

Colour ringing programme of the lesser spotted eagle (*Aquila pomarina*) population in Slovakia and its new results in the period 2009–2012

Program označovania populácie orla kriľavého (*Aquila pomarina*) farebnými krúžkami na Slovensku a jeho nové výsledky za obdobie rokov 2009–2012

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Abstract: In the years 2009–2012 a total of 316 individuals were marked in a colour ringing programme of the population of *A. pomarina* in Slovakia. From this a total of 39 inds. were ringed with yellow readable plastic rings with a two-place alphanumeric code (all young in a nest) and 277 inds. (273 young and 4 adult inds.) with light-blue rings. For the entire period of the programme of marking the *A. pomarina* population in Slovakia in the years 2000–2012 a total of 952 inds. were ringed, 933 of which were young birds in nest and 19 adult individuals. In the period 2009–2012 48 records were obtained from observations of 35 individuals of different age categories (31 individuals from one to 11 years old, three of unknown age and one young individual about one month after fledging the nest). The age categories of immature individuals were determined, and six were found to be one-year-old individuals (12.5%) in the second calendar year of life after their first return from wintering grounds, six were two-year-old eagles (12.5%) and five were three-year-old eagles (10.4%) which spent breeding periods in Europe at a relatively small distance from their place of hatching. Adult individuals were found to be in their current breeding grounds at distances of 8–249 km from their hatching place. In the period 2000–2012 three individuals were recorded 3× and four individuals 2×. The results confirm breeding site fidelity in adults, but also the fidelity of immature individuals to their hatching place, and the return of one-year-old individuals from their wintering grounds to the vicinity of their hatching place immediately in the first year of life (that is, in the second calendar year).

Abstrakt: V rokoch 2009–2012 sa na Slovensku označilo v programe farebného značenia populácie *A. pomarina* 316 jedincov. Z toho žltými odčítateľnými plastovými krúžkami s dvojmiestnym alfanumerickým kódom spolu 39 jedincov (všetko mláďatá na hniezde) a svetlomodrými krúžkami 277 jedincov (273 mláďat a 4 dospelé jedince). Za celé obdobie programu označovania populácie *A. pomarina* na Slovensku v rokoch 2000–2012 bolo označených 952 jedincov, z toho 933 mláďat na hniezde a 19 dospelých jedincov. V období 2009–2012 sa zistilo 48 záznamov o pozorovaní 35 jedincov rôznych vekových kategórií (31 jedincov jeden až jedenásťročných, tri jedince neznámeho veku a jeden mladý jedinec cca jeden mesiac po vyletení z hniezda). Determinované boli vekové kategórie imaturných jedincov, z ktorých bolo 6 jednoročných jedincov (12,5 %) v druhom kalendárnom roku života, po prvom návrate zo zimoviska, šesť dvojročných orlov (12,5 %) a päť trojročných orlov (10,4 %), ktoré sa zdržiavali v hniezdom období v Európe v relatívne malej vzdialenosti od miesta vyliahnutia. Dospelé jedince boli zastihnuté vo vzdialenosti 8–249 km od miesta svojho vyliahnutia na svojich terajších hniezdiskách. V období rokov 2000–2012 tri jedince boli zaznamenané už 3×, štyri jedince 2×. Výsledky potvrdzujú vernosť k hniezdisku u dospelých, ale aj vernosť imaturných jedincov k miestam ich vyliahnutia a návrat jednoročných jedincov zo zimoviska do blízkosti miest ich vyliahnutia hneď v prvom roku svojho života (teda v druhom kalendárnom roku).

Key words: colour rings, recovery rate, resighting rate, nest site fidelity, age categories, occurrence of immature individuals

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Introduction

In research on the biology of birds the permanent marking of individuals is in many cases essential. In birds of prey a wide scale of different technologies are used for marking birds (Varland et al. 2007). The most widespread method of marking individual birds is the use of ornithological rings. In addition, methods which are simpler and financially less demanding are used, such as wing tags, the decolouration of feathers and the clipping of windows in wings, in comparison with technologically and financially more demanding and sophisticated methods, such as data loggers and terrestrial and satellite telemetry. In Slovakia research on the *A. pomarina* population has been carried out for a long time. The results from marking with ornithological rings have been published regularly since 1975 in the reports of the Group for the Research and Protection of Birds of Prey and Owls in Slovakia (SVODAS) and in reports of the working group for the lesser spotted eagle of the Raptor Protection of Slovakia (RPS). Summary knowledge from ringing has been processed in “The Czech and Slovak Bird Migration Atlas” (Danko 2008) and supplemented with newer data (Danko et al. 2008). From the methods of marking *A. pomarina* individuals in the territory of Slovakia, wing tags (Danko 1989, 1992, Danko et al. 1996), clipping windows in wings (Danko 1989, Danko et al. 1996, Dravecký et al. 2008a), and terrestrial and satellite telemetry (Danko et al. 1996, Meyburg et al. 1993, 1995, 2000, 2004, 2005, Meyburg & Meyburg 2002, 2007, 2008) have all been used, and since 2000 coloured plastic readable rings have also been used (Maderič 2000, Dravecký et al. 2006, 2008a, b).

The method of marking birds with traditional ornithological rings has a great disadvantage in that if we want to obtain feedback data on the marked individuals, they must for the most part be captured again or otherwise gotten into the hands in order to get the infor-

mation by reading the text on the ring. For a longer time data was acquired particularly by shooting, discovery of dead, injured or ill individuals, or by later catching them in nets. As a result, birds in more recent times, in addition to ornithological rings, began being marked with coloured readable plastic rings with alphanumeric codes. At present the existence of top-notch optical technology, which strongly increases the powerful telescopes and telephoto lenses with digital cameras, creates favourable circumstances for reading rings or photographing rings and subsequently reading them from digital photographs directly in the camera or on a personal computer. Thus it is possible to obtain valuable data on the biology of birds, namely from living marked individuals without the need for repeated capture of the same individual.

The aim of this work was to use a method of marking individuals of *A. pomarina* using colour readable plastic rings in Slovakia (1) to identify individuals precisely in the field, (2) to determine and confirm individually-segmented age categories of the marked individuals, (3) to obtain data of the immature individuals movement in relation to the place of hatching, and (4) to determine the nest fidelity of adult individuals to their place of hatching. The exact identification of individuals further allows simple and precise determination of the age of the individuals, the state of the plumage of different age categories, longevity, the formation of breeding pairs, the fidelity of marked individuals in breeding pairs to nest sites or other points of interest from the biology of this species.

Material and methods

This article with results of colour marking of the *A. pomarina* population in Slovakia in the years 2009–2012 refers to published data from the years 2000–2008 (Dravecký et al. 2008a). In Slovakia the marking of the *A. pomarina* population with coloured readable plastic

rings (hereafter in the text only “coloured rings”) began in the year 2000 with the yellow series with a two-place alphanumeric code black in colour (Maderič 2000). From 2008 marking continued with the light-blue series with a two-place alphanumeric code black in colour (Dravecký et al. 2008a, b). This type of ring was used in Slovakia in the period 2009–2012. Similarly, in Europe from the year 2000 *A. pomarina*, and to a lesser extent also *A. clanga*, began being marked in Poland and Germany with coloured rings, and from 2007, within the SECR programme, also in Estonia, Lithuania, Latvia, Poland and Belarus (Dravecký et al. 2008b). Romania, Russian and Ukraine later joined the programme.

Maderič (2000) introduced the method of using yellow rings in Slovakia and Dravecký et al. (2008b) the light-blue rings within the SECR programme in Slovakia.

During the period of the programme of marking the population with coloured rings in Slovakia (2000–2012) 952 individuals were marked, 933 of which were young birds in nest and 19 were adults. Overall, for the period 2000–2010, 670 individuals were marked with yellow rings in Slovakia, 655 of which were pull. and 15 were adult individuals (Tab. 1a). In the years 2008–2012, 282 individuals were marked with light-blue rings, 278 of which were pull. and four were adult individuals (Tab. 1b). Aside from two young birds, all individuals

Tab. 1a. Overview of *A. pomarina* marked with **yellow** rings in Slovakia in the years 2000–2010

Tab. 1a. Prehľad označených *A. pomarina* **žltými** krúžkami na Slovensku v rokoch 2000–2010

¹ Dravecký et al. (2008a, b)

years, age / roky, vek	2000–2008 ¹			2009		2010		2000–2010		
ringer / krúžkovateľ	pull.	ad.	Σ	pull.	ad.	pull.	ad.	pull.	ad.	Σ
M Dravecký	149	0	149	19	0	0	0	168	0	168
D Karaska	101	0	101	9	0	1	0	111	0	111
B Maderič	94	0	94	0	0	0	0	94	0	94
J Kicko	61	0	61	1	0	0	0	62	0	62
K Šotnár	56	0	56	0	0	0	0	56	0	56
Š Danko	39	5	44	0	0	0	0	39	5	44
T Bělka	35	4	39	0	0	0	0	35	4	39
J Mihók	37	0	37	0	0	0	0	37	0	37
M Macek	8	0	8	9	0	0	0	17	0	17
P Vrlík	15	1	16	0	0	0	0	15	1	16
J Vrána	14	2	16	0	0	0	0	14	2	16
L Boháčik	7	0	7	0	0	0	0	7	0	7
O Šreibr	0	3	3	0	0	0	0	0	3	3
Σ	616	15	631	38	0	1	0	655	15	670

Tab. 1b. Overview of *A. pomarina* marked with **light-blue** rings in Slovakia in the years 2008–2012

Tab. 1b. Prehľad označených *A. pomarina* **svetlomodrými** krúžkami na Slovensku v rokoch 2008–2012

¹ Dravecký et al. (2008a, b)

years, age / roky, vek	2008 ¹			2009		2010		2011		2012		2008–2012		
ringer / krúžkovateľ	pull.	ad.	total	pull.	ad.	pull.	ad.	pull.	ad.	pull.	ad.	pull.	ad.	Σ
B Maderič	0	0	0	12	0	13	0	13	0	14	0	52	0	52
J Kicko	0	0	0	0	0	17	0	14	0	18	0	49	0	49
J Mihók	0	0	0	18	0	7	0	9	0	13	0	47	0	47
D Karaska	0	0	0	15	0	1	0	11	2	13	0	40	2	42
M Dravecký	5	0	5	0	0	9	0	13	0	14	0	41	0	41
Š Danko	0	0	0	5	0	2	0	4	0	8	0	19	0	19
K Šotnár	0	0	0	5	0	6	0	2	0	1	0	14	0	14
Pa Kaňuch	0	0	0	6	0	0	0	0	0	0	0	6	0	6
M Macek	0	0	0	3	0	0	0	0	1	0	1	3	2	5
O Suchánek	0	0	0	0	0	0	0	3	0	0	0	3	0	3
L Šnír	0	0	0	0	0	1	0	1	0	1	0	3	0	3
J Korňan	0	0	0	0	0	0	0	0	0	1	0	1	0	1
Σ	5	0	5	64	0	56	0	70	3	83	1	278	4	282

were concurrently marked with aluminium ornithological rings. The presented results are inclusive as of December 31, 2012.

In the period 2009–2012 there were 48 observations of 35 individuals of *A. pomarina* (Appendix 1), 33 of which were marked with coloured rings. Of them 30 individuals were marked in Slovakia (18 yellow and 12 light-blue); two individuals were marked with red rings in Poland, and one in Estonia with a white ring. Two individuals had only ornithological rings.

Among the analysed individuals were also nine observations which were acquired before 2009, but some of them were not published (Dravecký et al. 2008a). Observations of eagles without coloured rings in which the number of the ornithological ring managed to be read through use of a powerful telescopes or from a photograph were also included in the results. Four of them did not originally have a coloured ring, and four individuals had lost their coloured ring in the meantime.

For comparing the ratio of feedback reports obtained from classic ornithological aluminium rings (recovery rates) and the ratio of feedback reports read from plastic rings (resighting rates), we used our data from period 2000–2012 for the marking of *A. pomarina* in Slovakia. Included are only individuals that were marked in Slovakia and which upon reading still had the coloured ring. Fig. 14 – resighting rate “A” (individuals recorded several times are counted based on in the first year of sighting); resighting rate “B” – all resightings (repeated sightings are also included).

In Appendix 1 (column 17) for individuals ringed as pull. the time passed from ringing to sighting is also considered to be the age of the given individuals, expressed in years. In individuals which were ringed as adults the approximate age is expressed in years on the basis of the sum of two pieces of data: the age determined upon ringing and the time passed since ringing to the date of finding. The age of these individuals is expressed by the symbol > (older than) in Appendix 1.

Birds in the territory of Slovakia were recorded in the scope of periods of individual years from April 27 to September 12, thus mainly during breeding periods. In terms of months, eagles were sighted 1× in April, 9× in May, 10× in June, 17× in July, 7× in August and 3× in September. Once a long-dead individual was found in November.

Data on the distances of dispersal of *A. pomarina* individuals from their hatching place were explored in detail and summarised through descriptive statistics. Given the unfulfilled prerequisite of normality of the

division of their numbers, measure used was the median. For testing the significance of differences in the dispersal of *A. pomarina* individuals from their hatching place, we used the Mann-Whitney two-sample test, all from the program NCSS 2007 (Hintze 2007).

Results and discussion

Immature individuals and nest site fidelity

From 48 observations of marked lesser spotted eagles (Appendix 1) 35 individuals of different age categories were found (31 individuals one to 11 years, three of unknown age and one young individual about one month after flying from the nest, Fig. 1). Age categories of immature individuals were determined, from which six one-year-old individuals (12.5%) were found in the second calendar year of life after their first return from the wintering grounds, six two-year-old eagles (12.5%) and five three-year-old eagles (10.4%). An individual with light-blue ring number 39 was registered twice – as a two-year-old and as a three-year-old.

From among the one-year-olds, an individual with light-blue ring A2 was observed 8 km from the nest in which it had hatched. In another case a one-year-old eagle from Estonia with white ring EL (Fig. 2) was observed in the breeding period on June 1 in Slovakia 1080.0 km from the nest in which it hatched (Fig. 3). From this it follows that one-year-old eagles can not only remain in the vicinity of their place of hatching but

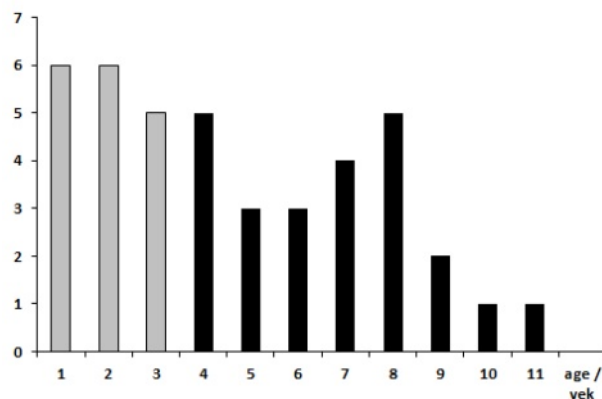


Fig. 1. Identified age categories of immature (grey column) and adult (black column) individuals of *A. pomarina* obtained in the course of this study on the basis of marking with coloured and ornithological rings.

Obr. 1. Determinované vekové kategórie imaturných (sivé stĺpce) a adultných (čierné stĺpce) jedincov *A. pomarina* zistených v priebehu tejto štúdie na základe označenia farebnými a ornitologickými krúžkami.



Fig. 2. One-year-old *A. pomarina* ringed in southern Estonia with white ring EL observed during breeding period in eastern Slovakia 1,080 km from its hatching place. Photo: 1 June 2012, Kucany, eastern Slovakia.

Obr. 2. Jednoročný *A. pomarina* krúžkovaný v južnom Estónsku s bielym krúžkom EL pozorovaný počas hniezdného obdobia na východnom Slovensku 1080 km od miesta vyliahnutia. Foto: 1. jún 2012, Kucany, východné Slovensko.

also be found at a relatively large distance from their nests. Their dispersal range can be considerable. From the mentioned cases (n=6) the median value of the dispersal distance is 122.0 km (Tab. 2).

Of the two-year-old eagles, three were found during the breeding period in the Východoslovenská rovina Lowlands and one in north-eastern Hungary. In the post-breeding period in the second half of August one was observed in southern Poland and in the Východoslovenská rovina Lowlands. Similarly, two individuals coming from this same nest from central Slovakia (light-blue 2C and light-blue 9F) were for one or two years recorded likewise in the Východoslovenská rovina Lowlands. The individual marked with yellow ring CI as a young bird in the nest in 2006 in the Liptovský Mikuláš District in central Slovakia remained as a two-year-old in the summer of 2008 for a long time in the company of a second eagle in Poland, near Nowy Targ, 42 km NE from the place of hatching. The individual marked with light-blue ring 5Z as a young bird in the nest in 2009 in eastern Slovakia was observed as a two-year-old in Hungary near the village of Tedej, 120 km south of the place of hatching. In the category of two-year-old eagles the minimum and maximum distances of dispersal from the place of hatching were 41.5 and



Fig. 3. The occurrence of *A. pomarina* immatures marked abroad and found in eastern Slovakia in 2012, Estonian white EL (one-year-old), Polish red E17 (one-year-old) and A57 (two-year-old). Yellow circle – place of ringing / hatching, blue circle – place of observation.

Obr. 3. Výskyt imaturných *A. pomarina* označených v zahraničí a zastihnutých na východnom Slovensku v roku 2012, estónsky biely EL (jedenoročný), poľské červené E17 (jedenoročný) a A57 (dvojnoročný). Žltý krúžok – miesto krúžkovania / vyliahnutia, modrý krúžok – miesto pozorovania.

Tab. 2. Distances between place of hatching and place of observation of immature individuals of *A. pomarina* in Slovakia

Tab. 2. Vzdialenosti medzi miestom vyliahnutia a miestom pozorovania imaturných jedincov *A. pomarina* na Slovensku

Legend / vysvetlivky: 1 – colour ring / farebný krúžok; 2 – ring colour / farba krúžka, Y – yellow / žltá, LB – light-blue / svetlomodrá, R – red / červená, W – white / biela; 3 – distance (km) / vzdialenosť (km); m – median / medián.

1 year old / 1 ročné			2 years old / 2 ročné			3 years old / 3 ročné		
1	2	3	1	2	3	1	2	3
A2	LB	8.0	CI	Y	41.5	SS	Y	58.0
C8	LB	39.0	39	LB	61.5	14	LB	46.5
8J	LB	62.0	A57	R	98.0	39	LB	41.5
9F	LB	182.0	5Z	LB	120.0	TL	Y	100.0
E17	R	333.0	2M	LB	124.0	PK	Y	4.6
EL	W	1080.0	2C	LB	183.0			
m		122.0			109.0			46.5

183.0 km respectively. The median distance of dispersal of 109.0 km was smaller than for one-year-old eagles (n=6) (Tab. 2).

Of five three-year-old individuals, two remained at or in the vicinity their hatching place in the breeding period, and two individuals remained as non-breeding in the Východoslovenská rovina Lowlands, while one stayed at the beginning of August in eastern Slovakia, in the Hornádska kotlina Basin. The individual marked with light-blue ring 39 in 2009 was observed in the years 2011 and 2012 in different locations in the Východoslovenská rovina Lowlands as a still not nesting individual. The median distance of dispersal for three-year-old individuals (n=5) was the smallest of all three immature age categories, with a min. of 4.6 and a max. of 100.0 km, i.e. a median of 46.5 km (Tab. 2).

The presented results of observations of immature individuals are very interesting because data is lacking regarding this age group of lesser spotted eagles in basic works on the biology of this species (Hudec & Černý 1977, Meyburg 1970, 1973, Danko 1992, Cramp & Simmons 1994, Karaska & Danko 2002). Meyburg et al. (2001, 2005, 2008), Dombrowski (2004) and Dravecký et al. (2008a) present knowledge from a number of newer studies. The question of occurrence, or spending time of one-year-old individuals in their second calendar year of life, was not clear even at the end of the 20th century. Danko (1992) states: “similarly we would like to find the answer to the question of where young birds live in their second calendar year of life, since they do not return to the breeding site, and many other thus far unexplained questions from the life of lesser spotted eagles”.

A similar statement was made by Karaska and Danko (2002), that “sub-adult individuals remain for the most part at wintering sites or on migratory paths; their occurrence in Central Europe in breeding grounds is therefore rare”. Movements of immature eagles mainly one year old ones after first wintering in Africa, were not very well known (Meyburg 1991, 1994, 1996, Meyburg et al. 2001).

Results from the programme of marking lesser spotted eagles with coloured rings from the years 2000–2008 in Slovakia, when immature birds were successfully identified in the age categories from 1–3 years, points to the fact that immature individuals were observed in Central Europe, ultimately even in the vicinity of their own breeding grounds, immediately in the first year of life, that is in the second calendar year after returning from wintering grounds to the expanded breeding area

(Dravecký et al. 2008a). Meyburg et al. (2008) report the first observation of a one-year-old German *A. pomarina* in Germany in July 2005, which was recognized by its colour ring. Meyburg et al. (2008) marked 10 juvenile individuals with satellite transmitters in order to determine the behaviour of one-year-old birds after the first wintering in Africa. Satellite telemetry, which is capable of continuously following the movement of immature individuals over long periods, could help resolve the question of movement and occurrence of immature individuals. For the deduction of general conclusions a larger number of young individuals must be marked in nests, which is, given the financially demanding operations of this method and for the high mortality of juvenile individuals during migration, rather difficult (Meyburg et al. 1995, 2000, 2001, 2008).

On the basis of data presented in Appendix 1 in this study we can state that one-year-old eagles return from their wintering grounds back to Europe and can remain at various distances from their place of hatching.

Occurrence of adult individuals

Of the 48 observations of marked *A. pomarina* 24 were of adult individuals, 15 of which were aged from 4–11 years (Appendix 1, Tab. 3). Six sightings (12.5%) were related to three adult individuals of unknown age. Five sightings were recorded of four-year-old eagles (10.4%), three of five-year-olds (6.25%), three of six-year-olds (6.25%), four of seven-year-olds (8.3%), five of eight-year-olds (10.4%), two of nine-year-olds (4.2%) and one sighting each of ten- and eleven-year-olds (2.1%) (Fig. 1).

The oldest observed individual, with yellow ring 54, was 11 years old. In the period from 2000–2012 three individuals were recorded 3 × (yellow 54 at 8, 10 and 11 years; yellow 21 at 3, 6 and 9 years and yellow RA at 6, 7 and 8 years after marking), four individuals 2 × (yellow YM at 7 and 8 years, yellow 4T at 4 and 5 years, light-blue 39 at 2 and 3 years and yellow HK at one year and two years). One eight years old individual with ornithological ring BL 060 was observed in June 36 km from its place of hatching (Fig. 4).

Achieving sexual maturity in *A. pomarina* is expected in the fourth year of life (Meyburg et al. 2005, Dravecký et al. 2008a). The first known (published) case of the successful breeding of a four-year old female at a distance of 59 km from the place of its hatching was published by Meyburg et al. (2005). The second case was found in Slovakia with an eagle with yellow ring

Tab. 3. Distances between the place of hatching and the place of observation of adult individuals of *A. pomarina* in Slovakia

Tab. 3. Vzdialenosti medzi miestom vyliahnutia a miestom pozorovania adultných jedincov *A. pomarina* na Slovensku
Legend / vysvetlivky: **1** – ring / krúžok; **2** – colour / farba, Y – yellow / žltá; **3** – distance from place of hatching (km) / vzdialenosť od miesta vyliahnutia (km), **4** – age (years) / vek (roky); m – median / medián

1	2	3	4
24	Y	8.0	4
BM	Y	8.0	4
4T	Y	249.0	4
XH	Y	33.0	4
BL468	None	17.5	5
BL410	None	52.5	6
RA	Y	17.0	6, 7, 8
YC	Y	3.0	6
J2	Y	177.5	7
YK	Y	21.5	7
YM	Y	6.5	7, 8
54	Y	22.0	8, 10, 11
BA02885	None	162.0	8
P9	Y	36.0	8
K4	Y	32.0	9
m		21.75	

4T, which successfully bred as a four-year old male. Unlike in Meyburg et al. (2005) the occupying of a breeding territory by a male (not a female) was recorded and it was at a significant distance from its hatching place. This male nested in the Prievidza District, 249.0 km west from its hatching place in eastern Slovakia, in the Humenné District. It successfully bred and raised its young in the years 2008 and 2009 at least (Dravecký et al. 2008a). Up to then it had not yet been shown that a three-year-old eagle had successfully bred and successfully raised young either as one bird or both from a breeding pair. Cramp & Simmons (1994) state that the age of first breeding of *A. pomarina* is not known, but the complete plumage of adult individuals is achieved the age of four years. In 15 adult individuals in this study aged 4–11 years the distance from the place of hatching was found to be at least 3.0 km and at most 249.0 km (Tab. 3), with a median of 21.75 km (n=15). Several of them were already living as breeding individuals in productive pairs and they raised young. The median value of the dispersal distances for adult individuals (a median of 21.75 km, n=15) is close to the median value of dispersal distance of three-year-old individuals (a median of 46.5 km, n=5), which would indicate that three-year-old individuals begin to remain in the place of formation of new pairs for future breeding.



E Hrtan

Fig. 4. Eight-year-old *A. pomarina* marked with ring BL 060 observed 36 km from its hatching place in eastern Slovakia. Information was read from digital photo of ornithological ring. Percentage of reading ornithological rings from digital photo is much lower (10.42%) in comparison with coloured rings (64.58%) (n=48). Photo: 8 June 2012, Trebišov, eastern Slovakia.

Obr. 4. Osemročný *A. pomarina* označený krúžkom BL 060 bol pozorovaný 36 km od miesta vyliahnutia na východnom Slovensku. Informácia bola odčítaná z fotografie ornitologického krúžku. Percento odčítaní ornitologických krúžkov z digitálnej fotografie je oveľa nižšie (10,42 %) v porovnaní s farebnými odčítacími krúžkami (64,58 %) (n=48). Foto: 8. jún 2012 Trebišov, východné Slovensko.

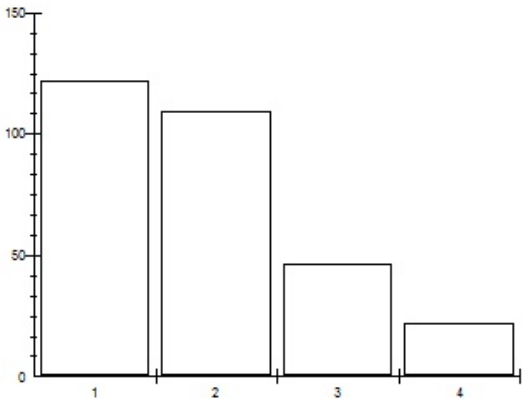


Fig. 5. Median of dispersal of age categories of *A. pomarina* individuals from their place of hatching. X-axis – age category: 1 – one-year-olds, 2 – two-year-olds, 3 – three-year-olds, 4 – adults (4–11 years). Y-axis – distance in km.

Obr. 5. Mediány rozptylu vekových kategórií jedincov *A. pomarina* od miesta ich vyliahnutia. Os x – vekové kategórie: 1 – jednoročné, 2 – dvojročné, 3 – trojročné, 4 – adultné (4–11 rokov). Os y – vzdialenosť v km.

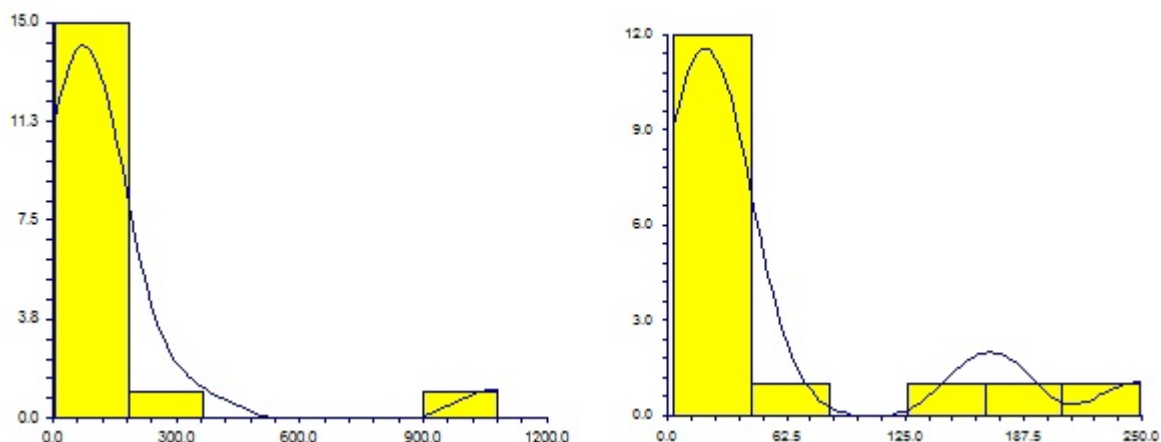


Fig. 6. Dispersal distances of immature (on the left) and adult (on the right) individuals of *A. pomarina* from their place of hatching. x-axis – distance (km), y-axis – number of individuals.

Obr. 6. Rozptyl vzdialeností imaturných (vľavo) a adultných (vpravo) jedincov *A. pomarina* od miesta ich vyliahnutia. Os x – vzdialenosť (km), os y – počet jedincov.

The dispersal of the age category of adults and three-year-old individuals is similar, but it is differentiated from the dispersal of two-year-old individuals (a median of 109.0 km, $n=6$) and from the dispersal of one-year-old individuals (a median of 122.0 km, $n=6$) (Fig. 5, 6). The Mann-Whitney two-sample test showed that the dispersal distances of immature individuals of *A. pomarina* from their hatching place are statistically greater than the distances of dispersion of adult individuals ($z_{0.05,1,31}=-2.342$; $p=0.0096$).

Breeding site fidelity

The fidelity of *A. pomarina* adults to a breeding site is confirmed by data of the eagle with yellow ring 21, which was observed in the surroundings of the nest after ringing in the year 2000 (a captured adult male) in 2003, 2006 and 2009. The eagle marked with yellow ring 54 as a young bird in the nest in the year 2000 (female) bred in the years 2008–2011 at a distance of 22.0 km from its hatching place. The individual with yellow ring RA (Fig. 7), marked as a young bird in the nest in 2004, bred in the years 2010–2012 at a distance of 17.0 km from the hatching site, and the eagle with yellow ring YM (Fig. 8), marked as a young bird in the nest in 2004, bred in 2011 and 2012 at a distance of 6.5 km from the hatching site. In Orava, near Oravská Polhora, an individual was captured in 2011 with a Polish ring, which had been marked as a young bird in the nest in 2003 near the village of Trzcanie in Poland. Light-blue ring 7U was added to it, and this individual

was also observed at the place of capture in 2012, which confirms its breeding site fidelity. Meyburg et al. (2004, 2007a, b) and Langgemach & Meyburg (2011) have shown besides other the long-term breeding site fidelity of *A. pomarina* adults.

Aggregations

Out of 48 observations in this study for the period 2009–2012, 16 observations (33.3%) come from the year 2012 from the Východoslovenská rovina Lowlands, from the Trebišov and Michalovce Districts (Appendix 2, 3). Marked individuals were often in groups with other *A. pomarina* in numbers from two to 49 individuals (Appendix 2). Groupings of *A. pomarina* in such large numbers mainly in the breeding period are rare in the territory of Slovakia, until the results found in this study pointed out, on the basis of exact determination of the age of observed individuals with the use of coloured rings, that in these groupings there were several cases of immature individuals from one to three years (Tab. 2). Of 11 individuals in this age category marked in Slovakia these were for example two one-year-old individuals, with light-blue ring C8 (Fig. 9) and light-blue ring 8J (Fig. 10), one one-year-old E17 (Fig. 11) and one two-year-old A57 (Fig. 12) from Poland, and one one-year-old EL from Estonia (Fig. 2). On the basis of these observations it is possible to assume the occurrence of similar aggregations formed by immature individuals in other parts of Central Europe as well, which commonly aggregated during the breeding period in lo-



J Kícko

Fig. 7. Six-year-old *A. pomarina* female with yellow ring RA photographed on the nest by phototrap on 4 July 2010, Liptovský Hrádok, central Slovakia. This female (age range 6–8 years) bred in this nest only 17.0 km from its hatching place in 2010–2012. Phototrap installed close to the occupied *A. pomarina* nest is one of the special methods for reading coloured rings.

Obr. 7. Šesťročná samica *A. pomarina* so žltým krúžkom RA fotografovaná na hniezde pomocou fotopasce 4. júla 2010, Liptovský Hrádok, stredné Slovensko. Táto samica (vo veku 6–8 rokov) hniezdila v rokoch 2010–2012 v tomto hniezde len 17,0 km od miesta vyliahnutia. Fotopasca inštalovaná v blízkosti obsadeného hniezda je jednou zo špecializovaných metód na odčítavanie farebných krúžkov.



J Míhók

Fig. 8. Eight-year-old breeding *A. pomarina* female marked with yellow ring YM carrying food to the nest. This female bred 6.5 km from its hatching place and 6.5 km from its parents' nest as well. Photo: 12 July 2012, Nováčany, eastern Slovakia.

Obr. 8. Osemročná hniezdiaca samica *A. pomarina* označená žltým krúžkom YM nesie potravu na hniezdo. Samica hniezdila 6,5 km od miesta vyliahnutia a 6,5 km od hniezda rodičovského páru. Foto: 12. júl 2012, Nováčany, východné Slovensko.



E Hrtan

Fig. 9. One-year-old eagle *A. pomarina* marked with light-blue ring C8 was confirmed only 39.0 km from its hatching place in eastern Slovakia immediately after its first wintering in Africa. Picture is an example of significant difference in the possibility of reading data from a coloured ring in comparison with an ornithological ring. It is a very good opportunity to study the plumage of one-year-old *A. pomarina* too. Photo: 14 August 2012, Trhovište, východné Slovensko.

Obr. 9. Jednoročný *A. pomarina* označený svetlomodrým krúžkom C8 bol potvrdený len 39,0 km od miesta vyliahnutia na východnom Slovensku hneď po prvom zimovaní v Afrike. Záber je príkladom výrazného rozdielu v možnosti odčítania údajov z farebného krúžku v porovnaní s ornitologickým krúžkom. Je to taktiež veľmi dobrá možnosť štúdie operenia jednoročného jedinca *A. pomarina*. Foto: 14. august 2012, Trhovište, východné Slovensko.



E Hrtan

Fig. 10. One-year-old *A. pomarina* with light-blue ring 8J observed in breeding period only 62.0 km from its hatching place in eastern Slovakia. Note rest of light spots on the breast in plumage coloration of one-year-old individual. Photo: 2 June 2012, Kucany, eastern Slovakia.

Obr. 10. Jednoročný *A. pomarina* so svetlomodrým krúžkom 8J pozorovaný len 62,0 km od miesta vyliahnutia na východnom Slovensku. Zostatok svetlých škvŕn na hrudi vo sfarbení operenia jednoročného jedinca. Foto: 2. jún 2012, Kucany, východné Slovensko.



E Hrtan

Fig. 11. One-year-old *A. pomarina* marked in eastern Poland with red ring E17 observed in breeding period in eastern Slovakia 333.0 km from its hatching place. Plumage coloration is uniformly brown without any visible light spots. Feathers have colouration of one-year-old *A. pomarina* individual showing wide colour variation. Photo: 16 June 2012, Trebišov-Čaplina, eastern Slovakia.

Obr. 11. Jednoročný *A. pomarina* označený vo východnom Poľsku s červeným krúžkom E17 pozorovaný v hniezdom období na východnom Slovensku 333,0 km od miesta vyliahnutia. Sfarbenie operenia je uniformne hnedé bez akýchkoľvek viditeľných svetlých škvŕn. Sfarbenie operenia u jednoročných jedincov *A. pomarina* vykazuje širokú farebnú variabilitu. Foto: 16. jún 2012, Trebišov-Čaplina, východné Slovensko.



M Balla

Fig. 12. Height and visibility of red ring with triplet alphanumeric code A57 first time used on *A. pomarina* in Poland. Two-year-old *A. pomarina* ringed in south-eastern Poland and observed in eastern Slovakia 98.0 km from its hatching place. Photo: 7 June 2012, Veľké Kapušany, eastern Slovakia.

Obr. 12. Výška a viditeľnosť červeného krúžku s trojmiestnym alfanumerickým kódom A57 prvýkrát použitým na *A. pomarina* v Poľsku. Dvojročný *A. pomarina* krúžkovaný v juhovýchodnom Poľsku a pozorovaný na východnom Slovensku 98,0 km od miesta vyliahnutia. Foto: 7. jún 2012, Veľké Kapušany, východné Slovensko.

cations with suitable food sources. This could be a partial answer to the question of where sub-adult individuals go up to the period of achieving sexual maturity, mainly the age categories of one-year-old and two-year-old individuals.

The territory of the Východoslovenská rovina Lowlands ranks indisputably among the more attractive locations for the formation of aggregates in terms of the biotopic and food requirements of certain species of raptors, including *A. pomarina*. Testimony to this is the concurrent recording of a high concentration of such common species of raptors on this territory, such as *Buteo buteo*, *Circus aeruginosus* and *Falco tinnunculus*, but also the common occurrence of rarer species like *Aquila heliaca*, *Haliaeetus albicilla*, *Circus pygargus*, *Falco cherrug*, *Falco vespertinus* and *Buteo rufinus*. The species representation of raptors at individual locations, commonly with the occurrence of colour-marked individuals of *A. pomarina*, is presented in Tab. 5. The occurrence of a relatively high number of raptors, and thus also colour-marked individual lesser spotted eagles at locations in the Východoslovenská nížina Lowlands in

2012, was probably conditioned by increased abundance of the common vole (*Microtus arvalis*) population, which is the basic element of the diet of *A. pomarina* in the Carpathians (Dravecký et al. 2008c). Groupings of lesser spotted eagles in numbers up to 50 individuals were found in eastern Slovakia in other years as well (Appendix 3), which testifies to the fact that this was not an exceptional phenomenon only in 2012. In connection with the increased number of common voles, aggregations of young individual eagles in common groupings with individuals of *A. pomarina* of unidentified age in numbers from 12 to 49 at the same time and at the same place formed in the mentioned areas (Appendix 3). Great attention was not devoted to monitoring the age categories of individuals of *A. pomarina*; determining them by colouration was therefore rather problematic and inexact. The use of coloured rings has enabled the exact identification of observed juveniles and immature individuals and enabled the assigning of them to categories of one-year-olds, two-year-olds, three-year-olds, and older eagles. Fig. 13 lists the origin of eagles marked in Slovakia which remained in the Východoslovenská nížina Lowlands in 2012.

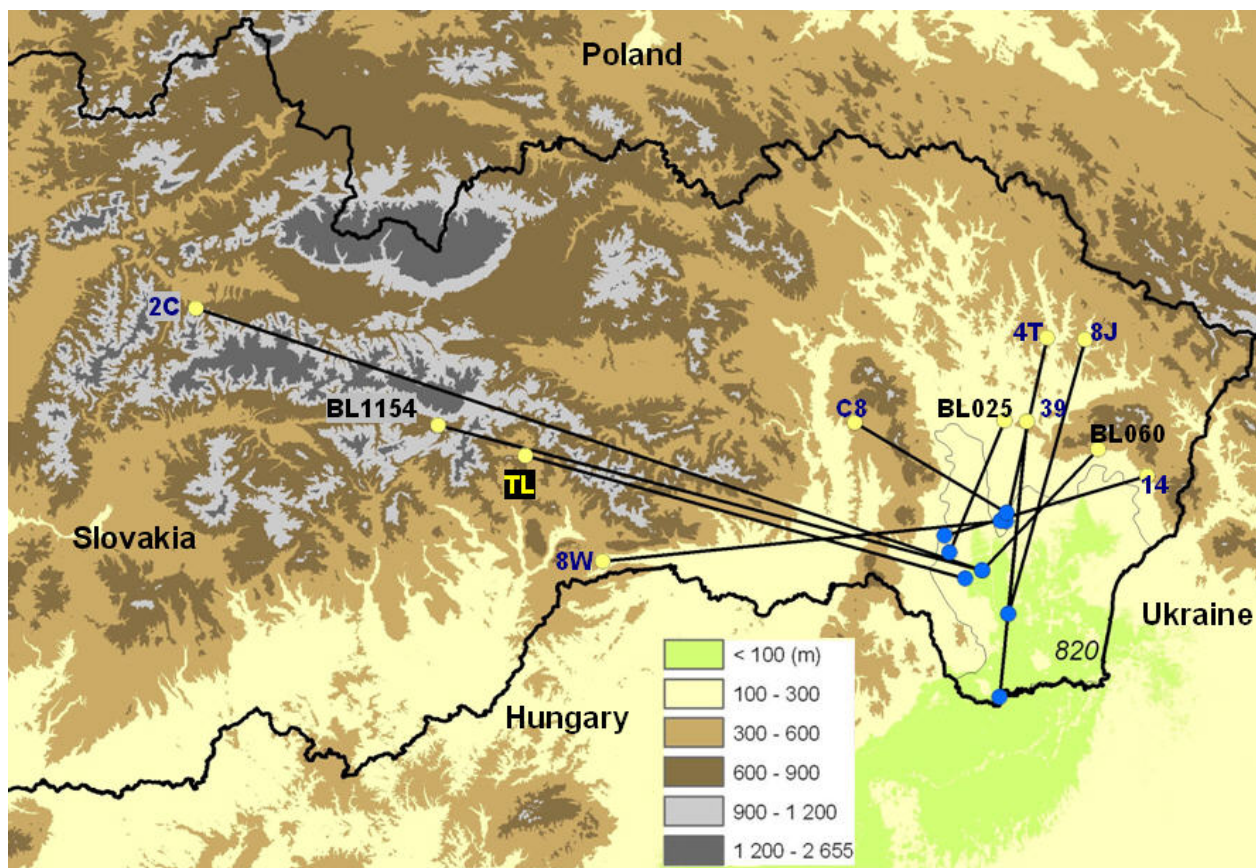


Fig. 13. Origins of *A. pomarina* marked in Slovakia, aggregating in the 2012 season in the Východoslovenská rovina Lowlands. Yellow circle – place of ringing/hatching, blue circle – place of observation. 820 – orographic unit Východoslovenská rovina Lowlands. Hypsographic scale – meters above sea level.

Obr. 13. Pôvod *A. pomarina* označených na Slovensku zdržujúcich sa v sezóne 2012 na Východoslovenskej rovine. Žltý krúžok – miesto krúžkovania/vyliahnutia, modrý krúžok – miesto pozorovania. 820 – orografický celok Východoslovenská rovina. Hypsografická škála – metre nad úrovňou mora.

In places of aggregation of eagles the type of land and method of its use are of primary importance in terms of quality of food sources, as they create the conditions for the occurrence of individual types of prey in the dietary spectrum of the eagles. A significant habitat appears mainly to be permanent grasslands consisting of meadows and pastures, and among these primarily freshly-cut meadows on which, due to the increased accessibility of prey, there is an increase in the number of lesser spotted eagles as well as individuals of other raptor species. Equally significant environments in which aggregations of raptors were recorded can also include flat agricultural areas with the stubble of grain and pulse crops, or freshly-ploughed or overturned fields on which agricultural technology has significantly disrupted the burrows of small terrestrial mammals and in this way, in

the given moment, also increased the availability of prey for birds of prey (Appendix 2, 3).

Very little is known regarding similar aggregations of lesser spotted eagles during the breeding period, unlike the hundreds of individuals stretching out during migration. From eastern Slovakia Švehlík (in Cramp & Simmons 1994) states that in breeding periods both sexes (but without young and immature individuals) gather in summer from time to time into small aggregations of up to 20 individuals in suitable locations with sufficient food resources. This describes similar aggregations to those presented in this study, but the difference lies in the fact that in these groupings the presence of immature individuals was clearly shown, which is in contrast with the above-presented statement. Several aggregations in which immature individuals were clear-

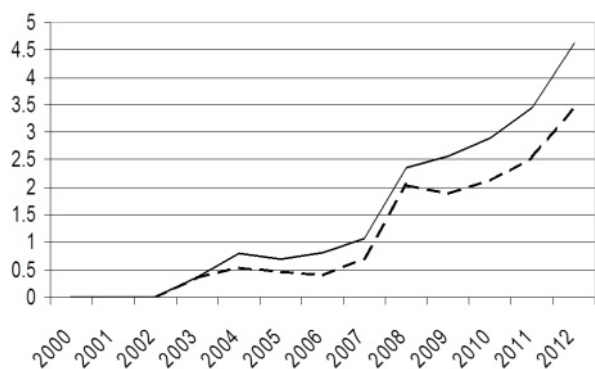


Fig. 14. Development of the share (in %) of resighting rates of *A. pomarina* marked with coloured rings in the period 2000–2012 in Slovakia (n=952). Only individuals that were marked in Slovakia are included and which upon re-reading still had the coloured ring. Thick dash line – resighting rate “A” (individuals recorded several times are calculated only in the first observation). Thin line – resighting rate “B” – all resightings (repeated observations are also included).

Obr. 14. Vývoj podielu (%) spätných hlásení *A. pomarina* označených farebnými krúžkami v období rokov 2000–2012 na Slovensku (n=952). Zahrnuté sú len jedince, ktoré boli označené na Slovensku a pri odčítaní mali stále farebný krúžok. Hrubá prerušovaná čiara – podiel spätných hlásení „A” – spätné hlásenia (viackrát zaznamenané jedince sú započítané len v prvom roku pozorovania). Tenká čiara – podiel spätných hlásení „B” – všetky spätné hlásenia (zahrnuté sú aj opakované pozorovania).

ly recorded point to the fact that these groups consist of different age categories and not only of adults. It is thus far difficult to show whether groupings consisting predominately of only immature individuals can exist separately, or what share they have in these groupings. The observations presented in this article demonstrate that groupings of lesser spotted eagles can also be formed by immature individuals coming from large distances from their place of hatching.

Evaluation of marking with coloured rings

Although for the first eight years of using the method of coloured marking of lesser spotted eagles in Slovakia, the share of resighting rates remained below the value of 1.0%, after the 2012 season the share of resighting rate “A” (individuals recorded several times are calculated only in the first year of sighting) achieved 3.5% (Fig. 14) and a 4.6% share of all resighting rate “B” (repeated sightings are included) from a total of 952 ringed individuals for the 12-year period 2000–2012.

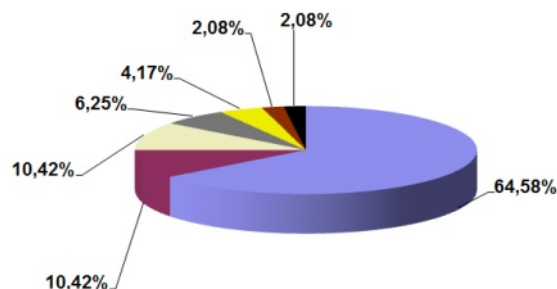


Fig. 15. The share of individual methods of obtaining data from marked lesser spotted eagles with coloured and ornithological rings in Slovakia in the years 2009–2012 (n=48).

Obr. 15. Podiel jednotlivých spôsobov získania údajov z označených orlov kríklavých farebnými a ornitologickými krúžkami na Slovensku v rokoch 2009–2012 (n=48).

Legend / vysvetlivky: light blue/svetlomodrá – reading a coloured ring from a digital photograph/odčítaný farebný krúžok z digitálnej fotografie, violet/fialová – reading of an ornithological ring from a digital photograph/odčítaný ornitologický krúžok z digitálnej fotografie, orange/oranžová – reading with the help of a powerful telescope/odčítaný výkonným monokulárom, grey/sivá – reading a coloured ring using a phototrap installed near a nest/odčítaný farebný krúžok fotopascou umiestnenou v blízkosti hniezda, yellow/žltá – reading a ring from an individual captured in a bird capture net/odčítaný krúžok z jedinca odchyteného do siete, brown/hnedá – reading a ring from an injured individual, odčítaný krúžok z poraneného jedinca, black/čierna – reading a ring from an found dead individual/odčítaný krúžok z nájdeného uhynutého jedinca.

This share, however, was achieved in a much shorter time than with the classic method of ringing. Some similarly evaluated periods of ringing with classic ornithological rings can serve for comparison, in which from 13 countries (ringing central) a share of 2.5% of resightings was achieved in *A. pomarina*, i.e. 41 resightings from a total of 1649 ringed individuals over approximately 100 years (Danko et al. 1996, Meyburg & Meyburg 2002), and for a shorter period of 34 years (1956–1990) from the territory of Slovakia only a 1.4% share was achieved from a total of 284 ringed individuals. In this case the resightings were from four individuals, three of which were dead and one injured that later died (Danko 1992). The recovery rate value of 1.8% share of resightings was significantly increased from the results of ringing 553 individuals with aluminium rings for the 60-year period 1934–1994 in Slovakia (Danko et al. 1996).

From 48 observations the most data was obtained 31× by reading a coloured ring from a digital photograph; subsequently, a great many less: 5× reading of an

ornithological ring from a digital photograph, similarly as 5× reading with the help of a powerful telescope, and 3× by reading a ring using a phototrap installed near the nest. The least amount of data was obtained 2× by reading a ring from an individual captured in a bird capture net and in one case from an injured (then dead) individual (Fig. 15). It follows from the above that a significant change has occurred in the method of obtaining data from ringed individuals of *A. pomarina*, namely from the classic acquiring of data from ornithological rings by capture or obtaining data from the finding of injured or dead individuals to a method of obtaining data by reading a ring from a digital photograph or directly from the display of the digital camera, or later in more detail from an image displayed on a personal computer. The effectiveness of using coloured rings and reading them with the help of digital photography and powerful telescopes points to a manifold increase many times in the efficiency of obtaining ornithological data in comparison with classic methods of obtaining data from ornithological rings.

The advantage of using coloured rings is indisputably the opportunity for reading a code primarily with the use of digital photography, with which there is a considerable difference in the readability of rings between classic rings and coloured rings (Fig. 9) and also the fact that live individuals can be monitored several times. The development and use of digital photography as well as specific technologies such as phototrap or cameras installed on nests and in other locations of regular occurrence of marked individuals shapes the possible creation in the future of close specialisations of ornithologists on deliberate searching for individuals thus marked. The application of these technologies can still significantly increase the number and share of resighting data and likewise can produce still more new knowledge on the biology of this species.

A basic deficiency of the method of marking lesser spotted eagles and other bird of prey with coloured rings is the length of their lifespan. Strong beaks, mainly of the golden eagles, can damage a plastic coloured rings. The same can also occur in Eastern imperial eagles as well as lesser spotted eagles. Proof of this lies the reading of ornithological rings on individual lesser spotted eagles which had also been marked with coloured rings, but at the time of reading they had only had the ornithological rings on their legs. This directly confirms that marked individuals have lost the coloured rings, or removed them themselves. In specific cases these were yellow rings BM, K4, P9 and the light-blue ring 2M, when individuals 2, 4, 8 and 9 years old had only ornithological rings on

their legs, the reading of which is very difficult. This deficiency in this method has led to a discussion on the production of new metal ornithological rings with the characteristics of readable rings including the appropriate deployment and size and colour of numerical or alphanumeric symbols. Readable metal rings for lesser spotted eagles have been used in Germany for a number of years already (Meyburg et al. 2008).

With the marking of individuals with coloured rings their proper placement is important. In several cases rings have been improperly placed either on the wrong leg, or by turning the ring in the improper direction for reading the code on the leg in the direction from the body of the eagle toward the talons. In several combinations this can then lead to the problem of incorrect reading of, e.g. codes XH, HX, HI, IH and the like. Therefore it is necessary to record exactly the position of each of the rings (the coloured and the ornithological) in the lists of records and to supplement them with photographs of the marked individuals.

Conclusion

Despite certain deficiencies in the method of marking individuals of *A. pomarina* with coloured ring, such as their lifespan, for a short period of years 2000–2012 this method produced an important increase in the number of resightings and observations of living marked individuals in the wild, and helped to identify the different age categories of eagles. In the course of the breeding period all age categories, from one-year-olds through to adult individuals, were found in the population in Slovakia. The identification of an individual on the basis of reading the ring using digital photography enables the colouring of eagles of different age categories to be studied, as well as their moulting, age, maturing, possibly the age of individuals when forming a breeding pair, and the first successful breeding of young. The results show that immature individuals can commonly aggregate in places with known sources of food, since they are not yet strictly bound to nest sites due to sexual maturity. Young individuals can group into common aggregations at various distances from their hatching places in locations with sufficient food sources. Modern technology such as phototrap and cameras enable the documenting of individuals for several years as they breed in the same nest or in the same breeding grounds generally for low costs of operation of this method. In contrast to the classic marking with ornithological rings, the method of using coloured rings has significantly increased the index of resightings regarding the number of ringed birds.

The obtained results can contribute to the protection of the lesser spotted eagle population and its habitats. It is especially necessary to emphasise the fact that to the credit of systematic carrying out of the mentioned programme in Slovakia, an important area in eastern Slovakia has successfully been identified in the Východoslovenská pahorkatina Hills and mainly in the Východoslovenská rovina Lowlands, where young and immature eagles in particular aggregate in relatively higher numbers thanks meanwhile to the preserved and suitable habitat, which offers them quality food resources. This aspect is even more important in that the majority of observed colour-marked eagles from these orographical units were recorded in two areas of the ecological network of European protected areas – Natura 2000, the Special Protection Area (SPA) of the Ondavská rovina Plain and Medzibodrožie, despite the fact that the lesser spotted eagle was not a criterion species for their being declared. This fact has its own importance for conservation work in terms of the need to update the subject of protection of existing regulations, which were declared in the above areas. Likewise, it is desirable that even for the places of occurrence which are found outside of these SPAs, adequate protection of habitats be ensured through the form of naturally cultivated agricultural land nearby. The achieved results confirm the justness and need for additional cooperation to go along with the already well-running international cooperation relating to colour marking of the lesser spotted eagle population in Europe, by which further interesting data from the biology of this species can be obtained.

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Appendix 1. Overview of observed *A. pomarina* marked with coloured and ornithological rings in Slovakia in the years 2009–2012 and some unpublished data from the period 2000–2008

Appendix 1. Prehľad pozorovaných *A. pomarina* označených farebnými a ornitologickými krúžkami na Slovensku v období rokov 2009–2012 a niekoľko nepublikovaných údajov z obdobia rokov 2000–2008

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	21	yellow	L	14 Jul 2000	ad. M	Hromoš	SL	SK	O Šreibr	49° 15'	20° 49'					this study
	BX 5560 Praha		R	7 Jul 2003	>8	Hromoš	SL	SK	T Bělka, D Horal	49° 16'	20° 49'	3	0.1	N	2y 11m 23d	
2.	21	yellow	L	14 Jul 2000	ad. M	Hromoš	SL	SK	O Šreibr	49° 15'	20° 49'					this study
	BX 5560 Praha		R	14 Jul 2006	>11	Plaveč	SL	SK	T Bělka	49° 15'	20° 50'	1	2.3	W	6y 00m 00d	
3.	21	yellow	L	14 Jul 2000	ad. M	Hromoš	SL	SK	O Šreibr	49° 15'	20° 49'					2,5
	BX 5560 Praha		R	24 May 2009	>14	Podzamok	SL	SK	A Chudý	49° 15'	20° 50'	1	1.6	E	8y 10m 10d	
4.	24	yellow	R	14 Jul 2000	pull.	Podolíneč	SL	SK	T Bělka	20° 32'	49° 17'					7
	L 2228 Praha		L	12 Jul 2004	4	Kamienka	SL	SK	T Bělka	49° 21'	20° 35'	3	8.0	NNE	3y 11m 28d	
5.	24	yellow	R	14 Jul 2000	pull.	Podolíneč	SL	SK	T Bělka	20° 32'	49° 17'					7
	L 2228 Praha		L	31 Jul 2004	4	Kamienka	SL	SK	T Bělka	49° 21'	20° 35'	5	8.0	NNE	4y 00m 17d	
6.	54	yellow	R	21 Jul 2000	pull.	Dúbrava	LM	SK	P Vrílik	49° 01'	19° 31'					1a
	BX 2559 Praha		L	30 Jun 2008	8	Kráľova Lehota	LM	SK	J Kicko	49° 01'	19° 49'	3	22.0	E	7y 11m 09d	
7.	54	yellow	R	21 Jul 2000	pull.	Dúbrava	LM	SK	P Vrílik	49° 01'	19° 31'					6
	BX 2559 Praha		L	23 Jun 2010	10	Kráľova Lehota	LM	SK	J Kicko	49° 01'	19° 49'	1	22.0	E	9y 11m 02d	
8.	54	yellow	R	21 Jul 2000	pull.	Dúbrava	LM	SK	P Vrílik	49° 01'	19° 31'					4
	BX 2559 Praha		L	28 Jun 2011	11	Kráľova Lehota	LM	SK	J Kicko, P Vrílik	49° 01'	19° 49'	1	22.0	E	10y 11m 07d	
9.	J2	yellow	R	6 Jul 2002	pull.	Rokytov pri HE	HE	SK	B Maderič	49° 07'	22° 02'					2
	BL 015 Bratislava		L	15 May 2009	7	Lipnica Mała	NT	PL	D Karaska	49° 29'	19° 39'	1	177.5	WNW	6y 10m 09d	
10.	BM	yellow	R	16 Jul 2002	pull.	Vojňany	KK	SK	T Bělka	49° 16'	20° 24'					this study
	BL 178 Bratislava		L	16 Jul 2006	4	Podolíneč	SL	SK	T Bělka, J Vrána	49° 17'	20° 31'	3	8.0	ENE	4y 00m 00d	
11.	K4	yellow	R	7 Jul 2003	pull.	Topolovka	HE	SK	B Maderič	48° 54'	21° 49'					this study
	BL 025 Bratislava		L	10 Sep 2012	9	Malý Ruskov	TV	SK	E Hrtan jr	48° 38'	21° 40'	2	32.0	SSW	9y 02m 03d	
12.	none			25 Jul 2003	pull.	Trzozanie	WP	PL	M Stój	49° 29'	21° 41'					4
	BA 02885 Gdansk		L	19 Aug 2011	8	Oravská Polhora	NO	SK	D Karaska	49° 32'	19° 27'	5	162.0	WNW	8y 00m 24d	
13.	7U	light blue	R	25 Jul 2003	pull.	Trzozanie	WP	PL	M Stój	49° 29'	21° 41'					this study
	BA 02885 Gdansk		L	16 Jul 2012	9	Oravská Polhora	NO	SK	D Karaska	49° 32'	19° 27'	3	162.0	WNW	8y 11m 21d	
14.	none			2 Jul 2004	pull.	O. Matiašovce	VV	SK	Pa Kaňuch	48° 58'	21° 46'					3
	BL 410 Bratislava		R	3 Sep 2010	6	Šebastovce	KS	SK	J Mihók	48° 38'	21° 16'	2	52.5	SW	6y 02m 01d	
15.	RA	yellow	R	4 Jul 2004	pull.	Lipt. Kľačany	LM	SK	P Vrílik	49° 02'	19° 28'					6
	none			4 Jul 2010	6	Lipt. Hrádok	LM	SK	J Kicko	49° 02'	19° 42'	4	17.0	E	6y 00m 00d	
16.	RA	yellow	R	4 Jul 2004	pull.	Lipt. Kľačany	LM	SK	P Vrílik	49° 02'	19° 28'					this study
	none			3 Jul 2011	7	Lipt. Hrádok	LM	SK	J Kicko	49° 02'	19° 42'	4	17.0	E	6y 11m 29d	
17.	RA	yellow	R	4 Jul 2004	pull.	Lipt. Kľačany	LM	SK	P Vrílik	49° 02'	19° 28'					this study
	none			12 Jul 2012	8	Lipt. Hrádok	LM	SK	J Kicko	49° 02'	19° 42'	4	17.0	E	8y 00m 08d	
18.	4T	yellow	R	9 Jul 2004	pull.	Pitčie	HE	SK	B Maderič	48° 54'	21° 57'					1a
	BL 263 Bratislava		L	27 Apr 2008	4	Nováky	PD	SK	S Harvančík	48° 44'	18° 34'	1	249	W	3y 09m 18d	
19.	4T	yellow	R	9 Jul 2004	pull.	Pitčie	HE	SK	B Maderič	48° 54'	21° 57'					this study
	BL 263 Bratislava		L	14 May 2009	5	Koš	PD	SK	S Harvančík	48° 45'	18° 34'	1	249.5	W	4y 10m 05d	
20.	YC	yellow	R	11 Jul 2004	pull.	Skároš	KS	SK	J Mihók	48° 34'	21° 23'					3
	BL 242 Bratislava		L	17 Jul 2010	6	Ždaňa	KS	SK	J Mihók	48° 36'	21° 23'	1	3.0	S	6y 00m 06d	
21.	YK	yellow	R	13 Jul 2004	pull.	Koš. Klečenov	KS	SK	J Mihók	48° 44'	21° 31'					4
	BL 246 Bratislava		L	5 May 2011	7	Šebastovce	KE	SK	J Mihók	48° 38'	21° 16'	1	21.5	SW	6y 09m 22d	
22.	YM	yellow	R	14 Jul 2004	pull.	Rudník	KS	SK	J Mihók	48° 43'	21° 00'					4
	BL 249 Bratislava		L	29 May 2011	7	Nováky	KS	SK	J Mihók, I Fabianová	48° 41'	21° 05'	1	6.5	NW	6y 10m 15d	

Appendix 1. continuation / pokračovanie

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
23.	YM	yellow	R	14 Jul 2004	pull.	Rudník	KS	SK	J Mihók	48° 43'	21° 00'					this study
	BL 249 Bratislava		L	12 Jul 2012	8	Nováčky	KS	SK	J Mihók	48° 41'	21° 05'	1	6.5	NW	7y 11m 28d	
24.	P9	yellow	R	19 Jul 2004	pull.	Jovša	MI	SK	Š Danko	48° 51'	22° 06'					this study
	BL 060 Bratislava		L	8 Jun 2012	8	Trebišov	TV	SK	E Hrtan jr	48° 36'	21° 46'	2	36.0	SW	7y 10m 19d	
25.	CI	yellow	R	4 Jul 2006	pull.	Jakubovany	LM	SK	J Kicko	49° 07'	19° 45'					3
	BL 576 Bratislava		L	27 Aug 2008	2	Nowy Targ	WM	PL	K Panszczyk	49° 26'	20° 03'	1	41.5	NE	2y 01m 23d	
26.	none		L	17 Jul 2006	pull.	Vyšný Klátov	KS	SK	J Mihók	48° 45'	21° 08'					4
	BL 468 Bratislava		L	3 May 2011	5	Šebastovce	KE	SK	J Mihók	48° 38'	21° 16'	2	17.5	SE	4y 09m 16d	
27.	none		L	17 Jul 2006	pull.	Vyšný Klátov	KS	SK	J Mihók	48° 45'	21° 08'					4
	BL 468 Bratislava		L	1 Nov 2011	5	Hlidsnémeti	BAZ	HU	A Korhut	48° 30'	21° 14'	7	29.0	SSE	5y 03m 14d	
28.	PK	yellow	R	7 Jul 2007	pull.	Rokytovec	ML	SK	B Maderič	49° 15'	21° 53'					3
	BL 649 Bratislava		L	17 Jul 2010	3	Krásny Brod	ML	SK	B Maderič	49° 13'	21° 54'	1	4.6	SSE	3y 00m 10d	
29.	XH	yellow	R	11 Jul 2007	pull.	Opatovce n/N	PD	SK	K Šotnár	48° 44'	18° 33'					this study
	BL 616 Bratislava		L	14 May 2011	4	Klátova N. Ves	PE	SK	Pa Kaňuch	48° 34'	18° 17'	1	33.0	NE	3y 10m 03d	
30.	HK	yellow	L	7 Aug 2007	ad. F	Lieskovec	HE	SK	Š Danko	48° 57'	21° 19'					1a
	BL 070 Bratislava		R	25 Jul 2008	>4	Lieskovec	HE	SK	Š Danko	48° 57'	21° 49'	1	2.0	SSW	0y 11m 18d	
31.	HK	yellow	L	7 Aug 2007	ad. F	Lieskovec	HE	SK	Š Danko	48° 57'	21° 19'					2
	BL 070 Bratislava		R	11 Jul 2009	>5	Lieskovec	HE	SK	B Maderič	48° 56'	21° 49'	1	2.0	SSW	1y 11m 04d	
32.	SS	yellow	L	30 Jun 2009	pull.	Východná	LM	SK	M Macek	49° 02'	19° 53'					this study
	BL 946 Bratislava		R	5 Aug 2012	3	Kľčov	SN	SK	J Kormančík, A Macková	49° 00'	20° 40'	6	58.0	W	3y 01m 05d	
33.	14	light blue	L	11 Jul 2009	pull.	Hlivštila	SO	SK	Š Danko	48° 48'	22° 15'					this study
	BL 791 Bratislava		R	21 May 2012	3	Veľký Ruskov	TV	SK	E Hrtan jr	48° 40'	21° 39'	1	48.5	WSW	2y 10m 10d	
34.	39	light blue	L	12 Jul 2009	pull.	Jasenov	HE	SK	B Maderič	48° 54'	21° 53'					4
	BL 673 Bratislava		R	12 Aug 2011	2	Veľký Kamenec	TV	SK	E Hrtan jr	48° 21'	21° 50'	1	61.5	S	2y 01m 00d	
35.	39	light blue	L	12 Jul 2009	pull.	Jasenov	HE	SK	B Maderič	48° 54'	21° 53'					this study
	BL 673 Bratislava		R	5 Jun 2012	3	Kucany	TV	SK	E Hrtan jr	48° 31'	21° 51'	1	41.5	S	2y 11m 23d	
36.	TL	yellow	L	17 Jul 2009	pull.	Vlachovo	RV	SK	M Dravecký	48° 47'	20° 23'					this study
	BL 849 Bratislava		R	31 Aug 2012	3	Trebišov	TV	SK	E Hrtan jr	48° 35'	21° 43'	1	100.0	ESE	3y 01m 14d	
37.	5Z	light blue	R	24 Jul 2009	pull.	Teriakovce	PO	SK	Pa Kaňuch	48° 59'	21° 19'					4
	BL 1035 Bratislava		L	4 Jun 2011	2	Tedej	HB	HU	I Balázs	47° 54'	21° 23'	1	120.0	S	1y 10m 10d	
38.	2C	light blue	R	2 Jun 2010	pull.	Lipt. Štiavnica	LM	SK	J Kicko	49° 02'	19° 22'					this study
	BL 1148 Bratislava		L	9 Jun 2012	2	Trebišov	TV	SK	E Hrtan jr	48° 36'	21° 46'	1	183.0	ESE	1y 11m 07d	
39.	2M	light blue	R	7 Jul 2010	pull.	Červená Skala	BR	SK	J Kicko	48° 50'	20° 07'					this study
	BL 1154 Bratislava		L	9 Jun 2012	2	Trebišov	TV	SK	E Hrtan jr	48° 36'	21° 46'	2	124.0	ESE	1y 11m 02d	
40.	A57	red	R	17 Jul 2010	pull.	Sanok	PRZ	PL	M Stój	49° 25'	21° 59'					this study
	BA 03951 Gdansk		L	7 Jun 2012	2	Veľké Kapušany	TV	SK	M Balla	48° 33'	22° 04'	1	98.0	S	1y 10m 20d	
41.	C8	light blue	R	8 Jul 2011	pull.	Brestov	PO	SK	J Mihók	48° 53'	21° 22'					this study
	BL 1220 Bratislava		L	14 Aug 2012	1	Trhovište	MI	SK	E Hrtan jr	48° 43'	21° 50'	1	39.0	ESE	1y 01m 06d	
42.	9F	light blue	R	11 Jul 2011	pull.	Lipt. Štiavnica	RK	SK	J Kicko	49° 2'	19° 22'					this study
	BL 1167 Bratislava		L	2 Aug 2012	1	Milhostov	TV	SK	E Hrtan jr	48° 39'	21° 45'	1	182.0	ESE	1y 00m 21d	
43.	A2	light blue	R	15 Jul 2011	pull.	Oreské	MI	SK	Š Danko	48° 52'	21° 55'					this study
	BL 803 Bratislava		L	11 Jul 2012	1	Vinné	MI	SK	E Hrtan jr	48° 48'	21° 57'	1	8.0	SSE	0y 11m 26d	
44.	E17	red	L	15 Jul 2011	pull.	Majdan	LU	PL	J Wójciak	51° 21'	23° 35'					this study
	BN 4849 Gdansk		R	16 Jun 2012	1	Trebišov	TV	SK	E Hrtan jr	48° 36'	21° 46'	1	333.0	SSW	0y 11m 01d	
45.	8J	light blue	L	24 Jul 2011	pull.	Zubné	ML	SK	B Maderič	49° 04'	22° 03'					this study
	BL 977 Bratislava		R	31 May 2012	1	Kucany	TV	SK	M Balla	48° 31'	21° 51'	1	62.0	SSW	0y 10m 07d	

Appendix 1. continuation / pokračovanie

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
46.	EL	white	L	27 Jul 2011	pull.	Kuikšilla	VA	EE	A Nurmila	57° 53'	26° 17'					this study
	R 12398	Matsalu	R	1 Jun 2012	1	Kucany	TV	SK	E Hrtan jr	48° 31'	21° 51'	1	1080.0	SSW	Oy 10m 04d	
47.	8W	light blue R	R	23 Jun 2012	ad. F	Hrušov	RV	SK	M Macek	48° 35'	20° 38'					this study
	BL 858	Bratislava	L	25 Jul 2012	>5	Trhovište	MI	SK	Š Danko	48° 42'	21° 49'	1	88.0	ENE	Oy 01m 02d	
48.	4T	light blue L	L	20 Jul 2012	pull.	Hrabovec n/L	HE	SK	B Mađenč	49° 04'	21° 56'					this study
	BL 1251	Bratislava	R	12 Sep 2012	2m	Trhovište	MI	SK	M Balla	48° 42'	21° 50'	1	41.5	SSW	Oy 01m 22d	

Legend / vysvetlivky: 1 – obs. no. – observation number / poradové číslo pozorovania; 2, 3 – colour ring / ornithological ring / farebný krúžok / ornitologický krúžok (2–3), 2 – code of colour ring / kód farebného krúžku, 3 – colour / farba / type and number of ornithological ring / typ a číslo ornitologického krúžku; 4 – leg / noha, R – right / pravý, L – left / ľavý; 5 – ringing / recovery date / dátum krúžkovania / nálezu; 6 – sex, age / vek / roky; 7, 8, 9 – ringing / recovery site / miesto krúžkovania / nálezu, 7 – locality / lokalita, 8 – district, region, county / okres, oblasť, kraj, BR – Brezno, HE – Humenné, KK – Kežmarok, KS – Košice-okolie, LM – Liptovská Mikuláš, LU – Lublin, MI – Michalovce, ML – Medzilaborce, PD – Prievidza, PO – Prešov, PRZ – Przemysl, RK – Ružomberok, RV – Rožňava, SL – Stará Ľubovňa, SO – Sobrance, VA – Valga, VV – Vranov n/Toptlou, WP – Województwo Podkarpackie; 9 – state / štát, EE – Estonia / Estónsko, HU – Hungary / Maďarsko, PL – Poland / Poľsko, SK – Slovakia / Slovensko; 10 – ringer / finder / krúžkovateľ / nálezca; 11, 12 – ringing / recovery coordinates / zemepisné súradnice miesta krúžkovania / nálezu; 13 – ring reading method / spôsob odčítania krúžku, 1 – read colour ring from digital photo / odčítaný farebný krúžok z digitálnej fotografie, 2 – read ornithological ring from digital photo / odčítaný ornitologický krúžok z digitálnej fotografie, 3 – read ring by telescope / odčítaný krúžok monokulárnym ďalekohľadom, 4 – read colour ring by phototrap on the nest / odčítaný farebný krúžok pomocou fotopascie na hniezde, 5 – captured to the net and released / odchytýny do siete a vypustený, 6 – read rings from living injured bird / odčítané krúžky zo živého poraneného jedinca, 7 – read ring from the dead bird / odčítaný krúžok z uhynutého jedinca; 14, 15, 16 – distance, direction, run time / vzdialenosť, smer, uplynutý čas, 14 – distance km / vzdialenosť km, 15 – direction N, S, E, W / smer S, J, V, Z, 16 – run time yy.mm.dd / uplynutý čas r.r.mm.dd; 17 – source / zdroj údajov – 1 – Dravecký et al. (2008a), 2 – Dravecký (2010), 3 – Dravecký (2010), 4 – Dravecký (2011), 5 – Chudý (2009), 6 – Kicko (2010), 7 – Meyburg et al. (2005), this study / táto štúdia. Italic writing – fallen rings from the legs of ringed eagles / spadnuté krúžky z nôh krúžkovaných orlov.

Appendix 2. Marked *A. pomarina* at a hunting site together with other individuals of *A. pomarina* and other raptors at locations in eastern Slovakia in the years 2011–2012

Appendix 2. Označené *A. pomarina* na lovisku v spoločensve iných jedincov *A. pomarina* a ostatných dravcov na lokalitách východného Slovenska v období rokov 2011–2012

Legend / vysvetlivky: **colour** / farba – LB – light blue / svetlomodrá, W – white / biely, R – red / červený, Y – yellow / žltý, ornit. – ornithological aluminium ring / hliníkový ornitologický krúžok; **D** – district / okres, TV – Trebišov, MI – Michalovce; **coordinates** – geographical coordinates N, E / zemepisné súradnice S, V; **species** / druh, **Ap** – *Aquila pomarina*, **Bb** – *Buteo buteo*, **Ft** – *Falco tinnunculus*, **Ah** – *Aquila heliaca*, **Ca** – *Circus aeruginosus*, **Cp** – *Circus pygargus*, **Br** – *Buteo rufinus*, **Ha** – *Haliaeetus albicilla*, **Fch** – *Falco cherrug*, **Fv** – *Falco vesperinus*; **biotope** / biotop – 1 – ploughed field / orané pole, 2 – cultivated field by disc mechanism / podiskované pole, 3 – meadows, pastures / lúky, pastviny, 4 – meadows / lúky, 5 – freshly cutted meadow / čerstvo kosaná lúka, 6 – stubble-field / strnisko, 7 – stubble-field after wheat / strnisko po pšenici, 8 – rolled field and stubble-field after wheat and rape / valcované pole a strnisko po pšenici a repke, 9 – freshly ploughed field / čerstvo orané pole, 10 – field / pole.

ring code / kód krúžku	ring colour / farba krúžku	age (year) / vek (rok)	date / dátum	locality / lokalita	D	N	E	Ap	Bb	Ft	Ah	Ca	Cp	Br	Ha	Fch	Fv	biotope / biotop	observer / pozorovateľ
39	LB	2	12 Aug 2011	Veľký Kamenec	TV	48° 21'	21° 50'	2										1	E Hrtan jr
14	LB	3	21 May 2012	Veľký Ruskov	TV	48° 40'	21° 39'	18	12	1	4	2	3					2	E Hrtan jr
EL + 8J	W + LB	1+1	1 Jun 2012	Kucany	TV	48° 31'	21° 51'	16	8	2		1						3	E Hrtan jr
A57	R	2	7 May 2012	V. Kapušany	TV	48° 33'	22° 04'	2	5									3	M Balla
BL 060	ornit.	8	8 Jun 2012	Trebišov-Čapliny	TV	48° 36'	21° 46'	9	6	1		6						4	E Hrtan jr
2C + BL 1154	LB + ornit.	2+2	9 Jun 2012	Trebišov-Čapliny	TV	48° 36'	21° 46'	6	9		1							5	E Hrtan jr
E17	R	1	16 Jun 2012	Trebišov-Čapliny	TV	48° 36'	21° 46'	6	12	2		6		1				4	E Hrtan jr
39	LB	3	5 Jul 2012	Kucany	TV	48° 31'	21° 51'	4	2									4	E Hrtan jr
A2	LB	1	11 Jul 2012	Vinné	MI	48° 48'	21° 57'	0							1			4	E Hrtan jr
9F	LB	1	2 Aug 2012	Milhostov, Bisce	TV	48° 39'	21° 45'	2	3									6	E Hrtan jr
C8	LB	1	14 Aug 2012	Trhovište	TV	48° 43'	21° 50'	6	1		4							7	E Hrtan jr
TL	Y	3	31 Aug 2012	Čerjaky	TV	48° 35'	21° 43'	6	8		2				1			2	E Hrtan jr
BL 025	ornit.	9	9 Sep 2012	Maliý Ruskov	TV	48° 38'	21° 40'	49	10	4		3		6		1	6	8	E Hrtan jr
4T	LB	3 m	12 Sep 2012	Trhovište	MI	48° 42'	21° 50'	32	30		3	4		1		1	2	9	M Balla

Appendix 3. Aggregations of *A. pomarina* at a hunting site together with other raptors at locations in eastern Slovakia in the years 2008–2012

Appendix 3. Agregácie *A. pomarina* na lovisku v spoločenstve iných dravcov na lokalitách východného Slovenska v období rokov 2008–2012

Legend / vysvetlivky: **D** – district / okres, **TV** – Trebišov, **MI** – Michalovce; **coordinates** – geographical coordinates N, E / zemepisné súradnice S, V; **species** / druh, **Ap** – *Aquila pomarina*, **Bb** – *Buteo buteo*, **Ft** – *Falco tinnunculus*, **Ah** – *Aquila heliaca*, **Ach** – *Aquila chrysaetos*, **Ca** – *Circus aeruginosus*, **Cp** – *Circus pygargus*, **Mm** – *Milvus migrans*, **Br** – *Buteo rufinus*, **Ac** – *Aquila clanga*, **Fch** – *Falco cherrug*, **Fv** – *Falco vespertinus*; **biotope** / biotop – 1 – ploughed field / orané pole, 2 – cultivated field by disc mechanism / podiskované pole, 3 – meadows, pastures / lúky, pastviny, 4 – meadows / lúky, 5 – freshly cutted meadow / čerstvo kosená lúka, 6 – stubble-field / strnisko, 7 – stubble-field after wheat / strnisko po pšenici, 8 – rolled field and stubble-field after wheat and rape / valcované pole a strnisko po pšenici a repke, 9 – freshly ploughed field / čerstvo orané pole, 10 – field / pole.

date / dátum	locality / lokalita	D	N	E	Ap	Bb	Ft	Ah	Ach	Ca	Cp	Mm	Br	Ac	Fch	Fv	biotope / biotop	observer / pozorovateľ
3 Jun 2008	Leles	TV	48° 29'	22° 02'	36	8						2					5	M Balla
20 Jun 2008	Leles	TV	48° 29'	22° 02'	24	6				4		4		1			5	M Balla
5 Aug 2008	Leles	TV	48° 29'	22° 02'	21												5	M Balla
31 May 2011	Kucany	TV	48° 42'	21° 50'	22							1					5	M Balla
22 Jun 2011	Pol'any	TV	48° 30'	21° 59'	12							2					5	M Balla
5 Apr 2012	Staré	MI	48° 51'	21° 53'	15												10	V Pečeňák
21 May 2012	Veľký Ruskov	TV	48° 40'	21° 39'	18	12	1	4		2	3						2	E Hrtan jr
1 Jun 2012	Kucany	TV	48° 31'	21° 51'	16	8	2			1							3	E Hrtan jr
9 Sep 2012	Malý Ruskov	TV	48° 38'	21° 40'	49	10		4			3		6		1	6	8	E Hrtan jr
10 Sep 2012	Malý Ruskov	TV	48° 37'	21° 40'	12	8	2									6	8	E Hrtan jr
12 Sep 2012	Trhovište	TV	48° 42'	21° 50'	32	30		3		4			1		1	2	9	M Balla
12 Sep 2012	Zbudza	MI	48° 50'	21° 53'	40	2	1	1	1								9	M Rinik