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Movements of a male greater spotted eagle (*Clanga clanga*) during its 2nd and 3rd calendar years

Pohyby samca orla hrubozobého (*Clanga clanga*) počas jeho druhého a tretieho kalendárneh roku

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Abstract: The greater spotted eagle (*Clanga clanga*) is poorly known compared to other European eagles. We tracked an immature greater spotted eagle during 2018–2020 within the eastern European part of the species' distribution, west of the Ural Mountains. Because so little is published about the annual movements of this species, especially from that region, tracking data from this single individual are valuable. 95% kernel density estimator (KDE) range sizes for the two complete winters in Yemen were 4,009 km^2 (2018), 1,889 km^2 (2019); 95% dynamic Brownian bridge movement models (dBBMM) encompassed 1,309 km^2 (2018) and 1,517 km^2 (2019). It returned to the same wintering area every year. During summer 2018, it settled into a small area (95% KDE = 126 km^2; 95% dBBMM = 21 km^2) near Birsk, eastern European Russia; in 2019 it wandered over a huge area (95% dBBMM = 66,304 km^2) of western Kazakhstan and southern Russia, south west of Yekaterinburg. Spring migration 2018 was west of the Caspian Sea; during 2019 it was east of it. Mean speed of spring migration was 160±120 km/day during 2018, and 132±109 km/day during 2019. Autumn migration passed east of the Caspian in both years, and the mean speed of migration was 62 ± 78 km/day in 2018, and 84 ± 95 km/day in 2019. During both spring and autumn migrations, the eagle made stopovers, mostly lasting 1–2 days. The eastern Alborz Mountains in northeastern Iran appeared to be an important stopover locale, where autumn stopovers lasted 19 days (2018) and 27 days (2019). These and other data suggest that most greater spotted eagles that spend summers west of about 42°E, winter in southern Europe, Asian Turkey, the Levant and Africa, and those that summer to the east of that meridian winter in southern Asia, including Arabia.

Abstrakt: Orol hrubzobý (*Clanga clanga*) je v porovnaní s ostatnými európskymi orlami málo známy. V rokoch 2018 – 2020 sme v rámci východoeurópskej časti areálu druhu, západne od pohoria Ural, sledovali nedospelého orla hrubozobého. Vzhľadom na malé množstvo publikovaných informácií o pohzbe tohto druhu v priebehu roka, najmä z tohto regiónu, sú údaje o pohybe nami sledovaného jedinca cenné. 95%-ný odhad jadrovej hustoty (kernel density estimation, KDE) veľkosti areálu jedinca počas dvoch zím v Jemene boli 4009 km^2 (2018), 1889 km^2 (2019); 95%-né dynamické Brownove modely prepojeného pohybu (dynamic Brownian bridge movement models, dBBMM) zahŕňali 1309 km^2 (2018) and 1517 km^2 (2019). Jedinec sa vrátil zimovať na to isté územie každý rok. Počas leta 2018 sa usadil v malom území (95% KDE = 126 km^2; 95% dBBMM = 21 km^2) v blízkosti Birska, európska časť Ruska; v roku 2019 sa pohyboval ponad veľké územie (95% dBBMM = 66 304 km^2) západného Kazachstanu a južného Ruska, juhozápadne od Jekaterinburgu. Na jar 2018 migroval západne od Kaspiku; v 2019 východne od neho. Priemerná rýchlosť jarnej migrácie bola v roku 2018 160 ± 120 km/deň a v roku 2019 132 ± 109 km/deň. V jeseni migroval východne od Kaspiku v oboch rokoch, priemerná rýchlosť migrácie bola 62 ± 78 km/deň v roku 2018 a 84 ± 95 km/deň v roku 2019. Počas jarnej aj jesennej migrácie robil orol zastávky trvajúce väčšinou 1 až 2 dni. Dôležitou migračnou zastávkou sa zdá byť východná časť pohoria Alborz v severovýchodnom Iráne, kde jesenné zastávky trvali 19 dní (2018) a 27 dní (2019). Tieto a ďalšie údaje naznačujú, že väčšina orlov hrubozobých, ktoré trávia letá západne približne od 42° východnej dĺžky, zimujú v južnej Európe, ázijskej časti Turecka, v Levante a v Afrike, a tie, ktoré trávia leto východne od tohto poludníka zimujú v južnej Ázii, vrátane Arabského polostrova.

Key words: satellite tracking, telemetry, migration, home range, stopovers

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Introduction

The greater spotted eagle (*Clanga clanga*) is a medium-sized, migrant eagle that breeds in forests located mostly in lowlands near wetlands or lakes. The breeding distribution lies between the boreal and steppe zones (i.e. mid-north latitudes) from easternmost Poland and the Baltic countries in the west to the Pacific Ocean in the east (i.e. NE China, Primorsky Krai, Russia), and spans more degrees of latitude in the west than in the east (Meyburg et al. 2016b, 2020b, BirdLife International 2021). The distribution of breeding greater spotted eagles in the Asian part of its distribution is patchy and little known (Väli et al. 2019). Breeding concentrations exist in the Volga-Ural region (e.g. Belaya River basin), the West Siberian lowlands (e.g. Tobol River basin), and in Altai-Sayan (e.g. Chulym River basin, Krasnoyarsk Krai) (Karyakin 2008, Karyakin et al. 2012).

Greater spotted eagle is considered to be globally Vulnerable (Meyburg et al. 1998, IUCN 2021). Habitat loss is considered the main cause of declines, though disturbance and persecution are also threats (Meyburg et al. 2001, 2020b, BirdLife International 2021, Väli et al. 2021). Across its vast distribution, but particularly east of the Ural Mountains, the annual movements of this rare species are rather poorly known. Information about migration and wintering is limited from across its distribution because ringing has revealed very little. Only a few tracking studies of small numbers of birds from the western borders of its global distribution have been published (Meyburg et al. 1995, 1998, 2005, Meyburg & Meyburg 2007, Dombrovski et al. 2018, Väli et al. 2018, 2021). Recently, a few birds have been tracked from as far east as areas near Vyazniki, Russia (~ 200 km east of Moscow, 56°E; A. Mischenko, V. Melnikov, https://gps.aquila-it.pl/en/migration-maps/greater-spotted-eagle-moscow). Greater spotted eagles tracked in those studies migrated south in autumn, some southwest towards Iberia, others south and south east towards Greece, the Balkan countries, Turkey and the Levant. Some birds migrated only as far as the northern rim of the Mediterranean, but others wintered in Arabia and north east and East Africa, as far south as Zambia (Meyburg et al. 1998, Pérez-García et al. 2014, Väli et al. 2021). Tracking studies from farther east are few and of limited duration, but show birds from wintering grounds in Arabia migrating toward summering areas in northern Kazakhstan, and bordering areas of Russia in eastern Europe and western Siberia (Meyburg et al. 1995, Strick et al 2011).

We describe two years' of movements by a young greater spotted eagle that summered in Kazakhstan and eastern European Russia and wintered in southern Arabia. This bird was caught by chance during a study that targeted mostly Egyptian vultures (*Neophron percnopterus*, McGrady et al. 2019, B. Meyburg & M. McGrady unpublished data), and is the only greater spotted eagle that we tracked. However, given the general lack of detailed data on the movements of greater spotted eagles, data from even this single individual are potentially indicative of the movements of greater spotted eagles from summering grounds in eastern European Russia.

Methods

We captured, using a padded leg-hold trap (Bloom et al. 2007), a juvenile greater spotted eagle on 14 January 2018 at the Muscat municipal landfill at Al Multaqaa, Oman (28.34°N, 58.46°E). We ringed and measured it (wing: 490 mm, mass: 1,875 g), and took a blood sample. The bird had a large light brown nape patch, which is typical for *C. clanga* – *C. pomarina* hybrids, but very rare in pure *C. clanga* (Clark 1988, Meyburg et al. 2016b). We tested whether the bird was indeed a hybrid using a set of neutral microsatellite and single-nucleotide polymorphism markers (Väli et al. 2010a, b); its sex was determined using the amplification of sex-chromosome specific loci of the chromo-helicase-DNA-binding protein gene (Fridolfsson & Ellegren 1999). Tests showed this bird to be pure *C. clanga*, and a male.

We fitted it with a 45g solar-powered GPS-PTT (Global Position System-Platform Transmitter Terminal; Microwave Telemetry, Inc., USA) as a backpack (Meyburg & Fuller 2007), and tracked it until 19 January 2020, when movement data ceased. [N.B. The eagle was observed and photographed without its transmitter, and identified from its colour ring in Kuwait on 17 October 2020 (R. AlHajii pers. comm.)]. Data from one partial and two complete autumn migrations and two complete spring migrations were collected. Data were also collected for two complete summers, two complete and one partial winter.

The PTT (ID = 47637) was programmed to acquire a GPS fix (including speed, bearing and altitude) every hour during 00:00–18:00 GMT, via the Argos system of satellites, which also provided Doppler locations of the bird (http://www.argos-system.org/manual/3-location/34_location_classes.htm).

GPS location data were visually screened for errors using QGIS 3.10, and R 4.02 (R Core Team 2020) using R-Studio (R-Studio Team 2020). R and R-Studio and the packages *move* (Kranstauber et al. 2012, 2020), *adehabitat*, *adehabitatHR* (Calenge 2006, 2015, 2020), and *ggplot2* (Wickham 2016) were used for analysing and visualizing data. All calculations were made using the North Pole Lambert Azimuthal Equal Area Projection (Gudmundsson & Alerstam 1988; WKID: 102017). In creating maps of the eagle's movement we used as background the digital elevation map from the U.S. Geological Survey (USGS) Earth Resources Observation & Science (EROS) Center, and satellite imagery available from Mapbox© & OpenStreetMap©. For all annual phases (i.e. summer, autumn and spring migration, winter) we used GPS data for our analyses. During summer 2019, major gaps (> 1 day) occurred in the GPS data. We filled those gaps, to the extent that was possible, by supplementing the GPS data with plausible Doppler locations (taking into account information on speed and the location of adjacent GPS data). The total distance travelled on migration (km) was the sum of the distance between migration locations. Mean daytime ground speed (km/hr) was the distance between daytime locations divided by the number of hours those locations spanned. Speed of migration (km/hr) was the Euclidean distance between successive night time roost locations divided by the available daylight hours on that day. The mean speed of migration (km/day) was the sum of distances between night-time roosts divided by the number of days on migration.

When GPS data were sparse around the beginning and end of migration, we used Doppler data to determine more precisely when migration started and ended. The date of departure on migration was defined as the first day the eagle changed behaviour, and moved along a trajectory away from either the summering or wintering area at the end of the relevant season. The eagle arrived from migration when it reached the known summering or wintering distribution, and movements became short and non-directional. However, the within-season pattern of movement varied from year to year (e.g. movement during summer 2018 was different than in 2019) and across seasons, and this sometimes obscured when, precisely, migration began or ended. In summer 2019 the bird's behaviour made determining precisely the arrival and departure dates difficult; we used a balance of evidence (e.g. date, rate and direction of movement, flight behaviour, habitat) to determine those.

Night-time was defined as the period between sunset and sunrise on the relevant date at the relevant latitude/longitude. On nights when multiple roost locations were recorded, the nominal location of the roost was the mean of all locations.

We defined stopover sites as locations during migration periods where the distance between successive night-time roosts was ≤10 km. We chose the 10 km criterion because in none of the three winters did the median distance between winter-time roosts (i.e. when the bird was settled) exceed this value. In some cases the eagle moved farther than 10 km during the course of 24 hrs, but then returned to within 10 km of the earlier roost. In light of the migration patterns of the two complete autumn migrations (2018 & 2019), we judged that the eagle was on migration when caught in Oman, and that the capture location was therefore a stopover. We used the same method to identify temporary settlement locations during summer 2019, but used a 30 km distance criterion for successive night-time roosts and that the eagle stayed for at least three days at the same locale.

For analysing movements during winter and summer we calculated the eagle's Utilization Distribution (UD), and mapped the resulting isopleths using dynamic Brownian Bridge Movement Models (dBBMM, Kranstauber et al. 2012) and a kernel density estimator

Tab. 1. Annual phases of a young, male greater spotted eagle tracked via satellite during 2018–2020. *Doppler locations were used to supplement GPS data. See methods for details, also Fig. 3.
Tab. 1. Ročné fázy satelitne sledovaného mladého samca orla hrubozobého počas rokov 2018 – 2020. * Dopplerove pozície boli použité na doplnenie GPS údajov. Pre viac informácií pozri Metodiku a Obr. 3.

season / obdobie	dates / dátum	duration (days) / trvanie (dni)	GPS locations (Doppler) / GPS lokalizácie (Doppler)
autumn 2017 (partial) / jeseň 2017 (čiastočne)	14 Jan–15 Feb 2018	33	546
winter 2017–18 / zima 2017–18	16 Feb–23 Apr 2018	67	1146
spring migration 2018 / jarná migrácia 2018	24 Apr–23 May 2018	30	461
summer 2018 / leto 2018	24 May–25 Sep 2018	126	788
autumn migration 2018 / jesenná migrácia 2018	28 Sep 2018–16 Jan 2019	111	1422
winter 2018–19 / zima 2018–19	17 Jan–25 Apr 2019	99	1678
spring migration 2019 / jarná migrácia 2019	26 Apr–23 May 2019	28	425
summer 2019* / leto2019*	24 May–1 Oct 2019	131	1069 (363)
autumn migration 2019 / jesenná migrácia 2019	2 Oct–28 Nov 2019	58	794
winter 2019–20 (partial) / zima 2019–20 (čiastočne)	29 Nov 2019–19 Jan 2020	52	681

(KDE; Worton 1989). Raster size was set for both calculations depending on the spatial extent of the eagle's movement in each season: 500 m for all winters and summer 2018, and 2,500 m for summer 2019. In calculating the dBBMM we set margin size to 3, window size to 7 and time step to 4 min (see https://bartk.gitlab.io/move/articles/move.html). For the KDE analyses we used the reference bandwidth (href), but excluded locations separated by less than an hour to standardize the sampling interval and reduce temporal autocorrelation (Limiñana et al. 2007). Excluded data were only Doppler locations because the collection of GPS locations occurred hourly. We did not calculate the KDE for summer 2019 because the eagle wandered widely, which caused isopleths to balloon excessively. We summarised the UDs for the dBBMMs at the 50%, 75%, 95% and 100% levels, and at the 50% and 95% levels for the KDEs.

We describe habitats at stopovers and non-migratory settlement areas as the predominant (>25%) IUCN Habitat Type (Level 1 for Natural & Level 2 for Artificial Terrestrial Habitats; See Jung et al. 2020) within a 10 km buffer around the stopover night-time roost location. We also visually examined zoomed-in satellite images of stopover and settlement areas, which provided further insight into the habitats used by the eagle at those places (see first summer).

Results

General description

The eagle was tracked for 735 days (14 Jan 2018–19 Jan 2020, Tab. 1). It wintered each year in southwestern Yemen (approx. 13.5°N, 43.8°E), spent summer 2018 in a small area of southern Russia (approx. 55.5°N, 55.5°E), and during summer 2019 wandered over a very large area in western Kazakhstan. It made stopovers of variable duration along the migration routes in both spring and autumn (Fig. 1). In total the eagle flew a minimum of 44,443 km (Tab. 2) during tracking.

Winter movements

The eagle wintered in southwestern Yemen in every winter it was tracked; winter ranges overlapped considerably (Fig. 2). Dynamic Brownian Bridge range size estimates averaged 47.5 ± 5.3 km^2 for the 50% isopleth, and 1,658.4 ± 357.1 km^2 for the 95% isopleth (N = 3, Fig. 2, Tab. 3). Winter arrival dates in Yemen were highly variable; only two days separated the two winter departure dates we recorded (Tab. 1). The main habitats in the area used by the eagle during winter were shrub and savanna (Tab. 4), though visual inspection of zoomed-in satellite images of the area revealed these areas to also include small villages and farmland.

Migration

Autumn migration was east of the Caspian Sea in both 2018 and 2019; spring migration was west of the sea in 2018, and east of it in 2019. (Fig. 3). Autumn migration was slower than spring migration (Tables 1 and 2). The mean migration speed in autumn was 96.4, 61.8 and 84.4 km/day for 2017 (Oman to Yemen), 2018 and 2019, respectively. For spring migration the values were 159.8 and 132.3 km/day for 2018 and 2019, respectively.

During the two complete migration cycles the eagle was tracked, six spring stopovers and 16 autumn stopovers were identified (Tab. 5 and Fig. 1). Counting the

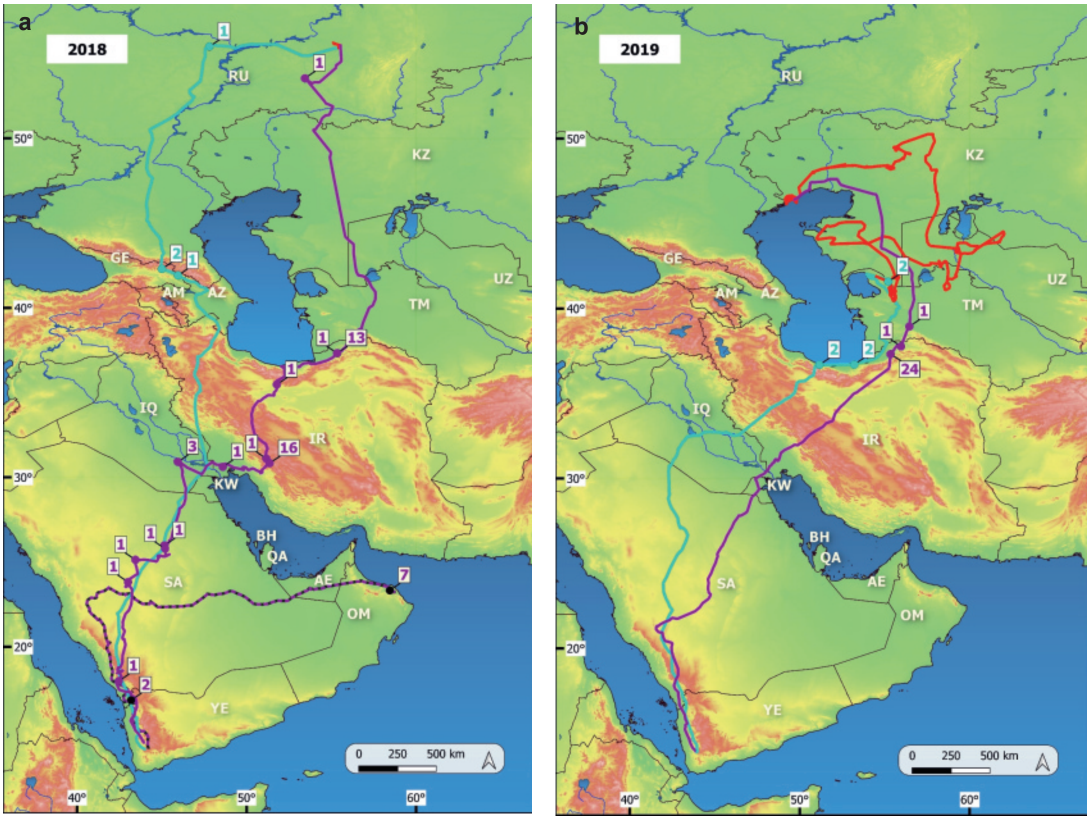

Fig. 1. Movements of a young, male greater spotted eagle tracked during 14 January 2018–19 January 2020, a) 14 January–31 December 2018, b) 1 January 2019–19 January 2020. Stopover locations are identified by the number of stopover days spent at each (i.e. 1 stopover day = 2 overnight roosts). Black and purple line = autumn migration 2017 (partial), light blue = spring migration, red = summer, purple = autumn migration.

Obr. 1. Pohyby mladého samca orla hrubozobého sledovaného od 14. januára 2018 do 19. januára 2020: a) 14. január – 31. december 2018, b) 1. január 2019 – 19. január 2020. Lokality zastávok sú označené počtom dní na nich strávených (t.j. 1 deň zastávky = 2 nocovania). Čierno-fialová čiara = jesenná migrácia 2017 (čiastočne), svetlomodrá = jarná migrácia, červená = leto, fialová = jeseň.

capture location as a stopover location, there were two stopovers during the partial autumn migration from Oman to Yemen. Most stopovers were used only once, and were at various locations. However, the eagle stopped in the Alborz Mountains, Golestan Province, Iran (approx. 37.5°N, 55.5°E), during both autumn migrations (See later), albeit in different locations.

Spring migration

Tables 2 and 3 detail spring migration distances and speeds; table 5 contains information about the stopovers made during spring migration in 2018 (N = 3), and 2019 (N = 3; Fig. 1).

On 24 April 2018 the eagle left its wintering area, and started its northward migration, crossing Saudi Arabia, Iraq and Iran, then flying west of the Caspian Sea through Azerbaijan. It crossed the Greater Caucasus in Georgia at or near the Arkhotisghele Pass (2,968 m, approx. 42.62°N, 44.89°E), then flew down the Asa River valley, and onto the east European Plain. It arrived at its summering location in southern Russia (approx. 55.43°N, 55.48°E) on 24 May (30 days after commencing migration, See Summer movements). The migration between wintering in Yemen and summering in Russia in 2018 spanned about 41.5 degrees of latitude. The mean daytime ground speed during spring migration 2018 was 13.6 ± 17.4 km/hr, N = 380 (Tab. 2). Three stopovers were recorded during this migration (Tab. 5, Fig. 1).

The path of spring migration 2019 was different than spring 2018, and took the eagle east of the Caspian Sea (Fig. 1), commencing on 26 April and ending on 23 May (Tab. 1) in western Turkmenistan, northwest of the town of Serdar (38.98°N, 56.28°E). The 2019 spring migration spanned about 35 degrees of latitude. The mean daytime ground speed during spring migration 2019 was 11.7 ± 16.4, N = 322 (Tab. 2). Three stopovers were recorded during this migration (Tab. 5, Fig. 1).

Summer movements

During summer 2018 the eagle settled initially (23 May) in a mostly forested area along the Belaya River, about 10 km south of the town of Birsk, Russia (approx. 55.49°N, 55.51°E), west of the Ural Mountains. On 6 June it moved to a forested location along that river, about 8 km northwest of the town. During summer 2018, the 95% KDE encompassed 125.7 km^2, the 95% dBBMM encompassed 20.7 km^2 (Fig. 4a, Tab. 3). It spent at least 99 days at this summer location. Habitat in the area used by the eagle was predominantly arable (Tab. 4), but close visual inspection of satellite images showed that almost 100% of the locations were in a strip of forest adjacent to the river. After 12 September and before migration, only a few locations were recorded, including a short (~ 20 km) movement west (downstream) before the eagle embarked on autumn migration (28 September); summering lasted 130 days (Tab. 1).

During summer 2019 (Tab. 1) the eagle wandered over a huge area of mostly western Kazakhstan (Fig. 2b), in contrast to its settled behaviour the previous summer. Over the course of summer 2019 it travelled at least 8,950.1 km; the 95% dBBMM encompassed 66,304 km^2 (Tab. 3). There was no overlap between the summer 2018 and summer 2019 ranges. The eagle settled for at least four days at a minimum of six locations during summer 2019 (Fig. 4b, Tab. 4). The main habitats at those settlement areas were rocky areas, savanna, shrub, and wetland.

Autumn migration

On 20 January 2018, six days after release at the capture site, the eagle moved to southwestern Saudi Arabia, then more slowly south to inland southwestern Yemen (Fig. 1), west of the city of Ibb (approx. 13.77°N, 43.92°E), arriving on 16 February and settling there for the rest of the winter. The movement from Oman to Yemen covered 4,241 km, and was achieved in 33 days. The mean daytime ground speed during autumn migration between Muscat and Yemen was 10.4 ± 13.3 km/hr, N = 354 (Tab. 3).

On 28 September 2018 the eagle commenced autumn migration. It followed a path east of the Caspian Sea, across Turkmenistan, Iran, southern Iraq and Saudi

Tab. 2. Summary of migratory movements by a young, male greater spotted eagle during different annual phases, 14 Jan 2018–19 Jan 2020.
Tab. 2. Súhrn migračných pohybov mladého samca orla hrubozobého počas rôznych ročných fáz, 14. január 2018 – 19. január 2020.

	great circle distance (km) / ortodróma	total distance (km) / celková vzdial.	mean speed ofmigration ± SD (km/d) / priem. rýchl. migrácie ± SD	max. distance covered in a single day (km) / max. denná vzdialenosť	mean daytime ground speed ± SD (km/hr) / priem. rýchlosť počas dňa ± SD	mean hourly speed of migration ± SD (km/daylight hr) / priem. rýchl. migrácie (km/hod. denn. svitu)	number of night roosts identified / počet zaznamenaných nocovísk
Oman–Yemen (autumn 2017) / Oman–Jemen (jeseň 2017)	1822.9	4106.9	96.4 ± 80.1	256.1	10.4 ± 13.2	8.7 ± 7.3	34
Yemen–Russia (spring 2018) / Jemen–Rusko (jar 2018)	4696.6	5562.6	159.8 ± 120.5	370.1	13.5 ± 17.4	11.6 ± 8.8	29
Russia–Yemen (autumn 2018) / Rusko–Jemen (jeseň 2018)	4589.5	7448.3	61.8 ± 78.2	516.2	6.3 ± 9.6	5.8 ± 7.2	95
Yemen–Kazakhstan (spring 2019) / Jemen–Kazachstan (jar 2019)	3249.4	4300.9	132.3 ± 108.8	399.0	11.7 ± 16.4	9.9 ± 8.3	28
Kazakhstan–Yemen (autumn 2019) / Kazachstan–Jemen (jeseň 2019)	3640.0	5103.7	84.4 ± 95.2	323.9	8.4 ± 12.8	7.7 ± 8.7	57

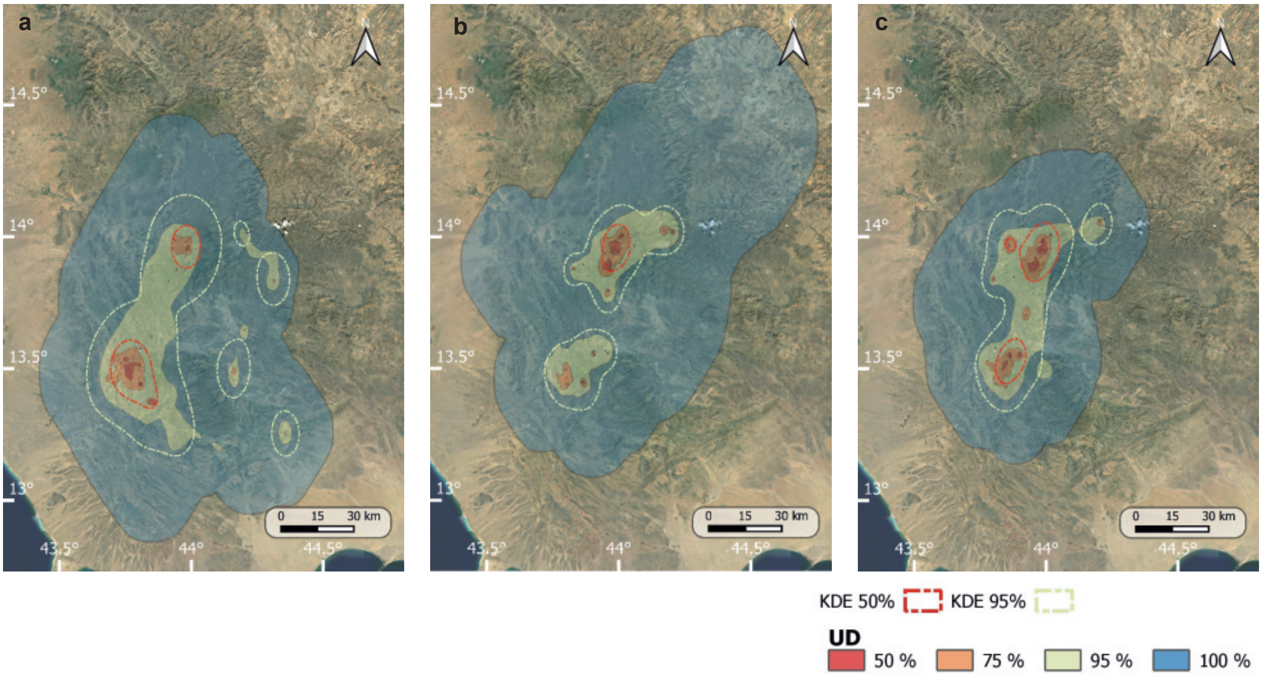

Fig. 2. Kernel Density Estimator (KDE) and dynamic Brownian Bridge Movement Model (dBBMM) representations of movements of a young, male greater spotted eagle in Yemen during the winters of: a) 2017–18, b) 2018–19 (complete), and c) 2019–20 (partial). NB: Scale is the same for all maps. UD: utilization distribution; KDE: 50% and 95% isopleth.

Obr. 2. Jadrový odhad hustoty (KDE) a dynamický Brownov model prepojeného pohybu (dBBMM) reprezentujúce pohyb mladého samca orla hrubozobého v Jemene počas zimy a) 2017 – 2018, b) 2018 – 2019 (celé) a c) 2019 – 2020 (čiastočne). NB: Mierka je rovnaká pre všetky mapy. UD: rozloženie využitia; KDE: 50 a 95% izolínia.

Arabia, then into Yemen (Fig. 1). It arrived at its wintering site after 81 days, on 16 January 2019. The 2018 autumn migration covered 7,448 km (Tab. 3), and spanned about 41.5 degrees of latitude. The mean daytime ground speed during autumn migration 2018 was 6.3 ± 9.6 km/hr, N = 871 (Tab. 3). Thirteen stopovers were recorded during this migration (Tab. 5, Figures 2 and 3); the eagle stopped for relatively longer periods (19 days in 2018, 27 days in 2019) in the Alborz Mountains, Iran, during both autumn migrations. The habitats at those locations were Arable and Grassland (Tab. 5), a characterization that agreed, in general, with visual examination of satellite images.

Autumn migration 2019 commenced on 2 October. The eagle migrated along a path that took it east of the Caspian Sea, and then along a similar route to that used in autumn 2018. The mean daytime ground speed during autumn migration 2019 was 8.4 ± 12.8 km/hr, N = 479 (Tab. 3). Three stopovers were recorded during this migration (Tab. 5, Figures 2 and 3). During the 2019 autumn migration the eagle flew 5,103.7 km, and its migration spanned about 30 degrees of latitude.

Discussion

Migration and the use of stopovers

Keeping in mind the wide longitudinal distribution of greater spotted eagle and that individuals can be short-, medium- or long-distance migrants, the behaviour of the bird that we tracked comported well with other tracking studies of greater spotted eagles (See: Meyburg et al. 2016b, 2020b, Väli et al. 2018, 2021), especially those that wintered in Arabia (Meyburg et al. 1995, Strick et al. 2011, Environment Agency Abu Dhabi (EAD) 2020, Kuwait Environmental Lens (KEL) unpublished data) – all migrated between Arabia to locations in Kazakhstan and southern Russia, west of the Urals, except the adult tracked by Meyburg et al. (1995), which migrated to the western Siberian lowlands east of the Urals. Also, migration arrival and departure dates were similar to other studies, as was ranging on summering and wintering areas, taking into account the age and breeding status of the tracked birds (Meyburg et al. 1995, Strick et al. 2011).

Tab. 3. Sizes (km^2) of ranges of a young, male greater spotted eagle during winters (2017–18, 2018–19 (complete), 2019–20 (partial)), and summers (2018, 2019).
Tab. 3. Veľkosti (km^2) okrskov mladého samca orla hrubozobého počas zím (2017 – 18, 2018 – 19 (celé), 2019 – 20 (čiastočne) a liet (2018, 2019).

	dBBMM UD 50 %	dBBMM UD 75 %	dBBMM UD 95 %	dBBMM UD 100 %	KDE 50 %	KDE 95 %
winter / zima 2017–18	46.7	284.7	2149.0	14711.4	556.5	4009.8
winter / zima 2018–19	41.5	243.0	1309.2	16087.4	177.9	1889.1
winter / zima 2019–20	54.4	330.2	1517.0	8690.6	472.2	2349.0
summer / leto 2018	1.1	4.5	20.7	1990.3	17.6	125.7
summer / leto 2019	464.0	6213.1	66304.0	768396.2	Not calculated	Not calculated

Tab. 4. Locations where a young, male greater spotted eagle settled for ≥4 days during summers and winters 2018–2020.
Tab. 4. Lokality, kde mladý samec orla hrubozobého ostal na ≥4 dni počas liet a zím 2018 – 2020.

phase / obdobie	arrival–departure dates / datum príletu – odletu	duration (days) / trvanie (dní)	mean latitude, longitude (decimal degrees) / priemerná zemepisná šírka, dĺžka (desatinné stupne)	habitat* / habitat*
winter 2017–18 / zima	19 Feb–3 Mar	13	13.423, 43.820	shrub[1]
	6–16 Mar	11	13.478, 43.777	shrub
	19–24 Mar	6	13.530, 43.778	shrub
	27–30 Mar	4	13.480, 43.788	shrub
	12–23 Apr	12	13.960, 43.986	savanna[2]
summer 2018 / leto	24 May–24 Sep	124	55.449, 55.496	arable[3]
winter 2018–19 / zima	22 Jan–3 Feb	13	13.504, 43.847	savanna, shrub
	5 Feb–6 Mar	30	13.880, 43.967	savanna
	8 –19 Mar	12	13.937, 43.968	savanna
	21 –25 Mar	36	13.978, 44.018	savanna
summer 2019 / leto	30 Mar–7 Jun	9	40.851, 55.528	desert4
	9 –12 Jun	4	41.025, 55.405	desert, grassland[5]
	17 Jul–27 Aug	42	49.472, 55.730	grassland
	5–8 Sep	4	46.465, 49.709	wetland[6]
	11 –14 Sep	4	46.455, 49.673	wetland
	17 –29 Sep	13	46.431, 49.768	wetland
winter 2019–20 / zima	29 Nov–7 Dec	9	13.945, 43.912	savanna, shrub
	10–21 Dec	12	13.909, 43.974	savanna
	23–27 Dec	5	13.525, 43.850	shrub, savanna
	29 Dec–3 Jan	5	13.665, 43.918	shrub
	07–18 Jan	12	13.762, 43.915	savanna, shrub

* IUCN Habitat Type. See text for details from visual examination of zoomed-in satellite images. /
Typ habitatu podľa IUCN. Pozri text pre viac informácií o vizuálnom posúdení zväčšených satelitných fotografií. [1]Kroviny, [2]savana, [3]orná pôda, [4]púšť, [5]trávnaté habitaty, [6]mokraď.

Generalizations about migration being affected by the ecology of the species, distance between summering and wintering areas, the existence of stopover sites, and age/experience/breeding status of the individual (Newton 2008) appeared to hold true for the tracked bird. Although detailed published data for greater spotted eagle are limited, the general pattern of migration of this species also finds similarities with other long-distance migrant raptors in Europe and Africa, particularly the closely-related lesser spotted eagle (*Clanga pomarina*; Meyburg 2021, Välli et al. 2021).

Our data and those from other greater spotted eagles that wintered in Arabia (two adult, one juvenile) show spring migration starting between 2 February (adult, Meyburg et al. 1995) and 26 April (this study), and ending between 21 April (Meyburg et al. 1995) and 5 June (Strick et al. 2011, See also RRRCN 2014, 2017a, b). Timing of spring migration for birds from farther west seems to be similarly variable, and linked to age (See: Väli et al. 2021). The bird we tracked arrived in the summering area almost a month later than the adult male tracked by Meyburg et al. (1995), and an adult of

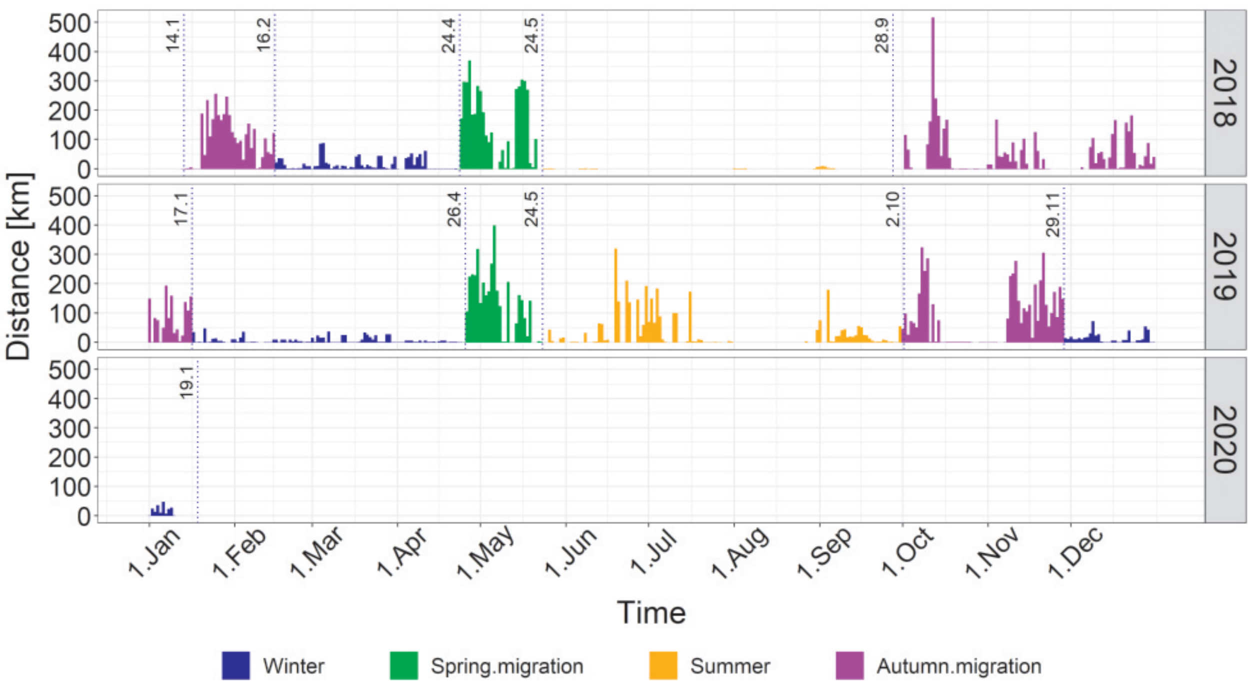

Fig. 3. Distance between successive night time roost locations of a young, male greater spotted eagle during January 2018–January 2020. Vertical lines indicate change of annual phase.

Obr. 3. Vzdialenosť medzi po sebe idúcimi miestami nočného odpočinku mladého samca orla hrubozobého v období od januára 2018 do januára 2020. Zvislé čiary označujú zmenu ročnej fázy.

unknown gender that wintered in Kuwait (KEL unpublished data). While on spring migration, it travelled at a rate similar to the adult eagle tracked by Meyburg et al. (1995), and others from the west (Väli et al. 2021). Although the bird we tracked was too young to breed, spring migration was faster than autumn migration (as it was for European birds migrating from Africa: Väli et al. 2021). Stopovers occurred during both spring migrations we studied (see later), but were not consistently located in or near large areas of wetter habitats. However, this result may have been affected by the scale of the habitat data we used as visual examination of satellite images showed that stopovers were sometimes near small areas of wetter habitat, near lakes, streams or in valleys.

Greater spotted eagles are generally present in Arabia from late September to late April–early May (Meyburg et al. 2016b, Väli et al. 2021). Autumn migration of tracked greater spotted eagles of different ages from the flyway used by our eagle commenced during 28 September (this study)–5 October (KEL unpublished data), and ended during 16 October (KEL unpublished data)–16 February (this study), and were not different than those recorded for eagles from more western parts (Väli et al. 2021). In the two years of our study, the bird we tracked commenced its autumn migration in the last week of September; its end was variable (15 Feb (2017–18), 16 January (2018–19), 28 November (2019–2020)). This variability in arrival dates on the wintering grounds was probably driven, at least in part, by food availability; as the bird travelled south it found places to forage with sufficient food to slow migration, and perhaps cause it to stopover. However, age/experience may have also played a part. The juvenile tracked by Strick et al. (2011) wandered in Arabia during its first winter, settled on the Indus delta, Pakistan during its second winter, and returned to the delta in the two subsequent years (NARC unpublished data). Autumn migration was consistently slower than spring migration for the bird we tracked: mean autumn 2018 = 61.8 km/day, mean autumn 2019 = 84.4 km/day. As in spring migration, the speed of our tracked bird fell within the range of highly variable speeds reported for western eagles (e.g. 57 km/day, Meyburg et al. 2005; 217 km/day, Dombrovski et al. 2018).

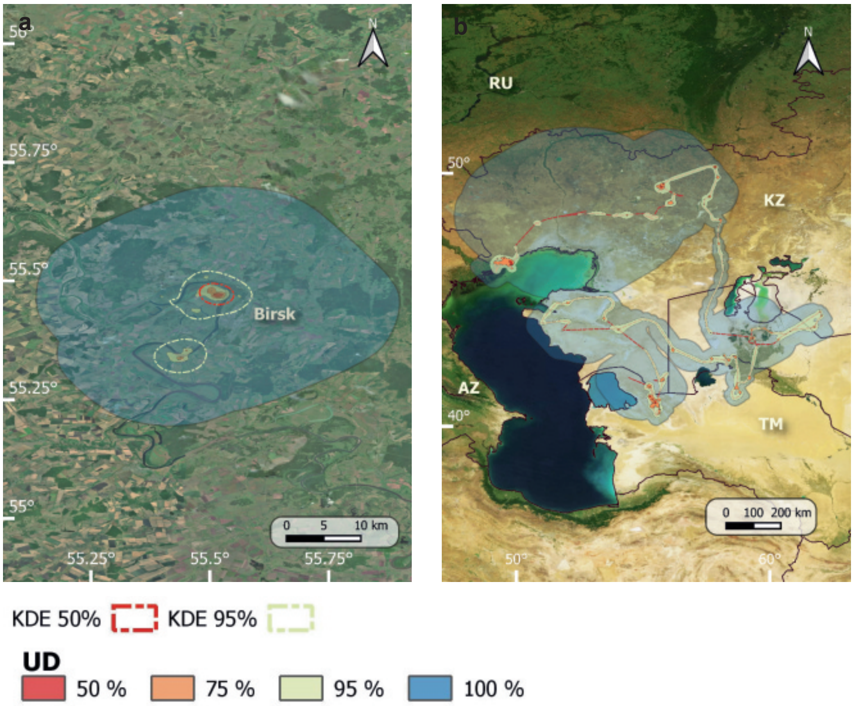

Fig. 4. Kernel Density Estimator (KDE) and dynamic Brownian Bridge movement model (dBBMM) representations of summertime movements of a young, male greater spotted eagle in: a) 2018, b) 2019. NB: Scale is different in a) and b). UD: utilization distribution; KDE: 50% and 95% isopleth.

Obr. 4. Jadrový odhad hustoty (KDE) a dynamický Brownov model prepojeného pohybu (dBBMM) reprezentujúce pohyb mladého samca orla hrubozobého počas leta v a) 2018, b) 2019. NB: Mierka máp je odlišná. UD: rozloženie využitia; KDE: 50 a 95% izolínia.

Stopovers were also made during autumn migration, especially in 2018, when they accounted for about 45% of the time spent on migration (Tables 1 and 5). The bird was captured at an autumn stopover (as revealed by its subsequent movement), where food (carrion) was super-abundant (Al Fazari & McGrady 2016). Thus, factors other than simply food availability appear to affect the settlement of greater spotted eagles in winter. Stopovers were more common, and comprised a greater proportion of the migration period in autumn than in spring. As with spring stopovers, there was no apparent link between the autumn migration stopovers and wet habitats when using only the IUCN habitat data, but satellite images revealed that stopovers were sometimes near small areas of wetter habitat.

Additionally, some individual greater spotted eagles wander after arriving on summering and wintering grounds (Strick et al. 2010, RRRCN 2014, 2017a, b, Meyburg et al. 2020b, unpublished data, Väli et al. 2021, KEL, Maciorowski unpublished data, this study), making it difficult to identify when exactly migration stops and wintering/summering begins. Wandering is likely more common in young individuals because they are anchored neither to breeding sites nor wintering areas. All young greater spotted eagles (N = 4) tracked in eastern parts of the European distribution have wandered on either or both summering and wintering grounds to some extent (Strick et al. 2010, RRRCN 2014, 2017a, b, this study).

Although data are still few, and there are sure to be exceptions, telemetry and the few ring recoveries that exist tentatively suggest that most greater spotted eagles that spend summers west of about 42–44°E, winter in Europe and Africa, and those that summer to the east of those longitudes winter in Arabia, southern and Southeast Asia (Meyburg et al. 1995, 2016b, 2020b, Strick et al 2011, RRRCN 2014, 2017a, b, Väli et al. 2021, but see also: "Rudy" http://en.orlikgrubodzioby.org.pl/artykul/satellite-tracking).

The bird we tracked showed fidelity to its wintering area, a characteristic of most adult greater spotted eagles that have been tracked (Meyburg & Meyburg 2005, Pérez-Garciá et al. 2014, Meyburg et al. 1998, 2016b, Maciorowski & Meyburg unpublished data, KEL unpublished data), but not of all young eagles (Strick et al. 2010, Meyburg et al. 2016b, Väli et al. 2021). This is consistent with the view that age and experience appear to influence, but not necessarily determine, fidelity to wintering sites (Newton 2008).

Stopover locations are where eagles might refuel, and modulate speed of migration in response to local environmental conditions (e.g. weather), and might be

Tab. 5. Migratory stopovers made by a young, male greater spotted eagle during 2018–2019. A = autumn, S = spring.
Tab. 5. Migračné zastávky mladého samca orla hrubozobého počas rokov 2018 – 2019. A = jeseň, S = jar.

	arrival date / prílet	departure date / odlet	location / lokalita	latitude, longitude / zempepisná šírka, dĺžka	habitat / habitat*
A 2017	Unknown	20/01/2018	Muscat, Oman	23.33, 58.45	Desert[1]/rocky areas[2]
	08/02/2018	11/02/2018	W Yemen / Z Jemen	16.84, 43.18	Arable[3], grassland[4]
S 2018	09/05/2018	11/05/2018	NE Georgia / SV Gruzínsko	41.91, 45.95	Forest[5], arable
	11/05/2018	14/05/2018	NE Georgia	42.30, 45.00	forest, grassland
	19/05/2018	21/05/2018	Chuwash, Russia / Čuvašsko, Rusko	55.48, 47.80	Shrubland[6]
A 2018	03/10/2018	05/10/2018	Orenburg, Russia / Orenburg, Rusko	53.43, 53.54	arable
	18/10/2018	01/11/2018	Alborz Mountains, NE Iran / Alborzské vrchy, SV Irán	37.32, 55.34	arable
	02/11/2018	04/11/2018	Alborz Mountains, NE Iran	37.32, 55.34	arable
	11/11/2018	13/11/2018	near Tehran, Iran / pri Teheréne, Irán	35.47, 51.78	desert
	19/11/2018	21/11/2018	S Central Iran, near Ahvaz / juh stredného Iránu, blízko Ahvazu	31.10, 51.16	shrubland, grassland
	21/11/2018	08/12/2018	S Central Iran / juh stredného Iránu	30.83, 51.35	shrubland, grassland
	13/12/2018	15/12/2018	S Iraq / J Irak	30.62, 48.59	arable
	17/12/2018	21/12/2018	SW Iraq / JZ Irak	30.91, 45.94	desert
	24/12/2018	26/12/2018	Central Saudi Arabia / stredná Saudská Arábia	25.99, 45.15	desert
	26/12/2018	28/12/2018	Central Saudi Arabia	25.79, 45.19	desert
	01/01/2019	03/01/2019	Central Saudi Arabia	25.13, 43.44	desert
	04/01/2019	06/01/2019	Central Saudi Arabia	23.82, 43.00	desert
	11/01/2019	13/01/2019	SW Saudi Arabia / JZ Saudská Arábia	17.97, 42.46	rocky areas, shrub
S 2019	10/05/2019	11/05/2019	NW of Tehran, Iran / SZ od Teheránu, Irán	36.69, 51.16	forest, wetland[7]
	11/05/2019	14/05/2019	E of Tehran, Iran / V od Teheránu, Irán	36.70, 53.20	arable
	21/05/2019	24/05/2019	Mangystau, Kazakhstan / Kazachstan	41.58, 55.21	desert
A 2019	10/10/2019	12/10/2019	Kopet Dag Mountains, Turkmenistan / pohorie Kopet Dag Turkménsko	38.94, 56.45	arable/grassland
	12/10/2019	14/10/2019	Alborz Mountains, NE Iran	37.77, 55.96	grassland/arable
	14/10/2019	08/11/2019	Alborz Mountains, NE Iran	37.32, 55.35	arable

[1]Púšť, [2]skaly, [3]orná pôda, [4]trávnaté habitaty, [5]lesy, [6]kroviny, [7]mokrade.

particularly important for young birds during their initial migrations (Newton 1979, Klaassen et al. 2014, Meyburg et al. 2017). Not all stopover sites comprised predominantly wetter habitats that are typically associated with greater spotted eagles. Indeed, this bird was caught at a stopover at a landfill surrounded by arid natural habitats. Most stopovers by our bird were used only once. However, the eagle stopped in the Alborz Mountains, Golestan Province, Iran, during both autumn migrations. A migration bottleneck has been identified between the northern slopes of those mountains and the Caspian Sea (Panuccio et al. 2018), and a tracked adult greater spotted eagle migrated in autumn along the southern slopes (Meyburg et al. 1995). Migration stopovers should be investigated more fully when data from other individuals are available.

For the bird we tracked, spring migrations took less time, its mean speed of flight was higher, and fewer stopovers were made than in autumn. Keeping in mind the benefits to adults of arriving early on the breeding grounds, these consistent differences between autumn and spring support the impression that individual greater spotted eagles are rather adaptable in terms of their migration behaviour, and can opportunistically modulate their migration (via stopovers or slower pace of migration) to feed. Indeed, the effect of stopping over may be the main reason the pace of autumn migration was slower for our tracked bird than reported for eagles from farther west (Väli et al. 2021). As with our bird, two juvenile eagles from nests in Altai, Russia made stopovers as they approached their wintering and summering grounds (RRRCN 2014, 2017a, b).

Winter and summer movements

The ecological and behavioural flexibility displayed by our bird and other tracked greater spotted eagles during migration (e.g. RRRCN 2014, 2017a, b, Väli et al. 2021, this study) extended to periods when not migrating, and was similar to that of young *C. pomarina* (e.g. Meyburg et al. 2007). When captured, the eagle we tracked was juvenile (about 7 months old). During 2018 it settled into a small summer home range (Figures 1 and 4), where the density of greater spotted eagle territories in the surrounding area was high (the nearest known nesting site was about 7 km away, Karyakin 2008). In 2019, the eagle did not show fidelity to the summering area of 2018, and behaved very differently (Figures 1 and 4). IUCN habitat types at places where it settled for short periods during the summer of 2019 were not what are normally thought of as being good for greater spotted eagles (i.e. wet). Much of the area over which the bird ranged in summer 2019 was steppe habitat comprised mostly of grasslands that might have held concentrations of small mammals (e.g. susliks).

Väli et al. (2018) states that winter home ranges are small (especially when compared to lesser spotted eagle, Meyburg & Meyburg 2009, Meyburg 2020b), and are typically at wetland sites (Maciorowski et al. 2019), but also at anthropogenic dump sites and sometimes drier locations (see also Meadows 2011). The winter home range of an adult greater spotted eagle that wintered in Yemen was about 50 km^2 (Meyburg et al. 1995), which is similar to the 50% dBBMM estimates for the three winters our bird was tracked.

The data we present are important in that they provide some of the first detailed information on the movements of an immature greater spotted eagle along this flyway over a longer period. Other information exists (e.g. Meyburg et al. 1995, Strick et al. 2010, RRRCN 2014, 2017a, b), but is not so detailed, and some data are, as yet, unpublished (e.g. EAD 2019, 2020, KEL, Meyburg et al., Maciorowski et al. unpublished data). Although data are from only a single individual, they appear to agree with the results of those other studies, and studies from farther west (See Meyburg 2020b, Väli et al. 2021 for summaries). However, when considering our results and comparing them with other studies it is important to keep in mind that gaps existed in our GPS data, and tracking technology has improved collection rates and accuracy (See: Poessel et al. 2017). As a consequence, data from more individuals using improved technology are needed to understand more fully the year-round ecology of greater spotted eagle, and promote their conservation.

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Spatial and temporal changes in the diet composition of the Eurasian eagle-owl (*Bubo bubo*) in Slovakia comparing three historical periods

Priestorové a časové rozdiely v zložení potravy výra skalného (*Bubo bubo*) na Slovensku porovnaním troch historických períód

Ján OBUCH

Abstract: The author evaluates his own data on the food of the Eurasian eagle-owl (*Bubo bubo*) in Slovakia using material he collected between 1975 and 2020. A total of 105,543 food items were identified in 254 samples taken at 136 localities. Mammals had the highest representation (Mammalia, 65 species, 58.4%), and the species composition of birds was diverse (Aves, minimally 140 species, 8.5%), but the common frog (*Rana temporaria*, 32.0%), from the lower vertebrates, is represented more abundantly. Invertebrates (Evertebrata, 0.1%) occurred in food residues only occasionally. The bulk of the samples were collected from eagle-owl nests. The samples were divided into three time periods (A–C), which differ in the manner of human land-use management: A up to the 1950s, with a smaller area of field plots and more extensive grazing in the uplands; B from the 1950s to the 1980s, during the Socialist period, with the concentration of agricultural production in large units; C the last 30 years, 1990 to 2020, with the gradual break-up of collective land management. The first period (A) is characterised by a strong dominance of frogs, particularly the European brown frog *R. temporaria* (44.6%), and a large share of small mammal species of the family Muridae (genera *Apodemus* and *Mus*). During the time of Socialism (B), eagle-owls adapted to hunting larger species of mammals and birds, and the share of frogs in their food fell by half (*R. temporaria*, 23.3%). With the decline in livestock production after 1990 (period C), the species diversity of birds increased: aquatic species and raptors in particular are on the rise. Successive overgrowth of pastures in the submontane zone is reducing the hunting territories of eagle-owls. The dominance of the common vole (*Microtus arvalis*) in their diet has gradually increased from period A (26.8%) to period C (37.3%). Data from eleven areas around Slovakia are evaluated separately for the three time periods. In period A, the highest proportion of frogs was in the Liptov region (*R. temporaria*, 68.2%), when eagle-owls nested deeper in the mountains. The proportion of frogs decreased towards lower areas, and in the Ponitrie (Nitra river basin) it was only 10.8%. At the same time, the share of *M. arvalis* and larger prey increased. A similar trend of increasing shares of larger prey towards lower locations also applied during the Socialist period (B). In the last 30 years (C), frogs in the higher river basins have given way to European water voles *Arvicola amphibius* and *M. arvalis*. In association with the progressive overgrowth of pastures, forest species such as the yellow-necked mouse (*Apodemus flavicollis*) and bank vole (*Myodes glareolus*) are increasingly prevalent, as are the white-breasted hedgehog (*Erinaceus roumanicus*) and various thrushes (*Turdus* sp.).

Abstrakt: Autor vyhodnocuje vlastné údaje o potrave výra skalného (*Bubo bubo*) z územia Slovenska z materiálu, ktorý zbieral v rokoch 1975 až 2020. Spolu z 254 vzoriek na 136 lokalitách bol determinovaný materál zo 105 543 kusov potravy. Dominantné zastúpenie majú cicavce (Mammalia, 65 druhov, 58,4 %). Pestré je druhové zloženie vtákov (Aves, minimálne 140 druhov, 8,5 %), ale početnejšie je zastúpený z nižších stavovcov skokan hnedý (*Rana temporaria*, 32,0 %). Len príležitostne sa vo zvyškoch potravy vyskytujú bezstavovce (Evertebrata, 0,1 %). Prevažná časť vzoriek bola zbieraná na hniezdach výrov. Vzorky boli rozdelené do troch časových období (A – C), ktoré sa líšia spôsobom hospodárskeho využívania krajiny človekom: A do 50 rokov 20. storočia s menšou výmerou poľných parciel a s rozšírenejšou pastvou v pohoriach; B v 50. až 80. rokoch 20. storočia v období socializmu s koncentráciou poľnohospodárskej výroby vo veľkých celkoch; C posledných 30 rokov 1990 až 2020 s postupným rozkladom kolektívneho vlastníctva pôdy. Prvé obdobie (A) sa vyznačuje silnou dominanciou žiab, najmä druhu *Rana temporaria* (44,6 %) a veľkým podielom malých druhov cicavcov z čeľade Muridae (rody *Apodemus* a *Mus*). V období socializmu (B) sa výry preorientovali na lov väčších druhov cicavcov a vtákov a podiel žiab klesol na polovicu (*R. temporaria*, 23,3 %). Útlmom živočíšnej výroby po roku 1990 (obdobie C) sa zvyšuje druhová diverzita vtákov: pribúdajú najmä vodné druhy a dravce. Sukcesné zarastanie pasienkov v submontánnom pásme zmenšuje lovné teritóriá výrov. Dominancia hraboša poľného (*Microtus arvalis*) sa postupne zvyšuje od obdobia A (26,8 %) po obdobie C (37,3 %). Údaje z 11 oblastí Slovenska sa vyhodnocujú osobitne pre uvedené 3 časové obdobia. V období A bolo najvyššie zastúpenie žiab na Liptove (*R. temporaria*, 68,2 %), keď výry hniezdili hlbšie v pohoriach. Pomerné zastúpenie žiab sa znižovalo smerom do nižších polôh a na Ponitrí tvorilo len 10,8 %. Zároveň sa zvyšoval podiel *M. arvalis* a väčšej koristi. Podobný trend zvyšovania podielu väčšej koristi smerom do nižších polôh platil aj v období socializmu (B). V posledných 30 rokoch (C) sú vo vyššie položených kotlinách žaby nahradzované hrabošovitými hlodavcami *Arvicola amphibius* a *M. arvalis.* V súvislosti so sukcesným zarastaním pasienkov sa zvyšuje podiel lesných druhov *Apodemus flavicollis* a *Myodes glareolus*, ale tiež ježa *Erinaceus roumanicus* a drozdov (*Turdus* sp.)

Key words: Eurasian eagle-owl, diet, Slovakia, spatial and temporal changes.

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Introduction

The Eurasian eagle-owl (*Bubo bubo*) is an apex predator which in central European conditions responds to the presence of available prey depending on human land management in the agricultural steppe. This activity in Slovakia has changed significantly over the last 100 years, with the gradual collectivisation of agricultural production during the 40 years of Socialism (1950 to 1989). In 1955, 39% of agricultural land was under common ownership; in 1961 this was up to 89% of the land (Tibenský 1978), and the last private lands in mountain areas were merged in the 1970s. The pasturage which prevailed in mountain areas (Häufler 1955) gradually disappeared, and pastures were converted into woodland as part of the delimitation designed to create a forest land fund. Pasturage was also gradually moved from mountain locations to foothill areas as a result of the establishing of national parks and protected landscape areas (Piscová et al. 2018). Since 1990 however, there has been a gradual dissolution of agricultural co-operatives and mainly a decline in animal production. The consequence is the successive overgrowth of former meadows and pastures in foothill areas with bushes and subsequently by forest stands, which has reduced the overall hunting area for Eurasian eagle-owls. In 1950, woodland covered 36.2% of the area of Slovakia; in 1990 this was 40.3% and in 2019 41.3%. The current annual increase is 10 km^2 of forest area (Moravčík 2020).

The first data on the food of the Eurasian eagle-owl are from the interwar period and the 1960s, from the foothills of the Tatra Mts (Schaefer 1967, 1972). In their collected work on the diet of the eagle-owl from the entire Palearctic, Jánossy & Schmidt (1970) present, in addition to Schaefer's interwar results, only the material of approximately 100 food items from the Slovenský kras Mts (Rožňava) and the Malá Fatra Mts (Terchová). Štollmann collected the pellets and Schmidt determined their content. I began my own systematic research in the mid-1970s. In addition to the areas that I processed, there are more comprehensive results from the Malé Karpaty Mts (Darolová 1990). My first studies of the eagle-owl diet were carried out in the Pohronie (Hron river basin, Obuch 1979), the Ponitrie (Nitra river basin, Obuch 1980a), the Turiec (Turiec Basin, Obuch & Darola 1980, Obuch 1982), the Žilinská kotlina Basin (Obuch 1980b), the Liptov Basin (Vondráček & Obuch 1980, Obuch 1981), the Muránská planina Plateau (Obuch 1985a, 2002a) and the Považie (Middle Váh river basin, Obuch 1985b). After 1990, the areas of the Slovenský kras Mts (Obuch 1992, 1998), the Rimavská kotlina Basin (Obuch 1995a, 2000), the Slovenský raj National Park (Obuch 1995b) and the Orava region (Obuch 1995c, Obuch & Karaska 2010) were also examined. We pointed out the breeding of the Eurasian eagle-owls in the valleys of the Nizké Tatry Mts before their afforestation in connection with botanical (Kučera et al. 2009) and speleological research (Kudla et al. 2019). More recently, I have presented summary results from research on the eagle-owl diet in Slovakia (Obuch 2018a) and outlined changes over time in the composition of its diet in some regions of this country (Obuch 2017, 2018b).

In the past, the Eurasian eagle-owl was persecuted by hunters, especially in countries with a tradition of breeding small feathered and furry game (Andreska & Andreska 2020). The first efforts to protect the Eurasian eagle-owl in the interwar period in Germany were linked with more comprehensive study of its diet (Uttendörfer 1939, 1952). At that time R. März devoted the most time to studying the food of the Eurasian eagle-owl. His data from the Českolipsko region in the

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northern Czech Republic (März 1940) were followed up some 40 years later by Vondráček & Honců (1978) and then after another 40 years by Andreska et al. (2021). A comparison of shorter time periods in the Nízky Jeseník Hills informed the work on the Eurasian eagle-owl diet by O. Suchý (Suchý 1980, 1990), which was followed by Havelková (2007). Following on from Schaefer's research in the 1930s and 1960s, I compared changes in the diet of the eagle-owl in 30-year periods in the Belianske Tatry Mts (Obuch 2002b).

In the work presented here, my own results are assessed after supplementation of data from 11 regions of Slovakia and their classification into three time segments. To make it possible to build on the current results in the future, I present in the appendices a complete list of identified species in the diet of Eurasian eagle-owls in the individual studied areas.

Material and methods

The characteristics of the areas and a list of the Eurasian eagle-owl food samples used for individual time periods are provided in the appendices (Appendix 1). When characterising the areas, the climate is described according to Konček (1980). The locations of the studied areas and sites are drawn on the map of Slovakia (Fig. 1). Most of the osteological material comes from the nests of eagle-owls located on rock shelves and in shallow cavities. In Slovakia, Eurasian eagle-owls also nest on ledges below deeper cliff overhangs and in caves with clay bottoms close to the rock walls (Obuch 1994). In suitable locations, they use the same site, or multiple sites in the same rock massif, for several years. Each year they dig a nesting hole, mixing older and younger layers of bone as they do so. In the first collections in the 1970s and 1980s, I distinguished nests that were still being used at that time (period B, 40,833 prey items) from long-abandoned nests with bones in the deeper layers of the soil (period A, 50,795 pieces). Items gathered from nests used since 1990 were included in period C (13,915 pieces). In some cases, a mixture of older bones were found in the eagle-owl nests which could not be separated due to the mixing. In such cases, the whole collection was assigned to the more recent period. This did not significantly affect the overall res-

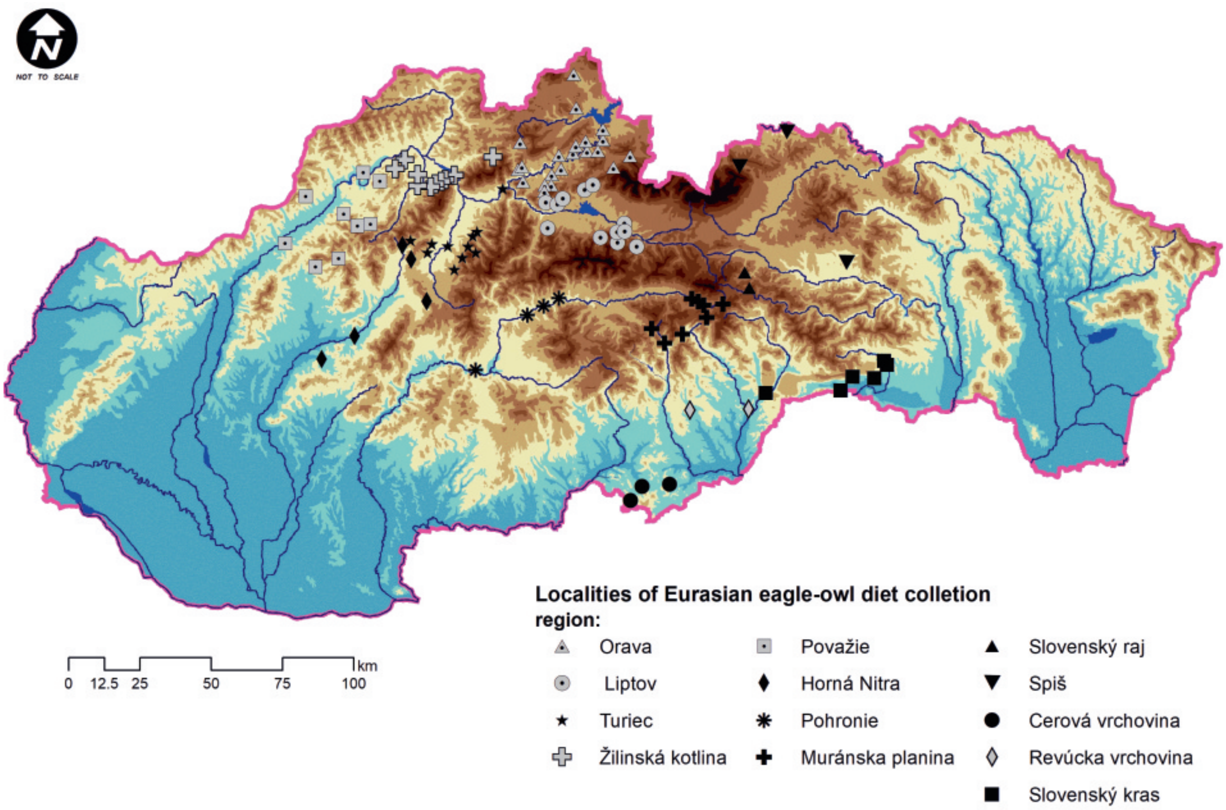

Fig. 1. Localities of Eurasian eagle-owl food sampling according to research area.
Obr. 1. Lokality zberov potravy výra skalného podľa skúmaných oblastí.

ult, because changes in the composition of fauna due to developments in land management occurred gradually over a period of one to two decades. Eagle-owls abandoned one of the nests in Komornícká dolina Valley after the death of one of the partners. Its skeleton, which was found near the nest, was dated by means of the radiocarbon method (C14) with 68% probability to the period of 1860 ± 30 years. Similarly, the bones from extinct eagle-owl nests at the Sokol locality were dated using the radiocarbon method (C14) to period A (1890 ± 50 years). On the basis of such dating, I assume that the vast majority of period A material is not older than 200 years (Kaizer et al. 2018). Most of the identified material came from the time of feeding the young in the spring. I removed food residues from nests by flooding the mixture of soil and passing it through a thick sieve in standing water. I soaked the fur from pellets and the organic impurities which floated to the surface of the water, together with the bones, in a hot solution of 5% NaOH. The heavy bones sank to the bottom of the sieve and the impurities washed out of it. The heavier fraction of rock fragments was separated from the lighter bones at the bottom of the sieve by using circular movements. After drying, the jawbones of mammals (maxilla and mandible, or some teeth) were sorted from the bones for species identification. With hares the heelbones (calcaneus) were also sorted, and the forelegs (humerus) from moles. From birds I identified four types of bones: beaks, feet, shoulder of the wing and lower leg bones (rostrum, tarsometatarsus, humerus and metatarsus). I determined the species of frogs based on the pelvic bone (os ilium), carp-type fish based on the pharyngeal teeth (os pharyngeum inferior), other fish and reptiles based on the jawbones, and invertebrates based on the heads (caput). The author's comparative collections were used in the identification process. The number of each species in the sample was calculated as the minimum possible (MNI) based on the most numerous of the identified body parts. The species name *Apodemus microps* was used in this study for the central European population of Ural field mice (*A. uralensis*) and the subgenus name *Terricola* within the genus *Microtus* (for the pine vole species *Terricola subterraneus* and *T. tatricus*). Due to the unclear differentiation of bone fragments between hooded crows *Corvus cornix* and rooks *C. frugilegus*, we use the common name *C. cornix + frugilegus*. Because a different methodology for processing collections and their identification was used by other authors, in this work I evaluate only my own results. The disadvantage of using older works is the inaccuracy in the determination of some taxa of mammals and birds. Moreover, in my work up to the 1980s, I identified *Apodemus* mice only to the genus level (*Apodemus* sp.) and only later specified them at the species level (Obuch 2004).

I used the marked differences from the mean (MDFM) method (Obuch 2001). Data are presented in modified tables, in which the order of species is arranged such that they create blocks with positive MDFM values (+1, +2) in the columns. The more numerous species without significant differences are listed below the dashed line, arranged according to decreasing total abundance. The bottom rows of the tables consist of the values of the diversity index H', calculated according to Shannon & Weaver 1949. Other less numerous species are listed beneath Table 1 and below the results from the areas presented in the appendices. The Collection database program (Šipöcz 2004) was used when summarising the results from individual samples and constructing the modified tables.

Results

Summary comparison of the food of the Eurasian eagle-owl from three periods in Slovakia

Mammals predominate in the material comprising 105,543 items of Eurasian eagle-owl prey in 254 samples from 11 areas of Slovakia (Mammalia, 58.4%, 45 species) (Table 1). Birds (Aves, 8.5%, minimum 140 species) have a lower proportion, but with high species diversity. In contrast, in the lower vertebrates (Amphibia, Reptilia, Pisces, 33.0%) one species of amphibian dominates: the common frog (*Rana temporaria*, 32.0%). The common vole (*Microtus arvalis*, 31.2%) has a similar prevalence among mammals, and among other mammals the European water vole *Arvicola amphibius* (7.2%), wood mouse *Apodemus sylvaticus* (4.6%) and brown rat *Rattus norvegicus* (3.0%) are more numerous. The incidence of any individual bird species is less than 1%.

The oldest period A is characterised by the small size of Eurasian eagle-owl prey, with high prevalence of *R. temporaria* (44.6%), lower representation of *M. arvalis* (26.8%), but a higher proportion of smaller mouse rodents (Muridae), especially *Apodemus* and *Mus* cf. *musculus*. The garden dormouse *Eliomys quercinus* was a relatively frequent species in all the compared areas of Slovakia. In the Socialist period B (30 to 70 years ago), the share of frogs in the Eurasian eagle-owl diet de-

Tab. 1. Summary of comparisons of Eurasian eagle-owl diet compositions in Slovakia over three historical periods.
Tab. 1. Sumárne porovnanie zloženia potravy výra skalného na Slovensku z troch období.

period (years ago) / obdobie (roky pred)	**A: >70**		**B: 30–70**		**C: <30**		**∑**	**%**
period No. / obdobie č.	**1**		**2**		**3**			
taxa / taxón								
Rana temporaria (n/ks)	1+	22,657	1-	9523	2-	1567	33,747	31.97
%		44.6		23.32		11.26		
Pelophylax cf. *esculentus*	1+	197	1-	45	2-	7	249	0.24
Apodemus sylvaticus	1+	3123	1-	1465	1-	300	4888	4.63
Apodemus microps	1+	1227	2-	177	2-	42	1446	1.37
Apodemus agrarius	1+	293	1-	102		72	467	0.44
Mus cf. *musculus*	1+	617	1-	270	1-	69	956	0.91
Terricola subterraneus	1+	182		116	2-	8	306	0.29
Eliomys quercinus	1+	82	1-	38	1-	10	130	0.12
Gallus gallus dom.	1+	20	1-	4			24	0.02
Galerida cristata	1+	29	1-	8		3	40	0.04
Lanius minor	1+	12		1			13	0.01
Corvus cornix + frugilegus	1-	344	1+	573		149	1066	1.01
Perdix perdix	2-	188	1+	655		145	988	0.94
Phasianus colchicus	2-	14	1+	80		18	112	0.11
Columba palumbus	1-	34	1+	70	1-	7	111	0.11
Streptopelia turtur	1-	18	1+	36		8	62	0.06
Strix aluco		118	1+	153	1-	28	299	0.28
Turdus viscivorus	1-	27	1+	41		10	78	0.07
Nucifraga caryocatactes	1-	3	1+	13		3	19	0.02
Sciurus vulgaris	1-	95	1+	154		51	300	0.28
Mustela nivalis	1-	155	1+	234		58	447	0.42
Sorex araneus	1-	25	1+	40		9	74	0.07
Cypriniformes sp.	2-	25	1+	119		27	171	0.16
Erinaceus roumanicus	1-	177	1+	614	1+	301	1092	1.03
Lepus europaeus	1-	269	1+	469	1+	174	912	0.86
Arvicola amphibius	1-	1816	1+	4337	1+	1428	7581	7.18
Rattus norvegicus	2-	449	1+	1561	2+	1194	3204	3.04
Columba livia dom.	3-	47	1+	287	2+	242	576	0.55
Streptopelia decaocto	3-	1	1+	35	1+	25	61	0.06
Spermophilus citellus	2-	14	1+	52	1+	28	94	0.09
Asio otus	2-	98	1+	309	1+	172	579	0.55
Turdus merula	2-	36	1+	128	2+	100	264	0.25
Anas platyrhynchos	2-	20		58	2+	53	131	0.12
Gallinula chloropus	2-	10		27	2+	45	82	0.08
Tachybaptus ruficollis	2-	2		9	2+	27	38	0.04
Cricetus cricetus		179		166	1+	80	425	0.40
Apodemus flavicollis		1532		1424	1+	667	3623	3.43
Myodes glareolus		326		349	1+	138	813	0.77
Glis glis	1-	49		76	1+	39	164	0.16
Micromys minutus		29	1-	11	2+	38	78	0.07
Ondatra zibethicus	2-	0		14	1+	9	23	0.02
Anas crecca	1-	10		11	1+	17	38	0.04
Fulica atra	2-	2		10	1+	15	27	0.03
Rallus aquaticus		10		7	1+	8	25	0.02
Vanellus vanellus	1-	27		70	1+	46	143	0.14
Columba oenas	1-	40		47	1+	24	111	0.11
Buteo buteo	1-	20		35	2+	40	95	0.09
Falco tinnunculus	1-	56		93	1+	76	225	0.21
Accipiter gentilis		14		13	1+	12	39	0.04
Bubo bubo	1-	9		21	1+	12	42	0.04
Garrulus glandarius	1-	45		79	2+	83	207	0.20
Pica pica	1-	69		79	1+	57	205	0.19
Corvus corax		4		4	1+	8	16	0.02

Tab. 1. Continuation.
Tab. 1. Pokračovanie.

period (years ago) / obdobie (roky pred)	**A: >70**		**B: 30–70**		**C: <30**		**∑**	**%**
period No. / obdobie č.	**1**		**2**		**3**			
taxa / taxón								
Turdus pilaris	2-	32		79	2+	71	182	0.17
Turdus philomelos	1-	99		186	1+	126	411	0.39
Sturnus vulgaris	1-	14		42	1+	27	83	0.08
Erithacus rubecula	1-	7		12	1+	11	30	0.03
Coccothraustes coccothr.		14		10	1+	14	38	0.04
Pelobates fuscus		85	2-	25	2+	87	197	0.19
Lucanus cervus	2-	1	2-	1	2+	34	36	0.03
Vulpes vulpes	1-	34		51	1+	23	108	0.1
Sorex minutus	1-	2		9		3	14	0.01
Cuculus canorus	1-	8		22		9	39	0.04
Anas querquedula	1-	6		17		7	30	0.03
Lacerta agilis	1-	16		27		12	55	0.05
Athene noctua		25	1-	9		8	42	0.04
Salmo trutta		119		86	1-	18	223	0.21
Nyctalus noctula		26		16	1-	1	43	0.04
Microtus arvalis (n/ks)		13,604		14,177		5189	32,970	31.24
%		26.78		34.75		37.29		
Talpa europaea		221		189		50	460	0.44
Coturnix coturnix		235		141		47	423	0.40
Alauda arvensis		157		140		51	348	0.33
Scolopax rusticola		117		111		28	256	0.24
Coloeus monedula		114		100		29	243	0.23
Microtus agrestis		78		85		19	182	0.17
Muscardinus avellanarius		68		66		14	148	0.14
Mustela erminea		53		66		19	138	0.13
Crex crex		39		45		16	100	0.09
Mammalia, 65 species / druhov		**25,008**		**26,565**	**1+**	**10,083**	**61,656**	**58.42**
Aves, min. 140 species / druhov	**1-**	**2588**	**1+**	**4338**	**1+**	**2047**	**8973**	**8.50**
Amphibia, Reptilia, Pisces	**1+**	**23,176**	**1-**	**9910**	**2-**	**1739**	**34,825**	**33.00**
Evertebrata	**1-**	**23**	**1-**	**20**	**2+**	**46**	**89**	**0.08**
∑		**50,795**		**40,833**		**13,915**	**105,543**	**100.00**
Diversity index H'		2.01		2.45		2.67	2.35	

Others prey species (Period no.–no. of items) / Ostatné druhy (Obdobie č. – počet):
Neomys anomalus (1–14; 2–7; 3–2), *Neomys fodiens* (1–38; 2–25; 3–6), *Crocidura leucodon* (1–17; 2–9), *Crocidura suaveolens* (1–17; 2–18; 3–6), *Rhinolophus ferrumequinum* (2–1), *Rhinolophus hipposideros* (1–2; 2–1), *Myotis mystacinus* (1–4; 2–6), *Myotis brandtii* (1–1; 2–1), *Myotis emarginatus* (3–1), *Myotis nattereri* (1–1; 2–1), *Myotis bechsteinii* (1–5; 2–4), *Myotis myotis* (1–23; 2–30; 3–7), *Myotis blythii* (1–2; 2–1), *Vespertilio murinus* (1–15; 2–10; 3–2), *Eptesicus serotinus* (1–32; 2–28; 3–4), *Eptesicus nilssonii* (3–1), *Pipistrellus pipistrellus* (1–10; 2–9; 3–1), *Barbastella barbastellus* (1–13; 2–10), *Plecotus auritus* (1–3; 2–6), *Plecotus austriacus* (2–1), *Dryomys nitedula* (1–37; 2–29; 3–5), *Sicista betulina* (1–17; 2–13; 3–5), *Rattus rattus* (1–3), *Terricola tatricus* (1–5; 2–4; 3–1), *Alexandromys oeconomus* (1–1; 3–1), *Chionomys nivalis* (1–6; 2–5), *Canis familiaris* (1–1; 3–1), *Martes foina* (1–1; 2–1), *Martes* sp. (1–1; 2–3), *Mustela putorius* (1–4; 2–7), *Mustela eversmanii* (1–1; 2–2), *Mustela vison* (3–1), *Felis catus dom.* (1–3; 2–4; 3–4), *Sus scrofa* (1–3), *Cervus elaphus* (2–1; 3–1), *Capreolus capreolus* (1–1), *Capra ibex hircus* (1–1), *Ovis ammon aries* (1–1; 3–1), *Podiceps cristatus* (2–1), *Podiceps grisegena* (2–1), *Podiceps nigricollis* (2–1; 3–3), *Ixobrychus minutus* (2–1; 3–1), *Nycticorax nycticorax* (2–1), *Anser anser dom.* (1–1), *Anser fabalis* (1–1), *Mareca penelope* (1–1), *Anas acuta* (2–1; 3–2), *Aythya fuligula* (2–1; 3–3), *Bucephala clangula* (2–1), Anatidae sp. (1–12; 2–18; 3–2), *Accipiter nisus* (1–13; 2–8; 3–8), *Pernis apivorus* (2–2), *Aquila pomarina* (3–1), *Aquila* sp. (3–1), *Circus aeruginosus* (3–2), *Circus* sp. (1–1; 2–2), Accipitridae sp. (1–1; 2–2; 3–1), *Falco peregrinus* (1–4; 2–4; 3–1), *Falco subbuteo* (3–2), *Falco* sp. (1–3; 2–3), *Tetrastes bonasia* (1–18; 2–15; 3–5), *Lyrurus tetrix* (1–4; 2–8), *Tetrao urogallus* (1–2; 2–4), *Meleagris gallopavo dom.* (3–1), Galliformes sp. (1–2; 3–1), *Porzana porzana* (1–10; 2–13; 3–7), *Zapornia parva* (1–1; 2–1; 3–2), *Porzana* sp. (1–1), Rallidae sp. (1–1; 2–3), *Charadrius dubius* (1–2; 2–10; 3–1), *Pluvialis apricaria* (2–1; 3–1), *Tringa glareola* (1–1; 2–3), *Tringa ochropus* (2–1), *Tringa* sp. (1–4; 2–2), *Actitis hypoleucos* (1–20; 2–12; 3–5), *Philomachus pugnax* (1–5; 2–2), *Limosa limosa* (1–1), *Gallinago gallinago* (1–5; 2–6; 3–6), *Gallinago* sp. (2–4), *Lymnocryptes minimus* (3–1), Limicolae sp. (2–4), *Chroicocephalus ridibundus* (2–2; 3–4), *Sterna hirundo* (1–1; 2–2; 3–1), *Chlidonias niger* (1–2; 2–2), *Columba* sp. (1–6), *Tyto alba* (1–3; 2–4; 3–2), *Asio flammeus* (1–2; 2–3; 3–2), *Otus scops* (1–2), *Aegolius funereus* (1–17; 2–13; 3–3), *Strix uralensis* (1–1; 2–3; 3–3), *Caprimulgus europaeus* (1–8; 2–12; 3–4), *Apus apus* (1–2; 2–1; 3–1), *Coracias garrulus* (2–3), *Upupa epops* (2–1),

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Tab. 1. Continuation.
Tab. 1. Pokračovanie.

Dryocopus martius (1–1; 2–8; 3–1), *Picus canus* (1–2), *Picus viridis* (2–2; 3–2), *Dendrocopos major* (1–1; 2–3), *Dendrocopos syriacus* (1–1; 3–1), *Dendrocopos medius* (2–1), *Dendrocopos leucotos* (1–1), *Jynx torquilla* (1–1; 2–3; 3–1), *Lullula arborea* (1–18; 2–12; 3–2), *Hirundo rustica* (1–4; 2–2; 3–1), *Delichon urbicum* (1–11; 2–12; 3–4), *Riparia riparia* (2–2), *Anthus trivialis* (1–4; 2–7), *Anthus pratensis* (3–1), *Anthus spinoletta* (1–3), *Motacilla alba* (1–6; 2–8), *Motacilla cinerea* (2–2; 3–1), *Bombycilla garrulus* (2–1), *Lanius excubitor* (1–1; 2–2; 3–1), *Lanius collurio* (1–19; 2–17; 3–3), *Acrocephalus palustris* (2–1; 3–1), *Hippolais icterina* (1–2), *Sylvia atricapilla* (1–2; 2–3; 3–2), *Sylvia* sp. (1–1), *Phylloscopus sibilatrix* (1–2), *Regulus* sp. (2–1), Sylviidae sp. (1–6; 2–1), *Muscicapa striata* (1–1; 2–1), *Saxicola rubetra* (2–1), *Oenanthe oenanthe* (1–2; 2–1), *Phoenicurus ochruros* (2–2; 3–4), *Turdus torquatus* (1–13; 2–17; 3–7), *Turdus iliacus* (1–3; 2–3), *Turdus* sp. (2–2), *Parus major* (1–4; 2–3; 3–1), *Periparus ater* (3–1), *Cyanistes caeruleus* (2–2; 3–1), *Lophophanes cristatus* (3–2), *Poecile palustris* (1–2), *Parus* sp. (2–1), *Sitta europaea* (2–1; 3–1), *Troglodytes troglodytes* (1–1; 2–1), *Cinclus cinclus* (1–1; 2–1; 3–1), *Emberiza citrinella* (1–20; 2–22; 3–10), *Emberiza calandra* (1–4; 2–2), *Emberiza schoeniclus* (1–1; 2–2), *Emberiza* sp. (1–1), *Fringilla coelebs* (1–17; 2–13; 3–10), *Carduelis carduelis* (1–4; 2–5; 3–4), *Carduelis spinus* (3–1), *Carduelis cannabina* (1–2; 2–2; 3–2), *Carduelis chloris* (1–2; 2–2; 3–3), *Pyrrhula pyrrhula* (1–1; 2–1), *Serinus serinus* (1–1; 2–1), *Loxia curvirostra* (1–2; 2–5), Fringillidae sp. (1–2), *Passer domesticus* (1–13; 2–14; 3–5), *Passer montanus* (1–1; 2–2; 3–3), Oriolus oriolus (1–1; 2–1), Passeriformes sp. (1–43; 2–61; 3–10), Passeriformes sp. juv. (1–1), Aves sp. (1–1; 2–21; 3–2), Aves sp. juv. (1–6; 2–8; 3–4), *Bombina variegata* (1–2), *Bombina* sp. (2–1), *Bufo bufo* (1–10; 2–14; 3–2), *Bufotes viridis* (1–3; 2–3; 3–1), *Bufo* sp. (1–2; 3–1), *Hyla arborea* (1–5), *Rana dalmatina* (1–1; 2–2), *Rana arvalis* (2–1), *Pelophylax ridibundus* (1–2; 2–3; 3–3), *Anguis fragilis* (1–1), *Lacerta viridis* (1–9; 2–12; 3–3), *Lacerta muralis* (1–1; 2–5; 3–2), *Lacerta* sp. (1–4; 2–3; 3–1), *Zootoeca vivipara* (1–1; 2–2; 3–3), *Natrix natrix* (1–4; 2–1), Colubridae sp. (1–1; 2–3; 3–2), Serpentes sp. (2–4), Pisces sp. (1–31; 2–31; 3–3), Hymenoptera sp. (1–1), Coleoptera sp. (1–14; 2–14; 3–11), *Astacus* sp. (1–1), Limacidae sp. (1–6; 2–5; 3–1).

Note: Numerical data in the table are given in absolute values, and positive and negative deviations (e.g 1 +, 2+, 1 -, 2-) are marked deviations from the mean (MDFM, Obuch 2001) for the species in these samples (see Methods).
Poznámka: Číselné hodnoty v tabulke sú uvedené v absolútnych hodnotách, kladné a záporné odchýlky (1 +, 2+, 1 -, 2- a podobne) sú výrazné odchýlky od priemeru (MDFM, Obuch 2001) druhov vo vzorkách (pozri Metodiku).

creased by nearly half (*R. temporaria*, 23.3%), and the share of *M. arvalis* increased less significantly (34.8%), ut the representation of larger prey from the classes of mammals increased significantly: northern white-breasted hedgehog *Erinaceus roumanicus*, European hare *Lepus europaeus*, *R. norvegicus* and *A. amphibius*, as did the birds: *Corvus cornix* + *frugilegus*, grey partridge *Perdix perdix*, common pheasant *Phasianus colchicus*, domestic pigeon *Columba livia domestica* and long-eared owl *Asio otus*. Some of these species still form a large part of the diet of eagle-owls even in period C (the last 30 years). This period is characterised by a further decrease in the number of *R. temporaria* (11.3%) and a slight increase in the share of *M. arvalis* (37.3%), but the proportion of forest rodent species *A. flavicollis* and *M. glareolus* has also increased, as has the diversity of birds, particularly waterfowl species, owls, and thrushes (genus *Turdus*) in particular from the songbirds.

Comparison of Eurasian eagle-owl diet composition in several areas of Slovakia

A – Period more than 70 years ago (Table 2): In the Liptov region we have finds of eagle-owls nests from this period in the Nízke Tatry Mts, which were deforested and grazed by sheep in the 16th–17th centuries: from Demänovská dolina Valley, Jánská dolina Valley, the valley below Malužina and from Komornícká dolina Valley. *R. temporaria* (68.2%) had high predominance in these finds, but the following mountain rodent species also occurred: European snow vole (*Chionomys nivalis*), northern birch mouse (*Sicista betulina*), hazel dormouse (*Muscardinus avellanarius*) and forest dormouse (*Dryomys nitedula*). The Ural field mouse (*A. microps*) also penetrated deeper into the mountains, and the European hamster (*Cricetus cricetus*) occurred in the finds from the edge of the Liptovská kotlina Basin. In the Orava region, which has a mosaic of narrow fields, meadows and pastures with discontinuous wooded enclaves, the prevalence of *R. temporaria* (42.4%) was lower, and *M. arvalis* had a higher proportion (29.0%), as did *R. norvegicus* and *A. amphibius* among the larger prey. In the Turiec area, eagle-owls nested on the border of a more intensively-farmed basin, so there was a greater share of rodents *M. arvalis* (32.2%), *R. norvegicus* and *M. musculus*, and the hamster species *C. cricetus* and common spadefoot toad (*Pelobates fuscus*) still occurred here. In the Žilinská kotlina Basin and the Rajecká kotlina Basin, the proportions of *R. temporaria*

Tab. 2. Differences in proportions of Eurasian eagle-owl prey species in period A (more than 70 years ago) in 8 regions of Slovakia.
Tab. 2. Rozdiely v zastúpení koristi výra skalného v období A pred viac ako 70 rokmi, v 8 oblastiach Slovenska.

region / oblasť	**Liptov**		**Orava**		**Turiec**		**Žilina**		**Považie**		**Ponitrie**		**Muráň**		**Spiš**		∑	%
region No. / oblasť č.	**2**		**1**		**3**		**4**		**5**		**6**		**7**		**8**			
taxa / taxón																		
Rana temporaria (n/ks)	1+	7719		2369		3915		6334	1-	1068	2-	226	1-	674		296	22,601	44.7
%		68.2		42.42		40		43.48		24.99		10.78		28.82		49.5		
Muscardinus avellanarius	1+	26		8		9	1-	10		5		2		6		1	67	0.13
Sicista betulina	1+	10		1		2	1-	0		1				3			17	0.03
Chionomys nivalis	1+	6															6	0.01
Accipiter gentilis	1+	8		1				3		2							14	0.03
Tetrastes bonasia	1+	12		3			1-	0								3	18	0.04
Delichon urbicum	1+	8		1				1		1							11	0.02
Bufo bufo	1+	8		1						1							10	0.02
Salmo trutta	1+	52	1-	3		20	1-	24	1-	1		1		3	1+	11	115	0.23
Dryomys nitedula	1+	19		5	1-	0	2-	0					1+	10		1	35	0.07
Microtus agrestis	1+	32		10	1-	3		17	1-	0			1+	12		4	78	0.15
Turdus philomelos		18	1+	22	1-	8		29		4	1+	9		3		3	96	0.19
Coloeus monedula		18	1+	27	1-	7		27	2+	32		2	1-	0			113	0.22
Apodemus agrarius		63	1+	85	2-	13	1+	105		20	1-	5	2-	0			291	0.58
Turdus torquatus		1	1+	10												2	13	0.03
Lanius collurio		6	1+	7				2				1		2			18	0.04
Rattus norvegicus	1-	39	1+	74	1+	137		126		43		15	1-	6		5	445	0.88
Sciurus vulgaris		20		10	1+	34	1-	13		10		2		2		4	95	0.19
Glis glis		12		5	1+	15		9		4				2			47	0.09
Mustela nivalis	1-	12	1-	7	1+	47		52		18		11		7		1	155	0.31
Mustela erminea	1-	4	1-	1	1+	18		18		7		1		2		2	53	0.10
Anas crecca					1+	7		1						1		1	10	0.02
Vanellus vanellus	1-	1			1+	14		7		1		2					25	0.05
Galerida cristata	1-	0		1	2+	23	1-	2		2				1			29	0.06
Microtus arvalis (n/ks)	1-	1786		1620	1+	3157		4248	1-	862	1+	825	1+	980	2-	61	13,539	26.78
%		15.78		29.01		32.26		29.16		20.17		39.36		41.9		10.2		
Mus cf. *musculus*	1-	63		85	1+	151		189		59	1+	62	2-	5	1-	2	616	1.22
Apodemus flavicollis	2-	103		159	1+	445		405	1+	160	2+	202	1-	41	1-	7	1522	3.01
Corvus cornix + frugilegus	2-	13		45	1+	96		85	1+	65	1+	28	1-	7		2	341	0.67
Pelobates fuscus	3-	0	2-	0	1+	43	2-	2	2+	31		4					80	0.16
Talpa europaea	1-	20		21	1-	31	1+	90	1+	33		5	1+	20		1	221	0.44
Myodes glareolus	2-	16	1-	13		68	1+	130	1+	45	2+	41	1-	8		3	324	0.64
Pelophylax cf. *esculentus*	4-	0	2-	2	1-	17	1+	109	2+	52	1+	15	2-	0			195	0.39
Coturnix coturnix	1-	20	1-	17		49	1+	93		27	1+	17		7		1	231	0.46
Alauda arvensis	1-	24		22	1-	17	1+	62		15		10		6		1	157	0.31
Lullula arborea		2		2			1+	10				2				1	17	0.03
Fringilla coelebs		3		2			1+	11		1							17	0.03
Garrulus glandarius		5		5		5	1+	20		7		2					44	0.09
Terricola subterraneus	1-	28	1-	5	2-	5	1+	101	1+	26		5		7		3	180	0.36
Pica pica	2-	0		4		14	1+	32	1+	13		2		1			66	0.13
Apodemus microps	1-	144	2-	51	1-	134	1-	258	3+	596		43	4-	0	2-	0	1226	2.42

Tab. 2. Continuattion.
Tab. 2. Pokračovanie.

region / oblasť **region No. / oblasť č.** **taxa / taxón**	**Liptov** **2**		**Orava** **1**		**Turiec** **3**		**Žilina** **4**		**Považie** **5**		**Ponitrie** **6**		**Muráň** **7**		**Spiš** **8**		**∑**	**%**
Nyctalus noctula	1-	1				3	1-	2	2+	17		2					25	0.05
Anas platyrhynchos	1-	0				4		4	1+	10						1	19	0.04
Falco tinnunculus	1-	5		8		12		15	1+	10				2		3	55	0.11
Gallus gallus dom.		2						8	1+	10							20	0.04
Columba oenas		5		5		4		9	1+	14		1				1	39	0.08
Columba palumbus		4		4		4		11	1+	8		3					34	0.07
Turdus merula	1-	2		2		7		6	1+	13		3		3			36	0.07
Strix aluco	2-	6		10	1-	14		39	2+	37		6		6			118	0.23
Cypriniformes sp.	1-	1		1		8		6	1+	9							25	0.05
Apodemus sylvaticus	2-	281		349		717		999	1+	457	1+	276	2-	40	3-	3	3122	6.17
Erinaceus roumanicus	1-	15		21		35	1-	38	1+	34	1+	25		6		2	176	0.35
Lepus europaeus	1-	38		24	1-	29		88	1+	37	2+	43	1-	5		3	267	0.53
Cricetus cricetus	1-	18	3-	0	2-	6	3-	5	3+	118	1+	22	1-	0			169	0.33
Perdix perdix	2-	9		24		36		51	1+	33	2+	27		4			184	0.36
Asio otus	2-	5		10		22	1-	17	1+	24	1+	12		5		1	96	0.19
Scolopax rusticola	1-	17		8	1-	12		43	1+	19	1+	10		4		4	117	0.23
Lacerta viridis											2+	9					9	0.02
Spermophilus citellus											1+	5		4		3	12	0.02
Eliomys quercinus		17	1-	4		21		19		10	1+	9		2			82	0.16
Streptopelia turtur		2		2				4		3		1	1+	5		1	18	0.04
Arvicola amphibius		397	1+	304	1-	189	1-	278	1-	66	1-	40	2+	388	3+	140	1802	3.56
Buteo buteo	1-	0		3		7		6		4							20	0.04
Turdus pilaris		7		7	1-	1		8		5		1					29	0.06
Columba livia dom.		7		3		8		19		5		1		1		2	46	0.09
Crex crex		7		2		11		9		2		4		1		2	38	0.08
Neomys fodiens		5		7		7		14		4							37	0.07
Vulpes vulpes		5		4		6		12		3		3					33	0.07
Eptesicus serotinus		3		5		2		14		3		1		4			32	0.06
Mammalia	**1-**	**3212**		**2896**		**5330**		**7301**	**1+**	**2666**	**1+**	**1659**	**1+**	**1572**		**247**	**24,883**	**49.21**
Aves	**1-**	**294**		**306**		**452**		**768**	**1+**	**431**	**1+**	**171**	**1-**	**85**	**1+**	**43**	**2550**	**5.04**
Amphibia, Reptilia, Pisces	**1+**	**7808**		**2381**		**4005**		**6493**	**1-**	**1170**	**2-**	**265**	**1-**	**681**		**308**	**23,111**	**45.71**
Evertebrata		**4**		**2**	**1-**	**0**		**7**		**6**		**1**		**1**		**0**	**21**	**0.04**
∑		**11,318**		**5585**		**9787**		**14,569**		**4273**		**2096**		**2339**		**598**	**50,565**	**100.00**
Diversity Index H'		1.37		1.94		1.91		1.96		2.66		2.4		1.73		1.82	2.01	

and *M. arvalis* were average, but the proportion of the edible frog (*Pelophylax* cf. *esculentus*) was higher, as was that of certain rodents: *A. agrarius*, *M. glareolus* and *T. subterraneus* and some birds: Eurasian skylark (*Alauda arvensis*), common quail (*Coturnix coturnix*), Eurasian jay (*Garrulus glandarius*) and common magpie (*Pica pica*). In the lower valley of the Považie region, along with *R. temporaria* (25.0%), the toad species *P. fuscus* was also more numerous among the amphibians, in addition to the larger mammalian species *E. roumanicus*, *L. europaeus* and *C. cricetus* and the mouse species *A. microps*, as well as the larger bird species *P. perdix*, the pigeons *Columba palumbus* and *C. oenas*, and the owls *A. otus* and *Strix aluco*. In the warmer Ponitrie basin, the eagle-owl diet featured a low proportion of *R. temporaria* (10.8%), as larger prey from the bird and mammal classes were available. In contrast, on the crags along the outer perimeter of the Muránská planina Plateau, where there is less arable land and more meadows and pastures, the voles *M. arvalis* (41.9%) and *A. amphibius* dominated.

B – The period of Socialism, 30 to 70 years ago (Table 3): fter the regime change in 1948, gradual changes in land use followed due to the collectivisation of agriculture, afforestation of pastures on steeper slopes and more intensive breeding of small game. These changes were manifested in the food strategy of the Eurasian eagle-owls: they started leaving the mountain locations and hunting for more prey in the foothills. The Liptov and Turiec regions still had relatively high proportions of *R. temporaria* (44.5% and 29.4% respectively), as did Orava with *M. arvalis* (41.8%) and together with the Horehronie and Spiš regions also *A. amphibius*. The lower parts of Považie, Ponitrie and Pohronie basins had higher proportions of larger species of birds in the eagle-owl diet, in particular *P. perdix*, *P. colchicus*, *C. livia domestica*, *A. otus* and *C. cornix* + *frugilegus*, and among mammals mainly hedgehogs *E. roumanicus* and hares *L. europaeus*. In the Ponitrie basin, Spiš region and the Slovenský kras karst area there was higher representation of *R. norvegicus* and *C. cricetus*, and locally also of European ground squirrel (*Spermophilis citellus*). Among the dormice, the garden dormouse (*Eliomys quercinus*) was more frequently hunted in the Turiec area, and in the Slovenský kras area the dormice *Glis glis* and *D. nitedula*. Among the smaller species of mice, *Mus musculus* was more numerous in the Turiec area, *A. sylvaticus* and *A. flavicollis* in the Považie and Ponitrie basins, and previously more abundant occurrence of *A. microps* was narrowed to the territories of the Ponitrie basin, Spiš region and Slovenský kras area. In the latter area, the occurrence of *P. fuscus* was more frequent as well, although previously it was a more numerous amphibian also in the higher-elevated basins.

C – Period of the last 30 years (Table 4): In the upper basins of the Orava, Liptov and Horehronie regions, arable land has been gradually transformed into grassy surfaces since the 1990s. The decline in frogs in the eagle-owl diet was compensated with a higher share of voles *M. arvalis* and *A. amphibius*. In the Žilinská kotlina and Turiec basins, the progressive overgrowth of grasslands by trees was manifested in increased representation of the forest species *A. flavicollis* and *M. glareolus*. The larger species *E. roumanicus*, *L. europaeus*, *R. norvegicus* and *C. livia domestica* were more abundantly hunted depending on local conditions in different parts of Slovakia. The occurrence of the species *A. microps*, *C. cricetus* and *P. fuscus* shifted to lower positions. During the Socialist period, the pheasant *P. colchicus* was also released into the wild in the Liptov and Turiec basins, where it was decimated under the pressure of predators and currently occurs only in the lower basins. Special conditions occur in the drier Spiš region, which lies in the rain shadow of the Tatra Mts; for this reason the steppe species *S. citellus*, *C. cricetus* and *A. microps* still occur here. In contrast, a peculiarity of the lower valley of the Turňa River in the Slovenský kras area are ponds and water meadows, meaning that aquatic bird species as well as the European water vole *A. amphibius* are more abundantly represented here.

Changes in the Eurasian eagle-owl diet in individual areas of Slovakia

Orava (Appendix 2): Overall, the species *M. arvalis* (37.5%), *R. temporaria* (28.8%) and *A. amphibius* (11.6%) dominate in all three time periods. Birds have a share of 7.6%. In the oldest period (A), the proportions of frogs (*R. temporaria*, 42.4%) and murine rodents *A. sylvaticus*, *A. microps*, *A. agrarius* and *M. musculus* were significantly higher. Among the birds, the representation of the western jackdaw (*Coloeus monedula*), at that time nesting in rocky massifs, was more numerous. During the Socialist period (B), the proportion of frogs was reduced by half (*R. temporaria*, 22.5%) and the proportion of vole-type rodents *M. arvalis* and *A. amphibius* increased. A further 50 % decline in the incidence of frogs in the most recent period (C) was caused by the availability of larger prey from the mammalian classes: *E. roumanicus*, *R. norvegicus*, *Sciuris vulgaris*, *Mustela nivalis* and birds *C. livia domestica*, *P. perdix*, *Buteo buteo*, *A. otus*, *G. glandarius* and *C. cornix*.

Liptov (Appendix 3): In total, *R. temporaria* (58.1%), *M. arvalis* (19.0%) and *A. amphibius* (6.3%) dominate in all periods. Birds have a 4.8% share. The proportion of frogs (*R. temporaria*, 68.2%) was extremely high in the oldest period (A), and this fell to 44.5% in the period of Socialism (B) and reaches only 4.0% in recently-sampled material (C). In period A, the Ural field mouse (*A. microps*) penetrated high into the mountains with pasturage. At the same time, the vole *Chionomys nivalis* descended to the valleys from alpine positions. In the Liptovská kotlina Basin, Eurasian eagle-owls hunted the hamster *C. cricetus*. In the period of Socialism (B), the mammals *L. europaeus*, *Talpa europaea*, *A. flavicollis*, *M. glareolus* and *M. nivalis* were more often hunted, and among the birds *P. perdix*, *F. tinnunculus*, *C. livia domestica*, *Columba palumbus*, *Strix aluco*, *Turdus merula* and *Coturnix coturnix*. In the present period (C) the proportion of mammals *E. roumanicus*, *R. norvegicus*, *A. amphibius* and *M. arvalis*, is increasing, and among the birds *A. otus*, *Vanellus vanellus*, *Anas platyrhynchos*, *G. glandarius* and *Pica pica* are now more prevalent.

Turiec (Appendix 4): The dominance of *M. arvalis* increased slightly from 32.3% in the oldest period (A) to 44.4% in the present (C). In contrast, the share of *R. temporaria* decreased from 40.0% in period A to 19.3% in period C. In the oldest period other species of frogs also appeared in the eagle-owl diet, but are currently absent: *Pelophylax* cf. *esculentus* and *Pelobates fuscus*. In period A, murine rodents *A. sylvaticus*, *A. microps* and *M. musculus* were more numerous, and currently the forest species *A. flavicollis* and *M. glareolus* are more abundant. At present, the proportion of birds (Aves) has increased, in particular thrushes (*Turdus*), crows and rooks (Corvidae), domestic pigeons (*C. livia domestica*), partridges (*P. perdix*) and certain species of raptors and owls. During the Socialist period (B), the proportion of larger mammal species in the food of *B. bubo* increased: *E. roumanicus*, *R. norvegicus* and *A. amphibius*.

Žilinská kotlina Basin (Appendix 5): In total for all periods, the species *R. temporaria* (36.6%) and *M. arvalis* (30.4%) were predominantly represented in the eagle-owl diet, while birds (Aves) had 7.7% representation. The decline in the dominance of *R. temporaria* from 43.5% in period A to 8.5% at present (C) is significant. The proportion of small mice *A. microps*, *A. sylvaticus* and *M. musculus* also fell, while the proportion of *A. flavicollis*, *A. agrarius* and *M. glareolus* increased. From the Socialist period (B) up to the present (C), a higher representation of larger prey species has persisted: *E. roumanicus*, *L. europaeus*, *R. norvegicus*, *A. amphibius*, *A. otus* and *C. livia domestica*. Among the birds, the following species were more numerous in the period of Socialism (B): *P. perdix*, *P. colchicus* and *C. cornix* + *frugilegus*, while in the latest period (C) the share of the common kestrel *F. tinnunculus* and thrushes (genus *Turdus*) has increased.

Považie (Appendix 6): In the lower parts of the Váh Valley, I collected material from eagle-owl pellets only from older periods A and B, and in the last 30 years I have not collected its food remnants in this area. The share of *R. temporaria* was lower (25.0%) in the oldest period (A) than in the higher-located valleys, and in the period of Socialism it fell to 5.0%. Among the frogs, the species *P.* cf. *esculentus* and *P. fuscus* were more abundantly represented in period A, and mammalian species *A. microps* and *C. cricetus* were more prevalent then. In the period of Socialism (B), the share of *M. arvalis* in the Eurasian eagle-owl diet increased significantly from 20.2% to 35.6%, and similarly as in the Žilinská kotlina Basin, the proportion of larger species of mammals and birds increased, except for *A. amphibius*. Carp-type fish (Cypriniformes) were hunted more frequently in localities near the Váh River.

Ponitrie (Appendix 7): Similarly as in the Považie area, the Ponitrie area has a warmer climate, but it is drier. For this reason, even in the oldest period, the proportion of *R. temporaria* was lower in the Eurasian eagle-owl diet, dropping from 10.8% in period A to 0.3% in period C. The dominant species *M. arvalis* (34.4%) showed a moderately declining trend (from 39.4% in period A to 27.5% in period C). The share of small murine rodents decreased significantly. In the period of Socialism (B) they were superseded by the larger rodent species *A. amphibius* and the birds *P. perdix*, *P. colchicus*, *C. cornix* + *frugilegus* and *A. otus*. In the latest period (C) mammals are more abundantly represented: *E. roumanicus*, *R. norvegicus* and *C. cricetus*, and among birds the domestic pigeon *C. livia domestica* and thrushes . The hare (*L. europaeus*, 2.5%) is evenly represented in the compared periods.

Pohronie (Appendix 8): The Pohronie region has similar climatic conditions as the Považie and Ponitrie basins. The Hron Valley, however, is predominantly narrower with less arable land. I have smaller samples of eagle-owl food from this area, which, however, confirms

Tab. 3. Differences in proportions of Eurasian eagle-owl prey species in period B (from 70 to 30 years ago) in 10 regions of Slovakia.
Tab. 3. Rozdiely v zastúpení koristi výra skalného v období B pred 30 až 70 rokmi v 10 oblastiach Slovenska.

region / oblasť **region No. / oblasť č.** **taxa / taxón**	**Liptov** **9**	**Turiec** **8**	**Orava** **10**	**Žilina** **7**	**Považie** **6**	**Ponitrie** **5**	**Pohronie** **4**	**Muráň** **3**	**Spiš** **2**	**Sl. kras** **1**	**∑**	**%**
Rana temporaria (n/ks)	1+ 2567	1+ 2124	1733	942	2- 212	2- 146	1- 147	928	716	5- 8	9523	23.32
%	44.47	29.4	22.53	20.46	4.99	7.37	14.38	22.8	26.76	0.52		
Columba palumbus	2+ 41	1- 5	15	1- 0	1- 2	3	1	3	1- 0		70	0.17
Neomys fodiens	1+ 9	3	6	2		1		4			25	0.06
Eliomys quercinus	7	1+ 13	1- 1	6	3	4	1		3		38	0.09
Mustela nivalis	43	1+ 80	2- 15	32	19	12	7	1- 10	1- 7	9	234	0.57
Salmo trutta	14	1+ 43	12	2- 0	1- 2	1- 0		5	10		86	0.21
Mus cf. *musculus*	1- 28	1+ 74	2- 11	27	1+ 43	10	1- 1	1- 9	2+ 61	6	270	0.66
Apodemus agrarius	13	1- 10	1+ 34	15	7	1- 0		1- 3	7	1+ 13	102	0.25
Arvicola amphibius	624	1- 360	1+ 1184	1- 243	3- 69	2- 77	117	2+ 1055	1+ 484	1- 124	4337	10.62
Microtus arvalis (n/ks)	1- 1274	3005	1+ 3212	1642	1513	637	330	1- 1065	1020	479	14,177	34.72
%	22.07	41.6	41.76	35.66	35.61	32.16	32.29	26.16	38.12	31.08		
Muscardinus avellanarius	10	1- 3	1+ 23	6	10		1	8	4	1	66	0.16
Sicista betulina	2		1+ 8						3		13	0.03
Erithacus rubecula			1+ 7		1	1		2		1	12	0.03
Turdus torquatus	3		1+ 10						4		17	0.04
Turdus pilaris	13	9	1+ 31	8	1- 3	6	2	5	1- 0	2	79	0.19
Turdus philomelos	1- 15	1- 24	1+ 57	20	27	11	1	18	7	6	186	0.46
Turdus viscivorus	4	1- 1	1+ 14	3	1	3	1	6	3	5	41	0.1
Sciurus vulgaris	18	33	1- 18	1+ 34	21	12		1- 9	7	2	154	0.38
Lanius collurio	1		3	1+ 8	1	1		1	2		17	0.04
Erinaceus roumanicus	1- 43	1- 70	2- 42	1+ 111	2+ 207	1+ 46	1+ 30	1- 33	3- 5	27	614	1.5
Perdix perdix	2- 34	1- 57	2- 42	1+ 145	2+ 207	1+ 81	20	2- 22	2- 6	1+ 41	655	1.6
Columba livia dom.	35	1- 35	1- 31	1+ 78	1+ 42	1+ 25	6	2- 8	1- 6	1+ 21	287	0.7
Apodemus sylvaticus	1- 165	218	1- 168	1+ 247	1+ 314	2+ 208	1- 14	2- 35	1- 38	58	1465	3.59
Lepus europaeus	1- 47	1- 37	1- 49	1+ 118	1+ 96	1+ 54	8	1- 20	1- 16	24	469	1.15
Phasianus colchicus	1- 3	1- 3	2- 0	1+ 16	2+ 34	1+ 17		1- 1	1- 0	6	80	0.2
Pelophylax cf. *esculentus*	1- 0	1- 2	2- 0	1+ 13	1+ 16	1+ 7	1	2		4	45	0.11
Apodemus flavicollis	1- 86	254	1- 185	188	1+ 298	1+ 160	29	116	2- 23	1+ 85	1424	3.49
Turdus merula	1- 11	1- 11	28	11	1+ 23	1+ 12	3	11	2- 0	1+ 18	128	0.31
Asio otus	1- 26	1- 37	1- 37	42	1+ 78	1+ 31	1+ 19	1- 19	1- 6	14	309	0.76
Corvus cornix + frugilegus	66	1- 81	100	68	1+ 121	1+ 43	1+ 24	1- 40	1- 19	1- 11	573	1.4
Anas platyrhynchos	1- 3	8	8	7	1+ 21	1	1+ 6	1- 0		4	58	0.14
Strix aluco	17	1- 14	1- 1.9	19	2+ 57	6	1+ 9	17	1- 1	4	153	0.37
Cypriniformes sp.	2- 1	2- 5	17	15	2+ 54	1- 0	2+ 24	1- 3	1- 0	1- 0	119	0.29
Myodes glareolus	1- 21	1- 32	2- 15	35	2+ 135	24	5	1+ 68	2- 4	10	349	0.85
Terricola subterraneus	19	1- 6	16	18	1+ 20	6	1	1+ 20	5	5	116	0.28
Columba oenas	1- 0	1- 1	2- 0	2	1+ 12	6		1+ 17	1	1+ 8	47	0.12
Falco tinnunculus	16	14	15	8	1+ 19	5	1	7	2	6	93	0.23
Coloeus monedula	15	1- 5	16	11	1+ 32	1	6	1- 4	1- 2	8	100	0.24
Cuculus canorus	1	1	1- 0	1	1+ 7	2		5	1	4	22	0.05

Tab. 3. Continuation.
Tab. 3. Pokračovanie.

region / oblasť	**Liptov**		**Turiec**		**Orava**		**Žilina**		**Považie**		**Ponitrie**		**Pohronie**		**Muráň**		**Spiš**		**Sl. kras**		**∑**	**%**
region No. / oblasť č.	**9**		**8**		**10**		**7**		**6**		**5**		**4**		**3**		**2**		**1**			
taxa / taxón																						
Garrulus glandarius		10		12		18		6	1+	14		2		1		13	1-	0		3	79	0.19
Nyctalus noctula		1				1		2	1+	8		1		2		1					16	0.04
Sturnus vulgaris		5	1-	2		7		7		3	1+	7		3		5				3	42	0.1
Lacerta agilis		1		3		1				1	1+	10				6		2		3	27	0.07
Lacerta viridis										2	1+	6								4	12	0.03
Spermophilus citellus	1-	0	2-	0	2-	0	1-	0	1-	1	1+	10			1+	16		1	2+	24	52	0.13
Cricetus cricetus	2-	4	2-	4	3-	0	3-	0		16	2+	30	1-	0	3-	0	1+	23	3+	89	166	0.41
Apodemus microps		27	1-	14	4-	0		18		26	1+	21	1-	0	2-	2	2+	45	1+	24	177	0.43
Rattus norvegicus	1-	159	1-	215	1-	196		188		174	1+	96	2+	107		176	2-	26	2+	224	1561	3.82
Alauda arvensis	1-	13	1-	16		26	1-	8	1-	7	1+	13	1+	13	1+	33		7		4	140	0.34
Scolopax rusticola		10	1-	8		19		9		16		7	1+	10		16		10		6	111	0.27
Porzana porzana				2		1				3					1+	6		1			13	0.03
Streptopelia turtur		1	1-	1		3		6		4		3		1	1+	13		1		3	36	0.09
Microtus agrestis		16	1-	5	1-	10		7	2-	0	1-	0			1+	16	2+	31			85	0.21
Pelobates fuscus				3	1-	0		2		1									2+	19	25	0.06
Glis glis		12		11		12		8		12		1		3	1-	2	1-	0	2+	15	76	0.19
Dryomys nitedula		5	1-	0		10		1		1						6			1+	6	29	0.07
Vulpes vulpes		6		8		6		6		5		5		2		4		2	1+	7	51	0.12
Streptopelia decaocto		5		6		6		4		4				2		2			1+	6	35	0.09
Vanellus vanellus		12		18	1-	5		6		10		3		5		3	1-	0	1+	8	70	0.17
Gallinula chloropus				5		3		3		2		2		2		4			1+	6	27	0.07
Mustela erminea		12		16	1-	7		6		6		5		3		5		5		1	66	0.16
Eptesicus serotinus		6		2	1-	0		1		6		2		1		7		3			28	0.07
Coturnix coturnix		18		29	1-	12		22		21		9		4		13	1-	3		10	141	0.35
Talpa europaea		32		30		37		22		20		11		6		22	1-	4		5	189	0.46
Pica pica		13		14	1-	9		7		11		6		2		12	1-	0		5	79	0.19
Crex crex		7		10		4		2		8		1		4		6		3			45	0.11
Sorex araneus		5		4		8		4		6		5				6		1		1	40	0.1
Mammalia	**1-**	**2717**		**4527**		**5296**		**3007**		**3062**		**1457**		**675**		**2730**		**1838**	**1+**	**1256**	**26,565**	**65.06**
Aves	**1-**	**464**	**1-**	**505**	**1-**	**625**	**1+**	**596**	**1+**	**892**	**1+**	**344**	**1+**	**175**		**387**	**2-**	**108**	**1+**	**242**	**4338**	**10.62**
Amphibia, Reptilia, Pisces	**1+**	**2591**	**1+**	**2189**		**1768**		**997**	**2-**	**295**	**2-**	**180**	**1-**	**172**		**950**		**729**	**3-**	**39**	**9910**	**24.27**
Evertebrata		**1**		**3**		**3**		**4**		**0**		**0**		**0**		**4**		**1**		**4**	**20**	**0.05**
∑		**5773**		**7224**		**7692**		**4604**		**4249**		**1981**		**1022**		**4071**		**2676**		**1541**	**40,833**	100.00
Diversity Index H'		2.1		2.03		2.04		2.51		2.85		2.84		2.59		2.31		1.91		2.86	2.45	

Tab. 4. Differences in proportions of Eurasian eagle-owl prey species in period C (most recent 30 years) in 10 regions of Slovakia.
Tab. 4. Rozdiely v zastúpení koristi výra skalného v období C za posledních 30 rokov v 10 oblastiach Slovenska.

region / oblasť	**Muráň**	**Orava**	**Liptov**	**Žilina**	**Turiec**	**Ponitrie**	**Pohronie**	**Spiš**	**Rimava**	**Sl. Kras**	**∑**	**%**
region No. / oblasť č.	**7**	**1**	**2**	**4**	**3**	**5**	**6**	**8**	**9**	**10**		
taxa / taxón												
Arvicola amphibius (n/ks)	2+ 501	1+ 228	1+ 101	1- 40	1- 237	2- 22	1- 10	87	2- 32	1+ 170	1428	10.26
%	30.27	14.54	15.05	4.34	4.34	2.49	4.24	12.66	3.48	18.91		
Microtus arvalis (n/ks)	592	1+ 742	1+ 306	1- 215	2426	1- 243	1- 48	264	1- 233	2- 120	5189	37.29
%	35.77	46.75	45.6	23.34	44.42	27.46	20.34	38.43	25.35	13.35		
Turdus pilaris	4	1+ 19	5	1+ 17	1- 13	3	2	2	3	3	71	0.51
Garrulus glandarius	5	10	1+ 10	3	1- 23	9	1	1	1+ 13	8	83	0.60
Erinaceus roumanicus	1- 15	41	1+ 32	1+ 28	1- 58	1+ 50	1+ 19	1- 8	1+ 28	22	301	2.16
Lepus europaeus	1- 7	1- 13	5	1+ 29	2- 25	1+ 26	5	1+ 25	17	1+ 22	174	1.25
Columba livia dom.	2- 3	1- 15	1- 6	1+ 46	1- 73	1+ 38	5	1- 3	20	1+ 33	242	1.74
Apodemus agrarius	1- 1	1- 3	1	2+ 28	2- 5	1- 0			2+ 34	1- 0	72	0.52
Falco tinnunculus	1- 2	4	3	1+ 12	39	4	4	2	2	4	76	0.55
Apodemus flavicollis	2- 20	3- 9	2- 5	2+ 202	1+ 341	36	1- 4	2- 5	1- 25	1- 20	667	4.79
Myodes glareolus	1- 5	2- 3	1- 0	2+ 33	1+ 89	1- 3	2	1- 0	1- 2	1- 1	138	0.99
Mus cf. musculus	7	1- 1		4	1+ 40	8		1	5	3	69	0.50
Rana temporaria	194	181	2- 27	1- 78	1+ 1055	4- 3	2- 7	3- 10	3- 11	5- 1	1567	11.26
Apodemus sylvaticus	1- 23	1- 13	1- 8	1- 11	1+ 153	1+ 34	1	11	1+ 38	1- 8	300	2.16
Turdus philomelos	1- 3	1- 5	5	10	1+ 67	1+ 15	4	3	11	1- 3	126	0.91
Sciurus vulgaris	6	9	1	4	21	1+ 8	1	1			51	0.37
Scolopax rusticola	4	3		2	10	1+ 8				1	28	0.20
Rattus norvegicus	126	1- 96	68	1- 49	2- 189	1+ 184	2+ 63	1+ 87	2+ 213	1+ 119	1194	8.58
Apodemus microps	1- 0	1- 0			1- 7	1+ 11		1+ 8	1+ 13	3	42	0.30
Turdus merula	8	1- 4	3	9	31	1+ 19	4	2	1+ 16	4	100	0.72
Columba oenas				1	1- 2	1+ 6	1		2+ 12	2	24	0.17
Lucanus cervus	1- 0				2- 0	2+ 21	2		1+ 9	2	34	0.24
Cricetus cricetus	2- 0	2- 0		1- 0	3- 0	1+ 20		2+ 34	1- 0	2+ 26	80	0.57
Corvus cornix + frugilegus	1- 6	17	7	5	54	5	7	1+ 14	1+ 17	1+ 17	149	1.07
Spermophilus citellus					2- 0	1		1+ 9		2+ 18	28	0.20
Coloeus monedula		3		4	1- 6	1		2+ 13		2	29	0.21
Pica pica	3	4	5	2	24	3	1	1+ 11	2	2	57	0.41
Mustela nivalis	3	8	2	3	24	3		1+ 11	1	3	58	0.42
Asio otus	1- 13	17	9	10	54	10	6	1+ 24	1+ 22	7	172	1.24
Micromys minutus	1- 0	1		1	1- 9	3			2+ 23	1	38	0.27
Phasianus colchicus				1	1- 0	5	3		1+ 9		18	0.13
Glis glis	4	4	1	1	1- 6		1	3	1+ 11	1+ 8	39	0.28
Gallinula chloropus	1- 0	2	1	1	12		1		1+ 8	2+ 20	45	0.32
Tachybaptus ruficollis			2	1	1- 3	2	1		3	2+ 15	27	0.19
Anas platyrhynchos	1- 1	5	5	2	22	2	2	1	4	1+ 9	53	0.38
Anas crecca				2	4	1	1			1+ 9	17	0.12
Fulica atra					4	1	1		2	1+ 7	15	0.11
Vanellus vanellus	1- 1	4	6	1	15	1	3	2	5	1+ 8	46	0.33
Perdix perdix	1- 8	19	6	1- 2	48	15	4	12	6	1+ 25	145	1.04

Tab. 4. Continuation.
Tab. 4. Pokračovanie.

region / oblasť	Muráň		Orava		Liptov		Žilina		Turiec		Ponitrie		Pohronie		Spiš		Rimava		Sl. Kras		∑	%
region No. / oblasť č.	**7**		**1**		**2**		**4**		**3**		**5**		**6**		**8**		**9**		**10**			
taxa / taxón																						
Pelobates fuscus	2-	0	2-	0	1-	0	1-	0	4-	0	1-	0			1-	0	1-	1	4+	86	87	0.63
Talpa europaea		10		4		2		4	1-	13		4				2		5		6	50	0.36
Alauda arvensis		6		4		3		1		19		4				3		5		6	51	0.37
Coturnix coturnix		8		4		1		3		22		2		1		1		1		4	47	0.34
Buteo buteo		4		9		2		2		15		2		2		1		3			40	0.29
Strix aluco		1		2		1		4		14		1		2				2		1	28	0.20
Sturnus vulgaris		1		4				3		6		6						4		3	27	0.19
Streptopelia decaocto				3				3		13		1		1				2		2	25	0.18
Mammalia		**1348**		**1200**		**547**		**662**		**3690**		**662**		**158**		**567**		**689**		**560**	**10,083**	**72.46**
Aves	**1-**	**102**		**191**		**91**	**1+**	**178**		**681**	**1+**	**195**	**1+**	**66**		**107**	**1+**	**189**	**1+**	**247**	**2047**	**14.71**
Amphibia, Reptilia, Pisces		**203**		**190**	**1-**	**33**	**1-**	**80**	**1+**	**1088**	**4-**	**7**	**1-**	**10**	**3-**	**13**	**2-**	**25**	**1-**	**90**	**1739**	**12.5**
Evertebrata		**2**	**1-**	**0**		**0**		**1**		**2.2**	**2+**	**21**		**2**		**0**	**2+**	**16**		**2**	**46**	**0.33**
∑		**1655**		**1581**		**671**		**921**		**5461**		**885**		**236**		**687**		**919**		**899**	**13,915**	**100.00**
Diversity Index H'		1.99		2.16		2.19		2.77		2.25		2.82		2.79		2.43		2.87		3.12	2.67	

a higher proportion of *R. temporaria* in the oldest period (A) and the dominance of *M. arvalis* in the diet (29.2%) and an increase in the proportion of larger prey in the most recent period (C), particularly the species *R. norvegicus* and *E. roumanicus*.

Muráňska planina Plateau (Appendix 9): Eurasian eagle-owls nested on the crags located around the perimeter of the plateau in its warmer southern part and in the colder part of the Horehronie basin. From the latest period (C) I have samples only from the Horehronie area. Only meadows and pastures feature here, and arable land is nearly absent. In the oldest period (A), smaller prey was represented mainly in the high proportion of *M. arvalis* (41.9%), *R. temporaria* (28.8%) and *A. sylvaticus*. The decline in their representation during the Socialist period (B) was mainly offset by an increase in the proportion of *A. amphibius* and birds. The proportion of larger prey, mainly *A. amphibius* and *R. norvegicus*, has further increased in the last 30 years (period C).

Spiš (Appendix 10): This extensive area from Slovenský raj National Park in the south to the Pieniny Mts in the north has a cold but drier climate due to the rain shadow of the Tatra Mts and the connection with the Galicia area in southern Poland. The oldest eagle-owl food samples (period A) come from the Slovenský raj National Park. In them there are high proportions of *R. temporaria* (49.5%) and *A. amphibius* and a low representation of *M. arvalis* (10.2%). Samples from the last 30 years (C) are from the Dreveník Crags with a low proportion of *R. temporaria* (0.15%) but a high share of *M. arvalis* (38.4%). Among the larger mammalian species are *R. norvegicus*, *C. cricetus*, *S. citellus*, *E. roumanicus* and *L. europaeus* and among birds *P. perdix*, *A. otus* and the Corvidae.

Rimavská kotlina Basin (Appendix 11): Eurasian eagle-owls nest around the perimeter of the Rimavská kotlina Basin in the Cerová vrchovina and Revúcká vrchovina Uplands. I have food samples from this area only from the last 70 years (B and C), when the species *M. arvalis* (25.3%) and *R. norvegicus* (20.7%) dominated, the proportion of birds was higher (Aves, 22.0%) and the frog *R. temporaria* lower (1.0%). More significant differences between the periods occurred in the proportion of *Apodemus* mices: in the period of Socialism, the species *A. flavicollis* and *A. sylvaticus* were more numerous, and the proportion of *A. agrarius* is currently increasing.

Slovenský kras Karst (Appendix 12): Eurasian eagle-owls nest on crags around the perimeter of the karst plateaux bordering with an agricultural landscape and having a warm climate. In the valley of the Turňa River there are larger ponds and water meadows. In the older eagle-owl food samples (period A) the representation of *M. arvalis* was higher (over 30%); in period B also mice (genus *Apodemus*), rats (*R. norvegicus*) and hamsters (*C. cricetus*). In the most recent period (C) the share of *A. amphibius* has increased, among birds the species *C. livia domestica*, *C. cornix* + *frugilegus* and aquatic species, and among frogs the species *P. fuscus*. Larger species of mammals *E. roumanicus*, *L. europaeus* and *S. citellus* and birds *P. perdix* and *A. otus* are evenly represented in the eagle-owl diet in the compared three time periods.

Discussion

When determining the age of bones from food residues of Eurasian eagle-owls in their nests, a problem arises due to their mixing of the upper layer to a depth of 5–10 cm when digging the nesting hole. After a certain time, the deeper layer is no longer disturbed; it is harder, so it can be separated, collected independently and assigned to an older period. Below shallow overhangs, after filling the sediment to a certain height, the eagle-owls leave the nest and settle elsewhere in the same rock massif. For example, at Plešovice (near Blatnica in the Turiec basin) they successively used eight places for nesting, where more than 10,000 food items were accumulated over more than 200 years. Sometimes, however, alternating of several places occurred in the same time period. In Komornícka dolina Valley in the Liptov region, they used four locations for nesting and at an additional three sites there were bones from their pellets (Kudla et al. 2019). After afforestation of the surrounding pastures during the Socialist period, they flew lower down into the basin for food, but after the crags became shaded by forest growth, they left the area. In most other localities, there were fewer suitable nesting sites and the eagle-owls used only one or two locations for a long period. In the Turiec basin, the Sokol locality was the most suitable place for nesting, where bones from 3,556 prey items were accumulated. After the nest was crushed by a large boulder, the eagle-owls left it and in the following years nested in less suitable habitats. In the Liptov and Turiec regions there were several suitable nesting habitats deeper in the mountains, which were abandoned after afforestation of the surrounding meadows and pastures caused the eagle-owls to move to less suitable places on the edge of the basins. There are fewer food remnants left by Eurasian eagle-owls in these places, which indicates little successful nesting due to predation of young eagles by carnivores or birds of prey. In the Žilinská kotlina Basin, the majority of the nests used during the Socialist period (B) have since been abandoned, based on inspections made in the last ten years. However, monitoring by vocalising indicates the eagle-owls have not left these localities completely, but they are probably nesting in less suitable habitats (Kicko 2017). At present, it is difficult to find crags at the edge of the mountains which climbers do not frequent, hikers do not adapt as viewpoints, or the inhabitants of the surrounding villages do not use as a picnic places. Most of the Eurasian eagle-owl food residues come from nests, and for the above reasons we obtained significantly less food samples from the latest period (C) than from the previous two periods.

From period A, we made most finds of eagle-owl pellets in higher mountain locations, where there was a lack of larger prey and they were forced to use frogs to successfully rear their young. The advantage here was safe nesting sites. From period B, the nests were closer to intensively-farmed land with larger prey available, but with the risk of persecution by hunters due to the owls preying on small feathered and furry game, although by a decree from 1965 the Eurasian eagle-owl belonged among the protected animal species. In period C, a decline in animal production occurred and thus a reduction in the food supply in abandoned farmyards and successive overgrowth of pastures in the foothills. The nesting of Eurasian eagle-owls in lowlands with an absence of crags, in abandoned buildings (Hrtan 2010), in the nests of raptors or in huts (Mihók & Lipták 2010) is being increasingly observed. There is a strong population of eagle-owls at present in northern Germany, where there are no crags suitable for nesting at all (e.g. Lindner 2010). The Eurasian eagle-owls have nested in areas with the absence of crags in the past, as evidenced by their long-term monitoring in the Nízky Jeseník Hills in Moravia (Suchý 1980, 1990). I obtained a larger number of small samples from 14 less suitable habitats from period C in the Ponitrie area, where L. Šnírer devoted himself intensively to studying their nesting.

My material summarizing the diet of the Eurasian eagle-owl in the territory of Slovakia over the last 200 years is a testimony to changes in the composition of fauna, especially birds and mammals, depending on changes in the economic use of land by humans. The shift from higher elevated basins in the north of Slovakia to lower locations in southern areas due to successive overgrowth of meadows and pastures is most pronounced in the increasing incidence of small mammalian species *A. microps* and *C. cricetus*, and frogs of the species *P. fuscus* in the owls' diet. A marked decline in incidence of the garden dormouse (*Eliomys quercinus*) is evident over the whole territory. In contrast, the current state is in line with the abundance of *A. amphibius* and *E. roumanicus* at higher elevations, and birds now feature more often among the prey of eagle-owls, for example, the domestic pigeon (*C. livia domestica*) and thrushes, but also various species of birds linked to the aquatic environment.

We processed similarly rich material from the recent and subrecent period in the area of central Norway (Obuch & Bangjord 2016). Frogs (*R. temporaria*, 36.7%) also dominated in a nest found at Hommelvik from a period of 300 years ago. Large numbers of this species are still present, especially in localities along the sea coast (e.g. Ormhaugfjellet, *R. temporaria*, 50.7%). This species was introduced on Frøya Island 30 years ago and has become an important part of the nutrition of juveniles, although larger prey is available there, particularly marine bird species. The significant decline in *R. temporaria* in the diet of eagle-owls in Slovakia may therefore be partly associated with the decrease in this species over the last 30 years, similarly as reported by Jeřábková & Zavadil (2020) in the Czech Republic. At a site on Halmøya Island the oldest layer of bones in the nest of an Eurasian eagle-owl dates back to 2500 years ago, and the next layer is from the period when the island was inhabited by the Vikings in the Middle Ages. At present, the island is uninhabited and overgrown with bushes. Changes due to the human settlement of the island are reflected in the composition of the food of the Eurasian eagle-owl in this locality. In the original steppe areas, e.g. in southern Kyrgyzstan (Obuch & Rybin 1993) or in Iran (Obuch 2014), the rich spectrum of prey of this apex predator indicates the spatial diffusion of native species of mammals depending on habitat conditions, although these too have been influenced by human activity down the millennia.

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Appendix 1. Record of Eurasian eagle-owl food samples used in summaries based on area and period. Key: 1–11: areas; A: period > 70 years, B: 70 to 30 years ago, C: < 30 years; loc.: locality, sample date.
Príloha 1. Zoznam vzoriek potravy výra skalného, použitých pri sumarizácii podľa oblastí a období. Vysvetlivky: 1 – 11: oblasti; A: obdobie > 70 rokov, B: pred 30 – 70 rokmi, C: < 30 rokov; k.ú., lokalita, dátum zberu.

1. Orava, Orava river valley, from 450 m a.s.l. (Párnica) up to 900 m a.s.l. (Zuberec). Climate: moderately warm to moderately cool, damp.
A. Zázrivá, Havrania skala, 22.8.1995; Párnica, Bralo, 28.5.1980, 22.8.1995; Istebné, Žiar, 14.10.1996; Jasenová, Brestová, 14.10.1977; Vyšný Kubín, dolina (valley) pod Chočom, 14.10.1977; Podbiel, Červená skala (rock), 10.8.1995.
B. Párnica, Bralo, 27.5.1980; Istebné, Žiar, 11.9.1994; Žaškov, dolina Uhlisko, 18.5.1994, 8.12.2015; Dolný Kubín, Srňacie, 17.5.1994; Pucov, Zlepence, 17.5.1994; Oravský Podzámok, hradná brála (castle crag), 9.8.1995; Krivá na Orave, Ostrý vrch, 10.8.1995; Krivá na Orave, Príboj, 18.5.1995; Podbiel, Podbielska skala, 21.6.1978; Oravský Biely Potok, lom (quarry), 18.5.1994; Habovka, Blatná dolina, 11.8.1995; Zuberec, Úplazíky, 1.9.1990; Tvrdošín, Krásna Hôrka, 29.4.1995; Sedliacka Dubová, 6.6.1995.
C. Párnica, Bralo, 11.6.2015; Jasenová, Brestová, 17.5.1994, Trstená, lom, 11.8.1995, 14.6.,2009; Oravská Jasenica, Bredovka, 19.5.1994, lom, 19.5.1994; Sihelné, Hrádok, 19.5.1994.
2. Liptov, upper Váh river valley, from 500 m a.s.l. (Likavka) up to 750 m a.s.l. (Malužiná). Climate: moderately warm to moderately cool, damp.
A. Valaská Dubová, Soliská, 26.5.1977; Liptovské Revúce, Zelená dolina, 15.5.1986; Liptovská Štiavnica, Komornícka dolina, Mladucha, 22.4.2019, Četné, 21.10.2018, 13.6.2020; Demänovská dolina, Zbojnícka jaskyňa (cave), 12.9.1982; Liptovský Ján, Jánska dolina, jaskyňa Tunelová, 29.7.2008, dolina Bielo 18.9.2008, apríl 2020; Malužiná, jaskyňa Malužinské okno, 19.4.2016.
B. Ludrová, Sokolka, 11.7.1976; Lúčky, 1.7.1977; Turík, 1.5.1978; Likavka, Válovy, 13.10.1977; Kvačany, Kvačianska dolina, 1.6.1992; Liptovská Štiavnica, Komornícka dolina, Mladucha, 28.11.2018, Veža, jún 2019, Četné, 22.4.2020; Liptovský Ján, dolina Bielo, apríľ 2020; Liptovský Hrádok, Borová sihoť (watermeadows), 17.8.2017.
C. Prosiek, Prosiecka dolina, 19.7.1995; Podtureň, obora (game reserve), 26.8.2013, 17.8.2017; Liptovský Hrádok, Borová sihoť, 1.5.2010; Hybe, 6.5.2009; Svarín, 1.11.2010.
3. Turiec, borders of Turčianska kotlina Basin and Veľká Fatra Mts and Žiar Hills, from 450 m a.s.l. (Krpeľany) up to 600 m a.s.l. (Vrícko). Climate: moderately warm, damp.
A. Necpaly, Havrania skala, 3.9. 1976; Blatnica, Zelenova skala, 2.9. 1976; Blatnica, Plešovica, hniezda (nest) 1, 2, 3, september 1976, Mošovce, Mošovské Červené, 30.5.1991; Slovenské Pravno, Sokol, 29.8.1976; Vrícko, Vrania skala, 2.7.1979.
B. Krpeľany, Sokol, 5.6.1982; Sklabinský Podzámok, Katova skala, 19.4.1992; Belá, začiatok doliny (upper valley), 19.4.1992; Necpaly, Nosáková, 3.9.1976; Blatnica, Blatnický hrad, 23.10.1975; Blatnica, Plešovica, 30.10.1977, 3.5.1990,19.8.1992, 9.6.2004; Socovce, Marské vŕšky (heights), 1982; Ondrašová, Moškovské skaly, 21.11.1976, 26.12.1979; Slovenské Pravno, Sokol, 7.4.1980, 1.11.1996.
C. Krpeľany, Sokol, 6.8.1997, Belá, začiatok doliny, 7.6.1995, 31.5.1996, 30.6.2015, 27.2.2019, 21.8.2019; Necpaly, Nosáková, 25.4.1994, 31.5.1996, 11.7.1997,17.9.2017, 2.9.2019; Platnica, Blatnický hrad (castle), 29.4.1998; Blatnica, Plešovica, 22.4.1994, 9.6.1995, 11.7.1997, 1.6.2004, 8.9.2009, 15.7.2015; Mošovce, lom, 16.9.1996, 24.9.1997, 17.4.2015, 20.2.2019; Rakša, lom, 9.4.2015, 9.7.2015; Socovce, Marské vŕšky, 1995; Ondrašová, Moškovské skaly, 2.5.1994, 18.10.1996, 11.7.1997, 16.7.2006,

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Appendix 1. Continuation.
Príloha 1. Pokračovanie.

17.6.2015, Slovenské Pravno, Sokol, 21.11.1996, 11.7.1997.
4. Žilinská kotlina Basin, Váh river valley from Strečno to Bytča, Rajčianka and Varínka, from 300 m a.s.l. (Bytča) up to 550 m a.s.l. (Terchová). Climate: moderately warm, damp.
A. Strečno, hrad, 10.6.1977; Stráňavy, kaňon Hýrov (canyon), 28.3.1979; Višňové, Valentínov diel (part), 25.3.1978, 22.3.1979, Turie, Turská dolina, 10.8.1978; Polúvsie, Kozol, 21.6.1980; Rajecké Teplice, Skalky, september 1977, 25.7.1978; Jabloňové, dolina Javor, 5.8.1978.
B. Terchová, Tiesňavy, 13.7.1976, Strečno, hrad, 8.6.1977, 1.8.1978, 12.11.2016; Turie, Turská dolina, 10.8.1978, Porúbka, Slnečné skaly, 25.6.1978; Lietava, 26.3.1978; Rajecká Lesná, Vraníny, 11.8.1978; Hričovské Podhradie, Hričovský hrad, apríl 1977; Paština Závada, 1.10.1976, Hlboké, 4.10.1978, 9.7.1982; Jabloňové, dolina Javor, 30.10.1983; Súľov, Roháč, 24.4.1977.
C. Krasňany, Kurská dolina, 13.11.2018; Strečno, hrad, december 2016, Stráňavy, Kojšová, 22.11.2016, Višňové, Hoblík, 23.5.2017, august 2017; Lietava, 13.11.2018.
5. Považie area, Váh river valley from Považská Teplá to Trenčín, from 210 m a.s.l. (Trenčín) up to 650 m a.s.l. (Vršatecké Podhradie). Climate: warm to moderately warm, moderately damp.
A. Považská Teplá, Veľký Manín, 5.10.1986; Belušské Slatiny, Ostré vŕšky, 26.2.1978, 13.3.1982; Mojtín, 2.3.1978; Pružina, Predhorie, 13.11.1976.
B. Považská Teplá, Veľký Manín, 19.7.1983; Uhry, Klapy, 5.11.1977; Belušské Slatiny, Ostré vŕšky, 13.3.1982, 27.11.1982; Vršatecké Podhradie, Vršatec, 26.12.1978, 6.10.2015; Čierna Lehota, 3.3.1979; Slatinka nad Bebravou, 10.12.1977, 8.1.1983; Trenčín, Skalka, 6.8.1983.
6. Ponitrie area, Nitra river valley as far as Nitra town, from 230 m a.s.l. (Ladice) up to 500 m a.s.l. (Vyšehradné). Climate: warm to moderately warm, moderately damp.
A. Malé Kršteňany, Veľký Vrch, 4.3.1979, 8.9.1980; Kľačno, 30.9.1979; Vyšehradné, 4.12.1979.
B. Malé Kršteňany, lom, 4.3.1979; Ráztočno, 17.7.1979;Vyšehradné, 4.12.1979.
C. Malé Kršteňany, Veľký Vrch, 28.2.1995, 18.5.2010, 28.4.2013, 29.5.2013, 4.8.2013; Malé Kršteňany, Chalmová, 28.2.1995, 9.4.2010, 12.5.2010, 22.6.2012, 11.5.2014; Klátová Nová Ves, 28.2.1995, 18.5.2010, 2.6.2012, 19.5.2013, 14.3.2015, apríľ 2016; Opatovce nad Nitrou, 27.4.2005; Partizánske, salaš (sheepfold), 21.5.2010, 21.5.2014; Nitrianske Rudno, lom, 18.5.2012; Krásna Ves, lom, 2.6.2012, 12.5.2013, 24.5.2014, 9.5.2015; Závada, 19.5.2013, 8.5.2014; Turčianky, 19.5.2013; Horné Otrokovce, 28.6.2014, 3.5.2016; Badice, 1.5.2014; Krnča, lom, 14.3.2015, 28.2.2016; Ladice, 4.5.2015; Jelenec, 4.5.2015.
7. Pohronie area, Hron river valley, from 170 m a.s.l. (Malé Kozmálovce) up to 430 m a.s.l. (Nemecká). Climate: warm, moderately damp.
A. Nemecká, 27.2.2017.
B. Budča, Boky, 10.10.1975; Slovenská Ľubča, Šupínska skala, 11.7.1978; Lučatín, tábor (camp), 16.2.2017.
C. Budča, Boky, 16.4.2004; Slovenská Ľubča, Šupínska skala, 27.2.2017; Lehôtka pod Brehy, Szabova skala, októbere 1996; Horša, 9.4.2019, Malé Kozmálovce, lom, 27.2.2020.
8. Muráňska planina Plateau, southern and northern borders of the plateau, from 400 m a.s.l. (Muráň) up to 900 m a.s.l. (Telgárt). Climate: moderately warm to moderately cool, damp.
A. Pohorelská Maša, Mašianske skalky, Obuch 1978; Muráňska Huta, Tesná skala, 9.4.1979; Telgárt, Dlhý Vrch, 29.4.1979.
B. Tisovec, Hradová, 30.10.1976; Tisovec, Čertova dolinka, 27.4.1978; Muráň, Javorníčkova dolinka, 15.5.1978; Muráň, dolinka Bodolová, 1.8.1980; Zlatno, dolina Zlatnica, 25.10.2001; Telgárt, Homoľa, 13.6.1979, 1.10.2001.
C. Zlatno, dolina Zlatnica, 25.10.2001, 13.8.2003; Valkovňa, Zlatnianske skaly, 29.6.2000, 17.8.2003, 2.8.2005, 17.5.2017.
9. Spiš region, Slovenský raj National Park, Poprad, Hornád and Hnilec river valleys, from 430 m a.s.l. (Žehra) up to 900 m a.s.l. (Ždiar). Climate: moderately warm to moderately cool, moderately damp to damp.
A. Stratená, Stratenský tunel, 9.7.1990; Vernár, 12.5.2014.
B. Vernár, Vernárska tiesňava (ravine), 26.10.1994; Spišské Podhradie, Dreveník, 16.9.1976; Ždiar, Monkova dolina, 31.7.1997.
C. Žehra, Dreveník, 8.4.2014, 14.7.2014; Haligovce, Haligovské skaly, 23.9.2003.
10. Rimavská kotlina Basin, borders of Cerová and Revúcka Uplands, from 190 m a.s.l. (Bretka) up to 280 m a.s.l. (Šiatorská Bukovinka). Climate: warm, moderately damp.
B. Belina, Belinská skala, apríl 1981; Bretka, Prielom Muráňky, 10.7.1992.
C. Belina, Belinská skala, 27.6.1995; Hrušov, lom (quarry), 9.4.1998; Drienčany, lom, 2.6.1995, 20.6.1996, 10.9.1997, 23.9.1998, 14.4.1999; Gemerské Dechtáre, Bagova skala, 21.4.1998, 2.6.2000, 20.9.2006; Šiatorská Bukovinka, lom, 22.4.1998; Bulhary, lom, 19.9.2006; Husiná, lom, 19.9.2006; Veľké Dravce, 19.9.2006.
11. Slovenský kras Karst area, lower borders of karst plateaux, from 180 m a.s.l. (Drienovec) up to 260 m a.s.l. (Jasov). Climate: warm, moderately damp.
A. Zádiel, Zádielská dolina, 19.9.1976.
B. Zádiel, Zádielská dolina, 19.9.1976; Jasov, jaskyňa, 19.9.1976, 18.9.1991; Debraď, Hatiny, 25.6.1977, 18.9.1991; Hrhov, Pod Kresaným, 29.10.1981.
C. Zádiel, Zádielská dolina, 12.5.1994; Debraď, Hatiny, 1996; Hrhov, Dolný Vrch, 30.3.2015; Drienovec, lom, 11.9.1997; Plešivec, lom, 27.8.1996.

Appendix 2. Comparison of Eurasian eagle-owl diets over three historical periods in the Orava region.
Príloha 2. Porovnanie potravy výra skalného z troch období na Orave.

obdobie (roky pred) / period (years ago)	**A: >70**		**B: 30–70**		**C: <30**		**∑**	**%**
period No. / obdobie č.	**1**		**2**		**3**			
taxa / taxón								
Rana temporaria (n/ks)	1+	2369	1-	1733	2-	181	4283	28.83
%		42.42		22.53		11.45		
Apodemus sylvaticus	1+	349	1-	168	2-	13	530	3.57
Apodemus microps	1+	51	3-	0	1-	0	51	0.34
Apodemus agrarius	1+	85	1-	34	1-	3	122	0.82
Mus musculus	1+	85	2-	11	1-	1	97	0.65
Coloeus monedula	1+	27	1-	16		3	46	0.31
Turdus merula	1-	2	1+	28		4	34	0.23
Turdus philomelos	1-	22	1+	57		5	84	0.57
Cypriniformes sp.	1-	1	1+	17			18	0.12
Arvicola amphibius	1-	304	1+	1184	1+	228	1716	11.55
Erinaceus roumanicus	1-	21		42	2+	41	104	0.70
Rattus norvegicus	1-	74		196	1+	96	366	2.46
Microtus arvalis (n/ks)	1-	1620		3212	1+	742	5574	37.52
%		29.01		41.76		46.93		
Sciurus vulgaris		10		18	1+	9	37	0.25
Mustela nivalis		7		15	1+	8	30	0.20
Columba livia dom.	2-	3		31	1+	15	49	0.33
Perdix perdix		24		42	1+	19	85	0.57
Buteo buteo	1-	3		9	1+	9	21	0.14
Asio otus	1-	10		37	1+	17	64	0.43
Garrulus glandarius	1-	5		18	1+	10	33	0.22
Turdus pilaris	1-	7		31	1+	19	57	0.38
Corvus cornix + frugilegus	1-	45		100		17	162	1.09
Turdus viscivorus	1-	3		14		4	21	0.14
Sturnus vulgaris	1-	0		7		4	11	0.07
Anas platyrhynchos	1-	0		8		5	13	0.09
Apodemus flavicollis		159		185	2-	9	353	2.38
Lepus europaeus		24		49		13	86	0.58
Talpa europaea		21		37		4	62	0.42
Alauda arvensis		22		26		4	52	0.35
Muscardinus avellanarius		8		23		2	33	0.22
Coturnix coturnix		17		12		4	33	0.22
Myodes glareolus		13		15		3	31	0.21
Scolopax rusticola		8		19		3	30	0.20
Falco tinnunculus		8		15		4	27	0.18
Microtus agrestis		10		10		5	25	0.17
Turdus torquatus		10		10		3	23	0.15
Strix aluco		10		9		2	21	0.14
Terricola subterraneus		5		16			21	0.14
Glis glis		5		12		4	21	0.14
Columba palumbus		4		15			19	0.13
Pica pica		4		9		4	17	0.11
Salmo trutta		3		12		1	16	0.11
Vulpes vulpes		4		6		6	16	0.11

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Appendix 2. Continuation.
Príloha 2. Pokračovanie.

obdobie (roky pred) / period (years ago) period No. / obdobie č. taxa / taxón	A: >70 1		B: 30–70 2		C: <30 3		∑	%
Dryomys nitedula		5		10			15	0.10
Mustela erminea		1		7		5	13	0.09
Sorex araneus		3		8		2	13	0.09
Neomys fodiens		7		6			13	0.09
Sicista betulina		1		8		2	11	0.07
Emberiza citrinella		2		8		1	11	0.07
Mammalia	**1-**	**2896**		**5296**		**1200**	**9392**	**63.21**
Aves	**1-**	**306**		**625**	**1+**	**191**	**1122**	**7.55**
Amphibia, Reptilia, Pisces	**1+**	**2381**	**1-**	**1768**	**1-**	**190**	**4339**	**29.20**
Evertebrata		**2**		**3**		**0**	**5**	**0.03**
∑		**5585**		**7692**		**1581**	**14,858**	**100.00**
Diversity Index H'		1.94		2.04		2.16	2.1	

Others prey species (Period no.–no. of items): Ostatné druhy (Obdobie č.–počet):
Sorex minutus (2–2), *Neomys anomalus* (1–1; 2–1), *Crocidura leucodon* (1–1), *Crocidura suaveolens* (1–1; 2–1), *Myotis nattereri* (2–1), *Myotis myotis* (1–2; 2–3), *Myotis blythii* (1–1), *Vespertilio murinus* (1–1; 2–1), *Eptesicus serotinus* (1–5; 3–1), *Nyctalus noctula* (2–1), *Pipistrellus pipistrellus* (3–1), *Plecotus auritus* (2–3), *Eliomys quercinus* (1–4; 2–1), *Micromys minutus* (1–1; 2–1; 3–1), *Ondatra zibethicus* (2–5), *Terricola tatricus* (1–3), *Chionomys nivalis* (2–3), *Martes foina* (1–1), *Mustela putorius* (1–2; 2–1), *Felis catus dom.* (1–1), *Cervus elaphus* (3–1), *Tachybaptus ruficollis* (2–1), *Ixobrychus minutus* (2–1), *Anas crecca* (2–2), *Anas querquedula* (1–1; 2–3; 3–1), *Aythya fuligula* (3–2), Anatidae sp. (3–1), *Accipiter gentilis* (1–1), *Falco subbuteo* (3–2), *Tetrastes bonasia* (1–3; 2–3; 3–1), *Lyrurus tetrix* (2–1), *Tetrao urogallus* (2–2), Galliformes sp. (1–1; 3–1), *Rallus aquaticus* (1–2; 2–1), *Porzana porzana* (1–1; 2–1), *Crex crex* (1–2; 2–4; 3–1), *Gallinula chloropus* (1–1; 2–3; 3–2), *Fulica atra* (1–1), *Charadrius dubius* (2–2), *Vanellus vanellus* (2–5; 3–4), *Actitis hypoleucos* (1–5; 3–1), *Philomachus pugnax* (1–1; 2–1), *Gallinago gallinago* (2–1), Limicolae sp. (2–1), *Columba oenas* (1–5), *Streptopelia decaocto* (2–6; 3–3), *Streptopelia turtur* (1–2; 2–3), *Cuculus canorus* (1–1; 3–2), *Tyto alba* (1–1; 2–1), *Bubo bubo* (1–2; 2–3), *Aegolius funereus* (1–2; 2–2; 3–1), *Athene noctua* (1–1), *Caprimulgus europaeus* (2–1; 3–1), *Dryocopus martius* (1–1; 2–1), *Jynx torquilla* (1–1), *Lullula arborea* (1–2; 2–2), *Galerida cristata* (1–1; 2–1), *Hirundo rustica* (3–1), *Delichon urbicum* (1–1; 2–6; 3–1), *Riparia riparia* (2–2), *Anthus trivialis* (1–3; 2–3), *Bombycilla garrulus* (2–1), *Lanius collurio* (1–7; 2–3), *Sylvia atricapilla* (1–1), *Regulus* sp. (2–1), *Muscicapa striata* (1–1), *Erithacus rubecula* (2–7; 3–1), *Turdus iliacus* (2–2), *Parus major* (2–1), *Cyanistes caeruleus* (2–1; 3–1), *Emberiza calandra* (2–1), *Fringilla coelebs* (1–2; 2–4; 3–2), *Carduelis carduelis* (2–3; 3–2), *Carduelis cannabina* (2–1), *Carduelis chloris* (1–1), *Pyrrhula pyrrhula* (2–1), *Coccothraustes coccothr.* (1–3), *Serinus serinus* (1–1), *Loxia curvirostra* (1–1; 2–1), Fringillidae sp. (1–1), *Passer domesticus* (1–1; 2–3; 3–2), *Nucifraga caryocatactes* (1–2; 2–4), Passeriformes sp. (1–5; 2–5; 3–1), Aves sp. (1–1; 2–1), Aves sp.juv. (1–1; 2–1; 3–1), *Bombina* sp. (2–1), *Bufo bufo* (1–1; 3–2), *Pelophylax* cf. *esculentus* (1–2), *Lacerta agilis* (1–4; 2–1; 3–2), *Lacerta* sp. (2–2; 3–1), Colubridae sp. (3–1), Pisces sp. (1–1; 2–2; 3–2), Coleoptera sp. (2–1), Limacidae sp. (1–2; 2–2).

Note: Numerical data in the table are given in absolute values, and positive and negative deviations (e.g 1 +, 2+, 1 -, 2-) are marked deviations from the mean (MDFM, Obuch 2001) for the species in these samples (see Methods).
Poznámka: Číselné hodnoty v tabulke sú uvedené v absolútnych hodnotách, kladné a záporné odchýlky (1 +, 2+, 1 -, 2- a podobne) sú výrazné odchýlky od priemeru (MDFM, Obuch 2001) druhov vo vzorkách (pozri Metodiku).

Appendix 3. Comparison of Eurasian eagle-owl diets over three historical periods in the Liptov region.
Príloha 3. Porovnanie potravy výra skalného z troch období na Liptove.

obdobie (roky pred) / period (years ago) **period No. / obdobie č.** **taxa / taxón**	**A: >70** **1**		**B: 30–70** **2**		**C: <30** **3**		**∑**	**%**
Rana temporaria (n/ks)		7719	1-	2567	4-	27	10,313	58.06
%		68.20		44.47		4.02		
Apodemus microps	1+	144	1-	27	1-	0	171	0.96
Apodemus agrarius	1+	63	1-	13		1	77	0.43
Lepus europaeus	1-	38	1+	47		5	90	0.51
Talpa europaea	1-	20	1+	32		2	54	0.30
Apodemus flavicollis		103	1+	86		5	194	1.09
Myodes glareolus	1-	16	1+	21			37	0.21
Mustela nivalis	1-	12	1+	43		2	57	0.32
Mustela erminea	1-	4	1+	12			16	0.09
Perdix perdix	2-	9	1+	34		6	49	0.28
Falco tinnunculus	1-	5	1+	16		3	24	0.14
Columba livia dom.	2-	7	1+	35		6	48	0.27
Columba palumbus	2-	4	1+	41			45	0.25
Strix aluco	1-	6	1+	17		1	24	0.14
Turdus merula	1-	2	1+	11		3	16	0.09
Corvus cornix + frugilegus	2-	13	1+	66		7	86	0.48
Rattus norvegicus	2-	39	1+	159	3+	68	266	1.50
Erinaceus roumanicus	2-	15	1+	43	2+	32	90	0.51
Arvicola amphibius	1-	397	1+	624	1+	101	1122	6.32
Asio otus	2-	5	1+	26	1+	9	40	0.23
Vanellus vanellus	2-	1	1+	12	1+	6	19	0.11
Pica pica	2-	0	1+	13	1+	5	18	0.10
Microtus arvalis		1786		1274	1+	306	3366	18.95
Anas platyrhynchos	1-	0		3	1+	5	8	0.05
Garrulus glandarius	1-	5		10	1+	10	25	0.14
Turdus pilaris	1-	7		13		5	25	0.14
Salmo trutta		52	1-	14			66	0.37
Apodemus sylvaticus		281		165	1-	8	454	2.56
Mus musculus		63		28			91	0.51
Microtus agrestis		32		16		1	49	0.28
Terricola subterraneus		28		19		1	48	0.27
Alauda arvensis		24		13		3	40	0.23
Sciurus vulgaris		20		18		1	39	0.22
Muscardinus avellanarius		26		10		3	39	0.22
Coturnix coturnix		20		18		1	39	0.22
Turdus philomelos		18		15		5	38	0.21
Coloeus monedula		18		15			33	0.19
Scolopax rusticola		17		10			27	0.15
Dryomys nitedula		19		5		2	26	0.15
Glis glis		12		12		1	25	0.14
Eliomys quercinus		17		7		1	25	0.14
Cricetus cricetus		18		4			22	0.12
Tetrastes bonasia		12		4			16	0.09
Neomys fodiens		5		9		1	15	0.08
Crex crex		7		7			14	0.08
Vulpes vulpes		5		6		2	13	0.07
Turdus viscivorus		9		4			13	0.07
Sicista betulina		10		2			12	0.07

Appendix 3. Continuation.
Príloha 3. Pokračovanie.

obdobie (roky pred) / period (years ago) **period No. / obdobie č.** **taxa / taxón**	**A: >70** **1**		**B: 30–70** **2**		**C: <30** **3**		**∑**	**%**
Accipiter gentilis		8		4			12	0.07
Micromys minutus		9		2			11	0.06
Delichon urbicum		8		2		1	11	0.06
Bufo bufo		8		3			11	0.06
Mammalia	**1-**	**3212**	**1+**	**2717**	**1+**	**547**	**6476**	**36.46**
Aves	**1-**	**294**	**1+**	**464**	**2+**	**91**	**849**	**4.78**
Amphibia, Reptilia, Pisces		**7808**	**1-**	**2591**	**4-**	**33**	**10,432**	**58.73**
Evertebrata		**4**		**1**		**0**	**5**	**0.03**
∑		**11,318**		**5773**		**671**	**17,762**	**100.00**
Diversity Index H'		1.37		2.1		2.19	1.73	

Others prey species (Period no.–no. of items): Ostatné druhy (Obdobie č.–počet):
Sorex araneus (1–3; 2–5; 3–1), *Sorex minutus* (2–3), *Neomys anomalus* (1–1; 2–1), *Crocidura suaveolens* (1–3; 2–2), *Myotis mystacinus* (1–1), *Myotis brandtii* (2–1), *Myotis bechsteinii* (1–1; 2–1), *Myotis myotis* (1–1; 2–1), *Vespertilio murinus* (1–2; 2–3), *Eptesicus serotinus* (1–3; 2–6), *Nyctalus noctula* (1–1; 2–1), *Pipistrellus pipistrellus* (2–3), *Barbastella barbastellus* (1–2; 2–1), *Plecotus auritus* (1–1), *Rattus rattus* (1–1), *Ondatra zibethicus* (2–1), *Chionomys nivalis* (1–6), *Canis familiaris* (3–1), *Martes* sp. (2–1), *Mustela putorius* (1–1; 2–2), *Felis catus dom.* (2–1; 3–1), *Sus scrofa* (1–2), *Capreolus capreolus* (1–1), *Ovis ammon aries* (3–1), *Tachybaptus ruficollis* (2–1; 3–2), *Anas crecca* (2–1), Anatidae sp. (2–1), *Accipiter nisus* (1–4; 2–1), *Buteo buteo* (2–4; 3–2), *Pernis apivorus* (2–1), *Aquila pomarina* (3–1), *Falco peregrinus* (1–1; 2–1), *Lyrurus tetrix* (1–4), *Tetrao urogallus* (1–1; 2–2), *Phasianus colchicus* (2–3), *Gallus gallus dom.* (1–2), *Rallus aquaticus* (1–1; 2–1), *Porzana porzana* (1–1), *Gallinula chloropus* (3–1), *Charadrius dubius* (2–1), *Tringa glareola* (1–1), *Actitis hypoleucos* (1–4; 2–3), *Gallinago gallinago* (1–3; 2–1), *Gallinago* sp. (2–1), *Chlidonias niger* (1–1), *Columba oenas* (1–5), *Streptopelia decaocto* (2–5), *Streptopelia turtur* (1–2; 2–1), *Cuculus canorus* (1–1; 2–1), *Bubo bubo* (1–3; 2–1), *Asio flammeus* (1–1; 2–1), *Aegolius funereus* (1–5; 2–3), *Athene noctua* (1–1), *Strix uralensis* (3–3), *Caprimulgus europaeus* (1–2; 2–1), *Dryocopus martius* (2–2), *Dendrocopos major* (2–2), *Dendrocopos medius* (2–1), *Jynx torquilla* (3–1), *Lullula arborea* (1–2; 2–1), *Hirundo rustica* (1–3), *Anthus trivialis* (2–1), *Anthus spinoletta* (1–1), *Motacilla alba* (1–1; 2–1), *Lanius minor* (1–1), *Lanius collurio* (1–6; 2–1), *Acrocephalus palustris* (2–1), *Sylvia atricapilla* (1–1), *Phylloscopus sibilatrix* (1–1), Sylviidae sp. (1–2), *Turdus torquatus* (1–1; 2–3; 3–1), *Turdus iliacus* (1–1), *Parus major* (1–1), *Cinclus cinclus* (1–1), *Emberiza citrinella* (1–4; 2–1; 3–1), *Emberiza calandra* (1–1), *Emberiza* sp. (1–1), *Fringilla coelebs* (1–3; 2–4), *Carduelis carduelis* (1–1; 3–1), *Carduelis cannabina* (1–1), *Carduelis chloris* (2–1), *Pyrrhula pyrrhula* (1–1), *Coccothraustes coccothr.* (1–1; 2–2), *Loxia curvirostra* (1–1; 2–3), *Passer domesticus* (1–1), *Passer montanus* (2–1), *Sturnus vulgaris* (2–5), *Nucifraga caryocatactes* (2–3), *Corvus corax* (1–1; 2–1; 3–2), *Corvus cornix* (1–1), Passeriformes sp. (1–3; 2–5), Passeriformes sp. juv (1–1), Aves sp. (2–1), Aves sp .juv. (1–3), *Bombina variegata* (1–2), *Bufotes viridis* (1–2), *Bufo* sp. (1–2), *Hyla arborea* (1–2), *Lacerta agilis* (1–1; 2–1), *Natrix natrix* (1–1), Colubridae sp. (2–1), Cypriniformes sp. (1–1; 2–1; 3–6), Pisces sp. (1–18; 2–4), Coleoptera sp. (1–1; 2–1), Limacidae sp. (1–3).

Appendix 4. Comparison of Eurasian eagle-owl diets over three historical periods in the Turiec area.
Príloha 4. Porovnanie potravy výra skalného z troch období v Turci.

obdobie (roky pred) / period (years ago)	**A: >70**		**B: 30–70**		**C: <30**		**∑**	**%**
period No. / obdobie č.	**1**		**2**		**3**			
taxa / taxón								
Rana temporaria (n/ks)	1+	3915		2124	1-	1055	7094	31.57
%		40		29.4		19.32		
Pelophylax cf. *esculentus*	1+	17		2	1-	0	19	0.08
Pelobates fuscus	1+	43	1-	3	2-	0	46	0.20
Apodemus microps	1+	134	2-	14	2-	7	155	0.69
Apodemus sylvaticus	1+	717	1-	218	1-	153	1088	4.84
Mus cf. *musculus*	1+	151		74	1-	40	265	1.18
Galerida cristata	1+	23	1-	0	1-	0	23	0.10
Mustela nivalis	1-	47	1+	80	1-	24	151	0.67
Salmo trutta	1-	20	1+	43		12	75	0.33
Erinaceus roumanicus	1-	35	1+	70	1+	58	163	0.73
Rattus norvegicus	1-	137	1+	215	1+	189	541	2.41
Arvicola amphibius	1-	189	1+	360	1+	237	786	3.50
Apodemus flavicollis		445	1-	254	1+	341	1040	4.63
Myodes glareolus		68	1-	32	1+	89	189	0.84
Columba livia dom.	2-	8		34	1+	73	115	0.51
Streptopelia decaocto	2-	0		6	1+	13	19	0.08
Perdix perdix	1-	36		57	1+	48	141	0.63
Falco tinnunculus	1-	12	1-	14	1+	39	65	0.29
Buteo buteo	1-	7		8	1+	15	30	0.13
Asio otus	1-	22		37	1+	54	113	0.50
Anas platyrhynchos	1-	4		8	1+	22	34	0.15
Gallinula chloropus	1-	0		5	1+	12	17	0.08
Erithacus rubecula		1			1+	7	8	0.04
Turdus philomelos	2-	8		24	2+	67	99	0.44
Turdus merula	1-	7		11	1+	31	49	0.22
Turdus pilaris	1-	1		9	1+	13	23	0.10
Pica pica	1-	14		14	1+	24	52	0.23
Garrulus glandarius	1-	5		12	1+	23	40	0.18
Lacerta agilis	1-	0		3	1+	7	10	0.04
Lepus europaeus	1-	29		37		25	91	0.40
Mustela erminea		18		16	1-	4	38	0.17
Microtus arvalis (n/ks)		3157		3005		2426	8588	38.22
%		32.26		41.6		44.42		
Corvus cornix + frugilegus		96		81		54	231	1.03
Coturnix coturnix		49		29		22	100	0.44
Sciurus vulgaris		34		33		21	88	0.39
Talpa europaea		31		30		13	74	0.33
Alauda arvensis		17		16		19	52	0.23
Vanellus vanellus		14		18		15	47	0.21
Strix aluco		14		14		14	42	0.19
Eliomys quercinus		21		13		6	40	0.18
Glis glis		15		11		6	32	0.14
Scolopax rusticola		12		8		10	30	0.13
Apodemus agrarius		13		10		5	28	0.12
Crex crex		11		10		3	24	0.11
Micromys minutus		9		4		9	22	0.10
Vulpes vulpes		6		8		6	20	0.09
Coloeus monedula		7		5		6	18	0.08
Terricola subterraneus		5		6		5	16	0.07
Muscardinus avellanarius		9		3		3	15	0.07

Appendix 4. Continuation.
Príloha 4. Pokračovanie.

obdobie (roky pred) / period (years ago)	**A: >70**		**B: 30–70**	**C: <30**		**∑**	**%**
period No. / obdobie č.	**1**		**2**	**3**			
taxa / taxón							
Microtus agrestis		3	5		6	14	0.06
Anas querquedula		5	5		4	14	0.06
Myotis myotis		7	4		2	13	0.06
Sturnus vulgaris		5	2		6	13	0.06
Anas crecca		7	1		4	12	0.05
Cricetus cricetus		6	4			10	0.04
Mammalia		**5330**	**4527**		**3690**	**13,547**	**60.28**
Aves	**1-**	**452**	**505**	**1+**	**681**	**1638**	**7.29**
Amphibia, Reptilia, Pisces	**1+**	**4005**	**2189**	**1-**	**1088**	**7282**	**32.4**
Evertebrata		**0**	**3**		**2**	**5**	**0.02**
∑		**9787**	**7224**		**5461**	**22,472**	**100.00**
Diversity Index H'		1.91	2.03		2.25	2.09	

Others prey species (Period no.–no. of items): Ostatné druhy (Obdobie č.–počet):
Sorex araneus (3–5; 2–4; 1–2), *Sorex minutus* (1–2), *Neomys anomalus* (3–3; 1–1), *Neomys fodiens* (3–7; 2–3; 1–1), *Crocidura leucodon* (3–2), *Crocidura suaveolens* (2–2; 1–2), *Rhinolophus ferrumequinum* (2–1), *Rhinolophus hipposideros* (2–1), *Myotis mystacinus* (2–1), *Myotis bechsteinii* (3–2; 2–1), *Vespertilio murinus* (3–6; 2–2; 1–1), *Eptesicus serotinus* (3–2; 2–2), *Eptesicus nilssonii* (1–1), *Nyctalus noctula* (3–3), *Pipistrellus pipistrellus* (3–5), *Barbastella barbastellus* (3–4), *Sicista betulina* (3–2), *Rattus rattus* (3–1), *Ondatra zibethicus* (2–4; 1–2), *Martes* sp. (3–1), *Mustela vison* (1–1), *Felis catus dom.* (1–2), *Sus scrofa* (3–1), *Tachybaptus ruficollis* (3–1; 2–1; 1–3), *Anas acuta* (1–1), Anatidae sp. (3–4), *Accipiter gentilis* (2–3; 1–5), *Accipiter nisus* (3–2; 1–4), *Aquila* sp. (1–1), Accipitridae sp. (3–1), *Falco* sp. (3–3), *Tetrastes bonasia* (2–1; 1–1), *Phasianus colchicus* (3–1; 2–3), *Gallus gallus dom.* (2–1), *Rallus aquaticus* (3–1; 2–3; 1–5), *Porzana porzana* (3–2; 2–2; 1–4), *Zapornia parva* (2–1), *Fulica atra* (2–2; 1–4), Rallidae sp. (3–1), *Tringa glareola* (2–3), *Tringa* sp. (3–2), *Actitis hypoleucos* (3–1; 2–1; 1–3), *Philomachus pugnax* (3–2), *Gallinago gallinago* (2–2), *Gallinago* sp. (2–1; 1–2), *Chroicocephalus ridibundus* (1–3), *Sterna hirundo* (1–1), *Chlidonias niger* (2–1), *Columba oenas* (3–4; 2–1; 1–2), *Columba palumbus* (3–4; 2–5; 1–2), *Columba* sp. (2–1), *Streptopelia turtur* (2–1; 1–4), *Cuculus canorus* (3–2; 2–1; 1–4), *Bubo bubo* (2–3; 1–2), *Asio flammeus* (2–1), *Aegolius funereus* (3–2), *Athene noctua* (3–2), *Caprimulgus europaeus* (3–1; 2–2), *Dryocopus martius* (2–1; 1–1), *Lullula arborea* (2–1; 1–2), *Hirundo rustica* (2–1), *Delichon urbicum* (2–1; 1–1), *Motacilla alba* (3–2), *Lanius excubitor* (1–1), *Lanius minor* (3–2), *Lanius collurio* (1–1), *Hippolais icterina* (3–2), *Sylvia atricapilla* (1–2), *Saxicola rubetra* (2–1), *Phoenicurus ochruros* (1–4), *Turdus iliacus* (2–1), *Turdus viscivorus* (3–3; 2–1; 1–4), *Turdus* sp. (2–2), *Parus major* (3–1), *Sitta europaea* (2–1), *Cinclus cinclus* (1–1), *Emberiza citrinella* (3–2; 2–2; 1–4), *Emberiza calandra* (3–1), *Fringilla coelebs* (1–2), *Carduelis carduelis* (3–3; 2–1), *Carduelis cannabina* (2–1), *Coccothraustes coccothr.* (3–2; 2–1), *Serinus serinus* (2–1), *Passer domesticus* (2–4), *Nucifraga caryocatactes* (2–2; 1–2), *Corvus corax* (2–1; 1–1), Passeriformes sp. (3–12; 2–12; 1–3), Aves sp. (2–1; 1–1), Aves sp. juv. (3–1; 2–1; 1–2), *Bufo bufo* (2–4), *Bufotes viridis* (2–1; 1–1), *Hyla arborea* (3–2), *Pelophylax ridibundus* (2–1), *Lacerta muralis* (2–2; 1–1), *Zootoca vivipara* (1–2), *Natrix natrix* (2–1), Cypriniformes sp. (3–8; 2–5; 1–10), Coleoptera sp. (2–3; 1–2).

Appendix 5. Comparison of Eurasian eagle-owl diets over three historical periods in the Žilinská kotlina Basin.
Príloha 5. Porovnanie potravy výra skalného z troch období v Žilinskej kotline.

obdobie (roky pred) / period (years ago)	**A: >70**		**B: 30–70**		**C: <30**		**∑**	**%**
period No. / obdobie č.	**1**		**2**		**3**			
taxa / taxón								
Apodemus microps	1+	258	2-	18	2-	0	276	1.37
Rana temporaria (n/ks)		6334	1-	942	2-	78	7354	36.60
%		43.48		20.46		8.47		
Pelophylax cf. *esculentus*		109	1-	13	1-	1	123	0.61
Mus cf. *musculus*		189	1-	27	1-	4	220	1.09
Terricola subterraneus		101	1-	18	1-	0	119	0.59
Apodemus sylvaticus		999		247	2-	11	1257	6.26
Microtus arvalis		4248		1642	1-	215	6105	30.38
Perdix perdix	2-	51	2+	145	1-	2	198	0.99
Phasianus colchicus	1-	8	1+	16		1	25	0.12
Sciurus vulgaris	1-	13	1+	34		4	51	0.25
Mustela nivalis		52	1+	32		3	87	0.43
Corvus cornix + frugilegus	1-	85	1+	68		5	158	0.79
Lanius collurio	1-	2	1+	8			10	0.05
Erinaceus roumanicus	2-	38	2+	111	2+	28	177	0.88
Lepus europaeus	1-	88	1+	118	1+	29	235	1.17
Arvicola amphibius	1-	278	1+	243	1+	40	561	2.79
Asio otus	2-	17	1+	42	1+	10	69	0.34
Rattus norvegicus	1-	126	1+	188	2+	49	363	1.81
Columba livia dom.	2-	19	1+	43	3+	46	108	0.54
Apodemus flavicollis	1-	405		188	3+	202	795	3.96
Apodemus agrarius		105	1-	15	2+	28	148	0.74
Myodes glareolus		130		35	2+	33	198	0.99
Falco tinnunculus	1-	15		8	2+	12	35	0.17
Turdus pilaris	1-	8		8	2+	17	33	0.16
Turdus philomelos	1-	29		20	1+	10	59	0.29
Turdus merula	1-	6		11	1+	9	26	0.13
Streptopelia decaocto	1-	1		4		3	8	0.04
Anas platyrhynchos	1-	4		7		2	13	0.06
Sturnus vulgaris	1-	5		7		3	15	0.07
Alauda arvensis		62	1-	8		1	71	0.35
Salmo trutta		24	1-	0			24	0.12
Coturnix coturnix		93		22		3	118	0.59
Talpa europaea		90		22		4	116	0.58
Strix aluco		39		19		4	62	0.31
Scolopax rusticola		43		9		2	54	0.27
Coloeus monedula		27		11		4	42	0.21
Pica pica		32		7		2	41	0.20
Garrulus glandarius		20		6		3	29	0.14
Eliomys quercinus		19		6		1	26	0.13
Mustela erminea		18		6		1	25	0.12
Microtus agrestis		17		7			24	0.12
Vulpes vulpes		12		6		3	21	0.10
Glis glis		9		8		1	18	0.09
Muscardinus avellanarius		10		6		1	17	0.08
Neomys fodiens		14		2			16	0.08
Athene noctua		11		4		1	16	0.08
Eptesicus serotinus		14		1			15	0.07
Sorex araneus		9		4		1	14	0.07
Vanellus vanellus		7		6		1	14	0.07

Appendix 5. Continuation.
Príloha 5. Pokračovanie.

obdobie (roky pred) / period (years ago)	**A: >70**		**B: 30–70**		**C: <30**		**∑**	**%**
period No. / obdobie č.	**1**		**2**		**3**			
taxa / taxón								
Myotis myotis		6		7			13	0.06
Buteo buteo		6		4		2	12	0.06
Crex crex		9		2		1	12	0.06
Columba oenas		9		2		1	12	0.06
Fringilla coelebs		11		1			12	0.06
Mammalia		**7301**		**3007**	**1+**	**662**	**10,970**	**54.59**
Aves	**1-**	**768**	**1+**	**596**	**2+**	**178**	**1542**	**7.67**
Amphibia, Reptilia, Pisces		**6493**	**1-**	**997**	**2-**	**80**	**7570**	**37.67**
Evertebrata		**7**		**4**		**1**	**12**	**0.06**
∑		**14,569**		**4604**		**921**	**20,094**	**100.00**
Diversity Index H'		1.96		2.52		2.77	2.22	

Others prey species (Period no.–no. of items): Ostatné druhy (Obdobie č.–počet):
Sorex minutus (1–2), *Neomys anomalus* (1–6; 3–1), *Crocidura leucodon* (1–8; 2–1), *Crocidura suaveolens* (1–5; 2–1), *Rhinolophus hipposideros* (1–1), *Vespertilio murinus* (1–2; 2–1; 3–1), *Nyctalus noctula* (1–2; 2–2), *Pipistrellus pipistrellus* (1–5), *Barbastella barbastellus* (1–5; 2–3), *Plecotus auritus* (1–1), *Dryomys nitedula* (2–1), *Micromys minutus* (1–6; 2–1; 3–1), *Rattus rattus* (1–1), *Cricetus cricetus* (1–5), *Ondatra zibethicus* (2–2; 3–1), *Terricola tatricus* (1–2), *Canis familiaris* (1–1), *Martes foina* (2–1), *Martes* sp. (2–1), *Mustela putorius* (2–1), *Felis catus dom.* (2–1), *Capra ibex hircus* (1–1), *Podiceps cristatus* (2–1), *Podiceps nigricollis* (2–1), *Tachybaptus ruficollis* (2–3; 3–1), *Anser fabalis* (1–1), *Anas crecca* (1–1; 2–1; 3–2), Anatidae sp. (1–2; 2–1), *Accipiter gentilis* (1–3; 2–1; 3–2), *Accipiter nisus* (1–4; 2–1), *Circus* sp. (1–1), *Falco peregrinus* (1–2; 2–2), *Falco* sp. (2–2), *Gallus gallus dom.* (1–8), *Meleagris gallopavo dom.* (3–1), *Rallus aquaticus* (1–1), *Porzana porzana* (1–2), *Zapornia parva* (3–1), *Gallinula chloropus* (1–5; 2–3; 3–1), *Fulica atra* (1–1; 2–2), *Charadrius dubius* (1–2; 2–3), *Pluvialis apricaria* (2–1), *Actitis hypoleucos* (1–8; 2–1; 3–1), *Philomachus pugnax* (1–1), *Gallinago gallinago* (1–1), *Chroicocephalus ridibundus* (2–1; 3–1), *Sterna hirundo* (2–1), *Chlidonias niger* (1–1; 2–1), *Columba palumbus* (1–11), *Columba* sp. (1–6; 2–35), *Streptopelia turtur* (1–4; 2–6; 3–1), *Cuculus canorus* (1–1; 2–1), *Tyto alba* (2–2), *Bubo bubo* (1–3; 2–3; 3–2), *Asio flammeus* (1–1; 3–1), *Aegolius funereus* (1–2; 2–1; 3–1), *Strix uralensis* (1–1), *Caprimulgus europaeus* (1–3; 2–2; 3–1), *Apus apus* (1–1; 3–1), *Dryocopus martius* (2–2), *Picus viridis* (3–2), *Dendrocopos major* (2–1), *Dendrocopos leucotos* (1–1), *Lullula arborea* (1–10), *Galerida cristata* (1–2; 3–1), *Delichon urbicum* (1–1), *Anthus pratensis* (3–1), *Anthus spinoletta* (1–2), *Motacilla alba* (1–3; 2–2), *Lanius excubitor* (2–1), *Lanius minor* (1–7), *Sylvia* sp. (1–1), *Phylloscopus sibilatrix* (1–1), Sylviidae sp. (1–4), *Muscicapa striata* (2–1), *Oenanthe oenanthe* (2–1), *Erithacus rubecula* (1–5), *Turdus torquatus* (3–3), *Turdus iliacus* (1–1), *Turdus viscivorus* (1–4; 2–3), *Parus major* (1–2), *Poecile palustris* (1–2), *Parus* sp. (2–1), *Emberiza citrinella* (1–5; 2–4), *Carduelis spinus* (3–1), *Carduelis chloris* (1–1), *Coccothraustes coccothraustes* (1–5; 3–4), *Passer domesticus* (1–6; 2–2), *Passer montanus* (2–1; 3–2), *Nucifraga caryocatactes* (1–1; 2–1), *Corvus corax* (1–2; 2–1; 3–2), Passeriformes sp. (1–6; 2–4), Aves sp. (2–7), *Pelobates fuscus* (1–2; 2–2), *Bufo bufo* (2–2), *Bufotes viridis* (2–2), *Hyla arborea* (1–1), *Anguis fragilis* (1–1), *Lacerta agilis* (1–4), *Lacerta muralis* (1–1), *Lacerta* sp. (1–1; 2–1), *Zootoeca vivipara* (1–1), *Natrix natrix* (1–2), Colubridae sp. (1–1), Cypriniformes sp. (1–6; 2–15; 3–1), Pisces sp. (1–6; 2–20), Hymenoptera sp. (1–1), Coleoptera sp. (1–5; 2–4; 3–1), Limacidae sp. (1–1).

Appendix 6. Comparison of Eurasian eagle-owl diets over two historical periods in the central Považie (Váh river basin) area.
Príloha 6. Porovnanie potravy výra skalného z dvoch období na strednom Považí.

obdobie (roky pred) / period (years ago)	**A: >70**		**B: 30–70**		**∑**	**%**
period No. / obdobie č.	**1**		**2**			
taxa / taxón						
Rana temporaria (n/ks)	1+	1068	2-	212	1280	15.02
%		24.99		4.99		
Pelophylax cf. *esculentus*	1+	52	1-	16	68	0.80
Pelobates fuscus	1+	31	2-	1	32	0.38
Apodemus microps	1+	596	4-	26	622	7.30
Cricetus cricetus	1+	118	2-	16	134	1.57
Erinaceus roumanicus	2-	34	1+	207	241	2.83
Lepus europaeus	1-	37	1+	96	133	1.56
Rattus norvegicus	1-	43	1+	174	217	2.55
Apodemus flavicollis	1-	160	1+	298	458	5.37
Myodes glareolus	1-	45	1+	135	180	2.11
Microtus arvalis (n/ks)	1-	862	1+	1513	2375	27.87
%		20.17		35.61		
Perdix perdix	2-	33	1+	207	240	2.82
Phasianus colchicus	2-	4	1+	34	38	0.45
Columba livia dom.	2-	4	1+	32	36	0.42
Asio otus	1-	24	1+	78	102	1.20
Turdus philomelos	1-	4	1+	27	31	0.36
Corvus cornix + frugilegus	1-	65	1+	121	186	2.18
Cypriniformes sp.	2-	9	1+	54	63	0.74
Vanellus vanellus	1-	1		10	11	0.13
Apodemus sylvaticus		457	1-	314	771	9.05
Apodemus agrarius		20	1-	7	27	0.32
Gallus gallus dom.		10	1-	1	11	0.13
Arvicola amphibius		66		69	135	1.58
Mus musculus		59		43	102	1.20
Strix aluco		37		57	94	1.10
Coloeus monedula		32		32	64	0.75
Talpa europaea		33		20	53	0.62
Coturnix coturnix		27		21	48	0.56
Terricola subterraneus		26		20	46	0.54
Mustela nivalis		18		19	37	0.43
Turdus merula		13		23	36	0.42
Scolopax rusticola		19		16	35	0.41
Sciurus vulgaris		10		21	31	0.36
Anas platyrhynchos		10		21	31	0.36
Falco tinnunculus		10		19	29	0.34
Columba oenas		14		12	26	0.31
Nyctalus noctula		17		8	25	0.29
Pica pica		13		11	24	0.28
Alauda arvensis		15		7	22	0.26
Garrulus glandarius		7		14	21	0.25
Glis glis		4		12	16	0.19
Muscardinus avellanarius		5		10	15	0.18
Eliomys quercinus		10		3	13	0.15
Mustela erminea		7		6	13	0.15
Buteo buteo		4		7	11	0.13
Crex crex		2		8	10	0.12
Columba palumbus		8		2	10	0.12
Mammalia		**2666**		**3062**	**5728**	**67.21**
Aves	**1-**	**431**	**1+**	**892**	**1323**	**15.52**
Amphibia, Reptilia, Pisces	**1+**	**1170**	**2-**	**295**	**1465**	**17.19**
Evertebrata		**6**		**0**	**6**	**0.07**
∑		**4273**		**4249**	**8522**	**100.00**
Diversity Index H'		2.66		2.85	2.9	

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Appendix 7. Comparison of Eurasian eagle-owl diets over two historical periods in the upper Ponitrie area.
Príloha 7. Porovnanie potravy výra skalného z dvoch období na hornom Ponitrí.

obdobie (roky pred) / period (years ago) **period No. / obdobie č.** **taxa / taxón**	**A: >70** **1**		**B: 30–70** **2**		**C: <30** **3**		**∑**	**%**
Rana temporaria (n/ks)	1+	226		146	4-	3	375	7.56
%		10.78		7.37		0.34		
Apodemus microps	1+	43	1-	21		11	75	1.51
Apodemus sylvaticus	1+	276		208	2-	34	518	10.44
Mus musculus	1+	62	1-	10	1-	8	80	1.61
Myodes glareolus	1+	41		24	1-	3	68	1.37
Arvicola amphibius	1-	40	1+	77		22	139	2.8
Corvus cornix+frugilegus		28	1+	43	1-	5	76	1.53
Perdix perdix	1-	27	1+	81		15	123	2.48
Phasianus colchicus	1-	1	1+	17		5	23	0.46
Asio otus	1-	12	1+	31		10	53	1.07
Rattus norvegicus	3-	15		96	2+	184	295	5.95
Columba livia dom.	3-	1		25	2+	38	64	1.29
Erinaceus roumanicus	1-	25		46	1+	50	121	2.44
Cricetus cricetus	1-	22		30	1+	20	72	1.45
Turdus merula	1-	3		12	1+	19	34	0.69
Turdus philomelos		9		11	1+	15	35	0.71
Garrulus glandarius		2		2	1+	9	13	0.26
Lucanus cervus	2-	0	2-	0	2+	21	21	0.42
Sciurus vulgaris	1-	2		12		8	22	0.44
Columba oenas	1-	1		6		6	13	0.26
Sturnus vulgaris	1-	1		7		6	14	0.28
Apodemus flavicollis		202		160	1-	36	398	8.02
Microtus arvalis (n/ks)		825		637	1-	243	1705	34.36
%		39.36		32.16		27.46		
Lepus europaeus		43		54		26	123	2.48
Coturnix coturnix		17		9		2	28	0.56
Alauda arvensis		10		13		4	27	0.54
Mustela nivalis		11		12		3	26	0.52

◄ **Appendix 6.** Continuation.
◄ **Príloha 6.** Pokračovanie.

Others prey species (Period no.–no. of items): Ostatné druhy (Obdobie č.–počet):
Sorex araneus (1–2; 2–6), *Sorex minutus* (2–2), *Neomys anomalus* (1–2), *Neomys fodiens* (1–4), *Crocidura leucodon* (1–2; 2–3), *Crocidura suaveolens* (1–4; 2–4), *Myotis mystacinus* (1–1), *Myotis myotis* (1–5; 2–4), *Myotis blythii* (1–1), *Vespertilio murinus* (1–2; 2–1), *Eptesicus serotinus* (1–3; 2–6), *Pipistrellus pipistrellus* (2–5), *Barbastella barbastellus* (2–2), *Plecotus auritus* (1–1; 2–2), *Spermophilus citellus* (2–1), *Dryomys nitedula* (2–1), *Sicista betulina* (1–1), *Micromys minutus* (1–4), *Ondatra zibethicus* (2–2), *Vulpes vulpes* (1–3; 2–5), *Mustela putorius* (1–1), *Mustela eversmanni* (1–1), *Felis catus dom.* (1–1; 2–1), *Ovis ammon aries* (1–1), *Tachybaptus ruficollis* (1–1; 2–1), *Nycticorax nycticorax* (2–1), *Mareca penelope* (1–1), *Anas crecca* (2–4), *Anas querquedula* (2–4), *Bucephala clangula* (2–1), Anatidae sp. (1–4; 2–6), *Accipiter gentilis* (1–2; 2–1), *Accipiter nisus* (1–3; 2–1), *Falco peregrinus* (1–1), *Falco* sp. (2–1), *Lyrurus tetrix* (2–4), *Rallus aquaticus* (1–3), *Porzana porzana* (1–1; 2–3), *Gallinula chloropus* (1–2; 2–2), *Fulica atra* (2–3), Rallidae sp. (2–2), *Charadrius dubius* (2–1), *Tringa ochropus* (2–1), *Actitis hypoleucos* (2–2), *Philomachus pugnax* (1–1), *Limosa limosa* (1–1), Limicolae sp. (2–3), *Sterna hirundo* (1–1; 2–1), *Columba* sp. (1–1; 2–10), *Streptopelia decaocto* (2–4), *Streptopelia turtur* (1–3; 2–4), *Cuculus canorus* (2–7), *Tyto alba* (1–1; 2–1), *Bubo bubo* (2–4), *Asio flammeus* (2–1), *Aegolius funereus* (1–1; 2–1), *Athene noctua* (1–6; 2–3), *Strix uralensis* (2–1), *Caprimulgus europaeus* (1–1), *Apus apus* (1–1), *Picus canus* (1–2), *Picus viridis* (2–1), *Dendrocopos major* (1–1), *Dendrocopos syriacus* (1–1), *Jynx torquilla* (2–2), *Lullula arborea* (2–3), *Galerida cristata* (1–2; 2–4), *Hirundo rustica* (1–1), *Delichon urbicum* (1–1; 2–2), *Motacilla alba* (2–1), *Motacilla cinerea* (2–1), *Lanius collurio* (2–1), *Phoenicurus ochruros* (2–1), *Erithacus rubecula* (1–1; 2–1), *Turdus pilaris* (1–5; 2–3), *Turdus viscivorus* (1–3; 2–1), *Cinclus cinclus* (2–1), *Emberiza citrinella* (1–4; 2–3), *Emberiza calandra* (1–2), *Fringilla coelebs* (1–1; 2–1), *Carduelis carduelis* (2–1), *Carduelis cannabina* (1–1), *Coccothraustes coccothr.* (1–2; 2–2), *Passer domesticus* (1–5; 2–1), *Passer montanus* (1–1), *Sturnus vulgaris* (1–2; 2–3), *Nucifraga caryocatactes* (2–1), *Corvus corax* (1–1), Passeriformes sp. (1–4; 2–14), Aves sp. (2–6), *Bufo bufo* (1–1; 2–2), *Bufotes viridis* (1–1), *Rana arvalis* (2–1), *Lacerta viridis* (2–2), *Lacerta agilis* (1–3; 2–1), *Lacerta muralis* (2–2), Serpentes sp. (2–2), *Salmo trutta* (1–1; 2–2), Salmonidae sp. (1–2), Pisces sp. (1–2), Coleoptera sp. (1–5), *Astacus* sp. (1–1).

Appendix 7. Continuation.
Príloha 7. Pokračovanie.

obdobie (roky pred) / period (years ago)	**A: >70**		**B: 30–70**		**C: <30**		**∑**	**%**
period No. / obdobie č.	**1**		**2**		**3**			
taxa / taxón								
Scolopax rusticola	10		7		8	25	0.50	
Pelophylax cf. *esculentus*		15		7		1	23	0.46
Talpa europaea		5		11		4	20	0.40
Spermophilus citellus		5		10		1	16	0.32
Lacerta viridis		9		6		1	16	0.32
Lacerta agilis		4		10			14	0.28
Eliomys quercinus		9		4			13	0.26
Strix aluco		6		6		1	13	0.26
Terricola subterraneus		5		6			11	0.22
Pica pica		2		6		3	11	0.22
Crocidura suaveolens		4		5		1	10	0.20
Turdus pilaris		1		6		3	10	0.20
Mammalia		**1659**		**1457**		**662**	**3778**	**76.14**
Aves	**1-**	**171**		**344**	**1+**	**195**	**710**	**14.31**
Amphibia, Reptilia, Pisces	**1+**	**265**		**180**	**3-**	**7**	**452**	**9.11**
Evertebrata	**1-**	**1**	**2-**	**0**	**2+**	**21**	**22**	**0.44**
∑		**2096**		**1981**		**885**	**4962**	**100.00**
Diversity Index H'		2.4		2.84		2.82	2.79	

Others prey species (Period no.–no. of items): Ostatné druhy (Obdobie č.–počet):
Sorex araneus (2–5), *Sorex minutus* (2–2; 3–1), *Neomys anomalus* (2–3), *Neomys fodiens* (2–1), *Crocidura leucodon* (1–4; 2–3), *Rhinolophus hipposideros* (1–1), *Myotis emarginatus* (3–1), *Myotis myotis* (2–1), *Myotis blythii* (2–1), *Vespertilio murinus* (1–2), *Eptesicus serotinus* (1–1; 2–2; 3–1), *Nyctalus noctula* (1–2; 2–1), *Barbastella barbastellus* (2–2), *Glis glis* (2–1), *Muscardinus avellanarius* (1–2), *Micromys minutus* (2–1; 3–3), *Apodemus agrarius* (1–5), *Dicrostonyx gulielmi* (1–1), *Lasiopodomys gregalis* (1–1), *Alexandromys oeconomus* (1–1), *Vulpes vulpes* (1–3; 2–5; 3–1), *Mustela erminea* (1–1; 2–5), *Mustela putorius* (2–1), *Felis catus dom.* (3–1), *Tachybaptus ruficollis* (3–2), *Anas platyrhynchos* (2–1; 3–2), *Anas crecca* (3–1), (1–1; 2–1), *Accipiter gentilis* (3–2), *Accipiter nisus* (2–1; 3–3), *Buteo buteo* (2–2; 3–2), *Falco tinnunculus* (2–5; 3–4), *Rallus aquaticus* (1–1; 3–2), *Zapornia parva* (1–1), *Porzana* sp. (1–1), *Crex crex* (1–4; 2–1; 3–2), *Gallinula chloropus* (2–2), *Fulica atra* (3–1), Charadrius dubius (2–3; 3–1), Vanellus vanellus (1–2; 2–3; 3–1), *Actitis hypoleucos* (1–2; 2–2), *Columba palumbus* (1–3; 2–3; 3–2), *Streptopelia decaocto* (3–1), *Streptopelia turtur* (1–1; 2–3; 3–2), *Cuculus canorus* (1–1; 2–2; 3–2), *Bubo bubo* (3–1), *Asio flammeus* (3–1), *Otus scops* (1–2), *Aegolius funereus* (1–1; 2–2), *Athene noctua* (1–4; 2–2; 3–1), *Caprimulgus europaeus* (2–1), *Coracias garrulus* (2–1), *Lullula arborea* (1–2), *Galerida cristata* (2–2), *Lanius excubitor* (1–1; 2–1), *Lanius minor* (1–1; 2–1), *Lanius collurio* (1–1; 2–1; 3–1), *Sylvia atricapilla* (2–2), *Oenanthe oenanthe* (1–2), *Erithacus rubecula* (2–1; 3–1), *Turdus viscivorus* (1–1; 2–3), *Parus major* (3–1), *Cyanistes caeruleus* (2–1), *Emberiza citrinella* (1–1; 3–1), *Carduelis chloris* (2–1), *Coccothraustes coccothr.* (3–2), *Passer domesticus* (2–2; 3–2), *Oriolus oriolus* (1–1; 2–1), *Coloeus monedula* (1–2; 2–1; 3–1), Passeriformes sp. (1–3; 2–9; 3–3), Aves sp. (3–1), Aves sp. juv. (1–1; 2–1), *Pelobates fuscus* (1–4), *Rana dalmatina* (1–1; 2–2), *Pelophylax ridibundus* (1–2; 2–2; 3–1), *Lacerta muralis* (2–1), Colubridae sp. (2–2), *Salmo trutta* (1–1), Cypriniformes sp. (3–1), Pisces sp. (1–3; 2–4), Coleoptera sp. (1–1).

Appendix 8. Comparison of Eurasian eagle-owl diets over three historical periods in the Pohronie (Hron river basin) area.
Príloha 8. Porovnanie potravy výra skalného z troch období na Pohroní.

obdobie (roky pred) / period (years ago) period No. / obdobie č. taxa / taxón	**A: >70 1**		**B: 30–70 2**	**C: <30 3**		**∑**	**%**
Rana temporaria (n/ks)	2+	56	147	2-	2.7	210	15.70
%		70	14.38		2.97		
Erinaceus roumanicus		1	30	1+	19	50	3.74
Rattus norvegicus	1-	2	107	1+	63	172	12.86
Arvicola amphibius		4	117	1-	10	131	9.79
Microtus arvalis (n/ks)	1-	12	330	1-	48	390	29.15
%		15	32.29		20.34		
Apodemus flavicollis			29		4	33	2.47
Corvus cornix + frugilegus			24		7	31	2.32
Cypriniformes sp.			24		3	27	2.02
Asio otus			19		6	25	1.87
Perdix perdix			20		4	24	1.79
Apodemus sylvaticus			14		1	15	1.12
Lepus europaeus			8		5	13	0.97
Alauda arvensis			13			13	0.97
Columba livia dom.			6		5	11	0.82
Strix aluco			9		2	11	0.82
Scolopax rusticola			10			10	0.75
Anas platyrhynchos		1	6		2	9	0.67
Myodes glareolus			5		2	7	0.52
Mustela nivalis			7			7	0.52
Turdus merula			3		4	7	0.52
Talpa europaea			6			6	0.45
Coloeus monedula			6			6	0.45
Mammalia	**1-**	**20**	**675**		**158**	**853**	**63.75**
Aves	**2-**	**2**	**175**	**1+**	**66**	**243**	**18.16**
Amphibia, Reptilia, Pisces	**2+**	**58**	**172**	**2-**	**10**	**240**	**17.94**
Evertebrata		**0**	**0**		**2**	**2**	**0.15**
∑		**80**	**1022**		**236**	**1338**	**100.00**
Diversity Index H'		1.09	2.59		2.79	2.69	

Others prey species (Period no.–no. of items): Ostatné druhy (Obdobie č.–počet):
Crocidura leucodon (2–1), *Myotis mystacinus* (2–1), *Myotis myotis* (2–4; 3–1), *Vespertilio murinus* (2–1), *Eptesicus serotinus* (2–1), *Nyctalus noctula* (2–2), *Sciurus vulgaris* (3–1), *Glis glis* (2–3; 3–1), *Eliomys quercinus* (2–1; 3–2), *Muscardinus avellanarius* (2–1), *Mus musculus* (2–1), *Terricola subterraneus* (1–1; 2–1), *Vulpes vulpes* (2–2), *Mustela erminea* (2–3; 3–1), *Tachybaptus ruficollis* (2–2; 3–1), *Anser anser dom.* (1–1), *Anas crecca* (2–1; 3–1), *Anas querquedula* (3–1), *Anas acuta* (2–1; 3–1), Anatidae sp. (2–6), *Accipiter gentilis* (2–1), *Accipiter nisus* (2–1), *Buteo buteo* (2–1; 3–2), *Pernis apivorus* (2–1), *Falco tinnunculus* (2–1; 3–4), *Coturnix coturnix* (2–4; 3–1), *Phasianus colchicus* (3–3), *Gallus gallus dom.* (2–1), *Rallus aquaticus* (2–1), *Crex crex* (2–4), *Gallinula chloropus* (2–2; 3–1), *Fulica atra* (2–2; 3–1), *Vanellus vanellus* (2–5; 3–3), *Actitis hypoleucos* (2–2), *Gallinago* sp. (2–1), *Columba oenas* (3–1), *Columba palumbus* (2–1; 3–1), *Streptopelia decaocto* (2–2; 3–1), *Streptopelia turtur* (2–1), *Athene noctua* (3–1), *Apus apus* (2–1), *Anthus trivialis* (2–1), Sylviidae sp. (2–1), *Turdus pilaris* (2–2; 3–2), *Turdus philomelos* (2–1; 3–4), *Turdus viscivorus* (2–1), *Emberiza schoeniclus* (2–1), *Fringilla coelebs* (3–1), *Coccothraustes coccothr.* (3–3), *Sturnus vulgaris* (2–3), *Garrulus glandarius* (2–1; 3–1), *Pica pica* (2–2; 3–1), Passeriformes sp. (2–1), Aves sp. (2–3), Aves sp. juv. (3–1), *Pelophylax* cf. *esculentus* (2–1), *Salmo trutta* (1–2), *Lucanus cervus* (3–2).

Appendix 9. Comparison of Eurasian eagle-owl diets over three historical periods on the Muránska planina Plateau.
Príloha 9. Porovnanie potravy výra skalného z troch období na Muránskej planine.

obdobie (roky pred) / period (years ago)	**A: >70**		**B: 30–70**		**C: <30**		**∑**	**%**
period No. / obdobie č.	**1**		**2**		**3**			
taxa / taxón								
Rana temporaria (n/ks)	1+	674		928	1-	194	1796	22.27
%		28.82		22.8		11.72		
Microtus arvalis (n/ks)	1+	980	1-	1065		592	2637	32.70
%		41.9		26.16		35.77		
Apodemus sylvaticus	1+	40	1-	35		23	98	1.22
Apodemus flavicollis		41	1+	116	1-	20	177	2.19
Myodes glareolus	1-	8	1+	68	1-	5	81	1.00
Alauda arvensis	1-	6	1+	33		6	45	0.56
Corvus cornix + frugilegus	1-	7	1+	40		6	53	0.66
Columba oenas	1-	0	1+	17			17	0.21
Rattus norvegicus	3-	6		176	1+	126	308	3.82
Arvicola amphibius	1-	388		1055	1+	501	1944	24.10
Erinaceus roumanicus	1-	6		33		15	54	0.67
Perdix perdix	1-	4		22		8	34	0.42
Asio otus	1-	5		19		13	37	0.46
Garrulus glandarius	1-	0		13		5	18	0.22
Spermophilus citellus		4		16	1-	0	20	0.25
Talpa europaea		20		22		10	52	0.64
Microtus agrestis		12		16		5	33	0.41
Lepus europaeus		5		20		7	32	0.40
Terricola subterraneus		7		20		2	29	0.36
Coturnix coturnix		7		13		8	28	0.35
Scolopax rusticola		4		16		4	24	0.30
Strix aluco		6		17		1	24	0.30
Turdus philomelos		3		18		3	24	0.30
Turdus merula		3		11		8	22	0.27
Mus musculus		5		9		7	21	0.26
Mustela nivalis		7		10		3	20	0.25
Dryomys nitedula		10		6		3	19	0.24
Muscardinus avellanarius		6		8		4	18	0.22
Streptopelia turtur		5		13			18	0.22
Sciurus vulgaris		2		9		6	17	0.21
Pica pica		1		12		3	16	0.20
Salmo trutta		3		5		5	13	0.16
Mustela erminea		2		5		5	12	0.15
Columba livia dom.		1		8		3	12	0.15
Eptesicus serotinus		4		7			11	0.14
Falco tinnunculus		2		7		2	11	0.14
Sorex araneus		2		6		2	10	0.12
Mammalia		**1572**		**2730**		**1348**	**5650**	**70.06**
Aves	**1-**	**85**	**1+**	**387**		**102**	**574**	**7.12**
Amphibia, Reptilia, Pisces	**1+**	**681**		**950**	**1-**	**203**	**1834**	**22.74**
Evertebrata		**1**		**4**		**2**	**7**	**0.09**
∑		**2339**		**4071**		**1655**	**8065**	**100.00**
Diversity Index H'		1.73		2.31		1.99	2.14	

Others prey species (Period no.–no. of items): Ostatné druhy (Obdobie č.–počet):
Neomys anomalus (1–1), *Neomys fodiens* (2–4; 3–3), *Crocidura leucodon* (2–1), *Myotis mystacinus* (1–2), *Myotis brandtii* (1–1), *Myotis nattereri* (1–1), *Myotis bechsteinii* (1–2; 2–1), *Myotis myotis* (2–2), *Vespertilio murinus* (2–1), *Nyctalus noctula* (2–1), *Barbastella barbastellus* (1–2; 2–2), *Plecotus auritus* (2–1), *Glis glis* (1–2; 2–2; 3–4), *Eliomys quercinus* (1–2), *Sicista betulina* (1–3; 3–3), *Apodemus microps* (2–2), *Apodemus agrarius* (2–3; 3–1), *Terricola tatricus* (2–1; 3–1), *Vulpes vulpes* (2–4), *Martes* sp. (2–1), *Felis catus dom.* (1–1; 2–1), *Cervus elaphus* (2–1), *Podiceps grisegena* (2–1), *Anas platyrhynchos* (3–1), *Anas crecca* (1–1; 2–1), *Anas querquedula* (2–3), *Aythya fuligula* (2–1), Anatidae sp. (1–1), *Accipiter gentilis* (2–1), *Accipiter nisus* (2–2; 3–1), *Buteo buteo* (3–4), *Circus* sp. (2–2), Accipitridae sp. (2–2), *Tetrastes bonasia* (2–5; 3–2), *Phasianus colchicus* (2–1), Galliformes sp. (1–1), *Rallus aquaticus* (1–1), *Porzana porzana* (1–3; 2–6), *Crex crex* (1–1; 2–6; 3–1), *Gallinula chloropus* (1–1; 2–4), *Fulica atra* (2–1), *Vanellus*

Appendix 10. Comparison of Eurasian eagle-owl diets over three historical periods in the Spiš region.
Príloha 10. Porovnanie potravy výra skalného z troch období na Spiši.

obdobie (roky pred) / period (years ago) **period No. / obdobie č.** **taxa / taxón**	**A: >70** **1**		**B: 30–70** **2**		**C: <30** **3**		**∑**	**%**
Rana temporaria (n/ks)	1+	296		716	4-	10	1022	25.8
%		49.5		26.76		0.15		
Salmo trutta	1+	11		10			21	0.53
Arvicola amphibius	1+	140		484	1-	87	711	17.95
Mus cf. *musculus*	1-	2	1+	61	2-	1	64	1.62
Rattus norvegicus	1-	5	2-	26	2+	87	118	2.98
Cricetus cricetus	2-	0	1-	23	2+	34	57	1.44
Asio otus		1	1-	6	2+	24	31	0.78
Perdix perdix			1-	6	1+	12	18	0.45
Lepus europaeus		3	1-	16	1+	25	44	1.11
Erinaceus roumanicus		2	1-	5	1+	8	15	0.38
Spermophilus citellus		3	1-	1	1+	9	13	0.33
Mustela nivalis		1	1-	7	1+	11	19	0.48
Pica pica			1-	0	1+	11	11	0.28
Corvus cornix + frugilegus		2		19	1+	14	35	0.88
Coloeus monedula			1-	2	1+	13	15	0.38
Apodemus sylvaticus	1-	3		38		11	52	1.31
Apodemus microps	2-	0		45		8	53	1.34
Microtus arvalis (n/ks)	2-	61		1020		264	1345	33.96
%		10.2		38.12		38.42		
Microtus agrestis		4		31	1-	1	36	0.91
Apodemus flavicollis		7		23		5	35	0.88
Scolopax rusticola		4		10			14	0.35
Turdus philomelos		3		7		3	13	0.33
Sciurus vulgaris		4		7		1	12	0.30
Columba livia dom.		2		6		3	11	0.28
Alauda arvensis		1		7		3	11	0.28
Mustela erminea		2		5		2	9	0.23
Terricola subterraneus		3		5			8	0.20
Talpa europaea		1		4		2	7	0.18
Apodemus agrarius				7			7	0.18

◄ **Appendix 9.** Continuation.
◄ **Príloha 9.** Pokračovanie.

vanellus (2–3; 3–1), *Actitis hypoleucos* (2–1), *Tringa* sp. (2–2), *Philomachus pugnax* (2–1), *Chroicocephalus ridibundus* (2–1), *Columba palumbus* (2–3; 3–1), *Streptopelia decaocto* (2–2), *Cuculus canorus* (1–1; 2–5), *Bubo bubo* (1–1; 2–4; 3–1), *Aegolius funereus* (1–1; 2–2; 3–1), *Athene noctua* (3–1), *Caprimulgus europaeus* (1–1; 2–3), *Coracias garrulus* (2–2), *Upupa epops* (2–1), *Dryocopus martius* (2–1), *Jynx torquilla* (2–1), *Lullula arborea* (2–4), *Galerida cristata* (1–1; 2–1), *Delichon urbicum* (2–1; 3–1), *Anthus trivialis* (2–2), *Motacilla alba* (2–2), *Motacilla cinerea* (2–1), *Lanius minor* (1–1), *Lanius collurio* (1–2; 2–1), *Acrocephalus palustris* (3–1), *Sylvia atricapilla* (2–1), *Phoenicurus ochruros* (2–1), *Erithacus rubecula* (2–2; 3–1), *Turdus pilaris* (2–5; 3–4), *Turdus viscivorus* (1–3; 2–6), *Parus major* (2–2), *Periparus ater* (3–1), *Lophophanes cristatus* (3–1), *Sitta europaea* (3–1), *Troglodytes troglodytes* (1–1; 2–1), *Emberiza citrinella* (1–1; 2–3; 3–1), *Emberiza calandra* (2–1), *Emberiza schoeniclus* (1–1; 2–1), *Fringilla coelebs* (2–3; 3–3), *Coccothraustes coccothraustes* (1–1; 2–4; 3–2), Fringillidae sp. (1–1), *Passer domesticus* (2–1), *Sturnus vulgaris* (2–5; 3–1), *Nucifraga caryocatactes* (2–1), *Coloeus monedula* (2–4), Passeriformes sp. (1–6; 2–3; 3–1), Aves sp. juv. (2–4), *Bufo bufo* (2–2), *Pelophylax* cf. *esculentus* (2–2), *Lacerta agilis* (2–6; 3–3), *Lacerta* sp. (1–2), *Zootoeca vivipara* (2–2; 3–1), *Natrix natrix* (1–1), Serpentes sp. (2–1), Cypriniformes sp. (2–3), Pisces sp. (1–1; 2–1), Coleoptera sp. (1–1; 2–1; 3–2), Limacidae sp. (2–3).

Appendix 10. Continuation.
Príloha 10. Pokračovanie.

obdobie (roky pred) / period (years ago)	**A: >70**		**B: 30–70**		**C: <30**		**∑**	**%**
period No. / obdobie č.	**1**		**2**		**3**			
taxa / taxón								
Myodes glareolus		3		4			7	0.18
Falco tinnunculus		3		2		2	7	0.18
Crex crex		2		3		2	7	0.18
Mammalia	**1-**	**247**		**1838**	**1+**	**567**	**2652**	**66.95**
Aves		**43**	**1-**	**108**	**1+**	**107**	**258**	**6.51**
Amphibia, Reptilia, Pisces	**1+**	**308**		**729**	**4-**	**13**	**1050**	**26.51**
Evertebrata		**0**		**1**		**0**	**1**	**0.03**
∑		**598**		**2676**		**687**	**3961**	**100.00**
Diversity Index H'		1.82		1.91		2.43	2.16	

Others prey species (Period no.–no. of items): Ostatné druhy (Obdobie č.–počet):
Sorex araneus (1–1; 2–1), *Neomys anomalus* (2–1), *Crocidura suaveolens* (2–1), *Myotis mystacinus* (2–2), *Myotis bechsteinii* (2–1), *Myotis myotis* (2–2; 3–3), *Eptesicus serotinus* (2–3; 3–1), *Glis glis* (3–3), *Eliomys quercinus* (2–3), *Dryomys nitedula* (1–1), *Muscardinus avellanarius* (1–1; 2–4), *Sicista betulina* (2–3), *Ondatra zibethicus* (3–1), *Terricola tatricus* (2–1), *Chionomys nivalis* (2–2), *Vulpes vulpes* (2–2; 3–3), *Anas platyrhynchos* (1–1; 3–1), *Anas crecca* (1–1), *Anas querquedula* (3–1), *Accipiter gentilis* (2–2), *Buteo buteo* (3–1), *Tetrastes bonasia* (1–3; 2–2), *Lyrurus tetrix* (2–3), *Tetrao urogallus* (1–1), *Coturnix coturnix* (1–1; 2–3; 3–1), *Gallus gallus dom.* (2–1), *Porzana porzana* (2–1), *Vanellus vanellus* (3–2), *Tringa* sp. (1–2), *Gallinago gallinago* (3–1), *Columba oenas* (1–1; 2–1), *Streptopelia turtur* (1–1; 2–1; 3–1), *Cuculus canorus* (2–1), *Bubo bubo* (3–1), *Aegolius funereus* (1–3; 2–2), *Athene noctua* (3–1), *Strix aluco* (2–1), *Strix uralensis* (2–1), *Dryocopus martius* (2–1), *Picus viridis* (2–1), *Dendrocopos syriacus* (3–1), *Lullula arborea* (1–1; 2–1), *Anthus trivialis* (1–1), *Lanius collurio* (2–2), *Turdus merula* (3–2), *Turdus torquatus* (1–2; 2–4), *Turdus pilaris* (3–2), *Turdus iliacus* (1–1), *Turdus viscivorus* (2–3), *Lophophanes cristatus* (3–1), *Emberiza citrinella* (1–1; 3–1), *Carduelis chloris* (3–1), *Coccothraustes coccothr.* (2–1), *Loxia curvirostra* (2–1), *Sturnus vulgaris* (1–1), *Garrulus glandarius* (3–1), *Nucifraga caryocatactes* (2–1; 3–1), *Corvus corax* (2–1), Passeriformes sp. (1–4; 2–3), Aves sp. (2–1), Aves sp. juv. (2–1), *Bufo bufo* (2–1), *Bufo* sp. (3–1), *Lacerta agilis* (2–2), *Lacerta* sp. (1–1), Cypriniformes sp. (3–1), Pisces sp. (3–1), Coleoptera sp. (2–1).

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Appendix 11. Comparison of Eurasian eagle-owl diets over two historical periods in the Rimavská kotlina area.
Príloha 11. Porovnanie potravy výra skalného z dvoch období v Rimavskej kotline.

obdobie (roky pred) / period (years ago)	**B: 30–70**		**C: <30**		**∑**	**%**
period No. / obdobie č.	**2**		**3**			
taxa / taxón						
Apodemus flavicollis	1+	16	1-	25	41	3.77
Apodemus sylvaticus	1+	16		38	54	4.96
Perdix perdix	1+	7		6	13	1.19
Rattus norvegicus	1-	12		213	225	20.68
Apodemus agrarius	1-	0		34	34	3.13
Microtus arvalis		42		233	275	25.28
Arvicola amphibius		8		32	40	3.68
Erinaceus roumanicus		8		28	36	3.31
Asio otus		5		22	27	2.48
Micromys minutus		1		23	24	2.21
Turdus merula		7		16	23	2.11
Lepus europaeus		5		17	22	2.02
Columba livia dom.		1		20	21	1.93
Corvus cornix + frugilegus		3		17	20	1.84
Apodemus microps		4		13	17	1.56
Phasianus colchicus		4		9	13	1.19
Columba oenas		1		12	13	1.19
Garrulus glandarius				13	13	1.19
Glis glis		1		11	12	1.10
Turdus philomelos		1		11	12	1.10
Rana temporaria				11	11	1.01
Gallinula chloropus		2		8	10	0.92
Lucanus cervus				9	9	0.83
Vanellus vanellus		3		5	8	0.74
Talpa europaea		1		5	6	0.55
Mus cf. *musculus*		1		5	6	0.55
Anas platyrhynchos		2		4	6	0.55
Alauda arvensis		1		5	6	0.55
Mammalia		**116**		**689**	**805**	**73.99**
Aves	**1+**	**50**		**189**	**239**	**21.97**
Amphibia, Reptilia, Pisces		**1**		**25**	**26**	**2.39**
Evertebrata		**2**		**16**	**18**	**1.65**
∑		**169**		**919**	**1088**	**100.00**
Diversity Index H'		2.89		2.87	2.94	

Others prey species (Period no.–no. of items): Ostatné druhy (Obdobie č.–počet):
Sorex araneus (2–1), *Neomys fodiens* (2–1), *Crocidura suaveolens* (2–2), *Myotis myotis* (2–1), *Nyctalus noctula* (2–1), *Myodes glareolus* (1–1; 2–2), *Ondatra zibethicus* (2–2), *Microtus agrestis* (2–1), *Mustela nivalis* (2–1), *Tachybaptus ruficollis* (2–3), *Anas querquedula* (1–2), *Accipiter gentilis* (2–2), *Buteo buteo* (2–3), Accipitridae sp. (2–1), *Falco tinnunculus* (1–1; 2–2), *Coturnix coturnix* (1–1; 2–1), *Rallus aquaticus* (2–1), *Crex crex* (2–1), *Fulica atra* (2–2), Rallidae sp. (1–1), *Scolopax rusticola* (1–1), *Streptopelia decaocto* (2–2), *Tyto alba* (2–2), *Bubo bubo* (1–1; 2–2), *Athene noctua* (2–2), *Strix aluco* (1–1; 2–2), *Galerida cristata* (2–1), *Erithacus rubecula* (2–1), *Turdus pilaris* (2–3), *Turdus viscivorus* (2–1), *Carduelis chloris* (2–1), *Sturnus vulgaris* (1–1; 2–4), *Pica pica* (1–3; 2–2), *Corvus corax* (2–1), Passeriformes sp. (1–1; 2–1), *Pelobates fuscus* (2–1), *Pelophylax* cf. *esculentus* (2–4), *Lacerta viridis* (1–1; 2–2), *Lacerta muralis* (2–1), Colubridae sp. (2–1), Cypriniformes sp. (2–5), Coleoptera sp. (1–2; 2–6), Limacidae sp. (2–1).

Appendix 12. Comparison of Eurasian eagle-owl diets over three historical periods in the Slovenský kras Karst area.
Príloha 12. Porovnanie potravy výra skalného z troch období v Slovenskom krase.

obdobie (roky pred) / period (years ago)	**A: >70**		**B: 30–70**		**C: <30**		**∑**	**%**
period No. / obdobie č.	**1**		**2**		**3**			
taxa / taxón								
Microtus arvalis (n/ks)	1+	53	1+	479	1-	120	652	25.15
%		34.87		31.08		13.35		
Apodemus sylvaticus		1	1+	58	1-	8	67	2.58
Apodemus microps		1	1+	24	1-	3	28	1.08
Arvicola amphibius	1-	10	1-	124	1+	170	304	11.73
Columba livia dom.		1	1-	21	1+	33	55	2.12
Corvus cornix + frugilegus		2	1-	11	1+	17	30	1.16
Tachybaptus ruficollis			2-	0	1+	15	15	0.58
Anas crecca			1-	0	1+	9	9	0.35
Gallinula chloropus		1	1-	6	1+	20	27	1.04
Fulica atra			1-	0	1+	7	7	0.27
Pelobates fuscus		5	2-	19	1+	86	110	4.24
Rattus norvegicus	2-	2		224		119	345	13.31
Cricetus cricetus		10		89	1-	26	125	4.82
Apodemus flavicollis		10		85	1-	20	115	4.44
Apodemus agrarius		2		13	1-	0	15	0.58
Perdix perdix		4		41		25	70	2.70
Erinaceus roumanicus				27		22	49	1.89
Lepus europaeus		2		24		22	48	1.85
Spermophilus citellus		2		24		18	44	1.70
Glis glis		2		15		8	25	0.96
Asio otus		2		14		7	23	0.89
Turdus merula				18		4	22	0.85
Coturnix coturnix		4		10		4	18	0.69
Vanellus vanellus		2		8		8	18	0.69
Anas platyrhynchos				4		9	13	0.50
Myodes glareolus		2		10		1	13	0.50
Mustela nivalis				9		3	12	0.46
Garrulus glandarius		1		3		8	12	0.46
Turdus philomelos		3		6		3	12	0.46
Talpa europaea				5		6	11	0.42
Columba oenas		1		8		2	11	0.42
Coloeus monedula		1		8		2	11	0.42
Falco tinnunculus		1		6		4	11	0.42
Mus cf. musculus		1		6		3	10	0.39
Vulpes vulpes		1		7		2	10	0.39
Alauda arvensis				4		6	10	0.39
Pica pica		3		5		2	10	0.39
Rana temporaria				8		1	9	0.35
Dryomys nitedula		2		6			8	0.31
Streptopelia decaocto				6		2	8	0.31
Turdus pilaris		3		2		3	8	0.31
Scolopax rusticola				6		1	7	0.27
Turdus viscivorus		1		5		1	7	0.27
Pelophylax cf.esculentus		2		4		1	7	0.27
Cuculus canorus		1		4		1	6	0.23
Terricola subterraneus		1		5			6	0.23
Phasianus colchicus				6			6	0.23

Appendix 12. Continuation.
Príloha 12. Pokračovanie.

obdobie (roky pred) / period (years ago)	**A: >70**	**B: 30–70**		**C: <30**		**∑**	**%**
period No. / obdobie č.	**1**	**2**		**3**			
taxa / taxón							
Crex crex	1				5	6	0.23
Gallinago gallinago	1		2		3	6	0.23
Bubo bubo			3		3	6	0.23
Sturnus vulgaris			3		3	6	0.23
Mammalia	**107**		**1256**		**560**	**1923**	**74.19**
Aves	**36**	**1-**	**242**	**1+**	**247**	**525**	**20.25**
Amphibia, Reptilia, Pisces	**7**	**1-**	**39**	**1+**	**90**	**136**	**5.25**
Evertebrata	**2**		**4**		**2**	**8**	**0.31**
∑	**152**		**1541**		**899**	**2592**	**100.00**
Diversity Index H'	2.88		2.86		3.12	3.09	

Others prey species (Period no.–no. of items): Ostatné druhy (Obdobie č.–počet):
Sorex araneus (2–1), *Neomys anomalus* (2–1), *Neomys fodiens* (1–1), *Crocidura suaveolens* (2–2; 3–1), *Myotis mystacinus* (2–2), *Myotis myotis* (1–2; 2–2), *Eptesicus serotinus* (3–1), *Nyctalus noctula* (1–1), *Pipistrellus pipistrellus* (2–1), *Plecotus austriacus* (2–1), *Sciurus vulgaris* (2–2), *Muscardinus avellanarius* (1–1; 2–1; 3–1), *Micromys minutus* (2–2; 3–1), *Ondatra zibethicus* (3–3), *Terricola tatricus* (2–2), *Alexandromys oeconomus* (3–1), *Mustela erminea* (2–1; 3–1), *Mustela putorius* (2–2), *Mustela eversmanni* (2–2), *Podiceps nigricollis* (3–3), *Ixobrychus minutus* (3–1), *Anas querquedula* (2–2), *Aythya fuligula* (3–1), Anatidae sp. (2–3; 3–1), *Accipiter gentilis* (3–1), *Accipiter nisus* (2–1), *Circus aeruginosus* (3–2), *Falco peregrinus* (2–1; 3–1), *Tetrastes bonasia* (3–1), *Rallus aquaticus* (2–1), *Porzana porzana* (3–3), *Zapornia parva* (3–1), Rallidae sp. (2–1), *Pluvialis apricaria* (3–1), *Gallinago* sp. (2–1), *Lymnocryptes minimus* (3–1), *Columba palumbus* (3–1), *Streptopelia turtur* (2–3), *Tyto alba* (1–1), *Athene noctua* (3–1), *Strix aluco* (2–4; 3–1), *Strix uralensis* (2–1), *Caprimulgus europaeus* (2–2; 3–2), *Lullula arborea* (1–1), *Galerida cristata* (3–1), *Hirundo rustica* (2–1), *Motacilla alba* (2–2), *Motacilla cinerea* (3–1), *Lanius collurio* (1–1; 3–1), *Erithacus rubecula* (2–1), *Emberiza citrinella* (2–1; 3–1), *Fringilla coelebs* (3–2), *Carduelis carduelis* (3–1), *Carduelis cannabina* (3–2), *Carduelis chloris* (3–1), *Coccothraustes coccothraustes* (3–3), *Passer domesticus* (2–1; 3–1), *Passer montanus* (3–1), *Corvus corax* (3–2), Passeriformes sp. (2–5; 3–1), Aves sp. (2–1), *Pelophylax ridibundus* (3–2), *Lacerta viridis* (2–4), *Lacerta agilis* (2–3), Serpentes sp. (2–1), *Lucanus cervus* (1–1; 2–1; 3–2), Coleoptera sp. (1–1; 2–3).

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Overview of raptor and owl ringing in Slovakia in 2020

Prehľad krúžkovania dravcov a sov na Slovensku v roku 2020

Roman SLOBODNÍK & Michal JENČO

Abstract: In 2020, 1296 raptors and owls (23 species) were ringed in Slovakia. The most abundant was the common kestrel (719 individuals), then the western marsh harrier (126) and saker falcon (92). The proportion of nestlings among all the ringed individuals was 76.7%. In the given period, 145 recoveries of raptors and owls (15 species) were recorded in the Bird Ringing Centre database. This number included 77 recoveries of colour-marked individuals recovered in our territory. There were 43 recoveries of birds ringed in Slovakia and resighted abroad. The last 25 recoveries were of individuals ringed abroad and recovered in Slovakia. In summary, most of the recoveries (of all types) were of red-footed falcon (69 recoveries), then common kestrel (17) and eastern imperial eagle (15). Most of the recovery circumstances were ring reading (almost 76% in total), findings of bird cadavers (6%) and recaptures (5%). Electrocutions and predations by other animals (3% each) were frequent causes of their deaths.

Abstrakt: V roku 2020 bolo na Slovensku okrúžkovaných 1296 dravcov a sov (23 druhov). Najpočetnejšie boli krúžkované sokol myšiar – 719 jedincov, kaňa močiana – 126 a sokol rároh – 92. Podiel mláďat zo všetkých okrúžkovaných jedincov predstavuje 76,7 %. V sledovanom období bolo v databáze Krúžkovacej centrály zaevidovaných 145 spätných hlásení dravcov a sov (15 druhov). 77 spätných hlásení sa týkalo jedinca označeného a zároveň aj nájdeného na našom území. 43 hlásení predstavovali vtáky označené na Slovensku a zaznamenané v zahraničí. 25 hlásení reprezentujú jedince označené v zahraničí a nájdené na Slovensku. V sumárnom počte bolo najviac hlásení (všetky typy) získaných u sokola červenonohého (69 hlásení), nasleduje sokol myšiar (17) a orol kráľovský (15). Väčšina okolností týchto hlásení tvoria odčítania krúžkov (spoločne takmer 76 %), nasledujú nálezy uhynutých jedincov (6 %) a kontrolné odchyty (5 %). Početnou okolnosťou sú aj zásahy elektrikou a ulovenia inými živočíchmi (po 3 %).

Key words: birds of prey, owls, ringing data, recoveries, Slovakia

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Introduction

The report on the results of raptor and owl ringing has been regularly published in the Raptor Journal in the past (Slobodník & Jenčo 2020 being the latest). Similarly to the last summary report, this report brings the same results from the viewpoint of the evaluation of collected data according to the annual overview of the Czech Bird Ringing Centre in Prague (Cepák & Klvaňa 2021 being the latest). In that period, ringing was perfomed on the basis of the decisions of the Ministry of Environment of the Slovak Republic permitting exemptions from the requirements of Act No. 543/2002 Coll. on nature and landscape protection. One exemption (Decision No. 269/132/05-5.1) authorises ringing of birds, including raptors and owls. The special exemption (Decision No. 664/297/05-5.1 pil) enables members of the Raptor Protection of Slovakia to make a research on raptors and owls and to ring them. Since 2019, a new exemption (Decision No. 3320/2019-6.3 of 8 April 2019) has been in force.

Results and discussion

In 2020, 1296 raptors and owls were ringed in Slovakia, which represented 2.1% of all birds ringed in Slovakia (62,456 individuals) in the given period (Jenčo & Repel 2021, Bird Ringing Centre Database). From the total number, raptors (Accipitriformes and Falconiformes orders) outnumbered the owls with 84.9% (1100 individuals, 15 species). Owls (Strigiformes order) represented only 15.1% (196 individuals, 8 species). Common kestrel (*Falco tinnunculus*) with 719 individuals, western marsh harrier (*Circus aeruginosus*) with 126 and saker falcon (*Falco cherrug*) with 92 were the most abundant raptors. Among the owls, it was long-eared owl (*Asio otus*) – 64 individuals, barn owl (*Tyto alba*) – 61, and Eurasian eagle-owl (*Bubo bubo*) – 27, which were most commonly ringed (Tab. 1). The given total number represents the highest amount of ringed raptors and owls in the history of ringing in Slovakia. Compared to year 2019 (Slobodník & Jenčo 2020), we observed a slight decrease of ringed nestlings and, by contrast, an increase in the number of ringed adult birds. Decreased number of nestlings is largely related to the local overpopulation of common vole in conditions of central Europe in year 2019 and subsequent decline of vole population in 2020 (Baláž et al. 2019), that was shown in the abundance of "mice-hunting" species of raptors and owls (i.e. Boháč 2019, Bělka et al. 2020, Horváth et al. 2020 or Škorpíková et al. 2020) and in subsequent ringing activities of some ringers (Slobodník & Jenčo 2020, Cepák & Klvaňa 2021). In spite of that, overall, we may observe in the ringing of raptors and owls an increasing trend, which we may see mainly in the number of ringed common kestrels representing 55.5% (Fig. 1). Among the remaining species, numbers of ringed individuals (e.g. *Haliaeetus albicilla*, *A. heliaca*, *C. aeruginosus* or *B. bubo*) remained stable. Another group comprised the species in which the number of ringed individuals is declining (e.g. *C. pomarina*, *B. buteo*).

The proportion of nestlings was 76.7% (994 individuals; Fig. 2), which is almost the same as it had been in Slovakia in the recent past (e.g. Slobodník & Slobodník 2012). In comparison with other ringed bird groups (orders, families), the proportion of chicks is higher (Jenčo & Repel 2019) not only in Slovakia but also in other countries (e.g. Walker et al. 2014, Cepák & Klvaňa 2021), which is caused by the long-term specialization of ringers focusing on the chicks of raptors and

Tab. 1. Raptors and owls ringed in Slovakia in 2020 (pull. – young, f. g. – full grown, A – bird ringed and recovered in Slovakia, Z – bird ringed in Slovakia recovered abroad, C – bird ringed abroad recovered in Slovakia).

Tab. 1. Dravce a sovy krúžkované v roku 2020 na Slovensku (pull. – mláďatá, f.g. – plne vyvinuté, A – vták krúžkovaný aj zaznamenaný na Slovensku, Z – slovenský krúžkovanec zaznamenaný v zahraničí, C – vták krúžkovaný v zahraničí zaznamenaný na Slovensku).

			recoveries / nálezy		
species / druh	**pull.**	**f.g.**	**A**	**Z**	**C**
Pandion haliaetus	0	0	0	0	1
Pernis apivorus	0	1	0	0	0
Haliaeetus albicilla	11	0	0	6	6
Circus aeruginosus	125	1	2	1	0
Circus pygargus	9	0	0	0	1
Accipiter gentilis	0	3	0	0	0
Accipiter nisus	0	14	2	0	0
Buteo buteo	6	16	0	0	0
Clanga pomarina	15	0	6	2	1
Aquila heliaca	23	0	5	4	6
Aquila chrysaetos	7	0	1	0	0
Falco tinnunculus	524	195	11	5	1
Falco vespertinus	35	0	42	22	5
Falco subbuteo	0	3	0	0	0
Falco cherrug	91	1	2	1	0
Falco peregrinus	20	0	2	1	2
Tyto alba	55	6	3	1	1
Otus scops	0	13	1	0	0
Bubo bubo	27	0	0	0	0
Athene noctua	13	2	0	0	1
Strix aluco	8	4	0	0	0
Strix uralensis	0	2	0	0	0
Asio otus	25	39	0	0	0
Asio flammeus	0	2	0	0	0
∑	994	302	77	43	25

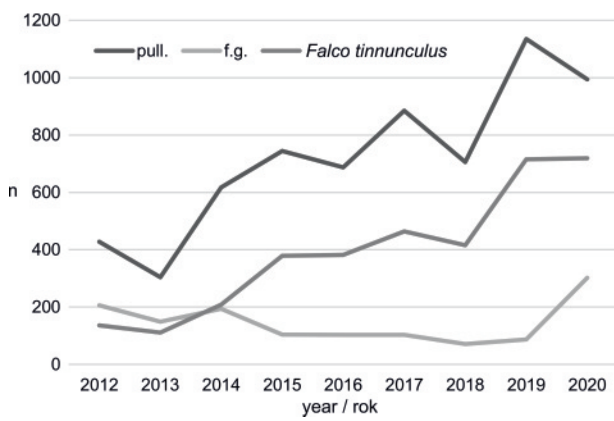

Fig. 1. Development of ringing of all raptors and owls, especially common kestrel, in Slovakia (2012–2020).

Obr. 1. Vývoj početnosti krúžkovaných dravcov a sov, osobitne sokola myšiara, na Slovensku (2012 – 2020).

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owls in their nests (e.g. Cepák et al. 2008, Saurola et al. 2013).

A c c i p i t r i f o r m e s o r d e r

Compared to the past, there was a significant decrease in the number of ringed birds of many species. European honey buzzard (*Pernis apivorus*), both kite species (*Milvus milvus* and *Milvus migrans*) or northern goshawk (*Accipiter gentilis*) were either not ringed at all or only minimally. From the viewpoint of their abundance though, we do not observe any significant decrease, except for the black kite (Černecký et al. 2020). But more likely they are now less in focus of ringers, because a higher number of mainly chicks on their nests was ringed in the past (Formánek 1977, Danko 1985, Slobodník & Slobodník 2010). In 2020, there was not even a single chick of the above-mentioned species ringed. By contrast, 11 chicks of white-tailed eagle (*Haliaeetus albicilla*) is the highest number recorded since 2016 (Slobodník & Jenčo 2020). This increased number of ringed chicks may be related to the increasing abundance of this species in Slovakia (Černecký et al. 2020). As far as the western marsh harrier is concerned, we continue to record an increased numbers of their nestlings being ringed in their nests, mainly thanks to the colour-ringing programme implemented mostly in eastern Slovakia (Jenčo & Repel 2018). In the case of Montagu's harrier (*Circus pygargus*), we deal with the ringing of chicks of semicolonially nesting pairs in Ponitrie associated with protection of nests from agricultural works (more in e.g. Millon et al. 2002, Krupiński et al. 2012, Poprach et al. 2016). Hen harrier (*Circus cyaneus*) and rough-legged buzzard (*Buteo lagopus*) were not ringed at all, as the specialization from the past continues to be absent (Formánek 1977, Danko 1985, Danko 1988, Danko 2000). For the past six years, the rough-legged buzzard has not been ringed in our territory (Slobodník & Jenčo 2020). In the case of common buzzard (Buteo buteo) the numbers of ringed birds are very low – in 2020, only six chicks were ringed in Slovakia, though it is one of the most abundant raptor species in Slovakia (Danko et al. 2002, Černecký et al. 2020). Numbers of ringed Eurasian sparrowhawks are connected mainly to the captures of songbirds during their autumn migration or on feeders. In comparison to the recent past, chicks have not been ringed (Jenčo & Repel 2020, Slobodník & Jenčo 2020). The number of ringed chicks of lesser-spotted eagles has still been falling significantly, mainly in the areas in which they were monitored for a long time in the past (Dravecký et al. 2015a, 2015b). With the next two eagle species, the numbers of ringed individuals remained stable despite the increasing abundance of both species (Bagyura et al. 2002, Černecký et al. 2020). All the ringed eagles were chicks in their nests (Tab. 1).

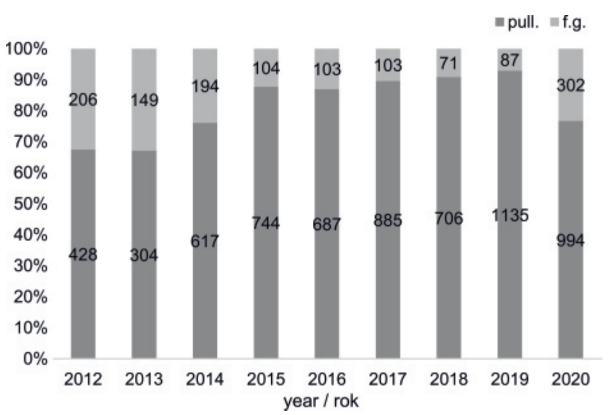

Fig. 2. Number of ringed chicks and other raptor and owl individuals in Slovakia (2012–2020).

Obr. 2. Počty okrúžkovaných mláďat a ostatných jedincov dravcov a sov na Slovensku (2012 – 2020).

F a l c o n i f o r m e s o r d e r

The common kestrel was the most frequently ringed raptor species in 2020 as well as it was in the past years (e.g. Danko 1985, Danko 1988, Cepák et al. 2008, Slobodník & Jenčo 2020). In this species, chicks ringed in their nest (or a nesting box) highly predominate. They has been ringed within the colour-ringing programme implemented mainly in western Slovakia (Jenčo et al. 2017). After significant increase in the number of ringed red-footed falcons (2016–2019), there was a slight decrease in the number of ringed chicks as well as it was in the case of common kestrel (Slobodník & Jenčo 2020). We attribute this decrease of ringed birds to the abundance of common vole, to which the raptors subsequently respond (Solonen et al. 2015). After its gradation in 2019 in central Europe, the common vole population decreased in 2020 (Baláž et al. 2019), what manifested itself in the number of ringed individuals, mainly chicks also in Slovakia (Tab. 1). Eurasian hobby has been ringed in Slovakia sporadically, compared to the past, when more attention had been paid to it (Lipták 2007) as shown in the number of ringed individuals (Formánek 1977, Slobodník et al. 2009). Even though its population is low, the saker falcon belongs to the species ringed the most (Chavko 2010, Chavko et al.

2014, Chavko et al. 2019). Just as in the case of the red-footed falcon, all the chicks were ringed in their nests. In the case of peregrine falcon, the number of ringed individuals has not increased despite the population and area trend in Slovakia getting higher (Chavko 2002). In Slovakia since 2018, every chick of both the big falcon species has also been ringed with colour rings (Jenčo & Repel 2018).

Strigiformes order

There has been a dramatic decrease in the barn owl population in central Europe (e.g. Mátics et al. 2017, Šálek et al. 2019) and in Slovakia (Danko et al. 2002, Černecký et al. 2020), whilst we consider the population estimate stated by Černecký et al. (2020) highly overestimated compared to reality. Development of the number of ringed chicks proves the given condition if we consider that in 2002, 170 individuals were ringed (Slobodník 2007). Not a single chick was ringed in Slovakia from 2011 until 2016 (Slobodník & Jenčo 2020), therefore 55 chicks ringed in 2020 has been the highest number since 2002 when 142 chicks were ringed (Slobodník 2007). Eurasian scops owl has been rarely ringed in Slovakia. That is the reason why 13 individuals ringed in 2020 is the highest number in history. The increased abundance of ringed individuals is linked to the methodological guideline (Lučan 2019, Cepák & Klvaňa 2021) and its targeted captures in southern Slovakia. The Eurasian eagle-owl population in Slovakia went through certain local changes (Flajs 2019, Černecký et al. 2020). Compared to the past the number of ringed chicks in total (22) is rather even (Slobodník 2007). In 2020, small forest species of owls: Eurasian pygmy owl, boreal owl (*Glaucidium passerinum*, *Aegolius funereus*) were not ringed at all. Ringing of chicks and young individuals has been absent in comparison with the Czech Republic (Klvaňa & Cepák 2018, Cepák & Klvaňa 2021). It is similar in the case of the little owl, though its abundance (Dobrý 2009), and mainly the fact that it is able to breed in artificial nest-boxes (e.g. Poprach et al. 2018), facilitates the possible specialisation and has led to a higher number of ringed individuals. Nest-boxes also help preventing the species from becoming locally extinct (Šálek et al. 2019). In both *Strix* and *Asio* species, the numbers of ringed birds are far lower than in the past, as this activity has been performed less frequently mostly in eastern or western Slovakia (Formánek 1977, Danko 1985, Danko 2000, Lengyel 2006).

List of selected recoveries (2012–2019)

During 2020, the ringing station database recorded 145 recoveries of raptors and owls (Tab. 1), from which there was at least one recovery in each of the 15 species recorded. The total proportion of recoveries was as follows – 77 recoveries were of an individual both ringed and recovered in our territory (i.e. Recovery Type A, Jenčo et al. 2016). Then there were 43 recoveries of birds ringed in Slovakia and resighted abroad (Type Z, 8 countries in total, Tab. 2), of which the most were recovered in the surrounding countries: Hungary (30 recoveries) and Austria (6). The other 25 individuals were ringed abroad and recovered in Slovakia (Type C, 6 countries in total, Tab. 3), in which cases most of them were ringed in Hungary (16), then Austria, the Czech Republic, Poland and Italy (totally 2 in each country) and Finland (1). In summary, most of the recoveries (of all types) were of red-footed falcon (69 recoveries), then common kestrel (17), and eastern imperial eagle (15). After assessing only the individuals ringed in Slovakia (Type A and Z), the order is identical, as follows: red-footed falcon (64), common kestrel (16), and eastern imperial eagle (9).

Most of the circumstances of these recoveries were ring readings (almost 76% in total) in which cases colour rings (66%) prevailed over aluminium ones (10%). Then there were findings of cadavers (6%) and recaptures (5%). Raptors and owls frequently die due to electrocution and some of them were caught by other predator (Tab. 3).

Tab. 2. Number of recoveries of raptors and owls ringed in Slovakia and recovered abroad (Z) and ringed abroad and recovered in Slovakia (C) in 2020.

Tab. 2. Počet spätných hlásení dravcov a sov krúžkovaných na Slovensku a zaznamenaných v zahraničí (Z) a krúžkovaných v zahraničí a zaznamenaných na Slovensku (C) v roku 2020.

country / krajina	Z	C
Albania / Albánsko	1	
Austria / Rakúsko	6	2
Czechia / Česko	2	2
Finland / Fínsko		1
Germany / Nemecko	1	
Hungary / Maďarsko	30	16
Italy / Taliansko		2
Poland / Poľsko	1	2
Serbia / Srbsko	1	
Ukraine / Ukrajina	1	
∑	43	25

Tab. 3. Finding circumstances of raptors and owls obtained from recoveries in Slovakia in 2020.
Tab. 3. Okolnosti nálezu dravcov a sov získaných zo spätných hlásení na Slovensku v roku 2020.

finding circumstates of bird / okolnosti nálezu vtáka	Z	A	A + Z	%
found dead / nájdený uhynutý	3	4	7	5.8
shot / zastrelený	1		1	0.8
caught and released by ringer / chytený a pustený krúžkovateľom	1	5	6	5.0
alive and probably healthy; metal ring read in field / živý; číslo hliníkového krúžku odčítané	6	6	12	10.0
electrocuted / usmrtený elektrickým prúdom	3	1	4	3.3
poisoned; poison identified / otrávený známou látkou	1		1	0.8
poisoned; poison not identified / otrávený neznámou látkou		1	1	0.8
dead on road / nájdený mŕtvy na ceste		1	1	0.8
taken by known predator / chytený známym predátorom		4	4	3.3
taken by unknown predator / chytený neznámym predátorom		2	2	1.7
general trauma; injured / prirodzené poranenie		1	1	0.8
alive and probably healthy; colour ring read in field / živý; číslo farebného krúžku odčítané	27	52	79	65.8
identification by satellite transmitter / identifikácia na základe vysielačky	1		1	0.8
∑	43	77	120	100

The most distant recoveries of individuals with Slovak rings were of saker falcon in Ukraine (1180 km) then of eastern imperial eagle in Albania (906 km) and common kestrel in Germany (608 km). Among the birds ringed abroad at the greatest distance and then recovered in Slovakia, there was a recovery of western osprey (*Pandion haliaetus*) ringed in Finland (1393 km) and two red-footed falcons ringed in Italy (both 627 km).

All the species from which there was at least one successful recovery (n = 15) in 2020 are listed in the selected recoveries.

For every recovery of a particular species, we state:

Species name
N – total number of recoveries recorded in 2020, divided according to the distance (S = 0–10 km, M = 11–100 km, L = > 100 km). C/Z/A: C – number of recoveries with rings from foreign centres recorded in the territory of Slovakia (station code and number of data in brackets), Z – number of recoveries with rings from N. MUSEUM SLOVAKIA recorded abroad (country code and number of data in brackets), A – number of recoveries with rings from N. MUSEUM SLOVAKIA recorded in Slovakia.

A selected recovery is given as follows:
1st line: station code, ring type and number, (sex and age when ringed is given in brackets), date of ringing, locality (district), country, name of the ringer (in the case of a ring from N. MUSEUM SLOVAKIA), rounded coordinates of the ringing locality.
2nd line: date of recovery, locality – district or region [country], name of the founder, rounded coordinates of the recovery locality.
3rd line: recovery circumstance code, distance between the ringing and recovery locality, time elapsed (= period from the ringing date to the recovery date) in the format y (year), m (month), d (day).

Sex:
M – male
F – female
N – unknown
Age:
1 – pullus
2 – full grown
3 – hatched during calendar year of ringing
4 – hatched before calendar year of ringing, exact year unknown
5 – hatched during previous calendar year
6 – hatched before previous calendar year, exact year

Acronyms used for the individual ringing centres (main name of the centre, country):
AUW – WIEN, Austria
CZP – PRAHA, Czech Republic
DER – RADOLFZELL, Germany
HGB – BUDAPEST, Hungary
IAB – BOLOGNA, Italy
PLG – GDANSK, Poland
SFH – HELSINKI, Finland
SKB – BRATISLAVA, Slovakia
Code of circumstances
01 – found dead

10 – shot
20 – caught and released by ringer
28, 29 – alive and probably healthy, metal ring read in the field
35 – electrocuted
37 – poisoned, poison identified
38 – poisoned, poison not identified
40 – dead on road
43 – hit wires
51 – general trauma, injured
53 – vital infection
58 – sick
60 – taken by unspecified animal
67 – taken by specified animal
78 – violent weather
81, 82, 87 – alive and probably healthy, colour mark (ring) read in the field
83 – identification based on wing-tags
85 – identification based on satellite transmitters

Western osprey (*Pandion haliaetus*)
N=1 (S 0, M 0, L 1) C 1 (Finland 1)

SFH M59187	(1N)	14.07.2012	Turku-Pori [Finland], Helsinki BRC	N60°41'	E21°42'
		20.04.2020	Rimavská Sobota [Slovakia], András Földi	N48°11'	E20°01'
			35; 1 393 km; 7y, 9m, 6d		

The single finding of this species is related to the spring migration and return to the nesting site in Scandinavia (Cepák et al. 2008). These individuals had already been recorded in our territory in the past (Slobodník et al. 2009). The finding also points out the danger of power lines for this species (Cepák et al. 2008, Demeter el al. 2004, Monti 2012). It seems to be a paradox that electric pylons represent frequent nesting sites of this species (Meyburg et al. 1995).

White-tailed eagle (*Haliaeetus albicilla*)
N=12 (S 0, M 3, L 9) A 5, Z 6 (Hungary 1, Austria 5), C 6 (HGB 4, CZP 2)

SKB SK203	(1N)	25.04.2015	Dunajská Streda [Slovakia], Jozef Chavko	N47°50'	E17°37'
		02.03.2020	Hajdu-Bihar [Hungary], Janos Tar	N47°41'	E21°07'
			28; 262 km; 4y, 10m, 7d		
SKB SK435	(1N)	28.04.2018	Dunajská Streda [Slovakia], Jozef Chavko	N47°48'	E17°43'
		06.01.2020	Niederösterreich [Austria], Klemens Wessely	N48°40'	E16°51'
		12.01.2020	Niederösterreich [Austria], Robert Kreinz	N48°40'	E16°51'
		26.01.2020	Niederösterreich [Austria], Robert Kreinz	N48°40'	E16°51'
		02.02.2020	Niederösterreich [Austria], Robert Kreinz	N48°40'	E16°51'
			28; 116 km; 1y, 9m, 5d		
SKB SK245	(1N)	27.04.2019	Levice [Slovakia], Ladislav Šnírer	N48°02'	E18°40'
		22.02.2020	Niederösterreich [Austria], Robert Kreinz	N48°40'	E16°51'
			28; 150 km; 0y, 9m, 26d		
CZP LX497	(1M)	16.05.2017	Kroměříž [Czechia], Hynek Matušík	N49°16'	E17°27'
		04.04.2020	Pezinok [Slovakia], Štefan Granec	N48°19'	E17°18'
			81; 106 km; 2y, 10m, 19d		
CZP LB7487	(2F)	30.05.2016	Břeclav [Czechia], Stanislav Čech	N48°40'	E16°57'
		22.10.2020	Malacky [Slovakia], Rudolf Jureček	N48°22'	E17°08'
			43; 35 km; 4y, 4m, 23d		
HGB E405	(1F)	24.05.2013	Fejér [Hungary], Bátky Gellért	N47°22'	E18°23'
		13.05.2020	N. M. nad Váhom [Slovakia], Jozef Chavko	N48°43'	E17°54'
			81; 153 km; 6y, 11m, 19d		

HGB H0119	(1N)	07.05.2015	Somogy [Hungary], Jakus László	N46°33'	E17°41'
		30.01.2020	Bratislava IV [Slovakia], Bohuš Číčel	N48°10'	E16°58'
			28; 187 km; 4y, 8m, 24d		
HGB H0674	(1N)	08.05.2019	Borsod-Abaúj-Zemplén [Hungary], J. László	N47°58'	E21°05'
		21.11.2020	Trebišov [Slovakia], Jozef Mihók	N48°36	E21°40'
			35; 82 km; 1y, 6m, 13d		
HGB H0227	(1N)	03.05.2019	Szabolcs-Szatmár-Bereg [Hungary], J. László	N48°18'	E22°14'
		10.11.2020	Trebišov [Slovakia], Ervín Hrtan	N48°37	E21°44'
			28; 51 km; 1y, 6m, 7d		

With the growing population of this species even in central Europe (Probst & Gaborik 2011), in the last period it is typical to read, report living individuals, mostly at foraging sites, which is often combined with the possibility of taking pictures, mainly in Hungary (SKB SK203, Horváth 2009). Ring reading is more likely to occur thanks to the colour-ringing programme, which has been implemented lately throughout most of Europe (Beran & Cepák 2010). The read individuals were largely young and juvenile individuals, as it is typical for them to roam over greater distances compared to the breeding individuals (Cepák et al.2008). Power lines continue to pose a great danger to this species (Demeter et al. 2004, Haas et al. 2005, Gális et al. 2019) which is proven by the recoveries of ringed individuals (HGB 0674, CZP LB7857).

Western marsh harrier (*Circus aeruginosus*)
N=3 (S 2, M 1, L 0) A 2, Z 1 (Hungary 1)

SKB D7258	(1N)	16.06.2020	Košice - okolie [Slovakia], Milan Olekšák	N48°36'	E20°51'
		07.09.2020	Borsod-Abaúj-Zemplén [Hungary], A. Huber	N48°33'	E20°49'
			01; 6 km; 2m, 22d		
SKB D7312	(1F)	22.06.2020	Košice - okolie [Slovakia], Milan Olekšák	N48°36'	E20°51'
		24.08.2020	Košice - okolie [Slovakia], Milan Olekšák	N48°36'	E20°51'
			01; 0 km; 2m, 2d		
SKB D6042	(1N)	07.07.2015	Košice - okolie [Slovakia], Milan Olekšák	N48°37'	E20°53'
		28.04.2020	Košice - okolie [Slovakia], Milan Olekšák	N48°32'	E21°09'
			81; 21 km; 4y, 9m, 22d		

Thanks to the focus on this species in eastern Slovakia, in the study period we recorded several valuable data (e.g. D6042) confirming the strong philopatry within it (Cepák et al. 2008, Slobodník & Jenčo 2020).

Montagu's harrier (*Circus pygargus*)
N=1 (S 0, M 0, L 1) C 1 (PLG 1)

PLG FS12598	(8M)	13.07.2018	Opolskie [Poland], Gdansk RC	N50°18'	E17°59'
		30.04.2020	Turčianske Teplice [Slovakia], M. Dobrota	N48°47'	E18°52'
			83; 180 km; 1y, 9m, 17d		

To catch an adult individual during its return to its nesting site is highly valuable data, even though it might have changed the nesting site from the previous year and, in some cases, individuals occupy nesting sites in greater distance (Arroyo et al. 2004). The recovery circumstance is interesting – the bird was read by means of a wing mark, which is frequently used with this species (Millon & Bretagnolle 2008), though the application of wing marks in the future is questionable from the viewpoint of conservation (Zuberogoitia et al. 2012).

Eurasian sparrowhawk (*Accipiter nisus*)
N=2 (S 2, M 0, L 0) A 2

SKB K7357	(3M)	05.10.2018	Nové Zámky [Slovakia], Vladimír Hošek	N47°50'	E18°43'
		04.10.2020	Nové Zámky [Slovakia], Vladimír Hošek	N47°49'	E18°44'
			20; 2 km; 1y, 11m, 29d		

Recapture after two years confirms the species' fidelity towards the territory even in the non-breeding season (Newton & Marquiss 1982, Newton & Wyllie 1992).

Lesser spotted eagle (*Clanga pomarina*)
N=9 (S 2, M 7, L 0) A 6, Z 2 (Hungary 2), C 1 (PLG 1)

PLG BN5690	(1N)	07.07.2016	Podkarpackie [Poland], Gdansk RC	N49°18'	E22°03'
		19.09.2020	Medzilaborce [Slovakia], Martin Šepeľa	N49°20'	E21°52'
			81; 14 km; 4y, 2m, 12d		
SKB BL1520	(1N)	10.07.2015	Košice - okolie [Slovakia], Miroslav Dravecký	N48°36'	E20°54'
		08.04.2020	Borsod-Abaúj-Zemplén [Hungary], Majercsák B.	N48°13'	E21°23'
		11.04.2020	Borsod-Abaúj-Zemplén [Hungary], Majercsák B.	N48°13'	E21°23'
			81; 56 km; 4y, 8m, 1d		
SKB BL1529	(4N)	03.05.2017	Snina [Slovakia], Miroslav Dravecký	N48°57'	E22°04'
		31.07.2020	Sobrance [Slovakia], Štefan Danko	N48°43'	E22°13'
			81; 27 km; 3y, 2m, 28d		
SKB BL813	(1N)	18.07.2013	Michalovce [Slovakia], Štefan Danko	N48°51'	E21°54'
		19.07.2020	Michalovce [Slovakia], Andrej Škuba	N48°51'	E21°54'
			81; 0 km; 7y, 1d		
SKB BL1311	(1N)	05.07.2012	Liptovský Mikuláš [Slovakia], Ján Kicko	N49°06'	E19°43'
		10.04.2020	Tvrdošín [Slovakia], Martin Jaroš	N49°17'	E19°33'
			28; 24 km; 7y, 9m, 5d		
SKB BL1736	(1N)	16.07.2015	Michalovce [Slovakia], Štefan Danko	N48°51'	E21°54'
		07.07.2018	Humenné [Slovakia], Štefan Mikiara	N48°54'	E21°54'
			81; 6 km; 2y, 11m, 21d		
SKB BL381	(1M)	10.07.2005	Prievidza [Slovakia], Karol Šotnár	N48°55'	E18°34'
		02.05.2020	Prievidza [Slovakia], Šotnár Karol	N48°49'	E18°34'
			28; 11 km; 14y, 9m, 22d		

Reading of this species after more than three years is a proof of successful rehabilitation from the spring of 2017 (BL 1529). The next recapture of a chick from Horná Nitra (SKB BL381) confirms the fidelity to the locality and the species' longevity (Kasparson 1966, Slobodník & Jenčo 2020). The mentioned individuals ringed in our territory confirm the quite strong philopatry (e.g. BL813) of the species (Meyburg et al. 2005, Cepák et al. 2008, Danko et al. 2008). From the viewpoint of the recovery circumstance, ring readings predominate thanks to the colour-ringing programme (Dravecký et al. 2008, Dravecký et al. 2013).

Eastern imperial eagle (*Aquila heliaca*)
N=15 (S 1, M 9, L 5) A 5, Z 4 (Albania 1, Hungary 2, Serbia 1), C 6 (AUW 1, DER 1, HGB 4)

SKB SK482	(1N)	13.06.2015	Michalovce [Slovakia], Štefan Danko	N48°06'	E21°08'
		07.08.2020	Trebišov [Slovakia], Ervín Hrtan	N48°21'	E21°48'
			28; 39 km; 5y, 1m, 25d		
SKB SK467	(1N)	08.08.2019	Hlohovec [Slovakia], Jozef Chavko	N48°30'	E17°50'
		11.01.2020	Bratislava V [Slovakia], Jozef Chavko	N48°02'	E17°05'
			51; 76 km; 5y, 3d		
SKB SK505	(1M)	20.06.2016	Topoľčany [Slovakia], Ladislav Šnírer	N48°31'	E18°13'
		17.01.2020	Nové M. nad Váhom [Slovakia], Vlasto Opatovský	N48°42'	E17°47'
			28; 39 km; 3y, 6m, 27d		
SKB A1000	(1N)	21.06.2008	Zlaté Moravce [Slovakia], Jozef Chavko	N48°25'	E18°29'
		27.01.2020	Nitra [Slovakia], Jozef Chavko	N48°13'	E18°01'
			28; 41 km; 11y, 7m, 6d		
SKB SK456	(1N)	21.06.2019	Nové Mesto nad Váhom [Slovakia], Jozef Chavko	N48°42'	E17°55'
		24.03.2020	Nové Mesto nad Váhom [Slovakia], Dušan Marko	N48°40'	E17°51'
			38; 7 km; 9m, 3d		
SKB SK418	(1N)	17.06.2016	Nitra [Slovakia], Jozef Chavko	N48°23'	E18°10'
		05.04.2020	Györ-Mosin-Sopron [Hungary], Miklós Váczi	N47°39'	E17°05'
			37; 113 km; 3y, 9m, 19d		
SKB A2054	(1N)	21.06.2015	Košice-okolie [Slovakia], Jozef Mihók	N48°33'	E21°16'
		05.04.2020	Borsod-Abaúj-Zemplén [Hungary], József Serfőző	N48°06'	E21°08'
			49; 81 km; 5y, 9m, 15d		
SKB SK467	(1N)	08.08.2019	Hlohovec [Slovakia], Jozef Chavko	N48°30'	E17°50'
		05.04.2020	Sherishtë [Albania], Jozef Chavko	N40°27'	E19°33'
			85; 906 km; 7m, 27d		
SKB SK561	(1F)	06.06.2020	Topoľčany [Slovakia], Ladislav Šnírer	N48°29'	E18°17'
		30.12.2020	Vojvodina [Serbia], Nenad Spremo	N45°40'	E19°05'
			10; 320 km; 6m, 24d		
DER RL1213	(1N)	05.07.2016	Burgenland [Austria], Matthias Schmidt	N47°43'	E16°56'
		21.03.2020	Senica [Slovakia], Jozef Chavko	N48°34'	E16°59'
			85; 95 km; 3y, 8m, 15d		
AUW BS0077	(1N)	05.06.2017	Burgenland [Austria], Matthias Schmidt	N47°43'	E16°55'
		21.03.2020	Skalica [Slovakia], J. Svetlík, R. Jureček	N48°42'	E17°06'
			85; 111 km; 2y, 9m, 15d		
HGB AAA2025	(1N)	04.07.2017	Györ-Mosin-Sopron [Hungary], Imre Fáter	N47°35'	E17°17'
		29.03.2020	Komárno [Slovakia], Tomáš Veselovský	N47°52'	E17°56'
			85; 58 km; 2y, 8m, 25d		
HGB AAA2021	(1N)	30.06.2017	Heves [Hungary], Fatér Imre	N47°37'	E20°26'
		16.09.2020	Dunajská Streda [Slovakia], Tomáš Veselovský	N47°48'	E17°41'
			81; 208 km; 3y, 2m, 17d		
HGB AAA2185	(1N)	25.06.2018	Borsod-Abaúj-Zemplén [Hungary], Budapest RC	N48°21'	E21°09'
		18.08.2020	Trebišov [Slovakia], Ervín Hrtan	N48°37'	E21°44'
			81; 70 km; 2y, 1m, 24d		

HGB AAA2196	(1N)	26.06.2018	Borsod-Abaúj-Zemplén [Hungary], Budapest RC	N48°19'	E21°51'
		17.09.2020	Trebišov [Slovakia], Ervín Hrtan	N48°37'	E21°44'
			81; 34 km; 2y, 2m, 22d		

Illegal poisoning (SKB SK456 and SKB SK418) or shooting (SKB SK561) continue to represent a risk for the species. All these factors are considered high-risk in the whole species area (Horváth et al. 2006). The recoveries of breeding individuals in the territory of Slovakia coming from abroad (HGB AAA2025, DER RL1213, AUW BS0077) are also interesting; we were able to find them by means of satellite telemetry (Meyburg 2010, Slobodník & Jenčo 2020). Thanks to the targeted work of birdwatchers in eastern Slovakia, ring readings predominate in the recovery circumstances in comparison with the past, when the movements of eastern imperial eagles were documented mostly through findings of injured or dead individuals (Cepák et al. 2008). The story of a chick ringed in its nest quite late in August is worth mentioning (SKB SK467). Later on, thanks to a transmitter, the bird was found injured, and after a successful recovery, it was released in the territory of Slovakia in January 2020. Three months later, based on the signal from the transmitter, we observed that it had died in the territory of Albania. Transmitters give us current valuable data from the viewpoint of dispersal and philopatry of eastern imperial eagles (Veselovský et al. 2018) including limiting mortality factors (Demeter et al. 2004, Horváth et al. 2006).

Golden eagle (*Aquila chrysaetos*)
N=1 (S 1, M 0, L 0) A 1

SKB SK132	(1M)	06.07.2020	Rožňava [Slovakia], Miroslav Dravecký	N48°48'	E20°38'
		26.08.2020	Rožňava [Slovakia], Milan Olekšák	N48°48'	E20°38'
			1; 0 km; 1m, 22d		

Mortality of golden eagles in the first year of their life is typical for this long-living species (McIntyre et al. 2010). The given individual, which was found dead with no details, is added to the quite abundant database of recoveries of ringed birds of this species (Slobodník & Jenčo 2020). We assume that a part of these recoveries falls into the category of the so-called bird criminality (Formánek 1977, Voskár 1988, Kropil 2002).

Common kestrel (*Falco tinnunculus*)
N=17 (S 10, M 4, L 3) A 11, Z 5 (Austria 1, Czechia 2, Germany 1, Hungary 1), C 1 (HGB 1)

SKB H25925	(1N)	12.06.2018	Bratislava IV [Slovakia], Roman Slobodnik	N48°11'	E17°02'
		19.03.2020	Bratislava IV [Slovakia], Roman Slobodnik	N48°09'	E17°03'
			81; -- km; 1y, 9m, 6d		
SKB H25901	(6F)	06.06.2018	Nitra [Slovakia], Roman Slobodnik	N48°18'	E18°05'
		18.04.2020	Nitra [Slovakia], Roman Slobodnik	N48°17'	E18°03'
			28; -- km; 1y, 10m, 12d		
SKB H27450	(1N)	30.06.2020	Bratislava V [Slovakia], Roman Slobodnik	N48°03'	E17°08'
		30.08.2020	Skalica [Slovakia], Pavel Štepánek	N48°44'	E17°07'
			81; 79 km; 0y, 2m, 0d		
SKB H25797	(1N)	19.06.2018	Nové Zámky [Slovakia], Roman Slobodnik	N48°05'	E18°02'
		18.06.2020	Břeclav [Czechia], Stanislav Čech	N48°49'	E16°50'
			35; 120 km; 1y, 11m, 29d		

SKB H27344	(1N)	17.06.2020	Trnava [Slovakia], Roman Slobodnik	N48°20'	E17°43'
		09.08.2020	Uherské Hradiště [Czechia], Jaroslav Křižka	N48°59'	E17°33'
			20; 73 km; 1m, 22d		
SKB H26353	(1N)	11.06.2019	Bratislava V [Slovakia], Roman Slobodnik	N48°01'	E17°07'
		22.05.2020	Burgenland [Austria], AURING, AUW	N47°44'	E16°51'
			01; 37 km; 11m, 11d		
SKB H27329	(1N)	16.06.2020	Bratislava V [Slovakia], Roman Slobodnik	N48°01'	E17°07'
		28.07.2020	Györ-Mosin-Sopron [Hungary], Vass Tibor	N47°35'	E17°25'
			35; 54 km; 1m, 11d		
SKB H26346	(1N)	16.06.2020	Bratislava V [Slovakia], Roman Slobodnik	N48°01'	E17°07'
		17.11.2020	Thüringen [Germany], Joachim Müller	N51°22'	E10°25'
			35; 608 km; 5m, 1d		
HGB HA44157	(1N)	04.06.2020	Bács-Kiskun [Hungary], Budapest RC	N46°40'	E19°05'
		05.07.2020	Brezno [Slovakia], Ján Žiak	N48°40'	E19°40'
			01; 227 km; 1m, 1d		

The increased number of ringed chicks in western Slovakia confirmed the complex migration manners of the species (Adriaensen et al. 1997, Holte et al. 2016). Some of our chicks migrated westerly or northwesterly (recoveries in the Czech Republic and Germany) and some individuals migrated to the south (the recovery in Hungary). At the same time, the birds from Hungary may come to our territory during their post-breeding dispersal (HGB HA44157) even very early after leaving the nest, which is true also vice versa (e.g. SKB H27329). These data have been known even from the past (e.g. Slobodník & Jenčo 2020). Ring reading confirms their high fidelity (SKB H 25901) or philopatry (e.g. SKB H25925) which is typical for the species (Cepák et al. 2008, Riegert & Fuchs 2011). Online broadcasting and installation of cameras thanks to which we were able to get several valuable data resulted in higher number of read rings, similarly to the cases of other raptor species (e.g. Kristan et al. 1996, Chavko et al. 2014). As far as the circumstances are concerned, collisions with power lines keep representing a risk factor (Formánek 1977, Kumbera 1977, Demeter et al. 2004, Gális et al. 2019, Škorpíková et al. 2019), which in 2020 by the findings of ringed individuals abroad was again confirmed.

Red-footed falcon (*Falco vespertinus*)
N=69 (S 65, M 0, L 4) A 42, Z 22 (Hungary 22), C 5 (HGB 3, IAB 2)

HGB HA33654	(1N)	03.07.2019	Györ-Mosin-Sopron [Hungary], Előd Győrig	N47°57'	E17°06'
		10.09.2020	Bratislava V [Slovakia], Jozef Chavko	N48°03'	E17°08'
			81; 8 km; 1y, 2m, 7d		
HGB HA27903	(1N)	10.07.2020	Fejér [Hungary], Solt Szabolcs	N45°59'	E18°31'
		15.09.2020	Bratislava V [Slovakia], Jozef Chavko	N48°03'	E17°08'
			81; 158 km; 10m, 26d		
HGB HA28324	(1N)	10.07.2020	Fejér [Hungary], István Staudinger	N47°11'	E18°17'
		23.09.2020	Bratislava V [Slovakia], Jozef Chavko	N48°03'	E17°08'
			81; 129 km; 2m, 13d		
IAB H219050	(1N)	27.06.2020	Parma & Reggio n.Emilia [Italy], Marco Gustin	N44°54'	E10°17'
		09.09.2020	Bratislava V [Slovakia], Jozef Chavko	N48°03'	E17°08'
			81; 627 km; 2m, 13d		

IAB H216993	(1N)	27.06.2020	Parma & Reggio n.Emilia [Italy], Marco Gustin	N44°54'	E10°17'
		07.09.2020	Bratislava V [Slovakia], Jozef Chavko	N48°03'	E17°08'
			81; 627 km; 2m, 11d		
SKB K6515	(1N)	03.08.2016	Bratislava V [Slovakia], Roman Slobodnik	N48°03'	E17°08'
		14.09.2020	Bratislava V [Slovakia], Jozef Chavko	N48°03'	E17°08'
			81; -- km; 4y, 1m, 11d		
SKB K6552	(1N)	19.07.2017	Bratislava V [Slovakia], Roman Slobodnik	N48°03'	E17°08'
		19.09.2020	Györ-Mosin-Sopron [Hungary], P. Spakovszky	N47°58'	E17°10'
			81; 8 km; 3y, 2m, 0d		

Recoveries of red-footed falcons were rather unusual in the past (Cepák et al. 2008, Slobodník & Slobodník 2011). Currently it is a species with the highest number of recoveries as it has been given more attention to it due to its conservation activities (Slobodník et al. 2017). From the viewpoint of the occurrence of individuals ringed as chicks in the territory of Hungary, we may observe settling of an individual in our territory (HGB HA33654) which belongs to the common population at the borderlands and includes also the non-abundant population in Austria (Dvorak et al. 2016). Post-breeding dispersal is recorded through two individuals of Hungarian origin, which occurred more than a hundred kilometres from the place of their hatching two months after they had been ringed (HGB HA28324 resp. HA27903). These movements are for this so-called loop migrant species typical; they fly from their nesting sites in the Carpathian Basin even to northern or western Europe (Palatitz et al. 2009, Gulawski et al. 2017, Kunze & Nennstiel 2020). Most of the recoveries come from the roost site near Bratislava; in 2020, there were dozens of individuals that is typical for this social species (Fehérvari et al. 2014). The higher number of individuals in this locality is related to great food supply in southwestern Slovakia and to gradation of common vole (Baláž et al. 2019). The great quantity of readings in the SPA Sysľovské polia confirms the species' philopatry to the nesting colony, while one individual belongs to the group of 16 chicks, which were ringed in 2016 at the beginning of the colour-ringing programme in Slovakia (Slobodník & Jenčo 2020). Reading of two individuals of Italian origin is a new finding (IAB H219050, H216993). These chicks belong to a rather new and isolated population near Parma (Calabrese et al. 2020). Genetic origin of this population is in Hungary, which is the main reason of the constant migration of birds from the Italian Peninsula through the Carpathian Basin (Sponza et al. 2001). As far as the circumstances are concerned, in 2020, four chicks were caught by northern goshawk that often hunts on red-footed falcons (Bagyura & Haraszthy 1994).

Saker falcon (*Falco cherrug*)
N=3 (S 1, M 1, L 1) A 2, Z 1 (Ukraine 1)

SKB D5825	(1N)	07.05.2016	Trnava [Slovakia], Jozef Chavko	N48°18'	E17°39'
		07.05.2020	Šaľa [Slovakia], Jozef Chavko	N48°16'	E17°51'
			81; 15 km; 4y, 0d		
SKB D7092	(1N)	22.05.2020	Dunajská Streda [Slovakia], Jozef Chavko	N48°03'	E17°24'
		31.07.2020	Dunajská Streda [Slovakia], Jozef Chavko	N48°03'	E17°26'
			35; 3 km; 2m, 9d		
SKB D7103	(1N)	26.05.2020	Trnava [Slovakia], Jozef Chavko	N48°19'	E17°37'
		24.07.2020	Rakivka [Ukraine], Maxim Gavrilyuk	N46°54'	E33°15'
			81; 1180 km; 1m, 28d		

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Thanks to the colour ringing, as in the case of red-footed falcon, the number of recoveries has increased significantly in the course of the last few years (Jenčo & Repel 2018, Slobodník & Jenčo 2020). This colour-ringing programme provides valuable information on the philopatry of nesting individuals (SKB D5825). In addition to that, we were able to identify a young saker falcon in Ukraine (SKB 7103) during the post-breeding dispersal (Prommer et al. 2012, Kouba et al. 2021). Power lines continue to be a significant factor of mortality for this species (Demeter et al. 2004, Kovács et al. 2014, European Commission, Directorate-General for Environment 2019), the highest mortality being in the case of chicks (Nemček et al. 2014). The given issue is dealt with in cooperation with the appropriate energy companies (e.g. by means of the LIFE13 project NAT/SK/001272 Energy in the land) in which case the risk localities have been greened also from the viewpoint of the occurrence of saker falcon (Gális et al. 2019).

Peregrine falcon (*Falco peregrinus*)
N=5 (S 0, M 1, L 4) A 2, Z 1 (Poland 1), C 2 (HGB 2)

HGB LY01811	(1N)	16.05.2014	Fejér [Hungary], Staudinger István	N47°15'	E18°08'
		24.03.2020	Malacky [Slovakia], Jozef Chavko	N48°15'	E17°06'
			81; 135 km; 5y, 10m, 8d		
HGB LY02891	(1F)	08.05.2017	Fejér [Hungary], Klébert Antal	N47°22'	E18°15'
		07.04.2020	Pezinok [Slovakia], Jozef Chavko	N48°27'	E17°19'
			81; 140 km; 2y, 10m, 30d		
SKB E3180	(1M)	07.06.2015	Nitra [Slovakia], Jozef Chavko	N48°22'	E18°10'
		07.04.2020	Malacky [Slovakia], Jozef Chavko	N48°28'	E17°16'
			28; 67 km; 4y, 10m, 0d		
SKB E4991	(1M)	15.05.2017	Martin [Slovakia], Jozef Chavko	N49°00'	E18°58'
		24.05.2020	Malacky [Slovakia], Jozef Chavko	N48°26'	E17°11'
			81; 145 km; 3y, 9d		
SKB E5005	(1M)	14.05.2019	Malacky [Slovakia], Jozef Chavko	N48°17'	E17°03'
		22.03.2020	Dolnoslaskie [Poland], Sławomir Sielicki	N51°02'	E16°11'
			81; 314 km; 10m, 8d		

Just as in the case of saker falcons, we get valuable results thanks to the colour-ringing programme (Jenčo & Repel 2018). This way ring readings contributed not only to information on philopatry of nesting individuals coming from Hungary (HGB LY01811, LY02891) but also to data on the settlement of young birds in Slovakia (SKB E3180 or E4991). Malé Karpaty Mts. have a prominent status in obtaining results, as they have been a subject of long-term monitoring of occupied nests by means of camera traps (Chavko 2016). Data on the occurrence of birds in Poland that were ringed here (SKB E5005) had been absent so far (Cepák et al. 2008).

Barn owl (*Tyto alba*)
N=5 (S 2, M 2, L 1) A 3, Z 1 (Hungary 1), C 1 (HGB 1)

HGB RE02310	(3N)	26.06.2017	Fejér [Hungary], Balázsi Péter	N47°21'	E18°19'
		09.03.2020	Komárno [Slovakia], Szabóné Jády Katalin	N47°47'	E17°53'
			40; 58 km; 2y, 8m, 13d		
SKB E5723	(1N)	04.09.2019	Nové Zámky [Slovakia], Roman Slobodnik	N47°49'	E18°32'
		22.01.2020	Bács-Kiskun [Hungary], Sápi Tamás	N46°47'	E19°08'
				01; 123 km; 4m, 18d	

SKB E5468	(1N)	21.05.2019	Dunajská Streda [Slovakia], Roman Slobodnik	N47°54'	E17°49'
		05.03.2020	Dunajská Streda [Slovakia], Richard Kvetko	N47°55'	E17°43'
			40; 7 km; 9m, 15d		
SKB E5441	(3N)	17.08.2018	Komárno [Slovakia], Roman Slobodnik	N47°52'	E17°55'
		25.06.2020	Dunajská Streda [Slovakia], Roman Slobodnik	N47°54'	E17°48'
				01; 9 km; 1y, 10m, 8d	
SKB E5781	(1N)	25.06.2020	Galanta [Slovakia], Roman Slobodnik	N48°00'	E17°48'
		31.10.2020	Dunajská Streda [Slovakia], Roman Slobodnik	N47°56'	E17°42'
			20; 11 km; 4m, 6d		

Mortaily of young barn owls (SKB E5723 or E5468) is rather high, mainly due to collisions with vehicles (Cepák et al. 2008, Marti et al. 2020). The same goes for individuals that might potentially recolonize the population from Hungary in southern Slovakia (HGB RE02310). From among the individuals restituted in 2018, we may mention the finding of a barn owl released in Žitný ostrov area and then found dead near its nesting box (SKB E5441). In the previous year, this individual has successfully bred here (Slobodník & Jenčo 2020).

Eurasian scops owl (*Otus scops*)
N=1 (S 1, M 0, L 0) A 1

SKB K7491	(5N)	11.05.2020	Michalovce [Slovakia], Matej Zámečník	N48°40'	E22°02'
		24.08.2020	Michalovce [Slovakia], Matej Zámečník	N48°40'	E22°02'
			20; -- km; 3m, 13d		

The single recovery is a proof of an individual having stayed in the locality as late as till the end of August (e.g. Klvaňa & Cepák 2020).

Little owl (*Athene noctua*)
N=1 (S 0, M 1, L 0) C 1 (HGB 1)

HGB VR09678	(1N)	31.05.2019	Fejér [Hungary], Budapest RC	N47°21'	E18°27'
		07.07.2020	Komárno [Slovakia], Roland Bobek	N47°47'	E18°10'
			t01; 53 km; 1y, 1m, 6d		

The finding of a dead individual ringed as a chick in Hungary and recorded in the district of Komárno in its breeding season is valuable. Transfers for more than 20 kilometres are very rare even in case of young birds (Génot 1995), though there are some records of transfers for a distance over 200 kilometres (Cepák et al. 2008).

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Corrigendum: Trend in an isolated population of the red-footed falcon (*Falco vespertinus*) at the edge of its breeding range (south-western Slovakia)

Korigendum: Trend izolovanej populácie sokola kobcovitého (*Falco vespertinus*) na okraji jeho hniezdneho rozšírenia (juhozápadné Slovensko)

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Abstract: Table 1 in original paper (Slobodník et al. 2017, Slovak Raptor Journal 11: 83–89) was published with incorrect data. Correct version is published here.

Abstrakt: Tabuľka 1 v pôvodnom článku (Slobodník et al. 2017, Slovak Raptor Journal 11: 83–89) bola uverejnená s nesprávnymi údajmi. Tu publikujeme správne údaje.

Key words: *Falco vespertinus*, isolated population, trend

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In the original paper written by Slobodník et al. (2017), the Table 1 (p. 86) was published with incorrect numbers of breeding territories, nests with clutches, unsuccessful nests, and fledged nestlings. The table

Tab. 1. Number of breeding territories, incubated clutches, failed nests and minimal number of fledged nestlings of the red-footed falcon (*Falco vespertinus*) in the Sysľovské polia Special Protection Area between 2004–2017.

Tab. 1. Počet hniezdnych teritórií, inkubovaných znášok, neúspešných hniezd a minimálny počet vyvedených mláďat sokola kobcovitého (*Falco vespertinus*) v Chránenom vtáčom území Sysľovské polia v rokoch 2004 – 2017.

year / rok	breeding territories / hniezdne teritóriá	nests with clutches / hniezda so znáškami	unsuccessful nests / neúspešné hniezda	fledged nestlings / vyvedené mláďatá
2004	4	4	2	5
2005	11	6	?	13
2006	2	2	1	3
2007	4	4	3	2
2008	2	2	0	3
2009	2	0	0	0
2010	2	2	1	2
2011	2	2	1	3
2012	0	0	0	0
2013	1	1	0	4
2014	3	3	0	11
2015	5	2	1	4
2016	5	5	0	19
2017	16	16	1	41
∑	59	49	10	110

showed the estimated numbers from the entire breeding range in Slovakia, not only from the Sysľovské polia Special Protection Area. Here, we present the correct version (Tab. 1).

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Post-fledging dependence period, dispersal movements and temporary settlement areas in saker falcons (*Falco cherrug*)

Období dospívání, disperzní pohyby a oblasti dočasných útočišť u raroha velkého (*Falco cherrug*)

Marek KOUBA, Roman SLOBODNÍK & Jozef CHAVKO

Abstract: Information on mortality rates and their causes in raptors and owls during the post-fledging dependency period (PFDP) and subsequent dispersal is essential for their more effective protection, including more efficient use of funds. Despite the importance of the above data, these data are not yet available for most birds of prey. The study aimed to provide and expand the knowledge in this field for saker falcon. We used satellite telemetry to monitor a total of six young birds since they left the nest boxes. All young birds survived the PFDP, but none survived to adulthood and died during the period of dispersal movements. The PFDP lasted 47 days (median value hereinafter), and the distance of individuals from the nest boxes during this period was 3.2 km (maximum distance 9 km). The area of the home range of the PFDP calculated by the 100% minimum convex polygon (MCP) method was 81 km^2. During the period of dispersal movements, the monitored individuals set up five temporary settlement areas with an area of 422 km^2 according to 100% MCP, where they stayed for 37 days. All individuals' mean length of movement routes throughout the monitoring period was 3862 km. The main finding of the present study is the fact that none of the monitored individuals survived the dispersal period. At least half of them died due to human activity (electrocution, hunting), which is probably unbearable in the long term for wild populations of most animal species. This shows the need to start eliminating all types of artificial traps (e.g., electrocution, hunting, poisoning, etc.) without delay, thus helping to prevent the decline of populations of many species in the shorter or longer time horizon.

Abstrakt: Informace týkající se míry úmrtnosti a jejích příčinách u dravců a sov během období dospívání a následné disperze jsou zásadní pro jejich účinnější ochranu včetně efektivnějšího využití finančních prostředků. Navzdory důležitosti výše zmíněných dat, nejsou tato data doposud k dispozici pro většinu dravých ptáků. Cílem této studie bylo poskytnout a rozšířit znalosti v dané oblasti u raroha velkého. Pomocí satelitní telemetrie jsme sledovali celkem šest mláďat od chvíle, kdy opustila hnízdní budky. Všechna mláďata přežila období dospívání, ale žádné se nedožilo dospělosti a zemřela během období disperzních pohybů. Období dospívání trvalo 47 dnů (medián; hodnoty mediánu jsou uvedeny i nadále) a vzdálenost jedinců od hnízdních budek během tohoto období činila 3,2 km (maximální vzdálenost 9 km). Rozloha domovských okrsků období dospívání spočtená metodou 100% minimálního konvexního polygonu (MCP) byla 81 km^2. Během období disperzních pohybů si sledovaní jedinci zřídili celkem pět oblastí dočasných útočišť s rozlohou 422 km^2 dle 100% MCP, které obývali 37 dnů. Délka pohybových tras všech jedinců po celé období sledování činila 3862 km. Zásadním zjištěním předložené studie je skutečnost, že ani jeden ze sledovaných jedinců nepřežil období disperze, přičemž minimálně polovina z nich zemřela následkem lidské činnosti (zabití elektrickým proudem, lov), což je patrně dlouhodobě neúnosné pro divoké populace většiny živočišných druhů, a jasně to ukazuje nutnost, začít neprodleně odstraňovat všechny druhy umělých pastí (např. zabití elektrickým proudem, lov, otravy atd.) vytvořených lidskou činností, a napomoci tak zabránit populačním poklesům mnoha druhů v kratším či delším časovém horizontu.

Key words: mortality rate, causes of death, satellite tracking, breeding period, minimum convex polygon, home range

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Introduction

From the point of view of current knowledge, we know migration routes or wintering sites of many species of raptors (Cepák et al. 2008). Less known is the information about resting and temporary stops (the so-called stopover site/s or temporary settlement area/s, hereinafter only TSA/s), including the speed of movements between them (Belthoff & Ritchison 1989). Among the least researched knowledge, we include the duration of post-fledging dependence period (hereinafter only PFDP, i.e. the period between fledging and reaching independence) (e.g., Gamauf & Dosedel 2012; Kouba & Šťastný 2012; Kouba et al. 2013; Nemček et al. 2016, Literák et al. 2020), while these studies often focus on the survival/mortality rate within a defined period (Penteriani & Delgado 2009), in this case, the PFDP. It is the appearance and development of satellite telemetry that can not only accurately determine this period in time and space, but it can also determine risk factors (Nemček et al. 2014) or show geographical limits for movements (McGrady et al. 2003; Limiñana et al. 2007, 2012; Cadahía et al. 2010). Another advantage of satellite telemetry is that it allows monitoring, for instance, even individuals who disperse over considerable distances after becoming independent and which could no longer be monitored by conventional radio telemetry. For their physical parameters, hawks and eagles (Meyburg et al. 2006), falcons (McIntyre et al. 2009) and possibly owls (Penteriani et al. 2005) are a suitable target group for the use of satellite telemetry. On the other hand, commonly used backpack harnesses may negatively influence behaviour and survival of both adult and juvenile individuals (Paton et al. 1991; Petty et al. 2004; Sunde 2006). Satellite transmitters with added mortality sensors also make it possible to record the mortality rate and its causes even in individuals which may be tens of thousands of kilometres away from their natal areas, thus revealing the essential information needed to protect the biodiversity and save many different, not only critically endangered species (Cogan et al. 2012; Graham et al. 2012).

Saker falcon (*Falco cherrug*) is widespread species throughout Eurasia, from Central Europe to East China (Baumgart 1991; Ferguson-Lees & Christie 2001; Bauer 2020). Similarly to the Carpathian Basin, South-western Slovakia, Eastern Austria and the South-eastern Czech Republic is the westernmost border of its nesting area (Gamauf & Dosedel 2012; Kovács et al. 2014). Populations from Austria, Hungary and Slovakia are interconnected, as evidenced by movements, especially of young birds, and the nesting of birds from other countries in neighbouring countries (Slobodník 2008; Slobodník & Jenčo 2020). The population, for instance, in Ukraine and east Slovakia, after its recent increase, shows currently a slightly declining trend again (Chavko et al. 2019), which is related to the reclassification within the IUCN Red List from the category "vulnerable" to the category "endangered" (BirdLife International 2022). On the contrary, the population in Slovakia is slowly growing (Černecký et al. 2020), which is mainly due to its positive population trend in the western part of the country (Chavko & Deutschová 2012; Chavko et al. 2014, 2019).

This study aimed to determine the duration of the PFDP and the home range sizes inhabited during this period by the fledglings of saker falcon in Slovakia. Also, to describe the dispersal movements of the monitored individuals, identify possible TSAs set up during the dispersal and determine their duration and area. Finally, to determine the rate and causes of mortality of young saker falcons during the PFDP and dispersal movements.

Material and methods

Six young birds (3x two siblings) of a saker falcon from three nesting boxes placed on high voltage transmission towers (Fig. 1) in the south-west of Slovakia near the villages of Bernolákovo, Lehnice and Topoľníky, were ringed with aluminium and coloured rings (Tab. 1) and equipped with backpack-type transmitters (Anitra Sys-

Fig. 1. The environment in Slovakia, currently commonly inhabited by saker falcons and also used for its nesting, is given since artificial nesting boxes designed for the target species are often hung on massive high-voltage pylons.

Obr. 1. Životní prostředí běžně obývané a využívané ke hnízdění rarohem velkým na Slovensku je dáno tím, že umělé hnízdní budky určené pro cílový druh jsou často vyvěšovány na mohutných stožárech vysokého napětí.

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Tab. 1. Basic breeding data, data related to satellite telemetry and monitoring of a total of six saker falcon fledglings (B1, B2, L1, L2, T1 and T2) and data describing the post-fledging dependence period of all monitored individuals.
Tab. 1. Základní údaje o hnízdění, data týkající se satelitní telemetrie a sledování celkem šesti mláďat raroha velkého (B1, B2, L1, L2, T1 a T2) a informace popisující období dospívání všech sledovaných jedinců.

evaluated characteristics	**individual data**						**median**	**mean**	**SD**
nestbox	Bernolákovo (B)		Lehnice (L)		Topoľníky (T)		-	-	-
date of nesting	26 March		19 March		19 March		-	-	-
date of hatching	25 April		18 April		18 April		-	-	-
no. of eggs	5		5		5		5	5	0
no. of hatchlings	5		5		5		5	5	0
no. of fledglings	5		5		5		5	5	0
ID of tracked individual	B1	B2	L1	L2	T1	T2	-	-	-
ring number (metal ring/colour ring)	D6791/A9	D6795/E9	D6714/P4	D6717/U4	D6758/A3	D9760/C3	-	-	-
sex	male	male	male	female	female	male	-	-	-
date fledging	10 June	10 June	1 June	2 June	1 June	1 June	-	-	-
no. of tracking days	102	81	52	128	168	80	92	102	38
no. of locations / fixes	60,728	4139	21,707	37,970	153,948	61,560	49,349	56,675	48,019
time spent moving (days)	20	14	7	15	37	14	15	18	9
time spent resting (non-moving; days)	82	67	45	113	131	66	75	84	29
length of movement route (km)	4583	4289	1693	3435	9086	2949	3862	4339	2322
overall average speed[a] (km/h)	1.89	2.19	1.34	1.11	2.25	1.55	2	2	0
average speed of movement[b] (km/h)	9.7	12.7	9.9	9.1	10.3	8.8	10	10	1
date of last record/death	19 September	30 August	23 July	7 October	15 November	19 August	-	-	-
cause of death	unknown	unknown	hunted	electrocuted	tornado	electrocuted	-	-	-
duration of PFDP[c] (days)	47	45	45	46	51	53	47	48	3
no. of locations / fixes during PFDP[c]	15,203	1713	9507	6385	10,609	14,776	10,058	9699	4685
distance from the nest during PFDP[c] (mean ± SD; km)	3.2 ± 2.1	3.2 ± 0.3	3.4 ± 2.2	3.1 ± 2.3	1.1 ± 0.9	1.7 ± 1.9	3.2	2.6	0.9
maximal distance from the nest during PFDP[c] (km)	16.0	4.6	8.5	13.6	6.2	9.1	9	10	4
home range size during PFDP[c] (100% MCP[d]; km^2)	78.7	23.5	84.2	108.4	19.8	84.8	81	67	33
home range size during PFDP[c] (95% MCP[d]; km^2)	63.3	6.1	81.2	45.3	9.0	45.0	45	42	27
home range size during PFDP[c] (80% MCP[d]; km^2)	32.1	5.6	69.9	41.9	4.1	20.8	26	29	23
date of independence	26 July	25 July	15 July	17 July	21 July	23 July	-	-	-

[a]Overall average speed of movement including both times spent moving and resting (non-moving) calculated automatically by BaseCamp software
[b]Overall average speed of movement including only time spent moving calculated automatically by BaseCamp software
[c]Post-fledging dependence period (PFDP)
[d]Minimum convex polygon (100%, 95%, 80% MCP)

tems s.r.o., Prague, Czech Republic), enabling their satellite telemetry monitoring, during the nesting season 2021. All the young birds were weighed, and their sex was determined based on their weight and size (females are ca 15% larger and ca 40% heavier than males) (Kovács et al. 2014). The transmitters used weighed 19 g and did not exceed 3% of the body weight of the marked individuals (e.g., Withey et al. 2001). The used partly solar GPS-GSM transmitters were programmed to collect data in a fixed five-minute interval. Still, these intervals were dynamically supplemented by a series of data collected in one-second interval started by flight detection when the transmitter batteries were sufficiently charged. Recording of positions at one-second intervals made it possible to create a detailed picture of the larger movements of the monitored individuals and their behaviour. Both types of data (five-minute and one-second) were merged before the whole analysis and were further always used all in together. The recorded GPS positions of individuals were first exported from the Anitra platform to GPX format and further analysed and processed using BaseCamp software (GARMIN®, Schaffhausen, Switzerland). The BaseCamp software automatically delivered results regarding time spent moving and resting (non-moving) and overall average speed and average speed of movement (Tab. 1). The GPS positions were then exported to the SHP (shapefile) format and further processed and evaluated in ArcGIS 9.5 (Esri, Redlands, USA). In this program in its freely available extension Home Range Tool for ArcGIS® (Rodgers et al. 2015) subsequently the areas of all home ranges listed below were calculated using the method of the minimum convex polygon (hereinafter only MCP) (Mohr 1947; Hayne 1949; Laver & Kelly 2008). The ranges were made for the 100% MCP variant and the 95% and 80% MCP with the setting "Selection Style:

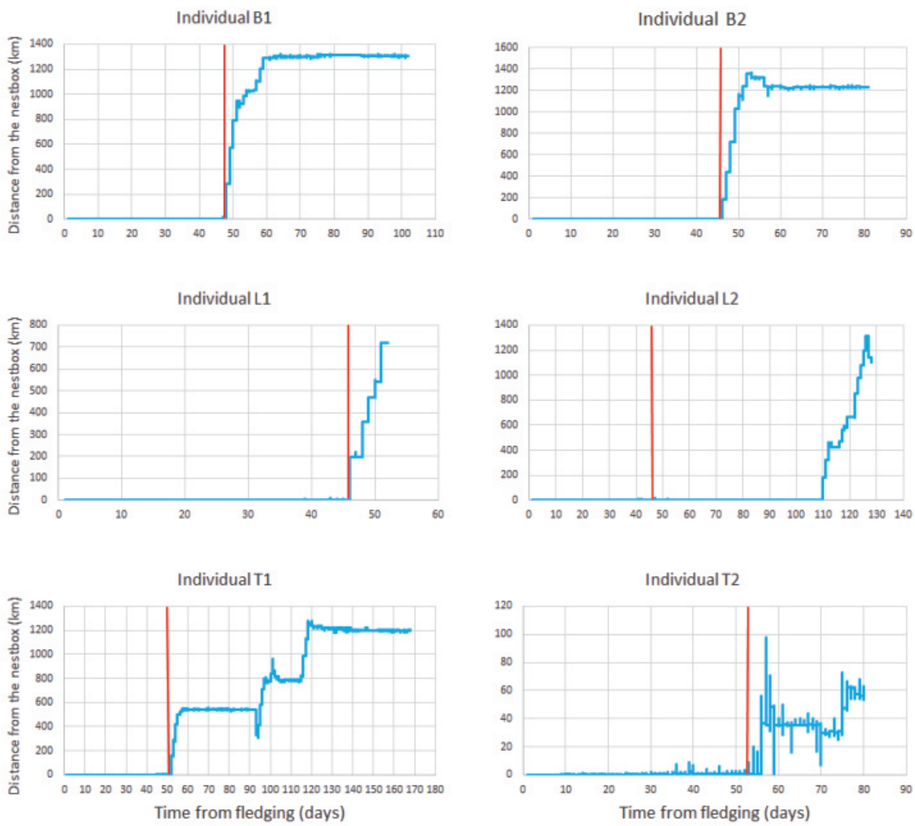

Fig. 2. Visualisation of the distance from the natal nest box and gradual moving of all six monitored young birds (B1, B2, L1, L2, T1 and T2) away from the nest box during the entire monitoring period (blue line). The vertical red line shows the end of the post-fledging dependence period and the beginning of the dispersal of individuals (only individual L2 dispersed later).
Obr. 2. Vizualizace pohybů a postupného vzdalování se od hnízdní budky všech šesti sledovaných mláďat (B1, B2, L1, L2, T1 a T2) po celou dobu jejich monitoringu (modrá čára). Svislá červená čára znázorňuje konec období dospívání a začátek období disperzních pohybů jedinců (pouze jedinec L2 zahájil disperzi později).

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User Centre". Furthermore, the distances of all obtained locations of individual young birds from the nest box were evaluated, and the lengths of all their movement routes were measured. All map materials were also created in the same software.

The duration of the PFDP was individually determined based on an analysis of the movements of all individuals when five of them performed a sudden dispersal movement (Fig. 2), which clearly defined their PFDP. In the case of the sixth individual (L2), the length of the PFDP was also determined based on data from the scientific literature (Nemček et al. 2014; Prommer et al. 2014; Rahman et al. 2015; Dixon et al. 2019) and by comparison with other monitored young birds and particularly its sibling. The TSAs of monitored individuals established during dispersal movements were defined as areas where individuals spent longer time in a relatively small area within which they repeatedly occurred in the same places, which was in direct contrast to movement patterns and distances that individuals were able to cover during a single day of the dispersal movement. Also, in the case of TSAs, it can be stated that when evaluating data on the movements of individuals, these areas became very clear on their own.

Results

A total of six young birds (4 males and 2 females) of the saker falcon were observed in 2021 from leaving the nest until their death, which occurred in the same year for all of them, and thus none of them survived to adulthood. These were three pairs of siblings, always randomly selected from five siblings hatched from equally numerous clutches. The monitoring took place from 1 June to 15 November 2021 (Tab. 1). The individuals were monitored for 92 days (median value is stated hereinafter), and 49,349 locations were recorded for each of them. The total length of their movement routes was 3862 km (Fig. 3). The young saker falcons spent 75 days by resting (non-moving) and 15 days by moving at an average speed of 10 km/h, as shown by the automatic evaluation of satellite data by the BaseCamp software. The last coordinates sent from the used transmitters came between 23 July and 15 November 2021.

The PFDP of all six young birds lasted 47 days, during which 10,058 locations of their occurrence were recorded for each of them (Tab. 1). The distance of individuals from nesting boxes during the entire PFDP was 3.2 km, and the maximum recorded distance was 9 km. The area of home ranges of the PFDP calculated by the 100% MCP method was 81 km^2 (Fig. 4), 45 km^2 (95% MCP) and 26 km^2 (80% MCP). All the young birds successfully became independent between 15 and 26 July 2021.

Subsequent dispersal movements occurred in four individuals (B1, B2, L1 and T1) in a very similar way, when the individuals suddenly left their PFDP home ranges and began to move significantly away from them every day (Fig. 2). For example, the female T1 reached 160 km from the nest during the first day of dispersal, 290 km on the second day and 420 km on the third (Fig. 4). Both her movement route and duration of monitoring were the longest among all the young birds, and during the dispersal, she established three TSAs. A total of three of the four individuals mentioned above set up at

Fig. 3. Nesting boxes, overall movement routes and locations of the last records of six young saker falcons monitored by satellite telemetry in 2021.

Obr. 3. Hnízdní budky, celkové trasy pohybu a polohy posledních záznamů šesti mláďat raroha velkého sledovaných pomocí satelitní telemetrie v roce 2021.

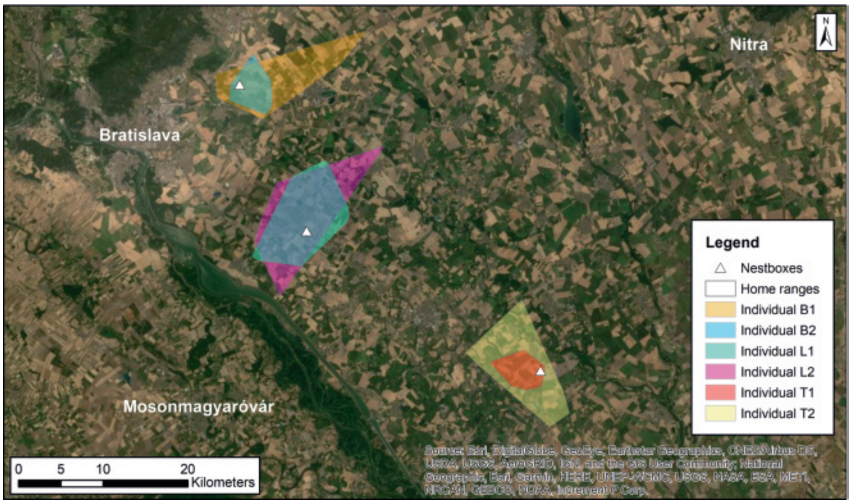

Fig. 4. Home ranges of the post-fledging dependence period recorded in the area of interest in Slovakia for six saker falcon fledglings from a total of three nests calculated by the 100% minimum convex polygon method.

Obr. 4. Domovské okrsky období dospívání zaznamenané v zájmovém území na Slovensku celkem pro šest mláďat raroha velkého úhrnem ze tří hnízd vypočítané metodou 100% minimálního konvexního polygonu.

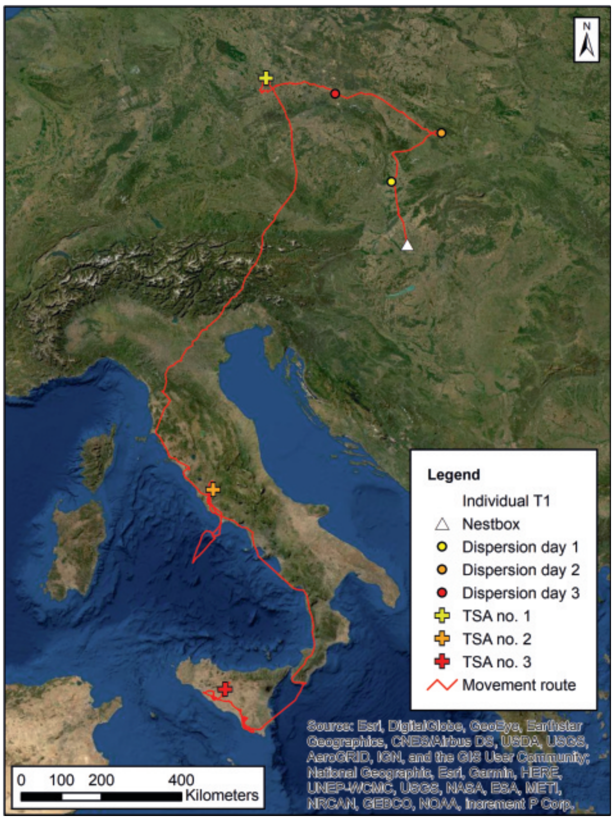

Fig. 5. The overall route of movement of the individual T1, including her occurrence at the end of the 1st, 2nd and 3rd day from the start of the dispersal (circles), including three temporary settlement areas (TSAs; crosses) established by this individual during dispersal movements.

Obr. 5. Celková trasa pohybu jedince T1, včetně jeho polohy na konci 1., 2. a 3. dne od zahájení disperzních pohybů (kroužky), včetně tří oblastí dočasných útočišť (TSA; křížky) zřízených tímto jedincem během disperze.

least one TSA during the dispersal (Figs. 5–9). Young saker falcons inhabited TSAs (n = 5 areas; individuals B1, B2, and T1; Tab. 2) for 37 days. Their recorded locations within the TSAs were 1203 km from the nest boxes (minimum and maximum distances were 1181 and 1221 km, respectively). The movement routes of individuals within the TSAs were 1582 km long. The TSAs of the three individuals mentioned above covered an area of 422 km^2, as calculated using the 100% MCP method, 326 km^2 (95% MCP) and 252 km^2 (80% MCP).

The female L2 stayed in an area (we also call it as TSA) that was directly related to the area inhabited throughout the PFDP, and this female remained near the natal nest box for a total of 110 days (Tab. 2). Only then a sudden dispersal movement followed in her case (Fig. 2). During the PFDP, this female stayed in an area of 108 km^2 according to 100% MCP and the subsequent TSA inhabited before dispersal movements occupied an area of 120 km^2 (100% MCP; Fig. 10).

The individual T2 did not set up any TSA, and his dispersal movements were quite different from those described above. After becoming independent, this young male moved in a wide area around the nest box until his death, specifically at a maximum distance of less than 100 km and an average distance of 39 ± 17 km (Fig. 11). According to 100% MCP, his home range during the PFDP covered an area of 85 km^2, and the area covered during his dispersal movements was 8884 km^2 (100% MCP; Fig. 11).

All monitored fledglings became independent, and the mortality rate was zero during the PFDP. However, none of the young birds most probably survived to adulthood, and all perished during the dispersal period.

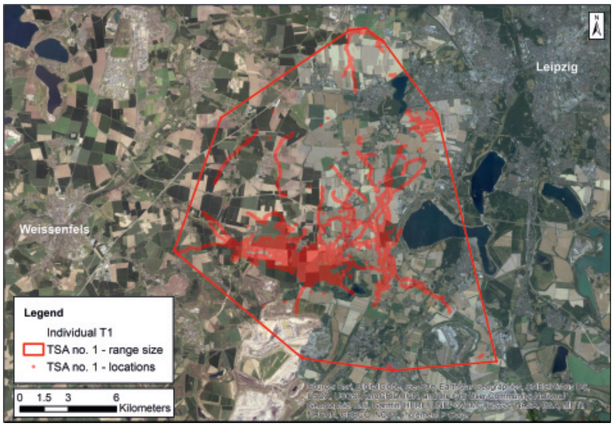

Fig. 6. Detail of the first temporary settlement area (TSA; calculated by the 100% minimum convex polygon method) set up during dispersal movements by the T1 individual in Germany near the city of Leipzig, including individual locations of her stay within this area.
Obr. 6. Detail oblasti prvního dočasného útočiště (TSA; spočteno metodou 100% minimálního konvexního polygonu) zřízeného během disperzních pohybů jedincem T1 v Německu u města Lipska, včetně jednotlivých lokací jeho pobytu v dané oblasti.

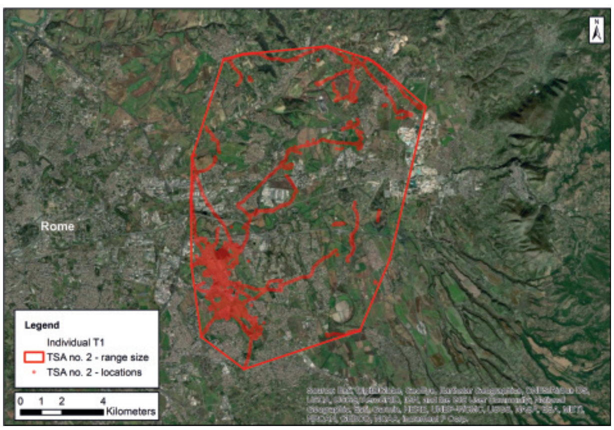

Fig. 7. Detail of the second temporary settlement area (TSA; calculated by the 100% minimum convex polygon method) set up during dispersal movements by the T1 individual in Italy near the city of Rome, including individual locations of her stay within this area.
Obr. 7. Detail oblasti druhého dočasného útočiště (TSA; spočteno metodou 100% minimálního konvexního polygonu) zřízeného během disperzních pohybů jedincem T1 v Itálii u města Říma, včetně jednotlivých lokací jeho pobytu v dané oblasti.

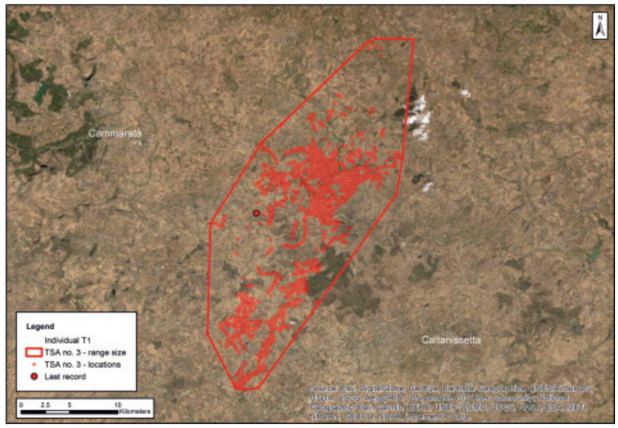

Fig. 8. Detail of the third temporary settlement area (TSA; calculated by the 100% minimum convex polygon method) set up during dispersal movements by the T1 individual in Italy in Sicily near the city of Caltanissetta, including individual locations of her stay within this area and the place of her assumed death.
Obr. 8. Detail oblasti třetího dočasného útočiště (TSA; spočteno metodou 100% minimálního konvexního polygonu) zřízeného během disperzních pohybů jedincem T1 v Itálii na Sicílii u města Caltanissetty, včetně jednotlivých lokací jeho pobytu v dané oblasti a místa jeho předpokládaného úmrtí.

Fig. 9. Detail of the two temporary settlement areas (TSAs; calculated by the 100% minimum convex polygon method) established during dispersal movements by the B1 and B2 individuals at the border of Ukraine and Russia near the town Krasnoperekopsk, including individual locations of their stay within these areas and the places of their assumed death.
Obr. 9. Detail oblastí dvou dočasných útočišť (TSA; spočteno metodou 100% minimálního konvexního polygonu) zřízených během disperzních pohybů jedinců B1 a B2 na hranicích Ukrajiny a Ruska u města Krasnoperekopsku, včetně jednotlivých lokací jejich pobytu v daných oblastech a míst jejich předpokládaných úmrtí.

Two individuals (L2 and T2) were most likely electrocuted (Slovakia and Greece; Fig. 3 and 11; last records of both individuals were located exactly below electric pylons of 22 kV and their transmitters were probably damaged by a short circuit), and one individual (L1) was caught by trappers (Kosovo; Fig. 3; Anonymous, in verb; illegal trapping on the same day at the site of the last GPS records of L1 individual was personally confirmed by local ornithologists who want to remain anonymous for security reasons). The longest living individual (T1) died in Sicily, most likely in connection with bad weather, when several tornadoes swept through Sicily at that time (Fig. 3 and 8; the transmitter stopped to move and subsequently also to transmit a signal on the day when the tornadoes swept through the area where the last GPS positions of T1 individual were recorded). The causes of death of the last two young birds (B1 and B2) could not be determined, but their last locations were in Ukraine near the Crimean Peninsula (Fig. 3 and 9). In these two cases, it is theoretically possible that their transmitters failed (though there were no signs of any issues with both transmitters, both were well charged, and no electric wires and pylons are in the area, sudden failures of hitherto well-functioning tags have already been documented [Anitra Systems s.r.o., in verb]).

Discussion

The data on mortality of the young birds can be considered the most important results of our study. While during the PFDP, we did not record the death of any of the six monitored saker falcons, which was a surprising finding since higher mortality of young birds of prey, as well as young birds of other species, is quite common in the period after leaving the nest (Adams et al. 2001; Keedwell 2003; Todd et al. 2003; Sunde 2005; Boileau & Bretagnolle 2014). On the other hand, the negative finding was that none of the six monitored individuals reached adulthood, and all died during the period of dispersal movements, although high mortality of young independent birds is quite common (Small et al. 1993; Prommer et al. 2012; Faccio et al. 2013), too. Low mortality (approximately 6%) of young saker falcons during the PFDP was also recorded in Mongolia, where most deaths were caused by birds of prey (Rahman et al. 2015). Low mortality of young birds of the target species during the PFDP was also found in Ukraine and Bulgaria (Prommer et al. 2014; Dixon et al. 2019). This coincidence could be because the saker falcon is a relatively large species, and the predation of its fledglings by other predators is not as common as it may be in smaller species of hawks, falcons or owls (Obuch & Bangjord 2016). Several studies also remarkably agree with our study regarding the high mortality rate of up to 100% in

Tab. 2. Data on a total of six temporary settlement areas set up by four young saker falcons (B1, B2, L2 and T1) during their dispersal movements.
Tab. 2. Údaje o celkem šesti oblastech dočasných útočišť zřízených čtyřmi mláďaty raroha velkého (B1, B2, L2 a T1) během jejich disperzních pohybů.

evaluated characteristics	individual data						median[f]	mean[f]	SD[f]
ID of tracked individual[a]	B1	B2	L2		T1		-	-	-
temporary settlement area – "TSA"	1	1	1	1	2	3	-	-	-
date of TSA establishment	7 August	6 August	18 July	27 July	12 September	3 October	-	-	-
duration of TSA (days)	44	25	64	37	12	44	37	32	12
No. of locations / fixes during TSA	33,221	1593	8867	25,397	15,577	32,681	25,397	21,694	11,906
length of TSA movement route (km)	1906	1582	581	1319	457	1941	1582	1441	542
distance of TSA from the nest[b] (mean ± SD; km)	1306 ± 7.7	1231 ± 4.3	2.8 ± 4.1	544 ± 2.9	785 ± 4.2	1203 ± 7.4	1203	1014	297
minimal distance of TSA from the nest[c] (km)	1284	1212	0.0001	531	775	1181	1181	997	293
maximal distance of TSA from the nest[d] (km)	1322	1246	19.1	554	791	1221	1221	1027	301
home range size of TSA (100% MCP[e]; km^2)	1657	1483	120	280	137	422	422	796	641
home range size of TSA (95% MCP[e]; km^2)	1585	1149	103	173	126	326	326	672	588
home range size of TSA (80% MCP[e]; km^2)	1156	894	74	94	57	252	252	491	449
date of TSA termination	19 September	30 August	19 September	1 September	23 September	15 November	-	-	-
cause of TSA termination	death	death	abandoned	abandoned	abandoned	death	-	-	-

◀ **Tab. 2.** Continuation.
◀ **Tab. 2.** Pokračovanie.

[a]Two monitored individuals, specifically L1 and T2, did not established any TSA
[b]Mean distance of all locations / fixes from the nest recorded for a given individual during the time of TSA duration
[c]Minimal distance from the nest recorded for a given individual during the time of TSA duration
[d]Maximal distance from the nest recorded for a given individual during the time of TSA duration
[e]Minimum convex polygon (100%, 95%, 80% MCP)
[f]Individual L2 was excluded from descriptive statistics calculations (n = 5; individuals B1, B2 and T1) because its TSA range was directly related to its PFDP home range

already independent young saker falcons recorded during the dispersal period (Gamauf & Dosedel 2012; Nemček et al. 2014; Prommer et al. 2014; Dixon et al. 2019; this study). One possible explanation is that the dispersal of this species is common over huge distances (up to tens of thousands of km) during which young saker falcons may encounter a vast range of possible dangers. Still, the really alarming fact is that electric lines and pylons cause most deaths of young saker falcons during this period (e.g., Nemček et al. 2014; Dixon et al. 2019). In our study, electrocution was reported in at least two cases. Power lines and pylons thus represent a significant cause of saker falcon mortality and can influence population demographics (Kovács et al. 2014; Demeter et al. 2018; Gális et al. 2019; Dixon et al. 2020).

The results of our study fit relatively well into the published information found on young saker falcons in terms of the duration of the PFDP and movement patterns during this period. We recorded an average duration of the PFDP 48 ± 3 days (range 45–53 days). The other two studies described the duration of the PFDP in the target species as 44 days (range 30–64 days) and 40 ± 4 days (range 31–52 days) (Prommer et al. 2014; Rahman et al. 2015). Thus, the duration of the PFDP does not seem to be affected by the specific area where the young saker falcons hatched (Ukraine, Mongolia or Slovakia). However, the question remains whether the duration of the PFDP of saker falcons is affected to a high degree by prey abundances, as described in other birds of prey (Alonso et al. 1987; Bustamante 1994; Kouba et al. 2013), as none of the above-mentioned

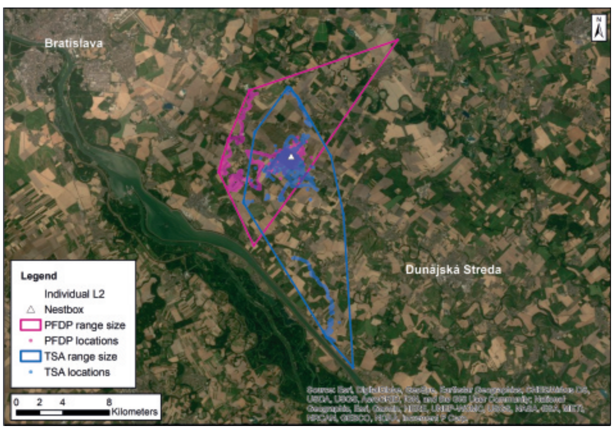

Fig. 10. Detail of the post-fledging dependence period (PFDP) home range of the L2 individual and her temporary settlement area (TSA; both ranges were calculated by the 100% minimum convex polygon method) set up after her independence, but still at the natal area in Slovakia near the town Dunajská Streda, including individual locations of her stay within both given areas.
Obr. 10. Detail domovského okrsku období dospívání (PFDP) jedince L2 a oblasti jeho dočasného útočiště (TSA; spočteno metodou 100% minimálního konvexního polygonu) zřízeného po nabytí samostatnosti včetně jednotlivých lokací jeho pobytu v obou daných oblastech. Oba okrsky na sebe u jedince L2 přímo navazovaly, a oba se tak nacházely v okolí hnízdní lokality na Slovensku u města Dunajská Streda, odkud jedinec pocházel.

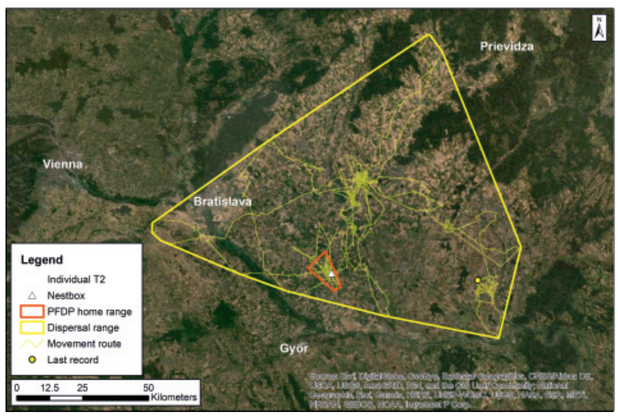

Fig. 11. The overall home range of the T2 individual recorded during the dispersal movement period and his home range of the post-fledging dependence period (PFDP; both ranges were calculated by the 100% minimum convex polygon method) located in Slovakia east of the capital Bratislava, including the movement routes recorded within both given areas and place of his assumed death.
Obr. 11. Celkový domovský okrsek jedince T2 zaznamenaný během období disperzních pohybů a jeho domovský okrsek období dospívání (PFDP; spočteno metodou 100% minimálního konvexního polygonu) nacházející se na Slovensku východně od hlavního města Bratislavy, včetně tras pohybů zaznamenaných v obou daných oblastech a místa jeho předpokládaného úmrtí.

studies on saker falcons estimated abundances of their prey. The same is true for the home range sizes throughout the PFDP of young saker falcons, as their home ranges have been described, but so far, no study has described the factors affecting the area of these ranges. In Mongolia, the average size of home ranges during the PFDP was recorded as 55 ± 24 km^2 (according to 100% MCP), but only for the period of 28 days from fledging. It is well comparable to the average area of 67 ± 33 km^2 (according to 100% MCP) found by us, recorded for the period approximately one third longer. Thus, it seems that even in the size of the home ranges during the PFDP, there are no fundamental differences across the habitats or continents where the target species breeds. However, significantly smaller home ranges during the PFDP were recorded in Bulgaria (14 km^2 according to 100% MCP), but these were recorded for reintroduced young birds tied to the releasing cages throughout the PFDP, where they regularly received supplementary feeding. In our opinion, these data are thus incomparable with our results.

An interesting behaviour has been described in many species of birds of prey during the dispersal movement period when individuals set up TSAs (e.g., Sielicki et al. 2009; Literák et al. 2020) in which they remain for different periods in a relatively small area. They repeatedly occur here in the same places, and then they suddenly leave the area and continue in probably random dispersal movements (Meyburg et al. 1995). The setting up of similar TSAs has also been recorded for saker falcons (Prommer et al. 2014; Nemček et al. 2016; Dixon et al. 2019). However, they have not yet been described in more detail. For example, Dixon et al. (2019) state the average time spent in each TSA as 27 days with the range of 2–66 days, and that individual TSAs can be used repeatedly. The TSAs recorded by us (excluding L2 individual for the reasons stated above, see the chapter Results) were maintained by individual falcons 32 ± 12 days on average (range 12–44 days). Their area was 796 ± 641 km^2 (mean ± SD; according to 100% MCP), and the locations recorded within these areas were 1014 ± 297 km away from the natal nest boxes. These data confirm that, within the dispersal, which takes place over vast distances, the TSAs are indeed relatively small, and the crucial question is why individuals set them up at all. The most probable reason is the high prey abundance in the given site, which the individual uses for some time, or until it is depleted (Dixon et al. 2017, 2020). It is also probably connected with transition from exploratory strategies, when animals have incomplete environmental information, to a more familiar way to exploit their activity areas as they get to know the environment better (Delgado et al. 2009).

Finally, we would like to make an appeal to the relevant authorities and all those responsible for installing high-voltage pylons and wires to make every effort to secure their electricity grids worldwide so that any organisms cease to be killed as a result. As our study and many others suggest, mortality as a result of injuries related to electric structures, posing a risk of collision or electrocution is enormous, reaching millions of birds worldwide each year (Jenkins et al. 2010), which is utterly unsustainable in the long term and, it is necessary to introduce measures that will reverse this very pessimistic trend as soon as possible (e.g., Šmídt et al. 2019).

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