

Common vole biological control in agricultural ecosystems of Castilla-y-León (Spain): reproductive productivity of raptors in artificial nest-boxes in relation to abundance fluctuations of the pest species

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The common vole (*Microtus arvalis* Pallas) is an arvicoline rodent whose distribution in Spain was limited to the mountain systems into the Iberian Peninsula northern half. From the 1970s onwards, a fast and progressive colonisation of this species took place towards the Duero river basin, until common vole became to be present in the whole of the Northern Plateau. This area in Castilla-y-León region, has large tracts of cereal steppe (>3 million hectares of arable land), where periodic common vole population outbreaks occurs causing important damages to crops. Biological control by promoting its natural predators is one of the types of action contemplated within the integrated management strategy for this species in Castilla y León. Biological control is considered an interesting ecologically-based rodent pest management (EBRM) tool, that seeks to reduce the impact of the common vole in an accessible and sustainable way through the knowledge of its ecology and that of its predators. In this study, more specifically, we propose the promotion of native raptors highly specialized in the capture of rodents, through an environmental enrichment based on the placement of nest boxes, which serve as a substrate for shelter, nesting and reproduction of these birds in agricultural areas with high risk of recurrent vole outbreaks. The results presented here correspond to five years monitoring experiences (2018-2022) in experimental areas (more than 600 nest boxes distributed in 8 municipalities) located in one of the most severely affected agricultural counties of Castilla y León. The installed nest boxes were specifically designed for occupancy by the common kestrel (*Falco tinnunculus*), barn owl (*Tyto alba*) and, to a lesser extent, little owl (*Athene noctua*). Nest boxes have been yearly monitored during the raptors breeding season, recording their occupancy by these species, breeding pairs, clutch size and number of hatched chicks. In parallel, the abundance of common vole in the study areas was monitored, in order to establish the relationship between raptors reproductive productivity and common vole population fluctuations. The obtained results point to an adjustment of the birds of prey reproductive capacity in the nest boxes in response to the availability of voles in the environment. Beyond the density of adult barn owls and kestrels and number of breeding pairs in the study areas, these variations are manifested in the size of their clutches and chicks hatched throughout the different years, although other factors not already considered in our study may also have some influence. The variations observed in these parameters are consistent with the hypothesis of a greater predatory pressure when the common vole increases its population size, both due to the number of raptors present and the effort required by each pair to raise their broods. Although further studies are needed to clarify all this, environmental enrichment by providing artificial nest boxes for rodent specialized raptors would contribute to reestablishing the prey-predator balance in agricultural areas with risk of common vole incidence.