TERROR LAKE HYDROELECTRIC PROJECT

FINAL REPORT ON MOUNTAION GOAT STUDIES

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SUMMARY OF FINDINGS

Mountain goats on northern Kodiak Island, Alaska were aerially surveyed three times per year from 1982 to 1986 to delineate winter, post-kidding, and summer ranges and to investigate the effects of the construction and operation of the Terror Lake hydroelectric project on the goat population. Relatively low elevations in northern Ugak drainages constituted the most important goat winter range in the area. Many goats remained in Ugak drainages during late spring and early summer, but Kizhuyak and Terror/Uganik drainages became increasingly important in the post-kidding distribution. Goat distribution during summer was similar to that observed during the post-kidding period. The minimum goat population in the study area ranged from 203 to 257 during the study period with densities up to 1 goat/1.2 km^2 in the alpine areas of northwestern Ugak/Kizhuyak drainages. Two subpopulations of goats were identified: northwestern Ugak/Kizhuyak and Terror/Uganik. The northwestern Ugak/Kizhuyak subpopulation appears to have increased from 1974 to 1982, stabilized from 1982 to 1985, and declined from 1985 to 1986. Similar data were not available for the Terror/Uganik subpopulation. Productivity averaged 29 kids:100 adults (22% kids) with a peak in 1983 of 28% kids and a steady decline to 17% kids in 1986. Annual sport harvest averaged 26.8 goats in the study area. Liberalized regulations resulted in increased harvests in 1984-86. Goats were observed in close proximity to project activities throughout construction and post-construction periods. Parturition occurred near intense project activity in the Falls Creek area throughout the study. Some short term displacement was noted, but no long-term effects on the goat population are suspected. The project had relatively few adverse impacts on the goat population because it was constructed on spring/summer range and it permanently altered only small amounts goat habitat.

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INTRODUCTION

The Kodiak Electric Association (KEA) proposed construction of a hydroelectric facility on northern Kodiak Island, Alaska in 1965. The facility was to consist of a dam on Terror Lake in the Kodiak National Wildlife Refuge, a 10 km tunnel through a mountain ridge to a penstock and powerhouse in the Kizhuyak River drainage. A 27 km powerline was to connect the powerhouse with the city of Kodiak. Serious consideration of the project began in 1977. In 1979 and 1980, the KEA contracted the Arctic Environmental Information and Data Center to provide information on mountain goats (*Oreamnos americanus*) in the proposed project area and estimate potential impacts of the project on this population (Hickock and Wilson 1979, Spencer and Hensel 1980). Construction of the project commenced in 1982. An additional 21 km powerline to the village of Port Lions was designed and constructed in 1983.

Studies to monitor the impacts of construction and operation of the hydroelectric project on wildlife were required by the Federal Energy Regulatory Commission as a condition for licensing. The requirement was intended to partially mitigate for habitat lost due to project construction. The Alaska Department of Fish and Game (ADF&G) was contracted by KEA and the Alaska Power Authority (APA) to conduct the study on mountain goats. Spencer and Hensel (1980) predicted that the project would displace goats and deter expansion of the population, so this study was designed to delineate movement patterns and seasonal ranges and document any changes which may have been caused by project activities. The study began in 1982 and continued through the project's construction phase (1982-1984) and for two years into the operational phase (1985-1986). This report summarizes the results of that study.

STUDY AREA

The study area is located on the northern portion of Kodiak Island, Alaska (Figure 1). It includes 1,,461 km^2 of the Kizhuyak, Terror, Uganik, and northwestern Ugak Bay drainages (Figure 2). Steep-walled glaciated valleys are topped by granite peaks to 1,343 m. The maritime climate of the area is influenced by the Japanese current and is characterized by frequent fog, rain, and wind. Temperatures are mild throughout the year and annual precipitation exceeds 180 cm.

Vegetation in the study area is primarily a mosaic of grass, forbs, and brush from sea level to about 450 m. Sedges, (*Carex* spp.) bluestem grass (*Calamagrostis canadensis*), willow (*Salix* spp.), and cottonwood (*Populus balsamifera*) are the dominant species in valley bottoms and lower elevations. Hillsides support dense stands of alder (*Alnus crispa sinuata*) and red elderberry (*Sambucus racemosa*) underlain with lady fern (*Athyriaceae*) and interspersed with meadows of bluejoint grass, fireweed (*Epilobium angustifolium*), and salmonberry (*Rubus spectabilis*). Alpine vegetation above 450 m varies from dwarf birch (*Betula* spp.) and willow stands in lower areas to mountain slopes covered with sedges (primarily *C. macrocheata*), crowberry (*Empetrum nigrum*), low-bush cranberry (*Vaccinium vitis-idaea*), and various forbs including lupine (*Lupinus nootkatensis*), geranium

(*Geranium erianthum*), paintbrush (*Castilleja unalaschensis*), and saxifrages (*Saxifraga* spp.). Cliff, ridgetops, and actively glaciated sites are sparsely populated with vegetation similar to that found on alpine mountainsides.

Mountain goats, brown bears (*Ursus arctos middendorfi*), and Sitka black-tail deer (*Odocoileus hemionus sitkensis*) are the only large mammals in the study area. Goats were originally introduced onto Kodiak Island in 1952 at Hidden Basin, in the southern part of the study area. Additional transplants were made in 1953 (Burris and McKnight 1973) and the population has continued to increase. At present, there are an estimated 400 goats on the island, approximately 300 of which occupy the study area.

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METHODS

Goat distribution data were collected during three aerial surveys per year for a five-year period (1982-1986). During each survey, attempts were made to census all goat habitat in the study area in a single day. When weather prevented this, prominent river valleys were used as break points between days. Data collected included group size and composition, time of day, slope, aspect, elevation, and vegetation on the site. All observations were plotted on U. S. Geological Survey 1:63,360 scale topographic maps.

Winter distribution surveys were flown in February or March with a Bell-206 Jet Ranger helicopter. Post-kidding surveys were flown with a helicopter in June. These surveys were directed at delineating wintering and kidding areas. Post-kidding surveys also provided parturition data.

Summer surveys were flown in August with a Piper Super Cub or Bellanca Scout fixed-winged aircraft. These surveys were comparable to those used since 1970 by ADF&G for goat survey and inventory data collection on Kodiak. Population trend as well as summer distribution data were obtained.

Incidental goat observations were recorded by biologists during weekly brown bear radio-tracking flights (Smith and Van Daele 1987) and by Terror Lake hydroelectric project personnel. These data were not rigorously analyzed, yet they provided insight into goat movements near project features, distribution, and movements between survey flights and some aspects of natural mortality.

Harvest data were collected by interviewing hunters and analyzing horns from harvested goats. All hunting in the study area was by permit and successful hunters were required to bring horns into the Kodiak ADF&G office for sex and age determination.

Impacts of project activities on goats were investigated by analyzing all goat observations from the 184.7 km^2 "primary impact area" (Spencer and Hensel 1980). Movements data from this area were obtained from annual winter, post-kidding, and summer survey flights. Goat behavior and parturition near project activities were described by incidental observations by biologists and project personnel.

RESULTS

Distribution

Winter Distribution

Relatively low elevations in northwestern Ugak Bay drainages contained the most important goat winter range in the study area (Figure 3). For the entire study period, 82% of the goats observed during winter surveys were in northwestern Ugak drainages with a mean elevation of 404 m (n = 490; range = 30-762 m) (Table 1). Kizhuyak and Terror/Uganik drainages each had 9% of the observations with mean elevations of 425 m (n = 54; range = 224-731 m) and 757 m (n = 53; range = 183-1,067 m), respectively. Overall, the mean elevation was 434 m (n = 597; range = 30-1067 m). Southerly and easterly facing slopes were the most common aspects used by goats during the winter surveys (Table 2).

Observability of goats was low during winter surveys due to the habitat occupied and snow conditions. Many goats were seen within and just above the brushline yet others in the brush were undoubtedly missed. Marginal weather conditions and inexperienced survey pilots also added to variability in the data. Coverage of northwestern Ugak and Kizhuyak drainages was comparable on all surveys, but surveys of the Terror/Uganik drainage were not as consistent. Data from individual surveys are contained in the following reports: 1982 data-Smith and Van Daele 1984; 1983 data-Smith et al. 1985; 1984 data-Smith and Van Daele 1986a; 1985 data-Smith and Van Daele 1986b; 1986 data-Appendix I of this report.

Post-kidding Distribution

Many goats remained in Ugak drainages during late spring and early summer (66% of the study period total), but Kizhuyak and Terror/Uganik drainages became increasingly important in the post-kidding distribution (20% and 14%, respectively) (Table 3, Figure 4). Goats were also observed at higher elevations than during winter surveys throughout the study area ($\bar{X}$ = 692 m; n = 1,039; range = 305-1,189 m). That pattern was consistent for major drainages as follows: Ugak drainages-638 m (n = 684; range = 305-945 m); Kizhuyak drainages-741 m (n = 205; range = 411-1,097 m); Terror/Uganik drainages-877 m (n = 147; range = 564-1,189 m). Southerly and easterly slopes were the most commonly used aspects by goats during the post-kidding surveys (Table 2).

Summer Distribution

Goat distribution during the late August surveys was similar to that observed during the post-kidding surveys, but goats were seen at higher elevations. Northwestern Ugak drainages still provided habitat for most goats in the study area (68%) (Table 4). Most of the goats observed were near ridgelines, in alpine cirques, or in passes at the head of major drainages (Figure 5). Similar patterns of use were noted in both the Kizhuyak and Terror/Uganik drainages which had 18% and 14%, respectively, of the goats observed in the study area. Goats throughout the area were noted at higher elevations than during the winter or post-kidding surveys ($\bar{x}$ = 8161 m; n = 1,146; range = 427-1,220 m). Mean elevations were also higher in every major drainage: Ugak-833 m (n = 785; range = 427-1,128 m); Kizhuyak-868 m (n = 209; range = 610-1,158 m); Terror/Uganik-999 m (n = 152; range = 640-1,220 m).

Goats were observed on all aspects during the summer surveys (Table 2). Use of ridgelines and passes resulted in more even distribution of aspects used and no apparent selectivity for any aspect.

Population

Population Size

Data from summer aerial surveys indicate that the minimum goat population in the study area ranged from 203 to 257 animals during the study period (Table 4). Minimum goat density in the areas surveyed ranged from 1 goat per 4.67 km^2 to 1 goat per 3.69 km^2. Alpine habitat in the study area (elevations greater than 450 m) had minimum goat densities ranging from 1 goat per 2.55 km^2 to 1 goat per 2.02 km^2. Minimum densities for Northwestern Ugak/Kizhuyak drainages averaged 1 goat per 3.43 km^2 (1 goat per 1.79 km^2 of alpine habitat) and for Terror/Uganik drainages 1 goat per 7.0 km^2 (1 goat per 4.79 km^2 of alpine habitat).

Highest densities occurred in drainages immediately adjacent to the original transplant site, yet small groups have pioneered suitable habitat islandwide. During the study period, goats were reported as far north as Sharatin Mountain, as far east as Barometer Mountain, as far south as Jap Bay, and as far west as Karluk Lake. An islandwide aerial survey in the summer of 1985 indicated a minimum population of 360 goats.

Goats in the northwestern Ugak and Kizhuyak Bay drainages have established definable annual use patterns which include a great deal of interchange between the two drainages. Summer survey data from 1974-1986 demonstrate the movement between drainages as annual increases in one drainage coincide with decreases in the other drainage (Figure 6, Table 5). The goat population in this area steadily increased from 1974 to 1982. Between 1982 and 1985, the minimum population level stabilized at around 210 goats. In 1986, summer surveys suggested the population experienced a 22% decline from 1985 levels (164 goats in 1986 versus 211 goats in 1985).

This decline may have been an artifact of the method of data collection, however, comparisons of winter and post-kidding surveys in 1985 and 1986 suggest a real decline. Comparisons of post-kidding surveys indicated a 21% decline (139 goats in 1986 versus 178 goats in 1985) and winter surveys indicated a 22% decline (107 goats in 1986 versus 138 goats in 1985).

Approximately 40-50 goats occupied the Terror/Uganik Bay drainage portions of the study area from 1982 to 1986. Goats in these drainages appeared to follow a movement pattern similar to that seen in northwestern Ugak/Kizhuyak drainages, however, much of their range was outside the areas surveyed both during the project and during historic management surveys (1974-1981). Consequently, detailed analysis of population trends in the Terror/Uganik drainages are not possible.

Productivity

A minimum of 232 kids was produced in the study area from 1982-1986 ($\bar{x}$ = 46.4/year; range = 27-65) (Table 3). The percentage of kids in the population during post-kidding surveys averaged 22% (range = 17-28%) with an average ratio of 29 kids:100 adults (range = 20:100-38:100). In the five-year period, production in the study area peaked in 1983 at 28% kids and declined steadily to 17% in 1986 (Figure 7). Weather data were not available for the study area, but productivity showed no correlation with neither mean temperatures nor total precipitation recorded in Kodiak city during each spring.

Northwestern Ugak drainages had the greatest mean annual production of kids throughout the study ($\bar{x}$ = 30.2; range = 13-48; n = 151), followed by Kizhuyak ($\bar{x}$ = 10.0; range = 6-14; n = 50) and Terror/Uganik drainages ($\bar{x}$ = 6; range 3-11; n = 30). Most of the decline in overall kid production was a reflection of productivity in the northwestern Ugak drainages. Kizhuyak and Terror/Uganik drainages did not experience similar declines (Figure 7).

Mortality

Hunters reported harvesting 134 goats from the study area between 1982 and 1986 ($\bar{x}$ = 26.8/year; range = 14-43 goats) (Table 6). Over half of the goats harvested were males (55%) and the mean age of all goats harvested was 3.5 years (range = 1-13 years). Most of the goats killed in the study area were taken in northwestern Ugak drainages (63%; n = 85). Twenty-eight percent (n = 37) were reported from Terror/Uganik drainages and 7% (n = 10) from Kizhuyak drainages.

Permits were required to hunt within the area and season dates were between 1 September and 31 October. Liberalization of regulations in 1984 increased the number of hunters afield and expanded legal hunt areas. A threefold increase in harvest (43 goats in 1984 versus 15 goats in 1983 and 14 in 1982) prompted a readjustment in regulations in 1985. In both 1985 and 1986, harvest in the study area was 31 goats.

Little information on natural goat mortality was obtained during this investigation. Comparison of the number and composition of goats observed during winter, post-kidding, and summer surveys in a given year were not analyzed because of the variability noted between these surveys. Two instances of brown bears attempting to prey on goats were observed in the study area. In one case, a project employee observed and photographed a bear charging a small band of goats near Falls Creek in the Kizhuyak drainage. One kid fell from the cliff as a result of the charge (Smith and Van Daele 1986a). The other case occurred in the same area on 23 June 1986. Incidental to a brown bear research flight, an ADF&G biologist observed an adult female bear make several charges at a group of goats. No goats were killed during the observation.

Project Impacts

Mountain goats were observed in close proximity to project activities throughout construction and post-construction periods. Ninety-one incidental goat observations were recorded by biologists and project personnel (Appendix II). Most of these observations (62%) were of goats frequenting the Falls Creek area in the Kizhuyak drainage. Up to 19 goats used that area in spite of road and dam construction and associated high levels of air and road traffic. Project employees reported that at least five kids were born near road and dam construction in 1983. Newborn kids were observed in the Falls Creek vicinity during post-kidding surveys during each year of this study (1982-3 kids, 1983-7 kids, 1984-5 kids, 1985-2 kids, 1986-4 kids). Goats were also observed walking along and across the access road. Goats were seen to use this area during all seasons, but observations were infrequent during winter months.

No goats were observed near the Terror Lake dam or reservoir during construction or post-construction periods. Goats were occasionally seen on ridges west of the lake. One set of goat tracks was noted on the dam in the spring of 1986.

Goats were observed within the primary impact area as delineated by Spencer and Hensel (1980) throughout this study with most use occurring during the spring and summer (Table 7). The greatest number of goats observed in the primary impact area was 73 (48 in Kizhuyak and 25 in Terror) during the 1984 post-kidding survey and the least seen was 0 during the 1982 and 1985 winter surveys. Survey data from the primary impact area did not indicate any changes in goat distribution which could be directly attributed to project activities.

Goat hunters used the project road, Shotgun Creek reservoir and the upper end of the Terror Lake reservoir for access to hunt areas. Although Terror Lake has been used as an access point since goat hunting started in 1968, project features allowed easier penetration into more remote goat habitat north of Mount Glottof and along the western ridge of upper Kizhuyak River.

DISCUSSION

During the 30 years since 17 mountain goats (7 males and 10 females) were introduced in the Ugak Bay area, goats have pioneered suitable habitat islandwide and have established annual use patterns on some parts of Kodiak Island. Within the Terror Lake hydroelectric project study area, two subpopulations appear to have become established; one group that ranges in the northwestern Ugak and Kizhuyak Bay drainages and another which uses the Terror and Uganik River drainages. These subpopulations are not discrete, but there appears to be little interchange between them and each exhibited unique annual movement and habitat use patterns.

In the northwestern Ugak and Kizhuyak drainages, goat movements are largely influenced by snow cover. During the winter, south-facing exposures and lower elevations are frequently used. Most goats were observed at the lower limit of the snow cover and on snow-free cliffs. Hjeljord (1973) stated that lady fern rhizomes and petioles were the main winter food source in the lower elevations and bunch grass and sedges were the principal food on the cliffs. Goats move into higher elevation as spring progresses and they do not hesitate to cross extensive snowfields to graze on developing vegetation in other drainages. Northwestern Ugak drainages still contained most goats in the study area during the spring, but Kizhuyak drainages received increased use at that time. Parturition occurred from mid-May to mid-June. Most nannies and newborn kids were seen on cliff faces or large rock outcrops, but no specific natal areas or habitats were identified in this study. Summer range was higher than spring range with more extensive use of alpine cirques, ridgetops, and inter-drainage passes. On summer ranges, forbs, especially flowering forbs such as lupine, are the preferred food (Hjeljord 1973).

Goats in the Terror/Uganik drainages appeared to have annual habitat use patterns similar to their counterparts in northwestern Ugak/Kizhuyak drainages. Although these goats ranged out of the study area for most of the year, it appeared that lower elevations near both Terror and upper Uganik rivers provided winter habitat. Ridges on either side of Goat Creek, west of Terror Lake, were the most frequently used areas during the spring and summer.

Goat densities in the northwestern Ugak/Kizhuyak drainages increased substantially from 1974 to 1982. This trend was probably a continuation of the expansion of the population since introduction. In 1982, goat densities stabilized and remained around 1 goat/4.5 km^2 until 1986. Although the overall density in these drainages is lower than the 1 goat/0.4 km^2 noted by Smith and Bovee (1984) in southeastern Alaska, goats occupied the 243 km^2 alpine area at densities up to 1 goat/1.2 km^2. All three aerial surveys in 1986 suggested at least a 21% decline in the number of goats in northwestern Ugak/Kizhuyak drainages from the previous year. If this decline is real, and not an artifact of data collection methods, it may be due to increased harvest, declining range quality or a combination of both factors. Liberalized hunting seasons resulted in a substantial increase in harvest in 1984-86. During the same period, kid production declined each year.

The stabilization and possible decline in goat density in northwestern Ugak/Kizhuyak drainages corresponds with Terror Lake hydroelectric project construction and operation. However, there are no data to suggest a correlation between these events. On the contrary, observations by project employees and biologists confirmed goat use, including parturition, in areas very close to project activities and features throughout the study period. Analysis of goat movements in the primary impact area described by Spencer and Hensel (1980) did not indicate any obvious changes in goat use patterns during the study period. Research methods were not sensitive enough to detect short-term movements or behavioral modifications of small numbers of goats that may have been caused by project activities. Chadwick (1973) reported that goats in Idaho appeared to move out of areas which received frequent helicopter use. Survey data suggested movements away from Terror Lake during dam construction in 1983 and some short-term displacement of goats along major flight paths between the project and Kodiak city may have occurred. However, goats in Falls Creek pass, an area which had very frequent helicopter traffic, became somewhat acclimated to the activity. Such variability in goat responses suggests that no definable "impact area" can be established.

No direct goat mortality attributable to project features or activities were noted during this study. The area inundated by Terror reservoir is not frequented by goats although it may have been infrequently used for movements across the valley. Terror Lake has provided access for goat hunters since the inception of goat hunting in 1968. The project enhanced access into hunting areas by providing road access, from Kizhuyak Bay across Falls Creek pass to Terror Lake, although motorized vehicle traffic is prohibited. Floatplane access was also improved with creation of the Shotgun Creek reservoir and expansion of Terror Lake. Hunters used the access points frequently during the 1984-86 seasons.

Smith (1986) noted that goat populations in southwestern Alaska that are in balance with other mortality factors can be rapidly depleted when human access is facilitated. However, in the Terror Lake project area all goat hunting is currently regulated by a limited number of permits, and any effects of improved access and increasing hunter success can be compensated for by altering permit availability.

Spencer and Hensel (1980) identified five potential adverse impacts on mountain goats associated with construction and operation of this hydroelectric project: 1) westward movement away from Terror Lake during construction; 2) displacement of goats utilizing Kizhuyak summer ranges into northwestern Ugak drainages and possible overpopulation of northwestern Ugak ranges during construction; 3) deterring the northward expansion of the goat population across the Kizhuyak-Terror divide; 4) permanent exclusion of goats from the power plant vicinity; and 5) temporary displacement of goats away from powerline construction. An apparent movement away from Terror Lake was noted during summer surveys in 1983, the year of peak construction activity in that vicinity (Smith et al. 1985). A similar movement out of Kizhuyak drainages was observed in the summer of 1983, however, this movement was suspected to be due to random interdrainage movements and not project related (Smith et al. 1985). No evidence of project

related displacements of goats into northwestern Ugak drainages was detected during this study. Goats did not expand into potential range north of the Kizhuyak-Terror divide during the project, but goats were occasionally observed north of the divide and frequent goat crossings of project roads suggest that the project did not present a barrier to northward expansion of the population. Goats were also observed above the powerhouse during both construction and operation. No goats were observed in the vicinity of the powerline during this study, hence no evaluation of temporary displacement away from powerline construction could be made.

The Terror Lake hydroelectric project had relatively few impacts on the mountain goat population because it was constructed in spring/summer range and it permanently altered only small amounts of goat habitat. Historically, only small bands frequented the construction areas. Had construction occurred in northwestern Ugak drainages where densities are much higher and year-round goat use is common, adverse impacts, undoubtedly, would have been greater. Winter ranges are especially critical. Construction activities causing permanent alteration or temporary displacement away from these ranges would have been detrimental to the population due to range overutilization, increased winter stress, and increased direct mortality associated with falls from icy cliffs.

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Table 1. Summary of aerial surveys of mountain goat winter distribution in the Terror Lake hydroelectric project study area, Kodiak Island, Alaska, 1982-1986.

Date	Northwest Fork Bay				Kizhuyak Bay				Terror/Uganik Bay				Total		
	Adults	Kids	Total	% Total [a/]	Adults	Kids	Total	% Total	Adults	Kids	Total	% Total	Adults	Kids	Total
27 and 26 Feb 82	59	19	78	99%	1	0	1	1%	0	0	0	0%	60	19	79
10 and 11 Mar 83	51	19	70	82%	9	4	13	15%	1	1	2	2%	61	24	85
23 Mar 84	88	34	122	81%	10	5	15	10%	11	2	13	9%	109	41	150
13 and 16 Mar 85	101	28	129	93%	9	0	9	7%	0	0	0	0%	110	28	138
15 Feb	72	19	91	63%	11	5	16	11%	30	8	38	26%	113	32	145
Total	371	119	490	82%	40	14	54	9%	42	11	53	9%	453	144	597

[a/] percentage of goats that were observed in each drainage during a given survey.

Table - Aspect use by mountain goats observed during aerial surveys of the Terror Lake hydroelectric project study area, Kodiak Island, Alaska, 1982-1986 (percentages in parentheses).

Aspect	Mountain Goat Observations		
	Winter	Post-kidding	Summer
North	15 (2.5%)	32 (3.1%)	83 (7.2%)
Northeast	23 (3.9%)	124 (12.0%)	107 (9.3%)
East	179 (30.0%)	284 (27.4%)	239 (20.7%)
Southeast	129 (21.6%)	153 (14.8%)	91 (7.9%)
South	78 (12.1%)	325 (31.4%)	194 (16.8%)
Southwest	148 (24.8%)	87 (8.4%)	271 (23.5%)
West	21 (3.5%)	30 (2.9%)	73 (6.3%)
Northwest	4 (0.7%)	1 (0.1%)	94 (8.2%)
Northerly[a]	42 (4.7%)	157 (11.2%)	284 (16.6%)
Easterly[b]	331 (36.7%)	561 (40.0%)	437 (25.5%)
Southerly[c]	355 (39.4%)	565 (40.3%)	556 (32.4%)
Westerly[d]	173 (19.2%)	118 (8.4%)	438 (25.5%)

[a] northerly exposure is the sum of north, northeast, and northwest aspects.

[b] easterly exposure is the sum of east, northeast, and southeast aspects.

[c] southerly exposure is the sum of south, southeast, and southwest aspects.

[d] westerly exposure is the sum of west, northwest, and southwest aspects.

Table 3. Summary of aerial surveys of mountain goat post-kidding productivity and distribution in the Terror Lake hydroelectric project study area, Kodiak Island, Alaska, 1982-1986.

	North Ugak Bay					Kizhuyak Bay					Terror/Uganik Bay								
Date	Adults	Kids	% Kids	Total	% Total [a/]	Adults	Kids	% Kids	Total	% Total	Adults	Kids	% Kids	Total	% Total	Adults	Kids	% Kids	Total
15 and 16 June 82	89	21	19%	110	62%	37	9	20%	46	26%	16	5	24%	21	19%	142	35	20%	177
9 June 83	118	48	29%	166	71%	27	11	29%	38	16%	24	6	20%	30	13%	169	65	28%	234
11 and 12 June 84	115	35	23%	150	59%	48	14	23%	62	25%	30	11	27%	41	16%	193	60	24%	253
12 and 19 June 85	119	34	22%	153	71%	19	6	24%	25	12%	32	5	14%	37	17%	170	45	21%	215
10 and 16 June 86	92	13	12%	105	66%	24	10	29%	34	21%	15	3	17%	18	11%	133	27	17%	160
Total	533	151	22%	684	66%	155	50	24%	205	20%	117	30	20%	147	14%	807	232	22%	1,039

[a/] percentage of goats that were observed in each drainage during a given survey.

Table 4. Summary of aerial surveys of mountain goat summer distribution in the Terror Lake hydroelectric project study area, Kodiak Island, Alaska, 1982-1986.

Date	Northwest Ugak Bay				Kizhuyak Bay				Terror/Uganik Bay				Total		
	Adults	Kids	Total	% Total [a/]	Adults	Kids	Total	% Total	Adults	Kids	Total	% Total	Adults	Kids	Total
12, 18, and Aug 82	92	39	131	53%	57	18	75	30%	37	6	43	17%	186	63	249
25 and 28 Aug 83	142	42	184	79%	17	9	26	11%	10	3	23	10%	179	44	233
27 Aug 84	116	38	154	75%	39	10	49	24%	-	-	-	-	155	48	203
26, 27 Aug and 6 Sept 85	140	36	176	68%	25	10	35	14%	38	8	46	18%	203	54	257
19 and 21 Aug 86	114	26	140	69%	20	4	24	12%	33	7	40	20%	167	37	204
Total	604	181	785	68%	158	51	209	18%	128	24	152	14%	890	256	1,146

[a/] percentage of goats that were observed in each drainage during a given survey.

Table 5. Mountain goats observed in northwestern Ugak and Kizhuyak Bay drainages, Kodiak Island, Alaska, during summer aerial surveys, 1974-1986.

Year	Goats Observed		
	Northwest Ugak	Kizhuyak	Total
1974	35	2	37
1975 [a]	36	5	41
1976	57	2	59
1977	63	26	89
1978	83	44	127
1979 [a]	119	7	126
1980	84	57	141
1981	148	19	167
1982	131	75	206
1983	184	26	210
1984	154	49	203
1985	176	35	211
1986	140	24	164

[a] no systematic aerial surveys conducted in 1975 and 1979.

Table 6. Number of mountain goats harvested in each major drainage of the Terror Lake hydroelectric project study area, Kodiak Island, Alaska, 1982-1986.

	HARVEST BY DRAINAGE																
	Northwest Ugak				Kizhuyak				Terror/Uganik				Total				
Date	Male	Female	Unk	Total	Male	Female	Unk	Total	Male	Female	Unk	Total	Male	Female	Unk	Total	Mean age
1982	5	5	0	10	1	0	0	1	0	1	1	2	7 [a]	6	1	14	2.6 yrs
1983	9	3	0	12	1	0	0	1	1	1	0	2	11	4	0	15	4.2 yrs
1984	15	11	2	28	1	0	0	1	11	3	0	14	27	14 [b]	2	43	5.3 yrs
1985	6	12	0	18	1	2	0	3	4	5	0	9	11	20	0	31	4.0 yrs
1986	10	7	0	17	3	1	0	4	5	5	0	10	18	13	0	31	3.5 yrs
Total	45	38	2	85	7	3	0	10	21	15	1	37	74	57	3	134	3.5

[a] includes one male killed in either northwest Ugak or Kizhuyak.
[b] includes one female killed in an unknown drainage in the study area.

Table 7. Mountain goats observed in the primary impact area of the Terror Lake hydroelectric project study area, Kodiak Island, Alaska, 1983-1986.

	Winter			Post-kidding			Summer		
	Kizhuyak	Terror	Total	Kizhuyak	Terror	Total	Kizhuyak	Terror	Total
1980 [a]	-	-	-	29	0	29	51	1	52
1981 [b]	-	-	-	-	-	-	16	-	16
1982	0	0	0	31	3	34	40	24	64
1983	13	0	13	34	2	36	20	10	30
1984	15	0	15	48	25	73	42	ND	42
1985	0	0	0	16	0	16	31	0	31
1986	16	0	16	25	3	28	10	3	13

[a] data from Spencer and Hensel (1980).
[b] data from ADF&G files, 1981 summer goat distribution survey.

Figure 1. Location of the Terror Lake hydroelectric project mountain goat study area, Alaska.

Figure 2. Terror Lake hydroelectric project mountain goat study area, Kodiak Island, Alaska (150 m contours)(Scale: 1 cm=2.0 km).

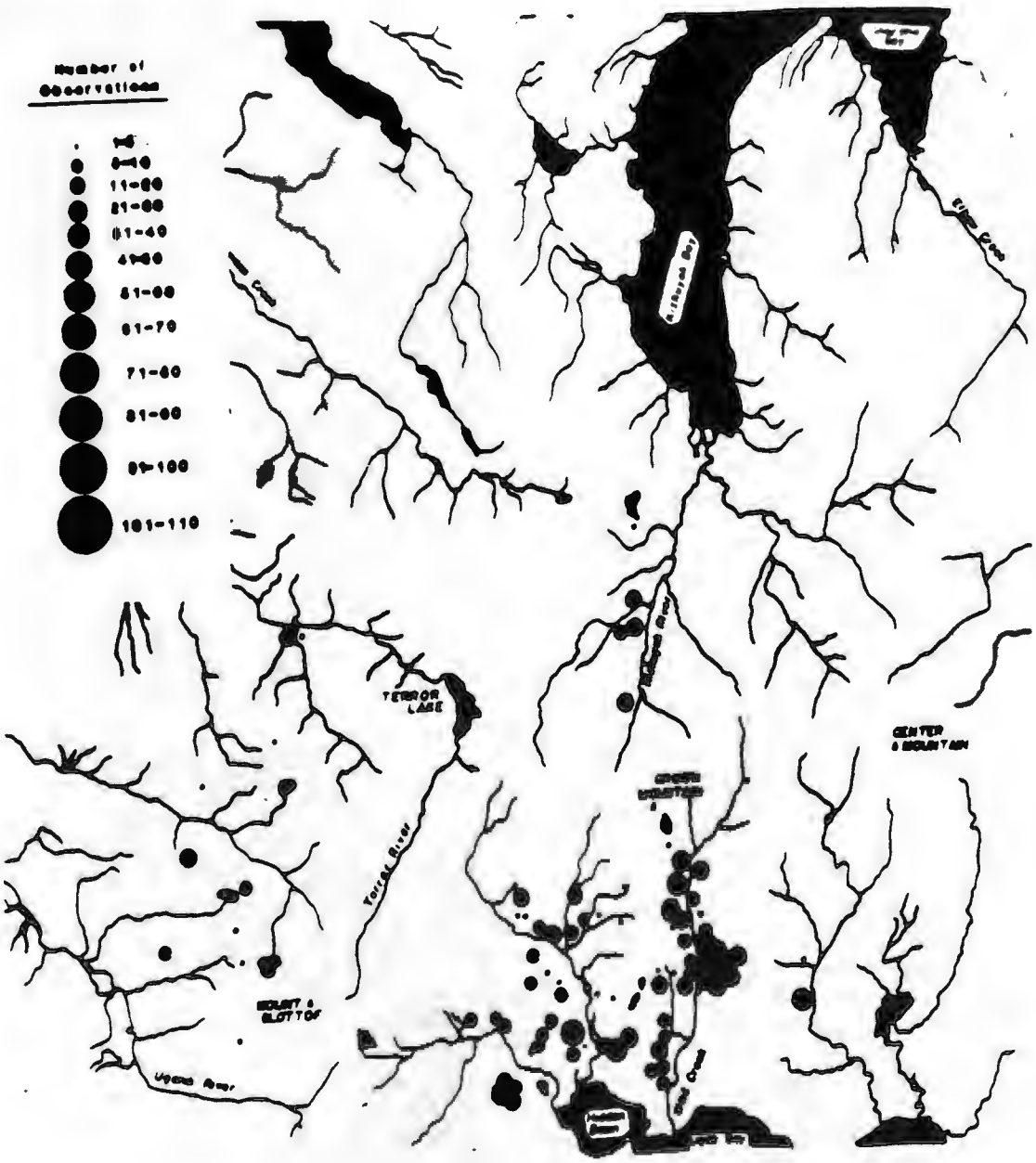

Figure 3. Winter distribution of mountain goats in the Terror Lake hydroelectric project study area, Kodiak Island, Alaska, 1982-1986 (Scale: 1 cm= 2.4 km).

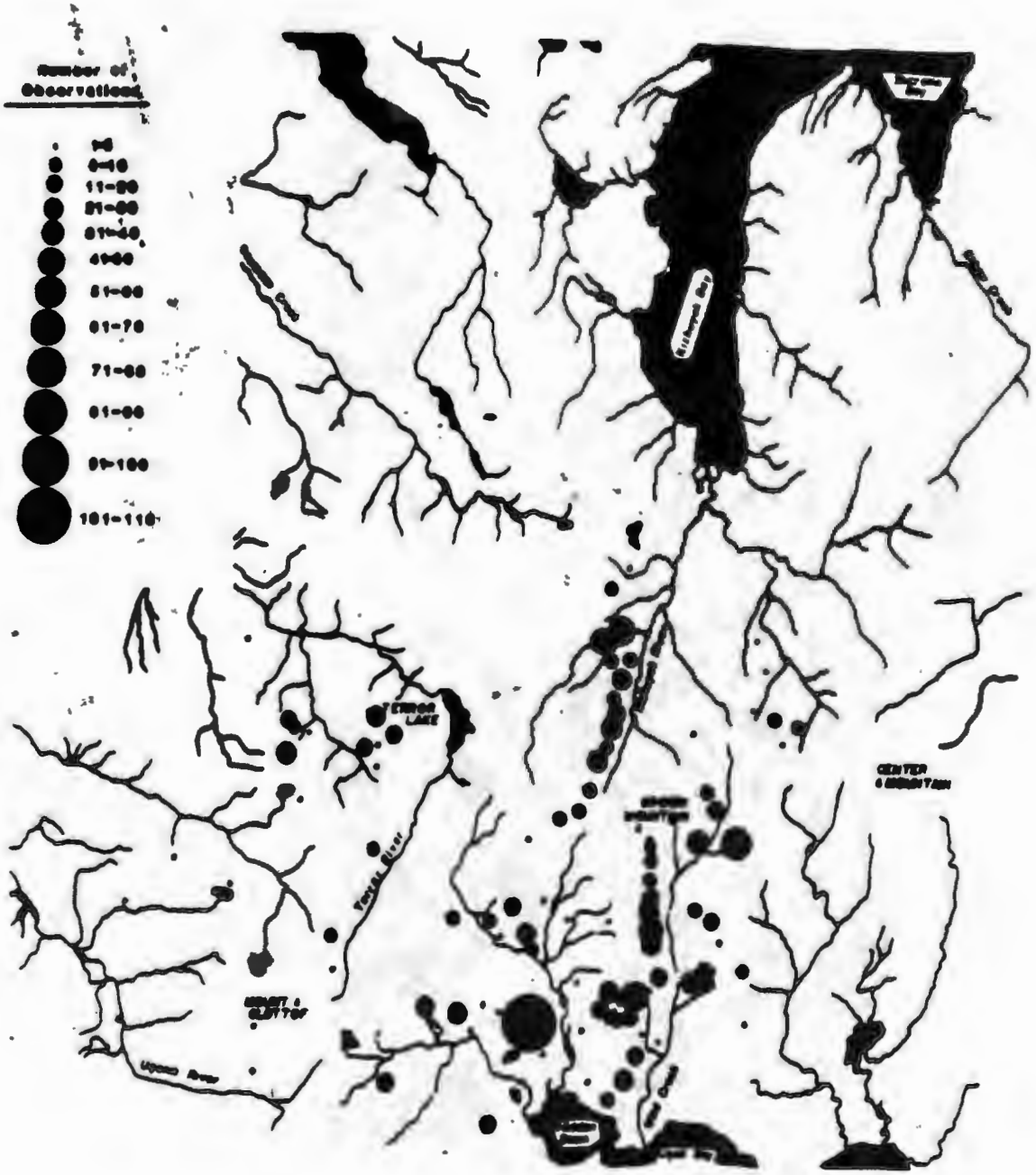

Figure 4. Post-kidding distribution of mountain goats in the Terror Lake hydroelectric project study area, Kodiak Island, Alaska, 1982-1986 (Scale: 1 cm=2.4 km).

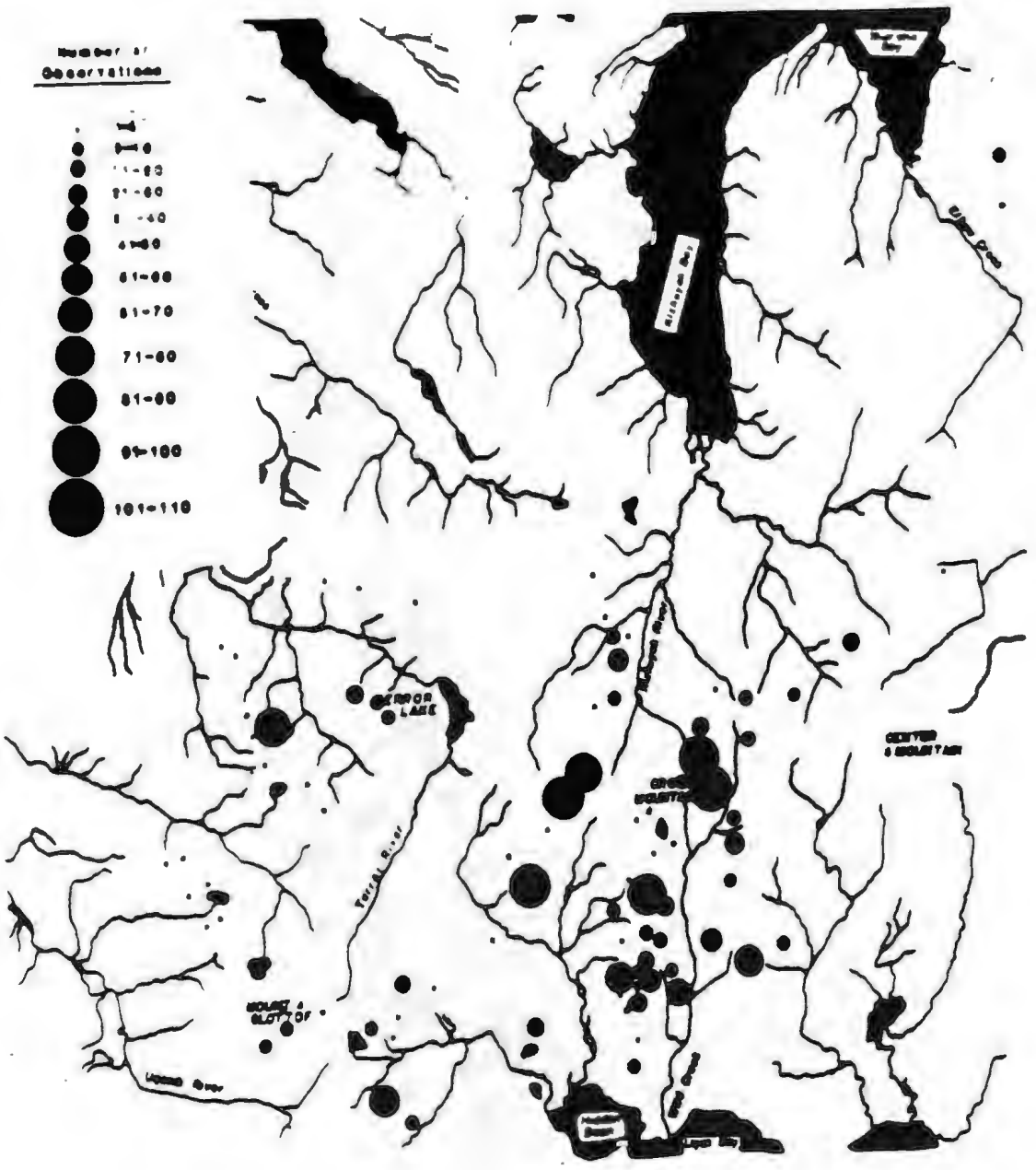

Figure 5. Summer distribution of mountain goats in the Terror Lake hydroelectric project study area, Kodiak Island, Alaska 1982-1986 (Scale: 1 cm=2.4 km).

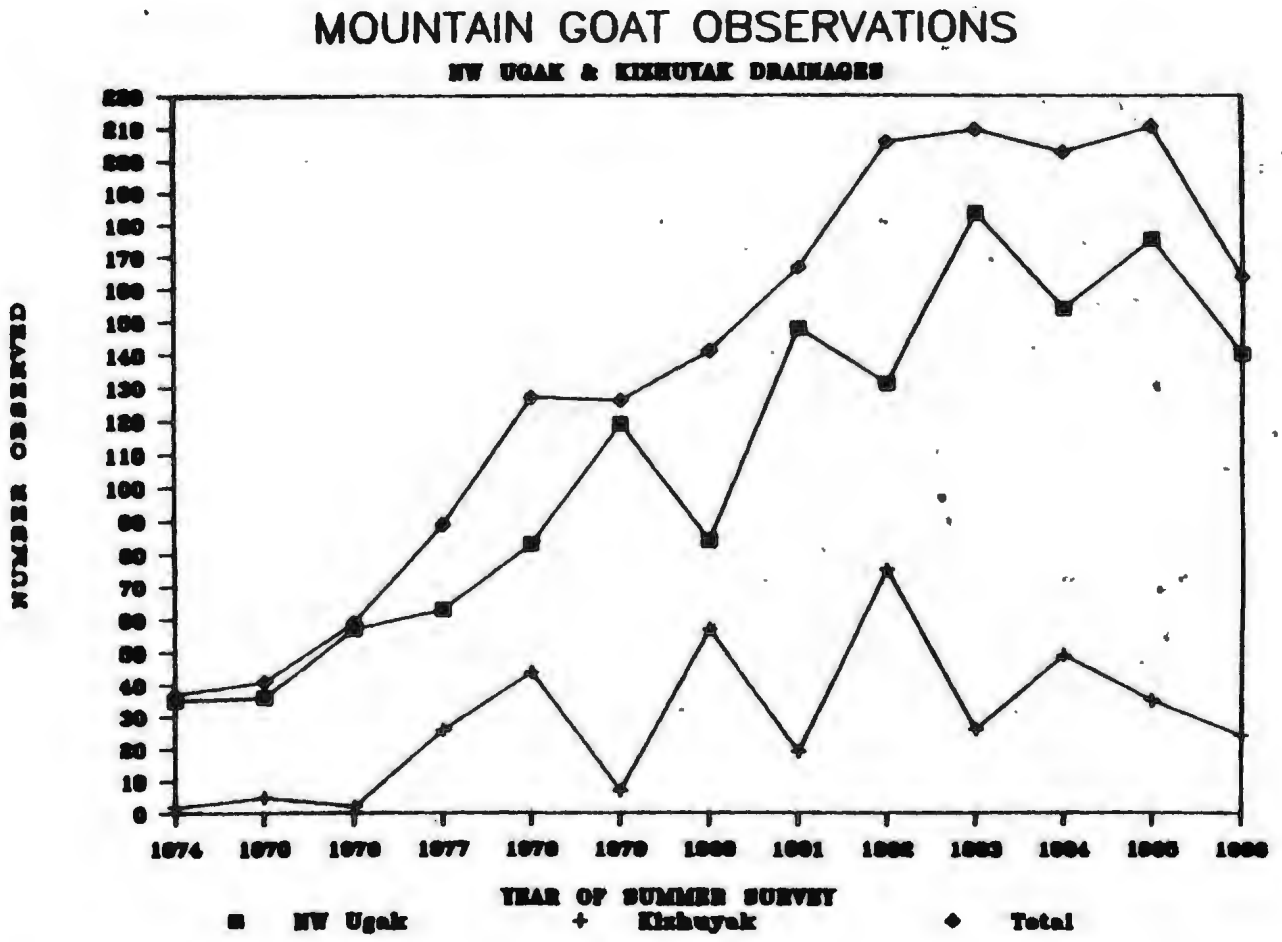

Figure 6. Mountain goat observations in northwestern Ugak and Kizhuyak drainages during summer surveys, Kodiak Island, Alaska, 1974-1986.

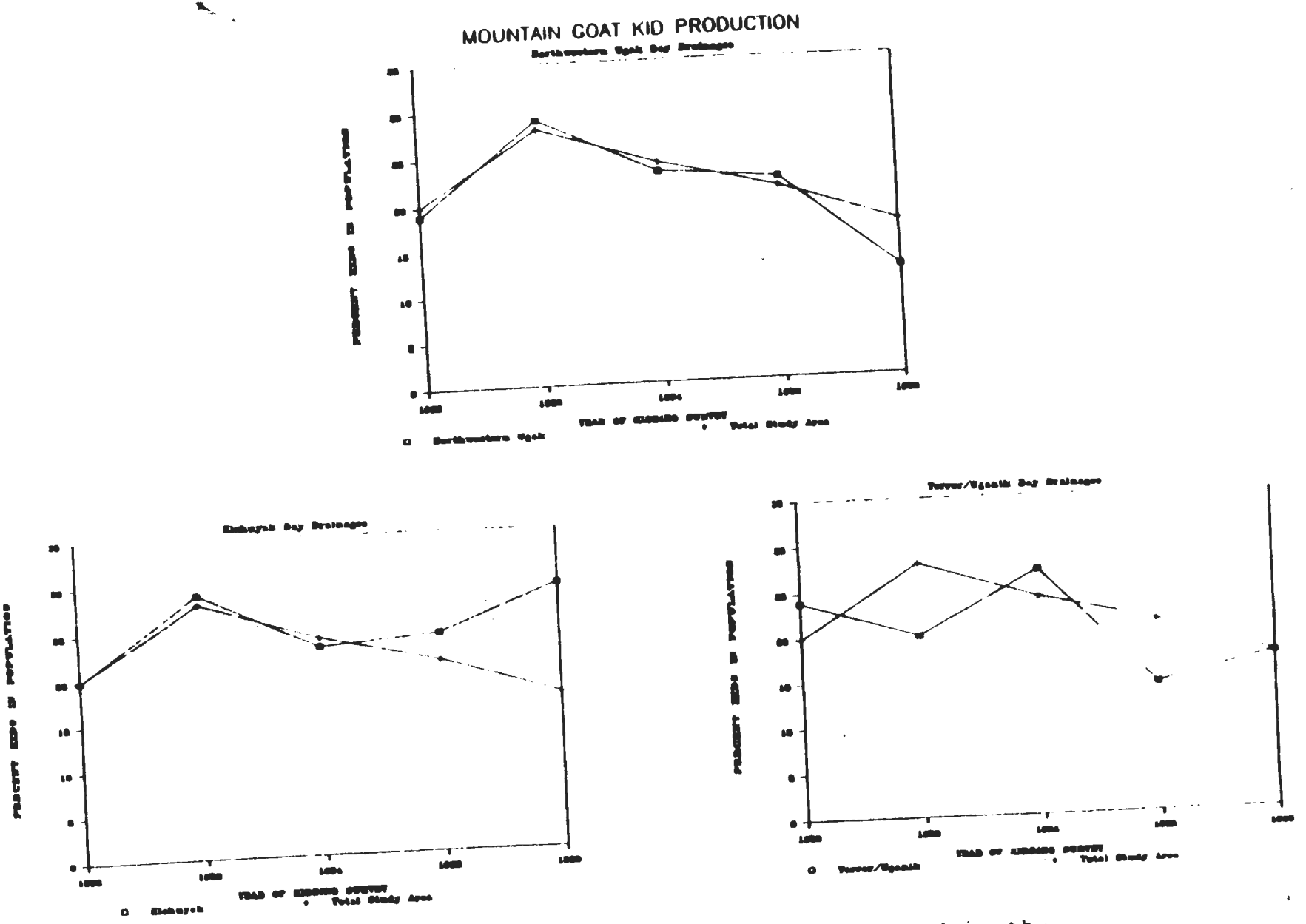

Figure 7. Mountain goat kid production observed in the Terror Lake hydroelectric project study area during post kidding surveys, Kodiak Island, Alaska, 1982-1986.

Appendix I. Mountain goat survey data - 1986

Table A. Winter distribution of mountain goats observed during an aerial survey of the Terror Lake hydroelectric project study area, Kodiak, Alaska on 15 February 1986.

Observation Number	Number of adults	Number of kids	Total Number	Aspect	Elevation (meters)	Drainage
1	2	2	4	SE	518	Kizhuyak
2	8	3	11	SE	549	Kizhuyak
3	1	0	1	SE	732	Kizhuyak
4	1	0	1	NE	168	Terror
5	2	0	2	SW	168	Terror
6	6	2	8	S	914	Terror
7	4	2	6	SW	914	Uganik
8	5	2	7	SW	1036	Terror
9	5	1	6	SW	975	Uganik
10	5	0	5	SW	1006	Uganik
11	1	0	1	E	1067	Terror
12	1	1	2	SW	792	Uganik
13	1	0	1	S	335	Hidden Basin
14	2	1	3	N	152	Hidden Basin
15	3	1	4	NW	305	Hidden Basin
16	1	0	1	SE	244	Hidden Basin
17	1	1	2	E	564	Hidden Basin
18	2	1	3	E	564	Hidden Basin
19	1	0	1	E	579	Hidden Basin
20	5	1	6	NE	579	Hidden Basin
21	4	0	4	SE	427	Hidden Basin
22	5	1	6	W	274	Hidden Basin
23	1	0	1	S	396	Wild Creek
24	4	0	4	SE	427	Wild Creek
25	2	0	2	SE	701	Wild Creek
26	7	2	9	E	518	Wild Creek
27	2	0	2	E	579	Wild Creek
28	3	1	4	E	518	Wild Creek
29	1	0	1	E	427	Wild Creek
30	2	2	4	E	328	Wild Creek
31	3	0	3	E	213	Wild Creek
32	1	1	2	W	259	Wild Creek
33	1	0	1	E	244	Wild Creek
34	2	0	2	E	274	Wild Creek
35	3	1	4	S	366	Wild Creek
36	1	2	3	S	366	Wild Creek
37	3	1	4	SW	335	Wild Creek
38	2	1	3	W	335	Wild Creek
39	4	2	6	S	701	Rough Creek
40	5	0	5	S	762	Rough Creek

Table 8. Post-kidding of mountain goats observed during an aerial survey of the Terror Lake hydroelectric project study area, Kodiak, Alaska on [illegible] and 16 June 1985.

Observation Number	Number of adults	Number of kids	Total Number	Aspect	Elevation (meters)	Drainage
1	2	1	3	S	701	Sharatin
2	1	0	1	SW	762	Terror
3	1	1	2	E	762	Terror
4	1	0	1	E	762	Terror
5	3	0	3	E	853	Terror
6	1	0	1	E	914	Terror
7	1	0	1	SE	1189	Terror
8	1	1	2	S	945	Terror
9	6	3	9	NE	610	Kizhuyak
10	1	1	2	E	701	Kizhuyak
11	1	0	1	NE	732	Kizhuyak
12	3	1	4	SW	427	Kizhuyak
13	1	0	1	SE	579	Kizhuyak
14	4	2	6	S	488	Kizhuyak
15	1	1	2	E	488	Kizhuyak
16	7	2	9	E	671	Kizhuyak
17	4	0	4	NE	914	Uganik
18	1	0	1	SW	884	Terror
19	1	1	2	S	792	Uganik
20	3	0	3	SW	701	Hidden Basin
21	5	0	5	S	732	Hidden Basin
22	2	1	3	NE	518	Hidden Basin
23	1	1	2	E	640	Hidden Basin
24	4	1	5	E	610	Hidden Basin
25	2	0	2	W	610	Hidden Basin
26	2	1	3	E	671	Hidden Basin
27	3	0	3	E	701	Hidden Basin
28	1	0	1	W	579	Hidden Basin
29	2	2	4	SW	610	Hidden Basin
30	5	0	5	E	610	Wild Creek
31	2	0	2	E	457	Wild Creek
32	3	0	3	E	610	Wild Creek
33	1	0	1	NE	610	Wild Creek
34	1	0	1	SE	549	Wild Creek
35	4	0	4	E	488	Wild Creek
36	2	0	2	E	671	Wild Creek
37	8	1	9	NE	610	Wild Creek
38	1	0	1	E	762	Wild Creek
39	3	0	3	E	610	Wild Creek
40	1	0	1	SE	762	Wild Creek
41	3	0	3	E	762	Wild Creek
42	10	2	12	E	701	Wild Creek

Table 5. (cont'd).

Observation Number	Number of adults	Number of kids	Total Number	Aspect	Elevation (meters)	Drainage
43	1	1	2	E	701	Wild Creek
44	3	0	3	E	762	Wild Creek
45	1	0	1	E	579	Wild Creek
46	1	0	1	E	549	Wild Creek
47	1	0	1	NE	518	Wild Creek
48	1	0	1	NE	457	Wild Creek
49	2	0	2	SE	732	Wild Creek
50	2	1	3	SE	640	Wild Creek
51	3	1	4	W	579	Wild Creek
52	5	0	5	SE	610	Wild Creek
53	1	0	1	SW	579	Wild Creek
54	1	0	1	SE	701	Wild Creek
55	1	1	2	SE	853	Rough Creek

Table C. Summer distribution of mountain goats observed during an aerial survey of the Terror Lake hydroelectric project study area, Kodiak, Alaska on 19 and 21 August 1986.

Observation Number	Number of adults	Number of kids	Total Number	Aspect	Elevation (meters)	Drainage
1	1	0	1	W	732	Kizhuyak
2	2	1	3	E	975	Kizhuyak
3	2	0	2	S	975	Wild Creek
4	3	2	5	W	701	Wild Creek
5	3	1	4	S	762	Wild Creek
6	8	1	9	S	762	Wild Creek
7	5	0	5	NE	640	Wild Creek
8	3	2	5	N	792	Wild Creek
9	3	1	4	N	823	Wild Creek
10	1	0	1	S	594	Wild Creek
11	2	0	2	N	914	Wild Creek
12	25	4	29	N	792	Wild Creek
13	1	0	1	N	625	Wild Creek
14	1	0	1	S	732	Wild Creek
15	4	1	5	SW	640	Wild Creek
16	7	1	8	NW	427	Wild Creek
17	1	0	1	SW	914	Wild Creek
18	1	0	1	SW	853	Hidden Basin
19	1	0	1	W	792	Hidden Basin
20	1	0	1	E	823	Hidden Basin
21	17	2	19	S	1067	Hidden Basin
22	2	0	2	S	1036	Hidden Basin
23	4	0	4	S	975	Hidden Basin
24	6	4	10	E	975	Hidden Basin
25	1	1	2	N	884	Kizhuyak
26	1	0	1	NE	975	Kizhuyak
27	1	0	1	SE	747	Hidden Basin
28	9	5	14	W	945	Hidden Basin
29	3	2	5	W	823	Hidden Basin
30	5	1	6	S	701	Sharatin
31	4	0	4	N	610	Kizhuyak
32	1	1	2	E	853	Kizhuyak
33	1	0	1	SE	975	Uganik
34	1	0	1	S	1219	Uganik
35	28	7	35	NW	1067	Terror
36	3	0	3	S	975	Terror
37	5	0	5	NE	823	Kizhuyak

Figure A. Distribution of mountain goats in the Terror Lake hydroelectric project study area, Kodiak Island, Alaska, 15 February 1986 (Scale: 1 cm=2.4 km).

Figure 8. Distribution of mountain goats in the Terror Lake hydroelectric project study area, Kodiak Island, Alaska, 10 and 16 June 1986 (Scale: 1 cm=2.4 km).

Figure C. Distribution of mountain goats in the Terror Lake hydroelectric project study area, Kodiak Island, Alaska, 19 and 21 August 1986 (Scale: 1 cm=2.4 km).

Appendix II. Incidental observations of mountain goats in the Terror Lake hydroelectric project study area, Kodiak, Alaska, 1982-1986.

Observation Number	Date	Number of Adults	Number of Kids	Total Goats	Aspect	Elevation (meters)	Drainage	Observer
1	5/22/82	1	0	1	SE	549	Falls Creek	ADF&G
2	5/22/82	1	0	1	SE	549	Falls Creek	ADF&G
3	5/22/82	2	1	3	S	823	Terror	ADF&G
4	5/22/82	1	0	1	S	671	Terror	ADF&G
5	7/06/82	2	2	4	S	640	Falls Creek	ADF&G
6	7/12/82	3	3	6	N	671	Falls Creek	ADF&G
7	7/20/82	1	1	2	N	671	Falls Creek	ADF&G
8	9/23/82	2	1	3	SE	---	Falls Creek	FWS
9	9/29/82	3	0	3	S	671	Sharatin	ADF&G
10	11/15/82	3	1	4	E	579	Kizhuyak	ADF&G
11	3/10/83	-	-	6	W	975	Uganik River	FWS
12	4/13/83	2	0	2	E	---	Terror	Proj
13	4/24/83	1	0	1	S	---	Falls Creek	Proj
14	4/25/83	1	0	1	S	152	Falls Creek	ADF&G
15	4/25/83	2	0	2	SE	305	Falls Creek	ADF&G
16	4/25/83	5	1	6	S	457	Kizhuyak	ADF&G
17	4/27/83	2	0	2	S	---	Falls Creek	Proj
18	4/30/83	2	1	3	S	183	Terror	ADF&G
19	5/16/83	5	1	6	S	---	Falls Creek	Proj
20	5/17/83	2	1	3	S	---	Falls Creek	Proj
21	5/17/83	4	1	5	S	---	Falls Creek	FWS
22	5/18/83	2	2	4	S	---	Falls Creek	ADF&G
23	5/19/83	3	2	5	S	---	Falls Creek	Proj
24	5/20/83	3	0	3	SE	---	Kizhuyak	Proj
25	5/20/83	1	0	1	SE	488	Falls Creek	ADF&G
26	5/20/83	1	0	1	E	488	Falls Creek	ADF&G
27	5/20/83	1	0	1	SE	335	Kizhuyak	ADF&G
28	5/21/83	1	2	3	SE	---	Falls Creek	Proj
29	5/22/83	2	0	2	E	---	Kizhuyak	FWS
30	5/22/83	1	2	3	SE	---	Kizhuyak	FWS
31	5/22/83	2	2	4	S	---	Falls Creek	FWS
32	6/10/83	4	3	7	SE	---	Falls Creek	Proj
33	6/10/83	5	5	10	S	---	Falls Creek	Proj
34	6/11/83	5	3	8	S	---	Falls Creek	Proj
35	6/14/83	1	2	3	S	---	Falls Creek	FWS

Appendix II. (cont'd)

Observation Number	Date	Number of Adults	Number of Kids	Total Goats	Aspect	Elevation (meters)	Drainage	Observer
36	6/16/83	6	7	13	SE	---	Falls Creek	Proj
37	6/18/83	3	3	6	S	---	Falls Creek	FWS
38	6/22/83	4	3	7	S	---	Falls Creek	FWS
39	6/24/83	2	1	3	E	---	Falls Creek	Proj
40	6/28/83	-	-	3	SE	---	Falls Creek	Proj
41	6/28/83	3	2	5	SE	---	Falls Creek	FWS
42	6/29/83	4	3	7	S	---	Falls Creek	FWS
43	7/11/82	4	3	7	S	---	Falls Creek	FWS
44	7/11/83	3	0	3	E	884	Watchout Cr	ADF&G
45	7/11/83	5	3	8	SE	884	Watchout Cr	ADF&G
46	7/20/83	2	0	2	NE	777	Uganik	ADF&G
47	7/20/83	2	0	2	SE	914	Uganik	ADF&G
48	7/21/83	1	0	1	N	---	Terror	FWS
49	8/03/83	2	2	4	S	---	Falls Creek	Proj
50	8/12/83	8	2	10	S	---	Falls Creek	Proj
51	8/12/83	-	-	10	S	---	Falls Creek	Proj
52	8/13/83	-	-	10	S	---	Falls Creek	Proj
53	8/14/83	8	2	10	S	---	Falls Creek	Proj
54	8/15/83	2	0	2	SE	1006	Watchout Cr	ADF&G
55	8/15/83	2	1	3	SE	1006	Watchout Cr	ADF&G
56	8/30/83	7	1	8	SW	792	Terror	ADF&G
57	8/30/83	2	0	2	S	---	Terror	FWS
58	9/03/83	1	2	3	S	---	Falls Creek	Proj
59	9/08/83	1	2	3	S	---	Falls Creek	FWS
60	9/10/83	3	2	5	S	---	Falls Creek	FWS
61	9/14/83	2	0	2	S	---	Terror	FWS
62	9/17/83	2	0	2	-	---	Terror	FWS
63	10/12/83	8	5	13	S	---	Falls Creek	FWS
64	10/13/83	3	2	5	S	---	Falls Creek	FWS
65	10/13/83	-	-	19	S	---	Falls Creek	FWS
66	10/21/83	10	0	1	E	701	Kizhuyak	ADF&G
67	11/23/83	-	-	5	S	---	Falls Creek	Proj
68	12/2/83	3	0	3	SE	427	Falls Creek	ADF&G
69	12/2/83	6	0	6	NE	244	Kizhuyak	ADF&G
70	12/2/83	1	0	1	E	259	Kizhuyak	ADF&G
71	12/2/83	3	0	3	E	335	Kizhuyak	ADF&G
72	12/2/83	3	0	3	SE	396	Kizhuyak	ADF&G

Appendix II. (cont'd)

Observation Number	Date	Number of Adults	Number of Kids	Total Goats	Aspect	Elevation (meters)	Drainage	Observer
73	3/19/84	2	0	2	SE	1006	Terror	ADF&G
74	5/06/84	3	0	3	S	---	Falls Creek	Proj
75	5/25/84	-	-	4	SE	----	Falls Creek	Proj
76	6/01/84	-	-	11	SW	---	Falls Creek	
77	6/05/84	6	3	9	SE	---	Falls Creek	FWS
78	6/11/84	-	-	6	S	---	Falls Creek	Proj
79	7/04/84	6	1	7	S	---	Falls Creek	Proj
80	8/13/84	3	1	4	S	945	Uganik	FWS
81	9/03/84	2	0	2	S	---	Falls Creek	Proj
82	6/15/85	7	0	7	SE	457	Falls Creek	ADF&G
83	10/4/85	3	1	4	-	---	Sharatin	ADF&G
84	5/28/86	8	1	9	S	457	Falls Creek	ADF&G
85	5/28/86	1	1	2	N	1128	Terror	ADF&G
86	5/28/86	1	0	1	NE	1069	Terror	ADF&G
87	8/14/86	4	1	5	SW	701	Sharatin	ADF&G
88	10/24/86	1	0	1	SE	640	Falls Creek	ADF&G
89	10/24/86	1	0	1	NW	792	Terror	ADF&G
90	12/05/86	7	1	8	SW	518	Falls Creek	ADF&G
91	12/05/86	1	0	1	SW	945	Terror	ADF&G