The Northern Lapwing (*Vanellus vanellus*) in Norway: Exploring the population decline through bird ringing data and habitat selection

Master thesis in Biology – Biodiversity, Evolution and Ecology

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ABSTRACT

The Northern Lapwing (*Vanellus vanellus*) is one of many farmland birds that have been suffering from population declines as a result of agricultural intensification over the past few decades. Through the use of ringing- and recovery data I have looked at the changes in the Norwegian population of Lapwings through time. Relating the changes to the changing circumstances surrounding the recovery of ringed Lapwings, I found that while the majority of recovered Lapwings previously were recovered shot, this is a less prevalent circumstance in recent decades. Using the ringing- and recovery data I have also created a Bayesian model for mortality, and in accordance with studies done in other countries I found that mortality has remained quite stable through time, thus not being the main reason for the population decline. I have also looked at habitat selection through a census study of Lapwings in different types of farmland habitats the region of Jæren, Rogaland the spring of 2013. Censusing a total of 192 farmland fields shared among 17 transects, observing in total 199 Lapwings, I did not find a statistically significant relationship between habitat selection and availability.

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1. INTRODUCTION

The past century has seen drastic changes in agricultural practices and land use, both in Norway and in the rest of the world. These changes affect the species using grassland and/or arable land for breeding, and over the past few decades many bird species breeding in agricultural areas have experienced significant population declines as a result of agricultural intensification (Siriwardena, Baillie & Wilson, 1998; Donald, Green & Heath, 2001; Benton, Vickery & Wilson, 2003).

One of the species following this declining trend is the Northern Lapwing (*Vanellus vanellus*), commonly referred to as Lapwing, a Palearctic farmland wader which has declined in abundance over much of its European breeding range (BirdLife International, 2012). Once a common sight on Norwegian farmland, Lapwings are now only found in a few select breeding areas around the country, and the declines in these areas over the past few decades have been significant (Byrkjedal et al., 2012; Olsen, 2013).

1.1 The Northern Lapwing

With its boldly patterned plumage, tufted black crown and impressive display flight, the Lapwing is an unmistakable bird in the agricultural landscape. Because of its attractive appearance and behavior the Lapwing is a popular bird among farmers, and across much of its range it's known as a "harbinger of spring" (European Commission, 2009; Olsen, 2013). Lapwings are adapted to breeding primarily in farmland; nesting on the ground and normally laying 3-4 eggs in a shallow scrape on the ground in short vegetation. Preferred Lapwing breeding habitat is considered to be wet natural grasslands, meadows and hay meadows with short swards and patches of bare soil (BirdLife International, 2012). In broad terms, Lapwing breeding habitat can be divided into two main categories: cropland/arable land (which includes cultivated farmland used for cereal production, grass production and permanent pastures), and pasture/rough grazing sites (which includes non-cultivated land like improved pastures and heather moors) (Byrkjedal et al., 2012).

Norway lies at the northern limit of the Lapwing's breeding range (European Commission, 2009). Reproductive Lapwing populations have been observed in all 19 counties in Norway (Kålås et al., 2010), although the majority of breeding occurs throughout southern Norway (Bakken, Runde &

Tjørve, 2003). In southern Norway, Lapwings start laying their eggs from late March to a while into April, depending on how warm the spring is (Lislevand, Byrkjedal & Grønstøl, 2002).

With the exception of some populations in temperate regions, most Lapwing populations are fully migratory (BirdLife International, 2012), wintering south and west of their breeding areas (European Commission, 2009). Lapwings migrate back to their breeding grounds in late winter/early spring, with migration peaking in late March in Northern Europe (European Commission, 2009). France and Spain, and to a lesser degree also The British Isles, are the most important wintering locations for Norwegian Lapwings (Bakken, Runde & Tjørve, 2003). The British Isles also play an important part during the fall- and spring migrations (Olsen, 2013).

1.2 Population status of the Lapwing

Global population

The Northern Lapwing has the northernmost distribution of all lapwing species (Lislevand, Byrkjedal & Grønstøl, 2002). Its global breeding range encompasses an area of over 7,000,000 km^2 (BirdLife International, 2004), ranging from the Atlantic to the Pacific Ocean between 35° to 70° northern latitude (European Commission, 2009). The global breeding population is concentrated in Europe, where it currently has an unfavorable conservation status (European Commission, 2009). Since 1970, declines have been reported from all European countries with a Lapwing population of over 50,000 breeding pairs (European Commission, 2009). The total breeding population was fairly stable between 1970 and 1990. While there were population decreases in Fennoscandia, UK and Germany during this time period, these decreases were balanced by increases or stability in large populations in Russia, Belarus and the Netherlands. Since 1990, however, there has been a significant decline involving all major populations (European Commission, 2009).

The International Union for Conservation of Nature [IUCN] operates with an estimated global population of between 5,200,000 and 10,000,000 individuals (BirdLife International, 2012), based on numbers from Wetland International (2006). The Lapwing is currently classified as a species of "Least Concern" (LC) on the IUCN Red List (BirdLife International, 2012). Despite the species having an apparent declining population trend, the decline is not believed to be rapid enough to approach the thresholds for "Vulnerable" under IUCN's population trend criterion (>30% decline over ten years or three generations). The species' range size and population size are also both too large to approach the "Vulnerable" thresholds (BirdLife International, 2012).

Norwegian population

Traditionally, little has been known about the population trends of Lapwings in Norway, and there has been few published time series data involving Lapwings (Byrkjedal et al., 2012). Assessments made in the period 1990-2003 place the number of breeding Lapwing pairs in the country between 40,000 and 80,000 (BirdLife International, 2004), although there are no quantitative data to back up these numbers (European Commission, 2009).

The Norwegian Lapwing population has had a positive growth and expansion since the end of the 19th century, but a few decades ago indications of a decline started becoming evident (Bakke, Runde & Tjørve, 2003). Reports from several different parts of Norway suggest a continued decline of the Lapwing population throughout the country, and although there has been a lack of quantified documentation of the change the Norwegian Red List assumes a decline of 15-30% (Artsdatabanken, 2014). The most recent version of the Norwegian Red List categorizes the Lapwing as "Near Threatened" (NT) (Kålås et al., 2010), and it has been suggested that the current population size may be less than 10,000 breeding pairs. (Mjølsnes, 2014).

Conducting annual censuses between 1997 and 2011, Byrkjedal et al. (2012) found an estimated population decline of 44% (or 53 % if estimated from the number of males) in the region of Jæren in Rogaland; one of the most important Lapwing breeding areas in Norway. In another important breeding area; Vest-Agder, Olsen (2013) found a decline of 83% in number of breeding pairs in the area when comparing censuses done in 1994 and 2012.

1.3 Threats to Lapwings

The European Union Management Plan 2009-2011 lists seven categories of threats believed to have a negative impact on Lapwing populations: Agriculture, infrastructure development, harvesting, pollution, predators, human disturbance and climate change (European Commission, 2009). Of these, agriculture, specifically agricultural intensification, is ranked as “High”, which is defined as causing or being likely to cause rapid declines of 20-30% over 10 years. Harvesting and predation are both ranked as “Medium” (10-20% declines over 10 years), while human disturbance is ranked as “Medium” on a local level.

In terms of threats to the overall population size, we can roughly divide between two main types of threats: those affecting breeding success and those affecting adult survival.

Threats to breeding success

Habitat quality is very important for the Lapwings’ breeding success, and there can be large differences in nest survival probabilities between different habitats (Berg, Lindberg & Källebrink). The overarching reason for the Lapwing decline is considered to be habitat changes linked to agricultural intensification (Siriwardena, Baillie & Wilson, 1998; Donald, Green & Heath, 2001; Benton, Vickery & Wilson, 2003). Extensive agricultural land use changes have resulted in a considerable loss of grassland habitats like pastures and meadows, and led to increased habitat fragmentation (Johansson & Blomqvist, 1996). When arable fields expand, important habitat features like ditches, habitat islands and other residual habitats are lost (Johansson & Blomqvist, 1996), and the uniform dense swards that characterize modern agricultural fields make for a much less diverse habitat than e.g. traditional hay meadows (Whittingham & Evans, 2004). The homogenous landscape also increases the predation risk on the Lapwings, as the nests are more exposed (Whittingham & Evans, 2004).

Use of heavy machinery is a big cause of nest destruction (European Commission, 2009), and nest losses caused by farming practices can be substantial (Galbraith, 1988; Shrubb, 1990; Baines, 1990; Berg, Lindberg & Källebrink, 1992). Many farmers take preventive measures when working on their fields; marking nests to avoid running over them, moving them out of the way before ploughing the fields and covering them with a bucket before spreading fertilizer (Lislevand, Byrkjedal & Grønstøl, 2002), but with modern farming practices this is becoming increasingly difficult (Olsen, 2013).

The increasing trend of autumn-sown rather than spring-sown crops affects breeding negatively (Shrubb, 1990). Lapwings show a high degree of habitat selection related to sward height in the breeding season (Berg, Lindberg & Källebrink, 1992), and generally avoid fields once the vegetation reaches a certain height (Sheldon et al., 2004). Too high swards hinder overview of the area and impede easy walking, which makes autumn-sown crops almost useless as breeding habitat for the ground nesting Lapwings (European Commission, 2009).

Threats to adult survival

Climatic variation is a factor that impacts Lapwings in all stages of life. Adult survival has been found to be negatively related to measures of winter weather severity, with mortality increasing significantly in bad winters (Catchpole et al., 1999). Peach, Thompson & Coulson (1994) found that two winter weather variables (mean winter soil temperature and total winter rainfall) could explain 55% of the variation in first-year survival and 69% of the variation annual adult survival in Lapwings in the UK. If the ground is frozen the Lapwings face major challenges collecting food, and in particularly cold and/or long-lasting winters it is not unusual to find Lapwings dead from a combination of starvation and freezing (Olsen, 2013).

Lapwings can be legally hunted in France, Greece, Italy, Malta and Spain (European Commission, 2009; BirdLife International, 2012). The annual harvest within the EU is estimated to be about half a million birds, which is considered to amount to under 9% of the autumn population (European Commission, 2009). The species is also hunted for commercial and recreational purposes in Iran (BirdLife International, 2012). While hunting is probably not the primary reason for the global Lapwing decline, it does have a negative impact on the population size and could work against conservation efforts (European Commission, 2009).

1.4 Scientific bird ringing

In many European countries, rigorous estimates of population trends are only available for short amounts of time due to lack of recorded data (Zídková, Marková & Adamík, 2007). This is where countries with a solid tradition of bird ringing have an advantage. Scientific bird ringing is a research method based on the individual marking of birds with (most commonly) numbered metal rings. Modern bird ringing dates back to 1899, and is considered to be one of the most effective methods to study the biology, ecology, behavior, movement, breeding productivity and population of birds (The European Union for Bird Ringing [EURING], 2007).

The recovery of ringed birds, dead or alive, provides us with valuable knowledge about the birds and their environment (Bakken, Runde & Tjørve, 2003). Tracking back the journeys of ringed birds helps us define their migratory routes and staging areas; information crucial for the planning and establishment of protected areas around the world (EURING, 2007). Ringing and recovery data also provides information that can be used for estimating population parameters such as survival and lifetime reproductive success; parameters are essential in determining the causes of changes in population sizes (EURING, 2007).

Scientists around the world have used ringing data to look at different aspects of the Lapwing population decline, e.g. Peach, Thompson & Coulson (1994) and Catchpole et al. (1999) using ringing data to estimate survival rates of British Lapwings in association with climate variables, and Zídková, Marková & Adamík (2007) used it to tie the population decline to hunting pressure. The ringing of Lapwings in Norway dates back to 1920, yet there have been very few (published) studies based on these data. Bakken, Runde & Tjørve (2003) gave an overview of the data in *The Norwegian Bird Ringing Atlas, Vol. 1*, and Lislevand, Byrkjedal & Grønstøl (2009) used it to look at dispersal and age of first breeding, but there has been a lack of studies using it in connection with survival estimates (Olsen, 2013).

1.5 Aims

My overarching aim with this project was to contribute to the knowledge of the factors affecting the Lapwing population in Norway. As previously mentioned, population size variations can be explained by factors related to two main aspects of Lapwing ecology; adult survival and breeding success, and I will be looking at factors relating to both of these.

PART 1: POPULATION CHANGE

My first and primary aim was to examine the variations in the Lapwing population in Norway through time. Using species observation data and ringing (and recovery) data I give an overview of the population size, and then attempt to relate these to changes to changes in circumstances of recovery and of estimated mortality.

PART 2: HABITAT SELECTION

My secondary aim was to look at habitat selection in Lapwings. Performing a census study in the field, I sought to get representative data on which types of agricultural habitats Lapwings preferred compared to accessibility.

The initial plan for the project also included a nest survival study where Lapwing nests in different habitats were monitored over time in order to get a view of how the different habitats affected breeding success. Due to a lack of nests in the study area this was unfortunately not possible, but in future research I recommend that such a study is done.

2. MATERIALS AND METHODS

To investigate the development of the Lapwing population in Norway I used two different sets of data: Species observations from Artsobservasjoner and ringing data from Ringmerkingssentralen.

2.1 Artsobservasjoner

One way of estimating the development of population over time is simply to look at the registered observations of the species over time. Artsobservasjoner (www.artsobservasjoner.no) is an independent service for reporting of species observations in Norway and Svalbard developed by [The Norwegian Biodiversity Information Centre]. The reporting service is used by both amateurs and professionals, and currently holds Norway's largest database for biological diversity. The reporting system for birds was developed in cooperation with Norges Ornitologiske Forening [The Norwegian Ornithological Society], and was launched in May 2008.

The data in Artsdatabanken is observation data, and therefore highly dependent on observer effort; i.e. how many people are doing observations and recording them in the database at any given time. In other words; the number of Lapwings observed annually does not alone tell us much about the population development of the species. A way to use the observation data to say something about population development is to look at it relative to the observation data of "comparable species" that are likely to have been subject to a similar sampling effort over time.

The Eurasian Curlew (*Numenius arquata*) and the Eurasian Oystercatcher (*Haematopus ostralegus*) are both reasonably comparable to the Lapwing as far as habitat and ecology goes, and like the Lapwing they have shown unfavorable population trends throughout their European range as a consequence of agricultural intensification (Byrkjedal et al. 2012). As they are similar types of birds and usually occur together in the same areas, it is reasonable to believe that people's interest in reporting them through time also has been approximately the same.

Through www.artsobservasjoner.no/fugler I fetched the data on individuals observed annually for these three species between 1969 and 2014. Observations date back to 1960 for all three species, but due to low numbers of observations in the first years I chose to begin my counting at 1969.

2.2 Bird ringing data and EURING codes

Scientific bird ringing data is a very useful tool for studying population development. All scientific bird ringing in Norway is organized by Ringmerkingssentralen [The Ringing Centre] at Museum Stavanger. Through them I got access to the Norwegian ringing dataset for Lapwings, which contains data on the ringing and recovery of all Lapwings ringed in Norway from 1920 to late 2013.

The scientific and administrative cooperation for bird ringing in Europe is organized through The European Union for Bird Ringing [EURING] (Bakken, Runde & Tjørve, 2003). Founded in 1963, EURING works to coordinate ringing stations and national ringing schemes across Europe (EURING, 2007). The EURING Data Bank was established in 1977, and contains data on the recovery of all birds ringed in Europe, stored in a standard format (EURING codes) and available to scientists worldwide (Bakken, Runde & Tjørve, 2003). The Norwegian ringing scheme utilizes the EURING codes, and unless stated otherwise my interpretations of ringing data are in accordance with the most recent manual (EURING Exchange Code 2000 v113).

Circumstances of recovery

An important column in the ringing dataset is that of Circumstances. This field, given by a two-digit EURING code (00-99), describes the circumstances of the encounter between observer and bird. The first of the two digits represents the so called primary division of circumstances, while the second specifies the situation further. As the number of Lapwings recovered under each specified circumstance is rather small, I have chosen to group some of the thematically related primary divisions together for the purpose of this project. In my results and discussion I will therefore be operating with the five groups, or sets of circumstances, described in **Table 1**.

Table 1. The grouping of EURING's primary division of circumstances, as used in this project.

Group	EURING code	Description from EURING
Unspecified circumstances	0	Unknown circumstances or unknown whether through man's agency or naturally (including attraction to domestic animals).
	8	Bird identified from something else than the metal ring.
	99	Totally unknown circumstance: not even stated to be 'found'.
Intentionally by man - shot	1	Intentionally by man - shot.
Intentionally by man - other means	2	Intentionally by man - other means (including trapped, poisoned, ring number read in field etc.). All captures (=ringing data) and recaptures (caught and released).
Accidentally by man	3	Intentionally by man - pollution.
	4	Accidentally through human agency (not pollution): including traffic accidents, collision with wires etc., entering man-made artefacts, accidents with machinery, drowned in artificial water.
Natural causes	5	Natural causes - diseases and other natural ailments.
	6	Predation by any animal other than man (except hunted by falconer's bird).
	7	Other natural causes. Drowned (in natural water bodies), trapped, tangled and collided with natural objects and also weather and starvation and thirst.

Condition

Another relevant column is that of Condition. This field, given by a one-digit EURING code (0-9), describes the condition of the bird when found. For the purpose of this project, I consider the condition of birds registered with code 0 to be unknown, code 1-3 to be dead at recovery and code 4-9 to be alive (even if sick or wounded) at recovery.

2.3 Mortality

In order to estimate the mortality (the number of deaths in a population per time) for the population of recovered birds in the ringing dataset, I made use of Bayesian analysis

The Bayesian model used to derive the mortality curve is described in detail in **Appendix 3**.

2.4 Habitat selection and availability

For the field study part of my project I wanted to explore which habitat types the Lapwings preferred relative to how much of this habitat type was available in an area. In order to do this I performed a census of Lapwings in different habitats in the region of Jæren in Rogaland, southwestern Norway, which is an important farmland district that belongs to the core breeding areas of Lapwings in the country (Byrkjedal et al., 2012), over a two week period between April 24th and May 7th, 2013. My methods were based in part on those used by Byrkjedal et al. (2012), who performed annual censuses of Lapwings, Curlews and Oystercatchers in the same region between 1997 and 2011.

I performed censuses in a total of 192 fields along a total of 17 road transects spread across the Jæren region (**Appendix 2**). Along the road transects I censused in all agricultural fields on both sides of the road; the number of fields in each transect ranging from 5 to 19, with a median of 10 and an average of 11. Areas along the transects that did not qualify as Lapwing breeding/foraging habitat (e.g. patches of woodland or construction sites) were excluded from the census, as were grassy areas that were too small for any birds to reasonably settle on (e.g. small lawns or enclosures). Most of the fields were clearly defined by fences. For the fields that lacked fences, or that had topographical features preventing me from getting a full overview, I defined the boundaries as the part of the field I could see. Maps of the transects and their defined fields are available in **Appendix 3**.

I used a car to travel along the transects; parking along the side of the road and making my observations from the edge of the censused fields. Ideally I would have performed the censuses from inside the car so as to cause as little disturbance as possible, but the birds did not appear to be affected by my presence. The time spent looking at each field varied according to the size of the field, as did the equipment I used. I used a set of Opticron imagic™ binoculars (8X magnification) for my initial observations, and then proceeded to a Swarowski ATX/STX spotting scope (25-60X magnification) in the fields where it was needed. In each field I noted the number of Lapwings I observed; identifying between males and females. The sexes can be differentiated by their plumage; Lapwing males usually have clearer and more contrasting colors on and a longer crest than the females, and they tend to have a longer tuft on their head (Lislevand, Byrkjedal & Grønstøl, 2002).

In each field I also noted down the habitat type. I divided the habitats into four types: “Cultivated grassland”, defined as cultivated, reasonably homogenous grassy fields used for grass production and/or permanent pasture; “Cereal fields”, defined as cultivated fields that appeared to be used for cereal production; “Tilled fields”, defined as fields that had been tilled/plowed, but where grass or cereal had not been sown or had not yet started growing, and “Natural pastures”, defined as non-cultivated fields that contained grass but were not used for grass production; rough grazing sites. In addition to the habitat classification, I briefly described distinctive habitat features like relative size, sward height, moisture, presence of grazing animals, recent fertilization etc. in a qualitative fashion.

To analyze the data I used the software package R version 3.0.2.

3. RESULTS

3.1 Data from Artsobservasjoner

As of September 28th, 2014, a total of 1,330,268 Lapwings, 421,740 Curlews and 1,826,024 Oystercatchers observed since 1969 had been registered in the Artsobservasjoner database.

The absolute numbers of Lapwings, Curlews and Oystercatchers registered annually have developed very similarly from 1969 until the present (**Figure 1**). Between 1969 and 2007 there was a steady and approximately linear increase in registered observations of all three species, with the increase for Lapwings being slightly steeper than for the other two species. Observations of all three species shot up from 2007 to 2008 (Lapwings increased by 190%, Curlews by 209% and Oystercatchers by 163%), and again from 2008 to 2009 (Lapwings increased by 248%, Curlews by 228% and Oystercatchers by 288%), and have remained high since.

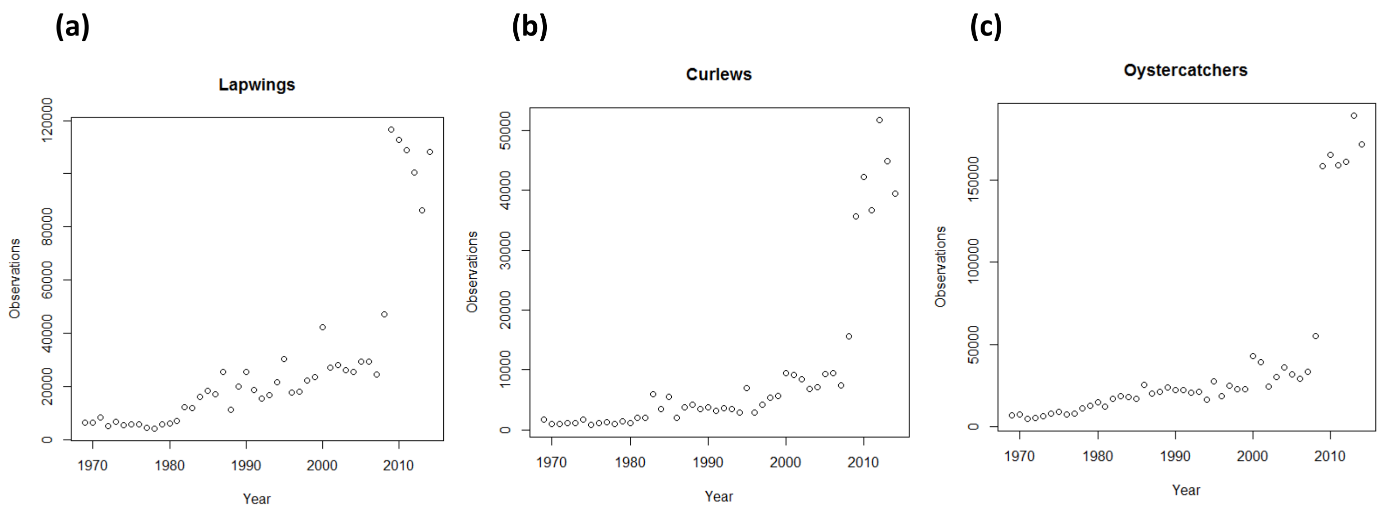

Figure 1. The number of (a) Lapwings (b) Curlews and (c) Oystercatchers observed annually, 1969-2014, as registered on www.artsobservasjoner.no.

The proportion of Lapwings observed relative to both Curlews and Oystercatchers has varied a lot through time. The smooth curve shows a fairly stable relationship between Lapwings and Oystercatchers until around 1990, followed by a steep and continued decline in the proportion of

Lapwings (**Figure 2a**). Between Lapwings and Oystercatchers we see a less stable relationship, with an increase in the proportion of Lapwings in the 1990s followed by a decline (**Figure 2b**).

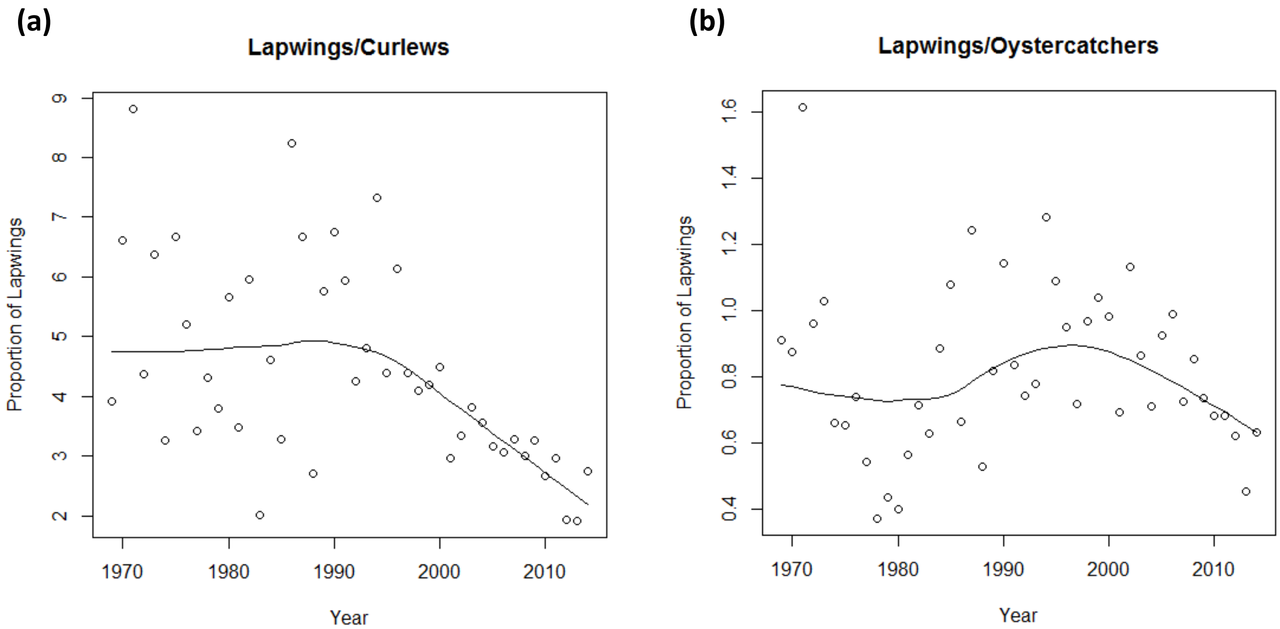

Figure 2. The proportion of Lapwings observed annually relative to (a) Curlews and (b) Oystercatchers, 1969-2014, as registered on www.artsobservasjoner.no.

3.2 Ringing and recovery

A total of 28,552 Lapwings have been ringed in Norway between 1920 and 2013, and 770 of these have been recovered at a later point in time. Of the 770 recovered Lapwings, 12 (1.6%) were ringed at an unknown/not recorded age, 741 (96.2%) as pullus, 2 (0.3%) as full-grown, 4 (0.5%) as first-year, 10 (1.3%) as after first-year and 1 (0.1%) as 2nd year. Of the 716 birds whose condition at recovery is known, 685 (95.7%) were recovered dead and 31 (4.3%) alive.

We see a clear pattern in the development of both ringing (**Figure 3a**) and recovery (**Figure 3b**) of Lapwings through the years. The annual number of ringings and recoveries increased near exponentially up until the 1950s and early 60s, with ringing reaching an all-time high peak in 1955. This peak was followed by a sudden and rapid decline in the early 1960s, and both ringings and recoveries remained at a low level until the early 1980s. A modest increase followed throughout the 1980s and 90s, before a new decline hit at the turn of the century. This decline has continued until the present day.

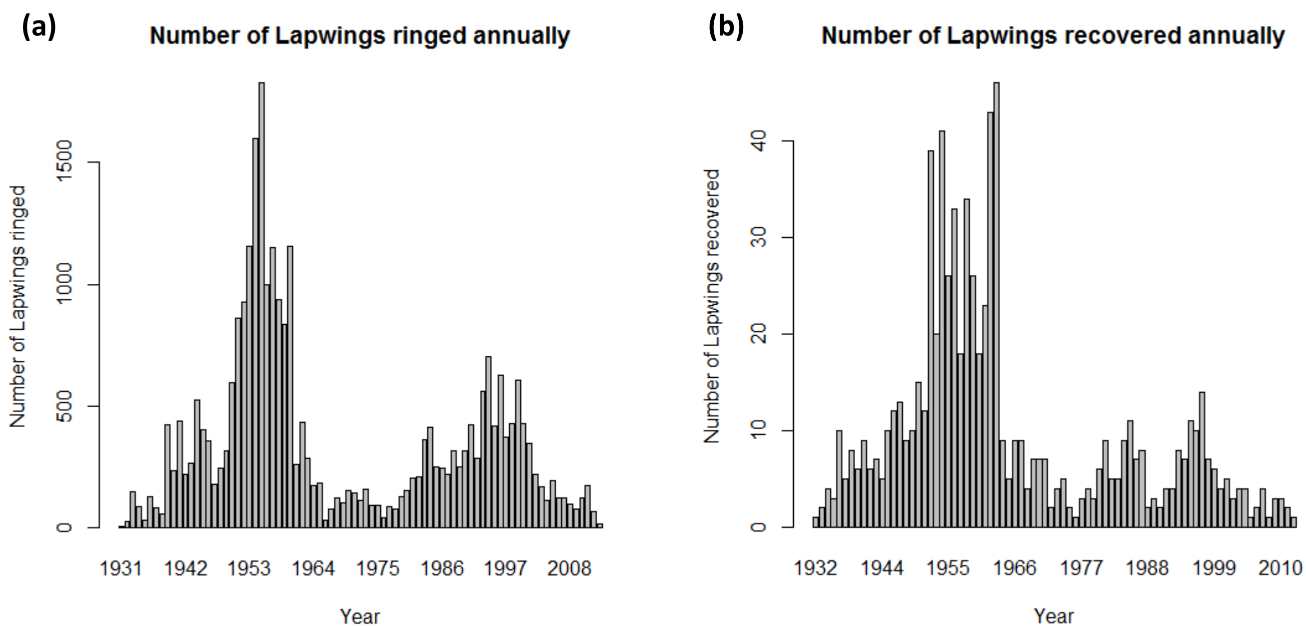

Figure 3. The number of Lapwings (a) ringed and (b) recovered annually, 1931-2013. There was one Lapwing ringed in 1920; this individual has been left out of the figure.

3.3 Circumstances of recovery

Lapwings ringed in Norway have been recovered under a total of 27 different circumstances, within 9 of the 10 primary divisions used by EURING. Of the 770 recovered Lapwings, the set of circumstances surrounding the recovery of 340 (44.2%) fell under "Unspecified circumstances", 249 (32.3%) under "Intentionally by man – shot", 44 (5.7%) under "Intentionally by man - other means", 75 (9.7%) under "Accidentally by man" and 62 (8.1%) under "Natural causes".

The proportion of Lapwings recovered under unspecified circumstances (**Figure 4a**) has decreased markedly between 1932 and 2013, while the proportions of the more specified sets of circumstances have increased. The first set of circumstances to start increasing markedly was that of intentional shooting (**Figure 4b**). This set of circumstances reached its peak in the 1950s and 60s, then to decline and eventually stabilize from the 1980s and out. The proportion of recovered Lapwings that had been taken intentionally by other means than shooting (**Figure 4c**) was very low for the first fifty years of ringing, but increased markedly from the mid-1980s. Recoveries where the bird had been impacted accidentally by man (**Figure 4d**) and by natural causes (**Figure 4e**) both saw moderate increases from the early 1970s, but while the latter has stabilized the former has been decreasing again since the turn of the century.

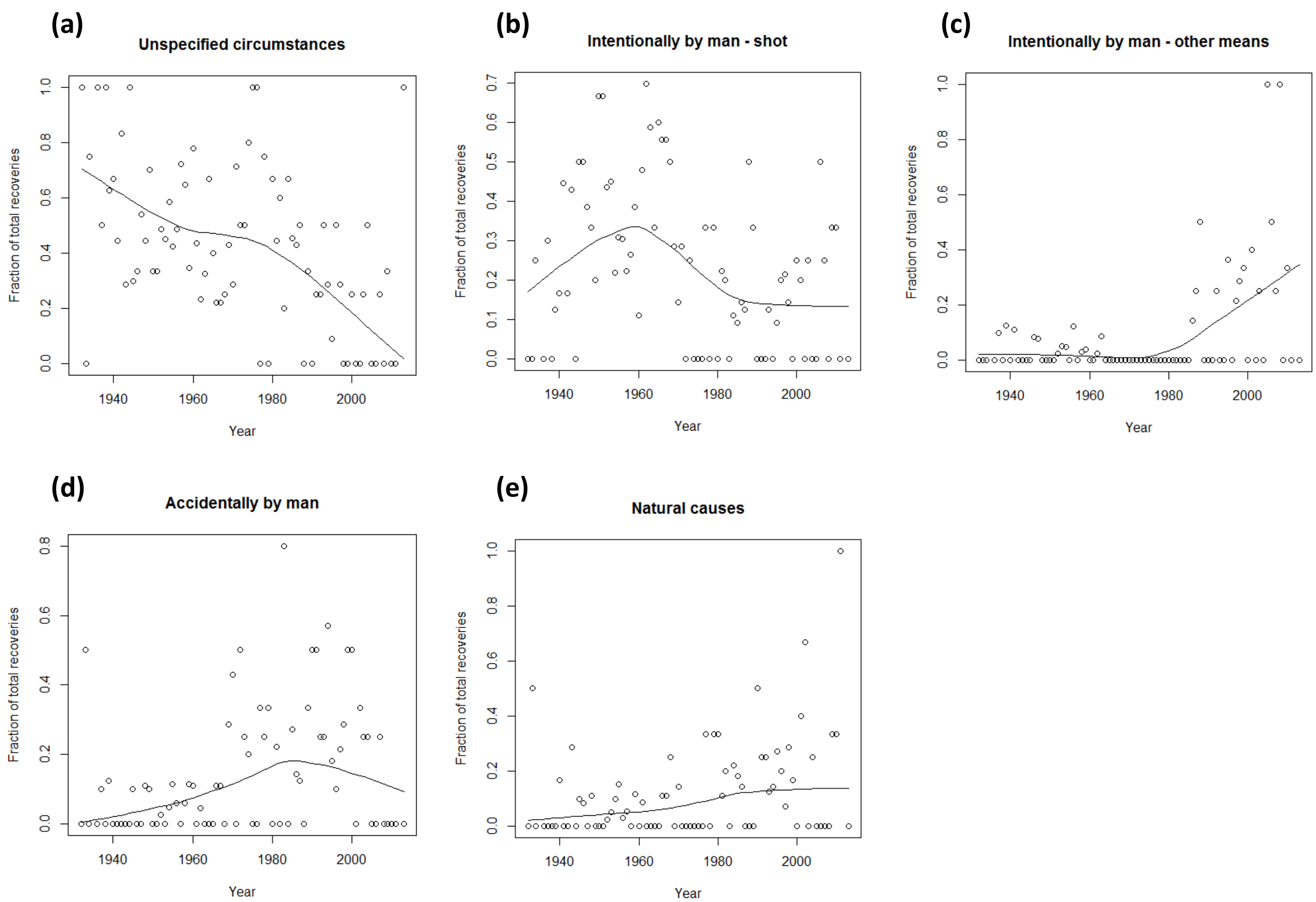

Figure 4. The proportion of Lapwings recovered annually under different sets of circumstances The annual number of Lapwings recovered under different sets of circumstances relative to the total annual number of Lapwings recovered, 1932-2013. (a) Unspecified circumstances, (b) Intentionally by man – shot, (c) Intentionally by man – other means (e.g. trapped or poisoned), (d) Accidentally by man, (e) Natural causes (e.g. disease or predation).

3.4 Mortality

765 of the 770 reported recoveries were used for the Bayesian analysis, i.e. five recoveries were eliminated. Of these, three Lapwings were registered as recovered the same day they were ringed, and two had the registered dates of ringing and recovery 48.7 and 66.6 years apart, respectively.

The mortality curve derived from the Bayesian modeling (**Figure 5**) shows that the estimated mortality of the recovered Lapwings has remained fairly even throughout the entire time period. The biggest variations in mortality occurred in the decades around 1960, when peak in mortality in the mid-1950s was followed by a drop in 1960 and another sudden peak around 1963. After 1963, mortality decreased until the late 1970s, when it again started increasing until it reached a small peak in the mid-1980s. Mortality slowly decreased again after this, but started increasing again around 2005. This increase in mortality is ongoing. The uncertainty is the smallest in the 1960s, as this is the time when the most Lapwings were recovered annually (**Figure 3b**). Similarly, the uncertainty is the largest at the beginning and the end of the time scale.

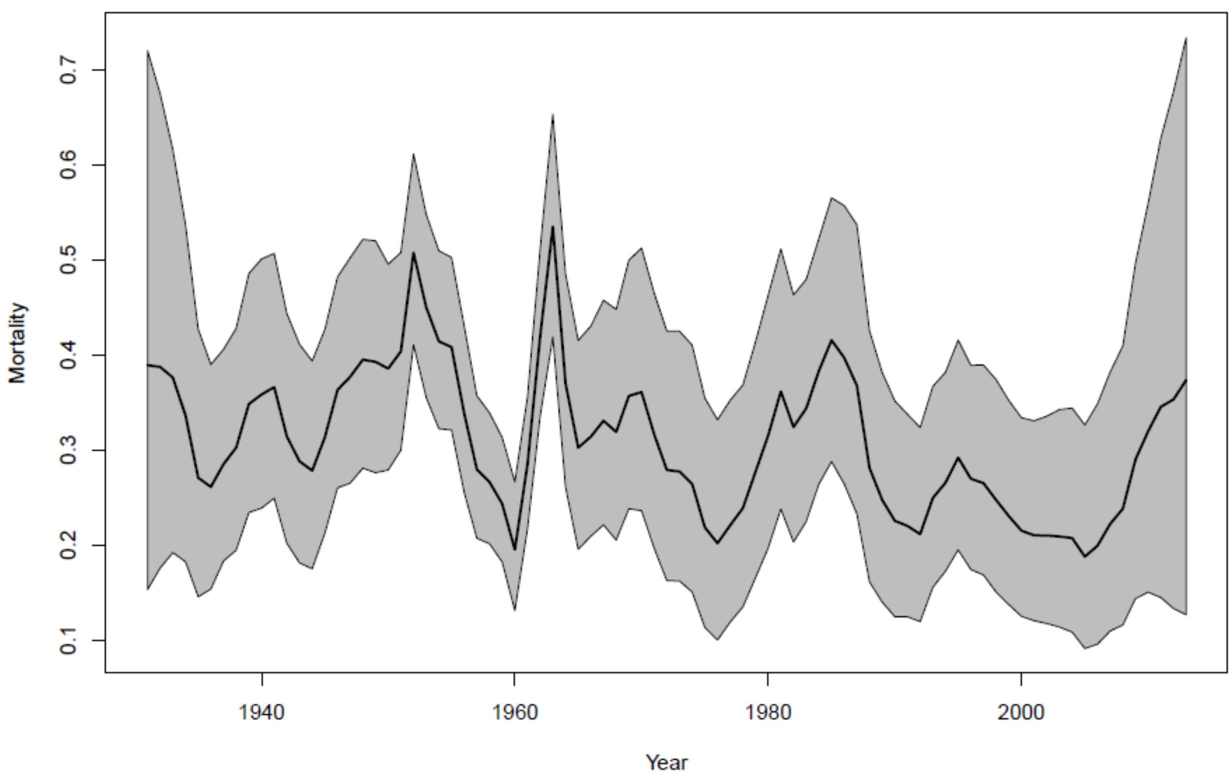

Figure 5. Mortality time series for recovered Lapwings, 1932-2013, estimated using Bayesian modeling. The gray area represents the level of uncertainty.

3.4 Habitat selection and availability

I counted a total of 199 Lapwings in my census; 116 of them I identified as males and 83 as females. Of these, 175 (87.9%) were observed in “Cultivated grassland” fields, 7 (3.5%) on “Cereal fields”, 14 (7.0%) on “Tilled fields” and 3 (1.5%) on “Natural pastures”. The full overview of the number of Lapwings observed in each field can be found in **Appendix 4**.

Carrying out Pearson’s Chi-square test on the data in **Table 2**, I found no statistically significant correlation between the number of habitats in each category where Lapwings were observed, and the total number of habitats in each category (p=0.5352). The distribution of Lapwings in the different habitat categories did not differ from random.

Table 2. The number of habitats in each category that had a presence/absence of Lapwings.

	Cultivated grassland	Cereal fields	Tilled fields	Natural pastures
With Lapwings	51	2	5	3
Without Lapwings	97	6	17	11
Total	148	8	22	14

4. DISCUSSION

4.1 Data from Artsobservasjoner

Annual registered observations of Lapwings, Curlews and Oystercatchers have developed in a similar fashion; the numbers increasing steadily until 2007 and then shooting up in 2008 and 2009 (**Figure 1**). This is consistent with the reporting system for birds being launched in 2008; the system made registering observations easier and increased the number of active contributors. Although registering observation data from before the launch of the online reporting system is possible, the majority of contributors primarily use the service to enter “current” observations.

When using the proportion of Lapwings relative to Curlews and Oystercatchers to discuss their relative population sizes, I make the assumption that the public interest in registering observations is approximately equal for the tree species. Before 1990, we see a large variation in the proportion of observed Lapwings relative to Curlews and Oystercatchers between years (**Figure 2**), though on average the size relationships appears quite stable. The points on the Lapwings/Curlews curve lie close to the smooth curve from the mid-1990s and out, making the smooth curve an accurate representation of the trend and indicating that the Curlew is a good comparison species for the Lapwing. This also makes sense from an ecological point of view, as Lapwings and Curlews have a quite similar ecology. While all three species breed on farmland in coastal areas, Oystercatchers primarily belong on the coastlines (Byrkjedal et al., 2012), and may be less affected by agricultural habitat changes. In recent years the Lapwing/Oystercatcher relationship also shows a quite clear trend, and both comparison species are interesting to examine further.

While all three species are known to have had unfavorable population trends, the registered observation data indicates that the Lapwings currently are worse off than the two others, having had a comparatively more negative population trend since the mid-1990s. These results are in accordance with the findings of Byrkjedal et al. (2012), who in their study of the three species in Jæren between 1997 and 2011 found that the local population of Lapwings had experienced a statistically significant decline over the entire census period, while the Curlew and Oystercatcher populations had remained more stable; beginning their decline 5-6 years after the Lapwings and stabilizing again in recent years.

4.2 Ringing and recovery

The almost exponential increase in the number of birds ringed and recovered annually (**Figure 3**) between 1931/32 and the 1960s is likely to indicate more about the bird ringing activity in the country than about the Lapwing population size. Up until the mid-1960s, comprehensive ringing of migratory birds in practice only occurred at one bird observatory in Norway (Bakken, Runde & Tjørve, 2006). In the early years of ringing, more birds also lost their rings. Steel rings, which are strong enough to remain on a bird through its lifetime, did not come into use in Norway until the mid-1960s (Bakke, Runde & Tjørve, 2003). By far the most Lapwings were ringed and recovered in the 1950s and 60s. Throughout the 1960s several new bird observatories were established along the coast of Southern Norway (Bakken, Runde & Tjørve, 2006). An increase in ringing activity also came in the 1980s and 90s, when organized ringing groups were established in the country (Bakken, Runde & Tjørve, 2006).

The decline in the number of Lapwings ringed and recovered annually from the mid-1990s and onwards is consistent with the decline in registered observations in Artsobservasjoner (**Figure 2**); providing further documentation of the Lapwing population decline over the past few decades.

4.3 Circumstances of recovery

With a total of 770 recovered Lapwings, the number of individuals recovered under each circumstance is not always very large. Particularly in the periods when ringing and recovery numbers are low, it is difficult to know how representative our results are of actual trends. Reporting habits aside, the 1950-60s part of the graph might be the most “reliable” in terms of reflecting reality, as the number of recovered Lapwings by far is at its highest here.

From being largely unspecified in the first few decades of ringing, the circumstances surrounding the recovery of Lapwings (**Figure 4**) have changed from being dominated by “Intentional shooting” up until the 1960s-70s to more and more being taken “Intentionally by other means”, “Accidentally by man”, or “Natural causes” in more recent decades. The decrease in the proportion of Lapwings recovered under unspecified circumstances probably indicates that the people reporting the recovered birds are doing more thorough paperwork now than before. The introduction of the standardized EURING codes made detailed reporting easier, and some of the development we see may reflect a development in the specificity of reporting habits rather than in the actual circumstances surrounding the recovery of the birds.

The majority of Lapwings recovered “Intentionally shot” been recovered outside of Norway. While hunting of Lapwings is forbidden in Norway, both France and Spain, the most important wintering locations for Norwegian Lapwings, normally allow hunting in the fall- and winter months (European Commission, 2009). A change in the proportion of this set of circumstances is therefore tied to changes in hunting habits and/or hunting legislation in these countries.

The steep increase in the proportion of Lapwings reported as shot up until the 1950s can probably to a degree be explained by the decrease in the proportion of birds reported under unspecified circumstances in the same time period. It is likely that many of the birds reported as with unspecified circumstances in the early years of ringing in fact had been shot, and as reporting became more detailed this would be reflected in a higher number of Lapwings registered as shot. The peak in the proportion of recovered Lapwings reported as shot also coincides with the peak in annual ringings and recoveries. It is difficult to say whether the peak we see is a result of Lapwing hunting actually being more common at that point, or if it is related to the amount of data available. When we after the early 1960s begin seeing a decrease in the proportion of shot Lapwings, this is less related to the changes in reporting habits, as the proportion of Lapwings recovered under unspecified circumstances also still is decreasing. The decrease in the proportion of shot Lapwings coincides with increases in the proportion reported to have been taken “Intentionally by other means”, “Accidentally by man” and by “Natural causes”, so we may be seeing a combination of less instances of shooting and more instances of the other circumstances.

The proportion of recovered Lapwings taken “Intentionally by other means” than shooting began increasing rapidly in the mid-1980s. The “other means” includes all captures by ringers (EURING 2010), and some of the increase might be explained by an increase in this type of recoveries. While bird ringing traditionally is dependent on other people recovering and reporting the ringed birds, scientists basing their research projects on actively going out and recovering their own ringed birds is becoming increasingly common (Bakken, Runde & Tjørve, 2003).

"Accidentally by man" includes impact with man-made structures like cars, wires and buildings. With e.g. traffic becoming a more and more relevant factor (in terms or the number of roads and cars), it makes sense that the proportion of recovered Lapwings impacted by this set of circumstances would increase with time. It is however curious to see that the proportion actually has decreased rather than increased since the 1980s. Are better safety measures in place? It is worth noting here that the total number of Lapwings in this category is 44; less than 6% of the total number of recovered Lapwings. The statistical significance can therefore be discussed.

The proportion of Lapwings recovered after being impacted by "Natural causes" (e.g. predation, illness or injury), has remained relatively low throughout the time period; increasing somewhat from the late 1970s and otherwise remaining stable. Predation is believed to have increased as a result of agricultural intensification, and while this factor to a large degree impacts breeding success (i.e. nests and chicks, rather than ringed adults), larger predators such as the Red Fox (*Vulpes vulpes*) can also take adult Lapwings. Although climate is independent on (local) human activity it is somewhat surprising to see it not be more heavily represented overall. Winter climate is considered to be an important factor in adult survival in Lapwings (e.g. Peach, Thompson & Coulson, 1994), and peaks in the number of Lapwings recovered under this circumstance may be connected to particularly cold winters. Like with "Accidentally by man", this is also a small category. With only 62 recoveries, or approximately 8% of the total number of recovered Lapwings, the statistical significance can also here be discussed.

4.3 Mortality

The mortality curve (**Figure 5)** shows the estimated mortality rate for the population of recovered Lapwings ringed in Norway through time. It does not represent the mortality for Lapwings (or even Norwegian Lapwings) in general, and the numerical values are higher than what is likely to be the actual mortality for the general Lapwing population. However, as the mortality in any given year is relative to the mortality in other years, it is reasonable to believe that the mortality of the population follows a similar trend over time. With the majority of circumstances being unspecified during the first few decades of recoveries (**Figure 4a**), it is difficult to say much about the cause of the variations in mortality in the early years. With the increasing number of Lapwings ringed and recovered, along with the larger degree of specificity of reported circumstances, we can make more reliable connections in more recent times.

The variation in mortality in the 1950s and 60s coincides with the spike in the number of ringed and recovered Lapwings (**Figure 3**), which we can see reflected in the relatively low degree of uncertainty on the mortality curve in this period. The proportionally most common set of circumstances surrounding recovery in this time period is "Intentional shooting" (**Figure 4b**), indicating that this is the main cause of the high mortality in the late 1950s and early 1960s. Despite the smooth curve showing a top in the proportion of shooting in 1960, when the mortality is at its lowest, the plotted points reveal that proportionally few Lapwings were recovered shot this particular year.

The decline in mortality after the mid-1960s coincides with the decline in the number of Lapwings ringed and recovered; the opposite of what would be the case if mortality was the main reason for the population decline. In terms of circumstances, the decline in mortality coincides with the decline in the proportion of Lapwings being taken "Intentionally by shooting" and the increase in the proportion being taken "Intentionally by other means", "Accidentally by man" and by "Natural causes" (**Figure 4c-e**). The mortality increases again in the 1980s; coinciding with the new increase in the number of ringed and recovered Lapwings. "Intentional shooting" is still declining, while the other specific circumstances are increasing. Over the past decade we see a slight increase in the mortality again, along with the declining number of ringings and recoveries. Sharpe, Clark & Leech (2008) found that adult survival rates of Lapwings in the UK had increased in recent decades. This is consistent with our results for much of the period, though our results suggest a new increase in mortality over the last few years.

So what can the mortality curve say about the population variation? At the point where the number of ringings and recoveries are the highest, mortality is both at its highest and its lowest.

While it does change somewhat, the mortality is reasonably stable, and ultimately it is at approximately the same level at the beginning and at the end of the period 1932-2013. In other words; changes in mortality does not appear to be the reason for the population decline observed in recent decades.

4.4 Habitat selection and availability

I did not find a statistically significant relationship between habitat selection and availability in my field study. The simplified implication of this is that the Lapwings in the Jæren region show no preference for one habitat category over the others, and that they are just as likely to settle down in cultivated as in non-cultivated fields. Considering the fact that agricultural intensification is considered to be the main cause of the Lapwing population decline, this is interesting. If the Lapwings had shown a statistically significant preference for one of the habitats, it would be interesting to look at how the availability of the different habitats in Jæren had changed over time.

Outside just the four habitat categories there are several environmental parameters that play a part in the Lapwings' habitat choice; relative size of the field, sward height, moisture levels, disturbance and so on. While there was no statistically significant difference between the different habitat categories in my study, observations did indicate that some types of fields were more likely to have Lapwings on them than others. Quantifying some of these environmental parameters could be useful in future analyses.

In their 15 years performing annual censuses in the same area, Byrkjedal et al. (2012) found that Lapwing males were statistically significantly overrepresented in "Cropland" habitats, and furthermore that Lapwing males showed a statistically significant population decline in "Cropland" habitats but not in "Pasture" habitats. My division of habitat types is slightly different than the classifications used by this study, but in terms of their two main habitat categories "Cultivated grassland", "Cereal fields" and "Tilled fields" can be pooled as "Cropland" habitats while "Natural pasture" falls under "Pasture" habitat.
Worth nothing about the field study I conducted is that the winter 2012/2013 was unusually harsh both in Norway and on the continent, with many long lasting and extreme cold periods. The

spring came later to Jæren than normal, and many Lapwings delayed their migration back from their wintering areas. Several of the early arrived Lapwings were discovered frozen/starved to death, and it is likely that fewer Lapwings than normal bred in Jæren in 2013 (Mjølsnes, 2014). This might also have affected their habitat selection in this particular year.

4.5 Conclusions and thoughts about the future

The Lapwing population decline in Norway over the past few decades is documented by both registered species observations and ringing data. In the same period we also see a slight increase in the mortality estimated in the Bayesian model. People have become more specific in reporting the circumstances surrounding the recovery of Lapwings over time. While shooting was the most prevalent among the specified sets of circumstances up until the 1980s, other sets of circumstances have become more prevalent in recent years, indicating that hunting may be less of a threat to the Lapwing population now than previously. Despite some variations, mortality does not appear to be the main reason for the population decline observed in Norway in recent decades. This is consistent with the conclusion from other studies indicating that breeding success rather than adult survival is the main reason for the global population decline. In their meta-analysis, Roodbergen, van der Werf and Hötker (2012) concluded that adult survival had stayed relatively stable on a global level over the last decades, and the total decline came from the reproductive output not being able to compensate for adult mortality.

I did not find a statistically significant relationship between habitat selection and availability in my field study, but overall agricultural habitat changes are considered to be the overarching factor affecting the population decline. To keep the decline in the Norwegian population at bay, it is important that we protect their breeding- and foraging habitats, whether that is cropland or pastures. Lapwings are well-loved birds, and the fact that many farmers already are taking measures to protect breeding Lapwings from their activity is a good sign when it comes to further conservation.

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APPENDIX 1. Population Model for Lapwing Mortality, made by Joseph Chipperfield

The mortality of the Lapwing population was modelled as a series of annual mortality rates with m_i representing the probability of an individual dying in time period *i*. The aim of the analysis is to derive the vector of annual mortality rates, **m**, where

$$\mathbf{m} = [m_1 \, m_2 \cdots m_n]^\mathsf{T}$$

and *n* is the number of time periods (years) in the study.

For each individual we are furnished with the following information: the date of the first capture of the individual and the date at which the individual was recovered. We also have information pertaining to the status of the individual when it was recovered. Most individuals were recovered dead but a small number were recovered alive. Find below the table of recovery statuses present in the dataset for the individuals used in this study:

Code	**Status**	**Earliest Date Individual Definitely Dead**	**Earliest Date Individual Could have Died**
1	Bird found dead but with no other information	Date of recovery	Assumed not more than six months before recovery date
2	Bird found freshly dead	Date of recovery	A week before the recovery date
3	Bird found dead but not in fresh condition	A week before the recovery date	Assumed not more than six months before recovery date
Other	Bird found alive	-	-

Therefore, for each individual we have two time periods of time that are relevant for the mortality of the lapwings: the time period in which the bird was definitely alive (henceforth referred to as the 'survival window') and the time period within which the bird died (henceforth referred to as the 'mortality window'). Given a particular vector of annual mortality rates, **m**, the probability of an individual, *i*, surviving each of the years that it was known to be alive is

$$p_i = \prod_k (1 - d_{ik} m_k)$$

where d_{ik} is the proportion of year *k* that individual *i* was known to be alive. Similarly, the probability of individual *i* dying during the time period within which it was known to have died is

$$q_i = 1 - \prod_k (1 - h_{ik} m_k)$$

where h_{ik} is the proportion of the year *k* that overlaps with the time period within which individual *i* is known to have died.

The probability of observing an individual's entire mortality history is therefore simply the product of the probability of observing the individual's survival window (p_i) and the individual's mortality window (q_i). In combination it is then possible to calculate the probability of observing the entire dataset of individual mortality histories, r, where

$$r = \prod_i p_i q_i$$

Whilst it is possible to fit the model as it currently specified to the dataset in order to estimate each of the annual mortality rates this would require the assumption that these rates exhibit no dependency through time. This is likely to a too simplistic implementation to accurately reflect changes in mortality and so we here restrict the mortality rates to follow an autoregressive process. Here we define the set of auxiliary variables, **w**, where

$$\mathbf{w} = [w_1 \, w_2 \cdots w_n]^\intercal$$

These variables follow a simple Gaussian random walk process such that

$$w_1 = \alpha$$
$$w_k = w_{k-1} + \beta_k$$

where

$$\beta_k \sim \mathcal{N}(0, \sigma)$$

and σ controls the inter-temporal variance between the auxiliary variables (effectively controlling the step length in the Gaussian random walk). The annual mortality rates are related to the auxiliary variables through the logit link function

$$\text{logit}(m_k) = w_k$$

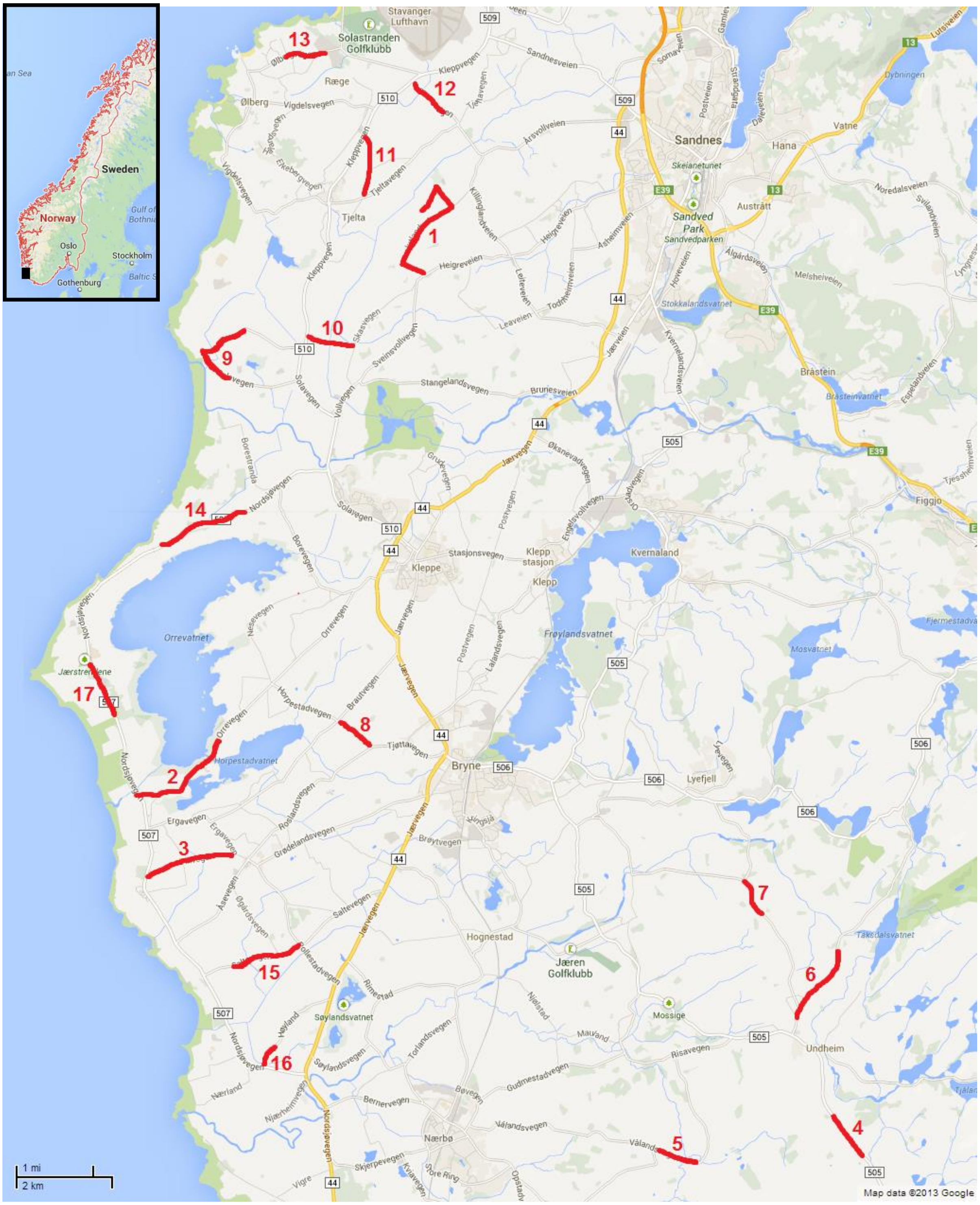
ensuring that the mortality rates remain within the range 0 to 1.

The model specified above was implemented for the JAGs Bayesian analysis software [1] using the BUGS model specification language. Estimates for the values of the parameters of interest were derived using Markov Chain Monte Carlo sampling using a total of 4 independent chains and running each chain for 21000 iterations (discarding the first 1000 iterations to allow for burn in).

References

1 Plummer, M. (2003) JAGS: a program for analysis of Bayesian graphical models using Gibbs sampling.

APPENDIX 2. Map of Jæren with transects



Map of Jæren. The road transects used for the census (numbered 1-17) are shown by the red lines on the map. The location of Jæren is shown by the black rectangle on the map of Norway.

APPENDIX 3. Transects with censused fields

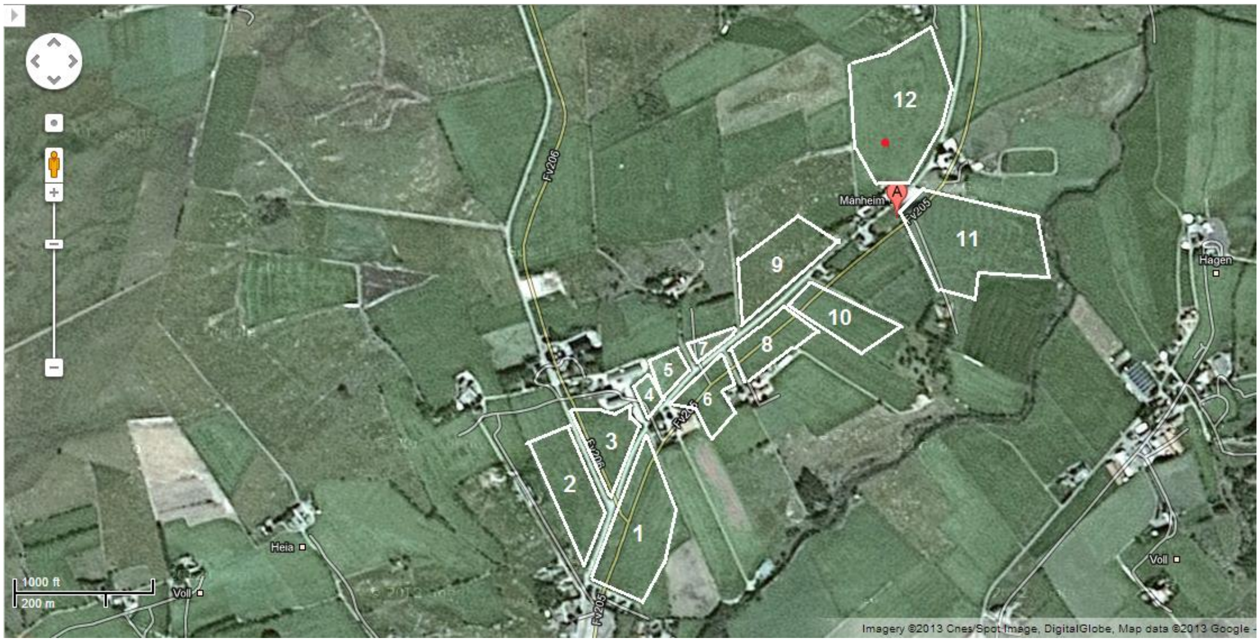
Transect 1. Jutlandveien

Transect 2. Orrevegen

Transect 3. Vikvegen

Transect 4. Undeheimsvegen

Transect 5. Vålandsvegen



Transect 6. Sælandsvegen

Transect 7. Timevegen

Transect 8. Horpestadvegen (Tjøtta)

Transect 9. Selevegen

Transect 10. Skasmyrvegen

Transect 11. Gamle Tjeltavegen

Transect 12. Gimravegen

Transect 13. Ølbergvegen

Transect 14. Nordsjøvegen (Bore)

Transect 15. Saltevegen


Transect 16. Høyland

Transect 17. Nordsjøvegen (Reve)

APPENDIX 4. Raw data from the field study. The habitat type and the number of Lapwings observed in each of the censused fields.

DATE	TRANSECT	FIELD	LAPWINGS (M)	LAPWINGS (F)	HABITAT
23.04.2013	1	1	0	0	Cultivated grassland
23.04.2013	1	2	0	0	Cultivated grassland
23.04.2013	1	3	0	0	Cultivated grassland
23.04.2013	1	4	1	1	Cultivated grassland
23.04.2013	1	5	0	0	Cultivated grassland
23.04.2013	1	6	0	0	Cultivated grassland
23.04.2013	1	7	0	0	Cultivated grassland
23.04.2013	1	8	0	0	Cultivated grassland
23.04.2013	1	9	0	0	Cultivated grassland
23.04.2013	1	10	0	0	Cultivated grassland
23.04.2013	1	11	0	0	Cultivated grassland
23.04.2013	1	12	0	0	Cultivated grassland
23.04.2013	1	13	0	0	Cereal field
23.04.2013	1	14	1	0	Cultivated grassland
23.04.2013	1	15	0	0	Cultivated grassland
23.04.2013	1	16	3	2	Cultivated grassland
23.04.2013	1	17	2	2	Cultivated grassland
23.04.2013	1	18	2	1	Cultivated grassland
23.04.2013	2	1	0	0	Cultivated grassland
23.04.2013	2	2	4	1	Cereal field
23.04.2013	2	3	2	0	Cereal field
23.04.2013	2	4	3	1	Cultivated grassland
23.04.2013	2	5	1	1	Cultivated grassland
23.04.2013	2	6	1	0	Cultivated grassland
23.04.2013	2	7	0	0	Cultivated grassland
23.04.2013	2	8	0	0	Cultivated grassland
23.04.2013	2	9	0	0	Cultivated grassland
23.04.2013	2	10	3	2	Cultivated grassland
24.04.2013	3	1	0	0	Cultivated grassland
24.04.2013	3	2	0	0	Natural pasture
24.04.2013	3	3	0	0	Cultivated grassland
24.04.2013	3	4	0	0	Cultivated grassland
24.04.2013	3	5	1	1	Cultivated grassland
24.04.2013	3	6	6	2	Cultivated grassland
24.04.2013	3	7	1	0	Cultivated grassland
24.04.2013	3	8	3	2	Cultivated grassland
26.04.2013	4	1	0	0	Cultivated grassland
26.04.2013	4	2	1	2	Cultivated grassland
26.04.2013	4	3	0	0	Cultivated grassland
26.04.2013	4	4	0	0	Natural pasture
26.04.2013	4	5	1	0	Natural pasture
26.04.2013	4	6	0	0	Cultivated grassland
26.04.2013	4	7	0	0	Cultivated grassland
26.04.2013	4	8	0	0	Cultivated grassland
26.04.2013	4	9	0	0	Cultivated grassland
26.04.2013	4	10	0	0	Natural pasture
26.04.2013	4	11	0	0	Cultivated grassland
26.04.2013	4	12	0	0	Cultivated grassland
26.04.2013	4	13	0	0	Cultivated grassland
26.04.2013	4	14	0	0	Cultivated grassland
26.04.2013	4	15	0	0	Cultivated grassland

26.04.2013	5	1	0	1	Natural pasture
26.04.2013	5	2	0	0	Natural pasture
26.04.2013	5	3	0	0	Natural pasture
26.04.2013	5	4	1	0	Natural pasture
26.04.2013	5	5	2	1	Cultivated grassland
26.04.2013	5	6	1	1	Cultivated grassland
26.04.2013	5	7	0	2	Cultivated grassland
26.04.2013	5	8	0	0	Cultivated grassland
27.04.2013	6	1	1	0	Cultivated grassland
27.04.2013	6	2	0	0	Cultivated grassland
27.04.2013	6	3	0	0	Cultivated grassland
27.04.2013	6	4	0	0	Cultivated grassland
27.04.2013	6	5	0	0	Cultivated grassland
27.04.2013	6	6	0	0	Cultivated grassland
27.04.2013	6	7	0	0	Cultivated grassland
27.04.2013	6	8	0	0	Cultivated grassland
27.04.2013	6	9	0	0	Natural pasture
27.04.2013	6	10	0	0	Cultivated grassland
27.04.2013	6	11	0	0	Cultivated grassland
27.04.2013	6	12	4	2	Cultivated grassland
27.04.2013	6	13	2	3	Cultivated grassland
27.04.2013	6	14	0	0	Cultivated grassland
27.04.2013	7	1	0	0	Cultivated grassland
27.04.2013	7	2	0	0	Cultivated grassland
27.04.2013	7	3	0	0	Cultivated grassland
27.04.2013	7	4	0	0	Cultivated grassland
27.04.2013	7	5	0	0	Cultivated grassland
27.04.2013	7	6	0	0	Natural pasture
27.04.2013	7	7	0	0	Natural pasture
27.04.2013	7	8	0	0	Cultivated grassland
27.04.2013	7	9	0	0	Cultivated grassland
27.04.2013	7	10	0	0	Cultivated grassland
27.04.2013	7	11	0	0	Natural pasture
28.04.2013	8	1	1	0	Cultivated grassland
28.04.2013	8	2	0	0	Cultivated grassland
28.04.2013	8	3	0	0	Cultivated grassland
28.04.2013	8	4	2	2	Cultivated grassland
28.04.2013	8	5	2	2	Cultivated grassland
28.04.2013	8	6	0	0	Cultivated grassland
28.04.2013	8	7	0	0	Cultivated grassland
29.04.2013	9	1	1	0	Cultivated grassland
29.04.2013	9	2	0	0	Tilled field
29.04.2013	9	3	1	1	Cultivated grassland
29.04.2013	9	4	0	0	Cultivated grassland
29.04.2013	9	5	0	0	Cultivated grassland
29.04.2013	9	6	1	0	Cultivated grassland
29.04.2013	9	7	1	0	Cultivated grassland
29.04.2013	9	8	0	0	Cultivated grassland
29.04.2013	9	9	1	0	Cultivated grassland
29.04.2013	9	10	0	0	Cultivated grassland
29.04.2013	9	11	0	0	Natural pasture
29.04.2013	9	12	0	0	Cultivated grassland
29.04.2013	9	13	1	0	Tilled field
29.04.2013	9	14	0	0	Tilled field
29.04.2013	9	15	0	0	Cultivated grassland
29.04.2013	9	16	0	0	Tilled field

29.04.2013	10	1	0	0	Cultivated grassland
29.04.2013	10	2	0	0	Cultivated grassland
29.04.2013	10	3	0	0	Tilled field
29.04.2013	10	4	0	0	Cultivated grassland
29.04.2013	10	5	0	0	Cultivated grassland
29.04.2013	10	6	0	0	Cultivated grassland
29.04.2013	10	7	0	0	Cultivated grassland
29.04.2013	10	8	0	0	Cultivated grassland
29.04.2013	10	9	6	5	Cultivated grassland
29.04.2013	10	10	3	2	Cultivated grassland
01.05.2013	11	1	0	0	Cultivated grassland
01.05.2013	11	2	0	0	Cultivated grassland
01.05.2013	11	3	0	0	Cultivated grassland
01.05.2013	11	4	0	0	Cereal field
01.05.2013	11	5	0	0	Cultivated grassland
01.05.2013	11	6	1	2	Cultivated grassland
01.05.2013	11	7	2	3	Cultivated grassland
01.05.2013	11	8	0	0	Tilled field
01.05.2013	11	9	0	0	Cultivated grassland
01.05.2013	11	10	0	0	Cultivated grassland
01.05.2013	11	11	0	0	Cultivated grassland
01.05.2013	11	12	1	1	Cultivated grassland
01.05.2013	11	13	0	0	Cultivated grassland
01.05.2013	11	14	0	0	Cultivated grassland
02.05.2013	12	1	0	0	Cereal field
02.05.2013	12	2	1	1	Tilled field
02.05.2013	12	3	2	3	Cultivated grassland
02.05.2013	12	4	0	0	Cereal field
02.05.2013	12	5	2	0	Tilled field
02.05.2013	12	6	0	0	Cultivated grassland
02.05.2013	12	7	0	0	Cultivated grassland
02.05.2013	12	8	0	0	Natural pasture
02.05.2013	12	9	0	0	Natural pasture
02.05.2013	12	10	0	0	Cultivated grassland
02.05.2013	12	11	0	0	Cultivated grassland
02.05.2013	12	12	0	0	Cultivated grassland
02.05.2013	13	1	0	0	Tilled field
02.05.2013	13	2	1	3	Cultivated grassland
02.05.2013	13	3	0	0	Tilled field
02.05.2013	13	4	0	0	Cereal field
02.05.2013	13	5	0	0	Cultivated grassland
02.05.2013	13	6	0	0	Cultivated grassland
02.05.2013	14	1	0	0	Cultivated grassland
02.05.2013	14	2	0	0	Cultivated grassland
02.05.2013	14	3	0	0	Cereal field
02.05.2013	14	4	0	0	Cultivated grassland
02.05.2013	14	5	4	2	Cultivated grassland
02.05.2013	14	6	0	0	Tilled field
02.05.2013	14	7	0	0	Tilled field
02.05.2013	14	8	1	1	Cultivated grassland
02.05.2013	14	9	1	1	Cultivated grassland
05.05.2013	15	1	0	0	Cultivated grassland
05.05.2013	15	2	2	0	Cultivated grassland
05.05.2013	15	3	0	0	Tilled field
05.05.2013	15	4	1	1	Cultivated grassland
05.05.2013	15	5	0	1	Cultivated grassland

05.05.2013	15	6	0	0	Cultivated grassland
05.05.2013	15	7	3	4	Cultivated grassland
05.05.2013	15	8	0	0	Tilled field
05.05.2013	15	9	0	1	Cultivated grassland
05.05.2013	15	10	0	0	Tilled field
05.05.2013	15	11	0	0	Cultivated grassland
05.05.2013	15	12	0	0	Tilled field
05.05.2013	15	13	0	0	Cultivated grassland
05.05.2013	15	14	1	1	Cultivated grassland
05.05.2013	15	15	0	0	Tilled field
05.05.2013	15	16	1	1	Cultivated grassland
05.05.2013	15	17	0	1	Cultivated grassland
05.05.2013	15	18	0	0	Cultivated grassland
05.05.2013	15	19	0	0	Cultivated grassland
05.05.2013	16	1	0	0	Cultivated grassland
05.05.2013	16	2	0	0	Cultivated grassland
05.05.2013	16	3	1	0	Cultivated grassland
05.05.2013	16	4	3	3	Cultivated grassland
05.05.2013	16	5	0	0	Cultivated grassland
05.05.2013	17	1	0	0	Cultivated grassland
05.05.2013	17	2	0	0	Cultivated grassland
05.05.2013	17	3	0	0	Tilled field
05.05.2013	17	4	2	0	Tilled field
05.05.2013	17	5	4	3	Tilled field
05.05.2013	17	6	6	2	Cultivated grassland
05.05.2013	17	7	0	0	Tilled field
05.05.2013	17	8	0	0	Cultivated grassland
05.05.2013	17	9	6	3	Cultivated grassland
05.05.2013	17	10	3	5	Cultivated grassland