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THE COMPARISON OF THE ORNITHOFAUNA OF BARA DVORINA AND GAJNA – THE SAVA RIVER FLOODPLAINS IN EASTERN CROATIA

Usporedba ornitofaune Bare Dvorine i Gajne – poplavnih područja rijeke Save Istočne Hrvatske

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ABSTRACT

The ornithofauna research of Bara Dvorina and Gajna pasture, both open floodplains of the Sava River protected by the Croatian law, and a part of Natura 2000 ecological network, was conducted monthly in 2021, with 12 field visits at each site, which included breeding, migration, and wintering seasons. A total of 138 bird species from 16 orders and 41 families were recorded: 120 at Bara Dvorina and 117 at Gajna pasture. The orders Passeriformes (66), Charadriiformes (16), Anseriformes (12), and Piciformes (7), as well as the families Anatidae (12), Scolopacidae (10), Muscicapidae (9), and Fringilidae (8) accounted for the majority of the recorded species. For each area, we furthermore calculated bird frequency based on observations, and categorized them based on habitat type, diet, population statuses, and the Red List categories. The main contributors to the differences in ornithofauna between Bara Dvorina and Gajna pasture are the level and the amount of water in depressions, the size and management of pastures and grasslands, and the number of mosaic plots. Bara Dvorina, which is larger in size and richer in water, has a more mosaic and diverse habitat, so that the area hosts more breeding, but also wintering and migratory birds, with greater frequency of observation. On the other hand, the Gajna pasture has more

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typical grassland species due to its better land management. Furthermore, more uncommon and rare species were recorded at Gajna; this indicates that this area is used as a stopover and feeding place for many birds. 22 species at Bara Dvorina, and 25 at Gajna pasture are on the Red List of Birds of Croatia, indicating that both areas are important for birds. In the future, more detailed and species-specific studies should be conducted. With proper land management, control of invasive species, mowing, and flood regulation, the condition of both Bara Dvorina and Gajna pasture could be improved.

Keywords: floodplains, Sava River, grasslands, pasture

INTRODUCTION

Floodplain areas are disturbance-dominated ecosystems with great biota and habitat diversity (oxbows, ponds, seasonally flooded fields, and forests) that alternate between terrestrial and aquatic phases (Ward *et al*. 1999, Ward *et al*. 2002). The natural river flow regime is a fundamental component in their enormous diversity (Junk *et al.* 1989). Low water level causes the floodplain to be cut off from the river, and develop its own biocenoses on land and in the remaining water (Junk 1997). Many aquatic and semi-aquatic species, such as invertebrates, amphibians, fish, and birds, rely on these habitats for their feeding, breeding, migration, and life cycles, which are often timed to coincide with periodic flood pulses (Holgerson *et al.* 2019). Human impacts such as river training and damming, floodplain disconnection, pollution, the introduction of alien species, and intensive forestry have dramatically altered the habitat conditions today (Schindler *et al.* 2016) and, in the future, they should be managed in a better way. The Ramsar Convention supports the smart use of wetlands and their sustainability, with the aim of preserving such essential habitats and stopping these negative actions (Ramsar Convention Secretariat 2013). Floodplains are also part of the Natura 2000 ecological network, which is Europe's most important conservation initiative. The 1979 Bird Directive and the 1992 Habitat Directive are the two key directives governing Natura 2000 (Maiorano *et al.* 2007).

The Sava River is a second major tributary of the Danube River, significant for its intact floodplains and alluvial wetlands. The Sava River basin contains Central Europe's greatest complex of alluvial floodplain wetlands and lowland forest complexes, shared among Slovenia, Croatia, Bosnia and Herzegovina, and Serbia (Zingstra *et al*. 2010). The Sava River basin contains 167 protected areas, including six Ramsar sites, eight national parks, and numerous nationally important bird and plant areas, as well as Natura 2000 sites (Komatina & Groelj 2015). The Lonjsko polje Nature Park, also a Ramsar site, is Croatia's largest and most important protected floodplain area in the central Sava basin, with roughly

51,100 ha of floodplain ecosystem (Gugić *et al.* 2012). There are several floodplain areas east of Lonjsko polje in the Brod – Posavina County: the Prašnik special forest reserve, the Iva pasture, the Jelas ponds, Bara Dvorina and the Gajna pasture (Pavičić 2011). This study was conducted at Bara Dvorina and the Gajna pasture east of the city of Slavonski Brod, both open floodplains between the Sava River and the dykes. In the study of Corine land cover changes in Croatia it is detected that small areas of grasslands along the Sava River are transformed in arable land (Radović *et al.* 2011). Comparing them to their historical use for grazing and mowing, natural and semi-natural open ecosystems are nowadays reduced and mostly degraded or abandoned (Crnobrnja-Isailović *et al.* 2015). The grasslands in both areas are used for cattle grazing. The cattle population has declined over time, although the Slavonian Podolian cattle, a native cattle breed, have lately been reintroduced (Mijić *et al.* 2015). According to a study of alluvial habitat usage (Schneider-Jacoby 2006), flooded pastures are the most important habitats for bird diversity. The first systematic study of the ornithofauna of Bara Dvorina was carried out in 2008 (Leskovar & Radović 2009); however, no studies have been carried out on the Gajna pasture. The aim of this research is to gather new, relevant data on both sites and compare them to gain insight into the composition of bird groups and species in these two geographically close areas with similar habitats, but different coverage, usage, and field conditions.

MATERIALS AND METHODS

The ornithofauna research of Bara Dvorina and Gajna pasture (Figure 1) was conducted monthly in 2021, with 12 field visits at each site which included breeding, migration, and wintering seasons of the birds. These areas are protected in the Republic of Croatia: Bara Dvorina as a special ornithological reserve, and Gajna as a significant landscape. Both of them form part of the Natura 2000 ecological network, with two common habitat types: 3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or the *Isoëto-Nanojuncetea*; and 3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*. 6510 Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*) are an additional habitat type for Bara Dvorina. Wet grassland is the most common land type at Bara Dvorina (51.2%). Gajna is a typical Slavonian flooded pasture, with the same dominant land type as Bara Dvorina, yet covering a larger surface (79.69%) (Natura2000, Natura2000a). The central coordinate for these two Natura 2000 sites are 45.091000 N 18.139000 E for Bara Dvorina, and 45.138893 N 18.224424 E for Gajna. The Bara Dvorina research area covers roughly 430 ha, while the Gajna pasture stretches over approximately 290 ha. Both research areas significantly overlap with the protected area's boundaries. Field visits were made in the morning, just after sunrise, during the greatest bird activity.

Figure 1. The location of research areas
Slika 1. *Smještaj istraživanog područja*

The main pond at Bara Dvorina was filled with water throughout the year, but during the flooding, the water filled some of the depressions in the surrounding large grasslands. Grasslands are used for cattle grazing present throughout the year. The wetland vegetation, such as sedges *Carex sp*., rushes *Typha sp*., and Marsh iris *Iris pseudacorus*, have overtaken the pond's edges, and an invasive species, the False indigo-bush *Amorpha fruticosa*, is also widespread. The community of White water lilies and Yelow water lilies (*Nymphaeto - Nupharetum*) can be found in the water. The forest habitat is found in the southern part of the study area near the Sava River, as well as in the northern part along the dyke.

Various elevations and depressions at the Gajna pasture, the largest of which is Velika Gajna, were occasionally filled with water (Figure 2). During the dry months, a specific mechanism allows the Gajna water to be filled from the Lateral Canal connected with the Sava River. Domestic animals of traditional autochthonous breeds, such as the Slavonian Podolian cattle and the Posavina horse, are raised on a large grassland, which, like the cattle at Bara Dvorina, are present throughout the research period. The transition from grasslands to bushy vegetation, as well as invasive plants such as the Common milkweed *Ascplepias syriaca* and the False indigo *Amorpha fruticosa* are present along the edges of Gajna.

Figure 2. Bara Dvorina (left) and Gajna (right). (Photo: Tomislav Mandir)
Slika 2. *Bara Dvorina (lijevo) i Gajna (desno) (Foto: Tomislav Mandir)*

During each field trip, an absolute count of bird species was made based on visual and sound observations. As the species were recorded during one field visit each month, we calculated their frequency. Species recorded 10–12 times were identified as common (C), 6–9 times as fairly common (FC), 3–5 times as uncommon (UC), and those recorded 1–2 times as rare (R). Population statuses were determined for each species in the following categories: breeding (B), migratory (M), wintering (W), and feeding (F). The species are further categorized into habitat groups based on where they were observed: floating vegetation and water surface (WA), coastal vegetation (CV), grassland (GR), shrubs and bushes (BU), and forest areas (FO). According to the observed type of diet on the field, the species are divided into insectivores (I), omnivores (O), carnivores (CA), granivores (G), and herbivores (H). For each species, the Red List status was determined according to the Croatian Red List of Birds (Tutiš *et al*. 2013) with the endangered categories: regionally extinct (RE), critically endangered (CR), endangered (EN), nearly threatened (NT), vulnerable (VU), least concern (LC) and unsuitable for assessment (NA). The Sørensen similarity index was calculated according to the formula: $C_N = 2c / (a+b)$, where c = number of species present in both areas, a = number of species present at Bara Dvorina, b = number of species present at Gajna. Scientific names and systematics are in accordance with the Dictionary of Standard Croatian Bird Names (Zavod za ornitologiju HAZU 2018). The data on the recorded bird species have been entered into the online database Observation (https://observation.org/). Some rare and interesting findings have also been entered into Fauna.hr (https://www.fauna.hr/).

RESULTS

A total of 138 bird species from 16 orders and 41 families were recorded during the research of the Bara Dvorina and Gajna pasture in 2021. Out of this number, 120 species were recorded at Bara Dvorina and 117 at Gajna pasture (Table 1), with the Sørensen index of similarity = 0.835. The orders Passeriformes (66), Charadriiformes (16), Anseriformes (12), and Piciformes (7), as well as the families Anatidae (12), Scolopacidae (10), Muscicapidae (9), and Fringilidae (8) accounted for the majority of the recorded species (Figure 3). The total number of bird species, as well as the number of orders and families, was similar in both sites. At Bara Dvorina, all 16 orders were recorded, and only two of the total 41 families were not. At the Gajna pasture, 14 orders of birds have been recorded with three families out of the 41 not recorded.

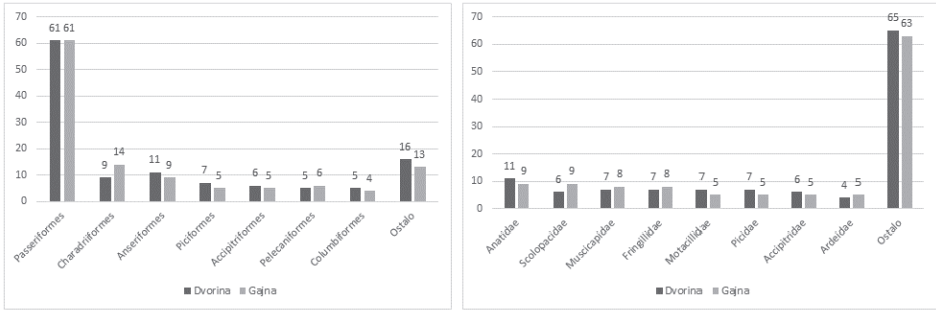

Figure 3. The bird order (left) and family (right) comparison at the Bara Dvorina and Gajna pasture.

Slika 3. *Usporedba redova (lijevo) i porodica (desno) ptica na Bari Dvorini i Gajni.*

More species belonging to the common (C) and fairly common (FC) bird groups have been recorded at Bara Dvorina than at the Gajna pasture, according to the frequency of observations (Figure 4). At Gajna, there were more uncommon (UC) and rare (R) observations. In terms of habitat type (Figure 4), the area of floating vegetation and water surface (WA), the area of coastal vegetation (CV), and the area of shrubs and bushes (BU) in both sites had a similar number of species. More forest (FO) species were recorded at Bara Dvorina, whereas more grassland (GR) species were recorded at Gajna. Bara Dvorina has more breeding bird species (56) than Gajna (46). In addition, Bara Dvorina has a higher number of migratory and wintering species than Gajna. More non-breeding species (29), which use the area for feeding during the breeding season have been recorded at the Gajna pasture than at Bara Dvorina (25) (Figure 5). The number of carnivo-

rous (CV), granivorous (G), and omnivorous (O) species was about the same in both areas, but the number of insectivorous (I) species was higher at Bara Dvorina (42) than at Gajna pasture (34) (Figure 5). 22 species recorded at Bara Dvorina and 25 at Gajna are included in the the Croatian Red List of Birds (Figure 6). The difference in the number of species in both areas, according to the endangered categories, is not significant.

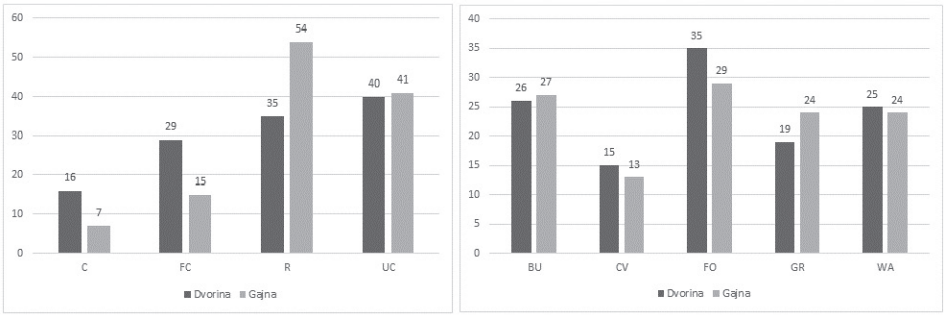

Figure 4. The bird observation frequency (left) and habitat type (right) comparison at the Bara Dvorina and Gajna pasture. Abbreviations are provided in Table 1.

Slika 4. *Usporedba učestalosti opažanja (lijevo) i tipa korištenog staništa (desno) ptica na Bari Dvorini i Gajni. Objašnjenje kratica u Tablici 1.*

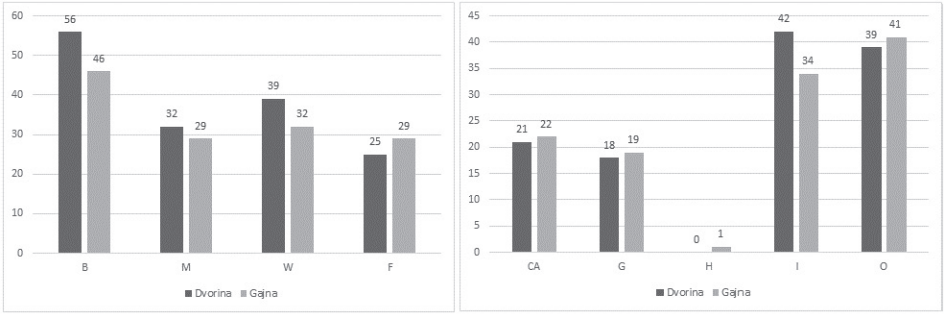

Figure 5. The bird season status (left) and diet (right) comparison at the Bara Dvorina and Gajna pasture. Abbreviations are provided in Table 1.

Slika 5. *Usporedba statusa populacija (lijevo) i prehrane (desno) ptica na Bari Dvorini i Gajni. Objašnjenje kratica u Tablici 1.*

Table 1. The list of bird species recorded at the Bara Dvorina and Gajna during the 2021 research.
B - breeding species, **F** – present in breeding season, but not breeding in research area, **M** – migratory species, **W** – wintering species
RE - Regionally Extinct breeding population, **CR** – Critically Endangered, **EN** – Endangered, **VU** – Vulnerable, **NT** – Near Threatened, **LC** – Least Concern, **NA** – Not Applicable, **DD** - Data Deficient
C – common, **FC** – fairly common, **UC** – uncommon, **R** – rare
WA – floating vegetation and open water, **CV** – coastal vegetation, **GR** – grassland, **BU** – bushes, **FO** – forest and trees
I – insectivore, **O** – omnivore, **CA** – carnivore, **G** – granivore, **H** – herbivore

Tablica 1. *Popis vrsta ptica zabilježenih na Bari Dvorini i Gajni tijekom istraživanja 2021. godine.*
B *– gnjezdarica,* ***F*** *– prisutna u gnijezdećoj sezoni, ali se ne gnijezdi u istraživanom području,* ***M*** *– preletnica,* ***W*** *– zimovalica*
RE *– Regionalno izumrle gnjezdarice,* ***CR*** *– kritično ugrožena,* ***EN*** *– ugrožena,* ***VU*** *– osjetljiva,* ***NT*** *– gotovo ugrožena,* ***LC*** *– najmanje zabrinjavajuća,* ***NA*** *– neprikladna za procjenu,* ***DD*** *- nedovoljno poznata*
C *– često promatrana,* ***FC*** *– relativno često promatrana,* ***UC*** *– manje često promatrana,* ***R*** *– rijetko promatrana*
WA *– plutajuća vegetacija i otvorena voda,* ***CV*** *– obalna vegetacija,* ***GR*** *– travnjak,* ***BU*** *– grmovi,* ***FO*** *– šuma i drveće*
I *– kukcojed,* ***O*** *– svejed,* ***CA*** *– mesojed,* ***G*** *– sjemenojed,* ***H*** *– biljojed*

No.	English name	Scientific name	Presence		Season		Observation frequency		Diet	Habitat	Red List
			Dvorina	Gajna	Dvorina	Gajna	Dvorina	Gajna			
1	*Coturnix coturnix*	Common Quail		+		B		R	O	GR	LC
2	*Phasianus colchicus*	Common Pheasant	+	+	B	B	FC	FC	G	GR	LC
3	*Cygnus olor*	Mute Swan	+	+	B	B,W	C	FC	G	WA	LC
4	*Anser anser*	Greylag Goose		+		W		UC	H	WA	VU
5	*Aythya ferina*	Common Pochard	+		M,W		UC		O	WA	LC
6	*Aythya nyorca*	Ferruginous Duck	+	+	M, F	M	FC	R	O	WA	NT
7	*Aythya marila*	Greater Scaup	+		W		R		O	WA	NA
8	*Spatula querquedula*	Garganey	+	+	M	M	UC	R	O	WA	NT

No.	English name	Scientific name	Presence		Season		Observation frequency		Diet	Habitat	Red List
9	*Spatula clypeata*	Northern Shoveler	+	+	M,W	M	UC	R	O	WA	RE
10	*Mareca strepera*	Gadwall	+	+	M,W	M	UC	R	O	WA	EN
11	*Mareca penelope*	Eurasian Wigeon	+	+	M,W	M,W	UC	UC	O	WA	LC
12	*Anas platyrhynchos*	Mallard	+	+	W,F	W,F	FC	C	O	WA	LC
13	*Anas acuta*	Northern Pintail	+		M,W		R		O	WA	LC
14	*Anas crecca*	Common Teal	+	+	M,W	M,W	UC	UC	O	WA	LC
15	*Tachybaptus ruficollis*	Little Grebe	+	+	B	W	C	UC	O	WA	LC
16	*Podiceps cristatus*	Great Crested Grebe	+		B		FC		O	WA	LC
17	*Columba livia* f. *domestica*	Feral Dove	+	+	F	F	UC	R	G	GR	LC
18	*Columba oenas*	Stock Dove	+		B,W		C		G	FO	VU
19	*Columba palumbus*	Common Wood-pigeon	+	+	B	B	FC	FC	G	FO	LC
20	*Streptopelia turtur*	European Turtle-dove	+	+	B	B	UC	UC	G	FO	LC
21	*Streptopelia decaocto*	Eurasian Collared-dove	+	+	F	F	UC	R	G	FO	LC
22	*Cuculus canorus*	Common Cuckoo	+		B		UC		I	FO	LC
23	*Rallus aquaticus*	Western Water Rail	+		F		R		O	CV	LC
24	*Crex crex*	Corncrake		+		B		R	O	GR	LC
25	*Gallinula chloropus*	Common Moorhen	+	+	B	B	FC	UC	O	CV	LC
26	*Fulica atra*	Common Coot	+	+	B	F	C	R	O	CV	LC
27	*Grus grus*	Common Crane		+		W		R	G	GR	LC

No.	English name	Scientific name	Presence		Season		Observation frequency		Diet	Habitat	Red List
28	*Cicionia nigra*	Black stork	+	+	B	M,F	R	R	CA	WA	VU
29	*Ciconia ciconia*	White stork	+	+	F	M,F	UC	R	CA	GR	LC
30	*Platalea leucorodia*	Eurasian Spoonbill	+	+	M,F	M,F	R	UC	O	WA	EN
31	*Bubulcus ibis*	Cattle Egret		+		M		R	CA	GR	NA
32	*Ardea cinerea*	Grey Heron	+	+	W,F	W,F	C	C	CA	WA	LC
33	*Ardea purpurea*	Purple Heron	+	+	M,F	M,F	UC	R	CA	WA	EN
34	*Ardea alba*	Great White Egret	+	+	W,F	W,F	C	C	CA	WA	EN
35	*Egretta garzetta*	Little Egret	+	+	M,F	M,F	UC	UC	CA	WA	VU
36	*Phalacrocorax carbo*	Great Cormorant	+	+	W,F	W,F	FC	FC	CA	WA	NT
37	*Vanellus vanellus*	Northern Lapwing	+	+	B	B	FC	FC	O	GR	LC
38	*Numenius arquata*	Eurasian Curlew		+		W		R	O	GR	VU
39	*Calidris pugnax*	Ruff		+		W		R	O	GR	LC
40	*Calidris alpina*	Dundlin	+	+	W	W	R	R	O	CV	EN
41	*Gallinago gallinago*	Common Snipe	+	+	M,W	W	FC	UC	O	CV	CR
42	*Actitis hypoleucos*	Common Sandpiper		+		W		UC	O	CV	VU
43	*Tringa ochropus*	Green Sandpiper	+	+	M	M,W	UC	UC	O	CV	NT
44	*Tringa erythropus*	Spotted Redshank	+		M		R		O	CV	LC
45	*Tringa nebularia*	Common Greenshank	+	+	M	M	R	R	O	CV	LC
46	*Tringa totanus*	Common Redshank		+		M,F		UC	O	CV	CR
47	*Tringa glareola*	Wood Sandpiper	+	+	M	M	UC	R	O	CV	LC
48	*Larus ridibundus*	Black-headed Gull	+	+	W	W	UC	UC	CA	WA	NT

No.	English name	Scientific name	Presence		Season		Observation frequency		Diet	Habitat	Red List
49	*Larus canus*	Mew Gull		+		W		R	CA	WA	LC
50	*Larus michahellis*	Yellow-legged Gul		+		W		R	CA	WA	LC
51	*Chlidonias hybrida*	Whiskered Tern	+		M,F		R		CA	WA	NT
52	*Sterna hirundo*	Common Tern		+		F		R	CA	WA	NT
53	*Circus aeruginosus*	Western Marsh-harrier	+	+	M,F	M,F	UC	UC	CA	WA	EN
54	*Circus cyaneus*	Northern Harrier	+	+	M,W	W	R	UC	CA	GR	LC
55	*Accipiter nisus*	Eurasian Sparrowhawk	+	+	B	F	UC	R	CA	FO	LC
56	*Accipiter gentilis*	Northern Goshawk	+		W,F		R		CA	FO	LC
57	*Haliaeetus albicilla*	White-tailed Eagle	+	+	W,F	F	R	UC	CA	WA	EN
58	*Buteo buteo*	Common Buzzard	+	+	B	B	C	C	CA	FO	LC
59	*Upupa epops*	Hoopoe	+		M		R		I	GR	LC
60	*Merops apiaster*	European Bee-eater	+	+	M,F	B	R	UC	I	BU	LC
61	*Alcedo atthis*	Common Kingfisher		+		F		UC	CA	CV	NT
62	*Jynx torquilla*	Eurasian Wryneck	+		B		R		I	BU	NA
63	*Picus canus*	Grey-faced Woodpecker	+	+	B	B	R	R	I	FO	LC
64	*Picus viridis*	Eurasian Green Woodpecker	+	+	B	B	FC	UC	I	FO	LC
65	*Dryocopus martius*	Black Woodpecker	+	+	B	B	FC	R	I	FO	LC
66	*Leiopicus medius*	Middle Spotted Woodpecker	+		B		FC		I	FO	LC

No.	English name	Scientific name	Presence		Season		Observation frequency		Diet	Habitat	Red List
67	*Dryobates minor*	Lesser Spotted Woodpecker	+	+	B	B	FC	R	I	FO	LC
68	*Dendrocopos major*	Great Spotted Woodpecker	+	+	B	B	UC	UC	I	FO	LC
69	*Falco tinnunculus*	Common Kestrel	+	+	F	F	UC	UC	CA	GR	LC
70	*Falco columbarius*	Merlin	+		M		R		CA	GR	VU
71	*Falco subbuteo*	Eurasian Hobby	+		F		R		CA	FO	NT
72	*Falco cherrug*	Saker Falcon	+		W		R		CA	GR	CR
73	*Oriolus oriolus*	Eurasian Golden Oriole	+	+	B	B	UC	UC	I	FO	LC
74	*Lanius collurio*	Red-backed Shrike	+	+	B	B	UC	UC	CA	BU	LC
75	*Lanius excubitor*	Great Grey Shrike	+	+	W	W	UC	UC	CA	BU	LC
76	*Garrulus glandarius*	Eurasian Jay	+	+	B	B	FC	UC	O	FO	LC
77	*Pica pica*	Black-billed Magpie	+	+	B	B	C	UC	O	BU	LC
78	*Corvus frugilegus*	Rook		+		W		UC	O	GR	LC
79	*Corvus corax*	Common Raven	+	+	B	B	C	C	O	FO	LC
80	*Corvus corone cornix*	Hooded Crow	+	+	B	B	C	C	O	FO	LC
81	*Poecile palustris*	Marsh Tit	+	+	B	B	UC	R	O	FO	LC
82	*Cyanistes caeruleus*	Eurasian Blue Tit	+	+	B	B	FC	UC	O	FO	LC
83	*Parus major*	Great Tit	+	+	B	B	C	C	O	FO	LC
84	*Alauda arvensis*	Eurasian Skylark	+	+	B	B	FC	FC	G	GR	LC
85	*Acrocephalus schoenobaenus*	Sedge Warbler	+	+	B	M	UC	R	I	CV	LC

No.	English name	Scientific name	Presence		Season		Observation frequency		Diet	Habitat	Red List
86	*Acrocephalus palustris*	Marsh Warbler	+	+	B	B	R	R	I	CV	LC
87	*Acrocephalus arundinaceus*	Great Reed-warbler	+	+	B	B	R	R	I	CV	LC
88	*Locustella luscinioides*	Savi's Warbler	+		B		R		I	CV	LC
89	*Delichon urbicum*	Northern House Martin	+	+	F	F	R	UC	I	GR	LC
90	*Hirundo rustica*	Barn Swallow	+	+	F	F	FC	FC	I	GR	LC
91	*Riparia riparia*	Sand Martin	+	+	F	F	R	R	I	GR	VU
92	*Phylloscopus sibilatrix*	Wood Warbler	+	+	M	M	UC	R	I	FO	LC
93	*Phylloscopus trochilus*	Willow Warbler	+	+	M	M	R	R	I	BU	NT
94	*Phylloscopus collybita*	Common Chiffchaf	+	+	B	B	C	R	I	FO	LC
95	*Aegithalos caudatus*	Northern Long-tailed Tit	+	+	B	B	C	UC	I	FO	LC
96	*Sylvia atricapilla*	Blackcap	+	+	B	B	FC	FC	I	BU	LC
97	*Sylvia nisoria*	Barred Warbler	+	+	B	B	R	R	I	BU	LC
98	*Sylvia curruca*	Lesser Whitethroat	+	+	B	B	UC	R	I	BU	LC
99	*Sylvia communis*	Common Whitethroat	+	+	B	B	UC	R	I	BU	LC
100	*Sitta europaea*	Eurasian Nuthatch	+	+	B	B	FC	R	O	FO	LC
101	*Troglodytes troglodytes*	Northern Wren	+	+	W	W	FC	UC	I	BU	LC
102	*Sturnus vulgaris*	Common Starling	+	+	B,F	B,F	FC	FC	O	GR	LC
103	*Turdus viscivorus*	Mistle Thrush	+	+	W	W	R	R	O	FO	LC
104	*Turdus philomelos*	Song Thrush	+	+	B	B	FC	R	O	BU	LC

No.	English name	Scientific name	Presence		Season		Observation frequency		Diet	Habitat	Red List
105	*Turdus iliacus*	Redwing	+	+	W	W	R	R	O	BU	LC
106	*Turdus merula*	Eurasian Blackbird	+	+	B	B	FC	UC	O	BU	LC
107	*Turdus pilaris*	Fieldfare	+	+	W	W	UC	UC	O	BU	NA
110	*Muscicapa striata*	Spotted Flycatcher	+	+	M	M	UC	R	I	FO	LC
108	*Luscinia megarhynchos*	Common Nightingale	+	+	B	B	UC	R	I	BU	LC
109	*Erithacus rubecula*	European Robin	+	+	W	W	FC	UC	I	FO	LC
111	*Ficedula hypoleuca*	European Pied Flycatcher		+		M		R	I	FO	LC
112	*Ficedula albicollis*	Collared Flycatcher	+	+	M	M	R	R	I	FO	LC
113	*Phoenicurus ochruros*	Black Redstart	+	+	F	F	R	R	I	BU	LC
114	*Phoenicurus phoenicurus*	Common Redstart		+		M		R	I	BU	LC
115	*Saxicola rubetra*	Whinchat	+	+	M	B	R	UC	I	GR	LC
116	*Saxicola torqatus*	Common Stonechat	+		B		FC		I	GR	LC
117	*Regulus regulus*	Goldcrest	+		W		R		I	BU	LC
118	*Prunella modularis*	Dunnock	+	+	W	W	R	UC	O	BU	LC
119	*Passer domesticus*	House Sparrow	+	+	F	F	R	R	G	BU	LC
120	*Passer montanus*	Eurasian Tree Sparrow	+	+	B	B	C	FC	G	BU	LC
121	*Anthus trivialis*	Tree Pipit	+	+	B	M	UC	R	I	FO	LC
122	*Anthus cervinus*	Red-throated Pipit	+	+	M	M	R	R	I	GR	LC
123	*Anthus pratensis*	Meadow Pipit	+	+	M,W	M,W	FC	UC	I	GR	LC

No.	English name	Scientific name	Presence		Season		Observation frequency		Diet	Habitat	Red List
124	*Anthus spinoletta*	Water Pipit	+		W		UC		I	CV	LC
125	*Motacilla flava*	Yellow Wagtail	+	+	B	B	FC	FC	I	GR	LC
126	*Motacilla cinerea*	Grey Wagtail	+		M,W		UC		I	CV	LC
127	*Motacilla alba*	White Wagtail	+	+	B,W	B	C	FC	I	GR	LC
128	*Fringilla coelebs*	Eurasian Chaffinch	+	+	B,W	B,W	FC	FC	O	FO	LC
129	*Fringilla montifringilla*	Brambling	+	+	W	W	UC	R	G	FO	LC
130	*Coccothraustes coccothraustes*	Hawfinch	+	+	B,W	B	FC	UC	G	FO	LC
131	*Pyrrhula pyrrhula*	Eurasian Bullfinch		+		M		R	G	FO	LC
132	*Chloris chloris*	European Greenfinch	+	+	B,W	F	C	R	G	BU	LC
133	*Linaria cannabina*	Eurasian Linnet	+	+	M,W	M	UC	R	G	BU	LC
134	*Carduelis carduelis*	European Goldfinch	+	+	B,W	W,F	UC	FC	G	BU	LC
135	*Spinus spinus*	Eurasian Siskin	+	+	W	W	UC	UC	G	BU	LC
136	*Emberiza calandra*	Corn Bunting	+	+	B	B	UC	FC	G	GR	LC
137	*Emberiza citrinella*	Yellowhammer		+		B		R	G	BU	LC
138	*Emberiza schoeniclus*	Reed Bunting	+	+	W	W	UC	UC	G	CV	LC

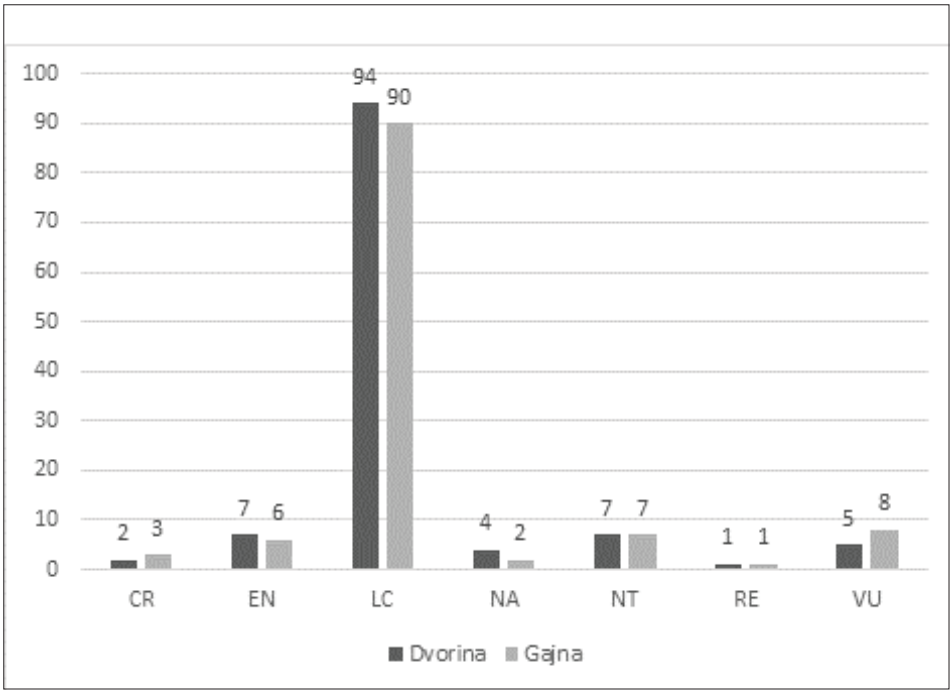

Figure 6. The bird Red List status comparison at the Bara Dvorina and Gajna pasture.
Slika 6. *Usporedba ptica na Bari Dvorini i Gajni s obzirom na Crveni popis.*

DISCUSSION

The Sørensen index of similarity is relatively high (0.835) between the two sites which confirms that the two flooded habitats have very similar ornithofauna. However, there are some variables that make these sites different. The main contributors to the differences in ornithofauna between the Bara Dvorina and Gajna pasture are: the level and the amount of water in depressions during the year, the size and the management of pastures and grasslands, and the number of mosaic plots.

The study of the water decrease effect in the Mediterranean wetlands (Causarano & Battisti 2009) has shown that with lower water level, vegetation type around the flooded areas tends to dry out, thus reducing the habitat suitability for water-obligate species. Bara Dvorina is richer in water due to the size of its main pond, which is large enough to sustain the water level throughout the year, and host breeding species such as the Great Crested Grebe *Podiceps cristatus*, the Little Grebe *Tachybaptus ruficollis,* the Common Moorhen *Gallinula chloropus*, and the Eurasian Coot *Fulica atra* nesting in dense coastal vegetation with standing water and slow moving water (Svensson *et al.* 2018). The largest pond at the

Gajna pasture (Velika Gajna) is considerably smaller and often shallow or dry during summer, which limits the number of breeding species. Birds that live in floodplains and other specialized organisms are sensitive to environmental changes, and should the trend of prolonged dry periods persist, it may potentially result in local extinction, particularly of the rarest or most threatened species (Jiménez *et al*. 2018). During winter and spring months, there is more water at both Gajna pasture and Bara Dvorina, so they serve as important stopovers for wintering and migrating birds. The winter flooding draws roosting and feeding birds, and creates an ideal feeding habitat for them by leaving shallow pools behind. The retaining winter floodwater also allows field water levels to remain high in the spring and early summer (Ausden 1996). In the seven-year survey of the Rit floodplain near Jagodina in Serbia, waterbirds were recorded only during large floods, which overlapped with the period of bird migration (Stanković 2013/2014). The species from the order Charadriiformes and the families Scolopacidae and Anatidae were the most numerous during the Rit research, which corresponds with the results at the Bara Dvorina and Gajna pasture. Although there were more species from Scolopacidae family observed at the Gajna pasture, which had smaller ponds and depressions to feed than Bara Dvorina, such as the Eurasian Curlew *Numenius arquata*, the Ruff *Calidris pugnax*, the Common Sandpiper *Actitis hypoleucos* and the Common Redshank *Tringa totanus*; other species, such as the Common Snipe *Gallinago gallinago* and the Wood Sandpiper *Tringa glareola* were more numerous at Bara Dvorina, where the greater surface was affected by the flooding. Also, food availability has a strong effect on waterbirds distribution (Pap *et al*. 2013). By lowering the resistance of the upper soil to penetration, increased field water levels are believed to increase the physical availability of soil macroinvertebrates for feeding snipe and other species (Ausden *et al.* 2018). Due to the larger open water surface and more water in the Bara Dvorina main pond, more birds were recorded during migrations and wintering, in particular the number of the wintering Anatidae species. Four species of diving ducks were recorded in this study: the Ferruginous Duck *Aythya nyroca* was present on both sites, but the Common Pochard *Aythya ferina*, the Tufted Duck *Aythya fuligula* and the Greater Scaup *Aythya marila* only at Bara Dvorina which is, as stated previously, deeper and provides more food sources. The Greater Scaup is typically absent from inland freshwater areas used by the related Tufted Duck or the Common Pochard (Marchowski e*t al.* 2020); in Croatia it has a status of an irregular species (Barišić *et al.* 2016).

The study results of Lubljansko barje (Tome 2002) indicated that floods are highly relevant for meadow birds, with nine out of ten species nesting in higher densities in flooded than non-flooded areas. In the study of topographic wetness index, based on digital elevation models used to predict the occurrence of bird species in floodplain meadows in France (Besnard *et al.* 2013), passerines

like the Whinchat *Saxicola rubetra*, the Yellow Wagtail *Motacilla flava*, the Corn Bunting *Emberiza calandra*, and the Reed Bunting *Emberiza schoeniclus* are likely to be found in regions with a significant chance of water accumulation. Most models predicted the appearance of the Whinchat, a hay meadow specialist. In most parts of its range, it breeds only in extensively managed grasslands and does not adapt well to changes in agricultural practices (Tome & Denec 2012). Grassland birds prefer large continuous breeding patches like Gajna over fragmented landscapes. Gajna is proportionally more covered in pastures and grasslands that are extensively managed, thus it hosts abundant populations of the Eurasian Skylark *Alauda arvensis*, the Yellow Wagtail, the Corn Bunting, but also a population of about 3-5 pairs of a declining Whinchat. In Ljubljansko Barje near the Sava River in Slovenia, the earlier mowing dates have negatively impacted the abundance of Whinchats over the years (Lenarčić 2019). Late mowing dates in particular have been shown to increase the reproductive success in meadow birds and thus the breeding density (Tome 2002) of species such as the Eurasian Skylark and the Northern Lapwing *Vanellus vanellus* since both of them prefer to breed in short vegetation (Chamberlain & Gregory 1999). The mowing period at Gajna is between 1st August and 15th September, which reduces negative effects on breeding grassland birds. Since 1989, the Brod Ecological Society (BED) has actively protected and maintained the Gajna area by engaging and encouraging the local population to adhere to the traditional grazing practices, ensuring a favourable water regime, removing invasive species, and preserving biodiversity (Beneš 2017). At Bara Dvorina, the mowing activity has already been observed around the end of June/beginning of July. This may explain both the lower abundance and the total number of grassland species compared to Gajna, as well as the absence of the Whinchat which was previously a recorded breeder at the Bara Dvorina grassland (Leskovar & Radović 2009). The Gajna pasture is an important foraging area for White Storks *Ciconia ciconia* and Black Storks (*Ciconia nigra*). A group of at least 58 White Storks and 18 Black Storks was observed during August 2020 foraging on the Velika Gajna pond (reported by Šimo Beneš). Schneider-Jacoby (2006) described that the breeding success of White Storks in the Sava River floodplains depends on the size of foraging area and the amount of available food, making alluvial grasslands and pastures their main feeding habitats. The Corncrake *Crex crex* inhabits wet meadows, where high vegetation develops during late spring and summer months. The Corncrake nests on the ground and inhabits neglected agricultural areas (Tutiš *et al.* 2013). A singing male Corncrake was observed at the Gajna pasture in May and early July. There was a noticeable degree of succession, mostly by the Common hawthorn *Crataegus monogyna*, but also the False indigo-bush and the Common milkweed, since the area is close to the edge of the Gajna pasture. During the monitoring of the Corncrake in Croatia in 2021 (Budinski *et al.* 2021), a drastic drop in the population was recorded, especially in

continental Croatia, in Donja Posavina. The neglect of mowing meadows, which are then occupied by the invasive False indigo-bush in flooded regions, and the conversion of mowing meadows into pastures are the main causes of the significant decrease stated in the study. The spread of the False indigo-bush on grassland may have negatively affected the Yellow Wagtail and the Eurasian Skylark populations too (Radović *et al.* 2013), which is the case at Bara Dvorina, where this invasive species is more common. The same study suggests that high water levels and the earlier False indigo-bush succession stage create suitable vegetation structure for the breeding of *Acrocephalus* and *Locustella* species. Although the Sedge Warbler *Acrocephalus schoenobaenus*, the Marsh Warbler *Acrocephalus palustris*, and the Great Reed Warbler *Acrocephalus arundinaceus* are recorded in both areas, their number is significantly increased at Bara Dvorina, where the Savi's Warbler *Locustella luscinioides* was also recorded.

When it comes to mosaic habitats, Bara Dvorina is structurally more diversified, consisting of forests (Posjeke forest), a flooded forest along the dyke, ponds, pastures, and grasslands with shrubs of varying heights. The Red-backed Shrike *Lanius collurio*, which prefers semi-open habitats with scattered or open growth of bushes, shrubs, hedges, and low trees (Kralj 2013), was therefore more abundant at Bara Dvorina. Brambilla *et al.* (2010) showed that 30 years after being abandoned, such habitats would be unsuitable for this declining species. The Gajna pasture, on the other hand, is dominantly covered in pastures and grasslands, has smaller ponds and depressions, and only a tight patch of flooded willow forest along the dyke. This is the reason for greater diversity and density of forest related species at Bara Dvorina, where all typical species from Picidae family for continental Croatia were recorded. Tallamy & Shriver (2021) imply that insectivorous bird species, whether they breed in the temperate zone after migration or after wintering at the site, need high insect populations to reproduce successfully. Bara Dvorina has more insectivorous species recorded than Gajna Pasture in this case due to its mosaic habitats, which provide not only a better environment for insect growth, but also different types of insects. More food sources and habitat types play a key role at Bara Dvorina, having 10 more breeding species than Gajna pasture. Considering the frequency of observations during field visits at Bara Dvorina, there are more common and fairly common species which means that most of the species stay in the area for longer periods for breeding or feeding. On the contrary, we can see more uncommon and rare species at Gajna, which indicates using the pasture for stopovers during migration and foraging by the Common Crane *Grus grus*, the Cattle Egret *Bubulcus ibis*, the Mew Gull *Larus canus*, the Eurasian Curlew, etc. Some rare observations at Bara Dvorina were an individual Saker Falcon *Falco cherrug* observed in January flying over and possibly using the area as a hunting and foraging ground, and a resting Merlin female *Falco columbarius*, which winters in Croatia, observed in March during the migration period.

Some of the recorded birds at both sites are of national and international importance. Comparing the Red List statuses, Gajna pasture has three species more on the Red List of the Birds of Croatia than Bara Dvorina. Among 16 Red Listed species that are common to both Bara Dvorina and Gajna, the endangered Purple Heron *Ardea purpurea* and the Great White Egret *Ardea alba*, and the vulnerable Little Egret *Egretta garzetta* use these sites for feeding. A few individuals of the Eurasian Spoonbill *Platalea leucorodia* were also recorded foraging the area, since they breed in nearby Jasinje fishpond in a mixed colony of herons and spoonbills (Mikuska *et al.* 2013). The Common Snipe has a status of a critically endangered breeder in Croatia, with Lonjsko and Sunjsko polje (Ćiković & Barišić 2013) being the closest to the research area. The Common Snipe was recorded wintering in small numbers, most interestingly in migratory population, with 57 individuals recorded foraging at Bara Dvorina in late March. The White-tailed Eagle *Haliaeetus albicilla* was observed throughout the year. According to the Dumbović Mazal *et al.* (2019), there are about 2 to 3 pairs of the White-tailed Eagle breeding in the area of the Jelas polje Natura 2000 ecological network. The Stock Dove *Columba oenas* is a vulnerable breeder, according to the Red List statuses in Croatia, which has between 300 and 600 breeding pairs, with the majority of its population in the Nature Park Papuk forests (Martinović 2016). The Stock Dove was regularly recorded at the Bara Dvorina throughout the research period, feeding in the nearby fields and grasslands. The wintering population is about 120 individuals and, during breeding season, 1-3 pairs were observed. Some of the nearly threatened species, such as the Common Kingfisher *Alcedo atthis*, the Black-headed Gull *Larus ridibundus*, and the Common Tern *Sterna hirundo* were recorded only at Gajna, since its south border is the Sava River. Natural embankments are formed by the grazing cattle hosting a small colony of European Bee-eaters *Merops apiaster* and Sand Martins *Riparia riparia*. It was interesting to note the presence of a pair of Common Redshanks during two breeding seasons at Gajna. The pair of Common Redshanks was observed on 2nd June 2020, and again in 2021 during the research period. The birds were present constantly from March to July, with an alarming bird recorded on 2nd July. In East Croatia, there were a few observations of Common Redshanks in Baranja and Slavonia during the breeding season, which indicates possible nesting (Mikuška *et al.* 2020). Although the breeding was not confirmed, their presence means that the Gajna pasture, in optimal conditions, may be a good breeding habitat for this critically endangered breeding species in Croatia.

Both Bara Dvorina and Gajna pasture, with their differences and similarities stated earlier, present important areas for breeding, migratory, and wintering birds. More specific research on different species should be conducted, related with relevant factors such as invasive species, flooding, and land management. Taking the good practice of the Gajna pasture management as an example, it

would be interesting to see the changes in the habitat and the bird composition at Bara Dvorina. Until then, the ornithofauna research should continue in both areas in order to see the long-term population trend related to the main factors of both areas.

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SAŽETAK

Istraživanje ornitofaune Bare Dvorine i pašnjaka Gajne, poplavnih područja rijeke Save, od kojih su oba zaštićena hrvatskim Zakonom o zaštiti prirode i dijelom ekološke mreže Natura 2000, provedeno je na mjesečnoj bazi tijekom 2021. godine s ukupno 12 terenskih obilazaka na svakoj lokaciji koji su obuhvatili sezonu gniježđenja, migracije i zimovanja ptica. Ukupno je zabilježeno 138 vrsta ptica iz 16 redova i 41 porodice, na Bari Dvorini 120, a na pašnjaku Gajni 117 vrsta. Redovi Passeriformes (66), Charadriiformes (16), Anseriformes (12), i Piciformes (7) kao i porodice Anatidae (12), Scolopacidae (10), Muscicapidae (9) and Fringilidae (8) činile su većinu zabilježenih vrsta. Za svako područje također je određena učestalost ptica na temelju opažanja i kategorizirane su na temelju staništa na kojem su promatrane, prehrane, statusa populacije i kategorija Crvenog popisa ptica u Hrvatskoj. Razlikama u ornitofauni između Bare Dvorine i pašnjaka Gajne najviše pridonose razina i količina vode u depresijama, veličina i upravljanje pašnjacima i travnjacima te broj mozaičnih ploha. Bara Dvorina, koja je veće površine i bogatija vodom, ima mozaičnije i raznolikije stanište pa se na tom području nalazi više gnjezdećih, ali i zimujućih i migrirajućih vrsta ptica s većom učestalošću promatranja tijekom godine. S druge strane, pašnjak Gajna ima više tipičnih travnjačkih vrsta zbog boljeg upravljanja i održavanja zemljišta. Također, na Gajni su zabilježene neuobičajene i rjeđe vrste koje upućuju na to da se ovo područje koristi kao odmorište i hranilište za mnoge ptice. Ukupno 22 vrste na Bari Dvorini te 25 na pašnjaku Gajni nalaze se na Crvenom popisu ptica Hrvatske, što ukazuje da su oba područja važna za ptice. U budućnosti bi trebalo provesti detaljnije istraživanje, a pravilnim upravljanjem zemljištem, kontrolom invazivnih vrsta, košnjom i regulacijom poplava, moglo bi se poboljšati stanje i Bare Dvorine i pašnjaka Gajne.