Mammal Inventory of Alaska's National Parks and Preserves

Lake Clark National Park and Preserve

Annual Report 2003

Joseph A. Cook
Stephen O. MacDonald
Museum of Southwestern Biology
MSCO3 2020
University of New Mexico
Albuquerque, New Mexico 87131
505-277-1358

January 2004

National Park Service
Southwest Alaska Network
Inventory and Monitoring Program

Cooperative Agreement H8R07010001
Task Agreement J8R07030002
Funding Source: National Park Service, SW Alaska Network

File Name: CookJ_2004_LACL_Mammals2003AnnRept_567479.pdf

Recommended Citation:
Cook, J. A., and S. O. MacDonald. 2004. Mammal inventory of Alaska's National Parks and Preserves: Lake Clark National Park and Preserve. Southwest Alaska Network Inventory and Monitoring Program, USDI National Park Service, Anchorage, AK. 34 pp.

Theme Keywords:
Mammals, small mammals, inventory, museum specimens

Placename Keywords:
Alaska, Southwest Alaska Network, Lake Clark National Park and Preserve, LACL, SWAN

Table of Contents

Abstract

This report details the inventory of mammals in Lake Clark National Park and Preserve (LACL) between 7 and 31 July 2003 as part of a cooperative effort of the Beringian Coevolution Project at the Museum of Southwestern Biology, University of New Mexico and the Inventory and Monitoring Program of the National Park Service of Alaska.

We begin the process of documenting the approximately 36 species of mammals that occur in the Park, with a primary focus on small mammals (i.e., shrews, voles, lemmings, weasels, porcupine, squirrels, and hares). This survey resulted in 856 primary specimens comprising 17 species.

Across all localities sampled, two shrews (*Sorex cinereus*, *S. monticolus*) and a murid rodent (*Clethrionomys rutilus*) were the most frequently captured species, comprising over 85% of all mammals sampled.

The discovery of singing vole (*Microtus miurus*) at Turquoise Lake constitutes a new mammal for the park and a major range extension for the species. This inventory also provided the first documented records in LACL of pygmy shrew (*Sorex hoyi*), montane shrew (*Sorex monticolus*), tundra shrew (*Sorex tundrensis*), little brown bat (*Myotis lucifugus*), and ermine (*Mustela erminea*). Two tiny shrews (*Sorex yukonicus*) collected at Turner Bay are only the second record of this rare species in the park and constitutes the latest additions to the 37 specimens now known to science.

The findings from this study, when combined with specimen information gathered from a review of holdings at the University of Alaska Museum and other major collections, bring the total number of documented small mammal species in LACL to 18 of 22 probable species, or 82% coverage.

The specific products of this inventory include a large collection of well-prepared, well-documented, and diverse preparations of mammal specimens and associated materials (tissues, parasites, fecal samples, digestive tracts) for taxonomic, zoogeographic, ecological, genetic, parasitological, epidemiological, and other research and management purposes.

Executive Summary

This inventory project was a cooperative effort of the Beringian Coevolution Project (BCP) at Idaho State University, now at the Museum of Southwestern Biology, University of New Mexico and the Inventory and Monitoring Program of the National Park Service (NPS-I&M) of Alaska. Other participating institutions included the University of Alaska Museum (UAM), USDA National Parasite Collection, University of New Mexico, and The Finnish Forest Research Institute (Vantaa Research Centre). Personnel involved in this field effort were Kurt Galbreath (crew leader), Natalie Dawson, Dolly Crawford, Kayce Bell, Joe Cook, Bill Leacock(NPS-I&M) and family.

This report details the inventory of mammals at 10 localities in Lake Clark National Park and Preserve (LACL) between 7 and 31 July 2003. We begin the process of documenting the approximately 36 species of mammals that occur in the Park, with a primary focus on small mammals (i.e., shrews, voles, lemmings, weasels, porcupine, squirrels, and hares).

The specific products of this inventory include a large collection of well-prepared, well-documented, and diverse preparations of mammal specimens and associated materials (tissues, parasites, fecal samples, digestive tracts). This survey (146 person-days and 4563 trap nights of collecting effort) resulted in 856 primary specimens (excluding embryos) comprising 17 species. All voucher specimens of mammals were deposited in the University of Alaska Museum.

Across all localities sampled in 2003, two shrews (cinereus shrew, montane shrew) and a murid rodent (northern red-backed vole) were the most frequently captured species (385, 109, and 238 specimens, respectively), comprising over 85% of all mammals sampled.

The findings from this study, when combined with specimen information gathered from a review of holdings at UAM and other major collections, bring the total number of documented small mammal species in LACL to 18 of 22 probable species, or 82% coverage.

The discovery of singing vole at Turquoise Lake constitutes a new mammal for the Park and a major range extension for the species. This inventory also provided the first documented records in LACL of pygmy shrew, montane shrew, tundra shrew, little brown bat, and ermine. The two tiny shrews collected at Turner Bay are only the second record of this rare species in the park and constitutes the latest additions to the 37 specimens now known to science.

Perspectives on the value of the specimen-based approach to inventory and monitoring are discussed, and recommendations for future efforts are enumerated.

Introduction

This report details an inventory of the small mammals of Lake Clark National Park and Preserve (LACL) between 7 and 31 July 2003. The Beringian Coevolution Project (BCP), previously centered at Idaho State University (ISU), but now at the Museum of Southwestern Biology (MSB), University of New Mexico, worked collaboratively with the Inventory and Monitoring Program of the National Park Service, Alaska, and the University of Alaska Museum (UAM) to conduct an inventory at selected sites throughout LACL to document the occurrence, relative abundance, and general habitat affinities of its small mammal fauna (Table 1).

This effort is beginning to provide a large series and variety of permanently preserved materials and associated data sets for taxonomic, zoogeographic, ecological, genetic, parasitological, epidemiological, and other research and management purposes. Because the fauna of Alaska is the least studied of the continent, these NPS inventories are an important contribution to our understanding of mammalian diversity.

Methods and Materials

Review of Museum Collections

Documentation of species' occurrence in LACL was complemented by a review of specimen holdings at the University of Alaska Museum (UAM) and other major collections, primarily the U.S. National Museum (USNM). Scientific and common names of mammals used in this report follow Wilson and Reeder (1993) and Wilson and Cole (2000), respectively. Vegetation classification generally follows Viereck et al. (1992).

Field Studies

The BCP field crew conducted surveys for small mammals at 10 general localities in 2003. Crew members included Kurt Galbreath (crew leader), Natalie Dawson, Dolly Crawford, and Kayce Bell, with Joe Cook and family helping during their stay at one locality. Bill Leacock, NPS-I&M, and family were indispensable members of the BCP field crew for most of the field season.

Our collecting strategy was designed to maximize the number and diversity of samples by using a variety of methods in available habitats. While particular effort was made to sample rare or undocumented small mammals, the sampling methods used also allowed us to evaluate the occurrence and relative abundance of the more common species.

Diversity of captured specimens was maximized by utilizing a variety of trap types, including snap traps (Museum Specials, rat traps) and live traps (44 oz. plastic drinking cups buried as pitfall traps, Sherman live traps). Larger species, such as arctic ground squirrel and snowshoe hares, were sampled with shotgun.

Traplines for shrews and voles were set in the range of available habitats and ecotones in each study location. Traplines typically consisted of 20 or more trap stations per line, with stations spaced 8-10 m apart. At each station, two snap traps or one snap trap and one pitfall trap were typically set within 2 m of each station point. The snap traps were baited with a mixture of rolled oats and peanut butter; pitfall traps were buried flush with the ground and left unbaited. Traps were usually set in the late afternoon and checked the following morning. Productive lines were usually kept in operation for two or more nights.

Between 7 and 31 July 2003, the BCP field crew sampled 10 general areas in LACL (Figure 1), for a total of 146 person-days and 4563 trap nights of collecting effort on 62 trapline transects. These transects were located in a variety of habitats and elevations (Table 3). Logistical support was provided by the National Park Service.

Field Locations

Chulitna Bay, Lake Clark (60.167N, 154.567W [NAD27]): 7-11 July 2003. A total of 11 trapline transects, established at three separate collecting sites (**Turner Bay**, **West of Chulitna River mouth**, **South of Chulitna River**) resulted in the capture of 243 animals, comprising nine species. Three of these—tiny shrew, northern bog lemming, little brown bat—were found only at this location.

Head of Lake Clark (60.383N, 153.833W [NAD27]): 11-14 July 2003. We sampled 99 small mammals of six species, including the first of several meadow jumping mice taken during our survey, using a total of 11 traplines set in a variety of herbaceous, scrub, and forest vegetation types.

Silver Salmon vicinity, Cook Inlet (59.983N, 152.667W [NAD27): 15-19 July 2003. A total of 195 small mammals of five species were sampled on 10 trapline transects in two separate general localities: **Johnson River** and **Silver Salmon Lakes**. We captured the highest number of meadow jumping mice (6) in this area of study.

Turquoise Lake (60.783N, 153.85W [NAD27]): 20-24 July 2003. A total of 143 specimens was sampled on 15 trapline transects established in a wide variety of habitats at various elevations. We found small mammal species richness highest at this locality (12 species), and the only site were we obtained samples of pygmy shrew, singing vole (a first for LACL), and collared pika.

Two Lakes vicinity (61.10N, 153.85W [NAD27]): 25-28 July 2003. The establishment of 15 trapline transects near **Two Lakes** and the **Necons River** resulted in the capture of six species and 156 total specimens.

Port Alsworth, Tanalian Mountain (60.20N, 154.217W [NAD27]): 31 July 2003. A small series of arctic ground squirrels was collected with shotgun one day in the hills near Port Alsworth. No trapline transects were established in this area; however, a tundra shrew (a first for LACL), a number of red squirrels, ermine, and several other fur-bearing species were obtained from some of the town's residents.

Specimen Processing
Each animal sampled was preserved as a scientific specimen in the form of a skeletal preparation or as a whole bodied fluid (ETOH) preparation. A small number of dried study skins were also prepared. Additional specimens were also obtained from several of the residents of Port Alsworth. Each crew carried a tank of liquid nitrogen in the field to preserve tissues (heart, liver, kidney, spleen, and lung) and embryos. These frozen specimens were transferred to ultra-low temperature freezers at UAM and MSB and are archived at -70° C. We preserved ectoparasites, and endoparasites from many of the mammals collected. These exceptional data sets will be used to address epidemiological, coevolutionary, taxonomic, and biogeographic questions. Intestinal tracts from shrews were also preserved. Field protocols allowed us to rigorously document and preserve specimens.

The primary voucher specimens from this study were accessioned into the mammal collection at UAM and are in process of curation. The samples of endoparasite are now at the US National Parasite Collection in Beltsville, MD and the Vantaa Research Centre in Vantaa, Finland. The samples of ectoparasites are being disbursed to qualified experts from MSB.

Results and Species Accounts

The specific products of this inventory include a large collection of well-prepared, well-documented, and diverse preparations of mammal specimens and associated materials (tissues, parasites, fecal samples, digestive tracts). A total of 856 small mammal specimens (excluding embryos) comprising 17 species was archived from LACL during the 2003 field season (Table 2).

Two shrews (cinereus shrew, montane shrew) and a murid rodent (northern red-backed vole) were the most frequently captured species (385, 109, and 238 specimens, respectively), comprising 85% of all specimens collected (Figure 2a-c).

This study, when combined with previous efforts and from specimen information gathered from holdings at UAM and other major collections, increased the total number of documented small mammal species in LACL to 18 of 22 probable species (Table 1), or 82% coverage.

Species Accounts
The following accounts summarize information on each species known or suspected to occur in LACL (Table 1). Detailed data on all specimens will be available in the UAM database and accessible on its website (http://arctos.museum.uaf.edu:8080/uam_db/).

Order **INSECTIVORA**—Shrews
Family **Soricidae**

Sorex cinereus, cinereus shrew
Cinereus shrews were numerous and widespread in 2003, resulting in the total capture of 385 individuals. Highest relative densities were found in the vicinities of Silver Salmon (12.7 animals captured per 100 trap nights of effort) and Chulitna Bay (11.7 animals/100 trap nights). This species is widely distributed in Alaska and generally common throughout its range.

Sorex hoyi, pygmy shrew
A single pygmy shrew was captured in a pitfall trap set in tussock-dwarf willow scrub along a south-facing boulder slope near the northeast corner of Turquoise Lake. This specimen constitutes the only record of the species in LACL. Previous records near the park are from the headwaters of the Chulitna River (USNM; Osgood 1904) and Nondalton (Rausch 1967), the southernmost record of the species at the base of the Alaska Peninsula.

The type locality of the only subspecies recognized in Alaska, *S. h. eximus*, was described by Osgood (1901) from a single individual collected east of the park at Tyonek on Cook Inlet.

Sorex monticolus, montane shrew
Montane shrews were found at all trapline localities and most frequently captured at Turquoise Lake (66 specimens; 7.3 captures/100 trap nights of effort). These samples comprise the first documented records in LACL of this widely-distributed shrew.

Sorex tundrensis, tundra shrew
An over-wintered tundra shrew was found dead and in good condition near a home in Port Alsworth at the end of our field season. This is the first documented record for LACL. Tundra shrews are found throughout most of Alaska, including the Alaska Peninsula. According to some authors (Junge et al. 1983, van Zyll de Jong 1983), this species also occurs in eastern Siberia.

Sorex yukonicus, tiny shrew
Two tiny shrews collected at Turner Bay comprise only the second documented record of this species in LACL. The first, from Turquoise Lake on 28 June 1999, is a single individual (SU 167362) recently discovered in the collections at Moscow (Russia) University by Dr. N. Dokuchaev (pers. com.). The Turner Bay tiny shrews were captured on consecutive days in the same pitfall trap set near the shore's edge (60° 10.827' N, 154° 33.897' W) in willow thickets interspersed with *Iris*, *Elymus* and *Carex*.

Order **CHIROPTERA**—Bats
Family **Vespertilionidae**

Myotis lucifugus, little brown bat
Several bats were seen (after 23:30 hr) flying around the lodge and camp south of the Chulitna River near Turner Bay. One male (IF 9213) and a pregnant female *M. lucifugus*

(IF9214) were captured in a mist net set near a shed surrounded by closed mixed forest. These constitute first specimen records for LACL. The species is known to occur, at least occasionally, as far south on the Alaska Peninsula as King Salmon (UAM, Parker et al. 1997).

Order **CARNIVORA**—Carnivores

Family **Canidae**

Canis latrans, coyote
A lone coyote was seen on Tanalian Mountain near Port Alsworth on 31 July 2003. To our knowledge, no specimens of this species, which first arrived in the region during the 20th century, has been preserved from the park.

Canis lupus, wolf
The BCP crew did not encounter any wolves but did note their sign at Two Lakes. No specimens of this widely-distributed canid have been preserved from the park.

Vulpes vulpes, red fox
Individual red foxes were seen at Chulitna Bay and Turquoise Lake. The partial carcass of a red fox trapped 3 November 2002 near Dice Bay (60.2222° N, 154.3987° W) was necropsied for parasites and its tissues sampled (IF 9928). The skull and a sample of muscle tissue was also preserved (IF 9911) from a red fox collected near Port Alsworth on 25 February 2003.

Family **Felidae**

Lynx canadensis, Canada lynx
A lynx was seen near the shore of Lake Clark near Tommy's Creek. The skull and a sample of muscle tissue was preserved (IF 9908) from a lynx captured on 17 February 2003 near Lake Clark (60.2192° N, 154.2497° W).

Family **Mustelidae**

Gulo gulo, wolverine
No wolverines or their sign were seen during the course of the study. No specimens of this wide-ranging mustelid have been preserved for study from within the park. Osgood (1904) considered wolverines to be rather common on the Alaska Peninsula.

Lontra canadensis, northern river otter
No river otters or their sign were observed or reported during this study, nor are there any voucher specimens from the park. This species is known to occur throughout the region and along the Alaska Peninsula to Unimak Island (USNM; Murie 1959, ADFG 1978). Osgood (1904) noted otters on Lake Clark when he visited the area for the U. S. Biological Survey in 1902.

Martes americana, American marten
No martens were encountered during this study; however, voucher material from three individuals trapped near Port Alsworth in November 2002 were preserved (IF 9910, 9912-13).

Mustela erminea, ermine
A live ermine was seen at Turner Bay and one was found dead of unknown causes at Turquoise Lake. Two winter-caught ermine from Port Alsworth (IF 9903-04) and one from Silver Salmon Creek (IF9905) were prepared as vouchers.

Mustela nivalis, least weasel
Least weasels were not observed or reported. The species appears to be sparsely distributed throughout much of its holarctic range, which includes the Alaska Peninsula as far west as Unimak Island (UAM, USNM; Murie 1959). The closest verifiable records to LACL of this weasel are Tyonek on Cook Inlet (USNM: Osgood 1904), Red Devil on the Kuskokwim River (UAM), and at the far end of the Alaska Peninsula near Cold Bay (UAM).

Mustela vison, American mink
Mink are known to occur throughout the region (Osgood 1904, Murie 1959, Manville and Young 1965, ADFG 1978); however, no sightings or sign of this semi-aquatic species were noted during this study, nor have any specimens been preserved from the park.

Family **Ursidae**

Ursus americanus, American black bear
An adult black bear was seen north of Port Alsworth on Tanalian Mountain. The distribution of this species coincides closely with the distribution of forests, resulting in their rare occurrence south of the sparse spruce forest near Iliamna Lake (ADFG 1973). USNM houses two specimens taken south of LACL at Iniskin Bay.

Ursus arctos, brown bear
The tracks of a brown bear were noted near the head of Lake Clark , and a number of animals were seen in the tidal flats near Silver Salmon. Specimens have been preserved from several locations in the park (UAM, USNM).

Order **ARTIODACTYLA**—Ungulates
Family **Cervidae**

Alces alces, moose
Our field crew observed a female moose on the east side of Turner Bay. There are no specimens of this species preserved from the park.

Rangifer tarandus, caribou
Caribou and their sign were seen only at Turquoise Lake. No specimens have been preserved from the park.

Family **Bovidae**

Ovis dalli, Dall's sheep
A group of eight Dall's sheep was seen on Tanalian Mountain, north of Port Alsworth, which is at the southernmost edge of this species' range (ADFG 1973). The only preserved specimens of this species from anywhere in the region are two in the USNM from the Chigmit Mountains (exact location unknown).

Order **RODENTIA**—Rodents
Family **Sciuridae**

Marmota caligata, hoary marmot
A marmot was seen but not collected in the mountains east of Turquoise Lake. Osgood (1904) mentioned sightings of marmots in the hills near Keejik (*sic*) on Lake Clark. This species is found along the length of the Alaska Peninsula (Allen 1904, Osgood 1904, Murie 1959). No specimens have been preserved from the park.

Spermophilus parryii, arctic ground squirrel
Arctic ground squirrels were sampled at Turquoise Lake and Port Alsworth. Osgood (1904) noted several pairs of ground squirrels occupying a short stretch of beach on Lake Clark and collected several (USNM) on the mountains about the head of the lake.

Tamiasciurus hudsonicus, red squirrel
Red squirrels were sampled near the Chulitna River, Turquoise Lake, and Two Lakes. A small series of red squirrels was also obtained from near Port Alsworth by a local resident. This species occurs farther south to the limit of spruce in the vicinity of Naknek Lake (Schiller and Rausch 1956).

Family **Castoridae**

Castor canadensis, American beaver
Beavers were noted at the head of Lake Clark and Turquoise Lake. No specimen of this species has been preserved from the park.

Family **Dipodidae**

Zapus hudsonius, meadow jumping mouse
Meadow jumping mice were sampled at the head of Lake Clark, Johnson River, Silver Salmon, and Turquoise Lake. Osgood (1904) collected several jumping mice for the USNM from near Keejik (*sic*) on Lake Clark. This mouse is found throughout the length of the Alaska Peninsula to (possibly) Unimak Island (Murie 1959).

Family **Muridae**

Clethrionomys rutilus, northern red-backed vole
The red-backed vole was the second most frequently captured small mammal species in 2003, accounting for 27 per cent of all trapline captures. It was found at all localities sampled. Relative abundance among localities ranged from 12.7 captures per 100 trap nights of effort to 1.88 captures per 100 trap nights. This holarctic vole occurs extensively throughout the state in a wide variety of habitat types.

? *Dicrostonyx groenlandicus*, collared lemming
No collared lemmings were found; however, the recent discovery by UAM of a mummified collared lemming in rocky alpine tundra habitat approximately 6.5 km west of The Cone (59°53'25"N, 153°55'41" W) and only about 50 km south of LACL, along with the capture of several collared lemmings near Kirschner Lake (59°26'58"N, 153°56'37.3" W), suggest the potential occurrence of this species farther north in the Chigmit Mountains and the park.

Lemmus trimucronatus, brown lemming
No brown lemmings were sampled in this study and there are no specimens to verify their occurrence. We suspect this widely-distributed lemming will eventually be documented in the park as it has been found in the upper reaches of the Chulitna River (Osgood 1904) and along the Iliamna River near Old Iliamna (USNM).

Microtus miurus, singing vole
The capture of eight singing voles at Turquoise Lake constitutes the first record of this species in LACL. These, together with several specimens collected by UAM in 2002 from east of the park (Max Lake, McCarthy River), extends the known distribution of this species southwest along the Alaska Range from Denali National Park (Manville and Young 1965, Cook and MacDonald 2002).

Microtus oeconomus, tundra vole
A total of 42 tundra voles were collected at six trapping localities. At no locality was this widespread species particularly numerous.

Microtus pennsylvanicus, meadow vole
Meadow voles were sampled (N = 25) at four localities in LACL. This vole was first recorded in the region by Osgood (1904). Schiller and Rausch (1956) reported this species on the Alaska Peninsula as far southwest as Naknek Lake.

Ondatra zibethicus, muskrat
No muskrats were observed during the course of this study. Osgood (1904) found them abundant in suitable aquatic habitats throughout the region and provided specimens from the mouth of the Chulitna River and the head of Lake Clark. Muskrats have not been documented south of Ugashik Lakes on the Alaska Peninsula (ADFG 1978).

Synaptomys borealis, northern bog lemming
A single northern bog lemming was collected in wet meadow habitat near the mouth of the Chulitna River, close to where Osgood (1904) first recorded the species in the region. Specimens of bog lemmings have been taken as far southwest as Cape Ugyak and Brooks River (Schiller and Rausch 1956).

Family **Erethizontidae**

Erethizon dorsatum, North American porcupine
A porcupine was seen crossing the runway at Chulitna Bay and another was noted at Turquoise Lake. Osgood (1904) found them sparingly throughout the region and was told by residents of Lake Clark that this species is quite common in that vicinity. Porcupines have been found along the entire length of the Alaska Peninsula (Murie 1959; USNM).

Order **LAGOMORPHA**—Pikas and Hares
Family **Ochotonidae**

Ochotona collaris, collared pika
Three pikas were collected at Turquoise Lake. Two pikas collected by McKay in 1882 (USNM; True 1886) in the Chigmit Mountains (exact locality unknown) have long been the only documented record of this species from anywhere in the region. Osgood (1904) mentioned pika sightings by local residents on the mountain near Keejik (sic) on Lake Clark. This species has not been reported farther south in the Aleutian Range.

Family **Leporidae**

Lepus americanus, snowshoe hare
Snowshoe hares were sampled at Turquoise Lake (N = 1) and along the Necons River near Two Lakes (N = 2). Osgood (1904) found hares especially abundant in 1902 about Lake Clark (where a series of specimens was preserved) and along the Chulitna River. This species does not range far beyond the limits of trees on the Alaska Peninsula (Murie 1959, ADFG 1978).

Habitat Affinities
Habitats of small mammals are often defined by their association with particular plants (Hoffmeister 1986). Under the influences of the topography, soils, climate conditions, and other ecological factors, plants may be placed into distinct groups referred to as vegetative communities, associations, or types. Mammals can often be associated with particular plant communities (some at the macro-scale, most others and especially the smallest ones to micro-habitat scales). Some species are restricted to few communities, others are found in many. The degree of a species' dominance in a particular vegetative community and its range across various communities often is related to varying population levels.

Populations of small mammals of high latitudes often fluctuate dramatically from year to year and season to season. These shifts in abundance, along with dynamic interspecific interaction (particularly among congeneric species) suggest that long-term studies of small mammal communities will be required to carefully assess the particular affinities of each species.

In addition to vegetation, other features and factors may influence a species' distribution, including topography, soil types, snow cover, availability of food or pathogens, and/or the presence of other important features such as water bodies, rocks, and ground litter. The unique biogeographic and evolutionary history of each species also influences its current distribution. Because Alaska's habitats have changed markedly since the last glaciation, the current distribution of nearly all species must be viewed within the dynamic geologic and climatic histories of these high latitudes.

Our preliminary work indicates that small mammals were unevenly distributed over the range of vegetation types sampled (Table 3, Figure 5). Red-backed voles, the dominant small rodent species in 2003, were sampled across a broad range of vegetation types, but were relatively most abundant in forested and scrub habitats (Figure 9). The local distribution of this flexible species may be closely tied to the presence of overhead cover, especially woody plant cover. Tall tussocks may serve as overhead protection in non-forested habitats.

Cinereus shrew populations appeared to be relatively high during this study. The general habitat requirements of shrews are related to invertebrate abundance and physical conditions such as temperature and moisture (Nagorsen 1996). All shrews seem to require sites with adequate ground cover. We found cinereus shrews occurring relatively evenly across the range of vegetation types sampled. Montane shrews were also somewhat numerous and broadly distributed but with over half their captures concentrated in scrub communities. The two tiny and one pygmy shrew captured were associated with scrub vegetation.

The three species of *Microtus*, while nowhere abundant, displayed differing patterns of habitat occupancy. Meadow voles were generally found concentrated in the wetter meadow habitats at lower elevations, while singing voles were restricted primarily to scrub and mesic-to-dry herbaceous habitats at higher elevations. Tundra voles, in contrast, occupied grassy situations across a relatively broad range of vegetation types and elevations.

Overall, small mammals were most diverse (species richness) and abundant in scrub and forest habitats (Figure 4, 5).

Discussion and Significance

This inventory confirms the importance of the Lake Clark National Park and Preserve for a rich assemblage of arctic, boreal, and southcoastal mammals. Of the Park's

approximately 36 species of mammals, most have holarctic distributions or close affinities with Old World species (e.g., Rausch 1963, Hoffmann and Peterson 1967, Hoffmann et al. 1979). Among small mammals, 18 of 22 species believed to occur in LACL are now documented with specimens (Table 1). In contrast, all but five of the remaining mammal species (less than 36%) are documented with vouchers, and among these none are documented with more than three specimens preserved for later study.

Small mammal species yet to be vouchered with specimens are least weasel, hoary marmot, brown lemming, and porcupine. Two more species may occur in the Park (water shrew and collared lemming) and an effort should be made to document these species.

Three species—two insectivores (cinereus shrew, montane shrew) and a generalized fruit-seed-leaf feeder (northern red-backed vole)—dominated the small mammal community of LACL in 2003, accounting for over 85% of all trapline captures. It is important to emphasize, however, that wide density shifts are the norm at high latitudes, so this year provides a single snapshot of relative densities across all these species.

This inventory provided the first documented records from LACL of pygmy shrew, montane shrew, tundra shrew, little brown bat, and ermine. The discovery of singing vole at Turquoise Lake constitutes a new species for the Park and extends the known range of this species to the southwest. The capture of the tiny shrew at Chulitna Bay is only the second locality record of this species in LACL, the first being a single specimen from Turquoise Lake and housed at Moscow University, Russia (N. Dokuchaev, pers. com.). The two new LACL specimens, when added with five other tiny shrews captured in Kobuk Valley National Park during this same time period, raises the total number of specimens known to science to 37 individuals (Figure 3).

The most significant and valuable product of this inventory is the large collection of well-documented and diverse preparations of scientific specimens.

Why specimens? As elucidated by Reynolds et al. (1996), voucher specimens and corresponding data assembled during field surveys of mammals are critical for accurate identification of the animals studied and for verification of the data gathered and reported as resulting from the investigation. Voucher specimens are particularly valuable for studies of the smaller species that are difficult to identify (e.g., shrews, *Microtus* voles) and these are often poorly known (most Alaska small mammals).

Long after the original inventory is completed, voucher specimens and their associated materials will be used for a wide array of studies such as taxonomic revisions, biogeographic and conservation studies (e.g., Cook and MacDonald 2001), evolutionary studies (Cook et al. 2001), parasitology (e.g., Hoberg et al. 2003), and epidemiology (e.g., Goethert et al. ms).

Voucher specimens also provide a critical historical baseline for assessment of change caused by natural or human perturbations. As they represent historical populations, the

value of large series of specimens increases through time, particularly as the diversity of many localities is degraded. Solid inventories of federal lands has become increasingly important as these lands often are now used to establish baseline conditions for investigations aimed at documenting anthropogenic influences and other impacts responsible for environmental change. Lessons learned from the Exxon Valdez disaster in Prince William Sound suggest that baseline data are critical to interpretation of impacts. NPS has an opportunity to incorporate regular (annual) sampling (and archiving) of select small mammals into their monitoring initiative. Such collections would prove invaluable for efforts to monitor temporal change in a major component of the biotic diversity of the Alaska's parklands. If these samples are not regularly archived, NPS will miss a tremendous opportunity to establish significant baseline datasets for future analyses of environmental change.

With PCR (polymerase chain reaction) and other innovations in the study of DNA, we now can examine and monitor genetic variation in populations of animals that were collected during different time periods; thus providing a more rigorous view of temporal genetic variation and population structure. For example, known contact zones between taxa can now be reanalyzed for temporal stability (but only if specimens from the contact zone were collected at regular intervals). Because of the dynamic geologic history of Alaska and the role that glaciers played in the distribution of organisms, these kinds of studies are essential to documenting and managing biodiversity. Recent concern with persistent organic pollutants (POPS) combined with rapid technological innovation with regard to our ability to track POPS, further enhances the utility of these specimens in such crucial areas of study such as monitoring environmental quality. Given the proximity of these Parklands to major industrialized activities such as mining and nuclear dumping, the baseline these specimens provide may indeed become critical to future NPS initiatives.

Without the preservation of specimens, inventories such as this one would have extremely limited value (either short-term or long-term). Federal tax dollars used for biodiversity assessments are most efficiently spent if agencies recognize the critical need for vouchers and provide support in both field and museum budgets for their preservation and maintenance (Reynolds et al. 1996).

While the importance of museum specimens should be generally recognized and their preparation considered essential to good science, for many the question remains: Why collect so many specimens?
Some perspectives:

- Alaska mammalogy is still in the early exploration phase. For most species of Alaska mammals, many areas, including LACL, are poorly known and inadequately represented in systematic collections. This point is acutely apparent when recent phylogeographic studies are reviewed (e.g., Fleming and Cook 2002; Stone et al. 2002; Fedorov et al. 2003).

- Small numbers of specimens will not adequately represent the inherent morphologic, genetic, and parasitic variation that exists within and among populations. Rigorous and statistically defensible scientific studies require large samples of well-preserved (and diverse) materials to account for age, sex, geographic, and/or individual variation. Taxonomic studies based on skull morphology may require undamaged material from 20 or more adult individuals of each sex per locality (i.e., a minimum of 40 adult individuals per population).

- Many of the shrews and small rodents are difficult or impossible to identify except through the careful study of specimens. Close examination of tooth pattern and comparison of body measurements and other characters are necessary to distinguish most of Alaska's shrews. Voles of the genus *Microtus* can also be especially difficult to differentiate.

- Considerable sampling effort is needed to document the rare and uncommon species. In this survey, several thousand trap nights were required to secure 2 tiny shrews.

- The number of animals removed from a population only has biological significance if it is related to the total number of animals in the population and their rate of replacement (Reynolds et al. 1996). Because Alaska's small mammals are short-lived and prolific, their reproductive potential is more than sufficient to accommodate low levels of removal through the sampling methods used in these inventory projects.

Recommendations for Future Inventory and Monitoring Efforts

1. Inventory studies must be viewed as an ongoing process and NPS must remain committed to continue the efforts begun in these initial inventories. Future monitoring efforts should include a sampling regime that regularly vouchers diverse preparations (specimens) of representative species. This initial inventory has set the stage for additional collaborative efforts to fully document the small mammal fauna of the LACL.

    - The discovery by 2003 of only three tiny shrews, *Sorex yukonicus*, in LACL demonstrates how much we have yet to learn about Alaska's small mammal fauna. Additional pitfall trapping in LACL and elsewhere in the state is needed to help determine the full geographic extent of this rare species' distribution, its ecological requirements, and to provide an adequate database of specimens to more precisely assess its taxonomic relationship with other Beringian shrews. Discovery of the tiny shrew in North America and its description as a new species within the last decade (Dokuchaev 1997) further illustrates the value of a specimen-based approach to inventory studies. Indeed, the initial detection of this new species to science was made possible only because large series of shrew

specimens sampled in surveys from the 1980s were preserved and thus available for later study by specialists.

- We believe that continued inventory efforts in LACL and elsewhere in the region will result in the discovery of the collared lemming, *Dicrostonyx groenlandicus*, beyond its currently known range. The distribution and taxonomic status of this reclusive lemming in general is poorly understood. In this account, we follow the conservative application of a single species name (and the resulting modification of subspecies listed by Hall, 1981) for Alaska collared lemmings used by Jarrell and Fredga (1993) and supported by Fedorov et al. (1999) and Fedorov and Goropashnaya (1999), while recognizing that this is not the last word on this subject. As noted by Engstrom (1999), the number of taxa from Alaska, in particular, is still in doubt, and further studies are needed to document the diversity of collared lemmings and illuminate the evolutionary history that may date as far back as the earliest radiation of arvicoline rodents (Musser and Carleton 1993).

2. LACL's exceptional fauna is composed of Western Arctic, Interior, and Southcoastal species that offer unprecedented opportunities for an array of studies that relate the dynamic glacial history of the region to the evolution and geography of its biota. The systematic relationships among Beringian shrews have been particularly problematic and are in need of further research efforts. Such investigations must be based on adequate series of diverse and well-preserved specimens. Considerable interest in the effects of climate change on biotic diversity suggests that studies of the fauna and flora of LACL could be key to understanding these impacts.

3. Ongoing efforts could expand our knowledge of the distributions and habitat preferences of arctic and boreal species that come in contact in LACL, and provide important baseline information for monitoring distribution shifts in relation to changes in climate. Long-term monitoring on biotic change is best accomplished by preserving materials from populations sampled periodically over time.

Acknowledgments

A project of this kind involved the hard work and diverse talents of many. The enthusiastic support of Lee Fink, Leon Alsworth, Jeff Caulfield, Shay Hurd and others at NPS is recognized. Special thanks to our field crew Kurt Galbreath (Cornell University), Natalie Dawson (UNM), Dolly Crawford (UNM), Kayce Bell (Idaho State University), Nella and Felipe Cook, Bill Leacock (NPS-I&M) and family. Thanks also to Brandy Jacobsen (UAM), Dr. Gordon Jarrell (UAM), Dusty McDonald (UAM) and others not listed above.

Literature Cited

Alaska Department of Fish and Game. 1973. Alaska's wildlife and habitat. Anchorage, Alaska. 144 pages + maps.

Alaska Department of Fish and Game. 1978. Alaska's wildlife and habitat. Volume II. Anchorage, Alaska. 74 pages + maps.

Allen, J. A. 1904. Mammals collected in Alaska by the Andrew J. Stone Expedition of 1903. Bulletin of the American Museum of Natural History 20 (Art. 24):273-292.

Cook, J. A., A. L. Bidlack, C. J. Conroy, J. R. Demboski, M. A. Fleming, A. M. Runck, K. D. Stone, and **S. O. MacDonald.** 2001. A phylogeographic perspective on endemism in the Alexander Archipelago of the North Pacific. Biological Conservation 97:215-227.

Cook, J. A., and **S. O. MacDonald**. 2001. Should endemism be a focus of conservation efforts along the North Pacific Coast of North America? Biological Conservation 97:207-213.

Cook, J. A., and **S. O. MacDonald**. 2002. Mammal inventory of Alaska's National Parks and Preserves: Denali National Park and Preserve. Annual Report to the Inventory and Monitoring Program, National Park Service, Alaska. 24 pages.

Douglass, R. J. 1984. Ecological distribution of small mammals in the De Long Mountains of northwestern Alaska. Arctic 37:148-154.

Engstrom, M. D. 1999. Collared lemmings, *Dicrostonyx*. Page 658 *in* The Smithsonian book of North American mammals. *Edited by* D. E. Wilson and S. Ruff. Smithsonian Institution Press, Washington, D.C., in association with the American Society of Mammalogists. 750 pages.

Fedorov, V. B., K. Fredga, and **G. H. Jarrell**. 1999. Mitochondrial DNA variation and the evolutionary history of chromosome races of collared lemmings (*Dicrostonyx*) in the Eurasian Arctic. Journal of Evolutionary Biology 12:134-145.

Fedorov, V. B., and **A. V. Goropashnaya.** 1999. The importance of ice ages in diversification of Arctic collared lemmings (*Dicrostonyx*): evidence from the mitochondrial cytochrome b region. Hereditas 130:301-307.

Fedorov, V. B., A. V. Goropashnaya, M. Jaarola and **J. A. Cook**. 2003. Phylogeography of lemmings (*Lemmus*): no evidence for post-glacial colonization of Arctic from the Beringian refugium. Molecular Ecology.

Fleming, M. A., and **J. A. Cook**. 2002. Phylogeography of endemic ermine (*Mustela erminea*) in southeast Alaska. Molecular Ecology 11:795-808.

Goethert, H. K., J. A. Cook, E. W. Lance, and **S. R. Telford III.** Submitted. Enzootic transmission of a distinct *B. microti* genotype in Alaskan microtine rodents. Emerging and Infectious Diseases.

Hall, E. R. 1981. The mammals of North America. Wiley-Interscience, New York. 1181 pages.

Hoberg, E. P., S. J. Kutz, J. Cook, and **K. E. Galbreath**. 2003. Arctic biodiversity: From discovery to faunal baselines—revealing the history of a dynamic system. Journal of Parasitology.

Hoffmann, R. **S.**, and **R. S. Peterson.** 1967. Systematics and zoogeography of *Sorex* in the Bering Strait area. Systematic Zoology 16:127-136.

Hoffmann, R. S., J. W. Koeppl, and **C. F. Nadler**. 1979. The relationships of the amphiberingian marmots (Mammalia: Sciuridae). University of Kansas Museum of Natural History, Occasional Paper 83: 1-56.
Hoffmeister, D. F. 1986. Mammals of Arizona. The University of Arizona Press and the Arizona Game and Fish Department. 602 pages.
Jarrell, G. H., and **K. Fredga**. 1993. How many kinds of lemmings? A taxonomic overview. Pages 45-57 *in* The biology of lemmings. Academic Press, London.
Junge, J. A., R. S. Hoffmann, and **R. W. Darby**. 1983. Relationships with the Holarctic *Sorex arcticus-Sorex tundrensis* species comples. Acta Theriologica 28:339-350. Department of the Interior, National Biological Service, Washington, DC. 530 pages.
Manville, R. H., and **S. P. Young.** 1965. Distribution of Alaska mammals. U.S. Fish and Wildlife Service Circular 211. 74 pages.
Murie, O. J. 1959. Fauna of the Aleutian Islands and Alaska Peninsula. North American Fauna 61:1-364.
Musser, G. G., and **M. D. Carleton.** 1993. Family Muridae. Pages 501-756 *in* Mammal species of the world: a taxonomic and geographic reference. *Edited by* D. E. Wilson and D. M. Reeder. Second Edition. Smithsonian Institution Press, Washington. 1206 pages.
Nagorsen, D. W. 1996. Opossums, shrews, and moles of British Columbia. Royal British Columbia Museum Handbook Volume 2. UBC Press, Vancouver. 169 pages.
Osgood, W. H. 1901. Natural history of the Cook Inlet region, Alaska. North American Fauna 21: 51-81.
Osgood, W. H. 1904. A biological reconnaissance of the base of the Alaska Peninsula. North American Fauna 24:1-86.
Parker, D. I., B. E. Lawhead, and **J. A. Cook.** 1997. Distributional limits of bats in Alaska. Arctic 50:256-265.
Rausch, R. **L.** 1963. A review of the distribution of holarctic recent mammals. Pages 29-43 *in* Pacific Basin biogeography; a symposium. *Edited by* J. L. Gressitt. Tenth Pacific Science Congress, 1961. Bishop Museum Press, Honolulu.
Reynolds, R. P., R. I. Crombie, R. W. McDiarmid, and **T. L. Yates**. 1996. Voucher specimens. Pages 63-68 *in* Measuring and monitoring biological diversity. Standard methods for mammals. *Edited by* D. E. Wilson, F. R. Cole, J. D. Nichols, R. Rudran, and M. S. Foster. Biological Diversity Handbook Series, Smithsonian Institution Press, Washington. 409 pages.
Schiller, E. L., and **R. Rausch**. 1956. Mammals of the Katmai National Monument, Alaska. Arctic 9:191-201.
Stone, K., R. Flynn, and **J. Cook**. 2002. Post-glacial colonization of northwestern North America by the forest associated American marten (*Martes americana*). Molecular Ecology 11:2049-2064.
True, F. W. 1886. An annotated list of the mammals collected by the late Charles L. McKay in the vicinity of Bristol Bay, Alaska. Proceedings of the U.S. National Museum 9:221-224.
van Zyll de Jong, C. G. 1983. Handbook of Canadian mammals. Part 1. Marsupials and insectivores. National Museum of Natural History. 210 pages.
Viereck, L. A., C. T. Dyrness, A. R. Batten, and **K. J. Wenzlick.** 1992. The Alaska vegetation classification. General Technical Report PNW-GTR-286. Portland, OR:

U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 278 pages.

Wilson, D. E., and **F. R. Cole.** 2000. Common names of mammals of the world. Smithsonian Institution Press, Washington, D. C. 204 pages.

Wilson, D. E., and **D. M. Reeder**. *Editors*. 1993. Mammal species of the world: A taxonomic and geographic reference. Second Edition. Smithsonian Institution Press, Washington. 1206 pages.

Table 1. Checklist of the land mammals of *Lake Clark National Park and Preserve,* Alaska. Current status: ● = present and substantiated with vouchered specimen, * = newly documented by BCP 2003 survey, ○ = present or probably present but not substantiated with a voucher specimen, **?** = status unknown but occurs close enough to the park to be looked for. Species highlighted in gray are considered "small mammals" as used in this report.

INSECTIVORA - Shrews
Family **Soricidae**
● *Sorex cinereus*, cinereus shrew
● *S. hoyi,* pygmy shrew *
● *S. monticolus*, montane shrew *
? *S. palustris*, water shrew
● *S. tundrensis*, tundra shrew *
● *S. yukonicus*, tiny shrew
CHIROPTERA - Bats
Family **Vespertilionidae**
● *Myotis lucifugus*, little brown bat *
CARNIVORA – Carnivores
Family **Canidae**
○ *Canis latrans*, coyote
○ *C. lupus,* wolf
● *Vulpes vulpes*, red fox *
Family **Felidae**
● *Lynx canadensis*, Canada lynx *
Family **Mustelidae**
○ *Gulo gulo*, wolverine
○ *Lontra canadensis*, northern river otter
● *Martes americana,* American marten *
● *M. erminea*, ermine *
○ *M. nivalis*, least weasel
○ *M. vison*, American mink
Family **Ursidae**
○ *Ursus americanus*, American black bear
● *U. arctos*, brown bear

ARTIODACTYLA - Ungulates
Family **Cervidae**
○ *Alces alces,* moose
○ *Rangifer tarandus*, caribou
Family **Bovidae**
● *Ovis dalli*, Dall's sheep
RODENTIA – Rodents
Family **Sciuridae**
○ *Marmota caligata*, hoary marmot
● *Spermophilus parryii*, arctic ground squirrel
● *Tamiasciurus hudsonicus*, red squirrel
Family **Castoridae**
○ *Castor canadensis*, American beaver
Family **Dipodidae**
● *Zapus hudsonius*, meadow jumping mouse
Family **Muridae**
● *Clethrionomys rutilus*, N red-backed vole
? *Dicrostonyx groenlandicus*, collared lemming
○ *Lemmus trimucronatus*, brown lemming
● *M. miurus*, singing vole *
● *M. oeconomus*, tundra vole
● *M. pennsylvanicus*, meadow vole
● *Ondatra zibethicus*, muskrat
● *Synaptomys borealis*, N. bog lemming
Family **Erethizontidae**
○ *Erethizon dorsatum*, N.A. porcupine
LAGOMORPHA – Pikas & Hares
Family **Ochotonidae**
● *Ochotona collaris*, collared pika *
Family **Leporidae**
● *Lepus americanus*, snowshoe hare

TABLE 2. Number of small mammals sampled at 10 general localities in *Lake Clark National Park and Preserve*, Alaska, between 7-31 July 2003.

SPECIES	LOCALITY										TOTALS
	Turner Bay	West Chulitna River	South Chulitna River	Head of Lake Clark	Johnson River	Silver Salmon	Turquoise Lake	Two Lakes	Necons River	Port Alsworth	
SHREWS											
Sorex cinereus	66	56	8	39	53	49	33	45	36		*385*
S. hoyi							1				*1*
S. monticolus	6	2	2	2	16	10	66	1	4		*109*
S. tundrensis										1	*1*
S. yukonicus	2										*2*
BATS											
Myotis lucifugus			2								*2*
CARNIVORES											
Mustela erminea							1			3	*4*
RODENTS											
Spermophilus parryii							5			5	*10*
Tamiasciurus hudsonicus			1				1	1		11	*14*
Zapus hudsonius				1	2	4	1				*8*
Clethrionomys rutilus	42	20	6	33	35	25	17	26	34		*238*
Microtus miurus							8				*8*
M. oeconomus		7	10	12			6	3	4		*42*
M. pennsylvanicus		10	2	12		1					*25*
Synaptomys borealis		1									*1*
LAGOMORPHS											
Ochotona collaris							3				*3*
Lepus americanus							1		2		*3*
TOTAL # SPECIMENS	*116*	*96*	*31*	*99*	*106*	*89*	*143*	*76*	*80*	*20*	***856***
TOTAL # SPECIES	*4*	*6*	*7*	*6*	*4*	*5*	*12*	*5*	*5*	*4*	***17***
TOTAL TRAP NIGHTS	*330*	*533*	*247*	*910*	*368*	*438*	*904*	*366*	*467*		***4563***

TABLE 3. Trapline transects at 10 general localities in *Lake Clark National Park and Preserve*, Alaska, July 2003.

GENERAL LOCALITY Lark Clark NP& P	LINE #	N LATITUDE	W LONGITUDE	ELEV (M)	MAX ERROR (M)	DATE	# TRAP NIGHTS	# CAPTURES BY SPECIES	VEGETATION TYPE
Turner Bay	1	60°10.815"	154°33.937	91.5	150	7-9 July 2003	100	29 *Sorex cinereus*, 3 *S. monticolus*, 27 *Clethrionomys rutilus*	Closed Mixed Forest
	2	60°10.841'	154°33.930	91.5	300	7-9 July 2003	84	37 *Sorex cinereus*, 3 *S. monticolus*, 2 *S. yukonicus*, 15 *Clethrionomys rutilus*	Open Tall Scrub: willow thickets along shoreline with blue-flag, beach grass, sedges next to water
West Chulitna River	1	60°10.539'	154°34.791'	91.5	200	7-10 July 2003	225	34 *Sorex cinereus*, 1 *S. monticolus*, 9 *Clethrionomys rutilus*, 4 *Microtus pennsylvanicus,* 2 *M. oeconomus*	Bryoid moss: moss, lichen, dwarf birch, grass, small spruce at edge of marsh
	2	60°10.659'	154°34.842'	91.5	75	7-11 July 2003	308	15 *Sorex cinereus*, 4 *Microtus pennsylvanicus*, 3 *M. oeconomus*, 1 *Synaptomys borealis*	Wet Graminoid Herbaceous: open marsh with moss and grass bordered by open spruce
	3	60°10.566'	154°34.495'	91.5	300	7-9 July 2003	100	7 *Sorex cinereus*, 1 *S. monticolus*, 9 *Clethrionomys rutilus*, 2 *Microtus pennsylvanicus,* 2 *M. oeconomus*	Needleleaf Woodland: black spruce, bog lowlands. Some bog birch, grasses, with bog cranberry, sphagnum
	4	60°10.740'	154°34.760'	91.5	100	8-10 July 2003	46	2 *Clethrionomys rutilus*	Open Mixed Forest: spruce and birch trees with ground cover of moss, cranberry, blueberry
South Chulitna River	1	60°10.652'	154°34.020'	91.5	100	7-10 July 2003	60	1 *Tamiasciurus hudsonicus*	Closed Needleleaf Forest: spruce by lodge yard
	2	60°10.792'	154°33.980'	91.5	100	7-10 July 2003	60	0 captures	Closed Needleleaf Forest: spruce
	3	60°10.650'	154°34.024'	91.5	100	7-10 July 2003	105	8 *Sorex cinereus*, 2 *S. monticolus*, 6 *Clethrionomys rutilus*, 2 *Microtus pennsylvanicus*, 8 *M. oeconomus*	Open Tall Scrub: some willow and grass in the middle of a yard
	4	60°10.692'	154°34.078'	91.5	25	9 July 2003	mist net	2 *Myotis lucifugus*	Shed surrounded by Closed mixed /spruce Forest
	5	60°10.650'	154°34.024'	91.5	200	10-11 July 2003	22	2 *Microtus oeconomus*	Graminoid Herbaceous: grassy area between bare earth (airstrip) and birch/alder thickets
Head of Lake Clark	1	60°23.826	153°50.832'	91.5	120	11-14 July 2003	183	5 *Sorex cinereus*, 2 *S. monticolus*, 8 *Clethrionomys rutilus*, 2 *Microtus pennsylvanicus*	Dense willow/sedge community adjacent to slough; black spruce, moss, labrador tea in upland areas
	2	60°23.588'	153°50.274'	198.25	600	11-13 July 2003	48	1 *Sorex monticolus*, 4 *Clethrionomys rutilus*	Black spruce, bog cranberry, currant, crowberry, devil's club forest mixed with rocky cliffs and open meadows
	3	60°23.888'	153°51.035'	91.5	150	11-13 July 2003	50	3 *Clethrionomys rutilus*	Closed Needleleaf Forest: spruce

TABLE 3. Trapline transects at 10 general localities in *Lake Clark National Park and Preserve*, Alaska, July 2003.

GENERAL LOCALITY Lark Clark NP& P	LINE #	N LATITUDE	W LONGITUDE	ELEV (M)	MAX ERROR (M)	DATE	# TRAP NIGHTS	# CAPTURES BY SPECIES	VEGETATION TYPE
	4	60°23.947’	153°51.282’	90	150	12-13July 2003	70	5 *Sorex cinereus*, 2 *Clethrionomys rutilus*, 2 *Microtus pennsylvanicus*	Wet Graminoid Herbaceous
	5	60°23.789’	153°49.808’		3.9	12-14 July 2003	225	7 *Sorex cinereus*, 2 *Clethrionomys rutilus,* 12 *Microtus oeconomus*, 1 *M. sp.*	Dry grass dominated meadow with scattered willow over old bog
	6	60°23’44.1”	153°50’33.8”	90	250	12-14 July 2003	150	10 *Sorex cinereus*, 8 *Clethrionomys rutilus*, 5 *Microtus pennsylvanicus*	Graminoid Herbaceous: grass with some lupine and horsetail; along bank of slough with open spruce forest inland
	7	60°23.955’	153°51.291	90	100	12-14 July 2003	60	4 *Sorex cinereus*, 2 *Clethrionomys rutilus,* 1 *Zapus hudsonius*	Wet Graminoid Herbaceous
	8	60°23.639’	153°49.941	102	4.6	12-14 July 2003	56	1 *Clethrionomys rutilus*	Large black spruce forest
	9	60°23.706’	153°50.320’	91.5	100	13-14 July 2003	24	3 *Sorex cinereus*, 1 *Clethrionomys rutilus,* 2 *Microtus pennsylvanicus*	Wet Graminoid Herbaceous-Tall willow with grass, rush, lupine understory bordering inland slough
	10	60°23.749’	153°50.652’	90	80	13-14 July 2003	24	3 *Sorex cinereus*, 1 *Microtus pennsylvanicus*	Wet Graminoid Herbaceous: slough edge with grass, willow, rose
	11	60°23.823’	153°50.300’	92		13-14 July 2003	20	1 *Sorex cinereus*, 2 *Clethrionomys rutilus*	Graminoid herbaceous between slough and black spruce forest
Johnson River	1	59°59.499’	152°40.094’	10	50	15-19 July 2003	170	27 *Sorex cinereus*, 14 *S. monticolus*, 23 *Clethrionomys rutilus*, 2 *Zapus hudsonius*	Bryoid Herbaceous: mat of moss with cotton grass and sedges, a few willows in marsh surrounded by alder bordering a lake
	2	60°00.929’	152°36.988’	10	103.4	15-16 July 2003	40	4 *Sorex cinereus*	Wet Graminoid Herbaceous: near tidal flats of river
	3	60°00.566’	152°36.827’	10	79.7	15-16 July 2003	42	5 *Sorex cinereus*	Mesic Graminoid Herbaceous: patches of alder surrounded by grassy open areas on hill west of ocean
	4	59°59’23.0”	152°39’24.9”	10	37	15-19 July 2003	16	1 *Clethrionomys rutilus*	Open spruce forest
	5	59°59.363’	152°39.690’	10	66.4	16-18 July 2003	90	17 *Sorex cinereus*, 2 *S. monticolus*, 11 *Clethrionomys rutilus*	Open sitka spruce with ferns and alder
	6	59°59’23.0”	152°39’24.9”	10	37	17-19 July 2003	10	0 captures	Open spruce forest
Silver Salmon	1	59°58.892’	152°40.100’	10	300	15-17 July 2003	210	21 *Sorex cinereus*, 8 *S. monticolus*, 14 *Clethrionomys rutilus*, 1 *Zapus hudsonius*	
	2	59°58.878’	152°39.865’	10	112.3	16-19 July 2003	54	2 *Sorex cinereus*, 6 *Clethrionomys rutilus*	Graminoid herbacous with scattered sitka spruce trees

TABLE 3. Trapline transects at 10 general localities in *Lake Clark National Park and Preserve*, Alaska, July 2003.

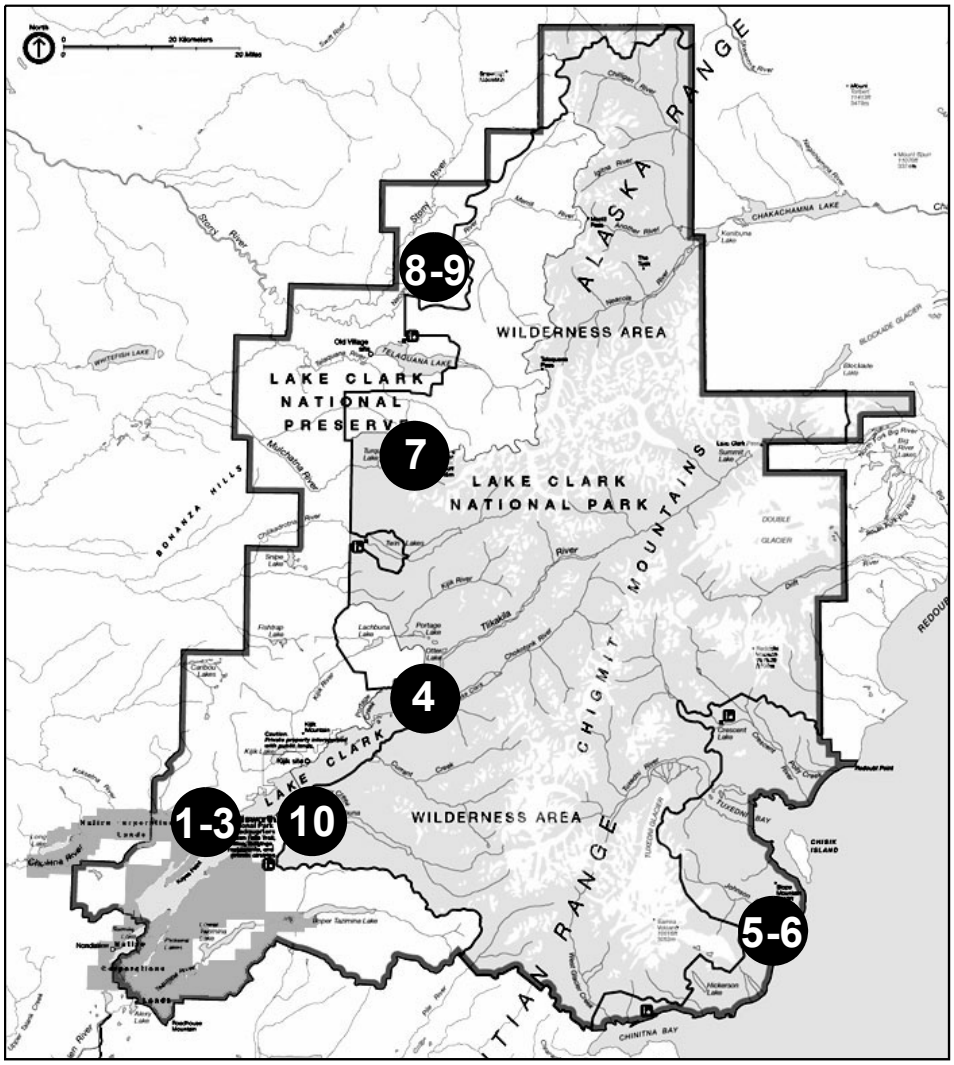
GENERAL LOCALITY Lark Clark NP& P	LINE #	N LATITUDE	W LONGITUDE	ELEV (M)	MAX ERROR (M)	DATE	# TRAP NIGHTS	# CAPTURES BY SPECIES	VEGETATION TYPE
	3	59°59.533’	152°40.429’	10-20	103.4	16-19 July 2003	144	26 *Sorex cinereus*, 3 *S. monticolus*, 4 *Clethrionomys rutilus*, 1 *Microtus pennsylvanicus*, 3 *Zapus hudsonius*	Herbaceous meadow with scattered alder and willow near edge of alder-ferns
	4	59°58.239’	152°39.798’	10	150	18-19 July 2003	30	2 *Sorex cinereus*, 1 *Clethrionomys rutilus*	Grassy-beach pea bank along river and trail
Turquoise Lake	1	60°47.298’	153°51.811’	735	56	20-23 July 2003	160	3 *Sorex cinereus*, 21 *S. monticolus*, 1 *Clethrionomys rutilus*, 1 *Microtus miurus*, 2 *M. oeconomus*, 1 *Spermophilus parryii*	Forb herbaceous along stream with willow, fern, fireweed, parsnip, some moss
	2	60°47.436’	153°51.912’	894	137.4	20-22 July 2003	74	1 *Sorex monticolus*, 3 *Clethrionomys rutilus*, 1 *Microtus miurus*	Boulders-willow-dwarf willow
	3	60°47.186’	153°51.516’		64	20-23 July 2003	54	3 *Sorex cinereus*, 6 *S. monticolus*, 1 *Clethrionomys rutilus*, 1 *Tamiasciurus hudsonicus*	Open Broadleaf Forest: *Populus* canopy with understory of alder and willow and herbaceous ground cover
	4	60°47.143’	153°51.497’	850	7.3	20-23 July 2003	3	0 captures	Graminoid herbaceous
	5	60°47.180’	153°51.679’		12.3	20-23 July 2003	40	1 *Sorex cinereus*, 3 *S. monticolus*, 1 *Clethrionomys rutilus*	Graminoid herbaceous: labrador tea, crowberry, cranberry, rushes
	6	60°47.135’	153°51.370’	1250	6	20-23 July 2003	15	3 *Sorex monticolus*	Graminoid herbaceous surrounding large boulder near avalanche chute
	7	60°47.216’	153°51.371’	1300-1600	49	20-22 July 2003	6	0 captures	Mesic graminoid herbaceous
	8	60°46.712’	153°50.817’		54.5	20-24 July 2003	130	3 *Sorex cinereus*, 1 *S. hoyi*, 11 *S. monticolus*, 5 *Clethrionomys rutilus*, 6 *Microtus miurus*, 1 *M. oeconomus*, 1 *Zapus hudsonius*, 1 *Spermophilus parryii*	Dwarf willow-tussock grass-boulder slope
	9	60°47’31.0”	153°51’32.1”	1050	27	20-23 July 2003	5	0 captures	Dry forb herbaceous
	10	60°47’41.2”	153°51’36.2”	1050	42	20-23 July 2003	60	1 *Clethrionomys rutilus*	Dry forb herbaceous
	11	60°47’39.2”	153°51’37.5”	1050	42	20-23 July 2003	102	1 *Sorex cinereus*, 1 *Clethrionomys rutilus*, 1 *Ochotona collaris*	Bryoid herbaceous (lichen) of rubble slope
	12	60°47.071’	153°51.586’		6.7	20-23 July 2003	12	0 captures	Stream bank with bare soil and dwarf willow; *Spermophilus* present
	13	60°46.759’	153°50.969’		14	20-24 July 2003	25	4 *Sorex monticolus*, 1 *Spermophilus parryii*	Stream bank with bare soil and dwarf willow
	14	60°47.234’	153°51.890’	735	64.7	21-24 July 2003	162	19 *Sorex cinereus*, 2 *S. monticolus*, 3 *Microtus oeconomus*	Willow dwarf scrub with understory of grasses, fireweed, some sedges

TABLE 3. Trapline transects at 10 general localities in *Lake Clark National Park and Preserve*, Alaska, July 2003.

GENERAL LOCALITY Lark Clark NP& P	LINE #	N LATITUDE	W LONGITUDE	ELEV (M)	MAX ERROR (M)	DATE	# TRAP NIGHTS	# CAPTURES BY SPECIES	VEGETATION TYPE
	15	60°47.362’	153°51.958’		200	22-24 July 2003	56	3 *Sorex cinereus*, 15 *S. monticolus*, 4 *Clethrionomys rutilus*	*Vaccinium*-willow-bog birch-poplar
Two Lakes	1	61°06.473’	153°51.178’		103.8	25-27 July 2003	10	26 *Sorex cinereus*	Shoreline
	2	61°06.720’	153°51.354’		1604	25-28 July 2003	208	8 *Sorex cinereus*, 17 *Clethrionomys rutilus*, 3 *Microtus oeconomus*	Long ridgeline
	3	61°06.741’	153°51.472’		15.7	26-28 July 2003	16	0 captures	Rock outcrop
	4	61°06.574’	153°51.301’		44.6	25-27 July 2003	20	1 *Clethrionomys rutilus*	Small aspen stand
	5	61°06.398’	153°51.262’	342	5.4	26-28 July 2003	54	9 *Sorex cinereus*, 1 *S. monticolus*, 7 *Clethrionomys rutilus*	Lakeshore edge of graminoids, bog birch, willow with alder and scattered black spruce
	6	61°06.416’	153°51.555’		15.6	26-28 July 2003	10	0 captures	Open dwarf tree scrub
	7	61°06.194’	153°51.412’	365	99	26-28 July 2003	48	2 *Sorex cinereus*, 1 *Clethrionomys rutilus*	Open Mixed Forest: spruce, birch, aspen, willow
Necons Rver	1	61°06.425’	153°51.427’		90.5	25-28 July 2003	164	4 *Sorex cinereus*, 2 *Clethrionomys rutilus*, 2 *Microtus oeconomus*	Mesic Graminoid Herbaceous: dry bog
	2	61°06.398’	153°51.262’	342	5.4	25-26 July 2003	41	2 *Sorex cinereus*, 2 *S. monticolus*, 8 *Clethrionomys rutilus*, 1 *Lepus americanus*	Alder shoreline with spruce and birch
	3	61°06.362’	153°51.152’	351	3.8	25-28 July 2003	90	13 *Sorex cinereus*, 12 *Clethrionomys rutilus*	Overgrown *Vaccinium*-bog birch meadow with scattered spruce
	4	61°06.362’	153°51.195’	317		26-28 July 2003	36	2 *Sorex cinereus*, 1 *S. monticolus*, 2 *Clethrionomys rutilus*	Birch forest
	5	61°06.370’	153°51.202’	345		26-28 July 2003	18	0 captures	Black spruce forest
	6	61°06’18.3”	153°51’31.9”		42	26-28 July 2003	20	1 *Clethrionomys rutilus*, 1 *Lepus americanus*	Open spruce/poplar mixed forest on southfacing slope
	7	61°06’13.4”	153°51’51.3”		23	26-28 July 2003	20	1 *Clethrionomys rutilus*	Low Scrub: alder and willow
	8	61°06.253’	153°51.796’	348		26-28 July 2003	78	15 *Sorex cinereus*, 1 *S. monticolus*, 8 *Clethrionomys rutilus*, 2 *Microtus oeconomus*	Pond edge with grass-bog birch border and alder-black spruce

Table 4. Relative abundance (captures/100 trap nights) of small mammals in three major vegetation types, Lake Clark National Park and Preserve, Alaska, field season 2003.

Species	FOREST	SCRUB	HERBACEOUS
Shrews			
Sorex cinereus	8.06	10.02	7.53
S. hoyi	--	0.09	--
S. monticolus	1.88	4.10	2.02
S. yukonicus	--	0.18	--
Small Rodents			
Clethrionomys rutilus	8.60	6.68	3.31
Microtus miurus	--	0.67	0.04
M. oeconomus	0.27	1.34	1.04
M. pennsylvanicus	0.27	0.38	0.86
Synaptomys borealis	--	--	0.04
Zapus hudsonius	--	0.09	0.27
All Species	19.5	23.5	15.3
Trap Nights	744	1048	2203



SAMPLING LOCALITIES

Chulitna Bay vicinity, Lake Clark (60° 10'N, 154° 34'W): 7-11 July 2003
1. Turner Bay
2. West of Chulitna River mouth
3. South of Chulitna River mouth

4. Head of Lake Clark (60° 23'N, 153° 50'W): 11-14 July 2003

Silver Salmon vicinity, Cook Inlet (59° 59'N, 152° 40'W): 15-19 July 2003
5. Johnson River
6. Silver Salmon Lakes

7. Turquoise Lake (60° 47'N, 153° 51'W): 20-24 July 2003

Two Lakes vicinity (61° 06'N, 153° 51'W): 25-28 July 2003
8. Two Lakes
9. Necons River

10. Port Alsworth, Tanalian Mountain (60° 12'N, 154° 13'W): 31 July 2003

Figure 1. General localities in Lake Clark National Park and Preserve, Alaska, sampled for small mammals in 2003.

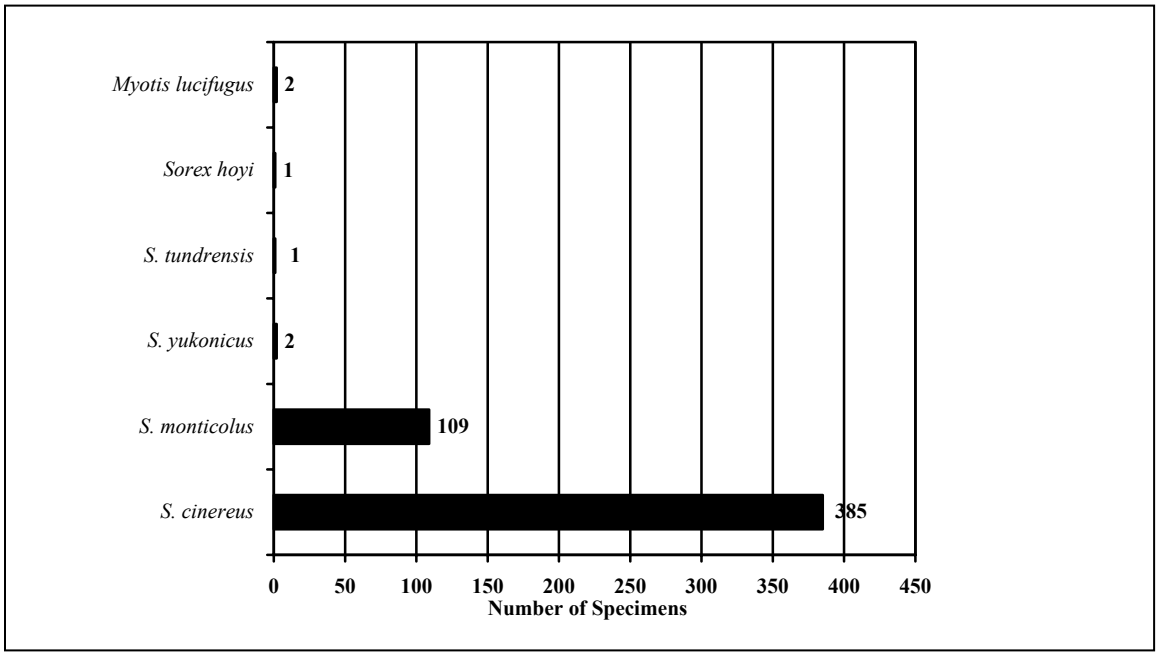


FIGURE 2a. Number of shrew and bat specimens sampled in Lake Clark NP&P, Alaska, during field season 2003.

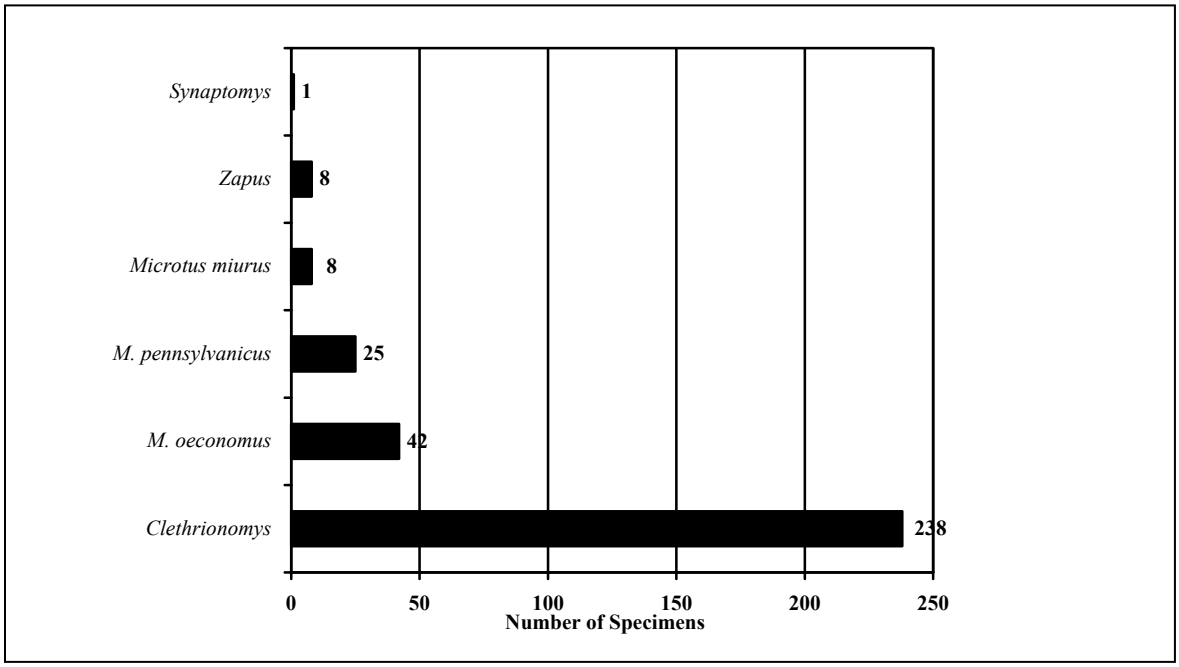


FIGURE 2b. Number of murid and zapodid rodent specimens sampled in Lake Clark NP&P, Alaska, during field season 2003.

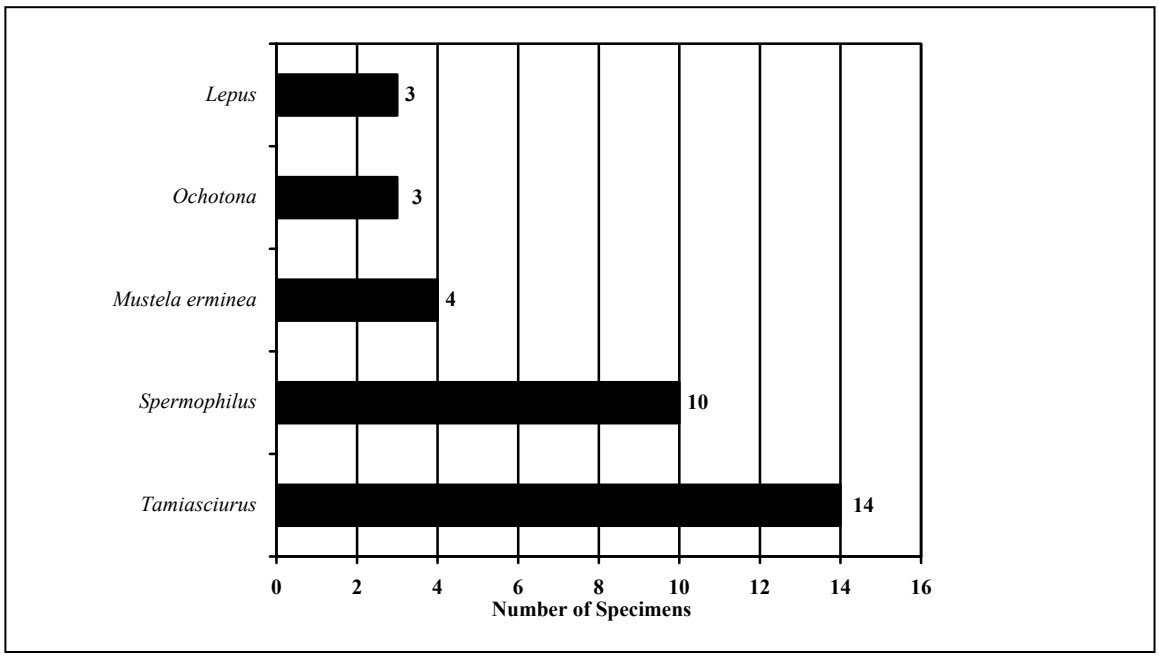


FIGURE 2c. Number of sciurid, mustelid, and lagomorph specimens sampled in Lake Clark NP&P, Alaska, during field season 2003.

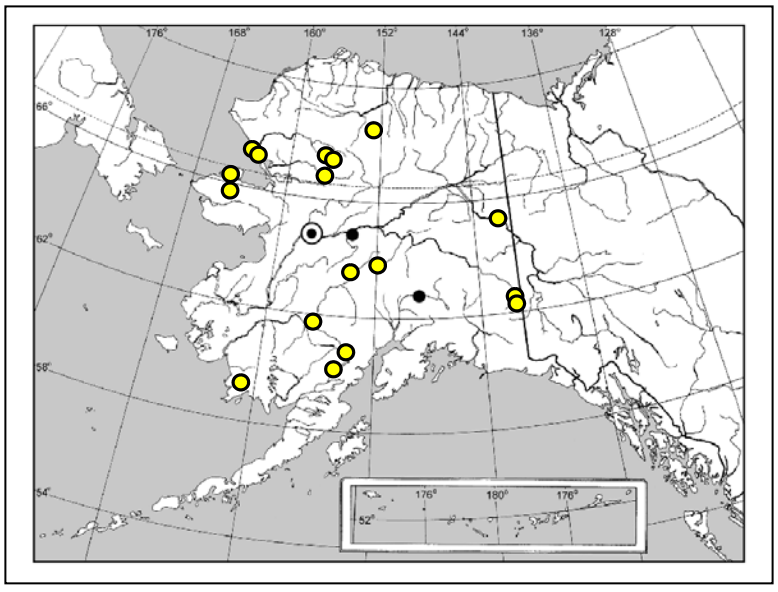


FIGURE 3. New locality records (open circles) of *Sorex yukonicus* since its original description (closed circles and type locality) by Dokuchaev (1997).

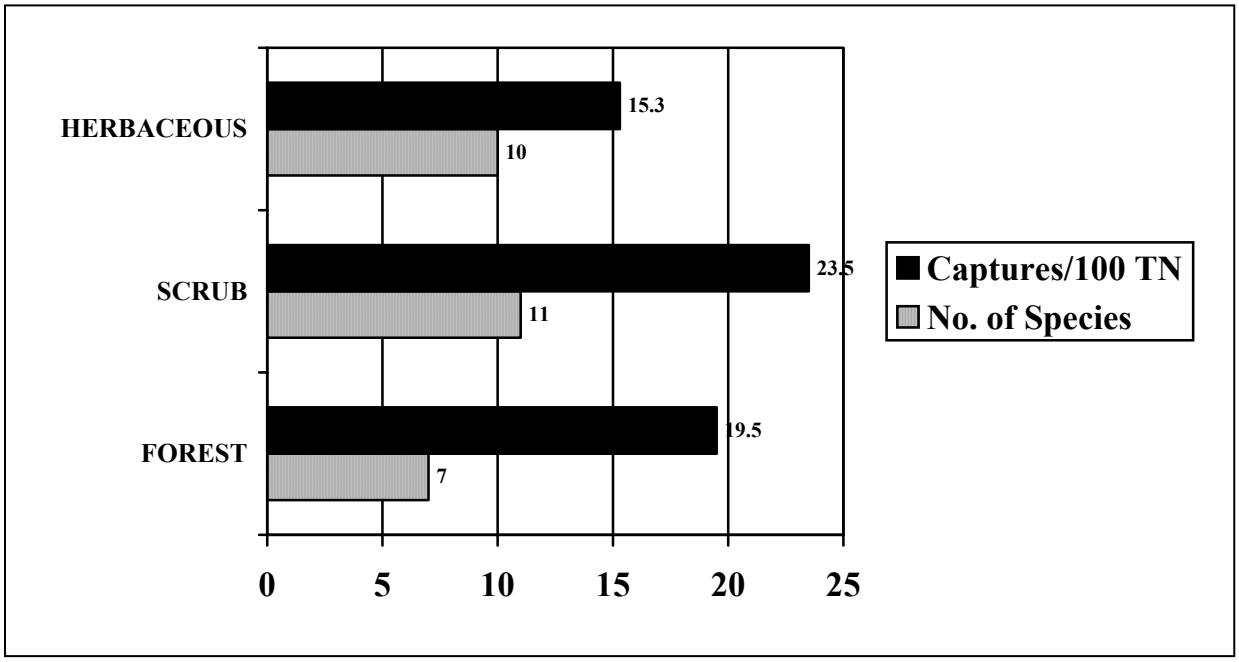
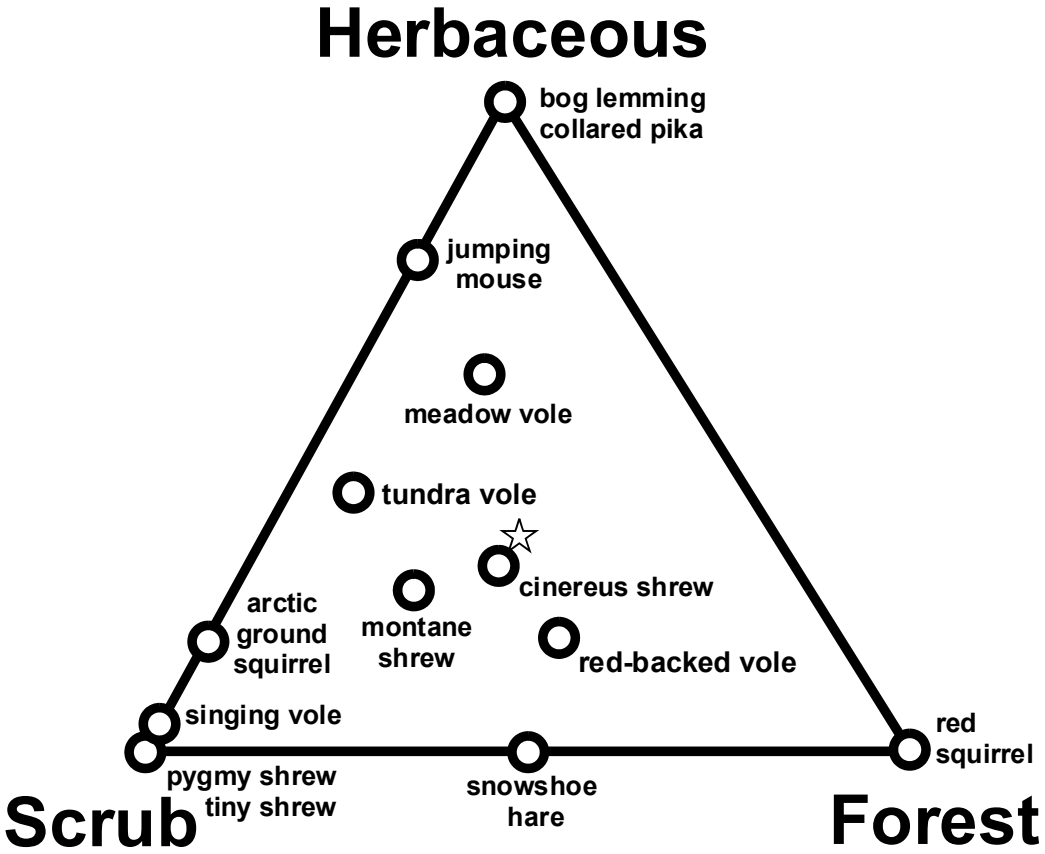


FIGURE 4. Relative abundance and species richness of small mammals in 3 major vegetation types, Lake Clark National Park and Preserve, Alaska, field season 2003.



	Forest	Scrub	Herbaceous
cinereus shrew	31%	38.8%	29.2%
pygmy shrew	--	100%	--
montane shrew	23.5%	51.25%	25.25%
tiny shrew	--	100%	--
red-backed vole	46.3%	35.9%	17.8%
singing vole	--	94.4%	5.6%
tundra vole	10.2%	50.6%	39.2%
meadow vole	17.9%	25.2%	56.9%
bog lemming	--	--	100%
meadow jumping mouse	--	25%	75%
arctic ground squirrel	--	81.8%	18.2%
red squirrel	100%	--	--
collared pika	--	--	100%
snowshoe hare	50%	50%	--

Percent captures in three major vegetation types

Figure 5. Proportion of small mammal specimens (relative abundance from Table 4) in three major vegetation types, Lake Clark National Park and Preserve, field season 2003.