

DYNAMICS OF COMMON *Sterna hirundo* AND LITTLE TERN *Sternula albifrons* POPULATIONS ALONG THE SAVA RIVER IN NORTH-WESTERN CROATIA BETWEEN 2002 AND 2019

Populacijska dinamika navadne čigre *Sterna hirundo* in male čigre *Sternula albifrons* ob Savi v severozahodnem delu Hrvaške med letoma 2002 in 2019

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Between 2002 and 2019, monitoring of Common Tern *Sterna hirundo* and Little Tern *Sternula albifrons* along the Sava River near Zagreb, Croatia was conducted. Natura 2000 site “Sava kod Hruščice” was designated to protect colony at river islands, with estimated population sizes of 100–150 pairs of Common and 20 pairs of the Little Tern. Flooding of the colony caused breeding failure in several years. Common Terns moved to breed on islands in gravel pits with a total population around 150 pairs, while Little Tern did not breed after 2010. In the last few years, terns have not bred at Hruščica and the only colony inside the Natura 2000 site is situated on a breeding platform at Siromaja gravel pit. Channelling of rivers and hydropower plants are the main threats, changing natural dynamics of water level and causing reduction of gravel sediment in rivers.

Key words: Common Tern *Sterna hirundo*, Little Tern *Sternula albifrons*, Sava River, monitoring, Natura 2000 site, threats

Ključne besede: navadna čigra *Sterna hirundo*, mala čigra *Sternula albifrons*, reka Sava, monitoring, območje Natura 2000, grožnje

1. Introduction

In Croatia, the Common Tern *Sterna hirundo* and Little Tern *Sternula albifrons* inhabit the Adriatic and continental regions. Continental populations of both species are concentrated along the middle stretches of the Sava and Drava Rivers, where gravel substrate and natural river morphological processes allow creation of river islands, their main breeding habitat. The Little

Tern is Endangered at the national level, while the Common Tern is Near Threatened (TUTIŠ *et al.* 2013). The main identified threats are channelling rivers, construction of dams, accumulations and embankments, and water pollution (TUTIŠ *et al.* 2013).

Along the Sava River, adequate natural breeding habitats are found in a relatively small area, around the city of Zagreb, where the river changes its flow from the fast upper to slow

lower flow. The area is designated as the Natura 2000 site „Sava kod Hrušćice“. It covers 1,527 ha of riverbed and gravel pits, riparian forests and agricultural land, with breeding population of the Common Tern estimated at 100–150 pairs, and of the Little Tern at 20 pairs (RADOVIĆ *et al.* 2005, NATURA2000 2019). The main threats are river canalisation, water pollution and unregulated recreational activities (RADOVIĆ *et al.* 2005). The Sava River at Zagreb has the Peripannonian pluvial-nival discharge regime, with maximum values in April and November (ČANJEVAC 2013). Such water regime, with low water levels between May and August, is favourable for breeding terns. However, the increase of the Sava River water level is not only the result of precipitation and melting of snow, but is also affected by hydropower dams upstream in Slovenia. Operation of hydropower plant is causing rapid and short-term fluctuations in downstream river flow, called hydropeaking. The fluctuations occur several times per day and cause flooding of low-lying islands along the river. Another effect of hydropower plants is a reduction of gravel sediment in the river. Dams interrupt the continuity of sediment transport, causing

lowering of riverbed by erosion, coarsening of bed material and loss of gravel (KONDOLF 1997). A long-term study showed a decrease in maximum annual concentrations and annual transfer of suspended sediment in the Sava River at Zagreb (TRNINIĆ & BOŠNJAK 2009).

Apart from the river itself, terns also bred at gravel pits around Zagreb: Abesinija (45°46' N, 16°09' E), Siromaja 2 (45°45' N, 16°11' E), Veliko Čiče (45°42' N, 16°05' E), Rakitje (45°47' N, 15°50' E) and Blato (45°46' N, 15°52' E). The first two belong to the Natura 2000 site „Sava kod Hrušćice“, while others are situated outside that area. Gravel pits may present safe breeding sites, but adequate habitats are rarely found: some gravel surfaces are dry only during the lowest water level, while others are close to the shore and may become connected with the mainland during the low water level, enabling access to predators. Only some lakes have islands that are high enough above the water to be safe from flooding, but these are often overgrown by vegetation.

This paper aims to give an overview of the dynamics and threats of tern populations along the Sava River in the surroundings of Zagreb.



Figure 1: Breeding sites around Zagreb (see Introduction for details)

Slika 1: Gnezdišća v okolici Zagreba (podrobni opisi v uvodu)

2. Methods

Monitoring of terns in Croatia started in 2002. In early years, more effort was given to the more threatened Little Tern, so exact data for Common Terns are missing (HRVATSKO ORNITOLOŠKO DRUŠTVO 2010). Repeated visits were carried out to known and potential colony sites from April to July (or August in years with late clutches). Between three and six visits were conducted annually until 2018. In 2018 and 2019, population size was monitored by weekly visits during the breeding season.

Monitoring was launched by the Institute of Ornithology, Croatian Academy of Sciences and Arts, and continued by the Croatian Ornithological Society until 2012. Monitoring of colonies on the Sava River between 2013 and 2016 was conducted by the Croatian Society for the bird and nature protection (MIKUSKA *et al.* 2017). From 2015, monitoring at Rakitje was conducted through cooperation of the Public Institution “Green Ring” and the Institute of Ornithology. In 2018 and 2019, it was carried out as part of the Interreg SI-HR project “ČIGRA”.

Data from monitoring reports, as well as authors’ own data were used. Monthly precipitation data were taken from the Croatian Meteorological and Hydrological Service (CMHS 2019) for meteorological station Zagreb - Grič.

3. Results and Discussion

3.1. Common Tern

The Common Terns were monitored from 2002, but complete data are at hand only for the period after 2009, when 152.9 (\pm 19.4) pairs on average bred annually in the surroundings of Zagreb (Table 1). In the early 2000s, the stronghold of the Common Tern population on the Sava River bred inside Natura 2000 site Sava kod Hrušćice, on a gravel island on the Sava River and occasionally in Abesinija gravel pit. However, breeding was found to be unsuccessful, due to flooding of the whole colony between 2003 and 2006. In 2004, terns colonised a low gravel island in the southern part of Rakitje gravel pit that existed until 2009. Between 55 and 70 pairs bred there, with the

exception of 2006, when only two pairs were recorded. In 2007, breeding on that island was unsuccessful, and next year terns started breeding on a gravel peninsula closer to the northern shore. In 2009, about 70 pairs started breeding at the peninsula, while 65–70 pairs bred on the island, which was again flooded after the start of the breeding season. That autumn, with the help of local gravel producer “Tempo”, the peninsula was converted into an island, which became the most important colony for Common Tern to date. However, to retain the habitat on the island suitable for breeding of terns, the Institute of Ornithology and the Public Institution “Green Ring” have been since 2015 regularly removing vegetation from the island during autumn and early spring.

In 2006, small waterbodies were excavated along the channel Sava–Odra, near Blato. Several small gravel islands formed there, providing appropriate nesting conditions for terns. Up to 120 pairs nested there until 2014. However, some islands were overgrown by vegetation, while surfaces of the others are too close to the water and are not suitable for breeding every year.

3.2. Little Tern

The Little Tern colony was situated on a gravel island inside the Natura site “Sava kod Hrušćice” with nests usually constructed very low above the water. After four years of unsuccessful breeding due to flooding (2003–2006), chicks finally successfully fledged in 2007. In the ensuing year, only about half of the pairs attempted breeding which, however, was unsuccessful once more. After that, the colony was abandoned. A final single breeding pair was observed there in 2010, but breeding was again unsuccessful (Figure 2). Individual pairs bred at gravel pits Rakitje in 2006 and Blato in 2008 and 2009, but colonies never formed there. So, in the period between 2002 and 2010, breeding was successful in only three years: 2002 and 2007 at Hrušćica and in 2009 at Blato (one pair). After 2010, no breeding of Little Tern has been recorded in the surroundings of Zagreb, although individual birds were observed, for example in the Common Tern colony at Rakitje on 2 June 2019.

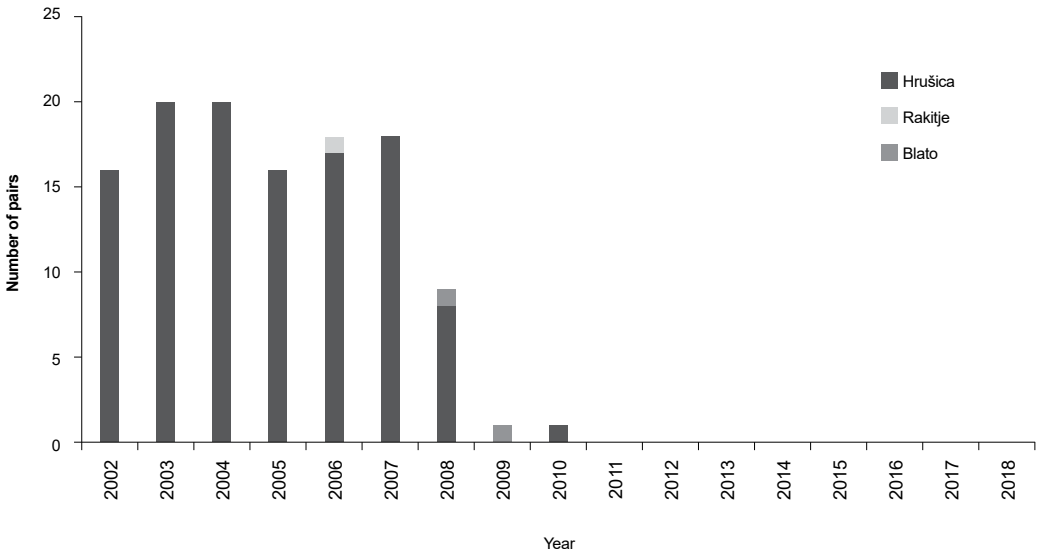


Figure 2: Numbers of Little Tern breeding pairs along the Sava River

Slika 2: Število gnezdečih parov male čigre ob Savi

3.3. Threats to tern colonies

Terns are generally considered to have high breeding philopatry, but site fidelity is often higher in large, stable colonies than in colonies in less stable habitat (GONZÁLEZ-SOLÍS *et al.* 1999, PALESTIS 2014). Frequent changes of colony location in the surroundings of Zagreb are the result of habitat instability. Colony size and breeding success vary annually, depending on water level and island vegetation cover. Increase of the water level during the breeding season (recorded for example on 2 July 2005 and 24 May 2006) caused, together with a lack of gravel sediment, repeated flooding of colonies situated on river islands, and was the main driver for displacing the colony to the surrounding gravel pits. In order to enable breeding of terns, regular removing of the vegetation from such islands is needed. Although being a relatively simple and cheap management method, its main weakness is that it must be done every year, preferably both before and after the breeding season.

More intensive monitoring in 2018 and 2019 enabled a more detailed tracking of the effect of water level change on tern breeding phenology.

Both seasons had atypical precipitation regimes. In 2018, heavy snowfall in February (precipitation was 102.3 mm) caused extremely high groundwater level, so all islands were flooded until mid-June. That year, terns started breeding on a breeding platform (size 8 × 8 m) installed within the Interreg SI-HR project “ČIGRA” in mid-May 2018 at Siro-maja gravel-pit inside the Natura 2000 site, and on a metal gravel excavator at Veliko Čiče gravel pit. Breeding at Rakitje started in mid-June, and the breeding season there finished 1.5 months later than usual with last unfledged chicks observed on 23 August 2018.

In 2019, the weather in winter was very dry and warm. Monthly precipitation values for the first three months of 2019 were between 16.9 and 39.5 mm, while the average values from the 1861–2018 period for the same months were 46.9–55.1 mm. By contrast, the precipitation was very high in May (123.1 mm, compared to an average of 82.0 mm). Therefore, in early May, terns started breeding on numerous small islands at Rakitje and Blato that emerged owing to the low water level, but were later flooded. After almost the entire colony at Blato was flooded in the last

Table 1: The number of breeding pairs of Common Terns near Zagreb. Total numbers are estimated taking into account the timing of nesting, as in some years terns move to another site after failure of their first clutch. + breeding was confirmed, but numbers are not known, * failure of the whole colony, ** breeding mostly unsuccessful, 0 locality was monitored, but no breeding was confirmed, empty cells - no data.

Tabela 1: Število gnezdečih parov navadne čigre pri Zagrebu. Ocena števila upošteva obdobje gnezdenja, saj lahko po propadu gnezda čigre gnezdiijo ponovno drugje. + gnezdenje je bilo potrjeno, število neznano, * propad celotne kolonije, ** gnezdenje večinoma neuspešno, 0 kolonija je bila opazovana, a podatkov o gnezdenju ni, prazen prostor – ni podatka.

| Year / leto | Sava / Hruščica | Rakitje | Blato | Abesinija | Siromaja 2 | Čiče | TOTAL |
|-------------|-----------------|---------|---------|-----------|------------|------|---------|
| 2002 | 50 | | | 20–25 | | | 70–75 |
| 2003 | | | | | | | |
| 2004 | 15* | 50 | | 10 | | | 75 |
| 2005 | +* | 45–50 | | | | | >50 |
| 2006 | +* | 2* | 65 | | | | >67 |
| 2007 | + | 55–60* | 50 | | | | >110 |
| 2008 | + | 55–60 | 1 | | | | >60 |
| 2009 | 70 | 135 | 50 | | | | 180 |
| 2010 | 30 | 40 | 150 | | | | 180 |
| 2011 | | 30 | 100 | | | | 130 |
| 2012 | 0 | 50 | 80 | 0 | | | 120 |
| 2013 | | 30–40 | 100–110 | | | | 130–150 |
| 2014 | 45 | 0 | 100–120 | | | | 145–165 |
| 2015 | 70 | 90–95 | | | | | 160–165 |
| 2016 | 50 | 100 | 0 | | | | 150 |
| 2017 | 0 | 100–110 | 50 | | | | 150–160 |
| 2018 | 0 | 106 | 0 | 0 | 30 | 51** | 140 |
| 2019 | 0 | 134 | >70* | 0 | 39 | 0 | 170 |

days of May, terns moved to Rakitje, where they produced replacement clutches. The breeding season there was prolonged, and finished about one month later than usual, with last unfledged chicks observed on 5 August 2019.

In 2013, the Natura 2000 site “Sava kod Hruščice” was designated to protect tern colonies, but with a lack of appropriate nature conservation measures colonies were devastated due to frequent flooding. The population of the Common Tern around Zagreb remained stable, but population moved from their natural habitat on river islands to artificial islands at gravel pits in the surroundings of the Sava River. Moreover,

the only colony inside the Natura site is on a breeding platform raised under the Interreg SI-HR project “ČIGRA” in 2018 to protect this species. Therefore, an effort was made to change the boundaries of the Natura site to include the most important nesting location today, the gravel pit Rakitje. The Little Tern unfortunately didn't accept the gravel pit islands as their nesting sites and no breeding attempt has been recorded since 2010. Therefore, the only inland breeding locality of that species nowadays is on the Drava River between Legrad and Repaš (MOHL 2001, TUTIŠ *et al.* 2013). Almost two decades ago, MOHL (2001) concluded that “a middle to long-term

disappearance of the Little Tern in Croatia can be expected if the ongoing impact of the water management in Croatia is not stopped”.

The main threats, channelling of the river and upstream hydropower plants, changed natural dynamics of the water level and caused a reduction of gravel sediment in the river. They were already identified as the main threats to the Sava River (SCHWARZ 2016). Changes in river management as well as restoration projects are needed to preserve the natural flow of the Sava River. An assessment of the restoration potential of the Sava River showed very high or high potential of the river stretch upstream and downstream from Zagreb (SCHWARZ 2016). Restoration projects should allow lateral erosion in adjacent floodplain areas, resulting in development of gravel bars and islands. Without restoration projects, prevention of further deterioration of the river course and proper management, the Natura 2000 site “Sava kod Hrušćice” will completely lose habitats needed to support the species for which it was designated.

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4. Povzetek

Med letoma 2002 in 2019 je potekal monitoring navadne čigre *Sterna hirundo* in male čigre *Sternula albifrons* ob Savi v okolici Zagreba. Natura 2000 območje “Sava kod Hrušćice” je bilo razglašeno z namenom varovanja kolonije na rečnih otokih. Ocenjena velikost tamkajšnje populacije je bila 100–150 parov navadne in 20 parov male čigre. Zaradi poplavljanja otokov so kolonije pogosto propadle. Okoli 150 parov navadne čigre je zato za nadomestno gnezdišče izbralo otoke v gramoznicah, medtem ko mala čigra po letu 2010 ne gnezdi več. V zadnjem letu čigre na Hrušćici niso gnezdile, edino zasedeno območje znotraj območja Natura 2000 je bil splav v gramoznici Siromaja. Regulacije rek in gradnje hidroelektrarn so glavne grožnje za čigre, saj spreminjajo naravno dinamiko in zmanjšujejo prenos proda po reki.

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