OUTLINE FOR THE SUMMARY OF CASE STUDIES ON MIGRATORY SPECIES

Name of respondent: Dr. Reuven Yosef Country: Israel

Function (optional): Director, International Birding & Research Center in Eilat
E-mail: ryosef@eilatcity.co.il
Contact address: P.O. Box 774, Eilat 88000, Israel

1. Title of the case study
1.1. Where has the case study been conducted? Eilat, Israel 1.2. At what level has the case study been carried out (e.g. local, national, sub-regional, global)? Local- - - 1.3. Other relevant background information on the case study: Ms attached
2. Migratory Species considered
Steppe Eagles Levant Sparrow Hawk
3. Range states, biomes involved
Eurasia Middle East Africa (sub-saharan)

4. Objectives of the case study
Monitoring

5. Lessons learned from the case study
Raptors and bio indicators – see ms

6. Future plans and recommendations
See ms

7. Reference materials in connection with this case study (also include relevant web pages)
See ms

Name of contact person for case study (in case it differs from the respondent): Dr. Reuven Yosef

Country: Israel
Function (optional): Director, International Birding & Research Center in Eilat
E-mail: ryosef@eilatcity.co.il
Contact address: P.O. Box 774, Eilat 88000, Israel

SIMULTANEOUS DECLINE IN STEPPE EAGLE POPULATIONS AND LEVANT SPARROWHAWK REPRODUCTIVE SUCCESS: COINCIDENCE OR A CHERNOBYL LEGACY?

Reuven Yosef[1] and Lorenzo Fornasari[2]

[1]*International Birding and Research Centre in Eilat, P.O. Box 774, Eilat 88000, Israel; and* [2]*Dept. Environmental Sciences, II Univ. of Milano "Bicocca", via Emanueli, 15, I-20126, Italy*

ABSTRACT. - Visual migration surveys, especially at bottlenecks, can be a vital tool to evaluate population fluctuations in environmentally sensitive species. Raptors are considered to be the ultimate bioindicators that help identify the aftermath of environmental catastrophes. Two species that are known to concentrate at Eilat are Steppe Eagles (*Aquila nipalensis*) and Levant Sparrowhawk (*Accipiter brevipes*). Substantial proportions of the global population are counted during the spring and autumn migrations. Counts from seven autumn and seven spring migration surveys have exhibited a constant decline in Steppe Eagle numbers. Further, the number of juveniles observed in these counts has dropped from 30% in the early 1980's, to less than 9% in the 1990s, to 1.4% in 2000. The numbers observed at Eilat are cause for concern because they are well below the range of the numerical fluctuations observed in previous surveys. Further, in Levant Sparrowhawks, a species far more difficult to census than Steppe Eagles, no decline in total numbers is evident. However, assuming that the ratio of age and sex classes of the birds trapped at Eilat is random, a significant change in the adult:juvenile ratio was noted between the population trapped in the 1980s and that sampled in the late 1990s. The cumulative evidence of the decrease in the total numbers of Steppe Eagles observed, the decreasing percentage of young that comprise the population, and the decrease in adult:young ratio in the Levant Sparrowhawk population trapped from 1987 onwards leads us to suggest that the Chernobyl accident on 26 April 1986 may have negatively affected wildlife populations not only to the west with the spread of the plume, but also farther east than previously assumed.

Key words: Steppe Eagle, Levant Sparrowhawk, migration, decline, Israel, Chernobyl.

Migratory species provide a challenge for conservation and management because of their mobility. Some well known problems facing long istance migrants are human encroachment on natural habitats, agriculture and its many facets such as pesticides and monocultures (cf. O'Connor and Shrubb 1986), recreation (cf. Knight and Gutzweiller 1995) or direct bird persecution (Bell and Owen 1990). Another factor that few biologists take into consideration is animosity among ethnic groups that leads to wars that have negative effects on the environment (RY, pers. obs.). At a local scale this might appear to be irrelavent to the global picture. However, war leads to a situation wherein great expanses of terrestrial habitat are changed dramatically and rendered inaccesible to researchers to verify either the status of populations or the abuses to which the environment is subjected during and after these conflicts. Another problem is the difficulty of monitoring populations in inaccessible areas. To evaluate wildlife population levels within these regions, it can often be most effective to sample organisms that leave the problematic region periodically. Hence, the value of studying migratory raptors. Raptors can be used as environmental indicators by counting their relative numbers over time in concentration areas (cf. Meyburg and Chancellor 1989).

The pros and cons of surveys of migrants were reviewed by Kerlinger (1989). While most of these surveys are from North American (e.g., Kerlinger and Gauthreaux 1985, Bednarz et al 1990), the techniques are applicable to regions and where there are threats to the bird populations, or to provide information about population levels in little known areas of the world like Central Asia.

Many articles have been published on the chemical, radio-active, and other types of contamination or pollution that continue unmonitored to date (cf. Chaussade 1990). There are also few publications about the effects of environmental change (e.g., Ellegreen et al. 1997), and the effects on, birds in general (e.g., Camplani et al. 1999) and, raptors of the Eurasian expanses in particular (e.g., Henny et al. 1998).

In the center of the region, where Eurasia and Africa meet, there is a concentration area where many species can be surveyed (Shirihai et al. 2000). Surveys of migrants passing thru these regions, like those conducted in northern Israel and at Eilat become important for indices to evaluate population status (e.g., Shirihai and Christie 1992, Yosef 1995, Shirihai et al. 2000).

After Safriel (1968) drew attention to the migratory bottleneck at Eilat, and Christensen et al. (1981) published their report on this phenomenon over Eilat, several counts have been conducted in spring and autumn (e.g., Shirihai 1987, 1988; Shirihai and Christie 1992; Shirihai and Yekutiel 1991, Yosef 1995).

In the Old World, most raptors breed north of latitude 35°N, and winter (austral summer) between 30°N and 30°S (Shirihai and Christie 1992). An estimated 3-5 million raptors from Europe and Asia migrate annually through the Middle East (Frumkin et al. 1995). Israel is located on the only land bridge between three continents, a junction for birds migrating south from Eurasia to Africa in autumn and north to their breeding grounds in spring (Safriel 1968). In autumn, except for Steppe Eagles (*Aquila nipalensis*) that concentrate at Eilat and stochastic events, southbound birds tend to migrate over a broad front. In the spring, the Red Sea and the Gulf of Aqaba act as a long deflection barrier forcing northbound raptors to concentrate in a very narrow area over the Eilat Mountains (Grieve 1996). Also, Eilat is situated at the northern edge of over 2000 km of continuous Sahel, Sahara and Sinai deserts. However, to the north-north-east there are still 650 km more of the Syrian desert, and due East the vast Arabian desert. Hence many birds land in the Eilat area to rest before (in autumn) or after (in spring) crossing the deserts (Safriel 1968). The return journey of the soaring birds that have survived the autumn migration and austral summer in Africa is directed north or north-east to their Palearctic breeding grounds (Frumkin et al. 1995).

We are unaware of any raptor banding stations or visual-migration surveys conducted on a regular basis on the eastern flyway of the Palearctic. Trans-Saharan raptors, returning to Europe and Asia, banded at Eilat in previous years have supplied some insight into their migratory biology and destinations (e.g., Clark et al. 1986, Gorney and Yom-Tov 1994), and bands have been recovered across Europe, Asia, and Africa (Yosef 1998a). The paucity of information for raptor populations in the Middle East, Africa, and Eurasia stresses the importance of implementing raptor banding projects and visual-migration surveys that will enhance our understanding of their migrations (Clark 1995). To date migration counts integrate information on bird populations over wide areas and often sample relatively large numbers of individuals at a single observation site, but they have been little used to monitor changes in population levels (e.g., Shirihai et al. 2000, Kjellen and Roos 2000). There are two main reasons for this: The first - it is often difficult to associate particular migrant populations with corresponding breeding and wintering populations; the second - many factors other than population change contribute to variability counts of migrants. The only study wherein migration indices were correlated with breeding data is Svensson's (1978) that showed that migration indices for several species at Swedish observatories were correlated with independently-derived results from the Swedish breeding bird census. He concluded, that the breeding bird census was a more efficient method for detecting population changes because of high variability in the migration indices, which he attributed mainly to the effects of weather conditions. However, at a continental scale most raptor species are poorly surveyed because they occur at relatively low densities and usually relatively low detectability. Thus, survey of concentrated migrants is the most practical, and cost-effective, method available for developing indices to population levels. Surveys of migrants can be supplemented by detailed analysis of ring encounters, and other techniques such as satellite telemetry, to determine breeding areas, migration routes, and wintering areas of sub-populations.

As previously mentioned, a large proportion of Steppe Eagles concentrate at Eilat during both autumn and spring migrations (Shirihai et al. 2000). Age class has been documented on the visual migration surveys and on average 70% of those that avail of the Eilat flyway are adults (Shirihai et al. 2000) and an as yet unknown proportion of the juveniles follow the central Negev route. Here we report a problem that we have elucidated from surveys of migrant Steppe Eagles that were initiated in 1977 and continue to date (Shirihai and Yekutiel 1991, Shirihai and Christie 1992, Yosef 1995, 1996, 1998b, Leshem and Yom-Tov 1996a, b, Shirihai et al. 2000).

Similarly, a co-operative raptor trapping and ringing program of the SPNI and the IBRCE was conducted from 1994-1998. This program was restarted by IBRCE in 1996 and continues to date. One of the species caught in large numbers is the Levant Sparrowhawk (*Accipiter brevipes*). The Levant Sparrowhawk is a typical raptor with reversed sexual size dimorphism and dichromatism (Cramp & Simmons 1980, Clark & Yosef 1997, Forsman 1998b, Gorney et al 1999, Yosef and Fornasari 2000). Levant Sparrowhawks are considered scarce (Cramp and Simmons 1980, Wallace 1983) and are one of the three-raptor species whose breeding distribution is limited to the western Palearctic (Hagemeijer & Blair 1997). Recent studies have illustrated that in spring Levant Sparrowhawks concentrate in the Eilat-Aqaba region in great numbers (e.g., 45,000 - 55,000 per season; Shirihai et al. 2000) and migrate north along the rift valley towards Syria and Lebanon (Frumkin et al. 1995), heading for Romania, Ukraine, Russia, and Syria (Yosef 1998).

Here we present data that simultaneous reductions in the overall population and number of juveniles observed on passage was affected in Steppe Eagles after spring 1986, and that a inversion of the adult:juvenile ratio in Levant Sparrowhawk coincided with the same period of time. The only environmental catastrophie to have occurred on the breeding grounds in spring 1986 of these two raptor species is the nuclear accident that demolished Chernobyl Unit 4, at 1:23 a.m. on April 26, 1986. In an enormous explosion of the reactor core, a mammoth amount of heat and disintegrated radioactive fuel violently erupted into the atmosphere. An atomic fire burned for days before Swedish authorities alerted the world to the nuclear fallout spewed high into the atmosphere. Following the accident many research papers pertaining to the effects on humans have been published (e.g., Bengsston 1987, Kazakov et al. 1992). In contrast, few relate to the avian communities that breed in the affected regions, mostly owing to govermental restrictions and fear of radioactive exposure. However, in recent years a small number of researchers have studied the effects of the Chernobyl accident at the breeding grounds (Ellegrin et al. 1997, Camplani et al. 1999) or on migration (Vigorita and Sgorbati 1991). Here we present a unique data set wherein population levels were monitored before, during and after the Chernobyl accident at one of the most important avian migratory bottlenecks of the western Palearctic, at Eilat, Israel.

METHODS

Visual raptor migration surveys are conducted at Eilat sporadically (for details of method of survey and positions see Shirihai and Christie 1992, Yosef 1995, Shirihai et al. 2000). All soaring birds are counted by deploying volunteers at traditional counting posts across the front of the passage route. Distances between observation posts are such that minimal overlap occurs. However, at the end of each day, data pages between neigbouring positions are compared to check and eliminate possible double counts (Shiriha et al. 2000). Ageing of Steppe Eagles in flight is relatively easy. Experienced observers can classify the birds into either juvenile (first-year), 2nd-winter, 3rd-winter, 4th-winter, 5th-winter or adult (Porter et al. 1981, Forsman 1998a,b, Clark 1999).

Levant Sparrowhawks were captured and ringed in the area immediately to the north of Eilat, Israel. The ageing of Levant Sparrowhawks was based on plumage, molt, and eye color; adults have brown eyes with a slight reddish cast and juveniles have pale to medium brown eyes (Clark and Yosef 1998). We quantified the relative abundance of the various sex and age classes for all seasons of raptor trapping at Eilat between 1984-1988 (cf. Clark and Yosef 1997, Gorney et al. 1999) and in 1992 and 1996-2000 (Yosef and Fornasari, in press; RY, unpubl. Data). We make the assumption that the numbers of birds trapped an unbiased sample of the population migrating through the region because most are caught in mist nets and not on lure animals (RY, unpubl. data).

Unless otherwise stated, all measured data are presented as mean ±SD, N, and range. We used simple linear regression to evaluate trends and chose $P = 0.05$ as the minimum acceptable level of significance.

RESULTS

The average for nine (1977, 1983, 1986 - 1988, 1994, 1997, 1998 and 2000) spring surveys that were limited to the Eilat mountains is 17,449 ± 7,335 (9,283 - 31,198) Steppe Eagles. In seven autumn migration surveys (1980, 1986, 1987, 1996 - 1999) conducted at Eilat, the average number of Steppe Eagles counted was 8309 ± 8346 (1,278 - 24,243). However, it is of interest that the larger numbers were observed in the 1980s; the lower counts are consistently from the 1990s for both the autumn (simple linear regression $y = -292.84x + 584768$, $R^2 = 0.6747$, $P = 0.0247$) and spring ($y = -77.711x + 156665$, $R^2 = 0.7991$, $P = 0.001$) surveys (Fig. 1, 2). There are no obvious fluctuations of numbers, just a severe drop between 1987 and 1988, and since the late 1980s the numbers have stabilized at approximately a third of the numbers observed in the 1980s.

In addition to the overall decrease in numbers, the ratio of juveniles in the migratory population has decreased considerably. The average percentage of juveniles in the 1980s was 30% and the 1990s it fell to 9%.

Eilat is situated at the northern edge of almost 2000 km of continuous desert regions of the Sahara and Sinai. Many birds land here to rest after crossing the deserts (Shirihai et al. 2000). We captured and ringed 1827 Levant Sparrowhawks from mid-April till early May. Unlike Steppe Eagle numbers, a higher ratio of juveniles was recorded in 1987, and only thereafter was there a decline in the number of juveniles trapped. The average age ratio of juveniles:adults for the period 1984-1987 was 14:10 (±0.34) as compared to 7:10 (±0.33) in the 1990s (Table 1).

DISCUSSION

The changes in numbers observed at Eilat for both, Steppe Eagles and Levant Sparrowhawks, are cause for concern. Not only are Steppe Eagle numbers well below the range of the fluctuations observed prior to 1986, but the percent of juveniles observed has dropped from 30% in the 1980s to less than 9% in the 1990s. There is little information on ecological prameters that may have affected numbers on the wintering grounds (Harrison et al. 1997). The Steppe Eagele feeds predominantly on allate termites, the emergence of which is unpredictable, except as linked to thunderstorms, which are also unpredictable in terms of yearly and local variation in amount and timing. Consequently, Steppe Eagles are locally and regionally sparse (or even absent) in some years and temporarily abundant and occurring in large flocks in the Kalahari veld at times after heavy rain. Steppe Eagle carcasses were also collected in South Africa and Botswana after application of Fenthion, an organophosphate insecticide (Keith and Bruggers 1998). Hence, it is almost impossible to evaluate the population status on the wintering grounds.

The importance of evaluating the Steppe Eagle populations at Eilat is further suggested by the fact that in a recent study, Meyburg et al. (1998) showed that of 14 Steppe Eagles caught in Saudi Arabia and one in South Africa, eight wintered in Africa, and all returned to the breeding grounds via the Eilat flyway. There are several possible factors that can influence the population fluctuations reported here. It is possible that on the breeding grounds the major food resources have declined, or their breeding habitats severely decreased. The latter is mentioned in the EBCC Atlas of European Breeding Birds wherein it is reported that Steppe Eagles have declined, and even become extirpated, in most of the east European countries and in the past century the western limit of the species has withdrawn eastwards by as much as a thousand kilometres (Hagemeijer and Blair 1997). It is estimated that about 20,000 breeding pairs exist. An alternative explanation for the decrease in our counts is that perhaps a larger proportion of the remaining population winters farther north than the traditional wintering grounds in Africa. Some Steppe Eagles may stop in the Arabian Peninsula. However, we consider the almost 40% drop in numbers observed at Eilat to be too large for interrupted migration to be the likely reason for the lower counts. Alternatively, it is possible that a large proportion of the population migrates via routes either to the south and east of Eilat, or further west and to the north. However, the consistency of the decline strongly disfavours the alternative route idea, which if responsible would likely result in wide fluctuations among years. Also, the above mentioned factors do not explain the decrease in the number of juvenile or immature birds. Shirihai and Christie (1992) report that an average of 30% of the population is non-adult. In contrast in recent surveys, only 9-13% are non-adult birds (Yosef 1996, Shirihai 2000, RY, unpubl. data). Because we know little about the numbers on the breeding and wintering grounds, only the surveys in Eilat are available to elucidate the population trends.

In many bird atlases, although they report a constriction of the breeding range eastward in recent decades, the Steppe Eagle is described as the commonest large eagle in the world (e.g., del Hoyo et al., 1994, Harrison et al. 1997). By contrast our data show a major decline on the major, known migratory route. For the Steppe Eagles observed at Eilat, the facts that the decline occurred immediately after 1986 and that the radioactive plume following the 1986 Chernobyl accident was blown in the direction of the known breeding grounds of the species, suggests that radioactive contamination could have negatively affected not only the survival of the adults but also their reproductive ability. The latter is of special concern because of the inability of the existing adult population to fledge enough young to sustain itself. This suggests that an additional crash is in the offing.

The implications of the data for Levant Sparrowhawks trapped at Eilat are similar to that of the Steppe Eagles. The findings of our banding study at Eilat are further substantiated by the fact that several of the individuals banded at Eilat have been recovered in subsequent years in areas affected by the Chernobyl disaster. The number of juveniles trapped in the 1980s was consistently greater than that of adults and in sharp contrast to that of the 1990s where the numbers of juveniles was almost always lower than that of adults (Table 1). The average ratio of juveniles:adults in the 1990s is half that of the 1980s. This suggests that the reproductive ability of the adult population is impaired. Although numbers counted on the visual migration surveys have not changed (Shirihai et al. 2000), the number of young comprising the population has halved. It appears that a substantial proportion of adults succumbed to the contamination resulting in a peak of juvenile:adult ratio in 1987, but then a drop occurred from 1988 onwards. This radioactive-contamination lingering effect was also reported by Jonsson et al (1999) who found that Chernobyl radioactivity persisted in two fish species (brown trout, *Salmo trutta*, Arctic charr, *Salvelinus alpinus*) that are widely eaten by humans in Scandinavia for a greater period of time than initially reported. This inverse ratio of young within the population suggests that in the very near future a decline in the population of the Levant Sparrowhawk should be expected.

In conclusion, the simultaneous decline in Steppe Eagle numbers observed on migration and the reduction in the relative percent of young, coupled with the inversion of the age ratio in the number of Levant Sparrowhawk trapped at Eilat , immediately after the Chernobyl accident in April 1986 suggests that it to be the reason of these demographic changes in the populations of these two, unrelated species. Although the two species breed in very different habitats, their distributional ranges overlap, and these areas are known to have received high dosages of contamination in the first week after the accident.

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Further, the data p :ate how visual migration surveys and banding data can be used for ıg, and indicate when more intensive study is required to assess p to elucidate the causes of the observed changes. Surveys c :de an important conservation tool to validate findings of breeding . Surveys of migrants may often be the best and only available inc changes. This is the case for the Steppe Eagle and Levant Sp ation at Eilat.

This study illustrat f coordinating the monitoring of breeding populations as well a necks. Hence, the conservation related options that remain a onservation efforts are concentrated in elucidating the true s while a viable population, and conservation options, still exist or t es to go almost extinct and then spend greater amounts of financial r e their recovery.

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Table 1. Age ratio of Levant Sparrowhawk (*Accipiter brevipes*) trapped at Eilat, Israel.

YEAR	JUVENILE	ADULT	Juv/Ad ratio
1984	88	70	1.28
1985	13	8	1.63
1986	70	71	1.01
1987	35	20	1.75
Avg.			1.40
1988	24	37	0.65
1992	2	19	0.10
1996	90	127	0.71
1997	63	57	1.11
1998	150	217	0.69
1999	135	261	0.52
2000	129	114	1.13
Avg.			0.70

Fig. 1. Results of Steppe Eagles per 100 hrs of observation on spring soaring bird surveys at Eilat, Israel.

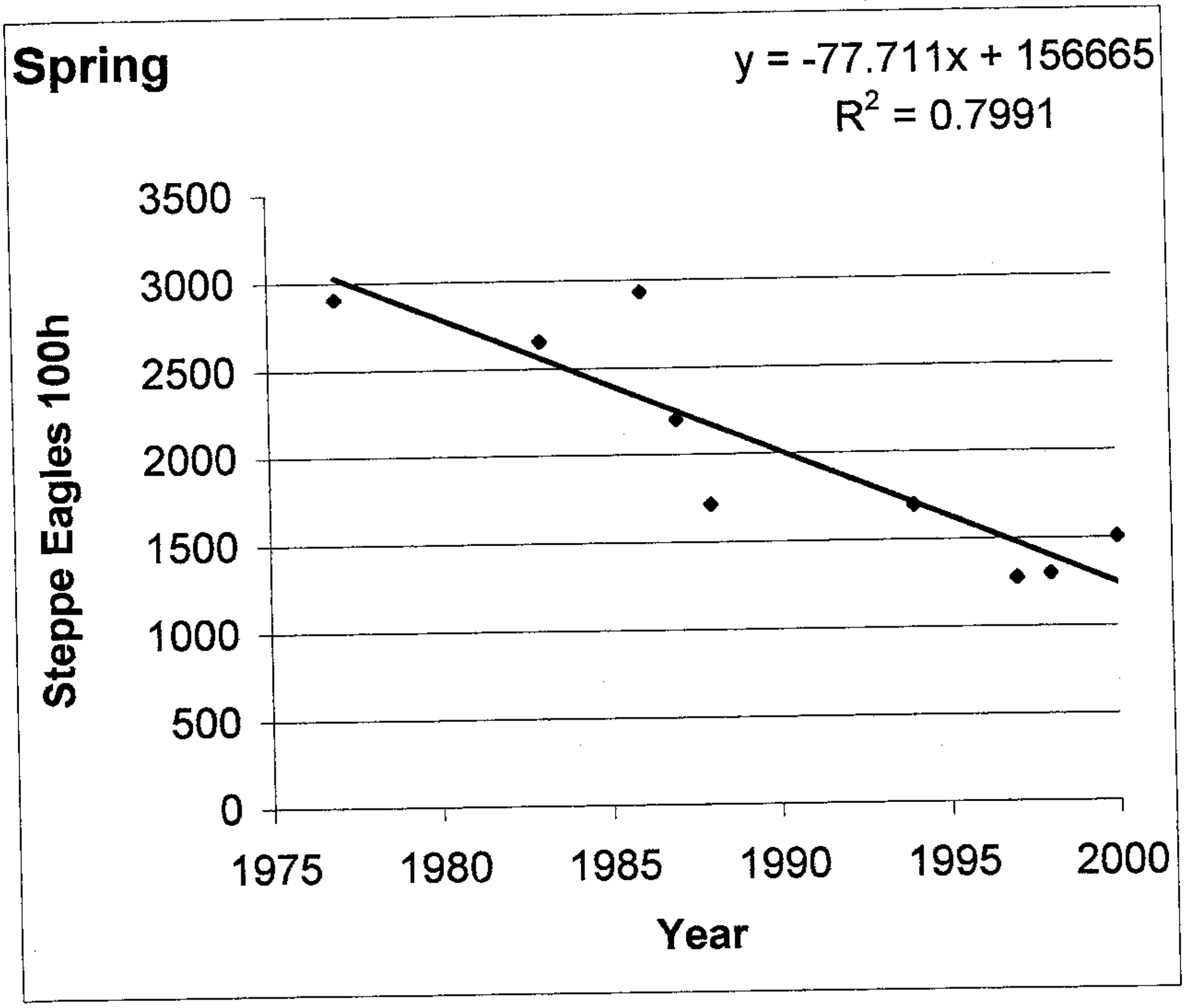

Fig. 2. Results of Steppe Eagles per 100 hrs of observation on autumn soaring bird surveys at Eilat, Israel.