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Effects of grass field margin management on food availability for Black-tailed Godwit chicks

J.M.R. Hanneke Wiggers [a], Jasper van Ruijven [a,*], Frank Berendse [a], Geert R. de Snoo [a,b]

[a] Nature Conservation and Plant Ecology Group, Wageningen University, Droevendaalsesteeg 3a, 6708 PB, Wageningen, The Netherlands
[b] Leiden University, Institute of Environmental Sciences, PO Box 9518, 2300 RA Leiden, The Netherlands

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ABSTRACT

Over the last six decades, populations of wader species like the Black-tailed Godwit (*Limosa limosa*) have sharply decreased in the Netherlands. Agricultural intensification has led to reduced habitat quality for meadow birds. As a consequence, reproductive success has declined. One of the main drivers of this decline in reproductive success is reduced food availability for meadow bird chicks. Agri-environment schemes (AES), designed to halt this decline, have so far been insufficient. Most of these AES focus on entire fields, but recent research suggests that differences in suitability exist within fields. Grass field margins may be more suitable for meadow bird chicks than the center of intensively managed grass lands. To improve existing meadow bird AES it could be beneficial to implement additional management in field margins of intensively managed grass fields. An already existing type of field margin AES with additional management is the botanical field margin. Here, we evaluate four different types of field margin management, including botanical field margins, focusing on aerial insects (an important part of the diet of Black-tailed Godwit chicks and Redshank chicks) in field centers and margins. Grass field margins contained more large aerial insects than field centers and, more importantly, additional management of the grass field margin increased the number of aerial insects in the margin. We conclude that combining meadow bird AES and botanical field margin management may enhance meadow bird food availability and improve the efficacy of AES.

1. Introduction

Biodiversity on agricultural lands in Europe has declined over the last six decades (Donald, Green, & Heath, 2001; Benton, Bryant, Cole, & Crick, 2002; Stoate et al., 2009). In the Netherlands, intensification of agricultural grassland management has caused a sharp decrease in the populations of wader bird species, including the Black-tailed Godwit (*Limosa limosa*) (Verhulst, 2007; Sovon Vogelonderzoek Nederland, 2012). As 40% of all European Black-tailed Godwits bred in the Netherlands in 2000, the Netherlands have an international responsibility for protecting this species (Teunissen & Soldaat, 2006). The intensification of agriculture is generally assumed to have major negative effects on the recruitment of new birds into the population (Donald et al., 2001; Roodbergen, Van der Werf, & Hötker, 2012). Major changes include earlier and more frequent mowing, increased fertilizer and pesticide application and lowering of the groundwater tables (Berendse, Chamberlain, Kleijn, & Schekkerman, 2004; Newton, 2004). The earlier mowing coincides with the nesting phase of the ground breeding birds, thereby causing the loss of clutches and chicks (Schekkerman, Teunissen, & Oosterveld, 2009) as well as reducing the area of chick foraging habitat (Schekkerman & Beintema, 2007). The increase of fertilization does not only allow earlier and more frequent mowing, but also increases the density of the vegetation, which makes it harder for the young birds to forage. In addition, increased fertilization and use of pesticides reduces flowering plants and plant species richness (Crawley et al., 2005) which can reduce the amounts of invertebrates, the main food source for the chicks (Beintema, Thissen, Tensen, & Visser, 1991; Vickery et al., 2001).

The last 30 years, agri-environment schemes (AES) have been used as measures to halt the decline of biodiversity on farmland by compensating farmers for loss of income when using more extensive farming methods. In the Netherlands, the most popular types of AES focus on meadow bird conservation or botanical biodiversity.

* Corresponding author at: Wageningen University, Nature Conservation and Plant Ecology Group, PO Box 47, 6700 AA Wageningen, The Netherlands. Fax: +31 317419000.
E-mail addresses: hanneke.wiggers@wur.nl (J.M.R.H. Wiggers), jasper.vanruijven@wur.nl (J. van Ruijven), frank.berendse@wur.nl (F. Berendse), snoo@cml.leidenuniv.nl (G.R. de Snoo).

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The majority of the meadow bird AES focus on the management of whole fields with stipulations such as later mowing, no fertilizer or higher ground water level. The most popular botanical AES focus on conservation of plant diversity in ditch banks and encompass the exclusion of fertilizer, manure and ditch sludge from the field margins to decrease nutrient supply, which has been shown to enhance plant diversity in the ditch banks (van Strien, Van der Linden, Melman, & Noordervliet, 1989; Bakker & Berendse, 1999). Since the first schemes were implemented in 1981, the area covered by meadow bird schemes has grown from 20,000 ha in 1991 to >220,000 ha in 2011 (van Paassen, Teunissen, Bolt, & Moons, 2010; Teunissen and Van Paassen, 2013) and today, thousands of kilometres of "botanical grass field margins", targeting botanical biodiversity in ditch banks exist.

Meadow bird schemes combine management of several grasslands in a so-called mosaic with different fields being managed differently. Some management types dictate a later time of mowing, others exclude fertilizer or dictate higher ground water levels. By managing the grass fields within the mosaic in different ways, suitable chick habitat is created in different parts of the mosaic at different times and for different species of meadow bird chicks. To this day however, results of meadow bird AES have disappointing results (Schekkerman, Teunissen, & Oosterveld, 2008; Oosterveld, Nijland, Musters, & De Snoo, 2011; Kentie, Hooijmeijer, Trimbos, Groen, & Piersma,2013).

The ideal chick habitat for Godwit chicks consist of an open, 15–30 cm tall, herb rich vegetation containing sufficient numbers of large insects (>4 mm) to permit successful foraging of the chicks while protecting them from predation and bad weather conditions (Schekkerman & Beintema, 2007). The conditions required for the development of such vegetation include low fertilizer inputs and high groundwater tables (Berendse, Oomes, Altena, & De Visser, 1994), which delay vegetation development during early spring and are not easily incorporated in farming practices on intensively managed grasslands, for economic reasons.

Although agricultural fields within a mosaic area are managed differently, a single field is usually managed in a single way. Research has shown however, that field margins can be more beneficial as chick habitat for meadow bird chicks than the centre part of the grass field (Kleijn, Berendse, Smit, & Gilissen, 2001; Oosterveld, Van Lierop, & Sikkema, 2009; Wiggers, van Ruijven, Schaffers, Berendse, & De Snoo, 2015). Even on fields with an intensive management, grass field margins are usually the most extensively managed part of the field with lower fertilizer input and higher groundwater levels. Kleijn et al. (2001) found that field margins may contain up to 96% of the botanical species richness of a field and contain a more heterogeneous vegetation structure. High plant species richness and heterogeneous vegetation structure have been found to increase the mean body size of several invertebrate species as well as to increase the total number and species richness of invertebrates (Woodcock et al., 2007; Woodcock et al., 2009). Meadow bird chick diets are diverse, but remains of aerial insects have been found in more than 90% of the faecal samples of Black-tailed Godwit (Beintema et al., 1991).

It is possible that the different vegetation structure and food availability in field margins would even make conventionally managed fields more or less suitable as meadow bird habitat. However, benefits for meadow bird chicks may be enhanced with additional management of the margin. As a meadow bird mosaic mainly consist of intensively managed grass fields, improving the grass field margins may considerably improve the quality of the mosaic. In this study we test the hypothesis that additional management of the field margins enhances their suitability for Black-tailed Godwit chicks by providing more food. We compared the number of aerial insects and vegetation characteristics in field margins with four different types of management, two of which are botanical field margin schemes. In addition, we compared field centers and field margins in intensively managed and extensively managed grass fields and we compared the different field centers.

2. Material and methods

2.1. Study area and management

This study was conducted in the Western Peat District of the Netherlands in the province of Zuid-Holland near Reeuwijk (52°2′N; 4°45′E). In this area, situated below sea level, dairy farming is the main form of agriculture and most of the farmland is grassland with peat or clay on peat soils, sown with mainly *Lolium perenne*. The pastures are long (0.2–1 km) and narrow (30–60 m) with 1–4 m wide ditches between the fields and sloped ditch banks of 0.5–1.5 m width. Ditches are cleaned every year. Water tables are controlled by the water board and maintained at a level of 0–50 cm below the surface of the field. Fluctuations in water table typically are small (i.e. 10–20 cm over the year).

Four different types of field margin management were studied (see Table 1). The first of the four types of margin management studied is the normal situation in the Netherlands (control). The margin is managed in the same way as the rest of the field with no restrictions on mowing date and ditch cleaning dredgings. Application of fertilizer is allowed up to one meter from the ditch. The second type of margin management is the botanical AES in ditch banks called 'botanical grass field margin'. This AES stipulates no application of fertilizer and ditch bank slurry in the two meter wide margin. The third type of margin management is an extended version of the botanical grass field margin with the additional stipulation that mowing is not allowed before June 1st. The fourth type of margin management is the field margin with meadow bird AES, which stipulates no mowing or grazing before June 15th and only application of farmland manure up to one meter from the ditch, and in contrast to the first three (which are on intensively managed grass fields), this one is on extensively managed fields with meadow bird AES (Table 1). This type of meadow bird AES is specifically designed to create suitable meadow bird chick habitat. On these fields no mowing, grazing or fertilizer is allowed until June 15th. The only type of fertilizer allowed on this field is farmyard manure.

The four types of margin management were measured in eight replicated blocks. In one block the control margin was missing (i.e.

Table 1
Overview of the different types of grass field margin management. The only type of fertilizer allowed on the meadow bird field is farmyard manure. Note that fertilization applies to the second meter only; fertilization of the first meter from the ditch is not allowed in the Netherlands.

Management type	Main field management	Mowing[c] allowed	Grazing[c] allowed	Fertilizer[c] allowed	Slurry allowed
Control	Normal	Yes	Yes	Yes	Yes
Botanical	Normal	Yes	Yes	No	No
Ext. botanical	Normal	No[a]	Yes	No	No
Meadow bird	Meadow bird management	No[b]	No[b]	No[b]	Yes

[a] Allowed after the first of June.
[b] After June 15.
[c] These stipulations depend on the data.