



## Distribution of the European water vole *Arvicola amphibius* (Linnaeus, 1758) in Mazowsze and southern Podlasie

Grzegorz LESIŃSKI<sup>1</sup>, Marek KOWALSKI<sup>2</sup>, Przemysław STOLARZ<sup>3</sup>,  
Jakub GRYZ<sup>4</sup>, Dagny KRAUZE-GRYZ<sup>5</sup> and Jerzy ROMANOWSKI<sup>6</sup>

<sup>1</sup>*Faculty of Animal Science, Warsaw University of Life Sciences – SGGW, Ciszewskiego 8, 02-787 Warsaw, Poland; e-mail: glesinski@wp.pl (corresponding author)*

<sup>2</sup>*Wildlife Society “Stork”, Jagiello 11, 08-110 Siedlce, Poland; e-mail: marek@bocian.org.pl*

<sup>3</sup>*Center for Human Ecology, Kościuszki 24, 05-075 Warsaw-Wesoła, Poland; e-mail: przem.stolarz@gmail.com*

<sup>4</sup>*Forest Research Institute, Sękocin Stary, Braci Leśnej 3, 05-090 Raszyn, Poland; e-mail: J.Gryz@ibles.waw.pl*

<sup>5</sup>*Faculty of Forestry, Warsaw University of Life Sciences – SGGW, Nowoursynowska 159, 02-776 Warsaw, Poland; e-mail: dagny.krauze@wl.sggw.pl*

<sup>6</sup>*Faculty of Biology and Environmental Studies, Cardinal Stefan Wyszyński University, Wóycickiego 1/3, 01-938 Warsaw, Poland; e-mail: j.romanowski@uksw.edu.pl*

**Abstract:** The paper presents distribution of the European water vole *Arvicola amphibius* (Linnaeus, 1758) in Mazowsze and southern Podlasie in areas situated within a 120-kilometer radius from Warsaw. Data published so far and unpublished results from analyses of the diet of three common species of owls were set up. The rodent is rare in the study area, especially when compared with southern, western and far northern Poland. Its largest population lives in Kampinos Forest, from where many localities are known. In other parts of the study area it is present locally. Only 14 localities were known outside Kampinos Forest in the years 2000–2017. It is even absent from large areas rich in various water bodies like e.g. Mazowiecki and Chojnowski Landscape Parks or Bolimowska Forest. Rarity of the European water vole was confirmed by 235 large samples of owls' food (at least 100 of vertebrate prey in each) equally distributed across Mazowsze and southern Podlasie, in which this species was not found.

**Key words:** Rodentia, Arvicolinae, distribution, Central Poland

### INTRODUCTION

Taxonomic status of Polish water voles *Arvicola* sp. is still not clear. Some of subspecies of previously distinguished species – *A. terrestris* (Linnaeus, 1758) – in the last decades have been considered as separate species. It cannot be excluded that in Poland there are two species: European water vole *A. amphibius* (Linnaeus, 1758) and montane water vole *A. scherman* (Shaw, 1801). The range of the latter covers the area of south part of the country (the region of Carpathian Mountains) where the subspecies *A. terrestris scherman* was recorded (Cassola 2016). Populations of this species show different habitat preferences (ecotype) than *A. amphibius* from the central and north Poland (Cais 1974).

The range of the European water vole covers most of the area of Poland, especially lowlands. Many localities of this species known till the year 1980 mainly were found during analyses of the owls' pellets (Raczyński 1983). Least localities were noted in those days in central Poland, especially in Mazowsze. One could have assumed that the picture was a bit distorted due to relatively small number of analysed sites in this part of the country and could have expected that further studies would reveal other localities of this species. However, the number of localities of the European water vole in central Poland has not increased recently (Zub 2017).

The aim of this study was to set up published and unpublished data on the distribution of the European water vole in Mazowsze and southern Podlasie and to estimate the status of its occurrence.

#### STUDY AREA, MATERIAL AND METHODS

Study area covered mainly Mazovian Lowland and fragment of southern Podlasie and was situated within a 120-kilometre radius from Warsaw. This is a lowland area cross-cut by large rivers: the Vistula, Bug, Narew, Pilica, Wieprz, Bzura, Wkra and Liwiec. Quite numerous oxbow lakes are present in the largest valleys. Larger wetlands are present in central and eastern part of the study area. Locally, especially in eastern, south-eastern and extremely western part, there are complexes of fishponds. Apart from published records, unpublished data collected in the years 1980–2017 from analyses of pellets of common owl species: the barn owl *Tyto alba* (Scopoli, 1769), long-eared owl *Asio otus* (Linnaeus, 1758) and tawny owl *Strix aluco* (Linnaeus, 1758) were also used in this study. Such material is a very good source of information on the distribution of small mammals including the European water vole. In regions, where the vole is common and numerous, it is often found in the diet of the barn owl (Wieluńska Upland – Lesiński 1991), long-eared owl (northern Podlasie – Lesiński et al. 2016b), or tawny owl (northern Podlasie – Lesiński et al. 2009, Gryz et al. 2011a).

The paper presents also data on sites, where the European water vole was not found in samples of owls' food containing at least 100 vertebrate prey items. There were 235 such samples (Appendix). This was done to delineate fragments of the study area, where the rodent is most probably absent.

#### RESULTS

Distribution of known localities of the European water vole in the study area (Table 1) was quite uneven. Till the end of the 20th century in the neighbourhood of Warsaw it was found only in Kampinos Forest. Larger groups of localities were noted in far northern part of the study area. One locality was known from southern Mazowsze (near Tomaszów Mazowiecki). In the years 2000–2017 the presence of the rodent was confirmed in Kampinos Forest, where it appeared rather common and numerous. It was also found in western Mazowsze (Głuchów, Popień, Drobin, Leszczyny Kolonia, Jeżewo), at the southern edge of Warsaw (Wilanów), in Kozienice Forest (in three squares of the Atlas of Polish Mammals), in southern Podlasie (Nowa Sucha, Kopcie, Suchożebry and surroundings of Siedlce).

Table 1. Localities of the European water vole noted in the study area (first records in particular sites from two study periods: 1957–1999 and 2000–2016 are presented).

In material from owl pellets: OP – without determination of species, Ao – *Asio otus*, Sa – *Strix aluco*, Ta – *Tyto alba*; number of individuals in parentheses, KNP – Kampinos National Park, APM – Atlas of Polish Mammals

Site	Square of APM	Date	Details of finding	Source of data
<b>Years 1957–1999</b>				
Bogate	14Gc	1957	OP	Raczyński 1983
Miastkowo	16Fh	1957	OP	Raczyński 1983
Mława	13Fi	1957	OP	Raczyński 1983
Ostrołęka	16Fg	1957	OP	Raczyński 1983
Rzekuń	16Fj	1957	OP	Raczyński 1983
Poniatowo	19Fl	1965	OP	Raczyński 1983
Raciąż	13Gg	1965	OP	Raczyński 1983
Wielki Łęck	12Ff	1965	OP	Raczyński 1983
Nature reserve „Niebieskie Źródła”	13Kd	Jun 26, 1968	Two individuals observed	Bartosz & Markowski 1972

Continuation of the Table 1

Site	Square of APM	Date	Details of finding	Source of data
Łąki Strzeleckie (KNP)	14Hk	1970	Caught in traps	Babińska 1972
Górzno	12Fd	1971	OP	Raczyński 1983
Jamno (Okręt pond)	12Ii	1972-1976	OP	Raczyński 1983
Grabina (KNP)	14Ia	Jun 7 and 11, 1981	Ao (9)	Unpublished data
Grabowy Grąd (KNP)	14Hi	Jun 22, 1982	Sa (5)	Lesiński et al. 2013
Ławy (KNP)	14Ib	Jun 8, 1983	Ao (1)	Unpublished data
Młynisko (KNP)	14Hk	May 25, 1983	Sa (1)	Lesiński et al. 2013
Kępa Kiełpińska near Łomianki	14HI	1983	Ao (1)	Romanowski 1988, unpublished data
Palmiry Łomna (KNP)	14Hk	Jul 18, 1984	Sa (1)	Lesiński et al. 2013
Gutocha near Jednorozec Stefanów	15Fe	Apr 1, 1985	OP (1)	Unpublished data
Suchodół	16Jh	Jun 14, 1990	Ao (1)	Unpublished data
Baranowo	16Ic	Jul 15, 1990	Sa (1)	Unpublished data
Bońkowo Kościelne	15Fe	Jun 26, 1991	Ta (1)	Unpublished data
Niezbórz	13Gb	Nov 6, 1993	Ta (1)	Unpublished data
Korfowe (KNP)	13Gc	Nov 6, 1993	Sa (1)	Unpublished data
	14Ia	Jul 12, 1999	Sa (2)	Lesiński et al. 2013
<b>Years 2000–2017</b>				
Kopcie near Grębków	17Ia	2000	Ta (1)	Urbanek 2004
Posada Demboskie (KNP)	13HI	Mar 31, 2000	Sa (3)	Lesiński et al. 2013
Drobin	12GI	May 20, 2000	Ta (1)	Unpublished data
Suchożebry	17Ib	Jul 14, 2000	Ta (1)	Unpublished data
Głuchów	13Jg	2002	Sa (2)	Gryz et al. 2011b, unpublished data
Division 83 of the Kampinos Forest District (KNP)	14Ia	Apr 2003	Sa (1)	Lesiński et al. 2013
Warsaw Wilanów	15Ig	Apr 19, 2004	Sa (1)	Gryz et al. 2008, unpublished data
Pionki	15Ki	2010	Observations – Sławomir Wąsik	Zub 2017
Kociołki	16Kd	2010	Observations – Sławomir Wąsik	Zub 2017
Policzna	16Kg	2010	Observations – Sławomir Wąsik	Zub 2017
Kępa	16If	May 3, 2010	Remains of one ind. eaten by predator – Agnieszka Parapura	Zub 2017
Popień	12Ji	Apr 10, 2011	Sa (1)	Gryz et al. 2011b, unpublished data
Brzozówka (KNP)	14Hj	Jul 20, 2011	Ao (2)	Unpublished data
Na Miny (KNP)	14Ib	Oct 3, 2011	Sa (2)	Lesiński et al. 2013
Kaliszki (KNP)	14Hk	Nov 8, 2011	Sa (1)	Lesiński et al. 2013
Cyganka (KNP)	14Ib	Mar 12, 2012	Sa (1)	Lesiński et al. 2013
Dąb Kobendzy (KNP)	13HI	Mar 16, 2012	Sa (1)	Lesiński et al. 2013
Zaborów (KNP)	14Ib	Mar 2012	Ao (2)	Lesiński et al. 2016b
Łazy Leśne (KNP)	13Ic	Apr 11, 2012	Sa (2)	Lesiński et al. 2013
Grabowy Grąd (KNP)	14Hi	Apr 22, 2012	Sa (5)	Lesiński et al. 2013
Nature reserve Stawy Siedleckie	17Ie	Apr 28, 2012	Two observations and a burrow – Martyna Paczuska	Zub 2017
Izabelin (KNP)	14Ib	May 2, 2012	Sa (1)	Lesiński et al. 2013
Stara Dąbrowa (KNP)	14Hj	May 3, 2012	Sa (1)	Lesiński et al. 2013
Ławy (KNP)	14Ib	Jun 3, 2012	Sa (2)	Lesiński et al. 2013
Roztoka (KNP)	14Ia	Sep 20, 2012	Sa (1)	Lesiński et al. 2013
Famułki Brochowskie (KNP)	13Ic	May 2014	Sa (2)	Unpublished data
Lipków (KNP)	14Ib	Jul 3, 2015	Sa (1)	Unpublished data
Nowa Sucha	16If	Mar 28, 2015	Sa (1) – Przemysław Stolarz	Zub 2017
Leszczyny Kolonia	12Ji	Apr 7, 2016	One individual observed – Jerzy Borowski	Unpublished data
Jeżewo near Zawidz	12Gh	Jul 11, 2017	Ao (1)	Unpublished data

From some areas we have data originating from long-term studies (Table 1, Appendix). In a village Bogate in northern Mazowsze, the rodent was recorded in 1950s but a large sample of owl pellets from the years 1991–2009 did not reveal its presence. Similarly, near Mława it was found in 1957 but was not recorded in the years 2015–2016 and on Kępa Kiełpińska, where the rodent was noted in 1983 but not in 1995–1996.

Analyses of communities of small mammals recorded in large samples of owls' food (Figure & Appendix) revealed many regions, where the European water vole was probably absent. It was not present in larger parts of Płoński and Ciechanów Uplands, Bolimowska Forest, Chojnowski and Mazowiecki Landscape Parks, Rembertów-Okuniew Forests and in Sterdyń Forests (between Nur and Sterdyń). In most of these sites, there are various water bodies and wetlands.

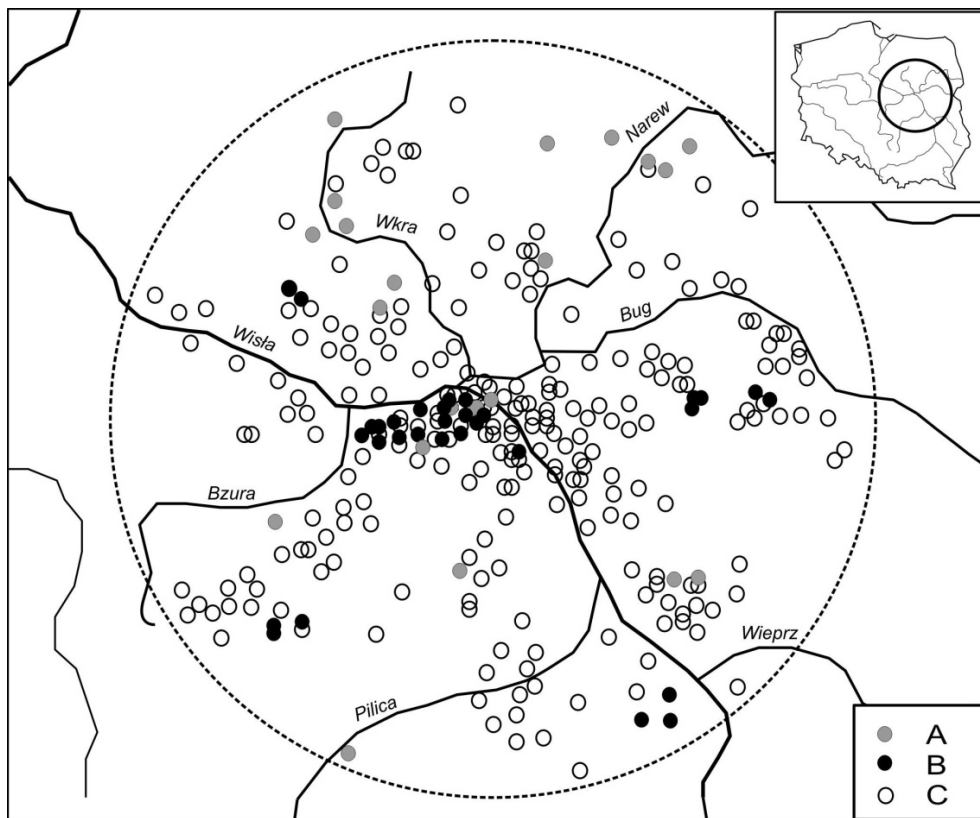


Figure. Distribution of localities of the European water vole in the study area in the years 1957–1999 (A) and 2000–2017 (B) and of sites, where the rodent was not found in large samples of the owls' food (at least 100 vertebrate prey items in each) collected in the years 1980–2017 (C).

## DISCUSSION

Comparison of localities of the European water vole found so far with those, where the species was not recorded indicates, that in areas situated within a radius of 120 km from Warsaw the rodent is rare and distributed unevenly. Kampinos Forest is one of a few larger refugia, in which the species is relatively numerous (Lesiński et al. 2013). The species was also recorded in Kozienice Forest (Zub 2017), but its numbers in the area is hard to assess. It is

absent from many forest complexes, even those with larger wetlands. Examples of the latter are areas such as: Bolimowska Forest (Lesiński et al. 2016a) or Mazovian Landscape Park with areas between Rembertów and Okuniew (Lesiński et al. 2016c).

The European water vole is more common in Mazurian Lakeland, in northern Podlasie (Kowalski & Lesiński 1988, Gryz et al. 2011a, Zub 2017), and also in western part of the country (Zub 2017). It is common in central Poland, even in areas with a small part of open waters and wetlands like e.g. Wieluń Upland (Lesiński 1991). Water voles (probably representing montane water vole) are frequent in the diet of owls in surrounding of Cracow (Bocheński Jr 1990, Lesiński & Stolarz 2012) and Przemyśl (Cais 1963), and in the Beskid Niski (Kulczycki 1964) or the Beskid Wyspowy (Ruprecht 2002). In some of these places the species seems to be numerous as evidenced by its big share in the diet of owls (Table 2).

Table 2. Percentage share of water voles (*Arvicola amphibius* or *A. scherman*) in the food of owls in area inhabited by its largest population in Mazowsze (Kampinos Forest) and in some areas of southern Poland; Ao – *Asio otus*, Sa – *Strix aluco*, Ta – *Tyto alba*

Study area	Years of studies	Owl species	Number of vertebrate prey items	Percent of <i>Arvicola amphibius</i>	References
Kampinos Forest	1980–2012	Sa	11,235	0.5	Lesiński et al. 2013
Kampinos Forest	1983–2013	Ao	1,109	0.2	Lesiński et al. 2016b
Wieluń Upland	1983–1988	Ta	21,839	0.2	Lesiński 1991
Paszkówka near Cracow	2007–2011	Sa	229	7.9	Lesiński & Stolarz 2012
Cracow suburbia	1984–1986	Sa	1,344	4.5	Bocheński Jr 1990
Beskid Wyspowy	1996	Sa	224	9.3	Ruprecht 2002
Bytom	2011–2016	Sa	391	1.5	Lesiński & Beuch 2016
Niepołomska Forest	1978–1979	Sa	474	0.8	Wasilewski 1990
Beskid Niski	1960–1961	Sa	267	8.2	Kulczycki 1964
Beskid Niski	1960–1961	Ta	3,332	3.2	Kulczycki 1964
Surroundings of Przemyśl	1958–1962	Sa	718	6.0	Cais 1963
Surroundings of Przemyśl	1958–1962	Ta	5,813	7.1	Cais 1963
Silesia	1977–1981	Ta	19,525*	0.8	Salata-Piłacińska 1994

It is probable, however, that the number of the European water vole in Poland, especially in northern and central parts of the country, has recently decreased due to expansion of the American mink *Neovison vison* (Schreber, 1777). Antagonistic relationships of the two species were described for some western European countries (Saucy 1999, Battersby 2005). Although there is not much evidence from our study area, possible decrease of the number of the European water vole could result in the extinction of its smaller populations and such were present in some regions of Mazowsze. Findings from several sites, where studies lasted long enough (Bogate, Mława, Kępa Kiełpińska), might confirm a declining trend in populations of the European water vole in recent decades.

The used study method – analysing of owl pellets – gives some limitations in detecting species connected with specific water habitats. Moreover, the European water vole shows cyclic fluctuations in numbers (Litvinov et al. 2013), and in smaller samples of owl pellets collected in years with low vole abundance the probability of its occurrence is low. It is not excluded that in some part of the study area, especially in the north, isolated populations not detected in this study still exist.

There is a need of intensifying studies on the distribution of this species in central Poland to assess whether declining trend is real and causes further decrease of the number of animals. Since observations of individuals might be burdened with error – possible confusing the European water vole with the common rat *Rattus norvegicus* (Berkenhout, 1769) or muskrat *Ondatra zibethicus* (Linnaeus, 1766) – it is best to apply the trap method or the analysis of owl pellets.

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## STRESZCZENIE

**[Rozmieszczenie karczownika ziemnowodnego *Arvicola amphibius* (Linnaeus, 1758) na Mazowszu i południowym Podlasiu]**

W pracy przedstawiono rozmieszczenie karczownika ziemnowodnego *Arvicola amphibius* na Mazowszu i południowym Podlasiu, na terenach zlokalizowanych w promieniu ok. 120 km od Warszawy. Zestawiono opublikowane dotąd dane oraz niepublikowane wyniki pochodzące z analiz diety trzech pospolitych gatunków sów: płomykówki *Tyto alba*, puszczyka *Strix aluco* i uszatki *Asio otus*. Gryzoń ten na terenie badań jest rzadki (Tab. 1, Ryc.), zwłaszcza w porównaniu z zachodnią i skrajnie północną Polską. Na południu kraju udziały karczowników (w większości prawdopodobnie reprezentujących gatunek *A. scherman*) w diecie sów są wyraźnie większe niż na Mazowszu i południowym Podlasiu (Tab. 2). Najwięcej stanowisk karczownika ziemnowodnego stwierdzono w Puszczy Kampinoskiej, gdzie aktualnie występuje prawdopodobnie największa jego populacja w tej części Polski. Poza tym kompleksem leśnym stwierdzany był bardzo lokalnie, a w latach 2000–2017 znanych było tylko kilkanaście stanowisk (Tab. 1). Nie występuje nawet na dużych terenach, bogatych w różne zbiorniki wodne, np. w Mazowieckim i Chojnowskim Parku Krajobrazowym, Puszczy Bolimowskiej. Rzadkość karczownika ziemnowodnego potwierdzają dane z 235 dużych prób pokarmu sów (przynajmniej po 100 ofiar kręgowych każda) (Appendix), w których nie wykazano obecności tego gatunku. Były one rozmieszczone dość równomiernie na Mazowszu i południowym Podlasiu (Ryc.).

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APPENDIX

The list of sites within a 120-kilometre radius from Warsaw, where samples of the owls' diet containing at least 100 vertebrate prey items but not the European water vole was collected. *Ao* – *Asio otus*, *Sa* – *Strix aluco*, *Ta* – *Tyto alba*, KNP – Kampinos National Park

Site	Owl species	Study years	Sample size	Source of data
Baboszewo	<i>Ta</i>	2000	428	Unpublished data
Baboszewo	<i>Ao</i>	2016–2017	515	Unpublished data
Bagno Jacka, Warsaw Wesola	<i>Sa</i>	2011–2016	1,426	Stolarz & Lesiński 2012, Lesiński et al. 2016c, unpublished data
Bagno Śmiardki, Zielonka	<i>Sa</i>	2013–2016	116	Lesiński et al. 2016c
Bazantarnia	<i>Sa</i>	2016	302	Unpublished data
Bądkowo Kościelne	<i>Ta</i>	2003–2004	592	Unpublished data
Belsk Duży	<i>Ao</i>	1992–1993	661	Unpublished data
Biała Rawska	<i>Ta</i>	1989–1991	121	Unpublished data
Białynin near Rawa Mazowiecka	<i>Ao</i>	2016–2017	283	Unpublished data
Bielsk near Plock	<i>Ta</i>	1989–2016	571	Unpublished data
Bielsk near Plock	<i>Ao</i>	2016–2017	1,417	Unpublished data
Bodzanów	<i>Ao</i>	2016–2017	138	Unpublished data
Bogate	<i>Ta</i>	1991–2009	2,126	Unpublished data
Boglewice near Grójec	<i>Ta</i>	1993	1,769	Unpublished data
Bogurzyn	<i>Ta</i>	1999	100	Unpublished data
Bogusławice near Płońsk	<i>Ta</i>	2004	149	Unpublished data
Borowie	<i>Ta</i>	1994	277	Unpublished data
Brzeźce	<i>Ao</i>	2012–2017	5,270	Stolarz & Lesiński 2015, Stolarz et al. 2017, unpublished data
Brzeźce	<i>Sa</i>	2005–2016	291	Unpublished data
Buchnik near Jabłonna	<i>Sa</i>	2007–2017	1,615	Unpublished data
Budy Sulkowskie	<i>Sa</i>	1993–1998	135	Unpublished data
Bulkowo	<i>Ao</i>	2016–2017	362	Unpublished data
Byliny Stare	<i>Sa</i>	2016	149	Unpublished data
Całowanie	<i>Ao</i>	1984–2016	434	Lesiński et al. 2016c, unpublished data
Celestynów	<i>Sa</i>	2014–2016	274	Lesiński et al. 2016c
Ceranów	<i>Sa</i>	2009–2014	164	Unpublished data
Ceranów	<i>Ta</i>	1994–1996	1,075	Unpublished data
Chorzele	<i>Ta</i>	1991	109	Unpublished data
Ciechanów	<i>Ao</i>	2017	470	Unpublished data
Cieksyn	<i>Ta</i>	1985	161	Unpublished data
Cybulice Duże	<i>Sa</i>	2000	316	Unpublished data
Czarnocin	<i>Ta</i>	2016	607	Unpublished data
Czerwińsk, Vistula river	<i>Sa</i>	2011	120	Unpublished data
Czerwona Liwska	<i>Ta</i>	1990	293	Unpublished data
Dłużew	<i>Sa</i>	2015–2016	240	Lesiński et al. 2016c
Doliska near Rogów	<i>Sa</i>	2004–2011	103	Gryz et al. 2011b, unpublished data
Drewnica Forest District, division 23	<i>Sa</i>	1997	118	Lesiński et al. 2016c
Drewnica Forest District, division 68	<i>Sa</i>	1997–1999	114	Lesiński et al. 2016c
Drwałew near Grójec	<i>Ta</i>	1992	280	Unpublished data
Dziecinów	<i>Ao</i>	1984–1990	334	Unpublished data
Dziekanów Leśny (KNP)	<i>Sa</i>	1982–2007	274	Unpublished data.
Dzięcioły Kolonia	<i>Sa</i>	2011–2014	622	Unpublished data
Garwolin	<i>Ao</i>	1989–1990	359	Unpublished data
Głowaczów	<i>Ta</i>	1992	880	Unpublished data
Głuchów	<i>Ta</i>	1989	952	Unpublished data
Goniwilk Nowy	<i>Ao</i>	1988–1997	1,253	Unpublished data
Goszczyń	<i>Ta</i>	1992	940	Unpublished data
Goworowo	<i>Ta</i>	1999	817	Unpublished data
Góra near Plock	<i>Ao</i>	2016–2017	137	Unpublished data
Góra Raabego (KNP)	<i>Ao</i>	1995	169	Romanowski & Żmihorski 2008
Górki near Rogów	<i>Sa</i>	2003–2011	169	Gryz et al. 2011b, unpublished data
Grębków near Węgrów	<i>Ta</i>	1990	184	Unpublished data

Grodkowo near Wyszogród	<i>Sa</i>	2013	210	Unpublished data
Grudusk	<i>Ta</i>	1991	416	Unpublished data
Gulin near Radom	<i>Ao</i>	1988–1992	1,142	Unpublished data
Gumino near Płońsk	<i>Ta</i>	1990	1,179	Unpublished data
Jabłonna	<i>Sa</i>	2007–2013	1,033	Unpublished data
Jabłonna rez.	<i>Sa</i>	2010–2016	687	Unpublished data
Jankowice near Jedlińsk	<i>Ta</i>	1992	110	Unpublished data
Janowo	<i>Ta</i>	1980–1984	7,797	Kowalski & Lesiński 1986
Jarczew	<i>Ao</i>	1991–1992	1,897	Unpublished data
Jasień	<i>Sa</i>	2005–2011	151	Gryz et al. 2011b, unpublished data
Jedlińsk	<i>Ta</i>	1992	821	Unpublished data
Jegiel rez. near Łochów	<i>Sa</i>	1988–2016	110	Unpublished data
Jeleniec	<i>Ta</i>	1992	645	Unpublished data
Jeruzal	<i>Ta</i>	1990–2001	128	Unpublished data
Kamionka near Latowicz	<i>Ta</i>	2000	403	Unpublished data
Kaszów	<i>Ta</i>	1992	249	Unpublished data
Kęblów Nowy	<i>Ao</i>	1989–1993	490	Unpublished data
Kępa Kiełpińska near Łomianki	<i>Ao</i>	1995–1996	638	Romanowski & Zmihorski 2008, unpublished data
Kiełpiniec	<i>Ta</i>	1999–2009	301	Unpublished data
Kiernozia	<i>Ta</i>	1991	1,932	Unpublished data
Kleczkowo near Ostrołęka	<i>Ta</i>	1990–1991	104	Unpublished data
Klembów, rez. „Dębina I”	<i>Sa</i>	1991–2017	2,714	Lesiński 2016, unpublished data
Klimonty near Mordy	<i>Ao</i>	1987–1993	609	Unpublished data
Kołacin near Rogów	<i>Sa</i>	2012–2013	226	Lesiński et al. 2014
Kołbiel	<i>Ta</i>	1990–2001	1,029	Unpublished data
Kompna near Łowicz	<i>Ta</i>	1988–1991	3,238	Unpublished data
Konstancin Jeziorna	<i>Sa</i>	2010–2012	332	Romanowski et al. 2014, unpublished data
Korytnica near Trojanów	<i>Ta</i>	1990	429	Unpublished data
Korytnica near Węgrów	<i>Ta</i>	1990	360	Unpublished data
Kostrzyn near Białobrzegi	<i>Ta</i>	1992	2,801	Unpublished data
Kozienice	<i>Ao</i>	1992–1998	112	Unpublished data
Krasne	<i>Ta</i>	2002	313	Unpublished data
Kraśnicza Wola	<i>Sa</i>	2011–2015	341	Romanowski et al. 2016
Krysk near Naruszewo	<i>Ao</i>	1996	1,301	Unpublished data
Krzesk near Siedlce	<i>Ta</i>	1990	591	Unpublished data
Krześlin near Suchożebry	<i>Ta</i>	1990	253	Unpublished data
Krzynowłoga Mała	<i>Ta</i>	1990–2000	319	Unpublished data
Krzywa Góra (KNP)	<i>Sa</i>	1989–2007	616	Lesiński et al. 2013, unpublished data
Kuczbork	<i>Ta</i>	1999	421	Unpublished data
Kuczki near Radom	<i>Ta</i>	1993	570	Unpublished data
Kuflew near Mrozy	<i>Ta</i>	1990	230	Unpublished data
Kuligów	<i>Ao</i>	2010–2012	449	Lesiński et al. 2016b
Kurdwanów	<i>Ta</i>	1993	104	Unpublished data
Kurowice near Sabnie	<i>Ta</i>	1990	272	Unpublished data
Lasek	<i>Ao</i>	2004–2007	218	Gryz & Krauze–Gryz 2015
Laski Forest District, division 1 (KNP)	<i>Sa</i>	1982–1984	164	Unpublished data
Laski Forest District, division 139 (KNP)	<i>Ao</i>	1993	258	Unpublished data
Laski Forest District, division 167 (KNP)	<i>Ao</i>	1999	210	Unpublished data
Latowicz	<i>Ta</i>	1990–2001	250	Unpublished data
Lelice	<i>Sa</i>	2013–2017	304	Unpublished data
Lipce	<i>Sa</i>	2013–2016	1,425	Gryz & Krauze–Gryz 2016a
Lisna near Skierniewice	<i>Sa</i>	2014–2016	746	Lesiński et al. 2016a
Liw	<i>Ta</i>	1990–1997	471	Unpublished data
Łęgonice Nowe near Grójec	<i>Ta</i>	1992	642	Unpublished data
Łomianki	<i>Ao</i>	1986–1990	1,090	Unpublished data
Magnuszew	<i>Sa</i>	1992–2002	870	Unpublished data
Maków Mazowiecki	<i>Ta</i>	1985	1,386	Unpublished data
Malkinia Górna	<i>Ta</i>	2000	707	Unpublished data
Michałowice	<i>Ao</i>	2016–2017	1,452	Unpublished data
Miedzna near Węgrów	<i>Ta</i>	1990	479	Unpublished data

Mikanów	Sa	2015–2017	106	Unpublished data
Mława, surroundings	Ta	2015–2016	412	Bardzińska 2016
Mława, surroundings	Ao	2015–2016	1,341	Bardzińska 2016
Mogielnica near Grójec	Ta	1993	132	Unpublished data
Mokobody	Sa	2013	184	Unpublished data
Mołożew	Ao	1992	107	Unpublished data
Morszków near Jabłonna Lacka	Ta	1990	192	Unpublished data
Mroków near Trojanów	Ao	1991–1995	603	Unpublished data
Natolin near Nur	Sa	2004–2017	1,591	Unpublished data
Nowe Miasto near Płońsk	Ta	1992	119	Unpublished data
Nowy Duninów	Ta	1989–2003	342	Unpublished data
Nowy Dwór Mazowiecki	Sa	1991–2017	319	Unpublished data
Nur	Ta	1995–1998	604	Unpublished data
Opinogóra Górna	Ta	1992	484	Unpublished data
Osmolin near Kiernozia	Ta	1991	596	Unpublished data
Ostrówek, Vistula river	Sa	2013	211	Unpublished data
Otwock	Sa	2004–2016	263	Lesiński et al. 2016c
Parysów near Garwolin	Ta	1990–2000	920	Unpublished data
Pańniki near Skierniewice	Sa	2014	123	Lesiński et al. 2016a
Piotrowice	Ao	1984–1990	858	Unpublished data
Płoniawy Bramura	Ta	1985	407	Unpublished data
Pniewnik near Węgrów	Ta	1990	100	Unpublished data
Pniewo Wielkie	Sa	1998–2000	808	Unpublished data
Podkowa Leśna	Sa	2010–2014	110	Romanowski et al. 2016, unpublished data
Ponurzyca	Sa	2002	264	Lesiński et al. 2016c
Popień	Ao	2009–2011	112	Gryz & Krauze-Gryz 2015
Poświętne Jedlińskie near Pionki	Ta	1990–1991	173	Unpublished data
Prusy	Ao	2014–2015	320	Gryz & Krauze-Gryz 2016b
Pruszków	Sa	2010	126	Romanowski et al. 2016
Pruszyń near Siedlce	Ta	1985–2000	557	Unpublished data
Przasnysz	Ta	1985–1991	4,110	Unpublished data
Przyłęk Duży near Rogów	Ao	2004–2007	218	Gryz & Krauze-Gryz 2015
Pszczonów	Sa	2014–2016	306	Unpublished data
Pułwy	Ao	1989–1990	124	Unpublished data
Pustki near Siedlce	Ao	1988	226	Unpublished data
Radzików Wielki near Mordy	Ta	1987–1991	1,614	Unpublished data
Rawa Mazowiecka	Ta	1988–1989	951	Unpublished data
Rogów	Sa	2011–2013	247	Lesiński et al. 2014
Rosochate Kościelne	Ta	1999	433	Unpublished data
Rościszewo near Sierpc	Ta	1989	108	Unpublished data
Ruda near Mińsk Mazowiecki	Sa	2013–2017	271	Lesiński et al. 2016c
Ruda near Skierniewice	Sa	2015–2016	165	Lesiński et al. 2016a
Samogoszcz	Ta	1991–1999	860	Unpublished data
Secymin, Vistula river	Sa	2012	136	Unpublished data
Seroczyn	Sa	1994–1998	598	Unpublished data
Sękocin	Sa	2007–2017	329	Unpublished data
Siecień near Płock	Ta	1989–2004	984	Unpublished data
Siedlce	Ao	1994	285	Unpublished data
Sikórz near Płock	Ta	1988–2004	114	Unpublished data
Słubice	Ta	1991	561	Unpublished data
Sobienie Biskupie	Ao	1984–1990	121	Unpublished data
Sobienie Kielczewskie	Ao	1984	105	Unpublished data
Sobienie Szlacheckie	Ao	1984	131	Unpublished data
Sobieszyn near Ryki	Ta	1991	332	Unpublished data
Sobowo near Płock	Ta	1989–2004	465	Unpublished data
Soczewka	Ta	1989	397	Unpublished data
Sokolniki near Żelechów	Ao	1993	155	Unpublished data
Sowia Wola Folwarczna	Sa	1997–2006	1,285	Lesiński et al. 2013, unpublished data
Stanin	Ta	1991–2000	929	Unpublished data
Staroźreby	Ta	2016	107	Unpublished data
Sterdyń	Ta	1990–1994	692	Unpublished data

Stoczek near Węgrów	<i>Ta</i>	1990–2001	273	Unpublished data
Stok Lacki near Siedlce	<i>Ao</i>	1988–1992	697	Unpublished data
Strzyżew near Łuków	<i>Ao</i>	1989	235	Unpublished data
Studzieniec	<i>Sa</i>	2014	322	Lesiński et al. 2016a
Szczałb	<i>Ta</i>	1999–2000	1,017	Unpublished data
Szreńsk	<i>Ta</i>	1999	615	Unpublished data
Szymanów near Sochaczew	<i>Ta</i>	1991	811	Unpublished data
Tustań near Naruszewo	<i>Sa</i>	2004–2008	1,107	Unpublished data
Tymianka	<i>Sa</i>	2004–2011	116	Unpublished data
Wandów near Łuków	<i>Ta</i>	1990–1991	257	Unpublished data
Warsaw Anin	<i>Sa</i>	2014	105	Lesiński et al. 2016c
Warsaw Bielany	<i>Sa</i>	1984–2017	753	Lesiński & Gryz 2012, unpublished data
Warsaw Kabaty	<i>Sa</i>	2005–2007	363	Gryz et al. 2017
Warsaw Kawęczyn	<i>Sa</i>	2010–2013	109	Gryz et al. 2017
Warsaw Las Sobieskiego	<i>Sa</i>	1993–2016	351	Lesiński & Stolarz 1999, unpublished data
Warsaw Łazienki	<i>Sa</i>	2004–2017	362	Gryz et al. 2008, unpublished data
Warsaw Młociny	<i>Sa</i>	1982–2017	913	Lesiński & Gryz 2012, unpublished data
Warsaw Natolin	<i>Sa</i>	2004–2007	160	Gryz et al. 2017
Warsaw Olszynka Grochowska	<i>Sa</i>	2011–2014	237	Gryz et al. 2017
Warsaw Skarpa Ursynowska	<i>Sa</i>	2006–2012	125	Gryz et al. 2017
Warsaw Tarchomin	<i>Sa</i>	2008–2017	1,387	Unpublished data
Warsaw Zakole Wawerskie	<i>Sa</i>	2011–2013	123	Gryz et al. 2017
Węgrzynowo	<i>Ta</i>	1992–2009	466	Unpublished data
Wieliszew	<i>Ao</i>	2014–2016	852	Unpublished data
Wierzbica near Radom	<i>Ta</i>	1993	497	Unpublished data
Wilczyška near Łuków	<i>Ta</i>	1990–1993	767	Unpublished data
Wiskitki	<i>Ta</i>	1988	136	Unpublished data
Wiśniew near Siedlce	<i>Ta</i>	1990	253	Unpublished data
Wojcieszków near Łuków	<i>Ta</i>	1991	728	Unpublished data
Wola Zadybska	<i>Sa</i>	2009–2012	495	Unpublished data
Wola Żelechowska	<i>Ao</i>	1988–1995	226	Unpublished data
Worów near Grójec	<i>Ta</i>	1992	2,004	Unpublished data
Wólka Dworska, Vistula river	<i>Sa</i>	2013	194	Unpublished data
Wólka Łasięcka	<i>Sa</i>	2009–2016	411	Lesiński et al. 2016a
Wysoczyzna near Mława	<i>Ta</i>	1991	325	Unpublished data
Zaborów Leśny (KNP)	<i>Sa</i>	1980–1997	194	Unpublished data
Zaczywilki	<i>Ao</i>	2005–2009	1,290	Gryz & Krauze–Gryz 2015
Zaczywilki	<i>Sa</i>	2004–2007	177	Gryz & Krauze–Gryz 2016a
Zakrzew near Radom	<i>Ta</i>	1992	398	Unpublished data
Zalesie Górne I	<i>Sa</i>	2010–2012	137	Romanowski et al. 2014
Zalesie Górne II	<i>Sa</i>	2010–2012	115	Romanowski et al. 2014
Zalesie Górne III	<i>Sa</i>	2010–2012	105	Romanowski et al. 2014
Zalesie Górne IV	<i>Sa</i>	2015	190	Unpublished data
Zasiadały near Garwolin	<i>Ao</i>	1989–1991	219	Unpublished data
Zawady near Kampinos	<i>Ta</i>	1993	463	Unpublished data
Zbójna Góra	<i>Sa</i>	2015–2016	152	Lesiński et al. 2016c
Zembrów	<i>Ta</i>	1990–2000	1,880	Unpublished data
Zielona near Żuromin	<i>Ta</i>	1990	203	Unpublished data
Zielonka	<i>Sa</i>	2002–2007	1,073	Lesiński et al. 2016c
Zielony Ług near Międzyzlesie	<i>Sa</i>	2015–2016	146	Lesiński et al. 2016c
Zimna Woda near Rogów	<i>Ao</i>	2004–2008	275	Gryz & Krauze–Gryz 2015
Zimna Woda near Rogów	<i>Sa</i>	2004–2007	810	Gryz et al. 2011b, unpublished data
Złaków Kościelny	<i>Ta</i>	2016	399	Unpublished data
Złaków Kościelny	<i>Ao</i>	2016	1,233	Unpublished data
Złotokłos	<i>Sa</i>	2006–2009	130	Romanowski et al. 2016
Zwierzyniec	<i>Sa</i>	2014–2016	600	Unpublished data
Zwola Poduchowna	<i>Sa</i>	2015–2016	176	Unpublished data
Zwola Poduchowna	<i>Ta</i>	1990	426	Unpublished data
Żabianka near Ryki	<i>Ta</i>	1991	804	Unpublished data
Żelechów	<i>Ta</i>	1994–2000	6,520	Unpublished data
Życzyn	<i>Ta</i>	1993–1996	407	Unpublished data