I 25

A MANAGEMENT STRATEGY FOR KENAI PENINSULA BROWN BEARS

Interagency Brown Bear Study Team

Kenai Peninsula, Alaska

1989

prepared by

Michael J. Jacobs

ACKNOWLEDGEMENTS

I would like to thank the people who helped conduct the field work. This document would not have been written without the diligent contributions of: J. S. Bevins, G. L. Risdahl, and C. A. Schloeder. Those responsible for the logistical support and provided their expertise are: E. E. Bangs, D. Logan, K. Nelson, C. C. Schwartz and N. L. Wieland. Other personnel that contributed time to this project or helped by reviewing the thesis and deserve recognition are: T. N. Bailey, R. L. Delaney, D. Holderman, B. Larned, S. D. Miller, M. Portner, B. A. Richey, K. Schneider, T. Schumacher, T. H. Spraker, W. Soroka, W. R. Staples, L. Van Daele, J. Westland.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

BASIC BROWN BEAR ECOLOGY FOR THE KENAI PENINSULA

1. Brown Bear Description

Size

Brown bears on the Kenai Peninsula are among the largest in North America, but generally are smaller than those on Kodiak Island and the Alaska Peninsula. Body weights for adult males range from 350 to 450 kg and adult females range from 200 to 350 kg.

Color

A typical Kenai Peninsula brown bear is chocolate brown in color but individuals range in color from dark brown to light blonde. Cubs-of-the-year and yearlings typically have a light colored ring around their neck and onto their chests. These "natal rings" usually disappear by the time they leave their mother.

Distribution and Occurrence

Brown bear habitat is available throughout the Kenai Peninsula with the exception of glaciated areas. Brown bears have been observed in all areas of the Peninsula north of Kachemak Bay (Fig. 1), but are most common west of the Kenai Mountains. This area provides adequate spring and

fall foods along the lower portions of the mountains, summer foods in the lowlands and den sites on steep slopes next to glaciers (Fig. 2). Habitat use varies seasonally and bear densities in specific areas vary throughout the year. In general, areas that provide adequate supplies of food throughout the year have the highest bear use. The highest reported occurrences of brown bear use have been in the benchlands between Skilak Lake and Tustumena Lake and south along the headwaters of the Ninilchik River, Deep Creek, Anchor River and Fox River. However, human activities affect this distribution. Relative population density seems to be lower than estimates from Kodiak Island or Admiralty Island.

2. Brown Bear Life History

Denning Chronology and Ecology

Throughout their range brown bears typically den in steep, undisturbed areas that have good snow retention characteristics (Craighead and Craighead 1972, Vroom et al. 1980, Servheen and Klaver 1983). Brown bears begin to move into denning areas in late October. Pregnant females are the first to enter dens. They are followed, chronologically, by females with cubs, lone females, and finally by males. In some areas den entrance is correlated with the first heavy snowfall of the year (Craighead and Craighead 1972). On the Kenai Peninsula males enter dens in

late October, through November. Females enter dens in October.

Emergence from dens sites is a gradual, generally occurring between March and June. Males are the first to leave their dens followed, chronologically, by lone females and females with cubs. Females accompanied by new cubs are usually the last bears to leave their den sites (Judd et al. 1983, Servheen and Klaver 1983, Schoen and Beier 1987, Smith and Van Daele 1988). On the Kenai Peninsula males emerge from their dens in late March and early April, with females emerging mid-April.

Movements and Home Range

Bears are capable of making large movements in short periods of time. However, the normal rate of movement per day is moderate (Canfield and Harting 1987).

On the Kenai Peninsula brown bears seem to move randomly in spring. The even distribution of staple foods may allow bears to range further to find preferred foods such as winter/wolf-killed moose and caribou. Bears move to salmon streams by mid-June and generally feed on salmon until late fall. During the fall scats consisting of berries are present along the salmon streams. This indicates that although salmon were a major food in the fall, berries were consumed also.

The area used throughout the year by an individual

brown bear is called its annual home range. Life-time home ranges include everything a bear needs to survive. The amount of area used by individual brown bear is dependent on habitat quality, bear density, sex and age of an individual. Home ranges are not considered territories and brown bears do not defend their borders, although a social hierarchy has been observed in some areas of concentrated food sources, such as a fishing location on a salmon spawning stream (Egbert and Stokes 1976). In the Brooks Range of northern Alaska annual home range sizes of almost 2000 km^2 have been noted (Reynolds and Hechtel 1980) while on Kodiak Island home ranges as small as 6 km^2 were observed (Smith and Van Daele 1988). Home ranges on the Kenai Peninsula averaged 500 km^2. Throughout their North American distribution, female brown bears have considerably smaller home ranges than males. Female offspring typically occupy home ranges near those used by their mothers when they become independent. Male offspring usually disperse away from their maternal home ranges soon after they become independent.

Brown Bear Foods

The staple bear foods present in spring were grasses (Graminae spp.), sedges (Carex/Juncus spp.), and horsetail (Equisetum spp.)(Bevins et al. 1984, Risdahl et al. 1986, Schloeder et al. 1987). These foods were first available

during in spring in avalanche chutes and wet areas. They were abundant and widely distributed across the Kenai Peninsula. Spring bear foods used on the peninsula were most similar to those reported in southeast Alaska, and the Alaska Peninsula (Mace 1987). Grasses, Sedges and Horsetail were used in nearly all North American ecosystems during all seasons. Wild ungulate carrion was also used by bears in many of the ecosystems in North America. Moose and Caribou calves and winter-killed carcasses are prefered spring foods on the Kenai Peninsula.

Where available, brown bears seasonally eat salmon along the many spawning streams during summer and fall. On the Kenai, salmon are abundant as they spawn in various streams and rivers. Timing of the salmon runs are spread throughout the summer and fall which provides a source of fish from June through October.

In addition to salmon, fall foods consist of numerous species of berries. Devil's club (Oplopanax horridum), highbush cranberry (Viburnum edule), blueberries and mountain cranberries (Vaccinium spp.) were common on the Kenai Peninsula. Carrion from hunter-killed game also provides fall food for brown bears.

Reproduction

Brown bear mating generally occurs from May-June. Both males and females range great distances during this time.

Specific breeding areas are not established. Observations of groups of 3 or 4 adults during breeding season are not atypical in areas with dense brown bears populations. Individual males and females are usually associated with each other for a period of a few days up to a few weeks, but pair bonds are weak and both individuals may move on to other mates.

Family breakup and cub dispersal

Brown bear cubs stay with their mother until they are 2.5 or 3.5 years old. Weaning occurs from mid-May to early July and the female typically mates soon after her cubs are weaned. Independent cubs often stay together in sibling groups for a few days to several months, staying within their mother's home range.

Mortality and Survival

Brown bears have no natural predators except for conspecifics and humans. Bears have the highest natural mortality rates in the first year of life. Estimates of 30-40% for cubs are reported (Bunnell and Tait 1985). Mortality rates decrease significantly as bears reach the age of 3.5 to 4.5. Average life span for brown bears is about 21 years.

Interactions with Black Bears

Black bears actively avoid brown bears in most cases. Cases of brown bear predation on black bears has been reported (Harting 1987). In areas such as the Kenai Peninsula where both black and brown bears occur together, the 2 species are usually separated by either time or space. It has been noted, however, that when human activities in an area increase, brown bears will vacate the area and black bears will fill the void (Nagy and Russell 1978).

Interactions with Humans

No factor affects brown bear survival more than humans. The coexistance of brown bears and humans is dependent on the continued protection of areas that are essential to their survival. Negative impacts caused by subdivisions, industrial developments, road and highway construction, improper sanitation procedures and recreational developments have been well documented. Harassment as well as displacement from prefered areas occurs when these types of human activities persist. The opposite can also occur where garbage or livestock attract bears to confrontations with humans. Restricting human activities is rarely a popular management objective but appears to be the best method of reducing negative human/bear interactions.

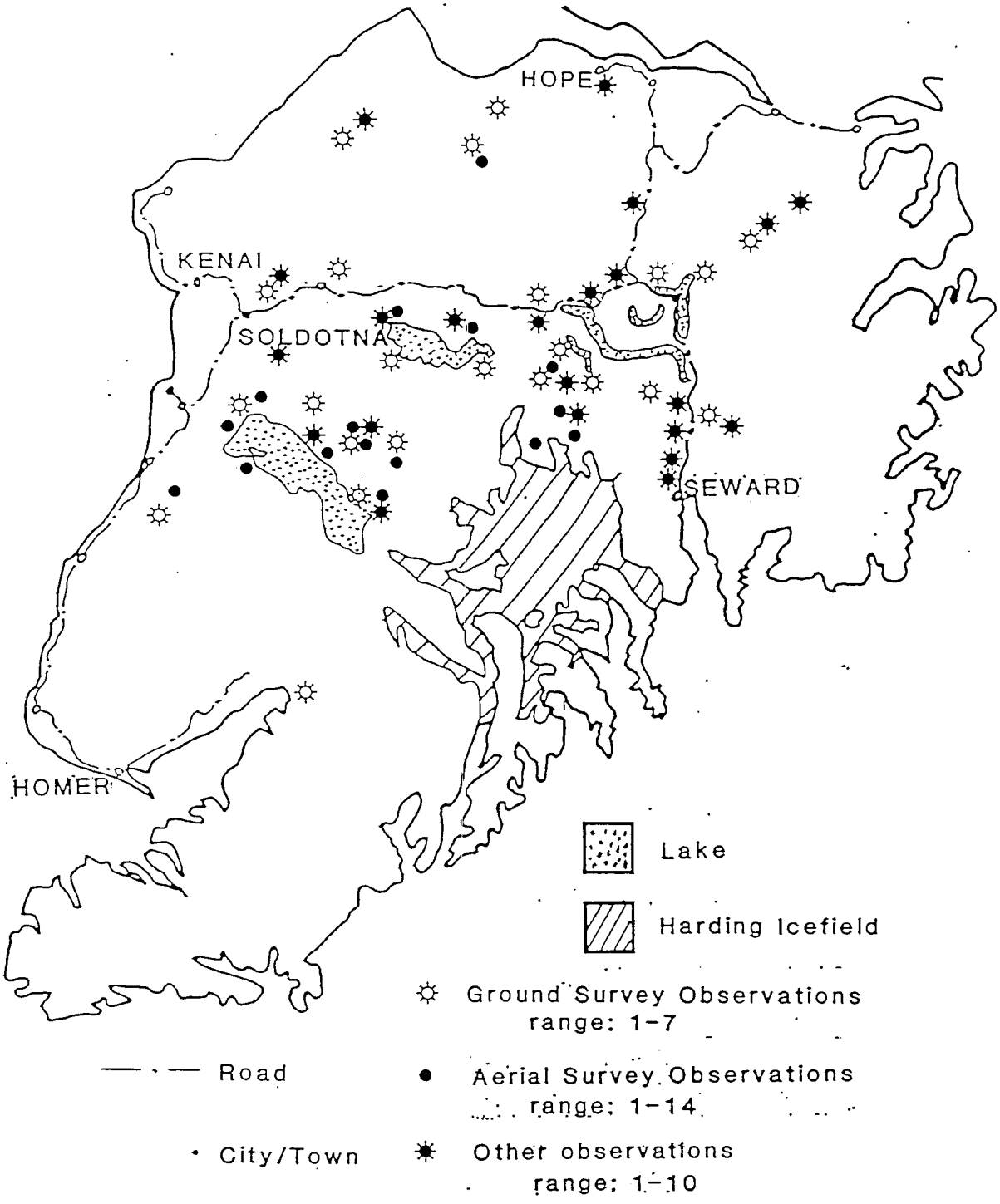


Figure 1. Summary of brown bear observations collected from Alaska Dept. of Fish and Game employees, U.S. Forest Service employees, U.S. Fish and Wildlife employees and the public from 1984 through 1987.

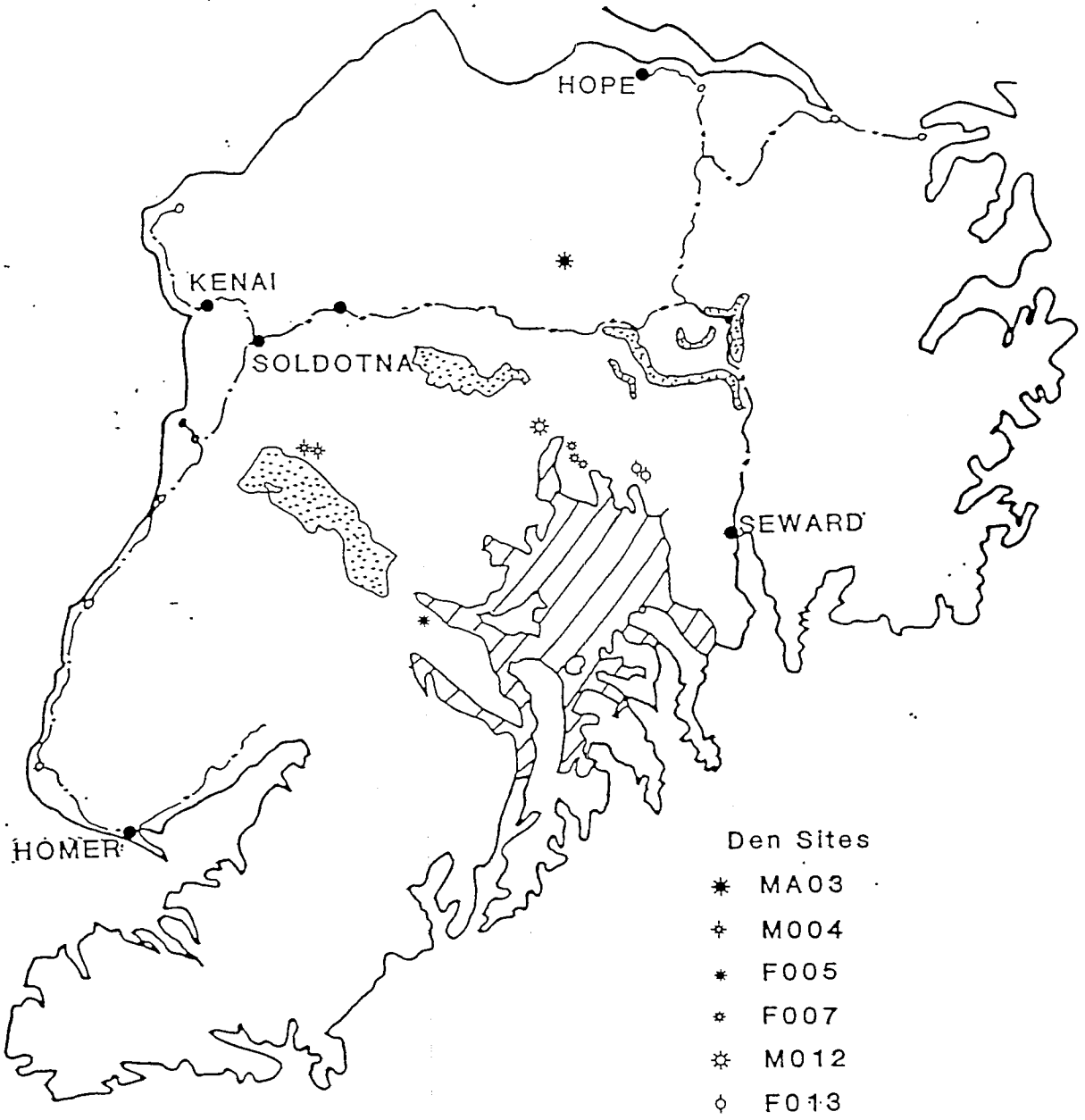


Figure 2. Ten den locations of collared brown bears located by aerial telemetry on the Kenai Peninsula, Alaska, 1978-1987.

RESEARCH SUMMARY

Increasing human activity and land development on the Kenai Peninsula, Alaska has brought about concern for the brown bear (Ursus arctos) population. The human population of the Kenai Peninsula has increased from 24,600 in 1977 to 43,000 in 1986. Because some human activities cause displacement and loss of critical habitat, research was proposed to address the situation and develop a management strategy to maintain a viable population size.

This document analyzes data collected from research conducted on the brown bear population and presents a management strategy. The data were collected from 1984 through 1987 and consisted of ground surveys to identify areas of brown bear use along salmon streams, aerial surveys, public observations, relocations of radio collared bears and harvest data.

The peninsula had an area of 23,310 km^2 with approximately 8800 km^2 of land used regularly by brown bears. This represented areas that bears or their sign were most frequently observed. Estimates of the brown bear population size on the peninsula are thought to be 150 to 250 by ADF&G and USFWS biologists, but were not based on capture-recapture techniques.

Relocations

Bears seemed to move randomly during the spring as spring bear foods are widely distributed across the peninsula. Carrion from winter/wolf-killed moose or caribou attracted collared bears and large movements to carcasses were observed. Use of salmon streams were clearly important for brown bears during the summer and fall. Between 1 July and 1 October, 73% of the relocations were on or very near salmon streams.

Annual home range sizes for males (949.6 km^2) were more than twice as large on the average as females (401.2 km^2). Home range sizes that were this large tended to overlap human developments which made bears more susceptible to human/bear conflicts. Males spent an average of 143.75 days in the den while females spent an average of 168.30 days. Den sites were located on similar slopes for both males and females (19.5°), and mean den site elevations were 389 m and 650 m for males and females respectively.

Observations

Brown bear observations from aerial surveys, ground surveys, and public sightings were used to estimate average litter sizes. Average litter size for females with cubs was 1.7; with yearlings was 1.9; and subadults was 2.0. When all age classes were pooled the weighted average litter size was 1.81.

Ground Surveys

Ground surveys supplied information about the distribution of brown bears across the peninsula. The areas of greatest use were: 1) Benchlands between Skilak Lake and Tustumena Lake, 2) Headwaters of Deep Creek, Ninilchik River, Anchor River and Fox River, 3) Chickaloon River drainage, 4) South Fork of the Snow River and 5) Johnson and Bench Lake area.

Based on track counts of 25 salmon streams, an average of 2.6 bears (range = 0-11) used a particular salmon stream at any one time. Large concentrations of bears using a salmon stream were not observed. Staple spring foods, grasses, sedges and horsetail were present in all of the 12 habitat surveys conducted.

Aerial Surveys

An average of 1.3 brown bears/hour were observed during 87.3 hours of aerial surveys. The highest rate of bears per hour were observed during the month of July (1.99 bears/hour).

Mortality

Annual mortality of brown bears had nearly doubled from 6.4/year to 13.2/year in the last nine years (Table 1)(Fig. 3). Seventy-nine percent of all harvested bears were killed

during moose season. Brown bear harvest was considered incidental to the moose harvest, therefore, an increase in the bear harvest was most likely a result of an increase in moose hunters during the last nine years. A spring brown bear season was added in game management unit (GMU) 15 and GMU 7 in 1978 and 1980, respectively, which increased total harvest numbers. The increase in yearly season length and access into hunting areas have also contributed to an increase in the harvest.

The sex ratio had shifted with the increase in the harvest (Fig. 4). From 1970-1978 the sex ratio of harvested bears was (male:female) 1.5:1, and was 0.9:1 from 1979-1987. Age distribution had fluctuated and did not follow a trend. Males were consistently the oldest bears in the harvest ranging from 1.5 to 28.5, while females ranged from 1.5 to 17.5 (Fig. 5).

Bears killed in defense of life or property (DLP) had not significantly increased from 1961 to 1987. Sex ratio among DLP deaths was 0.9:1. DLP's occurred between April and November but most frequently in late spring and early fall.

One of 4 bears tagged in 1978 and 3 of 13 bears tagged from 1984-1986 were killed in the reported harvest. This represents at least a 23% return.

Using Bunnell and Tait's (1980, 1981) model, maximum sustained mortality for the Kenai population was calculated

to be approximately 12% annually. By subtracting 5% natural mortality, 7% mortality could be caused by humans. This includes harvest, DLP, illegally killed and unreported kills. Three scenarios using population estimates from 100 to 300 provided a range of allowable human-caused mortalities from 7 to 21 bears/year (Table 2). The average estimate for the brown bear population was 200 bears, thus the estimated maximum number of human-caused mortalities per year was 14. Unreported and illegal kill rates were estimated by Brannon et al. (1988) and would translate to 1-2 bears per year when applied to the Kenai harvest. Once these are subtracted the reported mortality estimate was 12-13 bears per year. The average number of bears harvested on the peninsula was 16.3 per year from 1985-1987. Thus the Kenai harvest may be at or exceeding the recommended mortality rate.

RCR Trail Survey

The Russian River / Cooper Lake / Resurrection River (RCR) trail system was heaviest used trail by visitors to the peninsula. The trail system received approximately 5800 visitors per year. Use of the trail by campers and hikers did not change significantly from 1984 through 1986. Brown bear encounters/observations with hikers averaged 7 per year. The area the trail traverses between lower and upper Russian Lakes was the most common place (86%) that campers

and hikers encounter brown bears.

Conclusions and Recommendations

1) Although the data were limited, the brown bear population seemed to be at a low density. Future brown bear research should be directed at estimating the population and density by using capture-recapture techniques, although collecting a suitable sample will be a formidable task on the Kenai Peninsula.

2) Encroachment on essential habitat through road construction and land development has been shrinking current brown bear range by displacement or harassment. Although DLP's have not significantly increased, the potential for conflicts will increase as encroachment on essential habitat continues. The peninsula should be zoned according to areas that are essential, secondary or corridor and nonessential to brown bears. Each zone should have specific management recommendations with regard to potentially negative impacts on the brown bear population. Protection of salmon spawning sites used by brown bears should be foremost.

3) The harvest was increasing because of increased hunting pressure, longer season length, and easier access. The mean number of reported brown bear mortalities from 1985-1987 exceeded an estimated maximum human-caused mortality rate for a population size of 200 bears. Because the proportion of females in the harvest increased to

greater than 50%, this may indicate heavy hunting pressure of the population.

The harvest should be modified to reduce the total brown bear harvest and reduce the number of females killed. I recommend a maximum of 10-11 reported bear mortalities per year, 65%-70% male, to improve our margin of error until more definitive population data are available. This could be accomplished by shifting the harvest later into the fall and prohibiting the killing of any bears in family groups. Placing quotas on the number of bears harvested with a female subquota or closing the fall hunting season would be other methods to accomplish the management objectives.

4) The RCR trail system was located in essential brown bear habitat. Brown bears used the area during the spring, summer and fall. The trail should be monitored for visitor use at 3-5 year intervals and human/bear encounters recorded to detect trends. Using a Limits of Acceptable Change (LAC) format to determine the character and direction of future recreational activities on the trail system will determine the fate of the brown bear in this essential area. Other trails on the peninsula, where the potential for human/bear conflicts exists, should also undergo LAC evaluation.

Table 1. Reported brown bear mortalities on the Kenai Peninsula, Alaska, among all game management units 1961-1987.

GMU	1961-69	1970-78	1979-87	Total	male:female*
7	8	15	19	42	19:21
15A	11	13	24	48	27:20
15B	14	18	33	64	27:34
15C	24	23	43	90	46:42
morts./year (all units)	6.3	7.6	13.2		

* male:female ratios do not equal the total number because some bears were not sexed. One bear had no GMU recorded.

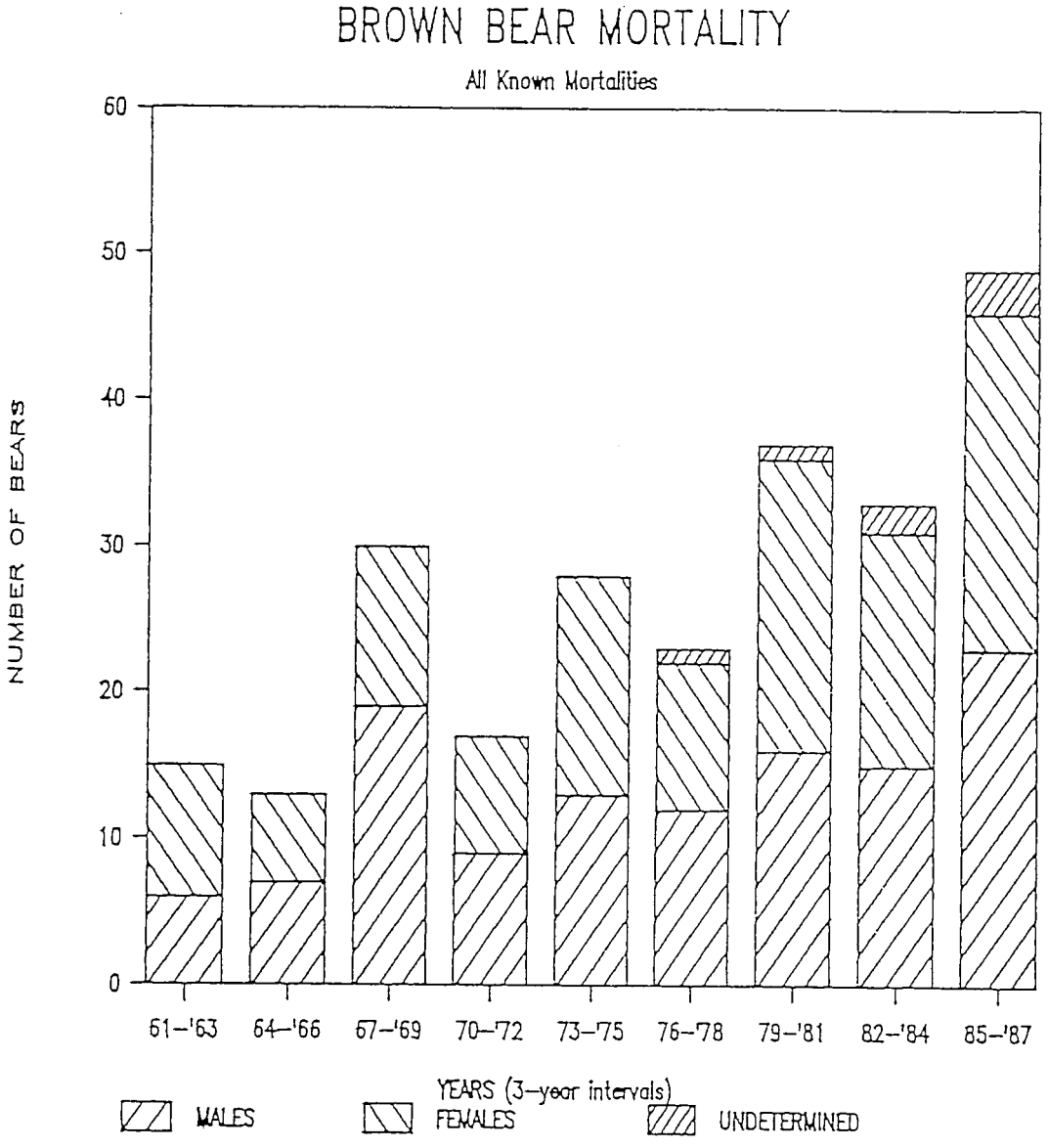


Figure 3. Brown bear mortalities on the Kenai Peninsula, Alaska, from 1961 through 1987. Some mortalities were not sexed, thus classified as undetermined.

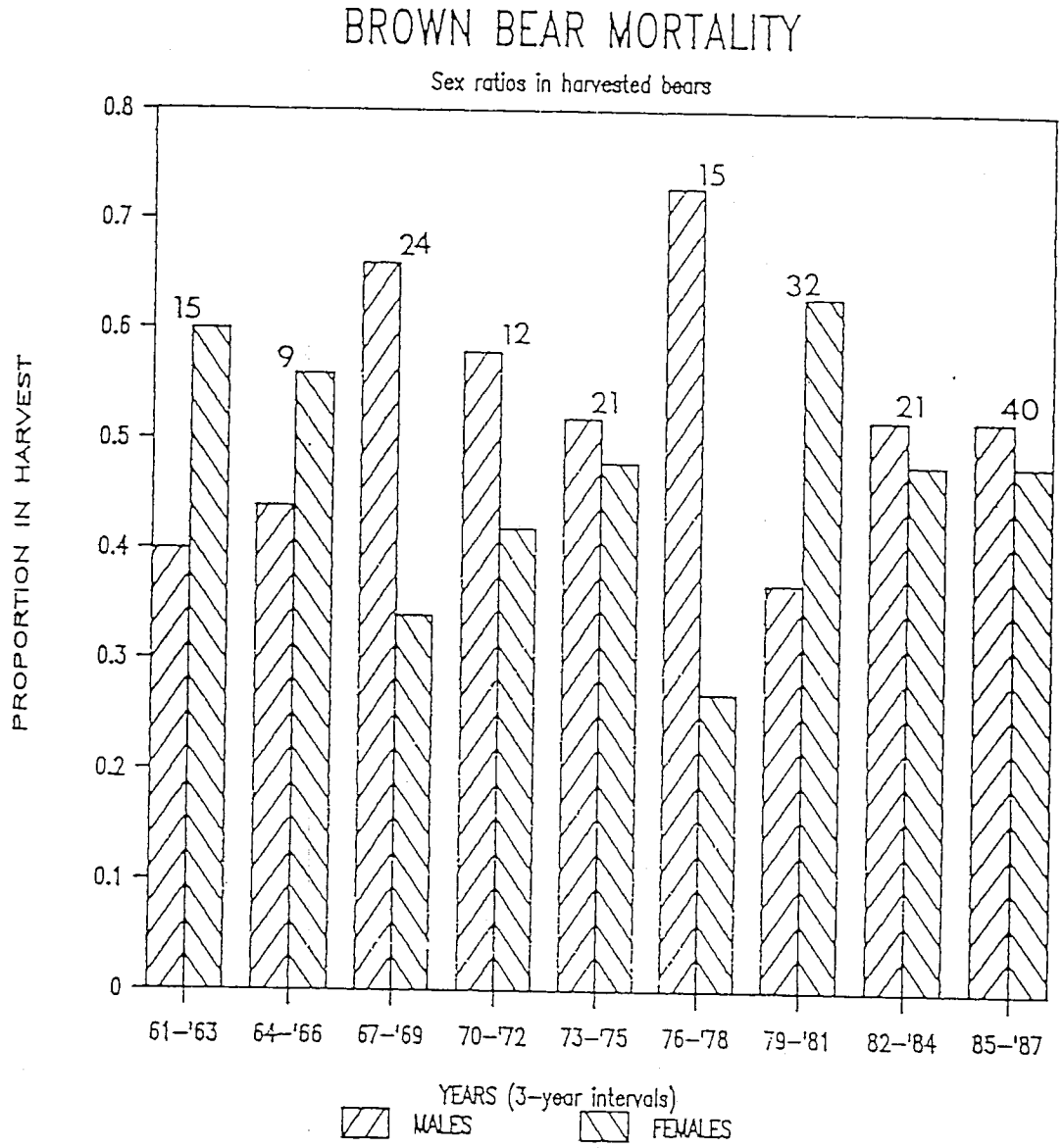


Figure 4. Sex Ratio in the harvest from 1961-87 on the Kenai Peninsula, Alaska. Sample sizes are located above each pair of bars.

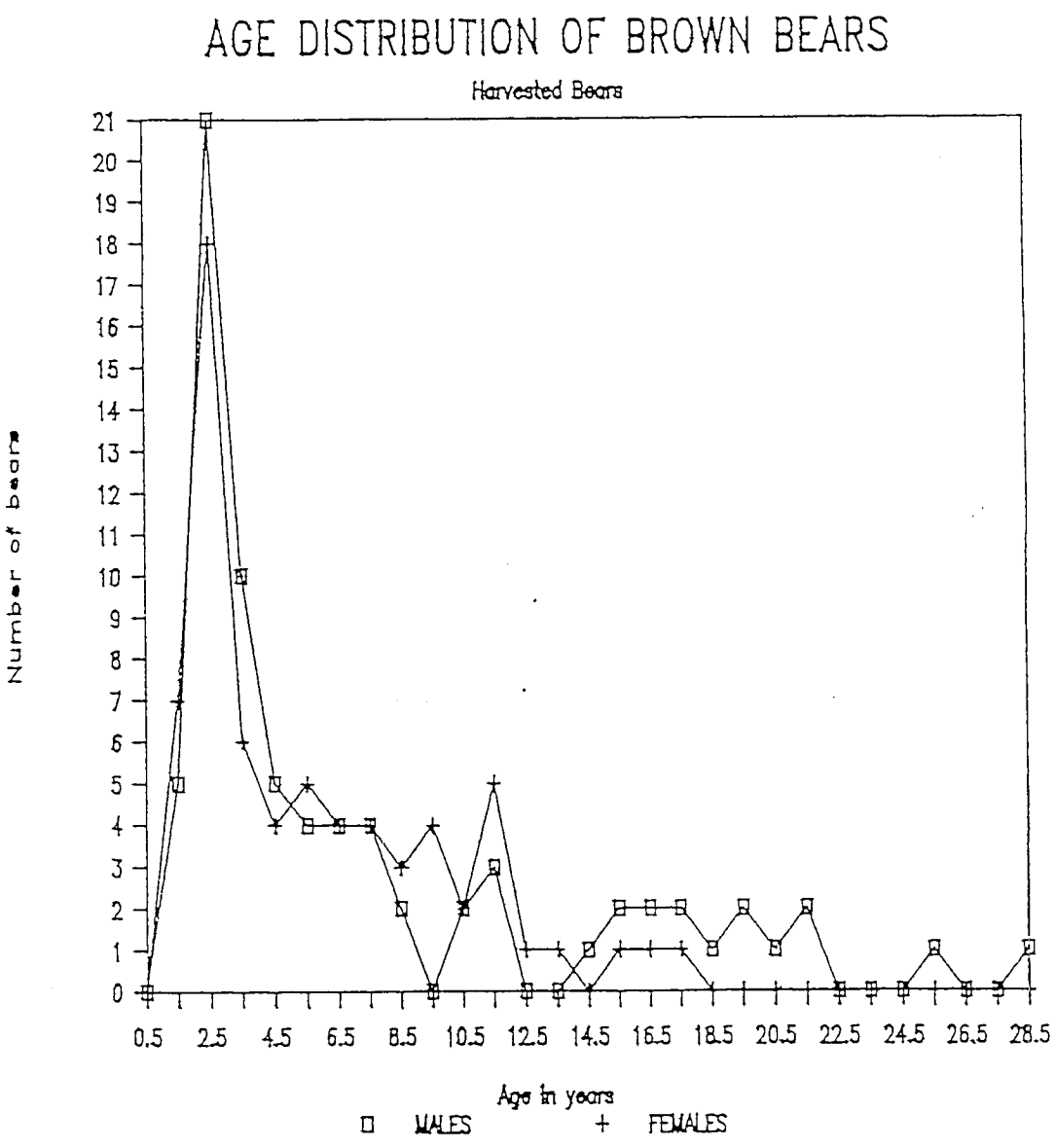


Figure 5. Age distribution in the harvest for males and females on the Kenai Peninsula, Alaska, 1967-87.

Table 2. Estimated maximum number of human-caused mortalities that could occur annually given a specified population size, a 12% maximum mortality rate and a natural mortality rate of 5% for adults.

Popul. size estimation	total mortalities @ 12%	natural mortalities @ 5%	human-caused mortalities allowable *
100	12	5	7
200	24	10	14
300	36	15	21

* Human-caused mortalities include harvest, defense of life or property deaths, unreported deaths and illegally killed bears.

BROWN BEAR MANAGEMENT

Management of brown bears is difficult. The basic techniques that biologists use to manage animal populations are not easily employed with brown bears. Without sufficient information biologists should make conservative management decisions, especially for a species with a low recovery rates. Conservative management can be identified from the management strategies used to manage low density brown bear populations in the lower 48 states and Canada. Conservative management can reduce the risk of making an error in judgement. Some of the risks that currently face Kenai Peninsula brown bear biologists are: 1) lack of reliable population assessment methods that would work on the Kenai; 2) maintaining genetic diversity and demographic stability in a small population of brown bears; 3) determining how to address continued land development and human activity in brown bear habitat; 4) a large proportion (>50%) of females are being harvested.

Population size and densities are very difficult to measure by means of line transect, capture-recapture, track counts and other methods, because of the excessive time, energy and cost required to obtain an accurate estimate. This is especially true for small populations of bears such

as the Kenai population. Estimates of sex ratios, survival rates, and age distributions vital in guiding the harvest of a population are based upon sample sizes that are generally inadequate. Therefore, management decisions should be made with more than population parameter estimates alone. Biological intuition and an understanding of the cumulative effects of human activities on mortality and habitat loss should also accompany management decisions

Current literature emphasizes specific concerns with regard to maintaining viable populations. These concerns are demographically and genetically related and argue that some species risk extinction if the population lacks demographic stability or genetic variability. Environmental or human-caused stochasticity are random events that can induce demographic or genetic change in a population. These events can be most critical to populations at low numbers. The result of a change in demography may result in a population's inability to reproduce. A genetic change may result in a reduction in genetic variability through founders effect, genetic drift and inbreeding depression (Schoenwald-Cox et al. 1983).

Although brown bears seem to have genetic variation in North America (Knudsen and Allendorf 1985), genetic diversity may be low on the Kenai Peninsula because the population was poisoned in the early part of this century (KNWR historical report 1938) which reduced the population

to low numbers. Further, immigration and emigration is probably minimal. This may or may not be a problem, but it should not be ignored.

To reduce the probability of demographic or genetic demise, bear populations must be managed above the minimum viable population (MVP) size. A MVP for selected species has been discussed in detail (Shaffer 1981,1986, Lehmkuhl 1984, Shaffer and Samson 1985, Suchy 1985, Reed et al 1986, Conner 1988). For brown bears an effective population size of 50 to 125 individuals is estimated to prevent negative inbreeding effects and assure short-term survival (Suchy 1985, Shaffer 1986). An effective population size of 500 individuals is estimated to prevent genetic drift and assure continued, long-term, adaptation (Soule 1980, Shaffer 1986). Simulation models used to determine MVP have increased the ability to determine the effects of changes in mortality and fecundity rates with respect to the survival of a population (Shaffer 1981, Harris 1984). However, point estimates for a MVP size should be viewed with caution.

Even if a population goal is selected, above a specified MVP size, the problem of determining the current status of the population remains. Population parameters (e.g. size, density, sex ratio, etc.), will remain difficult to measure with any accuracy. Questions such as, "how much human-caused mortality can the bear population sustain", "what amount of development or recreation will jeopardize

essential habitat" and "how much suitable habitat is needed to support a viable population" are the important issues that need to be determined. Information needed to provide a starting point for these questions is the data collected by the IBBST over the past 4 years. This information provided insight on the current distribution, movements, and relative abundance of brown bears on the Kenai Peninsula. Combining this information with current land use practices can help develop a cumulative effects analysis model.

A cumulative effects analysis (Weaver et al. 1985, USFS 1986) is an accepted method of determining how resources and environments change both naturally and from human activities. By analyzing these changes it is possible to evaluate the combined human impact on resources due to many types of activities. This analysis provides a clearer picture for land managers and enables them to see the probable results of their management decisions.

A large proportion of females in the harvest may indicate excessive hunting pressure and measures to reduce the number of females killed annually is suggested.

General Recommendations

Considering the available data and its limitations, and the desirability of assuring the survival of a brown bear population in the future, protection must be provided for essential brown bear habitats. Management of the Kenai population, would be best accomplished by retaining a large area of undeveloped land: 1) along the western slopes of the Kenai Mountains, including the Chickaloon drainage 2) in the benchlands between Skilak and Tustumena Lakes, 3) the headwaters of Deep Creek, Ninilchik, Anchor and Fox Rivers, 4) the Snow River/Nellie Juan drainages and 5) Johnson and Bench Lake areas on the eastern side of the peninsula. Corridors of habitat should be designated to connect these areas to ensure that areas of brown bear habitat are not isolated.

Harvest objectives should change for the peninsula. The need to reduce the number of females taken in the harvest should be addressed. This would decrease the risk of overharvest. Overall harvest should be reduced because population size and density are unknown but appear low. Natural mortality estimates for Kenai bears do not exist and age specific survival rates are unknown. A conservative strategy is logical when managing a species with a low recovery rate.

The major actions for managing Kenai brown bears should be:

1) provide enough a large enough continuous land base (suitable habitat)
2) eliminate or minimize disturbances in areas essential or seasonally important to bears
3) set a conservative harvest and reduce DLP conflicts

If these three items are accomplished, the crude methods of determining population trends would provide acceptable information, because the critical variables for the bears' survival would be satisfied, giving us a larger margin of error.

The Management Strategy

As the human population increases on the Kenai Peninsula, it becomes increasingly important to manage those types of human activities that negatively affect brown bear populations. The brown bear management strategy consists of two facets.

1) Zone the Kenai Peninsula to reflect differences in the area's importance to brown bear.

2) Modify the harvest objective in response to expanded information about brown bears on the peninsula.

Zoning Strategy

Zoning the Peninsula to manage bears is more accurately described as zoning to manage people. Zoning is the most effective way to provide the necessary protection of areas that are essential to bears. Three types of zones (essential, secondary, corridor and nonessential) were designated from IBBST research with regard to an area's importance to the population's survival. Some areas had high use by bears and provide a critical source of food, cover and space. These areas were designated as essential zones. Other areas had low or seasonal use or provided necessary travel routes across the peninsula. These were designated as secondary or corridor zones. Existing townsites, permanent campgrounds, and areas of high human

use generally were not considered important to brown bears and were designated as nonessential zones. Each zone has different management objectives. Criteria for determining the amount of area that each type of zone should encompass was based upon: (1) research addressing disturbance and displacement of North American brown bears by human activity; (2) estimates of the amount of habitat needed to support the desired population of bears and; (3) a realistic view of Kenai Peninsula land ownership.

Specific recommendations are outlined with respect to human activities, for each of the zones. Because the IBBST has no managing authority as a group, recommendations should be used as a guide for the individual agencies. Activities addressed are: road management, recreation (non-consumptive), mining, oil and gas exploration and development, housing development, timber operations, livestock grazing, garbage disposal, and aircraft disturbance (Fig. 6).

The desired minimum population size for the peninsula should be 300 bears. This would meet the requirements of a MVP size and provide a suitable density of bears on the peninsula. Food supply is probably not a limiting factor on the growth of the Kenai population, however, human activities and their associated impacts are. Therefore, I suggest the protection of 8800 km^2 for bear habitat. This area would be protected as either essential, secondary or

corridor zone. The protected area would be adequate for 300 bears as long as human activity is not excessive. If 300 bears occurred within the protected area, it would yield a density of 1 bear/29 km^2; close to the density reported by Miller (1987) for the Susitna area.

Essential Zone

Essential zones should be maintained in the most natural state possible. The purpose for this zone is simply to protect areas that are essential to the brown bear's survival. Protecting bears from disturbances that cause displacement and non-sport kills are of principal concern. Disturbance is most likely to occur from June through October when bears are feeding on salmon. Preventing development and limiting recreation in close proximity to these important areas will provide protection for both bears and people.

The largest portion of the essential zone designated for the peninsula lies within the Kenai National Wildlife Refuge and is managed as wilderness. Therefore, many of the recommendations are already in place for those areas. Essential sites outside the refuge are most vulnerable and in need of the most cooperation by the other land management agencies.

Management recommendations for essential zones are:
1) Maintain roadless conditions. Roads are considered to have a major impact on brown bear populations (Schallenberger 1976, Elgmork 1978, Jonkel 1982, Miller and Ballard 1982, McLellan and Shackleton 1988). Roads provide easier access for humans and hunters. Increased activity can cause displacement or avoidance of roads and surrounding areas which results in habitat loss. Where bears are habituated to roads, roads can provide them a travel route to housing developments. This increases the probability of human-bear encounters.

Existing roads should be closed to motorized vehicles. In some areas, such as designated wilderness on the refuge, motorized vehicles are already prohibited.

2) Allow camping, but sensitive areas (i.e. areas where the risk of a human/bear encounter is high), should be closed to hiking and camping at certain times of the year. Recreational activities previously thought to cause little or no impact on bears (i.e. hiking and camping), can cause displacement (Schleyer et al. 1984, McLellan and Mace 1985, Gunther 1986). The IBBST observed that brown bears left salmon streams after 4 days of snaring, even though transmitters were attached to the snares to reduce the number of visits by personnel to the stream. Bear activity was determined by the presence of fresh tracks.

Developments such as additional recreational cabins should not be built along trails in this zone as they can increase the probability of human/bear encounters.

3) Prohibit oil, gas, or mineral extraction except for existing walk-in mining claims. Road construction and the subsequent availability of access is the major problem with these types of developments (Schallenberger 1980, Jonkel 1982, Nagy et al. 1983). Avoidance of roads and the resulting habitat loss has been shown to be independent of traffic volume (McLellan and Shackleton 1988). The process of extraction is not necessarily the cause of displacement (Schoen 1986, USFS 1980). However, Harding and Nagy (1980) found that hydrocarbon exploration disturbed denning areas and caused abandonment.

4) Prohibit the construction of subdivisions or recreational cabins. Where subdivisions or recreational cabins already exist, garbage should be removed or incinerated quickly. Seasonal restrictions on use of recreational cabins in essential zones could be considered. The public should be educated about bear management objectives and methods for discouraging visitation by bears. Bears are not inhibited by housing or cabin developments if cover is present (Jonkel et al. 1978). Housing developments introduce garbage that can attract bears, eventually habituating them to this type

of food source (Servheen 1981). Subdivisions can also act as "population sinks"; areas that are within a bear's home range and therefore increase chances for human-bear conflicts (Knight 1987).

5) Prohibit logging operations. Existing logging roads should be closed to public access. Prescribed burning or "let burn" policies are acceptable practices and should be encouraged.

Some logging cuts are advantageous to bears because they stimulate growth of preferred bear foods (USFS 1986, Holland 1986). However, timing of the cut, placement and careful management of access are extremely important to reduce negative impacts. In most cases the negative effects caused by roads outweigh the positive effects of additional food plants. This is particularly true for a population that already has a reliable concentrated source of food (i.e. salmon) such as the Kenai population. Therefore, I do not recommend logging in essential zones.

Roads that provide access to timber cuts have the greatest impact to brown bears (Jonkel 1982). Human use of a logged area will almost certainly increase even after the cut is completed because of these roads (Craighead 1980, Archibald 1983). Continued human use eventually displaces brown bears or could end in a human-bear conflict.

Prescribed burns can be advantageous to brown bears by

enhancing growth of fruiting shrubs, grasses and forbs (Bratkovich 1986, USFS 1985c). Burns can be placed and timed to reduce impacts on brown bears (i.e. not near denning sites, fall feeding sites). Prescribed burns normally occur along existing roads or is done in remote areas by heli-torch. Therefore, it does not increase human access.

6) Prohibit livestock grazing. Grazing livestock in bear habitat has several negative impacts. Riparian areas along stream sides, seeps and springs are trampled and soil is compacted, reducing the productivity of fruiting shrubs, grasses and sedges (Jonkel 1982). Competition occurs between livestock and bears for spring grasses and sedges (Servheen et al. 1981). Bears will prey on livestock an thus livestock act as attractants, drawing bears into conflict with humans.

7) Enforce proper sanitation procedures in all bear habitat. Garbage and food should be stored out of reach of bears. Noncombustible garbage should be packed out. Bear-proof containers, raised platforms and meat poles are suggested for outfitters (Wood 1985) and unguided hunters. Cabin users should remove and burn garbage on a regular basis and should bear-proof their cabins (Zager and Jonkel 1980). Education programs (i.e. signs, pamphlets, etc.) for all

back-country users should be expanded (USFS 1982, 1985a, 1985b, 1985c, Brannon 1984).

8) Prohibit harassment by aircraft (fix-winged and helicopter). Disturbance of bears by aircraft has been well documented (Quimby 1974, Harding and Nagy 1980, Smith and Van Daele 1984, Campbell 1985). Specific lakes or portions of lakes should be closed to float planes during peak use by brown bears (see specific recommendations for Lower Kenai River Area).

Secondary and Corridor Zones

Secondary zones are defined as areas used by brown bear on the periphery of essential brown bear areas. The primary objective in this zone is to protect areas that are seasonally important. Increased public awareness of the importance and use of secondary zones by brown bears will help to decrease human/bear encounters.

Corridor zones are defined as areas that brown bears use to travel from one essential or secondary area to another. The major function for these zones is to allow for movement of bears to and from areas north and south of the Sterling highway and east and west through the Kenai Mountains. Movement to and from the Kenai Peninsula by brown bears occurs through a 17 kilometer wide strip of land. This corridor should also be managed to allow for

movement. Corridors are extremely important because they allow bears to disperse into lower density areas and breed. Movement of bears helps to maintain the genetic diversity of the population. Travel corridors will be the most difficult areas to justify protection. Corridors should be protected from developments because they restrict movements of bears. Housing developments, campgrounds, and industrial developments are potential dangers because they can also increase possible conflicts between bears and humans.

Management Recommendations for these zones are:

1) Close roads seasonally to public access. Road systems should be limited to the minimum necessary to accomplish the purpose (i.e. timber harvest), while enhancing and preserving bear habitat. Roads should be built to minimum standards (USFS 1985a) and constructed to facilitate their eventual closure. Roads should not cut through or parallel riparian zones. Motorized vehicles could be permitted on designated roads or seismic lines at specified times during the year.

2) Allow camping and hiking but encourage educational programs that teach methods of safe food storage and camp cleanliness.

3) Allow limited oil, gas and mineral development and extraction. This type of development should not be active during seasonally important times such as denning, (Schoen 1986). Roads created from these developments should be closed to the public from June through November. Off-site camps are recommended where applicable.

4) Limit the construction of recreational cabins. Bear conservation and public safety should be evaluated before approving cabin construction applications. Determining the cumulative human impacts that persist in the area should help in the evaluation. The LAC format should be used as the decision process.

5) Closely control logging operations and logging road construction. Roads should be closed to the public from May through November to avoid conflicts that could result in DLP deaths. Timing, placement, and type of the cut, combined with careful management of road access, are extremely important to reduce negative impacts. Detailed methods of cutting have been described to enhance bear habitat and reduce negative impacts to bears (Ruediger and Mealey 1978, Mealey 1979, 1986, Jonkel et al. 1979, Servheen 1981, USFS 1983, 1984, 1985a, 1985b, 1985c, Hillis 1985).

Prescribed burns are permitted and should be encouraged

where they are compatible with the management of other wildlife and fish.

6) Restrict livestock grazing. Stocking rate and seasonal limits should be placed on all grazing leases. Riparian sites should be fenced off to livestock to prevent degradation. Grazing leases should specifically require measures to protect areas important to brown bears.

7) Proper sanitation is as important in these zones as it is in the essential zone and should follow the same guidelines.

8) Prohibit harassment by aircraft. Current regulations should be adequate for management.

Nonessential Zone

Nonessential areas include town sites and heavily used recreational areas on the Kenai Peninsula (permanent campgrounds and public access sites for fishing). This zone is defined as area nonessential to brown bears because displacement has already occurred from human disturbance and settlement or they are absent from the area. These areas are used occasionally by brown bears, but management of bears in these areas is not considered a primary management goal.

Management recommendations for this zone should focus

on educating the public and developing policy to deal with problem brown bears. Recommendations are:

1) Provide educational programs to inform the public about human-bear encounters. This is particularly important in permanent campgrounds and at public fishing access areas. The public should be aware that bear encounters are possible in these areas.

2) Provide bear-proof garbage containers. This is will reduce campground habituation by both black and brown bears. Since permanent campgrounds provide garbage cans and dumpsters to the public, it will be necessary to follow a rigid schedule of collection and disposal. Garbage should be picked up late in the day to reduce the amount of garbage left in containers overnight.

3) Establish standard procedures for handling bears that roam into campgrounds, public fishing sites or town sites. Enforcement personnel should be familiar with a standard procedure. The recommended procedure is:

- the reported incident should be promptly investigated by the appropriate government officials.

- if a bear is present in a public area steps to protect human safety should be foremost. The attractant should be removed and action taken to repel the bear with

red pepper spray or rubber bullets if necessary. The conditioning of problem bears to avoid human activity should be the initial method of deterring these bears.

- bears that return, and threaten public safety may have to be destroyed. The bear should be trapped and destroyed in a humane way.

ZONE TYPE / ACTIVITY	ESSENTIAL	SECONDARY OR CORRIDOR	NONESSENTIAL
ROAD CONSTRUCTION	-Prohibited	-Not recommend -Build to minimum standards	-Not restricted
RECREATION	-No motorized recreation, -Seasonal back-country campsite closures	-Restricted motorized use -Education programs	-Education programs at public areas
OIL, GAS, MINERAL EXTRACTION	-Prohibited	-Limited development -Seasonal restrictions	-Not restricted
SUBDIVISIONS	-Prohibited	-Evaluation proceeding construction	-Not restricted
TIMBER OPERATIONS	-Prohibited except for burning	-Restricted except for burning	-Not restricted
LIVESTOCK GRAZING	-Prohibited	-Restricted	-Not restricted
SANITATION	-Enforce proper sanitation procedures	-Enforce proper sanitation procedures	-Enforce proper sanitation procedures
AIRCRAFT	-Prohibit harassment, -Seasonal lake closures	-Prohibit harassment	-Prohibit harassment

Figure 6. Proposed brown bear management guidelines for the Kenai Peninsula, Alaska.

Harvest Strategy

The ultimate purpose of each of the proposed harvest alternatives is to reduce brown bear mortalities from all sources and reduce the proportion of females in the harvest. There are several harvest alternatives that could produce these objectives depending upon population status, harvest trends and other demographic features.

1) Establish an upper limit on the harvest of brown bears. Quotas could be set for specific GMU's or overall. A female sub-quota should accompany this upper limit. If the human population on the peninsula increases further, brown bear hunting may increase and a limit should be established. Before Montana instituted a quota system in the Northern Continental Divide Ecosystem (NCDE), the reported sex ratio in the harvest was 53.8% males and 46.2% females (Brannon et al. 1988). After the quota system the harvest data indicate a shift in the sex ratio to 67.8% males, 32.2% females.

2) Shift the brown bear hunting season later into the fall, and prohibit the shooting of all family groups. This would reduce hunting pressure on bears and should reduce the number of females that would be vulnerable to hunters. The overlap of moose and brown bear hunting season should be eliminated or minimized. Gut piles are attractants and

could be a major factor in placing bears in proximity to hunters, increasing the potential for non-selective harvests. As the regulations stand, a female with a 2.5 year old offspring is legal to harvest. Prohibiting the harvest of any family group will provide greater protection of mature females.

3) Eliminate the fall brown bear hunting season. Fewer bears were harvested during the spring brown bear season and they were predominately male. This would meet the harvest objectives.

SPECIFIC AREA DESCRIPTIONS and RECOMMENDATIONS

The Kenai Peninsula was divided into 12 geographical areas. Each area was described individually to facilitate the land manager in finding the specific brown bear management objectives and recommendations. Specific designations for land units within each area are given to provide an even more detailed view of the units. The goal of this format is to assist the land managers in making decisions dealing with the development of areas on the peninsula. Development in the form of human habitation, recreation, oil, gas, and mineral extraction, and timber harvesting will be addressed when applicable.

The maps for the 12 geographic areas were divided up in a grid pattern for ease of locating a specific area (Fig. 7, 7a). Each of 19 maps represents a portion of the peninsula with respect to geographical area, land tenure and zoning. Maps are located directly following the area recommendations and include the following:

SWANSON RIVER	(area A)	CHICKALOON RIVER	(area B)
PLACER RIVER	(area C)	LOWER KENAI RIVER	(area D)
UPPER KENAI RIVER	(area E)	TUSTUMENA LAKE	(area F)
RESURRECTION RIVER	(area G)	NELLIE JUAN	(area H)
ANCHOR RIVER	(area I)	FOX RIVER	(area J)
FJORDS	(area K)	SELDOVIA	(area L)

Area "A" Swanson River

Description

The Swanson River area has the most development in terms of gas and oil extraction on the Kenai Peninsula. The Swanson river oil field lies in the near center of this area. The area is also traversed by many roads, especially in the western two thirds. Major habitat types in the Swanson River Area are lowland spruce and treeless bogs.

Brown Bear Abundance

This area may have once been prime brown bear habitat but it now receives relatively little brown bear use because of the considerable human use. Brown bear use is reported in the area sparsely throughout the summer, with greatest use in the fall. The upper Swanson River and the Swanson Lakes area is of greatest importance. Surveys conducted in the area by IBBST documented few predation sites even though there are large concentrations of red and silver salmon in several streams (Table 3).

Zoning

The western half of the Swanson River area is zoned nonessential and the eastern half is zoned secondary. Several sites appear to be seasonally used by brown bears and are thus zoned as secondary (Maps I-2,I-3). Important sites are portions of Sucker Creek and Pincher Creek.

Sucker Creek receives moderate brown bear use during the fall salmon spawning period.

Management Recommendations

The most important management objective in this area is to protect the secondary zone from excessive human development and activity. Recreationists should be warned about bears and persuaded to take the necessary precautions to avoid conflicts with bears. This responsibility is shared by state and federal agencies since much of the Swanson River area is within the KNWR.

Table 3. Estimated salmon escapements and brown bear use for the Swanson River Area, Kenai Peninsula, Alaska.

Drainage	King Salmon	Red Salmon	Silver Salmon	Pink Salmon	Dog Salmon	Bear Use
Swanson River	0	3000	6000	few	0	low
Sucker Creek	0	*	*	0	0	mod.
Bishop Creek	0	7500	?	few	0	low
Otter Creek	0	0	?	0	0	low
Seven Egg Creek	0	0	?	0	0	low
Pincher Creek	0	0	?	0	0	low
TOTAL	0	10500	6000+	few	0	
Average Spawn		Jul.10	Aug.28	Aug.		

? undetermined escapement
* included in the estimate for the Swanson River

Area "B" Chickaloon River

Description

The Chickaloon River area is located in the north central portion of the Peninsula. This area is fairly remote, however, the Mystery Creek road and pipeline road bisects the area. This road is closed to public access at the Sterling highway except during the fall big game season (August 30 - October 20). The Chickaloon area is chiefly designated as a minimal management area by the KNWR. A portion of the Lowland wilderness unit and the Mystery Creek wilderness unit make up the balance of the area.

Brown Bear Abundance

The Chickaloon River Area is an important area to brown bear during the summer and fall. The Chickaloon River provides some the best spawning habitat on the upper peninsula (Table 4). Because the area provides excellent spawning habitat combined with low human activity it is considered a high-use area for brown bears. Known predation sites for brown bears are located on the Chickaloon River from river mile 7 to 19. There is also bear use at a site on the Chickaloon River that is bisected by the pipeline road. Big and Little Indian Creeks receive salmon runs and some brown bear use. Both of these creeks have small areas in which salmon can spawn before they climb in elevation.

Mystery Creek receives large runs of red salmon but brown bear use was low to moderate.

Zoning

The Chickaloon area is zoned as essential to the north and secondary/corridor to the south (Maps I-3,I-4). The Chickaloon River area should be connected by a managed corridor to the largest continuous piece of brown bear habitat (i.e. the Skilak, Tustumena and Anchor River areas). Therefore, a corridor zone is also designated extending south from this area.

Management Recommendations

Limited access is recommended for the pipeline road. The current fall only opening which provides hunters (mainly waterfall) access appears compatible. The poor condition of the existing road limits its use, and we therefore do not recommend any improvements that would increase human use. The northern portion of this area should be as undisturbed as possible from mid-June to late October. In the southern portion of the area, bear/human encounters are likely near Fuller lake. This is within the proposed travel corridor and hikers, campers and horses should be educated about possible encounters with bears.

Table 4. Estimated salmon escapements and brown bear use for the Chickaloon River Area, Kenai Peninsula, Alaska.

Drainage	King Salmon	Red Salmon	Silver Salmon	Pink Salmon	Dog Salmon	Bear Use
S. Fork Chickaloon	2000	2000	?	0	0	high
N. Fork Chickaloon	600	0	?	0	0	
Lower Chickaloon	0	0	?	50000	0	high
Mystery Creek	1000	6500	?	0	0	mod.
Big Indian Creek	few	0	?	?	0	mod.
Ltl. Indian Creek	few	0	?	?	?	mod.
TOTAL	3600+	8500+	?	50000+	?	
Average Spawn	Jun.15	Jul.10	Aug.15	Aug.15		

? undetermined escapement

Area "C" Placer River

Description

The Placer River Area encompasses the Resurrection Creek drainage and East to Blackstone and Passage Bays. And from Cook Inlet and the Portage Creek valley south to Upper Trail Lake (Maps I-4,I-5). The Seward highway bisects this area along Canyon Creek, East Fork, and Grant Creek.

Brown Bear Abundance

Few brown bears use the Resurrection Creek and Hope region. Nearly all brown bear use is located in the eastern part of the Placer River area. Most bear sightings occur near Bench and Johnson Lakes, and along the Placer river near Spencer glacier. Brown bears use the area from April through November. Anadromous stream escapements are listed in Table 5.

Zoning

The Placer River Area has one region that is designated essential for brown bears. This region is located from Bench and Johnson Lakes to the Placer River. Brown bear observations in this location have been relatively high compared with other areas on the east side of the peninsula. Classifying a part of the Placer River area as an essential zone might seem difficult to understand since the railroad tracks run right through it. However, other than the trains

and crews working the tracks this area doesn't receive a large amount of human activity except during fall hunting season.

Retention of a travel corridor both north and south from this essential zone is important to the survival of those bears that use the area. The northern corridor is the peninsula's connection to the mainland. Any immigration that occurs to the peninsula must be through this corridor. From a genetic viewpoint this corridor is extremely important. The southern route that the bears are suspected to use is south along the west or east side of Andy Simons Mountain to Paradise Lakes. If this area was kept in a primitive state the bears would be able to travel from the Placer River to the North Fork of the Snow River to the South fork of the Snow to the Nellie Juan Valley to Kings Bay. The importance of the Nellie Juan Area to brown bears is unknown but it is suspected that bears do occur there.

Management Recommendations

Even though the town of Hope is not in the heart of brown bear range it poses a potential problem because of poor garbage management. It must be stressed that attractants such as open garbage dumps and campground dumpsters that are not bear-proof will draw bears to the area. These bears, usually end up dead. The USFS should bear-proof Porcupine campground and educate the people of Hope with respect to bears. Corridors should be maintained,

as described above, according to zoning objectives.

The Johnson Pass trail crosses the area and probably does not pose a threat to the bears because it is away from bear fishing spots most of the time. Visitor use should be monitored for increases and campers should be educated about possible brown bear encounters on this trail.

Table 5. Estimated salmon escapements and brown bear use for the Placer River Area, Kenai Peninsula, Alaska.

Drainage	King Salmon	Red Salmon	Silver Salmon	Pink Salmon	Dog Salmon	Bear Use
Resurrection Creek	500	0	250	35000	0	low
Sixmile Creek	500	0	?	?	?	low
East Fork River	0	0	?	50000	0	low
Granite Creek	1000	0	?	0	0	high
Placer River	0	?	500	0	0	high
Skookum Creek	0	0	?	0	0	mod.
Seattle Creek	0	0	0	?	0	low
Ingram Creek	0	0	0	?	0	low
Portage Creek	0	2500	500	?	?	low
TOTAL	2000	2500+	1250+	85000+	?	
Average Spawn	Jun.15		Aug.25	Aug.1	Aug.	

? undetermined escapement

Area "D" Lower Kenai River

Description

This area encompasses the portion of the Kenai River and its tributaries from the Russian River downstream. This includes the town sites of Kenai, Soldotna and Sterling. Area "D" is the most populated of the 12 areas. Most of the Lower Kenai Area is managed by the Kenai National Wildlife Refuge, however, state, native and private land ownership occur also.

The Lower Kenai Area is located in the rolling Kenai lowlands and provides excellent brown bear habitat. Major habitat types for the area are mixed upland forests, low growing spruce and treeless bogs. Deciduous hardwoods occur along the drainages and in disturbed sites.

Brown Bear Abundance

The benchlands that lie between Skilak and Tustumena Lake probably has the highest density of brown bears on the peninsula. Salmon are available in several streams in great abundance thus attracting the bears (Maps I-2,I-3,II-2,II-3,II-4). A summary of the fish escapements for the tributaries in this area are listed in Table 6.

Zoning

The Lower Kenai area is zoned essential except for the heavily populated western one-third and areas near the

Sterling highway. A corridor zone is designated for the area north of Skilak lake. This is to connect the benchlands with the Chickaloon River area. Permanent campgrounds are zoned nonessential.

Management Recommendations

Probable conflicts between humans and brown bears within this area are likely in several places. (1) Upper Russian Lake, (2) Aspen flats, (3) Outlet of the Kenai River at Skilak Lake and the Skilak loop area, and (4) Funny River horse trail. Because these 4 areas receive high brown bear use, special consideration to reduce conflicts in these areas is necessary.

Upper Russian Lake receives two runs of red salmon. The southern end of the lake needs to be maintained as undisturbed as possible. The south end of the lake should remain undeveloped so human activity is kept to a minimum. This can be accomplished by prohibiting the construction of new trails or cabins in this area.

The south end of the lake is used by brown bears and bald eagles during the spawning periods. Both species are disturbed by boaters and aircraft. To reduce this disturbance it is recommended that the south half (from Bear Creek, south) of Upper Russian Lake be closed off to float planes and boaters from 15 July to 15 October. Enforcement would be very difficult.

The number of recreationists using the existing trail

system should be monitored every five years to note trends in use. An upper limit of recreational use in the area during the salmon spawning period seems to be the only realistic approach to controlling the visitors should they increase dramatically.

Aspen flats is an area frequented by brown bears during the summer. There is a USFS cabin next to the Russian River in this area. Campers that use this cabin must be warned of possible bear encounters. Proper food and garbage storage is crucial to prevent the habituation of brown bears to human food. Relocating the Aspen Flats cabin to an area with less potential for human/bear conflicts should be considered.

Where the Kenai River flows from Skilak Lake, brown bear use is common when silver salmon are spawning. Because this area is in close proximately to both the town of Sterling and the Skilak loop road it is recommended that signs be posted warning people of the possibility of encountering bears there. Construction of new roads or cabins in the area of Torpedo Lake should be prohibited. The Cabins that do exist there should only be used in the winter, spring and summer to reduce conflicts with the bears in the fall.

The Skilak loop area is heavily used by recreationists throughout the summer. Development of the Skilak Loop Wildlife Management Area will increase the potential for

bear/human conflicts with both black and brown bears. Sanitation procedures as described in the previous zoning section should be a primary management concern. Bear-proof garbage containers and regular collection is important to avoid attracting bears to this area.

The Funny River horse trail cuts into the primitive wilderness area as the trail nears the Funny River. The potential for conflicts is greatest during a period from June to November. Use of the trail should be monitored for significant increases.

Table 6. Estimated salmon escapements and brown bear use for the Lower Kenai River Area, Kenai Peninsula, Alaska.

Drainage	King Salmon	Red Salmon	Silver Salmon	Pink Salmon	Dog Salmon	Bear Use
Lower Kenai River	*	*	2500	?	0	mod.
Slikok Creek	?	0	?	0	0	low
Beaver Creek	?	?	?	0	0	low
Moose River	few	500	?	0	0	mod.
Funny River	few	0	?	?	0	high
Killey River	8000	0	?	?	0	high
Benjamin Creek	600	0	0	0	0	high
U. Russian Lake	0	60000	2500	0	0	high
Hidden Lake	0	20000	500	0	0	mod.
Jean Creek	0	3000	0	0	0	
TOTAL	8600+	83500+	5500+	?	0	
Average Spawn	Jun.15	Jul.1	Aug.25	Aug.1	Aug.	

? undetermined escapement
* included in the other drainage estimates

Area "E" Upper Kenai River

Description

The Upper Kenai River Drainage includes all the tributaries that are upstream from where the Russian River enters the Kenai River. Because of the amount of human activity around Kenai Lake most of this area is not heavily used by brown bears.

Brown Bear Abundance

The most essential site for brown bears in the Upper Kenai River Area is the South fork of the Snow River. There are three sites where salmon spawn at in this drainage. All three are used by brown bear from July through September.

The area at the south end of Cooper Lake is used by brown bears in the spring. Observations and tracks are frequently seen along the trail, in avalanche chutes and riparian sites.

Brown bear observations and tracks are also seen along the shore of Upper Trail Lake and Trail Creek. This area is used by bears during the red and silver salmon runs. Salmon escapements are given in Table 7.

Zoning

Three essential zones are designated for bears in this area; Trail Creek, Snow River (south fork) and west of Cooper Lake (Maps I-4,I-5,II-4,II-5). Two Corridor zones

are designated to maintain travel routes 1) north and south along the east side of the Kenai Mountain range and 2) east and west through the Kenai Mountains south of Kenai Lake.

Management Recommendations

The corridor route south of Kenai Lake is extremely important to allow movement (i.e. dispersal, breeding) between the south fork of the Snow River and the western portion of the peninsula. Protection of the south fork of the Snow River from increased human activity is recommended. Making this a walk-in area may be the best way to insure the brown bear's presence in this drainage. This may be the best brown bear site on the eastern side of the Kenai Mountains because of its juxtaposition with the remote Nellie Juan drainage.

The north shore of Upper Trail Lake is used by brown bear and the impact of the Johnson Pass trail use should be of concern (see Placer River Area).

The Cooper Lake trail is part of the RCR trail system and human use of the trail system should be monitored as described in the executive summary of this document. Signs located at the trailheads, to educate trail users of potential bear encounters and ways to avoid them, are necessary.

Table 7. Estimated salmon escapements and brown bear use for the Upper Kenai River Area, Kenai Peninsula, Alaska.

Drainage	King Salmon	Red Salmon	Silver Salmon	Pink Salmon	Dog Salmon	Bear Use
Juneau Creek	90	few	0	0	0	low
Quartz Creek	?	0	?	0	0	low
Moose Creek	?	5000	0	0	0	low
Trail Creek	0	3500	?	0	0	high
Grant Creek	50	0	?	0	0	low
Ptarmigan Creek	50	40000	0	0	0	low
N. Fork Snow River	0	?	?	0	0	mod.
S. Fork Snow River	0	?	?	0	0	high
Crescent Creek	?	0	0	0	0	mod.
TOTAL	190+	48500+	?	0	0	
Average Spawn	Aug.15	Aug. 25				

? undetermined escapement

Area "F" Tustumena Lake

Description

The Tustumena Lake area includes all the tributaries that run into Tustumena lake plus Crooked Creek and the Kasilof River. Most of the Area is considered to be essential to brown bear survival. The Tustumena Area receives large numbers of red and silver salmon (Table 8). This concentration of fish along with the remoteness of most of the area surrounding the Lake provides excellent summer/fall habitat for bears.

Brown Bear Abundance

Brown bears are relatively numerous around Tustumena Lake. They are known to use nearly all the streams there. This area is a southern extension of the Lower Kenai Area and is considered very important bear habitat.

Zoning

All but the most western portion of the Tustumena Area is zoned essential (Maps II-2,II-3,III-2,III-3). The western portion of the area is heavily used by recreationists during the summer and fall. Because the area is designated wilderness by the USFWS, its management as a essential zone should be easier.

Management Recommendations

Recreational boaters on Tustumena Lake should be warned

of the dangers of camping at the mouths of the salmon spawning streams during the summer and fall.

The Cooked Creek fishing access is state operated. The area has recently undergone major renovation to provide recreationists with a higher quality facility. Bear-proof dumpsters should be installed to prevent the attraction of bears to the area.

Table 8. Estimated salmon escapements and brown bear use for the Tustumena Lake Area, Kenai Peninsula, Alaska.

Drainage	King Salmon	Red Salmon	Silver Salmon	Pink Salmon	Dog Salmon	Bear Use
Crooked Creek	3000	0	200	?	0	low
Nikolai Creek	0	12500	?	0	0	low
Shantalik Creek	0	5000	?	0	0	low
Bear Creek	0	58000	?	0	0	high
Pipe Creek	0	?	?	0	0	high
Moose Creek	0	17000	?	0	0	high
Indian Creek	0	?	?	0	0	high
Glacier Creek	0	55000	?	0	0	high
Seepage Creek	0	4600	0	0	0	high
Clear Creek	0	1700	0	0	0	mod.
Crystal Creek	0	900	0	0	0	mod.
TOTAL	3000	154700+	200+	?	0	
Average Spawn	Jul.25	Jul.15	Sept.7			

? undetermined escapement

Area "G" Resurrection River

Description

The Resurrection River Area includes tributaries of the river and several other creeks that flow into Resurrection Bay. Kenai Fjords National Park land and USFS land meet at Resurrection River. Most of this area however is privately owned. Salmon are abundant in the area (Table 9).

Brown Bear Abundance

Brown bear use of the this area is limited to a few sites (Maps II-4,II-5,III-4). The area around Bear Lake receives a moderate amount of use by brown bears. Most of the use is in the fall when silver salmon are present and human activity is lower.

At the headwaters of the Resurrection River, upstream from Boulder Creek, bear use is also considered moderate. It is not known how much of the Resurrection drainage is used by brown bears in the fall but the numbers of silver salmon that spawn are thought to be high.

Zoning

An area near the headwaters of the Resurrection River is zoned essential. The area near Bear Lake is zoned as secondary. Part of the corridor zone to the south of Kenai Lake is located in this area and includes Lost Lake.

Table 9. Estimated salmon escapements and brown bear use for the Resurrection River Area, Kenai Peninsula, Alaska.

Drainage	King Salmon	Red Salmon	Silver Salmon	Pink Salmon	Dog Salmon	Bear Use
Resurrection River	?	0	34000	?	0	mod.
Grouse Creek	0	150	500	?	0	low
Bear Lake	0	500	3500	0	0	low
Salmon Lake	0	?	?	?	0	low
Spring Creek	0	?	?	300	500	low
Tonsina Creek	0	0	?	4000	4000	low
TOTAL	?	650+	38000+	4300+	4500	
Average Spawn		Aug.1	Oct.14	Aug.28		

? undetermined escapement

Area "H" Nellie Juan

Description

Very little is known about the Nellie Juan Area with respect to brown bear use. Salmon spawning sites are abundant throughout the coastal fjords and Islands, but bears are not thought to inhabit the area in great numbers. There is a travel corridor that connects the interior peninsula with Kings Bay (Maps I-5,I-6,II-5,II-6,III-5). The Nellie Juan River drainage is connected to the south fork of the Snow River.

Bear Abundance

Brown bears are seen in the Paradise Valley and the Nellie Juan Drainage during the summer. Although observations are not common, the area is not commonly visited by large numbers of people. Therefore abundance is unknown.

Zoning

A portion of this area is zoned essential because of its position with respect to the Snow River and the interior of the peninsula. This area is very important to the bear population because it represents an area east of the Kenai Mountains that can support bears.

Management Recommendations

A portion of the Nellie Juan Area is presently

protected under the USFS wilderness classification. Because very little is known about its importance to the bear population it should be managed as essential until proven otherwise.

Area "I" Anchor River

Description

The Anchor River Area is an area extending from Clam Gulch, south along the coast to Homer, to the north eastern end of Kachemak Bay and then back to Clam Gulch in a line that includes the headwaters of Deep Creek and the Ninilchik River. This area is predominately state and private land (Maps II-1,II-2,III-1,III-2). The Anchor River area is made up several major drainages. These are the Ninilchik River, Deep Creek, Stariski Creek, Chakok River and Anchor River. These drainages provide spawning habitat for king and silver salmon. Because these species are the most abundant they are of greatest importance to brown bear in this area (Table 10).

Problems arising between brown bears and people are present in this area because of the amount of human activity occurring here during the summer and fall. An increase in human activity will result in the loss of essential brown bear habitat.

Brown Bear Abundance

The Anchor River - Spawning occurs into the headwaters of the Anchor with most occurring below Beaver Flats. Bears are using the river to fish as early as July and possibly earlier. Foot access to the middle section of the South

Fork Anchor River can be gained by the North Fork loop road.

The Chakok River - We can only assume that brown bear use portions of the Chakok during the salmon runs. With the large numbers of silver salmon that spawn in this river some brown bear use is likely.

Deep Creek - Spawning occurs along a large portion of the creek with the majority near the junction of the north fork and the middle fork of Deep Creek. There was heavy use by bears along the creek near the junction of the north fork and the middle fork by brown bear. Using track measurements, 11 individual brown bears were estimated to be using the area during the ground survey. Brown bear use is greatest during July when kings salmon are present, however, the bears continue to use the area in the fall when silver salmon spawn there.

Ninilchik River - Brown bear use is moderate to heavy in July. The lower portions of the Ninilchik are fished heavily by people. However, ADF&G allows fishing only on these lower portions to protect spawning habitat upstream.

Zoning

The Headwaters of these rivers and creeks are considered essential and are zoned accordingly. Some areas are secondary or nonessential as human settlements are spread in a horseshoe shape around this area. Because the area is mostly state and private land, management of this area will be extremely difficult to control.

Management Recommendations

Approximately 50 cabins are located on the ridges above the north fork of Deep Creek and many others are located on the middle and south fork and the Anchor River (Fig. 8). Numerous off-road-vehicle (ORV) trails are also located at the upper end of this drainage. Road-vehicle access is most evident along the river below South Beaver Creek and appears to be used by fisherman.

The cabins which are located around the headwaters of Deep Creek and the Anchor River pose a problem to this essential area. An essential zoning recommends that no motorized vehicles are used, roads are not built and new cabins should not be constructed. This ideal is not realistic in this area because state has allowed the cabins to become solidly established in the area. Because of the area's importance to brown bear this subdivision could act as a bear "population sink", attracting bears to conflicts. Therefore, it is important to manage this area to minimize negative impacts and avoid as many conflicts as possible. Recommendations are:

1) Disposal of garbage should be monitored by the state to be sure open pit dumps are not being created.

2) Establish ORV corridors that would consolidate and minimize effects on wildlife.

3) There should be critical review of applications for grazing leases.

4) Stocking rates should be established for domestic animal use or grazing on state land.

5) Disposal of state land to private individuals should be discouraged. Approximately 75-80 thousands acres of state land is in this area.

6) Legislative designation of the Deep Creek and Anchor River drainages as Wildlife Critical Habitat Areas should be proposed.

Table 10. Estimated salmon escapements and brown bear use for the Anchor River Area, Kenai Peninsula, Alaska.

Drainage	King Salmon	Red Salmon	Silver Salmon	Pink Salmon	Dog Salmon	Bear Use
Ninilchik River	2000	0	?	0	0	high
Deep Creek	1000	0	?	0	0	high
Stariski River	2000	0	?	0	0	low
Chakok River	2000	0	?	0	0	mod.
Anchor River	2300	0	?	0	0	high
TOTAL	9300	0	?	0	0	
Average Spawn	Jul.14		Sep.14			

? undetermined escapement

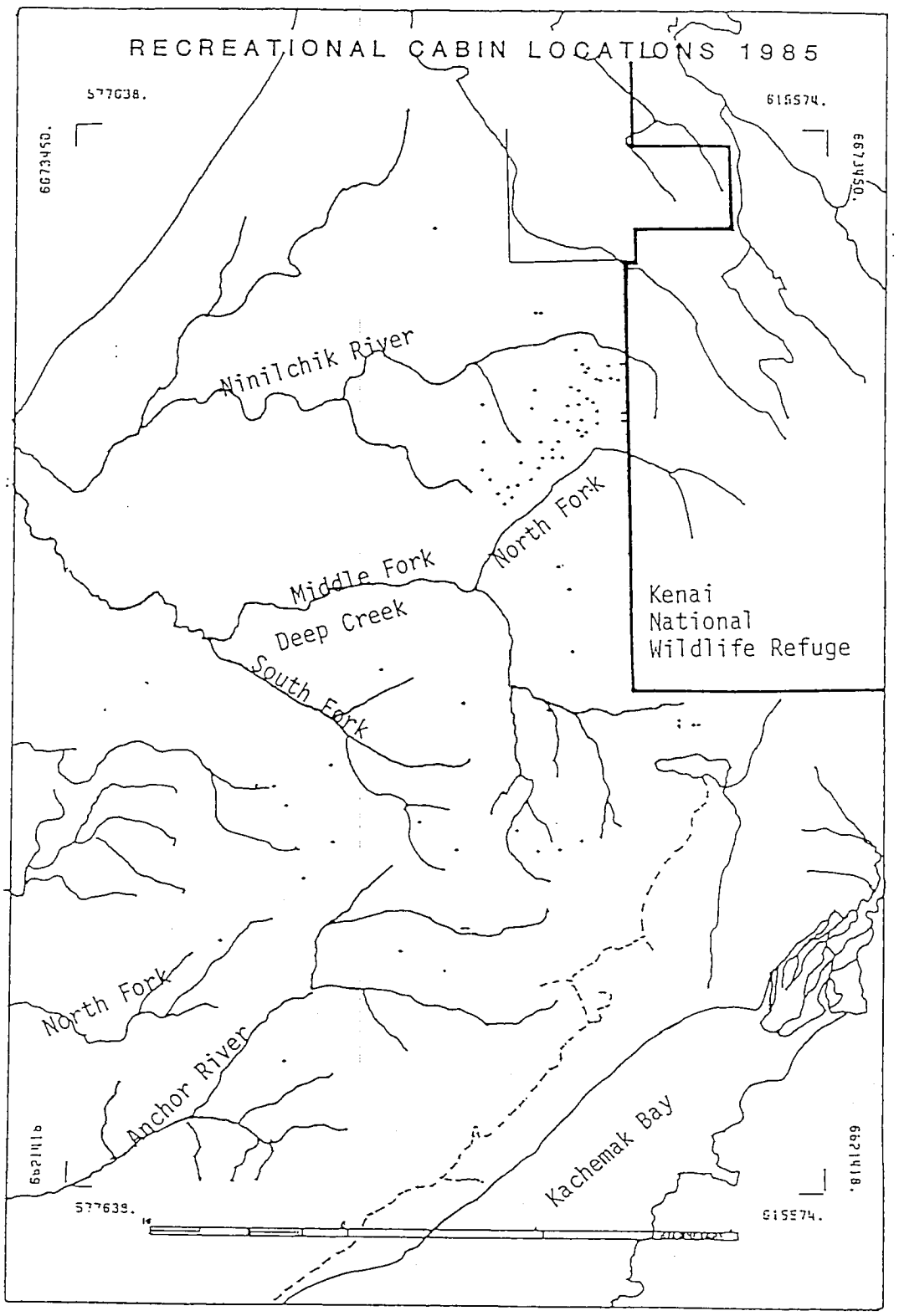


Figure 8. Recreational cabin locations in the Deep Creek-Anchor River areas of the Kenai Peninsula, Alaska, registered with the state as of 1985.

Area "J" Fox River

Description

This area includes Sheep Creek, Clearwater Slough, and the Fox River. The area receives both red and silver salmon runs (Table 11). The lower portion of the Fox River receives extensive human use and the lower valley supports about 60 permanent residents in the village of Delina. ORV trails and the river bed provide access as far upstream as Clearwater Slough.

Brown Bear Abundance

Brown bear use occurs along the Fox River, but is considered moderate to high compared to other areas on the peninsula. The portion of the Fox River, from Sheep Creek upstream, is used more often by bears; bear use below Sheep Creek also occur.

Zoning

The Fox River area is an important extension of the best bear habitat on the Peninsula. Therefore, much of this area is zoned essential (Maps III-2,III-3).

Management Recommendations

The use of motorized boats and ORV's along the Fox River upstream from the mouth of Sheep Creek should be prohibited from late June until November.

The settlements at the mouth of the Fox River should

practice proper garbage disposal.

An area of particular concern is the grazing lease located in the lower fox valley on state land. Stocking rates of domestic animals should be set and enforced by the state to minimize negative impacts. Agricultural developments such as hayfields and ranch construction should be prohibited.

Table 11. Estimated salmon escapements and brown bear use for the Fox River Area, Kenai Peninsula, Alaska.

Drainage	King Salmon	Red Salmon	Silver Salmon	Pink Salmon	Dog Salmon	Bear Use
Fox River	0	900	?	0	0	mod.
Clearwater Slough	0	?	1000	0	0	mod.
Sheep Creek	0	?	?	0	0	mod.
TOTAL	0	900+	1000+	0	0	
Average Spawn		Jul.14	Aug.14			

? undetermined escapement

Area "K" Fjords

Descriptions

This area includes most of Kenai Fjords National Park (Maps II-4,III-3,III-4). Brown bear use in this area is thought to be minimal. The Harding Ice field separates this area from interior Kenai Peninsula which probably makes travel between the areas rare. Therefore, the area is not considered essential for the Kenai population because movement of individuals from fjords to the interior is unlikely.

Brown Bear Abundance

The abundance of brown bear is thought to be very low.

Zoning

The area is managed by the National Park Service which does not permit sport/subsistence hunting, trapping, or commercial development.

Management Recommendations

The NPS only needs to consider management of brown bear in the Resurrection River Area.

Area "L" Seldovia

Description

The Seldovia area is known to have brown bears existing in it (Maps III-2,III-3,IV-1,IV-2,IV-3). However, not enough is known about movements from this area to the peninsula's interior. Bears could move from Kachemak Bay State Park to the interior of the peninsula. More information is needed about that area before we can properly advise management.

Brown Bear Abundance

Several brown bear sighting have been reported of in this area although none were recorded by the study team.

Zoning

No zone was applied to this area because of the lack of brown bear information.

Management Recommendations

State employees that work at the state park should be able to offer help in assessing this area for brown bear management.

Zoning and Tenure Maps

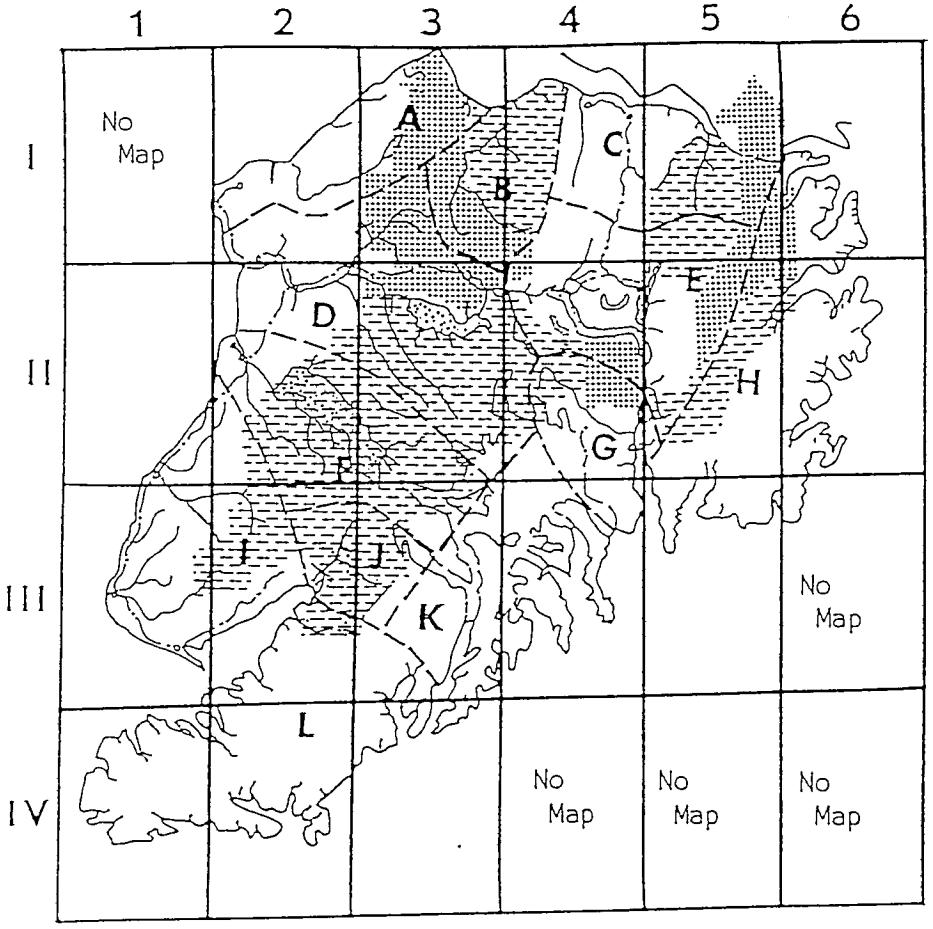


Figure 7. Key to the maps of the Kenai Peninsula, Alaska, showing geographical areas, land tenure and zoning.

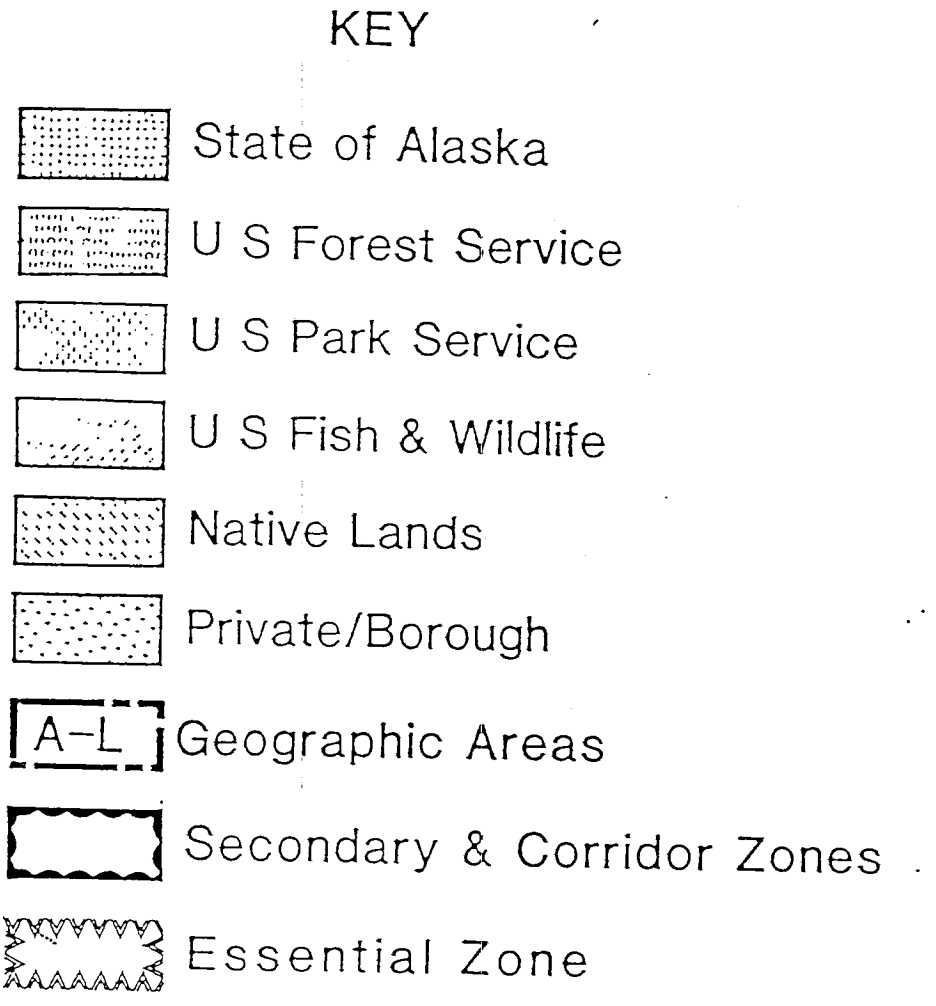
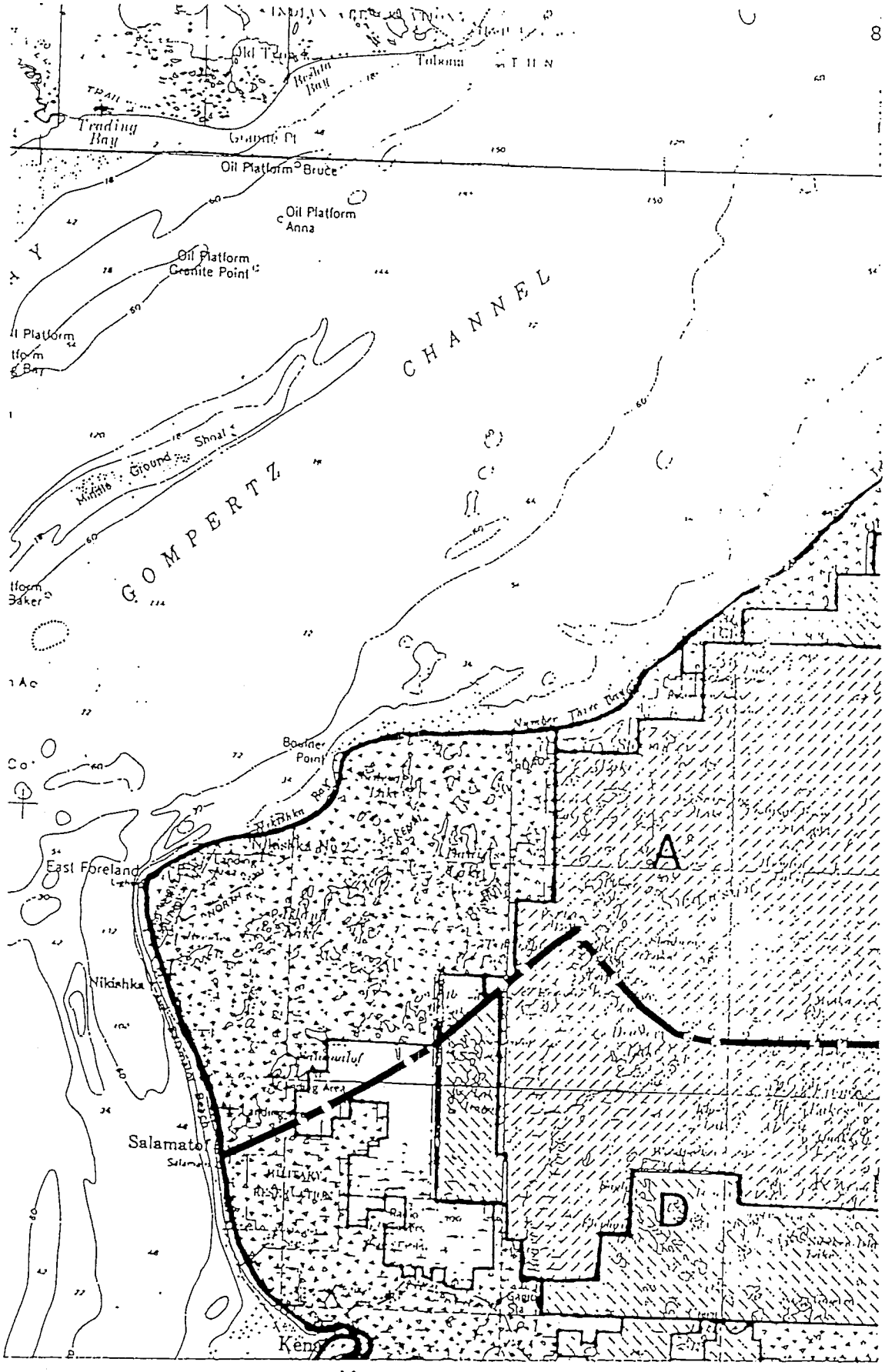
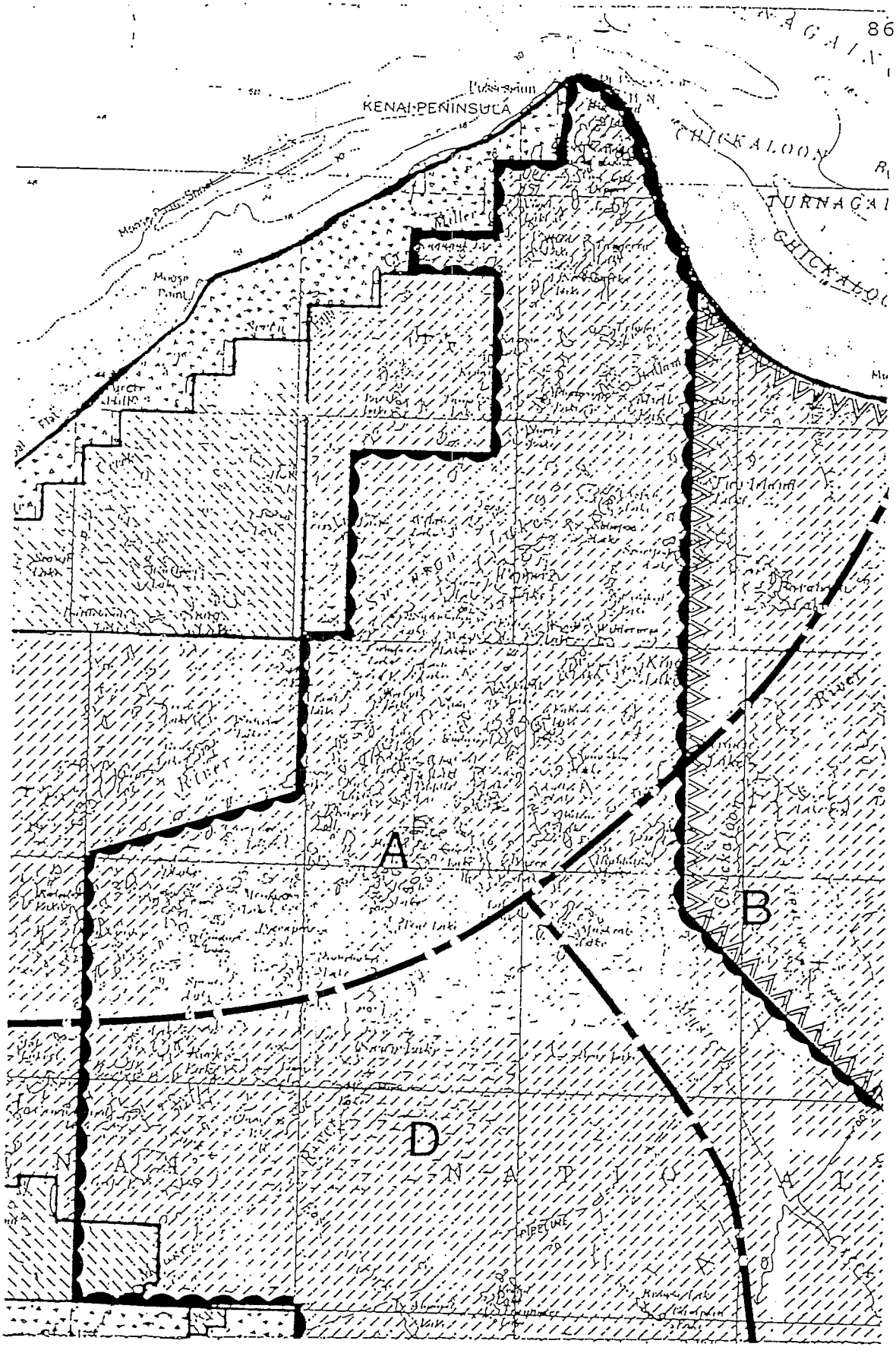


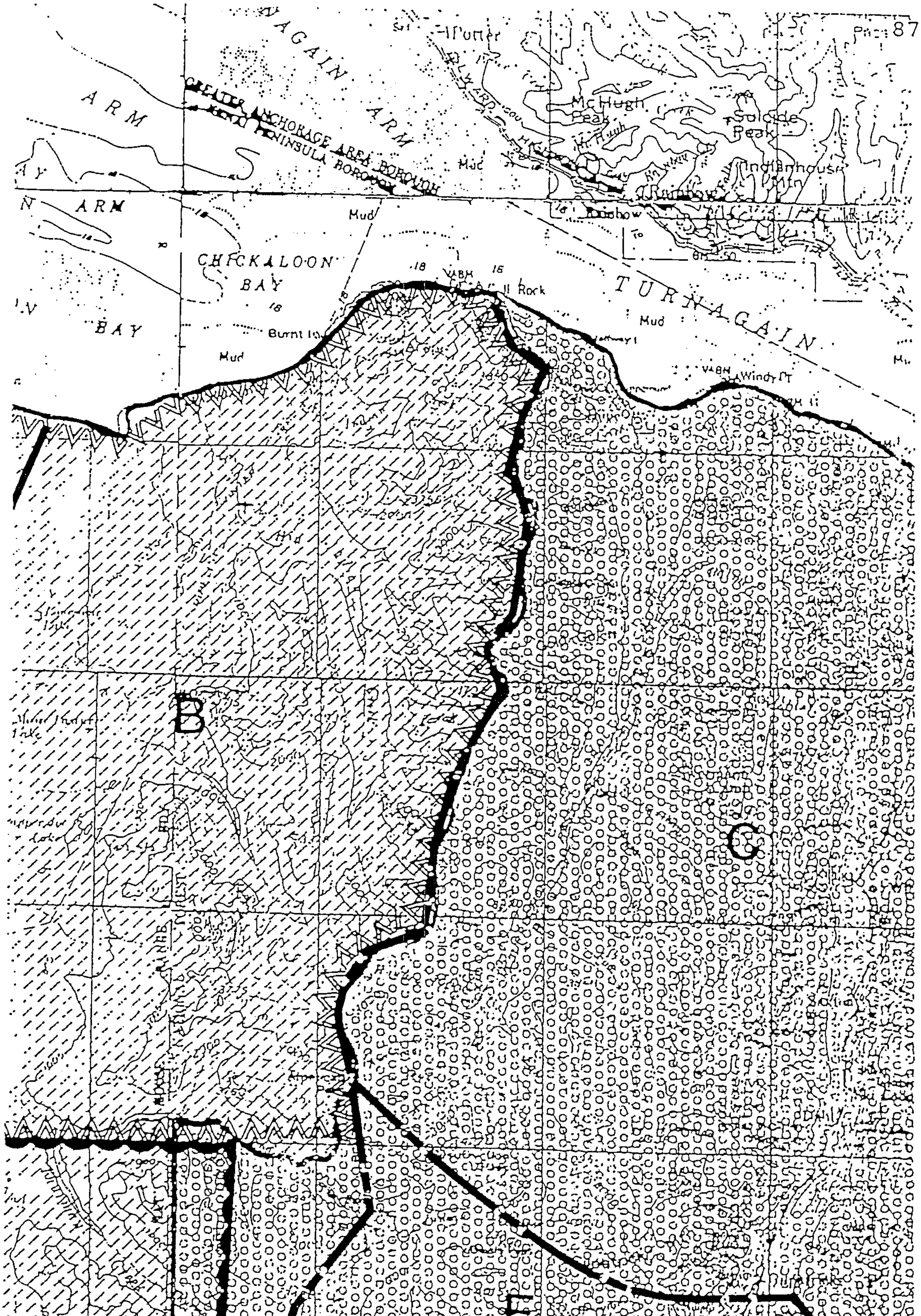
Figure 7a. Key to maps continued.


Old Town
Tuluma
T 11 N
Trading Bay
Granite Pt
Oil Platform Bruce
Oil Platform Anna
Oil Platform Granite Point
CHANNEL
Middle Ground Shoal
GOMPERTZ
Boulder Point
East Foreland
Nikishka
Salamatof
A
D

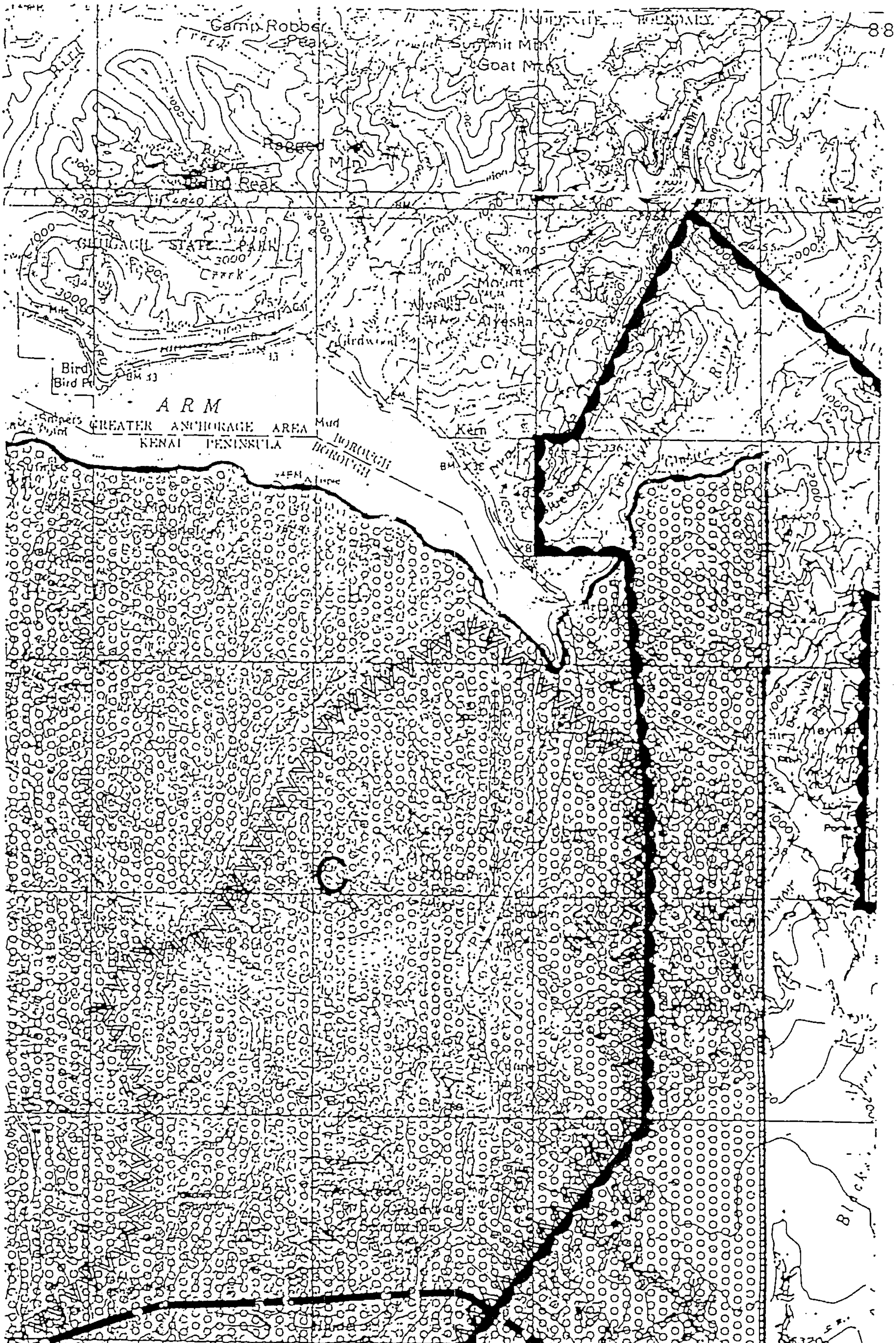
Map 1-2



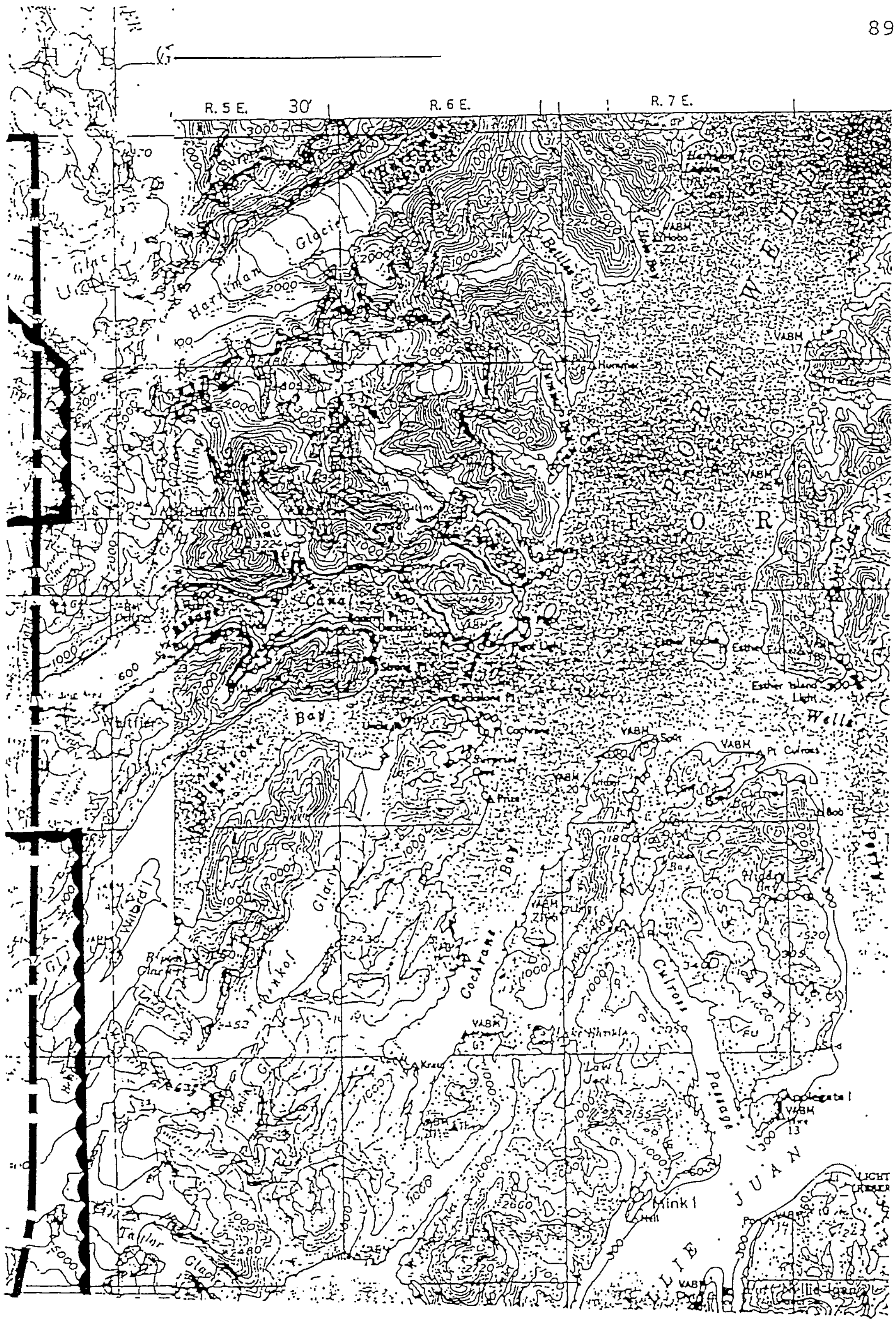
Map I-3


ARM
TURNAGAIN ARM
GREATER ANCHORAGE AREA BOROUGH
KENAI PENINSULA BOROUGH
McHugh Peak
Suicide Peak
Indianhouse
Rainbow
Mud
CHICKALOON BAY
BAY
TURNAGAIN
Burnt Is
Windy Pt
B
C
E
87

Map I-4


Camp Robber Peak
Summit Mtn
Goat Mtn
Ragged Mtn
Bird Peak
CHUGACH STATE PARK
Bird
Bird Pt
ARM
GREATER ANCHORAGE AREA BOROUGH
KENAI PENINSULA BOROUGH
Mount Alyeska
Girdwood
Kern
C

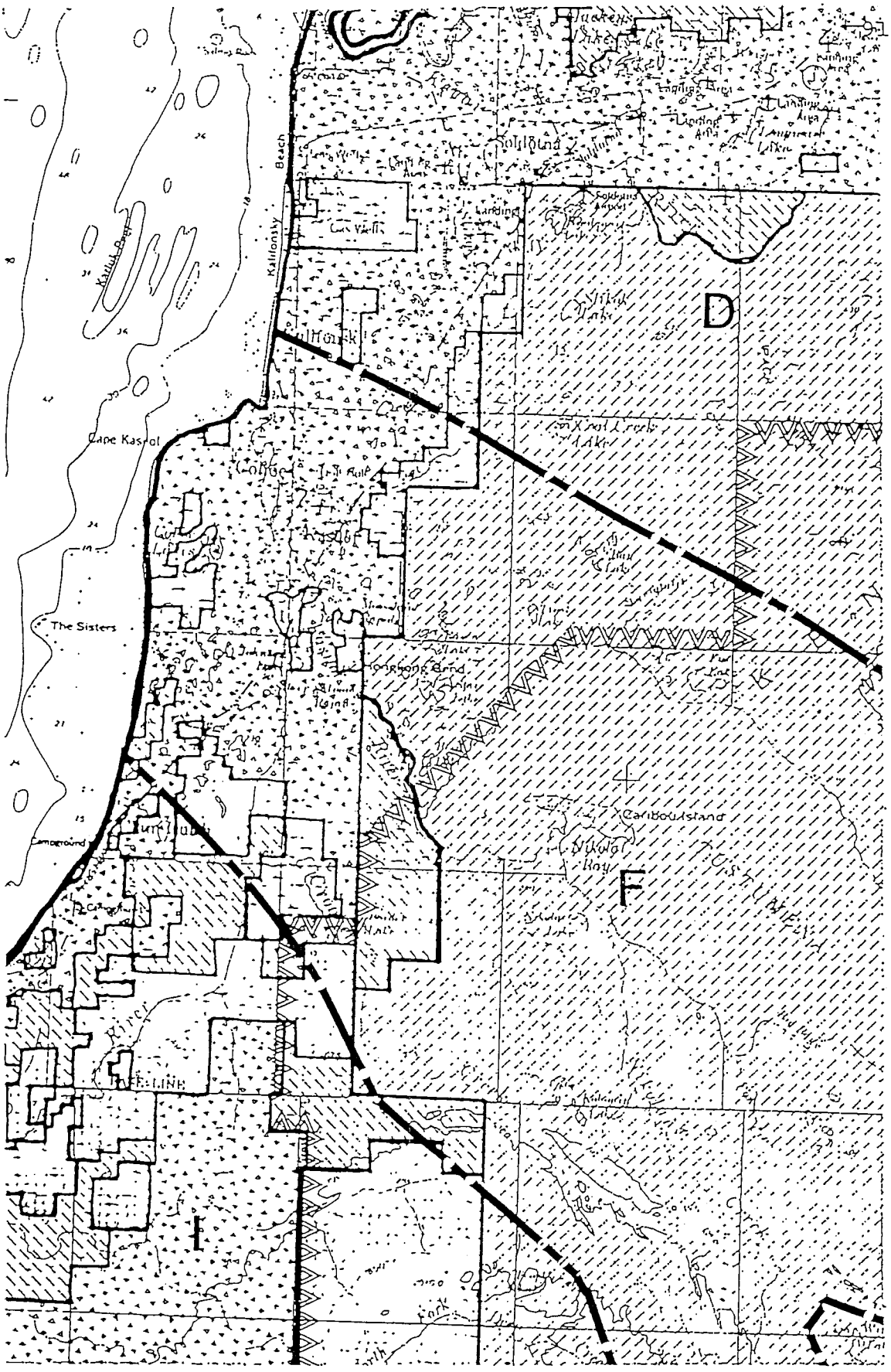
Map 1-5


R. 5 E.
30'
R. 6 E.
R. 7 E.
Harriman Glacier
Barry Glacier
Cascade Glacier
Coxe Glacier
Canal
Passage
Bay
Esther Island
Esther Island Light
Wells
VABM
Cochrane Bay
Culross Passage
Mink I
Applegate I
Tebenkof Glacier
Taylor Glacier
Whittier
Willard I
F O R E
JUAN
2000
1000
3000
600

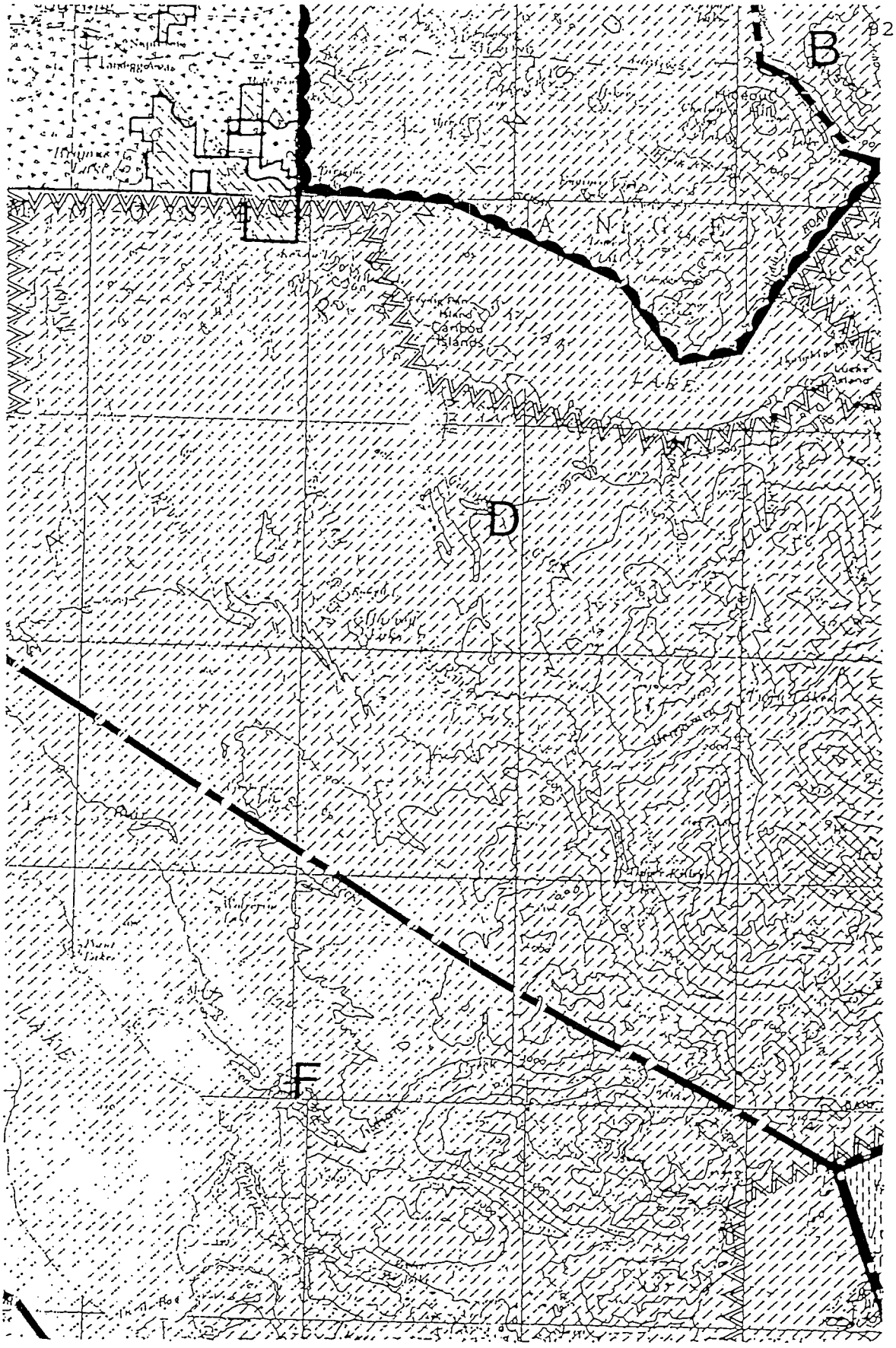
Map I-6


Cook Inlet
Albert Island
Tucketa Creek
Lake
Oldmans Bay
Swamp
Tidal Flat
Ninilchik

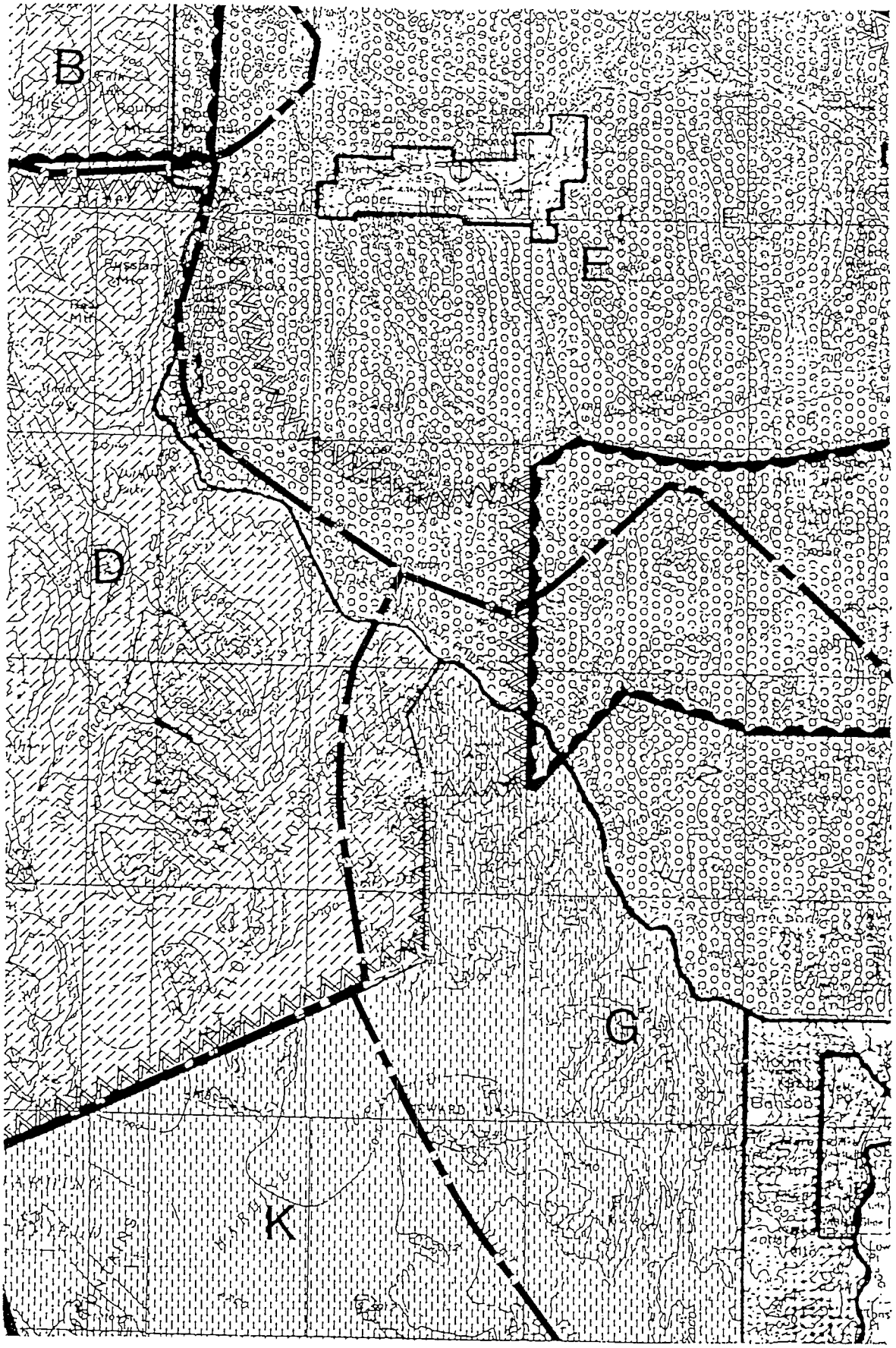
Map II-1


Beach
Kaluiasky
Cape Kasilof
The Sisters
Campground
Caribou Island
D
F
I

Map II-2

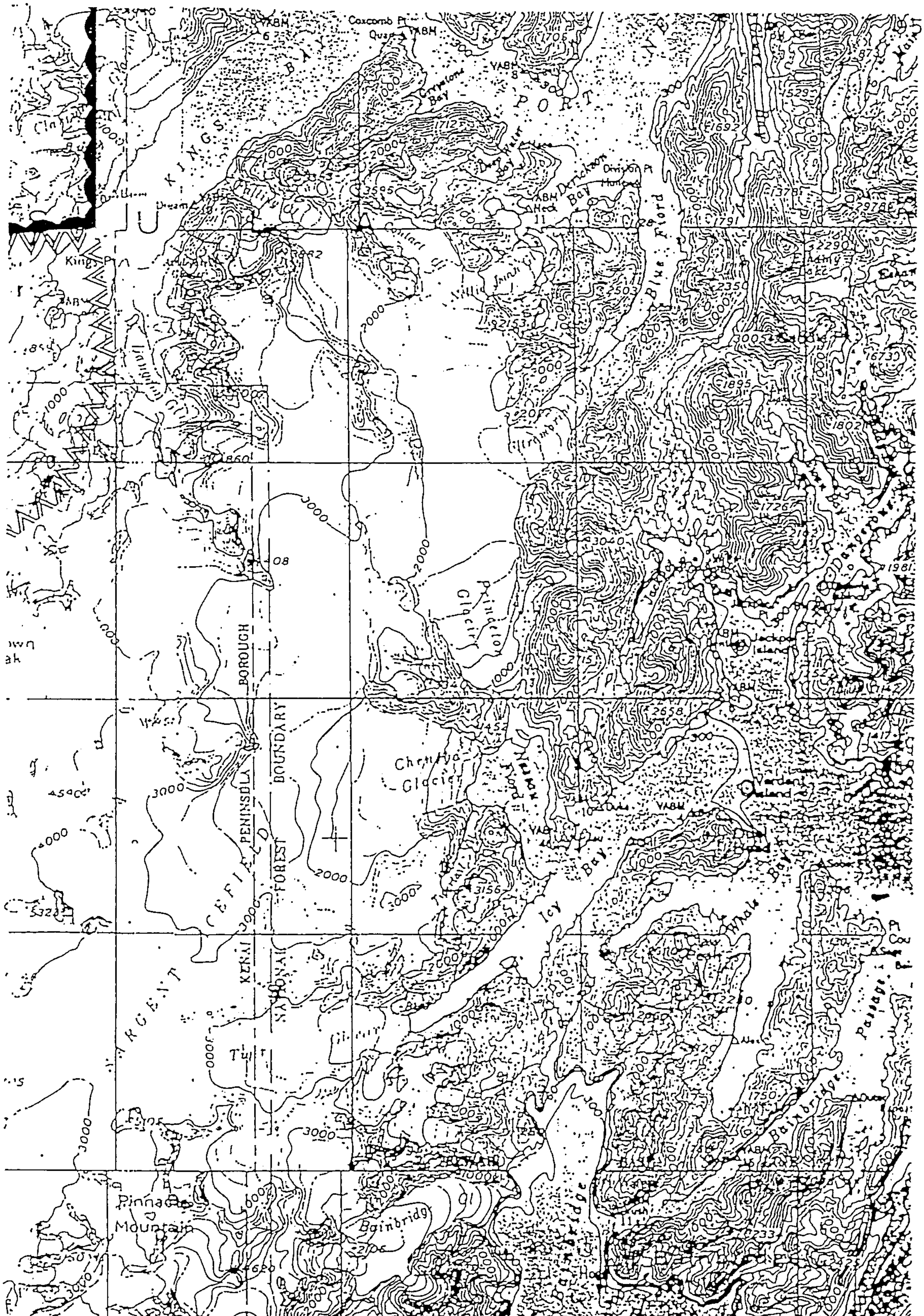


Map II-3

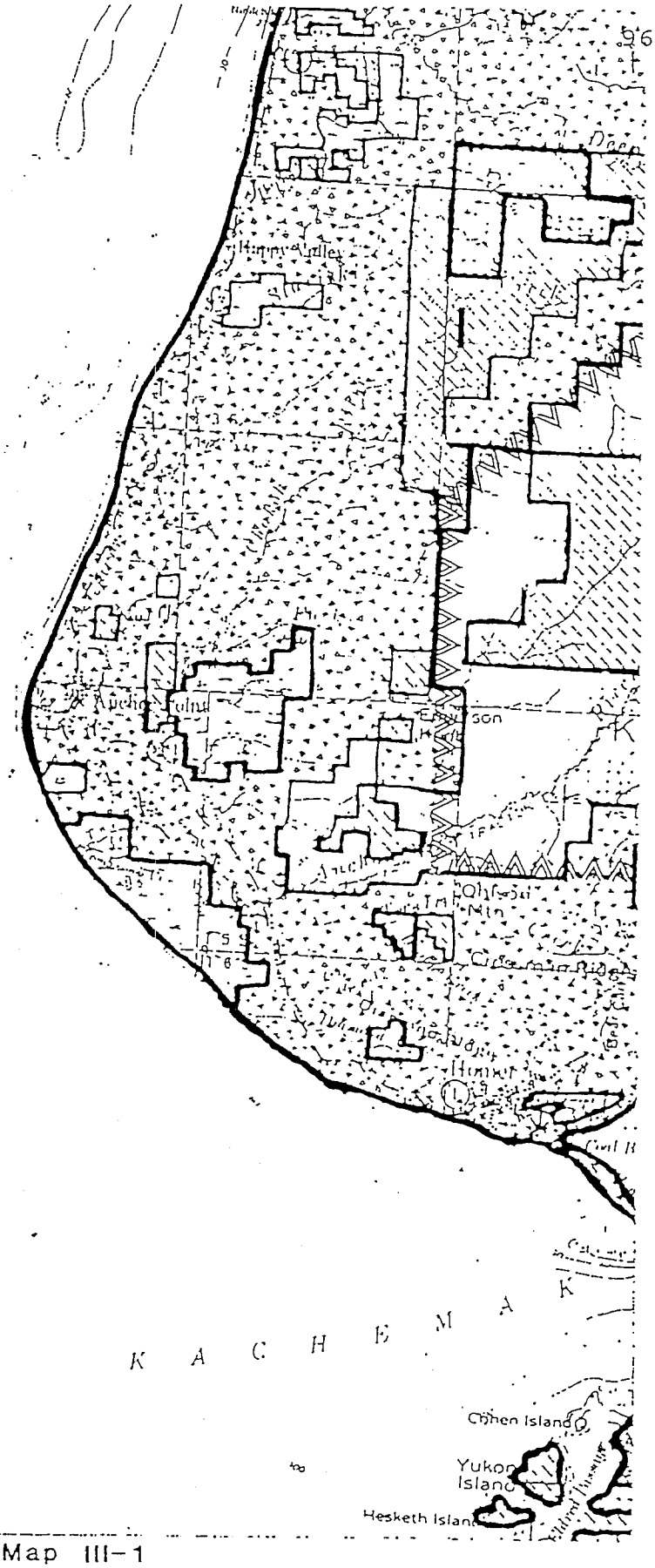


Map II-4

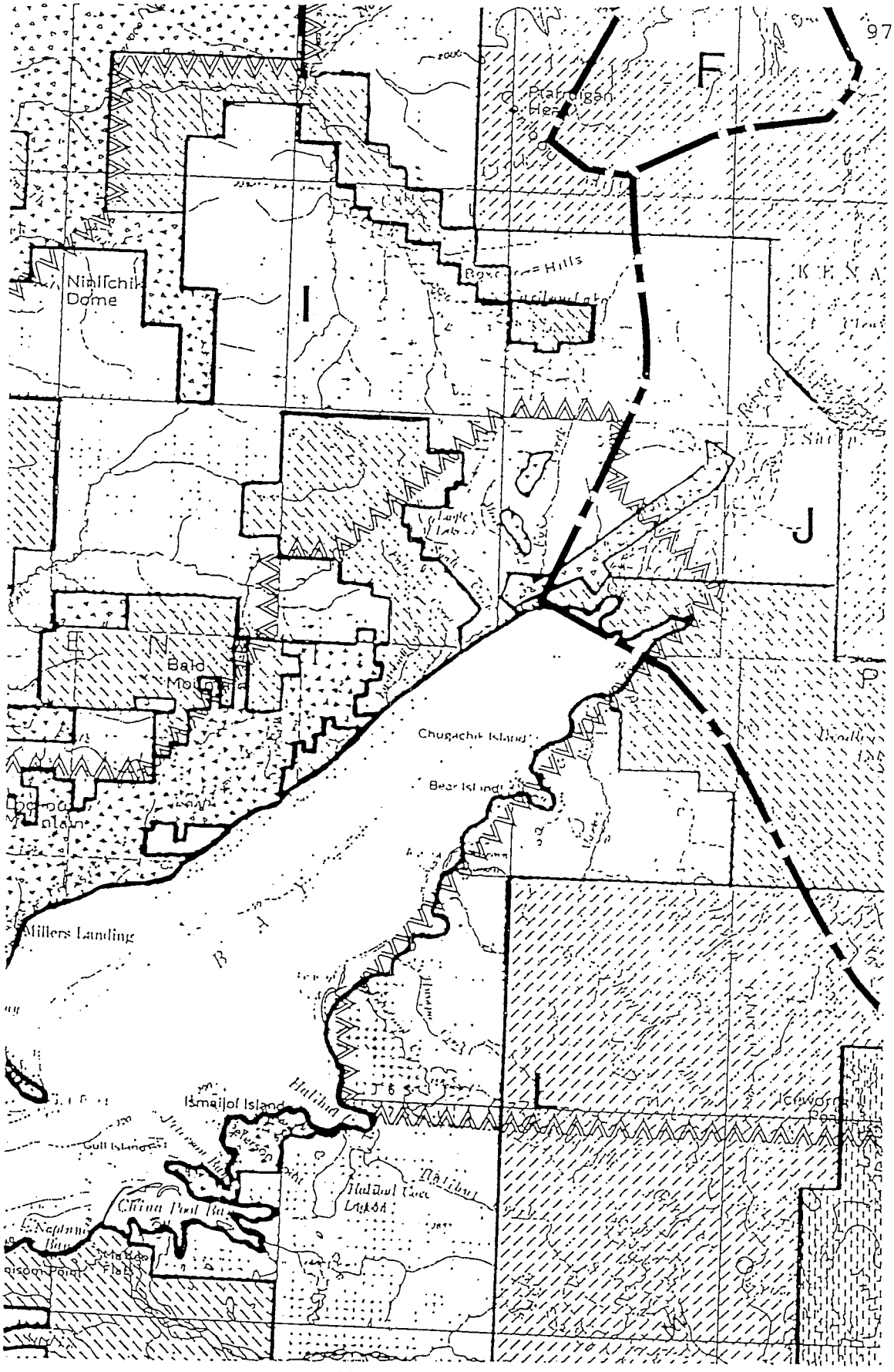
Map II-5


Coxcomb Pt
KINGS BAY
PORT NELLIE JUAN
Blue Fiord
Princeton Glacier
Icy Bay
Whale Bay
Verdant Island
KENAI PENINSULA BOROUGH
NATIONAL FOREST BOUNDARY
SARGENT ICEFIELD
Pinnacle Mountain
Bainbridge
Passage

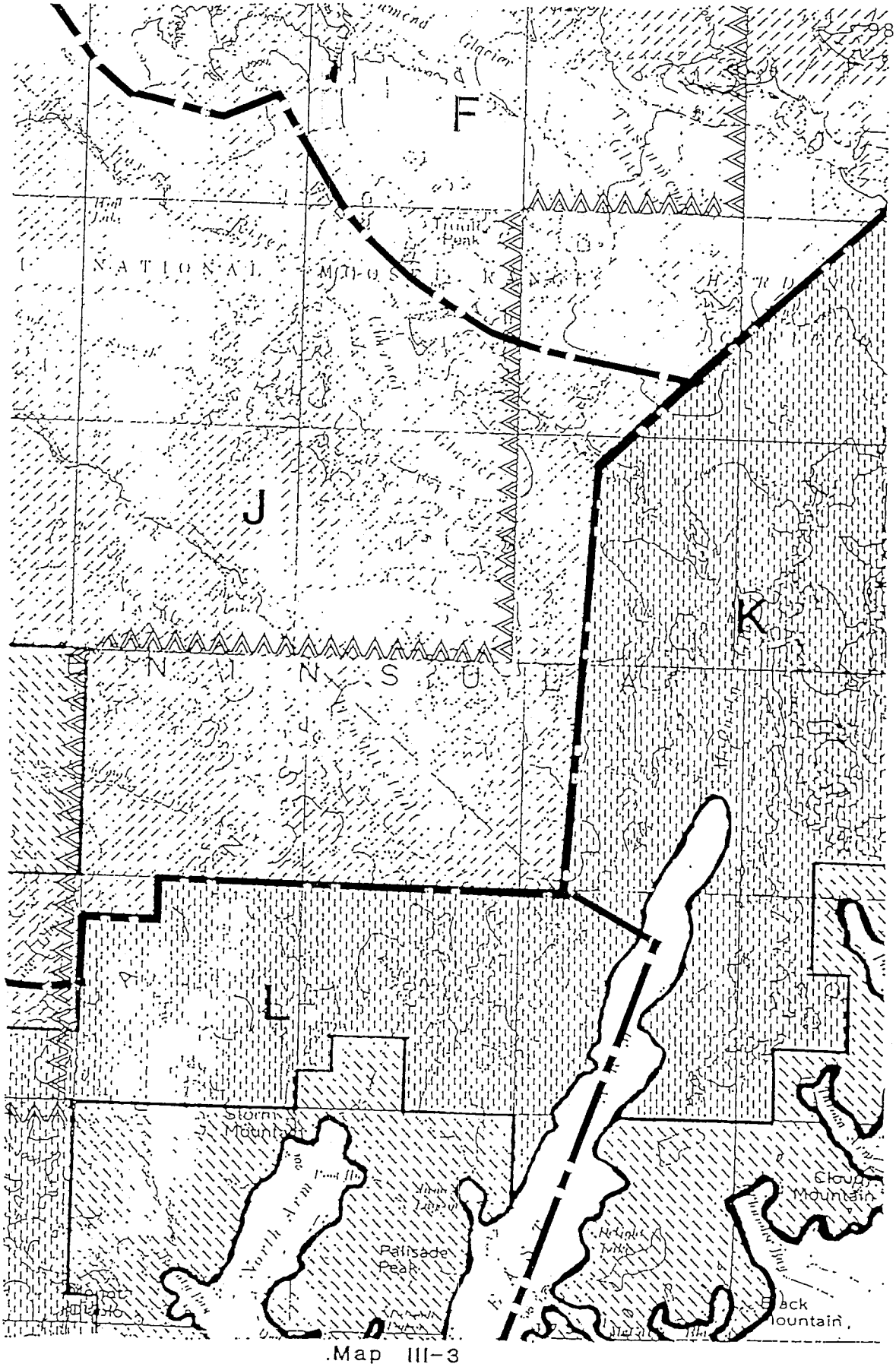
Map II-6



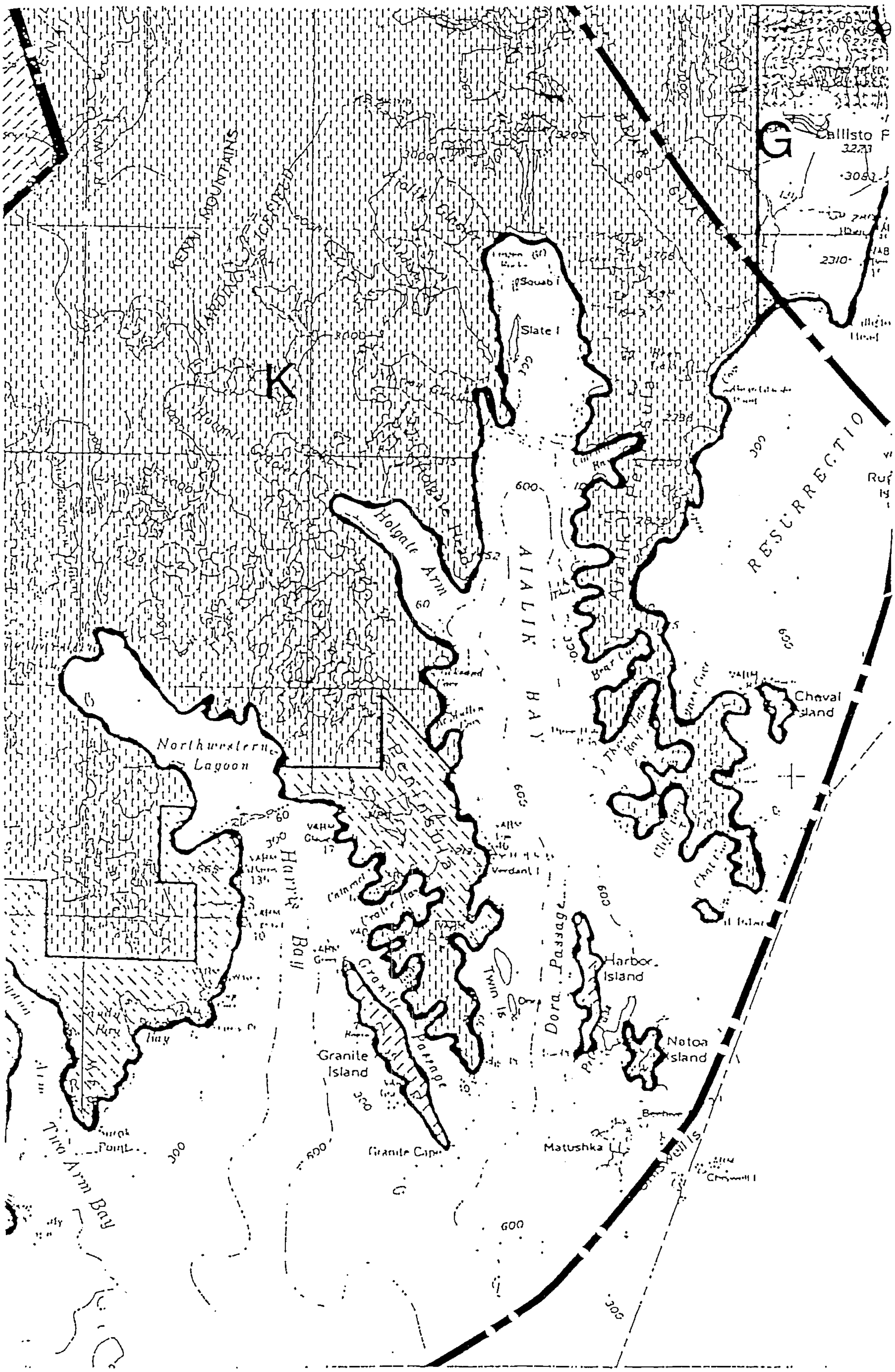
Map III-1

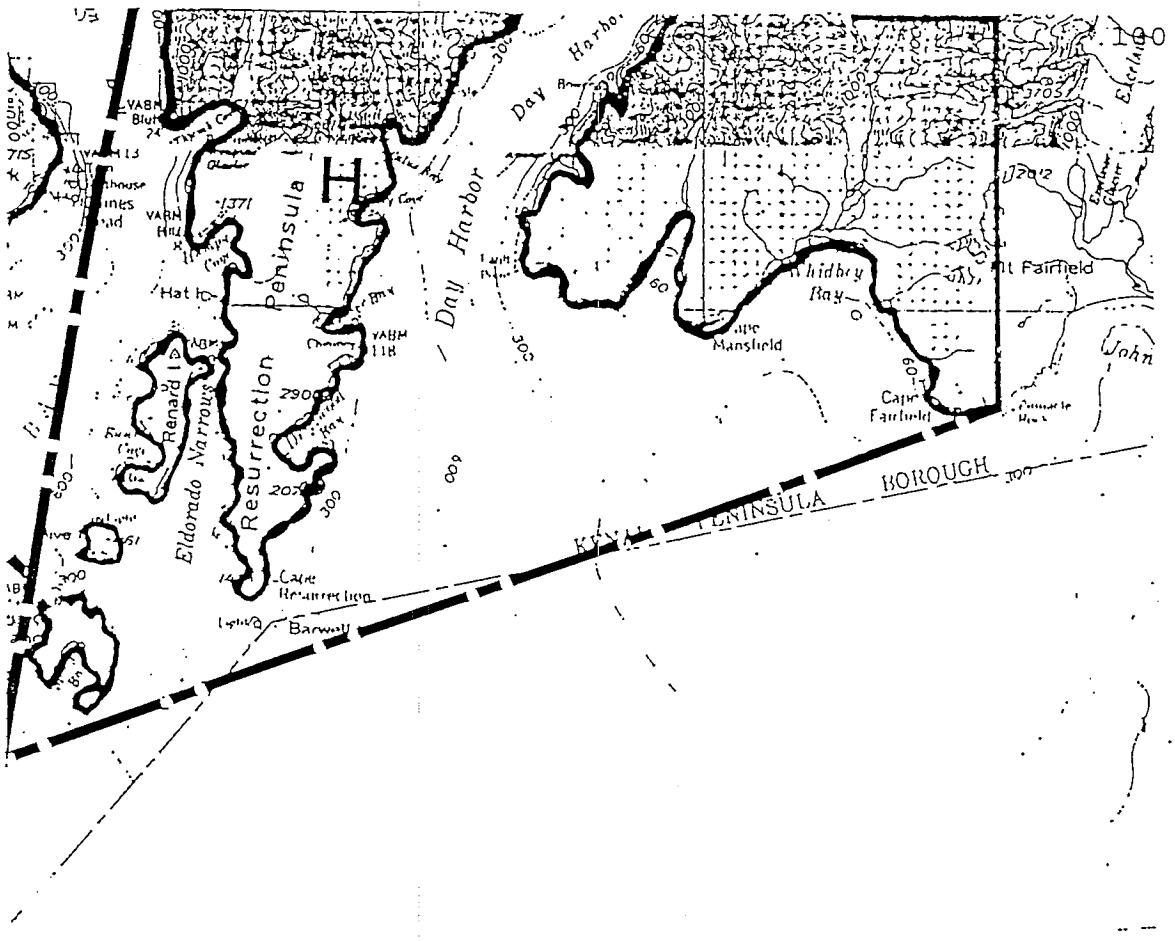

F
I
J
Niniltchik Dome
Bald Mountain
Chugachik Island
Bear Island
Millers Landing
Ismailof Island
Gull Islands
China Poot Bay
Halibut Cove Lagoon
Port Graham

Map III-2

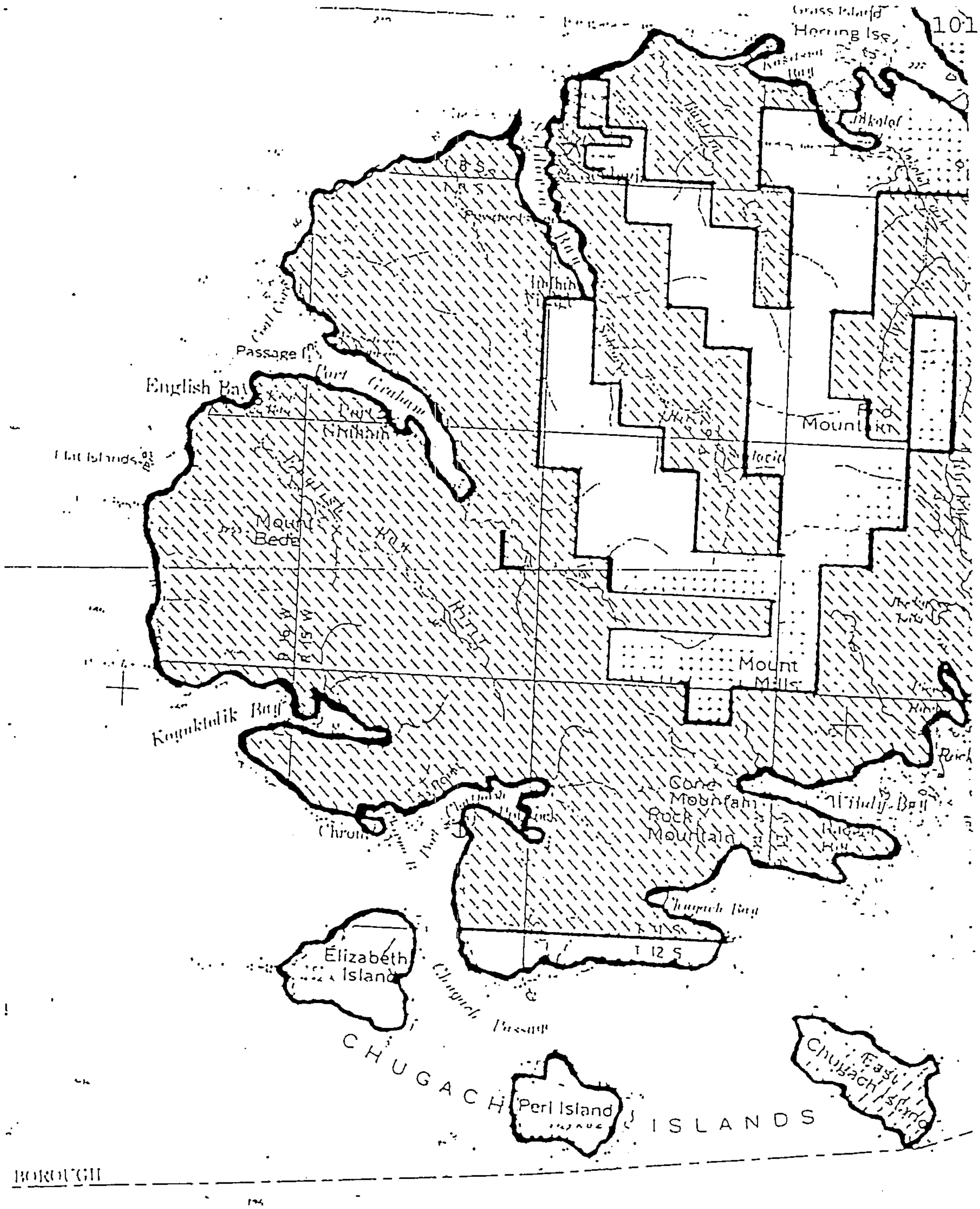

F
J
K
L
NATIONAL
Storm
Mountain
North Arm
Palisade
Peak
Cloud
Mountain

Map III-3

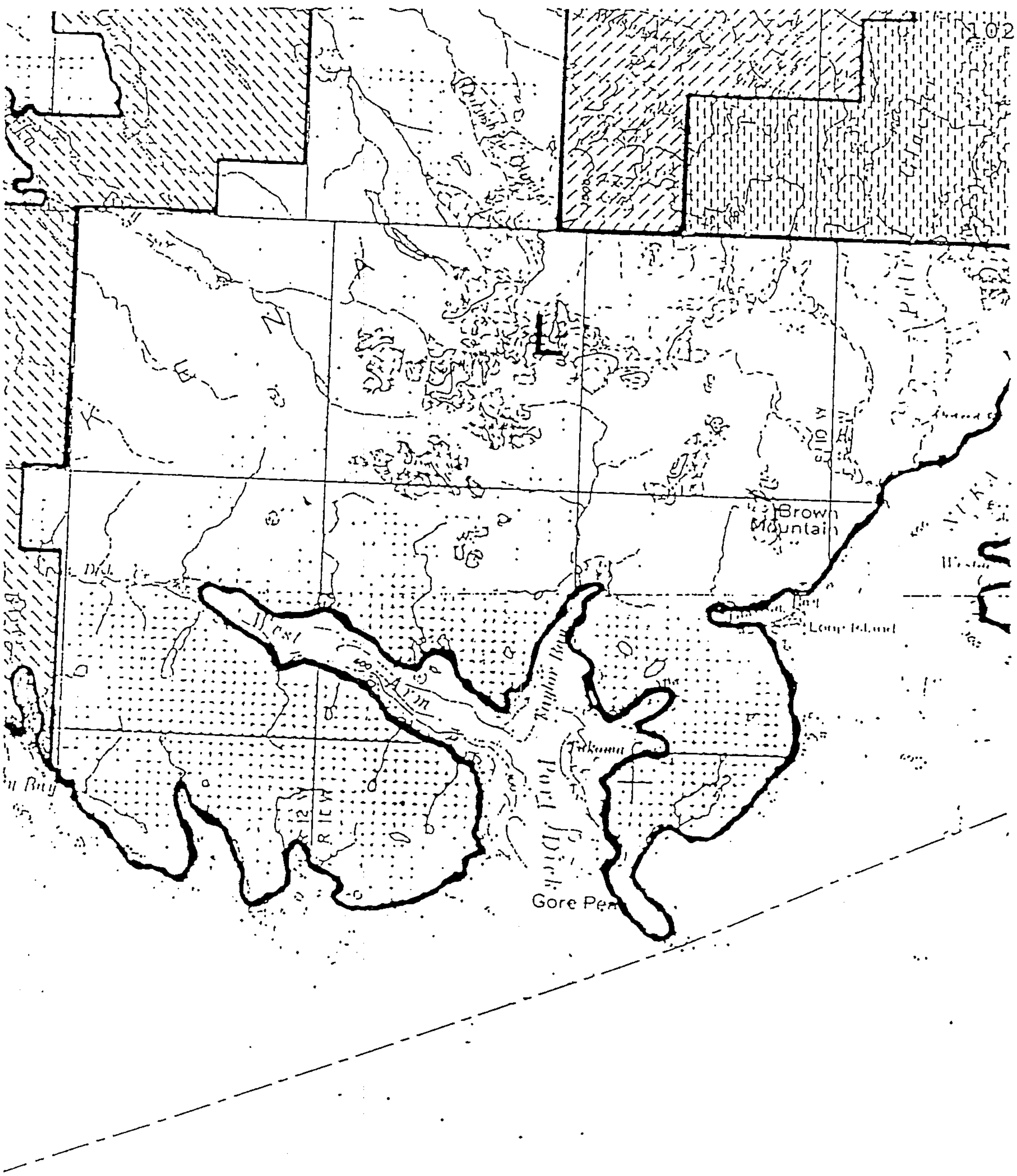

K
G
KENAI MOUNTAINS
HARDING ICEFIELD
Holgate Arm
AIALIK BAY
RESURRECTIO
Northwestern Lagoon
Harris Bay
Dora Passage
Twin Is
Harbor Island
Natoa Island
Chaval Island
Granite Island
Granite Cape
Matushka
Two Arm Bay
Verdant I
Slate I
600
300


Day Harbor
Resurrection Peninsula
Eldorado Narrows
Renard I.
Cape Resurrection
Barwell
Whidbey Bay
Mt Fairfield
Cape Mansfield
Cape Fairfield
KENAI PENINSULA BOROUGH

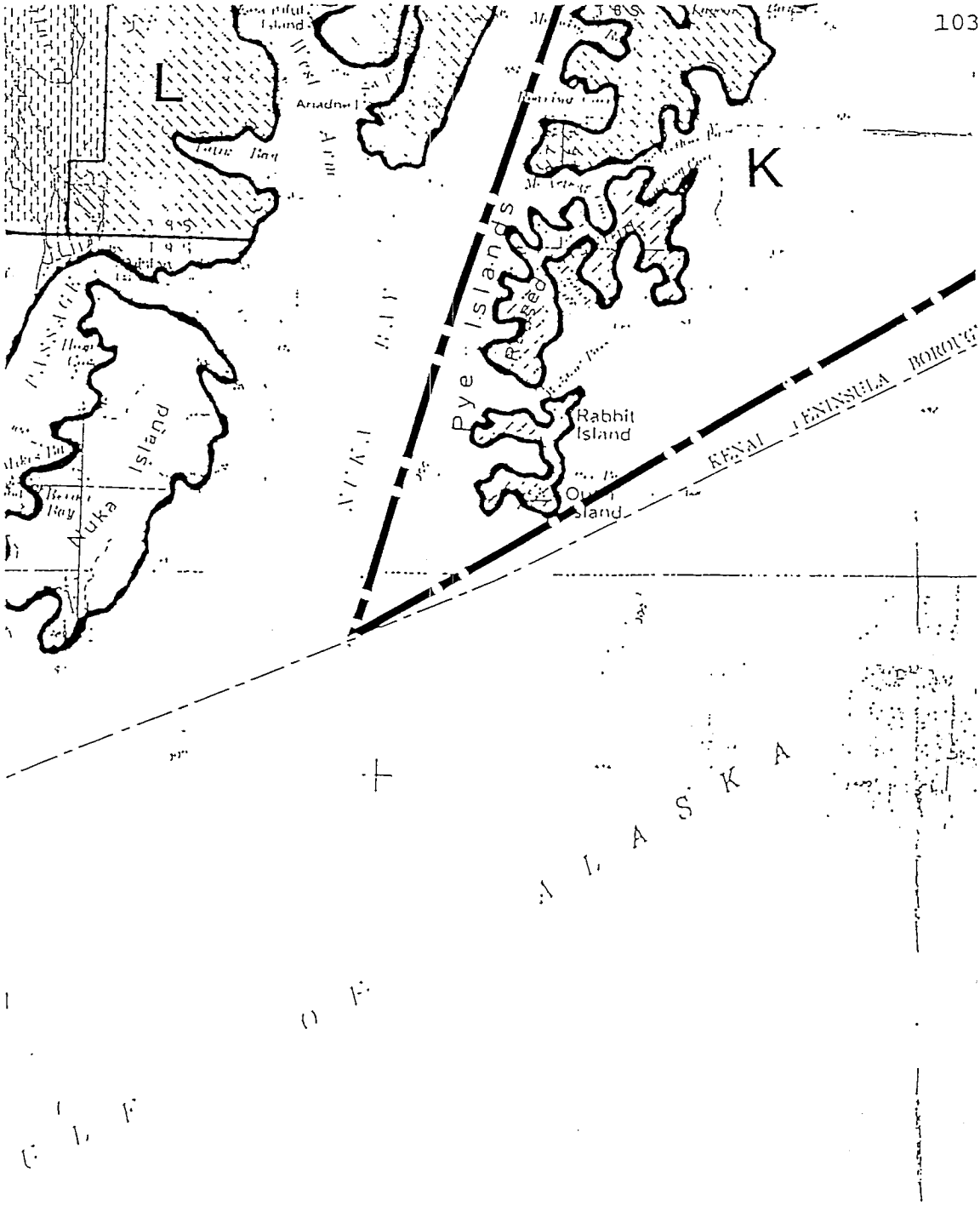
Map III-5


101
Herring Isl.
English Bay
Port Graham
Passage Is.
Port Chatham
Flat Islands
Mount Bede
Red Mountain
Mount Mills
Koyuktolik Bay
Cone Mountain
Rock Mountain
Windy Bay
Chugach Bay
T 12 S
Elizabeth Island
Chugach Passage
CHUGACH
Perl Island
ISLANDS
East Chugach Island
BOROUGH

Map IV-1



Map IV-2


L
K
Pye Islands
Rabbit Island
Aukа Island
KENAI PENINSULA BOROUGH
A L A S K A

Map IV-3

LITERATURE CITED

Bevins, J. S., C. C. Schwartz, E. E. Bangs, and K. J. Nelson. 1985. Kenai Penisula Brown Bear Studies: Report of the Interagency Brown Bear Study Team, 1984. Alaska Dept. Fish and Game, Misc. Publ. 103 pp.

Brannon, R. D. 1984. Influence of roads and developments on grizzly bears in Yellowstone National Park. U.S.D.I., Interagency Grizzly Bear Study Team, Bozeman, MT. 52 pp.

_____, R. D. Mace and A. R. Dood. 1988. Grizzly bear mortality in the northern continental divide ecosystem, Montana. Wildl. Soc. Bull. 16:262-269.

Bratkovich, A. A. 1986. Grizzly bear habitat compoments associated with past logging practices on the Libby Ranger District, Kootenai National Forest. Pages 180-184 In: G. P. Contreras and K. E. Evans, editors. Proc. Grizzly bear habitat symp. U.S.D.A., For. Serv. Intermountain Res. Stat., Ogden, Utah. Gen. Tech. Rep. INT-207.

Bunnell F. L. and D .E. N. Tait. 1980. Bears in Models and In reality -implications to management. Int.Conf.Bear. Res. and Manage. 4:15-23.

_____ and _____. 1981. Population dynamics of bears - implications. In: T.D. Smith and C. Fowler, editors. Dynamics of large mammal populations. John Wiley and Sons, New York. Pages 75-98.

_____ and _____. 1985. Mortality rates of North American bears. Arctic 38:316-323.

Campbell, B. H. 1985. Brown bear activity and impacts on nesting geese on the west Copper River Delta - 1984. Alaska Dept. Fish and Game, Anchorage, AK. Prog. Rep. 25 pp.

Canfield, J. and A. L. Harting. 1987. Home range and movements. Pages 27-33 In: M. N. LeFranc, Jr., M. B. Moss, K. A. Patnode and W. C. Sugg, III, editors. Grizzly Bear Compendium. The National Wildlife Federation. Washington, D.C.

Caughley, G. 1974. Interpretation of age ratios. J.

Wildl. Manage. 38:557-562.

Conner, R. N. 1988. Wildlife populations: minimally viable or ecologically functional? Wildl. Soc. Bull. 16:80-84.

Craighead, F. C., Jr., and J. J. Craighead. 1972. Grizzly bear prehibernation and denning activities as determined by radiotracking. Wildl. Monogr. 32. 35 pp.

Craighead, J. J. 1980. A proposed delineation of critical grizzly bear habitat in the Yellowstone region. Bear Biol. Assoc. Mono. Ser. No. 1. 20 pp.

Egbert, A.L. and A. W. Stokes. 1976. The social behaviour of brown bears on an Alaskan salmon stream. Int. Conf. Bear Res. and Manage. 3:41-56.

Elgmork, K. 1978. Human impact on a brown bear population (Ursus arctos l.). Biol. Conser. 13:81-103.

Gunther, K. 1986. Grizzly bear activity and interrelationships with backcountry recreational use in the Pelican Valley area of Yellowstone National Park. Report of the National Park Service, Bear Management Office, Yellowstone National Park. Preliminary prog. report. 53 pp.

Harding, L. and J. A. Nagy. 1980. Responses of grizzly bears to hydrocarbon exploration on Richards Island, Northwest Territories, Canada. Int. Conf. Bear Res. and Manage. 4:277-280.

Harris, R. B. 1984. Harvest and age structure as an indicator of grizzly bear population status. M.S. Thesis, Univ. Montana, Missoula. 204 pp.

_____, L.A. Maguire, and M. L. Shaffer. 1987. Sample sizes for minimum viable population estimation. Cons. Biol. 1:72-76.

Harting, A. L. 1987. Gizzly bear - black bear relationships. Page 77 In: M. N. LeFranc, Jr., M. B. Moss, K. A. Patnode and W. C. Sugg, III, editors. Grizzly Bear Compendium. The National Wildlife Federation. Washington, D.C.

Hillis, M. Enhancing grizzly bear habitat through timber harvesting. Paper presented at the Grizzly Bear Habitat Symposium, Missoula, MT, April 30-May 2, 1985.

Pages 176-179.

Holland, T. M. 1986. Grizzly bear habitat improvement projects on the South and Middle Fork Flathead River. Pages 190-194 In: G. P. Contreras and K. E. Evans, Editors. Proc. Grizzly bear habitat Symp. U.S.D.A., For. Serv. Intermountain Res. Sta., Ogden, Utan. Gen. Tech. Rep. INT-207.

Jonkel, C., N. McMurray, J. Perry, P. Zager and M. Haroldson. 1978. Bark beetles, timber salvage and the grizzly bear at Glacier View Ranger District, U.S. Forest Service, Columbia Falls, Montana. Border Grizzly Project, Univ. Montana, Missoula. Spec. Rep. No. 12. 21 pp.

_____, L. Lee, T. Thier, N. McMurray and R. Mace. 1979. Sullivan Creek grizzlies. Border Grizzly Project University of Montana, Missoula. Spec. report no. 23. 10pp.

_____. 1982. Five year summary report. Border Grizzly Proj., Univ. Montana, Missoula. Spec. Rep. No. 60. 277 pp.

Judd, S., R. Knight and B. Blanchard. 1983. Denning of grizzly bears in the Yellowstone area. Int. Conf. Bear Res. and Manage. 6-000-000.

Kenai National Wilife Refuge Historical Report. 1938. Management of moose herd on Kenai Peninsula, Alaska. Research proj. rep. March, April and May, 1938.

Knight, R. R. 1987. Mortality patterns and population sinks for Yellowstone grizzly bears, 1973-1985. Wildl. Soc. Bull. 16:121-125.

Knudsen, K. L. and F. W. Allendorf. 1985. Preliminary survey of genetic variation in grizzly bears. Univ. Mont., Missoula, MT. 17 pp.

Lehmkuhl, J. F. 1984. Determining size and dispersion of minimum viable populations for land management planning and species conservation. Env. Manage. 8:167-176.

Mace, R. D. 1987. Food Habits Summary. Pages 111-114 In: M. N. LeFranc, Jr., M. B. Moss, K. A. Patnode and W. C. Sugg, III, editors. Grizzly Bear Compendium. The National Wildlife Federation. Washington, D.C.

McLellan, B. N. and R. D. Mace. 1985. Behaviorof grizzly bears in response to roads, seismic activity and

people. Preliminary report, Can. Border Grizzly Proj., Cranbrook, B.C. 53pp.

_____ and D. M. Shackleton. 1988. Grizzly bears and resource-extraction industries: Effects of roads on behaviour, habitat use and demography. Journal of Applied Ecology 25,000-000.

Mealey, S. P. 1979. Guidelines for management involving grizzly bears in the greater Yellowstone area. U.S.D.I., Natl. Park Serv., Yellowstone Natl. Park, Wyo. and U.S.D.S., Forest Serv., Bridger-Teton, Shoshone, Custer, Gallatin and Targhee Natl. Forests. 136 pp.

_____. 1986. Interagency grizzly bear guidelines. U.S.D.A., For. Serv., U.S.D.I., Natl. Park Ser., Bureau of Land Mgmt., Idaho Fish and Game, Montana Dept. Fish, Wildlife, and Parks, Washington Game Det., Wyoming Game and Fish Dept. 99 pp.

Miller, S. D. 1987. Susitna Hydroelectric Project Final Report. Big Game Studies. Vol. 6 Black and Brown Bear. Alaska Dept. of Fish and Game. 276 pp.

_____, and W. B. Ballard. 1982. Density and biomass estimates for an interior Alaskan brown bear, (Ursus arctos), population. Can. Field Nat. 96:448-454.

Nagy, J. A. and R. H. Russell. 1978. Ecological studies of the boreal forest grizzly bear (Ursus arctos l.) - Annual report for 1977. Canadian Wildl. Service 72 pp.

_____, _____, A. M. Pearson, M. C. S. Kinglsey, and C. B. Larsen. 1983. A study of grizzly bears on the barren-grounds of Tuktoyaktuk Peninsula and Richards Island, Northwest Territories, 1974-1978. Can Wildl. Serv. Rep., Ottowa. 136 pp.

Quimby, R. 1974. Grizzly bear. Chapter II, In: R. D. Jakimchuk, editor. Mammal studies in northeastern Alaska with emphasis within the Canning River Drainage. Arctic Gas Biol Rep. Ser., Vol 24. 97 pp.

Reed, J. M., P. D. Doerr and J. R. Walters. 1986. Determining minimum populations sizes for birds and mammals. Wildl. Soc. Bull. 14:255-261.

Reynolds, H.V. and J. L. Hechtel. 1980. Big game investigations. Structure, status, reproductive biology, movements, distribution and habitat utilization of a grizzly bear population. Fed. Aid.

Wildl. Rest. Proj. W-17-11, Job 4.1R. Job Prog. Rep., Alaska Dept. Fish and Game, Juneau. 66 pp.

Risdahl, G. L., C. A. Schloeder, E. E. Bangs and C. C. Schwartz. 1986. Kenai Peninsula Brown Bear Studies: Report of the IBBST, 1985. Alaska Dept. Fish and Game, Misc. Publ. 92 pp.

Ruediger, W. and S. Mealey. 1978. Coordination guidelines for timber harvesting in grizzly bear habitat in northwestern Montana. U.S.D.A., For. Ser., Kootenai Natl. For., Montana, and Shoshone Natl. Forest, Wyo. 44 pp.

Schallenberger, A. 1976. Grizzly bear habitat survey. Badger Creek-South Fork Two Medicine management unit, Lewis and Clark National Forest. Border Grizzly Proj., Univ. Mont., Missoula. 21 pp.

_____. 1980. Review of oil and gas exploration impacts on grizzly bears. Int. Conf. Bear Res. and Manage. 4:271-276.

Schleyer, B. O., J. J. Jonkel, K. G. Rhoades, D. M. Dunbar. 1984. The effects of nonmotorized recreation on grizzly bear behavior and habitat use. U.S.D.I., IGBST, Bozeman, Montana. 83 pp.

Schloeder, C. A., M. J. Jacobs, N. L. Weiland, E. E. Bangs, C. C. Schwartz. 1987. Kenai Peninsula Brown Bear Studies: Report of the IBBST, 1986. Alaska Dept. Fish and Game, Misc. Publ. 53 pp.

Schoen, J. W. 1986. A review of Population status, forestry relationships, and predator management of brown/grizzly bears in North Americs. Pages 31-43 In: J. W. Schoen and L. Beier, Brown bear habitat preferences and brown bear logging and mining relationships in southeastern Alaska, Fed. Aid Wildl. Rest. Proj. Alaska Dept. Fish and Game, Juneau.

_____, and L. R. Beier. 1987. Brown bear habitat preferences and brown bear logging and mining relationships in southeast Alaska. Alaska Dept. Fish and Game. Fed. Aid in Wildl. Rest. Proj. W-22-4, Job 4.17R.

Schoenwald-Cox, C. M., S. M. Chambers, B. MacBryde and W. L. Thomas. 1983. Genetics and conservation: A referance for managing wild animal and plant populations. Benjamin / Cummings, London.

Servheen, C., 1981. Grizzly bear ecology and management in the Mission Mountains, Montana. Ph.D. diss., Univ. Mont., Missoula. 139 pp.

Shaffer, M. L. 1981. Minimum population sizes for species conservation. Bioscience 31:131-134.

_____. 1983. Determining minimum viable population sizes for the grizzly bear. Int. Conf. Bear Res. and Manage. 5:133-139.

_____. 1985. Population size and extinction: A note on determining critical population sizes. Amer. Nat. 125:144-152.

Smith, R. B. and L. Van Daele. 1984. Terror Lake Hydroelectric Project. 1982 brown bear studies. Prep. by Alaska Dep. Fish and Game. Prep. for Alaska Power Authority. 107 pp.

_____ and _____. 1988. Terror Lake Hydroelectric Project. 1987 Brown bear studies. Prep. by Alaska Dept. Fish and Game for Alaska Power Authority.

Soule, M. 1980. Thresholds for survival: maintaining fitness and evolutionary potential, pp. 151-169. In: M. E. Soule and B. A. Wilcox, editors. Conservation biology: an ecological evolutionary perspective. Sinauer Associates, Sunderland, Massachusetts.

Suchy, W. J., L. L. McDonald, M. D. Strickland and S. H. Anderson. 1985. New estimates of minimum viable population size for grizzly bears of the Yellowstone ecosystem. Wildl. Soc. Bull. 13:223-228.

U.S. Forest Service. 1980. Enviromental assessment, prospecting permit application, Consolidated Georex Geophysics. U.S.D.A., Forest Serv., Lewis and Clark Natl. Forest, Flathead Natl. Forest, Montana. 87 pp.

_____. 1982. Endangered threatened and sensitive plant and animal species and their habitats on the Targhee National. Forest. U.S.D.A., Forest Serv., Targhee Natl. Forest, St. Anthony, Idaho. 100 pp.

_____. 1983. Zoning guidelines for managing grizzly bear habitat in northern Idaho. U.S.D.A. Forest Serv., Idaho Panhandle Natl. Forest, Couer d'alene, Idaho. 27 pp.

_____. 1984. Facilitating grizzly - human coexistence - an integrated program. U.S.D.A., Forest Service,

Bridger-Teton Natl. Forest, Jackson Wyoming. 4 pp.

_____. 1985a. Grizzly management situation guidelines and augmentation discussion. Appendix 8. In: U.S.D.A. Forest Service, Kootenai National Forest proposed forest plan. U.S.D.A. Forest Sev., Kootenai Natl. Forest, Libby, Montana.

_____. 1985b. Grizzly bear standards and guidelines. Appendix G. In: U.S.D.A. Forest Service, Proposed forest plan for Gallatin National Forest. U.S.D.A. Forest Serv., Gallatin Natl. Forest, Montana.

_____. 1985c. Flathead National Forest plan: e.i.s. volume 1 and 2. Appendix E. In: U.S.D.A. Forest Service. Forest plan: Flathead National Forest. U.S.D.A. Forest Serv., Flathead Natl. Forest, Kalispell, Montana.

_____, Montana Dept. Fish, Wildlife and Parks, Bureau Land Managenment and U. S. Fish and Wildlife Service. 1986. Cumulative effects analysis process for the Rocky Mountain Front Northern Continental Divide grizzly bear ecosystem. Draft report. 36 pp.

Vroom, G. W., S. Herroro and R. T. Ogilvie. 1980. The ecology of winter den sites of grizzly bears in Banff National Park, Alberta. Int. Conf. Bear Res. and Manage. 4:321-330.

Weaver, J. R. Escana, D. Mattson, T. Puchlerz and D. Despain. 1985. A cumulative effects model for grizzly bear management. Paper presented at the Grizzly Bear Habitat Symposium, Missoula, MT, April 30-May 2, 19865. Pages 234-246.

Wood, K. H. 1985. The implementation Plan: implementing the information and facilities program to manage recreation use in grizzly habitat. U.S.D.A., Forest Serv., Rocky Mountain Region, Shoshone Natl. Forest, Wyo. 39 pp.

Zager, P. and C. Jonkel. 1980. Management guidelines for occupied grizzly bear habitat in northwestern Montana. Border Grizzly Proj., Univ. Mont., Missoula, Spec. Rep. No. 51. 17 pp.