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How to sustain meadow passerine populations in Europe through alternative mowing management

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ABSTRACT

Two decades of agri-environmental policy did not prevent a long term decline of grassland birds in Europe. Additional measures are therefore needed to sustain the populations. This study explored alternative mowing management regimes likely to secure demographic sources in the early mown grassland systems of western Europe, and to limit habitat loss after farming abandonment in countries of the former Eastern Bloc. Postponing grass cutting until after mid-July from 2009 to 2014 in half of the area of 4 study sites (29–55 ha each) in the Saône Valley (France), led to increased territory density and improved hatching success. Bird response however was species-specific: Corn Bunting *Emberiza calandra* territory density benefited the most from the alternative management, Yellow Wagtail *Motacilla flava* territory distribution tended to match the late mown areas, whereas the Whinchat *Saxicola rubetra* did not change its initial distribution. Temporary interruption of mowing in 8 meadow units (11.7–15.1 ha) of the Moskva Valley (Central Russia) was similarly correlated with higher territory density. Whinchat territory density decreased after one single year of mowing. After two consecutive years of mowing, Whinchat hatching success was lower and the Lesser Citrine Wagtail *Motacilla citreola werae* virtually disappeared. The tested alternative mowing regimes may therefore locally increase population density without negative density dependent effects on hatching rates. Implementing rotational mowing could reduce habitat loss caused by farming abandonment in Russia. Postponing mowing until after mid-July in patches of hay fields may sustain meadow bird demography in the remaining strongholds of western Europe.

1. Introduction

Growing evidence suggests that we may be witnessing an unprecedented decline in farmland birds in Europe (Voříšek et al., 2010). To date, agri-environment schemes (AES), which are the main available mechanism likely to mitigate the negative effects of farming practices over large areas (Vickery et al., 2004), have not succeeded in halting the on-going, large-scale negative trends in farmland bird populations (Breeuwer et al., 2009; Davey et al., 2010; Princé et al., 2012). AES principles could be improved to better offset the detrimental consequences of modern agriculture on biodiversity. It can be predicted however that some practices such as early mowing will be extremely difficult to reverse for achieving conservation objectives in intensively managed grassland systems. This major condition for the successful reproduction of meadow birds is most often hampered by farmers' reluctance to adopt a mowing chronology in accordance with breeding cycles, even with economic compensation (Horch and Spaar, 2007). Obviously, the problem already existed before agriculture intensification. Brehm (1868) reported that the number of Corncrakes *Crex crex* killed by mowers was higher than the number of those killed by hunters. In France in 1789, royal edicts forbade mowing before a certain period to preserve game birds (Young, 1792). Nowadays, reproductive outputs of meadow birds in Europe seem to be usually too low to compensate for adult mortality (Green, 1996; Roodbergen et al., 2012). The challenge therefore is to preserve demographic sources. Grassland management subsidies should focus on areas with less intensive management that aim at attracting high densities of grassland birds with a high reproductive success. The hatching success of meadow passerines is however likely to be density dependent (Broyer, 2009, 2011) and therefore investigations of reproductive success are needed in areas with increased bird density due to management changes.

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Such "ecological intensification" may be sought through late enough mowing or through intermittent (not every year) hay harvesting, likely not only to prevent the risk of bird mortality by mowers, but also to boost arthropod-prey abundance (Erhardt, 1985; Cattin et al., 2003; Baur et al., 2006; Marini et al., 2009; Buri et al., 2013), thereby enhancing carrying capacity for birds in grassland habitats.

Throughout Europe, a sharp contrast exists between western countries and the members of the former Eastern Bloc (Orlowski 2005; Wretenberg et al., 2007). In Russia, where a considerable proportion of European populations of certain meadow bird species breed, key-sites may be threatened by farming abandonment as a result of a long-lasting agricultural crisis (Mischenko and Sukhanova, 2006). Rotational mowing (i.e. mowing every second-fourth year) could be a possible adaptation to prevent forest encroachment in large, otherwise unmanaged, grassland places. Intermittent mowing then could help reduce habitat loss caused by farm abandonment. In Western Europe, the prevailing issue is early hay harvesting and nest or juvenile destruction by mowers. Usually, mowing postponement through AES programmes shortly after fledging time only aims at decreasing mortality during the harvesting period. But the obtained increase in population density may theoretically lead to higher competition between neighboring pairs, with negative consequences on nesting success (Broyer, 2011). However, in a previous work in late mown French grasslands, we observed high hatching success, similar to that recorded in extensively managed grasslands in Russia, whereas passerine territory density was high (Broyer et al., 2014). This study describes the variation in meadow passerine density and hatching rate after implementation of alternative mowing management in controlled experiments: either grass cutting postponement until after 15 July in the Saône Valley (eastern France), or temporary interruption of mowing in the Moskva Valley (Central Russia). So far, efforts to counteract the negative effects of agriculture intensification (including earlier mowing of meadows) have mainly been restricted to Western Europe, while the large grassland areas in Eastern Europe (Russia in particular) have largely been neglected. The high rate of natal dispersal in some meadow birds in Russia (Shitikov et al., 2011, 2013) suggests that long distance dispersal between countries might be important for maintaining European populations of meadow birds. The scale of this natal dispersal is however largely unknown.

The hypotheses tested here were that late enough mowing (in Western Europe) and a temporary interruption of hay harvesting (in Russia) may enable to increase passerine territory density without hampering hatching success. We focused here on hatching success for investigating the existence of possible density dependent effects because: 1) food shortage in the pre-breeding or laying period can result in a lower proportion of pairs attempting to breed (Enoksson and Nilsson, 1983; Rodenhouse and Holmes, 1992; Murphy et al., 1991; Tobias, 1997; Elmegaard et al., 1999), 2) food shortage may also cause low hatching success (Martin, 1987; Hatch and Hatch, 1990; Hamer et al., 1993; Schreiber and Kissling, 2005), 3) we observed in the Saône Valley a trade-off between territory density and hatching success after AES implementation (Broyer, 2011). We expected in this experiment that hatching success will not be negatively influenced by higher territory density.

2. Method

2.1. Study areas

The study was carried out in two flood plains, the Saône Valley in eastern France (46°18′ N 04°49′ E) and the Vinogradovo plain near the Moskva river in Central Russia (55°08′ N 38°45′E).

The consequences of late mowing on meadow passerine breeding were observed in 4 study sites (29, 40, 49 and 55 ha) of the Saône Valley, in which hay harvesting was experimentally postponed to the end of July (after 15 July) in half of their total surface area (50% delayed and 50% normal in each study site), and in 2 control sites (116 and 76 ha) without mowing delay (mowing period: 20 May–20 June and 10 June–5 July, respectively). The spatial patterning of delayed and normal mowing (i.e. in June) was in single blocks, not in interspersed patches. The effects of a temporary interruption of grass cutting were studied in 8 replicates (between 11.7 and 15.1 ha each) in the Vinogradovo flood plain. The size of these experimental units was defined after the results of a preliminary survey in 2006 in different flooded plains of the Vladimir and the Ryazan regions, indicating that passerine density was >11 territories per 10 hectares on average. We therefore considered that surface areas >10 ha for each replicate was sufficient in such habitat conditions. Each study site in both countries was made up of hay meadows only. At the level of each valley, similar conditions in all replicates, experimental and control grasslands: dominant flora, management prior to the experiments, surrounding landscape with open hay-meadows (for details, see Broyer et al., 2014), enabled us to avoid confounding effects.

In the Saône Valley, the study was carried out from 2009 to 2014. Mowing was postponed each year from July 2009. Bird breeding in 2009 was considered as the reference before the experiment. We accepted the risk of relying on a single survey in 2009 to derive baseline data as the reference point before the start of the experiment as the weather conditions were normal (neither drought nor spring flood). After mowing manipulation however, the breeding conditions of meadow birds were affected by a severe drought during the spring 2011, and by heavy rainfall and late flooding in 2013. The control areas however can determine the impacts of weather vs. management. In 2013 however, we decided to discard from the analysis two manipulated study sites which have been exceptionally flooded until the end of May.

In the Moskva Valley, the objective was to compare meadow bird breeding in the year following a presence or an absence of grass harvesting. Due to the travel distance to the study sites and the difficulty to negotiate alternative management in Russia, we could not apply identical sample sizes and survey methods in both experiments. The studied meadows were left unmown for several successive years until 2009. Each one was harvested in July 2010 and submitted to various management regimes thereafter:

Table 1
Comparison using AICc of GLMs explaining the variation in passerine territory density in 4 study sites with mowing postponement and in 2 control sites, with YEAR (2009 vs. 2010 + 2011 + 2012 + 2013 + 2014, i.e. before vs. after mowing delay), MANAG (presence vs. absence of alternative mowing management), PERCB, PERYW and PERWH (proportions of Corn Bunting *Emberiza calandra*, Yellow Wagtail *Motacilla flava* and Whinchat *Saxicola rubetra* territories) (Saône Valley, France, 2009–2014).

Models	*n*	*k*	AICc	ΔAICc	*w*
YEAR + MANAG + YEAR*MANAG + PERCB	36	5	183.15	0	0.76
YEAR + MANAG + YEAR*MANAG	36	4	187.06	3.91	0.11
YEAR + MANAG + YEAR*MANAG + PERYW	36	5	188.56	5.41	0.05
YEAR + MANAG	36	3	188.92	5.77	0.04
YEAR + MANAG + YEAR*MANAG + PERWH	36	5	189.63	6.48	0.03
MANAG	36	2	191.27	8.12	0.01
YEAR	36	2	210.23	27.08	0.00
(*)	36	1	210.47	27.32	0.00

	Estimate	St. Err.	*z*	*p*
Intercept	6.241	8.509	0.733	0.47
MANAG	4.138	5.607	0.738	0.47
YEAR	12.383	4.255	2.910	0.0069
YEAR*MANAG	−6.474	3.000	−2.158	0.039
PERCB	−19.552	7.829	−2.497	0.018