Daily movement patterns of common crane (Grus grus) during the staging period in lake Kvismaren

Caroline Westerlund 2013

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Abstract

I used GPS satellite tracking data to calculate the distance from roost, distance from consecutive position, amount of daily field visits and minimum convex polygon (MCP) for common crane (Grus grus) during their staging period in Lake Kvismaren, in southeastern Sweden in 2012. Common crane juveniles were marked with GPS transmitters and followed between August and October. The aim of the study was to gather knowledge about the daily movement patterns during the staging period and thus acquire knowledge about where to deploy accommodation fields to prevent crop damage by the common cranes. Based on my results I recommend 1-6 fields in a radius of 5 km from the roosting sites. One or two larger accommodation fields should be put up close to the roost and most of the fields should be placed with a distance of 500-1000 meters in between with the start 5 km from and towards the roost.

Keywords: Common crane, Grus grus, accommodation fields, movement pattern, GPS transmitter, roost, MCP, distance formula.
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Table of Contents

Abstract ........................................................................................................................ ii
Acknowledgements .................................................................................................. iii

1 Introduction ...................................................................................................... 6
   1.1 Overall aim ............................................................................................ 7

2 Methodology .................................................................................................... 8
   2.1 Tagging of cranes .................................................................................. 8
   2.2 The staging period in Lake Kvismaren ............................................. 9
   2.3 Four ways of measuring the movement patterns of common cranes: .......................................................... 10
   2.4 Early and late periods ........................................................................ 11
   2.5 Statistics ............................................................................................... 11

3 Results ............................................................................................................. 12

4 Discussion ....................................................................................................... 15

5 Conclusion ...................................................................................................... 19

References ................................................................................................................... 20

Appendix A: Map ...................................................................................................... 22
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Caroline Westerlund 2014-01-13

**Terminology**

**Accommodation fields**
Protected fields where the cranes are allowed to feed and reside. These fields are preferably assigned in areas where the cranes normally staging. If the field will be well used there will soon be a lack of food resources. Then barley or another for the cranes valuable food resource is spread over the field to make them continue to choose the accommodation field before other crop fields in the landscape.

**MCP**
Minimum convex polygon, measuring the area between given positions. In this case x and y-coordinates on a map. It chooses the outermost positions and draws a polygon surrounding the movement area of the crane. That means that this method includes also areas that the crane has never visited.

**Crane**
The only normally occurring crane species in Sweden is common crane (*Grus grus*). I will mention it as either common crane or crane.

**Field polygon layer**
A layer in the program ArcGIS containing spatial data that shows fields and their boundaries. It has been used together with the GPS-tracking data to determine where and when the cranes visits a field.
1 Introduction

The common crane (Grus grus) is a migrant bird that lives in indefinite monogamous pairs. They normally come to Sweden in March for breeding. The juveniles are fledged in late June-July. The crane family then moves to better feeding areas where they stay and fatten up before migrating south in late September-early October to mainly France or Spain (Mullarney et al. 1999).

Common cranes usually have their roosts in shallow waters such as wetlands or lakes (Månsson et al. 2013, Sparling & Krapu 1994) Lake Kvismaren is a valuable stop over area for the cranes during the staging in August and September, with its intensive farming and reconstructed bird lakes. Cranes gather in large flocks during the staging period and can cause extensive damage for the farmers and last year the government in Sweden paid 2,240,000 SEK (Karlsson et al. 2013) in compensation for the damage caused by grazing common cranes. Accommodation fields and scaring devices are deployed to prevent conflicts between the birds and farmers and knowledge about movement patterns of cranes makes it possible to more effectively estimate good locations establishment of accommodation fields (M. Hake et al. 2010) i.e. fields where foraging birds are allowed to feed and reside and where they are provided with more food if needed to attract them to stay there instead of foraging in crop where they can cause extensive damage. The knowledge may also help when deciding about when and where to put up scaring devices and aid when estimating the governmental support for expected damage and compensation for already done damage. In a larger perspective it can contribute to a better understanding about how to deal with future land management in a way that minimize human-crane conflicts and in the long term contribute to a more sustainable coexistence.

Since 2005 the number of cranes in Sweden have increased by approximately 25% to roughly 55,100 cranes in 2012 (Månsson et al. 2011). The last 30 years the number of cranes have at least more than doubled (Hermansson & Smitterberg 2009) partly as a result of unlimited amount of food in the farming landscape and the protection by law.
Overall aim
The purpose of this article is to describe the daily movement patterns of Common Crane (Grus grus) at their staging period in Lake Kvismaren and thus be able to give recommendations on where to put accommodation fields, how many there should be and how they should be places in relation to each other and in relation to the roost sites.

The aim is to answer the questions; A. How large are the daily activity areas? B. How far from the roost are they foraging at different times of the day and how long is the total movement distance per day? C. How many fields does a common crane visit on a daily basis? And moreover, do these results vary between the early staging season and the late?

The hypothesis is that the first position in the morning will be closer to the roost than the other day positions due to that the cranes are flying out in the landscape in search for a suitable foraging place. Further on the crane are assumed to have the evening positions closer to the roost-site compared to midday, as observed in the wintering areas in Gallocanta, Spain, (Alonso & Alonso 1992) before going back to the roost location.

I assume that the maximum distance from roost during the days are roughly 2,5-8 km (Alonso et al. 1994) and (Sugden et al. 1988) respectively. It might be worth to mention that I have not found any relevant information about the size of daily activity areas for foraging, grazing birds, in any literature I have sited. This part of the study has probably never been done before on common crane in Sweden. Therefore I have nothing relevant to compare with or to base any estimation on for daily activity areas.
2 Methodology

In this study I will focus on the daily movements of seven cranes using position data sampled from GPS transmitters. The study was carried out at Kvismaren (59-60° N and 15-16° E) in south-central Sweden. The pre-study tagging of common crane juveniles took place in the surroundings of Grimsö Wildlife Research Station (59° N and 15° E).

Lake Kvismaren is extensively cultivated and surrounded mainly by mixed deciduous but also pine and spruce forests. The lakes East and West Kvismaren were drained in favor for farming in the 1800’s but were restored with the start in 1978 for improving breeding and staging conditions for wetland birds (Anon. 2013).

The size of the study area was 315 km² (App. A) and the study was performed in the southern boreal zone. The growing season is approximately 160 days/year (Lundin 2006) with a mean annual temperature of 5°C (17°C in July, 16°C in August, 12°C in September 2012) (Anon. 2012) and an annual mean precipitation of 400 to 600 mm (Anon. 1990).

2.1 Tagging of cranes

Crane family groups were localized by surveying the area by car. This information was later used for finding and capturing crane juveniles for marking with rings and GPS transmitters. 7 juvenile cranes were marked in the research area close to Grimsö during June to August 2012 and their movement patterns at the Kvismaren area were followed during August to October.

They were caught by hand, just before fledge, after short distance runs from a car or hide. Juveniles with a weight of ≥3000 g were then equipped with GPS trackers (Picture 2.1) (Vectronics GPS-plus light-3). The tracker was attached with elastic textile bands to the back (picture 2.2) and is expected to fall off when the band is worn out. Moreover the cranes were ringed with 7 rings, for easy identification in field and to aid in further studies. Six rings were put in individual color combinations above the knee and one ring carried an individual number.

Picture 2.1
Johan Månsson weighing a juvenile crane
For each of the 7 tagged cranes I used eight specific days evenly distributed during the whole study period for studying the daily movement pattern. During these days positions from the cranes were obtained every half an hour (approximately between 4:00 am and 11:00 pm UTC) during each study day. In addition one midnight position was obtained at the roost-site. I have seen in the coordinate-data that the cranes rarely change their roosting sites. And in the case they do, the roosting sites in Lake Kvismaren are located less than one km in between, meaning that a movement between roost sites would be negligible in the scale of my study. The positions were displayed in ArcGIS 10.1 as points on a field polygon layer and these data were joined for estimating field visits.

I calculated the average values of each study day (8 study days per crane) and also the total average for every crane. The data were later divided and recalculated in an early (310812-160912) and late staging period (170912-041012). Each period thus lasted 17 days which contained 24 study days as up to three cranes could have their study days during one date. The division was done to be able to compare the early staging season when most cranes arrive to the area and the late staging season before cranes migrate south.
2.3 Four ways of measuring the movement patterns of common cranes:

1. Number of agriculture field visits per day.
2. Distance moved from roost.
3. Distance between consecutive positions and also overall movement distance per day.

Number of field visits per day
I choose to define a field as a farmed, continuous surface in the landscape which in this study are projected as a field polygon in an ArcGIS layer where lakes, wetlands, roads, fences, forest and ditches that surrounds it are excluded.

Two different definitions were used to define a field visit (Sparling & Krapu 1994);

Definition 1:
Every single GPS-position (visit) on a for that day new field.

Definition 2:
At least two consecutive GPS-positions on the same field i.e. at least half an hour should be spent at the field to be defined as a visit.

All data from when the crane visits the roost or are not visiting a field are excluded in the “number of field visits” calculations i.e. everything outside the fields projected in the “field polygon layer” in ArcGIS are displayed as null value for x and y coordinates in the attribute table.

Distance from roost
The distances to all daily positions from the previously used roosting site were calculated independent of habitat type i.e. not only positions on fields were used.

Distance between consecutive positions
Distance travelled was calculated by measuring the distance between the consecutive positions. Moreover, the total daily distance covered was estimated by summing the movement steps over the day.

Daily activity area (MCP)
The daily activity area was estimated trough minimum convex polygons (MCP) i.e.
“…The smallest polygon in which no internal angle exceeds 180 degrees and which contains all sites” (Burgman & Fox 2002).
2.4 Early and late periods

The data were divided in two periods, “Early” and “Late” to be able to compare early and late staging season and to see if there is a difference in movement patterns throughout the staging period. Behavior may for example change due to landscape changes i.e. changes due to farming practices during this period.

Early period and late period were defined depending on date and amount of study days. Both periods contain 24 study days each with dateline 310812-160912 for the early period and 170912-041012 for the late period. One of the cranes had all positions during the late period due to late arrival at Kvismaren and was therefore not included in the calculations for the comparison of early and late period.

2.5 Statistics

Calculations were carried out using Microsoft Excel 2010 and position data and MCP was computed in ArcGIS 10.1.

The distances were measured as Euclidean distance between coordinates, where $x_i$ and $y_i$ are the constant $x$- respectively $y$-coordinates for the roost location for distance from roost, and for distance from consecutive position $x_i$ and $y_i$ represents the previous position.

$$d = \sqrt{(x_i - x_{i-1})^2 + (y_i - y_{i-1})^2}$$

The purpose of this study is to gather quantitative, empirical data to be able to estimate locations for accommodation fields, and such also get a better understanding on where to put up scarring devices in relation to those. I have used no statistical analyses to calculate if there is any significant difference between the results.
3 Results

Number of field visits per day

The number of field visits per day varied slightly depending on the definition used (fig. 3.1 and 3.2).

![Figure 3.1 Average number of field visits displayed, using the first definition i.e. every new field is a visit. With standard deviation for the mean values for early resp. late, ±σ. Each point represents the average value for the 24 study periods of 6 cranes.](image1)

![Figure 3.2 Average number of field visits displayed, using the second definition i.e. two or more successive positions on a field is a visit. With standard deviation for the mean values for early resp. late, ±σ. Each point represents the average value for the 24 study periods of 6 cranes.](image2)

The number of field visits using the first definition is 9.2±2.3 and 9.8±3.0 respectively for early and late period. For the second definition the value for field visits is 5.6±1.5 and 5.0±1.2 field visits per day respectively for early and late period. There is no clear difference between the periods using the same definition, but the standard deviation, indicating larger variance, is largest for the late period using the first definition and for the early period using the second definition.

Distance from roost

![Figure 3.3 Total average distance from roost with displayed standard deviation, ±σ. Each point represents the average distance travelled by 7 cranes, during that specific time.](image3)

![Figure 3.4 a and b: Average distance from roost for the early a) respectively late b) period with displayed standard deviation, ±σ. Each point](image4)
represents the average distance travelled by 6 cranes, during that specific time.

The cranes spend most of the light hours approximately 5 km from roost i.e. 4±1 km from roost using all day data. Descriptively the standard deviation seems larger during the first hours and decreases throughout the day. This could indicate that the cranes get more stationary towards afternoon. There is no great change in average distance from roost until after midday when it seems that the cranes in general slowly starts to move towards the roost sites.

The distance between used sites and the roost are rather similar for the early and late as also indicated by a large variation (Fig. 3.4 a and b). The farthest distance from the roost-site was during the early period and was 11 km.

Distance from consecutive position

Cranes travel a distance of 15.5±5.0 km/day and the longest distance travelled during one day was 26.5 km (early period). The shortest distance travelled during one day was 7.1 km during the early period. The farthest distance between two consecutive positions occurred at 4.30 in the morning and was 9.5 km.

The distance travelled between two consecutive positions independent of time are 528±1156 m and 548±1149 m respectively for early and late period. The pattern of distance moved between consecutive positions confirms the pattern found for distance to roost i.e. the crane are moving more during the early hours of the day than during the middle day. Around 4.30 pm they again start to move greater distances.
when they turn back to the roosting sites.

Over all there are no visibly large differences between the early and late period for the travelled distance between two consecutive positions and total distance covered during one day.

**Daily activity area (MCP)**

The daily activity area for the whole staging season is 5.5±4.5 km².

![Figure 3.7 MCP showing the daily activity area in km² during early period respectively late period with displayed standard deviation, ±σ. Each point represents 24 study periods of 6 cranes.](image)

The daily activity area (MCP) was 5.5±4.0 respectively 5.5±5.0 km² during the early and late period. The largest daily activity area was 23 km² in the late period.
4 Discussion

I have studied 4 different aspects to be able to estimate the daily movement pattern of common cranes during their foraging in the farming landscape in Lake Kvismaren. Further I have used descriptive data to see if there is a difference in early and late staging season, but no statistical tests have been used because I have seen that there is no difference between the early and late period. The study has never been done before and therefore there is not much literature to cite in the subject. Therefore I also have read and referred to studies of geese, that have a similar behavior, and sandhill cranes that belong to the same family.

Number of field visits per day

I have shown that a common crane on average visit between 9-10 or 5-6 fields per day depending on definition (Fig. 3.1 and 3.2). I assume that the second definition gives a more representative value as a single position on a new field could be when the crane are residing there, but the crane could likewise be flying over the field and never actually visiting it. The second definition excludes bias due to that the crane are moving over areas or visit the field for a short time i.e. I also assume that the damage made on a field by a residing crane is larger with the time it spends on it due to that it is known to forage 80% of the light hours (Alonso et al. 1994). Also Alonso et al. (1994) found that cranes need 10-30 minutes to find out if a field is of good enough quality for foraging. If they do not find enough food in this time they will travel to another field. As the interval of the positions given by the GPS transmitters is 30 minutes I expect to partly cover this behavior i.e. using the second definition I also expect that I exclude fields that are less visited due to low habitat quality for the cranes.

The results (see fig. 3.1 and 3.2) show that there is no difference between the early and late period in number of field visits. No matter which definition is used. Moreover the standard deviation is almost the same for both periods with a slight difference. I do not consider this difference as significant as I have used data from only 6 cranes in the comparison.

Factors that could cause general variance in movement patterns and such amount of field visits could be a variation in amount of disturbance, by f. ex. varied use of scaring devices, general human activity and farming practices. Suppose that they are scarred from fields close to or of high quality and high protection value at a higher rate as the damage or perceived damage increase together with food depletion in the landscape with time. The probability that the cranes would increase their activity by moving between fields, especially of relatively high quality, is thus quite likely with a spreading of the damag-
To compare the distance from roost seen in other species, most species of geese have been seen to travel approximately 11 km (annual mean) out to their feeding sites (Béchet et al. 2010) and sandhill cranes have been observed to forage within 8 km of their roosting sites (Sugden et al. 1988).

The hypothesis saying that the first positions of the day would be closer to the roost than the others was true. But also the cranes are moving the longest distances, compared to the rest of the day, during the first hour after leaving the roost (See Fig 3.4 a and b).

Based on the average distance from roost an accommodation field should be located somewhere between the known roost sites (approx. 1 km out) and not further from known roost sites than 5-6 km in Lake Kvismaren. Taking into account that most standard deviation reaching past or to 6 km for the farthest average distances.

Distance from consecutive position

Descriptively there is no visible difference in the movement pattern between the early and late period. Figure 3.5 are very similar to the two comparisons in figure 3.6 a and b that are displaying a similar movement pattern during early and late staging season.

The results for distance from consecutive position show that the cranes
move the longest distances in morning and in the evening when they head out to the fields and back to the roost. The largest standard deviation also occurs during these hours. They are not as active during the middle day compared to mornings and evenings when they approximately move 500 meters between the positions. This pattern is described by Sparling & Krapu (1994) that says that “Cranes probably improve their foraging efficiency and reduce energy costs by remaining in the vicinity of their feeding grounds throughout the day”.

The approximate distance between accommodation fields would such be between 500-1000 meters due to the average distance moved and the standard deviation that indicates the variation for these positions.

**Daily activity area (MCP)**

The average activity area for a crane is approximately 5.5 km² during both early and late period. No account has been taken for where the cranes move except that we can see that all polygons have the starting and stopping position at the roost. A variation of used roosting-sites is irrelevant in the MCP calculations as the area is calculated using coordinates.

MCP is a way to estimate how large areas the crane would use even though it will never visit some fields that lie inside this area. This means that the crane probably use a smaller area in reality. But nevertheless, it is possible that the crane move somewhere inside this area.

Together with that the average distance from roost during a day is approximately 5 km I would recommend to put accommodation fields in an radius of 5 km and spread out with at least one field per 5 km².

**Statistics**

This study is limited due to that it is based on position data from 7 cranes and that only the data from 6 cranes have been used in the comparisons of early and late period. It is also limited due to that it is only performed one year. If the study were repeated on more cranes and for 2 or more years we could see if the slight differences occurring in my results are annual patterns or if they are due to randomness or caused by any environmental difference/ disturbance occurring during the year of the study.

The discussion and conclusion is consistently based on descriptive results rather than statistical. It could have been possible but not necessary to analyze if there is a significant difference in the distances, field visits and daily activity areas between the early and late period using for example students ttest. However I find it unnecessary due to the visibly similarity between the periods.

**Future research**

This study does not either include how the daily movement patterns are associated with the foraging behavior
Daily movement patterns of common crane (*Grus grus*) during the staging period in lake Kvismaren
Caroline Westerlund

Results
2014-01-13

or how factors in the landscape influence these patterns. Cranes are yet known to forage more than 80% of the daytime to meet their nutritional needs, and that they prefer to land where other cranes are already foraging especially when the landscape consists of low quality habitats with a few fields of good quality (Alonso et al. 1994). I expected this to show as the amount of habitats i.e. threshed or harvested fields increased in the landscape. The resources should probably get depleted fast with growing staging crane flocks during the later staging season.

These results are based on crane families that nest close to Grimsö and that stage in Lake Kvismaren. Maybe the results would be different if a study focuses on young, not yet paired cranes or if it is done in another area for example Hornborgasjön in Sweden or even in other countries. Further I think it would be interesting to see if my results are valid also for the northern parts of Sweden where the farming is not as extensive.
5 Conclusion

My general suggestions for the Lake Kvismaren area is to place 1-6 accommodation fields depending on the size of the fields i.e. between 5 and 20 ha. The fields should be spread out in the landscape, close to known roosting sites and depending on where the damage is most extensive in the landscape. Further they should be located approximately with a 500-1000 m distance with main direction towards the roost with the start at approximately 5 km out in the landscape. One or more accommodation fields close to (not more than 1 km from) known roosts could prevent the damage caused by the large flocks of cranes that forage close to the roost before night. Most scaring devices should be adjacent to valuable fields close to the roosting sites where large flocks of cranes gather up for grazing before heading back to the roost, and 5-6 km from the roost where cranes are most expected to reside most of the light hours. Scaring devices should of course not be stationed close to the accommodation fields where cranes should be left alone as far as possible and scaring them at those sites could result in a more spread out damage. I further recommend to put more food on the accommodation fields to prevent that the cranes cause damage on proximate fields in search for food as a consequence to that the habitat quality decreases on the accommodation fields. A habitat quality decrease could increase their moving activity and spread the damage in the landscape.
Daily movement patterns of common crane (Grus grus) during the staging period in lake Kvismaren
Caroline Westerlund

References

J. C. Alonso & J. A. Alonso, “Daily activity and intake rate patterns of wintering common cranes grus grus”, museo nacional de ciencias naturales (CSIC) & Departamento de Biología Animal, 1992


A. Béchet, J-F Giroux, G. Gauthier & M. Bélisle, “Why Roost at the Same Place? Exploring Short-Term Fidelity in Staging Snow Geese”, 2010

M. A. Burgman & J. C. Fox “Bias in species range estimates for minimum convex polygons: implications for conservation and options for improved planning. “, School of botany, university of Melbourne, 2002


J. Månsson, L. Nilsson & M. Hake, “Territory size and habitat selection of breeding common cranes (grus grus) in a boreal...
Daily movement patterns of common crane (Grus grus) during the staging period in lake Kvismaren
Caroline Westerlund

References
2014-01-13

landscape”, Grimsö Wildlife Research Station, Ornis Fennica 90:65-72, 2013


D. W. Sparling & G. L. Krapu, “Communal roosting and foraging behavior of staging sandhill cranes”, 1994

Appendix A: Map

Lake Kvismaren area with the positions during each study day displayed, each crane have its own color.