SHORT REPORT

The introduction of subsidies for grassland conservation in the Italian Alps coincided with population decline in a threatened grassland species, the Corncrake *Crex crex*

MATTIA BRAMBILLA* and PAOLO PEDRINI

Museo delle Scienze, Sezione Zoologia dei Vertebrati, Via Calepina 14, I-38122 Trento, Italy

*Correspondence**:**

Mattia Brambilla

Museo delle Scienze, Sezione Zoologia dei Vertebrati,

Via Calepina 14, I-38122 Trento, Italy.

E-mail: brambilla.mattia@gmail.com

Phone number: +390280616140; Fax number: +390280616180

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Capsule We analysed Corncrake population trends between 1997 and 2012 and evaluated changes before and after the introduction of subsidies for grassland conservation in 2000, which indirectly promoted unfavourable mowing practices over most grasslands in Trento province. According to both early and late season counts, the species has significantly declined in the study area since the early 2000s. Agri-environmental subsidies that are not adapted to the ecological requirements of the species may fail to achieve conservation objectives.

Agri-environmental schemes are likely to be the most important strategy to conserve biodiversity in farmed areas. Frequently they provide benefits to wild species (Davey *et al.* 2010b), but often the design of such schemes has not been based on their potential effects on biodiversity, which may result in only partial benefits, or even negative effects on many species (Kleijn & Sutherland 2003, Birrer *et al.* 2007, Davey *et al.* 2010a), including some of conservation concern (Kleijn *et al.* 2006). Agri-environmental schemes may not be sufficiently tuned to the ecological requirements of species (Kleijn *et al.* 2004), and often fail to enhance population trends (O'Brien & Wilson 2011, Princé *et al.* 2012). Reasons for lack of effects include a focus on small spatial scales, a lack of coordination among farmers at the landscape scale and restricted temporal scales (Siriwardena 2010).

In western Europe, permanent grassland represents one of the most biologically-rich agricultural habitats. Grasslands are vanishing in many areas because they have become financially less attractive; in particular, low-intensity farmed grassland is becoming increasingly rare (Ostermann 1998, Debussche *et al.* 1999, Donald *et al.* 2001, Vickery *et al.* 2001, Donald *et al.* 2002Romero-Calcerrada & Perry 2004, Brambilla *et al.* 2010, Nikolov 2010). To counteract the decline, subsidies for grassland maintenance have been made available to farmers in the Rural Development Programme of many European countries and regions. In many cases, subsidies just focus on maintaining grazing or mowing of grasslands, whereas they do not take into account the ecological needs of the species relying on grasslands and details on management at different temporal and spatial scales are lacking.

Here, we focus on the population trend of Corncrakes *Crex crex*, and on its relationship with the introduction of subsidies for grassland conservation in Trento province in the Italian Alps. The Corncrake is a threatened species tied to grasslands, and especially to tall swards and to low intensity management regimes (Berg & Gustafson 2007). We assessed the effect of a non-targeted subsidy for grassland conservation on the population of this priority species.

We separately considered early and late counts because within-season habitat and distribution (from low to high elevation) shifts (Brambilla & Rubolini 2009, Gilroy *et al.* 2010, Brambilla & Pedrini 2011, Brambilla *et al.* 2012), which can affect the estimation of population trends (Pedrini *et al.* 2012). We expected an almost immediate effect of changes in mowing practices introduced by subsidies on the population trend for late season data, and a weaker or delayed effect for early season data. This is because grassland mowing takes place in the middle of the breeding season, and so Corncrake abundance in the late season will be affected by changed mowing regimes in the first year, whereas effects on early season abundance will not be seen until at least the following year.

Trento province covers 6206 km^2 in the central-eastern part of northern Italy. Elevation ranges between 67 and 3769 m asl; 30% of the land is below 1000 m, and 50% between 1000 and 2000 m. The landscape is characterized by intensively cultivated and urbanized valley floors, mountainsides covered by woodlands interspersed with pastures, vineyards and secondary (anthropogenic) grasslands, and by alpine habitats at higher elevations (above 2000 m). Rainfall values range from 700 mm/year to 1500 mm/year (locally higher). Until some decades ago, grasslands were much more widespread, but underwent a drastic reduction (from 39 000 ha in 1982 to 29 000 ha in 2000; source: Trento province, Agriculture Department).

Subsidies for grassland conservation were introduced within the Rural Development Programme of the Trento province in 2000, and they were used to maintain 14 000 ha of grassland between 2000 and 2006; only 40 ha of grassland benefitted from agri-environmental schemes involving wildlife-friendly practices (low inputs, delayed mowing, unmown marginal strips) over the same period. In the subsequent Rural Development Programme (2007-2013), the subsidies continued to be the most adopted action in the province (over more than 20 000 ha), whereas the newly introduced measures for Corncrake conservation (delayed mowing and conservation of unmanaged patches) were applied only to 39 ha (Anon. 2010).

Within the province, we identified six study areas (including all main occurrence sites for Corncrakes; Tesino, 479 ha, average elevation 975 m asl; Alta Val di Non, 807 ha, 975 m; Val di Gresta, 356 ha, 1 175 m; Folgaria, 520 ha, 1 175 m; Andalo, 203 ha, 957 m; Vezzena, 114 ha, 1 401 m), all subjected to mowing promoted by the subsidies, although specific data on the extent of the mowing are not known. Each study area was divided into sectors that were simultaneously censused by different teams of observers. Calling males were counted by means of crepuscular/nocturnal surveys (22:30-03:00) in the six areas during 1997-2012, listening to spontaneous vocalizations every c. 300 m, and using playback (i.e. broadcast calls of males) if no male was singing (one minute of playback, three minutes of listening, repeated twice). The number of calling males is used as a population estimate for this (Schäffer 1995, Tyler & Green 1996, Schipper *et al.* 2011) and other elusive species (Poulin *et al.* 2005, Longoni *et al.* 2011). All areas were visited once in May-early June, before mowing (which in the study areas takes place around the 15th June, with inter-annual variations), and once in late June-July, after mowing. We avoided rainy and windy days. Field tests at the beginning of the research revealed how the number of males counted in consecutive field sessions before mowing was fairly constant, suggesting high vocal activity and detection rate (P. Pedrini *et al.*, unpublished data), as found for other rallids (Brambilla & Jenkins 2009); previous analyses revealed weak effects of census date within the survey period (Brambilla & Pedrini 2011). Not all the areas were visited each year; out of 84 cases, early count data were available for 73 areas/years, and late count data for 60.

We used the program TRIM (TRends & Indices for Monitoring data) 3.54 to assess population trends by means of a generalised estimating equations approach which takes into account overdispersion and serial correlation (Pannekoek & Van Strien 2001, Soldaat *et al.* 2007, Ludwig *et al.* 2008). The proportion of missing data within our counts was relatively low (Pannekoek & Van Strien 2001). We built separate models for early and late counts due to within-season changes in abundance (see above). The value of the population index was set at 1 in 1997 (first year used as reference). We ran six models: no time effects (counts vary across sites and not across time-points), time effects (effects for each site and time-point), simple linear trend (constant increase or decrease), linear trend with stepwise selection of change points (switching trend model with slope parameter changing at some time points) using default *P*-values (0.15 for entry and 0.2

for removal), stepwise selection of change points using more stringent *P*-values (0.05 for entry and 0.1 for removal). Then, for each period we selected the most parsimonious model according to the relative AIC value as calculated by TRIM. Indices calculated according to the “imputed” and “model” trend (cf. Pannekoek & Van Strien 2001) were identical to the third decimal; the former ones were shown. Linear trend models with stepwise selection of change points using default *P*-values had by far the lowest AIC values for both periods (ΔAIC > 10 for all other models in both periods).

In both periods, there was an initial increase, until 2000, followed by a sudden decrease in the number of calling males (Fig. 1). As expected, the decline in the first years after the introduction of subsidies was steeper in the late than in the early part of the breeding season. In the early season, the number of calling males (imputed value ± SE) was 50 ± 8 in 1997 and 24 ± 5 in 2012 (-52%; -65% from 2000 to 2012). The model for the early period included as change points the following years: 1999, 2000, 2002, 2004, 2005, 2006, 2008, 2010 (all $P < 0.183$). The overall trend (± SE) was equal to 0.93 ± 0.01 and was classified as “Steep decline ($P < 0.05$)”. In the late season, the number of calling males (imputed value ± SE) was 33 ± 12 in 1997 and 20 ± 7 in 2012 (-39%; -72% from 2000 to 2012). The model for the late period included as change points the following years: 1998, 2000, 2006, 2007 (all $P < 0.065$). The overall trend (± SE) was equal to 0.95 ± 0.02 and was classified as “Moderate decline ($P < 0.05$)”.

Spatial and temporal scales are a key issue for agri-environmental schemes (Siriwardena 2010), as well as the management of locally significant habitat types (MacMahon *et al.* 2012). For Corncrakes, spatial and temporal features of grass mowing are crucial: survival of adults, chicks and nests depend on methods and extent of mowing (Green *et al.* 1997a, Green *et al.* 1997b). Subsidies for grassland conservation in the Trento province, by encouraging mowing without consideration for when and where to cut the grass in relation to the ecology of target species, might have negative effects on Corncrakes. Indeed, with the introduction of the subsidies the Corncrake population started a marked decline in the province.

Our study covers a period regarded as favourable for Corncrakes at the Eurasian level. Most populations monitored during that time showed stability or increase, especially (but not exclusively, see Keišs 2003, Keišs 2004) where dedicated conservation measures were implemented (O'Brien *et al.* 2006). During the past 15-20 years, despite fluctuations typical for Corncrake populations (Cramp 1985), which also occurred within our area (Pedrini *et al.* 2012, Fig. 1), the species was stable or increasing in most countries for which data are available: in most western European states, a partial recovery has occurred since 1997 (with fluctuations), and the largest world population of the species (the Russian one) has been stable or increasing since 2002 (BirdLife International 2013). Therefore, the post-2000 decline in Trento province is very unlikely to be due to general/global factors, such as conditions during wintering or migration. The decline (2000-2012) followed an initial increase (1997-2000), and its onset which was coincident with the introduction of the subsidies for grassland conservation, with a stronger effect on late count data in the first two years, as expected. Subsidies changed the mowing system in the grasslands of the province.

Grasslands were once mown by single owners, in a mosaic fashion: each owner mowed their own land, and mowing was spread over several days or weeks, allowing birds to thrive in unmown patches. Small plots with other cultivations, small wetland patches and other marginal elements were also interspersed within the largest grasslands. With the subsidies, this system collapsed: adjacent fields belonging to different owners are now mown simultaneously by the same farmer, and marginal elements are removed to maximize the extent eligible for subsidies. This results in mowing within a short space of time over wide areas, and thus produces a homogeneous vegetation structure over large areas. Although there is no direct evidence that the introduction of subsidies caused the species' decline, it is very likely that the resulting mowing, with large extents cut simultaneously and without unmown patches, caused the disappearance of suitable habitat conditions (Berg & Gustafson 2007) and high mortality (Green *et al.* 1997b, Tyler *et al.* 1998).

Agri-environmental subsidies not adapted to the ecological requirements of the species may fail to promote species conservation. In this case, the lack of management recommendations in the subsidies for grassland conservation is the most likely cause of the negative trend of the Corncrake population, a species highly sensitive to farming practices. The extent of grassland that benefitted from agri-environmental schemes promoting a species-friendly management were too small (c. 0.1% of the total grassland extent that received subsidies) to compensate for the impact due to unfavourable mowing. The new Rural Development Programme will be launched in 2014, and to conserve Corncrakes, this should include a revision and correction of measures to address problems caused by the unsustainable mowing favoured by subsidies that are not adapted to the species' requirements. The identification of the most suitable sites for Corncrakes (Tattoni *et al.* 2012) is a priority. These sites will need targeted subsidies to promote appropriate methods for mowing (Green *et al.* 1997b) and its timing (Brambilla & Pedrini 2011), and the conservation of unmown patches with tall vegetation, especially in wetter areas (Berg & Gustafson 2007, Berg & Hiron 2011). Such measures have the potential to greatly enhance the value of the agri-environmental schemes for grassland conservation for Corncrakes (Pedrini *et al.* 2012) and other wild species.

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Figure 1. Corncrake trend according to early count data (A; May – early June) and according to late count data (B; late June – July; no data available for 1999), respectively. The date of the introduction of subsidies for grassland conservation (year 2000) is also shown by the arrow.