

DISTRIBUTION OF COMMON KINGFISHER (*ALCEDO ATTHIS*) IN THE RAMENA ŘEKY MORAVY NATIONAL NATURE RESERVE (CZECH REPUBLIC) IN RELATION TO THE COPPICE-WITH-STANDARD FOREST MANAGEMENT

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Abstract

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The paper brings results of a long-term monitoring of a breeding population of the Common Kingfisher (*Alcedo atthis*) carried out at the Morava River (an 11.11 km long section) in the Ramena řeky Moravy National Nature Reserve (Litovelské Pomoraví SPA, Czech Republic) in the years 1987–2012. Monitoring of breeding sites of the Common Kingfisher was performed using a modified nest searching method. In the study area, numbers of Common Kingfishers fluctuate significantly between 1 and 15 breeding pairs (i.e. between 0.09 and 1.26 breeding pairs per 1 km of the river). In a statistical analysis of data from the period 2005–2012, factors affecting distribution of Kingfisher nests in the study area were assessed. A statistically significant relationship was found between the distribution of Kingfisher breeding sites and the distribution of riparian stands of the floodplain forest in a coppice-with-standards forest. This finding is discussed in relation to the current tendencies to apply coppicing in areas of high conservation value.

Keywords: *Alcedo atthis*, breeding population, floodplain forest, coppice-with-standards, monitoring, Litovelské Pomoraví SPA

INTRODUCTION

The Common Kingfisher (*Alcedo atthis*) is a typical flagship species (Simberloff, 1998). In most European countries, numbers of breeding populations of the species have been declining (Štátný *et al.*, 2006). The Common Kingfisher is included in Annex I of the Birds Directive, listing species for which EU member states are obliged to establish Special Protection Areas within the Natura 2000 network (Hora *et al.*, 2002). In the Czech Republic, guidelines for management of forest

ecosystems in Special Protection Areas have been published recently (Knížátková & Lacina, 2010).

In the Litovelské Pomoraví SPA, breeding population of the Common Kingfisher has been monitored already since 1987 (Bureš, 1987). The study area covers a section of the Morava River protected as the Ramena řeky Moravy National Nature Reserve (Machar & Pechanec, 2011). It is a highly territorial species and its breeding territories on watercourses are usually about 2 km long (Libois, 1997). In the breeding season, approximately a half of repeatedly nesting pairs use

the same burrow (Čech, 2006a). Places suitable for nesting are occupied for many consecutive years; however, it is not known whether the same place is used repeatedly by the same individuals (Čech, 1995).

Within the TARMAG project, run at the Mendel University in Brno and the Palacký University in Olomouc, focussed on rare species important for the Natura 2000 network, monitoring of the Common Kingfisher in the Ramena řeky Moravy National Nature Reserve was extended to cover the study of selected ecological factors which may affect distribution of the breeding population of the Common Kingfisher in the area.

The aim of this paper is (1) to provide a review of data on development of the breeding population of the Common Kingfisher in the Ramena řeky Moravy National Nature Reserve obtained by monitoring since 1987, and (2) to discuss different aspects of conservation of this species of European importance in relation to the management of littoral stands and floodplain forests along the Morava River.

MATERIAL AND METHODS

Study Area

The Ramena řeky Moravy National Nature Reserve (NNR) was designated in 1990 to protect the main stream of the Morava River and its two arms with littoral stands in the middle of large complexes of floodplain forests, in the section between Litovel and Horka nad Moravou (Šafář, 2003). The reserve is a part of the Litovelské Pomoraví Special Protection Area (SPA), which was laid down by the Government Order No. 23/2005 Coll. and which also includes the status of Protected Landscape Area (PLA) (Fig. 1). In the Litovelské Pomoraví SPA, altogether 239 bird species have been recorded so far, of which 117 are currently breeding species, 9 are species with possible or probable breeding and 19 are species in which breeding was confirmed in the past (during the 20th century). Due to its position on a migration corridor of the Morava River, the SPA is an important stopover site. During spring and autumn migration, 217 species have been recorded there so far, while wintering has been observed in 84 species (Poprach & Machar, 2012).

Monitoring of the Common Kingfisher in the Ramena řeky Moravy NNR is carried out on the main stream of the Morava River, delimited by 49°41'6.451" N, 17°8'42.876" E at the beginning and 49°39'43.623" N, 17°12'14.742" E at the end of the section. Due to the meandering activity, the Morava River shows significant dynamic changes in the studied section. For data analysis, the total length of the studied section of the Morava River (11.110 km) was measured in the middle of the watercourse using the Google Earth application.

Forests adjacent to the studied section of the Morava river are a fluvial succession series of types of floodplain habitats with a prevalence of

the hornbeam-elm-ash forest group of a higher level (Machar, 2008) in the 2nd vegetation level in the geobiocenological concept (Zlatník, 1976). In the Czech typology of Natura 2000 habitats (Chytrý *et al.*, 2001), they are classified as hardwood forests of lowland rivers.

Data Collection

Occurrence of the Common Kingfisher in Litovelské Pomoraví has been recorded since 1977 (Bureš & Machar, 1999). Since 1987, regular monitoring of its numbers has been carried out there using the modified nest searching method (Bibby *et al.*, 1992) applied during canoeing down the river. Burrow occupancy is verified by observation of birds entering the burrow with prey (Janda & Řepa, 1986). In addition, the territory mapping method is also used and the so-called points of return are registered (Bureš & Retek, 1993). Since 2005, monitoring of the Common Kingfisher in the study area is a part of monitoring of the Litovelské Pomoraví SPA, which is guaranteed by a caretaker group under the Czech Society for Ornithology (www.biomonitoring.cz). Besides the Common Kingfisher, three other bird species associated with habitats of the meandering Morava River are also recorded during the monitoring: Common Sandpiper (*Actitis hypoleucos*), Little Ringed Plover (*Charadrius dubius*) and Grey Wagtail (*Motacilla cinerea*). In the period 2005–2012, occupied nests of the Common Kingfisher were localised using GPS. In some years, monitoring could not be performed for organisational or other reasons (1997–2002, 2006 and 2009). Exact monitoring dates in the particular years are chosen depending on the development of hydrological situation at the Morava River (current water level). Data are collected twice in each season in order to detect both the first (usually in May and June) and the second nesting attempt (usually in July).

Data Analysis

Based on the collected GPS data, a map of distribution of breeding sites of the Common Kingfisher occupied during the first and second nesting attempts in the years 2005, 2007, 2008, 2010, 2011 and 2012 was prepared using the ArcInfo software.

A possible relationship between the distribution of breeding sites of the Common Kingfisher and the defined qualitative factors potentially affecting the distribution of breeding sites was tested using the chi-square test of independence (Zvára, 2006). Null hypothesis significance testing was carried out at the significance level $\alpha = 0.05$. The chi-square criterion was calculated using the following formula:

$$\chi^2 = \frac{(P - O)^2}{O},$$

where P is the respective field of contingency table for the given tested factor and O is a value of expected frequencies.

Field data obtained in the breeding season using the tape measure (total height of the nesting wall from bank margin to river surface, distance of the burrow to bank margin) were used to compile contingency tables. The total length of nesting wall was estimated in the field using a 1:10 000 forestry map. Data on the occurrence of stands within the coppice-with-standards forest in the littoral belt were identified in the GIS environment using the data from the paper by Machar (2009) and verified visually in the field.

The obtained chi-square value is a measure of difference between the reality and the null hypothesis (assuming a positive relationship). The number of degrees of freedom in the table was determined using the following relationship:

$$f = (r-1) \times (s-1),$$

where r is a number of rows in the contingency table and s is a number of columns (Chrástka, 1996). For the obtained number of degrees of freedom, the calculated value of the test criterion is compared with its critical value in statistical tables.

RESULTS

In the study period 1987–2012, altogether 100 cases of breeding of the Common Kingfisher (first nesting attempt in the given year) were recorded

I: Density of the Common Kingfisher (*Alcedo atthis*) in the Ramena řeky Moravy National Nature Reserve (first nesting) in the period 1987–2012

Year	Number of pairs/1 km of the river
1987	0.09
1988	0.18
1989	0.36
1990	0.36
1991	0.45
1992	0.27
1993	0.36
1994	0.63
1995	0.81
1996	0.54
2003	0.63
2004	0.63
2005	0.18
2007	0.27
2008	1.26
2010	0.54
2011	0.90
2012	0.54

Monitoring of the Common Kingfisher was not carried out in the years 1997–2002, 2006 and 2009

in the Ramena řeky Moravy NNR. Numbers of the breeding population fluctuated markedly among years (Fig. 2). Density ranged between 0.09 and 1.26 breeding pairs per 1 km of the river (Tab. I). The highest number of breeding pairs was found in 2008 (14 pairs), when 85.7 percent of the pairs nested also for the second time in the same season.

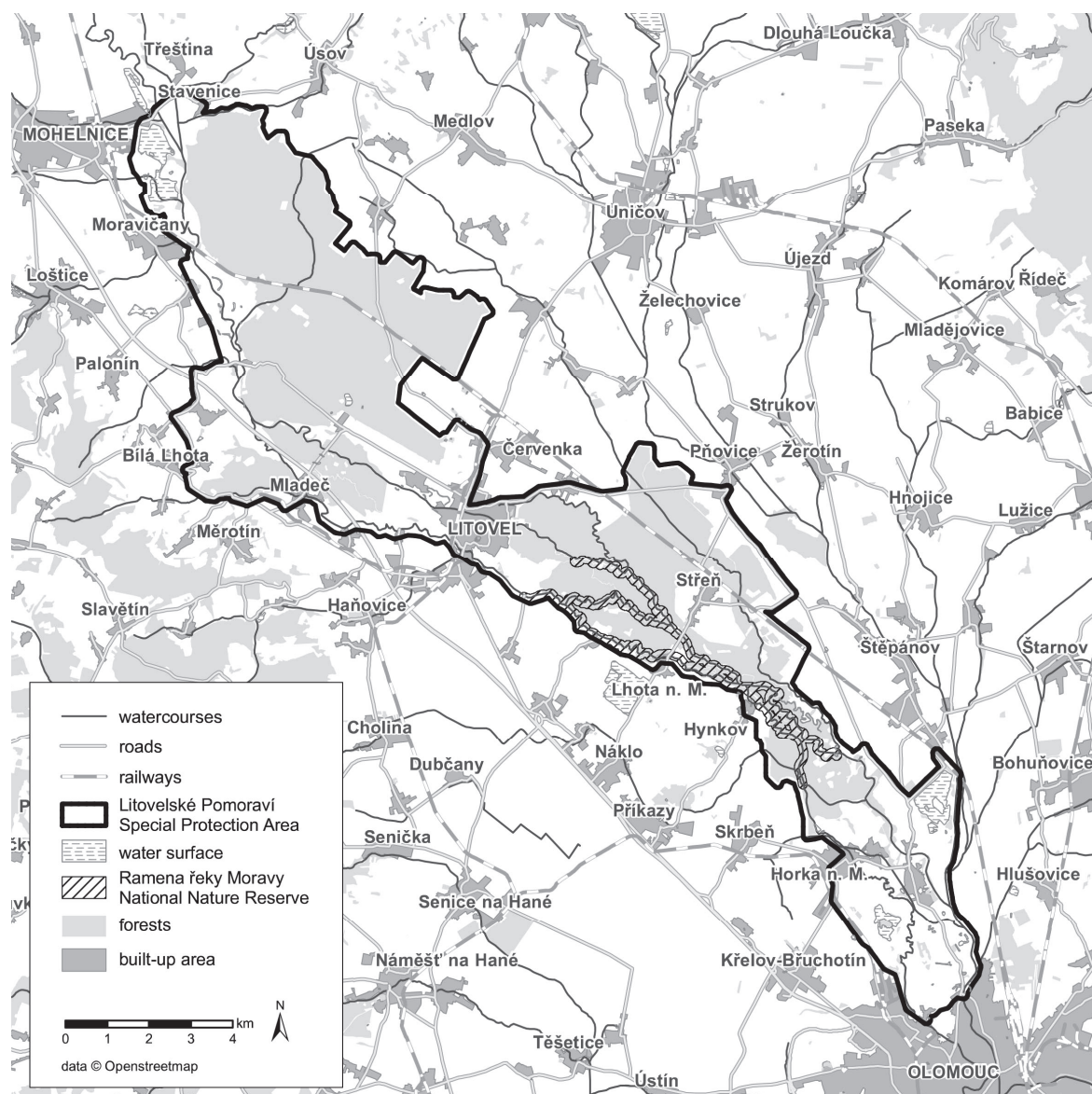
In the Common Kingfisher nests localised in 2005–2012, the total height of the nesting wall in the river bank ranged between 1.3 and 4 m ($n = 55$, mean 2.39 m), with most cases found between 1.6 and 3 m (78 percent of occupied burrows) (Fig. 3). Distance of the burrow entrance to water surface ranged between 0.7 and 3.5 m ($n = 55$, mean 1.86 m), with most cases found in the interval 0.7–2.0 m (73 percent of occupied burrows). Distance of the burrow entrance to bank margin ranged between 0.2 and 1.3 m ($n = 55$, mean 0.53 m), with most cases found in the interval 0.5–1.0 m (61.8 percent of occupied burrows).

Analysis of the distribution of breeding sites of the Common Kingfisher, based on GPS data collected in the years 2005–2012, shows conspicuous clusters of breeding sites on the meandering parts of the river (Fig. 4). Results of the chi-square independence tests suggest that the distribution of breeding sites of the Common Kingfisher in the study area does not have a statistically significant relationship with the height of nesting wall, its length nor the position of burrow entrance. On the other hand, a statistically significant correlation was found between the distribution of kingfisher breeding sites and the distribution of riparian stands of the floodplain forest within the coppice-with-standards forest. In this case, the obtained value of the test criterion $\chi^2 = 6.609$ was higher than the critical table value (5.991).

DISCUSSION AND CONCLUSION

In some European countries (Netherlands, Spain, Great Britain, Italy, Bulgaria), a long-term decline in numbers of the Common Kingfisher has been recorded in the last thirty years (Kucharski & Indykiewicz, 1996). In the Czech Republic, the Common Kingfisher is considered to be a regularly but not commonly breeding species (Čech, 2006b). In the period 2001–2003, population numbers of the Common Kingfisher in the country were estimated at 500–900 breeding pairs (Šťastný *et al.*, 2006), which is a slight increase compared to the period 1985–1989 when the numbers were estimated at 300–700 pairs (Šťastný & Bejček, 2003).

Numbers of the Common Kingfisher breeding population at a particular site tend to fluctuate markedly among years – during the periods of hard winter frost, kingfishers lose access to their main food, small fish, and a part of the population dies of starvation and exhaustion (Čech, 2009). The fluctuating numbers and density of breeding pairs of the Common Kingfisher observed in Litovelské Pomoraví in the study period may be

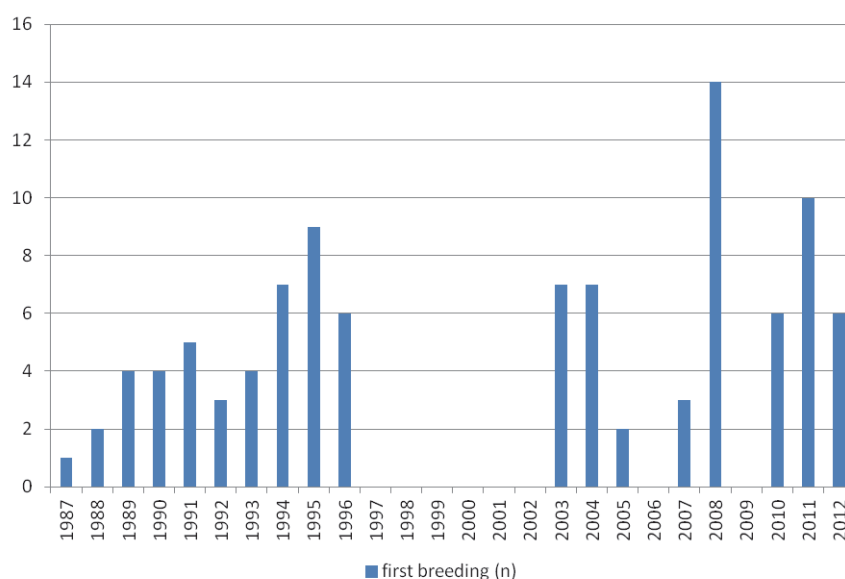


1: Map of the study area showing boundaries of the Litovelské Pomoraví Special Protection Area and the Ramena řeky Moravy National Nature Reserve

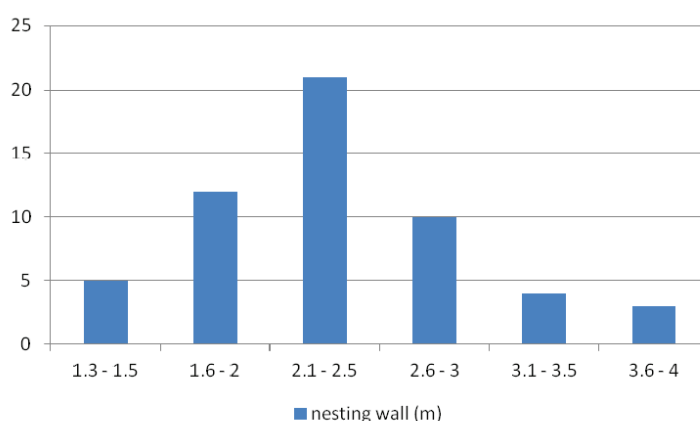
related to these factors. Such fluctuation in numbers of breeding Common Kingfishers is not exceptional. Křenek & Dvorský (2003) recorded 0.15 pairs/km of the Bečva River in 2000 and 0.18 pairs/km in 2001. Kočvara (2003) mentions 0.19 pairs/km of the Opava River. At four streams in the Beroun region with the total length of ca 55 km, Hallet & Doulcet (1982) recorded the mean density of 1 pair/9.1 km of the stream. Čech (2010) published results of a long-term monitoring of breeding occurrence of the Common Kingfisher in the Blaník region, based on repeated surveys on the same watercourses with the total length of 111 km. Their findings document the effect of severe winters and flooding on the numbers of breeding pairs: 1995 – 7 pairs, 1996 – 3 pairs, 1997 – 2 pairs, 1998 – 6 pairs, 1999 – 10 pairs, 2000 – 13 pairs, 2001 – 11 pairs, 2003 – 6 pairs.

The same author organised a national census of Common Kingfishers on ca 1100 km of watercourses in each of the years 2001–2003. The results showed a decline in numbers of breeding pairs: 1 pair/8.9 km in 2001, 1 pair/13.3 km in 2002 and 1 pair/17 km in 2003.

The unusually high number of breeding pairs of the Common Kingfisher in the study area in 2008 could have been caused by coincidence of several factors, positively affecting population numbers at the beginning of the breeding season – a mild winter probably enabled wintering of Kingfishers in high numbers and the good food availability in the spring 2008 was a result of low spring discharge in the Morava River, when the water was not muddied by flood sediments.



2: Development of breeding population of the Common Kingfisher (*Alcedo atthis*) in the Ramena řeky Moravy National Nature Reserve in the years 1987–2012 (first nesting, $n = 100$)
Monitoring of the Common Kingfisher was not carried out in the years 1997–2002, 2006 and 2009

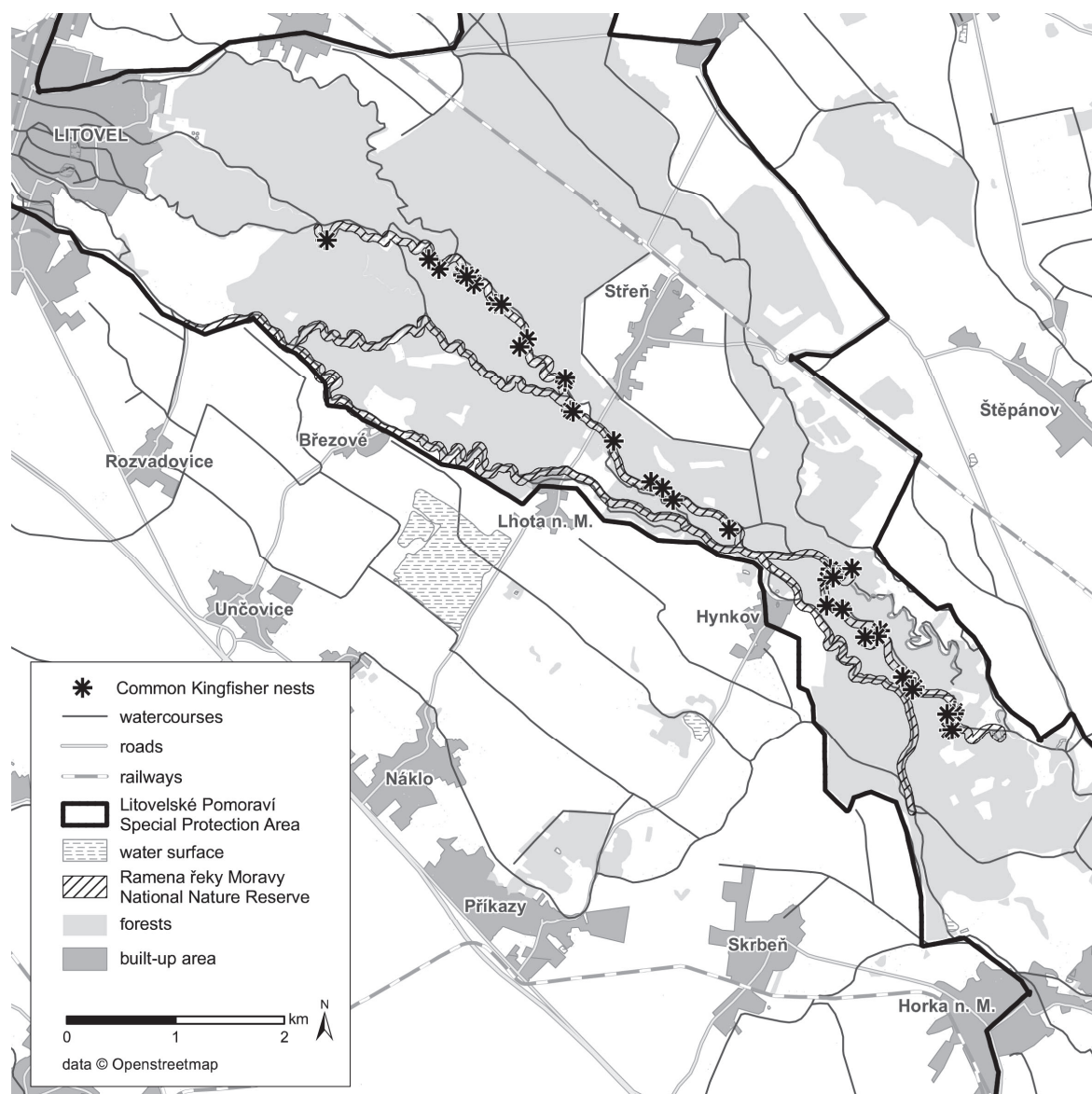


3: Height of breeding wall of the Common Kingfisher (*Alcedo atthis*) at the Morava river in the Ramena řeky Moravy National Nature Reserve in the period 2005–2012 ($n = 55$)
Monitoring of the Common Kingfisher was not carried out in the years 1997–2002, 2006 and 2009

On the other hand, the markedly low numbers of breeding pairs of the Common Kingfisher at the beginning of long-term monitoring in the study area at the break of the 1980s and 1990s was probably caused by strong industrial pollution of the Morava river at that time, which practically made it impossible for fish to survive (Loyka, 1993) and eliminated accessibility and availability of food for the Common Kingfisher. After the year 1989, water quality in the Morava River in Litovelské Pomoraví improved gradually but markedly up to the current state, enabling natural reproduction of the fish community (Hohausová & Jurajda, 2005). This process probably had a positive effect on the slowly increasing breeding numbers of the Common Kingfisher in the study area. The effect of water

quality in watercourses on numbers of breeding populations of the Common Kingfisher has been confirmed e.g. by Peris & Rodriguez (1997).

In the Czech Republic, the first nesting of Common Kingfishers usually starts already in the first ten-day period of April (Hudec & Štastný, 2005). During the long-term monitoring of the Common Kingfisher in the study area, marked inter-seasonal differences in the onset of breeding (both 1st and 2nd breeding attempt) were recorded in some years. E.g. in 2010, the beginning of first nesting was significantly delayed and occurred first in the second half of June. This was probably caused by a long period of rain in spring and consequently a long period of extremely high water level in the river, reaching the bank margin and making



4: Occupied nest burrows of the Common Kingfisher (*Alcedo atthis*) in the Ramena řeky Moravy National Nature Reserve in the period 2005–2012 ($n = 57$)

Monitoring of the Common Kingfisher was not carried out in the years 2006 and 2009

it impossible for Common Kingfishers to nest in vertical banks. At the same time, the very muddy water in the river made it impossible for Kingfishers to hunt fish. On the contrary, in 2011 the first nesting was recorded in the study area already during May.

Results of monitoring in the study area presented in this paper show that the inter-seasonal shift in the onset of both nesting attempts may reach several ten-day periods – depending on current weather and discharge conditions in the river (water level, turbidity). This finding is in accordance with the results published by Čech (2010), who reports that the breeding season of the Common Kingfisher in the Czech Republic is longer than thought previously.

Our metric data on the position of entrances to Kingfisher burrows in the river bank indicate

that during burrow building, Kingfishers need to eliminate two potential risk factors: (1) risk of nest flooding due to high water level in the river and (2) risk of nest predation due to low amount of soil above the nest, e.g. by a fox which may dig out the nest (Čech & Hora, 2006).

In the study area, the Common Kingfisher uses mainly vertical erosion banks of the Morava River for nesting. These vertical banks are formed by natural processes mainly in meanders of the main stream of the Morava river and less often also in natural sections of some side arms of the river or its tributaries (Kirchner & Ivan, 1999). However, Kingfishers do not nest at all theoretically suitable sections of the meandering Morava River in the study area. Results of long-term monitoring presented in this paper show certain preferences of

Kingfishers during nest site selection on the Morava River. The statistically significant correlation between the distribution of Kingfisher nests and the distribution of riparian forest vegetation in the coppice-with-standards forest in Litovelské Pomoraví is a result of forest management in riparian stands along the Morava River. The meandering stream of the Morava River, which is the main habitat of the local breeding population of the Common Kingfisher, is surrounded by a complex of floodplain forests. Dynamic development of river banks is determined, besides geological, geomorphological and hydrological conditions, also by forest management (Šindlar *et al.*, 2010). Full-grown trees on the bank may uproot due to river erosion (especially in the exposed parts of meanders), fall down to the river bed and block vegetation succession by disrupting the bank with their roots. Fallen trees in the river slow down the speed of flow and may consequently change the shape of the river bed relief with the formation of shallows, which enable the Kingfishers to hunt food more easily. Fallen trees in the river bed are also important „hunting habitats“ of Kingfishers.

Distribution of nest burrows of the Common Kingfisher may be affected by physical characteristics of the material making up the bank (Heneberg, 2004). In the study area, fluvisols which are used by Kingfishers for nesting are physically homogeneous (Kulhavý & Sáníka, 2009), the relationship between their physical parameters and the distribution of Kingfisher nest sites was thus not studied.

In a Common Kingfisher population breeding on the Bečva River, Straka & Grim (2007) found

a significant effect of river bank characteristics on nest site selection. No similar relationship has been recorded in the study area. In the flysch belt region at the Bečva River, the dynamics of river banks are much more pronounced than at the Morava River in Litovelské Pomoraví, where meanders of the branching system are rather stable, however, they are also subject to erosion development within a several-year horizon (Kirchner *et al.*, 1999). The Czech Nature Conservation Agency prefers a rather conservative approach to the management of littoral stands and forestry practices in the floodplain forest adjacent to the river in the SPA Litovelské Pomoraví (Bureš & Machar, 1999). But, it is not convenient for long-term conservation targets of the breeding population of the Common Kingfisher (Brinke *et al.*, 2010). Therefore, draft management guidelines for the Litovelské Pomoraví SPA (Poprach, 2004) have newly recommended management of littoral stands using the coppice-with-standards approach (Kadavý *et al.*, 2007) as one of the key actions in the SPA management plan. Coppicing with standards (Kadavý, 2013) in riparian forest stands may comply with both forestry and water management requirements (frequent logging in coppice and the existence of coppice itself correspond to basic requirements of the management and maintenance of riparian stands). In addition, leaving selected monumental trees within the area logged as reserved trees, which may sometimes be uprooted by river erosion and fall down to the river, meets nature conservation requirements.

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