
Eurasian Kestrel	0.004	0.244	–0.052	0.347*			
Merlin	0.428**	0.238	0.134	0.178	0.134		
Hobby	–0.023	0.112	–0.053	0.320*	0.101	0.016	
Peregrine Falcon	–0.083	0.358*	–0.564***	–0.064	0.034	0.318*	–0.023

Pearson's	Eur. Sp.hawk	Com. Buz.	R-l. Buz.	Osprey	Eur. Kest.	Merlin	Hobby
Red Kite							
White-tailed Eagle							
Marsh Harrier							
Nortern Harrier							
Montagu's Harrier							
Goshawk							
Eurasian Sparrowhawk							
Common Buzzard	–0.090						
Rough–legged Buzzard	0.553***	–0.216					
Osprey	0.494**	–0.093	0.045				
Eurasian Kestrel	0.081	0.369*	–0.090	0.475**			
Merlin	0.394*	0.389*	0.200	0.161	0.134		
Hobby	0.007	0.062	–0.093	0.278	0.051	0.016	
Peregrine Falcon	–0.070	0.703***	–0.381*	–0.167	0.079	0.434**	–0.249