CHAPTER X

WILDLIFE

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1.0 INTRODUCTION

Scoping meetings were held in 1988 with the Alaska Department of Fish & Game (ADF&G) and the Alaska Department of Natural Resources (ADNR) that resulted in priorities for wildlife habitat mapping, baseline surveys of raptor nesting, moose distribution and relative abundance, and occurrence of threatened or endangered species. Species of secondary interest among the regulatory agencies were song birds and small mammals. The agencies also emphasized the need for detailed information on browse utilization by moose and mapping of moose habitat values to provide a baseline for development of reclamation plans.

As a result of the priorities established above, Dames & Moore conducted surveys from June 1988 to mid-May 1989 that provided a data base which could be used for evaluating the potential impacts of construction and operation of the Wishbone Hill Coal Project and for developing wildlife mitigation and monitoring plans. The studies addressed the baseline requirements specified in the Alaska Surface Coal Mining Program regulations and provided the necessary information to support this surface coal mining permit application.

The terrestrial wildlife studies by Dames & Moore were conducted in parallel with vegetation, revegetation, and soils by other investigators. Interaction between the various studies improved the results of each study. This interaction was facilitated by early discussions with other investigators about vegetation types and habitat values and by putting the mapped data from each study into the Dames & Moore Geographic Information Management System (GIMS) so that the data could be overlaid for analysis.

During these comprehensive investigations of fish, birds, and mammals, studies of moose focused on geographic distribution and habitat utilization. As a result of this work and previous studies conducted by the Alaska Department of Fish and Game, a portion of the study area was identified as important winter range for moose. Since moose are considered the most important mammal species from the standpoint of human utilization, additional long term monitoring with aerial surveys was initiated in October 1989 and continued through April 1993. Addendum 1 contains a report that summarizes results from the long term study of the distribution and habitat use of moose in the vicinity of the Wishbone Hill coal project.

Concerning bald eagles, surveys have been conducted to search for potential nest sites within and adjacent to the proposed Wishbone Hill coal project. The U. S. Fish & Wildlife Service (USFWS) completed surveys on October 5, 1997, March 25, 2001, and March 22, 2003. The most recent survey was conducted by HDR Alaska, Inc. on May 5, 2009. Results from this work are presented in Addendum 2 and include the sites identified by the USFWS.

2.0 METHODS

2.1 Wildlife Surveys

2.1.1 Transects

In order to collect seasonal data on the abundance, distribution, and habitat utilization of birds, and mammals in the project area, a series of twenty-six 200 meter transects (Figure 1) were established in the project area. The locations of transects were selected prior to the initial field reconnaissance based on the location of various mine facilities and areas proposed for development. Transects were marked with labeled wooden lathe at each end and flagged with surveyor's tape. Transects were also included along the proposed haul road route between the project area and the Glenn Highway. In addition to surveys inside the project area, the shoreline of Wishbone Lake was covered on foot to record waterfowl and shorebirds.

Wildlife transects were surveyed a total of five times over the one year study period. This schedule was selected to coincide with important time periods such as courtship, nesting and rearing young, fall migration, and winter residency. Field reconnaissance surveys were conducted on:

- June 20-25, 1988
- September 2-3, 1988
- October 28-29, 1988
- March 14-16, 1989
- May 11-13, 1989

Transects were censured during the early morning hours during the spring and summer when birds and mammals would be the most active. During the fall and winter, surveys were conducted during

all hours of daylight. Surveys on the shoreline of Wishbone Lake and the haul road route were conducted in June 1988 and May 1989. Opportunistic observations of birds and mammals were also recorded throughout the project area during each survey period. Incidental wildlife observations were also recorded along Moose Creek by the fisheries field team during summer and fall salmon surveys and throughout the project area by other field personnel.

2.1.2 Bird Surveys

The primary focus of the bird study program was to collect baseline data on seasonal species composition, relative abundance and habitat preference of birds using the project area. The study was also designed to calculate relative density of birds by habitat type. These data could be used to calculate potential impacts of habitat loss from the proposed mining operations and to provide the basis for future surveys to assess reclamation efforts.

2.1.2.1 Density

The seasonal density of the common bird species in the project area was determined by a strip-census method which involved counting all species observed within 25 meters of the centerline of each transect. This band transect, 50 meters wide and 200 meters long, has a total area of 10,000 square meters (one hectare). The number of birds sighted in the transect divided by the area equals density (birds/hectare). Birds observed outside the band transect were recorded as supplemental observations along with the habitat type.

Each transect was censused by one or two observers walking slowly along the centerline of the transect and recording all bird observations. The spring and summer surveys included listening for singing males and observing any breeding activity. No special effort was made to look for nests but if any were located, they were recorded.

Density data from transects of similar habitat types were pooled to estimate overall density by habitat. Since the habitats along some transects were not homogenious, the dominant habitat type was used as the basis for density calculations.

2.1.2.2 Breeding Status

Categories of bird breeding status were based on observed behavior and physical evidence of nesting:

- Possible breeder - Present during the breeding season within a species normal breeding range but no direct evidence of breeding activity observed

- Probable breeder - Present in the proper habitat within the normal breeding range during the breeding season with males singing or defending a territory

- Confirmed breeder - Presence of an active nest, newly fledged young, adults carrying food or nest materials, or adults entering nest cavity.

All species of birds observed during the spring and summer surveys were assigned to one of these categories.

Raptors were surveyed in conjunction with other surveys with emphasis on locating stick nests which could be used for raptor nesting and cliff or bluff habitat along Moose Creek with any sign of nesting such as "whitewash" or old nest material. The habitats along Moose Creek were surveyed during the salmon counts during the fall of 1988. In the spring of 1989 special attention was given to recording presence of raptors or calls of raptors that might reveal nesting sites.

2.1.2.3 Habitat Associations

In addition to the census of transects, habitat associations were noted for birds observed and these data were compiled with the observations from the transects to determine the distribution of birds within habitats on the project site.

Habitats were initially defined in the field according to the level IV of Alaska Vegetation Classification (Viereck et al. 1986). Following the initial field assessment, it became obvious that some habitat units could be combined where bird occurrence was essentially identical.

2.1.3 Mammal Studies

2.1.3.1 Small Mammals

The occurrence and distribution of small mammals within the project area was documented by direct observation of tracks and sign and by the use of two sizes of snap traps (mouse and rat traps). These traps were baited with peanut butter and set overnight along the wildlife transects. The primary purpose of the snap trapping was identification of mice and shrews. A total of 24 traps were set in representative habitats on June 21, 1988 and recovered the following day.

2.1.3.2 Large Mammals

Fresh signs of moose were recorded on each of the wildlife transects during each survey. Incidental observations of moose habitat utilization were made throughout the project area with emphasis on delineation of winter range, calving areas or rutting areas.

Winter aerial surveys of the project area and the surrounding region were used to characterize overall seasonal moose distribution. Survey methods were patterned after those used by ADF&G to allow a comparison with historical moose data. The aircraft used was a Piper Supercub on wheels which maintained a flight elevation of approximately 300 feet above the ground and a speed of approximately 80 knots/hr. Flight lines were spaced at quarter mile intervals. The lone observer looked out both sides of the aircraft to a distance of about one quarter mile. The pilot also assisted in locating moose. Each observation was recorded on a hand-held tape recorder and on special forms and all moose observed inside the project area were plotted on a 1:63,360 topographical map. Notes on sex and age were also recorded when possible.

2.1.3.3 Moose Browse Utilization

A line-intercept method was used on each of the wildlife transects to determine the degree of browsing of the available shrubs. A measured string was stretched along each transect centerline. All shrubs touching the string were inspected for the presence of absence of browsing. Shrub height, and species were recorded for each intercept.

2.2 Habitat Mapping

The wildlife habitats of the Wishbone Hill project area were defined primarily on the basis of their use. Wildlife habitats also incorporated vegetation types delineated by other investigators. Information for defining and mapping the wildlife habitats was obtained from aerial photographs, vegetation maps, on-the-ground observations, and from wildlife field survey data.

The aerial photographs used were taken May 17, 1984 and June 22, 1985 at a scale of 1 inch = 1000 feet (1:12,000). Selected 1985 photos were enlarged to 1 inch = 500 feet to match the scale of the project basemaps. A pocket stereoscope was used when delineating habitat boundaries on 1:12,000 aerial photographs. Aerial photos were also used in conjunction with on-the-ground observations to determine the current status and develop the habitat definitions and with the vegetation map to verify the distribution of habitat types.

Data on wildlife species use of the habitats was obtained from seasonal transect field surveys and secondarily from observations by all the biologists on the project. This was supplemented by information from ADF&G survey records.

Habitat maps were developed by compiling the wildlife use information and consolidating the vegetation types into the best possible representation of wildlife habitats. Each habitat type is described in terms of wildlife use, i.e., how and when they use it, and features that are important to the wildlife.

3.0 RESULTS

3.1 Wildlife Habitat

The wildlife habitats of importance on the Wishbone Hill project area are shown on Plate X-1 and include:

1. Open Mixed Forest (507 ha or 1252 ac)
2. Closed Deciduous Forest (394 ha or 973 ac)
3. Tall Shrub (136 ha or 336 ac)

a. Alder (27 ha or 67 ac)
b. Willow (2 ha or 5 ac + small patches)
c. Young Birch (107 ha or 164 ac)

4. Lowland Meadow (42 ha or 104 ac)
5. Upland Meadow (141 ha or 348 ac)
6. Wet Low Shrub (2 ha or 5 ac)
7. Riverine (19 ha or 47 ac)
8. Barren (9 ha or 22 ac)
9. Residential (6 ha or 15 ac)

3.1.1 Open Mixed Forest

The Open Mixed Forest habitat type is the most widespread type on the project area and is important to notable wildlife species. This habitat includes Open White Spruce, Open Paper Birch, mixed open stands, and small inclusions of Upland Meadow.

This type has the greatest species richness of birds of the habitats in the project area. It is also important to moose, especially as winter range. This type not only provides a high volume of browse, but also contains many spruce stands that provide hiding cover and may also serve as thermal cover. A few bird species (e.g., Spruce Grouse, Varied Thrush, and Kinglet) are specifically associated with spruce forest.

3.1.2 Closed Deciduous Forest

The Closed Deciduous Forest habitat type is the second most abundant on the project area but is of less overall importance to wildlife than the open forest type. Bird diversity is moderate, and use of the Closed Deciduous Forest by moose is much lower than of the Open Mixed Forest. This habitat type includes Closed Paper Birch - Aspen, Closed Paper Birch, Closed Poplar/Alder, Closed Poplar - Alder - Willow, Closed Deciduous, Closed Paper Birch - Aspen/Upland Meadow, and Closed Poplar/Alder/Upland Meadow vegetation types.

3.1.3 Tall Shrub

The Tall Shrub habitat type, includes Alder, Willow, and Young Birch types. Bird species use of Tall Shrub habitats is similar to the Open Mixed Forest type. Other wildlife uses of shrub habitats differ, however. For moose, the Willow habitats are as important as the Open Mixed Forest type because willows are a preferred browse species. Young Birch habitat is important because it provides many small birch trees that provide a good source of moose browse. The Alder thickets and dense willow thickets provide essential habitat for snowshoe hares. These habitats correspond directly to the vegetation types with the same names.

3.1.4 Meadow and Low Shrub

Meadow and Low Shrub habitats have low bird diversity in the project area. Many bird species of other habitats are not associated with meadows, while other species are primarily associated with these open habitats. Alder Flycatcher, Orange-crowned Warbler, Lincoln's Sparrow, and Savannah Sparrow are associated with meadows. Snipe and Lincoln's Sparrow are found in the Wet Low Shrub type and wetter areas within meadows. The Lowland Meadows and Wet Low Shrub types include many low shrubs that are fed upon by moose. The Upland Meadows are used much less by moose. The Lowland Meadows near eskers appear to have the highest populations of voles and are therefore also important to their predators (ermine, hawks, and owls).

3.1.5 Riverine

Riverine habitat is important to Mergansers and Dippers. It was mapped as equivalent to the Riparian vegetation type, but is actually a narrower band including the streambed itself.

3.1.6 Barren and Residential

Barren areas and residential areas were included on the map for completeness, but they have minimal wildlife habitat value.

3.2 Wildlife Transects

The permanent wildlife transects represent a cross section of the major habitat types in the project area. The breakdown of habitat types on each transect and the corresponding vegetation types are

presented in Table 1.

During analysis of transect data, it was necessary to combine some habitats since transects often had a mixture of more than one habitat type e.g., transects with lowland and upland meadow components would also have a significant portion of low shrub and a few mature trees. These mosaics of forest, shrub and meadows were combined into the Meadow Low Shrub habitat type. Transects with a major meadow component were also grouped into this habitat type.

Residential and Barren habitat types were not included in this analysis, becaused neither of these habitats are important to wildlife in the project area.

3.3 Birds

3.3.1 Seasonal Bird Use

Birds likely to occur within the project area are shown in Table 2. Of these a total of 46 species of birds were documented in the project area during five seasonal surveys (Table 3). Thirty nine species were considered either probable or possible breeders and four were confirmed as breeding in the area. Only the Bald Eagle and Mew Gull were considered non-breeders and this was due to lack of breeding habitat.

The 1988 summer survey documented the greatest abundance and diversity of birds with 37 species, 17 of which were seen on the wildlife transects. The most abundant birds were the Dark-eyed Junco, Yellow-rumped warbler, Orange-crowned warbler, Blackpoll Warbler, Swainson's Thrush and Alder Flycatcher. Surveys around the margin of Wishbone Lake revealed a pair of common goldeneyes and a pair of common mergansers which probably nested at the lake.

Both numbers and species of birds dropped off significantly by the September 2, 1988 survey when only nine species were seen in the project area including, seven observed on the transects.
Winter had set in when the October survey was conducted. Snow depths were approximately 15 cm. and air temperatures were in the high 20's. A total of only six species were seen in project at that time including three on the wildlife transects. Foraging flocks of Black-capped Chickadees were the most conspicuous birds. Pine Grosbeaks and Golden-crowned Kinglets were seen in small

numbers on the transects.

The March survey showed the least bird activity of the year. Only three species were found in the project area with no birds seen on the transects. The Raven and Black-billed Magpie were only heard calling at a distance and one pair of Northern Shrikes were observed flying over the north end of the project area. Overall use of the area by birds in late winter was very sparse. These ground observations were also consistent with aerial surveys in February and March which revealed Ravens and Black-billed Magpies within the project area and Ptarmigan at higher elevations in the subalpine zone.

Breeding bird surveys in early May 1989 revealed many common species that had established territories. The most abundant were the Dark-eyed Junco, the Yellow-rumped Warbler, and the Orange-crowned Warbler. Three of the common birds found on the 1988 summer survey were not found and are likely late arrivers. These included the Alder Flycatcher, the Blackpoll Warbler and Swainson's Thrush. The Savannah Sparrow and White-crowned Sparrow were present in the area but had not commenced singing so numbers of these birds were difficult to assess. Wishbone Lake was still approximately 90 percent covered with ice at the time of the survey but waterfowl were seen in the open water areas. These included two pair of Green-winged Teal, one pair of Barrow's Goldeneye, and one pair of Mallards. All were engaged in courtship display and were probably going to nest in the area.

3.3.2 Habitat Utilization

The habitat with the greatest species richness was the Open Mixed Forest with a total of 24 species. This is probably the result of the greater diversity of vegetation in this habitat type. Three species appeared to have a particular affinity to this habitat and included Spruce Grouse, Varied Thrush and Ruby-crowned Kinglet.

The Closed Deciduous Forest type had a total of ten species. Although it is second in total area of the wildlife habitats in the project area, no species appeared to have a particular affinity for this habitat and most of the birds which use this habitat were also found in the mixed forest. The Tall Shrub type had a fairly diverse compliment of bird species with a total of 16 species.

3.3.3 Bird Density

Densities of birds were calculated from the wildlife transect census data from the summer of 1988 and spring of 1989. Since the summer survey was conducted late in the breeding season, not all birds were singing so densities presented here reflect total numbers of birds observed on the transects and not breeding pairs although many were assumed to be breeding. On the spring survey, males were singing on territories and numbers recorded on transects closely approximate the number of breeding pairs. Densities are presented by habitat type (Tables 4 and 5). Total counts by transect are presented in Appendix A.

The species with highest overall density on both the spring and summer surveys were the Dark-eyed Junco and the Yellow-rumped Warbler. Densities varied among habitat types. Birds listed above were widely distributed throughout the Closed Deciduous Forest and densities were too low to determine a pattern.

Among the more abundant birds in the project area, the Alder Flycatcher had a rather narrow range of habitat preference and exhibited a close association with the meadow complex. These birds were typically observed near the edge of meadows or in tree or shrub habitat within the meadow complex.

The Tall Shrub habitat was not well represented on the transects and little could be concluded from the low bird densities in this type. Shrub habitats off the transects sometimes appeared to have a greater diversity and density of birds than recorded on the transects.

The transects established along the route of the proposed haul road were in mature mixed forest and had spring bird densities within the range found for other mixed forest habitats. Species diversity during the summer survey of the entire road route added one species, the Brown Creeper, to the species list for Open Mixed Forest.

A total of four species of raptors were identified on the transects during the five seasonal surveys including: Bald Eagle, Northern Goshawk, Red-tailed Hawk and the Great Horned Owl. Of these, only the Bald Eagle would not be expected to nest in the general area. However, no sign of any raptor nesting activity was found on the project site on any of the wildlife surveys and no young

raptors were seen in the area. The Northern Goshawk was the only raptor observed in summer and winter.

3.4 Mammals

Mammals likely to occur within the project area are shown in Table 6.

3.4.1 Moose

Moose are clearly the most important mammal species from the standpoint of human utilization. Within Game Management Unit (GMU) 14-A, which includes the Wishbone Hill area, hunter numbers have varied between 2,250 and 2,856 annually since 1985. Hunters harvest an average about 540 moose each year in GMU 14-A and another 160 moose are killed by highway vehicles, trains, and poaching (ADF&G, 1988). Within the Moose Creek area, moose harvest has ranged between 32 and 37 moose during the same period.

3.4.1.1 Abundance and Seasonal Distribution

Alaska Department of Fish & Game surveys in 1982 projected an average density of 1.2 to 1.6 moose per square mile in the Matanuska-Susitna Borough. To the west of Moose Creek in the Government Peak area, ADF&G estimated moose densities of 7.4 to 8.1 moose per square mile in the winter of 1989. High densities of moose have been found to the west of the project area primarily between the 2000 and 3000 foot elevation between Moose Creek and Willow Mountain. The Wishbone Hill Coal Project area is east of Moose Creek and ranges in elevation from 700 to 1000 feet. In the Wishbone Hill area, Dames & Moore aerial surveys in the area from Moose Creek to Granite Creek between December 1988 and March 1989 revealed a healthy moose herd with densities ranging from 3.3 to 6.7 moose per square mile. In 1988 ADF&G estimated 5,600 moose occured in Game Management Unit 14A, which includes the Matanuska Valley Moose Range.

Aerial survey data have been collected by ADF&G since 1967 in Game Management Unit 14A which includes the Moose Creek to Granite Creek count area. ADF&G surveys are usually conducted from mid-November to late December. Within this area, moose densities have ranged from less than 1 moose per square mile in 1980 to more than 7 moose per square mile in 1968.

Prior to late November, moose within this count area are mostly found above the 1500 foot contour. They do not move into the project area until snow accumulates in the high country forcing them to move to lower areas.

Wishbone Hill Coal Project moose surveys between Moose Creek and Granite Creek, were flown in October, December, January, February, and March (Figures 2-6). Moose data collected during aerial surveys by Dames & Moore and ADF&G is found in Appendix B. High winds, which are common in the Matanuska Valley, prevented Dames & Moore aerial surveys in November 1988. In December, moose were clustered in two areas: upper Moose Creek above 1500 feet and upper Granite Creek from Knob Hill to the upper parts of the Granite Creek drainage. Much of the area between Wishbone Hill and Knob Hill appears to provide marginal moose habitat because it lacks plant species diversity and winter cover; many areas are dominated by relatively homogeneous stands of quaking aspen. However, no ground surveys were conducted outside of the project area to quantitatively assess moose habitat utilization. Habitat diversity increases in areas above the 1500 foot contour and below the 700 foot contour in this zone.

Early winter moose movement patterns in the proposed mine area involve a shift of moose from post rutting areas above the mine site to lower elevations where Open Mixed Forest habitat provides a blend of forage shrubs, escape cover and thermal cover. This habitat type is most common in the north half of the project area and along the haul road. However, the latter area is primarily mature forest with fewer shrubs. Winter moose use of the haul road area appears to be less concentrated than on the mine site. However, high densities (clusters) of moose in the haul road area were seen in active logging areas where slash from freshly cut birch timber provided a ready food source.

From November through January very few moose could be located in the area between the Glenn Highway and the Matanuska River. In February there was an increase in moose activity on the Matanuska River flood plain which appeared to be the result of moose moving in from areas to the south of the river.

In the spring as the snow recedes in the project area moose gradually move to higher elevation summer ranges. Much of the spring movement appears to occur from late April to early May. By calving time moose have mostly left the mine area. No calving activity was observed on the project

area during the 1988-89 study. In June 1988, a cow with one calf was observed near Buffalo Creek and tracks of adult and calf moose (possibly the same animals) were observed along Moose Creek and in meadows in the southeast corner of the project area.

Observations of moose sign on the wildlife transects verified the observations from the aerial surveys and suggested that a small number of moose use the project area during spring; the spring 1989 transect surveys revealed only two sets of recent moose tracks and there were no indications of calving activity in the area.

There are no known mineral licks, rutting areas, or other critical habitats reported in the literature for the proposed mine area and none could be found during field surveys.

3.4.1.2 Browse Utilization

Browse transect surveys conducted by Dames & Moore in June 1988 revealed some use by moose of all shrub species found on the wildlife transects (Figure 7). Browsed species included Willow, Cottonwood, Aspen, Birch, Alder, Prickly Rose, Highbush Cranberry, Mountain Ash, Raspberry, and Pacific Red Elder. Shrub Birch and Willow provided the greatest volume of browse based on transect surveys.

Browse utilization in the winter of 1988-89 appeared to be moderate based on moose distribution with heaviest use in the northern half of the project area.

3.4.1.3 Moose Winter Highway Mortality

According to the Alaska Department of Fish & Game (1988) there was a sharp increase in settlement of the Matanuska-Susitna Valley area in the 1980's with approximately 3500 new homes being constructed in 1983 alone. This development reduced the available moose winter range in the area and the increase in human population resulted in a higher winter moose mortality from highway vehicles. The Alaska Department of Puplic Safety estimates that an average of 86 moose are killed each winter on the highways in the Matanuska and Susitna Valleys.

3.4.2 Black Bears

Black bears are very common throughout southcentral Alaska. Their distribution is tied closely to forested areas. Maximum populations occur in semi-open forests where there is a mixture of habitat types and an abundance of berry shrubs, herbs, grasses, and succulent forbs (ADF&G 1973). The primary diet of Black Bears consists of plant materials, but they sometimes prey on spawning salmon and occasionally on young moose. In spring, most use is made of riparian and other wetland habitats and south-facing mountain slopes where vegetation greens up early. Streams with salmon runs such as lower Moose Creek may attract bears in summer and fall.

One set of bear tracks was found near Moose Creek during transect surveys and one female with two cubs was observed in the summer of 1988 along the access road north of Buffalo Creek.

3.4.3 Brown Bears

Brown bears are very common in portions of the Talkeetna Mountains (Miller and Ballard, 1982). However, Brown Bears are only occasional visitors to the Wishbone Hill area. Brown bears are most often seen in alpine areas where Arctic Ground Squirrels, Hoary Marmots, and food plants such as succulent forbs or berries are available or along fish streams where spawning salmon may be found in late summer and fall. Surveys by Dames & Moore in 1988 and 1989 showed no evidence of brown bears in the Wishbone Hill area.

3.4.4 Dall Sheep

Dall Sheep occur in the nearby Talkeetna Mountains (ADF&G 1973) including the extreme headwaters of Granite Creek and Moose Creek, but they have never been recorded in the subalpine habitats around Wishbone Hill and none were observed during Dames & Moore aerial survey which include mountain slopes up to the 2,500 foot contour.

3.4.5 Caribou

Caribou are common residents of the Talkeetna Mountains, but according to Hemming (1971), their normal seasonal movements do not include the Wishbone Hill area No signs of caribou were observed during the field study.

3.4.6 Small Mammals

Dames & Moore summer transect and snap trap surveys revealed nine small mammal species including: Porcupine, Red Squirrel, Snowshoe Hare, Tundra Vole, Singing Vole, Meadow Vole, Northern Red-backed Vole, Northern Bog Lemming, and Masked Shrew.

The fall survey in October 1988 was conducted just after a snow fall so tracks of animals were easily observed throughout the project area. Tracks of microtine rodents were common in many areas with the highest concentrations in low meadow habitats. This observation was verified after the snow melt in May when the remains of the tunnels and food caches could be seen throughout these habitats. The tracks of the major predators of these animals, the short-tailed weasel, were also quite abundant.

Tracks of the Snowshoe Hare were found mostly in Tall Shrub habitats around the project area. Numbers of tracks suggested a relatively low abundance for this species.

3.4.7 Fur Bearers

Species that are sought by local trappers include wolf, wolverine, fox, coyote, lynx, marten, mink, beaver, land otter, short-tailed weasel, and least weasel. Of these, wolves, wolverine, and coyote range widely in search of prey and should be expected to occasionally wander through the project area in the course of normal hunting activities. One coyote was seen on the north end of the project area during the aerial moose survey on February 2, 1989.

Lynx occurrence and abundance seems to be tied closely to the availability of snowshoe hare. At this time, snowshoe hares are in low abundance and no signs of lynx were observed on the study area.

Marten have been recorded within the Matanuska Valley but none were observed during the baseline surveys. Tracks of red fox, coyote, mink, beaver, and weasel were recorded within the project area by Dames & Moore biologists.

3.5 Threatened or Endangered Species

Two important species of raptors including the peregrine falcon, a classified endangered species (Endangered Species Act of 1973, as amended, 16 U.S.C. Sec. 1531, et seq.) and the bald eagle, a specially protected species (Bald Eagle Protection Act of 1940, as amended) and designated as an important species by the ADNR Commissioner, are seasonal visitors in the region.

American peregrine falcons may occasionally be found in the area between mid-April and September. The Cook Inlet Region is within the southern fringe of their breeding range and nesting pairs may occasionally be present but no nests have been reported near the project area.

Bald eagle habitat occurs throughout the Cook Inlet area. Most nest sites are located in large trees in coastal areas, along rivers, or large lakes. Bald eagles in Alaska are not listed as an endangered species. However, Federal regulations require that permanent facilities may not be located within 330 feet of nest sites. No bald eagle nests have been recorded within or near the project area. However, eagles were observed feeding on salmon carcasses below Moose Creek Falls in Tsadaka Canyon during the Dames & Moore fall fish survey in 1988.

4.0 SUMMARY

The entire project area is important as moose winter range and there is some use of the area by moose in summer and fall. Of 255 ha (630 acres) of moose habitat that would be disturbed by mining or project facilities there are about 101 ha (250 acres) of high density and 154 ha (380 acres) of moderate density moose winter range. With existing technology these habitats could be restored and moose browse production, escape cover, and thermal cover could be improved after mining.

During mining operations a corridor of undisturbed riparian habitat would occur along Moose Creek which would allow moose to complete their seasonal migrations.

In general none of the wildlife habitats in the project area appear to be unique or irreplaceable. All habitats in areas proposed for disturbance are well represented in adjacent areas. Overall habitat diversity for mammals and birds is limited.

There are no threatened or endangered species with the possible exception of migrating Peregrine Falcons. Bald eagles have been observed near the project area, but no nesting activity or potential nesting habitat was found.

5.0 REFERENCES

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6.0 RESPONSIBLE PARTIES

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David Erikson – Ornithology
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TABLES

Table 1 Habitat Types and Vegetation Types on Wildlife Transects*

Transect	Habitat type	Vegetation type
1	Closed Deciduous	Closed Paper Birch/Aspen
2	Meadow & Low Shrub	Lowland Meadow/Young Paper Birch
3	Closed Deciduous	Closed Paper Birch/Aspen
4	Closed Deciduous	Closed Paper Birch/Aspen
5	Meadow & Low Shrub	Lowland Meadow
6	Meadow & Low Shrub	Lowland Meadow
7	Closed Deciduous	Closed Poplar/Alder Closed Paper Birch/Aspen
8	Meadow & Low Shrub	Closed Paper Birch/Aspen Lowland Meadow
9	Closed Deciduous	Closed Paper Birch/Aspen Meadow Complex Lowland Meadow Upland Meadow
12	Open Mixed Forest	Open Paper Birch/White Spruce Meadow Complex Upland Meadow
13	Open Mixed Forest	Open Paper Birch/White Spruce Meadow Complex Upland Meadow
14	Open Mixed Forest	Open Paper Birch/White Spruce Meadow Complex Upland Meadow
15	Open Mixed Forest	Open Paper Birch/White Spruce
16	Open Mixed Forest	Open Paper Birch/White Spruce
17	Open Mixed Forest	Open Paper Birch/White Spruce Meadow Complex Upland meadow

Table 1 (Cont.) Habitat Types and Vegetation Types on Wildlife Transects

Transect	Habitat type	Vegetation type
18	Open Mixed Forest	Open Paper Birch/White Spruce Meadow Complex Upland Meadow
19	Tall Shrub	Closed Alder
20	Closed Deciduous	Closed Poplar Meadow Complex Upland Meadow
21	Meadow & Low Shrub	Young Birch Closed Deciduous Upland Meadow
22	Closed Deciduous	Upland Meadow
	Tall Shrub	Closed Alder Young Birch
23	Open Mixed Forest	Open Paper Birch/White Spruce
24	Open Mixed Forest	Open Paper Birch/White Spruce
25	Open Mixed Forest	Open Paper Birch/White Spruce
26	Open Mixed Forest	Open Paper Birch/White Spruce
27	Open Mixed Forest	Open Paper Birch/White Spruce
28	Open Mixed Forest	Open Paper Birch/White Spruce

* Transects 10 and 11 were deleted due to changes in the project area boundary.

Table 2
Birds Likely to Occur in
the Wishbone Hill Project Area

Birds

Spruce Grouse
Willow Ptarmigan
Rock Ptarmigan
White-tailed Ptarmigan
Bald Eagle
Golden Eagle
Northern Harrier
Sharp-shinned Hawk
Northern Goshawk
Merlin
Rough-legged Hawk
Swainson's Hawk
Red-tailed Hawk
American Kestrel
Peregrine Falcon
Gyrfalcon
Boreal Owl
Saw-whet Owl
Great Gray Owl
Great Horned Owl
Short-eared Owl
Snowy Owl
Hawk Owl
Whimbrel
Lesser Golden Plover
Greater Yellowlegs
Common Snipe
Sandhill Crane
American Robin
Varied Thrush
Water Pipit
Northern Shrike
European Starling
Orange-crowned Warbler
Yellow Warbler
Yellow-rumped Warbler
Townsend's Warbler
Wilson's Warbler
Tree Sparrow
Fox Sparrow
Song Sparrow
Golden-crowned Sparrow
White-crowned Sparrow
Dark-eyed Junco
Lapland Longspur
Snow Bunting
Pine Grosbeak
White-winged Crossbill
Common Redpoll
Hoary Redpoll
Pine Siskin
Horned Lark
Harelequin Duck
Common Merganser
Red-breasted Merganser
Mew Gull
Arctic Tern
Belted Kingfisher
Downy Woodpecker
Hairy Woodpecker
Three-toed Woodpecker
Black-backed Woodpecker
Northern Flicker
Olive-sided Flycatcher
Alder Flycatcher
Western Wood-Pewee
Tree Swallow
Violet-green Swallow
Cliff Swallow
Gray Jay
Black-billed Magpie
Raven
Black-capped Chickadee
Boreal Chickadee
Red-breasted Nuthatch
Brown Creeper
Dipper
Golden-crowned Kinglet
Ruby-crowned Kinglet
Northern Wheatear
Townsend's Solitaire
Swainson's Thrush
Hermit Thrush
Green-winged Teal
Mallard
Bohemian Waxwing

From: Bronson (1988) and Ritchie et. al (1981)

Table 3 Bird Species, Breeding Status and Occurence by Habitat Type, Wishbone Hill, 1988-89

SPECIES	STATUS*	Lakes and ponds	Rivers and streams	Wet meadows	Upland/Low meadows	Tall shrub	Decid. forest closed	Mixed forest open
Green-winged Teal (Anas crecca)	prbr	+						
Mallard (Anas platyrhynchos)	prbr	+						
Common Goldeneye (Bucephala clangula)	pobr	+						
Barrow's Goldeneye (Bucephala islandica)	prbr	+						
Common Merganser (Mergus merganser)	cobr		+					
Bald Eagle (Haliaeetus leucocephalus)	nobr		+					
Northern Goshawk (Accipiter gentilis)	pobr							+
Red-tailed Hawk (Buteo jamacensis)	pobr							+
Spruce grouse (Dendragrapus canadensis)	cobr							+
Willow Ptarmigan (Lagopus lagopus)	pobr							
Greater Yellowlegs (Tringa melanoleuca)	pobr			+	+			
Common Snipe (Gallinago gallinago)	pobr			+				
Mew Gull (Larus canus)	nobr		+					
Great Horned Owl (Bubo virginianus)	pobr							+
Western Wood-Pewee (Contopus sordidulus)	pobr							+
Alder Flycatcher (Empidonax alnorum)	prbr				+	+	+	+
Tree Sparrow (Tachycineta bicolor)	pobr			+			+	
Black-billed Magpie (Pica pica)	pobr							+
Steller's Jay (Cyanocitta stelleri)	pobr							+

* Breeding Status on project site
pobr = possible breeder (present during breeding season)
prbr = probable breeder (male singing, defending territory in proper habitat)
cobr = confirmed breeder (active nest, fledglings present or adults carrying food)
nobr = nonbreeder (not in proper breeding habitat or not seen during breeding season)

Table 3 (Cont.) Bird Species, Breeding Status and Occurence by Habitat Type, Wishbone Hill, 1988-89

SPECIES	STATUS*	Lakes and ponds	Rivers and streams	Wet meadows	Upland/Low meadows	Tall shrub	Decid. forest closed	Mixed forest open
Common Raven (Corvus corvax)	pobr			+				+
Black-capped Chickadee (Parus atricapillus)	pobr						+	+
Brown Creeper (Certhia americana)	pobr							+
American Dipper (Cinclus mexicanus)	pobr			+				
Golden-crowned Kinglet (Regulus satrapa)	prbr							+
Ruby-crowned Kinglet (Regulus calendula)	prbr							+
Swainson's Thrush (Catharus ustulatus)	prbr					+	+	+
Hermit Thrush (Catharus guttatus)	prbr					+		+
American Robin (Turdus migratorius)	cobr							
Varied Thrush (Ixoreus naevius)	prbr							
Northern Strike (Lanius excubitor)	pobr							
Orange-crowned Warbler (Vermivora celata)	prbr							+
Yellow Warbler (Dendroica petechia)	prbr					+	+	+
Yellow-rumped Warbler (Dendroica coronata)	cobr					+		
Blackpoll Warbler (Dendroica striata)	prbr					+	+	+
Wilson's Warbler (Wilsonia pusilla)	prbr					+		+
American Tree Sparrow (Spizella arborea)	pobr				+	+		
Savannah Sparrow (Passerculus sandwichensis)	prbr				+	+		
Fox Sparrow (Passerculus iliaca)	pobr					+		

* Breeding Status on project site
pobr = possible breeder (present during breeding season)
prbr = probable breeder (male singing, defending territory in proper habitat)
cobr = confirmed breeder (active nest, fledglings present or adults carrying food)
nobr = nonbreeder (not in proper breeding habitat or not seen during breeding season)

Table 3 (Cont.) Bird Species, Breeding Status and Occurence by Habitat Type, Wishbone Hill, 1988-89

SPECIES	STATUS*	Lakes and ponds	Rivers and streams	Wet meadows	Upland/Low meadows	Tall shrub	Decid. forest closed	Mixed forest open
Lincoln's Sparrow (Melospiza lincolnii)	prbr				+		+	
Golden-crowned Sparrow (Zonotrichia atricapilla)	prbr						+	
White-crowned Sparrow (Zonotrichia leucophrys)	prbr					+		
Dark-eyed Junco (Junco hyemalis)	cobr				+	+	+	+
Common Redpoll (Carduelis flammea)	pobr							+
Pine Grosbeak (Pinicola enuseator)	pobr					+	+	
Pine Siskin (Carduelis pinus)	pobr							

* Breeding Status on project site
pobr = possible breeder (present during breeding season)
prbr = probable breeder (male singing, defending territory in proper habitat)
cobr = confirmed breeder (active nest, fledglings present or adults carrying food)
nobr = nonbreeder (not in proper breeding habitat or not seen during breeding season)

Table 4 Total Numbers and Mean Densities by Major Habitat Types of Common Birds Sighted on Permanent Transects, June 21-24, 1989

	Closed Deciduous Forest								Open Mixed Forest							
	TRANSECT								TRANSECT							
SPECIES	1	3	4	7	8	20	Mean	Std.	9	12	13	14	15	16	Mean	Std.
Alder Flycatcher													1		0.17	0.40
Swainson's Thrush			2			1	0.50	0.76						1	0.33	0.49
Varied Thrush						1	0.17	0.37								
Orange-crowned Warbler					1	1	0.33	0.47								
Yellow Warbler												1			0.17	0.37
Yellow-rumped Warbler	1		2		1	1	0.83	0.69	2		1	1		2	1.00	0.82
Blackpoll Warbler		1		1			0.33	0.47					1		0.17	0.37
Wilson's Warbler												1			0.20	0.40
Savannah Sparrow				1			0.17	0.37								
Dark-eyed Junco	2	1	1	1	1		1.00	0.58	4					1	0.83	1.46

	Meadow Complex								Tall Shrub			All Habitats	
	TRANSECT								TRANSECT				
SPECIES	2	5	6	17	18	21	22	Mean	Std.	19	Mean	Std.	Mean	Std.
Alder Flycatcher	2	1	1	1	1	1	1	1.14	0.35				0.64	0.61
Swainson's Thrush	1			1				0.29	0.45				0.35	0.57
Varied Thrush													0.05	0.22
Orange-crowned Warbler	2			1		1		0.57	0.73				0.43	0.62
Yellow Warbler										1	1.00		0.29	0.45
Yellow-rumped Warbler	1							0.14	0.35				0.60	0.73
Blackpoll Warbler			2	1			1	0.57	0.73				0.35	0.57
Wilson's Warbler					1			0.14	0.35	1	1.00		0.23	0.42
Savannah Sparrow			1	1				0.29	0.45				0.21	0.41
Dark-eyed Junco		1		2	1		2	0.86	0.83				0.85	1.01

Table 5 Total Numbers and Mean Densities by Major Habitat Types of Singing Males for Common Birds Sighted on Wildlife Transects, May 11-13, 1989

	Closed Deciduous Forest								Open Mixed Forest							
	TRANSECT								TRANSECT							
SPECIES	1	3	4	7	8	20	Mean	Std.	9	12	13	14	15	16	Mean	Std.
Blacked-capped Chickadee		2					0.33	0.75						1	0.17	0.37
Varied Thrush		1					0.17	0.37								
Orange-crowned Warbler									1				1		0.33	0.47
Yellow-rumped Warbler	1	1					0.33	0.47	2		1		2	2	1.17	0.90
Dark-eyed Junco	1	1			1		0.50	0.50	2	1	1	1	1		1.00	0.58

	Meadow Complex								Tall Shrub			All Habitats	
	TRANSECT								TRANSECT				
SPECIES	2	5	6	17	18	21	22	Mean	Std.	19	Mean	Std.	Mean	Std.
Blacked-capped Chickadee										0			0.15	0.48
Varied Thrush										0			0.05	0.22
Orange-crowned Warbler										0			0.1111	0.31
Yellow-rumped Warbler					1	1		0.29	0.45	0			0.55	0.74
Dark-eyed Junco	2					1	1	0.57	0.73	1	1		0.07	0.64

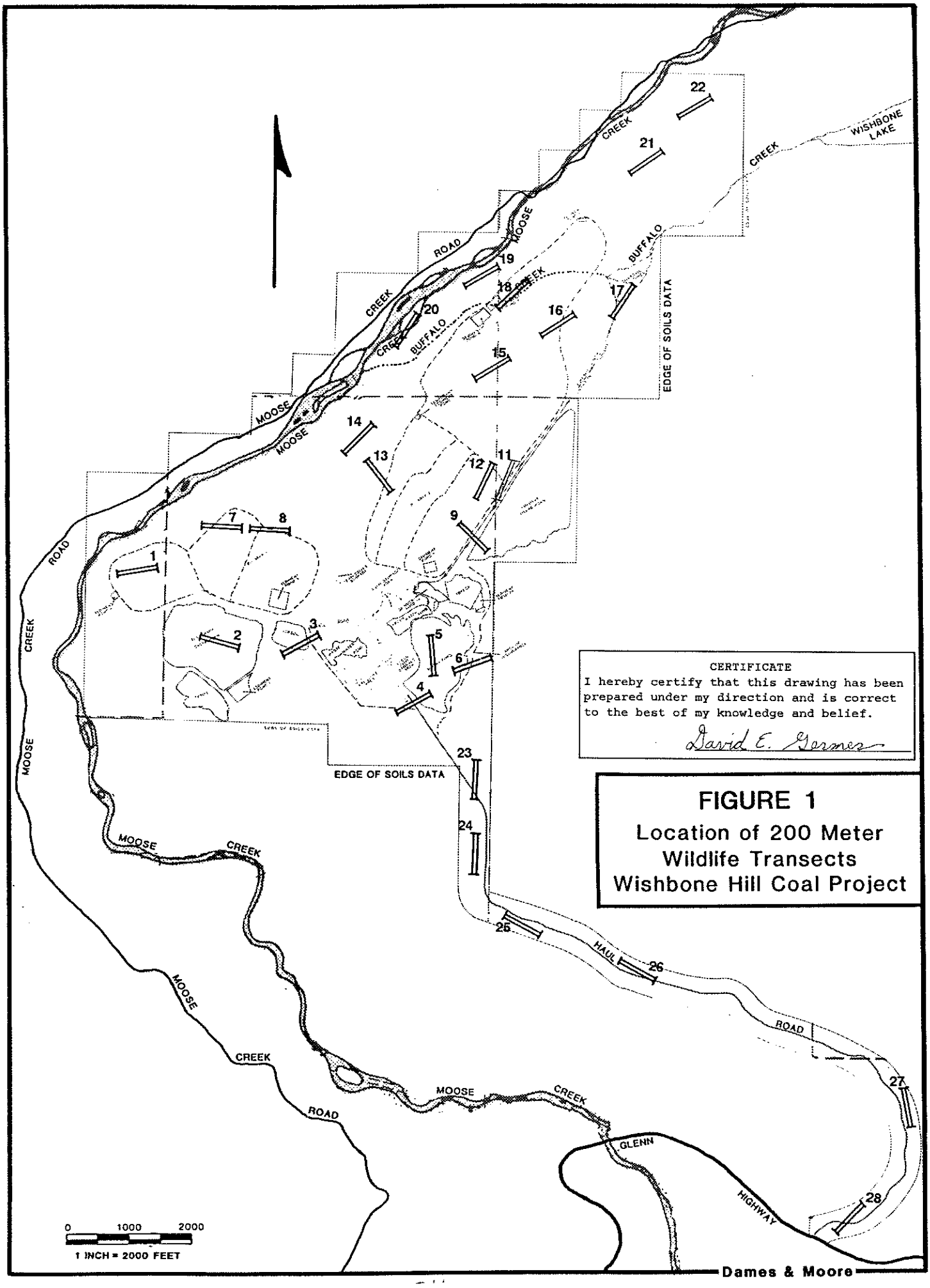
TABLE 6

Mammals likely to occur in the Wishbone Hill Project Area

Moose
Brown Bear
Black Bear
Lynx
Wolf
Coyote
Wolverine
Short-tailed Weasel (Ermine)
Least Weasel
Mink
Marten
Red Squirrel
Arctic Ground Squirrel
Snowshoe Hare
Hoary Marmot
Porcupine
Beaver
Muskrat
Red Fox
Land Otter
Caribou
Northern Flying Squirrel
Tundra Vole
Northern Red-backed Vole
Singing Vole
Meadow Vole
Northern Bog Lemming
Brown Lemming
Little Brown Bat
Meadow Jumping Mouse
Masked Shrew
Dusky Shrew
Northern Water Shrew
Pigmy Shrew

Source: MacDonald (1980), Rausch (1953), and Rausch (1963)

FIGURES



CERTIFICATE

I hereby certify that this drawing has been prepared under my direction and is correct to the best of my knowledge and belief.

David E. Gerner

FIGURE 1

Location of 200 Meter Wildlife Transects Wishbone Hill Coal Project

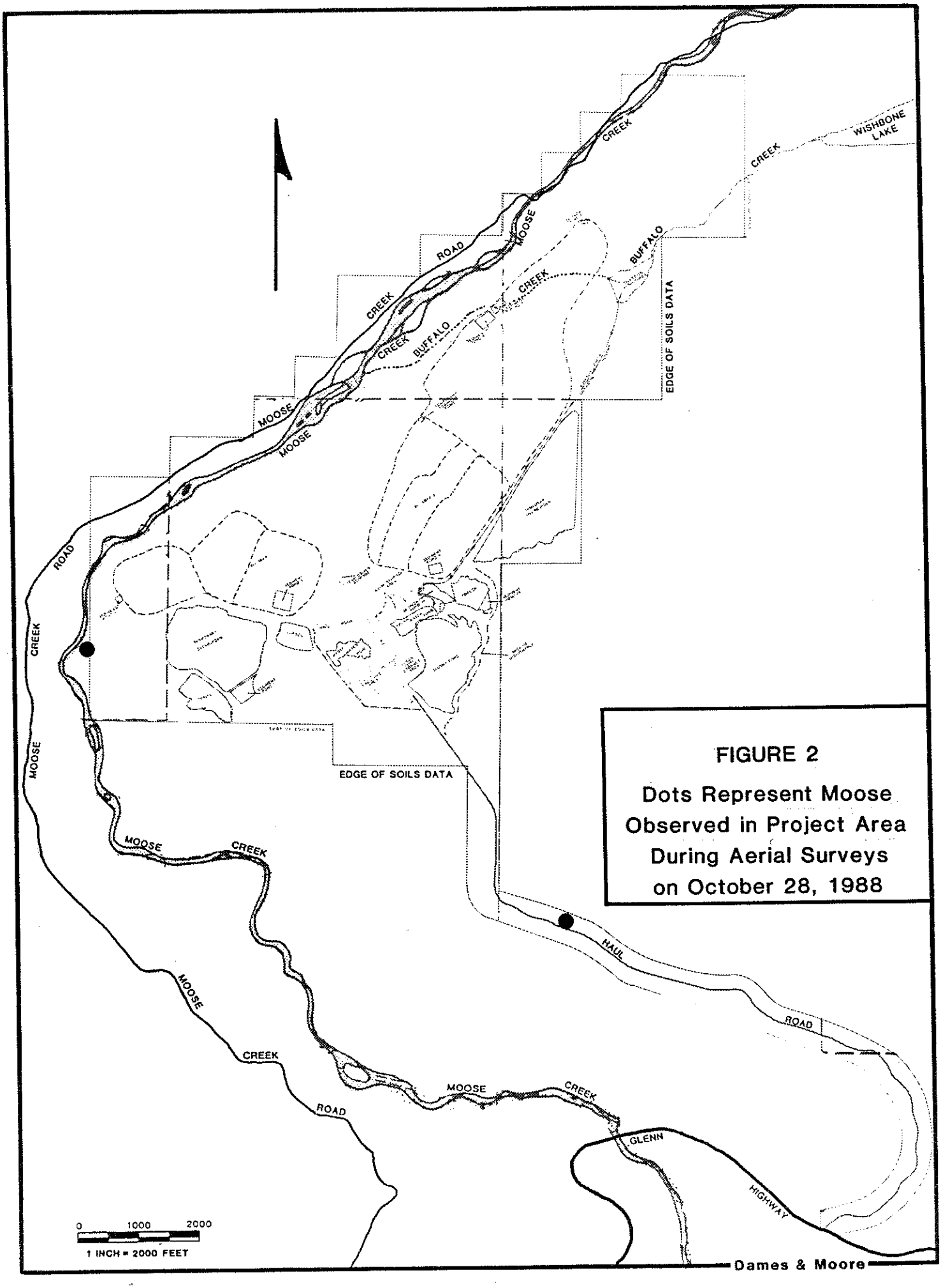


FIGURE 2

Dots Represent Moose Observed in Project Area During Aerial Surveys on October 28, 1988

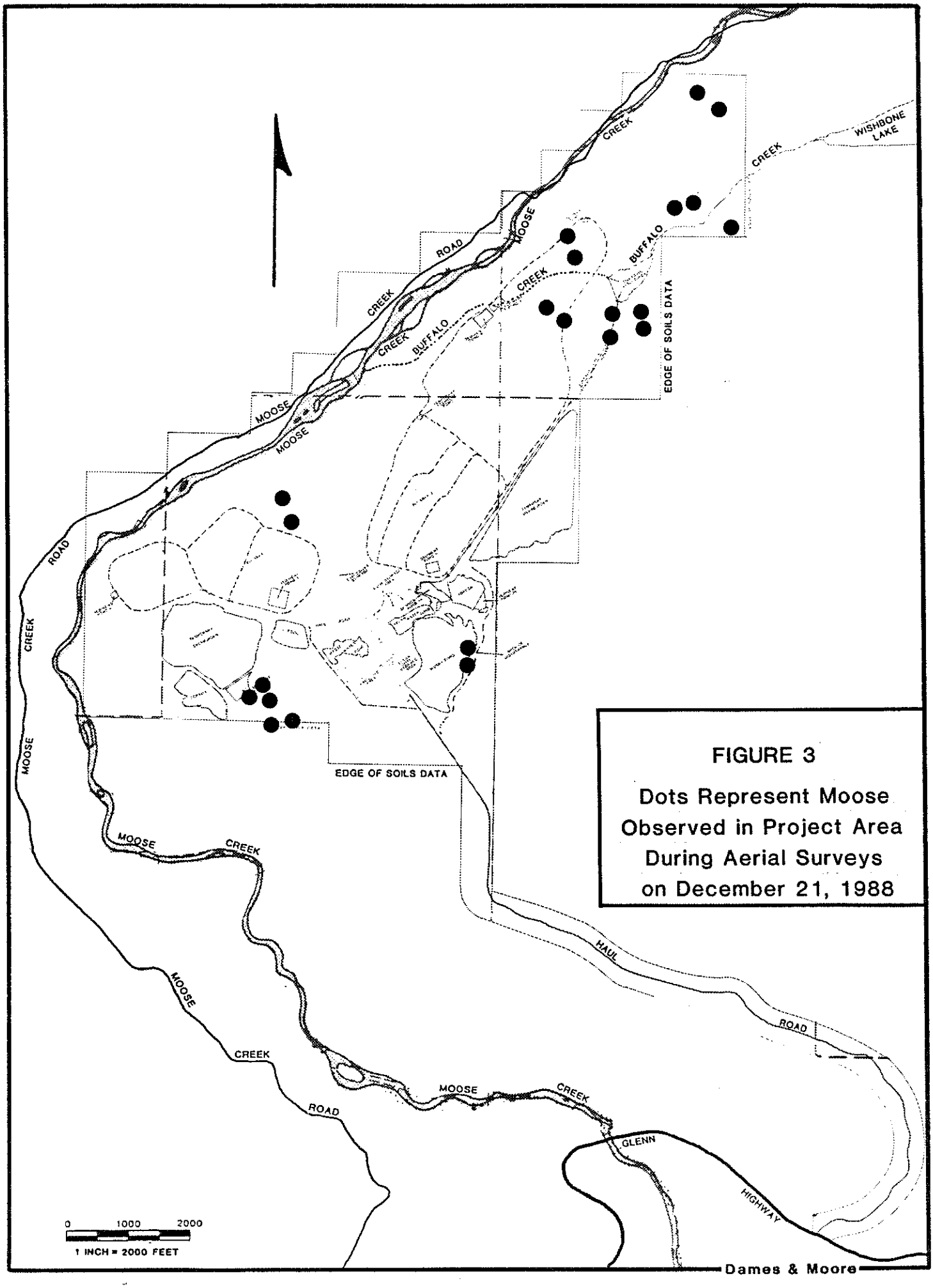


FIGURE 3

Dots Represent Moose Observed in Project Area During Aerial Surveys on December 21, 1988

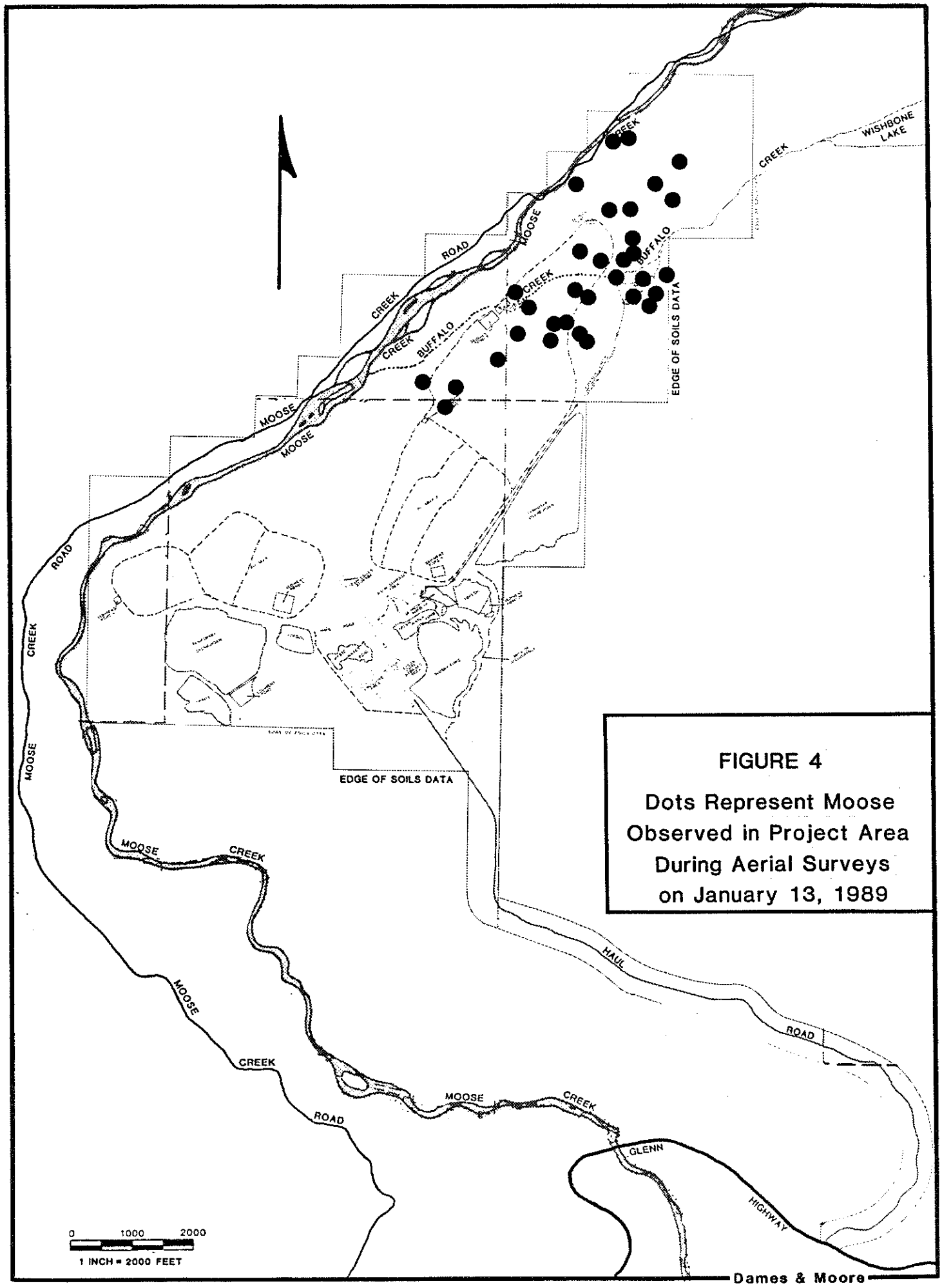


FIGURE 4

Dots Represent Moose Observed in Project Area During Aerial Surveys on January 13, 1989

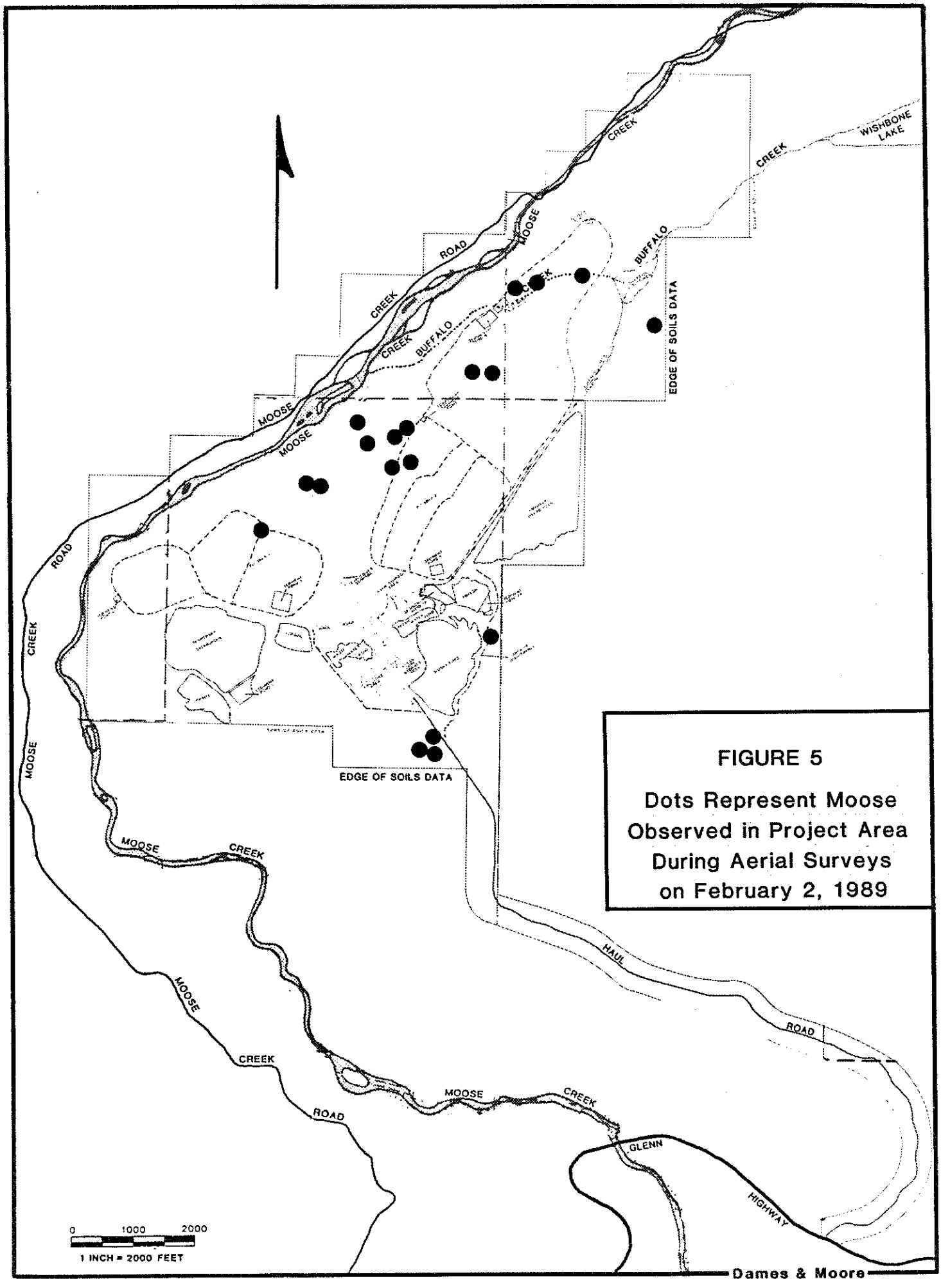


FIGURE 5

Dots Represent Moose Observed in Project Area During Aerial Surveys on February 2, 1989

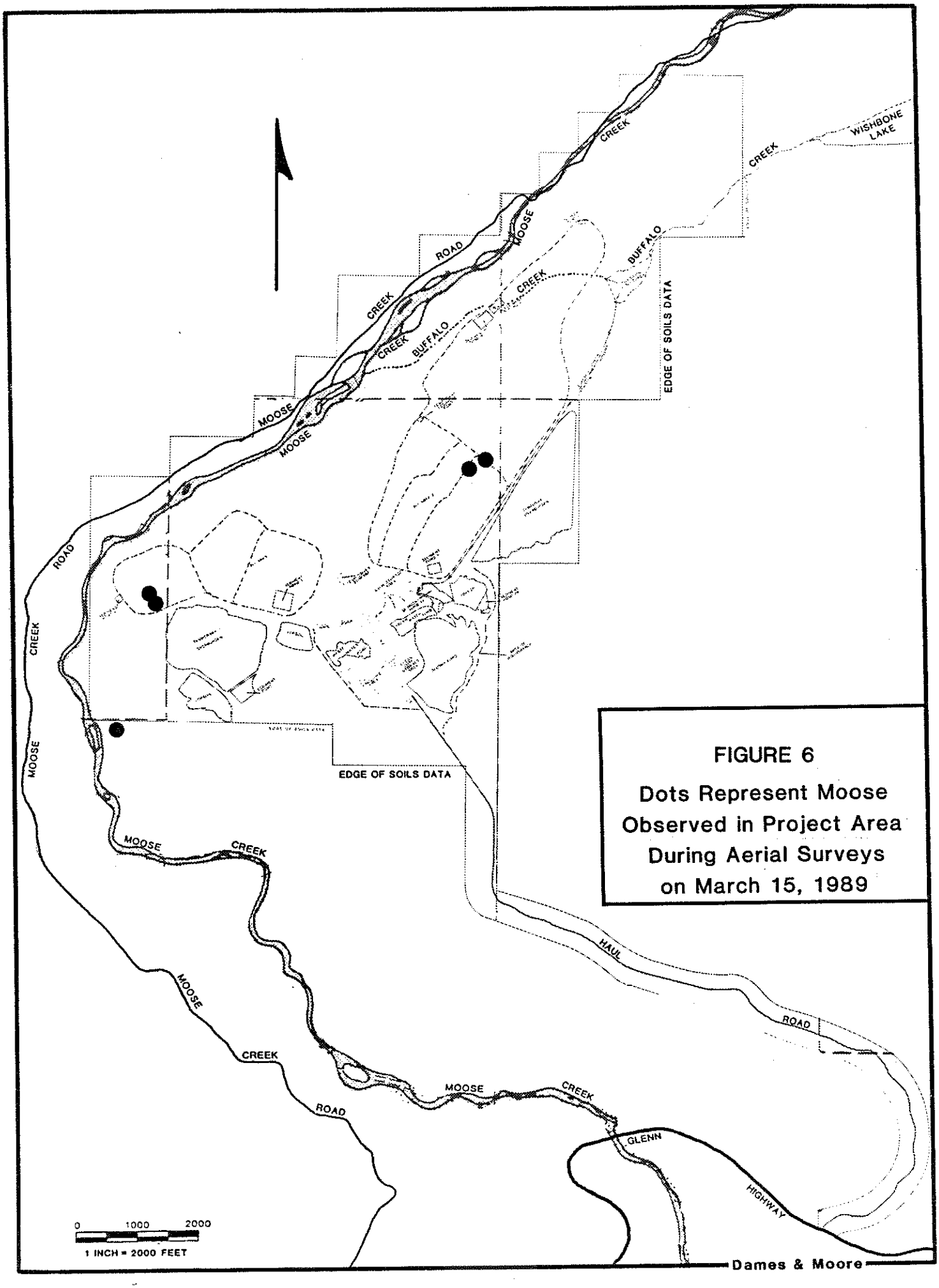
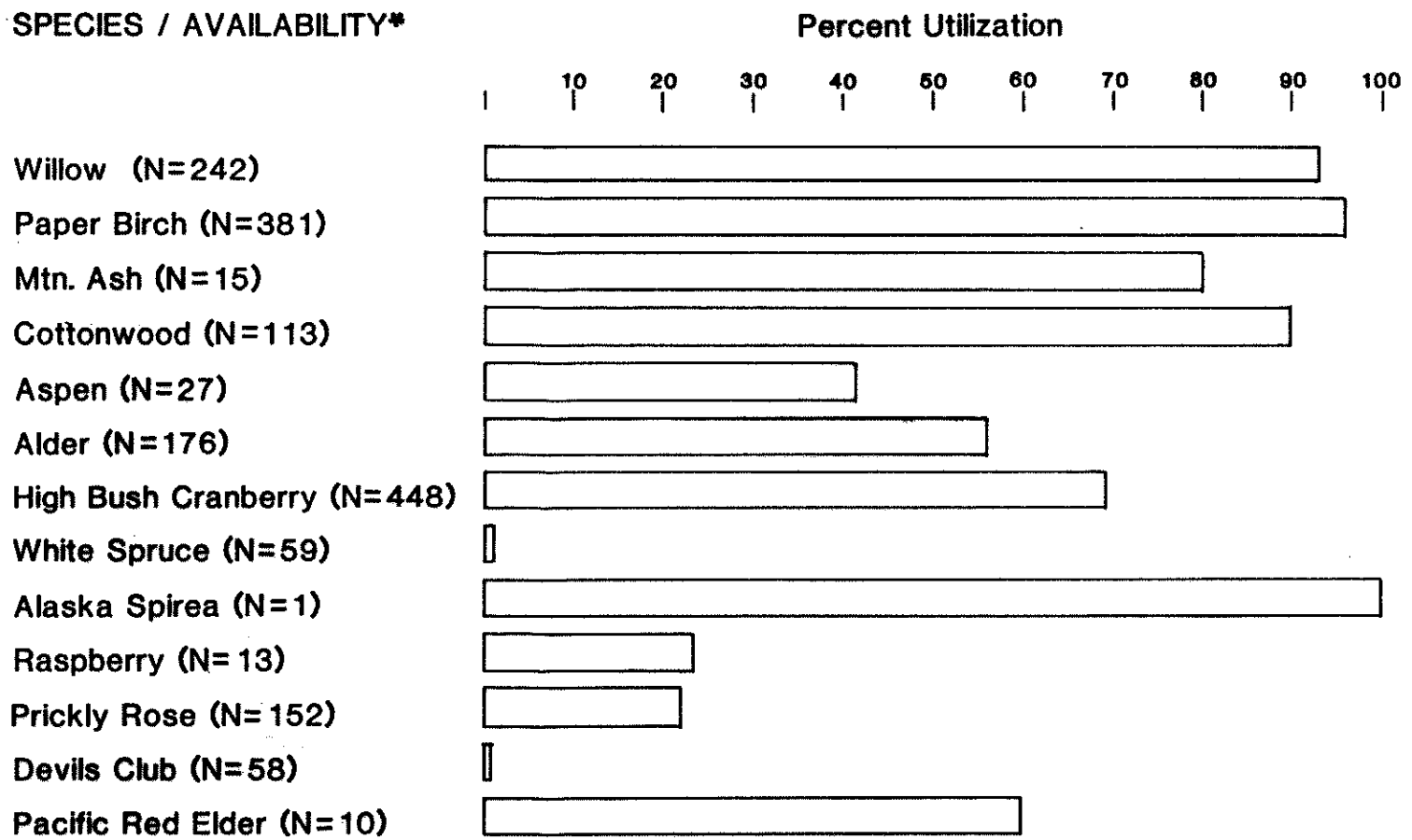


FIGURE 6

Dots Represent Moose Observed in Project Area During Aerial Surveys on March 15, 1989



* N EQUALS THE TOTAL NUMBER OF INDIVIDUAL SHRUBS INTERCEPTED BY STRING LINES ON ALL TRANSECTS.

FIGURE 7

Utilization of Shrubs by Moose Based on Twenty 200 Meter String Intercept Transects in the Wishbone Hill Area.

DAMES & MOORE

R 2 E

Wishbone Lake

Elk's Lake

SEE LEGEND

LEGEND

1 Open Mixed Forest
2 Closed Deciduous Forest
31 Tall Shrub A (Alder)
32 Tall Shrub B (Willow)
33 Tall Shrub C (Young Birch)
4 Lowland Meadow
5 Upland Meadow
6 Wet Low Shrub
7 Riverine
8 Barren
9 Residential

Total Area of Disturbance

All Habitats within the Permit Area NORTH of this Line are High Density Moose Winter Range.

All Habitats within the Permit Area SOUTH of this Line are Moderate Density Moose Winter Range.

WILDLIFE HABITAT STUDY BOUNDARY

PERMIT BOUNDARY

T 19 N
T 18 N

The core map area was photogrammetricaly mapped from photography of 5/8/84, 5/8/83, 6/22/85 by Air Photo Tech, Inc. of Anchorage, Alaska.

The core map area meets National Map Accuracy Standards at 1"=200' and smaller scales. Topographic and Planimetric features outside of the core area were taken from a photo enlarged 1" = 1mile USGS Anchorage C-6 quad map of 1987.

Horizontal datum is Alaska State Plane, zone 4.

Vertical datum is based on USC & GS monumentation.

Map Area

R 2 E R 3 E
T 19 N
T 18 N
Sutton
Palmer

North

500 250 0 500 1000 1500
SCALE IN FEET
1" = 500'
CONTOUR INTERVAL
5 FEET

SUBJECT REVISIONS			
REV.	DATE:	BY:	DESCRIPTION
1	2009	JH	MINOR REVISIONS

DESIGN BY:
DRAWN BY:
CHECK BY:
DWG FILE:
DATE DRAWN:

WISHBONE HILL MINE — PERMIT NUMBER 01-89-796

WISHBONE HILL
WILDLIFE HABITATS
WISHBONE HILL MINE

USIBELLI COAL MINE, INC.
P.O. BOX 1000, HEALY, ALASKA 99743
(907) 683-2226

PLATE No. X-1
SHEET No. 1 OF 1
REV. 1

APPENDICIES

APPENDIX A
BIRD TRANSECT DATA

APPENDIX A-1 Total Numbers of Birds Sighted on Wildlife Transects June 20-24, 1988

SPECIES	Transect No. 1	2	3	4	5	6	7	8	9	12	13	14	15	16	17	18	19	20	21	22
Spruce Grouse (Dendragrapus canadensis)																2				
Alder Flycatcher (Empidonax alnorum)		2			1	1							1		1	1			1	1
Swainson's Thrush (Catharus ustulatus)		1		2						1				1	1			1		
American Robin (Turdus migratorius)												1								
Varied Thrush (Ixoreus naevius)																		1		
Orange-crowned Warbler (Vermivora celata)		2						1							1			1	1	
Yellow Warbler (Dendroica petechia)												1					1			
Yellow-rumped Warbler (Dendroica coronata)	1	1		2				1	2		1	1		2				1		
Blackpoll Warbler (Dendroica striata)			1			2	1						1		1					1
Wilson's Warbler (Wilsonia pusilla)												1				1	1			
Savannah Sparrow (Passerculus sandwichensis)						1	1								1					
Lincoln's Sparrow (Melospiza lincolnii)												1				1				
White-crowned Sparrow (Zonotrichia leucophrys)												1								
Dark-eyed Junco (Junco hyemalis)	2		1	1	1		1	1	4					1	2	1				2

APPENDIX A-2 Total Numbers of Birds Sighted on Wildlife Transects September 2, 1988

SPECIES	*	Transect No. 1	2	3	4	5	6	7	8	9	12	13	14	15	16	17	18	19	20	21	22
Northern Goshawk (Accipiter gentilis)	1																				
Spruce grouse (Dendragrapus canadensis)	4																				
Black-capped Chickadee (Parus atricapillus)										4							1				
Varied Thrush (Ixoreus naevius)																				1	
Yellow-rumped Warbler (Dendroica coronata)										2											
Savannah Sparrow (Passerculus sandwichensis)					1																
Dark-eyed Junco (Junco hyemalis)		3			2			1	1		1	1							1		

* Observed outside transects

APPENDIX A-3 Total Numbers of Birds Sighted on Wildlife Transects October 27-29, 1988

SPECIES	*	Transect No. 1	2	3	4	5	6	7	8	9	12	13	14	15	16	17	18	19	20	21	22
Bald Eagle (Haliaeetus leucocephalus)	1																				
Northern Goshawk (Accipiter gentilis)	1																				
Black-billed Magpie (Pica pica)								1													
Black-capped Chickadee (Parus atricapillus)		25				1								4							
Golden-crowned Kinglet (Regulus satrapa)	1																				
Pine Grosbeak (Pinicola enucleator)									9			1									

* Observed outside transects

APPENDIX A-4 Total Numbers of Birds Sighted on Wildlife Transects March 14-17, 1989

SPECIES	*	Transect No. 1	2	3	4	5	6	7	8	9	12	13	14	15	16	17	18	19	20	21	22
Black-capped Chickadee (Parus atricapillus)																					
Common Raven (Corvus corvax)		3																			
Black-billed Magpie (Pica pica)		2																			
Northern Shrike (Lanius excubitor)		2																			

* Observed Outside & Transects

APPENDIX A-5 Total Numbers of Birds Sighted on Permanent Transects May 11-13, 1989

SPECIES	*	Transect No. 1	2	3	4	5	6	7	8	9	12	13	14	15	16	17	18	19	20	21	22
Greater Yellowlegs (Tringa melanoleuca)	1																				
Downy Woodpecker (Picoides pubescens)	1																				
Steller's Jay (Cyanocitta stelleri)	1																				
Black-capped Chickadee (Parus atricapillus)				2											1						
Ruby-crowned Kinglet (Regulus calendula)	2																				
Hermit Thrush (Catharus guttatus)	1																				
American Robin (Turdus migratorius)	1																				
Varied Thrush (Ixoreus naevius)				1																	
Orange-crowned Warbler (Vermivora celata)										1				1							
Yellow-rumped Warbler (Dendroica coronata)		1		1						2		1		2	2		1			1	
American Tree Sparrow (Spizella arborea)	1																				
Savannah Sparrow (Passerculus sandwichensis)	1																				
Lincoln's Sparrow (Melospiza lincolnii)																	1				
Golden-crowned Sparrow (Zonotrichia atricapilla)	1																				
White-crowned Sparrow (Zonotrichia leucophrys)	2																				
Dark-eyed Junco (Junco hyemalis)		1	2	1					1	2	1	1	1	1				1		1	1
Pine Siskin	2																				

* Observed outside of Transects

APPENDIX A-6 Total Numbers of Birds Sighted on Transects along Proposed Haul Road Route, May 13, 1989

SPECIES	*	Transect No. 23	24	25	26	27	28
Ruby-crowned Kinglet (Regulus calendula)	2						
Varied Thrush (Ixoreus naevius)	3						
Orange-crowned Warbler (Vermivora celata)	1					1	
Yellow-rumped Warbler (Dendroica coronata)	4				1		2
Dark-eyed Junco (Junco hyemalis)	3		1				

* Observed outside of transects

APPENDIX B

MOOSE TRANSECT AND AERIAL SURVEY DATA

Appendix B-1

Shrub utilization by moose on 200 meter transects

Transect 1			Transect 2			Transect 3			Transect 4			Transect 5			Transect 6		
No. Shrubs (N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height
1	-	1.5m	7	-	2.1m	7	-	2.1m	7	-	3.2m	6	-	1.75m	3	-	3m
4	100	1.75m	-	-	-	-	-	-	4	100	1m	5	40	0.5m	-	-	-
-	-	-	1	-	0.5m	-	-	-	5	80	0.8m	9	56	0.5m	-	-	-
2	100	1.5m	-	-	-	-	-	-	-	-	-	-	-	-	4	100	0.9m
2	100	1.75m	-	-	-	2	100	0.75m	1	100	1m	-	-	-	6	100	0.8m
26	100	1.75m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	4	100	0.5m	-	-	-	-	-	-	7	100	0.9m
-	-	-	35	89	0.8m	3	100	1.0m	2	100	1.25m	52	90	0.75m	-	-	-
24	96	2.2m	17	100	1.2m	27	100	1.1m	36	86	1.4m	2	50	0.5m	28	96	1.3m
16	69	2.2m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	100	2.5m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	1	-	0.5m	-	-	-	-	-	-
-	-	-	-	-	-	1	100	0.5m	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	2	100	1m	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	33	0.8m	4	-	-	15	20	0.5m	9	10	0.7m	5	-	0.5m	2	-	0.5m
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	0.5m
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	92	0.8m	6	33	0.5m	29	93	0.6m	81	47	0.9m	9	11	0.7m	17	71	0.6m

Appendix B-2
Shrub utilization by moose on 200 meter transects

Transect 7			Transect 8			Transect 9			Transect 12			Transect 13			Transect 14		
No. Shrubs (N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height
3	33	1.8m	3	-	2.3m	-	-	-	1	-	0.5m	1	-	5m	2	-	3.5m
55	93	1.5m	32	88	1.6m	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	16	0.6m
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	1	100	1.0m	-	-	-	-	-	-	-	-	-	-	-	-
5	60	1.5m	36	94	1.0m	-	-	-	1	100	1m	5	100	1m	7	100	2.5m
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	100	3.0m	42	98	1.7m	18	100	1.4m	33	100	1.6m	25	88	3.2m	10	70	1.7m
60	65	3.7m	15	33	1.5m	1	100	1m	1	100	1m	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	1	-	0.5m	-	-	-	-	-	-	1	100	1m	3	67	0.6m
1	-	0.5m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	3	-	0.75m	-	-	-	-	-	-	19	70	0.6m	36	-	0.6m
-	-	-	-	-	-	-	-	-	-	-	-	5	-	0.9m	31	-	0.9m
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	47	43	0.8m	13	78	1m	28	71	0.9m	46	96	0.9m	60	59	0.9m

Appendix B-3

Shrub utilization by moose on 200 meter transects

Transect 15			Transect 16			Transect 17			Transect 18			Transect 19			Transect 20		
No. Shrubs (N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height
6	-	1.8m	9	11	3.0m	3	33	4.3m	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	7	88	1.6m	5	100	1m
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	37	100	1.7m	-	-	-
-	-	-	5	100	0.7m	1	100	1m	3	100	1m	-	-	-	-	-	-
1	100	1m	-	-	-	-	-	-	3	100	1m	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	100	1.6m	22	95	1.9m	8	100	2.1m	3	100	1.7m	11	100	2.7m	4	100	2m
-	-	-	-	-	-	5	100	1.3m	-	-	-	44	68	2.1m	-	-	-
-	-	-	-	-	-	-	-	-	10	-	2.6m	-	-	-	8	25	3.25m
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	75	0.5m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	50	0.5m	-	-	-	2	50	0.75m	-	-	-	-	-	-	-	-	-
10	90	0.7m	2	-	0.75m	3	-	0.7m	3	-	1m	16	13	1.2m	10	10	0.9m
5	-	0.8m	-	-	-	-	-	-	-	-	-	9	11	1m	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	100	0.8m	26	85	0.9m	13	85	0.6m	-	-	-	32	69	1m	16	88	1.0m

Appendix B-4
Shrub utilization by moose on 200 meter transects

Transect 21			Transect 22		
No. Shrubs (N)	% Browsed Shrubs	Ave. Shrub Height	(N)	% Browsed Shrubs	Ave. Shrub Height
-	-	-	-	-	-
1	-	4m	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	2	100	2.25m
5	100	2.7m	10	100	2.4m
7	42	3.2m	7	-	4.5m
-	-	-	-	-	-
-	-	-	2	-	0.75m
-	-	-	-	-	-
4	100	2.5m	-	-	-
6	-	0.8m	-	-	-
1	-	0.5m	2	-	0.5m
6	-	1.3m	-	-	-
9	67	1.7m	1	-	2m
1	-	0.5m	-	-	-

WISHBONE HILL COAL PROJECT
MOOSE SURVEY FORM

Observer Hemming - Dames & Moore
Pilot Wiederkehr
Aircraft Super Cub
Time off 10:20 AM
Area Moose Cr. - Granite Cr.

Snow Condition 6"-8" base w/trace of new sno
Light Condition Clear
Weather Very light wind
Time on 2:30 PM
Date 21 December 1988

Group No.	Bulls			Cows			Lone calf	Unk sex/ age	Total moose	Above tree line (✓)	Remarks:
	Ylg	Med <50"	Lge ≥50"	w/o calf	w/1 calf	w/2 calf					
1				1	2	1	1		9	9	Upper Moose Cr.
2					1				2	—	Moose to Eska Cr.
3				1	1				3	—	Upper Eska Cr.
4		1		1				1	3	—	Eska to Moose Cr.
5					3				6		Moose to Eska Cr.
6		1						1	2		Eska to Moose Cr
7							1		1		Moose to Eska Cr
8		1			1			3	5		Eska to Moose Cr
9								1	1		Moose to Eska Cr
10					1			3	5		Eska to Moose Cr
11								2	2		N. Flank Wishbone
12								2	2		Top Wishbone Hi
13									-0-		Eska to Moose
14						2		2	8		Moose to Eska Cr.
15					1			1	3		Eska to Moose Cr
16					3				6		Moose to Eska
17									-0-		Eska to Moose
18		1			3			1	8		Moose to Eska
19								2	2		Eska to Moose Cr
20					2			1	5		Moose to Eska Cr
21						1		2	5		Eska to Moose
22					1				2		Moose Cr. to Eska
23					1				2		Eska to Moose Cr
24									-0-		Moose to Eska Cr

WISHBONE HILL COAL PROJECT
MOOSE SURVEY FORM

Observer Hemming - Dames & Moore
Pilot Wiederkehr
Aircraft Supercub
Time off 10:20 AM
Area Moose Cr. - Granite Cr.

Snow Condition 6"-8" w/ trace of new snow
Light Condition Clear
Weather Very light wind
Time on 2:30 PM
Date 21 December 1988

Group No.	Bulls: Ylg	Bulls: Med <50"	Bulls: Lge ≥50"	Cows: w/o calf	Cows: w/1 calf	Cows: w/2 calf	Lone calf	Unk sex/age	Total moose	Above tree line (✓)	Remarks:
1 25									-0-		Eska to Moose Cr.
2 26					1			3	5		Moose to Eska Cr.
3 27								1	1		Eska to Moose Cr.
4 28		1			2	1		3	11		Moose to Eska Cr.
5 29									-0-		Eska to Moose Cr.
6 30									-0-		Moose Cr. to Eska Cr.
7 31									-0-		Eska to Moose Cr.
8 32					1				2		Moose to Matanuska R.
9 33									-0-		Mat. R. to Moose Cr.
10 34					1				2		Moose Cr. to Mat. - below Hwy 1
11 35	END MOOSE CR. to ESKA CR.										
12 36	BEGIN ESKA CR. to GRANITE CR.										
13 37		1			6			5	18	6	Upper Granite Cr.
14 38		1			1			2	5		Granite to Eska Cr.
15 39					1			1	3		Eska to Granite
16 40		2						4	6		Granite to Eska
17 41								3	3		Eska to Granite
18 42					1	1		4	9		Granite to Eska
19 43					1			2	4		Eska to Granite
20 44									-0-		Granite to Eska
21 45					1				2		Eska to Granite
22 46					1	1		1	6		Granite to Eska
23 47		1				1		8	12		Eska to Granite
24 48									-0-		Granite to Eska

WISHBONE HILL COAL PROJECT
MOOSE SURVEY FORM

Observer Hemming - D&M
Pilot Wiesenkehr
Aircraft Supercub
Time off 10:20 AM
Area Moose Cr. - Granite Cr.

Snow Condition 6"-8" w/Trace of new snow
Light Condition Clear
Weather Very light wind
Time on 2:30 PM
Date 21 December 1988

Group No.	Bulls Ylg	Bulls Med <50"	Bulls Lge ≥50"	Cows w/o calf	Cows w/1 calf	Cows w/2 calf	Lone calf	Unk sex/ age	Total moose	Above tree line (✓)	Remarks:
1								11	2		Eska to Granite Cr
2									-0-		Granite to Eska
3									-0-		Eska to Granite
4									-0-		Granite to Eska
5									-0-		Eska to Granite
6									-0-		Granite to Eska
7									-0-		Eska to Granite
8									-0-		Granite to Eska
9									-0-		Eska to Granite
10									-0-		Granite to Eska
11	END ESKA CR. TO GRANITE CR.										
12											
13											
14											
15											
16											
17											
18											
19	Total Moose 173										
20	Total Calves 54										
21	31 Calves per 100 Moose										
22											
23											
24											

WISHBONE HILL COAL PROJECT
MOOSE SURVEY FORM

Observer Hemming – Demer & Moore
Pilot Wiederkehr
Aircraft Supercub
Time off 10:20 AM
Area Moose Cr. – Granite Cr.

Snow Condition 12" New Snow
Light Condition Sunny
Weather Clear – No Wind
Time on 3:10 PM
Date 13 January 1989

Group No.	Bulls			Cows			Lone calf	Unk sex/ age	Total moose	Above tree line (✓)	Remarks:
	Ylg	Med <50"	Lge ≥50"	w/o calf	w/1 calf	w/2 calf					
1					1			4	6	6	Upper Moose Cr.
2					1			1	3		Moose Cr. to Esker Cr
3					1			2	4		Esker to Moose Cr
4									-0-		Raven seen Moose to Esker Cr
5									-0-		Esker to Moose Cr
6					1			2	4		Moose to Esker C
7								4	4		Ptarmigan seen Esker to Moose C
8								3	3		Moose to Esker Cr
9									-0-		N. Flank Wishbone H
10		1			2			2	7		Over Wishbone Hil
11									-0-		Esker to Moose Cr
12		1			4	1		12	24		Magpie seen Moose to Esker C
13									-0-		Esker to Moose C
14					1			3	5		Moose to Esker Cr
15		1			3	2		5	18		Esker to Moose C
16					1			4	6		Moose to Esker Cr
17					4			2	10		Esker to Moose Cr
18						1		3	6		Moose to Esker C
19									-0-		Esker to Moose Cr
20					1			1	3		Moose to Esker Cr
21					1				2		Esker to Moose Cr
22								1	1		Moose to Esker
23					4			3	11		Esker to Moose C
24					2			4	8		Moose to Esker

WISHBONE HILL COAL PROJECT
MOOSE SURVEY FORM

Observer Hemming - D&M
Pilot Wiesekehr
Aircraft Supercub
Time off 10:20 AM
Area Moose Cr. - Granite Cr.

Snow Condition 12" New Snow
Light Condition Sunny
Weather No wind
Time on 3:10 P.M.
Date 13 January 1984

Group No.	Bulls: Ylg	Bulls: Med <50"	Bulls: Lge ≥50"	Cows: w/o calf	Cows: w/1 calf	Cows: w/2 calf	Lone calf	Unk sex/age	Total moose	Above tree line (√)	Remarks:
1							1		1		Eska Cr. to Moose Cr
2									-0-		Moose Cr. to Eska C
3									-0-		Along Glenn Hwy Eska Cr. to Moose C
4					1				2		Moose Cr. to Matanus
5									-0-		Mat R. to Eska Cr.
6					END MOOSE CR. to ESKA CR.						
7					START ESKA Cr. to GRANITE CR.						
8					2			6	10		Upper Granite Cr.
9									-0-		Granite to Eska C
10								1	1		Eska to Granite C
11									-0-		Granite to Eska
12								1	1		Eska to Granite
13					2	1		5	12		Knotthill to Esk
14					2			4	8		Eska to Granite C
15					2			6	10		Granite to Eska C
16					1			1	3		Eska to Granite C
17					1				2		Granite to Eska C
18	1					1		4	9		Eska to Granite
19									-0-		Granite to Eska C
20					2			1	5		Eska to Granite C
21									-0-		Granite to Eska C
22									-0-		Eska to Granite
23									-0-		Granite to Eska
24								1	1		Eska to Granite

WISHBONE HILL COAL PROJECT
MOOSE SURVEY FORM

Observer Hemming - DFM
Pilot Wiederkehr
Aircraft Supercub
Time off 10:20 AM
Area Moose Cr. - Granite Cr.

Snow Condition 12" New
Light Condition Sunny
Weather No Wind
Time on 3:10 PM
Date 13 January 1984

Group No.	Bulls: Ylg	Bulls: Med <50"	Bulls: Lge ≥50"	Cows: w/o calf	Cows: w/1 calf	Cows: w/2 calf	Lone calf	Unk sex/age	Total moose	Above tree line (√)	Remarks:
1									-0-		Granite to Eska C
2									-0-		Eska to Granite C
3						1			3		Granite to Eska C
4									-0-		Eska to Granite
5									-0-		Granite to Matanus
6					END	ESKA	CR.		to GRANITE		CR.
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18									Total Moose	193	
19									Total Calves	55	
20									28 Calves per 100 Moose		
21											
22											
23											
24											

WISHBONE HILL COAL PROJECT
MOOSE SURVEY FORM

Observer Hemming-Barnes & Moore
Pilot Wiederkehr
Aircraft Super Cub
Time off 10:05
Area Moose Cr. - ESKA Cr.

Snow Condition old
Light Condition Clear
Weather Cold -4° F.
Time on 1:30 PM
Date 2 February 1989

Group No.	Bulls			Cows			Lone calf	Unk sex/ age	Total moose	Above tree line (✓)	Remarks:
	Ylg	Med <50"	Lge ≥50"	w/o calf	w/1 calf	w/2 calf					
1								1	1		Upper Moose Creek
2									-0-		Moose Cr. to Eska Cr.
3					1				2		Eska to Moose Cr.
4								1	1		Coyote seen Moose to Eska Cr.
5									-0-		Eska to Moose Cr.
6								1	1		Magpie seen Moose to Eska Cr.
7								1	1		Eska to Moose Cr.
8								1	1		Moose Cr. To Eska Cr.
9								2	2		Eska to Moose Cr.
10								2	2		Moose Cr. to Eska Cr.
11								3	3		Eska to Moose Cr.
12					1		1	2	5		Moose Cr. to Eska Cr.
13					2	1			7		Eska over Wishbone Hill
14		1			1			2	5		Moose to Eska Cr.
15						2			6		Eska to Moose Cr.
16									-0-		Moose to Eska Cr.
17								1	1		Eska to Moose Cr.
18								5	5		Moose to Eska Cr.
19					1			2	4		Eska to Moose Cr.
20			1		1			2	5		Moose Cr. to Eska Cr.
21			1		1			1	4		Eska to Moose Cr.
22					2			3	7		Moose to Eska Cr.
23						1		4	7		Eska to Moose Cr.
24									-0-		Moose to Matanuska

WISHBONE HILL COAL PROJECT
MOOSE SURVEY FORM

Observer Hemming - D&M
Pilot Wiederkehr
Aircraft Super cub
Time off 10:05
Area Moose Creek - ESA Creek

Snow Condition old
Light Condition clear
Weather Increasing Wind *
Time on 1:30 PM
Date 2 February 1984

Group No.	Bulls			Cows			Lone calf	Unk sex/ age	Total moose	Above tree line (✓)	Remarks:
	Ylg	Med <50"	Lge ≥50"	w/o calf	w/1 calf	w/2 calf					
1									-0-		Shift to N-S transects to wind Matanuska to M
2								1	1		Move to Mad. R.
3					1	1			5		Mad. R to Project
4					2			1	5		Project to Mat. R
5								1	1		Mad. R. to Projec
6								1	1		Project to Mad. R
7									-0-		Mad R. to Proj.
8									-0-		Elk Lake to Mad
9								1	1		Mad. to N. [redacted]
10									-0-		[redacted] S. to Mad. R.
11					1				2		Mad. R to N.
12									-0-		N. to Mad. R.
13								1	1		Mad. R. to N.
14								1	1		N. to Mad. R
15									-0-		Mad. R. to N.
16					1			2	4		N. to Mad. R.
17									-0-		Mad. R. to N
18									-0-		Hunter L. to Mad
19					1			1	3		Mad. R to N.
20								2	2		N. to Mad. R.
21								1	1		Mad. R. to N.
22									-0-		N. to Mad. R.
23					1				2		Mad. R. to N.
24					1				2		N. to Mad. R

WISHBONE HILL COAL PROJECT
MOOSE SURVEY FORM

Observer Hemming-D & M
Pilot Wiederkehr
Aircraft Supercub
Time off 10:05
Area Moose Creek-Eska Cr.

Snow Condition old
Light Condition Clear
Weather Increasing Wind ↗
Time on 1:30 PM
Date 7 February 1985

Group No.	Bulls: Ylg	Bulls: Med <50"	Bulls: Lge ≥50"	Cows: w/o calf	Cows: w/1 calf	Cows: w/2 calf	Lone calf	Unk sex/age	Total moose	Above tree line (✓)	Remarks:
1								1	1		Matanuska R. to N
2									-0-		W. to Sutton
3					2				4		Sutton up Eska Cr
4	~	~	~	~ END	MOOSE CR.	to	ESKA	CR.	~	~	~
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											

Total Moose 107
Total Calves 31
29. Calves per 100 Moose
No Moose Above Treeline
21 Moose in Project AREA

WISHBONE HILL COAL PROJECT
MOOSE SURVEY FORM

Observer Dave Erikson-D&M
Pilot Bill Wiedicker
Aircraft Supercub
Time off 0930
Area Moose Creek to Eska Creek

Snow Condition
Light Condition
Weather Clear - no wind
Time on 1345
Date 3-15-89

Flight path

~~Group~~ No.	Bulls			Cows			Lone calf	Unk sex/ age	Total moose	Above tree line (✓)	Remarks:
	Ylg	Med <50"	Lge ≥50"	w/o calf	w/1 calf	w/2 calf					
Transect 1						1			3		(No Moose up Moose C
2						1		1	4		
3									0		
4									0		
5									0		
6									0		
7									0		
8									0		
9								1	1		
10									0		
11									0		
12									0		
13					1				2		
14					1	1		3	8		
15									0		
16								1	1		
17					1				2		
18									0		
19								1	1		
20								2	2		
21									0		
22					1			2	4		
23								1	1		
24									0		

WISHBONE HILL COAL PROJECT
MOOSE SURVEY FORM

Observer David Eriksen
Pilot Bill Wiediker
Aircraft Supercub
Time off 0930
Area Moose Creek to Esta Cr

Snow Condition
Light Condition Bright-Sunny
Weather Calm-Clear
Time on 1245
Date 3-15-89

Transect Group No.	Bulls: Ylg	Bulls: Med <50"	Bulls: Lge ≥50"	Cows: w/o calf	Cows: w/1 calf	Cows: w/2 calf	Lone calf	Unk sex/age	Total moose	Above tree line (✓)	Remarks:
25 1								1	1		
26 2					10			8	18		around logging area
27 3								1	1		
28 4								0	0		
29 5					1	1		5	10		
30 6					1			1	3		
31 7								1	1		
7? 8									0		
33 9									0		
34 10									0		
35 11									0		
36 12											end of area
37 13											
38 14											total 63
39 15											
40 16											
41 17											
42 18											
19											
20											
21											
22											
23											
24											

WISHBONE HILL COAL PROJECT
MOOSE SURVEY FORM

Observer Dave Erikson
Pilot Bill
Aircraft Super Cub
Time off 1245
Area Eska to Granite

Snow Condition
Light Condition bright sunny
Weather Clear - Calm
Time on 1405
Date 3-15-89

Transect Group No.	Bulls			Cows			Lone calf	Unk sex/ age	Total moose	Above tree line (✓)	Remarks:
	Ylg	Med <50"	Lge ≥50"	w/o calf	w/1 calf	w/2 calf					
1									0		No Moose up Granite Creek
2									0		
3									0		
4									0		
5								1	1		
6									0		
7					1	1			5		
8								1	1		
9								1	1		
10									0		
11						1		9	12		
12								2	2		
13					1		1	3	6		
14					1			1	3		
15								2	2		
16								5	5		
17								2	2		
18									0		
19									0		
20					1				2		
21									0		
22								1	1		
23									0		
24									0		Total 43

Dames & Moore

Wishbone Hill-Moose Survey

ADF&G Census Unit 8A

October 28, 1988

An aerial survey of the ADF&G Game census area 8A was conducted to locate and count all moose utilizing the area during the late october. The survey area was flown between 1:30 pm and 3:30 pm with survey conditions varying from moderate to poor largely due to air turbulence from a northeast wind. The survey area had received the first snow of the year within the previous two days and snow depths varied between six inches and one foot.

Survey methods were closely patterned after those used by Fish and Game to enable comparisons with previous years data and standard counts of adjacent areas. The aircraft used was a Piper Supercub on wheels on which maintained an elevation of approximately 300 feet the ground and a speed of approximately 80 nauts/hr. The lone observer looked out both sides of the aircraft to a distance of about one quarter mile. The pilot also assisted in locating moose. Each observation was recorded on a hand-held tape recorder and plotted on a 1:63, 360 topographic map of the area. Noted on sex and age were also made when possible.

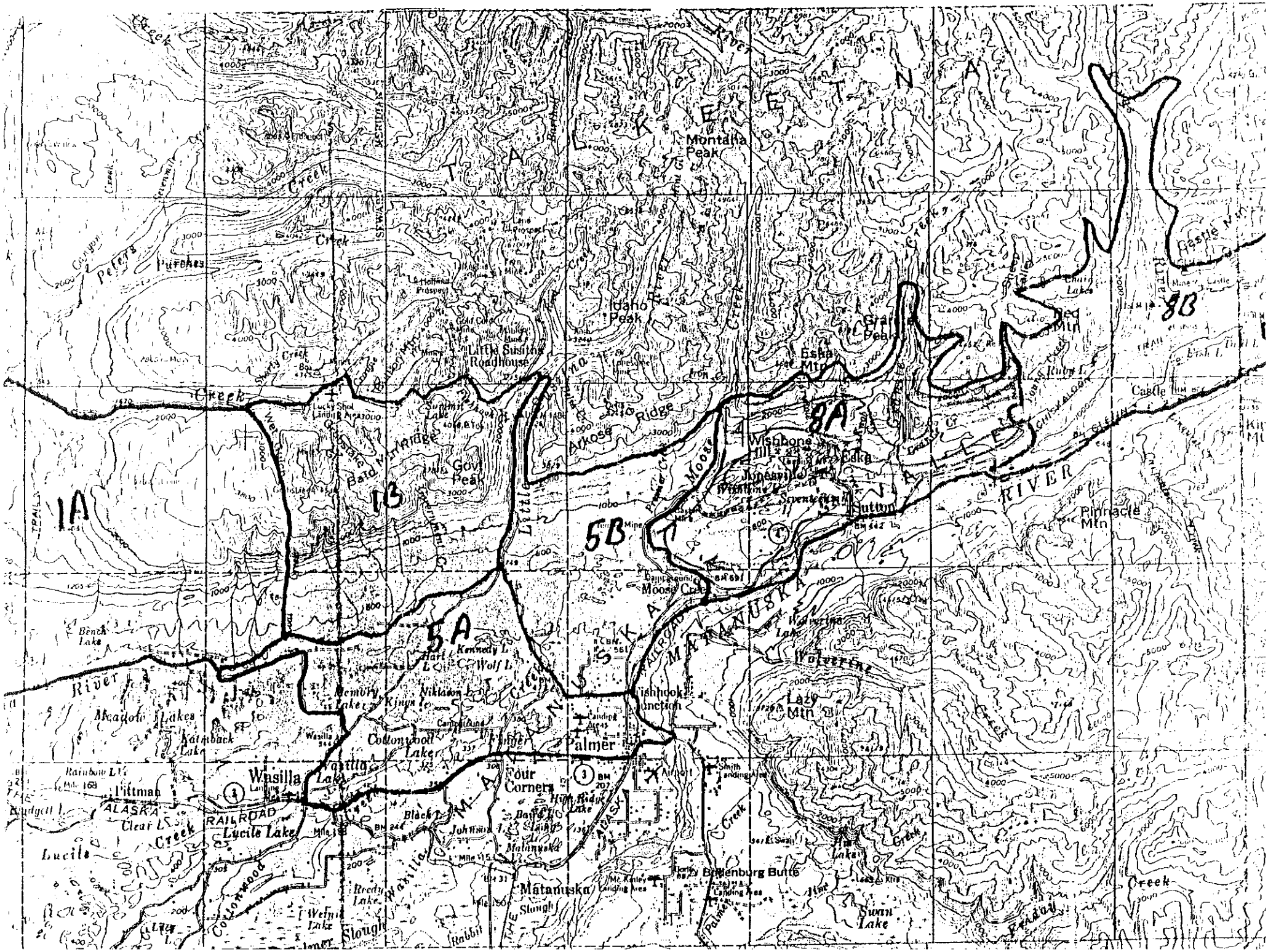
An intensive survey of the project site was made after completion of the entire Game Unit. The only difference in this survey was the flightlines were closer together so that total coverage was attained.

Results

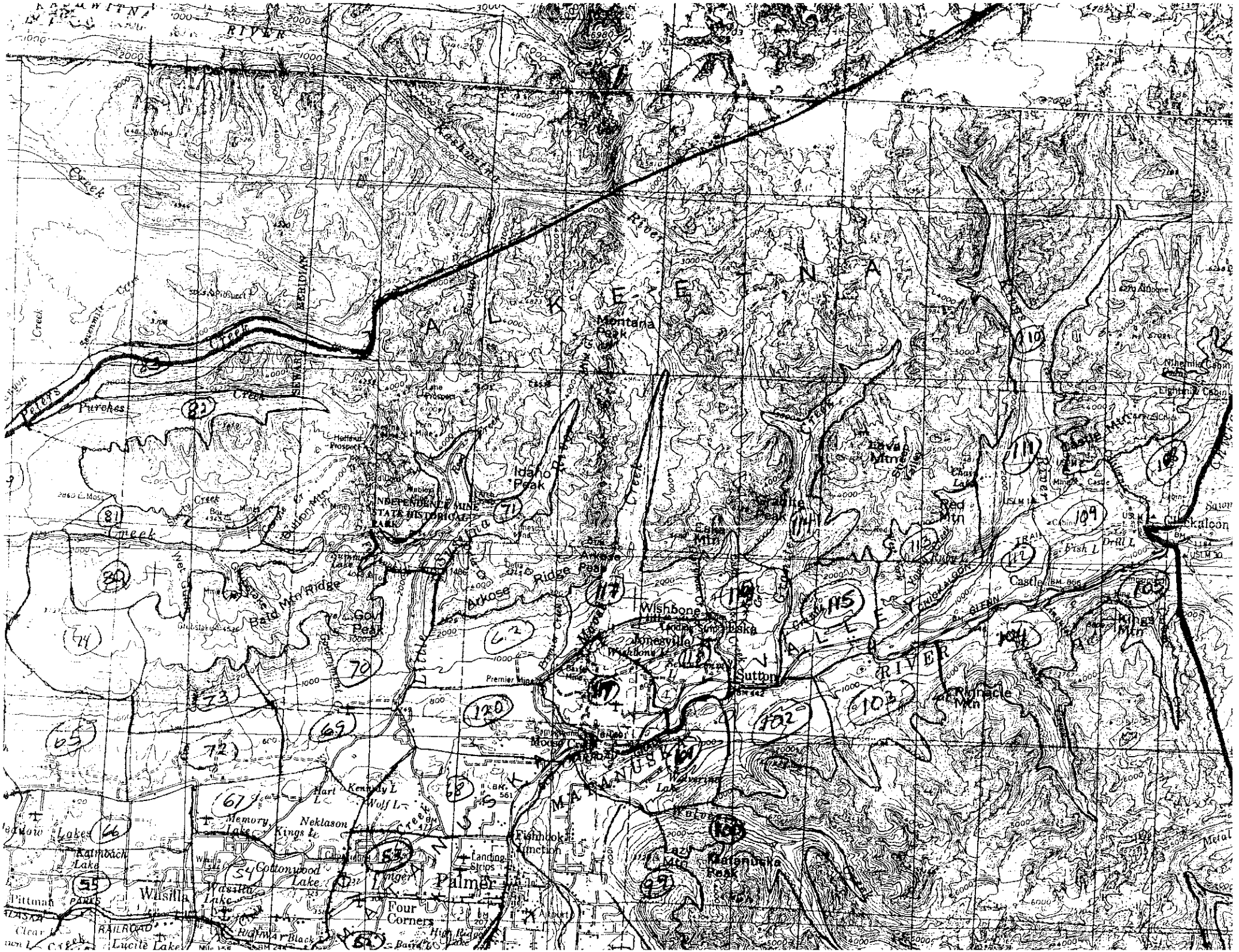
A total of 65 moose were located within the study area with eight bulls, 37 cows, two yearling, 1 calf and 25 unidentified adults. Forty seven of the moose (72 percent of the total) were located high on the mountain slopes have timberline (around the 3,000 foot elevation). The tracks in the snow at this elevation indicated moose were using this area to a much greater extent than the lower forested area and there was little indication they were moving to wintering areas.

Only five moose were found within the vicinity of the proposed project area. Two were located along the access road route, two were just east of the facilities area and one lone cow was sighted along Moose Creek south of the main bridge.

No moose were seen between Palmer and the Project Site as we flew to and from the census area along the Glenn Highway.



1A
1B
5A
5B
8A
8B
Montana Peak
Idaho Peak
Little Susitna Roadhouse
Govt Peak
Arkose Ridge
Esha Mtn
Red Mtn
Castle
Wishbone Hill
Jonesville
Sutton
Pinnacle Mtn
Moose Creek
Fishhook Junction
Palmer
Four Corners
Wasilla
Lucile Lake
Pittman
Lazy Mtn
Bodenburg Butte
Matanuska
Swan Lake
Cottonwood Lake
Meadow Lakes
Bench Lake
Kennedy L
Wolf L
Niklason L
Kings L
Memory Lake
Black L
Johnson L
Reedy Lake
Weinie Lake
Rainbow L
Clear L
Lucile
Wolverine Lake
Wolverine
Moose
Little
Creek
River
Peters
Purches
Castle Mtn
Ruby L
Fish L
Friday
Rabbit
Slough
ALASKA RAILROAD
MATANUSKA
VALLEY
RIVER



RIVER
Kashwitna
River
Creek
Peters
Purches
Creek
Montana Peak
Idaho Peak
INDEPENDENCE MINE STATE HISTORICAL PARK
Arkose Ridge
Bald Mtn Ridge
Govt Peak
Wishbone Hill
Jonesville
Eska
Sutton
Premier Mine
Moose Creek
Lava Mtn
Red Mtn
Castle
Kings Mtn
Pinnacle Mtn
Matanuska Peak
Fishhook Junction
Palmer
Four Corners
Wasilla
Wasilla Lake
Cottonwood Lake
Memory Lake
Kalmbach Lake
Lucile Lake
Pittman
Hart L
Kennedy L
Wolf L
Neklason L
Kings L
Landing Strips
Lazy Mtn
Wolverine Lake
Little Susitna
Wet Gulch
Sevenmile Creek
Sutton Mtn
Eska Mtn
Arkose Peak
Lake Prospect
Hatfield Prospect
Fish L
Drill L
Nihemile Cabin
Lightning Cabin
Castle Mtn
Chickaloon
Glenn
Chickaloon Trail
Matanuska
Valley
Railroad
Highway
Black
Clear L
Creek
Metal

ADF&G SURVEY

(11)

Form 3. Moose survey data gathered during standard or intensive searches of sample units.

SU no. 119 Date 2-28-89 Page 1 of 2

Survey area MYMP (14A) unit 119 119

Pilot/obs. BILLY/MOD Est. area ____ mi²

Type of search: Standard (e.g., 4-6 min/mi²) ☐
Intensive (e.g., 12 min/mi²) ☐

Dominant habitat RECENTLY LOG AREAS, MIXED FOREST, CLEARED AREAS

STANDARD SEARCH DATA SUMMA	
Strata	H ☐, M ☐, L ☐,
Total moose seen	27
Min. searched	135
Measured area (mi²)	
Search effort (min/mi²)	
Obs. density (moose/mi²)	
INTENSIVE SEARCH DATA SUMM	
No. moose std. search	3
No. moose int. search	6
Int. search time (min)	18

WEATHER:	Clouds	Precipitation	Temperature	Wind	Turbulence
	NA	NA	AIR 28°F	NA	NA

LIGHT — TYPE: Bright ☐, Flat ☒ — INTENSITY: High ☐, Med. ☒, Low ☐

SNOW AGE AND COVER — Fresh ☐, Moderate ☐, Old ☒ — Complete ☒, Some low veg. showing ☒, Bare ground showing ☐

SEARCH TIME — Stop time 5:38, Start time 4:03

REMARKS

In SCF plot(✓)	Group no.	Bulls/Activ. Yrlg	Med	Lge	Cows and calves/Activ. ♀	♀/1 calf	♀/2 calf	Lone calf	Unk. sex-age	Total moose	Remarks:
	1				1						
	2					1					
	3					1					
	4				1						
	5				2						
	6							1			
	7					1					
	8						1				
	9				3	2					
	10						1				
	11				1						
	12					1					
	13				2						
	14					1					
Sex-age totals		Y=	M=	L=	♀= 10	♀= 7 Ca= 7	♀= 2 Ca= 4	Ca= 1	U=	19 12	= Total M 31

ADF&G Survey

Form 3. Moose survey data gathered during standard or intensive searches of sample units.

SU no. 119 Date 2-28-89 Page 2 of 2

Survey area GMU 14A SU 119

Pilot/obs. _____ Est. area _____ mi²

Type of search: Standard (e.g., 4-6 min/mi²) ☐
Intensive (e.g., 12 min/mi²) ☐

Dominant habitat _____

STANDARD SEARCH DATA SUMMARY
Strata H☐, M☐, L☐, O☐
Total moose seen _____
Min. searched _____
Measured area (mi²) _____
Search effort (min/mi²) _____
Obs. density (moose/mi²) _____
INTENSIVE SEARCH DATA SUMMARY
No. moose std. search _____
No. moose int. search _____
Int. search time (min) _____

WEATHER: Clouds Precipitation Temperature Wind Turbulence

LIGHT

TYPE: Bright ☐ Flat ☐

INTENSITY: High ☐ Med. ☐ Low ☐

SNOW AGE AND COVER

Fresh ☐ Moderate ☐ Old ☐

Complete ☐ Some low veg. showing ☐ Bare ground showing ☐

SEARCH TIME

Stop time _____

Start time _____

REMARKS

In SCF & :(✓)	Group no.	Bulls/Activ. Yrlg	Bulls/Activ. Med	Bulls/Activ. Lge	Cows and calves/Activ. ♀	♀/1 calf	♀/2 calf	Lone calf	Unk. sex-age	Total moose	Remarks:
	#15				1						
	#16				6						
	#17					1					
	#18					1					
	#19				7	2					
	#20				9	3	1				
	#21				1						
	#22					1					
	#23				1						
	#24					1					
	11										
	12										
	13										
	14										
Sex-age totals		Y=	M=	L=	♀=25	♀= 9 Ca=9	♀= 1 Ca= 2	Ca=	U=	35 11	= Total Moose 46

ADF&G SURVEY

Form 3. Moose survey data gathered during standard or intensive searches of sample units.

no. 118 Date 3-1-89 Page 1 of 2

Survey area MVMR (GMU 14A) SU 118

Pilot/obs. Billy/mod Est. area _____ mi^2

Type of search: Standard (e.g., 4-6 min/mi^2) ☐
Intensive (e.g., 12 min/mi^2) ☐

Dominant habitat cottonwood, mixed forest, muskey

STANDARD SEARCH DATA SUMMARY

Strata H☐, M☐, L☐, O☐
Total moose seen 43
Min. searched 97
Measured area (mi^2) _____
Search effort (min/mi^2) _____
Obs. density (moose/mi^2) _____

INTENSIVE SEARCH DATA SUMMARY

No. moose std. search 10
No. moose int. search 10 or 11
Int. search time (min) 18

Probably movement into area 1 Dome ca

WEATHER:	Clouds	Precipitation	Temperature	Wind	Turbulence
	NA	NA	AIR 25°F	NA	NA

LIGHT

TYPE: Bright ☒ Flat ☐

INTENSITY: High ☐ Med. ☒ Low ☐

SNOW AGE AND COVER

Fresh ☐ Moderate ☐ Old ☒

Complete ☒ Some low veg. showing ☒ Bare ground showing ☐

SEARCH TIME

Stop time 12:50 1hr 37

Start time 11:13 am

REMARKS

In SCF plot(✓)	Group no.	Bulls/Activ. Yrlg	Bulls/Activ. Med	Bulls/Activ. Lge	Cows and calves/Activ. ♀	♀/1 calf	♀/2 calf	Lone calf	Unk. sex-age	Total moose	Remarks:
	1				2						
	2					1					
	3				2						
	4				2		1				
	5					1					
	6				1	1					
	7				1						
	8				1						
✓	9				3						
	10							1			
	11				2						
	12				1						
	13				4	1					
	14					1					
Sex-age totals		Y=	M=	L=	♀= 19	♀= 5 Ca= 5	♀= 1 Ca= 2	Ca= 1	U=	25 8	33 = Total Moose

ADF&G Survey

+INTENSIVE OW 12:57 OFF 1:12

OFF 2:50

Form 3. Moose survey data gathered during standard or intensive searches of sample units.

SU no. 118 cont. Date 3-1-89 Page 2 of 2

Survey area MNMR (GMU 14A) SU 118

Pilot/obs. _____ Est. area _____ mi²

Type of search: Standard (e.g., 4-6 min/mi²) ☐
Intensive (e.g., 12 min/mi²) ☐

Dominant habitat _____

STANDARD SEARCH DATA SUMMARY

Strata H☐, M☐, L☐, O☐
Total moose seen _____
Min. searched _____
Measured area (mi²) _____
Search effort (min/mi²) _____
Obs. density (moose/mi²) _____

INTENSIVE SEARCH DATA SUMMARY

No. moose std. search 10
No. moose int. search 10 or 11
Int. search time (min) 18

Probably moving out

WEATHER: Clouds Precipitation Temperature Wind Turbulence moderate

LIGHT

TYPE: Bright ☐ Flat ☐

INTENSITY: High ☐ Med. ☐ Low ☐

SNOW AGE AND COVER

Fresh ☐ Moderate ☐ Old ☐

Complete ☐ Some low veg. showing ☐ Bare ground showing ☐

SEARCH TIME

Stop time _____

Start time _____

REMARKS

In ICF	(✓)	Group no.	Bulls/Activ. Yrlg	Med	Lge	Cows and calves/Activ. ♀	♀/1 calf	♀/2 calf	Lone calf	Unk. sex-age	Total moose	Remarks:
		#15				1						
		2					1					
		3 (9)				1						
		4 (8)				(1)						
		5 (9)				1		1				
		6 (10)				1						
		7 (11)										
		(8) (A)							1			SAW lone calf on intensive
		10										Probably moved across road.
		11										on
		12										
		13										
		14										
x-age totals			Y=	M=	L=	♀= 5	♀= 1 Ca= 1	♀= 1 Ca= 2	Ca= 0	U= 0	7 3	10 = Total Moose

ADF&G SURVEY

NO MOOSE 1:36 9:40 ON STN 10:11 OFF

Form 3. Moose survey data gathered during standard or intensive searches of sample units.

no. 117 Date 3-1-89 Page 1 of 1

Survey area MVMR (GMU 14A) SU # 117

Pilot/obs. Billy / Mod Est. area _____ mi^2

Type of search: Standard (e.g., 4-6 min/mi^2) ☐
Intensive (e.g., 12 min/mi^2) ☐

Dominant habitat Alpine, mixed forest, muskeg

STANDARD SEARCH DATA SUMMARY

Strata H☐, M☐, L☐, O☐
Total moose seen 10
Min. searched 91
Measured area (mi^2) _____
Search effort (min/mi^2) _____
Obs. density ($moose/mi^2$) _____

INTENSIVE SEARCH DATA SUMMARY

No. moose std. search 0
No. moose int. search 0
Int. search time (min) 14

WEATHER:	Clouds	Precipitation	Temperature	Wind	Turbulence
	NA	NA	AIR 30°F	NA	NA

LIGHT

TYPE: Bright ☐ Flat ☐

INTENSITY: High ☐ Med. ☐ Low ☐

SNOW AGE AND COVER

Fresh ☐ Moderate ☐ Old ☐

Complete ☐ Some low veg. showing ☐ Bare ground showing ☐

SEARCH TIME

Stop time 11:11

Start time 9:40

REMARKS

In SCF plot(✓)	Group no.	Bulls/Activ. Yrlg	Med	Lge	Cows and calves/Activ. ♀	♀/1 calf	♀/2 calf	Lone calf	Unk. sex-age	Total moose	Remarks:
	1				1						ABOVE Timbuli
	2				1						
	3				2						
	4				1						
	5					1					
	6				1						
	7					1					
	8										
	9										
	10										
	11										
	12										
	13										
	14										
Sex-age totals		Y=	M=	L=	♀= 6	♀= 2 Ca= 2	♀= 0 Ca=	Ca= 0	U= 0	8 2	10 = Total Moose

ADDENDA

ADDENDUM 1

REPORT ON THE STUDY OF THE DISTRIBUTION AND HABITAT USE OF MOOSE IN THE VICINITY OF THE PROPOSED WISHBONE HILLCOAL PROJECT

Study of the Distribution and Habitat Use of Moose in the Vicinity of the Proposed Wishbone Hill Coal Project (Study Year 5)

Prepared for:
Idemitsu Alaska, Inc.
C/O McKinley Mining Consultants
Palmer, Alaska

Prepared by:
B & B Environmental, Inc.
3700 Woodland Drive, STE 700
Anchorage, Alaska

January 31, 1994

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Introduction

BACKGROUND

Investigation of biological resources in the vicinity of the proposed Wishbone Hill Coal Mine is continuing in preparation for development. During 1988 and 1989, Dames & Moore conducted comprehensive studies of terrestrial and aquatic resources in the area (Dames & Moore 1989). This included the distribution and habitat use exhibited by fish, birds, and mammals. During these comprehensive investigations, studies of moose focused on geographic distribution and habitat utilization. As a result of these studies and previous work conducted by the Alaska Department of Fish and Game (ADF&G), a portion of the study area has been identified as an important winter range for moose.

Long term monitoring of moose in the vicinity of the proposed Wishbone Hill Mine began in October 1989 and has continued each year (B & B Environmental, Inc. 1990, 1991, 1992). Results of previous investigations of moose in the vicinity of the Wishbone Hill Coal Mine indicate that few animals are observed in the area prior to mid-October (Dames & Moore 1989; B & B Environmental, Inc. 1990,1991, 1992). Immigration of moose to the Wishbone Hill Project Area vicinity begins in late October and continues through November as snow depth reduces the utility of High Elevation habitats. Areas of high concentration rutting have been identified in the zone extending from near the Little Susitna River, across the north portion of the study area, and continuing in an easterly direction (ADF&G 1985). Mineral licks or calving sites have not been observed in the immediate project vicinity.

OBJECTIVES

Additional monitoring was conducted between October 1992 and April 1993 to further delineate the distribution and habitat use demonstrated by moose during the winter months. This program had three objectives:

- Conduct aerial surveys of moose in the Project Area and in the immediate vicinity of the Project Area to establish:

    1. Distribution and habitat use demonstrated by moose during the winter.
    2. Age/sex composition of moose in the area, and
    3. Movement corridors into and through the area.

- Investigate the incidence of moose-vehicle accidents, and
- Begin compilation of a wildlife database that will include observations of wildlife throughout the life of the project.

Methods

MOOSE SURVEYS

Aerial surveys have been used to investigate abundance and distribution of moose in the study area since 1988. This methodology was approved by ADF&G as the technique to document the long term distribution and habitat use exhibited by moose. The boundaries of the survey area were defined by natural barriers around the perimeter of the development area. The boundary is depicted in Figure 1 and roughly corresponds to an area bounded by the Matanuska River on the south, Seventeen Mile Lake to the east, the 2000 foot contour to the north and an unnamed creek to the west.

To ensure that moose were not counted twice, the study area was divided into two sections, using Moose Creek as the boundary between sections. Each survey consisted of flying a predetermined route, which began at the point where Moose Creek crosses the 2000 foot contour. The survey progressed along parallel transect lines, approximately 300 feet apart, in an east-west orientation between Moose Creek and the Eastern boundary of the study area until the entire Eastern subdivision had been examined. The Western subdivision was surveyed in a similar manner.

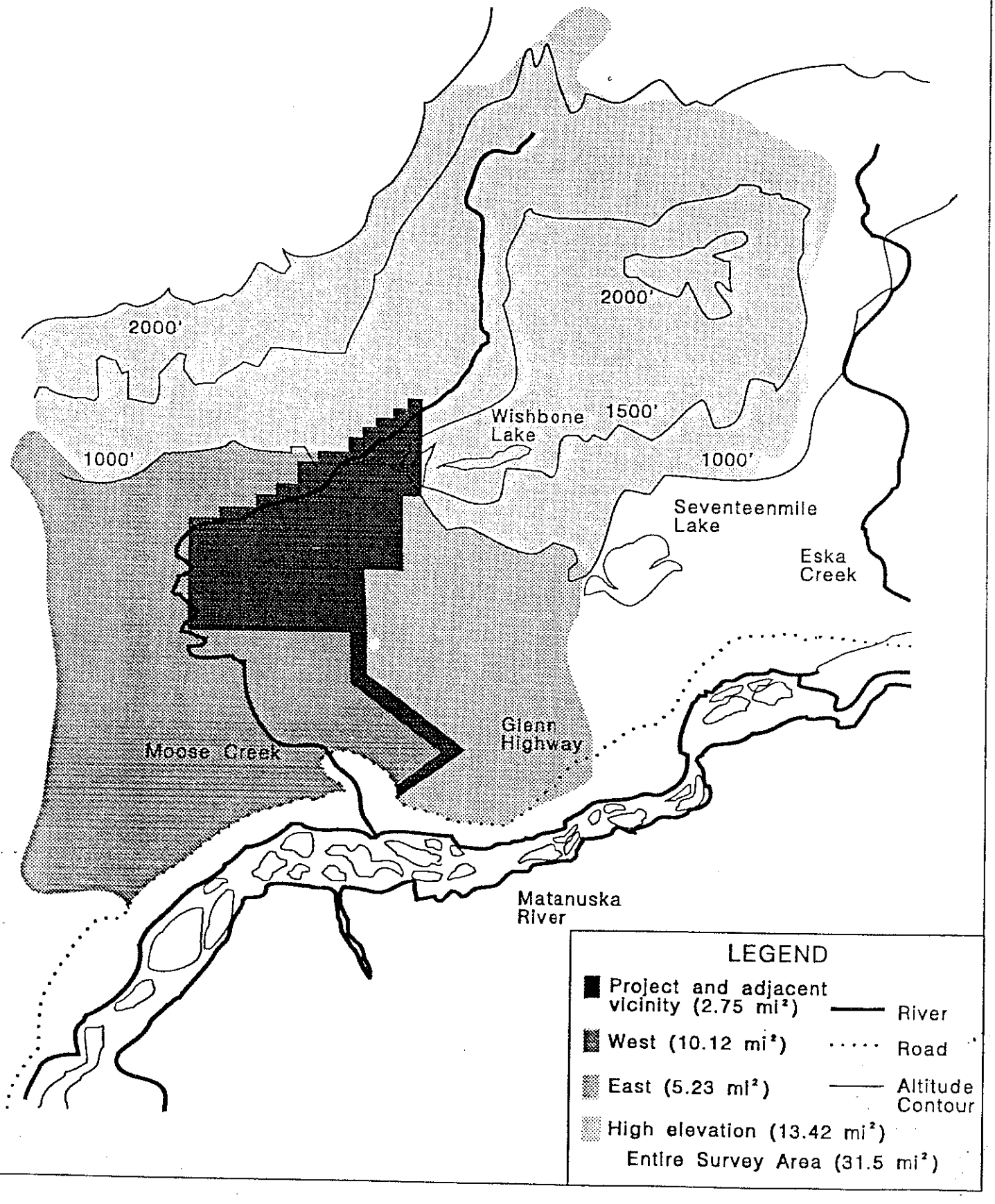
Nine aerial surveys were flown during the 1992/1993 winter season:

11/04/92	12/28/92	03/19/93
11/15/92	01/11/93	03/30/93
12/07/92	02/08/93	04/17/93

Surveys were conducted by a single observer from a Piper Supercub flying at approximately 45 mph at 100 to 150 feet above ground level. When fresh tracks or moose were observed, the aircraft circled until the observer was certain that all moose present had been counted. The average length of time required to complete a survey in 1992/1993 was 289 minutes (9.2 min/mi^2). This was comparable to the previous year's average survey time of 266 minutes (8.4 min/mi^2), 250 minutes (7.9 min/mi^2) and 271 minutes (8.6 min/mi^2) in 1991/1992, 1990/1991 and 1989/1990, respectively.

Investigation of moose visibility during winter surveys has shown that a minimum of four min/mi^2 is necessary to observe the majority of moose present in the typical spruce-birch habitat of interior Alaska. In situations where spruce forest is more prominent, the snow is deep, or moose density high, the time required for accurate counts increased to 6-8 min/mi^2 (Gasaway et al. 1986).

Figure 1. Geographic Delineation of Wishbone Hill Project Study Area



Upon sighting moose the investigator recorded:

- Number of moose present in the group,
- Sex of each adult,
- Approximate age of bulls (by antler size),
- Presence of calves, and
- Habitat being utilized.

Once males began shedding antlers, adult moose could no longer be accurately classified by sex. Consequently, all moose observed during surveys later than mid-January were recorded as either adults or calves. All information, including other wildlife observations, was entered onto standardized data sheets and the location of the animals was noted on a map of the survey area.

GEOGRAPHIC DELINEATION

During project related investigations of moose conducted in this area during 1988 and 1989, survey boundaries corresponded to the boundaries of Game Management Subunit 8A (Dames and Moore 1989). This area is bounded by Moose Creek on the west, Eska Creek to the east, Glenn Highway to the south, and the 2000 foot contour in the mountains to the north. Through discussions with ADF&G prior to the start of the 1989-1990 program, the survey boundaries were revised to encompass more land to the west and less to the east, thus placing the proposed development area in the central portion of the moose survey area (Figure 1). There have been no changes to the survey area boundaries since 1989.

The survey area occupies 31.5 square miles. To describe the geographic distribution of moose relative to the project area, the survey area was divided into four sections based upon natural obstructions such as Moose Creek and Wishbone Hill (Figure 1). The geographic blocks are as follows:

- **High Elevation (13.42 mi^2).** Highlands north of the project area, altitude between 1000-2000 feet, including Wishbone Lake
- **West (10.12 mi^2).** Area west of Moose Creek, south of the 1000 foot contour, and north of the Matanuska River.
- **East (5.23 mi^2).** Area east of Moose Creek, excluding the project area. Includes habitat north of the Matanuska River, below the 1000 foot contour.
- **Project (2.75 mi^2).** Wishbone Hill Permit Area and buffer zone.

HABITAT DELINEATION

Through previous investigation of the Wishbone Hill Project Area, habitats and vegetation types were described and mapped (Helm 1989). In accordance with the requirements for baseline studies in the Project area, the vegetation and habitat maps were submitted with the application for surface coal mine development to ADF&G and Alaska Department of Natural Resources (ADNR). Vegetation maps provided considerable detail regarding

species composition and distribution. Habitat maps were more generic, depicting geobotanical units that were likely to be utilized by wildlife. During the 1988 baseline studies, the aerial coverage of each vegetation type was calculated within the project area. Specific types were then grouped and the aerial coverage's summed to establish the area occupied by each habitat type.

Although these maps provide a considerable level of detail within the Project Area, no mapping has been completed for outlying portions of the study area. In order to account for the habitat types located within this additional region, the known percent vegetation coverage was extrapolated to encompass the entire study site. The projection of known habitats and the final classification was submitted to and approved by the ADF&G prior to conducting aerial surveys. This technique provided the basis for the habitat distributions used during the 1989/90 surveys. Further information regarding habitat distribution was gained during the 1990/91 surveys. The compilation of specific habitat location records resulted in a slightly revised estimate of habitat abundance and distribution. The adjusted habitat coverages were used during the calculations of the 1990/91, 1991/92 and 1992/1993 observations (Table 1).

The winter habitat classification is as follows:

- Closed Deciduous Forest: Closed canopy forest with greater than 50 percent canopy coverage. Dominant tree species include paper birch (*Betula papyrifera*), balsam poplar (*Populus balsamifera*) and quaking aspen (*Populus tremuloides*). Pure stands of paper birch are often found interspersed with pure stands of quaking aspen. The understory is comprised of prickly rose (*Rosa acicularis*), high bushcranberry (*Viburnum edule*) and Sitka alder (*Alnus sinuata*).

- Open Deciduous Forest: Forest with an open canopy of less than 50 percent coverage. Vegetation composition is similar to that of the closed deciduous forest, with a correspondingly greater percentage of undergrowth. In particular, early growth stages of paper birch and Sitka alder are common.

- Open Mixed Forest: Open forest with less than 50 percent canopy coverage. Dominant tree species are paper birch and white spruce (*Picea glauca*), interspersed with small areas of upland meadow. The understory is comprised of high bushcranberry, prickly rose and Greene mountain-ash (*Sorbus scopulina*). Additional stands of white spruce interspersed with balsam poplar and black cottonwood (*Populus trichocarpa*) are common, and are often found in low-lying, wet areas. In these locations, willows (*Salix spp.*) are the predominant undergrowth.

- Closed Mixed Forest: Forest with canopy coverage of greater than 50 percent, usually ranging from 50 to 70 percent within this study area. Tree species are primarily white spruce and paper birch, with a much higher percentage of spruce present than in the open mixed forests. Undergrowth is similar, although less abundant than occurs in open mixed forest.

- Herbaceous: Open areas with low scrub occurrence. Vegetation is primarily grasses and forbs. In this study area it is found primarily as a hydric habitat, with the corresponding abundance of sedges (*Carex spp.* and *Eriophorum spp.*) sphagnum mosses and some black spruce (*Picea mariana*).

- Birch: The majority of the Birch habitat is open woodland with 5 to 50 percent canopy coverage. Paper birch is dominant, occurring in mature stands interspersed with large open meadows. Additional species present are white spruce, balsam poplar, high bushcranberry and mountain ash. Other birch habitat consists of shrub birch thickets, comprised of shrub birch species such as resin birch (*Betula glandulosa*). In these areas, shrub alder and willow are common.

- Shrub Alder: Open area with less than five percent coverage by trees. Vegetation is almost exclusively Sitka alder which occurs primarily as a tall shrub. Alder interspersed with willow (particularly scouler willow (*Salix scouleriana*)) and shrub birch are common in transitional areas bordering birch shrubland

and low shrub or herbaceous areas. Other species such as bog-rosemary (*Andromeda polifolia*) and balsam poplar may also be present.

- Low Shrub: Open area with less than five percent coverage by trees. In most low shrub areas the dominant vegetation is willow (*Salix spp*), less than three feet tall. Species include feltleaf willow (*S. alaxensis*), Bebb willow (*S. bebbiana*), and Scouler willow. The willow are interspersed with a variety of herbaceous plants and low shrub species such as dwarf arctic birch (*Betula nana*). Shrub alder is also found, especially at the transition zone with tall shrubland.

- Barren: Areas containing less than five percent coverage by herbaceous or woody plants.

- Revegetated: Areas once disturbed which are now supporting naturally colonizing species such as willow, shrub birch and shrub alder.

- Disturbed/Residential: Areas already developed by man including commercial or residential zones. The majority of the disturbed locations in this study area are clear-cut patches within open mixed or closed mixed forest. Cutting occurred at various times during the past ten years.

- Riparian: Areas immediately adjacent to a stream or river to a distance of ten yards. Black cottonwood and balsam poplar are the prevalent tree species. Willow and tall Sitka alder are abundant. The understory is often comprised of horsetail (*Equisetum spp*), or devilsclub (*Oplopanax horridus*).

Table 1. Habitat Types in the Wishbone Hill Survey Area - (1992-1993)

Habitat Type	Estimated Aerial Coverage (mi^2)	Percent of Study Area
Open Mixed Forest (OMH*-1)** Open paper birch - white spruce (OBS)	12.95	41.1
Closed Deciduous Forest (CDH-2) Closed deciduous (CD) Closed paper birch-aspen (CBA) Closed poplar/alder (CPA) Closed poplar/alder-willow (PAW) Closed paper birch (mature) (CPB)	4.48	14.2
Birch (YB-33) Young birch (YB) Open birch (OB)	4	12.7
Shrub Alder (CA-31) Closed alder (CA)	2.71	8.6
Closed Mixed Forest	2.58	8.2
Disturbed/Residential (D-9)	1.89	6
Open Deciduous Forest	1.04	3.3
Riparian (R-7)	0.88	2.8
Low Shrub Wet low shrub scrub (WS-6) Closed willow (CW-32)	0.88	2.8
Herbaceous Upland meadow (UM-5) Lowland meadow (LM-4)	0.16	0.5
Barren (8)	0.01	0.03
Revegetated (RV)	0	0
Total	31.58	100.23

*Vegetation Map Code (Helm 1989)

**Habitat Map Code (Dames & Moore 1989)

Note: Vegetation and Habitat codes are provided for cross-reference among the Vegetation Study (Helm 1989), the Wildlife Report (Dames & Moore 1989) and the Winter Habitat Classification used in this report.

DISTRIBUTION OF MOOSE

To achieve the objectives of the moose surveys, observations of moose were evaluated relative to the habitats that they were observed using and in accordance with the geographic distribution of the animals.

Distribution of Moose by Geographic Region

The distribution of moose by geographic region was examined by two methods. Predicted numbers of moose for each area were calculated based on the size of each area, and then compared to field observations. In addition, distribution was analyzed by examining density of moose by geographic locations. This evaluation was performed for each sex and particular age grouping of moose observed.

Distribution of Moose by Habitat Types

Preference displayed by moose for specific habitat types was investigated by determining the number of expected moose in each habitat type based on calculated habitat coverage. This was compared to the number of moose occupying known vegetation types within the survey borders.

AGE/SEX COMPOSITION

The age/sex composition of moose in the area was examined and compared to data obtained from ADF&G (1987-1992) for Game Management Unit (G.M.U.) 14-A. G.M.U. 14-A was independently evaluated and compared to the current survey data to estimate the consistency of age/sex composition of the moose observed in this area. As later explained in Chapter 3, Age/Sex Composition, the ADF&G changed its survey methods after 1987 and no longer use count areas within game units, so the data from 1988 to 1992 was integrated into both Tables 7 and 8.

All historic ADF&G data were collected from aerial surveys completed from mid-November to late December, unless otherwise stated. In 1989-1990, age/sex composition information was taken from one December survey. In 1992-1993, four surveys were performed during this period; the mean is used for comparison.

MOVEMENT CORRIDORS AND MIGRATION

During aerial surveys, observations of moose tracks and paths were recorded, noting areas of substantial use. Heavily used trails suggest common routes and potential migratory paths. Directional movement can be interpreted from the tracks, leading to a determination of the general movement of animals through the area.

MOOSE-VEHICLE ACCIDENTS

The Alaska State Troopers maintain records of moose mortality and salvage data. Data are collected from October to April each year, when the majority of road-kills occur.

TERRESTRIAL WILDLIFE DATABASE

The wildlife database will maintain information regarding the number and species of animals and birds seen in the study area, once development of the mine begins. Data compilation will continue until post-mining rehabilitation. Employees working on the project will be required to attend an orientation course on environmental awareness, including descriptions of wildlife species expected to occur in the project area. Employees will report all observations to their supervisor. This information will be compiled by B & B Environmental, Inc., into a database, and retained as part of the Wishbone Hill Coal Mine project file.

Results

SUMMARY OF MOOSE ABUNDANCE

During the 1992/1993 season, a total of 1,481 moose were observed in the survey area. As outlined below, the number of moose observed in the area more than doubled from mid to late November, reaching a maximum of 244 moose on January 11, 1993 (Table 2). The number of animals remained high, varying between 134 and 244 moose, from January through March. A decline was noted during the March 19, 1993 survey and continued through the next two surveys.

Moose numbers followed the same general chronological pattern in 1992/1993 as observed in 1991/1992. In 1992/1993, the highest numbers of moose were sighted in mid-winter (late December to late January). A trend of fairly high abundance continued until early spring (mid-March to mid-April), when a substantial decrease in moose was observed.

Table 2. Moose Survey Comparison - (1989 - 1993)

1989/90 Survey Period		1990/91 Survey Period		1991/92 Survey Period		1992/93 Survey Period	
Date	Number of Moose	Date	Number of Moose	Date	Number of Moose	Date	Number of Moose
		10/31/90*	41	10/23/91	85		
		11/16/90	84	11/13/91	107	11/04/92	72
12/04/89	135	11/28/90	180	11/20/91	177	11/15/92	161
12/26/89	176	12/15/90	147	*12/29/1991	103 (Partial)	12/07/92	198
		01/06/91	146	01/11/92	332	12/28/92	237
01/26/90	125	01/23/91	159	01/18/92	275	01/11/93	244
		02/12/92	147	02/12/92	260	02/08/93	191
03/07/90	93	03/16/91	157	03/12/92	108	03/19/93	176
		04/12/91	62	04/06/92	76	03/30/93	134
04/24/90	30	04/26/91	52	04/20/92	39	04/17/93	68
Total:	559	Total:	1175	Total:	1459	Total:	1481

*10/31/90 : Incomplete Count - Approximately 1/3 of study area was surveyed.

*12/29/91: Incomplete Count - Approximately 1/3 of the study area was surveyed.

DISTRIBUTION BY GEOGRAPHIC REGION

Number of Moose

The Western and High Elevation areas accounted for the largest percentage of moose sightings (34.8% and 29.8% respectively). The Eastern portion of the study area had greater numbers of moose than the previous year's survey while the Project area continued to show the lowest abundance (Table 3).

Table 3. Summary of Moose Distribution by Geographic Region - (1989 - 1993)

(1992-1993) Geographic Region	Bulls (n)	Cows (n)	Calves (n)	Unknown Adult (n)	Total Moose (n)	Frequency (%)
High Elevation	13	228	79	122	442	30%
East	14	169	98	95	376	25%
West	15	269	117	115	516	35%
Project	2	80	30	35	147	10%
Entire Survey Area	44	746	324	367	1481	100%
(1991-1992) Geographic Region	**Bulls (n)**	**Cows (n)**	**Calves (n)**	**Unknown Adult (n)**	**Total Moose (n)**	**Frequency (%)**
High Elevation	9	241	127	139	516	35%
East	2	109	70	62	243	17%
West	12	237	110	162	521	36%
Project	4	67	57	51	179	12%
Entire Survey Area	27	654	364	414	1459	100%
(1990-1991) Geographic Region	**Bulls (n)**	**Cows (n)**	**Calves (n)**	**Unknown Adult (n)**	**Total Moose (n)**	**Frequency (%)**
High Elevation	14	114	124	243	495	42%
East	4	33	36	164	237	20%
West	16	105	53	108	282	24%
Project	5	48	40	68	161	14%
Entire Survey Area	39	300	253	583	1175	100%
(1989-1990) Geographic Region	**Bulls (n)**	**Cows (n)**	**Calves (n)**	**Unknown Adult (n)**	**Total Moose (n)**	**Frequency (%)**
High Elevation	16	82	15	*	113	26%
East	16	70	26	*	112	26%
West	23	103	37	*	163	38%
Project	5	31	10	*	46	11%
Entire Survey Area	60	286	114	*	434	100%

Summarization of Moose Distribution by Geographic Region - (1990 - 1993)

(1990-1993) Geographic Region	Bulls (n)	Cows (n)	Calves (n)	Unknown Adult (n)	Total Moose (n)	Frequency (%)
High Elevation	36	583	330	504	1453	35%
East	20	311	204	321	856	21%
West	43	611	280	385	1319	32%
Project	11	195	127	154	487	12%
Entire Survey Area	110	1700	941	1364	4115	100%
1989-1990 Data not used in summary due to change in survey methods - *1989 - 1990 Unknown Adults not recorded						

Due to the different aerial extent of each of the four geographic regions, it is not expected that each area would host similar numbers of moose. Therefore, predicted numbers of moose were determined by a consideration of the percent area encompassed by each region and the total number of moose recorded. Comparison of expected numbers of moose to actual field sightings demonstrate that the moose were not distributed randomly (Figure 2). The East, West, and Project regions were utilized to a greater extent than expected (+52.9 percent, 8.5 percent, and +13.7 percent, respectively). The High Elevation region was underutilized (Table 4).

Comparisons between expected and observed numbers of moose, in the surveys after 1989, show a continued trend of underutilization in the High Elevation area varying from -1 percent to -38.9 percent. Abundance in the Western area has varied as much as 40 percent, while the Eastern area continues to be overutilized. This trend has varied from a high of +55.6 percent during the 1988/1989 surveys to a +1 percent in 1991/1992. The Project area provided the most consistent sightings, the four year mean being a +33.4 percent (Table 4).

Table 4. Comparison of Expected and Observed Number of Moose in Each Geographic Region (1989 - 1993)

1992 - 1993 Geographic Region	Moose (Age/Sex)	Expected Number of Moose	Observed Number of Moose	Difference Between Expected and Observed (%)
High Elevation (13.42 mi²)	Bulls	18.7	13	
	Cows	317.8	228	
	Calves	138	79	
	Unknown	156.4	122	
	Total	630.9	442	-29.9%
West (10.12 mi²)	Bulls	14.1	15	
	Cows	239.7	269	
	Calves	104.1	117	
	Unknown	117.9	115	
	Total	475.8	516	8.4%
East (5.23 mi²)	Bulls	7.3	14	
	Cows	123.9	169	
	Calves	53.8	98	
	Unknown	60.9	95	
	Total	245.9	376	52.9%
Project (2.75 mi²)	Bulls	3.8	2	
	Cows	65.1	80	
	Calves	28.3	30	
	Unknown	32	35	
	Total	129.2	147	13.8%

1991 - 1992 Geographic Region	Moose (Age/Sex)	Expected Number of Moose	Observed Number of Moose	Difference Between Expected and Observed (%)
High Elevation (13.42 mi²)	Bulls	11.5	9	
	Cows	278.6	241	
	Calves	155.1	127	
	Unknown	176.4	139	
	Total	621.6	516	-17.0%
West (10.12 mi²)	Bulls	8.7	12	
	Cows	210.1	237	
	Calves	116.9	110	
	Unknown	133	162	
	Total	468.7	521	11.2%
East (5.23 mi²)	Bulls	4.5	2	
	Cows	108.6	109	
	Calves	60.4	70	
	Unknown	68.7	62	
	Total	242.2	243	0.3%
Project (2.75 mi²)	Bulls	2.4	4	
	Cows	57.1	67	
	Calves	31.8	57	
	Unknown	36.1	51	
	Total	127.4	179	40.5%

1990 - 1991 Geographic Region	Moose (Age/Sex)	Expected Number of Moose	Observed Number of Moose	Difference Between Expected and Observed (%)
High Elevation (13.42 mi²)	Bulls	16.6	14	
	Cows	127.8	114	
	Calves	107.8	124	
	Unknown	248.4	243	
	Total	500.6	495	-1.1%
West (10.12 mi²)	Bulls	12.5	16	
	Cows	96.4	105	
	Calves	81.3	53	
	Unknown	187.3	108	
	Total	377.5	282	-25.3%
East (5.23 mi²)	Bulls	6.5	4	
	Cows	49.8	33	
	Calves	42	36	
	Unknown	96.8	164	
	Total	195.1	237	21.5%
Project (2.75 mi²)	Bulls	3.4	5	
	Cows	26.2	48	
	Calves	22.1	40	
	Unknown	50.9	68	
	Total	102.6	161	56.9%

1989 - 1990 Geographic Region	Moose (Age/Sex)	Expected Number of Moose	Observed Number of Moose	Difference Between Expected and Observed (%)
High Elevation (13.42 mi²)	Bulls	26.2	16	
	Cows	134.1	82	
	Calves	24.5	15	
	Total	184.8	113	-38.9%
West (10.12 mi²)	Bulls	19.7	23	
	Cows	88.1	103	
	Calves	31.6	37	
	Total	139.6	163	17%
East (5.23 mi²)	Bulls	10.3	16	
	Cows	45	70	
	Calves	16.7	26	
	Total	72	112	55.6%
Project (2.75 mi²)	Bulls	4.1	5	
	Cows	25.5	31	
	Calves	8.2	10	
	Total	37.8	46	21.6%

Summary 1990 - 1993 Geographic Region	Moose (Age/Sex)	Expected Number of Moose	Observed Number of Moose	Difference Between Expected and Observed (%)
High Elevation (13.42 mi²)	Bulls	46.9	36	
	Cows	724.3	583	
	Calves	400.9	330	
	Unknown	581.1	504	
	Total	1753.2	1453	-17.1%
West (10.12 mi²)	Bulls	35.3	43	
	Cows	546.2	611	
	Calves	302.3	280	
	Unknown	438.2	385	
	Total	1322	1319	-0.2%
East (5.23 mi²)	Bulls	18.3	20	
	Cows	282.3	311	
	Calves	156.2	204	
	Unknown	226.5	321	
	Total	683.3	856	25.3%
Project (2.75 mi²)	Bulls	9.6	11	
	Cows	148.4	195	
	Calves	82.2	127	
	Unknown	119.1	154	
	Total	359.3	487	35.5%

Density of Moose

An examination of the number of moose per square mile demonstrates that the Western area had the highest density (11.0 moose/mi²). The Project area supported the second highest density with 6.0 moose/mi². Lower densities of moose were found in the High Elevation and Eastern geographic areas (3.7 and 4.1 moose/mi², respectively) (Table 5).

Table 5. Density of Moose by Geographic Region (moose/mi²) - (1992 - 1993)

Survey	High Elevation	East	West	Project	Total Area
11/4/92	4	0.5	1.9	1.5	2.3
11/15/92	6.6	1.3	8.2	6.2	5.1
12/7/92	1.6	7.3	15.5	7.6	6.3
12/28/92	3.4	8.4	16.8	6.9	7.5
1/11/93	4	5.2	20.7	10.6	7.8
2/8/93	4	6.1	12.2	4	6.1
3/19/93	4.4	3.9	12.1	5.5	6.6
3/30/93	3.5	2.9	9	4	4.3
4/17/93	1.5	1.6	2.3	7.3	2.2
Mean	3.7	4.1	11	6	5.4

Density of Moose by Geographic Region (moose/mi²) - (1991 - 1992)

Survey	High Elevation	East	West	Project	Total Area
10/23/91	4	1.9	1.5	2.1	2.7
11/13/91	4	1.5	3.6	3.2	3.4
11/20/91	6.5	2.9	4.8	9	5.6
1/11/92	6.3	13	14.1	13.4	10.5
1/18/92	6.5	5.5	9.9	21	8.7
2/12/91	5.2	12.4	10.3	7.2	8.2
3/12/92	1.9	4	4.2	6.9	3.4
4/6/92	2.2	3.6	2.4	1	2.4
4/20/92	1.9	1.5	0.4	0.7	1.2
Mean	4.3	5.1	5.7	7.2	5.1

Density of Moose by Geographic Region (moose/mi²) - (1990 - 1991)

Survey	High Elevation	East	West	Project	Total Area
10/31/90	2.6	1.2	-	-	1.3
11/16/90	2.7	1.5	2.4	5.8	2.7
11/28/90	4.4	4.4	7	9.8	5.7
12/15/90	3.4	1.7	5.9	11.6	4.7
1/6/91	4	7.3	3	9.1	4.6
1/23/91	4.8	9.6	3.5	3.3	5
2/12/91	3.8	9.9	2.8	5.8	4.7
6/16/91	5.4	7.3	2.7	6.9	5
4/12/91	3	1.7	0.4	3.3	2
4/26/91	2.8	0.8	0.3	2.9	1.7
Mean	3.7	4.5	2.8	5.9	3.7

Density of Moose by Geographic Region (moose/mi²) - (1989 - 1990)

Survey	High Elevation	East	West	Project	Total Area
12/4/89	2.1	3.8	6.8	6.6	4.3
12/26/89	2.7	10.1	7.5	4	5.6
1/26/90	-	-	-	-	4
3/7/90	2.3	6.7	1.6	4	3
4/24/90	1.3	0.8	0.2	2.2	1
Mean	2.1	5.4	4	4.2	3.5

The High Elevation and Project areas have shown an increase in moose density since 1989, however, in 1992/1993 the High Elevation area showed a .6 moose/mi² decrease from 1991/1992. The density in the West area decreased from 1989/1990 to 1990/1991, then increased during 1991/1992 to 1992/1993. Density decreased in the East during the 1992/1993 study. The average density of moose in the survey area has increased to an average of .59 moose/mi² since 1989.

DISTRIBUTION OF MOOSE BY HABITAT TYPE

Habitat Types Utilized

Of the eleven possible habitat types, moose were observed during the 1992/1993 survey most often in the Open Mixed Forest (n_{total}=504) (Table 6). Several habitat types supported moderate numbers of moose including:

Birch (n_{total}=175), Closed Deciduous (n_{total}=200), Open Deciduous (n_{total}=211), and Closed Mixed (n_{total}=170). The least used areas surveyed were Barren (n_{total}=9) and Disturbed Residential (n_{total}=3).

Table 6. Moose Distribution by Habitat Type (1992 - 1993)

Habitat Type	Bulls (n)	Cows (n)	Calves (n)	Unknown Adult (n)	Total Moose (n)	Frequency (%)
Closed Deciduous Forest	1	95	48	56	200	13.50%
Open Deciduous Forest	4	91	32	84	211	14.30%
Open Mixed Forest	20	249	111	124	504	34%
Closed Mixed Forest	5	96	42	27	170	11.50%
Herbaceous	2	15	6	8	31	2.10%
Birch	8	105	33	29	175	11.80%
Shrub Alder	1	36	17	14	68	4.60%
Low Shrub	1	21	8	5	35	2.40%
Barren	0	6	3	0	9	0.60%
Disturbed Residential	0	1	1	1	3	0.20%
Riparian	2	31	23	19	75	5.10%
Entire Survey Area	**44**	**746**	**324**	**367**	**1481**	**100%**

Moose Distribution by Habitat Type (1991 - 1992)

Habitat Type	Bulls (n)	Cows (n)	Calves (n)	Unknown Adult (n)	Total Moose (n)	Frequency (%)
Closed Deciduous Forest	1	39	25	21	86	5.90%
Open Deciduous Forest	3	46	32	43	124	8.50%
Open Mixed Forest	10	290	140	168	608	42%
Closed Mixed Forest	0	8	4	16	28	1.90%
Herbaceous	1	9	3	5	18	1.20%
Birch	8	87	48	50	193	13.20%
Shrub Alder	0	53	36	31	120	8.20%
Low Shrub	1	35	21	23	80	5.50%
Barren	0	1	2	1	4	0.30%
Disturbed Residential	2	17	12	30	61	4.20%
Riparian	1	69	41	26	137	9.40%
Entire Survey Area	**27**	**654**	**364**	**414**	**1459**	**100%**

Moose Distribution by Habitat Type (1990 - 1991)

Habitat Type	Bulls (n)	Cows (n)	Calves (n)	Unknown Adult (n)	Total Moose (n)	Frequency (%)
Closed Deciduous Forest	1	13	26	87	127	10.80%
Open Deciduous Forest	1	19	6	47	73	6.20%
Open Mixed Forest	19	141	90	205	455	39%
Closed Mixed Forest	3	19	7	13	42	3.60%
Herbaceous	0	1	1	4	6	0.50%
Birch	2	12	29	66	109	9.30%
Shrub Alder	5	45	47	58	155	13.20%
Low Shrub	1	10	5	4	20	1.70%
Barren	0	0	0	0	0	0.00%
Disturbed Residential	5	24	24	49	102	8.70%
Riparian	2	16	18	50	86	7.30%
Entire Survey Area	**39**	**300**	**253**	**583**	**1175**	**100%**

Moose Distribution by Habitat Type (1989 - 1990)

Habitat Type	Bulls (n)	Cows (n)	Calves (n)	Unknown Adult (n)	Total Moose (n)	Frequency (%)
Closed Deciduous Forest	4	17	5	*	26	7.50%
Open Mixed Forest	30	149	51	*	230	66%
Birch	2	5	1	*	8	2.30%
Shrub Alder	5	67	12	*	84	24.10%
Entire Survey Area	**41**	**238**	**69**	*	**348**	**100%**
*1989 - 1990 Unknown Adults not recorded						

Summary of Moose Distribution by Habitat Type (1990 - 1993)

Habitat Type	Bulls (n)	Cows (n)	Calves (n)	Unknown Adult (n)	Total Moose (n)	Frequency (%)
Closed Deciduous Forest	3	147	99	164	413	10.04%
Open Deciduous Forest	8	156	70	174	408	9.91%
Open Mixed Forest	49	680	341	497	1567	38%
Closed Mixed Forest	8	123	53	56	240	5.83%
Herbaceous	3	25	10	17	55	1.34%
Birch	18	204	110	145	477	11.59%
Shrub Alder	6	134	100	103	343	8.34%
Low Shrub	3	66	34	32	135	3.28%
Barren	0	7	5	1	13	0.32%
Disturbed Residential	7	42	37	80	166	4.03%
Riparian	5	116	82	95	298	7.24%
Entire Survey Area	**110**	**1700**	**941**	**1364**	**4115**	**100%**
1989-1990 Data not used in summary due to change in survey methods						

The 1989/1990 survey had only four habitat categories; Open Mixed Forest, Shrub Alder, Birch, and Closed Deciduous Forest. The survey area was reassessed for the 1990/1991 survey to reflect eleven habitats. During the 1990/1991, 1991/1992 and 1992/1993 surveys approximately 58 percent of the moose were observed in three habitats; Open Mixed Forest, Shrub Alder, and Birch. The greatest differences in frequency of moose observed from 1991/1992 to 1992/1993 survey was a decline of 7.6 percent in Open Mixed Forest and an increase of 9.6 percent in the Closed Mixed Forest habitat (Table 6).

Number of Moose

The largest habitat area, the Open Mixed Forest (12.9/mi^2: 41.1 percent of the study area), exhibited the greatest number of moose during the 1992/1993 survey (Table 7). The second highest density of moose was observed in the Open Deciduous Forest habitat (1.04/mi^2: 3.3 percent of the study area), with 408.8 percent more moose than expected. The Open Deciduous Forest habitat supported a greater than expected percentage when compared to the 1991/1992 survey.

Four other areas, Riparian, Open Deciduous, Low Shrub, and Herbaceous, which collectively make up 9 percent of the study area hosted 352 moose, or 169 percent more than were expected. The Closed Mixed, Closed Deciduous, and Open Deciduous areas showed the largest percentage of increase when compared to the 1991/1992 survey.

AGE/SEX COMPOSITION

Age Composition

The percent of calves in the Wishbone Hill survey area demonstrated a slight decrease from the 1991/1992 surveys (Table 8). The ratio of calves to cows showed a slight decrease, while the ratio of bulls to cows increased slightly from the 1991/1992 to 1992/1993 survey.

The ADF&G survey data in Count Areas 5 and 8 from 1987 to 1988 depicts an increase of bull/cow, calf/cow ratios, but an overall decline in total moose density in Count Area 8, and an increase in Count Area 5. From 1988 to 1992 bull/cow and calf/cow ratios, and the percentage of calves in the area decreased substantially, although there was an increase in cow density through the 1992/1993 surveys (Tables 8 and 9).

While the results of recent survey years are within the range observed since the early 1960's, it should be noted that the ADF&G methodology for determining moose populations and composition changed. ADF&G resolved that surveys, prior to 1988, had specific "count areas" within game zones and did not adequately estimate population size or acknowledge rapid rates of mortality until populations were low. Partial responsibility for this problem was a bias toward the moose occupying open habitats.

Table 7. Comparison of Expected and Observed Moose/Habitat Type - (1992 - 1993)

Habitat Type	Moose (Sex/Age)	Expected # of Moose	Observed # of Moose	Percent Difference
Closed Deciduous Forest	Bulls	6.3	1	
	Cows	105.9	95	
	Calves	46	48	
	Unknown	52.1	56	
	Total	210.3	200	-4.9%
Open Deciduous Forest	Bulls	1.2	4	
	Cows	20.9	91	
	Calves	9.1	32	
	Unknown	10.3	84	
	Total	41.5	211	408.4%
Open Mixed Forest	Bulls	18.1	20	
	Cows	306.6	249	
	Calves	133.2	111	
	Unknown	150.8	124	
	Total	608.7	504	-17.2%
Closed Mixed Forest	Bulls	3.6	5	
	Cows	61.2	96	
	Calves	26.6	42	
	Unknown	30.1	27	
	Total	121.5	170	39.9%
Herbaceous	Bulls	0.2	2	
	Cows	3.7	15	
	Calves	1.6	6	
	Unknown	1.8	8	
	Total	7.3	31	324.7%
Birch	Bulls	5.6	8	
	Cows	94.7	105	
	Calves	41.2	33	
	Unknown	46.6	29	
	Total	188.1	175	-6.9%
Shrub Alder	Bulls	3.8	1	
	Cows	64.2	36	
	Calves	27.9	17	
	Unknown	31.6	14	
	Total	127.5	68	-46.7%
Low Shrub	Bulls	1.2	1	
	Cows	20.9	21	
	Calves	9.1	8	
	Unknown	10.3	5	
	Total	41.5	35	-15.7%
Barren	Bulls	0.1	0	
	Cows	2.2	6	
	Calves	1	3	
	Unknown	1.1	0	
	Total	4.4	9	104.6%
Disturbed Residential	Bulls	2.6	0	
	Cows	44.8	1	
	Calves	19.4	1	
	Unknown	22	1	
	Total	88.8	3	-96.6%
Riparian	Bulls	1.2	2	
	Cows	20.9	31	
	Calves	9.1	23	
	Unknown	10.3	19	
	Total	41.5	75	80.7%

Comparison of Expected and Observed Moose/Habitat Type - (1991 - 1992)

Closed Deciduous Forest	Bulls	3.8	1	
	Cows	92.8	39	
	Calves	51.6	25	
	Unknown	58.7	21	
	Total	206.9	86	-58.4%
Open Deciduous Forest	Bulls	0.9	3	
	Cows	21.5	46	
	Calves	12	32	
	Unknown	13.6	43	
	Total	48	124	158.3%
Open Mixed Forest	Bulls	11	10	
	Cows	268.1	290	
	Calves	149.2	140	
	Unknown	169.7	168	
	Total	598	608	1.7%
Closed Mixed Forest	Bulls	2.2	0	
	Cows	53.4	8	
	Calves	29.7	4	
	Unknown	33.8	16	
	Total	119.1	28	-76.5%
Herbaceous	Bulls	0.2	1	
	Cows	3.3	9	
	Calves	1.8	3	
	Unknown	2	5	
	Total	7.3	18	146.6%
Birch	Bulls	3.4	8	
	Cows	82.8	87	
	Calves	46.2	48	
	Unknown	52.4	50	
	Total	184.8	193	4.4%
Shrub Alder	Bulls	2.3	0	
	Cows	56.1	53	
	Calves	31.2	36	
	Unknown	35.5	31	
	Total	125.1	120	-4.1%
Low Shrub	Bulls	0.8	1	
	Cows	18.2	35	
	Calves	10.1	21	
	Unknown	11.5	23	
	Total	40.6	80	97%
Barren	Bulls	0	0	
	Cows	0.2	1	
	Calves	0.1	2	
	Unknown	0.2	1	
	Total	0.5	4	700%
Disturbed Residential	Bulls	1.6	2	
	Cows	39.2	17	
	Calves	21.8	12	
	Unknown	24.8	30	
	Total	87.4	61	-30.2%
Riparian	Bulls	0.8	1	
	Cows	18.2	69	
	Calves	10.1	41	
	Unknown	11.5	26	
	Total	40.6	137	237.4%

Comparison of Expected and Observed Moose/Habitat Type - (1990 - 1991)

Habitat Type	Moose (Sex/Age)	Expected # of Moose	Observed # of Moose	Percent Difference
Closed Deciduous Forest	Bulls	3.8	1	
	Cows	92.8	13	
	Calves	51.6	26	
	Unknown	58.7	87	
	Total	206.9	127	-38.6%
Open Deciduous Forest	Bulls	0.9	1	
	Cows	21.5	19	
	Calves	12	6	
	Unknown	13.6	47	
	Total	48	73	52.1%
Open Mixed Forest	Bulls	11	19	
	Cows	268.1	141	
	Calves	149.2	90	
	Unknown	169.7	205	
	Total	598	455	-23.9%
Closed Mixed Forest	Bulls	2.2	3	
	Cows	53.4	19	
	Calves	29.7	7	
	Unknown	33.8	13	
	Total	119.1	42	-64.7%
Herbaceous	Bulls	0.2	0	
	Cows	3.3	1	
	Calves	1.8	1	
	Unknown	2	4	
	Total	7.3	6	-17.8%
Birch	Bulls	3.4	2	
	Cows	82.8	12	
	Calves	46.2	29	
	Unknown	52.4	66	
	Total	184.8	109	-41%
Shrub Alder	Bulls	2.3	5	
	Cows	56.1	45	
	Calves	31.2	47	
	Unknown	35.5	58	
	Total	125.1	155	23.9%
Low Shrub	Bulls	0.8	1	
	Cows	18.2	10	
	Calves	10.1	5	
	Unknown	11.5	4	
	Total	40.6	20	-50.7%
Barren	Bulls	0	0	
	Cows	0.2	0	
	Calves	0.1	0	
	Unknown	0.2	0	
	Total	0.5	0	-100%
Disturbed Residential	Bulls	1.6	5	
	Cows	39.2	24	
	Calves	21.8	24	
	Unknown	24.8	49	
	Total	87.4	102	16.7%
Riparian	Bulls	0.8	2	
	Cows	18.2	16	
	Calves	10.1	18	
	Unknown	11.5	50	
	Total	40.6	86	111.82%

Comparison of Expected and Observed Moose/Habitat Type - (1989 - 1990)

Habitat Type	Moose (Sex/Age)	Expected # of Moose	Observed # of Moose	Percent Difference
Closed Deciduous Forest	Bulls	18.17	4	
	Cows	77.15	17	
	Calves	22.65	5	
	Total	117.97	26	-78%
Open Mixed Forest	Bulls	10.99	30	
	Cows	54.96	149	
	Calves	18.77	51	
	Total	84.72	230	171.5%
Birch	Bulls	12.79	2	
	Cows	32	5	
	Calves	6.4	1	
	Total	51.19	8	-84.4%
Shrub Alder	Bulls	4	5	
	Cows	6.94	67	
	Calves	1.24	12	
	Total	12.18	84	865.5%

Summary Comparison of Expected and Observed Moose/Habitat Type - (1990 - 1993)

Habitat Type	Moose (Sex/Age)	Expected # of Moose	Observed # of Moose	Percent Difference
Closed Deciduous Forest	Bulls	15.6	3	
	Cows	241.4	147	
	Calves	133.6	99	
	Unknown	193.7	164	
	Total	584.3	413	-29.3%
Open Deciduous Forest	Bulls	3.6	8	
	Cows	56.1	156	
	Calves	31.1	70	
	Unknown	45	174	
	Total	135.8	408	200.4%
Open Mixed Forest	Bulls	45.2	49	
	Cows	698.7	680	
	Calves	386.8	341	
	Unknown	560.6	497	
	Total	1691.3	1567	-7.4%
Closed Mixed Forest	Bulls	9	8	
	Cows	139.4	123	
	Calves	77.2	53	
	Unknown	111.8	56	
	Total	337.4	240	-28.9%
Herbaceous	Bulls	0.6	3	
	Cows	8.5	25	
	Calves	4.7	10	
	Unknown	6.8	17	
	Total	20.6	55	167%
Birch	Bulls	14	18	
	Cows	215.9	204	
	Calves	119.5	110	
	Unknown	173.2	145	
	Total	522.6	477	-8.7%
Shrub Alder	Bulls	9.5	6	
	Cows	146.2	134	
	Calves	80.9	100	
	Unknown	117.3	103	
	Total	353.9	343	-3.1%
Low Shrub	Bulls	3.1	3	
	Cows	47.6	66	
	Calves	26.3	34	
	Unknown	38.2	32	
	Total	115.2	135	17.2%
Barren	Bulls	0.03	0	
	Cows	0.5	7	
	Calves	0.3	5	
	Unknown	0.4	1	
	Total	1.23	13	956.9%
Disturbed Residential	Bulls	6.6	7	
	Cows	102	42	
	Calves	56.5	37	
	Unknown	81.8	80	
	Total	246.9	166	-32.8%
Riparian	Bulls	3.1	5	
	Cows	47.6	116	
	Calves	26.3	82	
	Unknown	38.2	95	
	Total	115.2	298	158.7%

* 1989 - 1990 data not summarized do to changes in habitat type surveyed

In 1988, ADF&G first used the "Gasaway technique" in G.M.U., 14A. This method of estimating population size and composition is based on a stratified random sampling design modified from Siniff and Skog (1964) and Evan et.al., (1966). Once the study area, which may be from 300 to 4000 mi^2 is stratified, "sample units" within the study area are selected. The "sample unit" is surveyed using an intensive search pattern which may help estimate the percentage of moose missed. Sightability correction factors are generated for each strata, which are intended to eliminate bias due to an observers ability to see moose in different habitats. It may not be justifiable to compare G.M.U., 14A or the Matanuska Valley Moose range to the Wishbone Hill project area due to the different habitats and types of terrain.

ADF&G spring survey results of the Matanuska Valley Moose Range indicates an increase in the adult population, with a decline in calf observations during the spring of 1991. Population composition in the Wishbone Hill area reflects a general increase in all categories (Table 10).

Changes in Age/Sex Composition Throughout 1992/1993

Moose population age/sex composition varied throughout the 1992/1993 survey period. Calf/cow ratios in the first four surveys ranged from 32.6 to 44.7 calves per 100 cows. Calf/cow sightings decreased during the spring, as they did in the 1991/1992 survey, but the absence of calf sightings was not as prevalent as it was in the 1989/1990 survey. (Table 11,12 & 13)

Movement Corridors and Migration

The migratory activity of moose during the 1992/1993 survey period was similar to what was recorded in 1991/1992. Observation totals in the study area increased approximately 300 percent from October to January. During the 1992/1993 survey, densities increased, with a trend of usage in the East, West and Project areas. The greatest density was observed in the Western region late in mid-January. Sightings in the High Elevation area account for the relatively consistent density figures through February, which for the relatively consistent density figures through February, which may be attributable to a transitory process.

Moose Vehicle Accidents

During the winter of 1992/1993, between Mileposts 18 and 56, nine moose were reported killed by motor vehicles (ADF&G 07/14/93). The Buffalo Mine Road is located at mile 53.1. The proposed access road to the Wishbone Hill project will be located near milepost 56 (Table 14).

Table 8: Historical Data for Count Area #8 Moose Density & Age/Sex Distribution

Game Management Unit 14

Year *	Bulls/100 Cows	Calves/100 Cows	% Calves in Area	Bulls/mi²	Cows/mi²	Calves/mi²	Moose/mi²
ADF&G Data							
1966	14.2	38.1	24.6	0.3	2.2	0.8	3.3
1967	10.1	36.8	25	0.4	3.9	1.4	5.7
1968	12	44.8	28.6	0.5	4.2	1.9	6.6
1970	7.3	45.8	29	0.4	5.1	2.3	8
1971	8.8	38.2	25.8	0.3	3	1.2	4.5
1972	7.7	30.6	21.2	0.2	2.4	0.7	3.4
1973	6.2	41.9	28.3	0.2	2.8	1.2	4.2
1974	8.8	32.9	23.2	0.2	2.7	0.9	3.8
1975	6.5	33.8	28.2	0.1	1.3	0.5	1.9
1976	13.5	36.5	24.3	0.3	1.9	0.7	2.9
1977	10.5	45.8	29.3	0.3	2.4	1.1	3.7
1978	9.8	36.4	24.9	0.2	2.3	0.8	3.3
1979	12.2	35.7	23.8	0.3	2	0.7	3
1981	13.1	41.3	26.8	0.4	3.1	1.3	4.8
1982**	12.2	26.7	19.2	0.2	1.7	0.5	2.4
1986	14.5	36.5	24.2	0.4	2.9	1.1	4.4
1987	22.5	39.2	24.2	0.8	3.5	1.4	5.6
1988	26.1	55.1	30.3	0.4	1.6	0.9	2.9
1991	13.7	39.3	25.7	0.3	2.4	1.1	3.7
1992	11	38	25	0.3	2.7	1	4.1
Mean ADF&G	12	38.7	25.6	0.3	2.7	1.1	4.1
B & B Environmental Data							
1989	20.7	26.1	17.7	0.6	2.9	0.8	4.3
1990 Mean	12.5	35.5	23.8	0.4	2.9	1.1	4.4
1991 Mean	4.7	37.8	26.5	0.2	3.9	1.5	5.6
1992 Mean	6.8	34.4	24.3	0.3	4.1	1.4	7.8

* All ADF&G data was recorded during surveys in November or December

**Moose Creek to Granite Creek, Upper King River only portions surveyed

Table 9: Historical Data for Count Area #5 - Moose Density and Age/Sex Distribution.

Year *	Bulls/100 Cows	Calves/100 Cows	% Calves/Area	Bulls/mi²	Cows/mi²	Calves/mi²	Moose/mi²
ADF&G Data							
1963	--	--	27	0	0	0	3.1
1964	6.6	33.8	24.1	0.1	2.2	0.7	3.1
1965	22	54.6	30.6	0.7	3.1	1.7	5.6
1966	10	45	29	0.2	1.6	0.7	2.4
1967	10.7	47.3	29.9	0.3	2.5	1.2	3.9
1968	10.6	57.4	33.5	0.1	1	0.6	1.8
1970	3.6	43.9	29.7	0.1	2.2	1	3.2
1971	8.8	47.5	30.4	0.3	2.9	1.4	4.6
1972	3.4	31.5	22.8	0.1	1.7	0.5	2.3
1973	6.7	40	27.3	0.1	1.7	0.7	2.4
1974	12.2	47.1	29.1	0.3	2.8	1.3	4.6
1975**	18.4	67.4	37.5	0.1	0.5	0.4	1.3
1976	6.7	49	31.4	0.1	1.2	0.6	1.8
1977	7.9	50.6	31.9	0.1	1.8	0.9	2.9
1978	12	43.9	28.2	0.5	4.2	1.8	6.5
1979	8.6	40.3	26.9	0.1	1.5	0.6	2.3
1980	3.3	58.1	36.7	0.01	0.3	0.2	0.5
1981	8.3	59.4	35.4	0.1	1.1	0.6	1.8
1982	21.9	51	29.5	0.5	2.1	1.1	3.7
1986	2.5	44.3	30.2	0.02	0.9	0.4	1.3
1987	0.13	0.58	0.34	0.1	0.8	0.4	1.3
1988	26.1	55.1	30.3	0.4	1.6	0.9	2.9
1991	13.7	39.3	25.7	0.3	2.4	1.1	3.9
1992	11	38	25	0.3	2.7	1	4.1
Mean ADF&G	12.03	38.7	25.6	0.3	2.7	1.1	3.0
B & B Environmental Data							
1989	20.7	26.1	17.7	0.6	2.9	0.8	4.3
Mean 1990	12.5	35.2	23.8	0.4	2.9	1.1	4.4
Mean 1991	4.7	37.8	26.5	0.2	3.9	1.5	5.6
Mean 1992	6.8	34.4	24.3	.3	4.1	1.4	7.8

See Footnotes

Table 10. Matanuska Valley Moose Range Spring Survey Census.

Year	Adults	Calves	Total	% Calves	Adults/mi²	Calves/mi²	Moose/mi²
ADF&G Data							
2/28/89-3/1/89*	469	124	593	21	2.5	.67	3.2
3/4/91-3/7/91**	659	83	742	11	3.6	.45	4
03/24/93	200	32	232	14	1.1	0.2	1.3
Study Area Data							
Mean 2/91-3/91	123.5	28	152	18.4	3.9	.9	4
Mean 2/92-3/92	142.5	41.5	184	22.5	4.5	1.3	5.8
Mean 02/93-03/93	138	29	167	21	4.4	.9	5.3

* Gasaway Survey Method: Total Population Est. 829 +/- 120. All 16 sample units surveyed

**Gasaway Survey Method: Total Population Est. 860 +/- 33. All 16 samples units surveyed

B & B Data averaged from February and March surveys of respective years. Bull and Cow totals integrated under Adults.

Table 11. Age/Sex Distribution of Moose/Geographic Region - (1992 - 1993)

Survey Data	Survey Region	Bulls/100 Cows	Calves/100 Cows	% Calves
11/4/92	High	11.4	40	
	East	0	25	
	West	0	66.7	
	Project	0	100	
	TOTAL:	8.5	44.7	6.5%
11/5/92	High	10.6	22.7	
	East	16.7	100	
	West	11.5	53.9	
	Project	0	54.6	
	TOTAL:	10.1	37.6	12.7%
12/7/92	High	0	10	
	East	15.2	45.7	
	West	13	37	
	Project	5.6	11.1	
	TOTAL:	10.9	32.6	13.9%
12/28/92	High	5.6	19.4	
	East	7.6	52.8	
	West	6.4	33.3	
	Project	6.7	20	
	TOTAL:	6.6	35.3	18.2%
1/11/93	High	0	28.6	
	East	5.7	45.7	
	West	1.2	25.9	
	Project	0	26.1	
	TOTAL:	1.6	30.3	17.3%
2/8/93				
	TOTAL:			10.8%
3/19/93				
	TOTAL:			8.6%
3/30/93				
	TOTAL:			7.4%
4/17/93				
	TOTAL:			4.6%

02/08/93 - Sex was undetermined in later surveys due to antler loss, therefore ratio calculations have been omitted.

03/19/93 - " "

03/30/93- " "

04/17/93 - " "

Age/Sex Distribution of Moose/Geographic Region - (1991 - 1992)

Survey Data	Survey Region	Bulls/100 Cows	Calves/100 Cows	% Calves
10/23/91	High	2.9	51.4	
	East	0	66.7	
	West	0	25	
	Project	0	100	
	TOTAL:	1.8	50	32.9%
11/13/91	High	2.9	51.4	
	East	0	14.3	
	West	16.7	33.3	
	Project	0	50	
	TOTAL:	6.9	41.7	28%
11/20/91	High	8.8	45.6	
	East	0	66.7	
	West	12.5	27.7	
	Project	0	66.7	
	TOTAL:	8	48.7	31%
1/11/92	High	0	23.5	
	East	4.2	37.5	
	West	3.5	21.9	
	Project	9.5	66.7	
	TOTAL:	3.2	29	22%
1/18/92	High	4.5	109	
	East	0	100	
	West	0	107.7	
	Project	16.6	141.6	
	TOTAL:	4.5	113.4	27.6%
2/12/92				
	TOTAL:			26.5%
3/12/92				
	TOTAL:			13%
4/6/92				
	TOTAL:			18.4%
4/20/92				
	TOTAL:			12.8%

02/12/92 - Sex was undetermined in later surveys due to antler loss, therefore ratio calculations have been omitted.

03/12/92- " "

04/06/92- " "

04/20/92- " "

Age/Sex Distribution of Moose/Geographic Region - (1990 - 1991)

Survey Data	Survey Region	Bulls/100 Cows	Calves/100 Cows	% Calves
10/31/90	High	15.8	68.4	
	East	20	0	
	West	0	0	
	Project	0	0	
	TOTAL:	16.7	54.2	31.7%
11/16/90	High	12.5	37.5	
	East	14.3	0	
	West	18.8	31.3	
	Project	8.3	25	
	TOTAL:	13.6	28.8	20.2%
11/28/90	High	15	32.5	
	East	14.3	50	
	West	23.4	27.7	
	Project	20	60	
	TOTAL:	19	36.2	23.30%
12/15/90	High	6.5	41.9	
	East	0	28.6	
	West	4.8	38.1	
	Project	4.8	47.6	
	TOTAL:	5	40.6	27.9%
1/16/91				
	TOTAL:			25.3%
1/23/91				
	TOTAL:			17.6%
2/12/91				
	TOTAL:			16.3%
3/16/91				
	TOTAL:			21%
4/12/91				
	TOTAL:			16.1%
4/26/91				
	TOTAL:			15.4%

01/16/91 - Sex was undetermined in later surveys due to antler loss, therefore ratio calculations have been omitted.

01/23/91- " "

02/12/91- " "

03/16/91- " "

04/12/91- " "

04/26/91- " "

Age/Sex Distribution of Moose/Geographic Region - (1989 - 1990)

Survey Data	Survey Region	Bulls/100 Cows	Calves/100 Cows	% Calves
12/4/89	High	9.1	18.2	
	East	15.4	38.5	
	West	30.2	30.2	
	Project	14.3	14.3	
	TOTAL:	20.7	26.1	17.8%
12/26/89	High	3.2	12.9	
	East	24.2	36.4	
	West	14	38	
	Project	16.7	66.7	
	TOTAL:	14.2	32.5	22.2%
1/26/90				
	TOTAL:			19.8%
3/7/90				
	TOTAL:			26.9%
4/24/90				
	TOTAL:			0%

01/26/90 - Sex was undetermined in later surveys due to antler loss, therefore ratio calculations have been omitted.
03/07/90- " "
04/24/90- " "

Table 12: Age/Sex Distribution of Moose in Each Habitat Type - (1992 - 1993)

Survey Date	Survey Section	Bulls/100 Cows	Calves/100 Cows
11/04/92	Open Mixed Forest	5	40
	Closed Deciduous Forest	0	100
	Birch	18.8	43.8
	Shrub Alder	0	100
	Closed Mixed Forest	0	0
	Open Deciduous Forest	0	0
	Riparian Zone	0	0
	Low Shrub	0	0
	Herbaceous	0	0
	Disturbed Residential	0	0
	Barren	0	50
	Total:	8.5	44.7
11/15/92	Open Mixed Forest	12.8	46.2
	Closed Deciduous Forest	0	41.2
	Birch	11.1	22.2
	Shrub Alder	0	25
	Closed Mixed Forest	16.7	58.3
	Open Deciduous Forest	20	20
	Riparian Zone	0	50
	Low Shrub	16.7	0
	Herbaceous	0	0
	Disturbed Residential	0	0
	Barren	0	50
	Total:	10.1	37.6
12/07/92	Open Mixed Forest	25.6	28.2
	Closed Deciduous Forest	3.1	34.4
	Birch	13.6	18.2
	Shrub Alder	0	0
	Closed Mixed Forest	4	40
	Open Deciduous Forest	0	53.3
	Riparian Zone	0	100
	Low Shrub	0	0
	Herbaceous	0	0
	Disturbed Residential	0	0
	Barren	0	0
	Total:	~~10~~.9	32.6
12/28/92	Open Mixed Forest	5.4	37.5
	Closed Deciduous Forest	0	66.7
	Birch	0	20.8
	Shrub Alder	20	80
	Closed Mixed Forest	3.9	38.5
	Open Deciduous Forest	8	12
	Riparian Zone	50	50
	Low Shrub	0	66.7
	Herbaceous	16.7	33.3
	Disturbed Residential	0	0
	Barren	0	0
	Total:	6.6	35.3
01/11/93	Open Mixed Forest	1.7	28.8
	Closed Deciduous Forest	0	35
	Birch	0	20
	Shrub Alder	0	29.4
	Closed Mixed Forest	3.9	30.8
	Open Deciduous Forest	3.1	18.8
	Riparian Zone	0	66.7
	Low Shrub	0	0
	Herbaceous	0	0
	Disturbed Residential	0	0
	Barren	0	0
	Total:	1.6	30.3
02/08/93 through 04/17/93 - Sex was undetermined due to antler loss, therefore ratio calculations have been omitted.			

Age/Sex Distribution of Moose in Each Habitat Type - (1991 - 1992)

Survey Date	Survey Section	Bulls/100 Cows	Calves/100 Cows
10/23/91	Open Mixed Forest	0	26.1
	Closed Deciduous Forest	0	0
	Birch	20	80
	Shrub Alder	0	71.4
	Closed Mixed Forest	0	0
	Open Deciduous Forest	0	75
	Riparian Zone	0	50
	Low Shrub	0	50
	Herbaceous	0	0
	Disturbed Residential	0	0
	Barren	0	0
	Total:	1.8	50
11/13/91	Open Mixed Forest	10.4	27.6
	Closed Deciduous Forest	0	75
	Birch	0	80
	Shrub Alder	0	83.3
	Closed Mixed Forest	0	0
	Open Deciduous Forest	0	0
	Riparian Zone	6.7	20
	Low Shrub	0	77.8
	Herbaceous	0	0
	Disturbed Residential	0	0
	Barren	0	0
	Total:	6.9	41.7
11/20/91	Open Mixed Forest	5.9	51
	Closed Deciduous Forest	0	50
	Birch	20.7	48.3
	Shrub Alder	0	53.3
	Closed Mixed Forest	0	200
	Open Deciduous Forest	0	0
	Riparian Zone	0	60
	Low Shrub	0	20
	Herbaceous	0	0
	Disturbed Residential	0	0
	Barren	0	0
	Total:	8	48.7
01/11/92	Open Mixed Forest	2.5	24.8
	Closed Deciduous Forest	5.6	38.9
	Birch	3.1	31.3
	Shrub Alder	0	37.5
	Closed Mixed Forest	0	0
	Open Deciduous Forest	8	40
	Riparian Zone	0	37.9
	Low Shrub	0	0
	Herbaceous	0	0
	Disturbed Residential	16.7	33.3
	Barren	0	0
	Total:	3.2	29.1
01/18/92	Open Mixed Forest	0	103.6
	Closed Deciduous Forest	0	100
	Birch	0	100
	Shrub Alder	0	100
	Closed Mixed Forest	0	0
	Open Deciduous Forest	11.1	133.4
	Riparian Zone	0	133.4
	Low Shrub	16.6	133.4
	Herbaceous	0	0
	Disturbed Residential	16.6	100
	Barren	0	0
	Total:	4.5	113.4

02/12/92 through 04/20/92 - Sex was undetermined due to antler loss, therefore ratio calculations have been omitted.

Age/Sex Distribution of Moose in Each Habitat Type - (1990 - 1991)

Survey Date	Survey Section	Bulls/100 Cows	Calves/100 Cows
10/31/90	Open Mixed Forest	20	0
	Closed Deciduous Forest	0	100
	Birch	33.3	66.7
	Shrub Alder	12.5	75
	Closed Mixed Forest	0	0
	Open Deciduous Forest	33.3	0
	Riparian Zone	0	0
	Low Shrub	0	100
	Herbaceous	0	0
	Disturbed Residential	0	0
	Barren	0	0
	Total:	16.7	54.2
11/16/90	Open Mixed Forest	15.2	27.3
	Closed Deciduous Forest	0	0
	Birch	0	33.3
	Shrub Alder	16.7	41.7
	Closed Mixed Forest	100	0
	Open Deciduous Forest	0	0
	Riparian Zone	0	100
	Low Shrub	0	0
	Herbaceous	0	0
	Disturbed Residential	0	100
	Barren	0	0
	Total:	13.6	28.8
11/28/90	Open Mixed Forest	22	34
	Closed Deciduous Forest	16.7	66.7
	Birch	33.3	66.7
	Shrub Alder	11.8	47.1
	Closed Mixed Forest	25	0
	Open Deciduous Forest	0	0
	Riparian Zone	0	0
	Low Shrub	16.7	16.7
	Herbaceous	0	100
	Disturbed Residential	25	45
	Barren	0	0
	Total:	19	36.2
12/15/90	Open Mixed Forest	3.8	39.6
	Closed Deciduous Forest	0	75
	Birch	0	33.3
	Shrub Alder	0	87.5
	Closed Mixed Forest	7.1	21.4
	Open Deciduous Forest	0	20
	Riparian Zone	18.2	27.3
	Low Shrub	0	0
	Herbaceous	0	0
	Disturbed Residential	0	66.7
	Barren		0
	Total:	5	40.6
01/06/91 through 04/26/91 - Sex was undetermined due to antler loss, therefore ratio calculations have been omitted.			

Age/Sex Distribution of Moose in Each Habitat Type - (1989 - 1990)

Survey Date	Survey Section	Bulls/100 Cows	Calves/100 Cows
12/04/89	Open Mixed Forest	27.5	29
	Closed Deciduous Forest	0	0
	Birch	0	0
	Shrub Alder	0	17.4
	Total:	20.7	26.1
12/26/89	Open Mixed Forest	11.8	36.8
	Closed Deciduous Forest	20	33.3
	Birch	0	0
	Shrub Alder	17.2	20.7
	Total:	14.2	32.5
03/07/90 through 04/24/90 - Sex was undetermined due to antler loss, therefore ratio calculations have been omitted.			

Table 13. Density of Moose in Each Geographic Region Based on Age/Sex - (1992 - 1993)

Survey	Habitat	Bulls/Mi²	Cows/Mi²	Calves/Mi²	Unknown/Mi²	Total/Mi²
11/4/92	High	0.3	2.6	1		4
	West		0.8	0.2		1
	East		0.6	0.4		1
	Project		0.8	0.7		1.5
Total:		0.1	1.5	0.7	0	2.3
11/15/92	High	0.5	5	1.1		6.6
	West	0.2	1.2	1.2		2.5
	East	0.3	2.6	1.4		4.3
	Project		4	2.2		6.2
Total:		0.4	3.5	1.3	0	5.1
12/7/92	High		1.5	0.2		1.6
	West	1.3	8.8	4		14.2
	East	0.7	5.3	2		8
	Project	0.4	6.6	0.7		7.6
Total:		0.5	4.3	1.4	0	6.3
12/28/92	High	0.2	2.7	0.5		3.4
	West	0.8	10.1	5.4		16.3
	East	0.4	6.2	2.1		8.7
	Project	0.4	5.5	1.1		6.9
Total:		0.4	5.3	1.9	0	7.5
1/11/93	High		3.1	0.9		4
	West	0.4	6.7	3.1		10.1
	East	0.1	8.4	2.2		10.7
	Project		8.4	2.2		10.6
Total:		0.1	5.9	1.8	0	7.8
2/8/93	High		0.8	0.8	2.5	4
	West		2.3	2.5	7.1	11.9
	East		1	1	4.4	6.3
	Project		0.7	0.7	2.6	4
Total:		0	1.1	1.1	3.9	6.1
3/19/93	High		0.7	0.7	3.1	4.4
	West		1.2	1.2	5.2	7.5
	East		1.1	1.1	4.1	6.2
	Project		0.7	0.7	4	5.5
Total:		0	0.9	0.9	3.8	5.6
3/30/93	High		0.6	0.6	2.3	3.5
	West		0.6	0.6	4.4	5.5
	East		1.2	1.3	2.2	4.6
	Project				4	4
Total:		0	0.7	0.8	2.8	4.3
4/17/93	High		0.2	0.2	1.2	1.5
	West		0.8	0.8	1.5	3.1
	East		0.2	0.2	0.8	1.2
	Project		2.6	2.6	2.2	7.3
Total:		0	0.5	0.5	1.2	2.2

Density of Moose in Each Geographic Region Based on Age/Sex - (1991 - 1992)

Survey	Habitat	Bulls/Mi²	Cows/Mi²	Calves/Mi²	Unknown/Mi²	Total/Mi²
10/23/91	High	0.1	2.6	1.3		4.0
	West		1.2	0.3		1.5
	East		1.2	0.8		1.9
	Project		1.2	1.1		2.2
Total:		0.3	1.8	0.9	0	2.7
11/13/91	High	0.1	2.6	1.3		4.0
	West	0.4	2.4	0.8		3.6
	East		1.3	0.2		1.5
	Project		2.2	1.1		3.2
Total:		0.2	2.3	1	0	3.4
11/20/91	High	0.4	4.3	1.9		6.5
	West	0.4	3.2	1.3		4.8
	East		1.7	1.2		2.9
	Project		5.5	3.6		9.0
Total:		0.3	3.6	1.8	0	5.6
01/11/92	High		5.1	1.2		6.3
	West	0.4	11.3	2.5		14.1
	East	0.4	9.2	3.4		13.0
	Project	0.7	7.6	5.1		13.4
Total:		0.3	7.9	2.3	0	10.5
01/18/92	High	0.1	1.6	1.8	3.0	6.5
	West		2.6	2.8	4.6	9.9
	East		1.4	1.3	2.9	5.5
	Project	0.1	4.4	6.2	9.8	21.0
Total:		0.09	2.1	2.4	4	8.7
02/12/92	High	0.1	1.3	1.3	2.6	5.2
	West		2	2.4	6.0	10.3
	East		2.8	4.2	4.4	12.4
	Project		2.2	1.2	3.0	7.2
Total:		0.03	2	2.2	4	8.2
03/12/92	High		0.1	0.2	1.6	1.9
	West		0.5	0.5	3.3	4.2
	East		1.0	1.0	2.1	4.0
	Project		0.8	0.7	5.4	6.9
Total:		0	0.4	0.4	2.6	3.4
04/06/92	High		0.3	0.3	1.6	2.2
	West		0.4	0.4	1.7	2.5
	East		1.0	1.0	1.7	3.6
	Project		0.4	0.4	0.4	1.0
Total:		0	0.4	0.4	1.5	2.4
04/20/92	High		0.2	0.2	1.6	1.9
	West				0.4	0.3
	East		0.4	0.4	0.8	1.5
	Project		0.4	0.4		0.7
Total:		0	0.2	0.2	1.1	1.2

Density of Moose in Each Geographic Region Based on Age/Sex - (1990 - 1991)

Survey	Habitat	Bulls/Mi²	Cows/Mi²	Calves/Mi²	Unknown/Mi²	Total/Mi²
10/31/90	High	0.2	1.4	1.0		2.6
	West					
	East	0.2	1.0			1.2
	Project					
Total:		0.1	0.8	0.4		1.3
11/16/90	High	0.2	1.8	0.7		2.7
	West	0.3	1.6	0.5		2.4
	East	0.2	1.3			1.5
	Project	0.4	4.4	1.1		5.8
Total:		0.3	1.9	0.5		2.7
11/28/90	High	0.5	3.0	1.0		4.4
	West	1.1	4.6	1.3		7.0
	East	0.4	2.7	1.3		4.4
	Project	1.1	5.5	3.3		9.8
Total:		0.7	3.7	1.3		5.7
12/15/90	High	0.2	2.3	1.0		3.4
	West	0.2	4.2	1.6		5.9
	East		1.3	0.4		1.7
	Project	0.4	7.6	3.6		11.6
Total:		0.2	3.2	1.3		4.7
01/06/91	High			1.1	2.8	4.0
	West			0.6	2.4	3.0
	East			1.5	5.7	7.3
	Project			2.9	6.2	9.1
Total:				1.2	3.5	4.6
01/23/91	High			1.1	3.7	4.8
	West			0.5	3.0	3.5
	East			1.3	8.2	9.6
	Project			0.4	2.9	3.3
Total:				0.9	4.2	5
02/12/91	High			0.9	2.9	3.8
	West			0.3	2.5	2.8
	East			1.2	8.8	9.9
	Project			1.1	4.7	5.8
Total:				0.8	3.9	4.7
03/16/91	High			1.4	4.0	5.4
	West			0.5	2.2	2.7
	East			1.0	6.3	7.3
	Project			1.5	5.5	6.9
Total:				1.1	3.9	5
04/12/91	High			0.6	2.4	3.0
	West				0.4	0.4
	East			0.2	1.5	1.7
	Project			0.4	2.9	3.3
Total:				0.3	1.7	2
04/26/91	High			0.5	2.2	2.8
	West				0.3	0.3
	East				0.8	0.8
	Project			0.4	2.6	2.9
Total:				0.3	1.4	1.7

Density of Moose in Each Geographic Region Based on Age/Sex - (1989 - 1990)

Survey	Habitat	Bulls/Mi²	Cows/Mi²	Calves/Mi²	Unknown/Mi²	Total/Mi²
12/04/89	High	0.15	1.64	0.30		2.09
	West	1.28	4.25	1.28		6.82
	East	0.38	2.49	0.96		3.82
	Project	0.73	5.09	0.73		6.55
Total:		0.6	2.92	0.76	-	4.29
12/26/89	High	0.07	2.31	0.30		2.68
	West	0.69	4.94	1.88		7.51
	East	1.53	6.31	2.29		10.13
	Project	0.36	2.18	1.45		4.00
Total:		0.54	3.81	1.24	-	5.58
01/26/90	High					
	West					
	East					
	Project					
Total:		1.84	0.98	0.79	-	4
03/07/90	High	0.60	1.19	0.52		2.31
	West	0.20	0.89	0.49		1.58
	East	0.76	4.21	1.72		6.69
	Project		2.55	1.45		4.00
Total:		0.44	1.71	0.79	-	2.95
04/24/90	High	0.37	0.97			1.34
	West	0.10	0.10			0.20
	East	0.38	0.38			0.76
	Project	0.73	1.45			2.18
Total:		0.32	0.63	-	-	0.95

Tale 14. Moose Mortalities Recorded by the Alaska State Troopers

Occurring Between Mile-Post 18 and 56 of the Glenn Highway - (1989 to 1993)

1989/1990 Total:n=14		1990/1991 Total:n=6		1991/1992 Total:n=9		1992/1993 Total:n=9	
Date	Milepost Number	Date	Milepost Number	Date	Milepost Number	Date	Milepost Number
10/19/89	51.5	01/09/91	53	11/01/91	38	10/02/92	29
11/18/89	52.5	01/15/91	38.5	02/01/91	51.4	01/01/93	56.2
11/18/89	52.5	02/01/91	38	01/16/92	53	02/02/93	34
12/11/89	53.3	02/10/91	41	01/23/92	54.4	02/26/93	33.5
12/13/89	53	02/10/91	51.5	02/02/92	53	03/01/93	40
12/19/89	53.5	02/27/91	40	02/08/92	51.5	03/18/93	36
12/28/89	52			02/08/92	49	03/22/93	33
01/01/90	50.8			02/19/92	50.5	03/27/93	32
01/08/90	40			02/27/92	48	04/05/93	36
02/07/90	56.5			03/14/92			
02/15/90	54.5						
03/03/90	48						
03/15/90	53						
04/11/90	53.5						

Discussion

SUMMARY OF MOOSE ABUNDANCE

Overall 1992/1993 census results show an increase of 13 percent in the number of moose observed within the study area when compared to the previous two winters. Calf, cow and bull populations increased 16 percent, 66 percent and 16 percent respectively. The 1989/1990 survey results are not included in this comparison due to changes in survey methods.

DISTRIBUTION OF MOOSE BY GEOGRAPHIC REGION

During the spring and summer, moose are found throughout the area north and northeast of the study area. As snow begins to accumulate in higher elevations, the general movement of moose trends in a southwesterly direction towards the Susitna Valley. This migratory route appears to cross Moose Creek in the northern High Elevation area before heading south through the West geographic region. The alternate path brings moose directly into the Project and East wintering areas by traversing to the south of Wishbone Hill. During 1990/1991, large accumulations of snow early in the year most likely forced moose to lower elevations along the southern route through the study area. This route leads to Tsadaka Canyon which delays the east-west migration resulting in an accumulation of moose in the Project and East geographic areas during most of the winter. During 1992/1993, light snow accumulation in the study area early in the season allowed moose to use the northern migratory route which allows for an easy traverse of Moose Creek and avoids Tsadaka Canyon. Therefore, during winter 1992/1993, the density of moose was greater in the Western geographic area.

The majority of moose sighted in the High Elevation geographic area were concentrated on Wishbone Hill, particularly in the area adjacent to Wishbone Lake and on the south-facing slopes on the Western portion of the hill. Consequently, although the number of moose was considerably less than expected in the High Elevation area based on aerial coverage, these data do not represent the preference displayed for the Wishbone Hill vicinity.

The northern portion of the High Elevation area consists of wide expanses of open upland meadow which are subject to strong winds and deep snows. The low shrubs or scattered clumps of birch provide minimal shelter. Snow accumulation forces moose to relocate to areas of reduced snowfall, where movement is less restricted and browse more readily available. Varying use of the High Elevation area by moose between the last four survey years could possibly be attributed to weather conditions and snowfall. The winter of 1989/1990 was characterized by unusually cold temperatures and high snow depths. The difference between the expected and observed moose in the High Elevation area for the 1989/1990 survey year was -38.9 percent. During the 1990/1991, 1991/1992 and 1992/1993 survey years, the High area remained underutilized, but to a lesser extent, -1.1 percent, -17.0 percent, and -29.9 percent respectively.

DISTRIBUTION BY HABITAT TYPE

Weather conditions and local availability of various browse species govern the relative importance of any particular habitat. If food is abundant, moose will concentrate on more favored types of browse. Of the wide variety of adequate species, willow is the most preferred browse (LeResche and Davis 1971). The second most palatable species appears to be birch, which is heavily consumed in areas where willow is scarce (LeResche et. al. 1974). Alder, poplar and aspen also provide possible food sources (LeResche 1970).

The Open Deciduous habitat, accounting for only 3.3 percent of the total area available, exhibited the highest difference in number of moose predicted. This habitat contains an abundance of desired browse species such as early growth paper birch and Sitka alder.

Herbaceous habitat exhibited the second highest preference by moose. Characterized by a high diversity of grasses and forbs. This is also the case in the clear cut areas which comprise the majority of the disturbed habitat. Vegetative regeneration of the harvested area produces plentiful moose browse for many years (S. Strube, ADNR pers. comm., 1991). However, utilization of Disturbed habitat is low due to noise and disturbance.

The distribution of preferred habitats corresponds with observations of moose throughout the geographic areas. As noted previously, high moose numbers were observed in the East, West and Project areas. The vegetative composition of these areas is highly diverse, with interspersed pockets of Open Deciduous and Shrub Alder habitats. Areas of Birch in the Project and West areas tend to have less open meadows than on the exposed slopes in the northern High Elevations. Finally, moose in these areas have access to the Riparian zone along Moose Creek which borders the Project area.

The Birch habitat, which supported a somewhat smaller number of moose than expected, consists of scattered stands of mature trees interspersed with large areas of herbaceous vegetation. Browse is not the primary component of the habitat. Therefore, although birch is a favored browse species, it exists primarily in an unusable form and moose turn to alternate food sources. In addition, the open expanse of this area renders it subject to deep, drifting snows.

Climatic conditions may explain the varying use of the Open Mixed habitat noted between the four survey years. Deep snow hinders walking and demands more energy expenditure than normal. Consequently, moose limit foraging range and remain within sheltered areas where snow accumulation is less. In years with harsh conditions such as 1989/1990, moose may seek Open Mixed Forest where shelter and forage are in close proximity. During milder conditions, moose may be able to select more preferred and highly diverse habitats. This supports observations regarding the varying use of the Western geographic area which is predominantly covered by Open-Mixed Forest. Moose utilized the West area more than expected during 1989/1990, 1991/1992, and 1992/1993 whereas observed usage approximated expected numbers in 1990/1991.

AGE/SEX COMPOSITION

Comparison with historical data indicates that the ratio of calves to cows and bulls to cows in 1992/1993 are approximately the same as the 20 year average. The trend of low calf presence noted in the 1989/1990 surveys seems to have a reversed itself somewhat over the last three years. Small fluctuations in number and composition from year to year represent natural variations in birth rates and sex ratios. Large differences are usually caused by external environmental or man induced factors (i.e. hunting, development, etc.).

The low percentage of calves present in the study area during the 1989/1990, 1990/1991 survey years can possible be attributed to climatic conditions. The winter of 1989/1990 was characterized by an unusually high snowfall and cold temperatures. Moose are not deleteriously affected by snow depths of less than 16 inches. There is some restriction of movement at levels of 16 to 29 inches, but at depths greater than 29 inches movement is impeded. At depths over 37 inches, moose may not be able to move adequately enough to enable sufficient food intake (Coady 1973). Calves, with a much smaller body size, could be detrimentally affected by lesser snow depths.

Following a year with particularly adverse winter conditions, moose populations may continue to reflect the toll taken on certain age or sex classes. In addition, the weakened adult population may experience decreased reproductive success. However, the majority of fluctuations in moose composition and number can be attributed to natural yearly variation.

Fluctuations in age/sex composition were recorded during successive surveys in 1992/1993. This does not represent the trends within a single population of moose. Observations include sighting of individuals from various sub-groups of transitory and resident moose, which are utilizing the study area at any given time. This further compounds the existing natural variation in population composition and number, resulting in highly varying numbers in the study area between years.

MOVEMENT CORRIDORS AND MIGRATION

Moose are primarily migratory animals. Migration from rutting areas to winter habitats occurs during late November and early December. A common rutting area has been identified passing through the northern portion of the study region (ADF&G 1985). Within G.M.U., 14A, moose were found primarily above 1500 feet prior to late November (Dames and Moore, 1989). A moose wintering area is known to extend from Beach Lake near the Susitna River, passing south of Wishbone Hill, to Chickaloon (ADF&G 1985).

In the early winter there was much activity in the High Elevation area. In particular, tracks were seen in the area north of Wishbone Hill and east of Moose Creek. Heavily used trails appeared in an east-west direction above 1500 feet as well as along the valley bottom. Moose tracks were also noted in a north-south direction in the West area. It seemed that moose were moving from rutting areas into the winter habitat located within the study area, or passing through the Western region and continuing to other wintering areas located southwest of

Wishbone Hill. This is supported by observations of widely distributed moose throughout the northern section of the High Elevation area in the early winter.

From January to March moose tracks traversed primarily the area between Wishbone Hill and the Project and West geographic areas. A high proportion of tracks were also identified in the Riparian zone along Moose Creek and its tributaries to the northeast. These tracks likely reflect the movements of moose utilizing the study area as winter range. This is supported by the numerous observations of moose in the Wishbone Hill vicinity and utilization of habitats in the Project and West areas. The decrease in abundance of tracks and moose in the East area and in the northern portion of the High Elevation area during midwinter supports this interpretation.

In early spring moose begin migrating to calving areas. A known calving concentration area exists west of the northern portion of the survey area. Another calving area is found south of Wishbone Hill, on the south side of the Matanuska River (ADF&G 1985). March and April of 1993 saw a marked decrease in moose numbers throughout the area, which is consistent with previous years migratory tendencies; however, due to a lack of visible tracks, or moose movement, no definitive conclusion as to location, or exit route can be inferred. It is assumed that moose passed through the High Elevation, or in a southern direction along Moose Creek to spring range areas.

Summary

Based on observations from aerial surveys, a number of conclusions regarding moose distribution, habitat use, age/sex composition, and movement of moose throughout the survey area can be drawn. Accounting for area, the distribution of moose among the geographic regions in winter 1992/1993 tends to be primarily concentrated in the West area. Apart from migration through the High Elevation area, utilization in the high terrain centered on Wishbone Hill. The Project area supported a relatively lower density of moose. Normal movement into lower elevation winter habitats enables moose to escape high snow accumulation, thereby expending less energy foraging for more readily available browse.

The distribution of moose with regard to habitat type availability indicates greatest concentrations of moose in habitats showing a highly diverse mixture of preferred browse species, particularly willow species, resin birch, and Sitka alder. Habitats showing high utilization were Riparian, Open Deciduous, Barren, Closed Mixed and Herbaceous areas. Areas supporting minimal browse, such as Shrub Alder and Closed Deciduous were underutilized by moose. Open Mixed Forest, although not over-utilized, supported the largest number of moose due to its extensive aerial coverage.

A comparison of the age/sex composition of the moose recorded in 1990/1991 and 1991/1992 indicates that numbers of bulls and cows were consistent with historical data. Observations recorded during 1992/1993 survey show this bull/cow ratio slightly increasing over the previous year. The proportion of calves to cows remained consistent with previous years as did the density of calves. A certain amount of yearly fluctuation within age and sex classes represents natural variation in birth rates and sex ratios. It is likely that the adverse winter conditions in 1989/1990 also contributed to fluctuating numbers.

Small fluctuations in age/sex composition of moose observed throughout the winter represent transitory moose using the area. Originating in the rutting area in the north and northeast, the general movement of moose trends in a southwesterly direction towards the Susitna Valley. This migratory route appears to cross Moose Creek in the northern High Elevation area before heading south through the West geographic area. The alternate path brings moose directly into the Project and East wintering areas by traversing to the south of Wishbone Hill, or through the valley to the north.

Spring movement to calving grounds appears to trend westward across the northern portion of the High Elevation area. Alternately moose seem to move south, following Moose Creek or passing through the East area in a southeasterly direction towards the Matanuska River.

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Figure 2-1. Number of Moose Expected and Observed in Each Geographic Region (1992 - 1993)

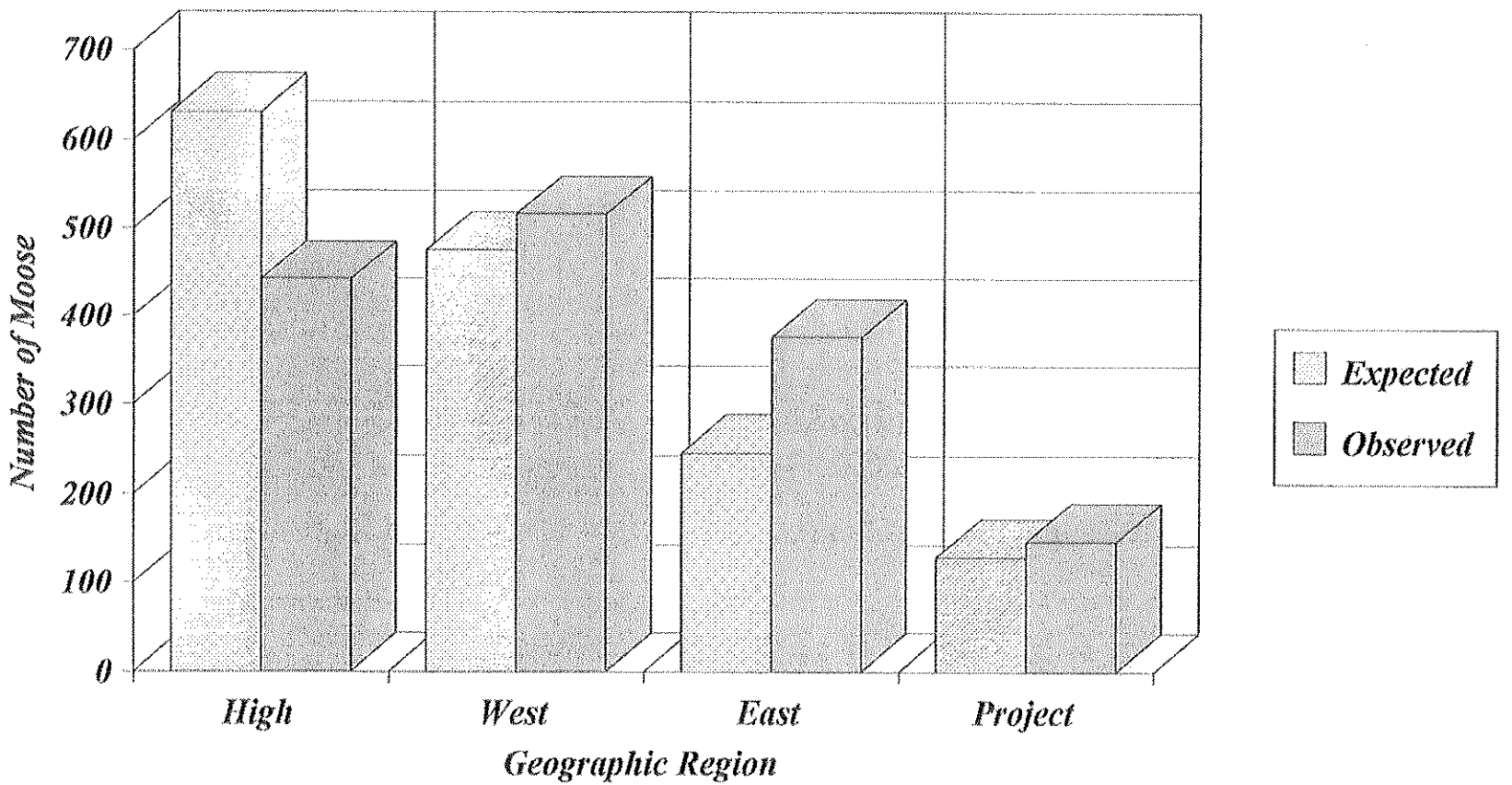
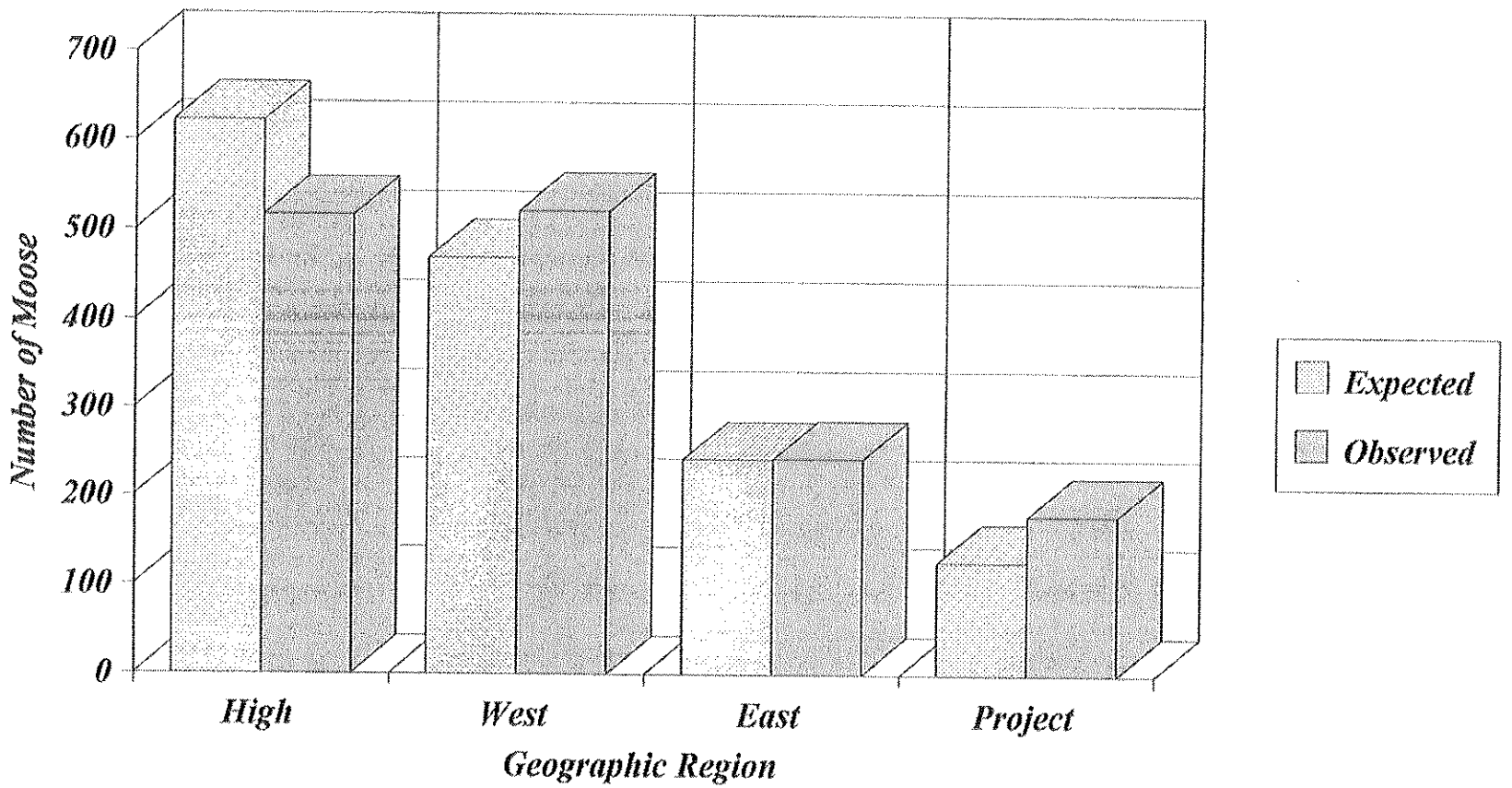


Figure 2-2. Number of Moose Expected and Observed in Each Geographic Region (1991 - 1992)



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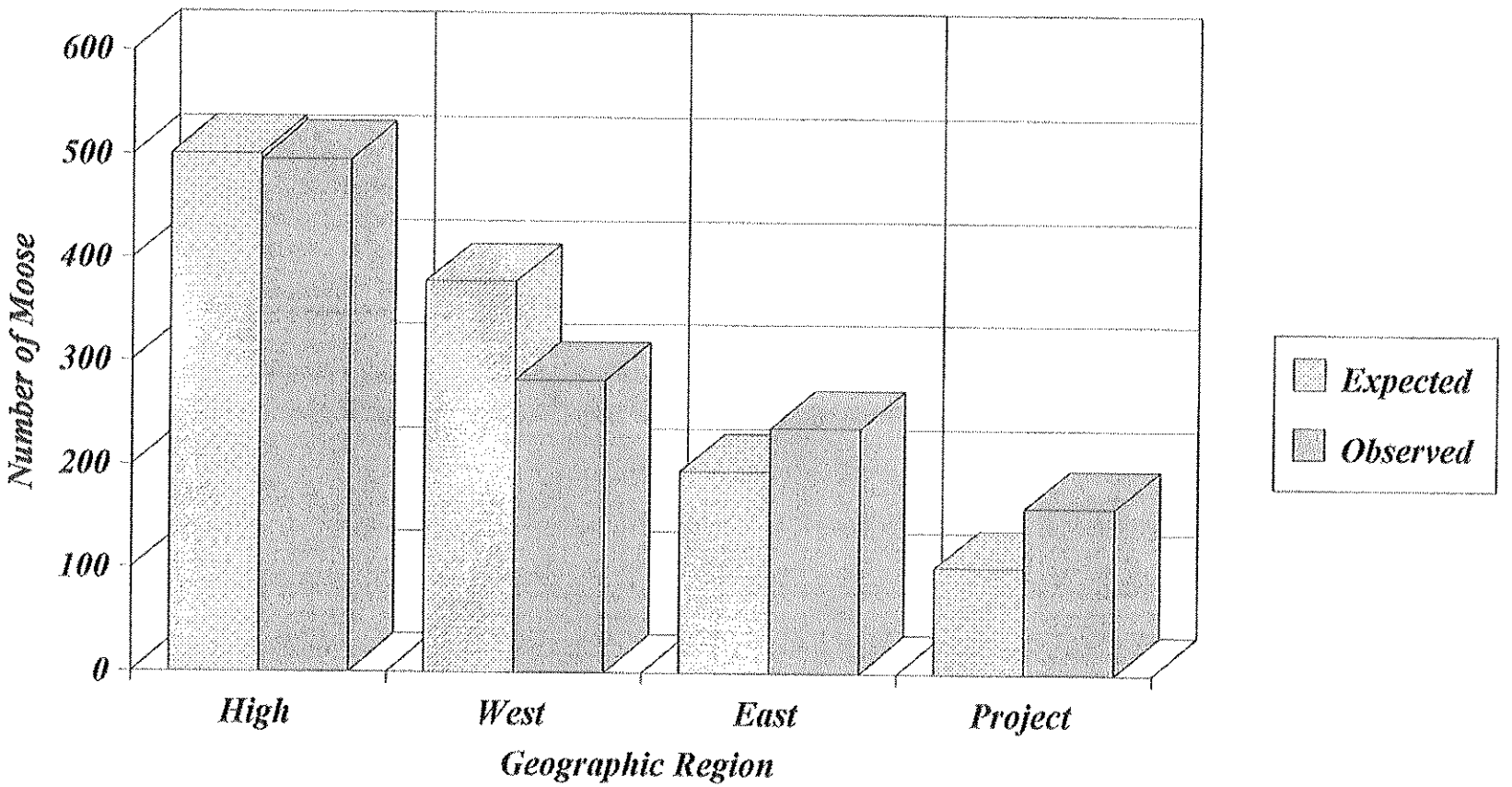


Figure 2-4. Number of Moose Expected and Observed in Each Geographic Region (1989 - 1990)

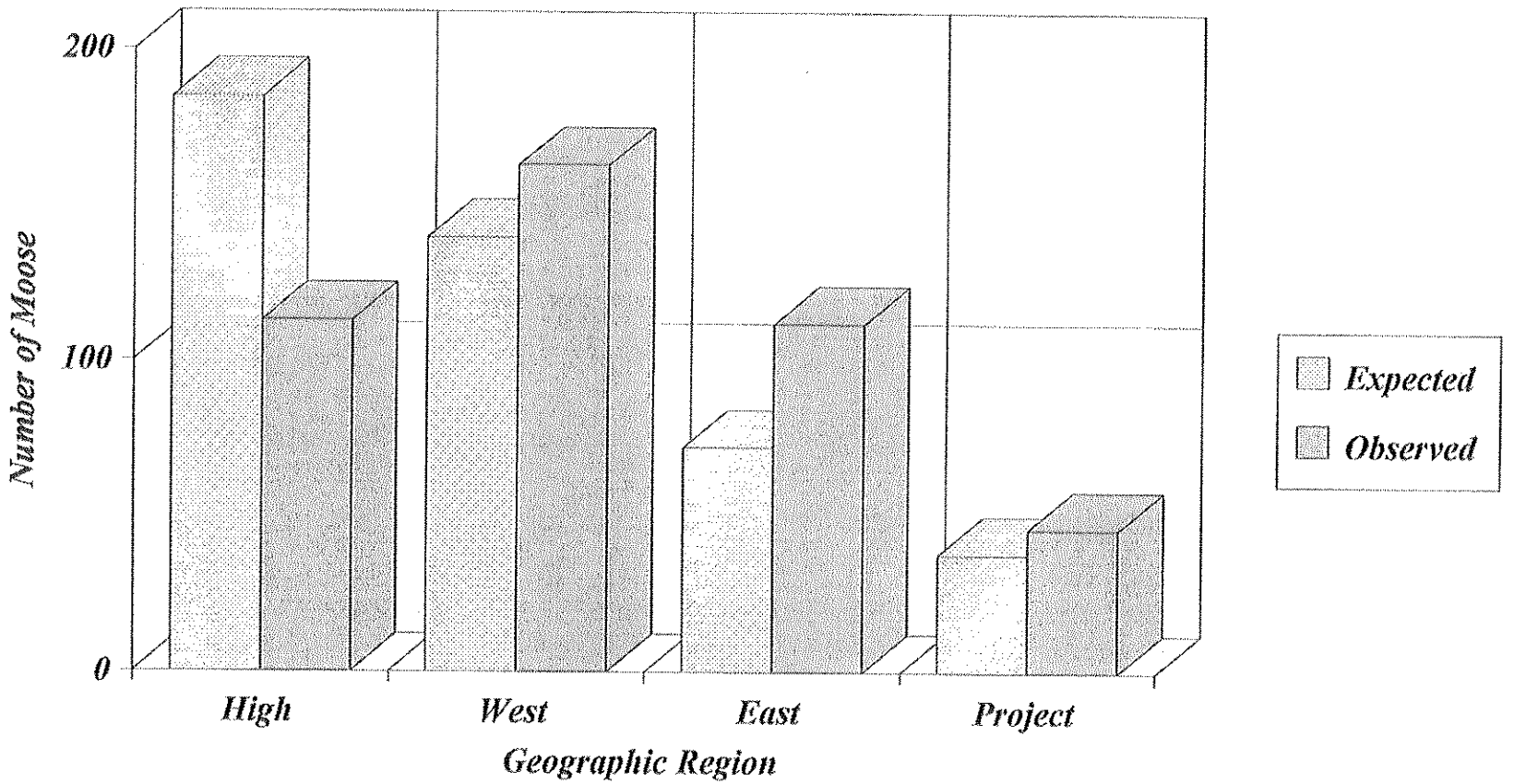
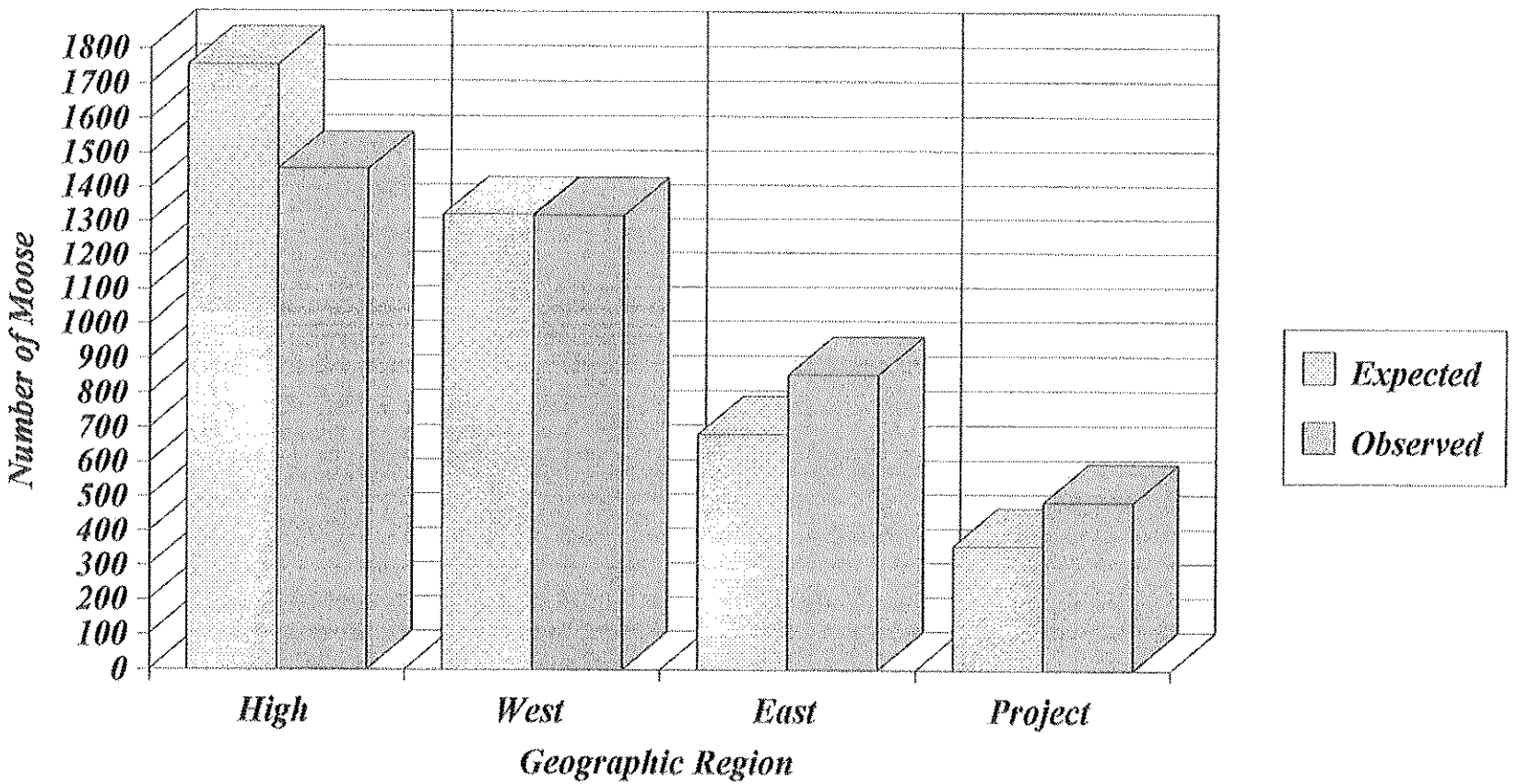
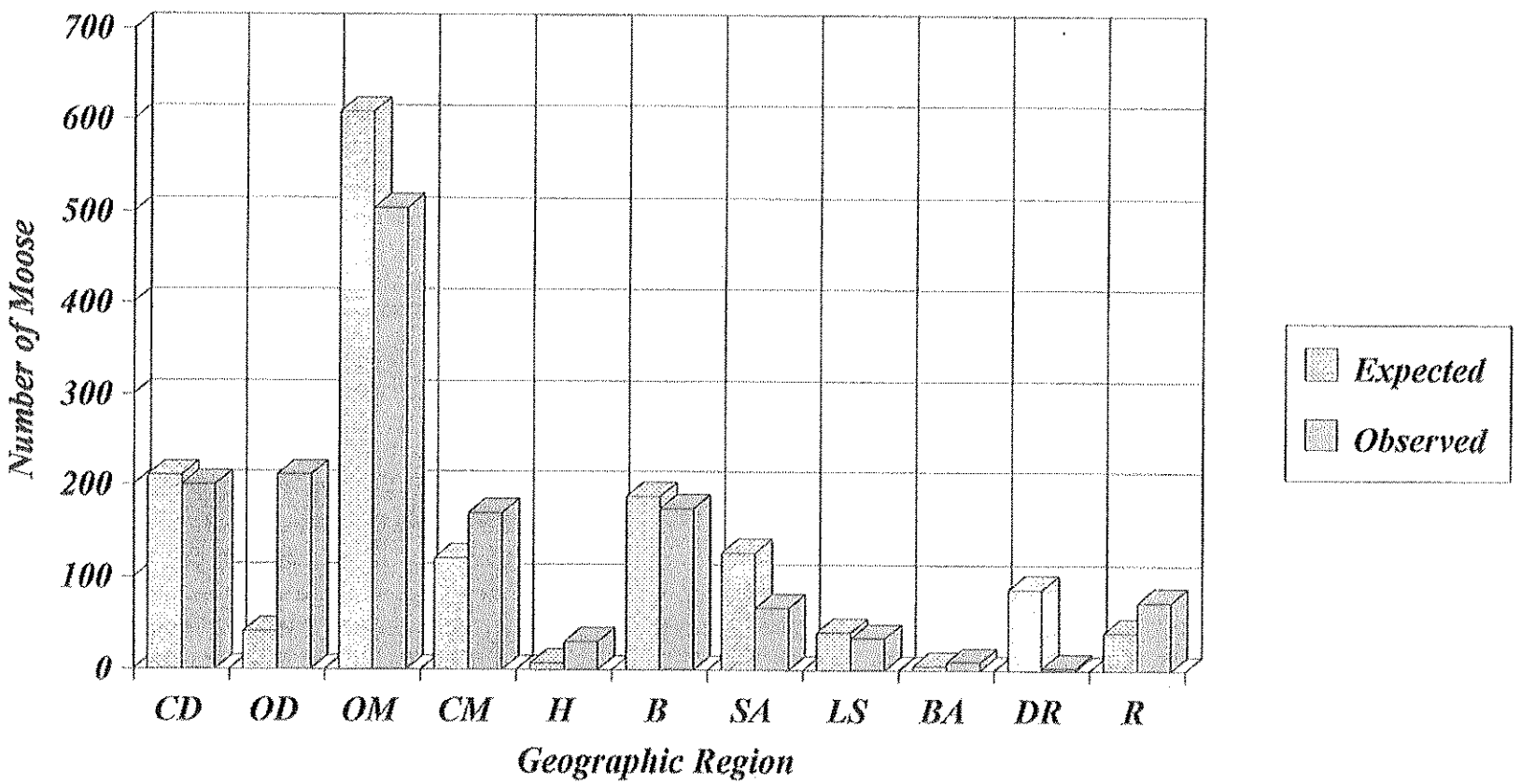


Figure 2-5. Number of Moose Expected and Observed in Each Geographic Region (1990 - 1993)



**1989-1990 data not summarized do to unrecorded unknown adults.*

Figure 3-1. Number of Moose Expected and Observed in Each Habitat Type (1992 - 1993)



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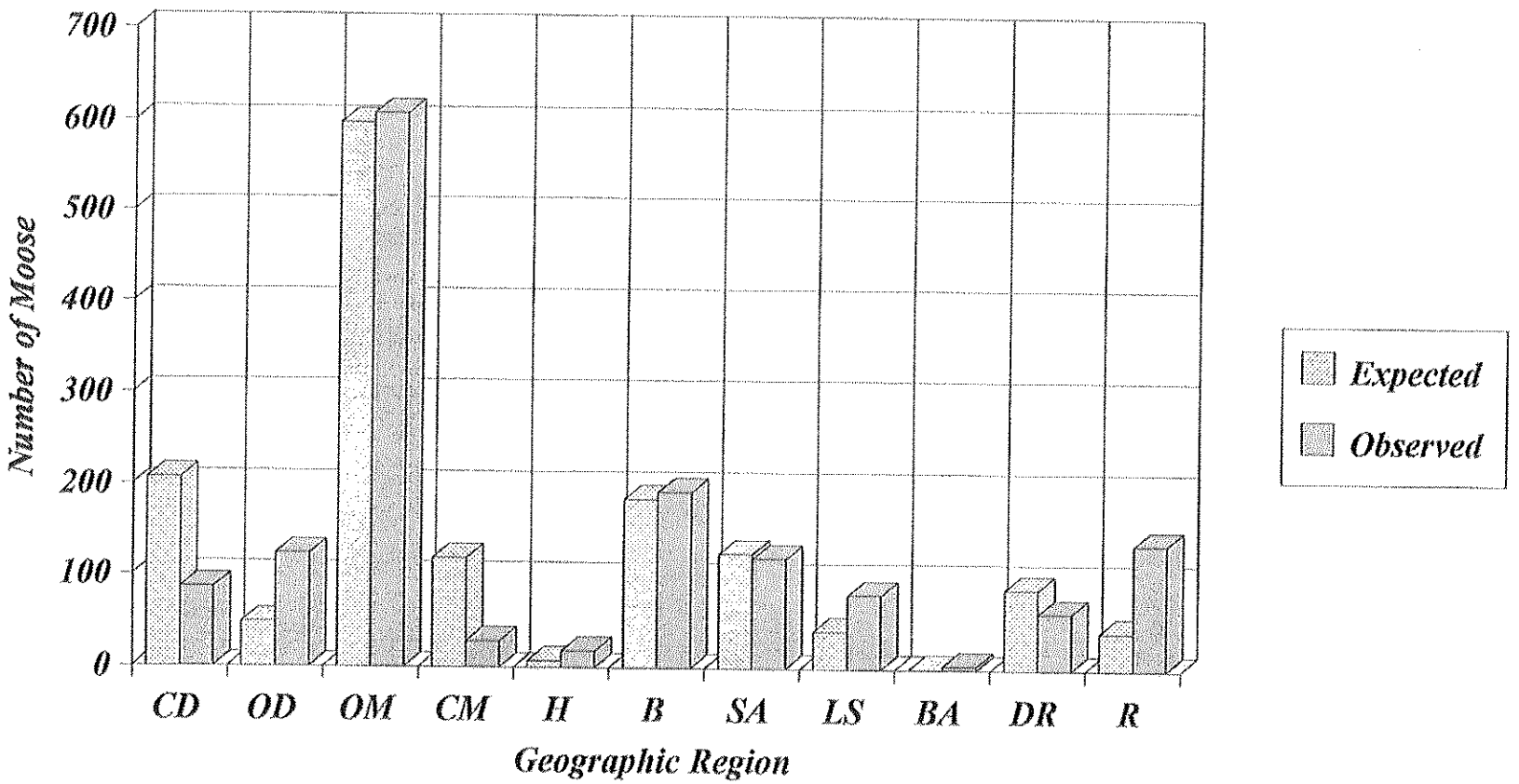


Figure 3-3. Number of Moose Expected and Observed in Each Habitat Type (1990 - 1991)

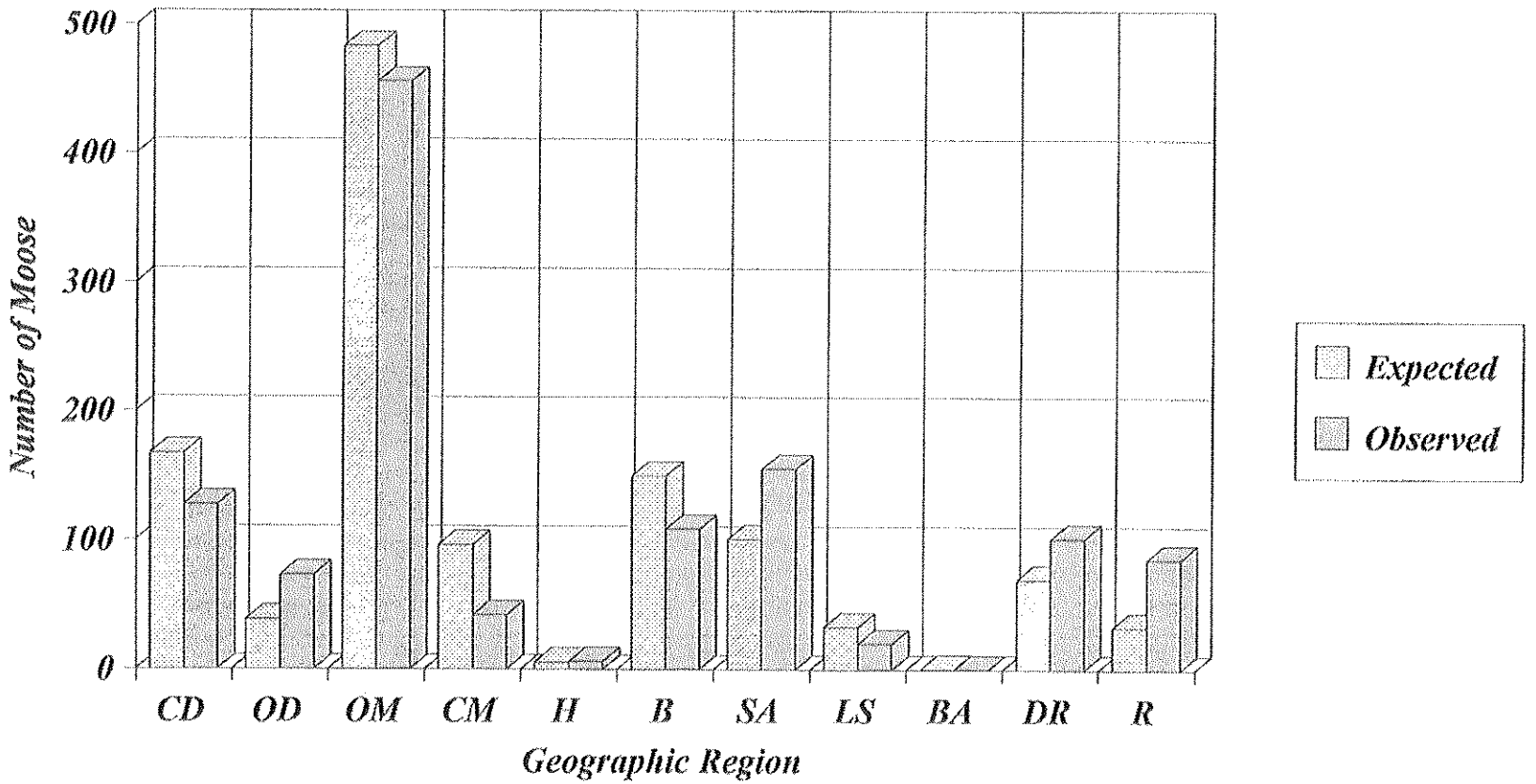


Figure 3-4. Number of Moose Expected and Observed in Each Habitat Type (1989 - 1990)

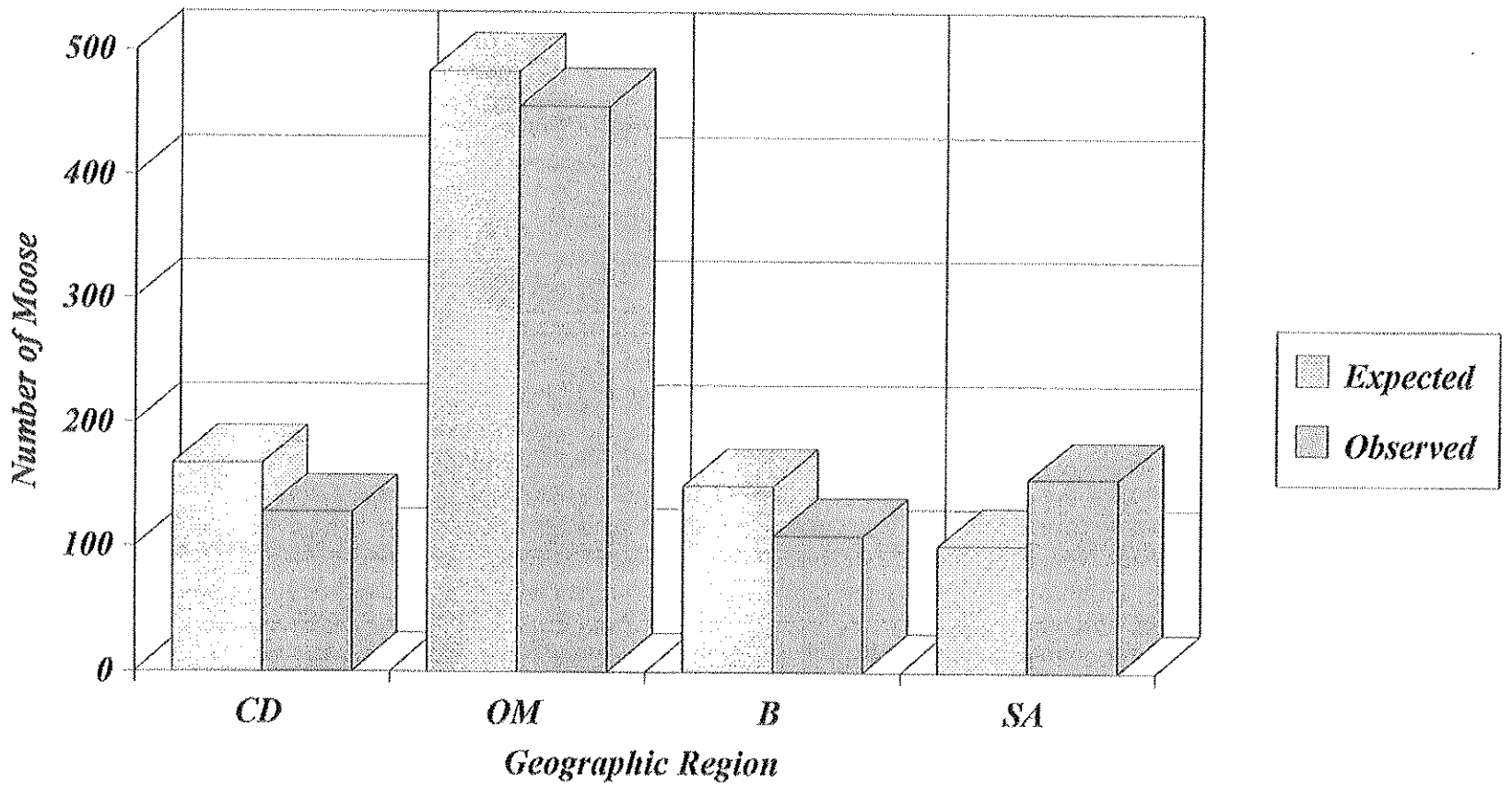
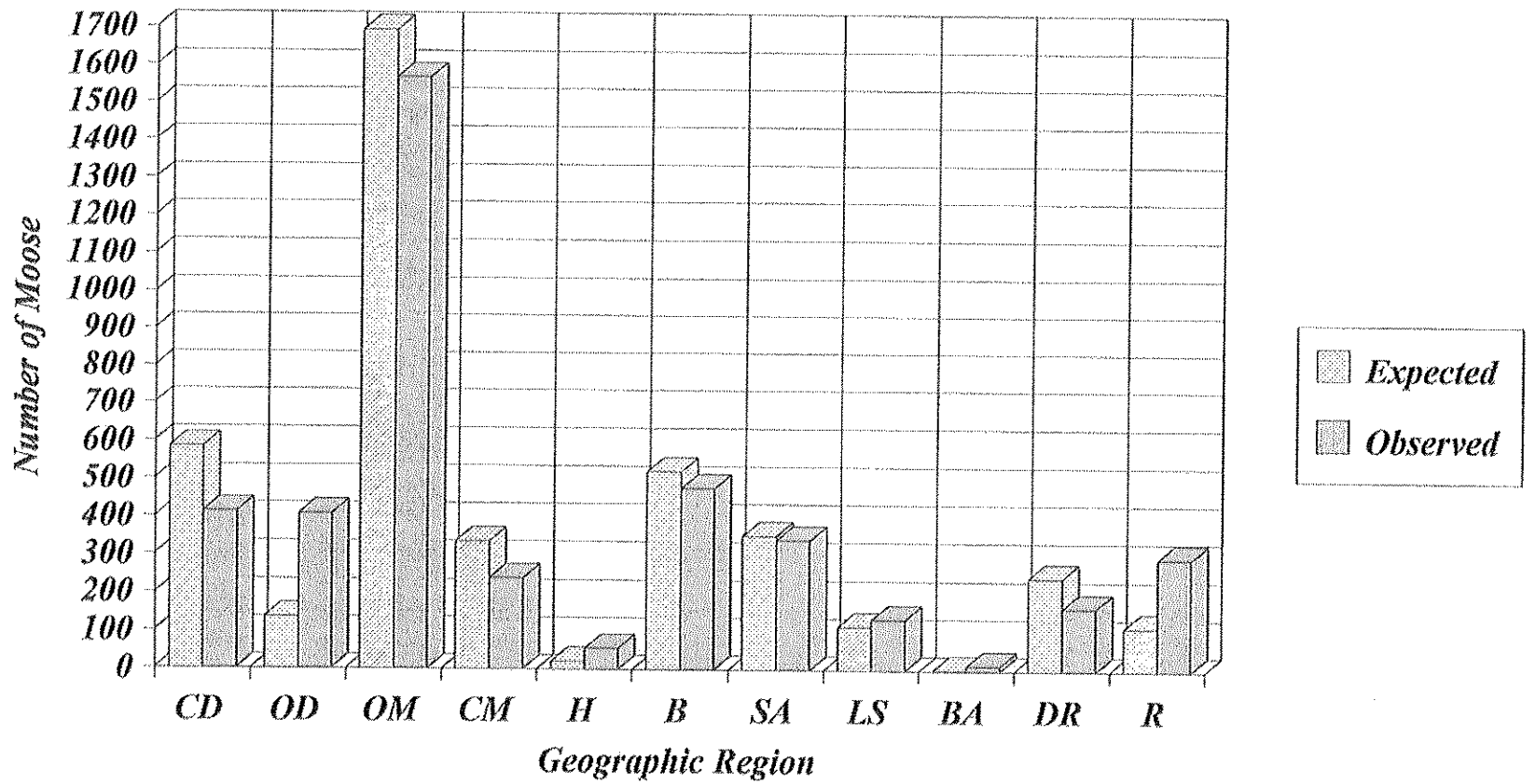


Figure 3-5. Number of Moose Expected and Observed in Each Habitat Type (1990 - 1993)



*1989 - 1990 data not summarized do to changes in habitat type surveyed.

Figure 4. Density of Moose by Age and Sex: Comparison with Historical Data

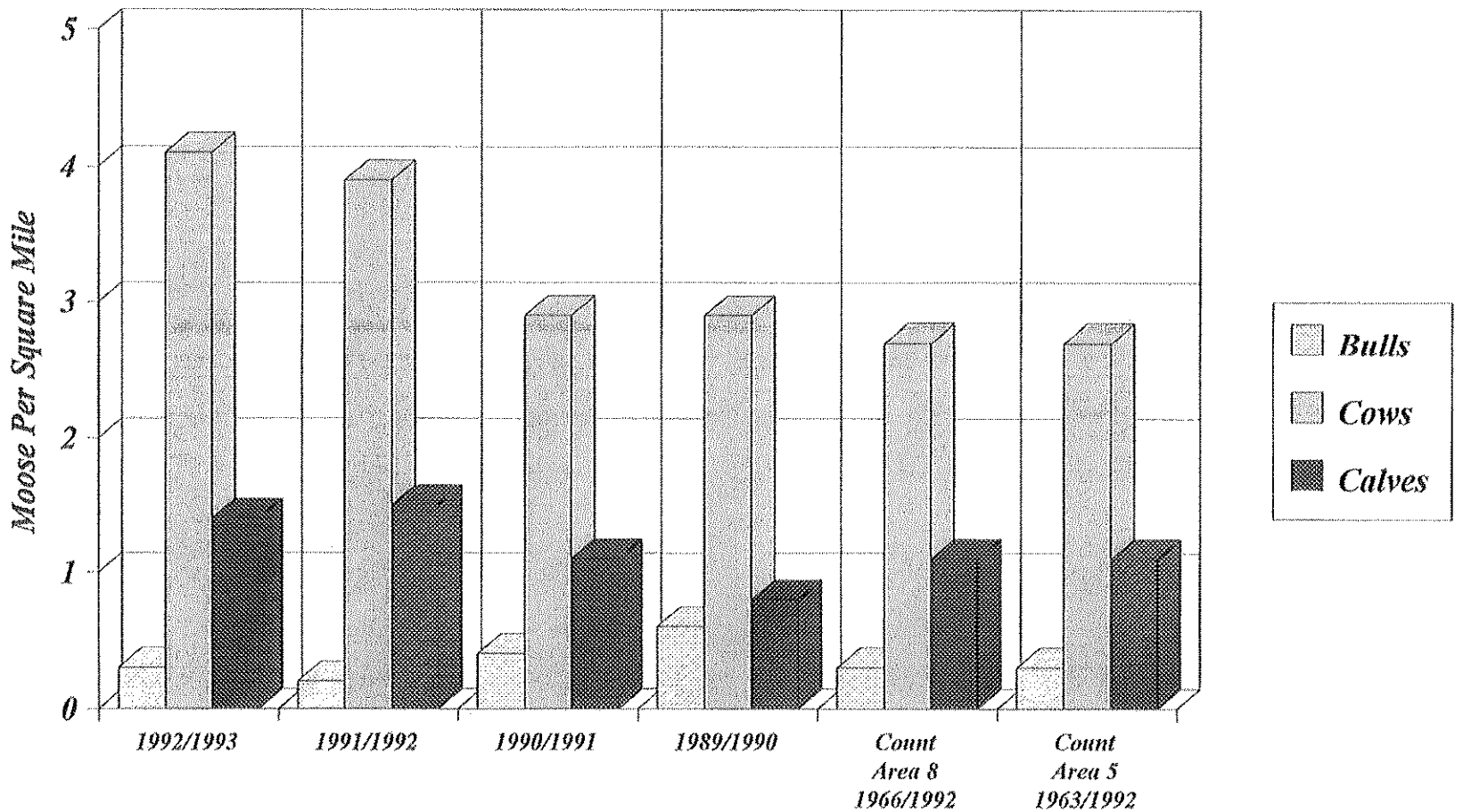


Figure 5-1. Change in Geographic Distribution of Moose by Survey (1992-1993)

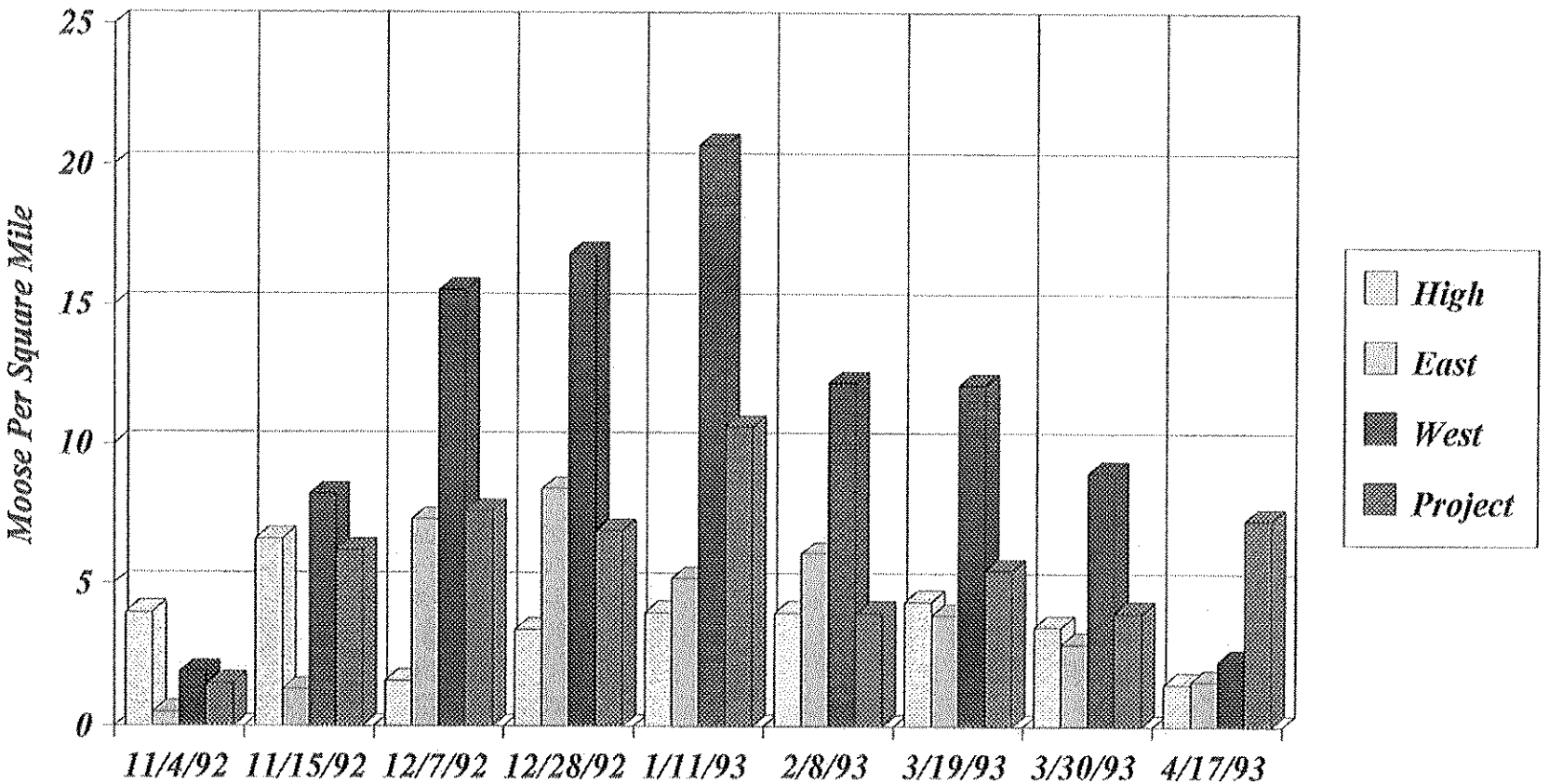


Figure 5-2. Change in Geographic Distribution of Moose by Survey

(1991-1992)

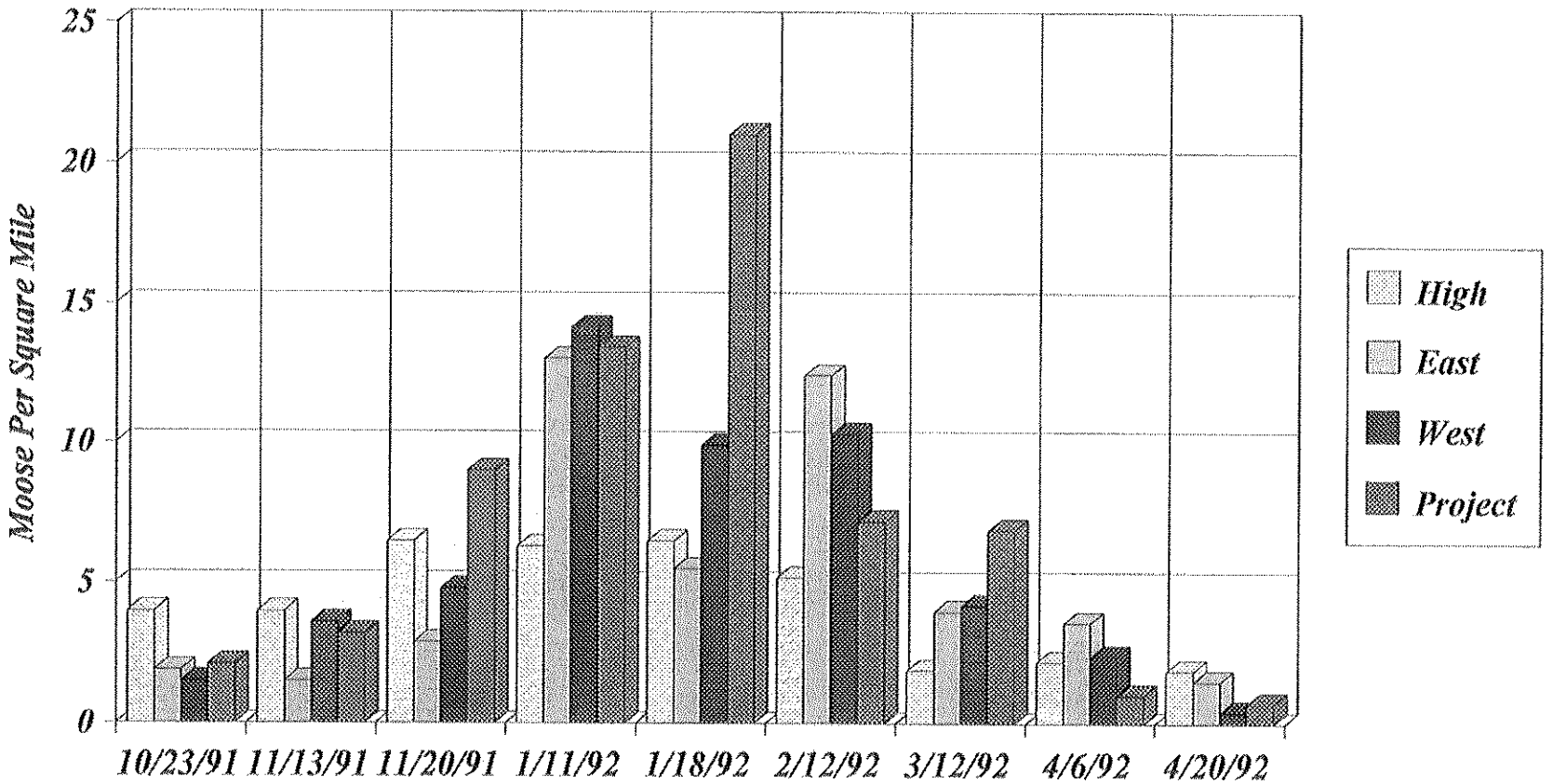


Figure 5-3. Change in Geographic Distribution of Moose by Survey (1990-1991)

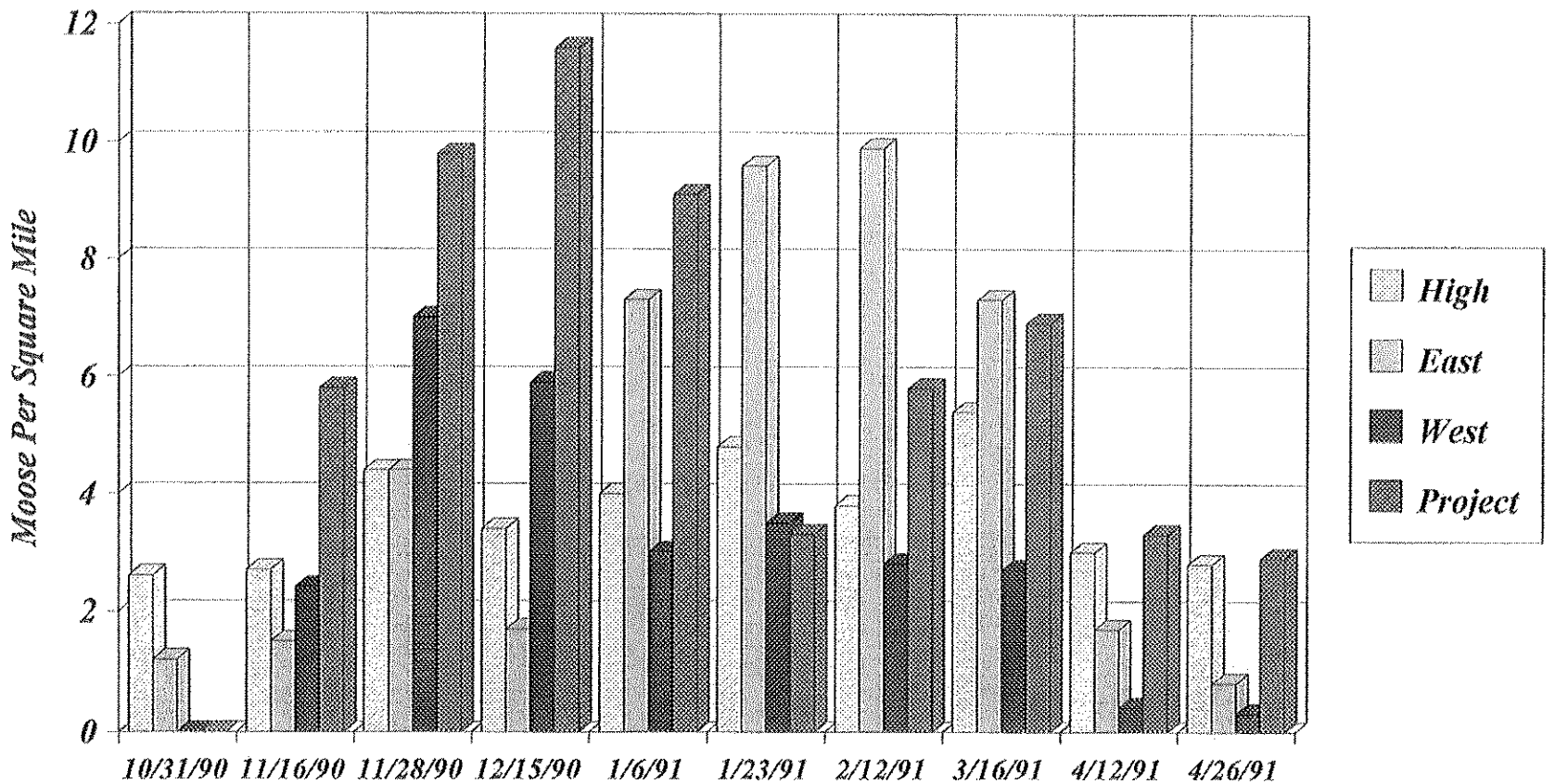
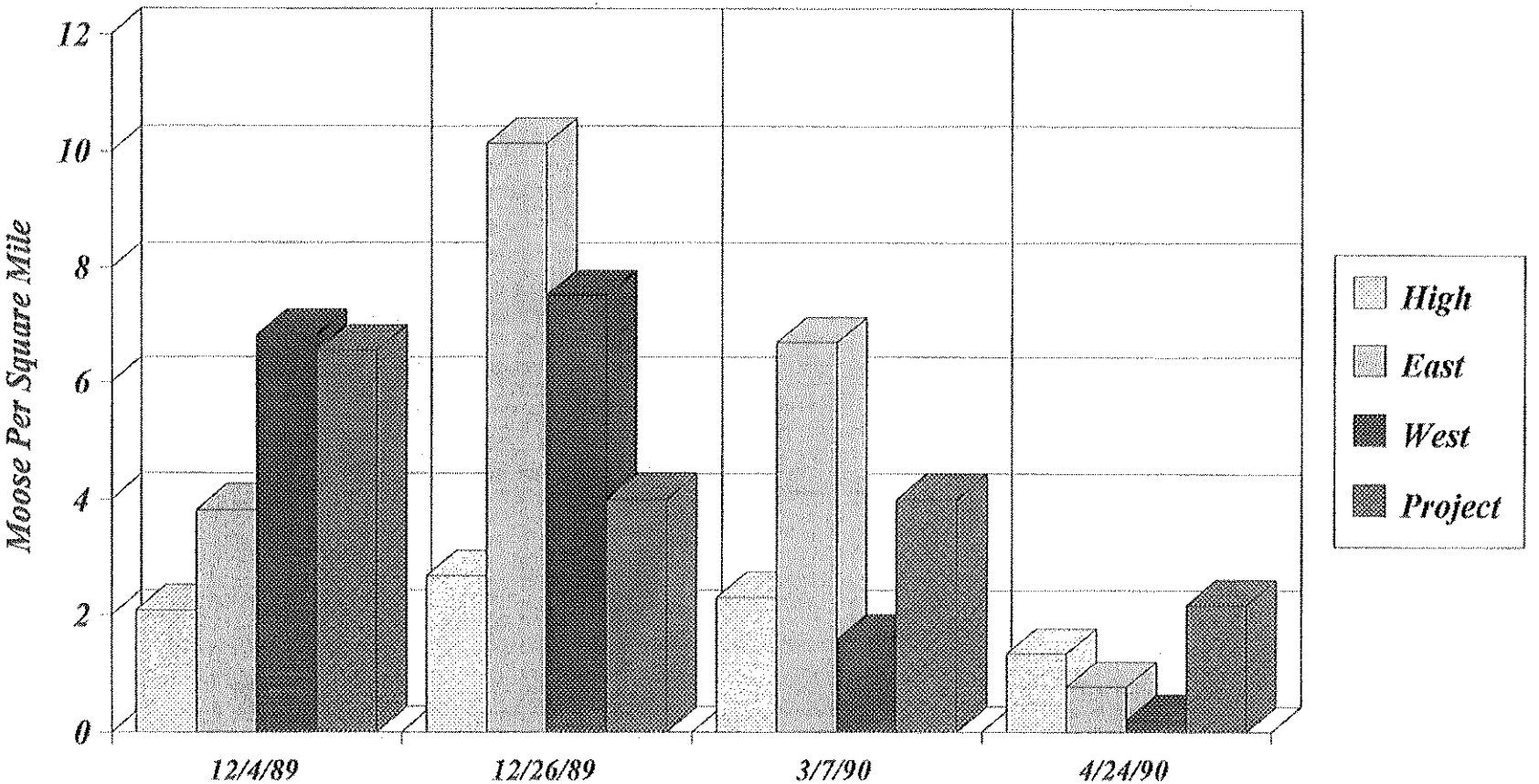


Figure 5-4. Change in Geographic Distribution of Moose by Survey (1989-1990)



ADDENDUM 2

MAY 5, 2009 BALD EAGLE NEST SURVEY

HDR | ONE COMPANY *Many Solutions*℠

Memorandum

To:	Usibelli Coal Mine, Inc.
From:	Jeff Schively, HDR Alaska, Inc.
Date:	May 14, 2009
Subject:	**Bald Eagle Nest Survey for the Wishbone Hill Project Area**

Introduction

Usibelli Coal Mine, Inc. is evaluating alternatives to begin mining coal at the Wishbone Hill Project, a historic coal mining area located north of the Glenn Highway approximately 12 miles northeast of Palmer, Alaska within the Matanuska Valley (Figure 1). The Wishbone Hill Project Area encompasses approximately 1,356 acres. North of the lease area are the Talkeetna Mountains; west is Moose Creek, and south is the Matanuska River. Most of the area is covered by undeveloped mixed birch/spruce/cottonwood forests and open graminoid/forb meadows. Disturbed areas, including stockpiles of mining spoils, cleared forest, and several unimproved gravel roads are intermixed across the central portion of the lease area.

A bald eagle nest survey was conducted on May 5, 2009 to search for possible nests within several proposed development areas of the project area. The survey also included searching for nests within a corridor outside of the project area along Moose Creek, an Alaska Department of Fish and Game listed anadromous fish stream, where the possibility for nests is greatest. Approximate surveyed areas are outlined on attached Figure 1.

Background

The bald eagle is protected under the Bald Eagle Protection Act of 1940 as amended (16 U.S.C. §§ 668-68d) and the Migratory Bird Treaty Act of 1918 (16 U.S.C. §§ 703-12). To avoid disturbing nesting bald eagles, the U.S. Fish and Wildlife Service (USFWS) recommends (1) keeping a distance between the activity and the nest (distance buffers), (2) maintaining forested (or natural) areas between the activity and around nest trees (landscape buffers), and (3) avoiding certain activities during the breeding season. The buffer areas serve to minimize visual and auditory impacts associated with human activities to nest sites. Ideally, buffers would be large enough to protect existing nest trees and provide for alternative or replacement nest trees. The USFWS recommends a primary 330-foot buffer zone around eagle nests to provide protection of the juvenile eagles in the nest tree and to buffer the tree from human activities during the nesting season (March through August). A 660-foot buffer is recommended to protect the nest from noise and disruptive activities and to protect nesting habitat. The secondary zone extends from the primary zone to a distance of 660 feet from the nesting tree. When topography or vegetation does not adequately protect the nest from human disturbance, the buffer zone may be increased by ¼ to ½ mile. However, the actual size of the buffer zone could vary depending on the eagle's tolerance for human disturbance[1].

Existing information regarding the location and status of bald eagle nests in southcentral Alaska is maintained by the USFWS, Anchorage Field Office. Before conducting the aerial survey, HDR Alaska, Inc. searched the USFWS Alaska Bald Eagle Nest Atlas database to determine if any recent surveys were conducted in the study area and if there were any known nests. The database documented two nests within

[1] U.S. Fish and Wildlife Service (USFWS). 2007. National Bald Eagle Management Guidelines.

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two miles of the study area (Map No. 8536, nests #9 and #11). These two nests were identified during surveys conducted on October 5, 1997, March 25, 2001, and March 22, 2003. Figure 1 shows the locations of the two nests as downloaded from the USFWS database.

Findings

On May 5, 2009, an aerial survey for bald eagle nests was conducted for Usibelli Coal Mine, Inc. The survey took approximately one hour, starting at approximately 11:00 AM and ending at approximately 12:00 PM. Weather conditions during the survey included sunny, clear skies with good visibility and temperatures in the upper 40s (Fahrenheit). Deciduous trees had not yet leafed out. The survey was flown using a Robinson R44 Raven I helicopter out of Merrill Field, Anchorage. Observers were Jeff Schively (HDR Alaska, Inc.) and Corri Feige (The Castle Mountain Group, Inc.).

No bald eagle nests were observed within the Wishbone Hill Project Area. Two nests were observed outside of the mine area and within the surveyed Moose Creek corridor to the west. For each identified nest, the observers recorded the coordinates of the nest, the tree species where the nest was found, the bird species if identified, the activity of the nest (active or inactive) and any general comments about the location of the nest. Nests coordinates were collected with a mapping-grade hand-held global positioning system (GPS) receiver. Coordinates and comments for each nest observed are shown on Figure 1. The two nests include:

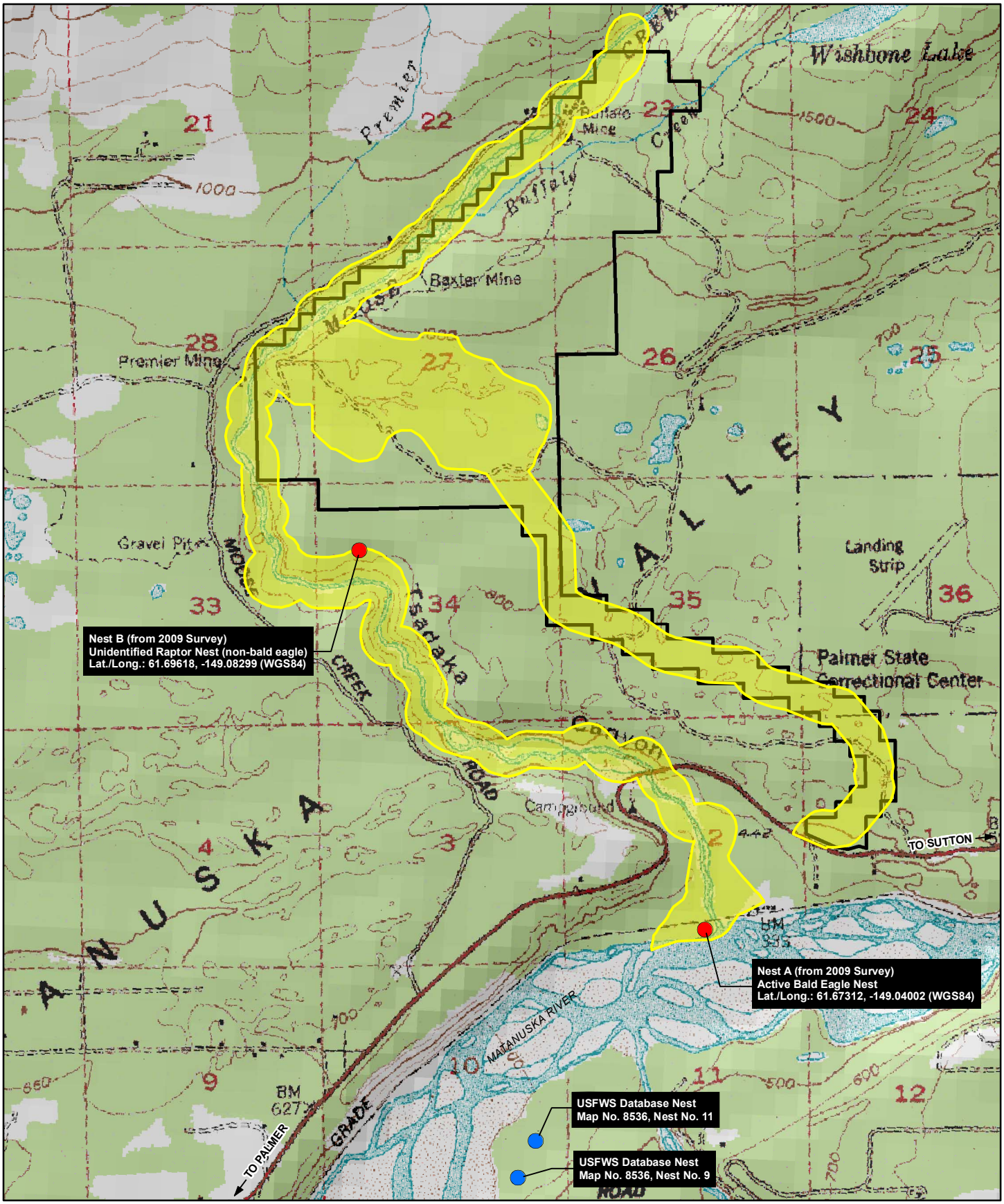
Nest A
Location: 61.67312, -149.04002 (WGS84)
Status: Active bald eagle nest
Description: The nest is located on a large black cottonwood tree near the confluence of the Matanuska River and Moose Creek. A female bald eagle was sitting on the nest at the time of the survey. The nest is situated approximately 0.7 miles southwest of the Wishbone Hill Project boundary.

Nest B
Location: 61.69618, -149.08299 (WGS84)
Status: Active unknown raptor nest (non-bald eagle)
Description: The nest is located on a large black cottonwood tree growing on a flat terrace high above Moose Creek. The nest is small, loosely constructed, and uncharacteristic of a bald eagle nest. An unidentified dark-colored raptor was observed in a nearby tree at the time of the survey indicating that the nest may be occupied by the raptor. The nest is situated approximately 0.2 miles west of the Wishbone Hill Project boundary.

GPS waypoints of the two bald eagle nests already documented in the USFWS database were uploaded to the observers handheld GPS and were easily found during the survey. USFWS mapped nest #9 appeared to be active with a bald eagle sitting on the nest and nest #11 is unoccupied for the 2009 nesting season.

No bald eagles or nests were observed within the Wishbone Hill Project Area. Nest A is the closest eagle nest to the project area; however, the nest is approximately 0.7 miles away on the opposite side of the Glenn Highway and Moose Creek.

Attachments
1. Figure 1 – 2009 Bald Eagle Nest Survey



N

MAP NOTES:
1. Nest locations shown in red were identified from an aerial survey conducted on May 5, 2009.
2. Nest locations shown in blue were taken from the U.S. Fish and Wildlife Service Bald Eagle Nest Database (accessed online September 2008); locations are from surveys conducted in 1997, 2001, and 2003.

Miles

0 0.25 0.5 1

LEGEND

- Wishbone Hill Project Area
- Approximate Survey Area
- May 2009 Surveyed Nests
- Bald Eagle Nests (from USFWS database)

2009 Bald Eagle Nest Survey

Wishbone Hill Project

Usibelli Coal Mine, Inc.

Figure 1