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The occurrence of amphibians in Zielona Góra in 2005–2008

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Abstract: During the period of 2005 to 2008, a study was conducted of amphibians at 25 ponds within the administrative boundaries of Zielona Góra (western Poland) – an agglomeration of 58.32 km² with a population of 118,000 residents. The ponds chosen for the study were varied by size, location, type of surroundings and origin. A total of 11 species of amphibians were confirmed in the study sites, whereas 14 species can be found in Zielona Góra's environs. The common toad *Bufo bufo* was the most common species found, while the marsh frog *Rana ridibunda* was the rarest. Aqueous habitats for amphibians are decreasing, especially those with standing water and wetlands. This is mostly due to increasing infrastructure development, the filling of aquifers with land or using them as trash dumps, as well as their eutrophication and desiccation.

Key words: amphibians, Amphibia, western Poland, Zielona Góra, urban environment

INTRODUCTION

The condition and functioning of European batrachian fauna is strongly influenced today by the broadly understood human activity, which is especially evident in areas with quickly developing urban agglomerations, as well as in areas intensively used for agriculture, tourism and emerging transportation corridor networks (e.g. Fröhlich et al. 1987, Corbett 1989, Kneitz 1998, Glandt et al. 2003, Głowaciński & Rafiński 2003, Meyer et al. 2004, Schlüpmann & Nettmann 2006). The impact of urbanization is most often negative – habitats populated by amphibians disappear or are transformed to such an extent that their restoration is impossible. This frequently leads to the extinction of entire amphibian populations or to a drastic decline in their numbers. But even with such unfavorable conditions, by preserving at least a remnant of suitable amphibian habitat, these animals are able to function for a certain time depending on the extent and speed with which changes are made in the environment.

There is insufficient knowledge about amphibians inhabiting cities in Poland, though several publications have appeared over the past few years on various aspects of this topic (e.g. Juszczyk 1989, Pawłowski 1993, Mazgajska 1996, 1998, Guzik et al. 1996, Mrowiec 1999, Siwak et al. 2000, Kierzkowski & Ogielska 2001, Chobotow & Czerniawski 2007). Zielona Góra is one of the cities where amphibians have been studied in the last several dozen years and where a negative influence has been documented on their population, primarily related to their quickly diminishing habitats (Najbar et al. 2005b).

The aim of this study is mainly to present the species composition and numbers of amphibians inhabiting selected ponds of Zielona Góra over the past few years.

Study area

Zielona Góra (51°53`–51°59` N, 15°26`–15°35` E) is one of the largest cities of the Lubuskie region, located in the western part of Poland and encircled by a moraine ridge known as the Zielona Góra Embankment (Wał Zielonogórski). The altitude of the city ranges between 80–200 m a.s.l. The vegetative season here is 223 days, with a mean temperature of 8ºC. The mean in January is -1.3ºC, 18.1ºC in July, and there are 188 days with no frost (WIOŚ 2000, Zajchowska 1972).

Zielona Góra`s period of most active development occurred in the mid-20th century and was related to growth in industry and transportation, attracting new residents, which led to its urban development. In 1950, Zielona Góra became a regional capital, which intensified the zoning of its space for building purposes. The city`s area grew from 2.71 km$^2$ to 32.07 km$^2$, with 38.5% comprising developed urban areas, 44% forests and 17.5% agricultural fields. The 1960`s saw the building of housing estates, the Higher School of Engineering, and the inclusion of Chynów and Jędrzychów villages into the city. As the interior and periphery of the city developed, 16 housing estates were linked and about 0.7 km^2 of the city was designated for industrial use (Kopij 1989, Benyskiewicz & Szczegóła 1991). In the 1980`s and 1990`s, as well as at the beginning of the 21st century, the housing estates added more buildings, new estates were developed and their infrastructure grew. To resolve transportation problems, an expressway and by-pass were built to direct traffic around the city. As of December 2008, the area of Zielona Góra is 58.32 km^2, including over 26.86 km^2 (ca. 46.0%) of forest, over 13 km^2 (ca. 22.3%) of developed area, over 5 km^2 (ca. 8.6%) of agricultural land, 0.11 km^2 (ca. 0.2%) of water bodies, 13.35 km^2 (22.9%) of unused land (wasteland), roads and other infrastructure. The city is inhabited by about 118,000 residents (www.zielona-gora.pl).

In historical times (mainly the 19th and 20th centuries) shallow, mineral deposits (brown coal, sand, gravel) located in different areas of the city were exploited with varying intensity until the mid-20th century. Over the decades, many shallow pits were excavated here, which quickly filled with water when left to their own devices, creating variously sized ponds of standing water. During the second half of the 20th century, the mining operations were successively shut down, with many of the ponds gradually disappearing as the pace of urban infrastructure development quickened. At the beginning of the 1970`s, there were still over 60 ponds within the city of about 0.01 to 3.7 ha in size, which began disappearing due to human activity and local drainage activities. In the meantime, several new ponds were constructed to retain water in the wettest terrains and in the vicinity of springs. Additionally, several small ponds were constructed on privately owned land. Today, about 35 ponds are estimated to still exist, comprising an area of 9 ha (Najbar et al. 2005b and own unpublished material). Several streams flow through Zielona Góra, the largest, Gęśnik located in the northern part of the city, as well

as, among others, Łącza (Zloty Potok), Pustelnik, Dłubnia and a few, short unnamed ones. At an average high level, their total area is about 8 ha. Historically, the city also had marshes with a total area of about 12 ha in some of its peripheral areas, especially along water-courses. Very little of this habitat remains today (www.zielona-gora.pl).

Methods

Data for this study were collected from 2005 to 2008 during the entire season of amphibian activity (March–October). Each water body was studied at least 3–5 times annually. Mating amphibians were counted or were captured in the water by hand or using a landing net. They were also identified by tadpoles, spawn appearance and voices. Three classes of abundance were distinguished: no more than 20 adult individuals, from 21 to 100, and more than 100 individuals.To the extent possible, green frogs were caught and identified using a key guide (Berger 1975). In analyzing results, all observations of green frogs were totaled regardless of their species.

Twenty-five permanent pools were selected for the study (those that had dried out only once or twice over 10 years) located in various areas of Zielona Góra (Fig. 1) and with one exception, generally characterized by the presence each year by a species of amphibian. They are named after the closest streets or some other feature enabling the sites to be identified for future studies. The ponds were characterized by type of pond, its surrounding environment and type of vegetation at its edge (Appendix 1). The area of each pond was determined on the basis of site visits conducted once (July 2005) (ponds 1–8, 10–18, 22–25) or topographical maps with the use of a CAD system (Auto CAD LT 2000)(ponds 9, 19–21).

Results

Eleven species of amphibians were confirmed in Zielona Góra in 2005 to 2008. These were: alpine newt *Triturus alpestris* (Laurenti, 1768), great crested newt *Triturus cristatus* (Laurenti, 1768), smooth newt *Triturus vulgaris* (Linnaeus, 1758), pool frog *Rana lessonae* Camerano 1882, common water frog (also known as edible frog) *Rana* kl. *esculenta* Linnaeus, 1758, marsh frog *Rana ridibunda* Pallas, 1771, moor frog *Rana arvalis* Nilsson, 1842, common frog *Rana temporaria* Linnaeus, 1758, common toad *Bufo bufo* (Linnaeus, 1758), green toad *Bufo viridis* (Laurenti, 1768), common spadefoot *Pelobates fuscus* (Laurenti, 1768)(Table 1, Appendix 1). Mating of amphibians occurred at 96% of the studied ponds (n = 25). The average number of species (± sd) was 5.16 ± 3.13 per pond. The number of species at specific ponds varied from 0 to 10 (Appendix 1).

The most widespread species of the area studied was the common toad, inhabiting almost all (92%) of the ponds studied, including a neglected one encircled with concrete (pond 2) and a pool providing a source of water for fighting fires (pond 12). It is also

the decidedly dominating species in terms of numbers (Table 1). Its population is quite numerous at several ponds located mainly in the southwestern part of the city (ponds 19–21, 24, 25). The common frog has an almost equally high presence (84%), as it was absent only in ponds located in built-up urban areas. It is however, decidedly less numerous than the earlier mentioned species (Table 1). The green toad, common water frog and smooth newt are moderately common species, inhabiting more than a dozen of the ponds studied. The same is true for the great crested newt, except that there are currently very few individuals found at specific breeding sites, with a tendency towards a decreasing population (Najbar 2005b). The alpine newt exhibits an analogous tendency,

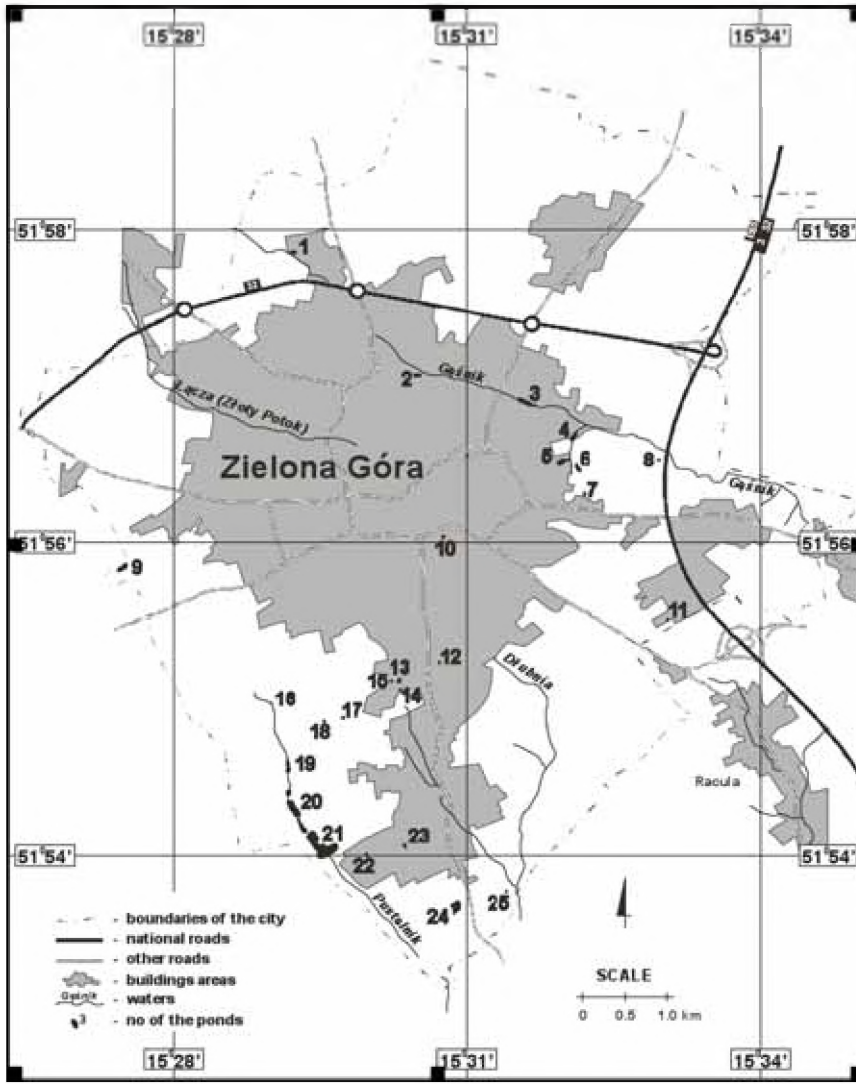

Fig. 1. Location of ponds selected for study in Zielona Góra.

Table 1. Frequency of occurrence and abundance of amphibians in ponds studied in Zielona Góra 2005–2008.

	Species	Number of occupied ponds (%, N = 25)	Number of ponds (%) in classes of amphibian abundance		
			1–20	20–100	> 100
1	*Triturus alpestris*	7 (28%)	7 (100)	-	-
2	*Triturus cristatus*	13 (52%)	10 (76.9)	3 (23.1)	-
3	*Triturus vulgaris*	16 (64%)	5 (31.25)	11 (68.75)	-
4	*Rana lessonae*	6 (24%)	5 (83.3)	1 (16.7)	-
5	*Rana* kl. *esculenta*	14 (56%)	5 (35.7)	4 (28.6)	5 (35.7)
6	*Rana ridibunda*	1 (4%)	1 (100)	-	-
4–6	green frogs total (*Rana esculenta* complex)	14 (56%)	5 (37.5)	4 (28.6)	5 (35.7)
7	*Rana arvalis*	4 (16%)	3 (75)	1 (25)	-
8	*Rana temporaria*	21 (84%)	10 (47.6)	10 (47.6)	1 (4.8)
9	*Bufo bufo*	23 (92%)	10 (43.5)	7 (30.4)	6 (26.1)
10	*Bufo viridis*	16 (64%)	10 (62.5)	6 (37.5)	-
11	*Pelobates fuscus*	8 (32%)	7 (87.5)	1 (12.5)	-

as its numbers are very unstable and low at most of the sites. The remaining species also currently occur rarely or very rarely in Zielona Góra, inhabiting at most a few ponds generally found in wooded areas (Appendix 1). The rarest species is undoubtedly the marsh frog, occurring in small numbers at only one pond located in the eastern part of the city (Table 1).

Discussion

In the 1970`s, 14 species of amphibians were confirmed to have regularly occurred within the administrative borders of Zielona Góra. These included all the species mentioned in the previous section as well as fire-bellied toad *Bombina bombina* (Linnaeus, 1758), common tree frog *Hyla arborea* (Linnaeus, 1758) and natterjack toad *Bufo calamita* (Laurenti, 1768), which were noted to have disappeared from the study area at various times during longer term research (Najbar et al. 2005b). This may indicate that amphibian habitats are shrinking and changing in quality within the agglomeration, or that other, as yet unknown factors, which may be numerous and have compound effects, are influencing these three species (Günther & Schneeweiss 1996, Sinsch 1998, Glandt 2004, Glandt & Kronshage 2004). All fourteen species still occur in the immediate

surroundings of the city. The presence of common tree frog and fire-bellied toad – species once frequently found in Zielona Góra (Gruhl 1929, Radkiewicz pers. inf.) – are regularly noted at several sites just outside the city's borders, while the natterjack toad was found in 2007–2008 at a site ca 10 miles away from the city's boundary (own unpublished data). It is also worth noting that the appearance several years ago of the marsh frog in a medium-sized pond located within a city forest (pond no. 6) is probably connected with its introduction (Najbar et al. 2005b).

The number of amphibian species confirmed in Zielona Góra is an average result for a Polish city. More – 12 species – have been confirmed in Warsaw, Lublin and Białystok, while the same number – 11 – in Oława, Kraków and Poznań (Pawłowski 1993, Guzik et al. 1996, Siwak et al. 2000, Majtyka 2006, Chobotow & Czerniawski 2007, Mazgajska 2008).

Given the fact that urbanized and extensively developed districts in Zielona Góra exist next to wooded areas (including sites that were formerly mined) traversed by streams, it is not surprising that the occurrence of amphibians there is quite variable. The least diverse batrachian populations are in the city center, where today practically no ponds exists, and those that remain contain single species of amphibians (pond 12) or none at all (pond 10) (Appendix 1). The situation at the city's periphery is different, as it is largely wooded there and has ponds of varying size, origin and intended use, as well as small, shallow streams. As a result, these sites are very important for amphibians. These areas are mainly in the southern and southwestern parts of the city, and should perhaps be considered key in sustaining most of the city's batrachian fauna over the longer perspective. In some of the ponds here (16–21, 24, 25), relatively numerous populations of most of Zielona Góra's amphibian species are still regularly noted. Their presence is connected to ponds overgrowing with vegetation, drainage ditches and the proximity of extensive forest complexes (moist and dry pine forests with a small mix of deciduous trees) traversed by a stream (Pustelnik) that provides water to nearby ponds, including the largest in the study area known as "Dzika Ochla". Besides the southwestern part of the agglomeration, remnants of valuable habitats containing amphibians still exist. These are mainly the ponds in the vicinity of Zielona Góra University's buildings (ponds 5–7), which have unfortunately been partially degraded due to inept re-cultivation (Fig. 2), which decreased their size and polluted the waters. It is worth to mention a clay-pit in the western part of the city (pond 9) and the areas adjacent to Gęśnik stream all along its course through the city. The ponds there are situated at the outskirts of the city, surrounded by woods or wastelands, which increases the chance for the amphibians living here to survive, even though their numbers are generally lower than in the southwestern part of the study area.

A significant threats to amphibian habitats in Zielona Góra are: the degradation of ponds by partial or complete filling, as well as changes in the physical, chemical and bacterial qualities of the water. This is a progressive process, which in recent years has resulted in the complete or temporary destruction of at least a dozen valuable shallow ponds that had no fish. These types of water bodies are especially significant for the existence of fast-disappearing newts (np. Fröhlich et al. 1987, Thiesmeier & Kupfer

Fig. 2. Significant sites with amphibians located in the southern part of Zielona Góra ceased to exist due to the placement of municipal waste collection facilities and dumping of municipal trash there (Dec. 2005).

Fig. 3. Example of pond devastation in northeastern Zielona Góra (pond no. 5; Mar. 2007). Construction work has been carried out here for over a year, and once it is completed, part of the pond once inhabited by rare amphibian species, among others, the three species of newt, is supposed to be reconstructed.

2000, Langton et al. 2001, Glandt 2006, Von Lindeiner 2007). Pollution and eutrophication, as well as the increased presence of humans, have contributed to the drastic deterioration of the water's physical and chemical properties in some of the ponds studied, and thus, their availability to amphibians (Fig. 2, 3). Trzcińska (2005), in her study of the annual cycle of changes in the physical and chemical indicators of selected surface water bodies in Zielona Góra, found great variability in quality and locally high pollution, especially from petroleum based compounds, biochemical sources (N, P, K) and heavy metals (Ni, Zn, Pb, Kd, Cr, Cu). The waters also were found to have a very low soluble oxygen content, categorizing them into the clean water class of III–V. The most polluted water bodies were those located adjacent to trash dumps and in agricultural areas (for example, community gardens) or in their close vicinity. Water pollution is undoubtedly the cause many amphibians mortality in the study area, which was frequently confirmed in previous years.

The long term drought prevailing in the region also has significance for many water bodies. The drought has caused water levels to drop periodically even up to 12 m (Wróbel 1989). Also important are other threats of anthropogenic origin, with rapidly increasing growth in automotive traffic worth mentioning as the cause of high amphibian mortality on roads (Pietruszka 2004, Najbar et al. 2005b, 2006).

In conclusion, it is also worth mentioning the extremely negative impact of the open, municipal waste water canal, which is 4.8 km long and located near the city's northwestern border. This canal is a trap for numerous migrating animals, including several species of amphibians (Rejowski 2004, Najbar et al. 2005a, 2007). Many studies have been conducted in western Europe on the impact of various hydrological and drainage structures, as well as waste water treatment plants on amphibians, depicting their danger to local batrachian populations and the losses they cause (e.g. Kaplan 1983, Krummenacher 1985, Gerloff 1989). In many cases, practical conclusions were drawn from these studies to institute appropriate protective measures. Despite papers published about the negative impact of the canal on the fauna of Zielona Góra, local officials have not yet taken an interest in resolving this problem.

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Streszczenie

[Płazy Zielonej Góry]

W latach 2005–2008 badano batrachofaunę 25 zbiorników wodnych zlokalizowanych w granicach administracyjnych Zielonej Góry (zachodnia Polska) – aglomeracji o powierzchni 58.32 km^2 zamieszkiwanej przez ok. 118 tys. mieszkańców. Wybrane zbiorniki były zróżnicowane pod względem wielkości, położenia, typu ich otoczenia i pochodzenia. Łącznie w obszarze badań stwierdzono występowanie 11 gatunków płazów, podczas gdy w okolicach Zielonej Góry występuje 14 gatunków. Najpospolitsza była ropucha szara (*Bufo bufo*), a najrzadsza żaba śmieszka (*Rana ridibunda*). Siedliska wodne płazów na terenie Zielonej Góry kurczą się, zwłaszcza w odniesieniu do zbiorników wód stojących i terenów podmokłych, do czego przyczynia się głównie postępująca rozbudowa infrastruktury, zasypywanie i zaśmiecanie akwenów, ponadto ich eutrofizacja bądź wysychanie.

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Appendix 1. Occurrence of amphibians in selected ponds of Zielona Góra in 2005–2008 and the characteristics of those ponds. Periodicity of ponds: + – permanent, - – seasonal. Type of pond: P – pool, R – reservoir, RT – retention pond. Classes of ponds' surrounding terrains: I – city center, II – areas with low, generally scattered buildings, III – urban parks, IV – suburban forests, V – open, wasteland areas with no industry, VI – community gardens.

Bodies of water description						Amphibian species												
No	Area [ha]	Periodicity	Location; type of pond, surroundings	Character of the bank	Dominant vegetation in and on the water	*Triturus alpestris*	*Triturus cristatus*	*Triturus vulgaris*	*Rana lessonae*	Rana kl. *esculenta*	*Rana ridibunda*	Green frogs total	*Rana arvalis*	*Rana temporaria*	*Bufo bufo*	*Bufo viridis*	*Pelobates fuscus*	Σ
1	0.20	+	Trasa Północna Street; V	shrubs, grasses surround the entire pond; 60% of the area has a well developed littoral zone	*Typha latifolia*, *Lemna minor*									+	+	+		3
2	0.12	-	Źródlana Street; P, II	concrete, sharply cut edges, a mound of sand enables access to and from the water										+	+	+		3
3	0.37	+	Dolina Zielona housing estate; R, II	concrete on two sides, tree cover				+		+		+		+	+	+		5
4	0.03	+	S. Wyspiańskiego Street; R, III	shrubs, grasses surround the reservoir, 30% with dense shrubs											+	+		2
5	0.17	+	Szafrana Street / by the Institute of Environmental Engineering; R, III	reconstructed in 2007/2008 (drained); grass is the only vegetation	up to 2006, mainly *Phragmites communis* (currently no vegetation)										+			1
6	0.27	+	Szafrana Street (in a woods); IV	trees, shrubs, grasses around the entire pond; well developed littoral zone	*Typha latifolia*, *Phragmites communis*, *G. aquatica*	+	+	+	+	+	+	+	+	+	+	+		10
7	0.04	+	Akademicka Street; IV	trees, shrubs around the entire pond; well developed littoral zone	*Typha latifolia*, *Phragmites communis*, *Glyceria aquatica*, *Lemna minor*	+	+	+		+		+	+	+	+	+		8
8	0.01	+	By route E65; RP, V	grasses, shallow, disappearing pond	*Phragmites communis*									+	+			2

9	2.83	+	By the Rybno housing estate; IV	trees, shrubs surround most of the pond; deep, moderately developed littoral zone	*Phragmites communis*, *Typha latifolia*, *Glyceria aquatica*, *Potamogeton natans*, *Lenna minor*		+	+	+	+		+	+	+	+	+		8
10	0.05	+	Sowiński Park, RP, III	sloping bank, grate-like concrete slabs, lack of vegetation														0
11	0.10	+	Głogowska Street; IV	trees, shrubs, grasses surrounding the entire pond; 30% of area has a well developed littoral zone	*Lenna minor*, *Phragmites communis*			+						+	+			3
12	0.20	+	Kożuchowska Street; II	concrete, steep bank with planks enabling access to and from the water; no vegetation												+		1
13	0.13	+	Waszczyka Street (housing estate); II	trees surround almost the entire pond; 2/3 of bank has a well developed littoral zone of trees			+	+		+		+		+	+			5
14	0.15	+	Waszczyka Street (park); R, III	trees surround the entire reservoir, a dam at one end, lack of a developed littoral zone	*Phragmites communis* *Lenna minor*			+		+		+		+	+			4
15	0.06	+	Botaniczna Street; R, II	grasses, no littoral zone; gentle banks	*Nymphea alba*			+						+	+			3
16	0.01	+	reservoir on Gęśnik stream (on the red trail); IV	trees surround the entire reservoir, a concrete dam exists at the outflow; about 15% with a littoral zone; about 70% reinforced with posts; steep banks in places	*Lenna minor*, *Typha latifolia*	+	+	+		+		+		+	+	+	+	8
17	0.02	+	allotment gardens „Leśna Polana"; VI	grasses, trees, moderately steep banks	*Phragmites communis*, *Lenna minor*	+	+	+	+	+		+		+	+	+	+	9
18	0.40	+	allotment gardens „Leśna Polana"; R, VI	grasses, moderately steep banks; 70% of area with well developed littoral zone	*Elodea canadensis*, *Lenna minor*	+	+	+		+		+		+	+	+	+	8

Continued on the next page

Bodies of water description						Amphibian species												
No	Area [ha]	Periodicity	Location; type of pond, surroundings	Character of the bank	Dominant vegetation in and on the water	*Triturus alpestris*	*Triturus cristatus*	*Triturus vulgaris*	*Rana lessonae*	Rana kl. *esculenta*	*Rana ridibunda*	Green frogs total	*Rana arvalis*	*Rana temporaria*	*Bufo bufo*	*Bufo viridis*	*Pelobates fuscus*	Σ
19	0.80	+	reservoir on Gęśnik stream (by the city swimming pond); R, IV	trees surround the entire reservoir; about 15% with a littoral zone, very gentle bank in places, in others moderately steep; outflow area is obstructed by a concrete dam	*Typha latifolia, Elodea canadensis, Lemna minor*	+	+	+	+	+		+		+	+	+	+	9
20	1.82	+	city swimming pond Ochla; R, IV	concrete bank, gentle; grassy terrain surrounding pond with woods at a distance of about 50–100 meters			+	+	+	+		+		+	+	+	+	8
21	3.70	+	„Dzika Ochla", R, IV	banks covered with grass, shrubs in places, with woods at a distance of about 50–100 meters; about 10% of pond is shallow, well developed littoral zone	*Typha latifolia, Phragmites communis, Glyceria aquatica, Lemna minor*		+	+	+	+		+		+	+	+	+	8
22	0.10	+	Nowojędrzychowska Street; II	gentle banks covered with grass, shrubs in some places	*Phragmites communis*									+	+			2
23	0.04	+	Konwaliowa Street; II	gentle banks covered with ornamental garden plantings	*Nymphea alba*		+							+	+			3
24	0.50	+	bus depot at Jędrzychowska Street; V	diverse banks, from very steep to gentle; pond is mainly surrounded by trees and shrubs; about 25% with well developed littoral zone	*Carex sp., Lenna minor*		+	+		+		+		+	+	+	+	7
25	0.10	+	behind the bus depot at Jędrzychowska Street (towards Dlubnia stream); V	very gentle banks, about 50% surrounded by trees and shrubs, in remaining area by sedges that also form the littoral zone	*Typha latifolia, Phragmites communis, Glyceria aquatica, Lemna minor*	+	+	+		+		+	+	+	+	+	+	9