3435

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

APPLICATION FOR LICENSE FOR MAJOR PROJECT

SUSITNA HYDROELECTRIC PROJECT

VOLUME 11

DRAFT

EXHIBIT E

CHAPTER 3

SECTIONS 4, 5, 6, & 7

HARZA-EBASCO
SUSITNA JOINT VENTURE

Alaska Power Authority

BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

APPLICATION FOR LICENSE FOR MAJOR PROJECT

SUSITNA HYDROELECTRIC PROJECT
DRAFT LICENSE APPLICATION

VOLUME 11

EXHIBIT E
CHAPTER 3 - FISH, WILDLIFE AND BOTANICAL RESOURCES
SECTIONS 4, 5, 6, & 7

November 1985

NOTICE

A NOTATIONAL SYSTEM HAS BEEN USED
TO DENOTE DIFFERENCES BETWEEN THIS AMENDED LICENSE APPLICATION
AND
THE LICENSE APPLICATION AS ACCEPTED FOR FILING BY FERC
ON JULY 29, 1983

This system consists of placing one of the following notations beside each text heading:

- (o) No change was made in this section, it remains the same as was presented in the July 29, 1983 License Application
- (*) Only minor changes, largely of an editorial nature, have been made
- (**) Major changes have been made in this section
- (***) This is an entirely new section which did not appear in the July 29, 1983 License Application

VOLUME COMPARISON

VOLUME NUMBER COMPARISON

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4 - WILDLIFE (**)

4.1 - Introduction (*)

Many species of wildlife inhabit the Susitna project study area, which includes the watershed of the Susitna River upstream from Gold Creek (Figure E.3.3.1), a corridor extending approximately 1 mile to each side of the downstream floodplain between Gold Creek and Cook Inlet, and the transmission corridors. While the ecological importance of all species that are members of the Susitna basin community is recognized, the emphasis of this report is on the wildlife resources which can be assigned priority based on relative abundance, regional rarity, or their contribution to recreation, subsistence, or commerce. Species classified as threatened or endangered are considered particularly important.

The complexity of interactions and relationships between species in any ecosystem necessitates a system of priorities in the development of mitigation plans. Consequently, some species require less intensive study then others. The content of Section 4.2, the baseline description of wildlife resources, reflects this prioritization of species. It should be recognized that the assigned priorities were used in developing a mitigation plan with recognized tradeoffs in benefits to some species at the expense of others.

Data on the vertebrate fauna in the Susitna basin were collected in several independent investigations. The Alaska Department of Fish Game (ADF&G) and University of Alaska (U of A) reports (listed below) provided most of the data and analyses presented in this document. Raw data and quantification to support interpretations are presented whenever source documents have provided such numbers. However, in many instances, such quantification has not been provided. In such cases, the discussion in this chapter relies on the interpretations and findings of the original investigators. References to source documents are given to allow the reader access to the original information. Data sources are as follows: moose - ADF&G (1982n, o, 1983i, p, 1984k, m), caribou - ADF&G (1982h, 1983c, 1984o, and 1985e), Dall sheep - ADF&G (1982d, 1983f, and 1983j), brown bear and black bear - ADF&G (1982e, 1983l, and 1984n), wolf - ADF&G (1982f, 1983g, and 1984d), wolverine - ADF&G (1982t, 1983h, and 1984f), furbearers - Gipson et al. (1982), ACWRU (1984), LGL and ACWRU (1984), and birds and small mammals - Kessel et al. (1982a and 1982b). Some recent information from these investigations was provided by personal communications and unpublished tables.

4.1.1 - The Vertebrate Fauna (*)

Birds and mammals are the wildlife groups of interest in this study. Kessel et al. (1982a, 1982b) encountered 135 species of birds in the Susitna Basin upstream from Gold Creek (Appendix E5.3); 82 species were found along the Susitna River floodplain downstream from Devil Canyon in June 1982 (Appendix E6.3). Sixteen species of small mammals (shrews, rodents, and hares) are known to occur in the middle Susitna Basin (Kessel et al. 1982a). The middle basin is defined as the watershed boundary of the Susitna River between its confluences with the Tyone River and the Chulitna and Talkeetna Rivers (Figure E.3.2.1.). Moose, caribou, Dall sheep, brown bear, black bear, wolf, and wolverine are big game species that occur in the project area. Furbearers include beaver, muskrat, river otter, mink, pine marten, red fox, lynx, coyote, and snort-tailed and least weasel (Gipson et al. 1982). Scientific names of bird and mammal species are listed in Appendices E5.3, E6.3, and E7.3.

4.1.2 - Threatened or Endangered Species (*)

No threatened or endangered species of wildlife (USDI 1980, 1985) have been encountered recently in the Susitna project area. In 1974, White (1974) observed two peregrine falcons along the Susitna River in the Devil Canyon impoundment area, and one inactive nest near the transmission line. Kessel et al. (1982a) observed no peregrine falcons or other threatened or endangered species during their 1981 and 1982 studies. The potential presence of peregrine falcons is discussed in greater detail in Section 4.2.3 (a). With the exception of the peregrine falcon, none of the species known to occur in the project area are rare, threatened, or endangered in the State of Alaska.

4.1.3 - Species Contributing to Recreation, Subsistence and Commerce (*)

All big game species of the project area are hunted for recreation, and the yearly big game harvest contributes to local and regional subsistence (Exhibit E, Chapter 5). Furbearers provide income for fur trappers in the Susitna region. Few birds are hunted in the project area. In theory, many species of wildlife contribute to nonconsumptive forms of recreation such as bird-watching, but the area is too remote to attract many people who come solely to see birds.

Moose, caribou, black bear, and brown bear are the most abundant big game species in the project area and are given highest priority. Dall sheep, wolf, and wolverine are regionally less abundant and are assigned secondary importance. Furbearers are considered less important than big game species. Beaver, marten, and muskrat are common enough to be readily available to trappers but have limited economic importance. Otter, mink, red fox, coyote, lynx, and weasel are given low priority.

Bird and small mammal species contribute little to consumptive use in the Susitna Basin. Certain bird species, such as bald and golden eagles (which have received national protection), trumpeter swans and other waterfowl, can be identified as high profile species and assigned priority on that basis. Other birds and small mammals have historically contributed little to recreation, subsistence, or commerce in the project area. In addition, each group includes a large number of regionally abundant species of which few can be assigned priority over others. These factors preclude a detailed analysis of the biology and anticipated impacts to individual species of small mammals and birds of the middle and lower Susitna basin. However, behavioral characteristics of these small-bodied animals, such as small movements and home range and use of micro-habitats, justify their treatment in groups of organisms with superficially similar requirements that will be affected in similar ways. These biases in treatment relative to the higher priority species are alleviated somewhat by the fact that mitigation to preserve habitat for larger species will also protect an assemblage of the small birds and mammals essential to the maintenance of a functioning wildlife community.

4.2 - Baseline Description (**)

4.2.1 - Big Game (**)

(a) Moose (**)

Studies of moose in the Susitna Basin have been conducted by the Alaska Department of Fish and Game in two discrete areas: (1) the middle and upper Susitna Basin, including all parts of the watershed upstream from the Devil Canyon damsite, and (2) the lower Susitna Basin, including the major valley and floodplain of the Susitna River from Devil Canyon downstream to the river mouth at Cook Inlet. The river basin below Devil Canyon can be divided into 3 sections based on river morphology. Between Devil Canyon and Talkeetna the river is characterized by rapid flow in a single channel generally less than 500 feet wide, with widely separated islands covered with mature forest. The banks are steep and covered with alder shrub and spruce-birch forests. Between Talkeetna and Montana Creek the river widens to about 1.2 miles and becomes braided with many small islands in a broad floodplain. Below Montana Creek the river is generally very broad, between 3 and 12 miles, with up to 15 channels and numerous sloughs and oxbow lakes. Disturbed habitats are much more abundant because of a long history of settlement and other development effects. Adjacent shores and large islands are heavily forested.

Studies in the middle and lower Susitna basins have addressed different aspects of moose ecology. The differences in approach primarily reflect the differences in topography and vegetation in each portion of the basin, as well as differences in the development scenarios and potential impacts in the two areas. Consequently, comparable information on moose in all areas of the Susitna Basin is not always available. The following discussion of moose ecology in the Susitna basin provides a summary of the current state of knowledge for moose in the middle and lower portions of the basin. Similarities and differences in various aspects of moose ecology that may be influenced by the Watana and Devil Canyon projects will also be discussed.

Most of the information contained in the following discussion is based in studies by ADF&G (1982a, b, 1983 i, p, 1984 k, m) in the middle and lower Susitna basins. Additional studies and communications are cited as necessary.

(i) <u>Distribution</u> (**)

Moose occur throughout the Susitna River drainage and, because of their regional contribution to recreation and subsistence, are one of the most economically important wildlife species in the region. Within the Susitna Basin, moose tend to be most abundant in the upstream area east of and including Indian River and within the main Susitna valley downstream from Montana Creek to the river mouth at Cook Inlet. Low numbers of moose presently inhabit the area between Indian River and Talkeetna.

- <u>Seasonal Movements</u> (**)

Moose in many northern areas undergo regular seasonal movements or migrations (see LeResche 1974 and Coady 1982 for a review). LeResche (1974) described moose migrations as regular annual movements that involve return to at least one common area each year. In some areas such as the Arctic Coastal Plain of Alaska (Mould 1979) or northern Minnesota (Van Ballenberghe and Peek 1971), migratory movements may involve distances of only 1.2 to 6.2 miles with little change in elevation. Migrations in mountainous areas usually involve large changes in elevation. Horizontal differences between summer and winter ranges may be as little as 1.2 miles (Knowlton 1960) or as great as 105 miles (Barry 1961). In interior Alaska, moose spend the summer at low elevations, move to high elevations during fall and early winter, and return to lower elevations during mid- to late-winter (Bishop 1969). Migration of moose appears to be an adaptation to optimize seasonal use of forage habitats (Coady 1982).

Weather conditions, particularly snow depth and structure, are among the most important factors associated with moose migration (Coady 1974, LeResche 1974). Winter severity may influence the distance moved by individuals as well as the proportions of moose in a population that migrates to different areas. For example, during a winter of light snow in south-central Alaska, some groups of moose overwintered on summer ranges while other groups migrated to adjacent winter range (Van Ballenberghe 1978). During winters of deep snow, however, almost all of the moose migrated from the summer ranges to low elevation winter ranges.

In the middle Susitna Basin, some groups of moose exhibit seasonal shifts in distribution. Other groups undergo very limited seasonal movements and remain in low elevation riparian and forest communities year-round. ADF&G (1982k) delineated 13 subpopulations of moose in the middle Susitna Basin on the basis of seasonal movement patterns.

Generally, moose in the project area move to higher elevations in October, presumably to breed, and then depending on snow conditions, begin moving downward reaching the lowest elevations occupied during the year from January through May (Figure E.3.4.1). Moose appear to be driven to lower elevations in winter by heavy snowfall; however, it appears that in an average or mild winter, temperature inversions and high winds make foraging and traveling easier at higher elevations. Consequently, moose may occupy relatively high areas in winter and spring depending on snow depths, temperatures, and other factors. Moose occupy lower elevations in late spring and early summer during calving. This may be related to earlier snow melt, earlier growth of spring forage, and perhaps increased cover requirements during calving.

In the Watana impoundment area an analysis of moose elevational use relative to availability was conducted for radio-collared moose monitored from 1976 to 1982 (ADF&G 1984m). On an annual basis, elevations ranging from 2,000 to 2,200 and 2,400 to 3,000 feet were used statistically more than expected based upon availability. Other elevations were used either statistically less than expected or in proportion to their availability. During winter and spring, elevations ranging from 1,600 to 2,000 and 2,200 to 2,800 feet were used statistically more than expected, while other elevations were used statistically less than expected or in proportion to their availability, reflecting the general downward movement of moose during these seasons (ADF&G 1984m).

In the Devil Canyon area, elevations ranging from 1,600 to 2,400 feet were used significantly more by moose than statistically expected based on availability, both year-round and during January to May, while elevations in excess of 2,800 feet were used either significantly less than expected or in proportion to their occurrence. Areas with elevations below 1,455 feet were used in proportion to their availability ADF&G 1984m).

Use of regional areas within the middle Susitna Basin by moose also appears to be influenced by slope steepness. Slopes were classified into four broad categories: flat--0 to 10 percent, gentle--11 to 30 percent, moderate--31 to 60 percent, and steep--61 to 90 percent. During both summer (May to August) and winter (November to April), 91 percent of moose relocations occurred on flat and gentle slopes (ADF&G 1982k). The aspect of the slope, however, did not appear to influence moose locations.

In general, riparian habitats are at least seasonally important to moose in all reaches of the lower Susitna River. Winter ranges for moose throughout the lower Susitna Basin are located in riparian areas. Riparian communities are also commonly used as calving areas by moose north of Talkeetna, as year-round habitat for moose in the Delta Island area, and as transition range for moose south of Talkeetna (ADF&G 1982j). (Moose in the area south of Talkeetna appear to utilize seasonal ranges on both sides of the river valley.)

- Special Use Areas (*)

  . Calving Areas (*)

    Parturition generally occurred between May 15 and June 15 in the years 1977 to 1980. To determine whether calving concentrations occurred in or adjacent to the proposed impoundment areas, all observations of radio-collared cow moose (n=37 in 1980; n=53 in 1981) in the middle Susitna basin were plotted (see Figure E.3.4.2 (ADF&G 1982k). Although this method included some cows which were not observed with calves, it did provide locations of areas where cows probably calve. (This error is likely to be small because calf mortality immediately following birth is high [Ballard and Taylor 1980, Ballard et al. 1981a] and many parturient cows would consequently not be observed with calves.)

    Cow moose were distributed throughout the middle Susitna Basin, but several concentrations of radio-collared cow moose were observed (ADF&G 1982k). These included: Coal Creek and its tributaries; the Susitna River from the mouth of the Tyone River downstream to a point several miles downstream from Clarence Creek; Jay Creek to Watana Creek; the area in the vicinity of the mouths of Deadman and Tsusena creeks; Fog Creek to Stephan Lake; and opposite Fog Creek to Devil Creek. Low shrub and open spruce habitats were the most common cover types in the vicinity of these concentrations. The importance of these sites as traditional calving areas is not known.

    Calving ranges for 36 moose were obtained in the lower Susitna Basin (ADF&G 1982j). Within the lower Susitna Basin, calving concentrations upstream from Talkeetna occurred in cover types different from those used downstream from Talkeetna. Six of 10 females and neither of 2 males north of Talkeetna were in riparian habitat during calving. Only 4 of 21 moose south of Talkeetna were in riparian habitats during calving. Cottonwood was the predominant cover type in the vicinity of most relocations during the calving period.

    Studies by ADF&G (1984k) indicate that most female moose south of Talkeetna leave the floodplain to calve, but that female moose north of Talkeetna return to floodplain areas for calving. Females in large islanded areas south of Talkeetna also were shown to remain in the floodplain for calving (ADF&G 1984k). A possible calving concentration was observed in the vicinity of Trapper Lake, but most cow moose were widely dispersed at varying distances from the Susitna River (ADF&G 1982j). On average, cow moose were located 9.1 miles from the river during the calving period. Cow moose in the area south of Talkeetna were generally observed in cover types more typical of calving habitat in other areas of Alaska (e.g., Rausch 1958; Bailey and Bangs 1980); a mosaic of spruce and alder interspersed with muskeg bog meadows was the most common cover type near relocations (ADF&G 1982j).

A common feature of calving habitats in the lower Susitna Basin is their close proximity to water (ADF&G 1982j). Although the presence of water may be an important attribute of calving sites, it is more likely that cow moose seek these areas because of the availability of newly growing herbaceous vegetation (LeResche and Davis 1973, ADF&G 1982j). Such vegetation would provide lactating cows and newborn calves with a readily available source of easily digestible, highly nutritious forage (Weeks and Kirkpatrick 1976, Fraser et al. 1980).

. Breeding Areas (o)

Breeding concentrations in the middle Susitna Basin were determined by plotting the locations of all radio-collared cow moose (n=37 in 1980) between September 20 and October 20 during 1977 to 1980 (see Figure E.3.4.3) (ADF&G 1982k). Most cow moose occupied upland sites away from the proposed impoundment areas (ADF&G 1982k). Concentrations occurred in the following areas: Coal Creek to the big bend in the Susitna River; Clarence Lake; uplands between Watana and Jay Creeks; Stephan Lake to Fog Lake; and the uplands above the mouth of Tsusena Creek. Other concentration areas away from the proposed impoundments include northwestern Alphabet Hills, the Maclaren River, and the area upstream from the mouth of Valdez Creek (ADF&G 1982k).

In the lower Susitna Basin, few moose were observed in riparian habitats during the breeding period (ADF&G 1982j). With the exception of moose that remained in riparian communities or on the river islands throughout the year, most moose were located farther from the Susitna River during the rut than during the calving period (ADF&G 1982j). Average distances from the river were 9.6 miles and 15.4 miles for cow and bull moose, respectively. Use of specific cover types during the breeding period was not assessed.

- River Crossings (**)

Between April 1980 and December 1982, 25 radio-collared moose crossed the Susitna River in the area of the proposed impoundments a total of 79 times ADF&G 1983i). Crossings occurred at all times of the year (Figure E.3.4.4). Exact locations of crossings could not be determined given the lag time between location and relocation of radio collared animals (Whitman 1985a, pers. comm.).

In general, movement patterns of most moose approximated the drainage patterns of creeks and tributaries of the mainstem rivers (Figure E.3.4.5). Consequently, most movements in the middle Susitna Basin involved a north-south movement pattern. Crossing sites for these generalized movements that occur within the proposed impoundment areas include the lower portion of Watana Creek, the Jay to Kosina creeks area, and the movement corridor along the Susitna River. No river crossings by moose have been documented in the reach between Devil Canyon and Portage Creek, where steep canyon walls physically prevent crossings.

(ii) Habitat Use (*)

- Cover Requirements (*)

Because moose are largely dependent on woody browse during winter and late spring, their distributions are more closely associated with the distribution of commonly utilized browse species than with other environmental factors (Coady 1982). However, the minimum requirements of moose for winter food and cover appear to be satisfied by a great diversity of habitat types across North

America, suggesting that moose are adaptable to a variety of conditions.

Habitat use by moose is most extensive during the summer and fall and is gradually restricted during the winter (LeResche et al. 1974). Lowland and upland climax shrub communities are heavily utilized during summer and fall. By early winter, moose commonly move to upland and lowland seral communities. During winters of deep snow, upland seral communities are abandoned in favor of lowland areas (ADF&G 1982k).

In western North America, shrub communities are the most important winter habitats for moose (LeResche et al. 1974). In particular, riparian willow (Salix spp.) stands provide high quality winter range. Maximum use of these areas occurs during mid- to late-winter and during severe winters. Areas of coniferous forests adjacent to riparian communities provide bedding areas and cover and so enhance the value of these shrublands for moose.

Riparian communities are perhaps the most important shrub habitats for moose (Coady 1982). Because riparian areas are frequently disturbed by alluvial action, they provide permanent seral habitats. Important seral shrub habitat is also created by fire, clear-cutting, and other disturbances that remove climax vegetation cover (LeResche et al. 1974, Davis and Franzmann 1979). In Alaska, the optimum age of browse growth following fires is less than 50 years and moose utilization of these areas usually peaks 20 to 25 years after burning (LeResche et al. 1974).

Site-specific information on habitat use by moose in the middle and lower Susitna basins was based on aerial assessments of the dominant plant species in the vicinity of each moose relocation (ADF&G 1982j, k). Although this method of evaluating habitat use provided some information on the apparent preference for different forest cover types, two problems were apparent.

The first problem is associated with diurnal differences in habitat use by moose. Linkswiler (1982) showed that habitat use by moose in Denali National Park was strongly associated with the time of day. In general, it appeared that moose rested in forested areas during the day and became active in more open cover types during the early morning and evening. Observations of habitat use in the Susitna Basin consequently may not accurately reflect the importance of some habitats to moose for activities such as feeding or nursing, except during the winter when habitat use is not greatly influenced by time of day.

The second problem associated with the assessment of moose habitat use during aerial surveys is that overstory cover types may not accurately reflect habitat components, such as browse availability, that strongly influence use by moose. For example, ADF&G (1982k) indicated that the middle Susitna and Nelchina River basins contain approximately 24 species of willow; yet moose commonly utilize only a few species of willow as browse (Wolff 1976). Because the distributions of willows and other shrubs are only partially related to forest cover types, assessments of habitat use by moose on the basis of forest cover types may be misleading. Approximate equivalents for aerially assessed cover types and Viereck et al. (1982) vegetation types are shown in Table E.3.4.1. Complete descriptions of the plant communities associated with each vegetation type appear in Section 3.2.2 of this chapter.

- Habitat Use in the Middle Susitna Basin (*)

In all seasons, spruce cover types were the areas most frequently used by 207 radio-collared moose in the middle Susitna Basin during the period October 1976 to August 1981, with sparse- and medium-density, medium-height black spruce (see Table E.3.4.2 comprising 40.5 percent of the total observations (ADF&G 1982k). Assuming that Linkswiler's (1982) results apply to the Susitna Basin, spruce habitats likely represent bedding or resting habitats. The combined areas of conifer forest and shrubland account for only 59 percent of the total area in the middle Susitna Basin, but based on the aerial surveys, received over 90 percent of the year-round use by moose.

Moose use of upland shrub habitats corresponded closely with observed elevational movements of moose in this part of the Susitna Basin (Table E.3.4.2). Moose were rarely observed in upland shrub habitats just prior to calving in April when they tended to be at low elevations (ADF&G 1982k). Use of the upland shrub habitat increased during the summer and peaked in October when 43 percent of all moose observed were in upland shrub habitat (ADF&G 1982k). High proportions of moose observed were in upland shrub habitat throughout the winter (ADF&G 1982k). As discussed earlier, the high use of this cover type during the winter is likely the result of mild winter conditions and consequently may not accurately represent moose habitat affinities during more severe winters.

During calving in May, 140 (52 percent) of 271 moose in the middle Susitna Basin were observed in sparse-to-medium-density, medium-height spruce habitats (ADF&G 1982k). These habitats, which generally occur near the river and its tributaries but outside the impoundment zones, may be selected by parturient females because of the availability of escape cover and the early green-up of the vegetation (ADF&G 1982k). Habitats such as birch, alder, and dense spruce cover types were not commonly used during the calving period (ADF&G 1982k).

- <u>Habitat Use in the Lower Susitna Basin</u> (**)

Habitat use data in the lower Susitna Basin are based on relocations of radio-collared moose collected between April 1980 and October 1983 and from supplemental moose censuses and surveys conducted through March 1984.

Habitat affinities of moose in the lower Susitna Basin differed among the areas south of and north of Talkeetna and, in some cases, appeared to be influenced by both the sex of the animal and the season (Tables E.3.4.2, E.3.4.3, E.3.4.4, and E.3.4.5). Because these results are based on a relatively small number of relocations for a small number of moose, differences in habitat use among male and female moose and among seasons may not be significant.

The 2 male moose collared north of Talkeetna were relocated 54 times between mid-March and mid-October 1981. All relocations were in nonriparian communities and most were dominated by alder, spruce, and birch cover.

Eight females collared north of Talkeetna were relocated 217 times. One hundred and ninety-six were in nonriparian communities dominated by alder, birch, and spruce. Seventy-six percent of the 21 riparian relocations were during the calving period. Riparian relocation sites were dominated by balsam poplar, alder, and willow.

South of Talkeetna, 5 radio-collared males provided 160 relocations, 147 in nonriparian habitats dominated by alder, birch, and spruce. The 13 riparian relocations were in sites dominated by alder, birch, spruce, and willow (Table E.3.4.4). Nineteen females south of Talkeetna provided 512 relocations. Four hundred and nine nonriparian relocations were dominated by alder, birch, and spruce. One hundred and three riparian relocations were in sites dominated by alder, spruce, birch, and balsam poplar (Table E.3.4.5).

Very dense concentrations of moose were observed by ADF&G at "disturbed sites" (ADF&G 1984k). The terminology "disturbed sites" is used loosely in reference to any parcel of ground where human activities have altered climax vegetation and resulted in the establishment of seral stages of vegetation which moose utilize as winter browse (ADF&G 1984k). These sites are thought to provide a substantial alternate, but temporary, food source for moose which normally winter on the Susitna River floodplain.

Data gathered from river censuses demonstrate that moose use of Susitna River floodplain habitats is closely related to winter weather conditions, particularly snowfall and the resultant depth of snowcover. Within years, mild weather conditions may preclude movements of large numbers of moose (1981-1982), early snows may initiate early moose movements (1982-1983) and late snows may delay moose movements to floodplain areas (1983-1984). Moose movements to floodplain areas may be rapid (1982-1983) or gradual (1983-1984). High levels of moose use may be sustained for long periods of time (1982-1983) or may be relatively short-lived (1983-1984). Abrupt decreases in moose numbers associated with ameliorating weather conditions, occurred in all winters. Even in mild winters, moose from some subpopulations apparently still moved to floodplain habitats (1981-1982).

- <u>Food Habits</u> (**)

Moose are primarily browsers, feeding predominantly on deciduous woody browse during winter months and on emergent and herbaceous plants as well as leaves and leaders of shrubs and trees during the summer (see Peek 1974b for a review). Food habits of moose are strongly influenced by browse availability, and thus there are some differences in the importance of various browse species to moose in the middle and lower portions of the Susitna Basin.

Browse utilization studies using the point-centered quarter method were conducted at randomly selected sites in the middle basin in 1982 (McKendrick et al. 1982 unpublished data). Only twigs at least 19 inches above ground were included, since snow precluded use of twigs below that height during most winters. The percent utilization of the most common moose browse species for all stands combined (n=2,712) were as follows: Richardson willow (9.8 percent); grayleaf willow (8.9 percent); diamond-leaf willow (8.3 percent); Sitka alder (5.3 percent); and resin birch (5.0 percent). Resin birch is the most common browse species in the middle basin.

Microhistological examination of moose fecal samples was used to estimate food habits (LGL and ADF&G 1985). Nine specific areas were sampled in the middle basin (Figure E.3.4.6). Results showed that willow was the dominant component of winter diets of moose for all sampled areas in the middle Susitna River basin (Table E.3.4.6). Based on percent dry weight composition of fragments identified in the diet, willow ranged from a high of 66 percent of the diet at the Watana Slide area to a low of 25 percent at the Tsusena Creek area. Within the seven areas in the upriver reach (Watana mouth to Oshetna River areas), willow comprised 59 percent of the diet. The transects in the upriver reach generally traversed a greater proportion of upland benches and coniferous forests where density of willow was probably higher than in the deciduous forests common to the lower reach (Devil Creek to Tsusena Creek). Composition of willow in the diet was lowest in the downriver stretch, where it comprised 31 percent in the two areas.

Contribution of resin birch to the diet was 10 percent for all areas, ranging from 2 percent at the Tsusena Creek area to 15 percent at the Oshetna River area (Table E.3.4.6). Excluding the Tsusena Creek area where it was very low, resin birch composed fairly consistent but relatively low percentage of the diets of moose over the study area.

Contribution of mountain cranberry to moose diets was greatest in the downstream reach of the Susitna River (Table E.3.4.6). Forty percent of the diet was mountain cranberry at the Tsusena Creek area, while the diet contained 26 percent mountain cranberry at the Devil Creek area. Percent composition in the diet was low for all other areas except Cassie Creek and Kosina Creek, which had 10 percent and 14 percent, respectively. The increased component of mountain cranberry in the diets at the two downriver areas seemed to be fairly closely tied to the decreased component of willow for those same areas.

Similarly, percent composition of unidentified graminoids was also greater at the downriver areas than upriver. Presumably, moose are foraging more at the dwarf shrub and ground layer vegetation levels in the downriver stretch where the primary food source of willow is less abundant. Percent composition of graminoids was relatively low in the diets of all other areas (Table E.3.4.6).

Moss was a fairly major component of winter moose diets in all areas, totaling 18 percent for all areas and ranging from 12 percent to 23 percent of the diet. It is likely that moss is consumed in the process of eating dwarf shrubs such as mountain cranberry.

Paper birch was present only in the diet at the Watana mouth area. Quaking aspen, alder, lichens, and unidentified forbs and shrubs were minor components of the winter diets of moose throughout the study area. Quaking aspen occurs relatively infrequently in the middle Susitna River basin. Snow cover persists throughout most of the winter, which would make lichens unavailable as winter forage.

A preliminary estimate of the winter carrying capacity for moose of the Watana impoundment zone (including all borrow areas, camps, village, and damsite) and the Susitna watershed upstream from Gold Creek was calculated from browse biomass estimates (n=678) obtained in 1982 (Table E.3.4.7). A detailed description of the methods used to determine the browse biomass and the assumptions involved in calculating carrying capacity are included in Appendix E8.3. The number of moose-days the area can support is based on a winter food intake value of 5.0 kg dry weight per day (Gasaway and Coady 1974), and includes only the twigs of the primary browse species listed above. Based on the assumptions, the areas within the impoundment zone and facilities near the damsite could support a resident population of 301 moose for 180 winter days. The upper and middle basins together have a winter carrying capacity of 23,037 resident moose. The summer carrying capacity of the impoundment zone and nearby facilities (based on a daily consumption of 11 kg dry weight) is about 5 times that calculated for winter.

Chatelain (1951) examined rumen contents of moose obtained from kills along the Alaska railway and from hunter kills in the lower Susitna Valley in the Talkeetna-Houston area. Willows, paper birch, balsam poplar, and trembling aspen constituted most of the winter diet. Shrubs such as alder, wild rose, and highbush cranberry were rarely consumed. A similar analysis by Shepherd (1958) also indicated that the winter diet of moose in the lower Susitna Valley was composed primarily of willows, paper birch, and trembling aspen. However, because both of these studies involved moose from nonriparian habitats at some distance from the Susitna River, they probably do not accurately reflect the diets of moose overwintering in riparian communities and on river islands in the Susitna River. In particular, trembling aspen is not present in riparian communities and so would be unavailable to moose as a winter forage.

Browse availability and utilization measurements were obtained from a number of riparian sample sites along the Susitna River during 1980 (ADF&G 1981i). Five browse species were considered: willows, balsam poplar, paper birch, highbush cranberry, and wild rose. A mean of 0.13 browse plants/ft^2 was recorded for all habitat types in the Susitna River valley between Portage Creek and the Delta Islands. Browse species were most utilized in equisetum/willow and medium-tall poplar/willow/alder habitats and least utilized in medium-dense climax poplar/spruce and sparse climax birch/spruce.

Percent utilization of willow and poplar was greatest in habitats where they occurred less frequently (ADF&G 1981i). Birch was seldom found on floodplain habitats, but where it occurred near the river, it was well utilized (26.9 percent). Highbush cranberry and rose were found mostly in tall or climax habitats but were less abundant than willows. Utilization of highbush cranberry and rose was also less than that of willows.

General observations indicated that alder was seldom browsed by moose but in some localities a small alder clump would be heavily browsed (ADF&G 1981i). Some islands with high quality browse were not used by moose every winter; moose sign on some islands indicated heavy use in the past but no use during the winter of 1979-1980.

- Home Ranges (*)

Moose population studies in both the middle and lower Susitna basins involved biotelemetry assessment of local and seasonal movements and home ranges (ADF&G 1982k, 1982j, 1983i, 1983p, 1984m, 1984k). A considerable volume of information on home range locations, sizes, and distance relationships to the proposed impoundments or river channel was obtained. The following discussion of home ranges concentrates on the numbers of home ranges that may be potentially affected by the impoundments in the middle Susitna Basin and by modification of riparian communities in the lower Susitna Basin.

. Middle Susitna Basin (*)

ADF&G (1984m) summarized seasonal and total home range sizes of radio-collared moose studied in the Nelchina and upper Susitna River Basins from October 1976 through early June 1982. Considerable variation in size was noted for both seasonal and total home range sizes. Some of the variation may be attributed to an insufficient number of locations (ADF&G 1984m). Total home range sites ranged from over 1,000 mi^2 to around 1 mi^2. Comparison of total home range size with numbers of locations for both calf and adult moose suggested considerable variation between individuals. Although weak correlations may exist, individual examination of the larger individual home range suggests two explanations. Larger range sizes for some calves were due to their dispersal away from the cow's home range. Therefore, subtraction of the area used by the calf while with the cow will reduce the size of the area and make them comparable with non-dispersing calf home ranges. However, for adults the larger home ranges were primarily the result of movements during the rut (September-November) and/or movements in April away from wintering areas. During these periods, moose appear to move farther and more frequently than during other seasons, except migration. An additional reason for the large size of some home ranges was that the method used included high, mountainous areas ($\geq$4,000 feet elevation) which are rarely used.

To determine the number of moose that seasonally and annually occupy areas within or immediately adjacent to the impoundment areas, ADF&G (1982k) delineated a 17.8 mile zone around the impoundment area. The width of the zone was the average length of the annual home ranges of 162 radio-collared moose in the middle Susitna Basin for which four or more observations had been made during 1980-1981. Based on total home range polygons for 168 radio-collared moose, ADF&G (1982k) found that 19 had home ranges that fell outside the 17.8 mile zone. Of the 149 moose with home range polygons either partially or entirely within this zone, 79 moose had home range polygons which were either partly or entirely contained within an area that encompassed the proposed impoundments and an arbitrarily selected 5-mile wide zone adjacent to the impoundment (5 miles is approximately 1/3 of the average home range length).

- Lower Susitna Basin (o)

All moose for which home range data are available in the lower basin were captured on or immediately adjacent to the Susitna River on April 17, 1980 or March 10-12, 1981. Riparian habitats of the lower basin are assumed to be winter range used in at least some years by all of these individuals. Most individuals of both sexes leave the riparian areas by mid-April (Table E.3.4.8), the males leaving 2 to 3 weeks earlier than females. ADF&G (1982j) divided the radio-collared sample into three loosely defined subpopulations, based on capture and relocation data (Table E.3.4.9 and E.3.4.10). All of these groups were found at greatest distances from the Susitna River in the summer (July 1 to August 31) and/or breeding (September 14 to October 31) periods. Downstream westside moose (moose radio-collared downstream from Talkeetna and spending the breeding season on the west side of the Susitna River) were found farther from the river than other groups; 4 miles average for 13 females in the breeding period, and 12 miles average for 2 males in the summer period.

Moose collared in the area upstream from Talkeetna and on the west side of the river were commonly relocated either within the river downstream from Talkeetna (i.e., river islands) or within 1 mile of the river (much of this area would presumably be riparian communities) (Table E.3.4.9) (ADF&G 1982j). In contrast, moose on the east side of the river downstream from Talkeetna did not commonly frequent the river or riparian areas (ADF&G 1982j). However, because of small samples, the above use patterns should be considered preliminary.

(iii) Population Characteristics (**)

- Historical Population Trends (o)

Although moose population studies specific to much of the middle Susitna Basin were not initiated until the late 1970s, the Alaska Department of Fish and Game has been conducting annual aerial censuses in Game Management Unit (GMU) 13 since 1955 (ADF&G 1982k). Portions of GMU 13, specifically Count Area (CA) 6, CA 7 and CA 14, occur partly or entirely within the middle Susitna Basin (Figure E.3-.4.7); survey data for those areas are presented in Tables E.3.4.11, E.3.4.12, and E.3.4.13. Historical descriptions of moose populations within

GMU 13 are provided by Rausch (1969), Bishop and Rausch (1974), McIlroy (1974), and Ballard and Taylor (1980). The following discussion is based on ADF&G (1982k).

During the 1950s, moose populations in GMU 13 increased rapidly and reached high densities about 1960. After the severe winter of 1961-1962, the population declined and continued to decline with severe winters occurring in 1965-1966, 1970-1971, 1971-1972, and 1978-1979. Fall cow-calf ratios, as well as several other indices of population productivity, declined sharply and reached a record low for the basin in 1975. Sex and age composition data for CA 7 and CA 14 have basically exhibited the same patterns described for the unit. Since 1975, the moose population appears to have increased slightly or remained stable, even though calf survival has remained relatively low.

- <u>Population Estimates - Middle Susitna Basin</u> (***)

Several censuses have been conducted of both the impoundment zones and the surrounding areas to determine the number of moose that could potentially be affected by construction and operation of the project. Three count areas east of the mouth of Watana Creek (Figure E.3.4.7) were censused during 1980 (November 5 to 9) and again in fall 1983 (November 4 to 9) to determine the regional abundance of moose. Information was categorized into four density strata (none, low, medium, and high) (Figure E.3.4.7). Portions of the primary moose study area described by ADF&G (1984m) (Figure E.3.4.8) not included within the count were then stratified using the same four categories. (The primary study area encompassed all point locations of radio-collared moose that were captured in or known to have used areas within the borders of the impoundments and other project facilities.) Density estimates derived from the count areas were applied to the primary study area to derive fall population estimates.

The 1980 fall population estimate for the primary study area was 2,265 moose, and in fall 1983 was 2,836 moose (ADF&G 1984m). The estimates undoubtedly include an unknown number of animals whose fall home ranges do not overlap project facilities. Regardless, probably 2,000 to 3,000 moose occupy the area surrounding and including the impoundments and other facilities at any given time; this is about 11 to 13 percent of the approximately 23,000 moose estimated to occur in GMU 13 (ADF&G 1984m).

Because radio-collared moose have been documented to occur more frequently in the impoundments during the winter months than at other times of the year (ADF&G 1983i), several winter censuses of the impoundment zones have been conducted. Observers conducting censuses of the Watana Stage III impoundment out to one-quarter mile from the 2,185 foot elevation maximum-pool level counted 42 moose on March 28, 1981, and estimated a population of 290 moose on March 25, 1982, 580 moose on March 28, 1983 (ADF&G 1983i), and 295 moose on March 29, 1985 (Ballard 1985 pers. comm.). ADF&G (1984m) estimated that up to approximately 50 percent (278) of the 580 moose estimated in the 1983 census were actually below the Watana Stage III impoundment high-pool level. Although greater or fewer numbers of moose may have actually been below the Watana impoundment high-pool level at any time during the four winters in which actual censuses were conducted, it is reasonable to suggest that approximately 150 to 300 moose occupy the Watana impoundment zone during late March of years with average or light snowfall accumulations (relative to the mean). Because each moose may enter and exit from the impoundments one or more times during a given winter, this should be considered a minimum estimate of the number of moose that use the Watana impoundment during normal winters.

Observers conducting censuses of the Devil Canyon impoundment out to one-quarter mile from the 1,463 foot elevation high-pool level on March 26, 1981 and March 31, 1983 estimated or counted population sizes of 30 and 14 moose, respectively (ADF&G 1984m). Similar to the Watana impoundment census, about 50 percent of the censused moose were probably located below the high pool level.

Censuses conducted to quantify the numbers of moose using the Susitna River floodplain downstream of the Devil Canyon Dam in winter included 6 in 1981-1982, 11 in 1982-1983, and 7 in 1983-1984. Censuses were flown periodically each year between October and April; all moose within the banks of the river floodplain and any of its interconnecting sloughs were counted (ADF&G 1984k). Census results are presented in four physiographic zones described by ADF&G (1982o) and illustrated in Figure E.3.4.9.

- Population Structure (*)

  . Middle Susitna Basin (*)

  Information on the population structure of moose in a portion of the Susitna Basin (GMU 13) is available since 1955 (ADF&G 1982k); summaries of a number of population ratios such as cow:calf ratios and sex ratios are summarized for CA 6, CA 7, and CA 14 in Tables E.3.4.2, E.3.4.3, and E.3.4.4. In all three count areas, the number of males per 100 females has declined substantially since 1955. Declines in the number of calves and twin calves per 100 females have also been observed. These data suggest that moose productivity in the middle Susitna Valley has declined over the past 25 years. Recent declines in productivity have been attributed largely to brown bear predation of young calves (Ballard and Spraker 1979; Ballard et al. 1980, 1981a; ADF&G 1985o). ADF&G regulates moose harvest in the project area by limiting the legal take to large males with at least a 36-inch-wide antler spread. This further reduces the number of males per 100 females, but is designed to protect the productive population because of low recruitment (due to high predation mortality).

  . Lower Susitna Basin (*)

  Information on the sex and age composition of moose in the lower Susitna Basin was obtained during the surveys described earlier for population estimates. Because composition surveys in the lower Susitna Basin included only information obtained during the late fall and winter of each year, (when males and females are more difficult to distinguish) only sex and age composition data from the early surveys in December 1981 and 1982 will be considered (Table E.3.4.5). Males tended to be less abundant than females in both years. Comparisons of the number of calves per 100 females in 1981 for the lower Susitna Basin (48.4) and the middle Susitna Basin (32.2, based on estimates from the census surveys) suggest that moose populations in the lower Susitna Basin may be slightly more productive than moose in the middle basin.

. Mortality Factors (o)

Moose populations in several areas of Alaska, including GMU 13 (which includes part of the Susitna Basin) have undergone population declines in recent years (McIlroy 1976). A series of severe winters during the 1970s are believed to have resulted in these declines, and low annual recruitment associated primarily with poor calf survival prior to November has been suggested as the predominant factor maintaining these populations at low levels (Ballard et al. 1980). Predation of moose calves by wolf and brown bear is believed to be the most important factor contributing to low calf survival. Other factors such as decreasing range quality, low bull:cow ratios, and periodic severe winters are thought to be less important influences on calf survival (McIlroy 1974).

Intensive studies of moose populations in the Nelchina Basin were undertaken by the ADF&G during the mid-1970s to determine which factors were most important in determining calf survival. Studies by Van Ballenberghe (1978) and Ballard and Taylor (1978) suggested that bull:cow ratios were not a major influence on population size. Several measures of physical condition of moose also suggested that moose in the Nelchina Basin were in good physical condition and that deteriorating range conditions were not a problem (Franzmann and LeResche 1978). Furthermore, artificial reductions in wolf populations resulted in no large increases in calf survival, suggesting that although moose were an important component of wolves' diets, wolf predation on moose was not a major factor in declining productivity (Ballard and Spraker 1979). In the course of these investigations, it became apparent that brown bear predation of young moose calves was a major source of calf mortality (Ballard and Taylor 1978, Spraker and Ballard 1979). A recent study of moose calf mortality in the Nelchina and upper Susitna River basins (Ballard et al. 1980) showed that of 136 calves radio-collared shortly after parturition, 55 percent died of natural causes by the following

November. Brown bear predation of moose calves accounted for 79 percent of the natural deaths.

Mortality of newborn moose calves in the middle Susitna Basin during 1980 and 1981 was high (ADF&G 1982k). By August 1, 1980, 23 (77 percent) of the calves were missing. Rates of 1980 calf loss were compared with those observed in 1977 and 1978 (Figure E.3.4.10). Although causes of moose calf mortality were not determined in 1980, the pattern of loss was quite similar to that observed in GMU 13 during 1977 and 1978 where predation by brown bear accounted for a high proportion of the natural calf deaths (Ballard et al. 1981a).

Calf mortality was not directly monitored during 1981 but indices of calf production suggest that brown bear predation may again have accounted for a large proportion of the natural deaths (ADF&G 1982k). Of the 46 sexually mature cow moose which could have produced calves, only 20 (43.5 percent) were observed with calves; four (20 percent) produced twins. The calving rate for known producers was 1.2 calves/cow. Of the 24 known calves, 14 (58.3 percent) were missing by July 28. This pattern of calf loss is again quite similar to that of 1977, 1978, and 1980 when predation by bears accounted for most of the losses.

Of the 52 radio-collared calves monitored during 1984, only 15% survived from birth to early November (ADF&G 1985o). The largest source of mortality was due to predation by brown bears. Brown bears killed 46% of the calves, while black bears and wolves killed eight to 6% of the calves, respectively. All other natural mortality factors such as drowning, coyote (Canis latrans) predation, etc. accounted for approximately 12%. Mortality from all causes was 85%. Excluding project-related mortalities (N = 7), total natural mortality (37 of 45) was 82%.

Although predation by brown bears appears to be the major cause of calf moose mortality during the summer and fall periods, winter severity is likely an important factor in determining productivity and survival. Ballard et al. (1981a) found that snow depths from the Monahan Flats area were significantly correlated with subsequent fall calf:cow ratios in CA 3 of GMU 13. During the period from 1970 to 1978, 45 percent of the variation in cow:calf ratios could be attributed to snow depth. Snow may alter the energy balance of moose by increasing metabolic requirements for locomotion and decreasing accessible energy reserves by limiting food availability (Coady 1974). Assuming that snow depths are an adequate index of winter severity, the strong relationship between cow:calf ratios and snow depths suggest that overwinter conditions and their influence on the condition of pregnant cows are an important factor in determining calf survival, and hence, population productivity. A winter severity index developed by ADF&G (1984m) indicates that the winter of 1982-1983 was more severe than average, 1980-1981 was milder than average, and 1981-1982 and 1983-1984 winters were about average.

Ballard and Taylor (1980) examined mortality rates of adult females based on the loss of radio-tagged cows in the middle Susitna Basin during 1976-1978. During the three-year study, they estimated that annual adult cow mortality averaged 6 percent.

While brown bears and wolves are important predators of moose and account for a significant percentage of natural mortality, hunting mortality is also an important factor affecting moose populations. Hunting, at least in recent decades, has been highly regulated within the Susitna Basin. In most years, take is restricted to bulls. A given rate of hunting mortality probably has less effect on the population size of moose than the same natural mortality rate, due to the bulls-only restriction. Since moose are polygynous, taking of bulls usually does not directly affect subsequent reproduction. Poaching mortality is less predictable and may account for additional mortality of breeding animals.

- Dispersal (o)

Limited evidence obtained during the radio-tracking program suggest that young moose from the middle Susitna Basin may disperse into other major drainages in the region (ADF&G 1982k). One male calf was observed to move 46.5 miles from Swimming Bear Lake to Coal Lake. Another male calf moved from near the mouth of Watana Creek to the upper reaches of Windy and Clearwater Creeks north of the Denali Highway.

Based on these two observations, ADF&G (1982k) suggests that moose populations in other drainages removed from the Susitna drainage may be partly dependent on the immigration of Susitna moose. Information on population sizes in the Susitna Basin during 1980 and 1981 similarly suggest that a portion of the increase in numbers of adult moose may have been the result of immigration from other areas. During 1980, 178 calves and 766 adults were observed in CA 7. In 1981, a total of 1,006 adults were observed. Even if all of the 1980 calves had survived (which is unlikely), the increase is 21.1 percent greater than expected. Although sampling errors might account for a major portion of this difference, immigration from adjacent areas may partly explain this increase in adult moose.

Evidence from moose studies in areas adjacent to the lower Susitna Basin suggest that the lower Susitna population is discrete from those in adjacent drainages. Moose-tagging studies in the Matanuska River valley (Rausch 1971) and in the Peters-Dutch Hills (Didrickson and Taylor 1978) found that emigration from these areas to the Susitna Basin was extremely low to nil.

(b) Caribou (*)

Caribou in the area affected by the proposed Susitna Hydroelectric Project are members of the Nelchina herd. This herd, one of 22 herds in Alaska (Davis 1978), is important to sport and subsistence hunters because of its size and proximity to population centers in south-central Alaska. Currently, the Nelchina herd contains about 24,000 animals (approximately 5 percent of the total statewide caribou population of 446,000).

Despite the great interest by hunters in harvesting Nelchina caribou (12,516 applications for 1,900 permits in 1984), the range remains relatively inaccessible. Human development is largely limited to the peripheries of the herd's range and consists primarily of the Alaska Railroad, Parks Highway, Denali Highway, Richardson Highway, Trans-Alaska Pipeline, and Glenn Highway.

Caribou studies for the Susitna project were conducted by ADF&G (1982h, 1983c, 1984o, 1985e). All data in this section not otherwise cited were obtained from these sources. Data in these reports were derived from radio-locations of 40 to 50 individuals for varying amounts of time between April 1980 and October 1984.

(i) Distribution and Movement Patterns (**)

The Nelchina herd occupies an area of approximately 12,800,000 acres bounded by 4 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 (Figure E.3.4.11.) The Nelchina range contains a variety of habitats, from spruce-covered lowlands to steep, barren mountains.

The Nelchina herd has been studied by the U.S. Fish and Wildlife Service (USFWS) and the ADF&G since 1948. During this time, it has remained essentially within the area outlined above; however, with the exception of the calving area, seasonal use of particular areas has varied.

Early records indicate that the herd wintered (January to March) in the upper Nenana River area in the early 1930s and in the Talkeetna Mountains in the late 1930s (Skoog 1968). From 1950 to 1955, the herd wintered from the Little Nelchina River and Glenn Highway north through the Lake Louise Flats to the Denali Highway. As the herd increased in size through the later 1950s and early 1960s, its winter range also increased in size, encompassing the upper Nenana River area, Monahan Flats, Talkeetna Mountains, and extending east across the Richardson Highway (Hemming 1971). The most recent studies of radio-collared caribou indicate that during the winters of 1980-1981 and 1981-1982 the primary wintering areas were the eastern Lake Louise Flat and Chistochina and Gakona River drainages. In 1982-1983 wintering caribou ranged from northeast of the Metasta Mountains to the Wrangell Mountains foothills throughout the Gakona and Chistochina River drainages and onto the eastern Lake Louise flat.

By early October 1983 nearly the entire herd was east of the Richardson Highway with most animals concentrated along the lower reaches of Sinona, Indian, and Boulder Creeks (ADF&G 1984o). During the winter period the herd divided into three wintering concentrations with interchange between all groups. The largest concentration (about 15,000) was along the Wrangell Mountain foothills between the Dadinia River and the headwaters of the Copper River. A small group of animals (perhaps 2,500 caribou) moved to the northeastern slopes of the Mentasta Mountains. The third group (about 6,500) wintered on the Lake Louise flat, primarily west of Lake Louise. The three groups remained separated into mid-March. The 1983-1984 winter distribution was the most dispersed observed during the period (1980 to 1984). More use of the western Lake Louise Flat occurred than during previous years while less use of the eastern Lake Louise Flat and Gakona and Chistochina River drainages took place. Wintering Nelchina caribou were spread over an east-west range of about 150 miles.

Spring movements of the herd have been rather consistent during the past few years (1980 to 1984). Migration from the wintering grounds crosses Lake Louise Flat and enters the calving grounds in the eastern Talkeetna Mountains (Figure E.3.4.12). Currently few animals cross the impoundment zone during spring migration. Most of the crossings occur in the big bend area of the Susitna either in the uppermost reaches of the proposed Stage III reservoir or out of the impoundment zone, with some crossings occurring between the mouths of Deadman Creek and Jay Creek (ADF&G 1982h, ADF&G 1984h). Historically, animals traveling to the calving grounds from the north crossed the Susitna between the mouths of Deadman Creek and Jay Creek (Hemming 1971).

During 1981 many animals used the frozen Susitna River between the Oshetna River and Kosina Creek as a travel route (ADF&G 1982h). In 1982 the river was open and as many as 1,000 animals (10 percent of the female segment of the herd) crossed the Susitna in the upper reaches of the impoundment zone. For the past two years (1983 to 1984) the main migratory route has ran south of the impoundment and very few crossings were recorded during spring movements.

Since 1949, the first year for which records are available, Nelchina caribou have utilized an area of about 640,000 acres in the northern Talkeetna Mountains for calving (Skoog 1968, Hemming 1971, Bos 1974). Although the precise areas used have varied, calving has taken place between Fog Lakes and the Little Nelchina River between about 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 (Lentfer 1965, Skoog 1968, Bos 1973). In each of the years 1980 to 1984, calving took place between May 15 and June 10 in the drainages of Kosina Creek, Goose Creek, Block River and Oshetna River (Figure E.3.4.13) (ADF&G 1982h, ADF&G 1984o, ADF&G 1985e).

During spring migration and calving, there is some segregation of sex and age groups. Although yearlings and barren cows lag somewhat behind parturient cows, they also move to the calving area, remaining scattered along its periphery (Skoog 1968).

Historically, the female-calf segment of the Nelchina herd has summered primarily 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 most years between 1950 and 1973, varying proportions of the female-calf segment (ranging from 0 to 100 percent) crossed the Susitna River from the calving grounds to the summer range on the north side of the river.

Summer distribution of Nelchina caribou has been similar throughout the last five years of study (1980 to 1984). The female-calf segment has utilized the northern and eastern Talkeetna Mountains; particularly heavy use has occurred between the Little Nelchina and Black Rivers. Radio-collared male caribou are generally scattered throughout the high country of the Nelchina Basin during summer.

Autumn (August 1 through September 31) was a time of dispersal and movement for the past five years (1980 to 1984). Generally, animals moved from summer range in the Talkeetna Mountains onto Lake Louise flat. In 1984 however, most radio-collared caribou remained on summer range during this period. Members of the Nelchina herd have crossed the impoundment zone during these movements. Most of these crossings occurred during August and September and involved only a few animals (ADF&G 1982h, 1983c, 1984o, 1985e). However, during 1982 as many as 1,500 animals (15 percent of the female segment of the herd) were reported to have crossed the upper Watana impoundment zone from the south (ADF&G 1983c).

Historically, Nelchina caribou have rutted in a wide variety of locations with the eastern Talkeetna Mountains and Lake Louise Flat being most extensively used. The Deadman-Butte Lakes area was also heavily used during years when major segments of the herd summered or wintered in the area. During the fall period, Nelchina caribou move extensively and the rut may take place in a number of locations (Skoog 1968). It appears that habitat type is not a critical determinant of rutting locations but rather rutting occurs in virtually any area that caribou might be moving through during that period (ADF&G 1985e).

During the past five years (1980 to 1984) rutting has generally involved a west to east movement that generally left animals in an area from the Talkeetna Mountains east to the Wrangell Mountains.

(ii) 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 sightings of groups with 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 upper Talkeetna River, Chunilna Hills, Alaska Range, and Gakona River. The first three of these suspected subherds use areas fairly close to the proposed impoundments, and several caribou in each were radio-collared by ADF&G (1982h). Relocations of these animals are shown in Figure E.3.4.14).

The resident subherd in the upper Susitna-Nenana area (Figure E.3.4.14) was estimated in 1981 to contain about 1,000 caribou (ADF&G 1982h); 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 from the main herd. K. Pitcher (1982 pers. comm) censused the caribou population in October 1982 in the area north and west of the Susitna River above Gold Creek, including the Clearwater Mountains. The western and northern boundaries were the Parks Highway and the Alaska Range. Five days were required to complete the census because of periods of bad weather, and thus caribou movements during the census may have complicated the counts. Also, about 10 percent of the main Nelchina herd moved through the southeastern portion of the census area, further complicating the data. Pitcher estimated that 2,500 caribou were in the count area, based on an actual count of 2,077 caribou and his subjective impressions of sightability and area coverage.

During early May 1980, four adult females and one adult male were radio-collared from this subherd (ADF&G 1982h). 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 on the Lake Louise Flats during the rut and early winter. In the fall of 1983, she again migrated through the range of the upper Susitna-Nenana subherd. Thus it appears that she was actually a main herd animal which migrated through the range of the upper Susitna-Nenana subherd at least during two years. It is likely that other main herd animals also follow this pattern (another animal collared in 1980 showed a similar pattern until killed by wolves). Therefore, the estimate of 2,500 caribou is considered high. Adequate data are not available to precisely estimate herd size. However, it probably ranges between 1,000 and 2,000 animals and in lieu of a better estimate, 1,500 caribou is the current ADF&G estimate for this subherd. The other three females remained in the upper Susitna-Nenana area throughout the study period, producing two calves in 1980 and two in 1981. The bull summered in the Clearwater Mountains, then joined the main Nelchina herd during the rut on the Lake Louise Flats.

The Chunilna Hills group appears to be a resident subherd numbering fewer than 340 animals (ADF&G 1982h). One radio-collared bull remained in the Chunilna Hills from April to November 1980 when it shed its collar. Two females were collared in the spring of 1981, both of which subsequently gave birth to calves in the area. No overlap with radio-collared animals from the main herd or other subherds was noted, although one female did move across the Talkeetna River.

Small groups of caribou, including cows and calves, have been seen in most of the side drainages of the upper Talkeetna River. This appears to be another resident subherd, probably of fewer than 400 animals, and having some spatial overlap with the main Nelchina herd. Three caribou in this upper Talkeetna River subherd (two adult females and one adult male) were collared on April 18, 1980 (ADF&G 1982h). These animals were relocated 50 times and were always found in drainages of the upper Talkeetna River or in the upper reaches of the nearby Chickaloon River (Figure E.3.4.14). One female raised a calf in 1980, and both raised calves in 1981. The male spent the summer of 1980 in the mountains west of the Talkeetna River.

(iii) Habitat Use (*)

Habitat use was analyzed from aerial determination of vegetation cover at each caribou relocation (ADF&G 1982h).

At one time or another during their annual movements, Nelchina caribou probably use most of the vegetation types in the Susitna area. However, ADF&G (1982h) found caribou mostly in spruce forest, shrubland, herbaceous vegetation types, and bare substrate types, with virtually no use of mixed or deciduous forests.

Nelchina caribou show considerable variation in habitat types used seasonally, and types used most by bulls are different from types used most by cows (Table E.3.4.14) (ADF&G 1982h). Bulls tend to use spruce forests more than cows in all seasons except autumn, whereas cow use of tundra-herbaceous types is greater during all seasons than bull use. These differences are likely a reflection of the tendency of bulls to remain much longer in the forested wintering areas and to summer at lower elevations than cows (see Figure E.3.4.15). Use of shrubland is similar for cows and bulls overall but differs seasonally. Bulls tend to use this habitat most in summer and autumn, whereas cows use it most during spring, calving, and summer (ADF&G 1982h).

As mentioned, differences between bulls and cows in habitat use were partly related to differences in elevation. The sexes occurred at about the same elevations during autumn, the rut, and winter, but females were consistently found at higher elevations during spring migration, calving, and summer (Figure E.3.4.15) (ADF&G 1982h).

The food habits of caribou vary seasonally with available plant forage (Skoog 1968). In spring and summer, grasses, sedges and the buds of willow and birch are important, and a wide variety of forbs are eaten as they become available. Except during years of late snowmelt when new growth is slow to appear, lichens are unimportant in the spring diet. In late summer, mushrooms are an actively sought, but minor, diet item. During autumn, browse becomes less important but sedges and grasses remain major diet components and lichens assume greater importance. Through the winter the diet of Nelchina caribou consists of about equal portions of graminoids and lichens (Skoog 1968).

(iv) Population Characteristics (*)

During the past three decades the Nelchina herd has experienced a population growth phase from 1950 to 1960, a peak from 1961 to 1965, a decline from 1966 to 1973 and another growth phase from 1974 to 1983 (ADF&G 1984o) (Table E.3.4.15). Currently the herd has 24,095 animals and low cow calf ratios for both 1983 and 1984 indicate reduced or even negative growth (ADF&G 1985e). ADF&G management objectives for the Nelchina herd currently include maintaining a population level of 20,000 adult animals (ADF&G 1982h).

The sex and age composition of the Nelchina herd remained almost the same from fall 1980 to fall 1981. Cows and bulls older than one year comprised 49.1 percent and 29.9 percent, respectively, of the herd in October 1981. Calves comprised 21.1 percent or 42.9 calves per hundred females one year and older (ADF&G 1982h). The proportion of bulls was high compared to the proportion observed in earlier years, a finding that would be expected in a growing population that had previously had a low proportion of males (Bergerud 1980).

Skoog (1968) estimated the overall pregnancy rate of Nelchina caribou to be 72 percent for females one year and older from 1957 to 1962. Full reproductive potential was not realized even in the fully adult age classes. Only 13 percent of yearling females were pregnant compared to 61 percent of two-year-olds and 89 percent of females three years and older. In 1980 and 1981, the proportion of calves in the post-calving aggregations averaged about 56 calves per 100 females one year and older (ADF&G 1982h). These data suggest that considerable calf mortality occurs shortly after birth. ADF&G estimated that calf survival to 11 months was 43 percent for 1980 calves and 60 percent for 1981 calves. Survival rates for older caribou (>1 year) were 93.5 percent for females and 87 percent for males.

Survival rates of caribou are influenced by many factors including disease, parasitism, weather, accidents, food availability, predation, and hunting. Parasitism and disease may kill a few caribou each year in the Nelchina herd, but these are not major mortality factors. Wet, cold weather during calving can result in high levels of calf mortality which Skoog (1968) believed could ultimately control caribou population levels. However, this is a factor that is more likely to affect coastal herds and more northerly herds than the Nelchina herd (Skoog 1968).

The major factors that are believed to control caribou mortality and, ultimately, population levels, both in Alaska and elsewhere, are food availability and predation (including hunting). However, over-grazing on preferred winter ranges may cause caribou to shift to new areas where forage is more abundant. Because many preferred plant species are slow to recover from the influence of heavy grazing, such ranges may not again be utilized by caribou for one or more decades e.g., the main Nelchina herd shifted away from winter ranges adjacent to the proposed Watana reservoir in the late 1950's to take advantage of available forage in the Wrangell Mountains some 130 miles to the east (Hemming 1971, 1975). Data from range exclosures established at various locations in the Susitna Basin in the 1950's confirm the slow recovery of winter range habitat north of the proposed reservoir (Pegau 1972, Lieb et al. 1985). Whenever parturient cows from the Nelchina herd must move greater distances to reach their calving ground some calves may be born enroute resulting in increased mortality to the newborn calves (Skoog 1968). Major shifts in caribou distribution may also affect the level of harvest by sport and subsistence hunters depending on the accessibility of the animals during a given hunting season. Based on current range trends increasing use of the proposed impoundment areas should be expected in the future (Bergerud 1980). Food availability in winter, because of snow cover, is likely to be more critical than availability in summer, and many early workers speculated that declines in caribou numbers in North America in the early 1900s were caused by winter forage (mainly lichen) destruction by forest fires (Scotter 1967). However, evaluations of more rigorous analyses (e.g., Henshaw 1968, Kelsall and Klein 1979, Klein 1967, Roby 1980, and Bergerud 1974a) show that starvation or even observable debilitation in caribou during winter is rare except in populations insulated from predators and prevented from dispersing to unoccupied habitats (Scheffer 1951, Klein 1968, Leader-Williams 1980).

Skoog (1968) believed that neither overgrazing nor fire had greatly affected the Nelchina range in the early 1960s. The herd was considerably larger then now, and food availability is unlikely to be a major factor affecting survival in the present herd.

Several authors have presented evidence that caribou numbers are effectively controlled by predation. For example, Kelsall (1968), Parker (1972), Miller and Broughton (1974), and Davis et al. (1980) all report evidence that caribou numbers have declined as predator (mainly wolf) numbers increased, or that caribou numbers have increased as predator numbers decreased. Bergerud, in two reviews (1974a, 1980), demonstrates convincingly that where capable predators (wolves, bears, lynx) are common and hunting by man is insignificant, caribou populations are effectively regulated by predation.

Since the introduction of firearms to North America, hunting has probably been the major cause of population declines (Bergerud 1974a, Calef 1980). Calef (1980) reported that in some herds in the Northwest Territories, hunter kill is in excess of annual recruitment. In the former case harvest may have been accelerated due to increasing caribou accessibility resulting from changing range use patterns.

Hunting and wolf predation probably account for about equal portions of the annual mortality of the present Nelchina herd (ADF&G 1982h). Table E.3.4.16) shows the level of hunter harvest from 1972 to 1981. During that time, hunter harvest in years for which herd size data are available has varied from 1.4 percent to 9.6 percent of the herd. Hunter harvest was about 4 percent in 1981.

Wolf predation has reportedly varied with the size of the wolf population (AFD&G 1982h). Skoog (1968) estimated that wolves took 1.1 to 2.6 percent of the herd from 1957 to 1962. More recently ADF&G (1982f) estimated wolf predation rates varying from 7 to 10 percent of the herd in 1973 to 2 to 3 percent in 1981. There appears to be no clear relationship between wolf and caribou population levels, possibly due to the high harvest of wolves (Figure E.3.4.16) (Bergerud 1980).

The average natural mortality rate for caribou 1 year and older of both sexes in 1981 was 8.1 percent. If the ADF&G (1982f) estimate of 2 to 3 percent mortality applies to adults as well as calves (as they suggest), then wolf predation combined with hunter harvest (3.9 percent--Table E.3.4.16) account for 50 to 60 percent of the annual adult mortality in the Nelchina herd.

(c) Dall Sheep (*)

Dall sheep studies were conducted in the middle Susitna River basin during 1980, 1981, 1982 and 1983 (ADF&G 1982d, 1983o, 1984j). The purpose of these studies was to determine the locations and seasons when sheep might be affected by project activities. The study area includes all drainages flowing into the Susitna River between Jay Creek and Gold Creek and all drainages west or north of the Susitna River south of the Denali Highway. Survey efforts were confined to areas of known or suspected Dall sheep habitat within this area (Figure E.3.4.17) (ADF&G 1982d). These areas contain semi-open, precipitous terrain, with rocky slopes, ridges, and cliffs.

(i) Distribution (*)

There are three general areas in the middle Susitna Basin that have steep rocky slopes at sufficient elevation to be potential Dall sheep habitat (ADF&G 1982d). The first of these areas is north of the Susitna River between the proposed Devil Canyon and Watana damsites. Aerial surveys were conducted in this area in the Portage Creek and Tsusena Creek drainages (Figure E.3.4.17). The second potential site for Dall sheep is in the mountains between the Susitna and Talkeetna Rivers, extending eastward from the Fog Lakes to Kosina Creek. The third area is north of the Susitna River, to the east of Watana Creek. This area was established as a population trend count area for Dall sheep by ADF&G in 1967 (Figure E.3.4.17).

ADF&G (1982d) conducted aerial surveys to determine the seasonal distribution and abundance of Dall sheep in the areas described above on July 22 and 23, 1980; on March 13 and 25, 1981; between May 13 and June 24, 1981; on July 28, 1981; and on March 23, 1982. The date, location, number, sex, and age of sheep were recorded for all sightings (ADF&G 1982d).

A total of 72 sheep (7 legal rams, 12 lambs, and 54 unidentified) were counted in the Portage Creek and Tsusena Creek drainages in July 1980. Four sheep were seen north of Portage Creek, two east of Tsusena Creek, and the other 66 were seen in the headwaters region of Tsusena Creek. 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 (north of Tsusena Creek), which was not surveyed in 1980. All of the sightings were far from the proposed impoundments and access roads.

During July 1980, only eight sheep (1 ram, 7 unidentified) were observed in the Watana Mountain - Grebe Mountain area. This area is used by sheep from a larger Talkeetna Mountains population. Earlier observations in 1977 suggested that at least 34 sheep were present on Mt. Watana. Numerous observations of sheep in the Terrace Creek area (a southern tributary of Kosina Creek) have been made, but no sheep were observed during the 1980 survey.

On March 25, 1981, a winter distribution survey was conducted in the same area surveyed in July 1980. Twenty-two sheep were sighted, and two groups of 3 to 4 tracks were seen. These data suggest that groups of sheep from the larger Talkeetna Mountains population are migrating into the area during winter. All sheep observations were located on the southern extreme of the count area, well away from the impoundment.

The Watana Hills area has been surveyed for Dall sheep by ADF&G yearly since 1967 (ADF&G 1982d). The data from the 1980 and 1981 surveys show the same general patterns as previous surveys (Table E.3.4.17). The 1981 count of 209 sheep was the second highest number of sheep recorded for this area. The percentage of lambs was similar to that of past years and suggests that productivity and survival are remaining constant. The small number of legal rams counted could reflect the rather high (13) sport harvest taken from this area in 1980. Although the 1981 count was relatively high, it is suspected that the population has remained stable or perhaps increased slightly (ADF&G 1982d).

Sheep in the Watana Hills area were surveyed in March of 1981 and 1982. Eighty-seven sheep were sighted in 1981 and 77 in 1982, all on south-facing slopes. Geist (1971a) suggested that south-facing slopes are an important part of Dall sheep winter range. They provide maximum exposure to winter sun and frequently have shallower snow than slopes with different aspects. Fewer sheep were observed than in the summer surveys, probably because of poor observability due to snow cover and/or movement of sheep from the area.

(ii) Mineral Lick Use (*)

Mineral licks are known to be important for Dall sheep and are a common component of spring ranges. Heimer (1973) suggested that they be considered a critical habitat requirement. The sheep in the Watana Hills area have been observed frequenting at mineral licks along the lower elevations of Jay Creek at an elevation of about 2,200 to 2,500 feet.

For the purposes of this discussion a small individual spot where licking has occurred will be defined as a lick "site". A specific geographical area along Jay Creek will be called a lick "area". A lick area may be composed of several smaller sites. The sum total of all licking areas along Jay Creek will be referred to as the Jay Creek mineral lick.

Lick use is highly seasonal, occurring mostly in spring and early summer (mid-May through mid-July in Alaska) (Heimer 1973). The Jay Creek lick sites are composed of lacustrine material, and interlayered sequence of fine sand to silty clays. Carbonate coating and calcite veins also occur in outcrops at some sites.

Jay Creek is on the north side of the Susitna River and flows into it at River Mile (RM) 209. The lick areas occur in the lower four miles of the creek, where elevations generally range from 1,900 feet to 3,000 feet. The major lick area is a steep bluff on the west bank of Jay Creek (Figure E.3.4.18. The bluff is located approximately two miles from the mouth of the creek and extends north along the creek about 0.2 miles, rising to an elevation of 2,550 feet. The bluff area is often the first visited by sheep (probably belonging to the Watana Creek Hills population) traveling to the area from alpine habitat five or more miles to the north or northwest.

Additional Jay Creek lick areas documented by ADF&G (1984j) are at the east ridge (elevation 2,260-2,285 feet), downstream (about 1,950 feet), upstream (about 2,190 feet), north bluff (above 2,300 feet), cabin ridge (about 2,290 feet), and ravine (about 2,240 feet) (Figure E.3.4.18).

Sheep trails and scat were also found near the area known as Red Cliffs, which is north of the boundary of the proposed Watana reservoir. Although no lick cavities were found, it appears that the area may be used as a mineral lick (ADF&G 1984j).

Detailed observation of sheep at the Jay Creek lick areas by ADF&G personnel extended from May 11 through July 11, 1983. Sheep were continually in the vicinity from May 21 to June 12. Another intensive use period occurred from June 16 to 20, when ewes first brought their lambs to the lick. Shorter use periods were recorded after June 20 and sheep were still seen at the site as late as August 10. Rams used the licks early in the season, followed by pregnant or barren ewes and yearlings. Ewe-lamb groups did not arrive until June 16 (ADF&G 1984j).

A minimum of 31 percent of the 1983 Watana Creek Hills population (estimated at 149 animals) used the Jay Creek lick area. A maximum of 31 individuals were seen in the lick area at one time (the most ever recorded) (ADF&G 1984j).

Observations in earlier years were less complete than those of 1983. During 1981, sheep were observed as early as May 6. Regular aerial observations of the Jay Creek area began on May 13 and continued to June 24. Sheep utilized the area on a relatively continuous basis through the last observation period on June 24. Observations of sheep at the Jay Creek lick during 1982 were incidental to other project activities. ADF&G 1983f reported that sheep were observed at the lick for the first time on June 8 and for the last time on July 8.

By measuring the amount of time that sheep spent at various elevations, using elevation increments of 100 feet, it was found that sheep spent most of their time above 2,200 feet. The sheep that could be viewed spent more of their time (25.7 percent) in the zone between 2,200 and 2,299 feet than at any other 100 foot zone (Figure E.3.4.19). However, this does not include time spent in areas not completely visible to the observer. When these periods of time are incorporated into the analysis, sheep spent only 13.8 percent of the time below 2,200 feet (Figure E.3.4.19).

Sheep-hours observed were compiled for various activities at nine elevation zones (ADF&G 1984j). Eighty-five percent of the licking activity occurred in two zones, 2,200 to 2,299 feet and 2,300 to 2,399 feet (Figure E.3.4.20).

As shown in Figure E.3.4.20, very little licking activity took place below 2,200 feet. Only 4 of the 27 different licking sites observed on the bluff occurred below 2,200 feet.

(d) Brown Bear (*)

Most of the site-specific information for brown bears in the Susitna Basin was obtained from recent studies by ADF&G (1982e, 1983l, 1984n, 1985n). Additional site-specific information was obtained from studies in the upper Susitna and Nelchina River basins during 1979 (Miller and Ballard 1980, Spraker et al. 1981).

(i) Distribution (*)

Brown bears or grizzly bears (the former term will be used throughout this report) are widely distributed and abundant in most parts of Alaska. Brown bears appear best adapted to relatively open, undisturbed areas with good cover and an abundance of perennial succulent herbs and/or fruit-bearing shrubs (Mealy et al. 1981). The omnivorous food habits of brown bears as well as their nongregarious social structure and high degree of mobility allow them to utilize resources in a large number of habitats throughout an expansive area (Knight 1980). Brown bears appear to be able to adapt to a variety of man-caused disturbances in their habitat. However, experience has amply demonstrated that brown bear abundance is usually incompatible with human presence; human-bear interactions commonly have resulted in the extermination of brown bears from settled areas through intensive hunting, trapping, and/or poisoning programs.

Brown bear research in the middle Susitna and Nelchina River basins has been ongoing since 1978 (Ballard et al. 1980, Spraker et al. 1981). Most studies were initially concerned with the effects of brown bear predation on moose, but more recent studies have concentrated on all aspects of brown bear ecology (ADF&G 1982e, 1983l, 1984n). No site-specific information is available on brown bear in the lower Susitna Basin. Within the middle Susitna Basin, brown bears generally are most abundant in open tundra habitats during most of the late spring and early fall periods. Many brown bears appear to utilize lower elevation spruce habitats during the early spring. Current information suggests that brown bears in the middle Susitna Basin are abundant and that populations are young and productive.

- Seasonal Movements (*)

  The brown bears' omnivorous feeding habits, social structure, behavioral interactions, and winter denning requirements necessitate extensive movements throughout large areas (Craighead and Mitchell 1982). It appears that the utilization patterns of large geographic areas by brown bears is largely dependent on the spatial and temporal availability of food. Information from a number of areas in Canada and the United States suggests that brown bears establish traditional movements to exploit dependable sources of food. Often these food sources are only seasonally available for short periods of time. Extensive traditional movements are common in many populations of brown bear (Pearson 1976, Reynolds 1979, Craighead 1980).

Based on 1,449 relocations of radio-collared brown bears in the middle Susitna Basin during 1980 (n=15), 1981 (n=18), 1982 (n=14), and 1983 (n=43), ADF&G (1982e) documented regular seasonal movements of brown bears that appeared to be associated with regional and elevational differences in food availability. Movements of brown bears from the middle Susitna Basin to Prairie Creek during July and August were perhaps the most notable regional movements observed during the study. These regular seasonal movements of brown bears appeared to be associated with high concentrations of spawning king salmon in Prairie Creek during this time of year.

During the period 1980 to 1983, an average of 27 percent of radio-collared project area brown bears were recorded at Prairie Creek during the king salmon spawning period, with a high of 36 percent in 1980 and a low of 13 percent in 1981 (ADF&G 1984n). Fifty-six percent of males were drawn to this region from a 2,800 square mile (mi^2) area, while 18 percent of females were drawn in from a 850 square mile area. Although a large number of animals may utilize this food source, it is not clear whether brown bears are dependent on the supply of salmon. For example, moderately dense brown bear populations exist in the adjacent Nelchina Basin without access to salmon (Miller and Ballard 1982). As suggested by ADF&G (1982e), Prairie Creek salmon may be an important buffer when other food sources such as berry crops are less available, and this additional food source results in a higher carrying capacity of the middle basin for brown bears. Many brown bears that move to the Prairie Creek area have portions of their home ranges north of the Susitna River, and therefore have to cross the river en route to or from Prairie Creek.

Movements of brown bears in the early spring also appear to be related to elevation and the availability of new plant growth (ADF&G 1982e). With the exception of sows with cubs, it appears that many brown bear moved to lower elevations on or near the Susitna River following emergence from overwintering dens. This was attributed to the relatively earlier melt-off of snow, particularly on south-facing slopes, and the subsequent availability of overwintered berries and new plant growth. Carcasses of winter-killed ungulates and new-born calves in these areas also would provide food for brown bears. Radio locations of brown bears in the middle Susitna Basin during the springs of 1980 and 1981 indicated that, excluding sows with newborn cubs (which remained at higher elevations), 62 percent and 52 percent of the radio-collared animals, respectively, moved to areas on or adjacent to the Susitna River (ADF&G 1982e). Analyses of 2,211 observation of brown bears in other than den-related activities showed marked preferences for the impoundment zones (p less than 0.05) (ADF&G 1985n). Selection for lower elevations was greater in the Watana impoundment zone than that of Devil Canyon, and was strongest during spring months (April 1 to June 30). Females with newborn cubs remained at high elevations throughout the year.

Although some of the regional and elevational movements of brown bears in the middle Susitna Basin may be related to forage availability, these movements may also be associated with brown bear predation of moose and caribou calves. Directional movements by four radio-collared brown bears to and from the calving grounds of the Nelchina caribou herd suggest that brown bears may move to calving areas primarily because of the availability of calves (ADF&G 1982e).

- Denning (**)

Brown bear dens in the middle Susitna Basin were on moderately sloping southern exposures, and were generally dug in gravelly soils either in tussock or shrub habitats (ADF&G 1982e). (Use of vegetation types for denning is discussed below.) None of the bears in this study reused den sites although many bears tend to use the same location in successive years (ADF&G 1984n). Brown bear den sites ranged in elevation from 2,330 to 5,151 feet with an average elevation of 4,202 feet (s.d.=717 feet, n=47).

Radio-collared brown bears in the middle Susitna Basin entered dens in late September-early October from 1980 to 1982, and emerged from those dens in mid April-early May (ADF&G 1984n).

(ii) Habitat Use (*)

Brown bears in other areas of Alaska and northern Canada utilize a wide range of vegetation communities. Habitat affinities of brown bears in the middle Susitna Basin were based on the predominant vegetation types in the vicinity of each relocation of the radio-collared bears as determined from aerial observations. Brown bear use of spruce vegetation types, which are concentrated around and in the proposed impoundments, was highest in May and June (Table E.3.4.18) (ADF&G 1982e). Bears tended to move to shrublands at higher elevations later in the summer (58 percent of the observations in September were in shrubland, whereas only 28 percent of the May sightings were in this type) (ADF&G 1982e).

Comparisons of the use of vegetation types by brown bears during the spring and the remaining portion of the year indicated that brown bears used spruce forests significantly more often during the spring than during other times of the year (ADF&G 1982e). As discussed earlier, sows with newborn cubs tended to remain at higher elevations; of 68 observations of sows with cubs, only 1 occurred in spruce habitat. Shrublands were most commonly used by sows with cubs (49 percent of the observations) followed by "other" habitats (35 percent), tundra (10 percent), and riparian communities (4 percent).

- Food Habits

Studies of the feeding habits of brown bears indicate that the species is omnivorous, feeding on a wide range of plants and animals. Although plant material may commonly comprise a major portion of the diet, it appears that brown bears prefer high-protein animal food (Craighead and Mitchell 1982).

From dietary studies of brown bears in interior Yukon (Pearson 1976) and in Yellowstone National Park (Craighead and Sumner 1980), it appears that brown bears most commonly utilize graminoids and forbs during the spring and early summer. As berries and fruits become more available, these also are incorporated into the diet. Brown bears will eat carrion, if available, and may also kill ungulates or other large mammals. Small rodents such as ground squirrels are most often consumed during the late summer.

As discussed earlier, brown bears are attracted to both natural and artificial food sources, particularly if food is abundant and readily available. Some brown bear populations traditionally form aggregations to feed on salmon during the major fish runs (Stornorov and Stokes 1972).

Information on the diets of brown bear in the middle Susitna Basin is limited. Overwintering berries and new green shoots of grasses and forbs are consumed during the early spring. Winter-killed ungulates as well as moose and caribou calves also are eaten. King salmon likely comprise much of the diet of bears moving to Prairie Creek during the salmon run in July and August. Berries such as Vaccinium spp. are likely consumed throughout the late summer and fall period.

One of the most notable results of the brown bear studies in the middle Susitna Basin is recognition of the importance of brown bear predation to moose recruitment. Ballard et al. (1981a) found that of 123 radio-tagged moose calves, 55 percent had died of natural causes by November (following their birth) and that 79 percent of all natural mortalities were caused by brown bear predation. Relocations of 23 radio-collared brown bears that were intensively monitored (twice per day) during the spring of 1978, showed that 14 of the 23 bears regularly relocated were observed at least once on a moose calf kill (Ballard et al. 1981a, Spraker et al. 1981). During the latter study, a total of 37 calf moose, 28 adult moose, 4 unidentified moose, 3 caribou, and 6 other species of mammals were killed by brown bears, yielding a total of 1 kill/5.6 observation days (1 moose/6.3 observation days). An intensive relocation was also undertaken in 1984. During the spring period twenty-six moose calf kills were positively identified for 16 radio-marked bears, an additional 8 kills of non-calf moose and 3 age- or species-unknown kills were also observed. This represents a total of 48 known or suspected kills of ungulates by these bears during the spring, approximately 3 per bear. Female with newborn cubs had the lowest predations rates (1.5

kills of moose calves/66.7 visuals), and females with yearlings had the highest rates (1/11.5 visuals). The low rates for females with newborn cubs doubtless reflects the elevational separation which typically separates these bears from other bears during the spring (ADF&G 1982e). This separation puts most females with cubs away from the area where most other bears are concentrated and also away from the areas where moose calves are being born. Although the full importance of this highly preferred food source to brown bears is not known, Craighead and Mitchell (1982) found spring weight gains only in brown bears able to secure ungulate calves or similar high protein diets.

- Home Range (*)

The average home range size of male brown bears in the middle Susitna Basin in the period 1980 to 1983 was 282,687 acres (n=24); for females it was 94,118 acres (n=52) (ADF&G 1984n) during the same period.

Comparisons of the home range sizes of brown bears in the middle Susitna Basin with brown bears in other areas indicate that bears in the Susitna Basin have relatively large home ranges (Table E.3.4.19) (ADF&G 1982e). Only home ranges of bears from northwestern Alaska (a relatively unproductive population) were larger. On the basis of this information, ADF&G (1982e) suggested that home range size and brown bear densities are inversely related and that both are a function of the distribution and abundance of food resources. The large home ranges of brown bears in the Susitna Basin, therefore, may reflect relatively low productivity of food items that are important to brown bears and/or a patchy distribution of important food items. Alternately, the attraction of a high quality food source such as Prairie Creek may induce bears to include large traversed areas into their home ranges.

As discussed previously for moose, home range analyses are useful in assessing the number of animals that may be affected by the proposed impoundments. ADF&G (1982e) examined the relationships between the home ranges of radio-collared brown bear during 1980 and 1981 and three arbitrarily chosen areas that included: (1)

the proposed impoundment, (2) a 1 mile zone around the proposed impoundments, and (3) a zone occupying areas 1 to 5 miles from the proposed impoundments.

The mean overlap of the home ranges of 19 brown bears with the impoundment was 5 percent (range of 0 to 25 percent), for the 1-mile zone it was 15 percent (0 to 48 percent), and for the 5-mile zone it was 52 percent (0 to 100 percent) (ADF&G 1982e). These figures under-represent the actual use by brown bears of the area in and adjacent to the impoundment area because the home range figures used in calculating the percent overlap are the total annual home ranges. Seasonal use by brown bears, particularly during the spring, is more intensive.

Similarly, analyses of the proximity of relocations to the proposed impoundments show that radio-collared brown bears selectively use areas that are close to the Susitna River, particularly during the spring period. Comparisons of the number of bear relocations in the impoundment areas, as well as in the two "impact" zones discussed earlier, indicate that use in the actual impoundment area was greater than expected during all periods (almost four times greater during the spring) and that use of the outermost zone (one to five miles was less than expected (ADF&G 1982e). However, these analyses may overestimate use of the impoundment zone by the middle basin population because of sampling bias.

(iii) Population Characteristics (*)

- Population Size (*)

Brown bear population estimates are extremely difficult and expensive to obtain because of the wide-ranging behavior of most individuals and their use of some habitats where sightability is poor. Miller and Ballard (1980) used a Lincoln Index to calculate a rough density estimate of 1 bear per 10,112 to 15,296 acres in the Susitna River headwaters during 1979. This estimate suggests that brown bear densities are intermediate between densities in southern and coastal Alaska and the Brooks Range (Table E.3.4.20). Based on an estimate of 1 bear per 10,112 acres, the brown bear study area (an area of 2,093,678 acres that includes the middle basin, see ADF&G 1982e) would have a population of approximately 206 brown bears. This estimate was reevaluated in 1983 (ADF&G 1984n), resulting in an estimate of 131 to 409 bears, with a mean value of 212. Preliminary analysis of the 1985 survey (ADF&G 1985n) produced an estimate of 224 bears.

- Population Structure (*)

  Information on the sex and age structure of the brown bear population in the middle Susitna Basin was available from GMU 13 harvest data during 1970 to 1980, the 1979 study of brown bears in the middle Susitna and Nelchina River basins (Miller and Ballard 1980), and from capture data from recent brown bear studies (ADF&G 1982e, 1983l, 1984n) (Table E.3.4.21).

  The age composition of brown bears captured in the middle Susitna Basin during 1980 and 1981 was 19.6 percent cubs, 11.8 percent yearlings, 12.7 percent two-year olds, 15.7 percent three- and four-year olds, and 39.2 percent adults. The moderately high percentages of young animals in the Susitna brown bear population suggest that the population is young and productive.

- Productivity (*)

  The mean litter size for brown bears in the middle Susitna Basin was 2.1 (range of 1 to 3), based on nineteen litters of newborn cubs observed with radio-collared females since 1978 (ADF&G 1984n). The mean litter size for the basin is comparable to those in highly productive brown bear populations on Kodiak Island and on the Alaska Peninsula, and is higher than litter sizes in the relatively unproductive Brooks Range brown bears (Table E.3.4.22).

  Of 32 cubs in 16 known litters produced in GMU 13 from 1978 through 1983, 15 (47 percent) died during their first year (ADF&G 1984n). One of these losses may have been capture-related. During the same time period, 12 "litter" of yearlings were followed, with six of these 20 bears (30 percent) dying before they were two years old. Causes of cub losses were not determined for most cubs, but predation by male brown bears was considered most probable (ADF&G 1982e, 1984n).

Three of six cubs fitted with mortality collars (activity sensing) in 1983 were killed by other brown bears. Comparisons of the reproductive rates of brown bears in the middle Susitna and Nelchina Basins with reproductive rates of other brown bear populations indicate that the Susitna and Nelchina Basins support some of the most productive brown bear populations in Alaska (Table E.3.4.23).

- Dispersal (*)

ADF&G (1982e) believed that dispersal of sub-adult brown bears, both to and from the study area, was probably common. Several instances of dispersal by radio-collared brown bears were recorded. One male, originally tagged as a 2-year-old in 1978 on the Susitna River north of the Denali Highway, was recaptured and radio-collared near Clarence Creek on the Susitna River. Another 2-year-old male was captured near Deadman Creek during the spring of 1981 and moved downstream (54.9 miles) to the vicinity of Moose Creek. During the fall, the same animal moved back to the vicinity of Sherman and Curry. The importance of dispersal in maintaining brown bear population levels in the Susitna River basin and in adjacent river drainages is not known.

- Sport Harvest (*)

ADF&G harvest data for brown bear in the Susitna brown bear study area are presented in Table E.3.4.24) (ADF&G 1984n). From 1970 to 1982, harvests averaged 24 per year (5 to 42). The mean age of brown bears taken during the period 1970 to 1982 was 6.1 years (5.8 for males and 6.5 for females). This relatively young age suggests that many project area hunters are not selecting large trophy bears. Of 656 bears that have been harvested and aged in GMU 13 from 1970 to 1980, 10 percent were yearlings, 29 percent were 2-years-old or less, 41 percent were 3-years-old or less, and 52 percent were 4-years-old or less (ADF&G 1982e). In recent years, sport hunters have applied pressure to extend brown bear seasons and bag limits in GMU 13. This pressure has largely resulted from research showing that brown bears are a major predator on moose calves (Ballard et al. 1980, 1981a). In addition, Miller and Ballard

(1980) suggest that there may be a harvestable surplus of brown bears in GMU 13.

(e) Black Bear (**)

All site-specific information on black bear populations in the Susitna Basin was obtained from recent studies by ADF&G (1982e, 1983l, 1984n, 1985n) during 1980-1984. Most of the data for 1981 and 1982 was for the middle Susitna Basin (upstream from the Devil Canyon damsite), but later studies also focused on bears downstream from Devil Canyon.

(i) Distribution (o)

Black bears are the most common and widely distributed of the three bear species in North America. They occur in most areas of Alaska as far north as the Brooks Range. Black bears are highly adaptable and are able to utilize a wide variety of habitats. Like brown bears, they are omnivores and their ranges and diet respond to regional and temporal changes in food availability. Prime black bear habitat can be generally characterized by relatively inaccessible forested terrain, thick understory vegetation, and abundant sources of plant foods such as succulent herbs and forbs, berries, and fruits (Pelton 1982).

Black bears appear to be moderately abundant in the middle Susitna Basin. However, because of the limited distribution of suitable habitats, black bears generally occur in the narrow fringe of forested habitat along and near the Susitna River.

- Seasonal Movements (**)

Based on relocations of radio-tagged black bears during 1980 to 1983, ADF&G (1982e, 1983l, 1984n) described the probable seasonal movements of black bears in the middle Susitna Basin as follows. In years of normal or abundant berry crops, many bears move in late summer, to somewhat higher country adjacent to the spruce habitats along the river, returning to their spring and early summer home ranges near the river to den. Most of these late summer movements are upstream (east) and in a northerly direction (ADF&G 1982e). In years of subnormal berry crops, most individuals make more extensive movements, moving long distances upstream or downstream in search of acceptable foraging areas or areas where salmon are available. These movements occur primarily along the main Susitna River, indicating that it is a main transportation corridor. Most individuals making these extensive movements return to their former home ranges, but some do not. In late summer and fall, particularly during poor berry years, these extensive movements of black bears may bring them in close contact with brown bears, possibly resulting in increased mortality of black bears through inter-specific predation (ADF&G 1982e).

Females with newborn cubs are exceptions to this general pattern of seasonal movements. Females with cubs make less extensive movements than other bears regardless of the berry crop.

- Denning (**)

Distributions of den sites of black bears in the Susitna Basin indicate that dens occur most commonly in steep terrain along the main Susitna River and its tributaries (ADF&G 1982e). However, the band of acceptable denning habitat appears to become narrower and more confined in upstream areas where dens are restricted to the immediate vicinity of the Susitna River.

Black bear dens in the Susitna Basin were generally located on moderately sloping hillsides; the mean slope of 15 dens located during 1980 and 1981 was 36 percent (range of 18 percent to 53 percent). Half of the dens were located on south-facing slopes, and the remainder were on east- to north-facing slopes.

As of 1985, 82 black bear den sites had been located within the study area; 23 downstream of Devil Canyon, 23 within the Devil Canyon dam impact area, and 36 within the Watana Dam impact area (ADF&G 1985n). The 82 black bear dens range in elevation from 625 feet to 4,340 feet; 5 dens were above 3,100 feet. The mean elevation for 79 dens was 2,018 feet (s.d.=600 feet). For 20 den sites in the vicinity of the proposed Devil Canyon impoundment, the mean elevation was 2,149 feet (range=1,400 to 4,340 feet, s.d=643). Of 34 den sites located in the vicinity of the proposed Watana impoundment, the mean elevation was 2,186 feet (range=1,675 to 3,450, s.d=541). Downstream of the Devil Canyon damsite, the mean elevation of

24 black bear dens was 1,599 feet (range=625 to 3,125 feet, s.d=631). Of the 82 black bear dens examined on the ground, 33 were in natural cavities and 41 were excavated. Eight had an unknown origin. Virtually all of the natural cavity dens appear to have been used in preceding years; some may have been used for decades or longer. Of 14 dug cavities examined, 7 were considered to have been previously used (ADF&G 1983l).

In contrast, black bears on the Kenai Peninsula were rarely found to reuse dens during successive years (Schwartz and Franzmann 1981b). ADF&G (1982e) suggest that the relatively high reuse of dens by black bears in the Susitna Basin may indicate a scarcity of acceptable den sites and/or habituation to specific sites.

Black bears usually emerge from dens in late April or early May, and most have entered dens by the end of October (ADF&G 1984n).

(ii) Habitat Use (**)

Habitat use by black bears in the middle Susitna Basin appears to be similar to general use patterns reported elsewhere in North America, where black bears most commonly inhabit forested areas with dense understory vegetation (Jonkel and Cowan 1971, Fuller and Keith 1980). Of 908 aerial observations of 53 bears in the Susitna Basin, black bears were most often located in shrubland (42.7 percent of observations) and spruce (39.4 percent) habitats (Table E.3.4.25) (ADF&G 1982e). Use of spruce habitats remained high througnout the year but was much less prevalent during the summer months. During August, black bears were often present in shrubland habitats adjacent to the spruce forests. This use of shrubland areas was thought to be related to seasonal increases in the availability of ripening berries (ADF&G 1982e). Use of spruce habitats appeared to differ among male and female bears. Of 126 locations of female bears during the summer period, 43 percent occurred in spruce habitats, whereas of 125 locations of males, only 30 percent occurred in spruce habitats (ADF&G 1982e).

An examination of habitat use by black bears within the proposed impoundment area for the Watana Stage I dam showed that deciduous forests and shrublands were used significantly more often than expected. Other habitat types were used approximately in proportion to their availability. In the deciduous forest cover type, closed birch and open birch forests accounted for all of the locations. Similar habitat associations were observed in black bear populations in northern Alberta (Fuller and Keith 1980).

- Food Habits (**)

Throughout their range in North America, black bears consume primarily grasses and forbs during the spring, soft mast (fruits and berries) of trees and shrubs during the summer, and a mixture of hard and soft mast during the fall. Only a small portion of black bear diets typically consist of animal matter and then primarily in the form of insects or carrion. Spring is generally a period of food scarcity and bears may often subsist on remaining fat reserves (Rogers 1976). Preferred high-quality foods of black bears are generally more abundant during the summer, and animals develop most of their fat reserves during this period.

Little site-specific information is available on the food habits of black bears in the Susitna Basin. As discussed earlier, berry crops such as blueberry and crowberry are an important component of the late summer diet, and movement of black bears into shrubland habitat is thought to be related to the availability of berries in these areas. The presence of devil's club berries in many scats suggested that these berries may be a greater attraction to black bears in downstream riparian areas than spawning salmon (ADF&G 1984n). Horsetails, grasses, and sedges were also common in scats. Although plant foods may constitute the staple diet during most of the year, black bears may also prey on moose calves during the spring (ADF&G 1982e). Black bear predation on moose calves is prevalent on the Kenai Pennisula, where 70 percent of the known predator-caused deaths were attributed to black bears (Franzmann et al. 1980). During intensive radio-monitoring of black bears during May 22 to June 22, 1981, one male bear was observed on one calf moose kill and one adult caribou kill. Later in July, the same bear was observed on a kill of a radio-collared adult moose. It is not known if the bear had killed these animals or if it was scavenging kills of another predator. ADF&G modeling suggests that black bear predation on moose during May 15 to July 15 amounts to 0.003 calves/bear/day and 0.001 adults/bear/day (ADF&G 1984n).

- Home Range (**)

During 1980 to 1983, the mean home range size of 90 black bears in the middle Susitna Basin was 32,865 acres; 21,251 acres for 47 females and 45,220 acres for 43 males. During 1981, however, the average home range size was 53,888 acres: 49,408 acres (200) for 11 females and 57,792 acres for 12 males. Although large variations in home range size between years may be partly related to the greater number of observations of bears during 1981, ADF&G (1982e) suggests that the larger home ranges may reflect relatively poor berry crops and the subsequent need for black bears to move greater distances to find suitable foraging areas. The observation of black bears north of the Denali Highway (a rare occurrence) during 1981 supports the suggestion that black bears made atypically long movements during the summer of 1981 (ADF&G 1982e). Comparisons of home range sizes of black bears on the Kenai Peninsula (4,096 acres for females and 24,192 acres for males) (Schwartz and Franzmann 1981b) with those of black bears in the Susitna area suggest that home ranges of black bears in the middle basin are larger.

The proximity of black bear home ranges to the proposed impoundments suggest that black bear distributions are closely associated with lower elevation habitats along the Susitna River. ADF&G (1982e) delineated two arbitrarily chosen zones around the proposed impoundment areas (one included all areas within 1 mile of the impoundments and the other included all areas 1 to 5 miles from the impoundments) to assess the potential effects of the impoundments and associated development on black bear populations. The mean overlap of 27 black bear home ranges with the impoundment areas was 14 percent (0 to 45 percent). Overlap in the two adjacent zones was 50 percent (0 to 100 percent) and 122 percent (56-195 percent) for the 1 mile and the 1 to 5 mile zones, respectively. The overlap can exceed 100 percent if the home range is within the zones around both impoundments.

(iii) Population Characteristics (**)

- Population Size (**)

  Based upon a variety of methods, including Lincoln Index, home ranges and aerial reconnaisance, the preliminary estimate of the black bear population between Devil Canyon and the Oshetna River is about 111 bears (ADF&G 1985n).

- Productivity (**)

  Black bear populations in the middle Susitna Basin appear to be fairly productive and healthy (ADF&G 1982e). This suggests that habitat is adequate, even if limited in extent.

  A total of 69 cubs from 32 litters were observed from 1980 to 1984. Mean litter size was 2.2 cubs, with a range of 1 to 4. Thirteen of these litters were observed in the natal dens. These litters have a larger mean size of 2.4 (2 to 4) (ADF&G 1985n). The observed litter size for 7 litters of yearling black bears was 1.9 (ADF&G 1982e).

  Litter sizes in the Susitna Basin appear to be similar to those reported for litters in other parts of North America. The mean litter size for black bears on the Kenai Peninsula was 1.9 cubs/litter, based on radio-collared animals (Schwartz and Franzmann 1981b). Erickson and Nellor (1964) reported an average litter size of 2.15 for black bears in Michigan and 2.0 for Alaska (the exact locale was not identified). Jonkel and Cowan (1971) documented litter sizes of 1.5 to 1.8 cubs/litter for a relatively unproductive black bear population in Montana over a several-year period.

  Although cub production appears to be quite high in the Susitna Basin, cub loss also is high. Based on only four litters that were observed prior to June 1981, four of nine (44 percent) cubs were lost. No losses of cubs from litters were observed on the Kenai Peninsula (Schwartz and Franzmann 1981). The high rates of cub loss in the Susitna Basin are believed to be related to the vulnerability of cubs to predation by brown bears and to the relatively high black bear densities (and intra-specific competition for suitable habitats) (ADF&G 1982e).

ADF&G (1982e) suggests, on the basis of available productivity indices, that the Susitna populations are not as productive as black bear populations on the Kenai Peninsula. This was based primarily on the older age of reproductive maturity in the Susitna Basin and the high rate of cub loss.

- Dispersal (*)

  Dispersal of black bears from the middle Susitna Basin may contribute to bear populations in adjacent areas. Dispersal of bears into the Susitna Basin appears less likely, however, because of the apparently saturated nature of black bear habitat along the Susitna River (ADF&G 1982e). Several instances of dispersal from the study area have been documented. One sub-adult male was captured at Clark Creek and was later shot near Hurricane on the Parks Highway. A four-year old male was captured north of the Susitna River and was later shot in an area 44 miles to the south. Three adult black bears moved downstream from the middle Susitna Valley to areas downstream from the Devil Canyon damsite. Two of these bears denned in the downstream areas.

- Sport Harvest (*)

  Based on Alaska Department of Fish and Game records for the 1973 to 1980 period, black bear harvests for GMU 13 averaged 66/year (range 45 to 85) during a 365 day season with a bag limit of 3 bears (cubs and females with cubs excluded from legal bag limit) (Table E.3.4.26) (ADF&G 1982e). Males constituted 74 percent of spring harvests and 65 percent of fall harvests. Most of the harvest (74 percent) occurred in the fall season when bears were taken incidental to moose or caribou hunts.

  The current harvest is well below the sustainable harvest level. At present, it appears that few hunters sufficiently prize black bear meat or pelts from GMU 13 to charter an aircraft to hunt away from the road system; only 35 percent of the hunters taking black bear from 1973 to 1980 recorded aircraft as their primary means of transportation Table E.3.4.26. However, it is probable that the increasingly restrictive seasons and conditions for moose and caribou hunting in GMU 13 will result in increased black bear hunting in this area, especially as more hunters become aware of the existence of substantial black bear populations in the unit.

Recorded black bear harvests in the Susitna study area from 1973 to 1980 averaged 8/year (a range of 1 to 15). In general, black bear harvests have been increasing in recent years with the largest recorded annual take occurring in 1980. The largest harvests have occurred in the downstream region of the Susitna River between the Indian and Talkeetna Rivers, the only portion of the study area currently accessible by river boat or highway vehicle.

(f) Wolf (**)

Wolves in GMU 13 have been the focus of many studies and a subject of controversy for over 30 years (Ballard 1981). The history of GMU 13 wolves between 1957 to 1968 is summarized by Rausch (1969). From 1948 to 1953, poisoning and aerial shooting by the federal government reduced wolf populations to low levels. By 1953, only 12 wolves were estimated to remain in the basin. The population expanded to a peak number of 400 to 450 by 1965 after federal predator control efforts were curtailed (Rausch 1969). Moose populations declined to low levels in the area, stimulating a series of predator-prey interaction investigations beginning in 1975 (Stephenson 1978, Ballard and Spraker 1979, Ballard and Taylor 1980, Ballard et al. 1980). Wolf control efforts were renewed in 1976 to 1978, but by 1980, the wolf population had returned to pre-control levels (Ballard 1981). Recent data on wolf distribution, habitat use, population characteristics, and detailed histories of individual wolves and their packs are provided by ADF&G (1982f, 1983g, 1984d).

(i) Distribution (**)

At least 19 wolf packs were known or suspected to be utilizing the Watana and Gold Creek watersheds from 1980 to 1984. At least six and possibly seven of these packs occur adjacent to, or partially overlap with, the project impoundments.

Individual wolf packs establish territories which, overlap little with adjacent packs (ADF&G 1982f). However, because of the large harvest of wolves in this area, packs are periodically eliminated, and areas with no wolves exist for varying periods of time until new packs are formed by animals dispersing from adjacent areas. ADF&G (1982f, 1984d) provided detailed histories of pack formation, membership changes, and disintegration for 13 packs, some beginning as early as 1977. These data indicate that pack territories appear to be more stable than membership (i.e., that a pack is defined by the area it defends rather than its size or individual members). This may be the direct result of the destabilizing influence of extended heavy hunting and trapping and the removal of key individuals from pack structure.

During the summer, activities of packs containing breeding adults are centered on den and rendezvous sites, the latter being above-ground sites where the pups play and are fed from the time they are about 2 months old. At least 16 den and rendezvous sites are known to be used by the packs in the Watana and Gold Creek watersheds. Dens are generally but not always roughly centered within a pack's territory, and each is frequently used for more than 1 year. Average distance between 35 dens in the Susitna and adjacent areas was computed to be 28.1 miles (ADF&G 1982f), a distance that compares well with 24.9 miles observed in the Brooks Range of Alaska (Stephenson and Johnson 1973).

(ii) Habitat Use (**)

Habitat types used by wolves vary widely (Paradiso and Nowak 1982) and in any particular area are probably determined largely by the habitat of their major prey. In the Susitna Basin, detailed data on habitat use were collected for the Watana pack between April 1980 and November 1981. This pack used a wide variety of habitats but was most frequently encountered in birch shrub, mixed low shrub, and woodland black spruce habitat types (ADF&G 1982f).

Wolf dens in the Susitna area are mostly old red fox dens taken over and dug out by wolves. The majority are located on slightly elevated sandy areas providing good drainage. Entrance holes face predominantly south or east. Both dens and rendezvous sites have been found in a variety of habitats. Overstory trees or shrubs at den sites include spruce, aspen, balsam poplar, paper birch, and willow in densities ranging from 90 percent cover to very sparse (ADF&G 1982f).

- Food Habits (**)

Food habits of wolves in the Susitna area were studied by both direct observation of kills and analysis of scats collected at den and rendezvous sites (ADF&G 1982f, 1983g, 1984d). The former method covers all seasons, whereas the latter provides only summer food habits.

Between 1980 and 1983, 7 radio-collared wolf packs were observed on 204 kills. Table E.3.4.27 presents data collected from these observations. Over half of the kills were moose, and caribou represented about one-third. Other prey, such as snowshoe hare, beaver, muskrat, and other small mammals made up the remaining percentage of kills. Calves accounted for about one-third of the moose kills, and comprised one-tenth of kills of caribou.

Table E.3.4.28 summarizes wolf summer food habits as determined from analyses of scats collected at den and rendezvous sites during 1980 and 1981. Moose of all ages were the most important summer food items during both years of study. However, ADF&G (1982f) suspected that the importance of calf moose was probably overemphasized by these data.

Predation rates in the Susitna area have been estimated to average one kill per pack every five days (ADF&G 1982f). Rates vary somewhat with pack size (Ballard et al. 1981b) but do not appear to vary seasonally (ADF&G 1982f) as has been suggested for some areas (Peterson 1980).

Studies of wolf food habits in the adjoining Nelchina Basin since 1975 have suggested that moose are the single most important food item (Ballard et al. 1981b). Adult moose are taken selectively from August through December, while short and long yearling moose (moose that are a few months younger or older than 1 year) comprise a disproportionate number of January to July kills. Wolves take relatively healthy moose in winter. Ballard et al. (1981b) found that during severe winters all ages of adult moose were taken in proportion to their representation in the population, but in average and mild winters disproportionate numbers of older adults were taken.

Caribou have comprised between 4 and 30 percent of Nelchina Basin wolf kills from 1975 to 1981. Excluding 1978, when the main body of the Nelchina caribou herd wintered in the Wrangell Mountains and thus was largely unavailable during winter, the importance of caribou in the diet of Susitna Basin wolves appears to have increased. (Wolf diets averaged 18 percent caribou for 1975 through 1977 in comparison to 26 percent caribou for 1979 through 1981). Some of the annual difference in percentage of occurrence of caribou could be attributed to the difference in the locations of wolf packs studied during these time periods in relation to distribution of caribou. Caribou distribution, however, is probably related to herd size (Skoog 1968). The Nelchina herd reached a record low of approximately 7,500 in 1972. Since that time, the population has increased to over 20,000. It is suspected that the increase in the caribou population generally has made caribou more available to wolves throughout the eastern Susitna Basin and adjacent areas. If true, this pattern would suggest that if the herd grows even larger, caribou will become more important as wolf prey. Assuming wolf populations in this area increase slightly or remain stable, a larger caribou population may have some positive benefits for moose, in that a larger percentage of the wolf kills may be comprised of caribou, relieving the moose population of some predation mortality.

- Home Range (*)

Each of the wolf packs studied by ADF&G (1982f, 1983g, 1984d) in the Susitna Basin maintained the same home range during the period that the pack existed as a stable unit. Wolf packs in this area occasionally defend their territories against other wolves, although intrusions into territories often occur when the home pack is not using that portion of the area. Observed pack home ranges varied in size from 79,570 acres to 627,890 acres and averaged 289,960 acres.

(iii) Population Characteristics (**)

Wolves in the Susitna Basin are heavily hunted legally and illegally and were subject to an intensive control effort by the ADF&G from 1975 to 1978. This control was an attempt to manipulate moose numbers experimentally by reducing predation. Whether the wolf population was at a low level in 1980 and 1981, when detailed studies related to the Susitna project began, is unknown. The population in the Susitna Basin from 1980 to 1984 ranged from about 25 in spring after the hunting/ trapping season to about 77 in fall when the pups join the hunting adults (Table E.3.4.29).

Although there has been much speculation, there is little agreement on the factors that control wolf populations. Van Ballenberghe et al. (1975) believed that pack density, prey abundance, and degree of exploitation varied so much among populations that the combination of factors controlling one population might be quite different from those controlling another. In the Susitna Basin human exploitation is quite clearly the most important factor. The is no bag limit on harvest of wolves in GMU 13 and the season is open from August 10 to April 30. In 1981 and 1982, almost half the fall population was removed through legal and illegal winter hunting. Including wolves taken during the wolf control program from 1975 to 1978, the average yearly harvest from the Susitna Basin and areas immediately adjacent (GMUs 13A, 13B, and 13E) averaged 38 and ranged from 26 to 68. Additional large numbers of wolves were taken illegally in each year (ADF&G 1982f). Similar hunting and poaching levels prevailed in 1983 and 1984.

Although there are few specific data, the maintenance of these high levels of harvest suggest high productivity in the population. ADF&G (1982f) did not report average litter size for the packs they studied, but their remarks suggest that six to eight pups were produced yearly by each pack. High productivity, both in terms of proportion of adult females that whelp and litter size, has been demonstrated in other exploited populations both in Alaska and elsewhere (Rausch 1967, Van Ballenberghe et al. 1975).

The large numbers of pups produced each year result in a large population of young wolves likely to disperse to other areas. ADF&G (1982f, 1983g, 1984d) gives numerous examples of radio-collared wolves that moved from one pack to another within the basin; wolves that established new packs in vacant areas; and wolves that left the basin entirely. Dispersal of individuals is often preceded by forays away from the pack home range and may be precipitated by death of most of the other pack members through sport hunting or poaching.

(g) Wolverine (*)

The wolverine remains one of the most poorly known of the larger carnivores, and few scientists have attempted to study wolverines in their natural habitat. Van Zyll de Jong (1975) states that the reason for this is that the species is uncommon, highly mobile, and restricted to the more remote and inaccessible parts of the country. Most wolverine studies in North America have reported on the species' breeding biology and other information obtained from carcasses (reviewed by Rausch and Pearson 1972). Recent advances in radio-telemetry have resulted in studies of wolverine movements, habitat use, and home ranges in northwestern Montana (Hornocker and Hash 1981), northwestern Alaska (Magoun 1982), and in the middle Susitna Basin (ADF&G 1982m, 1983h, 1984f).

(i) Distribution and Habitat Use (*)

Wolverines occur throughout the Susitna Basin and appear to show little preference for specific habitat types (Figure E.3.4.21). The lack of use of specific habitats is most likely related to the scavenging lifestyle of this species. Such a lifestyle dictates seasonally long movements, a relatively large home range, and a solitary existence (Hornocker and Hash 1981). Van Zyll de Jong (1975) states that "the wolverine's niche explains the relative rareness of the species in the community compared to the efficient hunters among carnivores that act as providers [of carrion], and it implies a direct relationship between the biomass and turnover of large herbivore populations and the abundance and distribution of wolverines." The wolverine's propensity for wandering far and wide, which increases its chances of finding widely scattered and immobile food, and its well-developed food-caching behavior are probably also adaptations to the scavenger role (Hornocker and Hash 1981).

Food availability appears to be the primary factor determining movements and home range sizes of wolverines (Hornocker and Hash 1981; ADF&G 1982m, 1984f). Breeding activity also influences the seasonal movements of males, and to a lesser extent, of females (Hornocker and Hash 1981; Magoun 1982). Temperature may also influence movements; Hornocker and Hash (1981) reported that, during the summer, wolverines of both sexes moved to higher, cooler elevations and traveled less during daylight hours. In the Susitna Basin, ADF&G (1984f) reported that changes in wolverine distribution occurred throughout the year and that food availability probably influenced these shifts. They noted a pronounced movement in spring, summer, and fall to higher elevations where arctic ground squirrels, marmots, and ground-nesting birds were abundant. Food is most available in the spring and summer, and wolverines consume a wide variety of food at that time (see Wilson 1982). Krott (1959) found carrion, small mammals, insects and insect larvae, eggs, and berries in the summer diet. Magoun (1982) found microtines, ground squirrels, marmots, and caribou in the spring and summer diets of wolverine in northwestern Alaska.

Movements to lower elevations during winter are apparently associated with the increased importance of carrion in the diet during the winter months. During winters of moderate-to-deep snow depths, the lower elevations along the Susitna River support high densities of moose (ADF&G 1982k). Also, fewer birds and small mammals are available at higher elevations during the winter months (Kessel et al. 1982a). Winter ground tracking indicated that wolverines were preying upon microtines, red squirrels, ground squirrels, and spruce grouse in addition to carrion (ADF&G 1982m). Both red squirrels and spruce grouse are restricted to forested areas, and other small mammals are also most abundant in coniferous and deciduous forests.

The degree of territorialism exhibited by wolverines in an area appears to be related to the turnover rate of the wolverine population. Magoun (1982) found that female wolverines in an essentially unharvested population occupied exclusive home ranges that were overlapped by those of males. She did not have enough data to determine whether adult male home ranges overlapped. Hornocker and Hash (1981) stated that wolverine home ranges in northwestern Montana overlapped between individuals of the same and opposite sex and claimed that territorial defense was essentially nonexistent. However, they were unable to establish the residency status of individuals in their population. Magoun (1982) reported that females with overlapping home ranges might be mother/daughter combinations, and that young males which have not yet dispersed might be overlapped by resident adult males. The data obtained on wolverines in the Susitna Basin indicate that, except for some overlap between adults and juveniles, individuals of the same sex occupy mutually exclusive home ranges. The overlap of ranges shown in Figure E.3.4.21 is caused mostly by the mortality of some of these animals during the studies. Hornocker and Hash (1981) suggested that trapping mortality in their study area, while not excessive enough to reduce population size, may have contributed to behavioral instability within the population causing a breakdown in the territorial system. They pointed out that unexploited mountain lion populations showed a highly refined system of territoriality, whereas exploited populations were not territorial at all. Exclusive use of home ranges by same-sex adult wolverines in the Susitna Basin and northwestern Alaska may, therefore, be a reflection of relatively low trapping mortality.

(ii) Population Characteristics (*)

The home range data obtained from the Susitna Basin study and from other studies can be used to estimate the number of wolverines present in the upper and middle basins. The home range sizes for 4 adult males located at least 5 times was 151,230 acres, 88,710 acres, 148,510 acres, and 139,860 acres. These ranges were smaller than those reported for males by Magoun (1982) (mean = 172,800 acres, but similar to the 104,320 acres value found by Hornocker and Hash (1981). Home range sizes for females located at least 5 times was 33,850 acres, 26,440 acres, and 17,790 acres..

If we assume that wolverines in the 4,032,640 acre middle and upper basins use all habitat types (including rivers, lakes, rock and ice), and further assume that adult male home ranges are mutually exclusive and contiguous, we arrive at an estimate of 40 adult males in the middle and upper basins. Reported sex ratios of wolverine kits taken from dens and of fetuses do not differ from a 1:1 ratio (Pulliainen 1968; Rausch and Pearson 1972); therefore, an estimated 40 adult females also occur in the area. According to Rausch and Pearson (1972

ADF&G 1984f), the effective reproduction of wolverines is 2 kits per litter. Hornocker and Hash (1981) believed that no more than half of the females on their study area were reproductively active in each of the five years of their study, and only 53 percent of mature females trapped in the Susitna Basin were reproductively active (ADF&G 1982m). About 40 kits are therefore added to the basin's population each year, resulting in a total summer estimate of 120 wolverines in the basin. This converts to a density of 1 wolverine per 33,920 acres (53 mi^2). This compares with other density estimates of 1 per 90 mi^2 in northwestern Alaska (calculated from Magoun 1982); 1 per 25 mi^2 in northwestern Montana (Hornocker and Hash 1981); 1 per 80 mi^2 in British Columbia (Quick 1953), and 1 per 77 mi^2 to 1 per 193 mi^2 in Scandinavia (Krott 1959). There are probably fewer than 120 wolverines in the middle and upper basins, since it is unlikely that wolverines use all areas; and emigration, immigration, and trapping and natural mortality probably result in a smaller population size. Some juveniles also occupy home ranges that do not overlap completely with those of adults.

Trapping is probably the main cause of mortality among wolverines in the Susitna Basin. A total of 27 wolverines was harvested from this area from 1979 to 1983; annual harvests ranged from 16 to 59 animals, with a sex ratio of 1:1.

(h) Belukha Whale (**)

The belukha whale is a widespread arctic and subarctic circumpolar species that inhabits coastal waters. In Alaskan waters, two discrete stocks, a Cook Inlet-northern Gulf of Alaska stock and a general Bering-Chukchi-Beaufort stock, have been identified based on migration patterns, summer concentration areas, and morphological differentiation (Sergeant and Brodie 1969, Murray and Fay 1979, Gurevich 1980). No evidence exists to indicate interchange between the Cook Inlet stock and the Bering Sea stock, and isolation has been suggested based on morphological differentiation. Current information on Cook Inlet stock was gathered by ADF&G (1983j, 1984g).

(i) Distribution and Habitat Use (**)

In winter, belukhas may be found in some of the ice-free bays in southern Cook Inlet. Some individuals apparently range across the northern Gulf of Alaska; sightings of belukhas have been reported from Shelikof Strait, Kodiak Island, and Yakutat Bay (Fiscus et al. 1976; Calkins and Pitcher 1978; Harrison and Hall 1978; Calkins 1979; and ADF&G unpublished data).

Belukhas aggregate in groups of two to several hundred individuals in spring and summer seasons. These concentrations have been attributed to exploitation of locally concentrated foods such as anadromous fish (Tarasevich 1960, Sergeant 1962) and to warmer estuarine water temperatures (Fraker et al. 1978). Belukha concentrations may also be associated with polygamous breeding in April and May, with calving (reported to occur in May through August in brackish lagoons) and with the subsequent nursing of neonates (Seaman and Burns 1981).

Most of the Cook Inlet population moves into upper Cook Inlet in spring and remains there through much of the summer. In spring and summer, concentrations develop near mouths of streams and rivers in the northern inlet, the largest concentration occurring annually between the mouths of the Little Susitna and Beluga Rivers, lasting from about mid-May through mid-June. (ADF&G 1984g). It appears that eulachon are the major prey species. Unknown amounts of king and sockeye salmon possible also may be eaten, particularly by adult male belukhas. It is unknown if the whales are eating out-migrating salmon smolt (ADF&G 1984g). There has also been speculation that the mouth of the Susitna River is a calving and nursing area for belukhas.

Aerial surveys were flown by ADF&G (unpublished data) in upper Cook Inlet between May 17 and August 27, 1982 and April 6 and July 20, 1983, to identify the timing and magnitude of belukha concentrations. Belukhas were concentrated in the inlet south of the Susitna River mouth from the date of the first survey through late June or early July, with a peak number of 300 animals counted on June 11, 1982. Due to turbid water, these counts are considered low. By July 8, the concentrations appeared to have broken up and less than 70 whales were sighted in the Little Susitna to Beluga Rivers area.

No calves were sighted during these surveys, but ADF&G attributed this to the low visibility in the turbid waters of the upper inlet and the difficulty distinguishing yearlings from newborns from the air, indicates that calves were likely to have been present when surveys began on May 17.

(ii) Population Characteristics (**)

Population estimates of the Cook Inlet stock from the mid-1960s indicated there were 300 to 1,000 belukhas in Cook Inlet, with a most accepted estimate of 500 animals (Klinkhart 1966). More recent surveys support this estimate (Calkins 1979; Calkins, unpublished data). ADF&G (1984g) reported 300 belukhas from direct counts in upper Cook Inlet on June 11, 1982, and indicated that, because the turbid water obscured the observers' vision, 2 to 3 times that many may have been present but could not be observed.

4.2.2 - Furbearers (**)

(a) Beaver (**)

(i) Distribution and Habitat Use (**)

Beavers are common and widely distributed throughout much of North America. They occur throughout the Susitna River drainage, from Cook Inlet upstream along the river, its tributaries, and ponds to elevations above 3,281 feet (Gipson et al. 1982). They are herbivorous and eat herbaceous and aquatic vegetation as well as the bark, twigs, and stems of trees and shrubs.

The Susitna River from Devil Canyon to the Delta Islands was surveyed for beaver sign in the summer of 1980 by Gipson et al. (1982). Use of the river by beavers increased progressively downstream from Devil Canyon. An overflight of the river in the summer of 1981 and intensive surveys in 1982 confirmed this observation (Gipson et al. 1982) (Table E.3.4.30). No beaver lodges, food caches, or dens were observed within the active floodplain between the Tyone River and Devil Canyon, but they do occur on some tributaries and lakes in the middle basin. In summer 1982, Gipson et al. (unpublished data) surveyed the river downstream from Devil Canyon using a river boat, helicopter, and ground surveys to determine beaver habitat preferences, lodge construction materials, and forage plants. Preferred food sources were willow (particularly feltleaf willow), balsam poplar, and paper birch. Alder was the primary material for lodge construction but was rarely found eaten (peeled). Peeled birch, poplar, and willow were also used for construction.

The Susitna River between the Deshka River and Portage Creek was divided into three sections on the basis of river morphology and vegetation characteristics: upper section from Talkeetna to Portage Creek, middle section from Goose Creek to the Talkeetna River, and lower section from the Deshka River to Goose Creek. Each section was divided into linear miles of floodplain parallel to the main channel, and each sample unit was one of the mile sections from the thalweg (the deepest part of the channel) to the active floodplain boundary on one side. Beaver habitats were classified according to the seven categories developed by the ADF&G Aquatic Study Team (ADF&G 1983k). Although described in terms of water type, habitat also included bank characteristics, water sources, and tree and shrub vegetation.

Seasonal changes in water level in the river may alter the habitat classifications. All habitats were classified at the time of beaver surveys.

The seven categories developed by ADF&G are briefly described below:

- Mainstem Habitat consists of those portions of the Susitna River that normally convey streamflow throughout the year. Both single and multiple channel reaches are included in this habitat category. Mainstem habitat is typically characterized by high water velocities and well armored streambeds. Substrates generally consist of boulder and cobble size materials with interstitial spaces filled with a grout-like mixture of small gravels and glacial sands. Suspended sediment concentrations and turbidity are high during summer due to the influence of glacial melt-water. Streamflows recede in early fall and the mainstem clears appreciably in October.

- Side Channel Habitat consists of those portions of the Susitna River that normally convey streamflow during the open water season but become appreciably dewatered during periods of low flow. Side channel habitat may exist either in well defined overflow channels, or in poorly defined water courses flowing through partially submerged gravel bars and islands along the margins of the mainstem river. Side channel habitats are characterized by shallower depths, lower velocities and smaller streambed materials than the adjacent habitat of the mainstem river.

- Side Slough Habitat is located in spring fed overflow channels between the edge of the floodplain and the mainstem and side channels of the Susitna River and is usually separated from the mainstem and side channels by well vegetated bars. An exposed alluvial berm often separates the head of the slough from mainstem or side channel flows. The controlling streambed/streambank elevations at the upstream end of the side sloughs are slightly less than the water surface elevations of the mean monthly flows of the mainstem Susitna River observed for June, July, and August. At intermediate and low-flow periods, the side sloughs convey clear water from small tributaries and/or upwelling groundwater. These clear water inflows are essential contributors to the existence of this habitat type.

  At high flows the water surface elevation of the mainstem river is sufficient to overtop the upper end of the slough.

- Upland Slough Habitat differs from the side slough habitat in that the upstream end of the slough is not interconnected with the surface waters of the mainstem Susitna River or its side channels. These sloughs are chracterized by the presence of beaver dams and an accumulation of silt covering the substrate resulting from the absence of mainstem scouring flows.

- Tributary Habitat consists of the full complement of hydraulic and morphologic conditions that occur in the tributaries. Their seasonal streamflow, sediment, and thermal regimes reflect the integration of the hydrology, geology, and climate of the tributary drainage. The physical attributes of tributary habitat are not dependent on mainstem conditions, and therefore were not included in the downstream beaver habitat surveys.

- Tributary Mouth Habitat extends from the uppermost point in the tributary influenced by mainstem Susitna River of slough backwater effects to the downstream extent of the tributary plume which extends into the mainstem Susitna River of slough.

- Lake Habitat consists of various lentic environments that occur within the Susitna River drainage. These habitats range from small, shallow, isolated lakes perched on the tundra to larger, deeper lakes which connect to the mainstem Susitna River through well defined tributary systems. The lakes receive their water from springs, surface runoff and/or tributaries, and were generally beyond the influence of downstream Project effects.

In all sections of the river, beaver were found to prefer slow-moving side channels or sloughs, as well as mouths of tributaries (see Table E.3.4.30). Such sites increase progressively downstream as the river channel becomes more braided. Beaver in the middle and lower sections are reported by residents to use bank lodges which have an underwater entrance and an air vent under a large tree. If this is the case, the "high activity" values in Table E.3.4.30 for these sections are low, since there is no detectable sign for these types of dens that would have been recorded.

There was no beaver sign seen in any of the sampled areas of mainstem habitat during the summer survey. Although this contradicts the results of the fall cache survey (see following section), it was felt that this was a valid indicator of summer conditions. Side channel and side slough habitats were used heavily by beaver. Sections with rocky banks typically had tracks and cuttings, while nearly all sections with silty banks had signs of moderate and heavy use. Upland slough habitat was used heavily, especially if willow was present. The tributary habitat of the middle section had varied vegetation and a fair amount of sign.

Slough and Sadlier (1977) identified the major components important to beavers as water depth, stability, and flow rate and distance to suitable food species. They found that the variables which correlated best with beaver population densities were low flow, low gradient (low erosion potential), and banks containing a high percentage of food species. Results of the 1982 survey agree with their work as well as the findings of Boyce (1974) and Hakala (1952), who reported that beavers in Alaska favor lakes or slow-moving streams bordered by subclimax stages of shrub and mixed conifer-deciduous forests. The results also agree with a study by Retzer (1955) who found that beavers avoid large rivers with narrow valleys and high velocity flows.

(ii) Population Characteristics (**)

Aerial surveys of food caches in the fall have been shown to be an accurate method of determining the number of active beaver colonies in an area (Hay 1958, Machida 1982). Aerial cache surveys were conducted in the falls of 1982 to 1984 between Talkeetna and Portage Creek (see Table E.3.4.31). Each cache provides overwinter food for 1 to 14 beaver, with an average of 5 beaver per caches in Alaska (Boyce 1974). Assuming this average to be valid for the project area, the caches observed would correspond to 70, 135, and 225 beaver for 1982, 1983, and 1984, respectively. The 225 beaver figure is believed to be the most accurate of the 3, as the 1982 survey was conducted during a period of flooding and the 1983 survey was conducted after partial freeze-up, each resulting in lower cache sightability. (LGL and Alaska Cooperative Wildlife Research Unit 1984).

These densities are comparable to the higher end of the range for interior Alaska reported by Boyce (1974), but no densities have been reported for rivers comparable to the Susitna.

Beaver densities would be much higher if beavers in nearby ponds and tributaries were included, but these areas are unlikely to be affected by the project and therefore were not sampled. Population estimates were not conducted for the river south of Talkeetna, because the anticipated impacts from the project are not predicted to affect beaver population densities in that section.

The 1982 survey also included Deadman Creek because of its proximity to the proposed access road. The density of beavers was 0.85/mile along the middle portion of Deadman Creek and was even higher in a marshy section of upper Deadman Creek (Table

E.3.4.31). An estimated 65 beavers currently occupy this creek.

Beaver populations are productive and can withstand moderate trapping pressure. First breeding occurs at age 2 or 3, and annual litters average three to four young thereafter (Hill 1982). Young beavers disperse during the summer of their third year, sometimes traveling as far as 124 miles to set up new lodges (Hill 1982). Trapping for beaver has historically been common along the Susitna River below Devil Canyon, along major tributaries, and around larger lakes like Stephan Lake (Gipson et al. 1982). Beavers in alpine areas have seldom been trapped because of the effort involved. These populations are vulnerable to environmental alteration and/or over-trapping because of their dependence on small, isolated riparian habitats (Gipson et al. 1982).

(b) Muskrat (*)

Muskrats are common and widely distributed throughout most of North America. They occur throughout the Susitna River drainage from Cook Inlet upstream along the river, its tributaries, and ponds to elevations above 3,280 feet. Muskrats are primarily herbivorous, with a diet that includes pondweed and swamp horsetail (Perry 1982).

The middle Susitna Basin was surveyed for muskrat sign in the early spring of 1980 by Gipson et al. (1982). All lakes within 3 miles of the Susitna River were surveyed by helicopter, from the confluence with the Oshetna River to Gold Creek. Muskrat pushups were observed on 27 (26 percent) of the 103 lakes surveyed (Table E.3.4.32). Most of the lakes and ponds with muskrat sign were above the river valley, between 870 and 2,840 feet in elevation. Populations of muskrats were also noted along slow-flowing sections of larger creeks, particularly where lakes drain into streams (Gipson et al. 1982).

A downstream survey of muskrat use of Susitna River habitats conducted by riverboat in the summer of 1980 indicated that muskrat numbers increase with distance from Devil Canyon (Gipson et al. 1982). Suitable slow-water habitat in sloughs and side channels increases in availability downstream from Talkeetna. No sign of muskrat was noted on the river between Devil Canyon and Talkeetna. Between Talkeetna and Montana Creek, sign of muskrat was limited to sloughs and marshy areas near the mouths of feeder streams. Muskrat sign was more commonly observed downstream from Montana

Creek where numerous side channels and sloughs occur (Gipson et al. 1982).

Trapping for muskrats has historically been common along the Susitna downstream from Devil Canyon, along major tributaries, including Indian River and Portage Creek, and around larger lakes, such as Stephan Lake. Muskrats in alpine streams and lakes have seldom been trapped because of the effort involved.

Muskrats are extremely susceptible to water level fluctuations (Bellrose and Brown 1941), and usually find braided rivers poor habitat because of lack of forage and burrow sites (Brooks and Dodge 1981). As such, there is little potential muskrat habitat in the active floodplain downstream from the Watana damsite. Muskrats are limited by water depth and velocity, winter freeze-out, and food availability much as beaver are, but are much more dependant upon herbaceous vegetation year-round.

Many muskrat probably occupy beaver colony sites (Errington 1961, Larin 1964, Curatolo et al. 1981) along the Susitna River that are outside the active floodplain. Below Montana Creek good muskrat habitat occurs in old channels now functioning as clear-water seeps which will not be affected by the project (Bredthauer and Drage 1982).

(c) River Otter (o)

Information concerning the distribution and abundance of river otters in the middle Susitna Basin was obtained during autumn aerial and winter ground surveys by Gipson et al. (1982) (see Tables E.3.4.33, E.3.4.34 and E.3.4.35, and Figure E.3.4.22). These data indicate that otters are common along the Susitna, its tributaries to 3,937 feet elevation, and around large lakes. This distribution is probably related to the distribution of prey of otters, which includes primarily fish and crustaceans (Ryder 1955, Knudson and Hale 1968, Toweil 1974, Gilbert and Nancekivell 1982).

In November 1980, an unusual concentration of otter tracks was found on the river ice within the proposed impoundment areas (Gipson et al. 1982). The significance of this track concentration is unclear, but it may represent upriver or downriver movements of otters prior to freezeup. It is also possible that the otters were concentrating along the river to feed on grayling, which were migrating out of the tributaries to overwinter in the Susitna.

Some otter trails were also observed in cross-country travel, away from bodies of water. Such tracks have been noted in other areas of south-central Alaska and may represent dispersing sub-adults (Gipson et al. 1982). Local trappers seldom take river otters because they are relatively difficult to trap, and the pelt values have usually not been high enough to justify the effort.

(d) Mink (o)

Mink are locally abundant in the middle basin along the river, its major tributaries to 3,937 feet elevation, and along lakeshores. Track counts from both air and ground in fall 1980 (Tables E.3.4.33 and E.3.4.34) suggest that mink are more abundant in the upper reaches (east of Kosina Creek) of the Watana impoundment area than they are elsewhere (Gipson et al. 1982). Two mink were radio-collared in 1980, but no data were obtained because one animal slipped its collar and the other's radio failed. Food habits of mink vary among areas, depending on prey availability. Small mammals and fish usually form the majority of the diet, but crustaceans and birds may also be eaten (Errington 1954, Wilson 1954, Korschgen 1958). Muskrats may form a major portion of the diet where they are available (Hamilton 1940, Sealander 1943).

(e) Marten (*)

Pine marten are common nocturnal mustelids found in spruce forests throughout interior Alaska. Information presented here is provided by Gipson et al. (1982), Buskirk (1983) and Alaska Cooperative Wildlife Research Unit (ACWRU) (1984), and are from 3 types of data: (1) radio-telemetry studies of home range, habitat use and activity patterns of 14 individuals from fall 1980 to fall 1981; (2) snow-tracking data on habitat use; (3) analysis of food habits from scats; and (4) aerial snow-track survey data on habitat use and relative density.

(i) Distribution (*)

Aerial surveys of the Susitna River flown in November 1980 indicated that marten were present at least as far downstream as Portage Creek and as far upstream as the Tyone River (Table E.3.4.33) (Gipson et al. 1982). They are locally abundant in the vicinity of the proposed Devil Canyon and Watana impoundments.

Gipson et al. (1982) found that home ranges of adult male marten were mutually exclusive but overlapped those of other sex/age classes. Average home ranges of 12 radio-collared adult males were 1,685 acres; female home ranges averaged 915 acres (n=3). Home range calculations for each sex excluded one animal with an unusually shaped home range (Buskirk 1983). Between spring and autumn 1981, some marten home ranges appeared to shift location and vary in size periodically. Rivers or large creeks often form partial home range boundaries in the study area. Telemetry data showed no indication of marten crossing a body of water that required them to swim (Buskirk 1983).

Home range sizes in the Susitna area are midway between the figure of 3,136 acres for 4 marten in Minnesota (Mech and Rogers 1977) and 1,024 acres for 5 marten in the Yukon Territory (Archibald 1980). Differences in home range sizes in different areas and seasons are attributable to variability of food resources (Lensink et al. 1955, Soutiere 1978).

An estimated density of 0.0034 marten per acre was calculated from radiotelemetry data on 10 adult male marten along the Susitna River between Deadman and Watana Creeks (ACWRU 1984). This estimate assumes a 1:1 sex ratio, with male and female territories overlapping and 65 percent juveniles in the population (a figure derived from trapper harvest data in the Yukon Territory by Archibald 1980). This leads to an estimate of 218 marten in the area directly affected by the project.

Information from former and present trappers indicates that marten continue to be economically the most important furbearer in the vicinity of the impoundment zones (Gipson et al. 1982).

(ii) Habitat Use (*)

Track counts from a November 1980 aerial survey indicate that marten are most numerous in coniferous and mixed forest and woodland and habitats below 3,281 feet elevation (Table E.3.4.33) (Gipson et al. 1982). The highest track counts occurred between Devil Creek and Vee Canyon (Table E.3.4.33).

Marten resting sites were located below ground in late autumn, winter, and early spring. In summer, when soil temperatures are lower than air temperatures, marten rest above ground. Summer resting sites could not be characterized because of the escape response of marten above ground. Thirty-one of 37 winter resting sites (83 percent) were in red squirrel middens or nests. All were in forest or woodland vegetation types.

- Food Habits (*)

The diet of marten shows some seasonal variation, but microtine rodents are the primary prey at all times of the year in interior Alaska (Lensink et al. 1955). Microtines had an 88.8 percent frequency of occurrence in scats from the middle Susitna Basin (Gipson et al. 1982) (Table E.3.4.36). Plant foods, such as bog blueberries, crowberries, mountain cranberries, and rose hips, are consumed most frequently in autumn, and attained an average frequency of occurrence of 23.3 percent. Bird remains were present in 9.6 percent of scats, most frequently in winter, and squirrels occurred in 6.8 percent, most frequently in spring.

(f) Red Fox (*)

Red foxes and their sign have been observed throughout the middle Susitna Basin, including the proposed Devil Canyon and Watana impoundments. During 1980 and 1981, Gipson et al. (1982) employed radio-tracking, snow-tracking, and aerial snow-tracking to determine fox distribution, abundance, and habitat use. Food habits were studied from scat analysis, stomach content analysis, and examination of food remains at dens and on fox trails. Aerial surveys were conducted to locate fox dens, and dens were surveyed periodically throughout summer to determine use. Further analyses of these data were provided by ACWRU (1984) and Hobgood (1984).

(i) Habitat Use (*)

Foxes in the middle Susitna Basin appear to prefer relatively high elevation areas near or above the timberline. Over 94 percent of early winter tracks were at elevations in excess of 2,120 feet (Hobgood 1984). Black spruce flats upstream from Vee Canyon are also commonly used. Some foxes use low elevation tributary deltas during autumn, then shift to alpine zones as snow depth and volume of water flowing over the ice increase. Other foxes remain above timberline year round. Trails in snow indicated that foxes commonly foraged in winter in areas above timberline frequented by large flocks of ptarmigan.

In aerial transects of furbearer tracks in fall 1980, almost twice as many tracks (151 vs. 79) were located south of the river as opposed to the north (Table E.3.4.37). This is in contrast to the greater number of active dens found on the north side. However, at the upper reaches of the proposed impoundment, fox density was observed to increase markedly and transects 1 to 11 (see Figure E.3.4.22 and Table E.3.4.37) had almost even numbers of tracks on the north and south sides (67 on the north and 51 on the south). All of the north side-south side discrepancy is accounted for in transects 12 to 14. The south side of the river above Vee Canyon changes from mountainous terrain to open, marshy flats which characterizes good fox habitat (Gipson et al. 1982).

Gipson et al. (1982) report that searches along the Susitna River and lower elevations of tributaries in late winter and early spring 1980 produced no evidence of foxes in these areas. Tracks and other signs were noted on river banks in the following late fall and early winter.

- Denning Habitats (*)

  Nineteen fox dens were located in the middle basin during baseline studies in 1981 (Figure E.3.4.23) (Gipson et al. 1982). Sixteen dens were located north of the Susitna River with several dens concentrated in the upper Watana Creek and upper Deadman Creek drainages. Gipson et al. (1982) report that several undiscovered dens are likely to exist on the south side of the river, but the aspect, physiography, and vegetation appear more favorable for denning and hunting on the north side.

  Dens are typically situated on an aspect facing south and/or west, and on well-drained prominences up to 16 feet above surrounding areas. Dens are also characterized by proximity to a lake of over 5 acres or a creek. Active dens were found between 2,395 and 3,495 feet elevation in areas of rolling hills adjacent to mountains (Hobgood 1984). All active dens located were in or near areas of medium-to-high ground squirrel density.

Foxes in this study area remained at den sites into October, much later than in other areas of Alaska (see Gipson et al. 1982) or elsewhere (Sheldon 1950, Storm 1972). Foxes in the Susitna project area appear to use den sites throughout the winter, as evidenced by clearing of snow from at least one entrance of most dens visited by observers during winter months.

- Food Habits (*)

Principal foods of foxes in the middle Susitna Basin were determined by Gipson et al. (1982) through direct observation of foxes, identification of remains at dens and on trails, scat analysis, and stomach analysis of foxes taken by trappers. In spring and summer, diets include arctic ground squirrels, red-backed voles, singing voles and vegetation. Ptarmigan are taken throughout the year and are major components of the diet in winter along with carrion and small mammals (Hobgood 1984). Muskrats are taken where available and may be relatively important to foxes in the vicinity of large lakes such as Stephan Lake, Clarence Lake, and Deadman Lake. Dispersing young muskrats and muskrats at pushups are especially vulnerable to predation by foxes.

Carrion is also identified as important by Gipson et al. (1982) based on the observations of foxes feeding on a carcass of moose and another of caribou near Watana Camp and on a sheep carcass on the east fork of Watana Creek.

Snowshoe hare are presently scarce in the Susitna study area and are, therefore, unimportant in the diet of foxes there. The scarcity of hares may be responsible in part for the relatively low number of foxes in the area, as well as the seasonal shifts by foxes to higher elevations where ptarmigan are available.

- Home Range (*)

Summer home ranges of adults foxes varied from 5,935 to 10,790 acres in the Susitna study area. Males averaged 9,865 acres, while females had smaller average home ranges of 7,390 acres (n=3). The larger size of home ranges in the Susitna study area compared with studies in midwestern states was attributed by Gipson et al. (1982) to the greater availability of food in the midwest.

(ii) Population Characteristics (*)

Six of 19 dens found in a 432,640 acres area in the middle basin in summer 1981 were active (Gipson et al. 1982). Dens were classified according to size and use as described in Table E.3.4.38; locations are mapped on Figure E.3.4.23. A seventh den was probably also active, giving a density of one family per 61,440 to 72,320 acres (a family usually consists of 4 to 6 foxes). Gipson et al. (1982) report that the most reasonable estimate of density is one family per 20,480 acres based on the assumption that at least one third of active dens were found in 1981.

Transect data demonstrate a marked increased in number of fox tracks encountered as one progresses upstream from Devil Canyon to the Tyone River. Fur harvest reports of the ADF&G indicate that 983 red fox pelts were exported from GMU 13 between 1976 and 1981. Four dealer locations account for 92 percent of the basin harvest: Cantwell, Gakona, Copper Center, and Glenallen. Cantwell, which lies closest to the study area, comprised 11 percent of the total 5-year GMU 13 export. Gipson et al. (1982) indicate that interviews with furdealers and trappers identify the upper Copper River-Solo Hills-Maclaren River area and the Crossman Lake area west of Paxson as the source of most foxes taken. One trapper indicated that most of the furs he buys are taken in open, marshy country and that prime fox habitat decreases from the Maclaren River to the Tyone-Oshetna-Susitna areas as flat open plains rise to mountainous alpine terrain (Gipson et al. 1982). Gipson et al. (1982) conclude that the Susitna project study area supports a low-density fox population relative to other areas in Alaska.

(g) Lynx (*)

The distribution of lynx in the middle basin is very limited at present. Tracks and scats have been found in several areas including the mouth of Goose Creek (probable lynx tracks seen from the air on November 19, 1980, and a dense concentration of scats and tracks found on October 22, 1981); the mouth of Jay Creek (tracks seen on October 30, 1981); and along Goose Creek, 1 mile from the mouth (tracks seen on November 3, 1981) (Gipson et al. 1982). However, considering the amount of effort involved in aerial and ground furbearer surveys, these track records indicate that few lynx occur in the middle basin.

In the past, lynx were apparently fairly numerous in the canyon country of the Susitna River, being found primarily in the forests along the river (Gipson et al. 1982). Trappers in the vicinity of the impoundments reported no sightings of lynx or their tracks, and reports from trappers in the Gold Creek area suggest that lynx have been uncommon there in recent years as well (Gipson et al. 1982).

Lynx population levels fluctuate in response to availability of snowshoe hares (Keith 1963), which were uncommon in the Susitna Basin in 1981 (Kessel et al. 1982a). Gipson et al. (1982) reported that historically, the frequency of natural forest fires increased from Portage Creek to the Tyone River, and speculated that snowshoe hare (and lynx) numbers may have been higher in the past. However, Kessel et al. (1982a) note that no fires have occurred in the Susitna Basin in the recent past, and they report that hare numbers appear to be chronically low in the Susitna area. If fire or other habitat change leading to an increase in snowshoe hares occurs, lynx populations will likely also increase. However, for the present, lynx are uncommon in the area.

(h) Coyote (*)

The distribution of the few coyotes occurring in the middle basin is generally limited to those areas downstream from Devil Creek. No coyotes or their tracks were observed by Gipson et al. (1982) during baseline studies in the Susitna area. Several sightings of coyotes in fall 1980 were reported and, other sightings of coyotes, or their tracks, have also been reported in the Gold Creek and Canyon areas. Coyotes have not been seen or taken by trappers upstream from Devil Creek. In the 1984 update to the Phase I studies, Gipson and others stated that they believe coyotes to be common below Portage Creek and abundant from the Gold Creek/Indian River area downstream (ACWRU 1984). The distribution and abundance of coyotes in the Susitna area is probably limited by wolves rather than by habitat, food availability, or trapping pressure. Wolves are usually aggressive toward coyotes within their home range.

(i) Short-tailed Weasel (o)

Short-tailed weasels are locally abundant in the middle basin, and their tracks have been observed in a variety of habitat types at elevations ranging from the banks of the

Susitna River to over 4290 feet. Transect surveys conducted in November 1980 yielded 746 short-tailed weasel tracks, 328 (44 percent) of which were counted on a single transect near the Tyone River (Table E.3.4.33). Most of the tracks (489 or 66 percent) were observed in woodland white or black spruce vegetation types; an additional 190 (25 percent) were counted in medium shrub types (Gipson et al. 1982). It appears that short-tailed weasels can meet their food and cover needs in a variety of habitat types. Short- tailed weasels have been taken both deliberately and incidentally by trappers on upper Tsusena Creek, in the Fog Lakes area, and elsewhere in the study area; but they are not a species of major economic importance.

(j) Least Weasel (*)

Least weasels occur at least sparsely throughout the middle basin and may be locally abundant. However, their small size and secretive behavior makes confirmation of their presence difficult. Several sets of tracks believed to be those of least weasels were seen in March 1980 along lower Watana Creek. The carcass of one least weasel, taken by a trapper at Fog Lakes, was obtained in February 1981, and a live least weasel was observed near the southeast edge of proposed Borrow Site A on October 25, 1981 (Gipson et al. 1982). The pelts of least weasels have practically no commercial value (Svendsen 1982), and, thus, information from trapping returns is rarely available to supplement direct observations.

4.2.3 - Birds (**)

Little was known about the birds of the middle Susitna Basin prior to initiation of baseline studies for the Susitna Hydroelectric Project. Baseline data on breeding birds of the middle basin presented here are primarily those collected and provided by Kessel et al (1982a and unpublished data), University of Alaska Museum. Data presented are from 3 sources: (1) twelve 25 acre bird census plots, (2) ground and aerial census of waterbodies, (3) six 2.75 to 4.25 mile winter bird transects, (4) helicopter surveys and ground reconnaissance of raptor nesting habitats, and (5) additional data on species presence, phenology and habitat use were obtained from casual observations of investigators and observations solicited from others working in the region (Kessel et al. 1982a; LGL 1985).

These data have been liberally drawn upon to provide much of the following text. However, additional information has been incorporated wherever appropriate.

Locations of census plots are shown in Figure E.3.4.24. Sites were selected in relatively uniform patches of vegetation that represented each of the major woody avian habitats present in the region (Kessel 1979). The alpine tundra plat was selected to include several of the widespread avian habitats of higher elevations. Each plot was censused eight times between May 20 and July 3, 1981 (and eight times between May 24 and July 2, 1982). Methods were modified from the territory census method (International Bird Census Committee (IBCC 1970).

The winter bird transects were selected to sample use of the potential highly affected forest habitat within the impoundment zones. The six transects were each censused three times during the winter of 1984-1985. Survey periods corresponded to early (November 29 to December 1), mid- (January 23 to 25), and late winter (March 27 to 29).

Locations of censused waterbodies are shown in Figure E.3.4.25. Ground censuses of 28 water bodies were conducted between July 8 and 29, 1981. Each water body was censused once by observers walking the shoreline or canoeing the edges, or by both methods simultaneously. Aerial surveys to monitor use of waterbodies during migration were conducted by helicopter between September 7 and October 4, 1980; May 3 to 26, 1981; and September 15 to October 23, 1981. The number of waterbodies surveyed varied each survey; the average was 34. Flights were made at approximately 50 mph and between 100 and 250 feet altitude. When flocks were encountered, the helicopter circled widely and slowly for an accurate count and identification. On lakes, the helicopter followed the shoreline for the survey; a single pass was made over smaller waterbodies. Large lakes were surveyed in sections.

Raptor surveys were designed specifically for cliff-nesters (especially golden eagles, gyrfalcons and peregrine falcons) and large tree-nesters (especially bald eagles). Information on other species was obtained incidental to these surveys and during ground-based plot surveys and waterbody surveys.

Raptor surveys were conducted in the middle basin by helicopter on July 6, 1980 and May 16 and 17, 1981 (Kessel et al. 1982a). All cliff nesting habitat and stands of large white spruce and cottonwood within approximately 3 miles of the Susitna River and its tributaries from Portage Creek (1980) and the Indian River (1981) to the mouth of the Tyone River were surveyed. The proposed access routes were surveyed on July 3 and 5, 1981. During surveys, the helicopter moved slowly past cliff faces at approximately 100-130 feet distance until the face was considered adequately scanned. In 1980 and 1981, active nests were visited from the ground between May 20 and July 13, 1981. In addition, all potential appearing peregrine falcon nesting habitat (e.g, especially partially vegetated cliffs) was examined by helicopter and on foot in June 1981.

Additional nesting locations were found during helicopter surveys completed during 1984 (Roseneau 1984). All known bald eagle nesting locations were also overflown and checked during other scheduled raptor work in summer 1985 (Roseneau 1985, Pers. Comm.).

A total of 135 species of birds were recorded in the middle basin. Their relative abundances (see Appendix E4.3) were largely a function of habitat availability. The most abundant species in the project area are common redpoll, savannah sparrow, whitecrowned sparrow, Lapland longspur, and tree sparrow.

Of the 135 species, 15 are ranked as rare in the middle and upper basin on the basis of current information: 4 raptors (osprey, American kestrel, snowy owl, boreal owl); 3 species of ducks (gadwall, blue-winged teal, ring-necked duck); 4 shorebirds (upland sandpiper, turnstone spp., surfbird, sanderling); 3 small land birds (black-backed three-toed woodpecker, western wood pewee, yellow warbler); and ruffed grouse. Most of these species were rare because they were either at the periphery of their geographic ranges or were limited by a lack of appropriate habitat. All 15 species are represented by larger populations in other portions of Alaska.

Baseline data on distribution, abundance, and habitat use of bird populations in the lower Susitna floodplain were collected by the University of Alaska Museum (Kessel et al. 1982b). Three types of avian surveys were conducted between Devil Canyon and Cook Inlet: (1) spring aerial surveys of waterbirds in 1981 and 1982; (2) a ground survey of all bird species in early summer 1982; and (3) an aerial survey for bald eagle nests in summer 1982.

At least 82 bird species were recorded along the lower Susitna floodplain in June 1982 (see Appendix E6.3).

(a) Raptors and Ravens (**)

A total of 10 raptor species were recorded upstream from Devil Canyon. Kessel et al. (1982a) recorded 10 raptor species upstream from Devil Canyon. Five of these species (six including the common raven, a functional raptor that often provides nests for some raptor species) are known to nest in the area, and at least two additional species probably breed there (Appendix E5.3). The presence of Broad Pass to the west and a pass to the east containing the Richardson Highway, both commonly used by a variety of migrating raptors and the absence of comparable passes in the immediate project area suggest that any migratory movements of raptors in the project area would likely be comprised primarily of local breeders.

Nesting locations are defined here as units of nesting habitat consisting of cliffs or stands of trees containing one or more raptor/raven nest sites. Nest sites are the actual nests or nest ledges on the cliffs, or the nests in trees used by the raptors or ravens. One pair of a given species uses only one nesting location per breeding season. However, the pair may have one or more alternate nesting locations that are used in other breeding seasons. The pair uses only one nest site at a nesting location per breeding season, but may have one or more alternate nest sites at the same nesting location that are used in other breeding seasons.

A total of 67 raptor/raven nesting locations have been found in the middle basin of the Susitna River (Tables E.3.4.39 and E.3.4.40). Some of these locations were identified during USFWS sponsored raptor surveys conducted in 1974 (White 1974), and many other locations were identified during Applicant sponsored surveys in 1980 and 1981 (Kessel et al. 1982a) and 1984 (Roseneau 1984), and during Applicant sponsored field work on other avian species in 1982 (APA 1983).

White (1974) found 27 raptor/raven nesting locations, including at least 14 active locations, in or near the project area in 1974. Kessel et al. (1982a) provided information on 14 nesting locations, including 12 active locations, in the same area in 1980, and 31 nesting locations, including 17 active locations, in the same area in 1981. Kessel (APA 1983) also made one miscellaneous observation of an active nesting location in the same area in 1982. These data represent 53 nesting locations that are present in or near the project area. Roseneau (1984) obtained updated information on these locations and discovered 14 additional nesting locations in the middle basin during helicopter surveys in 1984. Sixty-one nesting locations, the 53 previously reported and eight newly discovered, are located within the area covered by previous surveys, and six other newly discovered locations are located in adjacent areas outside of the area covered by the previous surveys. Eighteen of the nesting locations, including 17 inside of and one outside of the boundaries of the previous surveys, were active in 1984. During an informal fly-over of nest sites during summer 1985, two out of ten nests surveyed were active (Roseneau 1985, Pers. Comm).

No specific data on migratory movements of raptors were collected in the middle basin. However, the presence of

Broad Pass to the west and the Richardson Highway pass to the east, (both commonly used by a variety of migrating raptors and other birds) and the absence of comparable passes in the immediate project area, suggest that migratory movements of raptors in the project area would likely be comprised of local breeders. Table E.3.4.41 shows the general breeding phenology of golden eagles, bald eagles, gyrfalcons and ravens in Alaska. These schedules are applicable to the middle basin.

Distribution, abundance, and food habits are discussed below for each species. Although no data were collected on food habits of raptors in the Susitna Basin, they are unlikely to differ greatly from raptors in similar situations in other parts of the state.

(i) Golden Eagle (*)

Estimates of breeding populations of golden eagles in south-central Alaska, including the Alaska Range, are not available. However, this raptor nests at low densities throughout most of the state, including the arctic slope, and nesting occurs almost exclusively on cliffs (Roseneau et al. 1981). Golden eagles regularly build and maintain a number of simultaneous nests, often at locations several miles apart, which are used as alternates in different years (Brown and Amadon 1968, McGahn 1968, Roseneau et al. 1981).

The abundance of golden eagles in the central Alaska range is likely to be lower than that found in the middle Susitna Basin. In most of the Alaska Range, cliff-nesting locations for raptors tend to be widely dispersed (Bente 1981). However, if nesting cliffs are available, pairs of golden eagles may nest relatively close to one another. Murie (1944) found golden eagles nesting as close as 1.0 and 1.5 miles apart in Denali National Park in 1941 and 1939, respectively.

The abundance of active golden eagle nesting locations present in the middle basin in 1980 and 1981 (one pair per 9.18 miles 14.8 km of river) (Kessel et al. 1982a) was similar to that found along the Brooks Range portion of the Dalton Highway in 1979 (one active nest per 9.73 miles 15.7 km) (Roseneau and Bente 1979). The latter abundance appears to be one of the highest reported in Alaska. White et al. (1977) suggested that local populations of golden eagles may increase during years of high snowshoe hare populations; however, hares are relatively scarce in the middle basin in 1980 and 1981 (Kessel et al. 1982a). Murie (1944) noted that arctic ground squirrels were a major prey of golden eagles in Denali National Park in 1939 to 1941, and these rodents were abundant in the middle basin area during the study.

Golden eagles are opportunistic hunters. Diets vary from region to region according to prey availability and vulnerability. When available, mammals are an important component of their diet (up to 70 to 90 percent by weight), but birds and carrion are also often important. Nonbreeding of golden eagles occurs in some years, and there is some evidence to suggest that prey availability may influence breeding success (Brown and Amadon 1968).

In Alaska, there are few published reports of prey items found at golden eagle nests. Common items have included ground squirrels, marmots, snowshoe hares, ptarmigan, ducks, and other waterfowl.

Occasionally, both arctic and red foxes are taken. One pair on the Seward Peninsula took as many as five to six red foxes during the summer, and the fledgling from that nest attacked a red fox about two weeks after leaving the nest. Pairs nesting along sea coasts also take a variety of seabirds (both alive and as carrion), including young gulls and murres.

Carrion, often in the form of large game animals, may be particularly important during the early spring and the fall. Carrion also appears to be very important to sub-adult golden eagles. Large numbers of sub-adults frequent the calving and post-calving grounds of caribou herds. Up to six sub-adults have been found feeding at one time on wolf-killed and bear-killed caribou, and sub-adults occasionally kill caribou calves (Roseneau and Curatolo 1976, Roseneau et al. 1981). A total of 23 golden eagle nesting locations are known to occur near the project area in the middle basin of the Susitna River drainage (Tables E.3.4.39 and E.3.4.40).

(ii) <u>Bald Eagle</u> (**)

In Alaska, the majority of bald eagles nest coastally in southeast, southcentral and southwest Alaska; these populations may exceed several thousand pairs. North and west of the Alaska Range, numbers decline markedly and most nesting is associated with wetlands in portion of the Yukon (including the Tanana) and Kuskokwim River drainages (see Roseneau et al. 1981). A total of 10 bald eagle nesting locations are known to occur in the vicinity of the project in the middle basin of the Susitna River drainage (Tables E.3.4.39 and E.3.4.40). In total, surveys for nesting bald eagles in the lower Susitna floodplain discovered 38 nest sites, some of which undoubtedly represent alternate nest sites or alternate nesting locations (see Table E.3.4.42).

Bald eagles are opportunistic in their feeding habits, and diets vary from region to region according to the availability and vulnerability of prey species. Although they take a variety of live prey, bald eagles often rely heavily on local sources of carrion, may be attracted to dumps, and may pirate prey from other raptors, particularly osprey (Brown and Amadon 1968). Fish and birds are both important components of their diet.

In Alaska, bald eagles often rely on dead or dying salmon when they are available, and take a variety of other species of fish in shallow water or as carrion along shorelines. Waterfowl and seabirds (alcids, anatids and larids) also figure prominently in their diet, particularly in some coastal regions (e.g., the Aleutian Islands). Ritchie (1982) found fish and avian prey to have nearly equal frequency of occurrence (43.8 and 43.7 percent, respectively) in remains at nests along the Tanana River, where as mammal remains occurred in 12.6 percent of nests. Remains of <u>Anas</u> spp. (mostly mallard) constituted 17 of 28 occurrences of avian prey. Dead, dying, or injured birds are often taken from the water surface, but eagles are also quite capable of surprising and taking uninjured waterfowl and seabirds from the water surface or in the air. Even geese may be occasionally taken in flight (Brown and Amadon 1968), and sandhill cranes and swans have also been taken.

Diets of bald eagles nesting along the Susitna River are probably similar to diets of eagles nesting along the Tanana River. Salmon are undoubtedly important to many pairs of eagles in late summer and fall. Earlier in the year, other fish species (particularly whitefish, suckers and grayling) and waterbirds (especially waterfowl) constitute the bulk of their diet. Snowshoe hares and muskrats may also be taken on occasion.

(iii) Gyrfalcon (*)

Gyrfalcons are not abundant in southcentral and central Alaska, but they regularly nest throughout the Alaska Range. Cade (1960) estimated the total Alaska population at only about 200 to 300 pairs. Roseneau et al. (1981) considered that estimate too low, but doubted that the population exceeded 500 pairs. Numbers of nesting gyrfalcons may vary considerably between years (Cade 1960, Roseneau 1972, Swartz et al. 1975) but variation may be less over larger regions (Roseneau 1972). The majority of the Alaskan population is found in northern and western Alaska (Roseneau 1972, Roseneau et al. 1981), and gyrfalcons there tend to exhibit relatively low site fidelity from year to year (Cade 1960 and Roseneau 1972). However, in the Alaska Range, where suitable nesting cliffs are fewer and more widely dispersed, most sites appear to be used more regularly (Bente 1981). These gyrfalcon nesting locations have been reported in the middle basin (White 1974, Kessel et. al. 1982a) (Table E.3.4.40).

Gyrfalcons are year-around residents of the arctic and subarctic and are also opportunistic hunters. During the summer, their diets vary according to prey availability and vulnerability (Roseneau 1972), but they typically rely on only a few principal prey species for the bulk of their food.

The principal summer prey species include ptarmigan (often 70 to 90 percent by weight of their diet), arctic ground squirrels, and, in some regions, long-tailed jaegers (White and Cade 1971; Roseneau 1972). Migratory birds typically constitute no more than 15 to 20 percent by weight of their summer diet. In some regions of interior Alaska (e.g., the Alaska Range), ground squirrels surpass ptarmigan in importance (Cade 1960 and Roseneau 1972). In the winter, gyrfalcons are almost solely dependent on ptarmigan (Platt 1976 and Walker 1977), although in some high arctic regions, arctic hares are also important winter prey. The year-round reliance on ptarmigan and the high utilization of small mammals in the summer are important factors that have helped gyrfalcons to avoid serious biocide contamination and thus maintain healthy, non-endangered populations in the arctic.

Despite the reliance on a few principal prey species, gyrfalcons are capable of shifting to other food sources during the breeding season if the availability of a few prey species changes dramatically-- provided that other prey species are present (White and Cade 1971; Roseneau 1972). It has also been suggested that gyrfalcons may not breed in some years when prey availability is low.

(iv) Peregrine Falcon (o)

Peregrine falcons are distributed worldwide. Peregrines are specialists in avian prey and prey weights range from 50 g or less to over 600 g. In Alaska, the two endangered races, *Falco peregrinus anatum* and *F.p.tundrius*, rely on a broad prey base consisting of a variety of shorebirds, waterfowl, passerines and occassional small mammals (Cade 1960, Roseneau et al. 1981). In contrast to gyrfalcons, peregrines are diverse in their feeding habits, concentrating more on categories of prey, such as shorebirds, than on individual species. Their high use of migratory prey (especially shorebirds) on northern breeding grounds and on wintering grounds as far south as 30°S in South America has contributed to their endangered status as a result of biocide contamination. Recently, pollutant residues (biocides) have tended to decline in peregrine tissue. Since the late 1970's, in most of Alaska and in some other parts of North America, numbers and productivity of both endangered races have increased.

There were no confirmed sightings of peregrine falcons in the middle Susitna Basin during 1980, 1981, or 1982, despite the substantial number of man-hours spent on ornithological field work and on raptor surveys (Kessel et al. 1982a). White (1974) saw two individual peregrines during a June 10 to 15, 1974, survey; however, he found no sign of nesting. One of the birds was a "single adult male...roosting on a cliff about 4 miles upriver from the Devil Canyon Dam axis," and the other was "a sub-adult...about 15 miles upriver from the Devil Canyon Dam axis." White (1974) stated that the Yenta-Chulitna-Susitna-Matanuska drainage basin "seemingly represents a hiatus in the breeding range of breeding peregrines...," and Roseneau et al. (1981) stated that "the Susitna and Copper rivers both provide...very few...potential nesting areas for peregrines."

The Susitna River drainage does not provide habitat typical of or comparable to any important areas of peregrine nesting habitat in the boreal zone of Alaska (e.g., upper Porcupine, upper Yukon-Charley, middle Yukon, lower Yukon, upper Tanana and Kuskokwim river drainages). Key elements of the existing habitat in the Susitna River drainage, in addition to the surveys conducted for them, provide reasonable evidence that peregrines do not presently nest in the project area and that biologically significant numbers of them are unlikely to occur there naturally in the future with or without project development.

(v) Other Raptors (o)

No breeding records for owls were reported in the middle basin by Kessel et al. (1982a). Three of the five species of owls (great horned owl, hawk owl, and boreal owl) that have been recorded in the middle basin are year-round residents and probable breeders in mixed and coniferous forests (Appendix E5.3). The short-eared owl occupies open habitats in small numbers in summer, and a few may breed in the region. Snowy owls, occasional migrants, are rare in the middle basin.

Only single records of two species of owls (great horned owl and short-eared owl) were obtained along the lower Susitna River during the spring surveys (Appendix E6.3). Great horned owls are likely resi dents and breeders, especially in mature cottonwood stands along the river and sloughs.

Suitable nesting habitat for goshawks and great-horned owls consists primarily of occasional mature paper birch and paper birch-white spruce stands, which are most commonly found downstream from Devil Canyon. Some nesting habitat for other tree-nesting species (e.g., red-tailed hawks, American kestrels, sharp-shinned hawks, boreal owls, and hawk owls) and ground-nesting species (e.g., merlins, northern harriers, and short-eared owls) also occurs in the Susitna Basin, but no concentrated areas of nesting habitat are known or expected to occur.

The diet of owls and smaller raptors consists mainly of small rodents and small birds. Northern harriers feed on either small rodents or small birds in open terrain. American kestrels feed primarily on insects, small mammals, and occasionally small birds. Owls (great-horned owl, short-eared owl, hawk owl, and boreal owl) are generally specialists on small mammal prey, though great-horned owls may also take birds. Sharp-shinned hawks and merlins are specialists on small avian prey. Goshawks and red-tailed hawks rely on a combination of small mammal and avian prey.

(b) Waterfowl and Other Large Waterbirds (o)

The middle basin and the lower Susitna River floodplain above the delta do not support large concentrations of waterfowl or other waterbirds during either migration or the breeding season (Kessel et al. 1982a, 1982b). Avian use of discrete waterbodies and waterbody groups in the middle basin was low but varied considerably. An analysis of the relative importance of discrete wetland areas is included to identify potentially important areas.

The species composition of waterfowl in the middle basin showed some differences from that of central Alaska as a whole, in part reflecting the subalpine nature of much of the study area (Kessel et al. 1982a). Aldsquaw and black scoter were the most productive of the waterfowl in 1981 (Figure E.3.4.25). Both species are primarily tundra nesters, and the Alaska Range is the only inland nesting location known for black scoter in Alaska (Gabrielson and Lincoln 1959). The pintail, one of the most numerous ducks in central Alaska, occurred in relatively small numbers in the study area, in spite of the fact that both 1980 and 1981 were high population years for pintails in Alaska because of severe drought in the Canadian prairie provinces (King and Conant 1980, Conant and King 1981).

(i) Migration - Middle Basin (o)

The middle Susitna Basin, which is on a high plateau between the Alaska Range and the Talkeetna Mountains, does not appear to be a major migration route for waterbirds (contra U.S. Corps of Engineers (USCOE 1977) (Kessel et al. 1982a). A relatively small number of individuals were seen during three surveys in spring 1981 and six and five surveys in fall 1980 and 1981, respectively (Tables E.3.43, E.3.4.44 and E.4.45).

Scaup, including both lesser and greater scaup, were the most numerous species group during both spring and fall. Relatively large numbers of mallards and American wigeon also moved through during both seasons. Pintails were common during spring migration but uncommon in fall. Few geese or cranes were seen at either season (Kessel et al 1982a).

The middle Susitna Basin was less important to migratory waterfowl in spring than fall (Kessel et al. 1982a). Because ice breakup does not regularly occur until mid-May on many lakes in the middle basin little open water was available to early migrating waterbirds, such as the dabbling ducks and common goldeneye. Early migrants used the Susitna River itself and the thawed edges of lakes. Use of the middle basin's water bodies increased toward the end of May, concurrent with the availability of more open water and the influx of the later arriving loons, grebes, scaup, oldsquaw, scoters, and mergansers (Kessel et al. 1982a).

The pattern of fall movement in the middle basin was similar to that known for the rest of central Alaska (Kessel et al. 1982a). Peak numbers of American wigeon, pintail, and green-winged teal occurred during the first half of September; loons, grebes, and scaup during the second and third weeks of September; and mallards, scoters, buffleheads, and goldeneyes, from the last third of September to mid-October. Trumpeter and whistling swan migration occurred between the last week of September and the end of October (Kessel et al. 1982a).

(ii) Summer Use of Waterbodies - Middle Basin (o)

The wetlands of the middle basin supported relatively few waterbirds during the summer. An average density of only 0.09 adult loons, grebes, ducks, gulls, and terns/acre of wetlands and 0.01 broods/ acre of wetlands were found on 28 intensively surveyed water bodies in summer 1981 (Table E.3.4.46). By comparison, a census of 13 waterbodies in the upper Tanana River valley, similar in size class distribution to those surveyed in the middle basin, had average densities of 0.74 adult loons, grebes, ducks, gulls, and terns/acre of wetlands in 1977 and 0.45 adults/acre in 1979 (Spindler et al. 1981). Even when gulls and terns are excluded, the density of broods in the

Tanana River valley was markedly higher, at 0.03/acre than in the middle Susitna Basin. Productivity in the eastern portion of the upper Tanana River valley study area in 1979 was 30 to 40 percent lower than historical levels typical of Minto Lakes, Tetlin Lakes, and portions of the Yukon Flats are considered among the most productive wetlands in Alaska (Kessel et al. 1982a). Thus, the waterbodies of the middle basin appear to support a relatively impoverished population of waterfowl during the summer (Kessel et al. 1982a).

As discussed earlier, the species composition of waterfowl reflects the subalpine nature of the study area with oldsquaw and black scoter (tundra nesters) being the most productive species. Trumpter swans also breed commonly on the eastern end of the study area, from the vicinity of Oshetna River to at least the Maclaren River. On an informal flight over ponds of this area on August 4, 1981, Kessel et al. (1982a) recorded 19 observations of trumpeter swans. Forty adult birds were seen, including 9 pairs with broods (28 cygnets). This area is on the western edge of habitat used by the Talkeetna Basin trumpeter swan population which has more than doubled in the past 5 years (King and Conant 1980).

(iii) Relative Importance of Waterbodies - Middle Basin (o)

Kessel et al. (1982a) calculated relative importance values (I.V.) for each lake surveyed, which combined three commonly used measures of habitat quality: number of birds, density, and species richness. The I.V. values are an index to the relative importance of each waterbody included in a particular computation of the index, and are patterned on concepts presented by Curtis and McIntosh (1951). The I.V. for each waterbody was calculated each season as the sum of three ratios: (1) the mean number of birds per census for the water body divided by the sum of the means per census for all waterbodies censused; (2) the mean density of birds per census on the waterbody divided by the sum of the means per census for all waterbodies censused; and (3) the mean number of species per census for the waterbody divided by the sum of means on all waterbodies. Figures E.3.4.26 and E.3.4.27 compare relative I.V. ratings for all lakes surveyed in fall 1980 and spring 1981 respectively. Seasonal population statistics are listed in Table E.3.4.47 for the lakes that had the highest scores. The following discussions of individual waterbodies are based on Kessel et al. (1982a).

Stephan and Murder Lakes were among the top three waterbodies in I.V. for all seasons. Stephan Lake received twice as much use in fall as in spring, and supported high numbers of species and number of birds. Murder Lake consistently supported high densities. These lakes assumed additional importance in early spring and late fall because of ice conditions. Murder Lake, which reportedly has some open water all winter, provided some of the first open water for early spring migrants, as did the inlet of Stephan Lake; green-winged teal, mallards, and pintails were using this open water on May 3, 1981. Likewise, these lakes provided the last open water in fall and were used by the late migrants. Swans used these lakes during October, as other lakes in the region became ice-covered. Between 9 and 11 trumpeter swans frequented Murder Lake between October 10 and 18, 1981 (Kessel et al. 1982a); 11 to 22 unidentified swans were on Stephan Lake from October 9 to 23, 1981; and 120 swans were there on October 10, 1980.

Waterbody 131, near the mouth of the Maclaren River, consistently supported high levels of waterfowl abundance, density, and species richness. Its I.V. in spring was lessened by the fact that it was still frozen during the first two spring surveys. Because it was far from the proposed construction sites, it was not censused for breeding birds, but a flight over the lake on August 4, 1981, revealed a flock of some 100 molting ducks, mostly scaup, as well as a pair of trumpeter swans. This and WB 134 were the only duck-molting lakes found in the basin. A flock of 22 to 42 trumpeter swans congregated to feed on this lake throughout the first half of September 1980.

Waterbody 140, east of the Oshetna River, had the highest I.V. of 28 waterbodies censused during the breeding season. Not only did it have a high species richness (11 species), but it also supported a large number of birds and had an above-average density. It was also of above-average importance during migration, even though it thawed later and froze earlier than most other lakes.

Clarence Lake had the fourth highest I.V. during spring and fall migration, but was less important during the summer. It had a relatively high species richness during all seasons, being used by both diving and dabbling ducks during migration, but primarily by divers in summer.

Watana Lake was used in fall, especially in 1980, by migrant scaup, goldeneyes, and mergansers during the last half of September. Otherwise, it was of little importance to birds.

Pistol Lake in the lower Deadman Creek area had a relatively high I.V. in spring because of the number and diversity of birds it contained after it began to thaw toward the end of the first week of May. However, this relatively large lake was only of average importance during summer, and was little used in fall.

The southernmost Fog Lake supported high levels of abundance and species richness during all seasons. It received less use in spring than during other seasons, probably because ice cover was still extensive as late as May 17, 1981. On this date, ducks were heavily concentrated in the open water at the inlet end of the lake. This lake and WB 140 had the highest species richness (11 species) during summer.

Waterbody 032, a small lake at the west end of the Fog Lakes, supported a high density of birds in summer and showed high productivity (at least four broods of horned grebe and two of American wigeon seen on July 28, 1981). It was not monitored during migration.

Swimming Bear Lake, an alpine lake, received its primary use during summer. After it thawed in late May, it was occupied by at least five species of waterbirds (scaup, oldsquaw, scoter, mew gull, and arctic tern), three of which were observed with broods on July 29, 1981. Flocks of scaup and white-winged scoters were seen on the lake during the last half of September 1981.

None of the waterbodies in the middle basin had I.V.s as high as those calculated for some of the better wetland sites of eastern interior Alaska from data obtained during fall 1980 by Ritchie and

Hawkings (1981) (Figure E.3.4.27) and during spring 1980 by Ritchie (1980) (Figure E.3.4.26).

(iv) Lower Basin (o)

The lower Susitna River above the delta appears to be little used by waterbirds. Few birds were seen during spring aerial surveys in either 1981 or 1982 (Table E.3.4.48), or during the June 1982 ground surveys (see Appendix 3E). Few birds have also been seen on USFWS surveys (see King and Conant 1980). Overall, swans, white-fronted goose, scaup spp., common merganser and merganser spp. were the most abundant species seen. Numbers were highest in the last 23 mi of the river between the mouth of Yentna River and Cook Inlet.

Ice on the lower river apparently broke a week or more later in 1982 than in 1981. During the May 7, 1981, survey, the river above Talkeetna was breaking up and carrying a heavy load of ice chunks; whereas on May 10, 1982, this section of river was still almost entirely frozen. Since spring migration of dabbling ducks in central Alaska was only two to three days later in 1982 than in 1981 (Kessel, unpublished data), the main spring movement had passed through the Susitna region in 1982 before water became available in the river above Talkeetna.

In addition to early season ice above Talkeetna, the main reasons for the low use of the lower river appear to be its rapid flow and heavy silt load (Kessel et al. 1982b). These factors limit the development of aquatic plants and associated invertebrates, the main diet of most waterbirds, and make food invisible, except at shallow edges or in sloughs (Kessel et al. 1982b). Corroborating this assumption is the fact that the most numerous ducks on the river were fish-eating mergansers (Kessel et al. 1982b).

(c) Other Birds (*)

(i) Shorebirds and Larids (*)

Seven of the 19 species of shorebirds that occur in the middle basin are transients that occur only during migration (Appendix E4.3). An additional six species nest in alpine tundra habitats that will be little affected by the Susitna development. The six species that will be most affected (semipalmated plover, common snipe, spotted sandpiper, solitary sandpiper, and greater yellowlegs) nest on alluvial bars along the river edge or in lower elevation woodlands and meadows. No shorebirds overwinter in the Susitna region.

Five species of larids occurred in the middle basin in 1980 and 1981 (Appendix 3D, Kessel et al. 1982a). Two are confirmed breeders in the area: mew gull and Bonaparte's gull. Mew gulls were the only common larid species in the middle basin (Kessel et al. 1982a), breeding around lakes and rivers. Arctic terns and long-tailed jaegers were fairly common and undoubtedly bred in the area (Kessel et al. 1982a). Herring gulls were uncommon summer visitors (Kessel et al. 1982a).

Seven species of shorebirds were seen along the lower Susitna River during a June ground survey in 1982 by Kessel et al. (1982b) (Appendix E5.3). Spotted sandpipers were common breeders along shores of the main river as well as along its sloughs and feeder creeks; solitary sandpipers were also fairly common along the river. Semipalmated plovers were uncommon breeders on alluvia, and greater yellowlegs were uncommon probable breeders along the river. Winnowing common snipe were recorded at numerous locations. Only one migrant whimbrel was observed on an alluvial island below Talkeetna, and two female northern phalaropes were also seen on the river.

Six species of larids were recorded in the spring 1982 survey downstream from Talkeetna (Kessel et al. 1982b). Herring gulls were most common with at least 7 breeding colonies in the lower basin; the largest colony containing approximately 1,300 birds (Kessel et al. 1982b). Arctic terns and mew gulls were fairly common breeders on river bars in isolated pairs and small groups. Bonaparte's gulls were fairly common and probable nesters in spruce woodlands adjacent to the river. Parasitic jaegers and black-legged kittiwakes were also recorded in the lower reaches of the river. Neither species breeds in the area (parasitic jaegers breed in northwest and northern coastal Alaska, and the nearest black-legged kittiwake breeding colony is located at Chisik Island in Lower Cook Inlet).

(ii) Grouse and Ptarmigan (**)

Spruce grouse are year-round residents of mixed and coniferous forests in the middle Susitna Basin. Their status was given as fairly common by Kessel et al. (1982a) who reported a maximum density of 1.0 territories per 10 ha in white spruce-paper birch forest in 1981 (Figure E.3.4.24, Table E.3.4.49. Ruffed grouse were reported as a rare visitant by Kessel et al (1982a). Sharp-tailed grouse are a species apparently dependent upon early successional vegetation (Small 1985, Pers. Comm.). Sightings are reported regularly but infrequently in the Lake Louise-to-Glennallen region to the east of the project (Eide 1985, Pers. Comm.; Small 1985, Pers. Comm.). and suitable habitat is likely present near the upper end of the Watana - Stage III impoundment. Sharp-tailed grouse were not observed during surveys of the project area (Kessel et al. 1982a).

Willow, rock, and white-tailed ptarmigan were all recorded as breeders in the middle basin. Willow ptarmigan were common in low shrub thickets and attained a maximum breeding density of 0.5 territories per 10 ha in dwarf-low birch shrub (Table E.3.4.49) (Kessel et al. 1982a). Rock ptarmigan are also common in dwarf and low shrub at high elevations and in blockfields and also attained maximum breeding densities in dwarf-low birch shrub (Table E.3.4.49) (Kessel et al. 1982a). White-tailed ptarmigan were uncommon in dwarf shrub mat and blockfields, and are found at generally higher elevations than other ptarmigan, although attitudinal ranges may overlap considerably with rock ptarmigan (Kessel et al. 1982a).

Grouse and ptarmigan were not recorded along the lower Susitna River (Kessel et al. 1982b). However, spruce grouse are likely residents of adjacent forest habitats, and a few willow ptarmigan may migrate to riparian habitats in some winters.

(iii) Woodpeckers and Passerines (o)

In terms of numbers, woodpeckers and passerines comprise by far the greatest proportion of the birds inhabiting the middle Susitna Basin. Fifty-seven species have been recorded, and nine (possibly 10) of these are year-round residents (Appendix 3D) All of the woodpeckers and a large proportion of the passerines are forest species, but passerines are found in all vegetated habitats, from closed forest through shrublands to alpine tundra. Breeding densities in 1981 and 1982 of these terrestrial species are given in Tables E.3.4.49 and E.3.4.50, and are discussed in more detail below.

The four species of swallow and the dipper are closely associate with aquatic habitats, and they were not adequately represented in censuses of terrestrial habitats. Bank swallows and cliff swallows nest colonially, the former in cutbanks and the latter in areas of cliffs and in abandoned cabins. Tree swallows and violet-green swallows are not colonial and nest in a variety of habitats. Swallows capture food while flying over open expanses and often over lakes and rivers, if they are present. The dipper is a bird of clear, fast flowing streams. It forages year-round in shallow sections of streams and nests along streambanks and under bridges. Dippers are uncommon in the middle basin, but a few birds occur in each of the major creeks that drain into the Susitna River as well as along the middle and upper Susitna itself.

Thirty-nine species of woodpeckers and passerines were recorded along the lower Susitna River during the spring surveys. Six (possibly seven) are year-round residents (Appendix E5.3). Relative abundance of some species are discussed below.

(iv) Middle Basin Bird Communities (*)

Breeding populations of terrestrial birds in the middle basin were studied in 1981 (Kessel et al. 1982a) and in 1982 (Kessel, unpublished tables) by means of plot censuses. The number of territories of each species on the census plots in the two years is shown in Table E.3.4.49 and E.3.4.50. Breeding bird densities in 1981 and 1982 are compared in Table E.3.4.51.

Table E.3.4.52 lists the avian habitats (as described by Kessel 1979) represented in the 10 ha census plots and their approximate equivalents in Viereck and Dyrness (1980) vegetation types. Kessel et al. (1982a) caution against the use of Viereck and Dyrness types as avian habitat types because of: (1) a failure to differentiate between habitats of medium and tall shrub avian communities; and (2) a failure to restrict coniferous and deciduous forest types to exclusively (≥90 percent) coniferous or deciduous canopy coverage.

Density of breeding birds were substantially lower in most habitats in 1981 and 1982 (Table E.3.4.51). Kessel believes that the 1981 densities were probably closer to normal and that 1982 densities were abnormally low, probably the lowest since 1964. The low 1982 densities are attributed to extremely late environmental conditions relative to spring arrival dates of migrants in 1982. At the suggestion of the investigators the 1981 data is used in all analyses rather than a simple average of the two years.

Generally, the forest and woodland habitats supported higher densities of birds than the shrub communities. Highest densities found in forests were at a cottonwood forest plot near Sherman, which supported 1.7 bird territories/acre. The lowest densities in forest habitats were in the white spruce forest plot at the mouth of Kosina Creek (0.6 territories/acre). Of the shrub habitats, low-medium willow shrub had the highest densities (1.8 territories/acre) and alpine tundra the lowest (0.2 territories/acre). Although alpine tundra had the lowest bird usage, these types supported some bird species generally not found in other habitats, such as white-tailed ptarmigan, horned lark, wheatear, water pipit, gray-crowned rosy finch, and snow bunting.

Bird densities in habitats of the middle basin are similar to those in the upper Tanana River valley (Spindler and Kessel 1980). In both regions, coniferous forests were low-density habitats relative to other forest types. Deciduous and mixed forests, and shrubby woodlands in both regions supported intermediate densities, and low shrub habitat support low densities. Such differences in occupancy levels are affected by a number of factors, including in interior Alaska, habitat structural complexity and primary productivity (Spindler and Kessel 1980). Tall shrub habitats in interior Alaska support the highest avian densities (Spindler and Kessel 1980). Kessel et al. (1982a) attributed the lower densities in their Susitna tall-alder-shrub study plot to species composition of the shrub community. They contrasted the average to above-average productivity (Spindler and Kessel 1980) of the willow, thinleaf alder (Alnus tenuifolia) and balsam poplar which dominated the Tanana valley tall-shrub plot with the relatively low productivity of American green alder (Alnus crispa) (Spindler and Kessel 1980) which dominated in the middle Susitna Basin plot.

Kessel et al. (1982a) calculated Shannon-Weaver diversity indices (H') for each census plot (Table E.3.4.51). Diversity values are sometimes used as indicators of habitat quality. Values of H' ranged from 0.91 for the dwarf-low birch shrub plot in 1982 to 2.55 in the closed balsam poplar forest plot in 1981. With the exceptions of the white spruce forest plot in both years and white spruce woodland in 1982, all plots in forest habitats obtained indices >2.0. The tall alder shrub plot diversity index values were 2.05 in 1981 and 2.02 in 1982, while values in all other shrub and tundra habitats were all <2.0. The three greatest diversity values in both years were obtained in the balsam poplar forest, white spruce-paper birch forest, and black spruce woodland plots (Table E.3.4.51). The 1982 values on these more diverse plots were substantially lower than 1981 index values, the result of both reduced densities and reduced numbers of species. Habitats obtaining high values of H' are characterized by large numbers of species and large numbers of individuals of each species.

Each avian habitat type (as defined by Kessel 1979) in the middle basin supports a moderately distinct bird species association, as indicated in Table E.3.4.53.

Since migratory birds using the project area may have the option to move elsewhere when habitat is lost while overwintering species likely do not, the winter bird surveys were conducted to assess densities of overwintering species in habitats to be affected by the project. Forest habitats were concentrated on due to their occurrence in the impoundment zones, and the lack of current mitigation for loss of these habitats for birds (LGL 1985).

Table E.3.4.54 presents the results of these surveys. Boreal chickadees and gray jays were the only fairly abundant species of the 11 species observed, and were most populous all winter long. Both species strongly prefer white spruce forests and avoid deciduous forests. Gray jays also preferred white spruce woodlands. Although they were not very abundant, redpolls preferred deciduous forests where paper birch was dominant, presumably due to their dependence on birch seed as a winter food source (LGL 1985).

(v) Lower Susitna River Floodplain Bird Communities (*)

Information on the relative abundance and habitat use of terrestrial birds in the lower Susitna River floodplain was obtained during a ground survey conducted in June 1982 by the University of Alaska Museum (Kessel et al. 1982b). Abundance was determined by counts of singing birds in each habitat type.

Generally, following ecological tenets, both abundance and species richness increased progressively from the early to late vegetation successional stages (Table E.3.4.55) (Kessel et al. 1982b).

Species composition of the early successional stages was dominated by waterbirds, such as plovers, sandpipers, gulls, and terns. The only regular land bird was the white-crowned sparrow, which was common in medium-height shrub at thh last stages of early succession (Kessel et al. 1982b).

Species composition and abundance in the tall shrub and forest habitats of the lower Susitna River floodplain followed known patterns of habitat selection in central Alaska, except in the cottonwood forests. Several bird species normally associated with tall shrub communities (i.e., gray-cheeked thrush, blackpoll warbler, northern water-thrush and fox sparrow) were found to select nesting territories within riparian cottonwood forests, probably because these forests have a well-developed, tall shrub understory (Kessel et al. 1982b).

A profound effect of silt ground cover on avian abundance was also noted along the lower floodplain. Forest and tall shrub stands with a heavy ground cover of recently deposited silt were essentially devoid of birdlife. Earlier studies (Spindler and Kessel 1980; Kessel et al., unpublished data) have suggested that there is little preference by most terrestrial birds for specific taxa of plant ground cover, but apparently some kind of vegetative cover is necessary--undoubtedly because of its role in providing food resources (Kessel et al. 1982b).

4.2.4 - Non-Game (Small) Mammals (*)

Non-game (small) mammals of the project area include shrews, voles, lemmings, red squirrels, ground squirrels, marmots, pikas, snowshoe hares, and porcupines. Small mammals, by the nature of their size and visibility, are not high profile species. However, they are important ecological components of most northern ecosystems. Small rodents have been shown to be important in nutrient cycling; soil aeration; dispersal of seeds, mycorhizae and spores; control of insect pests; and as the primary or secondary prey of many carnivores (Grodzinski and Wunder 1975).

Kessel et al.'s (1982a) studies of small mammals were restricted to an area ranging 9.3 miles to either side of the Susitna River, extending from the Maclaren River on the east to near Sherman on the west (approximately 6.2 miles south of Gold Creek). Within this area, 49 trapline transects were established and operated in the falls of 1980 and 1982 and spring of 1981. Sites for the transects were selected to represent as broad a spectrum as possible of the various vegetation types in the region. Details on sampling techniques are provided in Kessel et al. (1982a). Information on small mammals was also obtained by opportunistic observations.

(a) Species Composition and Relative Abundance (o)

During the study period, 16 species of small mammals were trapped and/or observed in the middle basin (Appendix E7.3) (Kessel et al. 1982a). In addition, there was evidence of two other species occurring in the region: bats (two separate sightings of what were probably the little brown bat) and water shrews (tracks of a small mammal between ice openings on Watana Creek). The distribution of small mammals documented in the middle basin is similar to known distributions in the literature. However, the occurrence of arctic shrews in the study area constitutes a minor range extension; the closest previous record was from Denali National Park (Murie 1962).

The one spring and three fall trapline surveys involved a total of 23,061 trap nights of effort (Table E.3.4.56). Totals of 950, 138, 2,190, and 447 small mammal specimens were captured during the fall of 1980, spring of 1981, fall of 1981, and fall of 1982, respectively. A total of 1977 microtine rodents (6 species) and 1,748 shrews (4 species) was captured. Northern red-backed voles and masked shrews were the two most abundant species of small mammals, constituting 74 percent of the total captures. A total of 1,458 northern red-backed voles and 1,289 masked shrews was captured during the 1980 to 1982 studies. Other shrews captured were arctic shrews (303 specimens), dusky shrews (146), and pygmy shrews (10). Captures of microtines included 224 tundra voles, 103 meadow voles, 148 singing voles, 29 brown lemmings, and 15 northern bog lemmings (Table E.3.4.56).

Capture results illustrate the large population fluctuations that can be observed within and between years (Table E.3.4.56). The fall 1980, spring 1981, and fall 1981 sequence demonstrates the typical annual cycle of most short-lived multiparous small mammals. In such species, summer reproduction results in high population levels by fall, and winter attrition reduces the population to animals born late in the previous summer or fall. Superimposed on this annual cycle are yearly fluctuations in abundance demonstrated by the fall data for the three successive years. The most common microtines, northern red-backed voles, meadow voles and tundra voles, were most abundant in fall 1981, as was the most common shrew,tne masked shrew. All of these species exhibited very low fall populations in 1982. Fall 1982 capture rates were low for all species except singing voles, brown lemmings, and bog lemmings, throughout the study period. Northern red-backed voles were the most frequently captured microtine in all periods. Masked shrews were the most frequently captured shrew in all periods, in spite of their dramatic decline in abundance in 1982.

Six other species of small mammals were not trapped but were observed in the study area by Kessel et al. (1982a): arctic ground squirrel, hoary marmot, collared pika, red squirrel, porcupine, and snowshoe hare. Although no quantitative estimates of abundance were obtained for these species, limited information on distribution was collected and is reported below from Kessel et al. (1982a).

The arctic ground squirrel is a common and ecologically important mammal of the region. The largest numbers were observed on the drier slopes, knolls, and ridges above tree-line; only small numbers were observed at lower elevations. General observations indicate that the Susitna study area supports a relatively high and stable population of ground squirrels, probably comparable to densities reported elsewhere in the state (Kessel et al. 1982a). For example, in the Talkeetna Mountains to the south, Hock and Cottini (1966) removed 27 squirrels in one day from 0.12 acres

(22 squirrels/acre) with little apparent decrease in numbers; the squirrel population in this area remained high throughout 4 years of study. In the eastern Brooks Range, Bee and Hall (1956) counted 175 ground squirrels along a 0.62 miles ridge, and 70 squirrels on approximately 3.7 acres of hillside (nearly 19 squirrels/acre).

Hoary marmots were locally common residents of the alpine zone. Scattered colonies were found above treeline. None were seen within the proposed impoundment areas. Collared pika is another locally common alpine species, found on talus slopes at higher elevations. No pikas were seen below treeline. Densities of pikas in Denali National Park during 1962 varied from 2 per acre in large rock slides, to 10 per acre on small, isolated rock piles (Broadbooks 1965).

Red squirrels, porcupines, and snowshoe hares were generally confined to the forested areas of the basin. Red squirrels were present in coniferous forests throughout the area, but were most numerous in the mature spruce stands that occur along the larger creeks such as Watana and Tsusena Creeks. Porcupines are uncommon in the study area; a few individuals were sighted during the summer of 1980, and three to four sets of tracks were seen during the winter of 1980.

Snowshoe hares, a major source of food for predators over much of central Alaska, were generally restricted to areas east of Watana Creek. Localized "pockets" occurred primarily in the vicinities of Jay Creek, Goose Creek, and the lower Oshetna River. Snowshoe hare populations undergo 8- to 12-year cycles of abundance (Keith and Windberg 1978); peak densities may be as high as 15.6 hares/acre whereas densities may drop to as low as 0.05 hares/acre during population lows (Green and Evans 1940). Long-term information in overall hare abundance, provided by several local residents, indicated that the recent low number of hares is a chronic situation and not just a low phase of the population cycle.

(b) Habitat Use (*)

The following analysis of habitat use draws heavily from Kessel et al. (1982a).

(i) Shrews and Voles (o)

Forty-two trapping sites were organized by Kessel et al. (1982a) into floristically similar groups using a cluster analysis of frequency counts of 81 plant taxa from the vicinity of the sample sites (Figure

E.3.4.28). The clustered subgroups roughly correspond to the following vegetation types from Viereck and Dyrness (1980): sedge-grass and shrub tundra, sedge- grass and low willow shrub, herbaceous-mixed low shrub meadow, open white spruce forest, woodland spruce, black spruce bog (some low birch shrub sites were included in this group), paper birch-white spruce forest, cottonwood forest, tall alder shrub, and tall grass meadow. The number of captures of each small mammal species relative to these vegetation types is shown in Figure E.3.4.29.

Shrews and red-backed voles in the middle basin displayed a relatively broad and uniform distribution pattern across habitats (Figure E.3.4.29). Masked shrews, the numerically dominant shrew species, occurred at all trapping sites. They were most numerous in deciduous forest (particularly cottonwood), grassland, and tall shrub sites. Arctic shrews occurred at 29 trapline sites, with peaks of abundance on the drier, nonforested sites, particularly grassland (at low elevations) and low shrub (above treeline). Dusky shrews were thinly distributed across the vegetation types of the study area. Although dusky shrews were captured at 23 sites, no particular preferences were apparent; however, none were captured in the wettest sites. The capture of three pygmy shrews in cottonwood forest, one in white spruce forest, and one in grassland during fall 1981 and the capture of five specimens in open spruce forest and one in cottonwood forest during fall 1980 suggest a restriction of this species to forest habitats. Northern red-backed voles, the dominant microtine of the region, occurred on all but five <u>Microtus</u> species displayed stronger habitat specificity, as evidenced by their general restriction to open, nonforested sites (Figure E.3.4.29). Singing voles were captured on only 10 trapline transects. They were most abundant in open, low willow-birch shrub on relatively dry soils but were also found in herbaceous tundra and mat and cushion tundra above treeline. Tundra voles and meadow voles occurred primarily in sedge and grass-forb meadows and bogs. Tundra voles were captured on 22 sites (primarily grass-forb, but also sedge-grass), compared to 10 sites for meadow voles (primarily wet sedge-grass). Small numbers of brown lemmings were captured on 11 sites at or above treeline, usually in wet herbaceous and low shrub situations. Two bog lemmings were taken at lower elevations in mesic sedge-grass/low shrub meadow, one in grass meadow and one near a seepage in white spruce forest.

To summarize the differences in habitat use among the various species of small mammals, a standardized habitat niche breadth measure was calculated for each species captured during fall 1981 (Table E.3.4.57). The ubiquitous masked shrews and red-backed voles had the broadest habitat niche breadth, followed closely by dusky shrews and arctic shrews. Microtus species, particularly singing voles, had the narrowest habitat niche breadths, along with the rare or uncommon pygmy shrews, bog lemmings, and brown lemmings.

Small mammal community structures, especially as they relate to species dominance and habitat breadth, are highly correlated with population levels and species interactions. Because most northern microtine populations undergo extreme fluctuations in density (Krebs and Myers 1974), strict ecological boundaries are difficult to delineate. A small mammal population sampled Northern bog lemmings and brown lemmings were uncommon members of the small mammal community in the Susitna Basin. Bog lemmings are generally uncommon throughout their range, and little is known of their ecological requirements (Banfield 1974, West 1979, MacDonald 1980). In other areas of the state, small numbers have been taken primarily in shrub bogs and marshes (Osgood 1900, Dice 1921, West 1979, MacDonald 1980)--not unlike the few sites where they occurred during this study. Their diet is apparently restricted to sedges, grasses, some forbs (Cowan and Guiguet 1956), and mosses (West 1979).

Although the high country of the middle basin has an apparent abundance of suitable brown lemming habitat, only small, scattered numbers were captured during the 1980 and 1981 study. However, they have been found in fairly large numbers in other montane areas of central Alaska (by Kessel et al. 1982a). The low numbers in the Susitna area may be caused by a failure to sample the right habitats, or, more likely, to sampling during a period of low population levels. Brown lemmings are usually associated with wet sedge-grass tundra above treeline, but also are found locally at lower elevations in spruce bogs and wet meadows (Buckley and Libby 1957 and Banfield 1974). This species is almost completely dependent on a diet of sedges and grasses, although mosses may be important at times (West 1979).

(ii) Other Species (*)

Arctic ground squirrels inhabit herbaceous tundra and open shrub habitats above treeline (Kessel et al. 1982a). At lower elevations they also colonize riverbanks, lakeshores, moraines, eskers, road sidings, and other disturbed sites with subclimax vegetation (Banfield 1974, Kessel et al. 1982a). Kessel et al.'s (1982a) observations corroborate Bee and Hall's (1956) conclusion for the Brooks Range that the optimum conditions for ground squirrel colonies are:

- Loose permafrost-free soils on well-drained slopes;
- Vantage points from which the surrounding terrain can be observed; and
- Bare soil surrounded by vegetation in an early xerosere stage of succession.

Carl (1962) found that ground squirrels avoided sites where tall vegetation (greater than 8 inches) impaired vision. The effects of squirrel activity--e.g., burrowing, mound building, feeding, feces deposition--within areas of established colonies tend to maintain vegetation at an early successional stage (Carl 1962 and Youngman 1975).

During the snow-free months, ground squirrels provide an abundant, reliable food source for a number of mammalian and avian predators (Carl 1962, Murie 1962, Bente 1981, Olendorff 1976). At High Lake in 1981 the first ground squirrel emerged from hibernation the third week of April; the latest date in 1981 on which ground squirrels were seen was October 4 (Kessel et al. 1982a). These emergence and entrance dates are essentially the same as those reported by Hock (1960) and Hock and Cottini (1966) in the Talkeetna Mountains near Anchorage, and by Carl (1962) at Ogotoruk Creek, northwestern Alaska.

Hoary marmots and pikas are generally restricted to tundra/talus habitats at high elevations (Hoffman et al. 1979 and Kessel et al. 1982a). Both are ecotone species: their homes and shelters are in one habitat (rocks of various size and shape) and their food in another (herbaceous tundra types) (Broadbooks 1965). Hock and Cottini (1966) suggested that a portion of their marmot population underwent seasonal shifts in altitude, moving down from high rocky slopes in fall to sites having better conditions for winter denning and having an available food supply in early spring. An opposite seasonal movement apparently occurs in some Montana hoary marmot colonies (Barash 1974). The only suggestion of fall movement in the middle basin was the observation of several marmot trails and a single marmot traversing the 3,500-foot-high valley near Swimming Bear Lake (WB 150) in about 3 inches of snow on October 10, 1980 (Kessel et al. 1982a). Marmots hibernate longer than ground squirrels; in the Talkeetna Mountains near Anchorage, marmots emerge from hibernation during the first third of May and begin entering hibernacula in early September (Hock and Cottini 1966). Pikas are active throughout the year (Sheldon 1930, Broadbooks 1965, Hock and Cottini 1966) and store large quantities of dried plant material in late summer for use during the winter months.

The arboreal red squirrel occupies a variety of forest habitats, but prefers mature coniferous forest (Cowan and Guiguet 1956). White spruce forest is generally considered the optimal habitat in interior Alaska (Nodler 1973). Red squirrels feed primarily on the seeds of spruce, particularly white spruce, but supplement their diet with fungi, fruits, and even the buds of spruce and aspen (Smith 1967 and Nodler 1973). They store large quantities of spruce cones and mushrooms in middens for winter use (Murie 1927 and Streubel 1968). Buskirk (Kessel et al. 1982a) noted that red squirrel middens in the middle basin in fall 1981 appeared to be composed only of mushrooms and spruce buds. A massive cone crop failure caused by an area- wide epidemic of white spruce needle rust (<u>Chrysomyxa ledicola</u>) during 1980 (Kessel et al. 1982a) may explain why squirrels were storing such low-quality food as spruce buds (Smith 1967). Smith (1967) reported a 67-percent drop in a red squirrel population following the second year of a two-year cone crop failure in white spruce forest and suggested that the squirrels had emigrated into surrounding black spruce stands. Repeated cone crop failures could have similar effects on red squirrels in the middle basin (Kessel et al. 1982a).

In interior Alaska, Wolff (1977) found that snowshoe hare habitat preference depended on population density; during population lows, hares were restricted to dense black spruce forest and willow-alder thickets, but during highs they used a wider variety of vegetation types, including recently burned areas with minimal cover. He concluded that a patchy environment of recently burned sites with inclusions of unburned spruce was the preferred hare habitat. The chronic scarcity of snowshoe hares in the middle basin is probably related to a scarcity of suitable habitat (Kessel et al. 1982a). Recent burns and riparian shrub thickets are noticeably absent from this area (Kessel et al. 1982a).

4.3 Impacts (**)

Five classes of impacts to terrestrial vertebrates are anticipated to result from the Susitna Hydroelectric Project: (1) permanent habitat loss, including flooding of habitat and covering with gravel pads or roads; (2) temporary habitat loss and habitat alteration resulting from reclaimed and revegetated areas such as borrow areas, temporary rights-of-way, transmission corridors, and from alteration of climate and hydrology; (3) barriers, impediments, and hazards to movement; (4) disturbance associated with project construction and operation; and (5) consequences of increased human access not directly related to project activities. The acceleration of secondary development in the basin is an indirect impact which can be neither predicted nor controlled by the Applicant and is therefore excluded from this discussion. Specific impact issues associated with each class of impact are enumerated in separate tables and discussed in the following sections for each big game and furbearer species.

Permanent loss of specific vegetation types is shown in Table E.3.4.1 for the Watana Stage I, Devil Canyon Stage II and Watana Stage III facilities. Habitats altered by the transmission corridor and access roads are described in Tables E.3.3.31, E.3.3.32, E.3.3.40, E.3.3.41, and E.3.3.42. Impacts resulting from increased human access have already begun and will continue throughout the life of the project.

4.3.1 - Watana Stage I Development (**)

(a) Moose (**)

Moose are common in the Susitna River valley and are one of the most important wildlife species that will be affected by the Watana project. Activities associated with the construction of Watana facilities will affect moose mostly in areas adjacent to and within the dam and impoundment area. Activities associated with the filling and operational phases will affect moose in both the middle and lower Susitna Basins. Although Watana Stages I and III may benefit moose in some areas of the Susitna Basin, effects of the project could result in a decline in the number of moose and altered distributions of this species throughout the basin. Because both migratory and resident populations of moose utilize areas in the immediate vicinity of the proposed impoundment area (ADF&G 1982k), impacts associated with each phase of the project could influence moose populations in other drainages removed from the Susitna Basin.

In this discussion, impacts of the Susitna project on moose will be assessed by estimating the extent (temporal and spatial) to which carrying capacity for moose is reduced within the basin, and by the effect on population regulatory mechanisms (Figure E.3.4.30). The effects of developments that reduce carrying capacity or productivity of moose populations for more than 10 years will be considered as severe impacts. Moderate impacts may affect either a large proportion of the moose population for a short period (less than five years) or a smaller proportion of the population for long periods. Minor impacts will include very short term (less than one year) effects. A summary of anticipated and hypothesized impacts to moose appears in Section 4.3.6.

The direct impacts that will most severely affect moose populations in the middle Susitna Basin are, in order of decreasing severity: permanent loss of habitat, alteration of habitat, disturbance by machines and humans, hazards associated with the impoundment and drawdown zone, and blockage of movements. Moose in the lower basin will be affected mostly by alteration of habitat. The major indirect impact of the Watana Stage I development will be the provision of access to a previously remote area and a substantial increase in hunting pressure with subsequent increases in mortality rates at least for bulls.

(i) Construction (*)

Construction of the Watana Stage I Dam will involve intense construction activities at the actual damsite, establishment of a temporary camp and village ,removal of forest cover in many parts of the impoundment, and the excavation and transportation of borrow material. The major impacts on moose during construction will be habitat loss or alteration, disturbance, interference with seasonal movements, and mortality associated with construction activities.

- Habitat Loss (*)

Clearing of the impoundment area, camp and village sites, local transportation corridors, and operational areas will result in the permanent loss of some high quality habitat for moose in the middle Susitna Basin. (High quality habitats are those areas supporting moderate to relatively high browse production and having snow depths less than the regional average, areas where spring snowmelt occurs earliest, and/or areas used for calving.) Campsites, borrow pits, and construction access roads will temporarily alienate smaller areas of habitat from moose use. Moose will be affected by this loss of habitat in a variety of ways: browse availability will be reduced; winter range, calving areas, and breeding areas will be lost; movements may be altered as a result of behavioral or physical barriers; animals will be more vulnerable to predation and hunting (as a result of the loss of cover); and repeated human and mechanical disturbances may preclude use of some areas by moose. Accidental fires may also temporarily eliminate moose habitat, although in the long term would provide additional areas of high quality browse to moose.

Clearing of the impoundment area will remove a wide range of riparian, deciduous forest, coniferous forest, and muskeg communities which are important to moose during all or part of the year. Although some cleared areas may develop sparse successional growth prior to flooding, inundation will evenually permanently destroy these habitats. The distribution and occurrence of major plant communities in the Watana watershed are discussed in Section 3.2.1.

. Winter Use (*)

There is a general consensus that moose populations in North America are ultimately limited by the availability and quality of winter range (Coady 1982). High quality winter range of moose is characterized by (1) abundant trees and shrubs that are most preferred by moose as winter browse; (2) consistently low snow depths in relation to surrounding areas, and (3) good interspersion of young seral growth (for foraging) and older aged forest stands (for cover) (LeResche et al. 1974, Peek 1974b). The nutritional quality of browse (e.g., amounts of crude protein, fats, and carbohydrates; digestibility; total calories) also is important in determining the quality of winter range (Oldemeyer 1974). Other factors such as predation, hunting mortality, disease, and weather may reduce moose populations below the carrying capacity of the range (Figure E.3.4.30).

Although the quality and quantity of winter range are likely the limiting determinant for carrying capacity of moose, they are critical to moose survival only during severe winters. Winter severity, particularly snow depth, strongly influences the use of winter browse by moose (Coady 1974, LeResche et al. 1974). During mild winters, when snow depths are low throughout much of the range, few moose may utilize critical winter ranges. During severe winters, however, deep snows may force high numbers of moose to overwinter in limited areas. The limiting effect of critical winter range may thus be evident only during periods of severe winter conditions.

Although the effects of a severe winter were not observed during the current moose studies in the middle Susitna Basin (ADF&G 1984m), earlier studies of moose in the basin (USFWS 1975, Ballard and Taylor 1980) suggest that during severe winters with heavy snowfall, moose move from upland shrublands to mixed spruce deciduous woodlands at lower elevations. The Watana impoundment area includes several large areas of river valley bottomland that are probably important to survival of some moose during severe winters. Mild winters with limited snow cover during 1980 and 1981 are thought to have resulted in the use of upland areas by moose in the Susitna Basin and their absence from lower elevation sites. However, even during the moderately severe winter of 1984-1985, large numbers of moose were not observed moving to the impoundment zones.

Because low elevation riparian shrub, deciduous forest, coniferous forest, and muskeg habitats will largely not be available in areas adjacent to the impoundment, the removal of these habitats by initial clearing activities and later flooding will deprive moose of a large area of high quality winter range. Assuming that bottomland browse resources throughout the middle Susitna Basin are fully utilized by moose in severe winters, clearing and flooding of the impoundment will force moose to depend on and likely over utilize the remaining winter range. Moose which never use the impoundment area will also be affected by over utilization of these adjacent areas. Increased mortality would be expected caused by starvation and increased predation, whereas natality may decrease because of the poor physical condition of moose.

. Spring Use (*)

During recent moose studies (ADF&G 1982k, 1983i, 1984m), many radio-tagged animals moved to lower elevation habitats adjacent to the Susitna River during late spring. It is believed that these movements are related to the earlier snowmelt, early emergence of new plant growth in low elevation sites and perhaps increased cover requirements during calving (ADF&G 1982k, 1983i). Because moose typically have a negative energy balance during winter and are in poor physiological condition by late spring (Gasaway and Coady 1974), the availability of new plant growth may be critical to survival. During the spring, parturient cow moose commonly use low elevation sites along the middle Susitna valley, presumably to calve (ADF&G 1982k). The availability of new plant growth and suitable shrub cover in these low elevation sites is thought to be important to the survival of both the cow and her calf. Bull moose and cow moose without calves also utilize the low elevation habitats during the spring (ADF&G 1982k).

Clearing and flooding of bottomland areas would reduce availability of lower elevation sites where spring snowmelt and plant emergence appears to be more rapid. Because micro-climatic changes resulting from the impoundment delay spring green-up by 5 to 15 days (McKendrick et al. 1982) and because habitats which will remain available around the impoundment area are at higher elevations, some moose may be deprived of a large area of early spring habitat. This impact would be most severe following winters with deep snowfalls when moose may be dependent on the availability of these spring foraging areas.

Predation on moose calves by brown bears is a major mortality factor of moose during the spring and summer (Ballard et al. 1980), and displacement of parturient cow moose from their habitual calving areas by clearing activity may increase the vulnerability of their calves to predation.

. Summer and Fall Use (o)

Because most moose in the middle Susitna Basin commonly move to upland shrub habitats during summer and fall, loss of bottomland communities will not have serious effects on summer and fall habitat use. However, some sedentary (or non-migratory) moose remain in the valley bottoms throughout the year and these individuals would be displaced from their summer and fall range.

- Disturbance (*)

During construction of the Watana Stage I Dam and clearing of the impoundment area, human and mechanical disturbance will likely limit the use of several development areas by moose and could result in alterations in feeding behavior. Because undisturbed ungulates spend much of their active period searching for and consuming food (Hudson 1977), disruption of daily activities can reduce feeding activity to the point where an individual derives less energy from the resources consumed than it expends (Geist 1975). Ungulate energy balances are most delicate during the winter (Dorrance et al. 1975, Moen 1976). Therefore, disturbances are likely to have the most severe impacts on ungulates during this season.

Although repeated human and mechanical disturbances could result in an alteration of activity budgets with consequent impacts on growth, survival, and production, a more serious immediate impact is the alienation of some portions of the range as a result of possible avoidance of human activity areas. Prolonged avoidance would result in an effective loss of habitat, and animals may concentrate in limited areas of prime range or subsist on marginal range. Either scenario could result in over-browsing and a reduction in carrying capacity with eventual population declines (Sopuck et al. 1979).

Moose appear to be more tolerant of disturbances than most ungulates (Tracy 1977), particularly if disturbances are predictable, neutral stimuli such as moving vehicles (Kucera 1976, Schultz and Bailey 1978). Cow-calf pairs generally respond to disturbance more strongly than bulls and cows without calves (Tracy 1977). If moose are not directly approached by humans or machines, they appear to tolerate even moderate and high activity levels.

Assuming that the Watana Dam construction site and associated facilities are restricted to as small an area as possible and that hunting from project facilities and harassment is prohibited, moose would probably continue to utilize forested areas near these sites. (Hunting has been prohibited within a 10-mile corridor containing the Trans-Alaska pipeline and can be regulated by the Alaska Board of Game. Harassment is prohibited by state law and can be minimized by adequate enforcement.)

Because the clearing of the impoundment will involve noisy and unpredictable disturbances, moose will probably avoid the areas of active clearing. This and additional loss of habitat resulting from a lack of cover in cleared sites may gradually increase the intensity of use of browse in areas outside the impoundment area during the three-to-four-year clearing program. The concentration of moose in these areas would increase intraspecific competition for food and space. If the populations in these adjacent areas are at or near carrying capacity, mortality of moose as a result of starvation and predation may increase, natality may decrease, and carrying capacity and population productivity may decline.

Aircraft enroute to or from the Watana airstrip may cause minor disturbances to moose. In general, most aircraft are expected to maintain high altitudes except during landing and take-off, and will not be a major disturbance stimulus. The use of wooded areas on or in the immediate vicinity of several international airports in Canada suggests that if moose are not harassed, they will habituate even to frequent low altitude overflights (Green 1981).

- Interference With Seasonal Movements (*)

  Clearing of the impoundment area will not physically obstruct river crossings or seasonal movements but may interfere with these movements through avoidance of active clearing operations or the expansive clear-cut areas. Increased visual exposure to predators and hunters may inhibit moose from crossing these cleared areas. Several studies have documented avoidance of large clear-cut areas by moose (Hamilton and Drysdale 1975, Parker and Morton 1978, Tomm 1978); in general, moose appear reluctant to enter areas where they would be far (i.e., more than 163 to 218 yards) from forest cover.

- Mortality (*)

  An unpredictable number of moose may be killed as a result of collisions with vehicles on construction roads or other accidents associated with construction activities. Mortality by predators may also increase if impoundment clearing facilitates hunting by wolves. The effect of these mortalities on moose populations is likely to be minor. A discussion of the impacts of traffic on the Denali Highway to Watana access road is found in Section E.3.4.3.3.

(ii) Filling and Operation (**)

During the filling and operation phases of the Watana development, the major impacts to moose will be permanent loss of habitat, alteration of habitats upstream and downstream from the damsite, blockage of movements, disturbance, and increased accidents and hunting mortality.

- Permanent Loss of Habitat (*)

  As flooding of the impoundment area proceeds, a variety of bottomland and low elevation habitats along the Susitna River will be permanently lost. As discussed above for the construction phase of the project, clearing of the impoundment area will have already resulted in a substantial reduction of the value of these areas to moose. By the time these areas are flooded, few or no moose may be utilizing these areas. However, the impoundment will permanently alienate the area from moose use. The consequences of the loss of these low elevation areas have been discussed in the previous section.

Approximately 15,762 acres of vegetated habitat will be inundated or otherwise permanently lost as a result of the Watana Stage I Dam (see Section E.3.3.1). As a result of the habitat loss, moose will be forced into adjacent areas. Although it is not possible to predict the distances moose will disperse from the impoundment area, it is clear that densities in adjacent areas will increase during the clearing and filling of the impoundment. Increased moose densities could result in a decline in habitat quality in adjacent areas. If overutilization of food resources, particularly winter browse (generally conceded to be a major limiting factor in moose populations) occurs, increased mortality and decreased productivity can be anticipated.

During the operation of the Watana Stage I Dam, a maximum drawdown of 150 feet will create an unvegetated shoreline zone that, in the Watana Creek area, may be over 2,000 ft. wide. The impoundment level will be at its highest in August and September, and will generally decline between October and August. Although a few herbs and forbs may become established during early summer, most of the area will remain a bare slope. Fine material will gradually move downslope so that much of the upper drawdown zone will eventually be composed of coarser material. Except during crossings of the reservoir, it is unlikely that moose will utilize the drawdown area.

- <u>Alteration of Habitats</u> (**)

Watana Stage I will result in the alteration of plant communities in both the upstream and downstream Susitna Basins (Section 3.3). These alterations will affect moose use of existing habitats and may have some effects on the long-term productivity of populations.

. Upper Susitna Basin (*)

Based on analyses of home ranges and seasonal movements (ADF&G 1982k), radio-collared moose commonly utilize lower elevation habitats in close proximity to the future impoundment. Vegetation in the areas immediately adjacent to the impoundment may be altered as a result of several mechanisms such as minor changes in seasonal temperatures, wind direction, and speed (see Section 3.3). If the proposed reservoir decreases either spring daytime temperatures (Baxter and Glaude 1980) or insolation, the spring green-up period may be delayed. This phenomenon is complicated by the fact that some plants use photoperiod rather than temperature to trigger early spring growth (see Section 3.3.1). If snow depths along the impoundment shoreline increase, plant green-up may be delayed. Some parturient cow moose, as well as male and young moose, were apparently observed to move to lower elevation areas of the Susitna River during the early spring, presumably to utilize the early emerging vegetation (ADF&G 1982k, no actual numbers available). Assuming that the timing of the spring green-up is important to the condition of parturient cows and the survival of their calves, any delay in green-up may reduce the survival of the calves. If moose are forced to utilize areas where green-up is later (in comparison to other sites), a reservoir-mediated delay in green-up would further aggravate problems of nutritional stress during the spring period.

Erosion of the impoundment shore will likely occur during the period of maximum fill until the new banks become stabilized. In particular, permafrost slumping along the south shore of the impoundment may modify or eliminate large areas of habitat along the shore, although most of the unstable areas are steep slopes of little value as moose habitat. Areas of successional vegetation, favorable to moose, may develop on some of the resulting more gently sloping areas along the shores of the reservoir.

. Lower Susitna Basin (**)

Changes in the flow regime will alter the availability and local distribution of important moose habitat in the lower Susitna Basin. The extent of vegetation changes will vary considerably along the lower reaches of the Susitna River because of the diluting effect of tributaries as well as changing channel morphology (see Section 3.3.1). Differences between pre- and post-project flow regimes will be greatest upstream from Talkeetna; change in the frequency and duration of flooding, ice scouring events, and shifting of bed materials will be less noticeable as one progresses downstream.

The alteration of moose habitat in the reach between Watana and Talkeetna can be better predicted than for areas further downstream. Between Watana and Devil Canyon, the river is contained by bedrock outcrops and steep canyon sides; early successional vegetation favored by moose occurs mostly on islands and along a narrow band adjacent to the main channel. The lower summer flows and lack of ice scouring will result in the colonization of a narrow band by new vegetation and the succession of some areas now subject to vegetative recession to climax forest.

The effects of the Project on the quantity and quality of moose browse downstream from Talkeetna will be less than those between Devil Canyon and Talkeetna, but because the number of moose using the river increases as one moves downstream, small effects on vegetation could result in relatively greater effects on moose. In winters of deep snowfall (such as in 1982 and 1983), the amount of browse available above the snow surface probably limits the moose population, and in these winters, a decrease in availability of browse can be translated to a proportional change in the moose population supported along the river. In most winters, however, the amount of riparian vegetation does not limit the population, and changes in browse availabiity would be less important. The area colonized by early- and mid-successional vegetation will vary considerably during the license period depending on the timing of peak floods of the various tributaries and river stage at freeze-up.

- Blockage of Movements (***)

Big game animals attempting to cross the Watana reservoir will encounter increased widths of water throughout the majority of the impoundment zone. This could completely prevent movement if animals refuse to cross. Increased mortalities could also occur in the form of drownings.

Moose are powerful swimmers with great stamina and the ability to swim long distances with comparatively little effort (Merrill 1916, Hosely 1949, Peterson 1955). Edwards (1957) tells of hundreds of moose crossing lakes in British Columbia on their return from winter range. Roosevelt et al. (1902) writes of a moose swimming eight miles across Kachemak Bay on the Kenai Peninsula. Peterson (1955) reports on a bull and cow swimming nine miles across open water. Moose in Europe have been reported to frequently swim as far as 12 miles (Merrill 1916).

Moose cows and calves swim extensively (Allen 1979). Cows often use islands as calving areas in order to avoid predators and calves are forced to swim when very young (Allen 1979, Peek 1985 pers. comm.). Although calves occasionally drown when crossing rivers and lakes (Allen 1979), and do so at present in the project area (Whitman 1985b pers. comm.), this is usually related to the overall vigor of the individual rather than the conditions of the water body (Peek 1985 pers. comm.).

Moose attempting to cross the Watana Stage I reservoir will have to swim about 0.7 miles in most cases (range < 0.1 mile to 3 miles). Reservoir open water is not expected to be a barrier to moose movements given their swimming ability and willingness to take to the water, although some reduction in the frequency of crossing may occur (Bonar 1985 pers. comm.)

If swimming moose were to encounter rafts of floating debris such as felled trees and brush, drownings could occur. Edwards (1957) documents a case where debris rafts in an impoundment were causing extensive moose drownings due to animals becoming entangled in debris or being prevented from reaching shore by debris. The impoundment will be cleared prior to inundation and will be relatively free of debris which could limit moose movements.

The presence of mud flats around the reservoir has also been suggested as a potential barrier to moose movements and a possible mortality factor if moose become mired and unable to free themselves. Moose are well adapted to move through marshes, bogs and mud and are known to wade into such areas to forage with little or no difficulty (Allen 1979). The front hoofs are largers than the back ones and in soft mud the dew claws are frequently brought into play along with the spreading of the toes to provide increased surface footing (Peterson 1955). The long legs and barrel shaped body also aid moose in moving through areas where many animals would become hopelessly mired. Murie (1934) writes that moose have often been observed in salt licks moving about with only the shoulder hump visible above the mud. Mortality of moose mired in bogs is not unheard of, but Murie (1934) speculated that in most of these cases the animals are probably too old or too weak to release themselves. Few, if any mortalities or movement-related problems resulting from mudflats along the reservoir perimeter are expected.

Moose attempting to cross the Watana reservoir during periods of ice formation or decay (mid-November or early May) may fall through the ice and be unable to regain a solid footing. This type of big game accident occurs on natural bodies of water and has been reported widely in the open literature (Hosely 1949, Peterson 1955, Ritchie 1978, Allen 1979).

Generally these types of accidents are infrequent and involve individual animals. However, instances of groups of animals breaking through thin ice and drowning have been reported. Two mass drownings of elk have been recorded at the Blue Mesa reservoir in Colorado (Cornelius 1985 pers. comm., Rosette 1985 pers. comm.). The first of these drownings involved 20 elk and occurred some undetermined years ago., virtually no information is available on this incident but it was believed to have occurred in spring (Rosette 1985 pers. comm.). The second incident occurred in 1978 and involved 69 elk which broke through the ice and were discovered in spring under sheets of ice. The animals involved in the second incident were thought to have been scared onto the ice by hunters (Cornelius 1985 pers. comm.). Response to a survey of operators of hydroelectric projects in cold regions indicated that moose mortalities due to reservoir ice were either not observed or not considered a problem (HE 1985d). Bonar (1985 pers. comm.) reports that moose attempting to cross the reservoir of B.C. Hydro's Revelstoke project do on occasion break through the ice, but in most cases the animals are able to climb back out of the water, which is often over their heads, as long as the ice is strong enough. Out of about 20 observations of moose breakthroughs on the ice, Bonar (1985 pers. comm.) documented only 2 mortalities and 1 of these was due in part to the animal becoming entangled in debris after falling through. Bonar also noted that moose generally will avoid crossing the Revelstoke project's reservoir when ice conditions are unstable.

Although individual moose mortalities may result from weakened ice on the Watana impoundment, significant impacts to the local moose populations are not expected. The impoundment may in fact even improve crossing conditions along some reaches. In general, the ice cover on the reservoir will be competent more continuously and for a longer period of time than is presently the case. Moose currently have to deal with open leads in the river until early March and then again in late April (R&M Consultants 1984).

In the spring, some female moose cross the Watana impoundment area in either direction and calve on the opposite side. The majority of females probably do not cross the river prior to calving, as vegetative cover used for calving exists on both sides, and crossing appear to be infrequent. Parturition generally occurs in the middle Susitna Basin from May 1 through June 15, peaking between May 25 and June 2 (ADF&G, 1982k). Suitable calving habitat will remain on both sides of the Watana impoundment after filling, and the existing pattern of calving will probably continue. Although moose may be lost while attempting spring crossing, this loss is not likely to be important because relatively few individuals will be affected.

As winter drawdown of the reservoir proceeds the ice cover will fracture and become draped along the banks. In some cases, cracks will form as the ice drapes and settles over irregular shoreline topography leaving stranded polygons of ice along the shore.

The potential for ice related accidents will be greatest on the steeper slopes of the reservoir margin. Moose encountering sheet ice draped on these slopes will be subject to injury by slipping or falling. Ice sheets around impoundment margins are generally not a source of significant impacts to moose (HE 1985d). Bonar (1985 pers. comm.) reports that the fractured ice which settles in the large drawdown zone (about 100 feet) of the Mica reservoir in British Columbia presents no problem to moose or other ungulates. Although individual moose will occasionally die from ice-related accidents, the overall effect upon local populations is not likely to be significant.

The effects of windblown snow accumulation on wildlife are not expected to be important. Only moose will potentially be affected. The magnitude of effects of snow drifting on moose will depend on such factors as prevailing wind direction, fetch, wind velocities, cumulative snow depth, presence or absence of crusted layers in the snow profile, proportion of reservoir surface snow melted, slope of exposed impoundment shorelines, local variations in shoreline topography, and vegetation types on the windward reservoir margin.

As mentioned earlier, moose are uniquely outfitted for travel in bogs and muddy areas with front hooves larger than rear ones, functional dew claws, long legs and a barrel shaped body. These same characteristics aid the moose in travel through deep winter snows. Although deep snow may hinder the mobility of moose in localized areas, increasing their vulnerability to wolf predation, this effect is more likely to be important during a severe winter with deep snowfall, rather than as a result of local snowdrifting. Bonar (1985 pers.

comm) reports that snowdrifting resulting from winds blowing snow along or from impoundment zone ice at the Revelstoke project doesn't cause any problem to local big game species.

- Disturbance (*)

Mechanical and human disturbance should decline in the impoundment and construction areas once the Watana Dam Stage I is operational. Public access will continue to increase levels of disturbance, though at a level lower than during construction. If animals are not directly harassed, disturbances during the filling and operation stages, with the exception of hunting, will at most have a slight effect on moose distributions.

- Mortality (*)

During the filling and operational phases of Watana Stage I, hunting mortality of moose may be much greater than current levels. Hunting pressure will likely increase rapidly during the first 5 to 10 years of the project, and increased harvest of moose is expected. Hunting may prevent overbrowsing of remaining range by removing displaced animals (assuming adjacent areas would be overutilized as a result of moose dispersal from the impoundment area).

Some increased mortality due to animals falling through weak ice, drowning during crossings or slipping on the ice can be expected to occur, however as discussed earlier (see section entitled Blockage of Movements) such mortality should be insignificant. Highway and railroad kills associated with the Project are also not expected to be significant.

The impoundment will also affect predation rates on moose. The ratio of brown bear to moose may increase in the early years of filling and operation. Bears may also kill more moose to compensate for the loss of vegetation in spring. The drawdown zone and ice conditions may facilitate hunting of moose by wolves. If a severe winter occurs during or just after filling, the moose population may suffer high winter mortality, reducing its ability to sustain high levels of predation. These factors could allow predation to drive the moose population to low levels, with slow recovery because of sustained predation levels.

(iii) Quantification of Project Effects (*)

The loss or alteration of moose habitat in the middle basin during both winter and summer has been identified as the major impact of the project on moose. The population-based studies conducted to date indicate the magnitude of use of areas by the existing populations during the study, but do not allow a quantitative assessment of the potential of the habitat to support moose under varying environmental conditions. To estimate moose carrying capacity in the Susitna project area, a moose bioenergetics model has been developed. This habitat-based assessment, in combination with the population-based assessment currently underway, should provide a strong basis for impact prediction and mitigation planning.

Carrying capacity models based upon the nutrient requirements of the animal and the capacity of the range to supply these necessary nutrients have been recently developed (Moen 1973, Wallmo et al. 1977, Mautz 1978). The nutritional interfaces between the animal and range are forage selection, ingestion, and digestion. Forage quality can be assessed by measuring available nitrogen and energy. Other nutritional entities are requisite to the health of wild ungulates, but they are seldom the limiting factor. A simulation model of ruminant energy and nitrogen balance developed by D.M. Swift (1983) and Swift et al. (1981) has been adapted to moose (Regelin et al. 1981, Schwartz and Franzmann 1981b). This model predicts rates of daily forage intake and changes in body weight and composition of an individual moose based upon the composition and quality of ingested forage. The basic research necessary to adapt the model to moose was conducted at the Moose Research Center near Soldotna, Alaska, during the past several years. Required information to adapt the model to moose included moose energy and protein requirements, digestive capacity, rumen turnover time, rate of passage, and partitioning of energy from gross energy intake to net energy available for production.

The model estimates daily energy and nitrogen requirements for non-reproducing moose. Based on daily diet digestibility and nitrogen concentration, the model predicts total voluntary intake; rates of digestion and passage; partitioning of energy and nitrogen to maintenance, growth and fattening; changes in lean body mass and adipose reserves; and returns of energy and nitrogen to the ecosystem (Swift et al. 1981). Specific information on the range nutrient supply must be collected from each area where carrying capacity is to be predicted. The data needs are the amount of available forage, quality of the forage, and food habits of moose. The data are first used in the ruminant sub-model to predict daily intake rates. A separate model then estimates the potential carrying capacity of the area. The total amount of digestible energy and crude protein available to moose is calculated. The carrying capacity is determined by dividing the daily requirements for digestible energy and crude protein into the total amount available. Separate estimates are made, based upon crude protein and digestible energy. Carrying capacity can be expressed as the number of moose days of use or the number of moose, and can be predicted for summer or winter periods.

The ruminant sub-model has been adapted to moose and produces realistic outputs; however, the model has not been validated under field conditions. The model was validated using moose within four 1-mi^2 pens at the Kenai Moose Range. Potential carrying capacity was predicted in each enclosure, and each was stocked with moose at different densities. The moose were weighed periodically to determine if the sub-model correctly predicted changes in body weight.

Specific additional data needed to refine carrying capacity estimates of moose within the middle basin have now been collected and are listed below:

- Detailed vegetation maps of the Watana and Devil Canyon impoundments and surrounding areas along with the areal extent of each vegetation type.

- Food habits of middle basin moose based on microhistological analysis of fresh fecal pellets.

- Seasonal nutritional quality of middle basin browse species.

o Standing crop biomass of winter moose browse in the impoundments and within the middle basin.

Analysis of the results of these refinement studies is ongoing.

(b) Caribou (*)

Anticipated and hypothesized impacts to caribou are summarized in Section 4.3.6. Direct impacts include blockage of migratory routes, hazards associated with impoundment crossings, disturbance, and loss of habitat. Increased access will be a major indirect impact.

(i) Construction (*)

Construction activities in the immediate vicinity of the Watana Dam are unlikely to greatly affect caribou of the Nelchina herd.

The construction site will remove much less than one percent of infrequently used habitat. Although some caribou may encounter and avoid areas of intense human activity, this should not result in any population effects. Proposed borrow sites also cover less than one tenth of one percent of caribou habitat and are temporary facilities. Borrow sites A, D, and F are more likely to be frequented by caribou than are the other potential borrow sites. Most use of these areas is attributable to summer use by bulls, and it is unlikely that the cow/calf segment of the main Nelchina herd will come close to the borrow sites during annual movements. Although bull caribou appear to be less sensitive to human activity and disturbance than other portions of the herd, they may still avoid the areas during active mining to a limited extent. As a result, the borrow sites will represent an inconsequential loss of summer bull habitat. Caribou may avoid the construction camp and village, but again these areas remove a relatively small area of infrequently used habitat.

Considerable variations in the response of caribou to noise are reported in the literature, the response apparently depending on associated activity, time of year, and the nature of the noise (steady state or abrupt, infrequent noise). Responses range from flight behavior (Thompson 1972) to habituation. Bergerud (1972) found that the sound of trains and cars produced no visible responses in caribou.

Responses of caribou to vehicular noise are often a function of motion or scent rather than the noise *per se* (Bergerud 1972, Thompson 1972). Caribou in the northern Yukon and Alaska were subjected to the simulated sound of a gas compressor station during various phases of their annual life cycle (McCourt and Horstman 1974). Caribou avoided the simulated noise for distances of 650 to 2,650 feet from the source, but their migration and other activities did not undergo major disruptions.

Few observations have been made in nature of caribou responding to blasting or noise emissions analogous to blasting (i.e. sonic booms). Jakimchuk (1980) reported on the effects of repeated sonic booms over 24 penned reindeer for a period of 3 days and found generally moderate reactions (described as "slight startled responses") irrespective of boom levels. No extensive changes or panic reactions were observed and adaptability to increasing boom strength was noted.

Jakimchuk (1980) reviewed the available information concerning caribou responses to seismic blasting and reported that blasting at a distance of two to four miles does not appear to produce a reaction.

The presence of stationary objects (machinery) alone does not appear to induce avoidance reactions by caribou. Mountain caribou have been reported to lick grease from large machinery parked overnight (Johnson and Todd 1977). Jakimchuk et al. (1974) reported observing caribou feeding-craters within a few feet of oil storage tanks on caribou winter range in the northern Yukon.

Aircraft traffic will increase considerably in the middle basin as a result of the Project. The degree of response of caribou to aircraft disturbance depends on many factors, including: aircraft type, altitude and horizontal distance from the animals, season, group size and composition, previous activity, herd experience and habitat type. There is some evidence that aircraft disturbance could result directly in the death of young animals (deVos 1960, Miller and Broughton 1973). However, no unequivocal evidence of this for wild animals is available, and except for intentional harassment of animals by aircraft or low-altitude flights causing groups of animals to stampede, the main concern of aircraft harassment is related to its energetic effects. Caribou and other large mammals often react to a low-flying aircraft by running. The energetic cost of running in caribou can be 8 to 20 times the basal metabolism (Geist 1975), and there is some evidence that the energy costs to animals that show no overt response at all to disturbance are nevertheless increased (e.g., McArthur et al. 1979).

Most studies have found that, other factors being equal, fixed-wing aircraft are less disturbing than helicopters (Klein 1974, McCourt et al. 1974, Surrendi and DeBock 1976, Fischer et al. 1977, Miller and Gunn 1979), although horizontal and vertical (altitude) distances have not always been distinguished. Shank (1979) generalized results of all these studies and suggested that response levels decreased rapidly with increasing distance from the aircraft up to distances of about 250 feet. Beyond 250 feet, response levels decreased more slowly, and there was great variability in the level of response at particular altitudes. The results of both Fischer et al. (1977) and Miller and Gunn (1979) suggest that response levels decrease with increasing horizontal distance in a much more regular manner than the decrease in response with decreasing vertical distance.

From the various studies that have been conducted on large mammals, and by extrapolating from the domestic reindeer literature (Zhigunov 1968, Klein 1971), it is evident that very high levels of disturbance from low-flying aircraft could affect the productivity of caribou. However, since project pilots will maintain an altitude of at least 1,000 feet above ground level (agl) whenever possible, and will rarely travel over the calving grounds, there is little evidence to suggest that caribou would be seriously affected by aircraft associated with project construction and operation.

(ii) Filling and Operation (*)

The area to be flooded by the Watana Stage I impoundment represents much less than one percent of the Nelchina herd's range (ADF&G 1982h). Skoog (1968) considered the middle Susitna bottomland to be low quality grazing habitat, but noted its importance to migrating animals at several times of the year. The loss of caribou habitat as a result of inundation will, therefore, not be of major consequence to the herd, and by itself should not cause any change in herd size, productivity, or distribution patterns.

Information collected on the movements of the Nelchina caribou herd since 1947 indicates that the proposed Watana impoundment would intersect a major historic caribou migration route. This has led to concerns that the impoundment and other project facilities might serve as barriers to caribou movements, cause a decrease in use of portions of the range, increase the mortality rate, and tend to isolate one or more subherds having separate calving grounds. Many secondary impacts, whose probability would be even more difficult to predict, would follow, including increases in predator populations which would further increase mortality, decreases in the birth rate and in calf survival, and decreased potential carrying capacity because of alienation from use of some portions of the range.

A few animals from the Nelchina herd migrate across the Susitna River each year. The Watana impoundment area includes the reach of the river where most crossings have historically occurred, between Deadman Creek and the big bend of Susitna. Nelchina caribou have used numerous winter and summer ranges during the past 30 years (Table E.3.4.58, Figure E.3.4.31). Movements between these ranges often made it necessary for large segments of the herd to cross the Susitna (Skoog 1968, Hemming 1971). Historically, as numbers of caribou in the Nelchina herd increased, the frequency of shifts in range use and seasonal splitting of the herd increased and the herd expanded its range (Skoog 1968, Hemming 1975). As numbers decreased the area occupied by the herd contracted toward the traditional calving area south of the Sustina River (Hemming 1975).

It appears that there may be a close relationship between herd size and the potential for adverse impacts caused by the Susitna Hydroelectric Project. As the herd increases, large movements of caribou across the Watana impoundment could recur.

During the past three decades the Nelchina herd has experienced a population growth phase from 1950 to 1960, a peak from 1961 to 1965, a decline from 1966 to 1973 and another growth phase from 1974 to 1983 (ADF&G 1984o). Currently the herd has stabilized at about 24,000 animals and low cow:calf ratios for both 1983 and 1984 indicate reduced or even negative growth (ADF&G 1985e).

Massive movements of animals across the Susitna in the area of the proposed impoundments have not been documented since 1976 (ADF&G 1984o). It is likely that some members of the Nelchina herd will continue to cross the Watana reservoir annually in the future. As recently as 1982, an estimated 50 percent of the female segment of the Nelchina herd were reported in the area of the upper reaches of the proposed Watana impoundment while enroute to spring calving grounds (ADF&G 1983c). A smaller segment (perhaps 10 percent) actually crossed the Susitna River well upstream of the proposed impoundment zone, traversed the peninsula north of the big bend and then crossed the Susitna north of the gaging station (RM 224). The width of the river in this area will not be altered significantly as it is in the upper reaches of the impoundment. The Watana impoundment area could serve as a crossing route in future years for large numbers of migrating caribou.

Caribou are very likely the strongest swimmers of the entire deer family (Peterson 1955, Kelsall 1968). The animals have buoyant legs that allow the swimming animal to float high with head and back well above the water (Harper 1955, Kelsall 1968, Skoog 1968, Calef 1981). Their broad hooves with dew claws provide swimming animals with an exceptionally efficient means of propulsion (Kelsall 1968). Skoog (1968) reports observing a band of Nelchina caribou swim five miles across Lake Louise. In Canada, caribou commonly swim longer distances where large lakes (such as the Great Bear Lake) lie close to the path of major migration routes (Skoog 1968). Peek (1985 pers. comm.) reports observing a caribou cow and calf five miles from the shoreline of a lake in Canada swimming without apparent difficulty. The two animals were from a herd which had just crossed the lake, a distance of 12 miles.

Caribou calves take readily to the water and their mothers do not hesitate to swim rivers with them while they are only a few weeks old (Skoog 1968). The possibility of very young animals being drowned due to the impoundment does exist. However, the current of the Susitna at various locations along the river may pose a hazard equal to or possibly greater than the impoundment.

Flow velocities in the reservoir will be essentially zero. The open water of the reservoir will in many cases be easier to cross than the river as it currently exists. Currently, animals attempting to cross the river in the area of the impoundment encounter flow velocities ranging up to 8 feet/sec. or greater depending on the time of year. At least two and possibly three instances of moose calf drownings due to strong currents were documented in 1984 by ADF&G biologists in the area of the project (Whitman 1985b pers. comm.).

Stage I reservoir widths would range from less than 0.2 mile to about 2 miles, with a typical width of about 0.7 mile. Reservoir length with the Stage I dam would be about 40 miles. Big game attempting to cross the impoundment zone during Stage I operation would face a lesser barrier than the impoundment resulting from Stage III.

Logs and other debris in the impoundment may present an additional hazard to caribou crossing. Williston Lake presently has debris rafts covering several square miles which present obstacles to animals crossing the reservoir. On one occasion a group of five caribou crossing the reservoir in mid-July were caught in some logs and all of the animals drowned (Bonar 1985 pers. comm.). A program of log removal has been implemented at that project. Similar problems with debris rafts could occur on the Watana reservoir unless, as planned, clearing is undertaken prior to inundation.

The Watana impoundment should not cause any substantial caribou mortality during the summer and fall open-water period, but it could influence the movements of some caribou during that time. Large lakes and swift rivers can change the direction or timing of caribou movements. Skoog (1968) reported that "even though caribou are excellent swimmers and generally take readily to the water, frequently I have noted how a movement will change direction upon encountering a large lake or river and will parallel the waterway rather than cross it." Banfield and Jakimchuk (1980) state that "caribou prefer to avoid open water," and that large lakes are often crossed at narrow points or where islands provide interim stopping points. It thus seems likely that caribou approaching the reservoir in the Watana Creek vicinity, for example, might parallel the shore to an area where the impoundment is narrower.

The presence of mud flats around the reservoir has been suggested as a potential barrier to caribou movements and a possible mortality factor if caribou become mired and unable to free themselves. However, caribou are well adapated to move across boggy areas with hooves which are widely broadened with functional lateral digits (dew claws). These adaptation provides a considerable increase in the area supporting the animal (Skoog 1968). Hemming (1985b, pers. comm.) reports that extensive mud flats are crossed regularly during migration at tidally influenced river mouths on the Alaska Peninsula. Impacts to caribou movements or mortality of animals due to mud in the impoundment drawdown zone are expected to be insignificant.

Caribou of the Nelchina herd are also not expected to to be significantly impacted by weakened ice conditions on the impoundment. Crossings of the impoundment by large numbers of the herd during spring migration have not occurred in recent years. At present, most crossings of the Susitna occur in the big bend area, either in the uppermost reaches of the reservoir or out of the impoundment zone, with some crossings occurring between the mouths of Deadman and Jay Creeks (ADF&G 1982b, 1983c, 1984o).

The initial phases of ice cover deterioration commonly occur by mid- to late April on the Susitna (R&M Consultants 1984). These conditions are identified by flooded snow and overflow on the ice. This water on the ice generally results in an open water lead within a few days. By the end of April 1983 the Susitna River was laced with long narrow open leads (R&M Consultants 1984). Since caribou currently cross the Susitna in late April to early May (ADF&G 1983c, 1984o) hazardous ice conditions will probably continue to be encountered by animals under natural conditions.

Responses to a survey of operators of hydroelectric projects in cold regions indicated that caribou mortalities resulting from weakened ice were either not observed or not considered a problem (HE 1985d). Bonar (1985 pers. comm.) noted that woodland caribou in the vicinity of the Revelstoke project readily cross the reservoir during the winter, when ice conditions permit, in groups of up to 20 animals. To date, no ice related mortalities have been recorded. Even if caribou break through the ice they are quite capable of climbing out onto the ice covered shores or the surrounding ice surface (if it is sufficiently strong). Caribou have been reported migrating across sea ice often crossing wide open cracks and climbing onto ice floes (Skoog 1968, Calef 1981). Jakimchuk (1974) tells of caribou climbing onto floating ice during attempts to cross the Porcupine River.

As breakup of the Watana reservoir progresses, pieces of ice may either break out of the reservoir ice cover or be refloated from the bank as the reservoir begins to fill. These blocks of ice could impede crossings and where winds cause pile-ups, delay or prevent animals from leaving the impoundment.

Caribou will sometimes pause at hazardous river crossings and apparently wait for safer conditions (Hemming 1985b pers. comm.). Skoog (1968) reported that an ice-choked river in Canada held up a migration until almost 100,000 caribou were massed along one bank of the river. Lent (1966b) reports that the presence of thin ice or floating ice on the Noatak and Kobuk Rivers in Alaska has frequently deterred caribou crossings until ice that could support their weight formed on the river. Skoog (1968) observed caribou migrations temporarily stopped during spring break-up along the Susitna, Yukon, and Colville rivers until the ice disappeared. Hemming (1985b pers. comm.) states that during break-up and freeze-up on the Noatak River it is common to see caribou migrations stopped for a week or longer.

Caribou will also deflect movements around bodies of water and have been reported to course along the banks until a suitable crossing is found (Lent 1966, LeResche and Linderman 1975, Calef 1981, Bergerud et al. 1984). Calef (1981) reports on one such incident during the movement of the Beverly herd to wintering grounds in northern Saskatchewan. The early November migration was split around Selwyn Lake which had not yet frozen over.

It should be noted, however, that the pattern of pausing at hazardous river crossings and/or deflecting around them is not always observed (Bergerud et. al. 1984, Hemming 1985b pers. comm.). Jakimchuk (1974) reports that caribou persistently tried to cross the Porcupine River while it carried moving ice and at least 28 animals were drowned or crushed. Calef (1981) reports that the Thelon River in Canada presents similar hazards to the Beverly herd.

As winter drawdown of the reservoir proceeds, the ice cover will fracture and become draped along the banks. In some cases, cracks will form as the ice drapes and settles over irregular shoreline topography leaving stranded polygons of ice along the shore. The possibility of suspended ice shelves forming around the Watana impoundment has been suggested as a potential impact to movements of caribou (Hanscom and Osterkamp 1980). "Shelf ice" forms when reservoir water levels are allowed to remain constant during ice formation and they are drawn down after a competent ice cover is formed (Gatto 1982). Shelf ice is not expected to occur around the Watana reservoir since drawdown will be continuous during freeze-up.

Ice covered reservoir banks have been cited as dangerous obstacles to migrating reindeer in Scandinavia (Klein 1971, Villmo 1975). Similarly, ice deposition on the banks of the Watana impoundment has been mentioned as a possible hazard to caribou (Hanscom and Osterkamp 1980). Some members of the Nelchina herd regularly cross the Watana impoundment area during late April to early May (ADF&G 1982h, 1983c, 1984o). When caribou reach the impoundment it may be frozen as in years similar to 1981 or open water may exist as in years similar to 1982 (ADF&G 1983c). The presence or absence of ice sheets on the impoundment banks during this time is also unpredictable. Generally, it is thought that much of the stranded ice at higher elevations of the reservoir margin will either be totally melted or decaying by early May.

Even if animals encounter sloping ice sheets along the reservoir margin they will probably have little difficulty crossing these areas. Caribou are well known for their surefooted travel on ice. During their extensive migrations herds regularly traverse frozen bogs, lakes, rivers and streams. In winter the edges of the hoof grow quite long, the frog (footpad) wears down and becomes quite horny and the edges of the hoof become very sharp giving the animal a firm hold on ice and preventing it from slipping (Roosevelt et al. 1902, Kelsall 1968, Skoog 1968, Calef 1981). Loss of aged or weak animals may occur due to accidents on sloping bank ice but, in general, impacts to the overall population of the Nelchina herd are expected to be negligible.

(c) Dall Sheep (**)

Anticipated and hypothesized impacts to Dall sheep are summarized in Section 4.3.6. Impacts to Dall sheep resulting from the Watana Stage I development include disturbance and harassment and the inundation of portions of a mineral lick.

(i) Construction (**)

The three Dall sheep populations identified in the Susitna Basin are most likely to be affected by the project through disturbance (i.e., aircraft traffic, construction noise, presence of workers), habitat loss, and increased access by hunters. Each of the populations will be affected to a different degree as a result of their distribution in relation to project facilities.

The Mount Watana population does not usually occur near the impoundments, access roads, or borrow areas at any time of the year, and is likely to be affected only by low-flying aircraft crossing between the Susitna and Talkeetna River drainages. Disturbance from low-flying aircraft is also of concern with the Portage-Tsusena Creek population. The Watana Hills population will be affected by the project because of the partial inundation of a major mineral lick on Jay Creek used by this population. However, this impact will be insignificant during Stage I operation. As will be discussed, the frequent disturbance of sheep at the lick by recreationists is expected to be a greater potential impact than the eventual partial inundation of the lick will be. Potential disturbance impacts due to reservoir clearing will be avoided by scheduling clearing activities during periods of no or low lick use in the Jay Creek area.

The impact of intensified human activity on Dall sheep populations is not completely understood, but some general predictions can be made. If an animal is excessively aroused, as from human disturbance, the added cost of excitement or activity may interfere with health, growth, and reproductive fitness (Geist 1975). Ewes with lambs are particularly sensitive to disturbances (Smith 1954, Jones et al. 1963). Recent studies of free-ranging ungulates have found that the heart rate of an individual is a sensitive indicator of arousal, the first state of an alarm reaction to stress (Ward et al. 1976; MacArthur et al. 1979, 1982). These and other investigators have demonstrated consistent heart rate responses to disturbing visual or auditory stimuli, often in the absence of overt behavioral reactions. MacArthur et al. (1982) reported on the heart rate response of an unhunted population of mountain sheep (<u>Ovis canadensis</u>) to aircraft and vehicle traffic. No heart rate responses were associated with helicopter or fixed-wing aircraft at distances exceeding 1,300 feet from sheep. They found that direct overflights at 100 to 275 feet by helicopters caused sheep to run for 2 to 15 seconds and elicited a 2 to 3.5 times increase in heart rate. In Alaska, six studies have included observations on the response of Dall sheep to aircraft disturbances (Andersen 1971, Linderman 1972, Nichols 1972, Price 1972, Lenarz 1974, and Summerfield 1974), although only one of these (Lenarz 1974) presented quantitative data. Helicopters usually evoked a greater response from sheep than did fixed-wing aircraft. This is possibly because helicopters fly slower and closer to the sheep and are generally more noisy (especially "rotor popping") (Andersen 1971, Linderman 1972, Price 1972). No studies have been conducted to determine the responses of mountain sheep to aircraft flying at different altitudes, as have been conducted with caribou and muskoxen. The reaction of Dall sheep to low-flying aircraft is highly variable (Linderman 1972 and Price 1972), although Linderman found that sheep always reacted nervously and assumed the alarm posture (Geist 1971b) until the disturbance has passed. Lenarz (1974) found that "ewes" (including young rams not discernible from females) reacted more strongly to helicopters than did rams. Andersen (1971) and Price (1972) found that sheep were more easily disturbed by aircraft when congregated at mineral licks, which are usually located lower on slopes away from escape cover.

(ii) Filling and Operation (***)

Sheep using the Jay Creek licks spend most of their time above 2,200 feet (ADF&G 1984j), thus the impact of the Stage I reservoir will be minor. One low-use lick site will be inundated by the Stage I reservoir (downstream site; elevation 1,950 feet). Sheep use of the remaining sites should be relatively unaffected by the impoundment.

(d) Brown Bear (**)

Anticipated and hypothesized impacts to brown bears are summarized in Section 4.3.6. Probable factors regulating brown bear populations in the Susitna Basin and actions that might affect populations are illustrated in Figure E.3.4.32. The development of the proposed Susitna Hydroelectric Project may affect the local brown bear population through loss of habitat, increased hunting pressure, by impeding movements, through displacement of bears from presently used habitats which may result in locally more dense populations and greater intraspecific competition, and by increasing disturbance and brown bear-human confrontations.

(i) Construction (**)

The two major impacts of the Project on brown bears during the construction phase will be the loss of spring feeding areas during and after clearing, and potential direct mortality of bears resulting from bear/human conflicts at camps, construction sites, and bear concentration areas.

Several food sources have been identified that appear to be seasonally important to brown bears in the Susitna Basin. These include spawning salmon in July and August at Prairie Creek, early spring herbaceous growth and overwintering berries along the lower slopes near the river bottom, widely scattered berry patches on the benches above the river, carrion and moose calves near the river and its tributaries, and vegetation along tributaries such as Deadman Creek. Some bears may avoid areas of intensive human activity, thus affecting their movements between these widely scattered food sources. However, because brown bears range widely and frequent open habitats, it is unlikely that the intensive human activities near the damsite and borrow sites, or the presence of a cleared impoundment area in the last year or two of the construction phase, would prevent bears from reaching food sources outside the intensively used construction area.

The first years of construction will have an impact on bear food sources near the dam sites, where facilities and human activities will be concentrated. The availability of early spring foods to brown bears will be reduced as a result of direct removal at the construction sites, and by alterations of bear movements along the river. It is thought that the riparian areas are most important to bears in early spring, just after they emerge from dens. Snowmelt occurs sooner in these areas (particularly on south-facing slopes), making overwintering berries and green growth available to bears when they have low energy reserves. Moose calving is also common in riparian areas, and brown bears have been shown to be effective predators of both adult and young moose (Ballard et al. 1980, ADF&G 1985n).

These losses of early spring feeding areas near the damsites during the construction period are not likely to affect the population measurably. Brown bears eat sparingly for several weeks after emerging from dens during a transition stage from hibernation to normal activity (Craighead and Mitchell 1982). As food becomes increasingly available, the bears' food consumption increases. Craighead and Mitchell (1982) reported that bears in Yellowstone Park during April and May continued to utilize body fat stored the previous fall, and that weight gains were not noticeable until late July and August. Berry production appears to be highest on the benches above the river (above the impoundment level) where snowmelt occurs 1 to 3 weeks later than on the south-facing slopes below 2,200 feet. If bears are able to subsist on fat reserves for these few weeks, a more abundant food supply will become available.

Craighead and Mitchell (1982) also reported that although brown bears feeding primarily on green vegetation in spring failed to gain weight, those securing high-protein food such as carcasses, the young of big game species, or garbage maintained or increased their weight. This suggests that a decrease in ungulate populations may have as great an affect on bear conditions in the spring as would a decrease in the availability of green vegetation. Since project personnel would not be allowed to hunt, the effects of the project on moose during the construction phase are expected to be mostly distributional (as opposed to changes in population size), and no changes in caribou numbers are expected. Thus, it is unlikely that noticeable changes in the number of brown bears as a result of altered spring food availability will occur during the construction period. During the filling and operation phases, however, the loss of spring feeding areas may have a major impact on brown bears.

Brown bears have one of the lowest reproductive rates of any land mammal in North America (Bunnell and Tait 1978). This, coupled with the low densities of brown bears in most parts of their range, makes the impact of sustained high levels of mortality particularly severe (Craighead et al. 1974). Typically, causes of direct bear mortalities during construction of projects in their range include killings in "defense of life and property", control kills of nuisance animals by appointed agency or project personnel (Cole 1971); accidental deaths of bears during attempts to frighten or trap and transplant animals; and increased hunting and poaching pressure resulting from improved access and higher numbers of people (Rogers et al. 1976, Nagy and Russell 1978, Joint State/Federal Fish & Wildlife Advisory Team [JFWAT] files). Accidental deaths of bears from blasting or destruction of dens also occur but are less common (JFWAT files).

Brown bear populations and movements could be influenced by use of borrow sites as a result of disturbance during excavation and loss of habitat. Borrow Site C is not scheduled for use, but occupies the center of prime brown bear habitat in the area. Borrow Sites A, B, D, F, and H would also cause some displacement of individual bears whose home ranges overlap these sites; however, Borrow Sites B, F, and H are not likely to be used. Borrow Site E is in a spring foraging area, and would probably be lost temporarily due to excavation.

Human activity in bear habitat poses problems for people and for bears. Fatal attacks by bears occasionally occur when artificial food sources attract habituated bears to sites of human activity (Craighead and Craighead 1972b, Hamer 1974, Herrero 1976). Females with cubs, very old bears, and habituated bears pose the most serious threats (McArthur 1969). Brown bears quickly discover and utilize improperly disposed of food and garbage at camps, worksites, or dumps (Meagher and Phillips 1980). Besides serious maulings, minor injuries such as bites and scratches frequently result from attempts to feed bears (Eager and Pelton 1980). Serious bear/human conflicts occurred during the TAPS project (JFWAT files). On-site monitoring during construction of the Terror Lake Hydroelectric Project (Kodiak Island, Alaska) indicated that brown bears tolerate construction activities well. Bears did not noticeably abandon the project area, and some became habituated to human activities in the vicinity of the construction camps (H. Hosking 1984, pers. comm.). The implementation of the proposed Susitna project's garbage control and worker education programs should eliminate the creation of nuisance bears and greatly decrease the potential for bear-human encounters.

There are several specific areas and seasons where human/bear conflicts might occur. Areas where bears congregate to feed on salmon in late summer are likely to be attractive to project personnel as fishing sites. However, no salmon-producing streams occur within walking distance of the camp so few conflicts of this type are likely to occur. Brown bears tend to concentrate near the river to feed on vegetation during early spring soon after emerging from dens; thus, bear/human encounters near the construction site and borrow sites may be frequent at that time. Also, the camp is located in prime berry habitat used by bears in late summer and early fall.

Bears are reported to be one of the large mammals more sensitive to aircraft disturbance (Klein 1974, McCourt et al. 1974). The reactions of bears to aircraft have been recorded in several studies (Quimby 1974, Ruttan 1974, Harding 1976); there is much individual variation in their reactions, probably related in part to previous experience (Linderman 1974, Pearson 1975, Harding and Nagy 1977). Bears seem to react more strongly to helicopters than to fixed-wing aircraft (Quimby 1974, Harding and Nagy 1977). Low-flying aircraft near feeding sites could affect the productivity of brown bears if disturbance is frequent enough.

The impacts of the Project on brown bears downstream from the Watana dam will be limited mostly to aircraft disturbance and increased hunting, since downstream flows will not be altered until the filling phase. No measurable changes in the number of moose or other important prey species are expected, although there may be some noticeable shifts in the distribution of prey species away from the construction sites. Fish and mammal populations downstream from the Devil Canyon site would be affected primarily by increased fishing and hunting pressure, and impacts on brown bears could result given the current hunting and fishing regulation.

(ii) Filling and Operation (**)

The loss of habitat as a result of project impoundment clearing and filling and the partial avoidance of project facilities will have the greatest impacts on brown bears during the filling and operation phases. Indirect effects of decreased moose populations and increased hunting by people will also have measurable effects on brown bears.

The loss of spring foraging habitat due to dam construction and the proposed reservoirs will also impact current use patterns. Assuming a density of 1 brown bear per 14 square miles (ADF&G 1985n), 5 bears can be expected to occur in the impoundment zones at any given time, with 2 of these in the impoundment zone of Stage I. However, bear use of the impoundment zones appears to be much greater than would be expected on the basis of area alone. ADF&G (1985n) examined the number of brown bear sightings from 1981 to 1984. Based on 2,211 sightings of adult bears, they were able to test for nonrandom sighting distributions. Adult brown bears (older than 2.0 years) showed a marked preference for the Watana impoundment zone (based on the Stage III impoundment), using it 2.2 to 2.6 times as frequently as expected on the basis of availability (p less than 0.05). Females with cubs were the exception, showing a marked avoidance of the area. This was likely due to the increased chances of predation on the cubs if females took them into an area of high bear density.

The loss of early "green-up" sites and overwintered berry areas may affect brown bear nutritional status. Yearling bears, which emerge from dens in poorer condition and suffer higher rates of mortality than other age classes may be particularly sensitive to loss of overwintered berries as a spring food source

(APA 1983). In addition, moose calving also commonly occurs in these early spring riparian areas. Brown bears utilize moose, especially calves, as a food item (Ballard et al. 1980). A decrease in the number of moose available to bears, in combination with the loss of spring foraging habitat and other vegetation in the impoundment area, will cause a decrease in the carrying capacity of the project area for brown bears.

No brown bear dens discovered as of April 1985 would be inundated by Stage I, although some disturbance is likely (ADF&G 1985n). Displacement of bears from habitats presently used because of the project impoundments may result in locally more dense brown bear populations, particularly during spring. This increased density could result in greater competition and social strife between bears. Increased competition between brown bears could result in an increase in adult bear mortality and/or a decrease in cub survival. An eventual density equilibrium will be reestablished in the basin's brown bear population; but exactly how long this will take, and the extent and magnitude of the potential competition and strife is impossible to estimate.

Project impoundments are not expected to be a significant barrier to brown bear movements. Some interference with movements between food sources will occur, but the number of bears affected in terms of productivity and survival cannot be predicted. Brown bears usually emerge from dens in April, and have entered new dens by the end of October. The reservoir will be ice-free during most of the time bears are out of their dens. Open water in the reservoirs is not expected to prevent crossings by brown bears, but established movement patterns may be altered or inhibited. From 1980 to 1983, an initial average of 25 individual radio-tagged brown bears per year (before animal deaths or radio failures) were being monitored. Of these monitored bears, an average of 9 to 10 different bears per year crossed the Susitna River between Devil Creek and the Oshetna River (ADF&G 1984n).

Indirect impacts on brown bears downstream from Watana may result from reduced populations of moose and from increased hunting along the transmission corridor. Moose studies have been conducted along the lower river in an attempt to quantify project impacts. The carrying capacity of the areas adjacent to the river will decrease if moose populations are substantially reduced.

Another project-related brown bear impact could be the decrease in bear numbers due to hunting. Possible increased hunting pressure resulting from improved access after project construction could reduce the local bear population if no protection is provided through hunting regulations. Such increased hunting pressure would likely result in lower bear densities and a younger age structure in the brown bear population (ADF&G 1982e).

(e) Black Bears (**)

Anticipated and hypothesized impacts to black bears are summarized in Section 4.3.6. A large proportion of the acceptable black bear habitat in the middle basin will be eliminated. Blockage or alteration of normal movement routes will also occur, as will black bear/human conflicts.

(i) Construction (**)

The long-term impact of the Stage I development on black bears will be much greater than that for brown bears, since the impoundment and other project facilities will remove a large proportion of acceptable black bear habitat in the Watana area. However, habitat loss may not be the most serious impact on black bears during the first few years of the construction period when attraction to artificial food sources, disturbance of bears at denning and feeding sites, and increased levels of hunting are likely to have more serious effects (see Figure E.3.4.33.

Black bears in the vicinity of the proposed Stage I impoundment are primarily restricted to a band of conifer forest adjacent to the river. Between Watana Creek and the Tyone Rivers, this band of forest becomes increasingly constricted. The construction site, borrow sites, camp, airport, and other facilities will remove black bear habitat, thus concentrating the bears into the limited remaining areas. Black bears are more likely to frequent the camp and construction sites than are brown bears, and this will cause problems for both people and bears (see Section 5.3.1[d]). Deliberate feeding of bears by project personnel at construction sites would intensify the problem.

Black bear populations and movements will be affected by some of the proposed borrow sites. The greatest impact will be in Borrow Site D (west of Deadman Creek) which is in an area used by black bears foraging for berries in late summer (ADF&G 1982e). In the summer these benchland areas are used both by local resident bears as well as by bears moving to these areas from downstream locations. Borrow Site D is mainly covered by black and white spruce woodland and dwarf birch low shrub (Table E.3.3.44). The proximity of these open vegetation types to escape cover (especially forests) govern their use by black bear (ADF&G 1982e). Borrow Site D encompasses shrub cover types that are in close proximity to escape cover. Borrow Sites F (mid-Tsusena Creek), B (mouth of Deadman Creek), H (south of Fog Creek), and the north part of E (mouth of Tsusena Creek) are in forested areas where some individual black bears are resident. Of these, Site A would have the least impact on black bears and Site H the greatest based on available data (ADF&G 1982e). These borrow sites would reduce the amount of black bear habitat available in the project area. Borrow Site C would have negligible impact on black bear (ADF&G 1982e). Borrow Sites B, C, F, and H are secondary sites and not anticipated to be used in project construction.

Black bears in the Susitna Basin typically den at elevations below 3,000 feet. Since dens are concentrated near the river where human activity will be greatest, there is also the potential for disturbance to cause den abandonment or to make some denning areas unacceptable. Many of the dens sites are reused by the same or different bears, which may indicate a scarcity of acceptable sites. Human activity on the ground and low-flying aircraft can both cause den abandonment. Den abandonment in winter when the ground is frozen may result in a bear's death.

Because black bears will be concentrated near the river and may have increased movements while searching for food, any increase in hunting pressure during the construction period could have a substantial effect on the population. If black bears do increase their movements away from forested areas, as they do during berry crop failures (ADF&G 1982e), there is also a potential for increased mortality caused by encounters with brown bears.

(ii) Filling and Operation (***)

The major adverse effect of Stage I on black bears will result from a loss of foraging habitat due to impoundment filling. Loss of denning habitat will also be important, but habitat used for foraging will be the major population limiting factor.

The black bear habitat of the middle basin is essentially a narrow extension of the more productive and widespread black bear habitat areas downstream. Although the habitat found upstream from the Devil Canyon damsite is marginal black bear habitat, its loss will have an impact on the local black bear population. The long-term impact of the Watana development on the local black bear subpopulation will be greater than that for brown bears because the impoundment and other project facilities will remove a proportionally larger area of forested habitats especially suitable for black bears. Other types of construction-related effects may have adverse impacts on bears. Attraction to food sources, denning disturbances. and construction-related noise and activity may cause bears to alter existing habitat-use patterns, in some cases abandoning portions of home range, and in other cases becoming habituated to the presence of humans.

Black bears in the middle Susitna Basin are largely dependent on a bank of forested habitats occurring below about 3,000 feet along the Susitna River and its major tributaries. Of 908 aerial observations of 53 bears in the Susitna Basin, black bears were most often located in shrubland (42 percent of observations) and spruce (39 percent) habitats (ADF&G 1982e). Upstream of Tsusena Creek, this bank of forest becomes increasingly constricted along the river bottom, and the Watana Stage I and III impoundment will therefore remove a proportionally larger area of available black bear habitat than will Devil Canyon Stage II facility. Construction of the Watana Stage I development will remove about 13,166 acres of suitable forest habitats, as a result of the impoundments, dams and spillways, and other permanent facilities. The habitat types that will incur the greatest reductions relative to availability along the river will be mixed forests, which were found to be preferred by black bears in the Susitna project area (ADF&G 1982e). Similar habitat associations have been observed for black bear populations in northern Alberta (Fuller and Keith 1980).

Black bears will tend to concentrate in the limited remaining habitat areas at lower elevations along the impoundment shores. After a short-term increase in density, the middle basin black bear population will decrease to a lower total number of resident animals commensurate with the reduced carrying capacity of the remaining habitat. The short-term increase in black bear population density will occur during and shortly after the construction years and in the vicinities of camps and construction sites near the river, increasing the likelihood of bear-human encounters and the resulting elimination of "nuisance bears."

Based on the most recent data (ADF&G 1985n), 33 percent of all black bear dens known to occur in the vicinity of the proposed impoundments (Stages I, II, and III) have elevations near or below the normal maximum operating levels (NMOL) of the reservoirs. Of the 34 dens that have been identified in the vicinity of the Watana Stage I impoundment (NMOL = 2,000 feet), about 35 percent (12) of these dens occur below 2,000 feet and will be inundated. Flooding of black bear dens during winter has been reported as a cause of bear mortality (Alt 1984). The projected filling schedule for the Watana impoundment indicates that 11 of the 14 dens inundated would be covered by water during the summer months when dens are unoccupied (Table E.3.4.59). Three dens (Nos. 49, 73, 98) in the Watana impoundment may be flooded during the period (September to April) of black bear den use. If these dens are utilized during the years of inundation, this could represent a loss of three adult bears. The likelihood that these dens will be occupied is low because reservoir clearing activities will have removed the vegetation around the dens and in the adjacent areas. This removal of cover, and the construction activity associated with reservoir clearing, will probably be sufficient disturbance to cause dens 49, 73 and 98 to be abandoned. After project construction is complete, bear reuse of dens or denning areas that may be exposed due to reservoir drawdown will not be a problem; both the Watana and

Devil Canyon reservoirs are predicted to have minimum water levels (see HE 1985c) above all known den elevations during the time period (September-October) black bears enter their dens.

Black bears usually emerge from dens in late April or early May, and most have entered dens by the end of October (ADF&G 1984n). Thus, the reservoir will be ice-free during most of the time black bears are out of their dens. Black bears, like brown bears, are able to swim and the open water of the proposed impoundments should not be an absolute barrier to their movements. The number of black bears captured in 1980 and 1981 totaled 53. By March 1982, 19 of the originally collared bears had active radio-collars (ADF&G 1982e). Eleven new bears were captured and marked in May 1982, 8 with new radio-collars (ADF&G 1983l). Following the May 1983 tagging effort, 40 black bears were radio-collared, half of these were in the upstream study area (area of the proposed impoundments) (ADF&G 1984n). Of all the bears marked and monitored since 1980, an average of 12 different bears per year have crossed the Susitna River upstream of the proposed Devil Canyon Dam. Between 1980 and 1983, a total of 144 crossings, or an average of 36 crossings per year, were recorded in the proposed impoundment areas (ADF&G 1984n). The total of 144 crossings includes multiple-crossings by individual bears.

Downstream effects of the proposed project on black bears are not expected to be significant. Changes in floodplain vegetation and numbers and distribution of spawning salmon may have a slight effect on the distribution and movements of black bears downstream from Devil Canyon, but are not expected to decrease the size of the downstream population. Many radio-collared bears moved to the vicinity of downstream sloughs in late summer. Although black bears tended to congregate along sloughs where salmon were spawning, scat analyses show that devil's club berries appeared to be the major dietary component at these sites (ADF&G 1984n).

(f) <u>Wolf</u> (**)

Anticipated and hypothesized impacts to wolves are summarized in Section 4.3.6. Wolves may be affected by construction and operation of the Watana Stage I development by some loss of potential den and rendezvous sites, by disturbance, by increased hunting, and indirectly, by loss of food sources. The Watana pack, in particular, may be seriously affected by the loss of habitat for moose, their major prey species, within their territory.

No known dens or rendezvous sites will be flooded or destroyed by the present construction zone plans. Some den and rendezvous sites that have not been located may be destroyed, but because potential sites are relatively abundant in the Susitna Basis (ADF&G 1982f), this would not have a serious effect on wolf populations.

Under most circumstances, wolves readily habituate to man-made disturbance (Van Ballenberghe et al. 1975, Milke 1977). The major exceptions to this are disturbances at den sites in spring. During Susitna baseline studies (ADF&G 1982f), human disturbance at three den sites caused early abandonment of all three sites when adults moving the pups to new locations. In these cases, the pups were probably a month old and no pup mortality was noted. ADF&G (1982f) speculated that younger pups might be more likely to die if moved from the whelping den prematurely. Abandonment of dens after disturbance has also been noted in other areas of Alaska and in Canada (Carbyn 1974, Chapman 1977). Aside from disturbance at dens, disturbance alone is unlikely to cause noticeable changes in the distribution of wolves or home range use of individual packs.

A serious impact of increased interactions between humans and canids (wolves and foxes) is the threat of exposure to rabies. That wolves (and bears and foxes) do habituate to the presence of humans was demonstrated by problems encountered during the construction of the Trans-Alaska Pipeline (Milke 1977). Wolves were fed deliberately and were allowed to scavenge on unburned garbage at construction sites and camps. As a result, many animals became severe nuisances and were killed. In addition, instances of workers being bitten and requiring hospitalization and occasionally rabies vaccine occurred.

Loss of food sources through development impacts on prey species will likely be the most important impact of the Watana development on wolves (ADF&G 1984d). Wolves in the middle Susitna Basin prey primarily on moose and to a lesser extent on caribou. Caribou population levels are not likely to be seriously affected by the Watana development, but moose populations will be reduced. The extent to which this reduction actually affects wolves depends on the extent to which wolf populations are limited by food availability rather than by human exploitation, and on the distribution of the reduction in prey availability relative to territories of individual packs.

Van Ballenberghe et al. (1975) reviewed the available literature on factors controlling wolf populations. They believed that while social factors such as territoriality and stress were the ultimate factors controlling populations levels, an abundant food source lowered the threshold for action of social factors. They suggest that food is the main factor permitting the development of dense wolf populations (Figure E.3.4.34).

There are few data to indicate wolf population trends in relation to population trends of moose and caribou in the Susitna Basin. However, the consistently high harvest of wolves through the 1970s (Section 4.2.1[f]) suggests that the low caribou population and declining moose population in the early 1970s (Section 4.2.1 (a) and (b)) did not cause a substantial reduction in wolf numbers.

Project area wolf population levels are likely controlled at present by exploitation rates. Close to half the middle basin wolf population is removed each year by legal and illegal hunting (Section 4.2.1 [f]). In the likely event that this situation continues, the reduction in the moose population as a result of the project should have little effect on the regional wolf populations. Only if the harvest level is greatly reduced through better enforcement and/or altered management practices, will the density of moose and caribou become the major factor controlling the wolf population.

The Watana pack will be most affected by Stage I inundation. A major loss of habitat of its main prey species, moose, along with disturbance and wolf habitat loss will likely reduce the wolf carrying capacity in this pack's home range. If prey densities become the major factor controlling wolf populations, reduced moose numbers and altered caribou movements would affect the potential carrying capacity of the area and cause measurable changes in the productivity and territory size of as many as 10 other packs. Several wolf packs may also experience positive impacts because of improved hunting conditions along the impoundment shoreline, lower brown bear numbers, and altered distributions of moose and caribou.

Displacement of prey animals from the reservoir area may result in a temporary increase in wolf density in adjacent areas. However, the loss of habitat from the impoundment may cause adjustment of territory boundaries with neighboring packs, and a decrease in both wolf and moose density from temporarily higher levels would ensue.

(g) Wolverine (**)

Anticipated and hypothesized impacts to wolverine are summarized in Section 4.3.6. The Susitna Hydroelectric Project will have both positive and negative effects on the wolverine population in the middle basin. Wolverines will be most affected by changes in winter food availability and by higher trapping mortality resulting from improved access and a larger human population in the area. Other factors such as a localized avoidance of camps and roads, disturbance from aircraft and construction activities, and habitat loss caused by the impoundments and other project facilities are not likely to greatly affect the number or productivity of wolverines in the Susitna Basin. Loss of den sites is not likely to be a problem since wolverines den in a variety of habitats, generally on the surface of the ground under snow. No effects from any stage of the project are expected downstream from Devil Canyon. Each of these factors will be discussed in greater detail in the following sections.

The area in northwestern Montana studied by Hornocker and Hash (1981) contained a large reservoir 32.2 miles long and up to 4.4 miles wide, and thus some data are available on wolverine movements and ranges in relation to a large impoundment. They reported that "the size and shape of ranges were not affected by rivers, reservoirs, highways or major mountain ranges." Magoun (1982) stated that, although topographic features were not physical barriers to wolverine movements, they did appear to influence the shape of home ranges to some extent. Rivers, ridges, drainage divides, and well-defined breaks in habitat types often coincided with home range boundaries in her study area. Male home ranges appeared to be less affected by topographical features than did female ranges. Some home range boundaries in the middle Susitna Basin coincide with topographical features (see Figure E.3.4.21), but no clear relationship between the major features and most home range boundaries is evident. It is possible that the Watana Stage I impoundment might separate home ranges once it is in operation, but this will be more likely with the larger Stage III impoundment.

Based on the estimate of about one wolverine per 40,320 acres derived in Section 4.2.1 (g), the permanent loss of about 15,762 acres of vegetated land area caused by the Stage I impoundments, access roads, and other Stage I project features would lower the carrying capacity by about one wolverine. However, winter food supplies are usually greater at the lower elevations most affected by the project facilities and changes in the availability of winter food may affect wolverine movements, densities, and productivity. ADF&G (1984f) estimates that up to half of the wolverine in the middle Susitna Basin use at least part of the impoundment zones, but home range maps do not allow further quantifications.

The Watana Stage I impoundment will cause a decrease in winter food availability. Because a relatively high proportion of the inundated area is forested, there will be a substantial decrease in the availability of small mammals and grouse used by a few wolverines during winter. The size of the moose population in the vicinity of the Watana impoundment will decrease during the license period, but there may be an increase in the number of ungulate carcasses available to wolverine during the first few years after filling. Some mortality of both moose and caribou is expected from floating debris, thin ice conditions, and large mud flats in the drawdown zone; and predation by wolves and brown bears may increase along the shores of the impoundment. Higher winter mortality of moose near the impoundment is also expected during winters of moderate to deep snow. It is not clear whether the more rapid turnover of the moose population in the middle basin will offset the lower density of moose and small mammals. The effects of improved access from the roads and impoundment on wolverine, including increased trapping mortality and human presence, are discussed in Section 4.3.3 (g).

(h) Belukha Whale (**)

The majority of the Cook Inlet population of belukha whales appears to concentrate near the mouth of the Susitna River during the calving period. Studies were undertaken in 1982 to address the concern that project-related changes in water temperatures or anadromous fish runs at this critical period might interfere with calving success. For example, the elimination of calving by belukhas in the St. Lawrence River was attributed to hydroelectric development on the Manicougan and Outardes rivers and subsequent alterations in water temperatures.

Although water temperatures released from the dams will be 0-7°F warmer than natural temperatures, the dilution effect of other rivers and temperature exchange of the river with the air and ground will result in no post-project difference in water temperatures at the mouth of the river during May and June. Only about 10 percent or less of the post-project inflow into Cook Inlet will be from the Susitna River above Talkeetna. Thus, the dilution factor of other water sources and 151 river miles of temperature exchange with the environment will result in similar pre- and post-project water temperatures at the mouth of the river during the spring and summer aggregations.

Belukhas are thought to feed on the large runs of anadromous eulachon (a major run occurred between June 1 and 9, 1982) and on adult and out-migrating salmon. Eulachon spawn in the lower mainstem and in the lower tributaries of the river (McPhail and Lindsey 1970, ADF&G 1982b), and the project should have no effect on the number of eulachons available to belukhas (ADF&G 1984h). If all salmon spawning habitat in the sloughs upstream from Talkeetna were lost, about 5 to 8 percent of the salmon available to belukhas would be unavailable. Given this small potential decrease in food supply, the necessity of applying a correction factor of two or three times the number of belukhas counted during surveys (because of silty waters and submerged whales), and the fact that it cannot even be determined whether calves are present during surveys, it is extremely unlikely that any real or measurable decrease in the belukha population would occur as a result of the project. In addition, it is expected that salmon mitigation plans will fully maintain Susitna River production levels.

(i) Beaver (**)

The beaver population along the Susitna River may decrease as a result of Stage I development. Any decrease will be largely limited to downstream of Devil Canyon, and will result from altered winter flows and ice conditions.

(i) Construction (**)

No active beaver lodges were located during surveys of the impoundment area, borrow sites, and facility sites in 1982 (Gipson et al. 1982). Therefore, any construction effects would be limited to indirect impacts such as disturbance or siltation.

(ii) Filling and Operation (**)

A few beavers may periodically use the reservoir area. No beavers are known to overwinter in the impoundment area, and therefore, the flooding of this area is not expected to affect this furbearer species. The reservoir will be of little value to beavers after filling because of the annual drawdown.

Each year, for the period 1970 to 1982, beavers attempted to build lodges and food caches on Williston Lake in British Columbia, which has an annual drawdown of about 50 feet. One innovative colony built its lodge on a raft of floating logs, which moves up and down with the water level. Another colony had a series of burrows extending down to the minimum drawdown level.

During filling, the river will be passed directly through the dam during the winter months; therefore, the only effect of the dam on downstream flows will be during summer. During the operation phase, downstream flows will be higher than present in the winter, but lower in summer.

No beavers are known to overwinter in the river reach between Watana and Devil Canyon. At present, swift currents, fluctuating water levels, ice scouring events, and low abundance of early successional vegetation probably limit beaver use of downstream habitats (Figure E.3.4.35). Another limiting factor is the depth of water beneath the ice in winter. Beavers require at least 1.5 feet of open water under the ice for access to food caches and lodge entrances (Scott 1940, Hakala 1952). Since natural water depths are much less in the winter than in the summer, the winter flows determine which areas are suitable for overwintering beavers.

Downstream effects on beaver are difficult to quantify. Although there would likely be both positive and negative effects, the net result cannot be predicted at present. Downstream of the ice front in winter, water levels due to increased discharge and ice staging would be about equal to those experienced during current high summer flows. Since lodges are apparently occupied successfully during high summer flows, no negative effects due to rising winter water levels are expected within the lodges. In the event that such rising water and ice levels prevent access to beaver food caches or flood dens or lodges, some mortality would result.

Upstream of the ice front, beavers will likely fare better with than without the Project. Water levels will be more stable than at present, with reasonably high flows but no flooding. Lack of ice scouring and flooding will greatly reduce bank erosion, and resulting cache and lodge destruction. For at least the first half of the license period, early successional vegetation will increase along the Susitna, increasing available food supplies.

Effects on beaver downstream of Talkeetna are uncertain, but if they occur, they will be small in magnitude. Contributions from other rivers and tributaries will largely override project-related alterations to flow, ice cover, and vegetation.

(j) Muskrat (**)

Muskrats will be affected primarily as a result of improved access for trappers. Some habitat loss within the borrow sites and impoundment zone will also occur. With the exception of trapping mortality, the net impact on the muskrat population should be negligible.

Of the 103 lakes surveyed for muskrat sign in spring 1980, 17 lakes occurred within borrow sites D or E or the Watana impoundment zones (Table E.3.4.32). No sign was seen in any of the borrow sites, and 3 lakes with sign were found in the Watana Stage I impoundment zone. The number of muskrats this represents is unknown (pushups are temporary structures, and one muskrat can create many of these during a winter). A likely estimate of the number of muskrat to be lost as a result of this habitat loss is three to six animals.

If permanent village personnel and their families are allowed to trap in the area, muskrat populations throughout the lakes lying on either side of the Susitna River could be affected. Gipson et al. (1982) found muskrat sign in these lakes and noted their vulnerability to trapping.

Downstream effects of Watana Stage I will be both negative and positive in the same manner as discussed above for beaver. Increased open water in winter will be beneficial, but altered ice staging regimes downstream of the ice front may increase winter mortality. The net effect is unpredictable at present. No effects are expected downstream of Talkeetna.

(k) Mink and Otter (**)

(i) Upstream Effects (**)

Anticipated and hypothesized impacts to mink and otter are summarized in Section 4.3.6. Because mink and otter are moderately abundant in the middle Susitna Basin (see Section 4.2.2 [c,d]) and are

Clearing and flooding of the impoundment will eliminate a substantial proportion of good quality otter and mink habitat. High quality habitat for these semi-aquatic furbearers is generally characterized by moderate-to-slow-flowing streams and rivers with well-wooded banks. Ponds with abundant food, deep and stable water conditions, and an irregular shoreline also appear to be good habitats (Hodgdon and Hunt 1953, Knudsen 1962, Barber et al. 1975). Because the impoundment will result in a large drawdown zone, it is unlikely that the reservoir will be heavily utilized by mink or otter. Small declines in water levels (e.g., less than 3.3 feet) may actually benefit mink during the winter by creating air spaces under the ice that would allow them to hunt more easily (Errington 1943, Harbo 1958). However, the large drawdown area of the Watana Dam will probably be detrimental to otter and mink; it will isolate their bank dens from the reservoir during the winter and will probably reduce prey availability.

The extent to which otter and mink habitat will be reduced and the effects on local populations are difficult to assess. The impoundment will flood approximately 40 miles of the mainstem Susitna River. In addition, 14 miles of main tributaries will be inundated. The lower reach of Tsusena Creek will be disturbed by gravel removal. It is not known what these losses represent in terms of a proportionate reduction of available mink and otter habitat, but loss of tributary habitat is possibly more important than loss of mainstem habitat.

Clearing and flooding of the impoundment area will reduce prey availability for otter and mink. Clearing of forest cover will reduce the availability of some mink prey such as small mammals and waterfowl. Effects of erosion and consequent siltation, as well as effects of dust that are associated with clearing may also reduce the availability of fish and crustaceans. Flooding of the reservoir will probably result in further reductions in prey availability; crustacean distributions and productivity will probably be altered by the drawdown zone; and the species composition, abundance, and distribution of fish will change. In addition, because the reservoir will greatly expand the amount of aquatic habitat, fish will be less concentrated than they are at present and more difficult for otters and mink to capture. Reservoir and downstream mainstem turbidities will probably be too high for sight feeding by otter and mink. The net result of these changes, in addition to the change of shoreline habitats, will be an avoidance of the reservoirs by mink and otter. The effects on productivity associated with these dietary changes are unknown.

Clearing of the reservoir site and construction activities, particularly in close proximity to streams and rivers, may disturb mink and otter and may result in interference with daily activities or, in extreme cases, an avoidance of the area. Densities of the European otter, a species closely related to river otter, along the River Terre in England appear to be inversely related to the amount of human disturbance (recreational fisherman) and the amount of clearing of woodland cover along the river banks (MacDonald et al. 1978). Because recreational use of the upper reaches of streams along the north side of the impoundment will probably increase during construction and operation, and because the upper reaches of these streams may represent a moderate proportion of the remaining high quality habitat for semi-aquatic furbearers, disturbance effects on mink and otter could be important.

(ii) Downstream Effects (**)

Alteration of the river hydrology and vegetation communities as a result of the Watana Dam has already been discussed (Section 3.3.1). Both of these furbearers commonly concentrate in open water stretches of rivers and streams in winter (Barber et al. 1975), and therefore, the reach of permanently open water downstream from the Watana Dam may benefit small numbers of mink and otter. However, increased winter turbidities will reduce the value of the mainstem as sight-feeding habitat. Tributary mouths will continue to be important feeding areas.

(l) Coyote and Red Fox (**)

Coyotes occur in the Watana development area, but they are so uncommon in the upstream area that development activities are unlikely to have a quantifiable effect on them. Downstream effects of Stage I will have no known effect upon coyotes.

Coyotes do not appear to avoid areas of human activity; however, no studies have specifically evaluated the effects of human disturbance on this species. Ferris et al. (1978) demonstrated a significant preference of coyotes (based on winter track count surveys) for an area within 656 feet of a section of an interstate highway in Maine relative to an area 656 to 1,312 feet from the highway. Track surveys also indicated that coyotes occasionally used the right-of-way as a hunting or travel route. Penner (1976) similarly concluded that coyotes preferred large cleared areas and avoided undisturbed habitats within an oil sands development area in northwestern Alberta.

Coyotes are likely to exhibit a significant increase in population level in the development area only if wolves are eliminated. When encountered, wolves will exclude coyotes from their ranges through physical aggression. Only when wolf numbers are extremely low and packs are eliminated will resident wolves allow expansion of coyotes into their territories. If wolves are locally exterminated and excluded from portions of their territories near the development, coyotes may colonize localized areas in low numbers.

The major impact on red foxes will probably result from increased hunting, poaching, and trapping and killing of nuisance animals at camps and construction sites. Habitat loss from flooding of the impoundment will not have a great impact on foxes, since most individuals apparently utilize areas above the high water line of the impoundment (2,185 feet elevation) and areas to the east of the impoundment on the Lake Louise flats during winter seasons when food availability is most limited. Fox dens typically occur at elevations of 3,280 to 3,937 feet and no foxes or fox sign were found along the Susitna River or the lower reaches of its tributaries in late winter or spring during baseline studies (Gipson et al. 1982). Foxes did occur along the Susitna at other seasons. An abundance of avian and small mammal prey would be available for foxes during summer and fall, and loss of habitat along the river would probably have negligible or minor effects.

Although the fox population in the Susitna Basin is small (Section 4.2.2[f]), it is apparently a source of juveniles that disperse to adjacent areas (Gipson et al. 1982). An increased harvest of foxes from current levels is expected because of improved access and hunting and trapping by operationals workers and their families. Such an increase could eliminate this source of dispersing individuals.

Red fox do not appear to avoid areas of frequent human activity. Observations of red fox and the location of den sites in relation to the main road in Denali National Park showed that red foxes did not avoid areas of frequent human use and that in some cases would habituate to human disturbances (Tracy 1977). Red foxes in Gatineau Park, Quebec, appeared to commonly use areas in the immediate vicinity of human disturbance and showed little avoidance of areas frequented by snowmobilers (Neumann and Merriam 1972).

Foxes away from den sites habituate to human activity so readily that they can become a nuisance at construction and campsites if they are fed or allowed to feed on garbage (Milke 1977). The presence of scavenging foxes frequently leads to workers being bitten and occasionally needing hospitalization for rabies vaccine (Milke 1977). It also often leads to the destruction of the foxes.

(m) Other Furbearers (**)

This group includes species that occur primarily in forested habitats--marten, lynx, short-tailed weasel and least weasel. Impacts on marten are discussed in greatest detail. As mentioned previously (Section 4.2.2[c]), marten have historically been and continue to be economically the most important furbearer in the vicinity of the impoundment zones. Lynx are very uncommon in the middle Susitna Basin. Weasels are probably quite common, but there is little specific information on their abundance and distribution in the basin.

All of these species will suffer primarily as a result of the loss of forested habitats to the impoundment, borrow sites, and other project facilities. Probable factors regulating marten populations in the Susitna Basin and actions that might affect populations are illustrated in Figure E.3.4.36. Gipson et al. (1982) estimated the number of marten in the winter population directly impacted by loss of habitat in the Watana and Devil Canyon developments through a model based on the following data and assumptions:

- o Adult male marten home ranges are mutually exclusive and adjoin one another so that all marten habitat in the impounded area is inhabited (trapping likely affects this assumption);

- o Marten habitat is defined as forest, or wet graminoid herbaceous, and marten are restricted to these habitat types;

- A 1:1 sex ratio exists in all age classes of the population;

- Sixty-five percent of the population are juveniles (less than 1 year old) and juveniles appear in the harvest in proportion to their number in the population; and

- The mean home range size of male marten is 1,685 acres.

This model gives an estimated density for all age/sex groups of 0.0034 marten per acre. The Stage I impoundment facilities and access road would therefore affect about 64 marten.

There are obvious difficulties with the model. Aerial track surveys indicate that up to twice this density of marten may occur in the impoundment zones. Marten densities and home ranges vary among different forest types, being most common in dense, mature coniferous forest (deVos 1952, Douglass et al. 1976, Koehler and Hornocker 1977). Also, marten are found to a lesser extent in habitats not mapped as forest.

Clearing of forested areas at construction sites and borrow areas and the associated human disturbances may affect marten home range size and distribution. However, these types of changes will be most extensive in areas affected by the access route and transmission line and are discussed in Sections 4.3.4 and 4.3.5.

Lynx are uncommon in the Susitna Basin, probably because their major prey, snowshoe hares, have been historically uncommon. Habitat loss will probably eliminate the few lynx occurring near the impoundment.

Numbers of short-tailed and least weasels may also be reduced through habitat loss. Based on the amount of area affected, less than five percent of their population will be lost.

Construction activities and human disturbance could result in avoidance of the construction zone by furbearers. No information is available for lynx and weasels. Evidence suggests that marten are tolerant of moderate levels of disturbance in areas adjacent to logging operations (Clark and Campbell 1977, Soutiere 1978, Steventon and Major 1982).

(n) Raptors and Ravens (**)

General types of potential impacts to raptors that occur with development are summarized in Table E.3.4.60. The construction and operation of the Stage I Watana Dam will affect raptors through a number of mechanisms, the most important of which are habitat loss and disturbance. Habitat loss includes the flooding of suitable nesting cliffs, removal of trees used for nesting and perching, and a loss of hunting areas. Many of the tree and cliff nests within the impoundment area may be abandoned during the construction phase as a result of disturbance, and several nest sites immediately adjacent to the access road or borrow sites may also be abandoned.

(i) Habitat Loss (*)

- Nesting Habitat (*)

Nesting locations are defined here as units of nesting habitat consisting of cliffs or stands of trees containing one or more raptor/raven nest sites. Nest sites are the actual nests or nest ledges on the cliffs, or the nests in trees used by the raptors or ravens. One pair of a given species uses only one nesting location per breeding season. However, the pair may have one or more alternate nesting locations that are used in other breeding seasons.

The distribution, quantity, and quality of nesting locations and nest sites clearly limits the numbers and nest success of most raptors, including both cliff-nesting and tree-nesting species (Newton 1979). Cliff-nesters are especially limited by availability of nesting locations and nest sites in many regions because suitable nesting cliffs (i.e., those meeting the specific nesting requirements of a species) are fixed geologic features. In contrast, tree-nesters rely on vegetative features for nesting locations and nest sites. Succession and growth of vegetation is on-going and occurs relatively rapidly in contrast to formation of cliffs, and therefore, tree-nesting locations and nest sites are both lost and replaced in much shorter periods of time. However, for some tree-nesting species (e.g., bald eagles) the time required for replacement of a nest may represent several generations of birds, especially at northern latitudes. Because raptors are one of the few groups of birds whose distribution (within each species' breeding range), numbers, and even nesting success are clearly limited by the distribution, quantity, and quality of nesting locations and nest sites, mitigation measures which provide compensatory nesting locations and nest sites can be particularly effective (see Appendix E9.3).

There is no reason to doubt that most raptors in the Alaska Range are considerably more limited by nesting locations and nest sites than by other parameters such as food. Loss of nesting locations and nest sites will almost certainly be the single most important adverse impact of Susitna development to raptors in the Susitna River drainage. However, a distinction can be made between the prominent cliff-nesters (i.e., golden eagles, gyrfalcons) and the prominent tree-nesters (i.e., bald eagles, goshawks) that serves to help identify the relative degrees to which the Susitna Hydroelectric Project will impact populations of these two groups of raptors within the Susitna River drainage.

For golden eagles and gyrfalcons (cliff-nesters), most of the suitable nesting locations available in the Susitna drainage are clearly concentrated in the middle basin along the river and along the lower reaches of its tributaries between Vee Canyon and Devil Canyon. Despite the quantity of this habitat, gyrfalcons are apparently not numerous locally. The paucity of gyrfalcons, but the presence of a relatively larger number of golden eagles is likely a result of geography--the area is near the southern limit of the gyrfalcons' breeding range in south-central Alaska, but well within the breeding range of golden eagles. In contrast to the quantity and quality of cliff-nesting habitat concentrated along the Susitna River between Vee and Devil canyons, the occurrence of suitable nesting locations for golden eagles is much lower throughout the remainder of the middle and upper Susitna basins. Furthermore, the density of suitable nesting locations for golden eagles is probably relatively low throughout much of the remainder of the Alaska Range (Bente 1981). Regional topography further suggests that concentrations of cliff-nesting habitat similar to that found along the middle Susitna River basin are uncommon. As a consequence, direct losses of cliff-nesting locations in the middle basin as a result of construction of the Susitna Hydroelectric

Project are judged to be reasonably significant to the golden eagle population inhabiting the Susitna River drainage.

In the case of bald eagles and goshawks (tree-nesters), the majority of appropriate nesting habitat containing suitable nesting locations and nest sites clearly lies downstream of Devil Canyon. Upstream of Devil Canyon in the middle basin appropriate nesting habitat for both species is sparse. Farther upstream in the upper basin appropriate nesting habitat becomes nearly non-existent. Pairs of both species that nest throughout the Susitna River drainage upstream of Devil Canyon are clearly members of much larger downstream populations inhabiting the considerably greater amounts of appropriate nesting habitat found there. As a consequence, direct losses of bald eagle and goshawk nesting locations in the middle basin, as a result of construction of the Susitna Hydroelectric Project, are judged to be of reasonably minor consequence to populations of those species.

Specific losses of known nesting locations of both cliff-nesting and tree-nesting raptors and ravens are discussed in greater detail below. The reader is reminded that numbers and percentages given below represent known losses within the local vicinity of the Susitna Hydroelectric Project, and they should not be interpreted to necessarily represent the degree to which total Susitna River drainage populations or regional populations of these species are affected by the project.

Five of the 12 golden eagle (GE) nesting locations found upstream of the Watana damsite will be inundated as a result of filling of the Watana Stage I reservoir to a maximum operating level of 2,000 feet. Loss of these nesting locations will directly affect two or three nesting pairs of golden eagles. All five of these locations (GE-4, GE-5, GE-6, GE-8, GE-9, Figure E.3.4.37) are within the impoundment zone at elevations between about 1,700 feet and 1,840 feet.

Cliff-nesting habitat for golden eagles will become severely limited upstream from the Watana damsite once the impoundment is full. Loss of cliffs upstream from the Watana damsite may increase the importance of cliffs farther downstream in Devil Canyon, along Fog Creek, Tsusena Creek, and other streams draining into the Watana to Devil Canyon reach. However, airspace is restricted in much of Devil Canyon, many of the cliff areas appear to be exposed to higher levels of moisture, and existing cliffs may lack suitable ledges on which golden eagles could construct nests.

Golden eagles often have several alternative nesting locations, some perhaps four to five miles apart (McGahn 1968, Roseneau et al. 1981), and thus the five nests lost to the project do not represent five pairs of eagles. The middle Susitna River basin population of golden eagles will probably be reduced by two to three pairs as a result of the construction and filling of the Watana reservoir. No more than two of the five locations have been occupied in the two years for which complete data are available.

Seven of 10 bald eagle (BE) nesting locations known to occur near the project area are located upstream of the Watana damsite (Figure E.3.4.38). Three of these locations (BE-3 and BE-5, tree-nests, and BE-4, a cliff nest) will be inundated by the Watana Reservoir at the maximum operating level of 2,000 feet. All three are located within the Stage I impoundment zone, at elevations between about 1,630 feet and 1,910 feet. Estimated elevations of tree-nests are the approximate elevations of the bases of the trees. In both cases cited here the actual nest sites are about 40 to 50 feet above the bases of the tree. Estimated elevations given for cliff-nests are elevations of the actual nest sites. The removal of the three nesting locations will displace at least two and possibly three nesting pairs of bald eagles unless alternative sites are provided.

Bald eagle cliff-nesting locations are relatively rare throughout Alaska north of the Alaska Peninsula. For instance, in the entire Tanana River drainage where over 40 nesting locations are known (Roseneau et al. 1981) only one nesting location is on a cliff. Furthermore, almost all suitable white spruce and balsam poplar trees in the general vicinity of the Watana damsite are located within the impoundment area on tributary deltas and islands. Construction and filling of Watana Stage I may increase the importance of other potential nesting habitat downstream from the Watana damsite, including balsam poplar stands along Portage Creek and white spruce and balsam poplar near Stephan Lake and along Prairie Creek. In any event, it appears unlikely that habitat loss as a result of construction and filling of the Watana Stage I reservoir will have more than a local effect on the Susitna River bald eagle population, the majority of which inhabits the area downstream from Indian River (see Section 4.2.3[a]).

No known gyrfalcon nesting locations will be directly lost as a result of Watana Stage I construction. However, gyrfalcons often use nests constructed by other cliff-nesting species, including ravens and golden eagles (Cade 1960, White and Cade 1971, Roseneau 1972). Some of the golden eagle and raven nesting locations lost as a result of inundation or gravel mining may represent past or future locations used by gyrfalcons. In south-central Alaska and the Alaska Range, where nesting densities are low (Roseneau 1972, Bente 1981, Roseneau et al. 1981), use of other species' nests by gyrfalcons is less prevalent than in northern and western regions of the state where the majority of the Alaska gyrfalcon population breeds and winters (see Roseneau et al. 1981). It is therefore unlikely that habitat loss as a result of construction and filling of the Watana Stage I reservoir will have more than minimal effect on the middle Susitna River gyrfalcon population.

One of three (33 percent) known goshawk nesting locations in the middle basin will be lost to clearing and filling of the Watana Stage I reservoir (Tables E.3.4.39 and E.3.4.40). This nest location is the only one discovered to date upstream from the Watana damsite, beyond which typical goshawk nesting habitat becomes very scarce.

Sixteen of 21 previously used raven nesting locations in the middle basin will be lost as a result of construction and filling of the Watana Stage I reservoir.

Although a considerable number of raven nesting locations and cliff habitat will be lost, the consequences of this loss to ravens will be minor in comparison to those for other cliff-nesting species (particularly golden eagles). Ravens commonly nest in a wide variety of situations in Alaska, including man-made structures (Roseneau et al. 1981).

- Hunting and Perching Habitat (**)

In addition to loss of nesting habitat, it is anticipated that some loss of perching and hunting habitat for raptors will occur as a result of construction and filling of the Watana Stage I reservoir. Perching habitat will be lost primarily as a result of inundation of cliffs and the clearing of trees prior to reservoir inundation.

Most of these losses will occur concomitantly with losses of nesting habitat. Losses of perches, whether by inundation (cliffs and trees), materials excavation (cliffs and trees), clearing (trees) or blowdown (trees), are considered of minor consequence relative to losses of nesting locations. Man-made structures, especially transmission towers and smaller power poles, will also compensate in part for losses of perching habitat, because raptors commonly use such structures as perches to hunt from.

Loss of hunting habitat is more difficult to determine. Losses of hunting habitat are almost certainly to be of minor consequence, relative to losses of nesting habitat. Most raptors are limited by availability of nesting locations and nest sites, not food (Newton 1979). Furthermore, raptor "hunting habitat" and productive areas of prey habitat, including riparian zones and wetlands, are not necessarily equivalent.

Habitats such as riparian areas and wetlands are, of course, important because they tend to produce and concentrate prey species. However, areas that produce prey usually provide escape cover for the prey species that inhabit them. Some of the most important hunting habitat for many raptors is often overlooked because of confusion regarding nesting location, nest-site limitations vs. food limitation, and because "hunting habitat" is commonly assumed to be equivalent to areas of rich prey production. Some of the most important hunting habitat for many raptors consists of the air over rivers, lakes, unvegetated or little vegetated terrain, or over forested valley floors in mountainous terrain.

Peregrine falcons provide an excellent example. Peregrines hunt and capture wetland, forest, and shrubland birds as they attempt to cross over water in front of and to the sides of their river cliff-nesting locations. Thus, some of the very best peregrine nesting and hunting habitat in the boreal zone is found only along larger rivers (e.g., Yukon, Tanana), regardless of varying and diverse prey habitats and despite the fact that similar cliffs may be present along narrow side tributaries.

For other species of raptors, forest clearings, open meadows, and open mat-cushion tundra serve as important hunting habitat. Most raptors, and especially the larger species, have the capability to range relatively long distances from their nesting locations to hunt. Thus, loss of hunting habitat as a result of construction and operation of the Susitna Hydroelectric Project is unlikely to be of major consequence to most raptors inhabiting the Susitna drainage. Loss of hunting habitat will be compensated for in part by the creation of the long, relatively narrow impoundment over which potential prey species will pass. It is also unlikely that loss of any prey production habitat in the impoundment zone will be of a scale that will be of major consequence to most raptors inhabiting the middle and upper Susitna Basins.

The general degree of impact may be inferred from the data presented in Section 4.2.3(a); and additional information on hunting habitats of three of the prominent species found in the middle basin given below.

. <u>Golden Eagles</u> (o)

Golden eagles probably hunt throughout the middle and upper basins. However, they may avoid heavily treed areas, concentrating their effort above and outside of the impoundment area rather than in it. A tendency to hunt over open treeless areas, coupled with their varied diet that includes several upland species, suggests that the loss of hunting habitat caused by the project will have minor effects on golden eagles.

. <u>Bald Eagles</u> (o)

Bald eagles may hunt throughout the middle basin; however, they tend to spend greater amounts of time at lower elevations near water bodies than do golden eagles. Losses of hunting habitat to nesting bald eagles in the middle basin may therefore be greater than losses to golden eagles. However, some attraction of waterfowl to open water behind the dam or in the river downstream of it in early spring may compensate in part for some losses. Open water downstream from the Watana Stage I dam may provide important wintering habitat from the Watana Dam in an area in which none currently exists. At least a few bald eagles have overwintered in similar habitat along the Tanana River in mild winters (Ritchey 1974). However, the Watana Stage I impoundment, with its large drawdown and consequent lack of aquatic vegetation, is not anticipated to be particularly attractive to waterbirds as feeding habitat. On the other hand, bald eagles in the middle basin are more limited by availability of nesting habitat than by availability of food. Assuming water fowl are never attracted to the impoundment and fisheries never develop there, surrounding habitat, including tributaries and water bodies near the impoundment zone, is likely to be adequate for those eagles that remain after construction and filling of the Watana reservoir.

. Gyrfalcons (o)

Gyrfalcons may also hunt throughout the middle basin, but they tend to avoid wooded areas and probably concentrate their effort well above the impoundment zone. Their tendency to hunt in open, treeless areas including the alpine zone, coupled with their opportunistic nature, suggests that the loss of hunting habitat as a result of construction and filling of the Watana reservoir will not be a serious impact.

(ii) Disturbance (**)

Bald eagles and golden eagles are specifically protected under the U.S. Bald Eagle Protection Act of 1940 (as subsequently amended). A part of this act prohibits the "taking" of any bald or golden eagles, parts thereof, or the nests or eggs of such birds without a permit. "Take" is defined to include molest or disturb.

The act does not authorize the taking of bald eagle nests which interfere with resource development or recovery operations. Take may only occur for scientific or educational purposes at the discretion of the Regional Director (USFWS). Golden eagle nests may be taken during a resource development or recovery operation when the nests are inactive, if the taking is compatible with the preservation of the area nesting population of golden eagles (50 CFR 22.25).

In addition, there are state laws that provide protection for these and other raptor species. The ADF&G has also developed guidelines to protect raptor nests from destruction or disturbance.

Roseneau et al. (1981) reviewed and summarized most of the information on kinds and effects of disturbance to raptors. Most information is anecdotal. Responses of raptors to various types of disturbance are complex--several factors may affect the sensitivity of raptors to disturbance (Table E.3.4.61). Timing of the disturbance is an important factor (Table E.3.4.62), and effects of disturbance may be additive.

Responses of raptors to disturbance and the effects of these responses are often highly variable. In many cases, nesting raptors have shown a surprising degree of tolerance and habituation to disturbances; yet in other cases, the same types and levels of disturbance have had detrimental effects (Roseneau et al. 1981). In general, a mounting body of evidence suggests that raptors will habituate to and tolerate at least moderate forms of disturbance. The same body of evidence suggests that the most detrimental forms of disturbance are those that occur within territorial defense zones (i.e., nesting locations). Prolonged disturbances, multiple disturbances, and direct overt harassment from either the ground or the air are particularly harmful.

Some species of raptors appear to be less tolerant of disturbance than others. Of species in Alaska, golden eagles appear to be the most sensitive, especially to aircraft disturbance and human presence (see Roseneau et al. 1981). Although golden eagles, like most raptor species, are reluctant to flush from nests as a result of aircraft passage during incubation, they often leave their nests well in advance of approaching aircraft during the nestling period (Roseneau et al. 1981). Furthermore, they often leave their nesting areas quickly when people approach, often at considerable distances (e.g., as much as 0.5 miles from the nest). Several documented nesting failures of golden eagles have been blamed on human interference (Roseneau et al. 1981).

Twelve of the 23 golden eagle nesting locations known to occur near the project area are located upstream of the proposed Watana Stage I damsite (Figure E.3.4.37, Tables E.3.4.39, E.3.4.40). Eight of these (GE-1 through GE-6, GE-8, and GE-9) are within the area designed as Watana Borrow Site J, but that site has been eliminated from consideration as a borrow area. Five of the eight nesting locations (GE-4, GE-5, GE-6, GE-8 and GE-9), including the two that would have been subject to disturbance from Borrow Site J, will eventually be inundated.

Two additional golden eagle nesting locations that are located between the Watana and Devil Canyon damsites may be vulnerable to disturbance during borrow site excavation at Watana Borrow Site E (GE 11) and Watana Borrow Site H (GE-23). Borrow Site E is a primary source of aggregate, covering 445 acre of floodplain and adjacent terrain downstream of the Watana damsite. Site H, also an aggregate source, is located on the south bank, downstream of the damsite. Its use is considered extremely unlikely. GE-11, which consists of three separate nest sites, was previously thought to occur within Site E and, as a result, to be subject to physical destruction. Recent surveys proved this to be incorrect; material will be excavated from the river bottom at elevations of about 1,650 feet or less, whereas the three nest sites are located at elevations of between 1,750 feet and 1,800 feet and at horizontal distances of several hundred feet beyond the borrow site's northern boundary. However, Watana Borrow Site E will be a major source of material. Its boundaries are not fixed and excavation may occur to within a few hundred feet of the nest sites at GE-11. Watana Borrow Site H is of low priority and is not scheduled to be used. However, if it were used, excavation would occur to within several hundred feet of the nest site at GE-23.

Seven of 10 bald eagle nesting locations known to occur near the project area are located upstream of the Watana damsite (Figure E.3.4.38, Tables E.3.4.39, E.3.4.40). Three of the seven (BE-3, BE-4, and BE-5) are vulnerable to disturbance during reservoir clearing. However, all of the locations eventually will be lost as a result of Watana Stage I reservoir filling.

No known gyrfalcon (GYR) nesting locations appear susceptible to major disturbance from Watana construction; however, one location (GYR-1) may be susceptible to some disturbance during reservoir clearing.

At least one known goshawk (GOS) nesting location (GOS-1) will be susceptible to disturbance from reservoir clearing; this nest will eventually be inundated (Figure E.3.39). A second nesting location (GOS-2) is located in the Devil Canyon reservoir, but may be susceptible to some disturbance as a result of material excavation at Watana Borrow Site I.

Fourteen of 15 common raven nesting locations found in the vicinity of the Watana impoundment may be susceptible to disturbance during reservoir clearing operations. Two other nesting locations, located downstream from the Watana damsite, may be susceptible to disturbance during excavation of materials from Watana Borrow Site H, in the unlikely event that the site is excavated.

(o) Waterbirds (*)

Because of the low numbers of waterbirds in the Susitna Basin (Section 4.2.3[b]), impacts from the Watana development will not have a major effect on regional populations. Waterbirds of the basin will be affected during construction of the Watana development by loss of habitat, alteration of habitat and disturbance.

(i) Habitat Loss (*)

Loons, grebes, swans, and several duck species in the Susitna Basin occur primarily on lakes (Appendix 3D). Most species will not be affected seriously by loss of habitat since few acres of lake habitat will be flooded by the Watana Stage I impoundment. However, some species will suffer a permanent loss of breeding habitat in fluvial shorelines and alluvia: harlequin duck, common merganser, semipalmated plover, spotted sandpiper, wandering tattler, and arctic tern. Common goldeneyes and mergansers will lose nesting trees during reservoir clearing. Mergansers will nest on banks and other locations in the absence of cavities. Goldeneyes prefer to nest in relatively large diameter cavities. Prince (1968) reported the smallest cavity diameter in his study of common goldeneyes to be six inches. Most large trees are on the lower slopes of the Susitna Valley. About 85 percent of the forests in the Watana impoundment zone will be flooded during Stage I. Open water in fast-flowing streams and in the main channel itself provides winter habitat for the dipper of which a significant portion may be lost.

During filling, the sandbars, islands, and shorelines used by shorebirds will be flooded. Two breeding species (spotted sandpiper, and semipalmated plover) and about seven migrant species will be affected. The Susitna River does not support many migrant shorebirds and the loss of habitat for migrants will not be serious. However, all of the shorebird breeding habitat in the Stage I impoundment area will be lost.

(ii) Habitat Alteration (*)

During construction and filling, habitat alteration will occur primarily from clearing and flooding of shorelines. Clearing of forest will have little effect on waterbird habitats with the possible exception, as noted in the previous section, of cutting nest-trees. Flooding will probably affect harlequin ducks and fish-eating common and red-breasted mergansers through some loss of food resources. Mainstem fish populations are not expected to be seriously affected by flooding, but portions of the grayling populations in tributary streams may be lost (Section 2.3). Nevertheless, fish populations above impoundment level will probably remain sufficient to support the low merganser numbers in the area, and this impact will not be measureable.

Open-water areas below the dam and near the intake will provide habitat for spring migrants when other water bodies are still frozen. The reservoir will be of low quality to nesting waterfowl, but will provide loafing habitat for migrating waterfowl. In the drawdown zone, feeding habitat will also be provided for migrant shorebirds, whose main movement passes through central Alaska during the last three weeks of May. Feeding habitat for fall migrants will not be available as the reservoir will be full during that period.

(iii) Disturbance (*)

A number of sources of disturbance to waterbirds will exist during Watana Stage I construction. The main sources of disturbance will be borrow extraction from wetland areas, transport of borrow and other materials, and reservoir clearing. The construction of the dam itself is such a sufficiently localized disturbance that few waterfowl will be affected.

Waterbirds in tundra areas have been shown to avoid immediate areas of intense human activity (Barry and Spencer 1976). Similar avoidance may occur in other areas of open wetland. Clearing of the impoundment area, especially near the river and its tributaries and near wetlands and lakes, will be the most serious disturbance factor for most waterbirds. Clearing and associated heavy machinery traffic will physically destroy nests of some species if conducted between May and July. Disturbance will be intense during clearing operations, and many species will be affected.

Results of studies of the effects of aircraft disturbance on ducks (Gollop et al. 1974, Schweinsburg 1974, Schweinsburg et al. 1974, Ward and Sharp 1974) have found changes in behavior, but little short-term effect on distribution of nesting or moulting ducks. Except at Stephan Lake, geese and whistling swans occur in only small numbers during migration in the Susitna area and are unlikely to be much affected by disturbance. Trumpeter swans nest in the middle basin; however, Kessel et al. (1982a) report only one nest in the Fog Lakes area. Two other swan nests have been reported in the development area one on the east fork of Watana Creek and on the North Fork of the Talkeetna River approximately 5 to 10 miles downstream from the confluence with Prairie Creek. Other nests may occur in the area, although the majority of the basin population nests well to the east of the project area, and only small numbers occur in the Watana area during migration. Trumpeter swans are known to be sensitive to disturbance during the nesting and fledgling periods and any nests which occur in the project area would be adversely affected by even casual human intrusion (Hansen et al. 1971). Geese do not nest in the basin and are uncommon during migration; they are unlikely to be seriously affected by disturbance.

(p) Other Birds (*)

(i) Construction (*)

Terrestrial birds will be most affected during construction by habitat loss through clearing of the impoundment area, access roads, camps, borrow pits, and other facilities. Clearing of the impoundment area will affect the largest number of birds and will result in changes in the distribution and relative abundance of species in the area. Forest species will be replaced by birds of shrub and open habitats. Artificial habitats will be created for those species which will use these shrub and open habitats. Another impact to birds near construction zones is sensory disturbance from traffic, noise, dust, and people.

- Habitat Loss (**)

Areal losses of various vegetation types to Watana Stage I construction are presented in Table E.3.3.40. The proportionately most affected vegetation types will be forest types; in particular, black spruce woodland, spruce-birch-aspen forests, spruce-poplar forests, and birch-aspen forests. Black spruce forests, paper birch forests, and spruce-birch forests will also be highly affected. The 12 census plots studied by Kessel et al. (1982a) represent an overview of the terrestrial avian habitat types present in the middle basin. The bird census study plots, their avian habitat equivalents (as provided by Kessel et al. 1982a), and approximate vegetation type equivalents are presented in Tables E.3.3.6 and E.3.4.52.

Although they are a crude approximation of actual avian habitat, the loss of vegetation types provides the only available measure of the impacts of the Susitna project on most terrestrial avian species. Kessel et al. (1982a) provide two cautions in the use of Viereck and Dyrness (1980) vegetation types as avian habitats: (1) Viereck and Dyrness "tall shrubland" supports two more or less distinct avian communities (medium and tall shrub birds of Kessel [1979]), and (2) Viereck and Dyrness closed coniferous and deciduous forests (with a minimum of 75 percent closed canopy cover) are not restricted enough for true coniferous or deciduous forest bird communities (which require at least 90 percent coniferous or deciduous components in the canopy, according to Kessel et al. 1982a). If this is the case, loss of 0.4 percent of the combined Gold Creek and Watana watersheds tall shrub vegetation will affect two avian communities, medium shrub birds and tall shrub birds (see Table E.3.4.53). Also, loss of mixed conifer-deciduous forest may underestimate loss to the mixed conifer-deciduous forest bird community while loss of coniferous forests and deciduous forest may overestimate the loss to the coniferous forest and deciduous forest bird communities (see Table E.3.4.53).

With the exception of low mixed shrub, areal habitat losses are proportionally greater for the most densely occupied vegetation types. Although much overlap in species use of vegetation types occurs, species restricted primarily to deciduous and mixed forests will be most severely affected. These include spruce grouse; hairy and downy woodpeckers; alder flycatcher; blackcapped and boreal chickadees; brown creeper; varied, hermit and Swainson's thrushes; yellow-rumped and blackpoll warblers; northern waterthrush; and dark-eyed junco.

Kessel (1982b and unpublished tables) provided an estimate of numbers of breeding birds of each species lost based on 1981 and 1983 density data and general observations in the project area. These estimates, shown in Table E.3.4.63, are considered approximate order-of-magnitude figures. The total loss of breeding birds of these species is 30,220 for Stage I. Greatest losses will be for species which occur in high densities in a range of vegetation types and include Swainson's thrushes, ruby-crowned kinglets, yellow-rumped warblers, Wilson's warblers, common redpolls dark-eyed juncos, fox sparrows and tree sparrows. However, most of these species are abundant throughout the middle basin. The highest proportional losses will occur to species restricted to these vegetation types which suffer the highest proportional losses and include spruce grouse, hairy woodpecker, boreal chickadee, brown creeper, and northern water-thrush.

Permanent resident species are dependent on habitats within the middle Susitna River basin for obtaining food and shelter throughout the year, and loss of this habitat would reduce local populations. Table E.3.4.64 presents estimated losses for resident birds due to Stage I development. The greatest numerical losses would be for boreal chickadees, gray jays, redpolls, and white-winged crossbills. Total overwintering bird losses for Stage I are estimated at about 1,600 birds.

- Habitat Alteration (*)

Habitat alteration resulting from clearing and construction of buildings, dams, and borrow sites will have negative effects on some species and positive effects on others. For species which are restricted to forest habitats, development-related alteration will represent effective habitat loss (see above discussion). Species found in closed forests will be reduced in numbers near project-related. Areas affected by temporary facilities and borrow sites are relatively small and discrete. With or without reclamation these areas will eventually become early successional habitats. Species associated with edges and disturbed or artificial habitats will increase in these areas. Clearing of forest vegetation may increase bird species diversity through the creation of a different habitat type and associated edge effects, depending on the size of the clearing (Anderson et al. 1977). However, some researchers have found no true edge effect (Kroodsma 1982), and others have found a decrease in diversity (Anderson 1979) because of transmission line clearing through forested areas. Since forest vegetation in the Susitna basin supports a somewhat higher diversity of birds than shrub vegetation (Table E.3.4.51), there may be a decrease in bird diversity as the result of forest clearing.

Some species are capable of utilizing artificial habitats created by man and these species may benefit from certain habitat changes. For example, bank swallows and kingfishers may dig their nest cavities in sand walls of borrow sites that are not in use or even in less disturbed areas of large sites that are in use. Cliff swallows readily nest on buildings. Ravens and gulls will feed at refuse dumps if these are not properly maintained.

- Disturbance (*)

Disturbance to terrestrial birds will result primarily from road traffic and is discussed in Section 4.3.3(c). Some disturbance may also result from activities of people at borrow sites and the construction site, but there is little quantitative information about the effects of such disturbance. Local disturbance of this nature will not have any serious effect on overall populations of terrestrial birds.

(ii) Filling and Operation (*)

Since portions of the reservoir are to be cleared, most of the habitat loss associated with Stage I will occur during the construction phase and was discussed above. During filling, the species that will be affected are those that will have invaded the cutover area (mainly birds of shrub habitats) and birds dependent on shorelines, mudbars, and streams. These latter species are primarily shorebirds and the dipper. Dipper breeding and feeding habitat will be lost to the extent that the lower reaches of fast-running streams are flooded (see Chapter 2). Dippers also winter in the Susitna River drainage along open-water of fast-running streams, including the Susitna River itself. Open water in winter at the dam intake zone is not expected to serve as dipper habitat. Loss of open water in winter throughout the impoundment zone will exclude dippers from wintering there. However, the large open-water reach below the dam in winter should compensate for the loss of dipper wintering habitat above the damsite.

The abundance and species composition of birds along the downstream reaches of the river will change as new riparian vegetation invades areas of the floodplain and proceeds through the successional stages described in Section 3.3.1. These changes will be most visible in the reaches upstream from Talkeetna where alteration of vegetation will be most pronounced. Because bird densities and species diversities are highest in tall shrub and mature forest stands, the vegetation changes over 100 to 200 years could be considered beneficial to terrestrial breeding birds. However, the proportionate changes in species abundance in the study area as a whole will be very small during the license period.

(q) Non-Game (Small) Mammals (*)

Population densities of most species of small rodents fluctuate widely under natural circumstances (Krebs and Myers 1974, Kessel et al. 1982a). Consequently, it is difficult to predict postconstruction population levels. Although the populations of some species will be diminished because of the project, most species respond quickly to disturbance, abandoning some areas and colonizing new ones. In addition, reproductive rates of small mammals are high, and most populations can recover quickly from population reductions if sufficient food resources and space are available.

Only those species of small mammals that are restricted to forest habitats are expected to show marked decreases, primarily because of loss of forest to the impoundment and construction sites. These decreases may, in turn, be reflected in changes in behavior and/or population levels of certain carnivore or raptor species that depend on small mammals for prey.

During the Stage I construction phase, small mammals will mainly be affected by the clearing of the impoundment area, the borrow sites and the construction camp. About 13,872 acres of forest will be cleared. The species that are restricted to forest habitats which will be most affected are porcupines (Woods 1973), snowshoe hares, pygmy shrews, and red squirrels. Small numbers of hares and porcupines and extremely small numbers of pygmy shrews were observed in the project area. Because the area does not seem to be prime habitat for the former two species (Kessel et al. 1982a), their regional densities are not expected to be affected by the project. Red squirrels are common throughout the forested areas of the project area. About 2.6 percent of their preferred spruce habitat in the middle and upper basin will be cleared.

The other species that will be affected by clearing during Watana Stage I construction will be the northern red-backed vole. Red-backed voles were found in nearly every habitat type in the Watana Stage I area, but were most common in spruce and cottonwood forests.

During the filling stage, many of the areas cleared during construction will be colonized by early successional plant species and small mammals. Meadow voles are expected to thrive in such areas (Dabbs et al. 1974). Tundra voles, masked shrews, and arctic shrews may also recolonize these areas. As water levels rise during the filling stage, these populations of small mammals will be displaced. However, no substantial reductions in regional populations are expected as a result of these effects.

The major impact on small mammals during the operation phase of Watana Stage I Dam will be the changes caused by succession of disturbed areas, such as the borrow sites and camps, and of the newly exposed land downstream from the dam. Species that occur in grasslands and early successional communities will be favored initially. These include meadow voles, and in some cases, tundra voles, masked shrews, and arctic shrews. As succession progresses to shrublands, the habitat will improve for species such as northern red-backed voles and masked shrews.

4.3.2 - Devil Canyon Stage II Development (**)

(a) Moose (*)

Because of steep topography and extensive mature forests in the Devil Canyon area, fewer moose occur in this portion of the Susitna Basin than in the area to the east of Watana Creek (ADF&G 1982k). Distributions of moose observed during surveys in March 1981 suggest that moose were not common in the vicinity of the Devil Canyon damsite but became more abundant in upstream areas near the Watana damsite. ADF&G (1982k) estimated that 30 moose were present within the Devil Canyon impoundment area during a census in late March 1981. The snow depth recorded at Devil Canyon at that time was 29 inches; this census underestimates the number of moose that would be present during winters with deeper snows.

Because of the low numbers of moose in the Devil Canyon area, impacts on moose in this region will be of smaller magnitude than in the Watana development area. The range of impacts to moose that may result from the Devil Canyon project are similar to those already discussed for Watana Stage I. Potential impacts include loss of habitat, alteration of habitat, interference with seasonal movements, mechanical and human disturbance, hazards associated with the drawdown zone, and hunting mortality. Impacts associated with the access roads, the railway and transmission lines are discussed in Sections 4.3.4 and 4.3.5.

(i) Construction (*)

Construction of the Devil Canyon Stage II Dam will involve intense construction activity at the actual damsite, establishment of a temporary camp, removal of forest cover in the impoundment area, and the excavation and transportation of borrow material. The most important effects of construction on moose will be habitat loss, direct mortality, interference with seasonal movements, and disturbance.

As discussed for Watana Stage I, alteration of habitat resulting from construction activities will be minimal and effects on moose will be negligible.

- Habitat Loss (*)

An estimated 6,020 acres of vegetation will be permanently lost to the Devil Canyon Dam construction and development. Losses of major forest cover types in relation to their availability indicate that the greatest proportion of losses will occur in conifer (1,108 acres), and mixed forest cover types (4,125 acres) (Table E.3.3.41). Because moose in the Susitna Basin were more commonly relocated in spruce forest than in any other forest cover type (ADF&G 1982k), the loss of spruce habitat in the vicinity of Devil Canyon may be important to moose. However, the limited area of bottomland habitats and the steep slopes of the Susitna River valley in the Devil Canyon area probably limit present use by moose. Although almost all of the low elevation habitat will be lost, moose do not appear to commonly winter in the Devil Canyon area, and the loss of low elevation habitats probably will not appreciably alter overwinter survival of moose in the Devil Canyon area.

- Interference with Movements (o)

The Devil Canyon impoundment generally will not exceed 1 mile in width. Clearing of vegetation in the impoundment area may present a visual barrier to moose movements, and disturbances associated with clearing operations and construction could block or alter migration paths across or along the river. Moose relocations in the Devil Canyon area suggest that no major movement corridors for moose exist within the Devil

Canyon impoundment area, but more frequent crossings may occur once the Watana Stage I and III impoundment is present.

- Disturbance (o)

  Effects of disturbance on moose in the Devil Canyon area will be minimal and will be similar to those impacts discussed for the Watana Dam.

- Mortality (*)

  Although a few moose may be killed as a result of collisions with vehicles or other accidents associated with construction areas, the effect of those mortalities on moose populations will be negligible. (Access road and railroad mortality are treated in Section 4.3.4.) The major mortality factor associated with the construction of the Devil Canyon Dam will be the probable increase in hunting associated with the influx of construction workers and other personnel to a previously remote area. Although the workers will not be able to hunt while at the construciton camp, they may reenter the area during days off since the Denali Highway to Watana access road will be open to the public. Effects of hunting on moose are described in more detail for the two development areas in Section 4.3.4(a).

(ii) Filling and Operation (*)

Because of the smaller area, local topography, the small drawdown zone during most of the year, and the rapid filling sequence, the effects of the Devil Canyon Stage II on moose will be much less severe than those of Watana construction. The major impacts to moose will be alteration of habitat, loss of habitat, blockage of movements, direct mortality, and disturbance.

- Alteration of Habitat (*)

  As discussed for Watana Stage I, the Devil Canyon impoundment will cause some alterations of vegetation in the vicinity of the impoundment and in areas downstream from the dam.

  Alteration of vegetation in the vicinity of the impoundment may occur as a result of several micro-climatic changes such as seasonal temperatures, wind direction and speed. Effects of these changes on moose will probably be undetectable.

Alteration of vegetation downstream from the Devil Canyon site, however, may affect the distribution, abundance, and quality of moose habitat. The combined effects of the Watana and Devil Canyon dams will result in increased water temperatures in downstream portions of the river, and it is anticipated that with both dams, much of the Susitna River will remain open in winter from the Devil Canyon Dam to Talkeetna. Flow regimes following completion of the Devil Canyon Dam are not expected to differ greatly from flow regimes of Watana Stage I. Hence, no additional differences in vegetation resulting from lower water flows are expected with Devil Canyon Stage II. A more complete discussion of downstream impacts is found in Section E.3.4.3.3.

Because of the open-water conditions in portions of the Devil Canyon to Talkeetna reach of the river, ice scouring of lower level riparian areas will be reduced. Annual disturbance of successional growth in these areas will be reduced (flooding will still scour some areas), and the vegetation will begin to colonize the unvegetated band resulting from ice scouring during operation of Watana only.

Riparian communities on higher ground of the river channel will gradually succeed to cottonwood forest, but at the same time will extend downward into the newly exposed areas of the river channel. Browse will increase in abundance along the river once Devil Canyon is completed. However, such browse may be partially unavailable due to open water downstream of the dam, or of reduced value due to icing, as described above.

- Interference with Movements (*)

The Devil Canyon Stage II impoundment will turn approximately 26 miles of narrow fast-flowing river into a stable body of water with little or no current velocities. Widths of the reservoir will range from 500 to 3,800 feet. Currently the river in the area of the impoundment has swift currents (6 to 11 ft/sec) and precipitous canyon walls in many places. River widths currently range from 100 to 800 feet. Because of steep topography and extensive mature forests in the Devil Canyon impoundment area, fewer moose occur in this area than the area west of Watana Creek (ADF&G 1982a, 1984m). The expected improvement of crossing conditions should reduce the frequency of mortalities related to river crossings.

During the winter freeze period (mid-November to mid-May) the Devil Canyon reservoir will fluctuate very little. In fact, the reservoir water level is expected to remain constant from January to May. This situation will provide big game with relatively safe travel across the impoundment. Currently, animals have to deal with numerous open water leads in the river ice and steep ice cliffs and shelves in various areas.

It is expected that ice cover on the Devil Canyon reservoir will pose no significant impacts to big game attempting to cross. Numbers of mortalities from weakened ice on the impoundment are expected to be essentially the same or less than under natural conditions. Moose utilization of the impoundment area is low in any case.

Moose in the Devil Canyon to Talkeetna reach of the Susitna River overwinter in riparian habitats and on river islands of the Susitna River (ADF&G 1982j). Parturient cows apparently prefer to calve on river islands or in riparian areas, presumably because of the availability of high quality forage and reduced numbers of predators (Stringham 1974). It has been suggested that the presence of open water between the dam and Talkeetna may interfere with use of these river island habitats during the winter and the early portion of the calving period. However, Bonar (1985 pers. comm.) has reported that at the Revelstoke Hydroelectric Project in British Columbia, moose commonly go into the water during -20°F temperatures with no apparent reluctance.

- Disturbance (o)

Mechanical and human disturbance should decline in the Devil Canyon area once the dam becomes operational. Increased public access will maintain disturbance at a higher level than is currently encountered, but at a level much lower than during construction. If animals are not directly harassed, disturbances during the filling and operation stage will at most have slight effect on moose distributions.

- Mortality (o)

During the filling and operation of the Devil Canyon Dam, moose mortality may increase as a result of hunting and accidental deaths (see Section E.3.4.3.1[a]).

(b) Caribou (**)

- Interference with Movements (**)

As discussed in part (a) of this section, the Devil Canyon Stage II impoundment will turn a narrow fast-flowing river into a stable body of water with little or no current velocities. Caribou of the Nelchina herd are not expected to be impacted by the increased width of open water in the Devil Canyon impoundment. The impoundment area has been infrequently used by caribou either historically or in recent years (APA 1983). A small portion of the Nelchina herd may occasionally cross the impoundment, but as mentioned earlier crossing conditions are expected to be generally improved with the Project.

- Reservoir Ice (***)

During the winter freeze period (mid-November to mid-May) the Devil Canyon reservoir will fluctuate very little. In fact the reservoir water level is expected to remain constant from January to May. This situation will provide big game with relatively safe travel across the impoundment. Currently, animals have to deal with numerous open water leads in the river ice and steep ice cliffs and shelves in various areas.

- Disturbance (**)

There may be some impacts on caribou resulting from aircraft disturbance and the Watana to Devil Canyon road segment--these will be similar to those associated with Watana development, and are discussed in Section 4.3.1(b) and 4.3.3(b).

(c) Dall Sheep (o)

The construction, filling and operation of the Devil Canyon Dam will have no direct impact on any of the three Dall sheep populations in the middle Susitna Basin. All three populations are far removed from the damsite.

Any increase in air traffic to the Watana airstrip caused by the construction of the Devil Canyon Dam has the potential for disturbing the Mt. Watana-Grebe Mt. population (coming from the south) or the Portage-Tsusena Creek population (coming from the north). The effects of aircraft traffic on Dall sheep are discussed in Section 4.3.1(c).

(d) Brown Bear (*)

The impacts of the construction of the Devil Canyon Dam on brown bears will be similar to those during construction of the Watana Stage I Dam, except that the number of bears affected will be much smaller. The area near the Devil Canyon site is at lower elevations and is not prime habitat for brown bears.

Steep canyon walls will confine most of the Devil Canyon impoundment, thus minimizing the area inundated. There will be some loss of riparian areas, with their associated food sources - berries, early spring vegetation, and moose calves. No potential denning areas will be affected. Other long-term effects of the Devil Canyon development, such as increased hunting and aircraft disturbance, will be similar to those associated with the Watana Stage I development, but at a reduced scale.

Some human/bear contact is likely to occur during the construction of the dam, leading to increased bear mortality. As discussed in Section 4.3.1(d), improper food and garbage handling practices will increase problems with bears. Avoidance of areas of human activity by bears will cause some habitat loss, resulting in a lower carrying capacity for brown bears.

(e) Black Bear (**)

The effects of the Devil Canyon development upon black bear are anticipated to be of a much lower magnitude than either of the Watana stages. This is largely due to the much smaller areal extent of the Devil Canyon impoundment and the greater abundance of suitable black bear habitat beyond the impoundment zone. For the Devil Canyon impoundment, observed use of forested habitats significantly (p less than 0.05) exceeded expected values (based on relative areas) in the zone within one mile of the impoundment shoreline (ADF&G 1985n). Of the 21 dens that have been discovered in the vicinity of the Devil Canyon impoundment (NMOL=1,455 feet), only one is likely to be inundated. To date an additional 25 dens have been discovered outside the impoundment zones in the downstream study area (between Devil Canyon and Talkeetna).

The presence of the railhead and construction camp will add to the general disturbance level in the project area, although this effect is not expected to impede black bear use of any critical habitats. Most of the potential impacts discussed for the Watana development will exist, but at a much-reduced level. Downstream effects of the Devil Canyon impoundment should be the same as those discussed in Section 4.3.1(e).

(f) Wolf (**)

Impacts from the Devil Canyon development will be very similar to those from the Watana Stage I development. No known dens or rendezvous sites will be affected, and the loss of potential den sites is not expected to have significant effects on the wolf populations. Similarly, disturbance is not expected to affect wolves except possibly at den sites during May and June. Wolf pups moved from dens because of disturbance when they are very young may not survive (ADF&G 1982f).

It was argued in Section 4.3.1(f) that present wolf populations are unlikely to be seriously affected by loss of prey species. Although prey abundance does not appear to be limiting at present for wolves using the area of the Devil Canyon development, loss of prey habitat remains the major impact due to Stage II, as discussed in Section 4.3.2(a).

(g) Wolverine (**)

The effects of the Devil Canyon development on wolverine will be insignificant except for the potential of increased trapping as discussed in Section 4.3.3(g). Carrying capacity losses due to Stage II are estimated at much less than one wolverine. Quantification of the contact of wolverine home ranges with the impoundment is not currently possible, but is not expected to be significant. Because wolverines range over large areas, the relatively minor changes in food availability and the effects of intensive human activity near the construction site should not noticeably affect more than a few wolverines near the Devil Canyon development area.

(h) Belukha Whale (*)

For reasons discussed in Section 4.3.1(h), the operation of Stage II should have no real or detectable effect on the belukha whale population in Cook Inlet.

(i) Beaver (**)

Devil Canyon Stage II will have both positive and negative effects on beaver. Several beaver colonies now occurring within Borrow Site K and near the campsite (Gipson et al. 1982) will be adversely affected due to disturbance and habitat loss. Beaver will also be affected by ice staging as explained under Stage I (Section 4.3.1(i)). Some improvement in downstream habitat resulting from more stable flows and some lack of ice cover downstream will occur, as discussed in Stage I. Winter flows will be more stable with Stage II, and the ice cover and staging will be less. The ice front will probably stop near RM 133 (between Sherman and Gold Creek), resulting in an additional six miles of ice free water in late winter.

No beaver are known to overwinter in the Devil Canyon reservoir, and thus, no adverse impact is expected as a result of inundation. However, during the period between the filling of the Watana and Devil Canyon reservoirs, some beavers may colonize this reach and be initially displaced. If the reservoir level remains stable for several years as a result of several wet years, beavers may successfully colonize the impoundment. Beavers will probably attempt to colonize the impoundment in other years, but the drawdown in August and September during dry years and the rise in water level in normal years will occur at a critical time when food caches are being constructed and it is unlikely that beavers will successfully overwinter. Approximately 10 beavers are known to occupy the lakes in and adjacent to Borrow Site K and the proposed construction camp, and these areas will probably be lost during construction.

(j) Muskrat (**)

Construction of the Devil Canyon Dam should have no direct impacts upon muskrats. Gipson et al. (1982) found muskrat sign in 2 of 27 lakes surveyed in the development area. Neither of these lakes is in the impoundment zone or borrow sites. Some habitat loss may occur from building camp facilities if ponds and lakes are filled in for roads, work pads, etc. Downstream effects and trapping pressures will be similar to those described in Section 4.3.1(j) for Watana Stage I, although more open water in winter should increase the beneficial effects.

No impacts are foreseen from vegetation removal in the impoundment zone or from subsequent flooding.

(k) Mink and Otter (**)

Effects of the Devil Canyon construction and operation on mink and otter will be similar to those already discussed for the Watana project (Section 4.3.1[k]), but because of the smaller size of the impoundment and the more stable water level, effects will be less severe. Because mink are most abundant east of Kosina Creek, the Devil Canyon Stage II will probably have little effect on the regional population. Impacts to otter and mink are loss of habitat, reduction in prey availability, and increased human disturbance. Stage II will inundate about 32 miles of mainstem Susitna and about 11 miles of tributary habitat.

Because the construction of both Devil Canyon and Watana Dams will result in permanently open water from Devil Canyon to Talkeetna, mink and otter may be positively affected. Both species prefer areas of open water in rivers and streams in winter (Barber et al. 1975). Open water areas in the Devil Canyon reservoir during winter may also have beneficial effects.

(l) Coyote and Red Fox (*)

Coyotes are more common in the Devil Canyon area than in the Watana area, but they are still sufficiently uncommon that the project is unlikely to have any effect on them. As in the case of the Watana development, foxes will be affected primarily by increased trapping and by destruction of nuisance animals if garbage is not regularly incinerated or if regulations against feeding are not enforced. Habitat loss will not be a major impact since foxes tend to occur at mid and high elevations rather than in the forested areas along the river.

(m) Other Terrestrial Furbearers (*)

Lynx, weasels, and marten will all be affected by the Devil Canyon development primarily by loss of habitat. As in the case of the Watana development, no estimates of the potential reduction in numbers of weasels can be made. Few if any lynx will be lost because of the poor habitat and current low number. Habitat for approximately 22 marten will be lost to the impoundment and construction sites, borrow sites, etc.

Marten, lynx, and weasels may be disturbed by construction activity, but there is no evidence that they will vacate areas as a result of these disturbances.

(n) Raptors and Ravens (**)

Effects on raptors and ravens during the Devil Canyon Stage II development would be similar to those for Watana Stage I development, and would increase overall impacts to those species. However, the increase would represent a relatively small proportion of the total impact of both developments.

(i) Habitat Loss (**)

Only one of the 11 golden eagle nesting locations associated with the Devil Canyon project area, GE-14, would be inundated by the reservoir's maximum operation level of 1,455 feet. (Figure E.3.4.40). A nest is no longer present at GE-14 and the exact location of this historical nest site cannot be determined with certainty. However, the nest was probably located on one of three rock outcroppings at an elevation of about 1,450 feet or less. Even if the historical nest ledge escapes inundation, it may be too close to maximum operating level to be usable by golden eagles.

Another location, GE-13, will be partially inundated during filling of the Devil Canyon Reservoir and may become less attractive to the eagles. The nest site will remain about 55 feet above maximum operating level and 45 feet above maximum flood level (Figure E.3.4.40). It should be noted however, that Alaskan golden eagles occasionally nest at elevations of 50 feet or less above water. Furthermore, about 100 feet of cliff face will remain above water level. A new nesting ledge and nest could be constructed 75 to 80 feet above maximum water level as a mitigation measure, thus ensuring the continued viability of this nesting location.

All three nesting locations known to occur downstream of the Watana damsite are far enough from the proposed Devil Canyon impoundment zone that they will not be affected by inundation.

No known gyrfalcon nesting locations will be inundated by the Devil Canyon reservoir. One historical and currently inactive nesting location was suspected of being located in Borrow Site K. However recent surveys determined that the actual nest site lies at least 0.25 mile east of the easternmost boundary of Borrow Site K. One of three known goshawk nesting locations in the general vicinity of the Devil Canyon Dam will be lost to clearing and filling of the Devil Canyon Reservoir. The recently active nest location that will be lost is one of two discovered to date upstream of the Devil Canyon damsite. Total impacts on this woodland species are anticipated to be slight, because appropriate nesting habitat is relatively scarce in both impoundment areas.

Four of 25 previously used raven nesting locations in the middle basin will be completely lost as a result of filling of the Devil Canyon reservoir. One nest site at an additional nesting location will be inundated; however, sufficient cliff sites and at least one other nest site will remain well above maximum flood level (Figure E.3.4.40).

(ii) Disturbance (***)

Eleven of the 23 golden eagle nesting locations that are known to occur near the Susitna Project area are associated with the Devil Canyon area. Ten of these locations are between the proposed Devil Canyon and Watana damsites, and one is a short distance downstream of the Devil Canyon damsite. Four of the 11 locations (GE-13, GE-14, GE-16 and GE-18) may be subject to disturbance during the clearing of the Devil Canyon impoundment zone, if the clearing occurs during the nesting season and these locations are occupied (Figure E.3.4.37). It is assumed that adequate clearing will have been completed near GE-11 during earlier operations at Watana Borrow Site E, and that clearing operations will remain 0.5 miles or more from GE-12 and GE-23. One of these four locations, GE-14, is a historical nesting location (cliff) and currently contains no nesting sites. GE-18 is located downstream of the Devil Canyon damsite and lies in close proximity to: (1) the proposed Watana-to-Devil Canyon access road and bridge (the roadbed is about 0.25 miles north of the top of the cliff, and the access road bridge crossing is about 0.5 miles downstream to the west), (2) the Devil Canyon damsite (about 0.6 miles upstream to the east), and (3) the Devil Canyon Dam substation and transmission route (about 0.5 miles north). This location will be subject to disturbance during construction of the Devil Canyon Dam and associated facilities. During construction years the location will probably be avoided by nesting eagles. The close proximity of so many permanent features and sources of ongoing, potentially disturbing activities during the operation phase of the Project also may cause this nesting location to be permanently abandoned in favor of one with less human disturbance.

Three of the 10 bald eagle nesting locations known to occur near the project area are located downstream of the Watana damsite (BE-7, BE-8, and BE-10). Two of the three locations (BE-7 and BE-10) lie well south of the project area, near Stephan Lake, and will not be affected by project construction. The remaining location (BE-8) lies well downstream of the Devil Canyon damsite. This location (BE-8) is near the confluence of the Susitna and Indian Rivers, and may be vulnerable to disturbance from the activities associated with the construction and operation of the Devil Canyon to Gold Creek railroad link. The proposed railbed lies across the river, about 0.25 mile to the southeast.

One inactive gyrfalcon nesting location near the Devil Canyon impoundment area may be susceptible to disturbance during reservoir clearing operations and in post-project years. Disturbance from human presence may increase near it as recreation activities develop and increase along the impoundment edges. A second gyrfalcon nesting location lies about 0.25 miles east of Borrow Site K and may be susceptible to some minimal disturbance due to blasting activities, when blasting occurs during the nesting season in years when birds are present.

At least two known, recently active, goshawk nesting locations may be susceptible to disturbance from construction and filling of the Devil Canyon reservoir. One of these nesting locations is within the reservoir area and will eventually be lost during reservoir clearing operations prior to inundation. The other nesting location is situated well above maximum reservoir level, but disturbance from human presence may increase near it as recreational activities occur along the impoundment edges.

Six of 10 raven nesting locations found in the vicinity of the Devil Canyon impoundment may be susceptible to disturbance from reservoir clearing operations, and four of these will eventually be inundated. One nest site at one additional nesting location will be inundated, but sufficient cliff sites and at least one other nest site will remain well above maximum flood level after project completion. One of the five nesting locations that will not be inundated is located about 0.3 miles downstream from the Devil Canyon damsite and may be susceptible to disturbance during construction of the dam.

(o) Waterbirds (*)

Initially the clearing and construction activities at Devil Canyon may cause a temporary loss of suitable habitat for waterbirds. The Devil Canyon reservoir will fill to 1,455 feet and will be stable at that level in wet years. In average flow years, the reservoir may be drawn down to 1,435 feet in July but will be filled by September. In dry years the reservoir may be drawn down to near minimum level between June and October. Since Devil Canyon will regulate discharges from Watana, its water surface may experience daily fluctuations on the order of one foot. This should allow for the development of some vegetation in the impoundment, although suitable shallow shoreline areas will be somewhat limited. The open-water area near each end of the reservoir should benefit some early and later migrants when other waterbodies are frozen, and the relatively stable water level in each year will allow a low level of use, typical of large lakes of the region, for nesting by waterbirds along the shoreline. On the other hand, species of alluvial and fluvial shoreline habitats currently using the impoundment area will be eliminated. Breeding habitat for harlequin duck, common merganser, semipalmated plover, spotted sandpiper, wandering tattler, arctic tern, and dipper will be inundated. No significant amount of shorebird feeding habitat will be created by the Devil Canyon impoundment because of the small drawdown and steep shoreline.

Downstream effects will be similar to those discussed in Section 4.3.1(o). These will consist mostly of distributional shifts and minor changes in relative abundance of riparian species as vegetation proceeds through the successional sequence described in Section 3.2.1.

(p) Other Birds (*)

Devil Canyon development will result in the same types of impacts (habitat loss, habitat alteration, disturbance, direct mortality) with the same effects on terrestrial and shoreline birds as Watana development (see Section 4.3.1[p]).

Flooding of the Devil Canyon impoundment will increase the proportionate loss of forest habitats in the middle basin by several percent over that lost to Watana development. The largest losses will occur in paper birch, birch-aspen, spruce-birch, spruce-birch poplar, and spruce-poplar forests (Table E.3.3.41). Kessel (1982b and unpublished data) calculated order-of-magnitude losses for number of small- and medium-sized birds that would be lost to the Devil Canyon facilities (see Table E.3.4.63). An estimated 14,360 breeding birds will be lost to the Devil Canyon facility.

As is the case for the Watana development, the dipper will be affected by loss of breeding habitat in the lower reaches of feeder streams and loss of winter habitat (open water) in both feeder streams and the Susitna River itself. However, open-water below the dam should compensate for this loss of winter habitat.

The loss of overwintering birds due to permanent habitat losses is shown in Table E.3.4.64, and amounts to about 57 birds for Stage II. Largest losses will be for boreal chickadees, gray jays, and redpolls.

(q) Non-Game (Small) Mammals (*)

The types of impacts on small mammals that will result from construction of Devil Canyon Dam will be similar to those already discussed for the Watana Stage I Dam (see Section 4.3.1). The major impact will be loss of habitat due to clearing operations and subsequent flooding. The total area affected (approximately 8,838 acres) and percent of forested land affected (1.5 percent) are much smaller than in the Watana reservoir area. Thus, the impacts on small mammals are expected to be proportionately smaller.

4.3.3 - Watana Stage III Development (***)

(a) Moose (***)

Impacts of Watana Stage III development on moose will be similar to those outlined for Watana Stage I Section 4.3.1(a). The major differences between Stage I and III impacts are increased habitat loss and greater barriers to movements due to the increased area inundated by the Stage III reservoir.

(i) Construction (***)

Construction impacts on moose populations in the project area will be similar to those described earlier (Section 4.3.1(a)); however, the magnitude and duration of these impacts for Stage III will be somewhat less than for Stage I, due to the decreased construction period and the existence of facilities from Stage I construction. The major sources of habitat loss will be from impoundment clearing activities (from approximately 2,000 feet to 2,185 feet elevation), and use of Borrow Sites D and E, and Quarry Site A.

(ii) Filling and Operation (***)

During the filling and operation of the Watana Stage III development, the major impacts to moose will be permanent loss of habitat, alteration of habitat, and disturbance.

- Permanent Loss of Habitat (***)

The Watana Stage III development will remove an additional 17,121 acres of vegetated habitat in and around the Stage I impoundment zone. Of this acreage, 747 acres of quarry and borrow sites will be revegetated, leaving a total of 16,374 acres of habitat permanently lost (Table E.3.3.43).

Based on a preliminary assessment of the Watana primary impact zone (Figure E.3.4.8) ADF&G (1984m) determined that woodland black spruce, woodland white spruce, open black spruce and closed mixed forest were preferred habitat types (in relation to their availability) for moose. Willow habitat types were preferred when ecotones (borders of mapped vegetation types) were included but were not selected out of proportion to their availability when ecotones were excluded. During spring, willow habitat types were used proportionally less than their availability. Also, low shrub habitat types were used year-round in excess of their availability when ecotone areas were excluded. The Stage III impoundment zone will remove 8,523 acres of conifer forest (Table E.3.3.43) including spruce vegetation types which, based on these preliminary findings, moose prefer. Mixed forest (4,493 acres) and low shrub (1,308 acres) habitat types which are also preferred by moose will also be affected by the impoundment.

In the Susitna Basin, accumulated snowfall covers and restricts access to forage during the winter. In general, early winter snowfall occurs in October and November, December usually has less snow, and in the late winter January-to-March period the largest proportion of the yearly snowfall is received. It is in this January-to-March period that accumulating snow begins to restrict access to forage.

As reported by ADF&G (1982k), radio-collared moose in the middle and upper Susitna Basins were located more often in upland shrub and willow vegetation communities in the early winter (October-January) period, but in woodland and open coniferous spruce communities in the late winter (February-May) period. Browse in some black spruce stands in the middle Susitna Basin have been noted to receive heavy use by wintering moose. Observations of radio-collared moose during even relatively mild weather suggested that spruce communities were heavily used by moose. Numerous moose winter in the woodland and open spruce habitats on the north side of the Susitna River between Watana Creek and Jay Creek (ADF&G 1982n).

Whether this heavy use of forested stands in winter is related to snow depth in the stands is not known. There are few areas in the middle basin where spruce trees are tall and have canopies large enough to intercept a substantial proportion of incoming snowfall. In most spruce communities the trees are widely spaced and have small canopies so that snow depths are reduced only immediately beneath the tree canopy in a 4 to 7 foot diameter area. The snow depths between trees in spruce communities is usually as deep as in more open habitats. However, formation of wind-blown snow crusts may be inhibited within these forested types.

Although a few herbs and forbs may become established in the drawdown zone during early summer, most of the area will remain a bare mud slope. Fine material will gradually move downslope so that much of the upper drawdown zone will eventually be composed of coarser material. Except during crossings of the reservoir, it is unlikely that moose will utilize the drawdown area.

- Alteration of Habitats (***)

Watana Stage III will result in additional alteration of plant communities in the Susitna Basin (Section 3.3). These alterations will affect moose use of existing habitats and may have some effects on the long-term productivity of populations.

. Middle and Upper Basin (***)

During the operation of the Watana Stage III Dam, a maximum drawdown of 120 feet will create an unvegetated shoreline zone that, in the Watana Creek area, may be one mile wide at the widest point. The impoundment level will be at its highest in August and September, and will generally decline between October and August.

Erosion of the impoundment shore will likely occur during the period of maximum fill until the new banks become stabilized. In particular, permafrost slumping along the south shore of the impoundment may eliminate large areas of habitat along the shore, although most of the unstable areas are steep slopes of little value as moose habitat. Areas of successional vegetation, favorable to moose, may develop on some of the resulting more gently sloping areas along the shores of the reservoir.

The Stage III impoundment will alter additional habitat around the existing Stage I impoundment zone. A complete discussion of these impacts is found in Section 4.3.1.(a)(ii).

. Lower Susitna Basin (***)

As a result of the proposed Susitna Project there will be a change in the seasonal flow rates of the river. These changes in flow will affect moose downstream of the Devil Canyon damsite both positively and negatively through the flows' impact on river floodplain plant succession. The net effects of these impacts are very difficult to predict. At Gold Creek, river flows during the growing season (May to September) will be reduced by about half. Seasonal floods will essentially stay within the present river banks. As a result, some of the presently unvegetated bank areas in the reach from Devil Canyon to the Susitna-Chulitna confluence will begin to develop horsetail, dryas, willow, and balsam poplar plant communities. Barring disturbances by ice jams and floods, willow and balsam poplar reproduction will develop within 5 to 15 years of the last disturbing influence on sites having sandy or silty substrates (McKendrick et al. 1982, Helm et al. 1985).

Below Talkeetna, the effects of either reduced or increased flows will be moderated by the contributions of the Chulitna and Talkeetna Rivers. The effects on the plant communities are uncertain but some trends in impacts can be expected over time. For example, the primary impact of decreased flow during summer below Talkeetna will be to allow early successional vegetation to move down onto sites that are presently eroded by high summer flows. Thus, until a new equilibrium with the river is reached, new early successional stands will migrate toward the new level of peak flows, while other early successional stands (those less affected by high flows) will advance to alder and immature balsam poplar types (McKendrick et al. 1982, Helm et al. 1985).

Early successional plant stages appear to last up to 25 years or more from the time of the last major disturbance. The vegetation in early successional sites is mainly willow and balsam poplar, browse species especially useful to moose. About 25 or more years after the reduction of downstream flows and the stabilization of the river floodplain, mid-successional plant communities become established. These communities are characterized by alder, or immature balsam poplar, which by then have developed into tall shrubs or trees (McKendrick et al. 1982, Helm et al. 1985). The value of the mid-successional plant community to moose is low due to the lack of usable forage. Another reason is that the plants present in the area that are eaten by moose (ie. balsam poplar) have frequently grown too tall and are out-of-reach of feeding moose. Sixty years after stabilization of the substrate, the shrub understory of the mature balsam poplar and later vegetation stages have become mainly populated with prickly rose and highbush cranberry; plants of low forage value to moose.

- Blockage of Movements (***)

Big game animals attempting to cross the Watana Stage III reservoir will encounter increased widths of water throughout the majority of the impoundment zone. This could completely prevent movement if animals refuse to cross. Increased mortalities could also occur in the form of drownings.

Impacts of the Stage III reservoir on moose movements will be similar to Stage I. The major difference will be the increased width and length of open water which will be encountered. The Stage III reservoir will be about one mile wider at its widest point and about eight miles longer than the Stage I impoundment.

Moose are powerful swimmers with great stamina and the ability to swim long distances with comparatively little effort. Moose attempting to cross the Watana Stage III reservoir will have to swim about one mile in most cases (range < 0.1 mile to 4.5 miles). Reservoir open water is not expected to be a barrier to moose movements given their swimming ability and willingness to take to the water, although some reduction in the frequency of crossing may occur. If swimming moose were to encounter rafts of floating debris such as felled trees and brush, drownings could occur. The impoundment will be cleared prior to inundation and will be relatively free of debris which could limit moose movements or cause drownings.

The presence of mudflats around the reservoir has also been suggested as a potential barrier to moose movements and a possible mortality factor if moose become mired and unable to free themselves. Moose are well adapted to move through marshes, bogs and mud and are known to wade into such areas to forage with little or no difficulty (Allen 1979). Few, if any, mortalities or movement related problems resulting from mudflats along the reservoir perimeter are expected.

Moose attempting to cross the Watana reservoir during periods of ice formation or decay (mid-November or early May) may fall through the ice and be unable to regain a solid footing. This type of big game accident occurs on natural bodies of water and has been reported upon widely in the open literature. Generally these types of accidents are infrequent and involve individual animals. However, instances of groups of animals breaking through thin ice and drowning have been reported (refer to Section E.3.4.3.1). Response to a survey of operators of hydroelectric projects in cold regions indicated that moose mortalities due to reservoir ice were either not observed or not considered a problem (H-E 1985d).

Although individual moose mortalities may result from weakened ice on the Watana impoundment, significant impacts to the local moose populations are not expected (refer to Section E.3.4.3.4).

In the spring, some female moose cross the Watana impoundment area in either direction and calve on the opposite side. The majority of females probably do not cross the river prior to calving, as vegetative cover used for calving exists on both sides, and crossings appear to be infrequent. Parturition generally occurs in the middle Susitna Basin from May 1 through June 15, peaking between May 25 and June 2 (ADF&G 1982k). Suitable calving habitat will remain on both sides of the Watana Stage III impoundment after filling, and the existing pattern of calving will probably continue. Although moose may be lost while attempting spring crossing, this loss is not likely to be important because relatively few individuals will be affected.

Deposition of "sheet ice" will occur as the reservoir is drawn down throughout the winter. In some cases, cracks will form as the ice drapes and settles over irregular shoreline topography leaving stranded polygons of ice along the shore.

The potential for ice-related accidents will be greatest on the steeper slopes of the reservoir margin. Moose encountering sheet ice draped on these slopes will be subject to injury by slipping or falling. Ice sheets around impoundment margins are generally not a source of significant impacts to moose (H-E 1985d). Bonar (1985 pers. comm.) reports that the fractured ice which settles in the large drawdown zone (about 100 feet) of the Mica reservoir in British Columbia presents no problem to moose or other ungulates. Although individual moose will occasionally die from ice-related accidents, the overall effect upon local populations is not likely to be significant.

The effects of windblown snow accumulation on wildlife are not expected to be important. Only moose will potentially be affected. The magnitude of effects of snow drifting on moose will depend on such factors as prevailing wind direction, fetch, wind velocities, cumulative snow depth, presence or absence of crusted layers in the snow profile, proportion of reservoir surface snow melted, slope of exposed impoundment shorelines, local variations in shoreline topography, and vegetation types on the windward reservoir margin.

Although deep snow may hinder the mobility of moose in localized areas, increasing their vulnerability to wolf predation, this effect is more likely to be important during a severe winter with deep snowfall, rather than as a result of local snow drifting. Bonar (1985 pers. comm.) reports that snowdrifting resulting from winds blowing snow along or from impoundment zone ice at the Revelstone project doesn't cause any problem to local big game species.

(b) Caribou (***)

Impacts of the Watana Stage III development on Nelchina caribou will be essentially similar to those outlined in Section 4.3.1(b) - Watana Stage I. The major differences between Stage I and III impacts are increased reservoir width and length in Stage III. At its widest point the Stage III reservoir would be about one mile wider (at normal maximum pool elevation) than the Stage I reservoir. The Stage III reservoir would range from about 0.2 mile to about 3.5 miles in width with a typical width of about 1 mile. The Stage III reservoir will also be about eight miles longer than the Stage I configuration. The Stage III reservoir will therefore present a greater physical barrier to caribou movements. This increase is not expected to substantially increase its barrier effect compared to the Stage I reservoir.

Caribou may become habituated to the impoundment during Stage I operation or may alter their movement pattern to avoid lengthy crossing. If this habituation were to occur, animals might be better suited to deal with the more extensive impacts of the Stage III impoundment zone.

The construction of the Stage III dam and facilities with their associated heavy equipment activity, blasting, aircraft overflights, etc. will again present disturbance impacts similar to those experienced during Stage I construction (see Section 4.3.1(b).

(c) Dall Sheep (***)

Anticipated and hypothesized impacts to Dall sheep are summarized in Section 4.3.6. The most serious impacts to Dall sheep for the Stage III Watana development include disturbance and harassment and the inundation of portions of a mineral lick.

(i) Construction (***)

The three Dall sheep populations identified in the Susitna Basin are most likely to be affected by the project through disturbance (i.e., aircraft traffic, construction noise, presence of workers), habitat loss, and increased access by hunters. Each of the populations will be affected to a different degree as a result of their distribution in relation to project facilities. See Section 4.3.1(c) for a discussion of these impacts. It should be noted that the level of disturbance during Stage III construction will be less than during Stage I due to the reduced construction effort needed and the presence of an existing intrastructure of roads and other construction camp-related facilities.

(ii) Filling and Operation (***)

The Watana Hills sheep population may be affected by the Stage III Project because of the location of a mineral lick along Jay Creek. The use of this lick will be affected by the Project impoundment in the following ways:

- o The proposed reservoir will inundate part of the lick.
- o Wave action may erode licks just above the maximum reservoir levels.
- o Open water and/or ice in the reservoir along the creek may impair access to the lick on the east side of the creek.

For the purposes of this discussion a small individual spot where licking has occurred will be defined as a lick "site". A specific geographical area along Jay Creek will be called a lick "area". A lick area may be composed of several smaller sites. The sum total of all licking areas along jay Creek will be referred to as the Jay Creek mineral lick. Lick sites are shown in Figure E.3.4.18.

The Stage III Watana reservoir will be operated at a normal maximum operating level of 2,185 feet above mean sea level. Average annual drawdown will be to 2,077 feet. The maximum drawdown will be to 2,065 feet. During extreme flood events, the reservoir will rise to 2,193.3 feet for the 10,000-year flood and 2,200.5 feet for the probable maximum flood.

Sheep at the Jay Creek licks spend most of their time above 2,200 feet, thus the impact of the proposed project will be minor. During the peak lick use season (mid-May through June) the median reservoir elevation on May 1 will be 2,079 feet and will be below 2,085 feet 90 percent of the time. By July 1, the median reservoir water surface elevation will be 2,122 feet and will be below 2,142 feet 90 percent of the time. The proposed impoundment will completely inundate the downstream licking site (elevation 1,950 feet). The site is described as a low-use site (ADF&G 1984j). Another low-use lick area, the

Upstream site (at 2,190 feet), will not be impacted except during extreme flood events occurring in late summer when the reservoir is filled to its normal maximum operating level (2,185 feet). Lower elevations at the Bluff site will be inundated but these low elevations are also described by ADF&G as low-use sites.

Erosion of lick areas at or immediately upslope of elevation 2,185 feet is also a possible impact of the project. A field reconnaissance by a project geologist indicates that the lacustrine deposit in the Jay Creek lick area is of variable thickness and continuous throughout the lick area. Thus, any erosion near the upper levels of the reservoir could result in the deposit being exposed further back into the slope. Below the Cabin Ridge site (elevation 2,190 feet) erosion and undercutting of the steep slope may occur, resulting in the restabilization of the slope and exposure of the deposits further back into the slope.

At the western end of East Ridge, bedrock is exposed at elevation 2,215 feet. The elevation of this bedrock coupled with the fact that Jay Creek bends sharply at this point (due to either structural factors or to differential erosion) is indicative of a bedrock-controlled ridge. It is likely that bedrock is at or above the reservoir pool elevation and, therefore, East Ridge should be unaffected by reservoir water action.

The Bluff and Ravine lick sites should be largely unaffected by the impoundment, since both are primarily above the reservoir and should be minimally affected by erosion. At the Ravine lick minor erosion may occur immediately downslope of the lick, but since the ravine will be a shallow embankment of the reservoir it is anticipated that wind and wave erosion will be lessened. The Bluff lick is largely rock with talus slopes at the lower elevations and erosion impacts on the lick should be minor.

Ice cover on the impoundment is a concern at the Bluff and East Ridge lick sites, where it could impair sheep movement from the west side of the creek to licks on the east side. Ice cover greater than six inches is postulated to occur on the reservoir in early to late November, with breakup occurring in mid- to late May. Assuming these conditions, there could be a band of ice approximately 100 to 200 feet wide resting on the reservoir shoreline when sheep arrive at the site in early to mid-May. At sites with steep slopes, such as Bluff, ice may move downslope during drawdown (November to May) instead of collecting on the banks.

ADF&G (1984j) observed sheep crossing between the Bluff and East Ridge lick sites from May 11 to July 11, 1983, mostly during June. Ewe-lamb groups did not even arrive at the lick until June 16. Even in unusually cold years, ice should be almost completely gone from the impoundment by June. On south-facing slopes ice left stranded along the impoundment rim should be melted off even earlier than ice stranded on other aspects. On the basis of these observations, it is postulated that ice cover on the reservoir or ice stranded along the reservoir banks will not pose any significant impact to sheep use of the lick sites.

Muddy shoreline around the project reservoir has been suggested as a possible barrier to wildlife movements or source of mortality to animals attempting to cross the impoundment. Based on geological information currently available for the Jay Creek lick this problem is not expected to be encountered by Dall sheep using the lick. The slopes in the area between the bluff and east ridge lick areas are steep and composed of bedrock and coarse grained deposits for the most part.

Another possible impact to sheep movements across the impoundment is the presence of debris on the reservoir surface. This type of an impact is not expected at the Jay Creek lick due to planned reservoir clearing of vegetation in the impoundment zone. Reservoir clearing will be restricted to periods when sheep will not be utilizing the lick.

If ice stranding or open water poses a crossing barrier to sheep arriving in early May and sheep refuse to walk across the ice or swim the reservoir (less than 200 feet wide in May and June in the Bluff vicinity), they would have to move upstream approximately one mile to gain access above the impoundment zone. Heimer (1973) found that Dall sheep will travel 12 miles out of their way to visit a lick. He has found that fidelity to the Dry Creek lick is high year after year, approaching 100 percent for ewes and 80 percent for rams. It is reasonable to assume that sheep will make a strong effort to continue using the East Ridge and Cabin Ridge lick sites on the east side of Jay Creek even if they have to cross ice or circumvent areas of creek.

The consequences to the Watana Hills sheep population if the Jay Creek lick is abandoned for any reason are unclear. Several other mineral licks have been identified within the range of this population, but because sheep have a demonstrated high fidelity to specific licks, it is uncertain whether these alternative licks would replace Jay Creek. Many researchers have conducted chemical analyses of mineral lick soils in an attempt to explain why sheep visit licks, but the results have been conflicting or inconclusive. Contamination of samples from urine, feces, and/or muddy water have been cited as potential sources of error in these analyses. Many studies have found that sodium is relatively abundant in lick soils and is selectively sought by ungulates (see Stockstad et al. 1953). Heimer (1973) found that soil samples from high use sites within a mineral lick contained large quantities of clay minerals called zeolites which contain biologically available cations of sodium, potassium, calcium, and magnesium.

(d) Brown Bear (***)

The majority of impacts on brown bear associated with the Watana Dam will have occurred during Stage I. Stage III will increase the magnitude of some impacts, however.

Additional riparian habitat would be lost during Stage III mostly along Watana Creek and the mainstem of the Susitna River. The major habitat loss due to Stage III would be the benchlands which often provide abundant berry crops. These areas will likely contain somewhat higher moose densities during the first few years after reservoir clearing.

An increased potential for bear-human interactions would result from the presence of the construction camp as well as increased human activity away from the camp.

No known dens are susceptible to flooding by the Stage III impoundment.

(e) Black Bear (***)

Impacts for Stage III are essentially extensions of those discussed for Stage I in Section 4.3.1 (d). The major effects are expected to be loss of habitat for foraging and denning, hindrances to movement due to facilities and disturbance, and increased hunting and bear/human encounters.

After Stage III reservoir filling, it is likely that fewer black bears will forage or den along the Susitna River between Tsusena Creek and the Oshetna River. Transient bears may use areas adjacent to the impoundment, and a few bears may reside there year-round. However, removal of forage and cover habitats, along with a reduction in available denning habitat, will reduce the area's ability to support resident black bears. Bears continuing to use the area will be susceptible to hunting along the reservoir's margin.

Of the 22 black bear dens above the Stage I impoundment level in the Watana area, 6 (27 percent) will be impounded by the Stage III impoundment. This will result in a total loss by impoundment of 33 percent (18 of 54) of the project area black bear dens upstream of Devil Canyon.

Analysis of the location data within three nested zones of the black bear study area (i.e. the impoundment zone, one mile from impoundment shoreline, and one to five miles from the impoundment shoreline) revealed high selectivity for the impoundment areas by black bears. In the area that would be flooded by the proposed Watana Stage III impoundment, black bear use was two to four times higher than expected based on the area of the zone relative to other zones. Use was also higher than expected in the zone one mile from the impoundment shoreline. A total of 82 percent (14 of 17 individuals) of radio-tagged adult females monitored over four years (1980 to 1983) had some portion of their annual home range within the impoundments and would thus be affected by the proposed project. Application of 1982 census results have provided a population estimate in the census area of 86 black bears one year old or older (with a 95 percent confidence interval of 47 to 172 bears) (ADF&G 1983l).

Downstream effects of Stage III will be similar to those described for Stage I (Sections 4.3.1 (e)), but of a somewhat greater magnitude.

(f) Wolf (***)

Stage III impacts will be a continuation of those discussed for Stage I in Section 4.3.1 (f). No known den or rendezvous sites will be inundated, but potential sites will be. Disturbance will continue to be an important impact, particularly as reservoir clearing operations approach known den sites in the Watana and Jay Creek areas.

As project-related loss of moose habitat increases during Stage III, so will the magnitude of the major impact upon wolf populations in the Watana and Gold Creek watersheds. Whether or not this reduction in prey base has a marked effect upon wolf populations in the area depends to a large extent upon whether or not the current legal and illegal harvest rate (nearly 50 percent annually) continues.

The Watana pack will likely be greatly affected regardless of alterations in current harvest patterns. As a result of habitat loss, reductions in the moose population, and disturbance near den and rendezvous sites, this pack of roughly 14 wolves may be eliminated.

All effects of the Project upon wolves will tend to disrupt current pack territories, home range sizes, travel routes, and membership. Stage III will have the greatest effect upon these relationships when completed. An unknown amount of intraspecific strife may result as new pack structures and boundaries are established.

(g) Wolverine (***)

Direct habitat loss due to the Stage III impoundment will lower the carrying capacity for wolverine by about one animal, although more animals will have portions of their home ranges impounded. This may result in some increased intraspecific strife, but is not considered a significant effect.

Disturbance due to construction, reservoir clearing, and recreational activities are not considered of a large enough magnitude to have any population level effects on wolverine.

Harvesting of wolverine will continue to have significant effects upon the population, but this is largely controllable by ADF&G regulations.

(h) Belukha Whale (***)

For the reasons stated in Section 4.3.1(h), operation of Stage III should have no real or detectable effect on the Belukha whale population in Cook Inlet.

(i) Beaver (***)

Upstream Stage III effects on beaver will be similar to those for Stages I and II. No new borrow or construction sites are scheduled to be opened, and little additional acreage will be disturbed due to new facilities. Flows will be more stable year-round and the ice front will infrequently go upstream of RM 114 (between Chase and Curry). This will result in a 35-mile reach of river between Devil Canyon and RM 114 with relatively stable, ice-free winter flows. The extent that this will be beneficial to beaver colonization of this reach cannot be predicted at present. Changes downstream of Talkeetna may occur, but current monitoring abilities are insufficient to separate any such changes from natural variability.

(j) Muskrat (***)

Impacts due to Stage III will be similar to, and incremental to, those of Stage I. Access will not be markedly increased during Stage III, but the road across the dam may increase trapping pressure south of the Susitna River.

Habitat loss due to Stage III will not be as large as that of Stage I. Of the 64 lakes surveyed for muskrat sign in the Watana development vicinity by Gipson et al. (1982), 21 contained muskrat sign. Of these 21, two will be flooded by Stage III, with a resulting displacement of 2 to 4 muskrat.

Downstream effects will be similar to those described under Stage I [Section 4.3.1(j)], but the increased open water area in winter should increase the beneficial effects.

(k) Mink and Otter (***)

Upstream effects of Stage III will be similar to those discussed for Stage I [Section 4.3.1(k)], and of incremental but lower magnitude. Downstream effects will be essentially the same as with Stage I.

The Stage III clearing and impoundment will affect about 8 miles of mainstem Susitna, and about 11 miles of tributary streams. As discussed under Stage I, this loss of habitat will have a detrimental effect of unknown magnitude to mink and otter populations in the middle Susitna Basin.

Turbidity of the reservoir and downstream mainstem will be essentially the same under Stage III as Stage I. This will likely interfere slightly with hunting in large areas of water, but will probably not interfere with feeding on prey concentrations in areas such as tributary mouths.

(l) Coyote and Red Fox (***)

No significant additional impacts to either species are anticipated due to Stage III. See Section 4.3.1(l) for discussion of Stage I impacts.

(m) Other Terrestrial Furbearers (***)

Loss of habitat will be the major impact on lynx, weasels, and marten due to Stage III development. No estimate of the number of weasels potentially affected can be made at present, and few if any lynx will be affected due to low abundance and poor quality habitat. Based upon the same areal model used in Stage I, it is estimated that about 59 marten will lose habitat as a result of Stage III inundation.

(n) Raptors and Ravens (***)

General types of potential impacts to raptors that occur with development are summarized in Table E.3.4.62. Generally, the construction of the Watana Stage III Dam will have minor impacts upon raptor species in the middle basin due to construction disturbance and loss of habitat. The majority of habitat loss and disturbance will occur during the Stage I development. For a more complete discussion of disturbance and inundation impacts on raptors refer to Section E.3.4.3.3.

Two golden eagle nesting locations that are located between the Watana and Devil Canyon damsites may be vulnerable to disturbance during borrow site excavation at Watana Borrow Site E (GE-11) and Watana Borrow Site H (GE-23) Figure E.3.4.37. Borrow Site E is a primary source of aggregate, covering 445 acres of floodplain and adjacent terrain downstream of the Watana damsite. Site H, also an aggregate source, is located on the south bank, downstream of the damsite; its use is considered extremely unlikely. Golden eagle nesting location GE-11, which consists of three separate nest sites, was previously thought to occur within Borrow Site E and, as a result, to be subject to physical destruction. Recent surveys proved this to be incorrect, material will be excavated from the river bottom at elevations of about 1,760 feet or less, whereas the three nest sites are located at elevations of between 1,750 feet and 1,800 feet and at horizontal distances of several hundred feet beyond the borrow site's northern boundary. However, Watana Borrow Site E will be partially inundated by Stage II Devil Canyon. Its boundaries are not fixed and excavation may occur to within a few hundred feet of the nest sites at GE-11. Watana Borrow Site H is of low priority and is not scheduled to be used. However, if it were used, excavation would occur to within several hundred feet of the nest site at GE-23.

Raising of the maximum pool elevation of the Watana reservoir will have an effect on only one raptor nesting location. Gold eagle nesting location GE-2 will be partially lost because one of the three nest sites at it is situated about 85 feet below maximum operating level. This nest site will be inundated, but two other nest sites at the nesting location are about 115 feet above maximum operation level and about 100 feet above maximum flood level. As a result this location will remain usable by golden eagles.

Bald eagle nesting location BE-2 was formerly sited where disturbance from Stage III reservoir clearing would be realized and partial inundation of the nest tree during flood events would occur. Recent field observations have confirmed that this nest location has moved upstream about 0.5 mile and the former nest tree has been destroyed. This nesting location is no longer threatened by any project construction or operation activities.

No other major impacts to raptor populations are expected as a result of Stage III Watana Development.

(o) Waterbirds (***)

Impacts to waterbirds from the Stage III Watana development are expected to be minor because of low numbers of waterbirds in the Susitna Basin (Section 4.2.3[b]), and the prior elimination of much of the existing island, sandbar and established shoreline habitat by the Watana Stage I impoundment. For a discussion of the types of impacts which will be realized due to habitat loss and disturbance see Section 4.3.1.

(p) Other birds (***)

Impacts of the Watana Stage III impoundment on terrestrial birds will be essentially similar to those described for the Stage I development (see Section 4.3.1). Approximately 17,709 acres of habitat will be lost due to clearing and filling of the impoundment and clearing of borrow and quarry sites (Table E.3.3.42). Forest habitats, particularly black spruce woodland and spruce-birch-aspen forest, will be affected to the greatest extent. Other major habitat losses will include spruce forest, birch-aspen forest, and spruce-poplar forest. The total loss of breeding birds is estimated at 32,763 for Watana Stage III (Table E.3.4.63).

As for Stage I (Section 4.3.1), the largest numerical losses will be for species which occur in high densities in forested habitats such as Swainsen's thrush, ruby-crowned kinglet, yellow-rumped warbler, northern water thrush, dark-eyed junco, and various sparrows.

Overwintering bird losses due to habitat loss are presented in Table E.3.4.64. Total Stage III losses for these species are estimated at 1,787 birds. Species particularly affected would be boreal chickadees, gray jays, white-winged crossbills, and redpolls.

(q) Non-Game (Small) Mammals (***)

The types of impacts on small mammals that will result from construction of Watana Stage III will be similar to those already discussed for Watana Stage I (see Section 4.3.1).

During the construction phase, small mammals will mainly be affected by the clearing of the impoundment zone, borrow or quarry sites and any additional facilities (concrete batch plant etc.). About 13,767 acres of forest will be cleared.

4.3.4 - Access Roads and Railway (**)

Although access roads and the railway will be built in concert with the first two stages, they are discussed as a complete, integrated system in the sections that follow for clarity.

The Denali Highway to Watana access road will be built during Stage I, and will be closed to the public until Stage I is completed. Workers will be transported to the site by an air/bus transportation scheme during Stage I, and will not be allowed use of the access road. The air/bus scheme is scheduled to be evaluated after Stage I, and may or may not be continued. During Stage II, the Watana to Devil Canyon road will be built, as well as the Gold Creek to Devil Canyon rail spur. Both will be closed to public access during construction, and the rail spur will remain so throughout the life of the Project.

During Stage II, the Denali Highway to Watana road will be open to the public, although no road access will be possible across the Stage I dam. The Stage III construction period will see a closure of the road from the Denali Highway to Devil Canyon route south to the Watana damsite, and construction of a road across the top of the Stage III dam. Both of these roads will be open to the public after construction.

(a) Moose (*)

Anticipated impacts on moose due to the gravel access road from the Denali Highway to the Watana damsite and the later construction and operation of the Devil Canyon access road include a loss of habitat, alteration of habitat, disturbance and subsequent avoidance of the highway, interference with seasonal movements, and mortality. Moose will also be affected by the indirect impacts of the access road, particularly hunting. Moose numbers will decline locally as a result of hunting mortality and avoidance of the corridor by moose. The railway from the Gold Creek area will have similar effects to those mentioned for the access roads, except that hunting mortality should be lower (as a result of poor vehicular access) and collision mortality during the winter may be higher.

(i) Disturbance and Mortality (**)

The primary impact of the access roads will be the consequences of improved public access to previously remote areas in the Susitna Basin. Such improved access will probably result in localized declines in moose as a result of hunting, and by moose avoidance of the highway corridor due to disturbance. Declines in moose along newly opened roads or along roads in areas opened for hunting have been reported for a number of northern areas (Goddard 1970, Cumming 1974, Ritchey 1974, Beak 1979). Although a good portion of these declines in moose were the result of hunting mortality, moose probably also avoid areas in the vicinity of access corridors during the hunting period.

A slight decline in moose numbers during construction of the Watana access road can be expected as a result of collisions involving construction vehicles. Public access to the Susitna Basin will increase once the road is open to them, and increases in hunting pressure will occur in the areas.

Construction and operation of the Watana to Devil Canyon access road segment and the rail spur will result in similar but less severe impacts on moose. The Devil Canyon segment will provide new access to a relatively smaller area, much of which is poorer quality moose habitat than is the Watana Dam area. The rail spur will not provide as easy an access route to the general public as the roadways, and its use can be better controlled. Consequently, hunting pressure will not increase as in the case of the access roads. In addition, much of the area that will be affected by railway access supports relatively low numbers of moose as compared to lower reaches of the Susitna River.

The number of moose involved in collisions with vehicles on the proposed access roads and railroad will depend on the amount of traffic over the roads and the severity of winter conditions. Generally, moose in the project area move to higher elevations in October, presumably to breed, and then, depending on snow conditions, begin moving downward, reaching the lowest elevations occupied during the year from January through May. Moose appear to be driven to lower elevations in winter by heavy snowfall; however, in an average or mild winter, it is assumed that temperature inversions and high winds make foraging and traveling easier at higher elevations. Consequently, moose may occupy relatively high areas in winter and spring, depending on snow depths, temperatures, and other factors. Moose occupy lower elevations in late spring and early summer during calving (ADF&G 1984m). During severe winters, access roads and their associated roadside vegetation are attractive to moose as winter travel lanes and feeding sites.

During construction of the Devil Canyon Dam, collision mortalities along the 12-mile railroad spur from Gold Creek to the site may also occur. Trains are expected to make eight round trips per week on the rail spur during the period of peak construction of Devil Canyon Dam. Fewer trips are expected to occur during the winter months when moose are most susceptible to collision mortality. Railroad traffic is not expected to increase along the Anchorage to Fairbanks track, since cars would be added to scheduled trains to move materials to Talkeetna rather than adding trains.

Man-made transportation corridors such as snow-free roadways and railbeds can substitute for natural routes. Wherever these corridors intercept and/or parallel traditional ranges of moose, the animals may frequent the right-of-way (Child 1983). This fact, coupled with the lack of lateral movement and poor stopping ability of trains compared to that of automobiles, is expected to result in more collision mortalities per mile along the railroad spur during severe winters than along the access road.

Although some moose are likely to be killed by collisions with project vehicles on access roads and trains on the 12-mile rail spur, the numbers involved are not expected to significantly affect local moose populations because: (1) the air-bus worker transportation plan (see Mitigation Plans No. 14 and 15, Section 4.4.2) during peak construction years will reduce average annual daily traffic volumes on the access road to the order of 200 to 250 vehicles per day (Table E.3.4.65); (2) the open terrain that characterizes most areas adjacent to the access roads will enhance visibility for moose and drivers of vehicles; (3) rail traffic on the Anchorage to Fairbanks track is not expected to increase; and (4) access road and rail traffic are expected to be lowest during the winter months when moose are most susceptible to collision. Based on available unpublished data from the Alaska Department of Transportation and the Alaska Railroad, the moose collision mortality rate is expected to be less than 10 moose per year during peak construction years for all project access corridors.

(ii) Loss of Habitat (o)

Construction of the Watana and Devil Canyon access roads and the railway will result in loss of habitat associated with the construction corridor and borrow pits. Although the actual removal of moose browse will be small in relation to its availability in other areas of the Susitna Basin, the effective loss may be greater if moose avoid the access corridors or if migration routes are blocked. As discussed above, moose will tolerate disturbance along access corridors if they are not hunted. However, if hunting is permitted, moose may avoid an area several miles from the corridor, consequently increasing the effective area of lost habitat.

Based on existing information, no special use areas for moose such as wintering range, calving areas, or breeding concentrations will be rendered unusable by the road access corridors. However, because most special use areas will be inundated by the impoundments, these road corridors could affect the location of new special-use areas. Anticipating such changes is obviously difficult.

The problem of railway corridors in moose wintering areas and resulting collision mortalities has already been discussed.

(iii) Alteration of Habitat (o)

Construction of the access road and railway will necessitate the use of gravel berms that may impede or alter drainage systems (Boelter and Close 1974, Kemper et al. 1977). Permanent flooding of forested areas may result in the loss of some moose habitat through killing of trees and shrubs. However, growth of aquatic plants within flooded areas may partially compensate for this loss by providing additional summer forage. Drainage of wetland areas may result in a temporary increase in the growth of seral shrub communities, but without periodic flooding or disturbance, these areas will eventually develop into forest stands with low browse production.

(iv) Interference with Seasonal Movements (*)

The proposed road access corridors will cross several areas where moose migrate seasonally between summer and winter ranges (ADF&G 1982k). Concentrations of movements by radio-collared moose that may be affected by the Watana road include the Watana to Butte Creeks area, and the Watana to Deadman Creeks area (Section 4.2.1[a]).

During construction, mechanical activities may hinder some moose from crossing the road corridors, primarily as a result of moose avoiding the construction area. Avoidance of the road corridor would probably be most severe during the hunting season, if hunting is permitted. Steeply sloped road berms and/or the creation of deep snow embankments from road-plowing may act as physical barriers to moose crossings. As discussed earlier, the railway may interfere with movements of moose during the winter and early spring periods when snow embankments may either block movements by moose or trap animals within the cleared right-of-way.

(b) Caribou (*)

The upper Susitna-Nenana caribou subherd currently consists of some 1,500 animals and represents approximately six percent of the total Nelchina herd. The proposed project access road lies in an area between summer and winter ranges for an estimated 35 to 50 percent of this subherd. Calving by females of the upper Susitna-Nenana subherd has been dispersed over a wide area, primarily in the headwaters of the Susitna River, the Butte Lake area, Brushkana and Deadman Creek drainages and the Chulitna Mountains. This is in contrast to the main Nelchina herd, where females form a relatively cohesive group and give birth to their calves in a restricted geographic area. Summer range for this subherd is similar to calving range, although animals are often found at higher elevations. The primary wintering areas are the Butte Lake-Brushkana Creek area, Monahan Flat and along the Susitna River north of the Denali Highway (ADF&G 1984o). Several hundred caribou wintered in the Chulitna Mountains in 1983. Radio-collared caribou from the upper Susitna-Nenana subherd have migrated between summer range in the Chulitna Mountains and winter range to the east, crossing the proposed Denali access route (ADF&G 1984o). Thus, perhaps 35 to 50 percent of this subherd could cross the proposed access road twice a year (ADF&G 1983c). The majority of the spring crossings would occur between mid-May and mid-June and the autumn movements would occur between mid-August and mid-September (Pitcher 1984, pers. comm.). Classical migration patterns often associated with caribou in the north (e.g., long distance, highly directional movements) are not characteristic of the upper Susitna-Nenana subherd. The subherd occupies a geographically localized area of approximately 1,500 mi^2.

Large movements of caribou across the proposed Watana impoundment have not been recorded in about 10 years. It appears that major herd use of the range north of the Susitna River, usually occurred when winter range condition was good and population levels were relatively high. During recent years, when major herd use of that area has not occurred, the herd has been at low to moderate population levels and has used about 80 percent of its historical range (ADF&G 1984o). Hemming (1975) suggested that the range use, frequency of shifts in range, and seasonal splitting were positively correlated with herd size. As herd size increases, so will the probability of increased use of the northwestern portion of the range. However, with present

ADF&G management goals, the population of the Nelchina herd is not likely to approach the maximum historical levels.

The effects of vehicle traffic on caribou movements (a potentially more serious impact than by the actual presence of the road) can be minimized by reducing traffic volume. This will be accomplished in two ways (see Mitigation Plan No. 14, Section 4.4.2). First, public access will be controlled by 1) prohibiting all public access during Stage I construction (1989 to 1997); 2) allowing public access to Watana Dam but prohibiting access along the Devil Canyon access road during Stage II construction (1998 to 2002); and 3) allowing public access on the Watana access road to the Devil Canyon road cutoff and along the Devil Canyon access road, but prohibiting access on the Watana access road from the Devil Canyon cutoff to Watana Dam, during Stage III construction (2003 to 2008). Second, worker use of project access roads will be controlled by permitting only those workers with resident families to maintain private vehicles and drive private vehicles along the access roads at least during Stage I construction which represents the stage with the largest work force. The majority of the work force will reside at the construction site only during their two to seven week-long work shift. They will be transported to and from the Project using air or bus transportation or a combination of these transportation modes. Thus, average annual total daily traffic volume during the peak construction year (1997) will be about 200 vehicles per day (Table E.3.4.65). After the completion of Stage I construction in 1999, the yearly average work force is expected to range from 400 to 1,000 workers during the construction of Stages II and III. The air-bus transportation system is not expected to be implemented during this period unless wildlife and/or socioeconomic concerns indicate its need. Project-related average annual total daily traffic volume during this period is expected to range from 160 to 235 vehicles per day (Table E.3.4.65). Some additional traffic volume attributable to recreational use is expected during this period. However, recent surveys (H-E 1985k, ISER 1985) indicate that the Denali Highway receives most of its use from July 1 through September 15, a period during which impacts to big game are expected to be minimal.

In general, moving vehicles and/or the presence of workers will affect the local movements and behavior of caribou. Russell et al. (1978) reported that large trucks evoke a greater response (i.e., running or trotting away) by caribou than small vehicles, an observation also made by Surrendi and DeBock (1976) and Roby (1978). The responses of individual caribou to roads and traffic are extremely variable; some animals appear to avoid traveled roads (Cameron and Whitten 1979, 1980), whereas others will cross roads despite hunting and the presence of traffic (Johnson and Todd 1977; Russell et al. 1978; Bergerud et al. 1984). Carruthers et al. (1984) studied the response of the Nelchina caribou herd to the Trans-Alaska Oil Pipeline, and noted that virtually all caribou (99.5 percent) that encountered the pipeline crossed successfully. They determined that factors governing population size and seasonal distribution of the Nelchina herd were not affected by the presence of the pipeline.

In addition to the effect of traffic, the structure of the road itself has been postulated to affect caribou movements and behavior. Hanson (1981) found that experimental berms along roads on the North Slope of Alaska presented visual barriers to caribou movements. Berms greater than four feet above ground level had a pronounced effect in altering movements, but animals readily crossed berms less than four feet high. The deflection behavior was particularly apparent when caribou encountered barriers they could not see over. This effect is magnified in winter when snowclearing operations result in mounds of snow piled along the road. The visual barrier and poor footing on snow berms may contribute to caribou avoidance of roads in winter (Jakimchuk 1980). Bergerud et al. (1984) have disagreed with the idea that berms deflect caribou movements. They point out that berms are not unlike the bermlike features (eskers) and steep mountain ranges commonly encountered in caribou range, and which are readily traversed by the animals. They postulated that caribou seek the path that requires the least energy expenditure to travel, rather than respond to physical barriers with a fixed threshold height. During the migrations of the Kaminuriak caribou herd in Canada, the animals unhesitatingly cross drift fences 3 to 5 feet) high and jump fences greater than 6.5 feet high (Miller et al. 1972).

The greatest potential for road-related disturbance effects on the upper Susitna-Nenana subherd is for cows in late pregnancy and those with young calves. Female caribou are particularly sensitive to disturbances during the calving period (Lent 1966, Bergerud 1974b, Calef et al. 1976, Surrendi and DeBock 1976). Any caribou avoidance of the road corridor will probably be similar to the behavior of caribou from the Central Arctic herd that have been observed interacting with the Trans-Alaska Oil Pipeline and its associated haul road. Avoidance of the pipeline corridor by cow-calf groups in summer was attributed to the effects of human activity and traffic along the corridor. The responses were largely seasonal; avoidance was greatest during summer months, when cows were accompanied by subadults or young calves, and it declined by fall (Cameron and Whitten 1978).

The Central Arctic herd continued to migrate north and south, parallel to the Trans-Alaska Oil Pipeline and the Dalton Highway, during and after the construction period (1974 to 1977). Between 1973 and 1982 the herd had increased at an average annual rate of 13 percent. The construction and operation of two pipelines and the Dalton Highway through the center of the range of the Central Arctic herd and the proliferation of oil field facilities in the Prudhoe Bay area were not correlated with a negative population response by the herd between 1974 and 1982 (Bergerud et al. 1984).

The Nelchina caribou herd in Alaska has coexisted with highways for over 20 years (LeResche 1975). The herd experienced a rapid decline in numbers from 1962 to 1972-1973. The decline was coincident with an increase in wolf numbers (Rausch 1967), a decrease in calf survival, and an increase in hunting. The heavy hunter harvest has been considered the major cause of the decline (Doerr 1980). The herd continued to migrate across the Richardson Highway as their numbers decreased, even in the presence of intense human disturbance from hunting (Bergerud et al. 1984). As the Nelchina herd increased between 1955 and 1962, it expanded its range to include the same area it had used in the 1880's prior to the construction of most of the surrounding transportation corridors. As the herd increased it crossed the Denali, Glenn, and Richardson Highways. Roads were not a barrier to movement but did permit human access which greatly contributed to overhunting and the subsequent herd decline (Bergerud et al. 1984).

The Nelchina herd continued to decline after 1972 (ADF&G 1981h), and in 1976 protective measures were implemented by the ADF&G. By 1977, the herd was considered to be increasing (ADF&G 1982h). Construction of the Trans-Alaska Oil Pipeline, generally parallel to the Richardson Highway, was underway during the mid-1970's. The pipeline, which crosses herd migration routes, was completed in 1977 during the period of population recovery. The increase in numbers and productivity of the herd which has continued to present commenced during the actual construction period (Bergerud et al. 1984).

The Nelchina herd continues to cross the Richardson Highway. In addition, portions of the herd also cross the Denali Highway and Lake Louise road; although not important transportation corridors, these are used intensively for hunting. The migratory movements of the Nelchina herd result in the crossing of the Richardson Highway twice a year, once in spring and again during fall. While doing an aerial survey in October 1981, ADF&G (1982h) estimated that the herd was evenly distributed east and west of the Richardson Highway and the Trans-Alaska Oil Pipeline. Segregation of the herd was apparent, there being more calves and bulls east of the highway and pipeline. Portions of the upper Susitna-Nenana subherd regularly cross the Denali Highway during their annual movements.

The Fortymile caribou herd of eastern Alaska has experienced major population fluctuations (Davis et al. 1978). As the herd has increased or decreased, its range has also expanded or contracted. When the herd declined in the 1960s and 1970s, it stopped crossing the Steese Highway but continued to cross the Taylor Highway (Davis et al. 1978). Bergerud et al. (1984) postulated that the major impact of the Steese and Taylor highways has been to allow access by hunters, thereby contributing to the overharvest and decline of the herd. Bergerud et al. (1984) noted that no barrier effect on caribou or range abandonment has been documented for the Fortymile herd.

Surrendi and DeBock (1976) studied caribou associated with the Dempster Highway (Canada) and concluded that the road did not appear to be an insurmountable barrier to the animals. They recorded behavioral responses of caribou crossing the highway and noted that animals disturbed while attempting to cross during the day frequently would cross the road at night after traffic had ceased.

Unhunted caribou in Denali National Park cross the park road "fairly readily" but with caution, according to Tracy (1977), and have become habituated to the road and its steady, low volume traffic patterns.

Calving of the upper Susitna-Nenana caribou subherd occurs north of the Susitna River. The proposed Denali-Watana access road has been aligned so that it is to the west of the areas where most calving has recently occurred. Cows calving in the area may avoid the access road, but because of the dispersed calving by this subherd, only a small portion of calving females would be affected (ADF&G 1983c). During spring migration, pregnant cows that are accustomed to calving in the Chulitna Mountains, west of the proposed access route, may be delayed in crossing the road during periods of heavy traffic but are expected to cross during traffic lulls. The situation is expected to be short-term (2 years), however, occurring only during peak construction years. Light traffic volume, similar to that on the Denali Highway, is expected during the post-construction period. Because of its low profile (2 to 3 feet above original ground level), the road itself will not be a barrier. Snow accumulation in the area along the proposed access road varies from year-to-year (Table E.3.4.66), and snowplow ridges could make the road a barrier to caribou in heavy winters. This can be prevented by an appropriate snow removal policy.

Little effect is expected if the main Nelchina caribou herd expands and resumes migratory movements to and from the area north of the Susitna River because of the decreased traffic volume that will occur after project construction is completed. In general, the short-term nature (5 to 7 years) of peak construction traffic, the low traffic volume expected following construction, the fact that the Nelchina herd harvest is permit controlled, and the lack of evidence that any North American caribou herd size has been limited by introduced linear features (e.g. highways, railroads, pipelines) and associated disturbances (not including hunting) indicate that the access road will not significantly impact caribou numbers.

(c) Dall Sheep (o)

The effect of vehicle traffic along the access road on Dall sheep should be insignificant, since sheep are not expected to occur close to the roads. MacArthur et al. (1982) found that only 19 of 215 documented passes (8.8 percent) of sheep by vehicles evoked heart rate responses, usually of low amplitude. Moreover, 73.7 percent of all heart-rate responses occurred when vehicles passed within 82 feet of the sheep. They reported that only 2 of the 215 vehicle passes (0.9 percent) they recorded evoked withdrawal responses by sheep. In Denali National Park, Tracy (1977) found that the strength of reactions and the percentage of sheep showing visible reactions to buses and visitors decreased with increasing distances between the sheep and the road. No reactions were recorded by sheep at distances exceeding 2,460 feet from the road, whereas strong reactions were recorded only at distances less than 1,312 feet. Dall sheep have continued to use lambing and wintering areas along the Dalton Highway (Hemming and Morehouse 1976, Fancy 1980), in spite of intensive pipeline construction and vehicle traffic along that road. Disturbance due to air traffic is treated in Section 4.3.1(d). Increased disturbances from human access as described in Section 4.3.1(d) for the construction phase will also occur during operations as recreational use of the area increases.

If the project area is opened to the public following construction, there will likely be an increase in hunting pressure in locations adjacent to the access roads and the reservoir. The number of sheep harvested in the area is not expected to increase greatly, however, because most legal rams in the area are already being harvested each year. Serious population depletions resulting from the increased hunting pressure are thus not expected to occur.

(d) Brown Bear (**)

Both the Denali-Watana and Watana-Devil Canyon access road segments traverse prime brown bear habitat. Potential impacts of the access roads on brown bears include interference with movements, increased hunting and bear-vehicle collision mortalities, and a decrease in acceptable denning and feeding areas. Direct mortality from hunting and nuisance animal control would probably have the greatest effect on the population in the long term.

Tracy (1977) reported on the reactions of brown bears to the Denali Park Road. The densities of bears in study plots away from the road were consistently greater than densities along the road, suggesting an avoidance of roads by bears even where no hunting occurs. Many bears have habituated to the road, however, and those seen near the road were frequently engaged in such activities as nursing, playing, and sleeping, which suggests security and relaxation. The literature also includes a paper by Elgmark (1976), who reported that construction of a network of logging roads in Norway resulted in a lower density of brown bears, and a report by Miller and Ballard (1982) on the apparent short-term deflection of brown bear movements by the Glenn Highway in Alaska.

The access road is likely to cause some alterations in the movements of brown bears, but there is little evidence to suggest that it will block bear movements altogether. Increased access into the area is not anticipated to result in a significant number of bear-vehicle collisions. In addition to state regulations which forbid the harassment of wildlife by plane, aircraft disturbances of brown bears in the project area will be minimized through flight rules and altitude restrictions applicable to project personnel and activities. Construction of, and travel on, the proposed access roads should not affect brown bear denning activity. The nearest dens identified since 1980 were at high elevations in the Chulitna Hills and the uplands bordering upper Deadman and Watana Creeks, all approximately 1.5 miles from, and up to 2,000 feet higher than, the nearest portion of the proposed access road (based on data from ADF&G 1984n).

The Denali Highway-to-Watana segment of the access road outside the brown bear study area passes through what is probably prime denning habitat. Most bears dig new dens each year, and there does not seem to be a shortage of good denning areas, so population-level effects are likely to be negligible, unless activities commence in mid-winter after bears are already in dens (APA 1985i). However, a brown bear might establish a den location where it would be disturbed by winter road construction.

Abandonment of dens by bears in winter can result from human activity near the den (Craighead and Craighead 1972a,b; Harding 1976) or from disturbance caused by helicopters (Reynolds et al. 1976). However, construction activity, especially high noise levels, during the period of den establishment in the autumn and early winter may result in bears avoiding the corridor sufficiently to prevent disturbance inside the dens. Thus pre-construction or construction activities along the access corridor during the den-establishment period might help to avoid subsequent impacts on hibernating bears.

(e) Black Bear (**)

Increased access into the area is not anticipated to result in a substantial number of black bear-vehicle collisions. In addition to state regulations which forbid the harassment of wildlife by planes, aircraft disturbance of black bears will be minimized through flight rules and altitude restrictions applicable to project personnel and activities. Access road construction and subsequent traffic may disturb denning black bears, depending on the distance of the den from the road and the timing of the disturbance. Bears may avoid denning near the road if construction-related activities or vehicle traffic occur during October and early November, the period during which dens are established. Such avoidance behavior would help to prevent disturbances to denning bears later in the winter and early spring. Ten active black bear dens have been identified within two miles of the proposed access route since 1980; the average distance of these known den sites from the proposed route is 1.4 miles.

(f) Wolf (*)

The major effect of the access route on wolves will be an increase in the numbers of hunters and trappers able to shoot wolves in the area once the road is opened to the public. Currently, there are no plans to allow workers to have firearms or traps in camp. However, wolves may also be affected by disturbance from construction activities and traffic, and small numbers may be killed by vehicles. The number killed by vehicles is likely to be greater if wolves become habituated to vehicles through being fed. Since wolves habituate readily to traffic and noise under most circumstances, disturbance is unlikely to have major effects. However, wolves appear to be more sensitive to disturbance during the denning season. Carbyn (1974) documented abandonment of two wolf dens near highways after the roads were upgraded and traffic volumes increased. The proposed Susitna access route passes through the home ranges of at least three wolf packs. Two den sites and one rendezvous site are known from the general vicinity of the access route; additional sites most likely exist.

Impacts from increased access by hunters and trappers cannot be quantified but may be severe. As many as 8 to 10 wolves per year were taken in the immediate vicinity of the proposed impoundments between 1976 and 1982 (ADF&G 1982f) in spite of the relative inaccessibility of the area. Increases in the number taken may be beyond the replacement capabilities of the population or may reduce the ability of this population to produce excess animals that presently disperse to areas even more heavily hunted.

(g) Wolverine (**)

The direct loss of habitat caused by the access road will have an insignificant effect on wolverine. Hornocker and Hash's (1981) statement that "the size and shape of (wolverine home) ranges were not affected by rivers, reservoirs, highways or mountain ranges" suggests that the road and associated traffic will also have an insignificant effect on wolverine movements and availability of prey. It is not clear whether wolverine will utilize carcasses of animals killed by collisions with vehicles, but this is a possibility, especially during periods of infrequent vehicle use. The potential for wolverines to be killed by vehicles is very low, considering the low densities of wolverine and their wariness.

Increases in trapping pressure as a result of improved access is more likely to affect wolverines than any other project-related activity. Wolverines are highly susceptible to trapping because they travel widely and are readily attracted to baits. Hornocker and Hash (1981) reported that all of the wolverines they captured were missing one or more toes, and many had broken teeth; many of these mutilations were attributed to encounters with leg-hold traps. Van Zyll de Jong (1975) stated that although direct evidence of negative impacts on wolverine populations by human exploitation was lacking, they believed that indirect evidence strongly suggested such a relationship. Fifteen of the 18 known wolverine mortalities in Hornocker and Hash's (1981) study were human-caused. Increased trapping pressure in the Susitna Basin will probably cause some instability in the social structure of the population, thus causing noticeable shifts in home ranges. However, population effects of altered trapping mortality would be difficult to detect because of emigration of wolverine from areas of wolverine habitat surrounding the basin.

Wilderness or remote country where human activity is limited appears essential to the maintenance of viable wolverine populations according to Van Zyll de Jong (1975), but that Hornocker and Hash (1981) found the situation to be more ambiguous. The latter found that human uses of an area, including logging and recreation, were apparently of no major concern to wolverine as long as there was an elevational separation between the seasonal uses of the areas by wolverines and humans. Such a situation will exist in the middle Susitna Basin; the most intensive human use of the area will occur in summer when wolverines are using primarily higher elevation habitats. Access to these tundra areas afforded by the roads and transmission corridors may cause several wolverines to avoid portions of their range. Winter use of the impoundment areas, except for trapping, should be considerably less than that during snow-free periods.

(h) Furbearers (*)

The construction of the access road and the rail spur will result in some habitat loss for terrestrial furbearers, and may result in habitat loss for aquatic furbearers if wetlands are degraded. Minor effects on the local distribution of individuals of some species may also occur along the road. For example, Hawley and Newby (1957) believed that habitat openings were a psychological barrier to marten. Although subsequent studies have found that marten regularly cross openings 328 to 656 feet wide (Koehler et al. 1975, Soutiere 1978), the access route will result in a redistribution of home ranges.

Similarly, some foxes may avoid the road area, but most will habituate to traffic. Tracy (1977) found several fox dens within 328 feet of the road in Denali National Park and observed foxes traveling along the road while vehicles were using it. However, such habituation to human presence probably occurs only in the absence of trapping pressure. Access routing (Figures E.3.3.22 to E.3.3.25) is very near several red fox denning complexes, which, in the absence of mitigation could be made unusable or be physically destroyed.

Access to the Watana site from the Denali Highway has the potential to negatively impact large numbers of beaver. Approximately 65 beaver occupy 12.3 miles of upper Deadman Creek, a relatively broad stretch along the proposed access route. Similar beaver densities may occur in adjacent areas designated as material sites. Use of the valley bottom for the road and material sites would negatively impact at least 40 beaver.

Two opposing scenarios are reported in the literature on possible effects of road construction on beaver habitat. In one (Watson et al. 1973), diversion or impoundment of stream and subsurface water flows by road berms has a negative effect on downstream beaver ponds and lakes through the introduction of heavy sediment loads and increased turbidity. These are the effects of bank instability caused by the clearing of riparian vegetation associated with rights-of-way construction and maintenance. Heavy sediment loads result in the gradual filling of downstream ponds and lakes; increased turbidity reduces light penetration and inhibits growth of aquatic vegetation.

Alternatively, ponding at culverts and bridges and restricted subsurface flows caused by road berms have often created attractive sites for beaver colonization. The use of bridges and culverts as damsites by beaver is well documented (Bradt 1947, Hodgdon and Hunt 1953, Huey 1956, Rutherford 1964, Johnson and Gunson 1976). However, habitat improvement through the introduction of a road in prime beaver habitat along upper Deadman Creek is unlikely, and a reduction in beaver numbers is expected there as well as along other creeks in proximity to the access road.

Muskrats along the proposed access routes will be affected through habitat loss and increased trapping mortality. Gipson et al. (1982) found sign of overwintering muskrats in several of the lakes lying along the proposed route from Watana Dam to Devil Canyon Dam. Many of these muskrats occurred in conjunction with the high beaver densities noted along the proposed route from the Denali Highway to Watana Dam.

In addition to being very sensitive to water level changes which could occur because of draining or filling of ponds and lakes (Bellrose and Brown 1941), the small foraging area of muskrats, (usually within 33 feet of their house) makes them sensitive to loss of their preferred foods of aquatic and emergent plants (Butler 1940).

No substantial effects are anticipated on mink or otter populations with the possible exception of increased recreational disturbance resulting from public access to streams that may be important to these species.

The major impact of the access routes on furbearers is related to the probable increase in trapping pressure. The Susitna Basin is not heavily trapped at present and, for some species, the area may be a source from which animals disperse into more heavily trapped adjacent areas. The species that will be most affected by increased trapping pressure are probably marten, beaver, muskrat, and red fox. Marten are the most economically important furbearer in the basin; beaver and fox are also heavily exploited in adjacent areas. Mink and otter may be affected to a lesser extent, since they do not appear to be particularly desirable species in this part of Alaska (Gipson et al. 1982).

(i) Raptors and Ravens (*)

(i) Denali Highway to Watana Damsite (*)

Some nesting habitat for ground-nesting raptors (e.g., merlins, northern harriers, short-eared owls) may occur along the Denali-Watana section of the access road and may be lost; however, cliff-nesting habitat does not appear to occur within at least a few miles of the route, and only one tree-nest appears to be associated with it.

No golden eagle, gyrfalcon, goshawk, or raven nesting locations will be lost as a result of road construction between the Denali Highway and the Watana campsite and Watana damsite.

Bald eagle nesting location (BE-6), was initially located close to the Denali Highway-Watana access route. The route has since been realigned about 0.5 mile north and west of BE-6 to avoid physical impacts on the nesting location and to minimize potential disturbance during construction and operation.

(ii) Watana Damsite to Devil Canyon Damsite (*)

- Habitat Loss (*)

Some nesting habitat for ground-nesting and tree-nesting raptors may occur along the Watana-Devil Canyon section of the access road and may be lost; however, no known cliff-nesting habitat will be lost.

- Disturbance (*)

Two nesting locations, one golden eagle (GE-18) and one raven (R-21), may be susceptible to disturbance from the Watana-Devil Canyon section of the access road. Both are near the western end of the road, within about 0.2 to 0.3 miles of the centerline. Furthermore, a bridge will be built across the river about 0.5 miles downstream from the golden eagle location; the activity during construction may result in temporary abandonment of this site.

(iii) Devil Canyon Damsite to Gold Creek (*)

- Habitat Loss (*)

Some nesting habitat for ground- and tree-nesting raptors may occur along the proposed railroad access route from Devil Canyon to Gold Creek; however, no known nesting locations will be lost. No known cliff-nesting locations occur in this section of the access road.

- Disturbance (*)

Bald eagle nest BE-8 is located 0.25 mile from the railroad access route, which cannot be realigned. No restrictions are required to limit disturbance from ground activities at this distance, because it is the outer limit of the area within which major ground activity would be prohibited during the sensitive period. However, the railroad route is in conflict with the distance restriction on permanent facilities. The nest is on the opposite side of the river from the railroad; this will provide additional protection from disturbance. Nevertheless, it should be noted that all of the bald eagle nests in the lower Susitna Basin are at least 0.5 mile from the railroad. Because the railroad route cannot be realigned, there are no further measures that could be applied to protect against disturbance at that nest site if critical periods are not observed.

(j) Waterbirds and Other Birds (**)

Impacts of access roads on birds will result from habitat loss and alteration, disturbance from traffic and people associated with the project, direct mortality from both collisions with vehicles and increased hunting pressure, and indirect effects on nesting success because of increased recreational use. The most significant of these impacts vary with species group, but for most species, none will be as serious as the impacts resulting from the flooding of the impoundments.

Habitat alteration will include some opening of the canopy where the road passes through closed forest and shrubland. This may result in a change in species composition of breeding birds. In at least one instance (Jeglum 1975), building of a road that blocked drainage through a portion of the boreal forest has been shown to improve habitat for some waterbirds.

Effects of disturbances from road traffic will probably be minor for most species, but there are few quantitative data to support this argument. In one of the few quantitative studies of disturbance to songbirds, Ferris (1979) reported no differences in breeding bird densities adjacent and distant from four-lane and two-lane highways in Maine. He did find a small difference in species composition that was ascribed to edge effects adjacent to the highway.

Some species of low open habitats may be more affected. Van der Zande et al. (1980) found that two and possibly three of the four shorebird species they studied nested at lower densities up to at least 0.8 mile from both busy and relatively quiet roads. In some cases, nesting density was reduced by 60 percent. Quantitative studies of species nesting in open habitats in Alaska are not available, but similar effects could occur with ptarmigan, some shorebird species, and some passerine species.

Some birds will undoubtedly be killed by road traffic. Species such as spruce grouse will be attracted to the road as a source of gravel (Carbyn 1968), whereas scavengers, including ravens and possibly eagles, will be attracted by road-killed wildlife. However, mortality from collisions will probably have a lesser effect on gamebirds than will increased hunting pressure. The middle Susitna Basin is relatively inaccessible at present, and it is likely that little game bird hunting occurs there. When road access is provided, hunting will undoubtedly increase and will probably be concentrated along the road. Weeden (1972) found that hunters killed a much larger proportion of ptarmigan within 0.5 mi of the Steese Highway than farther away. The same would likely be true for other game birds.

Increased recreational use or human disturbance in wilderness areas in other parts of North America has been associated with various behavioral effects, and in some cases with reduced nesting success. Loons and grebes appear to be particularly affected by boating activity. Nesting success in both groups has been shown to decrease with increasing presence of boats and canoes (Ream 1976, Euler 1978, McIntyre 1978). Power boats may also destroy loon nests through wave action (Vermeer 1973).

Recreational activities, particularly in open habitats, may result in nest destruction by predators after incubating adults are flushed. This has been documented for at least two duck species and the Canada goose (Hammond and Forward 1956, MacInnes and Misra 1972). Presumably, similar nest losses could occur in upland tundra species flushed from their nests by all-terrain vehicles or other recreational activities.

(k) <u>Non-Game (Small) Mammals</u> (o)

The proposed access roads to the Susitna dams will traverse a wide variety of small mammal habitats, but will mostly be in shrubland and tundra. Although all species of small mammals are expected to be affected to some extent, only the species most affected (those living in shrubland and tundra habitats) will be discussed below. Impacts include increased mortality, impeded dispersal, presence of new habitats, and changes in drainage patterns.

In areas of moist tundra, the gravel berm that will constitute the roadbed will act as a barrier to dispersal of small mammals. Traffic on the road will cause increased mortality in local populations. However, no serious changes in regional population sizes or structures are expected.

The well-drained gravel of the roadbed will provide ideal burrow sites for arctic ground squirrels and singing voles. The revegetated areas on the edges of the gravel berm may also be colonized by meadow or singing voles and some species of shrews.

Portions of the road will likely cause subtle changes in drainage patterns in lateral areas which in turn may result in alterations to vegetation. The types of vegetation that become established will depend on whether water levels increase or decrease as a result of the road. Species composition of small mammals in these areas will shift accordingly, with brown lemmings, bog lemmings, and tundra voles preferring the wetter areas; and red-backed voles, singing voles, and shrews attracted to the well-drained areas.

4.3.5 - Transmission Lines (**)

The construction and operation of the transmission lines associated with the project will affect a wide variety of wildlife. The corridor that the transmission lines will follow as they leave the generating plants is generally westward following the Susitna River valley to Gold Creek near the Alaska Railroad route. At Gold Creek the corridor divides to provide for lines north to Fairbanks and south to Anchorage; in both cases, the corridor follows the Intertie. However, the lines to Anchorage will leave the Intertie just outside Willow and continue in a southerly direction across the Knik arm to Anchorage. Power generated by the Watana Stage I hydroelectric station will be distributed through transmission facilities which will extend over the full length of the corridor. Later when Devil Canyon Stage II and Watana Stage III are developed, the facilities will be supplemented with additional components along some parts of the corridor. The length of the corridor Sections and the number of lines contained within them are as follows (see Figure E.3.3.19):

	Corridor Length Miles	Stage I Watana	Stage II Devil Canyon	Stage III Watana	Devel- opment
	NUMBER OF 345 KV CIRCUITS				
1. Watana-to-Gold Creek	36	2	--	--	2
2. Gold Creek-to-Fairbanks	185	2	--	--	2
3. Gold Creek-to-Willow	79	2	--	1	3
4. Willow-to-Knik Arm (West)	43	2	--	1	3
5. Knik Arm Crossing	3	2	--	1	3
6. Knik Arm-to-Anchorage	19	2	--	--	2

The cleared width of the corridor will be 300 feet for 2 towers, 400 feet for 3 towers, and 510 feet for 4 towers (Figure E.3.3.26).

The development of a staged project will require staged development of transmission facilities to Fairbanks and Anchorage (Figure E.3.3.19). The first stage includes the following:

Substations	Line Section	Number of Circuits
Watana	Watana-to-Intertie switchyard near Gold Creek	2
Gold Creek (Southbound)	Switchyard-to-Willow	*2
Willow	Willow-to-Knik Arm	2
Knik Arm	Knik Arm Crossing	2
University (Anchorage)	Knik Arm-to-University	2
Gold Creek (Northbound)	Gold Creek-to-Healy	*2
Fairbanks	Healy-to-Fairbanks	2

*One circuit is the existing Anchorage-Fairbanks Intertie

As part of the Stage II Devil Canyon development, the transmission system will be supplemented by two single-circuit 345 kV transmission lines. These lines will be built between the Devil Canyon switchyard at the power development and the Gold Creek switching station.

From the Devil Canyon substation the lines will head directly west for a distance of approximately one mile where they will intersect the Watana to Gold Creek transmission corridor. From this point to the Gold Creek switching station the lines will share the same corridor as the Watana lines.

The Watana Stage III development will require a third 345 kV transmission line from Gold Creek to Anchorage. This line will be built parallel to existing lines. A partial map of the transmission corridor route appears on Figure E.3.3.7. Initial clearing will be done with a hydro-ax or other mechanical equipment. Vegetation will be cut to 6 inches for most of the corridor, as described in Section 3.4.2 and 3.4.3 (Figure E.3.3.26). Clipped vegetation will be stockpiled, then hauled to another site for burning or disposal. The vegetation will be maintained periodically by repeating these measures.

In general, the transmission corridor will impact local wildlife through disturbance during clearing, which will occur periodically throughout the life of the project and through habitat alteration. Disturbance is most likely to have a serious impact on nesting birds, particularly raptors near the corridor and raptors, small mammals, small terrestrial birds, and waterfowl which may suffer nest destruction within the cleared areas. Larger mammals which are sensitive to disturbance may avoid the corridor during clearing operations in areas where it overlaps their range (see sections below) but are unlikely to suffer any serious impacts. Moose calving concentrations and bear den sites, if they occur in the corridor, would be the most sensitive areas. Vegetation within the corridor will be maintained at early successional stages by periodic clipping. Areas of various vegetation types which will be altered by transmission corridor clearing appear in Tables E.3.3.29, E.3.3.30, E.3.3.31, and E.3.3.32. This will cause local alterations in home ranges of small species which are restricted to closed forests where they overlap the corridor. Large bodied, more mobile species will be less affected. Many species will benefit from the vegetation diversity which the corridor will provide. Small mammals (particularly voles) are likely to colonize the corridor and will provide an easily accessible prey for some raptor species. Small birds which will colonize the corridor will also provide accessible prey for raptors. Moose and black bear will also experience positive impacts.

(a) Big Game (*)

(i) Cook Inlet to Willow (*)

The southernmost segment of the transmission corridor, from Cook Inlet to Willow, traverses mostly forest vegetation types (Table E.3.3.29). The most common community types are closed and open mixed forest and closed birch forest. The big game species that are most likely to be affected by the clearing of these forest types are moose and black bears. Both of these species utilize browse in early-to-mid-successional stands, and would likely benefit from the vegetative communities present in the transmission corridor after clearing (Scotter 1971, Lindsey and Meslow 1977). There are little data quantifying the effects of such clearings in terms of population productivity, but the general conclusion is that transmission line clearing should increase carrying capacity for moose and black bears (Sopuck et al. 1979).

The disturbances caused by human activities during construction will be temporary effects. Most big game animals will relocate during the construction phase, but are expected to return once construction is completed (Commonwealth 1982). Serious impacts are expected only if clearing and construction occur near moose calving grounds or bear denning sites. Disturbance of animals at such sites could cause decreases in productivity. The increase in human activity in the area between Willow-Cook Inlet during the construction of the transmission line is unlikely to affect regional distribution of big game species. This area is already subject to high levels of human activity. The most abundant big game species--moose and black bear--are fairly tolerant of human disturbance; those species easily disturbed (i.e., wolf, wolverine, brown bear) are already rare in the area.

(ii) Healy to Fairbanks (*)

The transmission line right-of-way in this area will traverse mostly open spruce forests, along with mixed low shrub, open mixed forest, and open deciduous forest Table E.3.3.28). In all cases, community types that will be affected by clearing operations are widespread and abundant in the area.

Impacts are expected to be similar to those discussed in the Cook Inlet to Willow section above. Most of the direct impacts will occur during the construction period, when disturbance will cause big game species to relocate. After construction, moose and bears are expected to benefit from the early successional communities along the corridor. The other big game species are uncommon in this area.

(iii) Willow to Healy (*)

The transmission corridor from Willow to Healy (the Intertie) will have to be widened to accommodate the power from the Susitna project. Most of the Intertie is located in forest types: bottomland, lowland, and upland spruce-hardwood forests (Commonwealth 1982).

The additional clearing required will affect local populations of moose, caribou, Dall sheep, brown bears, and black bears. Animals that relocate because of disturbance from construction activities can be expected to return.

Most of the major impacts associated with transmission corridors (discussed in the preceding sections) will already be effective because of the existence of the Intertie. Thus, the modification required for the Susitna project is not expected to increase access, hunting, or long-term human disturbance levels.

(iv) Watana and Devil Canyon Dams to the Intertie (*)

The transmission corridor from Watana and Devil Canyon Dams to the Intertie traverses mixed spruce-hardwood forests and brush communities, paralleling the road and railroad access routes (Table E.3.3.32). Clearing required in forested areas will probably have a beneficial effect on black bear and moose.

(b) Furbearers (*)

Furbearers will be affected by construction of transmission lines caused by habitat alteration and increased trapping pressure resulting from improved access. Although it has been shown that clear-cut areas are not a barrier to travel by short-tailed weasel, least weasel, mink, marten, or other mustelids, cleared areas are usually not used for hunting (Soutiere 1978), and some furbearers may avoid disturbed areas. Forested areas offer better sub-nivian hunting conditions because the bases of trees, logs, and windfalls provide numerous entry points (Koehler et al. 1975). Forested habitat supporting approximately six marten (see winter model, Section 4.3.1 [m]) will be cleared for the transmission corridor.

Foxes and coyotes are sometimes attracted to cleared areas as movement corridors (Penner 1976). Both foxes and coyotes may benefit from the removal of forest vegetation, since they feed heavily on microtine rodents.

Transmission lines will increase access for trappers and could result in local population reductions of some furbearers, particularly in presently remote areas. Marten and red fox will probably suffer the greatest impact, since they are currently the target of most trapper effort. Least weasels, short-tailed weasels, and mink have historically received little trapping pressure.

(c) Birds (*)

The construction and operation of the transmission corridors will affect birds mostly as a result of changes in vegetation height, disturbance during initial construction and maintenance, and the electrocution or collision mortality of large raptors and swans from transmission wires. Since much of the transmission corridor passes through forest, forest species will be replaced by birds of shrub and open habitat. Species diversity may also change (see Section 4.3.1 [p][i] - Habitat Alteration).

Currently, there are no transmission lines in the vicinity of the project (the nearest comparable lines occur between Anchorage and Willow, and between Healy and Fairbanks). Shorebirds have collided with various kinds of guy wires in western coastal Alaska during foggy weather and collisions of birds (especially waterfowl) with overhead ground wires have been documented elsewhere in North America (James and Haak 1979). Among waterfowl, swans are particularly susceptible to collisions with power lines (Avery et al. 1978). In general, bird collisions with transmission lines are difficult to prevent (marking lines may minimize collisions to some extent), but also tend to be biologically insignificant (James and Haak 1979).

Birds of prey are susceptible to electrocution as a result of perching on the structures (Harrison 1963). Electrocution is the greatest potential impact of power lines on both raptors and ravens. However, the selected transmission tower and line configuration is such that little possibility for bird electrocution exists. However, the possibility of electrocution still exists along the single 345 kv construction transmission line to be built from Cantwell to Watana via the Denali Highway. Larger size is the greatest factor affecting species vulnerability to electrocution, due to greater winspan (Oldendorff et al. 1981). Consequently, golden and bald eagles are the most susceptible of the raptors inhabiting the area being considered. In addition, immature or sub-adult eagles are more susceptible to electrocution than adults. Buteos (e.g., red-tailed hawk and rough-legged hawk) are also vulnerable, but accipiters (e.g., goshawk and sharp-skinned hawks) and even the larger falcons (e.g., peregrines and gyrfalcons) are rarely electrocuted (Olendorff et al. 1981).

Only one known raptor nest occurs near the proposed transmission route, but this nest is of special concern because it was once occupied by peregrine falcons, an endangered species. The nest occurs along the Tanana River on the east side of the corridor between Healy and Fairbanks. This nest was first discovered in the early 1960s, but was inactive in the early 1970s (LGL 1984a). It was checked by the USFWS in 1982 and was also inactive that year. Whether or not it will be used again is unknown. If the nest is active during the construction of the line, the birds may abandon it as a result of the disturbance. If the nest remains inactive during line construction, however, it will most likely be acceptable for later use during the operational phase of the the line. If necessary, the transmission line in this area could be constructed during a time period that would reduce the likelihood of disturbing nesting peregrines. Furthermore, a Section 7 consultation, as required by the Endangered Species Act, will be conducted with the USFWS to help insure that the peregrine nest is not affected.

Potential disturbance to bald eagles as a result of construction and maintenance of the Intertie line between Willow and the Gold Creek switching station will probably be minimal because the majority of the known nesting locations and nesting habitat occur along the banks and on the islands of the Susitna River (Table E.3.4.42). Although no nests of bald eagles are known to occur in the immediate vicinity of the corridor centerline, some potential bald eagle nesting habitat may be lost as a result of clearing balsam poplar and white spruce trees in some sections of the proposed line.

Potential disturbance will be minimal to golden eagles and gyrfalcons as a result of construction and maintenance of the Intertie line between the Gold Creek switching station and Healy. No known nesting locations or nesting cliffs occur in the valley bottom along the proposed route. All known nests and nesting habitat are at elevations well above the valley floor. Although no nests of bald eagles are known to occur along the route north of the mouth of Indian River, some potential nesting habitat may be lost as a result of clearing poplar trees in some areas between Chulitna, Butte, and Hurricane.

Minimal disturbance of raptors and ravens in the study area is anticipated as a result of construction of the high voltage transmission lines between the Watana Dam and the Intertie. Only one golden eagle and two raven nesting locations may be susceptible (GE-18, R-13, and R-21). Potential for disturbance as a result of summer construction would be greatest at GE-18 and R-21 if these nesting locations were active in the year when construction occurred. This potential impact, although additive, is considered far less severe than the longer term potential impacts associated with nearby dam construction upriver and bridge construction and associated traffic downriver from GE-18 and R-21.

Table E.3.4.63 indicates 1,200 small to medium-sized breeding birds lost to the transmission line, less than 0.1 percent of the population within 10 miles of the Susitna River between the Maclaren River and Gold Creek.

(d) Non-Game (Small) Mammals (o)

The transmission lines for the Susitna project will traverse a wide variety of small mammal habitats. These transmission corridors will be cleared of trees and tall shrubs. Because most small mammals are ecotone species, they are expected to benefit from the edge effects created by the clearings. One example is the snowshoe hare, which relies on dense black spruce forests for cover, but prefers more open areas for forage (Kessel et al. 1982a). Overall, transmission corridors are not expected to adversely impact small mammals.

4.3.6 - Impact Summary (**)

This section summarizes those impacts on wildlife populations predicted to be of sufficient magnitude to influence mitigation planning. The emphasis is concentrated on what are considered to be the most serious impacts to wildlife population levels; both positive and negative impacts are discussed.

Herein we address impacts only from the perspective of the wildlife populations *per se*. An increase in wildlife abundance or production is a positive impact; a decrease in wildlife abundance or production is a negative impact. Project actions known or speculated to cause measurable changes in project area wildlife population or production levels are discussed, but those actions thought to cause negligible or no changes are not.

(a) Big Game (**)

The big game populations expected to be affected by the Susitna project are moose, black bear, brown bear, wolf, wolverine, Dall sheep, and caribou. The main effects on these species will be through habitat loss by inundation, interference with movements, habitat alteration, disturbance, collision mortality, increased necessity for killing nuisance animals, and the consequences of increased access afforded to hunters.

Moose will be most severely affected by habitat loss caused by inundation of spring and winter range. In winters of light to average snowfall, up to 300 moose occur in the impoundment zones (ADF&G 1982k). However, during winters with high snowfall, higher numbers of moose may move to the impoundment zones.

Moose displaced from the impoundment zones will compete for food and space with other moose. The consequences of this competition could reduce the carrying capacity of adjacent range with potential long-term effects on mortality rates, predator populations, and natality. Borrow sites, camps, and the airstrip at Watana will remove winter habitat for additional moose. Most of these areas will be revegetated after construction, but plant growth where topsoil has been removed will be very slow. Transmission corridors contain browse supplies that will support additional moose. The growth of browse vegetation between years of corridor maintenance (clearing) will increase the availability of winter browse for moose.

The reduced summer flows and increased winter flows will alter the distribution of floodplain communities downstream from Devil Canyon. When only Watana Stage I is operating, the width of the unvegetated floodplain between Devil Canyon and Talkeetna will increase slightly, but with full project, some of the floodplain will be recolonized by vegetation. Changes downstream from Talkeetna cannot be predicted because vegetation patterns will be influenced by snow depths each winter, by the speed of spring breakup, by flow releases as they are affected by power demand, and by river morphology along the various reaches. Because large numbers of moose (over 1,000 in 1982) move to the lower river floodplain, adverse effects could occur if vegetation patterns change.

Disturbance and altered movement patterns are unlikely to have detectable population-level effects. However, moose are capable of altering habitual movement patterns to adapt to changes in range, and no long-term population-level effects are anticipated to result from construction-related disturbances or altered movements.

The consequences of increased moose mortality caused by impoundment hazards, collisions with trains and vehicles, and increased predation levels will also impact local moose populations, at least during the construction period. These factors alone are likely to have much less effect on moose than will habitat loss. However, their cumulative effects with habitat loss may be more than additive during the construction period.

The Nelchina caribou herd will be most affected by interference with movements across the impoundment zone and access road. At the current herd size, no population-level effect is likely to be detected during the construction period. The access road may affect caribou movements and range use and its use for hunting may result in a reduction in upper Susitna-Nenana subherd numbers, but it is not expected to result in a significant impact to Nelchina herd numbers.

The Devil Canyon impoundment and transmission lines will have little effect on caribou. The Watana impoundment, however, could alter caribou movements and may result in water-crossing mortalities because of hazardous ice conditions or floating debris. The potential for increased mortality cannot be precisely predicted, since ice conditions will vary each year and the number of caribou crossing the impoundment as the herd expands is unknown.

Increased recreational use of the area may also impact caribou. The calving area and summer range of females with calves would be most sensitive. Heavy use of widespread areas by all-terrain vehicles would also reduce carrying capacity through vegetation damage. The ADF&G has expressed concern that impacts with no measureable effect on current population levels may nonetheless further reduce the ratio of harvest to demand, which is already low, by eliminating the option to allow a substantial increase in herd size for that reason.

Dall sheep will be affected primarily by partial inundation and disturbance at the Jay Creek mineral lick. Disturbance anticipated is mostly recreational, both during and after the construction phase, and from low-flying aircraft.

Brown bears will lose important spring feeding areas in the impoundment zones and will also be adversely affected by lower numbers of moose. Sows with cubs do not use the impoundment zones but about half of the remaining radio-collared bears moved there in spring during recent studies. During the construction phase, a number of bears may be killed for safety reasons. In addition, bear/human conflicts have a great potential to cause significant loss of work time for contractors, injuries to employees, and property damage. Management strategies and priorities beyond the control of the Applicant will determine to what extent hunting and poaching become severe mortality sources. Direct mortality from hunting and nuisance animal control would likely have a major effect on the population in the long-term.

No brown bear denning areas will be flooded by the impoundments. Because the relationship between brown bear foods and population levels is poorly understood, the impact of the project on brown bear carrying capacity cannot be predicted.

Black bears will be significantly affected by the Project, primarily as a result of inundation of denning and feeding habitat upstream from Tsusena Creek. The Watana Stage I and III reservoirs will inundate about 50 to 60 percent of the denning habitat occurring in that area (black bears are restricted to the band of forest along the river), whereas only a small portion of the denning habitat in the Devil Canyon reservoir vicinity will be lost. Additional denning areas will be impacted by road and transmission line construction. Bears residing downstream from Tsusena Creek may also be affected by Watana project facilities which may interfere with movements upstream in summer. Cumulative impacts of mortality from hunting, increased encounters with brown bears, and bear/human conflicts in concert with loss of denning and feeding habitats due to facilities and disturbance will reduce the black bear population in the middle basin.

Wolf populations in the Project area are currently controlled by human harvest levels (much of it illegal), and any reduction in moose numbers may or may not be a major factor under these conditions. Improved access in the project area may result in even heavier exploitation of wolves. The Watana pack would probably be reduced and possibly eliminated due to loss of hunting areas and reduced moose populations. Immediately following filling of both Watana Stage I and III reservoirs displaced moose would be more vulnerable to predation. Impoundment hazards and the advantages conferred on predators along the impoundments shoreline would also increase the availability of prey. The long-term effects of the impoundment are more likely to result in a reduced availability of prey for packs currently using portions of the proposed impoundments. Winter availability of caribou to individual wolf packs would vary from year to year. However, no net decrease in availability of caribou to the wolves of the middle basin is anticipated. Some loss of potential den and rendezvous sites would occur, but this is not considered serious. The extent to which increased access and use of the middle Susitna Basin would reduce wolf populations depend almost entirely on management priorities of the ADF&G and is beyond the control of the Applicant. Because wolves are uncommon downstream from Devil Canyon, changes in moose numbers there are unlikely to have any effects.

Wolverine will be affected primarily by improved access for trappers. Habitat losses will reduce wolverine numbers in the project area. Additional temporary loss of habitat due to both construction related and recreational disturbance is possible but likely to affect only small areas of the territories of a few individuals. Higher turnover rates hypothesized for moose populations would result in increased availability of carrion for a few years following filling of the reservoirs. After that, moose densities (and associated carrion) would decrease. Overall, changes in wolverine populations will be difficult to detect due to naturally low density and dispersal from surrounding productive habitat.

Belukha whales will not be measurably affected by the project at any time of the year.

(b) Furbearers (*)

Project effects on beaver populations along the Susitna River will be both positive and negative due to altered winter flows and ice conditions. The increased extent of ice-free water and greater flow stability downstream of Devil Canyon is likely to be beneficial, while the increased degree of ice staging in ice-covered reaches may be detrimental. In general, negative impacts will be greatest during Stage I operation and lowest during Stage III operation with the reverse situation true for the positive impacts. Long-term downstream effects following completion of Stage III are anticipated to be positive.

Local populations of beaver might be adversely affected during road and dam construction and would be vulnerable to increased trapping because of improved access. Approximately 40 beavers now occupy sections of Deadman Creek identified as potential borrow sites for road construction. No beavers reside in the impoundment areas, but the lakes in and adjacent to Borrow Site K at Devil Canyon support approximately 10 beavers. There are approximately 25 beavers along Jack Long Creek; these beavers could be adversely affected by increased siltation or clearing of riparian vegetation during construction of the railroad and staging area.

The project will have an insignificant effect on muskrat, except that improved access may result in increased trapping of some areas. No muskrat occur in lakes to be used as borrow sites or other facilities, but five lakes within the Watana impoundment zones (3 for Stage I, 2 for Stage III on lower Watana Creek) are occupied by muskrats. Approximately 5 to 10 muskrats would be lost because of impoundment filling and construction. Improved habitat for beaver downstream from the dams would also have a beneficial effect on muskrat, and could compensate for the minor loss of habitat within the impoundment. Changes in surface water patterns due to road construction and culvert placement could affect muskrats either positively or negatively.

Mink and otter would be adversely affected by clearing and inundation of the impoundment areas, removal of roadbuilding materials from Deadman Creek and wetland areas, and by increased trapping pressure. Both mink and otter are somewhat sensitive to disturbance and may suffer significantly from increased presence of fishermen and recreational users in remaining river habitat. About 116 miles of mainstem and major tributary habitat would be inundated. Few impacts on lakes and ponds will occur. Regulated flows are expected to improve downstream habitat for these species, and the stable water level on the Devil Canyon reservoir during most of the year will probably allow these species to reside there. Increased downstream winter turbidity levels will reduce mainstem sight feeding abilities for these species.

All upland furbearer populations are expected to decline for two main reasons: inundation of portions of their habitats by impoundments, and increased trapping pressure caused by easier trapper access.

Coyotes are uncommon upstream from Devil Canyon and are likely to remain so; therefore, the impact on this species will be negligible throughout the project area. Increases in numbers of coyotes would be anticipated only if wolves are severely reduced or eliminated. Red foxes will be adversely affected by loss of habitat in the impoundment area, habituation to human activity along the roads and at camps and landfills, and by increased trapping pressure. The access roads occur within 0.5 mile of several large red fox denning complexes, and local overharvesting of foxes may occur. Because foxes den and feed primarily at elevations above the impoundment level, major population effects due to habitat loss are not anticipated.

Marten would be the most severely affected furbearer species. Habitat supporting about 123 marten would be lost to the Watana reservoir; the Devil Canyon reservoir contains habitat supporting about 22 marten; and forested areas supporting about six marten would be cleared for transmission corridors. Improved access might allow a higher trapping yield from the remaining population, and local overharvesting of marten in some areas could occur. Major impacts on lynx, short-tailed weasel, and least weasel are not expected.

(c) Birds and Non-Game (Small) Mammals (**)

Birds will be affected primarily by habitat loss to inundation and disturbance of nests. Surveys for raptor/raven nesting locations were made in the middle basin of the Susitna River drainage in 1974, 1980, 1981, and 1984. These surveys have located 67 raptor/raven nesting locations in or near the project area. Of the 67 nesting locations, 23 are for golden eagle, 10 for bald eagle, 6 for gyrfalcon, 3 for goshawk and 25 for common raven.

Twenty-three golden eagle nesting locations are located in or near the project areas. At least five and possibly seven of these will be inundated and two additional nesting locations will be partially inundated. One of the two partially lost locations will remain usable by golden eagles in its present conditions, the other can easily be modified to maintain its viability. The loss of seven nesting locations may displace an estimated three or four nesting pairs of golden eagles. Seven other nesting locations that will not be inundated will be potentially vulnerable to disturbance as a result of reservoir clearing and material excavation from borrow sites.

Ten bald eagle nesting locations are located in or near the project areas, three of which will be completely inundated. The loss of these nesting locations may displace two or three actual nesting pairs of bald eagles. All three of the nesting locations are also potentially vulnerable to disturbing activities during reservoir clearing. A fifth nesting location that will not be lost or damaged by project actions is also vulnerable to disturbance from the railroad spur.

The Susitna River drainage does not provide habitat typical of, or comparable to, any important areas of peregrine falcon nesting habitat in the boreal zone of Alaska. The fact that key habitat elements are missing from the Susitna River drainage, in addition to the lack of peregrine observations during raptor surveys, provides reasonable evidence that peregrines do not nest in the project area and are unlikely to nest there in the future. One historical peregrine falcon nesting location (used in years past but currently inactive) occurs about 1.4 miles east of the proposed Healy-to-Fairbanks transmission line crossing of the Tanana River. This nesting location was last observed as active in 1963. Several other historical nesting locations occur along the Tanana River, paralleling the proposed transmission corridor, but all are more than two miles from the proposed route of the transmission line.

Six gyrfalcon nesting locations are in or near the project area. One of these may be subject to disturbance as a result of reservoir clearing activities. A second nesting location may be subject to minor disturbance during blasting activities.

Three goshawk nesting locations are within the project area. Two of these will be lost to clearing and impoundment filling. The loss of these nesting locations may displace two nesting pairs of goshawks. The third nesting location is potentially vulnerable to disturbance as a result of project activities.

Twenty-five common raven nesting locations are in or near the project areas. Twelve will be inundated and the losses may displace eight or nine pairs of nesting ravens. Six additional raven nesting locations will be partially inundated. However, sufficient cliff will likely remain above water in their vicinity to provide adequate nesting habitat after project completion.

Waterbirds of lacustrine habitats will suffer only minor impacts, since only 50 ac of lakes and ponds will be flooded. Trumpeter swans which nest on lakes near the project area may be adversely affected by low-flying aircraft. Most swan nests are some distance to the east of project facilities and no disturbance is anticipated. Birds of fluvial habitats will suffer a significant loss of habitat. Breeding habitat for spotted sandpiper, mew gull, harlequin duck, common and red-breasted merganser, semipalmated plover, wandering tattler, and Arctic tern will be lost. Additional losses of breeding habitat in forests will occur for goldeneyes and lesser yellowlegs. Sandbars, islands and riparian shoreline areas used for feeding, roosting and loafing by shorebirds will be flooded. River and stream flooding habitat for breeding dippers, mergansers, harlequin ducks and goldeneyes will be lost. Although the middle basin is not a migration corridor, the open water areas within the impoundments will likely be used for loafing by early migrants before other waterbodies are open. The drawdown zones may also be used as loafing habitat for migrant shorebirds, but food availability will be low. The impoundments are likely to offer very few food resources to migrants or residents, although low densities of fish and invertebrate prey will be present. Open-water areas downstream from the dams may benefit migrant waterfowl and shorebirds and provide winter habitat for the dipper. Although the large impoundments will greatly increase the surface area of water in the middle basin, the drawdown of the Watana reservoir will minimize its importance as lacustrine habitat. The Devil Canyon impoundment will be more appropriate lake habitat, although recreational boating will limit its use for shoreline nesters.

The total number of breeding terrestrial birds lost will be about 77,000. Proportionate losses are greatest for birds restricted to forest habitats. Habitat alteration will affect the distribution and abundance of species, again with birds restricted to closed forest habitats suffering losses, while species associated with edge disturbed, or artificial habitats will benefit. The increase in amount of edge may increase species diversity and density in localized areas. Bank and cliff swallows and kingfishers will experience increases in availability of nesting habitats. Ravens and gulls are likely to increase in numbers in the basin, particularly if refuse dumps are not adequately maintained.

Only those species of small mammals which are restricted to forest habitats are expected to experience a decrease in regional abundance. Porcupines, snowshoe hares, pygmy shrews and red squirrels will be most affected. Although they are found in nearly every vegetation type in the Watana area, red-backed voles are most common in spruce and cottonwood forests and will suffer a decrease of up to five percent in the basin population. Meadow voles may actually increase in the basin due to the appearance of disturbed and revegetated areas. The major impact of the projects on small mammals will be local alterations in the distribution and abundance of species.

4.4 - Mitigation Plan (**)

This mitigation plan has been developed for those negative impacts likely to have population-level effects on important species in accordance with the approach outlined in Sections 1.2 and 1.3. As discussed in those sections, mitigative measures have been prioritized as follows: avoidance, minimization, rectification, reduction, and compensation. Avoidance and minimization of impacts are best achieved by incorporating environmental criteria into preconstruction planning and design and by modifying certain construction practices. In many cases, measures to avoid, minimize, or rectify impacts to wildlife are identical to the preferred measures for mitigating impacts to botanical resources. The mitigation plan for botanical resources (Section 3.4.2) discussed modifications to engineering design and construction planning for environmental reasons, such as changes in the alignment of access roads and transmission corridors; avoidance of certain riparian areas for gravel extraction, consolidation, and resiting of certain project facilities; and rehabilitation of temporary construction sites. Since botanical resources assume their greatest importance as wildlife habitat, the wildlife and botanical resources mitigation plans complement each other. Measures discussed in the botanical resources plan that also apply to wildlife mitigation are repeated only when appropriate.

The impact summary (Section 4.3.6) describes the impacts and criteria used to identify impacts requiring mitigation. Impact issues are treated here in three categories: (1) impact mechanisms resulting in reduction in carrying capacity; (2) impact mechanisms which increase mortality, thereby altering population structure and the ability of populations to recover from other secondary impacts or natural mortality phenomena; and (3) disturbance. Impact issues defined in Section 4.3 as habitat loss, habitat alteration, and barriers to movement represent effective habitat loss and are treated as mechanisms resulting in reduced carrying capacity. An analysis of mitigation options is presented for each species or group for each mechanism. Separate mitigation and monitoring plans are then presented which may apply to an individual species or group (Section 4.4.2). A cost analysis and schedule for mitigation appear in Section 4.4.3, and Section 4.4.4 documents agency recommendations for mitigation.

4.4.1 - Impact Issues and Option Analysis (*)

The following discussion presents an analysis of mitigation options for each important impact. The options to be implemented are detailed in Section 4.4.2, and an analysis of residual impacts with the chosen mitigation plans appears in Section 4.4.3.

(a) Reduction in Carrying Capacity (*)

(i) Moose (*)

Project impacts on upstream habitat will reduce carrying capacity through inundation of spring and winter range. Approximately 38,156 acres (Table E.3.3.43) of vegetated habitat will be permanently lost to facilities, access roads, and impoundments for all stages. This represents winter habitat for about 300 moose based on carrying capacity estimates presented in Table E.3.4.7 and Appendix E8.3. The winter carrying capacity of the Watana permanent facilities is 266 moose; that for Devil Canyon is an additional 36. Additional habitat alteration due to temporary facilities and borrow sites will bring the total affected vegetated area to 41,227 acres. The total carrying capacity of these areas is about 340 moose. This impact cannot be avoided by the design of the project.

The impoundment zones may be important as a source of early spring foods and as calving areas, and also as winter range for moose (ADF&G 1982k). Their loss could be temporarily avoided by delaying clearing of the impoundment areas. However, the impoundment zones must be cleared to avoid producing large quantities of timber debris on the reservoirs. Habitat loss because of clearing could be minimized by: (1) scheduling clearing as close to reservoir filling as is feasible; (2) leaving relatively large "islands" of riparian vegetation uncleared; and/or (3) clearing only trees and tall shrubs, leaving the browse species preferred by moose.

To reduce vehicle traffic and impacts to other areas, it is preferable to burn the cleared vegetation in place rather than to transport it to some other area. In order to retain browse vegetation, the slash would have to be burned in piles (rather than a broadcast burn). The increased use of machinery required for piling may offset the benefits of preferential clearing of trees and tall shrubs.

Temporary disturbance during construction will affect approximately 3,071 acres of vegetated habitat. Minimization is possible by using side-borrow techniques for road construction, which will reduce the number of borrow sites, and by depositing spoil in the future impoundment areas or in depleted borrow sites. (This is discussed more fully in Section 3.4.2.[a][i].) Further minimization is possible by consolidating facilities. Rectification is possible through revegetation (Section 3.4.2[a][i]).

The dams and impoundments, access roads, and other facilities are essential to the Project, and thus, only compensation is feasible for mitigating the loss of habitat associated with these features.

Clearing of vegetation in the transmission corridor will result in habitat alteration. This alteration cannot be completely avoided because some clearing is necessary to permit construction to minimize maintenance costs and to permit rapid restoration of power in case of line breakage. Minimization could be accomplished by aligning the corridor through tundra types where possible and by designing the corridor to leave as much shrub vegetation as possible. Compensation for clearing could be provided by allowing shrubs and trees to grow between maintenance clearing, which would maintain the corridor in early seral stages preferred by moose and partially compensate for browse production lost due to other project features.

Moose displaced from the impoundment zones during construction and filling will compete for food and space with moose in adjacent areas. This may result in overbrowsing of areas adjacent to the impoundments and subsequently affect additional moose outside the impoundment areas. This impact may be avoided by managing the moose population through a controlled hunt of moose in excess of the carrying capacity.

It is unclear whether regulated flows will result in a net increase or decrease in the amount of browse available to moose in the Susitna floodplain downstream from the Devil Canyon Dam. However, because the lower basin may support very high densities of moose in some winters, a small decrease in browse availability could affect a large number of moose.

Minimization of adverse impacts is possible to a limited extent through regulating river temperature to maintain more normal ice conditions in the lower reaches of the river. Rectification may be possible through controlled flow releases, river training structures, and enhancement techniques. Additional compensation will occur because of the increased availability of winter browse which will result from the construction and maintenance of the transmission corridor. Much of the route is adjacent to the river and will provide winter browse in areas near to those in which browse could be lost.

(ii) Caribou (*)

A reduction in carrying capacity caused by blockage of movements by the Watana impoundment is considered unlikely based on information in the scientific literature. However, if such an effect were demonstrated, compensation would be the only feasible mitigation alternative.

The physical presence of the access road and the vehicle traffic and other human activities associated with it may interfere with the movements of caribou, particularly in the Denali Highway to Watana section. Avoidance of the road or failure to cross it would result in habitat loss and decreased carrying capacity of the project area for caribou.

Minimization is possible through routing of the access road from the Parks Highway, realignment to avoid the center of the calving ground, design changes to minimize physical and visual impacts (i.e., side-borrow construction), and reductions in traffic volume through a worker transportation program. Further minimization would be possible by regulating traffic on the road and by reducing dust.

(iii) Dall Sheep (**)

Partial inundation of the Jay Creek mineral lick and inundation of a portion of Jay Creek is not expected to reduce carrying capacity of the area for Dall sheep.

If a reduction in the level of lick use is noted, rectification is possible by exposing new mineral soil at the lick site in areas accessible to sheep and adjacent to escape cover.

(iv) Brown Bears (*)

Impoundment clearing is necessary to eliminate debris on the impoundment surface. The clearing of the impoundment zone and permanent facility areas will reduce the carrying capacity of the project area for bears by eliminating spring feeding areas and other habitats. Loss caused by clearing could be minimized (as described for moose above) by: (1) scheduling clearing as close to reservoir filling as feasible, and/or (2) leaving large "islands" of riparian vegetation uncleared.

Construction of temporary project facilities increase loss of habitat, but no avoidance is possible. Minimization is possible through use of side-borrow techniques for road construction which would reduce the number of borrow sites, and by depositing spoil in the future impoundment or in depleted borrow sites. Further minimization is possible by consolidating facilities. Rectification is possible through revegetation.

Compensation is the only mitigation alternative for the permanent habitat loss associated with the impoundments, dams, and permanent facilities..

A reduction in salmon spawning between Portage Creek and Talkeetna has been identified as a possible factor which would reduce carrying capacity for brown bear. This impact will be avoided through maintenance of downstream sloughs for salmon spawning (see Section 2.4.4 [a]).

A reduction in ungulate prey is also hypothesized to reduce carrying capacity for brown bear. Mitigation measures proposed for ungulate populations can avoid, minimize, or compensate for this impact.

The Prairie Creek area, which is a bear concentration area during salmon runs, is a sensitive area that occurs to the south of the direct impact zone. Project access roads may accelerate mineral and recreational development by private landowners in this area, making conflicts with bear use of this resource occur sooner than they would in the absence of the Project. This impact could be reduced through cooperative management of development and access by the Applicant and resource agencies.

(v) Black Bears (*)

Impacts of impoundment clearing, temporary facilities, permanent habitat loss, and reduced prey availability are similar to those for brown bear. Residual impacts to be treated through compensation are much greater for black bear than for brown bear for both denning and feeding habitats (see Sections 4.3.1 and 4.3.2).

Clearing of vegetation in the transmission corridor may also result in habitat loss. Some clearing is necessary to facilitate construction and maintenance and to permit rapid restoration of power in case of line breakage. Minimization could be achieved by aligning the corridor through tundra types where possible and by designing the corridor to leave as much vegetation as possible.

Additional habitat loss will result from the access corridor and interference of Watana facilities with upstream movements (see Section 4.3.1). Disturbance may also make some denning habitat unsuitable. Alignment of the road away from spruce forest habitats would minimize habitat loss.

(vi) Wolves (o)

Loss of hunting areas will reduce carrying capacity for wolves mostly through reduced prey availability. Mitigation measures proposed for ungulate populations will avoid, minimize, or compensate for this impact.

(vii) Wolverine (*)

Loss of winter foraging habitat will reduce carrying capacity for wolverine through reduced availability of prey. A detectable change in populations is unlikely. Minimization through consolidation of facilities, spoil disposal in the impoundment, and side-borrow techniques is possible.

(viii) Beavers and Muskrat (*)

The impoundments, facilities, and access road will impacts habitat for beaver and muskrat. Partial avoidance of the impact is possible through realignment of the access road route and design changes to reduce the area disturbed. Additional loss may be avoided by using only Borrow Sites D, E, and K and obtaining access road material from small upland sites rather than from Deadman Creek. Some compensation will occur through improved downstream habitat.

(ix) Mink and Otter (o)

Riverine habitat will be inundated and some stream habitat along Deadman Creek will be lost to the access road. Partial avoidance is possible through realignment of the road and design changes to reduce the area disturbed. Additional loss may be avoided by obtaining road material from outside Deadman Creek. Some compensation will occur through improved habitat downstream from the dams.

(x) Marten (*)

Forest habitat supporting approximately 150 marten will be lost to the impoundments access and transmission corridors. Selective clearing and narrowing of the transmission corridor could reduce the impact to marten by allowing free movements across the corridor. Marten movements are inhibited by open areas (see Section 4.3.4). No further avoidance, minimization, rectification, or reduction is possible for loss of preferred conifer forest habitat. Further mitigation would require compensation.

(xi) Raptors and Ravens (*)

Ravens are not limited by nest sites and are not anticipated to require any specific mitigation measures.

Project actions will cause the loss of the following number of raptor nesting locations: three bald eagle, two goshawk, between five and seven golden eagle, and one gyrfalcon. An unknown number of other cliff- and tree-nesting locations for owls and small hawks will also be destroyed. Loss of tree-nesting locations will occur during impoundment clearing, and could be temporarily avoided by leaving nest trees (and adjacent perch sites for bald eagle).

The actual number of breeding pairs of golden eagles affected will be three or four, as some of the nesting locations are alternate nest sites and unlikely to be used simultaneously. Most of the suitable cliff- nesting habitat upstream from the Watana Dam will be lost. Destruction of the golden eagle nesting location in Borrow Site E will likely be avoided. No minimization, rectification, or reduction is possible for other tree- or cliff-nesting locations. Compensation could be provided through the creation of cliff habitat, repositioning of some nests, and providing artificial platforms, nests, and/or cavities for tree-nesters.

Without mitigation, salmon runs may decrease in the reach downstream from Devil Canyon as far as Talkeetna. This may affect bald eagles in this reach. The impact will be entirely avoided by maintenance-level mitigation for salmon in this reach (see Section 2.4.4[a]).

(xii) Waterbirds (o)

The impoundment will flood riparian and river breeding and/or feeding habitats for spotted sandpiper, mew gull, harlequin duck, common and red-breasted merganser, semipalmated plover, wandering tattler, arctic tern, and dipper. Additional losses of nesting habitat in forests will occur for goldeneye and lesser yellowlegs. Trumpeter swans are not known to nest in any of the affected project areas. No avoidance, minimization, rectification, or reduction is possible. Densities of all waterbird species are low in the middle basin, and compensation on a scale comparable to loss is not realistic.

(xiii) Terrestrial Birds (*)

The impoundments and other project facilities will cause loss of habitat for some estimated 77,000 small terrestrial birds. No avoidance is possible. Reduction of loss in the most densely populated and high diversity habitats is possible through aligning access and transmission corridors away from these habitats. Although numerical losses are large and proportionate losses to the middle basin populations of some species are significant, specific in-kind compensation for each species on the exact scale of project impact does not appear realistic. Habitat enhancement measures for other species will provide some in-kind mitigation for certain assemblages of small birds, although the most highly affected communities (i.e., forest birds) will not be provided mitigation in this way.

(xiv) Small Mammals (*)

The impoundment and other project facilities will cause a significant loss of habitat for some species of small mammals. No avoidance is possible. All species are quite common in other areas, and only species restricted to forested habitats (i.e., red squirrel, porcupine, snowshoe hare, and pygmy shrew) would lose a large proportion of potential habitat in the basin. Reduction of loss to these species may be accomplished by aligning the access and transmission corridors away from forest habitat. Specific in-kind compensation for each species does not appear to be realistic. Habitat enhancement measures for other species will provide some in-kind compensation for certain assemblages of small mammals. The most severely affected species, mentioned above, will not be provided mitigation in this way.

(b) Mortality Factors (*)

(i) Hunting and Trapping Mortality (*)

Improved access to the middle basin is anticipated to have a negative impact on some wildlife populations by increasing mortality from hunting and trapping. Protection conferred through management by the ADF&G varies among species and areas.

Moose, caribou, and Dall sheep are considered high profile and high priority species. Census data collected annually by ADF&G will provide data sufficient for management through regulation of harvest for these species. Harvest of Dall sheep is stringently controlled, and nearly all legal rams are currently harvested each year. The legal take for this species is not likely to change, although, with improved access, demand may increase. The distribution of harvest of moose and caribou will change with improved access, effectively distributing the take over larger portions of the basin populations. The harvest of caribou, like that of Dall sheep, is controlled by permit. Because of increased success anticipated to result from improved access, the number of permits issued may be reduced. However, assuming that management goals for the Nelchina herd remain the same, the legal harvest allowed by ADF&G is also likely to remain constant. Caribou subpopulations with little or no current harvest will face increased mortality, while currently accessible populations may experience a decrease in hunter take. If management goals are altered to treat subpopulations of the herd, or to allow a change in herd size, the legal harvest may either increase or decrease. Moose harvest in the middle Susitna basin is not as stringently regulated as Dall sheep or caribou harvest. GMU 13 is a trophy management area for moose (only bull moose with racks at least 36 inches across may be taken), a strategy designed to protect the resource in an area with poor recruitment (see Section 4.2.1 [a]). With present regulations, improved access will increase the harvest of moose. Carrying capacity will simultaneously decrease because of loss of habitat resulting from development. Harvest regulations for moose are likely to be changed to maintain the remaining population of moose in the middle basin. ADF&G management can avoid negative impacts to moose caused by increased harvest resulting from improved access.

Improved access could also increase the illegal take of all species. For moose, caribou, and Dall sheep, which are all monitored and managed to assure future harvest opportunities, the impact of increased poaching would be transferred to the legal users through a decrease in the legal harvest.

Large predators (black bear, brown bear, and wolf) are considered competitors for the harvest of ungulates and are frequently given lower priority or are subject to control to insure future harvest opportunities for more desirable species. The current take of wolves is largely illegal. Improved access will reduce populations of these species in the absence of specific protection. For users, harvest opportunity will increase substantially until populations are reduced through overharvest or provided protection. Considering reduced moose populations and increasing harvest demand, reduced predator populations are likely to be considered advantageous. Protection is not likely until populations are reduced to a level in accordance with harvest goals of ungulates.

Furbearers are rarely given specific protection. Population data for furbearers are generally not collected by ADF&G, and local areas subject to heavy use are vulnerable to overharvest. The take of furbearers and the risk of overharvest are controlled by fur values. When fur values are high enough, access is probably a less important factor, and even relatively remote areas can become vulnerable to overharvesting. All furbearers are likely to become less available above the damsites because of adverse population effects of the Project.

Impacts of increased hunting and poaching mortality resulting from increased access can be avoided during construction by prohibiting access to nonproject personnel and by restricting and/or prohibiting hunting and trapping by project personnel. During operation, regulation of hunting and trapping will be under the jurisdiction of the ADF&G and beyond the control of the Applicant. Some compensation for project impacts on wildlife populations can be accomplished through improved management ability conferenced by providing data obtained through monitoring programs to the ADF&G and by continued interaction between the agencies in identifying and treating project impacts on both wildlife and user populations.

The powers of the Board of Game and the Commissioner of Fish and Game to regulate harvest in response to problems that might arise from the Susitna Hydroelectric Project were outlined by ADF&G (1983o). The two main problems requiring a regulatory response were : increased harvest and reduction of harvestable surplus. The following actions were identified as being frequently taken:

- o Shorten or close the season;
- o Schedule the season at a time when animals are less vulnerable or hunters are less efficient;
- o Reduce the bag limit;
- o Restrict the harvest to specific sex and age classes;
- o Create a closed area;
- o Create a special use area, e.g., where motorized vehicles are prohibited for hunting, thereby making hunters less efficient;
- o Use a permit hunt where a limited number of individuals are allowed to hunt; and
- o Use a registration hunt where hunters must check in before and after hunting. This allows careful monitoring of hunter effort and harvest. When the desired number of animals is harvested, the season is closed by announcement.

ADF&G (1983o) indicates that each of these actions has adverse secondary effects such as increasing the cost of management or restricting user opportunities. The typical sequence of events is: monitoring and identifying a problem; regulatory changes are proposed to the Board of Game by either ADF&G or any individual or group; extensive opportunities for public comment are provided; and the Board then choses regulations to avoid or minimize the problem with the least adverse impact on users. The Board typically responds within a one-year period (ADF&G 1983o). If the problem is acute, the season can be immediately closed by the Commissioner of Fish and Game.

(ii) Additional Mortality (*)

Mortality to populations of some species is likely to increase because of hazards associated with project features. The access road will cause accidental mortality of moose, caribou, some furbearers, small mammals, and birds. The rail access is likely to become a mortality factor for moose. Transmission lines are a source of collision mortality for waterfowl.

Electrocution can be totally avoided through proper pole/line configurations. No avoidance is possible for other mortality sources. Mortalities caused by collision with vehicles could be minimized through regulation of traffic when caribou are present in large numbers and through decreasing the maximum speed limit at all seasons. Further reductions could be conferred through minimizing or prohibiting private vehicle traffic, bussing employees to their work sites, and/or reducing the frequency of project vehicle traffic through a traffic-scheduling and control program.

The destruction of nuisance animals will be a source of mortality for bears, foxes, and wolves. The creation of nuisance animals will negatively affect the wildlife populations, the health and safety of project personnel, and the overall cost of the project. Bears, with their low reproductive potential, low densities, and large home ranges, will be susceptible to severe population-level impacts. The impact can be avoided only through strict enforcement of state regulations prohibiting feeding of wild animals; fencing all construction camps and landfills; incinerating all putrescible kitchen waste daily; covering solid waste landfills with soil daily; providing secure garbage containers in work areas and requiring their use by employees and adequate cleaning and emptying schedules; assigning personnel responsibility for maintaining clean work areas; and strictly enforcing all related regulations. During construction of the Trans-Alaska oil pipeline, workers were prohibited from feeding animals and infractions were treated through immediate firing. Infractions of this type increase the vulnerability of all project personnel to mauling and disease, and the problem must be dealt with seriously. No amount of facility maintenance or incorporation of specific design features will eliminate this impact if project personnel are not adequately informed and controlled. Additional problems commonly arise when comprehensive garbage incineration plans are not adequately implemented. The most typical shortcoming is careless incineration. Incinerators must be large enough or numerous enough to ensure that garbage is completely burned and not just charred. The project construction facilities, village, and campsites should also be fenced securely and gates monitored to maintain the effectiveness of fencing. In addition to the above mitigation measures, a worker orientation program including briefings on feeding regulations and project site cleanliness would assist in avoiding this impact. An animal control strategy with trained personnel should also be incorporated into project design to allow a timely and effective handling of any wildlife problems which may develop during construction.

(c) Disturbance Impacts (*)

Disturbance is likely to reduce productivity at specific den sites of foxes and wolves and nest sites of swans and raptors. In addition, disturbance by low-flying aircraft, particularly helicopters, may have an effect on population productivity of ungulates. Females in late pregnancy and young animals are particularly sensitive. These impacts can be partly avoided through the development of guidelines restricting project-related ground and air activity in identified sensitive areas. Protection criteria for Alaskan raptors are given in Table E.3.4.67.

Disturbance of bears in dens during winter months will cause direct mortality of individuals who abandon their dens. Because locations of all dens in the project area may not be known, restrictions of ground activity in identified sensitive areas will only partially avoid this impact.

Disturbance of Dall sheep at the Jay Creek mineral lick by clearing activity before flooding, boat traffic on the impoundment, and low-flying aircraft may affect the levels of lick use which could possible result in a decreased carrying capacity for the Watana Hills population. This impact can be avoided through regulation of access and air traffic in this area.

4.4.2 - Mitigation and Monitoring Plans (**)

This discussion describes the mitigation and monitoring plans incorporated into project design. Section 4.4.2 (a) describes the mitigation plans which have been incorporated into the project design as a result of impact analysis. Section 4.4.2 (b) identifies the data required during and after construction to ensure appropriate types and levels of mitigation and to verify predicted impacts and unanticipated impacts. Section 4.4.2 (c) contains a brief description of residual impacts.

(a) Mitigation Plans (**)

This mitigation plan addresses the impacts to wildlife resources described in Section 4.3. Mitigation measures for each impact issue have been developed according to the approach discussed in Sections 1.2 and 1.3 and are prioritized as follows: avoidance, minimization, rectification, reduction, and compensation. The specific measures developed are listed below under the appropriate mitigation category.

(i) Avoidance (**)

(1) Electrocution of raptors by all project transmission lines will be avoided by employing pole/line configurations and other safeguards proven effective in other parts of North America (Olendorff et al. 1981). Special attention will be given to wire-gapping and ground wire placement (Figure E.3.4.41), armless configurations (Figure E.3.4.42), and transformer installation (Figure E.3.4.43). Perch guards (Figure E.3.4.44) and elevated perches (Figure 3.4.45) will be used if necessary to further avoid electrocutions. These measures will totally avoid this impact.

(2) The impact of overharvest of game species with improved access will be avoided during Stage I

construction by prohibiting public access via the project access roads or air field, prohibiting employees and their families from using project roads or equipment for hunting or trapping, and by prohibiting the possession of firearms and traps in the construction camp and village. During Stages II and III the same prohibitions will apply except that portions of the access roads will be open to public use for hunting (see Mitigation Measure No. 14), unless the Alaska Board of Game institutes prohibitions. Data from monitoring investigations will be provided to the Board of Game to assist the Board in regulating hunting and trapping activities in the area. During the operation phase, the Applicant will have no control over harvest activities but will continue to provide any pertinent data to the ADF&G and Board of Game and assistance in their management activities.

(3) Options for small access route adjustments have been exercised to avoid site-specific habitat loss of disturbance of wildlife. These local modifications and the features avoided are documented in Figures E.3.3.22 to E.3.3.24. Red fox den complexes and surrounding habitat have been avoided by careful original routing or changes in alignment at MPs 28, 32, 34, and 36. Destruction of the bald eagle nest along Deadman Creek (BE-6) at MP 38 has been avoided through realignment of the access road northwestward and westward to pass 0.5 mile from the nest tree (Figure E.3.3.23). This distance will also minimize disturbance to the nesting pair. Siting of the Watana camp and village near this nest has also been avoided to avoid disturbance and/or habitat destruction near this nest.

As shown in Figures E.3.3.22 and E.3.3.33, additional route changes have been made to avoid impacts to surrounding palustrine vegetation, water quality, and resident fish of Deadman and Tsusena Creeks. These realignments are discussed from a fisheries standpoint in Section 2.4.

(4) The creation of nuisance animals will be avoided

or minimized through combined implementation of the following garbage-control and education measures:

- o An Environmental Briefing Program for employees will be required and will include briefings on regulations prohibiting feeding of animals and reasons for the restrictions.

- o State regulations prohibiting feeding of wild animals will be strictly enforced.

- o Construction camps and landfills will be fenced with bear-resistant fencing and gates will be monitored to ensure the effectiveness of the fencing.

- o Secure garbage containers will be required in work areas.

- o Personnel will be assigned the responsibility for picking up and disposing of all discarded refuse in work areas and along roads.

- o Putrescible kitchen wastes will be stored indoors and completely incinerated daily or more often, if required, in adequate incinerators.

- o Solid waste landfills will be covered with soil daily, or as required by permit stipulations.

Wildlife problems may persist to a small degree even with such precautions. Increased use of bear concentration areas by humans and attraction of bears to some sites (e.g., revegetated areas) may increase bear/human conflicts. The construction manager will be instructed to develop an animal control strategy directed at avoiding and minimizing all project-related problems and to respond promptly to any situations that arise.

(5) The Applicant has prepared the following five Best Management Practices (BMP) manuals (APA 1985a, 1985b, 1985c, 1985d, and 1985e) to be used in the design, construction and maintenance of the Applicant's projects:

- o Oil Spill Contingency Planning
- o Erosion and Sedimentation Control
- o Liquid and Solid Waste
- o Fuel and Hazardous Materials
- o Water Supply

These manuals are the result of a coordinated effort involving federal, state and local government agencies, and other groups. The manuals are surveys of practices that can be used to avoid or minimize environmental impacts from construction, operation, and maintenance of the Applicant's energy projects. In addition, a report entitled "Drainage Structure and Waterway Design Guidelines" (H-E 1985b) has been prepared, for the specific purpose of assuring that culverts and bridges are designed to meet the ADF&G's proposed regulations for these structures.

The project design engineer will be required to utilize the BMP manuals in the preparation of both design and construction documents. The Applicant intends that applicable guidelines contained in these manuals be incorporated where appropriate into the contractual documents for the project.

(6) Habitat loss and disturbance impacts to late spring brown bear and fall moose concentration areas in the vicinity of Tsusena Butte have been avoided or minimized by siting the Watana construction camp and village to the south, close to Borrow Site D. Alternative sites were examined which were within the subject concentration areas. These were preferred sites from various standpoints but were avoided, in large part due to the wildlife impacts they would produce.

(ii) Minimization (**)

(7) Impoundment clearing activities will be delayed as long as practical prior to filling and the minimum area will be cleared to be consistant with environmental and engineering requirements. Patches of riparian vegetation will be left uncleared until just prior to filling. Delayed clearing will temporarily avoid impacts of habitat loss to marten, moose, and black bear. Patches of vegetation will be left undisturbed for as long as practical around raptor nest sites. When these sites are cleared, it will be done prior to the

nesting season so that breeding pairs ill use alternate sites. Clearing in the vicinity of black bear dens will be conducted prior to the denning season and the dens will be destroyed so that bears will not attempt to use the during impoundment filling. A detailed reservoir clearing plan will be developed in consultation with resource agencies.

(8) Habitat loss for all species will be minimized through use of side-borrow techniques for road construction (described in Section 3.4.2[a][i]), depositing spoil in future impoundment areas or depleted borrow sites, and consolidation of project facilities. Side-borrow techniques will reduce the number of borrow sites required for construction of the access road between the Denali Highway and Watana. Airport, construction sites, and camp structures will be as confined and as close to the dams as possible.

(9) Minimization of habitat loss to the transmission corridor will be accomplished by selective clearing in the corridor (Figure E.3.3.26), leaving small shrubs and trees, and by leaving a 35-foot wide strip of vegetation up to 10 feet tall. Additional rectification for habitat loss will be provided by allowing vegetation to grow to a height of 10 feet during operation. The transmission corridor design is described more completely in Section 3.4.2. In forested areas, this management scheme will enhance habitat for moose and other wildlife preferring vegetation types in early successional stages. Impacts of habitat loss from other project features will be partially compensated for through increased carrying capacity for moose provided with this corridor design. Many other species (marten, hare) will also benefit from this corridor design because the retention of cover in the corridor will present less of a psychological or visual barrier to movements.

(10) Habitat alteration which will occur downstream from the Devil Canyon Dam will be reduced through the use of multilevel intake structures that will maintain river temperatures as close to normal as possible (see Section 2.4.2). Minimum flow requirements and other characteristics of the Case E-VI flow regime will also serve to minimize the

extent of flow regime changes. In addition, three-stage construction will produce temperature and flow changes in a gradual manner with the full effects of the project not occurring until about 20 years into the licensing period.

(11) Sensitive wildlife areas identified in the monitoring studies will be protected from disturbance from project-related aircraft by the following guidelines and measures. Exceptions will be made only when necessary for project construction:

- o Pilots will be required to maintain a minimum altitude of 1,000 feet above ground level except during take-off and landing throughout the basin.

- o Aircraft landings will be prohibited within 1.0 mile of the Jay Creek mineral lick between May 1 and July 15.

- o Aircraft landings will be prohibited within 1.5 miles of known active wolf or fox dens or rendezvous sites during May 1 through July 31.

- o Aircraft landings will be prohibited within 0.5 mile of all golden eagle nests between March 15 and June 1 and all active golden eagle nests between June 1 and August 31 (Table E.3.4.67).

- o Aircraft landings will be prohibited within 0.25 mile of all bald eagle nests between March 15 and June 1 and all active bald eagle nests between June 1 and August 31 (Table E.3.4.67).

- o Aircraft landings will be prohibited within 0.25 mile of all gyrfalcon nests between February 15 and June 1 and all active gyrfalcon nests between June 1 and August 15 (Table E.3.4.67).

- o An aircraft buffer zone of at least 0.25 mile or 1,000 vertical feet will be established around lakes used by trumpeter swans for nesting, brood-raising, and molting.

- All aircraft restrictions and schedules will be provided to aircraft pilots in a concise manual.

Ground disturbance of sensitive areas will be avoided through the guidelines and measures described below. For the purposes of this discussion, minor ground activity includes short-term reconnaissance and exploration type programs such as field inventories. Major ground activity involves large numbers of personnel, equipment, surface disturbance, noise, or vehicular activity, such as clearing, pad construction, blasting, and facility construction.

Protection criteria for nesting raptors which are currently accepted as guidelines by the ADF&G, and the USFWS were developed for the proposed Alaska Natural Gas Transportation System (Behlke 1980) by raptor biologists in the state. These general criteria were modified for application to the Susitna Basin based on known phenology of nests and are presented in Table E.3.4.67. Although there may be a very small amount of nesting activity before or after these dates, the vast majority of nesting attempts will be covered under the proposed criteria. In general, the early nest period is more sensitive and the criteria are more conservative in the early season, reflecting this difference. The following guidelines will serve to sensitive wildlife areas from project-related ground activities:

- Major ground activity will be prohibited within one mile of the Jay Creek mineral lick between May 1 and July 15. The reservoir adjacent to the lick will be closed to project-related boat and floatplane use within one mile of the lick. In addition, since essentially all lick areas will be within project boundaries (see Exhibit G, Plates G-6 to G-12), land areas in and around the licks will be closed to human use during this period.

- Clearing activities in the impoundment area will be restricted to nonsensitive periods near areas identified as sensitive to disturbance (e.g., concentrations of calving moose, brown and black bears, denning wolves, migrating caribou, raptor nests, etc.).

- o Major ground activity will be prohibited within 0.5 mile of all known active bear dens between September 15 and May 15.

- o Major ground activity will be prohibited within 0.5 mile of waterbodies used by swans during the nesting season and other times when swans are present.

- o Major ground activity will be prohibited within 1.5 miles of known active wolf or fox dens or rendezvous sites between May 1 and July 31.

- o Major ground activity will be prohibited within 0.5 mile of active golden eagles nests between March 15 and August 31, or within 0.5 mile of gyrfalcon nests between February 15 and August 15 (Table E.3.4.67). Known nesting locations will be assumed to be occupied until June 1 of each year after which, protection measures will be withdrawn for the remainder of the year if the nest is documented to be inactive.

In addition to the above general guidelines, specific measures were developed for raptor nests that are anticipated to be particularly vulnerable to disturbance:

- o Golden eagle nest GE-18 is located 0.6 mile downstream from the Devil Canyon damsite, and 0.5 mile from the transmission line. These distances will not require any restrictions on ground activities, provided the activities do not encroach on the 0.5 mile distance. However, the location of the bridge, currently proposed at a location 0.5 mile downstream of the nesting location, has not been fixed, and it is possible that engineering constraints will require repositioning of the bridge to some point 0.1 mile or more in either direction from the currently proposed site. Furthermore, the access road will pass about 0.25 mile from this nesting location and is relatively fixed in its location by the bridge location. Minimization of disturbance from construction activities will require that no major ground activity (including construction of the bridge) occur within 0.5 mile of the nesting location (and no minor ground activity within 0.25 mile) between March 15 and August 31 of all years, with the exception of the June 1 to August 31 periods of those years in which the nest is shown to be inactive. Disturbance after road construction will be kept to a minimum by ensuring that no activities occur south of the road or along the cliff-top for a distance of 0.5 miles east and west during the sensitive period. However, if the bridge is relocated upstream and closer to the nest for engineering purposes, it will be in conflict with the restriction on major ground activity. Because the final location of the bridge and access road approach are dependent on engineering constraints, there are no further mitigative measures that can be applied to protect the nesting location against disturbance from these two facilities. It is noted that disturbance can be partially controlled by strictly preventing activities east (upstream) of the bridge and south of the road. It is also noted that the road will be behind the cliff top and out of sight of the nest. This will provide an additional buffer against disturbance. However, golden eagles are quite sensitive to disturbance, and with disturbance on three sides of the nest (dam, road and bridge) the nest quite likely will be abandoned in spite of the mitigative measures. In this event, artificial nest sites will be provided in nearby areas where disturbance is not a problem.

o Bald eagle nest BE-8 is located 0.25 mile from the railroad access road route, which cannot be realigned. No restrictions are required to limit disturbance from ground activities at this distance because it is the outer limit of the area within which major ground activity would be prohibited during the sensitive period. However, the railroad route is in conflict with the distance restriction on permanent facilities. The nest is on the opposite side of the river from the railroad. This will provide additional protection from disturbance. Nevertheless, it should be noted that all of the bald eagle nests in the lower Susitna Basin are at least 0.5 mile from the railroad. Because the railroad route cannot be realigned, there are no further measures that could be applied to protect against disturbance at that nest site. If the eagles do not tolerate this disturbance, artificial nest sites will be provided in nearby areas farther from the railroad.

o Golden eagle nesting location GE-11 was thought to have been partially located within Borrow Site E. Recent surveys have determined that the nesting location consists of three nest sites that are several hundred feet upstream from the borrow area and at least 100 feet higher than the probable maximum elevation of borrow operations. Compliance with the restrictions concerning major ground activity will require that no quarrying occur within 0.5 mile of the nesting location (and no minor ground activity within 0.25 mile) between March 15 and August 31 of all years, with the exception of the June 1 to August 31 periods of those years in which the nest is shown to be inactive. However, it is noted that Borrow Site E will be a major source of material. Furthermore, its boundaries are not likely to be fixed until detailed drilling tests are made, and detailed schedules for removing material from it are not likely to be developed until engineering designs are finalized. Because of these factors, it cannot be confidently stated that quarrying activities will not occur within 0.5 mile of the nesting location during the sensitive time period. If quarrying activities encroach on the 0.5 mile distance during the sensitive period, the nest may be abandoned for the duration of the activities. If quarrying activities encroach on the 0.5 mile distance during the nonsensitive period, the nesting location will remain usable.

- o Golden eagle nesting location GE-23 (discovered in 1984) is located along the east side of Fog Creek and about 1,200 to 1,300 feet east of Borrow Site H's eastern boundary. Compliance with restrictions concerning major ground activity will require that no quarrying occur within 0.5 mile of the nesting location (and no minor ground activity within 0.25 mile) between March 15 and August 31 of all years, with the exception of the June 1 to August 31 periods of those years in which the nest is shown to be inactive. Borrow Site H is a low priority materials site, and probably will not be used during project construction. However, the possibility of Borrow Site H's being used cannot be entirely ruled out. Furthermore, its boundaries are not likely to be fixed until drilling tests are made, and detailed schedules for removing material from it are not likely to be developed until engineering designs are finalized.

  Because of these factors, it cannot be confidently stated that quarrying activities will not occur within 0.5 mile of the nesting location during the sensitive time period. If quarrying activities encroach on the 0.5 mile distance during the sensitive period, the nest may be abandoned for the duration of activities. If quarrying activities encroach within 0.5 mile during only the nonsensitive period, the nesting location will probably remain usable.

(12) Although complete avoidance of the impacts of altered caribou movements and range use is not possible, design changes in the access road and realignment to minimize effects on current major use areas of the Nelchina range will minimize or reduce its impact. Although this alignment avoids some areas utilized for caribou calving, some cows that calve in the mountains to the west of the road would still be affected. Changes in road alignment are described in greater detail in Section 3.4.2[a][i]. Use of side-borrow techniques will minimize physical and visual barrier effects of the road to caribou and other species. This technique results in a finished

road profile less than five feet above original ground level (see Figure E.3.3.20) and minimizes amount of habitat lost to material sites.

(13) Loss of forest habitat for black bear, marten, small birds, and small mammals will be minimized through the alignment of the access road and transmission corridor to avoid most forest areas; through using the narrowest corridor allowable; through minimizing the area used for borrow extraction by side-borrow techniques for road construction; and through consolidation of facilities. Loss will be temporarily avoided by delaying reservoir clearing operations until two or three years prior to filling. Habitat loss in the transmission corridor will be minimized by selective clearing and minimization of the width of cleared areas. Inhibition of marten and small mammal movements across the corridor will also be minimized by leaving a strip of vegetation along the centerline. The alignment of the access corridor has also been altered to avoid four red fox denning areas.

(14) The effects of vehicle traffic on caribou movements (a potentially more serious impact than the actual presence of the road) can be minimized by reducing traffic volume. This will be accomplished in two ways. First, public access will be controlled by prohibiting all public access during Stage I construction (1991 to 1999); (2) allowing public access to Watana Dam but prohibiting access along the Devil Canyon access road during Stage II construction (1996 to 2005); and (3) allowing public access on the Watana access road to the Devil Canyon road cut off and along the Devil Canyon access road, but prohibiting access on the Watana access road from the Devil Canyon cutoff to Watana Dam, during Stage III construction (2006 to 2012). Second, worker use of project access roads will be controlled by permitting only those workers with resident families to maintain private vehicles and drive private vehicles along the access roads at least during Stage I construction which represents the stage with the largest work force. The majority of the work force which will reside at the construction site only during their two- to seven- week long work shift. They will be transported to and from the project using air or bus transportation or a combination of

these transportation modes. Thus, average annual daily traffic volume during the peak construction year (1997) will be about 200 vehicles per day. After the completion of Stage I in 1999, the yearly average work force is expected to range from 100 to 1,000 workers during the construction of Stages II and III. The air-bus transportation system is not expected to be implemented during this period unless wildlife and/or socioeconomic concerns indicate its need. Project-related average annual daily traffic volume during this period is expected to range from 160-235 vehicles per day. Some additional traffic volume attributable to recreational use is expected during this period. However, recent surveys (H-E 1985k, ISER 1985) indicate that the Denali Highway received most of such use from July 1 through September 15, a period during which impacts to big game are expected to be minimal.

(15) The number of accidental big game deaths due to collisions with vehicles or trains along the access roads and railroad will be minimized through controlling traffic volume during the construction period by prohibiting public access and implementation of an air-bus transportation scenario (see Mitigation Plan 14, above). In addition, special instructions will be given to workers who use the access roads during critical collision seasons and times for collisions. Monitoring of mortalities will permit adjustments to be made in traffic scheduling and speed of traffic for both the access roads and railroad, if the problem becomes significant. Formal recommendations regarding the need for and degree of adjustments will be made by the Environmental Field Officer (EFO), in consultation with his staff and resource agencies.

(16) Loss of habitat for aquatic furbearers will be minimized by reducing gravel requirements through side-borrow techniques and utilizing only Borrow Sites A, D, E, and K. In addition, material for the access road in the Deadman Creek area will be obtained if necessary from small upland sites outside the Deadman Creek drainage (Figure E.3.3.7).

(17) The loss of raptor tree-nesting locations will be temporarily minimized by delaying impoundment

clearing operations until the two or three years prior to filling and, thereafter, by leaving islands of vegetation around known nesting locations. Clearing activities will be scheduled to avoid the early nesting season. Active nests will thereafter be protected by disturbance guidelines outlined in Mitigation Plan 11.

(iii) Rectification (**)

(18) Revegetation and fertilization of disturbed sites (described in Section 3.4.2[a][i]) will partially rectify the impact of vegetation removal. In particular, many revegetated sites will provide concentrated forage for moose for 2 to 30 years after the initiation of reclamation. Bears are also often attracted to such sites by the high productivity and early availability of spring forage.

(19) If monitoring of Dall sheep indicates that sheep use of the Jay Creek lick area is lower than was observed prior to reservoir filling and that the decreased use appears to be related to the project, new soil will be exposed from the same lacustrine deposit as is presently being used to rectify the impact. Sites near accessible escape cover will be selected for treatment (e.g., areas near the Ravine lick or Red Cliffs). Chemical testing will be conducted to ensure that selected sites contain rich sources of the same elements present in the soils at well used lick sites.

(iv) Reduction (**)

(20) Hazards to movement created by the impoundment will be reduced through clearing of the impoundment zone prior to flooding and through a program of debris removal as necessary to continue throughout the license period. Monitoring of the impoundment during the open water period will identify debris hazards.

(21) In general, the monitoring programs described in Section 4.4.2.(b) represent mitigation measures in that they allow for the reduction of impacts over time. Monitoring identifies unanticipated impacts and the level of predicted impacts so that construction or operational changes or modification of mitigation measures can be made. In

addition, monitoring provides feedback on the effectiveness of compensation measures so that modification to mitigation plans can improve their effectiveness and thus, reduce the net overall level of impacts.

(v) Compensation (**)

(22) Decreased availability of salmon to bears and eagles will be completely compensated for by modifying sloughs between Devil Canyon and the confluence of the Chulitna and Talkeetna Rivers to maintain existing salmon production (see Section 2.4.4[a]). Increased activity at Prairie Creek would have a negative effect on brown bears which make seasonal movements to the area during salmon runs. Increased activity is likely to occur along Prairie Creek even without the project as a result of development of Native lands in the area, but at a slower rate. The Applicant will assist resource management agencies in assessing this impact and in preparing recommendations for mitigating actions. Without protection, the stream is likely to be developed for mining or for recreational sites. The frequency of bear/human encounters is likely to increase in Prairie Creek, no doubt to the detriment of both parties. Deliberate recreational development would also be severely detrimental to the basin populations of bears who make regular movements to Prairie Creek.

The impacts of decreased availability of ungulate prey for brown bear, black bear, wolf and wolverine will be reduced through measures to avoid, minimize, or compensate for impacts to ungulate populations. It is possible, however, that brown and black bear populations will be allowed to decline through harvest as a management strategy to allow increased harvest of ungulates by humans. The project area is currently regulated by the most liberal brown and black bear seasons and bag limits in the state.

(23) As a compensation measure to mitigate for impacts to big game, the Applicant has provided partial funding for the development and field testing of a carrying capacity model for moose. In addition, the Applicant has fully funded the development of extremely detailed vegetation maps (which not only indicate specific vegetation types, but also the

relative abundance of moose browse plants) covering approximately 1.5 million acres including and surrounding project impact areas and an extensive two-year browse inventory of most of this area. Results of these efforts are providing "state-of-the-art" quantification of habitat impacts for all wildlife species and carrying capacity impacts for moose, as well as baseline estimates of browse densities on mitigation lands.

(24) The unavoidable loss of raptor nesting locations will be fully compensated for by site enhancement and the creation of artificial nesting locations. The techniques are described with examples by LGL (1984a). A bald eagle artificial nest demonstration project sponsored by the Applicant was initiated in early 1985. This project involved the building of five artificial nesting platforms and nests, and one artificial nesting structure and nest, for bald eagles in the middle Susitna River basin, and two artificial nesting platforms and nests for bald eagles in the Tanana River basin. This project is providing opportunities for testing and refining several basic construction, field assembly, and attachment techniques and for testing the effectiveness of various designs under differing circumstances and habitat types.

The following specific measures will be taken for mitigation purposes:

- A combination of several enhancement measures will provide artificial nesting locations for bald eagles. Such enhancement will be continued until at least four new successful nests have been established in the middle and upper basins. Nests that will be inundated will be reconstructed in adjacent areas. Natural-appearing artificial nests will be placed in appropriate trees (particularly large balsam poplar and white spruce) in suitable areas of habitat upstream of the Watana reservoir, downstream of the Devil Canyon damsite or along nearby tributaries such as the Oshetna River, Tyone River and Portage Creek (the latter tributary is currently unused by bald eagles but contains potential hunting habitat and poplar stands suitable for modification), and if necessary, in other nearby drainages, including Prairie Creek and the upper reaches of the Talkeetna River. Additionally, the canopies of other trees will be modified by removing tops or some upper limbs to make them more attractive and usable as nesting locations for bald eagles. Several artificial tripod or monopod structures containing natural-appearing artificial nests also may be constructed in nearby suitable areas, including the Fog Lakes and Tyone River lowlands. The success of these enhancement measures will be monitored until at least four successful bald eagle nestings occur after project construction.

- A combination of several measures also will be used to provide artificial nesting locations for golden eagles until losses have been successfully mitigated. Golden eagle nests that can be physically moved and reconstructed on cliffs at least 50 feet above maximum pool level will be identified. The feasibility of physically moving original nests to new points higher on cliffs will be tested, using an inactive nest. If moving original nests proves impractical, natural-appearing artificial nests will be provided at these sites. All repositioning or reconstruction of nests will occur before reservoir filling is completed. Other cliffs presently unused by golden eagles and suitable for enhancement measures also will be identified. Other cliffs presently unused by golden eagles and suitable for enhancement measures also will be identified. Artificial nest ledges and stick nests will be provided at these sites. Nest ledges will be created where needed on exposed cliffs using small explosive shape charges and/or hand tools. Metal or masonary ledges also may be attached to some cliffs. After artificial nest ledges are completed, natural-appearing artificial nests will be built on them. Areas where bedrock can be exposed by blasting and digging away overburden also will be identified for possible future construction of artificial nesting-cliffs (this backup measure also will make use of artificial nest ledges and nests). Ten artificial nesting platforms containing natural-appearing artificial stick nests for golden eagles also may be placed near the tops of transmission towers during the construction phase. The success of these mitigation measures will be monitored annually. Various combinations of these measures, including subsequent modifications, will be employed until the number of successfully nesting pairs of golden eagles equals the number of pairs lost to the project.

- Losses of nesting habitat for goshawks will be compensated for by providing artificial nests in nearby habitats and, if appropriate, by increasing the edge effect in large forest stands. Great horned and great gray owls commonly make use of abandoned goshawk nests in Alaska, and will, therefore, also benefit from these measures.

- Losses of nesting habitat for cavity and hole nesting raptors will be compensated for by providing artificial nesting sites in nearby areas of appropriate habitat. Twenty natural-appearing nest boxes will be built for American kestrels, boreal owls and hawk owls. Cavities will be created in the tops of several mature birch and spruce trees as an additional means of attracting hawk owls and other cavity nesting species. Nest boxes and artificially constructed cavities will be monitored until evidence of several successful nestings is found.

(25) Residual impacts remaining after implementation of the avoidance, minimization, rectification, and reduction measures described previously will mainly involve habitat reductions from inundating of land areas by the proposed reservoirs. Habitat compensation will be achieved for as many wildlife species as feasible that will be affected by the project, through the management and protection of appropriate habitats on nearby lands selected and designated for this purpose. The total acreage of dedicated compensation lands is contingent on the

extent of inundation and will be increased in three phases coordinated through time with the three-stage construction sequence. Compensation methods will entail 1) increased production of moose browse, significantly augmented by transmission corridor maintenance, to provide habitat compensation for moose and a variety of other species and 2) protection of important habitats already supporting productive wildlife populations, particularly those dependent on undisturbed forest and associated riparian and wetland areas.

Approximate acreages of major vegetation categories to be inundated during the three-stage construction sequence are shown in Table E.3.3.43. The objective of compensation land selection is to incorporate a combination of habitat types and management procedures that will support wildlife productivity levels that offset reductions in productivity resulting from reservoir filling and other facility construction. Productivity is defined as the ability of a wildlife population to replenish itself through reproduction. Because available lands in the project region are finite and often suitable for development by an expanding human population, land use designations in many cases place constraints on their use for wildlife mitigation. Therefore, compensation land selection has emphasized vegetation types with high habitat enhancement potential for suitable target wildlife species, with the objective of achieving maximum mitigation value per acre, thus minimizing the total acreage required for mitigation. Habitat compensation will therefore emphasize wildlife species likely to benefit most from habitat enhancement procedures. In addition, key habitat areas near the project that have been identified during project baseline studies will be designated and managed for habitat preservation.

Lands have therefore been assessed for two mitigative purposes: habitat enhancement and habitat preservation. Enhancement is proposed for habitat types that will respond to manipulation such as mechanical crushing or prescribed burning. Because such measures will remove existing stages of plant succession and replace them with earlier successional stages, enhancement will apply primarily to target wildlife species that require early successional stages for food or cover, and particularly to species in which population productivity and size are limited by the availability of early successional stages. For example, populations of moose, the most important species in the project area from economic and recreational standpoints, are known to be regulated by the availability of suitable browse on winter range. If manipulation is effective in increasing browse production in areas known to be used by moose as winter range, and if snow accumulation does not prevent the increased browse from being available to moose, the enhancement measure is likely to achieve compensation for project-related losses of winter range. Other species requiring early-successional vegetation, such as snowshoe hare, will also benefit. In some cases, even species generally considered to inhabit mature forest, such as marten, will hunt prey along the edges between disturbed and undisturbed vegetation and will benefit from complex patterns of edges, fingers, and islands of different successional stages. Patterns of vegetation manipulation will be designed in a manner that will maximize habitat diversity and the amount of edge in order to benefit these species.

Some species, such as river otter, mink, red squirrel, and spruce grouse, will not benefit from habitat enhancement measures because they require mature forest or wetland areas that can only be reduced in habitat value if manipulated. For these and other species requiring undisturbed areas, appropriate land areas will be set aside for habitat preservation.

Inparticular, it should be noted that measures to increase foodplant production for brown bears or black bears are unproven. It is possible that crushing of vegetation in lowland riparian zones may increase the biomass of herbaceous vegetation thought to be important to bears in early spring. Also, it is possible that burning of well-drained uplands may increase numbers and densities of berry-producing plants. Although such measures are being used to a limited extent in Montana as pilot projects to investigate the feasibility of grizzly bear habitat enhancement (Jonkel 1985 pers. comm.), it is not assumed that management measures aimed at moose and other species requiring early-successional, recently-disturbed vegetation will benefit bears in the Susitna Basin. Setting aside areas of existing high-quality bear habitat for preservation is seen as the best compensatory option for the Sustina project.

Together, moose browse management and the preservation of important habitats will achieve the greatest extent of feasible compensation for the greatest variety of mammal and bird species, and help to ensure the continuing presence and high productivity of these species in the project region.

Primary consideration for candidate land selection has been given to moose because 1) moose have far greater economic and recreational importance than any other species in the project region; 2) moose have large range requirements; and 3) habitat alteration to increase production and availability of moose browse is a practical option expected to benefit a variety of other wildlife species as well. The specific objective of moose habitat enhancement is to increase the availability of browse during winter, the population-limiting period, in locations known to be used by moose during winter. As discussed further below, moose habitat enhancement will involve feasible techniques already used in Alaska and elsewhere. Procedures for modifying moose habitat are varied, but all generally involve a selective reduction in the amount of mature vegetation in an area, with a concomitant increase in earlier successional stages of preferred food plants such as willow, balsam poplar (cottonwood), paper birch, and aspen Techniques that have been used and found effective for habitat management in Alaska include clearing to mineral soil, mechanical crushing or chaining, logging, and prescribed burning (HE 1984e).

The selection of candidate lands for habitat compensation has been guided by criteria developed in close coordination with State of Alaska and federal regulatory agencies, the Matanuska-Susitna Borough, and Alaska Native regional and village corporations. These criteria incorporate specific biological requirements and broader administrative considerations relating to agency management objectives and policies. Candidate land selection and management planning have involved the following general steps:

- Identification of a large pool of land areas proposed for habitat management and/or protection and generally meeting biological criteria;

- Refinement of the land pool to ensure consistency with agency land management policies and objectives and other agency-defined criteria as communicated to the Applicant;

- Application of existing wildlife distributional information, snowdepth data, aerial photography, vegetation maps, etc., to identify specific parcels, with a combined area exceeding probable project requirements, for onsite investigation;

- Definition of precise boundaries of land parcels, based on habitat suitability information collected in the field;

- Designation and prioritization of specific parcels as management units, and development of a detailed, site-specific habitat management or preservation program for each management unit, based on general estimates of acreage requirements;

- For moose, calculation of probable carrying capacity to be removed by each of the three construction stages, based on stratified sampling and biomass quantification of individual browse species, and analyses using a computerized, nutrition-based carrying capacity model;

- Translation of computer-generated carrying capacity reduction estimates into detailed acreage requirements for browse management units, based on predicted enhancement potential of each unit.

The process described above is an ongoing dynamic process undertaken in full cooperation with the interested agencies. It is expected that this process will continue until agreement is reached on all details of the habitat compensation program.

Criteria for final selection of habitat compensation lands have been or are being applied in the following sequence:

- Phase I (completed November 1984)

  - Identified lands consistent with the Susitna Area Plan (ADNR 1985)

  - Incorporated information on potential moose carrying capacity (habitat enhancement potential) based on ADF&G Habitat Division mapping (ADF&G 1984w)

  - Incorporated general information on snow depth distribution based on ADF&G Habitat Division mapping (ADF&G 1984w)

  - Added new candidate land areas, particularly in the extensive region upstream from Devil Canyon, based on helicopter reconnaissance by project moose biologists, vegetation specialists, and ADF&G Forestry Division prescribed burn expert

  - Prepared report reviewing habitat management methods to increase moose browse production in Alaska (H-E 1984e), and incorporated information into candidate land analysis

  - Prepared information matrix and maps of 20 preliminary candidate lands for agency review, and solicited agency comments on selection criteria at technical meetings and in written communications

- Phase II (completed June 1985)

  - Received written agency comments regarding selection criteria and specific candidate lands; based on these comments, four areas and portions of two others were eliminated from further consideration, and one was added

- Conducted fall 1984 field reconnaissance surveys of upstream and downstream candidate areas

- ADF&G Game Division conducted late winter (1985o) snowdepth and moose distribution surveys throughout the lower Susitna Basin and in portions of the middle basin, coordinated with the ADF&G Habitat Division's Regional Guides program

- Conducted late winter (1985) field reconnaissance surveys of downstream candidate areas

- Conducted spring 1985 field reconnaissance surveys of browse enhancement potential on candidate lands in the lower Susitna Basin

- Synthesized a) results of reconnaissance surveys of candidate lands; b) moose winter distributional information based on ADF&G winter moose studies sponsored by the Applicant, 1980 to 1985; and c) agency comments and recommendations

- Prepared shorter and more specific list of candidate lands (Table E.3.4.67) incorporating six lower basin (Figure E.3.4.45) and five middle basin areas (Figure E.3.4.46) to serve as the basis for detailed investigations (Phase III)

o Phase III (summer 1985)

- Conduct detailed review of aerial photography

- Incorporate detailed snowdepth information from late winter 1985 surveys

- Conduct systematic field assessments of Phase II candidate lands (and other high-potential areas that may be identified in the field)

- Evaluate results of aerial photograph and site assessments

- Define recommended habitat management units and prepare management plans (for moose browse enhancement and preservation of important habitats)

- Review recommended habitat management units and plans with appropriate agencies, and incorporate pertinent agency recommendations

- By fall 1985, prepare draft management plan for selected habitat management units, and solicit agency comments on the draft plan

o Phase IV (ongoing Consultative Effort)

- Evaluate and incorporate agency comments on Phase III draft management plan

- Complete moose browse inventory data analyses and carrying capacity reduction estimates for the three-stage construction sequence

- Based on above carrying capacity reduction estimates, prepare revised draft management plan incorporating specific acreage requirements and browse treatment schedules for appropriate habitat management units, linked to three-stage construction sequence

- Solicit and incorporate agency comments on revised draft management plan, and finalize the plan

From an original 20 candidate land areas, 11 areas were further evaluated prior to final selection, as shown in Figures E.3.4.46 and E.3.4.47, and described in Table E.3.4.68. Following this analysis, an additional area -- No. 12 (Willow Mountain) -- was also evaluated (Figure E.3.4.46, Table E.3.4.68). Three of the candidate lands upstream of Devil Canyon -- Nos. 7 (Prairie Creek), 8 (Devil Mountain), and 9 (Clark Creek - Tsusena Butte) -- and one downstream area -- No. 4 (lower Moose Creek) -- are under consideration for habitat preservation. Because project biologists are already familiar with these areas and are aware of their value as wildlife habitat, and because these areas would not be actively managed through habitat enhancement measures or other intervention, they will not receive further field study prior to their final designation as habitat management units. Moose Creek (No. 4) is under consideration for designation as a State Recreational River and thus may receive protection apart from the Susitna project. The remaining eight candidate areas are now being studied intensively in the office and directly in the field. Field evaluation includes:

- o A description of vegetation being utilized by moose in winter concentration areas;
- o Observations of degree of browse utilization
- o Descriptions of vegetation of lower-use areas adjacent to the heavily-used winter concentration areas;
- o An assessment of the potential of concentrated use areas and adjacent lower-use areas for increased browse production following habitat manipulation; and
- o An assessment of browse enhancement feasibility, including access to the area, and of the probable effectiveness of habitat manipulation technique.

At present, it is likely that areas No. 10 (Watana-Delusion Creeks) and No. 12 (Willow Mountain) will receive highest priority for designation as habitat management units. This is because site visits made in 1984 and 1985 have shown that they contain zones of vegetation that were heavily utilized by moose during winter, including the months of unusually deep snow accumulation in winter and early spring 1985, and because site assessments have indicated that the existing vegetation is appropriate for browse enhancement by prescribed burning or clearing. In addition, both areas have appropriate public ownership and land use designations (Table E.3.4.68).

Candidate areas No. 10 (Watana-Delusion Creeks) and No. 11 (Lower Coal Creek) are under consideration for prescribed burning. Site visits have shown that these areas are well-drained uplands supporting mature spruce forest with an understory containing a high proportion of willow. It is probable that prescribed burning would create seral fire habitat with a high percentage of willow on these sites. The Watana-Delusion Creeks area is preferred because 1) it is a moose winter concentration area; 2) it borders and is a continuation of an area to be inundated by the Watana impoundment during all three construction stages; and 3) it contains a greater number of natural fire boundaries, as it will be bordered by the reservoir itself as well as by unvegetated ridgetops and breaks in fuel continuity provided by tundra vegetation.

Candidate areas No. 12 (Willow Mountain) is located on state land within the Hatcher Pass Management Unit of the Willow Sub-Basin Area Plan. The areas consists of mixed paper birch-white spruce forests on gentle to moderate slopes with northwest to southwest aspects and is primarily between 1,000-2,000 feet in elevation. The area is utilized extensively by moose in winter and would be amenable to active browse management. The proposed techniques for habitat enhancement would entail clearing of mature forest vegetation in a mosaic pattern, maximizing residual cover and edge effect. The cleared areas would scarified, exposing mineral soil to provide an adequate seedbed for the regeneration of paper birch and other browse species.

The Applicant's current proposal for habitat compensation on mitigation lands through the 50-year license period is presented in Table E.3.4.69. The strategy involves two types of habitat manipulation: clearing and prescribed burning. Both methods will require total acreages larger than the areas directly affected by manipulation, especially prescribed burning. Areas of later successional habitat must be maintained adjacent to cleared or burned locations to provide cover. For clearing, from one-third one-third to two-thirds of the habitat management unit will be treated at any given time, with the remainder left undisturbed (Oldemeyer and Regelin 1980). For prescribed burning, 10 to 20 percent of the management unit will be treated, with 80 to 90 percent remaining unburned (H-E 1984e). In addition, a large habitat area near the Watana impoundment that is important to bears, moose, and furbearers, will be protected from development levels that would degrade its quality.

The proposed schedule for habitat manipulation and the effective compensation produced for moose is diagrammatically compared with habitat losses due to the project over the 50-year license period in Figure E.3.4.48. This figure is based on the habitat losses indicated in Tables E.3.3.40 E.3.3.41, and E.3.3.42 and includes allowance for the rehabilitation of areas only temporarily lost as wildlife habitat (total areas permanently lost are shown in Table E.3.3.43). It is also based on the following three assumptions:

1. Following clearing or burning, browse production steadily increases to a level 5 times the pre-treatment level after 5 years, maintains at that level for the next 15 years, and then steadily declines to pre-treatment levels over the next 5 years (25 years after crushing).

2. Different areas within a habitat management unit are cleared or burned at the end of the initial 20 years in order to increase habitat diversity within the management unit, maintain high browse production levels, and allow fuels to accumulate over a longer rotation period on the burn sites. In this way sites are treated at 40-year or longer intervals.

3. Following transmission line right-of-way clearing in forested areas, browse production steadily increases to a level two times the pre-treatment level after two years and is maintained at that level through right-of-way vegetation management. No browse production increases occur within rights-of-way on shrub or herbaceous vegetation types.

It should be noted that greater browse production increases have been measured as a result of Alaskan browse management programs and clearing operations than are assumed above (H-E 1984e).

The Applicant's current proposed strategy for compensation land management over the 50-year licensing period is presented in Table E.3.4.69 and illustrated diagramatically in Figure E.3.4.48. Cumulative losses of moose winter habitat resulting from the successive implementation of construction Stages I, II, and III will be offset by browse enhancement measures scheduled to compensate for the habitat losses as they occur. Because about five years will be required for a land area to reach maximum browse production following treatment, the scheduling of browse enhancement measures will anticipate each construction phase by appropriate intervals. To maintain maximum compensatory browse production throughout the 50-year licensing period, mitigation lands will be re-treated at approximately 20-year intervals.

The measures planned for moose browse enhancement are (1) prescribed burning of white spruce forest with willow understory to promote re-sprouting of willow (candidate area No. 10, Watana-Delusion Creeks), and (2) clearing mixed paper birch-white spruce forest, followed by scarification to expose mineral soil, to promote seedbed establishment by browse species (candidate area No. 12, Willow Mountain). Both proposed treatment areas encompass known important winter range lands used consistently by wintering moose from year to year. Moreover, one area (No. 10) is located adjacent to the Watana impoundment area and the other (No. 12) on the east side of the lower Susitna valley, providing mitigation not only for moose subpopulations in the immediate vicinity of the reservoirs, but also downstream from the dams.

For clearing, two contiguous habitat management units will be established on the upper west-facing slopes of Willow Mountain (Figure E.2.4.49 and Table E.3.4.69). Each management unit will comprise about 5,000 acres, together totaling about 10,000 acres (the acreage of candidate area No. 12; see Figure E.3.4.46). Because the treated areas should be about 60 percent of the total managed land, 2,500 acres will eventually be cleared in each habitat management unit for a total of 5,000 areas treated, with 5,000 acres remaining undisturbed.

At the start of Stage I construction, one of the two Willow Mountain habitat management units -- comprising 2,500 acres of mixed paper birch-white spruce forest -- will be cleared. Experience from the Kenai National Wildlife Refuge crushing program indicates that it is practical to crush about 640 acres per month with a single crushing machine (Johnson 1984, pers. comm.). This acreage is assumed to apply to clearing. To attain the acreage requirement, the entire 2,500-acre treatment area will therefore be cleared during two months of each of two consecutive winters: 1990 and 1991. Access constraints will require that equipment be brought in overland during the first winter to allow scarification when soil is warm and dry, used again during the next winter and summer for further clearing and scarification, respectively, and removed during the third winter.

Estimated conservatively, the clearing of 2,500 acres of nature forest will compensate for 10,000 acres of the approximately 22,000 acres of vegetated habitat expected to be removed by construction Stage I and II. To compensate for the remaining loss of about 12,000 acres, a prescribed burn of about 3,000 acres will be conducted during the late spring or summer of 1992 (or the nearest year providing prescription conditions) on south- or west-facing slopes of the Watana Hills (candidate area No. 10). These slopes presently support dense white spruce forest with understory consisting predominantly of resin birch and various willow species. The optimum total area needed to assure safe containment of the burn and adequate provision of cover habitats will be five times the target area. This is the ratio used by the Bureau of Land Management for a similar prescribed burn planned for the Alphabet Hills east of the project area (USBLM 1985). Sufficient acreage to provide this ration for all proposed burns is available within the candidate land area, which is estimated to contain about 50,000 acres (Table E.3.4.68).

Further browse enhancement will be required to compensate for the additional 16,000 to 17,000 acres of vegetated habitat expected to be removed by construction Stage III, as well as to maintain the benefits of previous measures to compensate for the sustained habitat loss resulting from Stages I and II. In 2006, a second prescribed burn of about 7,000 acres will be conducted in the Watana Hills near the Watana Reservoir. This second burn, on a different site near the original 1992 burn, will provide replacement browse production as browse on the original 3,000-acre area loses maximum productivity, and an additional 4,000 acres of browse enhancement to compensate for Stage III habitat losses. Furthermore, during 2010 and 2011, 2,500 additional acres will be cleared in the second of the two 5,000-acre habitat management units at Willow Mountain, downstream from the project area. This second treatment will create additional moose browse just as browse on the contiguous originally-treated management unit begins to lose maximum productivity. Evidence (discussed in HE 1984e) shows that optimum browse production can be expected for about 20 years following crushing. It is therefore expected that the treatment measures conducted in 2006, 2010, and 2011 will maintain moose habitat compensation for cumulative habitat removal by combined construction Stage I, II and III for the ensuing 20 years and more.

In 2026, a third prescribed burn of 7,000 acres will be conducted in the Watana Hills habitat management unit. This burn may include a portion of the 3,000-acre burn area originally treated in 1992. The 2026 burn will create continuing enhancement as browse in the area burned 20 years earlier, in 2006, begins to lose productivity, and will maintain habitat compensation in the Watana Hills management unit through the remainder of the licensing period. Four years later, during 2030 and 2031, clearing or crushing will be conducted within the first Willow Mountain habitat management unit originally cleared in 1990-91. This re-treatment of the 2,500 originally-cleared acres will sustain compensatory browse enhancement in the Willow Mountain area through the remainder of the licensing period.

Provided monitoring shows all treatment to be effective, the total area requirement, including undisturbed buffer zones, for active habitat management for all three construction stages will be about 45,000 acres: 10,000 acres dedicated to clearing (Willow Mountain) and 35,000 acres required for prescribed burning (Watana Hills). Of the total 45,000 acres, 19,000 acres will actually receive treatment; the remaining 26,000 acres will be undisturbed, providing cover for wildlife using the treated areas and habitat for other species requiring mature, undisturbed forest, shrubland, or wetland habitats.

A contingency management unit will be established to provide for alternative treatment if monitoring shows either crushing or prescribed burning to be ineffective. As presently planned, one or more prescribed burns would be conducted in the lower Coal Creek area (No. 12) to meet this contingency. Although it appears that the Coal Creek area may receive somewhat less winter use by moose than the Watana Hills area (ADF&G 1984m) direct on-site assessments have indicated that a prescribed burn in the coal Creek area would have a high probability of producing successful browse enhancement. Additional habitat compensation through increased browse production will result from clearing and maintenance of transmission corridor rights-of-way through forested areas. An estimated 6,118 acres of forest will be cleared for this purpose during Stages I, II, and III, and much of this acreage may produce shrub vegetation used as food by wintering moose.

(b) Monitoring Plans (**)

As discussed in Section 1.3 monitoring studies are recognized as an essential project mitigation feature that provides for a reduction of impacts over time. Monitoring will be conducted during project construction and operation:

- To insure that good construction practices are being utilized;
- To evaluate the effectivness of mitigation features;

- To verify impact predictions;
- To recommend changes in construction or operation practices or mitigation measures in order to further avoid, minimize, or reduce impacts.

Terrestrial monitoring for this project is divided into two broad categories: construction monitoring and long-term monitoring. During development of the three-stage project there will be considerable overlap of these monitoring categories. Monitoring plans for both monitoring categories are listed below.

(i) Construction Monitoring (***)

Construction monitoring activities will cover all project facilities, including access road construction and maintenance, transmission line construction, camp and village construction, material removal, material washing operations, reservoir clearing, and rehabilitation needed due to construction activities. Monitoring will be done to ensure that proper construction practices are being followed, that project facilities are being properly maintained, and that rehabilitation measures are being instituted in a timely and effective manner.

The Applicant has prepared five Best Management Practices (BMP) manuals (APA 1985a, 1985b, 1985c, 1985d, 1985e) to be used in the design, construction and maintenance of the Applicant's projects:

- Oil Spill Contingency Planning
- Erosion and Sedimentation Control
- Liquid and Solid Waste
- Fuel and Hazardous Materials
- Water Withdrawal and Storage

These manuals are the result of a coordinated effort involving federal, state and local government agencies, and other groups. The manuals are compendia of typical practices that can be used to avoid or minimize environmental impacts from construction, operation, and maintenance of the Applicant's energy projects. In addition, a report entitled "Drainage Structure and Waterway Design Guidelines" (HE 1985b) has been prepared, for the specific purpose of assuring that culverts and bridges are designed to meet the ADF&G's proposed regulations for these structures.

The BMP manuals will be provided to the design engineer, who will utilize them in the preparation of both design and construction documents. The Applicant intends that applicable guidelines contained in these BMP manuals be incorporated where appropriate into the contractual documents of the project. In this way, they become an integral part of the contract requirements for construction activities.

Construction monitoring will be implemented to ensure that proper construction practices, as detailed in the BMP Manuals and Drainage Structure and Waterway Design Guidelines are being followed and that project facilities are being properly maintained.

It is anticipated that environmental concerns and regulations during construction will be addressed through a continuing process of consultation between the Applicant and the resource agencies. The process has been ongoing since the Applicant initiated project-related studies. Agencies have already been involved in the review of the BMP manuals and Drainage Structure Guidelines, initial design of project features (as presented in feasibility reports and the original license application), and other project documents. It is anticipated that this process will continue through the design, construction, and operation periods.

The Applicant will continue its practice of regular consultation with individual agencies and other project participants. The Applicant envisions that these meetings will be held at least once every two months and will be the forum in which participants will be apprised of the current status of the work. These meetings will also provide for interactive discussions with the Applicant and its design contractors.

During the design process, specific features will be described in detail. For each major project feature (e.g. dam, spillway, camp, etc.), design memoranda will be developed. In areas where environmental concerns may be involved, these memoranda will be distributed to resource agencies for review and comment. Prior to construction, the agencies will also review the final design and means of construction with regard to permits, permit stipulations, and design and construction criteria. This will ensure conformance to approved practices.

Construction of the main access road will begin in the first year after license issuance. From that time until all stages of the project are complete, construction monitoring will occur. To build the project, the Applicant will hire a firm that will manage construction. This firm will hire contractors needed to build the project. To provide overall onsite responsibility for the Applicant, there will be a resident manager at the site; for the construction manager there will be a resident engineer. One of the main responsibilities of the resident manager will be to assure adherence to requirements of the FERC license and other agency permits and regulations. This will be implemented through the resident engineer.

Mitigation measures for construction will be part of contractual documents and will be adhered to just the same as any other contractual requirement (e.g., safety procedures required by OSHA). By incorporating the environmental concerns in the contract documents, the federal, state, and local agencies can be assured that these concerns will be enforced in the field. In order that environmental and regulatory concerns receive the same level of attention as is being devoted to other phases of project development, the Applicant has formed the position of Director of Environment and Licensing (DEL). The DEL has the same stature as the Director of Engineering, Director of Construction, and the Director of Administration. All of the aforementioned directors, as well as the Susitna Project Manager, are responsible to the Associate Executive Director of Projects.

As the onsite representative of the DEL, the Applicant intends to have at least one member of its staff designated as an EFO. The EFO will be required to be thoroughly familiar with plans and specifications, as well as the special regulatory permit stipulations and general environmental statutes and regulations. It will be the EFO's responsibility to enforce those portions of the construction contract documents that incorporate the environmental stipulations specified in the permits and license.

The EFO will directly interface with the Applicant's resident engineer and the construction manager. The onsite construction manager will be thoroughly familiar with the regulatory requirements and plans and specifications. These quality control personnel will give equal weight to technical and environmental concerns in carrying out their field inspection responsibilities. The EFO through the DEL will be the Applicant's field liaison with resource/regulatory agencies.

The Applicant is committed to working with an interagency review team and will support its effort by providing data, analysis and technical support. However, it does not support the concept of funding a full-time agency team for monitoring or consultation. The resource agencies may, at their own discretion and funding, have an observer onsite to assure themselves that agency interests are maintained. The Applicant will provide this observer with field support as needed. It will be the responsibility of the resource agencies to select this observer. If the observer sees a problem, he can relate this directly to the EFO, the agency concerned, or the FERC. Whether or not the resource agencies desire an onsite observer, the DEL will contact the appropriate agencies prior to the contractor beginning a major work item, in order that the agency may have the opportunity to request a site inspection.

The EFO will have a staff that assists him in assuring that environmental requirements of the contracts are carried out. If a violation of the contract occurs (such as principles of the BMP manuals are not being followed), the EFO will take action by notifying the appropriate person in the construction manager's organization. If no response occurs, the EFO will notify the DEL and the resident manager. The resident manager, in turn, will notify the construction manager to take corrective action. It is envisioned that this entire procedure will require only a short period of time (minutes). Depending on the incident, the appropriate resource agency will also be notified.

Construction monitoring by the EFO and his staff will cover the direct environmental effects of construction activities and will include the monitoring of reservoir clearing, road and other facility construction, and borrow and disposal practices for erosion and sedimentation problems; monitoring of drainage structure placement and operation; monitoring of fuel and hazardous waste storage and spill cleanup; monitoring of liquid and solid waste management; and the monitoring of reclamation activities and effectiveness. Additionally, other monitoring activities will be conducted during construction periods to provide specific information regarding the levels of construction-related wildlife impacts and the locations of sensitive areas. These monitoring plans are described below. Other monitoring activities will be conducted during construction periods, but these will extend into operation periods as well and are described under long-term monitoring.

(1) Data on the frequency and location of wildlife mortalities along the access roads and railroad will be continuously collected to provide a continual indicator of the significance of the problem, particularly for moose and caribou. Mortality data will be used to adjust traffic scheduling and speed if the problem becomes significant. Warning signs and notification of workers regarding the locations and times where collisions are a problem will also be used when monitoring justifies their need.

(2) The locations of active raptor nests and swan nesting, brood-raising, and molting areas, will be determined each spring during the construction phase to identify sensitive areas in which aerial and ground activity will be restricted (see Mitigation Measure No. 11). Additional information on the locations of black and brown bear dens and active fox and wolf dens in and near construction areas will also be collected during the construction period.

(3) Records will be maintained on the date, time, location, species, sex, age, and other pertinent circumstances surrounding all project-related incidents involving the killing of bears or other animals in defense of life or property and all other animal-human incidents involving injury to animals or humans.

(ii) Long-term Monitoring (**)

Long-term monitoring will be conducted in order to verify impact predictions, evaluate the effectiveness of mitigation features, and recommend changes in construction or operation practices or mitigation measures in order to further avoid, minimize, or reduce impacts. Long-term monitoring will be the responsibility of the DEL and the EFO. Specific long-term monitoring measures are identified below.

(1) Big Game: Records of impoundment crossings and impoundment-caused mortalities during the open-water and ice-covered periods will be collected. In addition to observations made incidental to other monitoring surveys and regular maintenance surveys, special surveys of the impoundments will be made during filling and the early years after filling and during critical seasons, such as breakup. Impoundment surveys will also identify possible hazards to wildlife crossings from floating debris and allow avoidance of impacts through removal (see Mitigation Measure No. 20).

(2) Moose: Population-level impacts of the project on moose will be monitored by conducting late-winter censuses of moose in the area around the impoundment zones. Censuses will begin two years prior to filling of Stage I.

(3) Caribou: Data on movements and herd size of caribou will be collected periodically throughout the license period in a cooperative effort with regular ADF&G management surveys. This information will be used to identify any unanticipated impacts and to provide information necessary to modify project construction or operation, if required. Particular attention will be placed on assessing the impact of the impoundment and access road as an impediment or hazard to movement.

(4) Dall Sheep: Data on the seasonal use of the Jay Creek mineral lick by Dall Sheep and the distribution of sheep use within the lick area will be collected prior to, during, and after filling to determine if the project has caused any changes in the degree and location of lick use. Annual surveys of the size of the Watana Creek Hills sheep population will also be conducted. If necessary, Mitigation Measure No. 19 will be implemented.

(5) Brown and Black Bear: Data on brown and black bear numbers and use of the project area will be collected through a combination of: (1) observations made on an incidental basis; (2) close examination of harvest records; and (3) periodic aerial surveys. This information will serve to verify the general level of impact on these species.

(6) Beaver: Information on beaver distribution and numbers will be collected through the use of fall cache surveys. These will be conducted in Deadman Creek at least twice prior to and after construction of the Watana access road. They will be conducted along the Susitna River between Devil Canyon and Talkeetna for two years prior to filling Stage I and then annually or biannually until sometime after Stage III is filled. These surveys will serve to verify impact predictions and modify mitigation or operation plans if necessary.

(7) Raptors: The locations of active raptor nests in the project area will be determined each spring to identify sensitive areas, to identify impacts, and to assess the effectiveness of mitigation. Surveys will continue during operation to provide data on the need for continued mitigation. Surveys will continue until full mitigation has been achieved.

(8) Downstream Habitat: Data on habitat changes in the downstream floodplain between Devil Canyon and the Yentna River will be collected to identify the availability of early successional habitats prior to and after filling of the three stages. Low-level aerial photographs of the floodplain will be taken at the same river stage 5 years prior to and immediately prior to Stage I filling and every 10 years thereafter during the license period. The relative amounts of early successional habitats will be compared.

(9) Browse Production: A monitoring program will be implemented and continued throughout the license period to document the browse production of lands enhanced for moose. Full replacement throughout the license period of the moose carrying capacity lost is the Applicant's goal. Winter moose use of enhancement lands will also be monitored to document the level of moose use on these lands.

(c) Residual Impacts (**)

(i) Moose (**)

The measure described above will provide complete mitigation for habitat loss to moose through enhancement of adjacent areas and downstream lands. The carrying capacity of the middle basin will be reduced and populations there may decrease. The development of a carrying capacity model will allow an estimate of both carrying capacity and current population level impacts. It will also allow evaluation of the enhancement techniques and determination of acreage required for enhancement. Enhancement of moose habitat beyond the level needed for moose habitat compensation provides out-of-kind mitigation for residual impacts to other species (see discussion of residual impacts on bears, wolves, marten).

(ii) Caribou (*)

The impacts of mortality factors and disturbance can be minimized as described above, and no population level effects are anticipated. The likelihood of a reduction in carrying capacity resulting from blockage of movements by the impoundment is not considered high. Continued monitoring of the Nelchina herd will allow evaluation of realized impacts. If unanticipated impacts are demonstrated, mitigation will be provided. No in-kind mitigation would be possible for a demonstrated decrease in carrying capacity of the Nelchina range.

(iii) Dall Sheep (**)

The impacts of disturbance at the Jay Creek mineral lick will be fully avoided through restrictions on activity in the area. Inundation is not expected to significantly affect lick use. The need for further mitigation will be determined by continued study of lick use and soil composition.

(iv) Brown Bears (**)

The creation and destruction of nuisance animals can be prevented by the measures outlined above. Disturbance impacts are also easily avoided or minimized. Slough enhancement for salmon and cooperative management of lands adjacent to Prairie Creek could fully mitigate for loss of these food resources. The loss of habitat has been minimized as much as feasible. No analysis of the value of habitat lost is possible. Adequate methods for evaluating brown bear habitat are not available. Brown bears are a low density species adapted to opportunistic utilization of a large number of available food resources in a very large home range. The impact of loss of spring feeding areas cannot be assessed, and a population-level effect ascribable to this impact would be difficult to demonstrate. Although enhancement measures for moose habitat will not fully mitigate for loss of spring forage for brown bears, burning may increase abundance of berries, a major fall and spring food of brown bears. At least partial compensation will be achieved by protection of important bear habitat in the project area. Any reduction in the bear population is likely to improve recruitment to moose and caribou populations.

(v) Black Bears (*)

The above discussion of brown bear is also applicable to black bear, except that black bear are generally restricted to forested habitat, a significant portion of which will be destroyed by the Susitna project. Residual impacts will, therefore, be much larger, and a significant decrease in black bear numbers and distribution between Tsusena Creek and the Oshetna River is anticipated. Increased recruitment in ungulate populations may result from decreased bear densities.

(vi) Wolves (*)

Disturbance of wolves at dens will be avoided as described above. Decreased availability of prey will be minimized through the mitigation measures proposed for ungulates. The Watana pack may be eliminated and the remaining packs' compositions and ranges are likely to shift and fluctuate until a new equilibrium is reached. Considering the increasing demand for harvest of ungulates and the possible decreased opportunity for harvest of moose in the middle basin, reduced wolf populations may be considered advantageous for moose and caribou populations.

(vii) Wolverine (o)

Wolverine are wide-ranging and occur in low densities. Therefore, loss of habitat and increased harvest are unlikely to cause a detectable decrease in wolverine abundance. The anticipated increase in availability of carrion caused by higher turnover rates in moose populations will mitigate for a decrease in food resources resulting from habitat loss. Further mitigation is not anticipated to be necessary.

(viii) Aquatic and Semiaquatic Furbearers (**)

Habitat loss upstream from the damsites may be compensated for through improved habitat along the river between Devil Canyon and Talkeetna. Loss of stream habitat in Deadman Creek will be minimized. Quantification of impacts and the extent to which mitigation is provided for muskrat, mink, and otter cannot be determined from currently available data. Partial compensation will be achieved through the preservation of mitigation lands containing important furbearer habitat. No compensation for increased harvest is possible beyond the provision of enhanced downstream habitat. If fur values are high, sustained high levels of harvest may decrease populations. Adjacent prime habitat, on which access will not be improved, will continue to be a source of colonizing individuals as long as those populations remain viable.

(ix) Terrestrial Furbearers (*)

Disturbance of red fox dens will be avoided. Loss of forest habitat for all species will be minimized. Precise quantification of residual impacts is not possible for any terrestrial furbearer. However, only marten are expected to suffer substantial population reductions and decrease in carrying capacity. Residual impacts for marten are large. Enhancement methods for moose will further increase loss of habitat for marten. Opportunities for mitigation for loss of forest habitat are limited both by management priorities for economically more valuable species. Partial compensation will be achieved through the preservation of mitigation lands containing important furbearer habitat.

(x) Raptors and Ravens (o)

Ravens are not limited by nest sites and are not anticipated to decrease in abundance in the middle basin. Mitigation will completely compensate for loss of nesting habitat and nesting locations for bald and golden eagles, and gyrfalcons. A precise assessment of impacts to other tree-nesting raptors which will be negatively affected is not possible. The increase in edge habitat near project facilities, the transmission corridor, and revegetated sites will enhance habitat for accipiters (goshawk and sharp-shinned hawk), thereby compensating for loss of the limited available habitat in the impoundment area. Ground-nesting species are not expected to suffer loss of nest habitat.

(xi) Waterbirds (o)

No in-kind mitigation is possible for loss of fluvial and river habitat for waterbirds. Disturbance impacts on trumpeter swan nests will be avoided as described above. Combined loss of breeding habitat and nest trees will reduce populations of waterbirds in the middle basin. However, waterbirds nest in low densities throughout the middle basin, and residual impacts represent a regionally insignificant loss of low-density habitat.

(xii) Other Birds and Small Mammals (*)

Numerical losses of small mammals and breeding birds are large in the impoundment areas. Additional losses will be minimized through alignment of the access road through tundra and low shrub habitats which support relatively low numbers and species richness. The mitigation measures proposed will leave large residual impacts, particularly for species restricted to forest habitats. Enhancement programs for moose will increase losses for these species, in both the lower and middle basins. No in-kind compensation on the project site can be obtained. Management priorities and conflicts between mitigation plans prevent specific compensation on a scale comparable to loss. However, the mitigation land and enhancement measures described in Mitigation Measures Nos. 9, 10, 8 and 25 will provide out-of-kind mitigation through the creation and protection of habitat for birds and small mammals of disturbed and early successional habitats.

4.4.3 - Cost Analysis and Schedules (***)

Schedules are indicated in the mitigation and monitoring plans described in Sections 4.4.2.1 and 4.4.2.2, respectively. To develop estimates of compensatory mitigation and monitoring 1985 cost estimates were prepared for each activity. Table E.3.4.70 presents estimated costs and the years of expenditures for implementation of the raptor nest site compensation program. This program is expected to cost $350,000. Estimated costs and the years of expenditures for habitat compensation on mitigation lands are shown in Table E.3.4.71. These costs total $2,800,000 plus $50,000 per year for the 50-year project life. Table E.3.4.72 presents long-term monitoring costs, including those associated with monitoring the effectiveness of two compensation programs identified above. These costs total $218,000 per year. However, it is assumed that as project operation continues and the levels of impact and effectiveness of mitigation are verified, monitoring costs will decline from these figures. Cost estimates do not include contingency costs or owner's administrative costs.

4.4.4 - Documentation of Agency Recommendations (***)

This section documents agency recommendations concerning mitigation measures and facilities during the comment period on this draft amended application. Comments and recommendations previously received during the extensive consultation/discussion process that was undertaken during the past several years have been incorporated to the extent practical in the text.

TABLES

TABLE E.3.4.1: COMPARISON BETWEEN AERIAL HABITAT CLASSIFICATIONS AND THOSE OF VIERECK AND DYRNESS (1980) USED TO CLASSIFY OBSERVATIONS OF RADIO-COLLARED MOOSE IN THE NELCHINA AND SUSITNA RIVER BASINS OF SOUTHCENTRAL ALASKA FROM 1977 THROUGH MID-AUGUST 1981

Aerial Habitat Classifications	Equivalent Classification from Viereck et al. (1982)[1/]
Dense tall spruce (white or unknown)	Open white spruce forest
Medium density, tall height spruce (white or unknown)	Open white spruce forest, open mixed forest, closed mixed forest
Sparsely dense tall spruce (white, black or unknown)	Woodland white spruce, open mixed forest, closed mixed forest
Dense medium height spruce (white, black or unknown)	Open black spruce forest
Medium density, medium height spruce (white, black or unknown)	Open black spruce forest, open mixed forest, closed mixed forest
Sparsely dense, medium height spruce (white, black or unknown)	Woodland white spruce, open mixed forest, closed mixed forest
Medium density, short spruce (black or unknown)	Open black spruce forest, open mixed forest, closed mixed forest
Sparsely dense short spruce	Woodland black spruce, open mixed forest, closed mixed forest
Riparian willow	Willow low shrub, wet graminoid herbaceous
Upland willow & brush	Willow low shrub, mesic graminoid herbaceous, mixed low shrub
Aspen	Closed balsam poplar forest
Riparian hardwood or unidentified	Open birch forest, closed birch forest
Alder	Closed tall shrub, open tall shrub, willow low shrub
Rock/ice	Rock/ice

[1/] With modifications from the Alaska Vegetation Classification Workshop (February 21, 1984)

Source: modified from ADF&G 1982k

TABLE E.3.4.2: MONTHLY USE OF HABITAT TYPES BY RADIO-COLLARED MOOSE OF BOTH SEXES AND ALL AGES AS DETERMINED FROM FIXED-WING AIRCRAFT FROM OCTOBER 1976 THROUGH MID-AUGUST 1981 IN THE MIDDLE AND UPPER SUSITNA AND NELCHINA RIVER BASINS

Vegetation[1/] Classification	Jan. #	Jan. %	Feb. #	Feb. %	Mar. #	Mar. %	April #	April %	May #	May %	June #	June %	July #	July %	Aug. #	Aug. %	Sept. #	Sept. %	Oct. #	Oct. %	Nov. #	Nov. %	Dec. #	Dec. %	Total #	Total %
Birch	0	0	0	0	0	0	0	0	2	.7	1	.3	1	.6	0	0	0	0	0	0	0	0	0	0	4	.2
Unidentified hardwood	0	0	0	0	0	0	0	0	0	0	1	.3	0	0	0	0	0	0	0	0	1	1.1	1	1.1	3	.2
Dense medium height black spruce	2	4.8	2	3.3	0	0	8	6.7	12	4.4	21	6.8	10	5.9	10	7.4	9	7.8	4	3.0	2	2.2	1	1.1	81	4.6
Dense medium height white spruce	0	0	0	0	0	0	3	2.5	2	.7	0	0	0	0	0	0	1	.9	2	1.5	1	1.1	0	0	9	.5
Dense short black spruce	2	4.8	1	1.7	1	.5	2	1.7	6	2.2	5	1.6	0	0	1	.7	5	4.3	1	.7	2	2.2	1	1.1	27	1.5
Dense tall black spruce	0	0	0	0	1	.5	1	.8	0	0	0	0	4	2.4	0	0	0	0	0	0	0	0	1	1.1	7	.4
Dense tall white spruce	1	2.4	6	10.0	7	3.4	4	3.4	9	3.3	8	2.6	2	1.2	0	0	2	1.7	2	1.5	2	2.2	4	4.3	47	2.7
Alder	0	0	0	0	0	0	0	0	0	0	0	0	2	1.2	2	1.5	0	0	0	0	0	0	0	0	4	.2
Dense medium height black spruce	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.5	0	0	0	0	0	0	0	0	2	.1
Medium dense medium height black spruce	4	9.5	17	28.3	57	27.8	38	31.9	84	31.0	59	19.1	36	21.3	23	16.9	27	23.3	18	13.3	13	14.1	17	18.3	393	22.5
Medium dense short spruce	6	14.3	2	3.3	21	10.2	7	5.9	15	5.5	29	9.4	9	5.3	11	8.1	8	6.9	2	1.5	2	2.2	2	2.2	114	6.5

TABLE E.3.4.2 (Page 2 of 2))

Vegetation[1/] Classification	Jan. #	Jan. %	Feb. #	Feb. %	Mar. #	Mar. %	April #	April %	May #	May %	June #	June %	July #	July %	Aug. #	Aug. %	Sept. #	Sept. %	Oct. #	Oct. %	Nov. #	Nov. %	Dec. #	Dec. %	Total #	Total %
Medium dense tall spruce	0	0	0	0	1	.5	3	2.5	3	1.1	2	.6	5	3.0	4	2.9	0	0	0	0	0	0	1	1.1	19	1.1
Medium dense tall white spruce	2	4.8	5	8.3	5	2.4	9	7.6	14	15.2	18	5.8	4	2.4	11	8.1	7	6.0	10	7.4	3	3.3	4	4.3	92	5.3
Upland brush and willow	14	33.3	18	30.0	34	16.6	12	10.1	44	16.2	72	23.3	53	31.4	32	23.5	29	25.0	58	43.0	35	38.0	40	43.0	441	25.2
Sparse dense medium spruce	8	19.0	6	10.0	58	28.3	24	20.2	56	20.7	57	18.4	21	12.4	17	12.5	14	12.1	24	17.8	19	20.7	11	11.8	315	18.0
Sparse short spruce	2	4.8	1	1.7	13	6.3	3	2.5	14	5.2	22	7.1	17	10.1	6	4.4	9	7.8	2	1.5	7	7.6	8	8.6	104	6.0
Sparse tall spruce	1	2.4	0	0	1	.5	0	0	4	1.5	0	0	5	3.0	4	2.9	1	.9	0	0	2	2.2	0	0	18	1.0
Sparse tall white spruce	0	0	2	3.3	6	2.9	5	4.2	6	2.2	14	4.5	0	0	13	9.6	4	3.4	12	8.9	3	3.3	2	2.2	67	3.8
Column Total	42	2.4	60	3.4	205	11.7	119	6.8	271	15.5	309	17.7	167	9.7	136	7.8	116	6.6	135	7.7	92	5.3	93	5.3	1747	100.0

[1/] Aerial habitat classifications and the approximate Viereck & Dyrness equivalents are given in Table E.3.4.1

Source: ADF&G 1982k

TABLE E.3.4.3: SUMMARY OF ELEVATIONAL USE BY APPROXIMATELY 200 RADIO-COLLARED MOOSE (BOTH SEXES AND ALL AGE CLASSES) FROM OCTOBER 1976 THROUGH MID-AUGUST 1981 IN THE MIDDLE AND UPPER SUSITNA AND NELCHINA RIVER

Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Mean elevation (feet)	2800	2736	2686	2577	2641	2690	2755	2790	2745	2997	2953	2955	2749
Standard deviation	461.8	468.0	442.4	461.9	449.0	426.6	531.2	509.6	451.8	488.6	480.4	475.7	
Sample size	66	98	285	204	341	424	218	174	130	193	168	116	2417
Range of elevations													
Minimum	1800	1400	1700	1500	1400	1300	-	1800	1800	1400	1450	1600	
Maximum	3900	3900	4600	4100	3800	4400	4200	4800	4000	4200	4400	4600	

Source: ADF&G 1982k

TABLE E.3.4.4: OCCURRENCE AND MEAN PERCENT OF CANOPY COVERAGE FOR SPECIES OF RIPARIAN (R) AND NON-RIPARIAN (NR) VEGETATION AND HABITAT TYPES OBSERVED AT RELOCATION SITES FOR 6 MALE MOOSE CAPTURED AND RADIO-COLLARED ALONG THE SUSITNA RIVER SOUTH OF TALKEETNA, ALASKA, AND MONITORED DURING CALVING, SUMMER, BREEDING, AND TRANSITIONAL PERIODS FROM MARCH 16 TO OCTOBER 15, 1981

Vegetative type	Seasonal Period[1/]															
	Calving				Summer				Breeding				All Transitions			
	NR	% (N[2/] =30)	R	% (N=0)	NR	% (N=38)	R	% (N=3)	NR	% (N=21)	R	% (N=4)	NR	% (N=58)	R	% (N=6)
Total % of relocations	100%		0%		93%		7%		84%		16%		91%		9%	
Alder	10	20	0	-	25	24	3	30	17	34	2	80	15	21	3	31
Birch	22	52	0	-	29	45	3	37	12	33	3	23	43	47	2	30
Spruce	24	28	0	-	30	19	3	23	20	21	2	25	53	35	5	16
Cottonwood	1	40	0	-	2	31	1	T	3	13	1	T	5	22	4	73
Sedge	7	30	0	-	2	20	1	20	0	-	0	-	1	50	0	-
Grass	5	37	0	-	4	23	0	-	0	-	0	-	2	55	0	-
Sedge and/or grass	0	0	0	-	15	35	0	-	13	32	2	10	5	55	0	-
Willow	7	26	0	-	2	35	0	-	1	10	0	-	6	23	5	15
Fern	0	-	0	-	2	10	0	-	0	-	0	-	1	10	0	-
Devil's Club	1	30	0	-	18	21	1	10	2	20	0	-	6	23	0	-
Horsetail	2	T	0	-	0	-	0	-	0	-	0	-	0	-	0	-
Muskeg	1	50	0	-	2	15	0	-	4	50	1	50	3	47	0	-
Aspen	0	-	0	-	0	-	0	-	0	-	0	-	3	38	0	-
Water	0	-	0	-	0	-	0	-	0	-	1	50	0	-	0	-

1/ Calving = May 14 - June 17; Summer = July 1 to August 31; Breeding = September 14 - October 31;
All Transitions = remainder of time from April 16 to October 15, excluding calving, summer, and breeding periods.
NR = non-riparian and R = riparian, within the outmost banks of the Susitna River;
Percent = average for percents of canopy coverage at sites where present;
T = trace, less than 10 percent per observation; and

2/ N = number of moose relocations (higher in every season in non-riparian vegetation types).

Source: ADF&G 1982j

TABLE E.3.4.5: OCCURRENCE AND MEAN PERCENT OF CANOPY COVERAGE FOR SPECIES OF RIPARIAN (R) AND NON-RIPARIAN (NR) VEGETATION AND HABITAT TYPES OBSERVED AT RELOCATION SITES FOR 19 FEMALE MOOSE CAPTURED AND RADIO-COLLARED ALONG THE SUSITNA RIVER SOUTH OF TALKEETNA, ALASKA, AND MONITORED DURING CALVING, SUMMER, BREEDING, AND TRANSITIONAL PERIODS FROM MARCH 16 TO OCTOBER 15, 1981

Vegetative Type	Seasonal Period[1]															
	Calving				Summer				Breeding				All Transitions			
	NR (N[2]=78	%	R (N=15)	%	NR (N=110)	%	R (N=16)	%	NR (N=68)	%	R (N=17)	%	NR (N=153)	%	R (N=55)	%
Total % of relocations	83%		16%		82%		13%		80%		20%		73%		26%	
Alder	12	27	9	34	64	28	12	41	51	27	14	34	37	27	16	31
Birch	50	56	7	34	107	40	11	36	57	41	8	38	137	48	18	41
Spruce	71	31	10	9	104	20	3	7	66	24	13	15	148	33	40	28
Cottonwood	1	60	10	55	2	10	12	35	2	10	9	43	12	31	40	63
Sedge	13	33	2	15	1	30	0	-	0	-	0	-	2	10	2	T
Grass	7	20	2	35	14	25	3	20	0	-	0	-	4	20	0	-
Sedge and/or grass	0	-	0	-	28	40	3	13	43	21	10	24	13	25	3	25
Willow	13	33	6	35	2	15	5	26	0	-	0	-	11	16	21	32
Fern	0	-	0	-	6	13	0	-	4	15	0	-	3	13	0	-
Devil's Club	1	10	0	-	57	19	1	10	5	12	0	-	15	21	3	13
Horsetail	2	0	0	-	0	-	0	-	0	-	0	-	2	T	0	-
Muskeg	14	50	0	-	4	43	0	-	9	52	1	50	2	45	0	-
Aspen	1	40	-	-	0	-	1	50	1	10	0	-	8	28	0	-
Water	0	-	0	-	0	-	0	-	0	-	1	50	0	-	0	-

1/ Calving = May 14 - June 17; Summer = July 1 to August 31; Breeding = September 14 - October 31;
All Transitions = remainder of time from April 16 to October 15, excluding calving, summer, and breeding periods.
NR = non-riparian and R = riparian, within the outmost banks of the Susitna River;
Percent = average for percents of canopy coverage at sites where present;
T = trace, less than 10 percent per observation; and

2/ N = number of moose relocations (higher in every season in non-riparian habitats).

Source: ADF&G 1982j

TABLE E.3.4.6: WINTER FOOD HABITS OF MOOSE BASED ON PERCENT DRY WEIGHT[1/] COMPOSITION OF THE DIET FOR NINE AREAS IN THE MIDDLE SUSITNA RIVER BASIN, ALASKA

Dietary Component	Devil Creek	Tsusena Creek	Watana Mouth	Watana slide	Fog Creek	Cassie Creek	Kosina Creek	Clarence Creek	Oshetna River	All Areas
Willow	32	25	51	66	56	61	57	63	64	54
Resin birch	10	2	13	7	8	7	9	8	15	10
Paper birch			4							<1
Mountain cranberry	26	40	1	<1	2	10	14	<1	<1	8
Quaking aspen			4						1	1
Alder									<1	<1
Lichen		1		<1						<1
Moss	15	14	20	19	23	17	12	20	15	18
Unidentified graminoid	12	13	2	2	4	<1	4	4	1	4
Unidentified forb & shrub	2	1	2	2	3	2	1	2	2	2

[1/] Due to rounding error, the dry weight may not total 100%

TABLE E.3.4.7: WINTER CARRYING CAPACITY OF THE WATANA IMPOUNDMENT ZONE (INCLUDING ADJACENT PROJECT FACILITIES) AND SUSITNA WATERSHED UPSTREAM OF GOLD CREEK FOR MOOSE BASED ON THE BIOMASS OF TWIGS AVAILABLE IN WINTER (SEE TEXT AND APPENDIX E.8.3 FOR DETAILED EXPLANATION OF METHODS USED).

Vegetation Type (Level 3)	Area (ha)		Available Browse (kg/ha)	n	Twig Biomass ($kg \times 10^3$)		Moose Days		Winter Residents	
	Impoundment Zone	Basin			Impoundment Zone	Basin	Impoundment Zone	Basin	Impoundment Zone	Basin
Open coniferous forest	3,844	96,100	29.9	240	114.9	2,873.4	22,980	574,680	127.7	3,192.7
Woodland coniferous forest	4,834	156,513	10.0	45	48.3	1,565.1	9,660	313,020	53.7	1,739.0
Open deciduous forest	326	968	5.5	15	1.8	5.3	360	1,060	2.0	5.9
Open mixed forest	1,480	23,125	34.0	15	50.3	786.3	10,060	157,260	55.9	873.7
Low mixed shrubland	1,853	520,250	29.8	363	55.2	15,503.5	11,040	3,100,700	61.3	17,226.1
TOTALS				678	270.5	20,733.6	54,100	4,146,720	301	23,037

TABLE E.3.4.8: DATES INDICATING CHRONOLOGY OF DEPARTURE FROM SUSTINA RIVER WINTERING AREAS FOR MALE AND FEMALE MOOSE RADIO-COLLARED ON THE SUSITNA RIVER DOWNSTREAM FROM TALKEETNA, MARCH 10-12, 1981

Date1/	Females		Males	
	Riparian2/	Non-riparian	Riparian	Non-riparian
March 10-12	16	0	4	0
March 16	9	7	4	0
March 23	8	8	1	3
April 3	7	5	0	2
April 6	7	9	0	4
April 14	3	7	0	1
April 20	6	11	1	3
April 22-23	4	13	0	4
April 28	3	14	0	4

1/ All individuals not relocated on each date.

2/ Riparian = individuals relocated within the outmost banks of the Susitna River;
Non-riparian = individuals relocated outside the outmost banks of the Susitna River.

Source: ADF&G 1982j

TABLE E.3.4.9: MINIMUM, MAXIMUM AND MEAN DISTANCE (km) TO THE SUSITNA RIVER FROM GEOMETRICAL CENTERS OF THE CALVING RANGE, SUMMER RANGE, AND BREEDING RANGE FOR MALE AND FEMALE MOOSE RADIO-COLLARED IN SEVERAL LOCATIONS ALONG THE SUSITNA RIVER BETWEEN DEVIL CANYON AND THE DELTA ISLANDS, ALASKA 1980-81

Sex	Calving range May 14 to June 17					Summer range July 1 to August 31					Breeding range September 14 to October 31				
Location[1]	N[2]	Min[3]	Max	Mean	SD	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD
Females															
Upstream	8	0.0	5.0	2.25	2.25	8	0.7	4.3	2.60	2.24	8	1.2	4.9	3.09	1.42
Downstream															
Westside	14	0.0	19.9	9.22	7.86	14	0	24.0	10.37	8.68	13	0	25.0	10.74	9.56
Eastside	4	2.1	4.6	5.33	2.63	7	2.2	10.1	6.67	3.54	7	32.2	16.9	8.91	6.28
Males															
Upstream	2	3.0	3.4	3.2	0.28	3	1.7	3.0	2.37	0.65	3	1.6	2.0	1.8	0.2
Downstream															
Westside	1	30.6	30.6	-	-	2	26.7	36.2	31.5	-	2	26.4	35.3	30.9	-
Eastside	5	1.5	30.9	9.80	12.06	6	3.2	29.2	10.48	9.96	6	2.0	28.8	10.28	9.49

1/ Upstream = moose radio-collared north of Talkeetna; downstream = moose radio-collared south of Talkeetna; westside = moose spending the breeding season on the west side of the Susitna River; and eastside = moose spending the breeding season on the east side of the Susitna River.

2/ N = moose seasons of data: 2 moose each studied 1 season = 1 moose studied for 2 seasons and each equals N=2.

3/ Min = minimum, Max = maximum and SD = standard deviation for distance values in each category.

Source: ADF&G 1982j

TABLE E.3.4.10: PROXIMITY TO THE SUSITNA RIVER OF RELOCATIONS OF 9 MALE (M) AND 29 FEMALE (F) MOOSE RADIO-COLLARED ALONG THE SUSITNA RIVER BETWEEN DEVIL CANYON AND THE DELTA ISLANDS, ALASKA, 1980-81

		Number		Distance of Relocations from River							
Location[1]	Sex	Individuals	Relocations	River	0-1.6km (0-1 mi)	1.6-4.8km (1-3 mi)	4.8-8.1km (3-5 mi)	8.1-16.1km (5-10 mi)	16.1-24.2km (10-15 mi)	24.2-32.3km (15-20 mi)	32.3+km (20+ mi)
Upstream											
	M	2[2]	74	3	36	29	6				
	F	10	222	21	82	90	22	6	0	1	
Downstream											
Westside	M	6[3]	162	13	10	55	21	43	0	19	1
	F	15	403	101	41	67	14	87	74	19	
Eastside	M	1[4]	45	0	0	2	1	0	9	11	22
	F	4[5]	166	5	4	17	32	77	22	9	

[1] Upstream - moose captured north of Talkeetna.
Downstream - moose captured south of Talkeetna.
Westside - captured moose that spent the breeding season to the west of the Susitna River.
Eastside - captured moose that spent the breeding season to the east of the Susitna River.

[2] One individual studied 1-1/2 years.

[3] One individual studied 1-1/2 years.

[4] One individual studied for 1-1/2 years.

[5] Three individuals studied for 1-1/2 years.

Source: ADF&G 1982j

TABLE E.3.4.11: SUMMARY OF MOOSE SEX AND AGE COMPOSITION DATA COLLECTED ANNUALLY IN COUNT AREA 6 IN GAME MANAGEMENT UNIT 13 OF SOUTHCENTRAL ALASKA

Date	Total Males Per 100 Females	Small Moose % in Herd	Calves per 100 Females	Incidence of Twins Per 100 Females With Calf	Calf % in Herd	Total Sample
1955[a]	84.1	11.0	43.2	5.6	19.0	400
1956[a]	61.6	7.7	28.1	0.0	14.8	351
1957[a]	43.3	3.5	38.3	10.2	21.1	256
1958[a]	44.9	6.4	40.2	6.9	21.7	957
1959			N O D A T A			
1960[a]	57.2	9.0	46.4	4.0	22.4	343
1961	70.1	12.5	48.4	16.0	22.2	424
1962	44.2	-	28.3	4.6	16.4	414
1963[a]	35.6	6.5	46.6	7.4	25.6	798
1964[a]	33.3	3.1	44.4	20.0	25.0	96
1965[a]	30.4	6.3	25.8	1.5	16.5	806
1966[a]	27.7	3.2	28.0	3.5	17.9	658
1967	29.7	3.4	28.8	0.8	18.1	681
1968	29.7	3.2	26.3	2.4	16.9	504
1969	35.7	7.8	33.5	2.8	19.3	384
1970	26.6	6.2	14.2	6.9	10.1	308
1971	30.0	2.8	22.8	3.9	14.9	362
1972	10.1	2.9	23.1	0.0	17.3	277
1973	20.7	5.2	19.0	2.3	13.6	324
1974	16.0	5.2	34.4	9.0	22.9	328
1975	17.6	5.7	18.5	5.6	13.6	279
1976	20.6	5.8	24.3	4.6	16.8	274
1977	16.7	3.7	33.8	13.2	22.4	352
1978	24.1	6.0	28.6	11.7	18.8	368
1979	14.6	2.2	25.3	9.3	18.1	326
1980	15.1	5.2	29.7	8.1	20.5	423
1981	26.5	9.6	38.6	5.1	23.4	530

Remarks: [a] Area boundary change - see ADF&G (1982k).

Source: Modified from ADF&G k

TABLE E.3.4.12: SUMMARY OF MOOSE SEX AND AGE COMPOSITION DATA COLLECTED ANNUALLY IN COUNT AREA 7 IN GAME MANAGEMENT UNIT 13 OF SOUTHCENTRAL ALASKA

Date	Total Males Per 100 Females	Small Moose % in Herd	Calves per 100 Females	Incidence of Twins Per 100 Females With Calf	Calf % in Herd	Total Sample
1957			NO DATA			
1958			NO DATA			
1959			NO DATA			
1960			NO DATA			
1961			NO DATA			
1962			NO DATA			
1963 1/	47.7	3.3	38.5	0.0	20.7	121
1964 2/	39.7	6.3	31.4	2.8	18.4	207
1965 1/	59.8	7.8	16.2	0.0	9.2	412
1966	48.3	3.8	20.1	0.0	11.9	293
1967	41.0	4.4	20.6	2.5	12.8	642
1968			NO DATA			
1969			NO DATA			
1970	34.7	5.0	42.1	8.6	23.6	864
1971	26.3	5.3	33.2	7.1	20.8	624
1972	20.6	2.0	17.5	3.7	12.6	665
1973	21.9	6.0	16.3	2.9	11.8	890
1974	12.6	3.0	28.3	6.3	20.1	672
1975	10.0	3.4	15.9	4.8	12.7	695
1976	12.3	3.2	21.6	7.1	16.1	865
1977	10.8	3.0	28.7	6.0	20.6	954
1978	14.8	5.9	20.2	4.1	15.0	1030
1979	8.8	1.8	23.3	5.8	17.7	838
1980	13.3	5.6	25.1	1.1	17.9	946
1981	14.2	3.4	31.6	0.0	21.7	1284

1/ Area boundary change - see ADF&G (1982a)

2/ Early 1965 data used for 1964.

Source: Modified from ADF&G 1982k

TABLE E.3.4.13: SUMMARY OF MOOSE SEX AND AGE COMPOSITION DATA COLLECTED ANNUALLY IN COUNT AREA 14 IN GAME MANAGEMENT UNIT 13 OF SOUTHCENTRAL ALASKA

Date	Total Males Per 100 Females	Small Moose % in Herd	Calves per 100 Females	Incidence of Twins Per 100 Females With Calf	Calf % in Herd	Total Sample
1955[1/]	105.6	10.5	73.2	10.6	26.0	200
1956			NO DATA			
1957	72.5	5.2	50.3	4.9	22.6	381
1958[1/]	86.8	5.0	37.0	7.4	16.6	441
1959			NO DATA			
1960[1/]	71.1	8.6	56.7	21.4	24.5	139
1961[1/]	62.0	12.2	55.7	7.6	25.6	555
1962	56.3	10.1	23.8	1.8	13.2	416
1963			NO DATA			
1964			NO DATA			
1965	28.6	7.2	21.6	0.0	14.4	278
1966[1/]	20.0	5.9	33.5	0.0	21.8	238
1967	39.0	3.9	34.1	2.9	19.7	355
1968[1/]	9.4	2.8	36.5	3.8	25.0	108
1969	17.5	4.0	40.1	2.0	25.4	405
1970	19.4	2.2	44.4	2.1	25.9	185
1971	27.1	5.7	20.7	5.0	14.0	300
1972	21.4	6.2	25.5	0.0	17.4	288
1973	22.0	5.1	17.3	2.0	12.4	411
1974	15.4	3.4	35.2	3.7	23.4	500
1975	9.9	3.3	21.7	1.9	16.5	333
1976	9.2	3.6	19.9	3.0	15.4	447
1977			NO DATA			
1978	20.5	6.6	18.3	2.0	13.2	379
1979			NO DATA			
1980	13.7	7.4	16.2	3.8	12.5	447
1981			NO DATA			

1/ Area boundary change - see ADF&G (1982k).

Source: Modified from ADF&G 1982k

TABLE E.3.4.14: PROPORTION (%) OF RADIO-COLLARED CARIBOU SIGHTINGS IN EACH VEGETATION TYPE

Habitat	Calving & Summer[1/]		Autumn[2/]		Rut, Winter, & Spring[3/]		Total	
	Cows	Bulls	Cows	Bulls	Cows	Bulls	Cows	Bulls
Spruce forest	0	23	37	25	59	78	34	51
Tundra-herbaceous	72	37	29	21	12	9	36	19
Shrubland	27	37	16	42	24	9	24	24
Bare substrate	1	3	18	12	5	4	6	6
(No. sightings)	(120)	(30)	(55)	(24)	(164)	(54)	(339)	(108)

1/ Calving generally occurs from 15 May - 10 June. Summer range use generally occurs from from 11 June - 31 July.

2/ Autumn shift generally occurs from 1 August - 31 September.

3/ Rut generally occurs in October. Winter range use generally occurs from 1 December - 31 March. Spring shift generally occurs from 1 April - 14 May.

Source: ADF&G 1982h

TABLE E.3.4.15: NELCHINA CARIBOU HERD POPULATION ESTIMATES
(Fall estimates for years after 1962)

Year	Total Estimate	Female Estimate	Male Estimate	Calf Estimate
1955	40,000 1/	-	-	-
1962	71,000 2/	-	-	-
1967	61,000 3/	-	-	-
1972	7,842	4,800	1,622	1,420
1973	7,693	4,646	1,268	1,779
1976	8,081	4,979	1,663	1,439
1977	13,936	7,509	2,868	3,559
1978	18,981	9,866	4,429	4,686
1980	18,713	9,164	5,673	3,876
1981	20,694	10,154	6,184	4,356
1982	21,356	10,199	5,650	5,507
1983	24,838	13,212	8,046	3,580
1984	24,095	13,912	5,495	4,688

1/ Watson and Scott (1956), February census.
2/ Siniff and Skoog (1964), February census perhaps should be adjusted downward by as many as 5,000 caribou due to presence of Mentasta heed
3/ Felt by some to be an unreasonably high estimate.

Source: ADF&G 1985e

TABLE E.3.4.16: REPORTED HUNTER HARVEST OF THE NELCHINA CARIBOU HERD, 1972-1981

Year	Total Harvest	Females		% of Total Females	Males		% of Total Males	% of Total Herd
		No.	(%)		No.	(%)		
1972	555	153	(28)	3%	338	(72)	21%	7%
1973	629	203	(33)	4%	411	(67)	32%	8%
1974	1,036	343	(34)	-	656	(66)	-	-
1975	669	201	(31)	-	441	(69)	-	-
1976	776	201	(26)	4%	560	(74)	34%	10%
1977	360	77	(22)	1%	275	(78)	10%	3%
1978	539	111	(21)	1%	416	(79)	9%	3%
1979	630	90	(14)	-	509	(81)	-	-
1980	621	117	(21)	1%	453	(79)	8%	3%
1981	901	164	(18)	2%	737	(82)	12%	4%

Source: ADF&G 1982h, unpubl. data

TABLE E.3.4.17: COMPILATION OF HIGHEST YEARLY COUNTS COMPLETED IN WATANA HILLS SHEEP TREND COUNT AREA

Year	Legal Rams*	Lambs	Total	% Legal Rams	% Lambs	Surveyor
1950	--	--	0	--	--	Scott
1967	--	--	230	--	--	Nichols
1968	--	--	183	--	26.6	Nichols, August
1973	10	40	176	5.6	22.7	McIlroy, August
1974	6	18	76	7.9	23.7	Harkness, April
1976	4	30	130	3.1	23.0	Eide, August
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
1981	2	43	209	>1.0	20.6	Westlund, July 28

Note: A legal ram is defined as having a 3/4 curl or greater horn. Beginning in 1979 a legal ram is defined as having a 7/8 curl or greater horn.

Source: ADF&G 1982d

TABLE E.3.4.18: NUMBER OF AERIAL BROWN BEAR OBSERVATIONS BY MONTH IN EACH OF 5 MAJOR HABITAT CATEGORIES

Habitat	May	June	July	August	September	October/ April	All Months (%)
Spruce	44	50	17	16	9	5	141
% of Months[1/]	31.2	35.5	12.1	11.3	6.4	3.5	(25.0)
% of Habitats[2/]	31.0	29.6	19.3	17.6	25.0	13.2	-
Riparian	16	26	22	20	4	1	89
% of Months	18.0	29.2	24.7	22.5	4.5	1.1	(15.8)
% of Habitats	11.3	15.4	25.0	22.0	11.1	2.6	-
Shrubland	39	75	46	52	21	5	238
% of Months	16.4	31.5	19.3	21.8	8.8	2.1	(42.2)
% of Habitats	27.5	44.4	52.3	57.1	58.3	13.2	-
Tundra	12	14	1	1	0	0	28
% of Months	42.9	50.0	3.6	3.6	0	0	(5.0)
% of Habitats	8.5	8.3	1.1	1.1	0	0	-
Other	31	4	2	2	2	27	68
% of Months	45.6	5.9	2.9	2.9	2.9	39.7	(12.1)
% of Habitats	21.8	2.4	2.3	2.2	5.6	71.1	-
All Habitats (%)	142 (25.2)	169 (30.0)	88 (15.6)	91 (16.1)	36 (6.4)	38 (6.7)	564 (100.0)

1/ The proportion of sightings of bears in spruce habitat that occurred in each month (e.g., 31.2% of the bear sightings in spruce occurred in May).

2/ For each month, the proportion of sightings that were in that particular habitat type.

Source: ADF&G 1982e

TABLE E.3.4.19: COMPARISON OF REPORTED HOME RANGE SIZES OF BROWN/GRIZZLY BEARS IN NORTH AMERICA

Area	Sex	Sample Size	Mean Home Range mi^2	Source
Kodiak Island, AK	M	7	9.3	Berns et al. 1977
	F	23	4.6	
Yellowstone National Park	M	6	62.2	Craighead 1976
	F	14	28.2	
Southwestern Yukon	M	5	110.8	Pearson 1975
	F	8	33.2	
Northern Yukon	M	9	159.8	Pearson 1976
	F	12	28.2	
Western Montana	M	3	198.1	Rockwell et al. 1978
	F	1	40.2	
Upper Susitna and Nelchina basins	M	14	305.0	This study (1978 and 1980 results only)
	F	19	122.0	
Northwestern Alaska	M	8	521.2	Reynolds 1980
	F	18	132.8	

Source: adapted from Reynolds 1980

TABLE E.3.4.20: DENSITIES OF SELECTED NORTH AMERICAN BROWN BEAR POPULATIONS

mi^2 Bear	Location	Source
0.6	Kodiak Island, AK	Troyer and Hensel 1964
6.0 1/	Alaska Peninsula, AK	Glenn, unpubl. data
8.2	Glacier National Park, Montana	Martinka 1974 2/
11.0	Glacier National Park, BC	Mundy and Flook 1973 2/
9-11	SW Yukon Territory	Pearson 1975
16-24	Upper Susitna River, AK	Miller and Ballard 1980
88 (16-300) 3/	Western Brooks Range (NPR-A), AK	Reynolds 1980
100	Eastern Brooks Range, AK	Reynolds 1976

1/ Data refer to a 1,800 mi^2 intensively studied area of the central Alaska Peninsula.

2/ Taken from Pearson 1975.

3/ Mean is for the entire National Petroleum Reserve, Alaska; the range represents values for different habitat types in this reserve. The highest density occurred in an intensively studied experimental area.

Source: ADF&G 1982e

TABLE E.3.4.21: AVERAGE AGE AND SEX RATIOS OF BROWN BEAR POPULATIONS IN THE MIDDLE AND UPPER SUSITNA AND NELCHINA RIVER BASINS

Subpopulations	Males: Average Spring Age (Years)	Males: (Range)	Males: n	Females: Average Spring Age (Years)	Females: (Range)	Females: n	Average Both Sexes (Years)	Sex Ratio % Males
GMU 13 fall harvests, 1970-1980	8.0	(3.5-23.5)	208	7.7	(3.5-28.5)	191	7.9	52
1979 Upper Susitna studies (Miller & Ballard 1980)	7.4	(3.5-21.5)	17	7.4	(3.5-16.5)	15	7.4	53
Middle Susitna Basin (1980-1981): all captures	7.7	(3.5-14.5)	14	7.9	(3.5-13.5)	15	7.8	48
Radio-collared bears (1980-1981) with ≥5 captures	6.0	(3.5-10.5)	4	8.6	(3.5-13.5)	13	8.0	24[1/]

1/ Because adult male bears lost their collars more easily than adult females, this ratio underestimated the percentage of males.

Source: ADF&G 1982e

TABLE E.3.4.22: LITTER SIZES OF VARIOUS NORTH AMERICAN BROWN BEAR POPULATIONS

Source	Area	Average litter size (no. of litters observed) at given age of litter		
		0.5 yr	1.5 yr	0.5-1.5 yr
Pearson 1975	Southwestern Yukon Territory	1.7(11)	1.5 (11)	1.6(22)
Martinka 1974	Glacier National Park, Montana	1.7(35)	1.8(30)	1.7(65)
This Study	Nelchina Basin, Alaska	2.3(9)	1.6(16)	1.7(10)
Reynolds 1976	Eastern Brooks Range, Alaska	1.8(13)	2.0(7)	1.9(20)
Reynolds 1980[1/]	Western Brooks Range, Alaska	2.0(33)	1.9(21)	2.0(54)
Mundy 1963	Glacier National Park, B.C.	1.9(81)	1.8(45)	1.9(126)
Klein 1958	Southeastern Alaska	2.2(25)	1.9(35)	2.0(60)
Glenn et al. 1976	McNeil River, Alaska	2.5(41)	1.8(69)	2.1(110)
Glenn 1976 & updated	Black Lake, Alaska Peninsula	2.1(19)	2.1(51)	2.1(70)
Hensel et al. 1969	Kodiak Island, Alaska	2.2(98)	2.0(103)	2.1(201)
Craighead et al. 1976	Yellowstone National Park	2.2(68)	-	-

[1/] Calculations from data presented in Table 3 of Reynolds (1980)

Source ADF&G e

TABLE E.3.4.23: REPRODUCTIVE RATES OF NORTH AMERICAN BROWN BEAR POPULATIONS

Area	Mean Age at 1st Production to Maximum Age of Breeding	Potential Reproduction Life ÷ Reproductive Interval		Litter Size		Potential Production of Cubs[1]	$\bar{x}$ Reproductive Rate (No. cubs/adult female/year)
Yellowstone Park (Craighead et al. 1976)	6.3 - 24.8	18.5 years / 3.40	x	2.24	=	12.2	0.66
Alaska Peninsula (Glenn et al. 1976)[2]	6.3 - 24.8	18.5 years / 3.77	x	2.50	=	12.3	0.66
Eastern Brooks Range (Reynolds 1976)[2]	0.1 - 24.8	14.7 years / 4.24	x	1.78	=	6.2	0.42
Western Brooks Range (Reynolds 1980)	8.4 - 24.8	16.4 years / 4.03	x	2.03	=	8.3	0.50
Nelchina Basin (This study)	5.2 - 24.8	19.6 years / 3.3	x	2.3	=	13.7	0.70
Nelchina Basin (This study)	5.2 - 14.4[3]	9.2 years / 3.3	x	2.3	=	6.4	0.70

1/ This potential may be close to actual in lightly hunted populations in Yellowstone and the Brooks Range, it probably over estimates productivity of heavily hunted population (Alaska Peninsula).

2/ Reynold's (1980) analysis of data presented by others.

3/ Maximum age based on age of 30 females (≥12 years) in the sport harvest 1970-1980.

Source: ADF&G 1982e

TABLE E.3.4.24: SUMMARY OF BROWN BEAR HARVEST FROM THE SUSITNA HYDROELECTRIC PROJECT AREA 1970-1982. INCLUDES DEFENSE OF LIFE AND PROPERTY KILLS

Year	Total Take	Average Age (N)			% Total Harvest Taken in Fall		
		Males	Females	Both	Males	Females	Both
1970	5	5.3(4)	6.8(1)	5.6(5)	100	100	100
1971	15	3.3(4)	8.4(11)	7.0(15)	100	100	100
1972	9	8.0(6)	4.1(3)	6.7(9)	100	100	100
1973	4	4.3(4)	2/	4.3(4)	100	2/	100
1974	22	6.4(11)	7.4(8)	6.8(19)	100	100	100
1975	34	7.4(16)	7.6(16)	7.5(32)	100	100	100
1976	24	7.3(10)	4.6(13)	5.8(23)	100	100	100
1977	13	7.0(13)	2/	7.0(13)	100	2/	100
1978	34	5.2(16)	6.1(12)	5.6(28)	100	100	100
1979	33	6.7(15)	6.5(10)	6.6(25)	100	100	100
1980	28	5.1(16)	5.0(8)	5.1(24)	71	82	75
1981	43	5.3(28)	6.0(13)	5.5(41)	76	86	79
1982	42	4.3(26)	7.3(15)	5.4(41)	91	81	79
1970-1982	306	5.8(169)	6.5(110)	6.1(279)			

1/ Only fall seasons prior to 1980.

2/ No females reported.

Source: ADF&G 1984n

TABLE E.3.4.25: NUMBER OF AERIAL BLACK BEAR OBSERVATIONS BY MONTH IN EACH OF 5 HABITAT CATEGORIES

Habitat	May	June	July	August	September	October-April	All Months
SPRUCE	82	95	54	68	44	15	358
% by Months[1/]	22.9	26.5	15.1	19.0	12.3	4.2	(39.4)
% by Habitat[2/]	50.3	46.3	35.8	31.8	30.8	46.9	
RIPARIAN	23	33	23	18	23	1	121
% by Months	19.0	27.3	19.0	14.9	19.0	.8	(13.3)
% by Habitat	14.1	16.1	15.2	8.4	16.1	3.1	
SHRUBLAND	50	70	69	119	71	9	388
% by Months	12.9	18.0	17.8	30.7	18.3	2.3	(42.7)
% by Habitat	30.7	34.1	45.7	55.6	49.7	28.1	
TUNDRA	3	3	3	6	2	0	17
% by Months	17.6	17.6	17.6	35.3	11.8	0	(1.9)
% by Habitat	1.8	1.5	2.0	2.8	1.4	0	
OTHER	5	4	2	3	3	7	24
% by Months	20.8	16.7	8.3	12.5	12.5	29.2	(2.6)
% by Habitat	3.1	2.0	1.3	1.4	2.1	21.9	
TOTALS	163 (18.0)	205 (22.6)	151 (16.6)	214 (23.6)	143 (15.7)	32 (3.5)	908 (100.0)

1/ The proportion of sightings of bears in spruce habitat that occurred in each month (eg., 22.9% of the bear sightings in spruce occurred in May).

2/ For each month, the proportion of sightings that were in that particular habitat type.

Source: ADF&G 1982e

TABLE E.3.4.26: SUMMARY OF REPORTED BLACK BEAR HARVESTS FROM ALASKA'S GAME MANAGEMENT UNIT 13, 1973-1980

Year	Total Sport Take	Average Age (n)[a] Males	Average Age (n)[a] Females	Average Age (n)[a] Both	% Males Spring	% Males Fall	% Males Both	% Total Harvest Taken in Fall Males	% Total Harvest Taken in Fall Females	% Total Harvest Taken in Fall Both	A[d]	B[d]	C[d]
1973	70	5.9(39)	5.2(20)	5.6	NA	63	63	100	100	100	49	14	-
1974	48	5.7(26)	7.8(14)	6.4	86	64	67	81	93	85	21	25	-
1975	67				75	75	75	67	67	67	19	36	-
1976	63	5.2(5)			63	70	67	63	55	62	21	26	55
1977[b]	58	5.1(26)	4.8(12)	5.0	81	64	69	66	82	71	19	26	52
1978[c]	70	5.4(13)			80	63	68	64	81	69	20	7	64
1979[c]	70				68	50	55	64	79	70	11	18	73
1980	85				77	74	75	67	71	69	24	32	67
73-80	531	5.6(121)	5.9(58)	5.7	74	65	68	71	79	74	23	184	63
Fall only -		5.5(88)	5.9(49)	5.6									
Spring only -		5.7(33)	6.3(9)	5.8									

[a] Mean age given only when n $\geq$ 5.
[b] Only fall bears aged.
[c] Only spring bears aged.
[d] A % of total take by non-residents.
B Number taken by hunters reporting aircraft as primary source of transportation.
C % of total where meat was salvaged for food.

Source: ADF&G 1982e

TABLE E.3.4.27: KILLS AT WHICH WOLF PACKS[1/] WERE OBSERVED IN THE WATANA AND GOLD CREEK WATERSHEDS DURING 1980-1983.

Species	1980/81	1981/82	1982/83	Total No.	Total Percent
Moose, Adult	19	11	12	42	21
Moose, Yrlg.	2	3	4	9	4
Moose Calf	23	8	11	42	21
Moose, Unknown	3	4	19	26	13
Total Moose	47	26	46	119	58
Caribou, Adult	14	14	19	47	23
Caribou, Calf	2	1	1	4	2
Caribou, Unknown	10	2	3	15	7
Total Caribou	26	17	23	66	32
Ungulate, sp. unk.	0	0	3	3	1
Sheep, Adult	0	1	1	2	1
Total Ungulate	73	44	73	190	93
Other: Beaver	2	1	1	4	2
Snowshoe	2	1	1	4	2
Unknown	4	1	1	6	3
Total Other	8	3	3	14	7
TOTAL	81	47	76	204	100%

1/ Six wolf packs were observed in 1980/81 and seven packs were observed in 1981/82 and 1982/83.

Source: ADF&G 1982f, 1983g, 1984d.

TABLE E.3.4.28: COMPARISONS OF FOOD REMAINS IN WOLF SCATS COLLECTED AT DEN AND RENDEZVOUS SITES IN 1980 AND 1981 FROM THE EASTERN SUSITNA BASIN AND ADJACENT AREAS

Food Items	1980 727 Scats		1981 290 Scats	
	No. Items	% Occurrences	No. Items	% Occurrences
Adult moose	105	12.00	24	6.15
Calf moose	369	42.17	87	22.31
Moose, age unknown	22	2.51	21	5.38
Adult caribou	30	3.43	31	7.95
Calf caribou	13	1.49	19	4.87
Caribou, age unknown	8	0.91	5	1.28
Moose or caribou	31	3.54	9	2.31
Beaver	48	5.49	37	9.49
Muskrat	26	2.97	24	6.15
Snowshoe hare	55	6.29	21	5.38
Microtine	40	4.57	37	9.49
Unidentified small mammal	15	1.71	20	5.13
Bird	16	1.83	8	2.05
Fish	1	0.11	2	0.51
Vegetation	22	2.51	5	1.28
Wolf	4	0.46	1	0.26
Unknown	70	8.00	39	10.00
TOTAL	875	100.00	390	100.00

Source: ADF&G 1982f

TABLE E.3.4.29: SEASONAL ESTIMATES OF WOLF NUMBERS USING THE WATANA AND GOLD CREEK WATERSHEDS (ALL PACKS COMBINED)

Season	Estimated Numbers
Spring 1980	40
Fall 1980	77
Spring 1981	42
Fall 1981	73
Spring 1982	25
Fall 1982	46
Spring 1983	25
Fall 1983	47

Source: ADF&G 1982f, 1983g, 1984d

TABLE E.3.4.30: NUMBER OF SAMPLE UNITS CONTAINING INDICATED LEVEL OF BEAVER ACTIVITY DURING SUMMER 1982 DOWNSTREAM SURVEY

Habitat	None No Sign Seen	Low Tracks, Cuttings	Mod. Dams, Trails	High Dens, Lodges	
Mainstem	22	-	-	-	
Side channel	22	6	1	4	UPPER SECTION n=38 mi.
Side Slough	2	3	1	5	
Upland Slough	-	2	2	3	
Mainstem	4	-	-	-	
Side channel	1	1	6	3	MIDDLE SECTION n=11 mi.
Side slough	-	1	3	1	
Upland slough	-	-	-	4	
Mainstem	1	-	-	-	
Side channel	1	-	3	9	LOWER SECTION n=8 mi.
Side slough	1	-	1	3	
Upland slough	*				

* Lower section contained no clearwater habitat in sample units surveyed. (See text for explanation)

Source: Gipson, unpub. data

TABLE E.3.4.31: AERIAL COUNTS OF BEAVER CACHES IN THE FLOODPLAIN OF THE SUSITNA RIVER BETWEEN DEVIL CANYON AND TALKEETNA (54 RIVER MILES)

Habitat	1982[1/] September 15	1983[2/] October 18-19	1984 October 4
Mainstem	2	11	13
Side Channels	2	2	4
Side Sloughs	7	3	14
Upland Sloughs	14	27	45
TOTAL	14	27	45
Colony Density	0.26/mi	0.50/mi	0.83/mi

1/ From LGL and Alaska Cooperative Wildlife Research Unit (1984)

2/ Alaska Cooperative Wildlife Research Unit (1984)

TABLE E.3.4.32: NUMBER OF LAKES WITH MUSKRAT PUSHUPS IN SPRING 1980 OCCURRING WITHIN BORROW AREAS AND IMPOUNDMENTS

	Lakes Sampled	# Lakes With Pushups	Total # of Pushups
Watana			
Borrow Areas D & E	8	0	0
Impoundment	9	5	13
Devil Canyon			
Borrow Areas	5	0	0
Impoundment	0	0	0

Source: Gipson et al. 1982

TABLE E.3.4.33: NUMBERS OF FURBEARER TRACKS SEEN DURING AERIAL TRANSECTS IN THE MIDDLE SUSITNA BASIN, NOVEMBER 1980

Transect[1/] Number	Marten	Fox	Short-tailed Weasel	Mink	Otter	Totals
A-1	41	1	3	5	2	52
A-2	80	0	7	1	6	94
A-3	91	9	5	3	0	108
A-4	198	0	20	0	3	221
A-5	84	0	11	1	0	96
A-6	163	0	6	0	1	170
A-7	202	23	39	0	2	266
A-8	86	11	0	2	5	104
A-9	85	11	1	2	0	99
A-10	125	20	95	2	3	245
A-11	39	30	58	2	1	130
A-12	40	38	96	5	1	180
A-13	7	60	77	5	3	152
A-14	112	10	328	6	3	459
Totals	1353	213	746	34	30	2376

1/ See Figure E.3.4.22 for transect locations.

Source: Gipson et al. 1982

TABLE E.3.4.34: TABULATION OF NOVEMBER 1980 AERIAL TRANSECT DATA, SPECIES BY VEGETATION TYPE

Vegetation Type	Marten	Fox	Short-tailed Weasel	Mink	Otter	Totals
Forest, white spruce	35	1	4	0	0	40
Forest, birch	3	0	2	0	0	5
Forest, poplar	0	0	1	0	0	1
Forest, black spruce	0	2	0	0	0	2
Forest, mixed	54	0	1	0	0	55
Alpine mat-cushion	3	5	29	0	0	37
Woodland, white spruce	525	5	88	1	0	619
Woodland, black spruce	605	61	401	3	1	1071
Woodland, mixed	29	0	5	0	0	34
Shrub, low	12	9	8	0	0	29
Shrub, medium	35	108	190	0	0	333
Shrub, alder	25	2	11	0	0	38
River ice	2	1	2	20	20	45
Lake ice	0	4	0	0	0	4
Creek ice	6	0	2	4	2	14
Marsh	3	4	0	3	0	10
River bar	9	8	1	3	7	28
Rock	0	0	1	0	0	1
TOTALS	1346	210	746	34	30	2366

Source: Gipson et al. 1982

TABLE E.3.4.35: NUMBER OF TRACKS OF OTTER AND MINK OBSERVED AT NORTH AND SOUTH SIDES OF 37 SUSITNA RIVER CHECK POINTS, NOVEMBER 10-12, 1980[1/]

Checkpoint Numbers	North		South	
	Otters	Mink	Otters	Mink
OM-1	3	0	0	0
OM-2	0	2	0	0
OM-3	0	0	0	0
OM-4	0	0	3	1
OM-5	0	0	2	0
OM-6	0	0	0	0
OM-7	0	1	0	1
OM-8	0	0	0	2
OM-9	0	0	1	0
OM-10	0	0	0	2
OM-11	4	1	0	1
OM-12	3	1	0	0
OM-13	0	0	0	1
OM-14	2	0	3	1
OM-15	0	0	4	0
OM-16	3	1	0	2
OM-17	0	3	0	4
OM-18	0	0	0	2
OM-19	0	0	1	2
OM-20	2	0	1	0
OM-21	1	1	0	0
OM-22	0	0	0	0
OM-23	2	1	0	2
OM-24	0	0	0	0
OM-25	0	0	0	0
OM-26	0	0	0	0
OM-27	0	0	4	0
OM-28	0	0	4	0
OM-29	0	0	0	2
OM-30	0	0	0	0
OM-31	0	0	0	0
OM-32	0	0	0	3
OM-33	0	2	0	3
OM-34	0	1	0	2
OM-35	0	1	2	3
OM-36	0	0	2	2
OM-37	0	1	0	2
Totals	20	16	27	38

1/ See Figure E.4.22 for locations of river check points.

TABLE E.3.4.36: RESULTS OF MARTEN SCAT ANALYSES BY SEASON, BASED UPON PERCENT FREQUENCY OF OCCURRENCE

	Autumn 1980	Winter 1980-81	Spring 1981	Autumn 1981	Unknown Season	Total
Unknown Mammal	0.0	0.7	3.9	0.7	0.0	1.2
Microtine	83.3	85.6	82.7	98.7	85.7	88.8
Shrew	16.7	2.7	2.9	0.0	1.3	2.4
Sciurid	4.2	9.6	15.4	0.0	3.9	6.8
Unqulate	16.7	0.0	1.9	1.4	6.5	2.6
Snowshoe Hare	0.0	1.4	0.0	0.0	3.9	1.0
Muskrat	0.0	3.4	2.9	0.0	0.0	1.6
Bird	4.2	17.1	12.5	3.4	5.2	9.6
Berry	41.7	39.7	29.8	1.4	19.5	23.3
Fish	0.0	0.7	1.0	0.0	1.3	0.6
Human Foods	0.0	0.0	0.0	0.0	7.8	1.2
Total Scats	24.0	146.0	104.0	148.0	77.0	499.0
Food Items/Scat	1.7	1.7	1.6	1.1	1.4	1.5

Source: Gipson et al. 1982

TABLE E.3.4.37: TRACKS OF RED FOXES ENCOUNTERED DURING NOVEMBER 1980 AERIAL TRANSECT SURVEYS

Elevation (m)	Number of Fox Tracks	
	North side Susitna	South side Susitna
516 - 547		1
548 - 581	2	4
582 - 613	5	-
614 - 645	1	-
646 - 677	-	-
678 - 709	-	-
710 - 741	20	2
742 - 774	9	6
775 - 806	10	18
807 - 838	-	2
839 - 870	12	47
871 - 902	5	1
903 - 935	-	38
936 - 967	5	1
968 - 1000	7	2
1001 - 1032	-	1
1033 - 1064	-	2
1065 - 1096	3	11
1097 - 1129	-	15
Total	79	151
Transects 1 - 11	67	51

Source: Gipson et al. 1982

TABLE E.3.4.38: RED FOX DEN CLASSIFICATION SYSTEM

Importance Ranking	Den Type	Description
1	Primary	Active or believed to have been active in 1979, 1980, or 1981. Natal den. Multiple burrow system. Believed to have traditional use. Large dirt mounds at burrow entrances and wear patterns. Five or more entrances.
2	Secondary	Not active in 1980 or 1981. Multiple burrow system. Large dirt mounds at entrances. Wear patterns but obscured to various degrees by recent vegetative recolonization. Probably natal den when in use. May be used as a resting site. Five or more entrances.
3	Primary Alternative	Found near primary or secondary sites. Signs of recent or present use. Two to five entrances usually. Probably occupied and used primarily by pups. First pup movements away from natal den are usually to these sites. Presence of digging activity.
4	Tertiary	Usually two to five entrances. Old food remains and/or scats present. Probably not used in recent years. May be used as a resting site.
5	Shelter	One burrow. Probably used for shelter only.

Source: Gipson et al. 1982

TABLE E.3.4.39: LOCATION AND STATUS OF RAPTOR NESTING LOCATIONS IN THE MIDDLE SUSITNA BASIN

Species	Nesting Location No.	Corresponding U of A Museum No. (Kessel et al. 1982a; B. Cooper 1982 pers. comm.)	Status[a] 1974[b]	1980[c]	1981[c]	1982[d]	1984[e]	USGS Talkeetna Mountains 15 ft x 30 ft Quad No.	Location Township	Range	Section	Estimated[f] Elevation m (ft)
Golden eagle	GE-1	V, C, ii	-	x	x	NC	x	C-1	T30N	R11E	8	725-737 (2,380-2,420)
	GE-2	D, T, gg	-	x	x	NC	x	D-2	T31N	R9E	17	640-701 (2,100-2,300)
	GE-3	E, kk, ll	-	x	x	NC	0	D-2	T31N	R8E	1	701-713 (2,300-2,340)
	GE-4	qq	-	-	0	x	0	D-2	T31N	R8E	22	558 (1,830)
	GE-5	F	-	x	0	NC	0	D-2	T31N	R8E	9, 10 boundary	564 (1,850)
	GE-6	-	0	-	-	NC	*	D-2	T31N	R8E	8, 9 boundry	533 (1,750)
	GE-7	R	-	-	x	NC	x	D-3	T31N	R7E	14	966 (3,170)
	GE-8	G	-	x	0	NC	0	D-3	T32N	R6E	28	518 (1,700)
	GE-9	ff	-	-	0	NC	0	D-3	T32N	R6E	29	533 (1,750)
	GE-10	-	-	-	0	NC	0	D-4	T33N	R5W	28	1,204 (3,950)
	GE-11	dd	-	-	0	NC	0	D-4	T32N	R4E	25, 26	533-549 (1,750-1,800)

TABLE E.3.4.39 (Page 2 of 6)

Species	Nesting Location No.	Corresponding U of A Museum No. (Kessel et al. 1982a; B. Cooper 1982 pers. comm.)	Status[a] 1974[b]	1980[c]	1981[c]	1982[d]	1984[e]	USGS Talkeetna Mountains 15 ft x 30 ft Quad No.	Location Township	Range	Section	Estimated[f] Elevation m (ft)
Golden eagle (cont'd)	GE-12	-	0	-	-	NC	0	D-4	T31N	R3E	14/15 boundary	610-640 (2,000-2100)
	GE-13	Z	-	0	0	NC	0	D-4	T31N	R3E	17	460 (1,510)
	GE-14	-	0	-	-	NC	*	D-4	T31N	R3E	12	<457 (<1,500)
	GE-15	X, Y	-	-	0	NC	0	D-5	T32N	R2E	22, 23	533-579 (1,750-1,900)
	GE-16	1	-	x	x	NC	*?	D-5	T32N	R2E	27	470-485 (1,540-1,590)
	GE-17	pp	-	-	0	NC	0	D-5	T31N	R2E	17	588 (1,930)
	GE-18	M	-	-	x	NC	-(*?)	D-5	T32N	R1E	32	335 (1,100)
	GE-19	-	NC	NC	NC	NC	0	D-1	T31N	R11E	19	914-945 (3,000-3100)
	GE-20	-	NC	NC	NC	NC	0	C-2	T30N	R8E	9	747 (2,450)
	GE-21	-	NC	NC	NC	NC	0	D-4	T32N	R5E	20	549-610 (1,800-2,000)
	GE-22	-	NC	NC	NC	NC	x	C-4	T30N	R3E	27	732 (2,400)
	GE-23	-	NC?	-	-	NC	0	D-4	T31N	R4E	15	561 (1,840)

TABLE E.3.4.39 (Page 3 of 6)

Species	Nesting Location No.	Corresponding U of A Museum No. (Kessel et al. 1982a; B. Cooper 1982 pers. comm.)	Status[a] 1974[b]	1980[c]	1981[c]	1982[d]	1984[e]	USGS Talkeetna Mountains 15 ft x 30 ft Quad No.	Location Township	Range	Section	Estimated[f] Elevation m (ft)
Bald eagle	BE-1	-	0?	-	*	NC	*	C-1	T31N	R12E	33	686 (2,250)
		RBN[h]	NP	NP	NP	NC	x	C-1	T31N	R12E	28	716[g] (2,350)
	BE-2	B	-	x	x	NC	x	C-1	T29N	R11E	9, 10	671[g] (2,200)
	BE-3	hh	x	-	0	NC	0	C-2	T30N	R10E	16	582[g] (1,910)
	BE-4	S	x	-	x	NC	x	D-2	T31N	R8E	11	533 (1,750)
	BE-5	A	x	x	*	NC	*	D-3	T31N	R7E	2	497[g] (1,630)
		RBN[h]	NP	NP	NP	NC	x	D-3	T31N	R7E	3	495[g] (1,625)
	BE-6	K	-	x	x	NC	x	D-3	T33N	R5E	34	754[g] (2,475)
	BE-7	N	-	-	x	NC	0	C-4	T30N	R3E	1	567[g] (1,860)
	BE-8	L	0?	x	x	NC	x	D-6	T31N	R2W	10	221[g] (725)
	BE-9	RBN[h]	NP	NP	NP	NC	x	C-1	T30N	R12E	9	683[g] (2,240)
	BE-10	-	-	-	-	NC	0	C-4	T30N	R2E	36	541[g] (1,775)

TABLE E.3.4.39 (Page 4 of 6)

Species	Nesting Location No.	Corresponding U of A Museum No. (Kessel et al. 1982a; B. Cooper 1982 pers. comm.)	Status[a] 1974[b]	1980[c]	1981[c]	1982[d]	USGS Talkeetna Mountains 15 ft x 30 ft Quad No.	Location Township	Range	Section	Estimated[f] Elevation m (ft)
Gyrfalcon	GYR-1	U	x?[g]	-	x	NC	C-2	T30N	R10E	11	686 (2,250)
	GYR-2	H	x	x[h]	0	NC	D-5	T31N	R2E	17, 18	587 (1,925)
	GYR-3	-	x	-	-	NC	D-5	T31N	R1E	5	?[i]
Goshawk	GOS-1	-	-	-	x	x	D-2	T31N	R8E	10, 15	518 (1,700)
	GOS-2	-	0?	-	-	NC	D-4	T31N	R4E	10	442 (1,450)
	GOS-3	oo	-	-	x	NC	D-5	T31N	R1E	4	549 (1,800)
Common Raven	R-1	-	0?	-	-	NC	C-1	T30N	R11E	7, 8	717? (2,350?)
	R-2	-	x	-	-	NC	C-2	T30N	R10E	11	671? (2,200?)
	R-3	JJ	x	-	0	NC	C-2	T30N	R10E	11	641 (2,100)
	R-4	-	x	-	-	NC	C-2	T30N	R10E	7, 8	610-778[g] (2,000-2,550)
	R-5	-	x	-	-	NC	D-2	T31N	R8E	12	641 (2,100)
	R-6	-	0?	-	-	NC	D-2	T31N	R8E	15	610 (2,000)

Species	Nesting Location No.	Corresponding U of A Museum No. (Kessel et al. 1982a; B. Cooper 1982 pers. comm.)	Status[a] 1974[b]	1980[c]	1981[c]	1982[d]	USGS Talkeetna Mountains 15 ft x 30 ft Quad No.	Location Township	Range	Section	Estimated[f] Elevation m (ft)
Common Raven (cont'd)	R-7	-	x	-	-	NC	D-3	T31N	R8E	7	534-549 (1,750-1,800)
	R-8	-	x	-	-	NC	D-3	T32N	R7E	33	519 (1,700)
	R-9	-	x	-	-	NC	D-3	T32N	R6E	25	488 (1,600)
	R-10	-	x	0	-	NC	D-3	T32N	R6E	28	488 (1,600)
	R-11	-	0?	-	-	NC	D-3	T32N	R5E	26, 35	564 (1,850)
	R-12	Q	-	-	x	NC	D-3	T32N	R5E	23, 26	625 (2,050)
	R-13	P, ee	-	-	x	NC	D-4	T32N	R5E	20	549 (1,800)
	R-14	mm, nn, cc	-	-	0	NC	D-4	T31N	R4E	14	549-580[j] (1,800-1,900)
	R-15	0, aa, bb	-	-	x	NC	D-4	T31N	R4E	15	519-580[k] (1,700-1,900)
	R-16	-	0?	-	-	NC	D-4	T31N	R3E	18	442 (1,450)
	R-17	-	0?	-	-	NC	D-4	T31N	R3E	13	442 (1,450)
	R-18	-	0?	-	-	NC	D-5	T32N	R2E	36	427 (1,400)

TABLE E.3.4.39 (Page 6 of 6)

Species	Nesting Location No.	Corresponding U of A Museum No. (Kessel et al. 1982a; B. Cooper 1982 pers. comm.)	Status[a] 1974[b]	1980[c]	1981[c]	1982[d]	USGS Talkeetna Mountains 15 ft x 30 ft Quad No.	Location Township	Range	Section	Estimated[f] Elevation m (ft)
	R-19	J	x	x	-	NC	D-5	T32N	R2E	27	458[l] (1,500)
	R-20	W	-	-	0	NC	D-5	T32N	R2E	33	366 (1,200)
	R-21	-	0?	-	-	NC	D-5	T32N	R1E	32	427 (1,400)

[a] Status unknown, x? = possibly active, x = active, 0? = apparently inactive, 0 = inactive, * = nest no longer present, *? = apparently nest no longe present, - = not reported (1974) or not located (1980) - 1981) (although suitable habitat was present in most cases), NC = not checked.

[b] Data from White (1974).

[c] Data from Kessel et al. (1982a), B. Kessel and B. Cooper (unpubl. data).

[d] Data from Kessel and Cooper (unpubl. data).

[e] Differences occur between elevations given here and those reported by Kessel et al. (1982). Original estimates were obtained by attempting to locate nests as accurately as possible on USGS 1:63,360 maps with contour intervals of 100' (majority) or 50' (Talkeetna Mtns),C-1 but it was often difficult to precisely locate nests and to locate them relative to tightly spaced contour intervals (Cooper 1982 pers. comm.). All elevations have been reviewed and some revisions were made; however, in some cases estimates given here may contain errors of as much as ±100'. All elevations must be considered approximate (unless otherwise noted) until the majority are rechecked with a precision altimeter.

[f] Elevation checked with helicopter altimeter (± 30-foot accuracy, 20-foot increments) on October 11, 1982.

[g] An adult was seen perched on the cliff (White 1974).

[h] Nest site occupied by an unidentified species in 1980.

[i] Apparently above 457 m (1,500 ft) and possibly as high as about 610 m (2,000 ft) (See White 1974).

[j] Exact location of this site is unknown.

[k] Three nest sites are present.

[l] Nest site near cliff-top, which is about 457-488 m (1,500-1,600 ft).

GE-1	2.4 km (1.5 mi) upriver from Vee Canyon and 1.1 km (0.7 mi) up a narrow canyon on the north side of the Susitna River. Three nests reported: 1980 nest 26 m (85 ft) up a 33 m (110 ft) cliff, 100 m (330 ft) back from and 67 m (220 ft) above unnamed creek; 1981 nest 8 m (26 ft) up 12 m (40 ft) cliff 81 m (265 ft) back from and 67 m (220 ft) above unnamed creek (Kessel et al. 1982a; Kessel unpubl. data); 1984 nest farthest upstream and highest of the three sites.
GE-2	4.2 km (2.6 mi) up the Susitna River from the mouth of Jay Creek and in a canyon on the north side of the Susitna River. Three nests reported: 1980 nest 5 m (15 ft) up 13 m (40 ft) cliff, 10 m (35 ft) back from and 18 m (60 ft) above unnamed creek; 1981 nest 1 m (5 ft) up 5 m (15 ft) vegetated cliff, 14 m (45 ft) back from and 33 m (110 ft) above unnamed creek (Kessel et al. 1982a; Kessel unpubl. data); 1984 nest highest of the three sites.
GE-3	2.4 km (1.5 mi) up Jay Creek from its confluence with the Susitna River. Three nests reported: 1981 nest 5 m (15 ft) up 30 m (100 ft) cliff, 150 m (490 ft) from west bank and 115 m (375 ft) above Jay Creek (Kessel et al. 1982a; Kessel unpubl. data); the nests were still present in 1984.
GE-4	1.6 km (1.0 mi) up Kosina Creek from its confluence with the Susitna River and on the east side of Kosina Creek. A single nest was identified as an inactive raven nest in 1981 but golden eagles constructed a nest there in 1982 (B. Cooper pers. comm. 1982). The nest was still present in 1984.
GE-5	1.0 km (0.6 mi) down the Susitna River from the mouth of Kosina Creek. A single nest reported: 32 m (105 ft) up 38 m (125 ft) cliff on north river bank (Kessel et al. 1982a). The nest was still present in 1984.
GE-6	2.8 km (1.7 mi) down the Susitna River from the mouth of Kosina Creek on the north bank of the river. White (1974) reported a golden eagle nest at this location in 1974, and his location was thought to correspond to GE-5 since the area he indicated did not appear to contain suitable

GE-6 (Cont.)	nesting habitat. However, the small cliff was re-evaluated in 1984. Although a nest was clearly no longer present, the cliff was comparable to some other marginal locations where golden eagles have built nests in Alaska (D.G. Roseneau unpubl. data).
GE-7	9.6 km (6.0 mi) down the Susitna River from the mouth of Kosina Creek. A single nest reported: 7 m (25 ft) up a 12 m (40 ft) cliff on a south-facing hillside high above the south bank of the river (Kessel et al. 1982a). The nest was still present in 1984.
GE-8	4.0 km (2.5 mi) down the Susitna River from the mouth of Watana Creek. A single nest reported: 13 m (45 ft) up a 23 m (75 ft) cliff, 40 m (130 ft) back from and 34 m (110 ft) above the north bank of the river. The nest was inactive in 1981 although it contained a fresh spruce lining (Kessel et al. 1982a; Kessel unpubl. data). The nest was still present in 1984.
GE-9	5.4 km (3.4 mi) up the Susitna River from the mouth of Deadman Creek. A single nest reported on a cliff on the north bank of the river (Kessel unpubl. data). The nest was still present in 1984 but it contained a large rock (the nest is no longer usable).
GE-10	11.2 km (7.0 mi) north of the proposed Watana damsite. A single nest reported high on the southeast side of Tsusena Butte (Kessel unpubl. data). The remains of the nest and a good ledge were still present in 1984.
GE-11	1.0 km (0.6 mi) down the Susitna River from the mouth of Tsusena Creek and 0.8 km (0.5 mi) up a small unnamed drainage. A single nest reported on the east side of the creek (Kessel unpubl. data). The nest on the east side of the creek was still present in 1984. In 1984 two additional, older, alternate nests were also discovered on the west side of the creek.
GE-12	White (1974) reported a golden eagle nest about 10 km (6.3 mi) down the Susitna River from the mouth of Fog Creek but his location was thought to correspond to GE-13, since the area he indicated did not contain

GE-12 (Cont.)	suitable nesting habitat. However, two nests and a previously used ledge were discovered in 1984 in a side canyon 8.6 km (5.4 mi) downstream of Fog Creek and 1.6 km (1 mi) up an unnamed creek on the north side of the river. The side canyon is now considered as the correct location of GE-12.
GE-13	9.4 km (5.9 mi) up the Susitna River from the mouth of Devil Creek. A single nest reported on a cliff on the north bank of the river (Kessel unpubl. data). The nest was still present in 1984.
GE-14	5.6 km (3.5 mi) up the Susitna River from the mouth of Devil Creek. White (1974) reported a golden eagle nest at this location on the west side of the river, but the nearest suitable habitat appeared to be 1.4 km (0.9 mi) and 2.0 km (1.3 mi) farther downstream (B. Cooper pers. comm. 1982). All three possible locations were searched in 1984; habitat tended to be marginal, but the nest reported by White (1974) might have occurred at any one of the three locales. (The exact location of this nest will likely never be known).
GE-15	2.8 km (1.8 mi) up Devil Creek from its confluence with the Susitna River. At least two nests reported: one on the cliffs on the west side of Devil Creek and one on the cliffs on the north side of a small, unnamed tributary that empties into Devil Creek (Kessel unpubl. data). Both nests were still present in 1984, and a third nest was discovered on the north side of the unnamed tributary.
GE-16	0.6 km (0.4 mi) up Devil Creek from its confluence with the Susitna River. A single nest reported: 30 m (100 ft) up 45 m (150 ft) vegetated cliff, 100 m (330 ft) back from and 120 m (395 ft) above Devil Creek on the west bank (Kessel et al. 1982a). The nest appeared to be gone in 1984.
GE-17	6.8 km (4.3 mi) down the Susitna River from the mouth of Devil Creek and 3.5 km (2.2 mi) up a small drainage that joins the river from the south. A single nest reported on the east side of the unnamed creek (Kessel unpubl. data). The nest was still present in 1984.

GE-18	3.4 km (2.1 mi) up the Susitna River from the mouth of Portage Creek. A single nest reported on a moderate-sized cliff on the north bank of the river (Kessel et al. 1982a). Efforts to relocate the nest in 1984 were unsuccessful. (This section of the canyon is difficult to survey--the nest may still be present.)
GE-19	2.4 km (1.5 mi) upriver from Vee Canyon and 9.5 km (5.9 mi) up a large unnamed tributary on the north side of the Susitna River. Four nests discovered in 1984: three on the east side of the creek and one on the west side of the creek.
GE-20	9.6 km (6.0 mi) up Kosina Creek on the southeast side about 0.5 km (0.3 mi) above the confluence of Gilbert Creek. A single nest discovered in 1984.
GE-21	4.8 km (3.0 mi) up Tsusena Creek on the southeast side. Three nests discovered in 1984.
GE-22	4.8 km (3.0 mi) up a west-flowing, unnamed tributary of Prairie Creek on the north side and about 4.2 km (2.6 mi) due east of Daneka Lake. Three nests discovered in 1984.
GE-23	2.1 km (1.3 mi) up Fog Creek on the north side. The remains of one old nest discovered in 1984.
BE-1	4.2 km (2.6 mi) up the Susitna River from the mouth of Tyone River on the east bank. White (1974) reported two closely associated nests on the east side of the Susitna River in 1974 that were no longer present by 1980-81. (These nests were probably constructed in white spruce.) Sometime after 1981 bald eagles reoccupied this section of the river. In 1984 a recently constructed nest was found in a live white spruce on the east side of the river only 0.8 km (0.5 mi) upstream from the two previous historical nest sites. The nest was still present in 1985.
BE-2	The original nest which was in the top of a white spruce (active in 1980, 1981, and 1984) fell down during winter 1984-85. However a nest nest was built near the top of another spruce tree almost exactly 0.5 miles upstream of the old site and on the same (west) side of the Oshetna River. An adult bald eagle was observed incubating/brooding in this nest.

BE-3	4.0 km (2.5 mi) down the Susitna River from the midpoint of Vee Canyon the the south bank of the Susitna River, just west of the mouth of a small unnamed tributary. A single nest reported in a live balsam poplar (White 1974; Kessel unpubl. data). The nest was still present in 1985.
BE-4	1.8 km (1.1 mi) up the Susitna River from the mouth of Kosina Creek. A single nest reported 25 m (80 ft) up a 33 m (110 ft) cliff on the north bank of the river (White 1974; Kessel et al. 1982a). The cliff nest (active in 1974, 1981 and 1984) was empty during 1985 and beginning to slump off of the ledge from the snow load and winds. However, a new nest was located in a poplar tree about 300 yds upstream of the old site along the north bank of the river. The nest tree is located about 50 ft north of the river bank and the base of the tree is about 10-15 ft above the river -- an adult bald eagle (likely the female) was observed brooding in the nest during summer 1985 (two large downy chicks were present during subsequent ground-based observations).
BE-5	8.8 km (5.5 mi) up the Susitna River from the mouth of Watana Creek. A single nest reported on a wooded island in a live white spruce (White 1974; Kessel et al. 1982a). The nest, relocated in 1980, was no longer present in 1981. Sometime after 1981 bald eagles reoccupied this section of the river. In 1984 a recently constructed nest was found in a live white spruce on the south side of a small island 0.4 km (0.25 mi) from the original island, and 0.8 km (0.5 mi) from the 1974-1980 nest site. The nest was still present in 1985.
BE-6	9.2 km (5.7 mi) up Deadman Creek from its confluence with the Susitna River. A single nest reported on top of a 15 m (50 ft) live broken-topped balsam poplar, 25 m (80 ft) from the north bank of Deadman Creek (Kessel et al. 1982a). The nest was still present in 1985.
BE-7	A single nest reported on the south shore of a small pond (WB105), 1.2 km (0.7 mi) east of the northeast end of Stephan Lake and on top of a 13 m (45 ft) live broken-topped balsam poplar (Kessel et al. 1982a). The nest was still present in 1985.
BE-8	1.0 km (0.6 mi) up the Susitna River from its confluence with Indian river. A single nest reported on top of a 23 m (75 ft) live broken-topped poplar, 4 m (15 ft) from the north river bank (White 1974; Kessel et al. 1982a). The nest was still present in 1985.

BE-9	0.5 km (0.3 mi) up the Tyone River and about 100 m from the northeast bank. The nest is in a live white spruce; it was not present in 1981 (Roseneau, unpubl. data). A recently-constructed single nest discovered in 1984. The nest was still present in 1985.
BE-10	5.6 km (3.5 mi) downstream from the south end of Stephan Lake on the west bank of Prairie Creek and 1.4 km (0.9 mi) southwest of the south end of Daneka Lake. A single nest discovered in 1984. The nest is in a live broken-topped poplar. The nest was still present in 1985.
GYR-1	At midpoint of Vee Canyon and 100 m (330 ft) up a 113 m (370 ft) cliff on the south bank of the Susitna River (White 1974, Kessel et al. 1982a).
GYR-2	6.8 km (4.2 mi) down the Susitna River from the mouth of Devil Creek and 2.6 km (1.6 mi) up a gorge on the south side of the river. Nest is 100 m (330 ft) up 105 m (345 ft) cliff in the creek canyon (White 1974, Kessel et al. 1982a).
GYR-3	1.8 km (1.1 mi) due south of the proposed Devil Canyon damsite. An active nest was reported in 1974 and White (1974) commented that it was "...back from high water limits about 1/2 mile...".
GOS-1	0.3 km (0.2 mi) west of the mouth of Kosina Creek on the south bank of the Susitna River (B. Cooper 1982 pers. comm.)
GOS-2	1.6 km (1.0 mi) up the Susitna River from the mouth of Fog Creek and on the southeast side of the river. Goshawk nests reported at this location in 1974 (White 1974).
GOS-3	2.0 km (1.3 mi) southeast of the Devil Canyon damsite in paper birch on steep slope (B. Cooper 1982 pers. comm.; Kessel 1982 pers. comm.).
R-1	2.4 km (1.5 mi) upriver from Vee Canyon and 0.6 km (0.4 mi) up a narrow canyon on the north side of the Susitna River. A nest was reported on the east side of the narrow canyon about 0.2 km (0.1 mi) from a small stream in 1974 (White 1974).

R-2	0.6 km (0.4 mi) up the Susitna from the midpoint of Vee Canyon. An active nest was reported on the north side of the Susitna River on a south-facing cliff in 1974 (White 1974).
R-3	At midpoint of Vee Canyon an active nest was reported on the south-facing slope of the north bank of the Susitna River in 1974 (White 1974).
R-4	5.6 to 6.6 km (3.5-4.1 mi) down the Susitna River from the midpoint of Vee Canyon on the north bank. An active nest was reported at this general location in 1974 (White 1974). It was probably located on one of the two small existing south-facing cliff areas.
R-5	1.6 km (1.0 mi) up Jay Creek from its confluence with the Susitna River. An active nest was reported about 0.1 km (300 ft) east of Jay Creek up a small unnamed tributary that joins Jay Creek (White 1974).
R-6	1.4 km (0.8 mi) up Kosina Creek from its confluence with the Susitna River. An active nest was reported about 0.2 km (0.1 mi) east of Kosina Creek on a northwest-facing hill (White 1974).
R-7	4.6 km (2.8 mi) down the Susitna River from the mouth of Kosina Creek. An active nest was reported on the north bank of the Susitna River in 1974 (White 1974).
R-8	5.0 km (3.1 mi) up the Susitna River from the mouth of Watana Creek. An active nest was reported on the north bank of the Susitna River in 1974 (White 1974).
R-9	1.0 km up (0.6 mi) the Susitna River from the mouth of Watana Creek. An active nest was reported on the north bank of the Susitna River in 1974 (White 1974).
R-10	4.6 km (2.8 mi) down the Susitna River from the mouth of Watana Creek. An active nest was reported on the north bank of the Susitna River in 1974 (White 1974). The nest was inactive in 1980 (Kessel et al. 1982a).

R-11	0.2 km (0.1 mi) down the Susitna River from the mouth of Deadman Creek. A nest was reported on the south bank of the Susitna almost opposite the mouth of Deadman Creek (White 1974).
R-12	1.4 km (0.9 mi) up Deadman Creek from its confluence with the Susitna River and 13 m (45 ft) up a 32 m (105 ft) cliff on the east bank of the creek (Kessel et al. 1982a).
R-13	4.2 km (2.6 mi) up Tsusena Creek from its confluence with the Susitna River. Two nests (alternates) were reported to be on a cliff on the east bank of the creek (Kessel et al. 1982a).
R-14	3.8 km (2.4 mi) up Fog Creek from its confluence with the Susitna River. Two nests (alternates) were located on the north side of the creek and another alternate nest was located on the south side (Kessel et al. 1982a).
R-15	2.4 km (1.5 mi) up Fog Creek from its confluence with the Susitna River. Two nests (alternates) were located on the north side of the creek and an active nest was located on the south side of the creek (Kessel et al. 1982a).
R-16	7.4 km (4.6 mi) up the Susitna River from the mouth of Devil Creek. Nests were reported on the north bank of the Susitna River in 1974 (White 1974).
R-17	7.4 km (4.6 mi) up the Susitna River from the mouth of Devil Creek and 0.5 km up a small drainage that flows south into the Susitna River. A nest was reported on the north shore of the Susitna River in 1974 (White 1974).
R-18	2.4 km (1.5 mi) up the Susitna River from the mouth of Devil Creek. A nest was reported on the north shore of the Susitna River in 1974 (White 1974).
R-19	1.0 km (0.6 mi) up Devil Creek from its confluence with the Susitna River and near the top of a cliff on the west bank of the creek. An active nest was reported here in 1974 (White 1974) and it was active in 1980 (Kessel et al. 1982a).

R-20	1.9 km (1.2 mi) down the Susitna River from the mouth of Devil Creek on cliffs on the northwest side of the river (Kessel unpub. data).
R-21	3.6 km (2.3 mi) up the Susitna River from the mouth of Portage Creek and 0.6 km (0.4 mi) downstream from the proposed Devil Canyon damsite on the north bank of the river. A nest was reported at this location in 1974 (White 1974).

TABLE E.3.4.41: BREEDING PHENOLOGIES OF EAGLES, GYRFALCON, AND COMMON RAVEN IN INTERIOR ALASKA

Species	Status[1/]	Dates of Phases of Breeding Cycle				
		Arrival/Courtship	Egg-Laying	Incubation	Nestlings	Fledging/Dispersal
Golden eagle[2/]	M	Mar 5-Apr 30	Apr 1-May 10	Apr 15-June 20	June 1-Sept 1	Aug 1-Sept 25
Bald eagle[2/]	M/R	Mar 10- May 1	Mar 20-May 10	Apr 30-June 30	May 20-Sept 15	Aug 1-Sept 30
Gyrfalcon[2/]	R	Mar 1-Apr 10	Apr 1-May 20	Apr 5-June 25	May 15-Aug 15	July 10-Sept 30
Raven[3/]	R	Mar 1-Apr 15	Apr 1-May 5	Apr 5-May 25	Apr 25-June 25	May 25-July 15

1/ M = migrant, R = resident

2/ Data summarized from Roseneau et al. (1981)

3/ Based on calculations from Kessel (unpublished data) and Brown (1974)

Source: Kessel et al. 1982a

TABLE E.3.4.42: DATA ON BALD EAGLE NESTS ALONG THE SUSITNA RIVER, BETWEEN DEVIL CANYON AND COOK INLET. NESTS IN 1980 WERE OBSERVED IN APRIL BY U.S. FISH AND WILDLIFE SERVICES; 1981 NESTS WERE LOCATED ON 26 JUNE BY TERRESTRIAL ENVIRONMENTAL SPECIALISTS, INC.; THE 1982 NESTS WERE RESULTS OF UNIVERSITY OF ALASKA MUSEUM SURVEYS. ALL 1982 NESTS WERE LOCATED IN LARGE, OLD COTTONWOOD TREES.

Year and Status			No. Chicks			Nest Height	Tree Height	Broken Topped	Tree dead or	Distance from river	Elevation
80	81	82	1982		Locality	(m)	(m)	?	alive	(m)	(m/ft)
N	A	I	0	62°40'N 149°55'W:*	Island in Susitna River 4 km downstream from Sherman	21	21	Yes	dead	250	182 (600)
N	A	A	2	62°20'N 150°10'W:	Confluence of Chulitna and Susitna rivers	25	33	No	dead	200	107 (350)
-	-	A	2	62°21'N 150°03'W:*	South bank of Talkeetna River 3 km upstream from confluence with Susitna River	27	30	No	live	3	116 (380)
-	-	A	1	62°19'N 150°08'W:	West bank of Susitna River opposite Talkeetna	30	33	No	live	10	107 (350)
N	A	A	≥1	62°13'N 150°06'W:	East bank of Susitna River 4.5 km upstream from Parks Highway Bridge	22	33	No	live	5	91 (300)
N	-	A	-	62°10'N 150°10'W:*	East bank of Susitna River 2 km downstream from Parks Highway Bridge	-	-	-	-	-	91 (300)
-	A	A	-	62°01'N 150°06'W:	Island in Susitna River near Sheep Creek Slough	-	-	-	-	-	76 (250)
N	-	A	-	61°49'N 150°10'W:	Island in Susitna River west of Kashwitna Lake	12	23	No	live	30	30 (100)
N	-	A	≥1	61°47'N 150°10'W:	Island in Susitna River opposite mouth of Willow Creek	23	30	No	live	10	30 (100)
N	-	A	1	61°46'N 150°13'W:*	Island in Susitna River 2 km west of mouth of Willow Creek	30	34	No	dead	90	24 (80)
-	-	A	2	61°45'N 150°15'W:	Northwest corner of Delta Islands	30	30	Yes	live	40	24 (80)
N	A	A	≥1	61°43'N 150°19'W:*	West bank of Susitna River .5 km upstream from mouth of Kroto Creek	28	28	Yes	live	100	30 (100
N	-	I	0	61°43'N 150°17'W:	East bank of Susitna River opposite mouth of Kroto Creek	22	30	No	live	20	27 (90)
N	-	A	≥1	61°40'N 150°19'W:	East bank of Susitna River opposite Kroto Slough	23	27	Yes	live	5	30 (100)
N	-	I	0	61°39'N 150°20'W:	Island in Susitna River near Kroto Slough	20	27	No	live	100	24 (80)
N	-	I	0	61°39'N 150°21'W:	Island in Susitna River near Kroto Slough	27	30	No	live	5	24 (80)
-	-	A	-	61°37'N 150°23'W:	Island in Susitna River 5 km upstream from Yentna River mouth	23	30	No	live	100	20 (60)
-	-	A	-	61°35'N 150°25'W:	Island at confluence of Yentna and Susitna rivers	-	-	-	-	-	17 (50)
-	-	A	≥1	61°28'N 150°30'W:*	East bank of Susitna River east of Flat Horn Lake	23	27	Yes	live	5	10 (30)
-	-	I	0	61°28'N 150°32'W:*	West bank of Susitna River east of Flat Horn Lake	23	25	Yes	live	3	10 (30)
-	-	A	-	61°24'N 150°30'W:	South end of Bell Island	-	-	-	-	-	7 (20)
-	-	I	0	61°22'N 150°36'W:	Northern end of Big Island	20	34	No	live	1	3 (10)
-	-	I	0	61°22'N 150°37'W:	West bank of Susitna River west of Big Island	18	23	No	live	2	3 (10)
-	-	I	0	61°20'N 150°38'W:	West side of Big Island	20	23	Yes	dead	20	3 (10)
-	-	I	0	61°20'N 150°38'W:	West side of Big Island	20	20	Yes	dead	20	3 (10)
-	-	I	0	61°25'N 150°28'W:	East bank of Susitna River near Maid Lake	-	-	Yes	-	-	3 (10)
-	-	I	0	61°22'N 150°31'W:	Island in the Susitna River west of Beaver Lake	-	-	Yes	-	-	3 (10)
N	-	-	-	61°22'N 150°01'W:	Confluence of the Chunilna and Talkeetna rivers	-	-	-	-	-	137 (450)

TABLE E.3.4.42 (Page 2 of 2)

Year and Status 80	81	82	No. Chicks 1982		Locality	Nest Height (m)	Tree Height (m)	Broken Topped ?	Tree dead or alive	Distance from river (m)	Elevation (m/ft)
N	-	-	-	62°20'N 150°05'W:*	Island 1 km up Talkeetna River	-	-	-	-	-	107 (350)
N	-	-	-	62°17'N 150°08'W:	Island in Susitna River 3 km downstream from Talkeetna	-	-	-	-	-	107 (350)
N	-	-	-	62°16'N 150°09'W:	West bank of Susitna River 6 km downstream from Talkeetna	-	-	-	-	-	107 (350)
-	A	-	-	61°59'N 150°07'W:	Island in Susitna River near mouth of Sheep Creek	-	-	-	-	-	60 (200)
N	-	-	-	61°54'N 150°07'W:	East bank of Susitna River near mouth of 196 Mile Creek	-	-	-	-	-	45 (150)
N	-	-	-	61°46'N 150°13'W:	North end of Delta Islands	-	-	-	-	-	30 (100)
-	A	-	-	61°28'N 150°32'W:	West bank of Susitna River west of Bell Island	-	-	-	-	-	7 (20)
-	A	-	-	61°27'N 150°30'W:	Island in Susitna River east of Bell Island	-	-	-	-	-	7 (20)
N	-	-	-	61°57'N 150°06'W:	Island in Susitna River 1 km upstream from Caswell Creek mouth	-	-	-	-	-	55 (180)

Key: N = nest, A = active nest, I = inactive next, - = data, * = exact location questionable.

Source: Kessel et al. 1982b

TABLE E.3.4.43: SUMMARY OF TOTAL NUMBERS AND SPECIES COMPOSITION OF WATERBIRDS SEEN ON SURVEYED WATERBODIES DURING AERIAL SURVEYS OF THE UPPER SUSITNA RIVER BASIN, FALL 1980

	DATE OF SURVEY						
Species	7 Sept	11 Sept	16 Sept	20 Sept	26 Sept	3 Oct	TOTAL
Loon spp.				4	1		5
Common loon		3	2	3			8
Red-necked grebe	2	3	4		5	3	17
Horned grebe	1	4	17	9	2	2	35
Swan spp.		34	29	9	12	20	104
Canada goose				1	20		21
American wigeon		155	325	97	88	56	721
Green-winged teal		30	83	9	1	2	125
Mallard	10	64	14	116	110	124	438
Pintail	60	60	53	21	3	4	201
Blue-winged teal		1					1
Northern shoveler		8	20				28
Ring-necked duck			2	12			14
Scaup spp.	165	347	499	370	293	180	1854
Oldsquaw	7	4	13	13	16	4	57
Black scoter		8	38	25	24	10	105
Scoter spp.[1/]				6	56	72	134
surf scoter		5	4	2			11
white-winged scoter	10			1	6	1	18
Bufflehead		33	40	95	127	101	396
Goldeneye spp.	15	36	68	124	95	133	471
Merganser spp.		8	30	36	68	19	161
TOTAL BIRDS	270	803	1241	953	927	731	4925
Total wetland area surveyed (km^2)	13.11	22.08	25.76	27.53	29.00	24.25	
Density (birds/km^2 of wetlands)	20.6	36.4	48.2	34.6	32.0	30.1	

1/ Surf or white-winged scoter

Source: Kessel et al. 1982a

TABLE E.3.4.44: SUMMARY OF TOTAL NUMBERS AND SPECIES COMPOSITION OF WATERBIRDS SEEN ON SURVEYED WATERBODIES DURING AERIAL SURVEYS OF THE UPPER SUSITNA RIVER BASIN, FALL 1981

Species	DATE OF SURVEY 15-16 Sept	26 Sept	26 Sept-9 Oct	12-19 Oct	20-23 Oct	TOTAL
Common loon	2	3	3	1		9
Arctic loon						
Red-throated loon						
Loon spp.						
Red-necked grebe	12	3	1			16
Horned grebe						
Whistling swan		18	24			42
Trumpeter swan	6		10	14		30
Swan spp.		41	25	22	13	101
Canada goose				50		50
Mallard	41	153	131	142		467
Pintail	32					32
Green-winged teal	13	3				16
Northern shoveler						
American wigeon	133		14	5		152
Canvasback						
Redhead						
Scaup, greater and lesser	479	166	51	90		786
Goldeneye, common and Barrow's	18	125	68	36		247
Bufflehead	17	20	29	52		118
Oldsquaw	15	31	7	1		54
White-winged scoter			69	13		82
Surf scoter				29		29
Black scoter	1	6	2	1		10
Scoter, spp.	69		1	92		162
Common merganser			1	2		3
Red-breasted merganser						
Merganser spp.	77	38		18		133
TOTAL BIRDS	915	607	436	568	13	2539
Total wetland area surveyed (km^2)	25.68	25.68	21.31	11.57	6.62	
Km^2 of 100% frozen waterbodies surveyed 1/	0	1.41	3.91	3.76 2/	2.00	
Density (birds/km^2 of wetlands)	35.6	23.6	20.5	49.1	1.96	

1/ Other waterbodies had at least some open water

2/ An additional 9.22 km^2 of 100% frozen waterbodies were not surveyed in mid-October because they were known to be frozen. By late October only Stephan and Murder Lakes still had some open water.

Source: Kessel et al. 1982a

TABLE E.3.4.45: SUMMARY OF TOTAL NUMBERS AND SPECIES COMPOSITION OF WATERBIRDS SEEN ON SURVEYED WATERBODIES DURING AERIAL SURVEYS OF THE UPPER SUSITNA RIVER BASIN, SPRING 1981

Species	DATE OF SURVEY 3 May	10 May	26 May	TOTAL
Common loon			4	4
Arctic loon			5	5
Red-throated loon			2	2
Loon spp.		3	4	7
Red-necked grebe			4	4
Horned grebe		1	1	2
Whistling swan				
Trumpeter swan	2		6	8
Swan spp.		11	10	21
Canada goose				
Mallard	97	78	121	296
Pintail	71	70	116	257
Green-winged teal	67	47	38	152
Northern shoveler		12	28	40
American wigeon	5	94	99	198
Canvasback		1		1
Redhead			28	28
Scaup, greater and lesser		103	513	616
Goldeneye, common and Barrow's		51	38	89
Bufflehead		2	10	12
Oldsquaw		2	84	86
White-winged scoter			16	16
Surf scoter		4	35	39
Black scoter		1	42	43
Scoter, spp.		12	74	86
Common merganser			7	7
Red-breasted merganser			2	2
Merganser spp.			25	25
TOTAL BIRDS	242	492	1312	2046
Total wetland area surveyed (km^2)	25.68	25.68	25.68	
Km^2 of 100% frozen waterbodies surveyed*	14.31	1.97	0	
Density (birds/km^2 of wetlands)	9.4	19.2	51.1	

* Other waterbodies had at least some open water.

Source: Kessel et al. 1982a

TABLE E.3.4.46: SUMMARY OF TOTAL NUMBERS AND SPECIES COMPOSITION OF WATERBIRDS SEEN ON LAKES SURVEYED IN SUMMER 1981 IN THE MIDDLE SUSITNA BASIN

Species	Summer 1981	
	Adults	Broods
Common loon	22	3
Arctic loon	2	0
Red-throated loon	8	0
Red-necked grebe	7	1
Horned grebe	5	5
Trumpeter swan	16	1
Mallard	10	1
Pintail	7	2
Green-winged teal	2	1
Northern shoveler	7	1
American wigeon	8	6
Scaup, greater and lesser	70	5
Goldeneye, common and Barrow's	6	1
Oldsquaw	47	11
White-winged scoter	81	0
Surf scoter	33	2
Black scoter	26	11
Scoter spp.	6	1
Red-breasted merganser	1	1
Merganser spp.	1	0
Northern phalarope	23	0
Mew gull	43	7
Bonaparte's gull	5	0
Arctic tern	48	0
TOTAL BIRDS	484	60
Total wetland area surveyed (ac)	5,066	5,066
Density (birds/100ac of wetlands)	9.55	1.18

Source: based on Kessel et al. 1982a

TABLE E.3.4.47: SEASONAL POPULATION STATISTICS FOR THE MORE IMPORTANT OF SURVEYED WATERBODIES OF THE MIDDLE SUSITNA RIVER BASIN, 1980-81. INCLUDED ARE WATERBODIES THAT WERE AMONG THOSE HAVING THE SIX HIGHEST IMPORTANCE VALUE RATINGS IN AT LEAST ONE SEASON

		Fall 1980**			Fall 1981**			Spring 1981††			Summer 1981			
Waterbody1/	Size (km^2)	Mean no. birds	Mean density (no/km^2)	Mean no. species	Mean no. birds	Mean density (no/km^2)	Mean no. species	Mean no. birds	Mean density (no/km^2)	Mean no. species	no. adults	Density of adults	no. species	no. broods
Murder Lake - WB107	0.15	39.0	260.0	4.3	38.0	253.3	3.0	51.3	342.2	5.0	23	153.3	5	1
Stephan Lake - WB106	3.55	156.0	43.9	9.5	168.5	47.5	5.0	99.7	28.1	7.3	87	24.5	9	2
(Tyone R - Oshetna R group - WB140)	0.90	53.5	59.4	5.0	30.5	33.9	2.5	48.3†	53.7†	3.7†	75	83.3	11	4
(Maclaren R- Tyone R group - WB131)	1.04	212.8	204.6	6.5	123.0	118.3	5.0	54.7†	52.6†	3.7†	-	-	-	-
(Clarence Lake group-WB145)	1.60	103.8	64.8	7.0	42.5	26.6	4.5	58.7	36.7	7.0	35	21.9	8	6
(Fog Lakes group I-WB059)	1.44	72.8	50.5	6.5	55.0	38.2	3.0	21.3	14.8	4.7	54	37.5	11	5
Watana Lake - WB148	1.25	95.8	76.6	3.8	34.5	27.6	2.0	21.3†	17.1†	3.0†	8	6.4	3	0
Pistol Lake (Lower Deadman Creek group-WB067)	0.76	19.0*	17.9*	4.0*	4.0†	5.3	1.5†	85.0	111.8	6.0	15	19.7	8	5
(Fog Lakes group II-WB032)	0.07	-	-	-	-	-	-	-	-	-	8	114.3	4	6
Swimming Bear Lake-WB150	0.57	-	-	-	11.5	20.2	0.5	4.7†	8.2†	0.7†	33	57.9	5	4

1/ Codes are those used by Kessel et al. (1982a)
* Combines WB 064-067
** September 11, 16, 20 and 26, 1980; September 15 and 26, 1981
† 100 percent frozen on at least one survey
†† May 3, 10, and 26, 1981
\- Not surveyed

Source: Kessel et al. 1982a

TABLE E.3.4.48: SUMMARY OF TOTAL NUMBERS AND SPECIES COMPOSITION OF WATERBIRDS SEEN DURING SPRING AERIAL SURVEYS OF THE LOWER SUSITNA RIVER, 1981 AND 1982

Species	Devil Canyon to Talkeetna (74 km)				Talkeetna to Montana (33 km)				Montana to Kashwitna Lake (29 km)				Kashwitna Lake to mouth of Yenta River (36 km)				Mouth Yenta River to Cook Inlet (37 km)			
	May				May				May				May				May			
	7/81	10/82	21/82	28/82	7/81	10/82	21/82	28/82	7/81	10/82	21/82	28/82	7/81	10/82	21/82	28/82	7/81	10/82	21/82	28/82
Arctic loon				2																
Red-throated loon																			1	1
Loon spp.																	8			
Red-necked grebe													1				4			
Swan spp.				2										2		1	60	400	20	
White-fronted goose																				
Brant																	2			
Canada goose										1				4			1			21
Green-winged teal	34				5				3											
Mallard	18	8	2	1	23	12			23			2	7	1		1	2	2	3	12
Pintail	13								3											3
American wigeon	2								14				4				9			5
Canvasback	2																20			
Scaup spp.		1			2												100			
Scoter spp.									2											
Goldeneye spp.	11		2		6				2				3				10			2
Bufflehead			2		2				14											
Common merganser			2	4			6	2							9	1	70	8	64	119
Merganser spp.	6		4		6				61				8				102			
Total no. species	11				7				9				9				14			
Mean no. birds/survey	29				16				31				12				296			
Mean no. birds/km	0.4				0.5				1.1				0.3				8.0			

Source: Kessel et al. 1982b, B. Kessel, unpubl. data

TABLE E.3.4.49: NUMBER OF TERRITORIES OF EACH BIRD SPECIES ON EACH 10-HECTARE CENSUS PLOT, UPPER SUSITNA RIVER BASIN, ALASKA, 1981

Species	Alpine Tundra	Dwarf-Low Birch Shrub Thicket	Medium Birch Shrub Thicket	Low-Medium Willow Shrub Thicket	Tall Alder Shrub Thicket	Cotton-wood Forest	Paper Birch Forest	White Spruce-Paper Birch Forest I	White Spruce-Paper Birch Forest II	White Spruce Forest	White Spruce Scattered Woodland	Black Spruce Dwarf Forest
Pintail				V								
Goshawk					V					V		
Marsh hawk												V
Spruce grouse					V	V	V	1.0	1.0	V	V	
Ruffed grouse										+		
Willow ptarmigan		0.5		V								V
Rock ptarmigan		0.7										
White-tailed ptarmigan	+											
American golden plover	V											
Greater yellowlegs											+	
Common snipe			V	V							0.5	1.0
Baird's sandpiper	0.8	V										
Long-tailed jaeger		V										
Short-eared owl		V		V								
Common flicker									V			
Hairy woodpecker						1.0			1.0			
Downy woodpecker						0.5						
N. three-toed woodpecker								V	0.3	1.0	V	V
Alder flycatcher						1.0						
Olive-sided flycatcher									V	V		
Horned lark	0.3	V										
Tree swallow			V	V		V						
Gray jay					1.0		V	0.5	0.5	1.0	+	V
Black-billed magpie					V							
Common raven												V
Black-capped chickadee						1.8	V	V	V			
Boreal chickadee							V	1.7	1.0	V	V	1.0
Brown creeper						2.0			1.0			
American robin					0.5		V			V	0.5	0.5
Varied thrush					1.5	10.0	3.5	2.5	3.3	2.9	V	V
Hermit thrush					2.2	V	6.1	3.8	V			
Swainson's thrush						6.9	5.5	5.4	8.0	3.0	V	V
Gray-cheeked thrush						3.8	V	V			3.9	2.5
Arctic warbler			4.8	3.6							2.8	

+ = Small portion of a breeding territory on census plot, counted as 0.1 in density and diversity calculations:
V = Visitor to plot

Source: Kessel et al. 1982a

TABLE E.3.4.49 (Page 2 of 2)

Species	Alpine Tundra	Dwarf-Low Birch Shrub Thicket	Medium Birch Shrub Thicket	Low-Medium Willow Shrub Thicket	Tall Alder Shrub Thicket	Cotton-wood Forest	Paper Birch Forest	White Spruce-Paper Birch Forest I	White Spruce-Paper Birch Forest II	White Spruce Forest	White Spruce Scattered Woodland	Black Spruce Dwarf Forest
Ruby-crowned kinglet						V	V	3.3	1.0	4.2	0.8	4.0
Water pipit	0.5											
Bohemian waxwing												V
Orange-crowned warbler											V	
Yellow-rumped warbler					+	7.0	9.8	7.5	9.5	1.0	0.8	2.5
Blackpoll warbler			V			4.4	3.9	1.8	0.5		2.0	1.5
Northern waterthrush						6.1	+	2.5	V			
Wilson's warbler			8.8	9.2	1.2	4.0	3.8	4.0			9.4	
Rusty blackbird												V
Common redpoll		V	V	1.5	V	2.5	2.0	2.0	3.0	V	0.5	1.0
Pine siskin							V			V		
White-winged crossbill					V	V		V	V	V	V	V
Savannah sparrow	1.0	5.8	3.0	12.3						V	2.5	0.8
Dark-eyed junco					2.8	1.8	2.5	3.9	4.5	2.5	2.0	2.0
Tree sparrow		2.5	11.8	15.0	1.5						7.9	2.6
White-crowned sparrow		0.3	4.1	3.8	+	3.5					6.5	2.5
Fox sparrow				V	1.6	4.6	1.0	1.9	V		3.5	2.9
Lincoln's sparrow				V								
Lapland longspur	1.0	0.8										
Snow bunting	0.2											

TABLE E.3.4.50: NUMBER OF TERRITORIES OF EACH BIRD SPECIES ON EACH 10-HECTARE CENSUS PLOT, UPPER SUSITNA RIVER BASIN, ALASKA, 1982

Species	Alpine Tundra	Dwarf-Low Birch Shrub Thicket	Medium Birch Shrub Thicket	Low-Medium Willow Shrub Thicket	Tall Alder Shrub Thicket	Cotton-wood Forest	Paper Birch Forest	White Spruce-Paper Birch Forest I	White Spruce-Paper Birch Forest II	White Spruce Forest	White Spruce Scattered Woodland	Black Spruce Dwarf Forest
Goshawk									V	+		
Marsh hawk			V									
Spruce grouse							+		0.5	+		
Willow ptarmigan		+		+								
Rock ptarmigan		V										
American golden plover	0.5											
Whimbrel												
Greater yellowlegs											+	
Common snipe		V	V	+							0.5	
Long-billed dowitcher		V										
Baird's sandpiper	2.0											
Great horned owler						V						
Hawk owl											V	
Short-eared owl		V										
Common flicker										V		
Hairy woodpecker						1.0						
Downy woodpecker						0.5						
N. three-toed woodpecker										0.5		
Olive-sided flycatcher										+		
Horned lark	0.6	0.3										
Tree swallow						V				V		
Violet-green swallow										V		
Gray jay					V			0.8	1.0	0.5	V	
Black-billed magpie					V							
Common raven	V											
Black-capped chickadee						2.0						
Boreal chickadee							V	1.0	2.0	V		
Brown creeper						+			1.0			
American robin					+	+				+	V	0.9
Varied thrush				+	0.5	3.5	2.0	2.0	1.0	1.0	V	
Hermit thrush					1.8		4.0					
Swainson's thrush					+	2.5	1.0	4.1	5.0	4.0		
Gray-cheeked thrush					3.0					V	1.3	2.5
Wheatear	V											

+ = Small portion of a breeding territory on census plot, counted as 0.1 in density and diversity calculations;
V = Visitor to plot

Source: Kessel, unpub. tables

TABLE E.3.4.50 (Page 2 of 2)

Species	Alpine Tundra	Dwarf-Low Birch Shrub Thicket	Medium Birch Shrub Thicket	Low-Medium Willow Shrub Thicket	Tall Alder Shrub Thicket	Cotton-wood Forest	Paper Birch Forest	White Spruce-Paper Birch Forest I	White Spruce-Paper Birch Forest II	White Spruce Forest	White Spruce Scattered Woodland	Black Spruce Dwarf Forest
Arctic warbler			5.0	3.0							2.0	
Ruby-crowned kinglet								2.8	3.8	4.1	1.5	1.8
Water pipit		2.0										
Orange-crowned warbler					0.8		V		+	V		
Yellow-rumped warbler					0.8	2.0	4.0	4.3	5.8	3.0		1.8
Blackpoll warbler						2.5	3.0	0.8	V	+	V	0.8
Northern waterthrush						2.3		1.3	+	V		
Wilson's warbler			2.7	4.0	2.3	V	2.0	3.5	0.3	V	3.7	
Common redpoll	V	V	V		V	V		V	V	1.0		0.5
Pine grosbeak									V	V		
White-winged crossbill										V		V
Savannah sparrow	1.0	8.3	3.2	6.3					1.0			+
Dark-eyed junco					2.3		3.3	2.8	5.0	3.5	V	1.4
Tree sparrow		3.0	7.8	7.6							3.6	1.5
White-crowned sparrow		+	2.0	3.4	V	1.5					4.5	2.0
Golden-crowned sparrow				0.8								
Fox sparrow			V		3.1	4.0	2.0	3.0			2.0	3.5
Lincoln's sparrow												V
Lapland longspur	1.0	0.5										
Snow bunting	V											

TABLE E.3.4.51: HABITAT DESCRIPTIONS OF 10 HA AVIAN CENSUS PLOTS

Kessel et al. (1982a) Plot Names	Equivalent Kessel (1979) Avian Habitats[1]	Approximate Viereck and Dyrness (1980) Equivalents[1]	Equivalent Mappable (1:63,360 Scale) Vegetation Type Units (McKendrick et al. 1982)
(1) alpine tundra	dwarf shrub mat (<0.4m), dwarf shrub meadow and block field	mat and cushion tundra, mesic sedge-grass tundra	[2] mat and cushion tundra, dwarf sedge shrub meadow mesic sedge-grass tundra.
(2) dwarf-low birch shrub thicket and (3) medium birch shrub thicket	low shrub thicket (0.4-1.1m), and medium shrub thicket (1.2-2.4m)	low shrubland (<1.5m) and tall shrubland (>1.5m)	low birch shrub
(4) low-medium willow shrub thicket	low shrub thicket (0.4-1.1m), and medium shrub thicket (1.2-2.4m)	low shrubland (>1.5m) and tall shrubland (<1.5m)	[3] low mixed shrub
(5) tall alder thicket	tall shrub thicket (2.5-4.9m)	tall shrubland (>1.5m)	tall shrubland
(6) cottonwood forest	deciduous forest (90% of canopy)	closed deciduous forest (75% closed canopy cover)	closed balsam poplar forest
(7) paper birch forest	deciduous forest (90% of canopy)	closed deciduous forest (75% closed canopy cover)	closed birch forest
(8) white spruce-paper birch forest I and (9) white spruce-paper birch forest II	coniferous forest (10-90% of canopy)	deciduous forest (25-75% closed canopy)	deciduous forest
(10) white spruce forest	coniferous forest (90% of canopy)	closed conifer forest (75% closed canopy cover)	closed conifer forest
(11) white spruce scattered woodland	scattered woodland ($\geq$5m)	conifer and deciduous woodland (10-24% closed canopy cover)	[4] woodland white spruce
(12) black spruce dwarf forest	dwarf forest (<5m, stunted growth 0.2-20% canopy)	conifer and deciduous woodland (10-24% closed canopy cover)	[4] woodland black spruce

1/ As given by Kessel et al. (1982a).

2/ Kessel et al. (1982a): "The alpine tundra plot contained 3 distinct avian habitats, all typical of and widespread in the high country of the region: dwarf shrub meadow, dwarf shrub mat and block field (rock scree)." "The dwarf shrub meadow was dominated by Carex microchaeta and contained significant quantities of dwarf shrub (up to 50% ground cover)..."

3/ Kessel et al. (1982a) characterized the low-medium willow shrub thicket plot as heterogeneous with medium height shrub birch and willow over 2/3 of the plot.

4/ White spruce scattered woodland and black spruce dwarf forest are assigned to woodland conifer types rather than the woodland mixed conifer-deciduous types suggested by Kessel et al. (1982a) on the basis of Kessel et al.'s (1982a) descriptions of plot vegetation. In particular, no deciduous tree component appears to have been present in either plot (see Kessel et al. 1982a:39 and Table 2, page 28).

TABLE E.3.4.52: COMPARISON OF BREEDING BIRD DENSITIES, 1981 AND 1982, MIDDLE SUSITNA RIVER

Avian Census Plots[4/]	No. Breeding Species 1981	No. Breeding Species 1982	Diversity[3/] (H') 1981	Diversity[3/] (H') 1982	Density (No. territories/ 10 ha) 1981	Density (No. territories/ 10 ha) 1982	Change[2/] (%)
(1) Alpine tundra[1/]	10	7	1.73	1.66	4.8	6.2	+23.1
(2) Dwarf-low birch shrub[1/]	7	6	1.29	0.91	11.9	11.6	0
(3) Medium birch shrub	5	5	1.48	1.49	32.5	20.7	-36.3
(4) Low-medium willow shrub	6	9	1.56	1.80	45.4	25.4	-44.1
(5) Tall alder shrub	10	9	2.05	2.02	12.5	11.8	-5.6
(6) Cottonwood forest	16	13	2.55	2.30	60.9	25.0	-58.9
(7) Paper birch forest	10	9	2.05	2.02	38.1	21.4	-43.8
(8) White spruce-paper birch forest I	14	11	2.47	2.26	41.8	26.4	-36.8
(9) White spruce-paper birch forest II	13	13	2.07	2.09	34.6	26.6	-23.1
(10) White spruce forest	8	13	1.83	1.84	15.7	18.1	+15.3
(11) White spruce woodland	16	9	2.29	1.95	43.8	19.2	-56.2
(12) Black spruce dwarf forest	13	11	2.43	2.13	24.8	16.8	-32.3

[1/] Based on 25-ha plot; other plots were 10 ha.
[2/] Overall number of territories on 150 ha of censused plots decreased 37.5 percent.
[3/] Shannon-Weaver diversity index.
[4/] Plot numbers from Table E.3.4.48 given in parentheses. Names from Kessel et al. (1982a).

Source: Based on Kessel et al. 1982a, Kessel unpub. data

TABLE E.3.4.53: MAJOR AVIAN HABITATS OF THE MIDDLE SUSITNA BASIN AND THEIR MOST COMMON AVIAN SPECIES

- Lacustrine Waters and Shorelines: arctic tern, mew gull, greater and lesser scaup, common loon
- Fluviatile Waters, Shorelines and Alluvia: spotted sandpiper, mew gull, violet-green swallow, harlequin duck
- Upland Cliffs and Block-fields: gray-crowned rosy finch, common redpoll, horned lark, American golden plover, water pipit
- Dwarf Shrub Mat: water pipit; American golden plover, horned lark, Lapland longspur, rock ptarmigan
- Low Shrub: savannah sparrow, tree sparrow, Lapland longspur, white-crowned sparrow
- Medium Shrub: tree sparrow, white-crowned sparrow, savannah sparrow, arctic warbler, Wilson's warbler
- Tall Shrub: hermit thrush, Wilson's warbler, fox sparrow, white-crowned sparrow, tree sparrow
- Scattered Woodland and Dwarf Forest: white-crowned sparrow, American robin, bohemian waxwing, tree sparrow, ruby-crowned kinglet
- Mixed Deciduous-Coniferous Forest: hermit thrush, dark-eyed junco, yellow-rumped warbler, Swainson's thrush, varied thrush
- Deciduous Forest: yellow-rumped warbler, common redpoll, Swainson's thrush, blackpoll warbler
- Coniferous Forest: ruby-crowned kinglet, varied thrush, dark-eyed junco, yellow-rumped warbler, Swainson's thrush

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Source: Kessel et al. 1982a

TABLE E.3.4.54: ESTIMATED DENSITIES (NO./KM^2) OF BIRD SPECIES RECORDED DURING THE 1984-1985 SUSITNA WINTER BIRD SURVEY[1/]

Species	Deciduous Forest (Birch)	Mixed Forest (Birch-Spruce)	Coniferous Forest (White Spruce)	Coniferous Forest (Black Spruce)	Woodland (White Spruce)	Dwarf Tree (Black Spruce)	Overall Density
Sprouse Grouse	0	0.4	0.8	0	0	0	0.6
Three-toed Woodpecker	0	0.3	0.3	0	0	0	0.2
Gray Jay	0	4.8	12.1	4.9	14.2	5.6	8.5
Black-billed Magpie	0	0	0.3	0	0	0	0.1
Common Raven	0	0	0.3	0	0	0	0.1
Black-capped Chickadee	0	0.4	0.5	0	0	0	0.3
Boreal Chickadee	0	11.7	18.8	13.8	8.2	4.4	13.3
Northern Shrike	0	0	0.3	0	0	0	0.1
Pine Grosbeak	0	0	0.3	0	3.6	3.3	0.7
White-winged Crossbill	0	0.8	1.4	7.7	11.7	5.4	3.3
Redpoll	5.3	5.1	2.5	0	0	0	2.5
TOTAL	5.3	23.6	37.6	26.4	37.7	18.7	29.7

1/ Habitats correspond to level 2 designations of Viereck et al. (1982), except for scattered woodland, a level 3 type within coniferous forest. Coniferous and mixed forests include both open and closed forests of those types.

Source: LGL 1985

TABLE E.3.4.55: RELATIVE ABUNDANCE OF BIRDS BY HABITAT AND VEGETATION SUCCESSION STAGE, LOWER SUSITNA RIVER FLOODPLAIN, JUNE 10-21, 1982. FIGURES ARE THE NUMBER OF BIRDS RECORDED PER 100 MINUTES IN EACH HABITAT

	Early Successional Stands			Mid-Successional Stands				Late Successional Stands		
Species	Alluvia	Dwarf & Low Shrub	Medium Shrub	Tall Willow Shrub	Tall Alder Shrub	Mixed Tall Shrub	Tall Alder-Inmature Cottonwood	Cottonwood Forest	Mixed Paper Birch-Cottonwood-White Spruce Forest	Mixed Paper Birch-White Spruce Forest
Goldeneye sp.								0.3		
Semipalmated plover	--------2.1--------------									
Spotted sandpiper	------13.0--------------									
Herring gull	*									
Arctic Tern	--------4.2--------------									
Downy woodpecker								0.3		
Hairy woodpecker			1.5		0.9	0.6	1.4	0.6		
N. three-toed woodpecker										0.6
Alder flycatcher				13.3	9.1	7.0	0.5	2.0	1.7	2.1
Black-capped chickadee					0.4			2.5	1.7	
Brown creeper										0.3
Varied thrush					0.9	0.6	1.0	5.4	1.7	2.1
Gray-checked thrush					4.6	8.2	2.9	7.1	8.3	1.7
Swainson's thrush					0.4			3.7	5.0	7.4
American robin				3.3	1.4			2.8	3.3	0.6
Ruby-crowned kinglet									1.7	2.4
Bohemian waxwing								1.1		0.3
Orange-crowned warbler						1.9			3.5	
Yellow warbler				3.3	1.8	1.9	7.3	0.3		
Yellow-rumped warbler					3.2	1.3	3.9	6.2	18.3	13.3
Blackpoll warbler				6.7	3.2	9.5	2.4	6.5	6.7	5.3
Northern waterthrush			1.5		7.3	12.0	2.9	12.5	10.0	3.3
Wilson's warbler						1.9		0.8	3.3	0.3
Common redpoll					0.9	5.7		0.6		2.1
Fox sparrow			1.5	3.3	4.1	1.9		4.3	3.3	1.5
White-crowned sparrow			13.8		2.3	1.3	0.5	2.5	1.7	1.2
Dark-eyed junco						0.6		1.7	1.7	2.1
Total no. of species	4	+	4	5	14	14	9	19	15	17
Total no. of species in stand type		8			17				22	
No. minutes of censuses/habitat	127	+	65	30	219	158	206	352	60	358
Total no. minutes of census per stand type		192			613				750	
Relative abundance/habitat	19.3	+	18.5	30.0	40.6	54.4	22.8	61.1	71.7	46.5
Total relative abundance per stand type		25.5			37.5				51.5	

Source: Kessel et al. 1982b

TABLE E.3.4.56: NUMBER OF SMALL MAMMALS CAPTURED PER 100 TRAP NIGHTS DURING FOUR SAMPLING PERIODS BETWEEN AUGUST 1980 AND AUGUST 1982, MIDDLE SUSITNA RIVER BASIN

Species	Captures per 100 Trap Nights (No. of Captures)				Number of Captures All Trapping Periods	Percent of Total
	Fall 1980	Spring 1981	Fall 1981	Fall 1982		
Sorex cinereus	9.12 (361)	0.93 (39)	11.36 (847)	0.56 (42)	(1289)	34.6
S. monticolus	2.42 (96)	0	0.64 (48)	0.03 (2)	(146)	3.9
S. arcticus	2.98 (118)	0.07 (3)	2.31 (172)	0.13 (10)	(303)	8.1
S. hoyi	0.13 (5)	0	0.07 (5)	0	(10)	0.3
Clethrionomys rutilus	8.41 (333)	2.23 (93)	10.95 (816)	2.89 (216)	(1458)	39.1
Microtus pennsylvanicus	0.33 (13)	0	0.74 (55)	0.47 (35)	(103)	2.8
M. oeconomus	0.61 (24)	0.05 (2)	2.12 (158)	0.53 (40)	(224)	6.0
M. miurus	0	0	0.91 (68)	1.07 (80)	(148)	4.0
Lemmus sibiricus	0	0.02 (1)	0.23 (17)	0.15 (11)	(29)	0.8
Synaptomys borealis	0	0	0.05 (4)	0.15 (11)	(15)	0.4
Total captures	24.00 (950)	3.30 (138)	29.38 (2,190)	5.98 (447)	(3725)	100.0
Number of trap nights	3960	4176	7455	7470		

Source: S.O. MacDonald, unpub. data

TABLE E.3.4.57: STANDARDIZED HABITAT NICHE BREADTH VALUES FOR TEN SMALL MAMMAL SPECIES SAMPLED BY SNAP AND PITFALL TRAPPING AT 43 SITES, MIDDLE SUSITNA RIVER BASIN, FALL 1981

Species (d_i)	Standardized Habitat Niche Breadth Value[1/]
Masked shrew (464.7)	0.60
Northern red-backed vole (454.8)	0.59
Dusky shrew (28.3)	0.45
Arctic shrew (96.3)	0.38
Brown lemming (10.2)	0.21
Tundra vole (87.7)	0.17
Northern bog lemming (2.2)	0.09
Meadow vole (43.8)	0.08
Pygmy shrew (2.8)	0.08
Singing vole (42.7)	0.05

1/ High niche breadth values indicate that a species habitat included a wide range of vegetation types whereas low values indicate that a species occurred in few vegetation types. (Niche Breadth Measures were Calculated Using Formula Employed by Krebs and Wingate (1976))

Source: Kessel et al. 1982a

TABLE E.3.4.58: SUSITNA HYDROELECTRIC PROJECT HISTORICAL RANGE USE OF NELCHINA CARIBOU

Year	Calving Grounds	Summer Range	Rutting Areas	Winter Range
1951-51	12	12,5	13,5,12	13,12
1952-53	12	12,5,15	13,12,15	13
1953-54	12	5,12	5,12,13	13
1954-55	12	5	5,6	13
1955-56	12	12,15	12,15,16	5,12,6,9
1956-57	12	5,12,15	5,6	5,1,6,11
1957-58	12	5,12	5,6,13,15	11,2,5,15
1958-59	12	5,12	5,13,11,12,13	11,15,1,5,6,13
1959-60	12	5,12	12,15,6	1,11,5,13
1960-61	12	5,9,6,12	13,15,5,11	5,11,1,2,13
1961-62	12	5,9,6,12	12,13,6,15	1,6,3,5,11
1962-63	12	5,12	13,15,6,12	1,13,2,5,11,15
1963-64	12	5,12	5,13,6,12	1,5,6,11
1964-65	1,5,12	5,12	5,9,13,6	1,5,6
1965-66	12,8,11	5	6,9,13	16,13,15
1966-67	12,8,11	5,4	9,11,13	16,13,1,2
1967-68	12	5,4,12	--	16,13,1,4,5
1968-69	12	5,12	13	12,7,8,11,2
1969-70	12	12,5	12	13
1970-71	12	5,12	13	16,13
1971-72	12	5,12	13	16,13,15
1972-73	12	12,5	12,15	15,7,13
1973-74	12	--	15,13,12	15,13,12
1974-75	12	12	--	16,13
1975-76	12	12	--	13
1976-77	12	12,5?	12,13	13,16
1977-78	12	12	12,13	13,16
1978-79	12	12	13	13,16
1979-80	12	12	--	13,7
1980-81	12	12,15	13	13,7
1981-82	12	12,15	13,7	

Source: ADF&G (1982h); modified and expanded from Skoog (1968): see Figure E.3.4.31

TABLE E.3.4.59: SUSITNA HYDROELECTRIC PROJECT BLACK BEAR DEN ENTRANCE DATES, ELEVATIONS, AND PROJECTED DATES OR TIME PERIODS WHEN IMPOUNDMENT WATER LEVELS WILL BE AT DEN ELEVATIONS

Dates during which black bears in the Susitna Hydroelectric Project area entered their dens:1/ September 20 to October 20, 1982
September 15 to October 25, 1983

Den No.	Den Elevation1/	Projected time period when impoundment water level will be at den elevation2/
		WATANA STAGE I
4	2000 ft.	mid-July
18	1840 ft.	late August to early September
20	1950 ft.	mid-June
21	2000 ft.	mid-July
49	1875 ft.	late September to early October
58	1675 ft.	late June
65	1900 ft.	mid-May
80	1725 ft.	mid-July
81	1960 ft.	mid-June
98	1875 ft.	late September to early October
		DEVIL CANYON STAGE II
40	1400 ft.	fall or winter
		WATANA STAGE III
2	2065 ft.	late August to early September
57	2025 ft.	late July to early August
73	2070 ft.	late September to early October
95	2150 ft.	late July to early August

1/ Data from ADF&G 1984n
2/ Data derived from APA (1985)

TABLE E.3.4.60: GENERAL TYPES OF IMPACTS TO RAPTORS

<u>Disturbance</u>

Construction and Operation Activities

- sudden loud noises (e.g., blasting, gas venting, etc.) can lead to panic flights and damage to nest contents
- noise, human presence, etc., can lead to disruption of daily activities

Aircraft Passage

- sudden appearance and noise can lead to panic flights and damage to nest contents

Human Presence Near Nests

- inadvertent - chance occurrence of people (and dogs) near nests; people may be unaware of nest, raptors, or raptor alarm behavior
- deliberate - curious passersby, naturalists, photographers, researchers can have impacts if safeguards are not taken

<u>Direct Impacts</u>

Intentionally Destructive Acts (as a result of increased public access)

- shooting
- legal or illegal removal of eggs, young, or adults
- rolling of rocks off cliff tops
- cutting of nest trees

Man-Made Structures and Obstructions

- raptors may be struck on roads where they may perch or feed
- may strike wires, fences, etc.
- may be electrocuted on power poles
- raptors sometimes attack aircraft, or may accidentally strike aircraft

Environmental Contaminants

- deliberate application and accidental release of insecticides, herbicides, petrochemicals, and toxic industrial materials can affect raptors and prey by affecting hormones, enzymes, shell thickness, bird behavior, egg fertility and viability, and survival rates of nestlings, fledglings, immatures and adults

Changes in Prey Availability

- decrease in prey abundance or loss of nearby hunting areas may affect territory size, efficiency of hunting, nest occupancy, nesting success, condition of adults and young
- changes may result from aircraft overflights, construction and maintenance activities, public access, etc.

<u>Habitat Loss</u>

Abandonment of area due to destruction of nest, perch or important hunting habitat

Source: Roseneau et al. 1981

TABLE E.3.4.61: FACTORS THAT AFFECT THE SENSITIVITY OF RAPTORS TO DISTURBANCES

Characteristics of the Disturbance

- type of disturbance
- severity (speed, loudness, suddenness, persistence, etc.)
- frequency of occurrence

Characteristics of the Bird

- the individual (individual differences in response)
- sex
- age
- 'mood' (a factor of recent activities, weather)
- territorial status (breeder, territorial non-breeder, or non-territorial floater)
- stage of annual life cycle (winter, migration, courtship, egg-laying, rearing young, etc.)
- occurrence of other disturbances or natural stresses at the same time
- previous experience with this type of disturbance (habituation may occur)

Topography

- nearness of disturbance to raptor or nest
- relative elevations (is nest or raptor above or below the disturbance? by what distance?)
- presence of screening features (trees, intervening hill)
- direction faced by nest relative to sun, wind, disturbance
- type of nest (exposed ledge, overhung ledge, cave)
- distance of nest above foot of cliff and below lip of cliff (i.e., 'security' of nest)

Time of Day

Weather at Time of Disturbance

Potential Predators Nearby

Type of Prey Utilized by the Bird (species, location, abundance)

Source: Roseneau et al. 1981

TABLE E.3.4.62: INFLUENCE OF TIMING OF DISTURBANCE ON THE POSSIBLE EFFECTS ON RAPTORS

Timing	Possible Effects of Disturbance
Winter	Raptor may abandon nest, roosting cliff, or hunting area (e.g., gyrfalcon)
Arrival and courtship	Migrant raptor may be forced to use alternative nest site (if available), may remain but fail to breed or may abandon nest site
Egg-laying	Partial clutch may be abandoned and remainder (or full clutch) laid at alternative nest; breeding effort may cease or site may be abandoned
Incubation	Eggs may be chilled, overheated, or preyed upon if parents are kept off nest too long; sudden flushing from nest may destroy eggs; male may cease incubating; clutch or site may be abandoned
Nestling phase	Chilling, overheating, or predation of young may occur if adults are kept off nest; sudden flushing of parent may injure or kill nestlings; malnutrition and death may result from missed feedings; premature flying of nestlings from nest may cause injury or death; adults may abandon nest or site
Fledgling phase	Missed feedings may result in malnutrition or death; fledglings may become lost if disturbed in high winds; increased chance of injury due to extra moving about; parents may abandon brood or site
Night	Panic flight may occur and birds may become lost or suffer injury or death
General	Undue expense of energy; increased risk of injury to alarmed or defending birds; missed hunting opportunities

Source: Roseneau et al. 1981

TABLE E.3.4.63: ESTIMATED[1/] NUMBER OF SMALL- AND MEDIUM-SIZED BIRDS THAT WOULD BE ELIMINATED THROUGH PERMANENT HABITAT LOSS AS A RESULT OF THE SUSITNA HYDROELECTRIC PROJECT

Species	Watana Stage I	Devil Canyon Stage II	Watana Stage III	Total
Spruce grouse	555	267	476	1,298
Willow ptarmigan	5	1	12	18
Am. golden-plover	1	+	+	1
Greater yellowlegs	3	+	20	23
Common snipe	105	5	163	273
Baird's sandpiper	6	+	2	8
Hairy woodpecker	124	87	92	303
N. 3-toed woodpecker	391	92	382	865
Gray jay	783	375	709	1,867
Boreal chickadee	748	478	577	1,803
Brown creeper	241	170	183	594
American robin	155	15	168	338
Varied thrush	688	867	1,471	3,026
Hermit thrush	713	481	509	1,703
Swainson's thrush	4,477	2,289	3,781	10,547
Gray-cheeked thrush	538	42	846	1,426
Arctic warbler	272	49	844	1,165
Ruby-crowned kinglet	3,772	1,300	3,528	8,600
Water pipit	19	4	49	72
Yellow-rumped warbler	4,882	2,678	3,940	11,500
Blackpoll warbler	820	387	737	1,944
Northern waterthrush	490	729	363	1,582
Wilson's warbler	1,654	850	2,754	5,258
Common redpoll	1,050	510	915	2,475
Savannah sparrow	640	169	1,075	1,884
Dark-eyed junco	3,807	1,740	3,414	8,961
Tree sparrow	1,161	181	2,559	3,901
White-crowned sparrow	780	81	1,717	2,578
Fox sparrow	1,330	513	1,460	3,303
Lapland longspur	10	1	17	28
TOTAL	30,220	14,361	32,763	77,344

1/ Numbers were derived from the densities of species territories on the respective bird census plots in 1981 and 1982 (Tables E.3.4.49 and E.3.4.50), multiplied by the area of corresponding vegetative types to be altered or destroyed by the project.

TABLE E.3.4.64: ESTIMATED NUMBER OF OVERWINTERING BIRDS THAT WOULD BE ELIMINATED THROUGH PERMANENT HABITAT LOSS AS A RESULT OF THE SUSITNA HYDROELECTRIC PROJECT

Species	Watana Stage I	Devil Canyon Stage II	Watana Stage III	Total
Spruce grouse	23	10	22	55
Three-toed woodpecker	14	8	13	35
Gray jay	423	132	507	1,062
Black-billed magpie	5	1	14	20
Common raven	5	1	14	20
Black-capped chickadee	18	9	16	43
Boreal chickadee	737	277	736	1,750
Northern shrike	5	1	14	20
Pine grosbeak	39	3	70	112
White-winged crossbill	161	27	232	420
Redpoll	179	105	149	433
TOTAL	1,609	574	1,787	3,970

Source: Based on densites of birds observed during winter bird surveys 1984-1985 (LGL 1985a, Table E.3.4.54).

TABLE E.3.4.65: SUSITNA HYDROELECTRIC PROJECT ANNUAL AVERAGE DAILY TRAFFIC ON THE DENALI-WATANA ACCESS ROAD DURING PEAK CONSTRUCTION YEARS AND SEASON (MID-APRIL TO MID-OCTOBER)

	Number of Trips 1/		
	(1997) Watana Stage I 2/	(2003) Devil Canyon Stage II 3/	(2009) Watana Stage III 3/
Buses 4/	10	0	0
Commuters to permanent residences 5/	0	50	65
Resident worker and dependent excursions during work week	96	50	59
Single status worker excursion 6/	0	37	41
Heavy trucks	70	20	60
Support materials and misc. traffic	26	4	10
TOTAL	202	161	235

1/ Numbers represent a forecast of average daily traffic counts during the peak construction year expressed as numbers of one-way trips per day. Traffic would be less in years before or after peak during each construction stage.

2/ Calculations are based on the assumption that an air/bus worker transportation program will be employed. Under this transportation program it was assumed that: 1) the majority of workers will be flown to and from the project, thus eliminating most worker vehicles from the project area; 2) that the majority of workers will live in the Anchorage or Fairbanks area; and 3) that the only workers allowed to have private vehicles at the project site are those who reside in the onsite village.

3/ Calculations are based on the assumption that private vehicles will be used to transport workers. Under this scenario it was assumed 1) transportation to and from work will not be provided for workers, 2) workers will be allowed to bring private vehicles on the access road, 3) worker rotation schedule will be three weeks on - one week off.

4/ Represents 5 round-trip, 40-passenger bus trips per day to accommodate those workers that live in or move to the Cantwell area.

5/ Assumes 1.7 workers per vehicle.

6/ Assumes two workers per vehicle.

TABLE E.3.4.66: SUSITNA HYDROELECTRIC PROJECT MINIMUM AND MAXIMUM CUMULATIVE SNOW DEPTH DATA (INCHES) FOR LOCATIONS IN THE PROPOSED SUSITNA HYDROELECTRIC PROJECT AREA AND ADJACENT REGIONS, 1982-84

Location	Elevation (ft)	Jan.	Feb.	March	April	May
Denali Hwy 1/ 2/	2700	8-10	5-10	10-15	10-13	0
Butte Creek 2/	3000	8-18	11-27	15-27	14-28	0-12
Watana Camp 2/	2200	7-14	8-22	*	8-18	0
Devil Canyon 2/	1350	13-37	21-37	29-38	29-38	0-6
Fog Lakes 3/	2120	*	11-22	14-23	20-30	9-25
Monahan Flats 3/	2710	*	20-29	19-41	23-35	23-45

1/ Snow station was on Denali Highway, 54 miles east of Cantwell. Proposed access road connection to Denali Highway will be approximately 20 miles east of Cantwell.

2/ Data from R&M Consultants, Inc. (1984).

3/ Data from R. McClure (1984, pers. comm.).

* No data available

TABLE E.3.4.67: STATE OF ALASKA TEMPORAL AND SPATIAL PROTECTION CRITERIA FOR NESTING RAPTORS[1]

Species	Sensitive Time Period[2]	Aerial Activity[3]	Minor Ground Activity	Major Ground Activity	Facility Siting	Habitat Disturbance
Peregrine falcon	April 15- August 31	1 mi h or 1500 ft v	1 mi	2 mi	2 mi	2 mi
Gyrfalcon	February 15- August 15	1/4 mi h or 1000 ft v	1/4 mi	1/2 mi	1/2 mi	-
Golden eagle[4]	March 15- August 31	1/2 mi h or 1000 ft v	1/4 mi	1/2 mi	1/2 mi	-
Bald eagle[4]	March 15- August 31	1/4 mi h or 1000 ft	1/8 mi	1/4 mi	1/2 mi	1/8 mi

Explanatory Notes

Raptor nest sites are assumed occupied until June 1 each year. After that date, protection measures for a specific nest site can be withdrawn for the remainder of the year if the nest is documented to be non-active.

It should be noted that any activity, disturbance, or habitat alteration that may affect historic or currently active peregrine falcon nest sites must be reviewed by the U.S. Fish and Wildlife Service, Office of Endangered Species, to evaluate the potential for detrimental impacts to the welfare of this endangered species.

Restrictions - The restriction columns provide temporal and spatial protection measures necessary to minimize disturbance to sensitive wildlife areas from aerial activity, minor ground activity, major ground activity, and the siting and operation of facilities.

Aerial activities include the potential disturbance effects from both fixed-wing aircraft and helicopters. The disturbance and "startling" impacts of low-level aircraft activity are of particular concern during raptor nesting.

Minor ground activity is characterized by limited, short-term, reconnaissance and exploration-type programs that do not involve significant amounts of personnel, equipment, surface disturbance, or noise. Examples of minor ground activity include foot reconnaissance, field inventories, topographic surveys, resistivity surveys, and some borehole/test pit exploration activities.

Major ground activity is characterized by extensive construction-related disturbance involving significant amounts of personnel, equipment, surface disturbance, noise, or vehicular activity. The duration of this disturbance may be either short-term or long-term, but the magnitude of overall activity is such that sensitive wildlife areas could be adversely affected. Typical major ground activities include clearing, pad construction, blasting, ditching, pipe laying, materials site development, and facility construction.

Facility Siting - The concerns of facility siting in proximity to sensitive wildlife areas include the long-term impacts of facility operation during duration of the project and the effects of habitat alteration on the integrity of wildlife use areas. Continuously occupied or operating facilities may generate noise or activity disturbance that could preclude wildlife occupation of a sensitive use area for the duration of the project. Alteration of adjacent habitats beyond the boundary of a defined wildlife use area may also discourage or preclude continued use of a sensitive area by wildlife.

[1] Derived from "Sensitive Wildlife Areas of the Northwest Alaskan Gas Pipeline Corridor," C. E. Behlke, State Pipeline Coordinator, letter to E. A. Kuhn, NWA, July 15, 1980 (see footnote 4 below). Protection criteria are accepted guidelines followed by the Alaska Dept. of Fish and Game and the U.S. Fish and Wildlife Service.

[2] Sensitive time periods listed here differ somewhat from broader phenological periods listed in Table E.3.4.41, but are specifically designed to encompass the great majority of nesting pairs during what are considered to be the most critical portions of the breeding season.

[3] h = horizontal; v = vertical.

[4] Sensitive time period dates were modified to reflect earlier nesting by some golden eagles that may winter in the Alaska Range in the milder years (Roseneau, unpubl. data) to allow for later fledging of some bald eagle nestlings (see Table E.3.4.41).

TABLE E.3.4.68: ATTRIBUTES OF CANDIDATE LANDS FOR WILDLIFE HABITAT C

( ) MAP REFERENCE CANDIDATE LAND AREA	SUSITNA AREA PLAN REFERENCE[a]	APPROXIMATE TOWNSHIP AND RANGE[a]	ESTIMATED TOTAL ACREAGE	OWNERSHIP[a]	PRIMARY LAND USE DESIGNATIONS[a]	UNRESOLVED LAND USE ISSUES? [a b]	PROPOSED SPECIAL
(1) ALEXANDER CREEK - KROTO SLOUGH - SUSITNA FLOODPLAIN	SUSITNA LOWLANDS 6D, 6E, 11A, 11B, 13D, 13E, 14A, 14E	SEWARD MERIDIAN: T17N,R6W T19N,R8W T17N,R7W T20N,R5W T17N,R8W T20N,R6W T18N,R6W T20N,R7W T18N,R7W T21N,R5W T18N,R8W T22N,R5W T19N,R5W T23N,R5W T19N,R6W	125,000	STATE	WILDLIFE HABITAT, PUBLIC RECREATION, WATER RESOURCES, FORESTRY	NO	YES 6D[1] 6E[2] 11A 11B 13D 13E 14E
(2) SUSITNA FLOODPLAIN	SOUTH PARKS HIGHWAY 2	SEWARD MERIDIAN: T21N,R5W T23N,R5W T22N,R4W T24N,R5W T22N,R5W T25N,R5W T23N,R4W	19,000	STATE	FORESTRY, PUBLIC RECREATION, WATER RESOURCES, WILDLIFE HABITAT	NO	NO
(3) SUSITNA RIVER CORRIDOR	PETERSVILLE ROAD 6D, 7D	SEWARD MERIDIAN: T24N,R5W T25N,R5W	2,000	STATE, BOROUGH	FORESTRY, PUBLIC RECREATION, WATER RESOURCES, WILDLIFE HABITAT	NO	NO
(4) LOWER MOOSE CREEK	SUSITNA LOWLANDS 11B	SEWARD MERIDIAN: T22N,R6W T23N,R6W T24N,R6W	7,500	STATE	PUBLIC RECREATION, WATER RESOURCES WILDLIFE HABITAT	NO	YES'
(5) CHIJUK CREEK	SUSITNA LOWLANDS 10A	SEWARD MERIDIAN: T22N,R7W T23N,R7W	23,000	MATANUSKA SUSITNA BOROUGH	BOROUGH LAND BANK: FORESTRY, PUBLIC RECREATION, WILDLIFE HABITAT	NO	NO
(6) WHISKERS CREEK	SOUTH PARKS HIGHWAY 3B	SEWARD MERIDIAN: T26N,R5W T27N,R5W T28N,R5W	35,000	MATANUSKA SUSITNA BOROUGH	BOROUGH LAND BANK: AGRICULTURE, FORESTRY, PUBLIC RECREATION, SETTLEMENT, WILDLIFE HABITAT	NO	NO
(7) PRAIRIE CREEK	TALKEETNA MOUNTAINS 1A	SEWARD MERIDIAN: T29N,R2E T30N,R2E T30N,R3E	10,000	CIRI & CIRI VILLAGE CORPORATIONS	NONE	NO	NO
(8) DEVIL MOUNTAIN	TALKEETNA MOUNTAINS 1C	SEWARD MERIDIAN: T31N,R3E T32N,R3E T32N,R4E	30,000	STATE SELECTED	PUBLIC RECREATION WILDLIFE HABITAT	NO	NO
(9) CLARK CREEK - TSUSENA BUTTE	TALKEETNA MOUNTAINS 1C	SEWARD MERIDIAN: T33N,R4E T33N,R5E FAIRBANKS MERIDIAN: T22S,R5W T22S,R6W	23,000	STATE	PUBLIC RECREATION, WILDLIFE HABITAT	NO	NO
(10) WATANA-DELUSION CREEKS	TALKEETNA MOUNTAINS 1C	SEWARD MERIDIAN: T32N,R6E T32N,R7E T33N,R6E T33N,R7E FAIRBANKS MERIDIAN T22S,R2W T22S,R3W	50,000	STATE, FEDERAL	PUBLIC RECREATION, WILDLIFE HABITAT	NO	NO
(11) LOWER COAL CREEK	TALKEETNA MOUNTAINS 1C	SEWARD MERIDIAN: T32N,R12E T33N,R11E T33N,R12E FAIRBANKS MERIDIAN T22S,R2E	50,000	FEDERAL	PUBLIC RECREATION, WILDLIFE HABITAT	NO	NO
(12) WILLOW MOUNTAIN	HATCHER PASS MANAGEMENT UNIT 18	SEWARD MERIDIAN: T22N, R2W & R3W T21N, R2W & R3W T20N, R2W & R3W	10,000	STATE	MINING, RECREATION, FISH AND WILDLIFE HABITAT, GRAZING	YES[19]	NC

MOOSE HABITAT QUALITY [d]	HABITAT MANAGEMENT POTENTIAL FOR MOOSE [e]	PREDOMINANT VEGETATION [f]	ESTIMATED SNOW DEPTH RANGE [8]	MOOSE CONCENTRATION AREA? [a]	HABITAT MANAGEMENT AGENCIES [h]	NEAR EXISTING OR PROPOSED SETTLEMENT? [a]	ACCESS [a]	TIMBER AND HOUSE LOG AVAILABILITY [a]	SPECIAL CONSIDERATIONS? [a]
MEDIUM & HIGH	HIGH	MIXED FOREST & SHRUBLAND	UP TO 40" [8]	YES	ADNR, ADF&G	YES: WILLOW SUB-BASIN COMMUNITIES; KROTO WEST HOMESTEADS; LOCKWOOD SUBDIVISION; LOCKWOOD & YENTNA HOMESTEADS	PARKS HIGHWAY, BOAT, FLOAT-PLANE, WINTER TRAILS	HIGH	YES[5]
MEDIUM & HIGH	HIGH	MIXED FOREST & SHRUBLAND	20" - 30"[9]	YES	ADNR, ADF&G	YES: CASWELL, MONTANA, SUNSHINE, TALKEETNA	PARKS HIGHWAY, BOAT, FLOAT-PLANE, WINTER TRAILS	HIGH	NO
MEDIUM & HIGH	HIGH	MIXED FOREST & SHRUBLAND	20" - 30"	YES	ADNR, ADF&G MAT-SU BOROUGH	YES: MONTANA, SUNSHINE, TALKEETNA	PARKS HIGHWAY, TALKEETNA SPUR ROAD, BOAT, FLOATPLANE, WINTER TRAILS	MODERATE	NO
HIGH[10]	HIGH[10]	FELTLEAF WILLOW, PAPER BIRCH, GRASSES [10]	20" - 30"	YES[10]	ADNR, ADF&G	YES: TRAPPER LAKE, CASWELL, MONTANA	WINTER OVER - LAND ACCESS FROM PARKS HIGHWAY & PETERSVILLE ROAD; BOAT FLOATPLANE	LOW TO MODERATE	YES[10]
MEDIUM	HIGH	PAPER BIRCH	20" - 30"	UNKNOWN	BOROUGH, ADF&G	YES: PARKER LAKE	WINTER OVER-LAND ACCESS FROM PETERS-VILLE ROAD; FLOATPLANE	HIGH	YES[11]
MEDIUM	LOW	MIXED FOREST	40" - 60"[8]	MOOSE PRESENT	BOROUGH, ADF&G	YES: TALKEETNA, CHASE, BLAIR LAKE	WINTER OVER-LAND ACCESS FROM PARKS HIGHWAY; BOAT; FLOATPLANE	MODERATE TO HIGH	YES[12]
MEDIUM	UNDE-TER-MINED	MIXED FOREST & SHRUBLAND	40" - 50"[8]	MOOSE PRESENT	OWNERS, ADF&G	YES: EXISTING LODGE ON STEPHAN LAKE	BOAT, FLOAT-PLANE	LOW TO MODERATE	YES[13]
UNDE-TER-MINED	UNDE-TER-MINED	SHRUBLAND & TUNDRA	40" - 50"[8]	MOOSE PRESENT	ADNR, ADF&G	NO	FLOATPLANE	LOW	YES[14]
HIGH	UNDE-TER-MINED	SHRUBLAND & TUNDRA	40" - 50"[8]	YES	ADNR, ADF&G	YES: EXISTING LODGE ON NE SIDE OF TSUSENA LAKE; AIRSTRIP 3 MI NORTH OF TSUSENA BUTTE	AIRCRAFT; EXISTING ACCESS BY ATV AND HORSES	LOW	YES[15]
MEDIUM TO HIGH	HIGH	CONIFER FOREST & SHRUBLAND	30" - 40"[8]	YES[16]	ADNR, ADF&G BLM	NO	BOAT; FLOAT-PLANE; EXISTING ACCESS BY ATV	LOW	YES[16]
LOW	HIGH	CONIFER FOREST & SHRUBLAND	20" - 30"	MOOSE PRESENT	BLM	YES: SUSITNA LODGE; DENALI HIGHWAY SETTLEMENTS	BOAT; FLOAT-PLANE; WINTER OVERLAND ACCESS FROM DENALI HIGHWAY	LOW	YES[17]
MEDIUM TO HIGH	HIGH	MIXED CONIFER - HARDWOOD	28" - 40"	YES	ADNR, ADF&G	NO	WINTER OVER-LAND ACCESS FROM WILLOW CREEK ROAD	LOW	YES[20]

TABLE E.3.4.68 (Page 2 of 5)

NOTES ON COLUMN HEADINGS

a. Information is from the Susitna Area Plan of April 1985 (ADNR 1985).

b. Unresolved land use issues refer to cases in which Susitna Area Planning team members have not yet reached agreement of appropriate land use designations for a management subunit.

c. Proposed special designations refer to planning team recommendations for legislative or administrative action to place a management subunit in a special public use category such as State Forest or State Recreational River.

d. Predominant (existing) moose habitat quality as determined from ADF&G mapping of existing winter carrying capacity for moose (ADF&G 1984w, Map B14a).

e. Predominant moose habitat enhancement potential as determined from ADF&G mapping of potential winter utilization and carrying capacity for moose (ADF&G 1984w, Maps B9b and B14b).

f. Predominant vegetation determined from ADF&G 1:500,000-scale vegetation community mapping of portions of the Susitna Planning Area (ADF&G 1984w, Map B15).

g. Approximate snow depth range determined from ADF&G 1:500,000-scale contour mapping of estimated yearly average snow depth accumulation (ADF&G 1984, Map B13).

h. ADNR Division of Forestry is responsible for forest management on state forests. Such management may include burning or clearing of vegetation for the purpose of habitat enhancement. ADF&G may be responsible for burning or clearing of vegetation for the purpose of habitat enhancement on other state lands. BLM will be responsible for the above functions on federal lands.

NOTES

1. The Alexander Creek corridor is recommended for legislative designation as a State Recreational River (ADNR 1985, p. 259).

2. State lands along Trail Ridge have been proposed for legislative designation to provide for long-term timber and habitat management, and to provide public recreation opportunities adjacent to the Yentna and Susitna River corridors (ADNR 1985, p. 259).

3. Because forest and wetland areas between Kroto Creek (the Deshka River) and the Kahiltna River have high potential for commercial forestry and contain important moose winter range, this subunit has been recommended for legislative designation (ADNR 1985, p. 276).

4. ADF&G ranked the Moose Creek-Kroto Creek (Deshka River) system the most important in the entire Susitna Planning Area in terms of habitat values and public use. It is one of five river systems in the Susitna Planning Area proposed for legislative designation by ADNR and ADF&G in the Southcentral Recreation Action Plan (ADNR 1985, p. 276).

5. This subunit (the Kroto Slough area) contains important trumpeter swan nesting, feeding, and staging habitat and has been recommended for legislative or administrative designation to protect swans. ADNR currently applies guidelines to this area intended to restrict off-road vehicle, motorboat, and aircraft activities from April 1 through August 31 of every year (ADNR 1985, pp. 287-288). This area also is in the heart of the most important moose winter range in the Susitna Planning Area. It will be kept in public ownership and recommended for legislative designation with habitat protection and management the major objective for the subunit. Timber harvesting will be allowed only when consistent with habitat management objectives (ADNR 1985, p. 285).

6. The Yentna River corridor contains important moose winter range and trumpeter swan nesting habitat, and serves as a route for transportation and recreational boating. This subunit will be recommended for legislative designation in recognition of its importance for habitat and recreation (ADNR 1985, p. 285).

7. This portion of the Susitna River floodplain will be recommended for legislative designation to protect opportunities for long-term timber and habitat management and public recreation (ADNR 1985, p. 291).

8. Studies of moose winter behavior indicate that 36 inches or more of snow accumulation can limit food availability for moose, both by covering browse vegetation directly and by limiting movement by moose to other areas where food may be available (ADF&G 1984w).

9. This candidate land area consists of river floodplain extending approximately 30 miles with a north-south orientation. Mean annual snow accumulation increases along this floodplain from south to north. The reach included within the candidate land area receives a mean annual snow accumulation of between 20 and 30 inches, making it highly suitable from this standpoint as moose winter range. The heavy winter use by moose actually observed during surveys of this portion of the Susitna River floodplain confirms this point (ADF&G 1984k).

10. The lower reach of Moose Creek between Gate Creek and the confluence of Moose Creek with the Deshka River is highly suitable for habitat management through preservation to maintain existing high winter carrying capacity for moose. The stream has numerous dense willow stands (predominantly feltleaf willow) which produce very large quantities of browse that was heavily utilized by moose during the severe winter (deep snow) conditions of early 1985.

Because the willow stands appear to be relatively stable for many years (unlike those of the Susitna River floodplain, which are rapidly overtopped by balsam poplar), habitat protection, rather than browse enhancement measures, is recommended. It is unlikely that the existing riparian habitat could be improved in any way (Harza-Ebasco 1985).

11. The Applicant is coordinating with the Matanuska-Susitna Borough in the preparation of the Borough's Chijuk Management Plan. Applicant and Borough representatives are considering a variety of options for habitat management compatible with the multiple uses proposed for this area.

12. The Applicant is coordinating with the Matanuska-Susitna Borough in reviewing the suitability of this candidate area for mitigation. On-ground inspections at three locations in June 1985 indicated that the area is not well suited for cost-effective moose browse enhancement (Harza-Ebasco 1985). However, additional on-site inspections will be made, and options for the preservation of mature forest habitats, in conjunction with timber harvest on other tracts in the area, are being considered.

13. Prairie Creek is a highly productive chinook salmon spawning stream which attracts major concentrations of brown bears during July and August (ADF&G 1982e, 19831, 1984n). This candidate land area is under consideration primarily to protect the fishery and preserve the brown bear feeding habitat which it maintains.

14. The Devil Mountain area is under consideration for brown bear habitat preservation. This area is heavily used by brown bears in late summer and fall, when the bears are probably feeding on berries and ground squirrels. This area also contains high-quality brown bear denning habitat (Miller 1985, pers. comm.).

15. The Clark Creek-Tsusena Butte area is under consideration for brown bear and moose habitat preservation. This area is heavily used by brown bears in the late spring during breeding season, when bears are more concentrated here than at any place in the study area except Prairie Creek during salmon spawning (see Note 13). Brown bears also den here in relatively large numbers. Both types of use by brown bears are probably due to the relatively remote, undisturbed character of the area, which also provides important habitat for moose. Black bears were abundant near the confluence of Clark and Tsusena creeks in late spring 1985 (Miller 1985, pers. comm.).

16. This area is under consideration for prescribed burning to increase moose browse production and potentially to increase forb, grass, and berry production for bears. The lower Watana Creek drainage supports high densities of moose during late winter (ADF&G 1984m). Bottomlands along lower Watana Creek will be inundated by the Watana impoundment, eliminating much of the best winter moose habitat in this area.

Because forested uplands bordering this portion of the impoundment appear to be well suited for browse enhancement by prescribed burning (see Harza-Ebasco 1984), a burn in this area would provide browse compensation immediately adjacent to a zone of significant impacts, and in an area likely to receive winter use by moose. The proposed burn location would lend itself well to fire control because it would be bordered by the reservoir itself as well as by unvegetated ridgetops and breaks in fuel continuity provided by tundra vegetation. Lower Watana Creek is a brown bear concentration area during the spring, when bears feed on overwintered berries; newly-grown grasses, sedges, and forbs; roots; winter-killed or weakened moose; and moose calves. The area also provides year-round habitat for black bears. A prescribed burn in the area has the potential to increase densities of preferred spring food plants and moose, thus benefitting bears.

17. This area is under consideration for prescribed burning to increase moose browse production and potentially to increase berry production for brown bears. The area's location between the Susitna River and the uplands of the upper Coal and Jay drainages should facilitate fire containment. The adjacent upper Coal Creek area is late summer and fall berry foraging habitat for brown bears, which may benefit if berry production is increased in the controlled burn area.

18. The Hatcher Pass Management Unit is within the Willow Sub-Basin Area Plan (ADNR 1982)

19. Refinement of management subunits within the Hatcher Pass Management Unit is still in progress, with completion expected in 1986.

20. Clearing of forest for browse enhancement may incorporate limited adjacent portions of the proposed Susitna State Forest.

TABLE E.3.4.69: PROVISIONAL PROPOSAL FOR HABITAT COMPENSATION ON MITIGATION LANDS

Map Ref[1]	Habitat Management Unit	Active Land Manager(s)	Target Species	Type of Management	Management Zone (acres)	Schedule for Treatment: S=Summer W=Winter	Area Under Active Treatment (acres)	Area Untreated (acres)
(12)	Willow Mountain	ADNR	Moose & early-successional/edge species; mature forest species	Clearing to mineral soil	10,000	WS1990-1991 WS2010-2011 WS2030-2031	Area A: 2,500 Area B: 2,500 Area A: 2,500	7,500 5,000 5,000
(10)	Watana - Delusion Creek	ADNR, BLM	Moose, sharp-tailed grouse, & early-successional/edge species; black & brown bear	Prescribed burning	50,000	S2001 S2021	Area A: 3,000 Area B: 7,000 Area C: 7,000	47,000 40,000 33,000
(7)	Prairie Creek[2] -Preservation Option A	CIRI Villages, CIRI	Brown bear; moose, furbearers	Habitat preservation	10,000	1989-2039 Preservation, no treatment	--	10,000
(9)	Clark Creek - Tsusena Butte[2] -Preservation Option B	ADNR	Brown & black bear; moose, furbearers	Habitat preservation	23,000	1989-2039 Preservation, no treatment	--	23,000

1/ Figures E.3.4.46 and E.3.4.47.

2/ The Prairie Creek and Clark Creek - Tsusena Butte areas are the two highest priority areas selected for habitat preservation. Mitigation lands are likely to encompass one or the other or a combination of the two areas.

TABLE E.3.4.70: RAPTOR MITIGATION COSTS

Item	Year(s) of Occurrence	Cost
Bald Eagle - Aritifical Nests & Nest Site Enhancement		
o Planning & Testing	1985-87	$ 100,000
o Implementation	1988-92	50,000
Golden Eagle - Artifical Nests & Nest Site Enhancement		
o Planning	1987	30,000
o Implementation	1988-92	150,000
Other Raptors		
o Planning	1987	5,000
o Implementation	1988-92	15,000
Monitoring (average annual cost)1/	1988-2037	10,000/year
TOTAL		$ 350,000 plus $10,000/year

1/ Cost also included in Table E.3.4.71.

TABLE E.3.4.71: MITIGATION COSTS FOR HABITAT COMPENSATION ON MITIGATION LANDS

Item	Year(s) of Occurrence	Cost[1/]
Vegetation clearing for browse production/habitat diversity		
o Inventory of habitat management units (approx. 10,000 ac) - includes general vegetation/browse mapping; moose distribution surveys; raptor, swan & general wildlife surveys	1989-90	$150,000
o Development of detailed management plan	1990	60,000
o Browse inventory of treatment areas	1990	100,000
o Treatment of 2,500 acres	1990-91	625,000
o Treatment of 2,500 acres	2010-11	625,000
o Treatment of 2,500 acres	2030-31	625,000
o Monitoring of browse production and moose utilization and modifying detailed management plan (average annual cost)	1990-2039	30,000/year[2/]
Prescribed burning for browse production/habitat diversity		
o Inventory of habitat management unit (approx. 50,000 ac) - includes same items as above; less effort required due to data base from project baseline/monitoring studies	1990	100,000
o Development of detailed management plan	1991	40,000
o Browse inventory of treatment areas (update of 1984-85 inventory)	1991	50,000
o Treatment of 3,000 acres	1992	75,000
o Treatment of 7,000 acres	2006	175,000
o Treatment of 7,000 acres	2026	175,000
o Monitoring of browse production and moose utilization and modifying detailed management plan (average annual cost)	1990-2039	30,000/year[2/]
General planning and management costs	1989-2039	50,000/year
TOTAL		$2,800,000 plus $110,000/year

[1/] Land costs associated with habitat preservation on private lands have not been determined.

[2/] Cost also included in Table E.3.4.72.

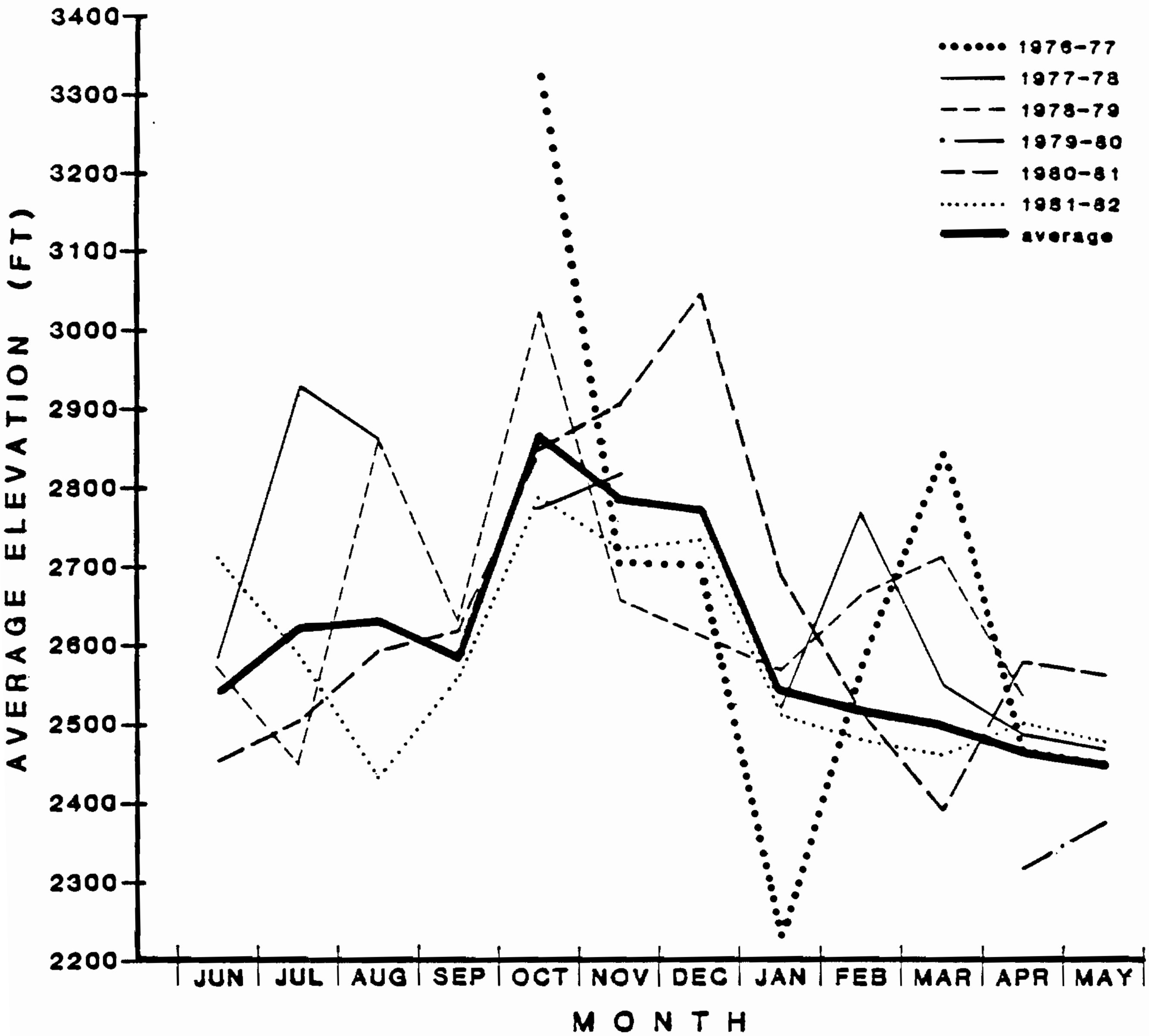
TABLE E.3.4.72: COSTS OF LONG-TERM WILDLIFE MONITORING

Item	Average Annual Cost
(1) Big Game Impoundment Surveys	$ 8,000
(2) Moose Winter Census	22,000
(3) Caribou Movement Surveys	26,000
(4) Dall Sheep Censuses & Lick Use Surveys	12,000
(5) Brown & Black Bear Surveys	18,000
(6) Beaver Colony Census	9,000
(7) Raptor Nesting Surveys	10,000 1/
(8) Downstream Habitat Monitoring	3,000
(9) Browse Production & Moose Utilization Monitoring on Mitigation Lands	60,000 2/
(10) Analysis and Annual Report	50,000
TOTAL	$ 218,000

1/ Cost also included in Table E.3.4.70.

2/ Cost also included in Table E.3.4.71.

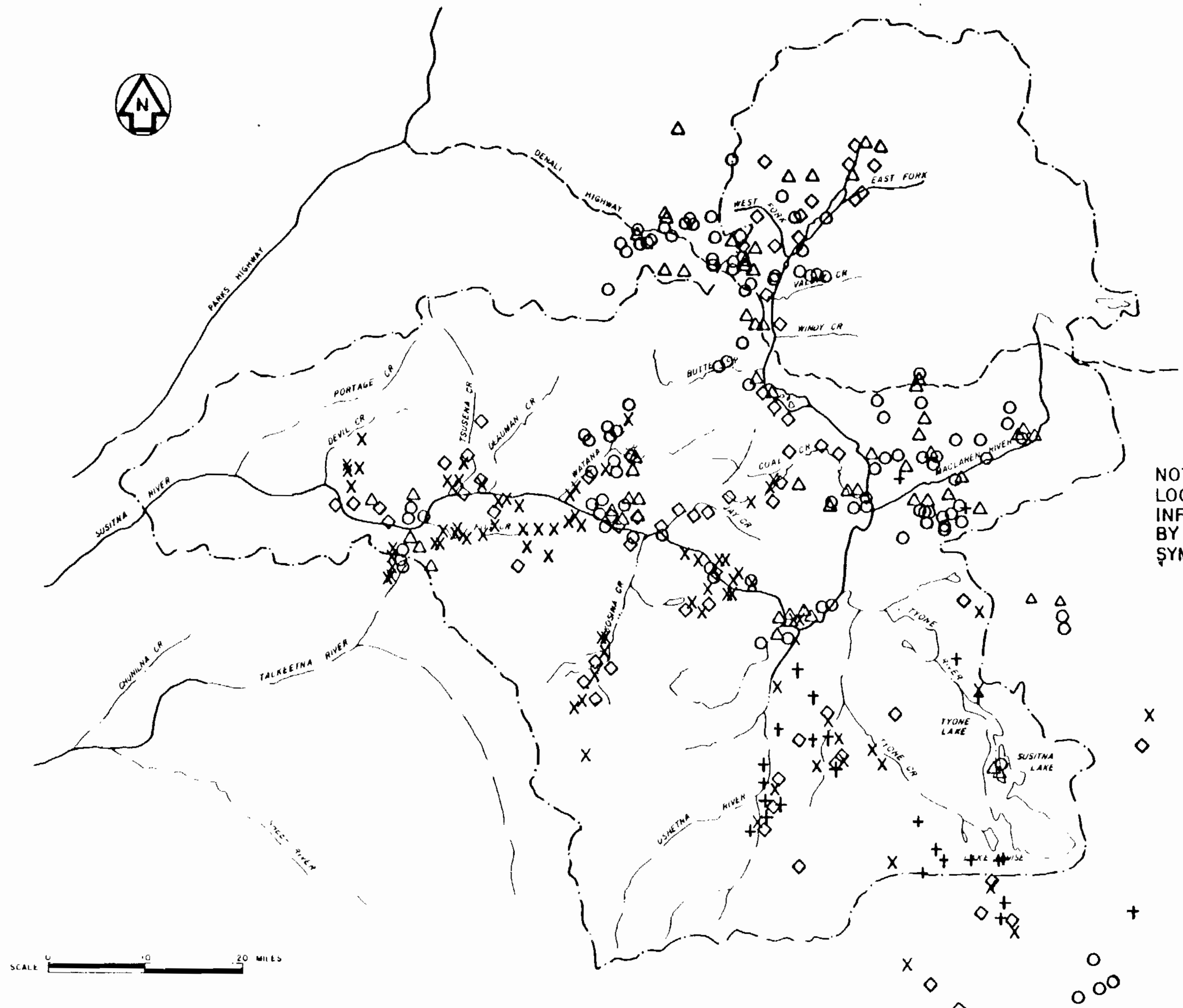
FIGURES



MEAN MONTHLY ELEVATIONS OCCUPIED BY 74 RADIO-COLLARED MOOSE FROM OCTOBER 1976 THROUGH MAY 1982 IN THE PROPOSED SUSITNA HYDROELECTRIC PROJECT AREA.

SOURCE: ADF&G 1984m

FIGURE E.3.4.1

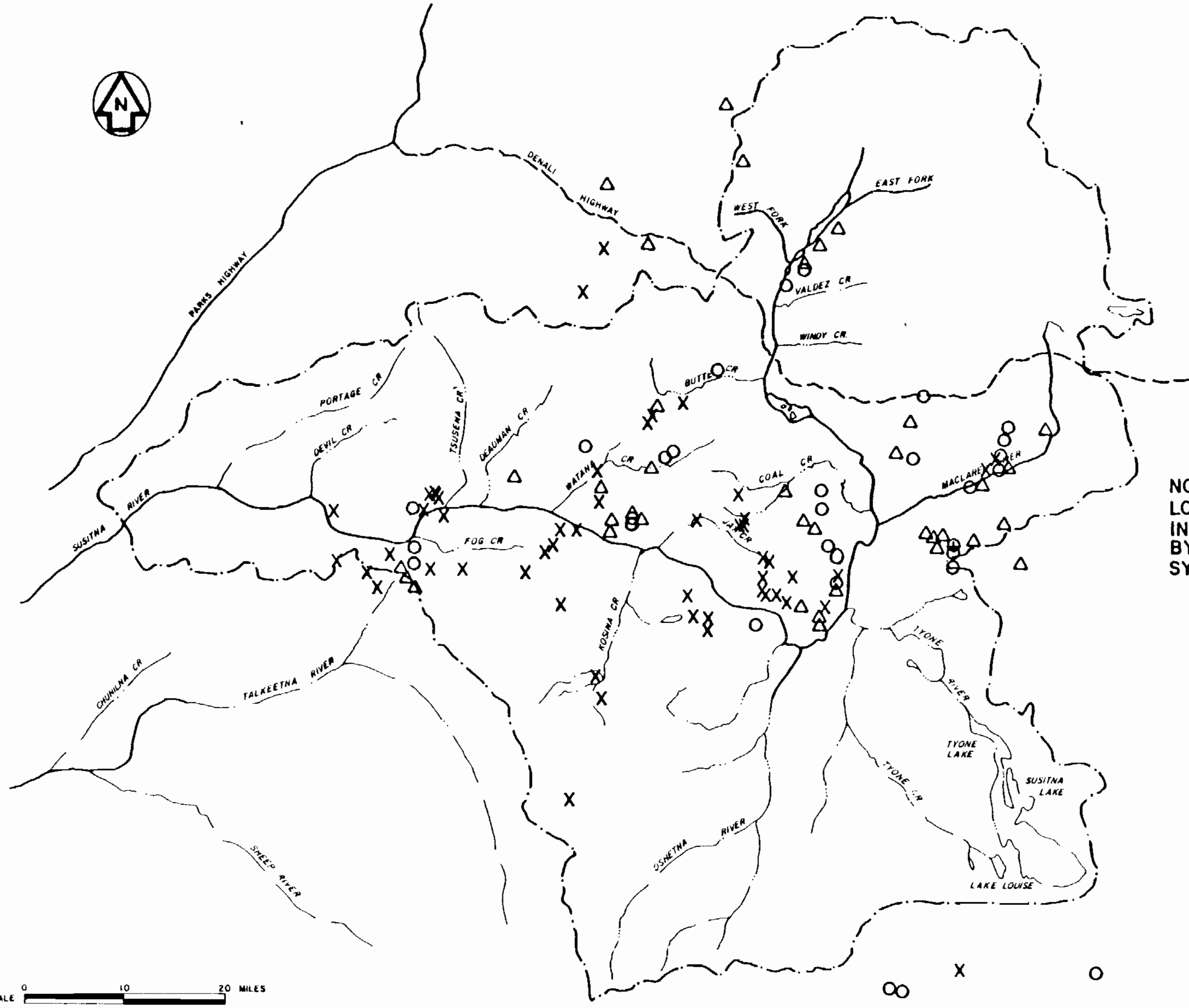


NOTE: SYMBOLS REPRESENT LOCATION BY YEAR. SUFFICIENT INFORMATION WAS NOT PROVIDED BY ADF & G TO MATCH SPECIFIC SYMBOLS WITH SPECIFIC YEARS.

LOCATIONS OF RADIO-COLLARED COW MOOSE DURING PARTURITION (MAY 15 – JUNE 15) FROM 1977 THROUGH 1981

E AL 1982

FIGURE E.3.4

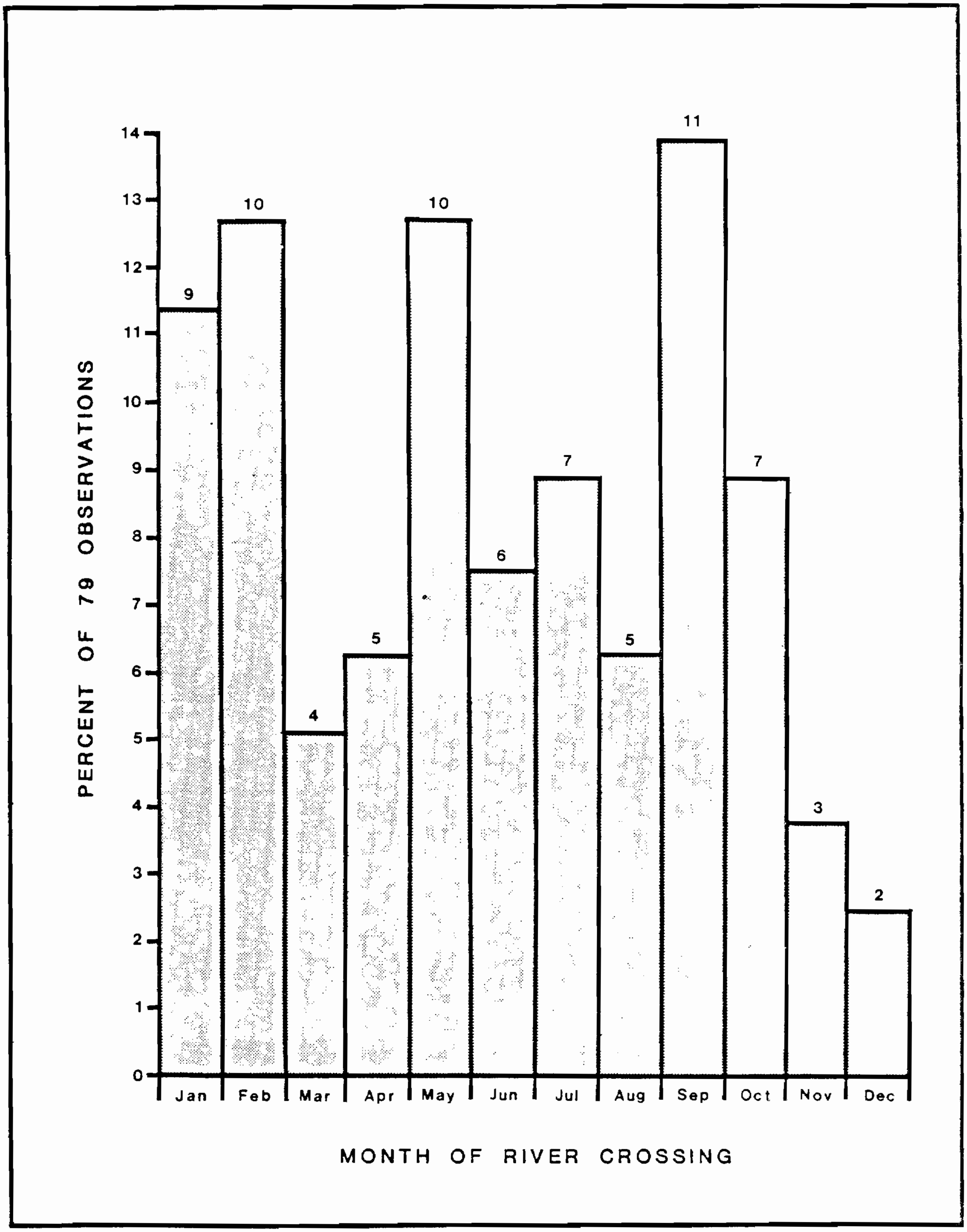


NOTE: SYMBOLS REPRESENT LOCATION BY YEAR. SUFFICIENT INFORMATION WAS NOT PROVIDED BY ADF&G TO MATCH SPECIFIC SYMBOLS WITH SPECIFIC YEARS.

LOCATIONS OF RADIO - COLLARED MOOSE DURING THE RUT (SEPTEMBER 20 - OCTOBER 20) FROM 1977 THROUGH FALL 1980

SOURCE: ADF&G 1982k

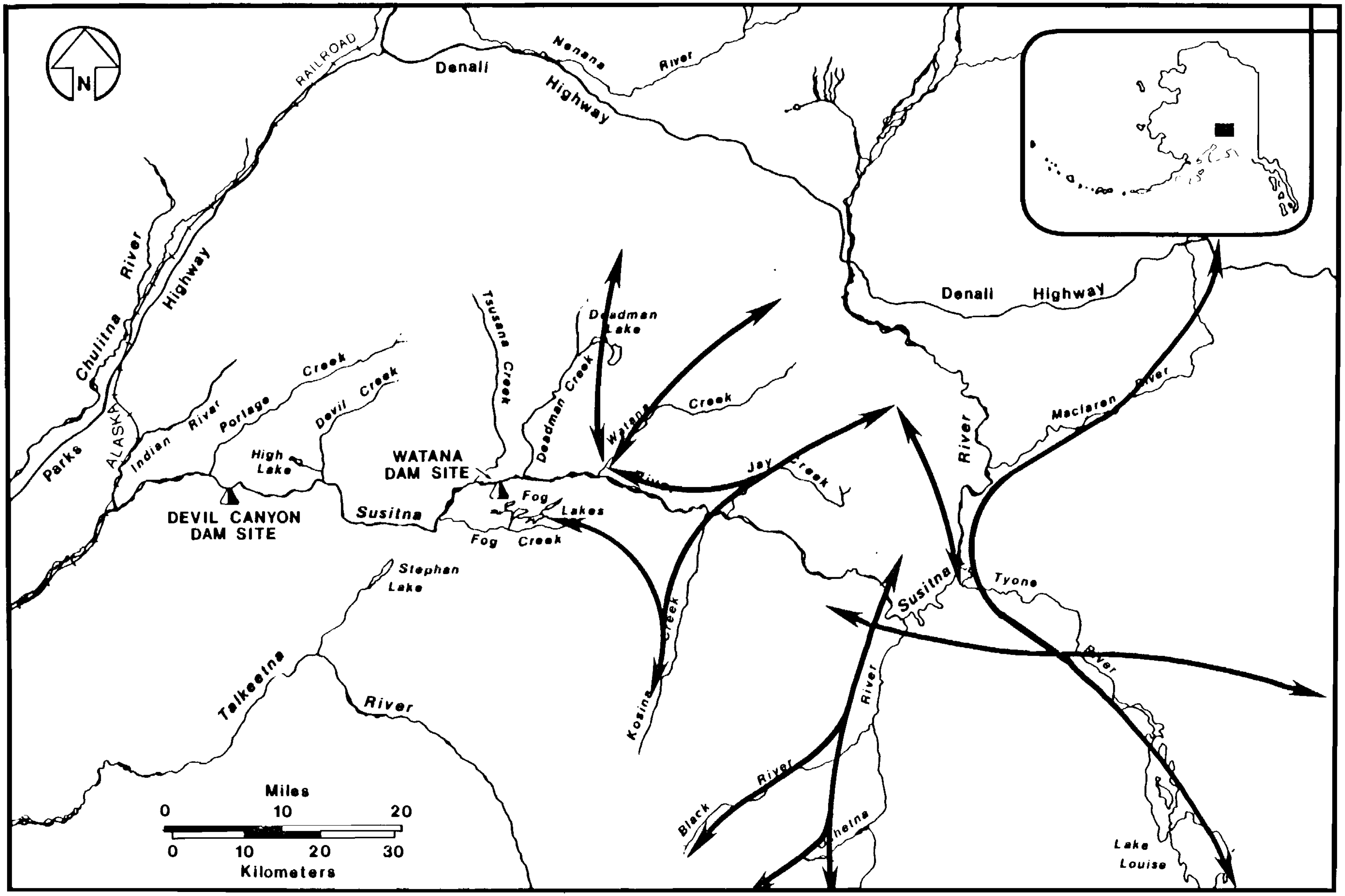
FIGURE E.3.4.3



Timing of 79 crossings by radio-collared moose of the middle Susitna River above Devil Canyon from April 1980 through December 1982

SOURCE: ADF&G 1983i

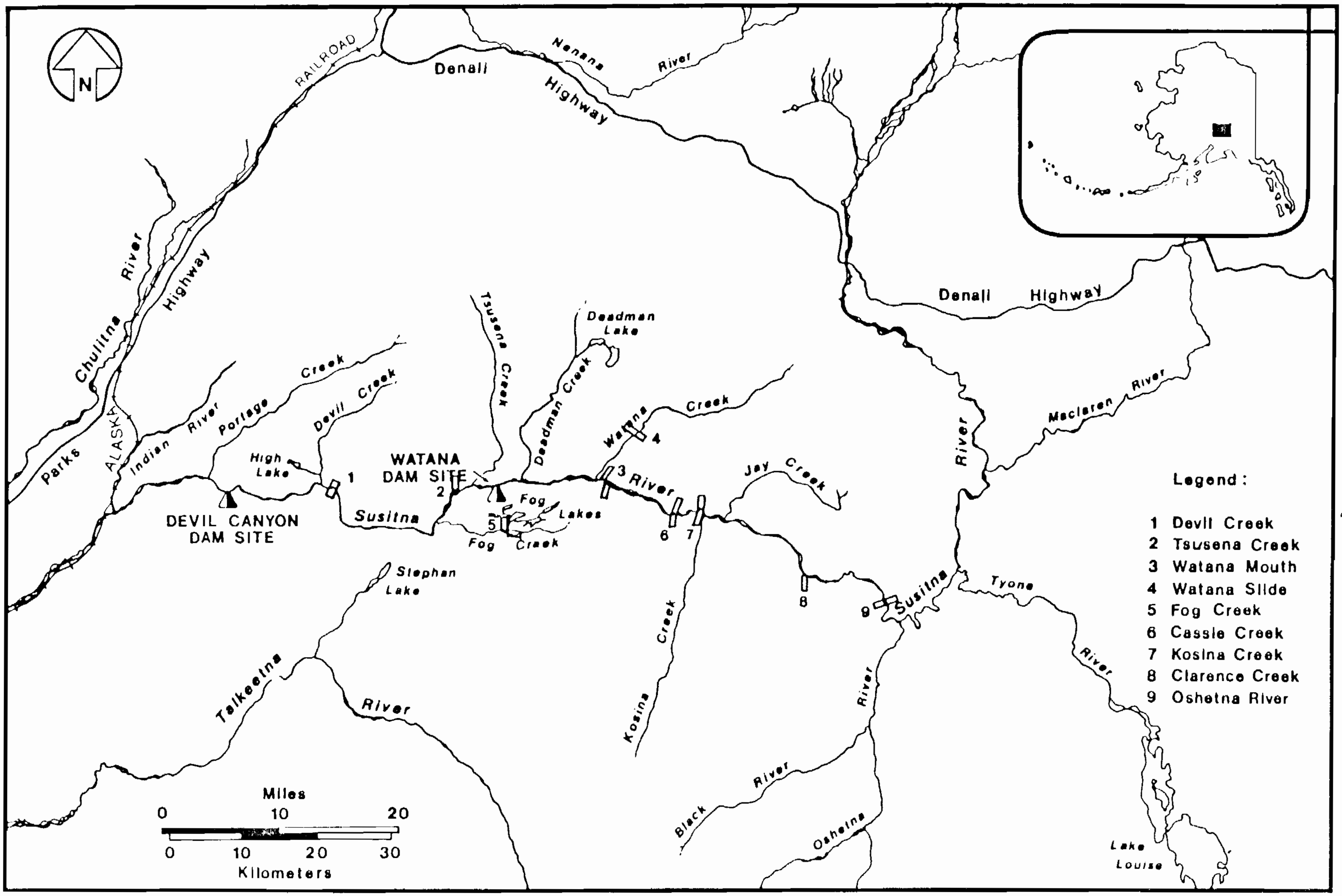
FIGURE E.3.4.4



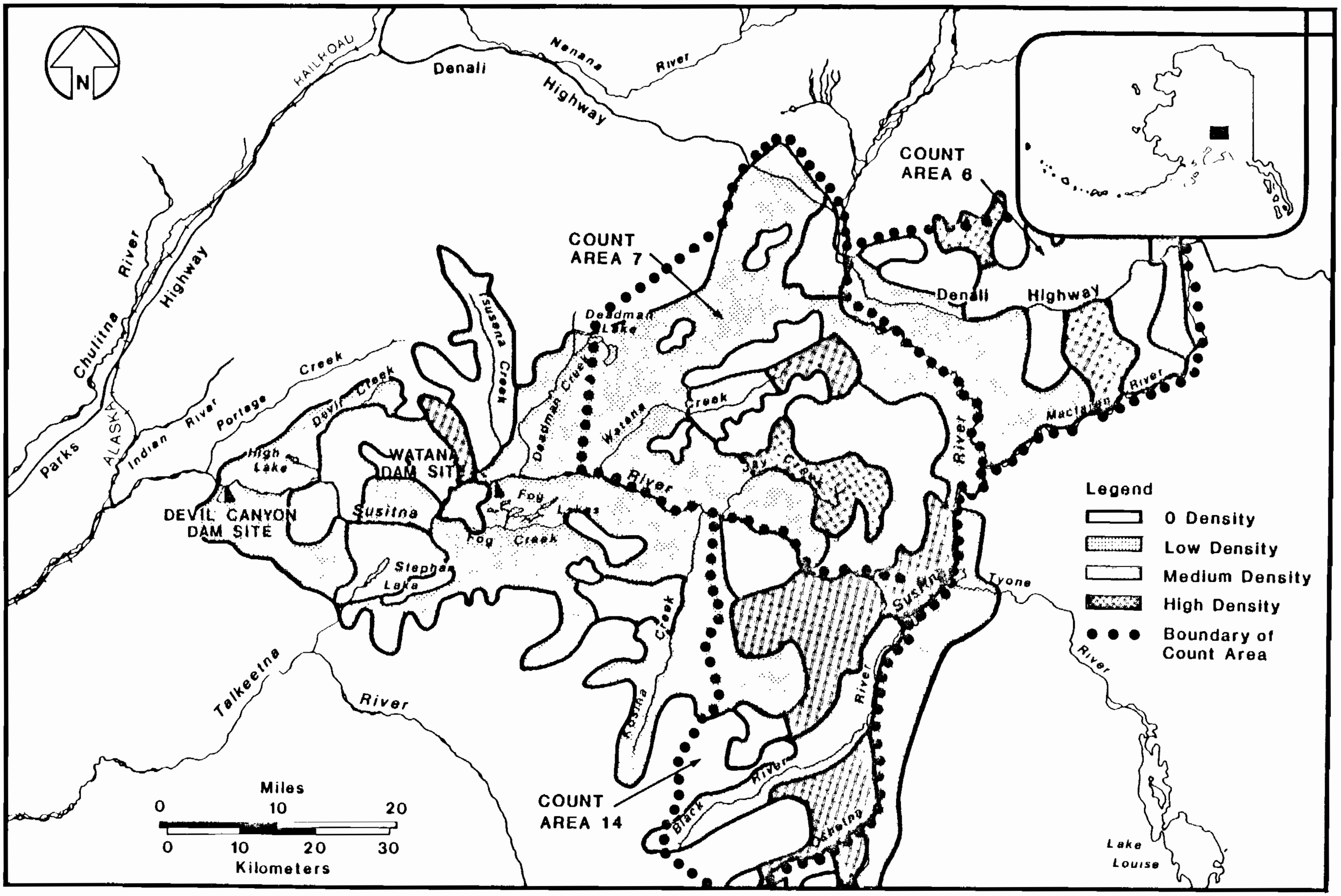
GENERAL MOVEMENT AND MIGRATION PATTERNS OF RADIO-COLLARED MOOSE FROM 1976 THROUGH 1983

SOURCE: ADF&G 1982h, 1983l, 1984m

FIGURE E.3.4.5



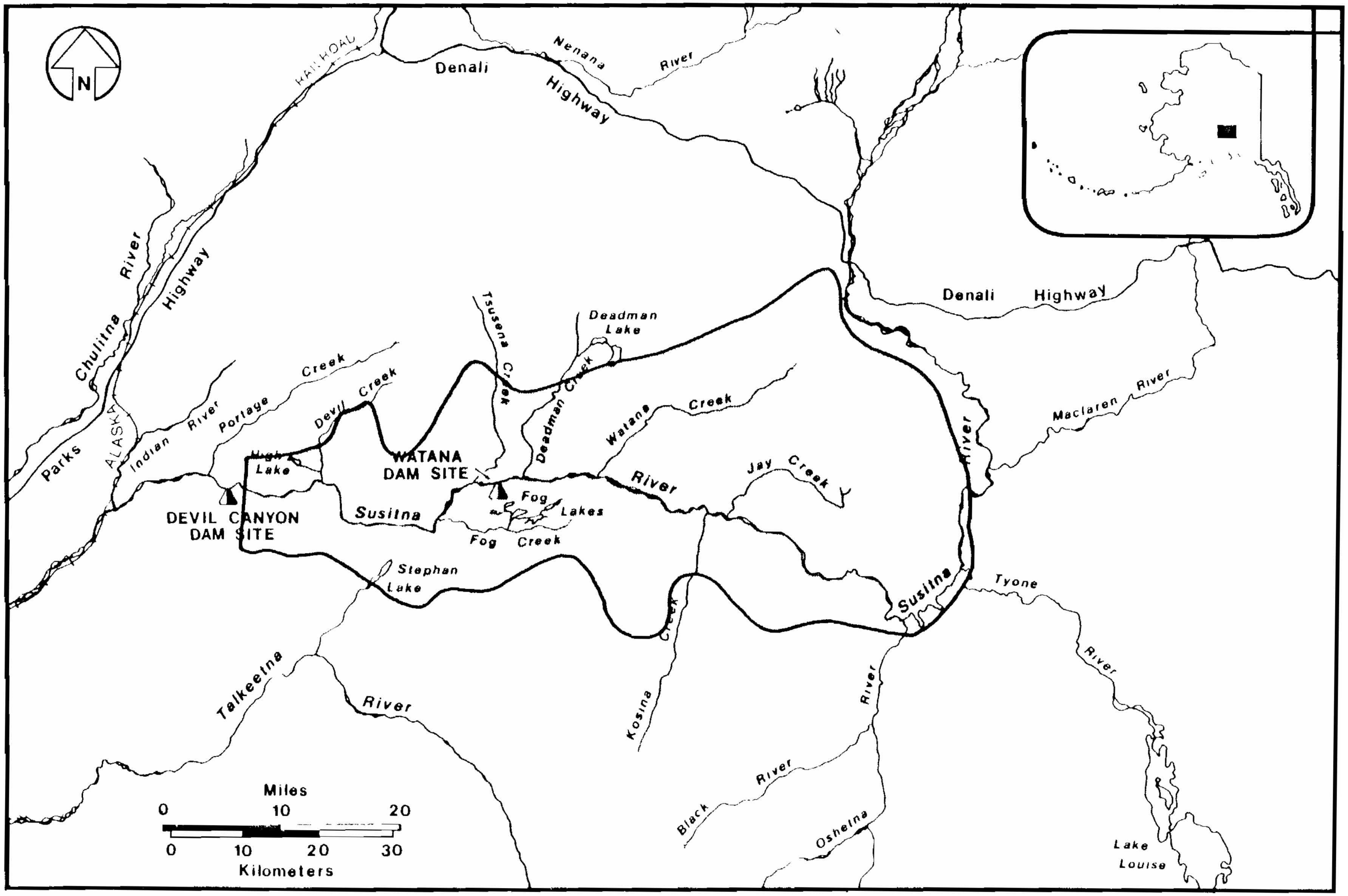
Transect locations for collection of winter moose fecal pellets for the moose food habits study. FIGURE E.3.4.6



FALL DISTRIBUTION OF MOOSE (NOVEMBER 1980) AND COUNT AREA BOUNDARIES UPSTREAM OF THE MOUTH OF DEVIL CANYON DETERMINED FROM STRATIFICATION AND CENSUS FLIGHTS

SOURCE: ADF&G 1982h

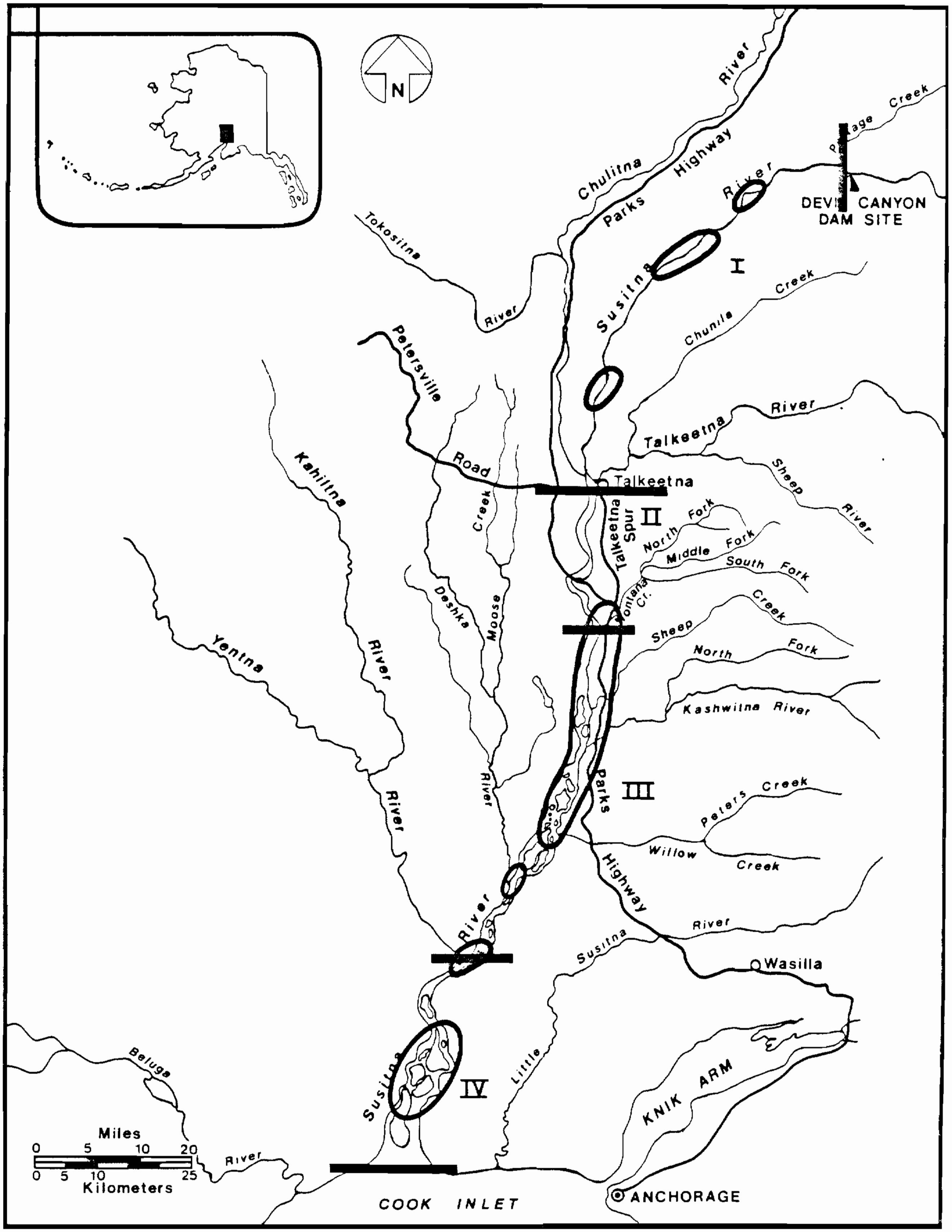
FIGURE E.3.4.7



PRIMARY MOOSE STUDY AREA

SOURCE: ADF&G 1983i

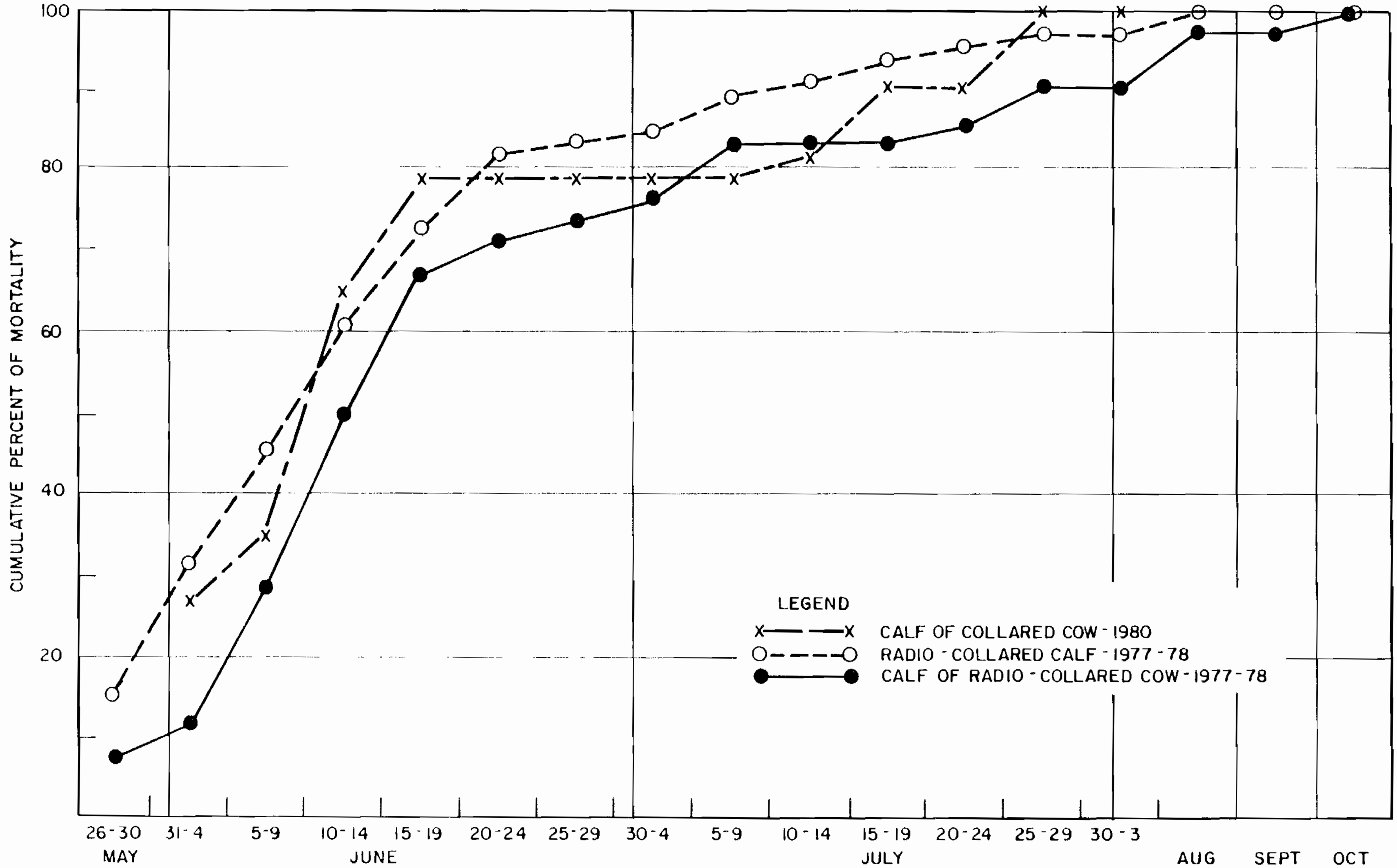
FIGURE E.3.4.8



CONCENTRATION AREAS WHERE 7 MALE AND 40 FEMALE MOOSE CAPTURED AND RADIO-COLLARED ALONG THE SUSITNA RIVER BETWEEN THE MOUTH OF DEVIL CANYON AND COOK INLET WERE RADIO-RELOCATED DURING THE WINTER PERIOD (1 JANUARY-28 FEBRUARY), 1980-1983. THE 4 PHYSIOGRAPHIC ZONES DESCRIBED BY ADF&G (1982j) ARE AS SHOWN.

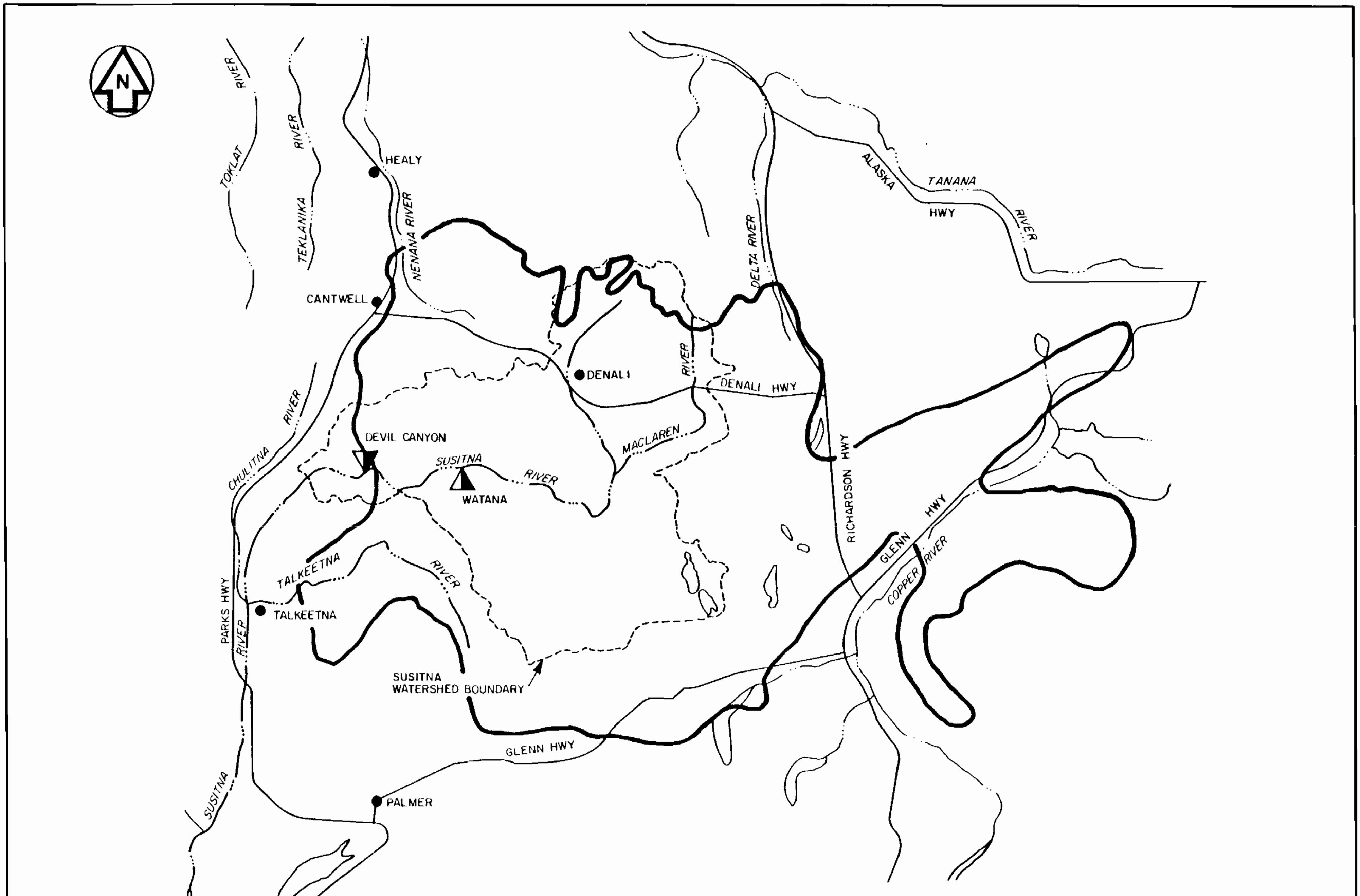
SOURCE: ADF&G 1984k

FIGURE E.3.4.9



DATES OF MORTALITIES OF COLLARED AND UNCOLLARED MOOSE CALVES DURING 1977, 1978, AND 1980 IN THE NELCHINA AND MIDDLE SUSITNA BASIN, ALASKA

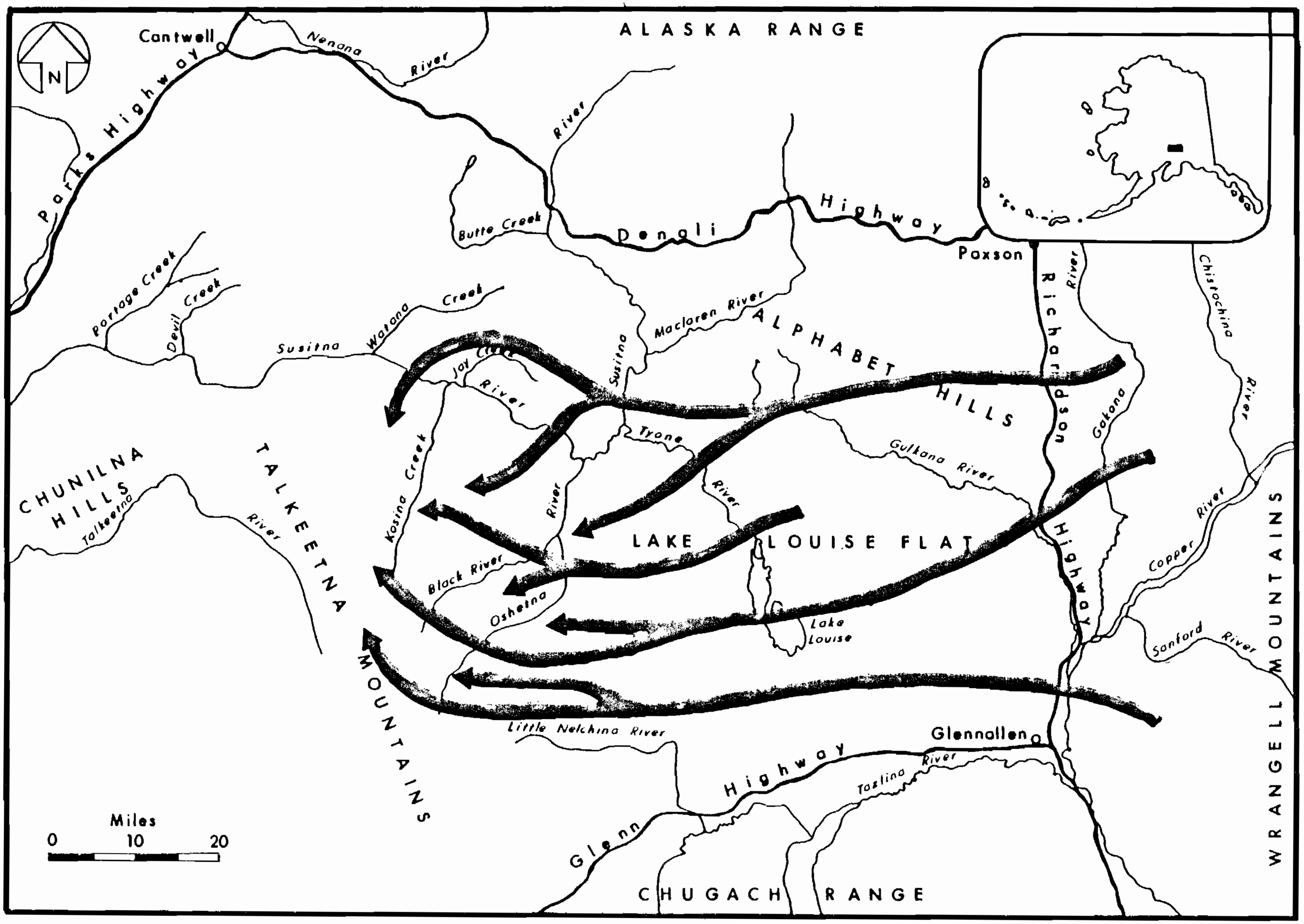
FIGURE E.3.4.10



HISTORICAL RANGE OF THE NELCHINA CARIBOU HERD

SOURCE: HEMMING 1971

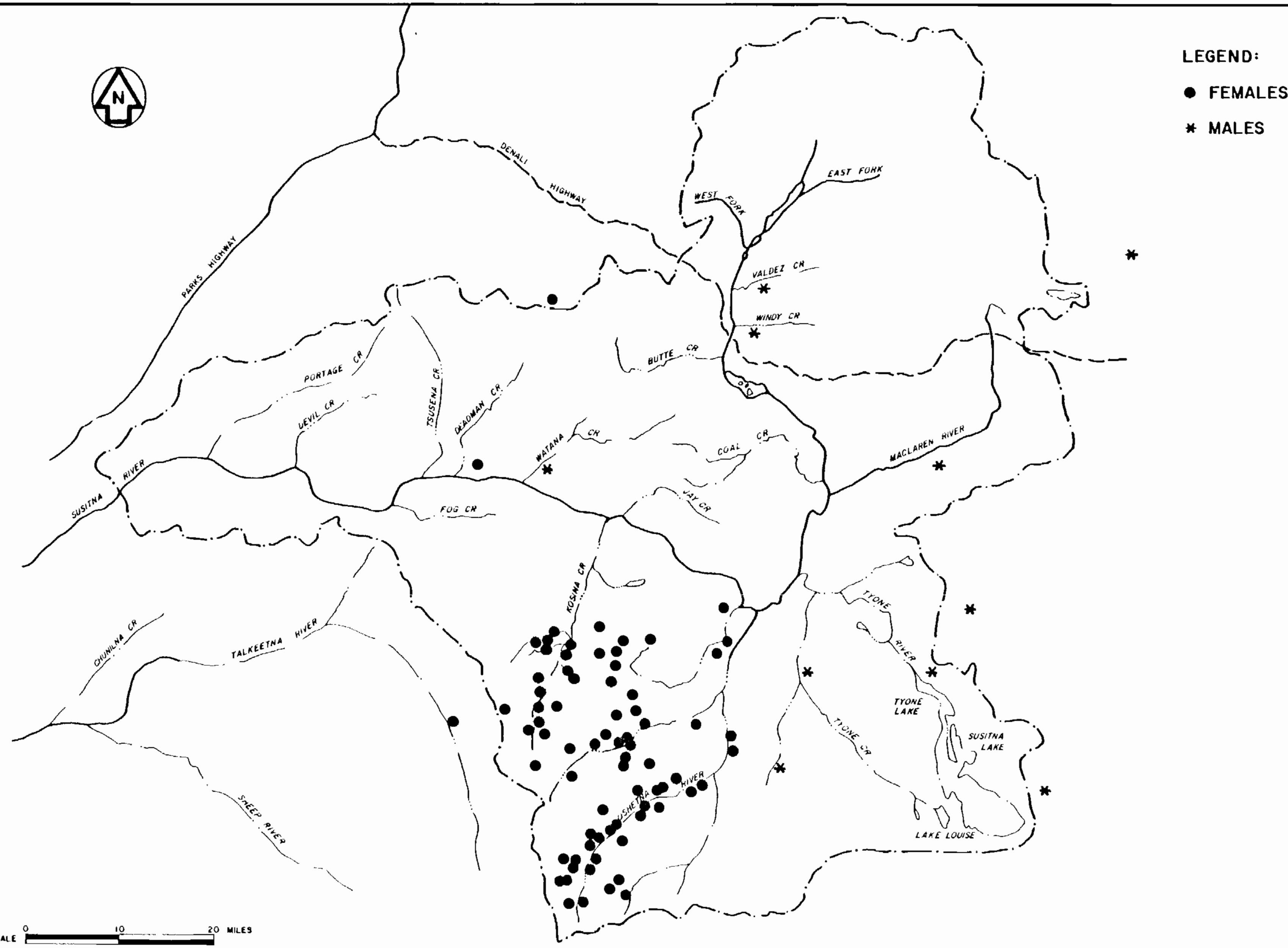
FIGURE E.3.4.11



SPRING MIGRATION ROUTES OF THE FEMALE SEGMENT OF THE NELCHINA CARIBOU HERD DURING 1980-1984

SOURCE: ADF&G 1982h, 1983c, 1984 o

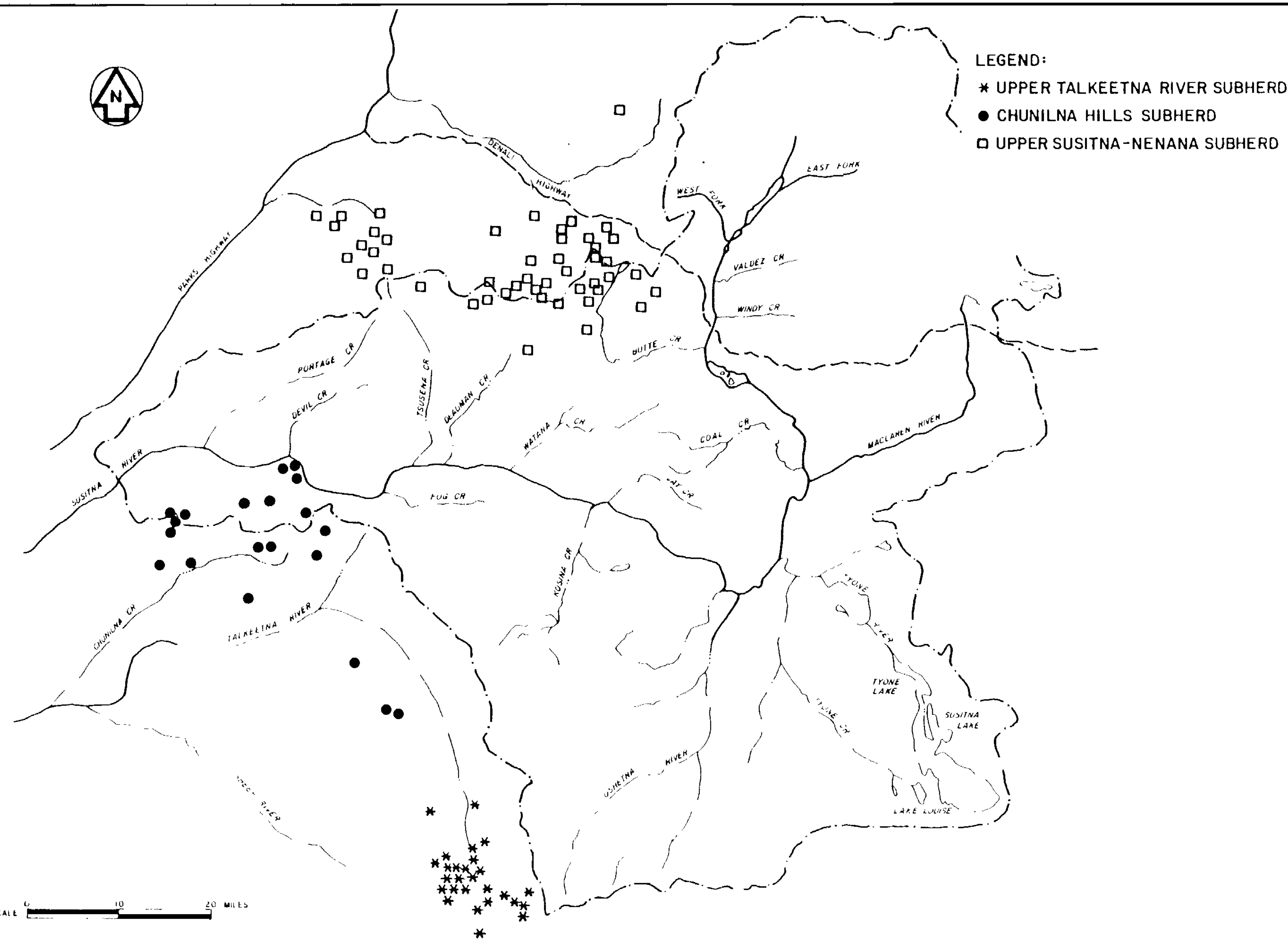
FIGURE E.3.4.12



DISTRIBUTION OF NELCHINA RADIO-COLLARED CARIBOU
DURING THE CALVING PERIOD MAY 15 THROUGH JUNE 10, 1980 AND 1981

SOURCE: ADE&G 1982h

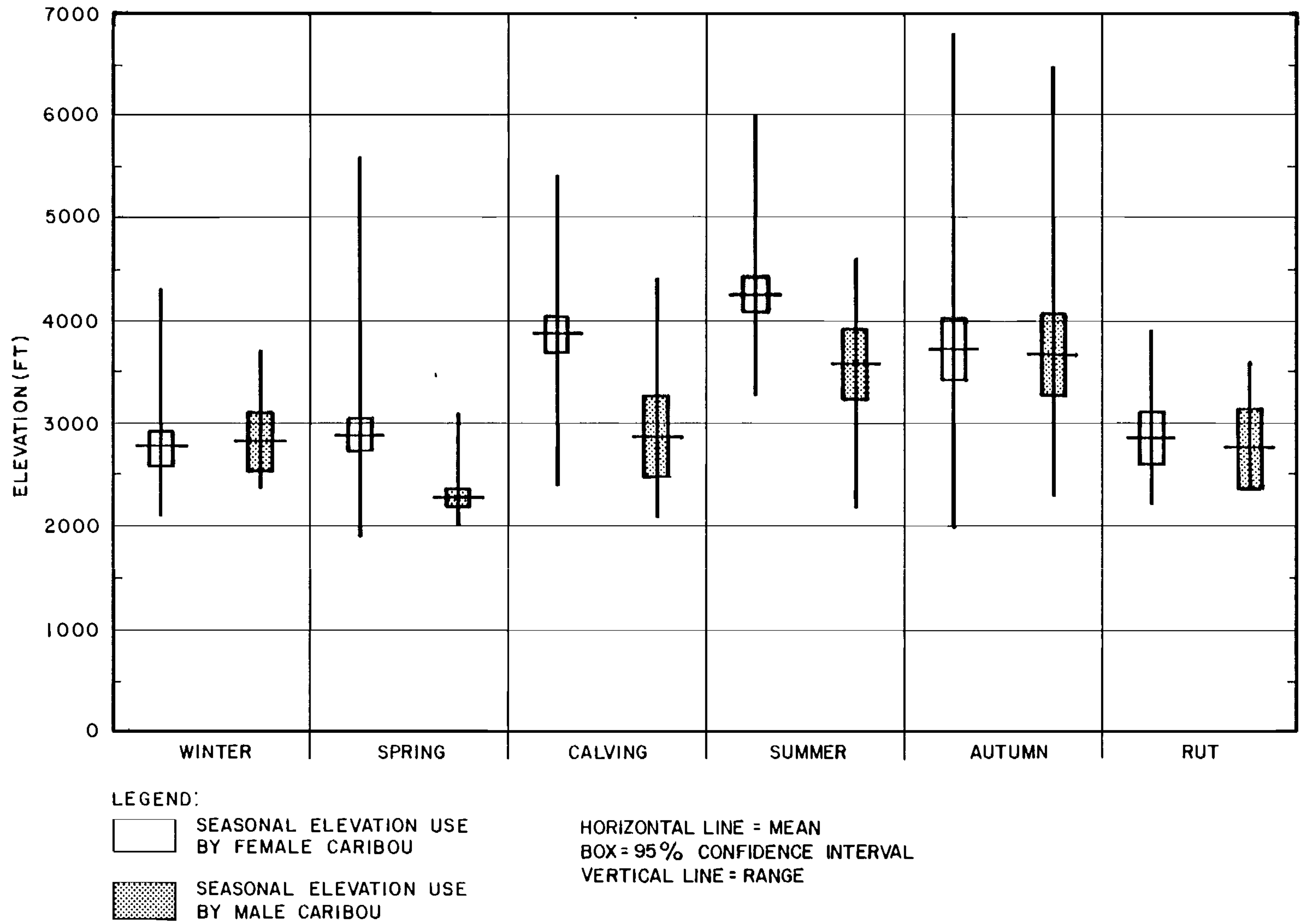
FIGURE E.3.4.13



LOCATION OF RADIO-COLLARED CARIBOU IN SUBHERDS, MAY 9, 1980 THROUGH SEPTEMBER 22, 1981

SOURCE: ADF&G 1982h

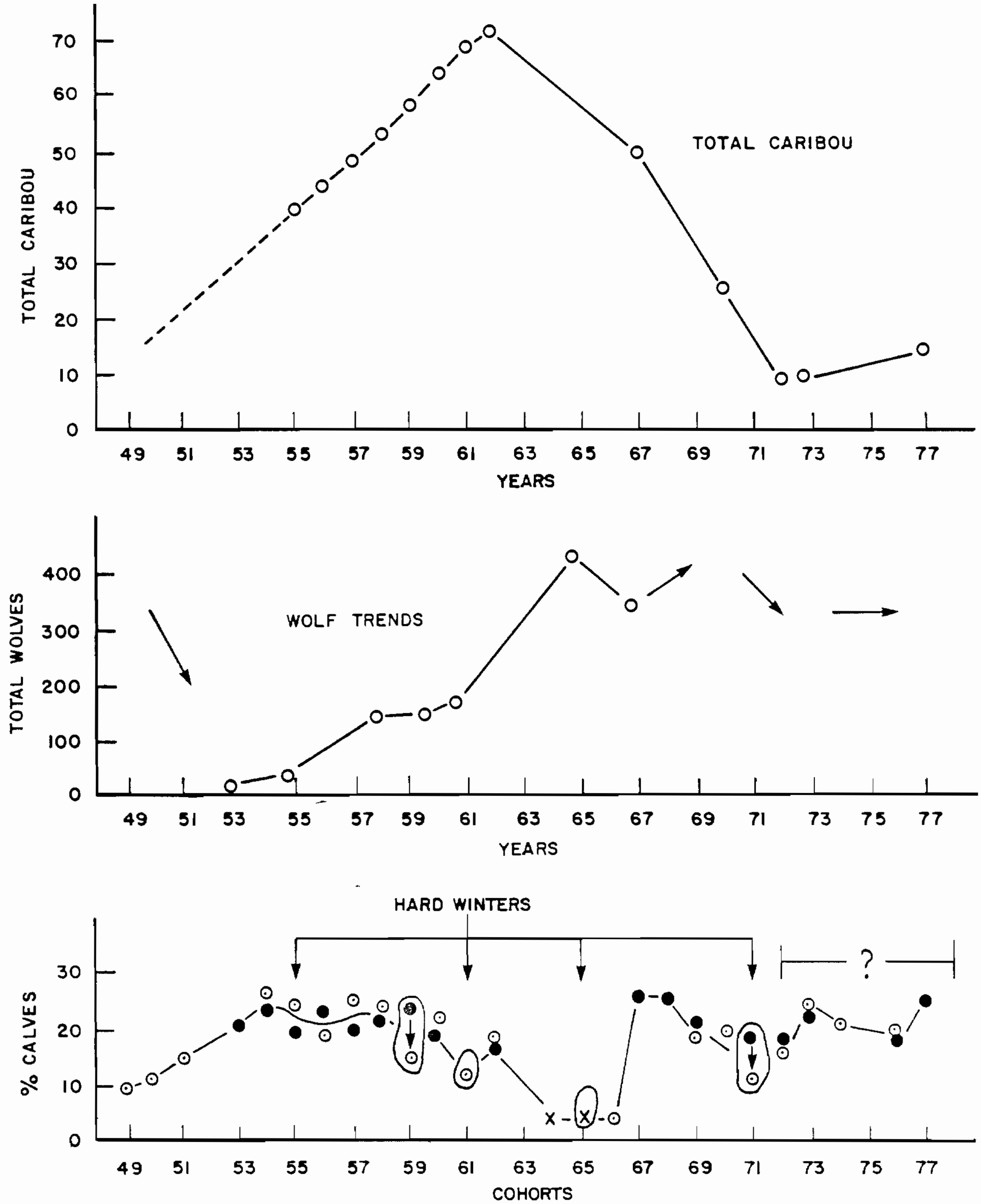
FIGURE E.3.4.14



SEASONAL ELEVATION USE BY CARIBOU FROM NELCHINA HERD

SOURCE: ADF&G 1982h

FIGURE E.3.4.15



LEGEND:

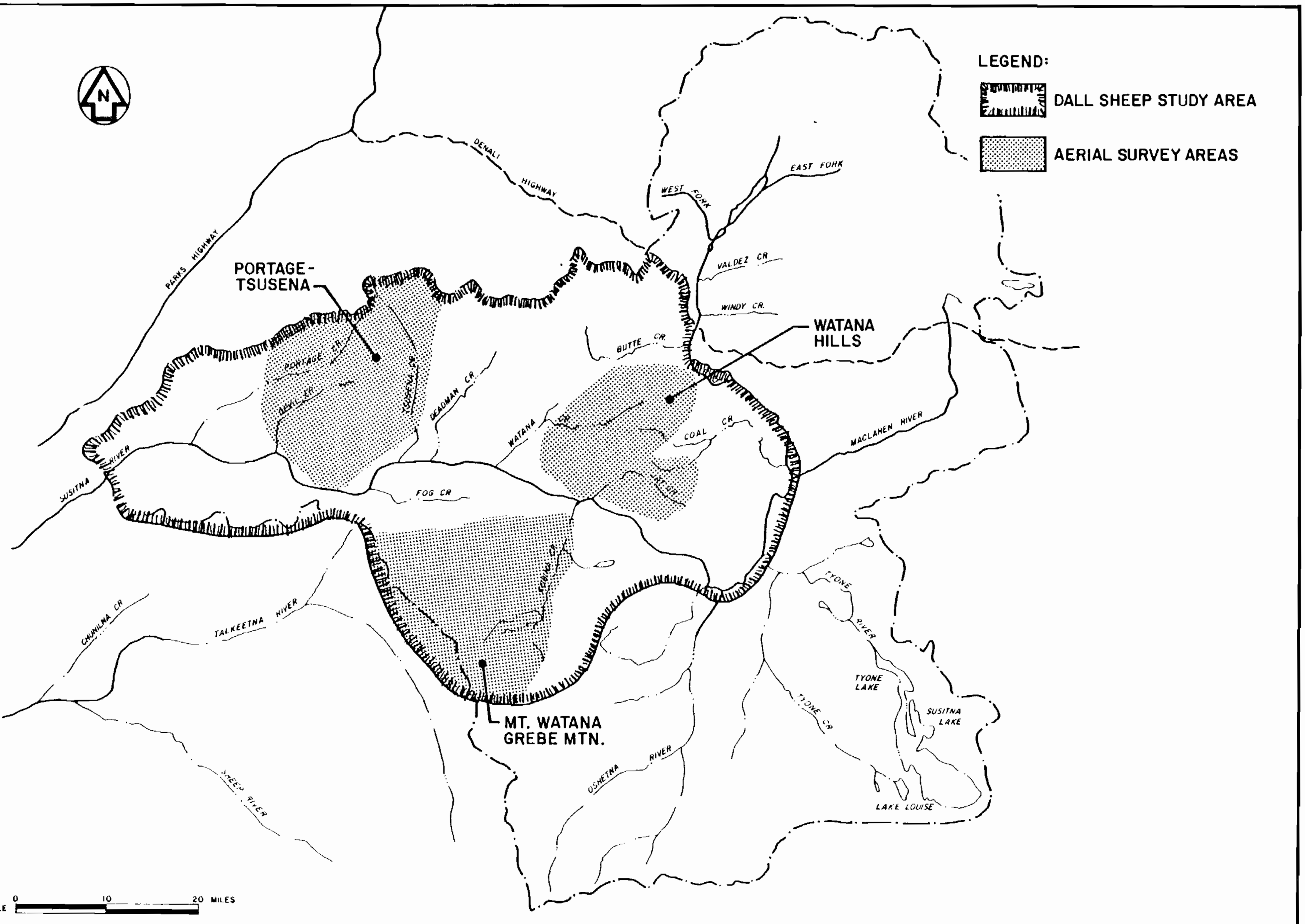
- ● AUTUMN
- ⊙ MARCH
- X BASED ON MANDIBLES
- ⬯ WINTER STARVATION

NOTE: FOR THE NELCHINA HERD IN ALASKA, WINTER STARVATION IS LISTED FOR THOSE YEARS IN WHICH THE PERCENTAGE OF CALVES IN THE SPRING WAS LOW AND THE PRIOR WINTER WAS SEVERE. HOWEVER, THE LOW CALF PERCENTAGES MAY BE DUE TO OTHER MORTALITY FACTORS OR TO SAMPLE ERROR.

CALF SURVIVAL COMPARED WITH WOLF NUMBERS AND TOTAL CARIBOU

SOURCE BERGERUD 1980

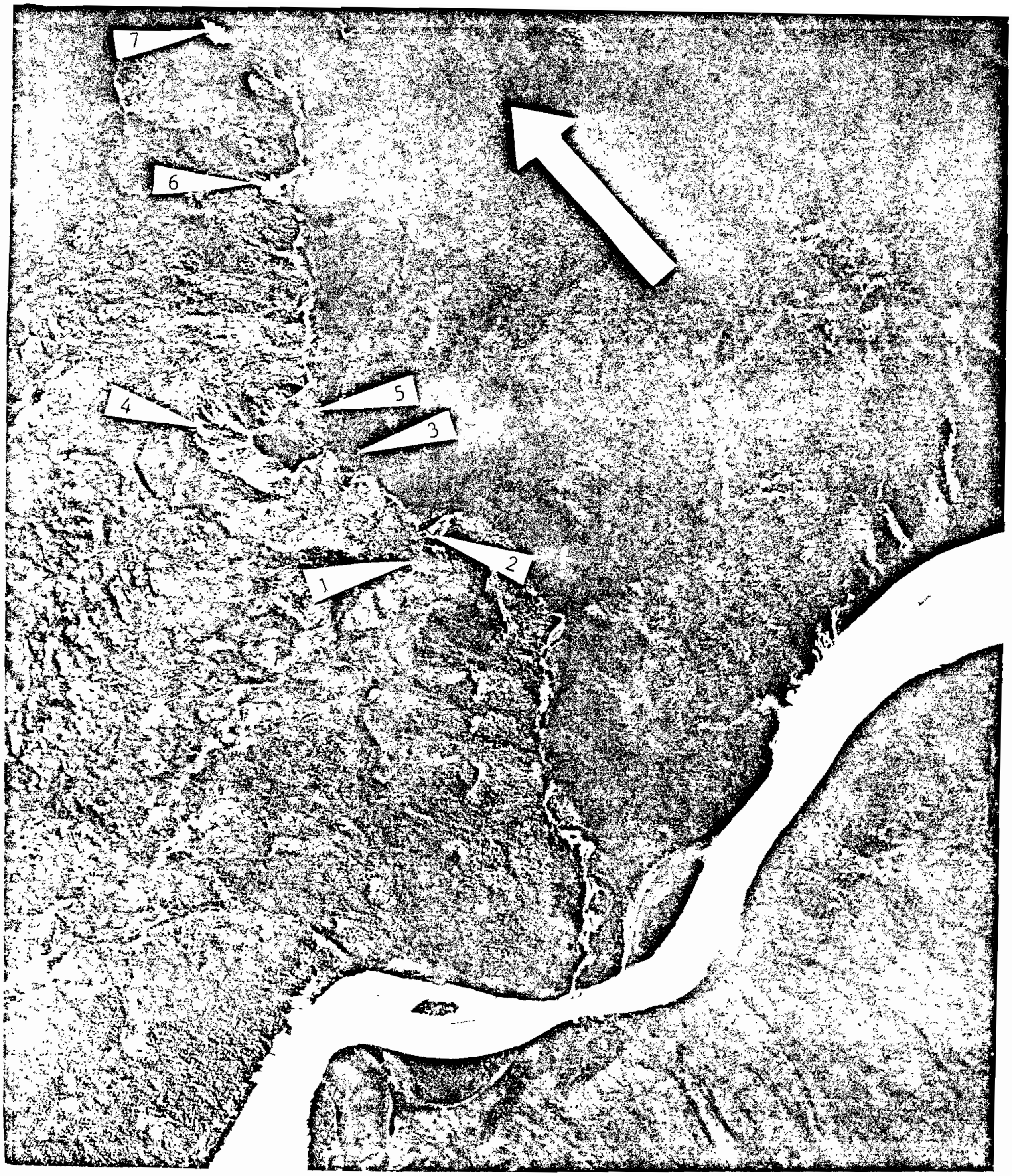
FIGURE E.3.4.16



LOCATION OF DALL SHEEP STUDY AND AERIAL SURVEY AREAS

SOURCE: ADF & G 1982d

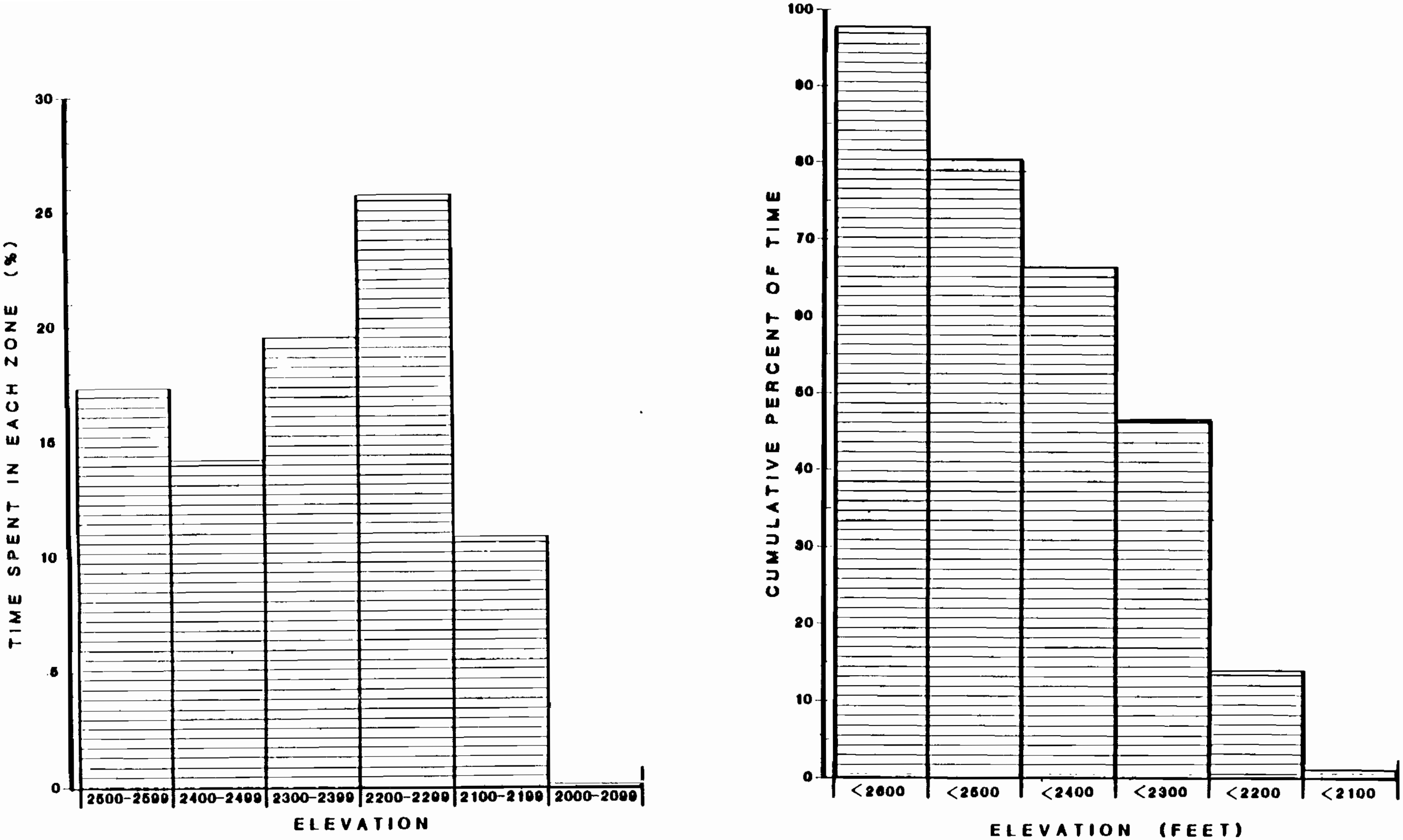
FIGURE E.3.4.17



AERIAL PHOTO OF THE JAY CREEK REGION, SHOWING LICK SITES. ARROW INDICATES TRUE NORTH. THE LICK SITES ARE NUMBERED AS FOLLOWS

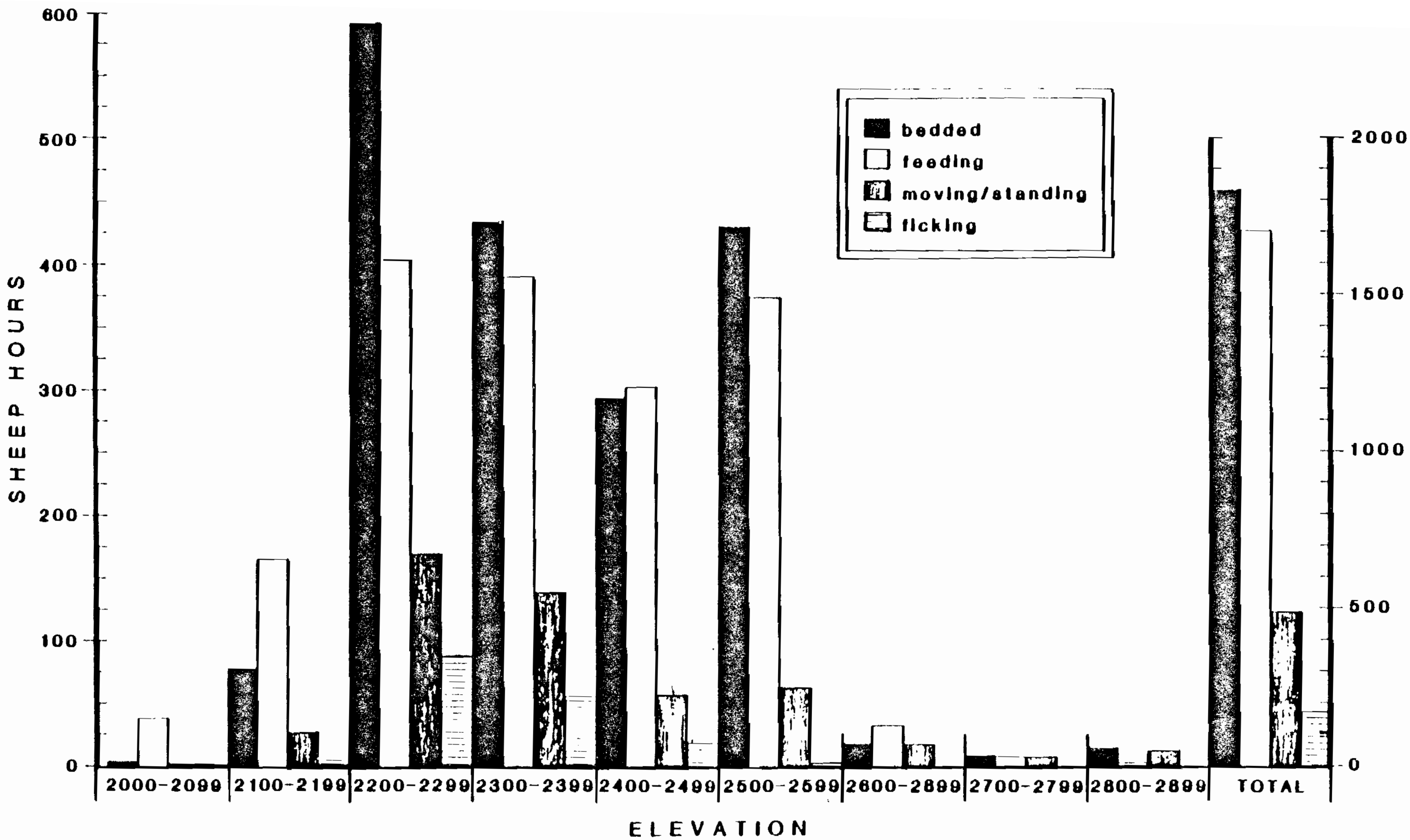
1. Ravine
2. Downstream
3. Cabin Ridge
4. Bluff
5. East Ridge
6. Upstream
7. North Bluff

FIGURE E 3.4.18



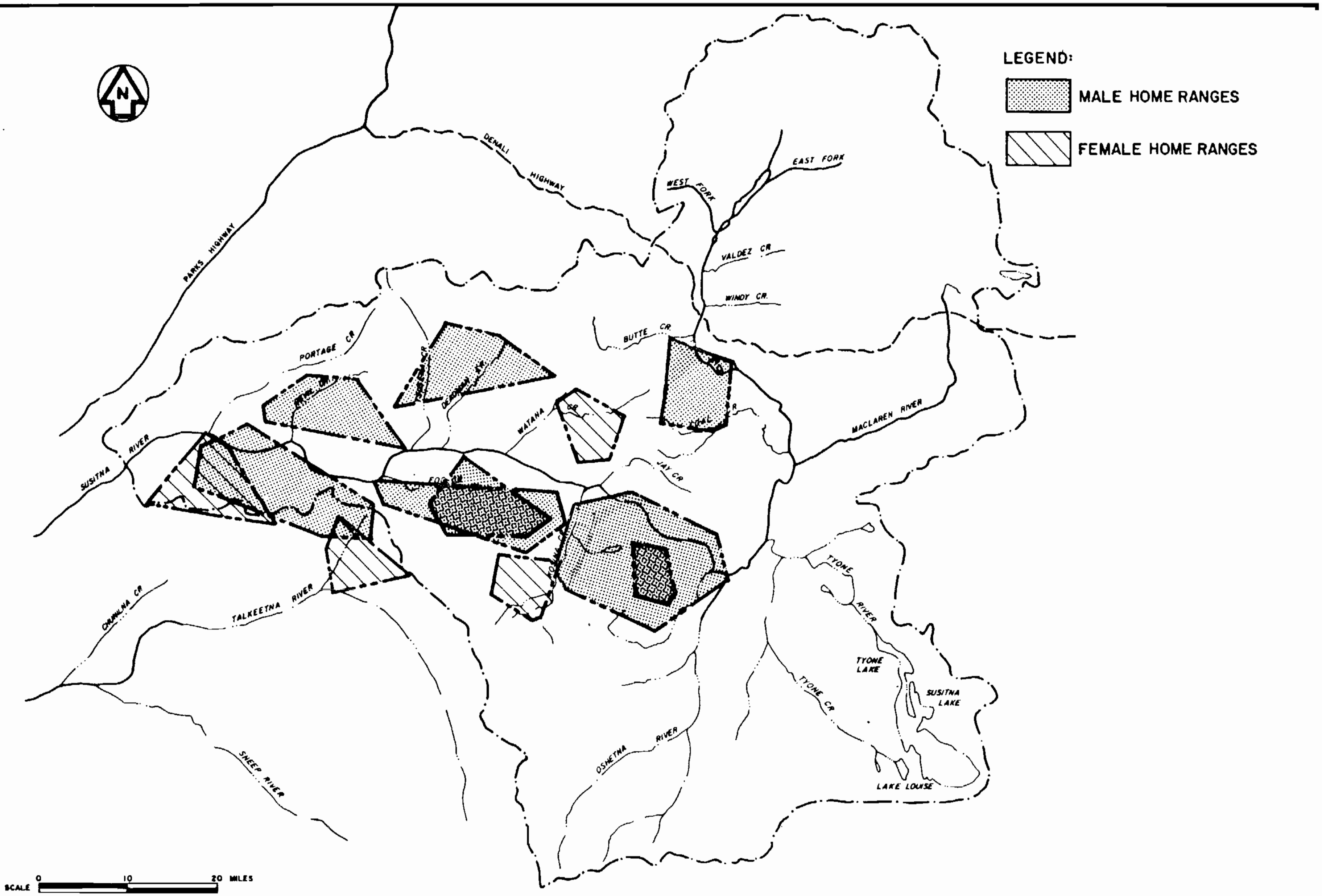
TIME SHEEP SPENT IN VARIOUS ELEVATIONS AROUND JAY CREEK LICK AREA

FIGURE E.3.4.19



TIME SHEEP SPENT IN ACTIVITIES BY ELEVATIONAL ZONE

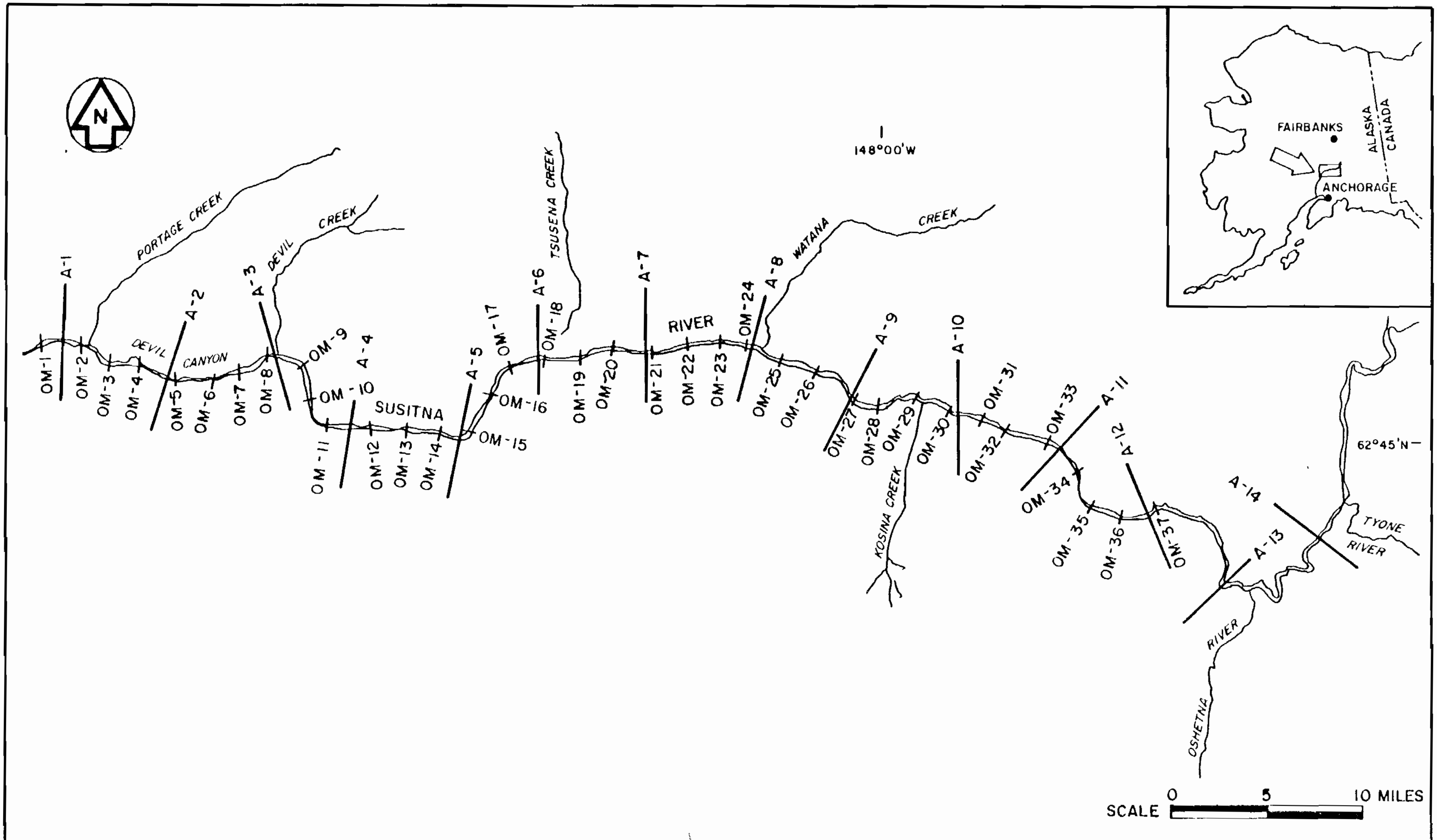
FIGURE E 3.4.20



OBSERVED HOME RANGES OF WOLVERINES IN THE MIDDLE AND UPPER SUSITNA BASINS BASED ON LOCATION OF RADIO-COLLARED ANIMALS, 1980-1982

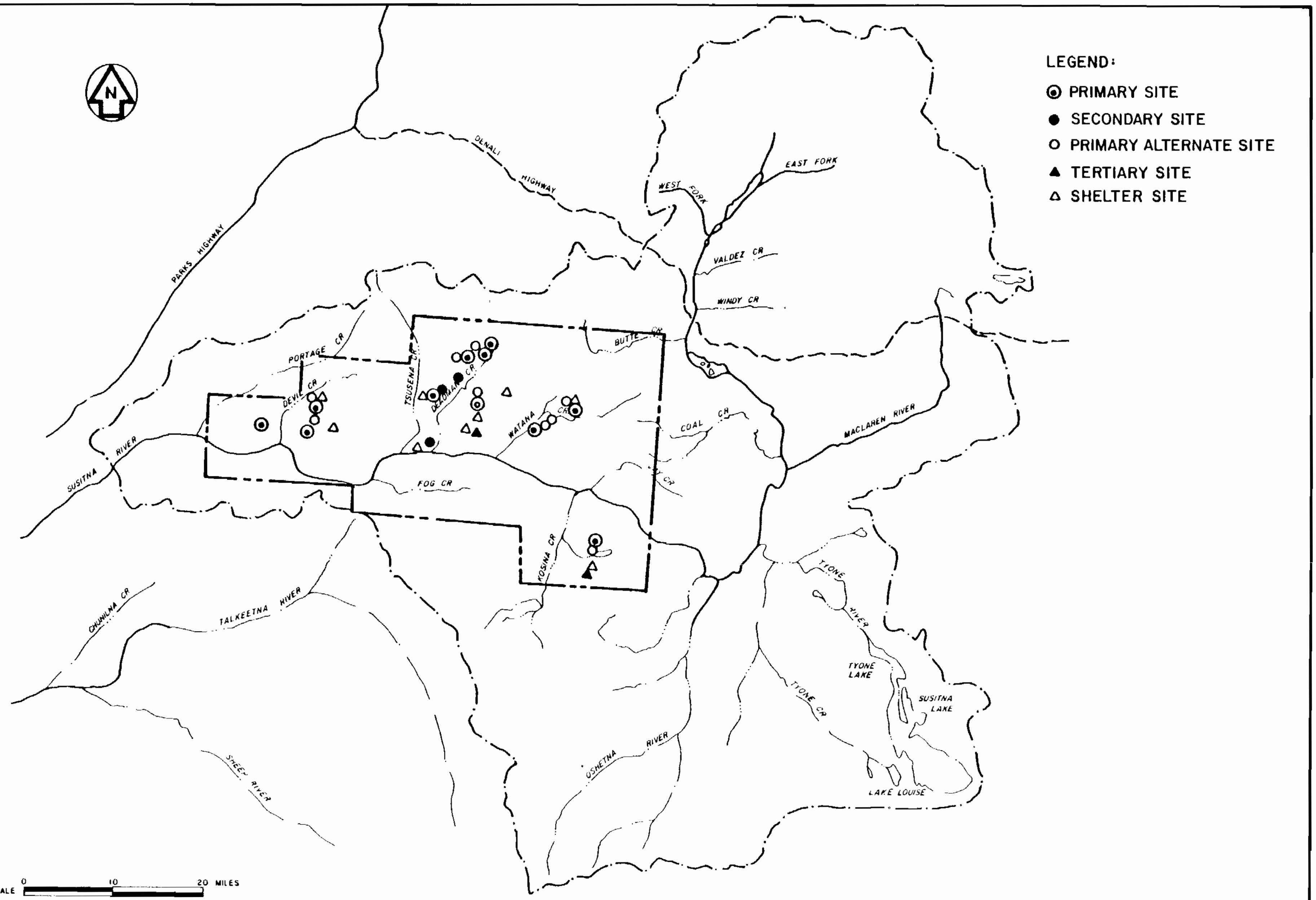
SOURCE: ADF&G 1982 M

FIGURE E.3.4.21



AERIAL TRANSECTS FOR FURBEARERS (A) AND CHECKPOINTS FOR OTTER AND MINK SIGN (OM)

FIGURE 3.4.2?

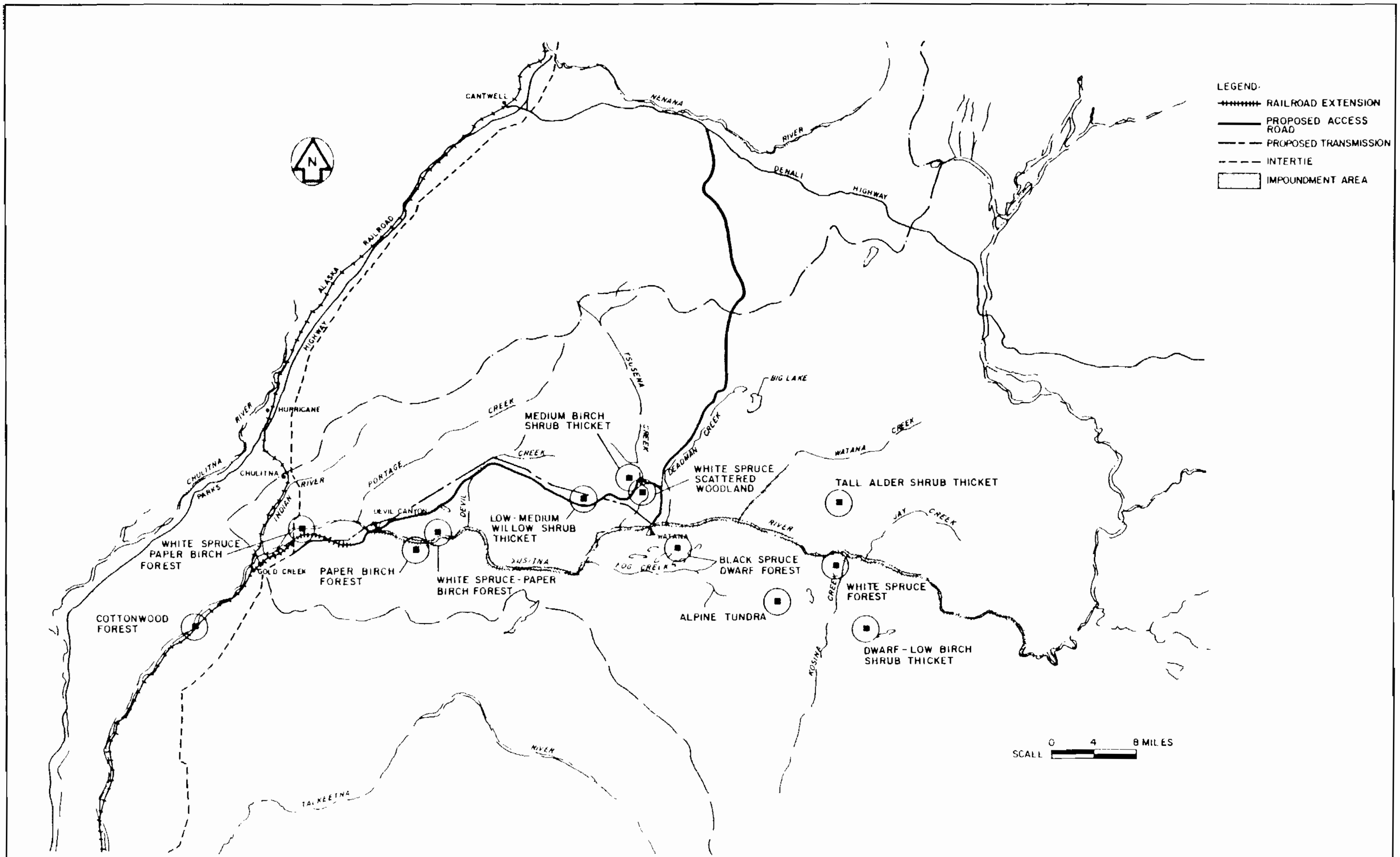


NOTE: SEE TABLE E.3.4.3 FOR RED FOX DEN CLASSIFICATION SYSTEM.

LOCATION AND CLASSIFICATION OF FOX DENS

SOURCE: GIPSON et al. 1982

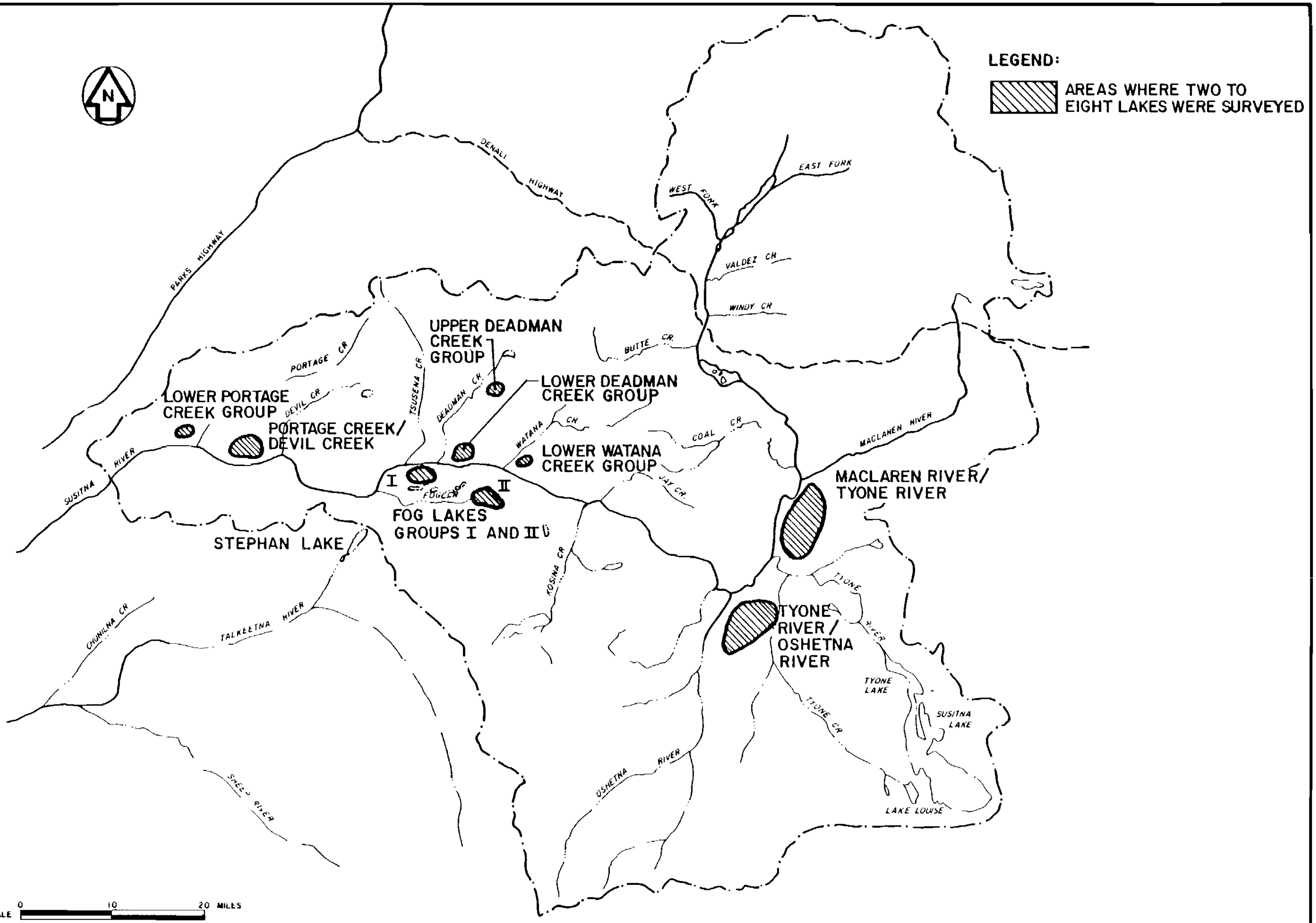
FIGURE E.3.4.23



LOCATIONS OF 12 BIRD CENSUS PLOTS
IN THE MIDDLE SUSITNA RIVER BASIN

SOURCE KESSEL et al 1982a

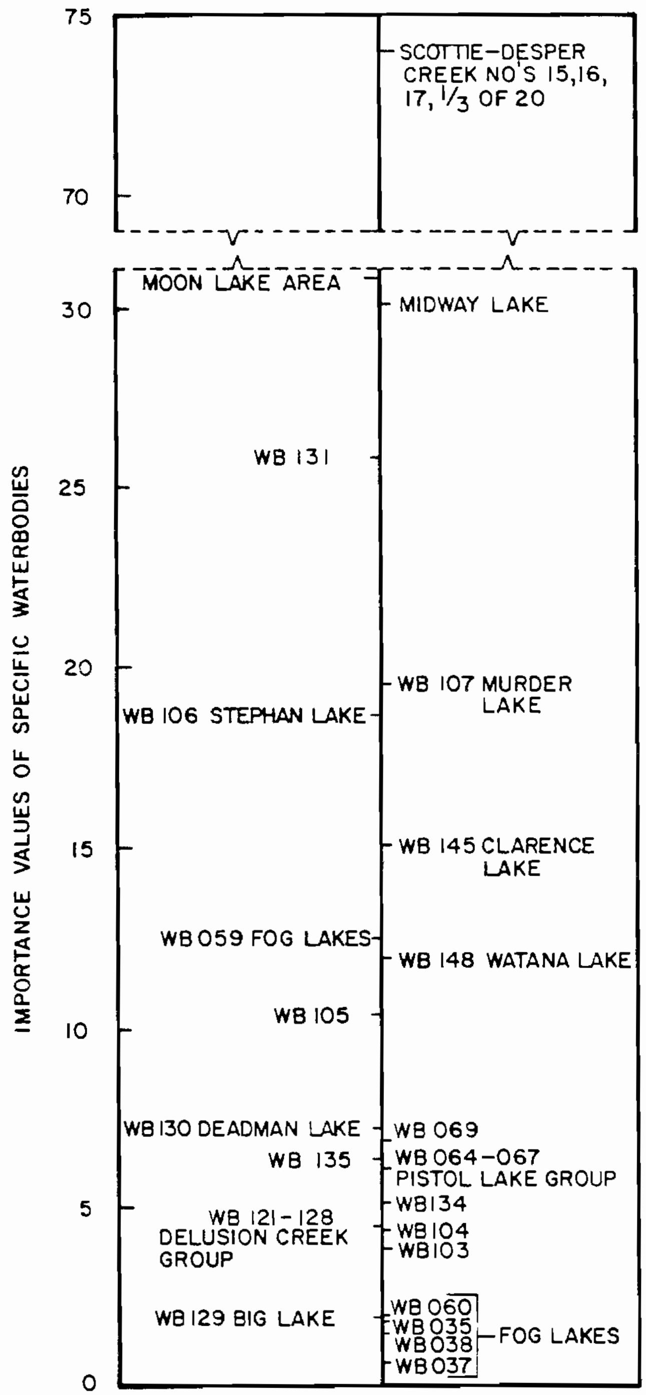
FIGURE E.3.4.24



LOCATIONS OF IMPORTANT LAKES AND LAKE GROUPS SURVEYED FOR WATERFOWL IN THE MIDDLE SUSITNA BASIN

SOURCE: KESSEL et al. 1982a

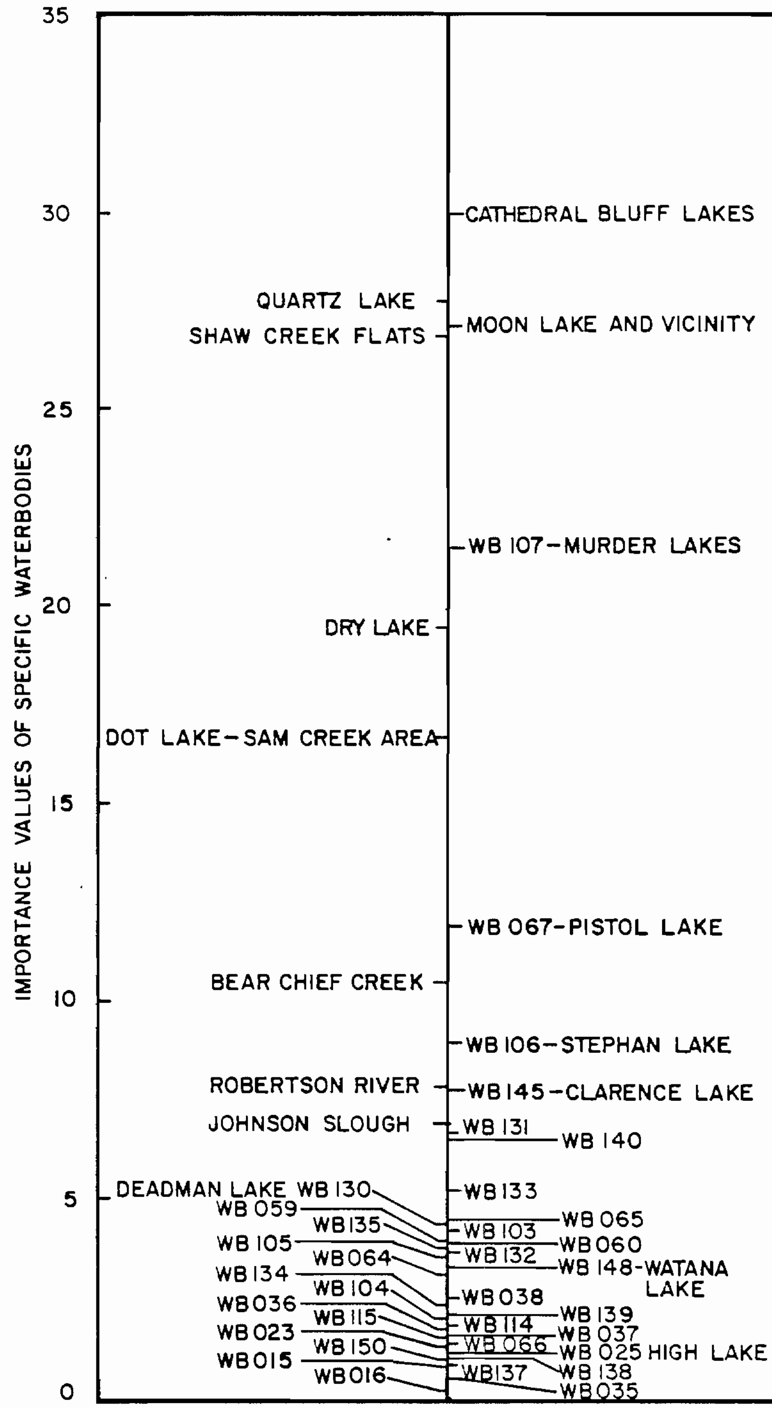
FIGURE E.3.4.25



IMPORTANCE VALUES OF WATER BODIES FOR MIGRANT WATERFOWL IN THE MIDDLE SUSITNA BASIN, UPPER TANANA RIVER VALLEY, AND SCOTTIE CREEK AREA – FALL 1980

SOURCE: KESSEL et al. 1982a

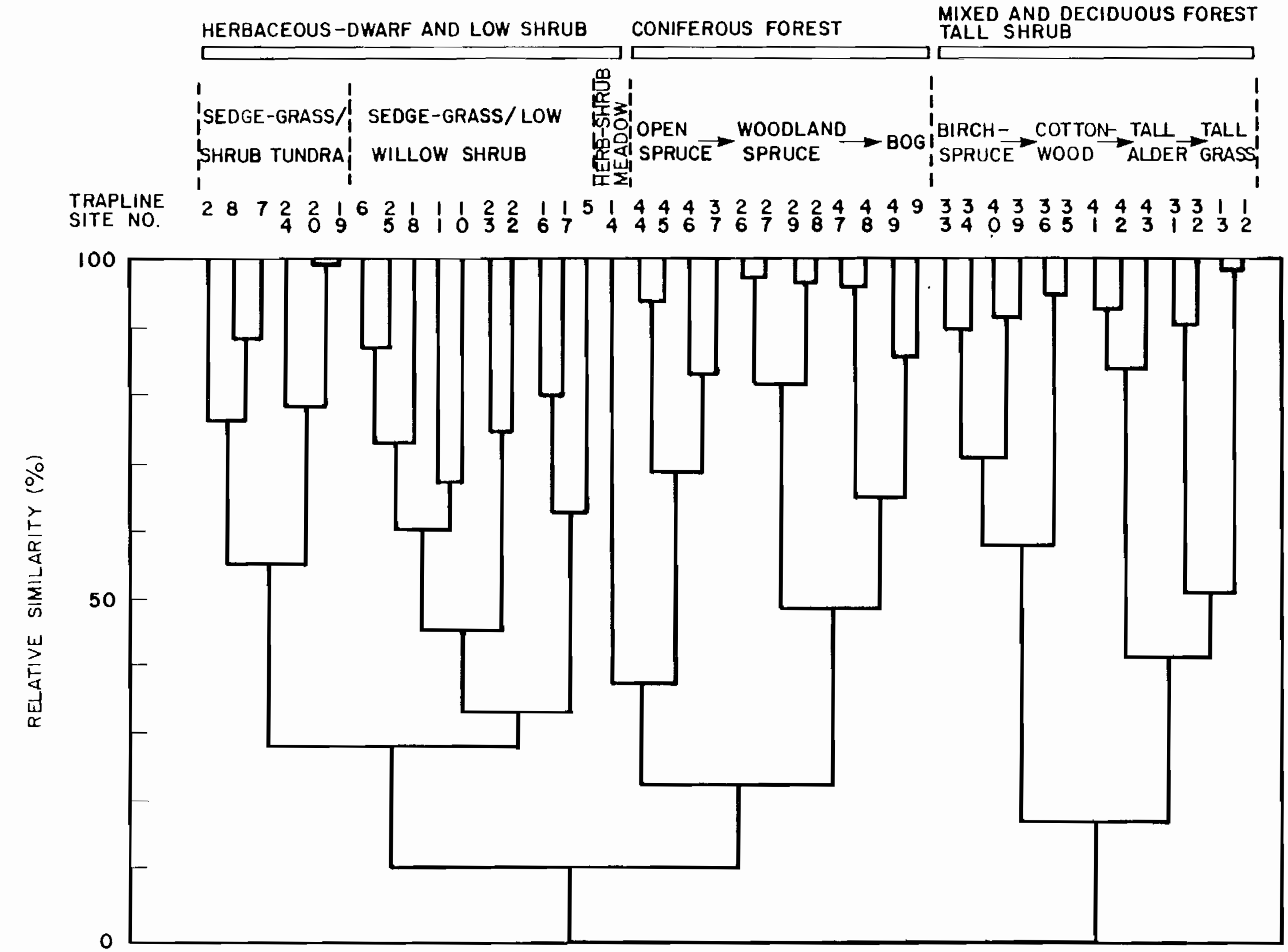
FIGURE E.3.4.2(



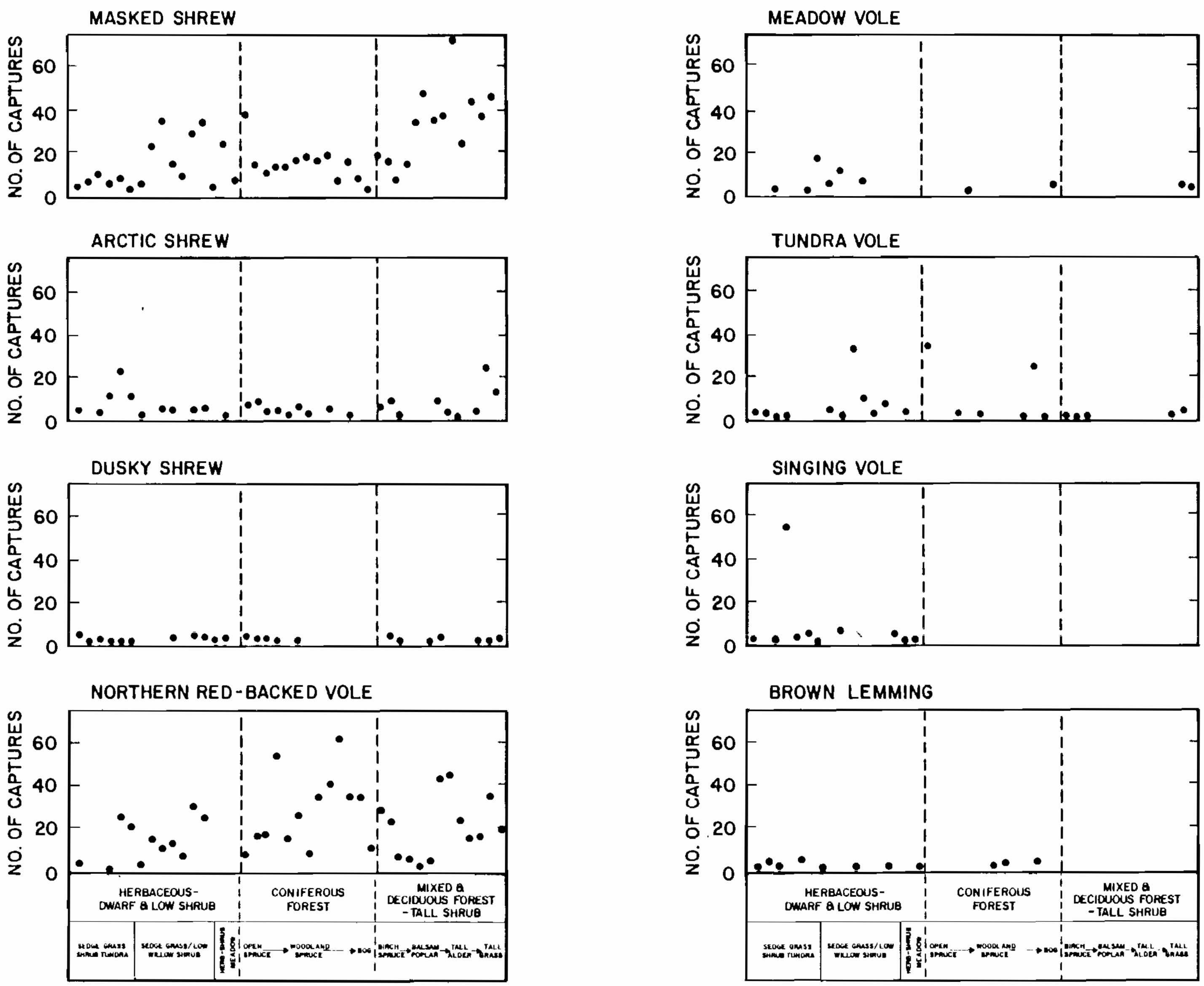
IMPORTANCE VALUES OF WATER BODIES FOR MIGRANT WATERFOWL IN THE MIDDLE SUSITNA BASIN, UPPER TANANA RIVER VALLEY — SPRING 1980

SOURCE: KESSEL et al. 1982a

FIGURE E.3.4.27



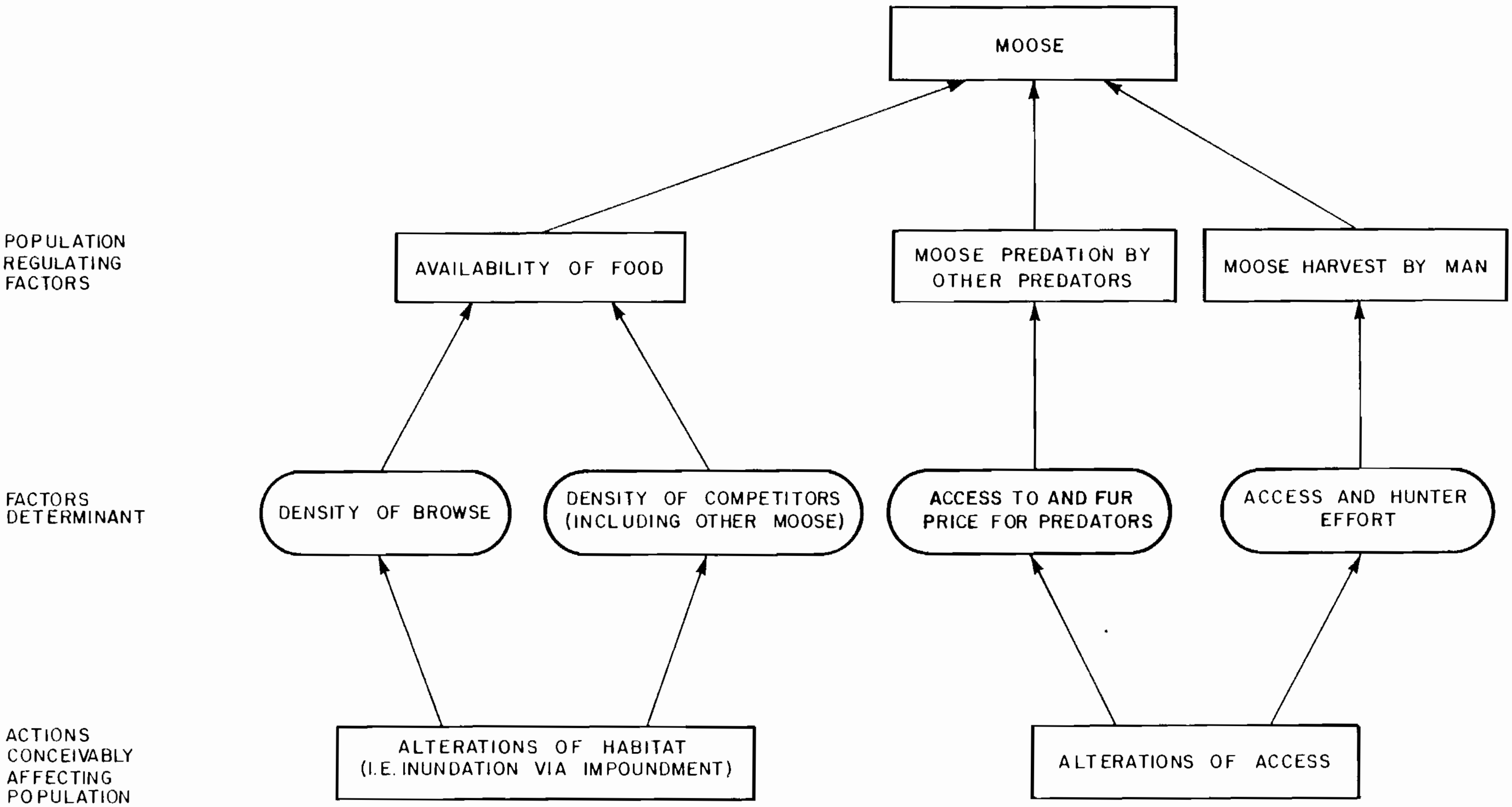
CLUSTERING OF 42 SMALL MAMMAL TRAPLINE SITES INTO SIMILAR VEGETATIVE GROUPINGS, BASED ON AN ANALYSIS OF FREQUENCY COUNTS OF 81 PLANT TAXA IN THE GROUND COVER



ABUNDANCE PATTERNS OF EIGHT SMALL MAMMAL SPECIES RELATIVE TO VEGETATION TYPES AT 42 SITES IN THE SUSITNA RIVER BASIN, ALASKA JULY 29-AUGUST 30, 1981

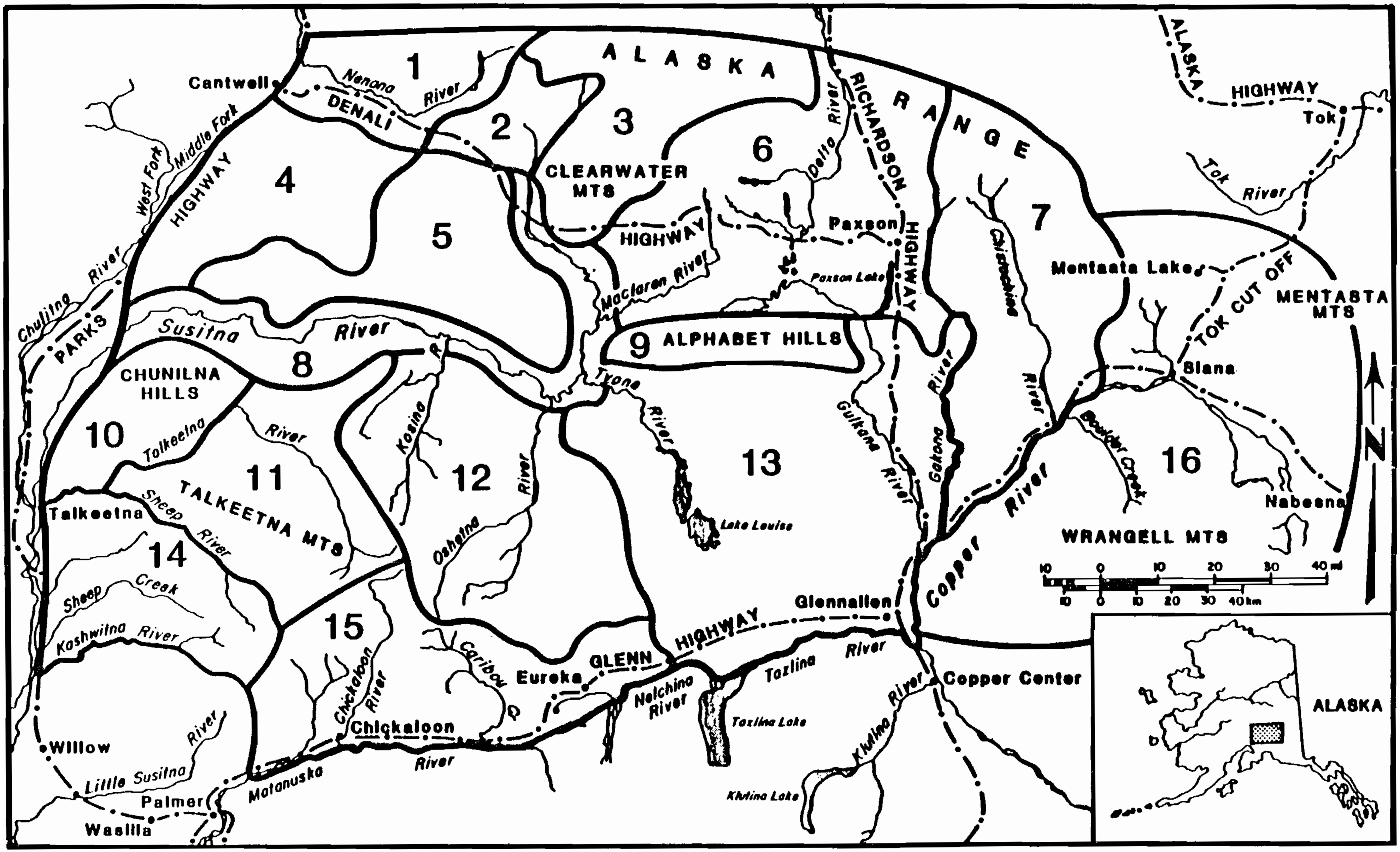
SOURCE: KESSEL et al. 1982a

FIGURE E.3.4.29



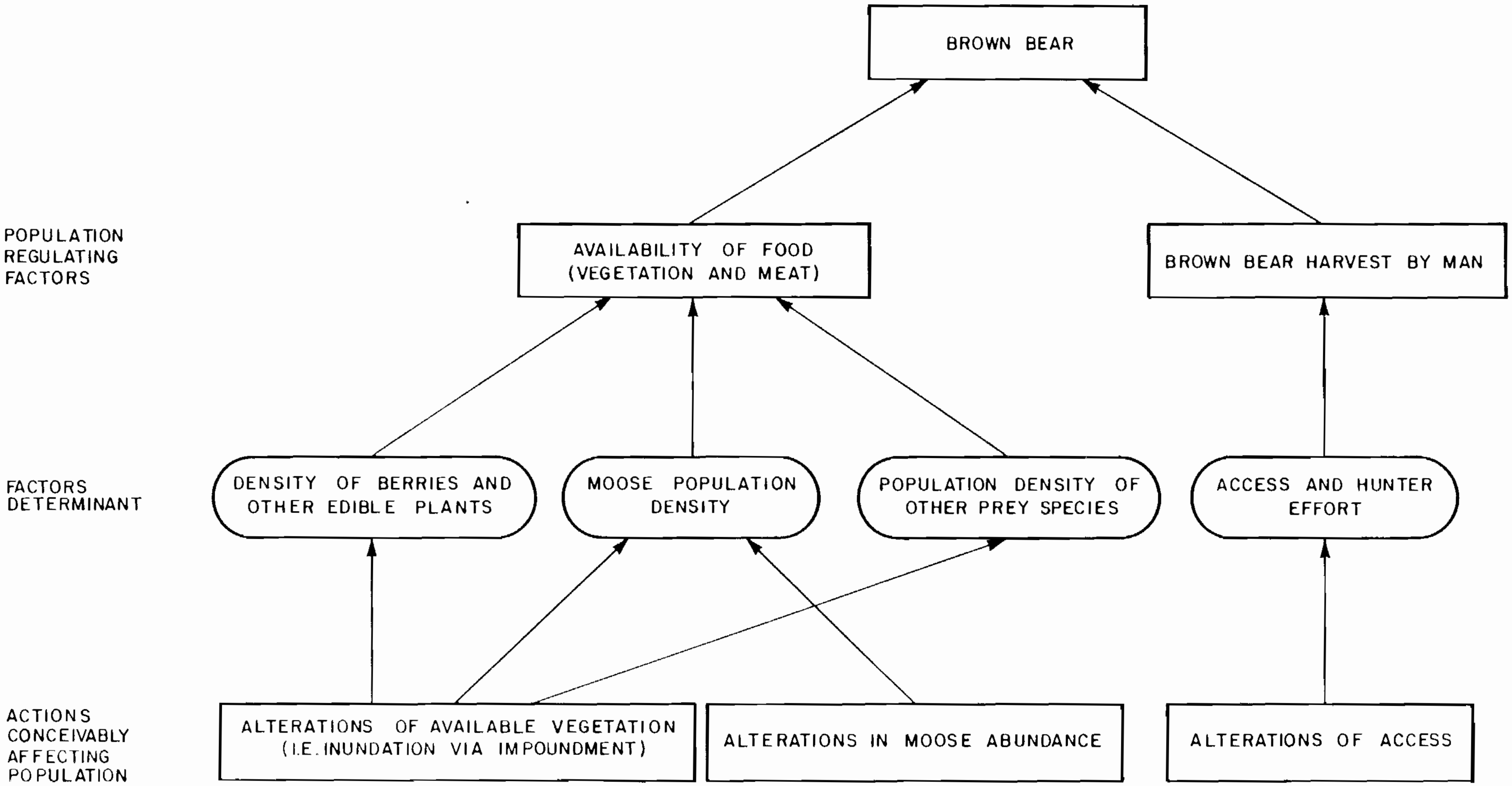
PROBABLE FACTORS REGULATING MOOSE POPULATIONS IN THE SUSITNA BASIN AND ACTIONS THAT MIGHT AFFECT THESE POPULATIONS

FIGURE 3.4.3



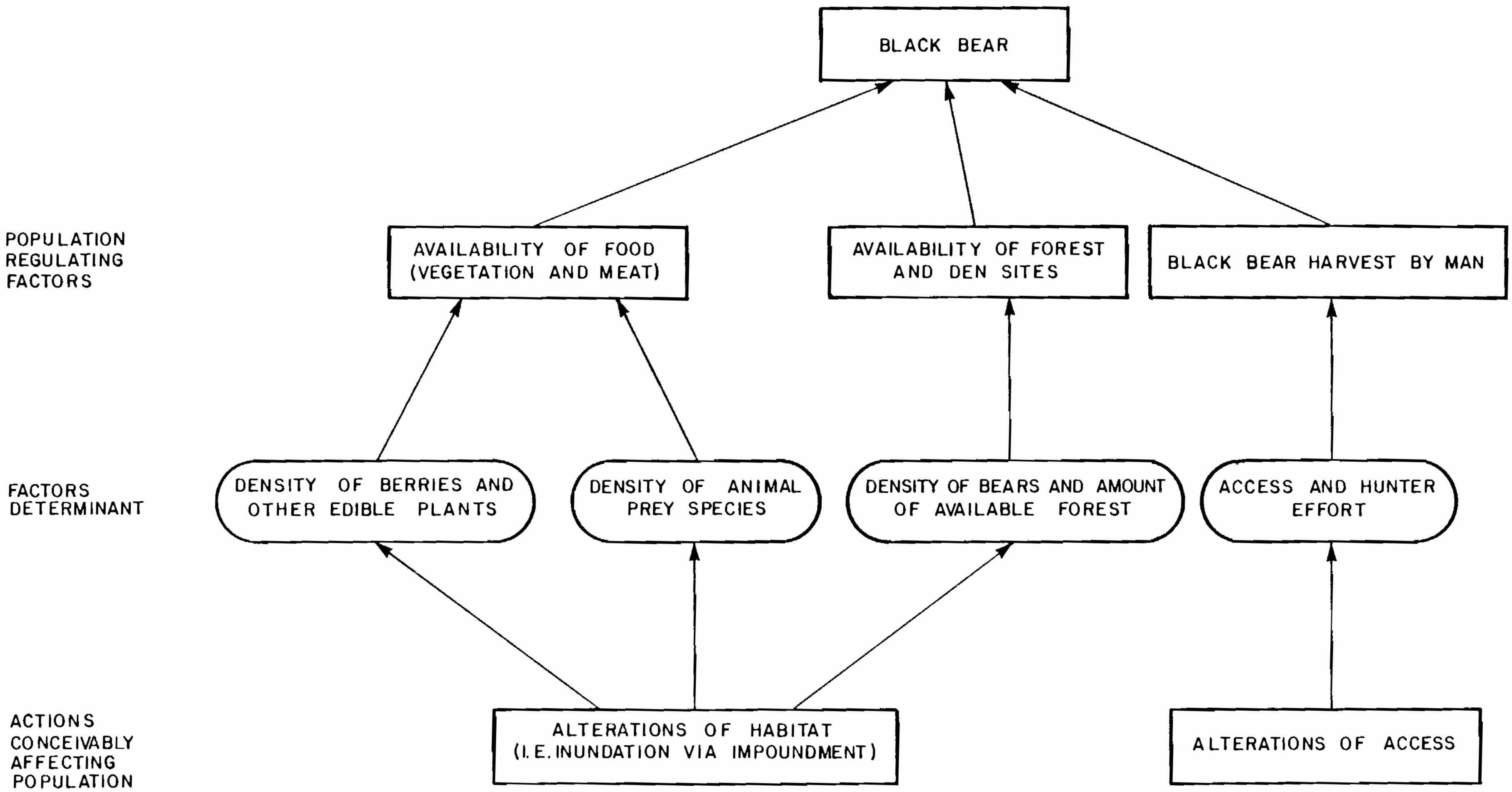
DIVISION OF NELCHINA RANGE INTO AREAL UNITS BASED UPON TOPOGRAPHY, VEGETATION AND CARIBOU USE
(ADF & G 1982h MODIFIED FROM SKOOG 1968)

FIGURE E.3.4.31



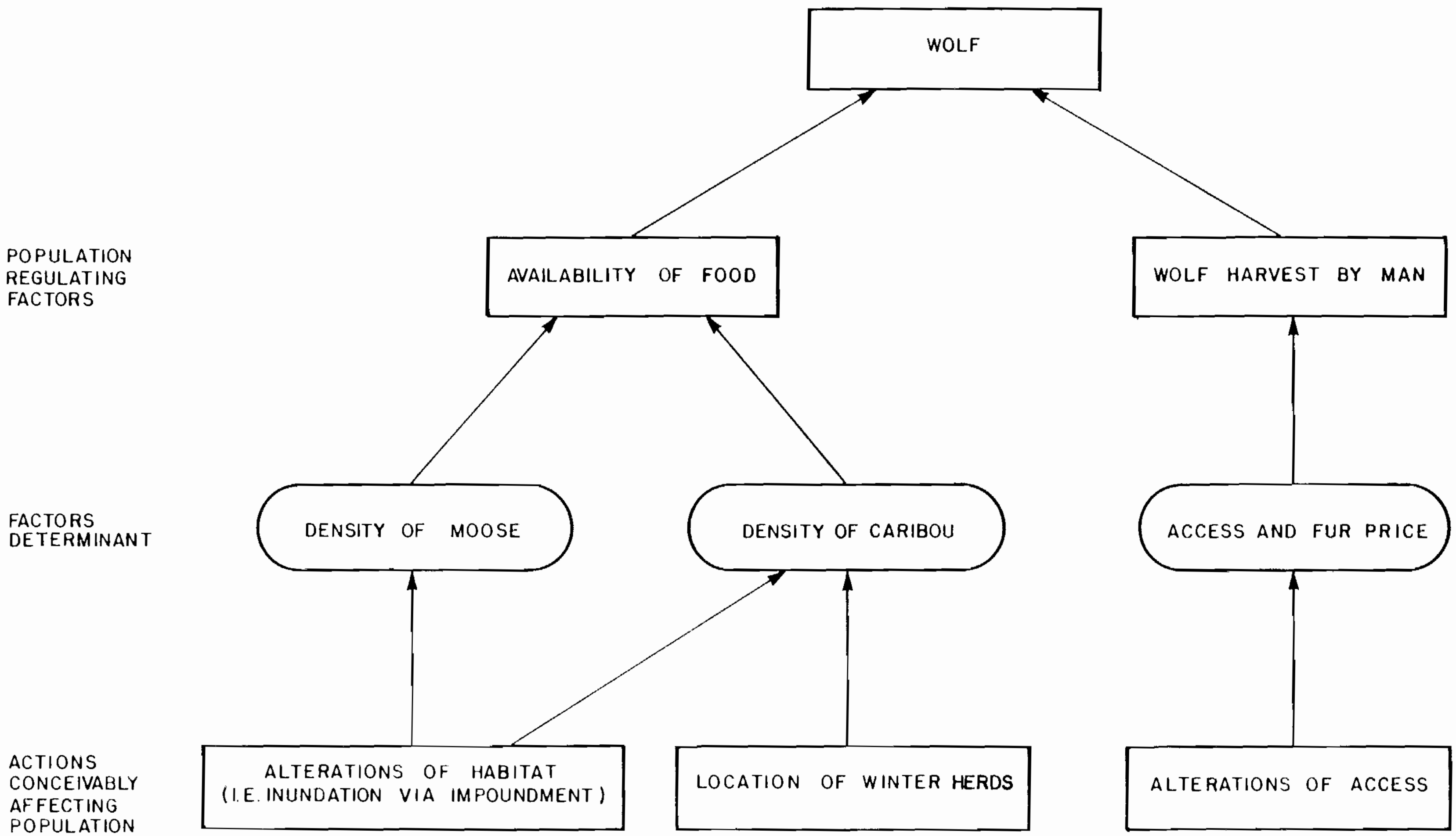
PROBABLE FACTORS REGULATING BROWN BEAR POPULATIONS IN THE SUSITNA BASIN AND ACTIONS THAT MIGHT AFFECT THESE POPULATIONS

FIGURE E 3.4[illegible]



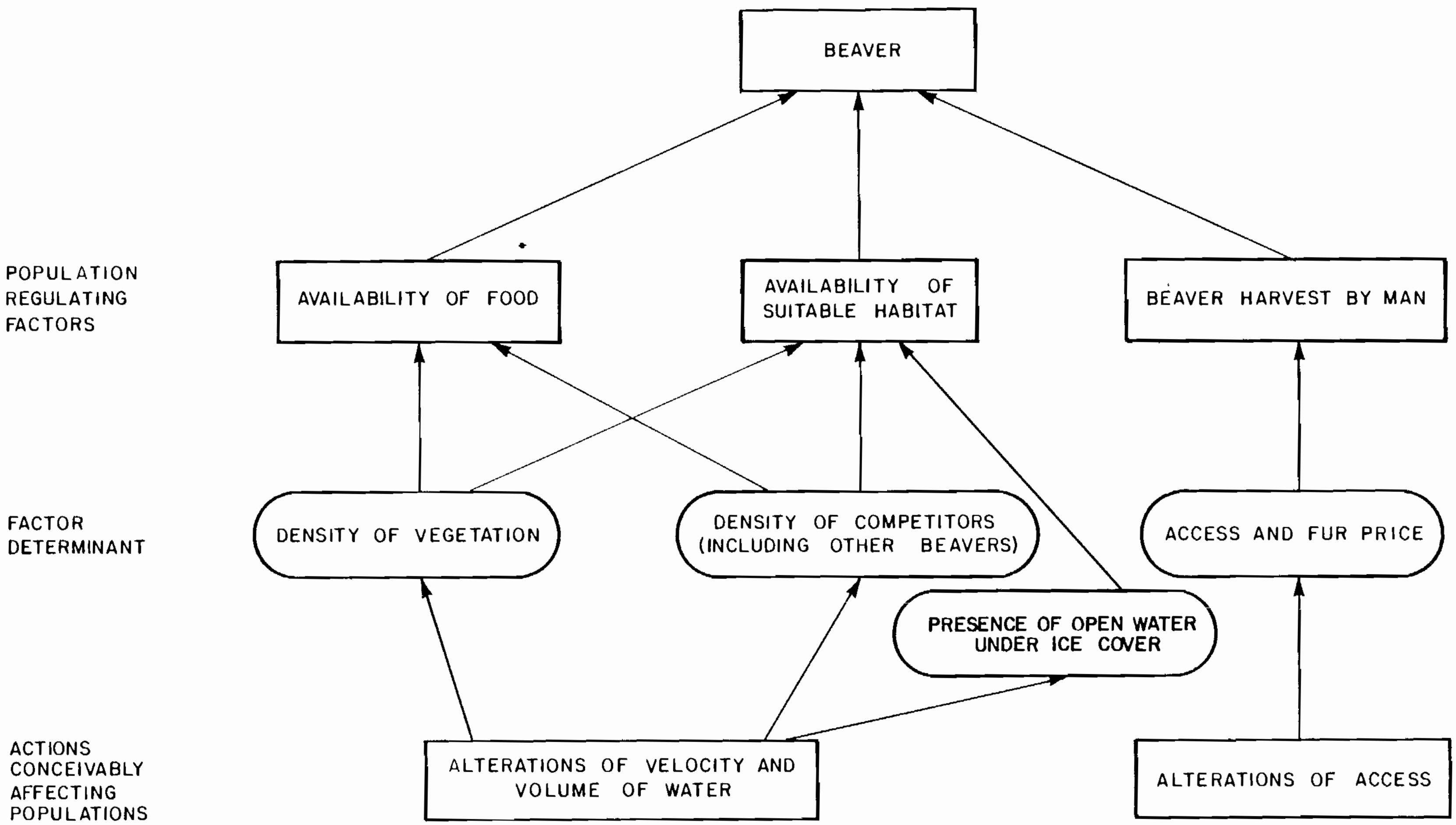
PROBABLE FACTORS REGULATING BLACK BEAR POPULATIONS IN THE SUSITNA BASIN AND ACTIONS THAT MIGHT AFFECT THESE POPULATIONS

FIGURE E.3.4.3



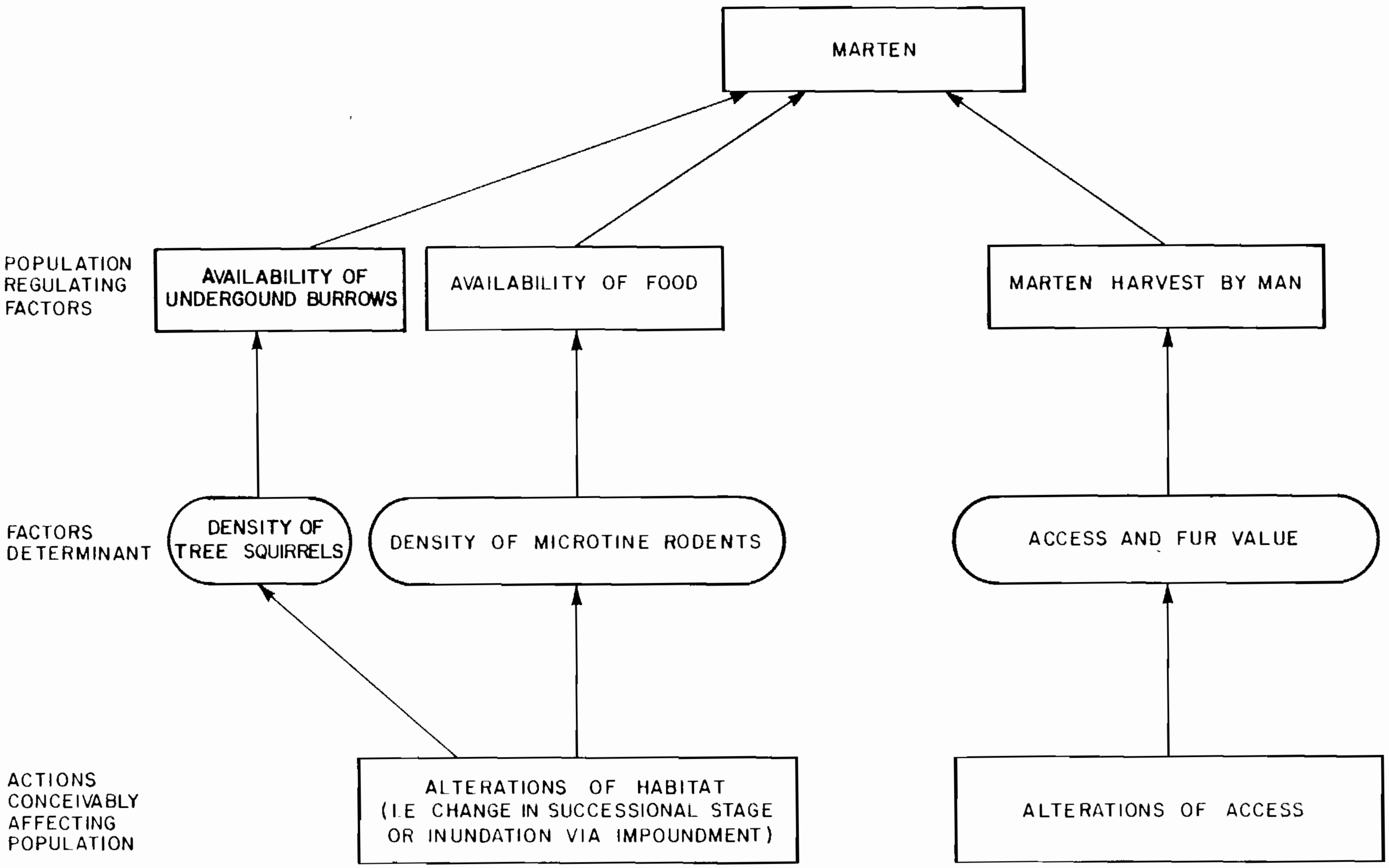
PROBABLE FACTORS REGULATING WOLF POPULATIONS IN THE SUSITNA BASIN AND ACTIONS THAT MIGHT AFFECT THESE POPULATIONS

FIGURE E.3.4.34



PROBABLE FACTORS REGULATING BEAVER POPULATIONS IN THE SUSITNA BASIN AND ACTIONS THAT MIGHT AFFECT THESE POPULATIONS

FIGURE E.3.4.35

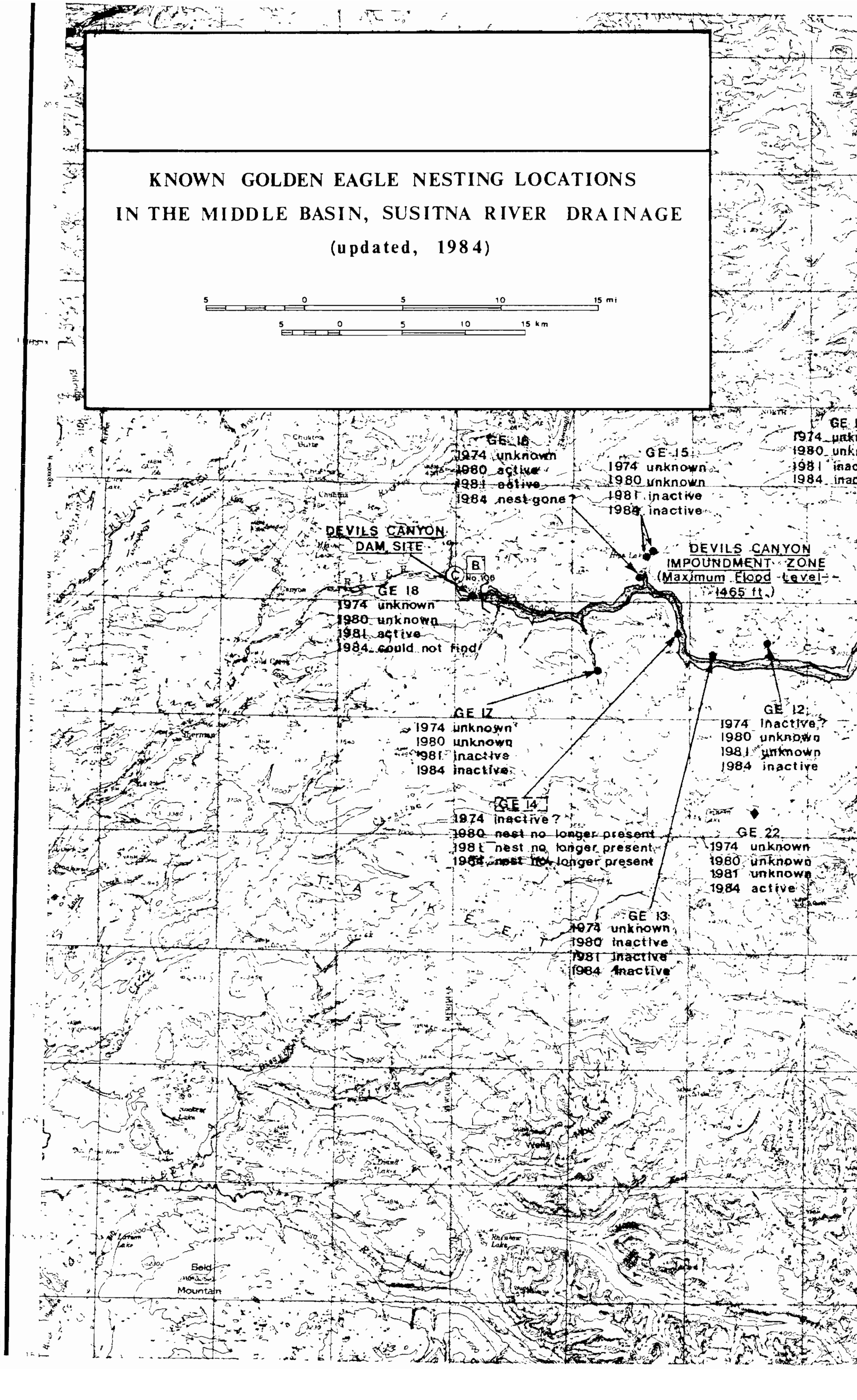


PROBABLE FACTORS REGULATING MARTEN POPULATIONS IN THE SUSITNA BASIN AND ACTIONS THAT MIGHT AFFECT THESE POPULATIONS

FIGURE E.3.4.36

KNOWN GOLDEN EAGLE NESTING LOCATIONS IN THE MIDDLE BASIN, SUSITNA RIVER DRAINAGE

(updated, 1984)



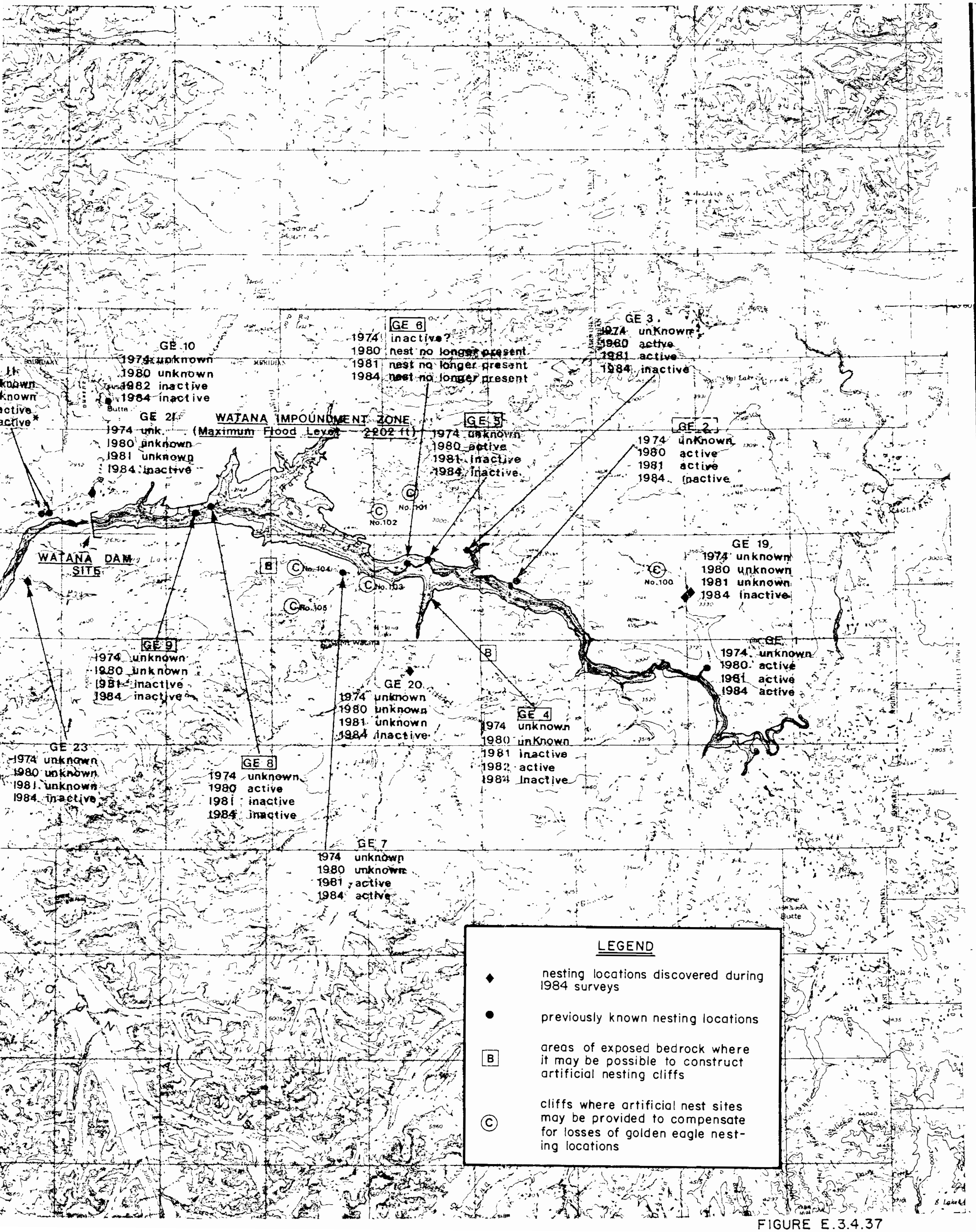
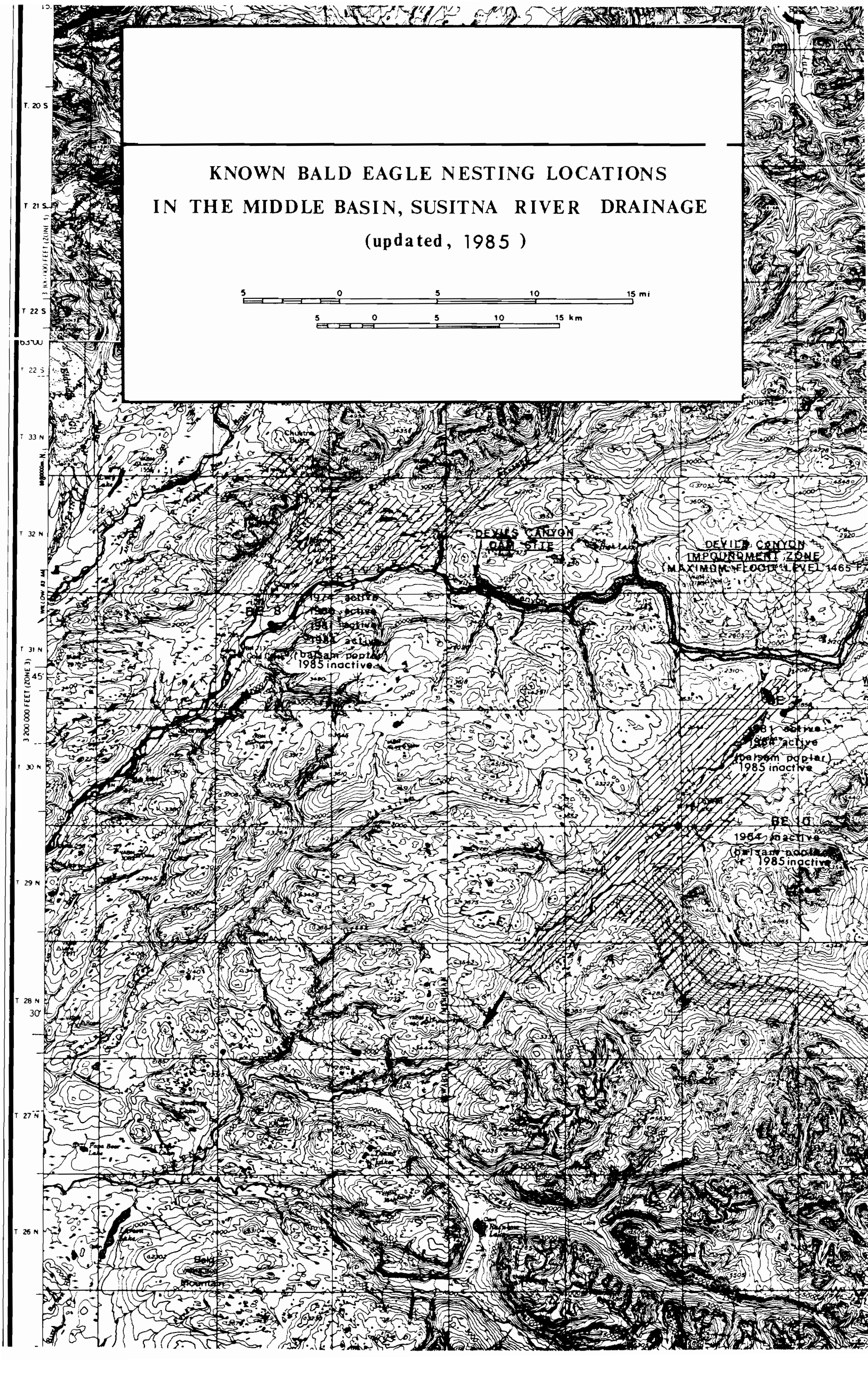


FIGURE E.3.4.37

KNOWN BALD EAGLE NESTING LOCATIONS IN THE MIDDLE BASIN, SUSITNA RIVER DRAINAGE

(updated, 1985)



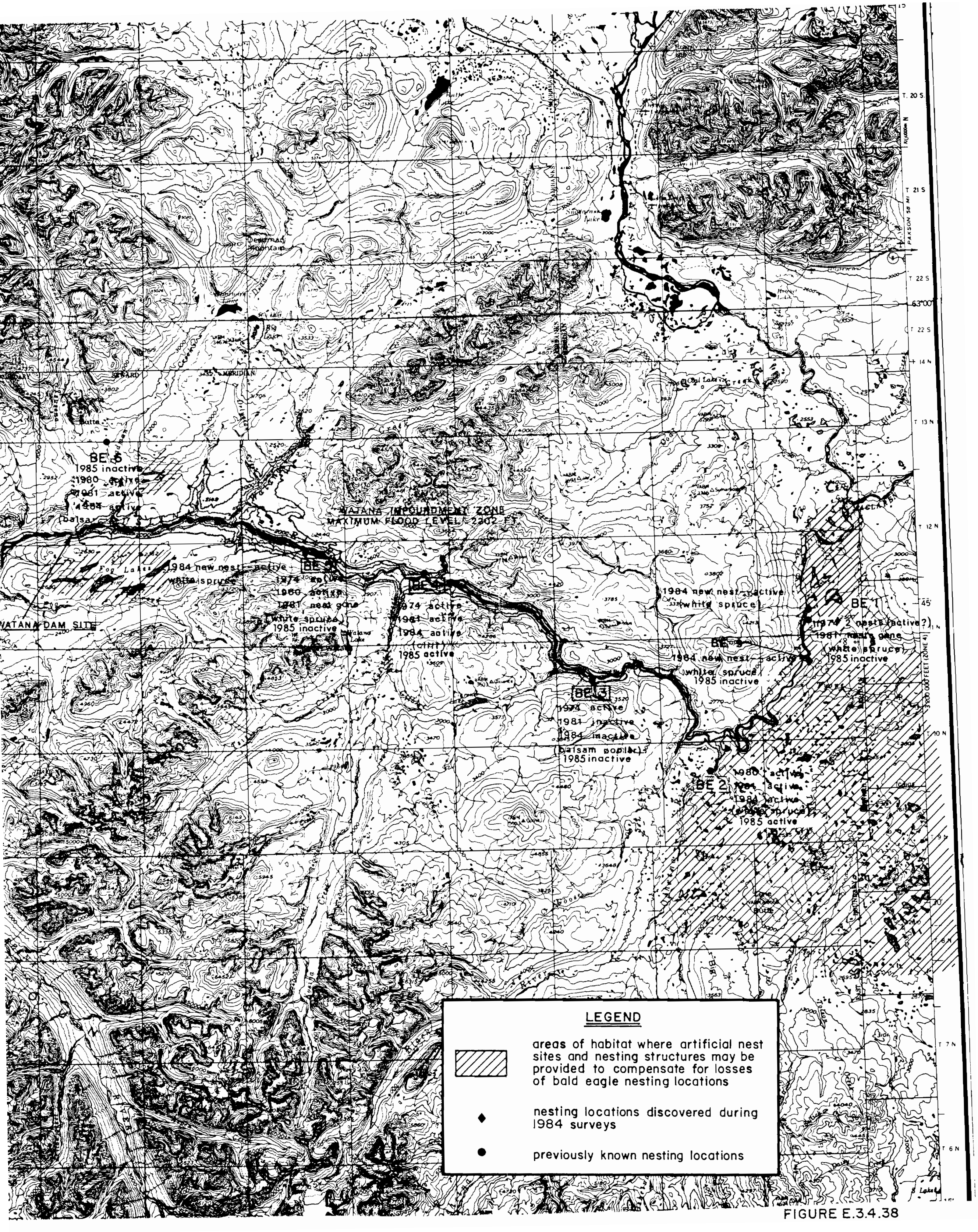
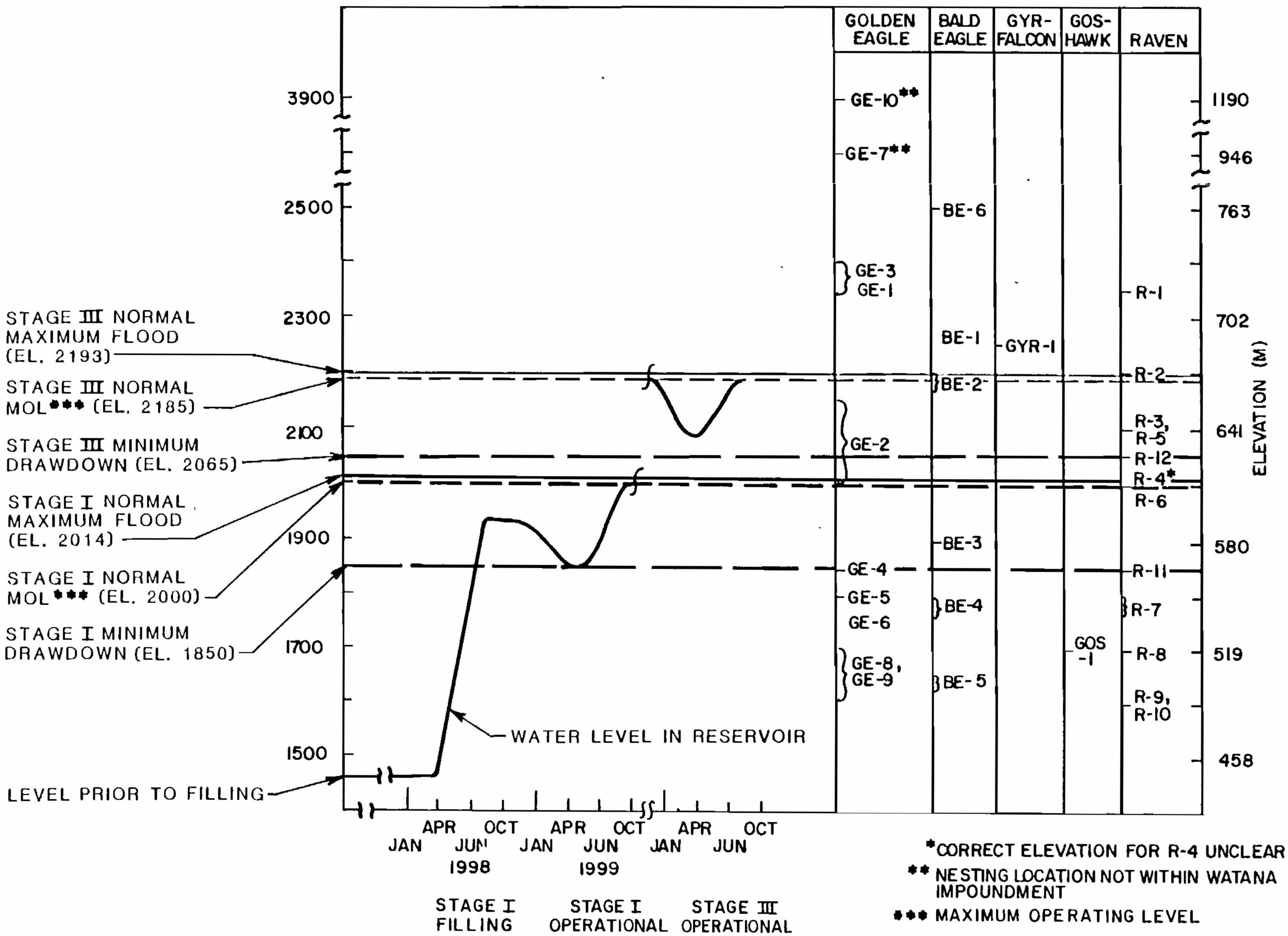
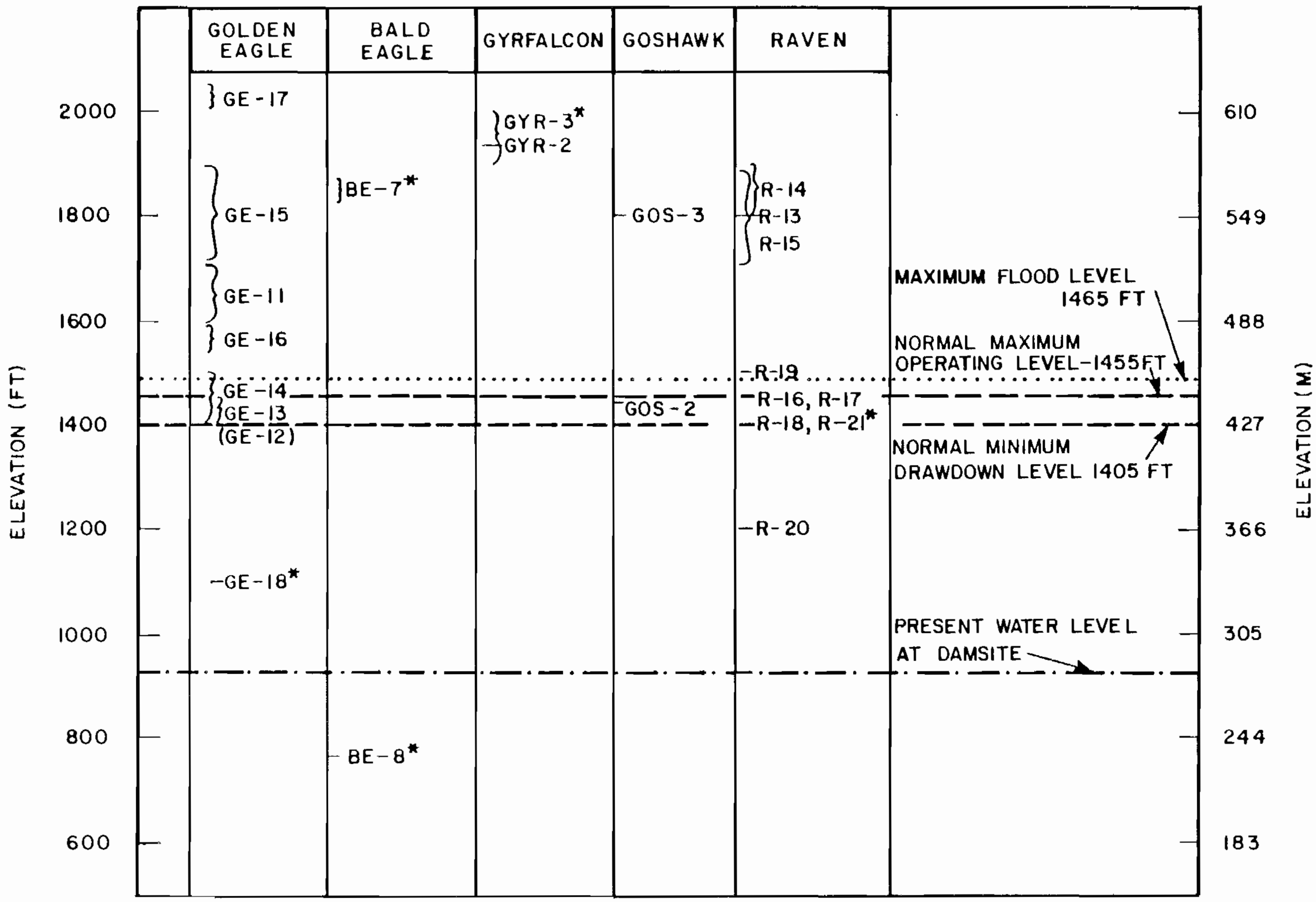


FIGURE E.3.4.38



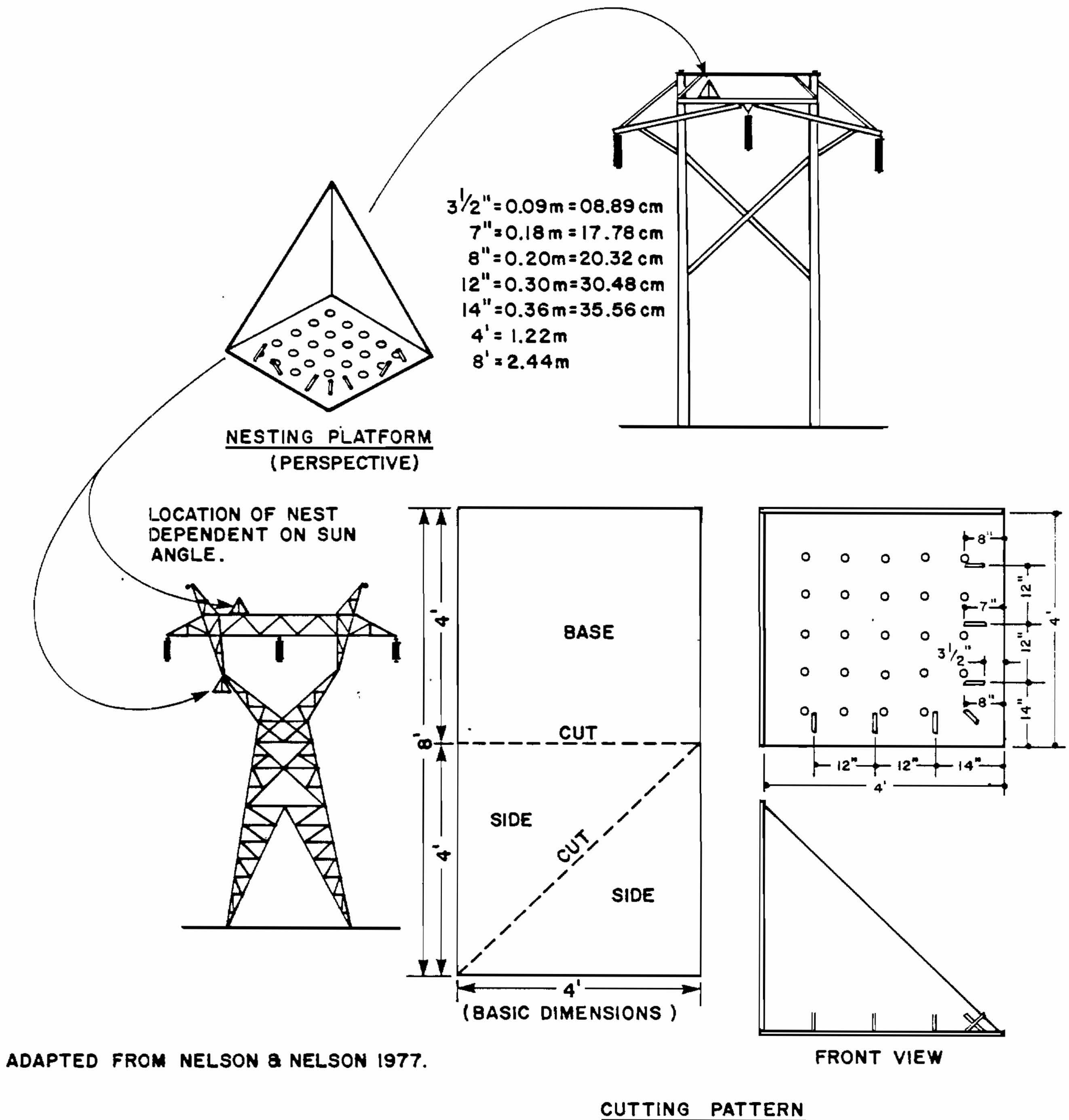
ELEVATIONS OF RAPTOR AND RAVEN NESTS IN THE VICINITY OF THE WATANA IMPOUNDMENT AREA IN RELATION TO FILLING AND OPERATION WATER LEVELS

FIGURE E.3 4.39



* NESTING LOCATION NOT WITHIN DEVIL CANYON IMPOUNDMENT

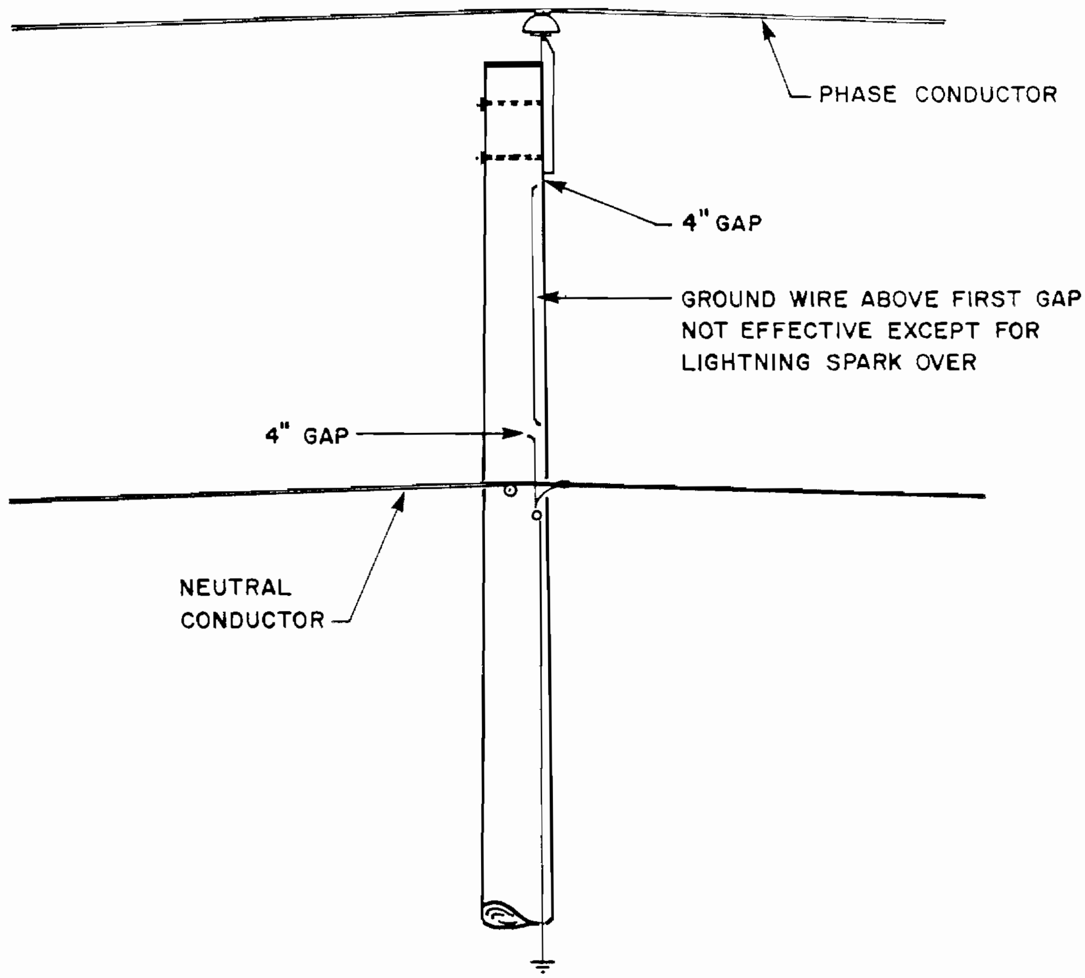
CHANGES IN ELEVATION OF THE DEVIL CANYON RESERVOIR DURING OPERATION AND ELEVATIONS OF RAPTOR AND RAVEN NESTS IN THE PROXIMITY OF THE IMPOUNDMENT ZONE



EAGLE NESTING PLATFORMS TO BE PROVIDED ON TRANSMISSION TOWERS

EXCERPTED FROM OLENDORFF et al. 1981

FIGURE E.3.4.41

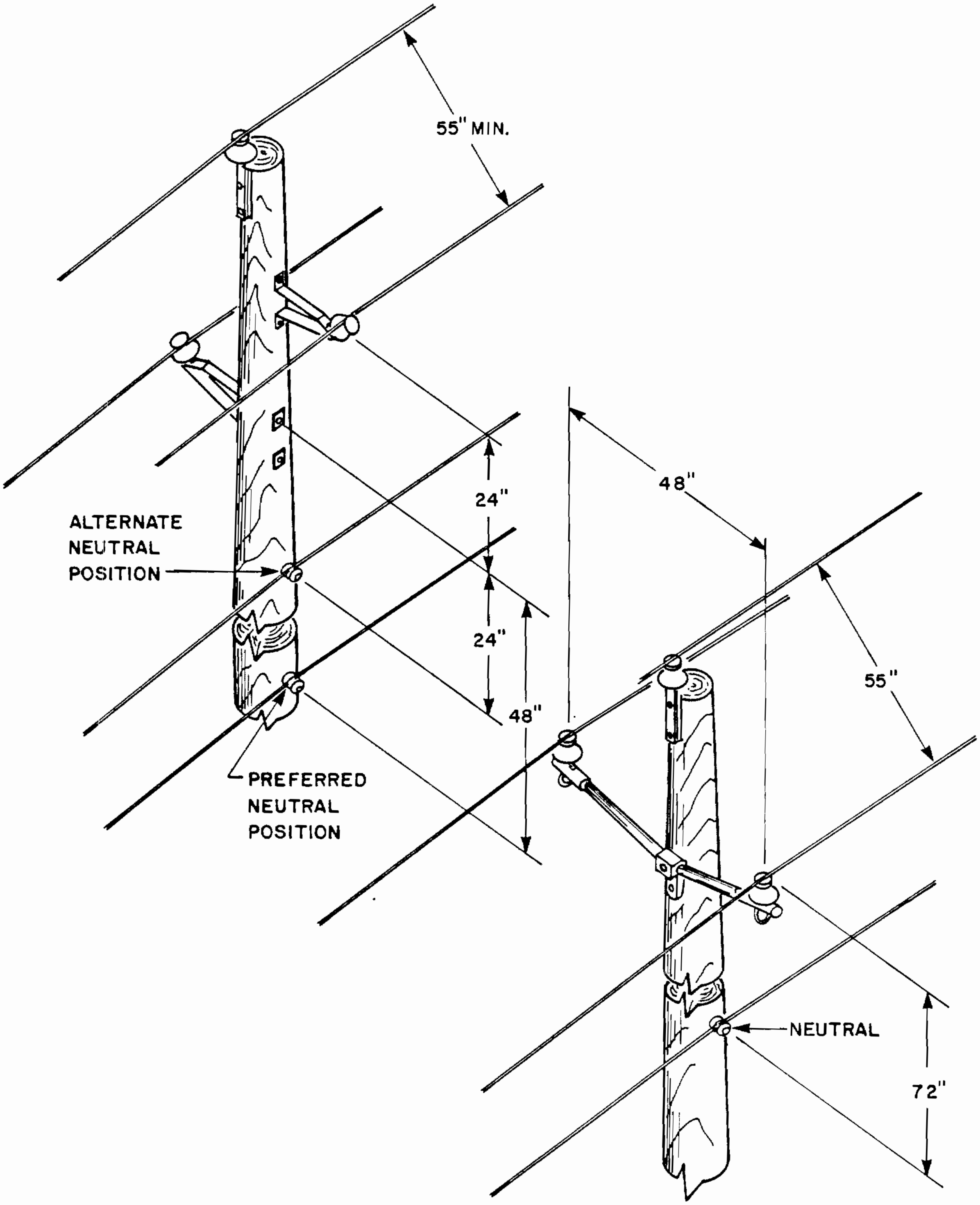


GROUND WIRE GAPPING

DESIGNED TO PROTECT RAPTORS FROM ELECTROCUTION

EXCERPTED FROM OLENDORFF et al. 1981

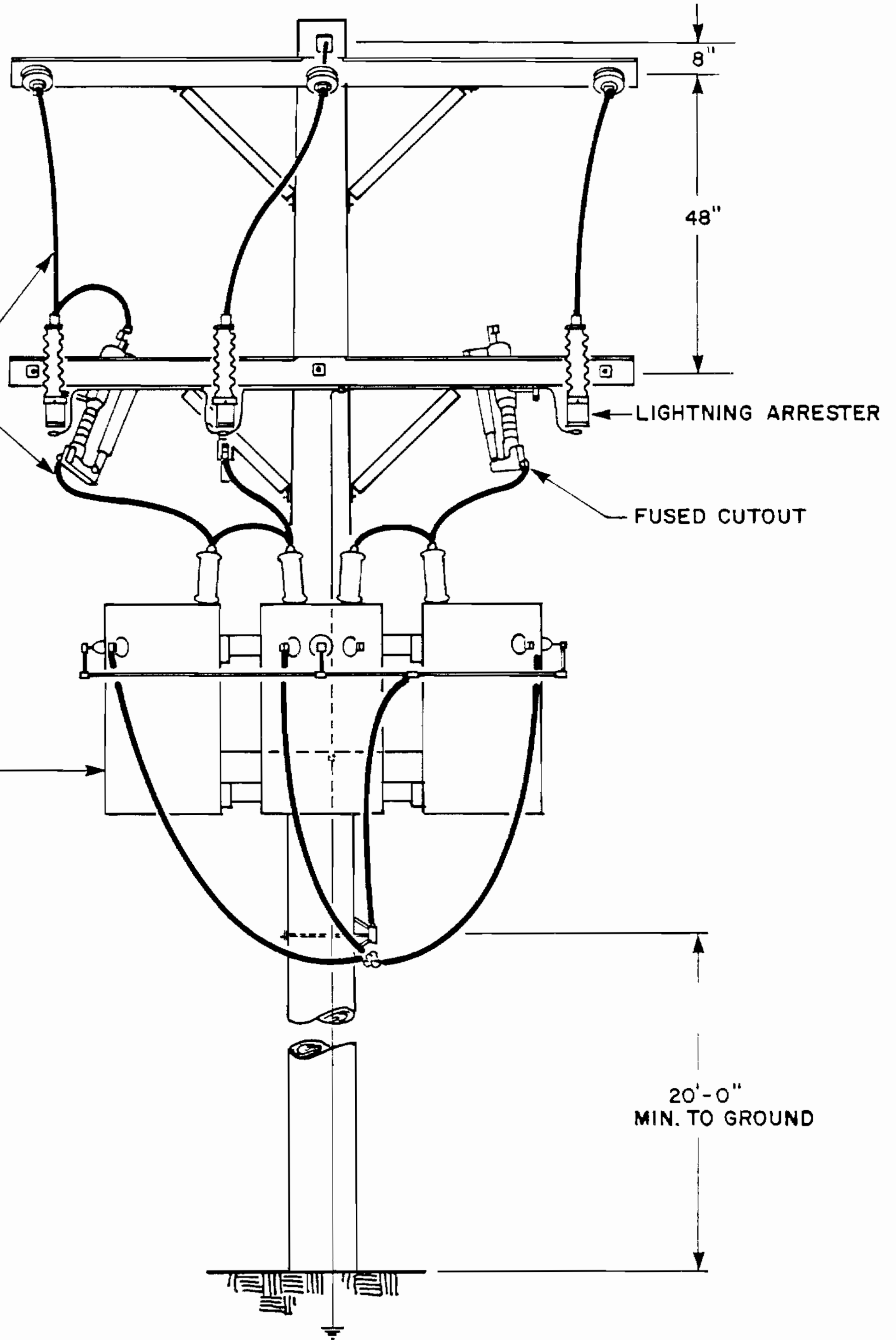
FIGURE E.3.4.42



ARMLESS CONFIGURATIONS
DESIGNED TO PROTECT RAPTORS FROM ELECTROCUTION

EXCERPTED FROM OLENDORFF et al. 1981

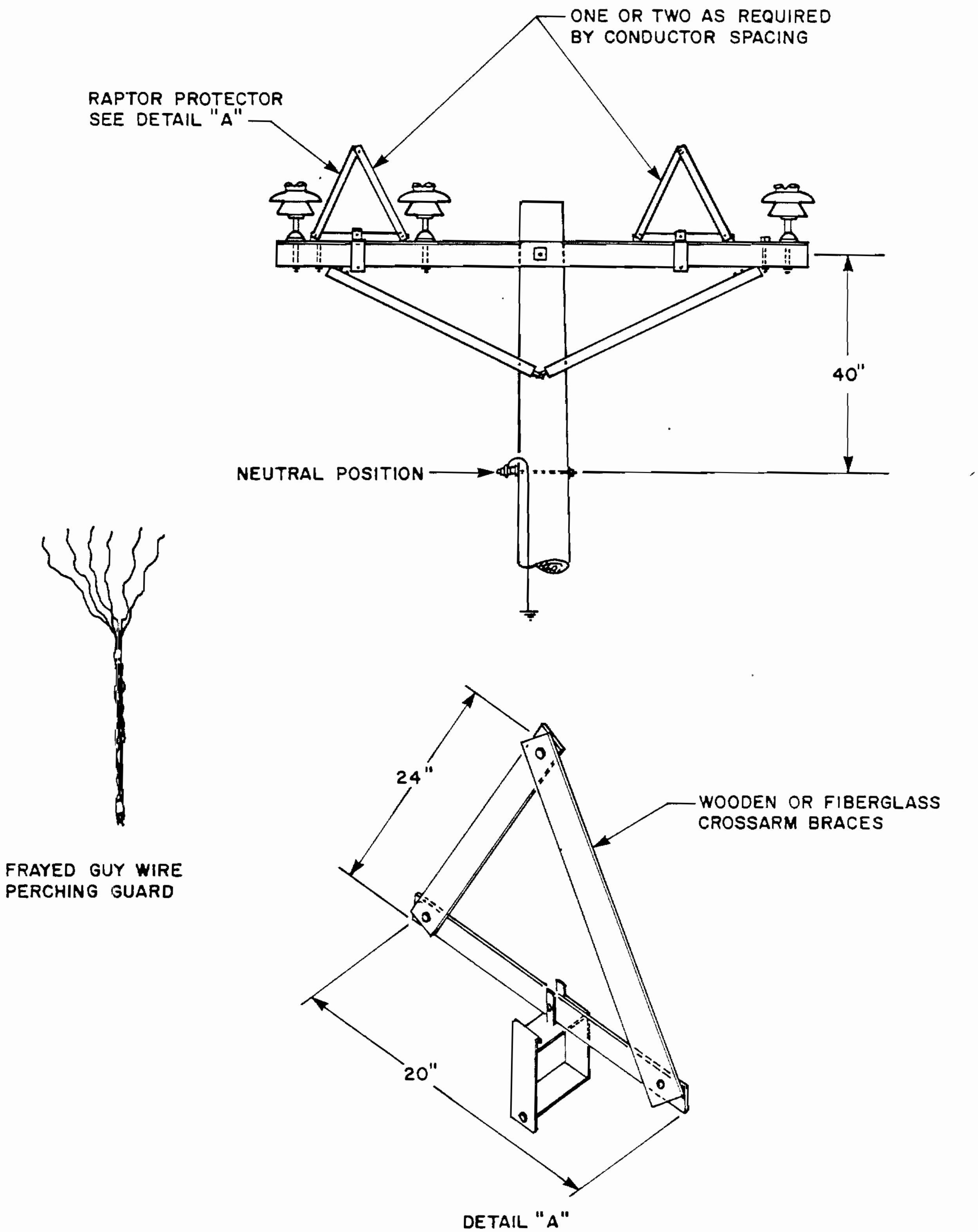
FIGURE E.3.4



INSTALLATION OF TRANSFORMER EQUIPMENT TO PROVIDE FOR RAPTOR PERCHING

EXCERPTED FROM OLENDORFF et al 1981

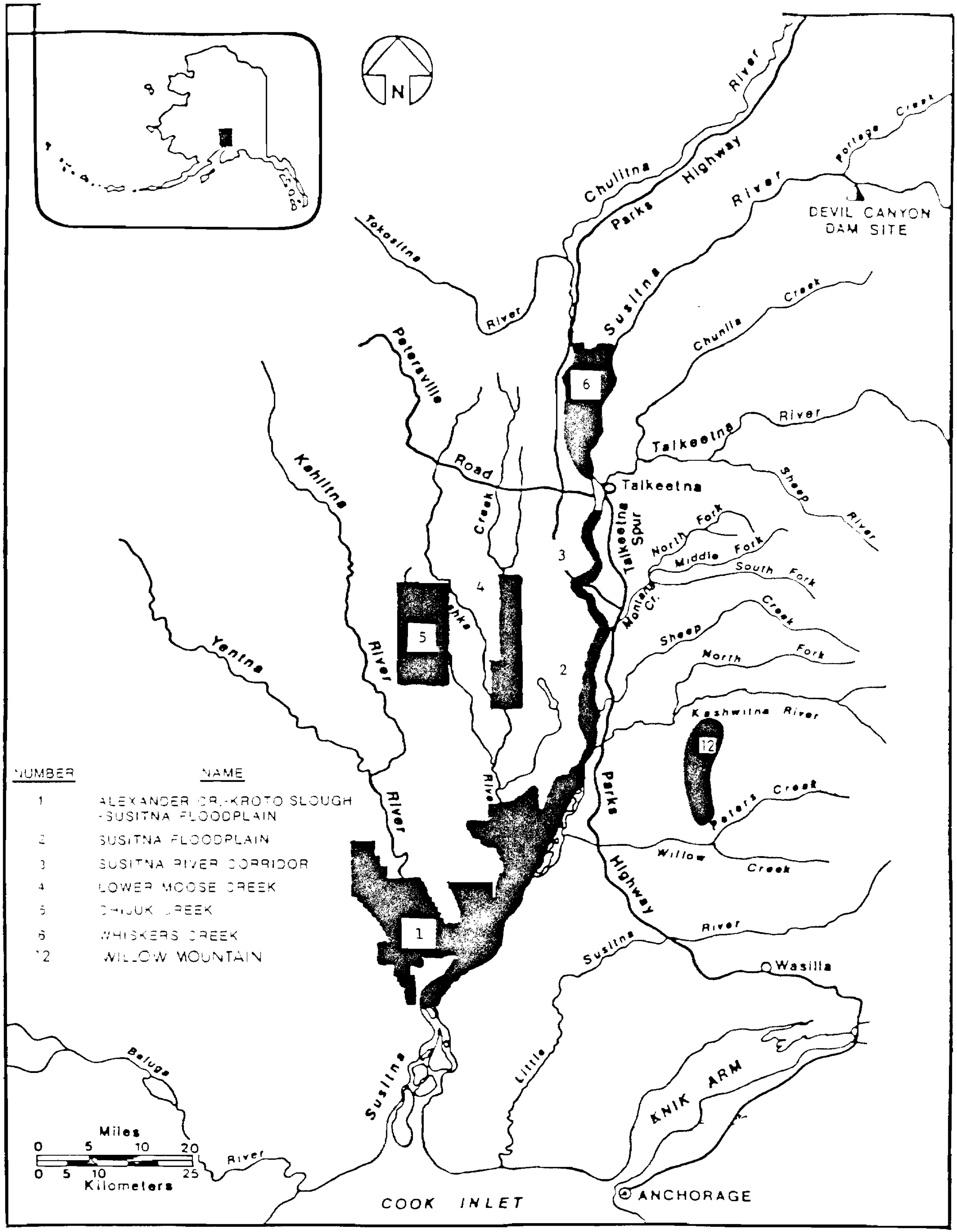
FIGURE E.3444



PERCH GUARDS
DESIGNED TO PROTECT RAPTORS FROM ELECTROCUTION

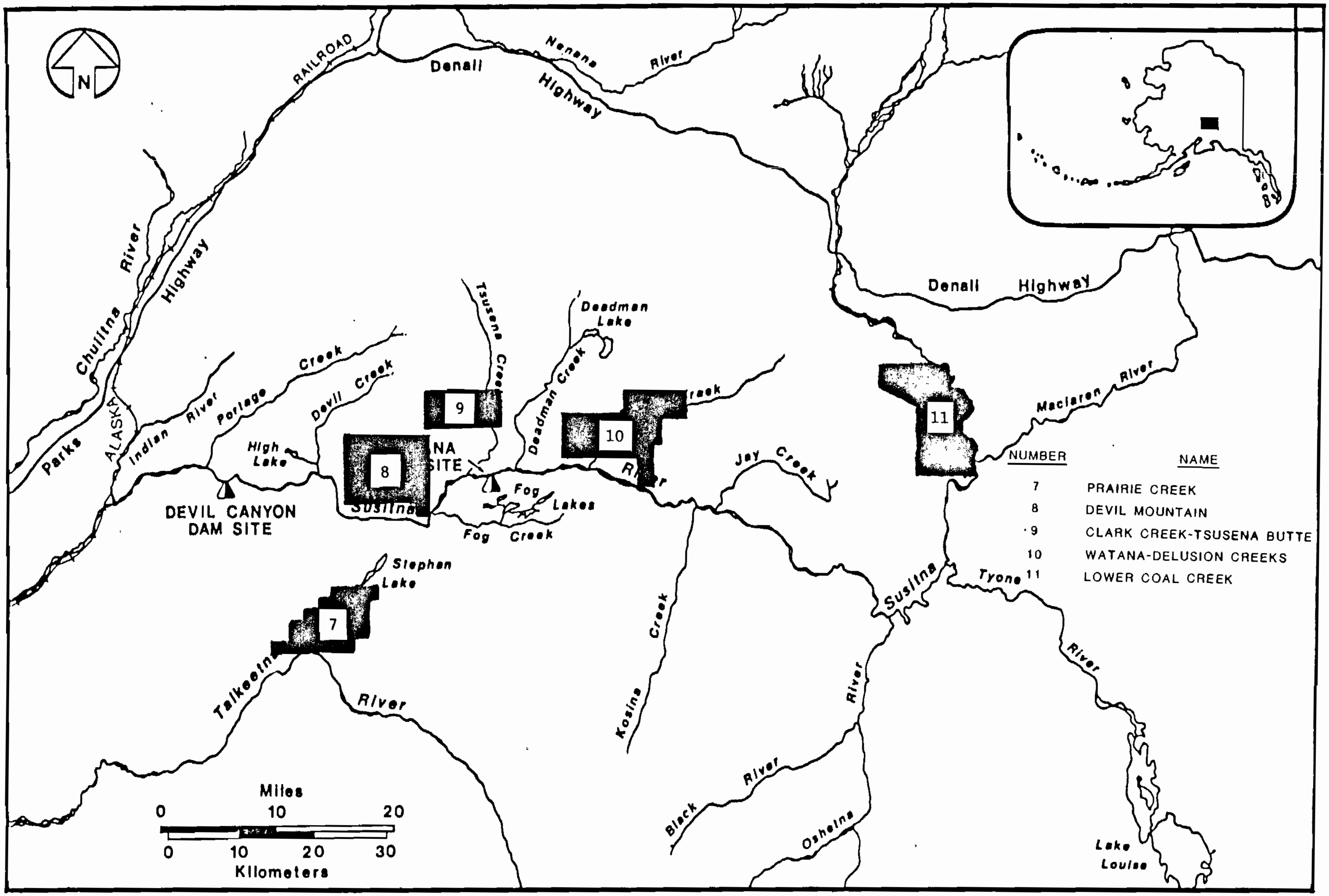
EXCERPTED FROM OLENDORFF et al. 1981

FIGURE E.3.4



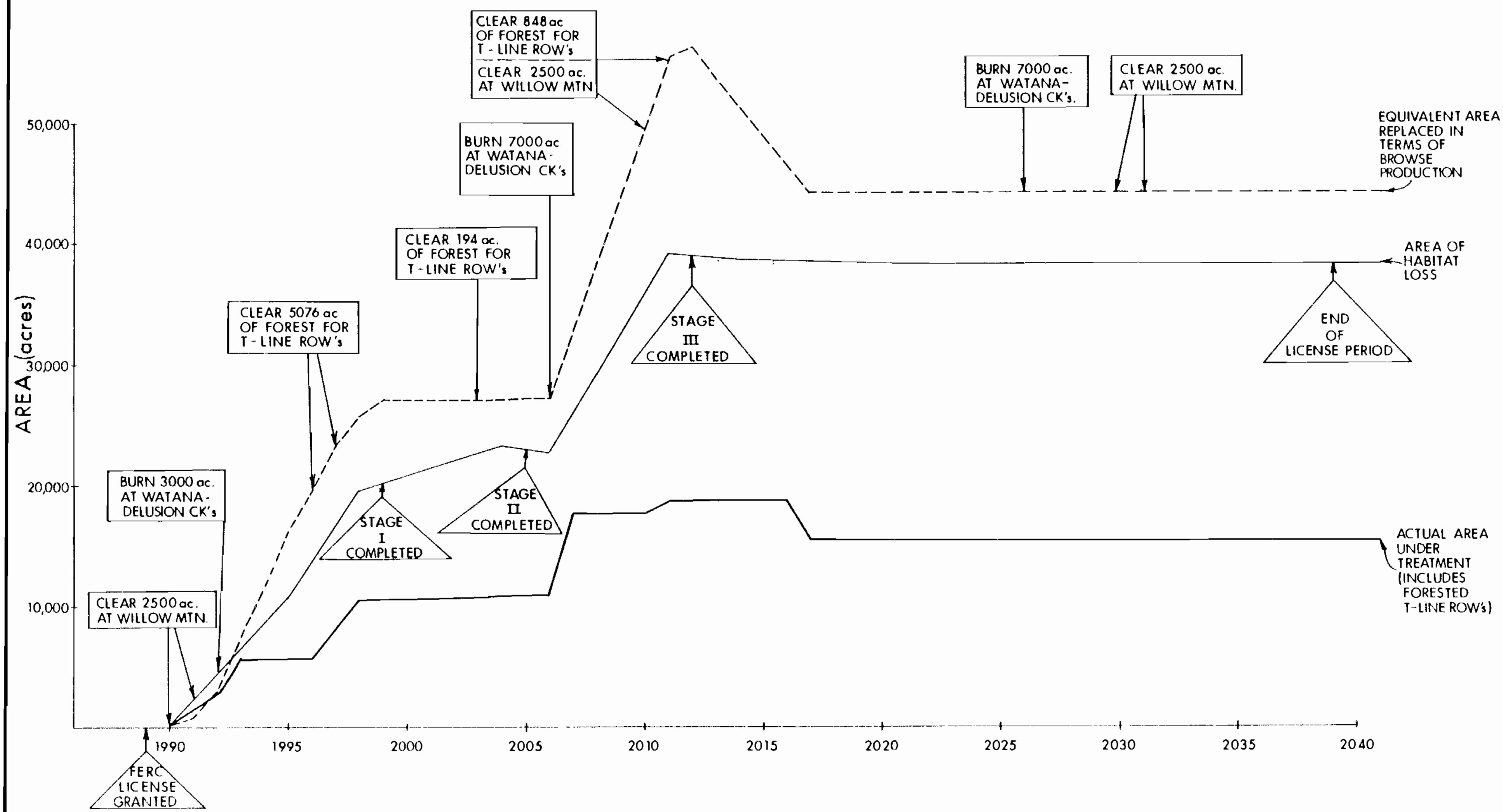
CANDIDATE LANDS FOR WILDLIFE HABITAT COMPENSATION DOWNSTREAM FROM DEVIL CANYON

FIGURE E.3.4.46



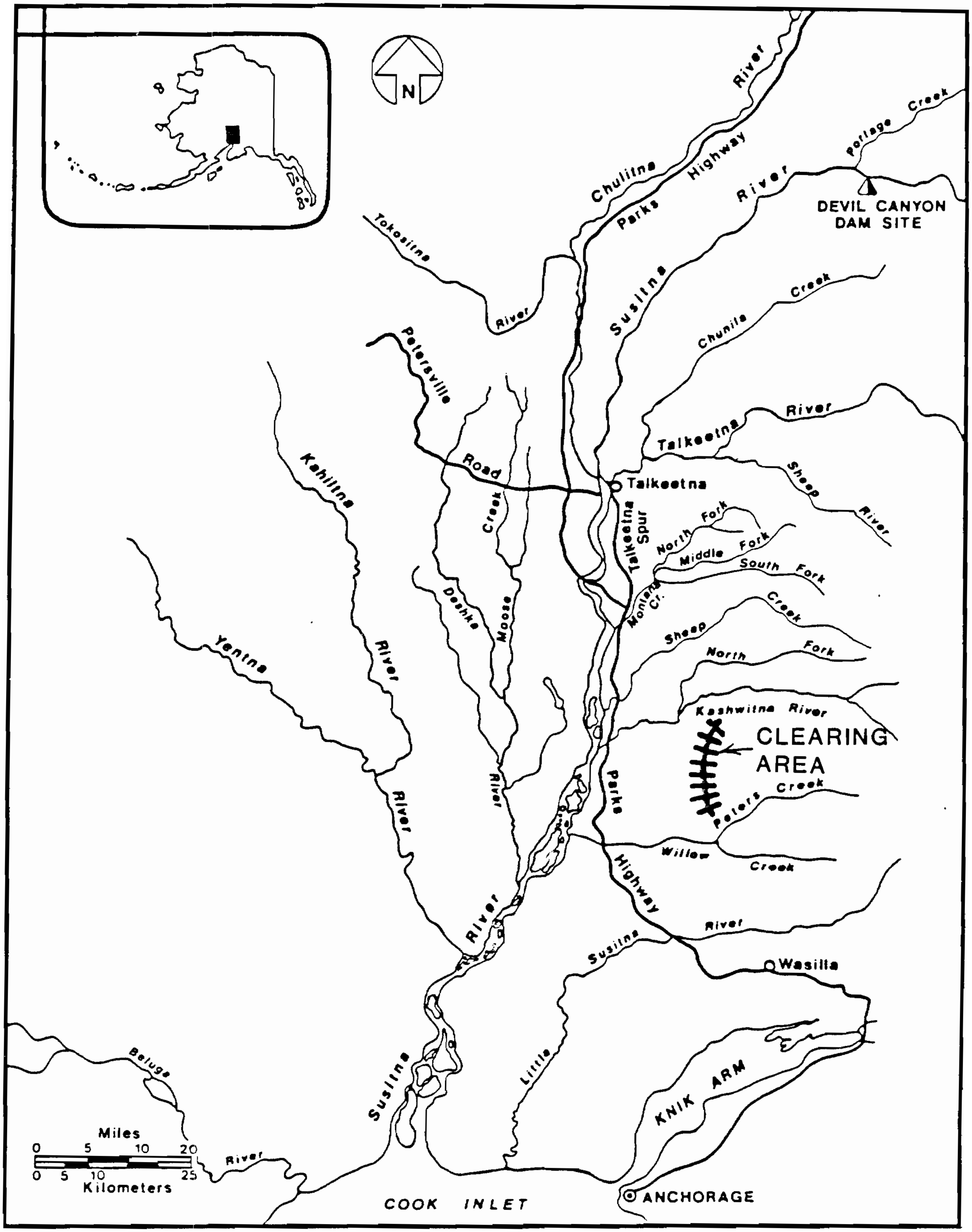
CANDIDATE LANDS FOR WILDLIFE HABITAT COMPENSATION
UPSTREAM FROM DEVIL CANYON

FIGURE E.3.4.47



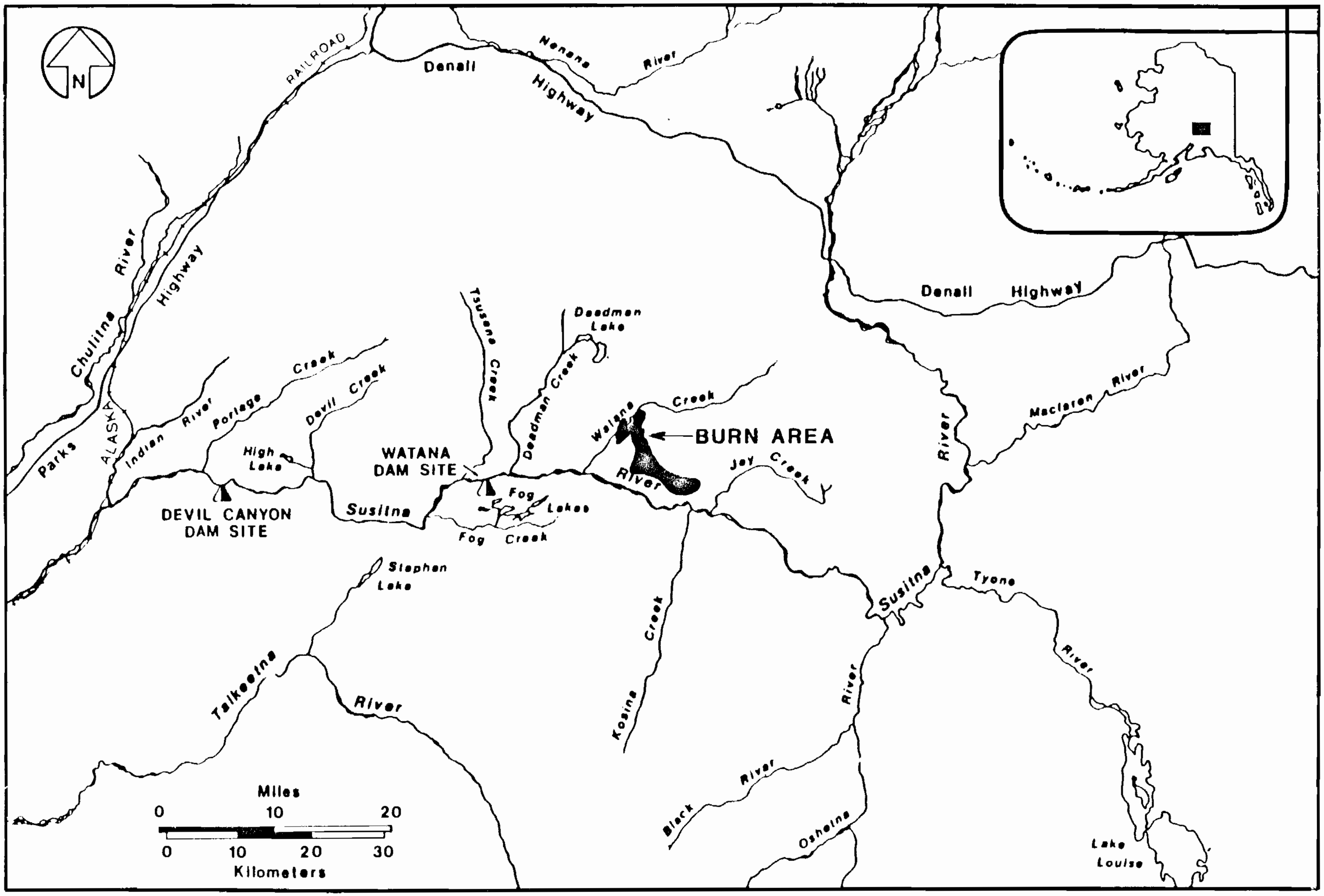
HABITAT COMPENSATION SCHEDULE FOR MOOSE AND OTHER EARLY SUCCESSIONAL/EDGE WILDLIFE COMPARED WITH SCHEDULE FOR HABITAT LOSS

FIGURE E 3 4.48



REPRESENTATIVE EXTENT OF AREA (SHOWN IN BLACK) TO BE ACTIVELY MANAGED BY CLEARING FOR HABITAT MANAGEMENT AT ANY POINT IN TIME (TOTAL AREA=5,000 AC)

FIGURE E.3.4.49



REPRESENTATIVE EXTENT OF AREA (SHOWN IN BLACK) TO BE ACTIVELY MANAGED BY BURNING FOR HABITAT MANAGEMENT AT ANY POINT IN TIME (TOTAL AREA 10,000 AC.)

FIGURE E.[illegible]

5 - AIR QUALITY/METEOROLOGY

SUSITNA HYDROELECTRIC PROJECT
LICENSE APPLICATION

EXHIBIT E - CHAPTER 3
FISH, WILDLIFE AND BOTANICAL RESOURCES

TABLE OF CONTENTS

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EXHIBIT E - CHAPTER 3
FISH, WILDLIFE AND BOTANICAL RESOURCES

LIST OF TABLES

5 - AIR QUALITY/METEOROLOGY (***)

5.1 - Introduction (***)

The predicted air quality impacts of the construction of Watana Stage I are described in detail in Appendix E11.3. The major air quality impacts will occur during the six-year construction phase. During that period the population at the site will be highest and construction activities at a maximum. The predominant pollutant will be fugitive dust generated by the soil excavation, haul trucks, and earthfill embankment placement activities. Sulfur dioxide and nitrogen oxides will be emitted from the construction vehicles, and also from point sources at the construction camp and operator's village.

Construction of the Watana Stage I Dam will require an Air Quality Permit to Operate from the Alaska Department of Environmental Conservation (ADEC), because regulated pollutants including fugitive dust will be emitted during construction from specific sources (incinerator, concrete batch plant, aggregate screening plant, campsite oil heaters, and emergency diesels generators) formally regulated by the federal and state governments. It is anticipated that the air quality analyses shown in Appendix E11.3 will suffice as the technical documentation for the permit.

5.2 - Existing Conditions (***)

5.2.1 - Meteorology (***)

The meteorological conditions at the Watana site are typical of the Alaskan continental regions. A meteorological station has been in operation at the Watana field camp since 1981 (R&M Consultants 1985a). The results from measurements during 1983 are listed in Table E.3.5.1. Typically, the average monthly temperature is below freezing between October and April; the precipitation is highest during summer; and the wind direction is predominantly up-valley or down-valley along the Susitna River, with the highest wind speeds occurring during the winter.

5.2.2 - Existing Air Quality (***)

The air quality at the site is pristine, because the Watana site is located far (approximately 90 miles) from the nearest existing source of air pollution, the 25 MW coal-fired plant at Healy. Healy is in the Nenana River basin which drains to the interior of Alaska and is separated from the project area by high mountains, therefore the local air masses from the Nenana and Susitna River basins do not mix. In anticipation of a PSD (Prevention of Significant Deterioration) review, an ADEC approved on-site monitoring program for total suspended particulates (TSP) was conducted in 1984 (APA 1985f). The measured TSP concentration at the Watana field camp was less than 10 ug/m^3, which represents the continental background value (Table E.3.5.2). Information provided by the ADEC leads the Applicant to believe that the existing concentrations of other pollutants are also near the continental background values established by the USEPA (EPA 1979a, 1981).

5.3 - Expected Air Pollutant Emissions (***)

5.3.1 - Point Emission Sources (***)

The following processes will produce stack emissions of air pollutants:

- o campsite refuse incinerator;
- o campsite emergency electrical generator; and
- o concrete batch plant.

The refuse incinerator will burn all refuse from the construction camp. Based on a peak labor force 2,625, with an additional 713 family members and a seven-month per year construction period, the incinerator will burn 9.9 tons per day and 2,148 tons per year of refuse.

The emergency electrical generators will be used to provide power to the construction camp during line power outages. It is assumed that 3 MW of emergency power will be required for roughly five percent of the seven-month per year construction period.

The concrete batch plant will have a 1,000 ton per hour capacity. Emissions will be controlled using either water sprays or fabric filters.

The predicted emissions from the above processes were calculated using AP-42 emission factors (EPA 1977b). The predicted 24-hour emission rates and the predicted annual average emission rates from each process are listed in Table E.3.5.3.

5.3.2 - Fugitive Dust Emissions (***)

The predominant pollutant that will be emitted during the dam construction will be fugitive dust. Fugitive dust will be emitted from each soil excavation operation, along the haul roads, and from the earthfill embankment placement operations. The predicted excavation operations, haul truck usage, and dam construction operations that will generate fugitive dust are described in detail in Appendix E11.3. The fugitive dust emission rates were calculated by applying the most recent emission factors (CDH 1984) to the proposed construction activities. The calcuated fugitive dust emission rates from each operation at the site are listed in Table E.3.5.4.

5.4 - Predicted Air Quality Impacts (***)

The calculated worst-case air quality impacts at the project boundary are listed in Table E.3.5.5. In no cases do the predicted impacts at the project boundary exceed either the allowable Alaska Ambient Air Quality Standard or the Federal Prevention of Significant Deterioration (PSD) Class II increments. A comparison of worst case projections at the boundary and air quality standards is presented in Table E.3.5.5.

The air quality impacts of TSP, SO_2, and NO_x during the dam construction were calculated using the Industrial Source Complex (ISC) computer dispersion model. It was assumed that the terrain along the plateau regions near the Watana site was flat. The computer model accounted for gravitational settling of all fugitive dust emissions. The procedures that were used to model the air quality impacts are described in detail in Appendix E11.3.

The short-term impacts would result on a dry summer day, during which artificial fugitive dust mitigations were applied. The annual average impacts take into account natural fugitive dust reductions resulting from rainfall and snow cover.

The fugitive dust emission rates shown in Table E.3.5.4 were calculated by assuming that the construction contractor will utilize extensive fugitive dust mitigations, including the following:

- o revegetation of disturbed areas;
- o application of water and other dust palliatives (as permitted) on the haul roads; and
- o limiting vehicle speeds.

Other measures specified by the Alaska Department of Environmental Conservation in the Permit to Operate may be required. The mitigation measures will also be specified by the Applicant in their contractual documents with the construction contractor.

5.5 - Regulatory Agency Consultations (***)

The Applicant has been working with ADEC to coordinate the air quality permitting for the Watana Stage I Dam construction. The following permitting steps have been completed:

- o May 3, 1984 - Applicant notifies ADEC of construction plans for Watana Dam.

- May 8, 1984 - ADEC advises Applicant that PSD increment should be met, and that on-site monitoring is required.
- May 29, 1984 - Applicant begins on-site monitoring to measure baseline air quality.
- January 1985 - Applicant submits to ADEC the final report on the on-site monitoring program.

TABLES

TABLE E.3.5.1: AVERAGE MONTHLY WEATHER CONDITIONS DURING 1983/1984

MONTH	Temperature (°C)	Precipitation (mm)	Wind Speed (m/sec)
Jan	-12.5	2.8	3.7
Feb	-10.0	2.8	4.3
Mar	-5.0	2.4	2.9
Apr	-1.1	2.4	2.5
May	5.3	15.2	2.6
Jun	10.5	39.4	2.7
Jul	12.2	113.4	2.7
Aug	9.0	117.8	2.5
Sep	4.7	8.0	2.5
Oct	-7.1	4.2	3.0
Nov	-10.7	0.2	3.3
Dec	-10.4	7.0	4.7
Annual	-1.4°C	316 mm	3.1 m/sec

Souce: R&M Consultants 1985.

TABLE E.3.5.2: CONTINENTAL BACKGROUND VALUES 1/ 2/

Pollutant	Micrograms per Cubic Meter
TSP	10 (24-hr. average)
SO_2	13 (24-hr. average)
NO_x	14 (annual average)
CO	575 (annual average)

1/ Ambient air monitoring is required to support a permit application unless the existing concentrations or the predicted ambient air quality impacts are less than the levels in this table.

2/ 18 AAC 50.510 (b)(1)-(4)

TABLE E.3.5.3: PREDICTED AIR POLLUTANT EMISSION RATES FROM POINT SOURCES

Pollutant and Averaging Time	Refuse Incinerator	Emergency Diesel Generators	Concrete Batch Plant
Particulates 1.			
o 24-hr (lb/day)	13.9	139.0	240.0
o Annual (ton/year) 2.	1.5	0.7	25.6
SO_2			
o 24-hr (lb/day)	24.7	256.0	0
o Annual (ton/year) 2.	2.7	1.4	0
NO_x			
o Annual (ton/year) 2.	3.2	10.2	0
Carbon Monoxide			
o 24-hr (lb/day)	346.0	1,042.0	0
o Annual (ton/year) 2.	37.5	5.6	0
Hydrocarbons			
o 24-hr (lb/day)	14.8	175.0	0
o Annual (ton/year) 2.	1.6	0.9	0

1. Particulate removal is 90% with the afterburner installed on the incinerator

2. Assume operations occur 7 months/year; 31 days/month

TABLE E.3.5.4: WORST CASE 24-HOUR EMISSIONS DURING DAM CONSTRUCTION

Operation	Spillway Excavation	Borrow D	Borrow D Toe Area	Borrow E	Dam Fill Area	Construction Camp
Fugitive Dust (lbs/day)						
Overburden Handling	0	40	0	0	0	0
Drilling	5	0	0	0	0	0
Blasting	52	0	0	0	0	0
Product Removal	13	117	0	0	0	0
Product Hauling	422	305	32	31	0	0
Fill Placement and Spreading	0	1	2	0	10	0
Exposed Area Wind Erosion	6	13	1	4	25	25
Storage Pile Wind Erosion	0	0	0	10	0	0
Traffic	0	0	0	0	0	84
Total Fugitive Dust, lbs/day	498	476	35	45	35	109
Tailpipe Emmissions (lbs/day)						
Particulates	82	35	23	26	24	0
Nitrogen Oxides	2,286	970	697	773	328	160

TABLE E.3.5.5: SUMMARY OF PREDICTED WORST CASE IMPACTS AT PROJECT BOUNDARY

Pollutant and Averaging Time	Predicted Impact (ug/m^3)1/	Allowable ASAAQS (ug/m^3)	Allowable PSD Class II Increment (ug/m^3)
Particulate Matter			
o Annual	1.6	60	19
o 24-Hour2/	30.2	150	37
Sulfur Dioxide			
o Annual	0.9	80	20
o 24-Hour 2/	8.9	365	91
o 3-Hour 2/		1,300	512
Nitrogen Oxides			
o Annual	15.0	100	None Established

1/ Does not include background pollutant concentrations: TSP - 5.0 ug/m^3; SO_2 - 2.0 ug/m^3; NO_x - 2.0 ug/m^3.

2/ Second highest calculated value during summer season.

6 - REFERENCES

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7 - GLOSSARY

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Accipiter - a member of the genus Accipter, short-winged hawks of the family Accipitridae, which includes kites, hawks and eagles.

Adipose fin - a small, thick, posterior dorsal fin containing much fatty matter, typical of salmonid fish.

Albedo - the percentage of incoming radiation reflected from a natural surface.

Alevins - newly-hatched salmonids before absorption of the yolk sac.

Alpine tundra - plant communities which occur above timerline. Vegetation is low and matlike, and includes a high proportion of grasses and sedges.

Anadromous fish - a fish that begins life in freshwater, migrates to and resides in the ocean until reaching maturity, then returns to freshwater to spawn (e.g. salmon, shad).

Aspect - appearance, composition, or inferred environmental implication of a rock body; also a particular compass direction or orientation.

Aufeis - an ice feature that is formed by water overflowing onto a surface, such as river ice or gravel deposits, and freezing, with subsequent layers formed by water again overflowing onto the ice surface and freezing.

Bankfill stage - the river stage (height above a known elevation) which results in a water level that just fills the banks of a stream at a given location without encroaching on the floodplain or overbank area.

Browse - a term used to describe woody plant material (primarily the recent year's twig growth) utlized as food by herbivores such as moose. The term may include nonwoody plant material such as leaves when consumed along with twigs.

calcareous - containing calcium carbonate, resembling calcium or calcide carbonate; growing on limestone or soils high in lime.

Calciphilic - having a tendency to grow in soils rich in calcium or limestone.

Closed forest - forested areas in which the overstory prevents most of the sunlight from reaching the ground.

Coniferous - plants which are cone-bearing and nondeciduous, such as pines and spruce.

Coregonid - member of the whitefish family Coregonidae; related to the salmonids.

Decadent - decaying or declining in vigor.

Deciduous - referring to plants which shed their leaves at a certain season each year.

Ecotone - the area where two or more plant communities meet and blend together.

Floristics - study of the species composition of vegetation.

Frazil ice - ice formed in flowing turbulent, supercooled water in rivers and lakes.

Fugitive dust - particulate air pollutant emissions that cannot reasonably be discharged through a stack or control device.

Gillnetting - a method of capturing fish by hanging nets in which the gills of the fish become entangled.

Glacial flour - finely ground rock particles, chiefly silt size, resulting from glacial abrasion.

Gley - a dense clay layer often present under waterlogged soils.

Ground truthing - the process of conducting onsite field checks to determine if aerial photograph interpretation is correct.

Herb - plant with a fleshy stem which generally has no persistent parts above ground, as distinct from woody-tissued shrubs and trees.

Herbaceous - a plant having the characteristics of an herb.

Lentic - relating to still water, such as lakes and ponds.

Lotic - relating to moving water, such as rivers and creeks.

Mainstem - the principal water-carrying stream in a basin - as used in the License Application, this term refers to the Susitna River and distinguishes it from any of its tributaries.

Mesic - referring to site conditions that are intermediate between wet and dry.

Micro-relief - slight changes in elevation within a limited area.

Milling area - an area in a river or stream where anadromous fish hold or rest prior to continuing their upstream movements.

Mixed forest - an area which contains both coniferous and deciduous trees.

Mosaic - a composite resulting from the joining of separate and different parts.

Mustelids - member of the family Mustelidae, which includes weasels, mink, skunk, otter, and marten.

Open forest - forested areas in which the spacing of trees and closure of the canopy is such that sunlight reaches the majority of the ground.

Parturient - bringing forth or about to bring forth young.

Peri-glacial - of, or pertaining to the outer perimeter of a glacier, particularly to the fringe areas immediately surrounding the continental glaciers of the geologic ice ages, with respect to environment, topography, areas, processes, and conditions influenced by the low temperature of ice.

PSD - Prevention of Significant Deterioration. A review that is part of the air quality permitting report.

Redd - the spawning nest of a fish.

Seral growth - the process by which any stage of a plant community which is transitory will eventually reach a climax condition.

Smolt - a young salmonid that has completed the process of physiological change required to survive a marine existence.

Sub-nivean - underneath the snow.

Successional stands - any stage of a plant community which is transitory and will eventually lead to a climax condition.

Taxa - plural of taxon

Taxon - a separate and distinct group in a formal system of classification.

Thermokarst - settling or caving in of the ground due to melting of ground ice.

TSP - airborne Total Suspended Particulate matter, a measure of air pollution.

Ungulates - hoofed mammals such as deer, caribou, and moose.

Vascular - containing vessels which conduct fluid; vascular plants are those of the division Tracheophyta, and includes the ferns and seed-bearing plants.

Xerosere - a plant successional stage originating on a dry site.

APPENDICES

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FISH AND WILDLIFE MITIGATION POLICY

EXHIBIT E - CHAPTER 3
APPENDIX E1.3
FISH AND WILDLIFE MITIGATION POLICY

NOVEMBER 1981
REVISED MARCH 1982
REVISED APRIL 1982
REVISED AUGUST 1985

1 - INTRODUCTION (**)

The fish and wildlife mitigation aspects of the Susitna Project have been addressed by the Applicant through consultation with the following resource agencies:

Alaska Department of Natural Resources,
Alaska Department of Fish and Game,
Alaska Department of Environmental Conservation,
U.S. Fish and Wildlife Service,
U.S. Environmental Protection Agency,
U.S. Bureau of Land Management, and
National Marine Fisheries Service.

This process has been ongoing since 1980 and is a dynamic process that will continue through project construction and operation, to the extent necessary to insure that mitigation goals are met.

A mandate of the Applicant's charter is to develop supplies of electrical energy to meet the present and future needs of the State of Alaska. The Applicant also recognizes the value of our natural resources and accepts the responsibility of insuring that the development of any new projects is as compatible as possible with the fish and wildlife resources of the state and the habitat that sustains them, and that the overall effects of any such projects will be beneficial to the state as a whole. In this regard, the Applicant has prepared a Fisheries and Wildlife Mitigation Policy for the Susitna Hydroelectric Project as contained herein.

2 - LEGAL MANDATES (**)

There are numerous state and federal laws and regulations that specifically require mitigation planning. The mitigation policy and plans contained within this document are designed to comply with the collective and specific intent of these legal mandates. Following are the major laws or regulations that require the consideration and eventual implementation of mitigation efforts.

2.1 - Protection of Fish and Game (AS 16.05.870) (*)

The Alaska state laws pertaining to the disturbance of streams important to anadromous fish address the need to mitigate impacts on fish and game that may result from such action. The pertinent portion of item (c) from Section 16.05.870 reads as follows:

> If the Commissioner determines to do so, he shall, in the letter of acknowledgement, require the person or governmental agency to submit to him full plans and specifications of the proposed construction or work, complete plans and specifications for the proper protection of fish and game in connection with the construction work, or in connection with the use, and the approximate date the construction, work, or use will begin, and shall require the person or governmental agency to obtain written approval from him as to the sufficiency of the plans or specifications before the proposed construction or use is begun.

2.2 - National Environmental Policy Act (*)

The National Environmental Policy Act (NEPA) (42 USC 4321-4347) was designed to encourage the consideration of environmental concerns in the planning of federally controlled projects. Regulations pertaining to the implementation of NEPA have been issued by the Council on Environmental Quality (40 CFR 1500-1508: 43 FR 55990; corrected by 44 FR 873 Title 40, Chapter V, Part 1500). Items (e) and (f) under Section 1500.2 (Policy) of these regulations describe the responsibilities of federal agencies in regard to mitigation.

Federal agencies shall to the fullest extent possible:

(e) Use the NEPA process to identify and assess the reasonable alternatives to proposed actions that will avoid or minimize adverse effects of these actions upon the quality of the human environment.

(f) Use all practicable means, consistent with the requirements of the Act and other essential considerations of national policy, to restore and enhance the quality of the human environment and avoid or minimize any possible adverse effects of their actions upon the quality of the human environment.

2.3 - Federal Energy Regulatory Commission (*)

Federal Energy Regulatory Commission (FERC) regulations also refer directly to the need for mitigation actions on the part of the developers of hydroelectric projects (18 CFR Part 4). The following reference is quoted from Section 4.41 of the Notice of Final Rulemaking as it appeared in the November 13, 1981, issue of the Federal Register (46 FR 55926-55953) and adopted. Exhibit E of the proposed FERC regulations should include, among other information,

> ...a description of any measures or facilities recommended by state or federal agencies for the mitigation of impacts on fish, wildlife, and botanical resources, or for the protection or enhancement of these resources...

The regulations go on to require details concerning mitigation including a description of measures and facilities, schedule, costs, and funding sources.

2.4 - Fish and Wildlife Coordination Act (915 USC 661-667) (*)

Item (a) of Section 662 of the Fish and Wildlife Coordination Act (FWCA) describes the role of the Federal agencies in reviewing federally licensed water projects:

> ...such department or agency first shall consult with the United States Fish and Wildlife Service, Department of the Interior, and with the head of the agency exercising administration over the wildlife resources of the particular State wherein the impoundment, diversion, or other control facility is to be constructed, with a view to conservation of wildlife resources by preventing loss of and damage to such resources as well as providing for the development and improvement thereof in connection with such water-resource development. FERC will comply with the consultation provisions of the FWCA.

3 - GENERAL POLICIES CARRIED OUT BY THE APPLICANT (**)

3.1 - Basic Intent of the Applicant (**)

In fulfilling its mandate, the goal of the Applicant is to mitigate the negative impacts of the Susitna Project on the fish and wildlife resources. The Applicant realizes that a highly coordinated planning effort, implemented through a program of ongoing consultation with the appropriate resource agencies, will be necessary to achieve this goal. Therefore, a decision-making methodology has been developed to provide a framework for addressing each impact and the mitigation options available. This methodology outline also identifies the process for resolving conflicts that may develop between the Applicant and the resource agencies. The FERC will resolve any disputes which the agencies and the Applicant cannot resolve. It is the intent of the Applicant to negotiate directly and resolve conflicts with the concerned agencies.

The Applicant has expanded the plan for fish and wildlife mitigation that was provided in the original license application. That plan is part of this document (see Sections 2.4, 3.4 and 4.4). Prior to this, any draft mitigation plans have been submitted to resource agencies for formal review and comment. The final mitigation plan to be implemented will be stipulated by the FERC. The responsibility for implementation of the plan will be that of the Applicant.

3.2 - Consultation with Natural Resources Agencies and the Public (**)

In order to achieve the above-mentioned goals, the Applicant has provided opportunities for the review and evaluation of concerns and recommendations from the public as well as federal and state agencies. During the early stages of planning, representatives of state and federal agencies have been encouraged to consult with the Applicant and the Applicant's representatives. Additional review and evaluation of the mitigation plan has been or will be provided through formal agency comments in response to state and/or federally administered licensing and permitting programs.

The Applicant has considered and will continue to consider all concerns expressed by members of the general public and regulatory agencies regarding the mitigation plan. Input from the public has been given appropriate consideration in the decision-making process as it pertains to the direction of the mitigation effort and the selection of mitigation options.

3.3 - Implementation of the Mitigation Plan (**)

The responsibility for implementation of the mitigation plan rests with the Applicant. Prior to implementing the plan, an agreement will be reached as to the most efficient and effective manner in which to execute the plan. The agreement will include stipulations to insure adherence to the accepted plan.

The mitigation plan includes a brief statement of each impact issue, the technique or approach to be utilized to mitigate the impact, and the goal expected to be achieved through implementation of these actions.

A mitigation monitoring plan will be necessary to insure the proper and successful execution of the mitigation plan and to determine its effectiveness. Monitoring will require both funding and commitments. These matters will be resolved through negotiation leading to mutual agreement among the various involved parties.

3.4 - Modification of the Mitigation Plan (**)

As part of the mitigation planning process, a monitoring plan has been established. The purpose of this plan is to monitor fish and wildlife populations during the construction and operation of the project to determine the effectiveness of the plan as well as to identify problems that were not anticipated during the initial preparation of the plan.

The mitigation plan will be sufficiently flexible so that, if data secured during the monitoring of fish and wildlife populations indicate that the mitigation effort should be modified, the mitigation plan can be adjusted accordingly. This may involve an increased effort in some areas where the original plan has proven ineffective, as well as a reduction of effort where impacts failed to materialize as predicted. Any modifications to the mitigation plan proposed as a result of the monitoring will not be implemented without consultation with appropriate state and federal agencies and approval of FERC. It is the intent of the Applicant to reach agreement with the resource agencies concerning modification of the plan prior to seeking FERC approval. The Applicant will seek approval of the resource agencies, with FERC as the final arbitrator. The need for continuing this monitoring will be reviewed periodically. The monitoring program will be terminated when the mitigation goals described in the plan have been achieved or determined unachievable. Termination will be subject to FERC approval.

4 - APPROACH USED TO DEVELOP THE FISH AND WILDLIFE MITIGATION PLAN (**)

The develoment of the Susitna Fish and Wildlife Mitigation Plans has followed a logical step-by-step process. Figure E.3.1.1 illustrates this process and identifies the major components of the process. The following discussion is based on Figure E.3.1.2 and uses the steps in that figure for reference purposes.

The first step in the approach (Step 1) entailed the identification of impacts that may occur as a result of the project. Each impacted resource and the nature and extent of the impact has be defined. The fish and wildlife resources will vary and identification may include a population, subpopulation, habitat type, or geographic area. The nature and degree of impact on each respective resource has been predicted to the greatest extent possible. This step has been undertaken by the Applicant through consultation with the resource agencies.

Following the identification of impact issues, the Applicant developed a logical order of priority for addressing the impact issues. This included ranking resources in order of their importance. The ranking took into consideration a variety of factors such as ecological value, consumptive value, and nonconsumptive value. Other factors were considered in the ranking, if deemed necessary. The impact issues were also considered in regard to the confidence associated with the impact prediction. In other words, those resources that will most certainly be impacted were given priority over impact issues where there was less confidence in the impact actually occurring. The result of this dual prioritization was be the application of mitigation planning efforts in a logical and effective manner. The results of the prioritization process were reviewed and will continue to be reviewed by the appropriate resource agencies. If additional impacts materialize, the plan will be modified as discussed in Section 3.4. This could also include a shift in the prioritization of impacts.

Step 2 is the option analysis procedure that was performed by the Applicant. The intent of this procedure was to consider each impact issue, starting with high priority issues, and reviewing all practicable mitigation options.

Mitigation for each impact issue was identified. If a proposed form of mitigation was technically infeasible, only partially effective, or in conflict with other project objectives, additional options including project modification were evaluated. All options considered were evaluated and documented. The result of this process was an identification and evaluation of feasible mitigation options for each impact issue and a description of residual impacts.

Step 3 concerned the development of an acceptable mitigation plan. The feasible mitigation options identified through Step 2, and a description and explanation of those deemed infeasible, were forwarded to the resource agencies for review and comment (APA 1984). Recommendations received from this review group were considered by the Applicant prior to the preparation of final fisheries and wildlife mitigation plan. The plans were then revised and described in the license application. The final fish and wildlife mitigation plans to be implemented will be stipulated by the FERC following discussions with the Applicant and appropriate natural resource agencies.

Additional items that may be addressed by the Applicant include recommendations concerning the staffing, funding, and responsibilities of the monitoring program. This will be done in consultation with the appropriate resource agencies.

Step 4 will be the implementation of the plan as agreed to during Step 3. This will commence, as appropriate, following the reaching of an agreement by all parties.

During the implementation of the plan, which will include both the construction and operation phases of the project until further mitigation is deemed unnecessary, the Applicant, in consultation with the resource agencies, will review the work and evaluate the effectiveness of the plan (Step 5). To accomplish this goal, the Applicant will have the responsibility of assuring that the agreed upon plan is properly executed. The Applicant will submit regularly scheduled reports concerning the mitigation effort and, where appropriate, propose modifications to the plan. In cases where the predicted impact does not materialize, it will be recommended that mitigation efforts be discontinued. These reports will be distributed to the FERC and state and Federal regulatory agencies for review.

Any plan modifications (Step 6) will be sent by the Applicant to the resource agencies for review and negotiation of modifications to the plan (Step 3). Following the reaching of an agreement on the modifications, they will be implemented (Step 4) and monitored (Step 5). Any modifications to the mitigation plan will not be implemented without consultation with appropriate state and Federal agencies and approval of FERC. As discussed in Section 3.4, it is the intent of the Applicant to reach agreement with the resource agenices concerning modification of the plan prior to seeking FERC approval. The Applicant will seek approval of the resource agencies, with FERC as the final arbitrator.

Following satisfactory implementation of any plan modifications and documentation of evidence that the goals of the modification have been reached, the mitigation planning process and monitoring will terminate (Steps 7 and 8).

APPENDIX E2.3
ENVIRONMENTAL GUIDELINES MEMORANDUM

EXHIBIT E - CHAPTER 3

APPENDIX E2.3

ENVIRONMENTAL GUIDELINES MEMORANDUM
(This Section has been Deleted)

APPENDIX E3.3

PLANT SPECIES IDENTIFIED IN SUMMERS OF 1980 AND 1981 IN THE UPPER AND MIDDLE SUSITNA RIVER BASIN, THE DOWNSTREAM FLOODPLAIN, AND THE INTERTIE

Pteridophyta				
Aspidiaceae				
Dryopteris dilatata (Hoffm.) Gray	Shield fern	U	D	I
Dryopteris fragrans (L.) Schott	Fragrant shield fern	U		I
Gymnocarpium dryopteris (L.) Newm.	Oak fern	U	D	I
Athyriaceae				
Athyrium filix-femina (L.) Roth	Lady fern	U	D	
Cystopteris fragilis (L.) Bernh.	Fragile fern	U		
Cystopteris montana (Lam.) Bernh.	Mountain fragile fern	U		
Matteuccia struthiopteris (L.) Todaro	Ostrich fern		D	I
Woodsia alpina (Bolton) S. F. Gray	Alpine woodsia	U		
Equisetaceae				
Equisetum arvense L.	Meadow horsetail	U		
Equisetum fluviatile L. ampl. Ehrh.	Swamp horsetail	U		
Equisetum palustre L.	Marsh horsetail		D	
Equisetum pratense L.	Meadow horsetail	U	D	
Equisetum silvaticum L.	Woodland horsetail	U		I
Equisetum variegatum Schleich.	Variegated scouring-rush	U	D	
Equisetum sp.	Horsetail			I
Isoetaceae				
Isoetes muricata Dur.	Quillwort	U		
Lycopodiaceae				
Lycopodium alpinum L.	Alpine clubmoss	U		
Lycopodium annotinum L.	Stiff clubmoss	U		
Lycopodium clavatum L.	Running clubmoss	U		
Lycopodium complanatum L.	Ground cedar	U		
Lycopodium selago L. ssp. selago	Fir clubmoss	U		
Thelypteridaceae				
Thelypteris phegopteris (L.) Slosson	Long beech fern	U		
Gymnospermae				
Cupressaceae				
Juniperus communis L.	Common juniper	U		I
Pinaceae				
Picea glauca (Moench) Voss	White spruce	U	D	I
Picea mariana (Mill.) Britt., Sterns & Pogg.	Black spruce	U		I
Monocotyledoneae				
Cyperaceae				
Carex aquatilis Wahlenb.	Water sedge	U		
Carex bigelowii Torr.	Bigelow sedge	U		
Carex capillaris L.	Hairlike sedge	U		
Carex canescens L.	Silvery sedge	U	D	I
Carex concinna R. Br.	Low northern sedge	U		

Carex filifolia Nutt.	Thread-leaf sedge	U		
Carex garberi Fern.	Sedge		D	
Carex limosa L.	Shore sedge	U		
Carex loliacea L.	Sedge	U		
Carex media R. Br. ex Richards.	Sedge	U		
Carex membranacea Hook.	Fragile sedge	U		
Carex podocarpa C. B. Clarke	Short-stalk sedge	U		
Carex rhynchophysa C. A. Mey.	Sedge	U		
Carex saxatilis L.	Sedge		D	
Carex spp.	Sedge	U	D	I
Eleocharis sp.	Spike rush			I
Eriophorum angustifolium Honck.	Tall cottongrass	U		
Eriophorum scheuchzeri Hoppe	White cottongrass	U		
Eriophorum vaginatum L.	Tussock cottongrass	U	D	I
Eriophorum sp.	Cottongrass		D	I
Scirpus microcarpus Presl.	Small-fruit bullrush		D	
Trichophorum caespitosum (L.) Hartm.	Tufted clubrush	U		
Gramineae (Poaceae)				
Agropyron boreale (Turcz.) Drobov	Northern wheatgrass		D	
Agropyron caninum (L.) Beauv.	Wheatgrass		D	
Agropyron macrourum (Turcz.) Drobov	Wheatgrass		D	
Agropyron sp.	Wheatgrass	U		
Agrostis scabra Willd.	Tickle grass	U	D	
Agrostis sp.	Bent grass	U		
Alopecurus alpinus Sm.	Mountain foxtail	U		
Arctagrostis latifolia (R. Br.) Griseb.	Polargrass	U		
Beckmannia syzigachne (Steud.) Fern	Slough grass		D	
Calamagrostis canadensis (Michx.) Beauv.	Bluejoint	U	D	I
Calamagrostis purpurascens R. Br.	Purple reedgrass	U		
Cinna latifolia (Trev.) Griseb. in Ledeb	Woodreed		D	
Danthonia intermedia Vasey	Timber oatgrass	U		
Deschampsia atropurpurea (Wahlenb.) Scheele**	Mountain hairgrass	U		
Deschampsia caespitosa (L.) Beauv.	Tufted hairgrass	U	D	
Festuca altaica Trin.	Fescue grass	U		
Festuca rubra L. Coll.	Red fescue	U		
Hierochloe alpina (Swartz) Roem. & Schult.	Alpine holygrass	U		
Hierochloe odorata (L.) Wahlenb.	Vanilla grass	U	D	
Phleum commutatum Gandoger	Timothy	U		
Poa alpina L.	Alpine bluegrass	U		
Poa arctica R. Br.	Arctic bluegrass	U		
Poa palustris L.	Bluegrass	U		
Trisetum spicatum (L.) Richter	Downy oatgrass	U	D	
Iridaceae				
Iris setosa Pellas	Wild iris	U		I
Juncaceae				
Juncus arcticus Willd.	Arctic rush	U	D	
Juncus castaneus Sm.	Chestnut rush	U		
Juncus drummondii E. Mey.	Drummond rush	U		
Juncus mertensianus Bong.	Mertens rush	U		
Juncus triglumis L.	Rush	U		
Luzula campestris (L.) DC. ex DC. & Lam.**	Woodrush	U		
Luzula confusa Lindeb.	Northern woodrush	U		
Luzula multiflora (Retz.) Lej.	Woodrush	U		
Luzula parviflora (Ehrh.) Desv.	Small-flowered woodrush	U		
Luzula tundricola Gorodk.	Tundra woodrush	U		
Luzula wahlenbergii Rupr.	Wahlenberg woodrush	U		

Liliaceae				
Lloydia serotina (L.) Rchb.	Alp lily	U		I
Streptopus amplexifolius (L.) DC.	Cucumber root	U	D	I
Tofieldia coccinea Richards	Northern asphodel	U		
Tofieldia pusilla (Michx.) Pers.	Scotch asphodel	U		I
Veratrum viride Ait.	False hellebore	U		I
Zygadenus elegans Pursh	Elegant death camas	U		I
Orchidaceae				
Listera cordata (L.) R. Br.	Twyblade			I
Platanthera convallariaefolia (Fisch.) Lindl.	Northern bog-orchis	U		
Platanthera dilatata (Pursh) Lindl.	White bog-orchis	U		
Platanthera hyperborea (L.) Lindl.	Northern bog-orchis	U		I
Potamogetomaceae				
Potamogeton epihydrus Raf.	Nuttall pondweed	U		
Potamogeton filiformis Pers.	Filiform pondweed	U		
Potamogeton gramineus L.	Pondweed	U		
Potamogeton perfoliatus L.	Clasping-leaf pondweed	U		
Potamogeton robbinsii Oakes	Robbins pondweed	U		
Sparganiaceae				
Sparganium angustifolium Michx.	Narrow-leaved burreed	U		
Dicotyledoneae				
Araliaceae				
Echinopanax horridum (Sm.) Decne. & Planch.	Devil's club	U	D	I
Betulaceae***				
Alnus crispa (Ait.) Pursh	American green alder	U		I
Alnus sinuata (Reg.) Rydb.	Sitka alder	U	D	I
Alnus tenuifolia Nutt.	Thinleaf alder		D	
Alnus sp.	Alder			I
Betula glandulosa Michx.	Resin birch	U		I
Betula nana L.	Dwarf arctic birch	U	D	I
Betula occidentalis Hook.	Water birch	U		
Betula papyrifera Marsh.	Paper birch	U	D	I
Boraginaceae				
Mertensia paniculata (Ait.) G. Don	Tall bluebell	U	D	I
Myosotis alpestris F. W. Schmidt	Forget-me-not	U		
Callitrichaceae				
Callitriche hermaphroditica L.	Water starwort	U		
Callitriche verna L.	Vernal water starwort	U		
Campanulaceae				
Campanula lasiocarpa Cham.	Mountain harebell	U		I
Caprifoliaceae				
Linnaea borealis L.	Twin-flower	U		I
Sambuons callicarpa	Pacific red elder			I
Viburnum edule (Michx.) Raf.	High bush cranberry	U	D	I

Caryophyllaceae				
Minuartia obtusiloba (Rydb.) House	Alpine sandwort	U		
Moehringia laterifolia (L.) Fenzl	Grove Sandwort			I
Silene acaulis L.	Moss campion	U		
Stellaria crassifolia Ehrh.	Chickweed			I
Stellaria sp.	Starwort	U		
Wilhelmsia physodes (Fisch.) McNeill	Merckia	U		
Compositae (Asteraceae)				
Achillea borealis Bong.	Yarrow	U	D	
Achillea sibirica Ledeb.	Siberian yarrow	U	D	
Antennaria alpina (L.) Gaertn.	Alpine pussytoes	U		
Antennaria monocephala DC.	Pussytoes	U		
Antennaria rosea Greene	Pussytoes	U		
Arnica amplexicaulis Nutt. ssp. prima Maguire	Arnica	U		
Arnica chamissonis Less. (?)	Arnica		D	
Arnica frigida C. A. Mey.	Arnica	U		I
Arnica lessingii Greene	Arnica	U		
Artemisia alaskana Rydb.	Alaska wormwood	U		
Artemisia arctica Less.	Wormwood	U		I
Artemisia tilesii Ledeb.	Wormwood	U	D	I
Aster sibiricus L.	Siberian aster	U	D	I
Erigeron acris subsp. politus (L.) (E. Fries) Schinz & Keller	Fleabane	I		
Erigeron humilis Graham	Fleabane daisy	U		
Erigeron lonchophyllus Hook.	Daisy		D	
Erigeron purpuratus Greene	Fleabane			I
Hieracium triste Willd	Wooly hawkweed	U		
Petasites frigidus (L.) Franch.	Arctic sweet coltsfoot	U		I
Petasites sagittatus (Banks) Gray	Arrowleaf sweet coltsfoot	U	·	
Petasites sp.	Sweet coltsfoot		D	I
Saussurea angustifolia (Willd.) DC.	Saussurea	U		I
Senecio atropurpureus (Ledeb.) Fedtsch.	Ragwort	U		
Senecio lugens Richards.	Ragwort	U		I
Senecio sheldonensis Pors.	Sheldon groundsel	U		
Senecio triangularis Hook	Ragwort			I
Senecio sp.	Ragwort			I
Solidago multiradiata Ait.	Northern goldenrod	U	D	
Taraxacum sp.	Dandelion	U		
Cornaceae sp.				
Cornus canadensis L.	Bunchberry	U	D	I
Crassulaceae				
Sedum rosea (L.) Scop.	Roseroot	U		I
Cruciferae (Brassicacea)				
Draba aurea Vahl	Draba			I
Cardamine bellidifolia L.	Alpine bittercress	U		
Cardamine pratensis L.	Cuckoo flower	U		
Cardamine umbellata Greene	Bittercress	U		
Draba nivalis Liljebl	Rockcress	U		
Draba stenoloba Ledeb.	Rockcress	U		
Parrya nudicaulis (L.) Regel	Parrya			I
Diapensiaceae				
Diapensia lapponica L.	Diapensia	U		I

Droseraceae				
Drosera rotundifolia L.	Sundew			I
Elaeagnaceae				
Shepherdia canadensis (L.) Nutt.	Soapberry	U	D	I
Empetraceae				
Empetrum nigrum L.	Crowberry	U		I
Ericaceae				
Andromeda polifolia L.	Bog rosemary	U		
Arctostaphylos alpina (L.) Spreng.	Alpine bearberry	U		I
Arctostaphylos rubra (Rehd. & Wilson) Fern.	Red-fruit bearberry	U		I
Arctostaphylos uva-ursi (L.) Spreng.	Bearberry	U		I
Cassiope tetragona (L.) D. Don	Four-angle mountain heather	U		I
Ledum decumbens (Ait.) Small***	Northern Labrador tea	U		I
Ledum groenlandicum Oeder	Labrador tea	U		I
Ledum sp.	Labrador tea		D	I
Loiseleuria procumbens (L.) Desv.	Alpine azalea	U		I
Menziesia ferruginea Sm.	Menziesia			I
Oxycoccus microcarpus Turcz.	Swamp cranberry	U	D	
Rhododendron lapponicum (L.) Wahlenb.	Lapland rosebay	U		I
Vaccinium caespitosum Michx.	Dwarf blueberry	U		
Vaccinium uliginosum L.	Bog blueberry	U	D	I
Vaccinium vitis-idaea L.	Mountain cranberry	U		I
Vaccinium sp.	Blueberry			I
Fumariaceae				
Corydalis pauciflora (Steph.) Pers.	Few-flowered corydalis	U		I
Gentianaceae				
Gentiana glauca Pall.	Glaucous gentian	U		
Gentiana propinqua Richards.	Gentian	U		
Menyanthes trifoliata L.	Buckbean	U	D	I
Swertia perennis L.	Gentian	U		I
Geraniaceae				
Geranium erianthum DC.	Northern geranium	U		I
Haloragaceae				
Hippuris vulgaris L.	Common marestail	U		
Leguminosae (Fabaceae)				
Astragalus aboriginum Richards.	Milk-vetch	U		
Astragalus alpinus L.**	Milk-vetch	U	D	
Astragalus umbellatus Bunge	Milk-vetch	U		
Hedysarum alpinum L.	Alpine sweet-vetch	U	D	I
Lupinus arcticus S. Wats.	Arctic lupine	U		I
Oxytropis campestris (L.) DC.	Field oxytrope		D	
Oxytropis huddelsonii Prosild	Huddelson oxytrope	U		
Oxytropis maydelliana Trautv.	Maydell oxytrope	U		
Oxytropis nigrescens (Pall.) Fisch.	Blackish oxytrope	U		I
Oxytropis viscida Nutt.	Viscid oxytrope	U		

		U	D	I
Lentibulariaceae				
Pinguicula villosa L.	Hairy butterwort	U		
Utricularia vulgaris L.	Common bladderwort	U		
Myricaceae				
Myrica gale L.	Sweet gale	U	D	I
Nymphaeaceae				
Nuphar polysepalum Engelm.	Yellow pond lily	U		
Onagraceae				
Circaea alpina L.	Enchanter's nightshade		D	
Epilobium angustifolium L.	Fireweed	U	D	I
Epilobium latifolium L.	Dwarf fireweed	U	D	I
Epilobium palustre L.	Swamp willow-herb	U		
Orobanchaceae				
Boschniakia rossica (Cham. & Schlecht. Fedtsch.	Poque	U	D	I
Polemoniaceae				
Polemonium acutiflorum Willd.	Jacob's ladder	U	D	I
Polygonaceae				
Oxyria digyna (L.) Hill	Mountain sorrel	U		I
Polygonum bistorta L.	Meadow bistort	U		
Polygonum viviparum L.	Alpine bistort	U		I
Rumex arcticus Trautv.	Arctic dock	U		I
Rumex sp.	Dock	U		I
Portulacaceae				
Claytonia sarmentosa C. A. Mey.	Spring-beauty	U		I
Primulaceae				
Androsace chamaejasme Hult.	Androsace			I
Dodecatheon frigidum Cham. & Schlecht.	Northern shooting star	U		I
Primula cuneifolia Ledeb.	Wedge-leaf primrose	U		
Trientalis europaea L.	Arctic starflower	U	D	I
Pyrolaceae				
Moneses uniflora (L.) Gray	Single delight	U	D	
Pyrola asarifolia Michx.	Liverleaf wintergreen		D	
Pyrola grandiflora Radius	Large-flower wintergreen	U		
Pyrola minor L.	Lesser wintergreen	U		
Pyrola secunda L.	One-sided wintergreen	U	D	
Pyrola sp.	Wintergreen			I
Ranunculaceae				
Aconitum delphinifolium DC.	Monkshood	U		I
Actaea rubra (Ait.) Willd.	Baneberry		D	I
Anemone narcissiflora L.	Anemone	U		I
Anemone parviflora Michx.	Northern anemone	U		I
Anemone richardsonii Hook	Anemone	U	D	I
Anemone sp.	Anemone			I
Caltha leptosepala DC.	Mountain marsh-marigold	U		I

Delphinium glaucum S. Wats	Larkspur			I
Ranunculus confervoides (E. Fries) E. Fries	Water crowfoot	U		
Ranunculus macounii Britt. (may be R. pacificus or something similar)	Macoun buttercup		D	
Ranunculus nivalis L.	Snow buttercup	U		
Ranunculus occidentalis Nutt.	Western buttercup	U		
Ranunculus pygmaeus Wahlenb.	Pygmy buttercup	U		
Ranunculus sp.	Buttercup	U		I
Thalictrum alpinum L.	Arctic meadowrue	U		
Thalictrum sparsiflorum Turcz.	Few-flower meadowrue	U	D	I
Rosaceae				
Dryas drummondii Richards.	Drummond mountain-avens	U	D	I
Dryas integrifolia M. Vahl.	Dryas	U		I
Dryas octopetala L.	White mountain-avens	U		
Geum macrophyllum Wild.	Avens			I
Geum rossii (R. Br.) Ser.	Ross avens	U		I
Luetkea pectinata (Pursh) Ktze.	Luetkea	U		
Potentilla biflora Willd.	Two-flower cinquefoil	U		
Potentilla fruticosa L.	Shrubby cinquefoil	U		I
Potentilla hyparctica Malte	Arctic cinquefoil	U		
Potentilla palustris (L.) Scop.	Marsh cinquefoil	U	D	I
Rosa acicularis Lindl.	Prickly rose	U	D	I
Rubus arcticus L.	Nagoon berry	U	D	I
Rubus chamaemorus L.	Cloudberry	U		I
Rubus idaeus L.	Raspberry	U	D	I
Rubus pedatus Sm.	Five-leaf bramble	U		I
Rubus sp.	Raspberry			I
Sanguisorba stipulata Raf.	Sitka burnet	U		I
Sibbaldia procumbens L.	Sibbaldia	U		
Sorbus scopulina Greene	Western mountain ash	U		I
Spiraea beauverdiana Schneid.	Beauverd spirea	U	D	I
Rubiaceae				
Galium boreale L.	Northern bedstraw	U		I
Galium trifidum L.	Small bedstraw	U		
Galium triflorum Michx.	Sweet-scented bedstraw		D	
Salicaceae***				
Populus balsamifera L.	Balsam poplar (or cottonwood)	U	D	I
Populus tremuloides Michx.	Quaking aspen	U		I
Salix alaxensis (Anderss.) Cov.	Feltleaf willow	U	D	
Salix arbusculoides Anderss.	Littletree willow	U	D	
Salix arctica Pall.	Arctic willow	U		
Salix barclayi Anderss.	Barclay willow	U		
Salix brachycarpa Nutt.	Barren-ground willow	U		
Salix fuscescens Anderss.	Alaska bog willow	U	D	
Salix glauca L.	Grayleaf willow	U		
Salix lanata L. ssp. richardsonii (Hook) A. Skwortz.	Richardson willow	U		
Salix monticola Bebb	Park willow	U		
Salix novae-angliae Anderss.	Tall blueberry willow	U	D	
Salix phlebophylla Anderss.	Skeletonleaf willow	U		
Salix planifolia Pursh ssp. planifolia	Planeleaf willow	U		
Salix planifolia Pursh ssp. pulchra (Cham.) Argus	Diamondleaf willow	U		
Salix polaris Wahlenb.	Polar willow	U		
Salix reticulata L.	Netleaf willow	U		
Salix rotundifolia Trautv.	Least willow	U		
Salix scouleriana Barratt	Scouler willow	U		
Salix sp.	Willow	U	D	I

Santalaceae				
Geocaulon lividum (Richards.) Fern.	Sandalwood	U		
Saxifragaceae				
Boykinia richardsonii (Hook.) Gray	Richardson boykinia	U		
Leptarrhena pyrolifolia (D. Don) Ser.	Leather-leaf saxifrage	U		
Parnassia palustris L.	Northern Grass-of-Parnassus	U		I
Parnassia kotzebuei Cham & Schlecht.	Kotzebue Grass-of Parnassus	U		I
Parnassia sp.	Grass of Parnassus			
Ribes hudsonianum Richards.	Northern black currant			
Ribes laxiflorum Pursh (may be R. glandulosum)	Trailing black currant		D	
Ribes triste Pall.	Red currant	U	D	I
Saxifraga bronchialis L.	Spotted saxifrage	U		
Saxifraga davurica Willd.	Saxifrage	U		
Saxifraga foliosa R. Br.	Foliose saxifrage	U		
Saxifraga hieracifolia Waldst. & Kit.	Hawkweed-leaf saxifrage	U		
Saxifraga lyallii Engler	Red-stem saxifrage	U		
Saxifraga oppositifolia L.	Purple mountain saxifrage	U		I
Saxifraga punctata L.	Brook saxifrage	U		
Saxifraga serpyllifolia Pursh	Thyme-leaf saxifrage	U		
Saxifraga tricuspidata Rottb.	Three-tooth saxifrage	U		I
Scrophulariaceae				
Castilleja caudata (Pennell) Rebr.	Pale Indian paintbrush	U		I
Mimulus guttatus DC.	Yellow monkey flower			I
Pedicularis capitata Adams	Capitate lousewort	U		
Pedicularis kanei Durand	Kane lousewort	U		I
Pedicularis labradorica Wirsing	Labrador lousewort	U		I
Pedicularis parviflora J. E. Sm. var. parviflora	Lousewort	U		
Pedicularis sudetica Willd.	Lousewort	U		
Pedicularis verticillata L.	Whorled lousewort	U		
Pedicularis sp.	Lousewort			I
Veronica americana				I
Veronica wormskjoldii Roem. & Schult.	Alpine speedwell			I
Umbelliferae (Apiaceae)				
Angelica lucida L.	Wild celery	U		
Heracleum lanatum Michx.	Cow parsnip	U	D	I
Valerianaceae				
Valeriana capitata Pall.	Capitate valerian	U		I
Violaceae				
Viola epipsila Ledeb.	Marsh violet	U		I
Viola langsdorffii Fisch.	Violet	U		
Viola biflora L.	Violet			I
Viola sp.	Violet			I
Nonvascular Plant Species				
Lichens				
Cetraria cucullata (Bell.) Ach.		U		
Cetraria islandica (L.) Ach.		U		
Cetraria nivalis (L.) Ach.		U		
Cetraria richardsonii Hook.		U		
Cetraria sp.		U		
Cladonia alpestris (L.) Rabenh.		U		

Cladonia mitis Sandst.		U
Cladonia rangiferina (L.) Web.	Reindeer moss	U
Cladonia sp.		U
Dactylina arctica (Hook.) Nyl.		U
Haematomma sp.		U
Lobaria linita (Ach.) Rabh.		D
Nephroma sp.		U
Peltigera sp.		U
Rhizocarpon geographicum (L.) DC.		U
Stereocaulon paschale (L.) Hoffm.		U D
Thamnolia vermicularis (Sw.) Schaer.		U
Umbilicaria sp.		U
Mosses		
Climacium sp.		U
Hypnum spp. and other feather mosses		U
Paludella squarrosa (Hedw.) Brid.†		U
Polytrichum sp.		U D
Ptilium crista-castrensis (Hedw.) DeNot.	Knight's plume	U
Rhacomitrium sp.		U D
Sphagnum sp.		U D

* Vascular plant species nomenclature according to Hulten (1968) except where noted. Lichen nomenclature according to Thomson (1979). Moss nomenclature according to Conard (1979).

** Nomenclature according to Welsh (1974).

*** Nomenclature according to Viereck and Little (1972).

† Nomenclature according to Crum (1976).

Source: after McKendrick et al. 1982

APPENDIX E4.3
PRELIMINARY LIST OF PLANT SPECIES IN THE INTERTIE AREA

EXHIBIT E - CHAPTER 3

APPENDIX E4.3

PRELIMINARY LIST OF PLANT SPECIES IN THE INTERTIE AREA
(This Section Has Been Deleted and its
Information Incorporated into Appendix E3.3)

APPENDIX E5.3

STATUS, HABITAT USE, AND RELATIVE ABUNDANCE OF BIRDS IN THE MIDDLE SUSITNA BASIN

APPENDIX E5.3: STATUS, HABITAT USE AND RELATIVE ABUNDANCE OF BIRD SPECIES IN THE MIDDLE SUSITNA BASIN

Species	Status[1]	Main Habitats	Relative Abundance[2]
Common loon *Gavia immer*	B	lakes	U-sp, F; FC-S
Arctic loon *Gavia arctica*	B?	lakes	U-sp, S
Red-throated loon *Gavia stellata*	B?	lakes, rivers	U-sp, S
Red-necked grebe *Podiceps grisegena*	B	lakes	U
Horned grebe *Podiceps auritus*	B	lakes	U
Whistling swan *Cygnus columbianus*	T	lakes	U-sp, F
Trumpeter swan *Cygnus buccinator*	B	lakes	U-sp, F, FC-S
Canada goose *Branta canadensis*	T	lakes, rivers	U-sp, F
White fronted goose *Anser albifrons*	T	lakes	U-sp
Snow goose *Chen caerulescens*	T	lakes	U-sp
Mallard *Anas platyrhynchos*	B	lakes, rivers	C-sp, FC-S,F
Gadwall *Anas strepera*	T, S	lakes	R-sp, S
Pintail *Anas acuta*	B	lakes	C-sp, FC-S, U-F
Green-winged teal *Anas crecca carolinensis*	B	lakes	FC-sp, S, U-F
Blue-winged teal *Anas discors*	T	lakes	R-sp, F
American wigeon *Anas americana*	B	lakes	FC
Northern shoveler *Anas clypeata*	B	lakes	U
Redhead *Aythya americana*	T	lakes	U-sp
Ring-necked duck *Aythya collaris*	T	lakes	R-sp, F

Species	Status[1]	Main Habitats	Relative Abundance[2]
Canvasback *Aythya valisineria*	T	lakes	U-sp
Greater scaup *Aythya marila*	B	lakes	C-sp, F
Lesser scaup *Aythya affinis*	B	lakes	FC-S
Common goldeneye *Bucephala clangula*	B	lakes, rivers	FC-sp, F, U-S
Barrow's goldeneye *Bucephala islandica*	B	lakes, rivers	
Bufflehead *Bucephala albeola*	T	lakes	U-sp, FC-F
Oldsquaw *Clangula hyemalis*	B	lakes	FC-sp, S; U-F
Harlequin duck *Histrionicus histrionicus*	B	rivers	FC
White-winged scoter *Melanitta deglandi*	T	lakes	FC
Surf scoter *Melanitta perspicillata*	B	lakes	U
Black scoter *Melanitta nigra*	B	lakes	FC
Common merganser *Mergus merganser*	B	lakes, rivers	U
Red-breasted merganser *Mergus serrator*	B	lakes, rivers	U
Goshawk *Accipiter gentilis*	B	deciduous and mixed forest	U
Sharp-shinned hawk *Accipiter striatus*	B?	coniferous and mixed forest	U
Red-tailed hawk *Buteo jamaicensis*	B	coniferous and mixed forest	U
Golden eagle *Aquila chrysaetos*	B	cliffs	FC
Bald eagle *Haliaeetus leucocephalus*	B	forests, cliffs	U
Marsh hawk *Circus cyaneus*	B?	meadows	FC-sp, F; U-S
Osprey *Pandion haliaetus*	T	lakes	R-sp

Species	Status[1]	Main Habitats	Relative Abundance[2]
Gyrfalcon *Falco rusticolus*	B, W	cliffs	U
Peregrine falcon *Falco peregrinus*	T?	cliffs	2 records (1974)
Merlin *Falco columbarius*	B?	scattered woodland, forest edge	U
American kestrel *Falco sparverius*	T	open forest	R-F
Spruce grouse *Canachites canadensis*	B, W	coniferious and mixed forest	FC
Ruffed grouse *Bonasa umbellus*	V	forest	R
Willow ptarmigan *Lagopus lagopus*	B, W	low shrub land	C
Rock ptarmigan *Lagopus mutus*	B, W	low , dwarf shrubland, block fields	C
White-tailed ptarmigan *Lagopus leucurus*	B, W	high elevation dwarf shrub tundra and block fields	U
Sandhill crane *Grus canadensis*	T	wetlands	U
Semipalmated plover *Charadrius semipalmatus*	B	alluvial bars	U
American golden plover *Pluvialis dominica*	B	dwarf shrub mat and meadow	C
Whimbrel *Numenius phaeopus*	B?	dwarf shrub meadow	U
Upland sandpiper *Bartramia longicauda*	B?	dwarf shrub meadow near scattered woodland	R
Greater yellowlegs *Tringa melanoleuca*	B?	wet, meadows, lakes and river shorelines	U
Lesser yellowlegs *Tringa flavipes*	T, S	lake and river shorelines	FC-sp; R-S
Solitary sandpiper *Tringa solitaria*	B?	scattered wood- land, forest edge near lakes	U

Species	Status[1]	Main Habitats	Relative Abundance[2]
Spotted sandpiper *Actitis macularia*	B	alluvial bars	C
Wandering tattler *Heteroscelus incanus*	(B?), T	tundra streams	U
Turnstone *Arenaria* sp.	T	alluvial bar	R
Northern phalarope *Phalaropus lobatus*	B?	wet meadows with ponds	FC
Common snipe *Capella gallinago*	B	wet meadows	C
Long-billed dowitcher *Limnodromus scolopaceus*	T	lake and river shores and bars	U-sp
Surfbird *Aphriza virgata*	B?	dwarf shrub mat	R
Sanderling *Calidris alba*	T	lake and river shores and bars	R-F
Semipalmated sandpiper *Calidris pusilla*	T, S	lake and river shores and bars	U-sp, R-S
Least sandpiper *Calidris minutilla*	B?	wet and dwarf shrub meadow	FC
Baird's sandpiper *Calidris bairdii*	B	dwarf shrub mat	U
Pectoral sandpiper *Calidris melanotos*	T	wet meadows, pond, lake edges	U
Long-tailed jaeger *Stercorarius longicaudus*	B?	dwarf shrub mat and meadow	FC
Herring gull *Larus argentatus*	T, S	lakes, rivers	U
Mew gull *Larus canus*	B, S	lakes, rivers	C
Bonaparte's gull *Larus philadelphia*	B, S	lakes, rivers, scattered spruce woodland	U
Arctic tern *Sterna paradisea*	B	lakes and lakeshores	FC
Great horned owl *Bubo virginianus*	B?, W	open and closed forest	U
Snowy Owl *Nyctea scandiaca*	T	tundra	R

Species	Status[1]	Main Habitats	Relative Abundance[2]
Hawk owl *Surnia ulula*	B?, W	mixed forest	U
Short-eared owl *Asio flammeus*	T, S, (B?)	open habitat	U
Boreal owl *Aegolius funereus*	B? W	mixed forest	R
Belted kingfisher *Megaceryle alcyon*	B?	cutbanks, rivers	U
Common flicker *Colaptes auratus*	B	forest edge	U
Hairy woodpecker *Picoides villosus*	B, W	deciduous and mixed forest	U
Downy woodpecker *Picoides pubescens*	B?, W	open deciduous and mixed forest	U
Black-backed three-toed woodpecker *Picoides arcticus*	B?, W	coniferous forest	R
Northern three-toed woodpecker *Picoides tridactylus*	B, W	coniferous forest	U
Eastern kingbird *Tyrannus tyrannus*	A	open shrubland	Accidental
Say's phoebe *Sayornis saya*	B	upland cliff	U
Alder flycatcher *Empidonax alnorum*	B?	medium and tall shrubs	U
Western wood pewee *Contopus sordidulus*	B?	deciduous forest	R
Olive-sided flycatcher *Nuttallornis borealis*	B?	open and scattered forest	U
Horned lark *Eremophila alpestris*	B	dwarf shrub mat, block field	C-sp, F; FC-S
Violet-green swallow *Tachycineta thalassina*	B?	riparian cliffs, rivers	FC
Tree swallow *Iridoprocne bicolor*	B?	rivers, lakes	FC
Bank swallow *Riparia riparia*	B	cutbanks, rivers	U
Cliff swallow *Hirundo pyrrhonota*	B	rivers, lakes	U, L

Species	Status[1]	Main Habitats	Relative Abundance[2]
Gray jay *Perisoreus canadensis*	B, W	coniferous and mixed forest	C
Black-billed magpie *Pica pica*	S, (B?) W	open tall shrubs, scattered forest	U
Common raven *Corvus corax*	B, W	riparian and upland cliffs	C
Black-capped chickadee *Parus atricapillus*	B, W	deciduous forest	U
Boreal chickadee *Parus hudsonicus*	B, W	coniferous and mixed forest	FC
Brown creeper *Certhia familiaris*	B	deciduous and mixed forest	U
Dipper *Cinclus mexicanus*	B? W	rivers, streams	U
American robin *Turdus migratorius*	B	forest, medium and tall shrubland	C-sp,S; U-F
Varied thrush *Ixoreus naevius*	B	forest, tall alder thickets	O-sp,S; U-F
Hermit thrush *Catharus guttatus*	B	strip forested slopes, tall-alder thickets	C-sp,F; U-F
Swainson's thrush *Catharus ustulatus*	B	forest	FC
Gray-cheeked thrush *Catharus minimus*	B	scattered spruce, dwarf spruce, deciduous forest	FC
Wheatear *Oenanthe oenanthe*	B	block fields	U
Townsend's solitaire *Myadestes townsendi*	B	cliffs	U
Arctic warbler *Phylloscopus borealis*	B	scattered forest, medium shrubland	FC
Golden-crowned kinglet *Regulus satrapa*	T	coniferous and mixed forest	U
Ruby-crowned kinglet *Regulus calendula*	B	coniferous forests	C

Species	Status[1]	Main Habitats	Relative Abundance[2]
Water pipit *Anthus spinoletta*	B	dwarf shrub mat, block field	C
Bohemian waxwing *Bombycilla garrulus*	B?	scattered forest	CTsp,F, U-S
Northern shrike *Lanius excubitor*	B	scattered forest, tall shrubs	U
Orange-crowned warbler *Vermivora celata*	B	scattered forest, medium and tall shrubland	U
Yellow warbler *Dendroica petechia*	T, S?	riparian willows	R
Yellow-rumped warbler *Dendroica coronata*	B	forest	C
Blackpoll warbler *Dendroica striata*	B	tall shrubs, forest	FC
Northern waterthrush *Seiurus noveboracensis*	B?	tall shrubs near water	FC
Wilson's warbler *Wilsonia pusilla*	B	medium shrubs with or without forest overstory	C
Rusty blackbird *Euphagus carolinus*	T, S? (B?)	open coniferous forest, tall shrubs	U
Pine grosbeak *Pinicola enucleator*	T, S (B?)	open coniferous forest	U
Gray-crowned rosy finch *Leucosticte tephrocotis*	B?	cliffs, block fields	U
Common redpoll *Carduelis flammea*	B, W	low shrubs, open woodland	A
Pine siskin *Carduelis pinus*	B?	mixed forest, tall shrubs	U
White-winged crossbill *Loxia leucoptera*	S, B?	coniferous forest	FC
Savannah sparrow *Passerculus sandwichensis*	B	low shrubs with graminoid ground cover	A
Dark-eyed junco *Junco hyemalis*	B	open and closed forest	C

Species	Status[1]	Main Habitats	Relative Abundance[2]
Tree sparrow *Spizella arborea*	B	low shrubs	A
White-crowned sparrow *Zonotrichia leucophrys*	B	low and medium shrubs	C
Golden-crowned sparrow *Zonotrichia atricapilla*	B?	low shrubs, dwarf spruce	U
Fox sparrow *Passerella iliaca*	B?	medium and tall shrubs with forest overstory	FC
Lincoln's sparrow *Melospiza lincolnii*	B?	low and medium shrubs near water	U
Lapland longspur *Calcarius lapponicus*	B	dwarf shrub, meadow and mat	A
Smith's longspur *Calcarius pictus*	B?	dwarf shrub, meadow and mat	U
Snow bunting *Plectrophenax nivalis*	B?	high elevation cliffs and block fields	FC

[1] B = breeding confirmed, B? = probably breeds, (B?) = possibly breeds, T = transient, W = winters, S = summers, A = accidental

[2] A = abundant, C = common, FC = fairly common, U = uncommon, R = rare, sp = spring, S = summer, F = fall, L = local

Source: adapted from Kessel et al. 1982a

APPENDIX E6.3

STATUS AND RELATIVE ABUNDANCE OF BIRDS SPECIES OBSERVED ON THE LOWER SUSITNA BASIN DURING GROUND SURVEYS CONDUCTED JUNE 10 TO JUNE 20, 1982

APPENDIX E6.3: STATUS AND RELATIVE ABUNDANCE OF BIRD SPECIES OBSERVED ON THE LOWER SUSITNA BASIN DURING GROUND SURVEYS CONDUCTED JUNE 10 TO JUNE 20, 1982 (Page 1 of 6)

Species	Status[1]	Relative Abundance	No. of Individuals Observed[1]
Arctic loon *Gavia arctica*	M		0 (2 seen in May 1982)
Red-throated loon *Gavia stellata*	M, (PB)[2]		6 (2 seen in May 1982)
Red-necked grebe *Podiceps grisegena*	M		0 (5 seen in May 1981)
Double-crested cormorant *Phalacrocorax auritus*		(R)[2]	1
Whistling swan *Cygnus columbianus*	M		0 (60 seen near mouth of river in May 1981 and 420 seen near mouth of river in May 1982)
Brant *Branta bernicula*	M		0 (2 seen in May 1981)
White-fronted goose *Anser albifrons*	M		<50 (89 seen in May 1981 and 51 seen in May 1982)
Snow goose *Chen caerulescens*	(M) (M)		1
Canada goose *Branta canadensis*	M, (PB)		3 (1 seen in May 1981 and 26 seen in May 1982)
Green-winged teal *Anas crecca*	M, (PB)	U	Several 2's and 3's (42 seen in May 1981)
Mallard *Anas platyrhynchos*	M, (PB)	U	6
Pintail *Anas acuta*	M, (PB)	U	≤6
American wigeon *Anas americana*	M, (PB)	U	Most numerous surface feeding duck; seen in pairs along main river and sloughs almost every day
Canvasback *Aythya valisineria*	M	U	a few individuals in aerial waterbird surveys
Greater scaup *Aythya marila*	M		2
Harlequin duck *Histrionicus histrionicus*			6
Surf scoter *Melanitta perspicillata*	M		2
Common goldeneye *Bucephala clangula*	M, B	U	4

Species	Status[1]	Relative Abundance	No. of Individuals Observed[1]
Common merganser *Mergus merganser*	M, (PB)	FC	Small flocks of up to 10 seen along the main river; most numerous ducks seen in May and June
Red-breasted merganser *Mergus serator*	M	FC	A few birds along the river; less common than its congenor
Bald eagle *Haliaeetus leucocephalus*	(M), B	U	17 active nests seen in riparian cottonwood stands
Sharp-shinned hawk *Accipiter striatus*	(M), (PB)		Several seen
Goshawk *Accipter gentilis*	(R), (PB)		Several seen
Red-tailed hawk *Buteo jamaicensis*	(M), (PB)		1
American kestrel *Falco sparverius*	(M), (PB)		1
Merlin *Falco columbarius*	(M), (PB)		A few seen hunting along river
Sandhill crane *Grus canadensis*	M		Several heard at a distance along main river (27 seen near mouth of river in May 1982)
Semipalmated plover *Charadrius semipalmatus*	(M), B	U	Nests in alluvium along the river
Greater yellowlegs *Tringa melanoleuca*	(M), PB	U	Seen and heard foraging along river
Solitary sandpiper *Tringa solitaria*	(M), (PB)	FC	Courtship rituals observed along river
Spotted sandpiper *Actitus macularia*	(M), B	C	Regularly seen; 5 nests seen along shores of main river, sloughs and feeder streams
Whimbrel *Numenius phaeopus*	M		Only 1 observed; assumed to be late northbound migrant
Common snipe *Capella gallinago*	(M), (PB)	FC	Winnowing snipe were heard and/or seen along the river

Species	Status[1]	Relative Abundance	No. of Individuals Observed[1]
Northern phalarope <u>Phalaropus lobatus</u>			2
Parasitic jaeger <u>Stercorarius parasiticus</u>			3
Bonaparte's gull <u>Larus philadelphia</u>	(M), PB	FC	Pairs and small groups seen feeding along main river and sloughs
Mew gull <u>Larus canus</u>	(M), PB	FC	
Herring gull <u>Larus argentatus</u>	(M), B	C	7 breeding colonies of 20 - 100 pairs seen on alluvial islands along river between Talkeetna and mouth of river
Black-legged kittiwake <u>Rissa tridactyla</u>	(T)	(R)	130; normally a pelagic species; nearest breeding colony at Chisik Island in lower Cook Inlet
Arctic tern <u>Sterna paradisaea</u>	(M), B	FC	Pairs and small groups
Great horned owl <u>Bubo virginianus</u>	(R), (PB)		Tracks seen; signs found in beach sand below Bell Island indicate this owl was feeding on dead eulachon
Short-eared owl <u>Asio flammeus</u>	(M)		Remains of one owl were found below Bell Island
Belted kingfisher <u>Megaceryle alcyon</u>	(PB)	U	Pairs regularly seen on feeder streams
Downy woodpecker <u>Picoides pubescens</u>	(R), (PB)		1 male observed in riparian cotton-wood forest
Hairy woodpecker <u>Picoides villosus</u>	(R), B	FC	Seen or heard regularly
Northern three-toed woodpecker <u>Picoides tridactylus</u>	(R), (PB)		2 seen in mixed forests along lower river
Common flicker <u>Colaptes auratus</u>	(M), (PB)		A few seen and heard in riparian cottonwood

Species	Status[1]	Relative Abundance	No. of Individuals Observed[1]
Alder flycatcher <u>Empidonax alnorum</u>	PB	C	Seen regularly (4th most numerous landbird
Tree swallow <u>Tachycineta bicolor</u>	(M), B	FC	Seen regularly; 3 nests seen
Violet-green swallow <u>Tachycineta thalassina</u>	(M), (PB)	U	Small numbers seen
Bank swallow <u>Riparia riparia</u>	(M), B	FC	Some colonies of 30 - 50 pairs
Cliff swallow <u>Hirundo pyrrhonota</u>	(M), B	LC	Seen only at Talkeetna where commonly breeds around building eaves
Gray jay <u>Perisoreus canadensis</u>	(R), (PB)		Very few seen or heard
Black-billed magpie <u>Pica pica</u>	(R)		1
Common raven <u>Corrus corax</u>	(R), (PB)	U	Uncommon but widely distributed
Black-capped chickadee <u>Parus atricapillus</u>	(M), B	FC	Seen regularly
Brown creeper <u>Certhia familiarus</u>	(M)		1
Gray-cheeked thrush <u>Catharus minimus</u>	(M), B	C	Seen regularly (5th most numerous passerine on census
Swainson's thrush <u>Catharus ustulatus</u>	(M), (B)	C	Seen regularly (7th most numerous small landbird)
Hermit thrush <u>Catharus guttatus</u>	(M), PB	U	Not recorded downstream from Talkeetna
American Robin <u>Turdus migratorius</u>	(M), B	FC	2 nests observed
Varied thrush <u>Ixoreus naevius</u>	(M), B	FC	Seen regularly (10th most common passerine
Golden-crowned kinglet <u>Regulus satrapa</u>	(M)		1

Species	Status[1]	Relative Abundance	No. of Individuals Observed[1]
Ruby-crowned kinglet *Regulus calendula*	(M), PB	FC	Seen regularly
Bohemian waxwing *Bombycilla garrulus*	(M)	U	Fewer than 12 seen
Northern shrike *Lanius excubitor*	(M), (PB)		2
Orange-crowned warbler *Vermivora celata*	(M), (PB)	FC	Seen regularly
Yellow warbler *Dendroica petechia*	(M), B	FC	1 nest seen; tall shrubs
Yellow-rumped warbler *Dendroica coronata*	(M), B	C	2nd most common passerine seen regularly in mixed forest, cottonwood and tall shrubs
Blackpoll warbler *Dendroica striata*	(M), B	C	3rd most common passerine seen regularly in tall riparian shrubs, cottonwood and mixed forest
Northern waterthrush *Seiurus noveboracensis*	(M), B	C	Most numerous passerine seen regularly in riparian cottonwood and mixed cottonwood
Wilson's warbler *Wilsonia pusilla*	(M), PB	FC	
Rusty blackbird *Euphagus carolinus*	(M), B	U	2
White-winged crossbill *Loxia leucoptera*	(M)	U	48
Savannah sparrow *Passerculus sandwichensis*	(M), PB	U	
Fox sparrow *Passerella iliaca*	(M), B	C	1 nest seen
Lincoln's sparrow *Melospiza lincolnii*	(M), B	FC	
Golden-crowned sparrow *Zonotrichia atricapilla*	(M), B	U	1 individual was heard just above Bell Island

Species	Status[1]	Relative Abundance	No. of Individuals Observed[1]
White-crowned sparrow *Zonotrichia leucophrys*	(M), B	C	9th most numerous passerine seen regularly in medium to tall shrub thickets and cottonwood forests on small islands
Dark-eyed junco *Junco hyemalis*	(M), B	FC	
Common redpoll *Carduelis flammea*	(M)	FC	
Pine siskin *Carduelis pinus*	(M)	U	A few were heard or seen in cottonwoods along river

[1]Includes information on migration from aerial surveys in May 1981 and 1982.

[2]( ) indicates assessments of status or relative abundance other than those provided by the University of Alaska museum.

[3]B = breeding confirmed, PB = probably breeds, M = migrant, R = resident

[4]R = rare, U= uncommon, FC = fairly common, C = common, LC = locally common

Source: adapted from Kessel et al. 1982b

APPENDIX E7.3
SCIENTIFIC NAMES OF MAMMAL SPECIES FOUND IN THE PROJECT AREA

APPENDIX E7.3: SCIENTIFIC NAMES OF MAMMAL SPECIES FOUND IN THE PROJECT AREA

Common Name	Scientific Name
Masked shrew	*Sorex cinereus*
Dusky shrew	*Sorex monticolus*
Northern water shrew	*Sorex palustris*
Arctic shrew	*Sorex arcticus*
Pygmy shrew	*Sorex hoyi*
Little brown bat	*Myotis lucifugus*
Collared pika	*Ochotona collaris*
Snowshoe hare	*Lepus americanus*
Hoary marmot	*Marmota callgata*
Arctic ground squirrel	*Spermophilus parryii*
Red squirrel	*Tamiasciurus hudsonicus*
Beaver	*Castor canadensis*
Northern red-backed vole	*Clethrionomys rutilus*
Meadow vole	*Microtus pennsylvanicus*
Tundra vole	*Microtus oeconomus*
Singing bole	*Microtus miurus*
Muskrat	*Ondatra zibethica*
Brown lemming	*Lemmus sibiricus*
Northern bog lemming	*Synaptomys borealis*
Porcupine	*Erethizon dorsatum*
Belukha whale	*Delphinapterus leucas*
Coyote	*Canis latrans*
Wolf	*Canis lupus*
Red fox	*Vulpes fulva*
Black bear	*Ursus americanus*
Brown bear	*Ursus arctos*
Marten	*Martes americana*
Short-tailed weasel	*Mustela erminea*
Least weasel	*Mustela nivalis*
Mink	*Mustela vison*
Wolverine	*Gulo gulo*
River otter	*Lutra canadensis*
Lynx	*Lynx candensis*
Moose	*Alces alces*
Caribou	*Rangifer tarandus*
Dall sheep	*Ovis dalli*

APPENDIX E8.3

METHODS USED TO DETERMINE MOOSE BROWSE UTILIZATION AND CARRYING CAPACITY WITHIN THE MIDDLE SUSITNA BASIN

EXHIBIT E - CHAPTER 3
APPENDIX E8.3
METHODS USED TO DETERMINE MOOSE BROWSE UTILIZATION
AND CARRYING CAPACITY WITHIN THE MIDDLE SUSITNA BASIN

Provisional estimates of moose browse utilization and carrying capacity were based on moose habitat research was conducted in the middle basin in 1982 by the Plant Ecology Team of the University of Alaska Agricultural Experimental Station. The objective of the moose browse study was to estimate the availability of browse and herbaceous plants for each vegetation type.

1 - FIELD METHODS

Sites sampled were randomly selected using a grid overlay on a vegetation map of the area within about 5 mi of potential dam impoundments. However, eight sites were located mid-slope at the phenology study sites on both north and south-facing slopes to insure that some samples occurred in the immediate impoundment area. Sites were classified to Levels IV and V of Viereck et al. (1982), when possible. Forty-seven stands were examined from July through August 1982. Some habitat types were sampled more intensively than others, based on their importance to moose and/or land area occupied by that type.

At each sample site, three parallel 50-m line transects were established, approximately 10 to 20 m apart. Every 10 m along each transect line, a plot (1 x 0.5 m) was located. Percent cover of each plant species, including trees less than 1.13 m in height, was estimated in each 0.5 m^2 plot. All grasses, sedges, forbs, and the current annual growth of tall shrubs were clipped in each plot. Clipped samples were bagged, oven-dried at 60°C for 48 hours, then weighed. Kg/ha of graminoids, forbs, and leaves and twigs of moose browse species were calculated by multiplying the biomass (in grams) from 0.5 m^2 plots by 20.

A circular plot with a 5 m radius was established every 10 m along each transect line. This plot was divided into 4 even-sized quadrants. Within each quadrant, the distance to the nearest stem of each browse species represented within a quadrant was measured. The basal diameter and average height of that stem was measured and the number of twigs, above 50 cm (19 inches), was counted and noted as to evidence of recent browsing. A twig was defined as a branch that had a diameter equal to the estimated diameter at point of browsing for that species. The average diameter at point of browsing for each species was estimated by randomly measuring twigs that were browsed at a number of sites over the entire study area. Percent utilization was determined by dividing the number of browsed twigs by the total number of twigs above 50 cm. At each site, 25 twigs from each browse species present were also randomly harvested at the average point of browsing. These twigs provided an estimate of biomass removed when the shrubs had been browsed by moose.

2 - CARRYING CAPACITY

A provisional estimate of moose carrying capacity was calculated from the browse biomass estimates obtained in summer 1982. The preliminary estimate shown in Table E.3.4.7 is based on the following data and assumptions:

1. Browse biomass estimates for each Level III vegetation type are representative of all other similar stands throughout the middle basin (e.g., all open conifer forest stands have the same biomass as those sampled).

2. The vegetation maps produced in 1980-81 accurately portray the vegetative cover of the middle basin (vegetation is being remapped now that low-level photography is available).

3. Moose in winter eat only the current annual growth of twigs of the following species: Richardson willow, grayleaf willow, diamondleaf willow, Sitka alder, and resin birch. The calculations assume that none of the twigs are consumed in summer, and that snow does not make any twigs unavailable. Both of these assumptions are in fact false; however, the analysis is also biased in the other direction because moose can consume more than the current annual growth of twigs, eat other browse species in winter, and consume some leaves and forbs available in winter.

4. A moose in winter requires 5.0 kg dry weight of browse per day (Gasaway and Coady 1974). This value takes into account the composition and digestibility of the diets of moose in interior Alaska.

5. Areas mapped as closed conifer forest, closed birch forest, closed mixed forest, tall shrub (mostly alder), and tundra, contain no moose browse available to moose in winter. Except for tundra and tall shrub types, these types cover only a small proportion of the middle basin, and closed forest stands support low browse biomass. Little, if any browse is available to moose in tundra areas and tall shrubs are mostly alder, which is not a preferred browse species.

6. The number of moose days the areas can support is calculated for the Watana impoundment and adjacent village and borrow sites and for the entire watershed upstream of Gold Creek. The number of winter residents these areas can support is calculated assuming that winter lasts for 180 days and food requirements are the same throughout that period, and that moose do not move into or out of the study areas.

APPENDIX E9.3

EXPLANATION AND JUSTIFICATION OF ARTIFICIAL NEST MITIGATION

EXHIBIT E - CHAPTER 3

APPENDIX E9.3

EXPLANATION AND JUSTIFICATION OF ARTIFICIAL NEST MITIGATION
(This Section has been Deleted)

APPENDIX E10.3

PERSONAL COMMUNICATIONS

EXHIBIT E - CHAPTER 3

APPENDIX E10.3

PERSONAL COMMUNICATIONS
(This Section has been Deleted)

APPENDIX E11.3

EXISTING AIR QUALITY AND METEOROLOGICAL CONDITIONS

EXHIBIT E - CHAPTER 3
APPENDIX E11.3
EXISTING AIR QUALITY AND METEOROLOGICAL CONDITIONS

1 - INTRODUCTION (***)

This appendix describes the air quality impacts and air quality regulatory status of construction of the proposed Watana Stage I Dam. The impacts of construction of the Devil Canyon Stage II Dam and Watana Stage III are not described, because the construction plans for those phases have not yet been developed in enough detail to perform detailed analyses.

The analyses described in detail in this appendix are divided as follows:

- Description of existing meteorological and air quality conditions at the Watana site;
- Description of stationary and non-stationary source emissions from construction operation equipment and facilities;
- Description of the proposed construction operations for Watana Stage I;
- Estimation of air pollutant emissions during the construction phase;
- Prediction of the ambient air quality impacts beyond the project boundary during dam construction;
- Summary of the regulatory status and air quality permitting requirements for construction of Watana Stage I;
- Description of applicable Alaska air quality regulations.

2 - EXISTING AIR QUALITY AND METEOROLOGICAL CONDITIONS (***)

2.1 - Meteorological Conditions (***)

Weather conditions at the Watana site are typical of the continental Alaska region. An onsite weather station has been operated at Watana since 1981 (R&M Consultants 1985a). The average monthly temperature, precipitation, and wind speed that have been measured at Watana are listed in Table E11.3.2.1. In general, precipitation is highest during the summer months. Wind patterns at the site appear to be influenced by the Susitna River valley.

2.2 - Existing Air Quality (***)

The air quality at the site is pristine, because the Watana site is located far (approximately 90 miles) from the nearest existing source of air pollution, the 25 MW coal-fired plant at Healy. Healy is in the Nenana River basin, which drains to the interior of Alaska, and is separated from the project area by hign mountains; therefore, the local air masses from the Nenana and Susitna River basin do not mix. In anticipation of a PSD (Prevention of Significant Deterioration) review, the Applicant conducted an air monitoring program approved by the Alaska Department of Environmental Conservation (ADEC) at the Watana site in the summer of 1984 (APA 1985f). Airborne total suspended particulate (TSP) concentrations were measured at the field campsite and at the river elevation. The mean TSP concentrations at the campsite and the river were 3.48 ug/m^3 and 4.57 ug/m^3, respectively.

No measurements of the concentrations of other pollutants were taken. The existing concentrations for nitrogen oxides (NO_x) is assumed to be 2.0 ug/m^3, based on established background values at other pristine locations (EPA 1979a). Similarly, the assumed background concentration of sulfur dioxide (SO_2) is 2.0 ug/m^3, based on other studies (EPA 1981).

2.3 - Regulatory Structure (***)

Alaska air pollution control regulations are administered by the ADEC. In regard to the Susitna Hydroelectric Project, ADEC has exclusive authority concerning potential air pollution impacts which may result from construction activities. Therefore, it is assumed that the applicable air pollution control agency is and will remain ADEC.

Ambient Air Quality Standards specify maximum pollutant concentrations in outdoor locations where the public has access (18 AAC 50.900(5)). The Alaska Ambient Air Quality Standards are given in Table E11.3.2.2 (18 AAC 50.020(a)). In areas where concentrations of air pollutants in the ambient air are less than the standards in Table E11.3.2.2, the concentrations must be kept below the standards, and no increase from new sources can exceed the Prevention of Significant Deterioration (PSD) Class II increments given in Table E11.3.2.3 (18 AAC 50.020(b)).

3 - EXPECTED AIR POLLUTION EMISSIONS (***)

3.1 - Stationary Source Emissions (***)

The emissions from the anticipated stationary facilities during the Watana Stage I Dam construction were estimated by utilizing the construction plans and by applying emission factors from AP-42 (EPA 1977b). The following stationary emission sources were considered:

- emergency diesel electric generators;
- construction camp refuse incinerator;
- batch concrete plant; and
- aggregate screening plant.

Each of the above stationary sources is described in the following sections. The predicted emission rates from each of the point sources are listed in Table E11.3.3.1

3.1.1 - Emergency Diesel Generators (***)

Emergency diesel generators will provide electrical power to the construction camp during line power outages. As a worst case, it was assumed that 3 MW of emergency power will be required for five percent of the time during the seven month construction season. The emergency diesel generators would consume approximately 5,200 gallons per day or 56,000 gallons per year of No. 2 diesel fuel. The pollutant emission rates were calculated using conservatively high AP-42 emission factors (EPA 1977b).

3.1.2 - Construction Camp Refuse Incinerator (***)

Construction camp refuse incinerators will burn all of the refuse from the project. These industrial incinerators will be equipped with afterburners for emission control. An incinerator will be at each construction facility. The highest refuse generation would occur during the Watana Stage I Dam construction. The expected peak population at the Watana campsite is 3,338 persons. The assumed per capita refuse generation rate was 2.7 kg/person day, based on observations at similar Arctic construction camps (EPA 1979c). The estimated maximum refuse generation rate is 9.9 tons per day, or 2,148 tons per year for the seven month operation. Pollutant emission rates from the industrial type incinerator were calculated using AP-42 emission factors (EPA 1977b).

3.1.3 - Concrete Batch Plant (***)

A concrete batch plant with a 1,000 ton per hour capacity will be used at the Watana Dam construction operation. The batch plant will use fabric filters and/or water sprays to control dust emissions. Based on AP-42 emission factors (EPA 1977b), each plant will emit approximately 10 lbs per hour or 26 tons per year of particulate matter, assuming continuous operation at projected design capacity.

3.1.4 - Aggregate Screening Plant (***)

The material from Borrow Site E will be washed and screened using a wet-process screening plant located in the borrow site. Because the material will be wet and the screening plant will use a wet process, the dust emissions from the plant are expected to be negligible.

3.2 - Fugitive Dust Sources (***)

3.2.1 - Description of Construction Operations (***)

The Watana Stage I Dam will be of earth and rockfill-type construction. The dam will be constructed of 32,107,000 cubic yards (cy) of fill. The dam structure will consist of the following components:

- o A 6,300,000 cy core of impervious soil;
- o Pervious sand and gravel filters upstream and downstream of the core, with a combined volume of 4,277,000 cy;
- o Rockfill forming a shell around the dam, with a volume of 21,590,000 cy.

Construction of the Watana Stage I Dam will require six years. During the peak construction period, a seven-day work week will be used, with two, ten-hour daily work shifts. Dam fill placement will be done between April and October of each year.

The exact construction procedures that will be used to construct Watana Stage I Dam have not yet been developed. The actual construction plan will be developed by the construction contractor to be selected by the Applicant based on competitive bids. The feasibility-level construction plans described in this section have been assumed by the Applicant for use only in the preliminary environmental studies.

The sources of fill material for the Watana Stage I Dam are depicted in Figure E11.3.3.1. The construction activities that will be performed at each location are listed in Table E11.3.3.2. The quantities of dam fill material that will be excavated from each source during the peak construction year are listed in Table E11.3.3.3. The soil properties for the dam fill material excavated from each source are listed in Table E11.3.3.4. The estimated number of pieces of equipment that will be used during the peak year are listed in Table E11.3.3.5.

The proposed construction operations at each fill material source are described below. Note that the operations described here are based on feasibility-level assumptions by the Applicant. The actual construction practices used by the construction contractor may be different from those described below.

- Borrow Site D (April-October) - The gravel-clay soil mixture for the dam will be excavated from Borrow Site D, on the plateau north of the dam site. An estimated 11,650 ton/day will be excavated during the peak construction period. Spoil material will be moved aside and the gravel and clay soils will be excavated by dragline. The soil will be transported in 40-cy haul trucks to a conveyor that will carry the soil down the bluff. The conveyor will discharge to a working stockpile; 40-cy haul trucks will then transport the soil from the conveyor to the dam embankment zones.

- Borrow Site E (April-October) - Sand-gravel material for the dam fill filters will be excavated by dragline from Borrow Site E, downstream of the dam. An estimated 6,500 ton/day will be excavated during the peak construction period. The wet sand and gravels will be stockpiled, screened, and washed at a gravel processing area within the borrow site. The washed gravel will be transported in 40-cy haul trucks to the dam embankment zones.

- Required Spillway Excavations (April-October) - The rockfill to be used for the outer layers of the dam will be excavated from the required excavations. An estimated 32,700 tons/day will be excavated during the peak construction period. The hard rock will be blasted, loaded into 40-cy haul trucks, and transported to a conveyor, which will carry the rock down the bluff. The conveyor will discharge to a working stockpile. The rockfill will be transported by 40-cy haul trucks from the conveyor toe to the dam embankment zones.

- Dam Embankment - The impervious core, filters, and rockfill will be spread, wetted/dried, and compacted in thin lifts, using rollers. The haul roads to the dam embankment zones will be constructed of clean gravel with binder material. Earthfill will be placed from April through October.

3.2.2 - Fugitive Dust Emission Factors (***)

The fugitive dust emission factors that were used are listed in Table E11.3.3.6. In general, the emission factors are based on surface mining operations. Those factors should be representative of emissions from the soil excavations and hauling during the Watana Dam construction.

3.2.3 - Assumed Fugitive Dust Mitigations (***)

For this study, it was assumed that fugitive dust would be reduced by a combination of natural weather conditions and applied controls. The applied mitigations that would be used during the summer season are listed in Table E11.3.3.6. Those controls represent the most efficient methods that are commonly recognized by the regulatory agencies (CDH 1984).

During the seven month construction season (April-October), there will be many days on which there is either snow cover on the ground or during which it rains. To calculate the annual average emissions, the following mitigations caused by natural weather conditions were assumed:

- o With the exception of drilling/blasting, there will be no fugitive dust emissions on days with snow cover on the ground. For this study, it was assumed that there is snow cover at Watana between October through April each year.

- o There will be no haul road fugitive dust emissions on days with more than 0.01 inch of precipitation. This assumption is consistent with the emission factor equations approved by the regulatory agencies (CDH 1984). The onsite meteorological data indicate that there are 75 days per year of precipitation during the seven-month construction season (R&M 1985a).

3.2.4 - Calculated Fugitive Dust Emissions (***)

The calculated worst-case 24-hour emission rates from each of the operation areas at Watana are listed in Table E11.3.3.7. Those emission rates would apply on a dry day during the summer, assuming applied mitigation meaures. The predicted annual average emissions are listed in Table E11.3.3.8. The average annual emission rates account for a seven-month construction period, with a combination of natural and applied mitigation measures.

3.3 - Tailpipe Emissions (***)

The estimated emissions of nitrogen oxides and particulate matter from the diesel equipment tailpipes are shown in Tables E11.3.3.7 and E11.3.3.8. The emission rates were estimated by applying the AP-42 emission factors (EPA 1977b) to the pieces of construction equipment that will be required during the peak year (see Table E11.3.3.5). The

AP-42 emission factors for tailpipe emissions are known to provide conservatively high emission rates. It is, therefore, likely that the estimated tailpipe emission rates shown in Tables E11.3.3.7 and E11.3.3.8 are considerably higher than the emission rates that will actually occur during the construction project.

4 - PREDICTED AIR QUALITY IMPACTS (***)

4.1 - Modeling Approach (***)

4.1.1 - Meteorological Data (***)

Meteorological data from the Watana field camp for the year 1984 were used for the computer dispersion models (ISC and ISCT). On-site meteorological data at the Watana site have been collected since 1981 (R&M 1985a). To choose the data year that best represents the "average" conditions, historical precipitation data for the Talkeetna National Weather Service station were compared with the measured precipitation values at that station for the period 1981 to 1984. The historical average precipitation at Talkeetna is 27.2 inches per year. The measured precipitation at Talkeetna 1981 through 1984 are listed below (NOAA 1984).

Year	Annual Precipitation (inches)
1981	35.07
1982	31.82
1983	22.81
1984	23.08

The measured precipitation at Talkeetna during the year 1984 was closest to the historical average. It was assumed that the weather conditions at Watana during that year were also typical of historical averages. The measured meteorological data for the Watana campsite for 1984 were, therefore, used as input to the air quality computer dispersion models.

The meteorological conditions at Watana were measured using an electronic weather station (R&M 1985a). The station continuously recorded wind speed, wind direction, temperature and precipitation. For this study, the atmospheric stability factors were estimated from the wind speed, using the EPA-approved methods (EPA 1977a). The annual average joint frequency distributions of wind speed, wind direction, and atmospheric stability class are shown in Table E11.3.4.1.

4.1.2 - Computer Methods Used

The Industrial Source Complex (ISC) computer model was used to predict the ambient air quality impacts of TSP, NO_x, and SO_2.

This model is suited for prediction of fugitive dust impacts near large construction operations such as the Watana Stage I Dam. The ISC model accounts for the following:

- o emissions from stacks or area sources;
- o particle removal by gravity settling; and
- o use of measured on-site meteorology.

The ISC Short Term (ISCST) model was used to determine which day of meteorological data resulted in the highest and second highest fugitive dust impacts at 16 radial points along the project boundary. Sequential hourly meteorological data for the period April 1984 through September 1984 were used along with the calculated worst-case, 24-hour emission rates shown in Tables E11.3.3.1 and E11.3.3.7. A screening run showed that the highest impact resulted by using the meteorological data for June 5, 1984, while the second highest impacts occurred on August 13, 1984. Since the Alaska regulations allow one exceedence per year of the 24-hour air quality standards, the meteorological data for August 13, 1984, were used in all subsequent computer runs. The measured meteorological conditions for that day are shown in Table E11.3.4.2

To calculate isopleths of the second-highest 24-hour TSP impacts, the ISCST model was used with:

- o the hourly meteorological data for August 13;
- o the calculated point source emission rates in Table E11.3.3.1; and
- o the calculated fugitive dust emissions shown in Table E11.3.3.7.

It was assumed that all of the fugitive dust emissions were subject to particle removal by gravitational settling. The following particle size distribution, settling velocities, and reflection coefficients were assumed:

Particle Size Range (microns)	Mass Fraction	Settling Velocity (m/sec)	Reflection Coefficient
30+	0.20	0.035	0.65
15-30	0.23	0.015	0.75
5-15	0.29	0.005	0.85
<5	0.28	0.001	1.00

The particle size distribution is based on the specified distribution for haul road fugitive dust (CDH 1984). The settling velocities and reflection coefficients are based on the ISC User's Guide (EPA 1979b).

The second highest 24-hour SO_2 impacts were calculated by using the meteorological data for August 13, 1984 and the SO_2 emission rates shown in Tables E11.3.3.1 and E11.3.3.7. It was assumed that the terrain on the plateaus near the Watana site was flat.

The annual average TSP, SO_2, and NO_x impacts during dam construction were calculated using the ISC Long Term (ISCLT) model, the annual average wind rose shown in Table E11.3.4.1, and the annual average emission rates shown in Tables E11.3.3.1 and E11.3.3.8. It was assumed that the terrain along the regional plateaus was flat, and that the fugitive dust emissions were subject to gravitational settling.

The impacts for averaging times of less than 24 hours were not directly modeled. Instead, the short-term impacts were calculated by multiplying the predicted 24-hour impact with the EPA-approved scaling factors (EPA 1977a).

4.2 - Predicted Air Quality Impacts (***)

4.2.1 - Dam Site (***)

The calculated impacts along the project boundary are listed in Table E11.3.4.3. In no cases did the predicted impact exceed the allowable Air Quality Standard or PSD Class II increments.

The predicted annual average and 24-hour average TSP isopleths are shown in Figures E11.3.4.1 and E.3.4.2, respectively. The ambient concentrations of TSP will be minimal beyond the project boundary.

4.2.2 - Access Road (***)

The daily traffic along the proposed access road should not cause significant air quality impacts. As a worst-case, it was assumed that all commuting will be done using buses for single-status workers or individual cars for families. The following assumptions were used:

- o peak construction camp population of 2,315 single-status workers plus 310 family-status;
- o each single-status worker will make one round trip per week, using buses carrying 30 persons; and
- o each family member will make a round trip every two days, in cars carrying three persons.

Using the above worst-case assumptions, the commuter traffic along the access road will consist of nine buses and 52 family cars per day. This predicted worst-case traffic volume is less than that allowed along the access road into Denali National Park. During the peak season at Denali Park, the traffic volumes are as follows: 51 buses per day; 65 private vehicles per day; and 13 Park Service trucks per day (NPS 1985). The air pollutant emissions along the Denali Park access road are probably much higher than those that will occur along the proposed Watana access road.

5 - REGULATORY STATUS (***)

5.1 - Compliance With Air Quality Regulations (***)

Based on the computer modeling described in Section 4.0, the emissions from construction of the Watana Stage I Dam will not cause exceedences of any air quality limitations. The predicted ambient concentrations of all pollutants at the project boundary during the dam construction are all below the applicable Alaska ambient air quality standards.

5.2 - Air Quality Permitting Requirements (***)

The construction of the Watana Stage I Dam will require a Permit to Operate from the Alaska Department of Environmental Conservation (ADEC). The permitting requirements are described in the Alaska regulations 18 AAC 50.300.

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TABLE E11.3.2.1

AVERAGE MONTHLY WEATHER CONDITIONS
DURING 1983/1984

Month	Temperature (°C)	Precipitation (mm)	Wind Speed (m/sec)
Jan	-12.5	2.8	3.7
Feb	-10.0	2.8	4.3
Mar	-5.0	2.4	2.9
Apr	-1.1	2.4	2.5
May	5.3	15.2	2.6
Jun	10.5	39.4	2.7
Jul	12.2	113.4	2.7
Aug	9.0	117.8	2.5
Sep	4.7	8.0	2.5
Oct	-7.1	4.2	3.0
Nov	-10.7	0.2	3.3
Dec	-10.4	7.0	4.7
Annual	-1.4°C	316 mm	3.1 m/sec

Source: R&M Consultants 1985.

TABLE E11.3.2.2

AMBIENT AIR QUALTY STANDARDS
(Concentrations in ug/m^3)

Pollutant	1-Hour Average 3/	3-Hour Average 3/	8-Hour Average 3/	24-Hour Average 3/	Annual Mean
TSP	None	None	None	150	60 1/
SO_2	None	1,300	None	365	80 2/
CO	40,000	None	10,000	None	None
O_3	235	None	None	None	None
NO_x	None	None	None	None	100 2/
PB	None	None	None	None	1.5 2/ (quarterly)

1/ Geometric mean.

2/ Arithmetic mean.

3/ Allowed to be exceeded once per year.

TABLE E11.3.2.3

PSD CLASS II INCREMENTS [1,2]
(Concentrations in ug/m^3)

Pollutant	3-Hour Average[3]	24-Hour Average[3]	Annual Mean
TSP	None	37	19 (geometric)
SO_2	512	91	20 (arithmetic)

1/ Source: 18 AAC 50.020(b)(2).

2/ No increments established for CO, O_3, NO_x, or Pb.

3/ Allowed to be exceeded once per year.

TABLE E11.3.3.1: PREDICTED AIR POLLUTANT EMISSION RATES FROM POINT SOURCES

Pollutant and Averaging Time	Refuse Incinerator	Emergency Diesel Generators	Concrete Batch Plant
Particulates 1			
o 24-hr (lb/day)	13.9	139	240
o Annual (ton/year) 2	1.5	0.7	25.6
SO_2			
o 24-hr (lb/day)	24.7	256	0
o Annual (ton/year) 2	2.7	1.4	0
No_x			
o Annual (ton/year) 2	3.2	10.2	0
Carbon Monxide			
o 24-hr (lb/day)	346.0	1,042	0
o Annual (ton/year) 2	37.5	5.6	0
Hydrocarbons			
o 24-hr (lb/day)	14.8	175	0
o Annual (ton/year) 2	1.6	0.9	0

1. Particulate removal is 90% with the afterburner installed on the incinerator.

2. Assume operations occur 7 months/year; 31 days/month

TABLE E11.3.3.2: CONSTRUCTION ACTIVITIES WATANA STAGE I DAM

Required Spillway Excavations (April-October)

- 32,650 tons/day excavated during peak period
- Rock drilling and blasting
- Rock loading to haul trucks
- Rock hauling to conveyor (1-mile round trip over 1 percent silt haul road (using 40-cy trucks at 20 mph vehicle speed
- Conveyor loading

Borrow Area D (April-October)

- 11,650 tons per day excavated during peak period
- Spoil material removal and reclamation
- Product removal by dragline
- Product loading onto haul trucks
- Soil hauling to conveyor (4-mile round trip over 1 percent silt haul road) using 40-cy haul trucks at 20 mph vehicle speed
- Dumping into conveyor
- Conveyor to dam site loading area

Borrow Area D Conveyor Toe (April-October)

- Conveyor unloading to stockpiles
- Stockpile loading to haul trucks
- Product hauling to dam site (1-mile round trip over washed gravel haul roads) using 40-cy haul trucks at 10 mph vehicle speed

Borrow Area E (April-October)

- 6,500 tons per day excavation rate during peak year
- Wet gravel excavation by dragline
- Wet gravel dumping into stockpiles
- Ten-day working stockpile
- Gravel screening plant (wet process, 100 ton per hour capacity)
- Washed gravel loading into trucks
- Hauling to dam site (5-mile round trip over washed gravel haul road) using 40-cy haul trucks at 15 mph vehicle speed

Damsite Operations

- Fill placement and compaction (April-October)
- Watering of fill
- Discing and scarifying
- Concrete batch plant (1,000 ton per hour capacity)

Construction Camp

- 3,338 peak population (single status, married, families)
- 3 MW of emergency diesel electrical generation
- 9.9 ton/day refuse incinerator

TABLE E11.3.3.3

ASSUMED PEAK YEAR EXCAVATION QUANTITIES
WATANA DAM

Borrow Area	Fill Type	Embankment Quantity (cubic yards/day)	Haul Quantity (tons/day)	Assumed Spoil Material (tons/day)
Required Spillway Excavation	Rockfill	20,300	32,650	Negligible
D	Impervious Fill	5,900	11,650	1,000
E	Filter and Shell Fills	4,000	6,500	Negligible

TABLE E11.3.3.4

ASSUMED EXCAVATED SOIL PROPERTIES
WATANA DAM

Borrow Area	Silt Content (percent)	Moisture (percent)
Spillway (rockfill)	1	2
D (impervious soil)	10	10
E (gravel)	5 (before washing) 0.25 (after washing)	15 (as excavated) 5 (after stacking)
Spoil Material	30	15

TABLE E11.3.3.5: DISTRIBUTION OF CONSTRUCTION EQUIPMENT FOR CONSTRUCTION OPERATIONS DURING PEAK YEAR OPERATIONS WATANA DAM

Required Spillway Excavations:	8 - 40-cy haul trucks 2 - D8 dozers 2 - Front loaders
Borrow Area D:	4 - 40-cy haul trucks 1 - 12-cy draglines 1 - D8 dozers 1 - D8 push cats
Borrow Area E:	3 - 40-cy haul trucks 1 - 12-cy draglines 1 - D8 dozers 1 - D8 push cats
Borrow Area D Conveyor Toe:	3 - 40-cy haul trucks
Dam Placement Area:	3 - D8 roller cats 3 - D8 push cats 3 - D8 dozers 2 - Water trucks 3 - Motor graders
General Haul Road Maintenance:	4 - Water trucks 2 - Motor graders

TABLE E11.3.3.6

LISTING OF ASSUMED EMISSION FACTORS AND MITIGATIONS
WATANA DAM [1/]

Operation	Emission Factor	Assumed Applied Mitigation and Efficiency
Spoil Removal	0.01 lbs/ton	None
Spoil Dumping	$\frac{K(0.0018)(s/5)(U/5)(H/5)}{(M/2)^2(Y/6)^{0.33}}$ lbs/ton	Minimize drop distance
Drilling	0.22 lbs/hole	Bag filter; 90 percent control
Blasting	25-78 lbs/blast	None
Product Removal	0.01 lbs/ton	None
Product Loading	Same as spoil dumping	
Storage Piles	1.7(S/1.5)((365-p)/235)(f/15)	Coherex; 50 percent control
Conveyor Dumping	$\frac{K(0.0018)(s/5)(U/5)(H/10)}{(M/2)^2}$	Minimize drop
Spoil Hauling	$K(5.9)(s/12)(S/30)(W/3)^{0.7}(w/4)^{0.5}$	Chemical binders; 85 percent control
Spillway Rock Hauling	Same as spoil hauling	Chemical binders; 85 percent control
Access Roads	Same as spoil hauling	Chemical binders; 85 percent control
Exposed Area	Same as storage piles	Reseeding and chemical binders; 75 percent reduction in affected area

1/ Emission Factor Reference: Colorado Health Department 1984.

TABLE E11.3.3.7: WORST CASE 24-HOUR EMISSIONS DURING DAM CONSTRUCTION

Operation	Spillway Excavation	Borrow D	Borrow D Toe Area	Borrow E	Dam Fill Area	Construction Camp
Fugitive Dust (lbs/day)						
Overburden Handling	0	40	0	0	0	0
Drilling	5	0	0	0	0	0
Blasting	52	0	0	0	0	0
Product Removal	13	117	0	0	0	0
Product Hauling	442	305	32	31	0	0
Fill Placement and Spreading	0	1	2	0	10	0
Exposed Area Wind Erosion	6	13	1	4	25	25
Storage Pile Wind Erosion	0	0	0	10	0	0
Traffic	0	0	0	0	0	84
Total Fugitive Dust lbs/day	498	476	35	45	35	109
Tailpipe Emissions (lbs/day)						
Particulates	82	35	23	26	24	0
Nitrogen Oxides	2,286	970	697	773	328	160

TABLE E11.3.3.8: ANNUAL AVERAGE EMISSIONS (TONS/YEAR) DURING DAM CONSTRUCTION

Operation	Spillway Excavation	Borrow D	Borrow D Toe Area	Borrow E	Dam Fill Area	Construction Camp
Fugitive Dust (lbs/day)						
Overburden Handling	0	62.8	0	0	0	0
Drilling	13.6	0	0	0	0	0
Blasting	5.5	0	0	0	0	0
Product Removal	0.8	7.6	0	0	0	0
Product Hauling	6.6	9.6	1.0	1.0	0	0
Fill Placement and Spreading	0	0	0	0.2	0.6	2.4
Exposed Area Wind Erosion	0	0	0	0.2	0.0	1.3
Storage Pile Wind Erosion	0	0	0	0.2	0	0
Traffic	0	0	0	0	0	1.3
Total Fugitive Dust lbs/day	498	476	35	45	35	109
Tailpipe Emissions (lbs/day)						
Particulates	82	35	23	26	24	0
Nitrogen Oxides	2,286	970	697	773	328	160

STABILITY CATEGORY 1

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (0.7500MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00177936	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00501456	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00485280	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00638951	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00711743	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00873503	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00566160	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00396312	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00363960	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00250728	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00283080	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00396312	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00582336	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00355872	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00202200	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00452928	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000

STABILITY CATEGORY 2

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (0.7500MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00024264	0.00291168	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00177936	0.00622775	0.00016176	0.00000000	0.00000000	0.00000000
45.000	0.00194112	0.01172759	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00372048	0.01043351	0.00024264	0.00000000	0.00000000	0.00000000
90.000	0.00372048	0.01520543	0.00016176	0.00000000	0.00000000	0.00000000
112.500	0.00218376	0.01342607	0.00016176	0.00000000	0.00000000	0.00000000
135.000	0.00064704	0.00477192	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00024264	0.00153672	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00016176	0.00177936	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00064704	0.00226464	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00080880	0.00250728	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00129408	0.00541896	0.00024264	0.00008088	0.00000000	0.00000000
270.000	0.00347784	0.00994823	0.00016176	0.00016176	0.00000000	0.00000000
292.500	0.00088968	0.00663215	0.00008088	0.00000000	0.00000000	0.00000000
315.000	0.00048528	0.00250728	0.00008088	0.00000000	0.00000000	0.00000000
337.500	0.00056616	0.00339696	0.00008088	0.00000000	0.00000000	0.00000000

STABILITY CATEGORY 3

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (0.7500MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00032352	0.00266904	0.00032352	0.00000000	0.00000000	0.00000000
22.500	0.00072792	0.00703655	0.00606600	0.00000000	0.00000000	0.00000000
45.000	0.00161760	0.01116143	0.00962471	0.00000000	0.00000000	0.00000000
67.500	0.00347784	0.01512455	0.01819799	0.00016176	0.00000000	0.00000000
90.000	0.00331608	0.01480103	0.01366871	0.00024264	0.00000000	0.00000000
112.500	0.00169848	0.00800711	0.00452928	0.00000000	0.00000000	0.00000000
135.000	0.00064704	0.00218376	0.00121320	0.00000000	0.00000000	0.00000000
157.500	0.00000000	0.00056616	0.00024264	0.00000000	0.00000000	0.00000000
180.000	0.00008088	0.00048528	0.00008088	0.00000000	0.00000000	0.00000000
202.500	0.00000000	0.00064704	0.00016176	0.00000000	0.00000000	0.00000000
225.000	0.00032352	0.00080880	0.00072792	0.00000000	0.00000000	0.00000000
247.500	0.00113232	0.00549984	0.00485280	0.00032352	0.00000000	0.00000000
270.000	0.00121320	0.01164671	0.01099967	0.00040440	0.00000000	0.00000000
292.500	0.00072792	0.00582336	0.00380136	0.00000000	0.00000000	0.00000000
315.000	0.00048528	0.00064704	0.00056616	0.00000000	0.00000000	0.00000000
337.500	0.00056616	0.00307344	0.00283080	0.00000000	0.00000000	0.00000000

TABLE E11.3.4.1

Joint Frequency Distribution for 1984

HARZA-EBASCO
SUSITNA JOINT VENTURE

STABILITY CATEGORY 4

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (0.7500MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00032352	0.00970559	0.00129408	0.00008088	0.00000000	0.00000000
22.500	0.00121320	0.01180847	0.00461016	0.00186024	0.00000000	0.00000000
45.000	0.00097056	0.01439663	0.01407311	0.00833063	0.00000000	0.00000000
67.500	0.00177936	0.01294079	0.02855062	0.06009379	0.00121320	0.00000000
90.000	0.00194112	0.01132319	0.01674215	0.03955029	0.00177936	0.00008088
112.500	0.00129408	0.00509544	0.00299256	0.00145584	0.00000000	0.00000000
135.000	0.00048528	0.00040440	0.00032352	0.00008088	0.00000000	0.00000000
157.500	0.00016176	0.00008088	0.00016176	0.00000000	0.00000000	0.00000000
180.000	0.00008088	0.00016176	0.00016176	0.00000000	0.00000000	0.00000000
202.500	0.00000000	0.00016176	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00008088	0.00048528	0.00024264	0.00000000	0.00000000	0.00000000
247.500	0.00024264	0.00283080	0.00647039	0.00711743	0.00000000	0.00000000
270.000	0.00024264	0.01310255	0.01431575	0.00824975	0.00000000	0.00000000
292.500	0.00064704	0.00881591	0.00574248	0.00250728	0.00016176	0.00008088
315.000	0.00048528	0.00097056	0.00040440	0.00000000	0.00000000	0.00000000
337.500	0.00032352	0.00331608	0.00177936	0.00088968	0.00000000	0.00000000

STABILITY CATEGORY 5

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (0.7500MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00153672	0.01860238	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00153672	0.02159494	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00347784	0.01868326	0.00024264	0.00000000	0.00000000	0.00000000
67.500	0.00461016	0.01747007	0.00032352	0.00016176	0.00000000	0.00000000
90.000	0.00258816	0.01924942	0.00024264	0.00008088	0.00000000	0.00000000
112.500	0.00161760	0.00711743	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00032352	0.00105144	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00016176	0.00056616	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00000000	0.00040440	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00008088	0.00032352	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00016176	0.00064704	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00056616	0.00307344	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00315432	0.00986735	0.00008088	0.00000000	0.00000000	0.00000000
292.500	0.00161760	0.01876414	0.00000000	0.00008088	0.00000000	0.00000000
315.000	0.00072792	0.00452928	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00056616	0.00889679	0.00000000	0.00000000	0.00000000	0.00000000

STABILITY CATEGORY 6

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (0.7500MPS)	WIND SPEED CATEGORY 2 (2.5000MPS)	WIND SPEED CATEGORY 3 (4.3000MPS)	WIND SPEED CATEGORY 4 (6.8000MPS)	WIND SPEED CATEGORY 5 (9.5000MPS)	WIND SPEED CATEGORY 6 (12.5000MPS)
0.000	0.00857327	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00938207	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.01447751	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.01407311	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.01463927	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00582336	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00218376	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00040440	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00080880	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00097056	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00121320	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00234552	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00647039	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.01067615	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00501456	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00784535	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000

TABLE E11.3.4.1 CONT.

Joint Frequency Distribution for 1984

HARZA-EBASCO
SUSITNA JOINT VENTURE

HOUR	FLOW VECTOR (DEGREES)	WIND SPEED (MPS)	MIXING HEIGHT (METERS)	TEMP. (DEG. K)	POT. TEMP. GRADIENT (DEG. K PER METER)	STABILITY CATEGORY	WIND PROFILE EXPONENT	DECAY COEFFICIENT (PER SEC)
1	242.0	1.00	9999.9	273.8	0.0350	6	0.3000	0.000000E+00
2	238.0	1.80	9999.9	280.8	0.0200	5	0.3000	0.000000E+00
3	226.0	2.20	9999.9	278.4	0.0200	5	0.3000	0.000000E+00
4	192.0	1.90	9999.9	273.6	0.0200	5	0.3000	0.000000E+00
5	193.0	2.60	9999.9	277.4	0.0000	4	0.2500	0.000000E+00
6	202.0	2.10	9999.9	276.6	0.0200	5	0.3000	0.000000E+00
7	246.0	1.30	9999.9	278.2	0.0000	4	0.2500	0.000000E+00
8	194.0	1.40	9999.9	280.3	0.0000	3	0.2000	0.000000E+00
9	284.0	1.10	9999.9	281.8	0.0000	2	0.1500	0.000000E+00
10	300.0	2.10	9999.9	283.4	0.0000	2	0.1500	0.000000E+00
11	2.0	1.00	9999.9	285.5	0.0000	1	0.1000	0.000000E+00
12	344.0	2.10	9999.9	286.3	0.0000	2	0.1500	0.000000E+00
13	3.0	1.60	9999.9	274.5	0.0000	2	0.1500	0.000000E+00
14	167.0	2.40	9999.9	289.1	0.0000	2	0.1500	0.000000E+00
15	207.0	3.30	9999.9	289.1	0.0000	3	0.2000	0.000000E+00
16	223.0	1.00	9999.9	274.7	0.0000	2	0.1500	0.000000E+00
17	221.0	3.70	9999.9	289.8	0.0000	3	0.2000	0.000000E+00
18	221.0	3.40	9999.9	290.4	0.0000	3	0.2000	0.000000E+00
19	204.0	2.70	9999.9	289.3	0.0000	4	0.2500	0.000000E+00
20	225.0	2.80	9999.9	287.7	0.0000	4	0.2500	0.000000E+00
21	234.0	2.20	9999.9	285.3	0.0200	5	0.3000	0.000000E+00
22	221.0	2.60	9999.9	283.2	0.0000	4	0.2500	0.000000E+00
23	257.0	1.80	9999.9	282.1	0.0200	5	0.3000	0.000000E+00
24	236.0	1.30	9999.9	273.8	0.0350	6	0.3000	0.000000E+00

TABLE E11.3.4.2

Hourly Wind Data for August 13, 1984

HARZA-EBASCO
SUSITNA JOINT VENTURE

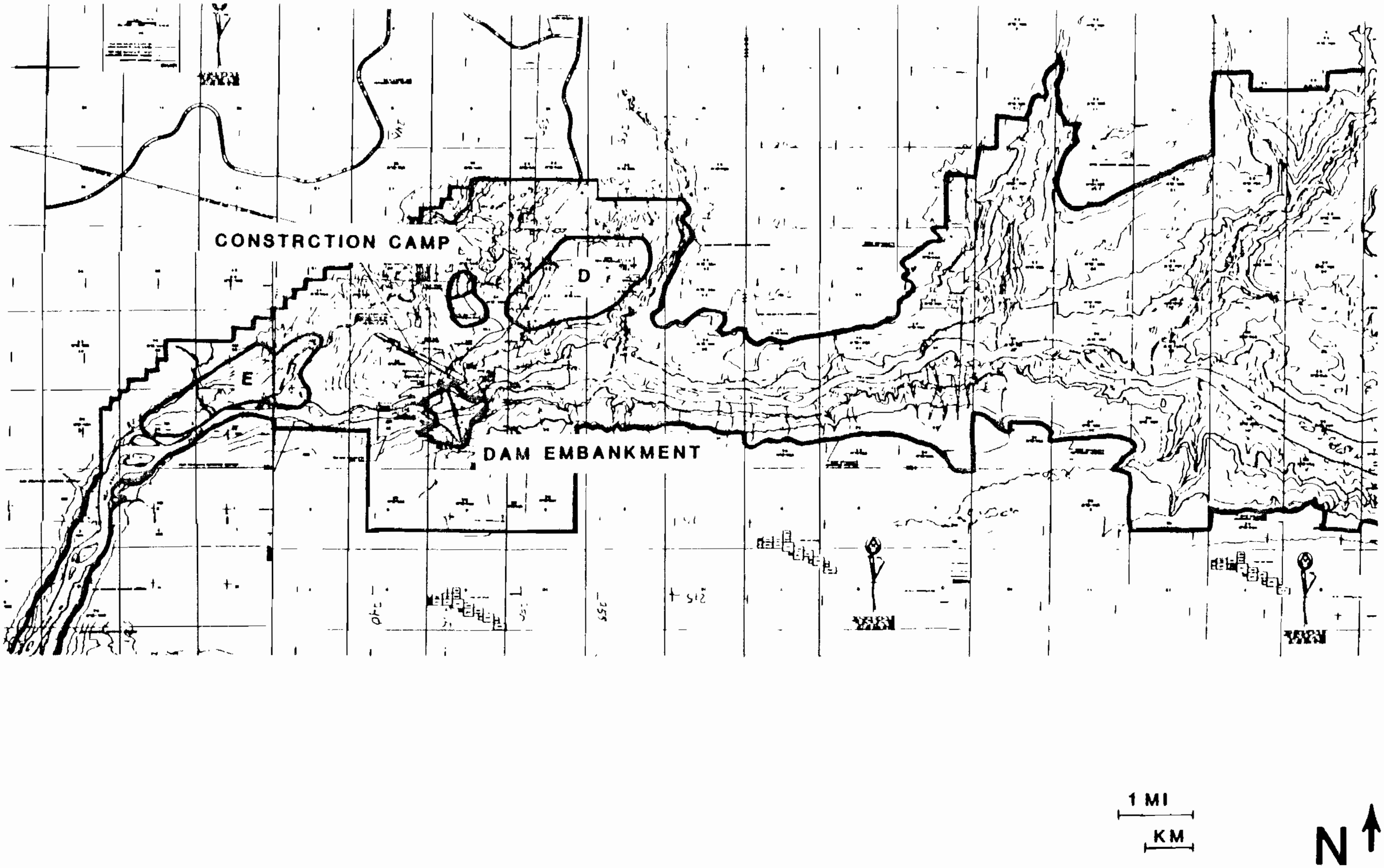
TABLE E11.3.4.3

SUMMARY OF PREDICTED WORST CASE IMPACTS AT PROJECT BOUNDARY

Pollutant and Averaging Time	Predicted Impact (ug/m^3) 1/	Allowable ASAAQS (ug/m^3)	Allowable PSD Class II Increment (ug/m^3)
Particulate Matter			
o Annual	1.6	60	19
o 24-Hour 2/	30.2	150	37
Sulfur Dioxide			
o Annual	0.9	80	20
o 24-Hour 2/	8.9	365	91
o 3-Hour 2/		1,300	512
Nitrogen Oxides			
o Annual	15.0	100	None Established

1/ Does not include background pollutant concentrations: TSP - 5.0 ug/m^3; SO_2 - 2.0 ug/m^3; NO_x - 2.0 ug/m^3.

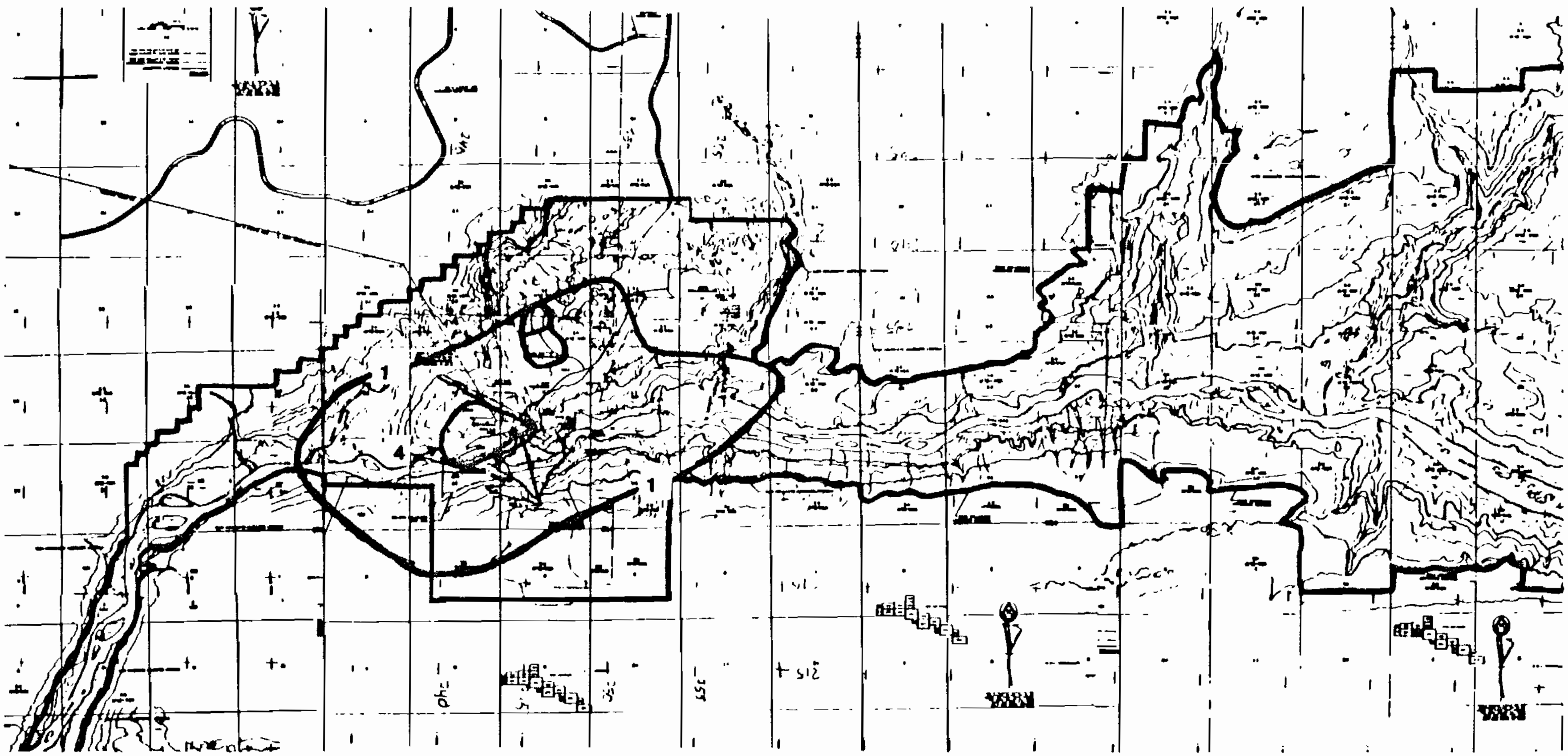
2/ Second highest calculated value during summer season.



HARZA-EBASCO
SUSITNA JOINT VENTURE

Proposed Borrow Areas and Fill Areas

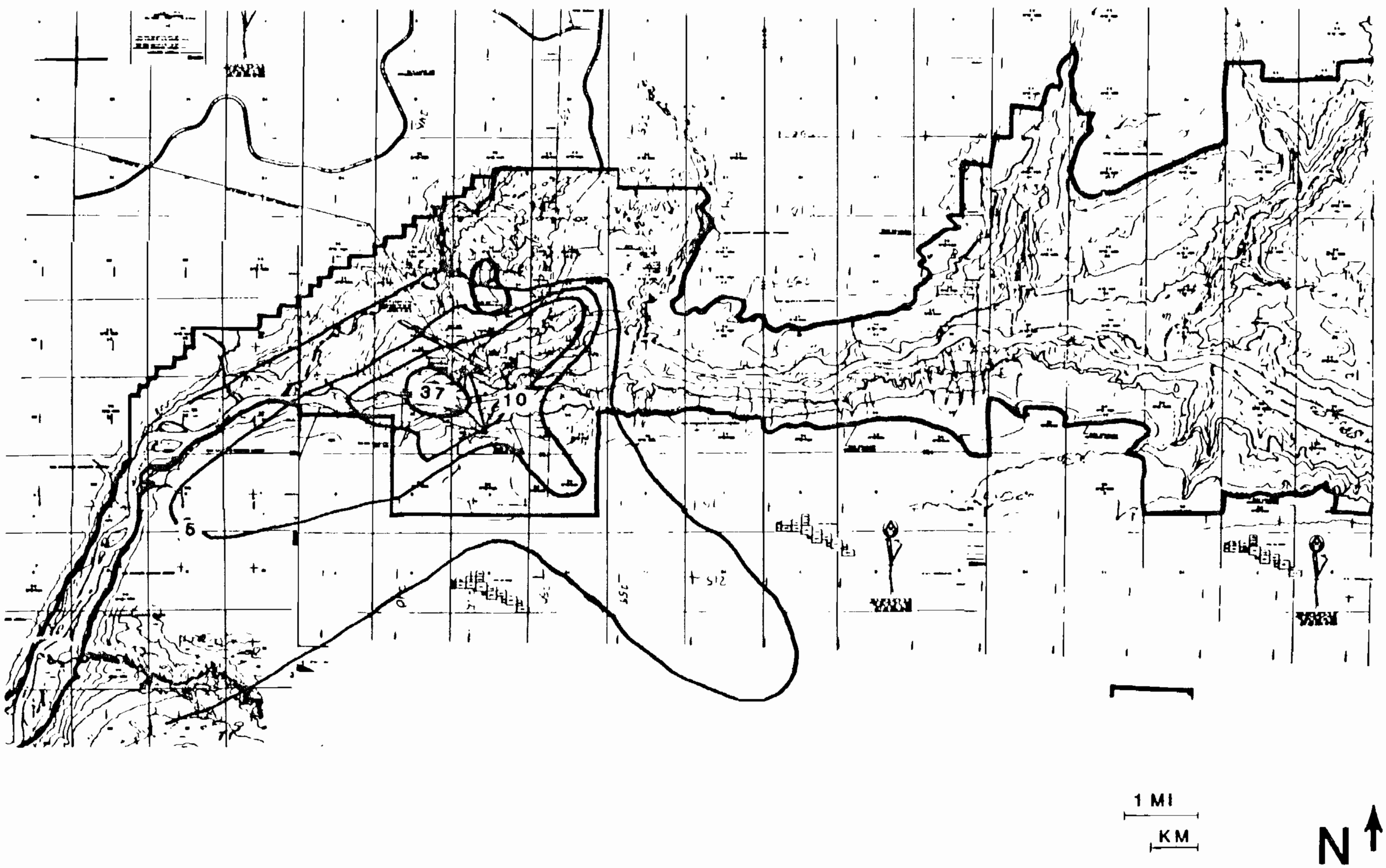
FIGURE E11.3.3.1



HARZA-EBASCO
SUSITNA JOINT VENTURE

Predicted Annual Average TSP Impact (ug/m^3)
(Note: Does Not Include 5 ug/m^3 Background Value)

FIGURE E11.3.4.1



HARZA-EBASCO
SUSITNA JOINT VENTURE

Predicted 2nd Highest 24-Hour TSP Impacts (ug/m^3)
(Note: Does Not Include 5 ug/m^3 Background Value)

FIGURE E 11.3.4.2