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DEER PELLET—GROUP SURVEYS IN SOUTHEAST ALASKA 1981-1987

by

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Job 2.9
Objective 1
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PREFACE

This report summarizes the objectives, methods, and results of deer pellet-group survey work conducted by the Department of Fish and Game in Southeast Alaska between 1981-87. It serves as the final report for Fed. Aid Wildl. Rest. W-22-6, Job 2.9, Objective 1. Pellet-group surveys will continue to be conducted annually by the Department as part of annual survey and inventory (S&I) activities. The results of 1988 and future surveys will be provided in Deer S&I reports as well as in an annual summary report available from the regional office in Douglas.

SUMMARY

The objectives, methods, and results of pellet-group surveys conducted in Southeast Alaska from 1981 through 1987 are documented in this report. During this time, 59 Value Comparison Units (VCU), or watersheds, were surveyed. For each VCU, transect locations, physiographic information, deer population density, and trend were described. The discussion focused on the appropriateness of using pellet-group counts to estimate (1) habitat value, (2) population trend, (3) relative deer density, and (4) absolute deer numbers. Critical assumptions and precautions associated with each objective have been outlined.

Pellet-group data, as currently collected, are adequate for assessing deer population trends within individual VCUs. Relative deer abundance among VCUs may also be assessed from pellet-group data, but on a coarse scale only. Habitat value should not be inferred from differences in pellet-group density between plots. In most circumstances, pellet-group surveys can not be legitimately used to arrive at absolute deer numbers.

Although the pellet-group survey has limitations, it is superior to other techniques for evaluating the relative status and trend of deer populations in Southeast Alaska. The Department's pellet-group survey program should be expanded.

Key Words: black-tailed deer, Odocoilius hemionus sitkensis, pellet-group counts, population assessment, old growth, Southeast Alaska.

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INTRODUCTION

Sitka black-tailed deer (Odocoileus hemionus sitkensis) are the most abundant and most widely hunted big game animal in Southeast Alaska. In 1985, 8,500 hunters spent over 50,000 hunter days afield and about $4.5 million to harvest nearly 15,000 deer (Fay and Thomas 1986). Information on the status and trend of deer populations is needed by wildlife and land managers who must recommend hunting seasons and bag limits as well as assess the quantity and mix of habitat needed to sustain desired deer population levels. The likely impacts of logging on deer populations (Wallmo and Schoen 1980, Schoen et al. 1985, Fagen 1988), as well as the statutory requirements to monitor such impacts (i.e., National Forest Management Act of 1976), make the collection of deer population data a high priority for both the Alaska Department of Fish and Game (ADFG) and the U.S. Forest Service (USFS).

Historically, deer population status has been evaluated from information passed on by sport hunters, surveys of hunter success rates, and field observations by biologists. While such methods can yield general indications of population trend, the desirability of a more objective and quantifiable technique for monitoring population status has been long-recognized (Klein 1957, Merriam 1961).

Many techniques to determine density estimates or population indices for deer or other large mammals require visual or photographic counts of segments of populations or entire populations (Connolly 1981). In Southeast Alaska such counts for deer are impractical because much of their habitat is heavily forested. Even in more open habitats, such as alpine meadows and beaches where deer are visible, only an unknown and varying proportion of the total population can be counted. Other methods (e.g., change-in-ratio estimates or estimates based on survival rates) require population composition data that have proven equally difficult to obtain. Because of these limitations, recent efforts in evaluating deer population status and trend in Southeast Alaska have relied on counts of fecal pellet groups.

Counts of pellet groups have been widely used as an index to population density for deer and other species of wildlife (Neff 1968, Fairbanks 1979, White and Eberhardt 1980). The primary advantage of enumerating pellet groups is that they are a visible, persistent, and immobile indicator of animal presence that can be sampled in the field and statistically analyzed. Because of these advantages, it is probably the most widely used deer census method in the western and northern United States (Ryel 1972). In this method, the mean density of pellet groups is determined through a field-sampling procedure that, in turn, provides an index of animal abundance. If the population has been sampled in an unbiased and representative manner and reliable data relating pellet-group density to deer density are available, then estimates of population size can be made.

In Southeast Alaska, pellet-group counts were first used by Merriam (1966a) during the mid-1960's; however, they were discontinued because of methodological problems and high manpower requirements. Barrett (1979) sampled pellet-group density in a watershed on Admiralty Island in 1971 to evaluate both deer density and habitat preference. His work documented unusually high pellet-group density in an old-growth hemlock-(Tsuga heterophylla) spruce (Picea sitchensis) forest, providing an early indication of the importance of this habitat to deer in winter. Since then, several researchers have measured pellet-group density to evaluate habitat utilization by black-tailed deer in Southeast Alaska (Wallmo and Schoen 1980, Schoen et al. 1981, Rose 1982, Kirchhoff et al. 1983).

In 1981 ADF&G initiated a region-wide program to identify important winter habitats of deer as well as important fish and wildlife Value Comparison Units (VCU) in the Tongass National Forest (ADFG 1982). Deer pellet-group densities, as well as vegetational and physical features, were sampled in a number of watersheds, or VCUs, throughout the region. Unlike earlier research, this effort was aimed at making VCU-level comparisons and quantifying changes in deer populations throughout the region.

The objectives, methods, and results of pellet-group surveys conducted from 1981 through 1987 in Southeast Alaska are documented in this report. Furthermore, we have evaluated the program's potential for monitoring deer population status and trend and have made recommendations for future program direction.

METHODS

Monitoring the status and trend of Sitka black-tailed deer in Southeast Alaska is a formidable task, because the deer range over a tremendously large and varied landscape that is both rugged and remote; i.e., deer occur in over 700 watersheds on the Tongass National Forest--a range of some 18,750 mi². Because field data cannot be collected from all VCUs, effort must be carefully allocated to those areas likely to yield the most representative and useful information. An initial and important step in the pellet-group sampling program involved the selection of individual watersheds for sampling.

VCU Selection

Since 1984 VCU selection has been based largely on the recommendations of area biologists in Juneau, Sitka, Petersburg, and Ketchikan; there has also been some involvement at the regional level by the program's coordinator. The following criteria have received at least some consideration in the selection process over the last 4 years.

High Human Use Area:

Every area biologist selected one or more VCUs in his management area that had received heavy hunting use by local residents. These VCUs were generally close to communities and had moderate-to-high deer populations. The primary objective in these areas was to monitor changes in deer populations over time and, in some cases, to evaluate the effect of those changes on hunter effort and success. Continued, regular sampling in these areas is deemed important. Additional sampling effort may be warranted in high-use areas near smaller communities.

Accessibility:

Certain VCUs are good candidates for selection simply because they are close to area offices and can be sampled inexpensively and reliably in almost any kind of weather. These VCUs are located near the larger communities of Juneau, Sitka, Petersburg, and Ketchikan and are accessible by vehicle or small skiff. Easy access is particularly important when crews are using floatplanes, skiffs, or vehicles; it is of lesser importance when work can be conducted from a large vessel.

Change Suspected:

Hunter reports or other information may suggest that the deer population in a portion of a Game Management Unit (GMU) is changing. The area biologist may desire more quantitative information on trends before making recommendations for regulatory change. This criterion may apply to areas where deer populations have been low and are believed to be increasing (e.g., Prince of Wales and Mitkof Islands), or it may apply in areas where deer declines are expected either because of deep winter snow or because the population may be exceeding the carrying capacity of the range.

Limited Information:

There are many areas of Southeast Alaska for which we have little or no information on deer production status and trends. Sampling in these VCUs gives biologists a better understanding of relative deer numbers and habitat conditions across their management areas and may alert them to situations that either suggest a change in hunting regulations or indicate potential concerns with respect to future logging and roading plans. Broader geographic coverage is desirable to provide information for the Tongass Land Management Plan (TLMP) revision in 1989.

Constant, Known Winter Range:

A key assumption of the pellet-group sampling program is that the measurement plots in a given VCU constitute an unbiased sample of pellet groups on the winter range. In most VCUs, annual changes in winter range size because of snow conditions is a significant factor. The assumptions regarding winter deer distribution are simpler on smaller, low-elevation islands where the entire land area is available and used by deer throughout the year; the entire island could be systematically or randomly sampled, with assurance that no segment of the population had escaped detection. Although relatively accurate information on population status and trend can be collected, these situations are atypical of the deer range in Southeast Alaska. Results may not be easily extended to other larger VCUs that include alpine summer range.

Transects Representative of the VCU:

As a rule, it is more difficult to obtain a representative sample in VCUs that are large and have complex physiographic features (e.g., large bays or fjords, slopes facing different aspects, clearcuts, and major river drainages). As VCU size increases, so does the variability of deer numbers across that landscape, requiring a greater sample size (i.e., more transects and plots) to accurately estimate populations. Sampling problems are minimized in small, steep, uniformly forested VCUs that are oriented along the coast or a road and have a single aspect. Sampling in such a VCU not only provides information that is more representative of the whole VCU, but it usually presents fewer logistical problems as well.

Other Objectives:

Pellet-group data collected in some VCUs during 1982-83 and designed to identify important attributes of deer winter range can be used to address other questions:

1. Sampling on the Level Islands presents an opportunity to evaluate deer response to secondary succession and thinning;

2. Transects around Lake Kathleen will provide an opportunity to compare prelogging and postlogging deer densities in a large, extensively logged watershed;

3. Deer trends on south Etolin Island may provide insight into interactions between predators, deer, and introduced elk.

4. Work conducted at Thayer Lake, Lake Eva, and on some of the VCUs on Prince of Wales Island can address questions of deer use relative to aspect and distance from tidewater.

Transect location

A typical VCU was sampled by 3 or more transects oriented roughly perpendicular to the coastline. Location of transects along the shoreline was not random; however, an attempt was made to have different aspects and gradients (e.g., valley bottom vs. hillside) represented in each VCU. Transect routes through clearcuts, second-growth, and windthrow were avoided, as were routes that intercepted ravines, cliffs, and large streams. Availability of safe, convenient boat or airplane landing sites was also a consideration in locating transect starting points.

Sample Area

Deer populations are most concentrated during the winter season when snow restricts them to lower-elevation, forested range (Schoen and Kirchhoff 1985); the area used by deer during this period is termed "winter range." For our sampling purposes, we defined this range as the area below 1500 feet (457 m) elevation and within 2.5 km (125 twenty-meter plots) of the coast.

The elevational criteria for winter range were based on 4 years of radio-telemetry data from Admiralty Island (Schoen and Kirchhoff 1985). We assumed a 6-month disappearance rate; i.e., pellet groups counted in early May were deposited from November through April. Analysis of radio-collared deer locations during that time period showed that 92% of all relocations (536/581) were below an elevation of 1500 feet. Most of the limited use outside that range occurred in November during an exceptionally mild winter. We concluded from these data that, in areas of steep topography, sampling to the 1500-foot contour would capture 95% or more of the "winter" deer use.

The distance-from-coast constraint (i.e., 2.5 km) is not based on data; rather, it is based on the transect length (125 plots) that a field crew is able to sample in an average day. Although much winter deer use can occur within 2.5 km of the coast, particularly in steep topography, in other circumstances (e.g., forested, low-elevation valleys) winter use occurs well inland (15-20 km) from the coast (Schoen 1978, Barrett 1979, Schoen and Kirchhoff 1985). To leave "interior" deer unsampled poses little problem in terms of trend monitoring; it becomes a more significant problem if total population estimation is the goal.

Sample Size

Table 1 shows the number of pellet-group plots required to calculate 95% confidence intervals (CI) for mean pellet-group density at various levels of precision. The goal in recent years has been to sample 300 plots per VCU. At moderate and high pellet-group densities, this sampling intensity should provide estimates that will lie within 15% of the true mean 95% of the time. For low-density areas, this sampling intensity will produce CIs within about 22% of the mean. It is important to recognize that these CIs and precision estimates only reflect variation among plots. Error introduced by such factors as nonrepresentative transect location and temporal or spatial variability in defecation rates and pellet-group persistence are not reflected. These latter factors take on heightened significance if absolute deer numbers, and not relative population trends, are the primary goal.

Field Methods

Methods used to measure pellet-group densities were adapted from Wallmo and Schoen (1980). Each transect consisted of a series of contiguous 1- x 10-m (i.e., 1981 and 1982) or 1- x 20-m (i.e., 1983 to present) plots extending from the beach or road uphill to a predetermined elevation or distance. The origin of each transect was permanently marked by some combination of tags, flagging, paint, or stakes. Beginning in 1987 transect location forms were used (Appendix A) in conjunction with 1:63,360 USGS topographic maps to form a permanent record of transect locations.

Transects were typically sampled by a team of 2 persons following a preselected compass bearing. Transects started at the beach (or some cases a road) and extended inland and uphill. The lead team member pulled a 10- or 20-m lead-core line or plastic-coated steel cable and stopped at 10- or 20-m intervals. The second team member, using a 0.5-m cord, counted all pellet groups within 0.5 m of either side of the cable (as measured to the approximate center of each group). All pellet groups, regardless of age, were counted. In 1987 counting and line-pulling duties were exchanged between team members every 5 plots to provide a basis for estimating variability between observers. A pellet-group was defined as 1 or more fecal pellets that, on the basis of similar size, shape, color, and position relative to other pellets, represented a discrete "group" or dropping.

The number of pellet groups per plot and the ancillary data on topographic and vegetative characteristics were recorded on preprinted waterproof forms (Appendix B). Detailed vegetative information was collected during the 1981-83 field seasons; more general habitat information has been recorded in subsequent years. Analysis in this report is limited to the pellet-group data.

Field sampling began in early spring as soon as the winter range was free of snow (i.e., usually in early April). Initially, we sampled VCUs in the southern half of the Tongass; we then progressed northward as snow conditions allowed. Sampling usually continued through the spring until late May when increasing shrub and herb cover made pellet-group sampling more time-consuming and less accurate.

Data Analysis

Summary statistics assumed that pellet-group data fit a negative binomial distribution. This assumption is consistent with the findings of Neff (1968), McConnell and Smith (1970), Stormer et al. (1977), Fairbanks (1979), and White and Eberhardt (1980) as well as our findings. The negative binomial distribution is described by 2 parameters: mean (m) and dispersion (k). From our data, m is estimated as the number of pellet groups per 20-m^2 plot. We assume m is proportional to the number of deer using an area over a constant time interval. The 95% CI is presented for each estimate of m to provide a measure of variability of the data. Comparisons between VCUs can be made if the habitat sampled is representative of each VCU and observability of pellet-groups is similar. Changes in deer density over time within a VCU are indicated by nonoverlapping CIs.

The parameter k describes the degree of clumping or dispersion of the pellet groups; low k values indicate a clumped distribution, and high k values indicate a more random distribution. The estimate of k likely reflects how deer behavior, habitat distribution, and snow cover interact to determine the winter distribution of deer. For example, in a VCU with patchy habitat or one in which snow conditions have forced deer to low elevations, the distribution of deer will likely be clumped; consequently, we would expect a low k value.

Maximum likelihood estimates of the parameters m and k were computed using a FORTRAN program developed by White and Eberhardt (1980). Finite rates of population increase (r) were calculated; stable populations had a value equal to 1.0, and increasing and decreasing populations had values >1.0, and <1.0, respectively (Connelly 1981). The percentage rate of increase is expressed as a percentage by subtracting 1 from r and then multiplying the result by 100.

To facilitate discussion of pellet-group density estimates among VCUs, general categories based on observed pellet-group densities (i.e., pellet groups per 20 m^2) were established. These included (1) extremely low, <0.5; (2) low, 0.51-1.0; (3) moderate, 1.01-2.0; (4) high, 2.01-3.0; and (5) extremely high, >3.0. Given the statistical uncertainty of pellet-group estimates, we suggest that only general-level comparisons among VCUs be made.

RESULTS

During the 7-year period covered in this report, pellet-group counts were conducted in 59 VCUs (on public and private land) throughout the northern and southern halves of the Alexander Archipelago (Figs. 1 and 2). Of those VCUs, 28 have been sampled in 2 or more years and eight have been sampled in 4 or more years. The number of VCUs sampled each year and the mean number of pellet plots per VCU are shown in Table 2. Sampling intensity was highest in 1982 and 1983 when numerous transects were run in a small number of VCUs. Since then, the general goal has been 300 plots per VCU--a sampling level that, at moderate deer densities (i.e., 1 pellet group/plot), should yield estimates within 15% of the mean 95% of the time.

Four heavily hunted VCUs in the region (i.e., Gravina Island, Woronkofski Island, Nakwasina Passage, and Shelter Island) were sampled intensively in 1984-86 (517-1267 plots) to provide a more precise index of deer density that could be correlated with hunter success statistics. To date, both deer density and hunter success in all intensively sampled areas have been high, limiting our ability to describe how changes in deer density have influenced hunter success. Intensive sampling was suspended in 1987, but it will be resumed when there is some indication that deer population densities in these areas have declined and an associated response in hunter effort and success might be expected.

Summary Statistics

The number, name, size (in acres), and percentage of commercial forest land (CFL) of each VCU sampled is provided in Table 3. For each year, summary statistics include the number of 20-m plots, mean number of pellet groups per plot, 95% CIs about the mean, and k (dispersion). Raw data sets are missing for some VCUs in some years (indicated by "----"); in these instances, CIs and k statistics could not be computed.

VCU Narratives

The following narrative section describes pellet-group results, general population trends, and vegetative and physical features found on each VCU sampled. VCU narratives are organized by GMU. Topographic maps showing the location, topography, and transect location for individual VCUs are provided in Appendix C.

Northern Mainland and Associated Islands (Unit 1C):

Auke Bay (VCU 27). All transects in this VCU were located on Portland Island in Auke Bay, near Juneau. Portland Island was the site of a deer research project designed to determine the relationship between pellet-group density and a known deer density. The island is small (0.15 mi^2), flat, and entirely forested. In the 9 months preceding sampling, it supported an average population of approximately 6 deer (46 $deer/mi^2$). Pellet groups on the island were sampled in May 1987 using methods similar to those used in other VCUs, although sampling intensity was much higher. Pellet-group density estimates are accurate for Portland Island, but they are obviously not representative of the Auke Bay VCU.

Inner Point (VCU 36). This drainage, located on the west side of Douglas Island, is popular with Juneau deer hunters. It is a small VCU containing low-volume forest; it is also brushy, particularly at lower elevations. An unusual spruce-*Vaccinium*-skunk cabbage (*Lysichitum americanum*) forest type is well represented here. Two of the transects ended at 1,500 feet, while the other (i.e., No. 2) was at a low elevation and consisted of 125 plots. The slope is moderate and easily traversed up to 1,500 feet. In 1985 snow cover caused the reading of two transects to end short of 1,500 feet. In 1986 rough water prevented access to transect No. 3; a transect starting at Inner Point and running directly uphill was substituted. This VCU contains a moderate density of deer that appears to be increasing.

Sumdum Glacier (VCU 65). This area was first sampled in 1987, primarily to verify reports of high deer numbers on Harbor Island. One transect was established on Harbor Island, and 2 transects were placed on the mainland south of Harbor Island. We found high densities of deer on Harbor Island and no evidence of deer use on the mainland. Transect No. 2, near Sumdum village, was extremely brushy, and if repeated, it should be moved 200 m to the west. Six moose (*Alces alces*) pellet groups were counted on this transect. Transect No. 3 (outside the VCU) followed a ridge with good overstory cover and a lush forb and *Vaccinium* understory that appeared to be excellent winter habitat. Wolves and deep snow probably have prevented deer from establishing a presence on the mainland. If this VCU is sampled again, we recommend that transect No. 3 be relocated on Sumdum Island.

Shelter (VCU 124). Located north of Juneau in lower Lynn Canal, this VCU is composed of Shelter and Lincoln Islands, and it is a popular destination for Juneau hunters. Shelter Island, the larger of the two, is primarily forested, while Lincoln Island contains more muskeg as well as numerous beaver ponds. The maximum elevation is 1,170 feet on the northern end of Shelter Island. Most transects end on the ridge that runs North-South along the island. This VCU was intensively sampled from 1984-1986, averaging 738 plots. In 1987 it was sampled at a reduced intensity of 288 plots (transects Nos. 4, 5, 6, 7, 8, 18). The starting location for transect No. 7 was missed in 1987, and it was run at least 1 mile south of its proper location. Pellet-group density estimates from the 1984-86 period are relatively accurate because of the large number of plots sampled and the uniform sampling effort over the entire island. Transect starting points are difficult to see from a skiff, but most can be located by crews walking the shore. Deer densities appear to be moderate to high; there has been an upward trend since 1984-86. A comparison of only those transects sampled in 1987 shows a similar pattern of increasing pellet-group densities through 1986 and a leveling off or slight decline in 1987. This decline may reflect the heavy harvest pressure incurred in 1986, when about 14 deer/mi^2 of habitat were taken from the Island (ADF&G, 1986).

Summary. Game Management Subunit 1C includes the mainland north of Cape Fanshaw up to and including Berners Bay and associated islands. Winter weather is typically colder; more snowfall occurs there than most of Southeast Alaska. Brown bears, black bears, and wolves inhabit the mainland, while black bears and occasionally brown bears occur on Douglas, Shelter, and Lincoln Islands. Although pellet-group counts have not been conducted on much of the mainland, deer densities there are believed to be low. Sampling on Douglas, Shelter, and Lincoln Islands indicated moderate-to-high densities of deer and an increasing trend through at least 1986.

Admiralty-Baranof-Chichagof Islands (Unit 4):

Barlow Cove (VCU 125). Located on the northern tip of Admiralty Island, it is a popular destination for Juneau hunters. Virtually the entire VCU is below 500 feet and within 2.5 km of the beach; it is dominated by low-volume, scrub timber. The VCU was intensively sampled in 1982 with 30 transects (2,567 plots) running completely across the peninsula between Barlow Cove and Lynn Canal and fanning out from the head of the cove southward. Sampling has been limited to 3 transects in subsequent years. The 1982 results are more representative of the area, because current transects avoid much of the muskeg areas on the peninsula. Deer were at moderate densities in this area.

Calm Station (VCU 127). Located on the exposed western side of the Mansfield Peninsula, this VCU was intensively sampled in 1982; moderate pellet-group densities were found. Swells in Chatham Strait make access to the exposed beaches of this VCU difficult or impossible on most days. Excessively steep terrain has caused additional sampling problems. Deer populations were moderate and appeared to be slightly higher than in adjoining VCUs on the Mansfield Peninsula.

Hawk Inlet (VCU 128). Much of the Department's deer/habitat research has occurred here, and it was intensively sampled in 1982 on both sides of the inlet, with transects running to 1,000 feet. From 1984-87, 3 transects were run only on the northwest side of the inlet. Transect No. 1 was changed in 1985 to start in the small cove 30 m north of the mapped starting point, and at approximately 700 feet, it turns to follow the ridge north. Deer populations appear moderate to high and are increasing.

Dorn Island (VCU 140). Located along the eastern shore of Seymour Canal, Dorn Island was sampled in 1984. Unprotected, rocky beaches make access difficult. In 1985 the survey was aborted because of rough sea conditions. This VCU is composed mostly of old-growth timber, and the transects are easily negotiated. It is probably not a good site for long-term trend monitoring because of access problems. Moderate densities of deer were indicated for this VCU during the single year of sampling.

Lake Kathleen (VCU 148). Lake Kathleen, on Admiralty Island, was sampled just prior to extensive clearcutting. Pellet-group density in this drainage will be periodically remeasured to document long-term impacts of even-aged forest management on deer populations. A secondary objective was to measure deer use on an interior site more than 3 miles from the coast. Five transects were run from the lake to both north and south facing hillsides (i.e., either 1,500 ft. or the USFS boundary, whichever occurred first). Deer populations in the area were high, particularly on the north-facing slope.

Thayer Lake (VCU 162). This landlocked VCU on central Admiralty Island provided an opportunity to measure deer use of "interior" forest habitat in winter. The transects were located approximately 10 miles from the coast and between 400 and 1,500 feet elevation on both north and south-facing slopes. Deer use was high in this VCU, which was generally characterized by good deer winter range (high-volume hemlock with abundant shrub or forb understory). This VCU should be sampled again after a severe winter to compare the deer population response with that of deer occupying more coastal VCUs.

Hood Bay (VCU 171). Located on western Admiralty Island, this VCU was sampled with 3 transects in 1987. Two of the transects were on south-facing slopes extending to 1,500 feet, while the other one extended up the river valley draining the South Arm. Transect No. 1 should be relocated 1 km west to avoid an extensive 60-year-old second-growth stand resulting from logging above the old cannery site. Transect No. 2 in the South Arm of Hood Bay runs through high-volume riparian spruce forest for the last 3/4 mile. Pellet-group densities for this VCU were high.

Pybus Bay (VCU 182). This large VCU, located on southern Admiralty Island, is an important deer and brown bear hunting area. Because of the area's size and heterogeneity, the 3 transects are not representative of the whole VCU. In 1985 sampling was curtailed on transects Nos. 2 and 3 because of snow above 800 feet. In 1987 the bearing and location for transect No. 2 were changed slightly. Therefore, the results from 1985 and, to a lesser extent, 1987 are not directly comparable to other years. Deer populations appeared moderate to high and show an increasing trend.

First No. 2 (VCU 208). This VCU on north Chichagof Island was intensively sampled in 1983. Most of it is below 300 feet, and much of the area includes muskeg and low-volume timber. Steep forested slopes occur in the southeast corner, where roading and timber cutting are planned. Access may be a problem along the exposed coastline in inclement weather. Deer density was moderate in 1983.

Pt. Augusta (VCU 211). This small, uniformly forested VCU was intensively sampled in 1983 with 11 transects. The shoreline is exposed to Chatham and Icy Straits, and access can be difficult in some weather conditions. Deer densities appeared moderate and were the highest for any VCU sampled on northeast Chichagof Island.

Tenakee Inlet (VCUs 221, 222, 234, 235, 236). These VCUs, all located in Tenakee Inlet, were lightly sampled in 1981. Access is good in the relatively protected waters of the inlet. Because the number of plots was so low during the 1981 sampling, estimates are unreliable. If information is needed from this area, VCU 222 is probably the best suited topographically for efficient sampling. Kadashan (VCU 235) has a road running adjacent to the winter range. Future sampling should be concentrated on the forested hillside above of the road. Corner Bay (VCU 236) has a logging road running its full length that could provide access into the interior. In 1981 the pellet-group density in each of these VCUs was low.

Broad Island (VCU 246). This VCU includes two large rivers that drain south into Peril Strait on southern Chichagof Island; it is topographically complex, with major east-, west-, and south-facing hillsides and large valley bottoms. The VCU cannot representatively sampled with 3 transects; it was sampled once in 1981 at low intensity. This is not a good candidate for regular monitoring, since an adjacent VCU (247) has been sampled during the last 5 years; the pellet-group density in 1981 was moderate.

Finger Mountain (VCU 247). Located in Hoonah Sound, this VCU was intensively sampled in 1983 when 20 transects totaling 2,145 plots were run. Since then, it has been sampled with 236-300 plots each year. Snow prevented the sampling of the higher elevations in 1985, resulting in unrealistically high pellet-group densities. Finger Mountain VCU is physiographically complex; representative coverage probably cannot be obtained with 3 transects. Repeating the same 3 transects, however, should yield useful trend data. Particularly good winter range is found in the Finger River valley (transect No. 2), which had the highest pellet-group density. Transect No. 1 was modified in 1986; it began 200 m east of the mapped starting location. In 1987 transect No. 1 was stopped at 1,100 feet because of snow, which is a recurrent problem on this transect. This VCU has consistently exhibited some of the highest pellet-group densities in the region, ranging from high to very high.

Cobol (VCU 275). This VCU is located in Slocum Arm on west Chichagof Island; it was sampled only once in 1984. The transects run through low-volume old growth, reaching subalpine vegetation at approximately 1,000 feet. This VCU provides information on relative density and trend along the outside coast. Pellet-group densities in this VCU were moderate in 1984.

Rapids Point (VCU 279). Located in Peril Strait on southern Chichagof Island, this VCU was intensively sampled in 1983 (i.e., 28 transects, 2,784 plots). This VCU was least favored by the crew because of the many side-hill transects on steep slopes. Pellet-group densities in 1983 were low.

Ushk Bay (VCU 281). This VCU, located in Hoonah Sound, was lightly sampled (i.e., 94 plots) in 1981. The two transects were located near the mouth of the bay to avoid clearcuts. Crews noted an abundance of bear sign in this VCU. Pellet-group density in 1981 was low.

Range Creek (VCU 288). Located on northern Baranof Island along Peril strait, this VCU was sampled intensively in 1983 and moderately in 1984 and 1985. This area is relatively small and contains a high proportion of muskeg. A steep canyon on one transect caused problems. Resampling may be worthwhile every several years to monitor trend in an area with poor winter range, particularly after severe winters. Low pellet-group densities were found in 1983 and 1984; moderate densities, in 1985 (probably an artifact of late snowmelt and truncated transects).

Lake Eva (VCU 295). Lake Eva, sampled in 1987, extends well inland on North Baranof Island and has a relatively small amount of coastline. Two of 3 transects were located at the head of the lake approximately 2 miles from the coast. These transects were reached by an established trail that was in poor condition. All 3 transects ended in snow at about 1,000 feet. Portions of the transects were arduous because of brush, steep slopes, and slide areas. Pellet-group densities in this VCU were moderate.

Nakwasina Passage (VCU 300). North of Sitka, it is a popular local hunting area that was sampled intensively in 1985 and 1986. In 1987 only 3 transects (195 plots) were sampled. A comparison of data from these transects in 1985, 1986, and 1987 (Table 3) suggests a significant decline in pellet-group density in 1987. Even with the high sampling intensity of 1985 and 1986, transects are probably not representative of the entire VCU, because much of it has been logged and the clear-cuts have not been sampled. The area is easily accessed from Sitka by skiff, even under poor weather conditions. Few of the starting locations are visible from the water, and they should be remarked. Heavy browsing on *Vaccinium* was noted on all transects. Although down from previous years, pellet-group densities in 1987 were still high.

Sealion Cove (VCU 305). Located on northern Kruzof Island, this VCU has been sampled annually since 1984. Late snowmelt in both 1985 and 1986 caused two transects to be prematurely stopped. In 1987 one transect was relocated across Kalinin Bay to avoid steep sidehills and ravines. Very heavy browsing pressure was evident on all three transects. Deer populations appeared to be increasing; however, snow problems and altered transect locations made such conclusions tentative. Based on browse condition and the very high number of deer, we anticipate a declining deer population in the near future.

Summary (Unit 4). Admiralty, Baranof, Chichagof, and adjacent islands compose GMU 4. Snowfall is highly variable throughout the area; the least amount of snowfall occurs along the outer coast of Baranof and Chichagof Islands, and the most snowfall occurs on eastern Baranof, Chichagof, and Admiralty Islands (Selkregg n.d.). Deer densities are high throughout the unit, although they appear to be somewhat higher in the western portion of the GMU; these higher densities are probably a reflection of milder winter weather. Deer densities throughout the unit are higher than in the rest of the region, probably resulting from an absence of black bears and wolves. An apparent decrease in pellet-group density was noted for Nakwasina (VCU 300) in 1987, and deer in other high-density areas should be monitored to determine if the populations stabilize or decline. Large portions of Unit 4 were not routinely sampled for pellet-group density, especially southern Baranof and northern Chichagof Islands.

Islands in the Kake, Petersburg, and Wrangell Areas (Unit 3):

<u>Security Bay (VCU 400)</u>. This VCU is the only area sampled on Kuiu Island. Because of its remoteness from Petersburg, access is difficult. Although Kuiu Island has historically supported high deer populations, deer are now reportedly scarce. Wolves and black bears are both present there; bears, in particular, are abundant. This VCU had the lowest pellet-group density (i.e., total of 8 pellet groups in 360 plots) of any area sampled in the region.

<u>Conclusion Island (VCU 417)</u>. Located in Keku Strait 1.5 miles east of Kuiu Island, this VCU is an important hunting area for residents of nearby Port Protection and Point Baker. The island is uniformly forested with mid- to high-volume timber, and it supports an abundant understory of <u>Vaccinium</u>. Forbs were virtually absent, except in steep areas (presumably because of deer foraging), and <u>Vaccinium</u> on the island showed signs of moderate browsing. Transects ran all the way across the Island, providing a relatively accurate density estimate. Deer density was high; particularly heavy use was concentrated at higher elevations (i.e., 500-800 feet).

<u>Big Level Island (VCU 434a)</u>. This island was intensively sampled in 1981 by ADF&G, in 1983 by U.S. Forest Service (USFS) and ADF&G, and again in 1986 by ADF&G. Our objective was to document existing deer densities in a recently logged area for future comparisons with those obtained after a severe winter (i.e., excessive snowfall) or advanced forest succession. Some experimental thinning took place on the island in 1983. A major portion of the island is either muskeg or noncommercial forest and has remained available for deer use during recent mild winters. The cutover beach fringe areas show signs of advanced succession and low deer use. Pellet-group densities are moderate and stable.

<u>Little Level Island (VCU 434b)</u>. This small island due west of Big Level Island was completely clearcut in the early 1970's. Conifer regeneration was rapid; by 1981 dense thickets covered much of the island and had begun to inhibit the understory.

The island was extensively thinned in 1983. Dense thinning slash in conjunction with forest succession are presumably responsible for the decline in deer numbers through 1986.

Castle River (VCU 435). Castle River VCU, located in Duncan Canal on Kupreanof Island, was sampled in 1984 and 1987. One transect is located on Big Castle Island, and two are located on Kupreanof Island. Pellet-group densities on the Kupreanof transects (one was relocated in 1987) remain extremely low. In 1987 most deer use was on Big Castle Island (i.e., 134 of 156 pellet groups), indicating increasing densities in the moderate range.

Woewodski (VCU 448). The transects are located on southwestern Mitkof Island. This area is accessible from Petersburg, and the transect starting points are well marked. Transects were run in 1984, 1985, and 1987; however, transects were shortened during 1985 and 1987 because of snow. Results indicate increasing densities in the low-to-moderate range.

Frederick (VCU 449). Located on northeastern Mitkof Island, this VCU was sampled intensively in 1981. Extremely low pellet-group densities were found.

Dry (VCU 454). Located on southeastern Mitkof Island, this VCU was lightly sampled in 1981 with 91 plots. Pellet-group densities were in the low range.

Vank (VCU 455). This VCU is composed of 6 small islands north of Wrangell where elevations are all below 1,500 feet. Four of these islands were sampled intensively in 1981; however, transect Nos. 1-5 on Rynda Island were not completed. No wolves are known to reside on any of the islands, but they probably have access to Greys and Rynda Islands via the Stikine Flats. Pellet-group densities ranged from moderate to high on Vank and Sukolof Islands, respectively, to low on Rynda and Greys Islands.

Woronkofski Island (VCU 461). This VCU, located near Wrangell, was selected as an intensive sampling area in 1985. The 1985 counts were hampered by snowcover, resulting in truncation of 7 of 10 transects; moderate densities of deer were indicated. Late snows precluded sampling in 1986. In 1987 3 transects were sampled on the southern side of the island. The upper portions of 2 transects were snow-covered. A comparison of these 3 transects between 1985 and 1987 indicated densities in the moderate-to-high range and an increasing trend. Deer densities on Woronkofski Island are among the highest in GMU 3.

Onslow (VCU 473). In this VCU 2 transects are located on Etolin Island, and one is on nearby Onslow Island. Annual sampling between 1984 and 1986 indicated low but increasing deer numbers. In 1987 deer densities declined slightly. Etolin Island had higher pellet-group densities than Onslow Island in all years. Because two of the transects are at low elevation and the other one has a southwestern exposure, snow is not usually a problem. Fifty elk were transplanted to this area of Etolin Island during January and March 1987. Two elk and abundant elk sign were observed by staff near the start of transect No. 3. It will be particularly interesting to monitor deer population trends if the transplanted elk prosper.

Coronation Island (VCU 564). Pellet-group surveys were conducted on Coronation Island in 1983 and 1985 by personnel from the Petersburg area office. The large increase in pellet-group density (from 0.78 in 1983 to 2.34 in 1985) is probably the result of differing sampling schemes or intensities. It is unlikely that such an increase in population density could actually have occurred. In contrast to the mid-1960's when deer were nearly eliminated by a transplanted wolf population (Merriam 1966a), they are obviously fairly abundant on Coronation Island.

Summary. GMU 3 comprises the central portion of Southeast Alaska, including Coronation, Kuiu, Kupreanof, Mitkof, Zarembo, Woronkofski, Etolin, and Wrangell Islands as well as adjacent small islands. The mainland and eastern islands tend to have cooler winter temperatures and greater snow accumulations than the western islands. Wolves and black bears are found throughout Unit 3. Deer populations in this area are generally low, ranging from extremely low on portions of Kuiu and Kupreanof Islands to moderate on southern Mitkof Island. The populations on some of the smaller islands such as Coronation, Conclusion, Woronkofski, Sokolof, Big Level and Little Level are high. Deer hunting in much of the unit is closed. Deer numbers are slowly increasing in much of the GMU (Smith et al. 1987); this view is supported by pellet-group count data from VCUs 435, 448, 461, and 564. Geographic coverage of the area would be more complete if additional pellet-group count sites were established on Zarembo, southern Kuiu, and northern Kupreanof Islands.

Prince of Wales and Associated Islands (Unit 2):

Red Bay (VCU 532). Located on northern Prince of Wales Island, this VCU was first sampled in 1987. Red Bay has been extensively logged, making it difficult to avoid clearcuts. All transects were shortened because of time limitations. Pellet-group densities were extremely low.

Warm Chuck (VCU 561). Located on Hecata Island off the west coast of Prince of Wales Island, this VCU is a popular hunting destination. Three transects were run in both 1984 and 1985; however, 1 transect was stopped at 1,000 feet in 1985 because of excessive snow cover. The crew reported difficulties on each transect because of blow-down, regrowth, and thick brush. Access by floatplane from Ketchikan is expensive. The 1984-85 counts indicated moderate densities of deer.

Snakey Lakes (VCU 578). This interior VCU, in the Thorne River drainage, is located in the central portion of Prince of Wales Island. The USFS established transects from the road system in 1986. The pellet-group density measured in this VCU was low.

Luck Lake (VCU 581). Transects were also established from the Prince of Wales road system by the USFS in 1986. This VCU, located on the northeastern portion of the island, has a limited coastline and extends inland along the Luck Lake drainage nearly 9 miles. The transects are located from 2.5 to 4 miles inland from the coast. Moderate pellet-group densities were found, indicating the importance of interior winter range to deer. Good deer numbers have been reported by hunters.

12 Mile (VCU 621). This VCU, located in Kasaan Bay on the east-central portion of Prince of Wales Island, was sampled by the USFS in 1985, 1986 and 1987. The transects were all terminated at about 1,100 feet in 1985 because of snow cover. Estimates of pellet-group density ranged from extremely low to low with no obvious trend.

Port Refugio (VCU 635). This VCU located on Suemez Island off the west coast of Prince of Wales Island. The USFS conducted pellet-group counts there in 1985, 1986, and 1987. Data between years are not completely comparable, because two transects were cut short in 1985: one because of snow cover and the other because of an injury. Pellet-group densities were high during 1985 and 1986 (i.e., comparable to some of the higher VCUs in Unit 4). In 1987 pellet-group density had decreased significantly.

Summary. Prince of Wales Island and associated western islands compose GMU 2. Winter weather is generally mild in this unit, having warmer temperatures and lower snowpacks than areas to the north and east. Deep snow conditions are more frequent on north Prince of Wales, particularly at higher elevations. Wolves and black bears occur on most islands. Deer populations appear to be quite variable, ranging from high on Suemez Island to extremely low in the Red Bay VCU on Prince of Wales Island. Observations of local hunters also appear to substantiate these findings. No trends in population growth are apparent from the data collected. Prince of Wales Island, with its extensive road system and ferry access, is an important hunting area. Additional sampling sites are needed on the northern and southern portions of the island. Suemez and Hecata Islands are the only west-coast islands that have been sampled; others should be added on an opportunistic basis. Pellet-group sampling in this area should be a priority during the next field season.

Southern Mainland and Associated Islands (Unit 1A):

Smugglers Cove (VCU 715). Located on the Cleveland Peninsula, this VCU was sampled once in 1981. Some transects overlapped into VCU 716. Continued sampling in this VCU is not recommended; more effort should be focused on the adjacent Helm Bay VCU. Low densities of pellet groups were found.

Helm Bay (VCU 716). Helm Bay (i.e., Cleveland Peninsula) was intensively sampled in 1981 and moderately sampled in 1984 and 1985. Only 2 transects were attempted in 1985; both were cut short at 1,000 feet because of snow cover. Low pellet-group densities were found during all years.

Margaret (VCU 738). The Forest Service sampled this VCU in the Traitors Cove area on northern Revilla Island in 1985 and 1986. Data are not strictly comparable between years, because both transect locations and sampling intensities varied. Pellet-group densities were low.

George Inlet (VCU 748). This VCU is accessible by skiff from Ketchikan. The transects do not provide a good indication of deer density throughout the VCU; however, they provide adequate trend data. Sampling was conducted in 1981, 1984, and 1985. Sampling intensity was light in 1981, and 1 transect was changed in 1984 to avoid a clearcut; the 1981 and 1984-85 data sets are not fully comparable. Pellet-group densities were in the low to extremely low range.

Whitman Lake (VCU 752). This roadside VCU south of Ketchikan was lightly sampled in 1981 (only 45 plots), and it showed an extremely low pellet-group density; it was resampled with different transects in 1987 with similar results. In 1987 snow-cover caused premature stoppage of all 3 transects between 1,200 and 1,400 feet.

Carroll Point (VCU 758). Located on southwestern Revilla Island, this VCU was sampled with a single transect by the USFS in both 1985 and 1986. Deer densities appeared low. Because of the small number of plots, this area should probably be combined with adjoining VCU 759.

Moth Bay (VCU 759). Directly adjacent to VCU 758, this area was sampled with 2 transects by the USFS in 1985 and 1986. Pellet-group densities were low. Because of geographic proximity and similar pellet-group densities, the Carroll Point and Moth Bay VCUs should be combined.

Lucky (VCU 760). This southern Revilla Island VCU was sampled by the USFS in both 1985 and 1986. This is a good sampling area after snowy winters, because two of the transects are at low elevations. The starting points for the transects need to be documented. Pellet-group densities were in the moderate category during both years and were the highest for any area sampled on Revilla Island.

Blank Inlet (VCU 764). This VCU, which is also located on Gravina Island, was lightly sampled (108 plots) in 1981; the transect location(s) is unknown. Limited data indicated moderate pellet-group densities.

Dall Head (VCU 765). Dall Head is another Gravina Island VCU that was lightly sampled (only 69 plots) in 1981; the transect location(s) is unknown. Low pellet-group densities were found.

Alava (VCU 769). This VCU, located on the southeastern tip of Revilla Island, was sampled by the USFS in both 1985 and 1986. Low pellet-group densities were found.

Wasp (VCU 772). Wasp is another southeastern Revilla Island VCU sampled by the USFS in 1985 and 1986. Extremely low to low pellet-group densities were found.

East Gravina Island (VCU 999). Northeastern Gravina Island was sampled at moderate levels in 1981 and at intensive levels in 1984, 1985, and 1986. In 1987 sampling was reduced to 3 transects (Nos. 1-3). This area is readily accessible from Ketchikan; some transects can be reached from the airport, while the rest are easily accessed by skiff. Pellet-group densities appear to have consistently increased from 1984 through 1986 and then leveled off in 1987. For trend monitoring, only 3 transects need to be repeated on a regular basis.

Summary. This subunit, composed of the mainland coast from the southern Cleveland Peninsula to the Canadian boundary and all islands east of Clarence Strait, is centered around the town of Ketchikan. The mainland and eastern Revilla Island portions of this subunit typically have more severe winter weather than the western areas. Wolves and black bears occur throughout the area, while brown bears are limited to the mainland. Deer densities are generally low throughout the subunit, although moderate densities occur in the Gravina Island and Lucky Cove areas. The pellet-group count data generally indicate increasing deer densities. Geographic coverage is generally good because of the number of VCUs sampled by the USFS. Areas that might be considered for future sampling include Annette Island, Duke Island, eastern Revilla Island, and the mainland east and south of Revilla Island.

Rates of Population Change

Mean annual finite rate of population increase (r) (Caughley 1977, Connolly 1981) was computed for VCUs on which multiple, comparable estimates of pellet-group densities were available (Table 4). The formula used follows:

> P_2 P_1 $(r)^t$, where, P_1 is the population size at time 1, P_2 is the population size at time 2, r is the rate of increase, and t is the number of years between time 1 and time 2.

The 1985 counts for those VCUs in which the data appeared biased because of late snowmelt were not included. In 26 of 31 cases, r exceeded 1.0, indicating a positive population growth.

Pellet-group densities in those VCUs sampled throughout the region increased at a mean annual rate of 1.17 between 1984 and 1987. The potential maximum rate of increase for Sitka black-tailed deer is unknown; however, it is probably in the range of 1.35-1.40 based on values for mule deer (*O. hemionus*) and Columbian black-tailed deer (*O. h. columbianus*) (Hatter 1984, Smith et al. 1987). Although estimated rates of increase between 1981 and 1987 are well below their biological potential, they are still relatively high, compared with those recorded in other naturally regulated systems (Connolly 1981:338).

From 1984 to 1986 the mean annual rate of increase for all VCUs included in this analysis was 1.30, while for 1986-87 the mean was 1.02, a significant decrease ($t = 3.41$, $P < 0.01$). Any number of factors might be responsible for this declining rate of population growth, ranging from increased predation (i.e., higher human, wolf, bear populations) to declining habitat conditions (i.e., reduced forage due to overbrowsing and/or secondary succession). Rates of population growth will always decline as habitat carrying capacity is approached. This situation may exist on portions of GMUs 4 and 1C.

DISCUSSION

The objectives of the Department's pellet-group sampling program have evolved from initially seeking to identify key winter habitat types for deer (1981-83) to monitoring deer population status and trend on individual VCUs. Data have been summarized at the regional level and distributed annually to area biologists for their interpretation and use in survey and inventory reports. Regional involvement in annual report writing, data interpretation, and/or program evaluation has been limited. The following discussion focuses on specific applications of these data, indicating where necessary assumptions are valid and where caution should be exercised.

Pellet-group Counts As An Index of Habitat Value

An initial objective of the pellet-group program was the identification of habitat characteristics associated with high winter deer use. Two assumptions attached to this objective are (1) pellet-group density is directly related to deer use (time and numbers), and (2) deer use is indicative of habitat quality (i.e., the capacity of the habitat to produce and/or support deer). The first assumption isn't necessarily true where defecation rates vary with behavior and habitat type (Anderson 1969, Collins and Urness 1981, Harestad and Bunnell 1987). This assumption should be tested before using pellet groups as an index to habitat value, particularly where preferences among habitats are subtle. The 2nd assumption (i.e., deer use is indicative of habitat quality) is well founded on theoretical grounds (Fretwell 1972, Rosenzweig 1981), and it can be applied to Sitka black-tailed deer in Southeast Alaska (Fagen 1988). However, because pellet-group counts represent accumulated deer use over the preceding 6-month to ≥1-year period (Fisch 1979, Schoen and Kirchhoff 1983, Harestad and Bunnell 1987), they are insensitive indicators of habitat quality during brief (but critical) winter periods.

Given these limitations, collection of habitat information in conjunction with pellet-group data should have relatively low priority. Habitat data that are currently collected (i.e., elevation, aspect, habitat type, and volume class and/or plant association) provide a useful characterization of the transects and, to a limited extent, the VCUs. We recommend a continuation of habitat data collection for this purpose, as long as it does not add significantly to the time required to complete the transects.

Pellet-group Counts As An Index of Change Over Time

The main objective of the pellet-group sampling program since 1984 has been to monitor annual changes and long-term trends in deer populations. The implicit assumption that pellet-group density is linearly related to deer density is probably valid (Julander et al. 1963). Most management and ecological problems can be approached with the use of indices of abundance from which the rate of population change can be calculated (Caughley 1977). Such indices may not provide population density, but for many practical purposes, it is sufficient to know the relative abundance of a species in different areas at different times (Dice 1941).

Addressing rates of population change, as opposed to population abundance, simplifies sampling considerations. On a typical VCU, a sample size of 300 plots should be sufficient to detect a 30% change in deer numbers 90% of the time (memorandum to R. Ball from M. Thomas, 2-14-84). Such increases, while biologically possible, are rarely observed in nature (Connolly 1981). As designed then, we cannot speak with statistical certainty about the slight-to-moderate population changes that are typically realized in a given area from year to year. There are several ways we can approach this problem. We can either (1) accept less rigorous statistical standards when interpreting these data, (2) increase sampling effort in VCUs where fine-scale information is needed, and/or (3) sample most VCUs at 2-3 year intervals when the magnitude of any population change may be greater. All of these options have been exercised in various VCUs.

An additional consideration is the lag time between when an individual deer dies and when the pellet groups deposited by that deer disappear. Pellet groups deposited by those deer that died in late winter will persist through the spring sampling period, resulting in an overestimation of the surviving deer population. The later this mortality occurs, the greater the bias. This should not create undue problems, as long as managers recognize this potential lag exists.

For pellet-group counts to serve as a valid index of population trend, certain important assumptions must be met. First, we must assume that defecation rates and pellet-group deterioration rates are similar from year to year. Studies have shown that deer defecation rates vary seasonally with changes in diet and pellet-group deterioration rates vary with varying exposure to snow, rain, and freezing temperatures (Fairbanks 1979, Fisch 1979, Harestad and Bunnell 1987). The effect of these factors has not been quantified in Southeast Alaska; however, because the climate is strongly influenced by stable maritime conditions, annual variability is probably relatively low. Where significant differences in weather between areas or years are known to occur, associated pellet-group data should be interpreted cautiously.

For pellet-group counts to accurately reflect population trends, we must also assume similar proportions of the deer population use the sampled areas during all years. We must also assume that a decreased pellet-group count indicates a reduction in deer numbers, rather than mass movements of deer in some years to unsampled portions of the VCU. Deer generally return to the same seasonal home range year after year, although they may winter at higher elevations during mild years, rather than in severe years (Schoen and Kirchhoff 1985). Since sampling effort ends at either an elevation of 1500 feet or 2.5 km inland, we risk missing a higher proportion of pellet groups during mild winters. This potential bias should be recognized when comparing pellet-group counts between mild and severe winters.

A final assumption is that all pellet groups are equally visible (countable) from year to year. A late spring snowfall can cover pellet groups at higher elevations in some years (e.g., 1985), making counts noncomparable. Similarly, warm springs and early vegetation leaf-out may reduce observability in some areas or years. Different counts may also be related to observer error (i.e., certain observers in some years have counted more carefully or distinguished discrete pellet groups differently than others).

Several precautions have been taken to minimize these potential biases. Snow-related error is minimized by excluding VCUs that typically receive heavy, late snowfalls at higher elevations or by sampling them late in the season. Error associated with vegetation obscuring pellet groups is minimized by sampling VCUs at similar phenological stages of development (e.g., south to north in the Archipelago) or by using more personnel to complete work in a shorter time. Observer variability can be minimized by using experienced field personnel, providing careful training for new field personnel, alternating counting duties every 5 plots on each transect (as in 1987), and having spot checks on individual plots to encourage accuracy (also done in 1987). Observer error during the 1987 field season will be quantified in a separate job report.

Given the above assumptions and potential sources of error, pellet-group indices have compared favorably with those of other census techniques. Jones and Mason (1983) found close agreement between pellet-group counts and nightcounts on Vancouver Island. A downward trend in pellet-group density paralleled a declining deer population in Colorado (Freddy and Bowden 1983). In Michigan, Ryel (1972) reported fair agreement between pellet-group counts and other indices of abundance. Neff (1968) concluded that the pellet-group count technique is valid and could be made to yield reliable data under most field conditions.

Finally, here in Southeast Alaska, increasing pellet-group densities recorded on most VCUs in recent years are consistent with the record mild winters Southeast Alaska has experienced regionally (U.S. Weather Service, unpubl. data., Juneau) and with increasing hunter harvest rates (ADF&G 1985, 1986).

Acknowledging the assumptions and cautions already cited, pellet-group surveys appear to provide a satisfactory means of collecting deer population trend information in Southeast Alaska.

Pellet-group Counts As An Index of Relative Deer Density

A secondary objective of the pellet-group program was to compare relative deer densities among VCUs. This objective shares similar assumptions discussed under the trend-monitoring objective, including the following: (1) pellet-group density is linearly related to deer density; (2) defecation rates and pellet deterioration rates are similar from area to area; (3) pellet groups are equally visible (countable) from area to area; and (4) similar proportions of the deer population are sampled in all areas.

The first assumption can be readily accepted. The second assumption is more questionable. Defecation rates in deep-snow areas may decrease when deer reduce intake and switch to woody browse (Wallmo 1981); however, pellet groups persist longer at cold temperatures and when protected from the elements by snow (Fisch 1979, Fairbanks 1979). Until these relationships can be satisfactorily quantified, caution should be exercised in direct proportion to the dissimilarities (i.e., topography, climate, and habitat type) between VCUs when making comparisons. The third assumption is also questionable. The presence of Salal, low-growing Alaska cedar (Chamaecyparis nootktensis) and/or dense Vaccinium thickets can obscure some pellet groups. The more vegetatively dissimilar 2 VCUs are, the more one should exercise care in drawing conclusions based on pellet-group data. A related but unquantified concern arises when data from 2 or more VCUs are collected by different field crews. While we believe results have been fairly consistent and comparable over the years (because of experienced field crews), this will be more of a concern should volunteers and/or inexperienced agency personnel be recruited for this work in the future.

Given the variety of habitat types and topography found in most VCUs, it is unlikely deer are distributed evenly across that landscape. Mean pellet-group densities recorded for different VCUs are dependent to a great extent on where transects are located. This problem is well illustrated in Harbor Island (VCU 65), Castle River (VCU 464), and Conclusion Island (VCU 417), where heavy deer use occurs on very small islands within a VCU. Because the sampling design emphasized those small islands, the high estimates for the VCU as a whole are biased.

In other cases, important winter deer habitat (old-growth forest) was selected for sampling over lesser-used habitat (e.g., clearcuts, muskegs, and noncommercial forests). Since sampling effort is concentrated in preferred habitats, the estimates are also biased. This bias is most pronounced in VCUs having large amounts of low-quality winter habitat that is avoided (e.g., VCU 300, Nakwasina, with its extensive clearcuts).

In VCUs composed entirely of low-elevation habitat (e.g., Shelter, Level, Sokolof, and Conclusion Islands), deer winter and summer on the same range. If pellet groups persist for more than 6 months, spring surveys will include both winter and summer pellets. In areas where alpine summer range is not available to deer, pellet-group densities are probably biased on the high side.

Even given these factors, pellet-group densities reflect large magnitude of differences in deer densities among areas. Pellet-group density estimates for most VCUs appear to correlate fairly well with subjective impressions of relative deer densities by biologists and hunters familiar with the areas. On that basis, it is probably valid to make general inter-VCU comparisons of relative densities using broad density categories.

We suggest the following broad density categories (i.e., mean pellet groups per 20 m^2) as meaningful: extremely low, <0.5; low, 0.5-0.99; moderate, 1.0-1.99; high, 2.0-2.99; and extremely high, >3.0. Such comparisons should be tempered by knowledge of how well the transects represent the VCUs of interest. Caution should be used in comparisons, particularly involving large physiographically complex VCUs where sampling may not be representative of the VCU as a whole and when the compared VCUs differ dramatically in habitat type and/or climate. Area biologists familiar with local VCUs are in the best position to judge the validity of inter-VCU comparisons.

Pellet-group Counts As An Estimator of Population Size

Concurrent with development of species management plans by ADF&G and revision of the Tongass Land Management Plan by the USFS, there has been some discussion about using pellet-group surveys to arrive at total population estimates for specific geographic areas. Use of pellet-group counts to estimate density would require meeting the assumptions already discussed above.

Beyond that, population estimation from pellet-group counts requires knowledge of absolute defecation rates and pellet-group deterioration rates (ideally, site- and year-specific) or knowledge of the relationship between pellet-group density and deer density. Although defecation rates for Sitka black-tailed deer are not known, rates for mule deer and Columbian black-tailed deer range from 10 to 23 groups/day, with a mean of about 13.5 (Neff 1968, Stordeur 1984). Rogers (1987) found that the defecation rates of white-tailed deer (Odocoileus virginianus) varied markedly according to the season and that penned deer deposited far fewer groups than did free-ranging deer.

Estimates of pellet-group deterioration also vary widely. Fisch (1979) found that under the forest canopy about 75% of the pellets completely disappeared within the 6-month period of May to October. On northern Admiralty Island, Schoen and Kirchhoff (1983) found that most pellets counted in spring were deposited after October and therefore accurately reflected winter deer use. This relatively short persistence period is supported by the results of experiments with elk pellets (Fairbanks 1979) in western Washington, which has a similar climate to Southeast Alaska. Marked pellet groups deposited in September 1986 on Portland Island were still clearly visible after 8 months; after 12 months, almost all had disappeared. A much longer persistence period was found in coastal British Columbia, where Harestad and Bunnel (1987) found the number of pellet groups counted on uncleared plots was 1-3 times higher than the number of groups deposited the previous year.

Knowledge of the absolute defecation rates and pellet-group disappearance rates of deer are not needed if pellet-group density can be equated directly with a known deer density. By introducing a known number of deer to Portland Island in Auke Bay (ADF&G 1987), information on the relationship between deer density and pellet-group density was obtained. More data of this type, collected under different seasonal weather conditions and at varying deer densities, are needed before population estimation across the Tongass should be attempted. Even then, a greater effort will need to be made to ensure the number of plots and the transect locations yield an adequate, unbiased sample of pellet-groups on the winter range.

Conclusions

Pellet-group data currently being collected in Southeast Alaska appear adequate for assessing population trends within individual VCUs. In addition, these data can be used to make valid (albeit general) comparisons of relative abundance among VCUs. We caution against placing undue significance on small differences in pellet-group densities measured over time or among areas. Defecation rates, pellet-group persistence, pellet-group visibility, and winter deer distribution may vary slightly from year to year and area to area, introducing confounding variation.

With some exceptions, pellet-group counts do not appear adequate to estimate absolute deer numbers in a VCU. Absolute population estimates would require the sampling of all winter range (including interior areas) in a random or carefully stratified fashion. Not only would this require substantially more transects and plots than are currently used, but those added plots would, in most cases, be relatively difficult to reach. For practical purposes, the task is impossible on large or physiographically complex VCUs.

In addition to these sampling problems, density estimates require knowledge of defecation and pellet deterioration rates or the relationship between deer density and pellet-group density. This information is either lacking or limited in Southeast Alaska. At present, deer population estimates are feasible only for those situations where the winter range is known with certainty (e.g., small, low-relief islands) and the entire population can be completely sampled. Examples of such situations already sampled include Portland, Sokolof, Greys, Rynda, Level, Leisnoi, Conclusion, Shelter, Lincoln, and Harbor Islands. In these cases, measured pellet-group densities should be converted to deer densities using the relationship between the two developed on Portland Island (Kirchhoff and Pitcher 1988).

Although pellet-group data has limitations, it appears superior to other techniques for evaluating the status and trend in deer populations in Southeast Alaska. The pellet-group data collected to date have already proven useful to area biologists in proposing or commenting on regulations before the Alaska Board of Game. These pellet-group data, in conjunction with hunter harvest information, will also be used to develop ADF&G species management plans and help guide future land-use decisions on national forest lands.

Recommendations

Although the program has been successful, a number of changes that are primarily from the standpoint of data management and reporting should be made. A biologist in the regional office should be assigned responsibility for overseeing and coordinating the pellet-group program. Duties should include budgeting, purchasing and maintaining field equipment, hiring and supervising technicians, scheduling field itinerary, arranging logistical support, summarizing data, and preparing an annual report.

A customized data management and analysis program should be written and installed on a microcomputer. The pellet-group coordinator should ensure that all data were entered properly and analyzed and the results distributed to the area biologists and other appropriate individuals and organizations in a timely manner. Annual survey results should be incorporated into the Big Game Data Index File (BGDIF). Files should be maintained in the regional office. These files should include information on all VCUs sampled; e.g., maps showing transect locations, "transect location forms" describing pertinent bearings and landmarks, written comments on special features or problems associated with each transect, and documentation of any changes in transect locations or counting procedures. Duplicate files located in each area office should contain copies of maps and documents pertinent to VCUs in that management area.

The USFS, particularly the Ketchikan area office, has played an important role in the pellet-group program. Besides collecting data independently on a number of VCUs on Prince of Wales and Revilla Islands, USFS staff have provided valuable logistical support. Forest Service involvement in this program should be encouraged and expanded to the extent permissible under the existing Memorandum of Understanding.

Value Comparison Units characterized by intensive roading and logging development have not been adequately sampled to date, even though some of these VCUs constitute important hunting areas. ADF&G, in conjunction with USFS personnel, should sample VCUs accessible to them from road systems, especially on Prince of Wales and Chichagof Islands. If deer population trends are going to be truly representative of an area, we will have to sample regrowth areas and clearcuts.

Information on the relationship between deer density and hunter success is needed to establish management guidelines for minimally acceptable population densities. To effectively evaluate the relationship between deer density and hunter success, hunter success at widely varying deer densities is required. Until substantial changes in deer density on intensive monitoring areas occur, we recommend that only 3 transects be sampled in each VCU. For purposes of trend monitoring, the 3 transects should be compared with the same 3 transects from previous years' work.

Most GMUs within the Region now have a reasonable sample of VCUs that have been surveyed for pellet groups and can be used in trend monitoring. We recommend that additional VCUs selected be fairly small, narrow, and oriented along the coast and have an elevational gradient of at least 1,500 feet within 2.5 km of the coast. It would also be desirable to have a small number of VCUs, such as low elevation islands, in which deer are resident throughout the year; these could be sampled during late springs when snow at higher elevations is a problem in many VCUs.

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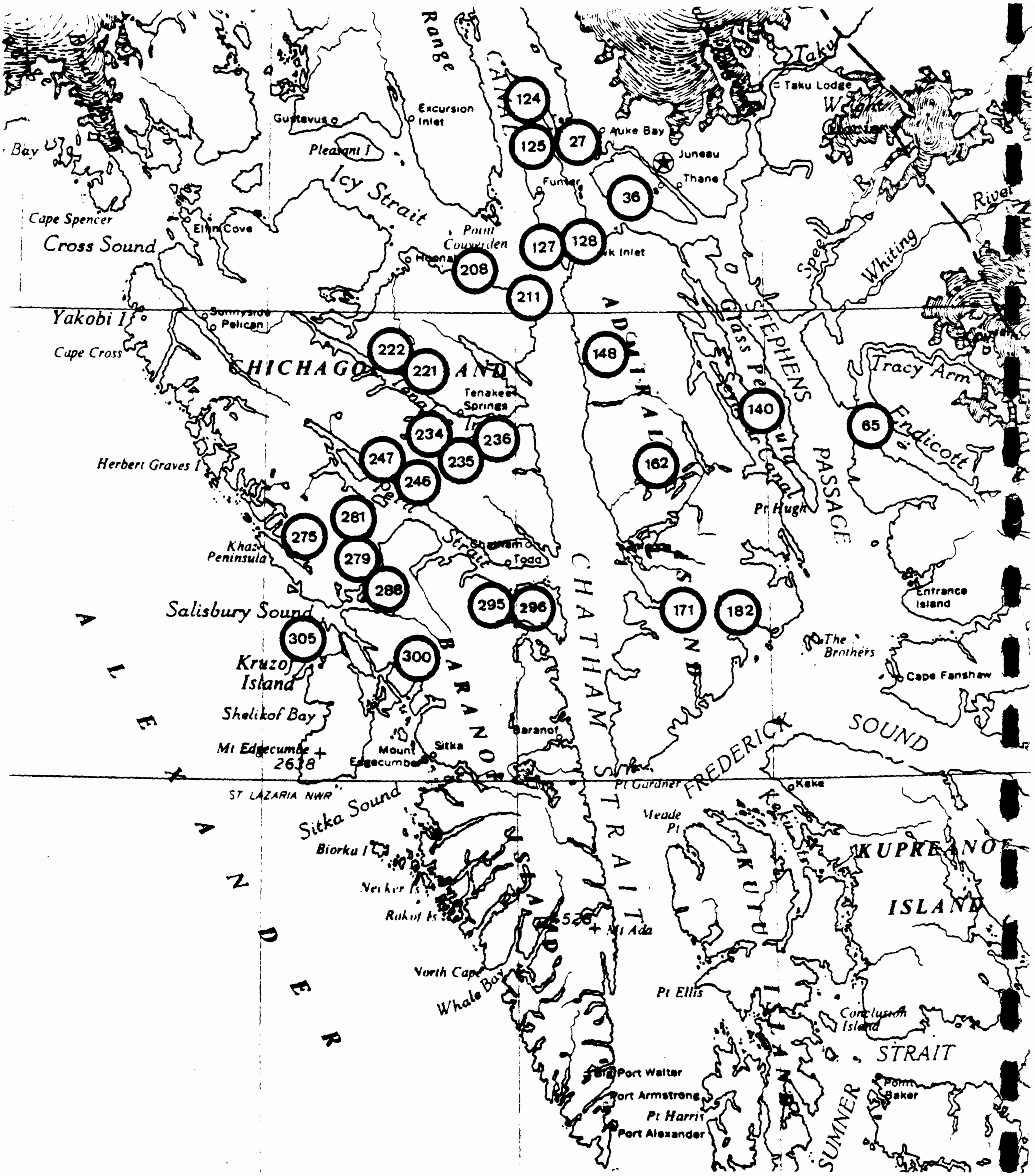


Fig. 1. Location of VCUs sampled in northern Southeast Alaska. Numbers refer to VCU number.

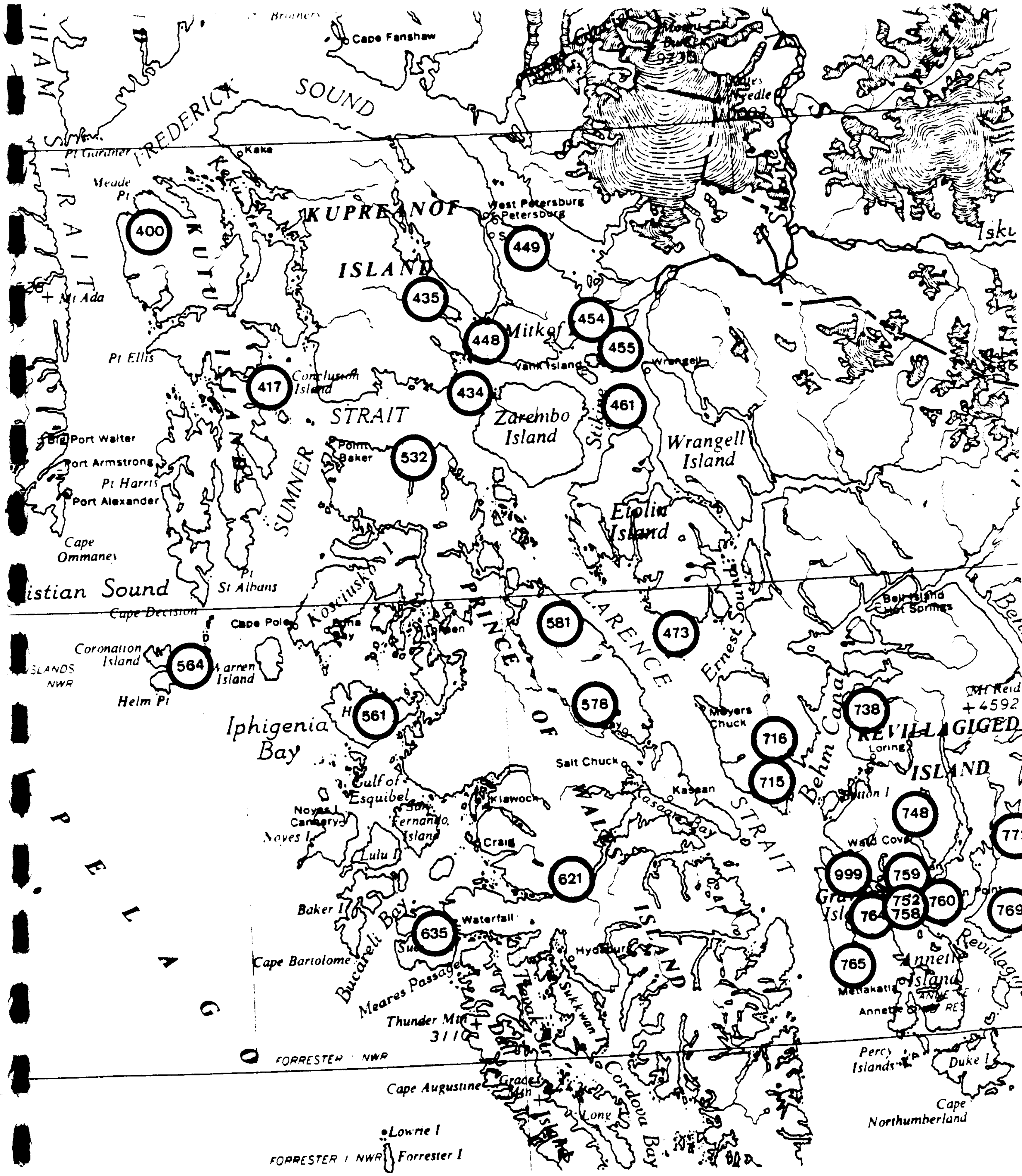


Fig. 2. Location of VCUs sampled in southern Southeast Alaska. Numbers refer to VCU number.

Table 1. Sample sizes (number of 20-m^2 plots) required to calculate confidence intervals with various levels of precision 95% of the time for low, moderate, and and high pellet-group densities; based on the negative binomial distribution after White and Eberhardt (1980).

	Low density mean pellets=0.5 K[a]=0.6	Moderate density mean pellets=1.5 K=1.0	High density mean pellets=2.7 K=1.2
% of mean	Sample size	Sample size	Sample size
10%	1409	640	462
15%	626	285	206
20%	352	160	116
25%	225	102	74

[a] A measure of the degree of clumping, or dispersion, in the data. Low numbers equals more clumped distributions.

Table 2. The number of Value Comparison Units (VCU) sampled and plots sampled per VCU for years 1981-87.

Year	No. of VCUs	Mean No. of plots/VCU
1981	20	298
1982	3	1,742
1983	7	1,392
1984	18	355
1985	25	362
1986	20	366
1987	22	251

Table 3. Pellet-group count statistics from southeast Alaska, 1981-87.

Value Comparison Unit (VCU)	Name	Land acres	% CFL	Year	N	Pellet Group Mean	95% CI	K
27	Auke Bay	15,245	45%	1987	381	0.99	0.87-1.12	1.66
36	Inner Point	3,965	44%	1985	256	1.30	1.10-1.51	1.09
				86	235	1.97	1.68-2.25	1.29
				87	262	1.76	1.53-2.00	1.61
65	Sumdum Glacier	40,906	15%	1987	262	1.76	1.53-2.00	1.61
				87	200	1.28	1.00-1.56	0.56
124	Shelter Island (all transects)	6,162	43%	1984	713	1.46	1.33-1.60	1.80
				85	774	1.82	1.67-1.97	1.24
				86	727	2.20	2.02-2.37	1.28
124	Shelter Island (Trans. 4-8, 18)			1984	300	1.52	1.34-1.70	2.07
				85	290	2.52	2.24-2.81	1.78
				86	292	3.24	2.91-3.57	2.14
				87	288	2.91	2.57-3.24	1.49
125	Barlow Cove	13,712	24%	1982	2,567	1.07	1.01-1.12	0.75
				84	347	1.69	1.46-1.92	0.98
				85	347	1.55	1.35-1.76	1.05
127	Calm Station	4,941	66%	1982	1,054	1.65	1.53-1.77	1.30
128	Hawk Inlet	14,318	57%	1982	1,605	1.21	0.99-1.42	0.67
				84	339	1.42	1.22-1.63	0.96
				85	270	1.69	1.43-1.95	0.91
				86	286	1.92	1.64-2.19	1.00
				87	278	2.54	2.19-2.89	1.04

Table 3. Continued.

Value Comparison Unit (VCU)	Name	Land acres	% CFL	Year	N	Pellet Group Mean	Pellet Group 95% CI	K
140	Dorn Island	9,485	81%	1984	230	1.27	1.02-1.53	0.69
148	Lake Kathleen	14,693	57%	1987	207	2.13	1.76-2.49	0.91
162	Thayer Lake	25,342	79%	1987	313	2.81	2.49-3.12	1.53
171	Hood Bay	44,355	79%	1987	358	2.31	1.99-2.63	0.76
182	Pybus Bay	41,501	62%	1981	390	1.34	1.16-1.52	0.93
				84	300	1.02	0.86-1.18	1.18
				85	269	1.86	1.60-2.12	1.22
				86	235	2.00	1.70-2.29	1.19
				87	242	2.03	1.69-2.37	0.78
208	First No. 2	6,613	32%	1983	1,155	1.12	1.01-1.22	0.63
211	Point Augusta	4,688	63%	1983	757	1.78	1.62-2.01	1.08
221	Whip Station	4,708	53%	1981	193	0.86	0.64-1.08	0.47
222	Sand Station	12,231	50%	1981	253	0.60	0.48-0.73	0.80
234	Inbetween	6,002	62%	1981	35	0.49	0.08-0.89	0.23
235	Kadashan River	33,641	53%	1981	96	0.54	0.32-0.76	0.43
236	Corner Bay	10,930	66%	1981	60	0.35	0.17-0.53	0.73
246	Broad Island	17,145	38%	1981	209	1.41	1.18-1.63	1.39

Table 3. Continued.

Value Comparison Unit (VCU)	Name	Land acres	% CFL	Year	N	Pellet Group		K
						Mean	95% CI	
247	Finger Mountain	15,918	38%	1983	2,145	1.17	1.11-1.24	1.09
				84	302	1.83	1.57-2.09	1.02
				85	279	3.23	2.79-3.67	0.96
				86	277	2.88	2.57-3.19	2.13
				87	236	3.11	2.71-3.52	1.35
275	Cobol	14,618	49%	1984	224	1.15	0.92-1.37	0.78
279	Rapids Point	7,637	65%	1983	2,734	0.77	0.73-0.81	1.34
281	Ushk Bay	20,770	38%	1981	94	0.63	0.41-0.85	0.71
288	Range Creek	6,929	33%	1983	1,788	0.51	0.46-0.55	0.60
				84	303	0.71	0.61-0.92	0.60
				85	224	1.32	1.02-1.62	0.44
295	Lake Eva	12,362	65%	1987	172	1.81	1.46-2.15	0.94
296	Portage Arm	16,101	59%	1981	213	0.53	0.39-0.68	0.50
300	Nakwasina (all transects)	19,575	48%	1984	196	2.51	2.14-2.88	1.48
				85	1,046	3.92	3.67-4.17	1.18
				86	715	3.50	3.26-3.76	1.15
300	Nakwasina (trans. 2, 3, 8)			1984	138	2.51	2.10-2.93	
				85	218	3.65	3.13-4.17	
				86	205	3.38	2.91-3.84	
				87	195	2.31	1.90-2.72	

Table 3. Continued.

Value Comparison Unit (VCU)	Name	Land acres	% CFL	Year	N	Pellet Group Mean	Pellet Group 95% CI	K
305	Sealion Cove	9,293	69%	1984	320	1.36	1.15-1.58	0.77
				85	292	2.57	2.23-2.91	1.06
				86	235	2.87	2.44-3.29	1.01
				87	226	3.31	2.82-3.80	1.00
400	Security	28,040	79%	1984	360	0.02	0.01-0.04	----
417	Conclusion Island	12,561	99%	1987	207	2.66	2.32-3.01	1.93
434a	Big Level Island	727	61%	1981	399	1.54	1.45-1.63	---
				83	336	1.56	--------	---
				86	382	1.66	1.41-1.90	0.66
434b	Little Level Island	263	92%	1981	114	2.48	2.02-2.94	---
				83	136	2.34	--------	---
				86	122	1.39	1.07-1.70	1.12
435	Castle River	32,724	36%	1984	312	0.19	0.12-0.26	0.20
				87	305	0.51	0.37-0.65	0.34
448	Woewodski	20,931	53%	1984	295	0.88	0.69-1.08	0.43
				85	209	0.72	0.58-0.85	1.13
				87	195	1.65	1.36-1.94	0.94
449	Frederick	6,835	70%	1981	945	0.08	0.06-0.11	0.09
454	Dry	11,033	75%	1981	91	0.92	0.56-1.28	0.80
455	Vank	8,437	99%	1981				
	a) Sokolof				900	1.73	1.61-1.85	---
	b) Rynda				281	0.25	0.18-0.32	---
	c) Greys				284	0.25	0.18-0.32	---

Table 3. Continued.

Value Comparison Unit (VCU)	Name	Land acres	% CFL	Year	N	Pellet Group Mean	95% CI	K
461	Woronkofski (all transects)	14,500	63%	1985	646	1.63	1.45-1.81	0.70
461	Woronkofski (trans. 10, 11, 12)			1985	218	2.01	1.62-2.39	0.77
				87	201	2.23	1.85-2.61	0.94
473	Onslow	28,947	55%	1984	321	0.37	0.28-0.46	0.45
				85	334	0.59	0.48-0.70	0.71
				86	347	0.72	0.59-0.84	0.90
				87	326	0.42	0.31-0.52	0.35
532	Red Bay	15,145	66%	1987	177	0.32	0.18-0.47	0.22
561	Warm Chuck	12,348	85%	1984	326	1.02	1.02-1.38	1.01
				85	295	1.60	1.36-1.84	0.90
564	Coronation	19,107	69%	1983	696	1.20	1.04-1.36	0.45
				85	228	2.34	--------	---
578	Snakey Lakes	6,431	84%	1986	279	0.62	0.51-0.73	1.39
581	Luck Lake	19,818	67%	1986	178	1.74	1.41-2.07	0.88
621	12 Mile	23,344	59%	1985	196	0.31	0.19-0.43	0.26
				86	300	0.64	0.48-0.81	0.28
				87	370	0.65	0.49-0.81	0.24
635	Port Refugio	9,118	50%	1985	317	2.69	2.27-3.12	0.59
				86	324	2.52	2.0902.96	0.47
				87	369	1.76	1.46-2.07	0.44

Table 3. Continued.

Value Comparison Unit (VCU)	Name	Land acres	% CFL	Year	N	Pellet Group Mean	Pellet Group 95% CI	K
715	Smugglers	13,659	50%	1981	147	0.48	0.30-0.66	0.34
716	Helm Bay	16,127	57%	1981	704	0.16	0.12-0.19	0.31
				84	302	0.54	0.44-0.65	1.18
				85	181	0.85	0.65-1.05	0.70
738	Margaret	19,286	67%	1985	515	0.57	0.47-0.66	0.56
				86	251	0.84	0.69-1.00	1.07
748	George Inlet	19,448	28%	1981	110	0.21	0.09-0.33	0.21
				84	344	0.27	0.19-0.35	0.28
				85	313	0.52	0.39-0.65	0.37
752	Whitman Lake	6,015	38%	1981	45	0.18	0.02-0.33	0.33
				87	187	0.16	0.09-0.23	0.47
758	Carroll Point	11,629	34%	1985	118	0.66	0.46-0.86	0.82
				86	118	0.75	0.56-0.95	1.33
759	Moth Bay	7,652	23%	1985	140	0.59	0.42-0.74	0.99
				86	156	0.98	0.79-1.17	1.79
760	Lucky Cove	12,377	43%	1985	335	1.16	1.00-1.33	1.11
				86	156	1.16	0.95-1.32	1.25
764	Blank Inlet	3,640	19%	1981	108	1.24	0.89-1.59	0.70
765	Dall Head	4,803	63%	1981	69	0.52	0.31-0.74	0.91
769	Alava Bay	13,563	60%	1985	311	0.52	0.39-0.65	0.30
				86	326	0.85	0.68-1.01	0.49

Table 3. Continued.

Value Comparison Unit (VCU)	Name	Land acres	% CFL	Year	N	Pellet Group Mean	Pellet Group 95% CI	K
772	Wasp Cove	4,882	90%	1985	271	0.41	0.31-0.51	0.52
				86	300	0.50	0.38-0.62	0.41
999	E. Gravina Island (all transects)	---	---	1981	226	1.06	0.89-1.22	1.93
				84	1,087	0.86	0.78-0.94	0.84
				85	1,172	1.23	1.13-1.32	1.09
				86	1,267	1.40	1.30-1.50	1.08
999	E. Gravina Island (trans. 1, 2, 3)			1984	376	0.88	0.73-1.03	0.65
				85	224	1.44	1.20-1.67	1.20
				86	346	1.62	1.43-1.81	1.60
				87	334	1.63	1.41-1.84	1.13

Table 4. Mean annual finite rate of increase (r) of pellet-group density estimates by Value Comparison Units (VCU).

VCU	Years	Rate of Increase[a] (r)
36-Inner Point	1985-87	1.16
124-Shelter	1984-85	1.25
124-Shelter	1985-86	1.21
124-Shelter[b]	1984-85	1.66
124-Shelter[b]	1985-86	1.29
124-Shelter[b]	1986-87	0.90
124-Barlow	1984-85	0.92
128-Hawk	1984-85	1.19
128-Hawk	1985-86	1.14
128-Hawk	1986-87	1.32
182-Pybus	1984-86	1.40
182-Pybus	1986-87	1.02
247-Finger	1984-86	1.25
247-Finger	1986-87	1.08
300-Nakwasina[b]	1986-87	0.68
305-Sealion Cove	1984-86	1.45
305-Sealion Cove	1986-87	1.15
435-Castle River	1984-87	1.39
448-Woewodski	1984-85	1.14
448-Woewodski	1985-87	1.28
461-Woronkofski[b]	1985-87	1.05
473-Onslow	1984-85	1.59
473-Onslow	1985-86	1.22
473-Onslow	1986-87	0.58
621-12 Mile	1986-87	1.02
635-Port Refugio	1986-87	0.70
999-Gravina	1984-85	1.43
999-Gravina	1985-86	1.14
999-Gravina[b]	1984-85	1.64
999-Gravina[b]	1985-86	1.13
999-Gravina[b]	1986-87	1.01
Overall Mean		1.17

[a] Note that there are no error estimates associated with these computed values. True rates of change may be significantly higher or lower than those presented for individual VCUs.

[b] Finite rates of increase calculated for 3 comparable transects on intensively sampled VCUs.

APPENDIX A.

Transect Location Form

TRANSECT LOCATION FORM

The purpose of this form is to enable crews to relocate transect starting points year after year. This form should be filled out once for every new or existing pellet-group transect. Please fill it out neatly and accurately.

VCU NO. __________ AZIMUTH ______________

TRANSECT NO. _____ DATE ______________

STARTING POINT

Marked on topographic map? (y/n) _____

General Location ____

____

____

With back towards starting point, find one or two recognizable landmarks (islands, rocks, points, buildings, etc.)

Landmark ________________________ Bearing to Landmark _____

Landmark ________________________ Bearing to Landmark _____

An aluminum tag should be nailed to a prominent tree at the starting point of each transect. This bearing tree should be marked with visible paint and/or flagging if possible.

General location of tree: (e.g., on 10' cliff above a beach with large boulders, 20' north of small creek) ____________

____

____

Bearing tree species? ___________ Diameter? ______________

Bearing tree marked w/ aluminum tag? (y/n)
w/ flagging? (y/n) color? ________
w/ paint? (y/n) color? ________

At the conclusion of the transect, please make some general comments. You might include information on ease of travel, topography, vegetation, unusual deer sign, other wildlife sign, and any particularly appealing or appalling aspects of the transect.

____

____

____

____

____

____

____

____

APPENDIX B.

Standardized Data Form

VCU NO. ________ DATE ____________________ TRANSECT ______ BEARING ________

CREW ______________ =1 ______________ =2 ASPECT ___ PAGE 1

	CREW	COUNT	ELEVATION	SPP.	VOL	IRI	CHECK	COMMENTS
001	1							
002	1							
003	1							
004	1							
005	1							
006	2							
007	2							
008	2							
009	2							
010	2							
011	1							
012	1							
013	1							
014	1							
015	1							
016	2							
017	2							
018	2							
019	2							
020	2							
021	1							
022	1							
023	1							
024	1							
025	1							
026	2							
027	2							
028	2							
029	2							
030	2							
031	1							
032	1							
033	1							
034	1							
035	1							
036	2							
037	2							
038	2							
039	2							
040	2							
041	1							
042	1							
043	1							
044	1							
045	1							

VCU NO. ________ DATE ________________ TRANSECT _____ PAGE 2

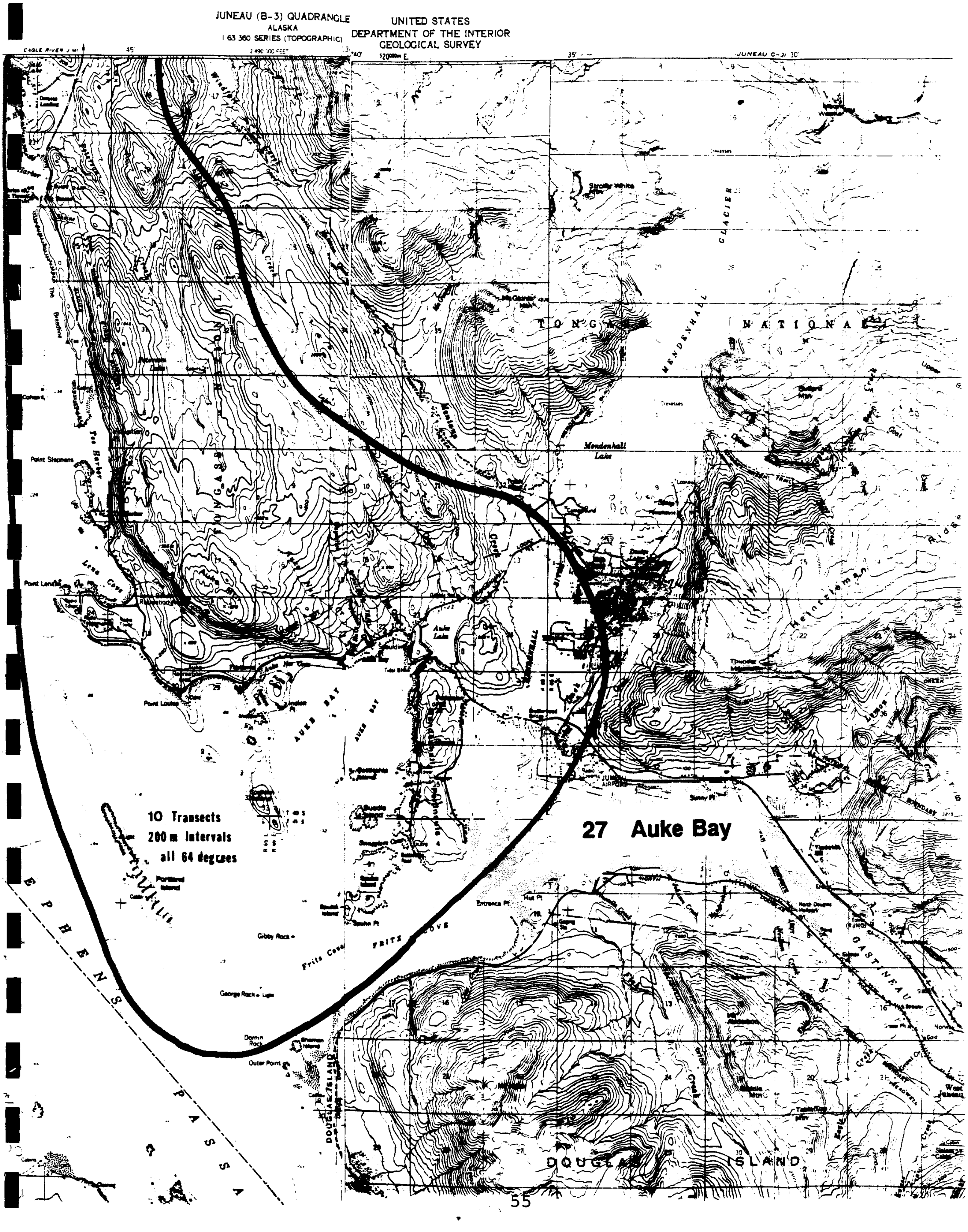
CREW		COUNT	ELEVATION	SPP.	VOL	IRI	CHECK	COMMENTS
046	2							
047	2							
048	2							
049	2							
050	2							
051	1							
052	1							
053	1							
054	1							
055	1							
056	2							
057	2							
058	2							
059	2							
060	2							
061	1							
062	1							
063	1							
064	1							
065	1							
066	2							
067	2							
068	2							
069	2							
070	2							
071	1							
072	1							
073	1							
074	1							
075	1							
076	2							
077	2							
078	2							
079	2							
080	2							
081	1							
082	1							
083	1							
084	1							
085	1							
086	2							
087	2							
088	2							
089	2							
090	2							

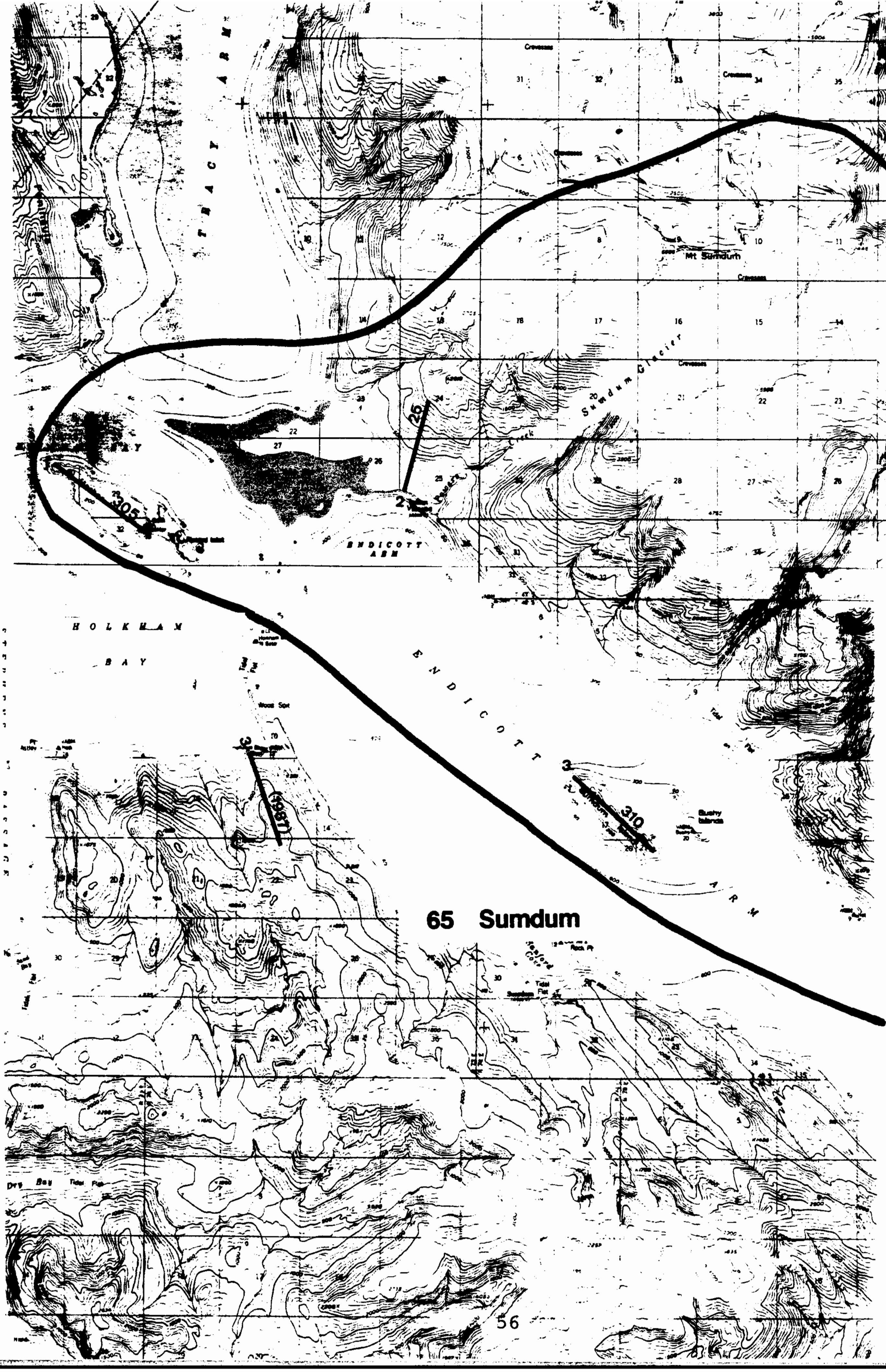
VCU NO. ______ DATE ____________ TRANSECT ______ PAGE 3

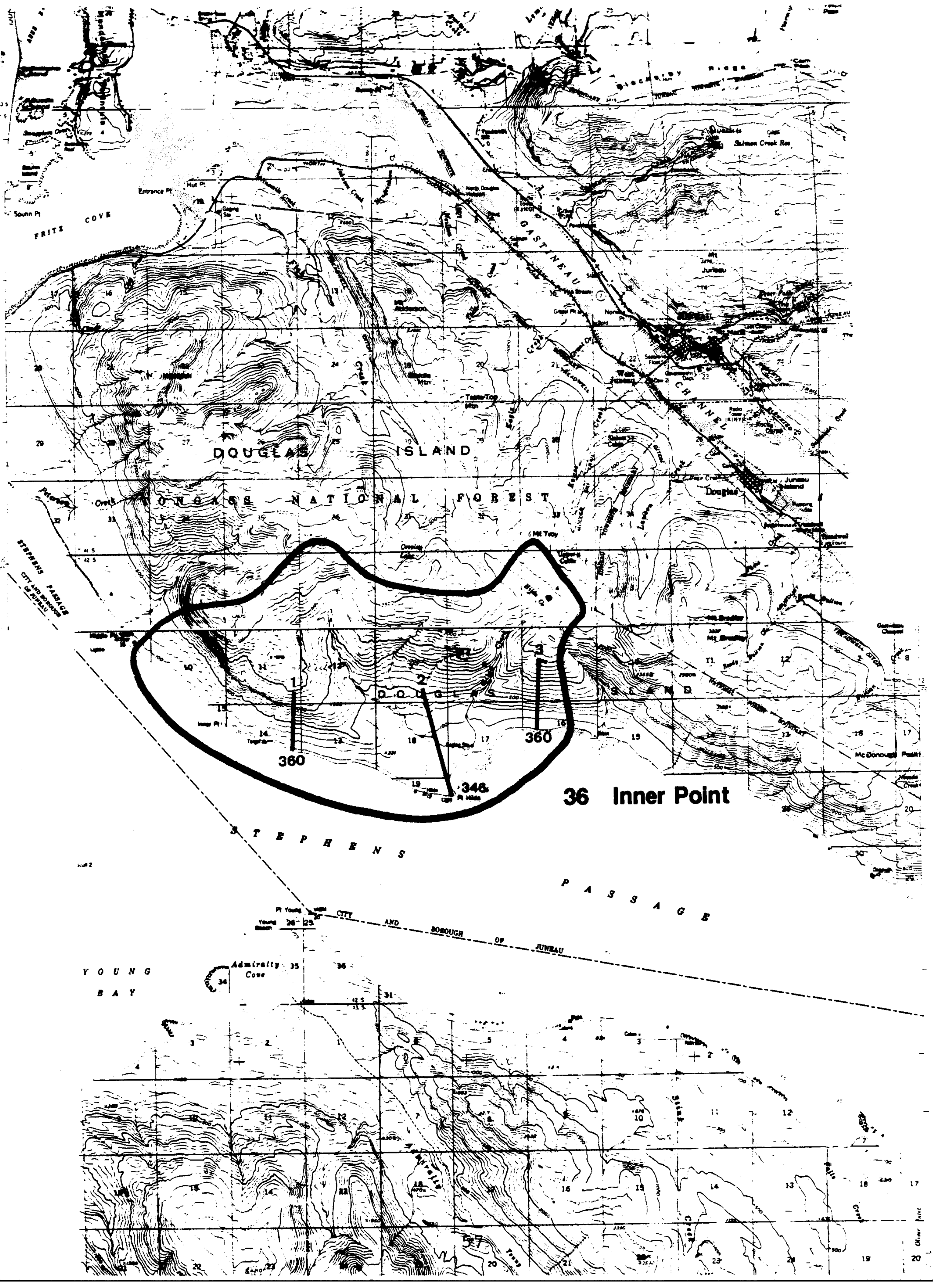
	CREW	COUNT	ELEVATION	SPP.	VOL	IRI	CHECK	COMMENTS
091	1							
092	1							
093	1							
094	1							
095	1							
096	2							
097	2							
098	2							
099	2							
100	2							
101	1							
102	1							
103	1							
104	1							
105	1							
106	2							
107	2							
108	2							
109	2							
110	2							
111	1							
112	1							
113	1							
114	1							
115	1							
116	2							
117	2							
118	2							
119	2							
120	2							
121	1							
122	1							
123	1							
124	1							
125	1							
126	2							
127	2							
128	2							
129	2							
130	2							
131	1							
132	1							
133	1							
134	1							
135	1							

APPENDIX C.

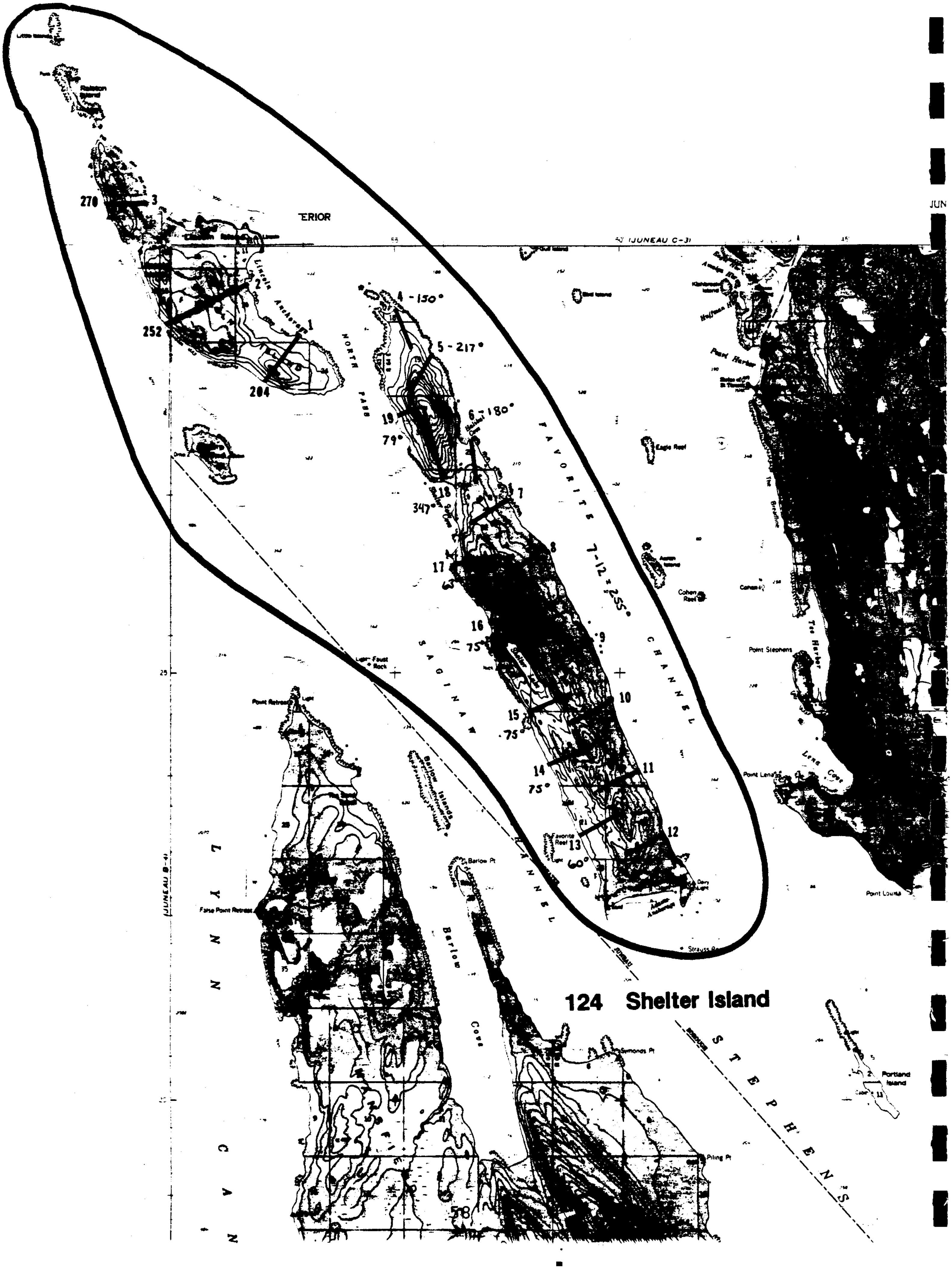
Value Comparison Unit Maps Showing Transect Locations And Bearing (Reduced Scale)

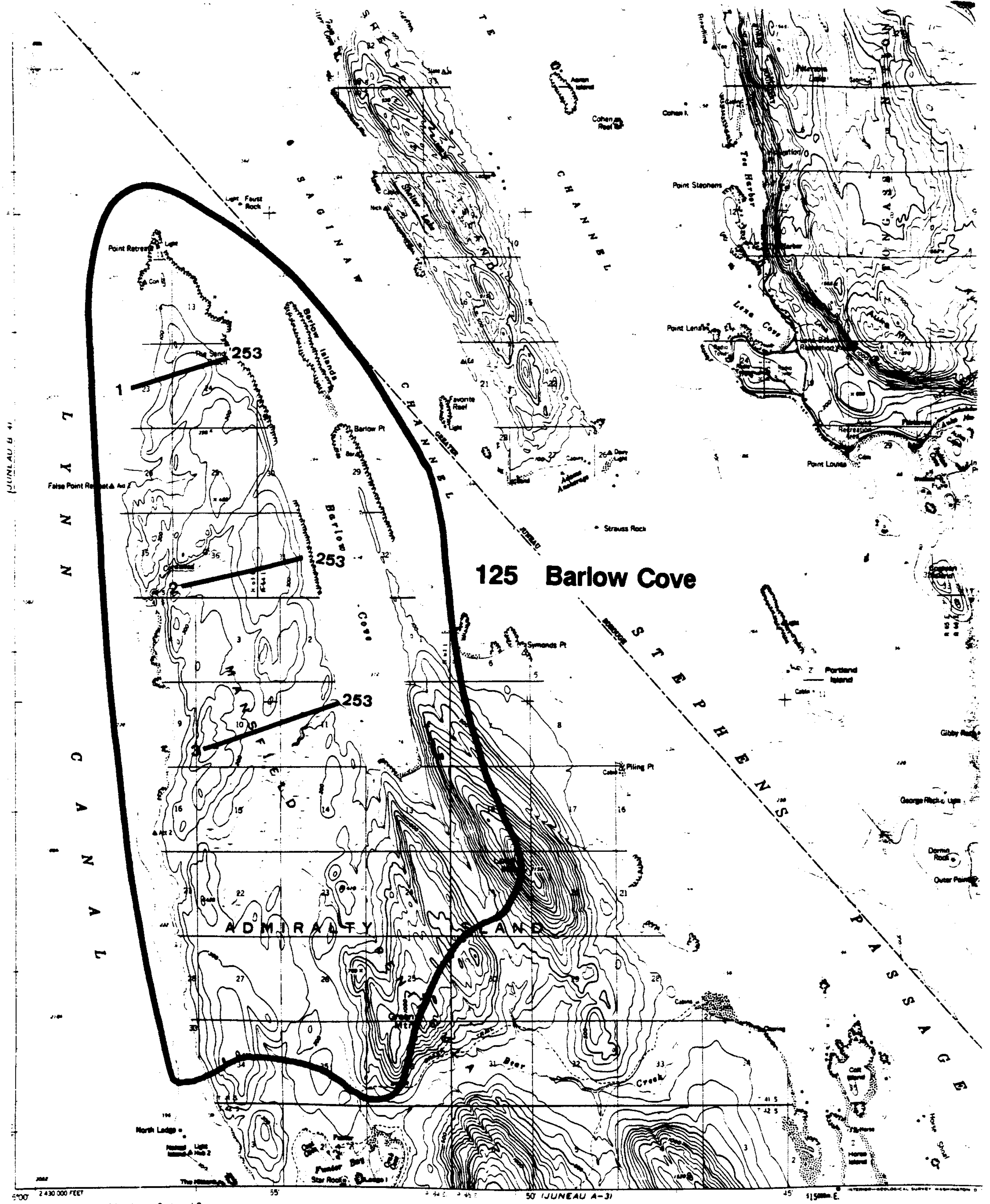

JUNEAU (B-3) QUADRANGLE
ALASKA
1:63 360 SERIES (TOPOGRAPHIC)
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
10 Transects
200 m Intervals
all 64 degrees
27 Auke Bay
TONGASS
NATIONAL
MENDENHALL GLACIER
Mendenhall Lake
Auke Lake
AUKE BAY
FRITZ COVE
Point Stephens
Point Lena
Point Louisa
Gibby Rock
George Rock
Portland Island
JUNEAU AIRPORT
DOUGLAS ISLAND
Outer Point
STEPHENS PASSAGE


65 Sumdum
T R A C Y A R M
E N D I C O T T A R M
H O L K H A M
B A Y
Sumdum Glacier
Mt Sumdum
Crevasses
Bushy Islands
Wood Spit
Dry Bay Tidal Flat
305
310
26
2
3



36 Inner Point


ERIOR
JUNEAU C-3
JUN
270
3
2
252
1
204
Lincoln Anchorage
NORTH PASS
4 - 150°
5 - 217°
6 - 180°
19
79°
18
347°
7
8
17
FAVORITE
7-12 = 255°
CHANNEL
16
75°
9
10
15
75°
14
75°
11
13
60°
12
SAGINAW
CHANNEL
Eagle Reef
Cohen Reef
Point Stephens
Tee Harbor
Point Lena
Lena Cove
Point Louisa
Point Retreat
False Point Retreat
Barlow Islands
Barlow Pt
Barlow Cove
Favorite Reef
Strauss Rk
Piling Pt
Portland Island
JUNEAU B-4
LYNN CANAL
STEPHENS
124 Shelter Island



2 430 000 FEET

50' (JUNEAU A-3)

Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1948. Field annotated 1962. Map not field checked

Selected hydrographic data compiled from USC&GS charts 8235 and 8302 (1960). This information is not intended for navigational purposes

Universal Transverse Mercator projection. 1927 North American datum 10,000-foot grid based on Alaska coordinate system, zone 1 1000-meter Universal Transverse Mercator grid ticks, zone 8, shown in blue

Land lines represent unsurveyed and unmarked locations predetermined by the State of Alaska, Division of Lands Folio CR-12 Copper River Meridian

Swamps, as portrayed, indicate only the wetter areas, usually of low relief, as interpreted from aerial photographs

All islands are within the Tongass National Forest

APPROXIMATE MEAN DECLINATION, 1962

SCALE 1:63 360

CONTOUR INTERVAL 100 FEET

DATUM IS MEAN SEA LEVEL

DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOWER LOW WATER

SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER

THE MEAN RANGE OF TIDE IS APPROXIMATELY 13 FEET

QUADRANGLE LOCATION

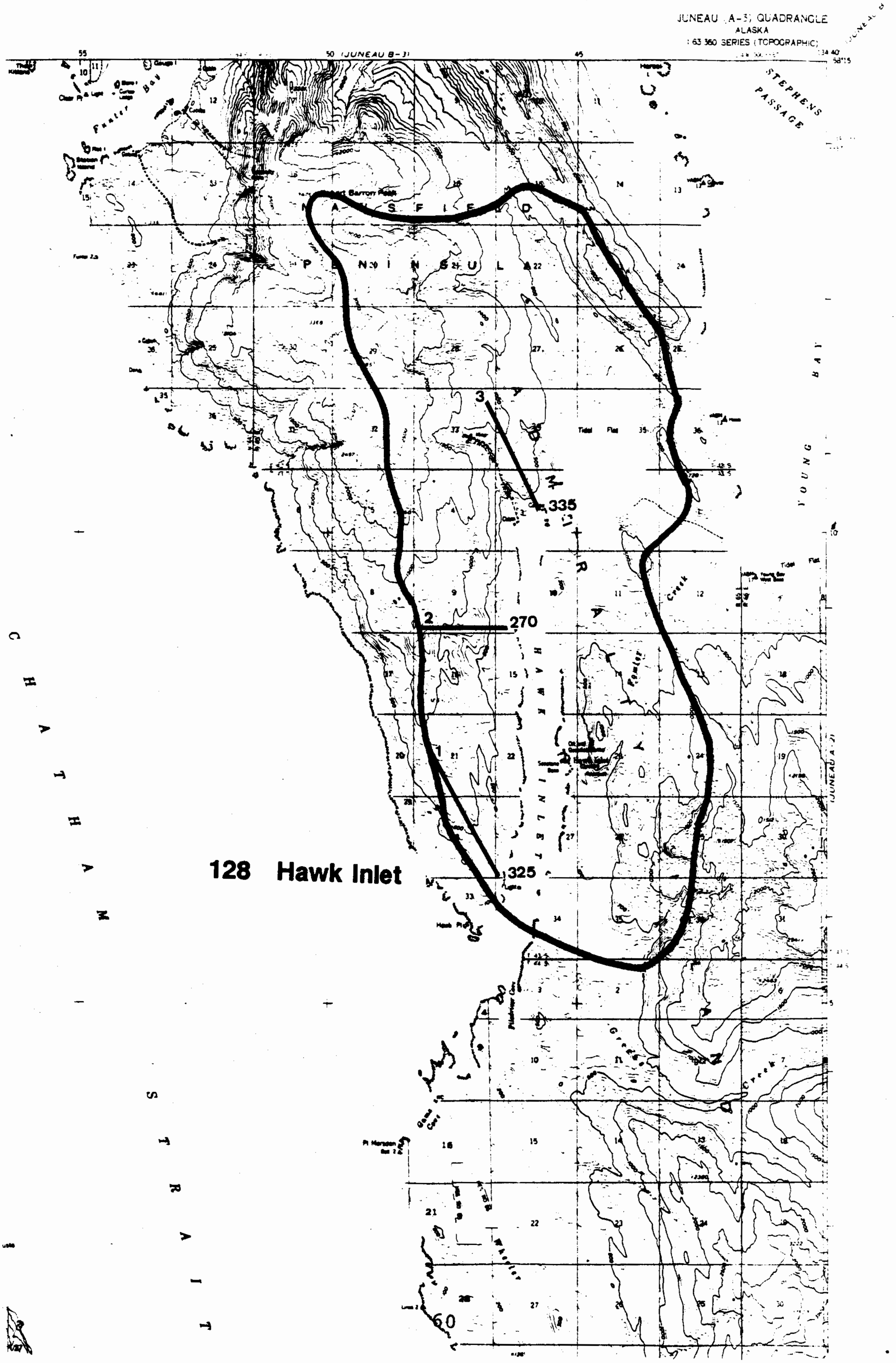
FOR SALE BY U.S. GEOLOGICAL SURVEY
FAIRBANKS, ALASKA 99701, DENVER, COLORADO 80225, OR WASHINGTON, D.C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

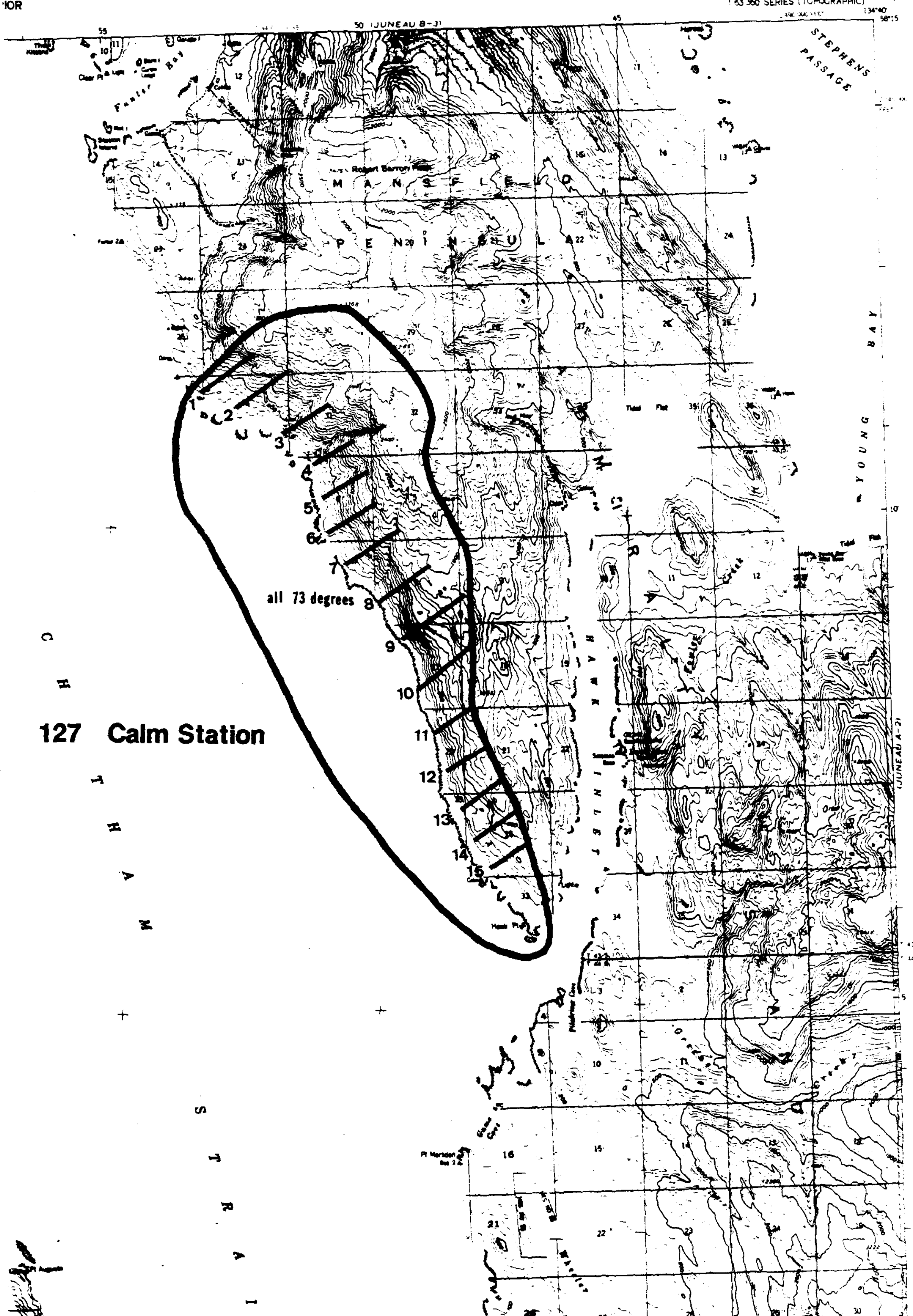
ROAD CLASSIFICATION

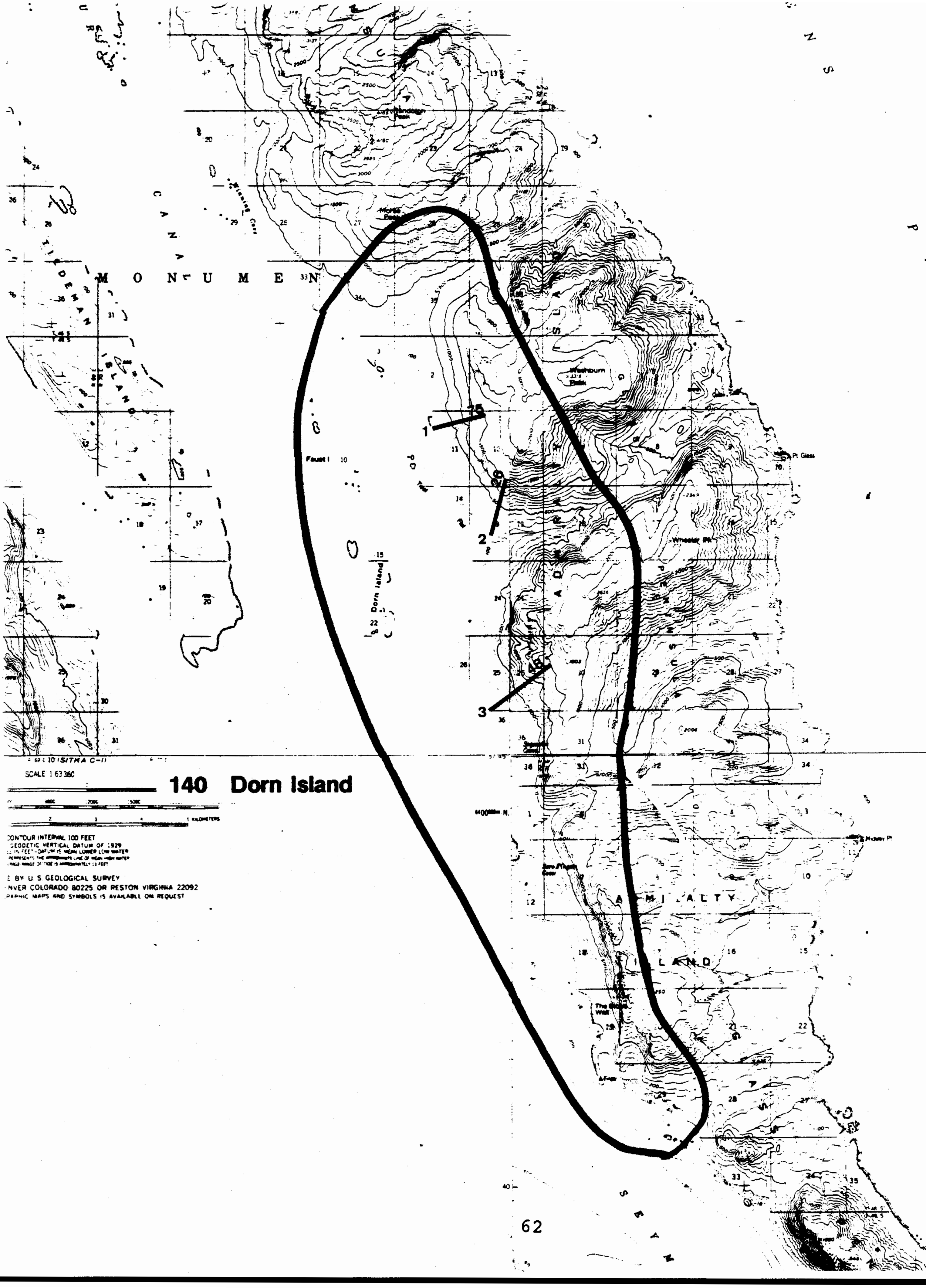
Medium-duty Light-duty

Unimproved dirt

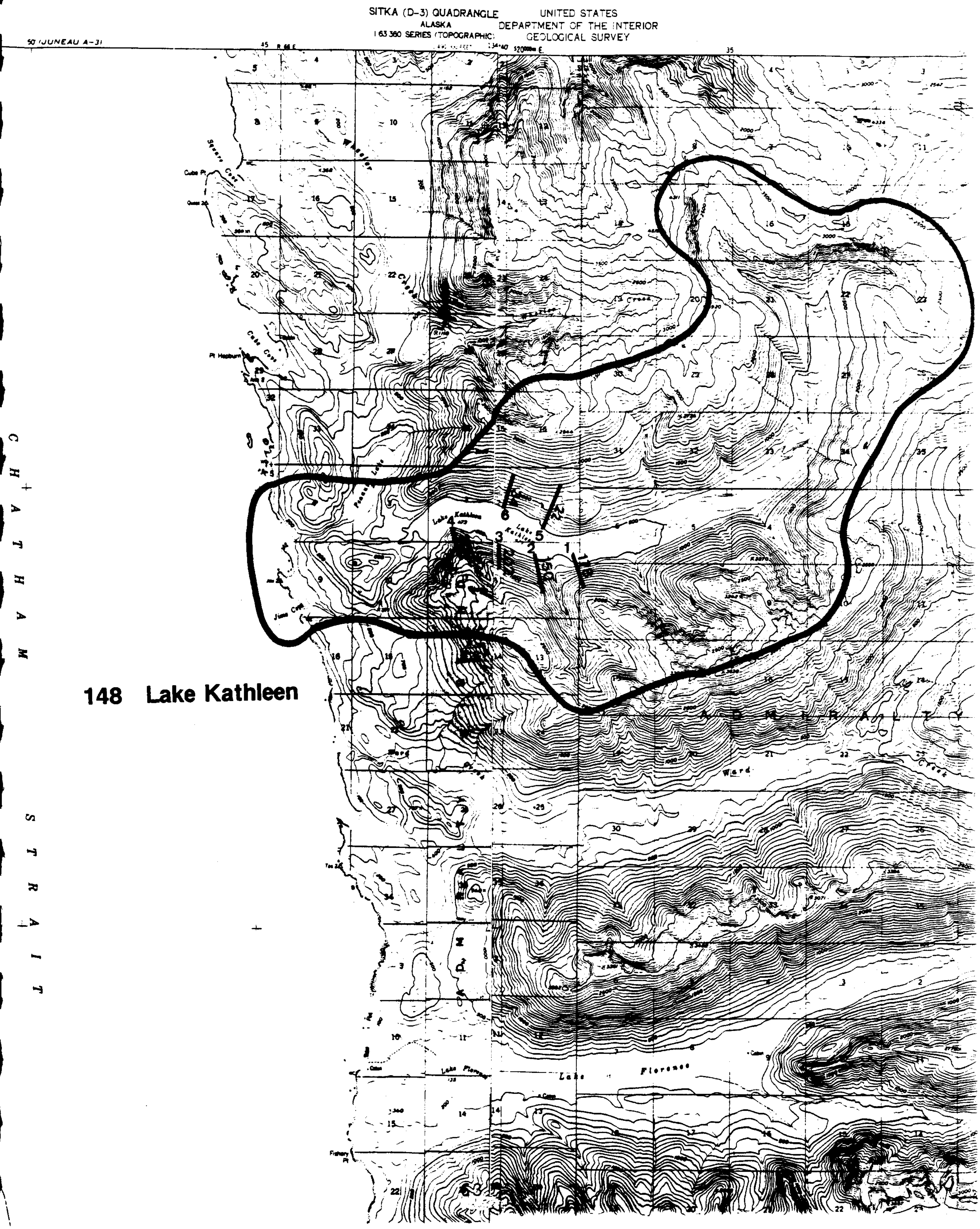
JUNEAU (B-


JUNEAU (A-3) QUADRANGLE
ALASKA
1:63 360 SERIES (TOPOGRAPHIC)
STEPHENS PASSAGE
MANSFIELD PENINSULA
HAWK INLET
YOUNG BAY
CHATHAM STRAIT
3
335
2
270
1
325
128 Hawk Inlet


JUNEAU (A-3) QUADRANGLE
ALASKA
1:63 360 SERIES (TOPOGRAPHIC)
50 (JUNEAU B-3)
STEPHENS PASSAGE
MANSFIELD PENINSULA
Robert Barron Peak
YOUNG BAY
HAWK INLET
CHATHAM STRAIT
Tidal Flat
all 73 degrees
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
127 Calm Station



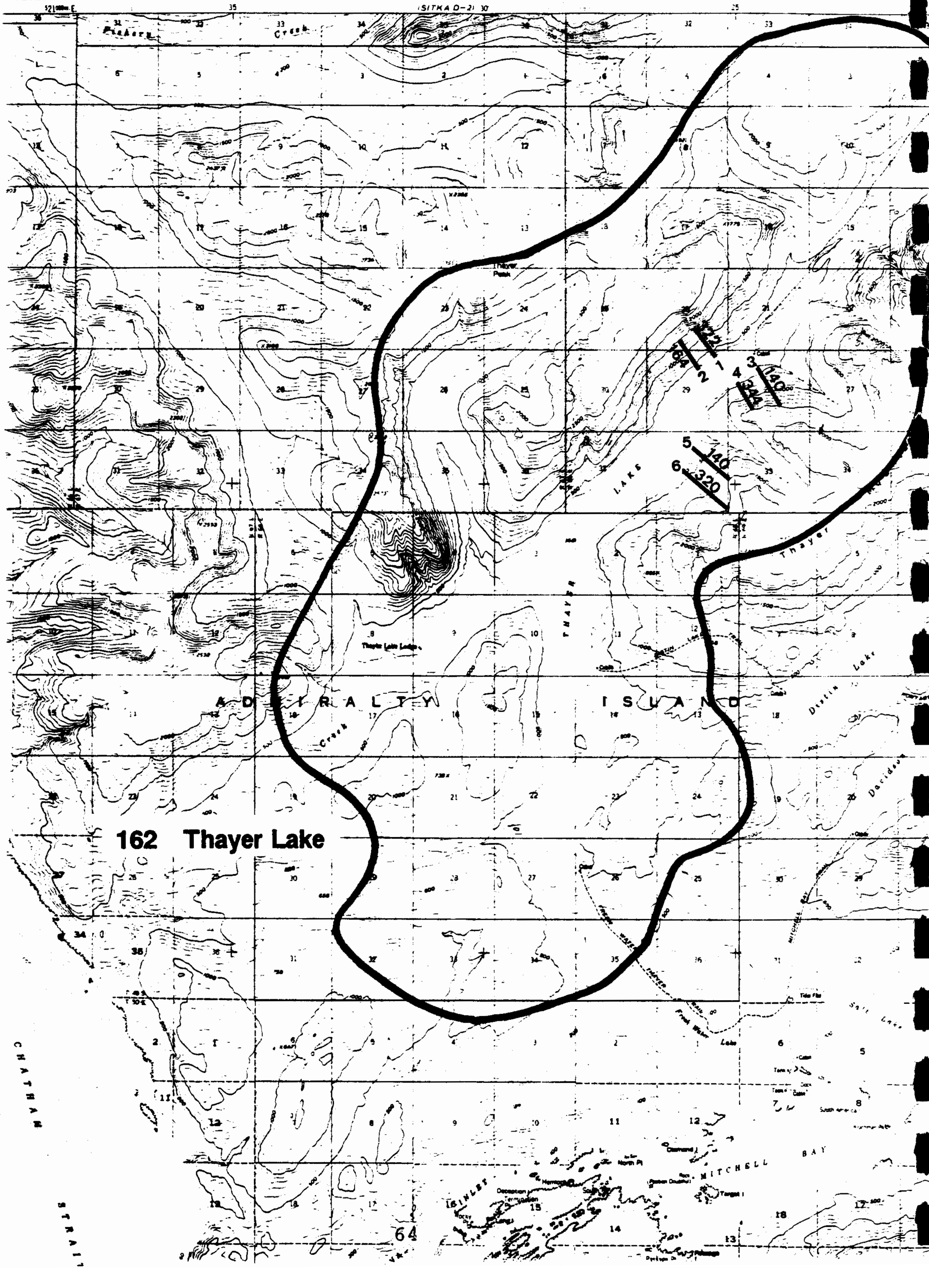
140 Dorn Island
SCALE 1:63 360
CONTOUR INTERVAL 100 FEET
BY U.S. GEOLOGICAL SURVEY
NVER COLORADO 80225 OR RESTON VIRGINIA 22092
APHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
MONUMENT
Dorn Island
Faust I
Washburn Peak
Wheeler Pk
Pt Glass
1
2
3

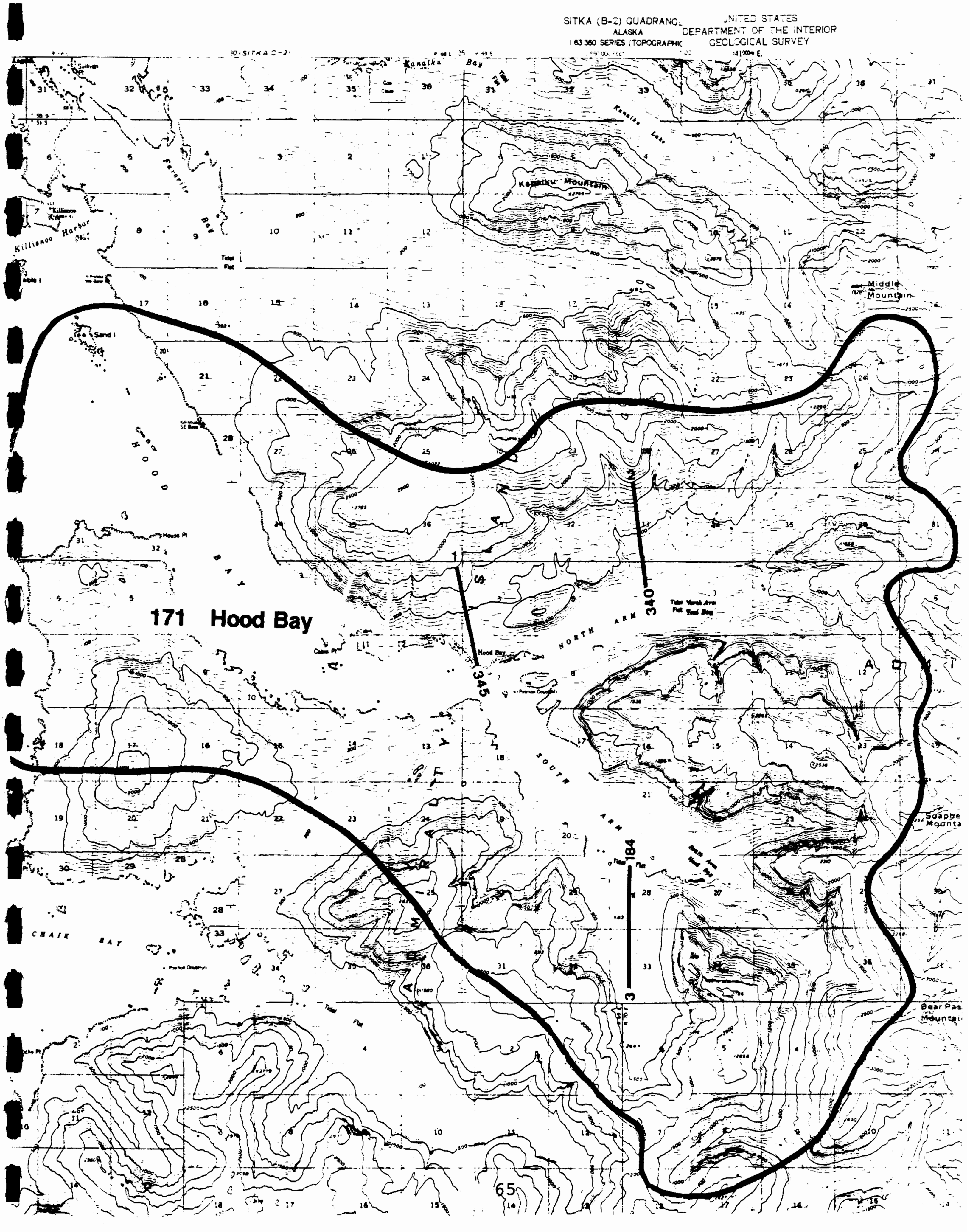


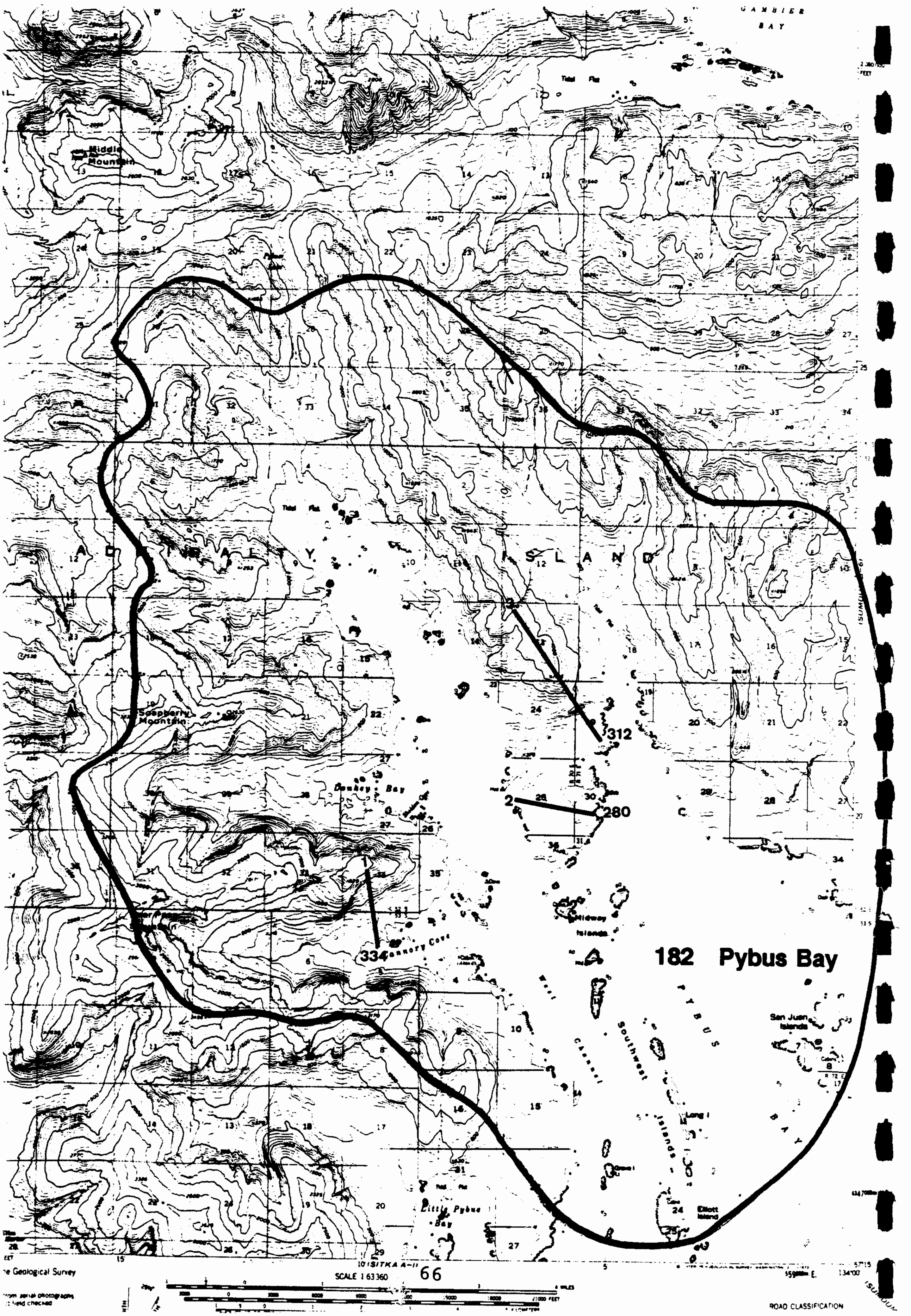
148 Lake Kathleen

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SITKA (C-2) QUADRANGLE
ALASKA
63 360 SERIES

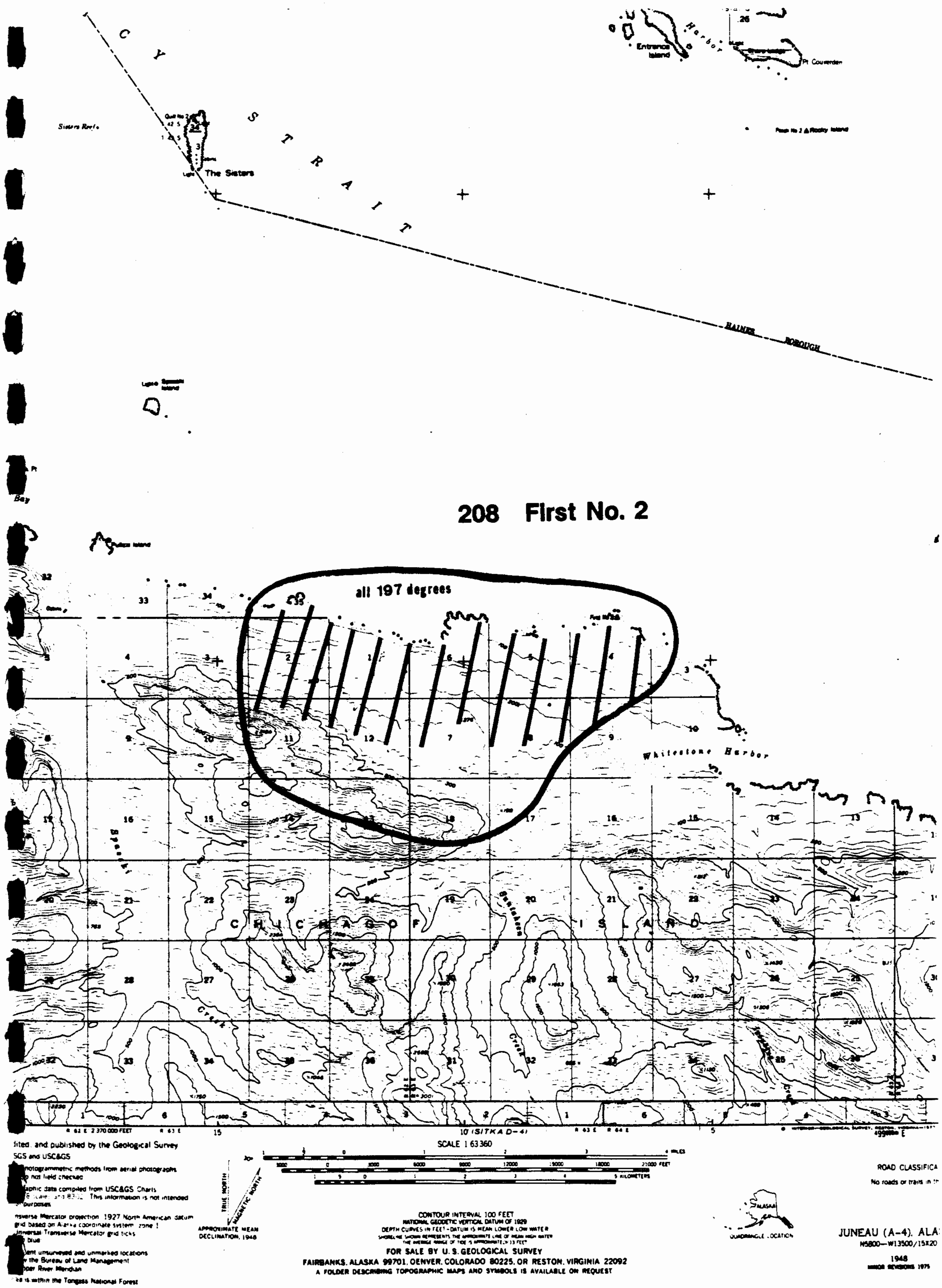



SITKA (B-2) QUADRANGLE
ALASKA
1:63 360 SERIES (TOPOGRAPHIC)
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Kanalku Bay
Kanalku Lake
Kanalku Mountain
Favorite Bay
Killisnoo Harbor
Tidal Flat
Middle Mountain
Sand I
House Pt
171 Hood Bay
HOOD BAY
340
345
184
NORTH ARM
SOUTH ARM
Tidal North Arm Flat Hood Bay
Hood Bay
Cabin Pt
Chaik Bay
Tidal Flat
Soapstone Mountain
Bear Pass Mountain

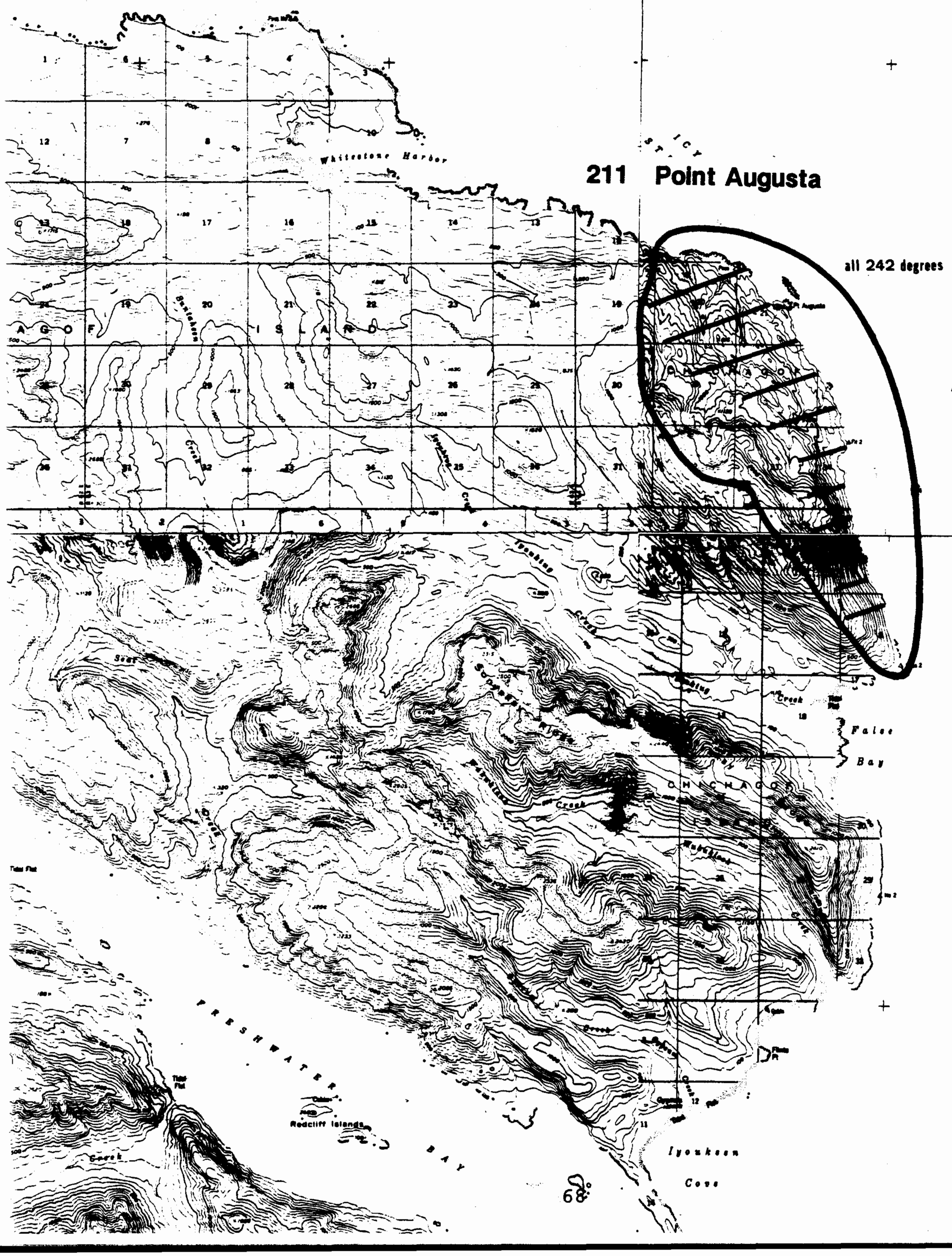


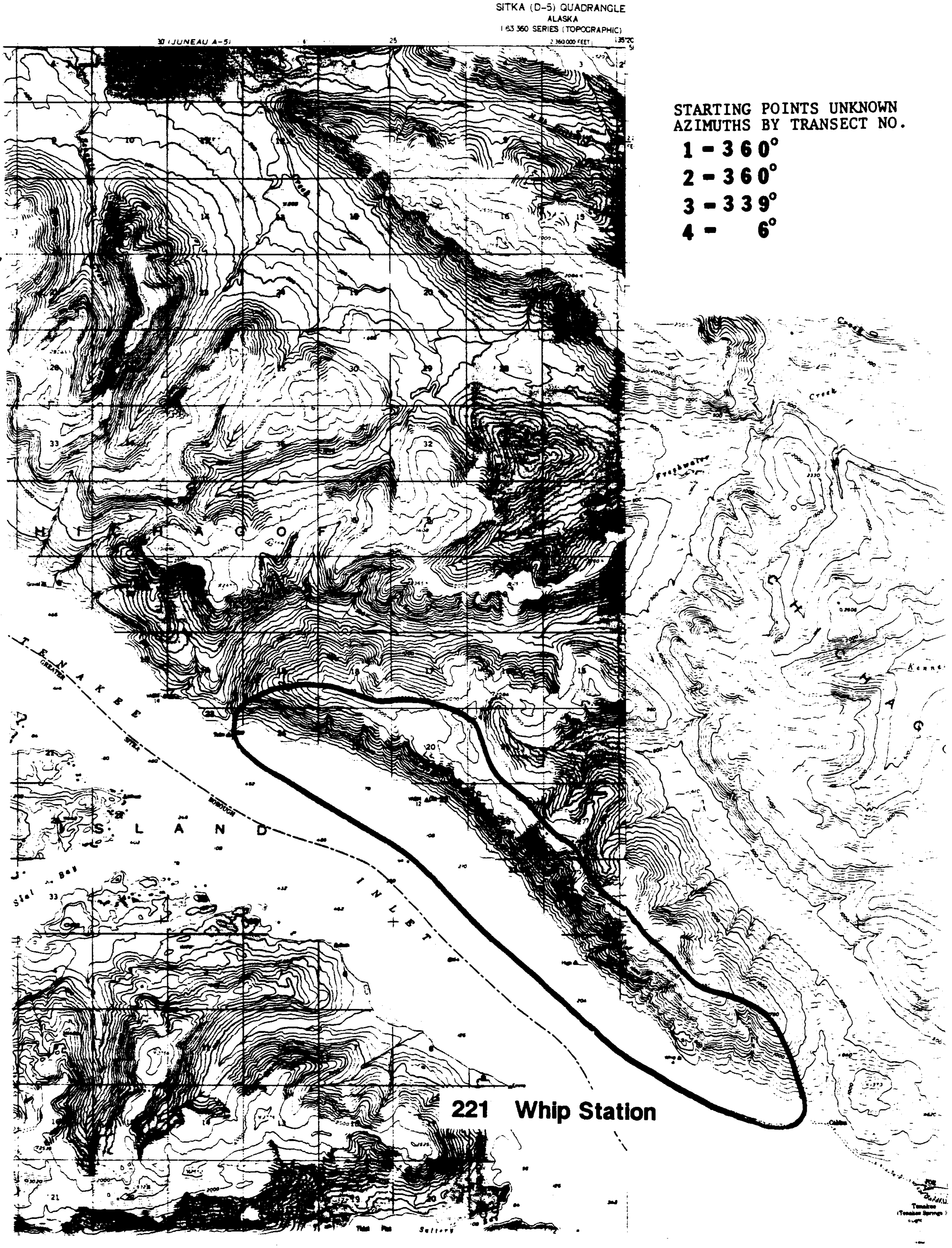
GAMBIER BAY
Middle Mountain
Tidal Flat
ADMIRALTY ISLAND
Soapberry Mountain
Donkey Bay
Cannery Cove
312
280
334
182 Pybus Bay
Midway Islands
West Channel
Southwest Islands
PYBUS BAY
San Juan Islands
Long I
Elliott Island
Little Pybus Bay
SITKA A-1
SCALE 1:63 360
Geological Survey
ROAD CLASSIFICATION

208 First No. 2



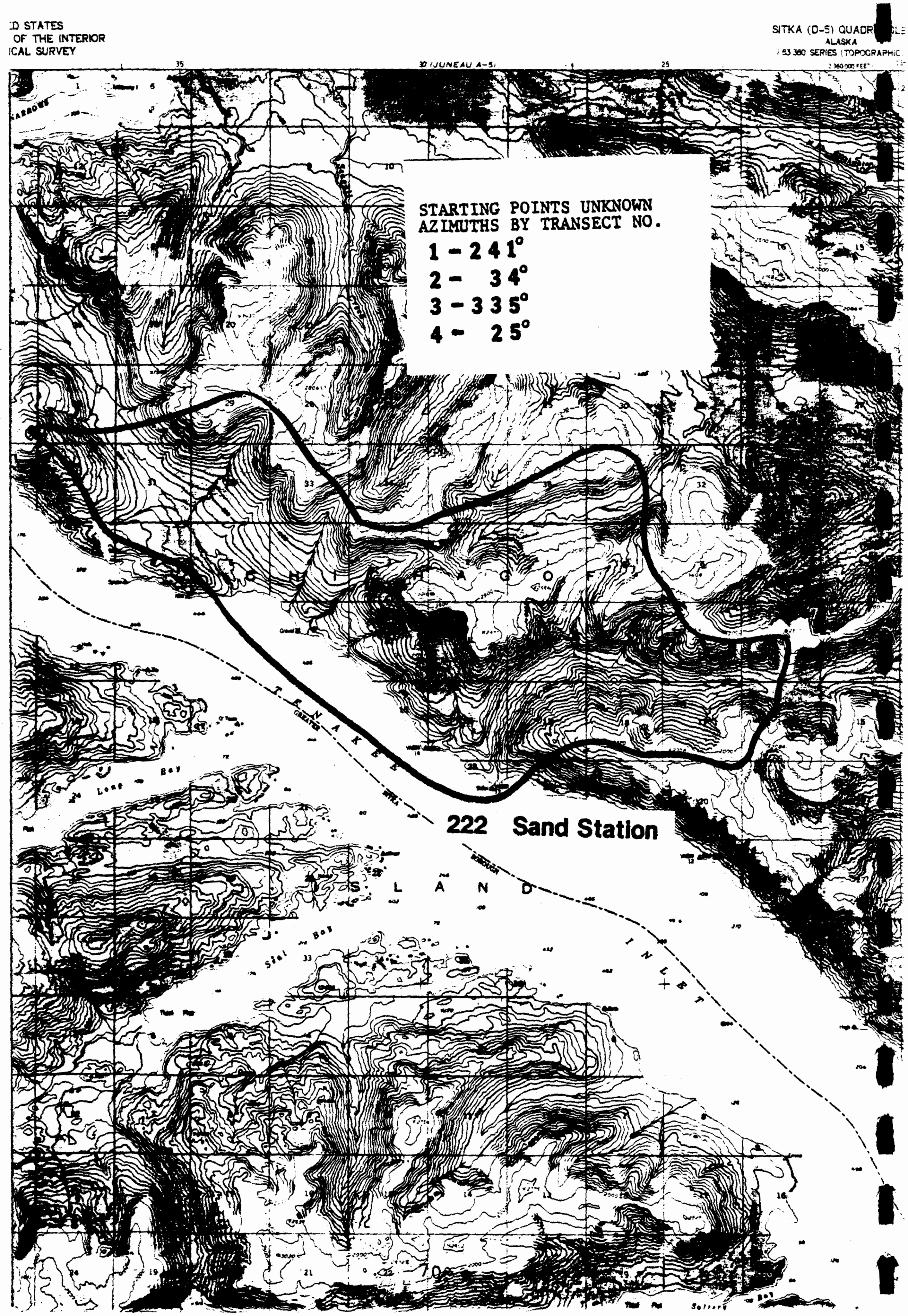
211 Point Augusta

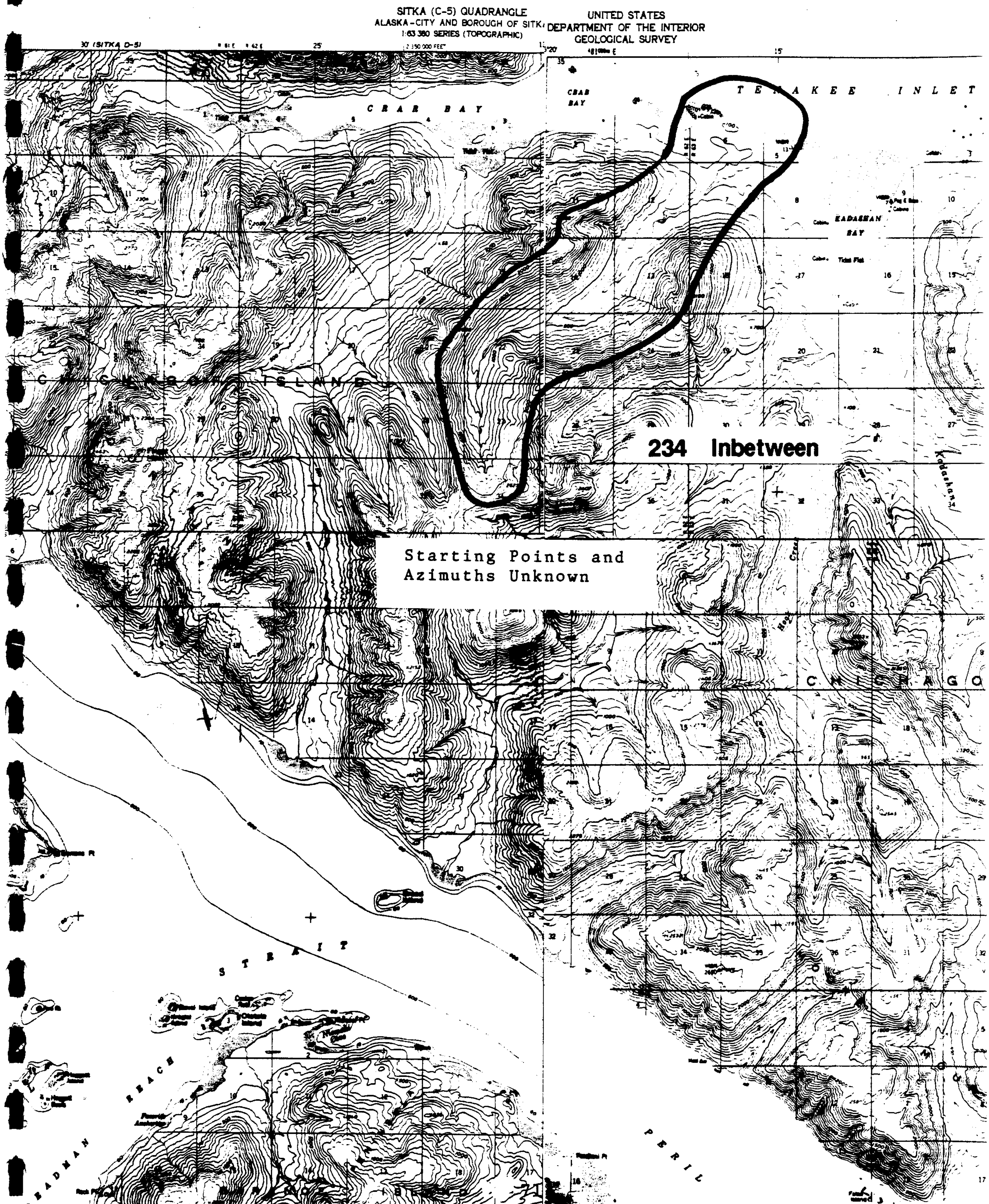


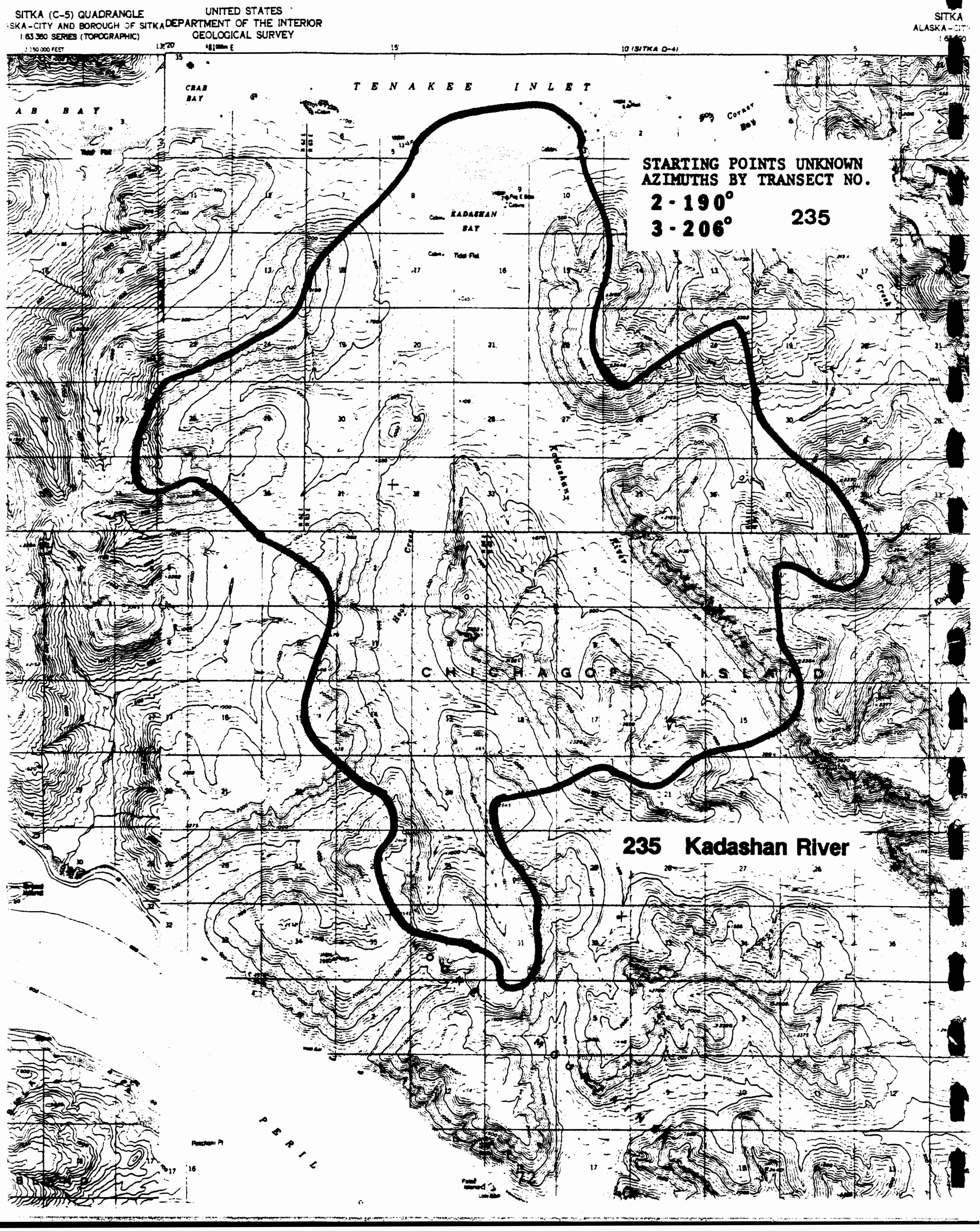


STARTING POINTS UNKNOWN
AZIMUTHS BY TRANSECT NO.

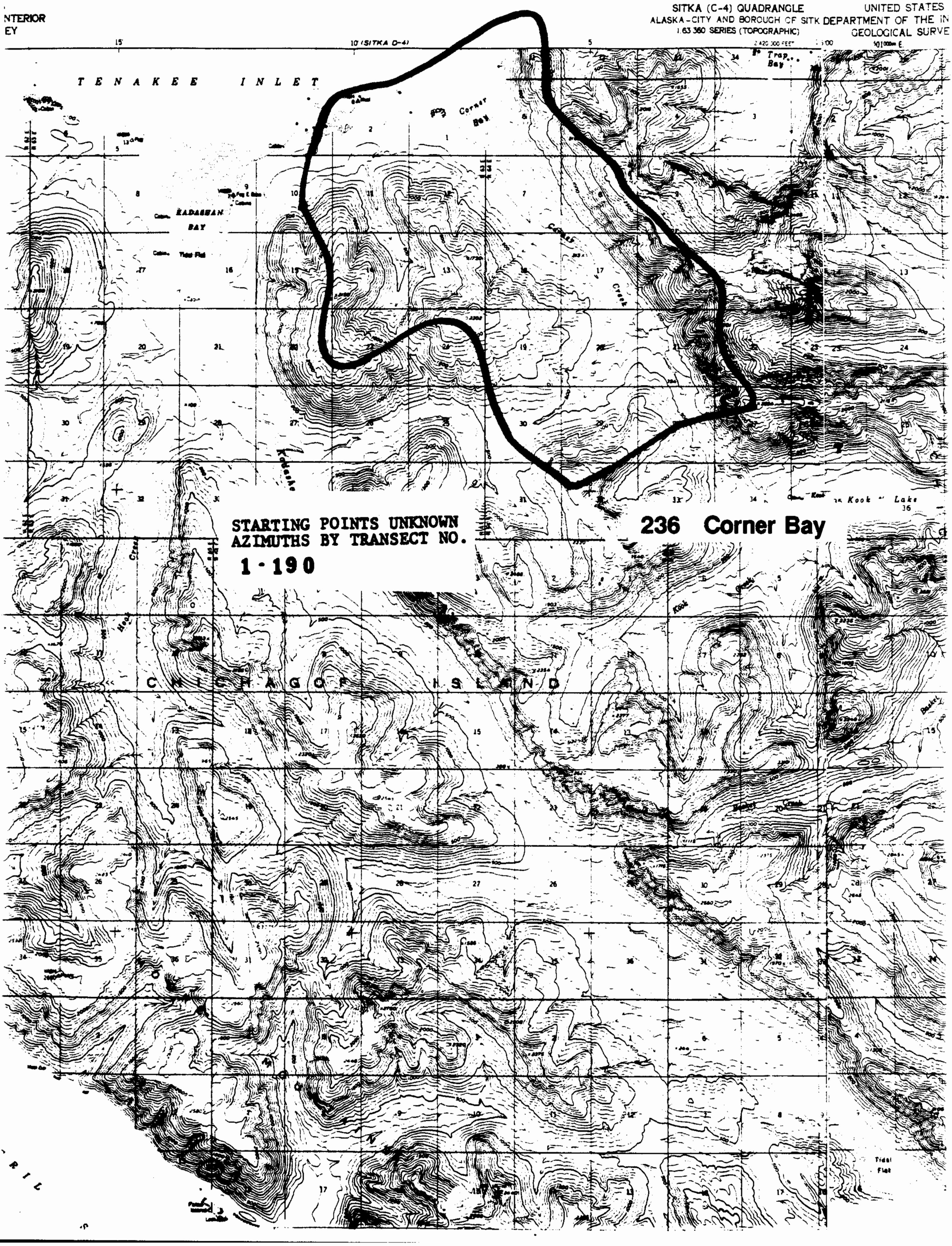
1 - 360°
2 - 360°
3 - 339°
4 - 6°

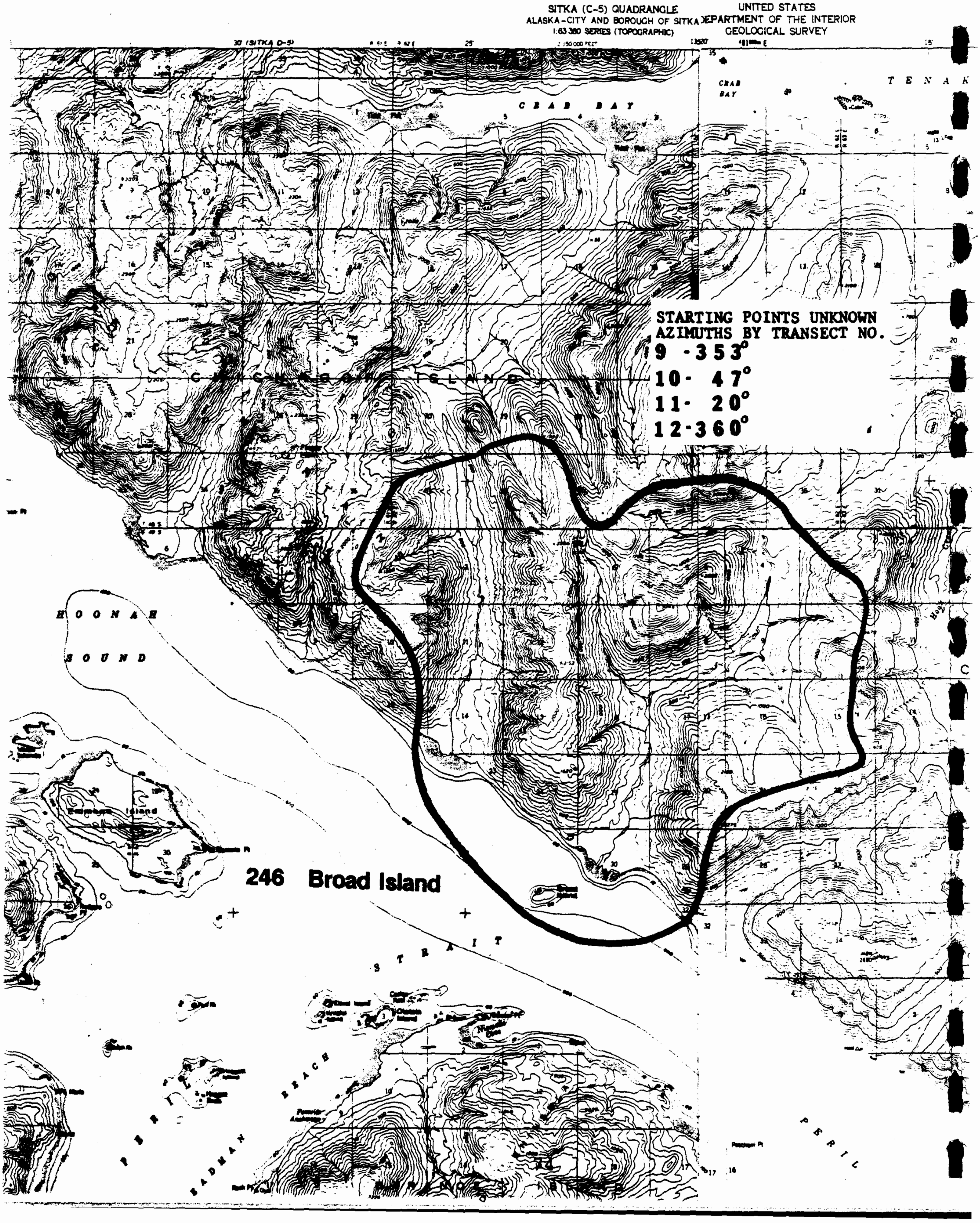

D STATES
OF THE INTERIOR
ICAL SURVEY
SITKA (D-5) QUADR
ALASKA
1:63 360 SERIES (TOPOGRAPHIC
STARTING POINTS UNKNOWN
AZIMUTHS BY TRANSECT NO.
1 - 241°
2 - 34°
3 - 335°
4 - 25°
222 Sand Station
T E N A K E E
I N L E T
S L A N D
Long Bay

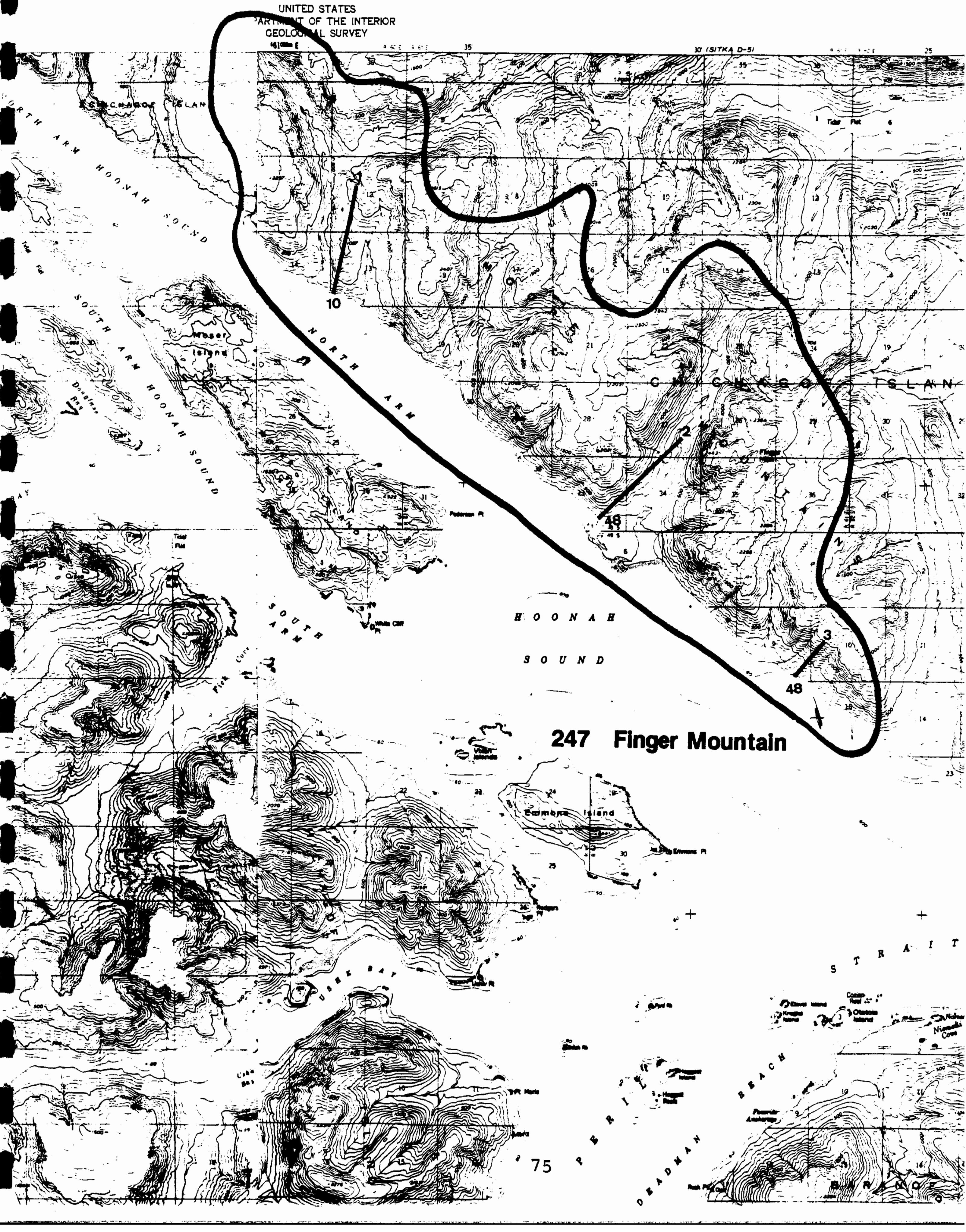

SITKA (C-5) QUADRANGLE
ALASKA-CITY AND BOROUGH OF SITKA
1:63 360 SERIES (TOPOGRAPHIC)
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CRAB BAY
TENAKEE INLET
KADASHAN BAY
CHICHAGOF ISLAND
234 Inbetween
Starting Points and
Azimuths Unknown
STRAIT
PERIL
DEADMAN REACH



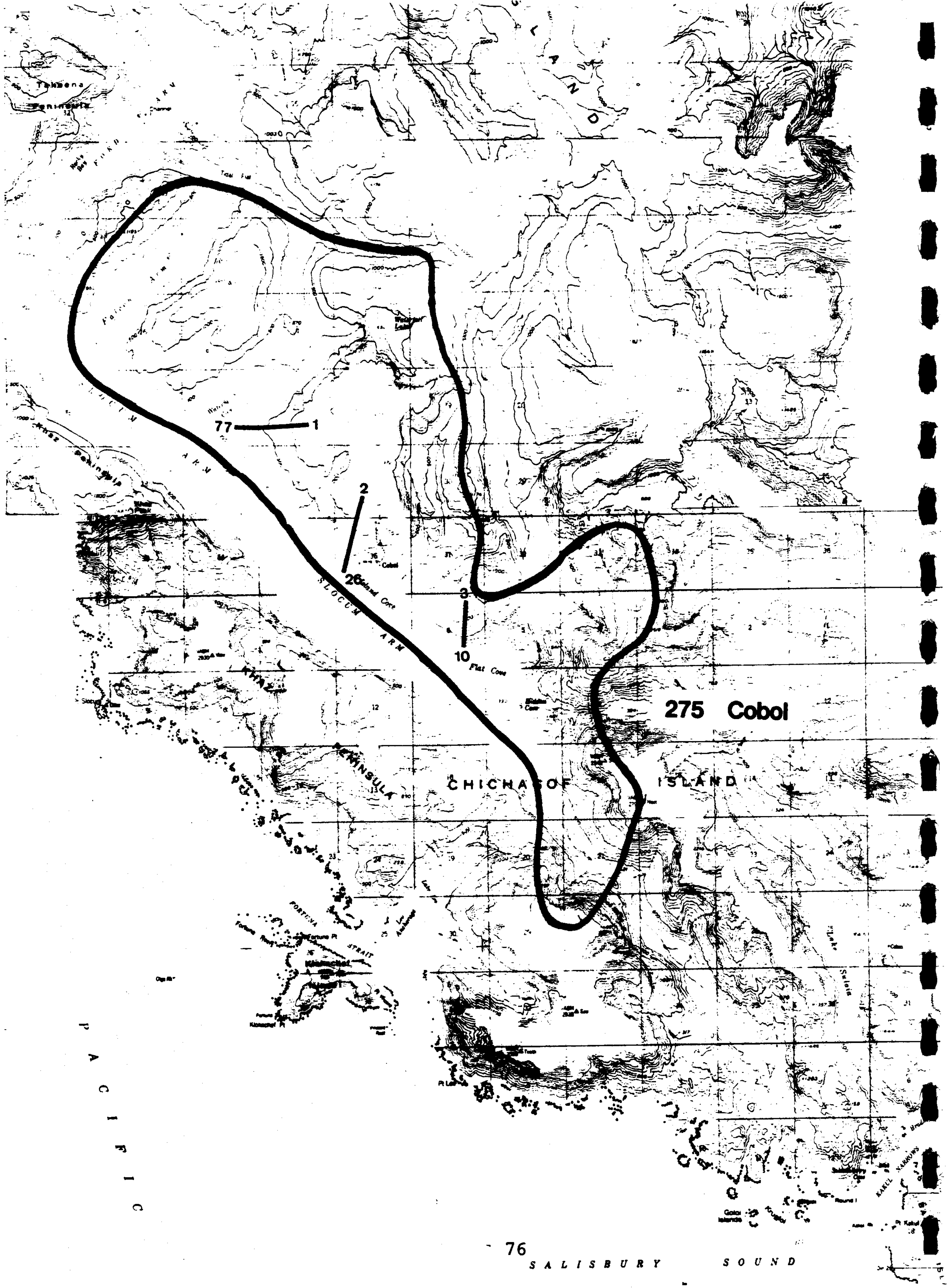
SITKA (C-5) QUADRANGLE
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
1:63 360 SERIES (TOPOGRAPHIC)
TENAKEE INLET
CRAB BAY
KADASHAN BAY
Tidal Flat
Kadashan River
CHICHAGOF ISLAND
PERIL
STARTING POINTS UNKNOWN
AZIMUTHS BY TRANSECT NO.
2 - 190°
3 - 206°
235
235 Kadashan River

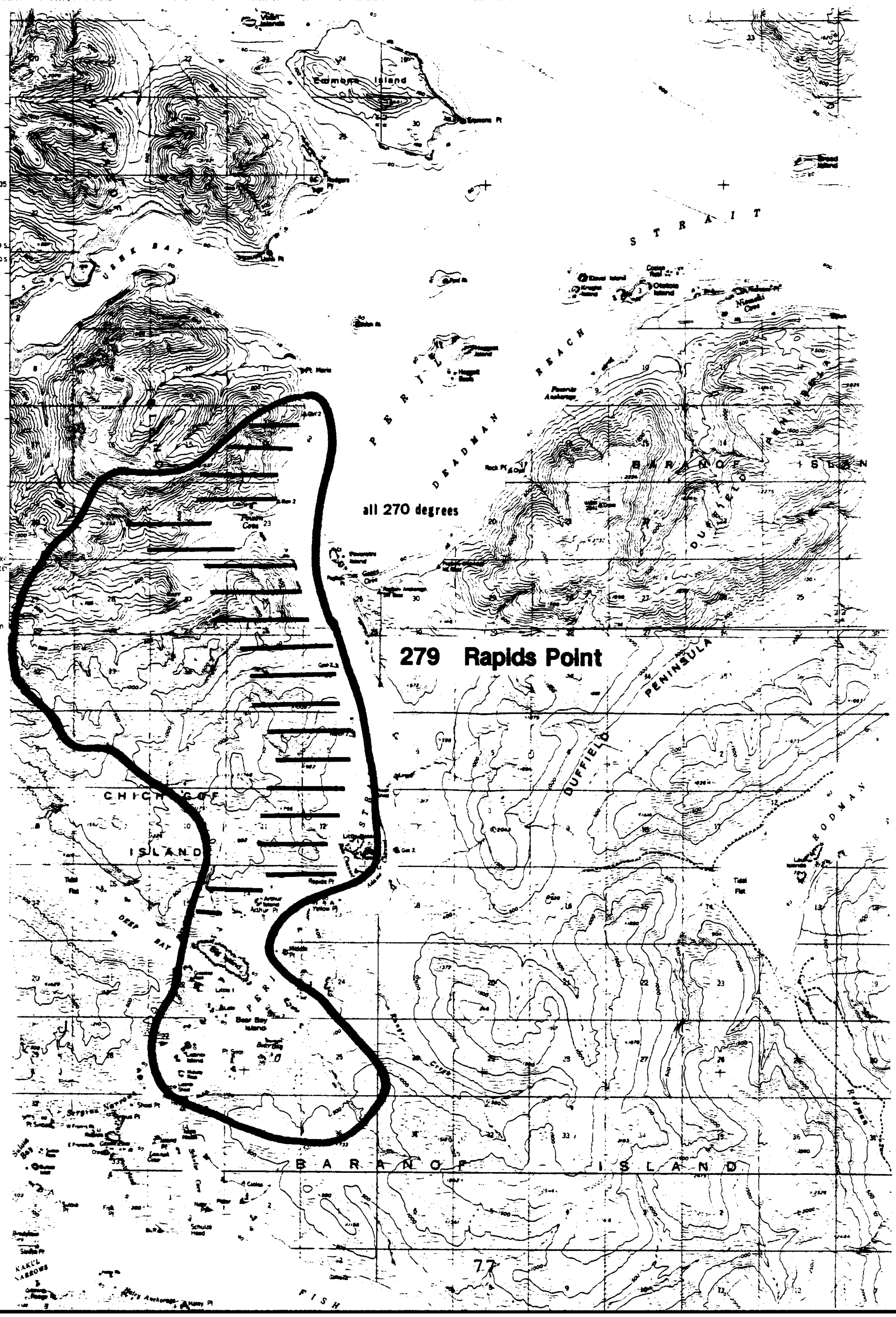

SITKA (C-4) QUADRANGLE
ALASKA-CITY AND BOROUGH OF SITKA
1:63 360 SERIES (TOPOGRAPHIC)
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
10' (SITKA D-4)
TENAKEE INLET
Corner Bay
KADASHAN BAY
Tidal Flat
Corner Creek
Kook Lake
Kook Creek
Basket Creek
CHICHAGOF ISLAND
STARTING POINTS UNKNOWN
AZIMUTHS BY TRANSECT NO.
1-190
236 Corner Bay

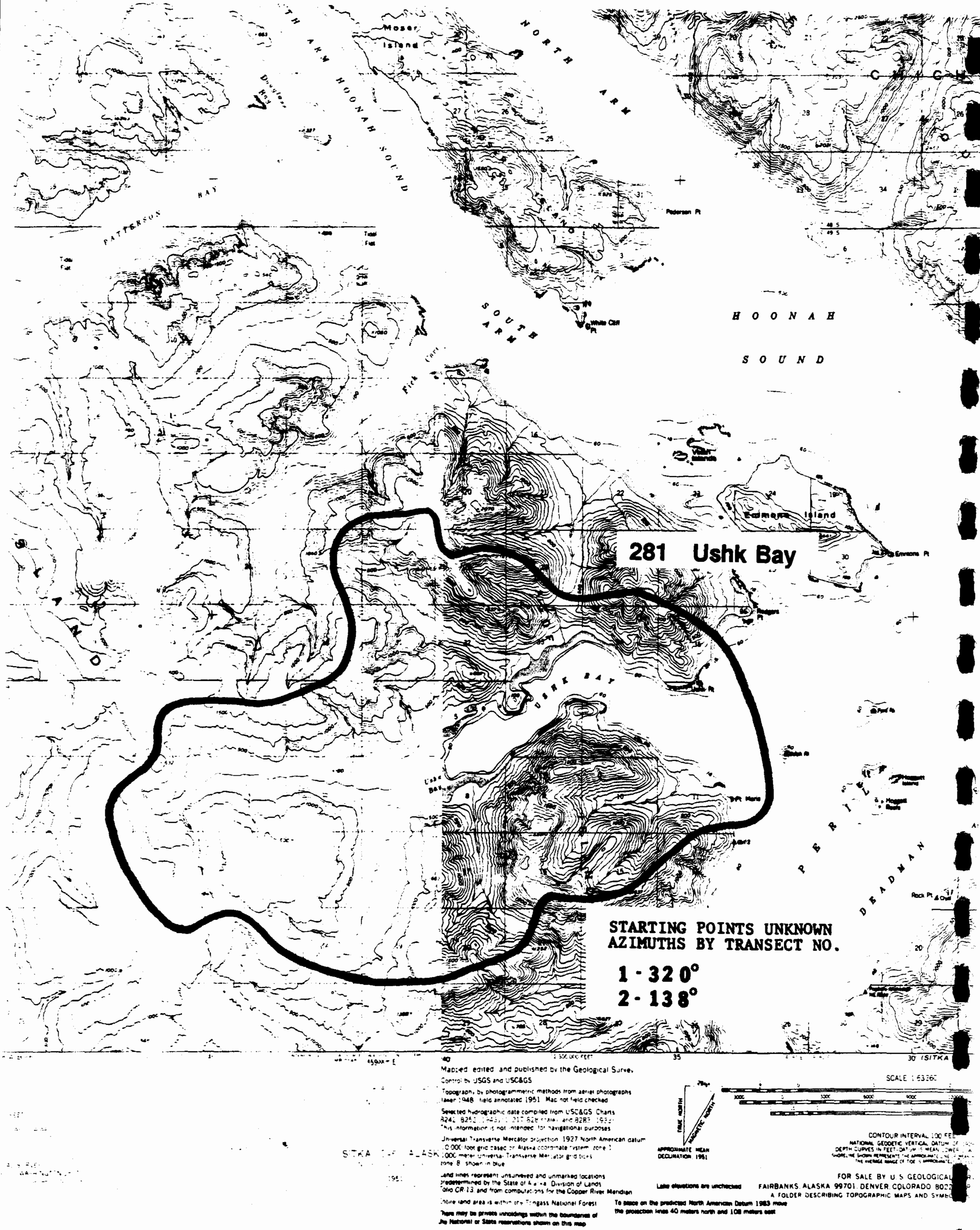

SITKA (C-5) QUADRANGLE
ALASKA-CITY AND BOROUGH OF SITKA
1:63 360 SERIES (TOPOGRAPHIC)
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CRAB BAY
HOONAH SOUND
STRAIT
PERIL
STARTING POINTS UNKNOWN
AZIMUTHS BY TRANSECT NO.
9 -353°
10- 47°
11- 20°
12-360°
246 Broad Island



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
(SITKA D-5)
NORTH ARM HOONAH SOUND
SOUTH ARM HOONAH SOUND
NORTH ARM
SOUTH ARM
HOONAH SOUND
CHICHAGOF ISLAND
Finger Mountain
Emmons Island
Emmons Pt
Pederson Pt
White Cliff
Fick Cove
USHK BAY
PERIL STRAIT
DEADMAN REACH
10
2
48
3
48
247 Finger Mountain

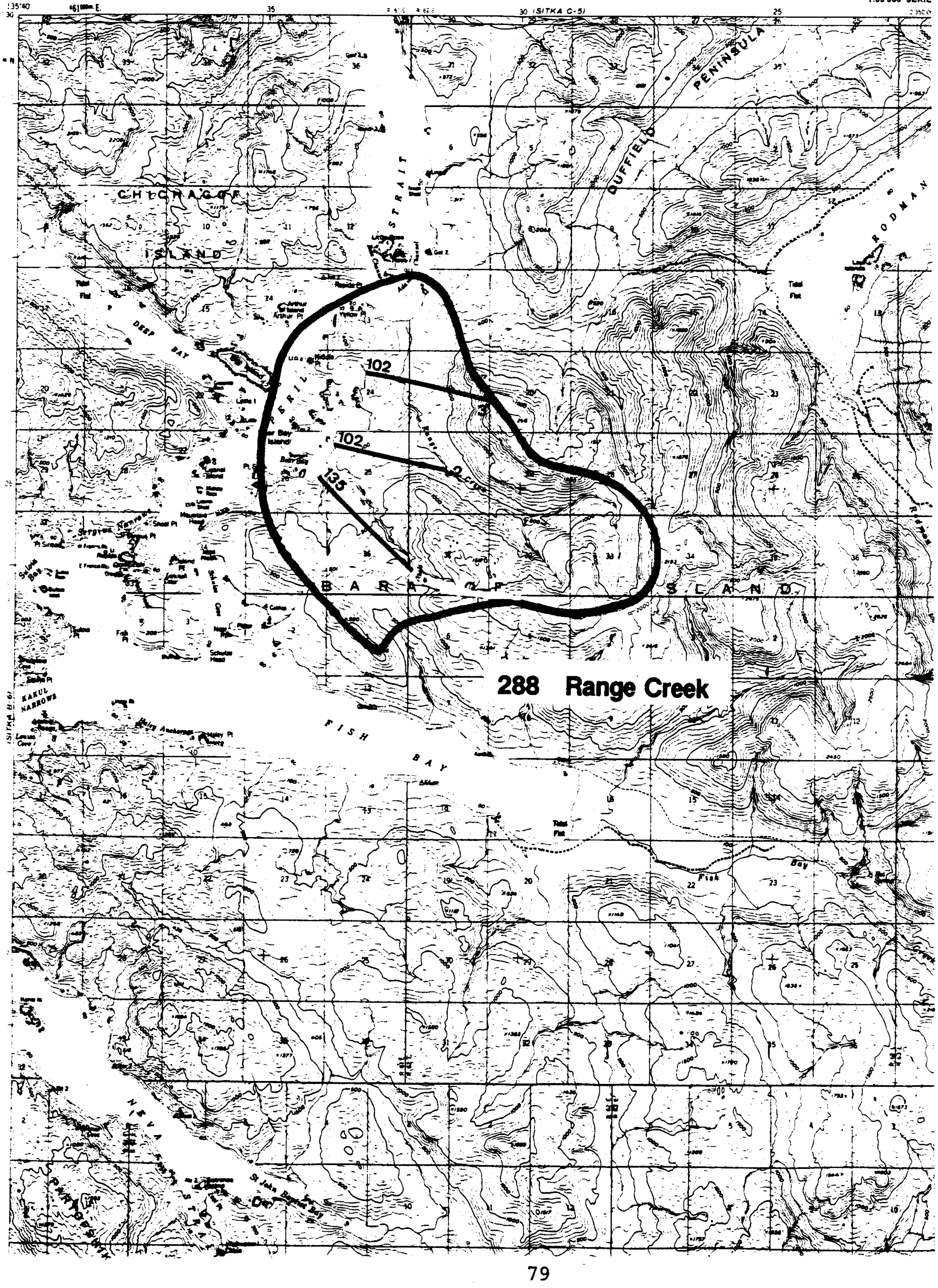

77
1
2
26
3
10
Flat Cove
275 Cobol
CHICHAGOF ISLAND
SLOCUM ARM
KHAZ PENINSULA
PACIFIC
SALISBURY SOUND
FORTUNA STRAIT
Khaz Peninsula
Cobol

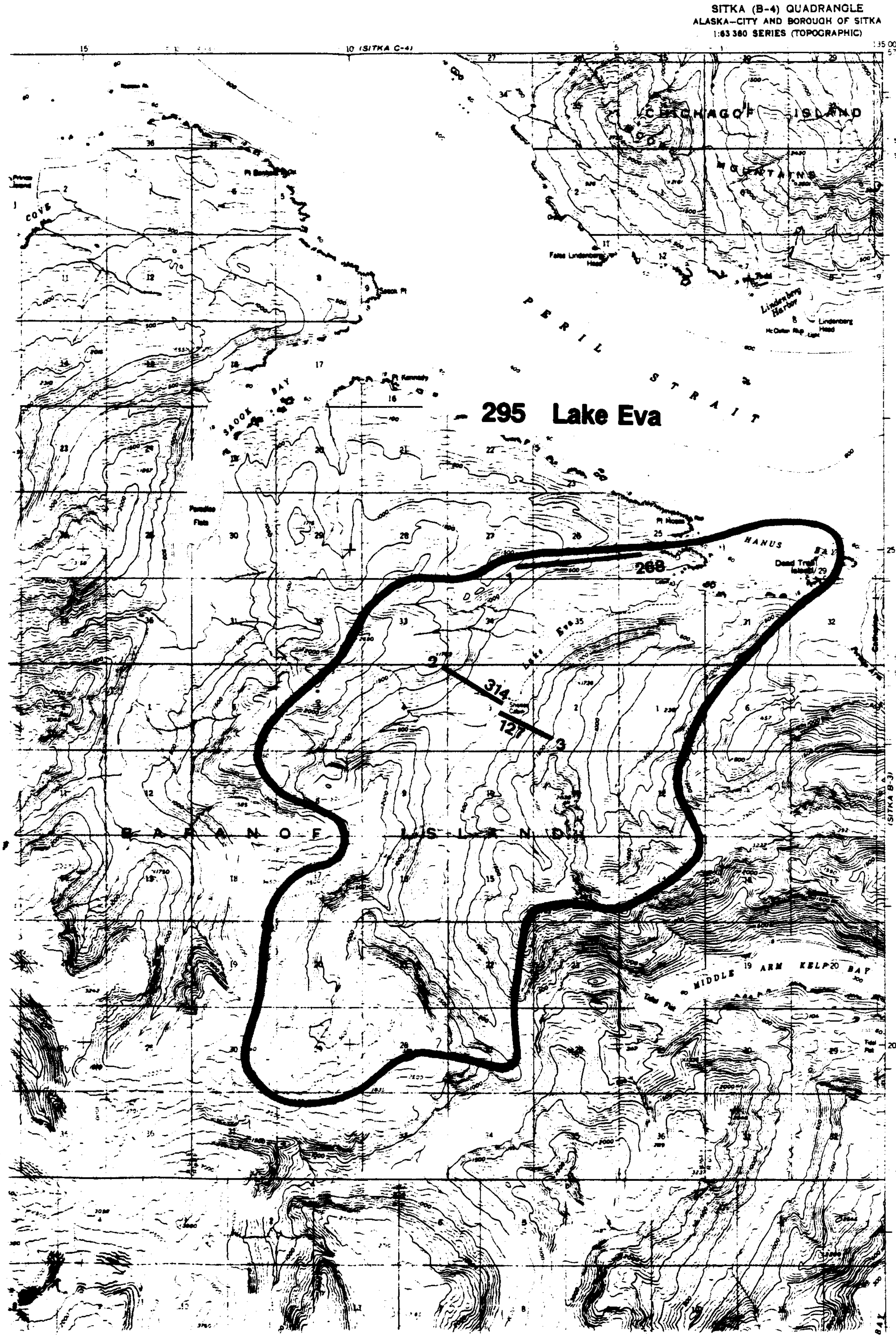

279 Rapids Point
all 270 degrees
S T R A I T
P E R I L
D E A D M A N
R E A C H
B A R A N O F
CHICHAGOF
ISLAND
DUFFIELD
PENINSULA
DEEP BAY
Rapids Pt
Bear Bay Island
B A R A N O F   I S L A N D
RODMAN
Tidal Flat
F I S H

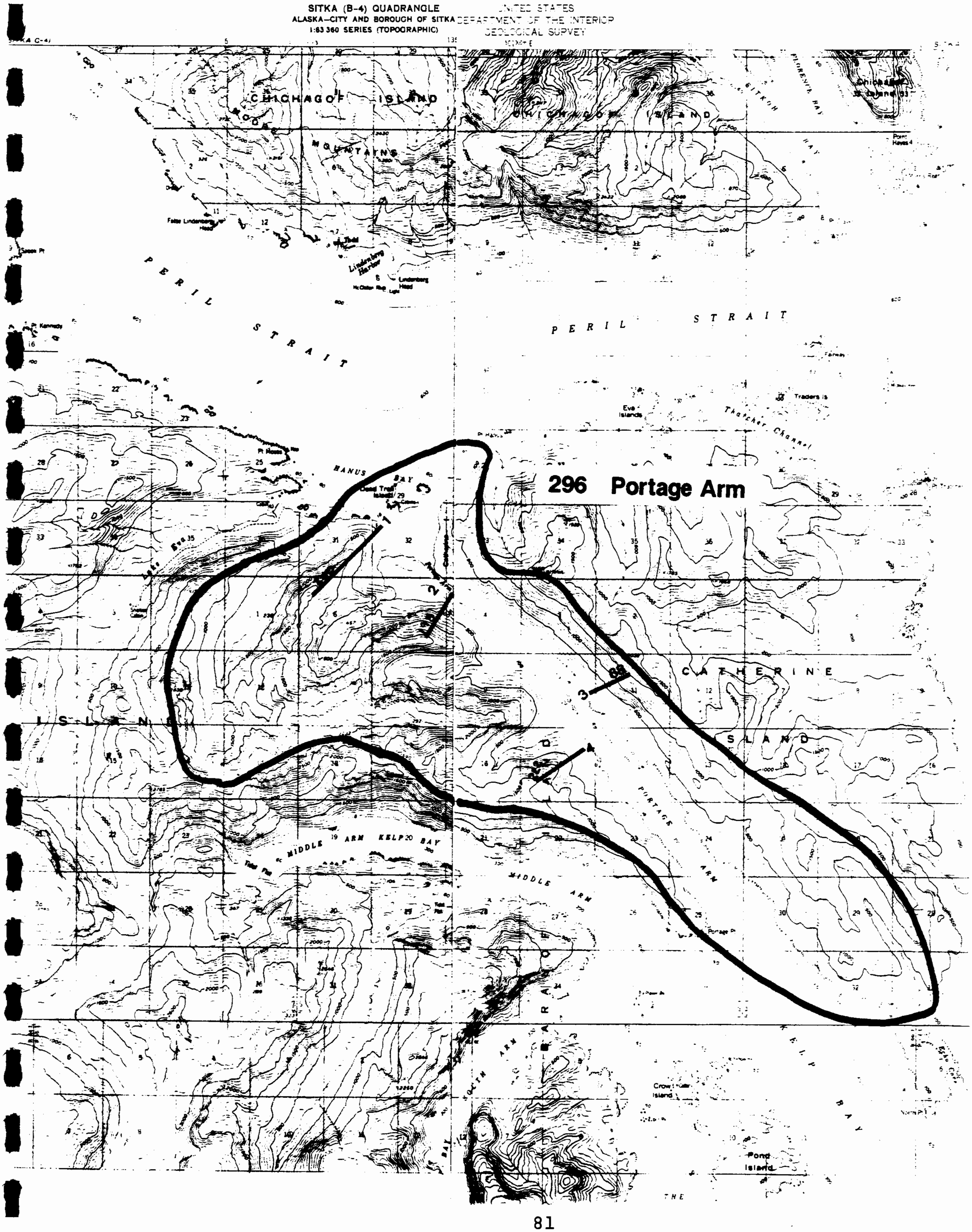

281 Ushk Bay
STARTING POINTS UNKNOWN
AZIMUTHS BY TRANSECT NO.
1 - 32 0°
2 - 13 8°
Moser Island
NORTH ARM
HOONAH SOUND
SOUTH ARM
PATTERSON BAY
Pederson Pt
White Cliff Pt
Emmons Island
Emmons Pt
USHK BAY
PERIL
DEADMAN
Rock Pt
Mapped, edited, and published by the Geological Survey
Control by USGS and USC&GS
Topography by photogrammetric methods from aerial photographs taken 1948. Field annotated 1951. Map not field checked
CONTOUR INTERVAL 100 FEET
APPROXIMATE MEAN DECLINATION 1951
Lake elevations are unchecked
FOR SALE BY U.S. GEOLOGICAL SURVEY
FAIRBANKS, ALASKA 99701, DENVER, COLORADO
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS
Entire land area is within the Tongass National Forest
To place on the predicted North American Datum 1983 move the projection lines 40 meters north and 108 meters east

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

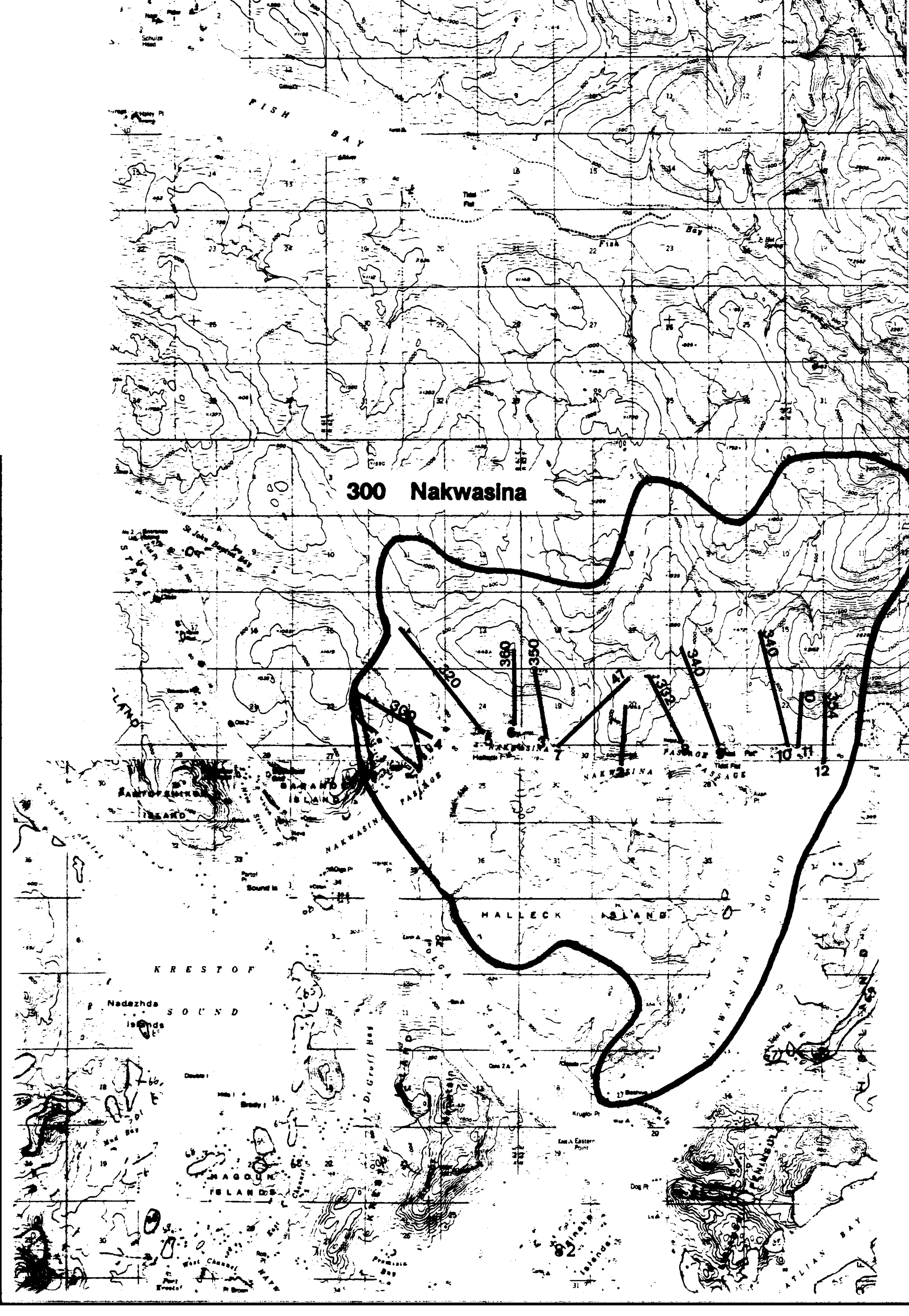
SITKA (B-5)
ALASKA–CITY AND
1:63 360 SERIE




SITKA (B-4) QUADRANGLE
ALASKA–CITY AND BOROUGH OF SITKA
1:63 360 SERIES (TOPOGRAPHIC)
295 Lake Eva
PERIL STRAIT
CHICHAGOF ISLAND
BARANOF ISLAND
HANUS BAY
MIDDLE ARM KELP BAY
268
314
127
Lake Eva
Dead Tree Island
Lindenberg Harbor
False Lindenberg Head
Lindenberg Head

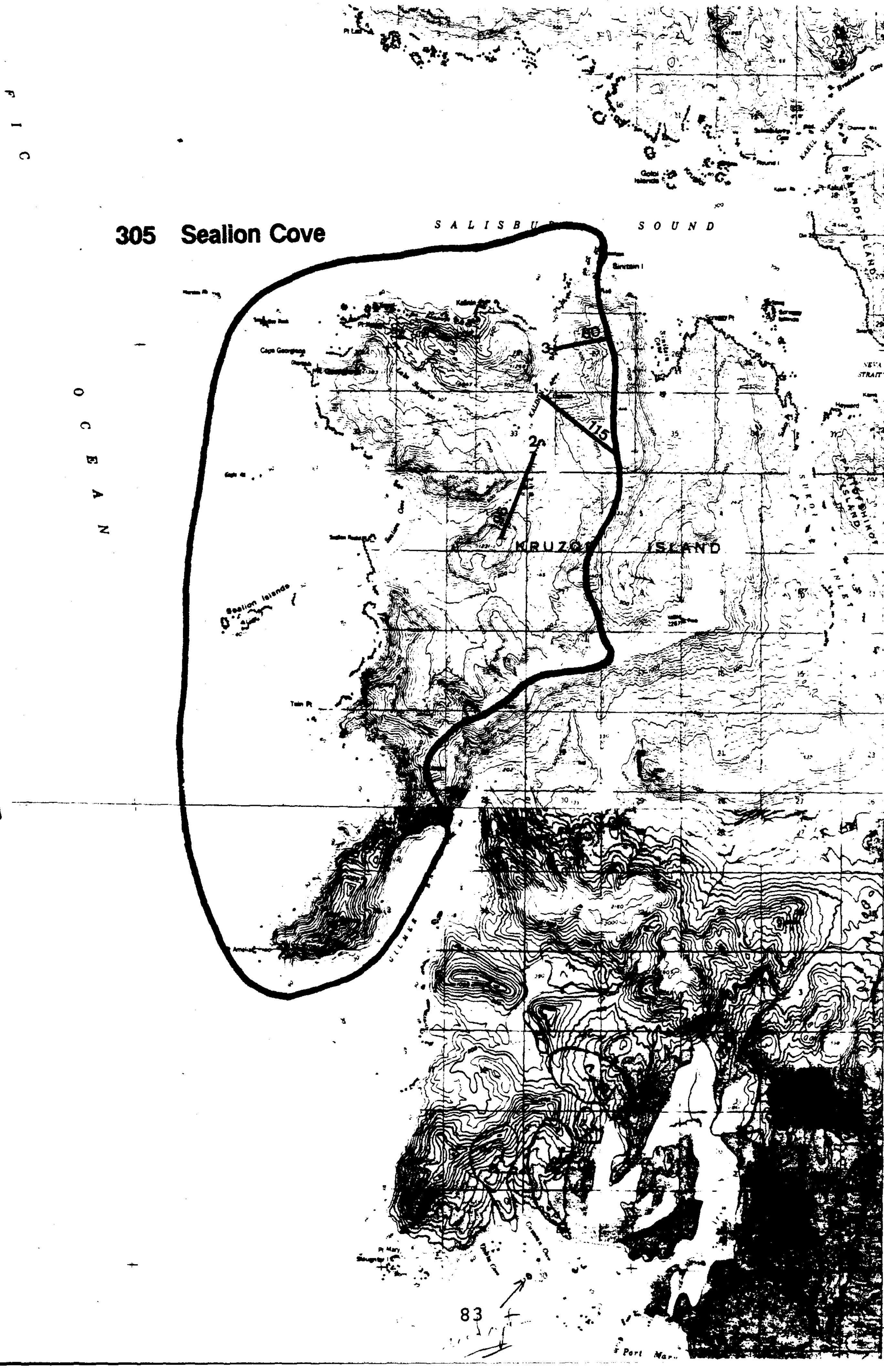


SITKA (B-4) QUADRANGLE
ALASKA—CITY AND BOROUGH OF SITKA
1:63 360 SERIES (TOPOGRAPHIC)
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CHICHAGOF ISLAND
MOUNTAINS
PERIL STRAIT
PERIL STRAIT
Lindenberg Harbor
Lindenberg Head
Pt Kennedy
Eve Islands
Traders Is
Thatcher Channel
HANUS BAY
Dead Tree Island
296 Portage Arm
CATHERINE ISLAND
ISLAND
PORTAGE ARM
MIDDLE ARM KELP BAY
MIDDLE ARM
Portage Pt
SOUTH ARM
KELP BAY
Crow Island
Pond Island

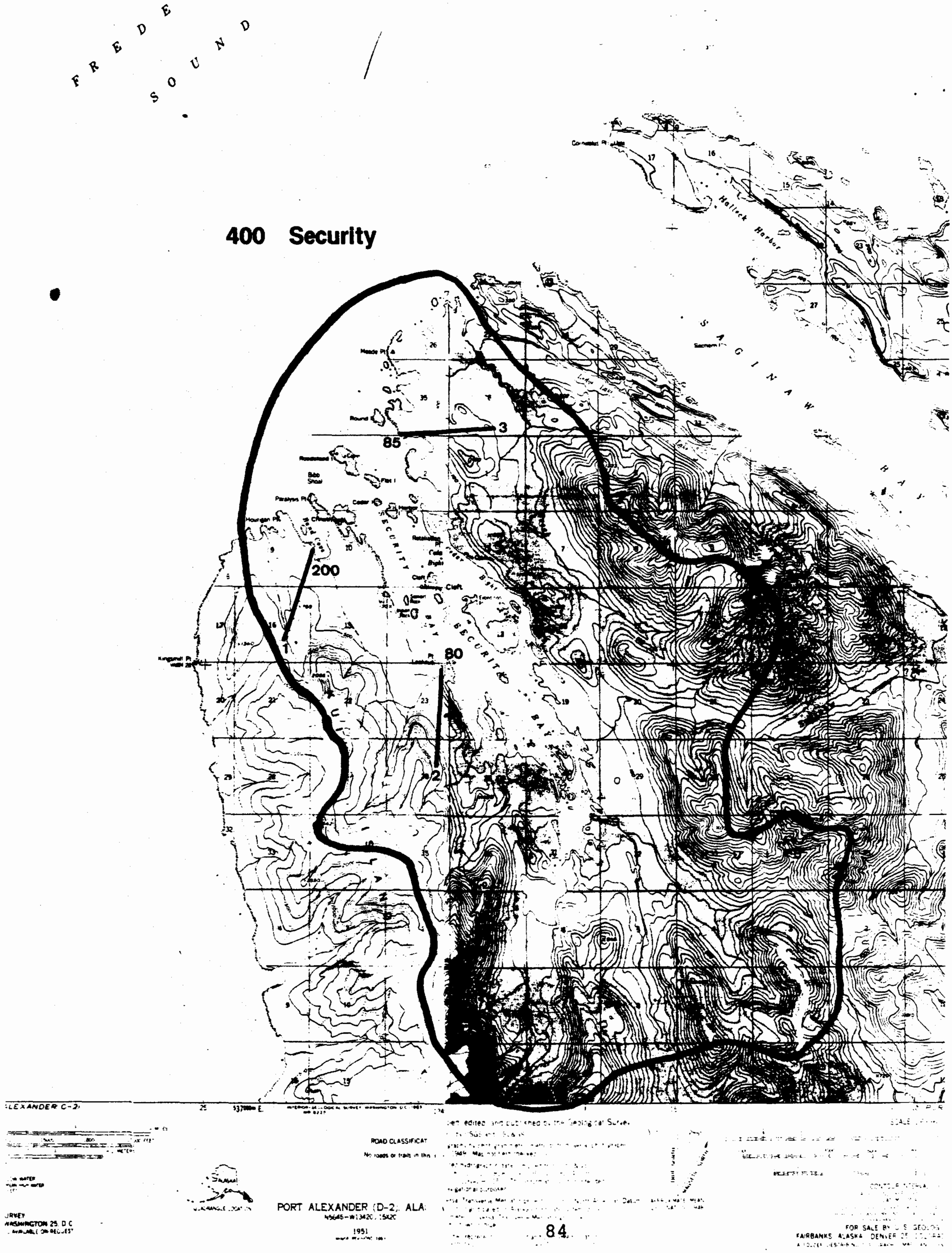


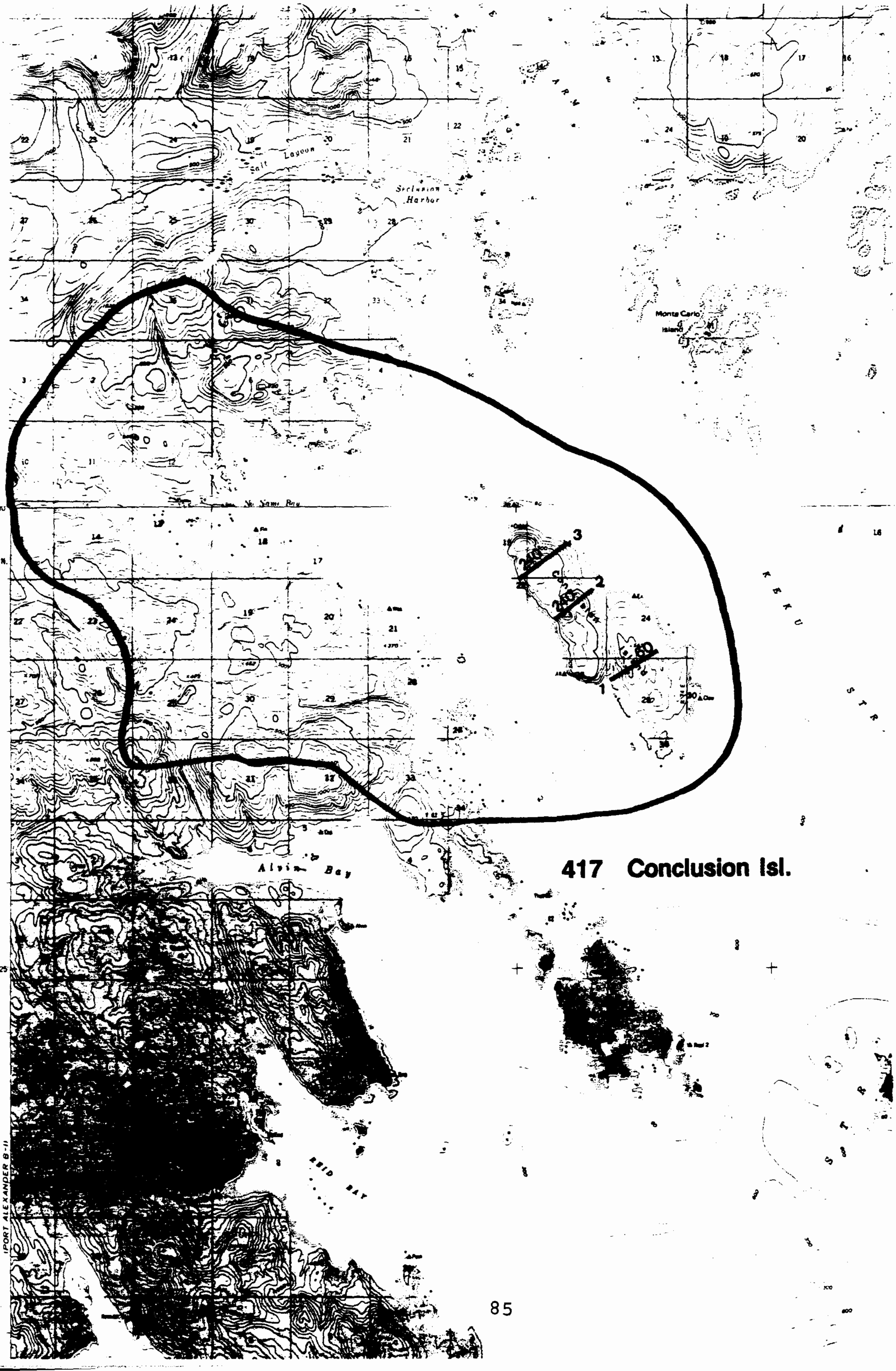
300 Nakwasina
320
360
350
47
302
340
340
HALLECK ISLAND
KRESTOF
SOUND
Nadezhda
Islands
NAKWASINA SOUND
NAKWASINA PASSAGE
Fish Bay
Tidal Flat
MAGOUN
ISLANDS
Krugloi Pt
Dog Pt
Eastern Point

305 Sealion Cove

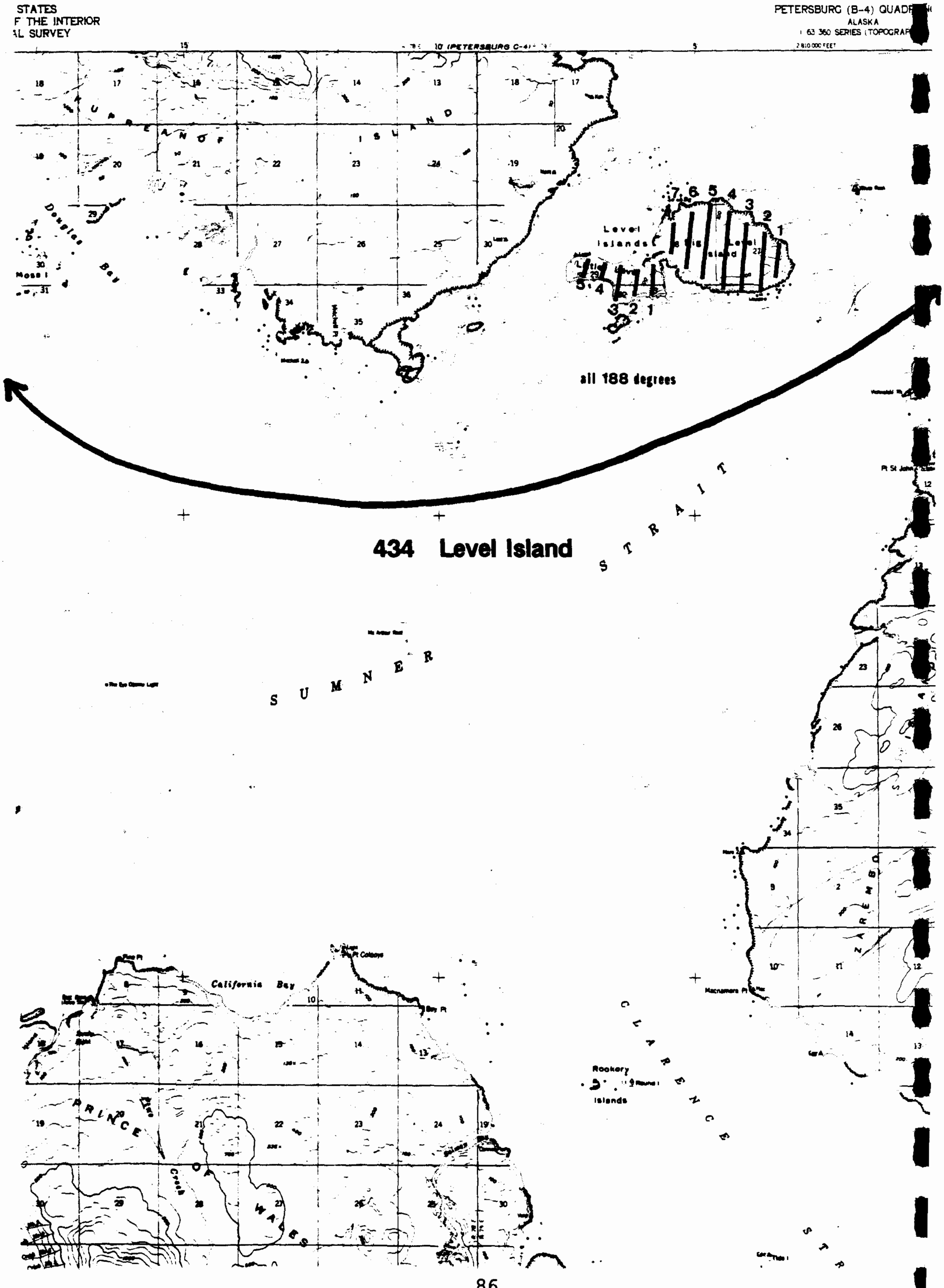


400 Security

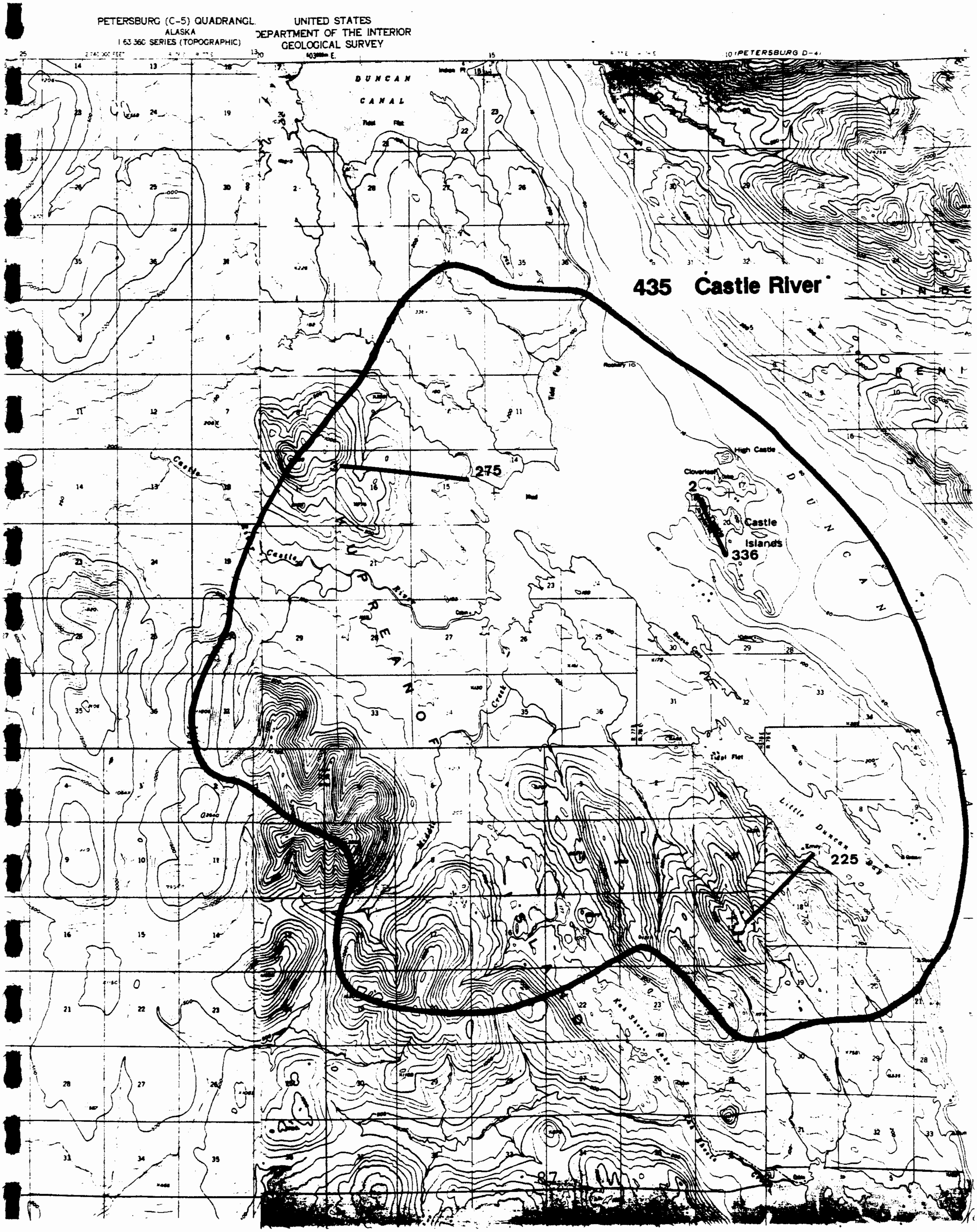


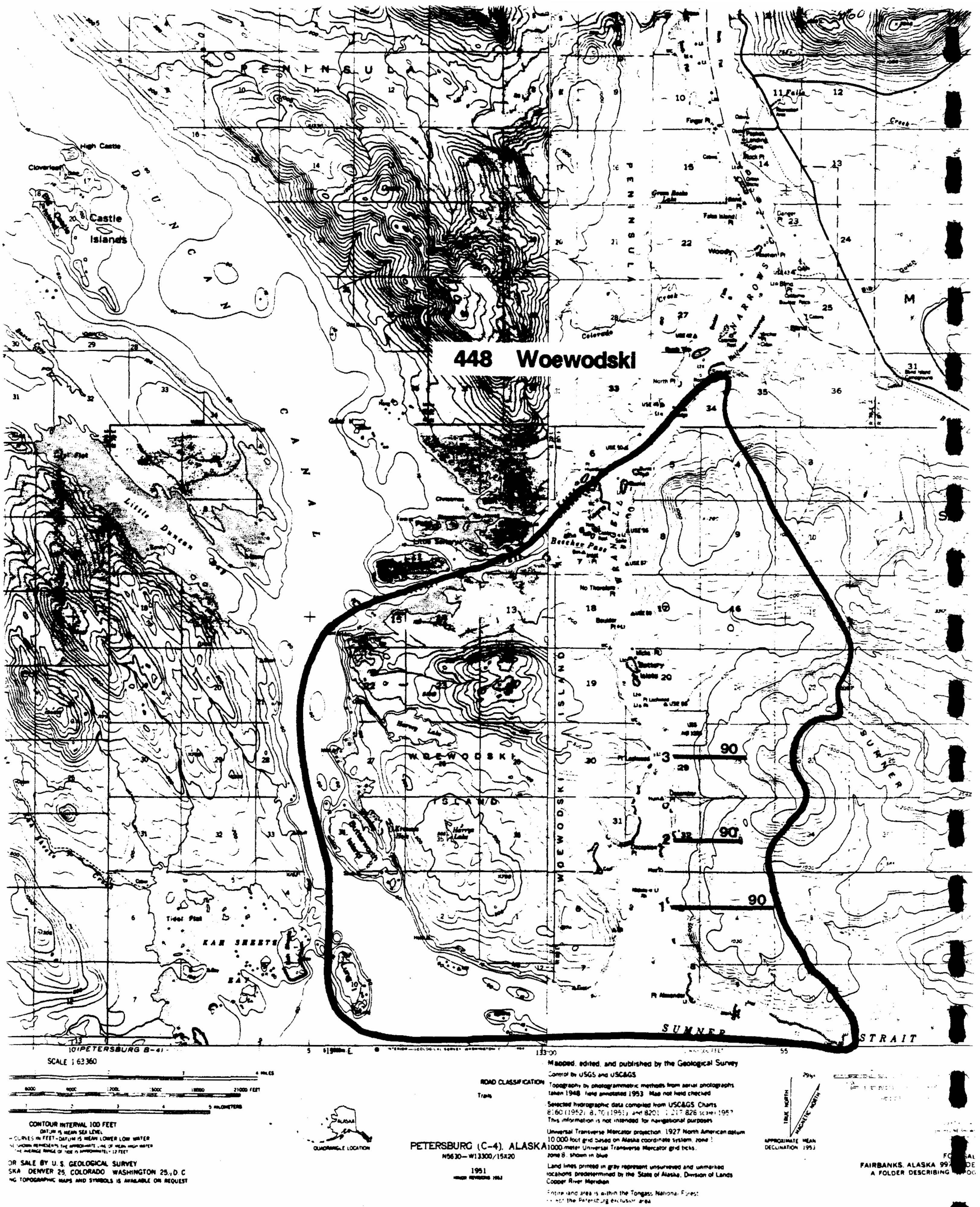


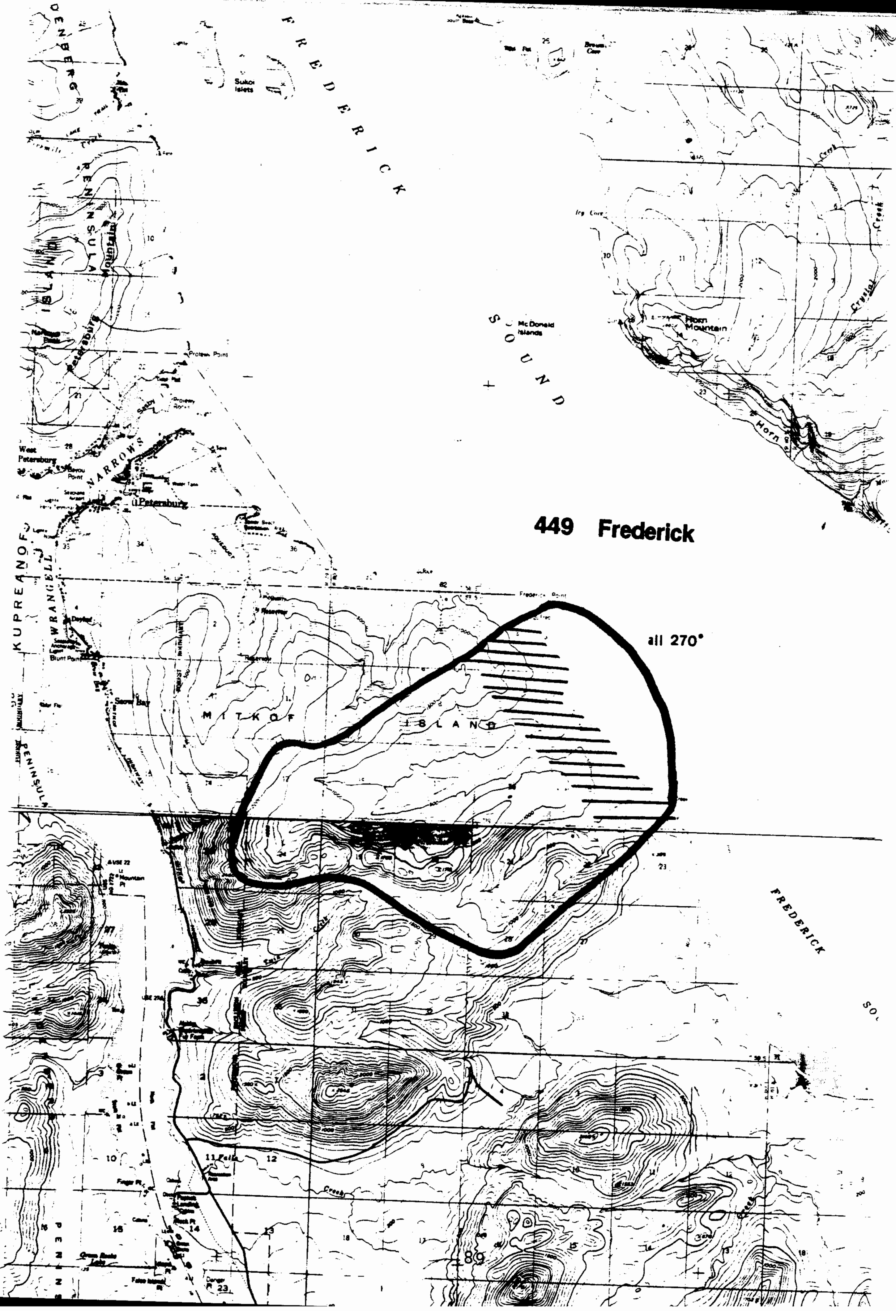
417 Conclusion Isl.

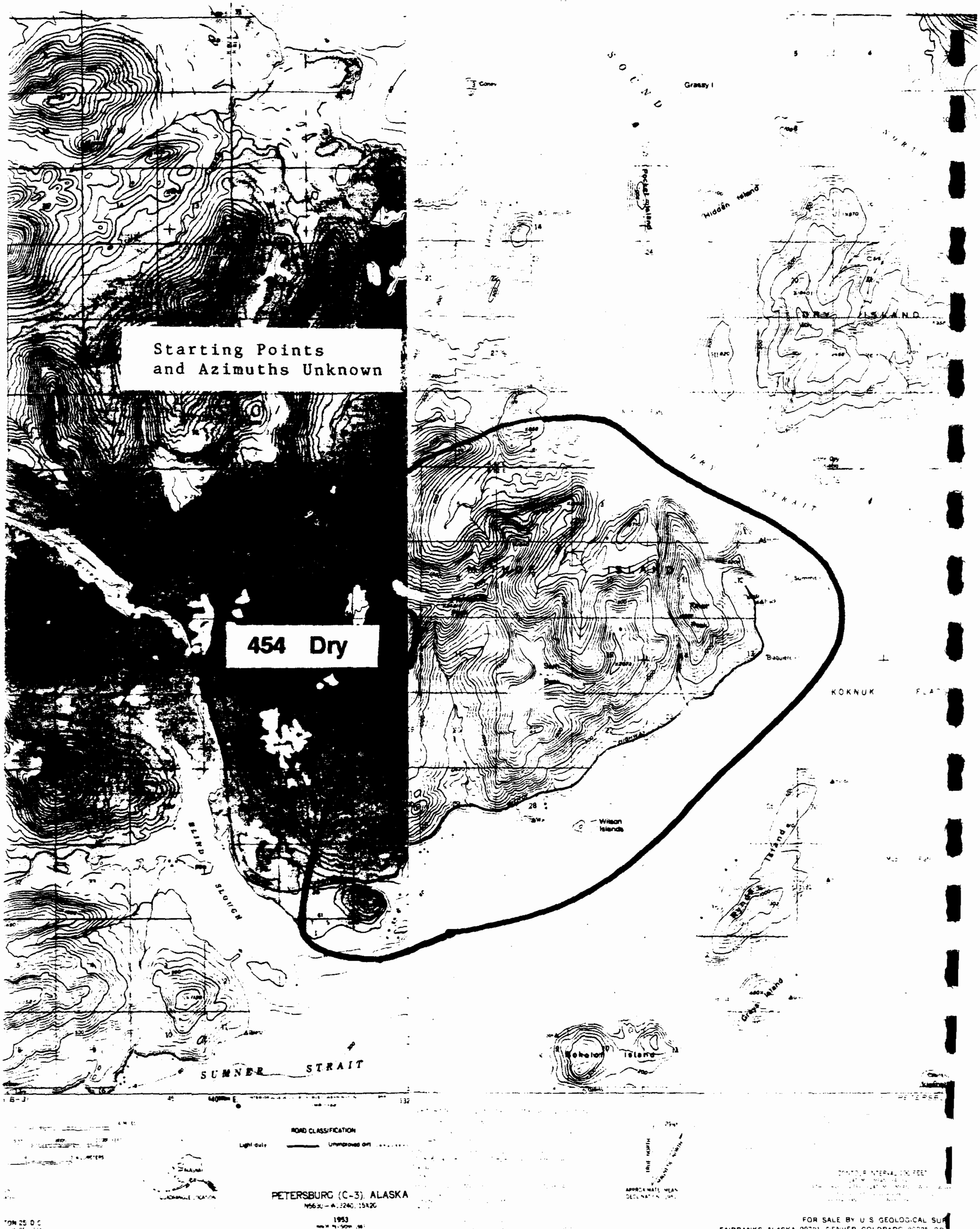


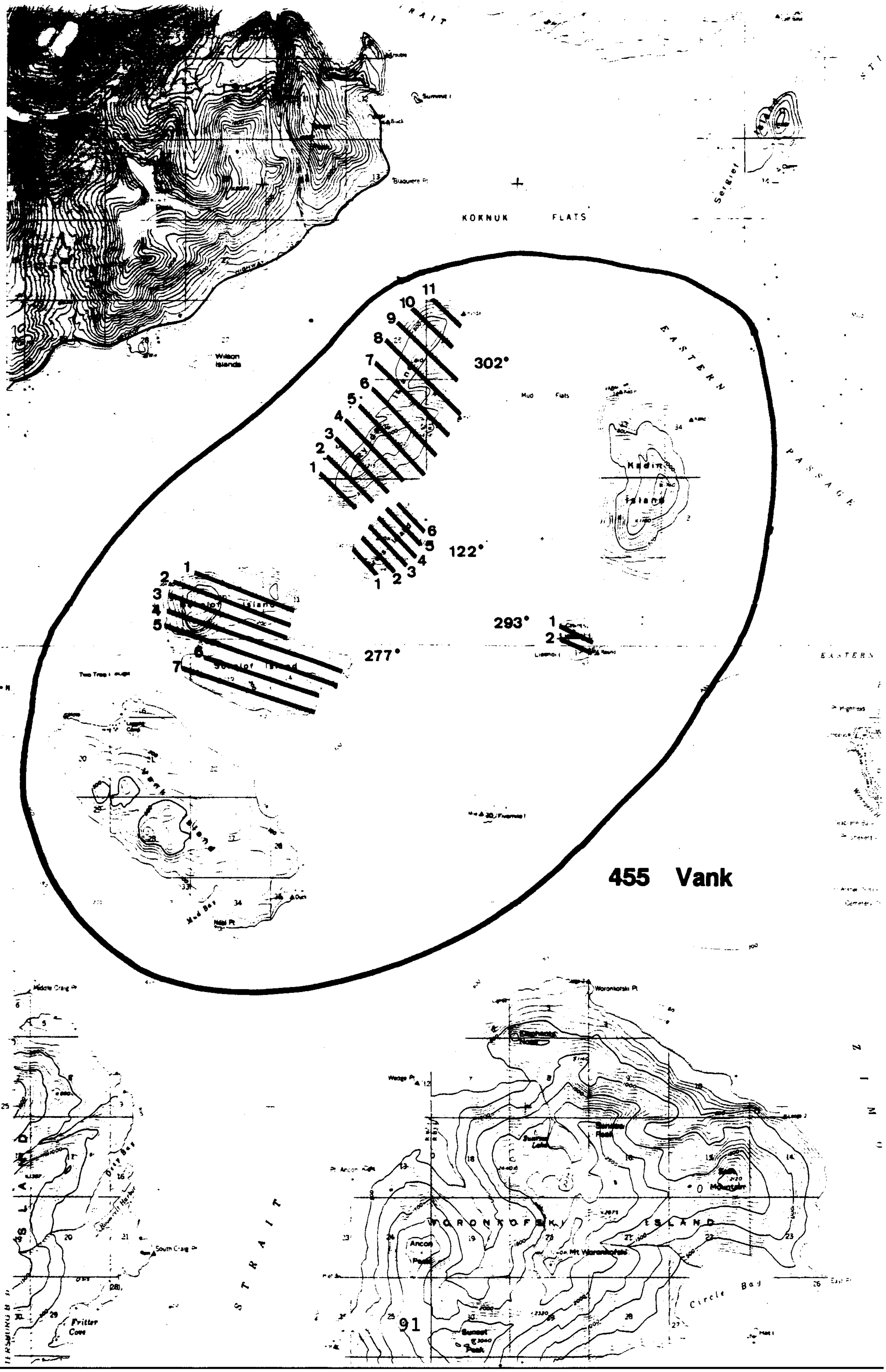
434 Level Island

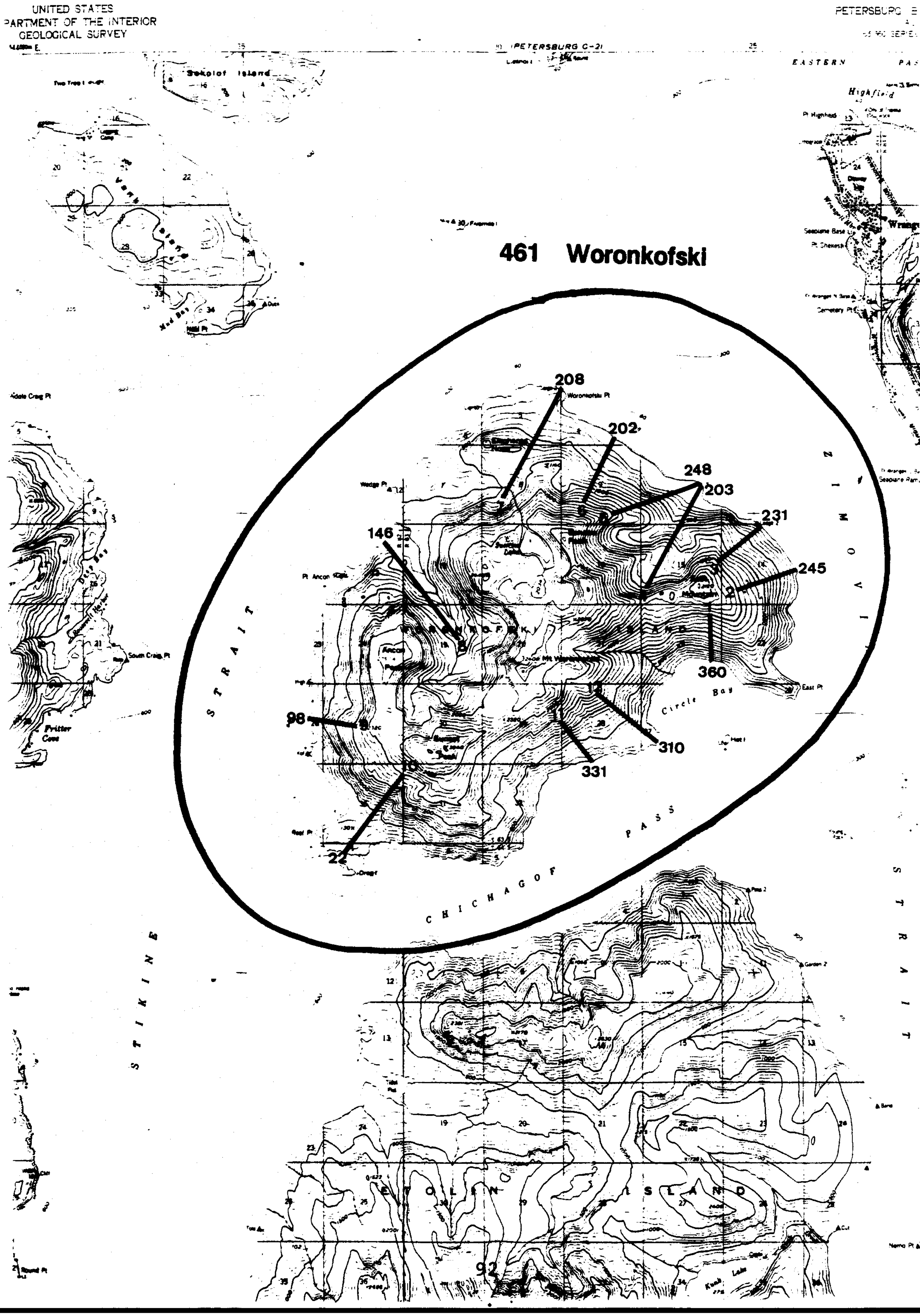

PETERSBURG (C-5) QUADRANGL.
ALASKA
1:63 360 SERIES (TOPOGRAPHIC)
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
PETERSBURG D-4
DUNCAN CANAL
Tidal Flat
435 Castle River
275
High Castle
Cloverleaf
2
Castle Islands
336
DUNCAN
Little Duncan Bay
225
87


448 Woewodski
90
90
90
PENINSULA
DUNCAN CANAL
WOEWODSKI ISLAND
WRANGELL NARROWS
SUMNER STRAIT
Castle Islands
High Castle
Cloverleaf
Little Duncan Bay
Beecher Pass
Harvey Lake
Tidal Flat
KAH SHEETS BAY
PETERSBURG B-4
SCALE 1:63 360
CONTOUR INTERVAL 100 FEET
DATUM IS MEAN SEA LEVEL
FOR SALE BY U.S. GEOLOGICAL SURVEY
DENVER 25, COLORADO WASHINGTON 25, D.C.
ROAD CLASSIFICATION
Trails
QUADRANGLE LOCATION
PETERSBURG (C-4), ALASKA
N5630—W13300/15X20
1951
Mapped, edited, and published by the Geological Survey
Control by USGS and USC&GS
Topography by photogrammetric methods from aerial photographs taken 1948. Field annotated 1953. Map not field checked
Selected hydrographic data compiled from USC&GS Charts
This information is not intended for navigational purposes
Universal Transverse Mercator projection. 1927 North American datum
Land lines printed in gray represent unsurveyed and unmarked locations predetermined by the State of Alaska, Division of Lands
Copper River Meridian
Entire land area is within the Tongass National Forest
APPROXIMATE MEAN DECLINATION 1953
FAIRBANKS, ALASKA
A FOLDER DESCRIBING

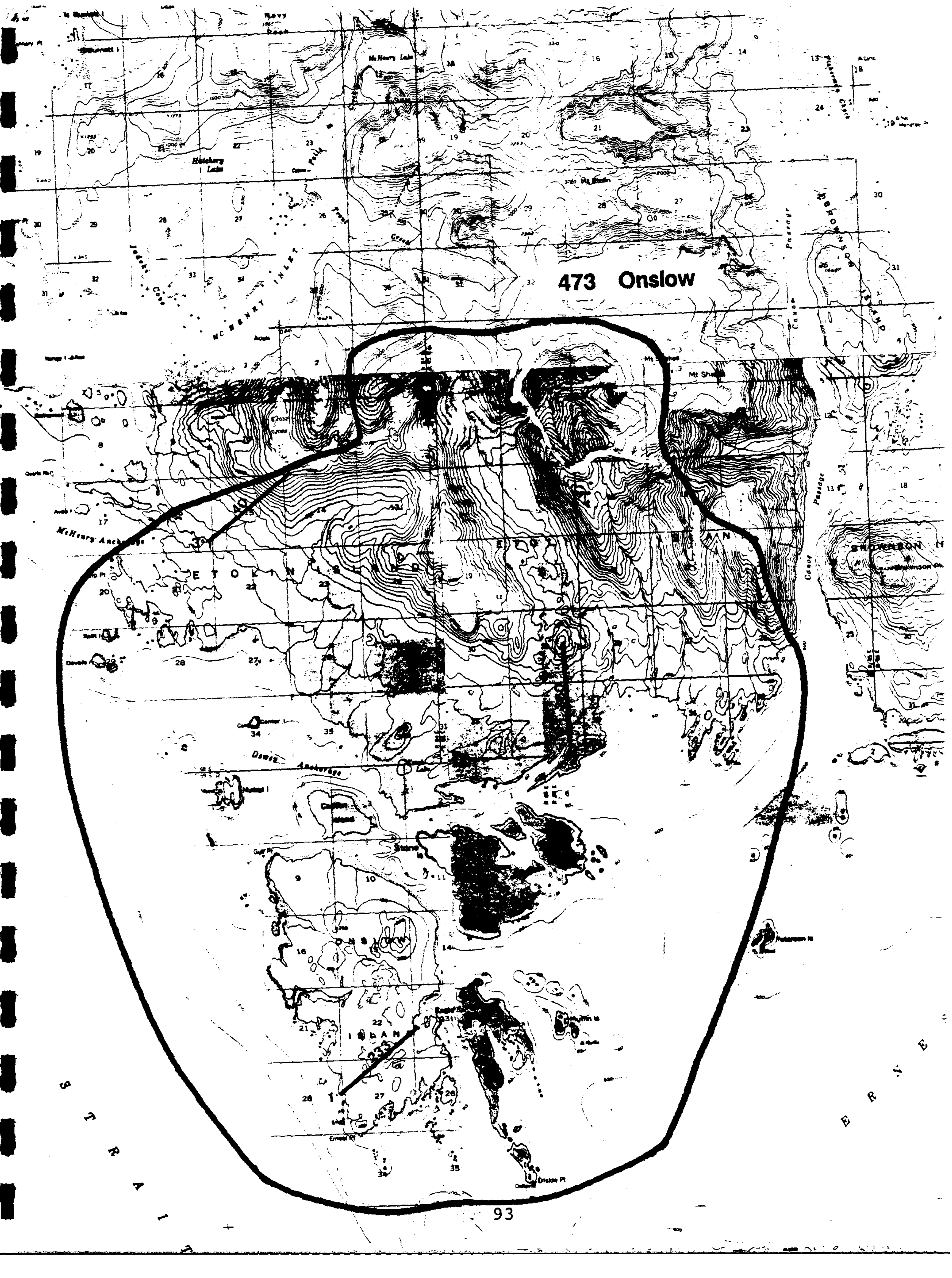

449 Frederick
all 270°
FREDERICK
SOUND
Sukoi Islets
McDonald Islands
Horn Mountain
Horn
Crystal
Creek
Icy Cove
Brown Cove
Frederick Point
Protection Point
West Petersburg
Petersburg
NARROWS
WRANGELL
KUPREANOF
PENINSULA
MITKOF
ISLAND
Blunt Point
Scow Bay
Mountain Pt
Finger Pt
Green Rocks Lake
Falls
Danger Pt
Creek
FREDERICK
SO


Starting Points
and Azimuths Unknown
454 Dry
Grassy I
Hidden Island
KOKNUK
Wilson Islands
BLIND SLOUGH
SUMNER STRAIT
ROAD CLASSIFICATION
Light duty
Unimproved dirt
PETERSBURG (C-3), ALASKA
1953
FOR SALE BY U S GEOLOGICAL SU
FAIRBANKS ALASKA 99701 DENVER COLORADO 80225 OR

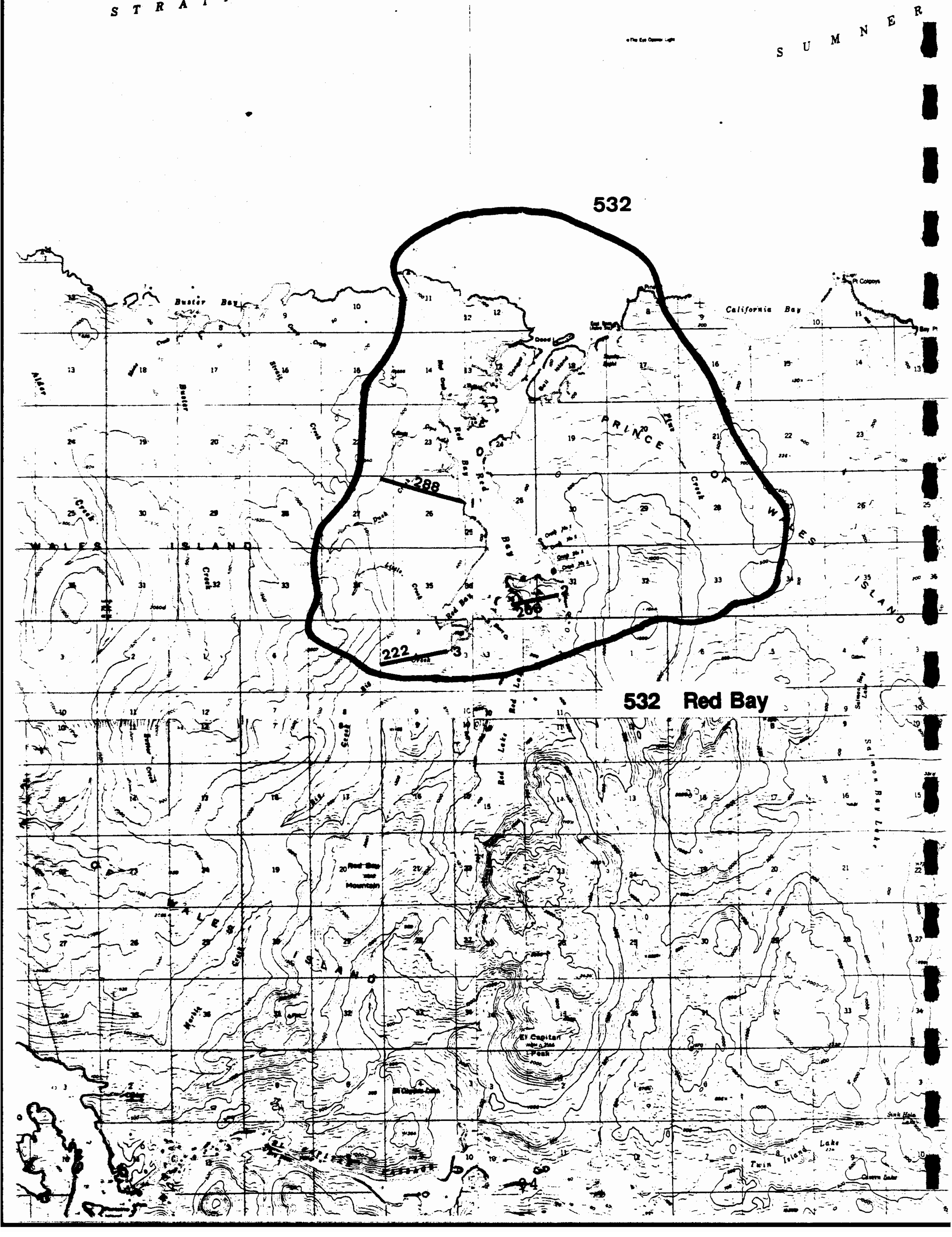

455 Vank
302°
122°
293°
277°
KORNUK FLATS
EASTERN PASSAGE
Mud Flats
Wilson Islands
Blaquiere Pt
Kadin Island
Sergief
Middle Craig Pt
South Craig Pt
Dry Bay
Fritter Cove
Woronkofski Pt
Wedge Pt
WORONKOFSKY ISLAND
Mt Woronkofski
Ancon Peak
Sunset Peak
Circle Bay
STRAIT



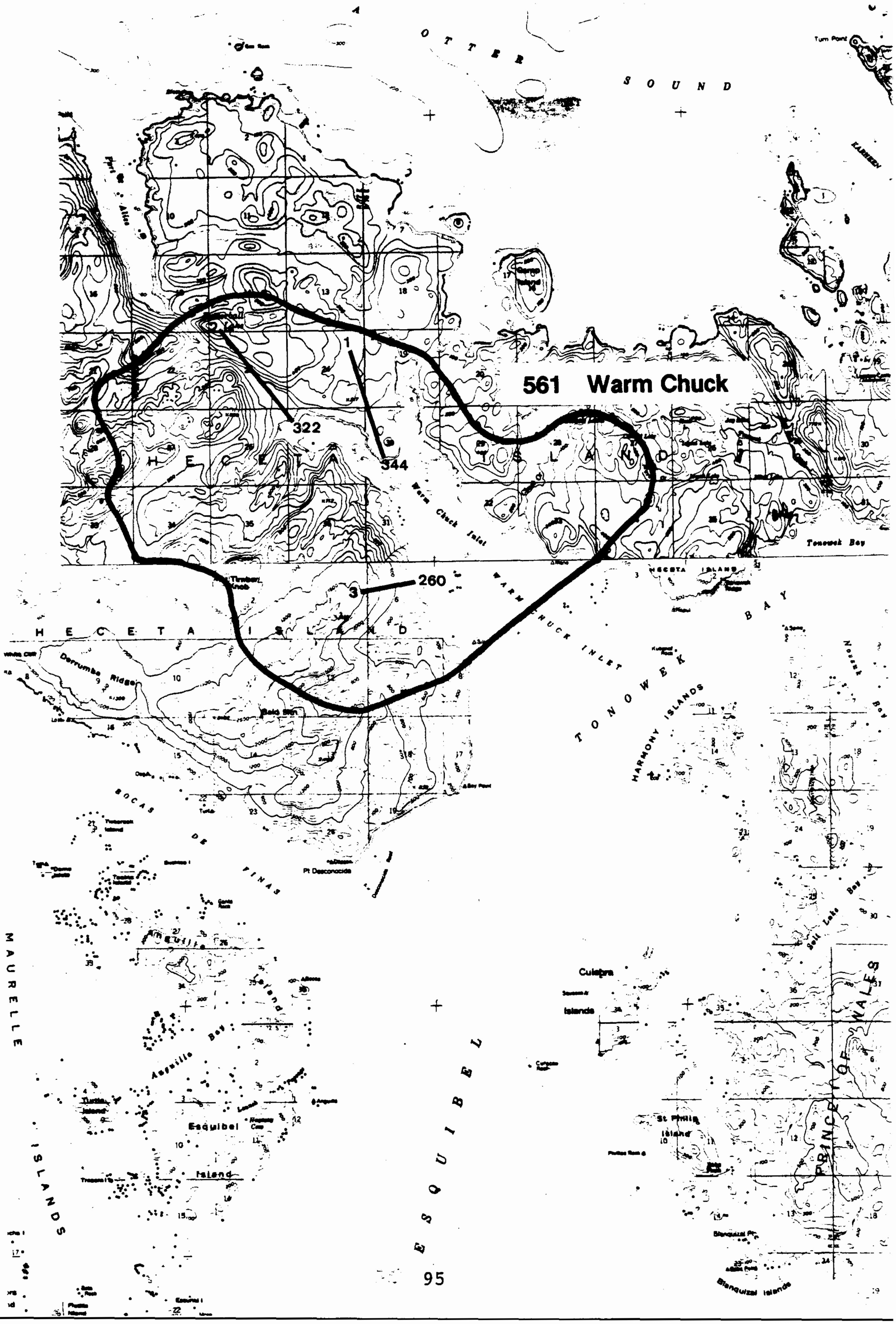
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
PETERSBURG
PETERSBURG C-2
461 Woronkofski
208
202
248
203
231
245
146
360
98
310
331
22
92
Woronkofski Pt
Wedge Pt
Pt Ancon
Ancon
Circle Bay
East Pt
Reef Pt
STRAIT
CHICHAGOF PASS
STIKINE
ZIMOVIA
STRAIT
Sokolof Island
Pt Highfield
Pt Chester
Cemetery Pt
Adele Craig Pt
South Craig Pt
Pritter Cove
Round Pt
EASTERN
ETOLIN ISLAND



473 Onslow
McHenry Anchorage
Dewey Anchorage
Onslow Pt

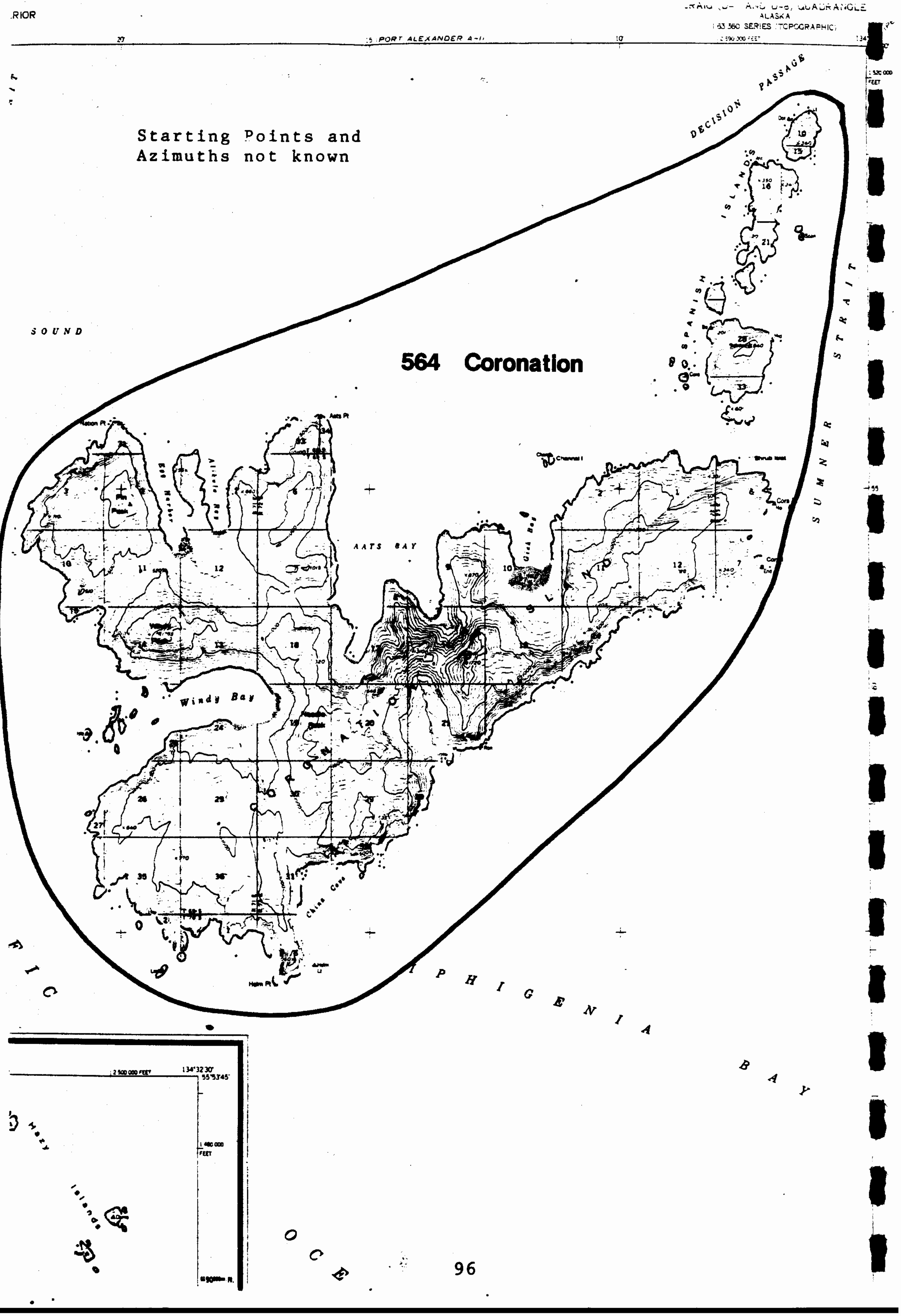


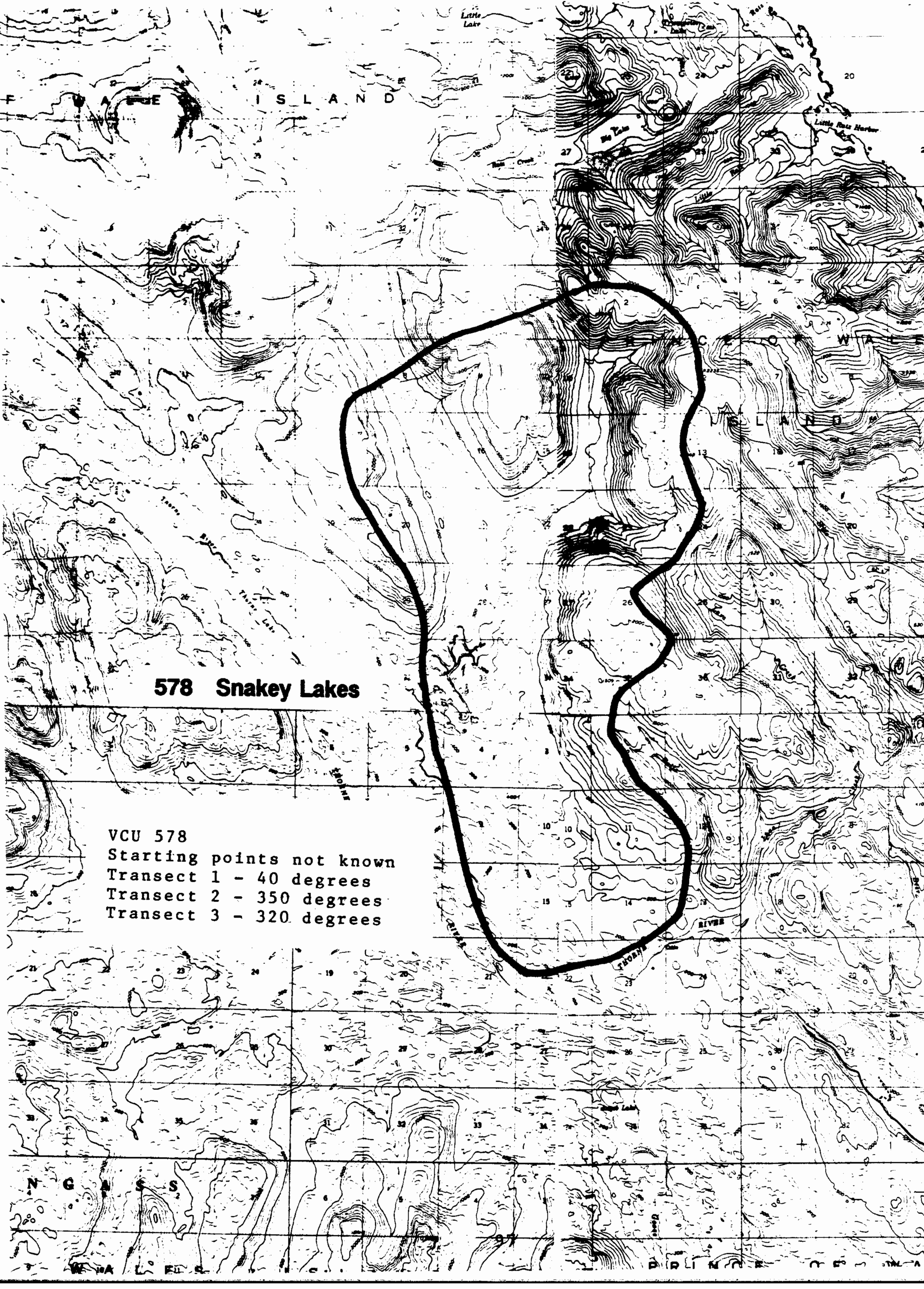
532
532 Red Bay
288
266
222
Buster Bay
California Bay
Red Bay
Red Bay Mountain
El Capitan Peak
Twin Island Lake


561 Warm Chuck
322
344
260
1
3
OTTER SOUND
HECETA ISLAND
Warm Chuck Inlet
WARM CHUCK INLET
TONOWEK BAY
Tonowek Bay
HARMONY ISLANDS
Derrumbe Ridge
BOCAS DE FINAS
Pt Desconocida
MAURELLE ISLANDS
ESQUIBEL
Esquibel
Island
Culebra
Islands
St Philip
Island
PRINCE OF WALES
Blanquizal Islands
Turn Point

Starting Points and Azimuths not known

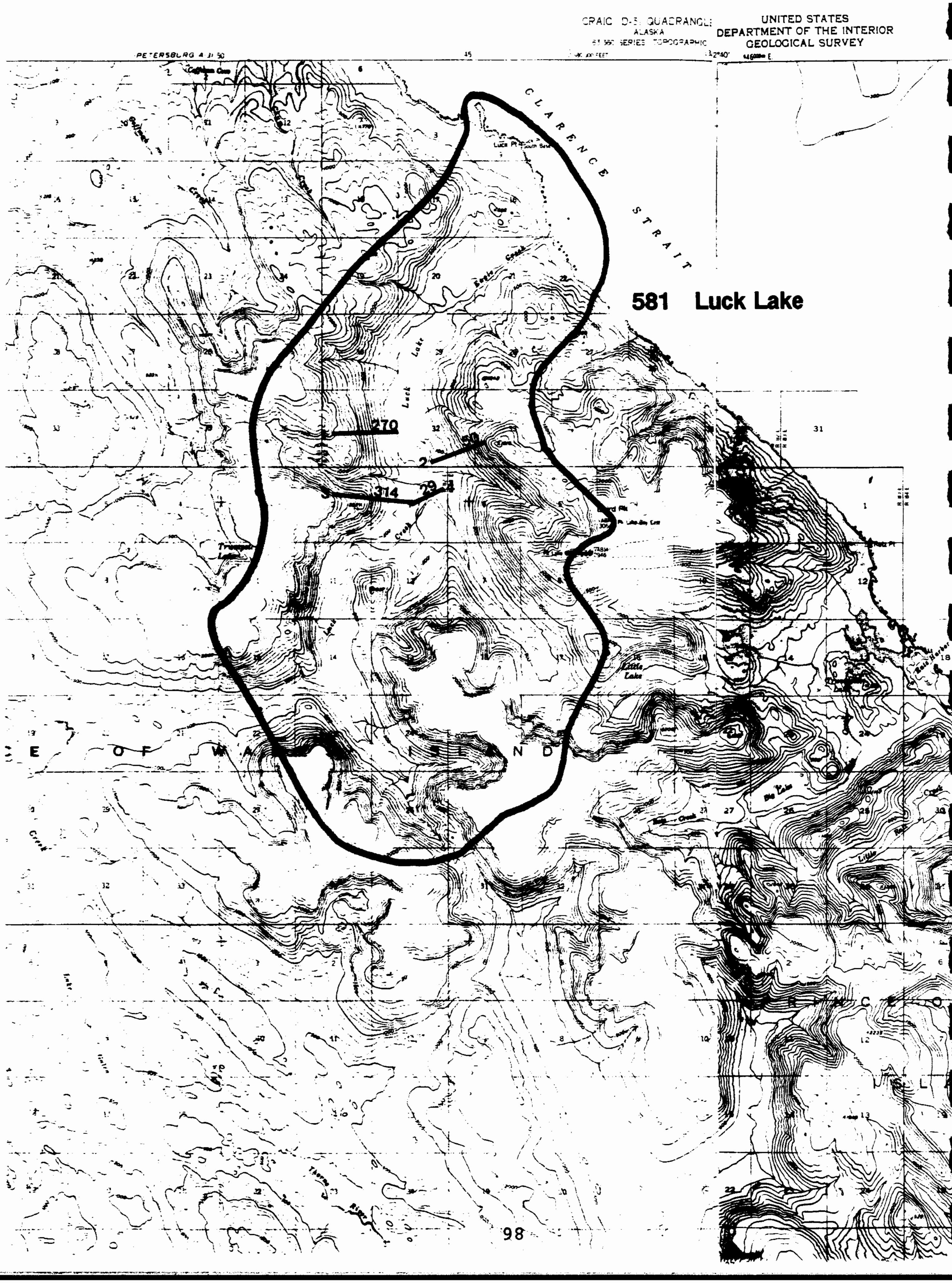
564 Coronation

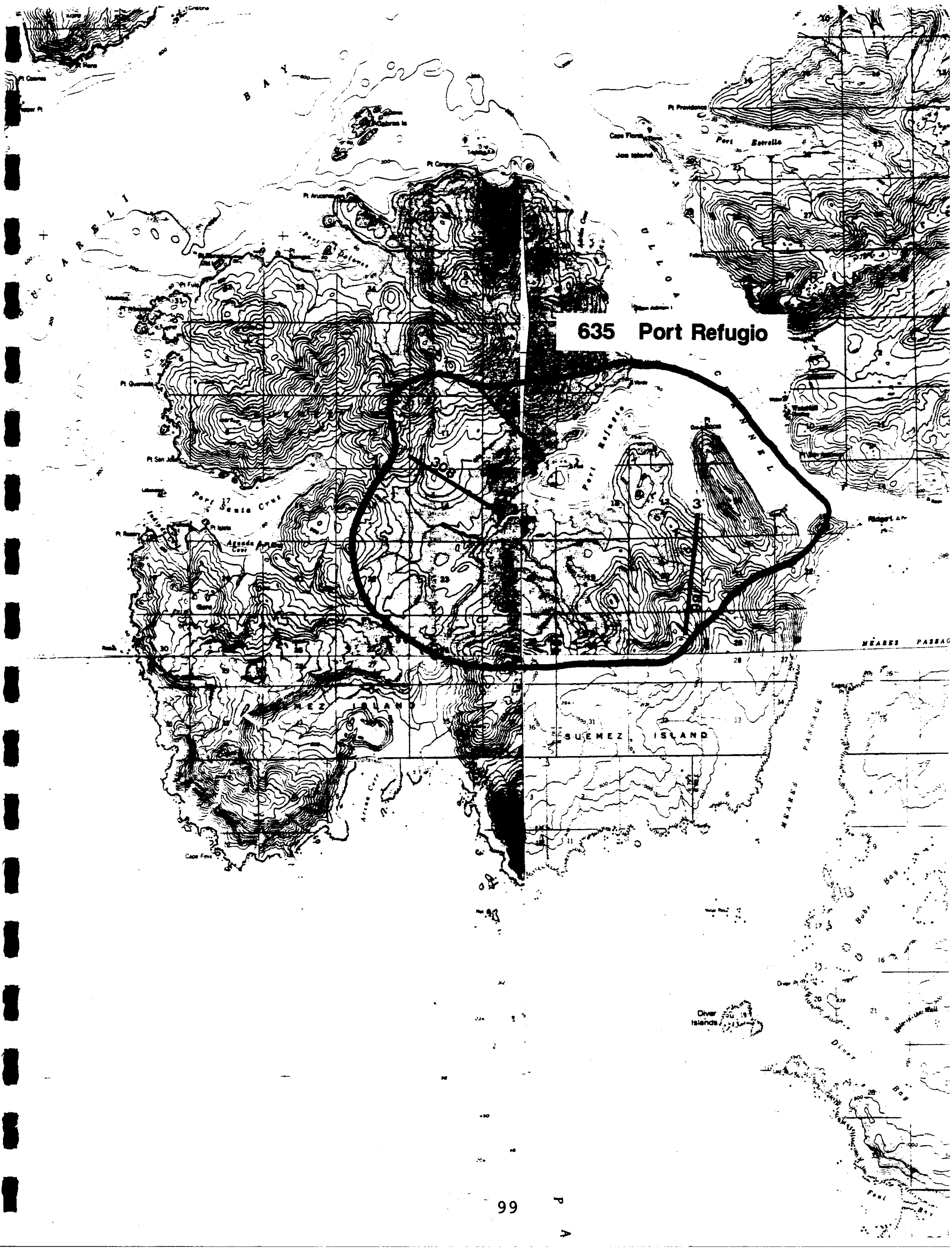




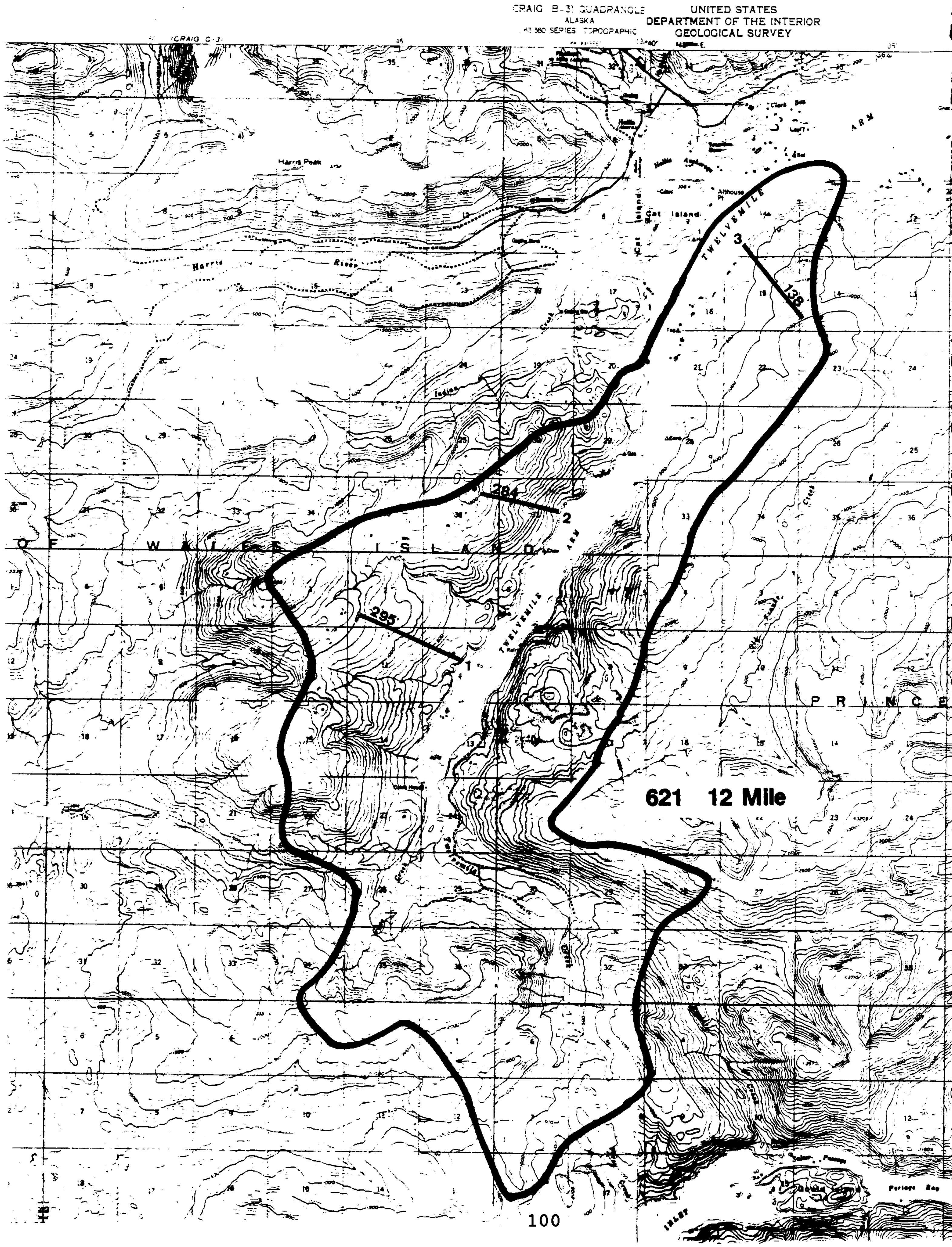
578 Snakey Lakes
VCU 578
Starting points not known
Transect 1 - 40 degrees
Transect 2 - 350 degrees
Transect 3 - 320 degrees
I S L A N D
Big Lake
Little Ratz Harbor
Thorne River

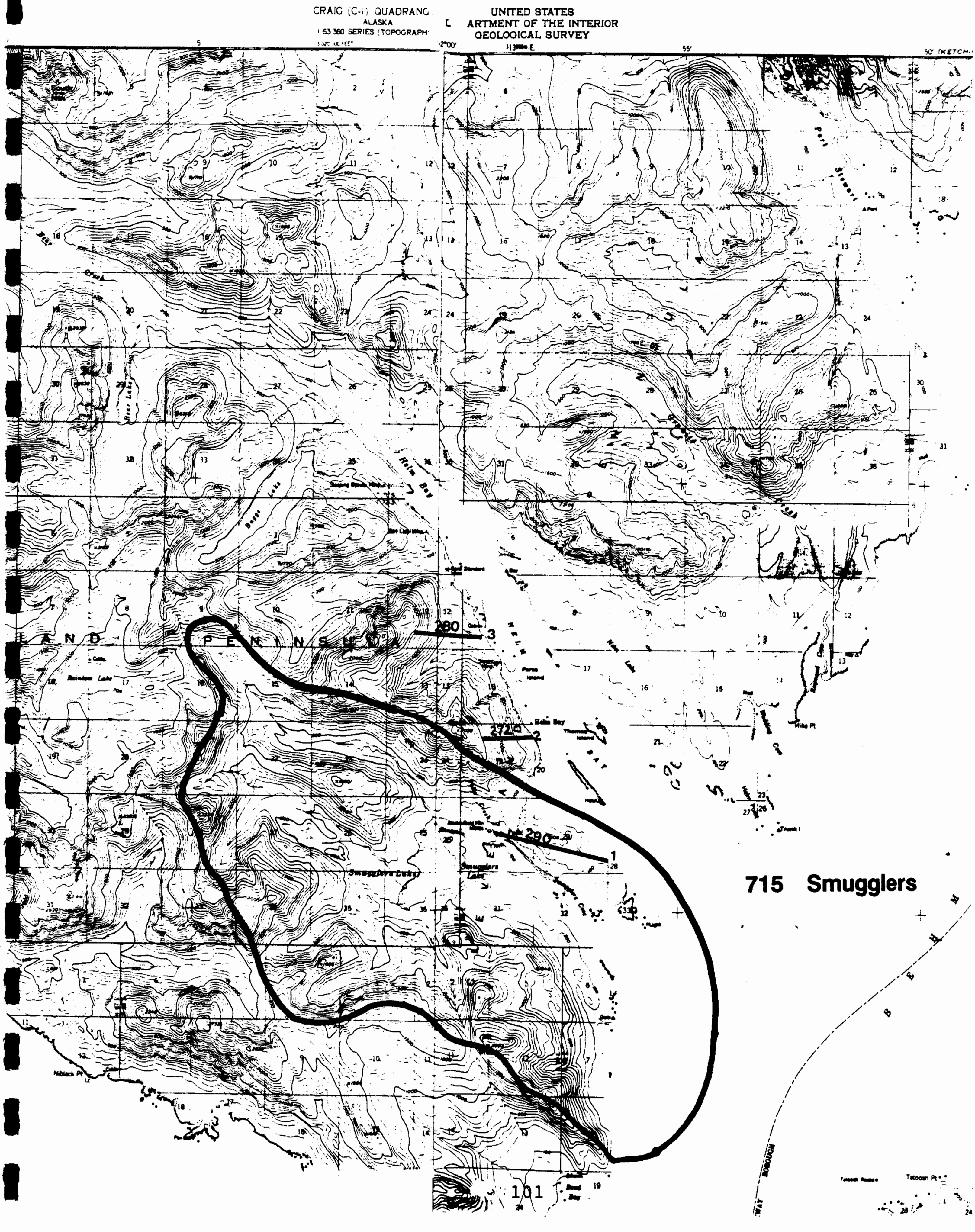
581 Luck Lake



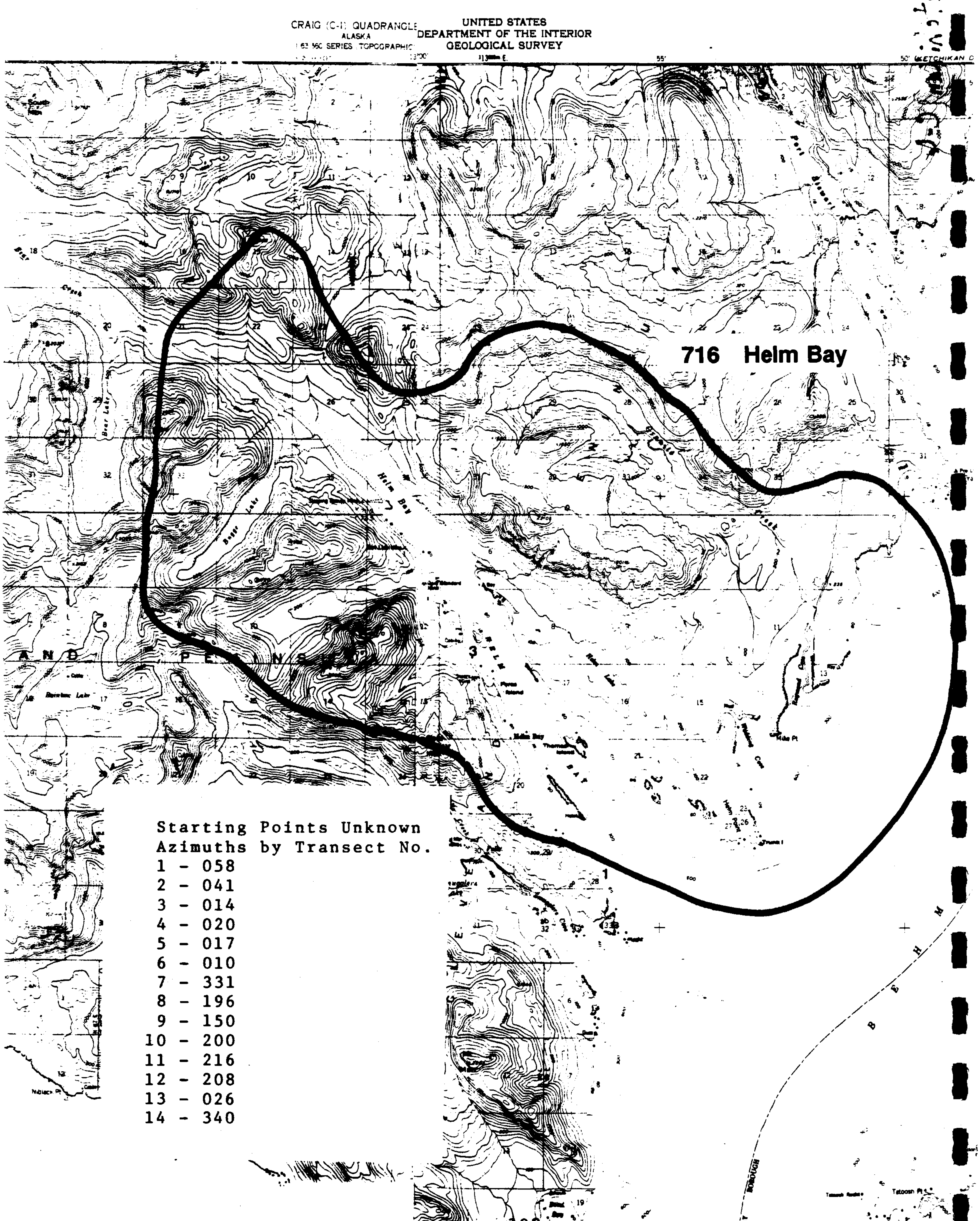


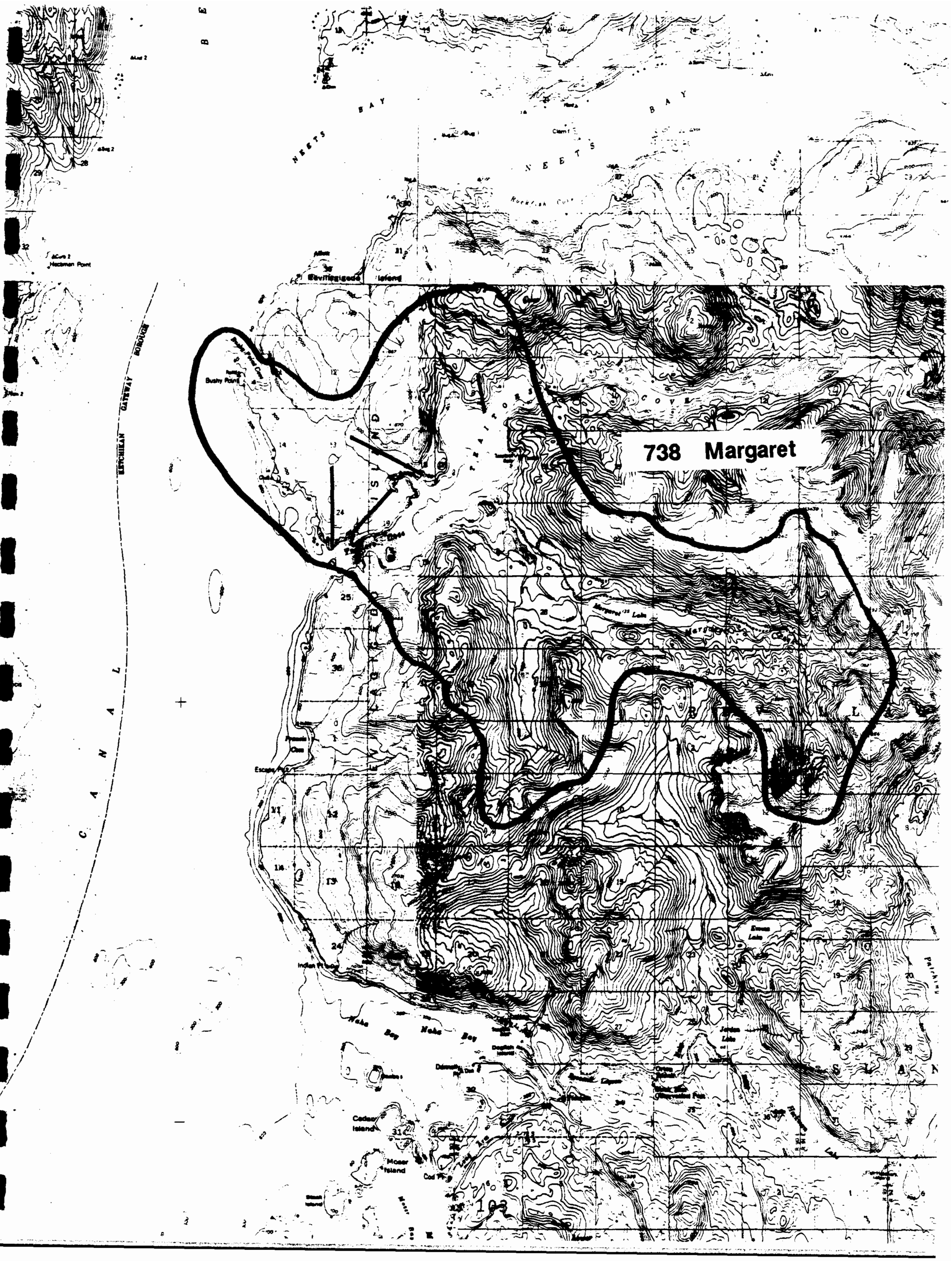
635 Port Refugio
BAY
CARELI
ULLOA
CHANNEL
Port Refugio
Port Santa Cruz
Port Estrella
Pt Providence
Cape Flores
Joe Island
SUEMEZ ISLAND
MEARES PASSAGE
Diver Islands
Cape Felix
308
3

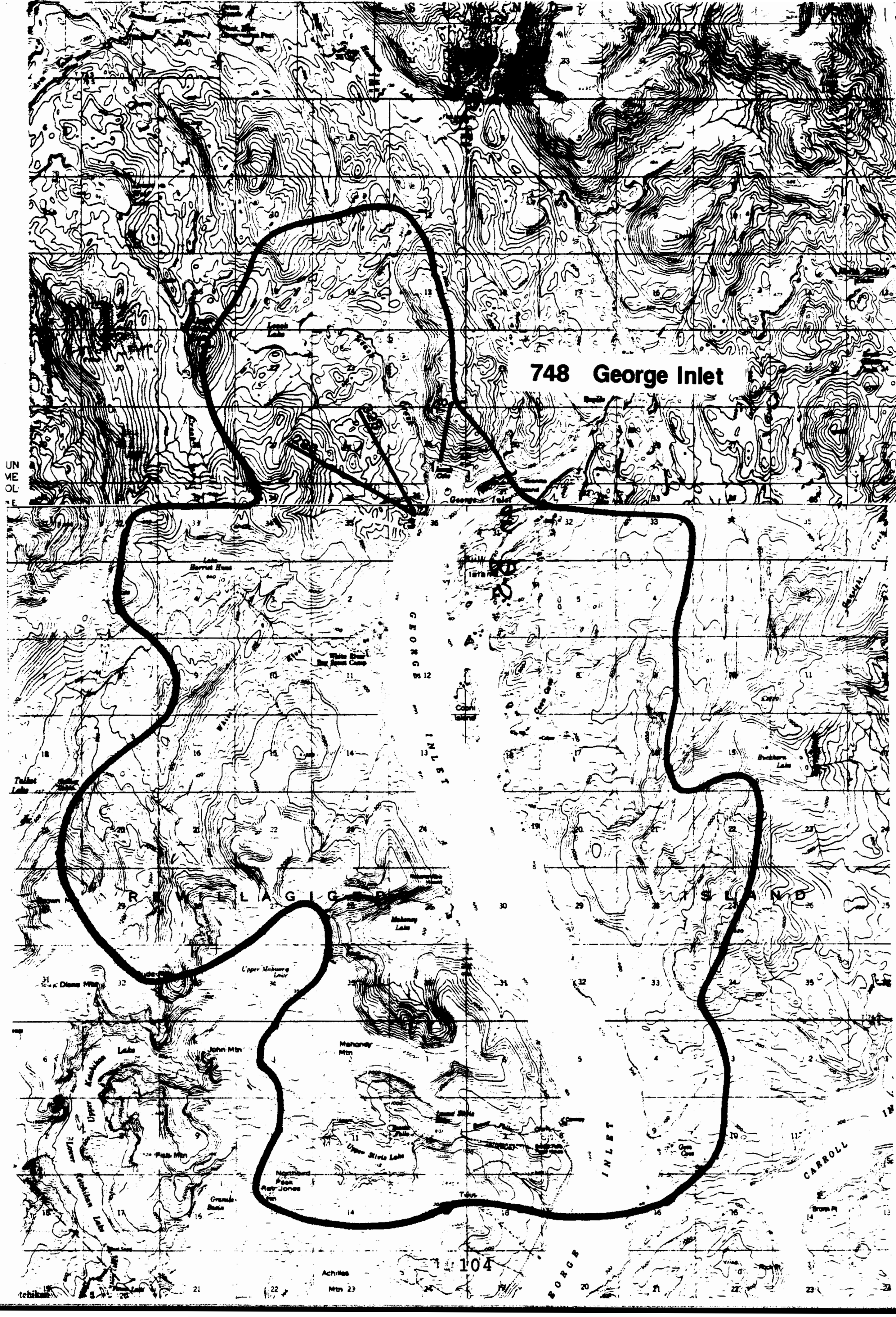

CRAIG (B-3) QUADRANGLE
ALASKA
63 360 SERIES TOPOGRAPHIC
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
(CRAIG C-3)
Harris Peak
Harris
River
Cat Island
Althouse Pt
TWELVEMILE
ARM
Indian
OF WALES ISLAND
PRINCE
3
138
284
2
295
1
621 12 Mile
Portage Bay
INLET

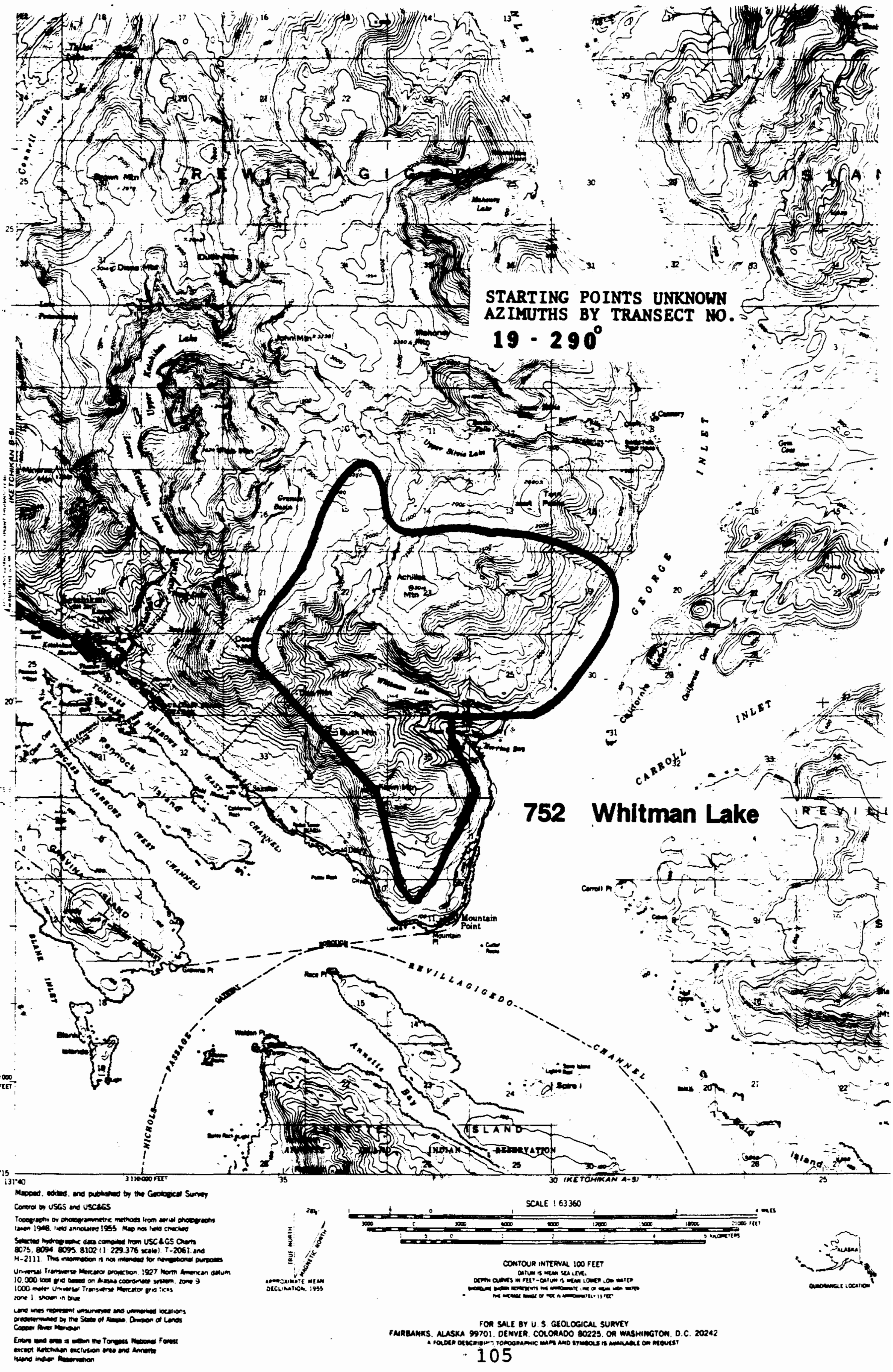


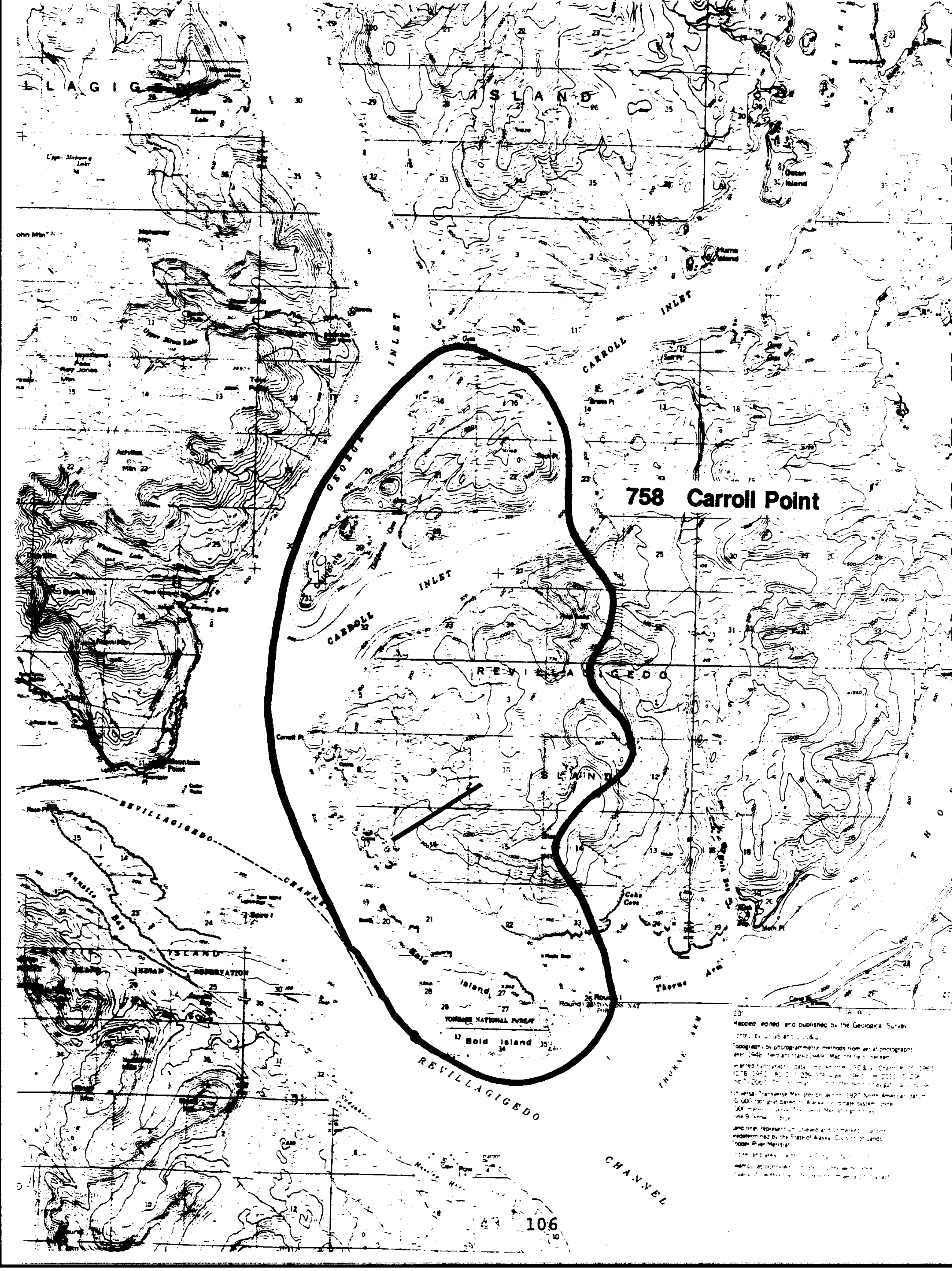
CRAIG (C-1) QUADRANG
ALASKA
UNITED STATES
ARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
280
3
272
2
290
1
Smugglers Lake
Helm Bay
Mike Pt
Tatoosh Pt
715 Smugglers

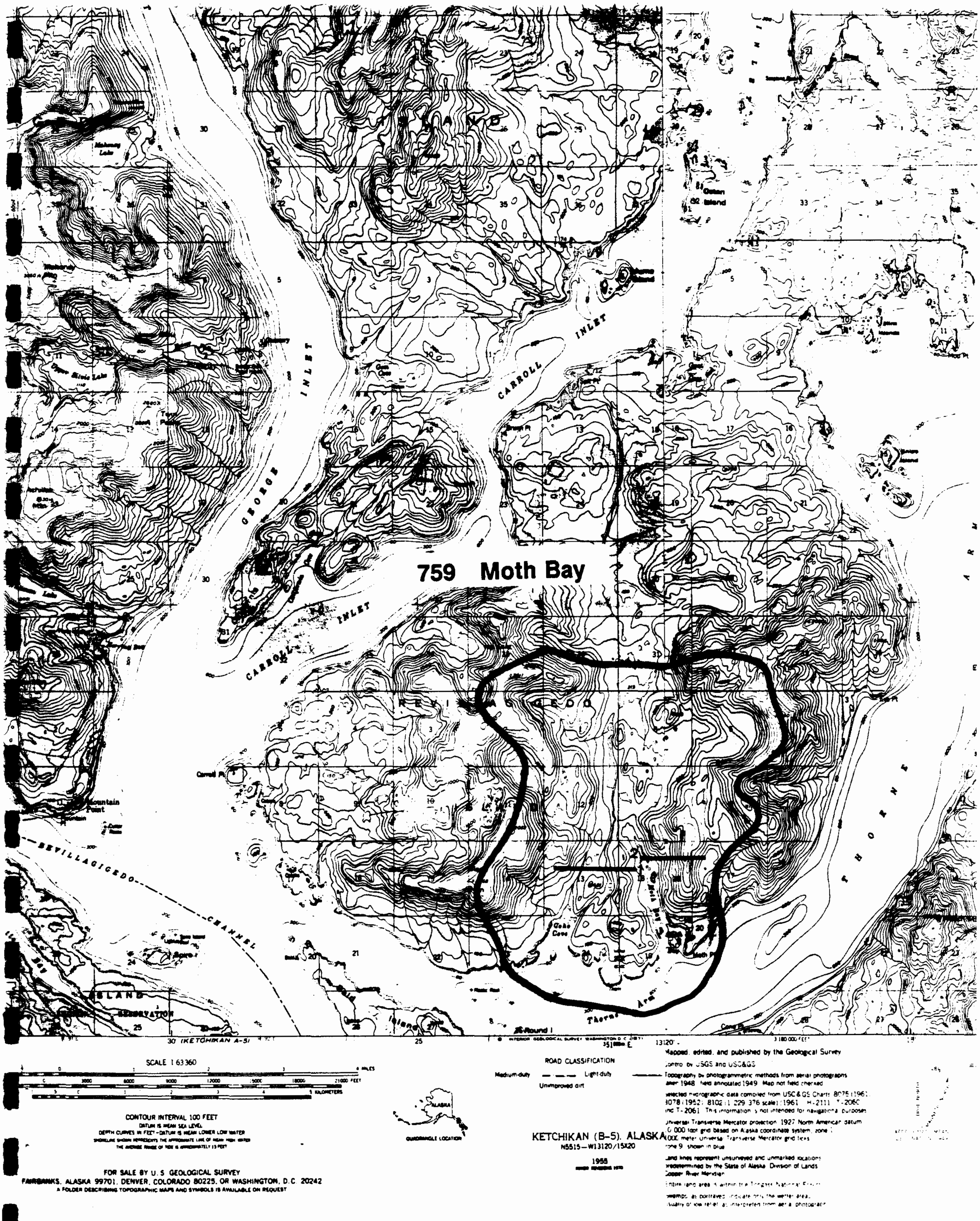

CRAIG (C-1) QUADRANGLE
ALASKA
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
716 Helm Bay
Helm Bay
Starting Points Unknown
Azimuths by Transect No.
1 - 058
2 - 041
3 - 014
4 - 020
5 - 017
6 - 010
7 - 331
8 - 196
9 - 150
10 - 200
11 - 216
12 - 208
13 - 026
14 - 340


738 Margaret
NEETS BAY
BAY
NEETS
Hackman Point
Bushy Point
KETCHIKAN GATEWAY BOROUGH
CANAL
COVE
Margaret Lake
Naha Bay
Indian Point
Escape Point
Cedar Island
Moser Island
Cod Point
Jordan Lake
Dogfish Island

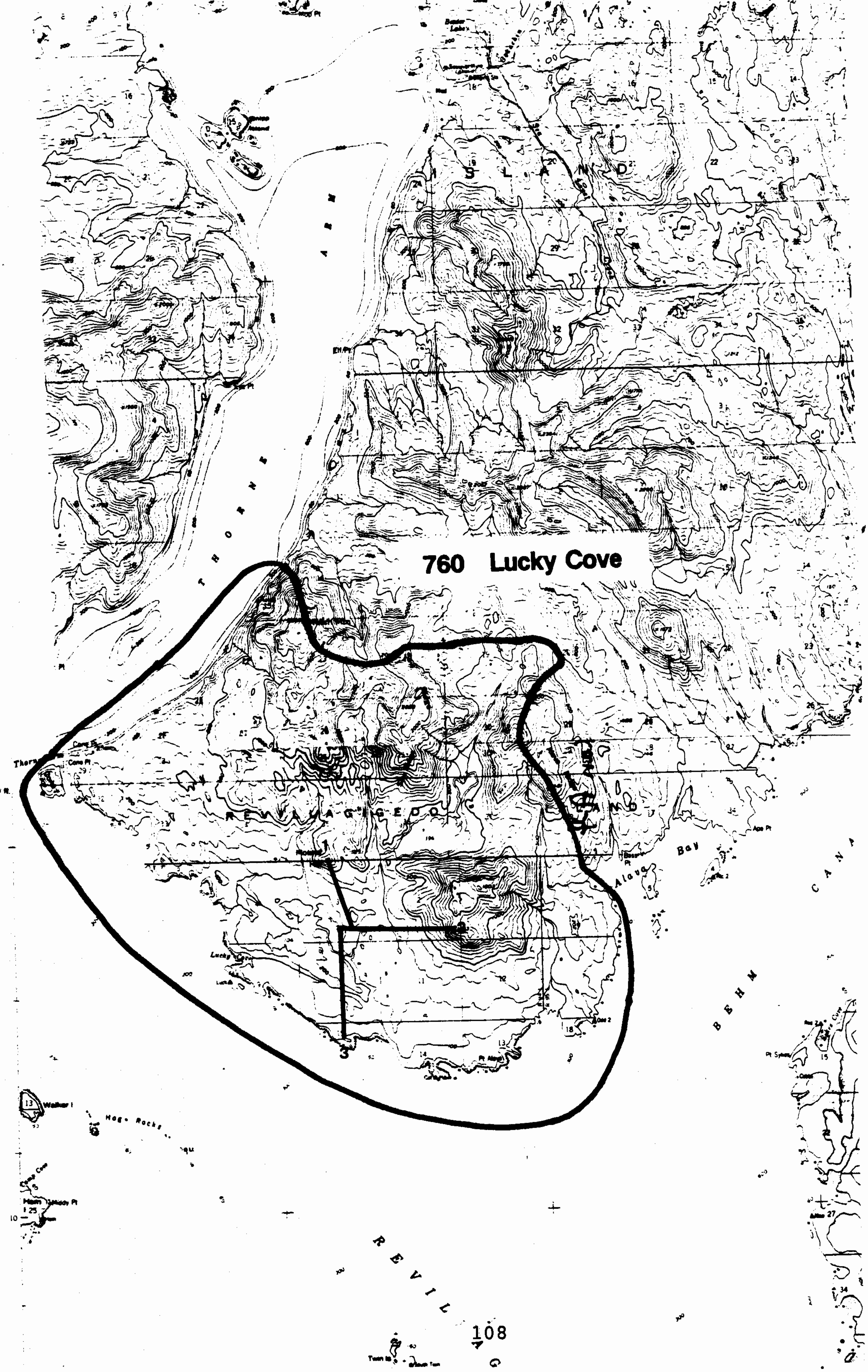

748 George Inlet
George Inlet
GEORGE INLET
INLET
Lake Harriet Hunt
White River Boy Scout Camp
Mahoney Lake
Upper Mahoney Lake
Mahoney Mtn
John Mtn
Upper Silvis Lake
CARROLL
Buckhorn Lake
Achilles Mtn


STARTING POINTS UNKNOWN
AZIMUTHS BY TRANSECT NO.
19 - 290°
752 Whitman Lake
GEORGE INLET
CARROLL INLET
REVILLAGIGEDO CHANNEL
Mountain Point
SCALE 1:63 360
CONTOUR INTERVAL 100 FEET
FOR SALE BY U. S. GEOLOGICAL SURVEY
FAIRBANKS, ALASKA 99701, DENVER, COLORADO 80225, OR WASHINGTON, D.C. 20242

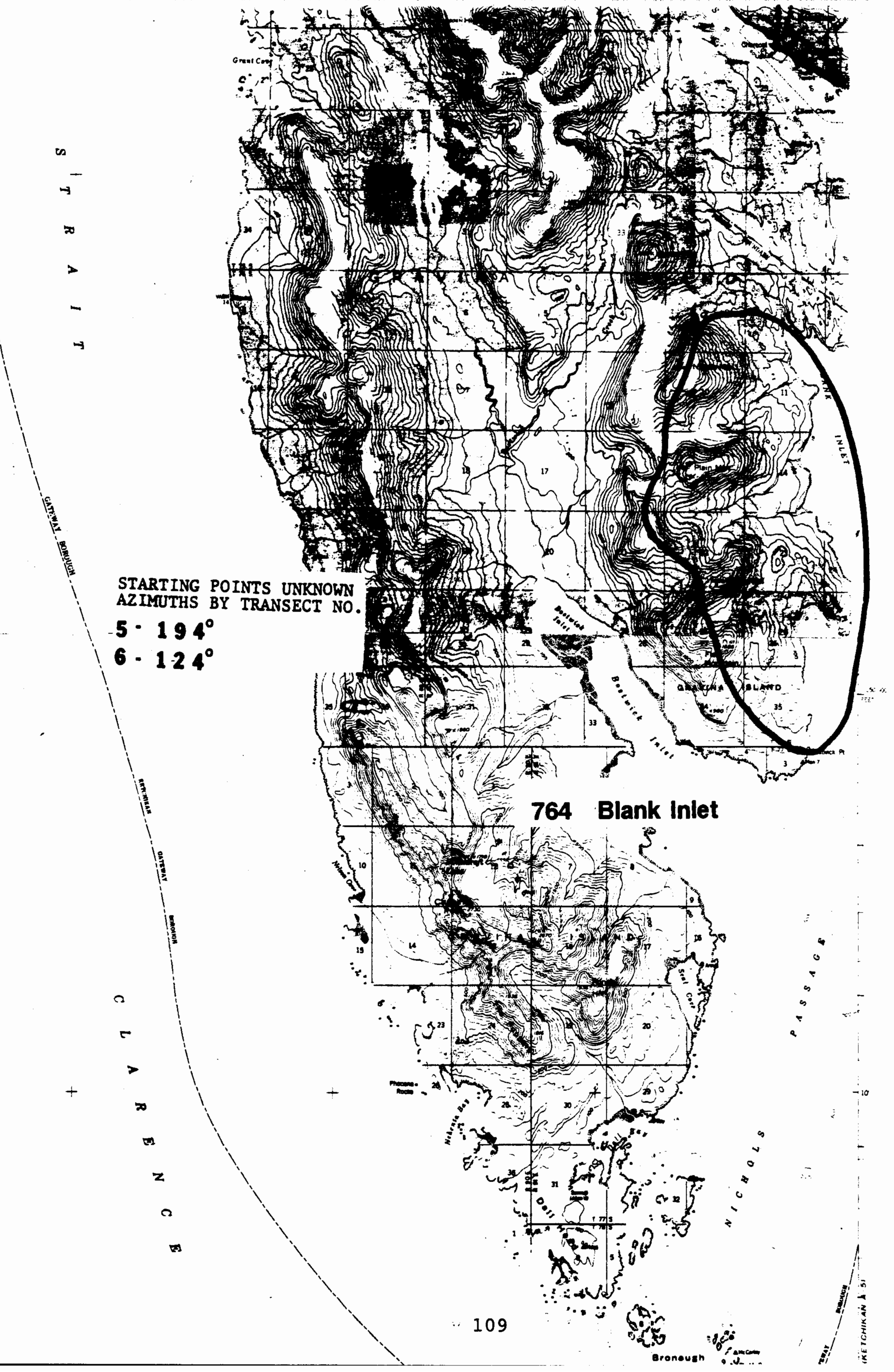

758 Carroll Point
CARROLL INLET
GEORGE INLET
REVILLAGIGEDO CHANNEL
REVILLAGIGEDO ISLAND
Carroll Pt
Bold Island
TONGASS NATIONAL FOREST
Hume Island
Thorne Arm
Upper Silvis Lake
Mapped, edited, and published by the Geological Survey



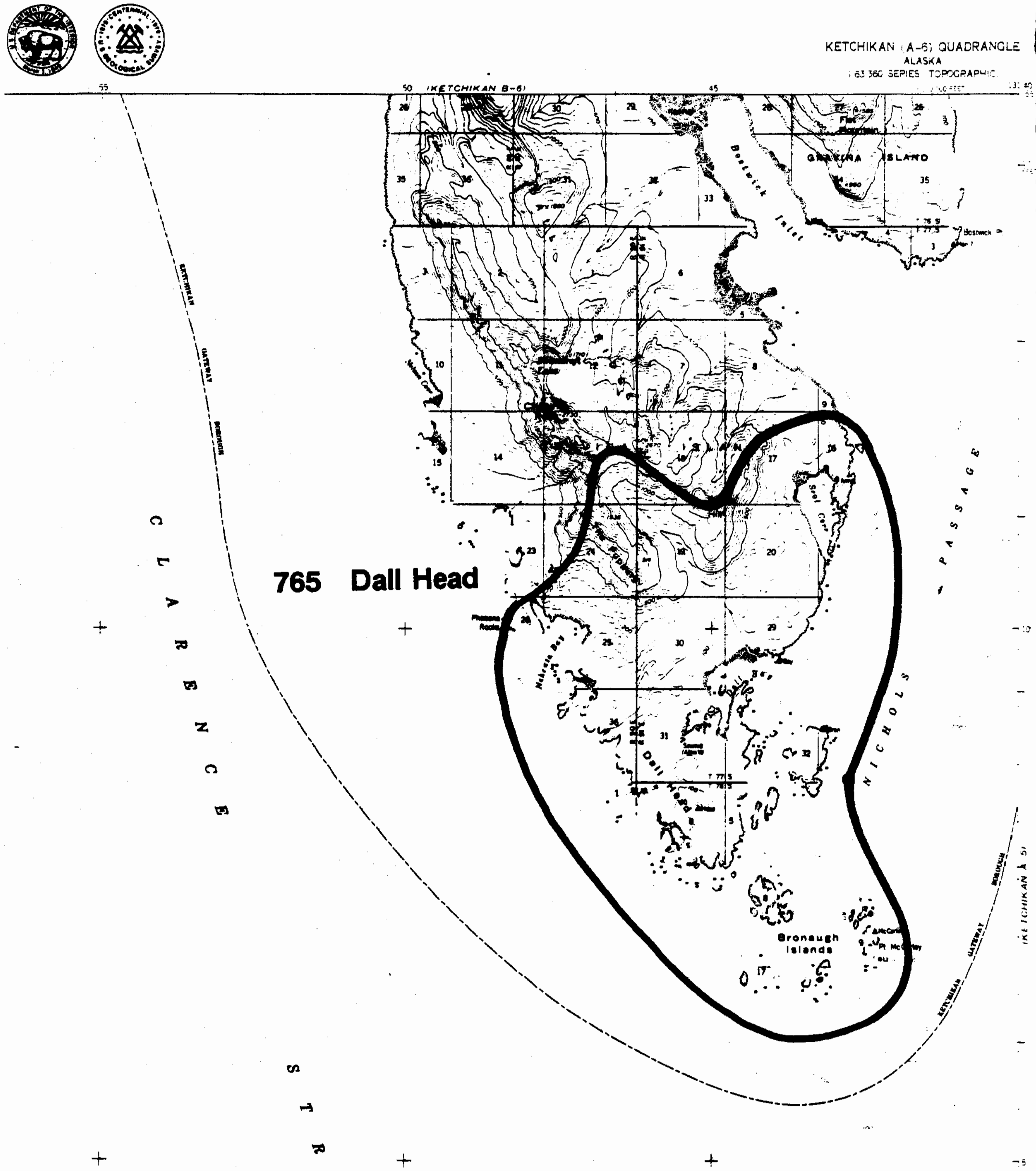
759 Moth Bay
GEORGE INLET
CARROLL INLET
REVILLAGIGEDO
REVILLAGIGEDO CHANNEL
THORNE ARM
Carroll Pt
Mountain Point
30 (KETCHIKAN A-5)
SCALE 1 63 360
ROAD CLASSIFICATION
Medium-duty
Light-duty
Unimproved dirt
CONTOUR INTERVAL 100 FEET
DATUM IS MEAN SEA LEVEL
DEPTH CURVES IN FEET—DATUM IS MEAN LOWER LOW WATER
QUADRANGLE LOCATION
FOR SALE BY U.S. GEOLOGICAL SURVEY
FAIRBANKS, ALASKA 99701, DENVER, COLORADO 80225, OR WASHINGTON, D.C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
KETCHIKAN (B-5), ALASKA
N5515—W13120/15X20
1955
Mapped, edited, and published by the Geological Survey
Topography by photogrammetric methods from aerial photographs
field annotated 1949 Map not field checked
Universal Transverse Mercator projection 1927 North American datum



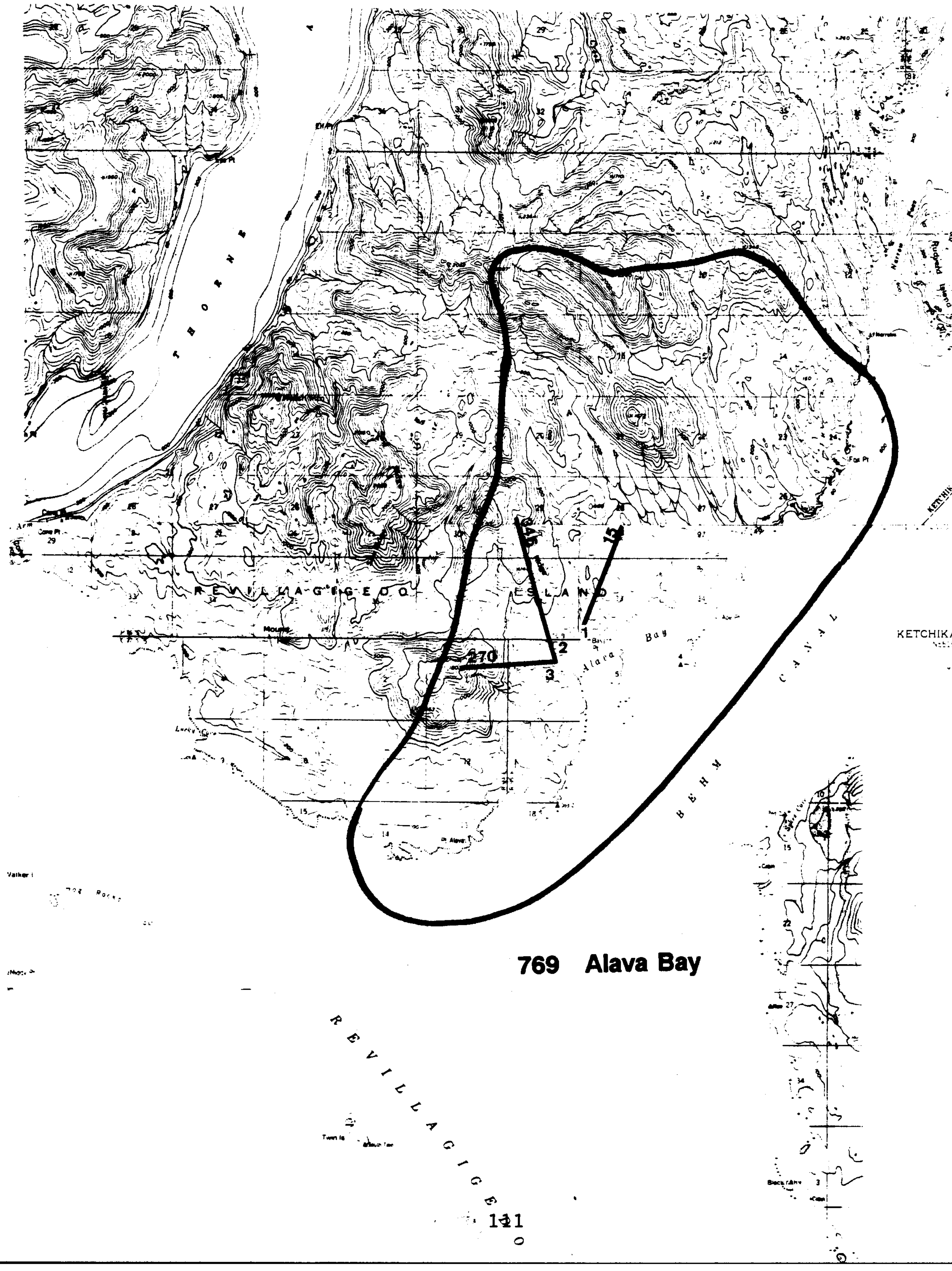
760 Lucky Cove
Lucky Cove
Walker I
Hog Rocks
Alava Bay



STARTING POINTS UNKNOWN
AZIMUTHS BY TRANSECT NO.
5 - 194°
6 - 124°



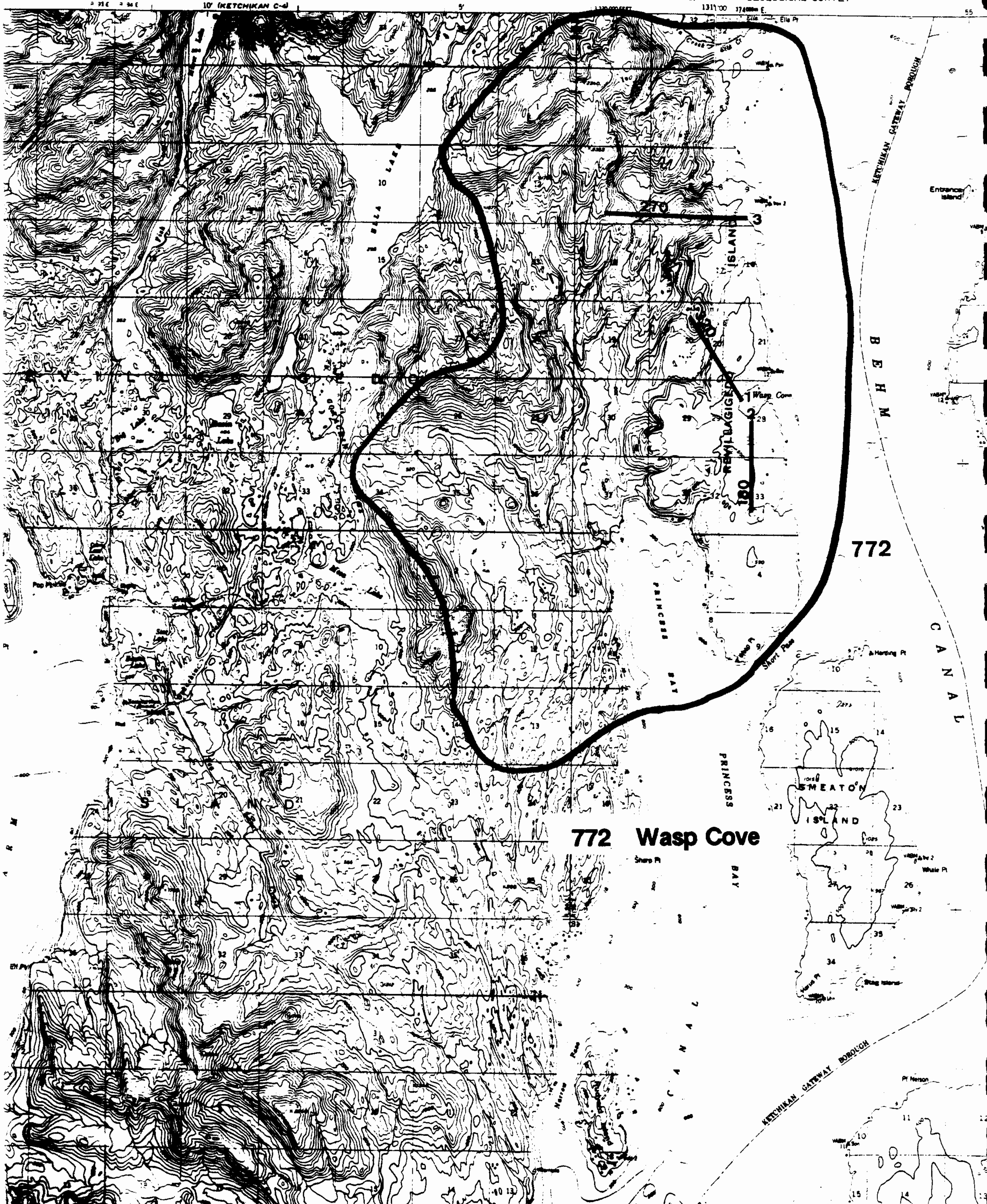
STARTING POINTS UNKNOWN
AZIMUTHS BY TRANSECT NO.
13 - 35°

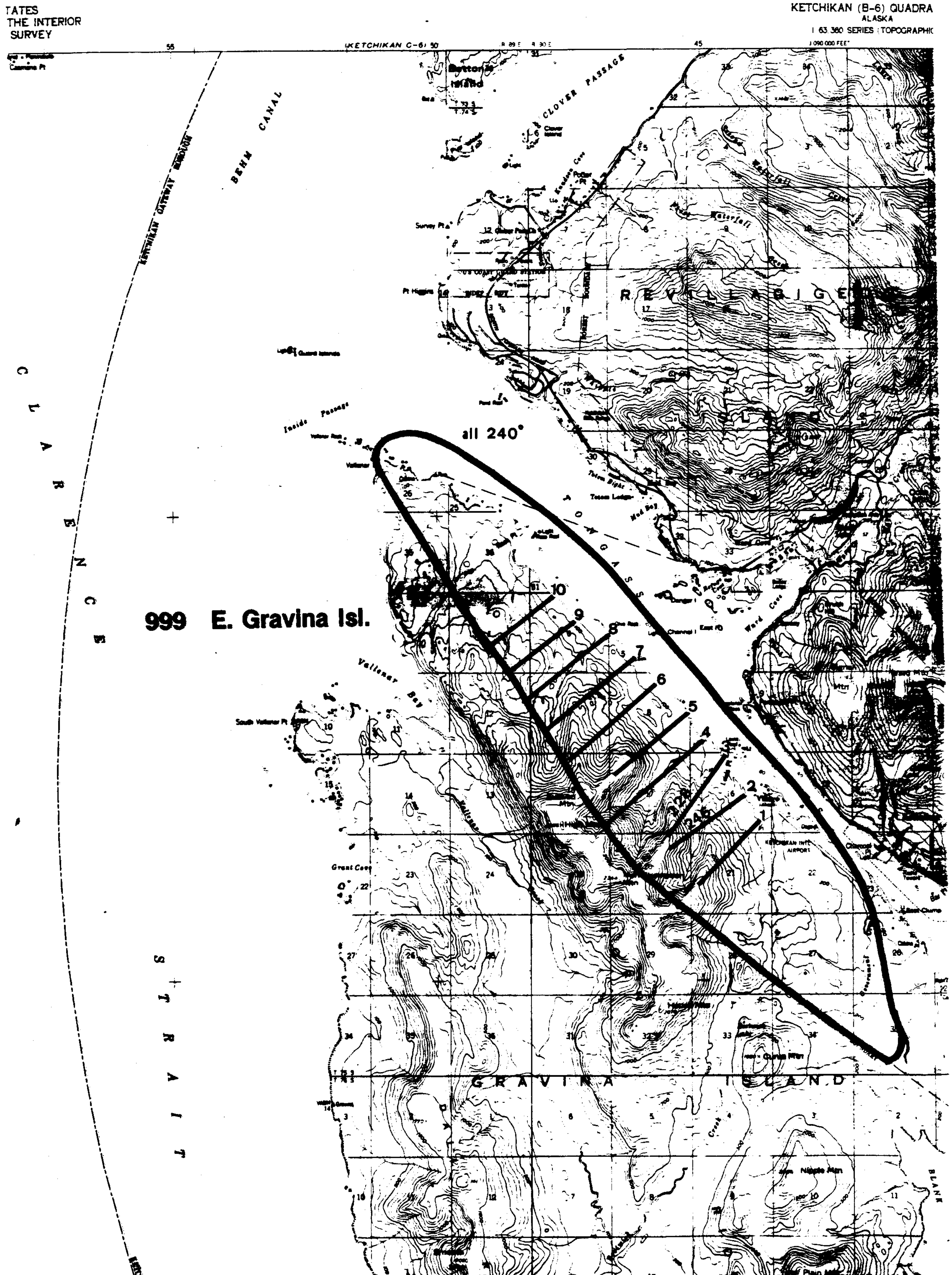


769 Alava Bay

KETCHIKAN (B-4) QUADRANGLE
ALASKA
1:63 360 SERIES (TOPOGRAPHIC)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY




TATES
THE INTERIOR
SURVEY
KETCHIKAN (B-6) QUADRA
ALASKA
all 240°
999 E. Gravina Isl.
10
9
8
7
6
5
4
3
2
1
BEHM CANAL
CLOVER PASSAGE
Inside Passage
Vallenar Bay
C L A R E N C E
S T R A I T
G R A V I N A   I S L A N D
KETCHIKAN INTL AIRPORT