BENEFITS OF EXTENSIVE AGRICULTURE FOR THE NIGHTINGALE, LUSCINIA MEGARHYNCHOS.

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ABSTRACT

Reversion to extensive agriculture has been proposed as a mechanism for the reversal of biodiversity declines in agri-ecosystems. Here we demonstrate the impacts of agricultural extensification on a rapidly declining bird species as an example of the potential benefits of such schemes. The nightingale, Luscinia megarhynchos, has undergone a 90% decline in the UK over the past 40 years, with only one stable UK population currently known. Following reversion to extensive agriculture in 2001, the population of nightingales on the Knepp Estate has rapidly increased, with significantly higher pairing rates than on neighboring intensive farms. This population may therefore represent the only example of increasing nightingale numbers in the UK. Whilst the long-term stability of the population remains to be seen, the potential for extensive agriculture to be employed in conserving such species should be further explored.

Keywords: Re-wilding, extensive agriculture, hedgerow management, farmland birds

INTRODUCTION

Agricultural land supports 50% of all European species (Guerrero et al. 2011), but over recent decades many have declined dramatically primarily due to increased agricultural intensity (Fuller et al. 2005, Smith et al. 2010). In particular, agricultural intensification has caused dramatic declines in European bird populations many of whose numbers have nearly halved across Europe since 1980 (Vickery et al. 2001, Butler et al. 2010, Eschen et al. 2012). There is an urgent need to reverse these declines, and identifying successful methods of doing so is a major conservation priority (Siriwardena et al. 1998).

Agricultural re-wilding is an extensive farming practice being trialed at several sites in Europe (Navarro and Pereira 2012). One key method is the use of large grazing animals at low stocking densities to drive natural regeneration of habitat mosaics that are beneficial to ecosystem functions and biodiversity (Vera 2000). Extensive grazing provides a complex balance between new growth and open habitat with an increase in scrub (Fuller et al. 2007). The benefits of selective grazing and trampling act to increase sward diversity and architecture compared to intensive agriculture (Helden et al. 2010, Eschen et al. 2012). Likewise, lower grazing pressures and hedgerow management levels enable field boundaries to grow larger, providing predation cover, nesting habitat, and increased invertebrate abundance; crucial factors in determining bird species richness (Kruess and Tscharntke 2002, Batary et al. 2010, Smith et al. 2010, Eschen et al. 2012), for review see Benton et al. (2003). Re-wilding schemes are few but wide spread (Marris 2009), but so far little has been published on their biodiversity impacts (Awaiting references from F.Vera). Quantifying the success of such re-wilding schemes in supporting species of conservation concern is now of great importance.

The nightingale, *Luscinia megarhynchos,* has declined by more than 90% since 1967 in the UK (Holt et al. 2012). Currently amber listed for the UK (Eaton et al. 2009), the continued decline of the species since the last review means that it now meets the criteria for red status in the Birds of Conservation Concern assessment (Holt et al. 2012). Nightingales are insectivorous birds with very specific habitat requirements. The loss of their primary habitat in the form of understory woodland has resulted in a

contraction of their range and decreased abundance (Wilson et al. 2002, Newson et al. 2012). Subsequently, nightingales rely increasingly on scrub-dominated habitat associated with secondary succession (Wilson et al. 2002, Hewson et al. 2005, Wilson et al. 2005). They require both dense understory scrub (against predation) and bare ground beneath the vegetation in which their invertebrate food sources are found (Wilson et al. 2005). The natural expansion of uncut hedgerows, combined with large herbivore browsing encourages the formation of habitats matching the needs of breeding nightingale (Wilson et al. 2005). The nightingale is therefore one of the species that we would expect to benefit from re-wilding of agricultural land. Here we investigate the effects of natural regeneration on a re-wilded agricultural landscape, and the consequences for local nightingale numbers in comparison with neighboring intensive farms.

METHODS

Study site

The Knepp Castle Estate, a privately owned farm in West Sussex (TQ 156 213), was awarded a Higher-Level Stewardship AES in 2001 to support the creation of an extensive grazing system on land that used to be managed intensively for arable and dairy farming. As the only project of its kind in the UK, it provides a unique opportunity to study rates of ecosystem recovery from intensive farming and impacts on biodiversity.

The southern block of the estate (470 hectares) has been allowed to regenerate naturally and experiences the highest intensity grazing, whilst the northern block (260 hectares) underwent reseeding and is less heavily grazed. Two neighboring farms using intensive faming practices were also surveyed. Court Farm is a privately owned 240 hectare mixed arable farm (TQ 122 233) where land use closely resembles that of the Knepp Estate prior to the re-wilding project, whilst Loch Estate (TQ 162 193) is a 800 hectare commercially run arable farm. Both external sites are located within four miles of the Knepp Estate.

Nightingale survey

Under intensive management the maximum number of nightingale recorded at Knepp was nine individuals during the 1999 BTO Nightingale Survey (Sussex Ornithological Society), which used comparable methods to those below across the whole estate.

We divided the full survey area into eight approximately equal sized sub-sites, each of which we visited twice according to a random number sequence between the 7th -20th May 2012 between dawn and 9am. We systematically surveyed each sub-site for male nightingale territories by walking along all hedgerows and scrub areas. In the absence of potentially suitable habitat, we listened for song from a central location within each field. We then visually located singing birds and recorded them by GPS to an accuracy of 5m. Nightingales are extremely territorial birds and territories are rarely closer than 50m; therefore individual territories could be confidently mapped without the likelihood of duplication (Holt et al. 2010).

We re-visited all mapped territories at night, between 00:00 and 02:30 from the 21st May to 4th June 2012. We re-located all territories by GPS, and spent ten minutes at each location listening for singing males. Any sites at which males did not sing at night were re-visited during daylight to confirm the male was still present. Paired nightingales have been found to cease nocturnal singing (Amrhein et al. 2002). We therefore presumed males singing at night during this period to be unpaired.

Habitat features

We measured the average width to the nearest meter (edge to edge of the woody vegetation), height to the nearest meter and browse height (first leaved vegetation from the ground) to the nearest 1/3 meter over a 10 m stretch of hedgerow centered on each singing nightingale, and at 95 random points across the study sites. At each of these sites we also estimated percentage cover of Hawthorn *(Crataegus monogyna)*, Blackthorn *(Prunus spiniosa*) and Sallow *(Salix* species) to the nearest 10%. We chose the 95 additional survey sites by generating random x and y coordinates of a

100m grid superimposed on the study area and selecting the nearest field margin to each of these points.

Analysis

We performed all statistical analyses using R software (R Development Core Team, 2011). We compared numbers of paired and unpaired nightingales on extensive and intensive land using a chi-squared test, and habitat correlates of paired and unpaired nightingale distribution using generalized linear models with quasi-binomial errors (Crawley 2007). Full models included management type, hedge height, width, percentage composition of hawthorn, blackthorn and sallow, and browse height. We derived minimum adequate models through sequential deletion of the least significant term, with the validity of each deletion confirmed by ANOVA.

RESULTS

Nightingale distribution

A total of 45 nightingale territories were found: 34 territories on the extensively managed Knepp Estate and a further 11 on neighboring intensively managed farms (see Figure 1). Based on BTO estimates of the UK population size in 1999 (5600-9350 males in 1999) and an annual decline of 3% (Robinson, 2005) the current population is expected to be 3769-6293 males. This therefore indicates that the extensively managed area contains 0.54-0.90% of the UK population.

Nightingales positively favored wide field margins (est=0.718±0.237, z=3.026, p= 0.003, R^2= 0.82), with no singing males found in margins less than 8m wide; no other model terms were significant. Only 12.7% of the randomly sampled sites on the extensively managed site, and 6.3% on the intensively managed sites had field margins in excess of 8m, suggesting strong selection of these sites by nightingale and the potential for further increase in the population.

On Knepp 79% of birds paired compared to 18% on neighboring intensive farms (est=3.674±1.162, z=3.163, p=0.002, R^2=0.35) and pairing was positively correlated

with the proportion of blackthorn at singing sites (est=0.039±0.016, z=2.366, p=0.0180, R^2=0.15).

DISCUSSION

Population declines in species associated with agricultural environments require a rapid conservation response (Newton 2004). Few studies have considered extensive agricultural systems as a management tool to increase habitat provision for bird species (Eschen et al. 2012). Here we provide evidence that an agri-environment scheme to revert land to extensive agriculture has led to the population of nightingale more than tripling, whilst all but two other populations (Hewson and Fuller 2012) in the UK have declined.

Contrary to previous studies that found roughly half of all nightingales paired (Amrhein et al. 2002, Amrhein et al. 2007), approximately 80% paired on extensively managed land and 20% on neighboring intensive sites. This suggests extensive agriculture provides particularly high quality habitat compared to intensive farmland.

The majority of nightingale territories were found in scrub or hedgerow habitat rather than the woodland habitat that they are traditionally associated with. This reinforces the reported shift in nightingale habitat type from understory woodland (Fuller et al. 2007). Hedgerows are often considered sub-optimal habitat, yet in many cases field margins comprise the majority or the only semi-natural habitat available across agricultural land (Fuller et al. 2001, Marshall and Moonen 2002). Given such a large percentage of Britain is taken up by agricultural land, changes to hedgerow management may prove to be a valuable conservation tool (Fuller et al. 2007). This is not an alternative to woodland management, but a complimentary measure to woodland coppicing and management techniques (Fuller et al. 2001).

Nightingale territories were only ever found in scrub or field margins of eight meters or more in width, and pairs were weakly associated with hedgerows containing a high proportion of blackthorn. This follows Wilson et al's work (Wilson et al. 2005) that suggests that broad width is needed to enable the central portion of the hedge to

establish maturity and provide a portion of open ground beneath the hedge canopy. Blackthorn is especially thorny and un-palatable to grazers, which aids in predation evasion. Croxton et al. (2004) also found that it sprouts larger number of root suckers than other hedgerow species causing it to increase the width and density of hedgerow faster than other species. There is still potential for further expansion of the Knepp population as hedgerow growth continues, with only an estimated 12% of the hedgerows on the site currently meeting the required width.

Broadening of hedgerows does not exclusively benefit the nightingale as many passerines rely on large areas of hedgerow to forage, roost and breed (Hinsley and Bellamy 2000). Several red-listed species, such as the willow tit (*Poecile montanus)*, marsh tit *(Poecile palustris)* and woodcock (*Scolopax rusticola*), primarily regarded as woodland birds are also associated with scrub layer and understory vegetation (Newson et al. 2012), and may therefore benefit from similar management techniques as the nightingale. Equally the red backed shrike (*Lanius collurio*) also depends very much on extensively farmed environments (Brambilla et al. 2007, Fuller et al. 2007).

In order to justify expansion of extensive agriculture techniques it must first be shown that key conservation aims are being achieved. This study focuses on a single species, but one that has been in serious decline in UK agricultural landscapes suggesting that it is sensitive to environmental change and may act as a good indicator of ecosystem health (Donald et al. 2001). Simple changes in agricultural policy have previously been shown to reverse population declines in species such as the corncrake (*Crex crex*) and the stone curlew (*Burhinus oedicnemus)* (O'Brien et al. 2006) Wilson et al. 2009). Given the current rate of decline of many farmland birds, triage methods that halt or reverse the decline of remnant populations may prove essential to the conservation of these species, and general ecosystem health. The encouragement of extensive management techniques, and specifically in the case of nightingale hedgerow expansion, through agri-environment schemes may provide one such conservation mechanism.

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