

**SMALL MAMMALS OF THE MUSKWA-KECHIKA  
MANAGEMENT AREA**

**FINAL REPORT  
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## INTRODUCTION

The Muskwa-Kechika Management Area (MKMA) in northern British Columbia was formally established in 1998 with the passing of the Muskwa-Kechika Management Area Act. Situated in the Cassiar Mountains and northern Rocky Mountains, the MKMA is an immense and diverse region (Fig. 1). The initial boundaries established in 1998 encompassed 4.4 million hectares. An additional 1.9 hectares from the Mackenzie Land and Resource Management Plan Area were added to the MKMA in November 2000<sup>1</sup>. The MKMA now covers 6.3 million hectares including 1.65 million hectares of new and existing protected areas buffered by about 4.65 million hectares of special management area.

This large and ecologically diverse wilderness area supports large wildlife populations and it is a significant area for hunting, trapping, and outdoor recreation. In addition, the area has enormous potential for resource development. Management of the MKMA is intended to be an innovative approach that will balance habitat and wildlife protection with resource development. Essential to managing the MKMA, is basic inventory data on the distribution and habitat requirements of various wildlife species. Considerable inventory data are available for the large mammals (ungulates, large carnivores) of the MKMA. Populations estimates and detailed information on the distribution and seasonal movements within the MKMA exist for many species of these large mammals. In contrast, the small mammal fauna (insectivores, bats, lagomorphs, and rodents) of the MKMA is poorly documented.

Existing data on small mammals of the MKMA consist mostly of historical collections and observations of small mammals made by various museums, a few published scientific papers summarizing museum field surveys, and unpublished field notes housed in various museums. Few modern small mammal inventories have been done in the MKMA or adjacent northern areas. In 1999, a seed proposal, *Small Mammals of the Muskwa-Kechika Management Area*, was submitted to the Muskwa-Kechika Trust Fund and received funding in April 2000. The objectives were: 1) develop a database that contains all existing small mammal records from the MKMA based on historical museum collections and recent inventories. 2) produce a report containing distribution maps, an analysis of small mammal inventory coverage in the MKMA, recommendations for future inventories, and a bibliography of published and unpublished literature on small mammals in the MKMA. The *Small Mammals of the Muskwa-Kechika Management Area* was intended as a pilot project that could be used as a starting point to focus future inventory work.

## STUDY AREA DESCRIPTION

### I. General

The MKMA has a diverse physiography and climate (Fig. 1). Northern limits of the MKMA are the Liard River. The western limits are in the Stikine Ranges (see Holland 1964) of the Cassiar Mountains east of Dease Lake. The major watershed in this portion of the MKMA is the Turnagain River. From the Cassiar Mountains, the MKMA boundary extends eastward across the Kechika River in the Rocky Mountain Trench into

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<sup>1</sup> Note this study was initiated before the addition of the Mackenzie area to the MKMA and the Mackenzie portion of the MKMA was not analyzed for this report.

the Muskwa Ranges of the northern Rocky Mountains. Southern limits in the Rocky Mountains are east of the Ospika River and north of the Ospika Arm of Williston Lake near Laurier Pass and the Graham River. Major watersheds on the eastern slope of the Rocky Mountain portion of the MKMA include: the Sikanni Chief, Prophet, Muskwa, and Toad Rivers. No communities or settlements occur with the boundaries of the MKMA. Fort Nelson on the Alaska highway and Dease Lake on the Stewart Cassiar highway are the closest communities. The only highway that traverses the MKMA is the Alaska Highway.

## **II. Ecological unit boundaries**

Three ecoprovinces and 11 associated ecosections are represented in the MKMA (Table 1; Fig. 2). The greater part (about 88%) of the MKMA lies in the Northern Boreal Mountains Ecoprovince which is generally made up of areas of mountains and high plateaus separated by wide valleys and lowlands (Demarchi 1996). The regional climate is dominated by prevailing westerly winds that bring Pacific air over the St. Elias Mountains and Boundary Ranges. The moisture content of the coastal air is greatly reduced when it reaches the area, giving rise to very dry conditions where rain shadow effects are strong. Precipitation, provided by summer time convective showers and winter frontal systems, is distributed evenly throughout the year. Arctic air masses frequently dominate the region in winter and spring, and the varied topography leads to complex patterns of surface heating and cooling and cold air drainage in the valleys (Demarchi 1996). The remaining portion of the MKMA is split roughly equally between the northern fringe of the Sub-Boreal Interior and eastern edge of the Taiga Plains ecoprovinces.

The Boreal Mountains and Plateaus ecoregion in the Northern Boreal Mountains Ecoprovince is an area of complex lowlands, plateaus, and rugged mountains. The Cassiar Ranges ecosection has the highest and most rugged mountains in the ecoregion, while the Kechika Mountains ecosection is in the rain shadow created by these mountains. The Northern Canadian Rocky Mountains ecoregion is dominated by high, rugged mountains and rounded foothills separated by wide valleys.

Much of the Sub-Boreal Interior Ecoprovince is in a rain shadow (particularly the Peace Foothills ecosection) and precipitation is delivered roughly evenly by summer showers and winter frontal systems. The Misinchinka Ranges ecosection that makes up the southeastern tip of the MKMA is an exception to this, as moist Pacific air often stall over the rugged mountains in the area. The southern end of the ecoprovince is near the typical southern limit of the Arctic air mass in January (Demarchi 1996).

The Taiga Plains ecoprovince is mainly a large lowland extending into the upper Mackenzie River Basin that has been dissected below the Alberta Plateau surface by the Liard River and its tributaries (Demarchi 1996). The climate is continental and cold, dense Arctic air flows unimpeded from the north, often covering the area in winter and spring. In summer, the location of the area between the Pacific and Arctic air masses leads to long periods of cloud cover and unstable weather. In colder or wetter years some soils may remain frozen year round (Demarchi 1996).

### III. Biogeoclimatic unit boundaries

Three biogeoclimatic zones and 10 associated subzones are represented in the MKMA (Table 2, Fig. 3). The Engelmann Spruce Subalpine Fir (ESSF) zone has a cold, moist, snowy continental climate. Average temperature is below 0°C for 5 to 7 months annually and above 10°C for 0 to 2 months (Meidinger and Pojar 1991). The mean annual precipitation within the zone ranges from 400 to 500 mm in drier areas to a maximum of about 2200 mm in wetter areas. About 50-70% of the precipitation falls as snow, and maximum snowpack accumulations range from about 1 to 4 metres. There is continuous forest cover at the middle to lower elevations and subalpine parkland at upper elevations in the zone. Engelmann spruce and subalpine fir are the dominant climax tree species in the zone, and lodgepole pine is a widespread seral species after fire. Deciduous tree species are rare in the ESSF (Meidinger and Pojar 1991). The moist very cold (mv) subzone is found in two variants (2 and 4) in the MKMA. This subzone is characterized by an ericaceous shrub layer, sparse herb cover, and relatively dense moss layer. Long, cold, snowy winters, wet, cool summers, and steep topography are factors which influence the assemblage of wildlife species found in the ESSF. Conifer forest is the most common habitat in the zone, and there are extensive areas of both old-growth/mature forests as well as young seral forests (Meidinger and Pojar 1991).

The Boreal Black and White Spruce (BWBS) zone in the region is located on an extension of the Alberta Plateau. The zone has a northern continental climate characterized by frequent arctic air mass outbreaks, very cold, long winters, and a short growing season. The average temperature is below 0°C for 5 to 7 months per year, and above 10°C for about 2 to 4 months per year. The mean annual precipitation ranges between 330 and 570 mm; about 35 –70 % falls as snow. White spruce, trembling aspen, lodgepole pine, black spruce, balsam poplar larch, subalpine fir and paper birch are the major tree species found in the BWBS. The wet cool (wk) and dry cool (dk) subzones are found in two variants, while the moist warm (mw) and moist very cold (mv) subzones are found in one variant in the MK.

The BWBSdk is located below the Spruce-Willow-Birch (SWB) or Engelmann Fir-Subalpine Fir ESSF zone and is dominated by white spruce and lodgepole pine. The BWBSmw generally covers the rolling topography between 350 and 1100 m. The dominant tree species are white spruce and trembling aspen. The BWBSwk is found on lower to middle slopes at elevations between 900 and 1399 m, above the BWBSmw and below the SWB and ESSF. The forest is dominated by white spruce or lodgepole pine.

The Spruce-Willow-Birch (SWB) zone is the most northerly subalpine zone in British Columbia, extending from about 57° N to about 70° N (Meidinger and Pojar 1991). In the study area the SWB is found at middle elevations ranging between 900 and 1500 m. The SWB is typically the subalpine zone above the BWBS, a position comparable to the ESSF further south. The climate is an interior subalpine type with mean annual temperature ranging between -0.7 and -3°C, and averages above 10°C for 1 to 3 months. Winter cold spells can be broken by chinook winds. The mean annual precipitation ranges between 460-700 mm, with 35-60% falling as snow. Lower elevations in the SWB are usually forested, with white spruce and subalpine fir as the dominant tree species. Pine and aspen are common in valley bottoms and lower slopes but subalpine fir dominates at higher elevations, particularly on northern and eastern

exposures. Balsam poplar, Engelmann spruce, paper birch, and larch are all absent from the SWB (Meidinger and Pojar 1991).

The Alpine Tundra (AT) zone occurs on high mountains throughout the province, generally above 2250 m in the southeast, above 1650 m in the southwest, above 1400 m in the northeast (typical in the MKMA), and above 1000 m in the northwest (Meidinger and Pojar 1991). The alpine climate is cold, windy, and snowy. Average temperature is below 0°C for 7 to 11 months per year, and frost can occur at any time. Mean annual precipitation ranges between 700 and 3000 mm, of which 70-80% falls as snow. The alpine zone is by definition treeless, although subalpine fir, Engelmann spruce, and white spruce are often found in stunted (*krumholz*) form. The vegetation is dominated by shrubs, herbs, bryophytes, and lichens, but most of the landscape is composed of rock, ice, and snow (Meidinger and Pojar 1991).

#### **IV. Protected areas**

There are 17 provincial parks and protected areas in the MKMA (Table 3). No national parks occur within the MKMA. The provincial protected areas range from 2 to 665135 ha in area with the total protected area about 1.1 million ha. The Northern Rocky Mountains protected area makes up nearly 60% of the total protected areas within the MKMA. Contiguous with Stone Mountain Provincial Park and Kwadacha Wilderness (Fig. 4), it represents the largest area of connected protected areas. Other protected areas within the MKMA are small and isolated.

### **METHODS AND MATERIALS**

#### **I. Small Mammal Data**

Our analyses were restricted to four groups of small mammals: shrews (Insectivora), bats (Chiroptera), lagomorphs (Lagomorpha), rodents (Rodentia). Most of the mammal records were derived from the BC Mammals Database (Nagorsen 2000), a Foxpro (.dbf file) database consisting of about 55,000 museum specimen records and 2,600 observational or literature records of terrestrial mammals from British Columbia. Most of the museum specimens which are housed in 26 North American museums have been examined by one of us (D. Nagorsen) to verify their identification and associated data. We initially extracted a smaller subset of records from northern British Columbia using taxonomic and location fields. Occurrences within the MKMA were determined by GIS analysis using UTM co-ordinates. Some of the mammal records predate reliable topographic mapping for British Columbia and most predate the advent of hand held GPS technology. Co-ordinates were based on general location descriptions recorded on specimen tags or field notes; most have a precision of about 1 km. Published papers and unpublished field notes were associated with many of the mammal records and they were used to refine co-ordinates. Copies of unpublished field notes from various museum expeditions are housed at the Royal British Columbia Museum. We also searched various government libraries in Prince George and Fort St. John for unpublished inventory reports on small mammals from the MKMA and adjacent areas in northern British Columbia. Because of restrictions on individual registered traplines, we could not use fur harvest return data as a source of distributional data for fur-bearers (i.e., Red Squirrel, Muskrat, Beaver) in the MKMA.

## II. GIS Analysis

All GIS analyses were done by one of us (Peter Tollestrup) at the GIS laboratory, University of Northern British Columbia. Most GIS datasets used in the project were obtained from the Ministry of Environment, Lands and Parks (MELP). Readily useable ARC/INFO coverages for biogeoclimatic and ecological units, lakes and rivers, and parks/protected areas were obtained from the MELP ftp site. The small mammal records were initially in spreadsheet files and were converted into ARC/INFO point coverages. Overlays were used to generate tabular data and maps showing the distribution of small mammal record sites relative to the MKMA boundary, ecological and biogeoclimatic units, parks and protected areas, lakes, rivers, highways, and population centres. Small mammal records from sites within the MKMA boundary were tallied by their biogeoclimatic and ecosection units, as well as Parks. Records outside of the MKMA but within biogeoclimatic and ecosection units represented in the MKMA were also included in the analysis; separate totals were tallied for records within and outside of the MKMA. The area in hectares as well as relative to the entire MKMA are included to indicate observation intensity. The number of locations represented by the records is included to give a tabular indication of the distribution of sample sites.

## RESULTS

### I. Mammal Studies in the Muskwa-Kechika Management Area

The earliest work in the MKMA region was done Andrew J. Stone on behalf of the American Museum of Natural History in New York. Stone visited various areas in northern British Columbia, the Yukon, and the Northwest Territories from 1896 to 1903. For a summary of his expeditions with observations on wildlife and aboriginal peoples see Stone (1905). Although Stone was primarily interested in large mammals particularly Thinhorn Sheep (the Stone Sheep subspecies was named in his honour), some small mammals were collected during his expeditions. The only expedition where he travelled within the existing MKMA boundaries was in 1897 when did some collecting in the Cassiar Mountains and along the Liard River (Allen 1897).

M.Y. Williams a geologist naturalist at the University of British Columbia summarized various wildlife observations made in the Fort Nelson and Liard River region in 1921 and 1992 (Williams 1933). However, most observations were birds; mammalian observations were limited to a few anecdotal sighting of fur-bearers and ungulates. The Laurier Pass area within and adjacent to the southern tip of the MKMA was studied by William Sheldon and Richard Borden in 1932. Sheldon and Borden were primarily interested in mountain sheep but they collected about 115 small mammals; their specimens, field notes, and maps showing locations of field camps are at the Division of Mammals, National Museum of Natural History, Smithsonian. Results from their research was published as a paper in the Journal of Mammalogy (Sheldon 1932) where they noted the absence of ground squirrels (*Spermophilus* sp.) and pikas (*Ochotona* sp.) in the northern Rocky Mountains and the diversity of habitat occupied by the Deer Mouse (*Peromyscus maniculatus*).

The American Museum of Natural History sponsored four expeditions to northeastern British Columbia from 1934 to 1937. In 1934 G.G. Goodwin (Snyder 1934 Expedition) collected specimens in the Halfway River area then joined Snyder at

Dorothy Lake, an lake in the Tuchodi Lakes area. Goodwin returned to the Tuchodi Lakes in 1935 (Snyder 1935 Expedition). Both of the Snyder Expeditions were funded by Harry Snyder businessman from Montreal interested in Stone Sheep. However, in addition to sheep specimens, Goodwin did collect representative samples of small mammals. In 1936 D.A. Feathers and others as part of the Ramsey expedition travelled from Hudson Hope to Halfway River, then to the Laurier Pass and Redfern Mountain areas. In 1937, Dillon collected small mammals in the Sikanni Chief-Goat Mountain area. No scientific publications were written of these AMNH expeditions but specimens and field notes are housed in the American Museum of Natural History. The 1936 study is particularly well documented with field notes supplemented by maps that show the locations of field camps and collecting sites.

Two expeditions were made along the new Alaska Highway during the 1940's. In 1943, A.L. Rand from the National Museum of Canada (now Canadian Museum of Nature) collected and observed mammals along the Alaska Highway between Dawson Creek and Watson Lake. Some of Rand's study sites fall within the boundaries of the MKMA. His publication (Rand 1944) which is based on his collections, observations, and interviews with trappers provides a good summary of the small mammal fauna along the Alaska highway and it contains historical photographs of representative habitats. Rand's research specimens and field notes are housed at the Canadian Museum of Nature. In 1947 and 1948, J. R. Alcorn collected small mammals along the Alaska Highway in British Columbia, southern Yukon, and southern Alaska (Baker 1951). His specimens and field notes are housed at the Mammalogy Division, Museum of Natural History, University of Kansas.

Throughout the 1950's and 1960's small collections were made from the Alaska Highway mostly in the Summit Pass area of Stone Mountain Provincial Park. Most were incidental opportunistic collections made by various biologists representing several museums: Charles Guiguet-Royal British Columbia Museum, Lee-Canadian Museum of Nature, Fuller-University of Alberta, Museum of Zoology, and Tom Manning-Canadian Museum of Nature. A number of historical collections were also made in areas peripheral to the MKMA but within biogeoclimatic and ecosection units represented in the MKMA. These records were included in the GIS analysis. The collections include the 1902 records of A. J. Stone and M. P. Anderson made in the Telegraph Creek-Mount Edziza area for the American Museum of Natural History (Allen 1903). Edward A. Preble collected numerous small mammal specimens from the Stikine, Finlay, and Peace River valleys, and from the Spatzizi Plateau in 1910 and 1913. Edmund Heller made large small mammal collections in the Dease Lake region in the spring and summer of 1914. Both Preble and Heller were employed by the US Biological Survey and their specimens are housed at the Division of Mammals, National Museum of Natural History, Smithsonian; their field notes are in the Smithsonian Archives. Smaller collections from the Spatzizi Plateau are housed in the Royal British Columbia Museum.

From our survey of government reports and various voucher specimens from various small mammal inventories in northeastern British Columbia deposited at the RBCM as well as interviews with government biologists, we found no record of any modern small mammal inventory being in the MKMA except for a superficial survey on the Turnagain River in the Cassiar Mountains by one of us (D. Nagorsen) in 1996 as a participant in the Turnagain River Research Expedition sponsored by The River League

(see Newman 1997). No small mammal trapping was done but mammal observations including locations geo-referenced with a GPS device were recorded from various sites including several alpine areas within the MKMA as well as areas to the west around Boulder City Lake. Several recent small mammal inventories have been done in adjacent areas in ecosystems represented in the MKMA. The most comprehensive were three bat surveys applying mist nets and bat detectors done in northeastern British Columbia in the 1990's. Results of these surveys were summarized in detailed unpublished reports: Wilkinson et al. (1995), Bradbury et al. (1997), Vonhof et al. (1997). Most of the bat work was concentrated around Highway 77, the Smith River area, and an area north of the Liard River near the Alaska Highway. Although outside the MKMA boundary, some of these sites are close to the MKMA and all occur in ecosystems represented within the MKMA. In contrast to the bats, no recent systematic inventories of rodents or insectivores applying modern sampling methods have been done in or near the MKMA. In 1992, Laura Darling inventoried rodents and insectivores in the Del Rio area west of Dawson Creek. A series of voucher specimens with associated location and habitat data are deposited in the collections of the RBCM but no report was prepared by Laura Darling summarizing results of her study. In 1994, Tanya Luszcz and Scott Harrison Ministry of Forests, inventoried rodents and insectivores in the Hackney Hills-Graham River area. A few voucher specimens with associated location and habitat data were deposited in the collections of the RBCM but no report was prepared and data on the species captured from their transects were evidently lost.

## **II. Small Mammals in the Muskwa-Kechika Management Area**

### ***A. Species Documented in the MKMA***

From the GIS analysis of specimen and observational records, 25 small mammal species occur within the boundary of the MKMA (Appendix 1). More than half of these species are rodents. Location records for each species are listed here. Species occurrences in ecological and biogeoclimatic units are summarized in Appendix 3 and Appendix 4

#### **Common Shrew (*Sorex cinereus*)**

RECORDS. 1). Muncho Lake Provincial Park, Alaska Highway, Muncho Pass, Mile 165 N of Fort Nelson. 2). Alaska Highway, Milepost 364.5. 3). Alaska Highway, Milepost 403. 4). Aline Lake; Liard River. 5). Liard River, At Junction Of Trout River. 6). Sikanni Chief River, Head of. 7). Toad River.

REMARKS. Although ecologically widespread across the province (Nagorsen 1996), the available records from the MKMA are all from forested habitats.

#### **Pygmy Shrew (*Sorex hoyi*)**

RECORDS 1). Liard River Hotsprings Park, Liard River Hot Springs.

REMARKS. Rand (1944) also captured three Pygmy Shrews at Irons Creek along the Alaska Highway, outside the MKMA.

#### **Dusky Shrew (*Sorex monticolus*)**

RECORDS. 1). Muncho Lake Provincial Park, Alaska Highway, Muncho Pass, Mile 165 N of Fort Nelson. 2). Laurier Pass. 3). Liard River, At Junction of Trout River. 4). Muncho Lake Provincial Park, Muncho Lake, NW Side. 5). Sikanni Chief River. 6).

Stone Mountain Provincial Park, Summit Lake, West End; Mile 393 Alaska Highway. 7). Stone Mountain Provincial Park, Summit Lake; Alaska Highway, Mile 104 N of Fort Nelson. 8). Stone Mountain Provincial Park, Summit Lake; Alaska Highway, Mile 392. 9). Toad River.

REMARKS. Although Rand (1944) and Baker (1951) found this species less abundant than the Common Shrew, it occupies a broader range of habitats.

**Water Shrew (*Sorex palustris*)**

RECORDS. 1. Goat Creek, Headwaters; 101 Miles NW Hudson Hope. 2. Sikanni Chief River, Head of.

REMARKS. Probably widespread throughout the MKMA in riparian streamside habitats.

**Little Brown Myotis (*Myotis lucifugus*)**

RECORDS. 1). Muncho Lake Provincial Park, Muncho Lake, NE end.

REMARKS. The only record within the MKMA is a nursery colony at Muncho Lake that consisted of about 74 bats roosting under the siding of a house (Baker 1951). A single Little Brown Myotis was found by J. R. Alcorn in an old house at Screw Creek on the Alaska Highway west of the MKMA. A nursery colony of several 100 females occurs in a natural cave (Guanosauna Cave) heated by hot springs on the Grayling River north of the MKMA (Nagorsen and Brigham 1993). Based on mist net captures Bradbury et al. (1997) and Vonhof (1997) concluded that this was the most abundant bat in their study sites on the Lower Liard River and Highway 77 northeast of the MKMA. and pregnant or nursing females were taken at various sites. The Little Brown Myotis is presumably widespread throughout the MKMA. Other than its use of man-made roosts in buildings and the nursery colony in a natural cave on the Grayling River, no data exist on the roosting biology of this species in northeastern British Columbia.

**Snowshoe Hare (*Lepus americanus*)**

RECORDS. 1). Turnagain River; Camp 5, 5 km E Three Forks Creek. 2). McDonald Creek, Mile 114, Alaska Highway. 3). Muncho Lake provincial Park, Muncho Pass. 4).

REMARKS. Rand (1944) reported observations along most of the Alaska Highway.

**Northern Flying Squirrel (*Glaucomys sabrinus*)**

RECORDS: 1). Lower Liard Crossing, Alaska Highway, 2). Robb Lake

REMARKS. Presumably ubiquitous throughout the MKMA.

**Hoary Marmot (*Marmota caligata*)**

RECORDS. 1). Cassiar River. 2).Laurier Pass, 2 mi W. 3).Laurier Pass. 4). Needham Creek. 5). Robb Lake,6).Turnagain River, Mountains 2 km NW; above Camp 4.

REMARKS. Presumably found throughout alpine areas of the Cassiar Mountains and Rocky Mountains in the MKMA.

**Woodchuck (*Marmota monax*)**

RECORDS. 1). Trout River and Liard River Jct, 3 mi WNW, Hot Springs  
REMARKS. Rand (1944) reported this species from Liard Crossing along the Alaska Highway outside the MKMA.

**Arctic Ground Squirrel (*Spermophilus parryii*)**

RECORDS. 1). Turnagain River, Mountains 2 km NW; above Camp 4. 2). Turnagain River, Mountains 3 km NW; above Camp 5.

REMARKS. The Arctic Ground Squirrel is associated with alpine-subalpine habitats in British Columbia (Nagorsen 2001). Curiously it has not been found in the northern Rocky Mountains. The only substantiated records from the MKMA are the two colonies observed by one of us (D. Nagorsen) in unnamed mountains above the Turnagain River in the Cassiar Mountains in 1996. A colony also occurs in the mountains above Rainbow Lakes south of the Turnagain River near the MKMA boundary.

**Least Chipmunk (*Tamias minimus*)**

RECORDS. 1). Muncho Lake Provincial Park, Muncho Pass, Alaska Highway, 165 Mi N Fort Nelson. 2). Alaska Highway, Mile 378.5. 3). Goat Mountain, Head Of Sikanni Chief River. 4). Laurier Pass, 2 mi W. 5). Laurier Pass, Borden River. 6). Liard River, South of. 7). McDonald Creek, Alaska Highway, 12 mi N Summit Lake. 8). Toad River, S Side of , 10 mi S, 21 mi E Muncho Lake. 9).Muncho Lake Provincial Park, Muncho Lake. 10). Needham Creek. 11). Sikanni Chief River. 12). Summit Lake, Alaska Highway. 13). Stone Mountain Provincial Park, Summit Lake; Alaska Highway, Mile 392. 14). Toad River. 15). Trout River and Liard River Jct, 3 mi WNW; Hot Springs. 16). Tuchodi Lakes. 17). Turnagain River, Mountains 2 km NW; above Camp 4. 18). Turnagain River; Camp 5, 5 km E Three Forks Creek.

REMARKS. Widespread throughout the MKMA where it ranges from lowland spruce forest to alpine habitats.

**Red Squirrel (*Tamiasciurus hudsonicus*)**

RECORDS. 1). Besa River. 2). Stone Mountain Park, Summit Pass, 10 mi S, 70 mi W Fort Nelson. 3). Stone Mountain Park, Summit Pass, 11 mi S, 70 mi W Fort Nelson. 4). Stone Mountain Park, Summit Pass, 12 mi S, 70 mi W Fort Nelson. 5). Stone Mountain Park, Summit Pass, 13 mi S, 70 mi W Fort Nelson. 6). Stone Mountain Park, Summit Pass, 14 mi S, 70 mi W Fort Nelson. 7). Stone Mountain Park, Summit Pass, 15 mi S, 70 mi W Fort Nelson. 8). Stone Mountain Park, Summit Pass, 16 mi S, 70 mi W Fort Nelson. 9). Stone Mountain Park, Summit Pass, 17 mi S, 70 mi W Fort Nelson. 10). Goat Creek, Headwaters; 101 mi NW Hudson Hope. 11). Keily Creek, Mouth Of. 12). Laurier Pass,13). Muncho Lake Provincial Park, Muncho Lake, 10). Toad River, S Side of , mi S, 21 mi E Muncho Lake. 11). Muncho Lake, Post Office. 12). Muncho Lake Provincial Park, Muncho Lake 13). Redfern Lake. 14). Robb Lake. 15). Sikanni Chief River. 16). Stinking Lakes; Sikanni Chief River, 115 mi NW Hudson Hope. 17). Summit Lake, Alaska Highway. 18). McDonald Creek; Alaska Highway, 12 mi N Summit Lake. 19). Toad River. 20). Trimble Lake, 106 mi NW. 21). Tuchodi Lakes. 22). Turnagain River; Camp 5, 5 Km E Three Forks Creek. 23). Alaska Highway, mi 550. 24). Trout River And Liard River Jct, 3 mi WNW Hot Springs.

**Beaver (*Castor canadensis*)**

RECORDS. 1). Keily Creek, 1 mi NW Of Mouth. 2). Keily Creek, Mouth Of.

REMARKS. Rand (1944) noted lodges and dams at various locations along the Alaska Highway. Fur harvest data should be analyzed to assess the distribution and relative of this species in the MKMA.

**Southern Red-backed Vole (*Clethrionomys gapperi*)**

RECORDS. 1). Goat Creek, Headwaters; 101 mi NW Hudson Hope. 2). Goat Mountain, Head of Sikanni Chief River. 3). Keily Creek, Mouth Of. 4). Keily Creek. 5). Laurier Pass. 6). Redfern Lake. 7). Robb Lake, 96 mi NW Hudson Hope. 8). Robb Lake. 9). Sikanni Chief River. 10). Tetsa River, N Bank, 10 mi S, 63 mi W Muskwa (=Fort Nelson). 11). Toad River. 12). Tuchodi Lakes.

REMARKS. This species reaches its northern limits within the MKMA. East of Summit Pass and possibly on the west slopes of the Muskwa Ranges, it is replaced by the Northern Red-backed Vole.

**Northern Red-backed Vole (*Clethrionomys rutilus*)**

RECORDS. 1). Alaska Highway, Mile 205. 2). Alaska Highway, Mile 401.9. 3). Alaska Highway, Mile 403.4. 4). Alaska Highway, Mile 438. 5). Muncho Lake Provincial Park, Muncho Lake, Post Office; 7 mi. N. 6). Muncho Lake Provincial Park, Muncho Pass; Alaska Highway, 165 mi N Fort Nelson. 7). Racing River, W Bank, 89 mi W; W Muskwa (=Fort Nelson). 8). Stone Mountain Provincial Park, Summit Lake, Alaska Highway. 9). Stone Mountain Provincial Park, Summit Lake, W End; Alaska Hwy Mile 393. 10). Stone Mountain Provincial Park, Summit Lake; Alaska Highway, mi 392. 11). Stone Mountain Provincial Park, Summit Lake; Alaska Highway. 12). Stone Mountain Park, Summit Pass, 10 mi S, 70 mi W Fort Nelson. 13). Stone Mountain Provincial Park, Summit Pass; Alaska Highway, 104 mi N Fort Nelson; Near Summit Lake. 14). , Tetsa River, N Bank, 10 mi S, 63 mi W Muskwa (=Fort Nelson). 15). Toad River, S Side, 10 mi S, 21 mi E Muncho Lake. 16). Tuchodi Lakes.

REMARKS. The Northern Red-backed Vole is presumably found throughout the Cassiar Mountains and reaches the western and southern limits of its range in the northern Rocky Mountains within the MKMA. However, because most records are from the Alaska Highway, its precise distribution within the Muskwa Ranges of the MKMA is unknown. Data from museum specimens and genetic studies (Canham and Cameron 1972) suggest that along the Alaska Highway this species ranges as far east as the Summit Pass. East of Summit Pass, it is replaced by the ecologically equivalent Southern Red-backed Vole. Southern limits of the range of Northern Red-backed Vole in the Rocky Mountains portion of the MKMA are unknown.

**Brown Lemming *Lemmus trimucronatus*)**

RECORDS. 1). Goat Mountain, Head of Sikanni Chief River. 2). Laurier Pass, 2 mi W. 3). Laurier Pass. 4). Sikanni Chief River, Head of.

REMARKS. An alpine species presumably found throughout the alpine-subalpine habitats of the Cassiar Mountains and Rocky Mountains in the MKMA. The Brown

Lemming is not found south of the Peace River-Williston Lake in the Rocky Mountains of British Columbia (Nagorsen 2001).

**Long-tailed Vole (*Microtus longicaudus*)**

RECORDS. 1). Goat Creek, Headwaters; 101 mi NW Hudson Hope. 2). Goat Mountain, Head of Sikanni Chief River. 3). Hells Gate. 4). Toad River, S Side, 10 mi S, 21 mi E Muncho Lake. 5). Muncho Lake, Post Office. 6). Muncho Lake Provincial Park, Muncho Lake, SE End. 7). Racing River, W Bank, 90 mi W; W Muskwa (=Fort Nelson). 8). Robb Lake, 96 mi NW Hudson Hope. 9). Sikanni Chief River. 10). Stone Mountain Provincial Park, Summit Lake, W End; Alaska Hwy Mile 393. 11). Stone Mountain Provincial Park, Summit Lake; Alaska Highway, Mile 392. 12). Stone Mountain Provincial Park, Summit Pass, 10 mi S, 70 mi W Fort Nelson. 13). Stone Mountain Provincial Park, Summit Pass; Alaska Highway. 14). Stone Mountain Provincial Park, Summit Pass; Alaska Highway, Near; Mile 104 N Fort Nelson. 15). 16). Trout River and Liard River Jct, 3 mi WNW Hot Springs.

REMARKS. Generally less abundant and more restricted in its habitat than the Meadow Vole. Rand (1944) reported it 'above timberline' in the Summit Pass.

**Meadow Vole (*Microtus pennsylvanicus*)**

RECORDS. 1). Alaska Highway, Mile 378. 2). Alaska Highway, Mile 403.4. 3). Aline Lake, Liard River. 4). Goat Creek, Headwaters; 101 mi NW Hudson Hope. 5). Goat Mountain, Head Of Sikanni Chief River. 6). Kechika River. 7). Keilly Creek, S Fort Nelson. 8). Keily Creek, 5 mi N Of Mouth. 9). Keily Creek, Mouth Of. 10). Laurier Pass. 11). McDonald Creek; Alaska Highway, 12 mi N Summit Lake. 13). Muncho Lake Provincial Park, Muncho Lake, NW Side. 14). Muncho Lake Provincial Park, Muncho Lake. 15). Muncho Lake Provincial Park, Muncho Pass; Alaska Highway, 165 mi N Fort Nelson. 16). Muncho Lake Provincial Park, Muncho Pass; Alaska Highway, 166 mi N Fort Nelson. 17). Muncho Lake Provincial Park, Muncho Lake; Alaska Highway, 172.5 mi N Fort Nelson. 18). Robb Lake. 19). Sikanni Chief River. 20). Stone Mountain Park, Summit Pass, 10 mi S, 70 mi W Fort Nelson. 21). Stone Mountain Provincial Park, Summit Pass; Alaska Highway, 104 mi N Fort Nelson. 22). Toad River, S Side, 10 mi S, 21 mi E Muncho Lake. 23). Trout River and Liard River Jct, 3 mi WNW; Hot Springs. 24). Trutch Station; Alaska Highway, Mile 201. 25). Tuchodi Lakes.

REMARKS. Generally associated with meadows and riparian habitats.

**Muskrat (*Ondatra zibethicus*)**

RECORDS. 1). Keilly Creek, S Fort Nelson. 2). Keily Creek, Mouth Of.

REMARKS. Rand (1944) noted old sign at Liard Crossing on the Alaska Highway outside the MKMA and summarized anecdotal information from trappers. Fur harvest data should be analyzed to assess the distribution and relative of this species in the MKMA.

**Heather Vole (*Phenacomys intermedius*)**

RECORDS. 1). Alaska Highway, Mile 403. 2). Toad River. 3). Turnagain River, Mountains 3 Km NW, above Camp 5.

Remarks. Known from the MKMA from only two museum specimens. One of us (D. Nagorsen) observed winter caches of cut willow twigs in the alpine area of an unnamed mountain above the Turnagain River.

**Bushy-tailed Woodrat (*Neotoma cinerea*)**

RECORDS. 1). Robb Lake. 2). Stone Mountain Provincial Park, Summit Lake; Alaska Highway, mi 392. 3). Stone Mountain Provincial Park, Summit Pass, 10 mi S, 70 mi W Fort Nelson. 4). Tuchodi Lakes.

REMARKS. Rand (1944) reported anecdotal accounts from trappers of this species in the canyons of the Toad River and one of us (D. Nagorsen) observed white-wash from Bushy-tailed Woodrats in a canyon of the Turnagain River west of the MKMA.

**Deer Mouse (*Peromyscus maniculatus*)**

RECORDS. 1). Alaska Highway, mi 438. 2). Alaska Highway, Mile 378. 3). Alaska Highway, Mile 378.5. 4). Alaska Highway, Mile 403.4. 5). Goat Mountain, Head Of Sikanni Chief River. 6). Keily Creek, Mouth Of. 7). Liard River; Hells Gate. 8). McDonald Creek; Alaska Highway, 13 mi N Summit Lake. 9). Muncho Lake Provincial Park, Alaska Highway, 106 mi N Fort Nelson. 10). Muncho Lake Provincial Park, Muncho Lake, NW Side. 11). Muncho Lake Provincial Park, Muncho Lake, SE End. 12). Muncho Lake Provincial Park, Muncho Lake. 13). Muncho River. 14). Robb Lake, 96 mi NW Hudson Hope. 15). Stone Mountain Provincial Park, Summit Lake, Tetsa River And Alaska Hwy. (Mile 380). 16). Stone Mountain Provincial Park, Summit Lake; Alaska Highway, mi 104 N Of Fort Nelson. 17). Stone Mountain Provincial Park, Summit Lake; Alaska Highway, mi 392. 18). Stone Mountain Park, Summit Pass, 10 mi S, 70 mi W Fort Nelson. 19). Stone Mountain Provincial Park, Summit Pass; Alaska Highway, 104 mi N Fort Nelson; Near Summit Lake. 20). Toad River, S Side, 10 mi S, 21 mi E Muncho Lake. 21). Trout River and Liard River Jct, 3 mi WNW Hot Springs.

REMARKS. Probably the most abundant and ecologically widespread small rodent in the MKMA.

**Meadow Jumping Mouse (*Zapus hudsonius*)**

RECORDS. 1). Alaska Highway, mi 550. 2). Trout River and Liard River Jct, 3 mi WNW Hot Springs. 3). Alaska Highway, Mile 403.

REMARKS. Presumably found throughout the MKMA in meadows and riparian habitats.

**Western Jumping Mouse (*Zapus princeps*)**

RECORDS. 1). Goat Creek, Headwaters; 101 mi NW Hudson Hope. 2). Keily Creek, Mouth Of. 3). Laurier Pass. 4). McDonald Creek; Alaska Highway, 14 mi N Summit Lake. 5). Sikanni Chief River. 6). Tuchodi Lakes,

REMARKS. Associated with a wide range of elevations and habitats.

**Porcupine (*Erethizon dorsatum*)**

RECORDS. 1). Stone Mountain Provincial Park, Summit Lake, 1 mi N, 4 mi E. 2). Turnagain River; Camp 5, 5 km E Three Forks Creek. 3) Muncho Lake Provincial Park, Muncho Pass. 4). Stone Mountain Provincial Park, Summit Pass.

REMARKS. Presumably found throughout the MKMA. Rand (1944) reported thick deposits of Porcupine faecal pellets in several small caves near 'timberline' in Muncho Pass.

### ***B. Hypothetical Species for the MKMA***

An additional 11 small mammals may occur within the MKMA but their occurrence has yet to be confirmed (Appendix 2).

### **Black-backed Shrew (*Sorex arcticus*)**

In British Columbia, this shrew is restricted to the extreme northeast where it inhabits wetland and bog habitats in the Taiga Plains Ecoprovince (Nagorsen 1996). Nearest known records to the MKMA are southwest of Kotcho Lake east of Fort Nelson. Nevertheless, our knowledge of shrew distributions in northeastern British Columbia is rudimentary and the Black-backed Shrew could inhabit lowland habitats in the Muskwa Plateau portion of the MKMA.

### **Big Brown Bat (*Eptesicus fuscus*)**

Although they captured no Big Brown Bats in mist nets, Bradbury et al. (1997) detected this species with bat detectors on 16 of 25 nights during their study on the Lower Liard River and Highway 77 northeast of the MKMA. Nagorsen and Brigham reported the range as far north as the Peace River, and this species has been found hibernating in winter as far north as Prince George. It appears likely that there is a year-round population of the Big Brown Bat in the MKMA.

### **Hoary Bat (*Lasiurus cinereus*)**

Bradbury et al. (1997) detected echolocation of the Hoary Bat on 3 of 25 nights during their study on the Lower Liard River and Highway 77 northeast of the MKMA. Similarly Vonhof et al. (1997) detected it at three sites. However, no Hoary Bats were captured during their bat surveys. As these northern records are more than 500 kilometres north of the previously known records of the Hoary Bat (Nagorsen and Brigham 1993), the occurrence of this bat in northeastern British Columbia including the MKMA needs to be confirmed by captures.

### **Silver-haired Bat (*Lasionycteris noctivagans*)**

Nagorsen and Brigham (1993) reported records as far north as the Spatzizi Plateau. Bradbury et al. (1997) detected echolocation calls of the Silver-haired Bat on 6 of 25 nights during their study on the Lower Liard River and Highway 77 northeast of the MKMA. Because of potential confusion with echolocation calls of the Big Brown Bat, the occurrence of this species in northeastern British Columbia including the MKMA needs to be confirmed by captures.

### **California Myotis (*Myotis californicus*)**

Wilkinson et al. (1995) captured the California *Myotis* on the Liard River, although Bradbury et al. (1997) and Vonhof et al. (1997) did not find this bat in subsequent bat inventories done in adjacent areas. As the northern-most records reported by Nagorsen and Brigham (1993) were from Wells Gray Provincial Park and the Queen Charlotte Islands, the records from the Liard River represent a significant range extension.

#### **Western Long-eared Bat (*Myotis evotis*)**

Bradbury et al. (1997) and Vonhof et al. (1997) reported a colony (probably a nursery colony) roosting in a cabin on the Smith River and captured it at several sites during their study on the Lower Liard River and Highway 77 northeast of the MKMA. Their records are far north of Prince George, the northern-most records given by Nagorsen and Brigham (1993). Except for the colony in the cabin at Smith River and the capture of a single male near a Northern Long-eared *Myotis* tree roost, no data exist on this species' roosting habitat in northeastern British Columbia.

#### **Northern Long-eared *Myotis* (*Myotis septentrionalis*)**

Because it was listed on the provincial red list (now downlisted to the blue list), Wilkinson et al. (1995), Bradbury et al. (1997) and Vonhof et al. (1997) focused most of their inventory effort on the Northern Long-eared *Myotis* in northeastern British Columbia. They reported a nursery colony in a cabin on the Smith River road and captured a number of individuals with mist nets at their study sites on the Lower Liard River and Highway 77 northeast of the MKMA. Although Nagorsen and Brigham (1993) reported Hudson Hope as the northern-most location for this bat in British Columbia, it has been found in Nahanni National Park in the Northwest Territories (van Zyll de Jong 1985) and its occurrence in northeastern British Columbia is not unexpected. Using radiotelemetry, Bradbury et al. (1997) and Vonhof et al. (1997) found 15 roost trees for this species that contained 1 to 58 bats. Most were in cracks in of Balsam Poplar, Trembling Aspen, and White Birch.

#### ***Myotis volans* (Long-legged *Myotis*)**

Bradbury et al. (1997) and Vonhof et al. (1997) captured Long-legged *Myotis* including breeding females during their studies on the Lower Liard River and Highway 77 northeast of the MKMA. There are also historical records (Nagorsen and Brigham 1993) from as far north as Atlin. This bat presumably occurs throughout the MKMA. No roosting data are available for this species in northeastern British Columbia. Vonhof (1997) captured a single male near a Northern Long-eared *Myotis* tree roost but there was no evidence that the Long-legged *Myotis* was roosting in the tree.

#### **Collared Pika (*Ochotona collaris*)**

The American Pika (*Ochotona princeps*) reaches its northern limits in the Rocky Mountains at Mount Robson Provincial Park. The Collard Pika, a species that reaches its southern limits in extreme northwestern British Columbia is the pika that would be expected to occur in the MKMA. Nearest records are in the Atlin area (Cowan and Guiguet 1965; Nagorsen 2001); there are no records of the Collard Pika from the northern Rocky Mountains or the Stikine Range of the Cassiar Mountains. Sheldon (1932) noted the absence of pikas in the northern Rocky Mountains in the Laurier Pass region and

Rand (1944) found no evidence for pikas in Muncho Pass and Summit Pass in the northern Rocky Mountains. Similarly one of us (D. Nagorsen) did not observe pikas in alpine areas of several unnamed mountains above the Turnagain River. Although existing data strongly suggest that the Collard Pika is absent from the MKMA, Rand (1944:46) stated, "The only information as to the occurrence of this animal was from that of Dr. Holland<sup>2</sup> who found pikas in the mountains above Sikanni Chief River, some 25 miles above the highway [Alaska Highway ]". More inventory is needed in talus habitats to confirm the absence of the Collared Pika in the MKMA.

### **Tundra Vole (*Microtus oeconomus*)**

This arctic vole reaches the southern limits of its range in extreme northwestern British Columbia (Cowan and Guiguet 1965; Nagorsen 2001). The nearest record to the MKMA is a series of specimens housed in the collections of the RBCM that were taken at Mount McDame near the Cassiar Mine in the Cassiar Mountains. It seems likely that the Tundra Vole occupies the Stikine Ranges of the Cassiar Mountains portion of the MKMA.

### **Northern Bog Lemming (*Synaptomys borealis*)**

Although there are no records from the MKMA, this vole is distributed across the entire province where it occupies various riparian, wetland, and alpine habitats (Nagorsen 2001). Nearest records to the MKMA are historical museum specimens from the Fort Nelson area and from Akue Creek. Nagorsen (2001) concluded that this was one of least known small rodents in the province.

## **III. GIS Analysis of Inventory Effort**

A total of 665 small mammal records were within the MKMA boundary, and more than 5,000 records exist from outside of the MKMA boundary but within ecosections or biogeoclimatic zones found within the MKMA. Locality records from within the MKMA exist for 25 of the 36 species of insectivores, bats, lagomorphs, and rodents that potentially inhabit ecosection or biogeoclimatic units represented within the MKMA.

A summary of total small mammal records by ecosection are summarized in Table 1; records for each species in each ecosection are given in Appendix 3. The Cassiar Ranges, Southern Boreal Plateau (not shown on Fig. 2 because of its small area), and Hyland Highland ecosections are over represented with the number of records greater than would be expected based on their areas relative to the entire MKMA. However, none of the records from the Southern Boreal Plateau are within the MKMA. The Hyland Highland ecosection also has a high number of records per sampling location (over 44 observations/site). All of the records for the Muskwa Foothills and Eastern Muskwa Ranges ecosections are from within the MKMA. There are no records for the Misinchinka Ranges, Muskwa Plateau, although these ecosections make up about 2% and 7% of the MKMA, respectively.

A summary of total small mammal records by biogeoclimatic unit are summarized in Table 2; records for each species in each biogeoclimatic unit are given in

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<sup>2</sup> George Holland was a flea expert with the British Columbia government and later the Biosystematic Research Institute in Ottawa. He had a good knowledge of British Columbia's small mammal fauna.

Appendix 4. The BWBS dk1, mw1, mw2 and SWB unr biogeoclimatic units are over represented based on records from outside of the MKMA and their areas relative to the entire MKMA. The BWBS mw1 is an extreme example of over representation, with over 16% of the total records within the MKMA in only 0.02% of its area. The BWBS mw2 and ESSF mv2 are not represented by any records within the MKMA, although they comprise 8.7% and 2.8% of the area. Locality records for the SWB mk biogeoclimatic are nearly all (about 88%) from within the MKMA.

There are few locality records from within the protected areas of the MKMA areas, and the number of different sites with mammal records are few (Table 3, Appendix 5). Of the 17 protected areas within the MKMA, mammal records exist for only 7. The largest park within the MKMA, the Northern Rocky Mountains, makes up nearly 60% of the protected area within the MKMA, but has only 20 records from 3 locations.

## **DISCUSSION**

### **I. Small Mammal Fauna of the MKMA**

Our analysis of the limited available data suggests that the MKMA supports a diverse fauna of bats, insectivores, lagomorphs, and rodents with as many as 36 species potentially occurring within MKMA. The fauna consists largely of small mammals that range throughout the southern Rocky Mountains and boreal forests of western Canada. But, several arctic species such as the Arctic Ground Squirrel (*Spermophilus parryii*), Northern Red-backed Vole (*Clethrionomys rutilus*), and possibly the Tundra Vole (*Microtus oeconomus*) extend into the western portion of the MKMA. The Rocky Mountain Trench and western slope of the Rocky Mountains appear to be barriers that delimit the western limits of these arctic species in the MKMA. Because the MKMA supports considerable ecosystem diversity, it offers considerable potential for studying small mammal community structure and fine scale habitat use in a range of northern ecosystems.

Ecological and physiographic barriers associated with the Rocky Mountain Trench and the eastern and western slopes of the northern Rocky Mountains have promoted taxonomic diversity in the MKMA and form a barrier among several taxa. Therefore, the MKMA has great potential for taxonomic research. The best example is the Northern Red-backed Vole and Southern Red-backed Vole (*Clethrionomys gapperi*) species. A contact zone between the two species exists somewhere near Summit Pass. Precise boundaries of this zone and the degree of interbreeding among these two species in the contact zone are unknown. A similar pattern is shown by subspecies of several mammals. Two subspecies of the Heather Vole (*Phenacomys intermedius intermedius* and *P. i. mackenzii*) come into contact in the MKMA. Some authorities (Cowan and Guiguet 1965) consider the Heather Vole to consist of two species: an eastern form (*P. ungava*) and a western form (*P. intermedius*). The races *P. i. intermedius* and *P. i. mackenzii* represent these two forms. To what extent they are in contact and interbreed in the MKMA is unknown. Subspecies of the Least Chipmunk (*Tamias minimus borealis* and *T. m. caniceps*), Red Squirrel (*Tamiasciurus hudsonicus preblei*, *T. h. columbiensis*), are also in contact in the Rocky Mountains area of the MKMA.

### **II. Limitations of the Inventory Data**

#### ***Zoogeography and General Distribution***

Locality records for small mammals in the MKMA are sparse. They are also biased temporally, spatially, and in terms of inventory techniques. Most of the available records are based on historical museum specimens or observations collected more than 40 years ago. It is conceivable that habitat changes particularly in areas along the Alaska Highway have altered the small mammal distributions and since these early inventories were done. Moreover, because these early inventories involved general museum collecting, modern sampling techniques (e.g., bat detectors or pitfall traps with drift fences) were not employed and records of species rarely captured in conventional small mammal traps such as the Pygmy Shrew (*Sorex hoyi*) are few. Geographically, the inventory coverage reflects the lack of roads in the MKMA. Of the 665 observations made within the MKMA, 243 are within 1 km of the Alaska Highway, 320 are within 2 km, and 351 are within 5 km. Other areas sampled historically such as Laurier Pass-Redfern Lake were areas accessible by well established pack horse routes. Ecological sampling in representative biogeoclimatic units or Ecosections reflects the bias for sampling along the Alaska Highway. The Hyland Highland and Southern Boreal Plateau ecosections are easily accessible from the highway, as the over represented biogeoclimatic units. A similar bias exists in the numbers of locality records from within the protected areas within the MKMA. Of 17 protected areas, data exists for only 7. Most small mammal records are associated with Muncho Lake and Stone Mountain provincial parks, areas adjacent to the highway. Given the temporal and sampling technique bias virtually the entire MKMA requires additional small mammal inventory work. However, some of the most poorly studied areas in the MKMA and highest priority for more inventory are the western portion in the Kechika Mountains and Cassiar Ranges Ecosections.

Predictions of species occurrences and ecosystem association using records adjacent to the MKMA also has limitations because most of these records are historical and share the same biases as the records from within the MKMA boundary. The one exception are the bat surveys conducted in the 1990's (Wilkinson et al 1995; Bradbury et al. 1997; Vonhof et al. 1997) near the MKMA. They applied modern inventory techniques and collected extensive habitat data for their study sites. Their biogeoclimatic zone units and Ecosections occur in the MKMA. However, the bat studies were done in summer and no information exists on bat hibernation sites in northeastern British Columbia (Nagorsen et al. 1993). Because these bats typically move no more than a few 100 kilometres between summer and winter roosts (Nagorsen and Brigham 1993), it is likely that most of these bat species hibernate in northeastern British Columbia. Wilkinson et al (1995) identified potential bat hibernacula along the Alaska Highway but the only survey of these sites was a single visit in February 1997 (see Bradbury et al 1997).

### ***Ecology***

Habitat data for the MKMA is largely restricted to occurrences in ecosections and biogeoclimatic zones. Community structure and fine scale habitat use of small mammals in the MKMA are virtually unknown. Because most of the data are derived from general museum collecting, there has been no systematic sampling in representative communities or habitats to determine relative abundance, species composition, and species diversity of small mammals. Modern ecological studies applying a range of trapping methods in various representative habitats are needed on the insectivores and rodents of the MKMA.

The one group for which detailed habitat data exist are the bats. However, even those data are limited. Because the focus was on one species, the Northern Long-eared Myotis, it was the only bat tracked by radiotelemetry to determine roosting ecology. Radio-tracking should be applied to other bats found in northeastern British Columbia. Because most of these bats are at the northern limits of their range in northeastern British Columbia any data on their roosting requirements would be invaluable.

## **RECOMMENDATIONS**

1. This study was initiated before the Mackenzie addition to the MKMA. The entire GIS analysis should be redone including the Mackenzie portion of the MKMA with its associated GIS themes (biogeoclimatic units, Ecosections, and protected areas, and boundary polygon). This will add additional ecosystems to the analysis and presumably capture additional historical small mammal records from the MKMA.
2. Data from registered trap lines and the provincial fur harvest should be included in the report and incorporated into the species accounts for furbearers.
3. Traditional knowledge from aboriginal groups and other individuals familiar with the mammalian fauna of the MKMA such as trappers, hunters, guide outfitters could be incorporated into the report. Most of the traditional knowledge will apply to fur bearers but it may include information on some of the conspicuous diurnal species such as the Hoary Marmot, Arctic Ground Squirrel, and pikas.
4. Although there are few modern small mammal inventories for the MKMA and adjacent areas, our attempt to acquire copies of available reports and mammal locations from specific study sites has been frustrating. For example, we have been unable to obtain a copy of the Wilkinson et al. (1995) bat report. Evidently, it is not available in the Fort St. John MELP office, nor is it available in Victoria in the MELP or MOF research libraries. The bat report by Bradbury et al. (1997) has a detailed list of study sites with UTM co-ordinates and habitat classifications but curiously the bat species taken at each site is not given. The only site data given in the report are for the Northern Long-eared Myotis. Other studies such as the Del Rio small mammal study evidently do not have any associated reports. We recommend that the results (reports, site data, RIC data sheets etc.) of all small mammal inventories from the MKMA and relevant areas should be deposited in a central repository (e.g. MELP research library) where it is readily accessible to all researchers.
5. We recommend that future small mammal inventory in the MKMA involve a broad approach that includes: 1) general presence-absence inventories across the MKMA to determine the broad distribution of species in the MKMA; 2) detailed population, habitat and community studies in representative habitats; 3) and taxonomic studies. BC Parks staff, guide outfitters, government biologists can contribute to the general inventories and they should be encouraged to record any observational records of conspicuous small mammals in the MKMA. Their observations should be deposited in central data repository.
6. Our small mammal study could be broadened to include the small carnivores (mustelids, skunks). Some historical museum records exists for these species in the MKMA and these data could be supplemented with fur harvest data and traditional knowledge.

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**Figure 1. Location and geographic features of the Muskwa-Kechika Management area**