

Annual movement pattern of a single individual Steppe Buzzard *Buteo buteo vulpinus* based on GPS tracking

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Abstract. Common Buzzard *Buteo buteo* is a raptor widely distributed in the Palaearctic Realm. Populations of a subspecies *Buteo buteo vulpinus* called Steppe Buzzard are strictly migratory and wintering in sub-Saharan Africa. However, detailed information about its individual movement pattern is missing. We equipped a nestling of Steppe Buzzard with a telemetry logger in eastern Ukraine in the 2021 breeding season. The bird was GPS-tracked till the end of 2022. We characterised its post-fledging period and area, periods and movement patterns of pre-migration vagrancy, two autumn and one spring migrations and winter and summer stays. The first and second autumn migrations (71 and 48 days, respectively) of the tracked bird headed south, along the east coast of the Black and Mediterranean Seas, across the Arabian Peninsula along the east coast of the Red Sea with a flight to Africa via the Bab-al-Mabdab Strait and further southeast to Zambia as wintering place. Back during the spring migration (76 days), the bird returned northeasterly along the west coast of the Red Sea and left Africa after crossing the Suez and returned to its natal area via the east coast of the Mediterranean and Black Seas. Thus, the loop migration of the Steppe Buzzard around the Red Sea was confirmed. During the summer period in 2022, the immature bird changed the area of occurrence from eastern Ukraine to western Russia supposedly as a result of war events in eastern Ukraine.

Key words: migration, raptor, behaviour, Europe, Africa, Ukraine, Zambia

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As an adaptation to seasonally fluctuating food supplies, many raptors in temperate areas perform seasonal movements like regular long distance shift (migration) of the whole population between non-overlapping northern breeding grounds and tropical wintering areas (Thiollay 1994). The Common Buzzard *Buteo buteo*, with a number of subspecies, is a raptor species widely distributed in the Palaearctic Realm. Populations of west and central Europe are sedentary or partially migratory, whereas north and east European and most Asiatic populations are migratory (Ferguson-Lee & Christie 2001). Steppe Buzzards *Buteo buteo vulpinus* which breed in Finland and Russia east to Yenisey River, east Ukraine, and elsewhere are highly migratory subspecies wintering mainly in East and South Africa (Väli & Vainu 2015, Väli & Mirski 2021). A zone of intergradation between European nominate *Buteo buteo buteo* (hereafter *buteo*) and *B. b. vulpinus*

(hereafter *vulpinus*) from Finland through west Russia, west Ukraine and east Romania have in the past been subspecifically distinguished as '*intermedius*' and '*zimmermannae*' (Ferguson-Lee & Christie 2001, McCarthy 2006). Migration strategy of Common Buzzards in Western Palearctic has been recently reviewed by Väli & Mirski (2021). Migratory behaviour of *buteo* and *vulpinus* is strikingly different: westerly distributed *buteo* is sedentary, partial migrant or short-distance migrant, while easterly distributed *vulpinus* is a long-distance migrant performing migrations up to 14,200 km. It was considered that different timing, routes and destinations of migration may be important drivers of their speciation (Väli & Mirski 2021).

During autumn (post-breeding) migration, hundreds of thousands of *vulpinus* including those from eastern Ukraine are bottlenecked at east coast of the Mediterranean and Black Seas (Viter 2018, Jobson et al. 2021, Väli & Mirski 2021).

Then birds continue migration across the Arabian Peninsula until Yemen to cross the Bab-al-Mandab Strait and enter Africa in Djibouti, while the flow through Israel and the Suez is much less important in this season. In eastern Ukraine, near Kharkiv, migration peaks in September (Viter 2018, Väli & Mirski 2021). On the east coast of the Black Sea, in Batumi, Georgia, the medium of migration was on 29 September and 90% of *vulpinus* migrated between 18 September and 13 October (Verhelst et al. 2011) entering Africa at the Bab-al-Mandeb Strait (peaking on 16–17 October in 1985 and 6–8 October in 1987) (Welch & Welch 1988). In Africa, some birds may stay wintering in Ethiopia but most birds probably continue to southern region of Africa (Väli & Mirski 2021).

In spring, only small numbers leave Africa through Bab-al-Mandab (Welch & Welch 1998, Jobson et al. 2021). Most *vulpinus* individuals continue the flight northward along the west coast of the Red Sea and enter Asia crossing the Suez showing therefore a loop migration pattern (Väli & Mirski 2021). More than a hundred of thousands *vulpinus* are seen in Egypt, close to the Suez (Hilgerloh 2009, Megalli & Hilderlogh 2013). The spring flight follows the east coast of the Mediterranean Sea and as many as 300,000 (more than 400,000 in 1986 and 1988) buzzards (98% *vulpinus*) pass over Israel to continue to the east coast of the Black Sea, where (as in Batumi) similar numbers to the autumn ones are observed in spring (Shirihai et al. 2000, Yosef et al. 2002, Väli & Mirski 2021). Adult *vulpinus* individuals leave their wintering grounds in South Africa in February, earlier than young birds (Herremans 2001). In March, thousands of *vulpinus* individuals were recorded in Zambia and Rwanda (Allerstam 1990). Between mid-March and late April the migration is distributed in Egypt (Hilgerloh 2009, Megalli & Hilderlogh 2013), following period from 22 March to 15 April when *vulpinus* migration peaks in Israel (few records before 22 February and beyond 2 June) (Shirihai et al. 2000). In Finland and in the Ural region of Russia, most birds arrive in the second half of April (Väli & Mirski 2021).

Current knowledge of *vulpinus* migrations and wintering grounds is mainly based on field observations. However, detailed information about *vulpinus* individual movement pattern is missing. There is also only scarce information about speed of *vulpinus* on their migration. One *vulpinus* trapped at Eilat, Israel was recovered in Eastern Europe 15 days later. It had covered 3300 km at a

mean speed of 220 km/day (on migration, *vulpinus* regularly pause to feed taking arthropods and, less often, rodents) (Shirihai et al. 2000). There is no information available about behaviour of floaters (non-breeding immature individuals) in the summer period.

We tagged one young *vulpinus* individual on a nest in eastern Ukraine in 2021 as a beginning of a larger project aimed at telemetry study of raptors originating from this area. Unfortunately, the Russian invasion and war made it impossible to carry out further research in this area. Although only one *vulpinus* individual was marked, it has been the only telemetrically tagged and tracked *vulpinus* with known origin to date. The bird was monitored until the end of 2022 and completed two autumn migrations, one spring migration, one wintering period and one summering period. Tracking this bird has provided a number of accurate data documenting annual migration patterns (exact routes, timing and speed in both autumn and spring migrations), behaviour in a winter quarter and during a summer period when the bird is one-year-old. On the basis of this monitoring we can substantially bridge the gaps in the knowledge of the individual behaviour of *vulpinus* — a relatively abundant raptor of Eastern Europe — which is the aim of the work.

A nestling (*pullus*) *vulpinus* was tagged on a nest in Komyshevakha (48.6304611 N, 37.4275583 E) in Kramatorsk Regional Landscape Park, Ukraine, on 1 July, 2021. The nest was found already in 2020. In 2021, there was only one nestling on the nest. The weight of the nestling was 780 g.

The bird was equipped with a telemetry logger OrniTrack-20 (solar powered GPS-GSM/GPRS tracker Ornitela, Lithuania, www.ornitela.com). The logger was fitted onto the back of the birds using harness (backpacks) consisting of a 6 mm Teflon ribbon encircling the body by two loops around the bases of the wings and joined in front of the breastbone (Appendix 1). The GPS positions of the birds were collected in setting one position per 1 h. They were sent as SMS text messages by local mobile operators to the Ornitela Centers in Lithuania, where they were saved and archived. To analyse the coordinates of bird positions and to create maps of migration routes, we used GIS and the software ArcGIS Pro (Esri, Redlands, CA, USA).

The following characteristics were collected for the monitored bird: the period of post-fledging stage (the period from the first leaving the nest to

leaving the post-fledging area), pre-migration vagrancy period (the period when the bird left the post-fledging area and moved over longer distances, especially in the west-east axis), autumn migration period (period of continuous movement mainly in the southwest direction to reach the wintering ground), stay on wintering grounds, spring migration (period when the bird left the wintering ground and continuously moved mainly in the northeast direction) and summer vagrancy period (movement of a non-breeding bird, floater, in the west-east axis in the breeding area of *vulpinus*). During migrations, the dates of crossing the borders between Asia and Africa were recorded. The size of the post-fledging area (the area near the nest where the bird was present, returning to the nest and could still have contact with the parents) and the size of the wintering area was determined in km² using a Minimum Convex Polygon (MCP) value of 95%.

Positions in the format 1/1/1 (one position, i.e. roosting position, i.e. the first recorded position after 00.00 of the given day/one day/one bird) were used to represent the movement trajectory. These positions were connected in chronological order and the resulting connector was used both to graphically represent the movement trajectory and to calculate the length (km) of migration and vagrancy routes. We also calculated average vagrancy and migration speeds (km/day), average speed in travel days (without stopover days) (km/day) and maximum speed per day. These speeds are parameters of the speed of the bird's movements during individual periods on a continental scale. The local movement of the bird during the day, reflecting e.g. the search for food, was deliberately not considered.

Stopovers were places on the routes of the monitored bird, when it stayed at one place (or within a maximum distance of 5 km from this place) for two or more nights consecutively. The number of stopovers and the total number of days spent on these stopovers, including the average number of days per stopover, were determined for individual periods/routes.

The southernmost position during autumn migrations and the northernmost position during the vagrancy summer period (distance — loxodrome, azimuth) in relation to the native nest and the closest position during the vagrancy summer period were characterized. In the summer vagrancy period in 2022, stays of the traced *vulpinus* individual were characterised especially for eastern Ukraine (war conflict, Guterres 2022), and

southwestern Russia (without war conflict). Wintering site fidelity was determined as the distance between wintering site I and wintering site II positions.

From 1 July 2021, the tracked bird spent the nights continuously on the nest until 14 July 2021 when it spent the first night outside the nest in the distance of 122 m. From this day, his post-fledging period began, which lasted until 26 August 2021. At that time, the tracked bird moved away from the natal nest to a maximum distance of 3250 m (25 August 2021). After that, the bird left the relatively small post-fledging area and never returned to the spot near the natal nest.

From 27 August 2021 to 26 September 2021, the bird moved mainly in the west-east direction with overnight stops and stopovers (vagrancy pre-migration period) (Figs 1 and 2). On 27 September 2021, the bird suddenly changed its behaviour and headed south-west to the winter ground which ended on 6 December 2021. The bird stayed at the wintering ground of a relatively small area in Zambia until 27 February 2022, apart from 16 to 22 January 2022, when it made a circular exploratory flight.

On 28 February 2022, the bird suddenly changed its behaviour and began to return to its natal area in Europe in a continuous northeast direction. The spring migration lasted until 14 May 2022.

Since 15 May 2022, the bird has been moving in the region of eastern Ukraine and the neighbouring region of south-western Russia, while it did not show the behaviour of a breeder with ties to its own nest, it showed signs of the behaviour of a floater, i.e. it wandered around the whole area with longer stopovers (= temporary settlement areas). It stayed in eastern Ukraine from 17 May to 19 June 2022 (34 days). From 14 May to 16 May 2022 and from 20 June to 3 October 2022 (109 days) *vulpinus* resided in southwestern Russia. The summering period lasted until 3 October 2022, when the bird went again south-west to the wintering ground identical as in the 2021/2022 wintering period. After five days on the wintering grounds, the logger stopped sending data, with no signs of signalling the bird's death.

The quantitative parameters of the bird's movement are presented in Table 1. The size of the post-fledging area was 0.14 km² (MCP95%). The period of stay at the wintering ground (including the inclusion of the time of exploratory flight) was 85 days. The wintering area size as MCP95%

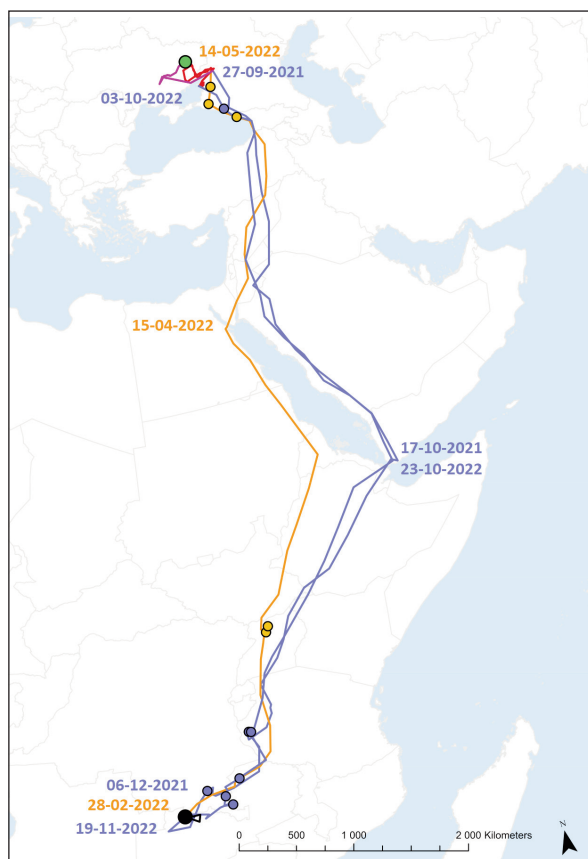


Fig. 1. Movement patterns of a Steppe Buzzard *Buteo buteo vulpinus* tracked. Green dot — natal nest; violet line — movement trajectory in pre-migration vagrancy period; blue line, data and dots — movement trajectories, data of beginning, finish and crossing the Bab-al-Mandab Strait, and stopovers in autumn migrations I and II; black dot — wintering ground; orange line, data and dots — movement trajectories, data of beginning, finish and crossing the Suez, and stopovers in spring migration; red line — movement trajectory in summer period.

without incorporating exploratory flight values was 3.8 km².

In relation to the natal nest, the southernmost position during autumn migration I was on 4 December 2021 (13.245069 S, 24.243965 E), 6976 km (loxodrome natal nest — southernmost position), 194° azimuth; during autumn migration II on 17 November 2022 (12.614983 S, 26.832186 E), 6864 km (loxodrome natal nest — southernmost position), 192° azimuth. The northernmost position during vagrancy summer period was on 27 May 2022, (48.822632 N, 37.790245 E), 34 km (loxodrome natal nest — northernmost position), 51° azimuth. The closest position at the time of the vagrancy summer period to the natal nest was same as the northernmost position.

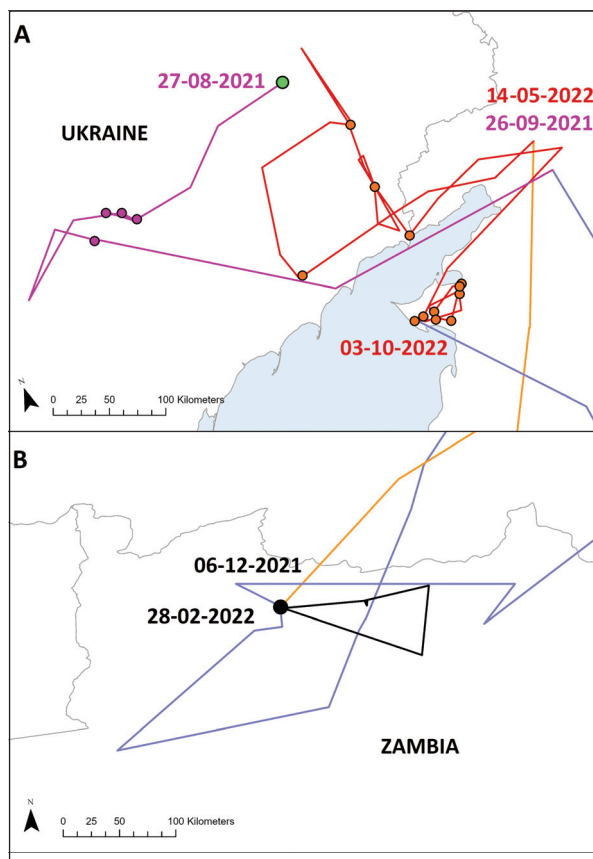


Fig. 2. Details of movement patterns of a Steppe Buzzard *Buteo buteo vulpinus* tracked. A — Natal area, summering period, B — wintering area. Green dot — natal nest; violet line, data and dots — movement trajectory, data of beginning; finish and stopovers in pre-migration vagrancy period; red line, data and dots — movement trajectory, data of beginning, finish and stopovers in vagrancy summer period; black dot, line and data — wintering ground, movement trajectory (exploratory flight), beginning and finish of wintering period; orange and blue lines — movement trajectories in spring and autumn migration, respectively (for details see Fig. 1).

The results of tracking the Buzzard individual we tagged provide a unique insight into the individual annual movement pattern of *vulpinus*. So far no other study of telemetry tracking of *vulpinus* with precisely defined origin has been available. Some adult *vulpinus* individuals on their spring migration were tagged with telemetry loggers in Israel in 2019 and few preliminary notes followed (Jobson et al. 2021, Thie et al. 2022). Prevailing spring and autumn migration routes on west and east side of the Red Sea, respectively, were documented (Jobson et al. 2021).

The post-fledging area of the tracked *vulpinus* individual was very small — only 0.14 km². In the breeding period, the small area of 0.98 km² was

Table 1. Quantitative parameters characterizing dynamics of tracked Steppe Buzzard *Buteo buteo vulpinus* movements. ^a — Movement trajectory is a link between overnight locations (i.e. always the first location on a given day), it does not take into account further movement during the day; ^b — Stopover is the designation of a place where the bird spent the night repeatedly for 2 or more nights in a row or a place where the subsequent places of overnight stay are no more than 5 km away from the previous place of overnight stay.

Parameter	Pre-migration vagrancy period	Autumn migration I	Spring migration I	Summer vagrancy period (floater)	Autumn migration II
Length (days)	31	71	76	142	48
Movement trajectory ^a (km)	427	9037	7911	1546	8328
No. of stopovers ^b	4	3	5	12	4
Length of stopovers (days)	23	16	29	117	9
No. of travel days	8	55	47	25	39
Average vagrancy/migration speed (km/day)	14	127	104	11	174
Average speed on travel days (km/day)	53	164	168	62	214
Maximum speed (km/day)	81	370	395	96	410

also documented in average for the breeding territories of *vulpinus* adults in eastern Ukraine (Vysochyn 2020). Home range of an adult male of breeding *buteo* covered 8.3 km² (95% KDE) (Väli 1917). Post-fledging areas represented by MCP95% for Black Kites *Milvus migrans* were even smaller and ranged from 0.02 km² to 0.125 km² (Literák et al. 2020).

Buteo juveniles tend to disperse in various directions before migration whereas adults seem to initiate migration directly from the breeding area (Strandberg et al. 2009). The behaviour of the tracked *vulpinus* juvenile was similar. It travelled mostly in west-east directions during pre-migration vagrancy before it began to migrate at the end of September.

Both autumn migrations of the tracked *vulpinus* individual headed south, along the eastern coast of the Black and Mediterranean Seas, across the Arabian Peninsula along the east coast of the Red Sea with a flight to Africa via the Bab-al-Mabdab Strait and further southeast to Zambia. Back during the spring migration, the tracked *vulpinus* individual returned northeasterly along the west coast of the Red Sea and left Africa after crossing the Suez and returned to its natal area via the eastern Mediterranean and Black seas. Thus, the loop migration of *vulpinus* around the Red Sea was confirmed (Jobson et al. 2021, Väli & Mirski 2021).

Recoveries of *vulpinus* individuals ringed in northeast Europe were reported from as far as in Zimbabwe and South Africa, at distances of up to 13,000 km (Ferguson-Lees & Christie 2001). Ringing recoveries of *vulpinus* individuals ringed

in Southern Africa during their winter stays showed their natal/breeding areas stretching roughly 3500 km from 24 °E in southern Finland to 93 °E near the Yenisey River (Oatley et al. 1998). The greatest distance from the Palearctic location to the wintering spot was 12,224 km. The tracked *vulpinus* individual in our study covered a length of 9037 km in the first autumn migration.

Common Buzzards avoid sea-crossing (Stanciu et al. 2017), so *vulpinus* on migration concentrates mainly around left and right sides of Black Sea and down through eastern Mediterranean countries. During the autumn and spring migrations, the tracked *vulpinus* individual was apparently part of the main stream of migrating *vulpinus* group both when crossing the Asia/Africa border via the Bab-al-Mandab Strait and in the east of Egypt (the Suez) and in Israel, respectively (Welch & Welch 1988, Shirihai et al. 2000, Hilgerloh 2009, Megalli & Hilderlogh 2013). However, the end of spring migration for the tracked *vulpinus* individual was later than in the second half of April, which is the time of return of birds in the breeding areas of Finland and the Urals, Russia, and is in line with the hypothesis that older and more experienced birds return to the breeding grounds earlier than young, inexperienced birds, and with knowledge of two main migration waves in spring comprising mainly adults in the first wave and immatures in the second wave (after mid-April) in Israel (Forsman 2015, Väli & Mirski 2021). The breeding experience in adults can accelerate their arrival date to the breeding site, as it was documented for example in Red Kites *Milvus milvus* (Literák et al. 2022).

The more frequent stopovers at the beginning and end of migrations are surprising, while the *vulpinus* individual we studied did not stop for more than 1 night during migration around the Red Sea. Migrating *vulpinus* individuals are observed usually solitary, in pairs or family parties (Ferguson-Lees & Christie 2001). They sometimes spend the night together. Large numbers of *vulpinus* individuals could be observed in bottlenecks of their migration routes such as the Bab-al-Mandeb Strait or on the eastern coast of the Mediterranean and the Black Sea (Shirihai et al. 2000, Yosef et al. 2002, Hilgerloh 2009, Megalli & Hilderloh 2013, Väli & Mirski 2021). Even outside these bottlenecks, large flocks of 2500 or more individuals can be observed due to adverse weather such as thunderstorms (Kasperek 1997). The question remains whether the tracked *vulpinus* individual was traveling alone or in any larger *vulpinus* formation. In East Africa, in areas northeast of Zambia, *vulpinus* is a common passage migrant and single to large flocks are observed mainly from September to November and from February to March (Stevenson & Fanshawe 2015). Travel period in this area of our tracked *vulpinus* fits well to these periods.

During autumn migration II, the tracked *vulpinus* individual was very fast (174 km/day), significantly exceeding the speed of tracked *buteo* Buzzards during autumn migrations (average 57 km/day, Strandberg et al. 2009). Other parameters of autumn migration speed were also significantly higher in *vulpinus* than in *buteo*: average speed on travel days 164 km/day and 214 km/day in *vulpinus* (in autumn migration I and II respectively) vs. 84 km/day in *buteo*, (Strandberg et al. 2009), maximum speed 410 km/day in *vulpinus* vs. 295 km/day in *buteo* (Strandberg et al. 2009).

During the spring migration, the tracked *vulpinus* individual moved more slowly (104 km/day) than during the autumn migrations. In adult breeding birds, one would expect a higher spring migration rate than autumn migration rate due to competition for breeding territories (see above). In the case of immature floaters (our tracked *vulpinus*), however, this driver disappears, which may explain the slower speed of spring migration. However, a remarkably similar speed (104 km/day) was the average value of spring migration speed for tracked *buteo* individuals (Strandberg et al. 2009). GPS tracking of Eastern Buzzards *Buteo japonicus* (previously a subspecies of Common Buzzard *B. buteo*) revealed migration routes of *B. j. burmanicus* and *B. j. japonicus* along

the Sea of Japan, but migration speeds comparable to our study were not published (Nakahara et al. 2022).

The bird we tracked, originating from eastern Ukraine, wintered in northeastern Zambia which belongs to areas used for *vulpinus* wintering (Ferguson-Lees & Christie 2001). In this connection, it is hard to believe results were recently published by Nyirenda et al. (2020) who reported that Steppe Buzzards *Buteo vulpinus* bred in Zambia during the wet season December–February (Nyirenda et al. 2020). This wet season corresponds to the wintering period of Palearctic *vulpinus* migrants. Thus, the truth must be that Nyirenda et al. (2020) either failed in determination of breeding raptors or they assumed breeding only according to observed non-breeding wintering *vulpinus* individuals.

Wintering *vulpinus* Buzzards adopt a wider range of habitats but they favour open country with dwarf shrubs or crop land/grassland mosaics (Oatley et al. 1998). Most of their hunting is done from a perch. Ring recoveries in Southern Africa have confirmed with high fidelity that the same *vulpinus* returned each October and sat on its customary pole or tree-top perch (Oatley et al. 1998). We can confirm this with our results, because the bird tracked by us returned to winter for the second time in the same small place where it wintered the first time. The home range of only 3.8 km² is surprisingly small, and the tracked *vulpinus* had to be sufficiently saturated with food in such small area.

It is not surprising that the tracked *vulpinus* individual did not breed during the first summer period, i.e. at the age of one-year-old, and behaved like a floater, because only few Common Buzzards breed before the age of three (Ferguson-Lees & Christie 2001). The tracked *vulpinus* individual returned to its natal area, but stayed in the area of eastern Ukraine for only about one month and then flew to the adjacent area of southwestern Russia, where it stayed for more than three months until the start of autumn migration on October 3, 2022. In eastern Ukraine, at that time, war conflict with intense combat activities was in contrast to the peaceful situation in the adjacent region of Russia, because on February 24th, 2022, the Russian Federation invaded Ukraine, with targeted attacks on Kyiv and the eastern regions (Guterres 2022). This different situation could have been the cause of the abandonment of the summering area in eastern Ukraine and the use of the summering area in the adjacent part of Russia.

Different behaviour in raptors caused by this war conflict years has been shown recently in Great Spotted Eagles *Clanga clanga* (Russel et al. 2024). Migrating eagles exposed to conflict events along their migration through Ukraine delayed their arrival to the breeding grounds and likely increased the energy cost of migration.

In conclusion, further telemetry research will be desired to reveal more details of individual movement patterns of *vulpinus* Buzzards from different areas of their range.

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REFERENCES

- Alerstam T. 1990. Bird migration. Cambridge University Press, Cambridge.
- Ferguson-Lees J., Christie D. A. 2001. Raptors of the World. Christopher Helm, London.
- Forsman D. 2015. The Raptors of Europe and the Middle East. A handbook of field identification. Christopher Helm, London.
- Guterres A. 2022. Statement by the Secretary-General – on Ukraine. 24 February 2022. Available at: <https://www.un.org/sg/en/content/sg/statement/2022-02-24/statement-the-secretary-general-ukraine> (accessed on 27 May 2024).
- Herremans M. 2001. Age-related differences in abundance and habitat occupation of Steppe Buzzards, *Buteo buteo vulpinus*, in the Western Cape Province. Ostrich 72: 105–108.
- Hilgerloh G. 2009. The desert at Zait Bay, Egypt: a bird migration bottleneck of global importance. Bird Conserv. Int. 19: 338–352.
- Jobson B., Allinson T., Sheldon R., Vanstelaant W., Buechley E., Oppel S., Jones V. R. 2021. Monitoring of migratory soaring birds in the East African-Eurasian flyway: a review and recommendation for future steps. Sandgrouse 43: 2–23.
- Kasperek M. 1997. On the migration of raptors through Yemen. Zool. Middle East 15: 29–31.
- Literák I., Balla M., Vyhnaľ S., Škrábal J., Peške L., Chrašč P., Systad G. 2020. Natal dispersal of black kites from Slovakia. Biologia 75: 591–598.
- Literák I., Raab R., Škrábal J., Vyhnaľ S., Dostál M., Matušík H., Makoň K., Maderič B., Spakovszky P. 2022. Dispersal and philopatry in Central European Red Kites *Milvus milvus* J. Ornithol. 163: 469–479.
- McCarthy E. M. 2006. Handbook of avian hybrid of the World. Oxford University Press, Oxford, New York.
- Megalli M., Hilgerloh G. 2013. The soaring bird spring migration bottleneck at Ayn Sokhna, northern gulf of Suez, Egypt. Sandgrouse 35: 25–35.
- Nakahara T., Nagai K., Iseki F., Yoshioka T., Nakayama F., Yamaguchi N. M. 2022. GPS tracking of the two subspecies of the Eastern Buzzard (*Buteo japonicus*) revealed a migratory divide along the Sea of Japan. Ibis 164: 1192–1200.
- Nyirenda V. R., Yambayamba A. M., Chisha-Kasumu E. 2020. Influences of seasons and dietary composition on diurnal raptor habitat use in Chembe Bird Sanctuary, Zambia: Implications for conservation. Afr. J. Ecol. 58: 719–732.
- Oatley T. B., Oschadleus H. D., Navarro R. A., Underhill L. G. 1998. Review of ring recoveries of birds of prey in Southern Africa: 1948–1998. Endangered Wildlife Trust, Johannesburg.
- Russell C. J. G., Franco A. M. A., Atkinson P. W., Väli Ü., Ashton-Butt A. 2024. Active European warzone impacts raptor migration. Curr. Biol. 34: 2272–2277.
- Shirihai H., Yosef R., Alon D., Kirwan G. M., Spaar R. 2000. Raptor migration in Israel and the Middle East: A summary of 30 years of field research. Tech. Publ. Int. Birding & Res. Centre in Eilat, Israel.
- Stanciu C.-R., Zaharia R., Chişamera G.-B., Cobzaru I., Gavril V.-D., Popescu-Mirceni R.-V., Murariu D. 2017. Aspects regarding raptors migration over the Black Sea. Trav. du Mus. Natl. Hist. Nat. Grigore Antipa 60: 517–536.
- Stevenson T., Fanshawe J. 2015. Birds of East Africa. Christopher Helm, London.
- Strandberg R., Alerstam T., Hake M., Kjellén N. 2009. Short-distance migration of the common buzzard *Buteo buteo* recorded by satellite tracking. Ibis 151: 200–206.
- Thie N., Corl A., Turjeman S., Efrat R., Kamath P. L., Getz W. M., Bowie R. C. K., Nathan R. 2022. Linking migration and microbiota at a major stopover site in a long-distance avian migrant. Mov. Ecol. 10: 46.
- Thiollay J. M. 1994. Family Accipitridae (Hawks and Eagles). In: del Hoyo J., Elliot A., Sargatal J. (eds). Handbook of the birds of the World. Vol. 2. New World Vultures to Guineafowl. Lynx Edicions, Barcelona, pp. 52–205.
- Väli Ü. 2017. Home range size and breeding dispersal of a common buzzard (*Buteo buteo*). Slovak Raptor J. 11: 111–116.
- Väli Ü., Mirski P. 2021. Eurasian buzzard *Buteo buteo*. In: Panuccio M., Mellone U., Agostini N. (eds). Migration strategies of birds of prey in Western Palearctic. CRC Press, Boca Raton, Florida, pp. 188–199.
- Väli Ü., Vainu O. 2015. Short-distance migration of Estonian Common Buzzards *Buteo buteo*. Ring. Migr. 30: 81–83.
- Verhelst B., Jansen J., Vansteelant W. 2011. South West Georgia: an important bottleneck for raptor migration during autumn. Ardea 99: 137–146.
- Viter S. G. 2018. Characteristics of birds of prey migration in the Kharkov Region, Ukraine. Raptor Conserv. 36: 73–107.
- Vysochyn M. O. 2020. [Diurnal birds of prey (Falconiformes) of the Donetsk Ridge: Features of the biotopic distribution and population dynamics in the anthropogenic load gradient]. PhD. Thesis, V. N. Karazin Kharkiv National University, Kharkiv.
- Welch G., Welch H. 1988. The autumn migration of raptors and other soaring birds across the Bab-al-Mandab Strait. Sandgrouse 10: 26–150.
- Welch G., Welch H. 1998. Raptor migration Bab el Mandab, Yemen — spring 1998. Phoenix 15: 11–12.
- Yosef R., Tryjanowski P., Bildstein K. 2002. Spring migration of adult and immature Buzzards (*Buteo buteo*) through Eilat, Israel: Timing and body size. J. Raptor Res. 36: 115–120.

STRESZCZENIE

[Przemieszczenia i wędrówki osobnika myszółowa wschodniego na podstawie telemetrii satelitarnej]

Myszółów zwyczajny jest ptakiem szponiastym szeroko rozpowszechnionym w Palearktyce. Populacje gniazdujące w zachodniej i centralnej Europie są osiadłe lub częściowe wędrówne.

Natomiast populacje ze wschodu Europy (m.in. z Finlandii, Rosji i Ukrainy) z podgatunku *Buteo buteo vulpinus* zwanego myszołowem wschodnim są migrujące i zimują we wschodniej i południowej Afryce. Brakuje jednakże dokładnych danych dotyczących okresu i szlaków wędrówek, prędkości przelotu czy przemieszczeń na zimowiskach.

Pisklę myszołowa wschodniego z gniazda w obwodzie donieckim na wschodzie Ukrainy zostało wyposażone w nadajnik satelitarny (w ramach planowanego większego projektu, który został przerwany w związku z działaniami wojennymi) w sezonie lęgowym 2021 (Apendyks 1). Przemieszczenia ptaka — rejestrowano pozycję GPS ptaka co godzinę — były monitorowane do końca 2022 roku. W pracy scharakteryzowano obszar, po którym ptak przemieszczał się po opuszczeniu gniazda i przed podjęciem wędrówek, opisano okres wędrówki i szlaki przelotu podczas dwóch migracji jesiennych i jednej wiosennej oraz przemieszczenia na zimowisku, oraz po powrocie z zimowisk. Opisano także prędkość przelotu oraz liczbę i długość trwania przystanków podczas wędrówki (Tab. 1).

Po wylocie z gniazda ptak początkowo nie oddalał się od niego dalej niż na odległość 3,3 km, następnie przed podjęciem pierwszej wędrówki przemieszczał się na wschód i zachód od gniazda

(Fig. 1, 2A). Podczas pierwszej i drugiej jesiennych migracji (trwającej odpowiednio 71 i 48 dni) ptak kierował się na południe, wzdłuż wschodniego wybrzeża Morza Czarnego i Śródziemnego, przez Półwysep Arabski wzdłuż wschodniego wybrzeża Morza Czerwonego z przelotem do Afryki na wysokości cieśniny Bab-al-Madab i dalej na południowy wschód Afryki (Fig. 1). Myszołów zimował w Zambii, za każdym razem przylatując w tę samą, relatywnie niewielką okolicę, podejmując tylko niewielkie przemieszczenia w okresie zimy (Fig. 2). Podczas wiosennej migracji trwającej 76 dni ptak przemieszczał się w kierunku północno-wschodnim wzdłuż zachodniego wybrzeża Morza Czerwonego, opuścił Afrykę po przekroczeniu Przesmyku Sueskiego i powrócił na wschodnią Ukrainę przez wschodnie wybrzeża Morza Śródziemnego i Czarnego (Fig. 1). W okresie letnim w 2022 r. ptak przemieszczał się po wschodniej Ukrainie, a następnie przeniósł się na południowo-zachodnią Rosję, prawdopodobnie w wyniku wydarzeń wojennych na wschodzie Ukrainy.

Obserwacje potwierdziły występowanie wędrówki pętlowej u myszołowa wschodniego. Zaobserwowane prędkości przelotu myszołowa wschodniego podczas wędrówki jesiennych były znacznie wyższe niż stwierdzone dla myszołowa zwyczajnego.

Appendix 1. Nestling *Buteo buteo vulpinus* tagged near Kramatorsk, Ukraine in 2021 during deploying a telemetry transmitter. Photo by Radek Zeman.

