FRAGMENTA FAUNISTICA 53 (2): 139–149, 2010
PL ISSN 0015-9301© MUSEUM AND INSTITUTE OF ZOOLOGY PAS

Amphibians of Oława

Tomasz MAJTYKA

Laboratory of Biology and Conservation of Vertebrates, Institute of Zoology, University of Wrocław, ul. Sienkiewicza 21, 50–335 Wrocław, Poland; e-mail: tapirus@op.pl

Abstract: Observations were conducted of 28 water bodies from 2006 to 2009 in Olawa, a mid-sized town (of about 31,000 residents) in southwestern Poland. 13 amphibian taxa were confirmed. These same taxa were also confirmed in the surrounding areas of the town. Twice as many amphibian species were found in areas affected to a lesser degree by urbanization than in heavily urbanized areas. Two groups of amphibians were distinguished, depending on their tolerance of urbanization at breeding ponds and surroundings: 1) species preferring only natural terrain or areas close to being natural – *Bombina bombina*, *Pelobates fuscus* and *Rana arvalis*; 2) taxa breeding in both natural areas as well as those under the pressure of urbanization – *Triturus cristatus*, *Triturus vulgaris*, *Bufo bufo*, *Bufo viridis*, *Hyla arborea*, *Rana esculenta* complex and *Rana temporaria*.

Key words: anthropogenic pressure, ecology, Poland, urbanization

INTRODUCTION

Growing human population numbers and rising consumption lead to the dynamic development of cities (Kowalewski 2005). Habitats remaining for wild animals, including amphibians, are ever decreasing. The main threats in cities to batrachian fauna are: elimination of water bodies – which are especially important because these animals breed in a water environment – and changes to the terrestrial environment, making it unsuitable habitat for amphibians (Hamer & McDonnell 2008). There is one more important factor in an urban environment – the constant and intense presence of humans. Together, all these factors result in degrees of urbanization pressure that differ in various areas of a city. This pressure impacts particular species of amphibians differently, leading to changes in the urban batrachian fauna, both in terms of numbers as well as in the quality of its population.

The main objective of this study is to verify the hypothesis that urbanization also causes a decrease in the species' diversity of amphibians in a town relatively smaller than the large regional city centers studied thus far (Mazgajska 1996, Siwak et al. 2000). Additionally, the sensitivity of specific amphibian species to various levels of urbanization pressure was assessed. Information was also collected about the spatial distribution of amphibians' breeding sites in Olawa in order to later compare the status of the populations and site use.

Study area

The town of Olawa is in the eastern part of the Lower Silesian Voivodeship (50°57`N, 17°18`E). It covers an area of 27.3 km^2. It is a county seat located near other large city agglomerations – 27 km. from Wroclaw and 55 km from Opole. The first mention of Olawa is from 1149 A.D., so the amphibians living in this area have been under anthropogenic pressure for quite some time. Currently, about 31,000 residents live in Olawa, giving a mean population density of almost 1140 persons/km^2.

Olawa is situated in a valley of two rivers: the Odra and Olawa, within the Silesian Lowlands. This area is characterized by lowlands in the vicinity of 120–140 meters a.s.l. A favorable climate provides a vegetative period of 220–227 days, the longest in Poland. The mean annual temperature is around 8.5°C, annual rainfall is 580 mm, and winter lasts only 69 days. It should be added that the maximum annual temperature variance is 53.3°C (-21.6°–+31.7°C) (Matwijowski 2004, Stanisławska et al. 2004).

There are various habitats within Oława`s administrative boundaries. Densely built-up areas (Jakub Sobieski and Bolesław Chrobry housing estates, the center city and industrial areas between the Odra and Olawa Rivers) are mainly found in the central and southeastern parts of the town. Low-rise buildings (Nowy Górnik, Folwark, Nowy Otok, Zwierzyniec Duży and the area of Olawa by the right bank of the Odra – near Oleśnicka Street) are generally in the western part of the town and a small part of its east-central area. Agricultural fields (grains, root vegetables) mostly make up the southern and southwestern parts of the town. Parks and other wooded lots are found in the central part of town. A dry pine forest growing on sandy terrain (river dunes), vegetation requiring more moisture and meadows are also located within the town`s boundaries to the north. To a lesser degree, meadows are located in the vicinity of the Odra channel, on river islands, and as wastelands in the southern and western parts of the town. In summary, 56.3% of the town is agricultural, of which agrarian fields comprise 91%. Other green areas (mainly meadows) comprise 7.8%, and woodlands only 5%. The areas surrounding Olawa are mainly agricultural fields, meadows, forests and villages.

There are about 45 water bodies located within the town`s boundaries. The majority of these are drainage ditches. Other types of water bodies are decidedly in the minority: there are ponds as well as one large sand excavation (on an island in the Odra). This study included 28, or 62%, of all these water bodies. Essentially, all the water bodies with standing water located within Olawa were included in the observations. Of the 28 water bodies, 25% were ponds whose edges were evidently changed by humans: bordered by paving stones, concrete or wooden palisades.

Methods

Amphibians were observed in 2006–2009 from March to July of each year. Each water body was visited at least several times per month. Capturing metamorphosed adults and larvae, searching for eggs and listening to breeding calls occurred at various times: during the day, evening, at night, on both sunny and rainy days.

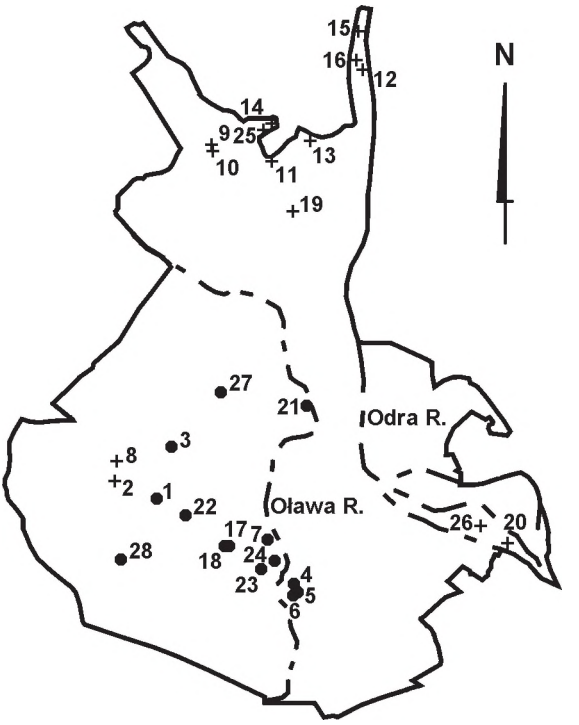

Fig. 1. The Olawa water bodies observed in 2006–2009. ● – located in areas strongly affected by anthropogenic pressure, + – located in areas weakly affected by anthropogenic pressure. The numbers refer to successive water bodies. The continuous line denotes the administrative boundaries of the city. The broken line represents rivers. The water bodies are numbered as in Tables 1, 2 and Appendix 1.

Rana lessonae, *Rana* kl. *esculenta* and *Rana ridibunda* were treated as one taxon – the *Rana esculenta* complex – for purposes of this study. All 3 forms found in Poland were confirmed in Olawa, based on the D.p./C.int (longevity of the first finger of hind leg in relation to longevity of metatarsal tubercule) and F./T. (relation in longevity of thigh to tibia) indexes (Juszczyk 1987), coloration, the development of breeding coloration and breeding calls. Identifying these frogs was problematic in many cases due to the occurrence of intermediate forms with no distinguishing morphological characteristics and coloration. It is also important to note that breeding sites for these frogs was determined only by the confirmed presence of eggs, tadpoles or breeding choruses of males.

28 water bodies were described in detail during the time observations were made (Fig. 1). Each water body was identified by its coordinates, and descriptions were made of the immediate surroundings, type of water body, area, duration (whether they held water throughout the entire year, dried out each year or dried out in dry years but maintained water in wet years), character of the edge, presence of shallows, maximum depth, presence of fish and water vegetation (including the presence of visible masses of algae that

develop in late spring) (Appendix 1). The geographic location and area of the water body was taken from the "geoportal.gov.pl" internet database (http://www.geoportal.gov.pl).

In analyzing the location of Olawa's water bodies, I distinguished two categories. The first includes water bodies located in or very near (20–400 m) areas largely inhabited or used by humans (housing estates, neighborhoods with villas, industrial areas) and/or frequently penetrated by humans (urban parks, allotment gardens). These areas are under considerable anthropogenic pressure. The second group consisted of water bodies in areas of low anthropogenic pressure. These were located far from buildings (500–1500 m) or near only single houses (150–500 m) in relatively natural areas for the entire town and/or rarely penetrated by humans (forest, meadow, farm field with many balks, former sand pits) or where the buildings were separated from the water body by a river, which significantly decreased the impact of humans. To confirm a species' sensitivity to the pressure of urbanization, the χ^2 statistic was used for all amphibian taxa inhabiting Olawa.

Results

13 amphibian taxa were confirmed during the research conducted within the administrative borders of the town of Olawa. They include: *Triturus cristatus* (Laurenti, 1768) and *Triturus vulgaris* (Linnaeus, 1758), *Bombina bombina* (Linnaeus, 1761), *Pelobates fuscus* (Laurenti, 1768), *Bufo bufo* (Linnaeus, 1758), *Bufo calamita* Laurenti, 1768 and *Bufo viridis* Laurenti, 1768, *Hyla arborea* (Linnaeus, 1758), *Rana arvalis* Nilsson, 1842, *Rana* kl. *esculenta* Linnaeus, 1758, *Rana lessonae* Camerano, 1882, *Rana ridibunda* Pallas, 1771 and *Rana temporaria* Linnaeus, 1758 (Table 1). These same species were also confirmed in the areas surrounding Olawa. This means that the species composition between the town and its surroundings does not differ.

In Olawa, most of the water bodies (82% of the sample tested) are used by amphibians for breeding purposes. On average, $\bar{x} = 2.5 \pm 2.5$ number of species breed at one water body. After dividing the Olawa water bodies into two groups (experiencing high or low anthropogenic pressure), it was found that significantly fewer species breed in water bodies under greater anthropogenic pressure ($\bar{x} = 1.4 \pm 1.4$ species vs. $\bar{x} = 3.6 \pm 3.0$ species respectively) (Mann-Whitney U test, $U = 53$, $p = 0.0409$). It is worth adding that an important function is served in the lives of these animals by those water bodies where no breeding amphibian species were found. They serve as hibernation sites or habitats for juvenile forms.

The numbers of specific species in the water bodies (Table 1) is diverse, as is the frequency of their use by particular amphibian species (Table 2).

Bufo calamita continues to be included among the herpetofauna of Olawa, despite the fact that it no longer breeds in the town. In earlier years (1999–2000), this toad bred within the town (water body no. 10), but later, the area surrounding this pond was changed by humans (trees were planted), resulting in the withdrawal of this species. Today, *Bufo calamita* breeds very close to the town's administrative border (at a distance of just 5 m away) and thus adult and juvenile individuals are found in Olawa.

Table 1. Amphibian taxa and their numbers confirmed in specific water bodies in the town of Olawa in 2006–2009. The water bodies were distinguished by two types (divided by a continuous line): water bodies above the line are highly affected by anthropogenic pressure, those under the line are weakly affected by anthropogenic pressure (see Methods). O – breeding site confirmed solely by the presence of eggs, L – breeding site confirmed only by the presence of larvae, † – former breeding site of the given species, currently absent.

No.	Taxon										
	Triturus cristatus	*Triturus vulgaris*	*Bombina bombina*	*Pelobates fuscus*	*Bufo bufo*	*Bufo calamita*	*Bufo viridis*	*Hyla arborea*	*Rana arvalis*	*Rana esculenta complex*	*Rana temporaria*
1	5	30			60					11	120
3											
4					30					50	
5	O										
6										40	
7											10
17	O	3									
18											20
21					5					5	
22					L						
23											
24											
27							10				
28					L					10	
2		5			20						50
8	10	20	20	10	10		†	10	10	40	40
9	O		5	5	20		†			20	
10	20	20	10	10	10	†	†	10	20	40	
11			†								
12	O	5	5		10			L		10	
13		L	50	L				L	20	20	
14			5						10	10	
15											
16				L							
19			5	10						5	
20			50	10	30				20	50	
25									5		
26										200	

Table 2. The number of breeding sites of a given amphibian taxon in relation to all water bodies studied in Olawa in 2006–2009.

	Taxon	Number of breeding sites	% breeding sites of all water bodies studied (N = 28)
1	*Triturus cristatus*	7	25.0
2	*Triturus vulgaris*	7	25.0
3	*Bombina bombina*	8	28.6
4	*Pelobates fuscus*	7	25.0
5	*Bufo bufo*	11	39.3
6	*Bufo calamita*	0	0.0
7	*Bufo viridis*	1	3.6
8	*Hyla arborea*	4	14.3
9	*Rana arvalis*	6	21.4
10	*Rana esculenta* complex	14	50.0
11	*Rana temporaria*	5	17.9

Three amphibian species – *Bombina bombina*, *Pelobates fuscus* and *Rana arvalis* chose breeding ponds far from areas under high urbanization pressure (χ^2 = 4.166 – 6.124, p = 0.0133 – 0.0412, with Yates' correction for continuity). The remaining taxa did not exhibit this dependence.

The northern part of the town and the area even further north between the Odra and Olawa Rivers deserve special mention. These areas have not been extensively exploited by humans and held numerous populations of almost all the amphibian species present in the lowlands of this region of Poland.

The largest breeding populations, numbering from 60–200 individuals were formed by the *Rana esculenta* complex, *Rana temporaria* and *Bufo bufo*. The *Rana esculenta* complex and *Bufo bufo* were represented in the highest number of water bodies (50.0% and 39.3% respectively), whereas *Rana temporaria* was not as frequently encountered. Many water bodies are located in undeveloped areas, where *Rana arvalis* dominated.

As mentioned earlier, all three "green frog" forms were confirmed in Olawa. *Rana ridibunda* inhabited only water body no. 26. Typical individuals of *Rana* kl. *esculenta* and *Rana lessonae* were encountered with significantly greater frequency in most of the water bodies where "green frogs" were confirmed.

Discussion

13 amphibian taxa were confirmed in Olawa. This is one of the highest numbers of species found in the cities or towns studied in Poland to date. This number is from 8 to 12 in other cities (Guzik et al. 1996, Mazgajska 1998, Baluka 2000, Siwak et al. 2000, Kierzkowski & Ogielska 2001, Sołtysiak 2004, Najbar et al. 2005, Chobotow

& Czarniawski 2007, Hetmański et al. 2008, Nowakowski et al. 2008). More species – 14 – inhabited only Zielona Góra (in the 1970`s) but that number has since dropped to 11 (Najbar et al. 2005). Presumably, the reasons for such a high number of breeding amphibians in Olawa are twofold. First, the town is not part of a larger agglomeration, so the pressure of urbanization is not that high yet. Second, most of Oława`s residents live in the central areas of the town. The periphery and entire northern portion consist of agricultural fields, meadows and forests, thus a mosaic landscape with many ecological niches resulting in high biological diversity exists.

The data on the impact of urbanization pressures on the diversity of amphibian species in Olawa are similar to those obtained in Białystok (Siwak et al. 2000) and Słupsk (Hetmański et al. 2008). In these cities, twice as many amphibian species bred in water bodies located in peripheral areas, that is, in ponds under low urbanization pressure, than in ponds situated in the city center under high urbanization pressure.

The avoidance of ponds in Olawa`s urbanized areas by *Bombina bombina*, *Pelobates fuscus* and *Rana arvalis* was also confirmed in Słupsk (Hetmański et al. 2008). Similarly, these species occur almost exclusively in the peripheral areas of other Polish cities (Kraków, Wroclaw, Zielona Góra, Lublin, Olsztyn), avoiding urbanized locations (Guzik et al. 1996, Kierzkowski & Ogielska 2001, Najbar et al. 2005, Chobotow & Czarniawski 2007, Nowakowski et al. 2008).

The dominance of the *Rana esculenta* complex found in this study (in terms of its population numbers as well as frequency of occurrence) was also confirmed in other cities: Warszawa (Mazgajska 1998), Białystok (Siwak et al. 2000), Wroclaw (Kierzkowski & Ogielska 2001), Chorzów (Sołtysiak 2004) and Lublin (Chobotow & Czarniawski 2007).

The author`s observations confirm that both species of "brown frog" found in Olawa (*Rana arvalis* and *Rana temporaria*) rarely breed in the same water body (Table 1), even when they occur in the same site. This is due to their different breeding pond preferences – *Rana temporaria* prefers small, open and often temporary ponds, while *Rana arvalis* prefers large, generally permanent water bodies, often with thick reed beds (Juszczyk 1987). The data analysis also shows that *Rana arvalis* decidedly prefers less urbanized areas, whereas *Rana temporaria* is found both in less and heavily urbanized sites.

It is worth mentioning that the location of the town in lowlands, as well as in an area with one of the mildest climates in Poland, favors an exceptionally long period of activity in the lives of amphibians. Confirmed sightings include, among others, occurrences of *Triturus vulgaris* in water after hibernation as early as January (Majtyka 2007), as well as still active *Rana* kl. *esculenta* at the end of November.

Considering that *Bombina bombina*, *Pelobates fuscus* and *Rana arvalis* clearly avoid areas of high anthropogenic pressure, it seems that they are the species most likely to become extinct in an urban environment.

Acknowledgements

I would like to express my sincere gratitude to my sister Urszula Majtyka, for undertaking the work involved in preparing the manuscript.

References

Baluka B. 2000. [Studies on the herpetofauna of Wałbrzych]. In: Zamachowski W. (ed.), Biologia płazów i gadów. V Ogólnopolska Konferencja Herpetologiczna, 26–28.06.2000, Kraków, pp. 10–12. Wydawnictwo Naukowe Akademii Pedagogicznej, Kraków, 188 pp. [In Polish]

Chobotow J. & Czarniawski W. 2007. Amphibians and reptiles of the urban area of Lublin (eastern Poland). Chrońmy Przyrodę Ojczystą, 63: 21–37. [In Polish with English summary]

Guzik M., Schimscheiner L., Zakrzewski M., Zamachowski W. & Zyśk A. 1996. Herpetofauna of Cracow city. Studia Ośrodka Dokumentacji Fizjograficznej 24: 247–262. [In Polish with English summary]

Hamer A. J. & McDonnel M. J. 2008. Amphibian ecology and conservation in the urbanising world: A review. Biological Conservation 141: 2432–2449.

Hetmański T., Jarosiewicz A., Salamon S. & Olech K. 2008. The influence of altering ponds and vehicles on the amphibian population of Słupsk In: Indykiewicz P., Jerzak L. & Barczak T. (eds), Fauna miast. pp. 341–346. Wydawnictwo SAR „Pomorze", Bydgoszcz. [In Polish with English summary]

Juszczyk W. 1987. Płazy i gady krajowe. Vol. 2. Państwowe Wydawnictwo Naukowe, Warszawa, 384 pp.

Kierzkowski P. & Ogielska M. 2001. Amphibians in the city of Wroclaw, Poland. Chrońmy Przyrodę Ojczystą, 57: 65–80. [In Polish with English summary]

Kowalewski A. T. 2005. Rozwój zrównoważony w procesach urbanizacji. Nauka 1: 123–146.

Majtyka T. 2007. Wieloletnie obserwacje pojawów traszki zwyczajnej *Lissotriton* (*Triturus*) *vulgaris* (L.) w wodzie po hibernacji. Przegląd Zoologiczny 51 (1–2): 47–50.

Matwijowski K. (ed.). 2004. Olawa. Zarys monografii miasta. Wydawnictwo DTSK Silesia, Wroclaw – Olawa.

Mazgajska J. 1996. Distribution of amphibians in urban water bodies (Warsaw agglomeration, Poland). Ekologia polska 44: 245–257.

Mazgajska J. 1998. [The studies on batrachofauna in Warsaw in 1992–1994]. In: Barczak T., Indykiewicz P. (eds), Urban fauna, pp. 231–240. Akademia Techniczno Rolnicza, Bydgoszcz, 263 pp. [In Polish with English summary]

Najbar B., Szuszkiewicz E. & Pietruszka T. 2005. [Amphibia in Zielona Góra and the disappearance of their sites located within the administrative borders of the town it the years 1974–2004]. Przegląd Przyrodniczy 49: 155–166. [In Polish]

Nowakowski J. J., Górski A., Lewandowski K. & Dulisz B. 2008. Płazy i gady Olsztyna. In: Indykiewicz P., Jerzak L. & Barczak T. (eds). Fauna miast. Wydawnictwo SAR „Pomorze", Bydgoszcz, pp. 151–167.

Siwak P., Kossakowski R. & Chętnicki W. 2000. Amphibians of Białystok. In: Latowski K. (ed.). Studia Biologiczne, pp. 117–121. Bogucki Wydawnictwo Naukowe S.C., Poznań, 173 pp. [In Polish with English summary]

Sołtysiak M. 2004. [The studies on batrachofauna in Chorzów – preliminary data]. In: Zamachowski W. (ed.), Biologia Płazów i Gadów – Ochrona Herpetofauny, VII Ogólnopolska Konferencja Herpetologiczna, 28–29.09.2004, Kraków, pp. 112–116. Wydawnictwo Naukowe Akademii Pedagogicznej, Kraków, 194 pp. [In Polish]

Stanisławska M., Marlinga J., Nowak P. & Kaniewski R. 2004. Program Ochrony Środowiska dla miasta Olawa. Załącznik do Uchwały Rady Miejskiej w Oławie. IME Consulting, Olawa.

Streszczenie

[Płazy Oławy]

Na obszarze administracyjnym miasta Oławy (23,7 km^2, ok. 31 tys. mieszkańców) poddano obserwacji 28 zbiorników wodnych (rys. 1). W latach 2006–2009 stwierdzono występowanie 13 gatunków taksonów (w tym 1 mieszańca). Były to: traszka grzebieniasta *Triturus cristatus*, traszka zwyczajna *Triturus vulgaris*, kumak nizinny *Bombina bombina*, grzebiuszka ziemna *Pelobates fuscus*, ropucha szara *Bufo bufo*, ropucha paskówka *Bufo calamita*, ropucha zielona *Bufo viridis*, rzekotka drzewna *Hyla arborea*, żaba moczarowa *Rana arvalis*, żaba wodna *Rana* kl. *esculenta*, żaba jeziorkowa *Rana lessonae*, żaba śmieszka *Rana ridibunda* i żaba trawna *Rana temporaria*.

Wykazano, iż urbanizacja wpływa negatywnie na różnorodność gatunkową płazów: na obszarach o niskiej presji urbanizacyjnej występuje 2 razy więcej gatunków niż na terenach silnie zurbanizowanych. Na terenie badań gatunkami najbardziej podatnymi na wymieranie w terenie miejskim są kumak nizinny, grzebiuszka ziemna i żaba moczarowa. Należy nadmienić, że batrachofauna miasta Oławy oraz jego okolic nie wykazuje żadnych różnic jakościowych.

Accepted: 8 December 2010

Appendix 1. Characteristics of the water bodies in Olawa based on data collected in 2006–2009. Abbreviations: Location: AF – arable field, AG – allotment gardens, CH – congested housing, FO – forest, GR – grove, ME – meadow, SH – scattered housing, UP – urban park, YP – young pine monoculture; Type: D – drainage ditch, E – sand excavation, K – puddle, P – pond, R – reed field, S – swamp; Periodicity: P – permanent, S – semi-permanent, T – temporary; Banks: B – paved, overgrown with herbaceous plants or trees and rushes, C – concrete, N – natural, overgrown with herbaceous plants/shrubs/trees and rushes, P – wooden palisades, overgrown with herbaceous plants; Shallows: + – present, – – absent; Fishes: + – present, – – absent.

No.	Coordinates	Location	Type	Area [ha]	Periodicity	Banks	Shallows	Depth [m]	Fishes	Water vegetation
1	50°56'33.7"N, 17°16'17.5"E	AG	D	–	P	P	+	0.4–1.0	+	*Alisma, Iris, Callitriche, Elodea, Hottonia, Lysimachia, Myosotis, Ranunculus, Lemna,* Algae
2	50°56'40.4"N, 17°15'51.6"E	AF	D	–	P	N	+	0.2–1.0	–	*Alisma*, *Carex*, *Phragmites*, *Callitriche*, *Hottonia*, *Lysimachia*, *Ranunculus*, *Lemna*, Algae
3	50°56'53.8"N, 17°16'25.5"E	CH	D	–	P	P	+	0.3	+	*Callitriche*, *Lemna*
4	50°56'00.1"N, 17°17'46.1"E	UP	P	0.63	P	B	+	1.0	+	*Sagittaria*, *Typha*, *Ceratophyllum*, *Lysimachia*, *Lemna*, *Nuphar*, Algae
5	50°55'57.2"N, 17°17'48.2"E	UP	P	0.18	P	B	+	1.0	+	*Lysimachia*
6	50°55'55.8"N, 17°17'45.9"E	UP	P	0.18	P	B	+	0.8	+	*Phragmites*, *Lemna*, Algae
7	50°56'16.8"N, 17°17'27.2"E	UP	D	–	S	N	+	0.2	–	*Callitriche*, Algae
8	50°56'48.1"N, 17°15'53.2"E	AF	P	0.14	P	N	+	1.0	+	*Alisma*, *Iris*, *Juncus*, *Phragmites*, *Typha*, *Callitriche*, *Chara*, *Hottonia*, *Lemna*, *Lysimachia*, *Myosotis*, *Ranunculus*, *Lemna*, *Potamogeton*, Algae
9	50°58'48.0"N, 17°16'55.7"E	YP	P	0.03	P	N	+	1.0	+	*Alisma*, *Juncus*, *Phragmites*, *Typha*, *Ceratophyllum*, *Elodea*, *Myosotis*, *Lemna*, *Nuphar*, *Potamogeton*, Algae
10	50°58'45.1"N, 17°16'56.0"E	YP	P	0.07	S	N	+	0.2–0.3	–	*Alisma*, *Juncus*, *Phragmites*, *Typha*, *Myosotis*, *Utricularia*, *Lemna*, Algae
11	50°58'42.5"N, 17°17'28.0"E	AF	K	–	T	N	+	0.1	–	Algae

12	50°59'17.4"N, 17°18'23.7"E	AF	P	0.08	P	N	–	0.3–2.0	+	*Alisma*, *Juncus*, *Sagittaria*, *Scirpus*, *Typha*, *Ceratophyllum*, *Myosotis*, *Lemna*, *Potamogeton*, *Spirodela*, Algae
13	50°58'50.1"N, 17°17'52.6"E	ME	R	1.60	P	N	+	0.5–0.8	–	*Phragmites*, Algae
14	50°58'54.1"N, 17°17'23.9"E	FO	P	0.02	P	N	+	< 1.0	+	*Iris*, *Juncus*, *Phragmites*, *Hydrocharis*, *Lemna*, *Spirodela*
15	50°59'31.9"N, 17°18'21.2"E	ME	P	0.02	S	N	+	0.1–2.0	–	*Acorus*, *Iris*, *Phragmites*, Algae
16	50°59'20.4"N, 17°18'20.6"E	ME	R	0.40	S	N	+	0.4–0.5	–	*Iris*, *Phragmites*, Algae
17	50°56'15.8"N, 17°16'59.2"E	AG	D	–	P	P	+	0.3	–	*Phragmites*, *Lysimachia*, *Myosotis*, *Lemna*, Algae
18	50°56'15.7"N, 17°16'58.0"E	AF	S	0.09	T	N	+	0.2–0.4	–	*Phragmites*, *Callitriche*, *Lysimachia*, *Myosotis*
19	50°58'28.6"N, 17°17'40.0"E	AF	D	–	P	N	–	0.3–0.5	–	*Typha*
20	50°56'15.1"N, 17°19'51.6"E	GR	E	0.79	P	N	+	0.3–0.5	+	*Phragmites*, *Typha*, *Fontinalis*, *Lemna*, *Spirodela*
21	50°57'07.9"N, 17°17'50.2"E	SH	P	0.07	P	N	–	< 1.0	+	lack
22	50°56'27.1"N, 17°16'34.6"E	AG	P	0.02	P	N	–	1.0	+	*Typha*, *Lemna*, *Myosotis*, Algae
23	50°56'06.8"N, 17°17'22.3"E	UP	S	0.04	P	N	+	0.3	–	*Phragmites*
24	50°56'08.9"N, 17°17'30.7"E	UP	D	–	S	N	+	0.1–0.2	–	lack
25	50°58'56.5"N, 17°17'28.1"E	FO	S	0.02	S	N	+	0.1–0.3	–	*Iris*, *Callitriche*, *Riccia*, *Lemna*
26	50°56'21.3"N, 17°19'36.4"E	GR	O	4.30	P	N	+	a few m	+	*Carex*, *Phragmites*, *Typha*, *Ceratophyllum*, *Myosotis*, *Myriophyllum*, *Ranunculus*, *Riccia*, *Utricularia*, Algae
27	50°57'14.9"N, 17°16'54.5"E	SH	P	0.02	P	C	+	0.3	+	Algae
28	50°56'10.4"N, 17°15'57.1"E	SH	P	0.05	P	N	+	0.2–0.4	+	*Glyceria*, *Iris*, *Juncus*, *Ranunculus*, *Phragmites*, *Rorippa*, *Typha*, Algae