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AQUATIC INVERTEBRATE DIVERSITY OF SMALL PONDS BY *EMYS ORBICULARIS* IN LATVIA

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Abstract
As shown in many investigations the European pond turtle (*Emys orbicularis*) is an opportunistic predator and omnivorous with a broad food niche (aquatic and terrestrial invertebrates Coleoptera, Decapoda, Odonata, Heteroptera, Gastropoda and others, and plant matter (algae, macrophytes)). To characterize the food resources of the European pond turtle one of the study aims was to examine taxa composition and observation of frequency of the macroinvertebrates and also taxa composition and quantitative structure of zooplankton communities in turtle ponds of Latvia. The investigated turtle ponds located in the protected nature area in the Southeast of Latvia, are very small (approximately from 0.08 to 0.01 ha) and shallow even dry (in July) with abundant surface and submerged aquatic vegetation. Qualitative macro-invertebrates and quantitative zooplankton samples were obtained using standard methods in June and July 2019 during the reproductive phase of turtles. Simultaneously water physico-chemical parameters were measured using a multi parameter probe (HACH Hydrolab DS5). In total 47 taxa of macroinvertebrates were identified. The most diverse groups were Coleoptera, especially Dytiscidae (15 taxa, mainly adult specimens). Hemiptera (Naucoridae, *Ilyocoris cimicoides*), Ephemeroptera (Beatidae, *Cloeon dipterum*), Odonata (Anisoptera, *Sympetrum* sp.) and Gastropoda (Planorbidae) were the most frequently observed taxa. Zooplankton communities were also taxa abundant, especially by Rotifera (46 taxa). The largest cladocerans (15 taxa) were represented by *Scapholeberis mucronata*, *Ceriodaphnia* sp., *Chydorus* sp., and also *Daphnia magna*, *Polychemus pediculus* in a smaller number. Copepoda cyclopoids, calanoids and their development stages (copepodite, nauplii) were quite numerous (6 taxa). In general, the turtle ponds have quite food rich for the European pond turtle.

Keywords: *Emys orbicularis* habitats, macroinvertebrata taxa diversity, zooplankton diversity.

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INTRODUCTION

The European Pond turtle *Emys orbicularis* (Linnaeus, 1758) is found in southern, central, and eastern Europe, in western and central Asia and in north Africa. *Emys orbicularis* is the most far distributed to the north species of turtle in Europe, and territory of Latvia for *Emys orbicularis* is the northern edge of the species distribution area (Fritz 2003, Meeske et al. 2026, Pupiņš & Pupiņa 2007, Uetz et al. 2025).

The *Emys orbicularis* has been listed as Near Threatened (NT) by the IUCN since 1996 due to severely fragmention of population and significant long-term population declines (Tortoise and Freshwater Turtle … 1996). The species is also protected in Europe by the Bern Convention (Annex I: strictly protected fauna species, Annexes II: requiring specific habitat conservation measures (year of revision 2011), 1979) and by EU Habitats Directive 92/43/EEC (Annex II: animal and plant species of community interest whose conservation requires the designation of special areas of conservation, 1992) (European pond terrapin - *Emys orbicularis* (Linnaeus, 1758) … 2025). In Latvia, *Emys orbicularis* is an extremely rare, endangered, with unfavourable - bad status species, and is included into the list of especially protected species of Latvia (The Cabinet of Ministers' Regulations No. 396 … 2000).

To provide suitable *Emys orbicularis* conservation and protection, and to an assessment of the European pond turtle distribution and occurrence, vitality of the population, environmental conditions, suitability of habitats and other management measures of the species protection, since the 80s of the last century has been realized many investigations and projects, including developed species management plan "The Plan of preservation of European pond turtle *Emys orbicularis*" (Pupins & Pupina 2014, Pupiņš & Pupiņa 2007).

One of the more important factors for the survival, migration and reproduction of the European pond turtle population is the suitability of qualitative habitats, especially for eggs-laying, feeding, and dormancy (Ficetola et al. 2004, Ducotterd et al. 2020, Pupiņš & Pupiņa 2007). Such small new habitats (ponds) for maintenance of *Emys orbicularis* in Latvia were created in 2010 - 2013 for the species renewal, maintenance and to support turtle survival at different life-history stages in the specially protected nature territory of Latvia, Nature Park "Silene" (Pupins & Pupina 2014) (Fig. 1).

The research aims to evaluate created habitats' biotic and abiotic features (physicochemical water parameters, zooplankton, macro-invertebrates) because such complex studies in ponds have not been conducted since their creation. We supposed that our results could be useful for further research, conservation planning and measures of *Emys orbicularis*.

Freshwater turtles feed primarily on aquatic invertebrates, in turn, the diversity of invertebrates is frequently used as an indicator of freshwater functionality, health and quality (Jeppesen et al. 2022, Solimini et al. 2006). Habitat complexity and heterogeneity are some of the most important factors structuring biotic assemblages (Ducotterd et al. 2020, Kovalenko et al. 2012). Ducotterd and authors (2020) researching the feeding behaviour of the European pond turtle by faecal analyses and metabarcoding in Switzerland revealed a large species richness in the diet of the European pond turtle, and results showed that the

European pond turtle feeding strategy follows an opportunistic and omnivorous pattern (consumed both plants and invertebrates, vertebrates). As well as investigations of the stomachs of other freshwater turtles (*Chelodina longicollis*, *Chrysemys picta*) and observation of how juveniles of *Emys orbicularis* captured large *Daphnia* show that large cladocerans are also eaten (Franch & Ramos 2016).

Figure 1. Habitats of *Emys orbicularis* site No. 1 and No. 2 in Nature Park "Silene" before (A) and after (B) creating (Google Earth service, SAS services) (Pupins & Pupina 2014).

MATERIAL AND METHODS

The study ponds of European pond turtle are located in the specially protected nature territory of Latvia, Nature Park "Silene" in the Southeast of Latvia (Fig. 2).

The habitats (ponds) are very small (approximately from 0.08 to 0.01 ha), shallow water, with depth from 0.30 – 1.35 m and even dried (in July) with abundant, quite diverse surface and submerged aquatic vegetation (*Phragmites australis*, *Potamogeton* sp., *Typha* sp., *Carex* sp. and other) (Fig. 3). The substratum of the study sites mostly consisted of sand, detritus and mud.

The studies of the ponds (sampling of zooplankton and macroinvertebrates) were carried out in June – July 2019, during the reproductive phase of turtles and in September 2019 (sampling of macroinvertebrates) (Fig. 4), except for Pond No. 1 (investigate only in June 2019), which was temporarily dried out in July and September 2019. Simultaneously measurements of the physicochemical parameters of water were done. In September 2019, only the physicochemical parameters measurements of water and sampling of macroinvertebrates were done.

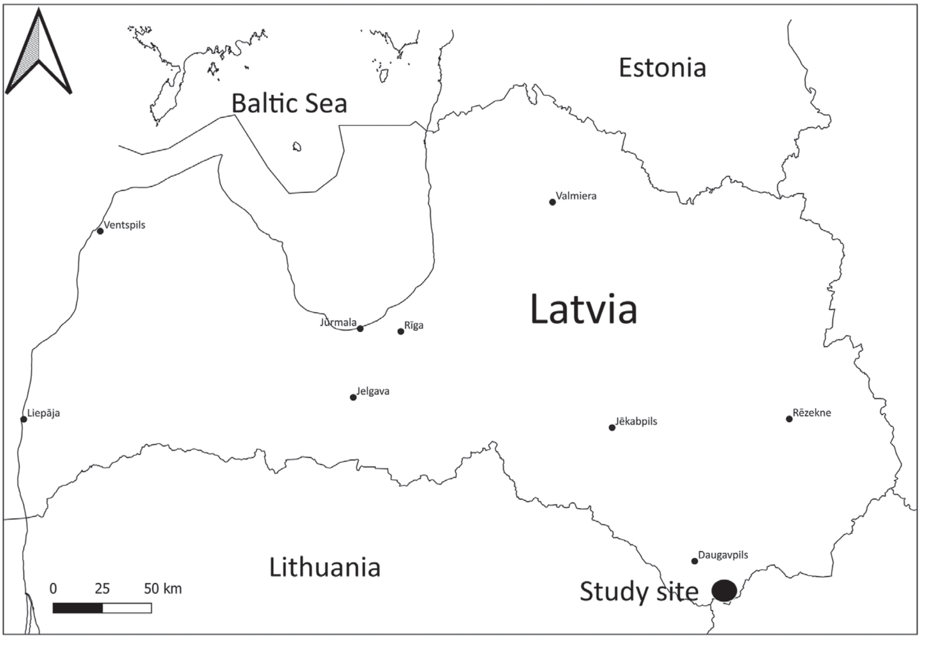

Figure 2. Location of the study site (QGIS, J.Paidere).

Figure 3. Pond habitats in study site. Image courtesy: J. Paidere, 2019.

Physicochemical water parameters – water temperature °C, conductivity µS cm^{-1}, dissolved oxygen mg l^{-1}, pH, chlorophyll α µg l^{-1} and oxidation-reduction potential (ORP) mV – were measured in situ using a HACH Hydrolab DS5 multiprobe.

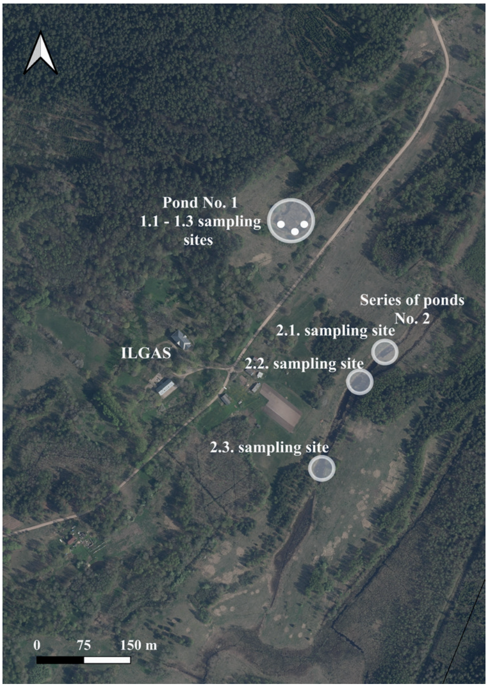

Figure 4. Sampling sites in the ponds (created on the basis of Latvian Geospatial Information Agency map, ortophoto map cycle 8, 2022 - 2024).

The sampling of zooplankton were performed in the littoral/ inshore parts of the ponds. The zooplankton samples were collected using Apstein type plankton net (64 µm), through which 100 liters of water were filtered from the water surface layer (0.5 – 1 m depth). The samples were preserved in ethanol (at least 70% solution) (APHA Plankton 10200... 2005). The analysis of zooplankton samples was conducted using ZEISS Axiovert 40C microscope (100 - 400 x magnification). The zooplankton 1 ml subsamples were analysed 6x repeatedly using gridded Sedgewick Rafter counting chambers, in total 6 ml sample's subvolume was examined APHA Plankton 10200 (2005). Specimens of zooplankton were determined by species, genus or family applying relevant identification guides - Bielańska-Grajner et al. (2015), Dussart & Defaye (2001), Flössner 2000, Flössner (2002), Hudec (2010), Kutikova & Starobogatov (1977), Kutikova (1970), Manuilova (1964), Nogrady & Segers (2002), Paidere & Škute (2011), Pontin (1978), Ruttner-Kolisko (1974), Scourfield & Harding (1994), Segers (1995), Segers (2007), Sloka (1981), Smirnov (1996).

The sampling of macroinvertebrates was performed in the inshore at one site. Qualitative (in June 2019) and semi-quantitative samples (July, September 2019) of macroinvertebrates were collected using a *Hydrobios* hand net with a mouth opening of 25 x 25 cm (500 µm mesh) in the wadeable (up to 0.5 m) depths by the sweeping technique. The final sample consisted of 10 to 12 sweep units (LVS EN ISO 10870: 2012). The samples were preserved in ethanol (at least 70% ethanol) for later identification and counting. Specimen identification was done with a ZEISS Stemi 508doc stereomicroscope using the literature: Timm (2015), Kriska (2013). As much as possible, animals were identified to the lowest taxonomic level.

Table 1. Physico-chemical parameters of the ponds.

Parameters/date/ and sampling sites	Pond No. 1 (1.1. - 1.3. sampling sites)			Ponds No. 2 (sampling sites of ponds 2.1., 2.2., 2.3.)		
	1.1.	1.2.	1.3.	2.1.	2.2.	2.3.
June, 2019						
Water temperature °C	30.6	31.5	25.8	25.7	27.6	26.3
Conductivity µS cm^{-1}	258	258	244	99	98	114
Dissolved oxygen mg l^{-1}	9.3	8.7	8.3	3.4	4.5	2.1
Oxidation-reduction potential mV	470	457	462	441	474	408
pH	6.8	7.2	6.4	6.0	6.1	6.1
Chlorophyll α µg l^{-1}	24.2	28.0	63.9	4.4	1.8	4.1
July, 2019						
Water temperature °C	n.d.	n.d.	n.d.	18.8	17.9	18.5
Conductivity µS cm^{-1}	n.d.	n.d.	n.d.	84	91	103
Dissolved oxygen mg l^{-1}	n.d.	n.d.	n.d.	3.3	4.6	4.2
Oxidation-reduction potential mV	n.d.	n.d.	n.d.	495	486	464
pH	n.d.	n.d.	n.d.	6.3	6.4	6.6
Chlorophyll α µg l^{-1}	n.d.	n.d.	n.d.	2.7	5.2	3.6
September, 2019						
Water temperature °C	n.d.	n.d.	n.d.	18.2	19.5	19.8
Conductivity µS cm^{-1}	n.d.	n.d.	n.d.	83	73	79
Dissolved oxygen mg l^{-1}	n.d.	n.d.	n.d.	3.3	5.8	4.7
Oxidation-reduction potential mV	n.d.	n.d.	n.d.	457	469	495
pH	n.d.	n.d.	n.d.	6.3	6.4	6.4
Chlorophyll α µg l^{-1}	n.d.	n.d.	n.d.	1.7	3.3	2.5

RESULTS AND DISCUSSION

Physico-chemical parameters

Water conductivity or water hardness, chlorophyll α, and dissolved oxygen are the main parameters differing among ponds in June 2019 (Tab. 1). The ponds can divided into two groups by conductivity - hard water (Pond Nr. 1, mean 254 µs cm^{-1}) and soft water (Ponds Nr. 2 mean 98 µs cm^{-1}) with the lower pH (mean 6.23).

Water physico-chemical parameters, in June 2019 differed evidently from July and September 2019 in terms of water temperature, chlorophyll α, and dissolved oxygen, as well as between the ponds (Tab. 1). In turn, the ponds Nr. 2 are characterized by similar concentrations of dissolved oxygen and chlorophyll, and values of electrical conductivity, pH and ORP, it is understandable because they have been created in the same cascade, one after the other. Such high water temperatures in June can be explained by the untypical warm spring in May and the early summer, when June's mean air temperature was +18.7 °C, the Latvian norm is +15.2 °C (Latvian Environment, Geology and Meteorology Centre ... 2019).

There is no research on phytoplankton in these ponds, but the high concentrations of chlorophyll α in Pond Nr. 1 may indicate that small ponds with rich organic matter, and high concentrations of phosphorus and nitrogen consequent to decaying vegetation are very suitable habitats, for example, for euglenophytes, as well as other flagellates belonging to cryptophytes, dinoflagellates, chrysophytes, raphidophytes and chlorophytes. Mixotrophic taxa, develop very well in such ponds (Poniewozik & Juran 2018, Willey et al. 1988).

Attention should be devoted to low oxygen concentrations. If such low concentrations of dissolved oxygen or lower are observed in winter, such conditions for the European pond turtle dormancy in ponds may be unfavourable (Pupiņš & Pupiņa 2007). High values of ORP show that there is enough dissolved oxygen present in the ponds for the processes of sediment decomposing, in healthy waters, ORP should read high between 300 and 500 mV (Horne & Goldman 1994).

Zooplankton

In total 67 taxa of zooplankton were identified. The most diverse groups were Rotifera, (46 taxa) (Appendix 1). The largest cladocerans (15 taxa) were represented by *Scapholeberis mucronata*, *Ceriodaphnia* sp., *Chydorus* sp., *Diaphanosoma brachyurum* and *Daphnia magna*, *Polychemus pediculus* in a smaller number respectively. Copepoda cyclopoids, calanoids and their development stages (copepodite, nauplii) were quite numerous (6 taxa) (Appendix 1). The obtained zooplankton data show that, in general, the turtle ponds have quite rich food for European pond turtles.

Macroinvertebrate

Fifty-four taxa of macroinvertebrate, belonging to Annelida, Mollusca, Arachnida, Insects and Crustacea were recorded from the ponds during the sampling period (Appendix 2).

The most diverse groups were Coleoptera, especially Dytiscidae, Hydrophilidae (22 taxa). Gastropoda (Planorbidae, *Planorbis (Planorbis) planorbis*, *Planorbarius corneus*), Bivalvia (Sphaeriidae, *Sphaerium corneum*), Hemiptera (Naucoridae, *Ilyocoris cimicoides*) in Ponds Nr. 2 site 2.2. and Ephemeroptera (Baetidae, *Cloeon dipterum*) in Ponds Nr. 2 site 2.1. were the most frequently observed taxa. In general, macroinvertebrate taxa has been found in the ponds are often and widely distributed in standing freshwaters (Deimantoviča et al. 2019, Timm 2015). Although the ponds were created only 10 years ago, zooplankton and macroinvertebrate communities in the studied ponds are quite

diverse, also as a diet source for the European pond turtle.
The first young adults and semi-adults the European pond turtles were released into the natura park “Silene” created ponds in 2014, and repeatedly in 2019 for restoration of *Emys orbicularis* population (Pupins & Pupina 2014). New monitoring data on European pond turtles show that of the released 62 turtles, the population consist of at least 36 specimens (Čeirāns & Pupiņš 2024). The heterogeneity and functionality of the created habitats facilitate the existence of metapopulations, thus increasing the likelihood of the long-term survival of the European pond turtle populations in the Nature Park “ Silene”. However, further assessment of population structure, life history, and dynamics must include studies of abiotic and biotic conditions.

CONCLUSIONS

During the complex study, the biotic and abiotic properties of the biotopes created in the ponds were evaluated (physico-chemical parameters of water, zooplankton, macroinvertebrates). We thought that our obtained data can be the basis for further research on conservation planning and measures of *Emys orbicularis*, as such comprehensive studies have not been carried out in the ponds since their creation.

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Appendix 1. Zooplankton composition of the ponds.

Taxa	Taxa composition between sampling dates and sites No.								
	1.1. Jun,12	1.2. Jun,12	1.3. Jun,12	2.1. Jun,12	2.1. Jul.,10	2.2. Jun,12	2.2. Jul.,10	2.3. Jun,12	2.3. Jul.,10
ROTIFERA									
Anuraeopsis fissa Gosse, 1851							*		
Ascomorpha ecaudis Perty, 1850								*	
Ascomorpha ovalis (Bergendal, 1892)					*		*		*
Asplanchna priodonta Gosse, 1850	*								*
Brachionus angularis Gosse, 1851									*
Brachionus calyciflorus Pallas, 1766	*		*	*	*	*		*	*
Cephalodella gibba (Ehrenberg,1832)	*		*	*		*	*	*	
Cephalodella sp. Bory de St. Vincent, 1826					*		*	*	*
Collotheca mutabilis (Hudson, 1885)							*		
Collotheca sp. Harring, 1913									*
Conochilus sp. Ehrenberg, 1834									*
Euchlanis dilatata Ehrenberg, 1832				*	*	*		*	
Filinia longiseta (Ehrenberg, 1834)									*
Gastropus stylifer (Imhof, 1891)									*
Kellicottia longispina Kellicott, 1879	*								*
Keratella cochlearis (Gosse, 1851)	*	*	*	*	*	*	*	*	*
Keratella hispida (Lauterborn, 1898)									*

Taxa	Taxa composition between sampling dates and sites No.								
	1.1. Jun,12	1.2. Jun,12	1.3. Jun,12	2.1. Jun,12	2.1. Jul.,10	2.2. Jun,12	2.2. Jul.,10	2.3. Jun,12	2.3. Jul.,10
Keratella quadrata (Müller, 1786)	*		*						*
Lecane flexilis (Gosse, 1886)					*				
Lecane ludwigii (Eckstein, 1883)		*						*	
Lecane luna (Müller, 1776)									*
Lecane lunaris (Ehrenberg, 1832)	*	*	*	*	*			*	
Lepadella ovalis (O.F. Müller, 1786)		*		*	*	*	*	*	*
Lepadella patella (Müller, 1773)		*	*	*		*		*	
Lepadella quinquecostata (Lucks, 1912)									*
Monommata sp. Bartsch, 1870						*		*	
Mytilina mucronata (Müller, 1773)		*			*	*		*	
Notholca acuminata (Ehrenberg, 1832)									*
Platyias quadricornis (Ehrenberg, 1832)				*	*	*			
Polyarthra sp. Ehrenberg, 1834	*				*				
Polyarthra vulgaris Carlin, 1943		*	*	*		*	*	*	*
Pompholyx sulcata Hudson, 1885	*								*
Rotifera sp. (Pallas, 1766)	*	*		*			*	*	*
Synchaeta sp. Ehrenberg, 1832	*	*	*	*	*	*	*	*	*
Testudinella patina (Hermann, 1783)		*			*			*	*
Testudinella sp. Bory de St. Vincent, 1826									*

Taxa	Taxa composition between sampling dates and sites No.								
	1.1. Jun,12	1.2. Jun,12	1.3. Jun,12	2.1. Jun,12	2.1. Jul.,10	2.2. Jun,12	2.2. Jul.,10	2.3. Jun,12	2.3. Jul.,10
Testudinella truncata (Gosse, 1886)		*							
Trichocerca capucina (Wierzejski & Zacharias, 1893)									*
Trichocerca cylindrica (Imhof, 1891)					*			*	
Trichocerca longiseta (Schrank, 1802)	*			*			*		
Trichocerca porcellus (Gosse, 1851)					*			*	
Trichocerca rattus (Müller, 1776)						*		*	
Trichocerca rousseleti (Voigt, 1902)									*
Trichocerca similis (Wierzejski, 1893)					*				*
Trichocerca sp. Lamarck, 1801									*
Trichotria truncata (Whitelegge, 1889)					*				
CLADOCERA									
Alonella nana (Baird, 1843)			*		*				*
Bosmina coregoni Baird, 1857	*								
Bosmina longirostris (O. F. Müller, 1776)	*								
Ceriodaphnia sp. Dana, 1853	*	*	*	*	*	*	*	*	*
Chydorus ovalis (Kurz, 1875)	*	*	*	*			*		*
Chydorus sphaericus (O. F. Müller, 1776)		*						*	
Daphnia cristata Sars, 1862									*
Daphnia cucullata (Sars, 1862)									*

Taxa	Taxa composition between sampling dates and sites No.								
	1.1. Jun,12	1.2. Jun,12	1.3. Jun,12	2.1. Jun,12	2.1. Jul.,10	2.2. Jun,12	2.2. Jul.,10	2.3. Jun,12	2.3. Jul.,10
Daphnia magna Straus, 1820	*	*	*						
Daphnia sp. O. F. Müller, 1785	*		*				*	*	*
Diaphanosoma brachyurum (Liévin, 1848)	*					*	*	*	
Kurzia latissima (Kurz, 1875)		*							
Polyphemus pediculus (Linnaeus, 1758)	*	*							
Scapholeberis mucronata (O. F. Müller, 1776)	*	*	*		*		*		
Simocephalus vetulus (O. F. Müller, 1776)			*						
COPEPODA									
Acanthocyclops sp. Kiefer, 1927			*						*
Cyclops sp. Müller, 1785	*		*	*	*	*	*	*	*
Eucyclops sp. Claus, 1893			*						
Eudiaptomus sp. Kiefer, 1932	*		*		*			*	*
Megacyclops sp. Kiefer, 1927				*					
Mesocyclops sp. Kiefer, 1927			*						
Copepodite	*	*	*	*	*	*	*	*	*
Nauplii	*	*	*	*	*	*	*	*	*

Appendix 2. Macroinvertebrate composition of the ponds.

Taxa	Taxa composition between sampling dates and sites No.											
	1.1. Jun,12	1.2. Jun,12	1.3. Jun,12	2.1. Jun,12	2.1. Jul.,10	2.1 Sept., 4	2.2. Jun,12	2.2. Jul.,10	2.2 Sept., 4	2.3. Jun,12	2.3. Jul.,10	2.3. Sept., 4
Annelida, Hirudinea												
Glossiphonia complanata (Linnaeus, 1758)							*	*	*			
Erpobdella testacea (Savigny, 1820)							*	*	*			
Erpobdella octoculata (Linnaeus, 1758)								*				
Placobdella costata (Müller, 1846)								*	*			
Bivalvia												
Sphaerium corneum (Linnæus, 1758)		*	*	*	*	*	*		*	*	*	*
Gastropoda												
Planorbis (Planorbis) planorbis (Linnaeus, 1758)	*		*	*	*	*	*	*	*	*	*	
Planorbarius corneus (Linnaeus, 1758)			*	*	*	*	*	*	*	*	*	*
Bathyomphalus contortus (Linnaeus, 1758)									*			
Viviparus contectus (Millet, 1813)						*	*	*	*	*	*	*
Stagnicola sp. Jeffreys, 1830						*		*	*		*	*

Taxa	Taxa composition between sampling dates and sites No.											
	1.1. Jun,12	1.2. Jun,12	1.3. Jun,12	2.1. Jun,12	2.1. Jul.,10	2.1 Sept., 4	2.2. Jun,12	2.2. Jul.,10	2.2 Sept., 4	2.3. Jun,12	2.3. Jul.,10	2.3. Sept., 4
Arachnida												
Argyroneta aquatica (Clerck, 1757)								*				
Ephemeroptera												
Cloeon dipterum (Linnaeus, 1761)				*	*	*	*	*	*		*	*
Plecoptera	*		*									
Odonata												
Lestes sponsa (Hansemann, 1823)	*	*	*					*		*		
Coenagrion sp. Charpentier, 1840				*	*	*			*	*		*
Sympetrum sp. Sulzer, 1776	*	*	*	*	*	*		*			*	
Sympetrum flaveolum (Linnaeus, 1758)			*	*			*					
Aeshna cyanea (Muller, 1764)							*					
Aeshna sp. Vander Linden, 1820					*						*	*
Hemiptera												
Notonecta (Notonecta) *glauca* Linnaeus, 1758	*	*	*					*	*			*
Ilyocoris cimicoides (Linnaeus, 1758)			*	*	*	*	*	*	*	*	*	*
Gerris sp. Fabricius, 1794				*	*							

Taxa	Taxa composition between sampling dates and sites No.											
	1.1. Jun,12	1.2. Jun,12	1.3. Jun,12	2.1. Jun,12	2.1. Jul.,10	2.1 Sept., 4	2.2. Jun,12	2.2. Jul.,10	2.2 Sept., 4	2.3. Jun,12	2.3. Jul.,10	2.3. Sept., 4
Ranatra (Ranatra) linearis (Linnaeus, 1758)							*					*
Nepa cinerea Linnaeus, 1758						*		*	*		*	*
Coleoptera												
Dytiscus sp. Linnaeus, 1758				*						*		
Dytiscus dimidiatus Bergsträsser, 1778								*				
Ilybius sp. Erichson, 1832	*				*				*			
Platambus sp.Thomson, 1859						*						
Hygrotus (Hygrotus) inaequalis (Fabricius, 1776)	*		*			*						*
Hygrotus (Coelambus) impressopunctatus (Schaller, 1783)						*						
Hygrotus sp. Stephens, 1828					*						*	
Hydaticus sp. Leach, 1817			*									
Hydaticus (Hydaticus) transversalis (Pontoppidan, 1763)				*				*	*	*		*
Hydaticus (Hydaticus) seminiger (De Geer, 1774)					*		*			*		*

Taxa	Taxa composition between sampling dates and sites No.											
	1.1. Jun,12	1.2. Jun,12	1.3. Jun,12	2.1. Jun,12	2.1. Jul.,10	2.1 Sept., 4	2.2. Jun,12	2.2. Jul.,10	2.2 Sept., 4	2.3. Jun,12	2.3. Jul.,10	2.3. Sept., 4
Graphoderus sp. Dejean, 1833				*		*						
Graphoderus bilineatus (Degger, 1774)			*									
Graphoderus zonatus (Hoppe, 1795)								*				
Acilius (Acilius) canaliculatus (Nicolai, 1822)								*	*			*
Trichoptera												
Triaenodes bicolor (Curtis, 1834)			*								*	
Hydroptilidae				*								
Limnephilus sp. Leach, 1815					*		*					*
Diptera												
Tanypodinae	*											
Chironomidae, pupae			*									
Chironomus sp. Meigen, 1803										*		
Atherix ibis (Fabricius, 1798)				*								
Crustacea												
Asellus aquaticus (Linnaeus, 1758)			*				*	*	*	*		