

CURATORIAL REPORT NUMBER 99

Records of Bats (CHIROPTERA) at Caves and Mines in Nova Scotia



By Max Moseley
Research Associate

NOVA SCOTIA
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Tourism, Culture and Heritage

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**Nova Scotia Museum
Nova Scotia Department of Tourism, Culture and Heritage
Halifax Nova Scotia
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Curatorial Reports

The Curatorial Reports of the Nova Scotia Museum make technical information on museum collections, programs, procedures and research accessible to interested readers.

This report contains the preliminary results of an on-going research program of the Museum. It may be cited in publications, but its manuscript status should be clearly noted.

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Executive Summary

Records of bats at caves and disused underground mines in Nova Scotia comprise museum specimens, catch-and-release identifications, sightings, field counts, echolocation records, and the presence/absence of droppings. In this Report, all known records up to the end of 2005 are collated, summarized and briefly assessed. Known sites are listed and described and a comprehensive bibliography is provided.

All seven species of bats found in the province are known to utilize caves and mines in some way, although this behaviour has not been confirmed here for all of them. Our four social bats are all non-migratory species that hibernate in the winter. *Myotis lucifugus*, *M. septentrionalis* and *Pipistrellus subflavus* overwinter in caves and mines. *Eptesicus fuscus* sometimes uses such sites but preferentially hibernates in buildings and similar places. All four are also known to, sometimes, use underground sites as summer roosts but in Nova Scotia this has only been confirmed for *M. lucifugus* and *P. subflavus*. Both the *Myotis* spp. and *P. subflavus* are also known to “swarm” at cave and mine entrances in the Autumn. Two of our migratory solitary tree bats (*Lasiurus borealis* and *L. cinereus*) have been observed swarming along with other bats at caves and mines in the USA but there is only one such record - of *L. cinereus* - in Nova Scotia. Our other solitary bat *Lasionycteris noctivagans* sometimes uses cave roosts elsewhere but there is only one, extra-seasonal, local cave record.

The records reveal that despite increasing interest, the utilization of subterranean sites by bats in the province is very poorly documented. Few underground sites in the province have been investigated for bat activity. Of the estimated 300 abandoned mine sites and approximately 50 explored natural caves there are records of bats at only 21, and the majority of extant records only relate to hibernating bats: the use of sites as summer roosts and Autumn swarming activity at cave and mine entrances are both very poorly surveyed. Knowledge of hibernacula is, also, very incomplete: many must remain to be discovered and the species composition of bats within them requires clarification. Much more information will be necessary if our bats and bat habitat are to be protected and conserved.

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Introduction

All Nova Scotia bats are members of the family Vespertilionidae. There are occurrence records of seven species.

Two *Myotis* species - the Little Brown Bat (*M. lucifugus*) and the Northern Long-Eared Bat (*M. septentrionalis*) – together with the Eastern Pipistrelle (*Pipistrellus subflavus*) are the most commonly recorded and collected. All three are gregarious non-migratory species that over-winter in the province, using caves and other underground sites such as abandoned mine workings as hibernacula. *M. lucifugus* is the most abundant bat in the province with an estimated population of ~300,000 (Scott & Hebda 2004). It is a generalist species probably ubiquitous throughout the province (Broders *et al.* 2003). *M. septentrionalis* is a forest species which is common and probably ubiquitous in suitable habitat, whilst *P. subflavus* is a rarer though locally common forest species probably restricted to the south and central region of the province (Broders *et al.* 2003).

One other social bat (*Eptesicus fuscus*) is provisionally included in the provincial list on the basis of a sight record in a cave hibernaculum (Scott & Hebda 2004). Based on its known bionomics elsewhere it is expected to be present here and sometimes to use caves and mines for hibernation. The absence of additional records may be due to the lack of winter surveys of buildings and other preferred hibernation sites.

The Silver-Haired Bat (*Lasionycteris noctivagans*), the Eastern Red Bat (*Lasiurus borealis*) and another lasiurid the Hoary Bat (*Lasiurus cinereus*), are rare to uncommon solitary tree bats which probably migrate south in the winter (Scott & Hebda 2004). In Nova Scotia they are at or near the northern limit of their ranges: Broders *et al.* (2003) even suggest that occurrence records of all three may be extra-limital in the province. There is one winter sight record of *L. noctivagans* in a local mine adit (Hebda 2006). *L. cinereus* winters primarily in the United States, Mexico, and Guatemala, but there are a few non-cave winter records from the northeastern USA: it has been noted very rarely roosting in caves in the USA but is not known to use them for hibernation (Garroway 2004 and references therein). There is one October echolocation record attributed to this species associated with other swarming bats near the entrance of Hayes Cave (Garroway 2004). Our other *Lasiurus* species, *L. borealis*, rarely or never enters caves although it swarms at cave entrances along with other bats in the autumn (Shump & Shump 1982). This behaviour has not been reported for this species in Nova Scotia.

Caves and mines are certainly an important, possibly critical, resource for bats in Nova Scotia:

- (1) Survival of hibernating bats depends on their ability to find sites that meet very specific microclimatic and morphological conditions and are relatively undisturbed during the winter, thus availability of suitable underground hibernacula may be a limiting resource for those bats that overwinter in the province.

- (2) Underground sites are also sometimes used as summer roosts by male bats, and some may be used as transient roosts in the autumn. Roost sites are not necessarily the same as those used as hibernacula.

- (3) Autumn swarming occurs at many cave and mine openings. The purpose and significance of swarming is not completely understood: it is usually explained as mating behaviour. Swarming is not confined to those bats that hibernate and thus is a strategy adopted both pre-hibernation and pre-migration. This suggests, in part, foraging

behaviour exploiting a concentration of flying insects in the column of relatively warm air flowing out of large underground cavities as ambient temperatures decrease in the autumn.

Thus it is possible that *all* local species of bats have to a greater or lesser extent some degree of ecological dependence upon caves and mines. It is also probable that many of these sites, *not only those used as hibernacula*, may be environmental resources used by these animals.

The Chiroptera are the most endangered group of land mammals in North America. Those hibernating or roosting in accessible underground sites are especially vulnerable to disturbance and destruction by human traffic and interference: they are physiologically and physically vulnerable, torpid, and concentrated - sometimes in very large numbers. Caves, mines and tunnels used for this or other purposes by bats may be destroyed e.g. by limestone or gypsum quarrying; or may be permanently sealed for reasons of human safety or concerns about legal liability: they can also be rendered unsuitable for bats by other less drastic physical alterations that nevertheless change the underground microclimate; or by pollution.

As recently as 25 years ago there was no protection either of bats or hibernacula in Nova Scotia. One significant site, Miller's Creek Cave, was quarried away *circa* 1981. Hayes Cave, a major hibernaculum, was subject throughout the winter to repeated disturbance by human visitors, and hibernating bats were being deliberately killed (Moseley 1972, Morris 1985). At one time in the early 1970s the then NS Department of Lands and Forests planned to permanently seal the entrance to Hayes Cave as a public safety measure. There were also reports in the 1960s of local children being paid by a biological supply company to harvest bats in quantity from Cave-of-the-Bats.

Today in general there is more social concern and political awareness than about the natural environment and matters such as biodiversity than in the past and there are increasing efforts to document and protect bat populations here in Nova Scotia and elsewhere. Even so, the situation is still not entirely satisfactory from the point of view of conservation.

There is less legal protection of bats and bat habitat than in some other jurisdictions. No bat species in Nova Scotia is listed under the Endangered Species Act S.N.S. 1998, c.11. They are subject to the provisions of the Wildlife Act R.S.N.S. 1989, c.504 and all are Yellow-ranked under the General Status of Wildlife classification. Yellow-ranking means that they are not considered currently at risk of extirpation or extinction but nevertheless may require protection or special measures in order to prevent them becoming at risk. Bats and their habitat are to be taken into account in environmental impact assessments. The provincial Department of Natural Resources (DNR) maintains a geo-referenced Significant Species and Habitats Database which is available for use by landowners and resource managers (Archibald 2004).

The two largest known hibernacula in the province are both now protected to some degree: one is gated. However, the filling in of abandoned mine openings as mandated by provincial legislation is undoubtedly resulting in destruction of undocumented hibernacula and other sites of ecological value to bats. DNR is aware of this problem as it relates to hibernacula and an effort is being made to identify those on Crown land and to list and gate priority sites: an internal fund has been established for this purpose. However, only a tiny fraction of the several thousand mine openings in the

province have been checked for the presence of bats, and the potential significance of such sites except as hibernacula is not being taken into account. Many private landowners faced with retroactive legislation and the resulting cost of rendering safe shafts and adits on their property are naturally and understandably unlikely to underwrite the substantial added costs of installing bat gates.

Public attitudes towards bats are changing and increasingly positive but this is not universal e.g. in spring 2004 DNR biologists found a number of bats that had been deliberately killed in a local hibernaculum (Archibald 2005).

More vigorous and effective action is probably necessary. The most urgent need now is for more information. It is a truism that protection and conservation must be based on detailed and accurate information, but our knowledge of bats at underground sites in Nova Scotia is still unsatisfactory and fragmentary. For example: we know the whereabouts during the winter of, perhaps, 5% of the provincial population of non-migratory bats, there are thousands of mine workings and other sites that have not been investigated; there are no records of bats from caves or mines on Cape Breton Island, or most of southern mainland Nova Scotia; the species composition of the populations even in known hibernacula remains uncertain or has simply not been evaluated; the significance of caves and mines for the four rarer species needs clarification; and there is little information about summer and autumn utilisation of subterranean sites and entrances.

The reports and records that we do have are scattered throughout many different and sometimes obscure sources: published papers, curatorial reports, student research theses, unpublished field reports and other observations by cavers and naturalists, and museum collections. Because these diverse materials have never been collected together and collated their usefulness has been limited.

This report is intended primarily as an effort to remedy this situation by providing a baseline database and bibliography of the available extant records up to the end of 2005 of the occurrence of bats at underground sites in Nova Scotia. The records are collated and summarised in Appendix 1 and 2. The alphanumeric codes used in the Appendices and throughout the following report are those I have used for caves, mines and tunnels in the Maritimes for which there are faunal records. Site numbers used in these tables are the standardised reference numbers now used by the Nova Scotia Museum of Natural History (NSMNH) for all recorded sites of speleological significance in the Province. The use of two overlapping systems has arisen unintentionally for historical reasons, but as both have become established I feel it necessary now to retain them.

I have also attempted (primarily from the point of view of conservation) to assess the records, draw some generalisations from them, and make a few suggestions for future investigations.

I would be grateful for notice of any omissions, corrections or suggested amendments.

Historical overview:

Interestingly the earliest published records of bats at underground sites in the province pay little attention to the most abundant: *Myotis lucifugus*. V. E. Gould and Robie Tufts found 36 *M. keenii septentrionalis* (now recognised as a separate species under the name *Myotis septentrionalis*) hibernating in Cheverie Cave (Gould 1936). A

specimen in the NSMNH collected 11 February 1935 and labelled "Cheverie" without further data (MIMS) must be one of these. There are no more reports until Dr Sherman Bleakney of Acadia University investigated several caves in Hants and Lunenburg counties during 1959-1964, finding the first examples of *Pipistrellus subflavus* in Nova Scotia, as well as new sites for *M. septentrionalis*: his reports are also the first to document evidence of summer use of local caves by bats (Bleakney 1965, Bleakney *unpub.*).

Bleakney also seems to have made the earliest formal identification of *M. lucifugus* in local caves or mines: there is a series from Hayes Cave collected during August 1959 in the NSMNH. A specimen from HC 17 March 1963 in the NSMNH collected by P. M. Taschereau (MIMS) appears to be the first definite winter cave record of this species.

In the mid-1960s the existence of large hibernacula with thousands of bats was also first being noted. Taschereau estimated 5000 bats in Hayes Cave in January 1963 (Morris 1985) and a short-lived local caving group calling themselves the Bluenose Grotto and Cave Exploration Society made a rough estimate of 2000 in Miller's Creek Cave in January of the following year. In 1965 Bleakney estimated the Hayes Cave hibernating bat population to be ~6000, a figure which agrees fairly well with that of Taschereau.

At that time there was little public or political interest in ecology and the environment, and scant evidence of any concerns about the welfare of bats in Canada. The first local conservation action came in 1972 with a proposal to make Hayes Cave a bat preserve (Moseley 1972) and initiation of an annual count in order to monitor the hibernating population. Although the site never became a formal bat preserve, and efforts to physically protect the cave failed when installed gates were quickly vandalised within days or weeks (Morris 1985), the proposal was an important step in a process that eventually led to the creation of Hayes Cave Provincial Park and it triggered ongoing interest in and scientific investigation of the cave and its environs, especially by staff and research associates of NSMNH (Scott 1979, Morris 1985).

In fact, for the next twenty-five years, interest in hibernating bats became almost exclusively focussed on the Hayes Cave site. An unfortunate consequence of this unintentionally purblind view was the loss of some ecologically and geologically important caves despite possible legislative remedies already being in place. The only other underground bat observations during this period seem to be a few incidental observations and rough counts made by the present writer in the course of subterranean exploration and mapping field trips.

Since 1996, however, there has been a burst of activity, aimed both at gaining wider knowledge and understanding of hibernating bats in the province and at their protection. The number of new observations during the last ten years will be apparent from the statistical summary (Table 1). A DNR-sponsored workshop, held at Acadia University in 1996, brought together the interested parties, and since then provincial DNR biologists have been investigating known and potential hibernacula and identifying priority sites on Crown land. Several new hibernacula have been discovered, new counts made, observations of late-summer swarming behaviour in the province have been made, and one major hibernaculum has been fitted with a well-designed bat gate (Archibald 2004, Khan *et al.* 2004). Some of this work was in cooperation with researchers at St.

Mary's University in Halifax, where Dr. Hugh Broders and his students have been investigating species composition, pre-hibernation and post-hibernation activity at several sites (Corning & Broders 2004, Garroway 2004). Taylor (1997) produced a rather perfunctory review but some useful new field data and observations. Staff of NSMNH has also continued collecting new field records and making observations.

Decade	No. of records
pre -1956	1
1956-1965	26
1966-1975	10
1976-1985	10
1986-1995	5
1996-2005	91

Table 1: Summary of number of records of bats at caves, mines and other underground sites in Nova Scotia, summed by decade (based on the data in Appendix I and II)

Recording methods:

Records of bats at subterranean locations may take various forms: collected museum study specimens, catch-and-release identifications, sightings, field counts, bat detector echolocation records, and the presence/absence of droppings. The NS records reflect the wider evolution in the methods used based on advances in technology, changes in researchers' attitudes and advancing understanding of the welfare needs of the bats themselves.

Study specimens obviously offer the greatest certainty for species identification but are not always possible to obtain, and in any case the killing of these animals for such purposes must never be undertaken lightly. Routine collecting and killing of bats for scientific purposes had largely been abandoned by the end of the 1970s: NSMNH abandoned this practice after 1973. Catch-and-release and sight records by an experienced observer are usually considered acceptable, providing that their status is made clear.

Until recently, most provincial cave and mine records were direct observations made underground. This has the serious disadvantage that it disturbs the animals. Underground counts are also extremely hard to make for many reasons in addition to the physical difficulty of working in such conditions. Hibernating bats are often in clusters in which it is impossible to distinguish and count individuals with certainty; they may squeeze in deep narrow crevices or old shot holes; or may simply be out of reach on high cave ceilings. By and large it is probable that most counts underestimate the number of individuals present, especially of the two less common species (*M. septentrionalis* and *P. subflavus*) which tend to be misidentified as *M. lucifugus* and often choose less accessible spots in which to hibernate.

It is worth pointing out here that where bats have been specifically noted as not present in a site, this is treated here as data – it is sometimes overlooked that the apparent absence of a species is often as useful to note as its presence.

The modern approach is to emphasise data collection in the vicinity of cave and mine entrances. Catch-and-release records of bats emerging from or entering sites during

the autumn swarming period are potentially invaluable in establishing the existence of unexplored hibernacula: especially at those sites where physical underground exploration is impossible or merely inadvisable. They also yield data about species, age, sex, size/weight and other physical measurements, and temporal changes in behaviour. The value of acoustic (echolocation) recordings at entrances is more dubious as evidence of bats underground: the relationship between autumn swarming at a site and its use as a hibernaculum is an uncertain one. This becomes very clear when we consider for example that the non-hibernating lasiurid bats can be observed swarming along with other bats. Echolocation records will however become increasingly useful in establishing the presence of these migratory bats and in understanding the swarming behaviour of these and other local species. It should be noted that determining which species are present by means of simple bat detectors is difficult: sophisticated detector systems which can help do this for some species are now available.

Some specialist bat researchers now claim that it is unnecessary to ever enter underground sites because all required measurements and sampling can be done outside. Although it is undeniable that from the point-of-view of the welfare of hibernating bats the less the disturbance the better, it can be argued that this is an extreme, even somewhat narcissistic, position. The present author is convinced that some direct underground observations will always be valuable and required as a complement to other data.

There are no reports of the recovery of banded individuals inside caves or mines in the province. There has been minimal banding of bats in Atlantic Canada.

For a general discussion of bat sampling techniques see Thomas & West (1989).

Summer utilisation of caves and mines:

The utilisation and ecological significance of underground sites for bat populations in mid-summer and during pre- and post-hibernation is still poorly understood in Nova Scotia. For full names of sites please refer to Appendix 1 and 2:

Mid-summer records: Bleakney (unpub.) noted bats and droppings in HC 3 August 1959 and in FC 29 July 1959. There are a number of museum specimens of *M. lucifugus* documented as collected from HC in June, July and early August. There are summer records of two male *P. subflavus* from FC and another male from HC. A few probable *P. subflavus* were observed roosting in the small side chamber not far inside the entrance of HC on 1 September 1997 (Moseley unpub.). There are as yet no underground summer occurrence records of *M. septentrionalis* from the province: however Fenton (1969) reported this behaviour by "*M. keeni*" (as well as *M. lucifugus*, *P. subflavus* and *E. fuscus*) in his study of Ontario bats.

Early-Fall records: during September and early October bats roost in caves and mines by day and continue feeding at night in preparation for hibernation: noticeable accumulations of droppings may result (Scott & Grantham 1985). Droppings have been observed in MC [late October 1971] (Moseley unpub.), HC (Scott & Grantham 1985), MIC [March 1997] (Taylor 1997) (presumably surviving in this cold dry cave from the previous autumn), LCM [mid September 1998] (Archibald 2005), and NL1 and NL3 [late August 1998] (Archibald 2005).

Recently Dr. Broders' group (St. Mary's University, Halifax) have investigated pre-hibernation activity at HC, FC, LCM and LSH using Harp traps, mist netting, and acoustic records (Corning & Broders 2004, Garroway 2004).

Notes on species:

Myotis lucifugus (LeConte) [Little Brown Bat]

Common: the most abundant and widespread of our bats (Scott & Hebda 2004). Hibernates in caves, abandoned mines, and other underground sites. Hibernation is thought to last from September until early or mid-May: the records from Nova Scotia are not inconsistent with this pattern. There has been a tendency in the past to record all hibernating cave bats as this species.

The Little Brown Bat is usually found in the open on cave walls and ceilings, and tends to form clusters of individuals. Taylor (1997) stated that it often hibernates in large clusters of thirty or more individuals, and Hebda (2006) observed it to occur mainly in clusters of thirty to forty in MIC. Research elsewhere has shown that it arouses at intervals during hibernation, moving to a cooler or warmer spot as temperatures fluctuate (Tuttle 1991): those in PT have been observed to change position over the winter (Hebda 2006).

The largest known hibernaculum in the province is HC. Most recent census: ~9000 (Taylor 1997) with *M. lucifugus* the most abundant. It has been assumed that ~95% are this species, but recent data throw some doubt on this (see *M. septentrionalis*, below). LCM contains ~3000 *Myotis* (Dauphinee 1996a) but the percentage of *M. lucifugus* has not been determined. MC (quarried away c.1981) was reported by a local informant to be a significant hibernaculum with ~2000 bats in the mid-1960s. CB, now a minor hibernaculum with <200 bats, may have been more important in the past: according to another informant “sackfulls” of bats were harvested for a biological supply company here sometime before 1970. The other documented minor but notable hibernacula are MIC (~600 counted in March 1997 [Taylor 1997]), HGP (~200, April 1987) [Moseley unpub.], and CC (~125, April 1997 [Moseley unpub.]). Several other known caves and mines contain a few hibernating individuals.

Mid-summer utilization of underground sites in the province has been confirmed in HC.

Myotis septentrionalis (Trouessart) [Northern Long-Eared Bat] (reported in older publications as *M. keenii* (Keen’s *Myotis*), which is absent from Nova Scotia, or later as *M. keenii septentrionalis*.)

This bat has been considered to be uncommon throughout the province, hibernating in small numbers in caves and mines at most, if not all, of the sites used by *Myotis lucifugus* and possibly some by itself (Scott & Hebda 2004). It often squeezes in narrow crevices, shot holes, etc. and is solitary or in small clusters. Gould (1936) reported it singly and in small groups in CC. Taylor (1997) reports it in clusters <10. In New Brunswick Christie & McAlpine (1984) noted that this bat prefers sites that are cooler than those selected by *M. lucifugus* but which still retain a high humidity: however it is frequently found associated with *M. lucifugus*.

Typically, *M. septentrionalis* has been presumed to be much less common than *Myotis lucifugus* within local hibernacula but because of its tendency to squeeze into crevices and because it is often misidentified as the latter, it is likely that in most cases the number actually present has been underestimated in direct underground counts. In a total of >76 Harp trap trapping hours at the entrances of four local hibernacula (HC, FC, LCM and LSH) during late August to October, 2003 and 2004, (Garroway 2003, Corning

& Broders 2004) a total of 803 bats were captured of which 554 (65.25%) were *M. lucifugus*, 277 (34.5%) *M. septentrionalis* and 2 (0.25%) *P. subflavus*.

There is also reliable observational evidence that at some sites *M. septentrionalis* is the most numerous bat: thus apparently either of the two local species of *Myotis* can predominate in hibernacula. *M. septentrionalis* was the only species present in CC whilst it predominated in GRM (Bleakney 1965) and Taylor (1997) estimated that 90% of hibernating bats in CB were this species. 65% of all Harp trap captures at LSH were also this species (Corning & Broders 2004) and it represented 71% of captures at FC (Garroway 2004). The sample size at FC was fairly small however. It is also present in some numbers in LCM, though counts made here do not distinguish it from *M. lucifugus* and it is uncertain which of the two is the most numerous (probably also a few in BB.)

Although trapping data must be treated with a degree of caution as a measure of the species composition within hibernacula (Garroway 2003) the balance of accumulating evidence is that the Northern Long-Eared is in general a more common bat in local hibernacula than formerly believed. Further investigation of its prevalence is desirable.

Mid-summer utilization of underground sites by this species in NS has not been observed, though it probably does occur.

Pipistrellus subflavus (F. Cuvier) [Eastern Pipistrelle]

Rare, western and central mainland only. Hibernates in caves and mines (Scott & Hebda 2004). Broders *et al.* (2003) surmised that the Nova Scotia population may be disjunct and genetically isolated. If so the population is nationally significant.

Solitary during hibernation, roosting alone, observed elsewhere to often choose the same spot from winter to winter (Tuttle 1991). Pipistrelles are known to choose hibernation sites where there are few temperature changes and where moisture readily condenses on their fur, preventing dehydration, and providing moisture to drink (Tuttle 1991): those I have seen were in the open, on cave walls or ceiling, but in small side passages rather than the main passages seemingly favoured by *M. lucifugus*.

Bleakney (1965) found one or two individuals in HC, FC, and GRM. A specimen now in NSMNH was collected at OV in May 1963. The species was not noted again until 1986 when a specimen was observed in HC (Moseley *unpub.*). It was then found at four sites (CB, HC, FC and MIC) a decade later by Taylor (1997). Garroway (2004) recorded echolocation sequences attributed to this bat throughout September and October 2003 at HC and FC. It is certainly often overlooked and probably present in small numbers in many or most hibernacula in mainland Nova Scotia, but never prevalent or common.

Confirmed from underground sites in NS in mid-summer.

Eptesicus fuscus (Palisot de Beauvois) [Big Brown Bat]

Hibernates preferentially in buildings but also in caves and mines (Scott & Hebda 2004). Except for the sight record from HC (Hebda, 2006) there are no provincial records. In the Maritimes it is at the north-easternmost limit of its range. A few specimens have been taken in southern New Brunswick, but there are no New Brunswick cave records (Christie & McAlpine 1984).

The HC sighting was of two individuals (not three as reported in error by Taylor [1997]) on the ceiling of the main passage (Hebda 2006).

Lasionycteris noctivagans (Le Conte) [Silver-Haired Bat]

A solitary tree-bat, rare in Nova Scotia, which is believed to migrate south in the winter (Scott & Hebda 2004). There is a reliable extra-limital sight record of a specimen in PT in February 1996: possibly a stranded storm-blown individual (Hebda 2006).

Lasiurus cinereus (Palisot de Beauvois) [Hoary Bat]

A solitary tree-bat, rare in Nova Scotia. *L. cinereus* winters primarily in southern California, southeastern United States, Mexico, and Guatemala, but has also been found in Michigan, New York and Connecticut during December and in Indiana during January (Anderson 2002) but not in caves: it has been noted very rarely roosting in caves in the USA but is not known to use them for hibernation (Garroway 2004 and references therein). There is one October echolocation record attributed to this species associated with other swarming bats near the entrance of HC. The record is clearly extra-limital so late in the season in Nova Scotia (Garroway 2004).

Lasiurus borealis (Müller) [Red Bat]

Rarely if ever enters caves but is known to swarm with other bat species at cave entrances in the autumn. This behaviour has not yet been observed in Nova Scotia.

Comments on known hibernacula in Nova Scotia:

62 sites of speleological significance (i.e. all the known natural dissolution caves together with those sea caves, mines and artificial tunnels from which there are fauna records) are currently documented in Nova Scotia. There are records and observations of bats from only 21 of these, and there are also many biologically yet undocumented mines and other sites. DNR has catalogued almost 6,700 openings spread over 300 abandoned mine sites in the province (Hennick 2003).

Except where given, please refer to Appendix 1 and Appendix 2 for literature references and other sources and Figure 1 for localities.

Hayes Cave (Site 9/Code HC)

Dissolutional cave in gypsum. Surveyed length = 365m. Situated within Hayes Provincial Park, hence subject to a useful degree of protection.

This is the largest known hibernaculum in Nova Scotia. There are several thousand bats present. The majority are *M. lucifugus*, but *M. septentrionalis* and *P. subflavus* also occur and it is the location of the single provincial sight record of *E. fuscus*. It is also of special importance because of the long series of counts now extending back for several decades.

Estimates of the size of the hibernating bat population in the cave were made in 1963 (January) by P.M. Taschereau (~5000) and in 1965 by J. S. Bleakney (~6000). The first attempt to measure the size of the population accurately was made in March 1972 by the present author assisted by a small team of local cavers. The roof area of the cave was visually divided into separate sections and the number of bats in each section counted and recorded. Second counts were made of a few random sections in order to estimate reproducibility: no statistical error was calculated but duplicate counts were in acceptable

- Site 3 Black Brook (BB)
- Site 4 Cave of the Bats (CB)
- Site 9 Hayes Cave (HC)
- Site 11 Woodville Ice Cave (WIC)
- Site 12 Frenchman's Cave (FC)
- Site 13 Frenchman's II (F2)
- Site 19 Minasville Ice Cave (MIC)
- Site 20 Cheverle Cave (CC)
- Site 21 Vanit Cave (VC)
- Site 23 McLellan's Brook Cave (MB)
- Site 46 Miller's Creek Cave (MC)
- Site 51 Peddler's Tunnel (PT)
- Site 52 Centre Rawdon Gold Mine (CRM)
- Site 53 Walton Barite Mine (WBM)
- Site 54 Lake Charlotte Gold Mine (LCM)
- Site 56 Gays River Gold Mine (GRM)
- Site 57 Hirscheffeld Galena Prospect (HGP)
- Site 58 New Laing adit #1 (NL1)
- Site 59 New Laing adit #2 (NL2)
- Site 60 The Ovens (OV)
- Site 62 Lear Shaft (LSH)

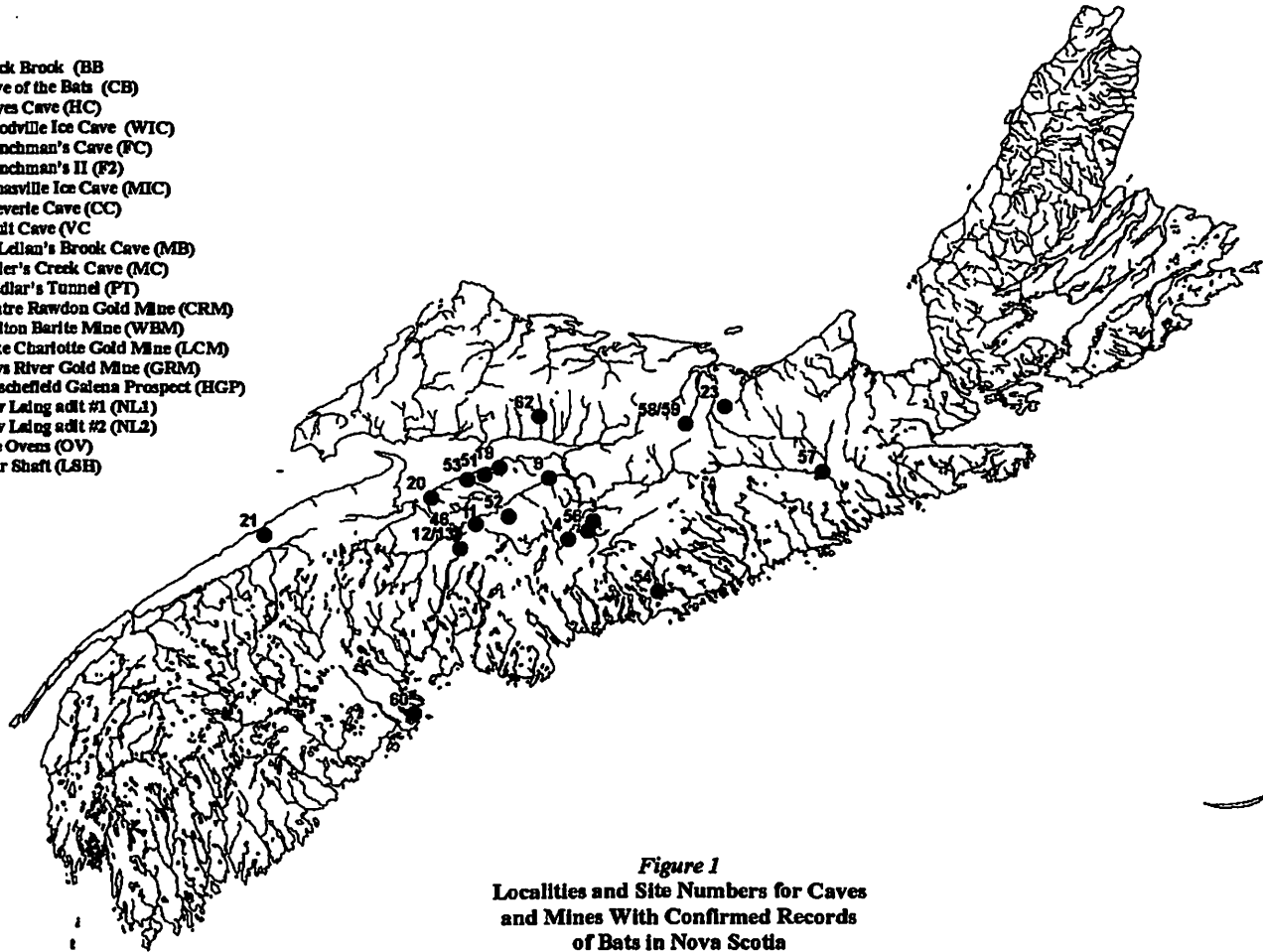


Figure 1
**Localities and Site Numbers for Caves
 and Mines With Confirmed Records
 of Bats in Nova Scotia**

agreement and the total number of bats counted (>6100) was comparable with the earlier estimates. This figure was considered to be adequate as a measure of the population size.

A few years later, in 1976, due to mounting concerns about the pressures on hibernating bats in the cave, a second count was done by the author* and assistants. This was again done in March to be directly comparable with the 1972 count. This census was designed to be more statistically valid than the previous one: a requirement of any useful monitoring programme. The technique was the same as that used in 1972 except that more sections were counted twice (always by two different counters) and an error calculated. The result, 4973 ± 330 , was interpreted as *prima facie* evidence indicating a decline in the hibernating population and thus it was decided that a regular annual count ought to be instituted. (* not by David Blake as reported in error in Morris [1985]).

In March 1977 the field technique was further refined by the present author by use of a double count of every section. The result, 3604 ± 360 , was considered as of some concern because it suggested an emerging trend of rapid decline. If taken at face value the numbers indicated that the population had decreased by as much as 40% in only six years. Frequent disturbance due to human traffic throughout the winter (casual visitors, drinking parties, school field trips, cavers and researchers) together with occasional deliberate killing of bats by ill-informed people was assumed to be the cause, although the worrisome possibility that the decline reflected a more general trend in the regional bat population was also considered.

In response to these findings, NSMNH assumed responsibility for an annual monitoring programme. Fred Scott supervised all the counts from 1978 to 1984. Starting in 1978, the census was carried out in the autumn instead of the late winter (both a March and an October count were made in 1978 to permit continuity of the data series). Scott also pointed out that there is some difficulty in interpreting the data series because count *accuracy* (as opposed to statistical *reproducibility* calculated from multiple counts) may be significantly affected by water levels in the cave which vary from year to year (Scott 1979).

Further details of the bat counts (including data on the longitudinal distribution of bats within the cave), the cave itself, and its environs may be found in Scott (1979) and Morris (1985).

The annual monitoring programme was abandoned after 1984 because the evidence by then pointed to stabilisation or recovery of the population using the cave for hibernation. Several new counts in the mid-1990s have given reassurance that the population has not only recovered but is now larger than it was in the 1960s and 1970s, and that it may be continuing to increase.

It has been suggested (Scott 1979) that the low counts in the years around 1977 may have been an artifact due to high cave water levels (see above) and perhaps other factors. This is certainly both possible and plausible. Circumstantial evidence in support is that attempts to physically protect the cave from human disturbance and vandalism failed because installed gates were vandalised within a short time. However the old wooden farm bridge across the Five Mile River collapsed in the mid-1970s making access often difficult during the winter months. Thus an alternative explanation is that the trends emerging from the counts are real and that *de facto* partial closure of the cave for much of the critical winter season has fortuitously permitted recovery of the hibernating bat population.

Although annual censuses are no longer required and probably inadvisable in order to minimise disturbance, an occasional count every few years may be worthwhile as a spot check of the health of the population and physical protection of the site ought still to be seriously considered. Despite the difficulty of fording the Five Mile River in midwinter, traffic has not entirely ceased: Garroway (2004) observed a number of casual visitors to the cave in late December 2003. Thomas (1995) demonstrated convincingly that even non-tactile human disturbance arouses hibernating *M. lucifugus* and *M. septentrionalis*.

Recent monitoring of autumn activity at the cave entrance led to the capture of 253 *M. lucifugus* and 116 *M. septentrionalis* in 2003 (Garroway 2004), and 228 *M. lucifugus* and 71 *M. septentrionalis* the following year (Corning & Broders 2004) i.e. 72% v. 28%. If representative, these numbers imply that the population of *M. septentrionalis* is considerably greater in this cave than previously believed, a point made by Garroway (2004).

Other major sites (>1000 bats)

SITE 54 (Code: LCM) – LAKE CHARLOTTE GOLD MINE

Abandoned mine adit, now gated. The site was identified as an important hibernaculum by DNR field staff in the mid-1990s and gated in 2004 (Archibald 2004, Khan *et al.* 2004). Major hibernaculum: ~3000 *Myotis* spp. Both species present but not counted separately. Harp trapping in October 2004 captured 4 *M. lucifugus* and 3 *M. septentrionalis*, suggesting a substantial population of the latter but unfortunately the sample is too small to be statistically meaningful. Based on advice from bat research specialists, the barrier was designed to permanently prevent human entry, so direct underground counts are no longer possible.

SITE 46 (Code: MC) – MILLER'S CREEK CAVE, a dissolutional cave in gypsum quarried away ~1981, was a major hibernaculum: ~2000 bats reported by local cavers.

Significant sites (50 – 1000 bats)

SITE 4 (Code: CB) – CAVE-OF-THE-BATS

Dissolutional cave in gypsum, with stream. Surveyed length = 70m. Significant hibernaculum: >200 bats, and an important site for *M. septentrionalis*: estimated 90% this species, 10% *M. lucifugus*. One sight record of *P. subflavus*. May have been a more important hibernaculum pre-1970 and, if so, the population may eventually recover if undisturbed. Monitoring is recommended, and gating might be advantageous.

SITE 19 (Code: MIC) – MINASVILLE ICE CAVE

Dissolutional cave in gypsum, mostly inactive, but with a small eucrenal spring. Estimated length = 80m. Significant hibernaculum with several hundred bats. The cave has two chambers connected by a short crawlway: hibernating bats prefer the innermost chamber which is warmer during the winter. Taylor (1997) reported air temperatures of 2°C and 6°C respectively in March 1997. There is uncertainty about the species

composition of the population. All three species of confirmed local cave hibernating bats were reported as present in 1997, but only *M. lucifugus* has been found since, despite careful search by an experienced observer.

SITE 20 (Code: CC) – CHEVERIE CAVE

Dissolutional cave in gypsum, inactive, apparently partly mined. Surveyed length = 89m. Significant hibernaculum (~200 bats) and old records indicate that only *M. septentrionalis* was present in the 1960s. Recent counts do not distinguish species, so it is possible that this is another site where this bat predominates. CC is possibly a historically good hibernation site that has been compromised by human traffic. It is a spacious cave with very easy access throughout the year: in the absence of disturbance in the winter the bat population might be expected to increase. A check of the species composition in this hibernaculum is urged, and gating of the site might be worthwhile.

SITE 52 (Code: CRM) – CENTRE RAWDON GOLD MINE

Abandoned mine adit. Length = 293m. Significant hibernaculum: ~650 bats. Species composition not determined. Further investigation is urged. The site might be relatively easy to gate.

SITE 57 (Code: HGP) – HIRSCHFIELD GALENA PROSPECT (Glenelg)

Abandoned mine adit. Surveyed length = 215m. Significant hibernaculum: 200-300+ bats. Species composition not confirmed, though probably mostly *M. lucifugus*. Further investigation is recommended.

SITE 62 (Code: LSH) – LEAR SHAFT, Londonderry

There are several extensive underground mine workings at Londonderry, and a number of openings. There are no underground records, and only one entrance, Lear Shaft, has been monitored for bat activity. Harp traps in September and October 2004 captured only 22 (35%) *M. lucifugus* and 40 (65%) *M. septentrionalis*, but in view of the great underground extent of the workings in the Londonderry mines, further investigation is strongly urged.

Small hibernacula (10 – 50 bats)

SITE 3 (Code: BB) – BLACK BROOK CAVE

Dissolutional cave in gypsum. Estimated length = 150m. Small hibernaculum: ~25 bats, thought to be *M. lucifugus* and *M. septentrionalis*. The accessible cave is wet and has two entrances so is likely unsuitable. However there is evidence of significant further cave passage in the immediate vicinity and thus the site may be more important than yet recognised.

SITE 12 (Code: FC) – FRENCHMAN'S CAVE and SITE 13 (Code: F2) – FRENCHMAN'S II.

Dissolutional caves in gypsum, hydrologically parts of the same cave system, with active stream. Total surveyed length = 140m. Although the historical records consistently report very few (<10) bats hibernating here, trapping at the cave entrance during September-October 2003 captured 17 (26%) *M. lucifugus*, 47 (71%) *M. septentrionalis* and 2 (3%) *P. subflavus* suggesting a bigger population. All three species have been confirmed hibernating.

Taylor (1997) suggested from comparison of October and mid-winter counts the possibility that the site is used primarily as a transient autumn roost, and he is supported by Garroway (2004) who cited temporal pre-hibernation echolocation and capture rates. However it is possible that most bats simply move into the warmer undisturbed inner chamber of FC which, to my knowledge, has never been checked for hibernating bats. The air temperature in the most sheltered part of the outer cave falls below 4°C in mid-winter. A constricted crawlway connecting the two parts of the cave constitutes an effective barrier for many people, but bats will have no difficulty negotiating it.

There is evidence of mid-summer utilisation by *P. subflavus*.

SITE 56 (Code: GRM) – GAYS RIVER GOLD MINE

Abandoned mine adit. Small hibernaculum, but no counts and no records since the 1960s and thus almost nothing is known about the numbers or composition of the population today. The early records indicate that *M. septentrionalis* was then predominant: *P. subflavus* present but *M. lucifugus* absent. Further investigation of this adit is urged.

Minor sites (<10 bats)

SITE 11 (Code: WIC) – WOODVILLE ICE CAVE

Dissolutional cave in gypsum, inactive. Surveyed length = 75m. Not significant as bat habitat: only solitary specimens of *M. lucifugus* seen. Probably unsuitable due to the large entrance, low temperature, and other microclimatic factors.

SITE 21 (Code: VC) – VAULT CAVE

In Triassic basalt: the only tectonic rift cave known in the province. Dry. Length = 25m. A few bats seen in October 1973; but the entrance was later sealed off by the local authorities and the cave is now inaccessible.

SITE 23 (Code: MB) – McLELLAN'S BROOK CAVE

Dissolutional stream cave in limestone. Surveyed length = 85m. Late summer bat activity [*Myotis* sp(p).] observed around the cave, but no underground records of bats. A winter count is desirable.

SITE 51 (Code: PT) – PEDDLAR'S TUNNEL

Abandoned mine adit in limestone. Length = 50m. Minor hibernaculum: shot holes are utilised by a few to several *M. lucifugus*. The site is notable for the record of *Lasionycteris noctivagans*.

SITE 53 (Code: WBM) – WALTON BARITE MINE

Abandoned mine adit. Length = 26m. Apparently not significant: only single bat seen mid-September 1998. However further investigation may be desirable.

SITE 58 (Code: NL1) and SITE 59 (Code: NL3) – adits at New Laing

Small abandoned mine trials. Late summer bat activity observed around the entrances; no underground observations.

SITE 60 (Code: OV) – THE OVENS

Series of active sea caves. Extent of use as hibernacula not established: specimens of all three confirmed local hibernating bats were collected here in the early 1960s. Further investigation is recommended.

Caution:

Underground exploration entails physical risk and is inadvisable for those without experience. Abandoned mines are particularly dangerous.

Permission to visit and enter any cave or mine must be sought and obtained beforehand. Sites may be on private land and the concerns of landowners about matters such as legal liability must be respected. Hayes Cave is a provincially protected site requiring formal written permission for entry.

Rabies has been reported in some bat populations elsewhere in North America.

Hibernating bats are very sensitive to disturbance, and are aroused from torpor even by non-tactile disturbance (Thomas 1995). Human traffic may cause increased winter mortality and/or abandonment of sites.

Sources and References

All cited published records are included in the references below. Some field records are contained in unpublished MSS. Dr. Bleakney's 1959-1964 handwritten field notes (cited above as "Bleakney *unpub.*") and my own field notes and records starting in 1967 ("Moseley *unpub.*") are both permanently archived in NSMNH files. I have relied on Barnes (1973) and the MIMS database for collection information on the series of bat study specimens in the NSMNH zoological collection.

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Appendix I Listing of Bat Species Recorded in Hibernacula by Site (Sites 3-20)

Site 3 (Code: BB) - Black Brook Cave, Halifax Co.					
<i>Myotis</i> spp.	12.IX.1997	6	Archibald 2005	Both species believed to be present (sight records).	
	27.III.1998	25	Archibald 2005		
Site 4 (Code: CB) - Cave-of-the-Bats, Halifax Co.					
<i>M. lucifugus</i> + <i>M. septentrionalis</i> *	Fall 1972	c.50	Moseley <i>unpub.</i>	There are unconfirmed reports that pre-1970 this site was a major hibernaculum with several thousand bats. * Taylor (1997) estimated the hibernating population to be 90% <i>septentrionalis</i> , 10% <i>lucifugus</i> . ** mostly ♂ (Archibald 2005)	
	22.II.1973	50-60	Moseley <i>unpub.</i>		
	XI. 1995	193	Hebda 2006		
	6.XI.1996	220	Taylor 1997		
	24.II.1997	120	Taylor 1997		
	17.X.1998	31**	Archibald 2005		
	6.X.2004	~100-150	Corning & Broders 2004		
18.X.2004	~100-150	Corning & Broders 2004	"In second chamber" Bat detector activity at entrance confirmed <i>Myotis</i> spp.		
<i>P. subflavus</i>	6.XI.1996	1	Taylor 1997	In side passage (Hebda 2006).	
Site 9 (Code: HC) - Hayes Cave, Hants Co.					
<i>M. lucifugus</i>	3.VIII.1959	no count	Bleakney <i>unpub.</i> & MIMS	"Most bats near the 400-500 ft. distance." 12, NSMNH, coll. Bleakney & Eaves. Droppings noted "throughout the cave"	
	29.VII.1961	no count	MIMS database	1, NSMNH, coll. P.M.Taschereau	
	17.III.1963	no count		1, NSMNH, coll. P.M.Taschereau	
	25.VI.1971	no count		1, NSMNH, coll. G. Hardy	
	4.VI.1973	no count		12, NSMNH, coll. Barnes & McClung	
	7.IX.2003*	n.a.	Garroway 2004	Trapped at entrance. .Adults: 2♀ 17♂ juv: 8♀ 11♂	
	14.IX.2003*		* = week ending	Trapped at entrance. .Adults: 10♀ 20♂ juv: 19♀ 25♂	
	21.IX.2003*			Trapped at entrance. .Adults: 1♀ 3♂ juv: 30♀ 20♂	
	5.X.2003*			Trapped at entrance. .Adults: 0♀ 0♂ juv: 15♀ 11♂	
	12.X.2003*			Trapped at entrance. .Adults: 4♀ 9♂ juv: 28♀ 18♂	
	19.X.2003*			Trapped at entrance. .Adults: 0♀ 0♂ juv: 1♀ 1♂	
	26.X.2003*			Trapped at entrance. No captures	
	3.XI.2003*			Trapped at entrance. No captures	
	24.VIII.2004	n. a.		Corning & Broders 2004	Harp trap at entrance. Adults: 3♀ 8♂ juv: 5♀ 5♂
	5.IX.2004				Harp trap at entrance. Adults: 7♀ 18♂ juv: 12♀ 14♂ (+105 age & sex not determined).
25.IX.2004				Harp trap at entrance. Adults: 7♀ 6♂ juv: 1♀ 0♂	
2.X.2004			Harp trap at entrance. Adults: 13♀ 16♂ juv: 2♀ 6♂		
BAT COUNTS: All species, but the majority are <i>M. lucifugus</i> with smaller numbers of <i>M. septentrionalis</i> , a few <i>Pipistrellus</i> .	I.1963	~ 5000	Morris 1978	Estimate by P. M. Taschereau	
	1965	~ 6000	Morris 1978	Estimate by J. S. Bleakney of hibernating bats.	
	26.III.1972	>6100	Moseley <i>et al.</i>	Duplicate counts of selected sections of cave indicated good reproducibility.	
	7.III.1976	4973 ± 330	Moseley <i>et al.</i>	Error estimated from duplicate counts of selected sections of cave.	
	III.1977	3604 ± 360	Moseley <i>et al.</i>	1 st double count of all sections. Error calculated.	
	12.III.1978	5126 ± 920	Double count (D. Blake <i>et al.</i>)		
	12.X.1978	4125 ± 259	Morris 1978	Double count (F. Scott and D. Blake)	
	28.X.1979	4726 ± 266	Morris 1978	Double count (F. Scott and D. Blake)	
	30.X.1980	6372 ± 324	Morris 1978	Double count (F. Scott and R. Ogilvie)	
	13.XI.1981	4750 ± 483	Morris 1978	Double count (F. Scott and R. Grantham)	
	27.X.1982	6426 ± 649	Morris 1978	Double count (F. Scott and R. Grantham)	
	31.X.1983	8040 ± 419	Morris 1978	Double count (F. Scott and R. Grantham)	
	14.XI.1984	6164 ± 1165	Morris 1978	Triple count (F. Scott, B. Maclean and H.Bagnell)	
	1993	~ 7300	Taylor 1997	no details of technique available	
17.IV.1996	7510	Dauphinee 1996b			
12.XI.1996	9120	Taylor 1997			
<i>Myotis</i> spp.	7.IX.2003-5.XI.2003		Garroway 2004	3352 echolocation sequences attributed to <i>Myotis</i> spp. recorded at entrance throughout this period.	
<i>M. septentrionalis</i>	1959-1964	a few	Bleakney 1965	1♀ coll. Taschereau 17.III.1963 in NSMNH (Barnes 1973); one coll. Bleakney 13.II.1960 in NSMNH (MIMS).	
	12.XI.1996	numerous	Taylor 1997		
	7.IX.2003*	n.a.	Garroway 2004	Trapped at entrance. .Adults: 2♀ 4♂ juv: 15♀ 15♂	
	14.IX.2003*		* = week ending	Trapped at entrance. .Adults: 0♀ 0♂ juv: 19♀ 22♂	
	21.IX.2003*			Trapped at entrance. .Adults: 0♀ 1♂ juv: 11♀ 7♂	
	5.X.2003*			Trapped at entrance. .Adults: 0♀ 0♂ juv: 1♀ 2♂	
	12.X.2003*			Trapped at entrance. .Adults: 1♀ 0♂ juv: 5♀ 4♂	
	19.X.2003*			Trapped at entrance. .Adults: 0♀ 0♂ juv: 1♀ 1♂	
	26.X.2003*			Trapped at entrance. .Adults: 0♀ 1♂ juv: 2♀ 2♂	

<i>M. septentrionalis</i> (ocnt'd)	3.XI.2003*			Trapped at entrance. No captures.
	24.VIII.2004	n.a.	Corning & Broders 2004	Harp trap at entrance. Adults: 34♀ 2♂ juv: 12♀ 3♂
	5.IX.2004			Harp trap at entrance. Adults: 5♀ 6♂ juv: 7♀ 6♂
	25.IX.2004			Harp trap at entrance. Adults: 4♀ 1♂ juv: 1♀ 1♂
	2.X.2004			Harp trap at entrance. Adults: 7♀ 10♂ juv: 0♀ 2♂
<i>P. subflavus</i>	3.VIII.1959	1 ♂	Bleakney 1965	Found in the side chamber near entrance (Bleakney <i>unpub.</i>). In NSMNH collection (MIMS).
	24.I.1960	no count	MIMS	Coll. Bleakney <i>et al.</i> In NSMNH coll.
	13.II.1960	2 ♂	Bleakney 1965, MIMS	Melanistic (Bleakney 1965). IN NSMNH coll.
	23.II.1960	1 ♀	Bleakney 1965	
	17.III.1963	1 ♂	Bleakney 1965	Specimen in NSMNH (Barnes 1973); coll Taschereau according to MIMS.
	28.II.1986	1	Moseley <i>unpub.</i>	Melanistic
	12.XI.1996	1	Taylor 1997	
	1.IX.1997	5	Moseley, <i>unpub.</i>	Roosting in the side chamber near entrance.
	7.IX.2003- 5.XI.2003	n.a.	Garroway 2004	59 echolocation sequences attributed to this species recorded at entrance throughout this period.
<i>Eptesicus fuscus</i>	12.XI.1996	2	Taylor 1997	Sight record by A.Hebda
<i>Lasiurus cinereus</i>	8.X.2003	n.a.	Garroway 2004	One echolocation sequence attributed to this species recorded at entrance (@ 21.27 hrs)
Site 11 (Code: WIC) - Woodville Ice Cave, Hants Co.				
<i>M. lucifugus</i>	14.X.1996	1*	Taylor 1997	Unsuitable for hibernating bats: probably because too cold.
	26.IV.1997	1	Moseley <i>unpub.</i>	* melanistic, yearling (Hebda 2006)
Site 12 (Code: FC) - Frenchman's Cave, Hants Co.				
Unidentified	14.X.1973	1	Moseley <i>unpub.</i>	
	5.X.1997	2	Moseley <i>unpub.</i>	
<i>Myotis</i> spp.	4.X.2004	no count	Archibald 2005	Bat Detector – activity around entrance.
	7.IX.2003- 5.XI.2003	n.a.	Garroway 2004	758 echolocation sequences attributed to <i>Myotis</i> spp. recorded at entrance throughout this period.
<i>M. lucifugus</i>	10.II.1960	1?	MIMS	in NSMNH. Coll. Bleakney.
	1959-1964	1**	Bleakney 1965	** "solitary individuals seen several times"
	14.X.1996	9	Taylor 1997	
	17.II.1997	2	Taylor 1997	
	7.IX.2003*	n.a.	Garroway 2004 * = week ending	Trapped at entrance. Adults: 0♀ 1♂ juv: 2♀ 1♂
	14.IX.2003*			Trapped at entrance. Adults: 0♀ 1♂ juv: 2♀ 2♂
	21.IX.2003*			Trapped at entrance. Adults: 1♀ 1♂ juv: 1♀ 5♂
	28.IX.2003*			Trap at entrance. No captures
	5.X.2003*			Trap at entrance. No captures
	12.X.2003*			Trap at entrance. No captures
	3.XI.2003*			Trap at entrance. No captures
1959-1964	1***	Bleakney 1965		***Solitary individuals seen several times.
19.II.1963	no count	Barnes 1973, MIMS	One ♀ collected 19.II.1963, Taschereau in NSMNH.	
3.III.1964	no count	MIMS	1, coll. D. Calder, NSMNH.	
14.X.1996	1	Taylor 1997		
17.X.1997	none	Taylor 1997		
7.IX.2003*	n.a.	Garroway 2004 * = week ending	Trapped at entrance. Adults: 0♀ 1♂ juv: 5♀ 13♂	
14.IX.2003*			Trapped at entrance. Adults: 0♀ 1♂ juv: 6♀ 12♂	
21.IX.2003*			Trapped at entrance. Adults: 0♀ 1♂ juv: 1♀ 5♂	
28.IX.2003*			Trapped at entrance. Adults: 0♀ 0♂ juv: 0♀ 2♂	
5.X.2003*			Trap at entrance. No captures	
12.X.2003*			Trap at entrance. No captures	
3.XI.2003*			Trap at entrance. No captures	
29.VII.1959	2 ♂		Bleakney 1965	Melanistic. "Hanging in a depression of roof a short way from the entrance." Droppings "scattered throughout the cave." (Bleakney <i>unpub.</i>). Specimens in NSMNH (Barnes 1973, MIMS)
19.V.1964	1 ♂	Bleakney 1965	Normal colour.	
14.X.1996	1	Taylor 1997		
17.II.1997	none	Taylor 1997		
Fall 2003	n.a.	Garroway 2004	Trapped at entrance. 2 specimens – no data in the report.	
7.IX.2003- 5.XI.2003	n.a.	Garroway 2004	17 echolocation sequences attributed to this species recorded at entrance throughout this period.	

Site 13 (Code: F2) - Frenchman's II, Hants Co.				
<i>M. lucifugus</i>	14.X.1996	2	Taylor,1997	
	17.II.1997	no bats found	Taylor 1997	
	5.X.1997	no bats found	Moseley <i>unpub.</i>	
Site 19 (Code: MIC) - Minasville Ice Cave, Hants Co.				
<i>M. lucifugus</i> (<i>M. septentrionalis</i> and <i>P. subflavus</i> ?)	23.IX.1995	32	Moseley <i>unpub.</i>	All three species reported as present by Taylor, but not distinguished in the counts. However, only <i>M. lucifugus</i> has been found since (Hebda 2006). * many droppings on floor (Taylor 1997)
	26.X.1996	64 (outer), 346 (inner chamber)	Taylor 1997	
	21.III.1997*	0 (outer), 630 (inner chamber)	Taylor 1997	
	15.IX.1998	29	Archibald 2005	<i>M. lucifugus</i> only, most in clusters 20-40.
	14.II.2004	0 (outer), 183 (inner chamber)	Hebda 2006	
	17.IX.2005	No counts but <i>M. lucifugus</i> present in both chambers (Hebda 2006)		
Site 20 (Code:CC) - Cheverie Cave, Hants Co.				
Unidentified	30.IV.1997	124	Moseley <i>unpub.</i>	The species now using the cave need to be identified: Bleakney found only <i>M. septentrionalis</i> in the 1960s.
	16.XI.1997	a few dozen	Moseley <i>unpub.</i>	
	17.IV.1998	200	Archibald 2005	
<i>M. lucifugus</i>	1959-1964	None	Bleakney 1965	
<i>M. septentrionalis</i>	11.II.1935	36	Gould 1936	12 collected -- all found to be ♂s
	1959-1964	no count	Bleakney,1965	The only species present.
	30.IV.1997	1	Moseley <i>unpub.</i>	
<i>P. subflavus</i>	1959-1964	None	Bleakney 1965	

Appendix II: Listing of Bat Species Recorded in Hibernacula by Site (Sites 21-62)

Site 21 (Code: VC) - Vault Cave, Kings Co.				
Unidentified	28.X.1973	A few	Moseley unpub.	
Site 23 (Code: MB) - McLellan's Brook Cave, Pictou Co.				
<i>Myotis</i> sp.	24.VIII.1998	Activity observed around entrance (Bat Detector 40-45KHz & visual)		Archibald 2005
Site 46 (Code: MC) - Miller's Creek Cave, Hants Co.				
Unidentified: assumed <i>M. lucifugus</i>	I.1966	~2000	Stevens pers. comm.	This site, quarried away in the early 1980s, appears to have been a major hibernaculum. Bat droppings noted in main chamber
	1974	Few dozen	Moseley unpub.	
	3.X.1971	no count	Moseley unpub.	
Site 51 (Code: PT) - Peddlar's Tunnel, Hants Co.				
<i>L. noctivagus</i>	14.II.96	1	Hebda 2006	in shot hole; not present 3 weeks later
<i>M. lucifugus</i>	14.II.1996	several	Hebda 2006	Bats present in several shot holes (counts not possible without dislodging). Taylor (1997) reported "3" apparently in error. Bats present in fewer shot holes in April than previous October suggesting movement during the winter (Hebda 2006).
	26.X.1996	several		
	6.IV.1996	several		
Site 52 (Code: CRM) - Centre Rawdon Gold Mine, Hants Co.				
Unidentified	8.V.1998	650	Archibald 2005	Not identified: mostly <i>lucifugus</i> ?
Site 53 (Code: WBM) - Walton Barite Mine, Hants Co.				
Unidentified	15.IX.1998	1	Archibald 2005	
Site 54 (Code: LCM) - Lake Charlotte Gold Mine, Halifax Co.				
<i>Myotis</i> spp.	4.IV.1996	2990	Dauphinee 1966a	Dauphinee (1966a) states that two spp. were believed to be present: not distinguished in the counts. Later collections confirmed both <i>lucifugus</i> and <i>septentrionalis</i> . * Survey for summer utilization of adit by bats ** Several dozen estimated (by Bat Detector @ 45MHz) flying outside adit near entrance. Droppings observed inside entrance. (Archibald 2005). NB: Detector picked up some signals from ~ 32-70 KHz.
	17.VI.1996	None*	Archibald 2005	
	19.III.1997	2973		
	1.IX.1998	3**		
	14.IX.1998	126**		
	20.IV.2001	2079		
	23.IX.2003	Few hundred		
	23.IV.2004	2761		
<i>M. lucifugus</i>	14.X.2004	no count		Corning & Broders 2004
<i>M. septentrionalis</i>	8.XI.1996	no count	Archibald 2005	3 bat specimens collected, all <i>septentrionalis</i> .
	14.X.2004	no count	Corning & Broders 2004	Harp trap at entrance: adults 1♀ 1♂ juv: 0♀ 1♂
Site 56 (Code: GRM) - Gays River Gold Mine, Halifax Co.				
<i>M. lucifugus</i>	1959-64	"absent"	Bleakney 1965	
<i>M. septentrionalis</i>	1959-64	"predominates"	Bleakney 1965	3 ♂s + 3 ♀ coll. 16.II.1962 are in the NSMNH collections (Barnes 1973, MIMS)
<i>P. subflavus</i>	II.1962	No count		2 ♂s collected this date by Bleakney in NSMNH coll. (Barnes 1973)
Site 57 (Code: HGP) - Hirschfield Galena Prospect, Glenelg, Guysborough Co.				
<i>M. lucifugus</i>	19.IV.1987	~ 200	Moseley unpub.	Assumed to be <i>lucifugus</i> , not confirmed
	winter 2003/04	>300	Archibald 2005	
Site 58 (Code: NL1) - adit # 1, New Laing, Pictou Co.				
Unidentified	28.VIII.1998	No count	Archibald 2005	Droppings observed inside entrance.
	3.IX.1998	No count		Bat activity around entrance (acoustic and visual)
Site 59 (Code: NL3) - adit # 3, New Laing, Pictou Co.				
Unidentified	28.VIII.1998	No count	Archibald 2005	Droppings observed inside entrance
	3.IX.1998	No count		Bat activity around entrance (acoustic and visual)
	25.IX.1998	No count		Increased activity around entrance (acoustic and visual)
Site 60 (Code: OV) - The Ovens, Lunenburg Co.				
<i>M. lucifugus</i>	23.IX.1961	No count	Barnes 1973, MIMS	1 specimen, collected this date, Bleakney, in NSMNH coll.
<i>M. septentrionalis</i>	18.V.1963	No count	Barnes 1973, MIMS	1 ♂, collected this date, Bleakney, in NSMNH coll.
Site 62 (Code: LSH) - Lear Shaft, Colchester Co.				
<i>M. lucifugus</i>	27.IX.2004	No count	Corning & Broders 2004	Harp trap at entrance: adults 3♀ 8♂ juv: 2♀ 7♂
	13.X.2004	No count	Corning & Broders 2004	Harp trap at entrance: adults 0♀ 2♂ juv: 0♀ 0♂
	20.X.2004	No count	Corning & Broders 2004	Harp trap at entrance: adults 0♀ 0♂ juv: 0♀ 0♂
<i>M. septentrionalis</i>	27.IX.2004	No count	Corning & Broders 2004	Harp trap at entrance: adults 4♀ 10♂ juv: 2♀ 2♂
	13.X.2004	No count	Corning & Broders 2004	Harp trap at entrance: adults 6♀ 5♂ juv: 6♀ 4♂
	20.X.2004	No count	Corning & Broders 2004	Harp trap at entrance: adults 0♀ 1♂ juv: 0♀ 0♂