Agriculture, Ecosystems and Environment 249 (2017) 123–129

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

Bat activity in rice paddies: Organic and conventional farms compared to unmanaged habitat

Roberto Toffoli*, Marco Rughetti

CHIROSPHERA Associazione per lo studio e la tutela dei chirotteri e l'ambiente, Via Tetti Barbiere 11, I 10026 Santena TO, Italy

ARTICLE INFO

Keywords:
Bats
Rice field
Organic farm
Conventional farm
Wetland
Northern Italy

ABSTRACT

Many bat species in Europe have suffered severe population declines during the 20th century, and the main drivers of this decline is likely the loss of foraging habitats at local and landscape levels due to farmland intensification, which also poses a serious threat to biodiversity and affects species interactions and ecosystem functions. Several studies reported positive effects of organic compared to conventional farming on bat populations and on nocturnal insect prey abundance.

We registered the flight and feeding activity of 12 bat species in rice paddies in Northwestern Italy to test the effect of wetland farm management and agricultural intensification on bats habitat use. Our study evaluated the different ecological roles of organic *vs* conventional rice farms and natural wetlands in conservation of bat species.

For the 12 species under study, flying activity was recorded in all three land management types. Only the genus *Pipistrellus* hunted in conventional and organic farms. *Myotis* sp, *Eptesicus serotinus* and *Hypsugo savii* were recorded hunting only in natural wetlands. *Rinolophus ferrumequinum* was detected only in natural wetlands. Bats fed in organic farms as well as in natural wetlands, whereas they were unlikely to forage in conventional farms. Conventional rice paddies do not provide ideal foraging sites for bats, likely due to the widespread use of pesticides, water management, and intensive weed control on embankments. Organic rice paddies, due to the less aggressive management, appear to have a higher habitat quality compared to conventional ones, and are therefore more suitable for feeding activities, possibly due to the greater availability of prey. Furthermore, while the limited ecological value of conventional farms for bat conservation is confirmed in this research for rice paddies, further effort should be made to preserve natural wetlands. We argued that farmland practices that maximise organic farming and ensure the conservation of natural wetlands, in accordance with the recent reform of the Common Agricultural Policy, are essential for bat conservation in agricultural environments and, more generally, to preserve biodiversity.

1. Introduction

Farmland biodiversity in Europe has been declining for decades, with a particularly steep trend occurring in the second half of the twentieth century (Stoate et al., 2001). There is extensive evidence that agricultural intensification is responsible for this decline. For example, countries with higher wheat yields have more threatened or recently extinct arable weed species (Storkey et al., 2012), plant species richness is negatively correlated to nitrogen input at a country-level scale (Kleijn et al., 2009), and large declines and range contractions have been reported for bird populations in countries with the highest cereal production (Donald et al., 2001, 2006).

Many bat species in Europe have suffered severe population depletions during the 20th century (Hutson et al., 2001), and the main drive of this decline was likely the loss of foraging habitat because of agricultural intensification (Walsh and Harris, 1996). Avoidance of intensively managed agricultural land by foraging bats has been noted in previous studies (Wickramasinghe et al., 2003); it has been suggested that agricultural intensification may be the main proximate cause for declines in insect prey abundance, that in an ultimate analysis may have negatively affected bat population growth rates (Stebbings, 1988; Wickramasinghe et al., 2004). In conventional farms, cultural practices often include the use of fertilizers and pesticides to maintain high agricultural productivity (Wilson et al., 2009), and that may negatively affect insect diversity and, as a consequence, decrease hunting opportunities for bats. The elimination of shrubs and herbaceous vegetation from field edges reduces the populations of many arthropods and modifies the structure of their communities (Cardarelli and Bogliani,

* Corresponding author.
E-mail addresses: rtoffoli@iol.it (R. Toffoli), marco_rughetti@libero.it (M. Rughetti).

http://dx.doi.org/10.1016/j.agee.2017.08.022
Received 13 April 2017; Received in revised form 6 August 2017; Accepted 16 August 2017

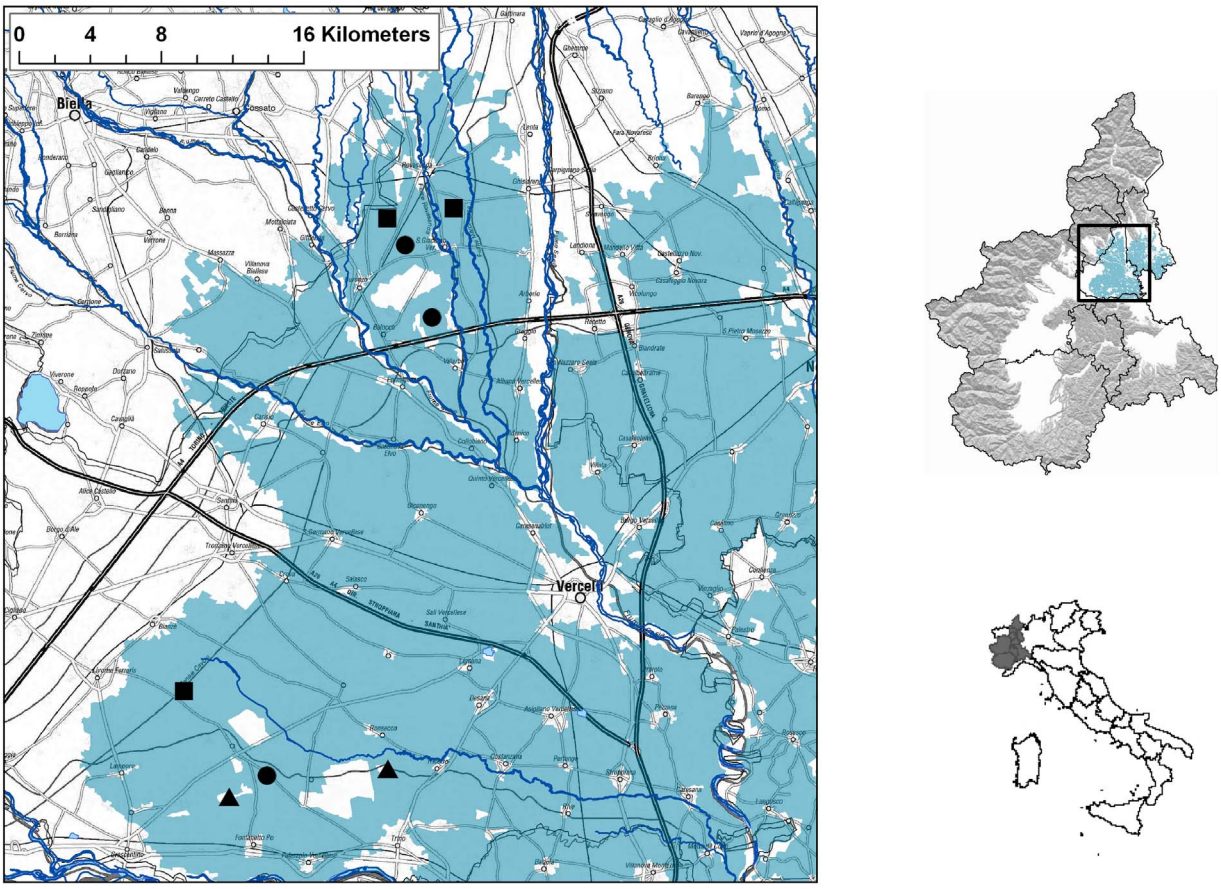

Fig. 1. Map of the area of study and surface of rice paddies (about 68,000 ha).
■ Organic rice farms, ● conventional rice farms, ▲ natural wetlands.

2014). To reduce the negative impact of conventional farms on biodiversity the reform of the Common Agricultural Policy (Hine et al., 2016) introduced several years of agri-environmental measures, including financial incentives for organic farming (Zanten et al., 2014), where the use of chemical inputs, such as synthetic fertilizers and pesticides is largely restricted. Several studies reported positive effects of organic farming on bat populations and the abundance of nocturnal insects on which they feed (Lesiński et al., 2013; Wickramasinghe et al., 2003, 2004). However in some cases the results are contradictory and no significant difference in bat foraging activity or in insect prey abundance between organic and conventional farms was observed (Davy et al., 2007; Pocock and Jennings, 2008).

Recent literature reported a tendency for organic farms to have higher species richness and a higher abundance of plants, invertebrates, birds (Bengtsson et al., 2005; Tuck et al., 2014) and bats (Lesiński et al., 2013; Wickramasinghe et al., 2003) compared to conventional crops. However, very few studies compared bat activity in conventional and organic cultivations using natural habitat as a reference (Davy et al., 2007).

Rice fields are temporary aquatic ecosystems, with periods of flooding during summer and drying during winter. This crop represent about 15% of the world's wetlands today (Lawler, 2001) and provides a critical habitat for the conservation of aquatic birds in many countries, such as southern Europe (Fasola and Ruíz, 1996). These artificial wetland ecosystems are highly dynamic; their physical and chemical parameters and water levels change very quickly, and their biological communities develop rapidly (Ferrari et al., 1984; Rossi et al., 1974). Natural wetland habitats are especially suitable for foraging bats (Flaquer et al., 2009; Russo and Jones, 2003; Salvarina, 2016; Wickramasinghe et al., 2003), likely because of the high insect densities (Vaughan et al., 1997), whereas in rice paddies, bats may play a fundamental role in pest control service (Puig-Montserrat et al., 2015). Therefore it is critical to evaluate the best-practices and practical management recommendations for promoting the conservation of bat species richness and population abundance in natural and artificial wetlands. However, the effects of intensifying rice paddies on bat communities are currently unknown, as well as the difference in bat activity between human managed and natural wetlands.

Here, we used data on flight and feeding activity in rice paddies in Northwestern Italy to test the effect of wetland farm management and agricultural intensification on bat habitat use using natural wetlands as a reference. Our study aims to evaluate the different roles of organic and conventional rice farms and natural wetlands in the conservation of bat species. Specifically, we investigated the predictions of two hypotheses: (1) organic rice fields provide a suitable substitute for foraging habitat for bats that typically forage in natural wetlands, and therefore we expect bat flying and feeding activity to be similar in organically managed farms and natural wetlands, (2) organically managed rice farms are better foraging sites than conventional rice paddies, and therefore we expected bat activity to be higher in organic compared to conventional farms.

2. Materials and methods

2.1. Study area

The research was conducted in a lowland area near Vercelli (45°18′N, 8°13′E; Piedmont, NW Italy). The landscape is uniform and dominated by large extension of rice paddies, which represent the dominant crop of about 68,000 ha (Ente Nazionale Risi, 2016). The