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ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

ENVIRONMENTAL STUDIES ANNUAL REPORT

Subtask 7.11 - Big Game

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by

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SUMMARY

This report embodies the initial findings with respect to the populations of big game -- bears, hoofed mammals, wolf and wolverine -- in the Susitna basin, and the potential impacts on these populations by the proposed Susitna Hydroelectric Project. It will be augmented by the work of another year before the final report of Phase I is prepared.

Biometrics and Data Processing

Field investigations of big game are being facilitated by the use of radio-collars. Relocations involve both repeated habitat descriptions and repeated physical locations, a body of data requiring initial standardization and periodic computer-aided analysis. Technical and conceptual problems associated with those requirements are outlined and proposed solutions presented. Computer resource requirements are identified and the progress to date in acquiring those resources and developing a production system is reported.

Brown and Black Bear

Both black bear (*Ursus americanus*) and brown bear (*U. arctos*) populations in the vicinity of the proposed Susitna hydroelectric dams appear to be healthy and productive. Brown bears occur throughout the study area while black bears appear largely confined to the finger of forested habitat along the Susitna River. This finger becomes progressively narrower proceeding upstream. In 1980, 27 brown bears and 27 black bears were captured, utilizing helicopter darting techniques. Adults were marked and radio-collared and periodically relocated. A total of 143 point locations were obtained for brown bears in 1980, 120 of these from 15 radio-collared individuals. A total of 229 point locations were obtained for black bears in 1980, 181 of these from 23 radio-collared individuals.

Winter denning sites (1980-81) of nine radio-collared brown bears are well above the proposed impoundment level. Brown bear uses of areas directly impacted by proposed impoundments appeared greatest in the early spring following emergence from dens. We speculate that brown bears may have been attracted to these areas in the spring by the early availability of both vegetable and animal foods. Important vegetable foods may include berries from the previous year, tubers, fresh grasses, and sedges which may be available earlier in these areas because of earlier snow melt. Animal foods utilized in these areas may be winter-killed or weakened moose and, somewhat later, moose calves. The proposed impoundments will presumably reduce this spring habitat.

The most interior run of salmon known in the study area occurs at Prairie Creek, a feeder stream running from Stephan Lake to the Talkeetna River. Four of 11 radio-collared brown bears moved to Prairie Creek during the summer salmon run. No fewer than 30 brown bears fished here in 1980. Brown bear movements to or from Prairie Creek may be inhibited by impoundments or access routes, thereby reducing the availability of this salmon resource to an appreciable proportion of the bears in the study area.

Studies in the headwaters of the Susitna River conducted in 1979 estimated a brown bear density of 1 bear/41-62 km^2. We conjecture that brown bear density in the impoundment area is roughly comparable to that in the area of the 1979 study. If so, the impoundment study area of 3,500 km^2 contains approximately 70 brown bears.

Capture and relocation records for black bears suggested that black bear distribution in 1980 was largely confined to or near the spruce forests found in the vicinity of the Susitna River and its major tributaries. These are the habitats which will be maximally impacted by the proposed impoundments; the restricted nature of black bear distribution in the study area suggests that these populations may be highly vulnerable to habitat losses by inundation as well as by disturbances associated with construction and improved access.

Black bear use within the spruce habitats was most prevalent in the early spring. In late summer 1980 many black bears moved to the more open shrublands adjacent to the spruce forests. This movement appeared motivated by the prevalence of berries (Vaccinium) in these open areas.

Black bears crossed the Susitna River more frequently than brown bears. This result probably reflects the relative proximity of black bear home ranges to the river. The motivation or importance of these river crossings for black bears is not known, nor is it yet known whether the proposed impoundments would represent a significant barrier to such crossings.

All five of the radio-collared black bears with 1980 dens in the vicinity of the Watana impoundment denned below 2,200 feet elevation, the approximate proposed high water mark of the Watana impoundment. Two of nine black bears denning in the vicinity of the Devil Canyon impoundment denned below the approximate proposed high water mark (1,450 feet); the average elevation of nine of these dens was 1,935 feet (1,300-2,750 feet). Nine of 14 black bear den sites were in spruce habitats and five were in shrubland habitats adjacent to spruce habitats. Thus it seems clear that many den sites utilized by black bear in 1980 would be inundated by the proposed impoundments. The impact of this den inundation on black bear populations is as yet unknown. In 1981 these den sites will be visited and their characteristics described.

Black bear density appeared variable throughout the study area. A very rough estimate of 1 bear/4.1 km^2 was offered for one area of relatively high density.

Bear studies in the remainder of Phase I will concentrate on collection of additional evidence on bear distribution and movements in the study area. Efforts will be made to increase the proportion of marked animals in the population throughout Phase I and Phase II. Among other things this will ultimately permit a more accurate estimate of bear populations in the impact area.

Caribou

The Nelchina caribou herd which occupies a range of about 20,000 mi^2 in southcentral Alaska has been important to hunters because of its size and proximity to population centers. The proposed Susitna impoundments would inundate a very small portion of apparently low quality caribou habitat. However, concern has been expressed that the impoundments and associated development might serve as barriers to caribou movement, increase mortality, decrease use of nearby areas and tend to isolate "subherds". Overall objectives of the current study are to evaluate potential impacts of the proposed hydroelectric project on Nelchina caribou and to suggest possible mitigating measures. Because of the changeable nature of caribou movement patterns, short-term studies of distribution and movements must be tempered with historical perspective. Fortunately the Nelchina herd has been studied continuously since about 1948 and records previous to that time have been reviewed. The primary methodology for this study is the repetitive relocation of radio-collared caribou. Population estimates are made with a modified version of the aerial photo-direct count-extrapolation census procedure.

Late winter distribution of caribou in 1980 was in the Chistochina-Gakona River drainages, the western foothills of the Alphabet Hills and the Lake Louise Flat. The two main routes to the traditional calving grounds in the northern foothills of the Talkeetna Mountains were across the Lake Louise Flat into the calving area via the lower Oshetna River and across the Susitna River in the area from Deadman Creek to the big bend of the Susitna. Calving occurred between the Oshetna River and Kosina Creek from 3,000 to 4,500 feet elevation. The main summering concentration of Nelchina caribou occurred in the northern and eastern slopes of the Talkeetna Mountains between Tsisi Creek and Crooked Creek, primarily between 4,000 and 6,000 feet. Most caribou were located on the Lake Louise Flat during the rut. During early winter the herd was split in two groups; one in the Slide Mountain-Little Nelchina River area and the other was spread from the Chistochina River west to the Gakona River through the Alphabet Hills to the Maclaren River.

It appeared (based on only 8 months data) that at least two small subherds with separate calving areas existed, one in the upper Talkeetna River and one in the upper Nenana-Susitna drainages. Insufficient data were available to evaluate the status of the Chunilna Hills group.

The Nelchina caribou herd was estimated to contain 18,558 animals in October 1980. Herd composition was estimated at 49.0 percent cows, 30.3 percent bulls and 20.7 percent calves.

It was apparent from historical records (and to a lesser degree from movements of radio-collared animals) that the proposed Watana impoundment would intersect a major migratory route. It seems possible that the impoundment could be a barrier to movement and a potential source of mortality, particularly during spring migration when females are in relatively poor condition and various combinations of ice shelving, ice sheets, overflow, ice floes and wind-blown glare ice could occur. The impoundment could tend to isolate the northwestern corner of the Nelchina range, an area which has been heavily used by caribou in the past. Access routes, roads, railroads, and air fields, could affect caribou movements depending on locations and amount of use. The proximity of the calving grounds to the Watana impoundment is of concern because of the traditional fidelity to this calving ground and the possibility that increased human access and activity could result in reduced use.

The Devil Canyon dam site and impoundment appears to have virtually no potential to impact Nelchina caribou. Conversely the Watana site would almost certainly have negative impacts although the extent cannot yet be predicted.

Dall Sheep

No sheep were radio-collared, but an aerial survey of known or suspected Dall sheep habitat in the vicinity of the proposed Susitna Hydroelectric Project was conducted in July 1980 to delineate sheep distribution. Three discrete areas of habitat were identified. Sheep in all three areas may be subject to disturbance from construction activities, helicopter traffic or access routes, although disturbance may be reduced or eliminated through routing or scheduling of human activities.

Sheep occupying the Watana Creek Hills were observed in lowland habitats that might be inundated by the proposed Watana impoundment. Little is known about the importance of this habitat to the population but it is possible that some attractant such as a mineral lick occurs there. If so, assessment of the impact of the Susitna Project on this sheep population will be more complex than anticipated and an expansion of the scope of the study will be necessary.

Wolverine

During April and May 1980, five adult wolverine were captured and four (3 males, 1 female) were radio-collared. Eighty-six radio locations were obtained during 1980.

Yearly home range sizes for two males were 399 km^2 and 272 km^2. The summer home range for a lactating female was 86 km^2. Summer movement patterns of the three male wolverine seemed to be influenced by the Susitna River. Only three occurrences of river crossings were documented during the study period. Within their home ranges, all radio-collared wolverine showed a fidelity toward upland shrub (willow-birch) habitats and toward southerly and westerly slopes.

All three male wolverine displayed a seasonal change in their home range usage. Preferences are presumably related to the wolverine breeding season and timing of ground squirrel emergence and caribou calving. Ground tracking during May and December, 1980 indicated wolverine dependence on small mammals for food.

Potential impacts on wolverine by the Susitna Hydroelectric Project include the following: loss of habitat due to inundation and construction (including roads and transmission lines), a probable reduction in prey densities, increased competition with other scavengers and predators, and a readjustment of home range size and seasonal movements.

There is evidence that wolverine are intolerant of human disturbance. Impacts from disturbance might be influenced by timing and placement of construction activities. For example, activities on southerly and westerly slopes are more likely to affect wolverines than are those on northerly or easterly slopes.

Downstream Moose

Moose populations in the Susitna Valley were relatively small in the early 1900's. Since then, man has altered the habitat through fires, logging, and farming, and the moose have increased. The lower Susitna River moose population does not appear to mix with the Matanuska Valley or Peters-Dutch Hills populations, but more study of movements is necessary.

Deep snow in winter has been documented as a cause of migration from rut and post rut areas in the Talkeetna Mountain foothills to the Susitna River and vicinity, but no studies have determined the relative use by moose of the Susitna River floodplain versus upland habitats near the river. The present study focusses on the seasonal distribution of moose populations using the lower Susitna, the relative magnitude of seasonal moose use of the Susitna floodplain and the relative use of associated habitats.

In April 1980, 10 moose were immobilized and equipped with radio collars. Various biological specimens were taken from the moose at the capture site. Periodic relocation flights were conducted to determine each moose's location and activity, and association with other moose and with habitat type.

The small sample of marked moose, and the difficulty of spotting unmarked moose in the timber, made determination of major seasonal patterns of population distribution impracticable, although a variety of individual patterns was noted. More work on seasonal movement and distribution is needed.

A preliminary survey of browse distribution and use along the river showed a mean of 1.4 browse plants per square meter. Willow, most prevalent in early successional stages, was consistently well browsed. Birch, near the river, was also a preferred forage. Cottonwood, rose, and highbush cranberry were less used, and alder was largely unused.

Potential for managing downstram plant communities for increased production of moose forage, if this proves a desirable avenue of mitigation, appears excellent.

Upstream Moose

Compared to caribou, most moose make relatively short seasonal movements. Thus far, both resident and migratory sub-populations have been identified. Presumably these both require the same general sort of winter range. Since the Watana and Devil Canyon impoundments will cover the lowest portion of the landscape, some present moose winter range will be inundated.

The size of spring-fall home ranges of cows with calves was found to be relatively large (16.8 km^2) compared to findings elsewhere (2.2 - 16.9 km^2, 7 studies). Although fidelity to seasonal ranges by marked individuals was high, some changed seasonal ranges, especially in winter. Seasonal use of plant communities corresponded to elevational distribution of plant communities and indicate seasonal elevational preferences of migratory moose.

Wolves

Intensive wolf studies have provided a good understanding of population densities, and use of prey. Population densities in Game Management Unit 13 have varied over recent years from 97 to 315 km^2/wolf. There has been some decline in wolf populations lately, presumably due to a heavy take by humans, but a strong tendency toward high reproductive gain following a spring of low wolf population indicates that the wolf population has marked recuperative powers.

Foods taken by wolves include moose (the major prey), caribou, beaver, snowshoe hare, and smaller mammals. Moose and caribou winter vulnerability to wolf predation is greater when snow is deeper. On the average, a wolf pack takes prey in winter at the rate of about 5-7 kg/day/wolf.

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1 - INTRODUCTION

Moose, caribou, brown and black bears, Dall sheep, wolves and wolverine constitute the big game animals of the Susitna basin and the subject of this report. These species have long been of concern to the Alaska Department of Fish and Game, whose biologists have pursued their study within, among other places, the Susitna basin, which constitutes part of Game Management Unit 13. Because of this experience, and the expertise that it has engendered, the AFD&G biologists were the logical choice to carry out the more intensive field investigations necessitated by the proposal to establish a hydropower complex on the Susitna River. Their program of investigation, carried out under the supervision of Karl Schneider, is impressive in concept and execution. This document is largely a compilation by Dr. Richard Taber of the 1980 reports produced by ADF&G.

1.1 - Big Game Biometrics and Data Processing: SuzAnne Miller and Danny Anctil

The objective of the biometrics and data processing project is to provide technical assistance in the quantitative and information-management aspects of the big game studies. The time constraints, volumes of data, and reporting requirements associated with the Susitna Hydroelectric Project Impact Assessment Studies mandate the development of efficient and accurate means of recording, analyzing, displaying and reporting the data collected. This can only be done by means of electronic data management systems.

Four major aspects of the big game studies have been identified as requiring support from the biometrics and data processing project:

(a) Animal distribution analysis.

(b) Habitat selectivity analysis.

(c) Species interaction analysis.

(d) Basic data processing and analysis.

1.2 - Brown and Black Bear Studies: Sterling Miller and Dennis McAllister.

Black bear (*Ursus americanus*) and brown bear (*U. arctos*) are widely distributed and abundant in Alaska. Black bear distribution in Alaska coincides closely with the distribution of forests, with the most abundant populations occurring in "open" forests rather than heavy timber; extensive open areas are usually avoided. Brown bears seem best adapted to open areas of tundra or grasslands although, like black bears, they inhabit a variety of different habitats in Alaska.

Taxonomically there is only one species of brown-grizzly bear. In common usage the term brown bear is utilized to refer to southern and coastal populations of this species and grizzly bear refers to northern and interior populations. Typically "brown" bears are larger and darker than "grizzly" bears. The brown-grizzly bears along the Susitna River described in this report are, most appropriately, referred to as brown bears.

Black bears in Alaska tend to be smaller than in many areas of the contiguous United States, most commonly they weigh 100-200 lbs. Several color phases of black bears are known, the Susitna population includes individuals that are black, cinnamon, and dark brown.

In Alaska, both species of bears spend the winter in dens. Black bears use a variety of den sites and structures ranging from substantial excavations on hillsides or under logs and trees to, less commonly, simple and relatively shelterless sites. Brown bears most commonly den in well excavated holes on high mountain slopes. The denning period for both species typically runs from October through April or May but annual, geographic, and individual variations are common. In the Susitna area a limited number of observations suggest that black bears enter dens earlier and emerge later than brown bears (Miller unpublished data).

Brown bears are more aggressive and dangerous to man than black bears. This may be the result of evolution in a more open environment without trees to serve as escape habitat and the corresponding need for more aggressive behavior to protect themselves and their offspring (Herrero 1972). The corresponding danger to man combined with the increased vulnerability to hunting associated with more open habitats, has led to great reductions in brown bear distribution and abundance in the contiguous United States. Except in Alaska and parts of Canada, the species is currently classified as endangered. Black bears, on the other hand, are still abundant throughout most of their original range.

Both species have evolved generalist and opportunist strategies and are, correspondingly, biologically compatible with many kinds of man-caused disturbances of their habitat. However, experience has amply demonstrated that brown bear abundance is usually incompatible with increasing human presence except in a few parks where bears are given a legal priority over human development activities.

Both species of bears are omnivorous, eating a wide variety of grasses, sedges, other herbaceous plants, roots and berries as well as animal protein when available. Populations with access to salmon may heavily utilize this resource during portions of the year. Brown bears have recently been shown to be significant predators on moose calves in the upper Susitna-Nelchina basin area (Ballard et al. 1980).

Brown bear research has been undertaken since 1978 in the Nelchina and Susitna River basins. This research has concentrated on the magnitude and effects of brown bear predation on moose but considerable life history data were also collected (Ballard et al. 1980, Spraker et al. 1981). In this region federal predator control programs conducted from 1948 to 1953 are suspected to have reduced bear populations to low levels.

In the last 20 years brown bear populations have increased and the current population appears to be abundant, young and productive. Fall harvests in the period 1970-1979 averaged 61 bears/year (30-84 bears/year) in Alaska's Game Management Unit (GMU) 13. This level of harvest is suspected to be less than the maximum sustainable yield of this population. In 1980 a May 10th thru 25th bear season was held; the same season will be held in 1981.

Until the present study, black bear research has not been conducted in the Susitna or Nelchina River basins. The abundance of black bears and relatively light hunting pressure in these areas permits a year-long open hunting season and an annual bag limit of three bears. An annual average of 63 black bears have been taken in GMU 13 from 1973-1979 (58-70 bears/ year). Relative to brown bears, black bears are highly productive and numerous and this population could sustain higher levels of harvest.

The overall objectives of black bear and brown bear studies mandated by proposed hydroelectric development on the Susitna River are:

> "To determine the distribution and abundance of black and brown bears in the vicinity of proposed impoundment areas; seasonal ranges, including denning areas, and movement patterns of bears; and seasonal habitat use of black and brown bears."

In Phase I of these studies, emphasis has been placed on determination of relative abundance and seasonal distribution of the two species in the vicinity of proposed impoundments, and on collection of baseline information on basic biology of impact-area bears in order to compare

Susitna-area populations with populations elsewhere. With these kinds of data available by completion of Phase I, Phase II efforts can concentrate on quantification of the levels of potential impacts and on the reasons for them.

The objectives of the first year of effort were primarily procedural rather than analytical: to radio collar a sample of both black and brown bears, to periodically locate these bears and pinpoint their locations, to locate den sites of radio-collared bears, to begin development of techniques which would permit an analysis of habitat selectivity by bears, and to begin the collection of baseline biological data by which to characterize impact-area bear populations.

1.3 - Caribou Herd Identity, Migration Patterns and Habitat Use: Kenneth Pitcher

The Nelchina caribou (*Rangifer tarandus*) herd, one of 22 herds in Alaska (Davis 1978), has been important to sport and subsistence hunters because of its size and proximity to population centers in southcentral Alaska. Between 1954 and 1980 over 100,000 caribou were killed by hunters (Skoog 1968; unpublished data Alaska Department of Fish and Game).

Because of its importance and accessibility, the Nelchina herd has been the most intensively studied caribou herd in Alaska (Doerr 1978). The U.S. Fish and Wildlife Service initiated research in 1948 and continued through 1959 under the direction of Chatelain, Scott and Skoog (Skoog 1968). The Alaska Department of Fish and Game has been continually involved with the Nelchina herd since statehood including intensive research on population, harvest, distribution, disease and range monitoring (Skoog 1968, Lentfer 1965, McGowan 1966, Glenn 1967, Hemming and Glenn 1968, 1969, Pegau and Hemming 1972, Neiland 1972, Pegau and Bos 1972, Pegau et al. 1973, Bos 1973, 1974, Alaska Department of Fish and Game Survey and Inventory Reports 1970-1980). Skoog's (1968) doctoral dissertation, a major work on caribou biology, deals largely with the Nelchina herd.

There is currently under study a proposal to construct a large hydroelectric project on the Susitna River in the western portion of the Nelchina caribou range. Impacts of the development, which may include two dams and impoundments, access roads and electrical transmission lines, on the Nelchina herd are unclear. Habitat loss due to inundation does not appear to be a serious consideration as <1% of the total Nelchina range would be involved. Skoog (1968) concluded that caribou usage of this area was largely limited to transient animals, although they occasionally spend time in the area in spring using snow free areas. The proposed Watana impoundment could serve as a barrier to migrating caribou. The area along the Susitna River between Deadman Creek and Jay Creek has served as a traditional migration route both during spring migration and the post-calving shift (Hemming 1971). Ice shelving along the edges of the reservoir has been suggested as a potential source of mortality to migrating caribou (Hanscom and Osterkamp 1980). Roads, railroads and electrical transmission lines have all been reported to disrupt caribou movements (Klein 1971, Vilmo 1975, Cameron et al. 1979). Disturbance associated with construction and maintenance of the hydroelectric facilities could result in a reduction of caribou use of nearby areas as shown for the Prudhoe Bay oil fields (Cameron et al. 1978). Proximity of the traditional calving grounds to the Watana impoundment is of some concern because of the importance of the area to the Nelchina herd and increased human activity in the area implicit to development. Suspected "subherds" in the general area of the proposed impoundment could become more isolated by development of the Susitna Hydroelectric Project depending on their movement patterns and routes and their reactions to the impoundments and related developments.

Overall objectives of this project are to evaluate the potential impacts of proposed Susitna hydroelectric development on the Nelchina caribou herd and to suggest possible mitigating actions. Specific objectives include: (1) determination of movement patterns, migration routes and timing of major movements with emphasis on activities occurring in the vicinity of proposed development; (2) delineation of subherds (based on separate calving areas); (3) estimation of numbers and sex and age of the main Nelchina herd and suspected subherds; and (4) determination of habitat utilization of Nelchina caribou.

Complicating the interpretation of data gathered during short-term studies of caribou migratory routes is the well recognized tendency for changes in use of winter and summer ranges (Skoog 1968). The analysis of data resulting from this study will have to rely heavily on historical information. It is fortunate that results of intensive research by Skoog (1968) and others on the Nelchina caribou herd are available and they will be used extensively in the analysis.

1.4 - Dall Sheep: Robert Tobey

Dall sheep (*Ovis dalli*) are known to occupy all portions of the upper Susitna River basin which contain extensive areas of habitat above 4000 feet elevation (Alaska Dept. of Fish and Game 1973). Three such areas lie close enough to proposed Susitna Hydroelectric Project impoundment areas that sheep using these areas may be impacted by the project. These areas are the Portage-Tsusena Creek drainages, the Watana Creek Hills (east of Watana Creek) and Mount Watana including the hills to the southwest.

Because Dall sheep usually are found at elevations above 3000 feet, the most likely adverse impact of the Susitna Hydroelectric Project appeared to be disturbance from construction activities and access roads. As a result the scope of this study was limited to a determination of the seasonal distribution and abundance of sheep adjacent to the proposed impoundments.

The study area includes all drainages flowing into the Susitna River from Gold Creek to Kosina Creek on the south and to the Denali Highway on the north. Survey efforts were confined to the three areas of known or suspected Dall sheep habitat within this area.

1.5 - Wolverine: Craig Gardner, Warren Ballard, and Donald Cornelius

The only information available on wolverine in the Susitna River basin comes from work conducted by Rausch and Pearson (1972) and ADF&G harvest records. Both sources provide a gross indication of population status. These studies do not, however, provide the types of information needed to determine the probable impacts of the proposed Susitna Hydroelectric Project on wolverine populations. The current study was initiated in April 1980 to:

(a) Determine distribution and abundance of the wolverine population utilizing the study area.

(b) Determine wolverine seasonal habitat requirements and movement patterns.

(c) Obtain an estimate of the population's age structure and sex ratio to determine population trends.

(d) Determine the wolverine's dependency on the area which will be inundated by the proposed dam system or developed through road or transmission line construction.

This report addresses preliminary findings of wolverine movements and home range size, habitat use, and distribution within the impact area. The report period only extends from 10 April through December 1980 due to the late arrival of radio telemetry equipment.

1.6 - Downstream Moose: Paul Arneson

The moose below the proposed impoundment and those above are distinguished by the designations downstream and upstream and treated separately in this study because the project would affect them in quite different ways.

In the early 1950's, the Susitna valley was termed "probably the most productive moose habitat in the (Alaska) Territory" (Chatelain 1951). It was not until man-caused fires and clearing of land during and after railroad construction created prime moose habitat that the moose population rapidly increased. Prior to 1930 few moose were found in the valley (Spencer and Chatelain 1953). At that time moose likely utilized riparian habitats and what few browse species were available in the mature spruce-hardwood forest. With the creation of new habitat, the moose population expanded and presently remains at relatively high levels.

The identities of moose populations that may use the Susitna River during some stage of their life cycle have not been determined. Moose in peripheral areas have been studied and do not appear to mix with populations that are found in the Susitna valley from the Deskha River on the south to Portage Creek on the north. An extensive collaring project in the Matanuska valley in the late 1960's revealed that most moose remained in the valley. Only three were known to emigrate out of the tagging area; one to Mt. Yenlo and two to Mt. Susitna (Rausch 1971). However, only visual collars were used, and observations normally occurred only on the wintering grounds. A radio and visual collaring project was conducted in 1975-1977 in the Peters-Dutch Hills area northwest of the Susitna River (Didrickson and Taylor 1978). No marked moose were known to have moved eastward to the Susitna River.

Therefore, the moose herd north of Willow to the proposed Devil Canyon dam site is likely a discrete population although various subpopulations likely exist within the overall population. The greatest number of animals spend the rutting period on the western foothills of the Talkeetna Mountains. Many remain in that vicinity until deep snow covers their forage, and they must migrate to lower elevations where riparian and disrupted habitats provide suitable winter forage.

Because no surveys have been conducted in the past to determine winter moose use of riparian habitats of the Susitna River, the only data we can use as a indicator of moose presence on or near the river are records of railroad and highway killed moose and documentation of dead moose on the river's islands during the severe winter of 1970-71. When deep snows persist in the Willow to Talkeetna areas, the incidence of railroad and highway-killed moose increases substantially. The most recent example of this is in the winter of 1978-79 when at least 171 railroad-killed moose were documented after a moderately heavy snow year. The following winter 1979-80 when much less snow fell, far fewer moose were recorded as railroad mortalities. During surveys in April 1971 following the severe winter of 1970-71, 155 winter-killed moose were tallied on the Susitna River and its tributaries. As stated by LeResche et al. (1974), "During harsh winters, river 'bottoms' become yarding areas for high densities of moose. When deep snow persists, overbrowsing may occur, and these areas have been the scenes of the most spectacular moose die-offs recorded in Alaska ...riparian communities are the habitat of last resort for wintering moose." Winter range is widely considered a limiting factor in the welfare of moose and other ungulate populations. Because moose are dependent upon secondary successional stages of vegetation for their winter forage, their winter range must be periodically disrupted by fire, land clearing, beaver activity or flooding in order to create the necessary transitory stage of vegetation (Chatelain 1951).

No research has been conducted to determine moose use of the important riparian winter range along the Susitna River, and only a few studies and quantitative records are available for that moose population in general. Chatelain (1951 and 1952) and Spencer and Chatelain (1953) reported on the early history and habitat use of moose in the Susitna valley. Rausch's (1959) research dealt with various parameters of population dynamics of the moose herd in the Matanuska and Susitna valleys. Bratlie (1968) further summarizes the status of the lower Susitna and Matanuska moose herds through 1967. LeResche (1974) briefly summarized the status of the Susitna moose. Since that time, the only information gathered concerning the welfare of the lower Susitna moose population has been the sex and age composition counts conducted most every fall, harvest data and some age data from railroad-killed moose.

When planning began for downstream moose studies on the proposed Susitna Hydroelectric Project, it was known that a paucity of quantitative data was available for the area of greatest impact and importance on the lower river. Therefore, basic research had to be initiated to meet the most obvious objectives. As the project continued, these objectives were periodically changed to meet changing conditions such as weather, logistics and other factors. The primary objectives of the study are:

(a) To determine the identity of moose subpopulations using the lower Susitna.

(b) To determine seasonal distribution and movement patterns of these moose subpopulations.

(c) To determine the relative magnitude of moose use of the lower Susitna.

(d) To determine the relative use by moose of various habitats along the lower Susitna and nearby areas.

(e) To summarize historic data as it pertains to the above objectives.

Secondary objectives are:

(a) To determine food habits of moose using the lower Susitna versus those using nearby areas.

(b) To determine the relative condition and productivity of the moose herd of the lower Susitna and vicinity.

During the first year of study, 4 of the 5 primary objectives have been partially fulfilled. Primary objective (a) will be accomplished in late winter if conditions permit.

1.7 - Upstream Moose: Warren Ballard, Donald Cornelius, and Craig Gardner

Prior to statehood, management of Alaska's moose involved little more than establishing liberal seasons, conducting sex and age composition counts, monitoring harvests and controlling predators when necessary. Within the past two decades, however, Alaska's human population has grown significantly (Yankee 1974) and moose populations have been declining. Consequently, management has become more intensive, requiring detailed knowledge of various population and habitat parameters which were not necessary when moose numbers were increasing between 1940 and 1960 (Bishop and Rausch 1974).

Between 1963 and 1974, over 88,000 moose were harvested in Alaska (ADF&G unpublished files). Of that number, 18 percent were from the

Nelchina basin (GMU-13). Moose numbers began to decline in the Nelchina basin after the winter of 1961-62 (Bishop and Rausch 1974). Deep snows were thought to be preventing the population from recovering. McIlroy (1974) suggested that low bull : cow ratios had influenced conception rates while Bishop and Rausch (1974) considered habitat deficiencies to be at least partially responsible for these declines.

Because of its depressed moose population and the importance of GMU-13 to the statewide harvest, a series of interrelated studies was initiated in 1975 in an effort to identify problems and possible solutions to aid in the population's recovery. These studies initially focussed on moose-wolf relationships, to test the hypothesis that wolf predation was responsible for low calf survival. A later study involved removing wolves from a portion of GMU-13, then measuring moose-calf survival in subsequent years. In order to evaluate the effects of wolf removal on study moose herds, it was necessary to accomplish the following: identify discrete moose populations and calving areas, and determine pregnancy rates, age structure, and physical condition of moose in these populations. During the early phases of this study renewed interest in developing hydroelectric power on the Susitna River prompted expansion of these moose studies to include a preliminary assessment of the potential impacts of Susitna River hydroelectric development on moose.

1.8 - Wolf Studies: Warren Ballard, Robert Stephenson, and Ted Spraker

Rausch (1969), Bishop and Rausch (1974) and McIlroy (1974) have described the history of the GMU-13 moose population. All pointed to an apparent inverse relationship between numbers of predators and numbers of ungulates. Moose apparently began declining after the severe winter of 1961-62. This decline continued and was hastened by severe winters occurring in 1965-66, 1970-71, and 1971-72. Fall calf: cow ratios declined sharply and reached a record low for the basin in

1975. Although wolf predation was not suggested as the main reason for the population decline, it was thought to have at least amplified the decline and, more importantly, prevented recovery during mild winters (Rausch et al. 1975). This concern coupled with the findings of Stephenson and Johnson (1972, 1973), which revealed a high percentage of calf moose in wolf scats, suggested that wolf predation on calves was preventing the moose population from increasing. Consequently a series of studies was initiated to obtain information on wolves, and on wolf-moose relationships in the Nelchina basin (Stephenson 1978, Ballard and Spraker 1979). The current study consists of a continuation of these, with the additional objective of assessing the probable impact of the proposed Susitna hydropower complex on wolves and their prey.

2 - METHODOLOGY

Since the basic task for 1980, for each of the large mammals found in the Susitna basin, has been to make estimates of distribution and habitat selectivity, there is much in common among them with regard to data records and analysis. Before field work is undertaken it is well to have a plan for the systematic quantification and coding of data, with the ultimate purposes of data processing in mind. Therefore, in this, and each subsequent section, data processing shall come first. In addition to the topics of distribution and habitat selectivity, data processing includes species interaction analysis and basic data processing and analysis, both included here.

2.1 - Data Processing

2.1.1 - Animal Distribution Analyses

Radio-telemetry techniques are being used by all the principal investigators. The large numbers of animals fitted with radio collars and the numbers of observations per animal dictate that automated means be used for data analysis and display. The cartographic nature of radio telemetry data creates special problems in data processing which require use of specialized computer resources.

2.1.2 - Habitat Selectivity Analyses

An important component in evaluation of the potential impacts of dam construction is understanding how the various species utilize the landscape available to them. The radio telemetry data are used to identify where animals are located and, in some cases, the activities in which the animals are engaged at that spot. However, in order to identify those elements of the landscape which influence animal distributions and movements, it is necessary to relate those observations to the total landscape available to each animal. Several conceptual and technical problems are associated with such analyses.

2.1.3 - Species Interaction Analyses

The direct impacts of the proposed hydroelectric project will undoubtedly vary among the big game species. However, close ecological relationships between species (e.g. predator-prey interactions) can result in indirect impacts which may not be immediately apparent with single-species analyses. The complexities of such analyses require the use of systems analysis techniques and specialized computer resources.

2.1.4 - Basic Data Processing and Analysis

Direct assistance to principal investigators in data processing and analysis is provided in the form of sampling designs, data collection and analysis techniques, statistical analyses and computer software.

2.2 - Area of Study

Because of differences in species distribution and range of movement, and because of a project distinction between the impoundment region and the downstream region, there are differences among the different species with respect to the specific part of the landscape within which its study took place. These differences are described by study, below.

2.2.1 - Black and Brown Bears

Captured bears were located along the Susitna River and its tributaries between Devil Creek (T32N/R8W, Talkeetna Mts. Quad) and the Vee site or gaging station (T30N/R10E, Talkeetna Mts. Quad).

The most distant bear captured south of the Susitna River was G293 (upper Tsisi Creek), 25 km south of the Susitna River. The most distant bear captured north of the Susitna River was G312 (T21S/R4W, Healy Quad), about 30 km north of the Susitna River. All black bears and half of the brown bears were captured within 5 km of the Susitna River.

Based on movements of radio-collared bears, the study area was expanded to include upper Chunilna Creek, the whole of Prairie Creek, the height of land separating upper Susitna drainages from Talkeetna River drainages, Kosina Creek, and drainages of the Susitna as far east as the Oshetna River, and upper Jay, Watana, Deadman and Tsusena creeks. The total area encompassed by movements of radio-collared brown bears included approximately 3,500 km^2. Because of the difficulty of radio-monitoring this large area, most monitoring efforts were concentrated on a core area within 15 km either side of the main Susitna River, encompassing an area of only 800 km^2. Bears ranging outside of this core area were radio-located less frequently than bears with a greater portion of their home ranges within the core area. Within this study area black bears were much less ubiquitous than brown bears. The main black bear study area was southeast and east of Devil Mountain to Tsusena Creek (T31-32N/R5-7W), an area which would be impacted by construction of the Devil Canyon dam. A secondary black bear study site, which would be impacted by the Watana dam, was centered around Deadman Creek (T32N/ R4-5W). The most upstream radio-collared black bear was in the vicinity of the Vee gaging station.

2.2.2 - Caribou

The Nelchina herd occupies an area of approximately 20,000 mi^2 bounded by four mountain ranges: the Alaska Range to the north, the Wrangell Mountains on the east, the Chugach Mountains to the south and the Talkeetna Mountains to the west (Hemming 1971).

The Nelchina Range contains a diverse variety of habitats ranging from spruce-covered lowlands to steep, barren mountains. Human development is largely limited to the peripheries of the Nelchina range and consists primarily of the Alaska Railroad, Parks Highway, Denali Highway, Richardson Highway, Trans-Alaskan Pipeline and Glenn Highway.

2.2.3 - Dall Sheep

Dall sheep occupy three areas within the study region which contain extensive areas of habitat above 4,000 feet in elevation: the Portage-Tsusena Creek drainages; the Watana Creek Hills (east of Watana Creek); and Mount Watana, including the hills to the southwest.

2.2.4 - Wolverine

The study area boundary follows the Susitna basin boundary in the west to its intersection with the Denali Highway on the north, the Denali Highway to its intersection with the Susitna River on the east, down the Susitna River to its confluence with the Tyone River to Tyone Lake, then a southwest line to the confluence of the Little Oshetna River with the Oshetna River and along the Oshetna River to its intersection with the basin boundary on the south.

2.2.5 - Downstream Moose

In the broadest sense, the study area was defined as the floodplain of the Susitna River below the proposed Devil Canyon dam, and those areas included in the home range of moose radio-collared on the Susitna River. In a practical sense, the study area was reduced to that portion of the Susitna River from approximately Portage Creek south to the Delta Islands. This portion of river was further subdivided into three physiographic sections: 1) From Portage Creek to the confluence of the Susitna and Chulitna rivers near Talkeetna, 2) From Talkeetna to the mouth of Montana Creek, and 3) From the mouth of Montana Creek to the southern end of Delta Islands. In addition, a specific study site consisting of several islands was selected near the mouth of Goose Creek and the north end of Sheep Creek Slough.

2.2.6 - Upstream Moose

Moose movements and habitat use were studied in the upper Susitna River basin upstream from Devil Mountain. Studies in relation to hydroelectric development focused on the immediate hillsides north of the river between Devil Mountain and the mouth of the Maclaren River.

2.2.7 - Wolves

Wolves were studied most intensively in the Susitna River study area, which has the following boundaries: the area is bordered on the north by the Denali Highway and extends from the Maclaren River at the Denali Highway south to Tyone Lake and Lake Louise, then to the Glenn Highway. The western boundary is generally defined as northwest from the Little Nelchina River along the upper elevations of the Talkeetna Mountains to near the mouth of Portage Creek and then northeast to the Denali Highway.

2.3 - Radio-telemetry

2.3.1 - Black and Brown Bears

Brown and black bears were captured by procedures described in Spraker et al. (1981) and Ballard et al. (1980). In brief, fixed wing aircraft (PA-18) were used to search for bears and bears were immobilized by darts fired from a helicopter (Bell 206B). Drugs utilized included phencyclidine hydrochloride (Sernylan), etorphine (M99) and its antagonist diprenorphine (M50-50), ketamine hydrochloride (Vetelar), and xylazine (Rompun).

Standard morphological measurements were taken of immobilized bears. When terrain conditions permitted, weights were obtained by means of a scale suspended from the helicopter or a hand-held scale. Specimens of blood and hair were collected to assess physiological condition. Identifying marks applied to all bears included: lip tattoos, ear tags, and ear flags. Individual bear numbers referred to in the report represent tattoo numbers with a "G" for brown bear and a "B" for black bears. Bears judged to have completed 80 percent or more of their growth were fitted with radio-collars which transmit in the range of 148.0-153.9 MHz. Ten bears were fitted with double transmitter collars designed so that one transmitter transmitted data on ambient temperature.

Because of the late arrival of new bear collars, some individuals were fitted with radio-collars designed for other species or used bear radios from other projects. Except for the double-transmitter bear radios, all new bear radios were designed with mortality sensors which halve the pulse rate when the collar is stationary for 2 hours, a change recognizable when a collar has been shed or the bear is dead; it also prolongs battery life by reduced electrical draw when bears are in dens.

Bears were captured on 10-22 April, 1-7 May and 18-19 August, 1980. In the first effort only brown bears were seen. Beginning on May 1 black bears were abundant, having emerged from their dens apparently between 22 April and 1 May. The August tagging effort was designed to capture black bears in mid-summer habitats, away from their 1979-80 dens. These summer captures avoided den-site selectivity biases which may have resulted had only spring-captured bears been followed to their 1980-81 dens.

Attempts to locate radio-collared animals were made on approximate 10 day intervals in 1980. Actual flights varied from this schedule depending on weather conditions and aircraft availability. Most radio location flights were made in a Cessna 180 based in Anchorage and refueled at Susitna Lodge or Talkeetna. Flights were made on 14, 22, and 29 May, 4, 12 and 23 June, 2, 10, 18 and 22 July, 4, 14, 22, and 27 August, 9 and 29 September and 9, 18, and 27 October. Additional radio-locations were made in conjunction with flights to locate other species in the Susitna study area. Reasonable efforts were made to visually observe all radio-located bears. The locations of all non-marked bears spotted during radio-location flights were also recorded. Locations were plotted on US Geological Survey maps (scale 1:63,360) and information on habitat type, behavior, associations, topography, etc. were recorded.

Data collected on monitoring flights were transferred to individual-specific data forms and maps which will be the basis for keypunching and digitizing.

Habitat-type information recorded during monitoring flights was restricted to the following broad categories identifiable from the air:

1. Sparse tall spruce
2. Mod. tall spruce
3. Dense tall spruce (riparian)
4. Sparse med. spruce
5. Mod. med. spruce
6. Dense med. spruce
7. Sparse low spruce
8. Mod. low spruce
9. Dense low spruce
10. Riparian willow
11. Upland willow
12. Willow birch
13. Aspen
14. Riparian hardwood
15. Marsh
16. Alder
17. Rock/ice

The nine habitat types which include spruce were broken down into categories reflecting relative densities and heights of the spruce component. Procedures to determine habitat selectivity from these data and/or data from vegetational mapping subtasks are under development.

Blood samples were analyzed for condition indices by Pathologists Central Laboratories, Seattle. Hair samples are stored for potential trace element analyses. Teeth were collected for aging according to procedures described by Stoneburg and Jonkel (1966) and Johnson and Lucier (1975). Feces collected during capture are stored for food habits studies (anticipated for Phase II). Captured bears were photographed.

2.3.2 - Caribou

Data on movement patterns, migration routes, timing of major movements, subherd status and habitat use were collected by periodic relocations of radio-collared animals. Caribou were captured by use of immobilizing drugs [etorphine (M-99) and xylazine (Rompun)] administered with projectile syringes (Cap-Chur equipment) shot from a helicopter. Radio-collars in the 152.0-153.0 MHz range, purchased from Telonics Inc., were used. Radio-collared caribou were relocated from a fixed-wing aircraft (Cessna 180 or PA-18-150) equipped with two Yagi antennas, one attached to wing struts on each side of the aircraft. Antenna leads were attached to a right/left switch box coupled to a radio-tracing receiver/scanner. Animals were located by balancing the transmitter signal between the two antennas through use of the left/right switch and orientation of the aircraft and following the signal. Forty-one caribou were radio-collared. However, as of 10 December, 12 collars had either been shed or the animals had died leaving 29 functioning transmitters on four males and 25 females. These included three animals in the upper Susitna area, two in the Talkeetna River area, and 24 in the main Nelchina herd.

2.3.3 - Dall Sheep

Dall sheep have not been subject to radio-telemetry to date, because their principal habitat is well removed from the impoundment area.

2.3.4 - Wolverine

Capture efforts were conducted during April and May 1980, using helicopter capture techniques (Ballard and Spraker 1979). A combination of 0.25 cc Sernylan (Bioceutic Lab., Inc.) and 0.20 cc Rompun (Barrett Division of Cutter Laboratories, Inc.) was used for immobilizing two wolverine. Because Sernylan is no longer commercially available, a combination of 0.4 cc etorphine (1 - mg/cc M-99, D-M Pharmaceuticals, Inc.) and 0.5 cc Rompun was used to capture the last three wolverine. Each captured wolverine was aged, sexed, weighed, measured, ear tagged and radio-collared. Data from each wolverine were recorded on a tagging form. After processing, wolverine immobilized with M-99 were injected with an equivalent cc dosage of the antagonist dipremorphine (2 mg/ml M 50-50, D-M Pharmaceuticals, Inc.). Each captured or necropsied wolverine is referred to by the last three digits of its assigned accession number.

Radio collars (Telonics, Mesa, AZ) were constructed of butyl rubber and had an inner circumference ranging from 29 to 39 cm. Each collar was equipped with a whip antenna which extended 26 cm from the collar. The entire unit weighed 232 g.

Radio locations were made approximately twice per week during April and once per week thereafter, similar to methods described by Mech (1974). Radio locations were recorded on a 1:63,360 U.S.G.S. map and activity, number of associates, and general habitat were described on a standard field form.

Aerial habitat classification followed a system described by Ballard and Taylor (1980). This system was specially designed to describe habitat from fixed-wing aircraft. For this reason and because we were more familar with it, it was used in lieu of Viereck's and Dyrness's classification system (1980). We believe that most of our classifications can be transformed to Viereck's and Dyrness's level 3 classification, which is probably as accurate as can be obtained from the air.

Wolverine tracks were followed on the ground during May and December 1980 in an effort to gather information pertaining to food habits and activity patterns. Tracks were initially found by aircraft. Tracks were then followed on snowshoes for 1 to 2 days.

Wolverine carcasses were purchased from hunters and trappers in Game Management Unit (GMU) 13 by offering $10.00 per carcass. Each carcass was necropsied in an effort to quantify age structure of the harvest, reproductive status, and morphometric measurements.

Wolverine observation forms were distributed to pilots, biologists and other investigators in the study area in an attempt to gather more data on wolverine distribution. Sightings of both wolverine and wolverine tracks, general description of habitat and activity were solicited. Harvest records from sealing forms and bounty records from 1962 to present were examined.

2.3.5 - Downstream Moose

The study began in April 1980 when 10 moose were captured: three in the upper section (1 bull, 2 cows) north of Curry, three in the middle section (2 bulls, 1 cow) plus one cow was collared at the middle-lower section boundary, and three in the lower section (1 bull, 2 cows) near the mouth of Sheep Creek. All were darted from a helicopter using 9 cc M-99 and 1 cc Rompun. Besides placing a radio/visual collar on each moose, orange ear-flagging and metal tags were placed in both ears. Blood, hair, a tooth and feces were collected from each moose, various morphometric measurements were made and each cow was palpated to determine pregnancy status. When given the antagonist M50-50 each moose recovered in a normal amount of time, and no mortalities occurred in the tagging operation.

Relocation flights of the radio-collared moose began 29 April 1980. Aircraft for these flights were: Cessna 172 and 180 and PA 18-150. Flights were conducted at approximately 10-day intervals during summer and fall and at 15-or-more-day intervals in winter when moose were not making long movements between relocations. At each radio-relocation of a collared moose the following parameters were recorded: date, time, location, visual relocation, antlers present, activity, number of young, association with other moose with a sex and age breakdown, habitat type, elevation, slope, aspect, weather conditions including snow cover and whether a photograph was taken.

After each flight the animal locations were plotted on 1:63,360 USGS quad maps, and the data were organized on keypunch forms. Later, location data will be digitized on a geoprocessor to facilitate analysis. Other data from each observation of radio-collared moose will be computerized at a later date.

2.3.6 - Upstream Moose

Adult moose were captured with the aid of a helicopter by darting with 10-cc aluminum darts fired from a CAP-CHUR gun with appropriate dosages of M-99 and Rompun. Helicopter capture methods were identical to those used previously on other Alaskan moose movement studies (Nielson and Shaw 1967). No attempt was made to capture yearling moose.

Captured moose were marked either with a radio collar, a colored, numbered visual collar, or both, permitting individual recognition from fixed-wing aircraft. One-half of the radio-collars were color-coded with canvas tape wrapped around the machine belting. Visual collars were similar to those described by Franzmann et al. (1974). Radio collars were constructed of machine belting 1.3 cm thick by 5.4 cm wide. Collars had an inner adjustable circumference ranging from 101 cm to 111 cm. The belting surrounded the radio components which were encased in dental acrylic, theoretically making the unit waterproof. The entire unit weighed 1,113 grams. Radio frequencies were in the 150.0 MHz range. Radio collars were purchased from A.V.M. Instrument Company (810 Dennison Drive, Champaign, Ill.) and visual collars were obtained from Denver Tent and Awning Co. (Denver, Colo.).

Each moose was also ear-tagged with a numbered Monel metal tag, fixed to the base of the ear. Most metal tags were accompanied by a 5 cm x 13 cm piece of colored plastic.

Radio signals were received with a 4-band, 48-channel portable receiver purchased from A.V.M. Instrument Co. Radio-collared moose were relocated from a Piper PA-18 Super Cub and STOL Cessna 180 fixed-wing aircraft. Tracking methods and equipment used were similar to those described by Mech (1974).

2.3.7 - Wolves

Wolves were captured for radio-telemetry studies with a CAP-CHUR gun and dart fired from a Jet Ranger 206B helicopter using methods similar to those described by Baer et al. (1978). Our capture technique differed from theirs in that we darted in all types of vegetative cover and while the animal was moving. Captured wolves were equipped initially with an adjustable machine belt radio collar manufactured by AVM Instrument Co., and later with an adjustable collar made of fiberglass and urethane manufactured by Telonics (Mesa, Ariz.).

Wolves were relocated with a portable radio-telemetry receiver manufactured by AVM Instrument Co. The receiver contained four bands with 12 channels per band and covered frequencies in the 150.0 to 152.0 MHz range.

2.4 - Population Studies

2.4.1 - Black and Brown Bears

Determination of the number of bears in the Susitna study area was defined as a major objective of the impact assessment study. Bear population estimates are exceptionally difficult and expensive to obtain and it is unlikely that an accurate estimate will be achieved with the funds available for Phase I bear studies. An imprecise estimate may be obtainable from radio-tracking determinations of home range size coupled with an estimate of the proportion of the population which is radio-collared. The precision of such estimates increases as the proportion of the population which is radio-collared increases. Because of the apparent abundance of brown bears in the Susitna study area and because of the large home range sizes of Nelchina brown bears (average=570 km^2, range=191-1,380 km^2, Miller and Ballard 1980), it will be expensive to obtain a precise estimate.

2.4.2 - Caribou

A modified version of the aerial photo-direct count-extrapolation census procedure (Hemming and Glenn 1969, Davis et al. 1979, Doerr 1979) was used to estimate the size of the Nelchina herd. This technique is composed of three separate procedures: (1) a complete count of all animals in the post-calving aggregation; (2) a composition count of these same animals to determine the proportion of adult females; and (3) representative fall composition sampling of the entire herd to determine the proportions of females, males and calves (Doerr 1979). Acceptance of four assumptions is necessary for the APDCE technique: (1) all females in the herd are present in the post-calving aggregations; (2) adult females are randomly distributed throughout the post-calving aggregations; (3) the sex and age cohorts are randomly distributed throughout the herd during fall; and (4) mortality of adult females from the time of post-calving aggregation to the fall composition counts is zero (Davis et al. 1979). An evaluation of these assumptions by Davis et al. (1979) indicated that all but assumption #3 were valid and that the collection of representative fall composition data was the most difficult procedure.

The fall population estimate is calculated from the following equation (Doerr 1979).

$$FP = N_a \times P_f \times S_f \times (1 + R)$$

where:

- FP = estimated fall population;
- N_a = number of animals in the post-calving aggregation;
- P_f = proportion of females in post-calving agregation;
- S_f = survival of females from the time of post-calving counts until the fall; and
- R = ratio of caribou other than females to females in the fall.

Reconnaissance flights were made in a C-180 to determine when caribou were suitably aggregated to census. PA-18-150 Super Cubs are used to survey the aggregations and the caribou herds were either photographed or directly counted. Hand-held, motor driven, 35 mm cameras were used to photograph caribou groups. The 35 mm color slides of caribou groups were projected on a paper screen and caribou images marked. The number of images were then counted.

A helicopter (Bell 206B) was used to sample the post-calving aggregations and the herd during the breeding season to estimate proportions of females, males, and calves. Groups of caribou were approached from the rear until the sex of each animal older than calves could be determined from the external genitalia (presence or absence of the vulva).

2.4.3 - Dall Sheep

Sheep observations were solicited from all Susitna study participants. Date, location, number, sex and age of all sheep observed and subsequently reported were recorded on 1:63,360 USGS topographic maps. Winter and spring observations were especially requested because they show seasonal distribution and, in some instances, habitat use.

An aerial survey was conducted with a PA-18 Super Cub on 22 and 23 July 1980 in an effort to determine sex-age composition and summer distribution. Sixteen hours were spent surveying sheep. All observed sheep were identified as to number, sex, and age class. Locations were plotted on 1:63,360 USGS maps. Methods used during the survey were typical of those used to survey sheep elsewhere in Alaska (McKnight and Hinman 1980).

2.4.4 - Wolverine

Data obtained during this study period are not sufficient for population analysis, but it is anticipated that preliminary population estimates will be available after another year of study.

2.4.5 - Downstream Moose

Data obtained during this study period were not sufficient for population analysis, but it is anticipated that preliminary population estimates will be available after another year of study.

2.4.6 - Upstream Moose

From 25 May through 13 June 1980, eight flights were made to determine the birth rate and calving area of radio-collared moose in the study area.

Teeth obtained from radio-collared moose were aged during the report period; in addition, teeth from wolf-killed moose in the study area were aged and bone marrow samples were analyzed to determine relative condition of moose preyed upon by wolves.

During August, 1980, 33 snow depth markers were installed along eight transects in moose habitat throughout the study area. These markers were read throughout the winter to determine the relationship between moose movements and snow depth. The markers were placed in areas used by moose during the March 1980 winter distribution survey and preliminary Susitna studies. Specific site selection was done in collaboration with Jeff Kaufman from R&M Consultants and George Calgett of the U.S Soil Conservation Service. Random stratified moose census counts were designed with the assistance of Dr. Wm. Gasaway, and carried out in late October and early November, 1980.

2.4.7 - Wolves

Through radiolocation and aerial observation wolf packs were identified and their seasonal ranges and composition determined.

2.5 - Food Availability and Use

This aspect of the study focussed on the food of moose particularly. Moose make much winter use of successional riparian shrubs and these shrubs would tend to be flooded by an impoundment or affected by changes in the seasonal magnitude of downstream flow.

2.5.1 - Downstream Moose

Techniques to be used in spring pellet group counts and browse utilization/density studies were researched and several experts in the field were contacted. Several designs were discussed, but it was decided that each project is unique, and methods of this type need to be "tailor-made" for the project. Therefore, several methods were tried during spring 1980 to determine which was best suited for the habitats involved and which were best suited for the degree of moose use in the area. Areas determined to have the greatest variance in 1980 will be sampled with greater intensity in spring 1981.

In the initial survey of the river, transect lines were randomly selected in the upper, mid and lower portions of each of the three sections. Transects followed existing section lines. On these transects the number of browse plants available to moose (or hare and beaver) were recorded on a strip 1 meter wide along the entire transect, but the transect was divided into 10-meter sections. Pellet groups were counted in a 2-meter width in each of the 10-meter sections. The habitat type in each 10-meter section was also recorded. Only the first 100-meters of upland habitat on opposite banks of the river were surveyed at each transect.

For the second portion of the study, one study site was selected near the mouth of Sheep Creek. Ten transects were randomly selected on the study area. Along each transect a 2 X 2 meter plot was used every 20 meters to record the browse availability/utilization. At the same location a 2-meter radius circle was used for pellet groups. The smaller plot size was chosen to better fit within given habitat types.

Five browse species were considered: willow (Salix sp), cottonwood (Populus balsamifera), paper birch (Betula papyrifera), highbush cranberry (Viburnum edule) and rose (Rosa acicularis). They were considered "browsable" if they were over 40 cm tall (i.e. available above or near the snowline in winter) and if their circumference at breast height was 13 cm or less (this circumference has been determined to be the maximum that can be broken over by moose while foraging). To be counted as a separate stem from a cluster of stems, the plant must have been surrounded by soil or if it was a "sucker" on a cut-off stump or mature tree it must have been at an angle of 45 degrees or less from the main stem of the plant. If it was between 45 degrees and perpendicular (90 degrees) to the trunk, it was classified as a branch and not a browse stem.

Only pellet groups containing 12 or more moose droppings and with their approximate geometric center within the transect were counted.

The habitat classification followed Viereck and Dyrness (1980) as closely as possible. Additionally, the density and height of plants were recorded. Four density categories were used: 1) Open (10% or less crown canopy cover), 2) Sparse (10-25%), 3) Medium (25-60%) and 4) Closed (60-100%). Four height categories were also used: 1) Low (1.5 m or less), 2) Medium (1.5-6.0 m [considered prime moose browse]), 3) Tall (6.0-9.0 tall, 5.0-13 cm dbh) and 4) Climax (9.0 m or more high, 13 cm or more dbh).

3 - RESULTS AND DISCUSSION

3.1 - Data Processing

In the first year of Phase I studies the biometrics and data processing efforts have concentrated on development of techniques and procedures designed to meet the objectives outlined previously. Delays in obtaining personnel and access to needed computer resources have resulted in little actual analysis being accomplished in the first year, but substantial progress has been made in development, and many kinds of analyses appear ready to begin early in the second year of Phase I studies. The following is a brief discussion of these techniques and procedures.

3.1.1 - Data Entry of Radio Telemetry Observations

Each time a marked animal is relocated the observer pinpoints the location on a map and records pertinent descriptive information (identity, behavior, associations, habitat, environmental factors, etc.) on a field form.

The types of descriptive information recorded vary among species. In order to facilitate analysis, the cartographic information about the location of the animal must be associated with the descriptive information. This process required handling the two types of information separately for data entry and conversion, and subsequently merging them for data analysis.

Descriptive data are transcribed onto standardized forms by the investigators. These data are subsequently key-punched and entered on the IBM computer at the Department of Administration, Division of Data Processing, Anchorage. A magnetic tape of these data is created and the information transferred to the Department of Natural Resource's geoprocessing center for analysis.

Cartographic information is converted to digital, x-y coordinates through the process of digitization. This involves placing a map on a digitizing table which, with the use of an electronic tracing tool known as a cursor, records the two-dimensional coordinates of a given location relative to known reference points. Defining the reference points requires registration of each map each time it is placed on the digitizing table. To avoid having to register the same map for every individual animal with sightings on that map, points of sightings are transferred from maps used in the field to mylar overlays, one for each animal for every base map on which it has been sighted. Digitization is done from these mylar overlays at the Department of Natural Resource's geoprocessing center, with registration of each base map required only once for each corresponding set of overlays.

The cartographic information from digitization is then combined with the descriptive information in a master file. This master file is continually updated as new information is gathered. A back up copy of the master file is created after each update.

3.1.2 - Data Analysis of Location Information

The Department of Natural Resources' geoprocessor was especially designed for automated analysis and display of geographic-based information. The geoprocessor is a mini computer with an array of associated peripheral devices such as a tape drive, disk unit, digitizer, lineprinter, computer terminals and an x-y drum plotter for drawing high quality color graphic displays on paper or mylar. The system includes a versatile set of computer programs (software) for performing functions on map-based information. These functions include calculating polygon-line interactions, polygon-polygon intersections, unions and relative differences, scale conversions, directions and distances between points and areas. Additional programs are available to perform functions on descriptive data such as sorting, selecting subsets, report writing, and mathematical calculations. User-specific software can also be written and integrated into the system.

Before committing the big game studies to utilization of the geoprocessor for data analysis, a pilot project was undertaken. This was intended to provide project personnel with the opportunity to gain a better understanding of its capabilities and limitations, and to iron out potential technical difficulties prior to actual use on real information. The pilot project consisted of creating a "dummy" set of animal sightings and going through the process of data entry and analysis. Three individual animals, two moose and one wolf were created with 25 sightings each. Descriptive data forms for each animal were created and observation points mapped on two USGS 1:63,360 scale maps. In developing the pilot project, several new computer programs had to be developed to perform the task of merging the cartographic and descriptive files. These programs have been tested and the system is now ready for the data entry process as previously outlined.

Several major problems have yet to be solved, for example, means of lumping observations in a meaningful fashion in order to define home ranges or areas of use. In the pilot project, home range polygons were defined by connecting the outermost points with straight lines. The area of each polygon and the areas of overlap can be determined by the geoprocessor. Other methods of describing areas of use may ultimately prove to be more meaningful, for example, ellipses encompassing a certain percentage of point locations.

3.1.3. - Habitat Selectivity Analyses

The radio telemetry observations provide information on where selected animals are at specific times. In order to utilize this information to analyze habitat selectivity by the various species several assumptions about these observations must be made, and information about areas where animals are not located is required.

The necessary assumptions are:

(a) The individuals which have been radio-collared represent a random sample from the population. This assumption may be violated if, during the capture process, certain individuals or groups of individuals have different probabilities of being captured. Females with young, for example, may be more secretive and less prone to capture in some species.

(b) The observations of an individual radio-collared animal represent a random sample from the distribution of that individual. All radio telemetry observations are made with the use of aircraft. The locations of individuals during times when the use of aircraft is not possible (e.g. inclement weather, hours of darkness) may differ substantially.

With these assumptions it is possible to compare areas which are utilized with those areas which are not utilized. However, several difficulties still remain. These include:

(a) Determining the total area available to an individual. This is an obvious requirement for the basis of the comparison. It makes little sense to compare areas which are not available to be selected.

(b) Accurately describing the landscape features. The particular components of the habitat which motivate selection may not be obvious or easily quantifiable. They may also vary with temporal conditions.

Two techniques for analyzing habitat selectivity are being considered. The first involves expanding the use of the geoprocessor to include landscape features. This would require that the landscape attributes be spatially defined and entered into the system via digitization. The level of resolution required and the complexity of the attributes would determine the level of effort necessary to accomplish this task. For example, topographic features could be digitized from standard USGS maps. However, capturing all the detail present in these maps would require an excessive effort and create data processing problems because of volume. Also, not all landscape features lend themselves to precise spatial definitions. Vegetation, for example, often occurs along continua. Aerial photos are being used by the Agricultural Experimental Station to create vegetation maps, but the vegetation types designated on the maps are based on overstory vegetation.

While the geoprocessor is an effective tool to overlay animal locations on landscape features, the degree of accuracy required to provide meaningful results is often beyond the level of the original maps. Extensive editing and integration of various maps may be required. For example, when vegetation maps made from aerial photos are electronically overlayed onto topographic maps, boundaries around water bodies and other dominant features rarely match up initially. Similarly, the ability of the observer tracking radio-collared animals to accurately pinpoint the location on a map can greatly influence the results. Likewise, the description of the habitat recorded by the observer at the time of sighting may not coincide with that entered from vegetation maps from aerial photos. Considering the problems associated with this technique for habitat selectivity analysis, it was decided that this technique would be applied on a trial basis only. Using the vegetation maps by the Agricultural Experimental Station, landscape features for the area of impoundment will be digitized. This technique will then be evaluated before expanding into areas outside impoundments.

The second technique for habitat selectivity analyses arose from consideration of the difficulties associated with the first technique. The basic premise of the second technique is that the most accurate information on the landscape features utilized by the various species is obtained from the observer recording the sighting. The process of transferring this information to maps introduces additional error. The second technique avoids this error by comparing landscape features at randomly selected points with those where animals were observed.

The experimental design for the second technique is as follows. The study area will be divided into sampling units based on ecological factors. Sample units will vary in size and shape and will be constructed such that it is reasonable to assume that the entire sample unit is available to any individual animal located in it. Once an animal observation has been made in a sample unit, random points will be selected within the sample unit. Observers will drop a marker from the aircraft at each random location and record the same landscape information as is recorded for animal sightings. The number of random locations selected will depend on the homogeneity of the sample unit and required accuracy. Standard statistical techniques will be used to compare the random locations with the animal observations.

3.1.4 - Species Interaction Analyses

Computer simulation modelling is an effective technique for analyzing species interactions. The most cumbersome aspect of simulation modelling is the computer program development. Specialized computer software for simulation modelling is commercially available. These software packages provide the user with program flexibility, enhanced output capability in the form of graphics, and streamlined input procedures which greatly reduce the effort required for program development. However, the majority of the commercial packages are aimed at economic and business applications. It is, therefore, necessary to develop our own simulation software package. Specifications for the software are presently being developed. Several months of program development and testing will be required to produce an operational system. Once this system is in place, simulation modelling of species interactions can proceed rapidly and efficiently.

3.2 - Black and Brown Bears

3.2.1 - Sex and Age Composition of Captured Animals

Fifty-four bears were captured and marked in 1980, 27 brown bears (Table 1) and 27 black bears (Table 2). One black bear (B303) was captured twice bringing the total number of black bear captures to 28. One bear of each species died during capture operations (B296 and G278).

Radio collars were placed on 15 brown bears and 11 of these remain active. Four brown bears shed their collars (G279, G214, G295, and G309), all of these were large males (average age = 9.2 years, range 4-12). One non-radioed bear (G311) was shot by a hunter. The total number of marked and radio-collared brown

Table 1

Brown bears captured in the spring of 1980.

# Tattoo	Sex	Age	Wt.	Capture Date	Frequency	Ear flags	Comments
277	F	10.5	225*	4/10	148.004	orange	w/ 2 ylgs, not marked
(278)	M	9.5	375*	4/19	--	--	Capture mortality
(279)	M	9.5	400*	4/20	(150.368)	orange	Collar shed by 6/12
280	M	5.5	300*	4/20	149.508	orange	Recollar next spring
(214)	M	4.5	300*	4/22	(151.512)	blue	Recaptured '78 bear-collar shed 9/9
281	F	3.5	250*	4/22	152.840	orange	Not turgid
282	M	4.5	325*	4/22	--	orange	
283	F	12.5	280*	4/22	148.950	orange	w/ 2 @ 2.5: 284 & 285
284	M	2.5	180*	4/22	--	white	w/ 283
285	M	2.5	180*	4/22	--	green	w/ 283
286	M	3.5	264	5/1	--	orange	
292	F	3.5	174	5/2	--	green	Turgid
293	M	4.5	277	5/2	150.041/.103	white	
294	M	10.5	607	5/2	150.142/.092	white	
(295)	M	12.5	589	5/3	(150.061/.102)	green	Collar shed by 5/4
299	F	13.5	285	5/4	150.041/.112	green	w/ 2 ylgs, turgid
297	M	1.5	65	5/4	--	orange	w/ 299
298	M	1.5	65	5/4	--	orange	w/ 299
306	F	3.5	163	5/4	--	white	Turgid
308A	M	6.5	480	5/6	152.830	white	--
308B	F	5.5	240	5/6	153.810	white	Turgid(?)
(309)	M	12.5	600	5/6	(150.650)	orange	Collar shed by 5/14
312	F	10.5	319	5/7	152.860	orange	w/ 311
(311)	M	(2.5)	227	5/7	--	orange	w/ 312, killed by hunter 9/16
313	F	9.5	286	5/7	152.820	orange	w/ 314 @ 2.5
314	F	2.5	154	5/7	--	orange	w/ 313
315	F	1.5	90*	5/7	--	green	alone

* Weight estimated () Indicates shed collar or dead bear

Table 2

Black bears captured in the spring and summer of 1980.

Tattoo	Sex	Age	Wt.	Capture Date	Frequency	Ear flags	Comments
287	M	10.5	225*	5/1	150.111/.082	white	
(288)	F	10.5	125*	5/1	(150.032/.122)	white	w/ 2 ylgs, turgid, collar shed by 8/27/80
289	F	9.5	130*	5/2	150.092/.062	white	w/ 2 ylgs, turgid
290	F	8.5	103	5/2	150.022/.142	blue	w/ 2 ylgs, turgid
(291)	M	(3.5)	73	5/2	(150.030)	orange	Post-capture mortality
(296)	M	(10.5)	227	5/3	(--)	--	Capture mortality
(300)	M	(7.5)	274	5/4	(150.023/.121)	orange	Post-capture mortality
301	F	7.5	115	5/4	153.850	green	w/ 1 ylg, turgid
(302)	M	8.5	287	5/4	(150.189)	blue	collar shed by 8/4/80
303	M	7.5	217	5/4	153.870	green	--
304	M	10.5	235	5/4	150.031/.080	orange	--
(305)	M	(9.5)	217	5/5	(151.350)	green	Shot by hunter 8/30/80
307	M	2.5	105	5/5	--	orange	--
310	M	2.5	85	5/6	--	blue/green	--
(316)	F	(12.5)	150*	5/7	(148.912)	blue	w/ 1 newborn, 1 ylg. shot by hunter 8/28/80
317	F	7.8	133	8/18	152.703	white	
318	F	5.8	126	8/18	152.690	white	w/ 1 cub
319	M	3.8	174	8/18	152.682	orange	
(320)	M	(4.8)	200*	8/18	(152.663)	orange	Shot by hunter 9/9/80
321	F	10.8	175*	8/18	152.673	white	
322	M	4.8	154	8/19	152.643	orange	w/ 324
323	M	2.8	122	8/18	152.612	orange	
324	M	5.8	190	8/19	152.624	orange	w/ 322
325	F	11.8	164	8/18	152.632	white	
(326)	F	(5.8)	125	8/19	(152.560)	white	w/ 2 cubs, shot by hunter on 8/28/80
327	F	5.8	118	8/19	152.653	white	w/ 2 cubs
328	F	6.8	150	8/19	152.573	white	w/ 303
303	M	7.8	260	8/19	152.870	orange	recapture

* Weight estimated ( ) Shed collar or dead bear

bears remaining in the Susitna study area (October 1980) by sex and age categories is shown in Table 3.

The sex and age composition of current radio-collared bears is shown in Tables 3 and 4. The sex ratio of adult brown bears captured for Susitna hydro studies is comparable to that in an earlier study nearby and in the 10 year harvest statistics for Unit 13 (Table 5). The age structure of hydro-project bears was younger than in these other subpopulations (Table 5), most likely the result of small sample size for hydro-project bears but possibly indicating locally heavy harvest levels.

Larger numbers of radio-collared individuals would be helpful for both species. This is especially the case for brown bears which will be subject to heavy hunting pressures in spring 1981 if weather conditions are good during the season. Given equivalent hunting losses of radio-collared black bears in 1981, by the end of Phase I studies active black bear radios will have been reduced to minimally acceptable numbers.

3.2.2 - Brown Bear Seasonal Distribution and Movements

Relocations in 1980 for 15 radio-collared brown bears (excluding offspring and sequential relocations at the same den site) total 120 points (Table 6). For the 11 bears with active radios in winter 1980/81, 107 relocations were obtained (3-14 per individual) (Table 6). Dens were tentatively located for 10 of these 11 bears. Sightings of unmarked brown bears totaled 23, yielding a total of 143 point-locations for brown bears in 1980.

These point-locations are in the process of being digitized. The digitization process is designed to facilitate mapping and analysis of the point-location data; detailed analysis of these data will be delayed until digitization is complete and until

Table 3

Sex and age composition of marked brown bears remaining in the study area in October 1980. Number with radio-collars is given in parentheses.

1980 Age	Males	Females
0-1	0	0
1-2	2	1
2-3	2**	1
3-4	1	3 (1)
4-5	3 (1)	0
5-6	1 (1)	1 (1)
6-7	1 (1)	0
7-8	0	0
8-9	0	0
9-10	1	1 (1)
10-11	1 (1)*	2 (2)
11-12	0	0
12-13	2	1 (1)
13-14	0	1 (1)
Totals	14 (4)	11 (7)

* One capture-related mortality not included (G214).

** One bear shot by hunter not included (G311).

Table 4
Sex and age composition of marked black bears remaining in the Susitna study area, October 1980. Number with radio-collars is given in parentheses.

1980 Age	Males	Females
0-1	0	0
1-2	0	0
2-3	3 (1)	0
3-4	1 (1)*	0
4-5	1 (1)**	0
5-6	1 (1)	2 (2)**
6-7	0	1 (1)
7-8	1 (1)*	2 (2)
8-9	1	1 (1)
9-10	0 **	1 (1)
10-11	2 (2)***	2 (1)
11-12	0	1 (1)
12-13	0	0 **
Totals	10 (7)	10 (9)

* One post-capture mortality not included (B291, B300).
** One bear shot by hunter not included (B305, B320, B326, B316).
***One capture-related mortality not included (B296).

Table 5

Average spring ages, in years, of Susitna area brown bear subpopulations, 3.0 years or older.

Subpopulation	Average Spring Age in Years	(Range)	n
	Males		
A*	8.0	(3.5-23.5)	208
B**	7.4	(3.5-21.5)	17
C***	6.0	(3.5-12.5)	11
	Females		
A*	7.7	(3.5-28.5)	191
B**	7.4	(3.5-16.5)	15
C***	6.6	(3.5-13.5)	9

* Game Management Unit 13 fall harvests, 1970-1980

** 1979 Upper Susitna studies (Miller and Ballard 1980)

*** 1980 Susitna Hydro studies

Table 6

Brown bear relocation records for 1980.

Brown Bear #	Sex	1980 age at capture	Capture Date-Last Location	Number of Relocations	No. River Crossings	80/81 Den Located
277*	F	10.5	4/10/80 - 8/27/80	5	0	yes
(278)	M	9.5	4/19/80 -	-	0	-
(279)*	M	9.5	4/20/80 - <6/12/80	1	0	-
280*	M	5.5	4/20/80 - 10/13/80	9	2	yes
(214)*	M	4.5	4/22/80 - <9/980	10	0	-
281*	F	3.5	4/22/80 - 10/13/80	13	1	yes
282	M	4.5	4/22/80 -	-	-	-
283*	F	12.5	4/22/80 - 10/9/80	10	0	yes
284**	M	2.5	4/22/80 -	-	-	-
285**	M	2.5	4/22/80 -	-	-	-
286	M	3.5	5/1/80 -	-	-	-
292	F	3.5	5//280 -	-	-	-
293*	M	4.5	5/2/80 - 10/13/80	6	2	no
294*	M	10.5	5/2/80 - 10/13/80	13	1	yes?
(295)*	M	12.5	5/3/80 - <5/4/80	1	1	-
299*	F	13.5	5/4/80 - 10/13/80	10	2	yes
297**	M	1.5	5/4/80 -	-	-	-
298**	M	1.5	5/4/80 -	-	-	-
306	F	3.5	5/4/80 -	-	0	-
308A*	M	6.5	5/6/80 - 7/2/80	3	0	-
308B*	F	5.5	5/6/80 - 10/13/80	14	5	yes?
(309)*	M	12.5	5/6/80 - <5/14/80	1	0	-
312	M	10.5	5/7/80 - 9/29/80	11	0	yes
(311)**	M	2.5	5/7/80 -	-	-	-
313*	F	9.5	5/7/80 - 10/13/80	13	0	yes
314**	F	1.5	5/7/80 -	-	-	-
315	F	1.5	5/7/80 -	-	-	-

*Radio-collared
( ) Indicates shed collar or dead bear.
** bears which are offspring of previously listed adults

sufficient data to draw preliminary conclusions are available. Only general hypotheses, based on the preliminary point-location data, will be presented.

Brown bear use of the area in the immediate vicinity of the Susitna River and proposed impoundments appeared to be greatest in the early spring, 4-6 weeks following emergence from dens. Eleven of the 21 bears (offspring excluded) captured in the spring of 1980 were within about 5 km of the Susitna River and most of these were on south-facing slopes from which the snow had melted. Inspection of feces collected from these bears suggests that many were feeding on berries (Vaccinium spp.) remaining from the previous year's crop. At least two of these bears were feeding on a moose carcass found on the bank of the Susitna River, this moose probably was a winter kill rather than a bear kill. It is a reasonable speculation that bear scavenging early in the spring would be concentrated in the moose winter range along the river, the area where most carcasses would be found. The steep south-facing slopes along the Susitna River are also the first areas to become clear of snow and many offer the earliest opportunity to forage for vegetable material (previous year's berries, spring sedges and other new growth, tubers, etc.).

Preliminary data suggest that many brown bears move to lowland areas soon after emergence from dens. The 1980 capture locations for seven of the nine bears followed to 1980/81 dens was lower than the elevations of the 1980/81 dens. The average elevation difference for these seven bears was 1,266 ft. (275-2,370 ft.) (Table 7).

The importance of these spring foraging areas will be documented early in the spring of 1981 by following bears as they emerge from their dens. If the same bears that were captured along the

Table 7

Capture and den site locations for brown bears captured in 1980.

Bear Number	USGS Quadrangle	Coordinates Township	Range	Meridan	Elevation (feet)
Capture Sites					
309	Talkeetna Mts.	31N	3E	Seward	2350
308B	Talkeetna Mts.	32N	3E	Seward	3350
315	Talkeetna Mts.	31N	3E	Seward	3250
286	Talkeetna Mts.	31N	4E	Seward	1450
294	Talkeetna Mts.	31N	4E	Seward	1395
283	Talkeetna Mts.	33N	4E	Seward	3875
313	Talkeetna Mts.	33N	4E	Seward	3650
308A	Talkeetna Mts.	30N	5E	Seward	3300
281	Talkeetna Mts.	32N	5E	Seward	2150
282	Talkeetna Mts.	32N	5E	Seward	2100
279	Talkeetna Mts.	32N	5E	Seward	1900
312	Healy	21S	5W	Fairbanks	3350
293	Talkeetna Mts.	29N	6E	Seward	3550
292	Talkeetna Mts.	30N	6E	Seward	3600
299	Talkeetna Mts.	31N	6E	Seward	3040
295	Talkeetna Mts.	32N	6E	Seward	1575
278	Talkeetna Mts.	28N	7E	Seward	3575
277	Talkeetna Mts.	30N	7E	Seward	3050
280	Talkeetna Mts.	30N	8E	Seward	2775
306	Talkeetna Mts.	32N	9E	Seward	2750
214	Talkeetna Mts.	30N	10E	Seward	1950
Den Sites*					
	Talkeetna Mts.	27N	2E	Seward	2700
	Talkeetna Mts.	31N	2E	Seward	2250
	Talkeetna Mts.	33N	4E	Seward	4150
	Talkeetna Mts.	22S	6W	Fairbanks	4750
	Talkeetna Mts.	22S	5W	Fairbanks	4500
	Talkeetna Mts.	22S	4W	Fairbanks	3350
	Talkeetna Mts.	29N	6E	Seward	4000
	Talkeetna Mts.	31N	7E	Seward	3850
	Talkeetna Mts.	30N	7E	Seward	4850

* Bear numbers for den site locations are not included to avoid utilization of this information by hunters in spring 1981.

river in spring 1980 return to these sites in spring 1981, the hypothesis that the impoundment area is selectively (preferentially) utilized by brown bears early in the spring will be supported. Such results were found in a Montana study (Singer 1978) where grizzly bears were observed to concentrate during spring and fall on the floodplain of the north fork of the Flathead River where they fed on rhizomatous grasses, several key forbs, roots and tubers. Singer found this use to be especially marked in years of heavy snowfall.

Prairie Creek which flows from Stephan Lake to the Talkeetna River is well known as an area where brown bears concentrate in July and August to feed on salmon, especially king salmon. Alaska Department of Fish and Game sport fisheries biologists characterize Prairie Creek as having one of the highest concentrations of spawning king salmon in the Cook Inlet region (Larry Engle, pers. comm.). In July, four radio-collared brown bears (of 11 with active collars) moved to Prairie Creek to fish for salmon. The first of the radio-collared brown bears that moved to Prairie Creek was G294, a large male. He was in the Fog Creek area on June 23 but had moved to Prairie Creek by July 2 and remained there until August 22; he was next seen near Chunilna Creek in October.

Other radio-collared bears that moved to Prairie Creek in July and August were G308B, G293, and G283. On August 10, past the king salmon peak, a minimum of 13 brown bears were verified as using Prairie Creek (4 marked adults, 7 unmarked adults and 2 cubs); local residents have reported seeing 20 bears at one time on Prairie Creek. Our guess is that 30-40 individual brown bears fished in this area in the summer of 1980.

The importance of the Prairie Creek salmon run to study area brown bears will be difficult to evaluate. Other studies (Miller and Ballard 1980) indicate that moderately dense brown bear populations exist in the Nelchina Basin without access to salmon. However, it is possible that the availability of this interior run of salmon might provide nutritional benefits that result in local bear populations that are more dense or less nutritionally stressed (larger individuals) than adjacent populations without access to a salmon run.

All of the radio-collared bears seen at Prairie Creek had portions of their home ranges north of the Susitna River and therefore had to cross the river enroute to or from Prairie Creek. The maximum number of times an individual brown bear was known to have crossed the Susitna River in 1980 was five (Table 6).

3.2.3 - Brown Bear Density

An imprecise estimate of brown bear density was obtained from intensive trapping and mark-recapture techniques conducted in the Susitna River headwaters in 1979 (Miller and Ballard 1980). This estimate is compared with other North American estimates in Table 8.

Based on this density estimate of 1 bear/41-62 km^2, the Susitna study area of 3,500 km^2 would have a population of 56-85 brown bears. It is our subjective evaluation that brown bear density in the Susitna study area is more likely to be higher than that estimated in our earlier study, rather than lower. However, using the midpoint of this estimate, 70 bears, it can be seen that only approximately 37 percent of the bears inhabiting the study area have been captured and that only 15 percent are currently radio-collared. An accurate density determination may be obtainable only when essentially all brown bears utilizing the study area have been captured and marked.

Table 8

Reported brown bear population densities in North America.

mi^2/bear	km^2/bear	Location	Source
0.6	1.6	Kodiak Island, AK	Troyer and Hensel 1964*
6.0	15.5	Alaska Peninsula, AK	Unpublished data (Glenn pers. comm.)**
8.2	21.2	Glacier Nat.Park,Montana	Martinka 1974*
11.0	28.5	Glacier Nat. Park, B.C.	Mundy and Flook 1973*
9-11	23-27	SW Yukon Territory	Pearson 1975*
16-24	41-62	Upper Susitna R., AK	Miller and Ballard 1980
88	288	Western Brooks Range	Reynolds 1980
(16-300)	(43-780)	Nat. Pet. Res., AK***	
100	260	Eastern Brooks Range, AK	Reynolds 1976

* Taken from Pearson 1975.

**Data refer to a 1800 mi^2 intensively studied area of the central Alaska Peninsula.

***Mean is for the whole of the Nat. Pet. Reserve, AK, the range represents values for different habitat types in this reserve where the highest density occurred in an intensively studied experimental area.

3.2.4 - Black Bear Seasonal Distribution and Movements

Relocations in 1980 for 23 radio-collared black bears (excluding offspring and sequential relocations at the same den site) totaled 181 points (Table 9). For the 16 bears with active radios prior to October 1980, 143 relocations were obtained (4-19 per individual) (Table 9). Dens were located for 14 of these 16 bears. The two black bears without den site locations had not been found since early September 1980; possibly their radios failed. Sightings of unmarked black bears totaled 48, yielding a total of 229 point locations for black bears in 1980. Complete analysis of this point location data will be delayed until digitization is completed and more points are available; only general and preliminary conclusions from these data will be presented here.

Black bear distribution in the study area primarily was confined to a finger of habitat along the Susitna River and its major tributaries. This finger becomes progressively narrower and supports fewer bears as one proceeds upstream. We did not see black bears from Kosina Creek to Clarence Creek; however, reports indicate that their distribution is continuous to the mouth of the Oshetna River. Small numbers occur upstream at least as far as the confluence of the Tyone and Susitna rivers.

Within the study area black bear numbers appear to be much higher on the north side of the Susitna River than on the south side. In the spring it is reasonable to speculate that this preference may result from relatively advanced plant phenology on the south-facing slopes along the north side of the river. However, the north side of the river apparently was preferred throughout the rest of the summer as well, reasons for this are unclear.

Table 9

Black bear relocation records for 1980.

Brown Bear #	Sex	1980 Age at Capture	Capture Date-Last Location	Number Relocations	No. River Crossings	80/81 Located
*287	M	10.5	5/1/80 - 10/13/80	15	0	yes
*(288)	F	10.5	5/1/80 - 8/27/80	15	0	-
*289	F	9.5	5/2/80 - 10/13/80	13	4	yes
*290	F	8.5	5/2/80 - 10/13/80	19	4	yes
*(291)	M	3.5	5/2/80 - 7/20/80	5	0	-
(296)	M	10.5	5/3/80 -	-	-	-
*(300)	M	7.5	5/4/80 -	-	-	-
*301	F	7.5	5/4/80 - 10/13/80	19	2	yes
*(302)	M	8.5	5/4/80 - 8/4/80	5	0	-
*303	M	7.5	5/4/80 - 9/9/80	14	2	no
*304	M	10.5	5/4/80 - 9/9/80	14	0	no
*(305)	M	9.5	5/5/80 - 8/30/80	8	2	-
307	M	2.5	5/5/80 -	-	-	-
310	M	2.5	5/6/80 -	-	-	-
*(316)	F	12.5	5/7/80 - 8/28/80	3	0	-
*317	F	7.8	8/18/80 - 10/13/80	5	0	yes
*318	F	5.8	8/18/80 - 10/13/80	5	0	yes
*319	M	3.8	8/18/80 - 10/13/80	5	4	yes
(320)	M	4.8	8/18/80 - 9/9/80	0	1	-
*321	F	10.8	8/18/80 - 10/13/80	5	0	yes
*322	M	4.8	8/19/80 - 10/13/80	4	0	yes
*323	M	2.8	8/18/80 - 10/13/80	5	2	yes
*324	M	5.8	8/19/80 - 10/13/80	5	0	yes
*325	F	11.8	8/18/80 - 10/13/80	5	0	yes
*(326)	F	5.8	8/19/80 - 8/28/80	2	0	-
*327	F	5.8	8/19/80 - 10/13/80	5	1	yes
*328	F	6.8	8/19/80 - 10/13/80	5	0	yes

*Radio-collared

( )Indicates dead bear or shed collar.

Black bears are well known to be primarily restricted to forested biomes; this may be because trees are needed to avoid predation on cubs (Herrero 1972). The distribution of black bears in the study area follows this pattern. Especially in upstream portions of the study area, spruce-forested habitats are primarily restricted to the vicinity of the Susitna River and its major tributaries; black bears were seldom observed very far from these spruce habitats. Black bears occur farther from the Susitna River in downstream portions of the study area, an apparent correlation with the wider distribution of spruce forests downstream relative to upstream.

No quantitative data are yet available on the proportion of black bear range which is forested, therefore, selectivity or preference for forested areas in the study area cannot yet be demonstrated. However, a preliminary and superficial analysis of the number of point locations of radio-collared bears which occurred in spruce habitats (habitat categories 1-9) and non-spruce habitats was attempted (Table 10). As can be seen, black bears were most commonly found in spruce forested habitats in the spring (72% of the point locations in May) and least commonly found in these habitats in September (35% of the point locations) (Table 10). Throughout the year 55 percent of the point locations occurred in spruce habitats. These data probably underrepresent the importance of spruce habitats to black bears as many observations classified as in non-spruce habitats were in close enough proximity to spruce habitats that these habitats were readily available to the bear should they be needed for escape or other purposes. This situation can be clarified by using the vegetation maps that have recently become available.

From the perspective of a black bear it is evident that not all spruce forests in the study area are equal. Some areas are much more densely populated by black bears than others that appear

Table 10

Monthly occurrence in spruce habitats for 23 radio-collared black bears in the Susitna study area (capture and den sites not included).

Month	No. Observations				
	In Spruce Habitats	In Non-Spruce Habitats	In Unspecified Habitats	Total	% In Spruce Habitats
May	23	9	2	34	72
June	17	9	1	27	65
July	11	14	0	25	44
August	28	24	1	53	54
September	9	17	0	26	35
Totals	88	73	4	165	55

equivalent with respect to the superficial appearance of the spruce component. An example of this is the apparent preference of black bears for the north side of the Susitna River, mentioned above. Detailed analyses of vegetation composition in these stands as well as food habits studies and perhaps, behavioral studies will be necessary to identify the habitat components which govern black bear distribution and abundance.

Data collected to date suggested that black bears are found least frequently in spruce habitats in late summer (July-September) (Table 10). At this time black bears increasingly concentrated on the tablelands between the Susitna River spruce habitats and the nearby foothills to the north. Observations as well as feces collected in August 1980 suggest that bears were seeking the ripening berries (Vaccinium spp.) which appeared much more abundant on the tablelands than in the spruce forests.

The most important tableland areas identified included the area around the Watana campsite, between Tsusena Creek and Delusion Creek, and the uplands between Devil Creek and Tsusena Creek, especially the eastern portion of this area (T31-32N/R4E) (Table 11). At the time black bears were using these tablelands, brown bears occurred primarily at higher elevations.

Black bears do use the south side of the Susitna River. They were occasionally located on the Fog Lakes Plateau and other areas, but data collected to date suggest the south side of the river is not preferred. One unmarked black bear was seen about 1 mile from Prairie Creek on August 4; however, Prairie Creek salmon do not appear to be an important food source for Susitna area black bears. Possibly the abundance of brown bears around Prairie Creek during the salmon run deters black bears. Residents of Stephan Lake Lodge report that they have not seen black bears along Prairie Creek during the salmon run.

Table 11

Black bear capture sites, 1980.

Bear Number	USGS Quadrangle	Township	Range	Meridan	Elevation (feet)
Capture Sites					
B287	Talkeetna Mts.	31N	3E	Seward	1850
B288	Talkeetna Mts.	31N	3E	Seward	1950
B289	Talkeetna Mts.	32N	5E	Seward	2050
B290	Talkeetna Mts.	31N	2E	Seward	1900
B291	Talkeetna Mts.	32N	5E	Seward	1625
B300	Talkeetna Mts.	30N	10E	Seward	2450
B296	Talkeetna Mts.	30N	10E	Seward	2850
B301	Talkeetna Mts.	30N	10E	Seward	2250
B302	Talkeetna Mts.	31N	8E	Seward	1850
B303	Talkeetna Mts.	32N	4E	Seward	2225
B304	Talkeetna Mts.	32N	4E	Seward	2225
B305	Talkeetna Mts.	33N	5E	Seward	2150
B307	Talkeetna Mts.	33N	4E	Seward	2350
B310	Talkeetna Mts.	31N	3E	Seward	2400
B316	Talkeetna Mts.	32N	4E	Seward	1750
B317	Talkeetna Mts.	32N	5E	Seward	2260
B318	Talkeetna Mts.	31N	4E	Seward	2025
B319	Talkeetna Mts.	31N	4E	Seward	1990
B320	Talkeetna Mts.	31N	4E	Seward	2400
B321	Talkeetna Mts.	31N	3E	Seward	2350
B322	Talkeetna Mts.	32N	6E	Seward	2375
B323	Talkeetna Mts.	32N	5E	Seward	2225
B324	Talkeetna Mts.	32N	5E	Seward	2400
B325	Talkeetna Mts.	31N	3E	Seward	2150
B326	Talkeetna Mts.	32N	5E	Seward	2400
B327	Talkeetna Mts.	32N	5E	Seward	2200
B328	Talkeetna Mts.	32N	5E	Seward	2225

Table 12

Black bear den sites, 1980-81.

Bear Number	USGS Quadrangle	Township	Range	Meridan	Elevation (feet)
Den Sites					
B287	Talkeetna Mts.	31N	3E	Seward	1750
B289	Talkeetna Mts.	32N	6E	Seward	1950
B290	Talkeetna Mts.	31N	3E	Seward	1850
B301	Talkeetna Mts.	30N	10E	Seward	2000
B317	Talkeetna Mts.	32N	4E	Seward	1850
B318	Talkeetna Mts.	32N	4E	Seward	2500
B319	Talkeetna Mts.	31N	2E	Seward	1300
B321	Talkeetna Mts.	31N	3E	Seward	2750
B322	Talkeetna Mts.	32N	5E	Seward	1950
B323	Talkeetna Mts.	32N	5E	Seward	1750
B324	Talkeetna Mts.	31N	4E	Seward	2190
B325	Talkeetna Mts.	31N	5E	Seward	1500
B327	Talkeetna Mts.	32N	5E	Seward	1975
B328	Talkeetna Mts.	32N	5E	Seward	1725

Of the black bears with four or more radio-locations, eight crossed the Susitna River at least once during 1980 and 12 had no crossings documented (Table 9). Three black bears were documented to have crossed the river four times (Table 9). Black bears crossed the river more frequently than brown bears and a higher proportion of the black bear population crossed the river. This was not unexpected as all radio-collared black bears were in the immediate vicinity of the Susitna River while the home ranges of many brown bears were not adjacent to the river. Reasons for frequent river crossings by black bears and the importance of those crossings to the bear population are not known.

Black bear den sites were located only from the air (Table 12). Den characteristics, including exact elevation, slope, aspect, habitat type, will be recorded from the ground after the bears have left. However, our aerial locations indicated that most black bear dens were below or near the proposed high water mark of the proposed impoundments (assuming 2,200 feet for the Watana dam and 1,450 feet for the Devil Canyon dam. Five dens used by radio- collared black bear were below the impoundment level (average elevation=1,925 ft, range=1,750-2,000 ft.). Two of the nine black bears denning in the impact area of the Devil Canyon impoundment had dens apparently below the impoundment level (average elevation=1,935 ft., range=1,300-2,750 ft.).

All of the dens in the vicinity of the proposed Watana impoundment are in spruce habitats along the river or tributaries such as Deadman Creek, and four of the nine black bear dens in the vicinity of the Devil Canyon impoundment are in spruce habitats along the river or tributaries such as Tsusena Creek.

Future studies should be directed at identifying habitat components critical for black bears and assessing the availability of these components outside of proposed impoundment areas. Such critical components may vary between years. For example, a food source used only lightly during years of abundant berries might be critical in years of berry crop failure.

3.2.5 - Black Bear Densities

No black bear density estimates are available from the study area or adjacent areas. Our subjective impression is that portions of the study area were very densely populated by black bears relative to other Alaskan habitats. The only available data that permit even a crude density estimate come from sightings of marked and unmarked black bears during the August tagging operation.

In 1 1/2 days of spotting effort (August 18-19), 35 bears were seen in approximately 259 km^2 of search area, four of these were marked. A radio-tracking effort on August 14 verified the presence of seven radio-collared black bears in the search area. A straightforward Lincoln Index on these observations yields an approximation of 61 bears in this area or 1 bear/4.1 km^2. An "adjusted" index (Richer 1975) yields an estimate of 58 bears (s.d.=19). These estimates should be viewed cautiously as there are many possible sources of bias in the technique and it covers only a small portion of the study area at a season when bears might have concentrated in search of a locally abundant food source. Regardless, the density estimate of 4.1 km^2/bear falls roughly at the mid-point of reported black bears densities in North America (Table 13). Our subjective evaluation is that further studies in the Susitna study area are more likely to reveal that the above density approximation is too low rather than too high, at least in the habitats where black bear density is highest.

Table 13

Black bear population densities in various North American localities (adapted from Modafferi 1978).

Source	Location	mi^2 Per Bear	km^2 Per Bear
McIlroy (1972)*	Alaska (coastal population)	0.1	0.3
Lindzey and Meslow (1977)	Washington (an island population)	0.3	0.8
Poelker and Hartwell (1973)	Washington (mainland population)	0.7-1.0	1.8-2.6
Piekielek and Burton (1975)	California	0.8-1.0	2.1-2.6
Beecham (1980)	Idaho (Councial area)	0.8	2.1
	Idaho (Lowell area)	0.9	2.3
Jonkel and Cowan (1971)	Montana (Bear Creek)	0.8-1.7	2.1-4.4
LeCount (1980)	Arizona	0.8	2.1
Pelton and Burghardt (1976)	Tennessee	0.5-1.0	1.3-2.6
Kemp (1972)	Alberta	1.0	2.6
Modafferi (1978)	Prince William Sound, Alaska	1.2	3.1
Erickson and Petrides (1964)	Michigan	3.4	8.8
Spencer (1955)	Maine	5.6	14.5
Clarke (1977)	New York (Adirondacks)	2.6	6.7
	New York (Catskill)	3.7	9.6
	New York (Allegany State Park)	10.0	25.9

* Probably estimated during seasonal concentration.

3.2.6 - Needs for Further Study

A larger proportion of bear populations in the study areas must be radio-collared in order to clearly establish seasonal use patterns and more accurately estimate density. This process will continue throughout the remainder of Phase I and into Phase II. The most cost-effective time to capture black bears is in early August when black bears appear to be most visible and vulnerable to capture. At this same time efforts should be made to mark black bears in portions of the study area where bears appear to be less dense, notably from Watana Creek upstream to the gaging station at the Vee Canyon. This will provide a more complete perspective of black bear populations and movements in the vicinity of the whole impoundment-impact area. Brown bear tagging efforts will be most effective in early spring (April-May).

An effort is planned for August 1981 to directly and intensively census areas of high black bear density and thereby to refine Lincoln Index density estimates.

Black bear and brown bear dens will be visited and marked in the winter of 1980/81 for subsequent studies of den site characteristics. Radio collars will be replaced at this time for some black bears, and some yearling black bears will be collared with experimental expandable radio collars to document foci of black bear dispersal. Both species will be intensively monitored following emergence from dens in order to document suggested intensive early spring usage of south-facing slopes along the river.

Bear feces will be collected whenever encountered, and the precise location where feces were found recorded. Feces will be analyzed to evaluate seasonal food habits during Phase II if funds are available.

The apparent heavy utilization by black bears of riparian habitats in the immediate vicinity of the Susitna River strongly suggests that downstream bear studies may be needed in Phase II. Under impoundment regulation procedures which would restrict periodic flooding and result in corresponding vegetational changes, the potential for downstream impacts on bears, especially black bears, cannot be ignored. Seasonal selection by bears for early successional, riparan habitats has been reported for brown bears in Montana (Singer 1980), black bears in Montana (Tisch 1961) and black bears in California (Kelleyhouse 1980).

Continuity of data on the same animal throughout both phases of the study is highly desirable. Radio collars placed on bears during 1980 have a maximum life span of 24 months and cannot be expected to last until the start of Phase II. Therefore, recollaring for Phase II studies should be done during 1981. These collars should be ordered by March 1981.

3.3 - Caribou

3.3.1 - Distribution and Movements

When field operations began in mid-April 1980 the main wintering concentration of caribou was spread over an area extending west and south from the Chistochina River to the Gakona River, along the southern foothills of the Alphabet Hills and throughout the Lake Louise Flat. Smaller numbers were also present in drainages of the upper Nenana, Susitna and Talkeetna rivers and the Chunilna Hills. During spring (20 April - 20 May) two routes of movements were primarily used; animals moved from the Lake Louise Flat into the foothills of the Talkeetna Mountains in the vicinity of the Oshetna River and caribou crossed the Susitna River north to south in the area from the big bend of the Susitna to Deadman Creek.

The majority of females (including 21 of 26 radio-collared females) utilized the traditional calving grounds between the Oshetna River and Kosina Creek in the northern foothills of the Talkeetna Mountains. Twelve of the 21 radio-collared females were seen with calves. The two females collared in the headwaters of Talkeetna River remained there through calving (and through the study period to date). One of these females reared a calf. Three of four females collared in the upper Susitna-Nenana drainages remained there through the calving period. Two of these females were known to produce calves. The calving period appeared to be about the same as previously reported, 15 May to 10 June (Hemming 1971).

Since 1949, the first year for which records are available, Nelchina caribou have utilized an area of about 1,000 square miles in the northern Talkeetna Mountains for calving (Skoog 1968, Hemming 1971, Bos 1974). While the precise areas utilized have varied, calving has taken place between Fog Lakes and the Little Nelchina River between 3,000 and 4,500 feet elevation. The only deviations have been during years with extremely heavy snow accumulations when some calving took place during the migration to the traditional calving grounds (Skoog 1968, Lentfer 1965, Bos 1973).

The main summering concentration of Nelchina caribou occurred in the northern and eastern slopes of the Talkeetna Mountains between Tsisi Creek and Crooked Creek. The upper Oshetna and Little Oshetna rivers appeared to be the center of the summer range. The caribou generally ranged considerably higher in elevation than during calving, primarily between 4,000 and 6,000 feet. One radio-collared animal was found at 6,800 feet. Additional summering caribou were found in the upper Talkeetna River, the Chulitna Mountains and the Butte Lake-Brushkana Creek area. Additionally, groups of summering bulls were found in the Jay Creek-Coal Creek area, the Clearwater Mountains, the Alphabet Hills, the Chunilna Hills and the Amphitheater Mountains. Skoog (1968) referred to additional summer "bull pastures" in the upper Nenana, Chickaloon and the Talkeetna river drainages.

Historically, the female-calf segment of the Nelchina herd has primarily summered in two areas: the eastern Talkeetna Mountains and across the Susitna River in the Brushkana, Butte, Deadman, Watana, Jay and Coal creeks complex (Skoog 1968, Hemming 1971). In 1960 and 1961 some females and calves summered in the Alphabet Hills and Amphitheater Mountains (Skoog 1968). Postcalving and summer movements of varying proportions of the female-calf segment (ranging from 0-100%) from the calving grounds and summer range in the Talkeetna Mountains across the Susitna River occurred in most years between 1950 and 1973. Timing of major movements ranged from mid-May through July. Crossings apparently occurred between Deadman Creek and the big bend of the Susitna.

In mid- to late August a portion of the main summering concentrations moved out of the Talkeetna Mountains onto the western portion of the Lake Louise Flat and in some cases into the Alphabet Hills. The exact routes of movement were not determined; however, it seemed that while a few animals may have crossed the Susitna River in the area of the proposed Watana impoundment, most probably moved onto the flat further to the east. Through September the distribution remained relatively stable with the main herd divided between the northeastern Talkeetna Mountains, the Lake Louise Flat and the Alphabet Hills.

During the rutting pause the "main" Nelchina herd was found almost exclusively on the Lake Louise Flat. Several hundred animals were located on Slide Mountain in the southeastern corner of the flat. The Talkeetna River and upper Susitna-Nenana radio-collared animals were not relocated during the rut; however, they were assumed to have remained in their normal ranges as they were found there both before and after the rut and were not found with the main Nelchina herd.

During early winter (2-5 December 1980, last survey) there were two main groups: the largest group was spread from the Maclaren River east through the Alphabet Hills and along the west fork of the Gulkana River across the Richardson Highway and trans-Alaskan pipeline to the Chistochina River; the other group was in the Slide Mountain-Little Nelchina River area. A few additional caribou were scattered through the Lake Louise Flat. The upper Susitna-Nenana and Talkeetna river groups remained in their normal ranges.

Nelchina caribou have utilized numerous winter ranges during the past 30 years ranging from upper Nenana-Yanert Fork drainages to the Talkeetna River east to the Mentasta and Wrangell mountains (Skoog 1968, Hemming 1971).

3.3.2 - Subherds

Eide (1980) suspected that subherds with separate calving areas existed in several areas of the Nelchina range. He based this conjecture on reports of sighting of animals, including young calves, in these locations during all seasons including the calving period. Locations of these possible subherds were the Watana Creek Hills (upper Susitna-Nenana drainages), the Talkeetna River, Chunilna Hills, Alaska Range and Gakona River. Because of their proximity to the proposed hydroelectric development and potential for increased isolation, radio collars were placed on animals in three of the suspected subherds: Talkeetna River, Chunilna Hills and upper Susitna-Nenana river drainages. Because of the changeable nature of caribou movements and the short duration of the study the results are preliminary and may be interpreted differently when additional data are available.

3.3.2.1 - Talkeetna River

Two adult females and one adult male were collared in late April. All remained in the area throughout the study period. One collared female raised a calf. Several other females with calves were seen. The bull summered in the Talkeetna Mountains west of the main river but returned to the headwaters in the fall. The tentative conclusion is that this is probably a legitimate resident subherd composed of approximately 400 animals.

3.3.2.2 - Chunilna Hills

One adult bull and one adult female were collared in late April. The female died within a month after capture. The bull remained in the Chunilna Hills through the fall. No sighting of females and young were made during the calving period. Insufficient data are available to speculate on subherd status.

3.3.2.3 - Upper Susitna-Nenana

Four adult females and one adult male were radio-collared in early May. One of the females migrated to the main Nelchina calving area, summered in the Talkeetna Mountains, migrated back through the upper Susitna-Nenana area in the fall and rejoined the main Nelchina herd during the rut and early winter on the Lake Louise Flat. The other three females remained in the upper Susitna-Nenana area throughout the study period, two producing calves. Other females with calves were seen. The bull summered in the Clearwater Mountains then joined the main Nelchina herd during the rut in the Lake Louise Flat. One of the main Nelchina radio-collared adult bulls summered in the upper Susitna-Nenana area before rejoining the main Nelchina herd on the Lake Louise Flat during the rut. It seems likely that a resident subherd of approximately 1,000 caribou exists in this area. However, the situation is confounded by movements of animals from the main Nelchina herd through the area and by use of the area by summering bulls and the main Nelchina herd.

3.3.3 - Population Size and Composition

Census activities were conducted from 2-5 July 1980. Reconnaissance flights showed that the post-calving female:calf segment of the main Nelchina herd (including 19 of 20 radio-collared females considered to be main Nelchina animals) was in an area of about 260 square miles in the southeastern Talkeetna Mountains. The area was subdivided into three areas based on geographical features and apparent composition of animals. A total of 17,061 caribou were counted: 9,771 in area A, 2,838 in area B and 4,907 in area C. Composition data from the three areas (Table 14) indicated significant differences (Chi-square = 143.15, $P<0.001$) in the proportions of males, females and calves. The composition sampling effort was not proportional to the numbers of caribou in each of the subareas, therefore the data were weighted (Table 14) to provide the most precise estimate of composition possible. An additional 244 caribou (including cows and calves) were found in peripheral areas and were assumed to have the same composition as the weighted estimate. Therefore the post-calving aggregation totaled 17,305 caribou with an estimated composition of 2,808 males $\geq$ 1 year, 9,285 females $\geq$1 year and 5,212 calves.

Fall composition data (Table 15) were collected on 14 October 1980 when the main Nelchina herd was distributed on the Lake Louise Flat during the rut. The ratio of males $\geq$1 year to 100 females $\geq$1 year was 61.9, the highest ever recorded for the Nelchina herd. While collecting the composition data it was felt that sampling was probably biased towards males. Large males were conspicuous. Also, concentrations of males usually occurred as the back of groups where sampling began. Often the

Table 14

Nelchina caribou post-calving sex and age composition data, 5 July 1980.

Area	MM per 100 FF	Calves per 100 FF	Calves		Cows		Bulls	
			N	%	N	%	N	%
A	19.8	54.8	222	31.4	405	57.3	80	11.3
B	76.9	37.4	107	17.5	286	46.7	220	35.9
C	33.5	67.6	184	33.6	272	49.7	91	16.6
Weighted*	30.2	56.1		30.1		53.7		16.2

* Weighing was based on composition samples and numbers of caribou counted (see text) in each of the subareas.

Table 15
Nelchina caribou fall sex and age composition data, 14 October 1980.

MM per 100 ♀	Calves per 100 ♀	Calves N	Calves %	Cows N	Cows %	Bulls N	Bulls %
61.9	42.3	170	20.7	402	49.0	249	30.3

groups fragmented and animals towards the front were not fully sampled. An indication that the data may have been representative or that observer bias has been consistent over time was the nearly perfect fit (r^2=0.99) of this year's ratio with the linear increase which has occurred since 1976. Indeed an increase in the proportion of males would be expected for a herd which is increasing and previously had a relatively low proportion of males.

The estimated fall population was calculated as follows:

$$18,558=17,305 \times 0.537 \times 0.978 \times (1+1.042),$$

where 17,305 = the number of animals in the post-calving aggregation, 0.537 = proportion of females in the post-calving aggregation, 0.978 = survival of females from the time of post-calving counts until fall and consists of an estimated 2.2 percent hunter harvest, 1.042 = ratio of bulls and calves to females in the fall. The figure 18,558 is the fall population estimate.

In recent times the Nelchina herd has increased from 37,000 in 1956 (Watson and Scott 1956) to 71,000± 11,867 in 1962 (Siniff and Skoog 1964) and then declined to about 8,000 in 1972 (Bos 1973, 1975). Since that time the herd has appeared to increase slowly to the present estimate of 18,558.

3.3.4 - Habitat Selection

Analyses of habitat use and selection are dependent on computer programs and habitat mapping not yet available when this report was prepared. Bos (1974) and Skoog (1968) remarked on habitat characteristics of the Nelchina calving grounds: 2,600 to 4,600 feet elevation, gently sloped, shrub birch, meadow, dwarf heath, relatively low snow pack and early snow loss. Characteristics of summering habitat include high elevation, wind exposure, scattered patches of snow and ice, grass, sedge, willow, dwarf birch and forbs (Skoog 1968, Hemming 1971). Suitable winter habitat characteristics include snow depths <60 cm, ice crust <3.8-6.4 cm, irregular terrain, forest and/or shrub cover, lichens, sedges, and windswept range (Hemming and Pegau 1970, Skoog 1968).

3.3.5 - Planned Activities for Remainder of Phase I

Distribution and movement studies and habitat selection studies will continue through Phase I with routine monitoring of radio-collared caribou. Increased emphasis will be placed on more frequent monitoring when animals are near the proposed impoundment sites, i.e. 15 April - 15 June and 1 August - 1 October. To more precisely evaluate subherd status at least two females will be collared in the Chunilna Hills area and monitored periodically, particularly during the calving period. Radio-collared caribou in the Talkeetna River and upper Susitna-Nenana subgroups will be monitored to better evaluate their subherd status. Population size of the Nelchina herd will again be estimated using the aerial photo-direct count-extrapolation caribou census technique.

During field activities well-worn caribou trails were noted in the vicinity of the proposed Watana impoundment. LeResche and Linderman (1975) and Skoog (1968) both remarked on the value of mapping caribou trail systems to document historical movement patterns. Plans include mapping the trail systems in the vicinity of the proposed impoundments to determine traditional crossing sites.

3.4 - Dall Sheep

3.4.1 - Watana Hills

The Watana Hills were established as a population trend count area in 1967 by ADF&G and have been counted seven times since then. The 1980 count of 174 sheep is higher than the 7 year average of 160 sheep (Table 16). If the low count of 76 sheep in 1974 is eliminated, the 6 year average is 175, suggesting that population numbers have remained stable. Also, the percentage of legal rams and lambs were similar. Some yearly variation is expected in count data because of differences in observers and counting conditions and minor population fluctuations.

The distribution of sheep observed in the Watana Creek Hills trend count area on 22 July indicated that sheep were generally widespread and all were at elevations above 3000 feet. Sheep distribution is likely to be more restricted during winter when deep snow and ice make portions of their range inaccessible. We would expect greater use of lower elevations, south facing slopes and windswept areas during winter. A late February or early March survey is planned to document winter distribution.

Several observations suggest significant use of habitat that may be directly impacted by the Watana impoundment. Three sheep observations reported in June 1980 were near the 2200 foot elevation on Jay Creek. One group consisted of 23 animals or 13 percent of the number of sheep counted in July. Other observations at the same time of year were near the 3000 foot level. The significance of these sightings is not known, however sheep often use mineral licks at that time of year. Some licks profoundly influence sheep distribution and movements (Heimer 1973). Two other licks have been identified in the area, but little is known of their use. Therefore, further investigation of sheep use of Jay Creek is warranted.

Table 16

Compilation of highest yearly counts completed in Watana Hills sheep trend count area.

	Legal Rams*	Lambs	Total	% Legal Rams	% Lambs		
1950			0			Scott	
1967	--	--	220	--	--	Nichols	
1968	--	--	183	--	26.6	Nichols	Aug.
1973	10	40	176	5.6	22.7	McIlroy	Aug. 1973
1974	6	18	76	7.9	23.7	Harkness	April
1976	4	30	130	3.1	23.0	Eide	Aug.
1977	4	33	152	2.6	21.7	Spraker	July 11
1978	5	34	189	2.6	18.0	Eide	July 23
1980	9	42	174	5.1	24.1	Tobey	July 22

* A legal ram is defined as having a 3/4 curl or greater horn.

3.4.2 - Mount Watana

An intensive search from Mt. Watana to Grebe Mountain resulted in a total of eight sheep (1 ram, 7 unidentified) being observed. While few historical data from this area exist, past observations indicate that larger numbers of sheep sometimes occupy this area. For example in 1977, 34 sheep were seen on Mt. Watana. Numerous observations have been made around Terrace Creek in recent years and a few sheep have been harvested in that vicinity from this area. Either sheep moved from the area or they were missed on the 1980 survey.

The pattern of sheep distribution to the south of the survey area suggests that sheep using the Mount Watana area may be part of a larger Talkeetna Mountains population (ADF&G 1973).

3.4.3 - Portage - Tsusena Creek

A total of 72 sheep (6 legal rams, 12 lambs and 54 unidentified) was counted in the Portage Creek and Tsusena Creek drainages. The only previous ADF&G survey in this area was a 1977 count of 91 sheep (8 legal rams, 18 lambs, 65 others). The 1977 survey included the Jack River drainage which was not surveyed in 1980. The sheep sighted were fairly high in the drainages and relatively far from proposed impoundments. Sheep may concentrate closer to the Susitna River in winter and may occupy habitat close to potential access routes. Therefore a winter distribution survey of the area will be conducted.

3.4.4 - Hunter Use

The 1980 harvest within the Susitna sheep study area was 13 sheep. Eight of these were considered to be trophy quality with horn lengths greater than 35 inches. Most of the harvest occurred in the Watana Creek Hills.

3.5 - Wolverine

From 10 April to 7 May 1980, five adult wolverine (4 males, 1 female) were captured and outfitted with radio collars. Capture of additional wolverine was precluded by poor tracking conditions caused by an early spring breakup. One male (941) died 2 days after capture due to capture related causes. Contact was lost with both 042 (fate unknown) and 044 (probably dropped collar) after 16 August and 9 October, respectively. Tagging locations and physical measurements are given in Table 17 and data on drug action in Table 18. Since the Sernylan was outdated, induction times of wolverine immobilized with this drug may not be indicative of normal induction times. The two successful M-99 immobilizations suggest that M-99 may be an adequate substitute for Sernylan (which is no longer available commercially).

3.5.1 - Movements and Habitat Selection

From April through December 1980, two wolverine were located on 86 occasions. Wolverines were visually sighted on 33 (38%) of the 86 locations. Home ranges were determined for all four wolverine, summer ranges for wolverines 042 and 044, and spring-fall ranges for 040 and 043 (Table 19).

The spring-fall ranges of 399 and 272 km^2 for two adult males are well below those for the Brooks Range, Alaska, where Magoun, (1979) reported an average male had a home range of 615 km^2. Similarly Krott (1959) believed a male wolverine could have a territory as large as 1,000 to 2,000 km^2 depending on food supply and competition from other species. In contrast, Hornocker (in press) reported an average home range of 388 km^2 for males and 100 km^2 for females. Bjarvall (in prep.) calculated home ranges for three lactating females (during different years) in Sweden to range from 109-221 km^2 (mean = 170 km^2). These reported ranges were somewhat larger than

Table 17

Tagging location and physical measurements of wolverine captured in the Susitna River Basin, 1980.

Accession Number	Date	Location	Sex	Est. Age	Weight	Body Length
116040	4/10/80	4.8km NW of Clarence Lk.	M	7-12	14.5kg	87.6
116041	4/19/80	5.6km upstream of mouth of Fog Creek	M	2-3	15.5kg	87.0
116042	4/19/80	Watana Creek	F	2-3	9.5kg	80.0
116043	5/06/80	4.0km SE of of Standing Bear Lake	M	1-2	17.7kg	81.9
116044	5/07/80	Across Susitna River from Stephan Lake	M	--	--	--

Table 18

Drug type, dosage, and subsequent induction time for wolverine captured in the Susitna River Basin, 1980.

Accession Number	Date	Sex	Wt. (kg)	Age	Drug	Dosage	Induction Time (min.)	Recovery Time (min.)
116040	4/10/80	M	14.5	7-12	Sernylan	0.25cc	36	--
116041	4/19/80	M	15.5	2-3	M-99	2mg	4	--
116042	4/19/80	F	9.5	2-3	Sernylan	0.25cc	11	90
					Rompun			
116043	5/06/80	M	17.7	1-2	M-99	0.4cc	14	7
					Rompun	0.5cc		
116044	5/07/80	M	--	--	M-99	0.4cc	12	2
					Rompun	0.5cc		

Table 19

Summary of home range size for four radio-collared wolverine in the Susitna River Basin, 1980.

Accession Number	Sex	Est. Age	Home Range (km^2)	Greatest Length Across Home Range (km)
040	M	Adult	399 - spring-fall	35.5
042	F	Adult	86 - summer	15.2
043	M	Adult	272 - spring-fall	19.4
044	M	Adult	378 - summer	49.8

Table 20

Comparison of annual wolverine harvests from 1962-63 through 1979-80 in Game Management Unit 13.

Year	Harvest	Year	Harvest
1962-63	37*	1972-73	140***
1963-64	32*	1973-74	121***
1964-65	65*	1974-75	96***
1965-66	102*	1975-76	105***
1966-67	132*	1976-77	85***
1967-68	86*	1977-78	58***
1968-69	No Data**	1978-79	69***
1969-70	No Data**	1979-80	57***
1970-71	No Data**		
1971-72	75***		

* Harvest figures are from bounty records.

** The bounty was discontinued on wolverines during this period, and no information on the harvest is available.

*** Harvest figures are from sealing records.

the home range of the lactating female 042 in this study, which was 86 km^2. Differences in observed home range size between Brooks Range and Susitna basin wolverine may result from differences in sampling intensity. However, we would expect the greater diversity and abundance of food items found in the Susitna basin to permit smaller home ranges.

All four collared wolverine showed a fidelity toward shrub (shrub willow and dwarf birch) dominated habitats, such habitats accounted for 54 percent (44 of 81) of the relocations. Using the vegetation maps, the percent occurrence of each habitat in the wolverine's home range will be calculated and inferences about wolverine habitat selection will be determined. Also, it will be very beneficial to characterize wolverine habitat by available prey species. Coordination between investigators of the small mammal, the ungulate, and the predator studies will be necessary to determine prey distribution.

In relation to topography, the four radio-collared wolverine appeared to favor southerly and westerly slopes. There was some evidence that the Susitna River formed a partial barrier to wolverine movements during the ice free period. No track sightings were observed on the main Susitna River, although we did not purposely search for them. There were only three occurrences of river crossing by radio-collared wolverine during the entire study period. All crossings (two by 040, one by 044) occurred during early spring, when the river was open but at reduced flow. Home ranges of the three male wolverine appeared to parallel the river as the greatest distance across their home ranges runs from east to west. Also, only 9 percent (6 of 66) locations were within 0.5 km of the river. Both Magoun (1979) and Hornocker (op. cit.) indicated that rivers were not barriers to wolverine movements. However, in both studies, rivers were much smaller than the Susitna which can reach flows of 90,000 cfs during the summer (U.S. Army, Corps of Engineers 1975). The low number of locations during the winter does not allow any inferences about usages of the river when it is frozen. It is known, however, that wolf packs in the study area use it as a travel corridor (Ballard et al. 1980).

Wolverine 043 also exhibited a gradual change in home range usage. Between 6 May and 27 June 1980, 11 of 14 observations were east of Devil Creek. However, from 27 June to 4 December, all observations were west of Devil Creek and east of Portage Creek. Without any knowledge of prey availability or distribution of females, it is impossible to make any inferences on the shift of home range preference of 043. Increased monitoring during the next spring and summer may give an indication how these different areas fulfill 043's seasonal requirements.

Wolverine 044 was collared on the Susitna River across from Stephan Lake on 7 May 1980. By 13 June 1980, 044 had moved approximately 70 km to the vicinity of Kosina and Tsisi creek drainages. It remained there until 26 August when it began moving back toward Stephan Lake. On 7 October, 044 was located 6 km east of Stephan Lake. Contact was lost after 8 October due to a probable slipped collar. This extensive movement after collaring went from a heavily timbered habitat to an upland shrub and tundra habitat. We suspect that timing of movement may be correlated with peak emergence of Arctic ground squirrels and marmots, which are more abundant in these higher, more open habitats. Ground squirrels and marmots are an important food species for wolverine in the Brooks Range (Magoun op. cit.) and northwestern Montana (Hornocker op. cit.). On several occasions during the summer we observed wolverine with ground squirrel kills.

3.5.2 - Ground Tracking

Ground tracking trips conducted in mid-May and early December 1980 indicated that wolverine were preying on small mammals. On 15 May, a fresh set of tracks of an uncollared wolverine within 043's home range was followed for approximately 5 km. Along this route many ground squirrels were observed and four squirrel tunnels had been excavated by the wolverine. There was no sign of capture. The wolverine was followed predominantly through alpine tundra and upland willow habitats.

On 1 December, wolverine tracks were followed along the north side of Watana Creek through a white spruce-*Salix* habitat which was interspersed with alder thickets corresponding with small drainages. The tracks were followed for approximately 5 km. The wolverine appeared to be hunting red squirrels. While in white spruce (*Picea glauca*) habitat, the wolverine appeared to investigate trees where squirrels had been present. He had excavated two red squirrel middens. As the wolverine came to an alder thicket, it crossed the thicket with no deviations, suggesting lack of preference for this habitat type. No evidence of a kill was observed.

3.5.3 - Carcass Collection and Analyses

Thirty-three carcasses were purchased from local trappers. Morphometric measurements, age, sex, and reproductive condition of the carcasses will be presented in the final report.

3.6 - Downstream Moose

On April 17, 1980, during collaring operations only 10 moose of the scheduled 20 were radio-collared. At that late date and after a reconnaissance flight revealed few moose on the Susitna River's flood-plain, it was assumed that only "resident" moose remained.

LeResche (1974) described three types of moose movement patterns. Type A were those moose that only moved short distances between seasonal ranges with little change in elevation. Another name for this type is "resident". Type B moose move medium distances between two seasonal ranges with significant differences in elevation between low winter and high summer-fall ranges. Moose of the Type C pattern move medium to long distances between three distinct seasonal ranges and significantly change altitude between low winter and high summer-fall ranges.

Much of the snow had melted by the April tagging operation, thereby exposing moose forage at all elevations. Moose activity along the river had substantially decreased, and it was thought that the Type B and C moose had left the river for higher elevations. As it turned out, moose exhibiting all three types of migratory behavior were collared. However, sample sizes were too small to fully assess population identities along the lower Susitna River. Future collaring efforts must have broader distribution on the wintering areas of the river to ensure that all subpopulations of moose are sampled.

Of the ten moose originally radio-collared, three females have shed their collars and one bull was killed during the September hunting season. The collars were put loosely on some moose because of their young age (mean age of the 10 collared moose was 3.5 years), small size and anticipated growth. When they shed their winter pelage, the collars were loose enough to slip over their heads. In the future, the collars will be fastened tighter and the design modified to make them less slippery.

3.6.1 - Population Distribution

The number of collared moose, currently six, and of radio-locations, 131, though small, have been sufficient to show that the downstream moose population is made up of subpopulations quite different with regard to seasonal movements and habitat use. Some individuals were virtually sedentary during the nine months of observation, while others used distinctly different seasonal ranges. It will remain in future work to establish the relative proportion of the population in each subpopulation.

From moose wintering on the river below Talkeetna, it was learned that some calve, summer, rut, and possibly winter in the flats west of the Susitna; some calve, summer, rut and possibly winter in the forest between the river and the mountains; while others spend spring, summer, fall and possibly winter in the western benches and drainages of the Talkeetna Mountains. No specific calving areas were recorded, but several rutting areas were documented. The latter were found deep into the creek and river drainages of the Talkeetna Mountains and on the benchland near timberline at the mouths of these canyons. Rutting bulls in the lowlands aggregated less and were frequently alone or in small groups of 2-4 moose.

Analysis of home range size, chronology of migration and distances of migration at this time would not be meaningful because of small sample sizes of observations. In general, the home and seasonal range size was quite varied. Because there were some "resident" (Type A) moose, home ranges were as small as approximately 25 mi^2. Seasonal ranges were often smaller. Type C moose had home ranges as large as 90 mi^2 or more. The timing and distances of migration were equally as varied. One cow moved from her summering to rutting area in early August while another did so in late September. The longest distance traveled between summering and rutting areas was 40 miles.

Home range size and migration distances were likely intermediate to those found for moose in other parts of Alaska or North America. This was a function of physiography where all life requisites were available between an area just west of the Susitna River eastward to the Talkeetna Mountain benches. Longer moose movements were unnecessary.

3.6.2 - Use of Riverine Habitats

A census of moose on and near the river is planned for later this winter. Rausch (1958) stated that the period of peak moose abundance along the railroad between Houston and Talkeetna was February and that movement from the foothills to the railroad tracks was a basic seasonal movement and was influenced but not necessarily caused by deep snow. Therefore, the peak use of riverine habitat also will be in February or early March, and the timing of the census should correspond to this moose use. However, the magnitude of moose use of Susitna riparian habitats may be correlated with the amount of snow cover. If the open winter continues as it has in 1980-81, the degree of moose use along the river may greatly underestimate that of a more "normal" winter snowfall.

Attempts to devise methods for determining moose use of the river at seasons other than winter failed. Only general impressions and not quantitative data could be stated. It was obvious from boat trips up and down the river in late May and June that a fair (quantity unknown) number of cows calved on islands in the river. Four cows with newborn calves were observed on the river and tracks of several others were seen on mud banks of islands. Islands in other areas were frequently used for calving because they were relatively predator free (Stringham 1974).

Nothing has yet been done to determine summer use of the river. The untimely theft of the project boat and motor precluded access to the river at that time. Flooding of much of the lowland areas of the river in July likely caused moose to leave the floodplain for higher ground adjacent to the river.

In fall it also appeared (from overflights but no quantitative data) that moose did not remain on the river floodplain. However, they were observed crossing the river by ADF&G biologists. Hunter success along the river in September also indicated that moose were either on or near the river in fall. Analysis of hunter report data, however, is not feasible because hunters are often secretive about the exact location of their moose kills.

In summary, moose use of riparian habitats along the lower Susitna River is greatest in winter, particularly winters of deep snow, is at least moderate during calving and during the fall, and is of an unknown level in summer.

3.6.3 - Browse Utilization

The riparian zone was sampled by means of 12 transects containing 840 plots. On each plot containing woody plants available as moose food, the amount available and degree of browsing, by species, was determined. The greatest density of browse plants (3.3 plants/m^2) occurred on abandoned agricultural fields. The mean for all habitats was 1.4 plants/m^2.

Willow was of particular interest because of the general belief that it is an important winter food for moose. Disturbed areas supported a greater density of willow than most other habitats, suggesting that natural or artificial disturbances favor this plant. It was used rather heavily, with a mean rate of use of 36.5 percent of that available.

Comparable mean use of other shrubs was found to be: cottonwood - 16.2 percent; birch - 26.9 percent; highbush cranberry - 15.9 percent; rose - 10.0 percent. This finding draws attention to birch and suggests that this shrub merits more investigation in the study region. Although it is not an important moose forage plant on the river floodplain, it is well utilized on upland sites.

Much alder was observed while the browse transects were being conducted, and at no time was it consistently taken by moose, although a few individual alders were browsed very heavily. In most areas it was taken, if at all, only in small quantities.

These preliminary studies have shown that there is a great deal of variability in the vegetational mosaic on and near the river, both with regard to species composition and growth form. With further investigation it should be possible to gain considerable insight into the ecological processes controlling the dynamics of this vegetational mosaic and so point the way toward potential management for increased available moose forage.

3.7 - Upstream Moose

3.7.1. - Home Range

Moose move within a home range and often use different seasonal home ranges. LeResche (1974) reported that seasonal home ranges of moose were consistently small regardless of how far a moose moved between seasons. Home ranges determined in the present study were consistently larger than the 5-10 km^2 (2-4 mi^2) he reported (Table 21). Winter home ranges in the present study range from 21 to 389 km^2 (8-150 mi^2), averaging 103 km^2 (39 mi^2), while summer home ranges varied from 8-210 km^2 (3-81 mi^2) and averaged 72 km^2 (28 mi^2).
Total areas occupied by individual moose (migratory and sedentary) were quite large, ranging from 44 to 1373 km^2 (17-530 mi^2) and averaging 339 km^2 (131 mi^2). These latter figures compare favorably with the total range given by Peterson (1955) for Ontario moose, but are considerably larger than those reported for Kenai Peninsula moose (Bailey et al. 1978).

Table 21

Reported home range size, cows with calves (LeResche 1974).

Locality	Season	Home Range Area km^2	mi^2	Reference
Montana	6 July 23 Sept	2.2	0.85	Knowlton 1960
Wyoming	6 June - 15 Sept	5.1	1.97	McMillan 1954
Ontario	15 Aug. - 31 Oct	6.0	2.32	DeVos 1956
Minnesota	11 June - 22 Aug	5.9	2.28	Van Ballenberghe and Peck 1971
Minnesota	15 May - 1 Oct	15.4	5.95	Berg 1971
Minnesota	15 May - 1 Oct	16.9	6.53	Berg 1971
Alaska	6 June - 31 Oct	8.4	3.24	LeResche 1966
Alaska	24 May - 1 Sept	16.8	6.49	This study

LeResche (1974) summarized studies indicating that cows with calves have smaller home ranges for a short time following parturition than do cows alone. This also appeared to be true in the present study.

The moose of the present study have tended to use the same seasonal ranges from year to year, as others have found (Van Ballenberghe 1978). However, individuals occasionally changed seasonal ranges, especially in winter.

3.7.2 - Plant Community Use

Plant communities within which moose were located, and the monthly total of such observations, are given in Table 22. There is a rough correspondence between the elevational distribution of plant communities and the seasonal elevational preferences of moose.

3.7.3 - Population Identity

On the basis of movement patterns of radio-collared moose, four discrete populations of moose were identified, as follows:

3.7.3.1 - Clearwater Mountains Western - Alphabet Hills Population

This population apparently consists of a highly migratory segment and a resident segment. Cows tagged in the Clearwater Mountains were extremely migratory. Most occupied the area only during late summer and fall. During November these animals migrated down the Maclaren River and Clearwater Creek to the bottomlands along the lower Maclaren River. Some moose wintered in the lower Maclaren area where they shared winter range with other moose which resided in the area year-round. Other Clearwater moose and some from the Maclaren River continued migrating south. These moose either followed the Susitna River or travelled through the Alphabet Hills down Monsoon Lake Creek where they eventually wintered either in old spruce burns on the south side of the Alphabet Hills or at the mouths of the Oshetna and Tyone rivers.

Table 22

Percentage utilization of plant communities by month.

	Months											
	J	F	M	A	M	J	J	A	S	O	N	D
Community												
Tall Spruce	6	12	5	27	15	13	6	29	13	19	8	18
Medium Spruce	38	48	49	49	52	36	31	29	31	29	39	23
Low Spruce	38	9	22	4	12	13	13	10	15	10	19	5
Riparian Willow	0	15	11	10	8	7	9	3	2	4	17	27
Marsh	0	0	0	0	2	2	4	5	0	0	0	0
Alder	0	0	3	5	0	5	10	8	4	8	0	0
Upland Willow	19	15	11	5	10	21	21	16	33	31	17	23
Cottonwood or Aspen	0	0	0	0	0	2	4	0	2	0	0	5
Sample Size	16	33	37	41	132	167	67	62	52	52	36	22

3.7.3.2 - Upper Susitna River Population

Moose from this population generally were year-round residents of the east, middle, and west forks of the Susitna River. Most made relatively short movements, moving from higher elevations in summer to lower elevations in winter. The mouths of Valdez and Windy creeks and the junction of the forks of the Susitna River received heavy moose usage through fall, winter, and early spring. This population's movements appear to correspond closely to the drainage patterns of the upper Susitna River.

3.7.3.3 - Upper Nenana-Brushkana Population

Moose from this population appear to be comprised of animals residing in the tributary drainages of the upper Nenana. These moose occupy the upper drainages in fall and summer but winter in lowland areas where they share winter range with year-round residents. Evidence suggests that some individuals may make extensive fall migrations down the Nenana River. There appeared to be a noticeable distinction between animals from this area and those utilizing the upper Susitna River drainages. Obviously, some exchange between these two populations occurs and, in fact, they may not be separate populations.

3.7.3.4 - Susitna River Population

On the Susitna River from Butte Creek down to Devil Canyon most of the study animals exhibited relatively short movements and had small home ranges. Movements were mostly altitudinal in nature with the exception of those cows tagged in upper Butte Creek. Those moose migrated down the Susitna River or Butte Creek where they wintered either at the mouth of Watana Creek or the vicinity of the Susitna bend. There did not appear to be much interchange of animals in an east-west direction. Existing evidence indicates these resident moose share winter range with other highly migratory populations.

3.8 - Wolves

Data on wolf populations reported here is drawn from project reports on Nelchina Basin Wolf Studies (Ballard and Spraker 1979, Stephenson 1978). Unless otherwise noted, this information pertains to the whole of Game Management Unit 13.

3.8.1 - Packs and Pack Attributes

Up through 30 June 1980, 103 individual wolves had been radio-collared in the study region. These were associated with approximately 22 different packs. The radio-collared wolves were relocated on 3,525 separate occasions; resulting in 6,927 wolf sightings. Wolf territories were for the most part non-overlapping, but there appeared to be changes in territory boundaries from year to year. Territory sizes for 14 intensively studied packs ranged from 268 to 864 mi^2, averaging 537 mi^2. Territory size appeared to increase for larger packs and for those packs in areas of low moose density.

3.8.2 - Relations to Prey

Radio-collared wolf packs were observed on 360 individual prey kills, 38 (10.6%) of which were also occupied by one or more brown bear. Moose comprised 72 percent of the observed kills. Calf and short-yearling moose comprised 20 percent of the total kill. Wolves were preying upon short and long-yearling age classes from January through July disproportionately to their presence in the moose population. Moose calves 0-6 months of age comprised only 6 percent of the kills.

Four thousand two hundred and ninety food items were identified in 3,624 wolf scats collected at den and rendezvous sites during a five-year period. Overall, calf moose was the most frequently identified food item (44%). Percent occurrence of various prey items in wolf scats is generally related to prey abundance. Occurrence of calf moose in scats was correlated with subsequent fall calf-cow ratios, suggesting that wolves were preying upon calf moose in proportion to their abundance. Scat data were converted to numbers of individual prey eaten which was then extrapolated to GMU 13 spring wolf population estimates. This analysis suggested that wolves in GMU 13 were preying upon from 434 to 1,013 moose calves annually from mid-May through mid-July.

One hundred twenty-five moose and 25 caribou kills were examined *in situ* to determine both cause of death and age and physical condition of prey taken by wolves. One instance of surplus killing of caribou by wolves was reported. The fat reserves of calf and short-yearling moose killed by wolves were significantly higher than those of calves dying from both accidental causes and winter kill. The conclusion was that the wolves were preying upon relatively healthy calf and short-yearling moose.

To determine whether age bore any relation to causes of moose mortality, the mean age of the moose at time of tagging can be considered a rough average for the population, and the two main classes of mortality - wolf and winter - can be compared to it. Tagged moose averaged about 7 years while wolf-killed moose were between 14 and 15 years of age. These findings suggest that wolves kill moose that are past their prime but far from ancient. Analysis of patterns for mild and severe winters showed that in mild winters older moose were preyed upon more heavily while during a severe winter wolves preyed upon adult moose of various ages in proportion to their presence in the population. A severe winter, then, tips the moose-wolf relationship in favor of the wolf.

Wolf predation upon caribou appears to be related to snowfall, since most caribou predation was observed in a winter (1978-79) of heavy snow. The caribou taken were of both sexes and a range of ages, and were generally in good physical condition. So as in the case of moose, it appears that caribou are rendered more vulnerable to wolf predation by heavy snow.

Quantification of wolf predation on moose, their principal winter prey, was possible through analysis of detailed records for representative packs. Table 23 summarizes this information for five packs ranging in size from two to nine wolves. The pack of two killed considerably more than they could consume, having over 16 kg (35 lb) of food available to each of them daily. The other packs were all quite similar in having 5-7 kg (11-15 lb) of food available per wolf per day, with one ungulate kill every four or five days. An estimate of the summer wolf predation on moose in Game Management Unit 13 is given in Table 24. Assuming a daily consumption rate of 5.8 kg (12.8 lb) per wolf per day, it is calculated that the mid- May through mid-July kill of adult moose, over a five-year study period, varied from 37 to 132, while the take of calves varied from 434 to 1013. During the same period an annual average of 33 adult caribou, 191 calf caribou, 168 beaver, 361 muskrat, 1100 snowshoe hare, 208 squirrel, and 4016 microtine rodents were consumed by the wolves of GMU 13. As might be expected, there are major differences from year to year and pack to pack in wolf diet within the Susitna basin.

3.8.3 - Population Studies

Wolf populations are at their annual high in the fall, when the pups join the pack, and at their annual low in the spring, when the losses due to mortality and dispersal have been felt. Trapping and shooting by humans appears to be a significant source of mortality, as evidenced by population increases in areas closed to these activities.

Table 23

Summary of predation statistics derived from intensive radio-monitoring of the Susitna and Tyone wolf packs during winters 1978-79 and 1979-80 in Game Management Unit 13 of southcentral Alaska.

Size of wolf pack	Kgs of available food/day/pack	Kgs of available food/day/wolf	Days/ungulate kill
9	60.1	6.7	3.6
8	38.9	4.9	4.9
7	36.9	5.3	4.2
4	22.9	5.7	4.0
2	32.8	16.4	8.3

Table 24

Estimated number of prey individuals consumed by Game Management Unit 13 wolves for a 61 day period ranging from approximately mid-May through mid-July 1975 through 1979 as extrapolated from wolf scat analysis and wolf population estimates.

Prey	Assumed weight (kg) of prey (from Table 44)	Estimated number of prey consumed by GMU 13 wolves based upon consumption rate of 5.8 kg/wolf/day[1/]					
		1975	1976	1977	1978	1979	Subtotal
Adult moose	427.5	132	90	45	37	42	346
Calf moose	39.0	435	1013	829	490	434	3201
Adult caribou	145.0	--	59	11	14	49	133
Calf caribou	12.0	97[2/]	246	117	75	329	864
Beaver	12.5	286	160	126	250	19	841
Muskrat	1.4	59	476	542	520	206	1803
Snowshoe hare	1.8	2494	1163	551	571	722	5501
Squirrel	.5	498	190	116	26	--	830
Microtine rodents	.1	2490	5710	6420	2570	2890	20080
Totals		6491	9107	8757	4553	4691	33599

1/ Estimated spring GMU 13 wolf population was as follows: 1975 - 235, 1976 - 269, 1977 - 165, 1978 - 121, 1979 - 136.

2/ Adult and calf caribou combined.

To determine wolf population densities in a biologically sound manner, it is necessary to identify those portions of the landscape that are not wolf habitat. In the present study it was established that glaciers and areas above 4000 ft. (1,219 m) were not frequented by wolves. Estimates for various years, for the study region, vary from 37.6 - 121.7 mi^2 per wolf (97-315.2 km^2/wolf), a range that spans many wolf population density estimates from parts of boreal North America where wolves are subject to shooting and trapping. The reported wolf density in Mt. McKinley National Park, where wolves are protected, 24-42 mi^2 per wolf (64-109 km^2/wolf) (Haber 1968) suggests that wolf densities would be greater if protected from man. A relationship between habitat productivity and wolf population density is suggested by the substantially higher wolf population density estimates for temperate Minnesota and Ontario (Table 25).

Table 25

Summary of reported wolf densities for North America.

Wolf density		Size of study area			
mi^2/wolf	km^2/wolf	mi^2	km^2	Location of study area	Source
3[1]	7.8	30	78	Coronation Isl., Alaska	Merriam 1964
4.6	11.9	210	544	Isle Royale, Michigan	Peterson 1976
6.9[2]	17.9	384	995	NW Territories	Kuyt 1972
7-10	18-26	210	544	Isle Royale, Michigan	Mech 1966
7.8-13.8[2]	20.2-35.7	1,274	3,300	Manitoba-Saskatchewan	Parker 1973
9.2	23.8	717	1,857	Minnesota	VanBallenberghe et al. 1975
10	26	1,000	2,590	Algonquin Park, Ontario	Pimlott et al. 1969
10	26	2,490	6,449	Minnesota	Olson 1938
10.6	27.5	4,203	10,886	Minnesota	Mech 1973
12.9-55.2	33.3-142.9	121-998	313-2584	Beltram, Isl. St. For., Minnesota	Fritts & Mech In Press
17	44	4,100	10,619	Minnesota	Stenlund 1955
24-42	62-109	1,500	3,885	Mt. McKinley Nat. Park Alaska	Haber 1968
25-40	65-104	7,500	19,425	SE Alaska	Atwell et al. 1963
25-29	65-75	1150-1845	2979-4779	Kenai Peninsula, Alaska	Peterson 1978
35	91	7,000	18,130	Tanana Flats, Alaska	Stephenson 1977
37.6-121.7	97-315.2	1932-4503	5004-11663	Nelchina Basin, Alaska	This study
40-83	104-215	--	--	Saskatchewan	Banfield 1951
50	130	2,000	5,180	NcKinley Nat. Park, Alaska	Murie 1944
50	130	20,000	51,800	Nelchina Basin Study area, Alaska	Rausch 1967
58	151	9,653	25,000	NE Alberta	Fuller & Keith 1980
60-120	155-311	48,0000	1,243,200	NW Territories	Kelsall 1957
65-124	168-321	3,600	9,324	NC Brooks Range, Alaska	Stephenson 1975
87-111(10[3])	225-287	4,200	10,878	W. Canada	Cowan 1947
88	228	593	1,536	W. Canada	Carbyn 1974
120	311	1,800	4,662	Baffin Isl., Canada	Clark 1971
200	518	109,000	282,310	Manitoba-Sasketchewan-NW Territories	Parker 1973

1/ Artificial situation - four wolves transplanted to Island.
2/ Wolves concentrated on caribou winter range.
3/ Maximum abundance on winter range.

4 - IMPACT ASSESSMENT

4.1 - Construction Impacts

4.1.1 - Watana Dam and Reservoir

The increase in human activity that will be necessitated by dam construction will probably cause an avoidance reaction on the part of brown bears, wolves, and wolverines. Other big game now using the immediate operations areas will probably avoid it or be subject to predation by humans. Some estimate of the magnitude of the habitat loss for each species can probably be developed by a study of present radio-marked individuals in relation to present sources of disturbance within the study region. For example, it has already been noticed that there have been no sightings of wolverines or of their tracks within 10 km of Watana camp.

Flooding will inundate much of the forest habitat now used intensively by black bears, the present black bear denning habitat, and a substantial stretch of river-bottom now used by moose in winter. Upland borrow areas, when they have been mined for gravel, will represent areas of habitat lost.

At the time this study was designed it was assumed that the only significant impact of the Susitna Hydroelectric Project on Dall sheep would be from disturbance from construction activities, helicopter traffic, etc. Such impacts could be moderated by avoiding areas used by sheep or scheduling activities at seasons when sheep use of an area was reduced. However, sightings of sheep along Jay Creek indicate a possibility of direct loss of habitat.

The Portage - Tsusena Creek sheep are likely to be impacted only by disturbance. With adequate data on seasonal distribution serious disturbance probably can be avoided. The status of the Mount Watana population is less clear. Limited data indicate that sheep occupied habitat close to the proposed Watana impoundment where disturbance and perhaps even habitat loss could be problems, but this distribution was not confirmed by the July 1980 survey. More information is needed.

The Watana Creek Hills population appears to be the most vulnerable of the three sheep populations. Its close proximity to the Watana impoundment and possible access routes makes disturbance a concern. The possibility of loss of seasonally important habitat has been raised by sightings of sheep on Jay Creek in June. The Watana Creek Hills population appears to be relatively isolated from other sheep populations. If the population were reduced below carrying capacity, recovery might be slower than it would be in a less isolated population where immigration from unaffected areas is more likely.

The scope of the Phase I sheep studies is not adequate to fully assess the impact of habitat loss. An attempt will be made to further document the use of lower elevations along Jay Creek in spring of 1981, but if a special attraction such as a mineral lick occurs there, expanded studies including ground observations and marking of animals would be necessary to evaluate its use.

4.1.2 - Devil Canyon Dam and Reservoir

Preliminary observations of brown bear denning sites in the study area suggest that the proposed impoundments would have little direct impact on the availability of brown bear denning sites. Most brown bear den sites found were well away from the river and at high elevations in the foothills or mountains surrounding the Susitna River (Table 7). The lowest den and that nearest to the river was found at about 2200 feet elevation about 3 km from the Susitna River, above the height of the Devil Canyon impoundment. It is likely that some brown bears den in areas which would be directly flooded by the impoundments, but this has not yet been documented.

The Prairie Creek salmon run is now heavily used by brown bears. The proximity of the Devil Canyon site, and associated roads and human activity to brown bear travel routes makes a negative impact probable.

Preliminary conversations with sports fish biologists (ADF&G) suggest that Prairie Creek salmon runs are unlikely to be negatively affected by the proposed impoundments, however specific salmon studies will not be completed for 5 years. Assuming the proposed dams have no impact on the strength of the salmon run in Prairie Creek, the main impact the proposed construction might have on bear movements is a physical blocking of seasonal movements to Prairie Creek.

It is unknown whether the bodies of water in the proposed impoundments would, in themselves, represent a significant barrier to bear movements, however this possibility cannot be discounted.

In addition, the strangeness of mud banks created by fluctuating water levels (if such occur in mid summer) might represent an equal or greater barrier, perceived or real, to bear movements across the impoundments. Heavily traveled access roads to the impoundments might also inhibit or block bear movements across these roads; any access road built from the Parks Highway to the Watana damsite would have to be crossed by some bears moving to or from the Susitna River and Prairie Creek. Observations of homing brown bears being deflected, both permanently and temporarily, by large, strange river beds and highways have been reported in Alaska (Miller and Ballard 1981). On the Alaska Peninsula, Lee Glenn (ADF&G pers. comm.) has observed movements of up to 50 km by bears enroute to McNeil River to fish for salmon. In our 1980 studies, the farthest a Prairie Creek bear (G293) was seen from Prairie Creek was approximately 100 km northeast of Prairie Creek.

4.1.3 - Access Road

Construction of access roads will presumably have the effect of causing large mammals to withdraw from the vicinity, or to be exposed to predation by humans. It is probable that the magnitude of the movement away from disturbance is related to the seasonal home range size of the individual animal, those with larger home range sizes moving farthest. Data now being obtained on radio-collared individuals will be helpful for the development of analyses of this avoidance phenomenon.

4.1.4 - Transmission Facilities

The effects due to construction, projected for access road above also pertain to transmission corridors. In both cases the lineal nature of the disturbance insures that it will cross the home ranges of a large number of individuals.

4.2 - Operation Impacts

4.2.1 - Watana Dam and Reservoir

The seasonal pattern of filling and drawdown will affect the formation of ice-shelves in winter and their persistence in early spring. The probable consequences of this for the caribou that are now thought to cross the Susitna River within the area of the projected impoundment have been considered by Hanscomb and Ostercamp (1980). These authors point out that the projected lowering of the impoundment level (based on the Corp of Engineers plan) during the winter will be: December - 10'; January - 30'; February - 15'; March - 15'; April - 10'; in May the water rises 20'. They hypothesize a late April - early May movement by the caribou toward their traditional calving grounds that would necessitate a crossing of the drawn-down reservoir, with its shelves and blocks of ice. They go on to say (pp. 6-8):

"We suggest that an ice-covered shore that is steep, contains cracks, or has the potential for caving under the weight of caribou, may present a serious obstacle to their crossing the reservoir.
. . . . Realistic assessment of the effects of ice shelving requires consideration of both caribou behavior and ice conditions. With regard to ice conditions, the greatest need is for a realistic model of the formation, growth, and decay of the reservoir ice cover. Some questions that should be addressed are: What are the shore conditions or slope values that may cause the settling ice cover to break, leaving cracks in which caribou could be injured or possibly trapped? What is the timing of this settling, cracking, and snow-cover development that might mask the cracks? The thickness of the settling ice cover will increase through the winter but what will the thickness distribution be? Will the wind keep the ice clear of snow? What are the maximum slopes of clear ice and snow-covered ice that the caribou can negotiate? How long will the ice-shelves remain after breakup, and will caribou be forced to negotiate melting (wet) ice shelves?"

"During the spring caribou migration, the reservoir may still be frozen in the Jay Creek area, where the caribou will be coming from the north down a slope between 40-60% slope. Probably the only problems the caribou would have getting down this shore would be falling into cracks formed as the ice sheets settle or breaking through the areas where the ice has bridged the gaps. The south bank has a slope that varies from 109% to 9%, with much of the shore between 30-60% slope, so it is possible the caribou would have trouble climbing out on the south side."

"The breakup dates of Jay and Kosina Creeks would also be important. If these two creeks break up before the caribou try to cross, there could be water flowing on top of the reservoir ice, and melted areas formed at the mouths of the creeks. An overflow, by itself, would probably cause no problems unless it cut a channel through the ice. Then the caribou might have trouble climbing out on the floating ice cover after swimming or walking."

"In the Oshetna River area these same questions need to be answered, but the situation is a little different. The slope on the north shore varies from 53.8% to 6.8% and on the south shore from 35.9% to 6.8%, so both shores have a more gradual slope than do those at Jay Creek. This area may be affected by the breakup of the Tyone River as well as the Oshetna River. For 3.7 miles (6 km) upstream of the Oshetna River, the draw-down of the reservoir may leave an ice sheet on the river bed and flood plain. When the Tyone River breaks up, water will be flowing into this ice-covered area. The actual effect is unknown but there could be ice jams and/or ice chunks floating in the area which would make it difficult or impossible for caribou to cross."

"In conclusion, it seems likely that the reservoir will cause the caribou some problems, but the seriousness of the problems cannot be realistically assessed until more information has been gathered on caribou behavior and on the ice conditions in the reservoir."

Although the ice conditions and caribou response discussed by Hanscomb and Ostercamp are as yet little understood, there is some knowledge available on the general needs and movements of caribou in the study region. According to Kenneth Pitcher, who has been studying these caribou most recently, it is apparent that impoundment resulting from construction of the proposed

Watana dam would intersect a major migratory route of the Nelchina caribou herd. During the initial 8 months of the current study only moderate use of this migratory corridor has occurred by radio-collared caribou (and presumably by all Nelchina caribou). Four radio-collared animals have crossed the proposed impoundment area a total of seven times. Five of the crossings were north to south while two were south to north. Historical reviews, however, indicate movements of virtually the entire female-calf segment of the herd across the proposed impoundment area in many years. During most years between 1950 and 1973, all or many of the females crossed from the calving grounds to summer in the greater Deadman-Butte Lakes area (Skoog 1968, Hemming 1971, Bos 1974). Varying proportions of the herd have wintered in upper Nenana-Susitna drainages in nearly all years. Between 1957 and 1964 this area was the major wintering area (Hemming 1971). Spring migration routes during those years would have undoubtedly crossed the impoundment area.

Large scale movements of caribou across the proposed impoundment area have not been recorded since about 1976 (Eide pers. comm.). However, based on past movement patterns and the quantity of good habitat available in the upper Nenana-Susitna area [Skoog (1968) considered some of this area the most important habitat for year-round use in the Nelchina Range] it seems inevitable that caribou will again use the area in large numbers. Movements to and from the calving grounds will again result in many caribou crossing the Susitna River in the area of the proposed Watana impoundment.

A possible reaction to the impoundment by caribou is complete avoidance and refusal to even attempt crossing. Another possible reaction would be avoidance by some components of the herd and attempted crossing by other segments. Cameron et al. (1979) documented avoidance of the trans-Alaska pipeline corridor by females and calves during summer. They also suggested avoidance by large groups, group fragmentation and/or decreased group coalescence near the pipeline corridor. Should animals attempt to cross the impoundment, spring migration would appear to pose the most serious problems. Pregnant females are often in the poorest conditions of the annual cycle at this time (Skoog 1968) and migratory barriers which normally could be easily circumvented could become sources of mortality. Klein (1971) suggested that when animals are in poor physical condition seasonal migrations are easily disrupted. The potential for injury or death to migrating caribou appears greater in spring than during other periods. Skoog (1968) mentioned several instances of injuries and death resulting from falls on or through ice. Both Klein (1971) and Vilmo (1975) mention ice shelving as a mortality factor of reindeer on reservoirs in Scandinavia. Spring breakup would probably occur during the migration, in many years posing additional hazards such as ice floes, overflow and wet ice shelves.

Crossings during summer and fall when the reservoir would be ice free appear to pose considerably less hazard. Caribou are excellent swimmers and are known to cross much larger bodies of water than the proposed impoundment (Skoog 1968). Young calves might have problems with this distance if migrations occurred shortly after calving. Water crossings have been reported as mortality factors but usually involved rivers rather than more placid bodies of water such as a reservoir (Skoog 1968).

It seems likely that the Watana impoundment would tend to isolate the northwestern portion of the Nelchina range (an area of about 4,000 mi^2). Historically this area has been heavily used as both summer and winter range by Nelchina caribou.

The proximity of the Nelchina calving grounds to the proposed Watana impoundments is of concern. According to Skoog (1968) the calving ground is the "focal point" of a caribou herd. The Nelchina herd has shown nearly complete fidelity to its calving ground since records were available in about 1950. The calving grounds are in one of the most remote and inaccessible regions within the Nelchina range. Developments of the Susitna Hydroelectric Project would change this. Expanded human access and activity, which have been shown to adversely impact caribou use of calving areas, would likely occur. Cameron et al. (1979) documented abandonment of a portion of the calving grounds of the central Arctic herd concurrent with development of the Prudhoe Bay oil fields.

Bergerud (1978) presents a somewhat different view and suggests that caribou are quite adaptable and will adjust to human construction and development. He states that the impacts of human development and harassment have been overstated and no good evidence is available indicating that development has caused abandonment of ranges. However, he does state that calving areas may be an exception and should be protected from both development and disturbance.

Another hypothetical interaction between the presence of the impoundment and the associated biota is the possibility that the impounded water will act as a heat sink to the extent that early snows will fall as rain on the reservoir and its shores. Depending on the magnitude of this effect, and the timing of winter snowfall, it is possible that there will be a shallow-snow zone around the reservoir. This could be of significant benefit to moose, both because of a greater availability of forage and because of reduced wolf predation.

Conversely, the reservoir should be colder than the ambient temperature in the spring, and so could have a delaying effect on the phenological development of nearby plant communities. This could reduce the amount of early spring forage available for newly emerged brown and black bears, as well as over-wintering moose.

4.2.2 - Devil Canyon Dam and Reservoir

This impoundment does not appear to intercept major caribou movements. Increased human activity, as with the Watana dam and reservoir may be a source of impact on wildlife in the area, for example, influencing movement of brown bears to the Prairie Creek salmon run.

4.2.3 - Access Road

Development of access corridors such as roads would probably have negative impacts on Nelchina caribou. An access route through the Deadman, Watana, Butte creek drainages to the Denali Highway would traverse a major migratory route through prime caribou habitat. Roads and railroads have been implicated in obstructing movements of caribou and reindeer (Klein 1971, Vilmo 1975, Cameron et al. 1979). Nelchina caribou do continue to cross the Richardson Highway, often in large numbers, and have done so during many years since about 1960 (Hemming 1971). Several studies (Miller and Gunn 1979, Calef et al. 1976) have recorded responses of caribou to aircraft disturbance and speculated on deleterious impacts. Cows and calves were most responsive to disturbance (Miller and Gunn 1979). Caribou showed increased sensitivity during the rut and calving (Calef et al. 1976).

Data on the deleterious effects of roads pertain mostly to caribou because of the past interest in and studies of the Alaska pipeline. But the other species of big game will also be affected. From studies of big game in national parks, where there is no hunting, and outside, where hunting is allowed, it seems clear that animals outside act as though they associate the sound of automobiles with disturbance, and keep clear of travelled roads. This has the effect of reducing the habitat available to them by the area from which they withdraw. In addition, access roads facilitate the penetration of hunters in larger numbers into regions hitherto inaccessible, further increasing disturbance as well as mortality.

4.2.4 - Transmission Facilities

Electrical transmission lines have been reported to disrupt movements of reindeer in Scandinavia (Klein 1971, Vilmo 1975) because of associated noises (hum) and because they are foreign objects in otherwise familiar surroundings. If electrical transmission lines are downstream from the proposed Watana dam site they should have little impact on caribou as long as they are routed near the river. Few caribou occur in this area. Other big game animals, however, occur in the downstream regions. Their probable reaction to a noisy power line is not yet known. Other impacts, both positive and negative, may occur along the transmission line route depending upon the extent of vegetation clearing required, and also the changes in habitat types.

4.2.5 - Downstream Flow Regime

Since moose forage, particularly, is associated with the riparian areas frequently disturbed by fluviatile processes, it would be expected that a major change in downstream flow patterns would influence downstream plant communities and, through them, downstream moose populations.

5 - MITIGATION

There appear to be three general ways that the impact of the proposed project could be reduced or mitigated: control of human activity; siting of routes and work-areas; and plant community management.

5.1 - Control of Human Activity

At present, the wildlife populations inhabiting the Susitna basin seem to be minimally influenced by contact with humans. The proposed project would bring much more human activity to the study area, with some inevitable detrimental effect. But this effect will be least if any human activity not essential to the project is kept to a minimum.

5.2 - Siting

Preliminary studies of all wildlife populations have shown patterns of habitat preference. While it is still too early to identify all the most valuable parts of the overall landscape for the various big game species, it is reasonable to expect that analyses of seasonal habitat use will demonstrate that some landscape units are more valuable than others, seasonally, for most or all big game species. Assuming that such information becomes available, it should be possible to take it into consideration in the siting of routes and work-areas, wherever a range of choices exists.

5.3 - Plant Community Management

The possible arenas for plant community management appear to exist, one hypothetical, as yet, and the other obvious. The hypothetical opportunity lies around the shores of the impoundments, and will exist if the presence of the impoundment creates a shallow-snow zone around the shore. Then this zone could be considered for enhancement as wildlife habitat.

The more evident opportunity lies downstream, where many opportunities to manage plants for the benefit of big game, particularly moose, exist. It would seem worthwhile to analyze the population ecology of the downstream moose in greater detail than has been possible to date, so as to identify the plant species and landscape units that would give the best return on an investment in habitat enhancement. Further, the secondary impacts of habitat enhancement measures on non-target plant and animal species should be assessed as part of the study of habitat management feasibility.

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7 - AUTHORITIES CONTACTED

Throughout 1980, there was close coordination among members of the ADF&G Susitna Project investigations, TES, and TES's big game consultant, R. Taber. In addition, the following were contacted by TES in relation to the big game studies.

Susitna Hydroelectric Project Steering Committee
Anchorage, AK.

- July 17, 1980: presentation by TES staff of entire environmental program.
- December 23, 1980; TES response to Steering Committee comments on Big Game Impact Assessment and Mitigation Plan Procedures Manual.