SEA OTTER STUDIES - 1970

by Karl Schneider
March, 1971

This report is a compilation of rough reports from the marine mammals staff files. It summarizes most of the work accomplished on sea otters during 1970. The analysis of much of the data is incomplete and many of the conclusions are tentative. This report is intended to present the data collected in a useful form and to indicate the progress and stage of thinking at the time it was prepared. It is intended for staff use only.

The contents of the report are as follows:

AERIAL COUNT OF SEA OTTERS - SOUTH SIDE OF THE ALASKA PENINSULA

March, 1970

Between March 16, and March 27, 1970, an aerial count of sea otters was made along the south side of the Alaska Peninsula from Shaw Island to Cape Lazaref on Unimak Island. Sanak Island, the Sandman Reefs, the Pavlof Islands, northern Shumagin Islands and Sutwick Island were included. A BLM Aero Commander N6392U was flown by Cal Ward at an altitude averaging 150 feet and an airspeed of 100 mph. Observers were Karl Schneider next to the pilot and Jim Faro behind the pilot. This is the same technique, aircraft, pilot and observers as were used in the 1969 Aleutian count. The count on March 27, was made in a Gruman Goose with Robert Wolfe substituting for Faro. Pups with their mothers were not counted.
Total Flying Time 26 hrs 35 min

Because of conditions of visibility and distribution of animals all of the counts made are considered to be low.

In general, the variability in factors influencing this type of count is so great that the results are not reliable for population estimates or for determining short-term fluctuations in dense populations. However, aerial counts should be useful to determine general distribution and abundance and to follow large changes in population size. Such changes are occurring where relatively dense populations are expanding into habitat that is either unoccupied or sparsely occupied. Aerial counts are also the quickest way to familiarize new personnel with large areas of habitat.

The following is a list of definitions of terms used to describe counting conditions. Application of these terms is completely subjective and based on the writer's experience.

Excellent - Surface of water relatively calm. Usually overcast with little surface glare. Single animals easy to spot at a distance.

Very good - Surface may be slightly choppy, but not enough confusing reflection to prevent spotting of animals off shore.

Good - Off shore animals may be difficult to spot but single animals near shore and in kelp beds and small pods everywhere are readily spotted.

Fair - Usually choppy or surface glare. Single animals in kelp beds or in the lee of rocks or shore and most groups of animals relatively easy to see. Other single animals and some pods in deep bays, in the shadow of cliffs or off shore may be missed.

Poor - Single animals difficult to spot and many pods may be missed, but conditions still good enough to get a rough idea of the distribution of animals.

The conditions encountered for each area are listed below.

Description of Conditions During March, 1970, Aerial Count of Sea Otters

March 20: Aniakchak Bay to Chignik Lagoon (10:22 AM - 12:40 PM). Conditions were generally fair with a heavy chop. The south side of Sutwick Island and the area between the island and mainland were poor with heavy surf. Visibility was very good inside Kujulik Bay, however many animals were scattered throughout the area. On two passes across the bay, 12 and 27 were seen, therefore many were probably missed. Similar scattering occured in Chignik Bay. The overall count for the area is probably low.

Pavlof Bay to Cold Bay (1:30 PM - 2:00 PM). Conditions poor with heavy chop and squalls. The count was superficial, however a second superficial count of this area was made on March 21, and only one otter was seen in Cold Bay.

Cold Bay to Cape Lazaref (3:10 PM - 4:20 PM). Conditions very poor, fair in a few spots. Heavy chop, dense kelp.

March 21: Northern Shumagin Islands (9:43 AM - 11:37 AM). Poor, with chop on windward sides. Fair on leeward sides (westerly wind) however air turbulence forced us away from high cliffs. Heavy surf created very poor conditions on the south side of Unga.

Pavlof Islands (11:45 AM - 12:58 PM). Conditions similar to those in the Shumagins.

Chignik Lagoon to Pavlof Bay (3:05 PM - 5:35 PM). Conditions varying from fair to poor with chop and surface glare. Count concentrated on points and better looking areas. Most deep bays not completely surveyed.

March 22: Sanak Islands (8:49 AM - 10:20 AM). Conditions fair to poor with chop on south side and surface glare on north side. Animals scattered and very difficult to see. Many otters on rocks. Count is probably very low.

Sandman Reefs (10:25 AM - 11:15 AM). Conditions similar to Sanak. With the exception of one pod of 450+, the animals were widely scattered and very difficult to pick out. Only those very close to the aircraft could be seen. Bad squalls moved in and the wind increased preventing a complete count of Deer Island and the eastern half of the reefs.

March 23: Wide Bay to Aniakchak Bay (11:23 AM - 1:40 PM). Conditions generally good at first becoming fair after Cape Providence with a light chop and some surface glare. Otters in Amber and Aniakchak Bays were widely scattered and many may have been missed.

Port Heiden to Naknek. Superficial counts were made from Ugashik Bay to Naknek on March 19, and from Port Heiden to Egegik on March 23. These were made under poor conditions by flying outside the surf line. The water was choppy and full of silt. No sea otters were seen.

March 27: Shaw Island to Puale Bay (10:30 AM - 12:05 PM). Conditions very good to excellent. High overcast and very little wind down to Katmai Bay. After this the conditions deteriorated rapidly to fair and the count had to be stopped because of a combination of bad weather and lack of fuel. As shown on the charts, the count was concentrated on the points and islands, however the good visibility allowed us to see well into the bays. We feel certain no concentrations were missed.

The numbers of sea otters counted are presented in the Table. Specific locations and numbers are shown on the charts. Where coverage of an area was not complete the approximate path of the aircraft is shown.

Discussion of Results

Surveys along the Alaska Peninsula have been fragmentary and most of those made were done under less than ideal conditions. There are a number of reasons for this. Weather tends to be poor along the south shore where squalls form along the mountains. Areas where an aircraft can refuel are north of the mountains and there are relatively few passes, therefore range of the aircraft is a problem. Also there is much shallow water off shore in the area from the Shumagin Islands to Sanak Island. Coverage of this area is difficult and many animals are undoubtably missed.

The present survey covered most of the area, however conditions were such that most of the counts are probably quite low. Despite these problems and a lack of continuity we have a fairly good picture of the recovery of sea otter populations in this area.

Reports from various individuals are available from the 1930's and 1940's. Major surveys by the Fish and Wildlife Service in 1951 (Jones), 1957 (Lensink), 1962 and 1965 (Kenyon and Spencer) covered at least portions of the area. In 1969, the southern Shumagin Islands were counted by the Alaska Department of Fish and Game and the present survey covered most of the rest of the area.

Basically there are four distinct population nuclei in the area. These centered around the Sanak Island-Sandman Reef area, the Shumagin Island area, the Sutwick Island area and the Augustine Island-Cape Douglas area. The following discussion is based on information from reports by Lensink and Kenyon and from Alaska Department of Fish and Game surveys.

Sanak Island-Sandman Reefs

Small numbers of sea otters have been reported at Sanak Island since 1922. No reports came from the Sandman Reefs until 1942. In 1948, 27 were sighted at Cherni Island. The 1951 aerial survey showed 65 around Sanak and 97 in the Sandman Reefs. In 1957, 251 were seen around Sanak and 508 around the Sandman Reefs. In addition, two were seen in the Pavlof Islands however few were on the mainland. In 1962, 548 were counted in the Sanak area and 638 in the Sandman Reefs. None were reported from the mainland or Pavlof Islands however, much of the increase was in the northern area around Deer Island. The 1962 survey was probably the best, being made under excellent conditions.

AERIAL COUNT OF SEA OTTERS - MARCH, 1970

Location	Count	Date	Partial or Complete Count	Visibility
Cape Lazaref - Cold Bay				
Cape Lazaref	3	3/20	Complete	Poor
Ikatan Peninsula	71	3/20	Complete	Poor
False Pass - Amagat I.	66	3/20	Complete	Poor
Cold Bay	1	3/21	Partial	Poor
TOTAL	141			
Sanak Islands	239	3/22	Complete	Fair to Poor
Sandman Reefs				
Clubbing Rocks	12	3/22	Complete	Fair to Poor
Cherni I. & Rocks	495+	3/22	Complete	Fair to Poor
Goose I.	7	3/22	Complete	Fair to Poor
Hay I.	18	3/22	Complete	Fair to Poor
Hunt I.	2	3/22	Complete	Fair to Poor
Deer I.	34	3/22	Partial	Fair to Poor
TOTAL	568+			
Pavlof Islands				
Inner Iliasik	2	3/21	Complete	Fair to Poor
Outer Iliasik	16	3/21	Complete	Fair to Poor
Goloi	2	3/21	Complete	Fair to Poor
Dolgoi	67	3/21	Complete	Fair to Poor
Poperechnoi	29	3/21	Complete	Fair to Poor
Ukolnoi	2	3/21	Complete	Fair to Poor
Wosnesenski	4	3/21	Complete	Fair to Poor
TOTAL	122			

Location	Count	Date	Partial or Complete Count	Visibility
Northern Shumagin Islands				
Unga	184	3/21	Complete	Fair to Poor
Popof	52	3/21	Complete	Fair to Poor
Korovin	46	3/21	Complete	Fair to Poor
Karpa	4	3/21	Complete	Fair to Poor
TOTAL	286			
Cold Bay to Beaver Bay	0	3/20-21	Partial	Poor
Beaver Bay to Kupreanof Pen.				
Beaver Bay	2	3/21	Partial	Fair to Poor
Cape Aliaksin	4	3/21	Partial	Fair to Poor
Guillemot I.	16	3/21	Partial	Fair to Poor
Kupreanof Peninsula	1	3/21	Partial	Fair to Poor
TOTAL	23			
Kupreanof Pen. to Castle Cape	0	3/21	Partial	Fair to Poor
Castle Cape to ~~Wide~~ Amber Bay				
Castle Cape-Castle Bay	16	3/21	Partial	Fair to Poor
Chignik Bay	118	3/20	Complete	Fair
Nakchamik I.	5	3/20	Complete	Fair
Hook Bay	13	3/20	Complete	Fair
Cape Kumliun	88	3/20	Complete	Fair
Kujulik Bay	1,199	3/20	Complete	Very Good
Univikshak I.	62	3/20	Complete	Fair
Cape Kumlik	54	3/20	Complete	Fair to Poor
Sutwick I.	14	3/20	Complete	Fair to Poor
Cape Agutka	197	3/23	Complete	Fair
TOTAL	1,766			

Location	Count	Date	Partial or Complete Count	Visibility
Cape Kunmik to ~~Wide Bay~~ C. Kubugakli				
Cape Kunmik	13	3/23	Complete	Fair
Nakalikok Bay & offshore islands	16	3/23	Complete	Fair
Chiginagak Bay	5	3/23	Complete	Fair
Agripina & Imuya Bay	105	3/23	Complete	Good
Wide Bay to Puale Bay	NOT	SURVEYED		
Puale Bay to C. Kubugakli	7	3/27	Partial	Fair
TOTAL	146			
Kashvik Bay to C. Chiniak	0	3/27	Partial	Very Good to Excellent
Cape Chiniak to Shaw I.				
Shakun Is. & Rocks	71	3/27	Partial	Very Good to Excellent
Kiukpalik I. to Shaw I.	0	3/27	Partial	Very Good to Excellent
TOTAL	71			

In the present survey, which was made under relatively poor conditions, 239 were seen in the Sanak area and 568+ in the Sandman Reefs. The latter count was incomplete and conditions were such that the number of otters was more a function of time spent counting rather than area covered. Obviously many were missed. As a result, not much can be said about total numbers. The main change evident is that 141 were seen along the mainland and eastern portion of Unimak Island and 122 were seen in the Pavlof Islands. This indicates that a fairly extensive movement northward and along the Peninsula is occuring.

A remnant population probably remained along the south side of Sanak Island in the early 1900's. By the late 1940's they began spreading into the Sandman Reefs. This northward expansion has continued to the present time. There is still unoccupied or sparsely populated habitat along the mainland shore and in the Pavlof Islands. There should be continued expansion of this population for a number of years although the numbers around Sanak Island and the western Sandman Reefs may have already reached a peak.

With the arrival of substantial numbers in the Pavlof Islands, this population is probably on the verge of mixing with the Shumagin Island population. No doubt some individuals have moved back and forth in the past, but the two populations are almost continuous at the present time.

As in past surveys, few otters were seen around the north side of Sanak Island and Caton Island. This is probably poor habitat for otters. The main population is around the south and west sides. The higher count on the west end is probably more a result of intensive searching rather than a higher population.

Shumagin Islands

This has been considered the largest of the four populations in the Alaska Peninsula area. The most recent counts have not been adequate enough to show any major increase in numbers in the last decade, however major changes in distribution have occured which are very similar to the pattern mentioned in the Sanak-Sandman population.

There were occasional reports of sea otters in the Shumagins in the 1930's. By 1947, Victor Scheffer estimated that 500 lived around Simeonof Island. In 1953, Hooper counted 633 around Simeonof and Little Koniuji Island. The 1957 survey showed 1,829. Most of these were in the southern islands. Five individuals were scattered in the northern islands and one was on the mainland shore near Elephant Point. The 1962 survey totaled only 1,352. The animals were scattered well off shore and the count was low. However the count on Nagai increased from 149 to 338 indicating a continued northward expansion.

In 1969, 1,510 were counted in the southern islands under relatively poor conditions. An additional 286 were counted in the northern islands in the present survey and 23 were seen along the mainland north of the Shumagins. Again survey conditions were not good.

There is a very clear expansion of the population from a center near Simeonof. Substantial numbers now occur on all the islands and repopulation of the mainland is occuring. The population in the northern islands should continue to increase and most of the habitat on the mainland is not occupied.

There is no evidence of an increase in total numbers since 1957. However, the last two surveys have been less than ideal and the large shallow off shore areas have not been covered adequately. Considering the survey conditions and the obvious extentions of range it is almost certain that the populations from Sanak Island to the Shumagins have continued to increase. In general, it appears that the southern islands and reefs have become fully populated and the northern areas are just developing significant populations. The entire area may be completely repopulated in the next 10 years. This will depend largely on the status and potential of the off-shore areas.

Sutwick Area

Reports of sea otters near Sutwick Island are available since 1936. This population was far removed from other populations and is probably a remnant left after hunting ceased. In 1951, Jones counted 388 between Cape Kumliun and Cape Kunmik. Most were near Sutwick Island. In 1957, 889 were counted. Nineteen of these were between Cape Kunmik and Cape Providence indicating some northeastward expansion. In 1962, 949 were seen with individuals straying as far as Cape Igvak and one between there and Cape Kuliak. In 1965, a stray otter was seen at Kinak Bay. A major shift in the population from Sutwick into Kujulik Bay occured. This may be the result of time of year and weather.

In the present survey 1,766 were counted between Castle Cape and Cape Kunmik. Again, the majority were in Kujulik Bay. Large numbers have moved ~~southwestward~~ northeastward ranging as far as Cape Kubugakli. The area from Wide Bay to Puale Bay was not surveyed because of weather.

The total count for the population was 1,912 even though conditions were less than ideal throughout the count and we feel many were missed. It is possible that the increase in numbers is entirely due to reproduction assuming a 10 percent annual increase. However it is difficult to compare surveys.

There is still room for expansion in both directions from this population. The greater movement to the northeast is probably the result of better habitat. The population around Kujulik Bay is very dense and a large movement of animals may occur if competition for food becomes serious. Otherwise we should expect to see continued steady expansion into adjacent areas for a number of years to come.

Augustine Island-Cape Douglas

For some time, a population has existed around the Augustine Island area at the mouth of Cook Inlet. In 1948, approximately 50 sea otters were reported from Augustine Island. Reports of sightings have been made from Shaw Island to Tuxedni Bay. In 1957, Spencer counted 40 at Augustine and one at Shaw Island. Lensink counted 52 on Augustine in 1959, but he considered it a poor count. In 1965, Kenyon counted 18 on Augustine and 101 in the Shaw Island-Cape Douglas area. In March of 1969, Loren Flag saw 62 around Augustine and in May 1969, Jim Faro counted 130 another observer saw about 30 some of which were probably not tallied by Faro.

On the present survey, Augustine Island could not be surveyed because of weather. No otters were seen around Cape Douglas but 71 were seen in Shakun Islands and rocks near the abandoned village of Kaguyak. These were probably from the Cape Douglas group.

It appears that the animals move about in the area. To date no complete survey of the area has been made at one time. Until this is done, little can be said about the population other than that several hundred probably occur there.

The following table is a summary of sightings and counts made by the U. S. Fish and Wildlife Service and the Alaska Department of Fish and Game. These data were collected by different individuals using different types of aircraft under varying conditions of weather. A strict comparison of numbers should not be made from this table.

SUMMARY OF SEA OTTER SURVEYS

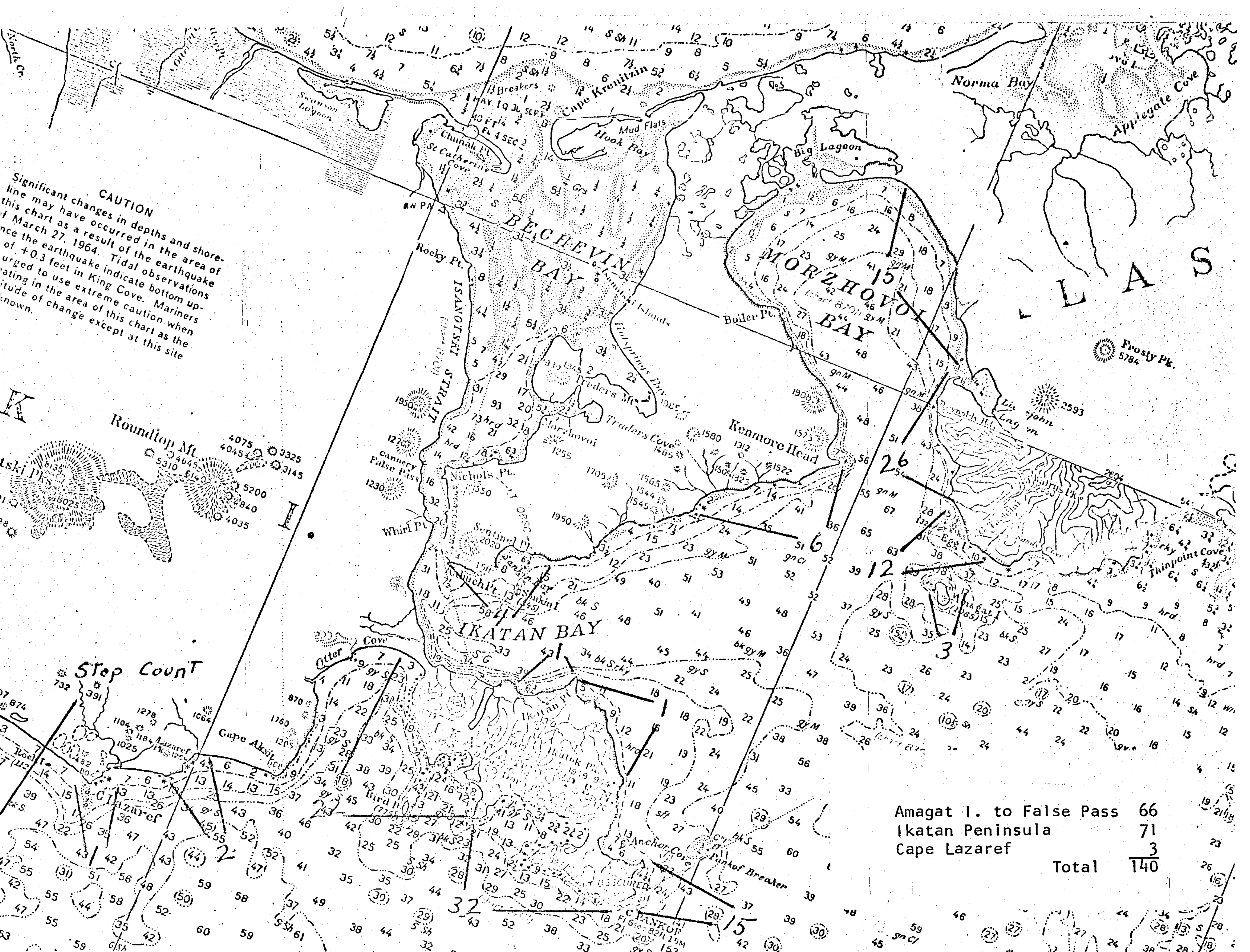
(Compiled by population from Lensink (1962 Thesis), Kenyon (1962 & 1965 Reports & Manuscript) and ADF&G Data.)

Location	Pre. 1951	1951	1957	1959	1962	1965	1969	1970
AUGUSTINE - C. DOUGLAS								
Augustine Island	Approximately 50 (1948)		40	52		18	130+	
Shaw I. & Douglas Area	Sightings from Shaw Is. to Tuxedni Bay		1	—		101	—	71
TOTAL			41	52		119	130+	71
ALASKA PENINSULA								
C. Kuliak - C. Igvak			0		1			7(+?)
C. Igvak - C. Kunmik			19		22			139
Aniakchak Bay & Amber Bay		8	6		47			197
Sutwick Area	Miscellaneous Reports	355	581		109			14
Kujulik Bay & C. Kumlik	Since 1936	12	103		684			1,253
C. Kumliun								101
Univikshak Island		13	180		86			62
Nakchamik Island					Not Surveyed			5

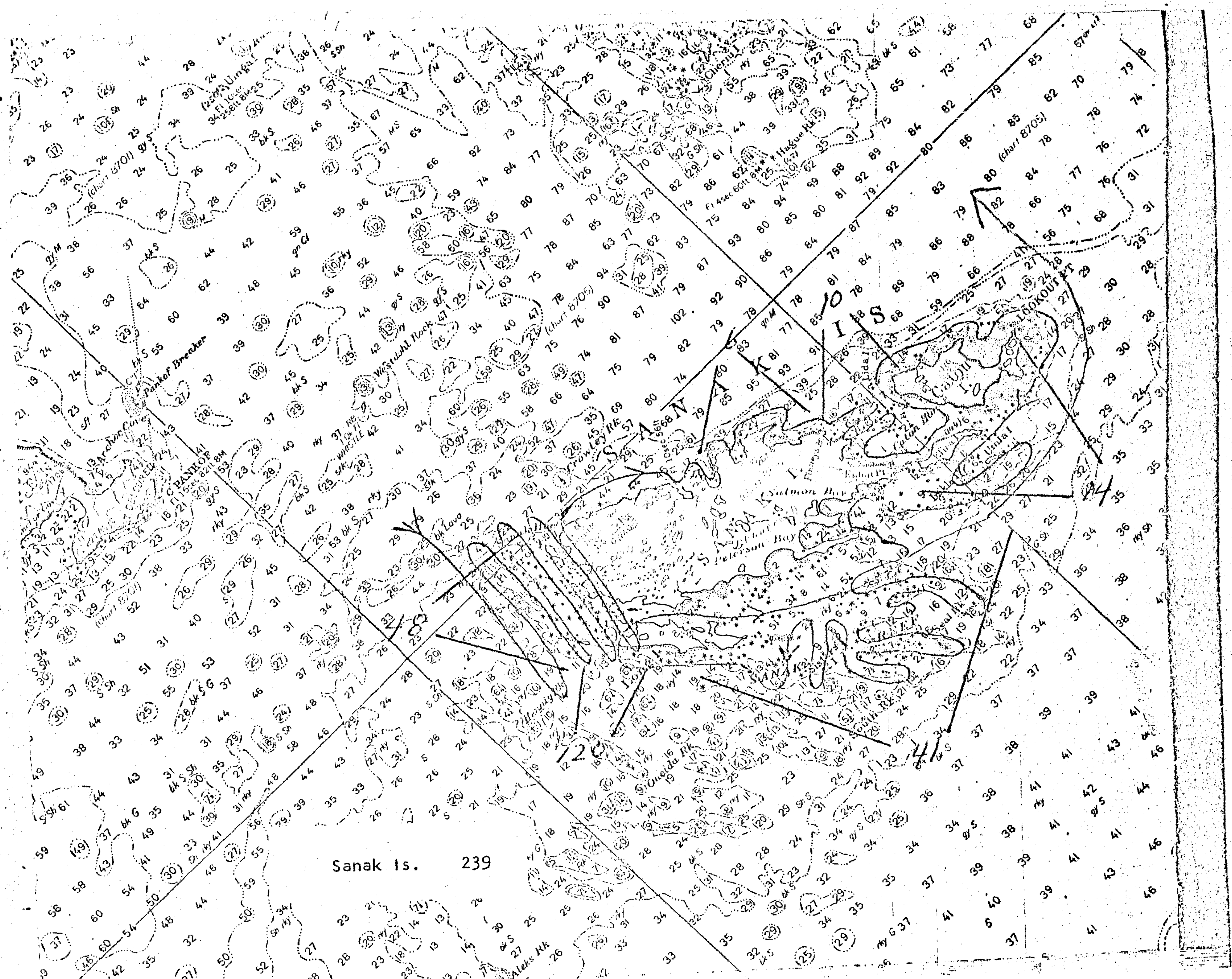
Location	Pre. 1951	1951	1957	1959	1962	1965	1969	1970
ALASKA PENINSULA (Cont.)								
Chignik Bay			0					118
Castle Bay & Cape								16
TOTAL		388	889		949			1,912
SHUMAGIN	Few Reports Before 1940							
Mainland Shore Kupreanof Pen. to Pavlof Bay			1					23
Unga Island			2		4			184
Popof Island			2					52
Korovin Island								46
Karpa Island								4
Andronica & the Haystacks			1				75	
Nagai			149		338		232	
Spectacle							8	
Bendel			268		105		27	
Turner							6	
Twins			7					

Location	Pre. 1951	1951	1957	1959	1962	1965	1969	1970
SHUMAGIN (Cont.)								
Near			3		14		150	
Peninsula			0		3		15	
Big Koniuji			220		222		296	
Little Koniuji & Atkins			430		255		290	
Simeonof	500 Estimate (1947)	633 (1953)	455		294		329	
Bird			160		38		76	
Chernabura			132		79		6	
TOTAL			1,830		1,352		1,510	309
SANAK - SANDMAN								
Mainland Shore Pavlof Bay to Unimak Bay								141
Pavlof Islands								
Wosnesenski Island			2					4
Ukolnoi Island								2
Poperechnoi Island								29
Dolgoi Island								67

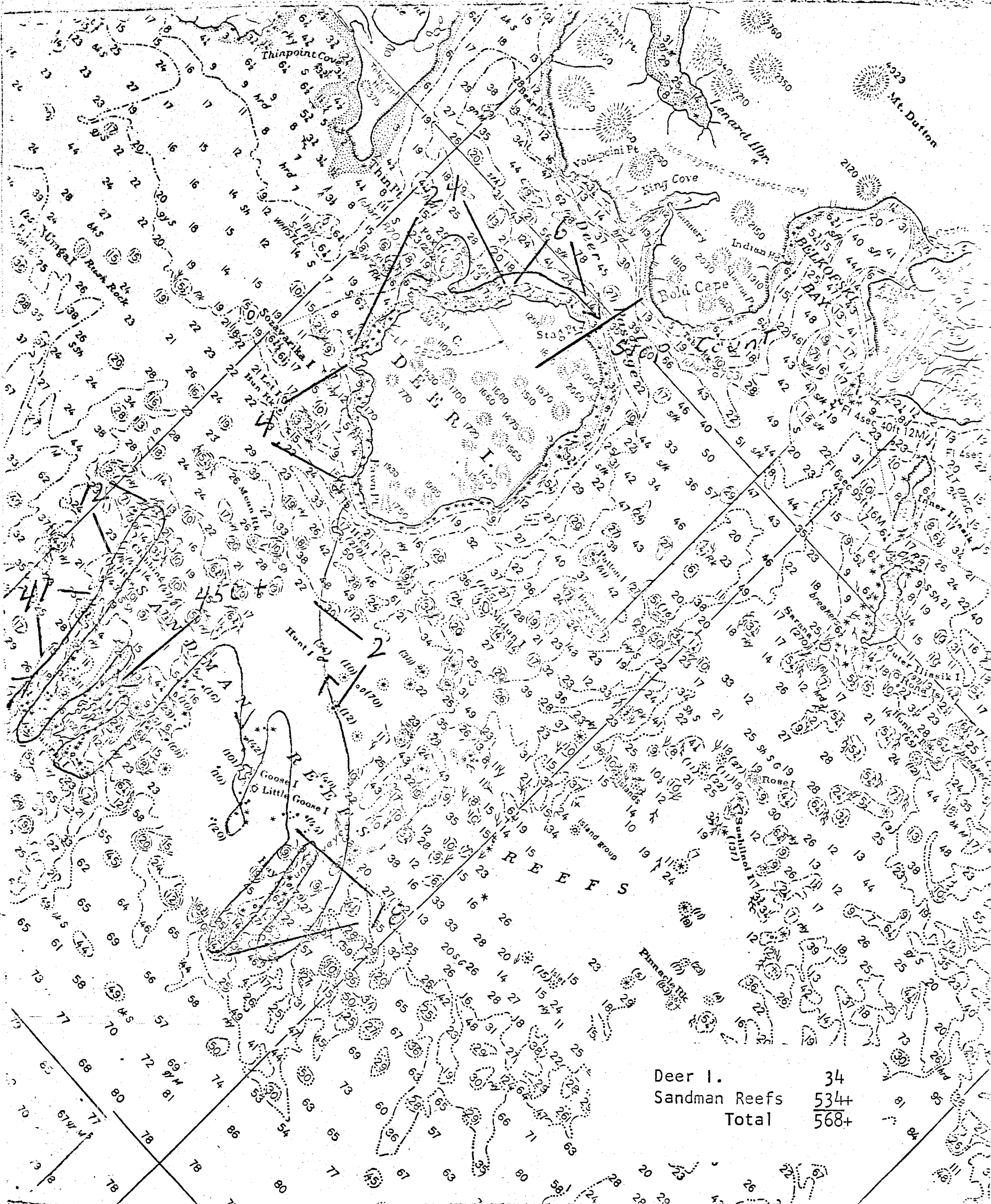
Location	Pre. 1951	1951	1957	1959	1962	1965	1969	1970
SANAK - SANDMAN (Cont.)								
Pavlof Islands (Cont.)								
Goloi Island								2
Outer Iliasik Island								16
Inner Iliasik Island								2
Sandman Reefs								
Cherni Island	27 (1948)		271		259			495+
Clubbing Rocks	No sightings before 1942	97	33		2			12
Goose Island			76		82			7
Deer Island & Other Reefs			123		295			54 (Incomplete)
Sanak Island	Sightings since 1922	65	251		548			239
TOTAL		162	754		1,186			1,070



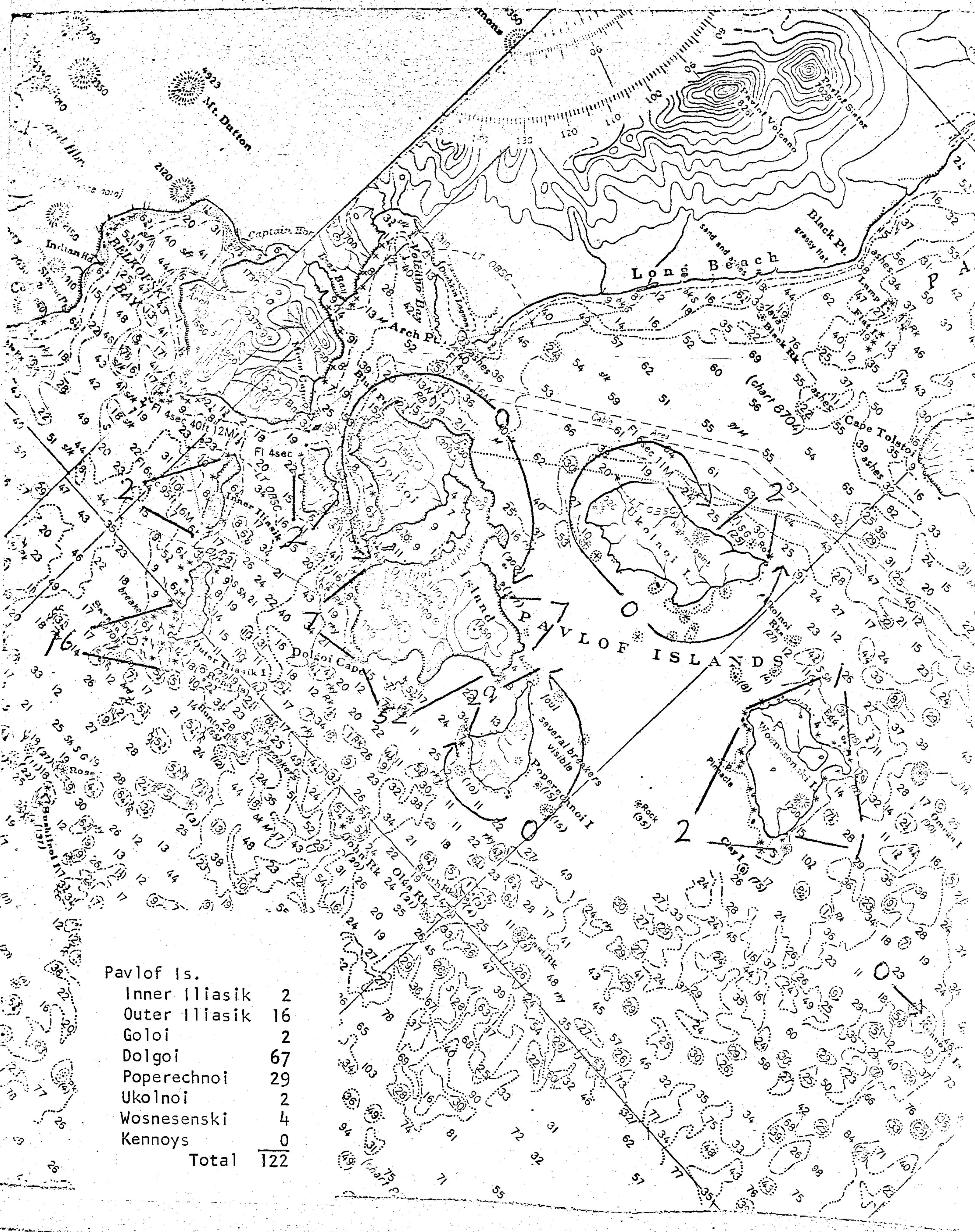
Amagat I. to False Pass	66
Ikatan Peninsula	71
Cape Lazaref	3
Total	140



SANAK IS.
Sanak Is.
239
Lookout Pt
Salmon Bay
Peterson Bay
Crowley Rk
Westdahl Rock
Pankof Breaker
C Pankof
Archer Cove
Hague Rk
Oneida Rk
South Rk
Aleks Rk
Unga I
Umla I
Caton I
Caton Hbr
Elma I
(chart 8705)
(chart 8701)

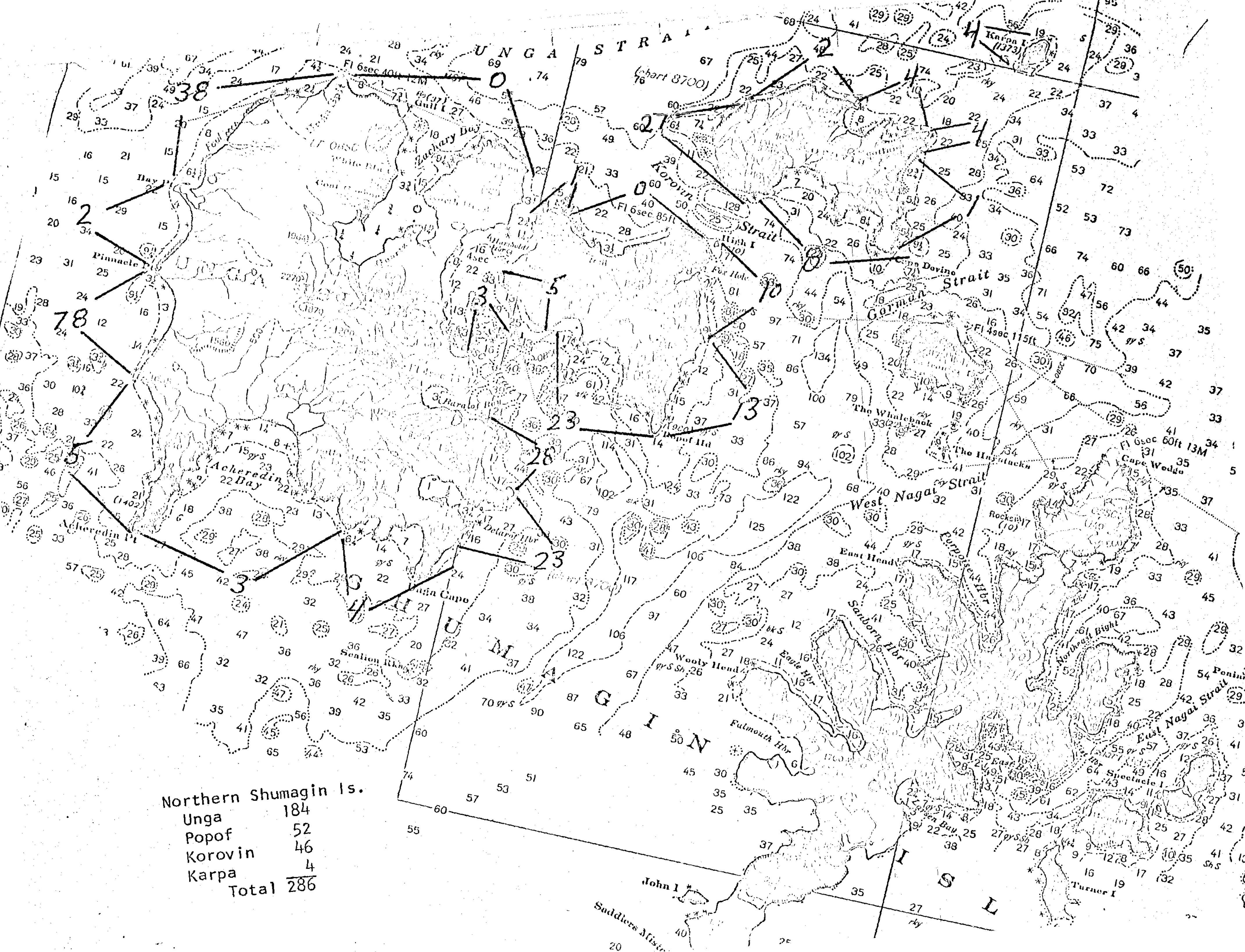


Thinpoint Cove
Thin Pt
Lenard Hbr.
Mt. Dutton
King Cove
Cannery
Bold Cape
Stag Pt
BELKOFSKI BAY
DEER I.
Goose I
Little Goose I
Hunt I
Island group
Rose I
Pinnacle Rk
Outer Iliasik I
Inner Iliasik
SANDMAN REEFS
Deer I. 34
Sandman Reefs 534+
Total 568+



Pavlof Is.

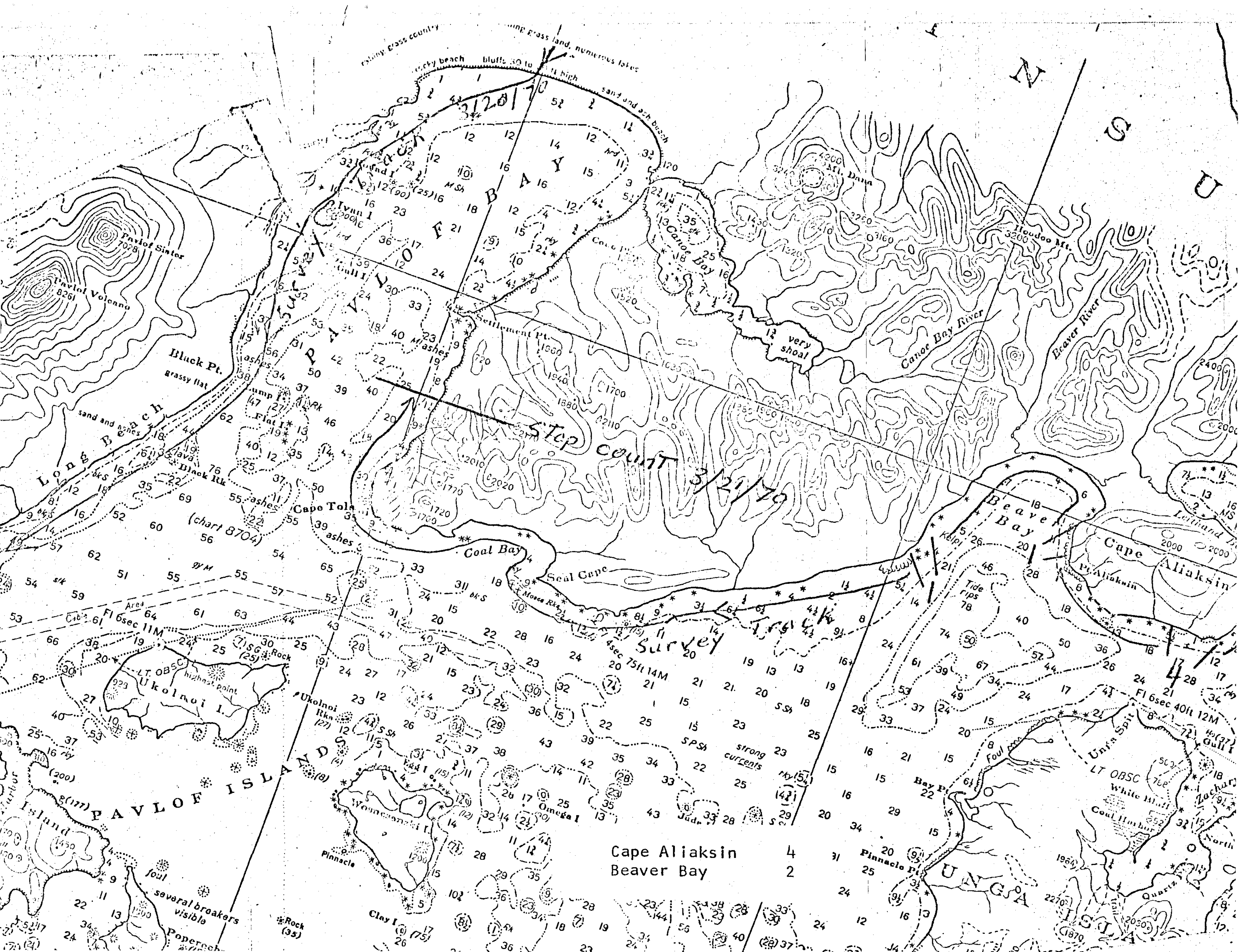
Inner Iliasik	2
Outer Iliasik	16
Goloi	2
Dolgoi	67
Poperechnoi	29
Ukolnoi	2
Wosnesenski	4
Kennoys	0
Total	122



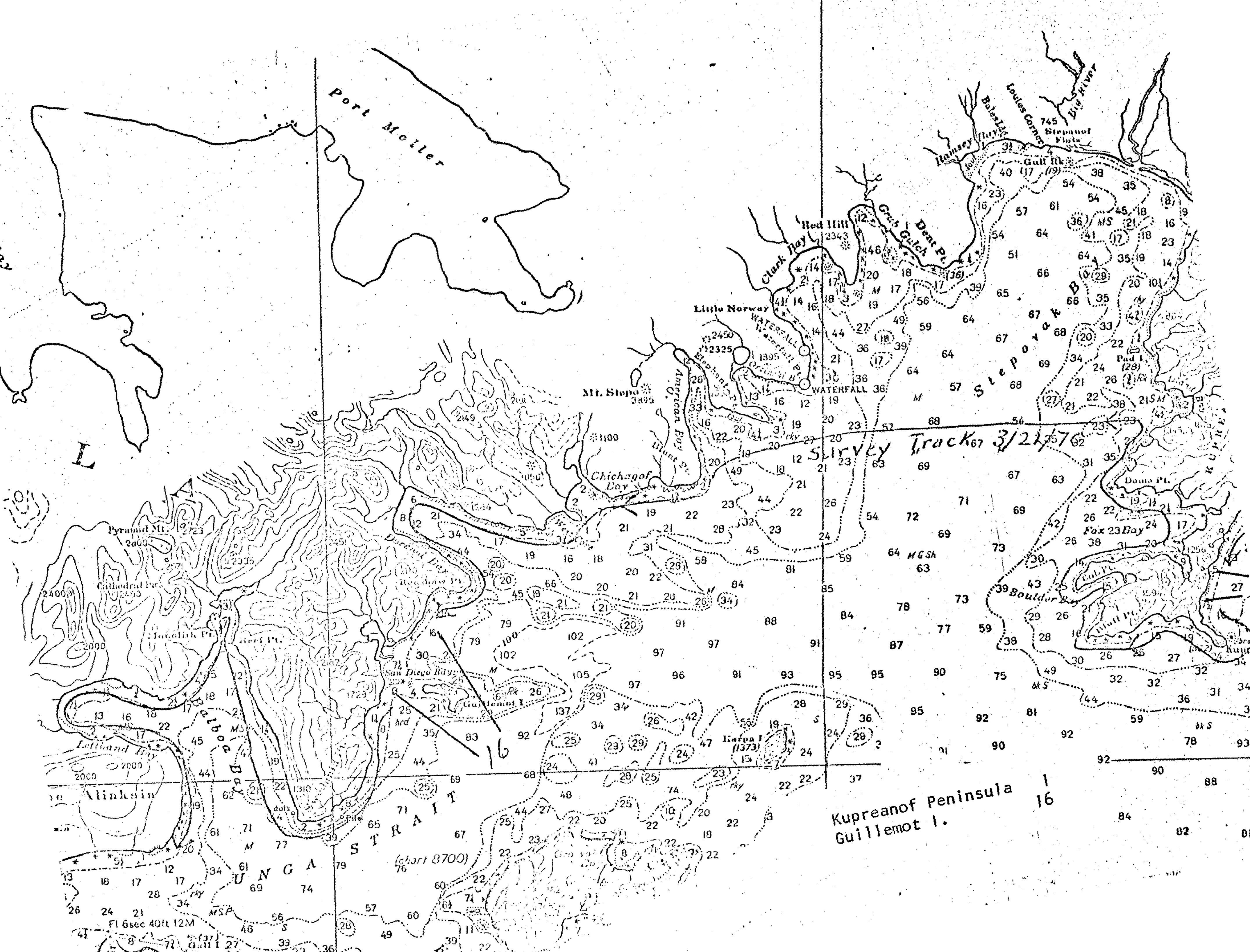
Northern Shumagin Is.	
Unga	184
Popof	52
Korovin	46
Karpa	4
Total	286

Kinzarof Lagoon
AERO R Rge 341
AERO Rot W&C
COLD BAY
(chart 8703)
P E N.
S K A
Mt. Dutton
Lenard Hbr.
Pavlof Sister 7028
Pavlof Volcano 8261
Black Pt.
grassy flat
sand and ashes
Long Beach
Black Rk
(chart 8704)
Volcano Bay
Arch Pt.
BELKOFSKI BAY
King Cove
Bold Cape
Deer Passage
DEER I.
Thin Pt
Sozavarika I
Fl 4sec 16M
Fl 6sec 11M
LT OBSC
Ukolnoi I.
PAVLOF ISL
Dolgoi
Dolgoi Island
Inner Iliasik I
Outer Iliasik I
Poperechnoi I
several breakers visible
foul
Green River

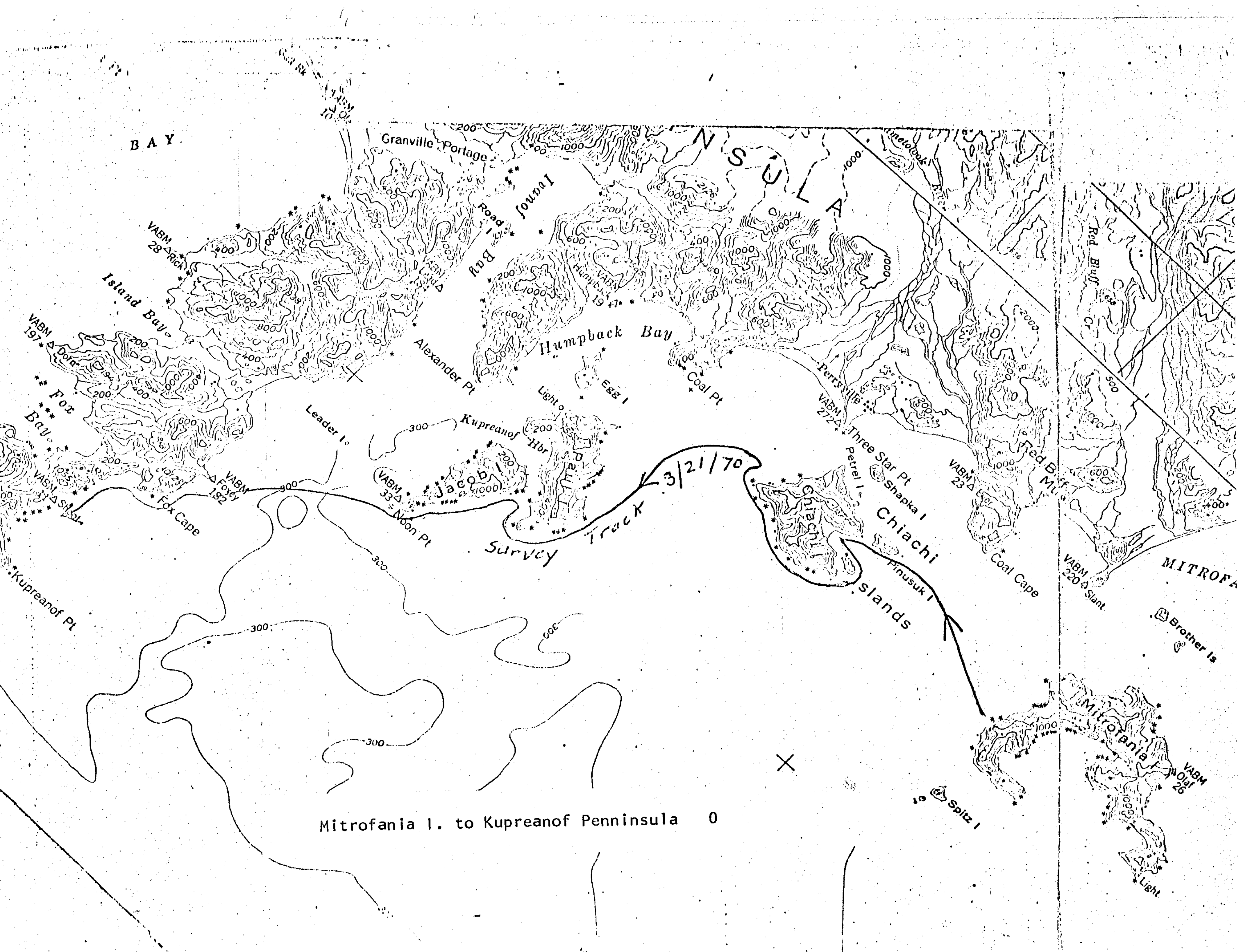
Cold Bay 1



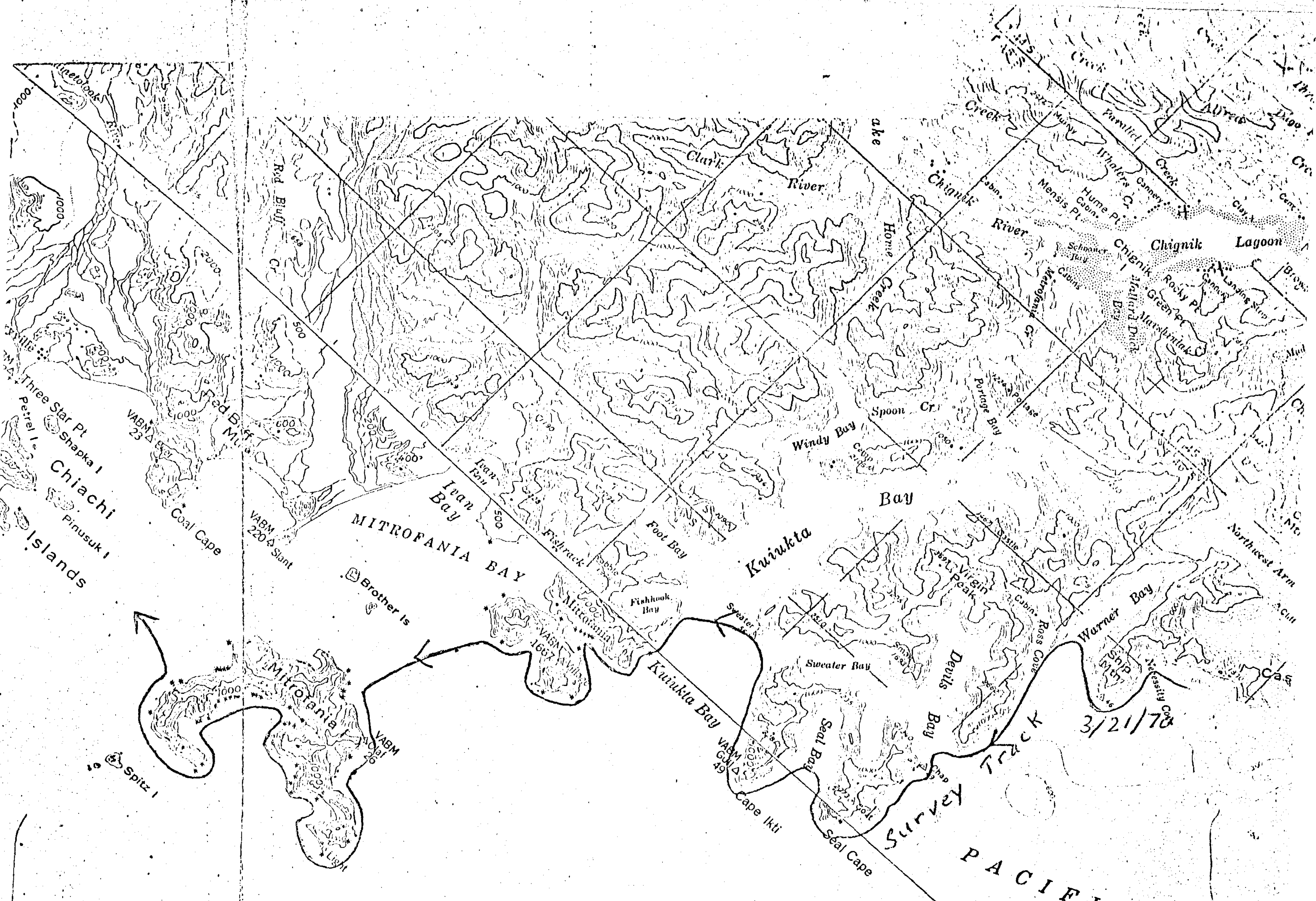
PAVLOF BAY
Pavlof Sister 7028
Pavlof Volcano 8261
Black Pt.
grassy flat
Long Beach
sand and ashes
Cape Tolstoi
Coal Bay
Seal Cape
Settlement Pt.
Canoe Bay
Canoe Bay River
Beaver River
Beaver Bay
Cape Aliaksin
Pt. Aliaksin
Mt. Dana
Hoodoo Mt.
very shoal
Tide rips
strong currents
Ukolnoi I.
Ukolnoi Rks
Wosnesenski I.
Omega I
Clay I
Pinnacle
Pinnacle Pt.
Bay Pt.
Unga Spit
White Bluff
Coal Harbor
UNGA ISLAND
PAVLOF ISLANDS
several breakers visible
(chart 8704)
Fl 6sec 11M
Fl 6sec 40ft 12M
4sec 75ft 14M
LT OBSC
Step count 3/21/70
Survey Track
3/20/70
Cape Aliaksin 4
Beaver Bay 2



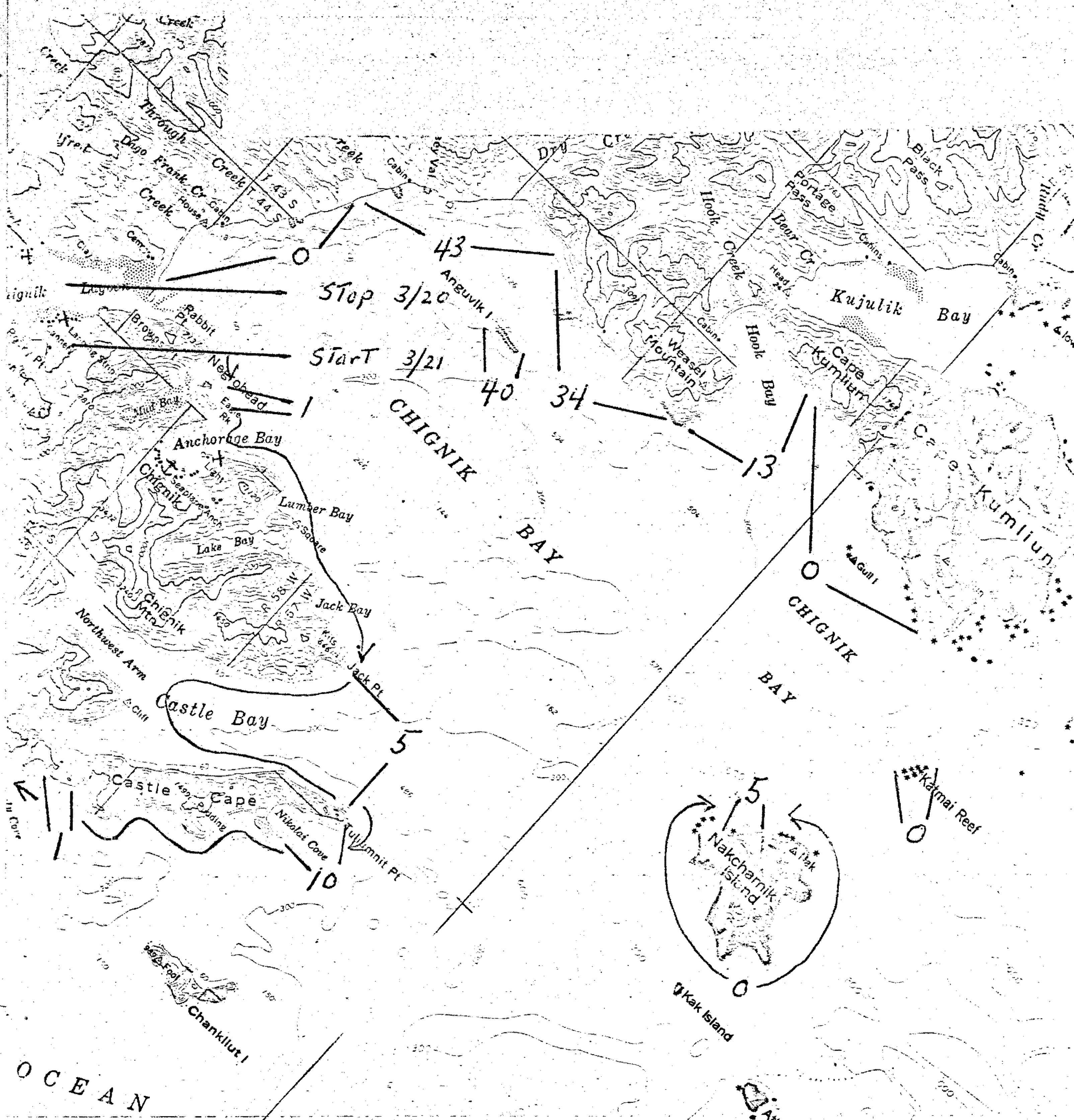
Port Moller
Big River
Stepanof Flats
Louies Corner
Bales Ldg
Ramsey
Gull Rk
Red Hill
Grub Gulch
Dent Pt.
Clark Bay
Little Norway
WATERFALL
Mt. Stepo
American Bay
Blunt Pt.
Chichagof Bay
Stepovak B
Survey Track 3/21/76
Doma Pt.
Fox Bay
Boulder Bay
San Diego Bay
Guillemot I.
Karpa I.
Pyramid Mt.
Cathedral Pk.
Balboa Bay
Lefthand Bay
Aliaksin
UNGA STRAIT
(chart 8700)
Fl 6sec 40ft 12M
Kupreanof Peninsula
Guillemot I.



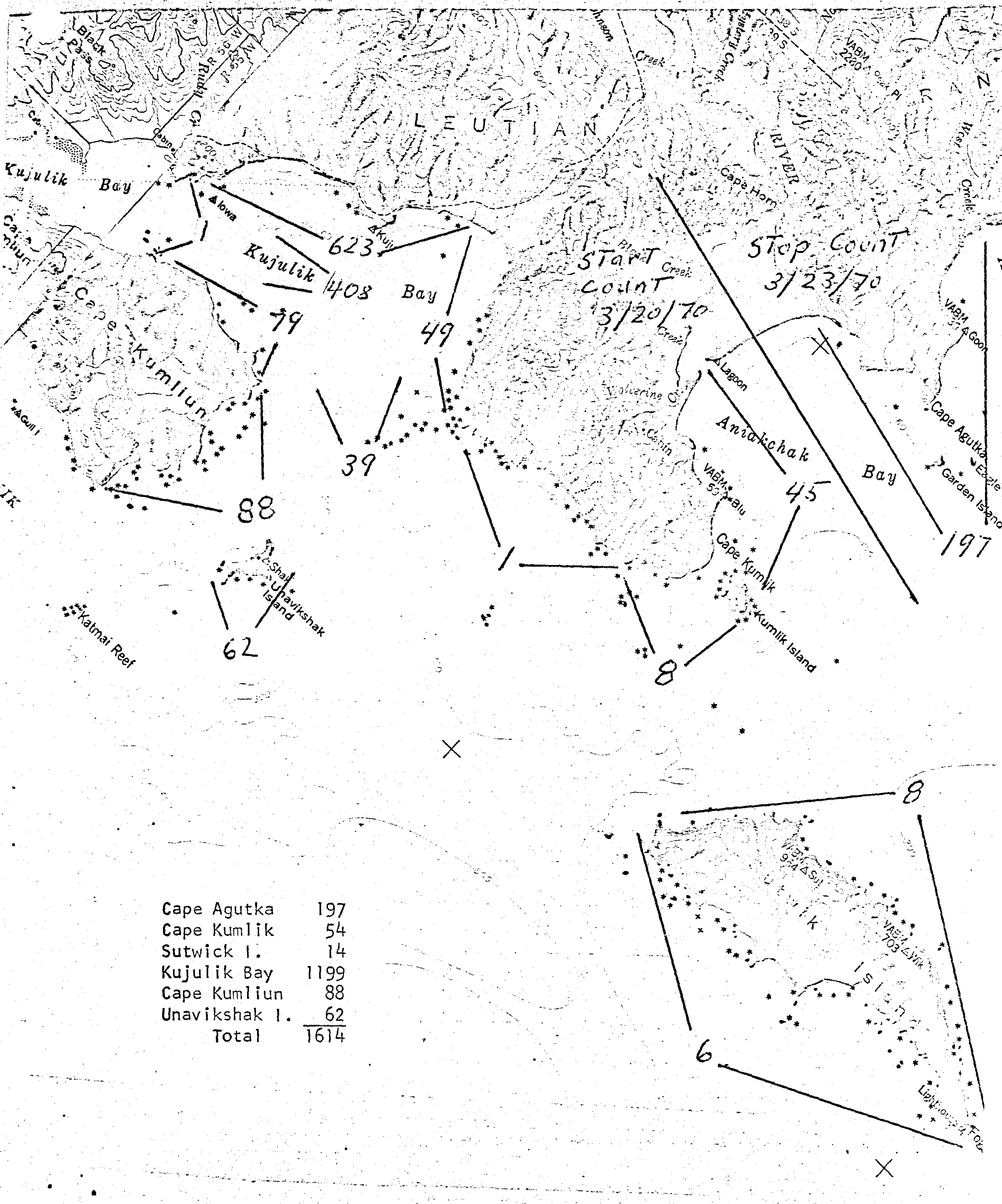
Mitrofania I. to Kupreanof Penninsula 0



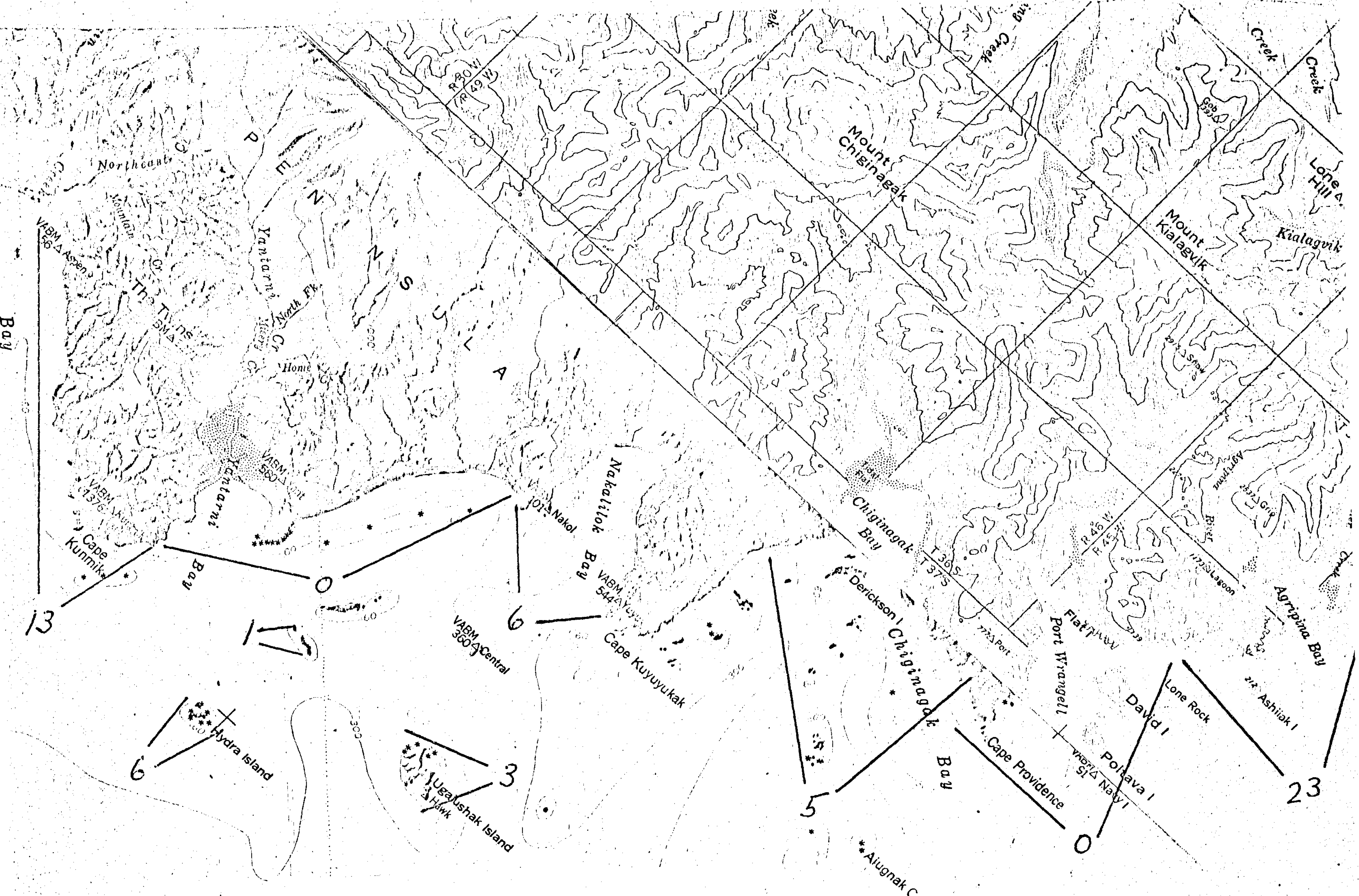
Warner Bay to Mitrofania I. 0



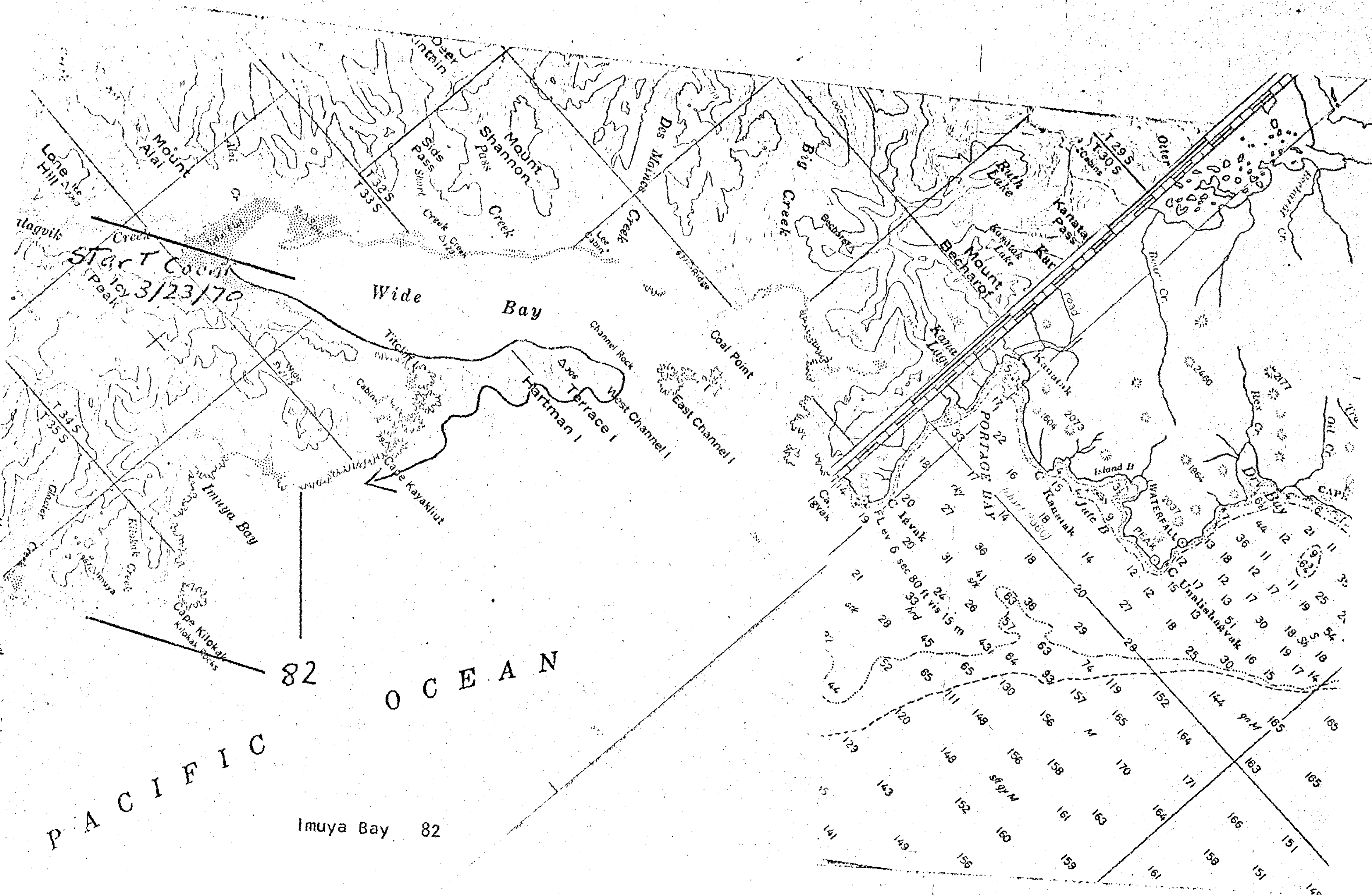
Hook Bay	13
Chignik Bay	118
Castle Bay - Castle Cape	16
Nakchamik I.	5
Katmai Reef	0
Total	152



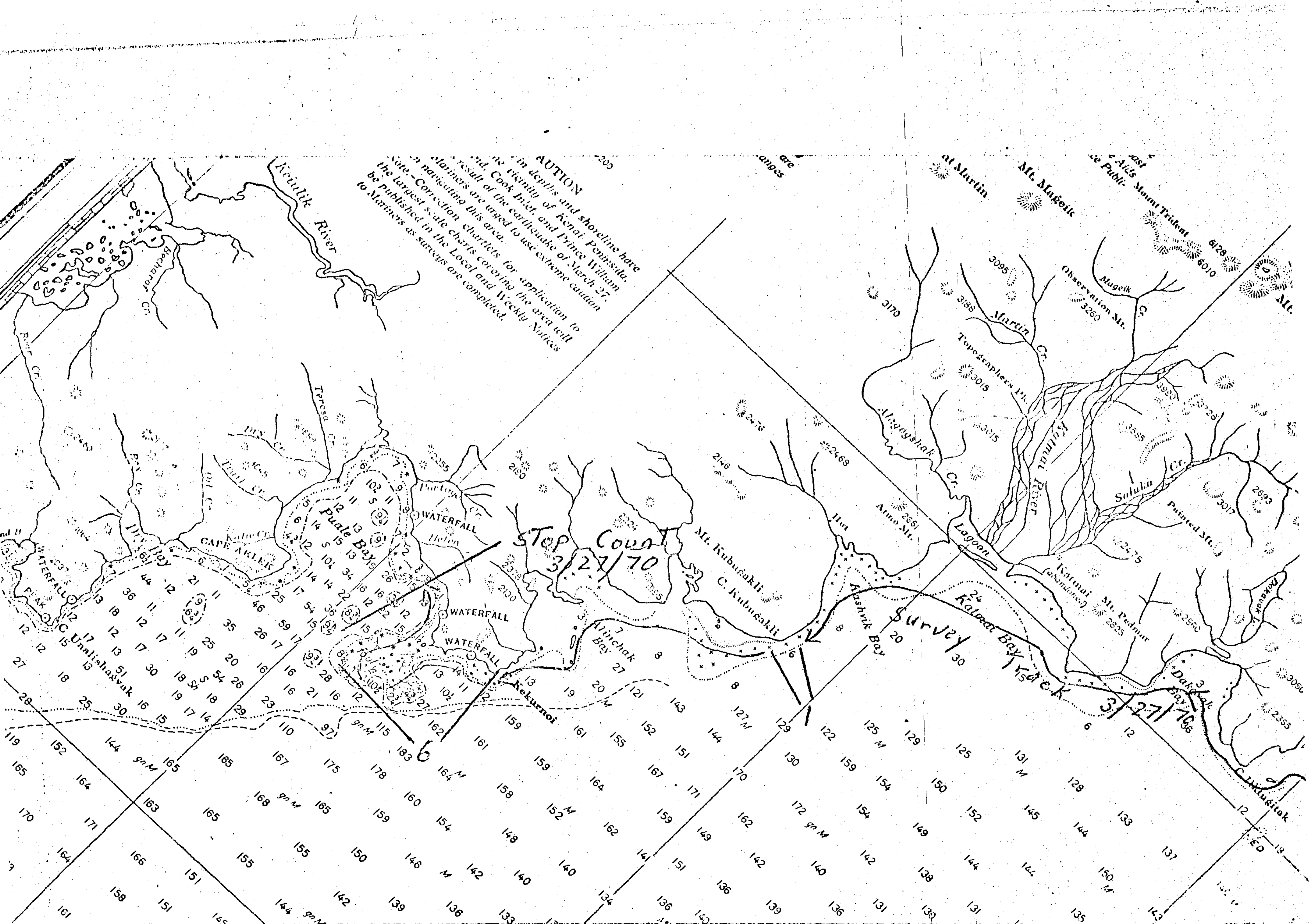
Cape Agutka	197
Cape Kumlik	54
Sutwick I.	14
Kujulik Bay	1199
Cape Kumliun	88
Unavikshak I.	62
Total	1614



Agripina Bay 23
Cape Providence to Cape Kunmik 34

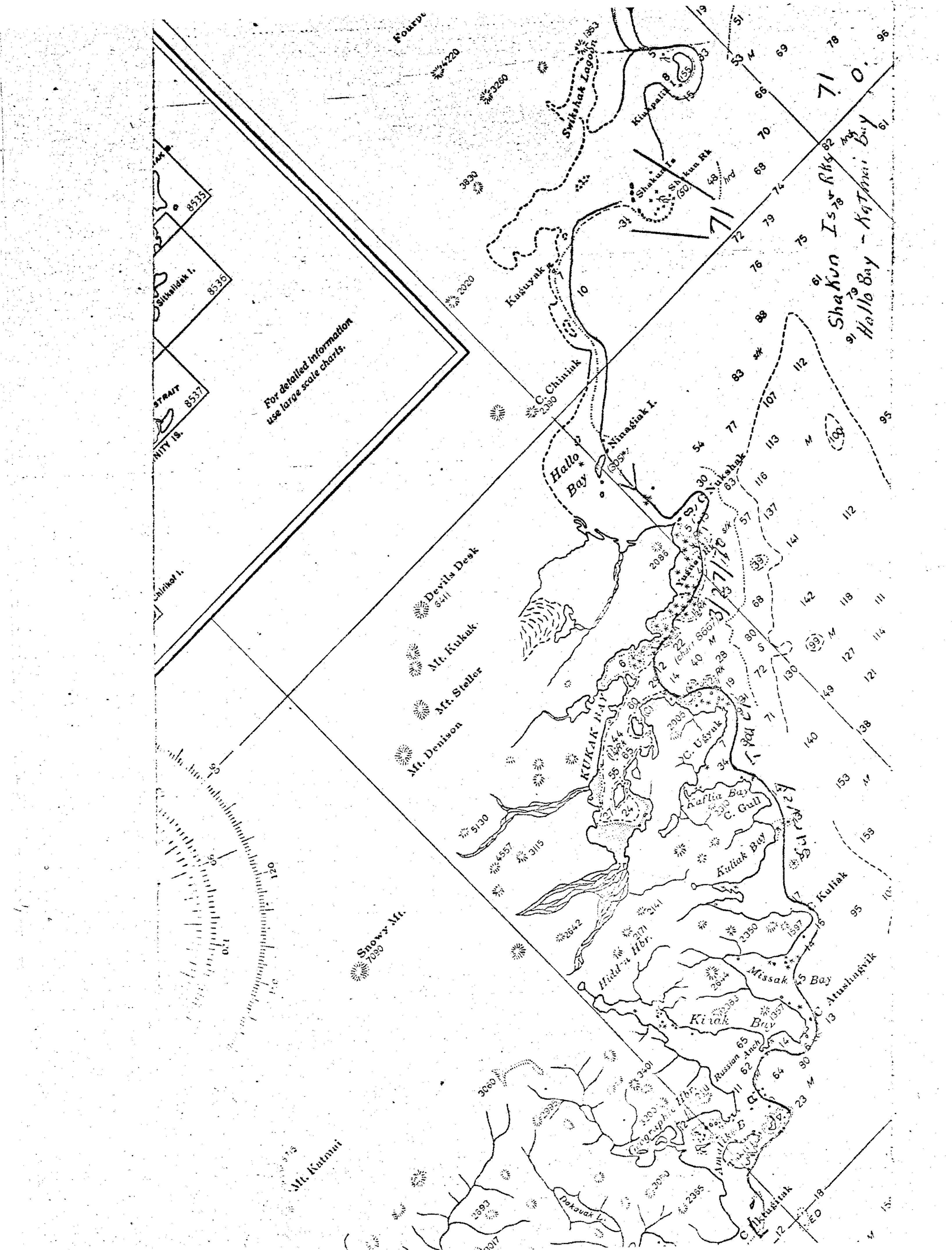


Becharof Cr.
Oil Cr.
Rex Cr.
Dry Bay
Bear Cr.
Otter
T 29 S
T 30 S
Cabins
Kanatak Pass
Ruth Lake
Kanatak Lake
Mount Becharof
road
Kanatak
C Unalishagvak
WATERFALL
PEAK
Island B
Jute B
C Kanatak
PORTAGE BAY
C Igvak
FL ev 6 sec 80 ft vis 15 m
Ca. Igvak
Big Creek
Coal Point
East Channel I
Ridge
Des Moines Creek
Lee Cabin
Channel Rock
West Channel I
Terrace I
Hartman I
Wide Bay
Mount Shannon
Pass
Creek
Sids Pass
Short Creek
T 32 S
T 33 S
Cape Kayakliut
Cabins
82 OCEAN
PACIFIC
Imuya Bay 82
Imuya Bay
Cape Kilokak
Kilokak Rocks
Kilokak Creek
Mount Alai
Alai Cr
Start Count 3/23/70
Icy Peak
Lone Hill
T 34 S
T 35 S
Glacier Creek

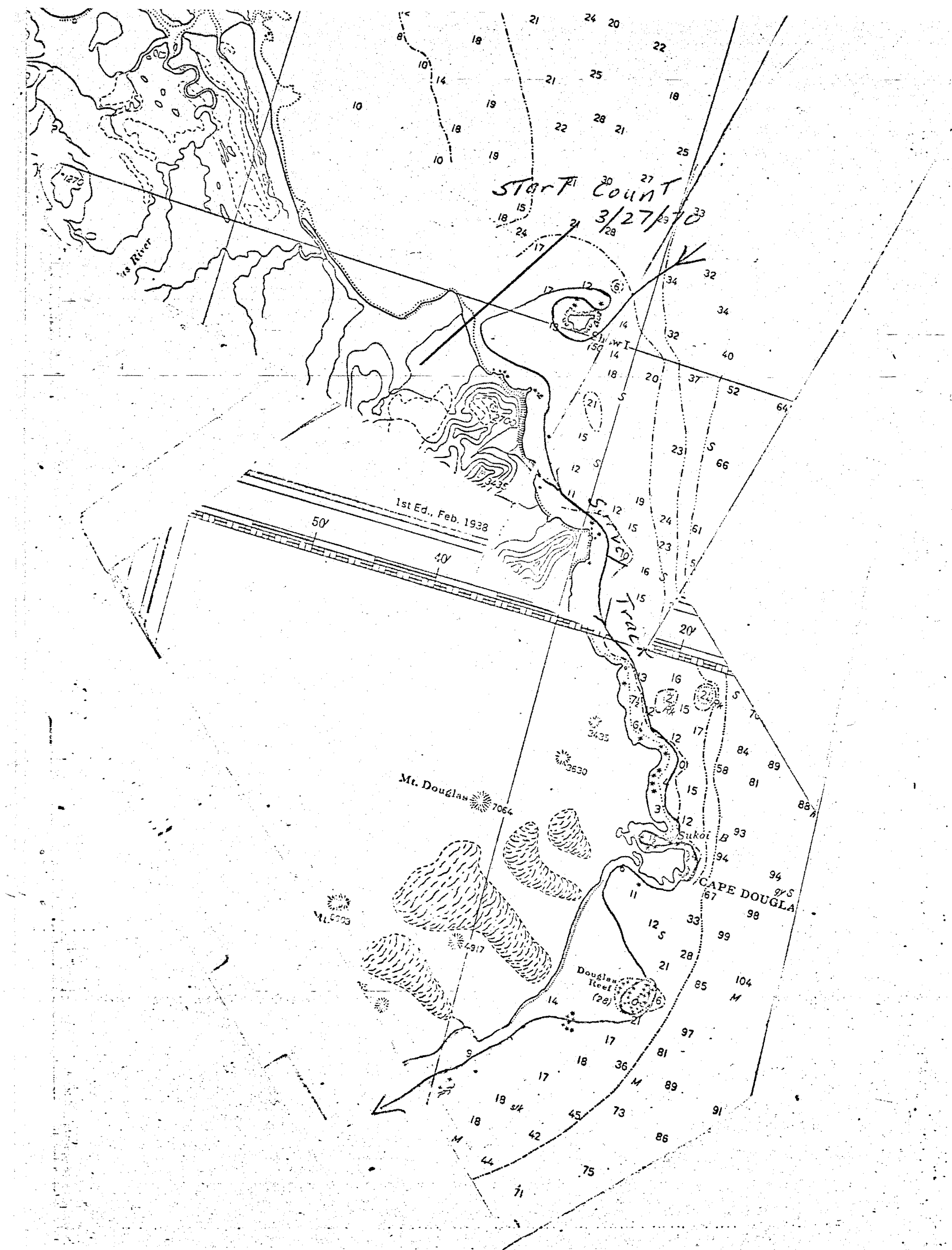


C. Kubugakli - Paule Bay 7

Puale Bay - Wide Bay ? Not Counted



For detailed information use large scale charts.
8535
Sitkalidak I.
8536
STRAIT
8537
Chirikof I.
Swikshak Lagoon
Kiukpalik I.
Shakun Is.
Shakun Rk
Kaguyak
C. Chiniak
Ninagiak I.
Hallo Bay
C. Nukshak
Devils Desk
Mt. Kukak
Mt. Steller
Mt. Denison
KUKAK BAY
C. Ugyak
Kaflia Bay
C. Gull
Kuliak Bay
C. Kuliak
Missak Bay
C. Atushagvik
Kinak Bay
Russian Anch.
Amalik B.
Dakavak L.
Snowy Mt.
Mt. Katmai
Shakun Is. Rks
Hallo Bay - Katmai Bay


Start Count
3/27/70
Shaw I.
1st Ed., Feb. 1938
50'
40'
20'
Trac
Mt. Douglas
7064
Sukoi B
CAPE DOUGLA
Douglas Reef

MARINE MAMMALS SURVEY - BRISTOL BAY TO AKUTAN ISLAND
June 2, 1970

OBSERVER: J. Vania
J. Faro

PILOT: George Tibbets, Jr.

AIRCRAFT: Piper Azetex

WEATHER: Partly cloudy throughout flight, wind 10 miles per hour or less, visibility generally excellent. One bad area and that was at Akutan Island. Air was turbulant there and we were unable to go completely around the island because of fog in Akutan Pass. Water had slight ripple throughout flight and ocassionally there was glare, but overall conditions for sighting animals was good.

Departed King Salmon 11:15 AM
Returned to King Salmon 7:45 PM

FLIGHT PATH: After leaving King Salmon, we went over to the north side of the Alaska Peninsula and proceeded down the coast flying at 300 to 600 feet of altitude. Generally, we flew about one mile off the beach. At Port Heiden, Moller, and Cinder River, we checked the outer sand bars for seals and some of the inner bars where I knew seal hauled out.

We did not cover Izembeck Lagoon very well. Instead, we flew offshore and checked Amak Island. We then fueled up at Cold Bay. Leaving Cold Bay, we continued down the north side of the peninsula (sea otter sighted) down to Cape Sharichef and crossed over to Akutan Island flying along the south side of it. We were able to get around Cape Morgan and fly down the beach a few miles but then had to turn back because of fog.

The flight path was then eastward to the north side of Tigalda Island. At Ugamak Island, we circled it completely flying at about 300 to 500 feet. We completed the survey at this point and returned to King Salmon generally following the route we had taken on the flight down.

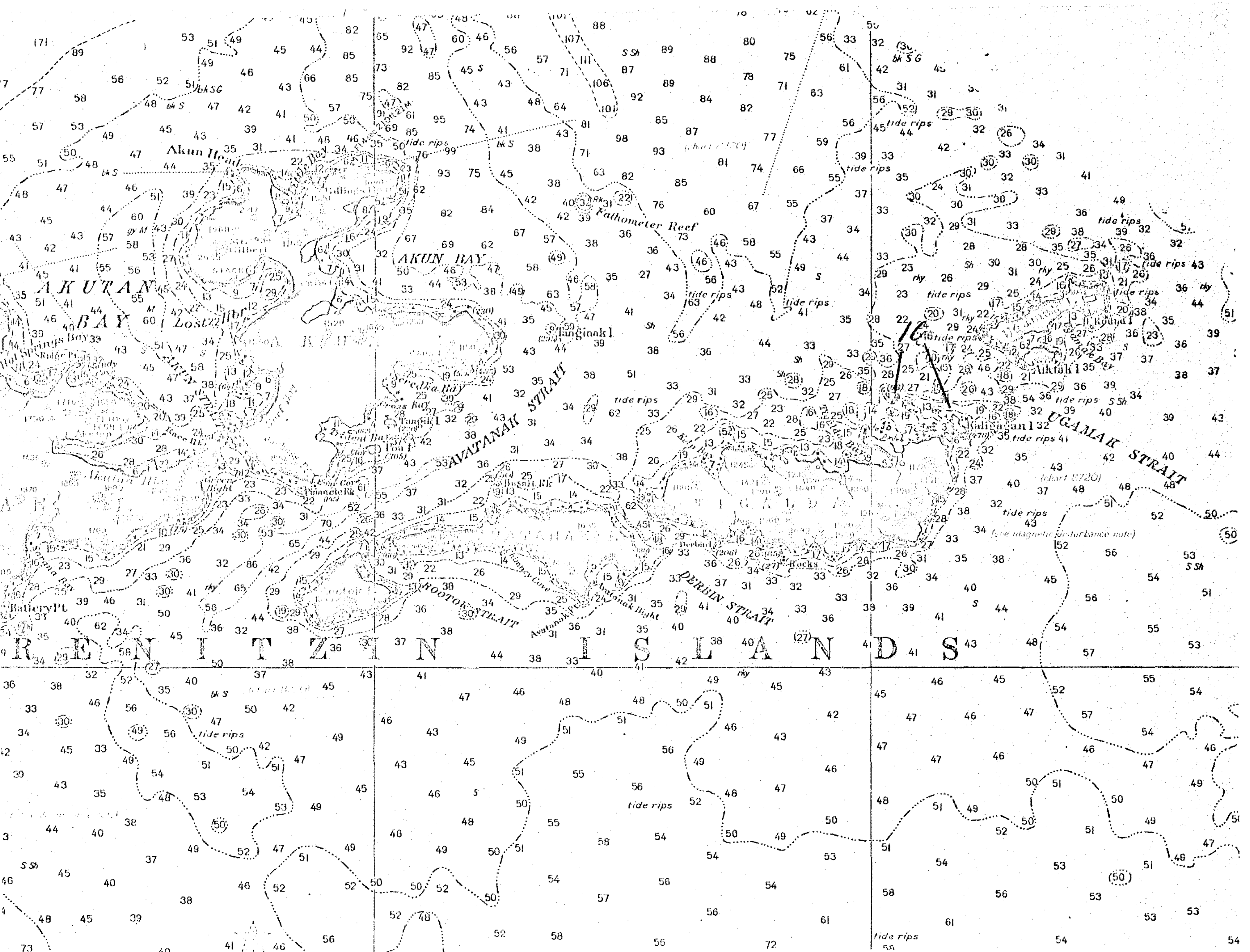
SEA OTTER SIGHTINGS

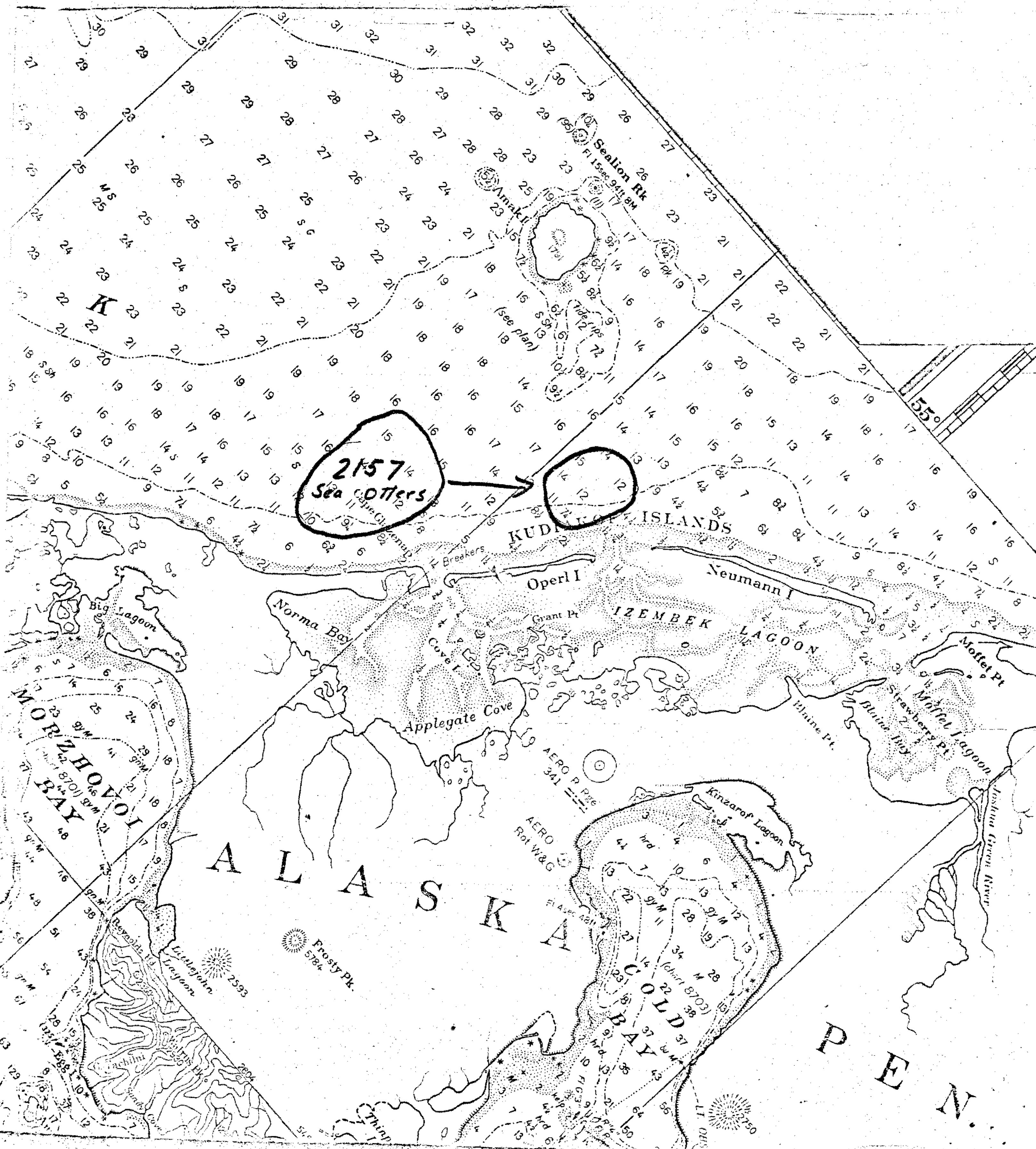
Seven pods of sea otter were seen south of Amak Island. These were photographed and later counted from the photographs. Because of the density in the larger pods and the fact that some animals in the smaller pods were diving when the pictures were taken, some individuals may have been missed.

The number counted in each pod is as follows:

	1071
	520
	357
	68
	36
	75
	30
TOTAL	2157

Several hours later the pods had drifted four or five miles northeastward (see map). In addition, one sea otter was seen at Amak Island and sixteen near Tigalda Island.


KRENITZIN ISLANDS
AKUTAN BAY
Akun Head
AKUN BAY
Fathometer Reef
AVATANAK STRAIT
UGAMAK STRAIT
DERBIN STRAIT
ROOTOK STRAIT
Tangik I
Kaligagan I
Aiktak I
Round I
Kelp Bay
Rocks
Battery Pt
Avatanak Bight
tide rips
(see magnetic disturbance note)
(chart 8720)


2157
Sea Otters
Sealion Rk
Amak I
(see plan)
Tide rips
K
Breakers
KUDIAKOF ISLANDS
Operl I
Neumann I
IZEMBEK LAGOON
Norma Bay
Big Lagoon
Cove I
Grant Pt
Applegate Cove
Moffet Pt
Moffet Lagoon
Strawberry Pt
Blaine Pt
Blaine Bay
Joshua Green River
55°
MORZHOVOI BAY
ALASKA
Kinzarof Lagoon
Frosty Pk.
5784
Littlejohn Lagoon
2593
COLD BAY
PEN.

SEA OTTER COUNT
BARREN ISLANDS and SHUYAK - AFOGNAK ISLANDS
June 9, 1970

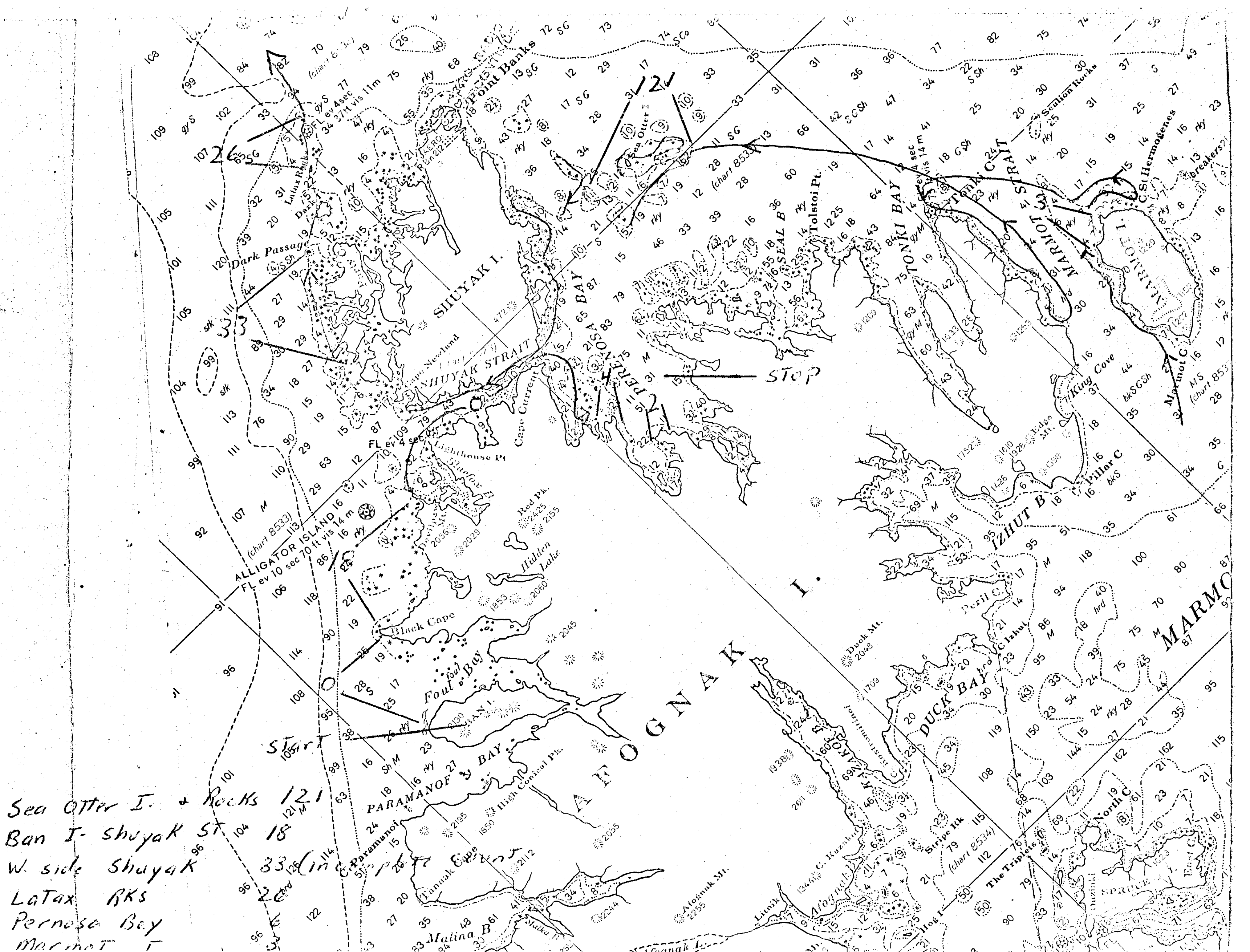
On June 9, 1970, an aerial survey of sea otter was flown in the Barren Islands and in the Afognak-Shuyak Islands area. A Gruman Goose was used with Schneider serving as the only observer. Offshore coverage was poor. Conditions of visibility were as follows:

Barren Islands - 11:40 AM to 12:25 PM - Water calm, moderate surface glare. Conditions very good. Count complete.

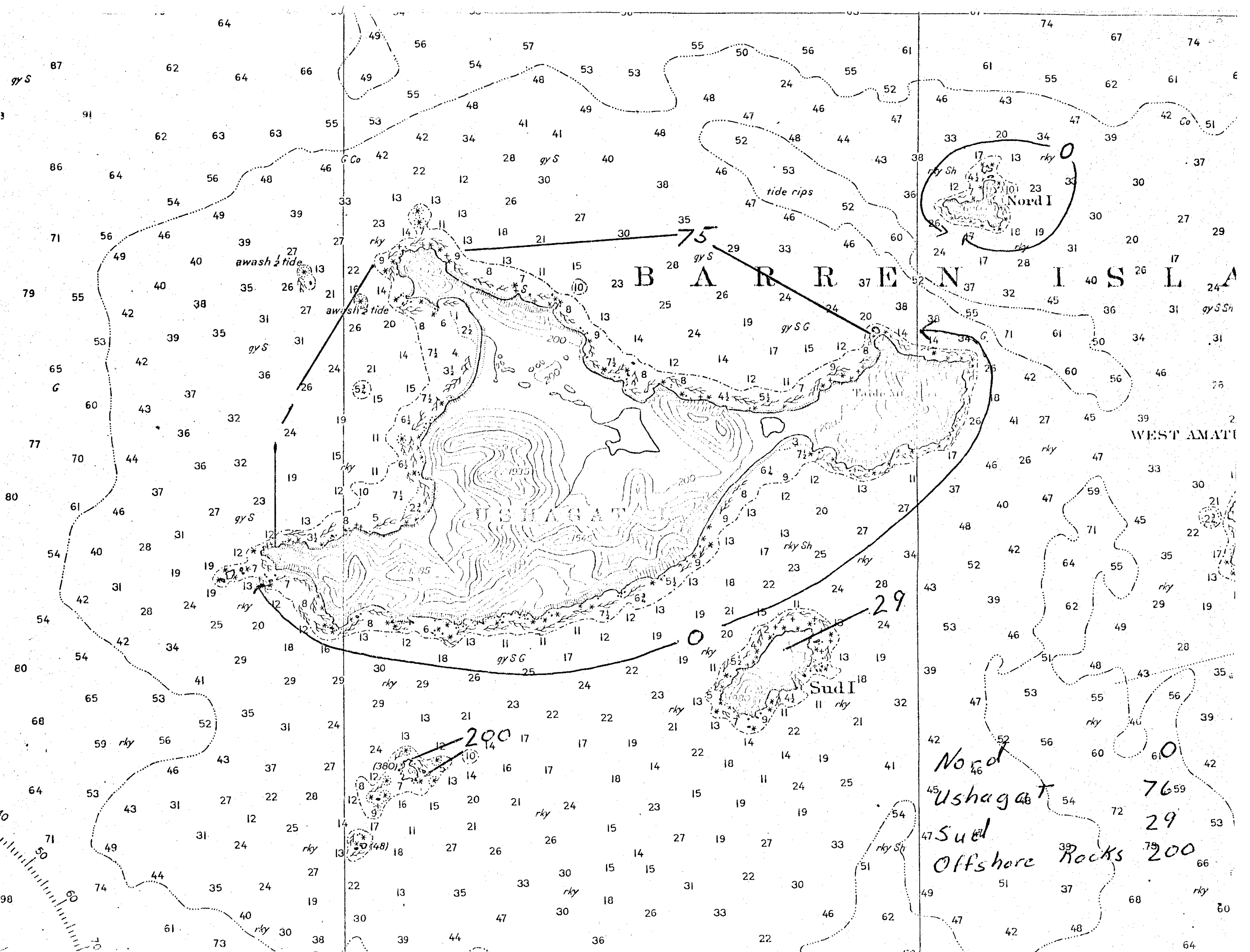
Ban Island to Pernosa Bay - 12:55 to 1:35 PM - Conditions similar to Barren Islands but surface glare worse in spots. Conditions generally good.

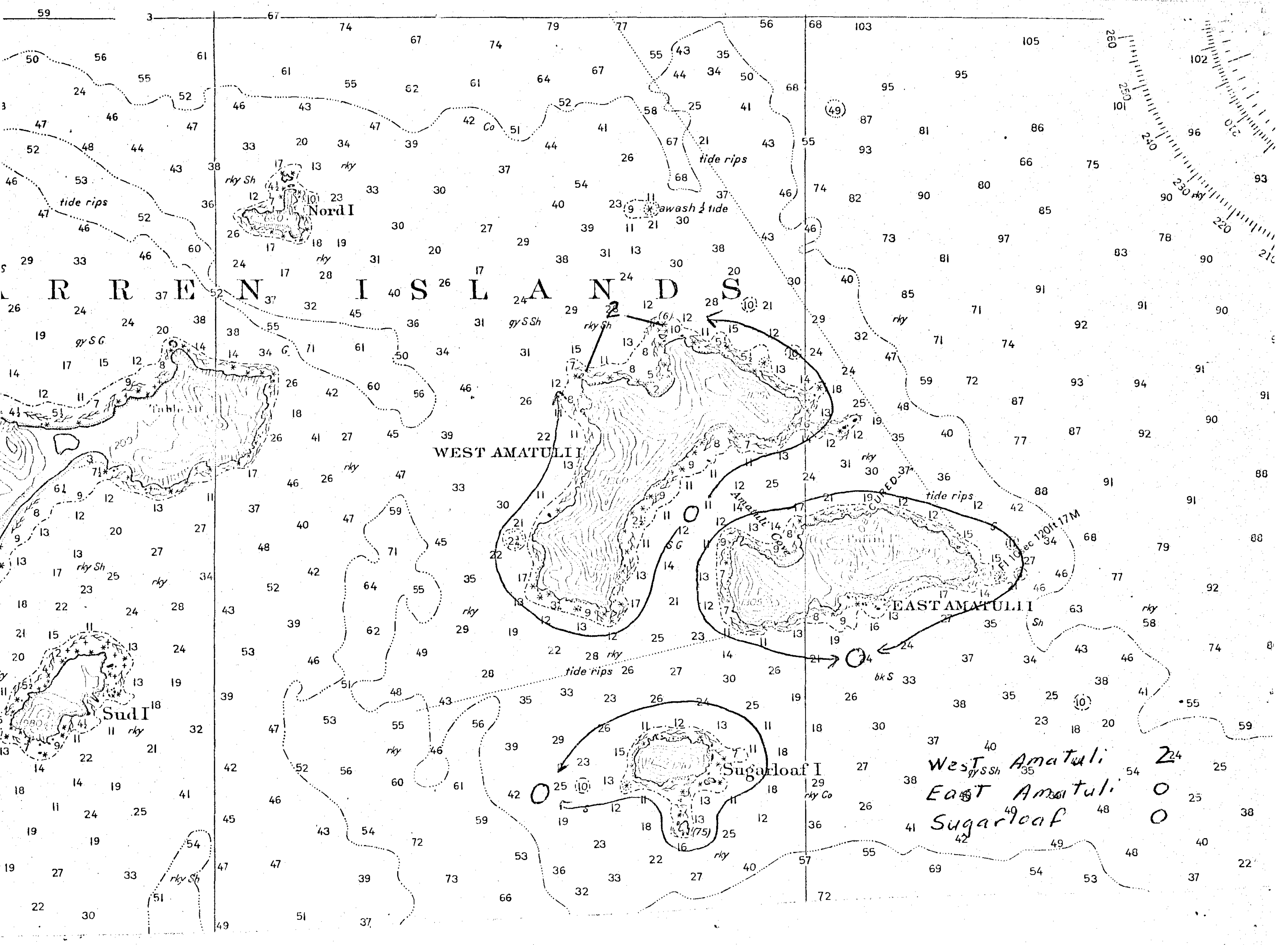
Marmot Island to Latax Rocks - 2:55 to 3:45 PM - Increased ripples on surface. Glare Bad. Conditions fair. Count around Sea Otter Island complete although some otter may have been scattered offshore. Remainder of count very superficial.

Area	Number of Sea Otters	Visibility	Complete or Partial Count
BARREN ISLANDS			
East Amatuli Island	0	Very good	Complete
West Amatuli Island	2	"	"
Sugarloaf Island	0	"	"
Ushagat Island	76	"	"
Rocks south of Ushagat	200	"	"
Sud Island	29	"	"
Nord Island	0	"	"
TOTAL	307		
AFOGNAK-SHUYAK ISLANDS			
Ban Island-Shuyak Strait	18	Good	Complete
Pernosa Bay	6	"	"
Marmot Island	3	Fair	Partial
Sea Otter Island area	121	"	Complete
East side of Shuyak	0	"	Partial
West side of Shuyak	33	"	"
Latax Rocks-Dark Island	26	"	"
TOTAL	207		



AFOGNAK I.
SHUYAK I.
SHUYAK STRAIT
MARMOT I.
MARMOT STRAIT
TONKI BAY
TONKI C
PERENOSA BAY
SEAL B
IZHUT B
DUCK BAY
PARAMANOF BAY
Foul Bay
Black Cape
Hidden Lake
Red Pk.
Duck Mt.
Afognak Mt.
Point Banks
Dark Passage
Latax Rocks
Sea Otter I
Cape Newland
Cape Current
Lighthouse Pt
Tolstoi Pt.
King Cove
Pillar C
Marmot C
C St Hermogenes
Sealion Rocks
Peril C
C Izhut
Stripe Rk
The Triplets
North C
Hog I
C. Paramanof
Tonnak Cape
High Conical Pk.
Malina B
ALLIGATOR ISLAND
FL ev 10 sec 70 ft vis 14 m
FL ev 4 sec
Stop
Start
Sea Otter I. & Rocks 121
Ban I - Shuyak St 18
W. side Shuyak 33
LaTax Rks 26
Pernosa Bay
Marmot I


BARREN ISLA
Nord I
Sud I
USHAGAT
WEST AMATU
tide rips
awash ½ tide
75
29
0
200
No of
Ushagat 76
Sud 29
Offshore Rocks 200



ISLANDS
Nord I
Sud I
WEST AMATULI I
EAST AMATULI I
Sugarloaf I
Amatuli Cove
tide rips
awash ½ tide
West Amatuli 2
East Amatuli 0
Sugarloaf 0

SEA OTTER COUNTS - KENAI
June, 1970 to January, 1971

Carl Divinyi flew aerial surveys of seals along the outside of the Kenai Peninsula on a monthly basis. He recorded all sea otters sighted on these surveys. The surveys did not cover the entire coast line and the type of aircraft, weather conditions and observers varied from one survey to another. Therefore, the seperate counts cannot be compared. However, when viewed in total they indicate the areas used by sea otters and the relative abundance of otters in each area.

The attached table presents the counts by broad areas.

SEA OTTERS COUNTED ON AERIAL SURVEYS OF KENAI PENINSULA
June, 1970 - January, 1971

AREA	JUNE 5 & 9	JULY 15-20	AUG. 14	OCT. 12	NOV. 12	JAN. 12
C. Junken - C. Resurrection	5	30	42	27	10	30
Resurrection Bay	2	2	0	4	2	NS
Aialik Bay	1	20	5	8	0	21
Harris Bay	8	18	7	5	3	* 25
Nuka Bay	106	56	NS	31	28	27
Port Dick	0	11	NS	NS	3	23
Rocky Bay - Port Chatham	121	125	NS	NS	9	26
Koyuktolik Bay - Port Graham	0	0	NS	NS	0	NS
Total	243	262	54	75	55	152

* 38 sea otters counted from shore and skiff 11/20/70.

AERIAL SURVEY
Prince William Sound
April, 1970

Between April 15 and 18, 1970, Carl Divinyi and Julius Reynolds flew an aerial survey of most of Prince William Sound using a Cessna 185. The survey was primarily to locate seals, however sea otter were counted. The following is a summary of the survey.

I departed Anchorage on April 14, via Alaska Airlines, and arrived in Cordova at 6:00 AM. Weather conditions prevented flying so Julius and I drove the local road network looking for anything in the way of wildlife.

April 15: Weather was a little better than yesterday so we decided to try surveying along the east side of the Sound up to Valdez Arm. We started the survey at Bomb Point and flew the coast and offshore islands up to Galena Bay.

Observations: Seal - Scattered small groups, with the majority of the animals being in Port Fidalgo. There were no noticeable concentrations (50 on up) of seals.

Sea Otter - A total of 105 otter were counted, with the majority (60) being located in St. Matthews Bay. The remainder of the animals were concentrated between Red Head and Knowles Head outside of Port Gravina.

Sea Lion - Small scattered groups in Port Fidalgo (60-80 total).

April 16: Weather inclement - no flying.

April 17: We flew Hawkins, Hinchinbrook, Montague, and Green Islands. Very few seal - many otter and two large concentrations of sea lions. (See maps for numbers and locations of seals, sea otter and sea lion.) We also counted 5 otter around Kayak Island.

April 18: Flew those islands from Montague Strait to Icy Bay and from Port Bainbridge to Knight Island Passage. (See maps for numbers and locations of seals, sea otter, and sea lions.)

Julius Reynolds continued the survey along the mainland from Knight Island Passage to Esther Island, and around Knight, Ingot and Eleanor Islands.

The area from Esther Passage to Valdez Arm, and Culross, Perry, Lone, Naked, Peak and Storey Islands were not surveyed.

SEA OTTER COUNTED
Prince William Sound
April, 1970

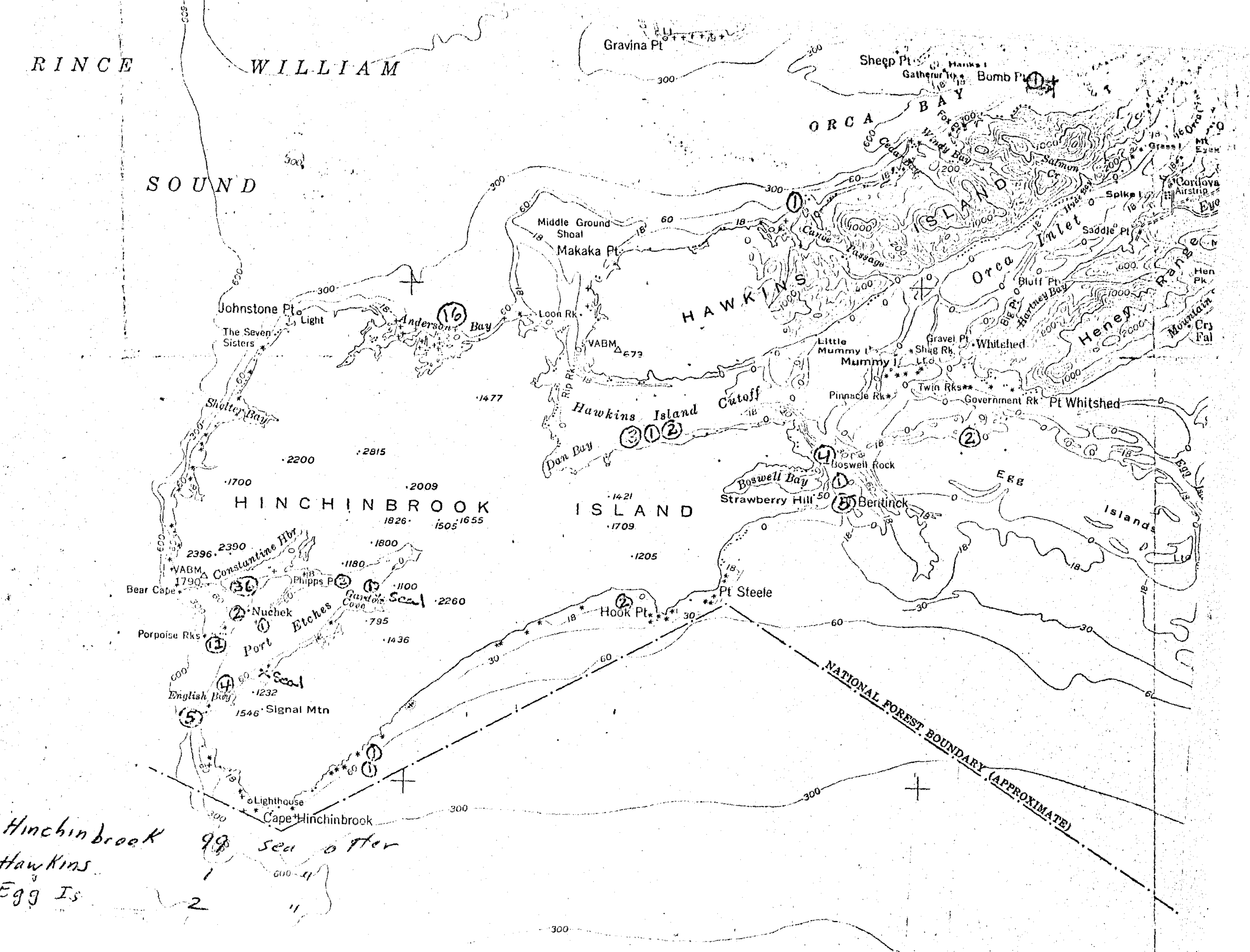
Area	Number of Sea Otter	Date
PORT BAINBRIDGE - ICY BAY		
Bainbridge Island	30	4/18
Evans Island	14	4/18
Elrington Island	4	4/18
Latouche Island	46	4/18
Whale Bay - Icy Bay	39	4/18
CHENEGA ISLAND - MAIN BAY		
Chenega Island and Dangerous Passage	33	5/2
Crafton Island	2	5/2
PORT NELLIE JUAN - ESTHER ISLAND		
Blackstone Bay	1	5/2
Culross Island	NS	
ESTHER PASSAGE - VALDEZ ARM	NS	
GALENA BAY - FISH BAY	103	4/15
FISH BAY - GRAVINA POINT	1	4/15
GRAVINA POINT - CORDOVA	1	4/15
HAWKINS ISLAND	1	4/17
HINCHINBROOK ISLAND	99	4/17
EGG ISLAND	2	4/17
MONTAGUE ISLAND	259	4/17
GREEN AND LITTLE GREEN ISLANDS	102	4/17
KNIGHT ISLAND	136	5/2
INGOT ISLAND	6	5/2
ELEANOR ISLAND	3	5/2
SMITH ISLAND	4	5/2
SEAL ISLAND	0	5/2
APPLEGATE ROCK	1	5/2
PERRY ISLAND	NS	

(continued)

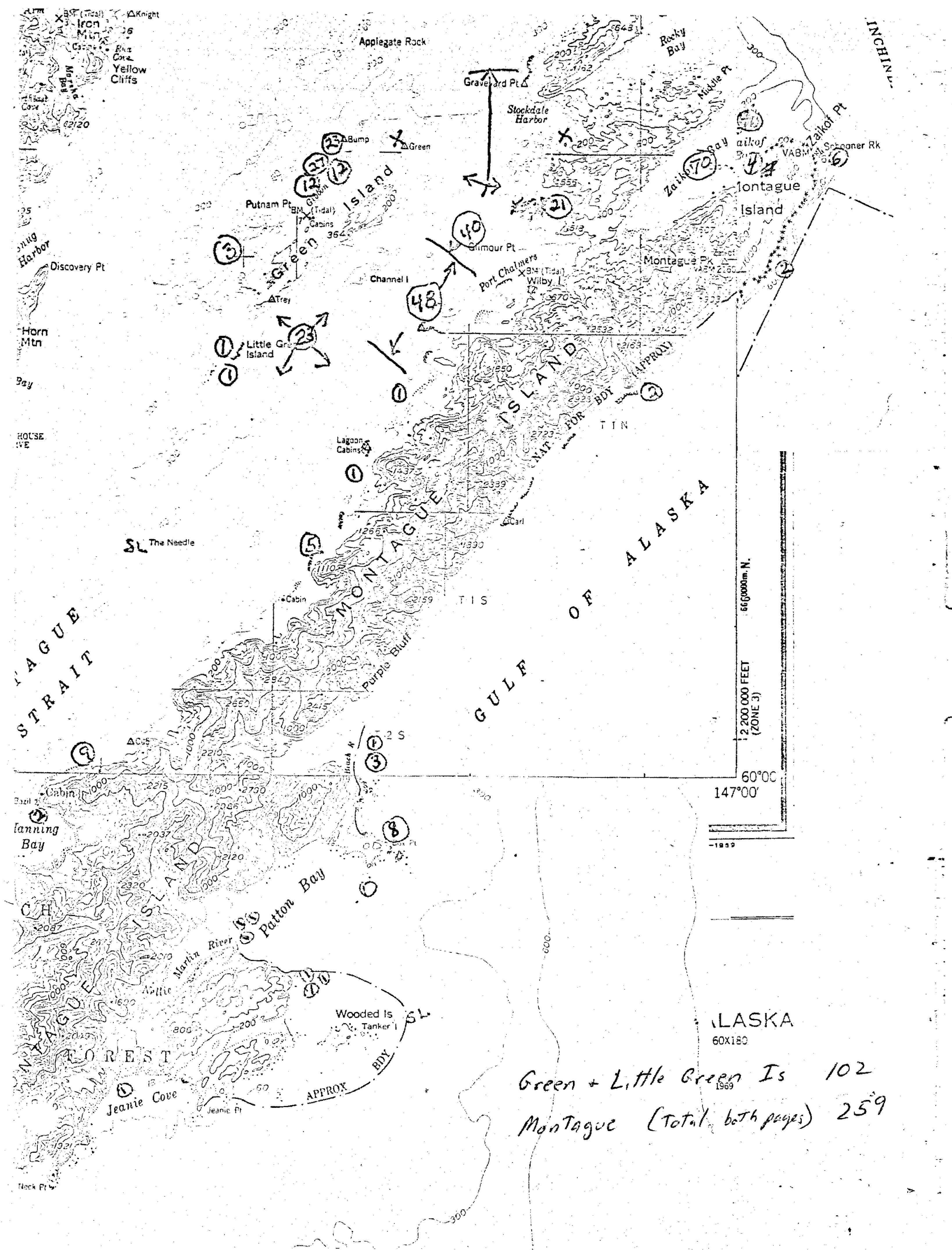
SEA OTTER COUNTED
Prince William Sound
April, 1970

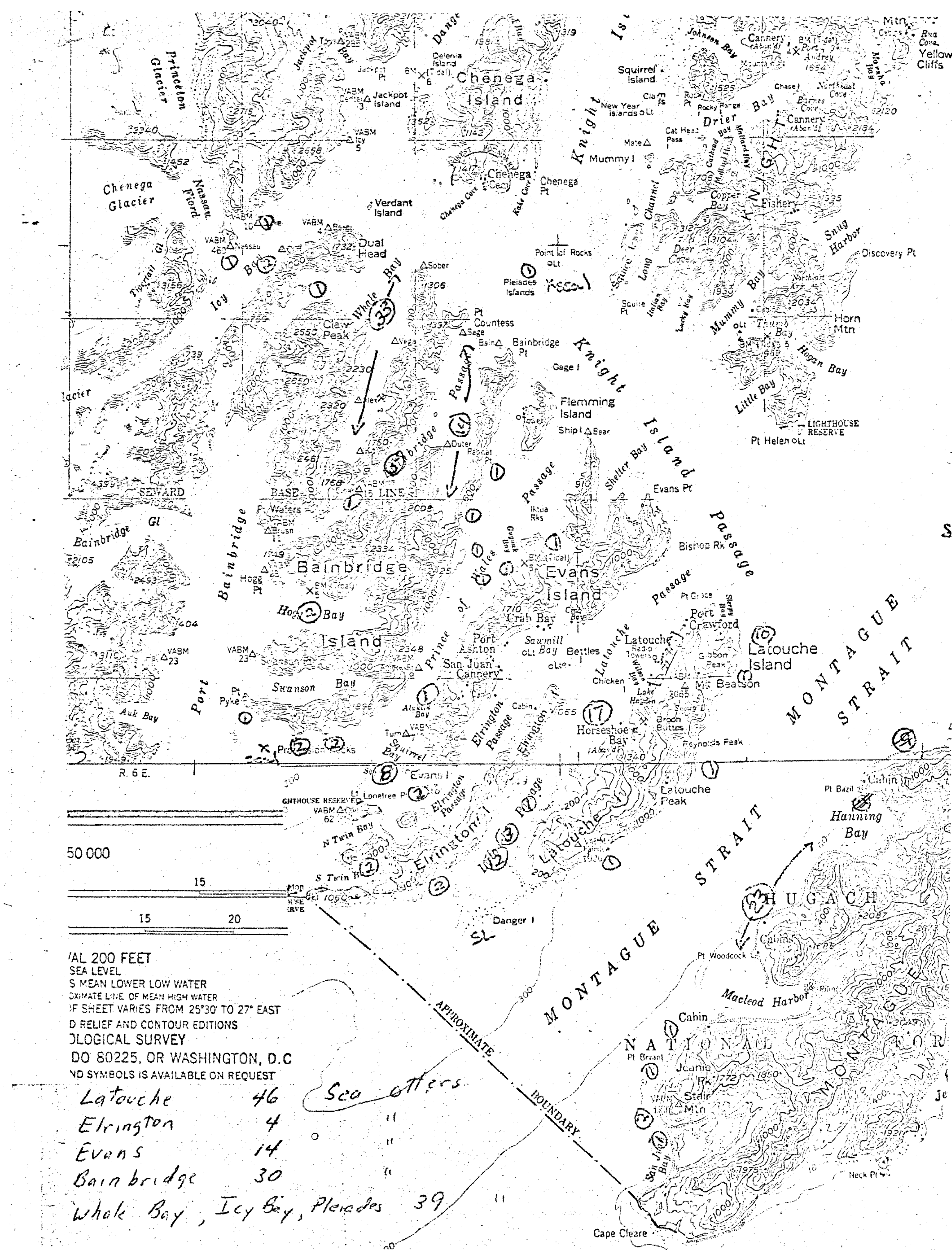
Area	Number of Sea Otter	Date
LONE ISLAND	NS	
NAKED ISLAND	NS	
PEAK ISLAND	NS	
STOREY ISLAND	NS	
KAYAK - WINGHAM ISLAND	5	4/17
TOTAL	892	

UN.TEL TATES
TMENT OF THE INTERIOR
EOLOGICAL SURVEY

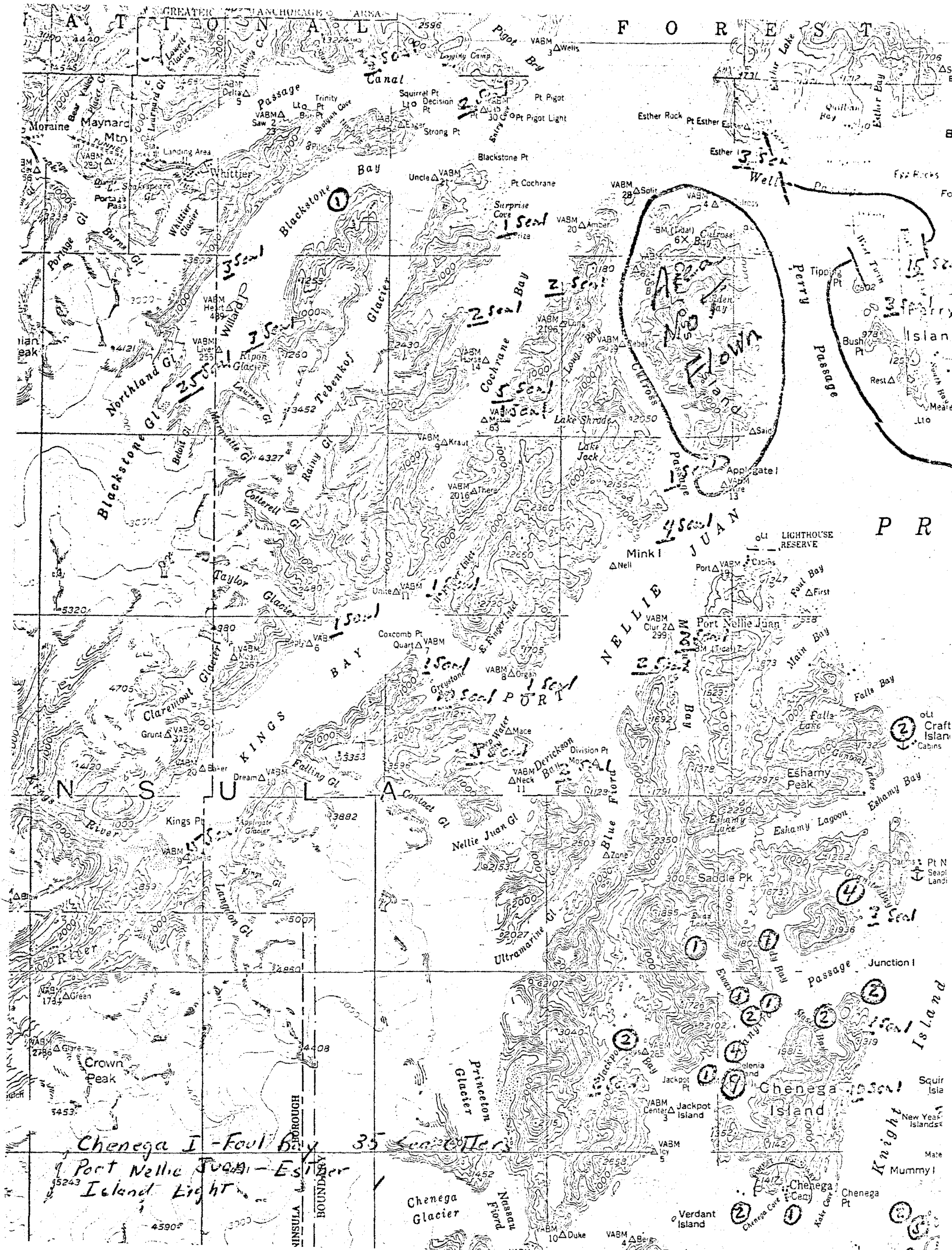


PRINCE WILLIAM SOUND
ORCA BAY
HAWKINS ISLAND
HINCHINBROOK ISLAND
Orca Inlet
Hawkins Island Cutoff
Egg Islands
Heney Range
NATIONAL FOREST BOUNDARY (APPROXIMATE)
Gravina Pt
Sheep Pt
Gatherer Pt
Bumb Pt
Cedar Bay
Windy Bay
Salmon Cr
Canoe Passage
Middle Ground Shoal
Makaka Pt
Loon Rk
VABM 673
Rip Rk
Dan Bay
Johnstone Pt
Light
The Seven Sisters
Anderson Bay
Shelter Bay
Constantine Hbr
VABM 1790
Bear Cape
Nuchek
Phipps Pt
Garden Cove
Port Etches
Porpoise Rks
English Bay
Signal Mtn
Seal
Lighthouse
Cape Hinchinbrook
Hook Pt
Pt Steele
Strawberry Hill
Boswell Bay
Boswell Rock
Bentinck
Pinnacle Rk
Little Mummy I
Mummy I
Gravel Pt
Shag Rk
Whitshed
Twin Rks
Government Rk
Pt Whitshed
Bluff Pt
Hartney Bay
Saddle Pt
Spike I
Cordova Airstrip
Hen Pk
Hinchinbrook 99 Sea otter
Hawkins 1
Egg Is 2

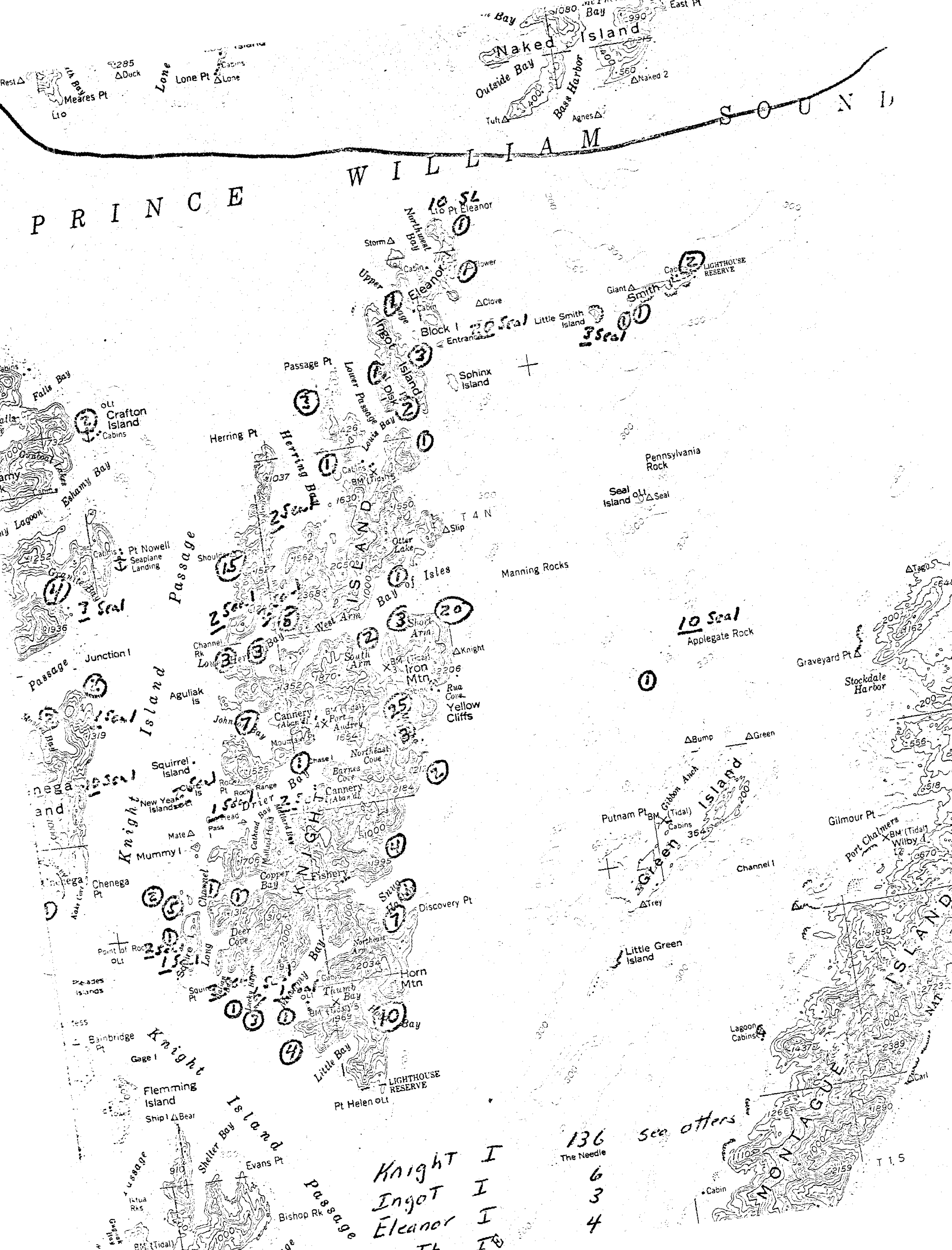

Iron Mtn
Knight
Yellow Cliffs
Applegate Rock
Rocky Bay
Graveyard Pt
Stockdale Harbor
Middle Pt
Zaikof Pt
Zaikof Bay
Schooner Rk
VABM
Montague Island
Bump
Green
Putnam Pt
Cabins
Green Island
Snug Harbor
Discovery Pt
Gilmour Pt
Port Chalmers
Wilby
Channel I
Trey
Montague Pk
Horn Mtn
Little Green Island
Lagoon Cabins
Carl
The Needle
MONTAGUE ISLAND
NAT FOR BDY (APPROX)
GULF OF ALASKA
MONTAGUE STRAIT
Cabin
Purple Bluff
6660000m.N.
2 200 000 FEET (ZONE 3)
60°00'
147°00'
Hanning Bay
Patton Bay
Martin River
Wooded Is
Tanker I
FOREST
APPROX BDY
Jeanie Cove
Jeanie Pt
Neck Pt
ALASKA
60X180
1969
Green + Little Green Is 102
Montague (Total both pages) 259



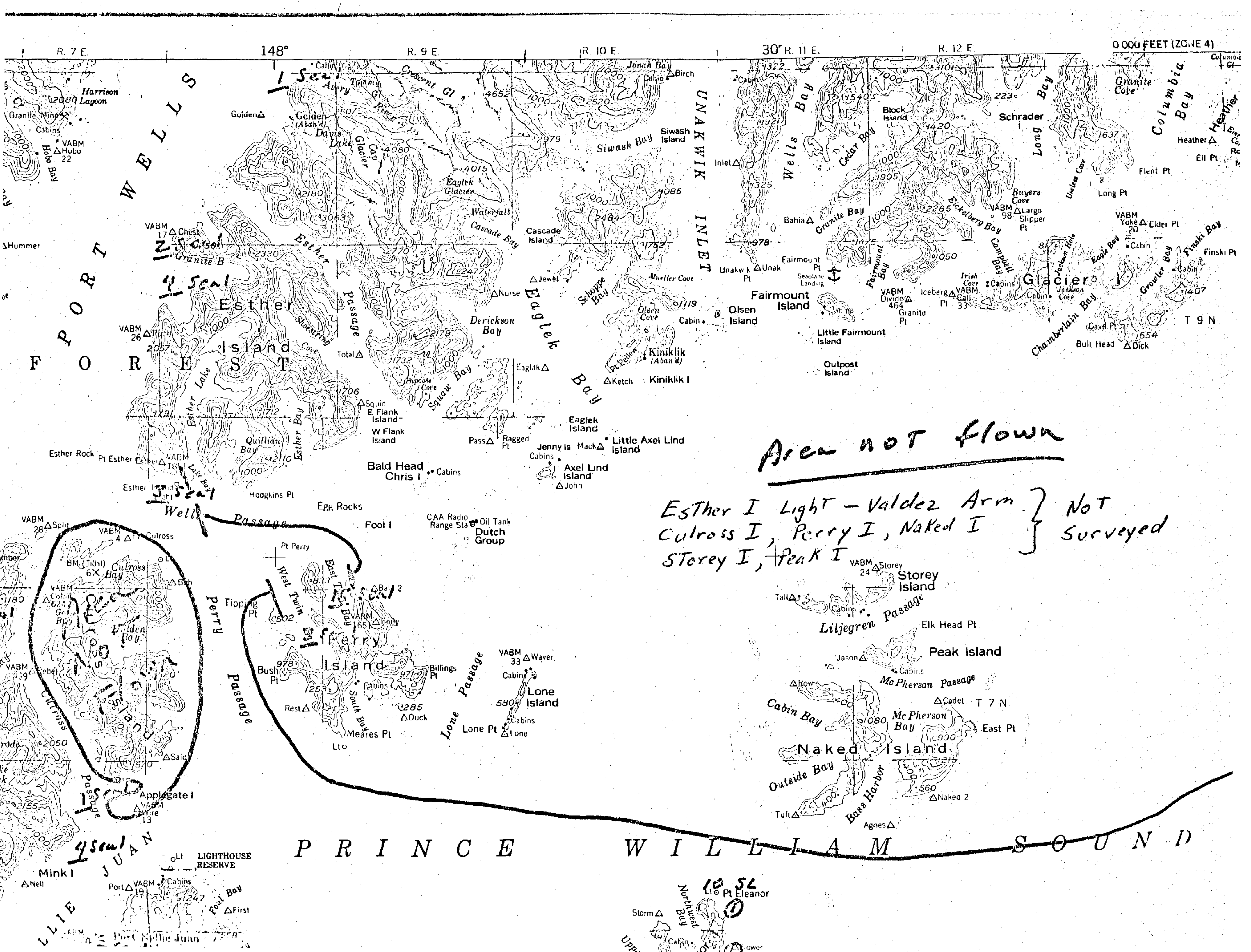
Latouche	46	Sea otters
Elrington	4	"
Evans	14	"
Bainbridge	30	"
Whale Bay, Icy Bay, Pleiades	39	"



GREATER ANCHORAGE AREA
NATIONAL FOREST
PENINSULA
PR
Passage Canal
Pigot Bay
Logging Camp
Wells
Delta
Saw
Trinity Pt
Squirrel Pt
Decision Pt
Pt Pigot
Pt Pigot Light
Strong Pt
Esther Rock
Pt Esther
Esther I
Esther Lake
Esther Bay
Quillian Bay
Maynard Mtn
Moraine
Landing Area
Whittier
Shakespeare Gl
Portage Pass
Portage Gl
Burns Gl
Whittier Glacier
Lowell Glacier
Learnard Gl
Blackstone Bay
Blackstone Pt
Uncle
Pt Cochrane
Surprise Cove
Prize
Amber
Split
Culross Bay
Cochrane Bay
Long Bay
Culross Passage
Culross Island
Lake Shrode
Lake Jack
Applegate I
Perry Passage
Perry Island
Tipping Pt
West Twin
Bush Pt
Rest
Northland Gl
Blackstone Gl
Willard Gl
Ripon Glacier
Tebenkof Glacier
Lawrence Gl
Marquette Gl
Beloit Gl
Cotterell Gl
Rainy Gl
Kraut
There
Taylor Glacier
Claremont Glacier
Grunt
Baker
Dream
Unite
Coxcomb Pt
Quart
W. Finger Inlet
E. Finger Inlet
Greystone
Organ
Mink I
Nell
Lighthouse Reserve
Port
Cabins
Foul Bay
First
Port Nellie Juan
Main Bay
Falls Bay
Falls Lake
Craft Island
Eshamy Peak
Eshamy Bay
Eshamy Lagoon
Eshamy Lake
Kings Bay
Kings River
Kings Pt
Kings Gl
Applegate Glacier
Falling Gl
Contact Gl
Deep Water Bay
Mace
Derickson Bay
Division Pt
Neck
Blue Fiord
Nellie Juan Gl
Zone
Saddle Pk
Ultramarine Gl
Langdon Gl
Crown Peak
Green
Glare
Princeton Glacier
Chenega Glacier
Nassau Fiord
Jackpot Bay
Jackpot Pt
Jackpot Island
Center
Icy
Junction I
Passage
Knight Island
Chenega Island
Chenega
Chenega Pt
Chenega Cove
Kakt Cove
Verdant Island
Mummy I
New Year Islands
Duke
Berg
Pt Nellie Juan
Seaplane Landing
Borough Boundary
1 Seal
2 Seal
3 Seal
4 Seal
5 Seal
15 Seal
3 Seal Well
All No Seals Flown
Chenega I - Foul Bay 35 Sea Otters
Port Nellie Juan - Esther Island Light



PRINCE WILLIAM SOUND
Naked Island
Outside Bay
Bass Harbor
East Pt
Meares Pt
Lone Pt
Pt Eleanor
10 SL
Northwest Bay
Upper Passage
Eleanor I
Block I
Entrance
Little Smith Island
Smith I
LIGHTHOUSE RESERVE
20 Seal
3 Seal
Ingot Island
Sphinx Island
Passage Pt
Lower Passage
Louis Bay
Herring Pt
Herring Bay
Crafton Island
Falls Bay
Bahamy Bay
Pt Nowell
Seaplane Landing
Pennsylvania Rock
Seal Island
Manning Rocks
25 Seal
2 Seal
1 Seal
Bay of Isles
West Arm
Short Arm
South Arm
Iron Mtn
Yellow Cliffs
Rua Cove
10 Seal
Applegate Rock
Graveyard Pt
Stockdale Harbor
Junction I
Aguliak Is
Knight Island Passage
Johnson Bay
Port Audrey
Cannery (Aband'd)
Northeast Cove
Barnes Cove
Squirrel Island
New Year Islands
Drier Bay
Mummy I
Chenega Pt
Copper Bay
Fishery
Discovery Pt
Deer Cove
Long Channel
Horn Mtn
Thumb Bay
Little Bay
LIGHTHOUSE RESERVE
Pt Helen
Putnam Pt
Green Island
Gibbon Anch
Channel I
Little Green Island
Gilmour Pt
Port Chalmers
Lagoon Cabins
MONTAGUE ISLAND
Bainbridge Pt
Gage I
Knight Island
Flemming Island
Shelter Bay
Evans Pt
Bishop Rk
Passage
The Needle
136 Sea otters
Knight I 6
Ingot I 3
Eleanor I 4



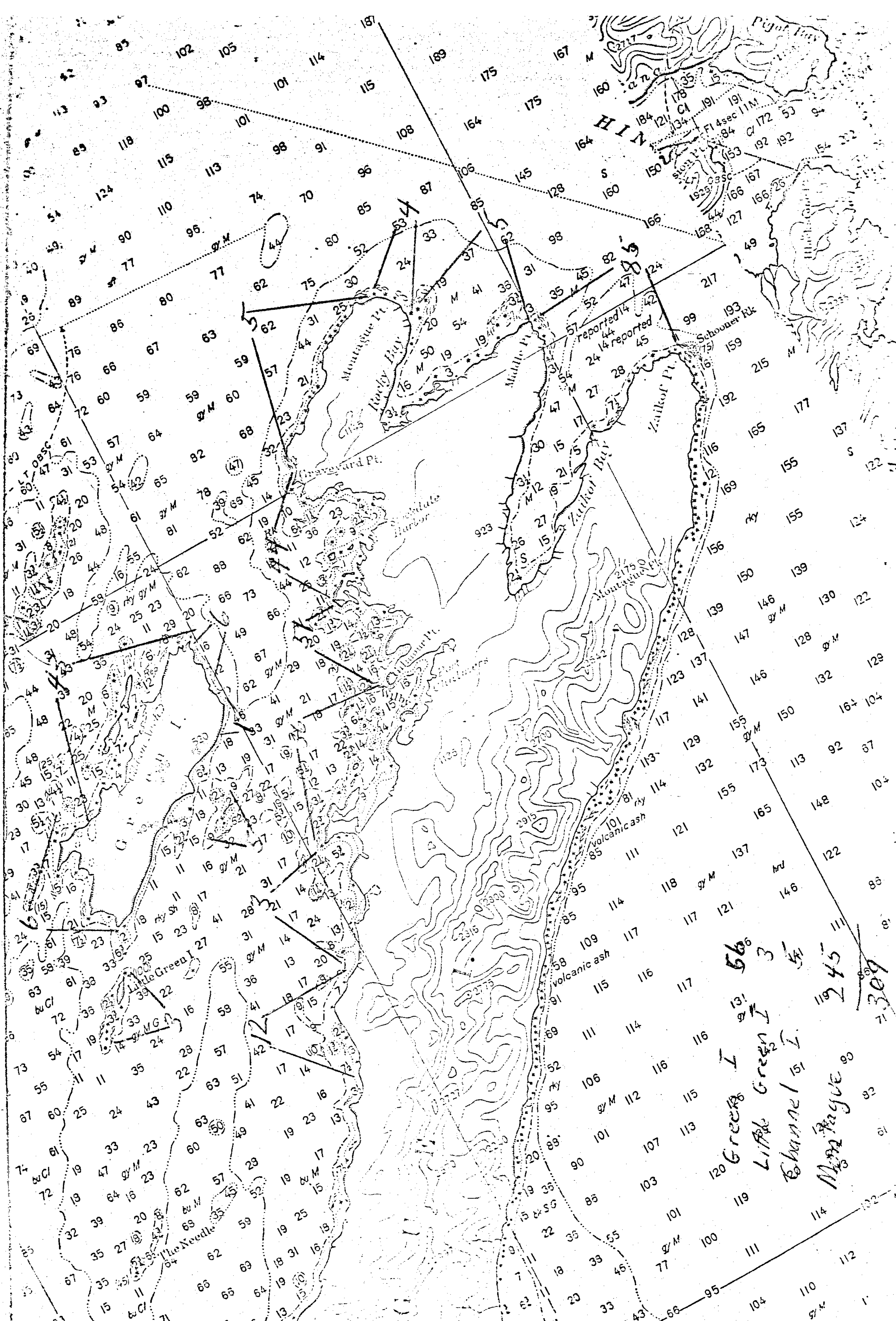
Area not flown
Esther I Light – Valdez Arm
Culross I, Perry I, Naked I
Storey I, Peak I
Not Surveyed
1 Seal
2 Seal
3 Seal
4 Seal
1 Seal
4 Seal
10 SL
PORT WELLS
FOREST
PRINCE WILLIAM SOUND
UNAKWIK INLET
Esther Island
Esther Passage
Eaglek Bay
Wells Bay
Columbia Bay
Long Bay
Schrader I
Fairmount Island
Olsen Island
Perry Island
Perry Passage
Well Passage
Lone Passage
Lone Island
Storey Island
Liljegren Passage
Peak Island
McPherson Passage
Naked Island
Cabin Bay
Outside Bay
Bass Harbor
Culross Island
Culross Passage
Mink I
LIGHTHOUSE RESERVE
R. 7 E.
148°
R. 9 E.
R. 10 E.
30' R. 11 E.
R. 12 E.
0 000 FEET (ZONE 4)
T 9 N
T 7 N

PRE-TRANSPLANT SURVEY OF SEA OTTERS
Green I. and Montague I. - July 17, 1970

On July 17, 1970 an aerial survey of sea otters was made in the area around Green Island and the adjacent coast of Montague Island. The purpose of the survey was to locate concentrations of animals prior to a capturing operation which began the next day. A Dornier twin-engine aircraft was used with Schneider, Reynolds and Somerville acting as observers. The sky was overcast, almost no wind and the sea calm. However, heavy rain showers interfered with forward visibility and the counting conditions were only fair on the average. Conditions were especially poor in Port Chalmers and Zaikof Bay. The count began at 2:10 p.m. and ended at 3:45 p.m.

The numbers and locations of otters are shown on the map. In addition, 16 sea otters were seen on a superficial look at Constantine Harbor on Hinchinbrook Island and a pod of 35 were seen three miles east of Johnstone Pt.

Most of the area included in the survey was traveled repeatedly in a skiff over the next four days. During this time the weather became calm and clear for the first time in several days and the bulk of the sea otters shifted from the coast of Montague out into the shallow areas between there and Green I. and to Green and Channel Islands. It was obvious that many otters had been missed in the aerial survey and that the population in the area is quite dense. A total of 48 sea otters were captured in three days of netting.


Pigot Bay
Fl 4sec 11M
Montague Pt.
Rocky Bay
Middle Pt.
Zaikof Pt.
Zaikof Bay
Schooner Rk
reported 14
14 reported
Graveyard Pt.
Port Chalmers
Green I.
Little Green I.
The Needle
Montague Pk
volcanic ash
Green I
Little Green I
Channel I
Montague

SEA OTTER SURVEY
Salisbury Sound to Cape Spencer
August 23-25, 1970

On August 23, 1970, an aerial search for sea otters was made from Salisbury Sound to Torch Bay in the area north of Sitka. A Helio Courier aircraft was used with Karl Schneider, Alan Courtright and Walt Cunningham serving as observers.

The water on the outside coast was too rough for good visibility however it was calmer in the lee of rocks and islands and visibility was fair to good.

On the initial survey only two otters were seen. These were both in Surge Bay on Yakobi Island. While returning after completing the count, we located approximately 25 in the same area we saw the first two. About 15 of these including at least one pup were in a single pod. This illustrates how relatively large numbers of otters can be missed from the air. The fact that none were seen in other areas does not mean that established populations do not exist elsewhere.

On August 24 and 25 a search of the release area north of Khaz Bay was made by the skiff. While flying into Klag Bay for this seach, two otters were seen near the old mine of Chichagof. Two miners who have been working there reported that two otters have been there off and on since May.

Rough weather and outboard problems restricted to the search area and the effectiveness of the search in that area. The following sightings were made:

8/24/70	1 Adult	West of Granite Islands
	1 Adult	South of Granite Islands
	1 Adult (w/pup?)	In rocks S.E. of Granite Islands
8/25/70	1 Adult	Southwest of Granite Islands

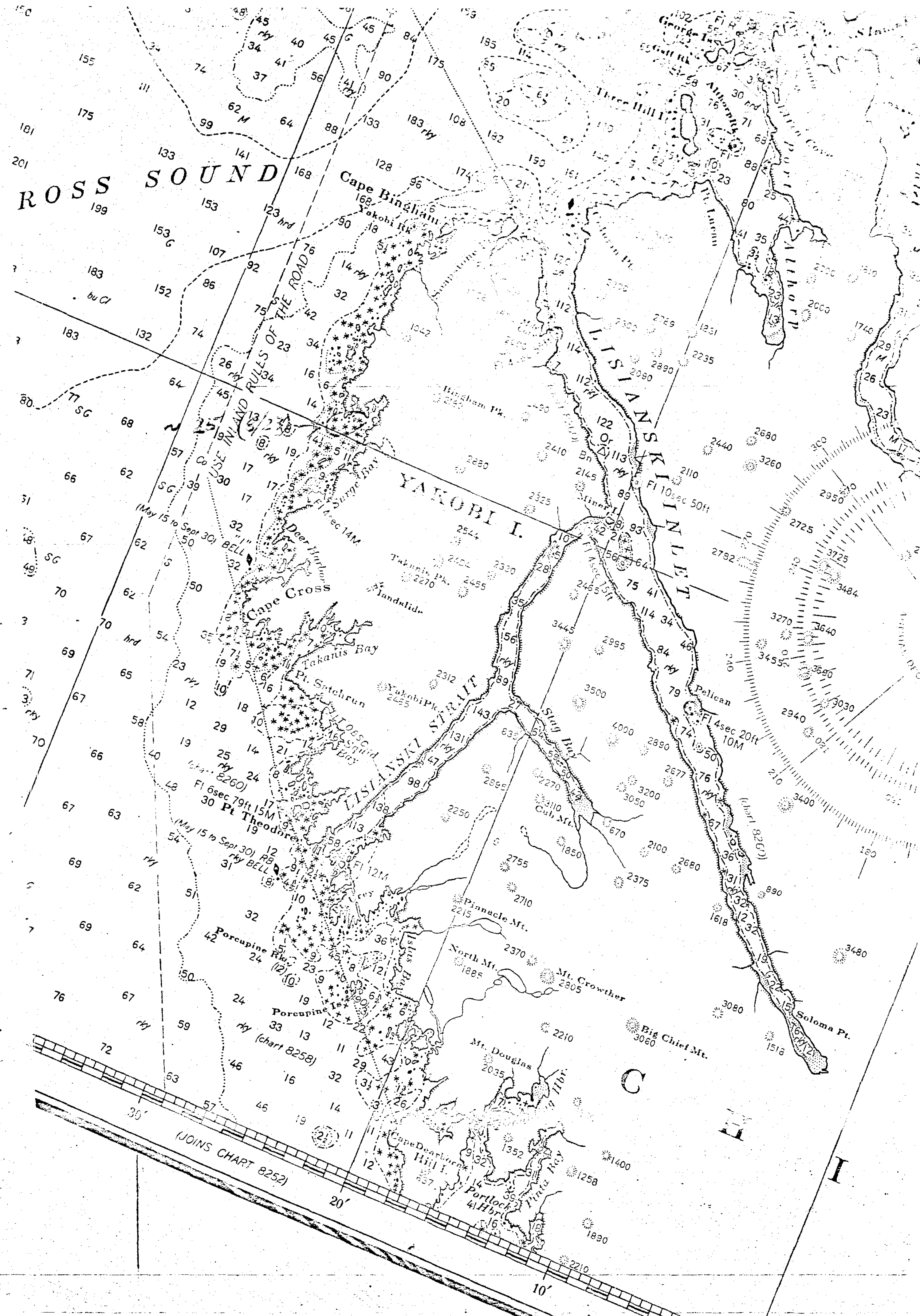
These sightings represent from four to seven animals.

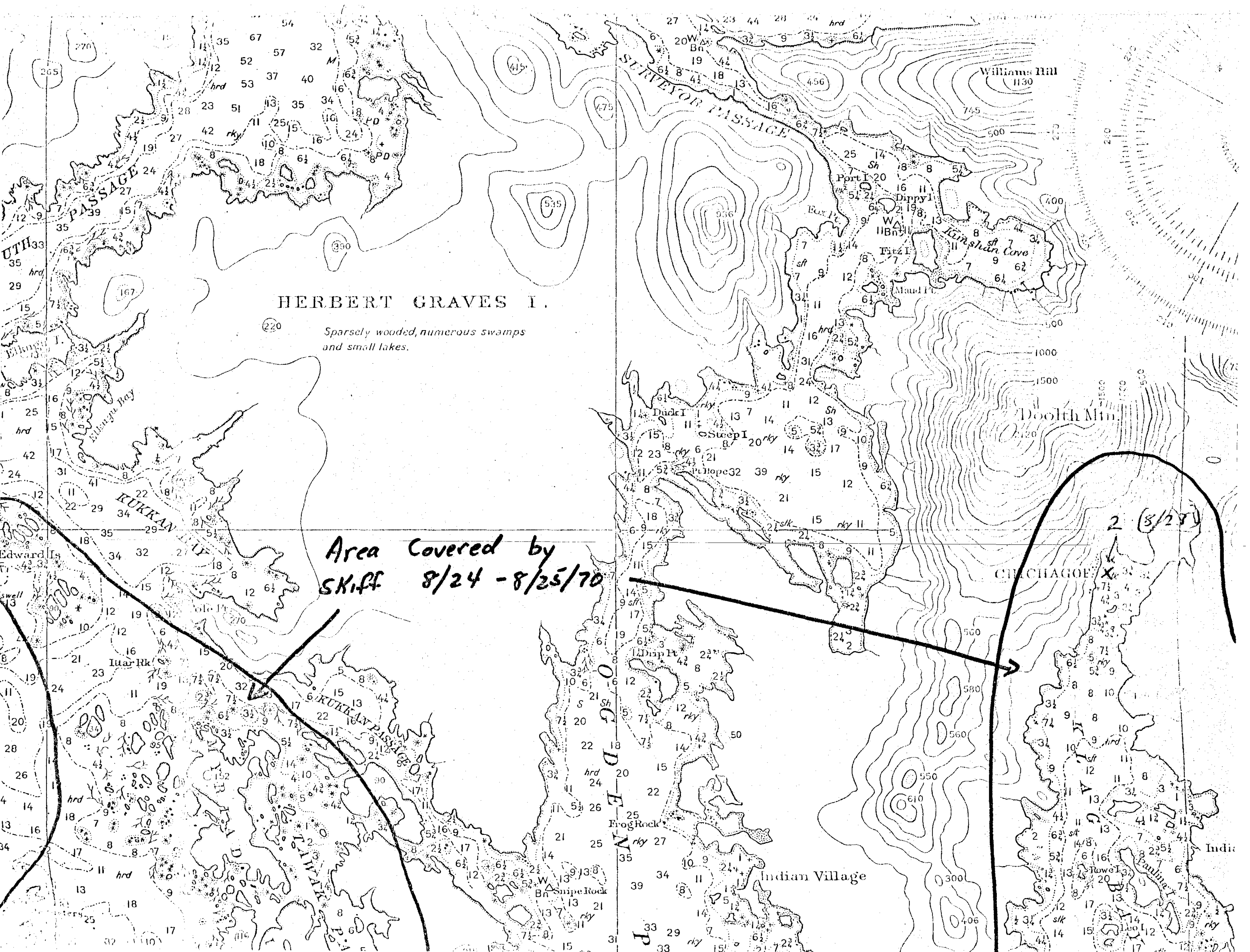
Reports over the last year indicate that sea otters regularly move in and out of Klag Bay and occasionally as far in as Sisters Lake.

The fact that the count in the Khaz Bay area was less than that made in 1969 does not mean much. The animals appeared to be scattered during the present count, the search did not include all of the nearby sea otter habitat and survey conditions were less than ideal.

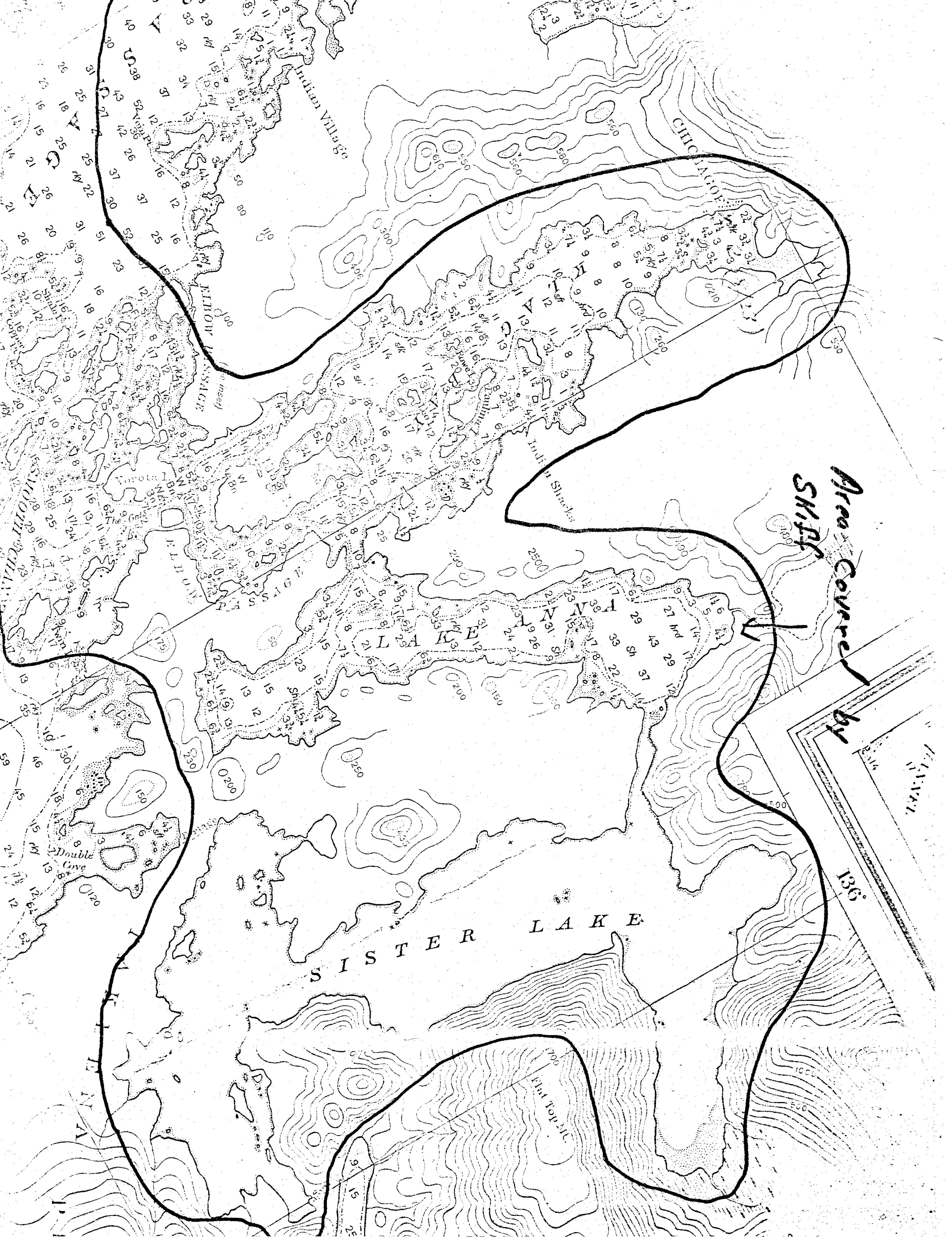
The population in Surge Bay appears to be separate and is probably well established. Two otters were reported in the same location in January 1966 after only 23 otters had been released near Khaz Bay. In 1969 two were seen in the same spot from the air.

While no estimate of the population of sea otters in the area can be made from the available information, it is evident that sea otters can be found along the entire west coast of Chichagof Island and that concentrations occur near Black Island and the Granite Islands north of Khaz Bay and in Surge Bay on Yakobi Island.

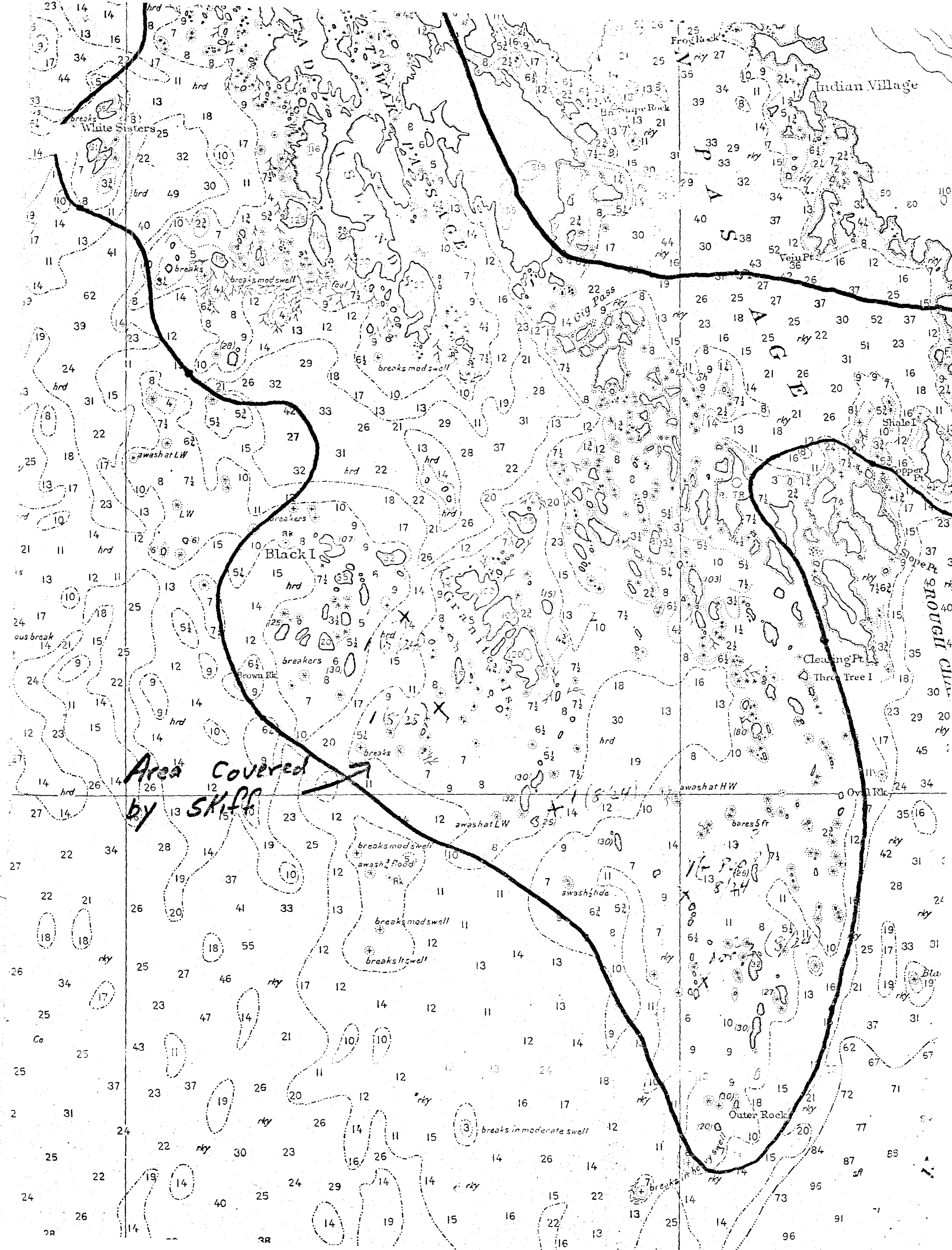

ROSS SOUND
Cape Bingham
Yakobi Rk
USE INLAND RULES OF THE ROAD
YAKOBI I.
LISIANSKI INLET
LISIANSKI STRAIT
Three Hill I.
George Is.
Gull Rk
Althorp
Port Althorp
Pt. Lucan
Bingham Pk.
Miner I.
Fl 10sec 50ft
Surge Bay
Fl 4sec 14M
Deer Harbor
BELL "1"
(May 15 to Sept 30)
Cape Cross
Takanis Pk.
Landslide
Takanis Bay
Pt. Satchrun
Yakobi Pk.
Squid Bay
Stag Bay
Pelican
Fl 4sec 20ft 10M
(chart 8260)
Fl 6sec 79ft 15M
Pt Theodore
(May 15 to Sept 30) RB rky BELL
Fl 12M
Cub Mt.
Pinnacle Mt.
North Mt.
Mt. Crowther
Porcupine Rk
Porcupine Is
(chart 8258)
Big Chief Mt.
Mt. Douglas
Soloma Pt.
Cape Dearborn
Hill I.
Portlock Hbr
Tiata Bay
(JOINS CHART 8252)
30′
20′
10′



HERBERT GRAVES I.
Sparsely wooded, numerous swamps and small lakes.
SURVEYOR PASSAGE
Williams Hill
Kinshan Cove
Port I.
Dippy I.
Fitz I.
Maud Pt.
Fox Pt.
Doolth Mtn.
CHICHAGOF
Duck I.
Sheep I.
Pt. Hope
Drip Pt.
OGDEN
Frog Rock
Indian Village
Snipe Rock
KUKKAN PASSAGE
KUKKAN BAY
Elfenda Bay
Edward Is.
Iltar Rk.
TAWAK
Area Covered by SKiff 8/24 - 8/25/70
2 (8/27)



Area Covered by Skiff
SISTER LAKE
LAKE ANNA
ELBOW PASSAGE
Indian Village
Double Cove
Flat Top Mt.


Area Covered by Skiff
White Sisters
Indian Village
Frog Rock
Vein Pt
Gig Pass
Shale I
Black I
Brown Rk
Granite Is
Clearing Pt
Three Tree I
Slope Pt
Oval Rk
Outer Rock
breakers
breaks mod swell
breaks in moderate swell
breaks lt swell
awash at LW
awash at HW
P A S S A G E

HARVEST AND TRANSPLANTS - 1970

Harvest

In May of 1970, a sea otter harvest was conducted on Tanaga Island, the Delarof Islands and Amchitka Island. The numbers to come from each island and the distribution of the kill around each island were planned in advance. Conservative estimates of the population were made and the total harvest numbers were based on these estimates. The harvest level for Tanaga and the Delarof Islands was set at 15 percent, assuming that the next harvest in these areas would be three years later so the rate of harvest would be 5 percent per year. Amchitka's harvest level was set at 10 percent, assuming an annual harvest and a harvest rate of 10 percent per year.

The harvest plan was based on information collected on a June 1968 skiff survey for Tanaga, on the 1965 USFWS aerial survey and the 1969 ADF&G aerial survey for the Delarofs, and on 1968 helicopter survey by the USFWS for Amchitka. There is good evidence that all the population estimates were low, especially for the Delarofs.

Hunting was done from two skiffs with two men each. Both men shot when possible. A 117-foot vessel was used for skinning and living quarters. Table 1 shows the schedule of the hunt with the daily harvest numbers.

Table 2 presents the projected and actual harvest numbers by area. Table 3 presents the numbers killed, pelts saved, specimen and pelt numbers used and the sex ratio of the kill for each area. Figures 1, 2 and 3 show the actual numbers and locations in more detail. Weather was the main factor causing deviations from the original harvest plan. Possible male areas were identified on the 1968 skiff survey on Tanaga. An attempt was made to concentrate more pressure on these areas to achieve a more balanced sex ratio. This effort is reflected in the sex ratio of the kill. A high degree of sexual segregation occurs at this time of year and without specific pressure on male areas we could expect 85 percent females to be taken as occurred on Amchitka. With the effort the female percentage was reduced to 65 percent on Tanaga. In the Delarofs a male area which had not been identified previously was hit and the effect was much the same.

Transplants

Two transplant operations took place in 1970. The first was done in the same manner as the 1968 and 1969 transplants. A total of 86 otters were captured at Amchitka. One aircraft load was shipped out. Twenty-nine were released in Oregon and 30 in Washington. The animals were held in floating pens at the release sites for several days to recover from the trip. Survival appeared to be excellent.

The second operation took place in Prince William Sound. The Canadian research vessel G B Reed came to the Green Island-Port Chalmers area with tanks built on deck. Forty-six sea otters were captured. Approximately 44 were alive when the vessel left Prince William Sound, however only 14 survived to be released off Vancouver Island.

Table 1. Schedule of the 1970 harvest.

April 20	10:30 p.m. depart Homer.	
May 1	Midnight arrive Adak, M/V Active.	
May 2	Refuel and prepare boat.	
May 3	Arrive off Tanaga at noon.	Killed 53 otter
May 4		138
May 5		88
May 6		131
May 7		143
May 8	Complete skinning, pack hides, etc. in p.m.	53 (a.m.)
May 9	Delarofs	144
May 10	Spent a.m. getting water at Amchitka.	43 (p.m.)
May 11		79
May 12	Clean up boat, take down shelter, pack gear.	83 (by mid afternoon)
May 13	9:00 a.m. arrive Amchitka, fly to Anchorage.	

Table 2. Projected and actual harvest numbers, May 1970.

	Projected Harvest		Actual Harvest	
Tanaga Island				
Bumpy Point - Hot Springs Bay	200		191	
Hot Springs Bay - Twin Bays	50		50	
Twin Bays - Cape Sasmik	50)		199	
Cape Sasmik - Tower	120)			
Tower - Tanaga Bay	180		166	
TOTAL		600		606
Delarof Islands				
Gareloi	20-25		0	
Kavalga, Ogliuga and Skagul	75-100		125	
Ulak and Amatignak	35-55		19	
TOTAL		150		144
Amchitka Island				
USFWS Counting Units 1 & 2	100		saved for transplant	
3	30		82	
4	50		36	
5	120		87	
TOTAL	300		205	

Table 3. Details of sea otters harvested in May 1970.

Tanaga Island

Total kill	606
Number of pelts saved	598
Number of small pup pelts discarded	8

Specimen numbers SO 70-4 to SO 70-609
Pelt numbers 3198-3769 and 3771-3796
(Seal #3770 void - damaged)

Approximate sex ratio - 220 males, 386 females, or approximately 64 percent females

Delarof Islands

Total kill	144
Number of pelts saved	138
Number of pups discarded	6

Specimen numbers SO 70-610 to SO 70-753
Pelt numbers 3797 to 3934

Sex ratio - 44 males, 100 females, or approximately 69 percent females

Amchitka Island

Total kill	205
Number of pelts saved	194
Number of pups discarded	11

Specimen numbers SO 70-754 to SO 70-958
Pelt numbers 3935 to 4128

Sex ratio - 27 males, 178 females or approximately 86.7 percent females

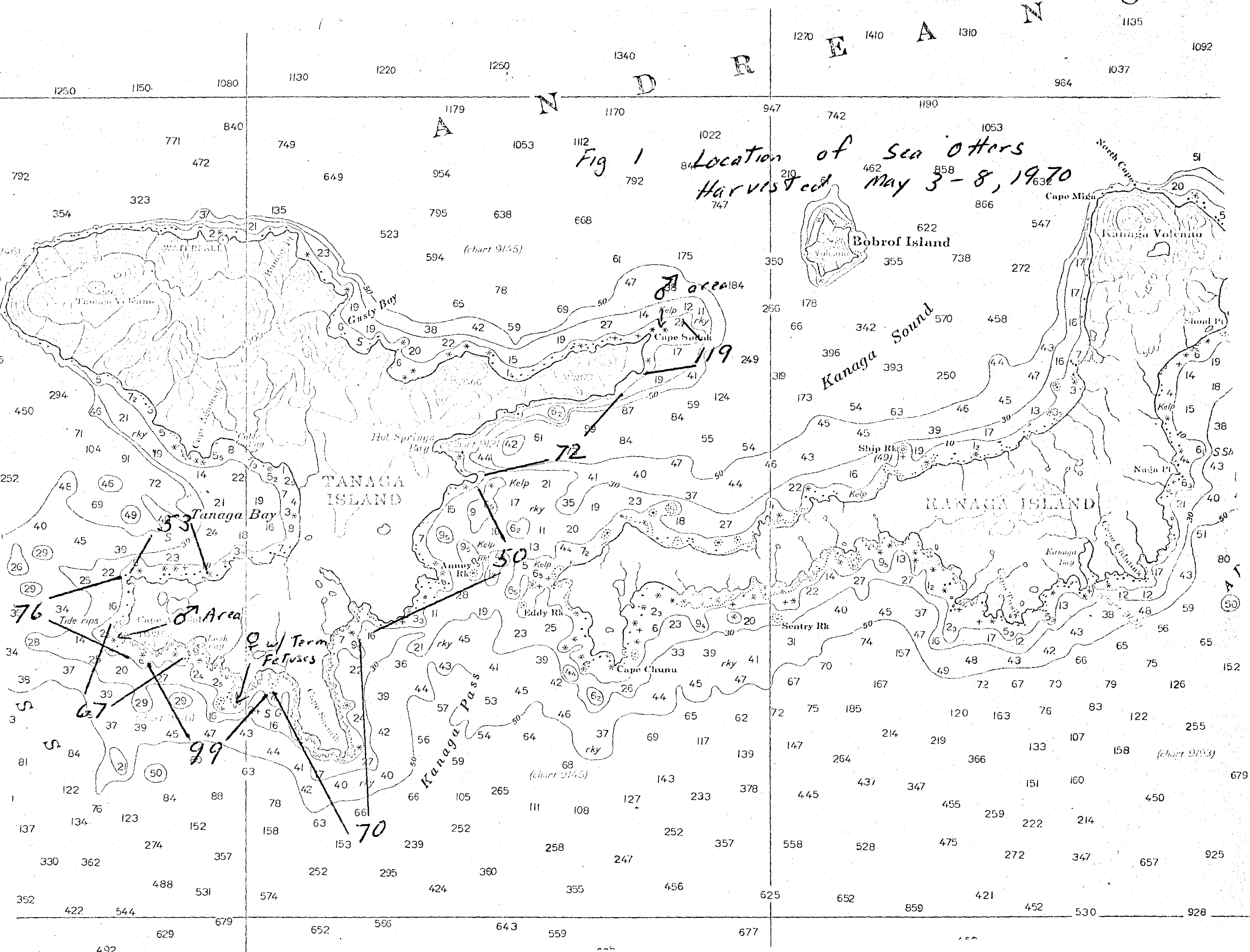
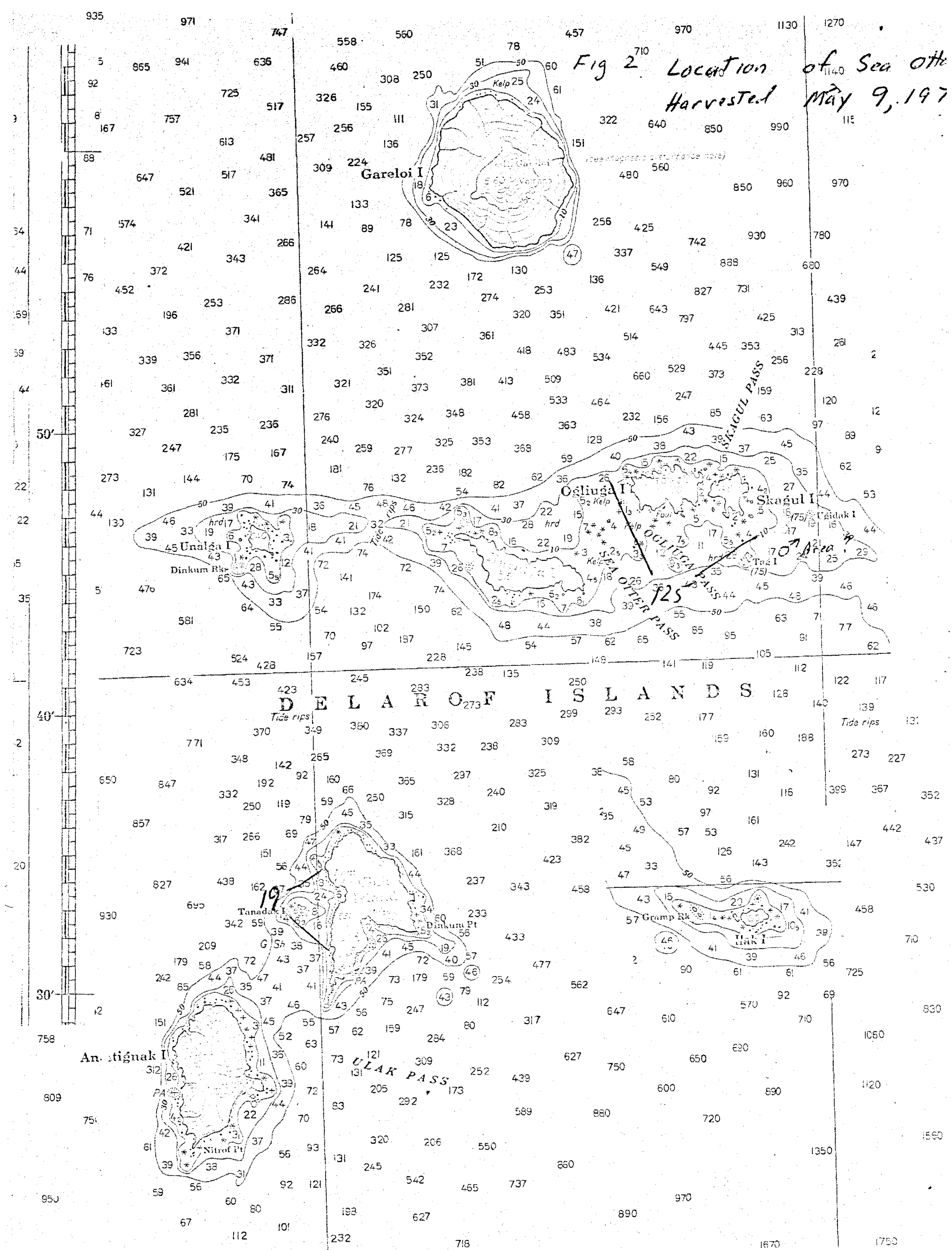


Fig 1 Location of Sea Otters Harvested May 3-8, 1970
Tanaga Island
Kanaga Island
Bobrof Island
Kanaga Sound
Kanaga Pass
Tanaga Bay
Gusty Bay
Hot Springs Bay
Cape Sudak
Cape Chunu
Eddy Rk
Sentry Rk
Ship Rk
Annoy Rk
Kanaga Volcano
Tanaga Volcano
Cape Miga
North Cape
Naga Pt
Shoal Pt
Kanaga Bay
Cape Chlunak
♂ area
♂ Area
♀ w/ Term Fetuses
119
72
50
53
76
67
99
70
Tide rips
(chart 9145)
(chart 9193)

Fig 2 Location of Sea Otter Harvested May 9, 197



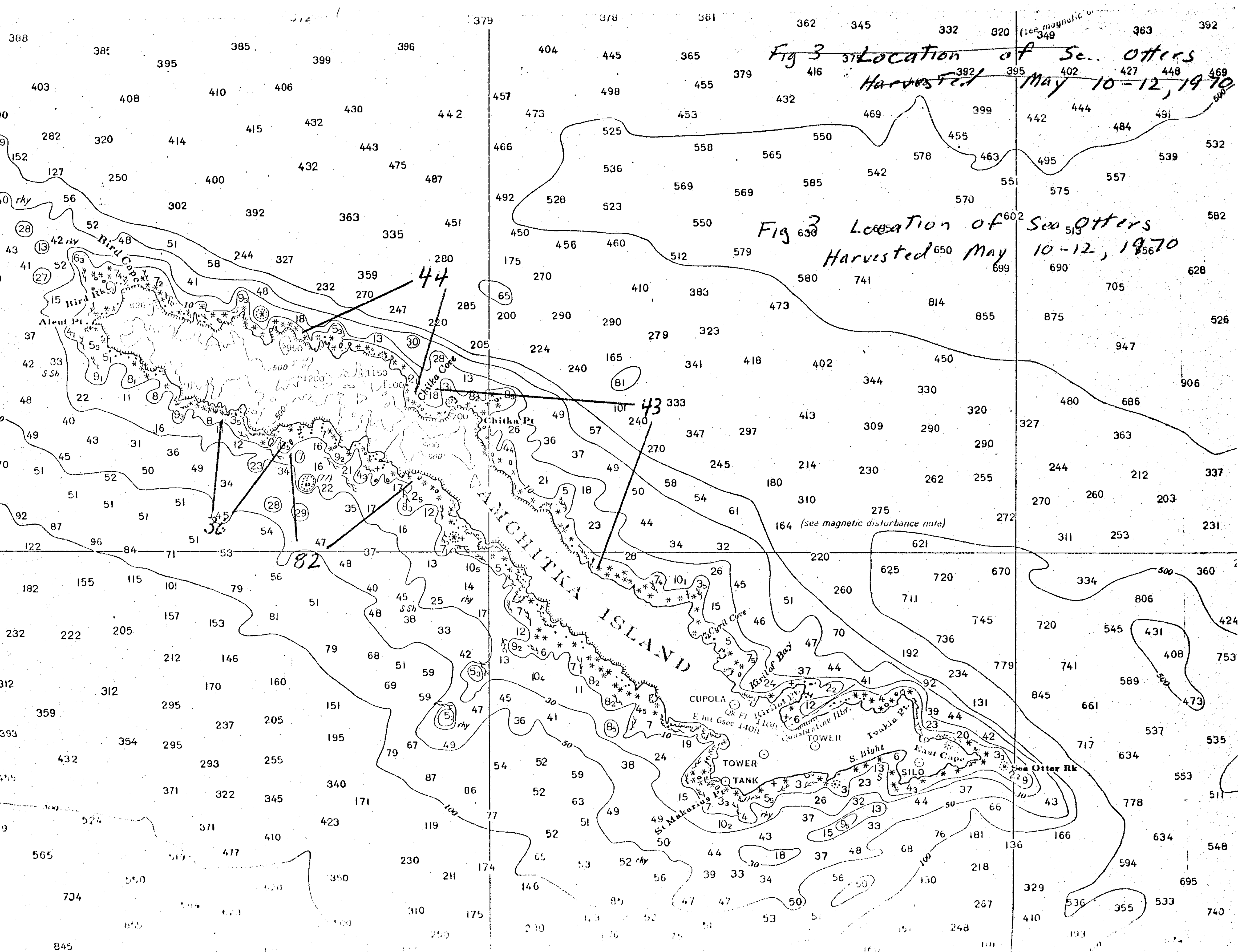


Fig 3 Location of Sea Otters Harvested May 10-12, 1970

Fig 3 Location of Sea Otters Harvested May 10-12, 1970

A combination of bad weather, a lack of time to let the otters recover from their capture and problems with the holding facilities probably caused the high rate of mortality.

Summary of Harvests and Transplants

Table 4 summarizes the sea otters removed from Alaskan populations in the last 20 years. An attempt has been made to remove 300 otters from Amchitka each year since 1967. Originally this number was set as 10 percent of the population which was conservatively estimated to toal 3000. Recent USFWS helicopter counts of up to 3927 show that this estimate definitely was low. In the past, the removal of animals was from the southeastern half of the island. The 1970 harvest was purposely concentrated toward the northwestern end in order to spread out the pressure and to learn something about the population in that area.

The numbers of animals released in all transplant attempts by the U. S. Fish and Wildlife Service and the Alaska Department of Fish and Game are presented in Table 5.

Table 4. Numbers of sea otters removed from Alaskan populations, 1951-70.[1/]

		1951	54	55	56	57	59	60	62	63	65	66	67	68	69	70
Amchitka I.	USFWS Studies	35	22	37	26	21	39				2					
	ADF&G Transplant													476	237	86
	ADF&G Harvest								180	311			205			205
	Other												5[2/]	24[3/]	14[3/]	1
	Total	35	22	37	26	21	39		180	311			210	500	251	292
Tanaga I.	ADF&G Harvest															606
Kanaga I.	ADF&G Harvest													318		
Adak I.	ADF&G Harvest												300	194		
Shumagin Is., Sanak & Unimak Is.	USFWS Studies							14						2		
Hinchinbrook I.	ADF&G Transplant										41					
	ADF&G Studies													1		
Montague & Green Is.	ADF&G Transplant											39				46
	ADF&G Studies													1		
Delarof Is.	ADF&G Harvest															
Ogliuga & Skagul																125
Ulak																19

1/ Includes all animals that were harvested, died during studies and transplant attempts or were transplanted to other areas or zoos. Does not include natural mortality or illegal kills.
2/ Woodland Park Zoo.
3/ Battelle Memorial Institute.

Table 5. Numbers of sea otters transplanted 1955-1970.

		1955	1956	1959	1965	1966	1968	1969	1970
Aleutians	Attu I.		5						
Pribilofs	Otter I.	19 1/							
	St. Paul I.			7					
	St. George I.						57		
	Yakutat Bay					10			
	Khaz Bay (Chichigof I.)				23	20	93	58	
Southeast Alaska	Yakobi I.						30		
	Biorka I.						48		
	Barrier Is.						55		
	Heceta I.						51		
	Cape Spencer						25		
British Columbia								29	14
Washington								29 2/	30
Oregon									29

1/ None believed to have survived.
2/ At least 13 died shortly after release.

NOTE: 1955 to 1959 by USFWS, 1965 to 1970 by ADF&G. In some cases one or two of the above animals died near the time of release.

SEXUAL SEGREGATION IN SEA OTTER POPULATIONS

by Karl Schneider
March, 1971

Workers have recognized for some time that sea otters tend to segregate by sex. Lensink (1962) described this segregation around the southeastern end of Amchitka Island and identified three "male areas" and three "female areas". He speculated that females used areas of more favorable habitat and that younger males were excluded by territorial males scattered throughout the female areas. The implication is that male areas contain younger or at least nonterritorial males.

Marakov (1965) mentions sexual segregation around Medny Island in the USSR's Commander Islands.

Kenyon (1969) gives a more complete description of the sexual segregation around the southeastern end of Amchitka and supports it with quantitative data from harvested animals.

Both Lensink (1962), and Kenyon (1969) were primarily describing hauling grounds used by different sexes. While Kenyon's harvested animals included otters near shore, neither study provided much information on the use of off-shore areas.

A knowledge of the degree of sexual segregation and the location of male and female areas is important to the management of sea otter populations. Harvests must be regulated to avoid putting too much pressure on one segment of the population. When capturing animals for transplants, it may be necessary to set nets in specific areas to obtain the desired sex ratio. In case of a localized kill of otters, such as when oil spills occur, it is important to know the distribution of sexes to evaluate the importance of the kill to the population.

By the same token, much can be learned about the distribution of sexes through harvest and capture operations. The area from which each sea otter was taken during the harvests of 1967, 1968 and 1970 was recorded. Because a single hunting party might kill 30 otters over up to 10 miles of coast in a few hours, it wasn't possible to record the precise locations. Therefore the coast was broken up into areas and the numbers killed in each area were totaled.

Figs. 1 - 5 show the locations of the areas. The letters correspond to those in Tables 1 - 4 which present the sex and age composition of animals harvested in each area. The ages of the 1968 animals were based on cementum deposition and reproductive condition. The other samples were broken down using body size. In general, all males under 25 lb, females under 20 lb and both sexes shorter than 100 cm were considered dependent pups. Females under 35 lb and 120 cm and males under 45 lb and 130 cm were considered subadults. These criteria probably underestimate the age of some animals. Cementum deposition information for the 1967 and 1970 samples is not available yet.

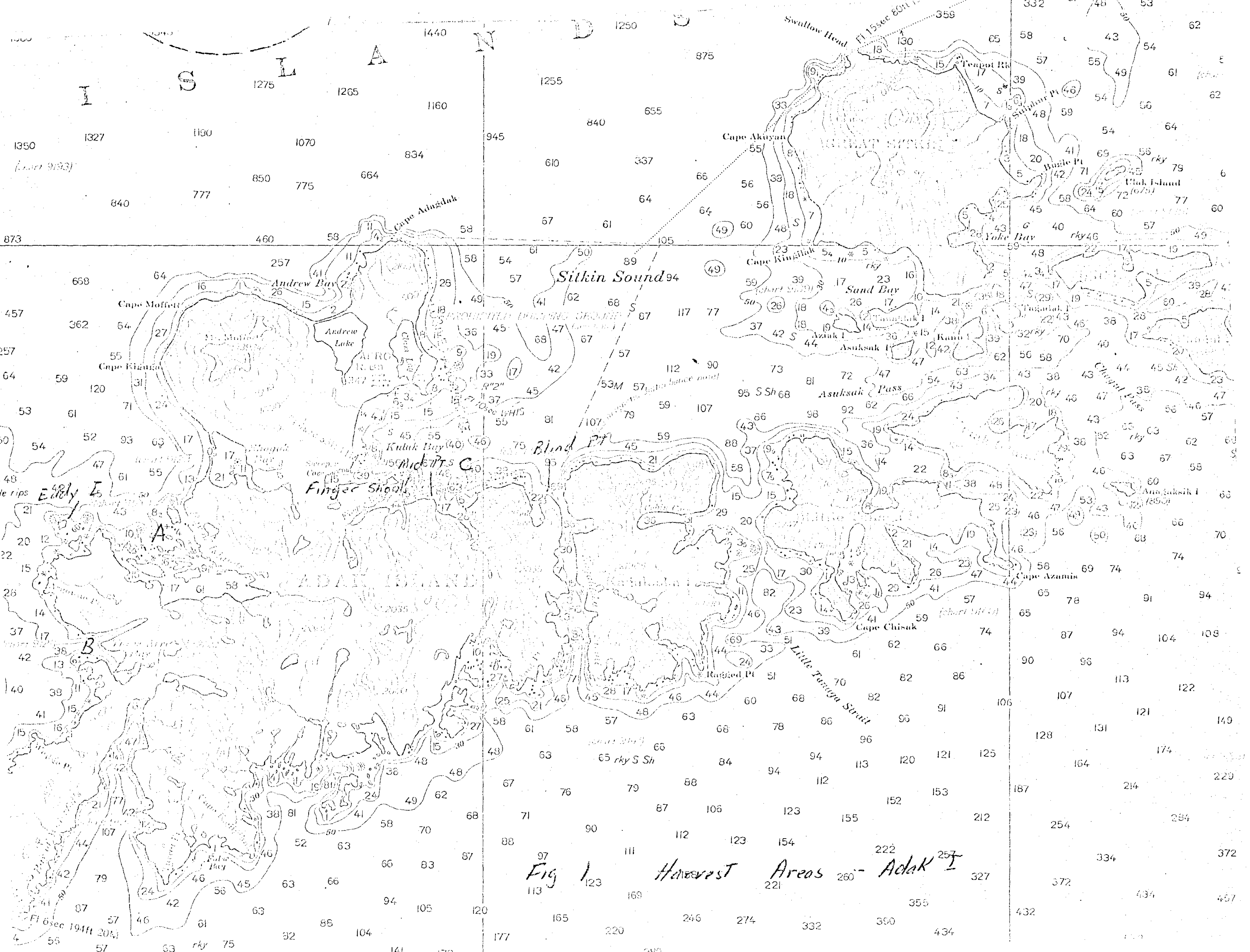


Fig 1 Harvest Areas - Adak I
Sitkin Sound
Finger Shoal
Bird Pt
Kulak Bay
Andrew Bay
Andrew Lake
Cape Adagdak
Cape Moffett
Cape Kiguga
Cape Akuyan
Cape Kiagilak
Swallow Head
Teapot Rk
Sulphur Pt
Bugle Pt
Ulak Island
Yoke Bay
Sand Bay
Aziak I
Asuksak I
Asuksak Pass
Kanu I
Chugul Pass
Anagaksik I
Cape Azamis
Cape Chisak
Little Tanaga Strait
Ragged Pt
Early I
A
B
C

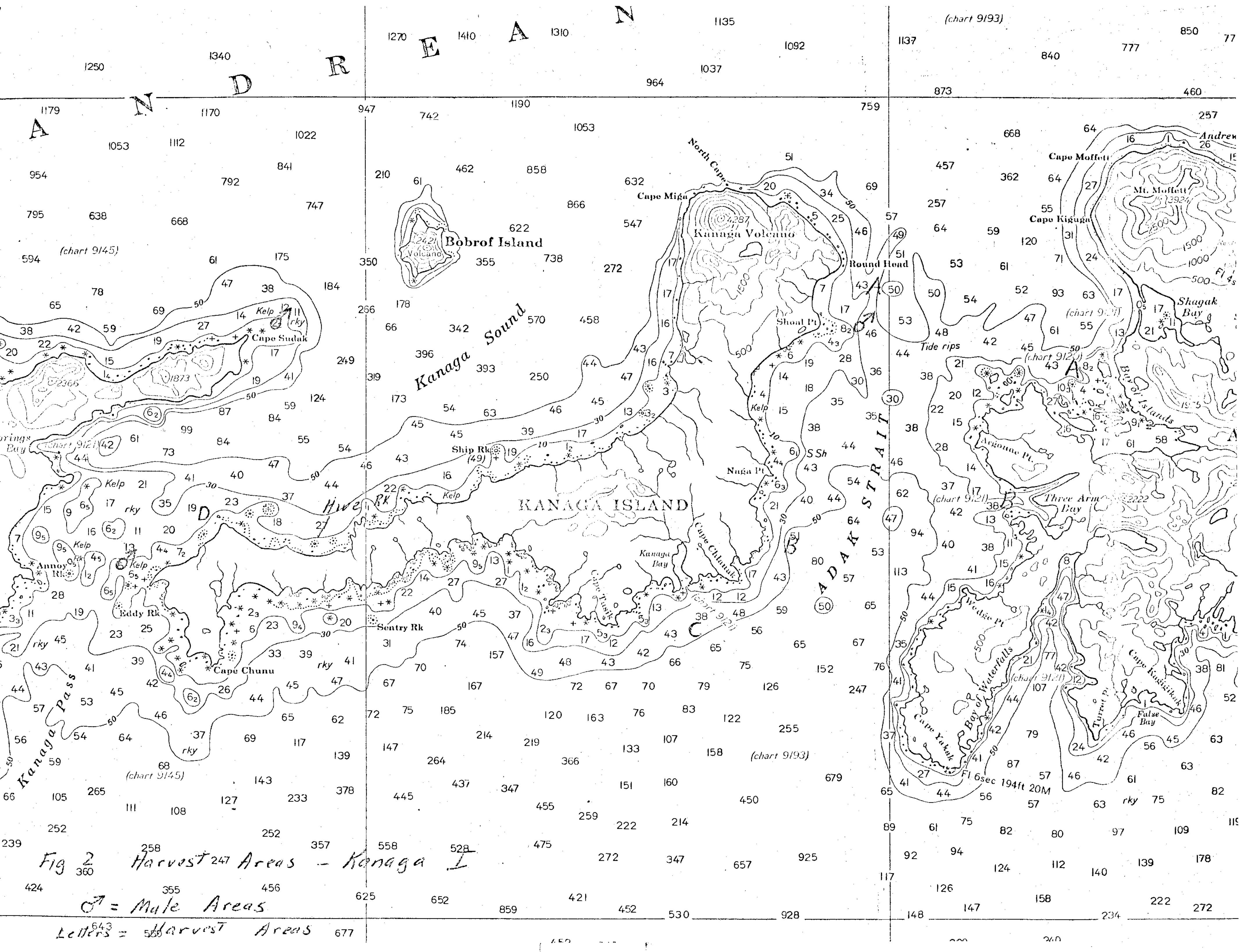


Fig 2 Harvest Areas - Kanaga I

♂ = Male Areas

Letters = Harvest Areas

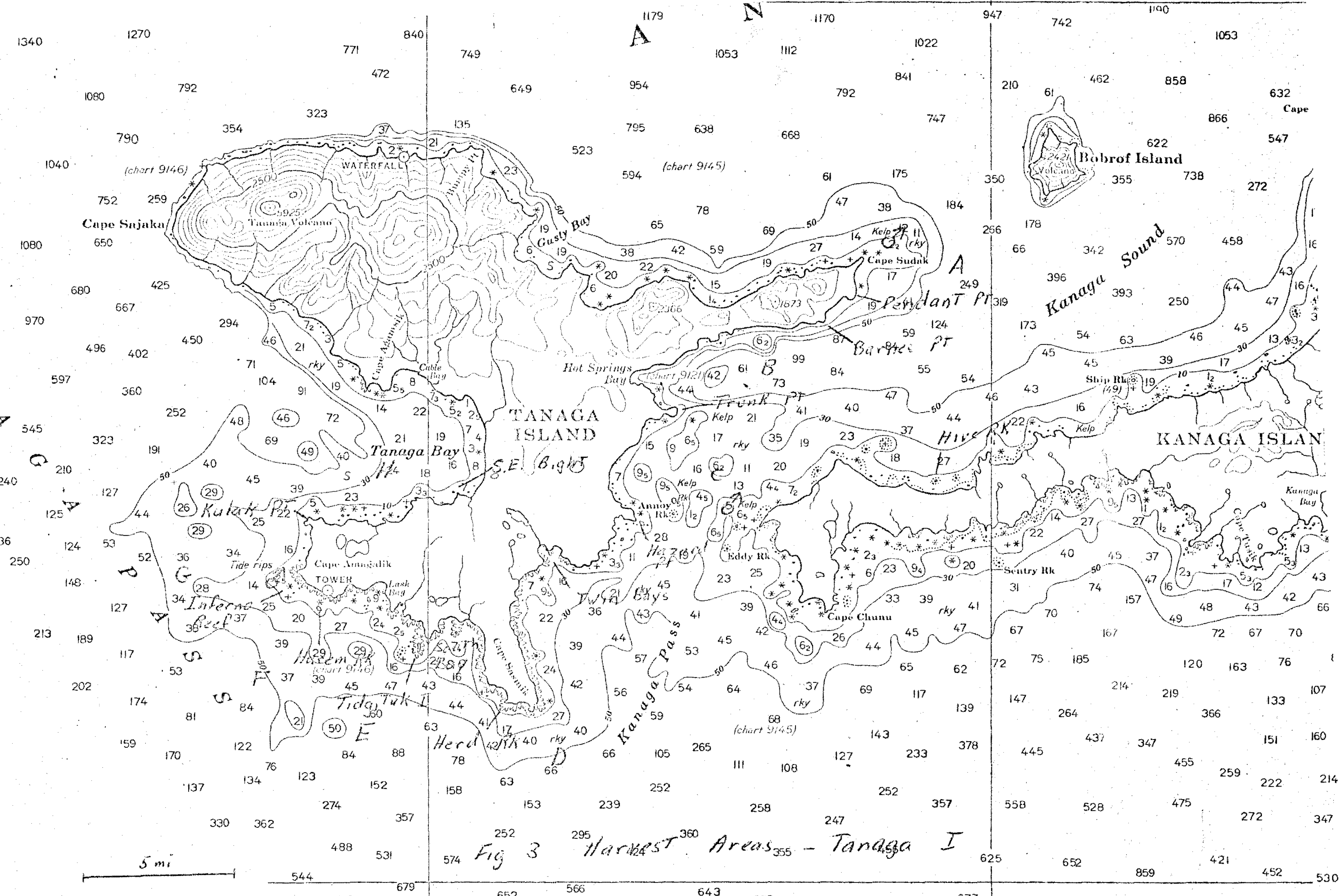


Fig 3 Harvest Areas - Tanaga I

♂ = Male Areas
Letters = Harvest Areas

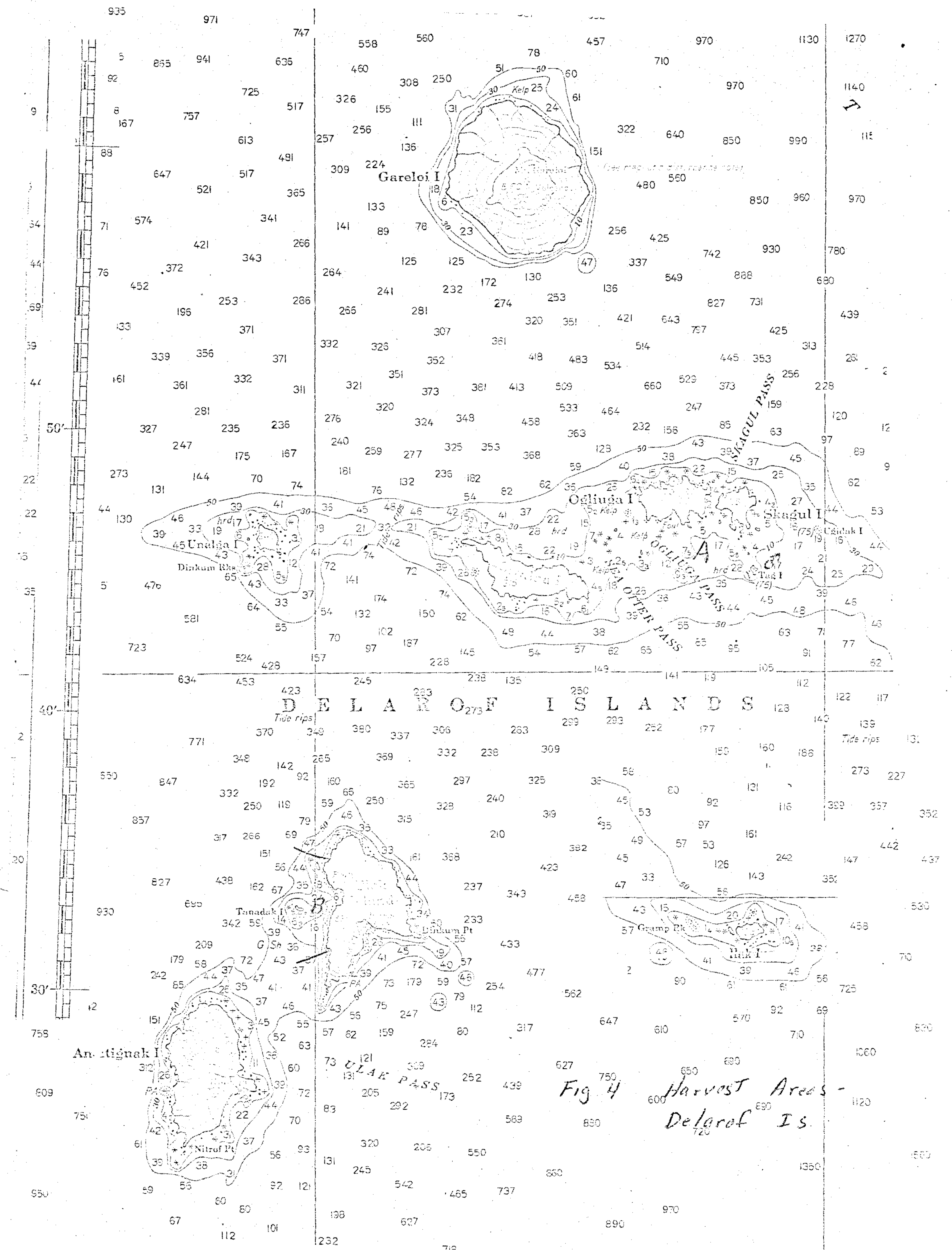


Fig 4 Harvest Areas - Delarof Is.

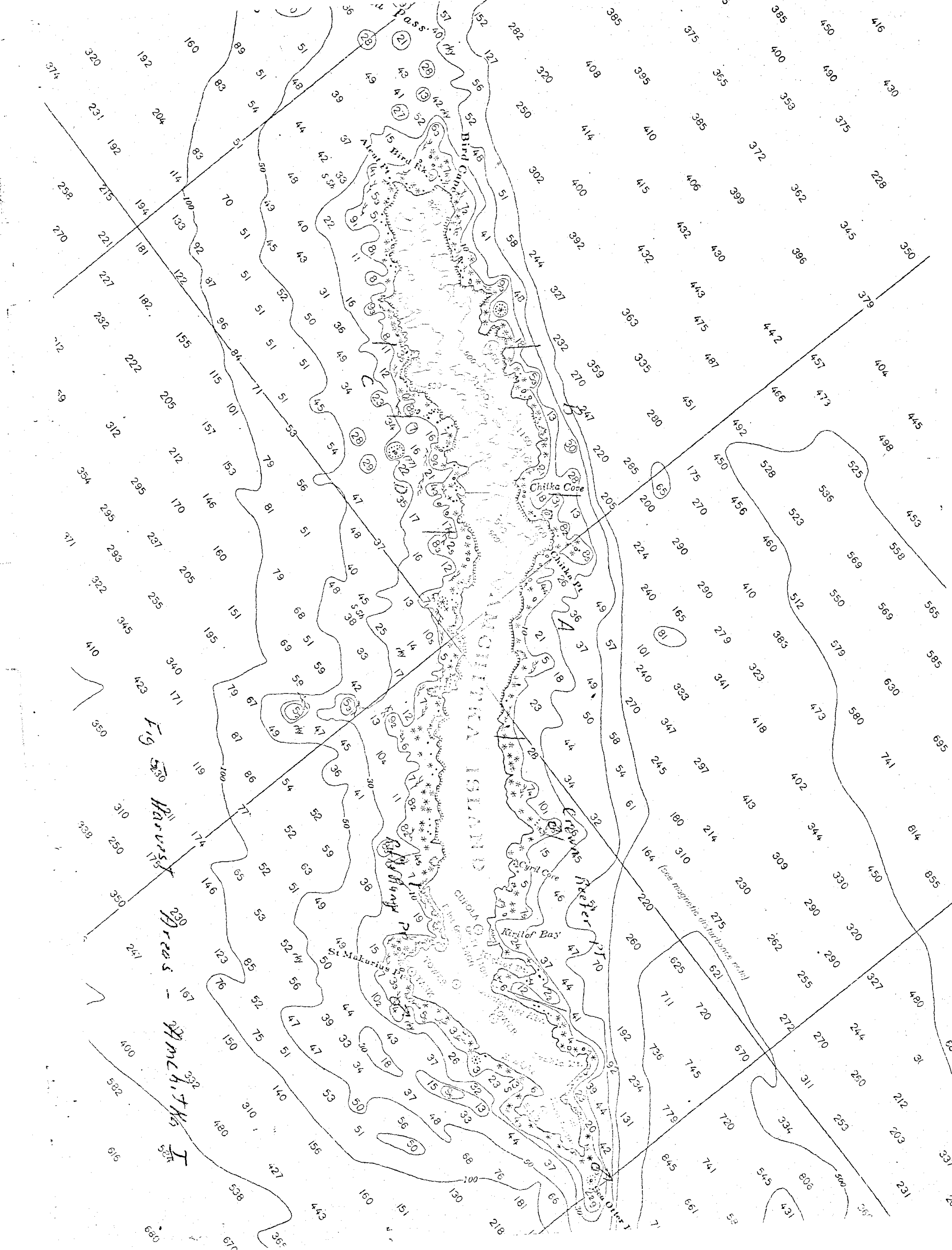


Fig 5 Harvest Areas - Amchitka I

Table 1. Sex Composition of Harvested Sea Otters - by Area - Fall Samples.

		Adults				Total			
		M	F	%M	%F	M	F	%M	%F
	ADAK I September 1967								
A.	Bay of Islands	68	196	25.8	74.2	80	220	26.7	73.3
	ADAK I October 1968								
A.	Bay of Islands	16	58	21.6	78.4	24	76	24.0	76.0
B.	Three Arm Bay	2	10	16.7	83.3	3	12	20.0	80.0
C.	Mid Point-Blind Point	20	42	32.3	67.7	28	55	33.7	66.3
	Adak Island Total	38	110	25.7	74.3	55	143	27.8	72.2
	KANAGA I October 1968								
A.	Round Head-Shoal Point	10	19	34.5	65.5	24	27	47.1	52.9
B.	Naga Point-Kanaga Bay	12	53	18.5	81.5	16	62	20.5	79.5
C.	Cape Chlanak-Cape Tusik	11	35	24.0	76.0	24	44	35.3	64.7
D.	Eddy Rock-Hive Rock	30	54	35.7	64.3	57	64	47.1	52.9
	Kanaga Island Total	63	161	28.1	71.9	121	197	38.1	61.9

Table 2. Sex Composition of Harvested Sea Otters - by Area - Spring Samples.

		Adults				Total (all ages)			
		M	F	%M	%F	M	F	%M	%F
	AMCHITKA I May 1970								
A.	Crown Reefer Point-Chitka Cove	3	32	8.6	91.4	6	37	14.0	86.0
B.	West of Chitka Cove	1	32	3.0	97.0	5	39	11.4	88.6
C.	8-10 Mi. S.E. of Aleut Point	1	28	3.4	96.6	4	32	11.1	88.9
D.	10-15 Mi. S.E. of Aleut Point	4	59	6.3	93.7	12	70	14.6	85.4
	Amchitka Island Total	9	151	5.6	94.4	27	178	13.2	86.8
	DELAROF IS. May 1970								
A.	Ogliuga Island & Skagul Island	21	67	23.9	76.1	41	84	32.8	67.2
B.	Ulak Island	2	10	16.7	83.3	3	16	15.8	84.2
	Delarof Islands Total	23	77	23.0	77.0	44	100	30.6	69.4
	TANAGA I May 1970								
A.	Cape Sudak-Pendant Point	40	26	60.6	39.4	79	40	66.4	33.6
B.	Barnes Point-Trunk Point	2	58	3.3	96.7	6	66	8.3	91.7
C.	Trunk Point-Twin Bays	3	36	7.7	92.3	7	43	14.0	86.0
D.	Twin Bays-South Bay	4	51	7.3	92.7	10	60	14.3	85.7
E.	South Bay-Harem Rock	6	84	6.7	93.3	9	90	9.1	90.9
F.	Lash Bay-Inferno Reef	27	10	73.0	27.0	50	17	74.6	25.4
G.	Harem Rock-Kulak Point	38	21	64.4	35.6	52	24	68.4	31.6
H.	Kulak Point-S.E. Bight	5	33	13.2	86.8	8	45	15.1	84.9
	Tanaga Island Total	125	319	28.2	71.8	221	385	36.5	63.5

Table 3. Sex Composition of Pup and Subadult Sea Otters Harvested - by Area - Fall Sample.

	Subadults				Pups				All Ages	
	M	F	%M	%F	M	F	%M	%F	%M	%F
ADAK I September 1967										
A. Bay of Islands	3	20	13.0	87.0	9	4	69.2	30.8	26.7	73.3
ADAK I October 1968										
A. Bay of Islands	0	15	0	100.0	8	3	72.7	27.3	24.0	76.0
B. Three Arm Bay	0	1	0	100.0	1	1	50.0	50.0	20.0	80.0
C. Mid Point-Blind Point	5	11	31.2	68.8	3	2	60.0	40.0	33.7	66.3
Adak Island Total	5	27	15.6	84.4	12	6	66.6	33.3	27.8	72.2
KANAGA I October 1968										
A. Round Head-Shoal Point	11	7	61.1	38.9	3	1	75.0	25.0	47.1	52.9
B. Naga Point-Kanaga Bay	0	2	0	100.0	4	7	36.4	63.6	20.5	79.5
C. Cape Chlanak-Cape Tusik	3	8	27.3	72.7	10	1	90.9	9.1	35.3	64.7
D. Eddy Rock-Hive Rock	24	9	72.7	27.3	3	1	75.0	25.0	47.1	52.9
Kanaga Island Total	38	26	59.4	40.6	20	10	66.6	33.3	38.1	61.9

Table 4. Sex Composition of Pup and Subadult Sea Otters Harvested - by Area - Spring Sample.

	Subadults				Pups				All Ages	
	M	F	%M	%F	M	F	%M	%F	%M	%F
AMCHITKA I May 1970										
A. Crown Reefer Point-Chitka Cove	1	3	25.0	75.0	2	2	50.0	50.0	14.0	86.0
B. West of Chitka Cove	1	3	25.0	75.0	3	4	57.1	42.9	11.4	88.6
C. 8-10 Mi. S.E. of Aleut Point	2	2	50.0	50.0	1	2	33.3	66.6	11.1	88.9
D. 10-15 Mi. S.E. of Aleut Point	4	10	28.6	71.4	4	1	80.0	20.0	14.6	85.4
Amchitka Island Total	8	18	30.8	69.2	10	9	52.6	47.4	13.2	86.8
DELAROF IS. May 1970										
A. Ogliuga Island & Skagul Island	16	9	64.0	36.0	4	8	33.3	66.6	32.8	67.2
B. Ulak Island	1	5	16.7	83.3	0	1	0	100.0	15.8	84.2
Delarof Islands Total	17	14	54.8	45.2	4	9	30.8	69.2	30.6	69.4
TANAGA I May 1970										
A. Cape Sudak-Pendant Point	35	13	72.9	27.1	4	1	80.0	20.0	66.4	33.6
B. Barnes Point-Trunk Point	2	6	25.0	75.0	2	2	50.0	50.0	8.3	91.7
C. Trunk Point-Twin Bays	3	6	33.3	66.7	1	1	50.0	50.0	14.0	86.0
D. Twin Bays-South Bay	1	7	12.5	87.5	5	2	71.4	28.6	14.3	85.7
E. South Bay-Harem Rock	3	3	50.0	50.0	0	3	0	100.0	9.1	90.9
F. Lash Bay-Inferno Reef	22	7	75.9	24.1	1	0	100.0	0	74.6	25.4
G. Harem Rock-Kulak Point	13	2	86.7	13.3	1	1	50.0	50.0	68.4	31.6
H. Kulak Point-S.E. Bight	0	11	0	100.0	3	1	75.0	25.0	15.1	84.9
Tanaga Island Total	79	55	59.0	41.0	17	11	60.7	39.3	36.5	63.5

Information from the 1967 Amchitka harvest and the 1968, 1969 and 1970 Amchitka transplant capturing operations is not comparable and is not presented here. However, knowledge gained from these operations has contributed to our understanding of sea otter distribution and this knowledge will be used in the following discussion. In general, this data confirms Kenyon's (1969) observations for the Amchitka area, although these summer and fall collections indicate a higher percentage of males in female areas than Kenyon reported from his winter and spring samples.

Kenyon (1969) states that female areas are more numerous and less discrete than male areas. He identified three male hauling grounds and 13 female hauling grounds on the southeastern end of Amchitka Island. Recent studies, involving netting and collecting animals off-shore, indicate that male areas remain discrete off shore. Usually these areas are off major points of land and pods of males often form in kelp beds directly off shore from the hauling ground.

Female areas, on the other hand, are not discrete at all. Any area that is not a male area can be considered a female area. Some areas may be more attractive to females with pups or certain areas may be more favorable for hauling out, but more females than males will be found almost everywhere, except in the discrete male areas. Therefore the main problem is to locate the male areas in a population. We have no evidence of any shift in the location of male areas over a period of time, so once an area is identified, the information should remain useful for management purposes for many years. Lensink (1962) and Kenyon (1969) correctly identified all of the male areas on southeastern Amchitka. Extensive harvesting and netting have not turned up any new areas.

Identification of Male Areas by Pup Counts

In June 1968, a survey of most of Tanaga and Kanaga Islands was made by skiff to gather information to be used in planning harvests from those islands. During this survey, females with pups were counted separately from single animals. No special effort was put into identifying pups. When a female obviously had a pup, it was recorded. Large pups often were separate from the females and some otters were seen only briefly in waves, kelp or at a distance. Therefore, many pups probably were missed and the counts should be considered minimal. Figs. 6 and 7 present the counts by area. A similar count was attempted by helicopter around Adak, but, for various reasons, the results are not considered useable.

From this skiff survey, a number of areas were judged to be possible male areas. Usually these were points or more exposed areas where relatively large numbers of single animals, but no pups, were seen.

Shoal Point, Kanaga Pass north of Eddy Rock and possibly Naga Point and Cape Tusik were suspected male areas on Kanaga Island. Cape Sudak and Cape Amagalik were considered male areas on Tanaga Island and the area around Hazard Point and Annoy Rock in Kanaga Pass was believed to blend with the Eddy Rock area.

The best way to confirm the presence of male areas is to collect animals from these areas. Harvests were conducted on Kanaga in October 1968 and on

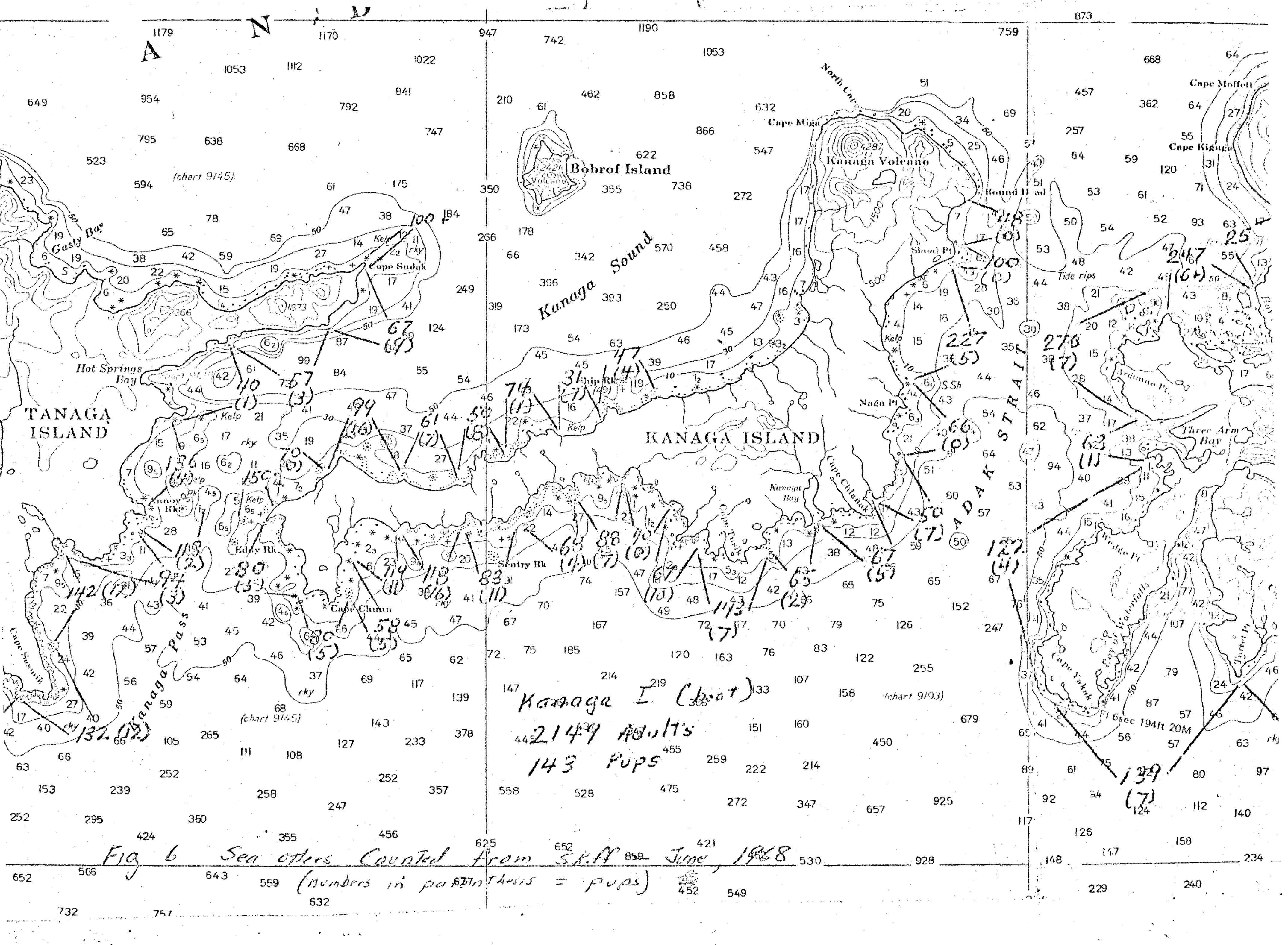


Fig 6 Sea otters Counted from SKAF June 1968 (numbers in parenthesis = pups)

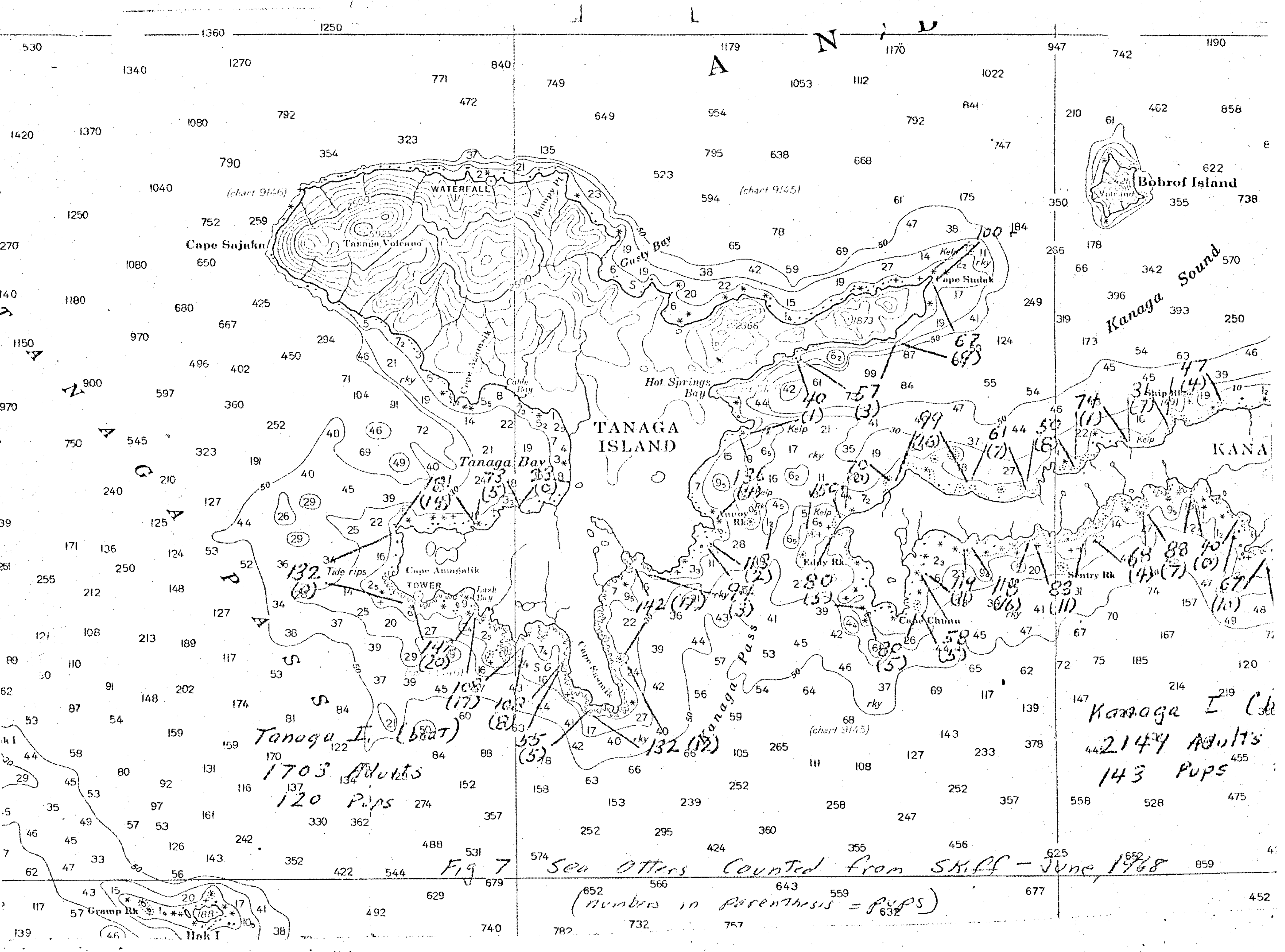


Fig 7 Sea Otters Counted from Skiff - June 1968
(numbers in parenthesis = pups)

Tanaga in May 1970. The sex ratios of the animals harvested are compared with the skiff survey pup counts in Table 5. The harvest areas are fairly broad while male areas are usually only a few hundred yards wide. As a result, a harvest area may include both a male area and portions of female areas to either side.

The hunting pressure is seldom even over an area. Often, a good portion of the kill in an area would come from one group of rocks. Therefore, the information in Table 5 must be tempered with some knowledge of how the hunting pressure was distributed.

Kanaga Island

Shoal Point - While a few more females than males were taken in this area, the percentage of males is considerably higher than one would expect in a female area. Because weather was less than ideal, much of the hunting pressure was directed to areas other than Shoal Point. Most of the females probably came from these areas. Therefore, Shoal Point is considered to be a male area.

Naga Point - There is no strong evidence that this is a male area. While no pups were recorded on the survey, the total number of otters counted was not high. Fairly extensive hunting of the area under good conditions yielded a sex ratio that would be typical of a female area. Therefore, it is assumed that there is no male area near Naga Point.

Cape Tusik - Cape Tusik was suspected as a male area more because of the nature of the area than any counts. The count included areas to both sides of the Cape which could contain females. Very little of the hunting was done at the Cape. Therefore, judgement on this area will have to wait until more information is available. Extensive hunting indicates that no male areas exist east of Cape Tusik to Cape Chlanak.

Kanaga Pass - From the count, it appears that a male area exists in the Pass, however the harvest area extended to Hive Rock and included a large portion of female area (Fig. 6). The area is too broad, as is shown in Table 5 where the number of pups counted for the whole area is relatively high. The results of the harvest confirm the conclusions drawn from the count. While the sex ratio for the entire area is roughly equal, most of the males came from Kanaga Pass. Some females without pups came from that general area but the majority of the females came from the area northeast of the Pass.

Tanaga Island

The Tanaga harvest showed the male areas more distinctly for several reasons. The total harvest was higher, the entire count area was covered in the harvest and the hunting pressure was recorded more precisely. Also, as will be shown later, sexual segregation is more pronounced in the spring.

Cape Sudak - Most of the hunting pressure was concentrated on the tip of the Cape. Some pressure was exerted on the area back toward Pendant Point which is a female area as shown by the count. The high percentage of males harvested from this area clearly confirms that the tip of the Cape is a male area.

Table 5. Comparison of Pups Counted with Sex Ratio of Harvest.

Area	June, 1968 Survey	October, 1968 Harvest				
			Adults		Total	
KANAGA ISLAND	Pups/100 Indep. Otter	Pups/100 Indep. Otter	%M	%F	%M	%F
Round Head-Shoal Point	0	8.5	34.5	65.5	47.1	52.9
Naga Point-Kanaga Bay	6.6	16.4	18.5	81.5	20.5	79.5
Cape Chlanak-Cape Tusik	5.1	19.3	24.0	76.0	35.3	64.7
Eddy Rock-Hive Rock	6.1	3.4	35.7	64.3	47.1	52.9

Area	June, 1968 Survey	May, 1970 Harvest				
			Adults		Total	
TANAGA ISLAND	Pups/100 Indep. Otter	Pups/100 Indep. Otter	%M	%F	%M	%F
Cape Sudak-Pendant Point	0	4.4	60.6	39.4	66.4	33.6
Barnes Point-Trunk Point	7.9	5.9	3.3	96.7	8.3	91.7
Trunk Point-Twin Bays	2.6	4.2	7.7	92.3	14.0	86.0
Twin Bays-South Bay	9.6	11.1	7.3	92.7	14.3	85.7
South Bay-Harem Rock	14.8	3.1	6.7	93.3	9.1	90.9
Lash Bay-Inferno Reef	----	1.5	73.0	27.0	74.6	25.4
Harem Rock-Kulak Point	0	2.7	64.4	35.6	68.4	31.6
Kulak Point-S.E. Bight	6.9	8.2	13.2	86.8	15.1	84.9

Annoy Rock/Hazard Point - The harvest did not confirm this area as a male area. However, the weather was marginal and this area was too rough to hunt. Therefore, the otters taken in the harvest were from either side of the Point and almost none were taken from the portion that is suspected to be a male area. Actually, Kanaga Pass is narrow and shallow. Otters feed in all parts of the Pass when weather and tide rips permit. This could be considered a single male area that serves both islands.

Cape Amagalik - Two harvest areas overlap this area, Lash Bay-Inferno Reef and Harem Rock-Kulak Point. The kill from both areas strongly reflects the presence of a male area. Most of the hunting pressure was concentrated on Inferno Reef and this is probably the main male area.

As shown above, we were able to identify four major male areas from a relatively superficial pup count. No male areas were located during the harvests that had not already been identified from the count. While more detailed observations, including field identification of males would be desirable, the pup counting technique appears to be an acceptable method,

Identification of Male Areas from Harvests

Because male areas are usually on well exposed points, it is possible to pick likely areas from a chart and then confirm these areas by collecting animals. This method avoids the expense, time and danger involved in surface surveys of remote areas. Actual collection of animals also provides the most concrete proof of the nature of an area.

The following is a description of the sex composition of areas for which no skiff count data was available.

Delarof Islands - No attempt was made to predict the location of male areas in the Delarof Islands. This is a difficult area to work in. Ogliuga, Skagul and a portion of Ulak Island were hunted on May 9, 1970. The hunting effort in the afternoon was concentrated around Tag Island and the rocks south of Skagul Island. While the entire kill is lumped together, most of the males were taken in the afternoon. The percentage of males taken for the day is higher than would be expected if only female areas were hunted. Most likely there is a male area near Tag Island.

Adak Island - Portions of Adak were hunted in 1967 and 1968. No attempt was made to identify male areas before or during either harvest. The harvest figures indicate that no male areas have been hunted. The Bay of Islands is a classical female area. The results of extensive hunting in the Bay and around Eddy Island indicate that there is definitely no male area there. The percentage of males taken between Mid Point and Blind Point was higher than might normally be expected in a female area, however the scarcity of subadult males indicates that no male area exists within this area. A large congregation of otters is often seen near Finger Shoals. This could be a male area, but we have no information from there. If this is a male area, a few stray males from there could account for the slightly higher number of males in the kill.

Amchitka Island - While much work has been done on Amchitka Island, almost all of the effort has been concentrated on the southeastern end from Crown Reefer Point to a few miles northwest of Rifle Range Point. During the 1970 harvest, an attempt was made to distribute the harvest over previously unstudied areas. Two areas were suspected to be male areas. These were the rocks off Chitka Point and either Bird Rock or Aleut Point. Weather prevented us from hunting the area around Bird Rock and Aleut Point.

The sex ratio of the kill does not indicate a male area near Chitka Point, however heavy waves prevented hunting off the point. Therefore, a male area could be there, but, because no animals were killed there, the kill figures would not reflect it.

Composition of Female Areas

Kenyon (1969) found that 93 percent of the adult otters and 63 percent of the juvenile otters in female areas were females. The May samples from the 1970 harvest agree with this. The mean percent of adult females in female areas was 93 percent. The mean percent of subadults, not including pups, was 73 percent. However, in the September and October samples only 77 percent of the adults in female areas were female. About 86 percent of the subadults were female.

The seasonal difference in the sex ratio of adults is consistant for all samples. These seasonal changes are most likely due to adult males moving into female areas to look for estrous females. During late winter and spring, breeding activity is at the lowest point of the year and fewer females are entering estrus. In fall, the number of estrous animals is at its peak and presumably more sexually mature males move into the female areas to breed. It is interesting to note that there were about three times as many males in female areas in fall as in winter and spring. Information from female reproductive tracts indicates that approximately three times as many females would be in estrus at any given time in fall. It appears that the number of adult males in a female area is directly proportional to the number of estrous females. From the data collected, there appear to be 1.5 to 2.0 males for each female with enlarged follicles at any given time, however hunter bias might influence this figure.

Ages have been estimated for otters harvested in 1968 on the basis of cementum layering. These age data indicate that virtually all of the males in discrete female areas are either pups (or very young subadults) or are 7 years old or older. No males between the ages of 2 and 6 were found. This strongly implies some form of territorial behavior among actively breeding males. Fighting among males has not been observed often, however a mature male at the Tacoma Zoo became intolerant of a subadult male in the presence of females. They frequently "fought" although neither seemed to attempt to injure the other. Finally, the young male had to be removed. Under wild conditions, the young male might have moved out of the area without repeated physical encounters.

Kenyon (1969) described the breeding behavior of sea otters. His description indicated that males patrolled an area and two to four males may pass a given point during a 3 or 4 hour period. Vandevere (1970) observed some males apparently defending a territory in California, but from his observations, it appeared that successful breeding males were more mobile. Perhaps established breeding males are more tolerant of each other. More likely, they maintain a separation from each other which limits the number in an area. In this way, a number of males might be patrolling the same area rather than each establishing a geographical territory. This might be advantageous where female concentrations shift from place to place as weather conditions change.

Why does the number of adult males in female areas decline when the number of estrous females declines? The limiting factor may be competition for estrous females rather than territory size. With fewer receptive females, competition would be greater causing some animals to leave the area. Another possible reason may be that males may have a seasonal fluctuation in fertility. Lensink (1962) found that all adult males produced sperm at all seasons. Limited studies since then support this, however it is possible that most of these males were collected in or near female areas. Also, while a male may produce sperm at all seasons, there may be less production at certain times of year.

A contributing factor may be that males are capable of feeding in more exposed areas than pregnant females or females with pups. With a reduced attraction to the female areas, either because of fewer receptive females or a reduced fertility in the male, the male may find it easier to obtain food away from the crowded female areas where competition for food is greatest.

The fact that the number of males does appear proportional to the number of estrous females indicates that competition for these females may play an important part in regulating the number of males in female areas.

The numbers of subadults in the samples is relatively low, so fluctuations in sex ratio may be due to sampling errors. However, the greater number of subadult males found in female areas in winter and spring may be a true increase made possible by the reduction in the number of breeding males. A subadult male would have fewer encounters with breeding males.

There are areas within what would normally be considered female areas where subadult males tend to congregate, particularly during the winter. These are usually areas with a marginal food supply that are not heavily used by females. Because there are few mature females in these areas, there are also very few breeding males. The subadult males using these areas seem to be transients that find less pressure from breeding males there. These areas are used less in summer, probably because calmer weather allows feeding farther off-shore reducing competition for food in the male areas.

Examples of areas within female areas that are used by subadult males are Constantine Harbor on Amchitka and possibly Finger Bay on Adak.

Segregation within Female Areas

In the course of the harvest on Tanaga in May of 1970, a large number of pregnant females with large fetuses were collected at one time. Most of these came from Tidgituk Island. This raised the possibility that females may segregate according to reproductive condition. Table 6 presents the numbers of females in each stage of the reproductive cycle by area on Tanaga Island. More pregnant animals were collected in the South Bay area and within that area most of the females with fetuses weighing over 100 g were collected near Tidgiktuk Island. This concentration was evident in the pup counts made in June 1968 when a very high percentage of pups was observed in the same area (Table 5). Most females with large fetuses in May would pup by June.

The data do not reveal any other areas of this type on Tanaga. Marakov (1965) mentioned a bay on Medny Island that was preferred by pregnant females and females with pups. Obviously all females do not go to a specific area to pup, but a female with a large fetus or small pup probably has more difficulty in exposed areas and seeks more protected areas. This tendency can be seen by the casual observer. Single animals are more likely to venture off-shore and remain in rougher waters. In some areas, such as Crown Reefer Point on Amchitka, there is a male area near the tip of a point. Males congregate directly off-shore. However, to either side of these male congregations, there are females that are not accompanied by a pup and probably do not have large fetuses. In this way, we may find segregation in a single kelp bed off a point. If we set a net near the outer margin of the kelp, we will catch almost all males. However, if we set a net to the side of the bed and closer to shore we will catch mostly single females. Nets set in a nearby bay will catch more females with pups.

Table 6 shows that an unusually high number of resorptions were found between Cape Sudak and Twin Bays. This is probably a reflection of poor physical condition of the otters in that area due to food shortages. Other data indicate a continuous decline in body condition from the east side of Adak to Kanaga Pass. There is some evidence that condition improves west of Kanaga Pass. The animals in the Kanaga Pass vicinity are probably in poorer condition than any of the other populations sampled. Therefore, the high incidence of resorptions in this area should not be considered an example of segregation within the population.

Composition of Male Areas

As mentioned earlier, the harvest areas were broader than any male area. Harvest areas containing male areas also contained portions of female areas. Our identification of the location at which each animal was collected is not precise enough to determine the exact composition of these male areas. Kenyon's (1969) data from winter and early spring harvests are more precise. His data indicate that at that time of year 98 percent of the adults and 80 percent of the juveniles using male areas were males. Of 128 males in male areas, 100 were adults and 28 were juveniles.

Experience from netting in the summer and harvesting in fall indicates that the percentage of males remains very high all year. While adult females may be very close to male areas, it appears unlikely that a significant number regularly use these areas at any time of year. While adult males enter female areas regularly and in predictable numbers for a specific purpose, females probably enter male areas only occasionally in stray movements.

Table 6. Reproductive Stage of Sexually Mature Sea Otters Harvested on Tanaga Island - by Area - May 1970.

	Area	Nonpregnant	Unimplanted Pregnant		Implanted Pregnant		Fetus Weight Class					Resorption	Total
			No.	%	No.	%	1	2	3	4	5		
A	Cape Sudak-Pendant Point	12	7	26	8	30	0	2	0	3	2	2	27
B	(Barnes Point-Hot Springs Bay	12	7	24	10	36	3	0	1	4	2	2	29
	(Barnes Point-Trunk Point	11	6	25	7	29	0	3	1	3	0	2	24
C	(Trunk Point-Twin Bays	7	9	39	7	30	2	1	1	1	2	2	23
	(Hazard Point-Twin Bays	4	3	27	4	36	0	0	1	1	2		11
D	(Twin Bays-Herd Rock	12	8	28	9	31	1	1	1	4	2		29
	(Twin Bays-South Bay	2	9	45	9	45	3	0	1	1	4	1	20
E	(South Bay-Lash Bay	6	9	29	16	51	1	0	0	9	6	1	31
	((South Bay-Harem Rock	17	14	31	14	31	2	0	1	5	6		45
F	((Lash Bay-Inferno Reef	4	1	9	6	55	2	1	1	0	2		11
G	(Harem Rock-Kulak Point	12	6	29	3	14	1	0	1	1	0		21
H	Kulak Point-S.E. Bight	13	9	28	10	31	2	0	1	2	5		32

Brackets indicate overlapping areas.

Juveniles of both sexes probably move more randomly than adults. While definite sexual segregation exists among younger animals, it is not as pronounced as in adults. Because subadult males are tolerated less by breeding males, they are more strictly confined to small areas than females of the same age. This has been demonstrated in fall harvests where extensive hunting over a large area will turn up only an occasional subadult male. Then when the hunters move to a definite male area large numbers of subadult males are taken in a very short time and in a very small area.

While Kenyon's data indicate that 22 percent of the males in male areas are subadults, our experience indicates that this percentage may be quite a bit higher, at least in fall. Such a seasonal change in the age composition of males sounds reasonable. We have demonstrated that adult males move into female areas in greater numbers in the fall, perhaps tripling their numbers in these areas. At the same time, fewer subadult males are found in the female areas. Presumably the adult males are coming from male areas and the subadults driven from the female areas move to the same male areas. The result would be a higher percentage of young males in male areas in fall than in spring.

The total number of males of all ages in female areas doubles in fall. About 13 percent of all animals taken in these areas in spring were males while 25 percent taken in fall were males. This suggests that the total number of males in male areas declines in fall. There are more adults leaving than subadults entering the area.

Population Sex Ratio

With the sexes segregating and with the degree of segregation changing seasonally and between age groups, it is extremely difficult to get a completely random harvest. As a result, we have not been able to determine the sex ratio of any population as a whole. With female areas being larger and in more protected areas where hunting is easier, there is a strong tendency to take more females than males, particularly in spring. We have shown that, through a concentrated effort, the percentage of males harvested can be increased, however even then the lowest percentage of females taken in recent harvests was 62 percent on Kanaga Island in October 1968. Similar results occur in capturing operations for transplants.

On all islands studied, there are fewer male areas than female areas. The male areas are very small, usually only a few hundred yards wide. The male feeding areas off male areas are also very narrow although they may extend farther off-shore. In short, that portion of the total available sea otter habitat included in male areas is very small.

All evidence indicates that there are more females in the population than males. While the percentage of males is probably greater than that indicated by most harvest statistics, it appears that at least 60 percent of the sea otters in the populations studied are females.

There are probably several factors contributing to this uneven sex ratio. First, our reproductive data indicate that 56 percent of the pups are females at birth. Secondly, Kenyon (1969) has found a higher mortality rate among newly weaned males. There is also some evidence that males might not live as long as females. These factors could easily account for the preponderance of females in the population.

It is possible that the higher rate of mortality in juvenile males is, in part, due to the breeding behavior of adult males and the resulting sexual segregation. Juvenile males tend to be restricted to male areas or areas of marginal feeding habitat where there is little competition from breeding males. During the winter, the feeding activity of young males would tend to be confined to small areas close to shore in male areas. Therefore, they may be subjected to greater competition for food than females of the same age which have a broader area in which to feed. Kenyon (1969) found that subadult males were less hardy in captivity than subadult females. Therefore, we can not adequately evaluate the influence of segregation on mortality.

The sex ratio probably varies from one population to the next. Very little juvenile mortality occurs in expanding populations eliminating that source of sexual selection. However, there is some evidence that males are more numerous among the first animals to repopulate a new area. While a high percentage of males might be found on a newly repopulated island, the loss of these males would alter the sex ratio of the parent population, even though juvenile mortality might not yet be a significant factor.

If the number of breeding males is regulated by the number of estrous females, an even sex ratio might produce a surplus of sexually mature males. This surplus would not be beneficial to the population and could be detrimental. This would permit the situation of an unbalanced sex ratio to evolve.

The segregation of sexes and ages and the composition of sea otter populations is complex. Unless we can understand the situation, we cannot fully evaluate the effects of mortality or habitat changes.

REPRODUCTION IN THE FEMALE SEA OTTER

by Karl Schneider
March, 1971

A total of 1358 female sea otter reproductive tracts collected between 1967 and 1970 have been examined. Ovaries were sliced with a razor blade and examined macroscopically. Uteri were macroscopically examined both internally and externally. Each tract was classified as to its stage in the reproductive cycle.

The following criteria were used in the classification:

Nulliparous - Horns of uterus small, thin and smooth. Usually no corpora lutea or corpora albicantia although there is occasionally evidence of a past ovulation, but no evidence of implantation.

Multiparous - Uterus thicker, corpora lutea and/or corpora albicantia present. Includes primiparous animals (these are not readily separated from multiparous animals).

Anestrus - Largest follicle under 3.5 mm, no corpus luteum.

Proestrus - Follicles over 3.5 mm.

Estrus - Follicles approximately 10 mm.

Unimplanted Pregnant - Corpus luteum present (usually under 10 mm and with a central antrum), no gross sign of implantation.

Implanted Pregnant - Visible swelling in uterine horn, usually with fetal membranes, embryo or fetus visible. Corpus luteum usually over 10 mm.

Post Partum - Uterine horn still noticeably enlarged; fresh, rough-looking placental scar, newly formed corpus albicans with some luteal tissue remaining.

The appearance of the uterus was used to confirm the classification. The thickness and shape of the horns, thickness and consistency of the uterine walls, coloration of the lining of the horns and condition of the rugae change with each stage. In most cases, it is possible to guess the condition of the tract by a superficial examination of its exterior. This appearance was used only to confirm what was indicated by structures in the ovary, however.

Table 1 summarizes the reproductive condition of the sexually mature females in the samples that are large enough for comparison throughout the year. In the following discussion, samples reported by Sinha, et al (1966) and Kenyon (1969) are included where possible. The January and March samples are from these studies.

Table 1 Reproductive condition of sexually mature sea otters

		Inactive ovaries			Active ovaries			Fetus Weight Class *					
Dates	Location	Anestrus	Post-Partum	Resorption	Proestrus + Estrus	Unimpl. Preg.	Impl. Preg.	1	2	3	4	5	Total
May 4-8, 1970	Tanaga I.	51 (16.8)	41 (13.5)	10 (3.3)	10 (3.3)	88 (28.9)	104 (34.2)	17 (5.6)	8 (2.7)	10 (3.3)	35 (11.4)	33 (10.9)	304
May 9, 1970	Delarof Is.	18 (23.4)	14 (18.2)	1 (1.3)	4 (5.2)	13 (16.9)	27 (35.0)	10 (13.0)	0	3 (3.9)	6 (7.8)	8 (10.4)	77
May 10-12, 1970	Amchitka I.	34 (24.6)	18 (13.0)	3 (2.2)	8 (5.8)	27 (19.6)	48 (34.8)	5 (3.6)	6 (4.3)	2 (1.4)	23 (16.7)	12 (8.7)	138
June 23 - August 13, 1968	**Amchitka I.	17 (38.6)	2 (4.5)	1 (2.3)	2 (4.5)	4 (9.0)	18 (40.9)	1 (2.3)	2 (4.5)	3 (6.8)	5 (11.3)	7 (15.8)	44
July 6 - August 8, 1969	**Amchitka I.	17 (36.9)	1 (2.2)	0	4 (8.6)	14 (30.4)	10 (21.9)	0	1 (2.2)	1 (2.2)	2 (4.3)	6 (13.2)	46
Sept. 10-17, 1967	Adak I.	72 (43.9)	5 (3.1)	0	16 (9.8)	31 (18.9)	40 (24.4)	6 (3.7)	6 (3.7)	8 (4.9)	9 (5.5)	11 (6.7)	164
Sept. 25 - Oct. 6, 1967	Amchitka I.	55 (47.8)	6 (5.2)	0	18 (15.7)	19 (16.5)	17 (14.8)	4 (3.5)	0	0	10 (8.7)	3 (2.6)	115
Oct. 12-15, 1968	Kanaga I.	58 (41.3)	6 (4.3)	1 (0.7)	13 (9.3)	31 (22.2)	31 (22.2)	4 (2.9)	4 (2.9)	7 (5.0)	11 (7.8)	5 (3.6)	140
Oct. 18-20, 1968	Adak I.	46 (46.0)	6 (6.0)	0	11 (11.0)	24 (24.0)	13 (13.0)	2 (2.0)	3 (3.0)	0	4 (4.0)	4 (4.0)	100

Numbers in parenthesis are percent of sexually mature females.

* Fetus weight class 1 = 0-1g, 2 = 1-10g, 3 = 10-100g, 4 = 100-1000g, 5 = 1000+g

** Transplant mortalities (all other samples from harvests)

There may be some problems associated with comparing samples taken from different islands and in different years, but, allowing for sampling errors, the data for the most part fit a definite pattern, indicating that the annual cycle remains fairly constant. The one outstanding exception is the number of pregnant animals in the two summer samples. In 1968, there were many more implanted pregnancies than unimplanted pregnancies and in 1969 the situation was reversed, however the total number pregnant was almost identical. These are the weakest samples, being relatively small, collected over a longer period of time and consisting of transplant mortalities. An average of the two samples fits the pattern established by the other samples. Relatively large samples are necessary because all stages of reproduction are found at all times of the year. The period from November to early January is not represented, however things are changing so rapidly during that period that any information from that time may be confusing unless a large sample was collected in a very short time.

The information in Table 1 is shown graphically with Kenyon's (1969) winter information in Figs. 1 and 2. It has often been demonstrated that sea otters breed and pup at all times of the year. A number of observers have noticed that more pups are born in the spring and summer than at other times and there have been conflicting reports about peak breeding times. Kenyon (1969) was the first to demonstrate seasonal changes in pregnancy rates but only his January and March samples were large enough to be at all reliable.

Figs. 1 and 2 demonstrate that there are considerable seasonal changes in the numbers of animals in each stage of the reproductive cycle. There is a definite period of increased breeding activity and a definite period of increased pupping. However, some animals are in each stage at all times of the year and these periods of increased breeding and pupping do not have distinct boundaries.

Each curve is influenced by two factors so it is difficult to isolate the magnitude of any single factor. For example: the percentage of implanted pregnancies will increase as blastocysts implant and decrease as births occur. The birth rate may be increasing but if the number of implantations increases at a greater rate the implanted pregnant curve will still rise. The animal remains in the anestrus, implanted pregnant, and unimplanted pregnant categories for a relatively long time and there may be considerable carry-over from one sample to the next. Because the animal spends a relatively short time in the proestrus-estrus and post partum categories, there is little, if any, carry-over from one sample to the next and the changes between samples are more likely to be absolute changes. The mean fetus weight class probably does not mean much because it does not take the actual number of animals in each class into account. When there are many implanted pregnancies and the mean weight class is low, there actually may be more Class 5 fetuses in the population than when there are few implanted pregnancies and the mean weight class is high. Therefore, the actual percentages of all sexually mature females with Class 1 and Class 5 fetuses have been plotted in Fig. 3. These curves represent the actual number of fetuses in the population. Because the sample sizes become quite small when the fetuses are divided into classes and the summer sample is believed

Fig 1

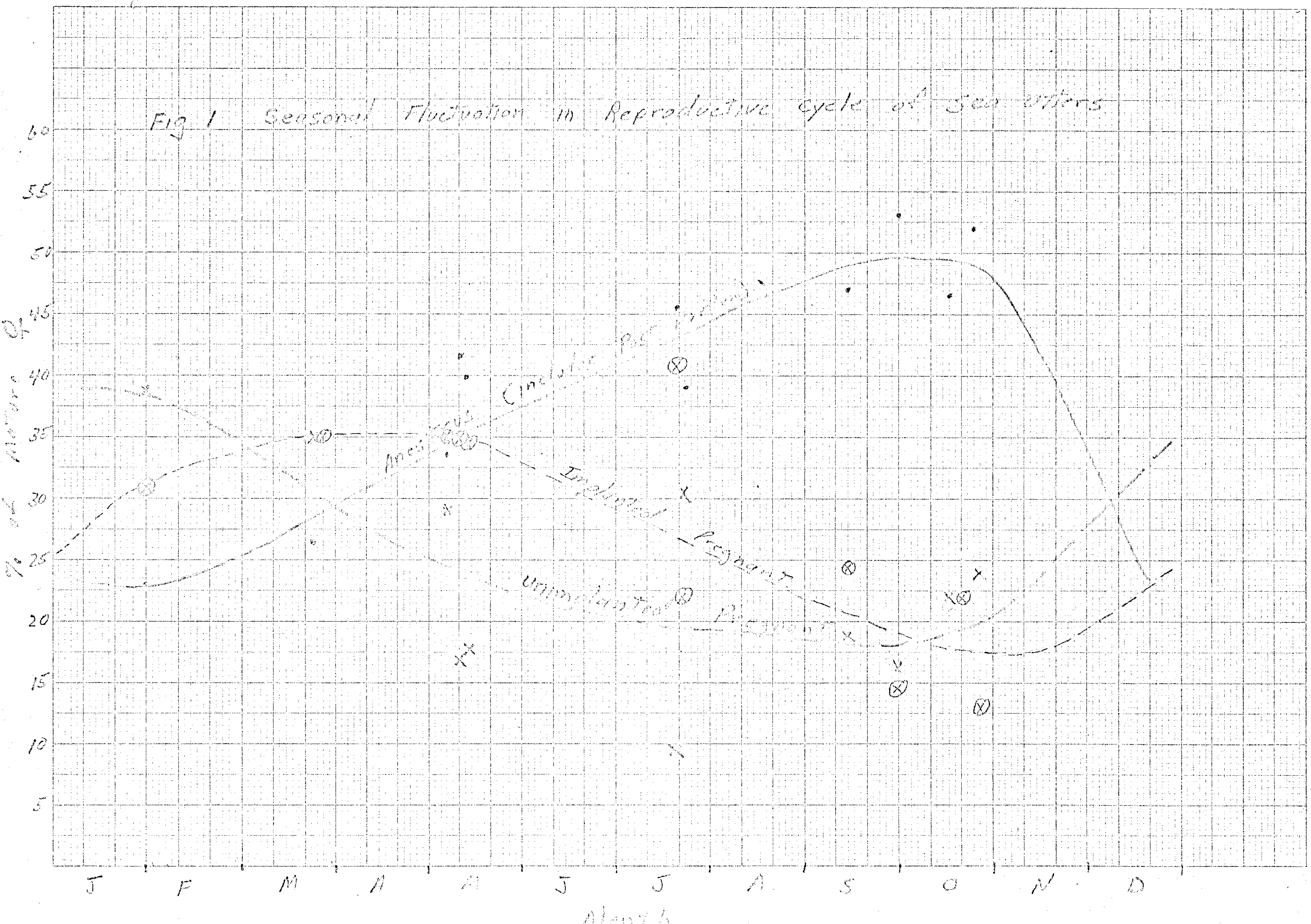


Fig 1 Seasonal Fluctuation in Reproductive cycle of Sea otters
% of Mature
60
55
50
45
40
35
30
25
20
15
10
5
J
F
M
A
M
J
J
A
S
O
N
D
Month
Anestrous
Implanted
Pregnant
Unimplanted

Fig 2

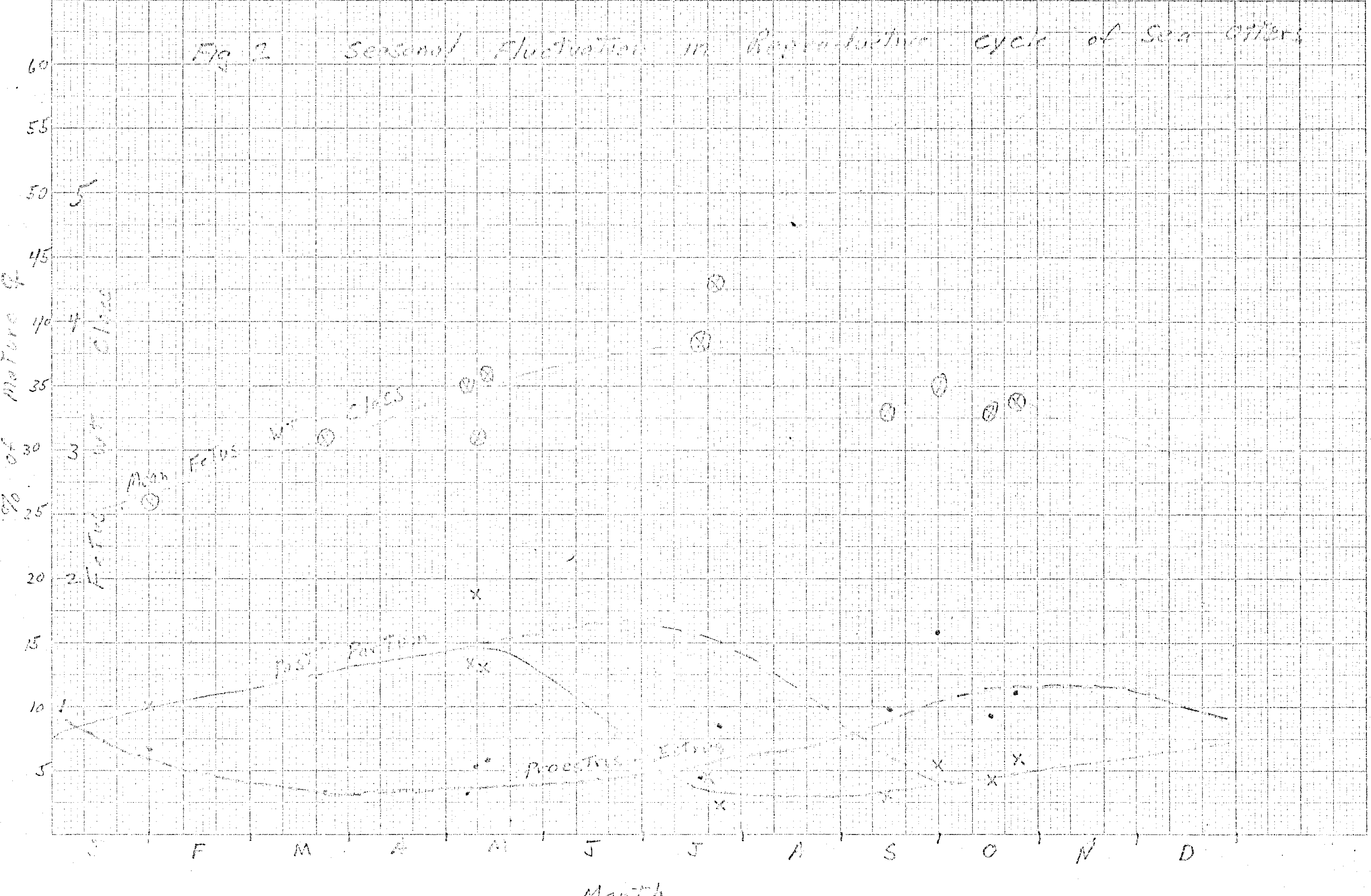


Fig 2 Seasonal fluctuation in Reproductive cycle of Sea otters
Mean Fetus Wt. Class
Fetus Wt Class
% of Mature ♀
Post Partum
Proestrus Estrus
J
F
M
A
M
J
J
A
S
O
N
D
Month
60
55
50
45
40
35
30
25
20
15
10
5
1
2
3
4
5

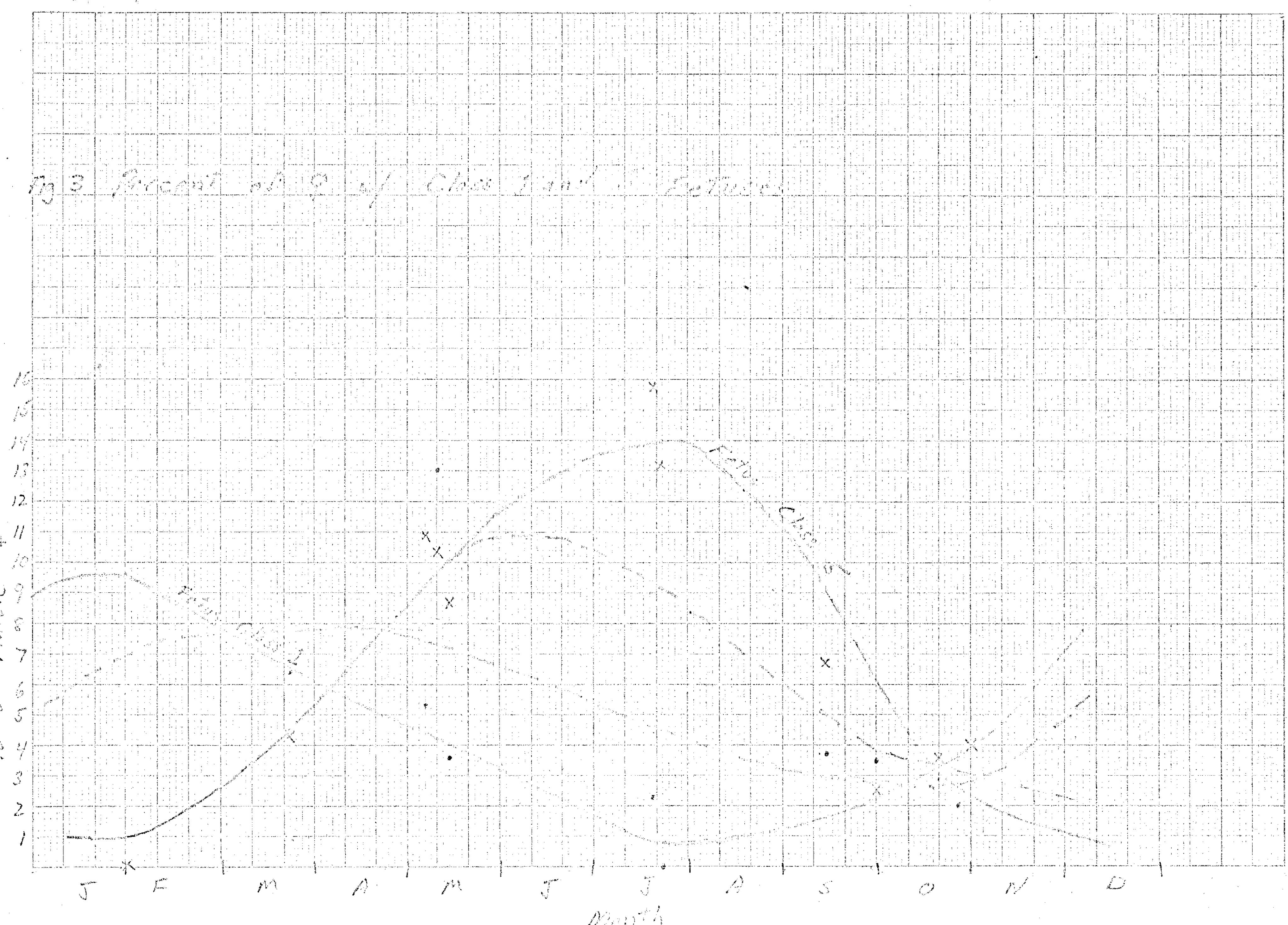


Fig 3
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Class 1
J
F
M
A
M
J
J
A
S
O
N
D
Month

to be biased, two curves for each class are shown. The solid curves approximate the data while the broken curves represent subjective adjustments to correct for sampling errors.

Discussion of the Annual Reproductive Cycle

The number of animals entering estrus rises in the fall. At this time the pregnancy rate is at its lowest point and a high percentage of anestrous (nonpregnant) animals are in the population. Breeding activity increases and at this time the number of sexually mature males in "female areas" increases.

The number of unimplanted pregnancies begins to rise sharply in October and November. At the same time the number of anestrous animals drops as these animals enter estrus, breed and become pregnant. This is the peak breeding season.

The birth rate is at its lowest during this period as is shown by the low number of post-partum animals and the low number of large fetuses.

By late November and December the implanted pregnant rate is increasing even though the birth rate is increasing slightly. This is due to new blastocysts implanting as is shown by the increase in Class 1 fetuses.

By January the period of greatest breeding activity has declined and the number of unimplanted animals reaches a peak as the number of blastocysts implanting equals the number of conceptions. The unimplanted pregnancy rate then begins to decline as fewer animals breed and more implant. The greater rate of implantation is reflected in a rise in the Class 1 fetuses as well as an overall increase in the number of implanted pregnancies. However, the rate of implantation is partially obscured by an increased birth rate removing animals from the total of implanted pregnancies. This increase in the birth rate is shown in the rise in post-partum females and a rise in Class 5 fetuses.

This condition of a low rate of breeding, high rate of implantation and increasing rate of birth lasts from February to May.

At this point, we come to the least reliable data. The summer samples are smaller, were collected over a period of seven weeks and were from animals that died as the result of capture and handling.

Therefore, while the data show that the post-partum rate decreases sharply indicating a reduction in the birth rate, the number of Class 5 fetuses reaches a peak indicating a very high birth rate. The true birth rate is probably somewhere in between. Females with very young pups (hence are post-partum) are wary and probably less likely to be caught in nets. Females with large fetuses appear to be more likely to die from handling. In several cases, twisting of the reproductive tract by a large fetus was the actual cause of death. Anestrous females (including post partum) on the other hand are less likely to die.

There is no question that the birth rate remains high during June and July. Kenyon's (1969) summer sample is limited but shows a large number of Class 5 fetuses. Again the sample is biased in favor of pregnant animals but not to large fetuses only. His field counts as well as observations by most other observers indicate an increase in the number of dependent young throughout the summer. The number of implanted pregnancies declines throughout the summer while the unimplanted pregnancy rate declines at a slower rate and breeding remains fairly constant at a low level. This indicates that through June there are more implantations than conceptions, however the birth rate is substantially greater than the implantation rate. By late July and August there are relatively few implantations taking place as shown by a leveling of the unimplanted pregnant rate and a low number of Class 1 fetuses. The number of Class 5 fetuses declines as a result of births during June, July and August.

Therefore the season of greatest pupping may be quite broad, running from April through August, possibly with the peak occurring in late May or June. Until a better summer sample is available we cannot pin down the peak of this "pupping season" with certainty. (See Fetal Growth Rate for further discussion on breeding and pupping peaks.)

Magnitude of Breeding and Pupping Peaks

If the information were precise, we could compare samples subtracting numbers of pups born and adding numbers of conceptions to determine the actual percent of females breeding, implanting and pupping in each month. Unfortunately, the data are not precise. Each curve is influenced by more than one factor and we do not know for sure the magnitude of any of these factors. However, by comparing some of the major samples we may be able to get a rough idea of how much higher the birth rate is at one time of year than another.

The combined May samples and the combined September and October samples provide the best comparison. Both are large samples. One occurs near the peak of pupping and a low point in breeding and the other is near the low point in pupping and the peak of breeding.

The number of Weight Class 5 fetuses, post-partum females, and proestrous-estrous females come closest to representing a particular event. The time spent in each category is comparatively short.

There were approximately three times as many Class 5 fetuses in May than in September-October. There were also about three times as many post-partum females in May. In September-October, there were two and a half to three times as many proestrous-estrous animals as in May. It would appear that the peaks of breeding and pupping are roughly three times as high as the lowest points.

At the lowest period of pupping, 2 to 3 percent of the females have Class 5 fetuses and should pup within a month. If we assume the post-partum stage lasts 1.5 to 2 months (see Recovery of the Uterus) it also appears that 2 to 3 percent pup in the lowest months of pupping.

Similarly about 3 percent of the females have enlarged follicles during the lowest period of breeding. We do not know how long this period lasts however.

At the peak of pupping about 10 percent of the females have Class 5 fetuses and should pup in the next month. About 15 percent are post partum indicating about 8 births per 100 females in the preceding month.

These percentages are probably slightly high because of hunter bias, avoiding females with pups. It appears that at least 2 to 3 percent of the mature females breed and 2 or 3 percent have pups in any month of the year. In the peak breeding months such as September and October, perhaps 7 to 10 percent breed and similarly in peak pupping months such as May, 7 to 10 percent of the mature females pup.

Gestation Period

Barabash-Nikiforov (1947) listed the gestation period of 8 to 9 months. This apparently was based on the case where a female mated in captivity as reported by Malkovich (1937). According to Barabash-Nikiforov, a pup was born 8 months later although it died. While it was fully formed, it may have been premature.

A number of births have occurred in captive animals held by the Department of Fish and Game in recent years. In all cases, the pups were small, usually less than 1600 g, but still larger than the smallest pups found in the wild. All died shortly after birth.

The gestation period of 9 months has been repeated in the literature but apparently these statements are based on Barabash-Nikiforov (1947).

Lensink (1962) also estimated a gestation period of 8-9 months based on field observations. He felt that the peak of breeding was in August or September and the peak of pupping was in March or April.

It has been demonstrated that the gestation period of sea otters includes a relatively long period of delayed implantation (Sinha 1966, Kenyon 1969, and present study). Therefore any attempt to estimate the length of gestation by examination of reproductive tracts must take both the unimplanted and implanted periods into account.

Kenyon (1969) presented an estimate of the implanted period by assuming that the cube roots of fetus weights fall in a straight line after the embryo is established (Hugget and Widdas, 1951) and by assuming that the European otter and American river otter would have similar fetal growth rates. By plotting term fetus weights on a line established by the European otter he estimated an implanted gestation of about 120 days not including the period for establishment of the embryo.

Kenyon (1969) then presents an estimate made by Dr. D. G. Chapman using the method of Hugget and Widdas (1951) where a regression line is fitted to the cube roots of the unweighted mean of the mean weights of fetuses in each of five weight classes plotted against the mean time of year.

From the regression coefficient obtained, he estimated an implanted period of 154 days. By taking the mean percent of the pregnant animals that are unimplanted pregnant, Chapman estimated the unimplanted period as about 7.5 months. Allowing a half month for establishment of the embryo he estimates a total gestation period of 12-13 months.

The data used by Chapman included a January-February sample of 26, a March-April sample of 49 and a May-August sample of only 9. The summer sample is more biased than the others and quite small yet the estimate relies heavily on this sample when fetus size is the greatest.

Table 2 presents a new estimate of the length of the implanted period using the method used by Chapman but including data from the present study in addition to Chapman's data. Table 3 presents a similar estimate of the length of the unimplanted period.

The following is a comparison of the two estimates:

	Chapman's Estimate	New Estimate
Unimplanted Period	230 days	66 days
Establishment of Embryo	15 days	15 days
Implanted Period	154 days	73 days
Total Gestation Period	399 days	154 days
or about	13 months	5 months

Obviously there is some problem with the samples, the technique or both. A similar calculation, made before the May sample had been collected, produced an estimate of 109 days for the implanted period and about 8 months for the total gestation period.

This method of calculation assumes that there are definite peaks in breeding and pupping. If breeding and pupping occurred evenly throughout the year, the average fetus size would remain constant throughout the year and the technique would not work. An ideal situation would be when all individuals breed and pup within very short periods. Sea otters do have peaks, but they are not well defined. Very large samples would be required in such a case, because there are always fetuses of all sizes and the periods of maximum breeding are broad.

Obviously Chapman's sample was inadequate. While the number of fetuses available for the latest estimate seems large and are well distributed throughout the year, the actual number in any one fetus weight class at any one time of year is small. A look at Table 1 shows that there is little consistency in many of the classes. (Fig. 3 shows that Class 1 and 5 fetuses do fit a pattern.)

Table 2. Estimated Length of Implanted Period.

Percent of Fetuses in each Weight Class

Time of Collection After January	Weight Class 1	2	3	4	5
1 month	31	15	15	38	0
3 months	18	12	22	35	12
5 months	18	8	8	36	30
7 months	3	8	16	29	45
9 months	20	7	10	40	23
10 months	14	18	12	33	23
Mean Time in Months After January	5.0	5.7	5.3	5.8	7.0
Cube Root of Unweighted Mean Weight	0.63	1.7	3.6	7.4	11.4

Specific Growth Velocity = 0.169/day
Estimated Implanted Period = 73 days

Table 3. Length of Unimplanted Period.

Months After January	Unimplanted Pregnant	Unimplanted Pregnant	Percent Unimplanted
1 month	35	26	58
3 months	49	49	50
5 months	128	179	42
7 months	22	37	37
9 months	50	57	47
10 months	55	44	56
Unweighted Average			48

All of the estimates rely very heavily on summer samples when the fetuses are largest. These samples are known to be biased, probably in favor of larger fetuses. There are more large fetuses at this time of year but it is exaggerated in these samples.

The latest estimate is not necessarily better than Chapman's even though it uses more and larger samples. The growth velocity is twice as high as that calculated for fur seal and a 5 month gestation period is not consistent with other information available.

This technique for estimating the implanted gestation period is not capable of providing a reliable estimate with the available data. Therefore, the 12 to 13 month estimate and any calculations based on it are meaningless.

Much of the discrepancy lies in the estimate of the unimplanted period. The present estimate that 48 percent of all pregnancies throughout the year are unimplanted is based on an even distribution of relatively large samples and is probably more accurate than Chapman's estimate of 60 percent.

There are several other ways of guessing at the length of gestation. Kenyon's (1969) estimate of an implanted period of 4 months using the cube roots of term fetus weights cannot be relied upon entirely, but it may be closer than the other estimates. If we estimate the unimplanted period from this using the 48 percent unimplanted factor and allow for the establishment of the embryo, we get a total gestation period of about 8.5 months.

Lensink's (1962) method of determining the peak breeding and peak pupping periods and taking the time between the peaks as the total gestation period has some merit. While Lensink tried to determine these peaks by field observations, we can determine them more accurately using the condition of reproductive tracts.

Lensink felt that the peak of breeding was in August or September. The data in Fig. 2 indicate that he may have seen the beginning of the period of greatest breeding activity, but that the peak is probably in October or possibly November. Lensink estimated the peak pupping period in March or April. Again the data indicate that he was seeing the beginning of the period of greatest pupping, but the actual peak is probably in June or July. At this time, the number of Class 5 fetuses is greatest. The number of post-partum females probably peaks and the number of implanted pregnant females is dropping from its peak. If the gestation period of the "average" animal lasts from October or November to June or July we get a period of 8 or 9 months. While Lensink's timing was early, the duration agrees with the present data.

The peak of implantation when the greatest number of blastocysts are implanting can also be roughly estimated from Figs. 1 and 3. In February the number of unimplanted pregnancies is dropping and the number of implanted pregnancies rising. Also, at this time the number of Class 1 fetuses probably reaches a peak.

Therefore it appears that the unimplanted period lasts 4 to 5 months and the implanted period from 4 to 5 months with a total gestation period of 8 to 9 months. It should be recognized that these estimates are based on general trends and not distinct changes. Therefore they are approximate. However, the relative length of the unimplanted and implanted periods agrees with the percentages noted previously and this estimate agrees with the one based on Kenyon's (1969) comparison with other species of otters.

If the gestation period were 12 months the percentage of pregnant animals would remain constant throughout the year. If it were only slightly longer or slightly shorter there would be only a slight fluctuation unless there were a distinct breeding period. Fig. 4 indicates a substantial fluctuation indicating a gestation period substantially shorter or longer than 12 months.

The peak of pregnancy occurs in February after the period of greatest breeding activity. The low point on the pregnancy curve occurs after those animals giving birth during the period of greatest pupping have pupped. That is: the highest point on the pregnancy curve occurs after the main breeding period and the lowest point is after the main pupping period. These periods actually last for 4 or 5 months so these points are well after the peaks of breeding and pupping.

The time between the peak when the highest number of females are pregnant and the low point when the fewest are pregnant should approximate the average gestation period. This is about 8.5 months (Fig. 4). The anestrus curve (Fig. 1) shows the same thing being a negative of the pregnancy curve.

With three different methods, we have estimated a gestation period of 8 to 9 months with the unimplanted period roughly equal to the implanted period. This agrees with the observed period in captivity (Barabash-Nikiforov, 1947) and with field estimates. Any gestation period differing greatly from this does not fit the data. Conceivably one could apply a 20 to 21 month period to the same information however, if this were the case, females would have to breed while accompanied by a pup or be on a four year reproductive cycle. This prospect stretches the imagination.

There is a definite possibility that the gestation period varies in sea otters as in land otters. This most likely would occur through variations in the unimplanted period. The above discussion refers to the average gestation period. Until better information to the contrary is obtained we must continue to assume that the average period is 8 to 9 months.

Fetal Growth Rate

If the estimates of the gestation curve are correct, Kenyon's (1969) Fig. 4 should approximate the growth curve of the fetus. Fig. 5 duplicates this and shows the actual weights. Fig. 6 shows the same information more graphically. It is possible to estimate the length of time spent in each weight class. Fig. 6 does not take the period for establishment of the embryo into account, so Weight Class 1 may be longer than shown, perhaps 15 days if we accept Chapman's (Kenyon, 1969) estimate.

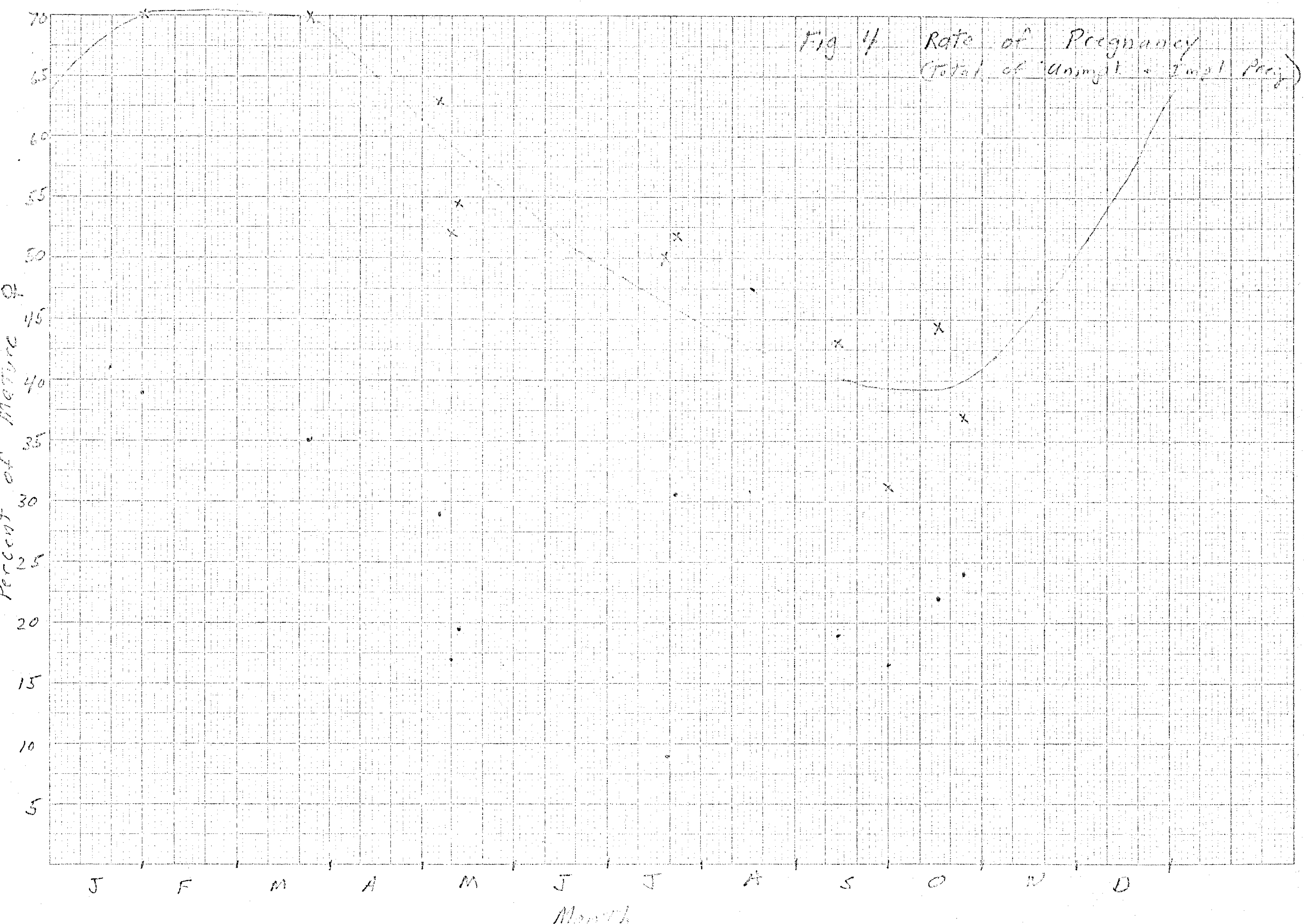
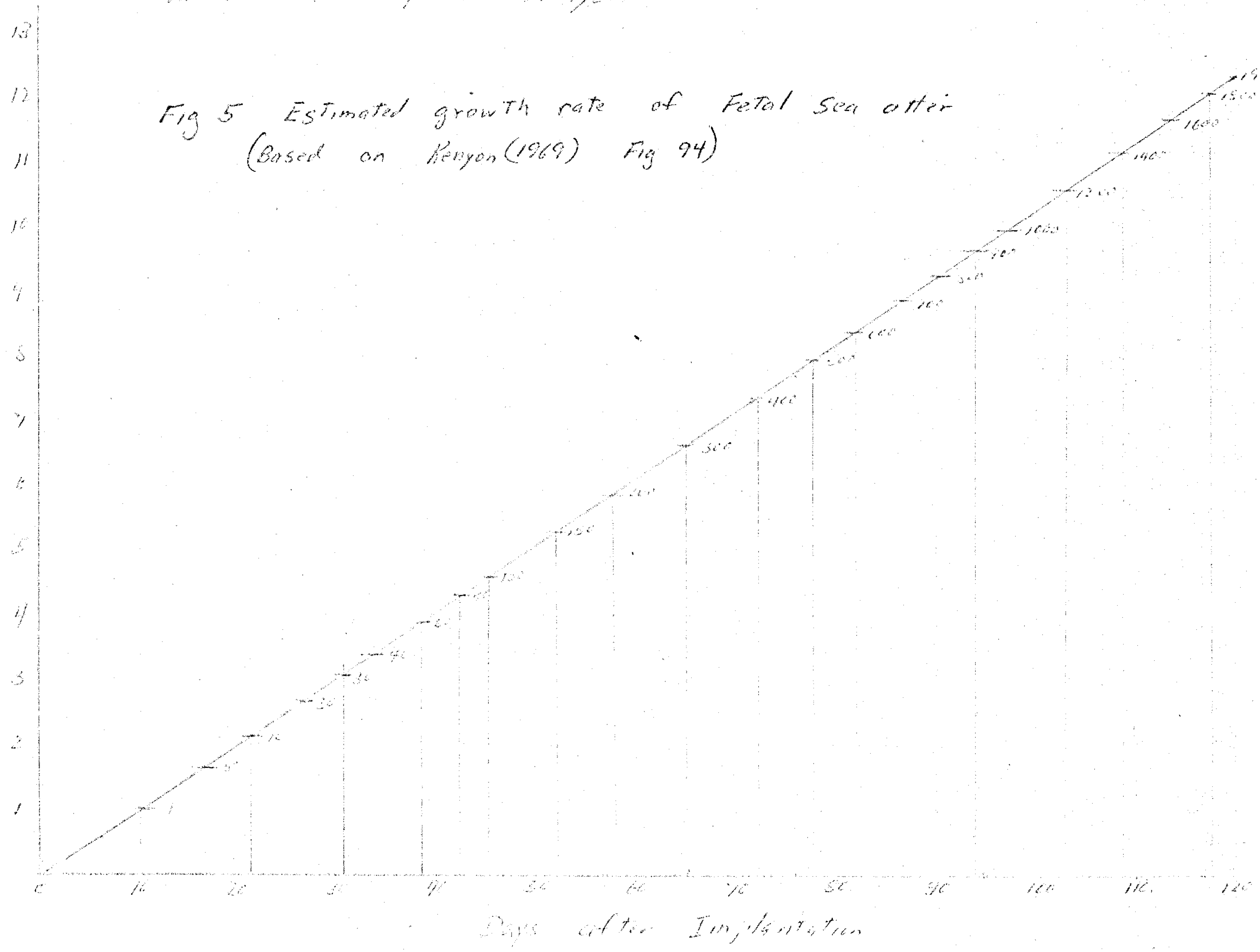


Fig 4 Rate of Pregnancy
(Total of Unimpl + Impl Preg)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
Percent of Mature ♀
J
F
M
A
M
J
J
A
S
O
N
D
Month

Based on Fig 41. Kenyon

Fetus Class
1 = 0-10 days
2 = 10-21 days
3 = 21-45 days
4 = 45-97 days
5 = 97-120

Fig 5 Estimated growth rate of Fetal Sea otter (Based on Kenyon (1969) Fig 94)



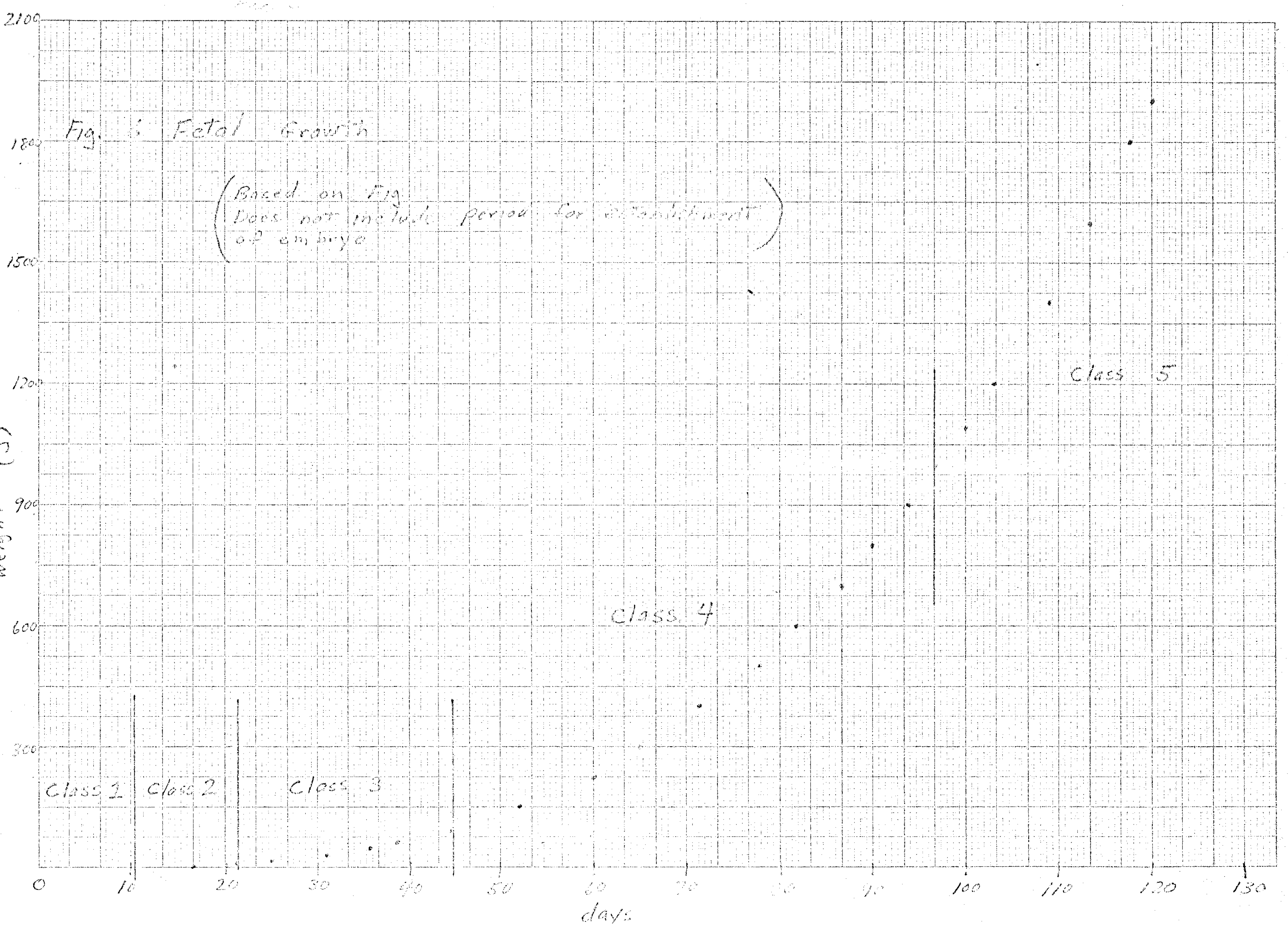


Fig. Fetal Growth
(Based on Fig.
Does not include period for establishment
of embryo)
Class 1
Class 2
Class 3
Class 4
Class 5
2100
1800
1500
1200
900
600
300
0
10
20
30
40
50
60
70
80
90
100
110
120
130
days

The short time span of Classes 2 and 3 explains the relatively small numbers and the lack of a consistent pattern found in those classes (Table 1).

Using this curve it should be possible to predict the time of birth and with less precision the time of implantation and conception of any particular fetus. By plotting the estimated birth dates of a large number of fetuses we should be able to draw curves which approximate the breeding, implantation and pupping rates of the population throughout the year.

Unfortunately there is overlap between samples collected at different times of year. Some of the samples are too small to provide a comparison. We would have to give weight to each sample in order to combine them. Therefore only the May, September and October samples are used. Where the September and October samples overlap two separate points are used. Fig. 7 presents the estimated birth dates grouped by month. Fig. 8 separates the dates into half month groups. February and March are not represented and April is an estimate based on post-partum females rather than fetus size (see Recovery of the Uterus after Parturition).

The peak in this curve may be exaggerated. It has been shown previously that fetus size is less consistent between samples than the other categories (Table 1) because the sample size of each grouping is small. Therefore the exact shape of the curve may not be correct. If, however, we assume the approximate timing of the peak is correct, we can construct a model of the breeding cycle based on our estimates of the gestation period. Such a model is already based on a fetal growth rate estimated from this estimated gestation period. Therefore our reasoning would be somewhat circular if we used this to prove the original estimate. However, we can see how this model fits the rest of the data. A good fit would tend to support the model and the estimates on which it is based.

For this model we use the curve in Fig. 8 to represent births. We assume a gestation period of 8 months with the unimplanted and implanted periods each lasting 4 months. Therefore we draw curves identical to the birth curve but moved backward 4 months for implantation of the blastocyst and 8 months for conception (Fig. 9).

A comparison of the peaks in Fig. 9 with the data in Figs. 1, 2 and 3 and the narrative based on those figures indicates a fairly close fit. The data indicate that the peaks may actually occur slightly later than indicated in Fig. 9, but in general the timing and distances between the peaks fit.

The sharpness of the birth curve indicates that the breeding, implantation and pupping peaks may be more distinct than indicated by the curves in Figs. 1 and 2. It is possible to fit curves with more abrupt changes to the data. Fig. 10 shows the same data with the curves drawn to more closely fit the model. Whether these curves are more accurate or not is open to debate. The data on which the birth curve is based is not that strong. The numbers in each month are relatively small. If such distinct peaks did occur, it seems likely that field observers would have seen the effects. Most field observations indicate broader peaks that are not well defined.

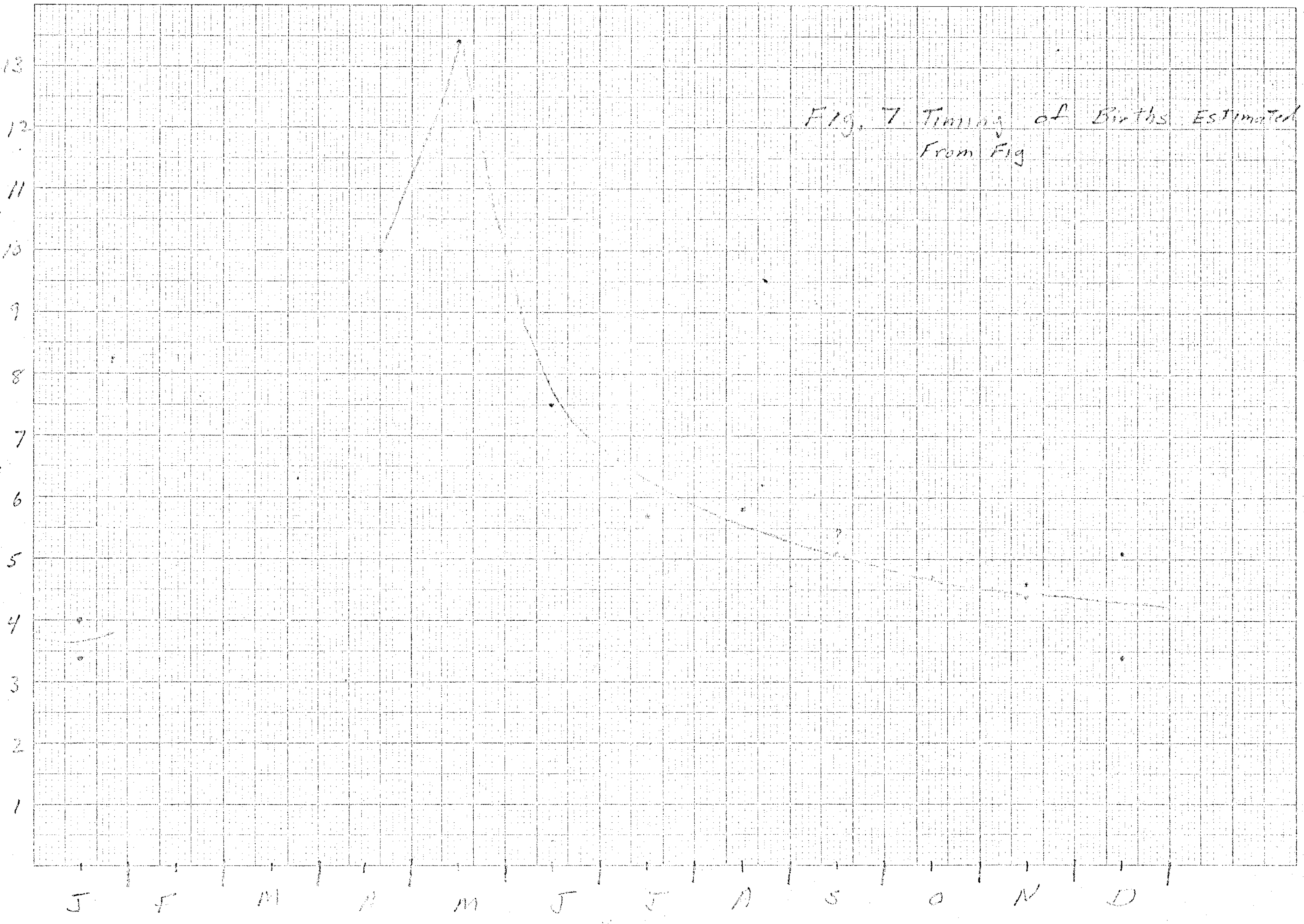


Fig. 7 Timing of Births Estimated
From Fig
13
12
11
10
9
8
7
6
5
4
3
2
1
J F M A M J J A S O N D

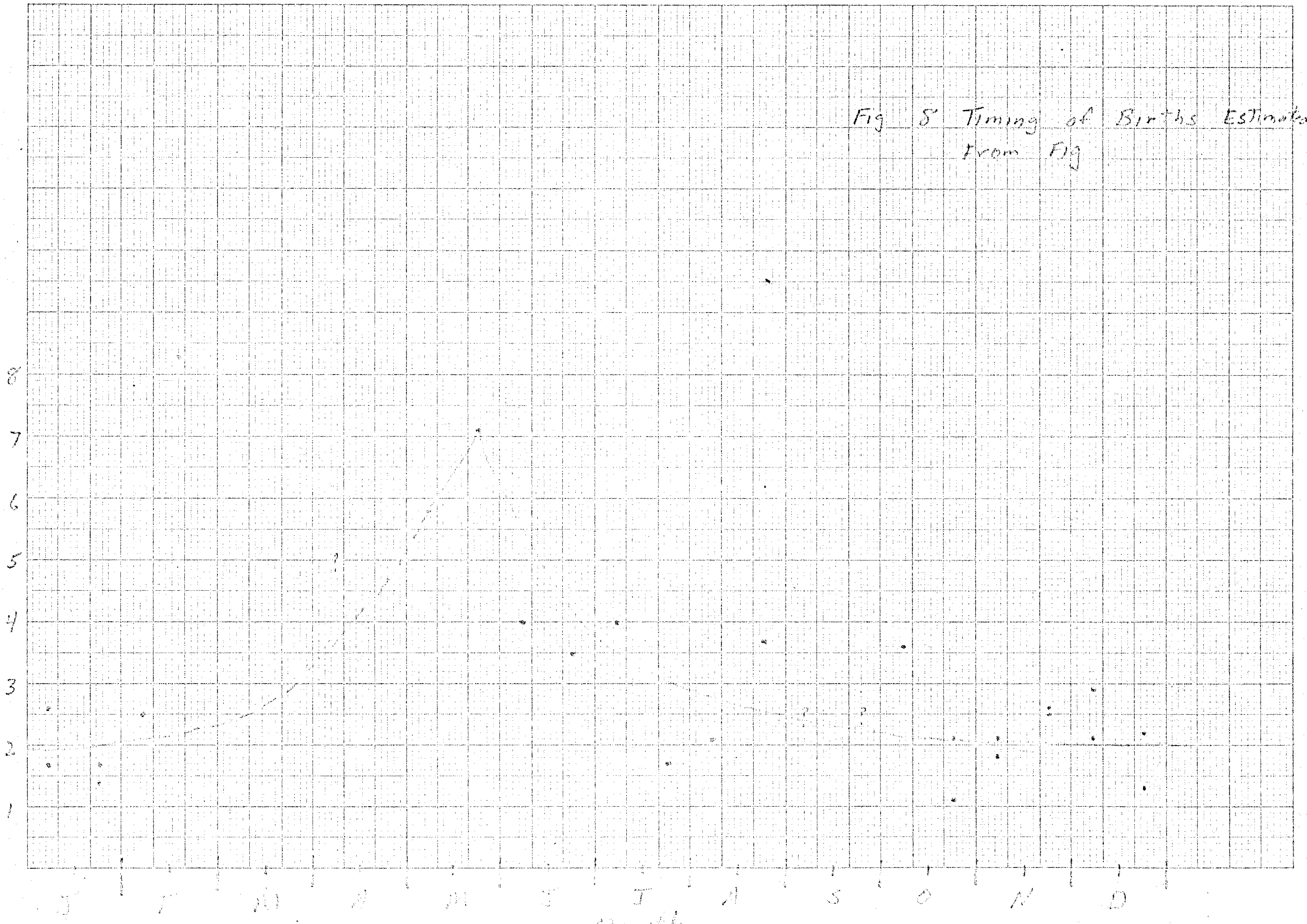
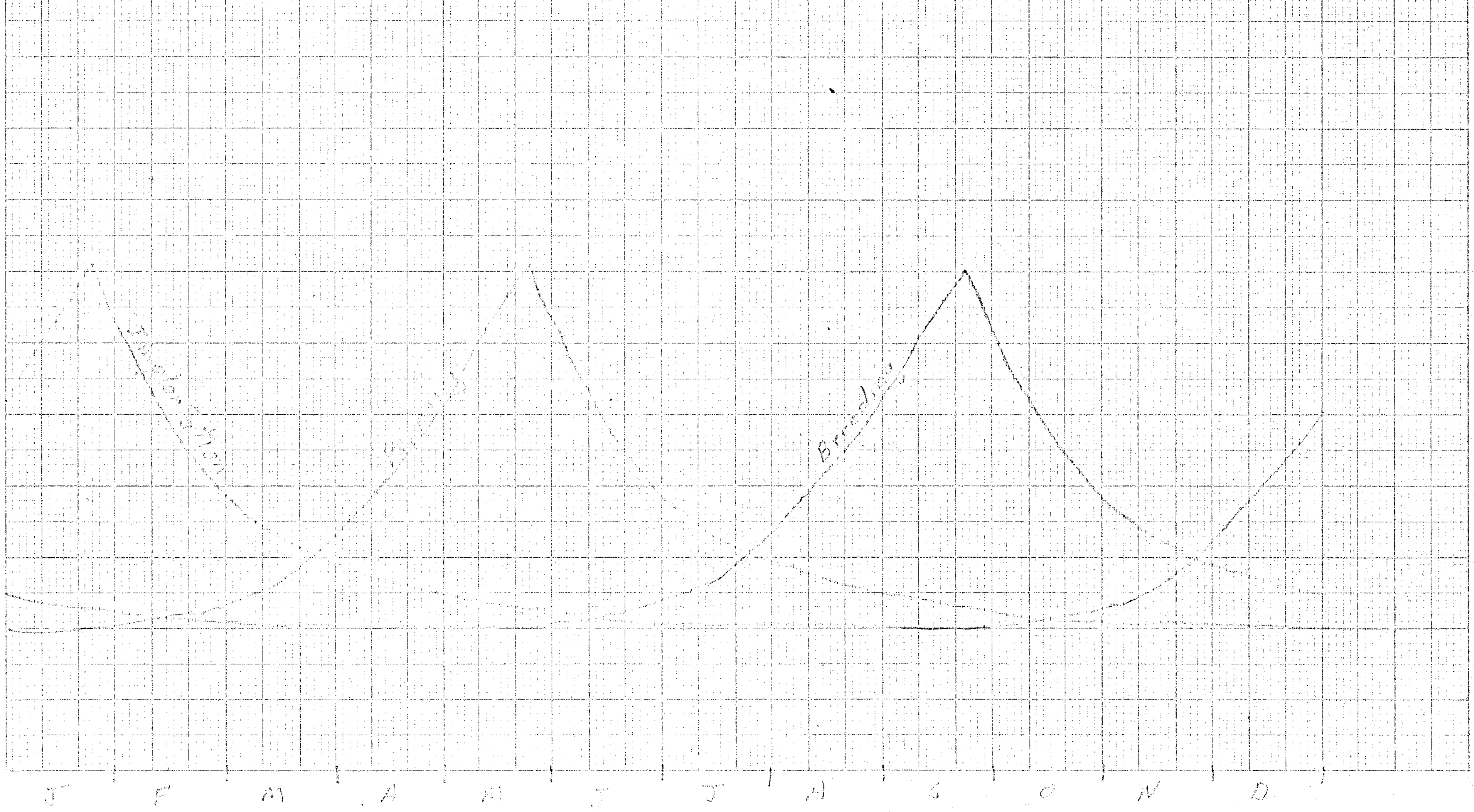


Fig 8 Timing of Births Estimated
From Fig
8
7
6
5
4
3
2
1
J
F
M
A
M
J
J
A
S
O
N
D

Fig 7 Model of Reproductive cycle based on fetus size and an assumed gestation period of 8 months with an implanted period of 4 months



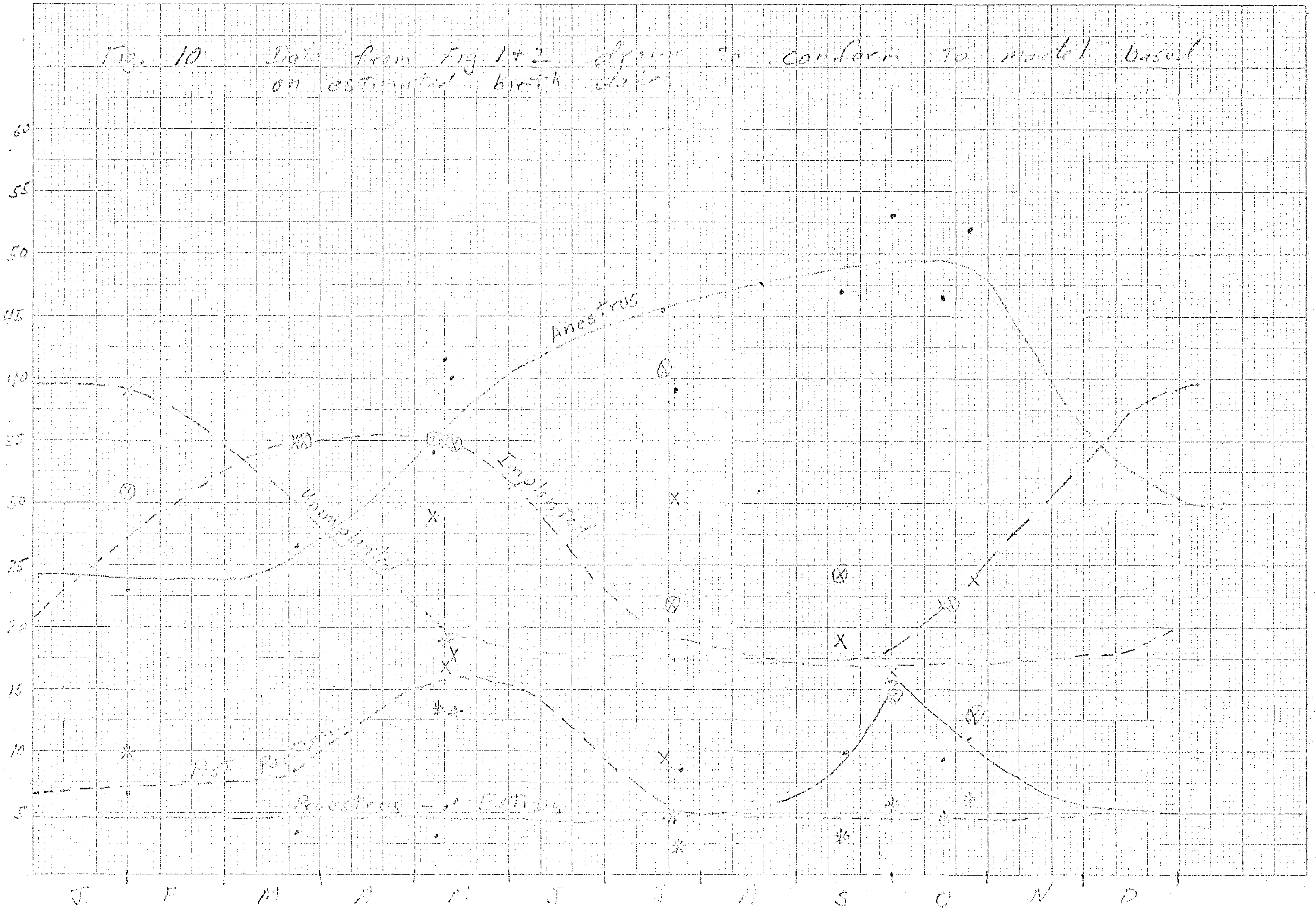


Fig. 10 Data from Fig 1+2 drawn to conform to model based on estimated birth dates

Age of Sexual Maturity

Tables 4 - 7 list the frequency of numbers of corpora albicantia and corpora lutea found in females of different areas. It should be recognized that the ages may not always be exact. Animals from Amchitka appear to become sexually mature when about 4 years old. It appears that more animals may become mature earlier on Adak. The information is too limited to draw any definite conclusions from this, however, the food availability is probably better at Adak and an earlier age of sexual maturity may be a response to better nutrition.

Frequency of Ovulation

From Tables 4 - 7 it can be seen that the maximum number of corpora albicantia for each age roughly equals the number of years after sexual maturity indicating that some animals ovulated once every year after maturity. It can be assumed that many corpora albicantia are invisible macroscopically after several years, particularly if they are not remnants of a corpus luteum of pregnancy. Therefore, it is possible that most females ovulate every year. This possibility is also supported by the high incidence of large follicles in lactating females (Table 10).

Maximum Breeding Age

Tables 4 - 7 indicate that at least some females continue to breed at a very old age. The samples are too small to determine whether a significant number become unproductive at any point.

Ovulation

Many mustelids are induced ovulators.

On September 14, 1967 a female was collected while copulating. She appeared to have ovulated shortly before. Because sea otters may copulate several times over a period of two or three days (Kenyon, 1969) ovulation may have been induced by a previous copulation.

Significance of Delayed Implantation and Timing of the Reproductive Cycle

Delayed implantation is a characteristic of the reproductive cycle of most mustelids. Several theories on the advantages of a delay have been advanced. Most assume that spring is the most favorable time of year for survival of newborn young, but that either a winter breeding season is not favorable or that the presence of a male, which occurs only during the breeding season, is advantageous for survival of the young of the previous pregnancy. Wright (1963) discusses the evolution of delayed implantation in mustelids and points out that there are exceptions even in arctic areas where time of birth might be considered more important, e.g. Mustella rixosa may be born at any time. Scheduling the breeding and parturition periods made possible by delayed implantation may be advantageous, but is not necessary.

Table 4. Frequency of occurance of Numbers of Corpora Albicantia
Amchitka - June-August 1968.

AGE (Years)	NUMBER OF CORPORA ALBICANTIA 1	2	3	4	5	6	7	8	9	10	11
0-1											
1-2											
2											
3											
4	1	1									
5	2 (1)										
6	1	1 (1)									
7		2 (1)	1								
8		1		1 (1)							
9				2 (1)	1 (1)	1 (1)					
10	1 (1)	4 (3)	2								1 (1)
11						2 (1)	1				
12	1 (1)		2 (1)	1 (1)							
13									1		
14					1	1 (1)					
15					2		1				
16					1						
17											
18											
19					1						

Numbers inside parentheses = Number of individuals with corpus luteum.

Table 5. Frequency of occurance of Numbers of Corpora Albicantia Kanaga - October 1968.

AGE (Years)	NUMBER OF CORPORA ALBICANTIA 1	2	3	4	5	6	7	8	9	10	11
0-1											
1-2											
2											
3											
4	2 (1)										
5	3	4 (1)	(Plus 2 with corpus luteum but no corpora albicantia)								
6	6 (3)	10(5)	1								
7	4 (4)		1 (1)								
8	4	5 (1)	3								
9	2 (1)	3	2 (1)	3 (3)	1						
10	1	3 (2)	5 (1)		1 (1)		1 (1)				
11	1 (1)	2	3	3 (1)	1 (1)	1					
12		1	4 (1)	1 (1)	2 (1)	1			1		
13		1 (1)	3 (3)	4 (1)	2 (2)		1 (1)				
14			1		1 (1)						
15	1 (1)		2						1	1 (1)	
16		1			1 (1)	1					
17										1 (1)	
18											

Numbers inside parentheses = Number of individuals with corpus luteum.

Table 6. Frequency of occurance of Numbers of Corpora Albicantia
Mid Pt.-Blind Pt., Adak - October 1968.

AGE (Years)	NUMBER OF CORPORA ALBICANTIA 1	2	3	4	5	6	7	8	9	10	11
0-1											
1-2											
2	1?	(Plus one with corpus luteum but no corpus albicans)									
3		(One with corpus luteum but no corpus albicans)									
4	2 (1)										
5		1			1(1)?						
6	1 (1)	1									
7		1 (1)									
8			1 (1)	1							
9		2 (1)			1						
10				1	1 (1)		1				
11		1		2	1 (1)						
12			1 (1)	1		1					
13		1	1		1		1				
14				1							
15	1 (1)										
16							1				
17											1
18				1							

Numbers inside parentheses = Number of individuals with corpus luteum.

Table 7. Frequency of occurance of Numbers of Corpora Albicantia
Three Arm Bay - Bay of Islands, Adak - October 1968.

AGE (Years)	NUMBER OF CORPORA ALBICANTIA										
	1	2	3	4	5	6	7	8	9	10	11
0-1											
1-2											
2	One with corpus luteum but no corpora albicantia										
3	One with corpus luteum but no corpora albicantia										
4	2	1?									
5	1 (1)	3	(Plus one with corpus luteum but no corpora albicantia)								
6	1 (1)	2 (1)									
7	1	2 (2)			1						
8		1 (1)	2 (1)	4 (1)							
9	2 (1)		2 (2)	1 (1)	1						
10	2 (1)		2	2	3	1					
11	1 (1)		2	2	3 (1)						
12			1		1 (1)	2 (1)					
13			2 (1)				1		1 (1)		
14	1										
15		1		1							
16											
17											
18											

Numbers inside parentheses = Number of individuals with corpus luteum.

The sea otter lives in an area of relatively uniform temperatures. However, storms tend to be more frequent and violent in fall and winter. Survival may be better in the late spring and summer. Therefore, there may be some advantage to birth in the late spring. However, there does not appear to be a great deal of advantage to a breeding season at any particular time of year.

Wright (1963) pointed out that most mustelids implant after daylight begins to increase, usually around February. This is the period when sea otters implant at the highest rate. If the time of implantation is influenced by daylight, the period when the greatest number of births occur could be shorter than the equivalent breeding period. The data do not show this, although the possibility cannot be ruled out.

The fact that substantial numbers of sea otters are breeding, implanting and pupping at all times of the year indicates that while there may be some advantage to certain events taking place at a particular time of year, that advantage is not great enough for a distinct breeding season to evolve.

Sea otters exhibit certain characteristics that are common to most mustelid breeding cycles, but these characteristics are not as well developed as in most species.

It is interesting to note that Wright (1963) correlated the molt of Mustella erminea with the implanted period. The molt began around the time of implantation and ended around parturition.

Sea otters molt all year and some are implanted pregnant at all times. At this time we cannot say whether any relationship between molt and pregnancy exists.

Fetal Orientation

Kenyon (1969) found that the number of caudally presented fetuses roughly equalled the number of cephalicly presented fetuses. He suggests that this indicates a lack of adaptation for birth occurring in water and infers that sea otters must give birth on land.

Fetuses of all weights in the present study also appear to be randomly oriented, however 97 Weight Class 5 fetuses (1000 g and over) showed 60 percent cephalic presentation while only 40 percent showed caudal presentation.

The orientation of large fetuses should be a better indicator of orientation at birth. Smaller fetuses may change position. Therefore, it appears that more sea otters are born head first than tail first.

If you accept Kenyon's premise that caudal presentation is necessary or at least beneficial to birth in water, this more recent information supports the supposition that birth occurs on land. The little information available indicates that birth does occur on land, but there have been unconfirmed reports of birth in water.

At least some sirenians are born head first indicating that caudal presentation is not necessary. North of Unimak Island a large population of sea otters lives off-shore. There is little evidence that any numbers come ashore. It seems likely that many of these animals are born in the water.

Location of Pregnancy

Of 305 implanted pregnancies, 138 fetuses (45 percent) had implanted in the left horn and 167 (55 percent) in the right horn. Most of the difference was in the 1970 Amchitka sample. Without this sample, 48 percent implanted in the left horn and 52 percent in the right horn. Kenyon (1969) found an equal number in each horn. If a real difference exists it is probably exaggerated by the 1970 Amchitka sample.

Out of 305 implanted pregnancies, the point of implantation was on the same side of the reproductive tract as the corpus luteum in all but three instances. In one case, the corpus luteum was in the left ovary and the fetus in the right horn. In the second case the corpus luteum was in the right ovary, but the fetus was in the left horn. In the third case there was a corpus luteum in each ovary and two fetuses (of different sexes) in the left horn.

It appears that blastocysts rarely cross from one horn to the other.

Because there is usually a relatively long period of time between parturition and the next estrus, there is little if any inhibitory effect on ovulation caused by the corpus of the previous pregnancy. The ovary producing the largest follicle appears to be random and there does not appear to be the tendency for a pregnancy to be from the opposite ovary from the previous pregnancy. In many cases, there are many more corpora albicantia in one ovary than in the other.

When a female loses a pup shortly after birth and enters estrus before the uterus has completely recovered and before the corpus luteum has completely degenerated, there may be some inhibitory effect. Of the 14 such cases identified, six had large follicles in the same ovary as the new corpus albicans and eight in the opposite ovary. It appears that any inhibitory effect by the degenerating corpus luteum only lasts for a short time.

A few cases were found where one ovary was not developed or otherwise not capable of producing ova. Because one ovary may support repeated pregnancies, such animals may be as productive as those with both ovaries active.

Kenyon (1969) reported that most implantations occur within the central third of the uterine horn. This held true for the animals in the present study, however they may implant anywhere. In one case with a near term fetus, the placenta covered the opening at the base of the horn apparently blocking the exit of the fetus.

Birth Weight

Barabash-Nikiforov (1947) listed the weight of a newborn sea otter as 2000 g. Kenyon (1969) presents the best quantitative data published to this time. He found a maximum fetus weight of 1869 g. While he found pups as small as 1020 g those under 3 lb (1.4 kg) had died shortly after birth. He estimated that successful birth weights range from 3 to 5 lb or 1.4 kg to 2.3 kg and for purposes of calculation assumes an average birth weight of 1850 g to 1900 g.

The weights of Weight Class 5 fetuses, the smallest pups found living in the wild and three pups born in captivity (all died within 24 hours) are presented in Fig. 11. These data tend to support Kenyon's (1969) estimate of the weight at birth. Few living pups weighing less than 1350 g or about 3 lb and few fetuses over 2000 g (4.5 lb) are found. Kenyon's upper estimate appears to be slightly high although there are extreme cases in both directions. One pup weighed only 2 lb (900 g) and one fetus could not be weighed accurately on available equipment but weighed over 2500 g.

One female with a 4 lb (1816 g) pup still had the placenta attached to the uterine wall and must have given birth shortly before being collected.

From Fig. 11 it appears that most pups are born when they weigh in the neighborhood of 1800 to 1900 g in most of the populations sampled. However, the Tanaga and Delarof samples indicate a birth weight of between 1600 and 1700 g. The Delarof sample is small, but the Tanaga sample is the largest, containing over a third of the large fetuses collected, and was collected at a time of year when the birth rate is very high.

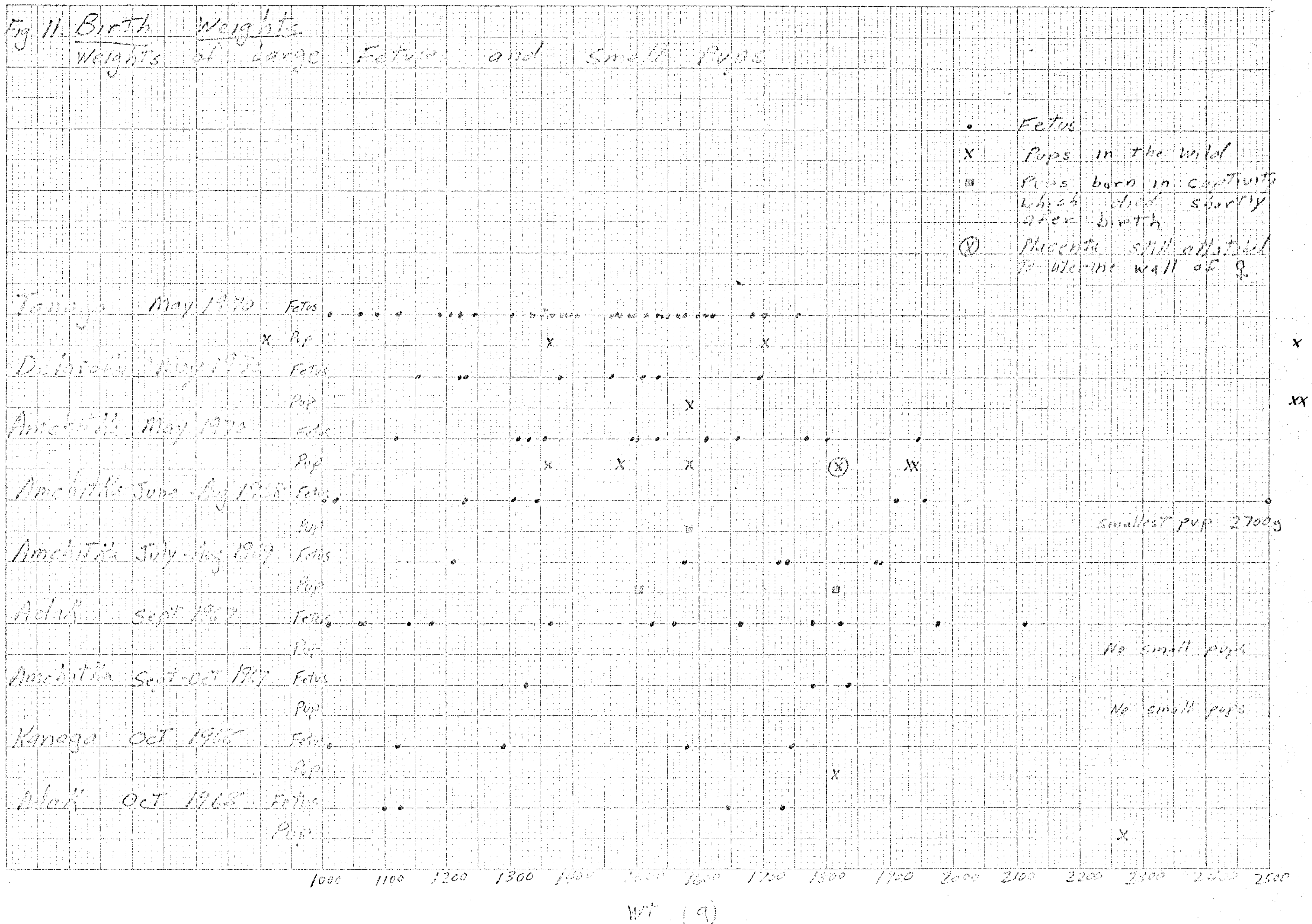
This may be a reflection of the physical condition of the adult females and indirectly a reflection of food availability. There are other factors indicating that the Tanaga population is declining because of overpopulation.

This lower birth weight raises the question of whether the pups are born earlier or whether they are in poorer condition when born. In an effort to gain some insight into this, the fetal weights of Class 4 and 5 fetuses from Tanaga were plotted against their total lengths (Fig. 12). Fetuses from other populations including eastern Adak which appears to be a very healthy population were checked against this curve formed by the Tanaga fetuses. In all cases, they fell well within the limits of the Tanaga data indicating that there is no difference in the weights of fetuses of a given length. It seems unlikely that a reduction in the rate of weight gain would be completely proportional to a reduction of linear growth. It appears that the rate of growth of fetuses is relatively constant, but that females in poor physical condition may not be able to support as large a fetus as those in good condition, so parturition occurs earlier.

This may have some effect on early pup survival, however we have no information on this.

Fig. 12 demonstrates some other interesting points. There is no difference in the weight-length ratio and the maximum fetus size of males and females.

VERNON ROYAL LINE R 2470-20 20 Squares to the inch



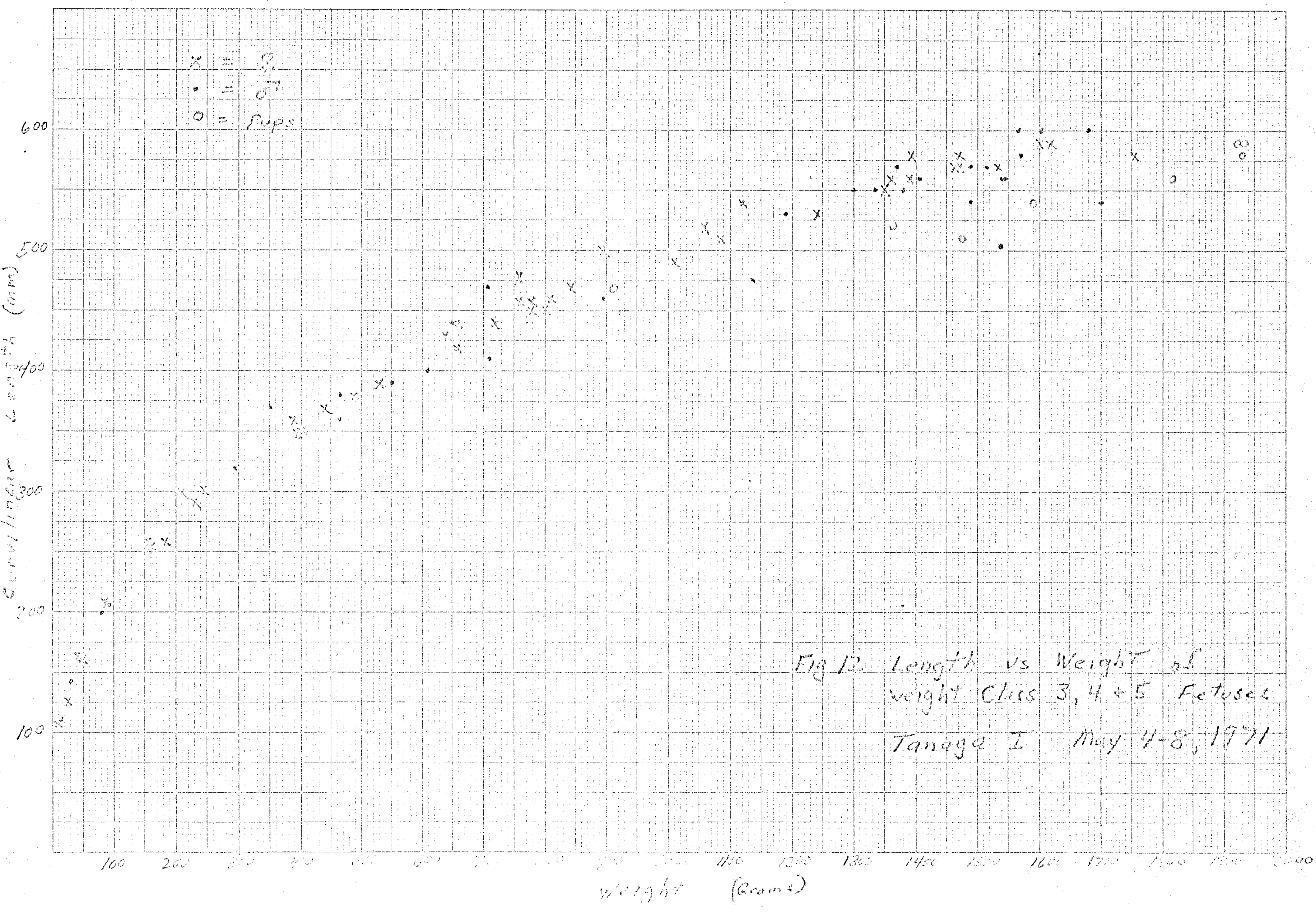


Fig 12. Length vs Weight of Weight Class 3, 4 + 5 Fetuses
Tanaga I May 4-8, 1971

This infers, although does not prove, an identical growth rate and birth weight for males and females. The circles on Fig. 12 show the weight-length ratio of pups. These fall below the curve formed by fetus weight-length ratios, indicating that pups of a given length are somewhat heavier than fetuses of the same length. This indicates an increase in weight immediately after parturition.

Sex Ratio at Birth

Kenyon (1969) found that, of 58 fetuses for which sex could be determined, 45 percent were male and 55 percent were female. He assumed an equal sex ratio until a larger sample could be obtained.

In the present study, 111 fetuses were male and 144 were female. When this sample is combined with Kenyon's, the sex ratio of 313 fetuses is 44 percent male and 56 percent female.

Sex Ratio of the Population

In the process of harvesting, capturing animals for transplants and delineating "male" and "female" areas, it has become apparent that there are more females in the population than males. Our general impression is that perhaps 60 to 65 percent of the sea otters are females. Kenyon (1969) demonstrated that more juvenile males than females are found dead on the beaches of Amchitka. The age structure of animals harvested in 1968 indicates that males may not live as long as females.

The lower birth rate, higher juvenile mortality rate and slightly shorter life expectancy of males could account for the unbalanced sex ratio in the population.

The sex ratio may vary from one island to another. Presumably there would be more females in a population that has reached the carrying capacity of the habitat where juvenile mortality is higher. There is some indication that males are the first to expand into new areas of unoccupied habitat. Therefore, in recently populated areas one might find more males. However this situation would be temporary.

Litter Size

The normal litter size of the sea otter is one. This has been recorded by almost every observer since Steller. Barabash-Nikiforov (1947) reported twins *in utero* and mentioned other reports of twin fetuses from the early days of hunting. Snow (1910) recorded a set of newborn twins. In more recent studies, both Sinha, et al (1966) and Kenyon (1969) found reproductive tracts with two corpora lutea but in all cases only one fetus was present. In thousands of hours of observation by many observers, no twin pups have been reported.

In the present study, 24 instances of multiple ovulations were recorded. Five of these resulted in twin fetuses and one in triplet fetuses. The information is summarized in Table 8.

Table 8. Multiple Corpora Lutea and Fetuses.

Total Pregnant Females	565
Implanted Pregnancies	316
Unimplanted Pregnancies with 2 CL (corpora lutea)	9
Implanted Pregnancies with 2 CL and 1 Fetus	8
Implanted Pregnancies with 3 CL and 1 Fetus	1
Implanted Pregnancies with 2 CL and 2 Fetuses	5
Implanted Pregnancies with 3 CL and 3 Fetuses	1
Total Multiple Ovulations	24
Percent Multiple Ovulations	4.2%
Percent of Pregnancies with Multiple Fetuses	1.9%
Corpora Lutea per Pregnancy	1.05
Fetuses per Pregnancy	1.02

From these data, it appears that in over 4 percent of the estrus cycles more than one ovulation takes place. Of these, about half result in the development of more than one fetus. In most cases, the fetuses were of a relatively large size and probably would have been born normally.

All multiple fetuses appeared to be the result of separate ovulations. All had separate placentas and in some cases were of different sexes. Four tracts with twins had both fetuses in the same horn, one had one in each horn and the tract with triplets had one fetus in one horn and two in the other. Another tract had skeletal remains of triplets in one horn that were being resorbed. Another tract appeared to have had five fetuses in one horn, but they were almost completely resorbed. One might infer that physically there is not enough room in one horn to accommodate more than two fetuses for any length of time.

With the exception of the newborn twins reported by Snow (1910), there are no documented records of female sea otters with twin pups. There are occasional unconfirmed reports of twin pups, but, as Kenyon (1969) points out, a female may tolerate a pup in addition to her own, but it is unlikely that a female could care for more than one pup. It is unlikely that more than one pup survives. In any case, only 2 percent of the pregnancies produce more than one pup. Multiple births cannot be a significant factor in the productivity of sea otter populations.

In Utero Mortality

The presence of a corpus luteum, without gross evidence of implantation, was assumed to be an unimplanted pregnancy. No attempt was made to locate unimplanted blastocysts. As a result, we have little information concerning the survival of the blastocyst. Of 206 reproductive tracts classified as nulliparous on the basis of the appearance of the uterus, 12 had one corpus albicans and one had two. Some of these may have been large attritic follicles. Others may have ovulated and even conceived, but implantation did not occur. All of these cases represent the failure of the animals first estrus.

A total of 16 resorptions or possible abortions were identified (Table 1). The following is a brief description of these with possible causes of some:

Description	Number
Resorption of blastocyst or ovum (corpus luteum degenerating, no evidence of implantation).	4
Failure at time of implantation (possibly because of growth inside horn adjacent to implantation site).	1
Resorbed or aborted fetus (implantation at end of horn).	3
Resorbed fetus (umbilicus twisted tightly).	1
Resorbed fetuses (three or more fetuses in one horn).	2
Resorbed fetus (cause unknown).	5

Six of these resorptions may have been caused by a lack of room for growth of the placenta because of crowding from other placentas, a growth or the end of the uterine horn. These six and the one with the twisted umbilicus are probably the result of random events or accidents.

The numbers of resorptions are too small to accurately measure the frequency of such occurrences although the relatively large number in the Tanaga sample (Table 1) may be a reflection of the physical condition of the animals. Part of this number is probably due to the fact that there are more pregnant animals in the sample. In general, the samples with the most pregnancies also contained the most resorptions. Half of the Tanaga resorptions can be attributed to random events, but five were still due to unknown causes. Eight of the 10 resorptions found on Tanaga came from a 20-mile stretch of shore, about 25 percent of the harvest area.

While concrete conclusions cannot be drawn from these data, they do raise the possibiliy that under certain conditions 5 percent of the pregnancies may fail.

Mortality at or near Parturition

Collecting methods were such that the presence of a pup with a female was often overlooked. Therefore the lack of a pup with a post-partum or lactating female did not mean that the pup had died. However, 14 females showing signs of recent pregnancy were entering estrus presumably having lost their pup shortly before or shortly after parturition.

Again the magnitude of this mortality cannot be determined but it appears to be of the same order as the *in utero* mortality.

Recovery of the Uterus after Parturition

Reproductive tracts were subjectively classified as post-partum or anestrous on the basis of degeneration of the corpus luteum (or appearance of the corpus albicans), the size of the horn of pregnancy and appearance of the placental scar. In an effort to get an idea of how long it takes for the tract to return to normal, the size of pups accompanying females in each category is listed in Table 9.

It appears that females pass the subjective boundary from post-partum to anestrus when the pup weighs about 10 lb and is around 75 to 80 cm long.

We do not know a great deal about the early growth of a sea otter pup, but judging from the growth curve established based on cementum deposition of older animals and from tooth eruption, a 10 lb pup is probably in its second month of life.

Table 9. Pups Accompanying Post-partum Females.

Sex	Weight	Total Length
M	2 lb	47 cm
F	3	52
F	4	56
M	5	60
F	5.5	65
F	6.25	65
F	7.75	70
M	10	81 (borderline post partum-anestrous)
F	11	82 (late post-partum)

Pups Accompanying Anestrous Females.

Sex	Weight	Total Length
F	10 lb	78 cm
M	11	79
M	12	84
F	13	83
M	13	92
M	16	83
M	17	91
M	19	87
M	19	90
F	21	107
F	22	96
M	22	101
M	24	97
M	26	100
F	28	103

Frequency of Breeding

Steller (1751) reported seeing female sea otters with newborn pups also accompanied by another pup that seemed to be no more than a year old. Murie (1940) recorded an instance of copulation by a female accompanied by a pup and Jones (1952) caught a young pup simultaneously with a copulating pair. Lensink (1962) felt that few females breed until the pup is a year old but mentions females with small pups also accompanied by large pups.

I believe that some of these observations may be misinterpretations of the situation. Females will occasionally leave small pups for a time, often near other animals. The pups Lensink mentions would be 2 years old and probably weigh 30-35 lb. Sea otters are gregarious and subadults may remain near other animals appearing to be accompanying their mother. I suggest that most of Steller's and Lensink's large pups were such cases.

Females with dependent pups probably do breed occasionally, but the most recent evidence indicates that this rarely occurs. Kenyon (1969) records no instances of females accompanied by pups copulating and states that he found no females known to be accompanied by a pup that were pregnant. This holds true for the animals collected in the present study. However, the nature of the harvesting operation is such that many females accompanied by pups were not recorded as such. Therefore, we are forced to look at lactating females and assume that they were accompanied by a pup at the time of collection or shortly before. Table 10 summarizes the reproductive condition of the lactating females. In the 1967 and 1968 samples, some animals with enlarged mammary glands were listed as lactating. As a result, some females with near term fetuses were included. Because this condition is considered to be associated with the unborn pup rather than a previous pup these animals were lumped with the anestrous animals in Table 10. In 1969 and 1970, the presence of milk was used as the sole criterion and no term animals were in the sample.

Of 246 lactating females, only one had an implanted fetus (excluding the near term animals from 1967-68). Several others had small corpora lutea indicating that they had recently become pregnant or possibly had large follicles which had luteinized, but were not actually pregnant. The remainder had enlarged follicles.

This information implies that females accompanied by a pup may enter proestrus and even ovulate, but that they only rarely mate. That they enter estrus is substantiated by the fact that the number of corpora albicantia in many tracts equals the age of the animal minus the three years prior to sexual maturity (see Tables 4-7). This indicates that large follicles tend to develop each year after sexual maturity is reached, whether the female is accompanied by a pup or not.

Some of those lactating females with small corpora lutea may have recently weaned or otherwise lost a pup and are already pregnant again. Malkovich (1937) took a pup (at least 3 months old) away from a female in captivity. She mated 12 days later where she had previously ignored the male. It appears that a female enters estrus shortly after weaning.

Table 10. Reproductive Condition of Lactating Females.

Location	Date	Inactive [1/]	Active [2/]	% Active
Bay of Is., Adak I.	Sept. 1967	9	1	10.0
Amchitka I.	Sept.-Oct., 1967	17	2	10.5
Mid Pt. - Blind Pt., Adak I.	Oct. 1968	19	3	13.6
Bay of Is., Adak I.	Oct. 1968	22	4	15.4
Kanaga I.	Oct. 1968	32	5 [3/]	13.5
Amchitka I.	July-Aug., 1969	4	2	33.3
Tanaga I.	May 1970	56	10	15.2
Delarof Is.	May 1970	18	3	14.3
Amchitka I.	May 1970	36	3	7.7
TOTAL		213	33	13.4

1/ Anestrous or pregnant with term fetus.

2/ Large follicles or corpus luteum present.

3/ Includes one implanted pregnancy with small fetus.

The question of how long it takes for a female to enter estrus again after losing a small pup arises. Eleven tracts of the 1970 sample and two of the 1968 Kanaga sample showed signs of being pregnant recently, but were in proestrus. These animals had an enlarged horn usually with a slightly pigmented area, but no actual placental scar and a recently formed corpus albicans. However, they also had enlarged follicles and the walls of the uterus were typical of proestrous animals. Another animal was similar but appeared to have already ovulated and a corpus luteum was present. In these cases, the female has lost a pup either through abortion or within the first weeks after parturition and has started into another estrus cycle. Three or four of these had follicles which may have started to become attritic. This may be because the uterus had not recovered sufficiently from the last pregnancy.

The implication of this information is that with a normal pregnancy and successful rearing of a pup, the female becomes pregnant only after the pup has been weaned. This may be a year after parturition. However, if the pregnancy fails or if a pup dies, even at birth, the female may become pregnant again in a few weeks rather than waiting the full year.

Kenyon (1969) suggests that the period between weaning and the next estrus may be long because he found animals that were not lactating but had a faint placental scar and an indistinct, but recent, corpus albicans. These animals were classified as anestrus in the present study. They are undoubtedly between weaning of their last pup and the next estrus. The number of such animals is greatest during September and October. At this time, the rate of estrus increases and the number of anestrous animals decreases sharply during the next few months. Therefore, many of these anestrous animals become pregnant within a month or two. Kenyon (1969) suggests that if the female keeps the pup for about a year that the period between births may be somewhat greater than two years. He is assuming a 12-13 month gestation period. However, the present study shows that the estimate of a 12-13 month gestation period was based on an inadequate sample. Estimates in the present study put this period at closer to 8 or 9 months. Presumably the anestrous, nonlactating females are in the 3 to 4 month period remaining.

This does not change Kenyon's (1969) point that the period between weaning and the next estrus may be long. It indicates that in a normal reproductive cycle it may be several months. However, as it was shown above, it is possible for a female to enter estrus very shortly after losing a pup.

We have demonstrated that sea otters breed at all times of year and it is possible for a female to become pregnant again after losing a pup sooner than she would have if the pup had survived. However, we have also demonstrated that annual peaks of breeding and pupping occur and that these peaks are similar in different years and in different populations. The assumption can be made that the average length of the entire reproductive cycle is some multiple of a year.

Kenyon (1969) assumes that the pup remains with its mother for about a year. Weights and measurements, cementum deposition, skull changes, observations in the wild and in captivity, all support this assumption although it cannot be said with certainty that it averages 12 months. It could be slightly more or less.

Assuming about 12 months for rearing the pup, 8 to 9 months gestation plus a few months rest between weaning and the next estrus, the average reproductive cycle takes two years.

This is supported by Fig. 4 which shows that slightly over half the mature females are pregnant in a year. Kenyon (1969) pointed out that his January and March samples were biased against females with pups and therefore in favor of pregnant females because of selective hunting. This bias applies to the fall samples as well. The summer samples were biased similarly because pregnant females appeared to be less resistant to handling during capture. Therefore, the percent of pregnant females is shown to be higher than it actually was. While no correction factor can be applied to all samples, the evidence indicates that the percent of pregnant females is usually around 10-15 percent lower than in the sample. For example, the 1970 Amchitka sample was less biased and was about 9 percent lower than the Tanaga sample which is known to be more biased. Also on a June skiff survey, 7 percent of the animals counted had pups that were readily identified. If we assume that this is the number of animals avoided it can be calculated that 15 percent of the sexually mature females, all of which are nonpregnant, were avoided. Actually this will vary with the hunter, weather, time of year, etc. However, it indicates the order of magnitude of the bias.

Using this as a rough correction for the data in Fig. 4, we find that about half or slightly fewer of the sexually mature females are pregnant each year or as indicated previously, the average female has a pup every two years.

Conclusions

1. While sea otters may breed or pup at any time of year, there are seasonal fluctuations in the numbers of females in each reproductive stage. The pattern of these fluctuations remains the same from year to year and population to population.

2. Breeding activity is highest in September, October and November.

3. More implantations occur during January, February and March than at other times of year.

4. The birth rate is highest during April, May and June.

5. Two and a half to three times as many females breed during the peak breeding months as during the months of lowest breeding activity.

6. Similarly, two and a half to three times as many females pup during peak pupping months.

7. During the period of lowest breeding activity, sexually mature females breed at a rate of 2 to 3 percent per month. During the peak of breeding 7 to 10 percent per month breed.

8. During the period of lowest pupping activity, 2 or 3 percent per month pup and during the peak of pupping 7 to 10 percent per month pup.

9. The gestation period is about 8 to 9 months on the average. About half of this time is an unimplanted period.

10. Female sea otters become sexually mature when 3 to 4 years old.

11. Females may ovulate on an average of once a year after sexual maturity is reached.

12. Females continue to breed at an old age.

13. Sea otters retain certain characteristics common to the reproductive cycles of many other mustelids, however exceptions are common. Scheduling of the reproductive cycle during the year may have some advantages or it may be a trait that has not been entirely lost through evolution.

14. Sixty percent of the near term fetuses are cephalicly oriented and 40 percent are caudally oriented.

15. Sea otters probably give birth both on land and in the water.

16. Blastocysts rarely cross from one uterine horn to the other.

17. Consecutive pregnancies may occur in the same horn. The side of pregnancy appears random.

18. Implantation usually occurs in the central third of the horn, but it may occur anywhere in the horn.

19. Birth weights may range from 900 g to over 2500 g, however most pups weigh 1800 g to 1900 g at birth.

20. Females from areas where the population is declining because of food shortages may pup earlier and, as a result, the pups' birth weight may average 200 g lower than normal.

21. Male and female fetuses grow at the same rate and are the same size at birth.

22. Body condition of the female has little effect on the growth rate of the fetus.

23. There is a rapid weight gain shortly after parturition.

24. The sex ratio at birth is 44 percent male and 56 percent female.

25. The normal litter size is one, however in 2 percent of the implanted pregnancies two or three fetuses survive to near term.

26. Multiple ovulations occur in 4 percent of the estrus cycles.

27. Females do not appear to be able to support more than two fetuses in a single horn.

28. Up to 5 percent of the pregnancies may fail due to in utero mortality after implantation.

29. An unknown, but probably significant, number of first pregnancies fail before implantation.

30. The uterus is usually considered recovered from a pregnancy when the pup weighs about 10 lb and is probably in its second month of life.

31. Sexually mature females normally have one pup every two years.

32. Females with a pup may ovulate, but rarely mate.

33. Slightly less than half of the sexually mature females are pregnant in any given year.

34. A female may enter estrus within a few weeks of losing a pup. Consequently she may become pregnant again without waiting the same length of time as if the pup had survived.

35. When a pup is weaned normally, there is a longer period, perhaps 3 or 4 months, between weaning and the next estrus.

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