RESEARCH PROJECT ON THE IMPACT OF LOW-LEVEL FLYING ON BATS

Component of the River Valley Ecosystems Study

Progress Report - Work Carried Out in 2005

PRELIMINARY

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Introduction

The river valleys located in the Military Training Area (MTA) of Quebec-Labrador are particularly appealing for low-level flying because they provide a natural corridor appropriate for training routes and they enable pilots to practise radar detection avoidance. Given the large concentration of low-level training flights in the river valleys and the biological importance of these environments, over the past few years, the Institute for Environmental Monitoring and Research (IEMR) has developed a research program designed to investigate the impact of overflights on the ecological components of these valleys. In addition, the increase in nocturnal military activities has recently brought to light the need to initiate studies of species that are active at night. It is against this backdrop that a research project was started in 2003 involving a species of nocturnal raptor associated with the river valleys – the boreal owl (*Aegolius funereus*) (Maisonneuve 2004 and 2005). A search of the literature on the effects of noise caused by aircraft on nocturnal wildlife species turned up only a limited number of publication titles that were somewhat relevant (FAPAQ 2003). The only references that truly dealt specifically with evaluating the effects of the disturbance caused by overflights on nocturnal species related to a study of the spotted owl (Pater et al. 1995, Delaney et al. 1999a and 1999b, Johnson and Reynolds 2002) and another study of a subspecies of desert kit fox (*Vulpes macrotis arsipus*) and the small mammals that it feeds upon (Bowles et al. 1995).

Of the nocturnal species likely to be associated with the river valleys, bats are a group worthy of interest. Owing to the very high abundance of insects found in these areas and the presence of water, riparian habitats are particularly important environments for bat foraging (Brigham et al. 1992, Cross 1986, Furlonger et al. 1987). These riparian environments are therefore much more highly frequented than the adjacent forest environments (Thomas 1988, Grindal et al. 1999, Seidman and Zabel 2001). In addition, the large trees generally found in riparian habitats provide excellent shelter for bats (Ormsbee and McComb 1998, Rabe et al. 1998). The literature search mentioned above did not reveal the existence of any studies aimed at evaluating the effects of aircraft on bats. Since that search was conducted, contacts with chiroptera specialists have made it possible to locate several <u>unpublished</u> works concerning studies of the impact of military activities on this species group. Some of those were designed mainly to assess the effects of activities carried out on the ground (BHE Environmental Inc. 2002, Martin et al. 2002). Only one study dealt specifically with evaluating the effects of low-level flying (Dalton and Dalton 1993). Although that study did not point to any negative effects, it involved bats in a nursery located in a mine, where the noise effects were probably lessened. Also, the study concerned a species of nectarivorous bat (*Leptonycteris curasoae*) and was carried out in a desert environment where conditions are not representative of those found in Quebec-Labrador.

In Quebec, there are eight species of bats. Five of them are considered resident species: the little brown bat (*Myotis lucifugus*), the big brown bat (*Eptesicus fuscus*), the northern long-eared bat (*Myotis septentrionalis*), the eastern pipistrelle (*Pipistrellus subflavus*), and the small-footed bat (*Myotis leibii*). The other three are considered migratory: the red bat (*Lasiurus borealis*), the hoary bat (*Lasiurus cinereus*), and the silver-haired bat (*Lasionycteris noctivagans*). Our knowledge of their distribution improves as the years go by. Recent inventories done in the Sept-Îles region and in the Mingan Islands Archipelago have made it possible to expand considerably the range of certain species that had hitherto been considered absent from these northern regions (van Zyll de Jong 1985, Gauthier 1996, McDuff et al. 1999 and 2001).

It is in this context that exploratory work was undertaken in 2004 in the North Shore region by the Ministère des Ressources naturelles et de la Faune (Maisonneuve et al. 2005). That first year of work made it possible to confirm the presence of bats of the genus *Myotis* in the region, both in the military training area and in the control sector. The basic data thus collected helped with the planning of the work to be carried out in 2005 for the purpose of conducting an adequate assessment of the effects of military activities on bats. This report takes stock of the results of the work that was done in the past year.

Hypotheses

Low-level flying could affect bats in different ways. Bats navigate and hunt mainly by means of a sophisticated echolocation system, and it is possible that the low-level flights have a negative impact on their hearing ability and, consequently, on their hunting efficiency at night. The flights may also cause a disturbance during the day, and this could interfere with the ability of females to feed their young and have an impact on their physical condition. The presumed effects of low-level flying would ultimately lead to a reduction in the breeding success of bats and, in the long term, to a decline in the abundance of these species in the areas where the low-level flying occurs. The disturbance might also cause the bats to leave the training area to look for quieter shelter elsewhere.

The hypothesis that this project is seeking to verify is therefore as follows:

There should be less bat activity in the training area than outside it.

Study Area

The work was carried out along the Natashquan River for the following reasons:

1. The logistics of the field work are facilitated because of the boreal owl research activities already under way in the same region.
2. The habitats along the banks of the Natashquan River are relatively homogeneous, making it easier to select appropriate sectors for experimental/control comparisons.
3. The Natashquan River is easily navigable over long distances.
4. The mouth of the river is located near the village of Natashquan, which is accessible by road, thus making it easier to transport equipment.

A stretch of the Natashquan River located to the south of the low-level flying area serves as a control sector, while another stretch situated within the flying area serves as an experimental sector (Figure 1). In addition, aircraft engaged in training exercises were observed while the work on bats was being carried out.

Methods

1. *Equipment*

Bats are detected by means of recordings of the ultrasounds they emit to get around and locate their prey. The calls of the species found in Quebec generally last 2 to 15 milliseconds (ms) and have a frequency of 5 to 110 kilohertz (kHz). The time interval between two calls is a few hundred milliseconds, and it gets shorter as the animal approaches an obstacle or prey. The characteristics of these calls are usually quite distinctive, making it possible to identify the species encountered, with the exception of two species associated with the genus *Myotis*, which cannot be distinguished by means of the Anabat equipment used and must therefore be placed in the same group.

When making recordings, units consisting of a bat detector (AnaBat II Bat Detector) connected to an AnaBat CF Storage ZCA Interface Module are used to store the data (vocalizations) directly on memory cards (Flash Memory Cards). Those units are left on all night, during which time they wait to receive ultrasound signals. When such signals are captured, they are transmitted to the recording module and digitized on the memory cards. The capacity of those cards makes it possible to store one week's worth of bat calls, while in continuous use.

In order to analyze the recordings thus digitized, the recordings are downloaded directly into a computer, and a sound analysis software program (AnaLookW version 3.2o) produces sonograms that make it possible to view and analyze the recorded calls. The bats are identified by comparing the sonograms with the ultrasonic signature of each species.

2. *Field Work*

Summer is a particularly important time for lactating female bats, and it is likely that any disturbance during that period has an impact on breeding success and consequently, in the long term, on the abundance of the bats present. The work was therefore carried out from July 5 to 20, a period during which bat rearing activities are concentrated.

Eight recording units were used every night, i.e., four in the training area and four in the control sector. The simultaneous use of units in the two sectors improves the chances of obtaining comparable weather conditions for each of the recording periods. At each station, the recording units were left on for a period of four nights, after which they were moved to eight new stations. The four-night period was supposed to ensure at least one night during which weather conditions would be conducive to bat activity. Four rotations were therefore carried out, the aim being to cover 16 stations in each sector, for a potential 64 nights of recordings per sector. However, during the third inventory period, two of the recording units used in the flying area got wet and stopped working properly after two nights of recording. Unfortunately, it was not possible to use those units during the subsequent inventory period. As a result, in the flying area, recordings were made over 52 nights at 14 stations, whereas the effort in the control sector was 64 nights at 16 stations (Figure 1, Appendix 1). That meets the criterion of 50 nights of recording in each of the sectors, which had been established in order to make it possible to detect a difference of three detections per night between the two sectors (Maisonneuve et al. 2005).

The recording units were placed on the ground, on open sites along bodies of water, at an angle of about 30° in relation to the horizontal. All of the sites selected were small bodies of calm water, preferred by bats (von Frenckell and Barclay 1987), located along main watercourses where the surface of the water is often more choppy. Some of those bodies of water were stretches of river that had been cut off from the main river when the water level dropped (Figure 2), whereas others were beaver ponds (Figure 3) or peatland ponds (Figure 4). The recording units came on at sunset and stayed on all night. Night length varied from 7 hours 38 minutes on July 5 to 8 hours 17 minutes on July 20.

Two mobile weather stations (Weather Wizard, Davis Instruments) were installed on July 5 less than 50 metres from the banks of the Natashquan River - one in the control sector (50°40’66’’N, 60°40’00’’W) and the other in the training area (51°10’50’’N, 61°37’96’’W). Those stations were programmed to collect meteorological data every half hour. The data collected were temperature, precipitation, and wind speed and direction. The reason for collecting meteorological data in the two sectors was that, in the event of differences between the two sectors in terms of bat activity levels, it could be determined whether the differences could be attributed to different weather conditions.

3. Statistical Analyses

One detection represents the pass of one bat, meaning that multiple detections may be due to the repeated passes of one or more individuals of the same species or of different species of bat. The detection of echolocation calls can therefore not be used directly to obtain an estimate of the number of individuals present. Rather, the number of detections is traditionally used as an indicator of bat activity (Thomas 1988, Betts 1998, Hayes 1997, Jung et al. 1999).

The mean detection rate per night was calculated for all species taken together (including unidentified detections), as well as for each of the identified species (by combining the detections associated with individuals of the genus *Myotis*). A variance analysis (ANOVA, SYSTAT 11, 2004) was used to compare this activity indicator (mean detection rate) between the flying area and the control sector and to examine the impact of the inventory period, as well as the combined impact of the inventory period and the study sector. The activity indicator values obtained were subjected to a square-root transformation so as to comply with the normality required by this analysis. In cases where it was not possible to transform the data in order to comply with normality (less abundant species), the Wilcoxon-Mann-Whitney and Kruskal-Wallis nonparametric tests (NPAR, SYSTAT 11, 2004) were used to compare the activity indicators obtained in the two sectors during the four inventory periods.

Results

In all, 1,003 bat passes were detected, and it was possible to identify 45% of them (Table 1). There was a total absence of bats at only 2 of the 30 stations covered, both of which were located in the flying area. Most of the identified detections (88%) were of bats of the genus *Myotis*, whose presence is confirmed throughout the coverage area (Figure 1). The red bat was the only other species regularly encountered, while a single hoary bat detection was obtained at the southernmost station in the control sector (Figure 1). An examination of the raw data (Table 1) seems to indicate a greater abundance of bats in the control sector, although this may be attributed to the fact that data were collected over 12 more nights there than they were in the flying area. The average number of detections obtained per night is a better indicator of bat activity on the different sites (Table 2).

The results of the variance analyses (Table 3) do not show any difference between the flying area and the control sector, both for all bat detections and for those attributed to the genus *Myotis*. Consequently, for all bats, an average of 8.3 ± 11.7 detections/night was obtained in the flying area, compared with 9.3 ± 8.3 detections/night in the control sector. Those values were 3.6 ± 4.0 and 3.4 ± 3.2 detections/night, respectively, in the case of bats of the genus *Myotis*. According to those same variance analyses, the inventory period had no impact on the bat activity indicator, and there was no interaction between the study sector and the inventory period (Table 3). Lastly, there was no difference in the red bat activity indicator between the two sectors (U = 130,000, P = 0.385), and it did not vary with the sampling period (H = 2.226, P = 0.527).

It was possible to note bat activity indicators at all times of night. Most detections (72.2%) were fairly evenly distributed in the first four hours after sunset, followed by a gradual decline in detections in the fifth hour, i.e., around 00:30 (Figure 5). Owing to a technical problem that arose while weather data were being downloaded, only the data collected at the station located in the control sector could be collected. However, given the similar levels of bat activity in the two sectors, it was less important to compare the weather conditions in those two sectors. The data collected by the weather station in the control sector showed that the total number of bat detections noted during each hour of the night followed more or less the same downward trend as the mean temperatures obtained during those same periods (Figure 5).

Discussion

Relative Abundance and Distribution of Species Detected

Most of the identified detections were attributable to bats of the genus *Myotis*, confirming the results obtained during the exploratory work carried out in the same region in 2004 (Maisonneuve et al. 2005), and were consistent with the inventories done elsewhere on the North Shore (Gauthier 1996, McDuff et al. 1999 and 2001) and in Newfoundland (Grindal 1998). Although it is difficult to identify the different species of the genus *Myotis* using Anabat-type devices, certain sonograms presented extreme cases that could be attributed to the northern long-eared bat, as was also the case in 2004. It is not possible to determine the relative contribution of this species and of the little brown bat to all of the detections obtained, although the results nonetheless make it possible to confirm the presence of these two species in the region. There are two possible ways to obtain a better picture of the relative abundance of these two species. The first would be to use a more high-performance (but also more expensive) device such as a Time expansion Pettersson bat detector. The second would be to identify specimens caught with nets. Such an exercise carried out in the western part of Newfoundland showed that the northern long-eared bat was abundant in that area, accounting for one-third of the individuals captured (Grindal 1998). The presence of the northern long-eared bat has been reported in Natashquan in the past (van Zyll de Jong 1985), and it is very likely that this species is also relatively abundant on the Quebec-Labrador peninsula.

Our observations of the presence of the red bat and the hoary bat represent extensions of the range of those two species. Until quite recently, the known range of the red bat did not go above the latitude of New Brunswick in eastern North America (van Zyll de Jong 1985). The presence of this species was recently confirmed along the coast in the Sept-Îles region (McDuff et al. 1999 and 2001) and more to the east in the Mingan Archipelago (Gauthier 1996). Our results indicate that this species is also fairly common inland, at least up to latitude 51°17’N, i.e., nearly 125 kilometres from the coast.

The presence of the hoary bat on the North Shore was reported for the first time in 2000, in the Sept-Îles region (McDuff et al. 2001), but that species was detected only at our southernmost station, located just 28 kilometres to the north of Natashquan. However, that observation extends the known range of the hoary bat 250 kilometres to the east. The presence of this species of bat on the Island of Newfoundland (Maunder 1988) is considered accidental (Grindal 1998), and our results indicate that the northern limit of its range is most likely located just a short distance from the Lower North Shore coast.

Bat activity could be confirmed at 94% of the stations covered, but the number of detections obtained was relatively low. Those results seem to indicate that bats are fairly well dispersed over the entire region but that they are not particularly abundant. Bat activity is known to be much greater in riparian habitats (Thomas 1988, Grindal et al. 1999, Seidman and Zabel 2001). Consequently, in order to be able to assess bat abundance along the Natashquan River adequately, the detection rates obtained can only be compared using data from studies in which acoustic inventories were also carried out in riparian habitats. Such a comparison (Table 4) shows that the bat activity indicator along the Natashquan River was, for equivalent recording periods, 3 to 22 times lower than it was elsewhere. This low level of activity could be attributed to the region’s relatively short summer, which would shorten the period conducive to bat activity.

Nocturnal Activity Pattern

A number of studies have shown that bats are particularly active during the hours right after sunset (Kunz 1973 and 1974, Swift 1980, Erickson and West 1996). However, along the Natashquan River, bats were particularly active in the first four hours after sunset (Figure 5). Similar results were also obtained in July in southeastern Alaska (Parker et al. 1996). July is the period during which bats lactate and reportedly prolong their foraging activity in order to meet the energy requirements of lactation (Kurta et al. 1989).

The gradual drop in temperature during the night, down to temperatures that are often below 12°C after midnight (Figure 5) and sometimes even near freezing in the hours before sunrise, very likely prompts bats to concentrate their foraging activity during the early hours of the night when conditions are the most suitable (abundance of insects and favourable temperature).

Assessment of the Effects of Low-Level Flying

The bat activity indicators obtained in the military training area were not significantly lower than those obtained in the control sector. Those results indicate that the low-level flights have no effect on the level of bat activity. However, the practice of low-level flying has declined gradually over the past few years in the study area, and the number of sorties in 2005 was probably much lower than it was at one time. It would have been useful to repeat the same study during a year of high military activity.

It should be pointed out as well that the assessment of the effects of low-level flying was based on only one activity indicator. It is not impossible that, even if bats are present and active, they may be disturbed during the day, which could hinder the females' nursing activities and affect their physical condition. The only way to determine if such effects are really being felt would be to study the behaviour of females fitted with transmitters. However, in view of the relatively low abundance of bats noted over this vast, inaccessible region, and given that it is very difficult to catch insectivorous bats owing to their ability to detect nets with their highly sophisticated navigation system, a considerable effort would be required to catch a sufficient number of individuals to make solid comparisons. Considering the uncertain future of low-level flying in Quebec-Labrador, it would probably be difficult to obtain support for such work.

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Table 1. Identification of bat calls recorded along the Natashquan River, July 2005

	Myotis spp.	*Lasiurus borealis*	*Lasiurus cinereus*	Not classified	Total
Flying area	180	24	0	205	409
Control	218	32	1	343	594
TOTAL	398	56	1	548	1003

Table 2. Mean detection rate per night at each acoustic inventory station for the different species or groups of species of identified bats

Station	Sector	Period[a]	*Myotis* spp.	*Lasiurus borealis*	*Lasiurus cinereus*	Not classified	Total
1	Flying area	1	4.0	0.0	0.0	3.3	7.3
2	Flying area	1	5.8	0.0	0.0	3.5	9.3
3	Flying area	1	4.3	0.0	0.0	1.3	5.5
4	Flying area	1	2.8	0.0	0.0	1.5	4.3
5	Flying area	2	0.0	0.0	0.0	0.0	0.0
6	Flying area	2	0.8	0.3	0.0	1.8	2.8
7	Flying area	2	4.3	0.3	0.0	2.8	7.3
8	Flying area	2	0.0	0.0	0.0	0.0	0.0
9	Flying area	3	4.0	0.0	0.0	3.8	7.8
10	Flying area	3	0.3	0.0	0.0	0.0	0.3
11	Flying area	3	9.5	0.5	0.0	16.5	26.5
12	Flying area	3	0.5	0.0	0.0	1.8	2.0
13	Flying area	4	0.3	0.0	0.0	1.0	1.3
14	Flying area	4	13.8	5.3	0.0	22.5	41.5
		Mean	**3.6**	**0.4**	**0.0**	**4.3**	**8.3**
17	Control	1	0.5	0.0	0.0	1.5	2.0
18	Control	1	2.3	0.3	0.0	2.3	4.8
19	Control	1	8.8	0.8	0.0	20.3	29.8
20	Control	1	3.3	0.0	0.0	4.3	7.5
21	Control	2	0.3	0.0	0.0	3.5	3.8
22	Control	2	3.5	1.0	0.0	4.8	9.3
23	Control	2	0.0	0.0	0.0	0.3	0.3
24	Control	2	3.5	0.0	0.0	4.8	8.3
25	Control	3	0.3	0.0	0.0	1.0	1.3
26	Control	3	4.3	0.3	0.0	11.8	16.3
27	Control	3	3.0	0.0	0.0	1.0	4.0
28	Control	3	6.8	0.3	0.0	7.3	14.3
29	Control	4	5.3	4.5	0.0	9.5	19.3
30	Control	4	10.8	1.0	0.0	7.3	19.0
31	Control	4	0.3	0.0	0.0	1.5	1.8
32	Control	4	2.0	0.0	0.3	5.0	7.3
		Mean	**3.4**	**0.5**	**0.0**	**5.4**	**9.3**

[a] 1 = July 5 to 8, 2 = July 9 to 12, 3 = July 13 to 16, 4 = July 17 to 20

Table 3. Results of variance analyses (ANOVA) examining the impact of the study sector and inventory period on the bat activity indicator

	Factor	dl	*F*	*P*
Total bats	Flying area/control	1	0.408	0.529
	Inventory period	3	1.753	0.186
	Sector x period	3	0.302	0.824
Myotis spp.	Flying area/control	1	0.024	0.879
	Inventory period	3	1.719	0.192
	Sector x period	3	0.247	0.863

Table 4. Average number of bat detections obtained in riparian habitats in different regions of North America

Region	Average number of detections	Length of recording period examined after sunset	Source
Southern British Columbia	~ 150/hour	90 min.	Grindall et al. 1999
Western Newfoundland	23.1/hour	2 hours	Grindal 1998
Northeastern California	24.7 – 48.0/hour	3 hours	Seidman et Zabel 2001
Southeastern Alaska	81.0/night	All night	Parker et al. 1996
Lower North Shore (Quebec)	6.9/hour	2 hours	Our study
	6.4/hour	3 hours	
	8.5/night	All night	

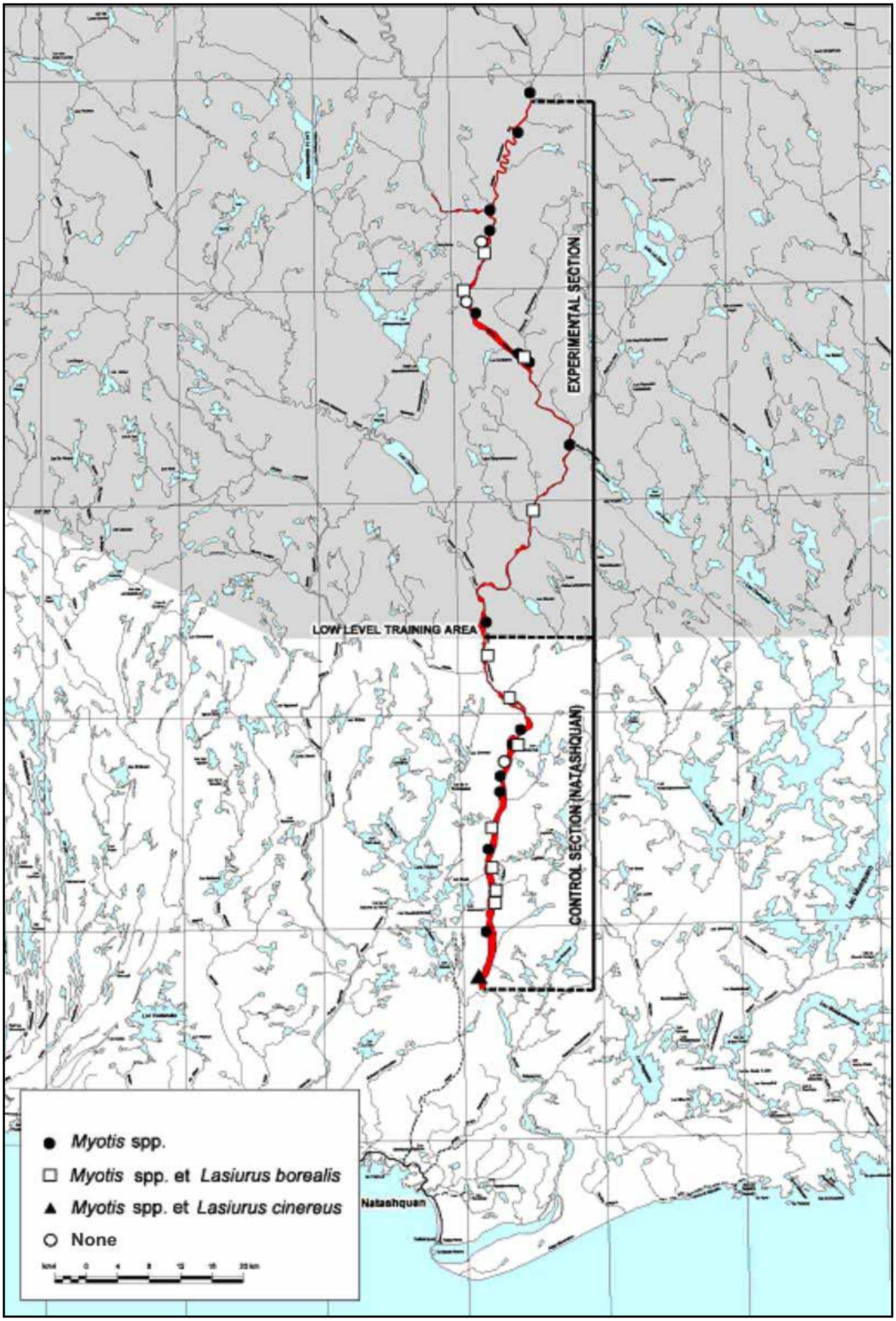

Figure 1. Location of bat acoustic inventory stations and distribution of the different species detected

Figure 2. Stretch of the Natashquan River cut off from the main watercourse during summer low water

Figure 3. Beaver pond on a small watercourse near a dried-up stretch of the Natashquan River

Figure 4. Recording unit at a peatland pond located along the Natashquan River

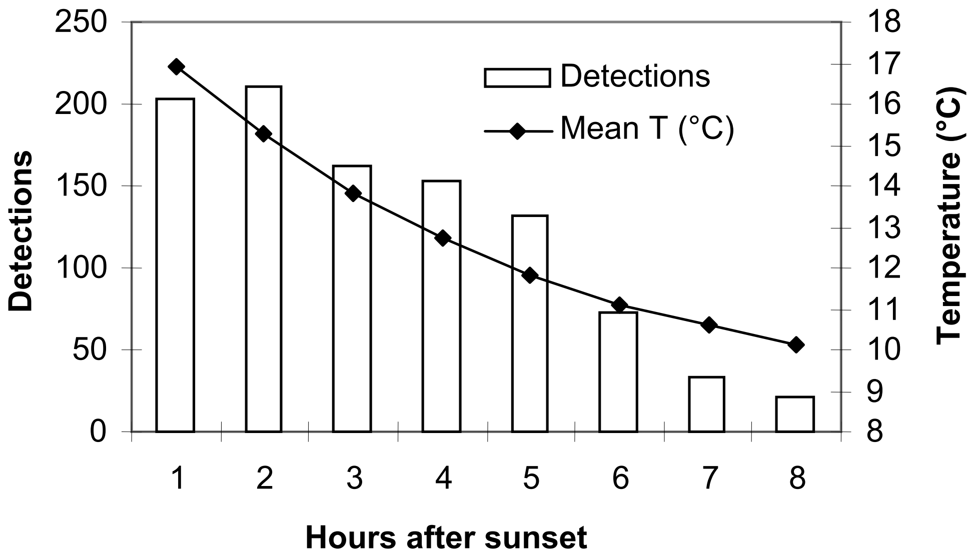

Figure 5. Temporal distribution of bat detections and mean temperatures by hour obtained along the Natashquan River, July 2005

APPENDIX 1

Appendix 1. Geographical coordinates of the 30 bat acoustic inventory stations along the Natashquan River, July 2005

Station	Latitude (N)	Longitude (W)
1	51° 28 48	61° 36 02
2	51° 26 01	61° 37 26
3	51° 20 35	61° 40 34
4	51° 19 07	61° 40 41
5	51° 18 22	61° 41 41
6	51° 17 33	61° 41 20
7	51° 14 53	61° 43 43
8	51° 14 07	61° 43 25
9	51° 13 17	61° 42 30
10	51° 10 23	61° 37 51
11	51° 10 07	61° 37 16
12	51° 09 46	61° 36 44
13	51° 03 54	61° 32 29
14	50° 59 20	61° 36 35
17	50° 51 30	61° 41 56
18	50° 49 10	61° 41 52
19	50° 46 07	61° 39 35
20	50° 43 48	61° 38 22
21	50° 42 55	61° 39 12
22	50° 42 49	61° 38 50
23	50° 41 39	61° 40 14
24	50° 40 39	61° 40 39
25	50° 39 31	61° 40 39
26	50° 36 60	61° 41 41
27	50° 35 29	61° 42 07
28	50° 34 10	61° 41 45
29	50° 32 34	61° 41 23
30	50° 31 42	61° 41 29
31	50° 29 40	61° 42 28
32	50° 26 19	61° 43 18