Acrocephalus 35 (162/163): 153–163, 2014
10.1515/acro-2014-0009

Effects of overgrowing at Cerknica Polje (southern Slovenia) on breeding farmland birds

Vpliv zaraščanja Cerkniškega polja (južna Slovenija) na gnezdilke kmetijske krajine

Dejan Bordjan[1], Ana Bordjan[2]
[1] Ul. 8 februarja 50, SI–2204 Miklavž, Slovenia, e–mail: dejan.bordjan@gmail.com
[2] Opekarniška 19, SI–1235 Radomlje, Slovenia, e–mail: ana.bordjan@gmail.com

Agriculture has a great impact on biodiversity in Europe. Populations of farmland birds are declining due to both intensification and abandonment of agriculture. The purpose of this study was to determine the effects of overgrowing on the diversity of birds at Cerknica Polje. Six vegetation types were identified on eight survey plots (15.2–31.6 ha each): Short grass – regularly mown wet meadows; Tall herbs – stands of Common Reed *Phragmites australis* and Reed Canary Grass *Phalaris arundinacea*; Sparse bushes – stands of low woody plants; Dense bushes – dense stands of bushes; Meadows with trees – mown meadows with scattered trees; Bushes with trees – hedges, trees and dense stands of bushes. In total, 34 species were registered. The heterogeneity of vegetation types correlated positively with the heterogeneity of bird species. The highest density of breeding territories and species was established in Bushes with trees, the lowest in Short grass. No species were registered in all vegetation types, and only Tree Pipit was recorded in five out of six types. Twelve species were registered in only one vegetation type. Cerknica Polje is an important breeding locality for species with the highest breeding density at the national level (e.g. Corncrake *Crex crex*, Curlew *Numenius arquata*, Skylark *Alauda arvensis*, Whinchat *Saxicola rubetra*, Sedge Warbler *Acrocephalus schoenobaenus*). These species breed in specific habitats with different stages of succession. A managing plan for the area should therefore combine abandoned plots in different stages of succession and large regularly mown areas. Abandonment of agriculture at Cerknica Polje has led to the emergence of areas with bushes in different succession stages. Efforts should be directed at preserving large complexes of mown wet meadows.

Key words: Cerknica Polje, succession stages, overgrowing, farmland birds
Ključne besede: Cerkniško polje, stopnje zaraščanja, zaraščanje, ptice kmetijske krajine

1. Introduction

Agriculture has a great impact on biodiversity in Europe (Veen *et al.* 2001). Around 50% of the entire European mainland is covered by farmland, grassland habitats included (Tucker & Dixon 1997). Farmland bird populations are declining in most parts of Europe (Mason & Macdonald 2000, PECBMS 2013), and over 70% of 173 priority farmland bird species have an unfavourable conservation status (Tucker & Dixon 1997). The total population of 39 common farmland bird species in Europe has declined by 54% from 1980 to 2012 (EBCC 2014). The major drivers of decline in farmland bird numbers are substantial changes in agricultural practices, mostly intensification (McLaughlin & Mineau 1995). In Central and Eastern Europe, the extent of this decline is generally lower, and its causes may differ from those in Western Europe, e.g. farmland habitats are also being lost due to abandonment (Veen *et al.* 2001, Reif *et al.* 2008, Tryjanowski *et al.* 2011).

A high density of woody plants has a strong negative effect on breeding grassland birds, but can also generate a new breeding habitat for certain other species (Tomovčík *et al.* 1999). Some ecologists claim that overgrowing contributes to the overall ecological

state of the environment (Cunder 1999). Greater heterogeneity means more different habitats, which in turn means more species. Many authors suggest that it is the heterogeneity of a landscape that has a key influence on biodiversity (O'Connor & Shrub 1986, Tucker & Dixon 1997, Vickery *et al.* 1999). Tucker & Dixon (1997) noted that 42% of priority bird species (SPEC) are dependent on the vegetation mosaic of their habitats. Vegetation structure has more influence on habitat selection than specific composition of plants (Tucker & Dixon 1997).

Permanent grasslands are an important part of farmland for birds (Beintema 1988), but also threatened by overgrowing (Veen *et al.* 2001). The high conservation concern of grassland areas for birds in Slovenia is noted in the Important Bird Area (IBA) network: 17 out of 25 sites recognised as internationally important for bird conservation were at least partly designated due to their important populations of grassland birds (Božič 2003). Despite this, relatively little research has been carried out on ecology in Slovenia (Tome 2002, Aleš 2004, Pangerc 2005, Koce 2010, Tome & Denac 2012) or effects of management practices on grassland birds (Denac 2003, 2007, Božič 2005a, Vukelič 2009).

Fluctuation of water levels and intermittence of wet and dry periods have, together with human activities, shaped the present appearance of Cerknica Polje (Gaberščik & Urbanc-Berčič 2002, Peršič 2002). The favourable state of grassland habitats at Cerknica Polje can be attributed to the regular flooding that prevents intensive land use (Smrekar 2002) and also leads to land abandonment (Martinčič & Leskovar 2002). With the abandonment of agricultural practices, farmland is subjected to gradual overgrowing (Veen *et al.* 2001). Between 1961 and 1991, the percentage of active farmers in Slovenia declined from 32% to 3.7% (Smrekar 2002). Although land use abandonment was not considered an important threat in the early 1990s (Trontelj 1993), it is now the greatest threat, along with drainage, to the grassland species of Cerknica Polje (Božič 2003). Several grassland birds (e.g. Corncrake *Crex crex*, Lapwing *Vanellus vanellus*, Skylark *Alauda arvensis*, Yellow Wagtail *Motacilla flava*, Tree Pipit *Anthus trivialis*) were listed as breeding species in a review by Polak (1993). A few of these, such as Yellow Wagtail, Whinchat *Saxicola rubetra*, Skylark and Corncrake, have been studied in more detail by Kus Veenvliet (2001, 2002) and Polak *et al.* (2004). The latter also discussed the possible negative effects of overgrown wet meadows on the local Corncrake population.

The aim of our work was to study the effects of grassland overgrowing on the diversity of bird species at Cerknica Polje and to discuss some management suggestions in the light of our findings.

2. Study area and methods

2.1. Study area

Cerknica Polje is a karst polje situated on the border between the central and southern parts of Slovenia at 550 m a.s.l. (Kranjc 2002). A more detailed general description of Cerknica Polje and its habitats was given by Polak (1993), Kus Veenvliet (2001), Polak *et al.* (2004) and Bordjan (2007). On average, Cerknica Polje is flooded for nine months every year (Kranjc 2002). The dynamics of flooding and drying of the lake changed in the 20th century due to human interference (Kranjc 2002). Generally, the lake empties earlier and more rapidly, so it is usually mostly dry in June (Trontelj 1993), resulting in faster succession (Martinčič & Leskovar 2002).

The natural vegetation cover in at least some parts of Cerknica Polje was forest (Šercelj 1974, Ilijanić 1978). Bush and herb vegetation communities, adapted to the high water content in the soil, are present (Martinčič & Leskovar 2002). The predominant land use type in the area is represented by extensive meadows used for hay (Perko & Orožen Adamič 1998), most of which are secondary in origin (Ilijanić 1978). Use of the area was made possible by extensive drainage in the 19th and 20th centuries (Kranjc 2002). Slower development of rural areas and negative demographic trends in recent decades have spurred widespread abandonment of farmland and consequently its overgrowing (Hočevar *et al.* 2004). There are two main types of overgrowing at Cerknica Polje: (1) with bushes and shrubbery, especially with Alder Buckthorn *Frangula alnus* (Kus Veenvliet 2001) in areas with less frequent floods, and (2) with reeds in regularly flooded areas (Trontelj 1993).

2.2. Survey plots

With the help of orthophotographs (GURS 2006), we surveyed Cerknica Polje for continuous grassland areas. All areas that could not be surveyed due to high density of bushes were excluded. We selected eight survey plots and subsequently mapped six different vegetation types (areas with similar vegetation structure) using ArcMap 9.3 on each plot (Figure 1):

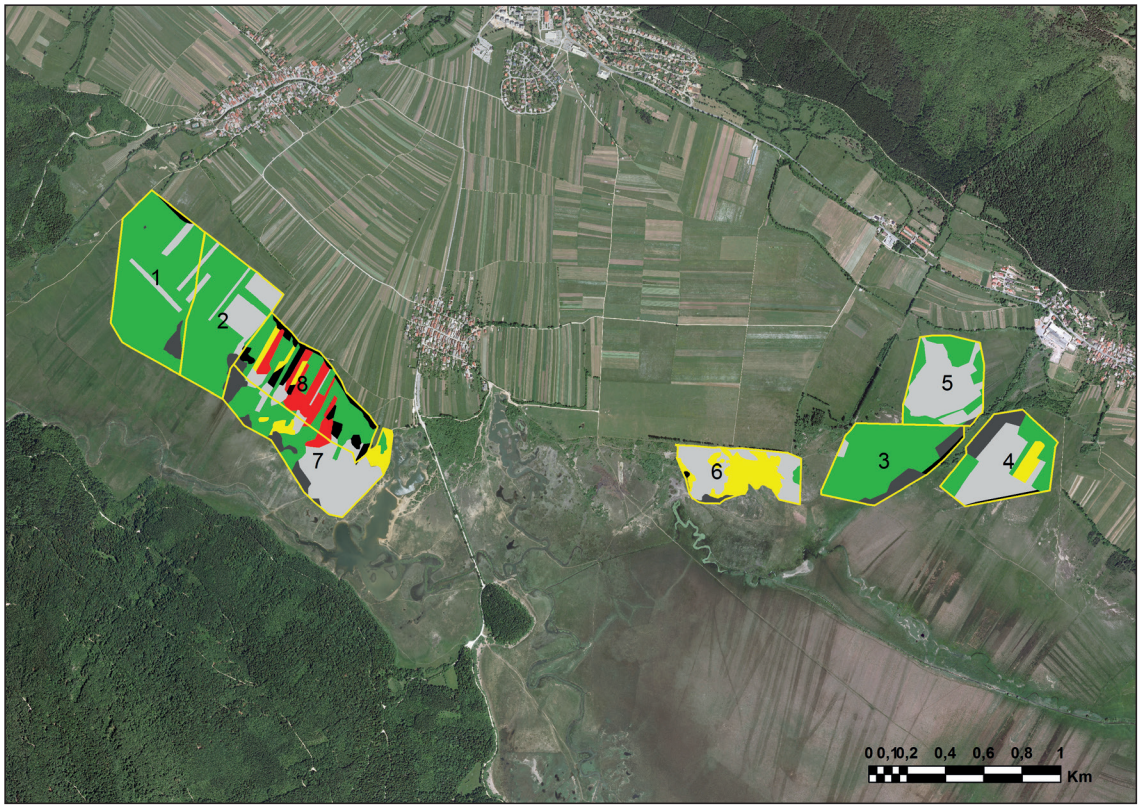

Figure 1: Map of the northern part of Cerknica Polje with survey plots (numbered as in text) and vegetation types (green – Short grass, dark grey – Tall herbs, light grey – Sparse bushes, yellow – Dense bushes, red – Meadows with trees, black – Bushes with trees) (1:250,000, The Surveying and Mapping Authority of the Republic of Slovenia)

Slika 1: Zemljevid severnega dela Cerkniškega polja z označenimi popisnimi ploskvami (oštevilčenimi kot v besedilu) in vegetacijskimi tipi (zeleno – Nizka trava, temno sivo – Visoke zeli, svetlo sivo – Redko grmičje, rumeno – Gosto grmovje, rdeče – Travniki z drevesi, črno – Grmovje z drevesi) (1:250.000, Geodetska uprava Republike Slovenije)

- ***Short grass***: mostly oligotrophic wet meadows with *Molinia caerulea* and mesotrophic wet regularly mown meadows,
- ***Tall herbs***: mostly Common Reed *Phragmites australis* stands, stands of tall sedges *Carex* sp. and stands of Reed Canary Grass *Phalaris arundinacea*,
- ***Sparse bushes***: several metres of open space among separate bushes; similar to "Short grass", but with a significant percentage of low woody plants, mostly willows *Salix* sp. and Alder Buckthorn,
- ***Dense bushes***: thicker stands of bushes, with little or no space between individual bushes,
- ***Meadows with trees***: mown meadows with scattered trees with ten metres or more between tree crowns,
- ***Bushes with trees***: hedges and small stands of trees usually accompanied by dense bushes.

The vegetation types are listed in advancing order of succession. "Meadows with trees" was not used in analysing the effect of overgrowing on selected bird species, because it combines two vegetation types from opposite ends of succession.

2.3. Bird census

Birds were surveyed using the territory mapping method according to Bibby *et al.* (2000). We plotted data on printed orthophotographs (scale 1:3000) (The Surveying and Mapping Authority of the Republic of Slovenia). All plots were surveyed between 29 Mar and 13 Jun 2007 six to eight times during the day, and twice during the night. A given plot was surveyed every 7–12 days. All selected survey plots were equipped with markers for delineation of survey routes. On plots with predominantly open landscape,

Table 1: Percentages (%) of vegetation types on separate plots. The most characteristic (> 25%) vegetation types are given in bold.

Tabela 1: Odstotki (%) vegetacijskih tipov na posameznih ploskvah. Najbolj značilni (> 25 %) vegetacijski tipi so prikazani v odebeljenem tisku.

Vegetation type / Vegetacijski tip (%)	Plot (area in ha) / Ploskev (površina v ha)							
	1 (31.6)	2 (24.4)	3 (21.0)	4 (19.9)	5 (17.3)	6 (15.2)	7 (24.0)	8 (23.9)
Short grass / Nizka trava	**88.6**	72.0	**83.0**	**28.8**	**34.3**	2.2	**28.8**	**40.7**
Tall Herbs / Visoke zeli	3.2	1.9	12.9	13.8	0.9	3.8	13.3	1.3
Sparse bushes / Redko grmičje	6.9	**26.0**	1.5	**46.6**	**64.8**	**51.4**	**46.0**	9.1
Dense bushes / Gosto grmovje				10.7		**42.1**	9.4	5.8
Meadows with trees / Travniki z drevesi							2.5	**25.0**
Bushes with trees / Grmovje z drevesi	1.3	0.1	2.6			0.5		18.1
Heterogeneity of vegetation types / Heterogenost vegetacijskih tipov	0.5	0.7	0.6	1.2	0.7	0.9	1.3	1.5

the distance between two routes was up to 100 m, and up to 50 m on more overgrown plots. Daytime visits were made between 5.15 and 9.45 hrs. A single visit of each plot took one to two hours, depending on the number of birds and field conditions. The census was carried out on days without strong wind or rain. We mapped all individuals registered on plots during the survey, their behaviour and precise locations. The minimum requirement for a territory was three separate registrations of presumably the same breeding pair, the only exception being the observation of strongly indicating breeding (e.g. feeding of juveniles) and nocturnal species that were surveyed only twice. All other individuals were regarded as visitors. A border territory was included in analyses, if more than half of the registrations were inside the survey plot. Data were analysed using ArcMap 9.3 software.

2.4. Statistical analysis

For comparison of species composition on different plots, the χ^2-test was used. The Shannon-Wiener diversity index (Krebs 2001) was used to calculate heterogeneity of bird species on plots and on vegetation types and the heterogeneity of vegetation types. Spearman's rank coefficient was used for evaluating the relationships between advancement of succession and heterogeneity of bird species on plots and on vegetation types. Spearman's rank coefficient was also used for evaluating the relationships between heterogeneity of vegetation types and heterogeneity of bird species, and for evaluating the relationships between advancement of succession and the number of territories of individual species. For this, only species with territories on more than one vegetation type were used (not counting "Meadows with trees"). *P*-values lower than 0.05 were considered significant.

3. Results

3.1. Features of survey plots

We selected eight survey plots varying between 15.2 and 31.6 ha in size. The only plot with all vegetation types was plot 8. The latter also had the highest heterogeneity of vegetation types (Table 1). The first three plots had the lowest heterogeneity of vegetation types and the highest percentage of "Short grass". Plot 5 was also characterized by low heterogeneity of vegetation types but, as opposed to the first three plots, had the highest percentage of "Sparse bushes".

3.2. Species composition and the number of breeding birds

In total, 34 species of breeding birds were registered (Table 2). The most numerous species was Yellow Wagtail with 43 breeding territories. Eight species had a single breeding territory. None of the recorded species were observed on all plots and only two, Yellow Wagtail and Tree Pipit, were registered on seven out of eight plots. Eleven out of 34 species were recorded on a single plot. The lowest number of breeding territories was registered on survey plot 3, the lowest number of species on plot

Table 2: Breeding densities on respective plots (breeding pairs per 10 ha)

Tabela 2: Gnezditvena gostota na posameznih ploskvah (gnezdeči pari na 10 ha)

Species / Vrsta	Plot / Ploskev							
	1	2	3	4	5	6	7	8
Coturnix coturnix	0.6	0.8		1.0				
Crex crex	0.3	0.8	0.5	2.0				
Numenius arquata		0.4	0.5					
Jynx torquilla								0.4
Falco subbuteo								0.4
Lanius collurio				0.5			2.1	0.8
Pica pica							0.4	0.4
Cyanistes caeruleus								0.4
Parus major								1.3
Periparus ater								0.4
Alauda arvensis	5.7	3.3	1.9					
Phylloscopus collybita								1.7
Sylvia atricapilla	0.3			1.0		5.3	1.3	5.0
Sylvia borin							0.4	
Sylvia nisoria				0.5		0.7	1.3	
Sylvia communis				3.5	1.7	3.9	4.2	0.8
Acrocephalus schoenobaenus		0.4	1.9	3.0		2.0	4.2	
Acrocephalus palustris			0.5	1.5	0.6	2.0	0.4	
Sturnus vulgaris						0.7		
Turdus merula						3.9	1.3	2.1
Muscicapa striata								0.8
Erithacus rubecula						9.2	0.4	2.5
Saxicola rubetra	1.6	3.7	1.0	4.0	6.4	1.3		
Saxicola rubicola				1.5	0.6			
Motacilla flava	0.9	2.9	3.3	3.5	4.7	6.6	0.4	
Anthus trivialis	0.3	0.8		0.3	3.5	2.0	0.8	1.7
Fringilla coelebs						0.7		1.7
Erythrina erythrina		0.4		2.0	1.7			
Chloris chloris								0.4
Linaria cannabina				1.0	1.2			
Carduelis carduelis							0.4	2.5
Serinus serinus								0.4
Emberiza citrinella						4.6	0.4	2.1
Emberiza schoeniclus			1.4			0.7	1.3	

1 (Table 2). The highest number of breeding birds and the highest breeding density was recorded on plot 6 (Figure 2). Differences in the total number of breeding birds between plots were statistically significant (χ^2 = 82.3, P < 0.001, df = 7). Heterogeneity of vegetation types (Table 1) correlated with heterogeneity of birds within the same plot ($r_{Spearman}$ = 0.88, P = 0.02, df = 6).

The highest density of breeding territories and species density was recorded in "Bushes with trees", the lowest in "Short grass" (Figure 3). None of the species were recorded in all vegetation types, and only Tree Pipit was recorded in five out of six types. Twelve species were registered only in one vegetation type. Of those, seven were recorded only in "Bushes with trees". None of the species were registered only in "Tall herbs" (Table 3). The highest breeding densities were recorded for Blackcap (14.8 bp / 10 ha) in "Bushes with trees" and Sedge Warbler (14.4 bp / 10 ha) in "Tall herbs".

Table 3: Breeding densities in respective vegetation types (breeding pairs per 10 ha)

Tabela 3: Gnezditvena gostota ptic na posameznih vegetacijskih tipih (gnezdeči pari na 10 ha)

	Vegetation type (area in ha) / Vegetacijski tip (površina v ha)					
Species / Vrsta	Short grass/ Nizka trava (91.6)	Tall herbs/ Visoke zeli (11.1)	Sparse bushes/ Redko grmičje (50.4)	Dense bushes/ Gosto grmovje (12.2)	Meadows with trees/ Travniki z drevesi (6.6)	Bushes with trees/ Grmovje z drevesi (5.4)
Coturnix coturnix	0.3		0.6			
Crex crex	0.8		0.2			
Numenius arquata	0.2					
Jynx torquilla						1.9
Falco subbuteo						1.9
Lanius collurio		0.9	0.8	1.6		1.9
Pica pica				0.8	1.5	
Cyanistes caeruleus						1.9
Parus major						5.6
Periparus ater						1.9
Alauda arvensis	2.8	0.9	0.6			
Phylloscopus collybita					1.5	5.6
Sylvia atricapilla			0.8	10.7	1.5	14.8
Sylvia borin				0.8		
Sylvia nisoria			0.2	3.3		
Sylvia communis			2.8	11.5		
Acrocephalus schoenobaenus	0.2	14.4	0.6	2.5		
Acrocephalus palustris		3.6	0.2	3.3		
Sturnus vulgaris			0.2			
Turdus merula			0.6	5.7		7.4
Muscicapa striata						3.7
Erithacus rubecula			0.6	12.3	1.5	3.7
Saxicola rubetra	1.6	0.9	4.2			
Saxicola rubicola			0.6	1.6		
Motacilla flava	1.6	2.7	4.6	6.6		
Anthus trivialis	0.2		2.4	5.7	1.5	1.9
Fringilla coelebs						9.3
Erythrina erythrina			1.4	0.8		
Chloris chloris			0.2			
Linaria cannabina			0.6	0.8		
Carduelis carduelis			0.2	0.8		3.7
Serinus serinus					1.5	
Emberiza citrinella			0.4	4.9	1.5	9.3
Emberiza schoeniclus		4.5	0.4			

3.3. Effects of overgrowing on birds

The density of breeding territories and the density of breeding bird species were in positive correlation with the advancement of succession stages (Territories: $r_{Spearman} = 0.90$, $P = 0.02$, df = 4; Species: $r_{Spearman} = 0.90$, $P = 0.02$, df = 4). Curlew was found only in "Short grass", while Quail and Corncrake were recorded in "Short grass" and "Sparse bushes". Species that were found in a habitat with bushes (Sparse and Dense) were mainly *Sylvia* warblers (Garden Warbler, Barred Warbler, Common Whitethroat) and some finches (Goldfinch, Greenfinch and Rosefinch), while species that were found in a habitat with trees (both vegetation

Table 4: Spearman's correlation coefficient between different stages of succession (represented here as the percentage of one or of a combination of two vegetation types on individual plots) and the number of breeding territories on individual plots for species that bred on more than one vegetation type (not counting "Meadows with trees"). Significant correlations are shown in bold.

Tabela 4: Spearmanov korelacijski koeficient med različnimi stopnjami sukcesije (predstavljeno tukaj kot odstotek ene ali dveh vegetacijskih tipov na posameznih ploskvah) in številom teritorijev vrst na posameznih ploskvah, ki so bile zabeležene na več kot enem vegetacijskem tipu (brez "Meadows with trees"). Značilne korelacije so prikazane odebeljeno.

Species / Vrsta	Percentage of Short grass/ Delež Nizke trave		Percentage of plot in early stages of vegetation (Tall herbs and Sparse bushes) / Delež ploskve v zgodnjih fazah zaraščanja (Visoke zeli in Redko grmičje)		Percentage of plot in late stages of succession (Dense bushes and Bushes with trees) / Delež ploskve v poznih fazah zaraščanja (Gosto grmovje in Grmovje z drevesi)	
	r	*P*	*r*	*P*	*r*	*P*
Coturnix coturnix	0.34	0.43	−0.17	0.79	−0.39	0.39
Crex crex	0.35	0.40	−0.09	0.84	−0.37	0.36
Numenius arquata	0.51	0.29	−0.25	0.64	−0.38	0.43
Lanius collurio	−0.38	0.37	0.14	0.76	0.63	0.13
Alauda arvensis	**0.85**	**0.03**	−0.65	0.11	−0.52	0.22
Sylvia atricapilla	−0.53	0.18	−0.15	0.74	**0.93**	**0.00**
Sylvia nisoria	**−0.81**	**0.04**	0.49	0.25	0.49	0.25
Sylvia communis	**−0.90**	**0.01**	0.71	0.06	0.44	0.28
Acrocephalus schoenobaenus	−0.48	0.23	0.39	0.34	0.29	0.48
Acrocephalus palustris	**−0.77**	**0.04**	0.68	0.08	0.23	0.59
Turdus merula	−0.59	0.15	−0.08	0.88	**0.85**	**0.04**
Erithacus rubecula	−0.59	0.15	−0.08	0.88	**0.85**	**0.04**
Saxicola rubetra	0.15	0.72	0.41	0.31	**−0.86**	**0.01**
Saxicola rubicola	−0.34	0.46	0.73	0.11	−0.31	0.50
Motacilla flava	−0.36	0.39	0.51	0.21	−0.39	0.39
Anthus trivialis	−0.60	0.12	**0.83**	**0.01**	0.05	0.92
Erythrina erythrina	−0.21	0.64	0.68	0.09	−0.52	0.22
Linaria cannabina	−0.32	0.46	0.76	0.07	−0.38	0.43
Emberiza citrinella	−0.59	0.15	−0.08	0.88	**0.85**	**0.04**
Emberiza schoeniclus	−0.23	0.57	0.04	0.98	0.33	0.43

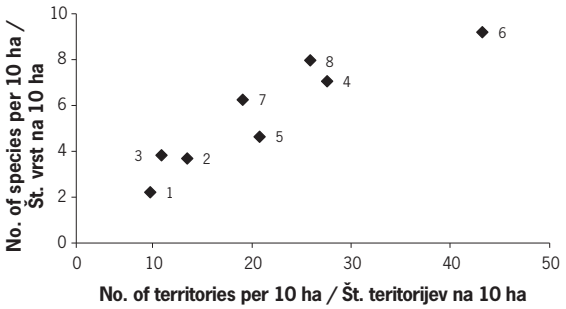

Figure 2: The number of species and territories per 10 ha of respective plots

Slika 2: Število vrst in teritorijev na 10 ha posameznih ploskev

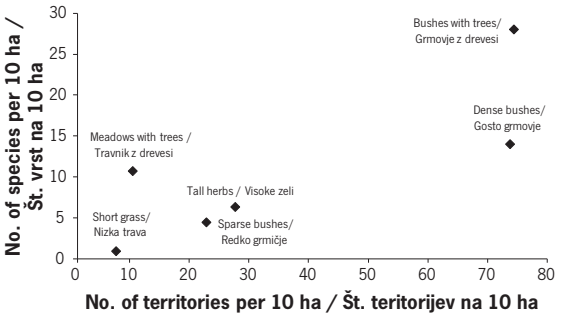

Figure 3: The number of species and territories per 10 ha of respective vegetation types

Slika 3: Število vrst in teritorijev na 10 ha posameznih vegetacijskih tipov

types) were mainly tits (Blue, Great and Coal Tits) and other tree-nesting species like Hobby, Wryneck, Chaffinch and Serin, but also Chiffchaff.

A significant correlation between breeding density and percentage of vegetation type or combination of vegetation types was found only in nine species. Two species showed a negative response to succession, six displayed a positive response, while Tree Pipit showed a preference for vegetation types in early succession stages (Table 4).

4. Discussion

The 34 breeding species registered constitute more than a third of all breeding species of Cerknica Polje (Polak 2002). The number of species and breeding densities were larger with advancing overgrowth, which supports the findings of Venier & Pearce (2005) who detected the highest diversity for later stages of succession. With progression of succession, the vegetation structure changes (Hopkins 1991) and heterogeneity of habitat increases (O'Connor & Shrub 1986, Vickery *et al.* 1999). The higher species diversity and overall breeding density of later succession stages could also be due to more widely dispersed resources in extensive open environments than in more closed ones (Kobal *et al.* 1999). Although the highest breeding density and species diversity was registered on plot 6, it was the plots with the lowest density (e.g. plots 1 and 3) that harboured some of the grassland species of greatest conservation concern, such as Curlew and Corncrake.

Cerknica Polje is an important breeding area for several of the species registered on our study plots (Denac *et al.* 2011), and some of them reach their highest breeding densities in Slovenia here. Although Rosefinch formerly bred at several sites around Slovenia (Geister 1995), Cerknica Polje is now its only regular breeding place (Atlas ptic 2014). The Curlew breeds only at two localities in Slovenia, Ljubljansko barje being the most important one (Denac *et al.* 2011). The Corncrake is a localised and declining breeder in Slovenia (Božič 2005b) and Cerknica Polje is its third most important breeding site (Denac *et al.* 2011). Barred Warbler is also a localised breeder in Slovenia, and Cerknica Polje is one of the five most important breeding areas in Slovenia (Denac *et al.* 2011). Skylark densities recorded at Cerknica Polje are not only high for Slovenia (Jančar & Trebušak 2000, Kerček 2009, Vukelič 2009), but also for central and western Europe (Cramp 1998). Yellow Wagtail and Sedge Warbler reach their highest and Whinchat their second highest breeding numbers in Slovenia at Cerknica Polje (Kus Veenvliet 2002, Tome *et al.* 2005, Kerček 2009, Denac *et al.* 2011). All the above mentioned birds breed in specific habitats (Cramp 1998) and are thus affected by advancing succession, as our study also shows, and all of them should be included in the management plan for the area.

Such a complex assembly of conservationally important birds needs a detailed management plan, that takes into account their preference for different succession stages. Unlike forest habitats, semi-natural grasslands need constant maintenance with mowing or grazing (Hopkins 1991, Šeffer *et al.* 1999). The optimal management for nature conservation purposes is extensive use of grasslands, which is practically identical to historical management (Beintema 1988). Land abandonment, however, transforms extensively managed meadows with low or sparse vegetation, which is an important breeding habitat for many species (Mason & Macdonald 2000), into later succession stages, thus in the long run excluding short grass species such as Curlews (Berg 1992, Remec 2007). Vegetation structure has a significant impact on habitat selection in grassland birds (Vickery *et al.* 1999); it changes substantially with advancing succession (Johnston & Odum 1956). Different species require different heights and densities of grass (O'Connor & Shrub 1986, Mason & Macdonald 2000). Higher and denser grass harbours a higher density of invertebrates but makes hunting more difficult (Sackl 1985). It provides safer nesting places as well as more singing and hunting perches (Tucker & Dixon 1999). Succession is a slow process; over the course of 12 years its effect became apparent at Cerknica Polje as regards Corncrake, whose population, besides fluctuating considerably between 1992 and 2004 due to highly variable water levels, shifted away from overgrown areas (Polak *et al.* 2004). On the other hand, intensive land use has a negative effect on grassland species (Denac 2007, Vukelič 2009). Due to the occurrence of many threatened species (Trontelj 1993, Polak 2002, Božič 2003) with different habitat requirements (Cramp 1998), the suggested management practices cannot be distributed uniformly over the entire area. On a wider scale, the management plan should consequently include a mix of abandoned areas that are occasionally reverted to earlier stages of succession and more or less regularly mown areas. As our study shows, high species diversity can be maintained with high habitat heterogeneity, even in a relatively small area. Due to land abandonment, areas of sparse and dense bushes are already present in most parts of Cerknica Polje (Gaberščik 2009). Thus the main

focus for management is maintaining large complexes of wet meadows. A mosaic of early succession stages and short grass habitats with positive effects on birds (Hellström & Berg 2001) can also be achieved with low density grazing (Söderstrom *et al.* 2000), but it is essential to define precise livestock loads for a given habitat, since excessively high loads have a negative effect on birds (Beintema & Müskens 1987, Milne & Osoro 1997, Söderstrom *et al.* 2000).

Some larger "Short grass" species need relatively large unbroken areas of extensive wet meadows (at least 100 ha) and thus nest in lower densities. On the other hand, as our study also shows, species found in sparse bushes and, even more so, in dense bushes can flourish at higher densities. Thus management plan for Cerknica Polje must include large regularly mown areas interspersed with smaller areas in different stages of succession; in other words, management should be directed at maintaining the present state of the area. Some examples are given below.

Areas of unbroken "Short grass" should be maintained in four separate areas of Cerknica Polje. The first is located west of Dolenje jezero (called Dolenjska blata), the second north of the rivulet Žerovniščica, the third on both sides of the rivulet Lipsenjščica (the part on the right side is called Predblatnice), and the fourth between Obrh and Levišče.

The areas described above should include small areas (several 10 m^2) of higher herbaceous plants. Such islands could be mown every second or third year on a rotational basis aimed at ensuring a suitable habitat for both true grassland species and species of early succession stages. These islands are already present, mostly along watercourses and in smaller depressions.

Several areas (up to 20 ha) on the drier edge of the Polje and on parts of fens should be left alone till late succession. Currently, the largest patches of late succession stages are situated north of the sinkhole Retje and between sinkholes Vodonos and Rešeto. Patches of overgrown fens are located on parts of Dujce, below Marof and between Martinjak and Grahovo. In the rest of Cerknica Polje, patches of late stages are small and far between.

5. Povzetek

Kmetijstvo ima velik vpliv na biodiverziteto Evrope. Populacije ptic kmetijske krajine zaradi intenzifikacije pa tudi opuščanja kmetijstva upadajo. Namen raziskave je bil ugotoviti vpliv zaraščanja na pestrost ptic na Cerkniškem polju. Na osmih popisnih ploskvah (15,2–31,6 ha) je bilo izbranih šest vegetacijskih tipov (*Nizka trava* – redno košeni mokrotni travniki; *Visoke zeli* – predvsem trstičja *Phragmites australis* in trstične pisanke *Phalaris arundinacea*; *Redko grmičje* – redki sestoji nizkih lesnatih rastlin; *Gosto grmovje* – gosti sestoji grmovja; *Travniki z drevesi* – košenice s posameznimi drevesi; *Grmovje z drevesi* – mejice in sestoji drevja z gostim grmovjem). Skupaj je bilo zabeleženih 34 vrst ptic. Heterogenost vegetacijskih tipov je bila v pozitivni korelaciji s heterogenostjo ptic. Najvišja gostota gnezditvenih teritorijev in vrst je bila zabeležena na *Grmovju z drevesi*, najnižja v *Nizki travi*. Nobena vrsta ni bila zabeležena v vseh vegetacijskih tipih in samo drevesna cipa *Anthus trivialis* je bila opažena na petih od šestih izmed njih. Dvanajst vrst je bilo zabeleženih samo na enem vegetacijskem tipu. Cerkniško polje je pomembno gnezdišče vrst ptic, ki tu dosegajo ene svojih najvišjih gostot v državi (npr.: kosec *Crex crex*, veliki škurh *Numenius arquata*, poljski škrjanec *Alauda arvensis*, repaljščica *Saxicola rubetra*, bičja trstnica *Acrocephalus schoenobaenus*). Vse te vrste gnezdijo v specifičnih habitatih, ki so zastopani v različnih stopnjah zaraščanja. Zato mora upravljavski načrt vključevati mešanico opuščenih območij v različnih stopnjah zaraščanja, ki se jih po potrebi vrača v začetno stanje, ter večja bolj ali manj redno košena območja. Zaradi opuščanja se na Cerkniškem polju že pojavljajo območja grmišč v različnih stopnjah zaraščanja. Tako je trenutni fokus upravljanja treba usmeriti v ohranjanje večjih kompleksov košenih mokrotnih travnikov.

6. References

Aleš K. (2004): Populacijski trend in izbor gnezditvenega habitata pribe *Vanellus vanellus* na Ljubljanskem barju. – Acrocephalus 25 (123): 187–194.

Atlas ptic (2014): Škrlatec *Carpodacus erythrinus*. – [http://www.ptice.si/atlas], 20/12/2014.

Beintema A. J. (1988): Conservation of grassland bird communities in the Netherlands. pp. 105–111 In: Goriup P. D. (ed.): Ecology and conservation of grassland birds. ICBP Technical Publication No. 7. – ICBP, Cambridge.

Beintema A. J., Müskens J. D. M. (1987): Nesting success of birds breeding in Dutch agricultural graslands. – Journal of Applied Ecology 24: 743–758.

Berg A. (1992): Habitat selection by breeding curlews *Numenius arquata* on mosaic farmland. – Ibis 134: 355–360.

Bibby C. J., Burgess N. D., Hill D. A., Mustoe S. (2000): Bird census techniques. Second Edition. – Academic Press, London.

Bordjan A. (2007): [Vpliv zaraščanja Cerkniškega jezera na ptice gnezdilke]. BSc thesis. – Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za biologijo, Ljubljana. (in Slovene)

Božič L. (2003): Mednarodno pomembna območja za ptice v Sloveniji 2. Predlog Posebnih začitenih območij (SPA) v Sloveniji. Monografija DOPPS št.2. – DOPPS, Ljubljana.

Božič L. (2005a): Populacija kosca (*Crex crex*) na Ljubljanskem barju upada zaradi zgodnje košnje in uničevanja ekstenzivnih travnikov. – Acrocephalus 26 (124): 3–22.

Božič L. (2005b): Gnezditvena razširjenost in velikost populacije kosca *Crex crex* v Sloveniji leta 2004. – Acrocephalus 26 (127): 171–179.

Cramp S. (ed.) (1998): The complete birds of the Western Palearctic on CD-ROM. – Oxford University Press, Oxford.

Cunder T. (1999): Zaraščanje kmetijskih zemljišč v slovenskem alpskem svetu. pp. 165–175 In: Gosar A., Kunaver J. (eds.): Sonaravni razvoj v slovenskih Alpah in sosedstvu. – Oddelek za geografijo Filozofske fakultete, Ljubljana.

Denac D. (2003): Upad populacije in sprememba rabe tal v lovnem habitatu rjavega srakoperja *Lanius collurio* v Šturmovcih (SV Slovenija). – Acrocephalus 24 (118): 97–102.

Denac D. (2007): [Populacijska dinamika repaljščice (*Saxicola rubetra*) v mozaiku nižinskih habitatnih tipov]. PhD thesis. – Univerza v Ljubljani, Biotehniška fakulteta Ljubljana. (in Slovene)

Denac K., Mihelič T., Denac D., Božič L., Kmecl P., Bordjan D. (2011): Poročilo monitoringa populacij izbranih vrst ptic Končno poročilo za Ministrstvo za okolje in prostor. Popisi gnezdilk spomladi 2011 in povzetek popisov v obdobju 2010–2011. – DOPPS, Ljubljana.

EBCC (2014): European wild bird indicators, 2014 update. – [http://www.ebcc.info/index.php?ID=558], 20/11/2014.

Gaberščik A. (2009): Kartiranje habitatnih tipov na območju Cerkniškega jezera. Poročilo projekta LIFE06NAT/SLO/000069 "Presihajoče Cerkniško jezero". – Biotehniška fakulteta, Ljubljana.

Gaberščik A., Urbanc-Berčič O. (2002): Ekosistem, ki ga ustvarja igra vode. pp. 51–57 In: Gaberščik A. (ed.): Jezero, ki izginja. Monografija o Cerkniškem jezeru. – Društvo ekologov Slovenije, Ljubljana.

Geister I. (1995): Ornitološki atlas Slovenije. – DZS, Ljubljana.

Hellström M., Berg Å. (2001): Effects of restoration and management regime on avifaunal composition on Swedish wet meadows. – Ornis Svecica 11: 235–252.

Hočevar M., Kušar G., Cunder T. (2004): Monitoring in analiza zaraščanja kraške krajine v GIS okolju. – Zbornik gozdarstva in lesarstva 75: 21–52.

Hopkins J. J. (1991): Vegetation structure and the conservation of wild plants and animals. pp. 12–17 In: Curtis D. J., Bignal E. M., Curtis M. A. (eds.): Birds and pastoral agriculture in Europe. Proceedings of the 2nd European forum on birds and pastoralism, 26-30 Oct 1990, Port Erin, Isle of Man. – Scottish Chough Study Group & Joint Nature Conservation Committee, Peterborough.

Ilijanić L. (1978): Vegetacijske razmere Cerkniškega jezera. – Zavod za vodno gospodarstvo SR Slovenije, Ljubljana.

Jančar T., Trebušak M. (2000): Ptice Kozjanskega parka. Acrocephalus 21 (100): 107–134.

Johnston D. W., Odum E. P. (1956): Breeding Bird Populations in Relation to Plant Succession on the Piedmont of Georgia. – Ecology 37 (1): 50–62.

Kerček M. (2009): Gnezdilke kopenskega dela zadrževalnika Medvedce (SV Slovenija). Acrocephalus 30 (141/142/143): 165–179.

Kobal S. N., Payne N. F., Ludwig D. R. (1999): Habitat/area relationships, abundance, and composition of bird communities in 3 grassland types. – Transactions of the Illinois State Academy of Science 92 (1/2): 109–131.

Koce U. (2010): [Prehranjevalna ekologija repaljščice (*Saxicola rubetra*) v mozaiku traviščnih habitatnih tipov]. PhD thesis. – Univerza v Ljubljani, Biotehniška fakulteta, Ljubljana. (in Slovene)

Kranjc A. (2002): Hidrološke značilnosti. pp. 26–37 In: Gaberščik A. (ed.): Jezero, ki izginja. Monografija o Cerkniškem jezeru. – Društvo ekologov Slovenije, Ljubljana.

Krebs C. (2001): Ecology: the experimental analysis of distribution and abundance. 5th Edition. – Benjamin Cummings, California.

Kus Veenvliet J. (2001): Rumena pastirica *Motacilla flava* na Cerkniškem polju. – Acrocephalus 22 (104/105): 23–28.

Kus Veenvliet J. (2002): [Izbira habitata travniških ptic pevk na Cerkniškem polju]. BSc thesis. – Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za biologijo, Ljubljana. (in Slovene)

Martinčič A., Leskovar I. (2002): Vegetacija. pp. 81–95 In: Gaberščik A. (ed.): Jezero, ki izginja. Monografija o Cerkniškem jezeru. – Društvo ekologov Slovenije, Ljubljana.

Mason C. F., Macdonald S. M. (2000): Influence of landscape and land-use on the distribution of breeding birds in farmland in eastern England. – Journal of Zoology 251 (3): 339–348.

McLaughlin A., Mineau P. (1995): The impact of agricultural practices on biodiversity. – Agriculture, Ecosystems & Environment 55: 201–212.

Milne J. A., Osoro K. (1997): The role of livestock in habitat management. pp. 75–80 In: Laker J. P., Milne J. A. (eds): Livestock Systems in European Rural Development. 1st Conference of the LSIRD network, 23rd–25th January 1997, Nafplio, Greece. – MLURI, Aberdeen.

O'Connor R. J., Shrub M. (1986): Farming and Birds in Europe. The Common Agricultural Policy and its Implications for Bird Conservation. – Academic Press, San Diego.

Pangerc T. (2005): [Frekvenca krmljenja mladičev pri repaljščici (*Saxicola rubetra*) in vpliv visokih steblik na lovni uspeh odraslih osebkov]. BSc thesis. – Univerza v Ljubljani, Biotehniška fakulteta, Ljubljana. (in Slovene)

PECBMS (2013): State of Common Birds in Europe, 2013 update. – CSO/RSPB, Prague, Czech Republic.

Perko D., Orožen Adamič M. (1998): Slovenija. Pokrajine in ljudje. – Mladinska knjiga, Ljubljana.

Peršič M. (2002): Jezero in jezerci – posebnosti skozi način

življenja jezercev. pp. 304–328 In: Gaberščik A. (ed.): Jezero, ki izginja. Monografija o Cerkniškem jezeru. – Društvo ekologov Slovenije, Ljubljana.

Polak S. (1993): Ptice gnezdilke Cerkniškega jezera in bližnje okolice. – Acrocephalus 14 (56/57): 32–62.

Polak S. (2002): Cerkniško jezero – mednarodno pomembno območje za ptice. pp. 236–247 In: Gaberščik A. (ed.): Jezero, ki izginja. Monografija o Cerkniškem jezeru. – Društvo ekologov Slovenije, Ljubljana.

Polak S., Kebe L., Koren B. (2004): Trinajst let kosca *Crex crex* na Cerkniškem jezeru. – Acrocephalus 25 (121): 59–70.

Reif J., Voříšek P., Šťastný K., Bejček V., Petr J. (2008): Agricultural intensification and farmland birds: new insights from a central European country. – Ibis 150: 596–605.

Remec I. Ž. (2007): [Gnezditvena ekologija velikega škurha (*Numenius arquata*) na ljubljanskem barju]. BSc thesis. – Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za biologijo, Ljubljana. (in Slovene)

Sackl P. (1985): [Untersuchungen zur Habitatwahl und Nahrungsökologie des Weißstorches (*Ciconia ciconia* L.) in der Steiermark]. PhD thesis – University of Graz, Graz. (in German)

Smrekar A. (2002): Gospodarski načrti. pp. 276–287 In: Gaberščik A. (ed.): Jezero, ki izginja. Monografija o Cerkniškem jezeru. – Društvo ekologov Slovenije, Ljubljana.

Söderstrom B., Pärt T., Linnarsson E. (2000): Grazing effects on between-year variation of farmland bird communities. – Ecological Applications 11 (4): 1141–1150.

Šeffer J., Stanová V., Viceníková A. (1999): Impact of floods and management on composition of meadow communities. pp. 103–117 In: Šeffer J., Stanová V. (eds.): Morava river floodplain meadows: importance, restoration and management. – DAPHNE, Bratislava.

Šercelj A. (1974): Paleovegetational investigations of the sediments of Cerkniško jezero (Lake of Cerknica). – Acta carsologica 6: 233–241.

Tome D. (2002): Effect of floods on the distribution of meadow birds on Ljubljansko barje. – Acrocephalus 23 (112): 75–79.

Tome D., Sovinc A., Trontelj P. (2005): Ptice Ljubljanskega barja. Monografija DOPPS št. 3. – DOPPS, Ljubljana.

Tome D., Denac D. (2012): Survival and development of predator avoidance in the post-fledging period of the Whinchat (*Saxicola rubetra*): consequences for conservation measures. – Journal of Ornithology153 (1): 131–138.

Tomovčík M., Darolová A., Kürthy A., Vongrej S., Chavko J., Noga M. (1999): Ecological relations of birds and floodplain meadow habitats. pp. 161–185 In: Šeffer J., Stanová V. (eds.): Morava river floodplain meadows: importance, restoration and management. – DAPHNE, Bratislava.

Trontelj P. (1993): O naravovarstvenem konceptu Cerkniškega jezera s poudarkom na varstvu ptic. – Acrocephalus 14 (56/57): 63–79.

Tryjanowski P., Hartel T., Báldi A., Szymański P., Tobolka M., Herzon I., Goławski A., Konvička M., Hromada M., Jerzak L., Kujawa K., Lenda M., Orłowski G., Panek M., Skórka P., Sparks T. H., Tworek S., Wuczyński A., Żmihorski M. (2011): Conservation of Farmland Birds Faces Different Challenges in Western and Central-Eastern Europe. – Acta Ornithologica 46 (1): 1–12.

Tucker G. M., Dixon J. (1997): Agricultural and grassland habitats. pp. 267–325 In: Tucker G. M., Evans M. I. (eds.): Habitats for Birds in Europe. A Conservation Strategy for the Wider Environment. BirdLife Conservation Series No. 6. – BirdLife International, Cambridge.

Veen P., Molnár Z., Pärtel M., Sammul M., Kukk T., Nagy S. (2001): Grassland ecosystems in Central and Eastern Europe. Prepared in the framework of the High Level Conference on EU Enlargement "The Relation between Agriculture and Nature Management", 22-24 Jan 2001. – [http://www.veenecology.nl/data/StatusreportGrasslandecosystems.PDF], 10/03/2007.

Venier L. A., Pearce L. J. (2005): Boreal Bird Community Response to Jack Pine Forest Succession. – Forest Ecology and Managment 217: 19–36.

Vickery P. D., Herkert J. R., Knopf F. L., Ruth J., Keller C. E. (1999): Grassland Birds: An Overview of Threats and Recommended Management Strategies. pp. 74–77 In: Bonney R., Pashley D. N., Cooper R. J., Niles L. (eds.): Strategies for bird conservation: the partners in flight planning process. – Cornell Lab of Ornithology, Ithaca.

Vukelič E. (2009): Vpliv načinov gospodarjenja s travišči na ptice gnezdilke Ljubljanskega barja (osrednja Slovenija). – Acrocephalus 30 (140): 3–15.

Prispelo / Arrived: 26. 11. 2010
Sprejeto / Accepted: 7. 1. 2015