Habitat Utilization by Bats in the Boreal Forest Ecosystem

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Abstract.

Habitat utilization by bats was studied in western Newfoundland from June to August, 1994. Bat activity in six habitat types was investigated using ultrasonic bat detectors. *Myotis lucifugus* was most commonly detected, with a possible case of *M. septentrionalis*. In the study area bats concentrated their activity over water, and observations indicate that bats may prefer areas of calm water more than turbulent ones. Further observations suggest that bats use forests to roost or commute to feeding areas while avoiding clearcuts. Insects were trapped to determine possible food sources and bat captures were implemented to determine species composition in the area and to begin a banding program.

Introduction

The Little Brown Bat (*Myotis lucifugus*), Northern Long Eared Bat (*Myotis septentrionalis*), and Hoary Bat (*Lasiurus cinereus*) are the only three species of bats that have been recorded in Newfoundland (Maunder 1988; van Zyll de Jong 1985), but they have not been intensely studied in the province, therefore little is known about their populations, habitat usage, or distribution on the island. Studies have shown that *Myotis spp.* are users of mature forests (Christy and West 1993), and that clearcutting reduces bat activity (Lunde and Harestad 1986). There is a concern here with bat ecology in old growth forests and the loss of habitat due to cutting. The objectives of this study were to; determine habitat utilization by bats in the Western Newfoundland Model Forest, identify possible maternity and roosting sites, and determine primary food sources and the effects of insect control and other practices on these species. Due to time and logistical constraints the maternity or roosting site search and insect control components of the study could not be carried out. Studies were designed to collect data on habitat preference by bats in western Newfoundland based on a selected number of habitat types within the study area, paying particular attention to cut and uncut areas. This information may be used to more accurately assess biodiversity within the model forest, contributing to the development of an integrated forest management plan. During the summer of 1994 these studies were carried out near Marten Pond, in western Newfoundland, where the selected habitat types could be found in close proximity to one another. The bat echolocation pulses, although not technically a call, will be referred to here as "bat calls" or "bat passes" (Fenton 1970; Hart, et al 1993).

Methods

To determine bat utilization of varying habitats, we selected six habitat types; forested pond, forested brook, forested road, clearcut brook, clearcut road, and bog/fen (see Appendix I for descriptions). Habitat sites were chosen to be independent of one another; they do not share a border. This prevents the activity at one site from influencing the results at another. The sites were divided into four stations at least 100 metres apart, to reflect variation within a habitat type. In monitoring bat activity we used two Mini 2 bat detectors designed by Ultra Sound Advice and built by Rakar Ltd, England. These were set to frequencies of 20 kHz for *Lasiurus cinereus* (Fenton et al. 1983), 45 kHz for *Myotis lucifugus*, and 70 kHz for *Myotis septentrionalis* (Fenton and Bell 1981). Each station per site was monitored for a 15 minute period, totalling one hour per site. Two people monitored a station together. Each person used a detector set to a different frequency. One detector remained at 45 kHz through the entire survey while the other was set at 20 kHz for one station and 70 kHz for the next. More time was spent at 45 kHz because this frequency is associated with Newfoundland's most common bat, *M. lucifugus* (van Zyll de Jong 1985). The bat calls were recorded on a calls per hour basis. Weather conditions (precipitation, cloud cover, fog, wind, humidity, and temperature) were recorded at the beginning of each site survey. Two different sites were surveyed each night, one starting just before dusk and the second 1.5-2.5 hours after dusk. Due to the fact that the time of dusk changes every day, real time cues were removed and time was recorded as time after dusk. Also the order in which the two sites were surveyed was reversed the next night they were surveyed, to give each site equal "dusk" coverage.

A mist netting program was implemented to aid in determining species composition in the study area and to begin a banding program in the event of further studies in this area. Early in the season mist nets were used to capture five *M. lucifugus* at Marten Pond, but bands were unavailable at that time so they were released unbanded. Successive netting attempts were unsuccessful, possibly due to learning behaviour by the bats (Kunz and Brock 1975). A Tuttle trap (Tuttle 1974) was also unsuccessful in capturing bats in the study area, but both the trap and mist nets have been used with success elsewhere to capture Little Brown Bats. To date 16 bats (all *M. lucifugus*) have been banded in Newfoundland, 13 at George's Lake, and 3 at Cochrane Pond Provincial Park.

Possible prey insects were collected at each of the habitat types. Floating sticky traps were deployed at the sites associated with a body of water. These traps consisted of a wire mesh cylinder covered with a plastic sheet, painted with Tangle-Trap (Tanglefoot Co.) and fixed to a styrofoam float (Kunz in Kunz 1988). At the dry sites these same traps without the floats were hung from the foliage at a height of two metres. Two Luminoc light traps (Biocom) were used to attract insects that may not have been caught by the passive traps. These traps used a Vapona (Green Cross) strip insecticide to kill any insects caught in the trap. All insect trapping was done at night for a four hour period to select nocturnal insects. Insects caught in the sticky traps were left on the plastic sheets and placed in wooden trays designed by the author (see Appendix II). Hard insects captured by the light traps were stored in vials of ethanol while the moths were stored in dry vials, as ethanol can degrade the samples. The insect samples will be identified to family at a later date.

Results

We surveyed on a total of 35 occasions from June 25 to August 18, 1994. The means, grouped by site, are shown in Table 1. All bat passes were counted, regardless of the species emitting it. We could not determine if two detections were made by one bat making two passes or by two bats, so all bat passes were counted as a measure of intensity of habitat use rather than a measure of bat abundance.

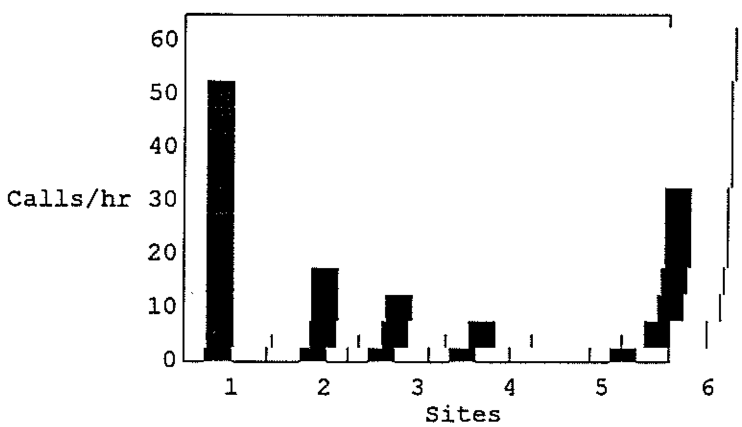
Table 1.
Habitat use by bats based on frequency of detection and mean number of calls per hour in six habitat types.

Site	Habitat Type	n Surveys	Freq. Detect.	Mean Calls/hr
1	Forested Pond	6	0.66	50.00
2	Bog	6	0.25	12.67
3	Forested Brook	6	0.21	11.33
4	Forested Road	8	0.19	4.50
5	Clearcut Road	5	0.00	0.00

6	Clearcut Brook	4	0.44	32.00

We found that sites 1 and 6 (forested pond and clearcut brook) showed more bat activity than the others. We tested H_o: There is no difference in bat activity among the six sites as measured by mean number of calls per hour. Using an $\alpha=0.05$ an analysis of variance showed that $P=0.017$, therefore we rejected H_o and accepted H_A: There is a difference in bat activity among the six sites as measured by number of calls per hour. The p-value 0.017, shows that there is only a 1.7% probability that our analysis is incorrect.

Figure 1.
Graph of mean calls per hour versus site



A Tukey HSD multiple comparison test (Zar 1984) using an $\alpha=0.05$ showed that sites 4 and 5 differ significantly from the others (Figure 1). Sites 1,2,3, and 6 were not significantly different from one another. Sites 4 and 5 are the forested road and the clearcut road, the only sites without nearby water. The results show that bat activity in the study area is greatest in areas associated with water.

We considered weather as a possible factor in skewing the results of the habitat statistics. The weather data was compiled into an index from -1 to 4, based on a weather component's effect on bat activity (see appendix III). We tested H_o: Weather, as classed by our index, has no effect on the number of bat detections per hour. Using an analysis of variance test with an $\alpha=0.05$, we found that $P=0.881$, therefore we cannot reject the null hypothesis. The habitat data is independent of weather for this study.

Discussion

Our detectors are capable of detecting frequencies from 15-160 kHz, but can only scan one frequency at a time. Bats emit their ultrasonic sounds over a range of frequencies, rather than at a fixed one (Fenton and Bell 1981). The ranges of emitted sounds in some species overlap, but each species has a frequency at which its intensity of emission is greatest (Thomas et al. 1987). We assumed that the high intensity emissions detected at 45 kHz were Little Brown Bats (Fenton and Bell 1981), even though we could not definitively separate species using bat detectors (Fenton 1970; Thomas and West 1984; Thomas et al. 1987). All species identification was confirmed with captured animals, to avoid any misinterpretation of echolocation pulses from the detectors. A common occurrence was the detection of a bat at two frequencies simultaneously, particularly 45 and 70 kHz, reflecting the ability of bats to emit sounds over a range of frequencies. When this happened, the emission was counted as one bat pass. On July 22, 1994, at site 4 (forested road), two separate bat passes were detected at 70 kHz but not at 45 kHz, which was also being monitored at that time. This frequency is associated with *Myotis septentrionalis* (Fenton and Bell 1981), but this can only be held as a probable example of its presence because of the above noted difficulties.

Our detectors were susceptible to background noise created by turbulent water. The rapids in the brooks caused ultrasonic emissions of their own, requiring us to hold the detectors a few metres back from the brook sides. This "static" has been documented as being a deterrent in bat foraging (von Freknell and Barclay 1986; Mackey and Barclay 1986). Observations of bat behaviour during surveying seem to support this, as we noted fewer detections at the turbulent brook stations, though small sample size makes statistical analysis difficult.

M. lucifugus is usually found roosting in buildings (Burnett and August 1981), but as there are only two buildings within the study area, neither of which are used by bats, we can assume that they use natural shelters. Natural roosts are usually in trees, but can also be under rocks, and rarely, in caves where the temperature regime is suitable (Fenton and Barclay 1980). Bats forage after dusk, then need to roost to digest their food before returning to feed again (Barclay 1982). A maternity colony of *M. lucifugus* was found under the bark of a live aspen tree in Manitoba within 250 m of a lake (Barclay and Cash 1985). Kurta (1986) states that *M. lucifugus* uses night roosts 10-700 m from foraging areas over water bodies, and Christy and West (1993) state that Little Brown Bats forage "a short distance from roosting sites". It has been suggested that roosting site availability more so than food supply is a limiting factor in bat populations (Fenton and Barclay 1980). Reduction of forested areas, particularly near water bodies, may deprive bats in forested areas of suitable roosting sites. Bats prefer mature forest to younger forest because older trees have large flakes of bark that bats can crawl under (Christy and West 1993). There is a concern that here, widespread clearcutting may reduce bat populations by reducing the number of possible roosting sites.

Attempts to locate roosting sites in our study area were hampered by the lack of a transmitter small enough for *M. lucifugus*. Such a transmitter has since been built by Holohil Systems, and roosts may now be located by tracking bats with radio telemetry receivers.

Site number five was the clearcut road site. This site was surveyed under the same conditions of time and weather as the others, yet not one occurrence of bat activity was recorded there. This may be due to the site being too far from a water body for foraging, that cutting has reduced the number of available roosting sites to where it is not usable by bats, or that the clearcut does not provide protective cover from predators while bats travel to feeding areas. This commuting cover may be important as bats can be attacked aerially by hawks and owls (Humphrey 1982). The forested road (Site 4) is also far away from water, and differs from the clearcut only in that the trees have not been removed, yet bat activity was recorded there. Observations at this site suggest that the road is being used as a corridor for travel to feeding areas from a roosting site, possibly it provides the necessary cover. The clearcut brook (Site six), lies in the same cutover as site five, yet bats were regularly observed there. The heavier growth along the brook may have provided necessary roosts and protective cover. This represents an area where further research is needed. Size and position of clearcuts in reference to water bodies may need to be addressed in order to determine the effects of cutting on bat ecology in the study area.

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Appendix I
Site Descriptions

Site 1. Forested Pond.
Marten Pond, located in the Western Newfoundland Model Forest, is a 1.5 km X 0.5 Km body of water surrounded by old growth forest consisting of Balsam Fir (*Abies balsamea*) and Black Spruce (*Picea mariana*).

Station 1. Pond edge backed by old growth Balsam fir and Black Spruce forest.
Station 2. Pond edge backed by moss and low shrub meadow.
Station 3. Pond edge backed by moss and low shrub meadow.
Station 4. Pond edge backed by old growth Balsam Fir and Black Spruce forest.

Site 2. Bog
A 400 m X 100 m bog of Sedge (*Carex flava*), Cotton grass (*Eriophorum spp.*) and mosses (*Sphagnum spp.*, *Dicranium spp.*) surrounded by Black Spruce and Larch (*Larix laricina*),it is bordered on one side by a small water body.

Station 1. Bog edge bordered by Black Spruce and Larch.
Station 2. Open bog, one-third of the way down the length of the bog.
Station 3. Open bog, two-thirds of the way down the length of the bog.
Station 4. Bog edge, at the opposite end from Station 1, bordered by Black Spruce and Larch.

Site 3. Forested Brook.
A brook (5 m wide) bordered on both sides by old growth forest of Black Spruce, White Spruce (*Picea glauca*), Balsam fir, and Larch.

Station 1. Rapids.
Station 2. Steady.
Station 3. Rapids.
Station 4. Pool.

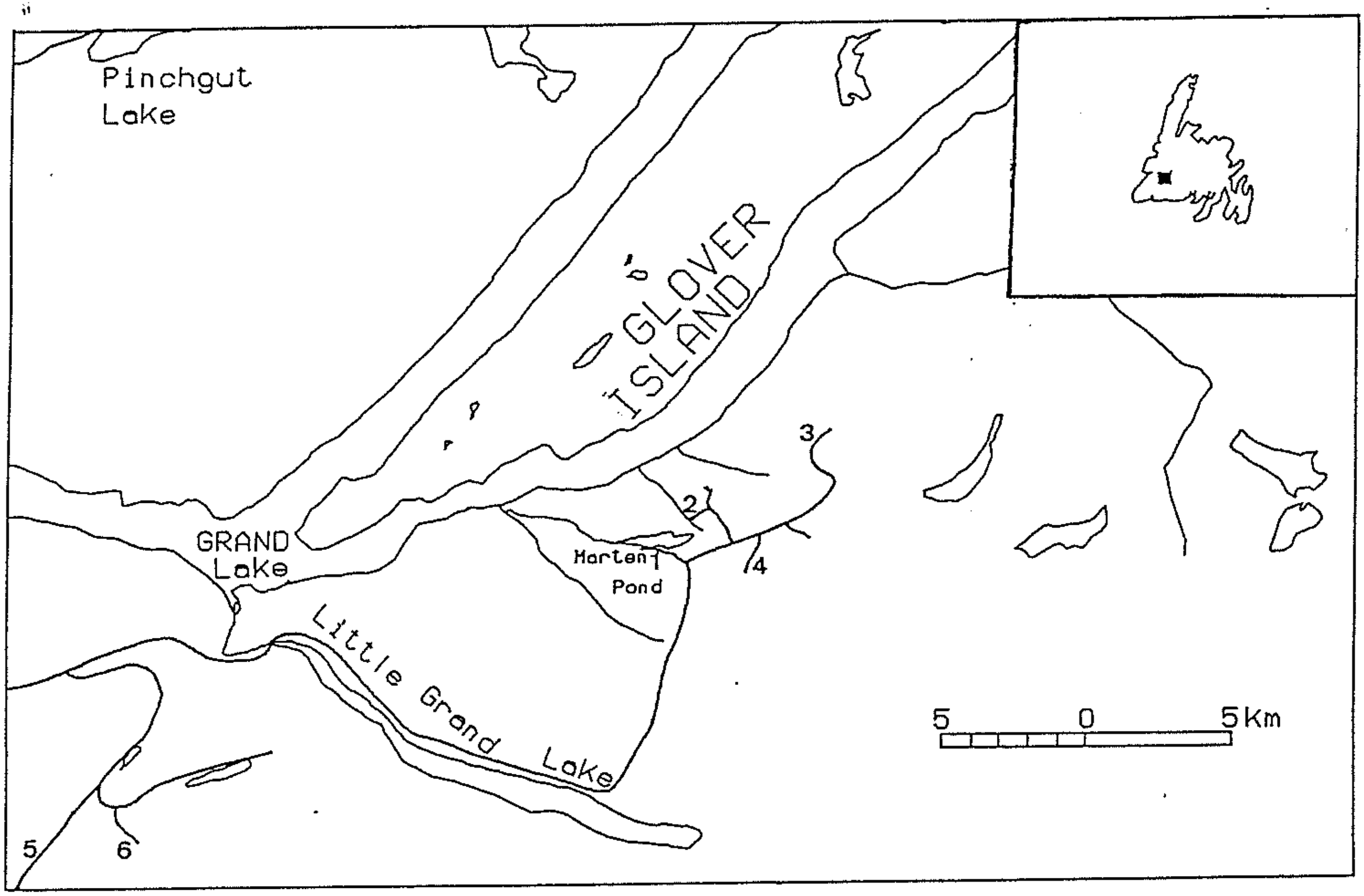
Site 4. Forested Road.
A woods road, on which there was no cutting, bordered on both sides by old growth forest of Black Spruce, Balsam Fir, and White Birch (*Betula papyrifera*).

Stations 1-4. The road is about two kilometres long and was divided into equal segments, with each station being about 700 metres apart.

Site 5. Clearcut Road.
A logging road, surrounded on both sides by extensive clearcuts that are less than ten years old.
Stations 1-4. Stations were chosen to be approximately as far apart as those at site four.

Site 6. Clearcut Brook.
A small (3 m wide) brook, running through a clearcut of less than ten years old, bordered on both sides by Mountain Alder (*Alnus crispa*) and Speckled Alder (*Alnus rugosa*).
Station 1. Pool.
Station 2. Rapid.
Station 3. Pool.
Station 4. Steady.

Appendix I (cont)
Figure 2.
Map of study area

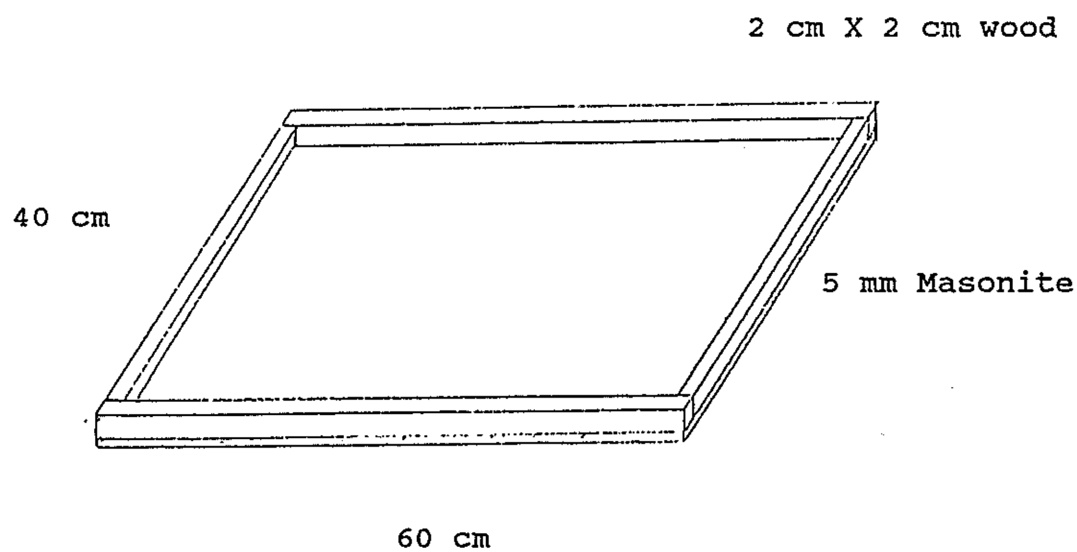


Study area is located in western Newfoundland, in the vicinity of Marten Pond. Numbers on the map indicate survey sites as such:

Site 1. Forested Pond
Site 2. Bog
Site 3. Forested Brook
Site 4. Forested Road
Site 5. Clearcut Road
Site 6. Clearcut Brook

Appendix II

Figure 3.
Wooden trays for the storage and transport of insects collected by sticky traps



Trays are nailed together with 2 cm nails. The materials used in these trays are readily available and construction is simple. When insect samples are placed in the trays, they can be stacked, using another piece of Masonite for a lid, and strapped or taped together for storage or transport.

Appendix III
Weather index used for the analysis of data

Data was collected on the basis of six different weather conditions; precipitation, cloud cover, fog, wind, humidity, and temperature. Humidity does not affect bat activity (Fenton pers. comm.) and cloud cover has a minimal effect on foraging bats and therefore is not a limiting factor on bat activity (Kurta 1986). Due to this, data on humidity and cloud cover was omitted from this index.

Table 2. Weather Index

Weather condition	Severity	Index
Precipitation	none mist showers rain	1 -0.5 -1 -1.5
Fog	present absent	-0.5 1
Wind	absent light strong	1 -0.5 -1
Temperature	≥ 10C < 10C	1 -1

When data on the weather for a night had been collected, the index for that night was compiled by adding the values for the severity of conditions that were present on that night. Rain deters bats from foraging (Fenton 1970, Kurta 1986), so it was given a negative index. Fog and wind resulted in a lower index as fog can attenuate echolocation pulses and wind can make flying difficult for bats and their prey (Fenton pers. comm.). A temperature of ten degrees Celsius has been regarded as a barrier for prey insects (Fenton pers. comm.), therefore the index is adjusted based on temperature. The compiled indices were grouped according to index value for analysis.