Agriculture, Ecosystems and Environment 219 (2016) 163–170

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

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

# Large grazing birds and agriculture—predicting field use of common cranes and implications for crop damage prevention

Lovisa Nilsson[a,*], Nils Bunnefeld[b], Jens Persson[a], Johan Månsson[a]

[a] Grimsö Wildlife Research Station, Wildlife Damage Center, Department of Ecology, Swedish University of Agricultural Sciences, SE-730 91 Riddarhyttan, Sweden

[b] Biological and Environmental Sciences, University of Stirling, Stirling FK9 4LA, Scotland, UK

ARTICLE INFO

*Article history:*
Received 24 August 2015
Received in revised form 9 December 2015
Accepted 17 December 2015
Available online 29 December 2015

*Keywords:*
Conservation
Crop protection
Geese
Wildlife conflict
Management

ABSTRACT

Increasing numbers of previously threatened large grazing birds (cranes, geese and swans) are causing crop damage along their flyways worldwide. For example, the number of reported incidents of crop damage caused by common cranes *Grus grus*, followed by regulated inspections and governmental compensation in Sweden, has increased over the last few decades and was valued at ~200,000 Euros in 2012. Consequently, their impact on agriculture is escalating which raises the need for evidence-informed preventative strategies. We surveyed arable fields for autumn staging common cranes in an area surrounding a wetland reserve in Sweden. We assessed the following factors in relation to the probability of cranes being present on fields: crop stage, crop type, distance to roost site, time of day, field size and time since harvest. Stubble fields had the highest probability of crane presence, progressively decreasing through grassland and grazing grounds, bare soil to growing crop. A stubble field at 5 km from a roost site had a predicted probability (95% CI) of hosting cranes of 0.25 (0.19–0.32). The probability of cranes visiting a field was linearly and negatively related to distance to the roost site. For example, the probability of crane presence increased from 0.05 (0.03–0.07) to 0.09 (0.06–0.15) when distance decreased from 5 to 1 km. At stubble fields, the probability of crane presence decreased with time since harvest and was highest for barley with progressively lower probability on wheat and oat. Illustrative scenario predictions developed from the models demonstrated that probability of crane presence could be high, 0.60 (0.42–0.77), if all favorable factors were combined (e.g. barley stubble, 1 day after harvest, 1 km from roost site). Given the existing framework of international conventions and prohibition of culling, there is a need for preventative strategies to reduce crop damage. Based on our results, such strategies should focus on providing cereal stubbles as diversionary fields, especially close to wetland roosting sites. Stubble field availability can be achieved by careful crop rotation planning. We suggest that crop rotation and time of harvest should be added to flyway management plans recently developed for some large grazing bird species to facilitate stable co-existence between conservation practices and agricultural interests.



## 1. Introduction

Increasing populations of large grazing birds such as cranes *Gruidae*, geese *Branta, Anser* and swans *Cygnus*, aggregate and forage on arable land in large numbers at staging sites along their flyways in Europe and North America (Amano et al., 2008; Le Roy, 2010; Sugden et al., 1988), which in turn may cause significant crop damage and economic losses (Heinrich and Craven, 1992; Lane et al., 1998; Lorenzen and Madsen, 1986). For example, the number of autumn staging common cranes *Grus grus* in Germany increased from 45,000 in 1987 to 225,000 in 2008, the number of geese in NW Europe increased by 24%, from about 3.5 million to 4.3 million between 1995 and 2008 and whooper swans *Cygnus cygnus* in Sweden increased from 2000 to 8000 individuals from 1970 to 2000 (Fox et al., 2010; Harris and Mirande, 2013; Mewes et al., 2010; Nilsson, 2002). The number of fields and farmers affected by damage from large grazing birds has increased as have costs for crop damage and preventative measures, for example, farmers have been compensated with ~190,000 Euros (in total 2005–2008) in Lake Der-Chantecoq, France (Salvi, 2010) and ~200.000 Euros (2012) in Sweden for damage caused by common cranes (Karlsson et al., 2013). These population changes, along with increasing crop

* Corresponding author. Fax: +46 18 67 2000.
*E-mail address:* lovisa.uk.nilsson@slu.se (L. Nilsson).

http://dx.doi.org/10.1016/j.agee.2015.12.021
0167-8809/

damage are the result of international agreements banning hunting and promoting habitat conservation (e.g. wetland restorations). These include the Convention on the Conservation of Migratory Species of wild animals (CMS), and within Europe, the EU Council Directives on the conservation of wild birds (2009/147/EC) and on the Conservation of natural habitats and of wild fauna and flora (92/43/EEC), as well as species-specific flyway management plans (Madsen and Williams, 2012). Additionally, these species have benefitted from the EU Common Agricultural Policy (CAP) that has promoted intensified agricultural practices with greater use of autumn-sown crops and larger field units (Jongman, 2002; Stoate et al., 2001). As a consequence of non-overlapping objectives between conservation and agriculture, we are now in the situation that the number of large grazing birds continues to increase and fuelling for a potential conflict between those aiming to maximize agricultural production and those aiming to conserve biodiversity (MacMillan and Leader-Williams, 2008; Redpath et al., 2015, 2013).

Damage to agriculture is commonly severe in the vicinity of protected wetlands, because they provide attractive roost and staging sites for large grazing birds (Kleijn et al., 2014; Vegvari and Tar, 2002), while the birds' resource needs are not often fulfilled within protected areas (Fox and Madsen, 1997; Woodroffe, 1998). Consequently, birds use agricultural land surrounding protected areas for foraging, causing crop damage (Alonso et al., 1983; Amano et al., 2007; MacMillan et al., 2004; Nowald, 2010). Damage to crops leads to complex secondary effects, such as reluctance from certain stakeholders to react positively to the introduction of new protected areas or other conservation initiatives, potentially hindering the effective conservation of other bird species or important environments (Dickman, 2010).

Management strategies can be developed following assessment of the probability of birds visiting different types of fields. Strategies should aim to reduce crop damage and its costs by steering birds to less damage-prone or less valuable fields, such as harvested or diversionary fields and to predict where high damage risk might occur (Jensen et al., 2008; Madsen et al., 2014; Sherfy et al., 2011). The need for an evidence-based strategy is crucial, especially because issues regarding large grazing birds in many areas are changing focus from conservation to population regulation and crop protection (Amano, 2009; Pullin et al., 2004; Tombre et al., 2013), including by culling wildlife (Hothorn and Muller 2010; Kuijper, 2011). However, for large grazing birds, culling is often prevented by international legislative protection as well as ethical or practical obstacles.

Therefore, alternative measures need to be considered. Preventative measures currently used are scaring practices, such as propane cannons, flags and scarecrows, restricted lethal control aimed to scare birds from damage prone fields, and diversionary fields to which large grazing birds are attracted and left undisturbed to forage (Jensen et al., 2008; Tømmervik et al., 2005; Vickery and Gill, 1999). However, to make informed decisions and to implement effective measures, it is of fundamental importance to understand the probability of finding birds at a field under given conditions (Jensen et al., 2008; Pullin et al., 2004). Probability of finding birds at fields is influenced by crop type and crop stage as well as food abundance and quality (Amano et al., 2004; Anteau et al., 2011; Leito et al., 2008). Food abundance is strongly linked to harvest practices as waste grain becomes available at stubble fields and depletes over time due to consumption, decomposition or germination of grains (Lovvorn and Kirkpatrick, 1982). Moreover, distance from roost sites affects the probability of finding large grazing birds at a field as they trade energy gain against travel costs (Bautista et al., 1995; Gill, 1996; Jensen et al., 2008) with a clear daily pattern where birds feed on fields during the daytime and rest over night at roosting places (Bautista and Alonso, 2013).

In this study, we investigated the predictability of finding common cranes *G. grus* on arable fields at a staging site connected to an important wetland reserve. Common cranes are a suitable model species as, like other large grazing species they cause significant damage to crops, incurring considerable costs to society through loss of agricultural production and increasing compensation payments (Borad et al., 2001; Bouffard et al., 2005; McIvor and Conover, 1994). Moreover, this is not a local challenge as cranes are known to cause crop damage along their European flyways (Le Roy, 2010; Nowald, 2010). The challenges faced by conservation will affect many areas in Europe where migratory cranes, geese and swans forage in large numbers in agricultural landscapes surrounding important wetlands used for roosting (Alonso and Alonso, 1992; Leito et al., 2008; Vegvari and Tar, 2002). The aim of this study was to quantify the probability of common cranes (hereafter cranes) visiting fields in relation to their characteristics in order to develop evidence-informed management actions to decrease damage to agriculture. To investigate this question we tested the following variables in relation to the probability of finding cranes on fields: crop type, crop stage, distance to roost site, time since harvest, time of day and field size.

## 2. Methods

### 2.1. Study area

The study was located in Kvismaren (59°10′N/15°22′E), 15 km southeast of Örebro in the boreonemoral zone of south-central Sweden. The landscape is flat and dominated by highly productive agricultural land, well suited for cultivating cereals, grass, carrots and potatoes. Harvesting generally starts in August and continues until early October with variations depending on crop type and weather conditions, resulting in dynamic availability of crop types and crop stages (Fig. S1, Supporting information). The average precipitation in September is 50–75 mm, but 2012 was very rainy, with 75–100 mm precipitation during September (SMHI, 2014) which delayed the harvest. The core of the study area is a nature reserve consisting of two shallow eutrophic lakes, 2.5 km apart, surrounded by narrow strips of grazed wetlands. The area is an EU Natura 2000 Special Protection Area (SPA) and is designated under the Ramsar convention of wetlands. Kvismaren has been a key area for large grazing birds from March to November for the last 30 years, partly for breeding but especially during autumn migration staging for cranes and several goose species, mainly bean geese *Anser fabalis* and greylag geese *Anser anser.* The shallow lakes provide suitable roosting sites and the surrounding agricultural landscape provides good conditions for foraging on crops, waste grains and invertebrates as well as drinking water in ditches surrounding the fields (Anteau et al., 2011; Madsen, 1985a; Sugden et al., 1988). Cranes are present at Kvismaren from mid-August to early October, with a peak in 2009–2013 of 15,500–19,500 cranes. Such large concentrations can cause damage to growing crops (e.g. cultivated and unharvested crops) and economical losses for farmers in the area (Karlsson et al., 2013). Crop damage occurs during the entire vegetation period in newly sown fields and during growth, but predominantly in August to October just before harvest when large numbers of cranes arrive. Costs in terms of governmental subsidies for crop damage preventative measures and compensation for yield losses in Kvismaren, have ranged from 48,000 Euros (in 2010) to 150,000 Euros (in 2012) (Johanna M. Wikland, Örebro county administrative board, pers. comm.). Preventative measures involve scaring practices such as scarecrows and propane cannons,