SPECIES STATUS, AND THE SPATIAL AND TEMPORAL PATTERNS OF ACTIVITY OF BATS IN SOUTHWEST NOVA SCOTIA, CANADA

HUGH G. BRODERS1,*, GREG M. QUINN1, AND GRAHAM J. FORBES1

ABSTRACT - Seven bat species have been recorded in Nova Scotia, but little information is available on their relative abundance, ecology, and migratory patterns. In the summer of 2001 we used echolocation and trapping surveys at Kejimkujik National Park, Brier Island and Bon Portage Island to help fill this information gap. Our results suggest that significant populations of *Myotis septentrionalis*, *M. lucifugus* and *Pipistrellus subflavus* occur in the province. Although we note the first breeding record of the red bat (*Lasiurus borealis*) in Atlantic Canada, survey results suggest this species is probably rare and that previous records were probably extralimital. Fewer than five echolocation sequences were attributable to each of hoary bat (*L. cinereus*) and silver-haired bat (*Lasionycteris noctivagans*) suggesting that Nova Scotia is at, or beyond, the northern fringe of the range of these species. We recorded three or fewer echolocation sequences of the big brown bat (*Eptesicus fuscus*), however, further work should be done in more human-populated areas to confirm the distributional range of this species. At Kejimkujik National Park, we captured *Myotis septentrionalis* (n = 26), *M. lucifugus* (n = 17), and *Pipistrellus subflavus* (n = 3). Despite lower capture success of *P. subflavus*, echolocation surveys suggest that this species is locally abundant. These records may represent the most northerly breeding population of this species and is the first noted, and maybe only, breeding population of this species in Canada. Poor trapping success for this species is likely the result of its foraging behaviour (i.e., flying high over open areas). On Brier Island we captured only two *M. lucifugus* and no echolocation sequences were identified as *P. subflavus*. The magnitude of all species activity at the still water site on Brier Island was one-third the average magnitude of activity at still water sites at Kejimkujik National Park. We captured and/or recorded *M. septentrionalis* only along forested trails, *P. subflavus* only over water, and *M. lucifugus* at all site-types. The overall nightly activity pattern of *M. lucifugus* was characteristic of the activity pattern of *Myotis* spp. recorded in other areas, with a peak in activity just after sunset followed by a progressive decline in activity through the remainder of the night. However, *P. subflavus* activity was more constant through the night.

INTRODUCTION

Occurrence records exist for seven species of bats in Nova Scotia (Taylor 1997, van Zyll de Jong 1985) but there have been no systematic

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surveys for bats in the province. Thus, basic information such as species richness and relative abundance is limited. The seven species recorded include the little brown bat (*Myotis lucifugus* Le Conte), the northern long-eared bat (*M. septentrionalis* Trouessart), big brown bat (*Eptesicus fuscus* Palisot de Beauvois), eastern pipistrelle (*Pipistrellus subflavus* Cuvier), red bat (*Lasiurus borealis* Gray), hoary bat (*L. cinereus* Palisot de Beauvois), and silver-haired bat (*Lasionycteris noctivagans* Le Conte). The Nova Scotia Department of Natural Resources has listed each of these species, except *E. fuscus*, as not at risk of immediate extirpation or extinction, but may require special attention or protection to prevent them from becoming at risk (the Yellow category). There is no listing for *E. fuscus*.

Nova Scotia is at, or above, the northern extent of the current known range for all reported species except *M. septentrionalis* and *M. lucifugus* (van Zyll de Jong 1985), and in southern New Brunswick only these two species are common (unpubl. data, H. Broders). With regard to the occurrence of other species in Nova Scotia, there are eight records for each of *L. cinereus* and *L. borealis*, and two records for *L. noctivagans* (Nova Scotia Museum of Natural History Collections). However, there are several reports of these three species flying ashore at Cape Cod, MA (Miller 1897), taken aboard ships off the coast of Nova Scotia (Brown 1953, Norton 1930, Peterson 1970), and points further south (Carter 1950, Mackiewicz and Backus 1956) in the fall, suggesting the possibility of a migratory movement across the Gulf of Maine from Nova Scotia. Nova Scotia has only one record of *E. fuscus* (a group of three individuals found hibernating in a cave; Taylor 1997). Bleakney (1965) reported 16 specimens of *P. subflavus* that were taken between 1959 and 1965. Taylor (1997) reported one individual of this species in each of three caves during a fall count in 1996 and several during a mid-winter count in 1997 at a different cave. In southern New Brunswick, Broders et al. (2001) recorded fewer than 100 echolocation records for *P. subflavus* over 1383 detector nights of sampling (less than 0.2 % of the recorded echolocation sequences) and none were captured in coastal Maine (Zimmerman and Glanz 2000).

This project had three goals. First, to determine the species richness and relative abundance of bat species in Nova Scotia. Secondly, to investigate the temporal activity patterns and habitat associations of the species present at an inland forested landscape and an island site. Finally, to investigate the local dynamics of the migration of bats in the province (if any significant local migration is occurring). Although it is well known that *L. borealis, L. cinereus,* and *L. noctivagans* migrate (Barclay 1984, Constantine 1966, Findley and Jones 1964, Miller 1897, Schowalter et al. 1978), little is known about the timing and dynamics of this phenomenon anywhere in North America. If there are any bats
migrating through the province, the northeast-southwest orientation of the province should have a “funnelling effect” and concentrate movement through islands off the southwest coast in the fall.

METHODS

We sampled 3–6 nights at each of Kejimkujik National Park (KNP; 44°40’N, 66°70’W) and Brier Island (BI; 44°15’N, 66°24’W) (Fig. 1) in four separate sampling periods in 2001 for a total of 34 sampling nights. Sampling periods were chosen to maximize the chances of detecting migratory species, and to monitor the changes in the magnitude of activity of these species at an expected migratory stopover site (i.e., BI) relative to an inland site (i.e., KNP) through expected migratory (late May and early September) and non-migratory (mid-June and mid-July) periods. Bats were trapped at ground level along forested trails using harps traps (Austbat Research Equipment, Lower Plenty, Victoria, Australia) and 2–10 m over rivers using mist nets (30 mm mesh size; Avinet, PO Box 1103, Dryden, NY, 13053-1103). For all captured individuals, we recorded species, sex, reproductive condition (by palpation, Racey 1988), body mass, and the lengths of the forearm, ear, and tragus, and placed a unique (varied color and number combinations) plastic split-ring band (3.1 mm
inside diameter; L&M Bird Leg Bands, Inc., PO Box 2943, San Ber-
nardino, CA, 92406) on the forearm. The edges of the bands were
filed smooth before they were used and males were banded on the
right forearm and females on the left forearm.

At KNP, echolocation sampling was conducted at four replicates
of three site-types (still water, rivers, and forests; i.e., 12 sites) that
were representative of the area. At BI, sampling was conducted at
site-types that were representative of the area and included four repli-
cates for each of coastal meadows and forests, three replicates of
inland bogs, and the only readily accessible fresh water site on the
island (12 sites in total). We used a balanced design that included
equal sampling intensity at all sites at both KNP and BI. During each
of the four sampling periods all 12 sites in each area were sampled
twice for a total of 24 detector-nights per area per sampling period
(192 detector-nights over the entire summer). A detector-night was
included in the analysis only if sampling was continuous from before
sunset until after sunrise (i.e., if the detector failed during the night
the site was re-sampled on the following night). Finally, to increase
the likelihood of detecting migratory species, we opportunistically
sampled ten partial nights on Bon Portage Island (BP; 43°27'N,
65°45'W) in September 2001; this was not part of any systematic
sampling regime.

At KNP and BI, echolocation sampling was conducted using 6–8
fully-automated ground-based Anabat II detectors interfaced directly to
laptop computers (running Anabat6 software; written by Chris Corben;
http://www.hoarybat.com) using the zero crossing analysis interface
modules (Titley Electronics, Ballina, N.S.W., Australia). The detectors
were similar in design and identical in functionality to that described by
O’Farrell (1998). At BP only one detector was used. The cone of
reception of all detectors was standardized (Krusic et al. 1996) such that
the area sampled by each detector was the same. Non-Myotis species
were qualitatively identified from echolocation sequences by compari-
son with known echolocation sequences recorded in other geographic
regions, published accounts (Betts 1998, Broders et al. 2001, Fenton and
Bell 1981, Fenton et al. 1983, MacDonald et al. 1994), and recordings
we made of known individuals in the study area. We quantitatively
identified a systematically selected sample of the Myotis spp. sequences
using holographic neural networks (Broders et al., in press) for each
detector night. Using this approach, calls were classified as M.
septentrionalis or M. lucifugus, or left unclassified. Based on data from
Fundy National Park, New Brunswick, we expect 3.5% and 11% of the
classified calls to be misclassified along forested trails and all other site-
types, respectively (Broders et al., in press). When it was not possible to
confidently identify non-Myotis species due to fragmented or short
sequences we placed the sequence into a broader category. Although *L. noctivagans* and *E. fuscus* are probably distinguishable (Krusic and Neefus 1996), due to the similarity of their calls (Betts 1998, Fenton et al. 1983), high levels of intraspecific variation (Betts 1998), and lack of a regional database of known calls for comparison, we did not distinguish between these species.

We used file size (i.e., number of bytes) of uncleaned echolocation sequences recorded as an index of the magnitude of foraging activity at a site (Broders in press). Due to interspecific differences in echolocation call intensity (Faure et al. 1993, Miller and Treat 1993) and foraging and commuting height above ground/water (and therefore detectability by ground-based detectors) we made no attempt to make quantitative interspecific comparisons of activity.

### RESULTS

#### Species diversity

At KNP we captured 46 bats (Table 1) during 52.2 mist net hours (one six-meter net set for one hour is one mist-net hour) at river sites and 75.8 harp-trap hours along forested trails. Two *M. septentrionalis* were captured twice. A 9.4 g pregnant *M. septentrionalis* was captured on 21 June 2001. On 12 July 2001 she was recaptured at the same site and was lactating, and her mass had decreased to 7.5 g. Secondly, a 7.2 g lactating *M. septentrionalis* was initially captured on 13 July 2001, and then recaptured on 06 September 2001 at the same site. Her mass was still 7.2 g and there were no signs of lactation. Since we captured pregnant and lactating females of *M. septentrionalis* and *M. lucifugus* on 20 June and 12 July, respectively, parturition for both species likely occurs in late June or early July in KNP.

On BI we captured two bats. Using a hand net, a juvenile male *M. lucifugus* was captured during daylight hours (circa 1700) at the ferry terminal on 16 July 2001. Based on the fact that young *M. lucifugus* are volant at three weeks of age (Fenton and Barclay 1980), parturition on BI must have occurred by 25 June. During 102.8 harp trap hours along forested trails we only captured one bat: an adult female *M. lucifugus* on 08 September 2001 near the centre of the island.

<table>
<thead>
<tr>
<th></th>
<th><em>M. septentrionalis</em></th>
<th><em>M. lucifugus</em></th>
<th><em>P. subflavus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mass (g)</strong></td>
<td>m (5)</td>
<td>f (21)</td>
<td>f (3)</td>
</tr>
<tr>
<td></td>
<td>6.3 (0.76)</td>
<td>7.3 (0.77)</td>
<td>7.0 (0.15)</td>
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<tr>
<td></td>
<td>7.0 (0.15)</td>
<td>9.1 (1.9)</td>
<td>8.3 (0.92)</td>
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<tr>
<td><strong>Forearm Length (mm)</strong></td>
<td>35.0 (0.71)</td>
<td>36.8 (1.11)</td>
<td>38.2 (0.76)</td>
</tr>
<tr>
<td></td>
<td>38.2 (0.76)</td>
<td>38.4 (1.2)</td>
<td>34.8 (1.04)</td>
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<tr>
<td><strong>Ear Length (mm)</strong></td>
<td>12.7 (0.88)</td>
<td>13.2 (0.88)</td>
<td>11.2 (0.58)</td>
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<tr>
<td></td>
<td>11.2 (0.58)</td>
<td>11.4 (0.44)</td>
<td>10.3 (0.29)</td>
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<tr>
<td><strong>Tragus Length (mm)</strong></td>
<td>5.6 (1.3)</td>
<td>5.9 (0.7)</td>
<td>4.2 (0.3)</td>
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<tr>
<td></td>
<td>4.2 (0.3)</td>
<td>4.0 (0.50)</td>
<td>3.5 (0.0)</td>
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Table 1. Morphometrics (mean ± s.d.) of 46 bats captured at Kejimkujik National Park, 2001. Number of captures in brackets after gender (m = male, f = female).
We recorded 59.2 megabytes of echolocation activity (30,471 Anabat sequence files) at KNP, BI, and BP from May–September 2001. Of all recorded activity, *Myotis* spp. comprised 83.9% of the total, *P. subflavus* comprised 12.4%, all other species combined comprised 0.02%, and the remaining 3.7% were placed in a *Myotis* spp.–*P. subflavus* category. We recorded four *L. cinereus* sequences, two at a river site in KNP on 05 September 2001 at 2033 and 2043 and two at a coastal meadow on BI on 11 September 2001 at 2215 and 2306. We recorded three sequences of either *L. noctivagans* or *E. fuscus*, on 06 September 2001 on BP at 2030 and 07 September 2001 at a river site in KNP at 2047 and 2201. There were five sequences recorded on BP on 06 and 07 September 2001 that could have been *P. subflavus* or *L. borealis*; these species can typically be identified but because all these sequences were short with fragmented calls, to be conservative, we did not attempt to identify them. Therefore, we did not detect any significant populations of migratory species at any of our sampling sites.

Coincidently to this study, on the property of Tracy and Bob LeBlanc in Sandbeach, Yarmouth Co., NS (the extreme southwestern tip of the province), an adult female *L. borealis* with four young were observed and photographed while roosting approximately four meters above ground level in a horsechestnut tree (*Aesculus hippocastanum* Linnaeus) throughout most of July. The bats were first observed in early July (young were already born) and they used the same roost until they left and were no longer seen after 4 August 2001. The adult was present at the roost with the young on all but two days: on one of these days there was a thunderstorm during the previous night and the details of the

<table>
<thead>
<tr>
<th>n</th>
<th><em>M. lucifugus</em></th>
<th><em>M. septentrionalis</em></th>
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<tr>
<td>Still water 667</td>
<td>0.83</td>
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<td>0.94</td>
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<td>-</td>
<td>-</td>
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<td>Meadow -</td>
<td>-</td>
<td>-</td>
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<th><em>M. septentrionalis</em></th>
<th>Unclassified</th>
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<td></td>
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<tr>
<td>Still water 170</td>
<td>0.90</td>
<td>0.03</td>
<td>0.08</td>
</tr>
<tr>
<td>River -</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Forest 159</td>
<td>0.61</td>
<td>0.12</td>
<td>0.27</td>
</tr>
<tr>
<td>Bog 15</td>
<td>0.90</td>
<td>0.02</td>
<td>0.08</td>
</tr>
<tr>
<td>Meadow 75</td>
<td>0.73</td>
<td>0.09</td>
<td>0.18</td>
</tr>
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</table>
other are not known. This represents the first breeding record of *L. borealis* in Atlantic Canada.

**Spatial and temporal distribution**

During trapping surveys *M. septentrionalis* was only captured along forested trails, *P. subflavus* was only captured at a river site, and *M. lucifugus* were captured at both river (n = 4) and forested trail (n = 13) sites.

Of the *Myotis* spp. echolocation sequences selected for quantitative identification, *M. lucifugus* constituted nearly all the activity (Table 2).

![Histogram](image)

**Figure 2.** Habitat specific activity levels (total bytes/1000) of bats at (A) Kejimkujik National Park and (B) Brier Island, 2001. Note the difference in y-axis scales.
Because at river and still water sites we expected (see Methods) that approximately 11% of the calls would be classified incorrectly, and the fact that of the identified calls from these site-types only 6% and 1%, respectively, were identified as *M. septentrionalis* we suspect that few, if any, of the total *Myotis* spp. activity recorded was attributable to *M. septentrionalis*. Along forested trails, where we expected a misclassification rate of 3.5%, 15% of the total *Myotis* spp. calls identified were attributed to *M. septentrionalis*. Thus, *M. septentrionalis* was recorded in low numbers along forested trails. Because of the low incidence of *M. septentrionalis* amongst the echolocation data we assume that the spatial and temporal *Myotis* spp. patterns in this echolocation dataset are primarily attributable to *M. lucifugus*.

Of the total activity of *M. lucifugus* recorded at KNP, 84.2%, 12.3%, and 3.5% was recorded at rivers, still water sites, and forested trails, respectively (Fig. 2a). *Pipistrellus subflavus* activity, like that of *M. lucifugus*, was concentrated over rivers (90% of the total activity), with only 10% of the total recorded at lakes. No echolocation sequences were identified as *P. subflavus* in the forest interior.

The magnitude of activity of *M. lucifugus* on BI was low (the still-water site on BI had approximately one-third the average magnitude of activity at still-water sites at KNP) and concentrated at the still-water

![Graph showing temporal activity patterns of *M. lucifugus* and *P. subflavus* at Kejimkujik National Park and Brier Island over all nights and sites.](image-url)
site (Fig. 2b). Coastal meadow and forested trail sites had lower and comparable levels of activity. Very low levels of activity were recorded at bog sites. On BI, *M. septentrionalis* was recorded along forested trails and at coastal meadows in low numbers (Table 2). No echolocation sequences recorded on BI were identified as *P. subflavus*.

Although there was a considerable amount of internight variation in the quantity and timing of activity of *M. lucifugus* at KNP, over all sites and nights there was an initial period of high activity shortly after sunset, followed by a slow progressive decline in activity through the remainder of the night (Fig. 3). On BI, *M. lucifugus* activity levels were lower and the temporal pattern was somewhat different. Similar to KNP there was a unimodal peak in activity immediately after sunset, but after this peak there was a rapid decline in activity and activity was constantly low throughout the remainder of the night (Fig. 3). *Pipistrellus subflavus* echolocation activity was more consistent through the entire night (Fig. 3).

**Incidental roosting observation**

We found a *M. septentrionalis* maternity colony in a live eastern hemlock (*Tsuga canadensis* Carrière; 21 m tall and 54 cm dbh) with a split in the trunk from about 1–9 m above ground level. The bats that we could see were approximately 6–7 m above ground level. The tree was approximately 15 m north of the Mersey River in a mature hemlock stand with some American beech (*Fagus grandifolia* Ehrhart), red maple (*Acer rubrum* Linnaeus) and red spruce (*Picea rubens* Sargent).

**DISCUSSION**

At least three species of bat have significant populations in Nova Scotia. *Myotis lucifugus* was present at all our echolocation sites and most trapping sites. Because it is a generalist species associated with forests and human-dominated environments (Barclay 1982, Jung et al. 1999, Kalcounis and Hecker 1996, Riskin and Pybus 1998), and because the northern extent of its range is beyond Nova Scotia (Christie and McAlpine 1984, Grindal 1999, van Zyll de Jong 1985), it is probably ubiquitous in the province. *Myotis septentrionalis* was recorded and trapped only at forest sites. Although we captured more *M. septentrionalis* than *M. lucifugus*, we recorded many fewer of their echolocation sequences, likely due to their low intensity echolocation calls (Faure et al. 1993, Miller and Treat 1993). This is a forest interior species (Caire et al. 1979, Jung et al. 1999, LaVal et al. 1977), and since its distributional range extends beyond Nova Scotia (Christie and McAlpine 1984, Grindal 1999, van Zyll de Jong 1985), it is likely ubiquitous throughout the forested regions of the province.
No *P. subflavus* were captured or recorded on BI, although relatively large numbers were recorded and three were captured at KNP. *Pipistrellus subflavus* is not considered a migratory species (Fujita and Kunz 1984, Griffin 1940); there are no reports of this species along expected migratory pathways (see Introduction), they only occur in low numbers in southern New Brunswick (Broders et al. 2001, Healy 2002), and they were not recorded on the island of Newfoundland (Grindal 1999). Thus, the Nova Scotia population may comprise a disjunct population. Our results support those of other studies (Broders et al. 2001, Davis and Mumford 1962, Krusic and Neefus 1996, LaVal et al. 1977) that suggest *P. subflavus* typically forages over water.

Known roost sites of *P. subflavus* include buildings (Winchell and Kunz 1996, Whitaker 1998), foliage of overstory trees (Carter et al. 1999, Vielleux et al. 2003), Spanish moss of understory trees (Menzel et al. 1999), and rock crevices (Lacki and Hutchinson 1999). We captured three *P. subflavus* females > 5 km from the nearest buildings and recorded echolocation sequences throughout KNP; therefore there is likely a breeding population in KNP, with colonies that occur in natural structures. If confirmed, this may represent the most northerly breeding population of this species, since the only recorded New England maternity colony is in Massachusetts (Winchell and Kunz 1996). Additionally, since there is no other published breeding records for this species in Canada, it may also represent the only, or first recorded, breeding population in Canada.

The nightly pattern of activity of *M. lucifugus* at KNP is different from conspecifics on BI as well as from sympatric *P. subflavus*. *Myotis lucifugus* activity at KNP peaked shortly after sunset and was followed by a progressive decline through the remainder of the night; this corresponds well with activity patterns of other *Myotis* spp. (Hayes 1997). Although activity on BI peaks after sunset as it does at KNP, there is a rapid decline in activity about one-third of the way through the night and then activity remains low for the remainder of the night. This pattern is similar to *Myotis* spp, on islands in southeast Alaska (Parker et al. 1996) and is probably the result of lower temperatures and decreased foraging efficiency late at night. At KNP, *P. subflavus* maintained relatively constant activity through the night. The reasons for the different patterns from *M. lucifugus* are unknown but there are at least three potential reasons. First, the *P. subflavus* population is at the northern fringe of the species range (van Zyll de Jong 1985) and individuals may need to forage longer to acquire sufficient energy. Secondly, there may be a sampling bias. As prey abundance decreases over the water through the night it may be more profitable for *M. lucifugus* to switch to foraging in the forest interior (e.g., O’Donnell 2000). In the forest interior they likely use less
intense echolocation calls (Miller and Treat 1993), and the individu-
als are less concentrated and therefore less likely to be recorded, even
though they are active. *Pipistrellus subflavus* may not have the mor-
phological adaptations required for foraging in such cluttered envi-
ronments, and remain active over the water. Finally, differences may
also result from interspecific dietary differences. *Myotis lucifugus* is
a generalist predator and may concentrate on swarms of ephemeral
insects that are only available shortly after sunset; thus, they are
forced to concentrate their foraging activity during this time. How-
ever, if *P. subflavus* preys on more cold-tolerant prey (e.g., Co-
leoptera; unpubl. data, H. Broders) that are active throughout the
night, then by maintaining constant activity through the night, popu-
lations may minimize intraspecific competition.

We recorded fewer than fifteen echolocation sequences (all in Sep-
ember) from, and captured no *L. cinereus*, *L. borealis*, or *L.
octivagans*; we suggest there are no significant migratory movements
of these species through Nova Scotia. Furthermore, since the roosting
and foraging habitats of these species are associated with forested
areas (Campbell et al. 1996, Constantine 1966, Fenton et al. 1980, Hart
et al. 1993, Krusic and Neefus 1996, Menzel et al. 1998, Perkins and
Cross 1988), if there were significant and widespread populations of
these species in the province we would expect to detect them in KNP
in midsummer. If there were a significant population in the province of
these species whose range was restricted, and did not include KNP, we
would expect to detect these species on the coastal islands in south-
western Nova Scotia early and late in the season during migration. It is
possible that migration occurs over a short time period and we did not
sample at the appropriate time, however, Miller (1897) recorded mi-
grating bats of all three species on Cape Cod, MA, from late August
until mid-September and regional oceanic records are temporally
widespread through the season (Brown 1953, Carter 1950, Mackiewicz
and Backus 1956, Norton 1930, Peterson 1970). Our surveys on BI and
BP occurred from 8–11 and 4–18 September, respectively, so it seems
unlikely we would have missed a migration event. We suggest that no
significant bat migration occurred in Nova Scotia in 2001, and unless
distributional range has changed in recent years, we suggest that previ-
ous records of these species in Nova Scotia were probably extralimital.
Although the recent *L. borealis* breeding record noted here is compel-
ing, the fact that we did not record any significant population of *L.
borealis* during our surveys, that it is the first breeding record for the
region, and that the female would have arrived here pregnant, suggests
that this is an extralimital record.

We recorded three echolocation sequences attributable to either
*E. fuscus* and/or *L. noctivagans*. Consequently, as previously dis-
cussed for *L. noctivagans*, *E. fuscus* was either not recorded or in very low numbers during our survey. *Eptesicus fuscus* is widespread throughout North America (van Zyll de Jong 1985) and commonly roosts in buildings (Brigham and Fenton 1986, Hamilton and Barclay 1994, Whitaker and Gummer 1992) and natural cavities (Betts 1996, Brigham 1991, Kurta 1994, Vonhof 1996). In New Brunswick this species is either very rare or absent from southerly forested regions (unpubl. data, H. Broders). However, because several *E. fuscus* records (including breeding) exist in more populated regions (Healy 2002, McAlpine et al. 2002), foraging is commonly associated with urban areas (Furlonger et al. 1987), and the species has adapted to hibernating in heated buildings which has permitted northward expansion of distributional range (Whitaker and Gummer 2000), it is possible that this species is more common in the province than our sampling indicates. Further work in more human-populated regions are necessary to clarify their regional distribution.

Technological advancements have permitted us to develop a much greater understanding of bat communities. From this study it is clear that there are three species of bats that are abundant in Nova Scotia (*P. subflavus* may only be locally abundant), but because of the biases associated with each technique, we still do not know the actual, or even relative, abundance of each of these species. It is imperative that further work is done to determine the spatial extent and ecology of *P. subflavus* in the region as this may represent a nationally significant population due to its isolation from populations further south.

**ACKNOWLEDGEMENTS**

Kejimkujik National Park and the New Brunswick Cooperative Fish and Wildlife Research Unit at the University of New Brunswick provided funding for this project. Detectors used for the project were borrowed from Fundy National Park, Kouchibougouac National Park, and Ian Thompson at the Canadian Forestry Service. Harp traps were borrowed from Stephen Woodley at Parks Canada. We thank Vicky Violette for conducting the echolocation sampling on Bon Portage Island and Amanda Lavers and Tracy Leblanc for providing the details of the red bats in Sandbeach. This manuscript has benefited from reviews by 2 anonymous reviewers.

**LITERATURE CITED**


