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DETECTION OF FOREST LOSS ON BLACK STORK (*CICONIA NIGRA* L.) BREEDING SITES IN THE RIVNE REGION (POLISSIA) BY A GIS ANALYSIS

The study aims to assess the scale of forest loss (mostly caused by logging) on breeding sites of the local Black Stork breeding population in the Rivne region of Ukraine, within the Polissia nature zone. The study is based on a GIS analysis of the Global Forest Watch data in intersection of circular buffers of different sizes around 141 Black Stork nests.

Forest logging was detected on 38,3% of breeding sites in the region, in 100 m buffers around nests. On more than 14% of breeding territories (in 100 m buffers) forest loss exceeded 20% of the total forest area. Therefore, logging is one of the major threats for the local Black Stork population. The method used for the forest loss detection by a GIS analysis seems to be effective for the search of territories with the violation of protection regime for rare birds when resources are limited.

Keywords: *Black Stork, Ciconia nigra, logging, threats, GIS.*

Introduction

One of the main reasons behind Black Stork rarity in Europe is degradation of forest habitats because of the intensive logging [2, 3, 5]. Continuous logging makes forests younger and forest stands more age-homogeneous. In Ukraine, Black Storks usually inhabit forest plots with the highest productivity, with old and thick trees, often with prevalence of oaks which have the highest commercial value for the industry (Bokotey et al., this issue). This creates risks not only for Black Stork habitats but also for individual nests to be cut down. Ukrainian legislation forbids any harmful activity in relation to animals listed in the national Red Book (e.g. Black Stork) but the control of the law compliance is not effective. We know quite many cases when Black Stork nests were cut down by forestry workers. Sometimes, these were even inhabited nests during a breeding season.

Even when logging activities are conducted at some distance from a nest it creates additional stress for nesting of Black Storks as species very sensitive to disturbance. Our study aims to estimate the scale of forest loss (logging) on breeding sites of the local Black Stork population in the region with the highest in Ukraine breeding density [4] of the species and to test the possibility of a distant detection of forest loss on Black Stork breeding sites.

Materials and methods

In this study we use the information about exact locations of 141 Black Stork nests recorded by GPS navigators (Garmin eTrex). All the nests are located within the Rivne region of Ukraine in the Polissia nature zone (forest zone). Data from other regions of the country was not used in the analysis. Nest locations were discovered within the scope of the "Ciconia Ukraina" project.

Current analysis of the forest loss on breeding territories of Black Storks is based on the Global Forest Watch (GFW) data [1] derived from a classification of satellite imagery. The

data is available as rasters with spatial resolution of 1 arc-second per pixel, or approximately 30 meters per pixel at the equator. This data represents forest loss in the period between 2001 and 2014 in comparison to the global forest coverage (with the same spatial parameters) in the year 2000.

The GFW data represents forest loss regardless of causes of a loss. For instance, it shows forest loss caused by logging, fires and by other reasons combined. In our study, we would like to focus on the forest loss caused by logging. Unfortunately, there is no way to separate different causes of a loss in the GFW data, but in the case of the Rivne region forest fires are not the main reason of the forest cover loss. Based on our experience and on the unpublished data we can estimate the scale of loss due to fires as less than 20%. Another 80% of the forest loss in the region is caused by logging.

The area (and the proportion) of forest loss was calculated in circular buffers of different sizes around nest (fig. 1). We used two approaches to calculate the area of a forest loss. Firstly, we calculated the number of pixels from the forest loss layer which intersected with the buffers of the following sizes: 0-100 m, 0-200 m, 0-300 m, 0-400 m, 0-500 m using the "Zonal statistics as table" tool from the ArcGIS 10.5 toolbox. Knowing the size of a single pixel (~22,4×22,4 m), we can easily calculate the area of forest loss by multiplying the amount of pixels by the area of a pixel.

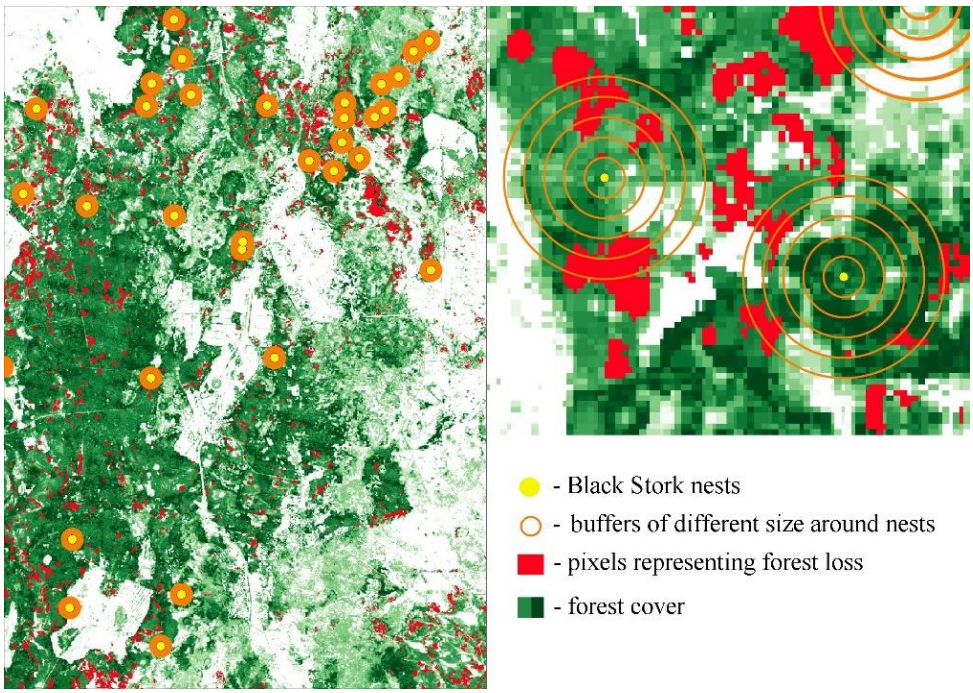

Fig. 1. The example of the GIS analysis of a forest loss area in buffers of a different size around Black Stork nests.

The results in the first approach were cumulative, because the area of forest loss for each of subsequent buffers (e.g. 0-500 m buffer) contained results from the all smaller buffers. Another approach was to calculate the amount of pixels in bands (rings) at the following distances: 0-100 m, 100-200 m, 200-300 m, 300-400 m, 400-500 m. The results in the second case are not cumulative and the scale of forest loss is assessed for each of the bands separately.

Apart from the analysis in buffers we created a map of forest loss in the region by aggregating pixels from the GFW data into 10×10 km squares using the "Zonal statistics as table" tool in ArcGIS 10.5. The map was used to analyze the distribution of nests in relation to the intensity of logging in the region.

Results and discussions

According to the results, the majority (61,7%; table 1) of the Black Stork nests are located on territories without a significant forest loss within a 100m radius around nests. Within the same radius forest loss in the range of 0-20% of a territory was found around other 24,1% of nests. The big scale of forest loss (20-100%) was present around 14,2% of nests. If the scale of forest loss in bigger buffers around nests (200 m, 300 m …) is taken into account, the proportion of intact territories decreases with the increase of buffer distances (see table 1). For example, in buffers 0-500 m around nests we found only 7,8% territories without any forest loss. Forest loss in the range of 0-20% was detected on the majority (83,0%) of the 500 m buffers around nests.

Table 1

The scale of forest loss in buffers of different sizes around Black Stork nests

Percentage of forest loss	Number of nests	Distance buffers (cumulative)				
		0-100 m	0-200 m	0-300 m	0-400 m	0-500 m
No loss	n	87	47	26	12	11
	%	61,7	33,3	18,4	8,5	7,8
0-20%	n	34	74	98	114	117
	%	24,1	52,5	69,5	80,9	83,0
20-40%	n	11	14	14	12	11
	%	7,8	9,9	9,9	8,5	7,8
40-60%	n	7	5	2	3	2
	%	5,0	3,5	1,4	2,1	1,4
60-80%	n	1	1	1	-	-
	%	0,7	0,7	0,7	-	-
80-100%	n	1	-	-	-	-
	%	0,7	-	-	-	-

Table 2

The scale of forest loss at different distances from Black Stork nests (in concentric buffer rings)

Percentage of forest loss	Number of nests	Distance buffers (bands)			
		100-200 m	200-300 m	300-400 m	400-500 m
No loss	n	48	30	21	21
	%	34,0	21,3	14,9	14,9
0-20%	n	70	89	98	96
	%	49,6	63,1	69,5	68,1
20-40%	n	17	19	21	22
	%	12,1	13,5	14,9	15,6
40-60%	n	5	3	1	2
	%	3,5	2,1	0,7	1,4
60-80%	n	1	-	-	-
	%	0,7	-	-	-
80-100%	n	-	-	-	-
	%	-	-	-	-

Some nesting territories have undergone almost complete logging, but such logging was detected only in the case of eight nests.

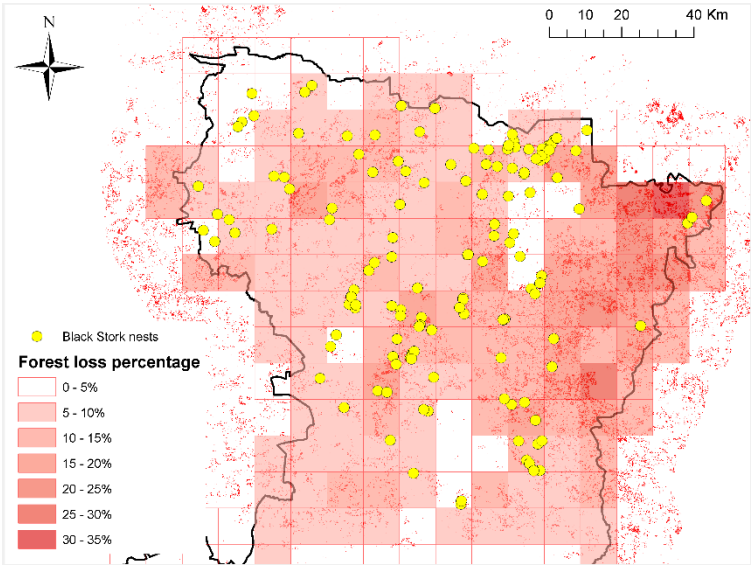

Fig. 2. The distribution of the Black Stork nesting locations in the Rivne Region in relation to the amount of forest loss.

If the distribution of the known Black Stork nests is compared with the map of forest loss in the region, the avoidance of the most heavily logged parts of the Rivne region is noticeable (see fig. 2). Up to 35% of the forest cover in some of 10×10 km squares in the eastern parts of the region have been lost since the year 2000. It is these eastern parts that have the smallest density of Black Stork nests. Moreover, all known nests in the sub-region have been lost because of the logging (those four yellow dots in the north-eastern part of the map).

Using the proposed approach, we have detected eight out of the eleven nests that were cut down (~73%; this figure is exact, because those nests were controlled). Therefore, the approach seems to be quite effective for the distant monitoring of nesting territories when resources are limited and it is not possible to check every nest by direct visiting.

Conclusions

In Ukraine, logging is one of the main threats for the local breeding population of Black Storks, as we have found evidence of logging on 38,3% of breeding sites in the Rivne region in 100 m buffers around nests. On more that 14% of breeding territories (in 100 m buffers) the forest loss was bigger than 20% of the area. Although we do not possess appropriate statistical data yet, the method of a forest loss detection by the GIS analysis seems to be effective for the search of territories with the violation of a protection regime for rare birds.

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Виявлення втрати лісу на гніздових ділянках чорного лелеки (*Ciconia nigra* L.) в Рівненській області (Полісся) за допомогою ГІС аналізу

Дослідження має на меті оцінити обсяги втрати лісового покриву (в основному через рубки) на гніздових ділянках локальної гніздової популяції чорного лелеки у Рівненській області України, в межах Полісся. Дослідження базується на ГІС аналізі даних Global Forest Watch в перетині з кільцевими буферами різного розміру навколо 141 гнізда чорних лелек.

Рубки лісу виявлено на 37,3% гніздових ділянок в межах 100-метрової буферної зони навколо гнізд. На понад 14% ділянок (у 100-метрових буферах) втрата лісового покриву перевищує 20% від загальної площі лісу в них. З результатів випливає, що рубання лісів є однією з основних загроз для локальної гніздової популяції чорного лелеки в регіоні. Апробована методика виявлення рубок за допомогою ГІС аналізу є ефективним засобом контролю дотримання охоронного режиму на гніздових ділянках рідкісних видів птахів за умови обмежених ресурсів.

Ключові слова: *чорний лелека, Ciconia nigra, рубання, загрози, ГІС.*

Струс Ю., Бокотей А., Дзюбенко Н.

Выявление потерь леса на гнездовых участках черного аиста (*Ciconia nigra* L.) в Ровенской области (Полесье) с помощью ГИС анализа

Целью исследования является оценка масштабов потери лесного покрова (в основном в связи с рубками) на гнездовых участках локальной гнездовой популяции черного аиста в Ровенской области Украины, в пределах Полесья. Исследование базируется на ГИС анализе данных Global Forest Watch в перекрытии с кольцевыми буферами разного размера вокруг 141 гнезда черных аистов.

Рубки леса выявлены на 37,3% участков в пределах 100-метровой буферной зоны вокруг гнезд. На более чем 14% участков (в 100-метровых буферах) потери лесного покрова превышают 20% от общей площади леса в них. Из результатов вытекает, что рубки леса являются одной из основных угроз для локальной гнездовой популяции черного аиста в регионе. Апробированная методика выявления рубок средствами ГИС анализа является эффективным средством контроля за соблюдением охранного режима на гнездовых участках редких видов птиц в условиях ограниченных ресурсов.

Ключевые слова: *черный аист, Ciconia nigra, рубки, угрозы, ГИС.*