Soaring bird migration over northern Israel in autumn

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ABSTRACT Israel is renowned for the large numbers of pelicans, storks and raptors which migrate through the country en route to and from African wintering areas. From 1990 to 1999, the autumn migration of soaring birds was intensively studied during the Northern Valleys Survey, one of the few comprehensive, long-term, ground-observation surveys in the Western Palearctic. The principal species, including White Stork Ciconia ciconia, Honey-buzzard Pernis apivorus, Levant Sparrowhawk Accipiter brevipes and Lesser Spotted Eagle Aquila pomarina, tend to concentrate in large numbers on a relatively narrow front, making them comparatively easy to monitor. This paper, which complements an earlier paper describing raptor migration at Eilat (Shirihai & Christie 1992), summarises the results of the survey between 1990 and 1999. For some species, long-term monitoring on migration routes provides critical information on world population trends, otherwise unobtainable from the breeding grounds.
Huge numbers of raptors which breed in the northern latitudes of Eurasia migrate to winter in warmer climates, mainly south of 30°N. Many of these migrate diurnally in flocks, covering large distances (up to 20,000 km) in relatively short periods, much of the journey being completed under daily near-fasting conditions. To conserve energy, raptors are forced to adopt passive flight – soaring and gliding – and to exploit the thermals which develop over land. As a result, they are reluctant to cross extensive bodies of open water over which passive flight is difficult. Consequently, large concentrations, or ‘bottlenecks’, of raptors form at strategic points, over straits and through narrow corridors.

One such bottleneck, the Levant (Israel and Egypt in particular), is well known for the vast numbers of migrant soaring birds which move between their breeding grounds in eastern Europe and western/central Asia, and wintering grounds in Africa. In the Middle East, most migratory soaring birds utilise one of two major routes in autumn. The ‘Caspian/Arabian route’ is used mainly by raptors breeding in western/central Asia and crossing into Africa at the southern end of the Red Sea, while the more westerly route, which is the focus of this paper, is used chiefly by raptors breeding in eastern Europe and western Asia. These birds pass east or west of the Black Sea, then cross Jordan and Israel to reach Sinai, and finally reach Africa at the northern end of the Red Sea. Within Israel, two major flyways are recognised: the western route passes over the central mountains and the eastern parts of the coastal plain, while the eastern route passes over the Jordan Rift Valley. In autumn, birds using both these flyways divert west over the northern/central Negev and south from there across the Sinai Peninsula. In contrast to the spring passage, routes across the southern Negev and Eilat are comparatively little used, and there are significant numbers of one species only, Steppe Eagle *Aquila nipalensis*.

In spring, the six most abundant Palearctic raptors to migrate through the Middle East (Honey-buzzard *Pernis apivorus*, Black Kite *Milvus migrans*, Levant Sparrowhawk *Accipiter brevipes*, Common Buzzard *Buteo buteo* of the race *vulpinus*, hereafter referred to as ‘Steppe Buzzard’, Lesser Spotted Eagle *Aquila pomarina* and Steppe Eagle) concentrate through the Levant in similarly large numbers during both seasons. These key species tend to concentrate in large numbers on a relatively narrow front, rather than the scattered, broad-front migration employed by many smaller species. For further details of each species, in both spring and autumn, see Shirihai *et al.* 2000.

Since 1982, ground-based observers have carried out systematic surveys of the autumn migration of soaring birds over Israel: Dovrat (1991), Tsovel & Alon (1991), Alon *et al.* (1992), Shirihai & Christie (1992), Leshem & Yom-Tov (1996a, 1998), Shirihai (1996) and Shirihai *et al.* (2000) are perhaps the most important summaries published to date. The position of the Jezreal and Bet Shean Valleys, in the north of Israel, provides a unique opportunity to conduct long-term monitoring of migrating populations of soaring birds, and the ‘Northern Valleys Survey’ is one of the few long-term ground-observation surveys in the Western Palearctic.

**Methods**

**Study site**

Between 1977 and 1987, the autumn soaring-bird survey was conducted over central Israel at Kfar Qassem (Dovrat 1991). In 1988, this survey was relocated to the Jezreal Valley and Bet Shean Valley, and renamed the ‘Northern Valleys Survey’. These two northern valleys encompass both the western and the eastern flyways, as defined above (Leshem & Yom-Tov 1998). Both surveys were operated under the aegis of the Israel Ornithological Centre, with DA acting as organiser between 1988 and 1994, and BG from 1995 onwards.

**Timing and site location**

The westernmost station in the northern valleys is 12 km inland from the Mediterranean Sea coast, while the easternmost station is 61 km
from the coast, in the Jordan Rift Valley. The stations are positioned in a more or less straight line from northwest to southeast across the migration corridor (fig. 1), and spaced at regular intervals, which permits the identification of most raptors passing through. For minimal coverage of a 35-km wide corridor, at least 12 stations, each 3 km apart, are operated. Even this level of coverage is, however, not always possible, and thus annual fluctuations should be treated with some degree of caution. All stations are numbered, and measured, according to their distance from the Mediterranean coast.

Each year, the Northern Valleys Survey commenced on 10th August, to coincide with the beginning of White Stork migration, with three or four stations operating between the Jordanian border and 54 km inland. As the season progressed and species composition changed, monitoring began at more westerly stations. From about 25th August, Honey-buzzards began passing through on a broader front, whereupon the survey was extended to within 17 km of the coast, and 13-14 stations were operated if possible. During Lesser Spotted Eagle migration, typically from 21st September to 15th October, counting stations were manned in a band extending from 11 to 46 km from the coast.

**Counting effort**

Stations were manned from approximately one hour after sunrise, to coincide with the departure of raptors from overnight roosts, until one hour before sunset. Each station was manned by a single observer, equipped with binoculars, telescope and a short-range radio. All observers were experienced and trained in the identification and counting of soaring birds, so that data from each station were directly comparable. Each day, observers were required to complete an observation form, detailing the species observed, numbers, times, approximate distance from station, and estimated altitude and direction of migration. By comparing daily observations, and using radios to communicate with adjacent observers during periods of active migration, it was possible to eliminate double-counting.

**Summary calculations**

For each species, the mean peak date was derived by comparing the mean total count for each calendar date across the ten years of the survey. As a guide to the length and timing of the key migratory window for each species, we calculated the period during which 90% of the total annual count occurred, subtracting the first and last 5% of the migrants logged (thus excluding atypically early or late birds). Standard linear regression analyses were used to determine trends, which are described only when significant at the P < 0.05 level.

To map the spatial distribution of migrating...
White Storks, Honey-buzzards, Levant Sparrowhawks and Lesser Spotted Eagles across the line of survey stations, the annual sum of birds that passed over each station was calculated for each two-hour period, from 07.00 hrs to 17.00 hrs. The average sum for each station and two-hour period was calculated for the period 1990-1995. Data were then mapped in a Geographic Information System using ArcView.

**Results**

During the survey, 35 species of raptors were observed, with a mean annual total of 450,995 individuals. Furthermore, mean annual counts of White Pelican, White Stork and Black Stork C. nigra together numbered 300,618 individuals. These totals include the majority of the Palearctic breeding populations of three species, White Pelican, Levant Sparrowhawk and Lesser Spotted Eagle. Table 1 provides the seasonal totals of all soaring-bird species during the 1990-1999 survey, which reveals that the four most abundant species were, in descending order, Honey-buzzard, White Stork, Lesser Spotted Eagle and Levant Sparrowhawk. Each of these four species has a characteristic migration pattern, both in timing and direction, which is described in the species accounts (below) and figs. 2-4.

For several species, there are large annual variations in total counts. There may be several explanations for these fluctuations, depending on the species:

(i) **Shift in migratory axis** In some years, part of the migratory axis passed to the east of the survey area, i.e. within Jordanian territory, and in such years numbers counted were low.

(ii) **Altitude of migration** The altitude at which birds pass over the count stations may vary according to weather (e.g. see Shamoun-Baranes *et al.* 2003), and this will affect counts, creating a bias towards low-flying birds (Kerlinger & Gauthreaux 1984; Kerlinger 1989). Counts of medium-sized and smaller species, such as Honey-buzzards, Levant Sparrowhawks and Red-footed Falcons *Falco vespertinus*, may be particularly influenced by this.

(iii) **Station position** The survey stations were positioned according to our existing knowledge of migratory patterns, but on days when migration routes shifted dramatically, either east or west of that anticipated (e.g. because of unusual weather conditions), the survey may have missed many birds. For example, on days with strong easterly winds, the entire axis of migration shifted west, towards the coast (Shirihai *et al.* 2000).

(iv) **Population fluctuations** Breeding may be more successful in some years than others, affecting both the numbers and proportion of juveniles within the population.

Of these, shifts in the altitude of migration and station position, as well as a significant passage to the east of the study area (see White Stork, below) have been directly observed to affect counts. Currently, there is insufficient evidence to suggest a substantial migration route of raptors in Jordan, and the effect of wind direction shifting the axis to the east of our study area has not been studied.

**Species accounts**

Each of the following accounts follows a similar format, beginning with a brief introduction describing a species’ status as an autumn migrant within Israel, including a summary of the main passage period. This is followed by a synopsis of the key factors which characterise migration through the country, including major passage routes and significant roosting areas. For seasonal totals of all species recorded during the Northern Valleys Survey (NVS) between 1990 and 1999, see table 1.

**White Pelican *Pelecanus onocrotalus***

White Pelican is an abundant passage migrant, with the majority following a route across northern, central and western regions. The main passage occurs between late September and mid November, with few recorded before mid August, or after mid November. Wintering birds continue to arrive until late December, however. The true numbers of White Pelicans migrating through Israel are, in fact, almost twice those recorded during the NVS, since this survey, aimed for the most part at monitoring soaring raptors, misses the peak of White Pelican passage, at the end of October (Leshem & Yom-Tov 1996a).

Like other large soaring birds, this heavy, broad-winged species prefers to migrate over land, but since White Pelican is essentially aquatic, passage occurs within 20 km of the coast, passing over the northeastern and Jezreal Valleys, the coastal plain and western Negev. Many reach Israel via western/central Lebanon and the Mediterranean, with others arriving from the northeast, and roost at northern stopover sites (including the Hula...
Soaring bird migration over northern Israel

Table 1. Annual totals of migratory soaring birds counted during the Northern Valleys Survey, Israel, in 1990-99.

| Year | White Pelican | Black Stork | White Stork | Unidentified stork | Honey-buzzard | Black Kite | Red Kite | Unidentified kite | White-tailed Eagle | Egyptian Vulture | Griffon Vulture | Eurasian Black Vulture | Short-toed Eagle | Marsh Harrier | Hen Harrier | Pallid Harrier | Montagu’s Harrier | Montagu’s/Pallid Harrier | Unidentified harrier | Northern Goshawk | Eurasian Sparrowhawk | Accipiter nisus/brevipes | Common Buzzard | Common (‘Steppe’) Buzzard | Lesser Spotted Eagle | Greater Spotted Eagle | Steppe Eagle | Eastern Imperial Eagle | Golden Eagle |
|------|----------------|-------------|-------------|--------------------|----------------|------------|----------|-------------------|-------------------|----------------|----------------|------------------------|----------------|-------------|----------------|----------------|----------------|-----------------------|-------------------|----------------|------------------------|----------------|----------------|------------------|----------------|----------------|-----------------|----------------|
| 1990 | 42,575         | 2,936       | 188,721     | 150                | 437,433        | 1,734      | 0        | 0                 | 83,701            | 1,516          | 350            | 3                     | 1,953          | 41,722      | 868            | 61              | 318             | 83,701                | 30                | 30             | 214                | 3               | 3               | 83               | 3              |
| 1991 | 30,584         | 3,299       | 235,906     | 7                   | 269,289        | 2,058      | 0        | 5                 | 70,295            | 1,550          | 144            | 5                     | 3,619           | 53,704      | 1,131          | 144             | 534             | 70,295                | 62                | 62             | 187                | 6               | 5               | 52               | 6              |
| 1992 | 45,163         | 1,344       | 173,677     | 120                | 228,574        | 1,369      | 1        | 2                 | 58,320            | 719             | 47             | 2                     | 31              | 37,738      | 888            | 47              | 27              | 58,320                | 48                | 48             | 181                | 22              | 22             | 22               | 22             |
| 1993 | 30,239         | 14,100      | 277,925     | 0                  | 476,565        | 28           | 0        | 0                 | 38,667            | 1,614           | 28             | 3                     | 321             | 38,667      | 58             | 22              | 22              | 38,667                | 26                | 26             | 22                 | 22              | 22             | 22               | 22             |
| 1994 | 30,733         | 7,269       | 293,728     | 0                  | 260,982        | 37          | 0        | 0                 | 68,009            | 1,614           | 28             | 3                     | 376             | 60,390      | 88             | 28              | 39              | 60,390                | 39                | 39             | 22                 | 22              | 22             | 37               | 37             |
| 1995 | 56,765         | 16,898      | 235,084     | 0                  | 221,669        | 37          | 0        | 0                 | 32,878            | 1,517           | 26             | 3                     | 352             | 63,900      | 88             | 28              | 39              | 63,900                | 44                | 44             | 22                 | 22              | 22             | 39               | 39             |
| 1996 | 28,917         | 7,403       | 295,411     | 0                  | 265,630        | 37          | 0        | 0                 | 52,804            | 1,045           | 22             | 3                     | 352             | 104,000     | 88             | 28              | 39              | 104,000                | 44                | 44             | 22                 | 22              | 22             | 39               | 39             |
| 1997 | 57,042         | 3,050       | 530,301     | 0                  | 544,215        | 37          | 0        | 0                 | 52,804            | 1,045           | 22             | 39                     | 376             | 191,000     | 88             | 28              | 39              | 191,000                | 44                | 44             | 22                 | 22              | 22             | 39               | 39             |
| 1998 | 36,502         | 3,617       | 165,624     | 0                  | 286,788        | 37          | 0        | 0                 | 54,370            | 1,328           | 28             | 39                     | 376             | 263,000     | 88             | 28              | 39              | 263,000                | 44                | 44             | 22                 | 22              | 22             | 39               | 39             |
| 1999 | 10,709         | 2,342       | 182,988     | 0                  | 236,127        | 37          | 0        | 0                 | 54,370            | 1,328           | 28             | 39                     | 376             | 263,000     | 88             | 28              | 39              | 263,000                | 44                | 44             | 22                 | 22              | 22             | 39               | 39             |
| Mean | 36,923         | 6,226       | 257,442     | 28                 | 322,727        | 1,701      | 0        | 0                 | 68,944            | 1,227           | 2               | 4                     | 315             | 35,890      | 1,227          | 35              | 35              | 35,890                | 15                | 15             | 3                  | 3               | 3               | 3                | 3              |

*Note: *All counts are based on surveys conducted in the Northern Valleys of Israel. The data includes both daytime and night-time observations. The totals are the sum of all observations made during the survey period.
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<table>
<thead>
<tr>
<th>Species</th>
<th>Mean Daily Migration Counts</th>
<th>Error Bars</th>
<th>Middle 90% Autumn Passage</th>
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<tr>
<td>Unidentified eagle <em>Aquila</em> sp.</td>
<td>136 58 9 3 0 0 5 16 6 2 24</td>
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<td>Booted Eagle <em>Hieraeetus pennatus</em></td>
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<tr>
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<td>9 26 9 4 20 5 9 16 34 9 14</td>
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<tr>
<td>Common Kestrel <em>Falco tinnunculus</em></td>
<td>3 41 2 28 60 144 17 38 45 30 41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red-footed Falcon <em>Falco vespertinus</em></td>
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<td></td>
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<tr>
<td>Hobby <em>Falco subbuteo</em></td>
<td>19 71 10 7 1 41 79 22 33 22 12 32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hobby/Red-footed Falcon <em>Falco subbuteo/vespertinus</em></td>
<td>187 274 81 29 100 105 0 0 34 0 81</td>
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<td>Unidentified raptor</td>
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</table>

**Fig. 2.** Mean daily migration counts for: (a) White Stork *Ciconia ciconia*, (b) Honey-buzzard *Pernis apivorus*, (c) Levant Sparrowhawk *Accipiter brevipes*, (d) Lesser Spotted Eagle *Aquila pomarina* Northern Valleys Survey, Israel, 1990–1999. Error bars show standard deviation. The figures show the middle 90% of autumn passage (see text) of the four species concerned.
Valley, Sea of Galilee, Bet Shean and Jezreel Valleys, Emek Zevulon, Ma’agan Mikhael and Emek Hefer). Typically, birds leave these stopover sites between 08.30 and 09.00 hrs, moving south directly to northern Sinai, crossing Israel within about eight hours (Leshem & Yom-Tov 1996a).

**Black Stork Ciconia nigra**

This fairly common autumn passage migrant migrates principally on a north-south or northeast-southwest axis, with passage concentrated over the east of the country, including the Golan, north-eastern valleys, Jordan River Valley, Dead Sea region and the Negev mountains, and only small numbers recorded within the coastal strip and extreme south. Extreme passage dates range from 6th August to late November; with most occurring between mid September and mid October. A few overwinter, chiefly in the northeastern valleys.

Table 1 reveals significant annual fluctuations during this survey, and that numbers peaked between 1993 and 1996. This period coincided with the manning of the easternmost count stations from late September into October; when most Black Storks occurred. In most other years, counting effort at this stage of the season was focused in the west, where Levant Sparrowhawks and Lesser Spotted Eagles predominate.

**White Stork Ciconia ciconia**

White Stork is an abundant passage migrant, with most movements through the northeast, east-central and north-central Negev. Smaller numbers occur irregularly in the southern Arava and Eilat regions, and throughout the west of Israel. Extreme passage dates range from 13th July to 10th November. During the NVS, the peak date varied from 23rd August to 7th September (mean 6th September), on which 13-36% of the annual total was recorded (mean 24%). Compared with other abundant species, passage of White Storks is relatively prolonged, and the number of days taken for the middle 90% of the population to pass ranged from 15 to 33 (mean 23). Numbers decline rapidly after mid September (fig. 2a).

The high variation in annual counts (table 1) is almost certainly due to changes in the migratory axis. Based on observations of numbers passing the easternmost survey station, in the Rift Valley near the border with Jordan, it is clear that large numbers pass through Jordan. During 1991, a survey in the Negev desert, 170 km south of the northern valleys, counted 140,000 White Storks in the first week of September. These birds were not reported by the NVS, having clearly entered Israel farther south (IOC unpublished data). In 1994, radar studies established that many did pass through Jordan, and were not counted by this survey. In the NVS study area, approximately 90% of migrants moved through on a narrow front ranging between 53 km and 61 km from the coast. In some years, an estimated 50% of the White Storks passing through Israel were not counted by the NVS, and instead crossed Israel between the Bet Shean Valley and the Dead Sea (thus south of our study area). The overall trend in numbers of migrants since 1990 is stable.

Unlike other species discussed here, White Storks reaching Israel may gather in huge concentrations to feed and drink before continuing with their migration. Nonetheless, there remains a high mortality among young birds, many of which die from exhaustion through dehydration, especially in the dry desert regions.

White Storks migrate principally in huge concentrations via the western Black Sea route (crossing the Bosporus), and after passing through the Levant enter Africa on a broad front via Sinai and the Gulf of Suez.

**Honey-buzzard Pernis apivorus**

Throughout northern and western Israel, Honey-buzzard is an abundant autumn passage migrant. Elsewhere, including Eilat and the southern Arava region, only small numbers occur: Extreme passage dates for the country are 4th August and 22nd November. In the NVS, the middle 90% of migrants passed through between 30th August and 16th September, on average, with the peak date ranging from 1st to 13th September (mean 4th September), when 13-28% (mean 19%) of the total annual count was recorded (fig. 2b). The peak migration pulse usually lasts for several days, e.g. in 1997, from 6th September to 9th September (the peak day), an extraordinary total of 361,921 birds was logged, with consecutive daily counts of 99,416, 68,545, 93,515 and 100,445.

Annual fluctuations appear to be related to a combination of altitude of migration, counting effort and, perhaps, annual breeding success; but they do not seem to be linked to wind direction, which is steady and fairly constant every year, nor to an eastward shift of the migratory axis. On many occasions, large numbers of Honey-buzzards have been recorded on radar but missed by ground observers. If a shift in migratory axis towards Jordan was responsible for the annual variations, it would be expected that higher than usual numbers would have been recorded from easternmost stations in years when counts in the west were low, but this was not the case.

Passage through the Middle East appears to be composed of Russian and east European birds, while those from western Europe, east to Sweden and central Europe, appear to use the Strait of Gibraltar and central Mediterranean routes (Hake et al. 2003). Based on counts at raptor migration watchpoints, the global population of Honey-
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84 & 85. White Pelicans Pelecanus onocrotalus on migration, northern Israel, October 2002. White Pelicans are abundant autumn passage migrants through Israel, with peak passage at the end of October. Favoured sites are used for staging: the flock in plate 85 is pictured at the Hola wetlands.

buzzard consists of several hundred thousand pairs, and numbers appear stable (Shirihai et al. 2000). Hagemeijer & Blair (1997) also considered European breeding populations to be stable.

In the northern valleys region, Honey-buzzards leave their roosts about an hour after sunrise, and between 07.00 hrs and 09.30 hrs the migratory axis remains in the east, with passage usually concentrated over one or two stations (mainly 44-50 km inland). During the following hour, the migratory axis moves slightly to the west (41-44 km inland) but by 11.00 hrs passage has switched
Abruptly to the west (mainly 17-30 km inland) and has almost ceased over the eastern stations. A similar pattern persists until about 13.30 hrs, when the axis starts to shift back towards the east. Until 16.30 hrs, passage is again mainly concentrated over the eastern stations (50-56 km inland), and continues to edge farther east until the evening, when many birds are seen passing several kilometres over the Jordanian border. This diurnal pattern (fig. 3), observed in most but not all years, reflects the progression of a sea-breeze front from the west, and sometimes birds can be observed correcting for drift late in the day, gliding in a more westerly direction to reach roost sites in the central mountains of Israel. On some days, the migration axis remained in the east throughout the day, while on other days a simultaneous western and eastern axis was noted. It seemed that on days characterised by a steady eastern axis, a strong westerly wind was already apparent during the early part of the morning. Observations during the earlier Kfar Qassem Surveys (KQS) showed Honey-buzzards migrating closer to the coast (13-47 km) than in the NVS (26-61 km).

Honey-buzzards are strongly concentrated in the Levant in autumn, birds passing either side of the Black Sea (and possibly also those crossing the Caucasus farther east) being funnelled through the region and into Africa via Sinai and the Gulf of Suez; very few are recorded in Arabia at this season.

**[Oriental Honey-buzzard *Pernis ptilorhyncus*]***

Although not recorded during the NVS, this species is a rare passage migrant through Israel, and it is thought that many may pass undetected. Recently, it has been discovered to be occurring with increasing frequency, during both spring and autumn migration (Granit 2003). Two were recorded in Israel in 1999 and eight in 2000, with one in the northern Negev in 1999 and two at Kfar Qassem in 2000, between 1st and 28th September. Oriental Honey-buzzards follow similar routes to, and migrate with, other raptors, mainly European Honey-buzzards, and, owing to a lack of knowledge and field experience, have probably been overlooked. In addition, counting conditions in the northern valleys are unfavourable for detecting Oriental Honey-buzzards within huge flocks of European Honey-buzzards.

**Black Kite *Milvus migrans***

Black Kite is a relatively common autumn passage migrant, which occurs throughout the country on a broad front, the majority in the north and west. In the NVS, 90% of passage occurred between 31st August and 4th October, with the early 5% between 22nd and 30th August and the remainder from 5th to 13th October. In most years, peak numbers occurred on or around 9th September,
when up to 20.4% of the migrating population passed through in the course of a single day. A secondary peak, often involving hundreds of birds, occurred in late September, and may reflect, at least in part, the arrival of wintering birds.

Counts from the NVS (table 1) are appreciably higher than those recorded during the KQS, where annual totals ranged from 293 to 1,195, with a mean of 676. Both autumn surveys have shown a trend of increasing numbers, which may reflect the higher numbers now wintering in Israel (most European populations appear stable or in slight decline; Hagemeijer & Blair 1997).

Despite the moderate or large numbers of migrants passing to the east of the Black Sea (with fewer at the Bosporus), the pattern of migration...
across the Middle East as a whole is still poorly known, and the main crossing point into Africa remains unidentified. Autumn surveys in Israel and Arabia involve comparatively small numbers only. This could be explained by this species using a broader, more disperse migration front in autumn (as indicated by the regional records summarised in Shirihai et al. 2000).
Red Kite *Milvus milvus*
Red Kite is essentially a vagrant to Israel in winter; reported on four occasions during the NVS, always in late September. These records have yet to be reviewed by the national rarities committee.

White-tailed Eagle *Haliaeetus albicilla*
A rare winter visitor to Israel, recorded just once during the NVS, on ?date ?date 1994.

Egyptian Vulture *Neophron percnopterus*
Egyptian Vultures are fairly common on passage, migrating on a broad front throughout the country, although the majority are seen in the west. They occur from mid August to mid November, and 90% of passage in the NVS was between 24th August and 8th October. Within this period, migrants were most numerous from 10th September until 2nd October, and peaked on or around 20th September, when up to 15.6% of the annual total passed on a single day.

Annual totals in the NVS (table 1) were appreciably lower than those recorded during the earlier KQS, (range 242-474, mean 322). The lower numbers recorded during the 1990s appear consistent with trends in breeding data from Europe and the Middle East. It is also possible, however, that the greater distance between counting stations in the NVS affected the ability of counters to record this species – the mean distance between stations in the KQS was 1.6 km in the west (where passage was concentrated) compared with 3 km in the NVS – and this may have exaggerated the population decline between the two surveys.

Griffon Vulture *Gyps fulvus*
Apart from a resident breeding population, Griffon Vulture is a scarce passage migrant throughout Israel. Most birds migrate through northern and western regions between mid September and early October, while in the south they typically appear later in October and into November. This difference in timing between the north and the south is apparently related to Aquila eagle passage, since in northern and western areas, Griffon Vultures are associated with the heavy passage of Lesser Spotted Eagles, while in the Eilat area, they typically associate with large flocks of migrating Steppe Eagles, which occur later in the autumn.

Eurasian Black Vulture *Aegypius monachus*
A rare winter visitor to northeast Israel, few are reported on migration and these typically occur later than the main survey period, mainly in October and November. Only one was recorded during the NVS, on 15th October 1992.

Short-toed Eagle *Circaetus gallicus*
Short-toed Eagle is a common passage migrant, occurring principally in the northern, central and western regions of the country. Extreme passage dates range from 17th August to 21st November.

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90. Adult Griffon Vulture *Gyps fulvus*, Gamla, northern Israel, October 2002. The long-term and, in many areas, dramatic decline in numbers of this species has not been reflected by decreasing numbers of migrants recorded in the Middle East (though numbers here have always been relatively small, and concentrated in the Levant). Following the recent collapse of Gyps vulture populations throughout the Indian subcontinent, however, there is grave concern that migrant populations of Griffon Vultures breeding in Asia may soon be affected in a similar way.
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91 & 92. Short-toed Eagles *Circaetus gallicus*, during passage through northern Israel, October 2002. Short-toed Eagles are common autumn passage migrants in Israel, mainly in the northern, central and western regions of the country. During the Northern Valleys survey, most were recorded between late September and mid October.

Hadoram Shirihai

Hadoram Shirihai
During the NVS, most were observed between 23rd September and 13th October, and peaked on or around 28th September, when up to 9.8% of the annual total occurred on a single day.

The mean annual total from the NVS (3,224) is half that recorded in the KQS. The reasons for this discrepancy may be similar to those described for Egyptian Vulture (see above), and thus exaggerated by different survey conditions. During the study period, the annual total of migrants counted has declined significantly ($r^2 = 0.49, P = 0.02$), although the exceptionally low count in 1999 (409) affected this result disproportionately. Short-toed Eagle has, however, like many other large raptors, undergone a substantial decline and range contraction since the nineteenth century.

Most Eurasian birds migrate to Africa via the western Black Sea route, funnelling through the Levant (using a more westerly course in autumn than in spring) and into Africa via the northern Gulf of Suez.

**Western Marsh Harrier** *Circus aeruginosus*
This is an uncommon, broad-front passage migrant throughout Israel, but rare in the southeast. In the NVS, 90% of birds passed through between 28th August and 16th October, with peak passage between 10th September and 5th October.

The NVS annual totals (table 1) are appreciably higher than those from the KQS (range 476-1,237, mean 848), and these differences are thought to reflect the location of survey sites, in particular the establishment of stations in eastern Israel during the NVS.

As for other harrier species (see below), counts during the NVS involved only birds on direct passage with other raptors, but this species will also interrupt its migration to feed in suitable habitat, and may form loose concentrations in favoured areas such as the Bet Shean Valley.

**Hen Harrier** *Circus cyaneus*
Hen Harrier is a late migrant to Israel, occurring from mid October, and thus rarely encountered during the NVS (table 1). Essentially, this is a winter visitor to the lowlands in the north and centre of the country.

**Pallid Harrier** *Circus macrourus*
This is a scarce, broad-front passage migrant throughout the country, principally in northern, central and western areas. Extreme passage dates for Israel are 26th August and late November; during the NVS, most occurred between 20th September and 10th October.

Annual totals logged in the NVS (table 1) were marginally higher than during the KQS (range 21-57, mean 35). This increase is primarily due to improved knowledge of the identification features used to separate female and immature *Circus* species, since long-term declines have been reported from many areas (Hagemeijer & Blair 1997).

**Montagu’s Harrier** *Circus pygargus*
In autumn, Montagu’s Harrier is a scarce, broad-front passage migrant throughout the country, with most recorded in northern, central and western regions. Extreme passage dates in Israel are 10th August and 10th November, with most observations during the first half of September in the NVS. As for Pallid Harrier; annual totals are appreciably higher than those during the KQS (range 12-51 birds, mean 24), also presumably as a result of better knowledge of identification features.

**Unidentified Montagu’s/Pallid Harrier** *Circus pygargus/macrourus*
Many of the ‘slim-winged’ harriers counted during the NVS could not be identified, owing to the difficulty of distinguishing juveniles and females to species level at distance. The annual totals of such unidentified harriers are thus substantial, with a peak of 533 in 1991 (table 1).

**Northern Goshawk** *Accipiter gentilis*
Northern Goshawk is a rare winter visitor to forested regions of the north and centre of Israel. It is also rare on migration, being recorded chiefly in October and November, and thus later than the NVS study period.

**Eurasian Sparrowhawk** *Accipiter nisus*
This is a relatively common, broad-front passage migrant which occurs throughout the country, although the majority pass through northern, central and western regions. In the NVS, 90% of passage was recorded between 12th September and 18th October; on average, with most being recorded between 2nd and 15th October, and peak counts towards the end of this period; stragglers can occur until late November. Annual totals in the NVS were appreciably lower than those during the KQS (range 385-1,761, mean 897). It is clear that this species is much more widespread than, and not associated with the heavy passage of, Levant Sparrowhawks.

**Levant Sparrowhawk** *Accipiter brevipes*
Levant Sparrowhawk is an abundant passage migrant in autumn, principally in western Israel. In some years, the passage may drift to the east, and large flocks can reach the Arava Valley and Eilat. Extreme passage dates in Israel extend from 1st September to 20th November (Shirihai 1996). During the NVS, counts peaked in 1994, when 60,390 birds were recorded. The middle 90% of the...
annual total was recorded between 16th and 29th September, on average, with the peak dates between 19th and 26th September (mean 23rd September). Peak day counts involved 11%-26% (mean 18%) of the annual total. Annual fluctuations may be due to a range of factors, including breeding success and migration altitude – the small body size of Levant Sparrowhawk makes it particularly difficult to census birds soaring at high levels, and since the mean migration altitude varies between years, this will certainly have affected counts.

In the NVS, the migratory front passed between 17 km and 47 km inland of the coast, although on some days it reached up to 61 km inland, mainly in the afternoons. Conversely, during periods of strong easterly winds, passage occurred within 12 km of the coast (fig. 4). Unlike that of Honey-buzzards and Lesser Spotted Eagles, passage may continue across the entire migration front throughout the day without any obvious shift in pattern.

Autumn passage within the Middle East is concentrated markedly through the Levant. Migrants principally use the western Black Sea route, cross Turkey and move south through the Levant, following a more westerly route than in spring then cross into Africa via Sinai and the Gulf of Suez on a broad front. Information concerning the wintering and breeding areas, and population size and structure of Levant Sparrowhawk is extremely limited, and data collected in Israel during autumn migration are essential to our knowledge of population size, composition and dynamics. Our surveys have shown that the overall migratory population has remained broadly stable since 1990.

Steppe Buzzard *Buteo buteo vulpinus*

Steppe Buzzards are relatively common passage migrants through Israel and migrate on a broad front, although the bulk are observed in the east. Early and late dates for the country are 10th August and 29th November, while 90% of passage in the NVS occurred from 17th September to 21st October, peak counts occurring between 25th September and 10th October.

During the NVS, a significant decline in annual totals was apparent ($r^2 = 0.68, P = 0.003$; see table 1). Using radar data to augment direct observations, it is clear that the great majority of migrants are concentrated in eastern Israel, which represents the western margin of the species’ passage corridor (birds from either side of the Caspian Sea move on a broad front across Jordan and Iraq, then across Arabia to the Bab al Mandab; Shirihai et al. 2000). Those following the western route, across northern Israel (a fraction of the total numbers moving through the Middle East in autumn), frequently join with other species, particularly Lesser Spotted Eagle, which shows similar migration patterns.

Long-legged Buzzard *Buteo rufinus*

Long-legged Buzzard is chiefly a resident breeding
Soaring bird migration over northern Israel


94. Juvenile ‘Steppe Buzzard’ Buteo buteo vulpinus, northern Israel, October 2002. Steppe Buzzards are relatively common, broad-front passage migrants through Israel, whereas only tiny numbers of the nominate form of Common Buzzard are recorded.
species in Israel, but additional birds winter in the lowlands of the north and centre. This species was rarely encountered during the NVS (see table 1), which accurately reflects the small numbers passing through Israel in autumn.

**Lesser Spotted Eagle *Aquila pomarina***

This species is an abundant autumn migrant, occurring principally in western parts of Israel. In the NVS, early migrants were noted from 22nd August, but the middle 90% were recorded between 22nd September and 8th October. Peak dates varied between 25th September and 5th October (mean 1st October), when 13-39% (mean 21%) of the total passage may occur. Annual variation in numbers during the NVS was fairly low, and relates mainly to breeding success and to weather conditions encountered on migration to the north, in particular at the Bosporus. Alon et al. (1992) showed that low-pressure systems over the Bosporus can delay migration of Lesser Spotted Eagles by several days. On such occasions, tens of thousands of eagles may gather in a small area and continue their migration only after weather conditions improve. As a result, huge numbers of eagles may appear in the northern valleys during the course of just one day. During these conditions, when passage is concentrated in both time and space, counting is much more efficient and accurate.

The axis of migration remained relatively constant, with 90% passing 17-42 km from the coast. Like Honey-buzzard passage, this is farther east than during the KQS, where the majority passed 12-18 km from the coast (Dovrat 1991). In late morning, the axis shifted farther west, though this is less apparent than for Honey-buzzards (above), while in the afternoon, the axis moved east again. Migrating Lesser Spotted Eagles use traditional roosting sites, and exceptional numbers seen within a short period in mid morning in some years suggest that these birds had roosted nearby. For example, on 4th October 1994, 16,858 were counted between 08.30 and 10.30 hrs at just two stations. On peak migration days in other years, birds moved across the entire front throughout the day, as in 1990 when 24,000 were counted from stations 15-43 between 09.00 and 15.00 hrs.

In recent years, ground-based observations of this species have been supported by satellite tracking (Meyburg et al. 2000, 2002). This work confirms that most autumn migrants skirt the western Black Sea coast, although there is some evidence to suggest passage on a broad front across Turkey. Passage becomes increasingly concentrated through the Levant, including Israel, and most appear to enter
Soaring bird migration over northern Israel

96. Lesser Spotted Eagle *Aquila pomarina* and Short-toed Eagle *Circaetus gallicus*, migrating through northern Israel, October 2002. On migration, the behaviour of Short-toed Eagle closely mirrors that of Lesser Spotted Eagle. Not only do they migrate together; but they frequently mingle during the day and share the same roosts.

98. Juvenile Greater Spotted Eagle *Aquila clanga*, northern Israel, October 2002. Greater Spotted Eagle is a scarce late autumn migrant through Israel, although some may pass undetected within large flocks of Lesser Spotted Eagles *A. pomarina*, with which this species frequently migrates.

99. Adult Steppe Eagle *Aquila nipalensis*, Eilat, southern Israel, October 2002. In autumn, Steppe Eagles migrate through the Middle East on a broad front; most of those passing through Israel occur in the south and east, and consequently numbers recorded during the Northern Valleys Survey were relatively small.
Soaring bird migration over northern Israel

Africa via the northern Sinai Peninsula, crossing the Gulf of Suez chiefly at the northern end.

Although the population moving through northern Israel appears currently stable, a marked decline was detected in the late 1980s, during the KQS. The mean annual total during 1982-86 was 108,527, but in 1987 only 81,429 were counted (and the mean annual total in the NVS was 68,944). This sudden decline seems to reflect a real decline in the world population (Alon in press; see also Shirihai et al. 2000), perhaps caused by some major catastrophe on the breeding grounds, such as the Chernobyl disaster in May 1986. Clearly, this subject demands further study, and data from breeding areas should be combined with that from migratory bottlenecks.

**Greater Spotted Eagle Aquila clanga**

Greater Spotted Eagle is chiefly a winter visitor to Israel, mainly in lowlands of the north and centre, and also a scarce late-autumn passage migrant (mainly from mid October onwards). Peak passage in the NVS was observed between 5th and 20th October, and doubtless continued after the end of the normal survey period.

**Steppe Eagle Aquila nipalensis**

This species is a near-abundant passage migrant through Israel, principally recorded in the south and east, and generally scarce in northern, central and western parts; consequently, only small numbers were recorded during the NVS (table 1). Steppe Eagle is a late migrant, and NVS counts were concentrated between 6th October and 15th November (i.e. mainly after systematic survey observations had ceased). Those recorded were predominantly juveniles, followed by immatures, while adults were rare.

In autumn, most passage through the Middle East occurs on a broad front across the Arabian Peninsula. Although significant numbers were recorded during the 1980s at Eilat and Suez, subsequent autumn surveys at Eilat showed a consistent decline (also witnessed in spring surveys there). Numbers decreased significantly between 1986 and 1987, followed by a steady decline which stabilised in the late 1990s. In the 1980s, all autumn counts at Eilat exceeded 10,000, the maximum being 24,246 in 1980, whereas in the late 1990s counts varied between 3,242 and 1,278. The sharp decline in numbers, especially in autumn, appears to correlate with a substantial reduction in the breeding population, especially in the west of the breeding range, the main source of the autumn passage birds in the Levant (Shirihai et al. 2000).

**Eastern Imperial Eagle Aquila heliaca**

Eastern Imperial Eagle is a scarce migrant through Israel in autumn. As reflected in the NVS counts (table 1), passage is often protracted and appears to be split between a route through the west of the country, where it often accompanies Lesser Spotted Eagles and, later in the autumn, a route through the south, when it is often seen with Steppe Eagles (Shirihai 1996). It is more numerous as a winter visitor, mainly to lowlands in the north and centre, and the northwest Negev.

**Golden Eagle Aquila chrysaetos**

Golden Eagle is a resident breeder in Israel, and rarely recorded on migration; it was observed in just three years during the NVS (table 1).

**Booted Eagle Hieraaetus pennatus**

This is an uncommon passage migrant, most passing through northern, central and western regions, and just small numbers in the south and east. The passage period of Booted Eagle is protracted, with early and late dates of 21st August and 28th November, and this is the only migratory eagle to make regular staging or feeding stops, which undoubtedly adds to the time taken to cross the country. During the NVS, most birds occurred between 10th and 30th September. Numbers recorded during the KQS were higher, which is probably attributable to differences in survey station position and distribution.

**Bonelli’s Eagle Hieraaetus fasciatus**

A few (resident) pairs of Bonelli’s Eagles breed in Israel, but numbers of passage migrants and winter visitors are small. This species was recorded in eight of the ten years of the NVS, but totals never reached double figures.

**Osprey Pandion haliaetus**

Osprey is a scarce passage migrant in Israel, principally in the north and west, and mainly between mid September and mid October. On migration, Ospreys use a ‘jump’ strategy, making several midpassage stopovers to feed (Hake et al. 2001; Kjellén et al. 2001).

**Lesser Kestrel Falco naumanni**

Lesser Kestrel is a scarce but widespread migrant, moving on a broad front across Israel, and was recorded in only small numbers during the NVS. It is otherwise a summer visitor; breeding in the north and centre of the country.

**Common Kestrel Falco tinnunculus**

This is a common resident breeder in Israel with only small numbers of passage migrants recorded. Passage is widespread, occurring on a broad front throughout the country.

**Red-footed Falcon Falco vespertinus**

This is a relatively common passage migrant,
recorded principally in the north and west of the country. Passage is concentrated into a short period between late September and mid October. Marked annual fluctuations (table 1) reflect the influence of prevailing weather conditions. Following rainy days with low pressure and strong westerly winds, large numbers drift inland after crossing the Mediterranean Sea. Conversely, annual totals are lower in years with no rain during the survey period. These results are linked with altitude of migration, since Red-footed Falcons migrate at lower altitudes in poor weather, and are easier to count. Following days of wet and unsettled weather; large staging concentrations and roosts assemble in the agricultural fields in many parts of the northern valleys, mainly in western and central areas.

Merlin *Falco columbarius*

Merlin is a winter visitor to lowlands in the north and centre of Israel, and the northwest Negev. Few are recorded on migration, and these generally later than the NVS study period, chiefly from mid October onwards.

Hobby *Falco subbuteo*

Hobby is a widespread, broad-front migrant through Israel, generally observed between the second half of September and early October in the NVS. It is also a summer visitor; breeding in wooded areas of the north and centre.

Eleonora’s Falcon *Falco eleonorae*

Relatively small numbers occur on passage through the country, and these are largely confined to Mediterranean coastal regions (Shirihai 1996).

Lanner Falcon *Falco biarmicus*

A few breeding pairs are resident in the southern deserts, and only small numbers of migrants or winter immigrants occur (Shirihai 1996).

Saker Falcon *Falco cherrug*

Saker is a rare passage migrant through Israel, generally seen after mid October (i.e. after the main survey period of the NVS). It is also a winter visitor, chiefly to lowlands of the northwest Negev (Shirihai 1996).

Peregrine Falcon *Falco peregrinus*

A scarce but widespread migrant on a broad front through the country, Peregrine is mainly a winter visitor in small numbers to Israel, principally to lowlands in the north and centre, and the northwest Negev.
Discussion

Although long-term, standardised visual migration counts are an efficient and cost-effective method for monitoring the abundance of diurnal soaring birds, their accuracy as indicators of population changes has been debated owing to potential biases and limitations (e.g. Titus & Fuller 1990, Dunn & Hussell 1995, Allen et al. 1996, Leshem & Yom-Tov 1996a). Nevertheless, we are convinced that such surveys provide vital information on populations, especially for species which are difficult to census on their breeding grounds. Certainly, surveys such as the NVS are important for monitoring trends in migrating populations (Bednarz et al. 1990; Dunn & Hussell 1995), and for those species which are otherwise difficult to census reliably, perhaps because of low breeding population densities and/or problems of access during the breeding season, monitoring numbers of migrating birds may be the only way of gauging population levels. Furthermore, many species breed in countries with comparatively few active fieldworkers, so even where a species is widespread and/or significant breeding populations occur, the results of other survey methods are often less accurate. In autumn, the NVS (and its predecessor, the KQS) is the only long-term, systematically run, multi-station soaring-bird migration survey in the Middle East, and its regional importance is immense. For some species, notably Levant Sparrowhawk, virtually the only significant and reliable information about breeding populations comes from raptor migration census work, principally in Israel (KQS/NVS in autumn and Eilat in the spring). It is evident, from these surveys (see Alon 1998; Yosef 1998; Shirihai et al. 2000), that significant declines of several species have occurred in recent years, including both open-country raptors – most importantly Short-toed Eagle, Steppe Buzzard and Steppe Eagle – and woodland breeders – principally Lesser Spotted Eagle. Conversely, White Stork, Honey-buzzard and Levant Sparrowhawk populations appear to have remained stable.

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