Shift in crop preference during the breeding season by Yellow Wagtails on arable farms in The Netherlands

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Abstract

As a result of agricultural intensification Dutch farmland bird populations are in steep decline. Yellow wagtail (*Motacilla flava flava*) is one of those species, but its decrease mainly occurred in grasslands, while in arable areas its population remains more or less stable. In contrast, populations of other typical birds of arable habitats, such as skylark (*Alauda arvensis*) and grey partridge (*Perdix perdix*) are declining strongly in this habitat type. The favorable status of yellow wagtails is probably caused by the crop mosaic composition of arable farms in the Netherlands, which often includes winter cereals, potatoes and sugar beet. This study focused on crop preference by yellow wagtails during the breeding season. Early in the breeding season yellow wagtails showed a strong preference for winter cereals. However, as the breeding season progressed yellow wagtails gradually shifted to broad-leaved crops, especially potatoes. The crop structure was measured to investigate preferences for vegetation height or bare ground. Yellow wagtails showed a strong preference for crops of 20-40 cm high. Higher crops were also used more than expected based on a uniform distribution, but to a lesser extent. Crops lower than 20 cm were not preferred. Regarding ground cover, yellow wagtails preferred crops with a ground cover of at least 60%. There was a negative association between yellow wagtail numbers and crops with less than 20% ground cover.

Keywords: farmland birds; winter cereals; potatoes; crop mosaic; agri-environment schemes

Zusammenfassung

Änderung der Habitatwahl von Schafstelzen *Motacilla flava flava* auf Ackerland in den Niederlanden während der Brutzeit

Durch die Intensivierung der Landwirtschaft gehen die Bestände niederländischer Feldvogelarten stark zurück. Die Schafstelze (*Motacilla flava flava*) gehört zu diesen Arten, aber ihr Rückgang erfolgte hauptsächlich im Grasland, während die Population im Ackerland relativ stabil blieb. Im Gegensatz dazu gingen dort Populationen anderer typischer Feldvögel, wie Feldlerche (*Alauda arvensis*) und Rebhuhn (*Perdix perdix*), stark zurück. Die günstige Lage der Schafstelze auf niederländischen Farmen ist wahrscheinlich auf die Zusammensetzung der Feldfrüchte zurückzuführen, die oft aus Wintergetreide, Kartoffeln und Zuckerrüben bestehen. Diese Studie beschäftigt sich mit der Habitatwahl der Schafstelze in der Brutsaison. Zu Beginn der Brutsaison bevorzugte die Schafstelze Wintergetreide. Später verschob sich diese Präferenz jedoch zugunsten breitblättriger Anbaupflanzen, vor allem Kartoffeln. Um Vorlieben für bestimmte Vegetationshöhen oder bloßen Erdboden zu untersuchen, wurde die Struktur der Anbauflächen erfasst. Schafstelzen zeigten eine starke Vorliebe für Pflanzen mit einer Höhe von 20–40 cm. Höhere Pflanzen wurden auch mehr genutzt, als eine Gleichverteilung vermuten ließe, aber weniger als Pflanzen in der 20–40 cm Höhenklasse. Pflanzen von weniger als 20 cm wurden weniger genutzt. Überdies bevorzugten Schafstelzen Anbaupflanzen mit mindestens 60% Bodendeckung. Es gab einen negativen Zusammenhang zwischen dem Vorkommen von Schafstelzen und Anbaupflanzen mit weniger als 20% Bodendeckung.

Introduction

Agricultural intensification has resulted in steep declines of farmland bird populations in Europe (e.g. Donald et al. 2001). The Netherlands is one of the most intensive countries in terms of farming and many farmland bird species have been placed on the national Red List (van Beusekom et al. 2005). Declines of bird populations have occurred in both grassland areas and arable areas. For some species, such as the skylark (*Alauda arvensis*) similar declines occurred in both habitat types. Some other species however, showed a much stronger decline in grassland areas compared to arable areas. An example of such is the yellow wagtail (*Motacilla flava flava*), of which the population is relatively stable in Dutch arable landscapes (Provincie Groningen 2003) and is one of the most common birds of arable fields, reaching densities from 15 to 20 breeding pairs per 100 hectares (Kragten and de Snoo 2008).

In current arable farming systems, several factors have been identified to be responsible for farmland bird population declines (Robinson and Sutherland 2002). Suitable breeding habitat has been limited by farm specialization, increased field size and the shift from spring to winter cereals (Chamberlain et al. 2000). Additionally, high inputs of pesticides and artificial fertilizers have limited food availability (Chamberlain et al. 2000; Stoate et al. 2009). Finally, as a result of more efficient harvesting methods and the disappearing of cereal stubble fields in winter, food availability for wintering birds is low and winter mortality rates have increased (e.g. Siriwardena et al. 2008). For long distance migrating species, such as yellow wagtail and black-tailed godwit (*Limosa limosa*), changing conditions in wintering areas have negative impacts on breeding population sizes as well (Zwarts et al. 2009).

Ground breeding farmland passerines, such as skylark and yellow wagtail, need multiple broods within a single breeding season in order to produce sufficient offspring to maintain population levels (e.g. Wilson et al. 1997). However, studies on skylarks showed that in modern arable landscapes possibilities for multiple breeding attempts are often limited (Wilson et al. 1997; Kragten et al. 2008). Skylarks prefer spring cereals as breeding habitat and the switch from spring cereals towards winter

cereals, is probably one of the main causes of skylark population declines (Donald 2004). In contrast to skylarks, British yellow wagtails (*Motacilla flava flavissima*)seem to prefer winter cereals and potatoes as breeding habitat (Gilroy et al. 2009). As these crops are the two most dominant crops in arable farming systems in the Netherlands, this could be an explanation for the stable population of yellow wagtails on Dutch arable fields.

In order to get a better understanding of why yellow wagtails are still relatively common in Dutch arable fields a study was designed to assess crop preference by breeding yellow wagtails in an intensively used arable landscape. Additionally, this study also focused on how crop preference changes over the breeding season. The results of this study could lead to recommendations for improving agri-environment schemes.

Methods

Study area

This study was carried out in two polders in the province of Flevoland, the Netherlands: Oostelijk Flevoland and Noordoostpolder. These polders were reclaimed during the 1950s and 1930s, respectively and were designed for optimal agricultural production. Both polders have a similar homogenous landscape which is characterised by rectangular parcels of approximately 22 (Noordoostpolder) and 30 (Oostelijk Flevoland) hectares. Soil type is clay of marine origin. Most parcels are bordered by ditches and larger waterways. The landscape is very open, the only tree lines are along roads and at several locations there are operational wind turbines. Land use is mainly agricultural and predominantly arable farming. Dominant crops are potatoes, winter cereals, sugar beet and onions. On average, about 3-4% of the farm area consisted of non-crop habitats, mainly grassy field margins and ditch banks. Fields are generally ploughed in autumn, with no stubble being left in winter. Pesticide use by farmers is comparable to other Dutch arable regions (de Snoo and de Jong 1999).

Data collection and analysis

The study was carried out in spring 2004 and 2005 on respectively 10 and 20 conventionally managed arable farms. All farms investigated in 2004 were investigated again in 2005. Mean farm size was about 40 ha. In 2004 a total area of 392 hectares was investigated, in 2005 816 ha. Mean territory densities per 100 hectares in both years were respectively 20.1 ± 11.4 (SD) and 14.1 ± 12.6 (SD). Dominant crops were potatoes, sugar beet, winter cereals and onions. An overview of crops grown on the farms and their relative acreage is given in Table 1.

To assess presence of breeding yellow wagtails, the standard method of the Dutch Breeding Bird Monitoring Project was employed (van Dijk 2004). Farms were visited five times between April and July. Visits were carried out from 30 minutes before sunrise till three hours after sunrise. Birds were mapped while walking transects along the field edges. Only birds showing behaviour indicating breeding were recorded. The following behaviour categories were considered as indicating breeding activity: (1) Singing males, (2) Displaying males, (3) Territorial conflicts between birds, (4) Birds carrying nest material, (5) Alarming birds and (6) Birds carrying food. Additionally to this, also yellow wagtail pairs present between April 15 – July 20 or individual birds present between June 1 – July 20 were also considered to be breeding. These dates are cf. van Dijk (2004).

Besides bird surveys, also crop height (cm) and ground cover (%) were determined for each crop. This was done at the same days as the bird surveys took place. This was done at randomly chosen fixed points with a minimum distance of 25 m from the field edge. Mean crop height was determined using a measuring stick. At the same locations as where the crop height was determined, ground cover was determined by visual estimation.

<TABLE 1>

In order to assess crop preference by breeding yellow wagtails, all farms were considered as one study area in which the birds could select their breeding habitat. This was done because most crops were not grown by all farmers. Then, the observed number of territorial yellow wagtails was compared with the expected values based on a uniform territory distribution over different crop types . This was done for all 5 visits on which breeding birds were counted. In this way crop preference could be analysed for different periods of the breeding season and shift in crop preference could be made clear.

To get more insight in the effects of crop height and ground cover on the presence of yellow wagtails, all records of yellow wagtails indicating breeding activity were assigned to categories of crop height and ground cover. For crop height the following categories were applied: 0-20 cm, 21-40 cm, 41-0 cm, 61-80 cm, 81-100 cm and >100 cm. Ground cover was expressed as percentage of soil covered with green vegetation. Used categories were: 0-20%, 21-40%, 41-60%, 61-80%, 81-100%. Also for the dominating crop types (winter cereals, potatoes, sugar beet and onions) presence of yellow wagtails was related to crop structure using these categories.

Results

Shift in crop preference

Basically, in both years a similar pattern of crop preference was found. During the entire breeding season yellow wagtails showed a preference for winter cereals, but the preference for this crop type decreased as the breeding season progressed (Table 2). Especially during the first part of the breeding season, territorial yellow wagtails were found mainly in winter cereals. In 2004 this was the case until approximately mid May, but in 2005 this lasted until mid June (Figure 1). In this period relative yellow wagtails numbers were high in winter cereals, varying from 37 to 60%, which was

much higher compared to the number of territories which should be expected based on a uniform distribution (Table 2). Although the relative numbers of yellow wagtails decreased in winter cereals later on in the breeding season, this crop type was still relatively important to the birds (19-33% of the records). Potatoes were only preferred during the second halve of the breeding season, and towards the end of the breeding season the preference for this crop type got stronger. At the end of the breeding season the majority of yellow wagtails was found in this crop type (40-51%). The other 2 dominant crop types, sugar beet and onions were not preferred by yellow wagtails. During the first periods of the breeding season, yellow wagtails were hardly recorded in sugar beet fields (0-4%), but as the breeding season progressed the number of yellow wagtails in sugar beet fields increased to 7-16%. Compared to winter cereals and potatoes, numbers were relatively low in sugar beets, but on a similar level as what could be expected under a uniform distribution. In onion fields, the presence of yellow wagtails was low as well and decreased as the breeding season progressed from 10-13% to 0-6%. In 2005, yellow wagtails seemed to have a weak preference for onions fields at the beginning of the breeding season, but after this there was a clear negative association between yellow wagtails and onion fields. From the minor crops, only tulips seemed to be of importance for yellow wagtails. Early in the breeding season this crop type held up to 30% of the territorial birds, while this crop only covered 0.5 % of the total area. As the season progressed the number of birds in this crop remained more or less equal, but numbers in other crop types increased.

<FIGURE 1>

<TABLE 2>

Preference for crop height and ground cover

Figure 2 shows the preference of yellow wagtails for crops with a certain crop height. During the whole breeding season there was a preference for crops with a height of 20-40 cm. Also crops higher than this were in general preferred, but to a lesser extent. During the first two sampling periods yellow wagtails showed a relative strong preference for crops of 60-80 cm high. These included mainly winter cereal fields. Crops lower than 20 cm were used less than expected if birds were to use the area uniformly.

In winter cereals most yellow wagtails were recorded when the crop was 60-100 cm high (70%). Besides this, 18% was recorded in winter cereals with a height of 20-60 cm and 12% of the records was made in crops taller than 100 cm. In potatoes 63% of the records were made when the crop was 20-40 cm high. Other records of yellow wagtails were made when the crop was lower than 20 cm (15%), between 40-60 cm (18%), or taller than 60 cm (3%). In sugar beet fields, yellow wagtails were mostly recorded when the crop was 20-40 cm high (75%). In sugar beet fields lower than 20 cm 13% of the records was made. This was also the case when the crop was 40-60 cm high. For onions, 66% of the records was made in fields of 0-20 cm high and 33% in fields of 20-40 cm high. These results indicate that mainly high cereals are used as breeding habitat by yellow wagtails, while broad-leaved crops such as potatoes and sugar beet are suitable when they are 20-40 cm high.

<FIGURE 2>

Figure 3 shows the preference of yellow wagtail for different categories of ground cover. In general there were positive associations between yellow wagtail presence and ground cover higher than 60%. Yellow wagtails especially preferred crops with a higher ground cover than 80%. Relatively strong negative associations were found with crops having a ground cover smaller than 20%.

All yellow wagtails in winter cereals were recorded when ground cover was between 80 and 100%. In potatoes, 73% of the records was done when ground cover exceeded 60%. Other records

were only done in crops with a ground cover smaller than 40%. For sugar beet a similar pattern was found as for potatoes. In total 81% of the records were done when ground cover exceeded 60%. Other records were done in sugar beet fields with ground cover between 20 and 40%. In contrast with this, most yellow wagtails (83%) in onions were recorded when ground cover was smaller than 20%. Only 17% of all records was done in onion fields with ground cover between 60 and 80%. These results strongly indicate that yellow wagtails prefer dense crop types, which provide sufficient cover.

<FIGURE 3>

Discussion

In general, small passerine birds need multiple broods in order to produce sufficient offspring to maintain population levels. Ground breeding farmland passerines, such as yellow wagtail and skylark often nest within arable crops. Cover provided by these crops determine whether a crop is suitable as nesting site. However, as crops grow, crop structure changes and consequently the suitability of a crop as nesting site. Therefore, ground breeding birds probably need a mosaic of crops delivering suitable conditions throughout the entire breeding season. This study showed that, especially during the first part of the breeding season yellow wagtails have a strong preference for winter cereals. As the breeding season progresses especially potatoes are being used more frequently as well. These results are similar to earlier findings in the UK (Gilroy et al. 2009) and indicate that an ideal crop mosaic for yellow wagtails should at least consist of winter cereals and potatoes. In the Netherlands, these crops are dominating on intensive arable farms. Probably as a result of this, densities of yellow wagtails tended to be higher on conventional arable farms compared to densities on organic arable farms (Kragten and de Snoo 2008). Especially the availability of winter cereals on organically managed farms is very limited and there are not many other crops providing enough cover early in the breeding season (Kragten et al. 2008).

231 Especially during the first period (April 15 – May 15) of the breeding season winter cereals
232 were preferred by yellow wagtails. This is probably because it was one of the few crops providing
233 sufficient cover during this period and being available in relatively large areas at the study sites.
234 Numbers of yellow wagtails present in tulips were also high during this period. Tulips provide cover
235 already in early April (crop height 20-40 cm, ground cover approx. 80%). Other dominant crops, such
236 as potatoes, sugar beet and onions are all spring sown crops providing only little cover during the first
237 halve of the breeding season. However, from more or less the end of May the preference for winter
238 cereals decreased and preference for potatoes increased. Also in sugar beet fields numbers of yellow
239 wagtails increased, but to a lesser extent compared to potato fields. The decrease in preference for
240 winter cereal fields is probably a result of the crop getting too high and dense as the breeding season
241 progresses. This is also a well known phenomenon for skylarks (e.g. Donald 2004; Kragten et al.
242 2008). However, during the second halve of the breeding season broad-leaved crops like potato and
243 sugar beet are yet providing sufficient cover. This possibly explains the partial shift from winter
244 cereals to these crop types.

245 It is not sure whether crop height or ground cover is the most explaining factor for yellow
246 wagtail abundance. Yellow wagtails are partly feeding on ground dwelling invertebrates, which might
247 mean that ground cover is the most determining factor. In onion fields most yellow wagtails were
248 recorded in fields with little ground cover. This could mean that food is easily available and perhaps
249 these fields are mainly used as feeding sites. However, crop structures can be very different between
250 crops. Potato fields might have a high percentage of ground cover, but birds have still access to the
251 ground to forage, while this is much less the case for a dense cereal crop with a similar amount of
252 ground cover. Besides that, small open patches, such as tramlines, can already be used as foraging
253 sites (Poulsen et al. 1998). So, dense crops can still provide sufficient foraging opportunities.

254 Another explanation for the shift in crop preference by yellow wagtails during the breeding
255 season might have to do with food availability. In another study invertebrate abundance was
256 investigated on the same farms which were used in this study (Kragten et al. 2010). During this study

invertebrates were sampled during the first week of June in the most dominant crops of the farms, including winter cereals and potatoes. Total invertebrate abundance did not differ between the two crop types, but the abundance of Diptera was more than seven times higher in potato fields. Diptera are known to be an important prey item for yellow wagtails (Holland et al. 2006) and therefore this could also have played a role in the increased use of potato fields during the second halve of the breeding season.

Although the preference for winter cereals decreased during the second halve of the breeding season, yellow wagtails were still frequently recorded in this crop type. This could indicate that some yellow wagtails also make their second nest in winter cereals. For skylarks it is known that second or third nests built in winter cereal fields are often built close to tramlines, where access to the ground is easier. Consequently, these nests suffer high predation rates as many ground predators use these tramlines to cross fields (Donald 2004). Therefore, more detailed studies should take place focusing on the breeding success of yellow wagtails in large scale arable habitats.

While interpreting the results of this study one should keep in mind that the results are based on records of birds showing breeding or territorial behavior. The location of the nest might be in a different field than where the bird was spotted. However, based on similar results found in other studies (e.g. Gilroy et al. 2009) this bias is probably limited.

As winter cereals and potatoes are dominating crops in Dutch arable landscapes, the crop preference of yellow wagtails as described in this study could be an explanation for the stable population development of this species compared to other ground breeding birds of arable fields (Provincie Groningen 2003). For other species, such as skylark, it is shown that the current crop mosaic in Dutch arable landscapes does not provide enough suitable habitat during the peak of the breeding season (Kragten et al. 2008). Probably because of this, skylark populations in arable habitats are in strong decline (Provincie Groningen 2003). However, providing a crop mosaic which provides suitable nesting sites during the entire breeding season is only one part of conservation of ground breeding farmland passerines. Additionally, there should be sufficient food available in order to assure

adult and chick survival. As yellow wagtails are insectivorous birds (Smith 1950; Gilroy et al. 2009a), they need insect rich habitats. Grassy or herbaceous field margins generally contain high numbers of invertebrates (Marshall and Moonen 2002). It is known that these margins are frequently used by birds and there are indications that this results in chicks with a better body condition (Teunissen et al. 2009). Also wet ditches and tracks are often used as foraging habitats (Gilroy et al. 2009a). Besides this, unsprayed crop edges are also known to be attractive foraging habitats for yellow wagtails (de Snoo et al. 1994). Finally, yellow wagtails frequently forage in the same fields that are used for nesting (Gilroy et al. 2009a). Several studies have shown that in organically managed fields (i.e. fields that lack inputs of chemical pesticides and artificial fertilizers) invertebrate abundance is higher compared to conventionally managed fields (e.g. Hole et al. 2005; Kragten et al. 2010). Consequently, organic farm management could have positive effects on the breeding success of yellow wagtails.

In most European countries agri-environment schemes for arable fields focus on field margin management or on installing set-aside plots. However, most ground breeding birds of arable fields use the crops as nesting sites. Especially field margin management is mostly aimed at creating insect rich habitats for birds, but generally does not provide suitable nesting habitat. Therefore, future agri-environment schemes should focus also on creating crop mosaics which provide suitable nesting sites throughout the entire breeding season. In this way ground breeding farmland passerines should be more able to produce a sufficient number of broods in order to maintain sustainable population levels.

Acknowledgements

I am grateful to all farmers giving permission to carry out bird surveys on their farms. Erwin Reinstra and Cathy Wiersema assisted with the field work. The comments of two anonymous reviewers significantly increased the quality of the paper.

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376

377 **Table 1** Abundance of crop types on studied farms given in mean percentage of cropped land covered

378 and percentage of farms growing these crop types.

Year	**2004**		**2005**	
	Area (%)	Farms (%)	Area (%)	Farms (%)
Potatoes	28	100	27	95
Sugar beet	16	80	15	80
Winter cereals	15	70	12	50
Onions	11	70	11	65
Other crops	29	80	35	85

379

380

Table 2 Crop preferences of yellow wagtails during the breeding season for the four main crops in the study area. Dark blocks indicate crop preference. Light blocks indicate a negative association.

		Round 1		Round 2		Round 3		Round 4		Round 5	
Year	*Crop type*	Obs	Exp	Obs	Exp	Obs	Exp	Obs	Exp	Obs	Exp
2004	Potato	5	28	8	28	32	28	43	28	51	28
	Onion	10	11	0	11	6	11	6	11	4	11
	Winter cereal	55	15	54	15	19	15	19	15	27	15
	Sugar beet	0	16	4	16	16	16	16	16	8	16
Year	*Crop type*	Obs	Exp	Obs	Exp	Obs	Exp	Obs	Exp	Obs	Exp
2005	Potato	25	27	12	27	20	27	25	27	40	27
	Onion	13	11	4	11	0	11	5	11	3	11
	Winter cereal	38	12	60	12	33	12	28	12	19	12
	Sugar beet	0	15	4	15	8	15	11	15	11	15

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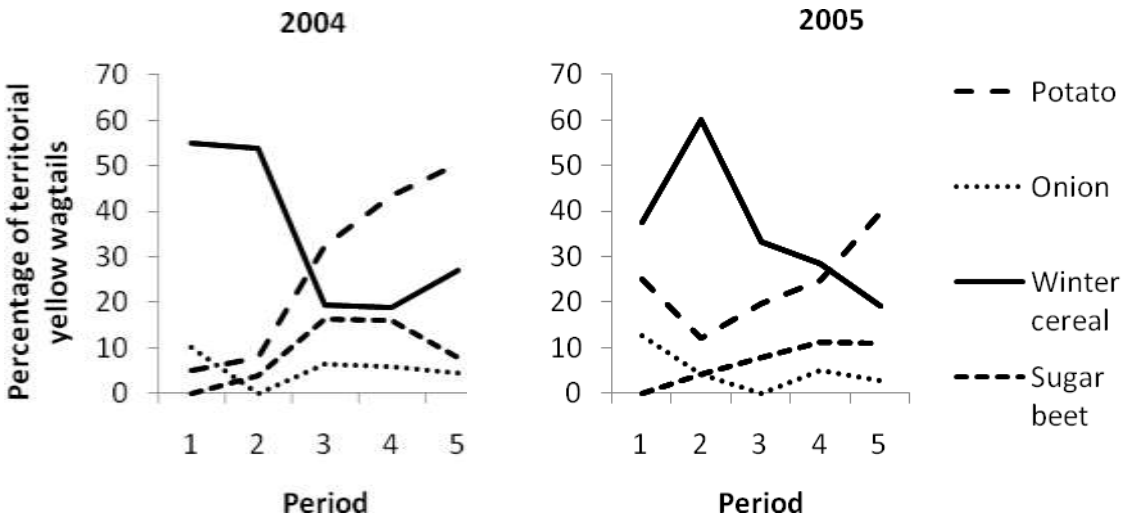

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388 **Figure 1** Shift in crop use by territorial yellow wagtails during the breeding season. Period 1 = April
389 15 - April 30; Period 2 = May 1- May 15; Period 3 = May 16 – May 31; Period 4 = June 1 – June 15;
390 Period 5 = June 15 – June 30.

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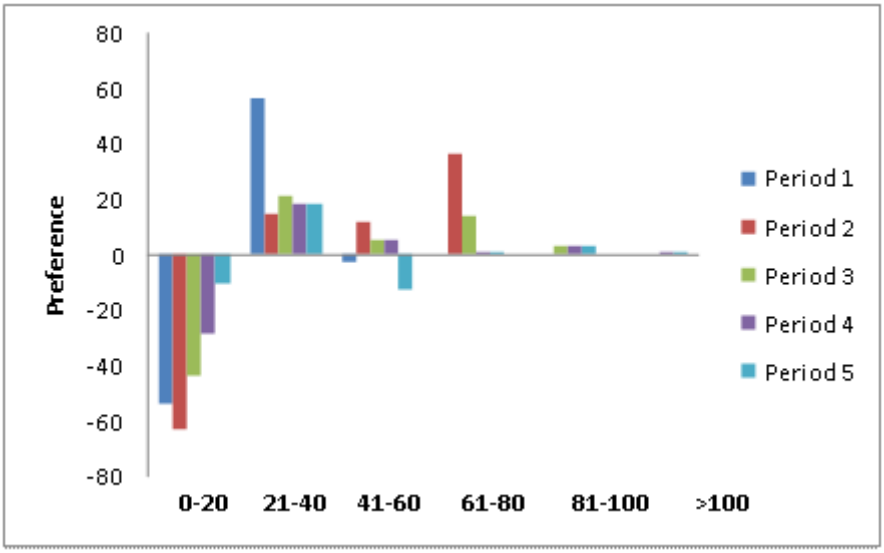

Figure 2 Preference of territorial yellow wagtails for certain crop heights. The vertical axis shows preference by birds based on the difference between observed numbers of birds and expected numbers in a uniform distribution. Positive values indicate a preference, negative values indicate avoidance. On the horizontal axis are categories of crop height (cm). Periods represent sampling periods. Period 1 = April 15 - April 30; Period 2 = May 1- May 15; Period 3 = May 16 – May 31; Period 4 = June 1 – June 15; Period 5 = June 15 – June 30.

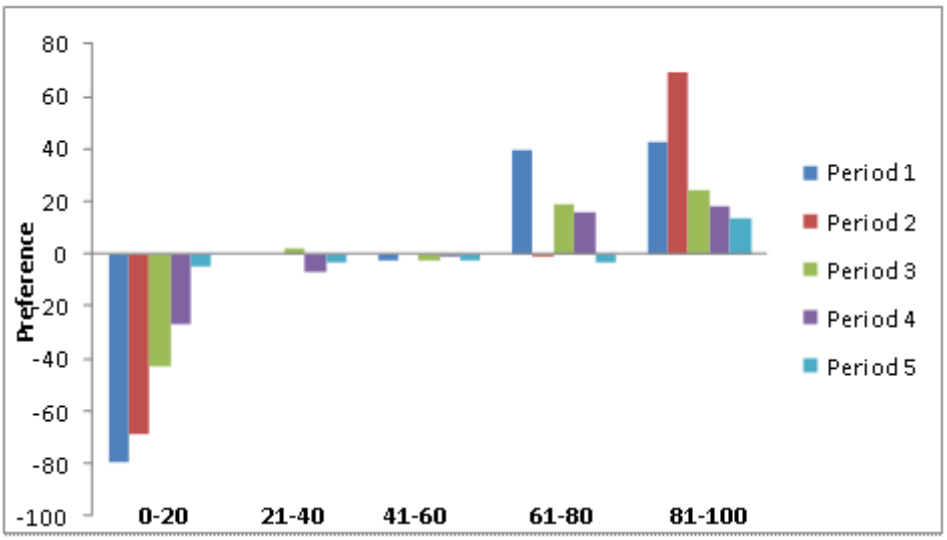

Figure 3

Preference of territorial yellow wagtails for crops with a certain ground cover. The vertical axis shows preference by birds based on the difference between observed numbers of birds and expected numbers in a uniform distribution. Positive values indicate a preference, negative values indicate avoidance. On the horizontal axis are categories of ground cover (%). Periods represent sampling periods. Period 1 = April 15 - April 30; Period 2 = May 1- May 15; Period 3 = May 16 – May 31; Period 4 = June 1 – June 15; Period 5 = June 15 – June 30.