

# Breeding distribution and ecology of the Black Stork *Ciconia nigra* in the Sava alluvial wetlands, Croatia

Martin Schneider-Jacoby

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During 1986-1988, a systematic ornithological study was carried out in the Sava wetlands in Croatia (Fig. 1). The study area covers 1,766 km<sup>2</sup> and supports a very high proportion of important biotopes: 612 km<sup>2</sup> of floodplain, 522 km<sup>2</sup> of autochthonous deciduous woodland (3/4 flooded), 119 km<sup>2</sup> wet pastureland, 121 km<sup>2</sup> hay meadows, 16 km<sup>2</sup> fish-ponds and 42 km<sup>2</sup> of rivers (Tab. 1). During the study, 469 observations of Black Storks were made and a total of 1,151 Black Storks seen. In 64% of the observations one stork was sighted, in 27% two individuals and on six occasions more than 30 birds were seen together (maximum 69). Most of the observations were conducted in April and May when the birds were making territorial flights over the riparian forests (Figs. 2, 3). 81% of the sightings were made in the floodplain. 60% of the observations were made of birds either in or in flight over wooded areas, 16% in wet pastureland, 5% in meadowland, 4% on fish-ponds and 3% on the Sava's tributaries. Black storks were observed in 44% of the 362 grid squares (2 x 2 km, Figs. 4, 6). Their distribution is discussed. Nests were seen in 26 of the squares, and in 45 grid squares territories existed. The population amounts to at least 70 breeding pairs. The area holds about 1% of the European population and is therefore of international importance.

**Key words:** Black Stork, *Ciconia nigra*, Sava alluvial wetlands, Croatia, distribution, population numbers, population density, habitat use, post breeding aggregation

## 1. Introduction

Floodplains are amongst the most threatened habitats in Europe (e.g. YON & TENDRON 1981). Only a few ornithological studies have been made in the floodplains in the middle course of the Sava river (e.g. ERN 1960; RUCNER 1967). The data published indicated a rich avifauna. In addition, the area which was already well known for its unique riparian inundation zone has been drained over the last 20 years with international aid (BÜSCHENFELD 1981 and 1987;

PRPIĆ 1984; PRPIĆ *et al.* 1979; SCHNEIDER 1986, Tab. 1).

The value of the intact parts of the Sava floodplain was not fully appreciated until recently (ERN 1990; GRIMMETT & JONES 1989; PRPIĆ & RAUŠ 1991; SCHNEIDER 1988; SCHNEIDER-JACOBY & ERN 1990). The Nature Protection Authority in Zagreb (Republički zavod, 1985) proposed creation of the Lonjsko Polje Nature Park, which was designated on 20

March 1990. The observations published in this paper are part of the research programme to document the avifauna of the area and to supplement the Park's protection plan. The Black Stork is one of the most important indicator species for documenting the importance of the Sava wetlands for conservation in Europe.

## 2. Method

On 466 days during 1986-1988, the avifauna in the study area (covering 1,766 km<sup>2</sup>) was recorded between Ivanić grad, Sisak, Dubica, Kutina, Novska, Okučani and Bosanska Gradiška (Fig. 1). In the main part of the area, I systematically examined the most important parts at fortnightly intervals during the breeding season. I drove around the large inundation zones by car, and explored some parts on foot or by bicycle. An examination of the northwestern part of the research area, 338 km<sup>2</sup> in size, was not possible due to the limited time available. Binoculars were used to scan forest areas, and a telescope was necessary for closer identification. All observations were noted with details of the site (grid square 2 x 2 km), behaviour, age, sex and biotope. The areas in which birds were observed were described in detail with regard to water level and agricultural use. Forest areas where pairs of Black Storks were seen circling were treated as territories.

The composition of the landscape was analysed using old maps drawn to a scale of 1:50,000 and a satellite photograph from the year 1986 (Tab. 1). The proportion of each biotope in each grid square and the proportion of observations were compiled using grid squares of 4 km<sup>2</sup>, as for the bird observations. The data were evaluated in the computing centre at the University of Constance, Germany, with the SAS statistical analysis programme.

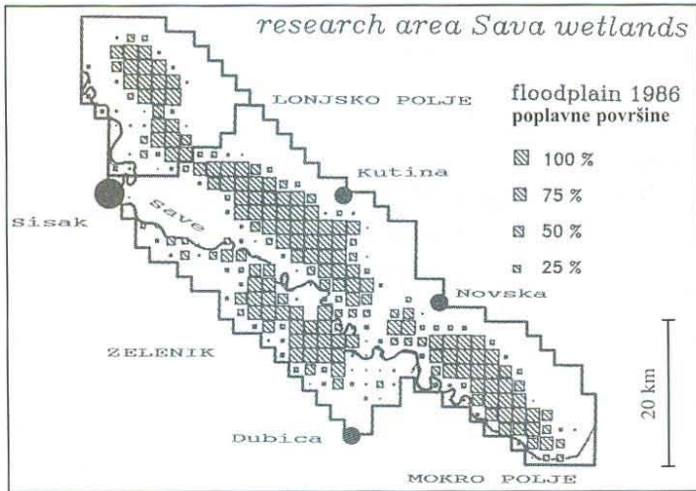
## 3. The research area

The research area contains one of the most important sections of the Sava floodplain (Fig. 2, Tab. 1). Tree quarters of the inundation area are forested and the study area is the largest area of continuous riparian forest in Central, Western and Southern Europe. As large parts of the Central Sava valley have been designated as protected areas due to their function as retention areas and retention basins, the original composition of the countryside has been preserved (SCHNEIDER-JACOBY & ERN 1990). However, in

**Table 1:** Size of the respective biotopes in the research area (number refer to biotopes in Fig. 8).

**Tabela 1:** Površina posameznih biotopov v raziskovanem območju (št. glede na biotope na sl. 8).

biotope	year, leto	
	before 1961 pred l. 1961 km <sup>2</sup>	1986 km <sup>2</sup>
floodplain poplavna površina	890	612
oxbows (1) mrtvice	10	8
flowing water (2, 7) tekoča voda	43	42
fish-ponds (10) ribniki	-	16
forests (8, 9) gozdovi	457	522
meadows (5) travniki	185	21
pastures(6) pašniki	227	119
hedgerow landscape (4) krajina z mejicami	633	228
reparcelled land (11) na parcele razdeljena zemlja	-	459
settlements (3) naselja	83	100



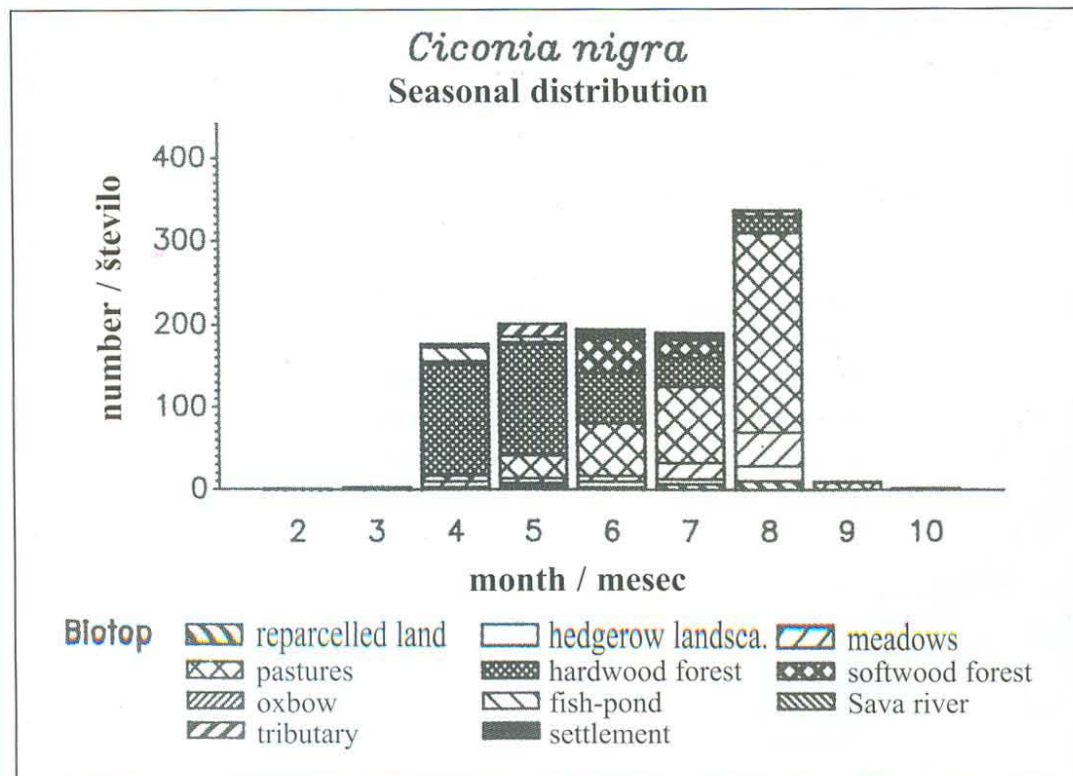
**Figure 1:** The research area covering the alluvial wetlands of the River Sava is situated downstream from Zagreb between the towns of Sisak, Kutina, Novska, Dubica, and Nova Gradiška. The remaining alluvial north-western parts are situated north and south of the River Sava. The north-western part was not regularly checked.

**Slika 1:** Raziskovano območje savske loke se razteza južno od Zagreba med mesti Sisak, Kutina, Novska, Dubica in Nova Gradiška. Preostali poplavni severozahodni deli ležijo severno in južno od Save. Severozahodni del ni bil redno preučevan.



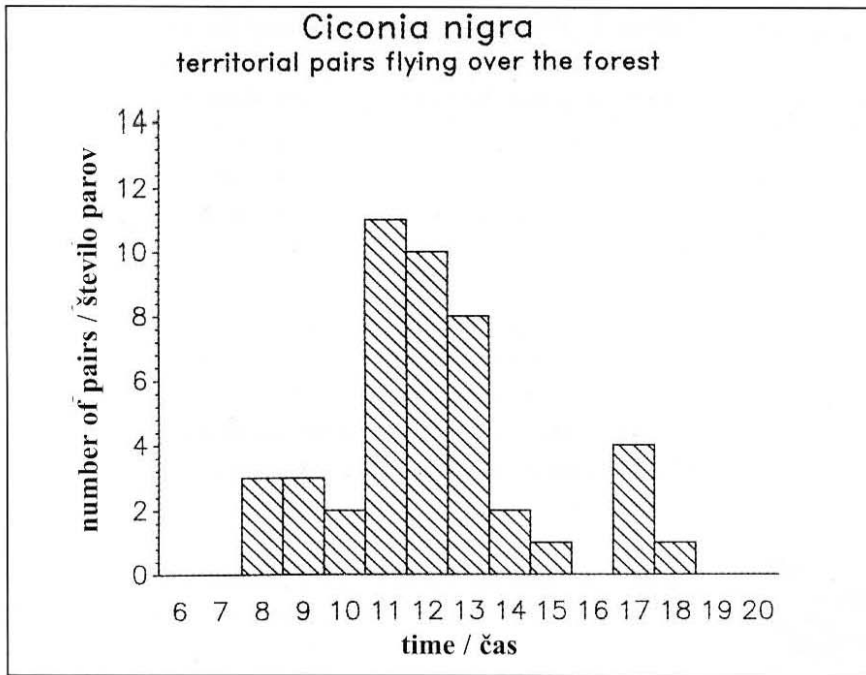
**Figure 1a:** Satellite picture of the research area.  
**Slika 1a:** Satelitski posnetek območja raziskave.

- water / vodne površine
- grassland-marsh / poplavni travniki
- agriculture / kmetijske površine
- grassland / travniki
- pasture / pašniki
- softwood-willow / mehcolesna loka
- Forest-Oak / trdolesna loka



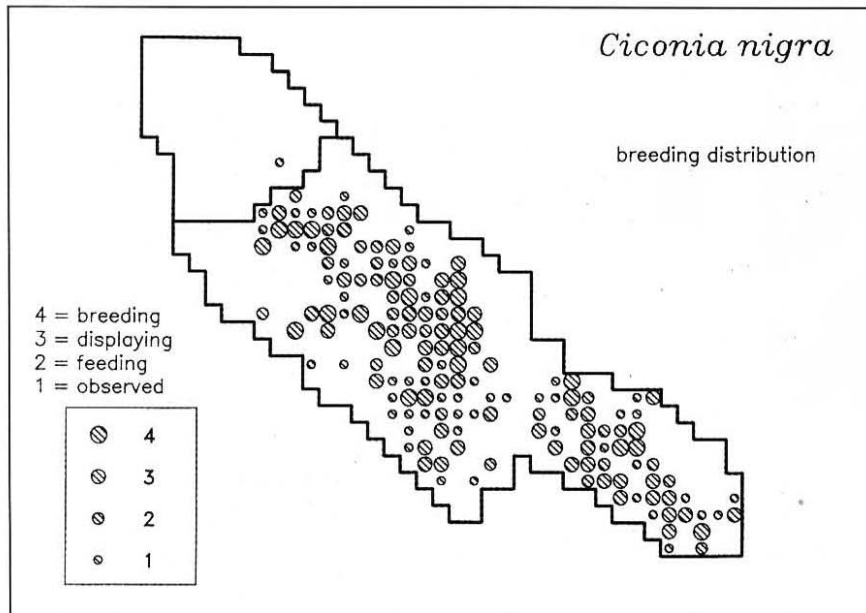
**Figure 2:** Seasonal distribution of the Black Stork in the various biotopes in the research area.

**Slika 2:** Sezonska razširjenost črne štokrlje v različnih biotopih raziskovanega območja:  
Reparcelled land = na parcele razdeljena zemlja, hedgerow landscape = krajina z mejicami, meadows = travniki, pastures = pašniki, hardwood forest = trdolesna loka, softwood forest = mehcolesna loka, oxbow = mrtvica, fish-pond = ribnik, Sava river = Sava, tributary = pritok, settlement = naselje



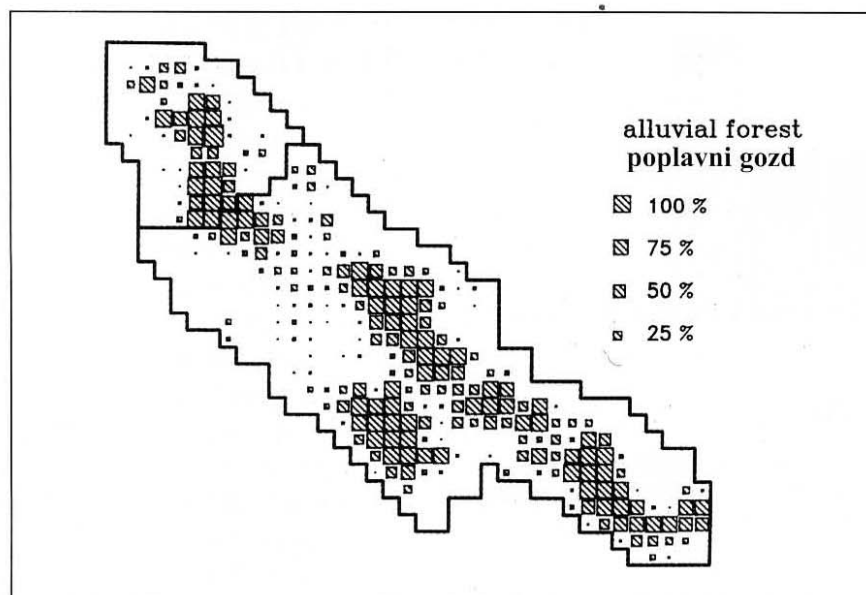
**Figure 3:** Distribution of territorial flights throughout the day (n = 65 pairs) in 1987 and 1988 over the forest of the Sava wetlands.

**Slika 3:** Porazdelitev območnega kroženja parov črne štoklje (n = 65 parov) v letu 1987 in 1988 nad gozdovi savske loke.



**Figure 4:** Breeding distribution of the Black Stork in the alluvial wetlands of the Sava River.

**Slika 4:** Gnezditvena razširjenost črne štoklje v savski loki: breeding = gnezdenje, displaying = območno kroženje para, feeding = prehranjevanje, observed = opazovanje



**Figure 5:** The map indicating the distribution of the alluvial forests. Some parts are now outside the inundation zone, due to the melioration programme.

**Slika 5:** Zemljevid razširjenosti poplavnih gozdov. Nekateri deli so danes zaradi melioracijskega programa že zunaj poplavnega pasu.

the northwest of the study area and downstream to Belgrade large areas have been drained as part of the reclamation programme "Sava 2000" (BÜSCHENFELD 1987; Koordinationi odbor 1973).

Despite the negative impact of human activities the study area is a well-preserved example of a lowland river with natural levees (SCHNEIDER-JACOBY & ERN 1990). Through deposition by the main flow of the river the banks have been raised. On the banks there are villages and a narrow strip of arable land. Behind this the tributaries stretch along the river plain itself with typical wet meadows, inundated pastureland and riparian forest (Figs. 1, 5, 7, 8). At the edge of the inundation zone there are today two fish-ponds and a reservoir.

## 4. Results

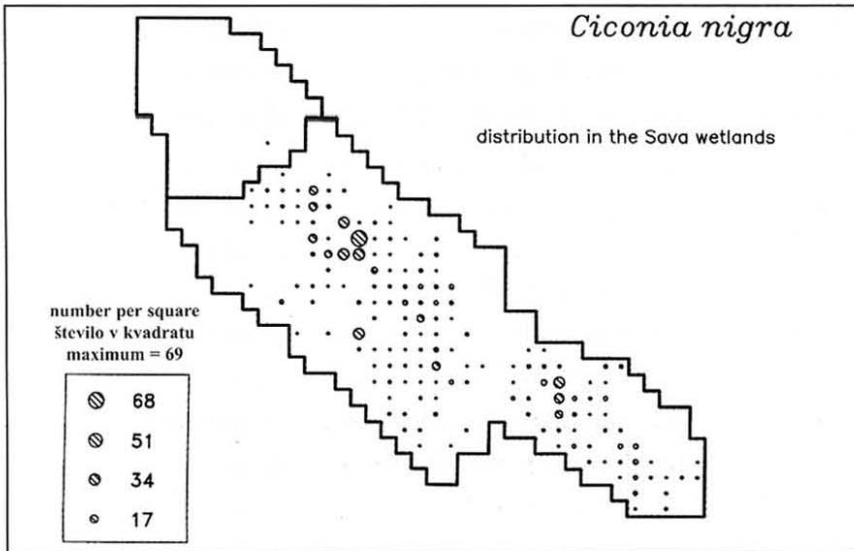
### 4.1. Breeding population

During the study, 469 observations of a total of 1,151 Black Storks were made and evaluated. 64% of the observations involved the sighting of one individual. In 27% of the observations 2 individuals were involved. It was difficult to assess the size of the breeding population, because the scope of the study did not allow a systematic search for the nests and their control. Despite this, 26 nests were found. Five nests were found along the Sava between Lonja and Greda in small coppices, where the nest was visible from the edge. In addition, several individual pairs may be breeding on the forest slopes, e.g. in 1986 the forester Stjepan Crnko showed me a nest in a forest belonging to the University of Zagreb north of Lipovljani. Also, Black Storks observed near the village Rajić flying to the floodplain from the forested slopes of the Psunj indicate the existence of further breeding pairs.

The most important method in recording the breeding population was counting circling territorial birds. Probably due to their high breeding density, Black Storks conduct territorial flights, like raptors, in April and May. As indicated by Fig. 2, a large number of observations were made during this period of storks flying over the forest. The best time to observe the circling pairs was between 10.30 - 14.30 (Fig. 3). The maximum number sighted from one point during the territory charting was on May 14<sup>th</sup> 1986 from the dams of the Okučani fish-ponds: 7 pairs and 2 individual birds flying over the riparian forests of the Međustrugovi in Mokro polje. The forest covers a surface area of about 15 km<sup>2</sup>. Two other adult birds and a bird in its second year were seen on the fish-ponds.

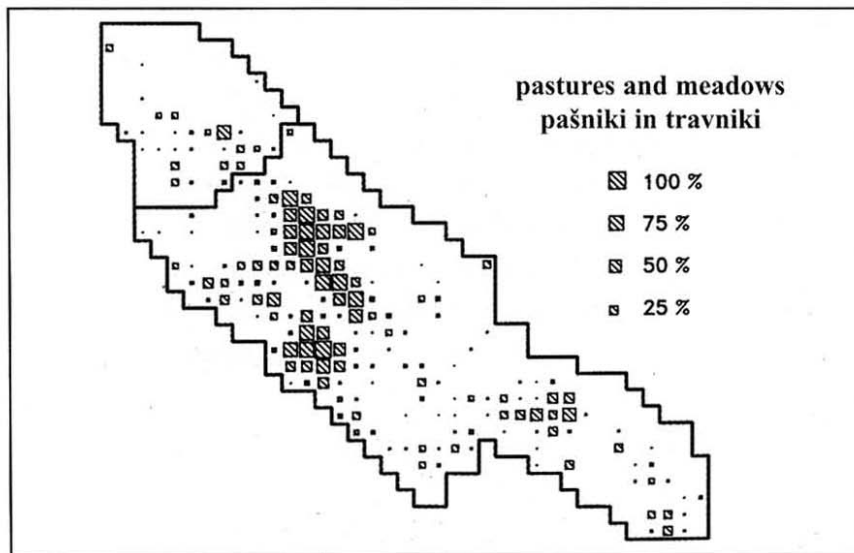
Black Storks were seen in 44% of the 362 grid squares (Fig. 4). In addition to the 26 grid squares in which nests were found, in 45 further grid squares circling pairs indicated the existence of further territories. The numerous observations and the high density of territorial pairs justify estimates of at least 70 breeding pairs. This works out at about one pair per 6.7 km<sup>2</sup> forest or 7.5 km<sup>2</sup> of the inundation zone in the study area, excluding the northern part. Thus, overall population density for the study area could be estimated to one pair per 20.4 km<sup>2</sup> surface area or about 5 pairs per 100 km<sup>2</sup>.

Large parts of the study area are densely populated by Black Storks. The species is therefore a good indicator for the forests and inundation zone. Logistic analysis with biotope proportions shows positive influence of hardwood forest (breeding site, Fig. 5), wet pastureland and meadows on breeding distribution ( $p < 0.0005$ ). The Sava river and the fish-ponds also had a significant positive effect on the breeding distribution ( $p < 0.005$ ). 81% of the observations were made in the inundation zone. Logistic analysis of the breeding distribution shows significant positive influence of the inundation zone on the birds distribution ( $p < 0.0005$ ).



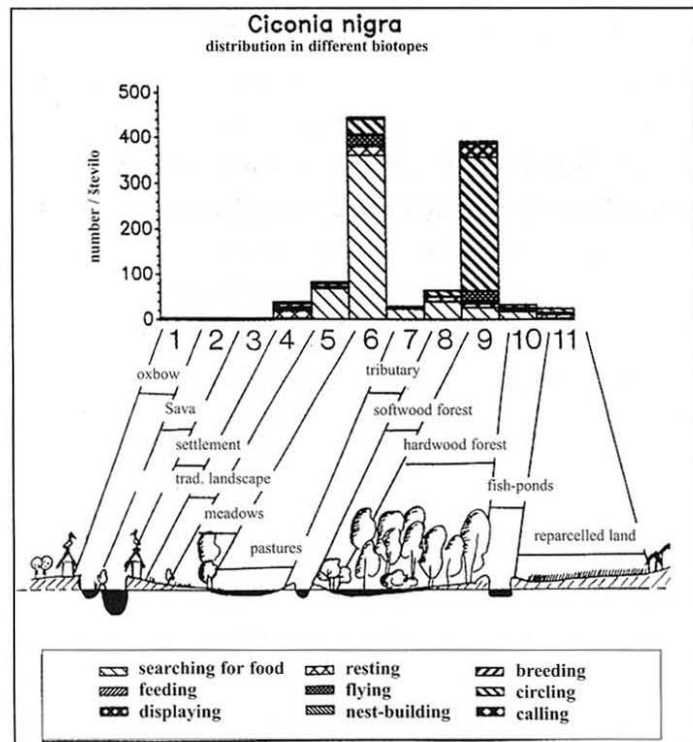
**Figure 6:** Quantitative distribution of the Black Stork in the Sava wetlands using the maximum number of birds observed in the grid squares.

**Slika 6:** Kvantitativna razširjenost črne štoklje v savski loki glede na največje število ptic, opaženih v posameznih kvadratih.



**Figure 7:** Distribution of pastures and meadows in the Sava wetlands. The remote parts are the Black Stork gathering sites.

**Slika 7:** Razširjenost pašnikov in travnikov v savski loki. Osamljeni deli v središču poplavnih polj daleč od naselij so zbirališča črne štoklje.



**Figure 8:** Number of Black Storks seen in different biotopes in the Sava wetlands (total = 1,151, number of observations = 469). The author was unable to obtain data for the importance of the hardwood forests as a feeding site. For biotopes see Fig. 2 and Tab 1.

**Slika 8:** Število črnih štokelj, opazovanih v različnih biotopih savske loke (skupaj = 1.151 osebkov, število opazovanj = 469). Avtor ni mogel dobiti podatkov o pomembnosti trdolesnih lok kot prehranjevališč. Glede biotopov glej sl. 3 in tab. 1. Aktivnosti: searching for food = iskanje hrane, resting = počivanje, breeding = gnezdenje, feeding = prehranjevanje, flying = letanje, circling = kroženje, displaying = območno kroženje, nest-building = graditev gnezda, calling = oglašanje. Za pojasnilo glede habitata glej sliko 2.

## 4.2. Feeding sites

The alluvial forests are the most important feeding areas for the breeding Black Storks. In some cases adult birds were seen searching for food in small streams or in damp depressions of the forests. Older birds seldom leave the forest. This is reflected in the very few observations made of Black Storks searching for food in April and May (Fig. 2). Fish-ponds are only used for a short time after the arrival from the wintering grounds.

However, from June onwards the picture changed significantly. Observations of Black Storks seen searching for food outside the forest increased dramatically (Fig. 2). This could be probably explained by an increase in the feeding requirements of the breeding pairs raising their young so that flights further away from nest sites were made to optimal feeding sites. Secondly, the non-breeders and recently fledged birds also gathered in the inundation zone. On six occasions more than 30 Black Storks were seen together (maximum 69, Fig. 6). Till September most birds left the study area (Fig. 3). The multiple regression for the maximum number of birds observed at one time per grid square with the proportions of each biotope yields the following equation:  $R^2 = 74\%$  ( $p < 0.0001$ ): maximum number =  $0.16 + 0.051$  wet pastureland (46.9%) +  $0.165$  softwood (18.1%) +  $0.387$  tributary (7.4%) +  $0.021$  meadow (1.4%).

The 174 most intensively studied grid squares were evaluated. The hardwood forest has no significant impact on the maximum number of Black Storks as these are distributed equally throughout the forests. This could also be a reason for the aggregations of larger numbers of birds in isolated areas of wet pastureland and softwood stands (Fig. 7). Here the non-breeders and immature birds are able to congregate without getting into conflict with territorial breeding birds. These gathering places are

characterized by an extensive grazing regime and shallow water.

Although 60% of observations in the forests were made in woodland and only 16% in wet pastureland, 5% in meadows and 4% in the fish-ponds, the number of birds observed in pastureland and hardwood forests is virtually the same (Fig. 8).

The habitats of Black Storks in the Sava river valley therefore do not include only the hardwood areas but also open areas in the inundation zone, such as wet pasture, meadows and softwood stands.

## 5. Discussion

During the three years in which the population survey was made, my task was to gain an overview of the 1,700 km<sup>2</sup> research area, including 600 km<sup>2</sup> of floodplain. While mapping raptor territories I was struck by similarities with territorial behaviour of Black Storks. The observations of up to 7 pairs circling simultaneously points to a very high density. This is also confirmed by the regular breeding of the Black Stork in small forests along the Sava.

The detailed description of SACKL (1993), who was the first to describe this behavioural phenomenon, confirms that flying displays in Black Stork may act as a form of territorial advertisement. SACKL's work also supports the method used by myself - in which the size of the breeding population was assessed by the recorded territories (Fig. 4).

In addition to the breeding populations, the congregations which gathered from June to August in the floodplain are of special significance (Fig. 6). According to the studies by FERRERO *et al.* (1993) and MIKUSKA (1993) this phenomenon is a post-breeding dispersal in which the Black Storks gather in suitable habitats. River courses with natural, uninterrupted floodplains are in the whole of the distribution



**Figure 9:** The river Strug before the flood.  
**Slika 9:** Strug pred poplavo.



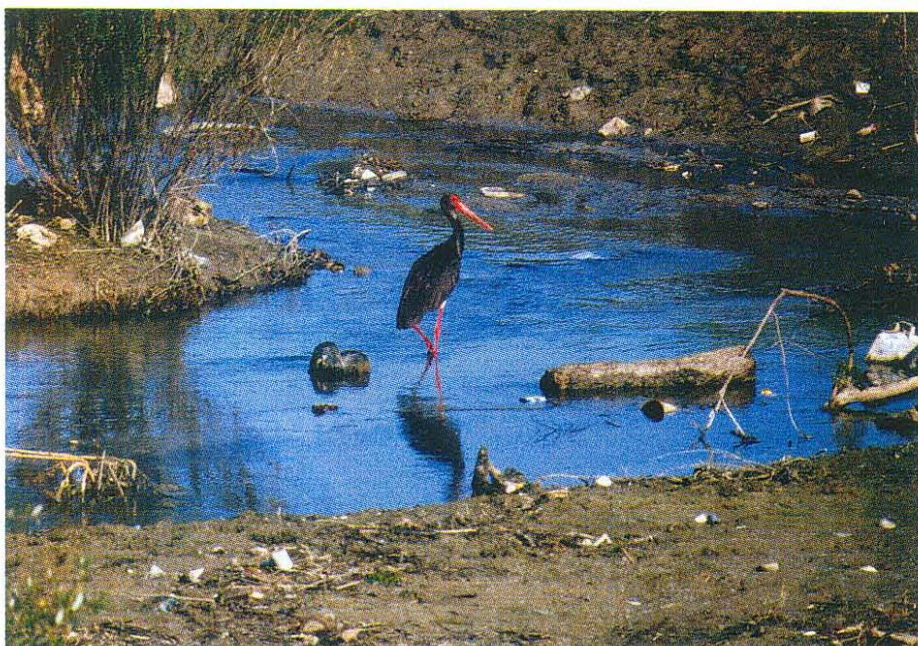
**Figure 10:** The river Strug during the flood.  
**Slika 10:** Strug med poplavo.

area the preferred resting places (FERRERO *et al.* 1993). The importance of natural fluctuations in water levels in creating ideal feeding and resting-places is described by MA MING (1993) for the Panam Reservoir in China.

Drained fish-ponds can provide structures similar to floodplain areas and are used as alternative biotopes. An example are the Boronka fish-ponds (Hungary, Somogy): after their purchase and designation as a protected area in 1992, 65 Black Storks congregated there (TÖMOSVARY & WINKLER *in lit*). In the Sava wet-

lands, however, natural floodplain habitats were preferred, although fish-ponds were also available (Figs. 2, 8). Remote or undisturbed mud and sand banks and shallow water zones were an important factor. It is significant that resting places are protected, because the stork groups are often driven away by human disturbance.

The Black Stork is a good indicator species for the size of the area in the Sava alluvial wetlands, which should be no doubt protected. The distribution maps allow clear identification of the most important parts of the study area (Figs. 4, 6). The entire closed breeding and feeding area in the study area must be included in the protection plan. Furthermore, an important part of the protection concept must be the preservation of extensive grazing in wet pastureland (Fig. 8, SCHNEIDER-JACOBY 1991). The Sava wetlands are internationally important as a breeding site for Black Storks. According to BOETTCHER-STREIM (1992), about 6,000 pairs of Black Stork breed in Europe. This means that about 1% of the European population is actually breeding in the alluvial wetlands of the Sava river.



**Figure 11:** Black Stork searching for food in the river Strug.  
**Slika 11:** Črna štoklja med prehranjevanjem v Strugu



## 6. Povzetek

**Schneider-Jacoby, M. (1999): Gnezditvena razširjenost in ekologija črne štorke *Ciconia nigra* v loki reke Save, Hrvaška. *Acrocephalus* 20: 167-176 .**

V obdobju 1986-1988 je bila v savski loki na Hrvaškem opravljena sistematična ornitološka študija o gnezditveni razširjenosti in ekologiji črne štorke. Območje raziskovanja obsega 1.766 km<sup>2</sup> z mnogimi pomembnimi biotopi: 612 km<sup>2</sup> poplavnih površin, 522 km<sup>2</sup> avtohtonih trdolesnih lok (3/4 poplavljenih), 119 km<sup>2</sup> mokrih pašnikov, 121 km<sup>2</sup> košenih travnikov, 16 km<sup>2</sup> ribnikov in 42 km<sup>2</sup> rek (tab. 1). Med študijo je bilo zabeleženih 469 opazovanj, med katerimi je bilo naštetih skupaj 1.151 črnih štorke. V 64% opazovanj je bila opažena ena štorke, v 27% dve in v šestih primerih več kot 30 osebkov hkrati (največ 69). Največ opazovanj je bilo zabeleženih aprila in maja, ko so bile ptice na teritorialnih preletih obrežnih gozdov (sl. 2, 3). 81% opazovanj je bilo zabeleženih na poplavnih površinah, 60% v gozdnatih predelih ali v letu nad njimi, 16% na mokrih pašnikih, 5% na travniščih, 4% na ribnikih in 3% na Savinih pritokih. Črne štorke so bile opažene v 44% od skupno 362 kvadratov v prikazani mreži (2 x 2 km, sl. 4, 6). Avtor v članku razpravlja o njihovi razširjenosti. Gnezda so bila opažena v 26 kvadratih in 45 kvadratov je bilo teritorialnih. Populacija tu živečih črnih štorke je ocenjena na najmanj 70 gnezdečih parov. To območje je zaradi dejstva, da v njem živi najmanj 1% evropske populacije, mednarodnega pomena.

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Dr. Martin Schneider-Jacoby, EURONATUR,  
Konstanzer Str. 22, D-78315 Radolfzell,  
Germany,  
e-mail: schneider-jacoby@t-online.de

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