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Ecological and Fishery Characteristics of Lakes Situated in the Future Western Polesie National Park

Ekologiczna i rybacka waloryzacja jezior znajdujących się na terenie projektowanego Zachodniopoleskiego Parku Narodowego

Экологическая и рыбацкая оценка озер, расположенных на территории планируемого Западнополесского национального парка

INTRODUCTION

The Łęczna-Włodawa lake district is a unique region with regard to nature with the physiographical elements mingling with those of Poland's Uplands. The lake district possesses the greatest complex of lakes beyond regions of the last glaciation (25). It extends between the rivers Tyśmienica, the right bank tributary of the river Wieprz and the river Bug and covers a vast lowland area of barely 155—165 m above sea level (1). At present, there are 66 lakes within the area of these two watersheds which exceed 1 ha. In the Wieprz river basin there are 43 lakes and 23 lakes in that of the river Bug (2). Most of the lakes have no natural tributaries and outlets. Some of them, however, are connected with the irrigation system of the Wieprz-Krzna Canal and serve temporarily as storage reservoirs (22).

The specific character of the Łęczna-Włodawa lake district is emphasized by considerable limnological differentiation of its lakes, and in some of them separated only by a short distance, one finds quite different trophy. Moreover, it is characteristic that they are not very deep and large, since only 7 lakes reach the maximum depth of barely 15 m and the area of only 5 lakes exceeds 100 ha (9, 18). 20 lakes out of all situated in the Wieprz drainage area are known for their natural beauty, and will soon become part of the Western Polesie National Park. There are only 3 lakes with the maximum depth more than 20 m (Piaseczno, Zagłębocze and Rogóźno) and 2 lakes (Uściwierz and Wytyckie), the area of which exceeds 100 ha.

Complex hydrobiological examinations were carried out in the spring of 1985

to analyse the lakes of the future National Park from the ecological and fishing point of view. The results were compared with those obtained in the years 1966—1969 and 1971—1975 in the spring season. Fishing usefulness and ecological value of these lakes with the direction of changes occurring in their biocenosis were analysed on the basis of studies conducted for many years.

Methods commonly used in limnology were used in collecting and analysing both chemical and biological materials.

The results were presented in the units accepted by the SI system.

GENERAL HYDROCHEMICAL CHARACTERISTICS

Physical and chemical properties of the lakes were changing in time and depended on the genesis and extent of the ecological degradation of the reservoir. Two important physical properties of water that is electrolytic conductivity and visibility underwent the greatest changes; this also referred to the chemical components: general oxygenation and calcium. Their values were clearly correlated with the trophic character of the lake.

Electrolytic conductivity ranged from 48.0—96.0 $\mu S - cm^{-1}$ in lakes Brzeziczno and Piaseczno to 820.0—909.0 $\mu S - cm^{-1}$ in lakes Sumin and Zienkowskie. Visibility ranged from 0.60 m in lake Łukie to 6.40 m in lake Zagłębocze reaching its highest values in deep lakes and its lowest values in shallow and very trophic lakes (Table 1) Total oxydability was differentiated and its values were clearly dependant on how clean the lake was. In the polluted lakes (Cycowe, Zienkowskie) it reached the values up to 56.0 mg O_2/dm^3, but in slightly polluted lakes (Uściwierz, Rotcze, Rogóźno, Piaseczno and others) its factor ranged from 4.9 to 18.4 mg O_2/dm^3 (Table 1).

Table 1. Groups of lakes in the future Western Polesie National Park

Feature / Lake	Surface ha	Depth max m	Visibility m	Conductivity $\mu S-cm^{-1}$	Calcium $mgCa/dm^3$	Oxydability mgO_2/dm^3
Piaseczno	84.7	38.80	4.70—5.60	72.0—80.0	1.1—7.0	4.9—7.2
Rogóźno	57.1	25.40	3.00—5.00	568.0—575.0	29.8—42.9	12.7—16.8
Zagłębocze	59.0	23.30	4.00—6.40	454.0—476.0	24.0—32.5	12.1—16.0
Bikcze	85.0	3.30	1.00—2.30	158.0—159.0	10.8—12.7	11.6—14.2
Brzeziczno	7.5	2.54	1.60—2.50	48.0—96.0	2.9—3.6	28.5—30.4
Ciesacin	8.0	2.40	1.70—2.00	413.0	24.4—27.2	13.0—30.4
Długie	31.5	—	1.40	—	21.8—23.4	13.7—14.1
Moszne	17.5	1.0	1.00	—	25.6—32.2	19.4—19.6
Nadrybie	46.8	1.95	1.95	—	16.0—20.4	12.2—12.3
Płotycze	14.0	3.40	1.28—2.00	—	29.2—31.0	13.4—13.9
Rotcze	42.7	4.30	1.00—1.80	518.0—575.0	32.6—40.5	11.9—31.2
Uściwierz	284.1	6.60	1.10—1.70	685.0	22.4—50.1	9.7—18.4
Uściwierzek	8.0	1.80	1.80	—	—	—
Cycowe	11.3	4.10	0.90—1.07	—	46.0	55.9
Gumienko	6.5	4.40	0.70—0.98	—	21.4—41.2	29.8—31.8
Łukie	150.1	6.50	0.60—2.25	529.0	41.4—73.7	15.8—24.0
Sumin	91.5	6.5	0.30—1.47	909.0	23.0—37.7	16.0—44.0
Wytyckie	550.0	3.40	0.70—1.10	769.0	45.4—69.3	22.1—37.6
Zienkowskie	7.6	4.90	0.30—1.25	758.0—820.0	50.4—65.3	33.6—56.0

Calcium was the only mineral element which showed the greatest differentiation. Its extreme values ranged from 1.1 mg Ca/dm³ in lake Piaseczno to 69.3 mg Ca/dm³ in lake Wytyckie (Table 1). This high differentiation in calcium content in the examined lakes is probably connected with the topographic situation of the lakes and intensity of biological changes occurring in them (21).

Thermal-oxygen conditions playing an important role in the hydrochemical characteristics of waters varied and depended on the maximum depth of lakes. In shallow lakes with the maximum depth not exceeding 10 m the differences in the absolute values of temperature and oxygen were slight between the surface and bottom layers of water. However, in deep lakes (more than 20 m) in the period of summer stagnation a clear thermal and oxygen stratification took place. At that time, temperature differences between the surface and the bottom were from 6 to 19°C and oxygen content ranged from 1.7 to 9.8 mg O_2/dm³. Taking into consideration the criteria of stability, most of the lakes examined may be regarded as polymictic and only 3 deep lakes as holomictic.

The remaining chemical compounds reached relatively low values and, occasionally, showed slight differentiation and were not much different from the values in lakes of other regions (20, 21).

On the basis of the statistical analysis of the physico-chemical factors exhibiting the greatest changes, the lakes situated within the future Western Polesie National Park can be divided into three distinct groups of lakes (Table 1).

1. Lakes of high visibility (3.0—6.4 m), low or average electrolytic conductivity (72.0—575.0 $\mu S - cm^{-1}$), low or average calcium level (4.9—16.0 mg/dm³), and well developed thermal and oxygen summer stratification. Lakes: Piaseczno, Rogóźno and Zagłębocze belong to this group.

2. Lakes of average visibility (1.0—2.0 m), low or average conductivity (48.0—685.0 $\mu S - cm^{-1}$), low or aevrage calcium content (2.0—50.1 mg Ca/dm³), average or fairly high oxydability (9.7—31.2 mg O_2/dm³), barely visible thermal stratification and rare oxygen stratification. They are the following lakes: Bikcze, Brzeziczno, Ciesacin, Długie, Moszne, Nadrybie, Płotycze, Rotcze, Uściwierz, Uściwierzek. The last two lakes constitute a transition to the third group of lakes.

3. Lakes of changing visibility, often below 1 m, high electrolytic conductivity (529—909 $\mu S - cm^{-1}$), average or fairly high calcium content (21.4—75.7 mg Ca/dm³), and total summer thermal-oxygen balance. Lakes: Cycowe, Gumienko, Łukie, Sumin, Wytyckie and Zienkowskie belong to this group.

Two lakes: Karaśne and Wąskie which were more and more grown over by plants in the years 1966—1969 disappeared completely. Two other lakes Długie and Uściwierzek from the second group are going through a stage of overgrowing by plants (there is no pelagic zone).

FAUNISTIC-ECOLOGICAL CHARACTERISTICS

475 taxons of water animals have been found to occur in the lakes of the future Western-Polesie National Park. These hydrobionts belong to three fundamental ecological formations: zooplankton — 265 species (175 taxons of rotifers, 58 taxons of cladocerns and 28 taxons of copepods), zoobenthos — 189 species (69 taxons of *Chironomidae*, 89 taxons of *Hydracarina*, 1 *Decapoda* species and 8 species of *Hirudinea*) and necton (*Pisces*)

Table 2. Rare and new species in Polish fauna

Species \ Lake	Piaseczno	Zagłębocze	Rogóźno	Rotcze	Zienkowskie	Cycowe	Sumin	Bikcze	Łukie	Uściwierz	Wytyckie	Nadrybie	Płotycze	Gumienko	Uściwierzek	Długie	Moszne	Ciesacin	Brzeziczno
Rotatoria																			
Brachionus bennini Leissling																			+
Cephalodella megalotrocha Wiszn.					×														
Cephalodella reimanni Donner	+									+									
Collotheca annulata (Hood)																			
Collotheca calva (Hudson)														×					
Keratella hiemalis Carlin	+	+	+																
Keratella paludosa (Lucks)					+														
Lecane signifera ploenensis (Voigt)																			+
Lecane stichaea Harring	+														×				
Lecane subtilis Harring et Myers																			+
Lepadella vitrea (Sephard)													+		+				
Monommata grandis Tess.																			
Monostyla ivli Wiszn.					×														
Proales falliaciosa Wulfert												+							
Testudinella incisa (Tornetz)															×			+	
Trichocerca gracilis (Tess.)						+													
Trichocerca insignis (Herrick)						+						+							
Trichocerca mus Hauer																			
Trichotria tetractis paupera (Ehrenberg)																	×		
Cladocera																			
Bunops serricaudata (Doday)									+									+	
Ceriodaphnia rotunda G. O. Sars									+										
Ceriodaphnia setosa Matile																			
Drepanothrix dentata (Euren)																			
Holopedum gibberum Zaddach	+																		+

Hydracarina																			
Arrenurus compactus Piers.	+																	+	
Arrenurus crenatus Koen.	+	+					+												
Arrenurus fimbriatus Koen.	+																+		
Arrenurus nobilis Neum.	+																		
Arrenurus perforatus George	+	+																	
Arrenurus pugionifer Koen.	+					+													
Arrenurus stjoerdalensis Thor.	×																		
Arrenurus subarcticus Ldbl.	×																		
Axonopsis complanata (Müll.)	+																		
Eylais infundibulifera Koen.	+														+				
Eylais mutila Koen.																		+	
Forelia brevipes (Neum.)	×					+	×											×	
Hydrachna piersigi Koen.																		+	
Hydryphantes crassipalpis Koen.															+				
Oxus longisetus (Berl.)	+	+				+			+										
Pionacercus uncinatus (Koen.)							+											+	
Chironomidae																			
Parachironomus vitiosus Goetgh.	+																		
Chironomus f.l. salinarius Kieff.	+																		
Cricotopus brevipalpis Kieff.	+																		
Guttipelopia guttipennis (V. d. Wulp)	+																		
Pagastiella orophila Edw.	+			+			+				+						+		
Parakiefferiella bathophila Kieff.	×																		
Paratendipes transcaucasicus Tshern.	+																		
Paratrichocladius triquetra Tshern.	×																		
Potthastia campestris (Edw.)	+																		
Psectrocladius bisetus Goetgh.	+																		
Stictochironomus connectens nr 2 Lip.	+			×															
Total of species	23	2	3	1	4	1	3	3	3	1	1	2	1	3	3	2	1	3	8

× — new species in Polish fauna.
\+ — rare species.

Table 3. Trophy indicating species in the lakes of the future Western Polesie National Park

Species \ Lake	Piaseczno	Zaglębocze	Rogóźno	Rotcze	Zienkowskie	Cycowe	Sumin	Bikcze	Łukie	Uściwierz	Wytyckie	Nadrybie	Płotycze	Gumienko	Uściwierzek	Długie	Moszne	Ciesacin	Brzeziczno
I. MESOTROPHY INDICATORS																			
Rotatoria																			
Chromogaster ovalis (Bergendel)	+	+	+																
Chromogaster testudo (Lauterborn)	+	+	+											+					
Conochilus unicornis Rousselet	+	+	+					+				+		+					+
Kellicottia longispina (Kellicott)	+	+	+	+			+	+			+						+		
Keratella hiemalis Carlin	+	+	+																
Cladocera																			
Alona affinis (Leydig)		+	+	+	+		+	+		+	+			+		+	+	+	
Alonopsis elongata G. O. Sars	+	+	+						+	+		+					+		
Holopedium gibberum Zaddach	+																		+
Leptodora kindtii (Foecke)	+	+	+			+			+	+	+								
Pleuroxus aduncus (Jurine)				+		+	+		+			+					+		
Pleuroxus uncinatus Baird					+	+			+		+								
Rhynchotalona falcata (G. O. Sars)	+	+		+			+				+								
Hydracarina																			
Arrenurus nobilis Neum	+																		
Arrenurus pustulator (Müll.)	+		+													+	+		
Arrenurus stjoerdalensis Thor	+																		
Arrenurus subarcticus Ldbl.	+																		
Chironomidae																			
Chironomus f.l. *bathophilus* Kieff.	+																		
Chironomus f.l. *salinarius* Kieff.	+															+			
Pagastiella orophila Edw.	+																		
Parakiefferiella bathophila Kieff.	+																		
Paratrichocladius triquetra (Tshern.)	+																		
Sergentia ex gr. *coracina* (Zett.)	+																		
Total bioindicators	19	9	9	4	2	3	4	3	4	3	5	3	—	3	—	3	5	1	2

II. EUTROPHY INDICATORS																			
Rotatoria																			
Anuraeopsis fissa (Gosse)				+	+	+				+		+	+		+	+		+	
Brachionus angularis Gosse					+	+	+	+											
Brachionus diversicornis (Daday)						+								+					
Filinia longiseta (Ehrenberg)					+	+	+	+		+		+	+		+	+			
Keratella cochlearis tecta Gosse	+	+	+	+	+	+	+	+	+	+		+	+		+	+			
Keratella quadrata Müll.		+	+	+	+	+	+	+	+	+	+	+	+		+			+	
Pompholyx sulcata Hudson	+	+	+	+	+	+	+	+	+	+	+	+	+						
Trichocerca pusilla (Jennings)						+						+	+		+				
Trichocerca similis (Wierz.)	+	+				+	+		+	+		+			+	+			
Diptera																			
Chaoborus flavicans (Meig.)	+	+	+	+	+	+	+					+					+	+	
Einfeldia ex gr. *carbonaria* Meig.								+	+	+	+	+	+					+	
Stictochironomus ex gr. *histrio* F.				+															
Total bioindicators	4	5	4	6	7	10	7	6	5	5	5	3	9	8	—	6	4	1	4
III. DYSTROPHY INDICATORS																			
Rotatoria																			
Conochilus unicornis Rousselet	+	+	+					+				+		+					+
Gastropus stylifer Imhof	+				+	+	+	+	+	+	+		+	+		+	+	+	+
Kellicotia longispina (Kellicott)	+	+	+	+			+	+			+						+		
Hydracarina																			
Arrenurus neumani Piers.																		+	
Arrenurus pustulator (Müll.)	+		+													+	+		
Limnochares aquatica (L.)		+	+						+				+			+		+	+
Diptera																			
Chaoborus flavicans (Meig.)	+	+	+	+	+	+	+						+					+	+
Cryptochironomus ex gr. *viridulus* (Fabr.)	+		+						+	+		+	+	+			+		+
Total bioindicators	6	4	6	2	2	2	3	3	3	2	2	2	4	3	—	3	4	4	5

— 20 species. Moreover, 161 taxons of microflora have been found in lakes Brzeziczno and Piaseczno. They are the only lakes, within the National Park where the species composition of algae has been thoroughly examined (13).

Among the fairly rich fauna of water invertebrates inhabiting the examined lakes there were 12 new species, 39 rare in Poland (Table 2) and 6 species peculiar from the ecological-zoogeographical point of view and 43 species playing an important role in ecological monitoring as indicators of water trophy (Table 3).

NEW SPECIES IN POLISH FAUNA, RARE AND PECULIAR

6 taxons of rotifers, 3 taxons of water mites and 3 taxons of chironomids were recognized as new species. For most of them the lakes situated in the future National Park have been the only place of occurrence so far.

Rotifers

1. *Cephalodella reimanni* Donner — occurs in southern Moravia, in over-flown arms of rivers. It was found in the littoral of lake Zienkowskie (17).

2. *Collotheca calva* (Hudson) — a phytofilous species, occurs in Europe. It was found in lake Gumienko (19).

3. *Lepadella vitrea* (Gephard) — this species in known to occur in different waters of Australia and South America. Found in lake Uściwierzek (17).

4. *Trichocerca gracilis* (Tess.) — a phytofilous species noted in USSR, USA and Tibet. It was found in lake Uściwierzek (19).

5. *Trichotria tetractis paupera* (Ehrbg.) — a periphytonous species occurring in USSR. Found in lake Moszne.

6. *Monostyla ivli* Wiszn. — a periphytonous—benthic species known to exist exclusively in lake Ohrid in the Balkans. It was found in the littoral of lake Zienkowskie (17).

Water mites

1. *Arrenurus stjoerdalensis* Thor — a post-glacial relict, found in the profundal and sublittoral waters of many European lakes. It occurs in these two zones of lake Piaseczno (10).

2. *Arrenurus subarcticus* Ldbl. — an arctic-subarctic element, known to exist only in different types of stagnant waters in Sweden. Found in the sublittoral and profundal waters of lake Piaseczno (11).

3. *Forelia brevipes* (N a u m.) — this species is known to exist in poorly eutrophized waters of Euroasia. Found in lakes: Bikcze, Brzeziczno, Cycowe and Piaseczno (10).

C h i r o n o m i d s

1. *Pagastiella orophila* E d w. — a benthic species noted only in Europe. It occurs at the muddy bottom of lake Piaseczno (7).

2. *Paratendipes transcaucasicus* T s h e r n. — a bentic species so far known to exist only in the pond near Tbilisi in the Caucasus. Found at the sandy littoral bottom of lake Piaseczno (7).

3. *Stictochironomus connectens* no. 2 L i p. — a benthic form found in the USSR rivers. It occurs at the sandy littoral bottom of lakes Rotcze and Sumin.

Two above-mentioned water mites, *Arrenurus stjoerdalensis* and *A. subarcticus* (post-glacial relicts), two crustacean species *Holopedium gibberum* Z a d d a c h and *Astacus leptodactylus* E s c h s c h. and one belongs to chironomids — *Chironomus* f.l. *salinarius* K i e f f. occurring in some of the lakes situated in the future National Park can be regarded as particular species from the ecological-zoogeographical point of view.

Holopedium gibberum is noted in the whole area of Holoarctic (6). In Poland a decrease in its area of occurrence is observed (16). After World War II it was found only in lakes Brzeziczno and Piaseczno in the Łęczna-Włodawa lake district (8) and in some Tatra lakes (5).

Astacus leptodactylus lives in the waters of Europe and Asia Minor (6). In Poland, due to the increasing water pollution is rarely encountered. In the Łęczna-Włodawa lake district it was found in lakes: Łukie, Rotcze and Sumin.

Chironomus f.l. *salinarius* lives in the rivers of Eurasia and in the Caspian and Black seas. This euryhaline form resists the salinity up to 21‰. In Poland it was found only in the river Supraśl (15) and in two lakes in the Iława lakeland (5). In the Łęczna-Włodawa lake district it was found in lakes Długie and Piaseczno.

SPECIES INDICATING TROPHY OF WATERS AND PLAYING THE KEY ROLE IN ECOLOGY OF LAKES

43 species of invertebrates were found to exist in the lakes of future National Park which can be used as indicators of water trophy (Table 3). 27 species living here may point to slightly eutrophic waters (mesotrophic) especially: *Chromogaster ovalis, Keratella hiemalis, Holopedium gibbe-*

Table 4. Species playing a key role in lake ecosystems of the future Western Polesie National Park

Species \ Lake	Piaseczno	Zagłębocze	Rogóźno	Rotcze	Zienkowskie	Cycowe	Sumin	Bikcze	Łukie	Uściwierz	Wytyckie	Nadrybie	Płotycze	Gumienko	Uściwierzek	Długie	Moszne	Ciesacin	Brzeziczno
Rotatoria																			
Asplanchna priodonta Gosse						+													
Filinia longiseta Ehrenberg																+	+		
Keratella cochlearis Gosse	+	+		+	+	+	+				+	+	+		+				
Keratella cochlearis hispida (Laut.)							+	+	+		+		+	+		+			
Keratella cochlearis tecta Gosse			+			+	+						+	+					
Polyarthra vulgaris Carlin				+	+			+			+								
Synchaeta pectinata Ehrenberg				+															
Cladocera																			
Bosmina coregonii Baird			+	+			+		+					+					
Ceriodaphnia quadrangula (O. F. Müll.)										+		+	+	+					
Chydorus sphaericus (O. F. Müll.)				+	+		+			+		+		+			+		
Daphnia cucullata (G. O. Sars)	+		+	+		+	+												
Diaphanosoma brachyurum Lievin	+						+					+							
Copepoda																			
Eudiaptomus graciloides Schm.	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+
Mesocyclops leuckarti Claus	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Hydracarina																		
Hydrodroma despiciens (Müll.)						+							+					+
Hydrochoreutes krameri Piers.	+								+									
Limnesia maculata (Müll.)	+													+				
Limnesia undulata (Müll.)								+										
Piona pusilla (Neum.)	+																	
Piona paucipora (Thor)	+	+	+													+		
Unionicola crassipes (Müll.)																		
Diptera																		
Chironomus f.l. *plumosus* (L.)				+	+			+			+		+					
Chaoborus flavicans (Meig.)		+	+															+
Einfeldia ex gr. *carbonaria* (Meig.)								+		+	+	+		+				
Procladius Skuse								+				+						+
Pseudochironomus ex gr. *prasinatus* (Staeg.)		+	+													+		+
Stictochironomus ex gr. *psammophilus* Tshern.	+																	
Sergentia ex gr. *coracina* (Zett.)	+																	
Tanytarsus ex gr. *mancus* (Walk.)	+			+														
Pisces																		
Abramis brama Cuv.		+					+	+		+			+					
Anguilla anguilla L.		+								+								
Carassius sp.				+								+	+	+				
Coregonus albula L.		+																
Esox lucius L.	+							+						+				
Rutilus rutilus (L.)	+		+	+				+	+				+					
Tinca tinca (L.)	+							+	+			+		+				
Silurus glanis L.							+											
Total species	15	9	9	11	7	8	10	12	9	7	7	9	10	12	2	6	6	2	7

Table 5. Species composition of fish and fishery type

Species \ Lake	Piaseczno	Zagłębocze	Rogóźno	Rotcze	Zienkowskie	Cycowe
	A	B	B	C	C	C
Coregonus albula (L.)	×	××				
Cyprinus carpio L.				×		
Carassius carassius (L.)	×	×	×	×××	×	×
Carassius auratus (L.)						
Tinca tinca (L.)	××	×	×	×	×	×
Abramis brama (L.)	×	×××	×××	×		
Blicca bjoerkana (L.)	×			×		
Alburnus alburnus (L.)	×	×	×			
Scardinius erythrophthalmus (L.)	×	×	×	××	×	×
Rutilus rutilus (L.)	×××		××	××	×	×
Stenopharyngodon idella (Val.)						
Aristichthys nobilis (Rich.)						
Silurus glanis L.				×		
Ictalurus nebulosus (Le Sueur)	×			×		
Anquilla anquilla (L.)	×	××	×	×	×	
Esox lucius L.	××	×	×	×	×	×
Perca fluviatilis L.	×	×		×		
Acerina cernua (L.)				×		
Stizostedion lucioperca (L.)						
Lota lota (L.)	×				×	
Total species	13	9	8	13	7	5

Occurrence: ××× — very numerous, ×× — numerous, × — not numerous or
Fishery type: A — bream — white-fish lake, B — bream — pike-perch lake,

rum, *Rhynchotalona falcata*, *Arrenurus nobilis*, *A. stjoerdalensis*, *A. subarcticus*, *Chironomus* f.l. *batophilus* and *Sergentia* ex gr. *coracina*. 12 other species indicate eutrophic waters, especially: *Anuraeopsis fissa*, *Brachionus angularis* and *Enfeldia* ex gr. *carbonaria*. Then, 9 invertebrate species occurring in the Łęczna-Włodawa lakes may be regarded as good indicators of waters with low amount of calcium and irch in humus acids (dystrophic). *Gastropus stylifer*, *Cryptochironomus* ex gr. *viridulus*, *Limnochares aquatica*, *Arrenurus pustulator* and *A. neumani* are of particular importance.

Some of the communities of trophy indicating species are of regional significance since they have been separated on the basis of environmental conditions existing in the Łęczna-Włodawa lake district (9, 12, 18).

of lakes in the future Western Polesie National Park

Sumin	Bikcze	Łukie	Uściwierz	Wytyckie	Nadrybie	Płotycze	Gumienko	Uściwierzek	Długie	Moszne	Brzezicz no
B	C	C	B	C	D	C	D	D	D	D	D
×	×	×	×			×	×				
×	×	×	×	×	×××	××	×××	×	×	×	×
	×							×			
×	××	×	×	×	××	×	×	×	×	×	×
×××	×××	×	×××	×			×				
×			×								
×	×	×	×	×	×	×	×	×			
×	××	×××	×	×	×	×××	×	×		×	×
			×								
							×				
××											
		×									
	×		××	×			×				
×	××	××	×	×	×	×	××	×	×	×	×
×	×	×	×	×		×	×				
×											
×			×								
				×							
12	10	9	12	9	5	7	10	5	4	4	4

single

C — tench-pike lake, D — crusian carp lake.

The key role in functioning of lake ecosystems is probably played by species occurring in great quantities (predominating in a given ecological formation) and by those reaching great quantities and high biomass (Table 4). Generally, they are eurytopic species occurring in lakes of different trophy. In the Łęczna-Włodawa lakes they are: *Keratella cochlearis, Polyarthra vulgaris, Bosmina coregoni, Chydorus sphaericus, Eudiaptomus graciloides* and *Mesocyclops leuckarti* from the plankton and *Chironomus* f.l. *plumosus, Procladius* Skuze from the benthos. Apart from them, species of narrow ecological requirements can be found in these communities, reaching great numbers only in certain biotic zones of some types of lakes. Among others, they are psammophilous larvae *Stictochironomus* ex gr. *psamophilus* and pelophilous form *Sergentia*

ex gr. *coracina*. Both taxons ocurred exclusively in lake Piaseczno but the former was the predominating benther in the littoral and the latter in the profound zone.

Mass occurrence of *Chaoborus flavicans* larvae in the profundal zones of lakes Rogóźno and Zagłębocze is worth noticing. They were frequently the only benthers in this zone and pointed to evident oxygen deficiency in the bottom layers of these lakes. On the other hand, however, these larvae occurring in huge quantities could be an essential source of food for fish of these species which tolerate unfavourable oxygen conditions.

In the necton of the examined lakes fish feeding on benthos were most abundant (Table 5). They were: *Abramis brama, Carassius* sp., *Rutilus rutilus* and *Tinca tinca,* which, having reached higher quantities may directly affect the benthos fauna. The second group was formed by predators, among which the predominating species were: *Anguilla anguilla* and *Esox lucius*. Rarely encountered, yet of economic significance, were *Silurus glanis* and *Lota lota*. These species may limit the numberes of fish eating plankton and benthos. It was only *Coregonis albula* which ate zooplankton. Herbivorous fish can play an important role in lake biocenoses and they were *Ctenopharyngodon idella* (lake Uściwierz) and *Aristichthys nobilis* (lake Gumienko).

Only 7 fish species in the future National Park are of great economic significance. They are: bream, predominant in lakes Bikcze, Sumin and Zagłębocze, tench and pike occurring in great numbers in lakes Bikcze and Piaseczno, white fish and eel in lake Zagłębocze, sheatfish in lake Sumin and perch-pike in lake Uściwierz.

ECOLOGICAL EVALUATION OF LAKES

The ecological value of lakes was based on the complex analysis on natural — countryside features. The lakes' geomorphological character was taken into consideration, as well as physico-chemical properties of water, diversity of water fauna, number of new species, rare species and those indicating water trophy and frequency of occurrence and abundance of species of great ecological significance. On the basis of this analysis 2 groups of lakes were distinguished: lakes of key importance for the ecological character of the lake district and lakes of minor importance.

The first group comprises 8 lakes, that is 2 mesotrophic lakes Piaseczno and Rogóźno, 3 eutrophic lakes Bikcze, Łukie and Sumin and 3 dystrophic lakes Brzeziczno, Długie and Moszne.

Lakes Piaseczno and Rogóźno are valuable water ecosystems from the point of view of scenery. They are deep lakes with well formed biotic

zones and belong to low trophy lakes encountered in European Mid-Lowlands. Thanks to the fact that these lakes possess a well shaped profundal, sublittoral and littoral zones with varying habitats, there is an abundance of flora and fauna in them (3, 7, 9, 12, 13, 18, 25, 26). They are also a shelter of numerous rare species, as well as of cold-sthenothermous and relict species of fauna (Table 2).

Lakes Bikcze, Łukie and Sumin are worthy of particular attention among the eutrophic lakes. Lakes Łukie and Sumin underwent some further slight ecological changes (9, 18) which brought about a fairly good quality of water in fauna with the presence of crayfish and sheatfish deserving to be noted. Moreover, lake Łukie is a shelter of very rich water birds including numerous colonies of swan. Lake Bikcze was surrounded by a ditch, thus the run-off of biogenes from the basin was limited causing an inhibition of eutrophication processes in it (15). So, this lake can be an excellent water body to study the ways of protection of surface stagnant waters against excessive eutrophication.

Dystrophic lakes Brzeziczno, Długie and Moszne constitute rare and very characteristic water ecosystems, an access to them is not easy, which helps them to keep their natural character. The beauty of these lakes is strengthened by the neighbouring swampy woods and vast high and intermediate peat-bogs with rare, relict flora. The scarcity of fauna and a considerable sharp of acidophilous species are characteristic features of these lakes rich in humus acids. They are very similar to Pomeranian lakes called "suchary".

The second group of lakes include the remaining lakes with minor ecological advantages. They are characterized by an advanced degradation caused either by natural processes of growing old, partly by hydrotechnical procedures (Canal Wieprz-Krzna) or by the run-off of biogenes from the neighbouring fields and meadows. The lakes in this group were: Ciesacin, Cycowe, Gumienko, Nadrybie, Płotycze, Rotcze, Uściwierz, Uściwierzek, Wytyckie, Zagłębocze and Zienkowskie.

FISHING VALUES OF LAKES

NATURAL EVALUATION OF FISHING USEFULNESS

Qualitative and quantitative analyses of zooplankton and zoobenthos were carried out to determine the potential of the lakes productivity. The results, taking also into consideration morphometry, character of the littoral zone, water quality and technical possibilities of utilizing the lakes from the point of view of fishery, helped to establish a three grade

scale of trophy (23) and thus three groups of lakes were separated.

1. High trophy lakes: Bikcze, Nadrybie, Płotycze, Rotcze, Sumin, Uściwierz and Wytyckie. They are tench-pike or crucian carp type lakes, with the muddy bottom, poor visibility and frequent oxygen deficiency at the bottom and abundant emerged macrophytes. Abundance of zooplankton was very high in most of the lakes. In June 1985 it ranged from 460 indiv./dm^3 in Uściwierz to 7280 indiv./dm^3 in Płotycze (Fig. 1). In the zoobenthos a high abundance was reached by *Chironomidae* and *Oligochaeta* which ranged from 1018 indiv./m^2 in Płotycze to 5280 indiv./m^2 in Bikcze (Fig. 1).

2. Lakes of average trophy; three lakes: Piaseczno, Rogóźno and Zagłębocze. Lake Piaseczno is a bream-white-fish type lake; it is deep, of high visibility without oxygen deficiency at the bottom and scarce flora in littoral zone. There were small numbers of zooplankton, 450 indiv./dm^3 and fairly rich zoobenthos, in which *Chironomidae* reached 2840 indiv./m^2 (Fig. 1). Lakes Rogóźno and Zagłębocze are bream-pike-perch type lakes. They are deep, of high visibility and frequent oxygen deficiency in the profundal and well developed stripe of helophytes and

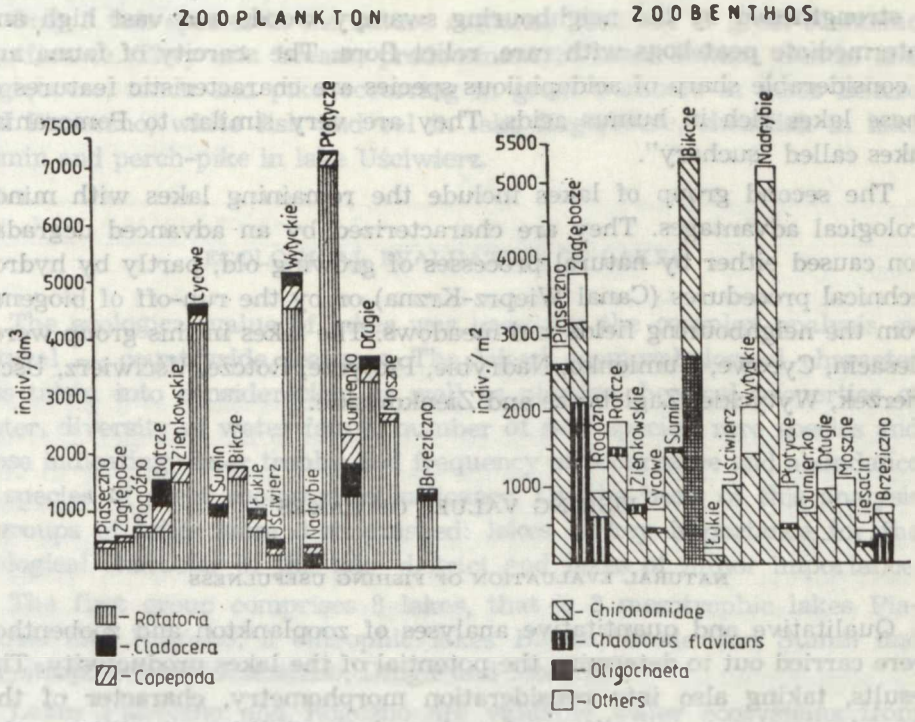

Fig. 1. Average abundance of some of the invertebrates groups in the lakes of the future National Western Polesie Park

elodeids in the littoral zone. Zooplankton abundance reached an average level of 540 indiv./dm^3 in Zagłębocze and 740 indiv./dm^3 in Rogóźno. Zoobenthos was on a low level in the profundal zone but reached fairly high levels in the littoral zone. There were high numbers of *Corethra* species in the benthos fauna of both lakes with 612 indiv./m^2 in Rogóźno and 2090 indiv./m^2 in Zagłębocze. The second group, not that abundant were *Chironomidae* with 306 indiv./m^2 in Rogóźno and 1070 indiv./m^2 in Zagłębocze (Fig. 1).

3. Lakes of poor trophy: Brzeziczno, Ciesacin, Cycowe, Długie, Gumienko, Moszne, Łukie and Zienkowskie. They are crucian carp or tench-pike type lakes. They are shallow, with 6 m maximum depth, muddy bottom, abundant vascular plants. They had poor or abundant zooplankton ranging from 1225 indiv./dm^3 in Łukie to 9755 indiv./dm^3 in Długie, and zoobenthos ranged from 153 indiv./m^2 in Łukie to 1938 indiv./m^2 in Długie.

PRESENT STATE OF FISHING ECONOMY AND ITS DIRECTIONS

Most probably lake fishery will be continued in the future National Park. It should be carried on in a sensible way, to reduce its degrading effect on lake ecosystems. It should give effective production results, and it should be in keeping with the fishing type of lakes protecting all the species and groups of ichtiofauna and water biocenosis as well. Sensible fishery management consists in: 1) determining production potential in a given type of lake; 2) estimating the proper qualitative and quantitative fish composition; 3) planned stocking with fry and proper fishing exploitation, 4) periodical evaluation of rate of growth of individual fish species and factual production results.

On the basis of these data the lakes under study can be divided into 3 groups according to the ways they are to be exploited:

1. Lakes of great economic significance which should be intensively exploited are: Bikcze, Łukie, Piaseczno, Rogóźno, Rotcze, Sumin, Uściwierz, Wytyckie and Zagłębocze at a total surface of 1404.2 ha. Fishery management in most of the lakes has been inappropriate so far. Stocking lakes with fry has been carried without considering proper breeding capabilities based on an increase in fish population and choice of suitable species. That is why production results of these lakes are low (annual average rarely exceeds 20 kg/ha), whereas potential possibilities approximate 40 kg/ha in lakes Łukie and Rotcze and over 30 kg/ha in lakes Sumin and Uściwierz.

2. Lakes of little economic significance with limited fish production and angling possibilities: Ciesacin, Cycowe, Gumienko, Nadrybie, Płotycze and Zienkowskie at a total surface of 94.2 ha. These lakes are utilized

as productive to the best of their abilities, they are irregularly stocked with fry and fish are irregularly caught.

3. Lakes which should be exluded from fishery management: Brzeziczno, Długie and Moszne at a total surface of 56 ha. They represent natural floral-water reservations and no fishing activities should be carried on in them.

ECOLOGICAL MENACE TO LAKES

Admittedly, the Łęczna-Włodawa lake district has largely retained its natural and original character but there is an increasing menace to the natural environment including water ecosystems, especially lakes. The following are the greatest dangers to the future National Park:

1. Intensification of agricultural production, intensive and often irrational mineral fertilization of fields and meadows, application of chemicals in plant protection and expanding animal breeding is of particular danger. Increasing amounts of biogenes (N,P,K) and poisonous substances (pesticides) flow into most of the lakes. A high load of liquid manure from neighbouring animal farms inflows other lakes (e.g. lake Zienkowskie). The Wieprz-Krzna Canal, apart from the positive role it plays for agriculture (regulation of water relations) also introduces periodically too fertile or polluted waters of the river Wieprz to some of the lakes (Bikcze, Ciesacin, Moszne, Nadrybie, Uściwierz and Uściwierzek) precipitating, thus eutrophication processes and ecological degradation of lake biocenosis.

2. Rapid and uncontrolled recreation and growing interests in tourist activities. The banks and littoral zones of lakes get damaged, those of most valuable natural values e.g.: Piaseczno, Zagłębocze, Rogóźno, Rotcze and Sumin. Organization of beaches and places for swimming, and most of all, concentration of summer resorts, temporary camps and ugly colonies of private summer houses cause dangerous changes in the character and functioning of many lakes and neighbouring woods and peat-bogs.

3. The growth of the Lublin Coal Basin may cause a deterioration in the quality of surface waters through the introduction of saline mine waters into them. These waters may be particularly dangerous to the natural groups of plants and animals because they are rich in chlorides (22). Moreover, the net of surface and underground waters will undergo considerable changes.

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STRESZCZENIE

Opierając się na wynikach badań, prowadzonych w okresie wiosennym w latach 1966—1969, 1971—1975 oraz w r. 1985, dokonano oceny wartości ekologicznych oraz przydatności rybackiej 20 jezior, położonych na terenie projektowanego Zachodniopoleskiego Parku Narodowego (Pojezierze Łęczyńsko-Włodawskie). Jednocześnie wskazano na dotychczasowe kierunki zmian zachodzących w biocenozach badanych zbiorników. W 3 podstawowych formacjach ekologicznych (zooplanktonie, zoobentosie i nektonie) stwierdzono 475 taksonów zoohydrobiontów. Wśród nich wyróżniono 12 gatunków nowych i 39 rzadkich w faunie Polski (tab. 2), 6 gatunków będących osobliwościami ekologiczno-zoogeograficznymi, 43 gatunki — wskaźniki stopnia żyzności wód (tab. 3) oraz 37 gatunków odgrywających kluczową rolę w funkcjonowaniu badanych ekosystemów wodnych (tab. 4). Do najcenniejszych pod względem przyrodniczym zaliczono jeziora: Piaseczno i Rogóźno (mezotroficzne), Bikcze, Łukie i Sumin (eutroficzne) oraz Brzeziczno, Długie i Moszne (dystroficzne).

Dokonano przyrodniczej oceny rybackiej przydatności badanych jezior wraz z określeniem ich typu rybackiego (tab. 5) oraz kierunków prowadzenia w nich gospodarki rybackiej. Zależnie od potencjalnych możliwości produkcyjnych w danym typie rybackim zbiornika oraz jego walorów przyrodniczych, badane jeziora podzielono na 3 grupy różniące się proponowanym sposobem użytkowania.

Przeprowadzono analizę zagrożeń funkcjonowania ekosystemów jeziornych. Do czynników stwarzających największe zagrożenie dla badanych jezior zaliczono: intensyfikację gospodarki rolnej, gwałtowny, nie kontrolowany rozwój rekreacji i turystyki oraz rozwój Lubelskiego Zagłębia Węglowego.

РЕЗЮМЕ

На основе результатов исследований, проведенных в течение весенних периодов 1966—1969, 1971—1975 гг. и 1985 г., дали оценку экологической ценности и пригодности для рыболовства 20 озер, расположенных на территории планируемого Западнополесского национального парка (Ленчиньско-Влодавское приозерье). Кроме того, указаны направления, в которых идут изменения, происходящие в биоценозах этих водоемов. В 3-х главных экологических формациях (зоопланктоны, зообентосы и нектоны) выявлено 475 таксонов зоогидробионтов. Из них выделено 12 видов новых и 39 редких для фауны Польши (табл. 2), 6 видов являющихся экологическо-зоогеографической достопримечательностью, 43 вида — показатели степени эвтрофности вод (табл. 3), 37 видов играют главную роль в функционировании исследованных водных экосистем. Наиболее ценным являются следующие озера: Пясечно и Рогузьно (мезотрофные), Бикче, Луке и Сумин (эвтрофные), Бжезично, Длуге и Мошне (дистрофные).

Оценена природа исследованных озер с точки зрения их пригодности для рыболовства, определен тип рыболовства (табл. 5) и направления развития рыбного хозяйства на этих озерах. В зависимости от производственных потенциальных возможностей, данного типа рыбного водоема и его природных достоинств, все исследованные озера разделили на 3 группы, отличающиеся друг от друга предлагаемым способом эксплуатации.

Проведен анализ опасностей, угрожающих функционированию озерных экосистем. К наиболее опасным для этих озер факторам отнесли: интенсификацию сельского хозяйства, бурное и неконтролируемое развитие туризма, развитие Люблинского угольного бассейна.