Summer distribution of the Pond bat Myotis dasycneme (Chiroptera, Vespertilionidae) in the west of Flanders (Belgium) with regard to water quality

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Marc VAN DE SIJPE
Bob VANDENDRIESSCHE
Paul VOET
Joost VANDENBERGHE
Johan DUYCK
Erik NAEYAERT
Mario MANHAEVE
Vleermuizenwerkgroep Natuurpunt v.z.w., Kardinaal Mercierplein 1, B-2800 Mechelen (Belgium)

Els MARTENS
Ministry of the Flemish Community, Nature division, Koning Albert II-laan bus 8, B-1000, Brussels (Belgium)

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ABSTRACT
The summer distribution of the Pond bat *Myotis dasycneme* in the west of Flanders was assessed by bat detector surveys and a radiotracking project focusing on hunting activity as well as commuting activity. A preliminary attempt was made to relate hunting activity to water quality data and some field observations of nocturnal insect activity. This study revealed new records of pond bats in the area including a small maternity roost. Recorded activity was high over broad waterways, lower over large ponds and medium sized waterways and very low over small waterways. Pond bats were observed hunting over waterways with different pollution levels from mild to heavier pollution. However more activity was recorded over waterways with mild and moderate pollution than over polluted waterways, whereas Daubenton's bat *Myotis daubentonii* was found hunting over all waterways regardless the pollution level.

KEY WORDS
Chiroptera,
Myotis dasycneme,
Belgium,
Summer distribution,
Water quality.

RÉSUMÉ

La distribution estivale du Murin des marais *Myotis dasycneme* dans l'ouest des Flandres a été déterminée par des prospections avec détecteur d'ultrasons et un suivi par radiolocalisation destinés à évaluer les déplacements et l'activité de chasse de l'espèce. Dans une analyse encore préliminaire, ces observations ont été mises en relation avec des données sur la qualité de l'eau des canaux et rivières et quelques observations sur l'activité nocturne des insectes. Cette étude s'est concrétisée par l'identification de nouvelles localisations régionales, dont une petite colonie d'élevage des jeunes. L'activité des murins des marais était élevée au-dessus des cours d'eau larges, plus faible au-dessus des grands étangs et des cours d'eau de moyenne largeur, et très faible au-dessus des petits cours d'eau. Des animaux ont été observés chassant au-dessus d'eaux moyennement à fortement polluées ; toutefois l'activité de chasse était plus intense au-dessus des eaux modérément polluées, contrairement au Murin de Daubenton *Myotis daubentonii* qui a été observé en activité de chasse au-dessus de tous les plans d'eau, sans distinction.

MOTS-CLÉS
Chiroptera,
Myotis dasycneme,
Belgique,
distribution estivale,
qualité de l'eau.

INTRODUCTION

The Pond bat, *Myotis dasycneme* (Boie, 1825), is a quite rare species within northern Europe with a summer distribution mainly restricted to lowland areas abundant in water from The Netherlands to Russia through Poland, southeast Slovakia and Moldova. In winter the southern border of its distribution area passes through the extreme north of France and the south of Belgium (Sluiter *et al.* 1971; Fairon *et al.* 1982; Dense *et al.* 1996; Horáček 1999).

Before the start of this study only two probable bat detector records have been reported from the province West-Vlaanderen: one over the canal Brugge-Sluis in the early 1980's by Rudy Vantorre (Vandendriessche 2001) and a second one at the water reservoir Blankaart in Woumen described by Johan Duyck (Duyck pers. comm.). Moreover, small summer populations including one roost have been reported in the neighbouring Dutch province of Zeeland (Mostert 1997).

Water quality in the densely populated lowland areas in Belgium remains very poor, as large amounts of domestic, industrial and agricultural effluents are still discharged into the nearest watercourse without purification. The intensifying agriculture and the dramatic increase in pig farming further deteriorated water quality, especially in the west of Flanders. Huge investments in purification facilities during the last decade resulted in a first modest water quality improvement, especially noticed in the large rivers (VMM 2003). Nevertheless average water quality is still poor today and the area's freshwater still ranks amongst the most polluted within Europe. This lowland area is crossed by many large waterways and canals, and many isolated ponds, offering a considerable potential hunting habitat for the Pond bat, used to scan large open water surfaces for prey. According to droppings analysed in The Netherlands (Britton *et al.* 1997) and northern Germany (Sommer and Sommer 1997) they feed upon Diptera (76 and 70% of volume respectively, including Chironomid pupae), and more or less on Coleoptera (11% in The Netherlands), Lepidoptera (11% and 3% respectively) and Trichoptera (1.5% and 27%).

The aim of this study was to determine the summer distribution of the Pond bat in the west of Flanders and to relate this distribution to the type of water body and to water quality (organic pollution).

MATERIAL AND METHODS

Study area

The study area is the province of West-Vlaanderen, the westernmost province of Belgium. The area is bordered by the North Sea, the French department Nord, the Belgian provinces of Hainaut and Oost-Vlaanderen and the Dutch province of Zeeland. The eastern part is more densely populated than the western part. Main land use is agricultural. This lowland area is relatively abundant in water. There are three rivers in the area: Leie, Schelde and IJzer. These rivers are canalised and broadened for inland navigation. During rainy periods they can be considered as slow flowing lowland rivers. However water becomes almost stagnant in periods with little rainfall as lock weirs maintain a minimum level. Additionally the area are hemmed in by several broad and medium sized canals and large ponds. The low-lying coastland and the IJzer river plane possess a dense network of ditches and small canals. The old town of Ieper is bordered by moats to the east and the south. The width of the waterways considered in this paper has been derived from the topographic atlas of Belgium (Nationaal Carthografisch Instituut 2002).

Bat detector surveys

Bat detector surveys have been carried out from 1998 to 2003. With regard to commuting activity, bats were counted from 30 minutes after sunset to 1.5 hours after sunset at a single point (e.g. a bridge). With regard to hunting activity presence or absence of bats was recorded 1.5 hours after sunset or later. Survey duration fluctuated between 30 minutes and 2 hours with most surveys lasting approximately 1 hour, covering up to 2 km of waterway. In the further analysis we only retained surveys between the 1st of April and the 30th of September.

A Pettersson D240 heterodyne / time-expansion detector and a Pettersson D220 stereo-heterodyne detector have been used. Flight directions were perceived directly in the field with the D220 detector. Time expansion recordings were made with an MZ-R35 Minidisc recorder and the recorded sequences were analysed with the Pettersson BatSound 2.0 program. Signals have been compared with literature data (Kapteyn 1993; Boonman *et al.* 1995; Limpens and Roschen 1995; Britton *et al.* 1997; Mostert 1997). Bats were also observed in the field in weak illumination, with torches or with an image intensifier (ITT Night Mariner 150 equipped with infrared LEDs, wavelenght 880 nm).

During surveys the heterodyne detector was tuned to 35 kHz, detecting the signals of pond bats, Daubenton's bats, *Myotis daubentonii*, and Nathusius' pipistrelles, *Pipistrellus nathusii*. Pond bats produce smacking sounds in most of the occasions, whereas Daubenton's bats always emit dry clicks (Limpens and Roschen 1995). Nathusius' pipistrelles often hunt over water bodies and also emit smacking sound, but sound quality and rhythm are quite different (Limpens and Roschen 1995). Visual observations were used to confirm the acoustic identification. The size difference between the Pond bat and the Daubenton's bat is obvious when the bats fly close to the observer (Ahlén 1990; Kapteyn 1995), and the Pond bat usually flies faster than the Daubenton's bat (Kapteyn 1995). Both species fly low over the water surface (max. 0.5 m), whereas the Nathusius' pipistrelle flies higher in the air (3 to 10 m).

Distinction between commuting and hunting activity was assessed by visual observations of the flight directions and by timing the surveys. The evening commuting activity of both pond bats and Daubenton's bats typically starts ca. 45 minutes to 1 hour after sunset and ends about 1 hour later (Voûte *et al.* 1974; Kapteyn 1995). Commuting flight is reported when all bats are flying in the same direction and don't return. Hunting flight is a sort of patrolling flight at very low height, bats flying to and fro over distances that often exceed 100 m. Hunting activity has been confirmed by detection of feeding buzzes with the bat detector and visual observations of bats capturing large insects (mainly with the image intensifier). Pond bats regularly capture large insects by a sudden and spectacular pursuit flight often extending some meters up in the air, over the water or over the reeds and willows (Ahlén 1990; Kapteyn 1995; Siemers *et al.* 2001).

RADIOTRACKING

A limited radiotracking project was carried out in July and August 2000 in order to find the roost of pond bats in the Ieper surroundings. Some pond bats have been mist-netted during their commuting flight over a canal and a moat. After identification one of them was fitted with a Holohil emitter (weight 0.5 g) prior to release. The surroundings have been surveyed with a receiver (RX98 from Televilt) during the following day in order to locate the marked bat in its roost (Lefevre *et al.* 2001; Vandendriessche 2001; Van de Sijpe 2001).

WATER QUALITY

In this paper we focus on organic pollution described by physico-chemical and biological criteria, other aspects of freshwater pollution such as heavy metals, pesticides, micro-pollutants and acidity have not been considered.

Physico-chemical water quality is mainly described by the oxygen concentration. The Prati Index for Oxygen (PIO), calculated from a number of oxygen measurements over the year, is used in order to compensate for oxygen super saturation resulting from the eutrophication phenomenon (V.M.M. 2003). The lower the PIO value the closer the oxygen concentration approaches 100%. The water quality can be evaluated as folllows: PIO = 0-1 – not polluted; 1-2 – mild pollution, acceptable quality; 2-4 – moderate pollution; 4-8 – pollution; >8 – gross pollution.

Ammonium and orthophosphate concentrations provide additional information with respect to organic pollution. Excessive concentrations of these nutrients lead to eutrophication which in turn causes severe oxygen fluctuations and a decrease in biodiversity of macro-invertebrates. (Mason 1981).

Biological water quality is described by the Belgian Biotic Index (BBI) (De Pauw and Vannevel 1991). Non biting midges Chironomidae resist the low oxygen levels typical for polluted freshwater. Most caddis flies Trichoptera and mayflies Ephemeroptera are very sensitive to low oxygen levels, they disappear when organic pollution increases. The evaluation of BBI is: 9-10 – very good biological quality; 7-8 – good biological quality; 5-6 – moderate biological quality; 3-4 – bad biological quality; 0-2 – very bad biological quality.

All water quality data used in this paper originate from V.M.M. (Vlaamse Milieu Maatschappij – Flemish Environmental Society) except the biological data from the Ieper town moats (“Vestingen”) that are issued from a local water quality investigation (Storme 1997).

The use of the different waterways for commuting and hunting by both pond bats and Daubenton’s bats, type and water quality (according to PIO. and BBI. indices) was tested by Chi-square tests.

RESULTS

For a detailed overview of the result, see Annex 1.

COMMUTING ACTIVITY

The highest level of commuting activity of pond bats (Table 1) was recorded over the canal Ieper-IJzer, near Boezinge, where we found a maternity roost. Some other roosts may be inferred from the commuting activity over the town moats of Ieper, and more probably in the vicinity of the river Schelde. A larger number of bats was recorded south of Diksmuide than north of this place. Few bats were observed crossing the border, possibly coming from Oostburg colony (Mostert 1997), and only one bat was recorded over the Canal Nieuwpoort – Plassendale. Pond bats commuted over the different types of waterways (Table 2) without any significant choice ($\chi^2 = 4.611$, df = 4, p = 0.330).

Some large numbers of commuting Daubenton’s bats were recorded too: 155 individuals in the village of Zillebeke near the town of Ieper, 72 individuals over the canal Ieper-IJzer near Merkem, 48 individuals over the Stenensluisvaart in Woumen, etc. However they tend to use less frequently broad canals ($\chi^2 = 8.337$, df = 4, p = 0.080).

Table 1. — Commuting activity of *Myotis dasycneme* in the west of Flanders recorded by bat detector in 1998-2003: main waterways, number of commuting bats (n) and possible origin of bats.

Waterway	n	Origin of commuting paths
Kanaal Ieper-IJzer (near Boezinge)	31	Known maternity roost (Boezinge), activity starting early in the evening
IJzer (south of Diksmuide)	5	Bats coming from the south, probably from the Boezinge roost
IJzer (north of Diksmuide)	2	Bats coming from the south, late in the evening (remote roost?)
Vestingen Ieper (town moats of Ieper)	7	Unknown roost, some bats originating from the town
IJzer (at Nieuwpoort)	2	Unknown roost, commuting activity starts relatively early here, suggesting the vicinity of a roost
Kanaal Nieuwpoort-Plassendale (at Rattevallebrug – Middelkerke)	1	Unknown roost, bats originating from Nieuwpoort
Kanaal Brugge-Sluis (near Sluis)	2	Unknown roost, bats coming from The Netherlands relatively late in the evening
Schelde (near Escanaffles)	10	Unknown roost, commuting activity starting from the village of Escanaffles along the Schelde
Kanaal Bossuit-Kortrijk (north to Moen)	5	Unknown roost, maybe the same as bats commuting over the Schelde (origin Escanaffles?)

Reproduction

Over a few adult females mistnetted when commuting over the canal Ieper-IJzer, near Boezinge (5 km north of the town of Ieper), one was lactating. An other female fitted with an emitter revealed the first ever reported maternity roost of the Pond bat in Belgium. The roost was located in a factory at a distance of 500 m from the canal Ieper-IJzer. Analysis of droppings collected in this roost revealed Chironomidae/Ceratopogonidae, Lepidoptera and a number of undetermined insect fragments as well (Motte, pers. comm.). In July 2003 a maximum of 31 commuting pond bats have been counted over the canal in the vicinity of the roost. Further bat detector research revealed that the flight routes over the canal Ieper-IJzer north of Boezinge always pointed towards the river IJzer and then after the mouth of the canal at Knokkebrug towards the north probably as far as Stuivekenskerke or even further (distance from roost 20 km or more). Other commuting pond bats were found over the river Schelde and the neighbouring canal Bossuit-Kortrijk. These animals seem to originate from Escanaffles, a village on the Schelde banks. The roost has not yet been found.

Hunting activity

Hunting activity of pond bats (Table 2) was recorded in 46% of the surveys (90% of the surveys for Daubenton's bats). Pond bats hunted mostly over broad canals (56% of surveys), broad lowland rivers (46%) and town moats (57%). Activity decreased with canal width: medium canals (23%) and small canals (7%). Activity over large ponds (28%) was lower than over broad canals and rivers. The choice for a hunting habitat was significant for pond bats ($\chi^2 = 22.640$, df = 6, $p < 0.001$), contrary to Daubenton's bats ($\chi^2 = 0.884$, df = 6, $p = 0.990$).
The highest hunting activity of pond bats was recorded over sites with moderate to good water quality (Table 2) with 62% of surveys for PIO 2-3 and 70% of surveys for BBI 7. Average activity (46% of the surveys) was reported over the best water quality sites: PIO < 2, BBI 8-9. The lowest activity was recorded over poor water quality sites: PIO > 3, BBI ≤ 6. The differences are significant for both PIO and BBI categories ($\chi^2 = 12.527$, df = 3, $p = 0.006$; $\chi^2 = 21.926$, df = 3, $p < 0.001$ respectively). Hunting activity of pond bats was found to be significantly higher ($\chi^2 = 4.672$, df = 1, $p = 0.031$) at sites with Trichoptera larvae (62%) than at sites without

Table 2. — Hunting activity of pond bats and Daubenton's bats according to the type of waterway, the Prati Index for Oxygen (PIO), the Belgian Biotic Index (BBI) and presence/absence of Trichoptera communities.
PIO and BBI classification only applies to broad and medium sized lowlands rivers, canals and town moats and exclude the data of small canals and ponds. Ieper town moats are excluded from PIO classification and included in BBI classification.

	Total number of surveys	Surveys with pond bats	% of surveys with pond bats	Surveys with bats chasing insects	Surveys with Daubenton's bats	% of surveys with Daubenton's bats
A: broad lowland rivers	41	19	46 %	0	37	90 %
B: medium lowland rivers	12	1	8 %	0	12	100%
C: broad canals	105	59	56 %	4	100	95 %
D: medium canals	56	13	23 %	0	51	91 %
E: small canals	15	1	7 %	0	11	73 %
F: town moats	215	123	57 %	4	183	85 %
G: large ponds	72	20	28 %	0	68	94 %
PIO > 4	40	12	30 %	0	37	92 %
PIO 3-4	53	10	19 %	0	50	94 %
PIO 2-3	103	64	62 %	3	97	94 %
PIO < 2	13	6	46 %	1	11	85 %
BBI 0-4	16	2	12 %	0	14	87 %
BBI 5-6	157	50	32 %	0	142	90 %
BBI 7	222	156	70 %	7	197	89 %
BBI 8-9	13	6	46 %	1	11	85 %
Waterways with Trichoptera	205	127	62 %	5	175	85 %
Waterways without Trichoptera	203	87	43 %	3	189	93 %

Trichoptera larvae (43%). Hunting activity of Daubenton's bats was almost the same for all types of water bodies and all pollution levels (typically 90% of the surveys).

Some observations of hunting pond bats refer to slightly brackish rivers and canals in the coastal area such as the downstream part of river IJzer and the canals Nieuwpoort-Plassendale and Nieuwpoort-Duinkerke where chloride levels fluctuate between 100 and >1000 mg/l. No pond bats have yet been observed over the highly brackish Boudewijnkanaal (mg/l Cl > 10000) but Daubenton's bats were observed foraging there.

A comparison between two canals

The canal Ieper-IJzer has a width of 40 m between Ieper and Boezinge and is located close to the known maternity roost. Physico-chemical quality is moderate (PIO = 2.62) but biological quality is good (BBI = 7). Within the group of moderate polluted waterways this canal ranks amongst the less polluted. However it is characterised by algal blooms in summer. The good biological quality of this canal mainly results from a high diversity in Mollusca (V.M.M 2003). Water quality is not good enough to support Ephemeroptera or Trichoptera communities. This canal only supplies Chironomidae to hunting pond bats. Preliminary analysis of droppings in the Boezinge roost near this canal confirms the presence of small Diptera (Motte, pers. comm.). The large insects hunted by pond bats over this canal are probably Lepidoptera, that were identified in the droppings from the Boezinge roost as well.

On the other hand the canal Brugge-Sluis is less polluted (PIO = 1.61, BBI = 8). This canal supports large numbers of Trichoptera, Ephemeroptera as well as small Diptera. Some algal blooms are also reported though they are less intense than in the canal Ieper-IJzer (lower ammonium and orthophosphate concentration). The canal Brugge-Sluis is regularly used by foraging pond bats and Daubenton's bats. However, we feel that hunting pond bats are less numerous there than over the canal Ieper-IJzer. If the nearest roost is the known colony in Oostburg (The Netherlands) then the canal Brugge-Sluis would be a relatively remote foraging ground for this colony.

DISCUSSION

SUMMER DISTRIBUTION

Most pond bats have been recorded in the south of the study area with a known roost at Boezinge and presumable unknown roosts at Ieper and Escanaffles. In the north of the area records are low. In absence of historical data the dynamics of the population of Pond bat in the area remains obscure. Daubenton's bat is much more widespread over the waterway network and numbers of commuting bats were found to be higher. Daubenton's bat is even omnipresent in the very open low-lying pasture landscapes such as the coastal area and the IJzer river plane. This situation seems to be at the opposite of the situation in very open landscapes in the north-western Dutch lowlands where the Pond bat is very common and the Daubenton's bat is scarce in the absence of ancient woodland (Kapteyn 1995). Since Daubenton's bat mainly forages on Chironomidae (Mostert 1997), one could expect at least some competition between the two species.

The Pond bat is more adapted to hunt over large open water surfaces than over small surfaces because of its relatively high wing load and associated fast flight, its restricted manoeuvrability and its ability to use a long range sonar consisting of almost constant frequency signals at 35 kHz. (Kapteyn 1995; Mostert 1997; Siemers *et al.* 2001) The affinity for large open water surfaces is confirmed in our surveys. The lower activity recorded over large ponds could be an underestimation as it is likely to miss hunting bats whilst surveying large water surfaces from the banks with a bat detector. On the other hand, it is very unlikely to miss pond bats hunting over linear elements like canals and rivers if width is less than 50 m.

Local characteristics may also play an important role. For example, there is a huge difference in hunting activity of pond bats over the different parts of the Ieper town moats. Hunting activity is higher in the eastern moat than in the broader south-western moat. This pattern has probably something to do with insect abundance.

WATER QUALITY AND HUNTING ACTIVITY

Since Chironomidae occur in polluted water as well as in clean water and since they are the most important prey of the Pond bat (Britton *et al.* 1997; Sommer and Sommer 1997), one can expect hunting activity over waterways within a wide range of pollution levels. Indeed we recorded hunting pond bats over sites with moderate and heavy pollution, but activity was higher over sites with mild pollution and good biological quality, including a preference for waterways with Trichoptera communities. Trichoptera are reported to be an important prey in northern Germany (Sommer and Sommer 1997). In this study pond bats have been observed hunting over all the three main broad waterways where Trichoptera larvae have been found: the canal Brugge-Sluis, the northern part of the canal Bossuit-Kortrijk and the Ieper town moats. The few Ephemeroptera species (*Cloeon*, *Baetis*, *Caenis*) occurring in lowland areas are adapted to stagnant or slow flowing freshwater habitats. Ephemeroptera have not yet been reported in pond bat droppings.

Although hunting activity has been reported over the polluted river Schelde, pond bats have not been recorded over a number of other polluted waterways like river Leie and the canal Gent-Oostende. Daubenton's bats have been observed foraging over all those waterways.

Water quality is not the only factor for hunting activity as it was illustrated by the comparison of two canals. The vicinity of a maternity colony seems to be also very relevant.

LIMITATIONS

Hunting activity was calculated from qualitative data only (presence or absence of hunting activity in a number of surveys) and not from quantitative

Annex 1. — Surveys overview with respect to hunting and commuting activity of pond bats and Daubenton's bats over the main waterways C: broad canals, D: medium canals, E: small canals, F: town moats , G: large ponds. Biologic water quality data for Vestingen Ieper: Ammonium, orthophosphate and chloride concentrations in 2002. Y: presence, N: absence.

Type of waterbody	Name	Stretch (for waterways) or location (for ponds)	Width classification (m) for waterways or area (ha) for ponds	Number of surveys for commuting activity	Surveys with commuting pond bats	Surveys with commuting Daubenton's bats	Number of surveys with regard to hunting activity	Surveys with hunting pond bats
A	Leie	Wervik-Waregem	25-50	0	0	0	5	0
A	Schelde	Spiere-Oudenaarde	25-50	8	8	6	6	2
A	IJzer	Diksmuide-Nieuwpoort	25-50	6	4	6	13	8
A	IJzer	Knokkebrug-Diksmuide	25-50	4	4	4	17	9
B	IJzer	Roesbrugge-Knokkebrug	15-25	2	1	2	12	1
C	Boudewijnkanaal	Zeebrugge-Brugge	> 50	0	0	0	2	0
C	Afleidingskanaal van Schipdonk	Zeebrugge-Maldegem	25-50	0	0	0	2	0
C	Leopoldkanaal	Zeebrugge-Maldegem	25-50	0	0	0	2	0
C	Kanaal Brugge-Sluis	Brugge-Sluis	25-50	4	4	3	8	4
C	Kanaal Gent-Oostende	Beernem-Brugge	25-50	0	0	0	3	0
C	Kanaal Gent-Oostende	Brugge-Oostende	25-50	0	0	0	4	0
C	Kanaal Roeselare-Leie	Roeselare-Ooigem	25-50	0	0	0	7	0
C	Kanaal Bossuit-Kortrijk	Bossuit-Zwevegem	25-50	10	10	5	20	10
C	Kanaal Bossuit-Kortrijk	Zwevegem-Kortrijk	25-50	1	1	0	5	2
C	Kanaal Ieper-IJzer	Ieper-Boezinge	25-50	42	38	26	52	43
D	Kanaal Ieper-IJzer	Boezinge-Knokkebrug	15-25	22	21	20	22	8
D	Handzamevaart	Kortemark-Diksmuide	15-25	0	0	0	2	0
D	Kanaal Nieuwpoort-Duinkerke	Nieuwpoort-Adinkerke	15-25	0	0	0	6	1
D	Kanaal Nieuwpoort-Plassendale	Nieuwpoort-Plassendale	15-25	1	1	1	8	4
D	Lokanaal	Fintele-Veurne	15-25	0	0	0	5	0
D	Verwezen kanaal Komen-Ieper	Palingbeek area	15-25	0	0	0	13	0
E	Bergenvaart	Veurne-Houtem	3-15	0	0	0	1	0
E	Grote Beverdijkvaart	Fintele-Nieuwpoort	3-15	0	0	0	1	0
E	Houtensluisvaart	Woumen	3-15	0	0	0	4	0
E	Stenensluisvaart	Woumen	3-15	1	0	1	4	0
E	Vladslovaart	Vladslo-Nieuwpoort	3-15	0	0	0	1	0
E	Verwezen kanaal Komen-Ieper	Ieper	3-15	0	0	0	4	1
F	Vestingen Ieper	Eastern part	25-50	12	12	1	145	104
F	Vestingen Ieper	Southeastern part	> 50	0	0	0	47	17
F	Vestingen Ieper	Southwestern part	> 50	0	0	0	23	2
G	Bergelenput	Gullegem	8 ha	0	0	0	2	0
G	Blankaart vijver	Woumen	40 ha	2	0	2	8	0
G	Dikkebus vijver	Dikkebus	36 ha	0	0	0	15	8
G	Gavers	Harelbeke	60 ha	0	0	0	6	1
G	Nieuwkapelle vijver	Nieuwkapelle	8 ha	0	0	0	1	0
G	Roksemput	Oudenburg	35 ha	0	0	0	1	1
G	Spaarbekken Blankaart	Woumen	60 ha	0	0	0	1	0
G	Spaarbekken IJzer	Nieuwpoort (Sint-Joris)	50 ha	0	0	0	4	2
G	Verdronken weide	Ieper	10 ha	0	0	0	11	4
G	Zillebeke vijver	Zillebeke	28 ha	3	0	3	23	4

of the west of Flanders (Belgium) recorded by bat detector in 1998-2003. A: broad lowland rivers, B: medium lowland rivers, * sample tennisveld, ** sample speelplein, *** sample voorvestingen. P.I.O.: Prati Index for Oxygen, B.B.I.: Belgian Biotic Index.

% of surveys with hunting pond bats	Number of surveys with pond bats chasing insects	Surveys with hunting Daubenton's bats	% of surveys with hunting Daubenton's bats	VMM sampling location number	P.I.O. in 2002	Mean ammonium concentration (mg/l)	Mean orthophosphate concentration (mg/l)	Mean chloride concentration (mg/l)	B.B.I. in 2002	Trichoptera	Ephemeroptera	Chironomidae	Other aquatic diptera	Aquatic coleoptera	Aquatic hemiptera
0%	0	3	60%	579000	5.94	4.03	0.76	96	4	N	N	Y	Y	N	N
33%	0	6	100%	177100	5.40	1.22	0.34	53	4	N	N	Y	N	N	N
62%	0	12	92%	910000	2.96	1.11	0.56	116	7	N	Y	Y	Y	Y	Y
53%	0	16	94%	910900	2.63	1.82	0.67	95	6	N	Y	Y	Y	N	N
8%	0	12	100%	913000	3.85	1.07	0.37	71	7	N	Y	Y	N	N	Y
0%	0	2	100%	816040	3.67	2.36	0.33	10772	–	–	–	–	–	–	–
0%	0	2	100%	765010	3.58	2.62	0.59	125	5	N	N	Y	N	N	N
0%	0	2	100%	6000	3.32	1.79	0.68	705	6	N	N	Y	N	N	N
50%	0	8	100%	1000	1.61	0.56	0.10	105	8	Y	Y	Y	Y	Y	Y
0%	0	3	100%	775700	5,36	3.14	0.52	84	4	N	N	Y	N	N	N
0%	0	4	100%	770000	4.07	2.18	0.52	256	5	N	N	Y	N	N	N
0%	0	7	100%	643000	3.86	0.93	0.16	51	6	N	N	Y	N	N	N
50%	0	19	95%	659000	4.19	0.92	0.30	56	5	N	N	Y	N	N	N
40%	1	3	60%	657000	1.96	0.40	0.08	49	9	Y	Y	Y	Y	Y	Y
83%	3	50	96%	946000	2.62	1.01	0.15	43	7	N	N	Y	N	N	N
36%	0	20	91%	942000	3.35	1.86	1.13	113	6	N	N	Y	N	N	N
0%	0	2	100%	917850	6.19	3.67	0.85	74	4	N	N	Y	N	N	N
17%	0	5	83%	683000	3.10	0.74	0.59	334	–	–	–	–	–	–	–
50%	0	7	87%	856500	2.00	0.60	0.32	805	5	N	N	Y	N	N	N
0%	0	5	100%	687020	4.00	0.85	0.32	246	5	N	N	Y	Y	N	N
0%	0	12	92%	946600	2.93	0.56	0.10	33	–	–	–	–	–	–	–
0%	0	1	100%	689000	2.79	0.63	0.41	587	–	–	–	–	–	–	–
0%	0	1	100%	676000	2.87	0.88	0.71	429	6	N	N	Y	N	N	N
0%	0	4	100%	933000	4.00	1.59	0.88	89	7	N	Y	Y	N	Y	Y
0%	0	4	100%	934000	3.58	0.94	0.46	62	7	N	N	Y	N	N	N
0%	0	1	100%	691000	3.02	1.32	0.91	163	6	N	Y	Y	N	N	N
25%	0	0	0%	–	–	–	–	–	–	–	–	–	–	–	–
72%	4	123	85%	*	–	–	–	–	7	Y	Y	Y	N	N	Y
36%	0	41	87%	**	–	–	–	–	6	Y	Y	Y	N	N	Y
9%	0	19	83%	***	–	–	–	–	5	N	Y	Y	N	Y	Y
0%	0	2	100%	–	–	–	–	–	–	–	–	–	–	–	–
0%	0	7	87%	936540	3.60	0.89	0.32	51	–	–	–	–	–	–	–
53%	0	14	93%	951030	2.18	–	–	–	–	–	–	–	–	–	–
17%	0	5	83%	633050	0.90	–	–	–	–	–	–	–	–	–	–
0%	0	1	100%	–	–	–	–	–	–	–	–	–	–	–	–
100%	0	1	100%	–	–	–	–	–	–	–	–	–	–	–	–
0%	0	1	100%	–	–	–	–	–	–	–	–	–	–	–	–
50%	0	4	100%	909400	1.94	1.06	0.49	259	–	–	–	–	–	–	–
36%	0	11	100%	–	–	–	–	–	–	–	–	–	–	–	–
17%	0	22	96%	953040	–	–	–	–	–	–	–	–	–	–	–

data (number of foraging bats, number of feeding buzzes per time unit, number of bat passes per time unit). The results are not corrected for proximity of roosts. The canal Ieper-IJzer and the Ieper town moats are both characterised by high Pond bat activity but are also located near the largest roost in the area. Since high numbers of surveys have been done at these sites their influence on the total percentages could be high. Standardised monitoring programs using bat detectors or radiotracking would be more valuable tools in order to quantify hunting activity. In the absence of more precise quantitative data our preliminary results should be handled with care.

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REFERENCES

AHLÉN I. 1990. — *Identification of bats in flight.* Katarina Tryck AB, Stockholm.

BOONMAN A. M., LIMPENS H. J. G. A. & VERBOOM B. 1995. — The influence of landscape elements on the echolocation of the Pond bat *Myotis dasycneme. Rhinolophe* 11: 39-40.

BRITTON A. R. C., JONES G., RAYNER J. M. V., BOONMAN A. & VERBOOM B. 1997. — Flight performance, echolocation and foraging behaviour in pond bats *Myotis dasycneme* (Chiroptera: Vespertilionidae). *J. Zool. (Lond.)* 241: 503-522.

DENSE C., TAAKE K.-H. & MÄSCHER G. 1996. — Sommer und Wintervorkommen von Teichfledermäusen (*Myotis dasycneme*) in Nordwestdeutschland. *Myotis* 34: 71-80.

DE PAUW N. & VANNEVEL R. 1991. — *Macro-invertebraten en waterkwaliteit.* Stichting Leefmilieu v.z.w., Antwerpen.

HORÁČEK I. 1999. — *Myotis dasycneme* (Boie, 1825), *in* Mitchell-Jones *et al.* (eds), *The atlas of European Mammals.* Academic Press, London: 108-109.

FAIRON J., GILSON R., JOORIS R., FABER T. & MEISCH C. 1982. — Cartographie provisoire de la faune chiroptérologique belgo-luxembourgeoise. *Bull. Centre Baguement Rech. Cheiroptérol. Belg.* 7: 1-125.

KAPTEYN K. 1993. — Intraspecific variation in echolocation of vespertilionid bats, and its implications for identification *in*. Kapteyn (ed.) *Proceedings of the first European bat detector workshop.* Netherlands' Bat Research Foundation, Amsterdam: 45-47.

KAPTEYN K. 1995. — *Vleermuizen in het landschap. Over hun ecologie en verspreiding.* Schuyt & Co., Haarlem.

LEFEVRE A., VAN DEN BOSSCHE W., VERKEM S. & VERSWEYVELD S. 2001. — *Bats and the Habitats directive in Flanders.* Druk in de weer, Gent.

LIMPENS H. J. G. A. & ROSCHEN A. 1995. — *Bestimmung der mitteleuropäischen Fledermausarten anhand ihrer Rufe. Begleitheft zur Lern- und Ubungskassette.* NABU-Umweltpyramide. Bremervörde.

MASON C. 1981. — *Biology of freshwater pollution.* Longman Group Ltd, Singapore.

MOSTERT K. 1997. — Meervleermuis *Myotis dasycneme* (Boie, 1825), *in* Limpens *et al. (*eds), *Atlas van de Nederlandse vleermuizen*. K.N.N.V. Uitgeverij, Utrecht: 124-150.

NATIONAAL CARTOGRAFISCH INSTITUUT 2002. — *Topografische atlas van België,* Uitgeverij Lannoo, Tielt.

SIEMERS B. M., STILZ P. & SCHNITZLER H. U. 2001. — The acoustic advantage of hunting at low heights above water; behavioural experiments on the European 'trawling' bats *Myotis capaccinii, M. dasycneme* and *M. daubentonii. J. exp. Biol.* 204: 3843-3854.

SLUITER J. W., VAN HEERDT P. F. & VOÛTE A. M. 1971. — Contribution to the population biology of the Pond bat, *Myotis dasycneme* (Boie, 1825). *Decheniana* 18: 1-44.

SOMMER R. & SOMMER S. 1997. — Ergebnisse zur Kotanalyse bei Teichfledermäusen, *Myotis dasycneme* (Boie, 1825). *Myotis* 35: 103-107.

STORME B. 1997. — *Wateronderzoek van de vestingen.* Eindwerk Techn. Inst. Immaculata, Ieper.

VAN DE SIJPE M. 2001. — De vondst van een kraamkolonie van de *Meervleermuis Myotis dasycneme* te Boezinge en verdere gegevens over deze soort in de regio Ieper*, in Referatenmap 4de Belgische Vleermuizenstudiedag*. IBGE. – BIM, Brussels: 25-26.

VANDENDRIESSCHE B. 2001. — Vleermuizen in West-Vlaanderen, een overzicht van 4 jaar zomeronderzoek. *Zoogdier* 12(3): 25-29.

V.M.M. 2003. — Vlaamse Milieumaatschappij. http://www.vmm.be

VOÛTE A. M., SLUITER J. W. & GRIMM M. P. 1974. — The influence of the natural light-dark cycle on the activity rhythm of pond bats *Myotis dasycneme* (Boie, 1825) during summer. *Oecologia* 17: 221-243.