DOI: 10.1515/frp-2015-0010
Available online: www.lesne-prace-badawcze.pl
REVIEW ARTICLE

Leśne Prace Badawcze / *Forest Research Papers*
March 2015, Vol. 76 (1): 88–107
e-ISSN 2082-8926

The Borki Primeval Forest as an important forest bird area

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Abstract. This paper presents an overview of bird research carried out in the Borki Primeval Forest during the last 30 years. The Borki Primeval Forest can be considered as one of the most important forest bird sites in Poland. Its avifauna comprises 139 breeding species, including 11 rare and endangered species listed in the Polish Red Data Book of Animals as well as 30 species listed in Annex I of the EU Birds Directive. Despite its relatively small area, the Borki Primeval Forest holds at least 1% of Polish breeding population of as many as 12 bird species. For seven out of these species it is one of the most important breeding sites in the country. The avifauna of the Borki Primeval Forest consists mostly of typical forest birds including 24 indicator species which are associated with natural forests. The richness of bird species in the Borki Primeval Forest and the abundance of several valuable groups of breeding species are the result of a high landscape and habitat diversity as well as a relatively small anthropopression combined with a high degree of naturalness of forest stands.

Keywords: the Borki Primeval Forest, avifauna, important bird areas, forest birds, natural forests, indicator species

1. Introduction

The Borki Primeval Forest is a dense forest complex of area close to 20.000 ha. It is situated on a strongly undulating area in the eastern part of the Masurian Lake District. Postglacial landscape is here very varied with numerous hills of terminal moraine, kames, eskers and kettle holes filled with moors as well as lake valleys. The Borki Primeval Forest belongs to one of a few large forest complexes in Poland dominated by deciduous and mixed forests growing on fertile habitats.

The main forest plant community is here an oak-hornbeam forest, with multispecies forest stand in which Norway spruce (*Picea abies* L. Karst.) has a significant share. In the Borki Primeval Forest there dominate 60 year old forest stands, which occupy about 60% of the forest area, whereas, forest stands aged 100 years and more grow on approximately 10% of the forest area. The Borki Primeval Forest is known as a sanctuary of rare animal species, such as: the European bison, wolf and lynx. Valuable avifauna of this area has become a basis for its recognition as a bird sanctuary of international importance (International Bird Area – IBA) and as a Natura 2000 bird site 'The Borki Primeval Forest' PLB280006 of an area of 18,962.8 ha (Rąkowski et al. 2010; Wilk et al. 2010).

The purpose of this paper is to provide a characteristic of avifauna of the Borki Primeval Forest based on the research conducted there over 30 year period as well as to assess the ornithological value of the area, taking special account of abundant valuable groups of birds and of habitat conditions.

2. The history of ornithological research in the Borki Primeval Forest

The earliest report on avifauna of the Borki Primeval Forest can be found in Tischler's (1941) monograph devoted to birds of East Prussia. The first post-war study on local avifauna was conducted by the Institute of Environmental Protection in Warsaw within the programme of Integrated Monitoring Station (IMS). The Station was set up in 1984 in the western part of the Borki Primeval Forest next to forester's lodge Diabla Góra (Siuta 1994). Ornithological research was made already in the first years of the Station's activity, from 1984 to 1987, under the programme of forest ecosystem monitoring. The research

Received: 27.06.2014, reviewed: 21.07.2014, accepted: 2.09.2014.

included a preliminary survey of bird species composition in the whole complex of the Borki Primeval Forest (Gromadzki and Jezierski 1984; Gromadzki and Przystupa 1987). Further research on avifauna was conducted in the years 1989–1990, within the framework of environmental inventory for the planned Borki Primeval Forest Landscape Park (Rąkowski 1989; Rąkowski and Szańkowski 1990; Chabros et al. 1990). Since 1991, bird study has become a permanent part of IMS's Borki Primeval Forest monitoring research programme. In 1994 a periodically repeatable ornithological research began on three permanent plots for avifauna monitoring. The plots were set up in the three most widespread types of forest communities in the Borki Primeval Forest, including: oak-hornbeam-, riparian- and mixed coniferous forest (Szańkowski 1991; Piasecki 1992; Rąkowski and Czarnocki 1997; Czarnocki and Rąkowski 2000; Rąkowski et al. 2012, 2013). Under the IMS' programme the avifauna was additionally surveyed over the whole area of the Borki Primeval Forest (Rąkowski 1998) and at its outskirts.

Irrespective of ornithological research conducted within IMS programme, the Borki Forest avifauna was also investigated from the perspective of the area designation as IBA (it was included in the system of International Bird Areas – IBA) (Gromadzki et al. 1994; Sidło et al. 2004; Wilk et al. 2010). After recognising the Borki Primeval Forest as a Natura 2000 bird site, the most comprehensive ornithological inventory of this area in recent years was conducted by Sikora et al. (2011). Dispersed information on birds occurring in the Borki Primeval Forest can also be found in some other papers devoted to the Poland's avifauna (Tomiałojć 1990, Tomiałojć and Stawarczyk 2003, Gromadzki 2004, Sikora et al. 2007, Rąkowski et al. 2010).

3. Methods

In order to characterise the avifauna of the Borki Primeval Forest several types of data source were used, most of them were not published:

1. The results of large-scale bird inventory on whole area of the Borki Primeval Forest conducted with the use of various methods (Gromadzki and Jezierski 1984; Gromadzki and Przystupa 1987; Rąkowski and Szańkowski 1990).

2. The results of the most comprehensive bird population inventory in the recent years conducted in the Borki Primeval Forest in 2011 with the participation of a team of six experienced ornithologists (Sikora et al. 2011). The following methods were adopted in the inventory:

– inventory work was conducted from 10 March to 31 July (jointly 8 controls)

– bird species populations numbering up to 50 pairs were counted on the entire area of the Borki Primeval Forest whereas species populations numbering over 50 pairs were counted in randomly chosen plots or transects

– in order to count population numbers of selected species (owls, woodpeckers, rails, hazel grouse) birds were lured using bird voices

– census of water birds was carried out either from the shores of water reservoirs or from a kayak

– estimation of the number of breeding populations was made only for the species listed in Annex I to the Directive 2009/147/WE (the Birds Directive) and for some other selected species (mainly waterfowl, birds of prey and woodpeckers).

3. The results of preliminary survey of avifauna at the outskirts of Borki Primeval Forest (Rąkowski et al. 2013).

4. Approximate evaluation of the number of breeding populations of selected bird species in the Borki Primeval Forest (Gromadzki et al. 1994; Rąkowski 1998; Sidło et al. 2004; Wilk et al. 2010; SDF 2013).

5. The results of bird's censuses conducted with the use of the combined cartographic method (Tomiałojć 1980) on chosen sample plots arranged in different parts of the Borki Primeval Forest (Rąkowski and Czarnocki 1997; Czarnocki and Rąkowski 2000; Rąkowski et al. 2012, 2013).

All the bird species which met the criteria of 'confirmed breeding' and 'probable breeding' according to the Polish Ornithological Atlas (Sikora et al. 2007), were recognised as breeding birds in the Borki Primeval Forest. All the species which met the criterion 'possible breeding' according Sikora et al. (2007) and species which used to breed in the area, though their breeding was not recently confirmed, despite the presence of suitable habitats, were recognised as birds which are likely to nest in the area under study.

The numbers of breeding populations of individual bird species in the Borki Primeval Forest were defined on the basis of results from recent inventories and estimates (Sikora et al. 2011, SDF 2013). In case of more common species whose number of individuals could not be defined during the inventory, a recently determined density of breeding pairs at the study plots was given (Rąkowski et al. 2013).

In the roster of birds encountered in the Borki Primeval Forest a group of species was identified whose local populations attain at least 1% of their nationwide breeding populations. The presence of the latter species testifies to the high ornithological value of the area. The above-mentioned criterion is consistent with C6 criterion used for evaluation of the Natura 2000 birds sites (Gromadzki 2004).

4. The avifauna of the Borki Primeval Forest

Bird species breeding in the Borki Primeval Forest and at its outskirts are listed in the Table below. The list was made on the basis of results from the above-described ornithological research conducted in the years 1984–2013.

Table 1. List of bird species breeding in the Borki Primeval Forest in the years 1984–2013

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
1.	*Botaurus stellaris*	L	Ch, PCzK**,** PCzL, **BD**		5–6 m	3, 4, 5, 7, 9, 10, **11**, 14	nests in the reeds on larger lakes in the eastern part of BPF
2.	*Ciconia nigra*	L	Ch (s), **BD**	+	10–13 p	3, 4, 5, 7, 9, 10, **11**, 14	about 1% of this species nationwide breeding population nests in the area
3.	*Ciconia ciconia*	L	Ch, **BD**		12 p	3, 4, 5, 7, 9, 10, **11**, 13, 14	nests in settlements in forest clearings and at the outskirts of BPF
4.	*Cygnus olor*	L	Ch, BD		9 p	3, 4, 5, 7, **11**	nests on lakes and ponds in the eastern part of BPF and on its western border
5.	*Anas strepera*	L	Ch, BD		6–10 p	3, 4, 5, 7, **11**	nests on lakes in eastern part of BPF
6.	*Anas crecca*	L	Ł, BD		+	3, 4, 5, 7, **11,** 13	nests on midforest swamps and at the BPF outskirts
7.	*Anas platyrhynchos*	L	Ł, BD		+	3, 4, 7, **11,** 13	nests on midforest swamps, ponds and lakes, and on reservoirs created by beavers damming up streams
8.	*Aythya ferina*	D	Ł, BD			3, 4, 7	in the 1980s and 90s, this species was nesting on ponds and lakes in the eastern part of BPF
9.	*Aythya fuligula*	D	Ł, BD			3, 4, 7	in the 1980s and 90s, this species was nesting on ponds and lakes in the eastern part of BPF

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
10.	*Aythya nyroca*	D	Ch, **BD**			1, 4, 7	in the 1980s and 90s, this species was nesting sparsely on ponds and lakes in the eastern part of BPF
11.	*Bucephala clangula*	L	Ch, BD		20–30 p	3, 4, 5, 7, **11**, 12, 13, 14	nests on midforest swamps, ponds and lakes and on reservoirs created by beavers damming up streams. Near to 2% of its nationwide breeding population nest in the BPF
12.	*Mergus merganser*	L	Ch		1 p	1, 4, 7, **11**, 12	irregularly nests on midforest ponds, lakes and watercourses and on reservoirs created by beavers
13.	*Tachybaptus ruficollis*	L	Ch		20–30 p	3, 4, 5, 7, **11**, 13	nests on midforest ponds and on small water reservoirs at the outskirts of BPF
14.	*Podiceps cristatus*	L	Ch		10–25 p	3, 4, 5, 7, **11**	nests on bigger lakes in BPF and at its outskirts
15.	*Bonasa bonasia*	L	Ł, PCzL, **BD**	+	620–830 m	3, 4, 5, 6, 7, 9, 10, **11**, 12, 13, 14	hazel grouse population in BPF is one of the most numerous in the country and reaches 2% of its nationwide population
16.	*Perdix perdix*	L	Ł, BD		+	1, 4, 7, 13	species occurs only at the outskirts of BPF
17.	*Coturnix coturnix*	L	Ch, PCzL, BD		+	11, 13	species occurs only at the outskirts of BPF

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
18.	*Pernis apivorus*	L	Ch, **BD**	+	30–40 p	3, 4, 5, 7, 9, 10, **11**, 14	in BPF nests more than 1% of its nationwide breeding population
19.	*Milvus migrans*	L	Ch (s), PCzL, PCzK, **BD**	+	0–2 p	3, 4, 5, 7, 9, 10, **11**, 14	this species nests irregularly in old forest stands in eastern parts of BPF
20.	*Milvus milvus*	M	Ch (s), PCzL, PCzK, **BD**	+		3, 7, 10	nesting of this species is possible; it was repeatedly observed during the breeding period
21.	*Haliaeetus albicilla*	L	Ch (s), PCzL, PCzK, **BD**	+	3–4 p	3, 4, 5, 7, 9, 10, **11**, 13, 14	white-tailed eagle population in BPF tends to increase; in the 1980s and 90s, a nesting of 1–2 pairs was observed
22.	*Circus aeruginosus*	L	Ch, **BD**		5–7 p	3, 4, 5, 7, 9, 10, **11**, 13, 14	nests in the reeds on the shores of lakes in eastern parts of BPF and on its western border
23.	*Accipiter gentilis*	L	Ch	+	13–15 p	3, 4, 5, 7, **11**, 13	nests in dispersion on whole BPF area
24.	*Accipiter nisus*	L	Ch	+	+	3, 4, 5, 7, 11	nests mainly at the outskirts of BPF
25.	*Buteo buteo*	L	Ch	+	+	3, 4, 7, 11	most numerous bird of prey in BPF, dozens of pairs are nesting there
26.	*Clanga pomarina*	L	Ch (s), PCzL, PCzK, **BD**	+	20–23 p	3, 4, 5, 7, 9, 10, **11**, 13, 14	in BPF nest over 1% of its nationwide breeding population
27.	*Pandion haliaetus*	L	Ch (s), PCzL, PCzK, **BD**		2 p	3, 4, 5, 7, 9, 10, **11**, 13, 14	in BPF nest around 5% of its nationwide breeding population

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
28.	*Falco tinnunculus*	M	Ch			3, 4, 7	this species used to breed in clearings and at the outskirts of BPF; in recent years, it was not stated here, but its nesting is possible
29.	*Falco subbuteo*	L	Ch	+	1–5 p	2, 3, 4, 7, **11**	nests at the outskirts of BPF
30.	*Rallus aquaticus*	L	Ch, BD		4–20 p	1, 4, 7, **11**	nests on swamps and on the shores of lakes in BPF and its outskirts
31.	*Porzana porzana*	L	Ch, PCzL, **BD**		0–1 p	1, 4, 5, 7, 9, 10, **11**, 14	irregularly nests on the marshy shores of ponds and lakes in eastern part of BPF
32.	*Porzana parva*	L	Ch, PCzK, PCzL, **BD**		7 p	5, 9, 10, **11**, 14	nests by the lakes and in river valleys in south-eastern part of BPF
33.	*Crex crex*	L	Ch, PCzL, **BD**		30–40 m	3, 4, 5, 7, 9, 10, **11**, 13, 14	nests on wet meadows in BPF, it is more numerous at its outskirts
34.	*Gallinula chloropus*	L	Ch, BD		+	1, 4, 7, 11, 13	nests on marshy shores of ponds and lakes in eastern part of BPF
35.	*Fulica atra*	L	Ł, BD		+	1, 4, 7, 11	nests on midforest ponds and lakes in eastern part of BPF
36.	*Grus grus*	L	Ch, **BD**		150–160 p	3, 4, 5, 6, 7, 8, 9, 10, **11**, 12, 13, 14	in BPF nest 150–160 pairs, which is more than 1% of its nationwide breeding population; within last 30 years, this species markedly increased its population numbers in this area

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
37.	*Charadrius dubius*	L	Ch		+	3, 4, 5, 7, 11	single pairs nest on exposed shores of lakes and on abandoned ponds, mostly in the eastern Forest part of BPF
38.	*Vanellus vanellus*	L	Ch, BD		+	3, 4, 7, 11, 13	nests by the midforest ponds and on swampy meadows at the outskirts of BPF
39.	*Gallinago gallinago*	L	Ch, BD		+	3, 4, 5, 7, 11, 12, 13	nests on midforest meadows and on bogs
40.	*Scolopax rusticola*	L	Ł, PCzL, BD	+	+	3, 4, 5, 7, 11, 12, 13	nests on midforest bogs
41.	*Tringa ochropus*	L	Ch, BD	+	160–280 p	3, 4, 5, 6, 7, 9, 10, **11**, 12, 13, 14	in here nest around 3% of its nationwide breeding population; BPF is one of the most important breeding sites of this species in Poland
42.	*Actitis hypoleucos*	D	Ch, BD			1, 4, 5, 7	species used to nest in 1980s and 90s by midforest lakes and watercourses
43.	*Larus ridibundus*	L	Ch, BD		+	3, 4, 13	species once used to nest by midforest lakes and ponds, currently nests only at the outskirts of BPF
44.	*Sterna hirundo*	L	Ch, **BD**		6–8 p	3, 4, 7, **11**, 14	nests by lakes and ponds in eastern part of BPF
45.	*Chlidonias niger*	L	Ch, **BD**		18–20 p	3, 4, 7, **11**, 14	nests by lakes and ponds in eastern part of BPF

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
46.	*Columba oenas*	L	Ch, BD	+	40–50 p	3, 4, 5, 7, **11**, 12, 13, 14	nests mainly in regions with preserved older forest stands
47.	*Columba palumbus*	L	Ł, BD	+	0.6–1.7 p/10 ha	12, **13**	quite numerously nests in the whole BPF
48.	*Streptopelia decaocto*	L	Ch, BD		+	1, 4, 5, 7, 11	nests close to buildings in clearings in BPF and at its outskirts
49.	*Streptopelia turtur*	L	Ch, PCzL, BD	+	20–40 p	4, 6, 7, **11**, 12, 13, 14	nests in dispersion on whole BPF area
50.	*Cuculus canorus*	L	Ch	+	+	11, 13	numerous species on whole BPF area and on its outskirts
51.	*Strix aluco*	L	Ch	+	+	3, 4, 6, 7, 11, 12, 13	nests mainly in regions with preserved older forest stands
52.	*Glaucidium passerinum*	M	Ch (s), PCzL, PCzK, **BD**	+		12	species observed for the first time in BPF in 2012, its nesting is possible
53.	*Asio otus*	M	Ch	+		2, 4, 7	species once breeding in BPF; its breeding was not confirmed during comprehensive inventory in 2011; however, it is unlikely for this species to stop nesting here
54.	*Apus apus*	L	Ch		+	3, 4, 7, 11, 13	nests mainly close to buildings in clearings and at the outskirts of BPF

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
55.	*Caprimulgus europaeus*	L	Ch	+	+	6, 7, 9, 10, 11, 13	nests close to young pine forest stands and in clear cut areas as well as in their vicinity
56.	*Alcedo atthis*	L	Ch, **BD**		+	3, 4, 5, 7, 9, 10, 14	Nests on banks of larger watercourses, mainly in eastern part of BPF
57.	*Upupa epops*	D	Ch, BD			3, 4, 7	in the 1980s and 90s, this species was nesting on clearings and at the outskirts of BPF
58.	*Jynx torquilla*	L	Ch		+	2, 4, 7, 11, 13	nests mainly at the outskirts of BPF
59.	*Picus canus*	L	Ch, **BD**	+	5–10 p	5, 9, 10, **11**, 14	nests mainly in eastern part of BPF
60.	*Dryocopus martius*	L	Ch, **BD**	+	50–80 p	3, 4, 6, 7, 8, 9, 10, **11**, 12, 13, 14	nests mainly in regions with preserved older forest stands
61.	*Dendrocopos major*	L	Ch	+	1.3–2.,5 p/10 ha	**13**	most numerous woodpecker in BPF
62.	*Dendrocopos medius*	L	Ch, **BD**	+	230-310 p	**11,** 12, 13, 14	in here nest close to 2% of its nationwide breeding population; BPF is one of the most important sanctuaries of this species in Poland
63.	*Dendrocopos leucotos*	L	Ch, PCzK, PCzL, **BD**	+	12-18 p	3, 4, 5, 6, 7, 9, 10, **11**, 12, 13, 14	in here nest close to 3% of its nationwide breeding population; BPF is one of the most important sanctuaries of this species in Poland

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
64.	*Dendrocopos minor*	L	Ch	+	60–120 p	**11**, 13	this species occurs both in the forest interior and at its outskirts
65.	*Picoides tridactylus*	L	Ch, PCzK, PCzL, **BD**	+	1–5 p	5, 9, 10, **11**, 13, 14	valuable species, connected with natural forests, registered for the first time in BPF in the 1990s
66.	*Lullula arborea*	L	Ch, **BD**	+	15–20 p	2, 4, 7, 9, 10, **11**, 13	nests mainly close to coniferous forest stands and in clear cut areas
67.	*Alauda arvensis*	L	Ch, BD		+	3, 4, 7, 11, 13	nests in clearings and at the outskirts of BPF
68.	*Riparia riparia*	D	Ch			2, 4, 7	in the 1980s and 90s, this species was nesting sparsely in small gravel-pits at the outskirts of the BPF area
69.	*Hirundo rustica*	L	Ch		+	3, 4, 7, 11, 13	nests within human settlements on clearings of BPF and at its its outskirts
70.	*Delichon urbicum*	L	Ch		+	3, 4, 7, 11, 13	nests within human settlements in clearings of BPF and at its outskirts
71.	*Anthus trivialis*	L	Ch	+	+	11, 13	nests mainly close to coniferous forest stands
72.	*Anthus pratensis*	L	Ch		+	1, 4, 7, 11, 13	nests in clearings in BPF and at its outskirts
73.	*Oenanthe oenanthe*	L	Ch		+	1, 3, 4, 7, 11, 13	nest s in clear cut areas and at the outskirts of BPF

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
74.	*Motacilla flava*	L	Ch		+	3, 4, 7, 11, 13	this species nests mainly at the outskirts of BPF
75.	*Motacilla alba*	L	Ch		+	3, 4, 7, 11, 13	nests in clearings and along wider roads
76.	*Troglodytes troglodytes*	L	Ch	+	3.4–5.8 p/10 ha	**13**	one of the most numerous breeding species in BPF
77.	*Prunella modularis*	L	Ch	+	0.6–3.3 p/10 ha	**13**	one of the most numerous breeding species in BPF
78.	*Erithacus rubecula*	L	Ch	+	5.5–10.0 p/10 ha	13	second in terms of numbers (next to finch) breeding species in BPF
79.	*Luscinia luscinia*	L	Ch		+	3, 4, 7, 11, 13	species nests in clearings and at the outskirts of BPF
80.	*Luscinia svecica*	L	Ch, PCzK, PCzL, **BD**		5 p	5, 13, **14**	species nests in clearings and at the outskirts of BPF
81.	*Phoenicurus ochruros*	L	Ch		+	3, 4, 7, 11, 13	nests in human settlements on clearings and at the outskirts of BPF
82.	*Phoenicurus phoenicurus*	L	Ch	+	+	3, 4, 7, 11, 13	nests mainly in human settlements in clearings and at the outskirts of BPF, less frequently in the forest interior
83.	*Saxicola rubetra*	L	Ch		+	3, 4, 7, 11, 13	nests on clearings of BPF and at its outskirts
84.	*Saxicola rubicola*	M	Ch		+	13	occurrence of this species on the border of BPF was stated for the first time in 2013

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
85.	*Turdus merula*	L	Ch, BD	+	2.4–4.2 p/10 ha	**13**	one of the most numerous breeding species in BPF
86.	*Turdus pilaris*	L	Ch, BD		+	3, 4, 7, 11, 13	nests mainly at the outskirts of BPF
87.	*Turdus philomelos*	L	Ch, BD	+	3.1–6.7 p/10 ha	**13**	one of the most numerous breeding species in BPF
88.	*Turdus iliacus*	L	Ch, BD	+	+	3, 4, 5, 6, 7, 11, 12, 13	nests mainly in swamp forests and close to midforest bogs
89.	*Turdus viscivorus*	L	Ch, BD	+	+	11, 12, 13	nests in dispersion on whole BPF area
90.	*Locustella naevia*	L	Ch		+	1, 4, 7, 11, 13	nests mainly on the border of BPF, less frequently in the forest interior
91.	*Locustella fluviatilis*	L	Ch		+	1, 4, 7, 11	nests mainly at the outskirts of BPF
92.	*Locustella luscinioides*	L	Ch		+	3, 4, 7, 11	nests mainly at the outskirts of BPF
93.	*Acrocephalus schoenobaenus*	L	Ch		+	1, 4, 7, 11, 13	nests mainly at the outskirts of BPF
94.	*Acrocephalus palustris*	L	Ch		+	1, 4, 7, 11, 13	nests mainly at the outskirts of BPF
95.	*Acrocephalus scirpaceus*	L	Ch		+	1, 4, 7, 11	nests in the reeds around lakes and ponds in the eastern part of BPF
96.	*Acrocephalus arundinaceus*	L	Ch		+	3, 4, 7, 11	nests in the reeds around lakes and ponds in the eastern part of BPF
97.	*Hippolais icterina*	L	Ch		+	11, 13	nests mainly on the border of BPF, less frequently in the forest interior

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
98.	*Sylvia nisoria*	L	Ch, **BD**		10–20 p	2, 4, 7, **11**, 14	nests mainly in clearings and at the outskirts of BPF
99.	*Sylvia curruca*	L	Ch		+	2, 4, 7, 11, 13	nests mainly in clearings and at the outskirts of BPF
100.	*Sylvia communis*	L	Ch		+	3, 4, 7, 11, 13	nests mainly in clearings and at the outskirts of BPF
101.	*Sylvia borin*	L	Ch	+	+	3, 4, 7, 11, 13	nests mainly on the border of BPF, less frequently in the forest
102.	*Sylvia atricapilla*	L	Ch	+	4.8–5.7 p/10 ha	**13**	one of the most numerous breeding species in BPF
103.	*Phylloscopus sibilatrix*	L	Ch	+	0.8–3.1 p/10 ha	13	one of the most numerous breeding species in BPF
104.	*Phylloscopus collybita*	L	Ch	+	1.7–4.2 p/10 ha	**13**	one of the most numerous breeding species in BPF
105.	*Phylloscopus trochilus*	L	Ch	+	0.6–3.3 p/10 ha	**13**	one of the most numerous breeding species in BPF
106.	*Regulus regulus*	L	Ch	+	1.9–4.1 p/10 ha	**13**	one of the most numerous breeding species in BPF
107.	*Regulus ignicapilla*	L	Ch	+	0.6–1.4 p/10 ha	**13**	occurrs mainly in forest stands with spruce domination
108.	*Muscicapa striata*	L	Ch	+	1.3–5.0 p/10 ha	13	one of the most numerous breeding species in BPF
109.	*Ficedula parva*	L	Ch, **BD**	+	250–500 p	3, 4, 6, 7, 8, 9, 10, **11,** 12, 13, 14	in here nests over 1% of its nationwide breeding population, BPF is an important sanctuary of this species in Poland

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
110.	*Ficedula albicollis*	L	Ch, **BD**	+	150–170 p	3, 4, 5, 6, 7, 8, 9, 10, **11,** 12, 13, 14	in here nests around 2% of its nationwide breeding population; BPF is one of main national sanctuaries of this species
111.	*Ficedula hypoleuca*	L	Ch	+	1.7–5.,0 p/10 ha	**13**	one of the most numerous breeding species in BPF
112.	*Aegithalos caudatus*	L	Ch	+	+	13	nests most willingly in forest stands with birch
113.	*Poecile palustris*	L	Ch	+	1.6–2.5 p/10 ha	13	one of the most numerous breeding species in BPF
114.	*Poecile montanus*	L	Ch	+	0.9–1.4 p/10 ha	**13**	one of the most numerous breeding species in BPF
115.	*Periparus ater*	L	Ch	+	+	12, 13	nests mainly in dense coniferous forest stands
116.	*Lophophanes cristatus*	L	Ch	+	+	8, 11	nests mainly in dense coniferous forest stands
117.	*Parus major*	L	Ch	+	4.7–6.7 p/10 ha	**13**	one of the most numerous breeding species in BPF
118.	*Cyanistes caeruleus*	L	Ch	+	3.1–6.7 p/10 ha	13	one of the most numerous breeding species in BPF
119.	*Sitta europaea*	L	Ch	+	2.1–5.0 p/10 ha	**13**	one of the most numerous breeding species in BPF
120.	*Certhia familiaris*	L	Ch	+	2.8–5.0 p/10 ha	**13**	one of the most numerous breeding species in BPF

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
121.	*Remiz pendulinus*	M	Ch			1, 4, 5, 7	species once breeding in clearings and at the outskirts of BPF; in recent years, its nesting was not confirmed but possible
122.	*Oriolus oriolus*	L	Ch	+	+	13	this species nests both in the forest interior and at its outskirts
123.	*Lanius collurio*	L	Ch, **BD**		200–300 p	3, 4, 7, 9, 10, **11**, 13, 14	nests mainly in clearings, clear cut areas and at the outskirts of on BPF'
124.	*Lanius excubitor*	L	Ch		+	1, 4, 7, 11	nests mainly in clearings in BPF and at its outskirts
125.	*Garrulus glandarius*	L	Ch	+	+	13	this species nests both in the forest interior and at its outskirts
126.	*Pica pica*	L	(Ch)		+	3, 4, 7, 11, 13	nests on clearings and at BPF's outskirts
127.	*Nucifraga caryocatactes*	L	Ch, **BD**	+	+	3, 4, 5, 7, 11, **13**	nests in dispersion on whole BPF area
128.	*Corvus monedula*	L	Ch		+	3, 4, 5, 7, 11, 13	nests colonially close to settlements situated in clearings and at the outskirts of BPF
129.	*Corvus cornix*	L	(Ch)		+	3, 4, 7, 11, 13	nests in clearings and at the BPF's outskirts
130.	*Corvus corax*	L	(Ch)		+	3, 4, 7, 11, 12, 13	this species nests both in the forest interior and at its outskirts
131.	*Sturnus vulgaris*	L	Ch		+	3, 4, 7, 11, 13	nests mainly at the outskirts of BPF, less frequently in the forest interior

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
132.	*Passer domesticus*	L	Ch		+	3, 4, 7, 11	nests in clearings close to buildings
133.	*Passer montanus*	L	Ch		+	1, 4, 7, 11, 13	nests in clearings and at the outskirts of BPF, often close to buildings
134.	*Fringilla coelebs*	L	Ch	+	15.0–20.0 p/10 ha	**13**	the most common breeding species in BPF, dominating in numbers in various types of forest stands
135.	*Serinus serinus*	L	Ch		+	6, 7, 11	nests mainly in clearings and at the outskirts of BPF
136.	*Carduelis chloris*	L	Ch		+	2, 4, 7, 11, 13	nests mainly at the outskirts of BPF
137.	*Carduelis carduelis*	L	Ch		+	3, 4, 7, 11, 13	nests mainly at the outskirts of BPF
138.	*Carduelis spinus*	L	Ch	+	+	11, 12	nests mainly on area with dominance of coniferous forest stands
139.	*Carduelis cannabina*	L	Ch		+	1, 4, 7, 11, 13	gniazduje głównie na obrzeżu Puszczy/ nests mainly at the outskirts of BPF
140.	*Loxia curvirostra*	M	Ch	+		2, 4, 7, 11	species observed occasionally in BPF during breeding season; its nesting is possible
141.	*Carpodacus erythrinus*	L	Ch		+	1, 4, 7, 11, 13	nests mainly at the outskirts of BPF and in forest clearings
142.	*Pyrrhula pyrrhula*	L	Ch	+	+	3, 4, 6, 7, 11, 12	sparse breeding species in BPF
143.	*Coccothraustes coccothraustes*	L	Ch	+	2.8–6.3 p/10 ha	**13**	one of the most numerous breeding species in BPF

No.	Species	Breeding status[1]	Conservation status[2]	Typical forest species[3]	Current number/density of breeding population[4]	Sources of data on number/breeding status of species[5]	Comments[6]
144.	*Emberiza citrinella*	L	Ch		+	3, 4, 6, 7, 13	nests on the outskirts, in clearings and clear cut areas in BPF and sparsely in forest interior
145.	*Emberiza schoeniclus*	L	Ch		+	3, 4, 7, 11, 13	nests in reeds on the shores of lakes and ponds, mainly in the eastern part of BPF

BPF: The Borki Primeval Forest

[1] L – breeding species; M – breeding possible; D – species breeding in the past. Bold type marks the species whose breeding population in the Borki Primeval Forest constitutes at least 1% of nationwide breeding population.

[2] Ch – strict protection; (Ch) – partial protection; (s) – protected species with obligatory protection zone; Ł – hunted species; PCzK – Polish Red Data Book species (Głowaciński 2001); PCzL – Polish Red Data List species (Głowaciński 2002), BD – Species protected according to the Birds Directive; bold type marks the special protected species included into Appendix I of the Birds Directive.

[3] Bold type marks forest species associated with forests of high naturalness (according to Zawadzka and Zawadzki 2006).

[4] Data concerning numbers and densities in years 2010–2013. The range of breeding population number refer to the estimated data; 'p' number of breeding pairs, 'm' males. In case of numerous species, estimated densities refer to the year 2013. The species is breeding in the Borki Primeval Forest, but no population number assesment is available .

[5] 1 – Gromadzki i Jezierski 1984; 2 – Gromadzki i Przystupa 1987; 3 – Rąkowski i Szańkowski 1990; 4 – Siuta et al. 1994; 5 – Gromadzki et al. 1994; 6 – Rąkowski i Czarnocki 1997; 7 – Rąkowski 1998; 8 – Czarnocki i Rąkowski 2000; 9 – Sidło et al. 2004; 10 – Wilk et al. 2010; 11 – Sikora et al. 2011; 12 – Rąkowski et al. 2012; 13 – Rąkowski et al. 2013; 14 – SDF 2013. In case of common species, only the most recent sources of data on their number were used. Bold type marks the source of most recent data on breeding population number.

[6] BPF – The Borki Primeval Forest

As results from Table 1, nesting of 145 species was recorded in the Borki Primeval Forest in the years 1984–2013. Currently, the breeding avifauna of the Borki Forest consists of 139 species, including seven species, whose nesting was not confirmed, but is possible. In general, among 139 breeding species occurring in the Forest, 128 are under strict protection (including seven species, for which there is an obligation of establishing the protection zones), three species are under partial protection and eight species are game.

Among breeding avifauna of the Borki Primeval Forest there are 32 rare species (23%), in that number those included in the Polish Red Data Book of Animals (Głowaciński 2001), Red List of Threatened Animals in Poland (Głowaciński 2002) and those listed in Annex I of the Birds Directive (Gromadzki 2004). To the most valuable components of the Borki Primeval Forest's avifauna there belong 11 threatened species listed in the Polish Red Data Book, including: bittern, black kite, red kite, white-tailed eagle, lesser spotted eagle, osprey, little crake, pygmy owl, white-backed woodpecker, three-toed woodpecker and bluethroat.

Population numbers of 12 species indicatory of international ornithological value of the Borki Primeval Forest constitute at least 1% of their nationwide breeding populations. This group of birds embraces: black stork, common goldeneye, hazel grouse, honey buzzard, lesser spotted eagle, osprey, common crane, green sandpiper, white-backed woodpecker, middle spotted woodpecker, red-breasted flycatcher and collared flycatcher. For seven of those species, and namely: osprey, green sandpiper, white-backed woodpecker, middle spotted woodpecker, common goldeneye, hazel grouse and collared flycatcher, the Borki Primeval Forest is one of the main breeding sanctuaries in the country. Common crane population occurs here with an exceptionally high density (Stawarczyk and Tomiałojć 2003; Sikora et al. 2007; Wilk et al. 2010; Sikora et al. 2011; SDF 2013).

The majority of bird species recorded in the Borki Primeval Forest are associated with forest ecosystems. 66 birds are typically forest interior species while the remaining ones are associated with bogs and lakes, swamps and bushes, open and semi-open areas in clearings and at the edges of the Borki

Primeval Forest. The latter group covers also synanthropic species observed close to human settlements. It is worth noting that among the typical forest species nesting here as many as 24 out of 28 species were recognised by Zawadzka and Zawadzki (2006) as the species associated with the natural forests and thus indicative of a high biological diversity of forest ecosystems. To such species belong, first of all, the hole-nesting species such as woodpeckers: black, grey-headed, white-backed and three-toed and also flycatchers: red-breasted and collared. This proves that the degree of naturalness of forest ecosystems in the Borki Primeval Forest, characterised by large quantity of dead wood and large number of hollow-bearing trees in forest stands, is relatively high.

By comparing species composition of breeding avifauna of the Borki Primeval Forest in the 1980s and 90s (Rąkowski and Szańkowski 1990; Siuta et al. 1994; Rąkowski 1998) with the current data (Wilk et al. 2010; Sikora et. al. 2011; Rąkowski et. al. 2013; SDF 2013), it is evident that some species ceased to nest in the Borki Forest, though they were formerly recorded here as breeding species, including: common pochard (*Aythya ferina*), tufted duck (*Aythya fuligula*), ferruginous duck (*Aythya nyroca*), common sandpiper (*Actitis hypoleucos*), sand martin (*Riparia riparia*) and hoopoe (*Upupa epops*). A reason underlying the disappearance of species related to aquatic habitats may be abandoning of fish pond management and drying of some ponds mainly in the eastern part of the Borki Primeval Forest. The absence of sand martin is probably due to the removal of small gravel pits that once were present in the Borki Primeval Forest and were used as breeding sites by this species. The absence of hoopoe is probably connected with the reduction of open spaces in the forest openings and clearings resulting from natural succession on the abandoned meadows and fields.

The new elements of breeding avifauna of the Borki Primeval Forest, not recorded in the last decades of the 20th century and occurring presently include: three-toed woodpecker, pygmy owl, common quail, bluethroat and the European stonechat. The presence of the first two of the above-listed species can be linked with the increase of the area of habitats suitable for these species, including older forest stands with hollow-bearing trees. Also, it may be possible that these species could not be detected during earlier inventories due to their low population numbers. The remaining three species are mainly associated with semi-open areas at the outskirts of the Borki Primeval Forest, and it is possible that during earlier research, they were not detected because of insufficiently accurate penetration of ecotone habitats fringing the Forest borders.

Summary

The ornithological research conducted in the Borki Primeval Forest over the last 30 years revealed the presence of an exceptionally rich avifauna. The Borki Primeval Forest is one of the most valuable sanctuaries of forest birds in Poland. Despite its small area, intense forest management and dominance of forest stands of lower age classes, its value as a bird sanctuary, can be compared with many much larger forest complexes (Wilk et al. 2010; Sikora et al. 2011).

The most important factors determining exceptional ornithological value of the Borki Primeval Forest are:

1) occurrence of 139 breeding species, which constitute about 60% of all breeding bird species in Poland;

2) presence of 32 threatened and rare nesting species, which constitute nearly one-fourth of all species nesting in the Borki Primeval Forest, including 11 species from the Polish Red Data Book of Animals (Głowaciński 2001) and 30 species listed in Annex I to Directive 1009/147/WE (Birds Directive);

3) occurrence of 12 species, the breeding population of which in the Borki Primeval Forest covers at least 1% of their nationwide breeding population, while most of the species are considered as rare on the country scale;

4) importance of the Borki Primeval Forest as one of the most valuable national breeding sites for seven rare species, including: white-backed woodpecker, osprey, green sandpiper, middle spotted woodpecker, common goldeneye, hazel grouse and collared flycatcher,

5) nesting of 24 out of 28 country's species considered as typical for natural forests the occurrence of which testifies to a high degree of forest stands naturalness, sufficient supply of dead wood and a high biological diversity of the forest complex.

There are several reasons why the Borki Forests represent such high ornithological values. One of the most important factors conditioning the diversity of local avifauna is varied postglacial landscape. The large spectrum of landscape forms is reflected in the large variety of different habitats located next to each other within a relatively small area. Another factor supporting the richness of avifauna is a large number of forest and open wetlands, which constitute jointly about 25% of the Borki Primeval Forest area. Numerous midforest water reservoirs of different sizes of both natural (lakes) and artificial (ponds) origin, as well as small reservoirs resulting from beaver activity create conditions for the occurrence of aquatic and wetland bird species that enriches this region's avifauna.

Another factor distinguishing the Borki Primeval Forest from other large lowland forest complexes in Poland where the poor coniferous forest habitats dominate, is a relatively high fertility of local forest habitats. In the Borki Forests there prevail multispecies stands of oak- hornbeam forests providing abundance of niches which support a great diversity of avifauna.

A very important factor is also a considerable accordance of the local forest plant communities with potential habitat fertility (Chabros et al. 1990), which causes the local forests to be similar in characteristics to natural forest and is reflected in the presence of many valuable bird species. Also di-

versified spatial and age structure of forest stands, which are influenced by both natural factors (mosaic landscape with significant height difference) and forest mangement, are supporting the diversity and richness of avifauna. A significant factor conditioning the presence of rich avifauna is also a low anthropopression in the Borki Primeval Forest area. It is is due to a low population density, lack of larger settlements, as well as a relatively low tourist traffic. The latter results from the lack of tourist infrastructure and difficult accessibility of many areas within the Primeval Forest.

Conflict of interest

None declared.

Acknowledgement and financial support

The author would like to express his gratitude to Dr Jadwiga Sienkiewicz for her tremendous help in preparation of this article.

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Translated by: Anna Wyszyńska