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Examensarbete i ämnet biologi
Department of Wildlife, Fish, and Environmental studies
Umeå
2014

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Credits: 15 HEC
Level: G2E
Course title: Bachelor degree thesis in Biology at the Department of Wildlife, Fish, and Environmental Studies
Course code: EX0571
Programme/education: -

Place of publication: Umeå
Year of publication: 2014
Cover picture: Kjetil Hansen
Title of series: Examensarbete i ämnet biologi
Number of part of series: 2014:14
Online publication: http://stud.epsilon.slu.se

Keywords: rustic bunting, Emberiza rustica, swampy forests, habitat modeling, bird survey, playback

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Abstract

The rustic bunting (*Emberiza rustica*) is a bird breeding in swampy boreal forests of Russia and Fennoscandia. In the last decades, populations in Norway, Sweden and Finland have declined drastically. The factors behind this decline are not fully understood and, among other things, there is a lack of quantitative habitat data from the breeding territories. In this study, 19 habitat variables are used to model presence of rustic bunting. Swampy forests in boreal Sweden were surveyed using playback and habitat variables were measured at both presence points and randomly generated points. The data were analyzed by generating all possible GLMs with one or two variables and ranking these models according to their AICc value. The individual variables were ranked using Akaike weights. The variables *broadleaf trees 3-5m tall* and *water surface coverage* stood out as the most important: they were both included in the top model and received top scores in the Akaike weights. This study is the first to analyze rustic bunting habitat in a quantitative manner and offers a starting point for making spatial predictions of rustic bunting habitat, which is important to further understand the situation at breeding grounds.

Introduction

Around the world, long-distance migrating birds are in decline (Holt 2000, Sanderson et al 2006, Heldbjerg and Fox 2008, Both et al 2009). Different hypotheses to explain this have been brought forward, including phenology mismatch (Jones and Cresswell 2009, Saino et al 2011) and sensitivity to habitat changes along the migration route (Bairlein and Hüppop 2004, Schaub et al 2005).

The rustic bunting (*Emberiza rustica*) is one of these declining species. It migrates in spring from the wintering grounds in Central Asia, China and Japan to breeding grounds in the boreal forests of Russia and northern Fennoscandia (Svensson et al 1999). This passerine bird appears to be rapidly declining in the parts of its breeding range for which trend data are available (Väisänen and Lehikoinen 2012, Green and Lindström 2014, Hansen 2014). For Russia, where a large proportion of the rustic bunting population breeds, no data has been published for the English-speaking audience.

In Norway, the rustic bunting has suffered an estimated population decline of 98% in the last 10-16 years, and 90% since 2008 (Hansen 2014). In 2014, the whole Norwegian population was estimated to merely 4-6 pairs, and the species is predicted to be soon lost from Norway (Hansen 2014). The rustic bunting is classified as Endangered (EN) by the Norwegian Red List (Kålås et al 2010). However, results from last years' monitoring (Hansen 2014) support moving it to Critically Endangered (CR).

In Sweden, the rustic bunting is one of the five species that has declined most dramatically during the last decade, together with bohemian waxwing (*Bombycilla garrulus*), willow ptarmigan (*Lagopus lagopus*), common eider (*Somateria mollissima*) and eurasian coot (*Fulica atra*) (Green and Lindström 2014). Between the years 1998-2013 the population declined by 5.3% every year (Green and Lindström 2014). Ringing data from Stora Fjäderägg ringing station, located in the Gulf of Bothnia, show a negative trend since the 1980s (L. Edenius, pers. comm., July 28th 2014).

In Finland, results from the national breeding bird survey program show that the population has decreased by 5.3% annually in 1981-2012 (Väisänen and Lehikoinen 2012). This equals a total population decline of 82.5% for that time period. Migration bird counts since 1979 from Hanko Bird Observatory in southwestern Finland also suggest a negative trend (Lehikoinen et al 2008).

Of the birds breeding in Sweden, the rustic bunting probably belongs to the species we have least knowledge about. It is sparsely seen on migration, as it usually resides in dense shrubby habitats and easily avoids detection (Svensson et al 2009). It is known to breed in swampy forests in northern Sweden (Svensson et al 1999) and such places are rarely visited by people. In June 2013, when the rustic bunting is most certainly on its breeding grounds, no more than 86 observations were reported to the Swedish Bird Report System (Nilsson and Södercrantz 2014). This can be compared with 2334 observations for reed bunting (*Emberiza schoeniclus*) and 2357 for yellowhammer (*E. citrinella*) for the same time period. This supports the argument that the rustic bunting is rarely seen on its breeding grounds.

Öhrn (1963) describes the typical rustic bunting habitat as very wet swampy forests with high abundance of birch (*Betula pubescens, B. pendula*) and alder (*Alnus incana*). In Norway, Hansen (2014) has made detailed habitat descriptions. He found rustic bunting territories on locations that were strongly affected by ground water, especially in combination with beaver activity.

Against the background of the rustic bunting population decline and the lack of quantitative habitat data, the following question will be addressed in this study:

- What habitat variables are most important for presence of rustic bunting in swampy forest?

The general purpose of this study is to increase the knowledge about rustic buntings' breeding habitat as a first step in understanding why it has decreased so markedly the last decades, and if this decline can be explained, partly or completely, by the circumstances on the breeding grounds.

Methods

Study area

The rustic bunting appears to be virtually absent from the coastal regions of the Baltic Sea while being more abundant in the inland region (Green and Lindström 2014, Nilsson and Södercrantz 2014). Due to this fact, a study area around the village of Åmsele in Västerbotten County was chosen. It is 51x42 km large and situated 90 km west of the Baltic Sea (Figure 1).

The study area is characterized by boreal forest, dominated by Norwegian spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*). The topography has to a large extent been shaped by the last ice age with hills, ridges and rivers. These landscape features have a north-west to south-east direction. A large part of the study area is covered with mires, especially in the east. These mires appear to be nutrient poor. Higher abundances of birch are usually found along streams, lakes and in forests with moving ground water close to the surface. The area has been affected by humans mainly from forest drainage and logging.

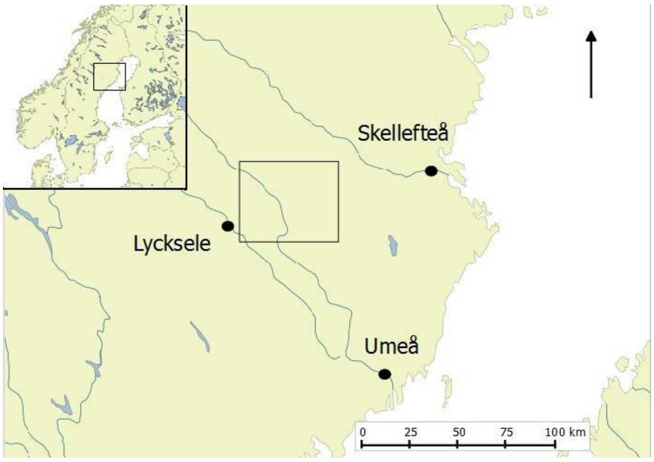

Figure 1. A map showing the study area.

Selection of survey objects

Results from the national survey of swampy forests conducted 1990-1998 (Rudqvist 1999) were used to find potentially suitable habitat patches, so-called survey objects, within the study area. Clear-cuts from 1998-2014 (Salén 2014) were removed from the swampy forest map layer using Arcmap 10.2. Fragments smaller than 1 ha were removed from further analyses. From the 272 remaining swampy forest objects, 150 objects were randomly selected. To avoid spatial autocorrelation, the selection was performed stepwise; any object closer than 500 m from previously selected objects were omitted from the rest of the selection process. Thus, the result was a selection of 150 survey objects where all were situated more than 500 m apart from each other. Of the 150 survey objects, 73 were visited in the field. Survey objects nearby each other were visited the same day to increase efficiency. However, the same part of the study area was never visited two consecutive days.

Field work

The field work was conducted from May 20th to June 17th 2014. This time period was chosen to match the peak activity of rustic bunting in their territory. The field work was initiated on May 20th to minimize the risk of missing late arrivals. To avoid visiting territories where early pairs had already left, the field work was terminated on June 17th. The breeding phenology notes from Öhrn (1963) support choosing this period of time. Field work was carried out in the mornings between 2 and 10 am (on rare occasions until 11 am). According to Öhrn (1963), the song activity has its peak in the early morning hours.

The survey objects were surveyed by foot using playback with a mixture of songs and warning calls from several recorded individuals (xeno-canto.org). Sound provocation has proven efficient in other song-bird studies (Sliwa and Sherry 1992, Boscolo et al 2006, Kubel and Yahner 2007), including the Norwegian study on rustic buntings by Hansen (2014). The playback was played constantly and in all habitats during surveying. To maximize the number of bird encounters, surveying was also performed in habitats between survey objects. Birds encountered outside the survey objects were also included in the analyses. A rustic bunting was usually detected from its warning call or song before it was seen. When a bird was detected, a coordinate was taken at the spot where it was first seen singing. If there was no singing, the coordinate was taken at the spot where the bird was first seen. Such a point will from now on be referred to as a “presence point”.

Vegetation survey points were generated randomly within each survey object. The number of points generated varied with object size; ranging from 1 point for the smallest survey objects to 4 points for the largest. To confirm absence, bird calls were played at each vegetation survey point for at least 5 minutes. Both the presence points and the vegetation survey points were visited once. The advantages of such a study design (more points visited, larger areas surveyed) was considered to be more significant than the disadvantages (increased risk of false absences and false presences).

A total of 18 vegetation variables were measured at both the presence points and the vegetation survey points (Table 1). Another variable, "distance to nearest small stream", was calculated for all points using Arcmap 10.2 and a shape file for small streams provided by Lantmäteriet (Lysell 2013).

Habitat modeling and Akaike weights

Logistic generalized linear models (GLMs) were run to model presence of rustic buntings, using the vegetation survey points as absence data and the presence points as presence data. To avoid overfitting of the models, the ”one-in-ten rule” was applied to limit the number of potentially explanatory variables (Peduzzi et al 1996). In this case, the number of presence observations (n=24) limits the number of explanatory variables to two. Consequently, all possible subsets with 0, 1 or 2 variables were run and ranked according to their AICc value using R package MuMIn (Bartoń 2014). The use of AICc, rather than AIC, is strongly recommended for small datasets with many explanatory variables (Burnham and Anderson 2002). The effect each variable in the best model had on rustic bunting presence probability was estimated by assigning news values to one variable while keeping the other variable constant, and vice versa. Akaike weights were calculated for all variables using the R package MuMIn (Bartoń 2014).

Results

Rustic buntings were observed at 24 points. A total of 109 vegetation survey points were visited in 73 survey objects. The data distribution for all 19 variables is shown in table 1. The top ten GLM models (of a total 173 generated models) are presented in Table 2. In the output, all models were ranked according to their AICc value. Notice that all top ten models had two variables; models with only one variable generally performed worse. The best model scored an AICc value of 100.57 (res. dev. = 94.38) and included the variables *water surface* and *broadleaves 3-5m*. The null model had an AICc value of 127.60 (res. dev. = 125.57). Assigning new values for the variables in the best model had the following effect: Probability of presence went from 18% to 40% when the number of *broadleaves 3-5m* was increased from 0 to 10 (*water surface* kept constant at 20%) and from 16% to 29% when *water surface* was increased from 0% to 30% (*broadleaves 3-5m* kept constant at 4). Akaike weights for all variables are presented in Table 3. *Broadleaves 3-5m* and *water surface* had the highest importance for rustic bunting presence, followed by the variables *dwarf-shrubs*, *broadleaves 1-3m* and *stream distance*.

Table 1. Variable names and data distribution for all variables collected in the field at both presence points and vegetation survey points. *Stream distance* was measured after field work using Arcmap 10.2. The variables with no units shown in parentheses are count data. Variables for trees >10m were measured in an area of 200m^2. All other variables were measured in an area of 100m^2.

Variable	Min	Max	Median
stream distance (m)	0.15	1068	68
turf height (cm)	20	130	40
water surface (%)	0	50	0
mosses (%)	2	95	90
dwarf-shrubs (%)	0	100	70
shrubs 0-1m (%)	0	95	10
number of turfs	2	139	22
broadleaves 1-3m	0	156	7
broadleaves 3-5m	0	15	1
broadleaves 5-10m	0	22	2
broadleaves >10m	0	17	1
pine 1-3m	0	22	0
pine 3-5m	0	16	0
pine 5-10m	0	20	0
pine >10m	0	17	0
spruce 1-3m	0	39	2
spruce 3-5m	0	12	1
spruce 5-10m	0	15	1
spruce >10m	0	18	1

Table 3. The variables ranked according to their Akaike weights. The weights were calculated using all possible GLM models with one or two variables. The sign shows whether the variable had a negative or positive effect for probability of rustic bunting presence.

Variable	Akaike weight	Sign
broadleaves 3-5m	0.7584	+
water surface	0.6146	+
dwarf-shrubs	0.2574	-
broadleaves 1-3m	0.1974	+
stream distance	0.0894	-
turf numbers	0.0217	+
broadleaves 5-10m	0.0143	+
broadleaves >10m	0.0109	-
turf height	0.0096	-
spruce >10m	0.0041	-
pine >10m	0.0037	-
shrubs 0-1m	0.0036	+
mosses	0.0028	-
pine 3-5m	0.0021	+
pine 5-10m	0.0021	+
pine 1-3m	0.0019	+
spruce 1-3m	0.0012	+
spruce 5-10m	0.0011	-
spruce 3-5m	0.0010	-

Table 2. The top ten generalized linear models using one or two variables, and the null model. The response variable (y) is the logit link expression for the probability of rustic bunting presence. The models are ranked according to their AICc value. The significance of each term is shown in three significance levels: p<0.05 (*), p<0.01 (**) and p<0.001 (***).

Model rank	Model formula	AICc value	Residual deviance
1	y ~ -3.0608*** + 0.0885 x water surface*** + 0.3030 x broadleaves 3-5m***	100.57	94.38
2	y ~ -1.0613* - 0.0262 x dwarf-shrubs*** + 0.2635 x broadleaves 3-5m***	102.45	96.26
3	y ~ -2.7863*** + 0.0817x water surface*** + 0.04120 x broadleaves 1-3m**	103.43	97.24
4	y ~ -1.8476*** - 0.0062 x stream distance* + 0.3409 x broadleaves 3-5m ***	104.75	98.56
5	y ~ -0.9019* - 0.0252 x dwarf-shrubs** + 0.0368 x broadleaves 1-3m**	105.63	99.45
6	y ~ -1.5482*** - 0.0072 x stream distance* + 0.0463 x broadleaves 1-3m***	106.65	100.5
7	y ~ -3.4210*** + 0.0363 x turf numbers* + 0.2905 x broadleaves 3-5m***	107.82	101.6
8	y ~ -2.7137*** + 0.0309 x broadleaves 1-3m* + 0.2341 x broadleaves 3-5m**	108.49	102.3
9	y ~ 0.3523* - 0.0307 x dwarf-shrubs*** - 0.1763 x broadleaves>10m *	108.81	102.6
10	y ~ -3.2452*** + 0.0350 x turf numbers** + 0.0445 x broadleaves 1-3m**	109.01	102.8
Null	y ~ 1	127.60	125.57

Discussion

The most important variables to predict rustic bunting presence were *broadleaves 3-5m, water surface, dwarf-shrubs, broadleaves 1-3m* and *stream distance*.

Small broadleaf trees (mainly birch) are of high importance in the rustic bunting habitat. In the Akaike weights, *broadleaves 3-5m* received the highest score and *broadleaves 1-3m* was at fourth place of the 19 variables. At least one broadleaf variable was included in all top ten models (Table 2). Probably the broadleaf trees provide a structure that appears attractive to the rustic bunting. A couple of observations were done at locations where spruce was the dominating tree species, but the general structure was the same: dense and young tree vegetation, 3-10 meters tall.

The variables *water surface* and s*tream distance* were both included in two of the top ten models and were in second and fifth place in the Akaike weight ranking, respectively. The presence of water appears to be important for the bird. All territories were found in the vicinity of ponds of still standing water and/or a small, slowly flowing stream. A strong influence of water is probably preventing trees from growing large and keeps the vegetation rather low (<10m) and dense; a vegetation structure that attracts the rustic bunting. It is also probable that the small ponds provide a significant food supply. The rustic bunting eats insects during breeding season and commonly forages around such ponds (Cramp and Perrins 1994).

Dwarf-shrub coverage (*Vaccinium myrtillus, V. vitis-ideae, V. uliginosum*) was included in three of the top ten models and was of high importance in the Akaike weight analysis. It was negatively correlated with rustic bunting presence. A large cover of dwarf-shrubs probably indicates that the habitat is too dry for the rustic bunting.

This study adds some new knowledge about the rustic bunting habitat on breeding grounds. Still, there is little known about the situation on wintering grounds and along the migration route. Extensive bird harvests in Asia appears to have had drastic negative effects on the closely related yellow-breasted bunting (*E. aureola*) (Birdlife International 2014), and this has been brought forward as a possible explanation for the rustic bunting decline as well. Three rustic buntings ringed in Sweden have been found on bird markets in China (Fransson 2006). However, there is yet no data available on the actual extent and numbers of rustic bunting harvests in this region.

Conclusions

This study has pointed out two habitat characteristics to be of special importance for the rustic bunting: 1) broadleaf trees 1-5 meters tall and 2) access to stagnant water and/or a slowly flowing stream. Although a few rustic bunting habitat descriptions have been published before, this study is the first to analyze the rustic bunting habitat in a quantitative manner.

Future

Little is known about the rustic bunting, both on breeding grounds, wintering grounds, and on migration. It remains an interesting field of research, especially considering the drastic population decline in recent time. Using the data presented in this study it is possible to make a spatial model to predict where rustic buntings breed. Laser data (lidar) could be incorporated in this model; a comprehensive and detailed scan of Sweden has been completed and the Swedish University of Agricultural Sciences is now developing GIS map layers for a number of vegetation variables. Lastly, studies of breeding success can provide better knowledge of habitat quality and population structure.

Acknowledgements

Thanks to my supervisor Lars Edenius, and my assistant supervisors Adriaan de Jong and Jean-Michel Roberge, for your support and enthusiasm from the first meeting until the last report draft. Thanks to Anton Larsson, Martina Bochenková and Sebastian Olofsson for your comments and your new perspectives.

References

Bairlein, F., & Hüppop, O. (2004). Migratory fuelling and global climate change. *Advances in ecological research*, *35*, 33-47.

Bartoń, K. (2012). MuMIn: multi-model inference. *R package version*, *1*(2).

BirdLife International (2014) Species factsheet: Emberiza aureola. Downloaded from http://www.birdlife.org on July 24th 2014.

Boscolo, D., Metzger, J. P., & Vielliard, J. M. (2006). Efficiency of playback for assessing the occurrence of five bird species in Brazilian Atlantic Forest fragments. *Anais da academia brasileira de ciências*, *78*(4), 629-644.

Both, C., Van Turnhout, C. A., Bijlsma, R. G., Siepel, H., Van Strien, A. J., & Foppen, R. P. (2009). Avian population consequences of climate change are most severe for long-distance migrants in seasonal habitats. *Proceedings of the Royal Society B: Biological Sciences*, 277(1685), 1259-1266.

Burnham, K. P., & Anderson, D. R. (2002). *Model selection and multimodel inference: a practical information-theoretic approach*. Springer.

Cramp, S., & Perrins, C. M. (Eds.). (1994). *The birds of the Western Palearctic*. *Vol 9: Buntings and New World Warblers* .Oxford University Press. pp. 240-250.

Fransson, T. (2006). Naturhistoriska riksmuseet, Ringmärkningscentralen. Downloaded from www.nrm.se on Oct 16th 2014. *In Swedish.*

Green, M. & Lindström, Å. Övervakning av fåglarnas populationsutveckling. Årsrapport för 2013 (2014). Biologiska institutionen, Lunds universitet, Lund. *In Swedish with English summary*.

Hansen, K. (2014). Vierspurvsprosjektet – status 2014. Fylkesmannen i Hedmark, miljø-vernavdelingen. *In Norwegian.*

Heldbjerg, H., & Fox, T. (2008). Long-term population declines in Danish trans-Saharan migrant birds: Capsule Long-distance migrant birds show less favourable trends than sedentary/short-distance species. *Bird Study*, *55*(3), 267-279.

Holt, J. P. (2000). Changes in Bird Populations on the Highlands Plateau, North Carolina (USA), 1946-1995, with Emphasis on Neotropical Migrants. *Natural Areas Journal*, *20*(2), 119-125.

Jones, T., & Cresswell, W. (2010). The phenology mismatch hypothesis: are declines of migrant birds linked to uneven global climate change? *Journal of Animal Ecology*, *79*(1), 98-108.

Kålås, J. A., Viken, Å., Henriksen, S. & Skjelseth S (red.), 2010: Norsk rødliste for arter 2010. *Artsdatabanken, Trondheim*. *In Norwegian.*

Kubel, J. E., & Yahner, R. H. (2007). Detection probability of Golden-winged Warblers during point counts with and without playback recordings. *Journal of Field Ornithology*, 195-205.

Lehikoinen, A., Ekroos, J., Jaatinen, K., Lehikoinen, P., Lindén, A., Piha, M., Vattulainen, A., Vähätalo, A. (2008). Lintukantojen kehitys hangon lintuaseman aineiston mukaan 1979–2007. *Tringa*, *35*, 313-321. *In Finnish.*

Lysell, G. (2013). GIS layer *Vägkartan Vektor – hl_1402*, Lantmäteriet. Data downloaded from https://maps.slu.se/get/ on April 4th 2014.

Nilsson, J., & Södercrantz, K. (2014). Swedish Bird Report System, ArtDatabanken, SLU. Data downloaded from http://svalan.artdata.slu.se/birds on Aug 28th 2014.

Peduzzi, P., Concato, J., Kemper, E., Holford, T. R., & Feinstein, A. R. (1996). A simulation study of the number of events per variable in logistic regression analysis. *Journal of clinical epidemiology*, *49*(12), 1373-1379.

Rudqvist, L. (1999). Sveriges sumpskogar: resultat av sumpskogsinventeringen 1990-1998. Skogsstyrelsen. *In Swedish.*

Saino, N., Ambrosini, R., Rubolini, D., von Hardenberg, J., Provenzale, A., Hüppop, K. Hüppop, O., Lehikoinen, A., Lehikoinen, E., Rainio, K., Romano, M. & Sokolov, L. (2011). Climate warming, ecological mismatch at arrival and population decline in migratory birds. *Proceedings of the Royal Society B: Biological Sciences*, *278*(1707), 835-842.

Salén, F. (2014). GIS layer *sksUtfordAvverk24*, Skogsdataportalen, Skogsstyrelsen. Data downloaded from http://skogsdataportalen.skogsstyrelsen.se/Skogsdataportalen/ on April 21st 2014.

Sanderson, F. J., Donald, P. F., Pain, D. J., Burfield, I. J., & Van Bommel, F. P. (2006). Long-term population declines in Afro-Palearctic migrant birds. *Biological conservation*, *131*(1), 93-105.

Schaub, M., Kania, W., & Köppen, U. (2005). Variation of primary production during winter induces synchrony in survival rates in migratory white storks Ciconia ciconia. *Journal of Animal Ecology*, *74*(4), 656-666.

Sliwa, A., & Sherry, T. W. (1992). Surveying wintering warbler populations in Jamaica: point counts with and without broadcast vocalizations. *Condor*, 924-936.

Svensson, S., Svensson, M., & Tjernberg, M. (1999). *Svensk fågelatlas*. Sveriges ornitologiska förening. 528-529 pp. *In Swedish.*

Svensson, L., Zetterström, D., Mullarney, K., & Grant, P. J. (2009). *Fågelguiden: Europas och Medelhavsområdets fåglar i fält*. Bonnier fakta. 394-395 pp. *In Swedish.*

Väisänen, R., Lehikoinen, A. (2012). Suomen maalinnuston pesimäkannan vaihtelut vuosina 1975–2012. *Linnut – vuosikirja*, 62-81. *In Finnish.*

Öhrn , B. (1963). *Barrskogsfåglar*. Norstedts. pp. 113-131. *In Swedish.*

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