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Long-term Changes in Autumn Migration of Selected Soaring Bird Species at Burgas Bay, Bulgaria

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Abstract: The paper presents data of the autumn migration along the Western Black Sea migration route (Via Pontica) collected since 1979 with special attention to the changes of migration numbers and peak days of the ten most numerous soaring bird species. We found long-term increase in the migration numbers of *Pelecanus onocrotalus*, *Ciconia ciconia*, *Ciconia nigra*, *Circaetus gallicus*, *Circus aeruginosus*, *Accipiter brevipes*, *Clanga pomarina*, *Aquila pennata* and *Falco vespertinus*. All collected data confirm that the Burgas Bay is the place with the highest and increasing autumn migration numbers of the great white pelican and the red-footed falcon in Europe. Due to our long experience in migration observations, we introduce four new terms (flyshed, sandglass site, migration period and peak's migration period) and propose a classification of the sandglass sites according to the flight types and migration behaviour of the soaring birds. Additionally, we outline the need for covering of a wider segment of the migration route through a chain of observation points, including specialised radar and the usefulness of joint and synchronised efforts by all teams at the basic observation points in Europe and Asia Minor on a continental scale.

Key words: bottleneck site, flyshed, migration period, peak migration period, sandglass site, soaring birds, *Via Pontica*

Introduction

The observation point (hereafter abbreviated as OP) at the Burgas (=Bourgas) Bay is situated at the Western Black Sea Migration Route. This route is commonly known as *Via Pontica* and is a part of the main migration highways through Europe and the Western Palearctic (Porter & Beaman 1985, Zalles & Bildstein 2000, Forsman 2016). *Via Pontica* plays a key role in the migration of soaring birds from the eastern parts of Europe, where it is not sufficiently studied. Unlike other well-known observation sites in Europe, the Burgas Bay OP has some distinguishing features. It covers not only the area where the soaring birds fly over with a gliding and flapping flight, but also an area above which the birds gain altitude by soaring flight and in which they stay for the night or remain for a rest during a couple of days. Due to these patterns, the Burgas OP is a valuable site for both studying the numbers of the passing soaring migrants and for collecting data on their age and sex composition, their biology, ecology and behaviour.

Another distinguishing feature of the Burgas Bay OP is its proximity (about 230 km) to one of the biggest OP, the Bosporus Strait, with its long history and abundant data on the migration of soaring birds. The Bosporus is the original *check-point* for the OP of the Burgas Bay during the autumn migration, while the OP at the Burgas Bay plays the same role for the Bosporus during the spring migration (Fig. 1). Doubtless, the importance of both sites for the avian and for the human security have been increasing significantly after building of one of the biggest airports in the world, situated at 35 km NW of Istanbul.

Bird migration of soaring birds at the Burgas Bay was relatively well described in a number of publications referred by Koenigstedt & Robel (1982), Zalles & Bildstein (2000), Michev et al. (2012) and Harris (2013). The most exhaustive among them was the paper by Michev et al. (2011), which contained detailed data on the autumn migration of soaring birds along this migration route between 10th August and 31st October of the years 1979-2003, n=20. After this period, till 2017 a new series of long-term data were collected at the Burgas Bay and the whole data set (from 1979 to 2017, n=32) was analysed. The present paper reports the results of this analysis concerning the migration numbers and peak days of ten selected soaring bird species with the idea to outline eventual temporal changes.

Materials and Methods

Study Area

Almost all surveys were carried out mainly from the observation point (42° 33' 32.9'' N; 27° 29' 17.8'' E) situated it the area of the complex wetland Atanasovsko Ezero (IBW1900 in Michev & Stoyneva 2007, Michev et al., 2018), at the westernmost point of the Black Sea and the Burgas Bay. The observations made from this OP covered the entire surface area of the wetland (declared as a Nature reserve, Ramsar site with code 292, part of Natura 2000 network with code BG0000270 and IBA site with code BG036) and its surroundings within a radius of about 4 km incl. arable fields and vineyards to the west and north-east. This territory is the richest bird site in Bulgaria with 333 species recorded till December 2014 (Michev et al. 2018). The dry and treeless southern slopes of Iztochna Stara Planina Mts. (Eastern Balkan Range), which serve as thermal air-sources used by the soaring birds, the international airport with rather intensive traffic in summer and autumn, a part of the Burgas Bay and the city of Burgas are also observed from this OP.

Data collection

The visual tracing of the soaring birds' migration was carried out in the period 1979-2003 (Michev et al. 2011) and after seven years again, in the same way, between the usual dates 10th August and 31st October 2011. In addition, data from the second half of September 1976 quantitative data for some raptors were collected and later published by Königstedt & Robel (1982). In 2004-2010 observations were carried out by a Danish group with leaders Erik Moulgard and Hans Henik Scou, who kindly provided their unpublished data. Also during the second half of September 2012-2017 visual observation were realised by another Danish team leaded by the late Finn Enemark (Laursen et al. 2016) and by a Dutch - Belgian group with organizers Gerard Troost and Arjan Boele (unpublished data for 2014-2017, kindly provided to us with permission to include them in this paper). Overall, a 32 years long-term data set between 1979 and 2017 was completed and analysed with special attention to the migration numbers and peak days of ten selected soaring bird species.

In 2011, the observer's team, binocular telescope (Carl Zeiss Jena 20–40 x 120) and methods applied were the same as used by Michev et al. (2011). Additionally, in order to avoid miscounts and to determine the exact numbers of the large flocks of white storks and great white pelicans, we used a video camera and computers (video camera Handycam Sony HDR 520 VE with hard disk 240 Gb and resolution 1920 x 1080, optical tele-converters RAYNOX with coefficients 1.54x and 2.2x for additional magnification of flocks at a big distance and Picture Motion Browser - Viewer - Browser – Calendar). They were used in parallel with the visual counts. In the cases of poor visibility, special attention was paid to avoid misidentification of both species of pelicans and/or of pelicans and storks.

For the purposes of this paper, we used comparative quantitative analyses of the species mean numbers and peak days during the second half of September in 1979-2003 with the same periods of 2011 and 2012-2017. From all 38 soaring migrants, registered at Burgas Bay during the autumn survey of 1979-2017, we selected ten species: great white pelican (*Pelecanus onocrotalus*), white stork (*Ciconia ciconia*), black stork *(Ciconia nigra*), Levant sparrowhawk *(Accipiter brevipes),* short-toed snake eagle (*Circaetus gallicus),* marsh harrier (*Circus aeruginosus*), common buzzard (*Buteo buteo*), lesser spotted eagle (*Clanga pomarina),* booted eagle (*Aquila pennata*) and red-footed falcon (*Falco vespertinus*). They were the most numerous and their peak migration periods generally coincided with the second half of September, with exception of the great white pelican and of the white stork. Therefore, data collected during 2012-2017 for the last two species were excluded and, additionally, breeding population data on the great white pelican provided by Marinov et al. (2016) and for the white stork those of Samusenko (2014), Vaitkuvienė & Dagys (2014) and BirdLife International (2017) were taken into account. For the other eight species we used our data for the second half of September 1979-2003 and 2011, as well as data published for 2012-2016 by Laursen et al. (2016) and the unpublished data for 2014-2017 of Arjan Boele and his colleagues from the Netherlands and Belgium.

Statistical analyses

Statistical data processing was done using the Wilcoxon rank-sum test for paired data. Analyses

were carried out with STATISTICA v. 4. Shifts in the mean number of migrating species in the period 1979-2017 were assessed using the regime shift technique (Basseville & Nikiforov 1993, Rodionov 2004). Some of our results (between 27th September and 31st October 2011) were presented each next day on the Internet Page of the Trektellen, The Netherlands (www.trektellen.nl).

The contributions of the authors were as follows: Tanyo Michev – co-leader of the project, text preparation; Lyubomir Profirov – co-leader of the project, composition of tables with data for the period 2004-2017; Boyan Michev – field observations, video and computer processing, filling up of data into Trektellen data base; Lyubomir Hristov – field observations, video and computer processing; Assen Ignatov and Emilian Stoynov – field observations; Nesho Chipev – statistical analyses.

Results

Terminology

During the work on this paper we discovered some terminological disadvantages, or inconsistent usage of the same terms by different authors. Therefore, as a first result we would like to introduce the following new terms, which we used during our surveys.

This refers firstly to the widely used term *Bottleneck site.* It was commonly used for those sites, which are situated at straits, bays, coasts, capes, passes and are characterised with huge numbers of soaring migrants (Fig. 1). Recently, the same term has been applied for all sites, which exceed 5000 migrating storks or 3000 raptors. In this understanding we have to accept that the north-eastern territory of Bulgaria is covered by tenfold more *bottleneck sites,* which fulfil this requirement (Michev et al. 2012). Therefore, we suggest to use the new term ***Sandglass site*** for the well-known sites with huge concentrations of soaring birds (like Falsterbo, Organbidexka, Gibraltar, Messina, Burgas, Bosporus, Batumi, Borcka, Eilat and others), where numbers exceed at least ten times the abovementioned values and to keep the term *Bottleneck site* for less significant migration sites.

The sandglass sites could be clearly distinguished by the flight types or behaviour of the migrants. Accordingly, the following original classification of the sandglass sites was successfully applied during the study (Table 1):

SF – Site for fly over only with an active flapping flight and without stopping for soaring, overnighting or staying for several days; usually such sites are situated at sea surfaces or forests;

SG – Site for fly over only with gliding flight and without stopping for soaring, overnighting or staying for several days; usually such sites are situated at sea surfaces or forests;

Fig. 1. Main sandglass sites around the Black Sea and in the Eastern Mediterranean (after Zalles & Bildstein 2000)

SR – Site for fly over with mainly gliding and soaring flight; usually such sites are situated at arable or fallow land, stubble fields, rocky areas and other places with thermals;

SO - Site for overnighting (*bird hotels*); usually such sites are situated around/in wetlands, fallow land, stubble fields, forests, single trees and other places without human disturbance.

SoS – Stop over site for a longer stay of more than twenty-four-hour period; such sites are situated in large wetland complexes with foraging resources and absence of human disturbance; these sites have great conservation importance.

We introduce also the term *flyshed* by similarity to the term *watershed* (=catchment area of a given river). It is defined as that part of the breeding area (or the whole area) from which a given migration species starts to migrate to the wintering areas. Thus, the succession of soaring bird migration can be represented as follows: Flyshed (area, which is equal or smaller than the breeding range of a given species) – Flyway/Migration Route (with several *bottleneck* and/or *sandglass* sites and *bird hotels* for overnighting and roosting) – Wintering Areas.

According to Michev et al. (2011) the *main migration period* (MMP) is the period between the two dates (one near the beginning of the passage, one near the end) after/before which the average migration count for three successive days was less than one individual. The *peak's migration period* (PMP) of a given species was defined by the same authors as the period within which peak numbers were recorded in at least two years of the all period of study. In this way, the occasional dates with peak numbers are excluded.

Migration assessment

The assessment of the migration was done firstly as

Table 1. Classification of ten selected soaring migrants according their flight type and migration behaviour at the Burgas Bay Observation Point. Abbreviations: SF – Site for flapping flight, SG - Site for gliding flight, SR - Site for soaring flight, SO - Site for overnighting, SoS - Stop over Site (for details see the text of the paper)

Species	SF	SG	SR	SO	SoS
Pelecanus onocrotalus	Occasionally	+	+	+	+
Ciconia ciconia	Occasionally	+	+	+	+
Ciconia nigra	Occasionally	+	+		
Accipiter brevipes	+	+	+		
Circaetus gallicus	+	+	+		
Circus aeruginosus	+	+	+	+	+
Buteo buteo	+	+	+		
Clanga pomarina	Occasionally	+	+		
Aquila pennata		+	+		
Falco vespertinus	+	+			

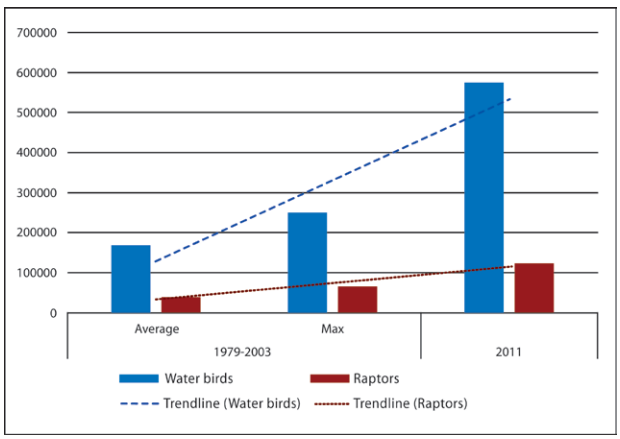

Fig. 2. Comparison of the mean and maximum numbers of water birds and raptors during 1979-2003 and their numbers in 2011.

comparison between the data for 1979-2003 and for 2011, when we registered 26 species of soaring migrants with 573,556 ind., among them 450,023 water birds and 123,533 raptors. The total numbers of both groups of soaring birds were almost twice higher than their maximum numbers recorded in 1979-2003 (Fig. 2). The numbers of migrating water birds and raptors observed in 2011 were compared with the mean numbers of the same species of water birds and raptors observed in the period 1979-2003 using Wilcoxon's rank-sum test. The numbers of migrating raptors in 2011 were significantly higher ($p=0.0078$) than their mean numbers in 1979-2003. The same was true for the water bird species ($p=0.049$).

The results of the performed year-to-year comparison of the 2011 counts with the numbers of soaring bird species for every year of the period 1979-2003 showed that almost all years of the last period had significantly lower numbers of the same migrating species of raptors and water birds as compared to their numbers in 2011. This is especially valid for the seven years between 1982 and 1988, and also for the eight years between 1996 and 2003 ($0.01>p>0.00005$). These findings indicate characteristic patterns in the time-series data in the 1979-2003 period. Using the technique of Rodionov (2004), we found a significant shift of the means towards increase in the average values of the total numbers of both raptors and water birds. The shift in the total numbers of migrating individuals started in 1999 for water birds and in 1989 for the raptors. The results of the further analyses of the above presented migrants at the OP Burgas Bay, including the other available data on ten selected species are presented in Fig. 4 and discussed below in taxonomic order.

Great white pelican (*Pelecanus onocrotalus*)

The European breeding population is estimated at 4900-5600 pairs with a trend to increase (BirdLife International 2017). The species is known as a long-distance and partial migrant on narrow front. In the Western Palaearctic it is a long-distance migrant in narrow front from Eastern Europe to Eastern and South Africa, where also numerous breeding colonies exist (Crivelli et al. 1991, Bowker et al. 2010). The first more important sandglass site along the migration route of the species after the Danube River Delta is the wetland complex of the Burgas Bay, surrounded by 9000 ha lakes, salterns, marshes and river mouths. The flight type and migration behaviour of the great white pelican is shown on Table 1. Its migration along the Black Sea coast has been studied well, including studies with radars (Michev et al. 1987). During the 1979-2003 surveys, the average autumn number was 20,946 ind. with maximum 37,703 ind. (Michev et al. 2011). In the autumn of 2011 the total number was estimated to be 61,705 ind. and exceeded twice the maximum count of the previous period. The birds migrating *via* the Burgas Bay originate from a flyshed, which includes the most north-western part of its breeding range – the Danube

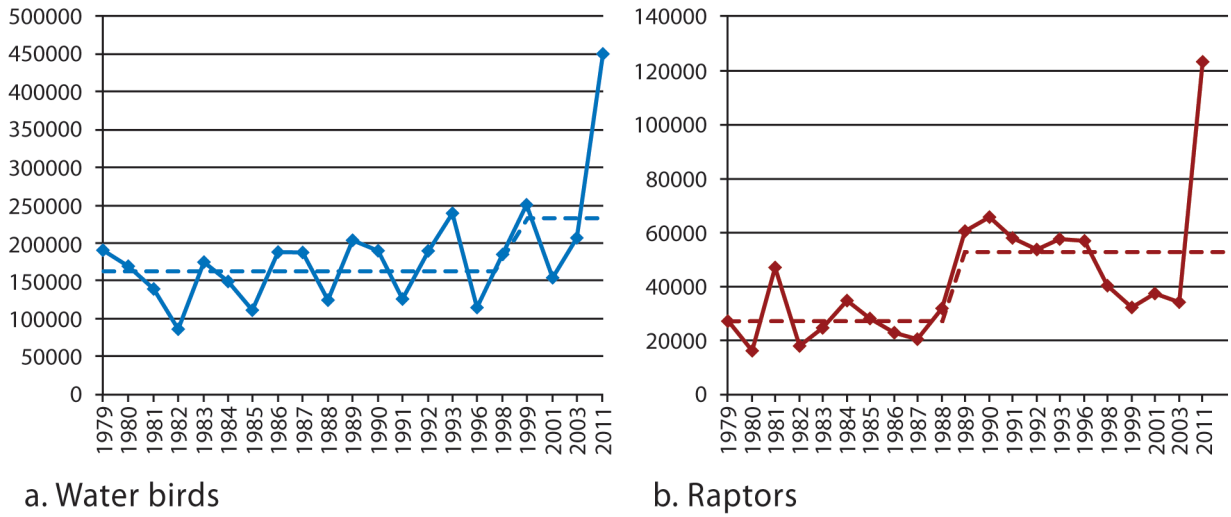

Fig. 3. Comparison of the mean and maximum numbers of water birds and raptors during 1979-2003 and their numbers in 2011.

Table 2. Numbers of the eight selected soaring migrants during the second half of September 2004-2017

Year	*Ciconia nigra*	*Circaetus gallicus*	*Circus aeruginosus*	*Accipiter brevipes*	*Buteo buteo*	*Clanga pomarina*	*Aquila pennata*	*Falco vespertinus*
2004	557	126	191	91	1041	5481	60	102
2006	1729	184	318	204	524	9886	90	69
2007	3914	281	1077	5	5039	17002	59	1510
2008	4627	196	799	776	5902	24153	157	1166
2009	2885	221	449	39	6662	12679	65	4575
2011	1998	204	476	255	4866	6867	134	1051
2012		359	492	45	5783	16326	49	1137
2013		211	627	83	3628	33736	128	1458
2014	3781	411	942	347	2098	46013	197	741
2015	6293	650	1479	463	9759	27386	466	8683
2016	4523	540	714	685	6850	28665	242	1909
2017	5077	383	1468	208	7380	22104	296	15895

River Delta, North Black Sea and Azov Sea coast with all adjacent wetlands like river deltas, mouths, limans, marshes, lakes, etc. In this flyshed, the number of migrating great white pelicans was estimated at ca. 5,000 pairs (Catsadorakis et al. 2015) or 15,000 ind. (10,000 ad. and 5,000 juv. birds at breeding success about 1 juv./pair). The abovementioned impressive difference from 2011 data could not be explained only by the presence of huge number of non-breeding adult and immature birds during the summer in the Danube River Delta or by inaccurate counts at the breeding colonies, or by the both. High autumn migration counts in Israel (40,000-80,000 ind.) were reported by Hatzofe (2014). The origin of the summering non-breeding adult and immature great white pelicans in the Danube River Delta could be clarified after mounting satellite transmitters on them (Kiss & Nichersu 2002). By that time, we have to accept the hypothesis of Kiss (1992) and Michev et al. (2011) about the African origin of some non-breeding adult and immature GWP in the Danube River Delta. The possibility for inaccurate counts of the largest great white pelicans breeding colony of Hrecisca-Buhaiova at the Danube River Delta seemed unlikely until the publication of Marinov et al. (2016), who counted ca.17,000 pairs (15,000-19,000). These data corresponded rather well with our figures for the autumn migrants of the species over Burgas but were in contradiction with the assessment of BirdLife International (2017) for only 4,900-5,600 breeding pairs in Europe. Based on the data for the period 1979-2003 (Michev et al. 2011), we could assume that the increase of the great white pelican autumn migrants at Burgas and of the breeding pairs in the Danube River Delta, respectively, has started after 1985 (Fig. 4a). Our data for 2011 (present study) and later data of Marinov et al. (2016) has allowed outlining a clear trend of in-

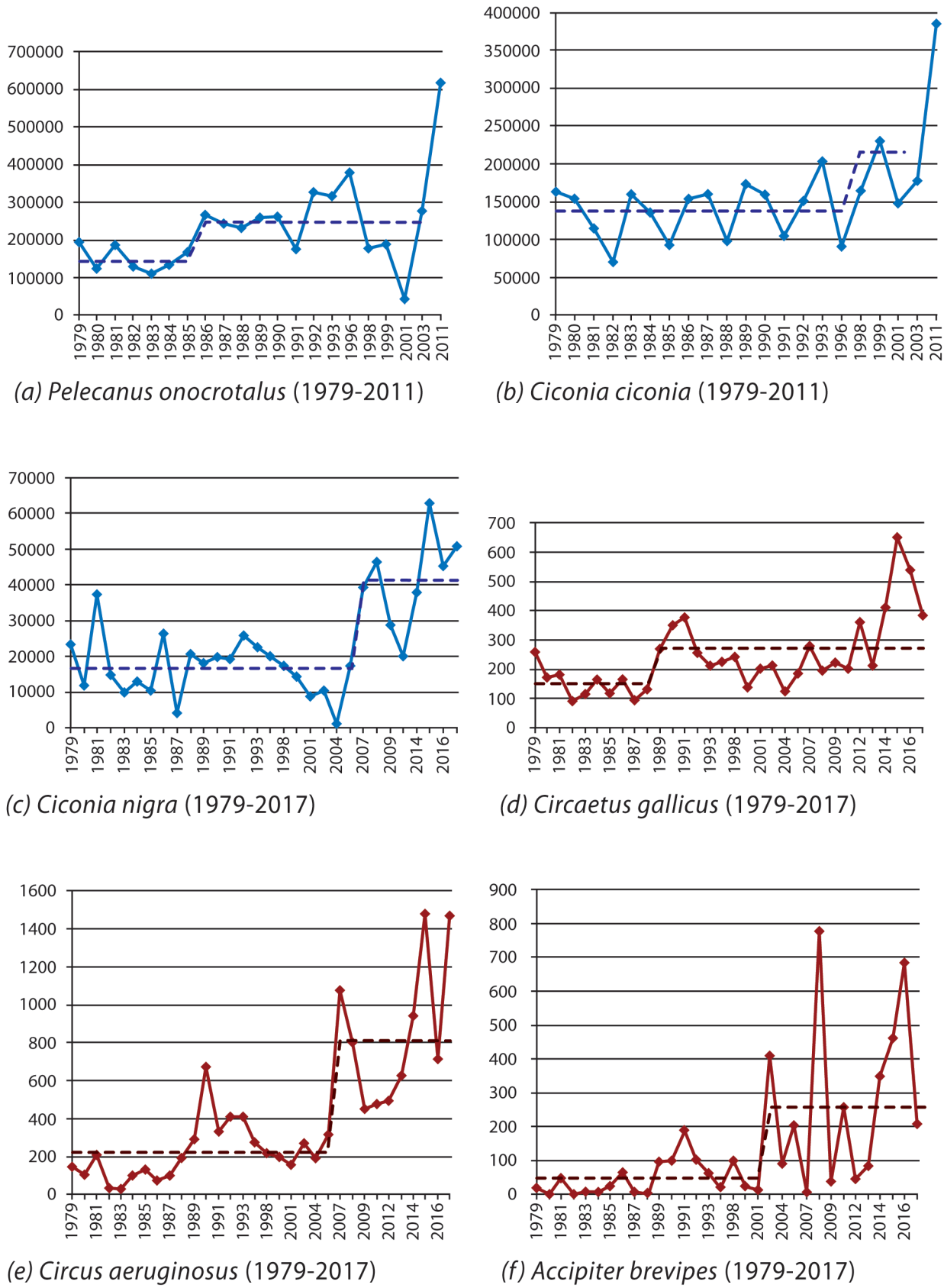

Fig. 4. Significant shifts ($p<0.1$) in the means of the numbers of selected migrating soaring birds in time series data sets at the Burgas Bay during the second half of September 1979-2017: (a) *Pelecanus onocrotalus,* (b), *Ciconia ciconia*, (c) *Ciconia nigra,* (d) *Circaetus gallicus,* (e) *Circus aeruginosus,* (f) *Accipiter brevipes*.

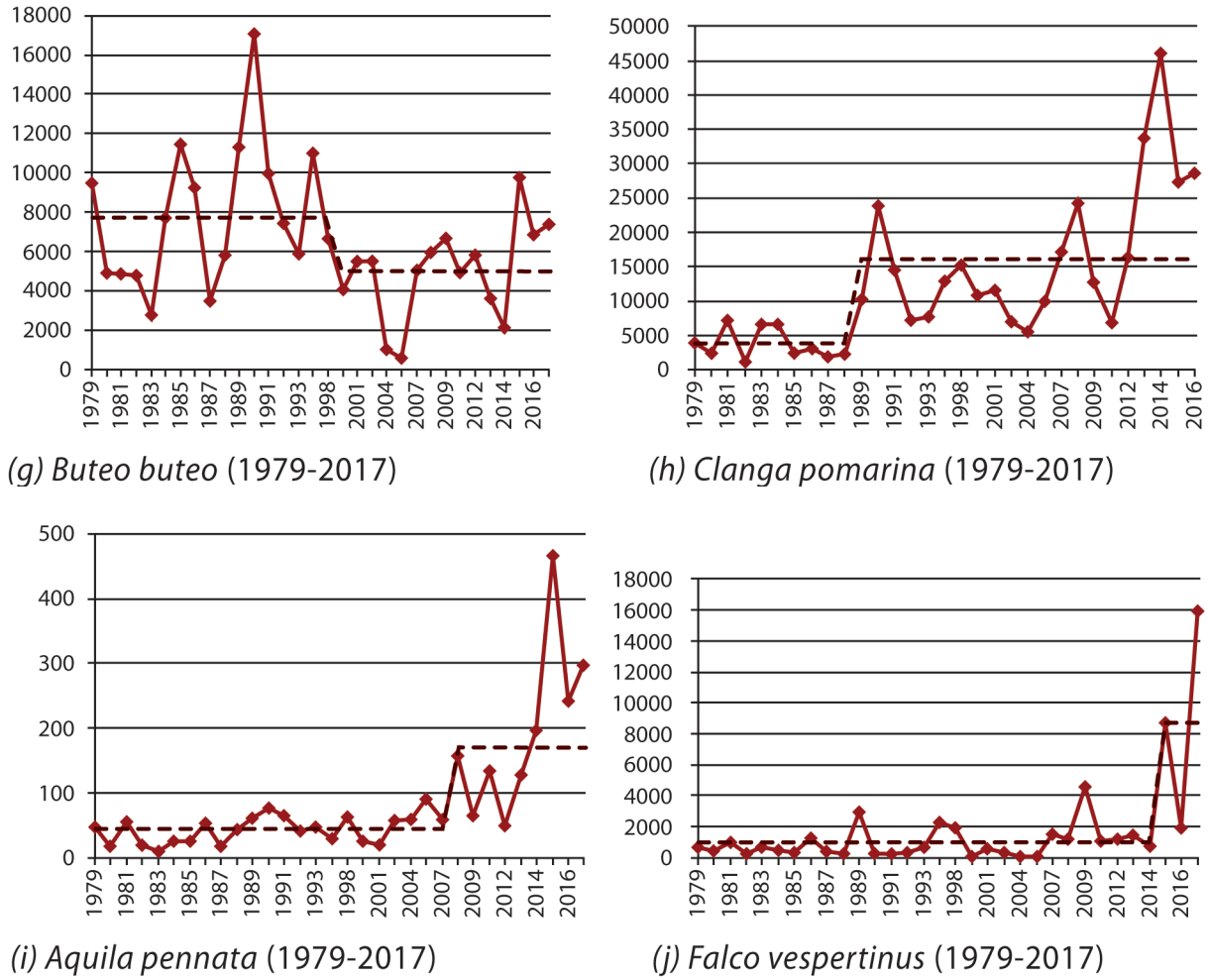

Fig. 4. Continued: (g) *Buteo buteo,* (h) *Clanga pomarina*, (i) *Aquila pennata,* (j) *Falco vespertinus*.

crease of the species migrating numbers since 1979-2003. This trend concerns the breeding population of the flyshed of the Burgas Bay OP, which covers the Danube River Delta and Ukraine. The international counts on 6th May 2017 have recorded 37,334 ind. which represents a 63% increase for the species due predominately to the Danube breeding population (Wetlands International 2017). These data are in an agreement with our findings of the increase and size of species population in the recent years. All collected data prove that the Burgas Bay is the place with the highest and increasing autumn migration numbers of the great white pelican in Europe.

White stork (*Ciconia ciconia*) – Eastern breeding population

The European breeding population is estimated at 224,000-247,000 pairs with a trend to increase (BirdLife International 2017). The Central and Eastern European /Sub-Saharan African population is 177,340–194,428 pairs or 354,680-388,856 mature ind. (BirdLife International 2015). The species is known as a long-distance migrant on a narrow front. The flight type and migration behaviour of this species in Atanasovsko Ezero and its surroundings are shown on Table 1. The flyshed of the white storks, passing through Gibraltar covers the territory of Western Europe (western breeding population), while birds from the remaining part of Europe (eastern breeding population) cover the flyshed of white storks passing via Burgas, the Bosporus, Israel, etc. (Van den Bossche 2002).

Similarly to the previous period (Michev et al. 2011), during the autumn of 2011, the white stork was the most numerous soaring bird migrant at the Burgas Bay OP. Its flight type and migration behaviour in Atanasovsko Ezero and its surroundings are shown on Table 1. The total numbers in 2011 (384,134 ind.) were significantly higher than the maximum numbers (229,444 ind.) during the period 1979-2003. The peak day in 2011 – 1st September - was in the scope of peak dates, established for 1979–2003 (21st August – 1st September).

The white storks, passing through Burgas, originate from the flyshed, which is relatively large and includes parts of Eastern Germany, Poland,

Hungary, Slovakia, the Czech Republic, Estonia, Latvia, Lithuania, Western Russia, Belarus, Ukraine, Moldova, Eastern Romania and North-Eastern Bulgaria. In some of the abovementioned countries there is a marked breeding numbers' increase (Samusenko 2014, Vaitkuvienė & Dagys 2014). According to BirdLife International (2015), the total breeding population of the white stork in these countries is ca. 215,270–223,586 mature individuals. With the young birds (ca. 2,3 juv./pair) this number is reaching about 463,000–481,000 ind. The same is the expected white storks' number at the Burgas sandglass site, but in fact it is about 20% lower. The explanation lies in the radar observations of Michev et al. (1987, 2011) which have showed that some flocks are crossing the Burgas Bay without being registered. The abovementioned data show also that, at present, the Burgas Bay OP, with its shape and pattern, is not suitable for following the exact quantitative changes of white stork's breeding population. Krumenacker (2012) comes to similar conclusions about the idea to use the data about soaring bird migration from Eilat sandglass site for establishing changes of their breeding populations. Based on the collected data it is possible to conclude that in the period after 2001 the white stork showed no significant shifts in the numbers, although a trend for some increase was observed with fluctuations in the numbers approximately every three years between 1979 and 2001, with very high numbers registered in 2011 (Fig. 4b). This finding was valid for the breeding population in the above described flyshed of the Burgas Bay OP and coincided with the trend for all of Europe reported by BirdLife International (2017).

Black stork (*Ciconia nigra*)

The European breeding population is estimated at 9,800-13,900 pairs with a trend to increase (BirdLife International 2017). The species is known as a long-distance migrant on a narrow front. Its flight type and migration behaviour at Atanasovsko Ezero and its surroundings are shown in Table 1. In the second half of September, the mean number in 1979-2003 was 1,739 ind., in 2011 – 1,998 ind. and in 2012-2017 the totals varied between 3,781 and 6,293 ind. In 2017 the peak numbers were much higher and the peak day was later than those in the second half of the period 1979-2003 (Table 3). These data and the mean shift analysis proved the trend for increase since 2007 (Fig. 4c). This trend is valid for the species flyshed of Burgas Bay OP, which probably covers the eastern part of its breeding range in Europe. The autumn migration numbers for the Bosporus were estimated by Fülöp et al. (2014) at 16,088 ind. between 22nd September and 10th October 2008. For comparison, the total numbers between 10th August and 31st October 2011 at the Burgas Bay were 3,487 ind.

Short-toed snake eagle (*Circaetus gallicus*)

The European breeding population is estimated at 17.600-20,900 pairs with a trend of increase (BirdLife International 2017). The species is known as a long-distance migrant on a narrow front. Its flight type and migration behaviour of this species at Atanasovsko Ezero and its surroundings are shown in Table 1. In the second half of September, the mean number in 1976 was 136 ind., in 1979-2003 -199 ind., in 2011 – 204 ind. and in 2012-2017 the totals varied between 211 and 650 ind. In 2017 the peak numbers were higher and the peak day was earlier than those in the second half of the period 1979-2003 (Table 3). These data and the mean shift analysis proved the trend for increase since 2013 (Fig. 4c) with significant increases (shifts) in the mean numbers of 1987-1993 and 2013-2017 (Fig. 4d). These trends are valid for the species' flyshed of the Burgas Bay OP, which covers the breeding range in the eastern part of Europe. The autumn migration numbers for the Bosporus were estimated by Fülöp et al. (2014) as 4,242 ind. between 22nd September – 10th October 2008. For comparison, the total numbers between 10th August and 31st October 2011 at the Burgas Bay were 315 ind.

Marsh harrier (*Circus aeruginosus*)

The European breeding population is estimated at 99,300-184,000 pairs with a recent trend of increase (BirdLife International 2017). The species is known as a partially migrant on a broad front. Its flight type and migration behaviour at Atanasovsko Ezero and its surroundings are shown in Table 1. In the second half of September, the mean number in 1979-2003 was 218 ind., in 2011 – 476 ind. and in 2012-2017 the totals varied between 492 and 1,479 ind.

In 2017 the peak numbers were higher and the peak day was earlier than those in the second half of the period 1979-2003 (Table 3). These indicated two periods of significant increases (shifts) in the mean numbers: 1989-1994 and 2011-2017 (Fig. 4e). The findings are valid for the species' flyshed of the Burgas Bay OP, which covers the breeding range in the eastern part of Europe. The autumn migration numbers for the Bosporus have been estimated by Fülöp et al. (2014) at 49 ind. between 22nd September and 10th October 2008. For comparison, the total number between 10th August and 31st October 2011 at the Burgas Bay was estimated at 1435 ind.

Levant sparrowhawk (*Accipiter brevipes*)

The European breeding population is estimated at 3,500-6,900 pairs with an unknown trend (BirdLife

Table 3. Comparison between three periods in the second half of September 1979-2003 (Michev et al. 2011), 2011 (present study) and 2017 (Trektellen Data Base and Boele et al. (in litt.)

Date/ Species	Year	September					
		Totals 15th-30th September	Totals Change	Seasonal Peak	Peak Number	% from Total 15-30.09	Peak Move
Ciconia nigra	1979-2003	1739	To increase	25 Sep	215	12,4	To later dates
	2011	1998		22 Sep	799	40,0	
	2017	5077		27 Sep	1723	33,9	
Circaetus gallicus	1979-2003	199	To increase	2 Oct	26	13,1	To earlier dates
	2011	204		22 Sep	60	29,4	
	2017	383		21 Sep	60	15,7	
Circus aerugi nosus	1979-2003	218	To increase	16, 18 Sep	21	9,6	To earlier dates
	2011	476		16 Sep	186	39,1	
	2017	1468		18 Sep	663	45,2	
Accipiter brevipes	1979-2003	64	To increase	17 Sep	16	24,8	To later dates
	2011	255		24 Sep	110	43,1	
	2017	208		24 Sep	80	38,5	
Buteo buteo	1979-2003	7419	Fluctuate	2 Oct	1669	22,5	To earlier dates
	2011	4866		30 Sep	1346	27,7	
	2017	7380		27 Sep	2801	38,0	
Clanga pomarina	1979-2003	7952	To increase	24 Sep	1272	16,0	To later dates
	2011	6867		23 Sep	4108	59,8	
	2017	22104		29 Sep	7097	32,1	
Aquila pennata	1979-2003	40	To increase	18 Sep	5	12,5	To later dates
	2011	134		17 Sep	26	19,4	
	2017	296		21 Sep	50	16,9	
Falco vesperti nus	1979-2003	764	To increase	28 Sep	111	14,5	Fluctuate
	2011	1051		24 Sep	270	25,7	
	2017	15895		27 Sep	10517	66,2	

International 2017). The species is a long-distance migrant on a broad front. Its flight type and migration behaviour at Atanasovsko Ezero and its surroundings are shown in Table 1. In the second half of September, the mean number in 1979-2003 was 64 ind., in 2011 – 255 ind. and in 2012-2017 the totals varied between 45 and 685 ind. In 2017 the peak numbers were higher and the peak day was earlier than those in the second half of the period 1979-2003 (Table 3). This showed a long-term trend for increase in numbers with significant shift after 2003 (Fig. 4f). This trend is valid for the migrating population at the Burgas Bay OP and, hence, to the breeding population of its flyshed, which covers the species breeding range north and north-east of the Burgas OP. The autumn migration numbers for the Bosporus were estimated by Fülöp et al. (2014) at 2,455 ind. between 22nd September and 10th October 2008. For comparison, the total number between 10th August and 31st October 2011 at the Burgas Bay was 310 ind.

Common buzzard (*Buteo buteo*)

The European breeding population is estimated at 814,000-1,390,000 pairs, which equates to 1,630,000-2,770,000 mature ind. (BirdLife International 2016). The species is known as long-distance migrant (predominately subspecies *vulpinus*) and short-distance migrant on a wide front, only partly wintering in Bulgaria (subspecies *buteo*). Its flight type and migration behaviour at Atanasovsko Ezero and its surroundings are shown in Table 1. In the second half of September, the mean number in 1976 was 2,464 ind., in 1979-2003 -average 7,419 ind., in 2011 – 1,998 ind. and in 2012-2017 the totals varied between 2,098 and 9,759 ind.

During the 1979-2003 surveys, the subspecies *vulpinus* was the most numerous migrant among the raptors at the Burgas Bay OP. Annual totals varied from 7,963 to 31,746 ind., with a mean of 17,739 (Michev et al. 2011). In the autumn of 2011 it continued to be the most numerous migrant among the soaring raptors. However, in 2011, the total number

of migrating birds of the species (99,048) exceeded three times the maximum number for 1979-2003. A unique eruption of migration number (registered for the first time at the Burgas Bay OP) included 40,706 ind. that passed within a single day (19th October), which was the peak day in the autumn migration of the species during 2011. A similar eruption of common buzzards' migration number was registered at Borcka, where 135,000 birds were counted on 28th September 1976 (Gensbol 2008). During the second half of September 2012-2017 totals varied between 2,098 and 9,759 ind. with mean 5,916 ind., while during the same period of 1979-2003 the mean was 7,952 ind. In 2017 the peak number was 7,380 and the peak day was earlier than those of the period 1979-2003 (Table 3). All these data do not lead to certain conclusions, but on the base of Fig. 4g one could assume a trend to decrease. Actually, the main migration period for the species continues in October and migration dynamic remains unclear.

The autumn migration numbers for the Bosporus were estimated by Fülöp et al. (2014) at 74,055 ind. between 22nd September and 10th October 2008. For comparison, the total number between 10th August and 31st October 2011 at the Burgas Bay was 99,048 ind.

Lesser spotted eagle (*Clanga pomarina*)

The breeding population in Europe is estimated to be 16,400-22,100 breeding pairs with a stable trend (BirdLife International 2017). The species is known as a long-distance migrant on a narrow front. Its flight type and migration behaviour at Atanasovsko Ezero and its surroundings are shown on Table 1. In the second half of September, the number in 1976 was 2,856 ind., in 1979-2003 -average 7,952 ind., in 2011 – 6,867 ind. and in 2012-2017 the totals varied between 16,326 and 46,013 ind. In 2017 the peak number was higher and the peak day was later than those in the second half of the period 1979-2003 (Table 3). This indicated a long-term trend for increase in numbers with significant shift after 2003 (Fig. 4h). The registered trend is valid for the species' flyshed of the Burgas Bay OP, which covers almost all breeding range. The autumn migration numbers for the Bosporus were estimated by Fülöp et al. (2014) at 58,327 ind. between 22nd September and 10th October 2008. For comparison, the total number between 10th August and 31st October 2011 at the Burgas Bay was 7,342 ind.

Booted eagle (*Aquila pennata*)

The European breeding population is estimated to be between 23,100 and 29,100 pairs with a fluctuating trend (BirdLife International 2017). However, according to Gensbol (2008) it is much less, 4,400-5,200 pairs, concentrated mostly in Russia and Spain. The species is known as a long-distance migrant on a narrow front. Its flight type and migration behaviour at Atanasovsko Ezero and its surroundings are shown on Table 1. In the second half of September, the mean number in 1976 was 21 ind., in 1979-2003 -40 ind., in 2011 – 134 ind. and in 2012-2017 the totals varied between 49 and 466 ind. In 2017 the peak number was higher and the peak day was later than those in the second half of the period 1979-2003 (Table 3). These data showed a certain trend of increase in number of migrants, significant especially after 2012 (Fig. 4i). The registered trend is valid for the species' flyshed of the Burgas Bay OP, which covers the Eastern European part of the breeding range. The autumn migration numbers for the Bosporus were estimated by Fülöp et al. (2014) as 192 ind. between 22nd September and 10th October 2008. For comparison, the total numbers between 10th August and 31st October 2011 at the Burgas Bay were 202 ind.

Red-footed falcon (*Falco vespertinus*)

The breeding population in Europe is estimated to be 23,000-55,000 pairs with 90% in Russia and Ukraine (Gensbol 2008). The assessment of BirdLife International (2017) is higher – between 30,300 and 63,400 pairs with a trend of decrease. The species is known as a long-distance migrant on a narrow front. Its flight type and migration behaviour at Atanasovsko Ezero and its surroundings are shown in Table 1. In the second half of September, the number in 1976 was 52 ind., in 1979-2003 -average 764 ind., in 2011 – 1051 ind. and in 2012-2017 the totals varied between 741 and 15,895 ind. (16,746 ind. reported for 2017 by Boele et al., in litt.). In 2017 the peak number was higher (10517 ind. on 27th September) and the peak day was later than those in the second half of the period 1979-2003 (Table 3). Our analyses of the available data showed that there was a significant increase during the 2014-2017 period (Fig. 4j). The data of Laursen et al. (2016) and Arjan Boele et al. (in litt.) confirm the statement of Michev et al. (2011) and Forsman (2016) that the Burgas Bay is the place with the highest autumn migration numbers of the red-footed falcon in Europe. The autumn migration numbers for the Bosporus estimated by Fülöp et al. (2014) between 22nd September and 10th October 2008 were 105 ind. For comparison, the total numbers between 10th August and 31st October 2011 at the Burgas Bay were 1,225 ind.

Discussion

After a seven-year interruption in our migration counts following our first long-term survey (1979-2003), an assessment of the number of migrating soaring birds was carried out again in 2011. A num-

ber of species with unusually high numbers were registered. This finding stimulated us to analyse our data and all other available data. The main conclusion was that there were clear patterns of long-term changes in the number of migrating soaring bird species at the Burgas Bay OP. Concerning the total numbers of water birds and raptors, they displayed clear and statistically significant shifts in the mean numbers within the period 1979-2003. For water birds, the increase in the numbers of migrating individuals started in 1999 and remained higher until the end of the period, while for the raptors the shift seemed to have started since 1989 with a separate unprecedented peak in the numbers of most species in 2011. To confirm these findings an analysis of the available data for the period 2011-2017 was carried out. Similar long-term changes (compared to 1979-2003) were established for ten selected migrating species, as follows: 1) long-term certain increase – for the great white pelican (*Pelecanus onocrotalus*), white stork *Ciconia ciconia*), black stork (*Ciconia nigra*), short-toed eagle (*Circaetus gallicus*), marsh harrier (*Circus aeruginosus*), levant sparrowhawk (*Accipiter brevipes),* lesser spotted eagle (*Clanga pomarina*), booted eagle (*Aquila pennata*), red-footed falcon (*Falco vespertinus*); 2) long-term decrease with some fluctuations – *Buteo buteo.* Actually, the main migration period for the species continues in October and migration dynamic remains unclear. The maximum numbers of all selected species were registered during 2011-2017.

The total numbers of both soaring water birds and raptors counted in 2011 were significantly higher compared to the maximum for 1979-2003. For the water birds, the increase started in 1999 and in 2011 it marked a twofold increase. For the raptors, the increase seemed to have started since 1989. Within the collated data series for all migrating soaring species in the period 1979-2017, the following unusual daily eruptions in the numbers of bird species were registered: common crane (5th October 1979 – 3,453 ind.; mean peak number 183 ind.) and honey buzzard (4th September 1996 – 8,779; mean peak number 739, Michev et al. 2011), common buzzard (19th October 2011 – 40,706, present study; mean peak 19,256 for 1979-2003), lesser spotted eagle (21st September 2014 – 27,740, Laursen 2016; mean peak 1,669 for 1979-2003), red-footed falcon (27th September 2017 – 17,648, Arjan Boele et al., in litt.; mean peak 111 for 1979-2003).

The results and phenomena reported in this study cannot be easily explained. Among the possible explanations could be the presence of variation in the counts either due to unusual meteorological conditions (strong wind, rain, mist, etc.) or to shifts of some of the migration routes. On the other hand, our findings could also indicate some significant increases in the numbers of certain species in parts of their breeding areas. However, it is also possible that a much higher migrating number has always been present, but only unusual conditions in a given year have allowed observers to register them. The reported eruptions in the number of some species give us a reason to hypothesise that the magnitude of migration through this sandglass site could have been much higher than the observed one. All these possibilities need further research and confirmation.

Concerning the present shape and pattern of observation (one observation point without radar for birds), it is not possible to cover all migration paths and roads at the Burgas Bay and to follow exactly the quantitative changes of breeding populations of migrating soaring birds in their breeding ranges. To do so, a chain of minimum five OPs together with specialised radar for birds are needed. The chain should include also at least one OP for offshore observations on a boat, or on the Black Sea islet Sveta Anastasiya. Despite this need of further research with application of more modern methods, we would like to stress that yet the visual observations of soaring bird migration at the Burgas Bay give valuable data and also reveal great possibilities for training in flight identification of raptors, as well as for ecological and conservation education. The significant increase of migrant numbers and remarkable growth of the aerial traffic in the last years will enhance also the importance of the visual observations for safeguard against bird collisions.

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