Status of the Northern Long-eared Bat (Myotis septentrionalis) in Alberta

M. Carolina Caceres
M. J. Pybus

Alberta Wildlife Status Report No. 3

Published By:

Alberta
ENVIRONMENT

Alberta Conservation Association

Publication No. T/366
ISBN: 0-7732-5126-X
ISSN: 1206-4912

Series Editor: David R. C. Prescott
Illustrations: Brian Huffman

For copies of this report, contact:

Information Centre - Publications
Alberta Environmental Protection
Natural Resources Service
Main Floor, Bramalea Building
9920 - 108 Street
Edmonton, Alberta, Canada T5K 2M4

Telephone: (780) 422-2079

OR

Communications Division
Alberta Environmental Protection
#100, 3115 - 12 Street NE
Calgary, Alberta, Canada T2E 7J2

Telephone: (403) 297-3362

This publication may be cited as:

Caceres, M. C., and M. J. Pybus. 1997. Status of the Northern Long-eared Bat (Myotis septentrionalis) in Alberta. Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Report No. 3, Edmonton, AB. 19 pp.

PREFACE

Every five years, the Wildlife Management Division of Alberta Natural Resources Service reviews the status of wildlife species in Alberta. These overviews, which have been conducted in 1991 and 1996, assign individual species to 'colour' lists which reflect the perceived level of risk to populations which occur in the province. Such designations are determined from extensive consultations with professional and amateur biologists, and from a variety of readily available sources of population data. A primary objective of these reviews is to identify species which may be considered for more detailed status determinations.

The Alberta Wildlife Status Report Series is an extension of the 1996 *Status of Alberta Wildlife* review process, and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are potentially at risk in the province (Red or Blue listed), that are of uncertain status (Status Undetermined), or which are considered to be at risk at a national level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Reports in this series are published and distributed by the Wildlife Management Division of Alberta Environmental Protection, and are intended to provide detailed and up-to-date information which will be useful to resource professionals for managing populations of species and their habitats in the province. The reports also are designed to provide current information which will assist the proposed Alberta Endangered Species Conservation Committee to identify species that may be formally designated as endangered or threatened under the Alberta Wildlife Act. To achieve these goals, the reports have been authored and/or reviewed by individuals with unique local expertise in the biology and management of each species.

EXECUTIVE SUMMARY

The Northern Long-eared Bat (Myotis septentrionalis) is a solitary, forest-dwelling bat commonly found in eastern Canada and the United States. It also is encountered infrequently in western Canada including Alberta. At present, the Northern Long-eared Bat is included on the "Blue List" of species that may be at risk in Alberta (Alberta Wildlife Management Division 1996). This designation is based on the relative rarity of this species in the province, and its apparent reliance on mature forest habitats.

The Northern Long-eared Bat has a broad distribution in Alberta, north of a line extending from Cold Lake to Jasper. Within this area, the species most often is reported from the Boreal Forest and northern Foothills Natural Regions, although there are several records from the Peace and central Aspen Parklands. During the winter, the Northern Long-eared Bat hibernates with other bat species in caves or abandoned mines. Two hibernacula have been found: one in the Boreal Forest Natural Region (a cave in Wood Buffalo National Park); and one in the Foothills Natural Region (Cadomin Cave). In summer, the Northern Long-eared Bat roosts individually under peeling bark or in cavities of partially-decayed trees. Recent evidence from other parts of the species' range suggests that roost trees used by the Northern Long-eared Bat tend to be taller and wider than are randomly available, and that these trees are generally found in old-growth forest stands. Although the specific habitat requirements of the species in Alberta have not been investigated, this apparent preference may mean that the provincial distribution is patchy within the known range. In addition, the availability of suitable hibernaculum sites may further limit the species distribution in the province.

The Northern Long-eared Bat is relatively uncommon in Alberta, and current population size and trends cannot be estimated with available data. The species may be at risk due to habitat loss associated with forestry practices, as well as disturbance or destruction of hibernacula. However, without additional information regarding the biology of this species, potential impacts on its abundance and distribution can not be properly assessed. The recent change towards a more positive attitude about bats in general may be an important tool to help manage and conserve bat populations.

ACKNOWLEDGEMENTS

We thank R. Barclay (University of Calgary), H. Bryant and H. Smith (retired) (Provincial Museum of Alberta), L. Crampton (Boston University), A. and G. Roberts (independent consultants) and L. Wilkinson (B.C. Ministry of Environment, Lands and Parks) for information provided on captures of the Northern Long-eared Bat in Alberta and British Columbia. We thank D. Prescott and S. Brechtel (Alberta Natural Resources Services), H. Bryant and R. Barclay for their careful review of earlier versions of this document, D. Ryerson (Alberta Natural Resources Service) for editorial assistance and J. Horb for producing the maps.

Preparation of this report was supported by the Wildlife Management Enhancement Fund of Alberta Natural Resources Service, and the Alberta Conservation Association.

TABLE OF CONTENTS

PREFACE iii

EXECUTIVE SUMMARY iv

ACKNOWLEDGEMENTS v

INTRODUCTION 1

HABITAT 1
1. Winter Hibernacula 1
2. Summer Roosting and Foraging Habitat 2

CONSERVATION BIOLOGY 3

DISTRIBUTION 6
1. Alberta 6
2. Other Areas 6

POPULATION SIZE AND TRENDS 6

LIMITING FACTORS 9
1. Climate 9
2. Hibernacula 9
3. Summer Roosts 11

STATUS DESIGNATIONS 11
1. Alberta 11
2. Other Areas 11

RECENT MANAGEMENT IN ALBERTA 12

SYNTHESIS 12

LITERATURE CITED 14

APPENDIX 1. 18

APPENDIX 2. 19

INTRODUCTION

The Northern Long-eared Bat (Myotis septentrionalis) is found in many regions of Canada. Although there are numerous records of its presence in eastern Canada and the United States (Barbour and Davis 1969, Dobbyn 1994, Kurta 1995, van Zyll de Jong 1985), it has only been recorded sporadically in western Canada (Barbour and Davis 1969, Nagorsen and Brigham 1993, Smith 1993). Presently, the Northern Long-eared Bat is on the "Blue List*" of species which may be at risk in Alberta (Alberta Wildlife Management Division 1996).

This report summarizes recent information on the Northern Long-eared Bat, as a step in reviewing the status of this species in Alberta. Before proceeding, it should be noted that prior to 1980, the Northern Long-eared Bat was considered to be a subspecies of M. keenii and was occasionally referred to as "Keen's Bat", or the "Eastern Long-eared Bat" (Fitch and Schump 1979, van Zyll de Jong 1979). Presently M. keenii is restricted to the Pacific Northwest, and any references to this species from outside that area are considered to refer to M. septentrionalis (van Zyll de Jong 1979).

It should also be noted that many specific aspects of the ecology of M. septentrionalis are poorly understood. However, there has been much recent information on the ecology of other Myotis species, in Alberta and elsewhere in North America (Crampton 1995, Schowalter 1980, Vonhof and Barclay 1996, Whitaker and Rissler 1993). Although there is some variation in characteristics among species, there also are broad similarities within the genus. Thus, whenever specific biological information is not available for M. septentrionalis, reference may be made to what is known about other species of Myotis which occur in western Canada.

* See Appendix 1 for definitions of selected status designations

HABITAT

Habitat selection by the Northern Long-eared Bat can be divided into two major components: winter hibernacula as well as summer roosting and foraging habitat.

1. Winter Hibernacula. - The Northern Long-eared Bat hibernates in caves or abandoned mines (Caire et al. 1979, Griffin 1940, Hitchcock 1949, Mills 1971, Schowalter 1980, Swanson and Evans 1936, Thomas 1995). Within a cave, M. septentrionalis generally occurs with other species of bats, but forms a small proportion of the total hibernating population (Griffin 1940, Hitchcock 1949, Schowalter 1979, Thomas 1993). Thus, hibernating Northern Long-eared Bats are never abundant (Barbour and Davis 1969) and the largest hibernating group recorded was approximately 300 individuals in a cave in Quebec (Thomas 1993). They made up approximately 25% of the total population within the hibernaculum.

There are two known hibernacula used by Northern Long-eared Bats in Alberta: Cadomin Cave (53°00'N; 117°20'W; Schowalter 1980), and Wood Buffalo National Park (60°00'N; 114°00'W; Schowalter 1979). The hibernacula were shared with Little Brown Bats (M. lucifugus) and Long-legged Bats (M. volans), but specific site preferences within the hibernacula differed among species. Northern Long-eared Bats made up zero to three percent of the total number of bats collected at any one time at these sites. In August and early September (Schowalter 1980). Full torpor and hibernation begins when there are no longer sufficient numbers of

flying insects to make continued foraging worthwhile (usually after one or two killing frosts in September).

In general, bats choose hibernaculum sites that provide a relatively constant, low (0^o to 4^oC) temperature with high humidity and no air currents. Within these sites, Northern Long-eared Bats usually hang singly in small narrow crevices and may therefore be easy to overlook (Caire et al. 1979, Kurta 1995). Despite their inconspicuous roosts, most records of Northern Long-eared Bats are of individuals found during hibernation. Anecdotal evidence suggests that Northern Long-eared Bats prefer moister and cooler sites (caves/mines or regions of a cave/mine) than Little Brown Bats in the same hibernaculum (Barbour and Davis 1969, Hitchcock 1949).

Depending on weather conditions, bats of Myotis spp. in Alberta generally begin emerging from the hibernaculum in late April or early May (Pybus 1986a).

2. Summer Roosting and Foraging Habitat. - Northern Long-eared Bats commonly use crevices behind peeling bark or cavities in partially-decayed trees as summer day roosts (Clark et al. 1987, Mumford and Cope 1964). Individuals will switch among a number of roost trees, sometimes on a daily basis; however, roosts tend to be within a few hundred metres of each other (Crampton 1995, Vonhof and Barclay 1996). Although characteristics of trees used as roost sites in Alberta have not specifically been investigated, recent studies in the White Mountain National Forest of New Hampshire (Sasse and Pekins 1996) and the Interior Cedar-Hemlock Zone of British Columbia (Caceres, unpubl. data) indicate that tall, wide-diameter, partially-dead trees with a high percent of the bark remaining are favoured by the Northern Long-eared Bat. Such trees tend to be found in over-mature forest stands (Sasse and Pekins 1996, Caceres, unpubl. data). Although the boreal forests of Alberta differ from the forests of New Hampshire and British Columbia in terms of major tree species, canopy structure, and climatic conditions, it seems likely that the same general roost-tree characteristics will be selected by Northern Long-eared Bats in this province.

Studies of foraging and habitat use also indicate the importance of mature forest stands to Northern Long-eared Bats. In the Interior Hemlock Forest Zone of British Columbia, 19 (25%) of all bats captured in old-growth forest stands (>120 years) were Northern Long-eared Bats. Unlike M. septentrionalis, the other Myotis species (M. evotis. M. lucifugus, M. volans and M. californicus) were distributed both in old-growth forest and logged areas (Caceres, unpubl. data).

As with many Myotis spp., gender and reproductive status affect the choice of summer roosting habitat. Reproductive female Northern Long-eared Bats may gather in small colonies in buildings (Barbour and Davis 1969, Brandon 1961), or in cavities in trees. Most males or non-reproductive females roost singly in trees; however, they may also roost singly in buildings, behind shutters, under shingles, or in other available crevices (Brandon 1961, Hamilton and Whittaker 1979, Mumford and Cope 1964, A. and G. Roberts, pers. comm). The relative importance of man-made structures for day roosts for M. septentrionalis in Alberta is unknown, but extensive work by bat specialists in the province has resulted in very few records of their presence at buildings. Within thick forests, summer activity may be focused along watercourses and small ponds (Fenton et al. 1983, van Zyll de Jong et al. 1980). Similarly, activity also was high in the

vicinity of artificial light sources (streetlights, yardlights) in association with the increased availability of night-flying insects. These isolated habitats fulfill a critical need and may affect choice of summer day roosts and night foraging areas.

In the eastern part of the species' range, caves, abandoned mines, or rock crevices are used occasionally as day roosts or temporary summer night roosts (used for short times during the nightly foraging period; Mills 1971). However, these sites are unlikely to be important in northern areas such as Alberta, as they may be too cold for summer use. Warm roosts are particularly important to reproductive females and juveniles. Adult females maintain a constant body temperature (and avoid torpor) in order to maximize fetal development. Juvenile bats are born naked and grow rapidly for the first four weeks after birth (Fenton 1983). Maximum energies are directed towards growth. A warm (and preferably hot) roost is essential to rapid growth and development.

CONSERVATION BIOLOGY

The Northern Long-eared Bat is one of five species of Myotis which occur in Alberta. The species is most likely to be confused with the Little Brown Bat (M. lucifugus) or the Western Long-eared Bat (M. evotis), but can sometimes be distinguished from these species on the basis of ear length (14 to 19 mm versus 9 to 17 mm and 17 to 22 mm in M. lucifugus and M. evotis, respectively; Nagorsen and Brigham 1993). Generally, when lightly pressed forward, the ears of Northern Long-eared Bats extend slightly beyond the end of the nose. In a similar position, the ears of Little Brown Bats do not reach the end of the nose and in Western Long-eared Bats they extend well beyond the nose (at least 5 mm; (van Zyll de Jong 1985). The Western Long-eared Bat also tends to have much darker wing and ear membranes and paler fur than the Northern Long-eared Bat (Nagorsen and Brigham 1993, van Zyll de Jong 1985). However, the distinguishing characteristics of these species require careful examination as, at first glance, these three species appear alike. In addition, it is not possible to differentiate these species in flight, and their echolocation calls broadly overlap at approximately 40 to 45 kHz (Fenton et al. 1983).

The average size reported for the Northern Long-eared Bat is 7.4 g with forearm length of 36.4 mm (van Zyll de Jong 1985). Females tend to be slightly larger than males. In addition, a full-term fetus may add up to 25% to the body weight of a pregnant female. However, size is a highly variable characteristic and adult Northern Long-eared Bats as small as five grams, with a 34 mm forearm, have been caught (Nagorsen and Brigham 1993, Caceres, unpubl. data.).

Female Myotis bats begin visiting their hibernaculum between August and early October. Suitable hibernaculum sites have a narrow range of environmental conditions and thus bats may have to travel long distances to reach an appropriate site. Although the distance travelled between the summer habitat and the hibernaculum site generally is not known, banding recoveries indicate that some Little Brown Bats that summer in north central Alberta travel to the Hinton area to hibernate (Alberta Wildlife Management Division, unpubl. data). It seems reasonable to assume that Northern Long-eared Bats also may travel long distances to reach their hibernacula.

Male and female Myotis spp. return to the same hibernaculum year after year. Some Little Brown Bats banded in Cadomin Cave in

the late 1970s (Schowalter 1980) have been recaptured as recently as 1997 (Alberta Wildlife Management Division, unpubl. data).

Swarming and mating in Myotis spp. occur in the fall, generally at the hibernaculum site. Females then store sperm over the winter. A single egg is fertilized when the female arouses from torpor and leaves the hibernaculum in the spring (Racey 1982). Gestation (fetal development) is approximately 60 days and parturition (birth) occurs in late June and July (van Zyll de Jong 1985).

During the summer, bats must accumulate enough resources to maintain the high metabolic costs associated with flight, and to gain sufficient fat reserves to hibernate for the winter. Female bats must accumulate greater energy reserves than males in order to produce and care for the offspring (Barclay 1991). Canadian species of Myotis generally add 30 to 40% of their summer weight in fat to use as energy reserves during hibernation (Nagorsen and Brigham 1993, Thomas et al. 1990).

Environmental conditions influence the ability of a female bat to successfully raise an offspring in any given season. When conditions such as high rainfall, cold weather, or windy evenings reduce insect availability, females may not be able to gather enough food and may delay or forego reproducing during that season (Grindal et al. 1992). In addition, lactating females need adequate food to meet their own energy needs as well as produce milk for the pup.

Young bats (pups) are particularly vulnerable immediately after birth. At this time they are unable to fly and are totally dependent on the female for food. Any alteration of the roost that precludes entry or exit of the adults (such as a homeowner blocking a roost entrance) will result in death of the pup. Exclusion practices to remove bats from interior roosts in buildings should not be done between late June and mid August.

Unlike other small mammals, all North American Myotis spp., including the Northern Long-eared Bat, are relatively long lived. The record age of a Northern Long-eared Bat in the wild is 19 years (Kurta 1995). Also in contrast to most small mammals, each female bat produces only one young each year. Most mortality in North American bat species occurs in the juvenile age class and many pups do not survive their first year (Tuttle and Stevenson 1982). Additional mortality occurs during the hibernation period. If winters are harsh, or if bats cannot obtain the fat reserves necessary to survive this period, they may starve. Juveniles are particularly vulnerable during hibernation because they have a relatively short time after their birth to build up fat reserves (Nagorsen and Brigham 1993). Predation does not appear to be a major cause of mortality for bats as they are not the primary prey for any natural predators. Owls and magpies are known to successfully take individual bats as they roost in open sites, but this probably does not have an effect on the overall population size. However, specific investigations of survival in juvenile and adult Northern Long-eared Bats in Alberta or elsewhere have not yet been undertaken.

Like all bat species in Canada, the Northern Long-eared Bat feeds exclusively on insects. Myotis bats are generalist insectivores, and their diet is limited only by the size of the insects they are capable of catching. Although moths and beetles make up the majority of the diet of Myotis spp., mosquitos, black flies, and other noxious pests also are consumed. Within the group of Myotis bats, differences in foraging strategy (Fenton 1990, Fenton and Bell 1979) are used to reduce overlap and

competition. Most insectivorous bats feed on flying insects (these bats are called "hawkers"). Other bats (known as "gleaners") use passive listening as well as echolocation to locate and capture insects resting on leaves, tree trunks or against buildings. This technique is an apparent foraging advantage in cooler conditions when the abundance of flying insects is reduced (Taylor 1963).

Northern Long-eared Bats are opportunistic and will hawk insects from the air or glean prey from substrates (Faure et al. 1993). Given the abundance of flying insects in Alberta, it is unlikely that lack of food is a concern for bat populations in the province! However, the disappearance of suitable food following killing frosts in the fall is the primary factor initiating hibernation.

Generally, M. septentrionalis uses various food items including species of Hemiptera (true bugs), Lepidoptera (moths), Hymenoptera (bees and wasps), Diptera (flies), and Homoptera (includes leafhoppers and aphids; van Zyll de Jong 1985). In late summer and fall, species of Coleoptera (beetles), Trichoptera (caddis flies), and Lepidoptera were most common in the diet.

Feeding activity in Myotis bats peaks soon after emergence from the day roost (shortly after dusk) and again in the period immediately before active bats return to the day roost (pre-dawn). These periods correspond to peaks in insect activity. However, the occurrence and duration of these activity peaks is highly variable and may be dependent upon air temperature, insect availability, precipitation, and energy needs of individual bats. Bats take extreme measures to conserve energy in all aspects of their basic behaviours. For example, they roost upside down in order to minimize the risk of damage to their fragile wing membranes and to reduce the energy needed to attain flight. From this position, gravity is used as the means initiating flight. As they release the toes on their rear legs, they begin to fall and need only extend their wings and catch the air in order to gain lift and propulsion. Similarly, bats have a locking mechanism in their toes that allows them to hang upside down without falling from their roost but without expending energy to retain a good grip. In each toe, they have a circular sheath around the tendon. It prevents the toes from uncurling when the bat is roosting. This is similar to the locking mechanism in the knees of a horse that allows the horse to sleep while standing. Of course, torpor during hibernation is the extreme in conservation of energy.

Parasites and diseases probably have minimal impact in most insectivorous bat species. However, bats can become infected with rabies virus and thus pose a public health concern. Rabies virus can cause fatal infections in all warm-blooded mammals and birds and is a concern for public safety and livestock health throughout the world. However, its presence in northern insectivorous bats is limited, particularly in Canada (Pybus 1986b, Rosatte 1987). It is of note that Northern Long-eared Bats are not known to harbor significant amounts of rabies and no cases have been reported in western Canada.

DISTRIBUTION

1. Alberta - In Alberta, the Northern Long-eared Bat is most often reported in the Boreal Forest Natural Region, and the northern section of the Foothills Natural Region (Figure 1). The largest number of captures have occurred at Cadomin Cave (Schowalter 1979, H. Smith, pers. comm), and 16 of 30 specimens in the Provincial Museum of

Alberta were collected at this site (Appendix 2). There also are limited records from the Peace Parkland subregion and from the northern regions of the Central Parkland (Figure 1, Appendix 2).

Taken together, current records suggest that the range of the Northern Long-eared Bat is continuous across Alberta, north of Cold Lake, Edmonton, and Jasper (Figure 1). However, few surveys of bats have been undertaken in appropriate regions of the province (Holroyd 1983, Schowalter 1979, Alberta Wildlife Management Division, unpubl. data) so it is possible that the range of the Northern Long-eared Bat may be more extensive than indicated. Furthermore, this distribution is based on a small number of captures, and given that current research suggests bats tend to be selective in the micro-habitats (i.e., forest stand) they occupy within their range, local distributions probably are patchy.

2. Other Areas - The Northern Long-eared Bat is found throughout most forested regions of Canada (except on the west coast and the northern portion of the boreal forest; Figure 2) but is captured more regularly in eastern Canada and the United States than in western Canada. However, the apparent scarcity of records in western regions may reflect sample bias in the small number of people looking for or able to identify M. septentrionalis.

The species has been found regularly in southern Ontario, southern Quebec, and in the maritime provinces, as well as in eastern regions of the United States (Dobbyn 1994, Godin 1977, Hamilton and Whitaker 1979, Thomas 1993, van Zyll de Jong 1985). The range of the Northern Long-eared Bat in the United States extends from the Canadian border south to northern Florida (Rice 1955) and west into North Dakota, South Dakota, Nebraska, and Wyoming (Knox Jones et al. 1983, Turner 1974). In Canada, the documented range of the Northern Long-eared Bat extends north into central Quebec, and northern parts of Ontario, Manitoba, Saskatchewan, and Alberta, as well as the southwest corner of the Northwest Territories (Nagorsen and Brigham 1993, Nagorsen and Nash 1984, Smith 1993, van Zyll de Jong 1985, Wrigley 1974). The western boundary of the range appears to be the west slope of the Canadian portion of the Rocky Mountains north of Revelstoke, British Columbia (van Zyll de Jong et al. 1980).

Overall, the known range of the Northern Long-eared Bat is primarily restricted to forested regions, with a distinct avoidance of the prairies, coastal rainforests, and southern Rockies. Occasionally, M. septentrionalis is captured in the central plains of the United States but these situations occurred in forest remnants or in caves used for hibernation (Turner 1974).

POPULATION SIZE AND TRENDS

Throughout its range, the Northern Long-eared Bat normally is found in small numbers relative to other Myotis species. Given the few records of this species in Alberta, it is impossible to estimate the provincial population size of the Northern Long-eared Bat. However, several general surveys of bats

Figure 1. Site records and presumed distribution of the Northern Long-eared Bat in Alberta. Numbered sites are described in Appendix 2.

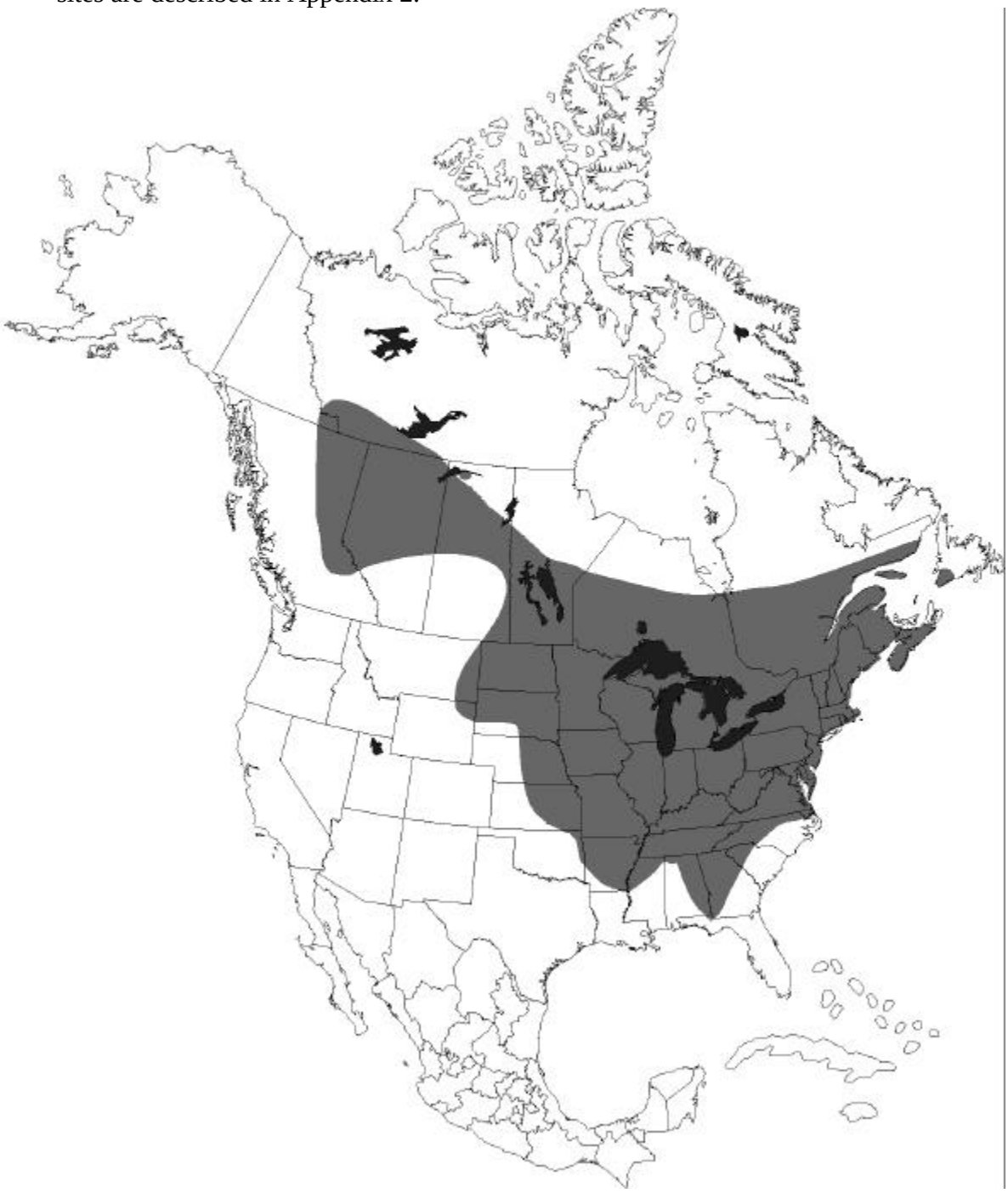

Figure 2. Range of Northern Long-eared Bat in North America (after van Zyll de Jong 1985).

in the province indicate that the species is relatively uncommon. Northern Long-eared Bats were a small proportion of the individuals hibernating in both Cadomin Cave (Schowalter 1980) and in Wood Buffalo National Park (Schowalter 1979). In addition, one of 99 bats captured in the Lac La Biche area (Crampton1995), one of 18 bats captured at Elk Island National Park (Holroyd 1983), and four of 443 bats captured in central Alberta (Pybus, unpubl. data) were identified as M. septentrionalis. With such scant data, it is not possible to assess any trends in the size of the provincial population. Current information is sufficient to conclude only that the Northern Long-eared Bat appears to be uncommon in Alberta, and absent from the prairie regions.

LIMITING FACTORS

1. Climate - In general, bat distributions and abundance in Canada tend to be limited by climate and availability of suitable roost sites (van Zyll de Jong 1985). Overlying this trend is a pattern of decreased diversity and abundance of bats with increasing latitude north of the equator. As such, in the northern temperate regions of Canada, the number of bat species and individuals is relatively low. The most northerly distribution tends to coincide with the limit of mean annual growing season of 120 days; that is, the period during which the mean daily temperature remains above 6°C (van Zyll de Jong 1985). This appears to reflect the minimum time needed for female bats to produce young and have them successfully grow and develop to the stage where they can survive hibernation. Thus climate may be the ultimate limiting factor on the northern distribution of Northern Long-eared Bats.

Similarly, the size of the population of Northern Long-eared Bats in the northern portion of their range (i.e., in Alberta) also will be limited by geography and latitude. Estimates of population are further hampered by the fact that the species is a forest-dwelling bat that is difficult to find. Due to its scarcity and inconspicuous nature, little is known about the specific habitat requirements of the Northern Long-eared Bat in Alberta and it is difficult to make an accurate assessment of factors which specifically limit population size or distribution. However, the most critical times are during hibernation and summer, particularly for adult females and juveniles (Tuttle and Stevenson 1982).

2. Hibernacula - The availability of suitable hibernacula may be a limiting factor in Northern Long-eared Bat populations. Abandoned mines or natural caves may be in short supply over much of the species' range in northern Alberta. In addition, environmental limitations that govern successful hibernation make many mines and caves unsuitable (Anonymous 1996). When the number of hibernacula is low, bat populations are disproportionately clumped at a time when they are most vulnerable. This increases the risk that catastrophic impact may seriously reduce the population.

Hibernating bats are particularly sensitive to disturbance. They have limited stored energy

supplies and have no opportunity to replace energy expended during the winter. In order to conserve energy, Northern Long-eared Bats, like many bat species, are true hibernators. That is, they enter a state of torpor where their internal body temperature approaches freezing, their breathing and heart rate are significantly slowed, and all unnecessary movement is avoided. Bats will however arouse from torpor to seek water, move to another location if environmental conditions become unsuitable (for example, if the hibernaculum become to warm or too cold), or if they are physically disturbed. Most often this latter disturbance is related to human activity within the hibernaculum.

Each time a bat arouses from torpor, it uses significant energy supplies to warm its body temperature and increase its metabolic rate. For example, Little Brown Bats use an average of 108 mg of fat (the equivalent of 68 days of torpor) each time they arouse (Thomas et al. 1990), and arousals generally account for 80 to 90% of the energy expenditure in hibernating animals during the winter. Thus, if bats repeatedly arouse during the winter, they may expend all their energies and die. Hibernating bats are more sensitive to human presence than previously supposed. Thomas (1995) documented arousal and flight of hibernating bats within 30 minutes of humans entering a hibernaculum of Little Brown and Northern Long-eared Bats. The disturbing stimulus appeared to be the mere presence of humans and their associated lights and sounds. At no time did any of the humans touch or closely approach the hibernating bats. Further, the disturbance continued for up to seven or eight hours after the humans had left the cave. This implies that aroused bats may have been disturbing torpid bats, resulting in other bats arousing. Thus the original disturbance by humans is magnified among the hibernating bats.

The effects of disturbance are somewhat mitigated by differing levels of individual sensitivity. Not all bats arouse each time there is a disturbance. Regardless, human activity within a hibernaculum should be kept to a minimum. In some cases it may be desirable to prevent unnecessary disturbance by sealing the entrance to a hibernaculum. Barred gates may be used to allow entry only to bats and authorized humans or to limit access to times when bats are not at risk (for example, summer). However, there are some inherent problems with this approach. Unfortunately, restricting entry has the potential to result in vandalism and persecution of bats using the cave. Similarly, recreational users of caves may not agree with the restricted access. The whole picture of use of the cave, vulnerability of the bats, frequency of disturbance, and potential impacts of arousal needs to be evaluated clearly before using restricted access as a management tool.

In addition to disturbance within the hibernaculum, the abundance of the Northern Long-eared Bat may be limited by closing or otherwise altering old mines or caves which are essential for hibernation. Although there are no records of closures of known bat hibernacula in Alberta, such situations have occurred elsewhere (Taylor 1995, 1996, Tuttle 1996). Furthermore, our lack of knowledge regarding the hibernation sites of the Northern Long-eared Bat in Alberta could lead to unintentional disturbance or destruction of hibernacula. Changes to the internal environment within a hibernaculum also may result in its abandonment by the bats.

In addition to providing critical winter habitat, hibernacula also are important as sites of swarming in many bat species. This is a critical period and the only time when

large numbers of male and female bats occur in the same place at the same time. In Alberta, swarming of Myotis spp. at Cadomin Cave occurs in late August and early September (Schowalter 1980). Although a few Northern Long-eared Bats were caught, it is not known if Cadomin Cave is a primary swarming site for this species. However, the 10 individuals caught is the most Northern Long-eared Bats reported at one time in Alberta.

Many bats that swarm at a site do not hibernate there (Fenton 1983). Thus protection of swarming sites is particularly important and has implications beyond the population that uses the specific hibernaculum. Alteration of the site or disturbance of the bats during swarming should be kept to a minimum.

3. Summer Roosts **-** The requirements for summer roosts can be very specific for female bats and not all partially-dead trees are suitable for roosting (Barclay and Brigham 1996, Crampton 1995, Vonhof and Barclay 1996). In addition, we do not have a clear understanding of the roost tree characteristics specifically preferred by the Northern Long-eared Bat in Alberta. Thus, although the boreal forest covers a vast area, it is difficult to assess either the proportion of forest that can be considered suitable habitat for this species, or the impacts that may result from various resource extraction activities (such as forestry). Research in British Columbia suggests that old growth forest stands are the preferred habitat of the Northern Long-eared Bat (Caceres, unpubl. data). It is vital to know if this is also the case in Alberta.

STATUS DESIGNATIONS

1. Alberta **-** In 1991, the status of the Northern Long-eared Bat was listed as "Undetermined" because of the lack of information on the biology and population trends of this species (Alberta Fish and Wildlife 1991). However, in 1996, the species was moved to the "Blue List" of species which may be at risk in the province (Alberta Wildlife Management Division 1996). This change in status was based on the relative rarity of the species in the province, and on its apparent reliance on mature trees for roosting.

Although the provincial colour lists offer no legal protection for wildlife species, hibernacula of the Northern Long-eared Bat, and all other bats in Alberta, are afforded protection from disturbance between September 1 and April 30 under Section 38 (1) of the Alberta Wildlife Act.

As a group, bats are identified in the Wildlife Act (1986) as "non-licence" species. This designation means that bats can be hunted or harvested without a permit. However, it is not legal to possess live bats in Alberta (Section 3, Captive Wildlife Regulation, Alberta Wildlife Act) due to the concern for public safety.

2. Other Areas **-** The Committee on the Status of Endangered Wildlife in Canada does not consider the Northern Long-eared Bat to be at risk (COSEWIC 1996). However, given its broad range and relatively abundant populations, the species appears to be secure in eastern portions of the country. On the contrary, the status of M. septentrionalis in the western provinces is unique. The Northern Long-eared Bat is on the "Red List" (candidates for legal designation as threatened or endangered) in British Columbia (Stevens 1995). This designation was assigned because of the very few occurrence records and limited information regarding its population status in the province. The province currently is

undertaking various programs to improve the knowledge of this, and other, bat species in British Columbia.

Information regarding Northern Long-eared Bats in Saskatchewan is limited to a few site records of individual bats (van Zyll de Jong 1985). There are no programs underway to assess the status or population size in the province.

RECENT MANAGEMENT IN ALBERTA

No management or research activities specifically focused on Northern Long-eared Bats have taken place in Alberta.

SYNTHESIS

An accurate assessment of the status of a species requires an understanding of its basic biology, including population size and trends over time. For the Northern Long-eared Bat, we have some basic information concerning its life history and habitat preferences and can make limited inferences from knowledge of closely related species to fill in some information gaps. However, there are no good census data on which to predict population size or trends. There has been only limited investigation of M. septentrionalis in Alberta. Current knowledge suggests only that the species occurs at low densities across a broad area of northern Alberta, and that it apparently prefers mature forest stands for roosting and foraging during the summer. Caves appear to be the preferred hibernacula. Clearly, more information is required before the status of the Northern Long-eared Bat in Alberta can be accurately determined.

An appropriate first step towards gaining a better understanding of the Northern Long-eared Bat in Alberta would be to initiate extensive, summer trapping and detailed echolocation surveys at various locations within the province. These surveys should be accompanied by intensive research programs, including radiotelemetry studies, which would allow identification of roost sites and a quantitative assessment of the habitat requirements and preferences of this species. Such information would also clarify potential factors which might limit the abundance and distribution of the Northern Long-eared Bat in the province.

A systematic evaluation of all sources of information relating to potential and actual hibernacula and swarming sites should be undertaken. This would consist of two components: a review of previous records and anecdotal references as well as collection of new data. The former should include contact with the Alberta Speleological Society, local natural history clubs, and Alberta Natural Resources Service. The latter is best done in August and early September, before winter torpor occurs (so as to minimize the disturbance of hibernating bats). Methods of protecting cave and mine habitats, and minimizing human activity in known hibernacula also should be evaluated.

The current programs of public awareness and education regarding bats in general should be continued and improved. The provincial network of local nature centres is an excellent source of information and promotion of bats. On a broader scale, the Provincial Museum of Alberta hosted "Masters of the Night" in 1994/95. This "bat-friendly" program exposed approximately 79,000 people, 40 to 50% of which were elementary school students, to a wealth of knowledge and experiences with bats. Further to this, the Grade Two curriculum in Alberta currently includes a unit on bats and encourages a positive attitudes towards the group. Bats are recognized as an integral part of the fauna of Alberta. As a result, thousands of young children are introduced to the positive, friendly, and important aspects of bat biology. The Bat Conservation Society of Canada (a small local group primarily in Calgary) should be encouraged to continue promoting awareness and knowledge of bats in the province. Bat Conservation International in Austin, Texas, promotes

international awareness of all bat species. A general acceptance and recognition of the role of bats as an essential component of natural ecosystems around the world may be the most important and valuable tool we have for conserving and managing bat populations.

LITERATURE CITED

Alberta Fish and Wildlife. 1985. A policy for the management of threatened wildlife in Alberta. Alberta Fish and Wildlife Division, Edmonton, AB. 34 pp.

Alberta Fish and Wildlife Division. 1991. The status of Alberta wildlife. Alberta Forestry, Lands and Wildlife. Edmonton, AB. 49 pp.

Alberta Wildlife Management Division. 1996. The status of Alberta wildlife. Alberta Environmental Protection, Natural Resources Service. Edmonton, AB. 44 pp.

Anonymous. 1996. Protection program for bat hibernacula in Quebec. Ministere de l Environment et de la Faune, Quebec, PQ. 23 pp.

COSEWIC. 1996. Canadian species at risk. Committee on the Status of Endangered Species in Canada, Ottawa, ON. 18 pp.

Barbour, R. W., and W. H. Davis. 1969. Bats of America. The University Press of Kentucky, Lexington, KY. 286 pp.

Barclay, R. M. R. and R. M. Brigham (eds.). 1996. Bats and forests symposium. Research Branch, B. C. Ministry of Forests, Victoria, B. C. Working Paper 23/1996. 292 pp.

Barclay, R. M. R. 1991. Population structure of temperate zone insectivorous bats in relation to foraging behaviour and energy demand. J. Anim. Ecol. 60: 165-178.

Beer, J. R., and A. G. Richards. 1956. Hibernation of the Big Brown Bat. J. Mammal. 37: 31-41.

Brandon, R. A. 1961. Observations of young Keen Bats. J. Mammal. 42: 400-401.

Caire, W., R. K. LaVal, M. L. LaVal, and R. Clawson. 1979. Notes on the ecology of Myotis keenii (Chiroptera, Vespertilionidae) in Eastern Missouri. Am. Midl. Nat. 102: 404-407.

Clark, B. S., J. B. Bowles, and B. K. Clark. 1987. Summer occurrence of the Indiana Bat, Keen s Myotis, Evening Bat, Silver-haired Bat and Eastern Pipistrelle in Iowa. Proc. Iowa Acad. Sci. 94: 89-93.

Crampton, L. 1995. Habitat selection by bats and the potential impacts of forest fragmentation on bat populations in aspen mixedwood forests in northern Alberta. M.Sc. thesis. University of Calgary, Calgary, AB. 114 pp.

Dobbyn, J. 1994. Atlas of the mammals of Ontario. Federation of Ontario Naturalists, Don Mills, ON. 120 pp.

Faure, P. A., J. H. Fullard, and J. W. Dawson. 1993. The gleaning attacks of the Northern Long-eared Bat, Myotis septentrionalis, are relatively inaudible to moths. J. Exp. Biol. 178: 173-189.

Fenton, M. B. 1983. Just Bats. University of Toronto Press. Toronto, ON. 165 pp.

Fenton, M. B. 1990. The foraging behaviour and ecology of animal-eating bats. Can. J. Zool. 68: 411-422.

Fenton, M. B., and G. P. Bell. 1979. Echolocation and feeding behaviour in four species of Myotis (Chiroptera). Can. J. Zool. 57: 1271-1277.

Fitch J. H., and K. A. Shump Jr. 1979. Myotis keenii. Mammalian Species 121:1-3.

Griffin, D. R. 1940. Notes on the life histories of New England cave bats. J. Mammal. 21: 181-187.

Godin, A. J. 1977. Wild mammals of New England. Johns Hopkins University Press, Baltimore, MD. 304 pp.

Grindal, S. D., T. S. Collard, R. M. Brigham, and R. M. R. Barclay. 1992. The influence of precipitation on reproduction by Myotis bats in British Columbia. Am. Midl. Nat. 128: 339-344.

Hamilton, W. J., and J. O. Whitaker. 1979. Mammals of the eastern United States, 2nd ed. Cornell University Press, Ithaca, NY. 346 pp.

Hitchcock, H. B. 1949. Hibernation of bats in southeastern Ontario and adjacent Quebec. Can. Field-Nat. 63: 47-59.

Holroyd, G. L. 1983. A brief survey of the bats of Elk Island National Park. Blue Jay 41: 217-222.

Kurta, A. 1995.Mammals of the Great Lakes region, revised edn. University of Michigan Press, Ann Arbor, MI. 376 pp.

Knox Jones, J., D. M. Armstrong, R. S. Hoffmann, and C. Jones. 1983. Mammals of the northern Great Plains. University of Nebraska Press, Lincoln, NE. 379 pp.

Mills, R. S. 1971. A concentration of Myotis keenii at caves in Ohio. J. Mammal. 52: 625.

Mumford, R. E., and J. B. Cope. 1964. Distribution and status of the Chiroptera of Indiana. Am. Midl. Nat. 72: 473-489.

Nagorsen, D. W., and R. M. Brigham. 1993. Bats of British Columbia: Royal British Columbia museum handbook. University of British Columbia Press, Vancouver, BC. 164 pp.

Nagorsen D. W., and S. V. Nash. 1984. Distributional records of bats from the James Bay region. Can. Field-Nat. 98: 500-502.

National Research Council. 1995. Science and the Endangered Species Act. National Academy Press, Washington, DC. 271 pp.

Pybus, M. J. 1986a. Bats of Alberta. Alberta Fish and Wildlife, Edmonton, AB. 16 pp.

Pybus, M. J. 1986b. Rabies in insectivorous bats of western Canada, 1979 to 1983. J. Wildl. Dis. 22: 307-313.

Racey, P. A. 1982. Ecology of bat reproduction. Pp 57-103 in Ecology of Bats (T. H. Kunz, ed.). Smithsonian Institution Press, Washington, DC. 425 pp.

Rice, D. W. 1955 . Myotis keenii in Florida. J. Mammal. 36: 567.

Rosatte, R. C. 1987. Bat rabies in Canada: history, epidemiology, and prevention. Can. Vet. J. 28: 754-756.

Sasse, D. B., and P. J. Pekins. 1996. Summer roosting ecology of Northern Long-Eared Bats (Myotis septentrionalis) in the White Mountain National Forest. Pp. 91-101 in Bats and forests symposium (R. M. R. Barclay and R. M. Brigham, eds.).

B. C. Ministry of Forests Working Paper 23/1996, Victoria, BC. 292 pp.

Schowalter, D. B. 1979. Notes on the distribution of bats in Alberta and Saskatchewan. Blue Jay 37: 179-187.

Schowalter, D. B. 1980. Swarming, reproduction and early hibernation of Myotis lucifugus and M. volans in Alberta, Canada. J. Mammal. 61:350-354.

Smith, H. C. 1993. Alberta mammals, an atlas and guide. Provincial Museum of Alberta, Edmonton, AB. 238 pp.

Stevens, V. 1995. Wildlife diversity in British Columbia: distribution and habitat use of amphibians, reptiles, birds, and mammals in biogeoclimatic zones. Research Branch, B.C. Ministry of Forests., Wildlife Branch, B.C. Ministry of Environment, Lands and Parks, Working Paper 04/1995, Victoria, BC. 288 pp.

Swanson, G., and C. Evans. 1936. The hibernation of certain bats in southern Minnesota. J. Mammal. 17: 39-43.

Taylor, D. 1996. Protecting bats in mines. Bats 14: 8-9.

Taylor, D. A. R. 1995. North American bats and mines project makes major progress. Bats 13: 3-4.

Taylor, L. R . 1963. Temperature and insect flight. J. Anim. Ecol. 32: 99-117.

Thomas, D. W. 1993. Lack of evidence for a biological alarm clock in bats (Myotis spp.) hibernating under natural conditions. Can. J. Zool. 71: 1-3.

Thomas, D. W. 1995. Hibernating bats are sensitive to non-tactile human disturbance. J. Mammal. 76: 940-946.

Thomas, D. W., M. Dorais, and J. M. Bergeron. 1990. Winter energy budgets and cost of arousals for hibernating Little Brown Bats, Myotis lucifugus. J. Mammal. 71: 475-479.

Turner, R. W. 1974. Mammals of the Black Hills of South Dakota and Wyoming. Univ. Kansas Museum Natur. Hist.. Misc. Publ. No. 60. Lawrence, Kansas. 178 pp.

Tuttle, M. 1996. Wisconsin gains key bat sanctuary. Bats 14: 3-7.

Tuttle, M. D., and D. Stevenson. 1982. Growth and survival of bats. Pp. 105-150 in Ecology of Bats (T.H. Kunz ed.). Smithsonian Institution Press, Washington, DC. 425 pp.

van Zyll de Jong, C. G. 1979. Distribution and systematic relationships of long-eared Myotis in western Canada. Can. J. Zool. 57:987-994.

van Zyll de Jong, C.G. 1985. Handbook of Canadian mammals 2: Bats. National Museums of Canada, Ottawa, ON. 212 pp.

van Zyll de Jong, C. G., M. B. Fenton, and J. G. Woods. 1980. Occurrence of Myotis californicus at Revelstoke and a second record of Myotis lucifugus for British Columbia. Can. Field-Nat. 94: 455-456.

Vonhof, M. J., and R. M. R. Barclay. 1996. Roost-site selection and roosting ecology of forest-dwelling bats in southern British Columbia. Can. J. Zool. 74: 1797-1805.

Whitaker, J. O., and L. J. Rissler. 1993. Do bats feed in winter? Am. Midl. Nat. 129: 200-203.

Wrigley, R. E. 1974. Mammals of the sandhills of southwestern Manitoba. Can. Field-Nat. 88: 21-39.

APPENDIX 1. Definitions of selected legal and protective designations.

A. Status of Alberta Wildlife colour lists (after Alberta Wildlife Management Division 1996)

Red	Current knowledge suggests that these species are at risk. These species have declined, or are in immediate danger of declining, to nonviable population size
Blue	Current knowledge suggests that these species may be at risk. These species have undergone non-cyclical declines in population or habitat, or reductions in provincial distribution
Yellow	Species that are not currently at risk, but may require special management to address concerns related to naturally low populations, limited provincial distributions, or demographic/life history features that make them vulnerable to human-related changes in the environment
Green	Species not considered to be at risk. Populations are stable and key habitats are generally secure
Undetermined	Species not known to be at risk, but insufficient information is available to determine status

B. Alberta Wildlife Act

Species designated as "endangered" under the Alberta Wildlife Act include those defined as "endangered" or "threatened" by *A Policy for the Management of Threatened Wildlife in Alberta* (Alberta Fish and Wildlife 1985):

Endangered	A species whose present existence in Alberta is in danger of extinction within the next decade
Threatened	A species that is likely to become endangered if the factors causing its vulnerability are not reversed

C. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 1996)

Extirpated	A species no longer existing in the wild in Canada, but occurring elsewhere
Endangered	A species facing imminent extirpation or extinction
Threatened	A species likely to become endangered if limiting factors are not reversed
Vulnerable	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events
Not at Risk	A species that has been evaluated and found to be not at risk
Indeterminate	A species for which there is insufficient scientific information to support status designation

D. United States Endangered Species Act (after National Research Council 1995)

Endangered	Any species which is in danger of extinction throughout all or a significant portion of its range
Threatened	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range

APPENDIX 2. Site locations of the Northern Long-eared Bat in Alberta. Map numbers refer to points in Figure 1.

MAP #	LOCATION	DATE	SOURCE/ MUSEUM NUMBER	LATITUDE/ LONGITUDE
1	Cadomin Cave	1976	H. Smith (pers. comm.) / Banded	53^{0}00' N / 117^{0}20' W
1	Cadomin	20 Sep 1977	PMA / Z77.62.5	53^{0}00' N / 117^{0}23' W
1	Cadomin Cave	17 Aug 1978	PMA / Z78.83.5, Z78.83.6	53^{0}00' N / 117^{0}20' W
1	Cadomin Cave	22 Aug 1978	PMA / Z78.84.1	53^{0}00' N / 117^{0}20' W
1	Cadomin Cave	31 Aug 1978	PMA / Z78.88.1, Z78.88.2	53^{0}00' N / 117^{0}20' W
1	Cadomin Cave	Sep 1978	H. Smith (pers. comm.) / 2 Capture/Release	53^{0}00' N / 117^{0}20' W
1	Cadomin Cave	Sep 1978	H. Smith (pers. comm.) / Banded: 4 bats	53^{0}00' N / 117^{0}20' W
1	Cadomin Cave	31 Jul 1979	PMA / Z79.110.1, Z79.110.2	53^{0}00' N / 117^{0}20' W
1	Cadomin Cave	10 Aug 1979	PMA / Z79.116.1,Z79.116.2, Z79.116.3, Z79.116.4, Z79.116.5, Z79.116.6, Z79.116.7, Z79.116.8	53^{0}00' N / 117^{0}20' W
1	Cadomin Cave	Aug 1979	H. Smith (pers. comm.) / Banded: 3 bats	53^{0}00' N / 117^{0}20' W
1	Cadomin Cave	09 Sep 1979	M. Pybus (pers. comm.) / Banded	53^{0}00' N / 117^{0}20' W
2	Hinton	01 Sep 1990	M. Pybus (pers. comm.) / Banded	53^{0}40' N / 117^{0}60' W
3	Edson	11 Aug 1980	PMA / 83.23.9	53^{0}35' N / 116^{0}26' W
3	Edson	09 Aug 1991	M. Pybus (pers. comm.) / Banded: 2 bats	53^{0}35' N / 116^{0}26' W
3	Edson	14 Aug 1991	M. Pybus (pers. comm.) / Banded	53^{0}35' N / 116^{0}26' W
4	Edson area	N/A	UA / UA field No. 160	53^{0}35' N / 116^{0}25' W
5	Whitecourt	02 Jun 1981	PMA / 83.23.8	54^{0}90' N / 115^{0}41' W
6	Drayton Valley	12 Sep 1980	PMA / Z81.20.1	53^{0}13' N / 114^{0}59' W
7	Spruce Grove	01 Sep 1976	PMA / Z76.101.1	53^{0}33' N / 113^{0}54' W
8	Edmonton	03 Aug 1976	PMA / Z76.123.1	53^{0}32' N / 113^{0}32' W
8	Edmonton	01 Jun 1978	PMA / Z78.69.1	53^{0}32' N / 113^{0}38' W
8	Edmonton	04 Jun 1979	PMA / Z79.87.1	53^{0}33' N / 113^{0}38' W
8	Edmonton	19 Aug 1981	PMA / 83.23.7	53^{0}33' N / 113^{0}28' W
9	Elk Island National Park	29 Jul 1983	Holroyd (1983) / Capture/Release	53^{0}50' N / 112^{0}80' W
10	Lac La Biche area	1993	Crampton (1995) / Capture/Release	54^{0}80' N / 111^{0}80' W
11	Fort Mackay area	08 Jul 1983	PMA / 83.22.1	57^{0}10' N / 111^{0}37' W
12	Peace River	23 Aug 1977	PMA / Z77.144.1	56^{0}13'N / 117^{0}16' W
13	Grande Prairie	16 May 1978	PMA / Z78.123.1	55^{0}10' N / 118^{0}48' W
14	Spirit River	08 Sep 1981	PMA / 83.23.6	55^{0}47' N / 118^{0}50' W
15	High Level	23 Oct 1975	PMA / Z75.106.1	58^{0}31' N / 117^{0}05' W
16	Wood Buffalo National Park	08 May 1978	PMA / Z78.49.2	59^{0}47' N / 112^{0}19' W
16	Wood Buffalo National Park	N/A	NMC / 43405	59^{0}40' N / 112^{0}19' W

[1] PMA = Provincial Museum of Alberta; UA = University of Alberta Museum of Zoology; NMC = National Museum of Canada; UA and NMC data taken from van Zyll de Jong (1979).