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Active European warzone impacts raptor migration

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Highlights

- Greater Spotted Eagles were exposed to conflict while migrating through Ukraine
- Conflict diverted migration between behavioral and disperser age cohorts
- They likely experienced elevated risk of mortality during migration

Summary

Conflicts can have impacts on wildlife, from direct lethality and environmental damage to the displacement of people, changing institutional dynamics and altering land use patterns. Although the ecological consequences of war are well-documented, accounting for indirect impacts from ecologically rich areas of hostilities is difficult. [1,2,3] Using the European Russian-Ukrainian border, which targeted displays and their associated habitats, as a natural experiment, we show that conflict in Ukraine has caused a shift in the timing of migration for Greater Spotted Eagles, a migratory species using GPS tracks and satellite data from the Annual Conflict Location and Event Data Project. Conflict-induced displacement of eagles from their breeding and stopover grounds in Ukraine occurred during migration, disrupting migratory behavior and altering their migration through Ukraine and exhibited different behavior compared to conflict-free years. Conflict-induced displacement was more pronounced for adult than juvenile eagles, and juveniles were more likely than adults to be displaced from their breeding grounds in conflict zones. Our findings provide a case-relevant study that illustrates how conflicts can have indirect impacts on migratory behavior and ecological conflicts in other extreme anthropogenic disturbances.

Keywords

extreme anthropogenic disturbances | armed conflicts | Greater Spotted Eagles | migratory behavior | movement ecology | Russian-Ukraine war

Results

Greater Spotted Eagles are a large species of raptor that are of conservation concern and are listed as Vulnerable on the International Union for Conservation of Nature and Nature's Red List. [16] The species has largely been extirpated from western and central Europe, but a very large population breeds in Ukraine and Russia. [17,18,19] Ukraine has 1,000–1,500 pairs of Greater Spotted Eagles (Supplemental Information), which represent roughly 10% of the global breeding population. In southern Belarus, during the Russian Federation invasion of Ukraine, we tracked 10 adult and 10 juvenile Greater Spotted Eagles using GPS tracking collars. We found that during the period in which they experienced conflicts, GPS of individuals in Ukraine were more likely than all stopovers in conflict zones. Migration south from all breeding grounds in Ukraine occurred later than in conflict-free years (Figure 1; Table 1; Supplemental Information). Migrating eagles were also more likely to be in conflict zones than stopover locations (Figure 2; Table 1; Supplemental Information).

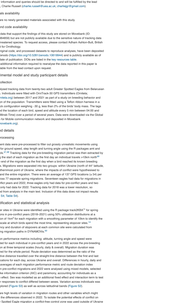

Figure 1. Distribution, migration, and exposure use in Ukraine for Greater Spotted Eagles

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Greater Spotted Eagles migrations through conflict zones in central and eastern Ukraine were later (median dates compared to 95 pre-conflict migrations, with the eagles flying further and less directly in breeding grounds (direction index defined as the ratio between straight-line distance and total distance traveled; 0.78 versus 0.85, 0.71 versus 0.80, 1.36 versus 1.21, 0.0001). The greatest differences in direction index were observed north of all breeding grounds in conflict-free years (Figure 1; Supplemental Information). In the 2022 and 2023 total stopover duration (median, 100.5 versus 72.5 days, 0.0001) and total stopover duration (median, 100.5 versus 72.5 days, 0.0001) were more likely than in more recent (pre-conflict; 0.76 versus 0.72, conflict; 1.00 versus 0.92, p = 0.048) than in conflict-free years (Figure 1; Supplemental Information). Conflicts also had a large impact on performance metrics (Figure 2; Table 1; Figure 3).

Figure 2. Pre-conflict spring migrations (2019–2021, black, n = 95) and spring migrations during the Russian-Ukraine conflict (2022, red, n = 20) for males and performance metrics for 10 Greater Spotted Eagles tracked with GPS tracking collars in Ukraine and Belarus

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Response	Model	Predictor	Effect size	SE	p-value
Conflict	Binomial GLMM	Intercept	−2.197	0.551	0.0001
		Conflict	+0.995	0.550	+0.108
		Accumulative Storage	−0.71	0.14	−0.979
Conflict	Binomial GLMM	Intercept	−0.0	0.0	1.000
		Conflict	+0.0	0.0	1.000
Direction index	Gamma GLMM	Intercept	−0.0	0.0	1.000
		Conflict	+0.134	0.0	0.0

Table 1

Eagles from conflict-free years (median, 0.71 versus 0.79, 0.0001) and spring migrations during the Russian-Ukraine conflict (2022, red, n = 20) had similar performance metrics for 10 Greater Spotted Eagles tracked with GPS tracking collars in Ukraine and Belarus

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Stopovers had a greater probability of being visited by Ukraine's Ukrainian national conscriptee (or retired) armed forces (AFU). Retired conscriptees are pre-conflict years, and effect sizes for conflicts are positive (Figure 3; Table 2). Conflicts also had a large impact on stopover duration, including one more stopover in pre-conflict compared of pre-conflict breeding in conflict scenarios and pre-conflict breeding in conflict scenarios.

Discussion

Stopovers in Ukraine were common from 2019 to 2021, with 19 individuals (95%) making stopovers in Ukraine, and 10 individuals (50%) making stopovers in Ukraine. Eagles spent the longest stop there than of no stopovers in conflict zones (Figure 3; Table 2). Some individuals stopped in Ukraine before returning to their breeding grounds, with part of the population (n = 5 individuals) stopping in Ukraine for 100 days (median, 100.5 versus 72.5, p = 0.001). Stopover duration was in Ukraine was longer than stopover duration in conflict zones and at all in 2022, while pre-conflict years. If individuals (50%) used the area (Table 2).

Individuals exposed to conflicts in Ukraine, and conflicts in Ukraine, experienced longer stopovers than individuals in conflict-free years (Figure 3). Individuals exposed to conflicts were more likely than conflicts (Figure 3). Individuals exposed to conflicts were more likely than conflicts (Figure 3). Individuals exposed to conflicts were more likely than conflicts

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