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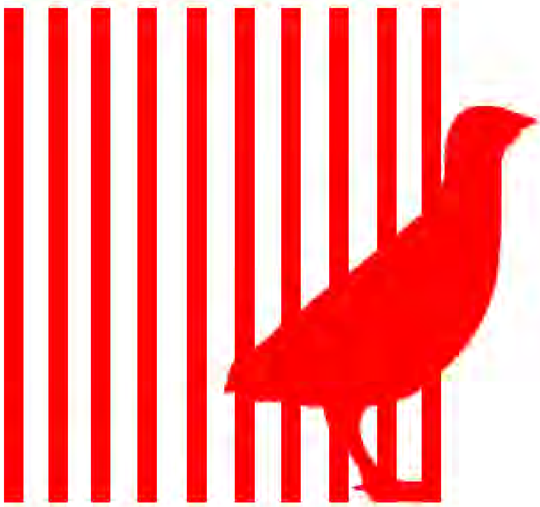
# The Corncrake - A misfit in the agricultural landscape

## An ecological niche factor analysis of the Corn Crake in Uppland, Sweden



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*Kornknarren är icke stor fågel men gav oss en upplysning om, att de vardagligaste naturuppleverlser ännu icke kunna förklaras med kända naturlagar och således måste tillsvidare anses övernaturliga och för övrigt antagas på god tro. Du har aldrig sett kornknarren i åker eller på ängen, men tror att han finns. Kommer nu en jägare som skjutit en fågel, då vore du än mer övertygad om dess befintlighet, fastän jägaren vore en ljugare. Men därmed är icke kornknarrens höstflyttning förklarad: att millioner oflygga fåglar kunna flyga över stora vatten och vandra över Alpgletscher. Då detta icke kan förklaras på naturligt sätt, så är det övernaturligt, och vi har därmed erkänt att vi ibland måste tro på det övernaturliga, eller på underverk.*

Strindberg, A. En blå bok.

# Abstract

There has been a distinct decline of farmland birds all over Europe during the last decades. The major reasons are agriculture intensification through drainage, conversion and abandonement. The Corn crake (*Crex crex*) is one of the species in the agricultural landscape that has been affected by habitat loss and degradation due to these measures. Suitable breeding sites have disappeared through drainage and land reclamation of old riverine meadows which have compelled the birds to search for new habitat, primarily crop lands and ley. In addition to habitat loss, there is a problem with early mowing, which in combination with relatively late breeding results in destroyed nests and eggs and killed chicks.

The most important factor in conservation projects is the maintenance of high-quality habitat and in later years the monitoring of habitats has been made easier. Powerful tools like ecological modelling techniques in Geographical Informations System (GIS) and Global Positioning Systems (GPS) facilitates the evaluation of the habitat situation on a larger scale. The GIS software Biomapper together with GPS was used in this work to examine the habitat situation and preferences of the Corn crake.

An ecological niche factor analysis (ENFA) based on presence points from 2007 showed that the Corn crake habitat in Uppland differs from the average available habitat. According to these results the Corn crake is a generalist inside this habitat. However, when using presence points from a census in 2008 the outcome was quite different. The data suggested that the Corn crake in Uppland is a habitat generalist but that the Corn crake habitat differs substantially from the average available habitat.

# Sammanfattning

Fågelarter knutna till jordbrukslandskapet har under flera årtionden stadigt minskat i populationsantal. Trenden har varit densamma i hela Europa och de huvudsakliga orsakerna är intensifiering av jordbruket genom dränering, omvandling och övergivande av mark. Kornknarren (Crex crex) är en av arterna i jordbrukslandkapet som drabbats hårt av förändringarna. Dränering och nyodlingar på strandängarna har tvingat kornknarren att söka upp nya häckningsplatser vilket ofta har blivit åker och vall. Förutom habitatförlusten är den tidiga slåttern också ett problem. I kombination med en relativt sen häckning resulterar den ofta i förstörda reden och ägg och döda ungar.

Den viktigaste komponenten i ett framgångrikt bevarandeprojekt är bevarandet av högkvalitativa habitat. På senare år har habitatstudier i större skala underlättats av GIS och GPS. För denna studie användes GIS-programmet Biomapper och GPS för att undersöka kornknarrens preferenser och situation gällande habitatet.

En ecological niche factor analysis (ENFA) baserad på en inventering från 2007 visade att kornknarrens habitat skiljer sig från det genomsnittliga, tillgängliga habitatet. Vidare beskrivs arten som en generalist inom habitatet. När inventeringen från 2008 används blir resultatet delvis ett annat. Kornknarren i Uppland beskrivs fortfarande som en generalist men dess habitat skiljer sig avsevärt från det genomsnittliga, tillgängliga habitatet.

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# Introduction

Two of the largest threats to wildlife are: loss and degradation of habitat (Johnson 2005). One of the most affected habitats in terms of species loss is the agricultural landscape, with 46 % of all the species on the Swedish red list occuring here (Gärdenfors 2005). Of these, at least 15% are bird species (Gustafson 2006). This loss and degradation has made natural grasslands one of the most threatened ecosystems in the world (Keišs 2006). To understand the historical decline and the present situation for farmland species it is essential to be aware of the history of the agricultural landscape. This is a landscape that has experienced an extended transformation since the end of the 1800s when degradation began with extensive draining (Gadd 2000). Hayfields lost their importance in the early 20th century when many meadows were transformed into farmland and drained, whilst others were abandoned and became overgrown. These actions lead to a loss of the important mosaic structure in the landscape (Risberg 1988). Following the Second World War there was a modernization of the agriculture, consisting of mechanized grass mowing, pushing the transformation of habitats further. At this time it also became possible to mow earlier in the season due to intense fertilization. One of the most significant changes in this post-war management of grassland was the replacement of traditional hay meadows with grass grown for silage. This switch in green fodder implied a great change. From cutting the hay on one single occasion late in the season the silage grass was cut two or more times and cut too early in the season for the grass seed to set (Chamberlain *et al.* 2000).

All these agricultural changes from the end of the 1800s to 1987, but first and foremost from 1970 to 1987, represents the first out of three distinct phases of agricultural policy in Sweden. This intensification period resulted in a 98 % decrease of wet meadow due to drainage, from 1 200 000 ha in 1870 to 24 000 ha 1990 (Bernes 1994). The second phase began in 1987 when a set-aside program was introduced as a result of the huge surplus of cereals. The agricultural production and the use of fertilizers and pesticides went down and this period lasted for eight years. The third phase started in 1995 when Sweden joined the EU and the Common Agricultural Policy (CAP) and the production supporting subsidies from that resulted in a new increase of agricultural production (Wretenberg 2006).

The intensification in productive regions and abandonment in marginal farmland that followed from increased demands on agriculture lead to a loss of heterogeneity at the farmland level (Wretenberg *et al.* 2006). This has had a huge negative impact on all species in the agricultural landscape in the whole of Europe. The decline has affected the continents biodiversity and recent analyses confirm that these declines are correlated with agricultural intensity (Zámečník 2008).

## Description of the Corn crake habitat

One of the species affected by the changes in agriculture is the Corn crake, a small and secretive rail species. The preference for substantially drier environments differentiates the Corn crake from the other members of the rail family (Keišs 2006). Hidden in tall vegetation with an inconspicuous plumage and a secretive life style, the only sign of its existence is often the inimitable call of the males. The call has given the birds its latin, onomatopoetic name, *Crex crex*. The Corn crake occurs overall in low numbers in patches in the southern and central parts of Sweden (Figure 1).


**Figure 1.** Three important areas within the Swedish population. Two areas are found in the Baltic on the islands of Gotland and Öland. The Swedish mainland population is concentrated to the central parts and mostly to the provinces of Uppland and Västmanland.

The global population breeds in a belt from Great Britain and France to Russia. It migrates to the wintering grounds in Africa between August and September and returns in May or June (Figure 2). The large and heterogeneous habitat on the wet grasslands provides suitable niches for a large range of species. This makes the Corn crake a good umbrella species for the biodiversity of wet grasslands habitats (Wettstein & Szép 2003).With the passing of years, the Corn crake habitat has changed. The original habitat in primaeval times is thought to have been riverine meadows and lowland marshes with vegetation dominated by *Carex*, *Iris* and *Typhoides* (Green *et al.* 1997). The shortage of this habitat nowadays due to loss and degradation has forced the Corn crake to go for the second best, and that is grasslands, especially arable land. These are mainly habitats where vegetation is removed annually, e.g by mowing, but also by burning or grazing (Birdlife international 2005). A majority of the population is now present on ley for production of hay and silage (Risberg 1987). Regardless if it is riverine meadow or farmland, the most important factor for a suitable breeding habitat and thus the distribution of the Corn crake, is the vegetation structure. It must be at least 20 cm tall and provide a dense cover but the bird must still be able to walk through (Wretenberg 2007).

There are two distinct problems with the current meadow management concerning Corn crakes in grassland habitats. The Corn crake seems to be favoured by disturbance of the vegetation but not if it is continuous (Berg *et al.* 2003) and that is why the first problem regards grazing. It is the dominating management method of today and it has been shown that Corn crakes avoid grazed meadows, since the vegetation becomes too low and sparse (Gustafson 2006). Mowing creates the tallest vegetation and is preferable but it is not a solution without complications. Early mowing is the second problem. This causes low breeding success and is assumed to be the main threat to the survival of the Corn crakes in Sweden (Ottvall 1999). Mowing from the inside and out and saving refuges of higher unmown vegetation in conjunction to the mowed fields for the remaining part of the breeding season are solutions that have been proven to work (Tyler *et al.* 1998). Conservation measures like these, which reduces losses of chicks and eggs during mowing, leads to a modest increase in productivity but were estimated to be sufficient enough to reverse the long term decline of the Corn crake population in Britain (Green 1999). There is an established connection between the population development and date of mowing. A study showed that if mowing took place earlier than in the end of July, the population declined rapidly, whereas later date of mowing lead to a stable or even increasing population (Green *et al.* 1997). If mowing takes place earlier than late June, it will destroy the first nests and remove tall vegetation habitat. Fields with early mowing are unlikely to grow tall enough for replacement nests so there will be no second brood either. If the mowed fields grows tall enough again, they are often grazed or mowed again which minimizes the chance for successful breeding (Green *et al.* 1997). The fact that the median date of the first harvest of hay and silage fields has been brought forward more than two weeks in Sweden since the 1970s (Ottvall 1999) makes it easy to understand the difficulties for the Corn crake. 2007).


**Figure 2.** Global breeding grounds in Europe and Asia and wintering grounds in southern parts of East Africa (e.g Tanzania and Zambia).

Later mowing is thus preferable but perhaps mowing every few years can create an even better habitat. The effect of different mowing frequencies on vegetation height and structure needs further studies (Gustafson 2006). Thus, creating and maintaining a suitable Corn crake habitat is a delicate balancing. Intense management leads to short vegetation and no, or too little management results in swamp forests (Berg & Gustafson 2007). The meadow management nowadays favours management dependent species that prefers short vegetation. This is the majority of the meadow species, such as waders like Lapwing *Vanellus vanellus*, and passerines like Meadow pipit *Anthus pratensis* and Skylark *Alauda arvensis* (Berg & Gustafson 2007). This can in the long run result in a shortage of habitat for the Corn crake and birds preferring similar surroundings with unmanaged or extensively managed vegetation (Berg *et al.* 2003). In this category we have species like Whinchat *Saxiola rubetra*, Common whitethroat *Sylvia communis*, Grasshopper warbler *Locustella naeviaans* and Common rosefinch *Carpodacus erythrinus* (Berg & Gustafson 2007). It is possible to avoid this conflict and combine management strategies but that takes large meadow areas big enough to include a range of different vegetations heights (Berg & Gustafson 2007).

## The situation today

There are population estimates of Corn crakes of 60 000 in the end of the 1800s (Ulfstrand 2003) and a major decline is obvious, but it is impossible to say how the Corn crake population has fluctuated in terms of population numbers during the years as a response to the transformation of the landscape. There is only scarce information regarding the population size before 1958 and the national census that year, but it is most likely that the population reached the small size of today already by the late 1940s (Wretenberg *et al.* 2006). The Swedish Corn crake population of today is assumed to be fairly stable but all the population estimates are nothing more than vague guesses due to the secretive lifestyle of the bird and an incomplete inventory work. Hopefully the picture will clear a bit since the Corn Crake became the national inventory species of 2008 (SOF 2008). One calculated average is 260 males (Berg *et al.* 2003) while another estimate states around 1 000 males on the Swedish mainland (Gärdenfors 2005). Even so, it is not clear whether or not the population is totally self-supporting and the species is listed as vulnerable in Sweden (Gärdenfors 2005). The low survival rate, probably around 0.2 and 0.3, is low for a bird species and postulates two successful broods every breeding season in order to maintain a steady population (Green 2004). There has been reported successful breeding but to what extent is not known and a just because there is a calling Corn crake male at a site that does not have to be a sign of breeding (Keišs 2006). Because of the concealed behaviour of the species, the knowledge of productivity, dispersal and annual survival of Corn crakes is still rudimentary and that is of course a huge problem in the conservation effort (Green *et al.* 1997).

## Increase?

The Corn crake was near extinction in several countries in the 1980s (Birdlife International 2005) but there has been an increase of the population in Europe during the recent years. The reason for this recovery is not clear. It is however hardly connected to the recent measures that have been taken in Sweden to favour the species, since the increase has not occurred on sites where efforts have been made (Wretenberg 2007). But perhaps restoration and clearance measures initially had a positive effect on the population size (Berg *et al.* 2003). One explanation of the increase is abandoned, overgrowing areas in less fertile agricultural regions (Wretenberg *et al.* 2007). However, if this is the reason, this increase is considered short term since both intensive and abandoned agriculture is damaging for the species.

The most probable explanation to the recovery is temporary favourable breeding conditions in former Soviet-Union-dominated countries. This has lead to an increase of the total world population (Schäffer & Green 2001). The global estimate is 1 000 000 – 10 000 000 individuals and it is listed as "Near Threatened" globally (BirdLife International 2004). There is so to speak a corncrake buffer in Eastern Europe that probably provides Western Europe with birds and slows down the decline. It is likely that there is an influx of migrating Corn crakes from the Baltic States keeping the Swedish population somewhat stable (Berg *et al.* 2003). This illustrates the important fact that conservation of long distance migration birds is an issue without country borders (Wretenberg *et al*. 2006). These species are threatened by our globally changing environment and can be affected by environmental changes at several locations (Wettstein & Schäffer 2000). Little is for example known about the situation of the Corn crake at their wintering grounds in East Africa, and that is important knowledge for a successful conservation effort.

## Remote sensing

The maintenance of high-quality habitat is fundamentally important for conservation and in most cases wildlife management equals habitat management (Johnson 2005). Thus, studies of habitat and predictions of species distribution are essential for good and effective conservation (Hirzel *et al.* 2001). The use of spatially explicit models has increased during the past two decades. Linking Geographic Information Systems (GIS) with multivariate models have enhanced the possibility to understand both species-habitat associations and made it possible to derive habitat suitability (HS) maps to ease the interpretation of the habitat preferences of a species (Traill & Bigalke 2006).

## Purpose

The purpose of this study was to investigate niche breadth and habitat choice of the Corn crake in Uppland, Sweden using presence points from censuses from 2007 and 2008 and ecological niche factor analysis implemented in the computer program Biomapper to estimate habitat specialisation.

# Material and methods

## Census

An inventory took place between the 3rd and the 19th of June 2008. The method was partially derived from a previous inventory that was done in 2006 (Berg 2006). The areas were chosen with guidance from the Svalan database, a reporting site on the internet, oral communication with ornithologists Mats Edholm and Ulrik Löthberg, as well as mail correspondence with members of the public. Well known sites with continuous yearly visits by Corn crake's were primarily chosen as well as some areas with less known activity. Each of the areas were first censused by car to get an overview since the Corn crake can be heard from distances of more than 1 km (Pettersson 2007). It ended up with a total of eleven areas where Corn crakes were observed (Table 1). Each site was visited once during night time between 23.00 hours and 04.00 hours. According to previous studies, the maximum singing activity goes on between 23.00 hours and 02.00 hours GMT (Tyler & Green 1996). The observations took place during the night when weather conditions were favourable which meant no precipitation and a clear sky (Berg 2006).

**Table 1.** The eleven areas with singing Corn crake males.

| Name | Coordinates |
|---|---|
| Alstasjö (Hamra) | Lat: N 59º 44' 30.03"<br>Long: E 17º 14' 7.00" |
| Alstasjö (Skjutfält) | Lat: N 59º 45' 15.81"<br>Long: E 17º 16' 1.04" |
| Bergby (Vendel) | Lat: N 60º 10' 26.72"<br>Long: E 17º 35' 53.84" |
| Bälinge mosse | Lat: N 60º 1' 50.47"<br>Long: E 17º 26' 36.04" |
| Exarby | Lat: N 60º 14' 13.27"<br>Long: E 17º 37' 9.78" |
| Gunnarsbo/Månkarbov. | Lat: N 60º 13' 3.19"<br>Long: E 17º 28' 54.56" |
| Gunnarsbo | Lat: N 60º 13' 31.35"<br>Long: E 17º 28' 33.69" |
| Kyrksjön | Lat: N 60º 14' 49.90"<br>Long: E 17º 42' 48.31" |
| Marma | Lat: N 60º 30' 23.51"<br>Long: E 17º 28' 57.47" |
| Revelsta | Lat: N 59º 48' 51.43"<br>Long: E 16º 56' 41.48" |
| Salsta | Lat: N 60º 2' 47.27"<br>Long: E 17º 44' 20.97" |

## Ecological niche factor analysis

The ecological niche factor analysis (ENFA), is a multivariate analysis, built on the ecological niche concept (Hutchinson, 1957). The ecological niche can be seen as a subset of cells in the ecogeographical space where the focal species has a reasonable probability to exist (Hirzel *et al.* 2002). Or put in other words, a n-dimensional hypervolume where all the ecogeographical variables (EGVs) connected to the organism can be found (Basille *et al.* 2008).

The ecological niche concept is a suitable starting point when to analyse presence-only data, and that is ENFA:s key feature (Hirzel *et al.* 2002). Niche models like ENFA requires only presence data in contrast to the other two habitat models: the regression model and the conception model. The two latter models require both absence and presence data (Xuezhi *et al.* 2008). The fact that ENFA only requires presence data, enables analysis of organisms where absence data is hard to obtain. The Corn crake is one such example where use of absence data can be problematic in the evaluation of habitats, since ascertained absence is not necessary the same as a not suitable habitat. That can in turn lead to an incorrect interpretation of habitat suitability for the organism. So the important question is: are the animals really absent due to an unsuitable habitat (Basille *et al.* 2008)? An absence can be either true or false. Another term for it is zeroes (Martin *et al.* 2005). A true absence means that the animals for some reason are not present in the habitat. Maybe they have not yet, colonized their whole suitable habitat. This absence could be due to hunting, the history of colonization and demographic stochasticity (Basille *et al.* 2008), or just chance (Martin *et al.* 2005). A false zero on the other hand is an incorrect absence and may substantially bias analyses (Hirzel *et al.* 2002). There are two types of false zeroes. Either the animal is not discovered, for some reason during the time of survey, even though it is present or it can also be just temporarily absent in an actually suitable habitat (Martin *et al.* 2005). Because of these facts, in many cases, the absence of observation at a given position can not for sure be interpreted as a true absence. Therefore, it is a good idea to rely solely on presence data (Basille *et al.* 2008).

## The model

Models predicting the spatial distribution of species, sometimes called habitat suitability models or resource selection functions, are currently gaining interest (Hirzel *et al.* 2006). ENFA is one of them and it compares the distribution of ecological predictors at the locations where the species has been observed to a reference set describing the whole study area (Xuezhi *et al.* 2008). Just as with the Principal Component Analysis, all predictors (e. g. slopes, distances, bedrock, vegetation) are summarized into a handful of uncorrelated factors, which contains most of the information (Hirzel *et al.* 2001). The first of these factors is marginality (M). By measuring the difference between the ecological niche from the average available habitat, the marginality identifies the preference of the individual, population or species for specific conditions of the environment among the whole set of possibilities (Basille *et al.* 2008). Hence, it is the ecological distance between the species optimum and the mean habitat in the whole area (Xuezhi *et al.* 2008). It ranges from 0 to 1 and a high marginality near 1 equals very specific preferences for the studied organism. Specialization (S) or niche breadth appears as a consequence of the narrowness of the niche on some environmental variables (Basille *et al.* 2008). It is defined as the ratio of the ecological variance in the mean habitat to that of the focal species (Xuezhi *et al.* 2008). The coefficient ranges from one to infinite. This fact makes it more manageable to use Tolerance (T) instead. Tolerance is the inversed Specialisation and ranges from 0 to 1. Close to zero represents a specialist and close to 1 represents a generalist (Xuezhi *et al.* 2008). ENFA extracts one axis of marginality and several axes of specialization and by the computation of these it can provide a measure of the realized niche (Basille *et al.* 2008). Studies based on this model can interpret the relation between species habitat utilization and niche factors (Xuezhi *et al.* 2008). With this model it is possible to answer two questions. Where can the organisms establish and what does the organism search for? (Basille *et al.* 2008).

## The Habitat suitability map

From the result of the ENFA (eigenvectors and eigenvalues) it is possible to build a habitat suitability map in Biomapper. This map is a result of a comparison between all the pixels in the map and the pixels where the organism is present and each pixel is assigned a suitability index value between 0 and 100 (Hirzel *et al.* 2002). It is then possible to divide them in to different categories or bins, depending on their suitability. Thus, if we choose two bins the pixels in the suitability map can be either suitable or unsuitable.

## Data preparation and program computation

Two components are needed for an ecological niche factor analysis in Biomapper and those are ecogeographical maps and species maps. Ecogeographical maps contain the ecogeographical variables, EGVs that plays a role in the environment of the species. When it comes to the Corn crake it can be for example distance to water and vegetation types. At least two ecogeographical maps is needed. In this study two bands, 4 and 5, from an unclassified Landsat 7 ETM+ image (Acquisition date: 2002/08/04, path/row: 193/18, Zone: 34N) were used as ecogeographical maps. The second component needed for an ENFA is the species map. In this case two censuses from 2007 and 2008 were used. The 95 presence points from 2007 was collected from the database Svalan of the Swedish Ornithologists Association webpage and the 27 presence points from 2008 came from my own census. The species map and the ecogeographical maps were then manipulated so that all maps had the same resolution and extent. The CircAn module in Biomapper was used to create a 5 pixel buffer around each point and the Booleanisator module made the species maps binary. When all maps matched, a correlation matrix was computed in order to perform the ENFA. After that it was all set to start the ecological niche factor analysis and to create a habitat suitability map. Finally the habitat suitability map was cross validated with ten partitions.

# Results

## Census

The census in June 2008 resulted in 27 calling Corn crakes and presence points at 11 locations (Table 1).

## Ecological niche factor analysis

When combining species map and ecogeographical maps in the factor computation there are several outputs. In addition to global correlations matrix, global means, species covariances matrix and species means we also receive eigenvectors and eigenvalues affiliated to them. The eigenvalues are a key to a correct result. They require some attention and must be greater or equal to zero (Table 2 and 3).

**Table 2.** Eigenvalues from ecological niche factor analysis with presence points from 2007.

| Value | Expl. Spec. | Cum. Expl. Specialization |
|---|---|---|
| 1.303 | 0.646 | 0.646 |
| 0.713 | 0.354 | 1.000 |

**Table 3.** Eigenvalues from ecological niche factor analysis with presence points from 2008.

| Value | Expl. Spec. | Cum. Expl. Specialization |
|---|---|---|
| 1.489 | 0.604 | 0.604 |
| 0.977 | 0.396 | 1.000 |

The ecological niche factor analysis also produces a score matrix containing three different factors. These are marginality (M), specialization (S) and tolerance (T) and constitutes the core of the analysis (Table 4 and 5). They give information about the focal species and in contrast to the eigenvalues, these numbers are interpretable straight away and enables us to get a direct ecological understanding.

**Table 4.** Results from score matrix using 97 presence points from 2007.

| | |
|---|---|
| Marginality (M) | 0.506 |
| Specialization (S) | 1.004 |
| Tolerance (T) | 0.996 |

**Table 5.** Results from score matrix using 27 presence points from 2008.

| | |
|---|---|
| Marginality (M) | 0.948 |
| Specialization (S) | 1.111 |
| Tolerance (T) | 0.900 |

Marginality (M) is the first factor and a measure of how much the ecological niche of an organism differs from the average, available habitat. The figures from the analysis with presence points from 2007 indicate intermediate habitat preferences while the figures from the other analysis adverts strong prefererences. Specialization (S) or niche breadth describes the narrowness of the niche on some environmental variables. Because it ranges from one to infinity it is easier to use tolerance (T), which is the inversed specialization. Both results have a high tolerance which represents a generalist.

Next step in Biomapper is to create a habitat suitability map using earlier computations. With this function it is possible to illustrate the results and identify areas of suitable habitat (Figure 3 and 4). The maps indicate that when using data from 2007 a larger part of the province of Uppland was deemed suitable as compared to 2008. In both years unsuitable areas corresponded with the presence of large coniferous forests.

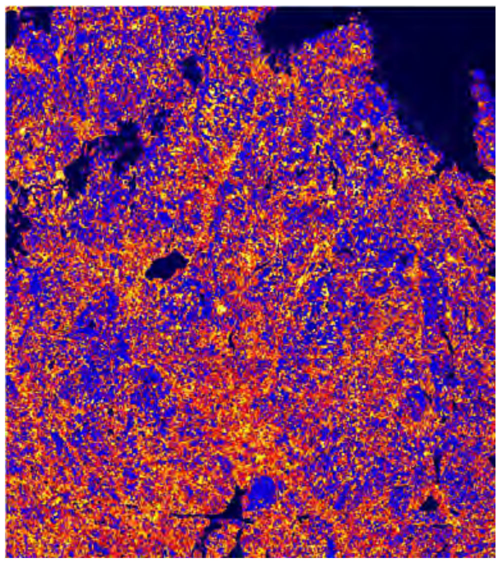

**Figure 3.** Habitat suitability map using presence points from 2007. Map values ranges from 0 to 100. Higher values means lighter (yellow/red) areas and a more suitable habitat.

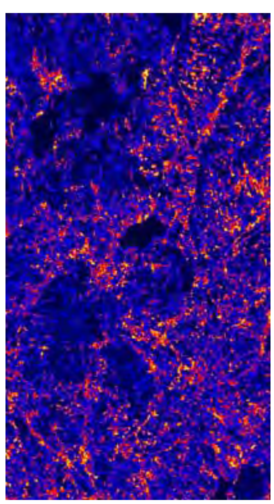

**Figure 4.** Habitat suitability map using presence points from 2008. Map values ranges from 0 to 100. Higher values means lighter (yellow/red) areas and a more suitable habitat.

# Discussion

## Model and census complications

The results from the two different ecological niche factor analyses differed slightly. When using presence points from 2007 the Corn crake habitat in Uppland differs from the available average habitat. The result also describes the bird as a generalist inside this habitat. When using the presence points from 2008, the analysis shows that the Corn Crake prefers a habitat that differs significantly from the average available habitat but that it still is a generalist inside its habitat. Unfortunately I am quite sceptical to both these results. During the census I experienced that all habitats with calling Corn crakes except one looked very much the same, with identical vegetation and landscape structure. They were all very specific habitats, that differ significantly from the average habitat in the landscape of Uppland. Therefore I expected the results to show a high marginality and low tolerance to reflect an animal that seeks a very specific habitat compared to the available average habitat in which it is more of a specialist than a generalist.

I thought long and hard about treating the presence points from the two years separate or together. Finally I decided to go with the first. Partly because I felt that the presence points from the different years differed in accuracy. One point from 2007 could represent several birds detected at the same time and the GPS locations pointed out did not seem that accurate. In addition, the knowledge of the observer was unknown, so these two arguments lead to two different species maps. One with fewer but more accurate presence points from 2008, on a smaller background and the other with more but not so accurate presence points from 2007, on larger background. The reason the background differs is that the ecogeographical maps are given the same extent as the species map in Biomapper so they match, and the 27 presence points from 2008 covers a smaller area of Uppland.

The delicate problem at this point with two maps with different results was to know which map that was correct. Due to the fact that the census was done in two different ways and in two different years, that was not possible to decide. The most probable answer is that unfortunately none of them are more correct than the other. Something seems to be wrong with the ecogeographical maps derived from the bands of the satellite image. Biomapper never complained about incorrect ecogeographical maps during the computations that went on without complications, including the EGV map verification, but something is definitely wrong. For some reason it is not possible to use all my six ecogeographical maps at the same time without receiving incorrect figures, outside the interval of 0-1 for marginality and specialization. The only two bands from the satellite image possible to use together are band 4 and 5. They give information about among other things separation of land/water and estimation of water in vegetation and soil. How important these factors are for a suitable Corn crake habitat is unknown but presumably they do not play an important role. This information from two bands is too scarce and all information from the six bands is needed to give a more complete picture of the complex web of ecogeographical variables that creates the Corn crake habitat. Valuable information about the habitat preferences of the Corn crake was thus lost with the other four bands.

There is no satisfactory explanation to this problem even though Biomapper experts, including the creator of the program Alexandre Hirzel, have been consulted. Right now, the only explanation that theoretically still can solve this mystery, although it can seem far-fetched and unlikely, is the one that concerns extreme values. If this is the case, the majority of the presence points are associated with extreme map values, around 0 and 255. Such values should be uncommon (A. Hirzel, pers.com.). As a result of these problems the habitat suitability maps in this study are not reliable. There is a big difference between the two years and perhaps it is caused by many presence points not so accurate pointed out during the census 2007. There are a lot more suitable habitats available according to the map with presence points from 2007 compared to 2008. But even if the map from 2008 is more reliable the lack of important information from the four bands that could not be included in the analysis makes it impossible to work further with the map. Even if the results had been reliable it would have been preferable to use a more recent and interpreted satellite image as ecogeographical map. Extensive landscape changes can happen in five years time and if the image is interpreted it is possible to see vegetation type preferences and ratiocinate directly from the map, for a more accurate result.

The advantage of ENFA as a presence-only model implies at the same time several drawbacks. First of all it is a weakness that there are no absences to counterbalance the presences (Hirzel *et al.* 2006). The second drawback for presence-only data important to be aware of is the unknown sampling bias associated with ad hoc. Factors like accessibility, distance to cities and type of environment often have a big effect on the sample. The last drawback concerns the risk of overstating the number of rare species compared to the common species (Zaniewski *et al.* 2002).

There are possible complications also in the early stage of a study like this. Conducting a census of Corn crake can be a bit problematic. Due to its secretive life style the only life sign possible to detect is the song from a calling male. Thus the presence points only represents the habitat preferences of males. This fact excludes the females and young and their habitat preferences remains thus unknown. This can be problematic since Corn crakes have relatively large territories (5 – 15 ha), including several different types of micro habitat (Berg & Gustafson 2007). Differences in ecological niches for cryptic and highly related species as well as for different sexes in different species have been demonstrated in earlier studies (Signorell *et al.* 2008)

A circumstance that can have lead to few detected males in this census is the date. It was performed a little bit too early in the breeding season. The breeding started for real about one week later, than the commence of our census (last week of June, Ulrik Löthberg pers. comm.). A census at that time would probably have rendered in more than 27 Corn crakes. Another obvious problem for censuses of Corn crakes is pairing, because when the male and female pair up the male ceases to sing. Only 12 % of the males in a study sang at night when they had been accompanied by a female during the preceding day and males were always silent when they were accompanied by a female at night. This pair bond lasts for about seven to ten days (Tyler & Green 1996) and can for obvious reasons obstruct the census and thus, lead to incorrect results and interpretations.

## Common agricultural policy, CAP

As mentioned above the majority of the global population lives in Eastern Europe (e.g. the Baltic States and especially Russia) where more favourable conditions seem to exist. The question is though how long the situation will stay like this. The EU-memberships of Estonia, Latvia and Lithuania in 2004 will most likely be a backlash for the Corn Crake populations there. The former, favourable situation for farmland birds in these states was a result of the collapse of the communism in the 90s and the low intense agriculture (Green *et al.* 1997). Therefore, farmland in these new member states boasts a disproportionate share of the EU´s biodiversity (Zámečník 2008). But that will in all likelihood change with the intensive farming methods being introduced. Since the Latvian accession to European Union many abandoned areas have been mowed and even ploughed again in 2005 when the agricultural funds, CAP became available. This will result in change of land use and that will not favour the corncrake (Keišs 2006). The same course of events as in Latvia can be assumed to occur in Estonia and Lithuania since the EU-membership and the agricultural funds should have the same effects in these countries (Zámečník 2008).

The global population increase is severely threatened by CAP and it is mentioned as one of the main problems. CAP expenditures represents over 40 % of the total EU budget and is therefore a powerful force that simultaneously supports greater productivity and inhibits extensification (Zámečník 2008). The second catastrophic decline in biodiversity in Europe is predicted unless CAP is radically reformed (Zámečník 2008).

Hopefully, the Swedish population is self-reproducing even without the probable influx from Eastern Europe and will remain stable. But still a lot of questions remain regarding the situation and habitat preferences of the Corn crake in Sweden.

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