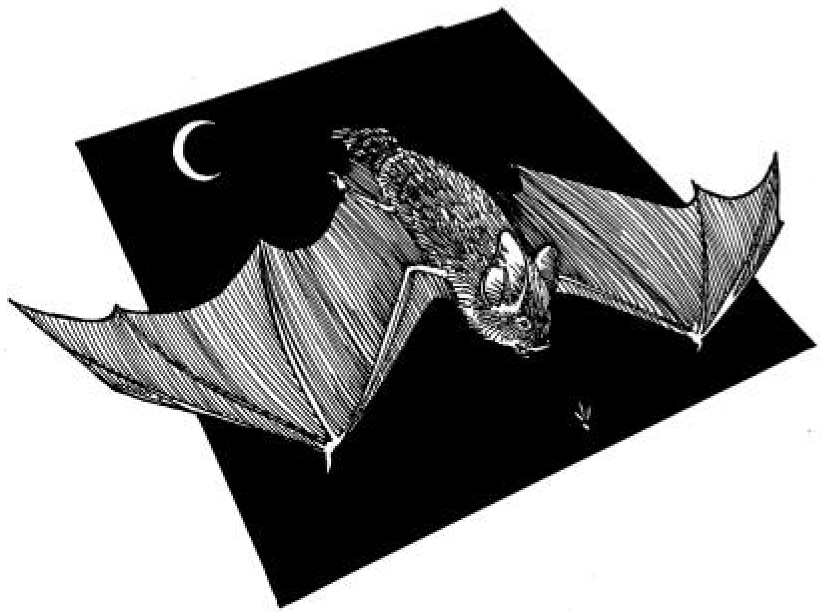
Fisheries & Wildlife Management Division

RESOURCE STATUS AND ASSESSMENT BRANCH

Survey of the Bats of Central and Northwestern Alberta



Alberta Species at Risk Report No. 4

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

Survey of the Bats of Central and Northwestern Alberta

Maarten J. Vonhof
and
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This project was completed when the Fisheries and Wildlife Management Division was part of Alberta Environment; this division is now part of Alberta Sustainable Resource Development.

EXECUTIVE SUMMARY

Previous bat studies conducted in Alberta have been limited in geographical scope, and no long-term, province-wide, standardized monitoring has ever been conducted. A standard protocol for surveying bats in Alberta (Vonhof 2000) was recently developed, with the goal of ensuring that all studies on bats in the province collect the same types of information in standard formats. Here we report the results of a study with the dual purpose of surveying bats in central and northwestern Alberta, while at the same time performing a field test of the newly-developed protocols. The specific objectives were to 1) initiate baseline bat surveys in central and northwestern Alberta to identify species' occurrences, possible range extensions, and forest habitat associations, 2) evaluate the standard protocols and provide recommendations as to their effectiveness, 3) increase public awareness of and interest in bats in Alberta, and 4) provide future directions for bat research in Alberta.

Surveys were conducted at six study areas in central and northwestern Alberta: Edmonton, Rainbow Lake, Sousa Creek, Caribou River, Wabasca River and Lesser Slave Lake. These six study areas encompassed six natural subregions, including dry, wet, and central mixedwood, boreal highlands, lower foothills and central parkland. Sampling of bats followed the standard protocols outlined in Vonhof (2000). Bats were captured using mistnets placed directly over the surface of water bodies or perpendicular to forest edges along cutlines and roadways, depending on the characteristics of the netting site. Captured individuals were identified to species, sexed, and aged as adults or juveniles (young of the year). In addition, bat detectors were used at most netting sites to quantify the number of passes and feeding buzzes made by three species groups: *Myotis* spp., larger-bodied bats (*Eptesicus fuscus* and *Lasionycteris noctivagans*) and hoary bats (*Lasiurus cinereus*).

Mistnetting took place on 36 nights for a total of 141 hours, or a total of 494.6 net-hours. In total, 86 adult and 19 juvenile bats were captured (2.9 bats per night or 0.21 bats per net-hour): 43 adults in the Edmonton area, and 43 adults and 19 juveniles in northwestern Alberta. Four species of bats were captured during surveys in central and northwestern Alberta: big brown (*Eptesicus fuscus*), silver-haired (*Lasionycteris noctivagans*), little brown (*Myotis lucifugus*), and northern long-eared (*M. septentrionalis*) bats. Little brown bats accounted for the greatest proportion of adult captures, with 73% (n = 63) of captures, followed by northern long-eared (n=17), big brown (n=4), and silver-haired (n=2) bats. No bats were captured in the Caribou River study area. Of the remaining study areas, adult male and female little brown bats were captured in all but the Rainbow Lake area, while northern long-eared bats were captured in all areas with the exception of Lesser Slave Lake. Two male and one female big brown bat were captured at Sousa Creek, while a single female was captured at Wabasca River. Adult silver-haired bats were only captured in the Edmonton area, with two females captured at a single study site (Moss Lake) in Elk Island National Park.

At every study area where females were captured at least some of those females were reproductive. The only non-parous adult females captured during the survey were a single northern long-eared bat captured at Sousa Creek and 10 little brown bats captured at Wabasca River (n = 4), Lesser Slave Lake (n = 2) and in the Edmonton area (n = 4). Juvenile bats of three species (little brown, n=14; northern long-eared, n=1; and silver-haired, n=4) were captured in

the Wabasca River and Lesser Slave Lake areas. The only study area where no reproductive females or juveniles of any species were captured was Rainbow Lake.

Myotis spp. bats were detected within all study areas surveyed, and exhibited higher levels of activity than the other two categories of bats at all study areas, with the exception of Sousa Creek. Big brown/silver-haired bats were detected in all but the Rainbow Lake study area, while hoary bats were only detected at the Lesser Slave Lake study area.

Prior to this study, only a few, scattered records were available for these four bat species in northern Alberta. The captures presented in this study significantly extend our knowledge of the distribution of these species in Alberta. Range extensions in the northwest portion of the province were observed for little brown, northern long-eared, and big brown bats, and gaps in the distribution were filled for all species. For big brown bats in particular, the captures at Sousa Creek and Wabasca River were major range extensions for this species. The results of this and other recent studies highlight the poor state of our knowledge of bats in Alberta, and the fact that with even small amounts of effort we can significantly increase our understanding of the species' occurrences and the range limits of bats in the province. Our knowledge of the distribution, summer and winter habitat requirements, movements and population trends of all species of bats in Alberta is extremely limited. These information gaps suggest the need for more research, and call into question the potential listing of any bat species in Alberta as *Secure*. Although the northern long-eared bat was relatively common in the areas surveyed, the results of this study do not support a change in status from *May Be At Risk* in Alberta, as a relatively small number of areas were surveyed, and we still know little of their habitat requirements, their relative abundance in different areas, and how they are being affected by anthropogenic disturbance.

1.0 INTRODUCTION

Alberta is home to 9 of the 20 species of bats found in Canada (van Zyll de Jong 1985). As the only major night-time predators of insects, including both agricultural and forest pest species, bats fill an important niche. Furthermore, bat populations number in the millions, if not tens of millions, outnumbering most other types of mammals, with the exception of rodents. Bats are found in all of the province's diverse range of landforms and habitat types, from the prairies to the mountains to the boreal forest, and across this range of ecosystems exhibit a wide range of habitat associations, behaviours, as well as roosting and foraging strategies. Several species reach the northern extent of their range within Alberta, and their peripheral distribution may have important implications for their biology and conservation. Thus, the nine bat species in Alberta are an important component of the province's biodiversity, and worthy of both further study and conservation efforts. However, anthropogenic disturbance in the form of oil and gas, forestry, and agricultural development currently affects habitats used by bats across the province. A first step towards a better understanding of this group of species is establishing their distribution and status, especially in parts of the province where little work has been done.

Bats have been the subject of relatively few studies in Alberta, and consequently our knowledge of them lags behind that of other more conspicuous mammals. The studies that have taken place have largely occurred in the southern half of the province, and little effort has been focussed on bats in the boreal forests of northern Alberta. As a result, little is known about basic aspects of bat biology such as their distribution within the province, the timing and nature of reproduction, the requirements and mechanisms for overwintering, and the use and selection of critical habitats. Studies on their distribution, relative abundance, and foraging and roosting habitat requirements are urgently needed.

Eight species of bats occur regularly in Alberta. Of these, the northern long-eared bat, *Myotis septentrionalis*, has the general status of *May Be At Risk*, the western small-footed bat, *M. ciliolabrum*, is considered *Sensitive*, and the long-legged bat, *M. volans*, is considered *Status Undetermined* (Alberta Sustainable Resource Development *In prep*). Previous bat studies conducted in Alberta have been limited in geographical scope, and no long-term, province-wide, standardized monitoring has been conducted. The distribution of bats in the northern part of the province is virtually unknown, with few records available (Smith 1993). Recent bat surveys in northern British Columbia have greatly expanded the known range of some species (Wilkinson *et al*. 1995, Bradbury *et al*. 1997, Vonhof and Wilkinson 1999), and similar findings may also occur in Alberta.

A standard protocol for surveying bats in Alberta (Vonhof 2000) was recently developed, with the goal of ensuring that all studies on bats in the province collect the same types of information in standard formats. In turn, this will promote centralized tracking of bat studies in the province to identify information gaps, facilitate monitoring of bat distributions and population trends using a centralized database, promote information-sharing between projects, and enable between-project and between-year comparisons. Here we report the results of a study with the dual purpose of surveying bats in central and northwestern Alberta, while at the same time performing a field test of the newly-developed protocols. The specific objectives were to 1) initiate baseline bat surveys in central and northwestern Alberta to identify species' occurrences, possible range extensions, and forest habitat associations, 2) evaluate the standard protocols and provide recommendations as to their effectiveness 3) increase public awareness of and interest in bats in Alberta, and 4) provide future directions for bat research in Alberta.

2.0 STUDY AREAS

Surveys were conducted at six study areas in central and northwestern Alberta (Table 1, Figure 1). These six study areas encompassed six natural subregions, including dry, wet, and central mixedwood, boreal highlands, lower foothills, and central parkland (Appendix 1). The Edmonton study area was surveyed in late June/early July and once in late August. This area included mainly sites in Elk Island National Park and the Cooking Lake – Blackfoot Recreation Area to the east of the city, in the dry mixedwood subregion (Figure 2). Three additional sites located west and northwest of Edmonton were also visited (Figure 2), two of which were in the central parkland subregion, and one of which occurred in the dry mixedwood subregion. The other five study areas were located in northwestern Alberta, and were surveyed in succession as part of a circuit in July and early August. The Rainbow Lake (Figure 3) and Sousa Creek (Figure 4) areas were situated in the wet mixedwood natural subregion, and the Caribou River area was situated in the dry mixedwood subregion (Figure 5). The Wabasca River area was situated in the central mixedwood natural subregion, but one study site (WR-e) sat on the border between the central mixedwood and boreal highlands subregions (Figure 6). The Lesser Slave Lake area was located at the junction between three natural subregions (Figure 7). One study site (SL-a) was located at the boundary between the central mixedwood and lower foothills subregions, while the other (SL-b) was located in the dry mixedwood natural subregion (Figure 7).

Table 1. Study areas surveyed for bats during 2000. The dates surveyed, the number of nights in which sampling took place and the number of study sites visited are indicated.

Study Area	Dates Surveyed	No. of Nights Sampled	No. of Study Sites Visited
Edmonton Area	20 June – 3 July, 13 July, 23 August	12	10
Rainbow Lake	12 July – 16 July	4	4
Sousa Creek	17 July – 22 July	6	5
Caribou River	23 July – 24 July	2	2
Wabasca River	25 July – 31 July	7	6
Lesser Slave Lake	3 August – 6 August, 17 August	5	2

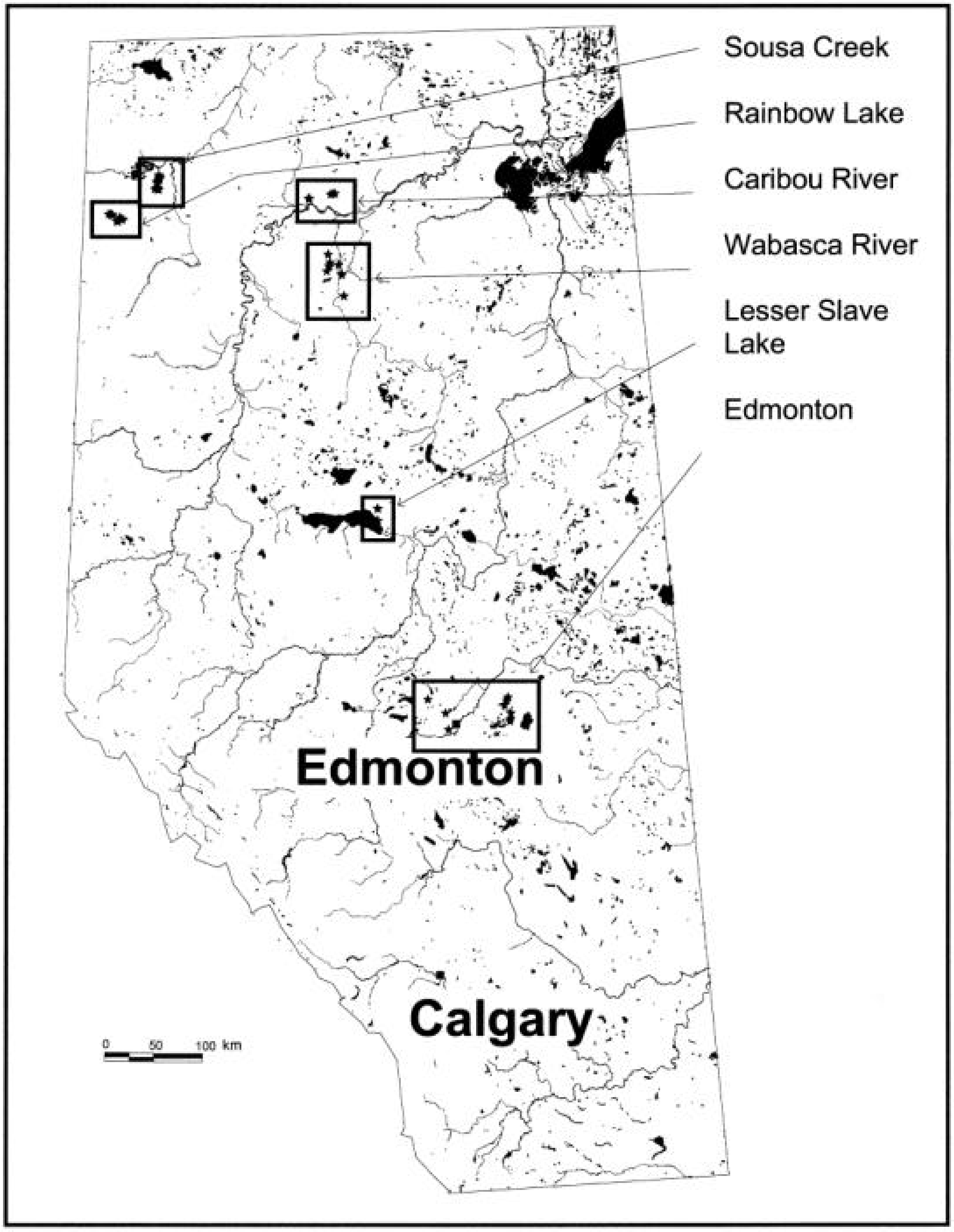

Fig. 1 Locations of study areas sampled for bats in central and northwestern Alberta during 2000.

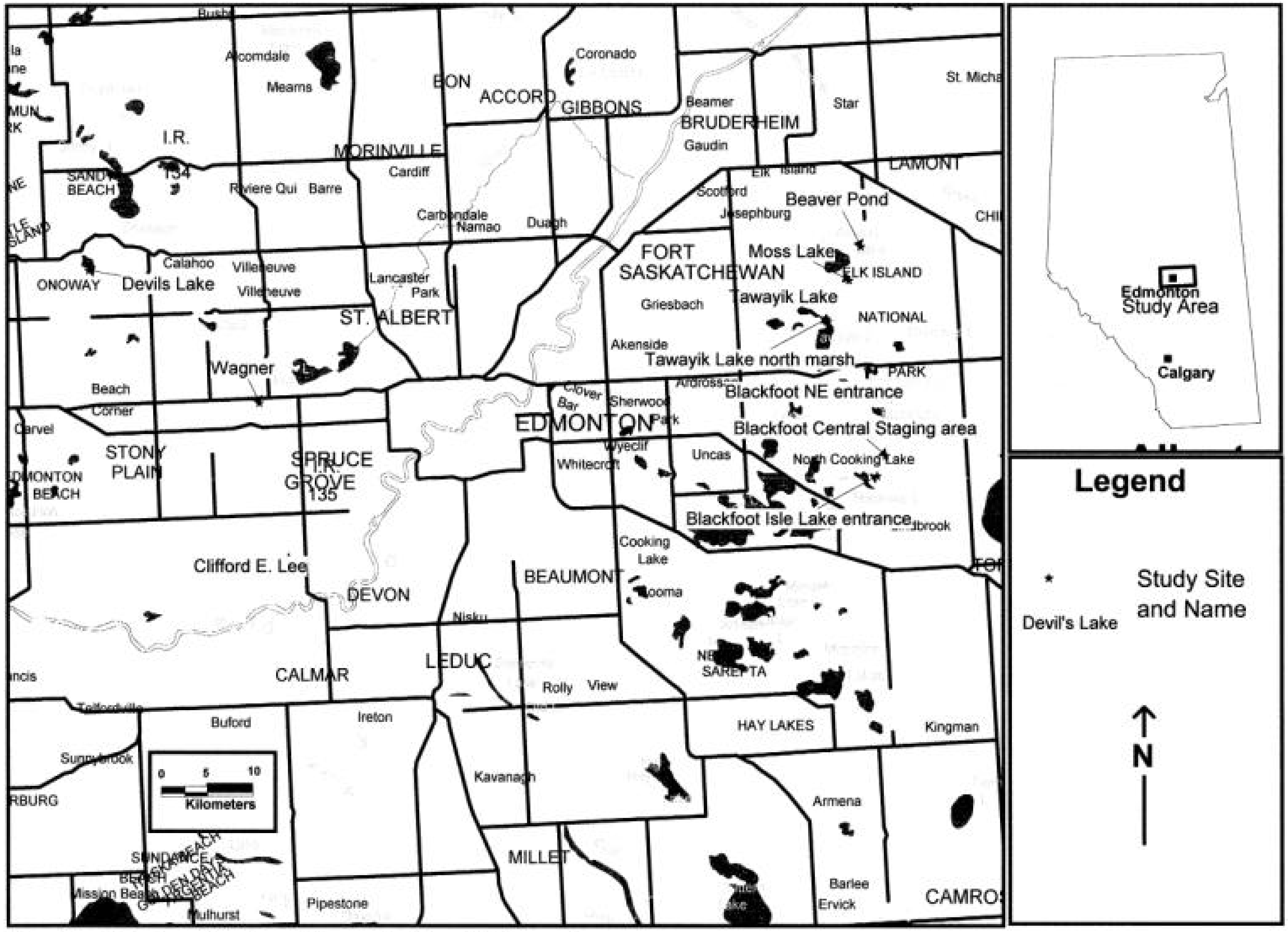

Fig. 2. Study site locations in the Edmonton area.

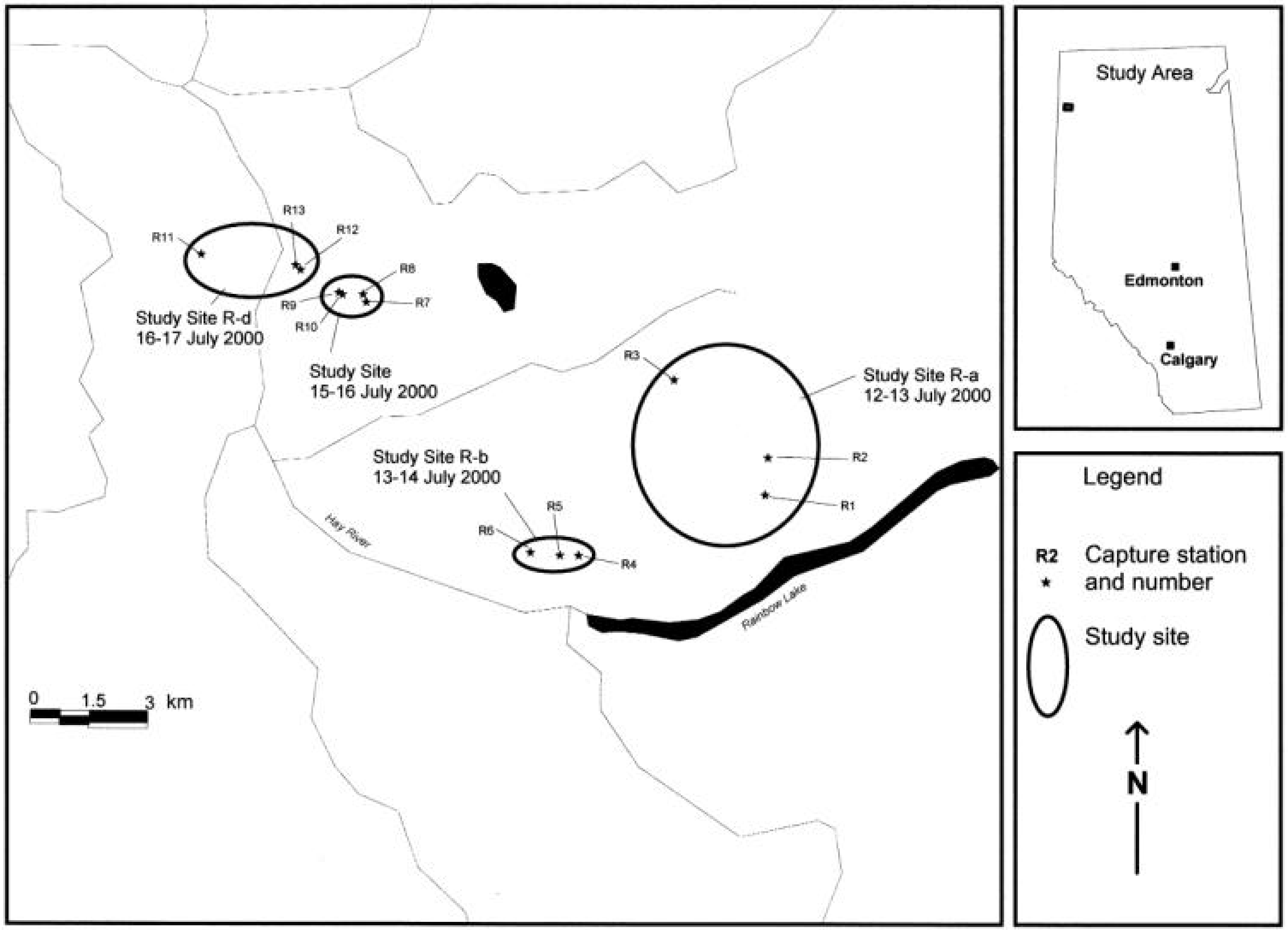

Fig. 3. Study site and capture station locations in the Rainbow Lake study area.

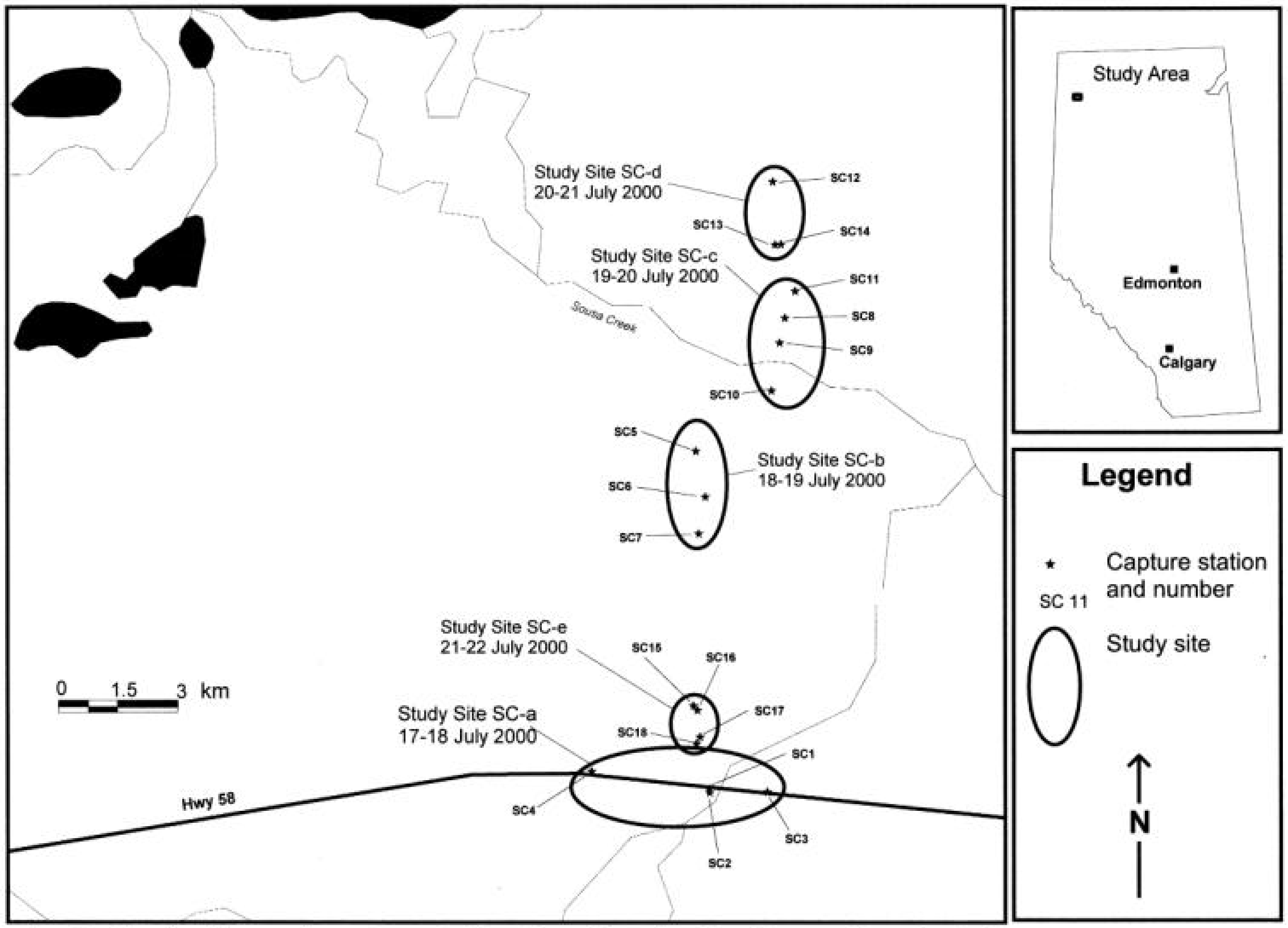

Fig. 4. Study site and capture station locations in the Sousa Creek study area.

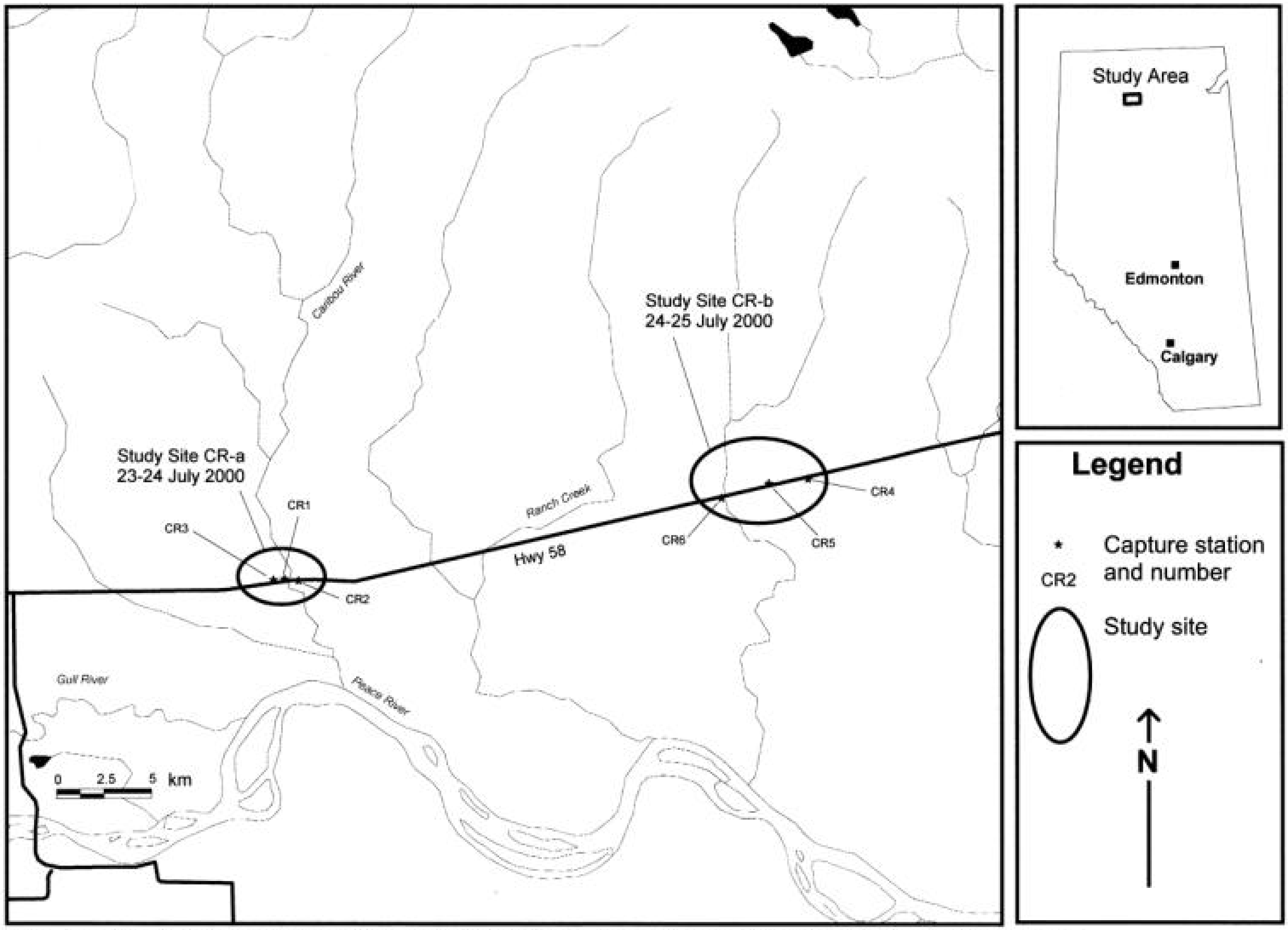

Fig. 5. Study site and capture station locations in the Caribou River study site.

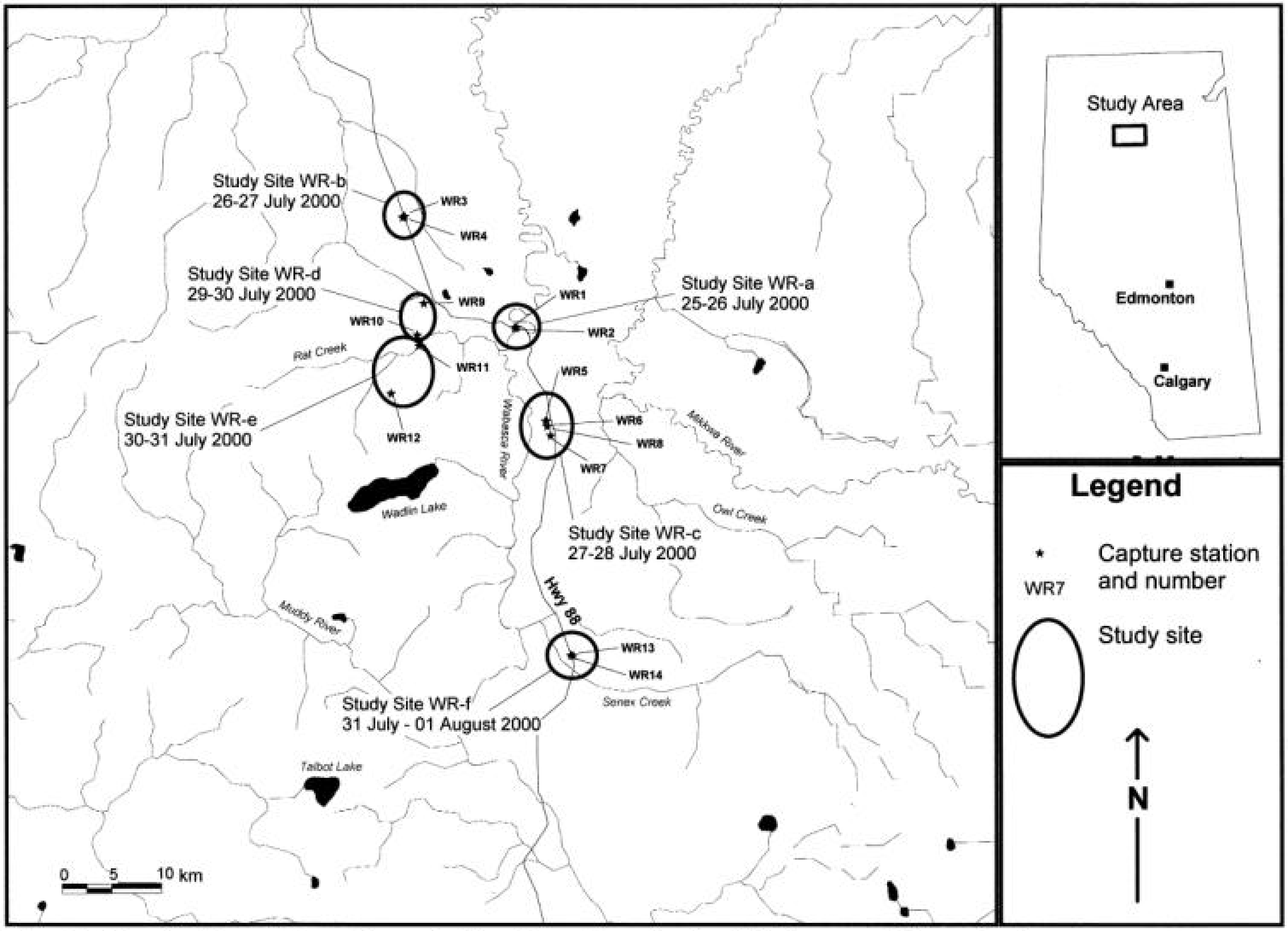

Fig. 6. Study site and capture station locations in the Wabasca River study area.

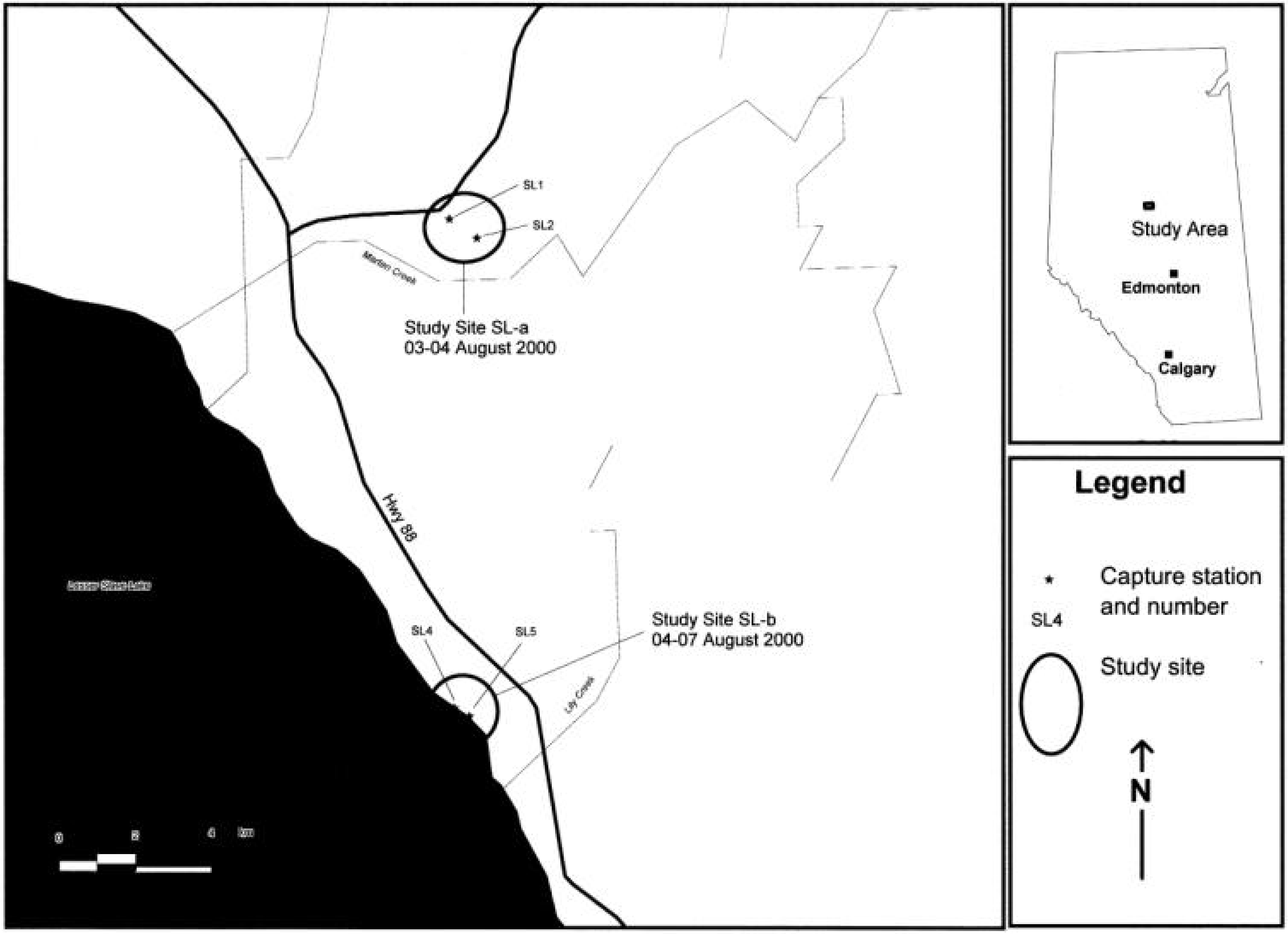

Fig. 7. Study site and capture station locations in the Lesser Slave Lake study area.

3.0 METHODS

3.1 Bat Captures

Within each study area, a number of study sites – locations where bats were sampled on a given night – were established. Study sites were selected based on the presence of suitable habitat, including marshes, small ponds, clearings, cutlines, trails and overgrown roads. Cutlines proved to be the most successful netting sites in all areas and preference was given to netting these areas. Sampling of bats followed the protocols outlined in Vonhof (2000). At each study site 3-7 mistnets (mean 4.9) ranging in length from 6 to 12 m were set. A mean of 41.2 m of nets was erected on a given night. Mistnets were placed directly over the surface of water bodies or perpendicular to forest edges along cutlines and roadways, depending on the characteristics of the netting site.

Captured bats were held in cloth bags for a minimum of one hour before taking measurements, to ensure clearing of the digestive tract. Individuals were identified to species, sexed, and aged as adults or juveniles (young of the year) based on the degree of ossification of the metacarpal-phalange joints (Racey 1974). Mass and forearm length were measured and reproductive condition (Racey 1974) was assessed for all captured individuals (see Appendix 2 for all bat capture data). All data were recorded on standard data sheets accompanying the protocol and entered into the Biodiversity Species Observation Database (BSOD) of Alberta Fisheries and Wildlife.

3.2 Bat Detectors

An Ultrasound Advice Mini bat detector was used at most netting sites to quantify the number of passes (an individual bat emitting a series of echolocation pulses) and feeding buzzes (a series of echolocation calls that increase in intensity and repetition rate characteristic of an attempt to catch an insect; Fenton 1982). The operator switched back and forth between 20kHz, 30 kHz, and 50kHz at 10 minute intervals, keeping the interval consistent within a night. Sampling with a bat detector was generally continuous through the sampling period, unless a number of bats were captured in mistnets or it began to rain. Species groups were distinguished on the basis of the characteristic frequencies of their echolocation calls as in Vonhof (2000): *Myotis* spp. have calls which reach 50 kHz, larger-bodied bats (*Eptesicus fuscus* and *Lasionycteris noctivagans*) have calls that sweep down to 30kHz, and hoary bats (*Lasiurus cinereus*) have calls which sweep down to 20kHz, and have a slow repetition rate. At the Lesser Slave Lake study area a Pettersson D280 bat detector was used in combination with the Mini detector. No detection data are provided from the Edmonton study area, due to equipment problems. Because detection is the primary means of determining the presence of hoary bats in Alberta (Vonhof 2000), detectors were operated at 20 kHz for longer periods of time (mean ± SD: 30.0 ± 15.5 min) than they were at the other two frequencies (17.6 ± 5.82 min for both 30 and 50 kHz) at any given site on a particular night.

4.0 RESULTS

4.1 Sampling Effort and Bats Captured

Mistnetting took place on 36 nights for a total of 141 hours, or a total of 494.6 net-hours (a single 12 m net set up for one hour equals one net-hour). Nets were up for an average of 4.0 hours (range 1.25 – 6) per night.

In total, 86 adult and 19 juvenile bats were captured (2.9 bats per night or 0.21 bats per net-hour): 43 adults in the Edmonton area, and 43 adults and 19 juveniles in northwestern Alberta. Capture data on each individual bat are summarized in Appendix 2.

4.2 Species Captured

Four species of bats were captured during surveys in central and northwestern Alberta: big brown (*Eptesicus fuscus*), silver-haired (*Lasionycteris noctivagans*), little brown (*Myotis lucifugus*), and northern long-eared (*M. septentrionalis*) bats. Little brown bats accounted for the greatest proportion of adult captures, with 73% (n = 63) of captures, followed by northern long-eared (n=17), big brown (n=4), and silver-haired (n=2) bats (Figure 8).

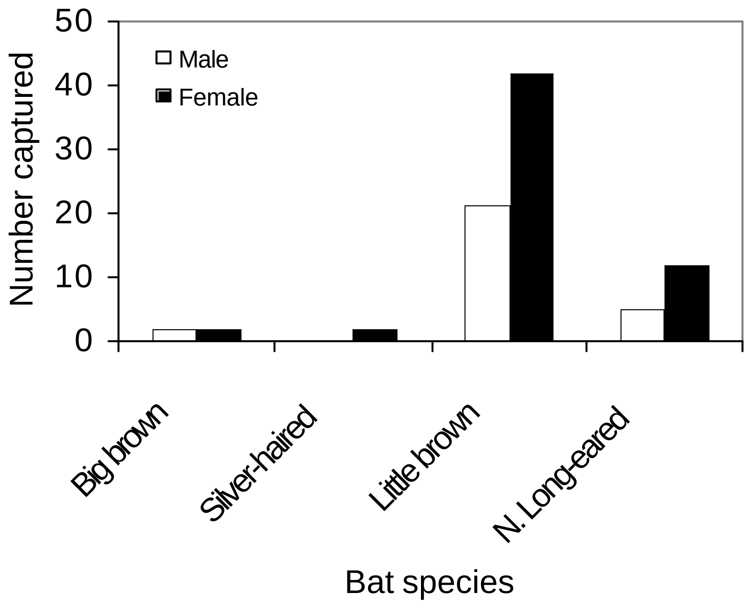

Figure 8. The total number of female and male adult bats of each of four bat species captured in central and northwestern Alberta in 2000.

4.3 Locations of Bat Captures

No bats were captured in the Caribou River study area (Figure 9). Of the remaining study areas, adult male and female little brown bats were captured in all but the Rainbow Lake area, where no little brown bats were captured (Figure 10). Northern long-eared bats were captured at all areas with the exception of Lesser Slave Lake (Figure 11). Only male northern long-eared bats were captured at Rainbow Lake, while only females were captured at Wabasca River. Both male and female northern long-eared bats were captured at Sousa Creek and the Edmonton area. Two male and one female big brown bat were captured at Sousa Creek, while a single female was captured at Wabasca River (Figure 12). Adult silver-haired bats were only captured in the Edmonton area (Figure 13), with two females captured at a single study site (Moss Lake) in Elk Island National Park.

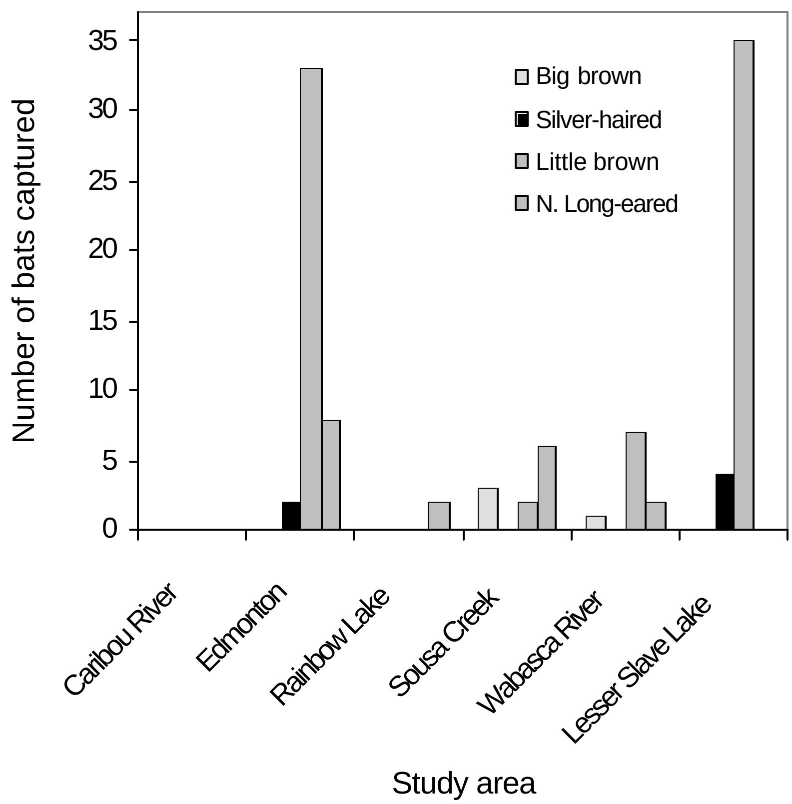

Figure 9. The total number of adult bats of each of four species captured at the six study areas in central and northwestern Alberta in 2000.

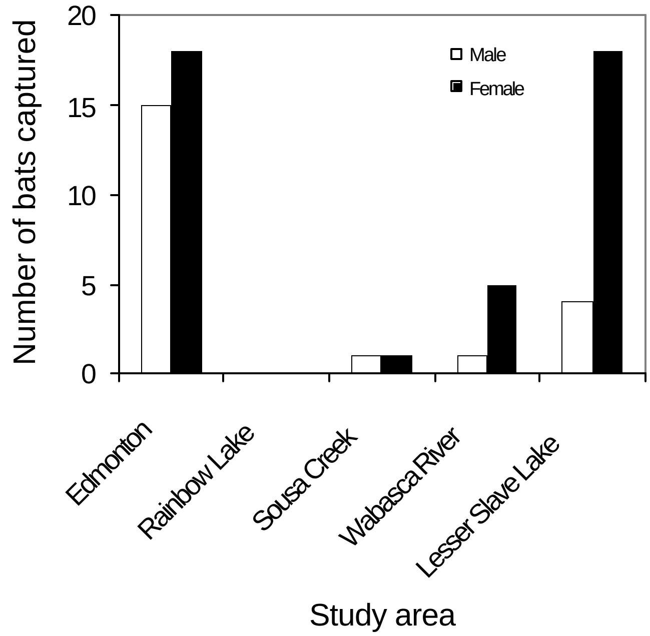

Figure 10. The total number of adult male and female little brown bat bats captured at each of the study areas in central and northwestern Alberta in 2000.

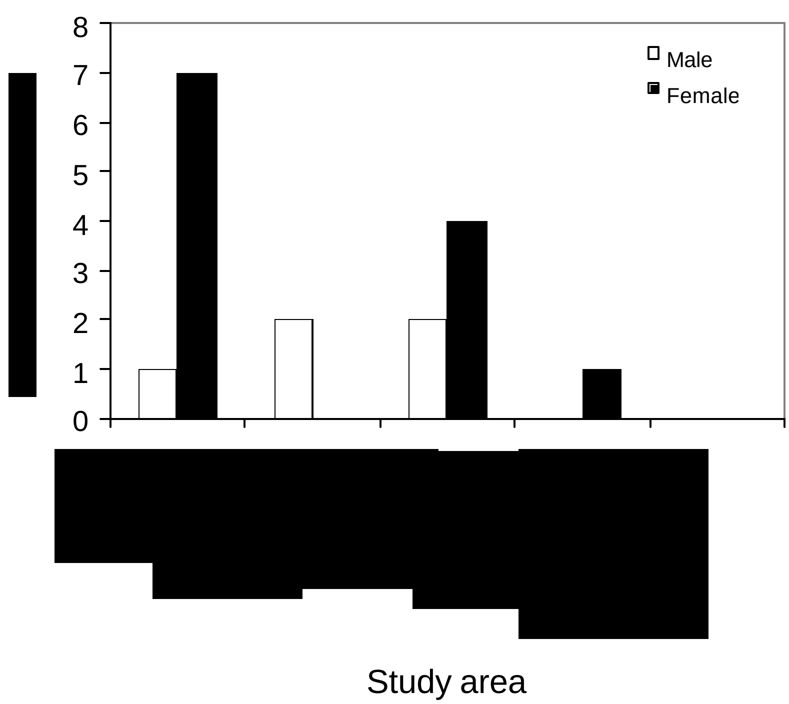

Figure 11. The total number of adult male and female northern long-eared bats captured at each of the study areas in central and northwestern Alberta in 2000.

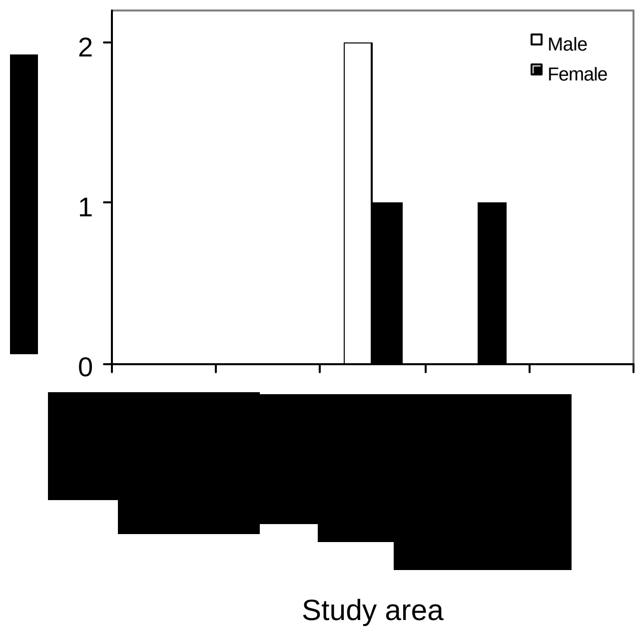

Figure 12. The total number of adult male and female big brown bats captured at each of the study areas in central and northwestern Alberta in 2000.

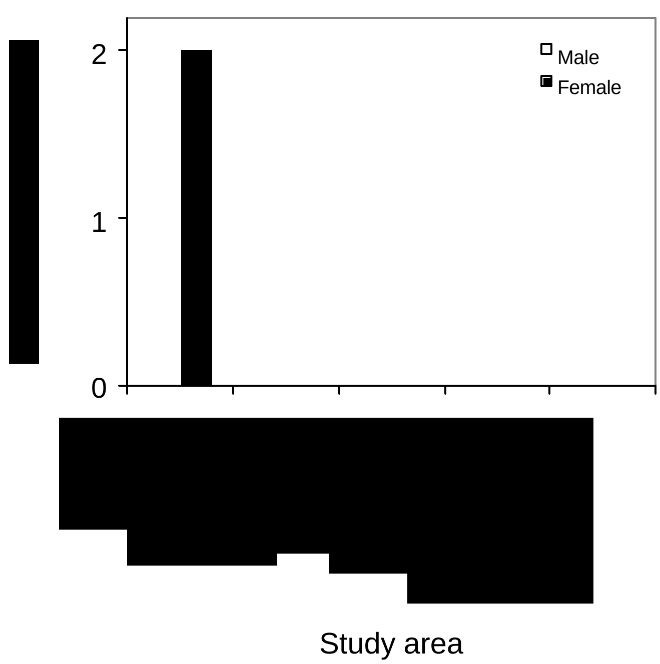

Figure 13. The total number of adult male and female silver-haired bats captured at each of the study areas in central and northwestern Alberta in 2000.

At every study area where females were captured, at least some of those females were reproductive (pregnant, lactating, or post-lactating; Figure 14). All silver-haired and big brown bat females were reproductive. The two silver-haired bats captured in Elk Island National Park were pregnant and post-lactating. The two female big brown bats were lactating and post-lactating. Pregnant female little brown bats were only captured in the Edmonton area, while lactating females were captured in the Edmonton, Sousa Creek, and Lesser Slave Lake study areas. Post-lactating little brown bats were captured in the Edmonton, Wabasca River, and Lesser Slave Lake areas. Pregnant and lactating northern long-eared bats were captured in the Edmonton and Sousa Creek areas, and lactating females were captured in the Wabasca River area. The only non-parous adult females captured during the survey were a single northern long-eared bat captured at Sousa Creek and 10 little brown bats captured at Wabasca River (n = 4), Lesser Slave Lake (n = 2) and the Edmonton area (n = 4). Juvenile bats of three species were captured (Figure 15). Male and female silver-haired bat juveniles were captured at Lesser Slave Lake, while a single female juvenile northern long-eared bat was captured at Wabasca River. Juvenile little brown bats of both sexes were captured at Lesser Slave Lake, and a single juvenile male was captured at Wabasca River. The only study area where no reproductive females or juveniles of any species were captured was Rainbow Lake.

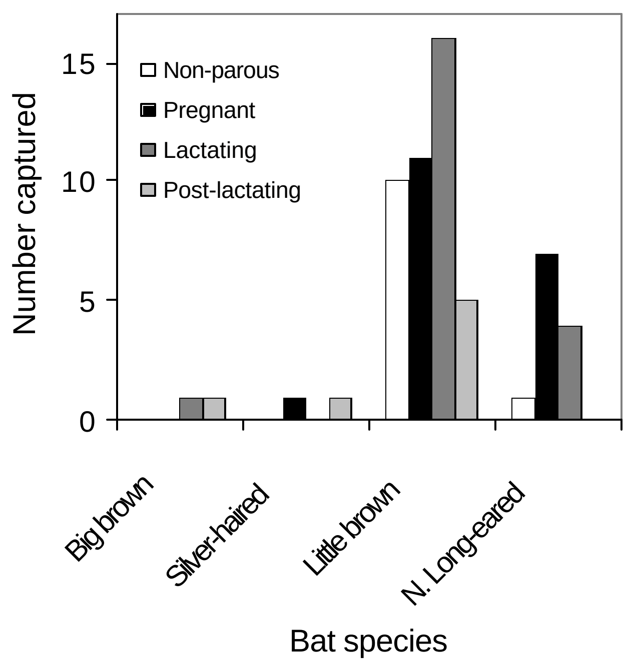

Figure 14. The number of adult females of each bat species captured in central and northwestern Alberta in 2000, indicating reproductive condition.

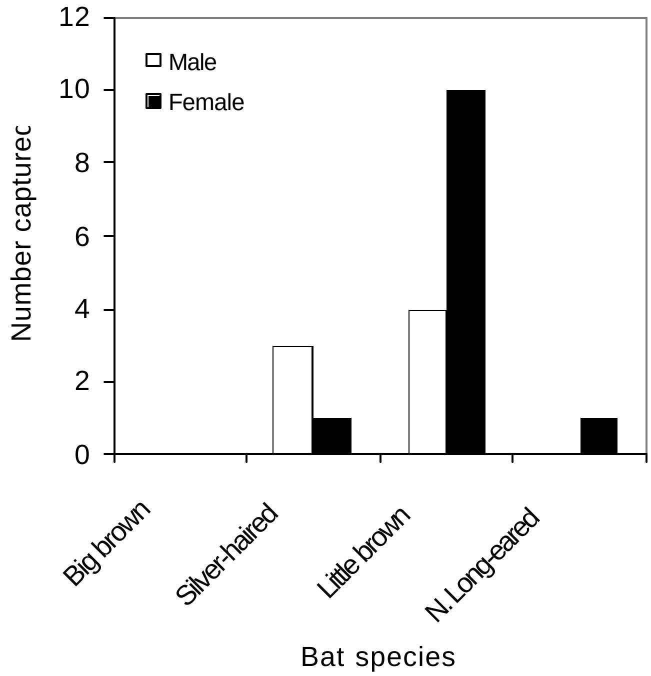

Figure 15. The total number of juvenile bats of each of the four bat species captured in central and northwestern Alberta in 2000.

4.4 Exposed Diurnal Roosts

Buildings in the Lesser Slave Lake town-site were examined for the presence of day-roosting bats on 5 days (1-4 August and 18 August), following Riskin and Pybus (1998). A total of 9 adult (5 female, 4 male) and 4 juvenile (3 female, 1 male) little brown bats were captured roosting on the sides of buildings. No adult females showed signs of reproduction. Bats were usually located beneath overhangs or awnings and were tucked into corners.

4.5 Bat Detection

Myotis spp. bats were detected within all study areas surveyed (Figure 16), and exhibited higher levels of activity than the other two categories of bats at all study areas with the exception of Sousa Creek, where higher big brown/silver-haired bat activity was recorded (Figure 17). Big brown/silver-haired bats were detected in all but the Rainbow Lake study area (Figure 17), while hoary bats were only detected at the Lesser Slave Lake study area (Figure 18).

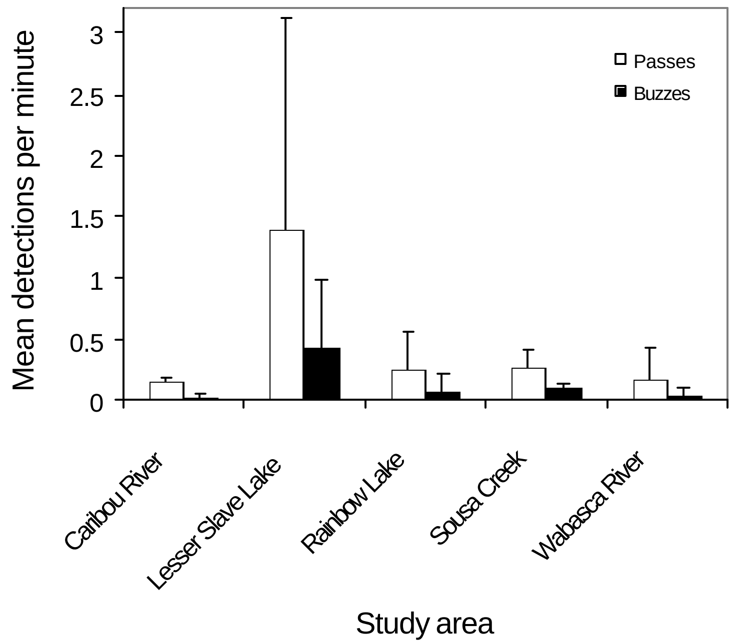

Figure 16. The number of bat passes and feeding buzzes made by *Myotis* spp. bats detected in each of the study areas in central and northwestern Alberta in 2000.

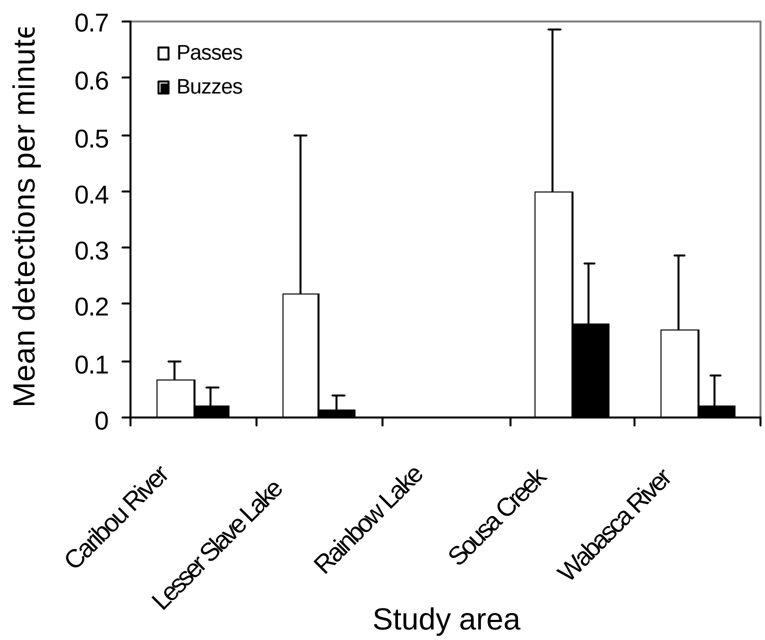

Figure 17. The number of bat passes and feeding buzzes made by big brown/silver-haired bats detected in each of the study areas in central and northwestern Alberta in 2000.

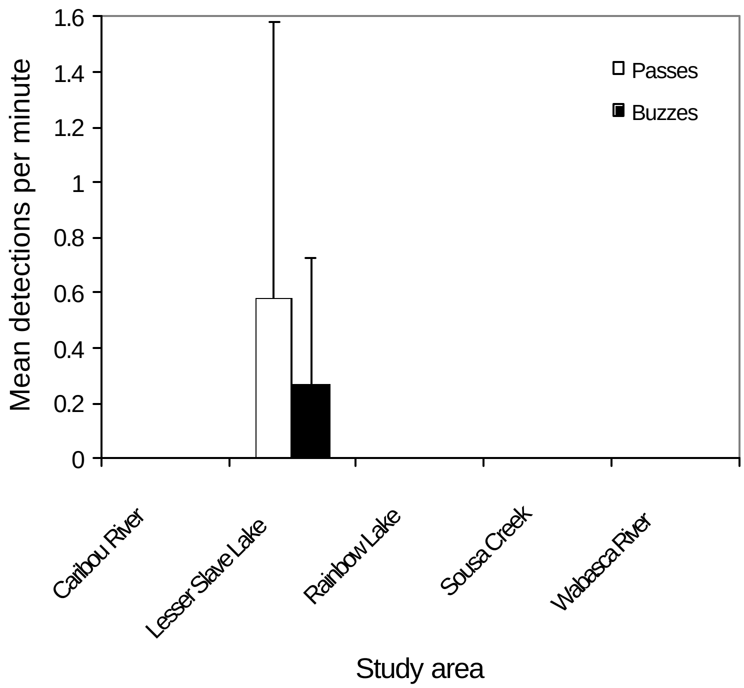

Figure 18. The number of bat passes and feeding buzzes made by hoary bats detected in each of the study areas in central and northwestern Alberta in 2000.

4.6 Public Education

Every effort was made to inform the public about bats and this study. Thirty-two people received in-depth demonstrations of the techniques used to study bats, and explanations of the biology of bats. Another 12 people received brief explanations of the study and its objectives, and had questions about bats answered. In addition, two sessions (13 July and 23 August) were held for interested Alberta Fisheries and Wildlife staff in Elk Island National Park to provide training in the important aspects of the biology of bats as it relates to habitat management, and the techniques used to study bats in the field. Maarten Vonhof and Dan Riskin were interviewed in depth on the A-Channel's Big Breakfast Show on 29 June about the biology of bats and the surveys conducted this summer.

5.0 DISCUSSION

According to the locations of captures and extrapolated distributions presented in Smith (1993), the bat captures presented in this study significantly extend our knowledge of the distribution in Alberta of all four bat species. Little brown bats had previously been captured in the eastern portion of Wood Buffalo National Park to the east, and in the Peace River region to the south. Although this species was thought to be distributed throughout the province, the captures in the Sousa Creek and Fort Vermilion areas fill in a large gap in its projected distribution. The distribution of northern long-eared bats in northern Alberta is based on scattered records from

Wood Buffalo National Park, Fort McMurray, High Level and Peace River. The capture of this species in both the Rainbow Lake and Sousa Creek study areas fills in the distribution in the extreme northwest of the province, while the captures in the Wabasca River area fill in the north central portion. No records are presented for the Edmonton area in Smith (1993), and yet this species was relatively common in Elk Island National Park. The capture of silver-haired bats at Lesser Slave Lake represents a minor extension of the known distribution, while the captures of big brown bats at Sousa Creek and Wabasca River are major range extensions for this species. Aside from two records in Wood Buffalo National Park, all other previous records of big brown bats are from south of the Athabasca River.

Other studies in 2000 in other areas of the province have also resulted in range extensions. For example, in only seven nights of mistnetting, L. Wilkinson (pers. comm.) captured the same four species captured in this study as well as an adult male western long-eared bat (*M. evotis*) south of Grande Prairie. None of these species had ever been captured in this part of the province, and for western long-eared bats the capture represented a significant northward range extension. Similarly, C. Wright and L. Hollis (pers. comm.) captured large numbers of the western small-footed bat (*M. ciliolabrum*) in the Red Deer River and South Saskatchewan River valleys near Bindloss, Alberta. Western small-footed bats are considered to be rare in Alberta, and yet at this site, representing the eastern edge of the range of this species in Alberta, it was the most common species captured.

The results of all of these studies highlight the poor state of our knowledge of bats in Alberta, and the fact that with even small amounts of effort we can significantly increase our understanding of the species' occurrences and the range limits of bats in the province. The survey work presented here was a preliminary effort, and focussed briefly on a small number of widely spread areas. A general finding of studies on bats is that a large amount of effort is required to determine the presence of rare species (reviewed in Voss and Emmons 1996). It is likely that future work in the same areas will still result in information gains and the capture of additional species. Both western long-eared and long-legged (*M. volans*) bats were captured in the boreal mixedwood forest north of Fort Nelson in northeastern British Columbia (Vonhof and Wilkinson 1999), and therefore are likely to occur further to the north in the boreal forest than their current known range in Alberta. Similarly, big brown bats were captured at only a few sites in extreme northern Alberta (Sousa Creek and Wabasca River areas [this study], eastern Wood Buffalo National Park in Smith [1993]), and their distribution is still unclear. This species most likely occurs in other areas between the Athabasca River (Smith 1993) and the sites further north, and may still be captured further north with additional effort. Coverage of different areas and different natural subregions in northwestern Alberta was incomplete in 2000, and future work should endeavor to include these other areas and natural subregions. Furthermore, there are still many other regions of the province where our knowledge of bat species' presence is still poor, including the northeastern corner of the province in particular, as well as many sites in southeastern and southwestern Alberta.

The northern long-eared bat has the general status of *May Be At Risk* in Alberta (Alberta Sustainable Resource Development *In prep*). However, the results of this study suggest that, at least in the areas surveyed, this species is relatively common. It was the only species captured at Rainbow Lake, and the second most commonly captured species in the Edmonton and Wabasca

River study areas. In recent survey work in northern British Columbia, northern long-eared bats were found to be more common than previously expected (Wilkinson *et al*. 1995, Vonhof and Wilkinson 1999), and their status was subsequently changed from red- to blue-listed. However, these studies demonstrated the selection of mature trembling aspen and balsam poplar trees as roost-sites in the boreal mixedwood forest, and trees of this type are heavily utilized by the forestry industry. The results of this study do not support a change in status in Alberta, as a relatively small number of areas were surveyed, and we still know little of bat species' requirements, their relative abundance in different areas, and how they are being affected by anthropogenic disturbance.

The state of our knowledge of bats in Alberta is extremely poor. As mentioned above, with even small amounts of effort we are making large leaps in our knowledge of species' occurrences and range boundaries. Only one systematic survey of summer roosting habitat for forest-dwelling bats has ever been undertaken (Crampton and Barclay 1998), in spite of massive resource exploration and extraction in the boreal forest. Our knowledge of over-wintering requirements is similarly lacking, with only four known hibernacula identified (M. Pybus, pers. comm.), and no indication of migratory routes used by hoary or silver-haired bats. Although our general impression is that certain species, such as little brown and big brown bats, are abundant, we simply do not know if populations of any bat species in Alberta are stable, increasing, or decreasing. We have no records of roost locations or estimates of roost densities, and currently have no accurate means of determining population sizes for any bat species. Furthermore, the majority of bat species are dependent at least in part on wildlife trees in forested ecosystems, which are under intensive industrial pressure. These information gaps indicate a need for more research, and call into question the potential listing of any bat species in Alberta as *Secure*.

The capture of reproductive female or juvenile big brown, little brown, and northern long-eared bats at the Sousa Creek and Wabasca River study areas in extreme northern Alberta was worthy of note. Lower ambient temperatures may result in lower roost temperatures, and gestation length in pregnant females is negatively related to roost temperature (Racey 1973, Racey and Swift 1981). Furthermore, lower seasonal temperatures result in decreased numbers of reproductive females and numbers of young successfully fledged (Grindal *et al*. 1992, Lewis 1993). Clearly, these bats have behavioural and thermoregulatory adaptations to deal with the colder temperatures and shorter night lengths at these latitudes. The selection of suitable roost-sites may be extremely important for reproductive female bats at these latitudes (Vonhof and Wilkinson 1999), and the protection of suitable habitat is critical for maintaining populations of these species in the northern portions of the province. Males, on the other hand, may roost in cooler areas where they can reduce thermoregulatory costs by entering torpor (Hamilton and Barclay 1994), and are able to take advantage of cooler habitats (Barclay 1991). However, we observed no evidence of sexual segregation between males and females, as has been observed between populations of western long-eared bats in valleys versus mountains in the Kananaskis region (Barclay 1991).

The hoary bat is a fast-flying species that tends to fly in open habitats or above the canopy (Shump and Shump 1982). While it is possible to catch this species in more arid regions where standing or slow-moving water is limited, in the northern part of the province where standing water is abundant it is much more difficult to capture. Ultrasonic detection is therefore the primary means of determining the presence of hoary bats in Alberta (Vonhof 2000). Not unexpectedly, no hoary bats were captured during this study, but this species was detected at one study area (Lesser Slave Lake). Activity levels for hoary bats were higher than for silver-haired/big brown bats in this area, and the detection rate was the second highest for any species group in any study area. However, the detection of hoary bats at Lesser Slave Lake coincided with the use of a new bat detector, and it was subsequently determined that the original bat detector used at all of the other study areas in northwestern Alberta was not functioning properly at 20 kHz. Thus, we cannot determine whether hoary bats were present at any of the other sites and were simply not detected, and these sites should be re-sampled in the future to ascertain their use by this bat species.

The detection of hoary bats at the Lesser Slave Lake study area is significant, as this area is used heavily by migratory birds, and the detection of hoary bats in August at this site may indicate that they also migrate through this area. Netting in this area was performed in collaboration with the Avian Monitoring in the Boreal Forest Canopy Project already in place in Lesser Slave Lake Provincial Park (R. Ebel, pers. comm.). This resulted in the highest number of captures of any site, with over 30% of the captures of adult little brown bats for the entire study, as well as the majority of juvenile little brown and the only juvenile silver-haired bats. The canopy project would be ideal for a cooperative effort to monitor both bird and bat populations at a fixed site in the boreal forest. Netting success was clearly increased with the use of nets in the canopy, and furthermore, this site is an excellent location to examine whether migratory pathways of birds and bats intersect. We know virtually nothing about the migratory pathways used by hoary and silver-haired bats in Alberta, and netting at known locations in the spring and fall, as has been done with birds, is the best means to establish these pathways, as well as to examine population trends.

The use of bat detectors while netting is generally not useful for comparing relative bat activity between sites, as different sites are not sampled simultaneously, and it is therefore impossible to control for other factors influencing bat activity, such as environmental conditions (Vonhof 2000). However, bat detectors are useful for determining whether all species groups are being successfully sampled using mistnets, and for detecting the presence of species that are difficult to capture, including hoary, big brown, and silver-haired bats. It is encouraging to note that bats were detected but not captured at only one study area (Caribou River). Furthermore, aside from this one area, wherever *Myotis* spp. and silver-haired/big brown bats were detected using ultrasonic detectors, at least one member of the species group was captured using mistnets.

5.1 Review of Standard Protocols

Although the original idea was to develop the standard protocols in advance and then field test them, in actual fact the development of the protocol took place concurrently with the majority of the field work. Therefore, many of the concerns and potential problems with the protocols were addressed as their preparation proceeded. However, there are several points to highlight about the effectiveness of the protocol:

1. Placing mistnets over standing or slow-moving water is the most efficient means of capturing bats in many areas (Kunz and Kurta 1988, Vonhof 2000). However, in the northern portion of the province standing water is very abundant, and few bats were captured in this situation. In contrast, netting efficiency was the highest using mistnets placed across cutlines, and to a

lesser extent across roadways and small clearings. Future survey work in the northern half of the province should therefore focus mistnetting effort on these types of locations, rather than over water.

2. Increasing the height of mistnets, by linking together mistnet poles or using a canopy netting system, also increased capture efficiency. Stacking mistnets one above the other, in particular, was observed to increase capture success, as bats trying to avoid one mistnet often flew into the other net. Single mistnets at ground level tended to be ineffective, and yet many bats were captured in the bottom of two mistnets stacked together. Increasing the height of mistnets will increase the chances of capturing larger-bodied bat species that tend to fly higher, and indeed, all captures of silver-haired and big brown bats were made using stacked or canopy nets. Rope and pulley systems may be used to raise and lower the mistnets, and are easy to set up and use (Kunz and Kurta 1988, Kunz *et al*. 1996).
3. If bat detectors are used while mistnetting, but are not being used to make comparisons between study sites, habitats, or species groups (where sampling effort must remain constant), then detectors should be set at 20 kHz to detect hoary bats for as long as possible during a sampling session to maximize the chances of detecting this species. Obviously, detectors should be used to detect the other species groups as well, but ultrasonic detection is the primary means to determine the presence of hoary bats in Alberta.
4. A distinct tradeoff exists between the size of the survey area and the number of nights that can be spent at any one study area or study site. For example, the maximum number of nights spent at a particular study area during the circuit in northwestern Alberta was seven days at the Wabasca River area. However, in order to capture rare species a large amount of effort across the season is required, and this was simply not possible for any study area during the survey. Future surveys should either try to minimize the size of the area being surveyed, or ensure that study areas, and possibly particular study sites, are visited more than once during a season, to maximize the chances that all of the bat species in a given area are captured or detected.
5. The protocols and accompanying data sheets ask the user to collect a lot of information, particularly on environmental conditions during the sampling period, and habitat description data for each bat capture or ultrasonic detection station. These data are quite time consuming to collect, and may interfere with other activities, depending on the specific objectives of the project. Until a data management system is in place, and specific objectives for the use of that information developed, the possibility of reducing the quantity of information required should be considered.

6.0 MANAGEMENT IMPLICATIONS AND FUTURE DIRECTIONS

The development of the standard protocols for surveying bats in Alberta was an important first step towards better understanding of species' occurrences and range limits in the province. The results of the first year of surveys presented in this report are encouraging: significant range extensions were observed for three of the four bat species, and reproductive populations were encountered in all but one study area. Furthermore, the newly developed protocols withstood their first field test. Future surveys in the province are likely to yield similarly exciting and useful results. The following are our recommendations for future work on bats in Alberta:

1. Further survey work should be conducted in central and northwestern Alberta. Study sites visited during this survey should be revisited, and new study areas should be established in natural subregions not included in this survey. Increasing the sampling effort in this portion of the province will be the only means to capture or detect the presence of species which are rare or difficult to capture.
2. Surveys should be expanded to other regions of the province where our knowledge of species' presence and range limits is lacking. Very few regions have been adequately sampled, and numerous gaps in our knowledge exist. Priority should possibly be given to northeastern Alberta over other areas, because of the high levels of industrial development in this region.
3. Available locations and data (species, sex, age, etc.) on all bats captured in previous studies on bats in Alberta should be compiled in electronic format (database and/or GIS coverages). This will provide a clear indication of what work has taken place and where, and will facilitate the identification of information gaps and survey priorities. Policies concerning data ownership and distribution must be in place before this process begins.
4. A central database or data storage system should be established to store all data collected on bats in the province. The main goal of the standard protocols is to ensure that all studies collect the same data in standard formats, to promote centralized tracking of bat studies, information sharing between projects, and comparisons of different studies, species, or regions. A centralized database is the best means of ensuring that all of the data are compiled and can be made available to interested parties. The database should be in addition to BSOD, which is not compatible with much of the data being collected on bats.
5. Surveys for hibernacula in Alberta should be a strong priority. At least six of the nine species of bats in Alberta hibernate, and these bats may spend up to eight months of each year in their hibernaculum. While hibernating, bats are extremely susceptible to human disturbance, and may utilize valuable stored energy reserves necessary to survive the winter if disturbed (Thomas *et al*. 1990, Speakman *et al*. 1991, Thomas 1995). In spite of the critical habitat they provide for bats, very few hibernacula have ever been found in Alberta (M. Pybus, pers. comm.). Thus, the identification and protection of existing hibernacula is paramount to the conservation of bats in the province. Potential sites may be identified by talking to Alberta Fisheries and Wildlife staff, mining companies, caving groups, and through public awareness programs. Surveys should be conducted at potential sites in the fall and spring using harp traps, mistnets, and/or remote ultrasonic detectors to determine if bats are entering or exiting. Alternatively, potential sites in caves may be entered during the summer by qualified personnel to determine if bones or carcasses are present, provided that all safety measures are in place. Once hibernacula are found, the next step will be to determine where the individuals using each hibernaculum spend the summers, and how far bats will move between summer roosting areas and overwintering sites.
6. Similarly, we know virtually nothing about the two species of migratory bats (hoary and silver-haired; red bats are only known from two records) in Alberta. Specifically, we have no knowledge of where bats are migrating from or to, the pathways and stopover points they may use, and whether any individuals overwinter in the province. Surveys conducted in the spring or fall at sites throughout Alberta is one way to determine if and when bats may be passing through a particular area. Another option is to provide training, equipment and possibly personnel to banding stations that monitor migratory birds, to additionally mistnet at night to monitor bats. In addition, it is possible to assign captured individuals to their source

population using DNA fingerprinting (see below) and/or stable isotopes, if the background studies on genetic or isotopic structure have been conducted. Determining the path and timing of migration for either species will likely require a huge amount of effort, but identification and protection of migratory pathways is extremely important for the conservation of these species, and we must start somewhere.

7. Studies on the roosting habitat requirements of forest-dwelling bats in Alberta are urgently required. All bat species in the province make use of forested habitat to some extent, and yet only one study has focussed on identifying roost-sites and patterns of roost selection for forest-dwelling bats (Crampton and Barclay 1998). Elk Island National Park is a good site for determining roosting habitat requirements of northern long-eared, little brown, and silver-haired bats, as it contains numerous accessible and productive mistnetting sites, and road and trail access is excellent. However, it may be more prudent to situate a study of this nature in an area or areas being modified by industrial development, where bat habitat is more at risk.
8. Although they are not at risk in the same way as forested habitat, building roosts provide important habitat to bats in Alberta. Several species of bats are known to regularly use building roosts, including little brown, big brown, long-legged, western long-eared, and silver-haired bats (Nagorsen and Brigham 1993). Bats roosting in buildings regularly come into conflict with humans, and are often displaced or killed when unwelcome. Identification of building roosts is feasible through public awareness campaigns and radio-tracking studies, and protection of existing sites should be explored in consultation with property owners. Once identified, populations within selected roosts may be regularly monitored, which is the best means available to determine population trends for any bat species (Thomas and LaVal 1988). A database should be developed to track known roost locations, bat species and bat populations within roosts.
9. The Avian Monitoring in the Boreal Forest Canopy Project already in place in Lesser Slave Lake Provincial Park (R. Ebel, pers. comm.) provides an ideal location for a cooperative effort to monitor both bird and bat populations at a fixed site in the boreal forest. Both little brown and silver-haired bats were captured at this site, hoary bats were detected, and at least northern long-eared and big brown bats are likely to be present as well. Netting success was clearly increased with the use of nets in the canopy, and furthermore, this site is an excellent location to examine whether migratory pathways of birds and bats intersect (see above).
10. An examination of the genetic population structure of all bat species in Alberta would provide a firm basis for answering a number of questions that are directly related to the conservation and management of bats. Using microsatellite and/or mitochondrial DNA it is possible to determine whether distinct genetic populations are present for a given species (Avise 1994). Studies of this nature will 1) help identify subspecies and evolutionarily significant units for the purposes of managing biodiversity; 2) provide the necessary background to be able to assign captured migratory or hibernating individuals, or individuals using exposed diurnal roosts in late summer, to a source population; and 3) help to determine the extent of genetic variation within populations, and gene flow between populations and between broad habitat types (e.g., prairie vs. mountains vs. boreal forest) within each species.
11. Surveys for temporary diurnal roosts (Riskin and Pybus 1998) should be a part of all studies in the province. This behaviour appears to be widespread, and the timing of roosting and the bat species involved should be documented across the province.
12. All studies in Alberta should collect ectoparasites from captured bats. Ectoparasites are a conspicuous feature of bats everywhere, and are an important component of biodiversity in

Alberta along with their bat hosts. They are relatively easy to collect and store, and information on their distribution and hosts will be relatively easy to acquire in combination with the surveys for bats.

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Appendix 1. Locations of study sites from the field work in 2000. Natural Subregions: BH = boreal highlands, CM = central mixedwood, CP = central parkland, DM = dry mixedwood, LF = lower foothills, WM = wet mixedwood.

Site #	Study Area	Study Site	Natural Subregion	NAD	Zone	UTM Easting	UTM Northing
1	Edmonton	Clifford E. Lee Nature Sanctuary	CP	83	12	314564	5921388
2	Edmonton	Beaver Pond	DM	83	12	380449	5950336
3	Edmonton	Devil's Lake	DM	83	11	691314	5954343
4	Edmonton	Tawayik Lake	DM	83	12	376110	5942388
5	Edmonton	Tawayik Lake, north marsh	DM	83	12	376016	5942702
6	Edmonton	Blackfoot - NE entrance	DM	83	12	382160	5933341
7	Edmonton	Moss Lake	DM	83	12	378821	5946732
8	Edmonton	Blackfoot - Islet Lake	DM	83	12	380065	5924893
9	Edmonton	Blackfoot - Central Staging Area	DM	83	12	381213	5927049
10	Edmonton	Wagner Natural Area	CP	83	12	312780	5938733
11	Rainbow Lake	R-a	WM	27	11	365829	6463933
12	Rainbow Lake	R-b	WM	27	11	361009	6462367
13	Rainbow Lake	R-c	WM	27	11	355526	6468929
14	Rainbow Lake	R-d	WM	27	11	351262	6470159
15	Sousa Creek	SC-a	WM	27	11	403175	6496476
16	Sousa Creek	SC-b	WM	27	11	402847	6504949
17	Sousa Creek	SC-c	WM	27	11	405092	6508296
18	Sousa Creek	SC-d	WM	27	11	404788	6511701
19	Sousa Creek	SC-e	WM	27	11	402786	6498557
20	Caribou River	CR-a	DM	27	11	564680	6486792
21	Caribou River	CR-b	DM	27	11	589550	6491962
22	Wabasca River	WR-a	CM	27	11	595701	6416159
23	Wabasca River	WR-b	CM	27	11	584594	6427423
24	Wabasca River	WR-c	CM	27	11	598918	6406750
25	Wabasca River	WR-d	CM	27	11	586512	6418657
26	Wabasca River	WR-e	CM / BH	27	11	586027	6414383
27	Wabasca River	WR-f	CM	27	11	601304	6383016
28	Slave Lake	SL-a	CM / LF	27	11	637264	6157330
29	Slave Lake	SL-b	DM	27	11	637780	6144295

Appendix 2. Data on bat captures in central and northwestern Alberta during the summer of 2000. Study site numbers correspond to Appendix 1, LSL refers to bats captured using exposed diurnal roosts in the Lesser Slave Lake townsite. Taxon codes: EPFU = *Eptesicus fuscus*, LANO = *Lasionycteris noctivagans*, MYLU = *Myotis lucifugus*, MYSE = *Myotis septentrionalis*. Sex: f = female, m = male. RC: np = non-parous, p = pregnant, l = lactating, pl = post-lactating. Age: a = adult, j = juvenile. Blanks indicate missing values.

Study Site	Month	Day	Observation	Capt Time	Taxon Code	Sex	RC	Age	Weight (g)	Forearm Length (mm)
1	6	22	00-ALS-01	22:45	MYLU	f	np	a	8	38.6
1	6	22	00-ALS-02	22:45	MYLU	f	np	a	6.5	39.43
1	6	22	00-ALS-03	22:45	MYLU	f	p	a	10	39.33
1	6	22	00-ALS-04	22:45	MYLU	f	p	a	9.5	40
1	6	22	00-ALS-05	22:45	MYLU	f	p	a	9.5	37.53
1	6	22	00-ALS-06	22:57	MYLU	f	p	a	9.5	38.77
1	6	22	00-ALS-07	0:15	MYLU	f	p	a	9	39.87
3	6	24	00-ALS-08		MYLU	f	p	a	12	38.9
3	6	24	00-ALS-09		MYLU	f	p	a	9.5	38.2
4	6	25	00-ALS-10	23:20	MYLU	f	p	a	9	40.03
4	6	25	00-ALS-11	23:25	MYSE	f	p	a	7.5	36.5
4	6	25	00-ALS-12	23:20	MYLU	m	ns	a	10	39.93
4	6	25	00-ALS-13	0:24	MYSE	f	p	a	9	37.33
4	6	25	00-ALS-14	23:20	MYLU	m	ns	a	7.5	37
4	6	25	00-ALS-15	23:50	MYSE	f	p	a	8	38.77
4	6	25	00-ALS-16	23:20	MYLU	f	p	a	9.5	40.73
4	6	25	00-ALS-17	23:20	MYLU	m	ns	a	7.5	38
4	6	25	00-ALS-18	23:20	MYSE	f	p	a	9.5	38.47
4	6	25	00-ALS-19	1:30	MYSE	f	p	a	6.5	36.7
5	6	26	00-ALS-20	0:33	MYSE	f	p	a	10	36.97
6	6	27	00-ALS-21	23:30	MYLU	m	ns	a	8.5	38.47
6	6	27	00-ALS-22	23:20	MYLU	f	p	a	7.5	37.7
6	6	27	00-ALS-23	23:04	MYLU	f	l	a	8.5	39.27
6	6	27	00-ALS-24	23:14	MYLU	f	np	a	10	.
6	6	27	00-ALS-25	23:20	MYLU	m	ns	a	8.5	38.1
6	6	27	00-ALS-26	23:30	MYLU	m	ns	a	5.5	34.85
6	6	27	00-ALS-27	23:14	MYLU	m	ns	a	7	38.7
7	6	29	00-ALS-28	22:55	MYLU	f	p	a	11.5	39.27
7	6	29	00-ALS-29	23:05	LANO	f	p	a	12	40.73
7	6	29	00-ALS-30	0:00	MYSE	f	l	a	8	37.53
8	6	30	00-ALS-31	23:20	MYLU	m	ns	a	8	38.7
8	6	30	00-ALS-32	23:20	MYLU	m	ns	a	9.5	39.53
8	6	30	00-ALS-33	23:25	MYLU	m	ns	a	8	39.4
8	6	30	00-ALS-34	23:25	MYLU	m	ns	a	8	37.93

cont.

Appendix 2, cont.

Study Site	Month	Day	Observation	Capt Time	Taxon Code	Sex	RC	Age	Weight (g)	Forearm Length (mm)
8	6	30	00-ALS-35	23:20	MYLU	m	ns	a	7	38.17
8	6	30	00-ALS-36	23:25	MYLU	f	l	a	11	38.5
8	6	30	00-ALS-37	1:40	MYLU	m	ns	a	8	37.93
8	6	30	00-ALS-38	1:40	MYSE	m	ns	a	8	37.23
8	6	30	00-ALS-39	1:40	MYLU	m	ns	a	10	38.93
10	7	3	00-ALS-40	23:55	MYLU	m	ns	a	9.5	38.83
11	7	13	00-ALS-41	1:25	MYSE	m	ps	a	6	38.1
14	7	17	00-ALS-42	0:18	MYSE	m	ps	a	7	37.7
16	7	19	00-ALS-44	0:30	EPFU	m	s	a	22	47.9
16	7	19	00-ALS-45	2:12	MYSE	f	l	a	8	38
16	7	19	00-ALS-46	3:20	MYSE	f	p	a	8	37.6
16	7	19	00-ALS-47	3:20	MYSE	m	ns	a	9	37.9
17	7	19	00-ALS-48	23:51	MYSE	m	ps	a	6	35.7
17	7	20	00-ALS-49	0:59	EPFU	f	pl	a	27	50.3
17	7	20	00-ALS-50	1:23	MYLU	f	l	a	10	38.1
18	7	21	00-ALS-51	0:51	MYLU	m	s	a	11	40
19	7	22	00-ALS-52	0:35	EPFU	m	s	a	21.5	49.8
16	7	23	00-ALS-53	0:40	MYSE	f	np	a	9	39.3
16	7	23	00-ALS-54	1:15	MYSE	f	l	a	9	37.4
23	7	27	00-ALS-55	0:16	MYLU	f	np	a	10	38.9
24	7	27	00-ALS-57	23:42	EPFU	f	l	a	23	49.6
24	7	28	00-ALS-58	1:12	MYLU	f	np	a	10	39.4
24	7	28	00-ALS-59	1:47	MYLU	m	ns	j	7.5	37.4
24	7	28	00-ALS-60	2:34	MYSE	f	l	a	9	38.2
24	7	28	00-ALS-61	23:36	MYLU	f	np	a	10.5	40.6
24	7	29	00-ALS-62	0:58	MYLU	f	np	a	10	38
24	7	29	00-ALS-63	1:05	MYLU	m	ns	a	9	37.4
26	7	30	00-ALS-64	23:31	MYSE	f	np	j	6.5	37.8
27	8	1	00-ALS-65	1:27	MYLU	f	pl	a	11.5	38.6
28	8	3	00-ALS-75	23:34	MYLU	m	s	a	8.5	38.4
29	8	4	00-ALS-78	23:12	MYLU	f	np	j	7	37.8
29	8	5	00-ALS-79	0:34	MYLU	f	np	j	8	37.4
29	8	5	00-ALS-80	0:34	MYLU	f	np	j	8.5	37
29	8	5	00-ALS-81	1:54	MYLU	f	l	a	9.5	38.4
29	8	5	00-ALS-82	1:54	MYLU	f	pl	a	10	38.7
29	8	5	00-ALS-83	1:54	MYLU	f	l	a	11	39.3
29	8	5	00-ALS-84	2:48	MYLU	m	ns	j	6	36.5
29	8	5	00-ALS-85	2:48	LANO	f	np	j	10	41.1
29	8	5	00-ALS-86	22:46	MYLU	f	np	j	6.5	34.4

cont.

Appendix 2, cont.

Study Site	Month	Day	Observation	Capt Time	Taxon Code	Sex	RC	Age	Weight (g)	Forearm Length (mm)
29	8	5	00-ALS-87	22:46	MYLU	f	np	j	8	38.9
29	8	5	00-ALS-88	22:46	MYLU	f	np	j	8	38.3
29	8	5	00-ALS-89	22:46	MYLU	f	l	a	11	39.4
29	8	5	00-ALS-90	22:46	MYLU	m	ns	j	8	38
29	8	6	00-ALS-91	0:06	MYLU	f	pl	a	12	40.3
29	8	6	00-ALS-92	0:06	MYLU	m	ns	j	8	37.6
29	8	6	00-ALS-93	0:23	MYLU	f	l	a	10	39.7
29	8	6	00-ALS-94	1:00	MYLU	f	l	a	13.5	38.9
29	8	6	00-ALS-95	1:45	MYLU	f	l	a	11	38.8
29	8	6	00-ALS-96	1:45	MYLU	f	np	a	9.5	37.9
29	8	6	00-ALS-97	1:45	MYLU	f	l	a	12	40.3
29	8	6	00-ALS-98	1:45	LANO	m	s	j	9	40.3
29	8	6	00-ALS-99	1:45	MYLU	f	l	a	10.5	37.6
29	8	6	00-ALS-100	1:45	MYLU	f	l	a	9.5	38.8
29	8	6	00-ALS-101	1:45	MYLU	f	l	a	9	38.7
29	8	6	00-ALS-102	1:45	MYLU	f	np	j	7.5	38.5
29	8	6	00-ALS-103	1:45	MYLU	m	s	a	8	37.3
29	8	6	00-ALS-104	2:15	MYLU	f	np	j	8.5	40.9
29	8	6	00-ALS-105	2:15	MYLU	f	np	j	8.5	39.5
29	8	6	00-ALS-106	22:25	MYLU	f	pl	a	9.5	39.2
29	8	6	00-ALS-107	22:25	MYLU	m	s	a	9.5	37.2
29	8	6	00-ALS-108	22:25	MYLU	f	np	j	7.5	37.8
29	8	6	00-ALS-109	23:35	MYLU	f	l	a	11	39.5
29	8	6	00-ALS-110	23:35	LANO	m	s	j	10.5	42.6
29	8	7	00-ALS-111	0:38	MYLU	m	s	a	11	40.1
29	8	7	00-ALS-112	1:30	LANO	m	s	j	11.5	41.8
29	8	7	00-ALS-113	1:58	MYLU	f	l	a	11	39.8
29	8	7	00-ALS-114	1:58	MYLU	f	l	a	12	39.9
29	8	17	00-ALS-115	00:55	MYLU	f	np	a		38.4
7	8	23	00-ALS-118	21:25	LANO	f	pl	a	12.5	42.5
7	8	23	00-ALS-119	21:30	MYLU	f	np	a	10	39.7
7	8	23	00-ALS-120	21:37	MYLU	f	pl	a	13	38.7
LSL	8	1	00-ALS-66	18:53	MYLU	m	ns	a	7	38.8
LSL	8	1	00-ALS-67	18:53	MYLU	f	np	j	7	36.6
LSL	8	2	00-ALS-68	20:20	MYLU	f	np	a	9	40.3
LSL	8	2	00-ALS-69	20:20	MYLU	f	np	a	8	38.1
LSL	8	2	00-ALS-70	20:20	MYLU	f	np	a	9	39.1
LSL	8	2	00-ALS-71	20:20	MYLU	m	ns	j	7	38
LSL	8	2	00-ALS-72	20:20	MYLU	f	np	j	7	39

cont.

Appendix 2, cont.

Study Site	Month	Day	Observation	Capt Time	Taxon Code	Sex	RC	Age	Weight (g)	Forearm Length (mm)
LSL	8	3	00-ALS-73	18:24	MYLU	f	np	a	9	36.8
LSL	8	3	00-ALS-74	18:25	MYLU	m	s	a	10	39.7
LSL	8	4	00-ALS-76	13:47	MYLU	m	s	a	9	37.2
LSL	8	4	00-ALS-77	13:47	MYLU	f	np	j	7.5	37.3
LSL	8	18	00-ALS-116	19:10	MYLU	m	ns	a	9.25	40.5
LSL	8	18	00-ALS-117	19:10	MYLU	f	np	a	7.25	38.5

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