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Movements of imperial eagle *Aquila heliaca* juveniles and description of monitored areas in the border zone between Austria, Hungary and Slovakia

Pohyby mláďat orla kráľovského *Aquila heliaca* a opis sledovaných oblastí v prihraničnej oblasti medzi Rakúskom, Maďarskom a Slovenskom

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Abstract: Five juveniles of the imperial eagle were tracked during 2011–2012. Movements were monitored in the western part of Slovakia and in the border area between Austria, Hungary and Slovakia. Three eagles came from the Záhorská nížina Lowlands and the others from the Malé Karpaty Mts and the Podunajská nížina Lowlands. Post-fledging movements were recorded in areas around the nests. Post-fledging areas covered a large territory (minimum convex polygons – 89, 941, 969 km^2). During the post-fledging period the eagles carried out exploratory flights (12–33 km from the nest). One temporary settlement area (TSA) was identified in the border area between Austria, Hungary and Slovakia (minimum convex polygon – 68 km^2). Two eagles with radio transmitters were recorded in this area. In the TSA and the post-fledging areas two habitat categories were dominant: arable land and forests. Heterogeneous agricultural areas were also important in the TSA (8%).

Abstrakt: Počas rokov 2011 a 2012 bolo monitorovaných päť juvenilov orla kráľovského. Pohyby boli monitorované v západnej časti Slovenska a v pohraničnej oblasti medzi Rakúskom, Maďarskom a Slovenskom. Tri orly pochádzali zo Záhorskej nížiny a ostatné z Malých Karpát a Podunajskej nížiny. Pohyby po opustení hniezda boli zaznamenané v oblastiach okolo hniezd. Oblasti využívané po vyletení z hniezda pokrývali veľké územie (minimálny konvexný polygón – 89, 941, 969 km^2). Počas obdobia po vyletení z hniezda orly vykonávali prieskumné lety (12–33 km od hniezda). V pohraničnej oblasti medzi Rakúskom, Maďarskom a Slovenskom bolo identifikované jedno dočasne osídlené územie (minimálny konvexný polygón – 68 km^2). Dva orly s rádiovou vysielačkou boli zaznamenané v tomto území. V územiach obývaných po vyletení z hniezda a v dočasne osídlenom území boli dominantné dve kategórie biotopov – orná pôda a lesy. V dočasne osídlenom území boli tiež významné heterogénne poľnohospodárske oblasti (8%).

Key words: telemetry, habitat cover, temporary settlement area, post-fledging area, landscape structure.

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Introduction

The imperial eagle *Aquila heliaca* is a globally threatened species. It primarily breeds in open and semi-open landscape with woodland, groups of trees, windbreaks and solitaire trees. The population in central Europe is partial-migrating (Danko 2008). Migration and movement to southern areas is mainly characteristic for juveniles and immature birds (Danko 2008). Adults usually remain in their territories during the non-breeding season (Hudec and Šťastný 2005). Ringing data from Slovakia show several recovery locations in Slovakia, Hungary and Greece (Danko 2008). Previous telemetry studies were conducted in the western and eastern parts of Slovakia, with both radio and satellitte telemetry methods being used (Danko et al. 2011). Imperial eagles use temporary settlement areas (TSA), which are important for immature birds. Evaluation of telemetry data for birds from Hungary showed the most important temporary settlement areas in the eastern part of the country (Horváth et al. 2008).

The aim of the present study was to complete the knowledge about movements of juvenile birds, and identify the temporary settlement area and post-fledging areas in the western part of Slovakia. The second aim of

this study was to obtain information about the habitat cover in the monitored areas. The new data can be used in species and landscape protection. The border area between Austria and Slovakia is a potentional area for wind park constructions. These data and research can help to improve the protection of nesting pairs and the entire area.

Material and methods

Study area and telemetry

The study was carried out in the western part of Slovakia – in the Záhorská nížina Lowlands, the Podunajská nížina Lowlands and the Malé Karpaty Mts – and in the border area between Austria, Hungary and Slovakia (Fig. 1). The radio transmitter (28 grams TW-3 1 /2AA) for leg-mount use (Biotrack Ltd.) was attached to five imperial eagle juveniles named Dano, Dorota, Dana, Šarlota and Oliver. The transmitter weight reached 1.0–1.5% of the body weight. The transmitter contained a pasture sensor for recording the type of behaviour. We set up eight car routes in the study area, aiming to increase the chances of receiving signals from the transmitters. In the field we used a three-element yagi antenna, Icom R-20 radio scanner, GPS unit (Garmin e-trex 10), Vortex binocular (10×42) and Nikon monocular (30×65). The monitoring of movements started at the end of July. One eagle (Dano) was tagged in 2011 and the other four eagles in 2012. The flying ability and behaviour of the bird with the transmitter was checked in the field. The maximum signal range was 16 km in flight, 4.4 km on the tree and 2.2 km on the ground. For the telemetry the homing method (Kenward 2001) was used, and distances were estimating based on the signal strength in the flat terrain. The distance estimation was also tested in the field, when the bird with the transmitter was visually observed and the signal strength was simultaneously checked. In three cases the individual was visually observed and identified by local ornithologists. Two different areas were classified during the movement analysis: the post-fledging area and temporary settlement area (TSA). Post-fledging areas mean those areas occupied by juveniles after fledging, within the parents' territory (approx. radius 20 km from the nest). The calculated area also contains positions recorded more than 20 km away from the nest, in cases when the individual returned to the area of the parents´ territory. The second type of occupied area was the temporary settlement area, an area occupied by eagles more than 20 km from the natal area for more than five days.

Data analysis

The TSA and post-fledging areas were represented with 100% minimum convex polygons (MCPs) and 95% characteristic hull polygons (CHPs). Locations of the birds, 100% MCPs and 95% CHPs were visualised and calculated using the Quantum GIS program (version 1.8.0.). The 95% CHP (Downs & Horner 2009) method was used for the clarification of the monitored area. All calculations were performed in the ETRS89/ETRS-LAEA coordinate reference system. Maps were created using Openstreetmap (2013) layers as background layers. The LibreOffice programm (The Document Foundation 2012) was used for the data management. The cover of habitats was analyzed from the CORINE raster layer (2006, raster resolution 100x100m) for 95% CHPs.

Results

Movements

Movements of the imperial eagles (Fig. 1) were monitored in the western part of Slovakia and in the border area between Austria and Hungary. All individuals were from three natal areas (Tab. 1).

In the post-fledging areas the eagle Dano spent the time near the nest (1–2 km) and in the parents' main hunting territory (4–11 km from the nest). After leaving the post-fledging areas, he occupied the TSA in the Austria – Hungary border area. In this area he was observed regularly in a group of other imperial eagles (2–3 inds) and white-tailed eagles (2–6 inds). Night roosting places were recorded in windbreaks and in a small forest in the border area. The second eagle Oliver was recorded over a large area (the Záhorská nížina Lowlands, the Podunajská nížina Lowlands and the Malé Karpaty Mts). Part of this area in the Podunajská nížina Lowlands is an important TSA for imperial eagles. Oliver did long exploratory flights. He was twice recorded flying over the Malé Karpaty mountains. The third eagle Šarlota moved in similar parts of the Záhorská nížina Lowlands, the Podunajská nížina Lowlands and the Malé Karpaty Mts. She was also recorded many times flying over the Malé Karpaty Mts. Two siblings from the Záhorská nížina Lowlands, the eagles Dana and Dorota, were recorded in different areas after they left their natal area. Dana was recorded flying over the Malé Karpaty Mts and in the border area between Austria, the Czech Republic and Slovakia. Dorota was found in the same TSA as Dano one year ago. The last location was from the border area between Austria and Hungary in the Kommassantenwiesen Nature Reserve.

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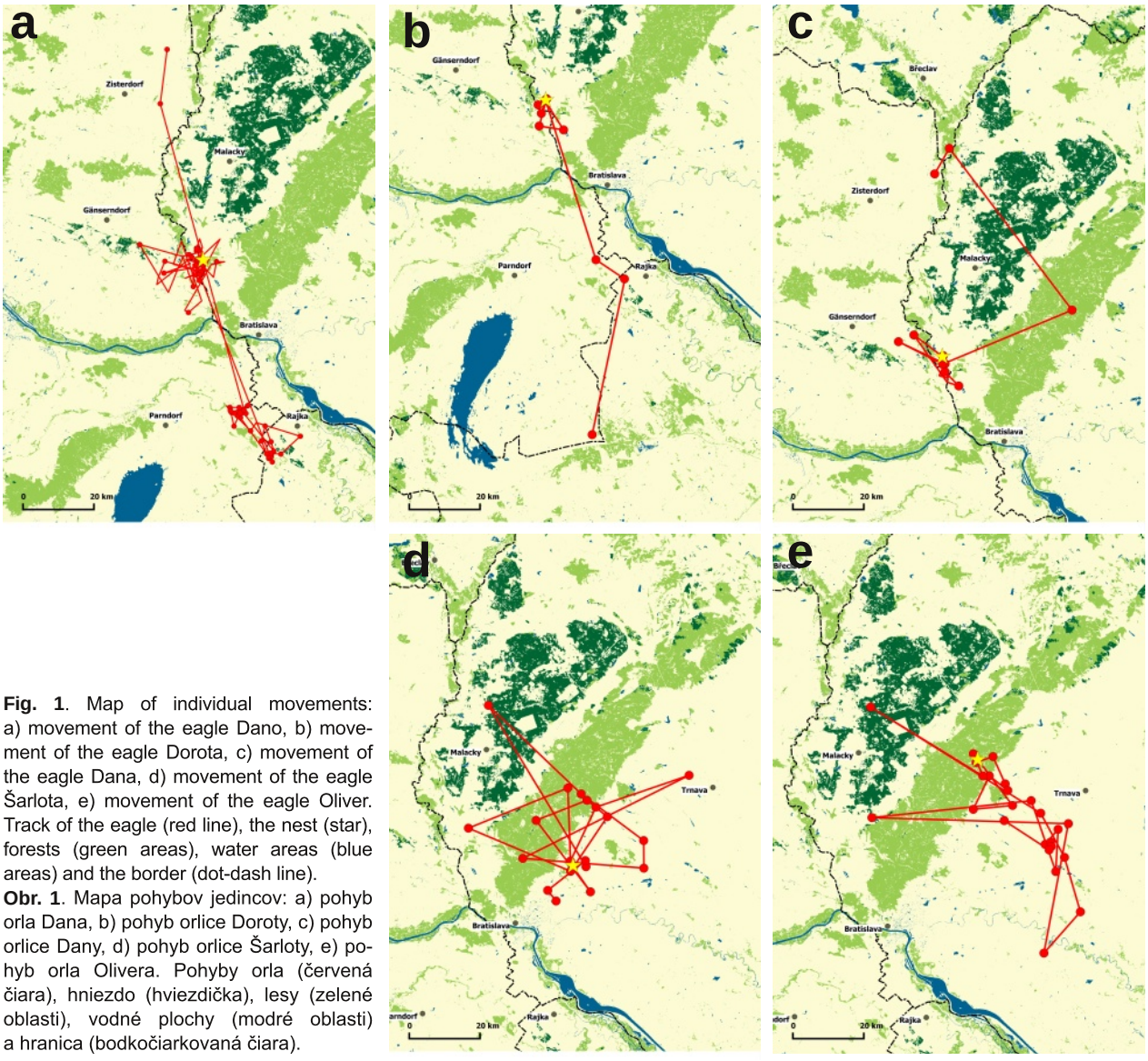

Fig. 1. Map of individual movements: a) movement of the eagle Dano, b) movement of the eagle Dorota, c) movement of the eagle Dana, d) movement of the eagle Šarlota, e) movement of the eagle Oliver. Track of the eagle (red line), the nest (star), forests (green areas), water areas (blue areas) and the border (dot-dash line).
Obr. 1. Mapa pohybov jedincov: a) pohyb orla Dana, b) pohyb orlice Doroty, c) pohyb orlice Dany, d) pohyb orlice Šarloty, e) pohyb orla Olivera. Pohyby orla (červená čiara), hniezdo (hviezdička), lesy (zelené oblasti), vodné plochy (modré oblasti) a hranica (bodkočiarkovaná čiara).

Tab. 1. Data on eagles with radio transmitters. ind. – individual, s – sex (m – male, f – female), rp – recorded positions, vs – visual observations, lt – lasting of telemetry, na – natal area
Tab. 1. Údaje o orloch s rádiovými vysielačkami. ind. – jedinec, s – pohlavie (m – samec, f – samica), rp – zaznamenané pozície, vs – vizuálne pozorovania, lt – trvanie telemtrie, na – oblasť vyliahnutia

ind.	sex	rp	vo	lt	na
Dano	m	71	26	August 2011 – May 2012	Záhorská nížina Lowland
Oliver	m	24	6	August 2012 – December 2012	Malé Karpaty Mts.
Šarlota	f	20	2	August 2012 – September 2012	Podunajská nížina Lowland
Dana	f	12	2	July 2012 – September 2012	Záhorská nížina Lowland
Dorota	f	10	4	July 2012 – November 2012	Záhorská nížina lowland

Tab. 2. Temporary settlement areas and post-fledging areas. Calculated area for 100% minimum convex polygon (MCP) and for 95% characteristic hull polygon (CHP). ind. – individual, ta – type of area (PFA – post-fledging area, TSA – temporary settlement area), pe – period
Tab. 2. Dočasne osídlená oblasť a oblasti využívané po vyletení z hniezda. Rozloha vypočítaná pre 100 % minimálneho convexného polygónu (MCP) a pre 95 % charakteristického polygónu (CHP). ind. – jedinec, ta – typ oblasti (PFA – oblasť po vyletení, TSA – dočasne osídlené územie), pe – obdobie

ind.	ta	pe	MCP [km^2]	95% CHP [km^2]
Dano	PFA	August – September	89	71
Oliver	PFA	August – December	969	507
Šarlota	PFA	August – September	941	605
Dano	TSA	October – February	68	57

Tab. 3. Cover of habitats in the temporary settlement area and post-fledging areas. ind. – individual, pfa – post-fledging area, tsa – temporary settlement area
Tab. 3. Pokrytie biotopov v dočasne osídlenej oblasti a v oblastiach využívaných po vyletení z hniezda. ind. – jedinec, pfa – oblasť po vyletení, tsa – dočasne osídlené územie

	PFA			TSA
category / ind.	DanoH	Oliver	Sarlota	DanoD
arable land[1]	62.4	60.3	40.5	78.4
forests[2]	14.3	25.4	38.6	12.1
pastures[3]	10.7	0.3	0.5	0.0
heterogeneous agricultural areas[4]	7.6	2.1	2.4	8.0
urban fabric[5]	4.3	5.5	5.2	0.0
scrub and/or herbaceous vegetation associations[6]	0.8	1.2	2.3	1.1
inland wetlands[7]	0.0	0.1	0.2	0.0
mine. dump and construction sites[8]	0.0	0.1	0.4	0.0
industrial. commercial and transport units[9]	0.0	0.5	1.9	0.5
artificial. non-agricultural vegetated areas[10]	0.0	0.5	0.7	0.0
inland waters[11]	0.0	0.8	0.2	0.0
permanent crops[12]	0.0	3.3	7.0	0.0
∑	100	100	100	100

1 – orná pôda, 2 – lesy, 3 – pasienky, 4 – heterogénne poľnohospodárske oblasti, 5 – urbanizovaná zástavba, 6 – kroviny a/alebo trávne areály, 7 – vnútrozemské mokrade, 8 – areály ťažby, skládok a výstavby, 9 – priemyselné, obchodné a dopravné areály, 10 – areály sídelnej nepoľnohospodárskej vegetácie, 11 – vnútrozemské vody, 12 – trvalé plodiny

M o n i t o r e d a r e a s

One temporary settlement area (TSA) and three post-fledging areas were recorded (Tab. 2). Eagles Šarlota and Oliver used larger areas (Fig. 2). They spent more time far away from the nest, but they returned to the parents´ territory. Their exploratory flights were longer and more frequent than those by the eagle Dano (Šarlota – max. 33 km from the nest, Oliver – 38 km, Dano – 12 km). The TSA for one of the eagles Dano was smaller than the post-fledging area. Both individuals (Oliver and Šarlota) crossed the Malé Karpaty Mts and they explored the Záhorská nížina Lowlands. The cover of habitats (Tab. 3) in the nesting areas showed a high proportion of arable land. The tree cover of the forest habitat varied between 14–39%. Other habitat categories had lower cover in the post-fledging areas. In the TSA, the arable land and heterogeneous agricultural areas covered a higher proportion of the area than in the post-fledging areas.

Discussion

Movements of imperial eagles have been analysed in several European countries: in Bulgaria (Gradev et al. 2011a, 2011b), Hungary (Meyburg et al. 1995, Kovács et al. 2008) and Slovakia (Danko et al. 2011). In Slovakia, eagles monitored with telemetry (Danko et al. 2011) were recorded in temporary settlement areas in western Slovakia (between the towns of Trnava, Sereď and Senec, and near Jaslovské Bohunice, Kolárovo and Palárikovo villages). Two eagles from this study were recorded in the area between the three towns (Trnava, Sereď and Senec). Another TSA was found in the border area between Nickelsdorf, Pama, Rusovce and Bezenye. Two eagles from the Záhorská nížina Lowlands were recorded here. This

area is important for immature and adult eagles (Horváth et al. 2008, Wichmann pers. comm.). Imperial eagles from the Záhorská nížina Lowlands also used the nearby TSA on Bernhardsthaler Ebene plain in Austria (Horal 2009). In the Záhorská nížina Lowlands there is no recorded TSA, although a higher number of eagles was recorded during the cropping of fields.

In Austria the landscape structure (the main part of the TSA) is different from that of the neighbouring countries. Plots are smaller with various crops compared with the large monoculture areas in Slovakia and Hungary. This study shows the highest cover of arable land and forests in the post-fledging areas and in the temporary settlement area. In the TSA in this study there are numerous hares and pheasants. Diversity of crops and intensive game management allow a high game density in the area, which attracts predators. Due to the intensive agriculture, the extensive managed habitat categories (pastures, heterogeneous agricultural areas) cover smaller areas. The area of forest in the post-fledging areas of two eagles corresponds with the location of the nest (placed in the forest) and with exploratory flights over the Malé Karpaty Mts. In the TSA foraging habitats dominate (arable land, heterogeneous agricultural areas), and the forest cover is lower than in the post-fledging areas. In Hungary, three habitat categories dominate in eagle territories: sunflower, winter wheat and natural grassland (Kovács et al. 2008). In Slovakia, two juvenile eagles monitored with telemetry preferred corn stubble, rape, grassland, barley and ploughed fields in the agricultural land (Danko et al. 2011).

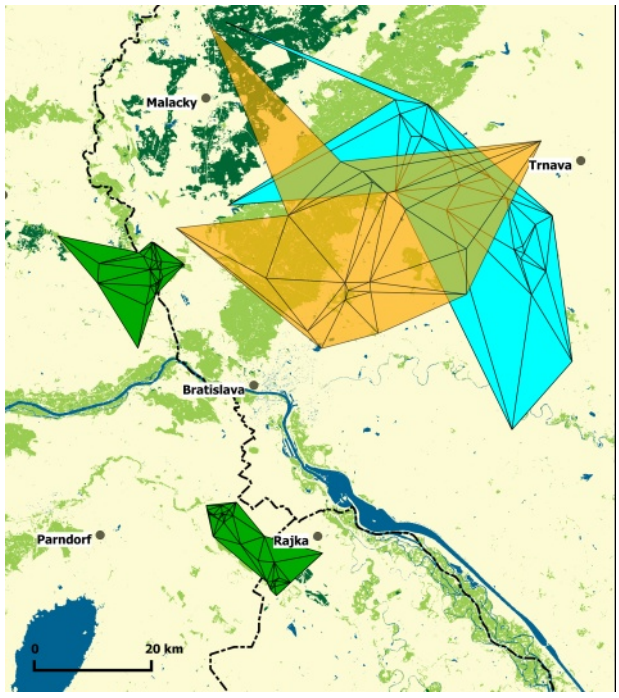

Fig. 2. Map of the temporary settlement areas and the post-fledging areas expressed by the 95% CHP method. Post-fledging area of the eagle Šarlota (orange polygon), post-fledging area of the eagle Oliver (blue polygon), post-fledging and the temporary settlement area (near Rajka village) of the eagle Dano (green polygons).
Obr. 2. Mapa dočasne osídlenej oblasti a oblastí po vyletení vyjadrených pomocou 95% CHP metódy. Oblasť po vyletení orlice Šarloty (oranžový polygón), oblasť po vyletení orla Olivera (modrý polygón), oblasť po vyletení a dočasne osídlená oblasť (blízko obci Rajka) orlom Danom (zelené polygóny).

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