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Habitat preference of Common Sandpipers *(Actitis hypoleucos)* along the River Rába, Hungary

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Abstract We investigated habitat preference of Common Sandpipers as part of a monitoring program in the Őrség National Park, Hungary. Field observations were conducted during the summers between 2008 and 2012 along a 47-km long section of the River Rába. During the observations we recorded the number and location of birds on the river bank. We divided the studied area into 1 km long sections and measured the proportion of the visually distinguishable habitat types (water, low gravel and sand bank, vegetation and degraded area) from a digitalized map. Furthermore, we recorded the number of the low banks and the number of bends of the river within each section, as well as the sections' distance from the closest hydroelectric power plants and human settlements. In 2012 we also performed a detailed habitat mapping, recording the proportion of the vegetation types along the river bank and the number of fishing spots, embankment strengthenings and gravel banks. We tested the correlations between these habitat variables and number of birds present in the river sections. Our results show that Common Sandpipers were observed more frequently in locations which have (1) larger number and area of low gravel and sand banks, (2) less dense vegetation, and (3) lower proportion of degraded habitats. These findings can be taken into account in the conservation management of River Rába.

Keywords: wetlands, shorebird, territory, gravel bank, conservation

Összefoglalás Az Őrségi Nemzeti Park monitoring programja keretében a Rábán előforduló billegetőcankók élőhely választását vizsgáltuk. Az állományfelmérés 2008–2012 nyarán történt a Rába 47 km-es szakaszán. Ennek során rögzítettük a folyó partvonala mentén megfigyelt egyedek számát és előfordulási helyét. A folyót 1 km-es szakaszokra osztottuk fel, majd a szemmel jól lehatárolható élőhelytípusok (folyó, zátony, vegetáció, degradált terület) arányát minden egyes szakasz esetében légi felvételekről mértük. Ezen felül felmértük a szakaszokban található zátonyok számát, a kanyarok számát, valamint a szakaszok távolságát a folyóra telepített vízierőművektől és a folyó mentén található településektől. 2012-ben egy részletes terepi élőhely-térképezést is végeztünk, amely során a folyó mentén található növénytípusok előfordulási gyakoriságát, valamint a horgászhelyek és partfalerősítések számát jegyeztük fel. Teszteltük az egyes környezeti változók és a madarak előfordulási helye és egyedszáma közötti korrelációk erősségét. Az elemzések eredményei alapján a madarak nagyobb számban fordulnak elő (1) a nagyobb számú és területű zátonyokkal rendelkező, (2) növénytakaróval kevésbé sűrűn benőtt, és (3) a kevesebb degradált élőhelyet magában foglaló folyószakaszokon. A vizsgálat eredményei felhasználhatók a Rába jövőbeni természetvédelmi kezeléséhez.

Kulcsszavak: vizes élőhely, partimadár, territórium, kavicspad, természetvédelem

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Introduction

Wetlands and their wildlife are among the most threatened ecosystems in Europe and also worldwide (Wetlands International, www.wetlands.org). They are endangered by several factors such as agricultural drainage, regulation of water flows, infrastructural developments, industrial and communal pollution and climate change. Since approximately 50% of wetlands disappeared in the last century, these habitats are one of the main targets of nature conservation (Ward *et al*. 1999).

The Common Sandpiper *(Actitis hypoleucos)* is a typical species of the avifauna of Hungarian wetlands, especially rivers and fishponds, particularly in the River Rába and Szigetköz (Hadarics 2012). Although it is still common and widespread all over Europe, it is subject to the same threats as other wetland species and therefore deserves attention (Dougall *et al*. 2010, BirdLife International 2013). Due to its seemingly stable population, very few studies investigated the species and we know little about its habitat preferences in Hungary (but see Barbácsy 1977). For this reason we have chosen to investigate the habitat use of the Common Sandpiper on the River Rába, where a high proportion of its Hungarian population is thought to breed (Haraszthy 2000). The estimated Hungarian breeding population is 150–180 pairs (Hadarics & Zalai 2008).

In general, habitat choice of birds is primarily influenced by the availability of food (McCollin 1998), suitable nesting sites, and the presence of potential predators (Martin 1993). According to previous studies, the Common Sandpiper prefers stone, gravel, rocky, muddy or sandbanks along rivers during the breeding season (del Hoyo *et al*. 1996, Snow & Perrins 1998). While adult birds often feed on grasslands in the river valleys, older chicks exclusively feed in shingly areas of the river (Yalden 1986). Size of territories along the river banks was 100-300 m and it decreased with shingle width in Britain (Holland *et al*. 1982b, Jones 1983, Yalden 1986). According to some studies, the elevation of these gravel banks relative to water level determined whether they were suitable for the nesting (Yalden 1986, Ürmösi-Incze 2005). It was also shown in previous studies that Common Sandpipers are sensitive to habitat deterioration and human disturbance (Vickery 1991, Yalden & Holland 1993).

The objective of the present study was to collect data on the habitat use of Common Sandpipers, and contribute to the conservation of this wetland species in its Hungarian stronghold, the River Rába. We surveyed the distribution of individuals along the river and compared stretches that were used by the birds (i.e. where we observed sandpipers during the census) with those that were not used. We were primarily interested in how the amount of gravel or sand banks, the vegetation of the shore and potential anthropogenic effects of the stretches relate to the abundance of Common Sandpipers.

Materials and methods

Study site and species

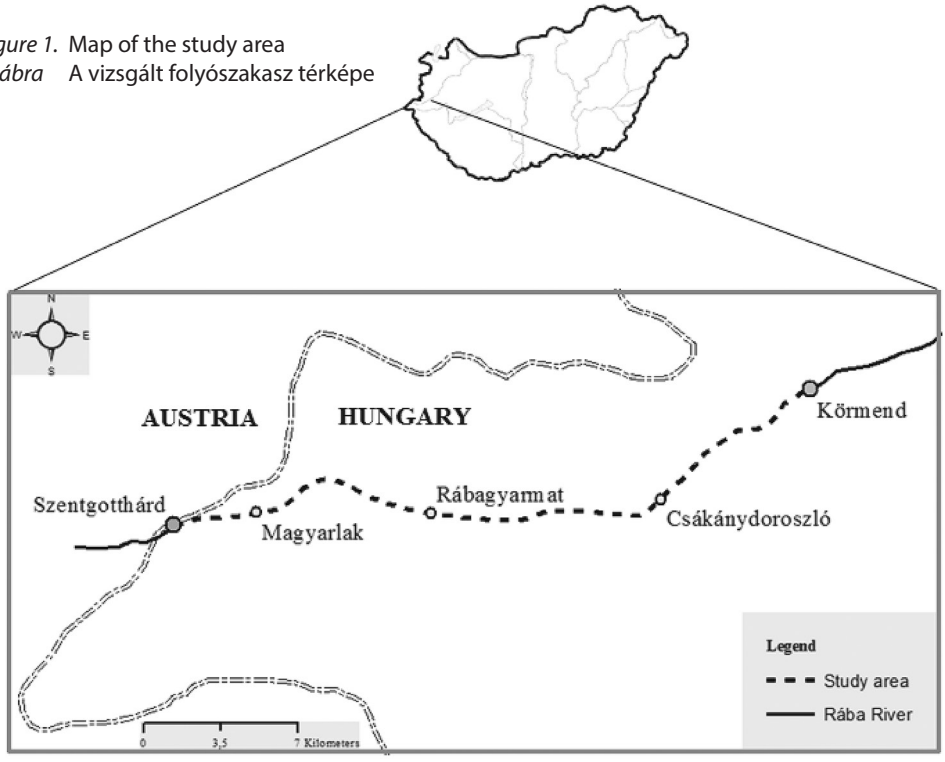
The River Rába is among the few water flows in Hungary that have not been the subject of water regulations in the last centuries and is still freely meandering in its valley for more than 100 km (Tardy 2007). The river valley currently has a mixture of natural and altered habitats. Large sections of the river bank are relatively undisturbed and have natural vegetation, e.g. soft-wood forests and bushes, sedge meadows, and sparsely vegetated gravel or sand banks. Increasing areas of these

habitats have been occupied by invasive plant species during last few decades, of which the Japanese Knotweed *(Fallopia japonica)* and the Himalayan Balsam *(Impatiens glandulifera)* have the largest abundance. Other parts of the river's valley have been transformed to agricultural fields or used for recreation (e.g. camps for tourists). The river valley provides habitat and breeding site for several bird species of both national and European community interest, such as the White-tailed Eagle *(Haliaeetus albicilla)*, the Black Stork *(Ciconia nigra)*, the Bee-eater *(Merops apiaster)*, the Little Ringed Plover *(Charadrius dubius)* and the Common Sandpiper (Tardy 2007).

Common Sandpipers arrive in Hungary during the second half of April, start to breed in late April and early May, and finish the rearing of the broods by the end of June (Haraszthy 2000). The breeding can be prolonged due to the loss of first clutches, when birds may attempt a second breeding. Although the number of Common Sandpipers currently breeding along the River Rába is not known, their breeding is repeatedly verified by the presence of nests and chick rearing families (Barbácsy 1977, T. Hammer personal observations).

We investigated Common Sandpipers' habitat preference in two ways. First, we recorded the number of individuals and their locations along the 47 km section of River Rába, between the towns Szentgotthárd and Körmend *(Figure 1)*. Then we tested the correlations between the abundance of birds and specific habitat variables (see below) measured from aerial orthophotos of the study area. Second, in 2012 we conducted a detailed habitat mapping of the areas used by the sandpipers and compared the habitat characteristics of these areas to a set of randomly chosen sample areas along the river that were not used by the birds.

Figure 1. Map of the study area
1. ábra A vizsgált folyószakasz térképe



Bird censuses

We counted the number of Common Sandpipers during brief census periods (1-3 days each year) in late spring or early summer, that presumably coincided with the breeding season of the local breeding population, although late migrants and non-breeding birds could also have been included in the counts. We counted the birds from the water that allowed a good visual survey of the river banks where most of the birds stayed. During the census we moved slowly along the river by canoes and recorded the location of each Common Sandpiper using a Garmin Legend HCx GPS recorder, with an approximate accuracy of ± 5 m. If an individual moved away in the direction of river's flow after its first observation, we followed it until it flew back in the opposite direction of the census (which typically occured ca. 100-200 m from the place of first observation). Thus we only recorded a bird as a new individual when the previously recorded sandpiper was seen to turn back.

Measuring habitat variables from aerial photos

The first set of habitat variables were measured from aerial orthophotos (color depth: 24 bit, 0.5 metre/pixel). First we divided the studied river area into 1 km long sections *(Figure 2)*. For each section we analysed a 100 m wide area, that extended 50 m on both sides from the midstream of the river (i.e. the total analysed area of each section was 100 × 1000 m, *Figure 2*). We chose to measure habitat variables within 50 m from the midstream because Common Sandpipers usually stay and nest near the riverside (Yalden 1986). Since the river bed is usually 15-20 m wide, the 50 m wide zones typically included 30-40 m wide areas of the river bank at both sides of the river.

For each section, we measured the following habitat variables that we could clearly recognize on the orthophotos: (1) water area: the area of the river surface, (2) low bank area: the extent of gravel and sand islands and peninsulas along the shore, (3) vegetation area: vegetated areas with only moderate human impacts (mostly shrubby or woody vegetation), (4) degraded area: intensively used areas, e.g. agricultural fields and built-up areas. We delineated the border lines of these habitat types on the photos using ArcGis 10.1.1 (ESRI 2012), then measured the total area of each habitat type within each section *(Figure 2)*. Finally we calculated the proportion of each habitat type within the sections by dividing the area of each habitat type by the total area of the sections.

In addition, we determined (5) the number of discontinuous low banks and (6) the number bends of the river bed (with angles larger than 45°). (7) We also measured the sections' distance from the nearest hydroelectric power plant in the flow direction. (8) To characterize potential anthropogenic effects we divided the sections into two groups: (i) the border of the nearest town or village was closer than 500 m to the border of the section, or (ii) it was farther than 500 m (we obtained identical results using a 1000 m threshold distance; results not showed). Finally, as an additional measure of the state of the sections' vegetation (i.e. natural *versus* degraded), we used habitat mapping data (according to the General National Habitat Mapping System, Bölöni *et al*. 2011) available for the study area from 2010-2011. This data set categorizes the larger vegetation patches on a five-point scale according to their composition (naturalness index, Németh & Seregélyes 1989). Using this data set we measured the proportion of (9) the least

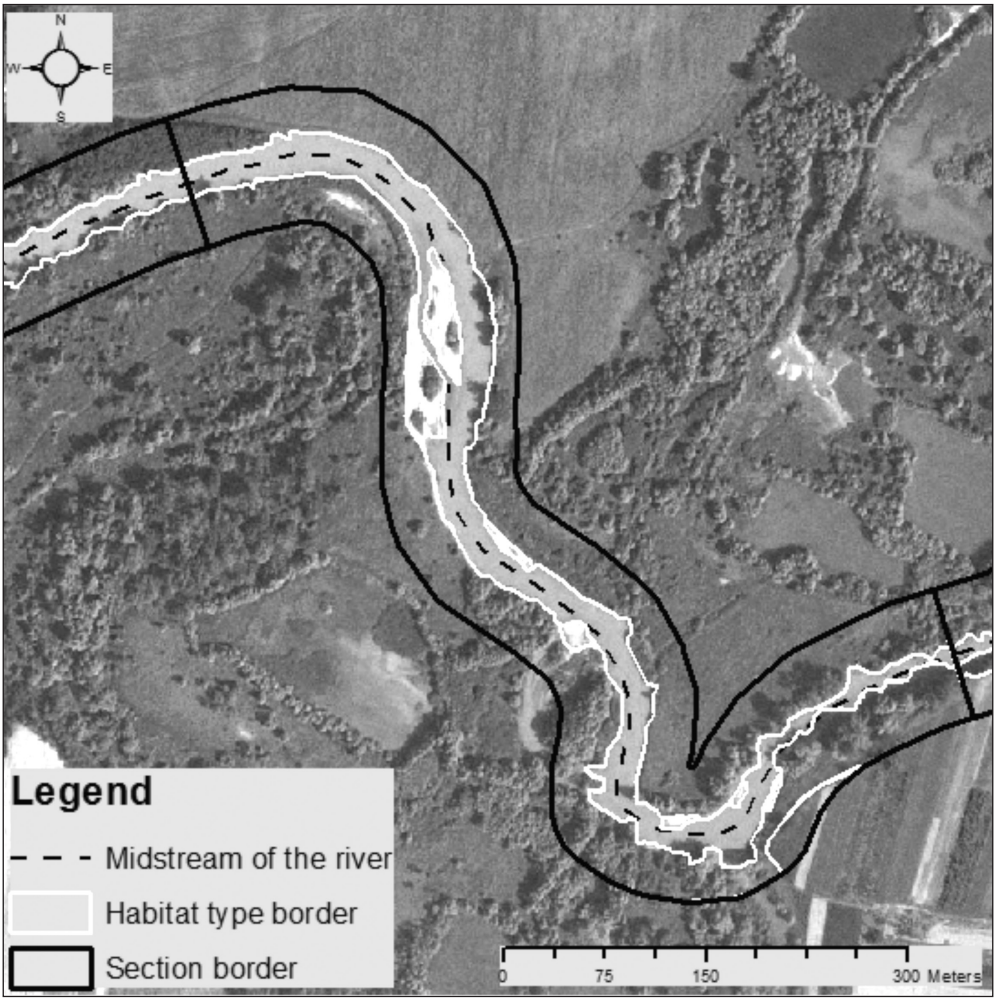


Figure 2. An example of the 1 km sections used in the analysis as a sampling unit
2. ábra Példa az 1 km-es szakaszokról, amelyeket az elemzésekben mintavételi egységként használtunk

natural habitats (naturalness score 1) and (10) the most natural habitats available in the study area (naturalness score 4) for each section.

Habitat mapping

A detailed habitat mapping was conducted in pre-selected parts of the study area on 23 and 24 June 2012. For this purpose, we divided the studied river area into 100 m long 'small sections' and categorized these sections into two groups on the basis of the previous occurance of Common Sandpipers: (i) sections used and (ii) not used by the birds as inferred from the census. From these two groups we chose randomly 20-20 small sections, that were visited and a habitat map was created for in the field, recording the following variables: the areas covered by (1) the invasive Japanese Knotweed, (2) by the invasive Himalayan Balsam, (3) by woods, (4) shrubs and (5) other non-invasive vegetation. Furthermore, we recorded

the (6) number of fishing spots (used by local anglers), (7) number of gravel and sand banks, and the (8) number of embankment strengthenings (stone walls attached to the side of the river bank).

Statistical analysis

For the first set of analyses (correlations between bird abundance and habitat variables measured from aerial photos) we calculated the average sandpiper number for each 1 km long section, which was the average of the five counts recorded during the five yearly censuses. First we tested whether this measure of bird abundance was related to the ten habitat variables by using bivariate Spearman rank correlations (for continuous habitat variables) and Mann-Whitney U test (for comparing bird numbers between sections with and without a settlement within 500 m). Then we used a general linear model to conduct a multi-predictor analysis of the census data. The initial model included all ten habitat variables as predictors, and then the non-significant variables were removed from the model by backward stepwise selection, i.e. in each iteration we removed the predictor variable with the largest P value, until only the significant ($P < 0.05$) predictors remained in the model.

In the second set of analyses, we compared the eight habitat variables measured by habitat mapping between small sections used versus not used by Common Sandpipers, using Mann-Whitney U test. All statistical analyses were performed in the R statistical environment (R.2.14.1.). All statistical tests were two-tailed.

Results

The Common Sandpipers' number was highly variable among years and also between the river sections within a year *(Table 1)*.

In the first set of analyses (based on bird census data), bivariate correlations showed that the abundance of Common Sandpipers was related to three habitat variables: their abundance increased significantly with the water area of sections, and also with the number and area of low gravel and sand banks *(Table 2)*.

The result of the multi-predictor linear modell partially corroborated these findings. First, as in the bivariate analyses, sandpiper abundance significantly increased with the area of the low gravel and sand banks *(Table 3)*. Furthermore, bird abundance significantly decreased with increasing vegetation area and with increasing area of the most degraded habitats (naturalness score 1; *Table 3*).

Year	Date of counting	Total number	Average (± SE) number per 1-km river section	Minimum and maximum number per 1-km river section
2008	5 – 7 May	85	1.81 ±1.042	0 – 6
2009	10 – 12 May	22	0.47 ± 0.59	0 – 3
2010	29 June	11	0.23 ± 0.45	0 – 5
2011	17 – 18 May	25	0.53 ± 0.79	0 – 3
2012	24 – 25 May	9	0.19 ± 0.53	0 – 2

Table 1. The number of Common Sandpipers observed during yearly censuses along the River Rába, between Szentgotthárd and Körmend

1. táblázat A Rába Szentgotthárd és Körmend közötti szakaszán megfigyelt billegetőcankók száma a vizsgálat éveiben

Habitat variable	Test statistics	P	n
Water area	0.396	0.006	47
Area of low banks	0.356	0.014	47
Number of low banks	0.409	0.004	47
Vegetation area	–0.181	0.224	47
Degraded area	0.054	0.715	47
Numbers of river bed's bends	0.212	0.151	47
Proximity to hydroelectric plant	0.002	0.987	47
Proximity to human settlement*	273	0.517	47
Proportion of least natural habitats (naturalness score 1)	–0.014	0.934	35
Proportion of most natural habitats (naturalness score 4)	0.228	0.186	35

Table 2. Bivariate analyses of the relationships between the average number of Common Sandpipers and ten habitat variables, measured in 1km sections of River Rába. Table shows Spearman correlation coefficients and associated P values, except for proximity to human settlement (binary variable, marked by *) where Mann-Whitney U-test was used. Sample size is different between analyses because habitat naturalness data were not available for 12 sections

2. táblázat A Rába 1 km-es szakaszain regisztrált átlagos billegetőcankó szám és a tíz élőhelyváltozó közötti kapcsolat elemzése egyszerű korrelációkkal. A táblázat a Spearman rang-korrelációs koefficienseket és a tesztekhez tartozó P értékeket mutatja, az emberi települések közelsége kivétel (bináris változó, *-al jelölt) amelynek hatását Mann-Whitney U-teszttel vizsgáltuk. A mintaszámok (n) különböznek az elemzésekben, mivel az élőhelyek természetességéről 12 folyószakasz esetében nem volt adatunk

In the second set of analyses, habitat mapping data also showed that the number of the low gravel banks was significantly higher in those 100 m long sections which were used by the sandpipers, than in the unused sections *(Table 4)*. There were no differences between the two groups of areas in other habitat variables, i.e. in the areas covered by invasive vegetation and by other vegetation types, and in the numbers of fishing spots and embankment strengthenings *(Table 4)*.

Discussion

In this study we found that the abundance of Common Sandpipers on River Rába is related to the number and total area of low gravel and sand banks, i.e. the birds prefer river sections where a large area of low banks are available. The effect of this habitat variable was confirmed by all three types of our analysis. This preference may be explained by the fact that gravel and sand banks are the main feeding habitats of the species where they can feed on macro-invertebrates (Holland *et al.* 1982b). Our results therefore confirm the findings of several previous, larger-scale studies showing that the width of shingly banks is positively related to the number of nesting Common Sandpipers (Yalden 1986). Diet analyses showed that majority of the species' food items are taken from the ground surface and therefore they prefer open habitats against densely vegetated ones for feeding (del Hoyo *et al.* 1996, Snow & Perrins 1998). The im-

Habitat variables	Slope	t	P
Area of low banks	0.171	2.678	0.011
Vegetation area	–0.023	–2.261	0.031
Proportion of least natural habitats (naturalness score 1)	–5.471	–2.392	0.023

Table 3. Results of the multi-predictor analysis of the relationship between average number of Common Sandpipers in 1 km long river sections and habitat variables (predictors). Table shows the final linear model, including only siginficant predictors of bird number (n= 35 sections)

3. táblázat Az átlagos billegetőcankó szám és az élőhelyváltozók (független változók) közötti kapcsolat többváltozós elemzésének eredményei. A táblázatban a végső modell szerepel, melyben csak azok a független változók szerepelnek, amelyek szignifikáns kapcsolatban állnak a madarak számával (n= 35 folyószakasz adata)

Habitat variables	U	P
Area of invasive Japanese Knotweed	233	0.117
Area of invasive Himalayan Balsam	159	0.524
Wooded area	125	0.108
Shrub area	152.5	0.428
Area of other non-invasive vegetation	190.5	0.765
Number of low banks	105	0.006
Numbers of fishing spots	180	1.0
Numbers of embankment strengthenings	162.5	0.504

Table 4. Results of the analyses of habitat map data, collected in 2012. Habitat variables were compared between 100 m long areas used by Common Sandpipers (n= 20) and randomly selected controll areas (not used by the birds, n= 20) by Mann-Whitney U-test

4. táblázat 2012-ben végzett élőhely-térképezés eredményei. Az élőhelyváltozókat a billegetőcankók által használt (n=20) és random kiválasztott, madarak által nem használt 100 m-es szakaszok (n=20) között hasonlítottuk össze (Mann-Whitney U-teszt)

portance of gravel and sand banks is also underlined by the fact that older chicks exclusively feed in this habitat (Yalden 1986), and territory size decreases with the area of these habitats (Jones 1983).

The effect of some other variables on the abundance of Common Sandpipers was less consistent among the analyses. The water area was positively related while the vegetation area was negatively related to the abundance of sandpipers in one of the correlative analyses (either in the bivariate or in the multi-predictor tests, respectively). We suspect that the wider the river, the larger the area of low banks and consequently the smaller area is covered by vegetation. The river builds low banks where it becomes wider and slows down. This explanation is also supported by the strong negative relationship between the proportion of water area and vegetation area ($r = –0.574$; $P < 0.001$).

Furthermore, some of the analyses also showed that the proportion of deteriorated habitats (naturalness score 1) is negatively re-

lated to the presence of Common Sandpipers. These areas are dominated by Himalayan Balsam that provides no suitable habitat for the species. However, the presence of alien plants may not be the sole reason for this relationship, because in the habitat mapping data we did not find differences in the abundance of two alien plants between areas used and not used by sandpipers.

We found no relationship between the abundance of Common Sandpipers and the proximity of the river sections to hydroelectric power plants. This is in contrast with a study conducted on the river Danube in the Szigetköz area, where the abundance of Common Sandpiper increased near dams, probably due to the low water level that created suitable feeding habitats for these birds (Báldi *et al.* 1998). We suspect that two contrasting effects of dams on Common Sandpipers' abundance may cancel out each other in our analysis. On the one hand, the water level is artificially elevated above the dams and therefore low banks are not available here for the Sandpipers. On the other hand, the river stretches just below the dams are suitable habitats due to low water level (see also Báldi *et al.* 1998). Since Sandpipers can occasionally move between the two sides of the dam, this may cause more frequent occurrence of birds on both sides of the dam than in sections further away of dams.

Similarly, there was no relationship between the distance of settlements and the presence of sandpipers. However, this result does not mean that these birds are not susceptible to anthropogenic effects (see Vickery 1991, Yalden & Holland 1993), rather we believe that human disturbance does not necessarily increase towards the settlements. There are many types of human activities, such as fishing, water tourism, and agricultural works that occur all along the river, and these can potentially mask the effect of the proximity to settlements.

Our results on the habitat use of Common Sandpipers have two important implications for the conservation of this bird species. First, since low gravel and sand banks seem to be the most important habitat element for Common Sandpipers, River Rába should be allowed to continue its destroying and building work whereby it creates these open habitats (Arlettaz *et al*. 2011). Regulations by cutting through river banks or stabilizing banks by stone or concrete embankments can reduce suitable habitats in a great extent. Second, the deterioration of natural habitats through, for example, the spread of alien plant species and intensive agriculture next to the river reduces suitable feeding places for Common Sandpipers. Therefore conservation management should find the way to control these detrimental processes.

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