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Habitat use by waterbirds at Rački ribniki, NE Slovenia

Raba habitata vodnih ptic račkih ribnikov, SV Slovenija.

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The difference in habitat use by the observed waterbird species at Rački ribniki (Rače Ponds, NE Slovenia) was studied between June and August 2011. It was assessed that different waterbird species, even closely related species like *Aythya* ducks, use wetlands differently, with Tufted Ducks *A. fuligula* observed more on Open water and Ferruginous Ducks *A. nyroca* more often amongst Floating vegetation. The latter was used more often probably due to the abundance of food in the habitat. Highest species richness was recorded on Floating vegetation as well. This was reflected in species richness of individual ponds, where ponds with more floating vegetation had higher species richness. Although Coots *Fulica atra* were expected to utilize Floating vegetation more often due to their feeding preferences, they were observed more often on Open water probably feeding on fish fodder available there. The difference in habitat use by the families and nonbreeding individuals of the same species was noted, too, mostly by observing families in habitats that provide more cover from predators (Reeds), or more invertebrate food (Floating vegetation) for the young that often feed on different food than adults. Furthermore, it was suggested that overall management of wetlands should consider providing more suitable wetlands with larger aquatic vegetation cover.

Keywords: Rački ribniki, waterbirds, habitat use
Ključne besede: Rački ribniki, vodne ptice, raba habitata

1. Introduction

The type of habitat a species uses and the extent of overlap with habitat of other species are dependent on how we describe the habitat (Jones 2001). We tend to lump all wetland species in the same basket, but detailed analysis of their feeding habitat usually reveals a considerably different picture (Murkin *et al.* 1997, Clark & Shutler 1999). For example, many wader species use their own strategy and a different microhabitat when foraging together (Granadeiro *et al.* 2007; Lantz *et al.* 2011). The same applies for dabbling ducks, where some feed mainly on land (i.e. Wigeon *Mareca penelope*), while others, like Shoveler *Spatula clypeata*, feed mainly from the water surface (Arzel & Elmberg 2004).

Since similar species may use the same habitat in a different way (Clark & Shutler 1999; Hino *et al.* 2002), the habitat use has an important consequence for nature conservation. For a successful conservation it is necessary to know which species are using what habitat and how (Ma *et al.* 2010). This is especially important for the areas used for both economical activities and conservation. Due to the

importance of habitat use for conservation purpose, it is more and more often part of bird studies in Slovenia, including studies of waterbirds such as of five riverbed species on the Drava river (Božič & Denac 2017), the Mediterranean Shag *Gulosus aristotelis* (Bordjan *et al.* 2013), Harriers *Circus* sp. (Vogrin 1997) and the Mallard *Anas platyrhynchos* (Bordjan 2020). Also, three studies have been published in Slovenia so far, showing distribution of different wetland species within a selected wetland (Bordjan 2012, Deberšek & Bordjan 2016, Koce 2018), indicating habitat partitioning in those species/groups. While several studies on waterbirds have been carried out at Rački ribniki (Vogrin 1998, Vogrin 1999, Vogrin 2001, Vogrin 2002, Denac *et al.* 2011), none have dealt with habitat partitioning or conservation resulting from habitat use. The site is an Important Bird Area (Denac *et al.* 2011) and as such part of Nature 2000 network (Ur. l. 2013). Several conservationally important species nest in the area and since ponds are privately owned it is important to evaluate the significance of different habitats for these species for future management purposes.

Slovenia is considered a country with many wetlands (Uhan & Bat 2003) that cover less than 1% of the entire country. 0.3% of Slovenia is covered by about 1,300 bodies of standing water (Remec-Rekar & Bat 2003). Most of them are artificial in their origin, such as gravel and clay pits, accumulations and created ponds comprising 31.01km^2 or approximately half of all lakes and ponds (Remec-Rekar & Bat 2003). Artificial water bodies usually look different from natural ones and have different ecological role (Georgiadis *et al.* 2010). Artificial lakes and ponds in Slovenia look mostly similar in their appearance. They are often small with more or less steep banks, with little or no riparian or aquatic vegetation. The consequence is that only a few sites are internationally important for breeding wetland birds (Denac *et al.* 2011). Wetlands with higher species richness are shallower, have more varied topography, are larger and have vegetation with variable cover-to-water ratios (Gibbs *et al.* 1991; Ma *et al.* 2010).

The aim of the paper was to study the difference in habitat use among the observed waterbird species and to evaluate the importance of separate fishponds depending on aquatic vegetation. Additionally, we wished to consider conservational importance of different habitats.

2. Study area and Methods

2.1. Study area

Rački ribniki are part of the Rački ribniki – Požeg Landscape Park situated in the western part of Dravsko polje in NE Slovenia. The park measures 484 ha (Municipality Rače-Fram 2020) of which 76 ha are covered by standing water bodies (Vogrin 1994; Vogrin 1999). Rački ribniki are composed of three fairly large fishponds (Veliki, Mali and Gajič) and several smaller fish rearing ponds. They are surrounded by forests on the western and southern sides and by a tree hedge that cuts into arable land and meadows on the eastern side. Fishponds are divided by a dike with paved road that is frequently used by visitors. The road is lined with trees towards Gajič and reeds toward Veliki ribnik. All fishponds are shallow (less than 1m on average) and used as a fish farm for warm-water fish like the Common Carp *Cyprinus carpio*. Veliki ribnik is the largest of the three, covering 20 ha. On its northern side, it is lined with the Cattail *Typha* stand and covered with the Yellow Floating Heart *Nymphoides peltata* (Vogrin 1999). Thin belt of Reeds *Phragmites australis* is present on the eastern and south-eastern sides. In the recent years, the Water Caltrop *Trapa natans* has been spreading on the southern side. The youngest, constructed in the seventies, and the second largest with 8.5 ha is Gajič (Vogrin 1994). It has less water vegetation than other fishponds and its banks are mostly bare or overgrown by bushes and trees. Mali ribnik is the smallest of the three with 4.5 ha. On the northern side it is covered by a sizable Cattail stand and predominantly by Water Caltrop (Vogrin 1999). For the purpose of this survey, fishponds were termed A (Veliki ribnik), B (Gajič), C (Mali ribnik) and D (smaller ponds in the N), as shown in Figure 1. Birds, especially waterbirds, were under thorough research in the 1990s. The species richness and abundance was studied (Vogrin 1999), as well as breeding (Vogrin 2001; Vogrin 2002) or migration of the selected species (Vogrin 1998). Data from these and later surveys were used for IBA proposal (Denac *et al.* 2011) and in a designation of SPA Črete (SI5000027).

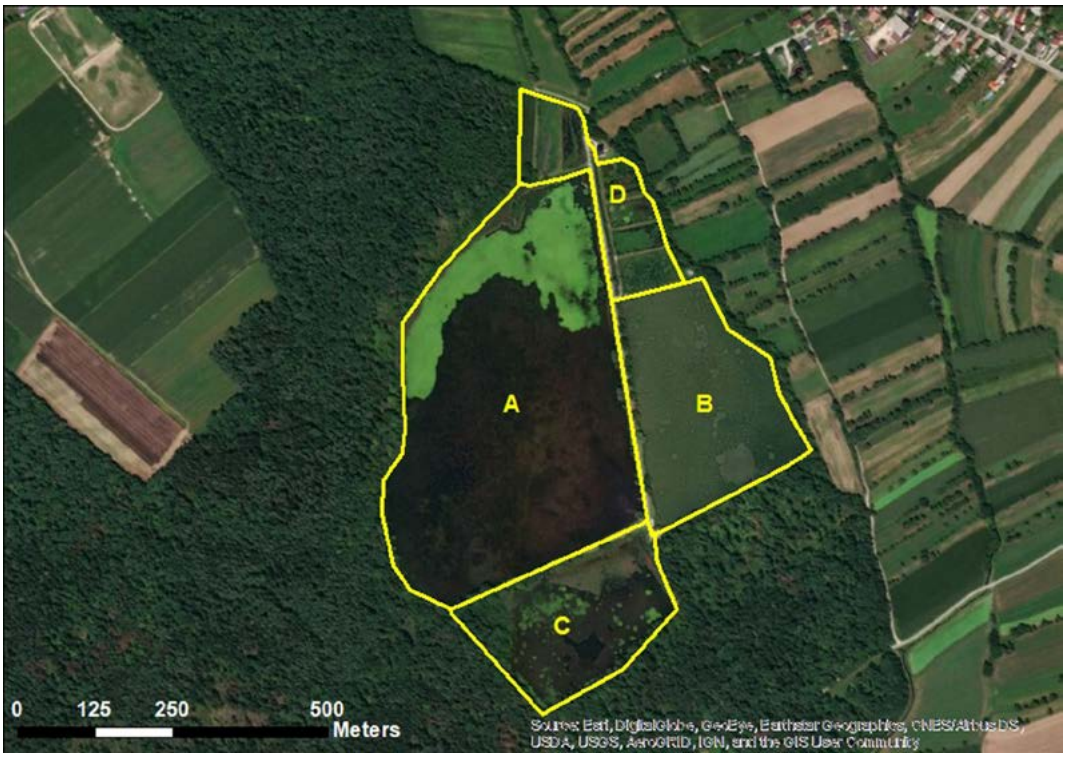

Figure 1: Study area with Fishponds: A – Veliki ribnik, B – Gajič, C – Mali ribnik, D – several smaller fishponds

Slika 1: Območje raziskave z ribniki: A – Veliki ribnik, B – Gajič, C – Mali ribnik, D – manjši ribniki

2.2. Methods

Waterbirds were surveyed 16 times in several-day intervals between 26 June 2011 and 14 August 2011, using binoculars and a spotting scope (20–60x). Survey was carried out at different times of day for at least 30 minutes on every occasion from the paved road or from a watchtower at the southern side of Fishpond B. Fishponds were surveyed to the greatest extent possible, with no major differences between the surveys. In the previously prepared form we recorded date and time of the survey, the number of observed species, the location, the habitat and the behaviour of observed individuals. We classified all habitats in five groups: Bank (shoreline around all fishponds), Reeds (both Cattail and Common Reed), Floating vegetation (including Pondweed *Potamogeton natans* in smaller ponds D), Mixed vegetation (including both reeds and floating vegetation) and Open water. Due to the low visibility in reeds we grouped both reeds and mixed habitat together in Reeds (both characterized by a different density of emergent vegetation) for analysis. We calculated the surface of each habitat with the use of satellite image in ArcMap 10.5 program (ESRI 2015), where we combined the map with an approximation from observations in the field (e.g. border between Open water and Floating vegetation). For calculating the area of the Bank, we used arbitrary distance of 1m from the edge of the water. Since the area of individual habitats was more or less estimated and not measured, some error was expected. For this reason, we approximated the area of individual habitats to the nearest 1%. All habitats were present in all fishponds with the exception of Fishpond B (Table 1). Individuals of all species were counted separately even if in a flock. Families and immature

individuals were treated as one unit regardless of the number of fledglings in a family. All herons and egrets were grouped into one taxonomic category. Of all observed behaviours, only feeding and resting had enough observations for statistical analysis.

Chi-square test was used for testing the habitat use. For this, the share of estimated area of habitat with the share of individuals in that habitat was compared. Herons and Tufted Ducks were excluded from this test, since they were present in only one and two habitats, respectively. Furthermore, the difference in habitat use between families and other individuals for species with more than a minimum of ten observations (Fay & Gerow 2018) of families was tested. The difference between habitat use for resting and feeding behaviours for species, where the selected behaviour in at least three habitats was observed, was also tested. Program R (R Core Team 2017) was used for all chi-square tests.

3. Results

3.1. Habitat use of observed waterbirds

More than half of the individuals of all species were observed on Open water and a third on Floating vegetation. Three species of *Aythya* ducks were absent from at least one habitat, while herons as a group were observed in one habitat only (Table 2). Tufted Duck *Aythya fuligula* was the only species that was observed almost entirely on Open water, while almost three quarters of Crested Grebe *Podiceps cristatus* were observed in the same habitat. Mute Swan *Cygnus olor*, Crested Grebes and Coot *Fulica atra* were evenly distributed among the observed habitats compared to what was available, while the rest were distributed unevenly with one or two habitats being preferred (Table 2). There was a difference in habitat use in the observed individuals compared to families in Mallards (Chi^2: 53.9, df = 3, $p < 0.001$), Crested Grebes (Chi^2: 27.0, df = 2, $p < 0.001$) and Coots (Chi^2: 146.3, df = 3, p = $p < 0.001$) but not in Little Grebe (Chi^2: 2.9, df = 2, p = 0.238). Mallard families were observed more often amongst Floating vegetation and Open water, whereas Crested Grebe and Coot families were observed more often amongst Floating vegetation and Reeds.

Five species observed in all habitats and with enough collected data (Table 2) used different habitat while resting compared to feeding (Table 3) and three species with both behaviours observed in the same three habitats used habitat differently for each behaviour (Crested Grebe: Chi^2: 16.6, df = 2, $p < 0.001$; Little Grebe: Chi^2: 7.5, df = 2, $p < 0.001$; Coot: Chi^2: 106.9, df = 2, $p < 0.001$). Mallard, Little Grebe and Common Moorhen predominantly fed on Floating vegetation, while Crested Grebes and Coots fed largely on Open water (Table 3). The preferred habitat was similar for resting. Mallard was an exception with the majority of individuals resting on Bank and only some on Floating vegetation. Reeds were important for feeding Little Grebe and resting Common Moorhen.

3.2. Presence of waterbirds on individual Fishponds

Most waterbirds were counted on Fishpond A (81.7%) and the least on Fishponds D (1%; Table 4). Although the majority of individuals were observed

Table 1: Percentage of habitats on fishponds rounded to 1%

Tabela 1: Odstotki habitatov na ribnikih zaokroženi na 1 %

Fishpond / Ribnik	Reeds / Trstičje	Floating vegetation / Plavajoča vegetacija	Open water / Odprta vodna površina	Bank / Brežina
Veliki ribnik(A)	11	21	67	1
Gajič (B)	0	5	94	2
Mali ribnik(C)	23	53	22	2
Small fishponds / manjši ribniki (D)	26	25	42	7
All / Skupaj	11	22	65	2

Table 2: Number and percentage of individuals of waterbirds observed in different habitats and results of Chi² test between available area of individual habitat and the number of individuals counted. Statistically significant results are presented in bold.

Tabela 2: Število in odstotek osebkov vodnih ptic, opazovanih v različnih habitatih, in rezultati Chi² testa med posameznimi habitati in številom preštetih osebkov. Statistično značilni rezultati so označeni krepko.

		% of individuals in different habitat / % osebkov v različnih habitatih				Chi² test		
Species / Vrsta	Number / Število	Bank / Brežina	Floating vegetation / Plavajoča vegetacija	Open water / Odprta vodna površina	Reeds / Trstičje	Chi2	df	p
Cygnus olor	16	18.8	18.8	43.8	18.8	5.0	3.0	0.172
Anas platyrhynchos	429	19.1	28.7	21.7	30.5	**37.4**	**3.0**	**< 0.001**
Aythya ferina	90	0.0	76.7	22.2	1.1	**332.4**	**2.0**	**< 0.001**
Aythya fuligula	53	0.0	13.2	86.8	0.0			
Aythya nyroca	404	0.0	95.0	2.7	2.2	**193.0**	**2.0**	**< 0.001**
Herons / Čaplje	18	100.0	0.0	0.0	0.0			
Podiceps cristatus	355	0.3	19.2	74.6	5.9	6.0	3.0	0.110
Tachybaptus ruficollis	224	0.9	32.1	35.7	31.3	**9.0**	**3.0**	**0.030**
Fulica atra	5,729	3.2	30.6	62.4	3.7	6.1	3.0	0.109
Gallinula chloropus	85	9.4	70.6	1.2	18.8	**34.0**	**3.0**	**< 0.001**
Totall /Skupaj	7,403	4.0	34.3	55.4	6.3			

Table 3: Percentage of individuals of observed waterbird species resting or feeding in separate habitats

Tabela 3: Odstotek opazovanih osebkov vodnih ptic med počitkom in prehranjevanjem v različnih habitatih

		Bank / Brežina	Floating vegetation / Plavajoča vegetacija	Open water / Odprta vodna površina	Reeds / Trstičje
Anas platyrhynchos	Feeding / Prehranjevanje	0	93.5	0	6.5
	Resting / Počitek	87.8	10.0	0	2.2
Podiceps cristatus	Feeding / Prehranjevanje	0	5.0	88.3	6.7
	Resting / Počitek	0	34.6	57.7	7.7
Tachybaptus ruficollis	Feeding / Prehranjevanje	0	44.4	24.4	31.1
	Resting / Počitek	4.0	64.0	28.0	4.0
Fulica atra	Feeding / Prehranjevanje	0	8.1	81.1	10.8
	Resting / Počitek	0.1	34.5	63.6	1.8
Gallinula chloropus	Feeding / Prehranjevanje	0	89.1	0	10.9
	Resting / Počitek	29.4	47.1	0	23.5

Table 4: Number and percentage of individual waterbirds observed at separate fishponds

Tabela 4: Število in odstotek posameznih vrst vodnih ptic, opazovanih v posameznih ribnikih

		Fishpond / Ribnik [%]			
Species / Vrsta	Number / Število	Veliki ribnik (A)	Gajič (B)	Mali ribnik (C)	Small ponds / manjši ribniki (D)
Cygnus olor	18	77.8	11.1	5.6	11.1
Anas platyrhynchos	501	46.9	23.6	24.4	5.2
Aythya ferina	106	28.3	0.0	71.7	0.9
Aythya nyroca	574	7.3	0.0	92.7	0.0
Aythya fuligula	74	71.6	0.0	21.6	0.0
Herons / Čaplje	21	21.1	73.7	0.0	5.3
Podiceps cristatus	503	81.1	6.8	12.1	0.0
Tachybaptus ruficollis	314	39.2	14.5	45.8	1.3
Fulica atra	7,005	94.3	0.3	4.7	0.7
Gallinula chloropus	112	20.5	1.0	74.3	8.9
Total / Skupaj	9,223	81.7	2.6	14.7	1.0
Density (ind. / ha) / Gostota (os. / ha)	262.8	376.7	27.7	301.9	45.2

on Fishpond A, the density (individuals per hectare) was only slightly higher than on Fishpond C. The density at Fishponds D was almost twice as high as at the much larger Fishpond B (Table 4). All species were observed only on Fishpond A, whereas herons were absent from Fishpond C, the same as diving ducks from Fishpond B (Table 4). The majority of Common Pochards, Ferruginous Ducks, Common Moorhens and almost half of Little Grebes were observed on Fishpond C. Most herons were observed on Fishpond B, while the majority of Tufted Ducks, Mute Swans, Coots, Crested Grebes and nearly half of Mallards were observed on Fishpond A. None of the species were observed in any significant numbers on Fishponds D (Table 4).

4. Discussion

Different waterbird species, even closely related species like *Aythya* ducks, use wetlands differently, with Tufted Duck observed more on Open water and Ferruginous more amongst Floating vegetation. Habitat partitioning was noted for dabbling ducks (Arzel & Elmberg 2004), shorebirds (Burger *et al.* 1977), terns (Safina 1990) and also between Red-crested *Netta rufina* and Common Pochard (Amat 1984) among others. We also found difference in habitat use between families and nonbreeding individuals of the same species, mostly by observing families in habitats with more cover (Reeds) and with more invertebrate food (Floating vegetation). The young and immature birds are more susceptible to predation than adult birds (Hill 1984, Stafford & Pearse 2007) and in many cases have preference for different food. In Mallard, for instance, plant seeds are increasing in percentage with duckling age, while invertebrates are on decrease (Drilling *et al.* 2020). The studied species feed mostly on or amongst water vegetation (Billerman *et al.* 2020), so it is not surprising that almost all species were recorded in at least some parts amongst emergent or Floating vegetation. One of the species that is closely tied to Floating vegetation is Ferruginous Duck (Smole 2005, Petkov 2012, Carboneras & Kirwan 2020a), as confirmed in the present study. Our results also support the different preference for Floating vegetation among different *Aythya* ducks (Smole 2005, Billerman *et al.* 2020), with Ferruginous Duck having the highest preference and Tufted Duck the lowest. Although we observed major importance of water vegetation in most species, in

some studies Mallard was recorded among reeds in much greater percentage (Ulenaers & Dhondt 1991, Hattori & Mae 2001, Kloskowski *et al.* 2010). Apart from food and hunting, water birds use water vegetation also as a safe nesting or resting area (Kloskowski *et al.* 2010), as also noted at Rački ribniki (Martinc 2015).

Open water was present on all larger fishponds and it is there that fish farmers fed the fish (Martinc 2015, *pers. observation*). Coots feed on different small animals and plant parts, including fish fodder, picked from the surface or in shallow water (Taylor & Kirwan 2020). They were observed picking and diving for food at places where fish were fed (*pers. observation*), thus explaining the presence of high number of Coots on Open water compared to Floating vegetation where they would feed naturally (Taylor & Kirwan 2020). Additionally, high percentage of Coots also rested on Open water, suggesting that many stayed close to feeding spots.

Many waterbirds use the shore for resting, preening or feeding (Billerman *et al.* 2020). One of these species is Mallard. Moreover, Mallards and Mute Swans are often habituated to human presence (Logar 2009), and can often find food out of water (Ciaranca *et al.* 2020, Drilling *et al.* 2020), thus it is not surprising that both were commonly observed on shore. While we did not record Mallard feeding on shore and did not classify Swans behaviour, both are often fed by local people (*pers. observation*). Apart from resting on shore, Mallards also rested amongst Floating vegetation and in Reeds. The latter was probably underestimated due to vegetation denseness (Hattori & Mae 2001) as was assumed for Common Pochard and Ferruginous Duck in Donji Miholjac (Smole 2005). Both Mallard and Mute Swan were observed in all habitats, reflecting their ecological plasticity (Ciaranca *et al.* 2020, Drilling *et al.* 2020) and at the same time explaining their wide distribution in Slovenia (Blažič 2019, Bordjan 2019c). On the other hand, both Common Pochard and Ferruginous Duck use only specific habitat within wetlands. Their preference for shallow sites with aquatic and emergent vegetation (Smole 2005, Bordjan 2019c, Bordjan 2019d, Carboneras *et al.* 2020, Carboneras & Kirwan 2020a) limits them to only a few suitable breeding sites in Slovenia (Bordjan 2013, Bordjan 2014, Bordjan 2015, Bordjan 2016, Bordjan 2017, Bordjan 2018, Bordjan 2019d, Bordjan 2019a, Bordjan 2019b). This confirms that the more specialised species is, the more threatened it is (Clavel *et al.* 2011).

Our study also confirmed that the size of the water body influences the species richness and abundance. This is not only through size (Sebastián-González & Green 2014) but also through higher habitat heterogeneity (Ma *et al.* 2010). Presence of different habitats in a small area enhances habitat heterogeneity that in turn enhances species richness (Moreno-Rueda & Pizarro 2009). In short, the more habitats one fishpond contains, the more species it can hold. This could explains the absence of certain species at Fishpond B compared to both Fishponds A and C. Water vegetation, being marginal, emergent or floating, influences the presence of many wetland species, with intermediate density being attractive for most (Gibbs *et al.* 1991), thus, explaining the presence of so many species at Fishpond C.

Considering solely the number of standing waterbodies in Slovenia (Remec-Rekar & Bat 2003), small population of some species is somewhat surprising, suggesting that most of our standing waterbodies are not suitable for most waterbird species. Indeed, the rarest breeding waterbirds in Slovenia are those that prefer shallow, richly vegetated waterbodies for their breeding. *Aythya* species, for example, need more naturally managed water bodies, e.g. shallow lakes with abundant emergent, floating and submerged vegetation (Carboneras *et al.* 2020, Carboneras & Kirwan 2020a, Carboneras & Kirwan 2020b), like Fishponds A and C compared to most water bodies in Slovenia that are more like Fishpond B. A more natural management would also benefit other duck species (*Anas* sp., *Mareca* sp., *Spatula* sp.) with rather small breeding populations in Slovenia (Mihelič *et al.* 2019) and unfavourable conservation status both in Slovenia and Europe (Denac *et al.* 2011, BirdLife International 2015). Although this was not part of this study, the depth and topography may be mainly due to the size and more or less evenly shallow ponds one of the key reasons apart from presence of water vegetation that influences the presence of waterbirds (Ma *et*

al. 2010). While topography has not been studied in Slovenia, the depth was proven important in the study at Šaleška lakes where most waterbirds were recorded near shore and deep centres of lakes were mostly devoid of birds (Deberšek & Bordjan 2016). Dabbling ducks use shallow inshore areas compared to offshore habitats disproportionally more frequently (Arzel & Elmberg 2004). The depths smaller than 25 cm have the greatest diversity of species (Ma *et al.* 2010). Overall management of wetlands should consider providing emergent, submerged and floating vegetation with variable cover-to-water ratios, accommodating species-specific habitat needs with focusing on species with unfavourable conservation status and low abundance (Gibbs *et al.* 1991).

5. Povzetek

Med junijem in avgustom 2011 smo spremljali rabo različnih habitatov na vodnih površinah Račkih ribnikov v Krajinskem parku Rački ribniki-Požeg (SV Slovenija). Razliko rabe trstičja, plavajoče vegetacije, odprte vodne površine in brežine smo preučevali na treh ribnikih in skupini manjših bazenov, ki so se med seboj razlikovali po velikosti in poraščenosti z vodno vegetacijo in obrežnim rastjem. V nalogi smo ugotovili razlike v rabi habitatov med posameznimi vrstami, tudi med ozko sorodnimi, kot so race potapljavke *Aythya* sp. Tako smo večino kostanjevk *A. nyroca* opazili med plavajočo vegetacijo, večino čopastih črnic *A. fuligula* pa na odprti vodni površini. Plavajoča vegetacija je bil tudi sicer habitat z največjo pestrostjo vrst. Najbolj enakomerna razporeditev med habitati je bila ugotovljena pri labodu grbcu *Cygnus olor* in liski *Fulica atra*. Zabeležili smo tudi razliko v rabi habitatov med posameznimi osebki ter družinami istih vrst, s pogostejšo izbiro plavajoče vegetacije pri družinah. Prav tako vrste uporabljajo v različnih deležih posamezne habitate za različna vedenja. Večina vrst je za počivanje pogosteje uporabljala plavajočo vegetacijo kot za prehranjevanje. Največja izjema je bila mlakarica *Anas platyrhynchos*, ki je počivala v glavnem na brežini, prehranjevala pa se je v glavnem med plavajočo vegetacijo. Potrdili smo tudi domnevo, da večje vodne površine premorejo več vrst, vendar pa ima izredno velik vpliv na to tudi heterogenost habitatov na posamezni vodni površini. Razumevanje rabe in pomena posameznih habitatov na vodnih površinah je zelo pomembno pri upravljanju mokrišč za namene ohranjanja redkih vrst.

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