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On the spatial distribution and the spring return schedule of White Stork in Lithuania

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The white stork (Ciconia Ciconia) is a national bird of Lithuania and by the density of its population Lithuania takes the first place in the world [2, p. 265], which explains our interest in the bird's distribution. There were four white stork censuses in Lithuania in 1959, 1974, 1984 and 1994–1995. Our study is based on a very thorough white stork census of 1994–1995 [1]. This one was part of a wide international programme coordinated by Germany. As a result, a rich information concerning nesting pairs, total number of fledged youngs, "stork density" etc was gathered throughout some 30 countries in Africa, Asia, and Europe [2]. In [3], the white stork population dynamics from 1978 till 1996 was investigated in Charente-Maritime, France.

In this report, we examine the spatial distribution of white storks in Lithuania and also some consistent patterns of their arrival in the springtime. We possess a detailed information for all 41 districts of Lithuania but in some cases we exclude the western district of Šilutė, where the number of white storks is at least twice as big as in any other district:

	County	*TotalArea*	*X*	*n.pair*	*north*	*east*
1	Akmenė	105475	66377	412	270	105
2	Alytus	140990	93640	670	56	175
...	...	...	...	...	...	...
31	Šilutė	224325	168465	2094	161	19
...	...	...	...	...	...	...
40	Vilnius	222001	122326	538	88	262
41	Zarasai	133436	76605	322	207	319

Here *TotalArea* is the total area of the district (ha), X (= *UsefulArea*) is the "useful" area of the district, i.e., X = *TotalArea* – (*forests* + *swamps* + *roads* + *built-up area* + *water bodies*), *n.pair* is the number of nesting pairs, and, finally, *north* and *east* are the coordinates of the district center (in km, from the southernmost and westermost points of Lithuania, respectively). Note, first, the fact that the number of pairs does not depend on the useful area (see Fig. 1). This is also confirmed by the regression analysis (for the data without Šilutė district):

lm(formula = n.pair $\sim X$*, data = CICONIA)*

Coefficients:

	Estimate	*Std. Error*	*t* value	$Pr(>\|t\|)$
(Intercept)	3.432e+02	1.341e+02	2.559	0.0146
X	1.459e−03	1.458e−03	1.001	0.3230

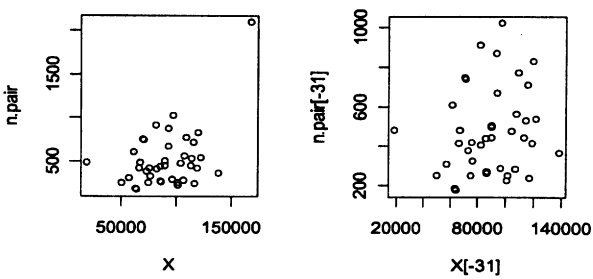

Fig. 1. Scatterplot of useful area X versus number of nesting pairs pairs *n.pair* (with Šilutė district (left) and without it (right)).

We see that our data does not reject the hypothesis that the coefficient at X in the model *n.pair*$= 343,2 + 0,001459X$ equals 0. In other words, the number of white storks in Lithuania has not yet reached saturation. On the other hand, the density of white storks, i.e., the value of the ratios *n.pair/TotalArea* or *n.pair/UsefulArea*, is greater in the western districts of Lithuania (see Fig. 2).

We investigated two possible explanations of this fact: the density depends on 1) total inshore area and 2) rainfall in the district. In the table below, we present the average precipitation for the period of April–October *prec*, the number of water bodies *w.nr*, the total area of water bodies *w.area*, the total inshore area *w.coast* (the latter parameter is not available in the records, however, under the assumption that all water bodies are convex and of "the same form", the 1 km wide total coastal area is proportional to $\sqrt{w.area \cdot w.nr}$), useful area X and the density of nests *nest.dens* (=$n.nest/X$):

	district	*prec*	*w.nr*	*w.area*	*l.coast*	X	*nest.dens*
1	Akmenė	405	10	2426	623.0249	66377	0.003178812
2	Alytus	430	76	7408	3001.3544	93640	0.003833832
3	Anykščiai	461	83	5316	2656.9998	18700	0.002292000
4	Biržai	417	20	3282	1024.8122	104387	0.003649880
5	Ignalina	450	213	13965	6898.7477	86024	0.002603924
...							

The scatterplots in Fig. 3 show and the regression analysis (see below) confirm that the nest density does not depend on *l.coast* but depends on *prec*. As the rainfalls are bigger in the western areas, this partially explains the density pattern observed.

lm(formula = nest.dens∼prec, data = ccc)

Coefficients:

	Estimate	*Std. Error*	t value	$Pr(>\|t\|)$
(Intercept)	−8.744e−03	2.297e−03	−3.806	0.000486
prec	2.658e−05	5.178e−06	5.133	8.22e−06

In the second part of our report, we investigate the first white stork arrival day in the springtime. It is known that the climate warming in general [4]–[6] and the temperature pattern of the given year in particular influence the whole living cycle of a bird. Our

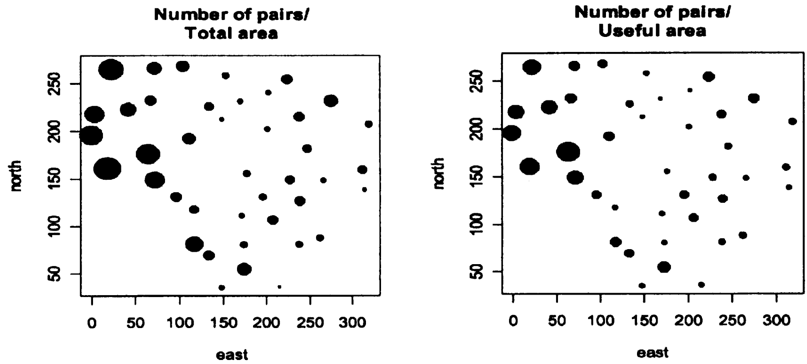

Fig. 2. Every circle corresponds to a district; the density of the white stork in the district is proportional to the radius of respective circle.

argument rest on the data collected in the National Žuvintas reservation from 1966 till 1997. Actually, the data concerns 148 species of birds and renders an account on the first appearance date of the bird as well as the temperature before that day. We tested the hypothesis that the forward spring fosters an early arrival of the first white stork. Though it is difficult to expect to get a firm confirmation of this hypothesis (since the white stork is a long-distance migrant), we prove that these two variables are definitely related.

The white stork returns to Lithuania along the coastal line of the Baltic Sea and then spreads eastwards. Clearly, the first stork's arrival to Žuvintas date is much affected by random factors and the arrival date of the first, say, 25% of white storks would be much more informative; however, it would take enormous efforts to collect such a data. In Fig. 4 (right), we present a scatterplot of the average temperature of the first 104 days of a year (from January 1 till April 14; for example, the 75th day is March 15) versus the first white stork's arrival day (this day ranged between the 74th and 97th day of the year; the most probable day was the 86th day (see Fig. 4, left)). The central graph of Fig. 4 represents the time series of the average temperature (January 1–April 14) of the years 1966–2000 – a slight evidence of the temperature increase in these latter years. The regression analysis shows that the coefficient at *Temperature* in the model *Day* = 81.812 – 0.906∗*Temperature* (cf. Fig. 4, right) is undoubtedly significant (the

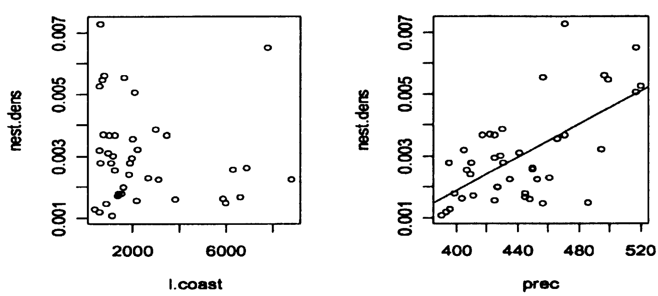

Fig. 3. Scatterplots of *l.coast* versus *nest.dens* (left) and *prec* versus *nest.dens* together with the regression line (rigt).

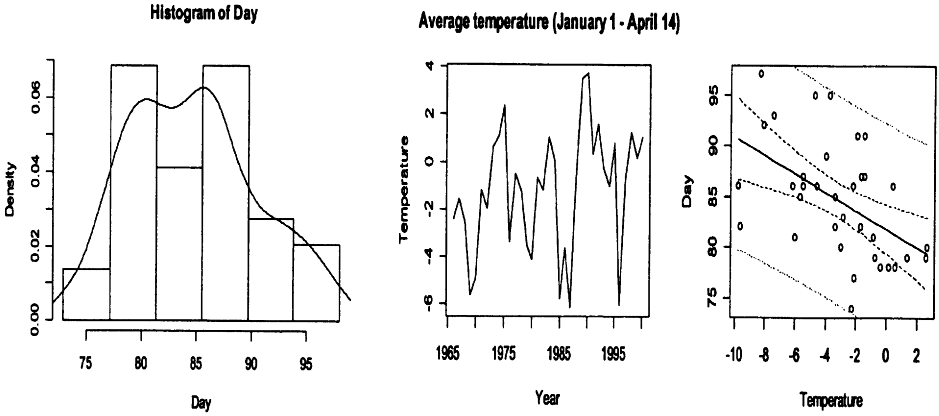

Fig. 4. Histogram and kernel density estimate of the first white stork arrival day (left); average temperature (January 1–April 14) (center); scatterplot of average temperature (January 1–March 15) versus the first white stork arrival day together with the regression line (right).

p-value of F-statistics is 0.00165), in other words, this gives a clear evidence that (the late winter) temperature influences the first white stork arrival date.

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Baltųjų gandrų pasiskirstymas Lietuvoje ir ju pavasarinio grįžimo ypatumai

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Darbe pateikti argumentai pagrindžia teiginius, kad 1) gandrų skaičius Lietuvoje dar nėra pasiekęs įsisotinimo ribos ir 2) didesnis gandrų tankis Lietuvos vakarinėje dalyje gali būti paaiškintas didesniu kritulių kiekiu toje dalyje. Taip pat įrodome, kad pirmojo gandro atskridimo į Žuvinto rezervatą data priklauso nuo paskutiniųjų žiemos mėnesių temperatūros.