Ecology, physiology and behaviour

Variation in early life movements, protected areas and habitat use in juvenile Montagu's harriers (*Circus pygargus*) from central Italy

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Assessing individual differences and variability in movement patterns is essential to improve our understanding of the evolution and ontogeny of migratory strategies. In long-distance migratory species, fledged juveniles are extremely time-constrained in learning the essential skills for survival and preparing for migration, thus immediately facing a risky phase of their lives. Here we used high-resolution GPS/GSM transmitters fitted to juvenile Montagu's harriers (*Circus pygargus*) from central Italy to collect information on their movement ecology during early life stages, namely the post-fledging dependence period (PFDP) and the pre-migratory phase (PMP), until autumn migration. We were interested in investigating the spatiotemporal variation in home range, movement patterns, and habitat use during different stages of this period.

After fledging, individuals showed high variability, in both space and time, in home range size, daily distances covered, distance to nest and PFDP length. Residence time at the natal site significantly decreased, while the time interval between revisits in the natal area significantly increased as the PFDP progressed. During the PMP, explored areas and distance to nest (up to 320.8 km) varied among individuals, despite daily distances covered (27 ± 40 km/day) and time allocation between traveling (60.7%) and foraging (39.3%) were similar across individuals. The PMP lasted 38 ± 14 days. Land cover composition of foraging locations was mostly represented by agricultural lands (~78.2%), though habitat use differed among individuals. More than 76% of such locations were located outside protected areas. Our novel individual-based tracking study improves previous knowledge based on field studies on the early life stages of the Montagu's harrier. High interindividual variability in movement patterns, broad-range exploratory movements and foraging locations "off-the-radar" of the protected area network make the application of standard conservation measures difficult, raising concerns about the long-term preservation of this vulnerable migratory species in Italy.