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AERIAL SURVEYS OF SEA OTTERS IN THE NORTHWESTERN GULF OF ALASKA AND SOUTHEASTERN BERING SEA (RU 673)

envirosphere company
A Division of
EBASCO SERVICES
INCORPORATED

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OCSEAP Research Unit 673

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Principal Investigator

John J. Brueggeman

Contributors

Gregory A. Green
Richard A. Grotefendt
Douglas G. Chapman

ABSTRACT

Aerial surveys were conducted in the northwestern Gulf of Alaska and southeastern Bering Sea to determine the distribution and abundance of sea otters. Four, 15-day surveys were flown between March and October 1986, from a DeHavilland Twin Otter aircraft along 17,823 nmof trackline. A total of 7,580 groups of 22,791 sea otters were observed in the Shumagin, North Aleutian Basin, and St. George Basin (Fox Islands) planning areas. Sea otter densities were highest in the Shumagin Planning Area, lowest in the St. George Basin, and intermediate in the North Aleutian Basin.

Areas of peak use shifted seasonally within the North Aleutian Basin and Shumagin planning areas. However, there was no indication of a major seasonal movement of sea otters between these two planning areas. Sea otter numbers have apparently increased in the Fox, Pavlof, and northern Shumagin islands and decreased in the Sanak and southern Shumagin islands since earlier surveys. Abundance estimates of sea otters ranged from 15,346 - 17,835 for the Shumagin area, 9,061 - 13,091 for the North Aleutian Basin, and 858 (one survey only) for the St. George Basin; total abundance for the study area was estimated between 26,775 and 29,295 without correcting for animals submerged or missed on the surface. These abundance estimates combined with the observed numbers in the major island complexes, suggest the sea otter population has declined in the North Aleutian Basin and increased in the Shumagin area and St. George Basin.

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1.0 INTRODUCTION

Sea otters (Enhydra lutris) were historically distributed along the entire Pacific coast of North America from Baja California to the western Aleutian Islands (Kenyon, 1982). Sea otters also occurred along the coasts of Siberia, northern Japan, and the Kurile and Commander Islands (Kenyon, 1982). Commercial exploitation of sea otters began in 1742 with the Russian fur trade and ended in 1911 when the animals were afforded protection under an international fur seal treaty. During the 170 years of unregulated harvest approximately one-half million sea otters were killed (Kenyon, 1969), and by 1911 fewer than 2,000 animals remained worldwide. Since protection, the sea otter populations began a slow recovery that originated from 13 small remnant populations in Alaska, California, and the Soviet Union (Kenyon, 1969). During the 1960s and 1970s growth was rapid and the world population has subsequently recovered to an estimated 150,000 (Johnson, 1982). Much of the sea otters' original range, especially south of Alaska remains unoccupied except for small isolated populations (Kenyon, 1982).

The most dramatic recovery of sea otters has occurred along the Aleutian Islands and the Alaska Peninsula where over 80 percent of the world population presently resides (Calkins and Schneider, 1985). Information on sea otter abundance, distribution, and habitat use patterns in the northwest Gulf of Alaska and southeastern Bering Sea is incomplete or, because of the rapidly expanding and fluctuating nature of their populations, out of date. Most information is derived from surveys conducted by the U.S. Fish and Wildlife Service in the 1950s and 1960s (Lensink, 1960; Kenyon, 1969), the Alaska Department of Fish and Game in the 1960s and 1970s (Schneider, 1976), and Cimberg et al. (1984) in the 1980s. Cimberg et al. (1984) repeated the flight lines surveyed by Schneider (1976) and concluded that the sea otter population along the north side of the Alaska Peninsula had declined by 60 percent during the six years between studies. They further reported

a seasonal decline of 86 percent during winter, from which they postulated a seasonal migration between the Bering Sea and the North Pacific Ocean through False Pass.

In 1986, we surveyed the coastal waters north and south of the Alaska Peninsula and the Fox Islands of the eastern Aleutian Islands to characterize their use by sea otters and other marine mammals.

The primary objectives of this study were to:

1. Characterize sea otter abundance and habitat use in the study area on a semi-seasonal (four surveys) basis from spring to fall .

2. Investigate the possibility of an annual sea otter migration between the Bering Sea and the North Pacific Ocean through False Pass.

Our surveys were part of an MMS/OCSEAP study to determine the effect of proposed petroleum exploration and development on marine mammal populations in the Shumagin, North Aleutian Basin, and St. George Basin planning areas as stipulated by the Outer Continental Shelf Lands Act, the National Environmental Policy Act, the Marine Mammal Protection Act, and the Endangered Species Act. Aerial surveys were conducted during four 15-day periods in 1986: Survey 1, 1-15 March; Survey 2, 28 June-12 July; Survey 3, 18 August-1 September; and Survey 4, 2-16 October. Measurements presented in this report are in British units. The units of measurement directly correspond to the original survey data except for bathymetric measurements. Bathymetric measurements were converted to British units from the original charts to maintain consistency, but the metric equivalents are given in parentheses in the report.

Acknowledgments:

We thank the following: C.E. Bowl by, S. Landino, B. Hanson, M. Herder, and R. Small for participating as observers and data recorders during the surveys; K. Kenyon for assistance in the technical aspects of this study; the pilots and mechanics of the NOAA Corps; the Cold Bay FAA and National Weather Service staff, who provided us with weather reports; the Izembek National Wildlife Refuge staff who provided us with historical records and supportive data; and the employees with Reeve Air, Pavlof Services, and residents of Cold Bay who provided assistance. We are also grateful for the support provided by L. Jarvela, NOAA, and the Minerals Management Service staff. The project was sponsored by the Minerals Management Service, Department of the Interior, through an interagency agreement with the National Oceanic and Atmospheric Administration, Department of Commerce, as part of the Outer Continental Shelf Environmental Assessment Program (Contract No. 85-ABC-00093).

2.0 STUDY AREA

The study area location was north and south of the Alaska Peninsula and the Fox Islands in waters less than 38 fm (70 m) deep (Figure 1). Surveys were conducted along the north side of the Peninsula from Unimak Island to Port Heiden. Surveys along the south side extended from Unimak Island to Pavlof Bay and included the Sandman Reefs, and the Sanak, Pavlof, and Shumagin island complexes (Figure 2). The Fox Islands surveys (Figure 2) included all islands between Avatanak Island and Samalga Island, except Ugamak which was not surveyed due to potential conflict with an ongoing northern sea lion study.

The substrate the north of the Peninsula is sandy with some gravel mix laid along a gentle gradient slope (McDonald et al., 1981). This area supports a very high clam population (McDonald et al., 1981). A small rocky reef exists around Amak Island providing one of the few attachment substrates for kelp on the Bering Sea side of the Peninsula (0' Clair, 1981). Amak Island and surrounding rocks are the only islands north of the Peninsula. Another rocky reef supports a small kelp bed at Cape Sarichef on the east end of Unimak Island. The area south of the Peninsula is rocky-bottomed with numerous reef and island complexes. Extensive kelp beds exist in the shallow water areas. The nearshore bathymetry surrounding the islands of the Fox Islands complex is comprised of narrow shallow bands of rocky substrate and deep water fiords. Kelp patches are numerous in the shallow zones.

The oceanography along the Alaska Peninsula within the study area is primarily influenced by the Alaska Coastal Current (ACC). The narrow ACC, fed by snowmelt and runoff, travels southwestward along the south side of the Alaska Peninsula then enters the Bering Sea through Unimak Pass before flowing northeastward into Bristol Bay (Royer, 1981; Schumacher and Moen, 1983). This current is also influenced by the persistent and heavy winds typical of the Alaska Peninsula and the Aleutians. Mean monthly wind speeds, ranging between 13-16 kt, are

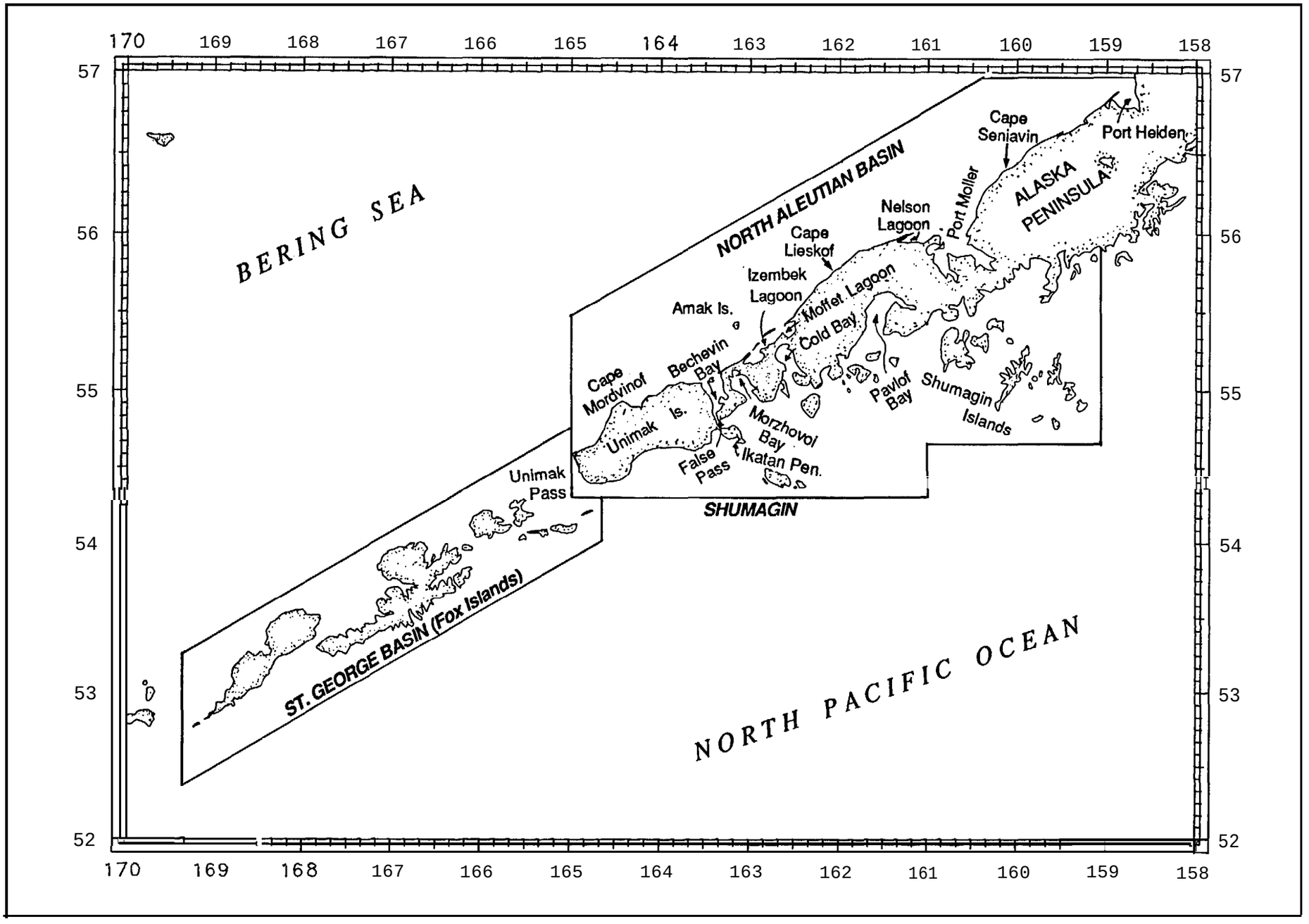

Figure 1. Study area showing stratification of planning areas.

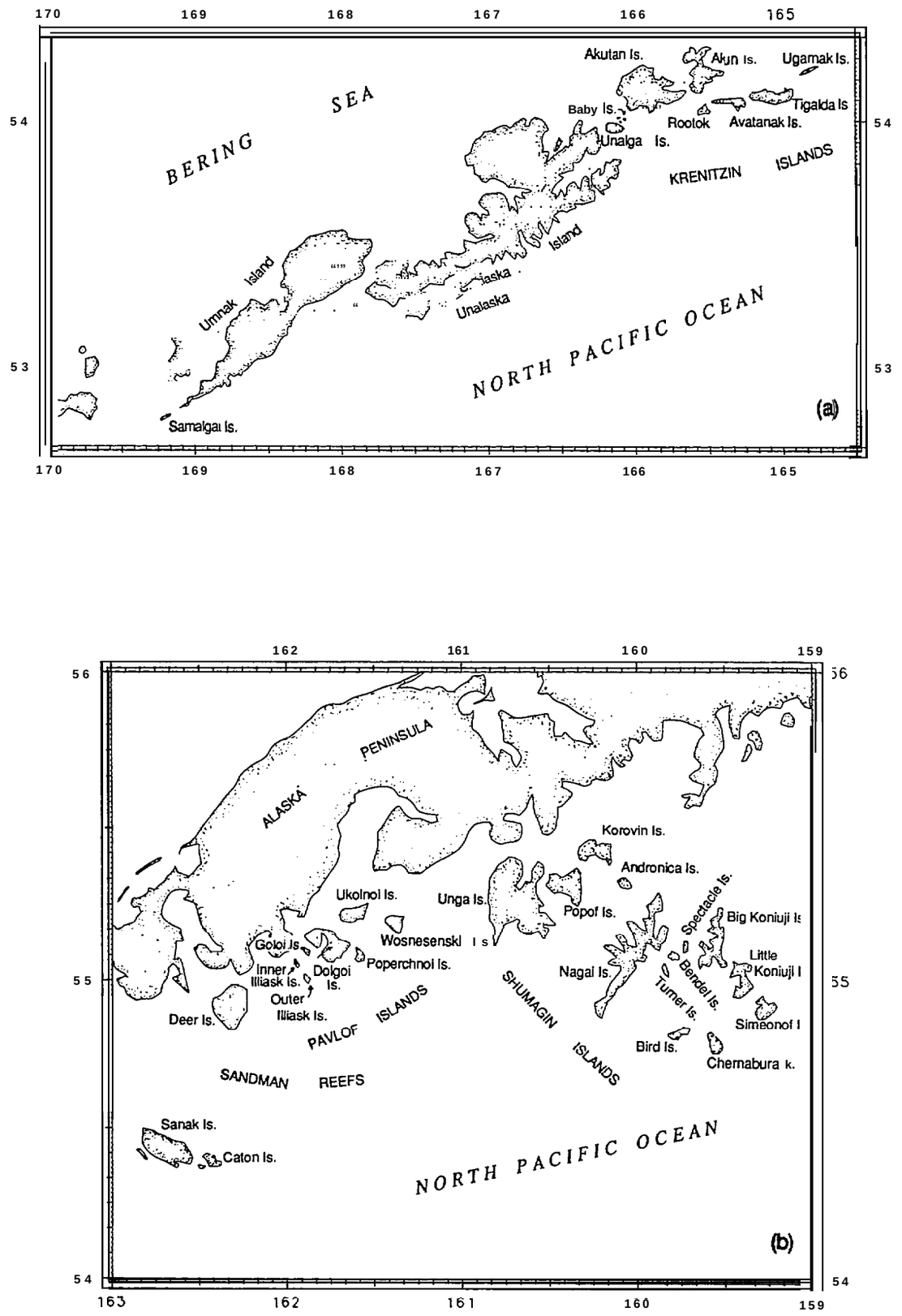

Figure 2. Place name map of the islands comprising the St. George Basin (a) and Shumagin (b) planning areas surveyed during this study.

most persistent during winter when there are frequent cyclonic storms. These winds are also locally intensified by the orographic effects created by major bays and volcanic mountains. The current and winds greatly influence the biological oceanography in the study area.

The northwestern Gulf of Alaska and Fox Islands climate is maritime with little influence from continental air masses. Both daily and seasonal air temperature extremes are confined to fairly narrow limits and readings below 0°F (-18°C) are rare. Some ice forms in the protected portions of the Peninsula bays during winter, but the sea is ice free. Conversely, the Bering Sea is partially covered with sea ice from approximately October through June. Although the southern limit of the pack ice is north of the study area, landfast ice typically reaches its southern limit at approximately Port Moller, and, during particularly cold winters, landfast ice may reach Unimak Island (Schneider and Fare, 1975; O'Clair, 1981). Landfast ice is present in the study area from approximately January through March.

3.0 METHODS

3.1 SURVEY DESIGN AND PROCEDURES

The study area was divided into the North Aleutian Basin, Shumagin, and St. George Basin planning areas (Figure 1). Systematic, coastal, and island surveys were conducted in these areas. Systematic surveys consisted of north-south oriented tracklines equidistantly spaced every 1.8 nm (3 minutes of longitude) and extending from the shore to approximately the 38 fm (70 m) isobath. Sea otters seldom inhabit water deeper than 38 fm (Schneider 1976). Systematic tracklines were distributed from Cape Mordvinof on Unimak Island to Cape Seniavin in the North Aleutian Basin and from Ikatan Peninsula to the Shumagin Islands in the Shumagin planning area. These surveys were designed to survey open water areas. The second type of survey, termed coastal, consisted of shoreline surveys primarily along the Alaska Peninsula and Unimak Island. These surveys were designed to survey near-shore areas missed by the systematic survey. The third type of survey, termed island surveys, consisted of flying the perimeter of islands. Coastal and island surveys were flown 0.25 nm from the shoreline. Total otter count was used to estimate abundance for islands, whereas, density was calculated to estimate abundance for the coastal and open water areas. This combination of survey types was required to accurately census the project area. Flights conducted between systematic tracklines, during high altitude transits, overland, or during unsuitable weather conditions were termed deadheads. Deadheads were non-effort flights used only to describe sea otter distribution. Systematic, coastal, and island survey types were full effort flights used in the analysis of sea otter abundance and distribution.

The survey pattern was directed at systematically censusing the entire project area. The allocation of 65 hr of flight time per survey period was sufficient to achieve 100 percent coverage of the survey track design. A priority of importance was established for the survey sequence in the planning areas. The first priority was to initially

survey the north and south sides of False Pass for the purpose of addressing the migration objective. The second priority was to conduct one day of survey effort in the St. George Basin for the purpose of comparing sea otter abundance in each planning area. The third priority was to survey the Shumagin and Pavlof Island complexes. The last priority was to survey the remaining portions of the North Aleutian Basin and Shumagin planning areas comprising the project area. Seven flight days were required to fully achieve these priorities. One adjustment was made to the surveys after the June-July period. Surveys were conducted along every systematic trackline in the North Aleutian Basin from Bechevin Bay to Cape Lieskof. Every second trackline was surveyed from Cape Mordvinof to Bechevin Bay and from Cape Lieskof to Cape Seniavin. The first area contained much higher sea otter densities than the latter two areas. This adjustment permitted a total systematic survey of the North Aleutian Basin but a greater allocation of effort in high density sea otter areas. No adjustment was instituted in the Shumagin Planning Area. Every planned trackline was flown between the eastern end of Unimak Island and the Shumagin Islands. Systematic surveys were not conducted around most of Unimak Island because much of the water was too deep to be effectively used by sea otters. No adjustment was made to the St. George Basin survey plan; only coastal and island surveys were conducted there because most of the open water area was deeper than 38 fm.

Surveys were conducted from a DeHavilland Twin Otter aircraft equipped with an auxiliary fuel tank to extend the flight duration to 10 hr. Surveys were flown at 300 ft and air speed was maintained at 100 kt during systematic transects and coastal and island survey flights. Air speeds greater or less than 100 kt occurred only during deadhead flights. Two observers, positioned on each side of the aircraft behind the pilot and co-pilot, relayed observations to a data recorder in the aft section of the aircraft. Observers viewed the survey area through bubble windows providing downward and forward visibility. Sea otters were counted within three distance intervals spaced at right angles from the flight line of the aircraft: 0.0-0.125 nm, 0.125-0.25 nm and 0.25-0.5 nm. Using a clinometer and marks placed on the windows, the

observers were able to identify the distance interval or band containing a sea otter. Marks were observer-specific and they were frequently checked and calibrated to ensure accuracy. A third observer rotated with the primary observers every 2 hr to reduce fatigue. The third or off-duty observer generally rested but also backed-up the other observers through a rear (flat) window during periods of frequent marine mammal encounters. Third observer observations were, however, noted separately so as not to confound consistency in observer effort. The influence of altitude and airspeed on probability of detection is unknown but both variable values were as low as safety procedures permitted.

A Hewlett-Packard 85 computer, interfaced with the aircraft's Global Navigation System (GNS) and radar altimeter, provided the data recorder with continuous time, altitude, latitude, and longitude data. The recorder combined these data with sighting and environmental information given by the observers. Sighting information included number of animals, group size, species, survey band, behavior, number of pups, and whether the sighting included animals potentially previously observed. A group was defined as animals in close proximity of each other, usually within 3-4 body lengths. Environmental information included sea state according to the Beaufort Wind Scale with sea state descriptors (Black and Adams, 1983), visibility, and glare (Appendix A). Environmental conditions were recorded at the beginning and end of each transect or whenever conditions changed.

3.2 ANALYTICAL PROCEDURES

The analyses concentrated on sea otter distribution and abundance. Chi-square analysis was followed to test the uniformity of sea otter distribution by longitude and water depth. Regression analysis was used to determine trends for non-uniform sea otter distributions. The dependent variable was number of otter groups per nautical mile of trackline for n segments of trackline. The dependent variable was weighted in proportion to the length of the trackline segment.

Regression analysis and the weighting of the dependent variable were performed by using the BMDP software package (Dixon, 1983). Lastly, Chi-square analysis was used to test the independence of sea otter observations between planning areas and survey periods. Analyses were performed on animals grouped into the following five categories: 1, 2, 3, 4-9, $\geq$ 10 animals. Chi-square analysis was also used to determine the independence of systematic and coastal survey types. The frequency distribution of sea otters in these five categories was not significantly different between survey types ($P > 0.05$) so the surveys were pooled. Random surveys were also combined with these types since effort was small, and counting procedures and conditions were similar to the other types. (The results of the other Chi-square analyses are beyond in the results.) Island surveys were treated separately for every analysis. All tests were performed at the 0.05 level of significance.

Abundance was calculated according to Method I described by Estes and Gilbert (1978). The density of sea otter groups ($\hat{R}$) equals $\Sigma y_i / \Sigma x_i$ with variance

$$(1)\quad S_{\hat{R}}^2 = \left(\Sigma (y_i^2/x_i) - \hat{R}\Sigma y_i\right) / (n-1)(\Sigma x_i)$$

where y_i = the number of sea otter groups in strip i, xi = the area of strip i, and n = number of strips. This method assumes that the expected number of otter groups and the variance of the number of groups are proportional to the sample area which various investigators have demonstrated to be true (Estes and Gilbert, 1978). The abundance of groups $\hat{T}_G = \hat{R}A$ with variance

$$(2)\quad V(\hat{T}_G) = A(A - \Sigma x_i) S_{\hat{R}}^2 \ ,$$

where A = the area of the sample space or planning area.

The estimated abundance of sea otters ($\hat{T}_y$) is derived by multiplying the estimated number of groups ($\hat{T}_G$) by the mean group size ($\bar{G}$). The estimated variance equals

$$(3)\quad V(\hat{T}y) = V(\bar{G}\hat{T}_G) = \bar{G}^2 V(\hat{T}_G) + \hat{T}_G^2\, V(\bar{G}) - V(\hat{T}_G) V(\bar{G})$$

where $V(\bar{G})$ = variance of the mean group size.

Abundance estimates were calculated for each season for each planning area except for the St. George Basin. This latter estimate was based on the total count of otters observed on the islands. Mean group size and variance were calculated from the data base specific to each survey period for the North Aleutian Basin and Shumagin planning areas. Abundance estimates were summed for all planning areas by season to derive a total estimated number of sea otters in the project area.

Approximate ninety-five percent confidence intervals were calculated for each abundance estimate according to the following expression.

$$(4)\quad \hat{T}_y \pm (1.96)\sqrt{\frac{V(\hat{T}_y)}{n}}$$

where n = number of strips or segments surveyed.

Confidence intervals were calculated to bracket our estimates. The intervals do not include the true sea otter population size, since our estimates contained certain biases. Consequently, our data provide minimum population estimates, as well as a point of future comparison for evaluating trends.

4.0 RESULTS

4.1 NUMBERS AND SURVEY EFFORT

A total of 7,580 groups of 22,791 sea otters were recorded along 17,823 nm of trackline surveyed in the North Aleutian Basin, Shumagin, and St. George Basin (Fox Islands) planning areas between March and October, 1986 (Table 1). Approximately 55 percent of the sea otters were encountered in the North Aleutian Basin, 41 percent in the Shumagin area, and 4 percent in the St. George Basin (Fox Islands). Survey effort was correspondingly highest in the North Aleutian Basin (51 percent), intermediate in the Shumagin area (45 percent) and lowest in the St. George Basin (4 percent) (Figure 3).

The North Aleutian Basin and Shumagin areas were surveyed during all four periods while the St. George Basin was surveyed during only one period (Table 1). Effort averaged 1,503 nm (± 471 SD) for the North Aleutian Basin and 1,221 nm (± 768 SD) for the Shumagin area during the four survey periods. A total of 704 nm were surveyed in the St. George Basin during the June-July survey period. The survey effort for all areas combined was highest in June-July when weather conditions were best, and it was lowest in August when prolonged periods of high wind and fog were encountered. Figure 4 (a-d) shows the systematic lines surveyed during this study.

Surveys were primarily conducted during good to excellent visibility conditions and 0-3 Beaufort sea states (Table 2; Figure 5). Good to excellent conditions occurred during 90-98 percent of the effort for every survey period in each planning area. Sea states between 0-3 occurred during approximately 90 percent of the survey effort in each planning area. Approximately 60-91 percent of the survey effort in the Shumagin area was during 0-2 sea states and 31-42 percent was during 0-1 sea states. These values compare to 55-69 percent and 22-24 percent for 0-2 and 0-1 sea states, respectively, in the North Aleutian Basin. Survey conditions for the St. George Basin were better than

Table 1. Survey effort (rim) and numbers and groups of sea otters observed in the study area, March-October 1986, under all survey conditions.

Survey Period	North Aleutian Basin			Shumagin			St. George Basin[a]			Total		
	No.	Group	Effort[b]	No.	Group	Effort	No.	Group	Effort	No.	Group	Effort
1 (March)	2,143	939	1,966	2,811	1,083	3,162	--[c]	--	0	4,954	2,022	5,128
2 (June-July)	5,578	1,168	2,969	3,714	1,185	2,607	859	290	704	10,151	2,643	6,280
3 (August)	2,170	824	1,790	897	398	1,013	--	--	0	3,067	1,222	2,803
4 (October)	2,645	890	2,295	1,974	803	1,317	--	--	0	4,619	1,693	3,612
Total	12,536	3,821	9,020	9,396	3,469	8,099	859	290	704	22,791	7,580	17,823

a/ Fox Islands.

b/ Effort in nautical miles.

c/ Dash signifies no survey.

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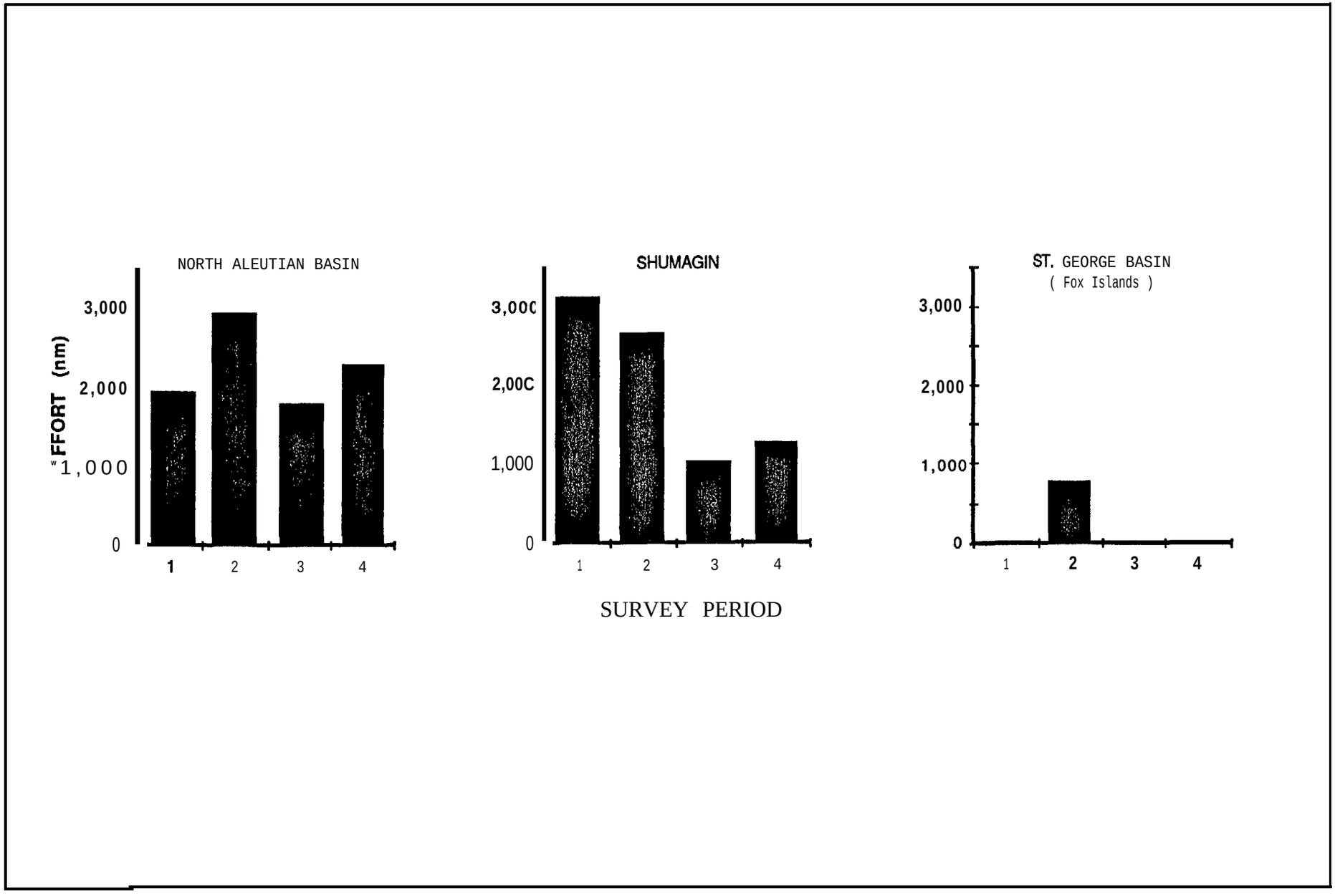

Figure 3. Survey efforts accomplished in the North Aleutian Basin, Shumagin, and St. George Basin planning areas by survey period.

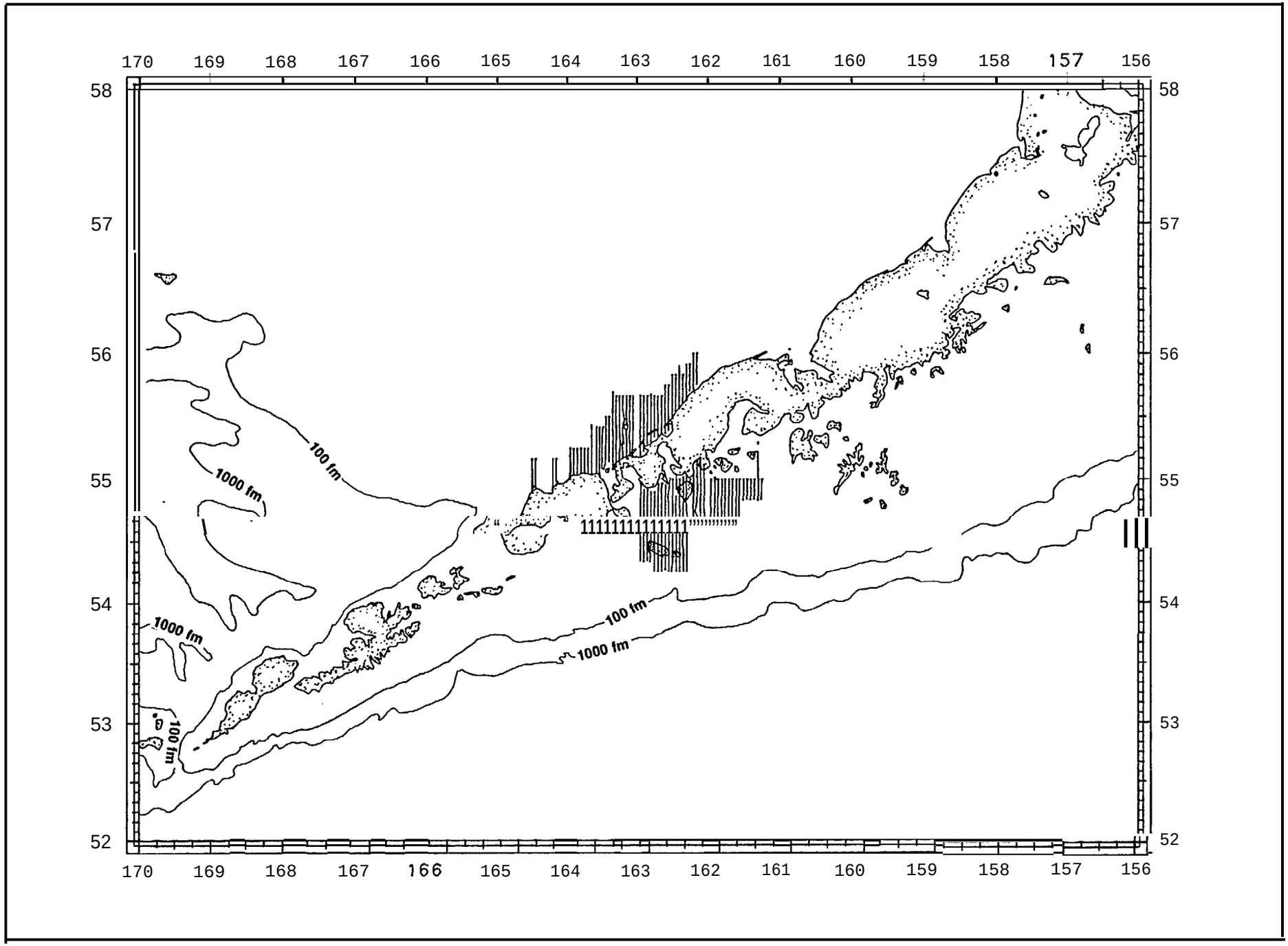

Figure 4a. Systematic lines surveyed in the study area during March 1986.

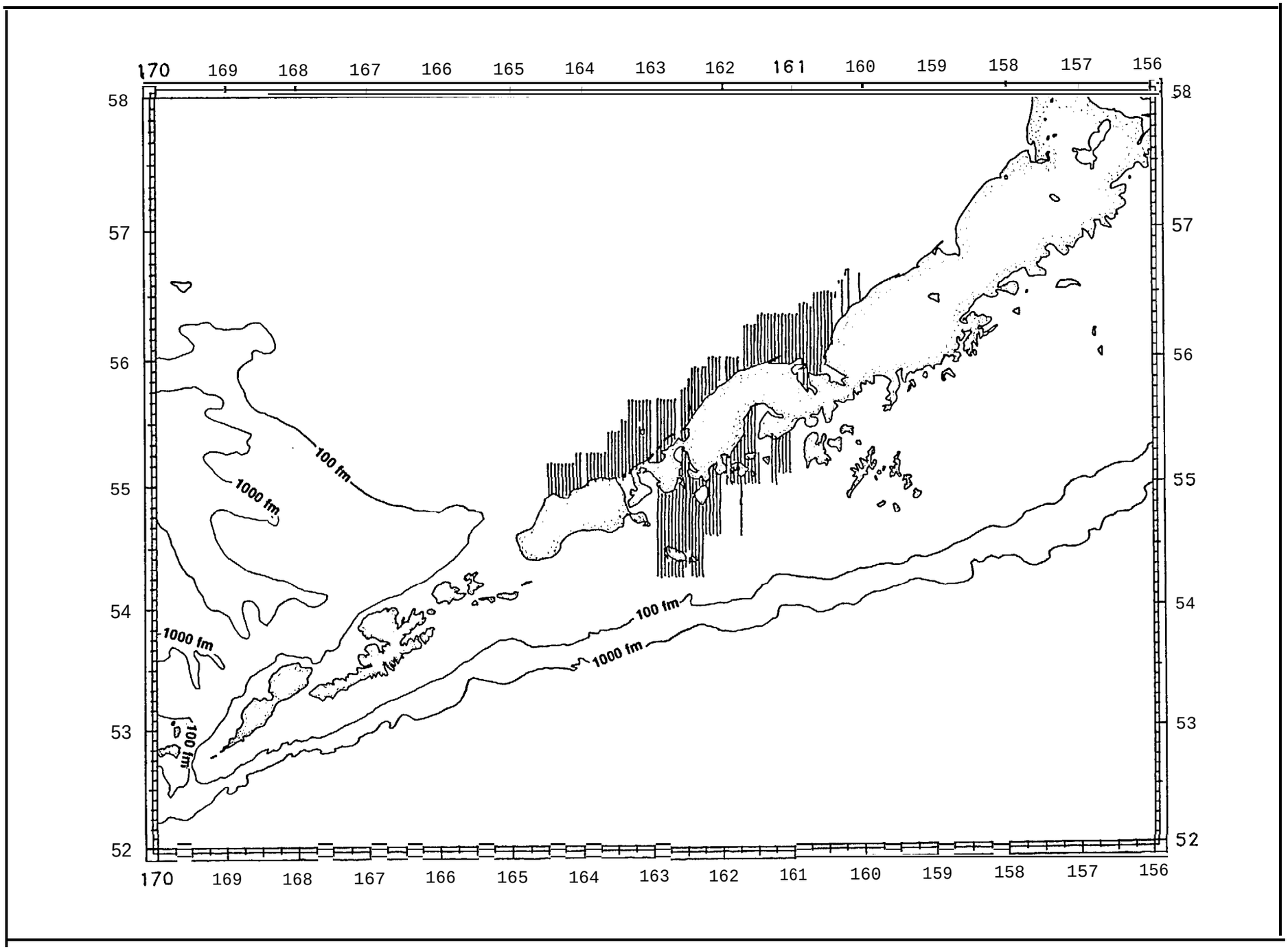

Figure 4b. Systematic lines surveyed in the study area during June/July 1986.

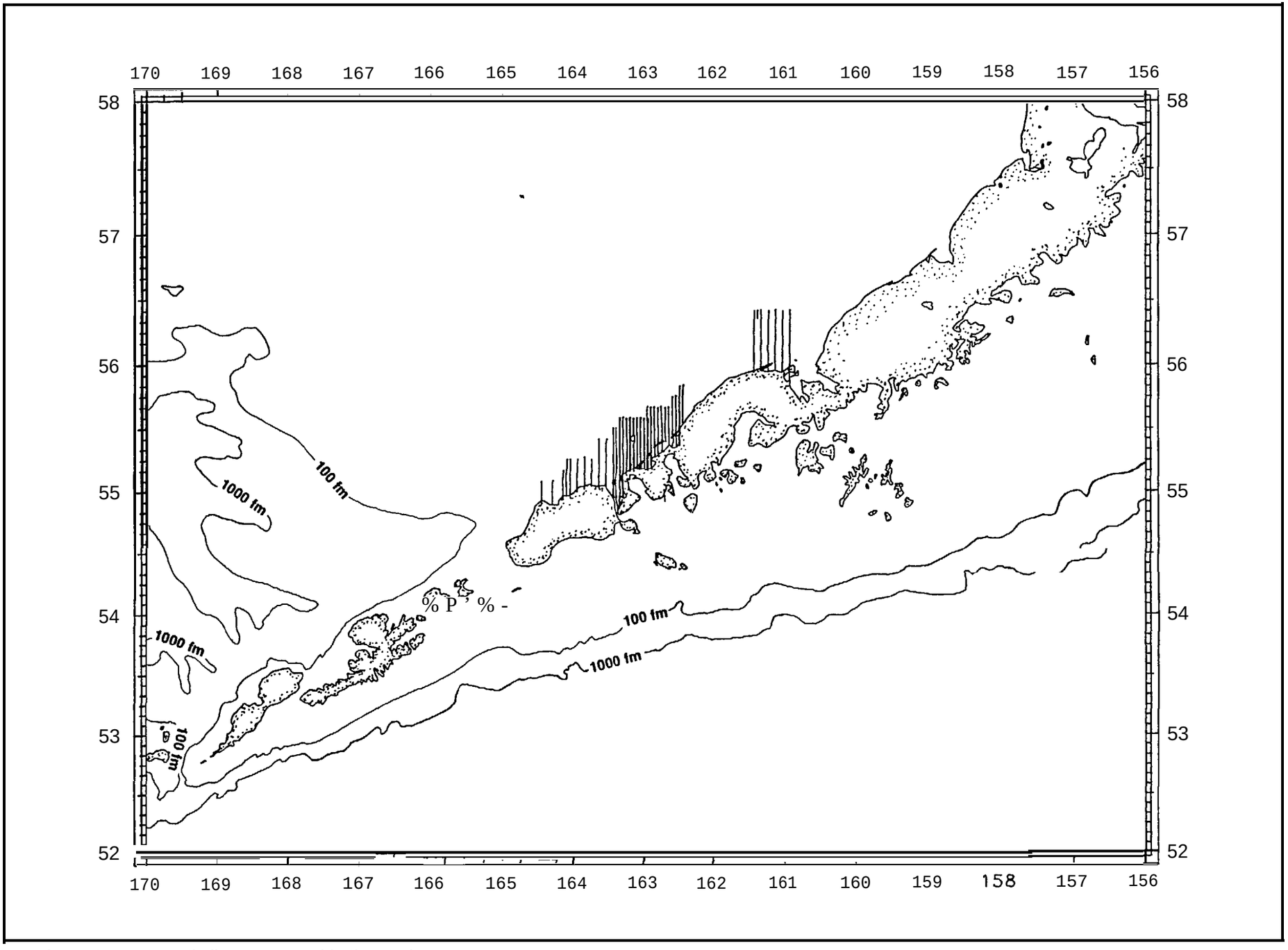

Figure 4c. Systematic lines surveyed in the study area during August 1986.

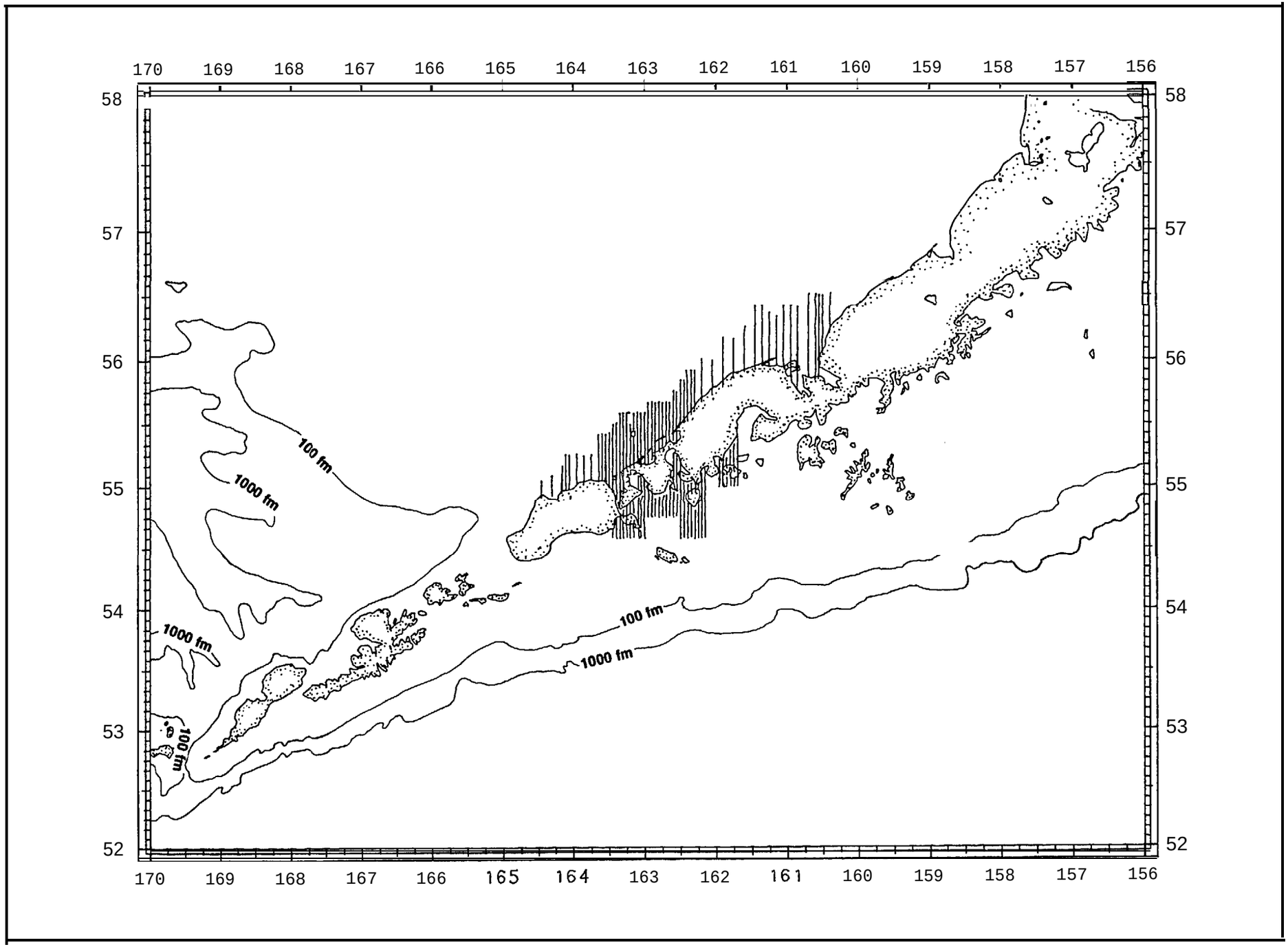

Figure 4d. Systematic lines surveyed in the study area during October 1986.

Table 2. Survey conditions in the study area, March-October 1986.

Survey Period[a]	Planning Area	Survey Distance[b]	Visibility (percent)						Beaufort Wind Scale (percent)					
			EX	VG	GO	FA	PO	UN	0	1	2	3	4	5
1	North Aleutian	1,403	19	26	43	12	0	T[c]	5	24	26	27	18	T
	Shumagin	1,981	30	22	38	9	T	0	1	33	27	26	12	1
	Subtotal	3,384	25	24	40	10	T	T	3	29	27	26	14	1
2	North Aleutian	2,165	15	33	50	2	1	T	3	21	33	38	5	0
	Shumagin	1,751	21	31	46	1	0	1	0	31	29	32	8	0
	St. George	558	43	24	32	1	0	0	0	47	24	20	8	1
	Subtotal	4,474	20	31	46	2	T	T	1	28	30	34	7	T
3	North Aleutian	1,056	20	43	32	5	0	0	0	22	44	29	5	T
	Shumagin	388	23	48	26	3	0	0	0	42	49	6	3	0
	Subtotal	1,444	20	45	30	5	0	0	0	27	46	23	4	T
4	North Aleutian	1,360	22	42	35	T	0	0	1	28	40	27	5	T
	Shumagin	761	31	39	30	T	0	0	0	40	43	14	3	0
	Subtotal	2,136	25	40	33	T	0	0	T	32	41	22	5	T
Total	North Aleutian	5,984	18	35	42	4	T	T	2	23	35	31	8	T
	Shumagin	4,881	26	30	39	5	T	T	1	34	32	24	8	1
	St. George	558	43	24	32	1	0	0	0	48	24	20	8	1

a/ Survey period 1 = March, 2 = June-July, 3 = August, and 4 = October.

b/ Distance (rim) was calculated for systematic and coastal surveys; deadheads were excluded from this analysis.

c/ T signifies <1 percent.

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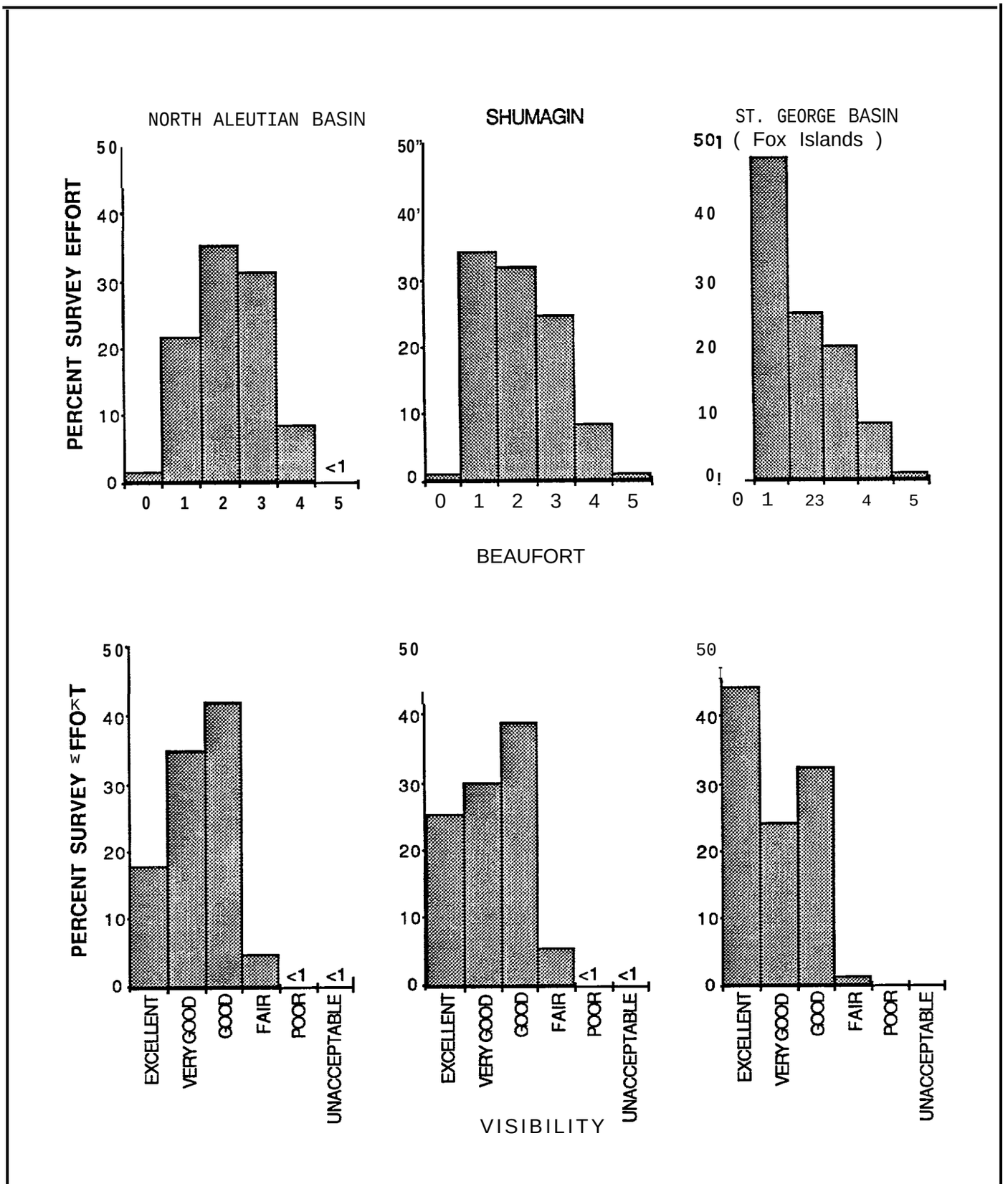

Figure 5. Percent effort by Beaufort Sea State and visibility in the North Aleutian Basin, Shumagin, and St. George Basin planning areas, 1986.

these ranges. Over 55 percent of the survey effort occurred during O-2 sea states in all planning areas for every survey period. Kenyon (1969) and Estes (1974) reported that calm sea conditions, similar to the O-2 sea states, are required to accurately count sea otters.

Sea otter detectability was significantly ($p < 0.05$) influenced by sea state and visibility conditions during our surveys (Table 3). Chi-square analysis showed that the observed number of sea otter groups fell substantially below the expected numbers during sea states of 2 or 3 in combination with good visibility conditions. This relationship was most noticeable for groups containing 1 or 2 individuals which represented almost 90 percent of the otters recorded. Visibility conditions of fair or poor and sea states of 3 or 4 were considered unacceptable for detecting sea otters beyond treating the sightings as general distributional information. Consequently, our analysis was based on data associated with survey conditions defined by O-1 sea states combined with good to excellent visibility conditions or 2 sea state with very good conditions. Approximately 53 percent (3,991) of the total otter groups were recorded during these conditions.

4.2 DISTRIBUTION

4.2.1 North Aleutian Basin

Sea otters were widely distributed between Cape Mordvi nof (164°30′ W) and Cape Seniavin (160°W) in the North Aleutian Planning Area (Figure 6a-d, Appendix Table B-1). The distribution, however, was not uniform (Figure 7). Chi-square analysis showed that the observed number of groups did not equal the expected number encountered among 15, 20-minute segments of longitude ($P < 0.05$). The numbers of sea otters observed in bands 0.0-0.125 and 0.125-0.25 nm were pooled to increase sample size for this analysis, since the mean group size did not differ significantly ($P > 0.05$) between bands. Consequently, the analysis was based on a total 2,167 groups of 5,040 sea otters surveyed along 6,524 nm.

Table 3. Observed and expected number of sea otter groups by the Beaufort sea state and visibility combinations recorded during the surveys. [a/]

Group Size Class		Beaufort Sea State - Visibility Combination [h/]						X^2 [c/]
		O-1 EX	O-1 VG	O-1 GO	2 VG	2 GO	3 GO	
1	O [d/]	1260	254	169	1052	153	627	393.4
	E	900	196	97	1076	203	1043	
2	O	309	76	45	279	40	163	98.6
	E	233	51	25	279	53	270	
3	O	76	20	14	59	6	44	34.7
	E	56	12	6	67	13	65	
4-9	O	109	30	10	72	12	46	64.5
	E	71	16	8	85	16	99	
> 10	O	59	31	11	56	11	40	51.6
	E	53	12	6	64	12	74	

a/ Analysis based on sea otters seen on systematic and coastal surveys.

b/ EX = Excellent, VG = Very Good, and GO = Good.

c/ $X^2.05 = 11.1$, 5 df.

d/ O = Observed, E = Expected.

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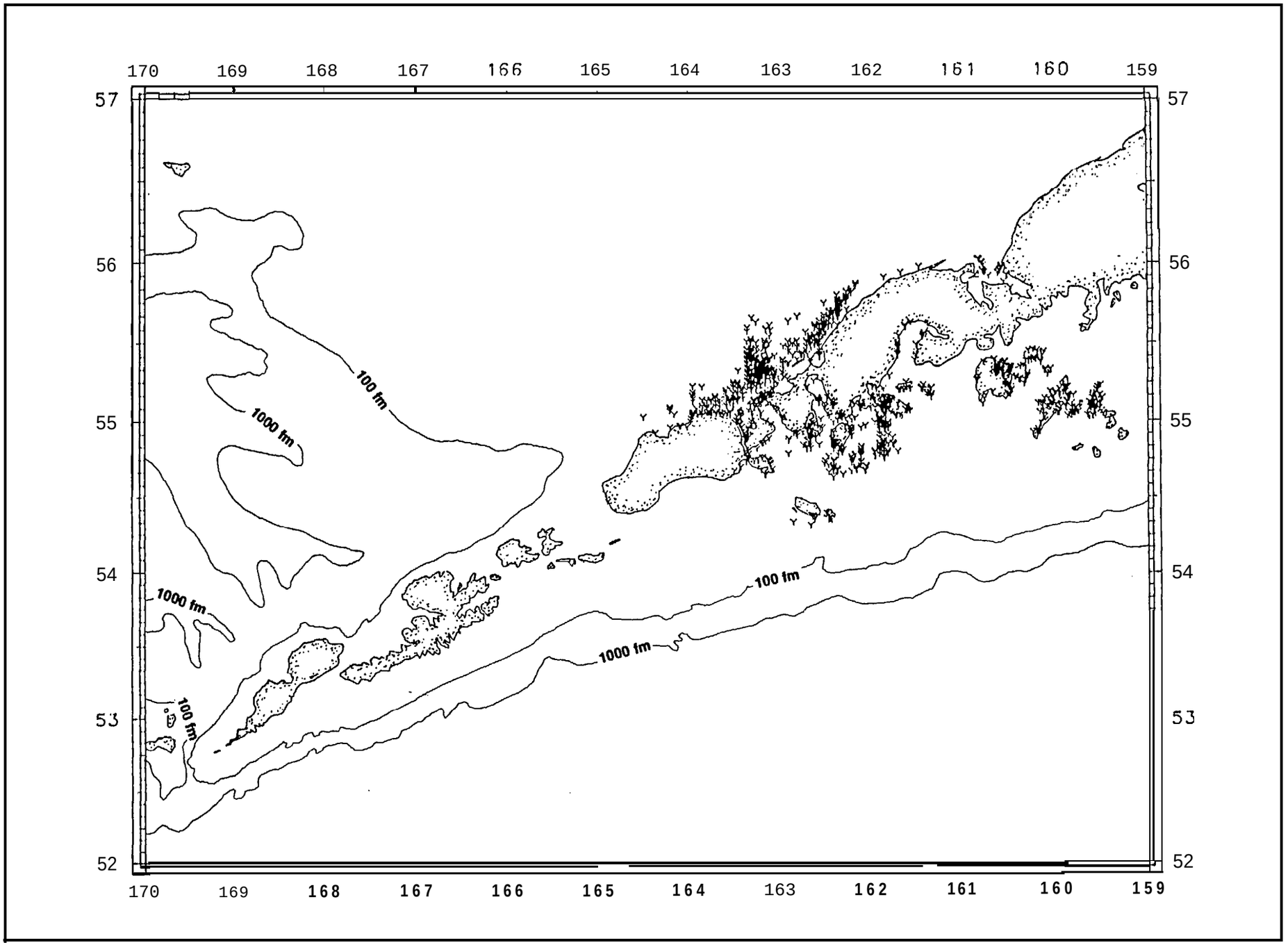

Figure 6a. Distribution map of sea otter groups observed in the study area during March 1986.

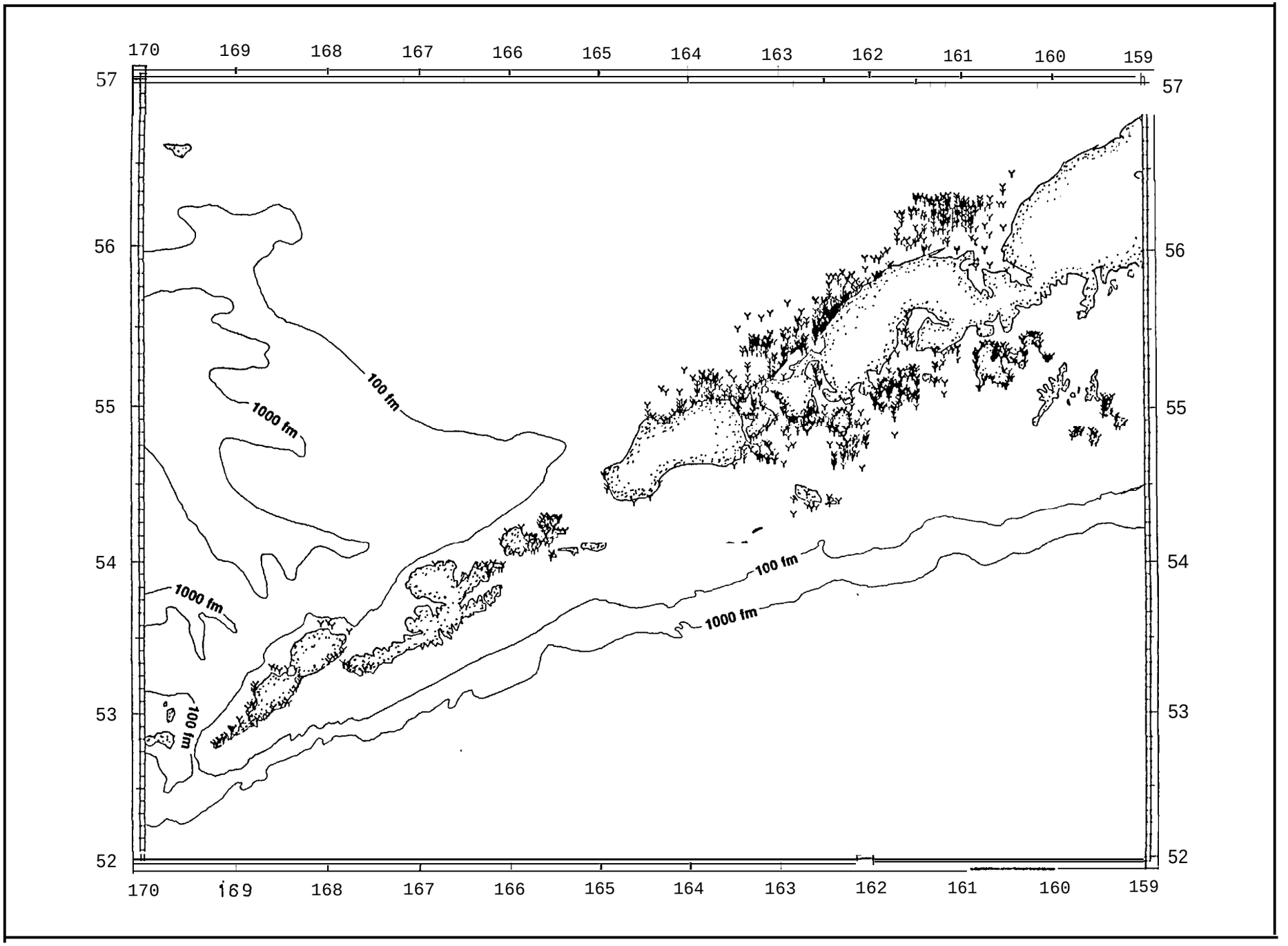

Figure 6b. Distribution map of sea otter groups observed in the study area during June/July 1986.

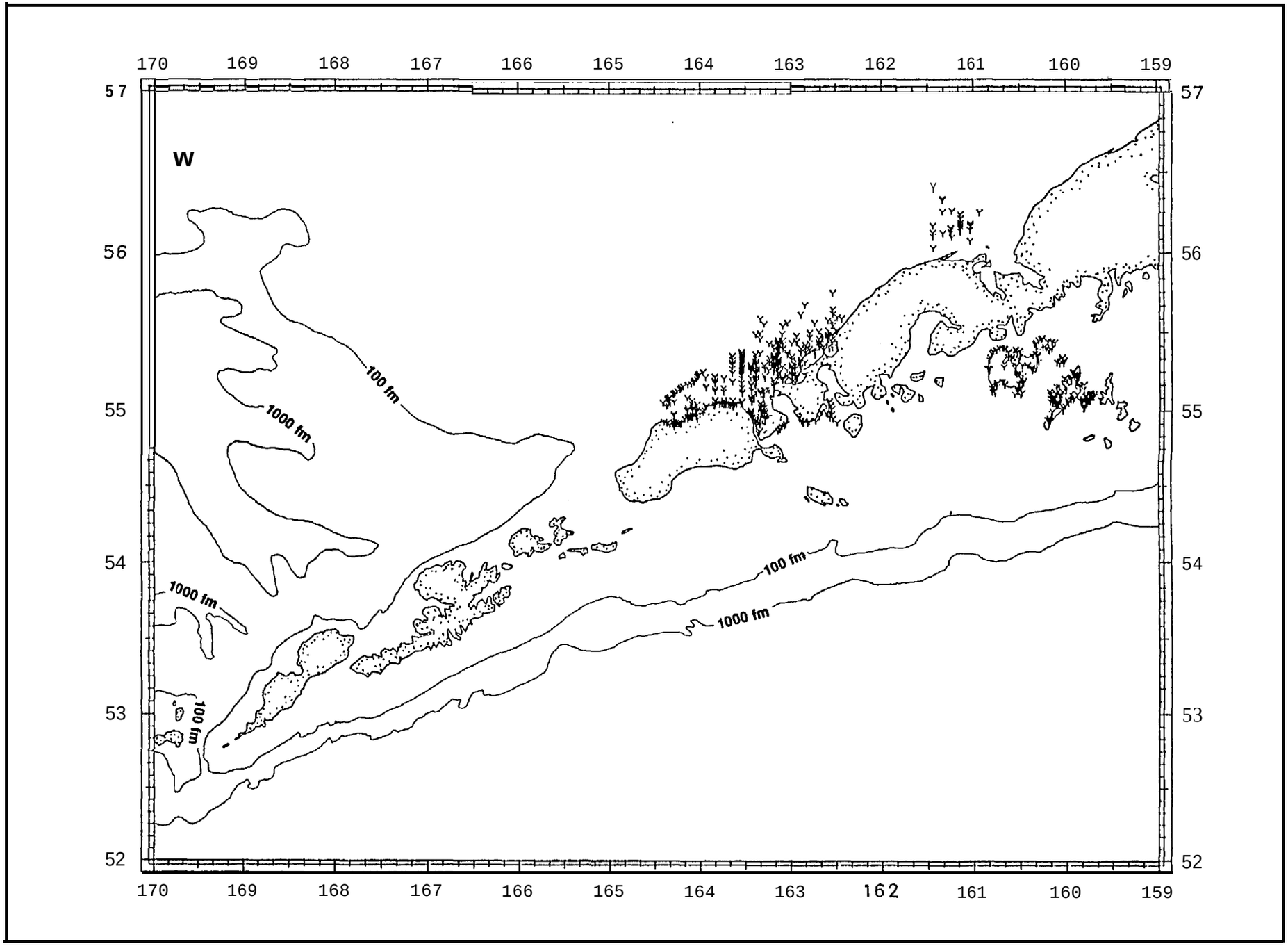

Figure 6c. Distribution mapofsea ottergroups observed in the study areaduring August 1986.

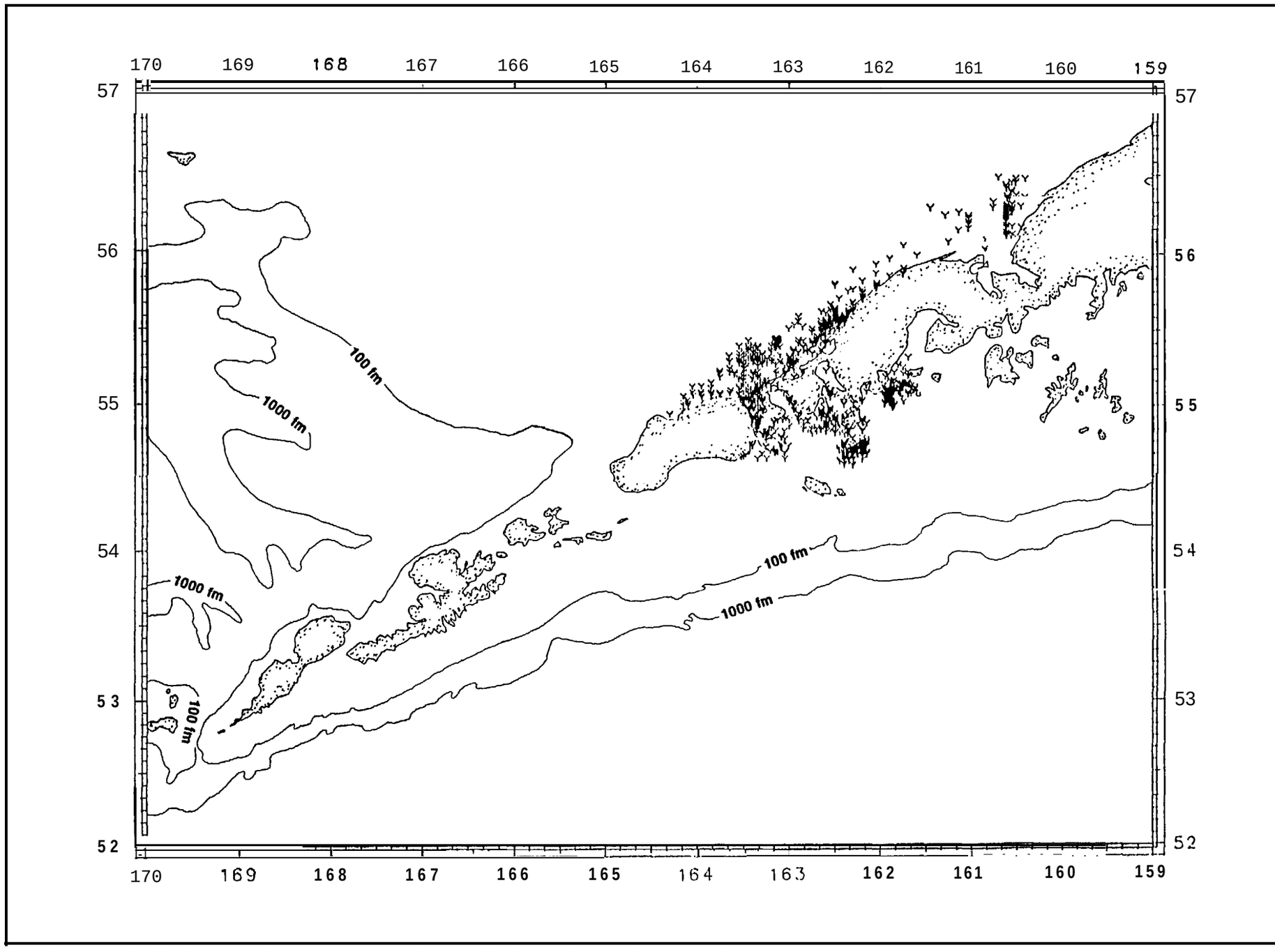

Figure 6d. Distribution map of sea otter groups observed in the study area during October 1986.

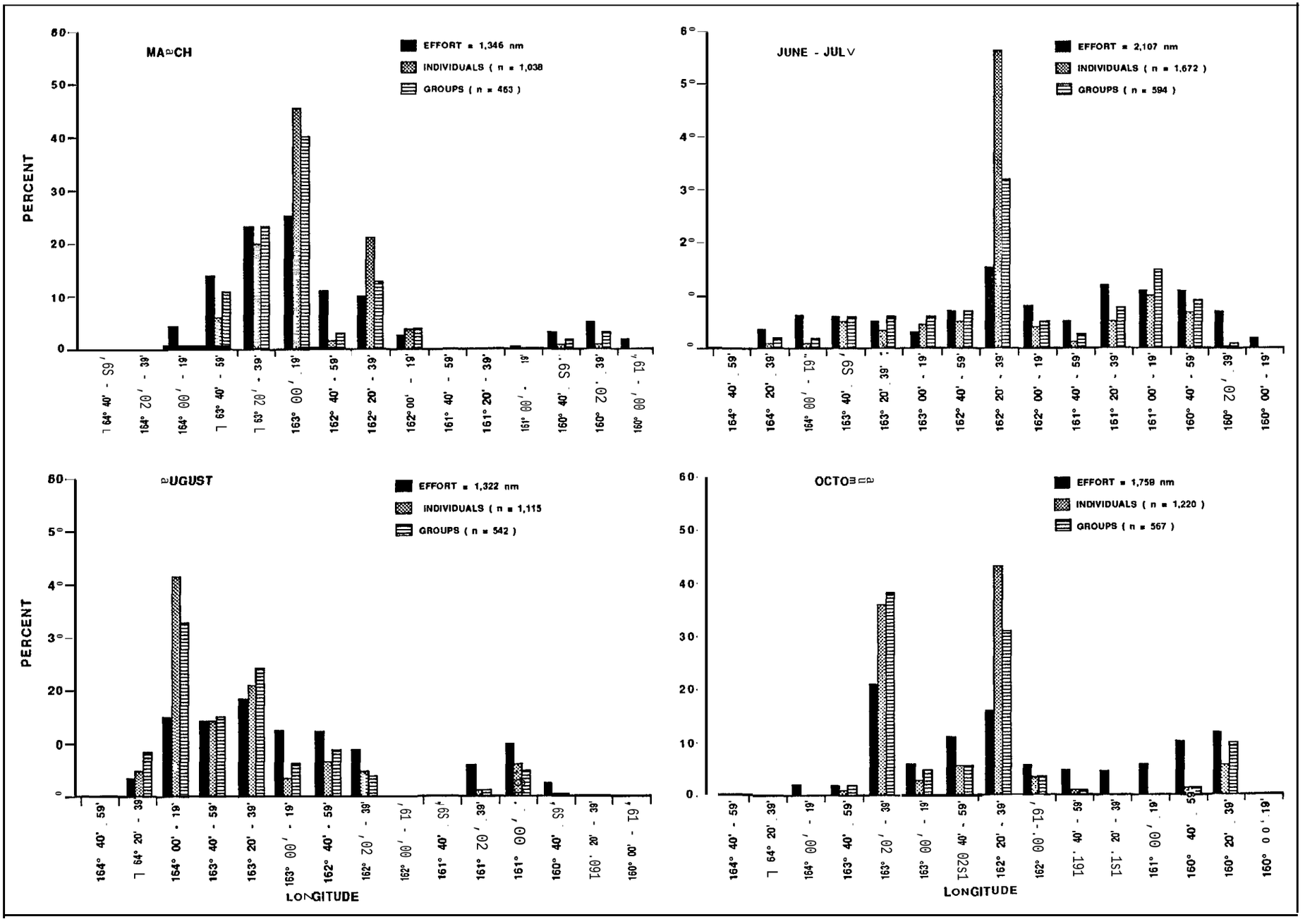

Figure 7. Percent survey effort accomplished and percent and groups of sea otters observed by 20-minute segments of longitude in he North Aleutian Basin March-October 1986.

Almost 90 percent of the sea otters were observed between Cape Mordvinof and Cape Lieskof (162°W), where 68 percent of the total survey effort occurred (Figure 6a-d). Seasonal use of this area was widespread but variable except for the waters off Moffet Lagoon (162°20′ - 162°39'W) where high numbers of otters were observed during March, June-July, and October. In addition, otters were seasonally abundant north of Izembek Lagoon (163°00' - 163°19'W) in the vicinity of Amak Island during March, east of Cape Mordvinof at Slime Bank (164°00' - 164°39'W) during August, and north of False Pass in Bechevin Bay (163°20′ - 163°39'W) during August and October. Few otters were observed west of Cape Mordvinof. These results show that the waters north of Izembek and Moffet lagoons were seasonally important to sea otters, and that the distribution of otters shifted from this area in the spring and early summer to an area from Bechevin Bay to Cape Mordvinof (Slime Bank) in the late summer, and then to the vicinities of Bechevin Bay and Moffet Lagoon in the fall in relatively high concentrations. This shift may be related to breeding activity.

The area east of Cape Lieskof to Cape Seniavin contained approximately 10 percent of the sea otters observed in the North Aleutian Planning Area (Figure 6a-d). Sea otters appeared to be widespread in this area during each season except October, although effort was small during March and August. Much of the area was covered with landfast ice during March. A comparison between June-July and October suggests a shift in otter distribution from Nelson Lagoon (160°40′ - 161°20'W) to the east side of Port Moller (161°20′ - 161°40'W) (Figure 7). No otters were observed east of Cape Seniavin.

Chi-square analysis indicated that sea otters were not uniformly ($P < 0.05$) distributed by water depth (Table 4). Sea otters were rarely encountered in water greater than 38 fm deep and were most common in waters less than 22 fm deep. Regression analysis was used to determine if a significant trend occurred between sea otter density and depth. The regression coefficients were not significant ($P > 0.05$), but there was a decreasing trend in otter density from shore to deep

Table 4. Number and groups of sea otters observed in various depth classes in the North Aleutian Planning Area, March-October 1986, under selected survey conditions .[a/]

Depth Class (fm)[b/]	Survey 1			Survey 2			Survey 3			Survey 4			Total		
	Effort (rim)	No.	Groups	Effort (rim)	No.	Groups	Effort (rim)	No.	Groups	Effort (rim)	No.	Groups	Effort (rim)	No.	Groups
0-11	634	333 (489)	139 (218)[c/]	747	660 (593)	246 (211)	474	572 (400)	295 194)	513	606 (356)	261 (165)	2,368	2,171	941
12-22	377	495 (291)	218 (130)	629	798 (499)	226 (177)	315	185 (266)	72 129)	554	491 (384)	218 (179)	1,875	1,969	734
23-33	210	191 (162)	91 (72)	663	202 (526)	114 (187)	445	348 (375)	166 183)	583	116 (404)	84 (188)	1,901	857	455
>33	124	19 (96)	15 (43)	68	12 (54)	8 (19)	88	10 (74)	9 (36)	11(-I	7 (76)	4 (35)	390	48	36
Total	1,345	1,038	463	2,107	1,672	594	1,322	1,115	542	1,760	1,220	567	6,534	5,045	2,166
X^2 [d/]		259.7	111.4		419.0	54.2		155.9	99.6		473.3	149.3			

a/ Selected survey conditions are the following Beaufort sea state and visibility combinations: 0 EX, 0 VG, 0 GO, 1 EX, 1 VG, 1 GO, and 2 VG.

b/ Data were originally analyzed by the metric depth classes of 0-20 m, 21-40 m, and >60 m in order to correspond with results of previous studies by Schneider (1976). Furthermore, bathymetric charts showing the level of resolution necessary for the analysis of otter distribution by depth were only available in metric units. Depth classes were subsequently converted to fathoms in this table to correspond to nautical measurements.

c/ Numbers in parentheses are expected values.

d/ $X^2_{.05}$ = 7.8, 3 df.

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water for all survey periods except March when most of the 'sea otters were found in waters 12-22 fm deep. During the March survey, all of the 0-11 fm and half the 12-22 fm water depth zones were covered with a two to eight rim-wide ($\bar{x}$ = 4.4 nm) band of 20-90 percent coverage of brash and pancake sea ice. Large numbers of otters were concentrated along the seaward edge of the ice. Some otters were observed hauled out on large pancake ice, especially in Port Moller.

4.2.2 Shumagin

Sea otters were widely distributed from the Shumagin Islands to Unimak Pass (Figure 6a-d, Appendix Table B-2). Distinct sea otter concentrations were found in the Sandman Reefs and near the mouth of Cold Bay (161°40' - 162°40'W) during March and October (Figure 8). Sea otter distribution during June-July was more uniform than for the other survey periods, but particularly high numbers of otters were counted near False Pass and Morzhovoi Bay (163°00' - 163°19'W). The reason for this westward sea otter shift is unclear. The relatively small numbers of sea otters observed near False Pass during the spring and fall suggest that there was little influx of otters from the North Aleutian Basin to the Shumagin area. Few otters were seen along the south side of Unimak Island or in the shallow offshore waters around the Sanak Islands.

Sea otters were also widespread in the Sanak, Deer, Pavlof, and Shumagin Island complexes (Figure 6a-d). The Sanak Island (Sanak and Caton) group was surveyed during March and June-July and yielded a high of 13 otter sightings (Table 5). Deer Island was also surveyed during these two periods, with a high of 245 otters counted during March. All seven islands of the Pavlof complex were surveyed during March, six during June-July, and four during October. The highest total count was 620 otters which was derived by summing the seasonal high count for each island. Dolgoi Island, the largest island in the group, had the highest count (185) and Wosnesenski Island the lowest count (29). Counts for the other islands ranged from 54 to 113 sea otters. Environmental conditions during these surveys generally featured low sea states (l-2) and very good to excellent visibility conditions.

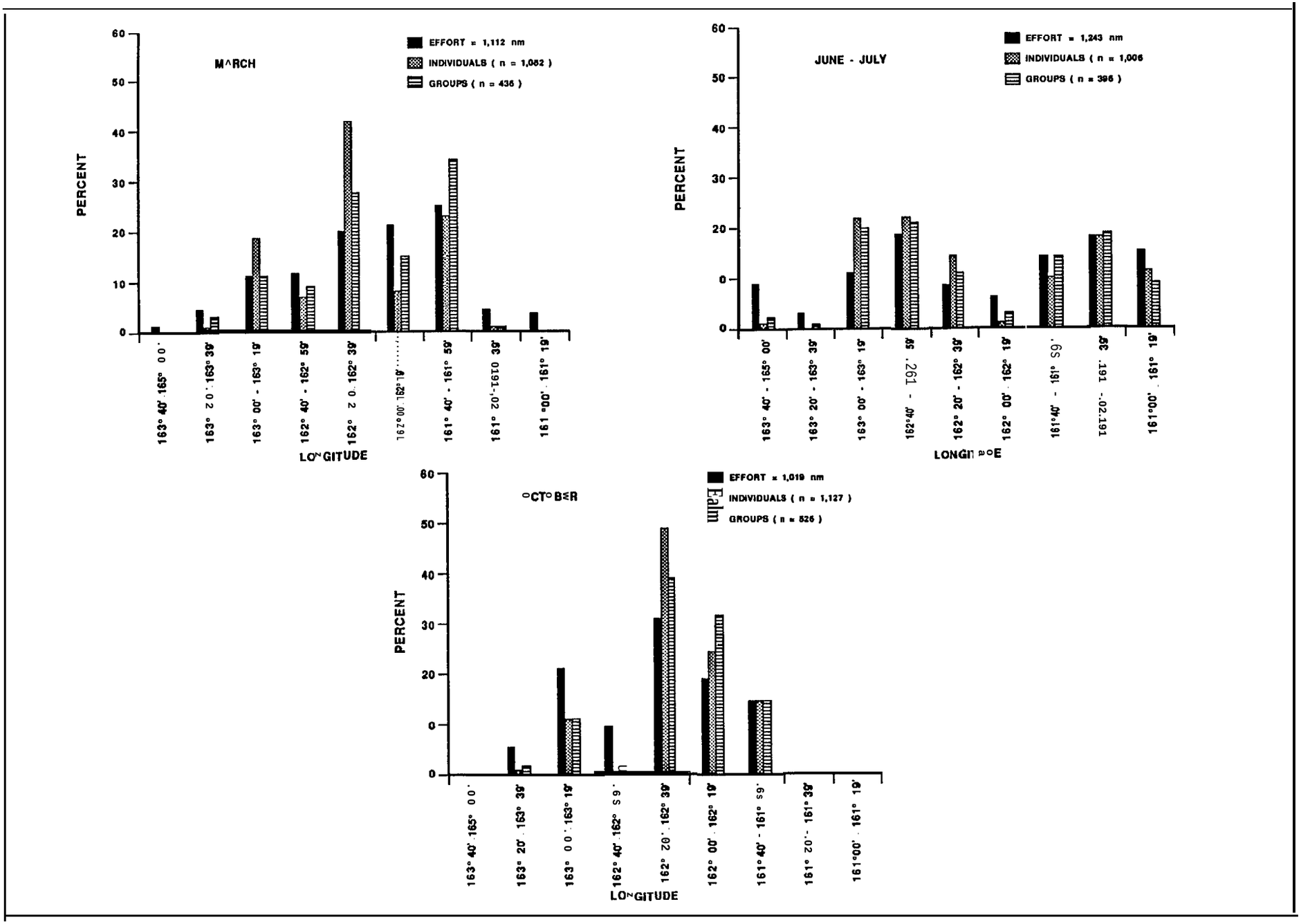

Figure 8. Percent survey effort accomplished and percent individuals and groups of sea otters observed by 20-minute segments of g in the Shumagin planning area, March-October 1986.

Table 5. Numbers of sea otters recorded from coastal surveys of the Deer Island and the Sanak, Pavlof, and Shumagin island complexes, 1986.

Islands	Survey 1			Survey 2			Survey 3			Survey 4		
	No.	Sea State	Vis.[a]	No.	Sea State	Vis.	No.	Sea State	Vis.	No.	Sea State	Vis.
Sanak/Caton	13	2-3	VG-GO	9	2	VG-GO	---	---	---	---	---	---
Deer Island	245	2-3	VG-GO	103	1-3	EX-GO	---	---	---	---	---	---
Pavlof Islands												
Dolgoi	89	2-3	VG-GO	149	1-2	EX-GO	---	---	---	185	2	VG
Goloi	49	1	VG	54	2-3	VG-GO	---	---	---	113	1	EX
Inner Illiask	67	2	GO	77	3	GO	---	---	---	55	2	VG
Outer Illiask	21	2	VG-GO	60	1-3	GO	---	---	---	82	2	VG
Wosnesenski	29	2-4	VG-GO	---	---		---	---	---	---	---	---
Ukolnoi	46	2-4	VG-GO	54	1	GO	---	---	---	---	---	---
Poperechnoi	26	1-4	EX-GO	80	1	EX	---	---	---	---	---	---
Shumagin Islands												
Unga	232	1	EX	568	1-2	EX-VG	348	1-2	EX-VG	---	---	---
Popof	46	1	EX	72	1	EX	43	1-2	EX-VG	---	---	---
Korovin	27	1	EX	101	1-2	EX-VG	48	1-2	EX-GO	---	---	---
Andronica	10	1	EX	31	1	EX	15	1	EX-VG	---	---	---
Nagai	100	1	EX	---	---	---	184	1-3	EX-GO	---	---	---
Big Koniuji	52	1	EX	---	---	---	---	---	---	---	---	---
Turner	4	1	EX	---	---	---	6	1	EX-VG	---	---	---
Bendel	16	1	EX	---	---	---	35	1	VG	---	---	---
Spectacle	7	1	EX	---	---	---	17	1	VG	---	---	---
Little Koniuji	---[b]	- - - - - -		65	1	EX	---	---	---	---	---	---
Simeonof	---	---	---	65	1	EX	---	---	---	---	---	---
Chernabura	---	---	--	13	2-3	VG-GO	---	---	---	---	---	---
Bird	---	---	---	80	2	VG	---	---	---	---	---	---

a/ EX . Excellent, VG . Very Good, GO . Good

b/ Dash signifies no survey.

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The Shumagin Islands were surveyed during March, June-July, and August, although not all 13 islands were surveyed during each survey period (Table 5). The four northern Shumagin Islands (Unga, Popof, Korovin, and Andronica) were surveyed all three times and the highest total count was 772 otters (June-July). Unga Island which averaged 383 otters over three surveys had a high of 568 animals during June-July. The nine islands comprising the southern Shumagins had a total count of 517 otters. Nagai Island had the highest count (184) and Turner Island the lowest count (6). Counts for the other islands ranged from 13 to 80 sea otters. Environmental conditions during the Shumagin Island surveys largely featured low sea states (l-2) and very good to excellent visibility conditions.

4.2.3 St. George Basin

The Fox Islands were surveyed only during the June-July survey period. All nine main islands were at least partially surveyed except for Ugamak and Avatanak. Ugamak was avoided to prevent disturbance to an ongoing NOAA sea lion study and Avatanak was fogged-in. There were 858 sea otters recorded at seven islands and none at Tigalda (Table 6). Thirty-three percent (287) of the otters were recorded at Umnak and Samalga islands and 26 percent (226) at Akun Island. Significant numbers were also found at Unalaska (177) and Akutan (146). The other two islands surveyed (Rootok and Unalga) in the Fox Island complex had 15 or fewer otters. Survey conditions were similar to the other island complexes.

4.3 POPULATION CHARACTERISTICS

4.3.1 Group Size

The mean group size of sea otters in the North Aleutian Basin and Shumagin planning areas (excluding islands) was 2.339 (Table 7). Mean group size was essentially identical among survey periods or between the North Aleutian Basin and Shumagin planning areas. Sea otters

Table 6. Numbers of sea otters recorded in the Fox Islands and the conditions under which they were surveyed, July 1986.

Islands	Number	Sea State	Visibility
Ugamak	--- a/	---	---
Tigalda	0 b/	1	EX
Avatanak	---	---	---
Rootok	15	1	EX
Akun	226	1-2	EX-VG
Akutan	146	1-2	EX-VG
Unalga	7	1	EX
Unalaska	177	1-3	EX-GO
Umnak/Samalga	287	1-3	EX-GO
Total	858		

a/ Dash signifies no survey.

b/ Incomplete survey of island.

c/ EX = Excellent, VG = Very Good, GO = Good.

Table 7. Mean group sizes of sea otters observed in North Aleutian Basin and Shumagin planning areas under selected survey conditions, March-October 1986[a/]

Survey Period[b/]	N. Aleutian Basin			Shumagin			Total		
	n	$\bar{x}$	SE	n	$\bar{x}$	SE	n	$\bar{x}$	SE
1	464	2.239	0.201	436	2.482	0.251	900	2.357	0.160
2	594	2.815	0.237	396	2.540	0.219	990	2.705	0.167
3	541	2.061	0.169	20	1.450	0.352	561	2.039	0.163
4	567	2.152	0.172	526	2.143	0.185	1,093	2.147	0.126
Total	2,166	2.330	0.100	1,378	2.354	0.124	3,544	2.339	0.078

a/ Selected conditions are the following Beaufort sea state and visibility combinations: OEX, OVG, OGO, 1 EX, 1 VG, 1 GO, and2 VG. Otters counted during island surveys were not included in this analysis.

b/ Survey period 1 = March, 2 = June-July, 3 = August, and 4 = October.

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encountered around the islands in the Shumagin and St. George Basin planning areas were excluded from this analysis because of incongruities between survey types.

The frequency distribution of group sizes (animals were grouped into size classes 1, 2, 3, 4-9, ≥10 for analysis) was not significantly different ($P > 0.05$) between the North Aleutian Basin and Shumagin planning areas so the data were pooled for each survey period (Figure 9). Over 80 percent of the groups contained one or two animals during each survey period. Many of the pairs were a single adult and one pup. Groups ranging from 10 to 75 animals were observed during each period but they represented less than 5 percent of the sightings. The small number of large groups may be due to survey times not coinciding with daytime periods otters form large groups (Estes, 1977; Garshelis, 1983). Other investigators have reported that these larger groups or rafts normally contain primarily males (Garshelis, 1983).

The frequency distribution of group sizes was significantly different ($P < 0.05$) among survey periods in the North Aleutian Basin but not in the Shumagin area. The proportion of groups comprising 2 animals increased during the summer survey periods probably because of an increase in mother/pup groups. A similar increase was not reflected in the Shumagin area because the analysis did not include surveys of islands where pups were prevalent. Observations during all surveys suggest the pupping season primarily overlapped the two summer survey periods for the North Aleutian Basin and Shumagin planning areas (see below).

4.3.2 Pups

There were 267 pups observed in the three planning areas of which 174 were observed under selected survey conditions (Table 8). Pups were difficult to detect from the aircraft, but they were widespread in the planning areas (Figure 10 and Appendix Tables B-3, 4). The 76 pups observed under selected conditions in the North Aleutian Basin were primarily in the nearshore area (Appendix Table B-5) from Moffet Lagoon to Slime Bank near Cape Mordvinof. There were 140 pups counted in the

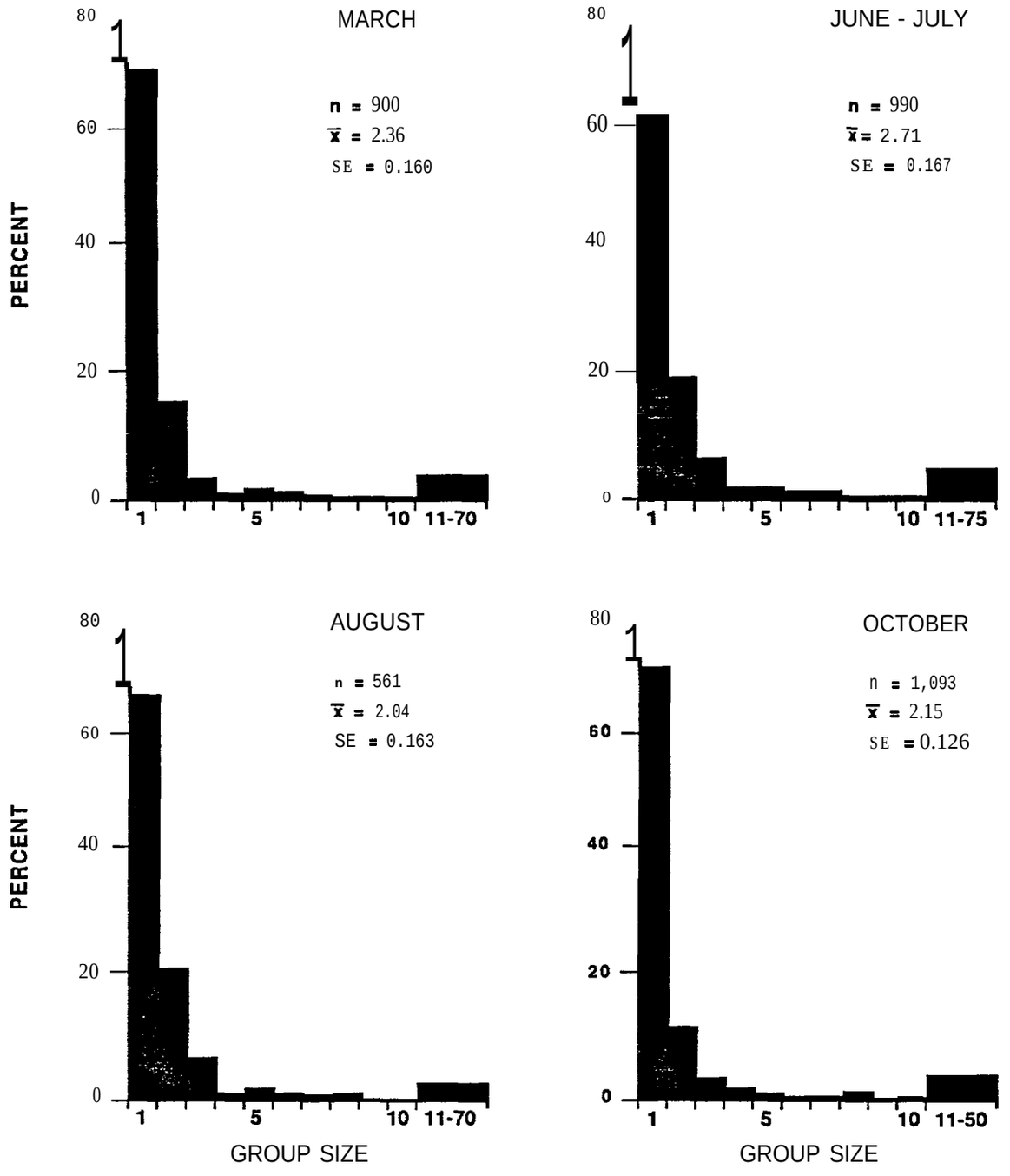

Figure 9. Percent frequency of sea otter group sizes observed in the study area, March-October 1986.

Table 8. Numbers of sea otter pups observed in each planning area, 1986.

Survey Period	North Aleutian Basin	Shumagin	St. George Basin	Total
1	8 (5) [a]	22 (14)	--- [b]	30 (19)
2	28 (15)	58 (33)	8	94 (56)
3	66 (48)	40 (30)	---	106 (78)
4 "	17 (8)	20 (13)	---	37 (21)
Total	119 (76)	140 (90)	8	267 (174)

a/ Pups observed under selected survey conditions shown in parentheses.

b/ Dash signifies no survey.

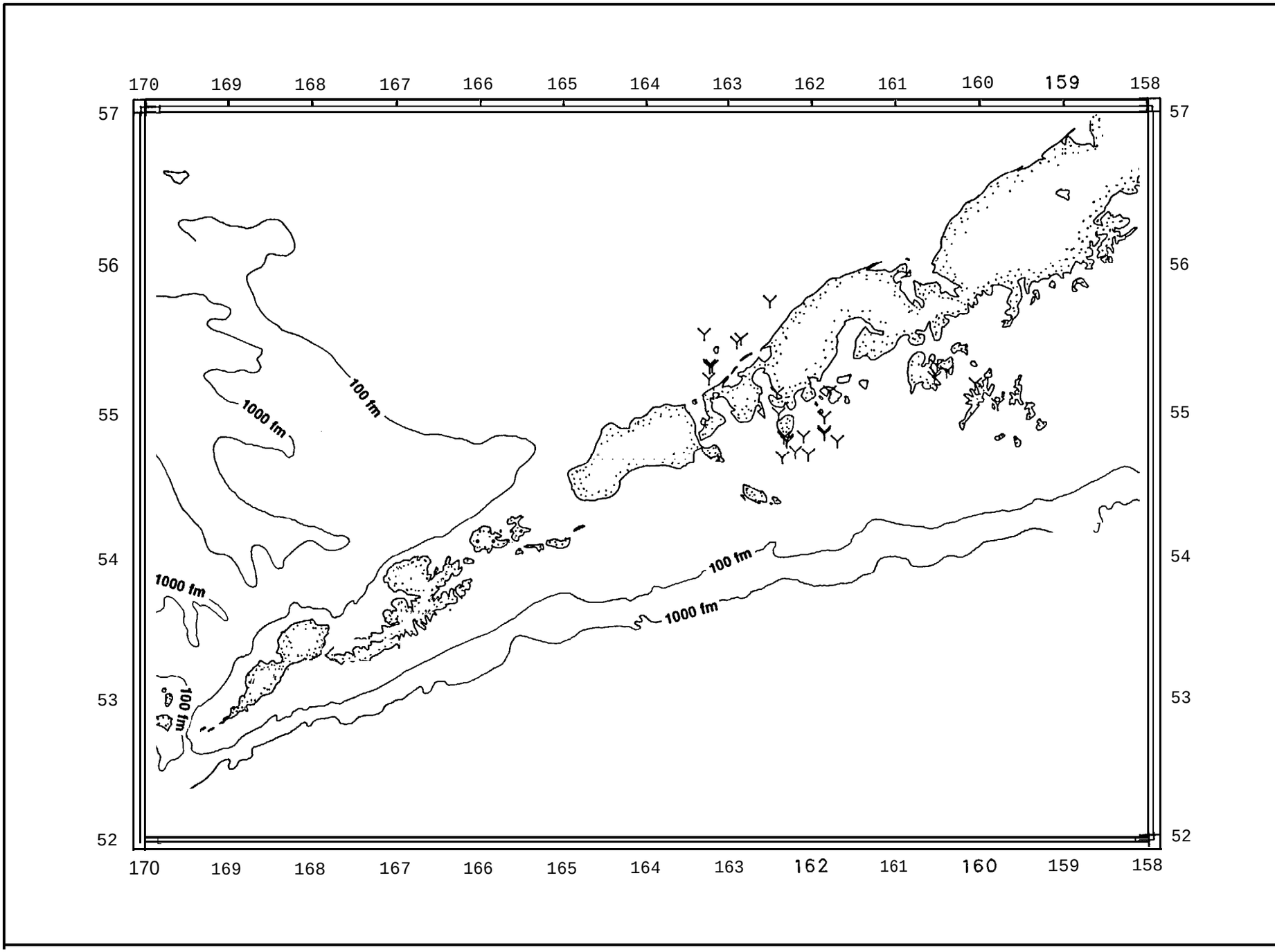

Figure 10a. Locations of sea otter pups observed in the study area during March 1986.

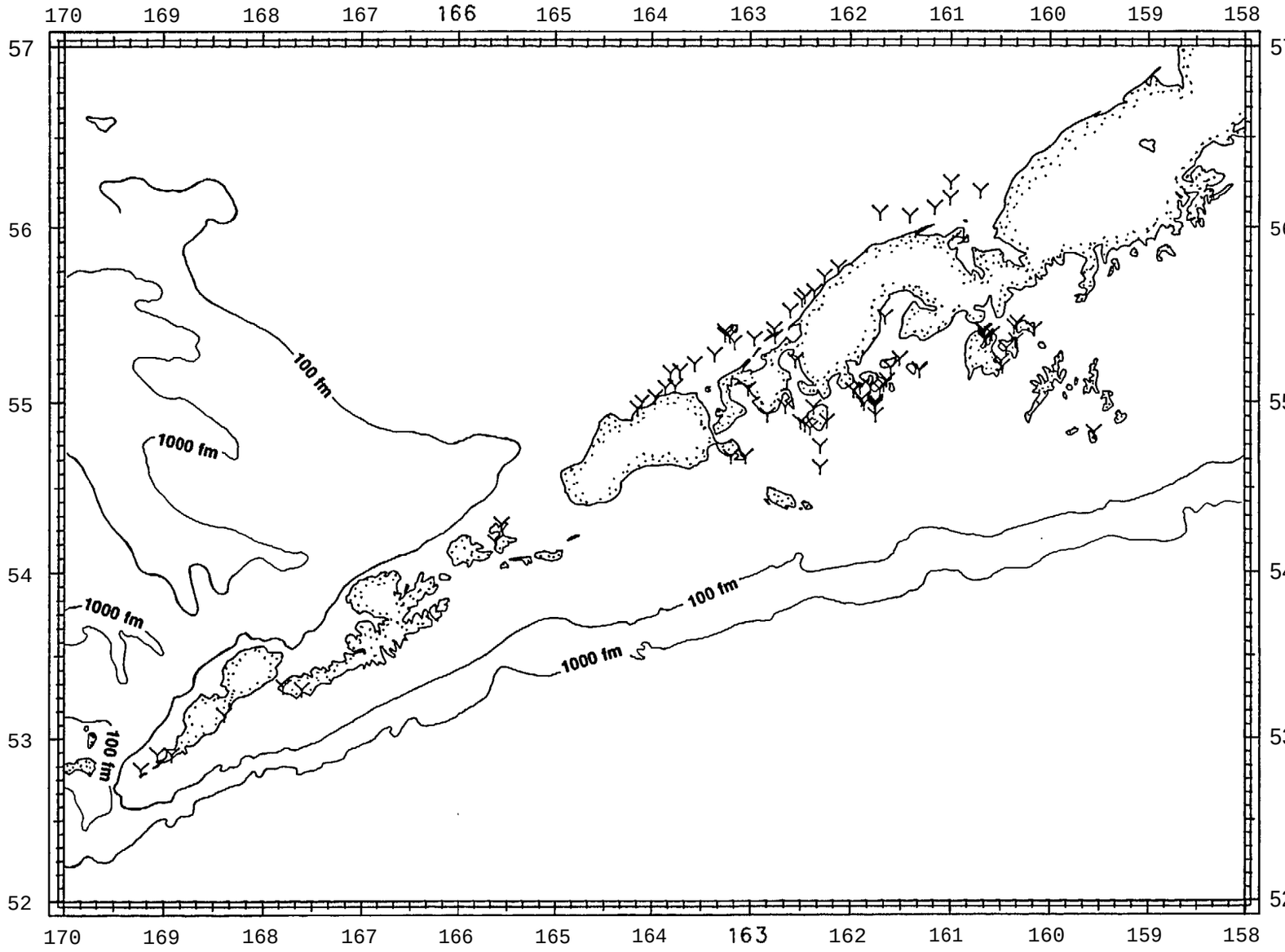

Figure 10b. Locations of sea otter pups observed in the study area during June/July 1986.

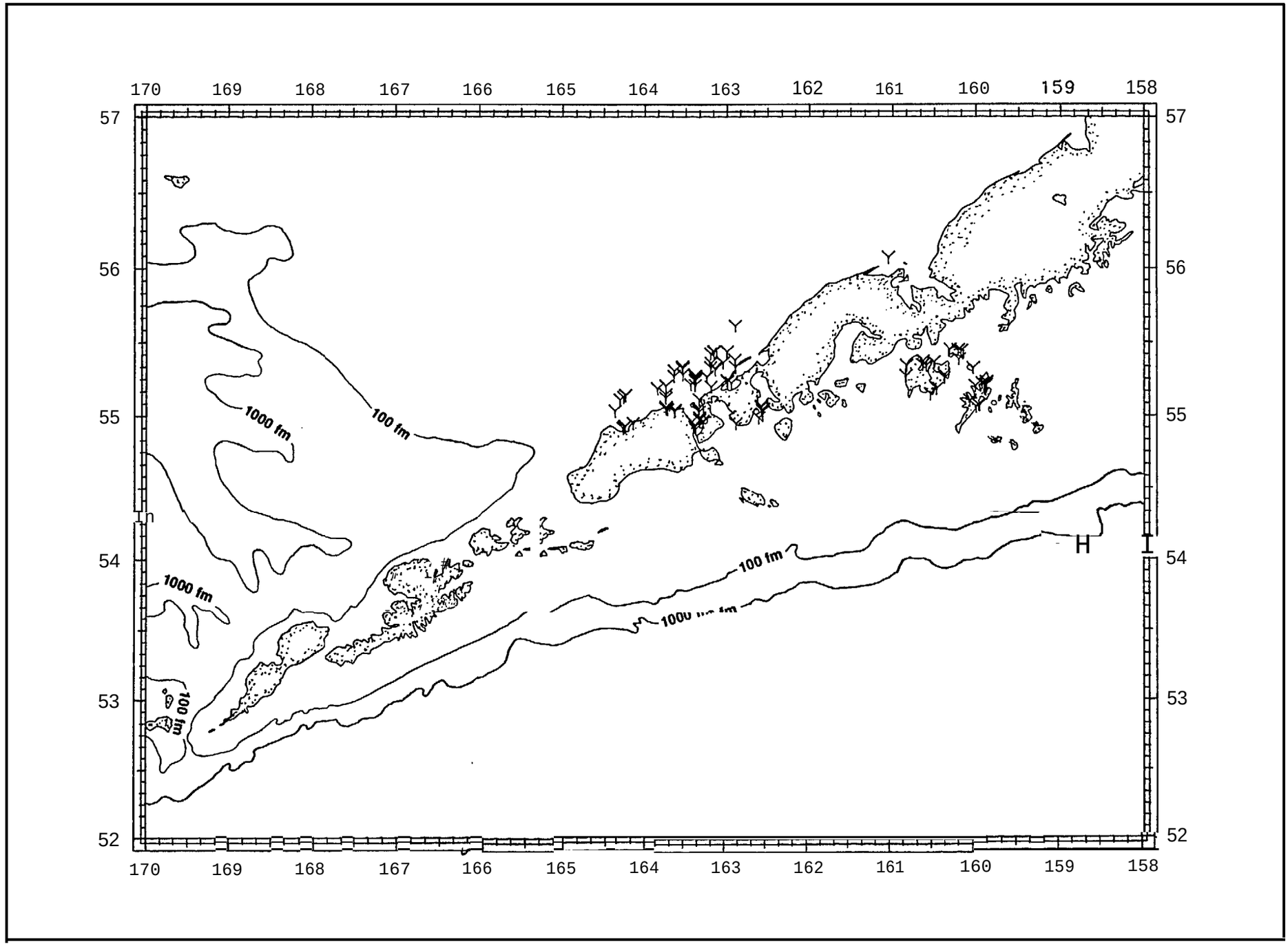

Figure **10c. Locations of sea otter pups observed** inthestudyareaduringAugust1986.

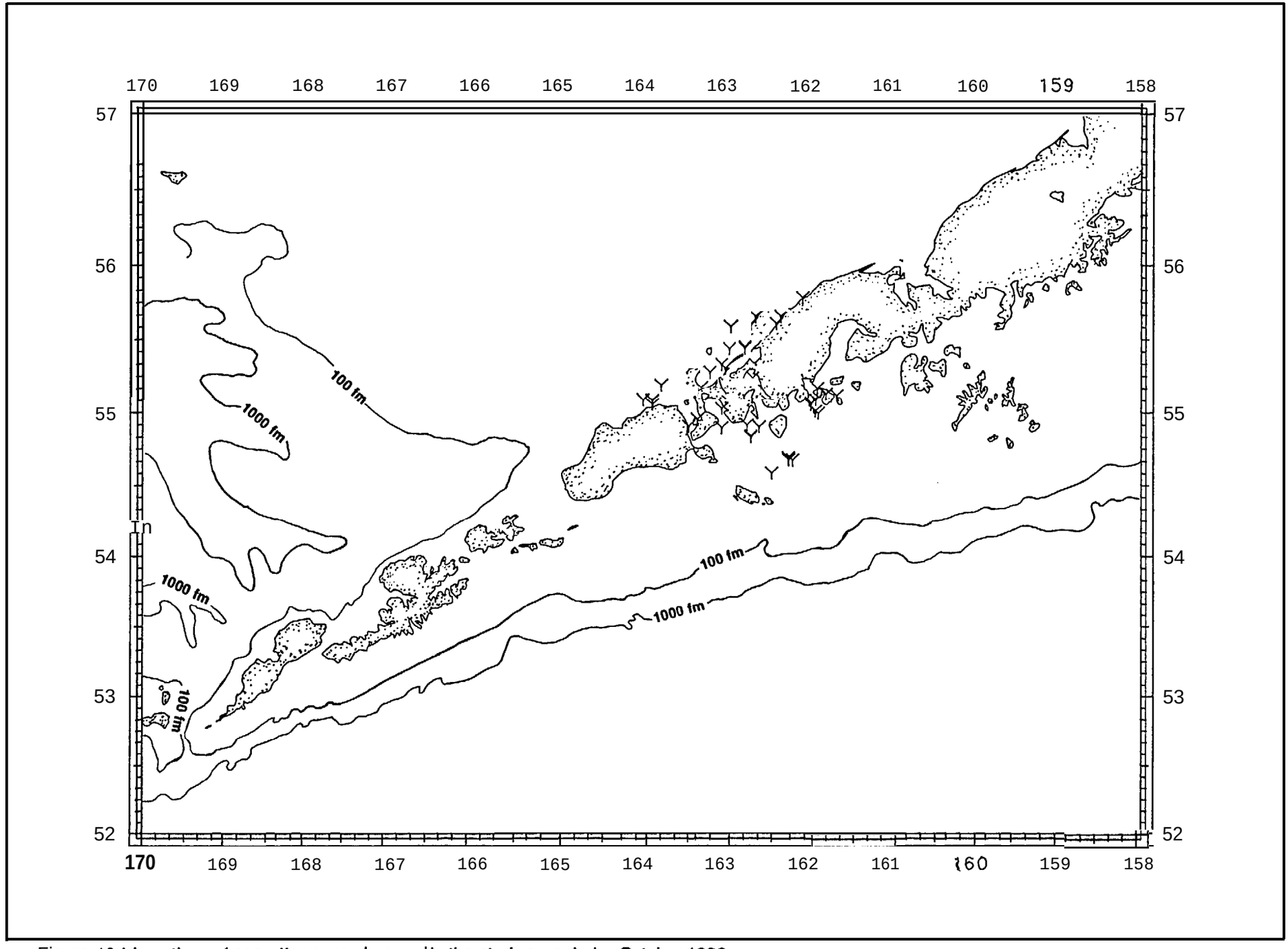

Figure 10d. Locations of sea otter pups observed in the study area during October 1986.

Shumagin area under all survey conditions including 59 pups in the Shumagin Islands, 17 pups in the Pavlof Islands, and 5 at Deer Island; no pups were observed in the Sanak Island group. Islands at which pups were observed in the Shumagins included: Unga (30), Nagai (13), Popof (6), Korovin (7), Andronica (1), Bendel (1), and Chernabura (1). Pups occurred at all of the Pavlof Islands. Lastly, eight pups were observed in the Fox Islands of the St. George Basin. Pups were observed at Akun, Unalaska, Umnak, and Samalga islands. These results show that breeding populations of sea otters occurred in all three planning areas, but the relative importance of these areas for pup production could not be determined from our data.

4.3.3 Rafts

There were 163 rafts of 4,718 otters observed over a wide distribution (Table 9) in the three planning areas (Figure ha-d). For purposes of the study, a raft was defined as a group of otters containing at least ten animals (Kenyon, 1969). Groups of this size or greater consist mainly of males (Kenyon, 1969; Garshelis, 1983). The rafts we report were observed during calm seas and good to excellent visibility conditions. Rough seas ($\geq$ Beaufort 3 sea state) cause animals in rafts to disperse (Garshelis, 1983).

There were 80 rafts of 1,685 sea otters observed in the North Aleutian Basin (Table 9, Appendix Table B-6). Raft sizes averaged about 21 animals and ranged from 10 to 75. Chi-square analysis indicated no difference in number of rafts by season ($X^2 = 1.39$, 3 df). Rafts were widespread in the Basin but the distribution was not uniform ($P < 0.05$). Fifty-four percent (43) of the rafts were found between longitudes 162°20'W and 162°39'W. Rafts were observed in this area during all surveys except August. Most (64 percent) rafts observed during August were found west of 163°40'W; a region where only one raft (June-July) was Observed during the other surveys. Only three rafts (4 percent) were found east of Cape Lieskof. Otter rafts were not uniformly distributed by water depth (Appendix Table B-8). Ninety-one percent of the rafts were found in water less than 22 fm (40 m) deep.

Table 9. Rafts (≥ 10 animals) of sea otters observed in the three planning areas.

Survey Period	North Aleutian Basin		Shumagin[a/]		St. George Basin		Total	
	No.	Ind.	No.	Ind.	No.	Ind.	No.	Ind.
1	17	344	24	471	--	--	41	815
2	15	687	26	442	14	296	70	1,425
3	48	278	--	--	--	--	14	278
4	8	376	19	399	--	--	38	775
Total	80	1,685	69	1,312	14	296	163	4,718

[a/] Twenty additional rafts were observed in the Shumagin Islands.

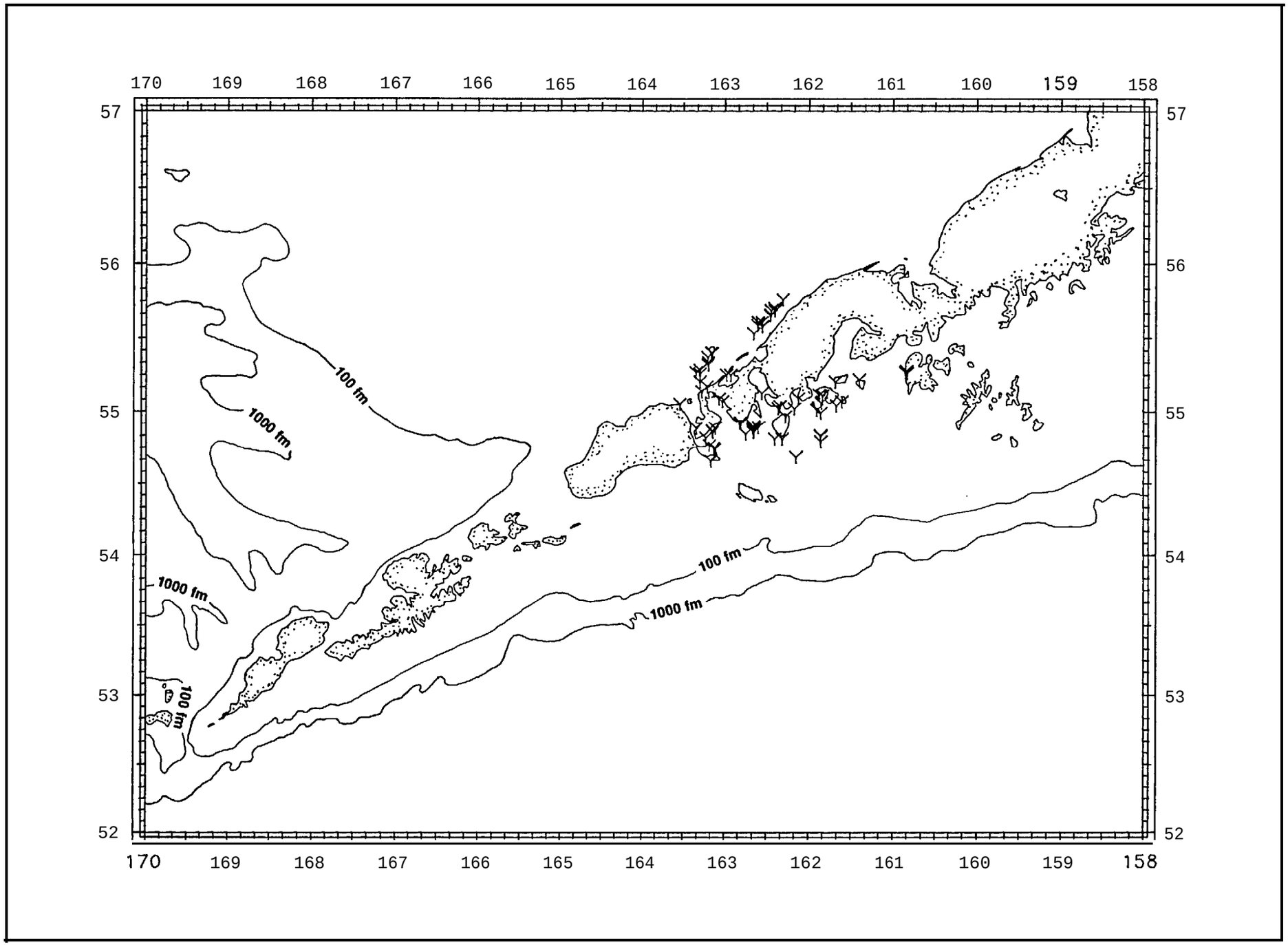

Figure 11a. Locations of sea otter rafts (groups> 10 individuals) observed in the study area during March 1986.

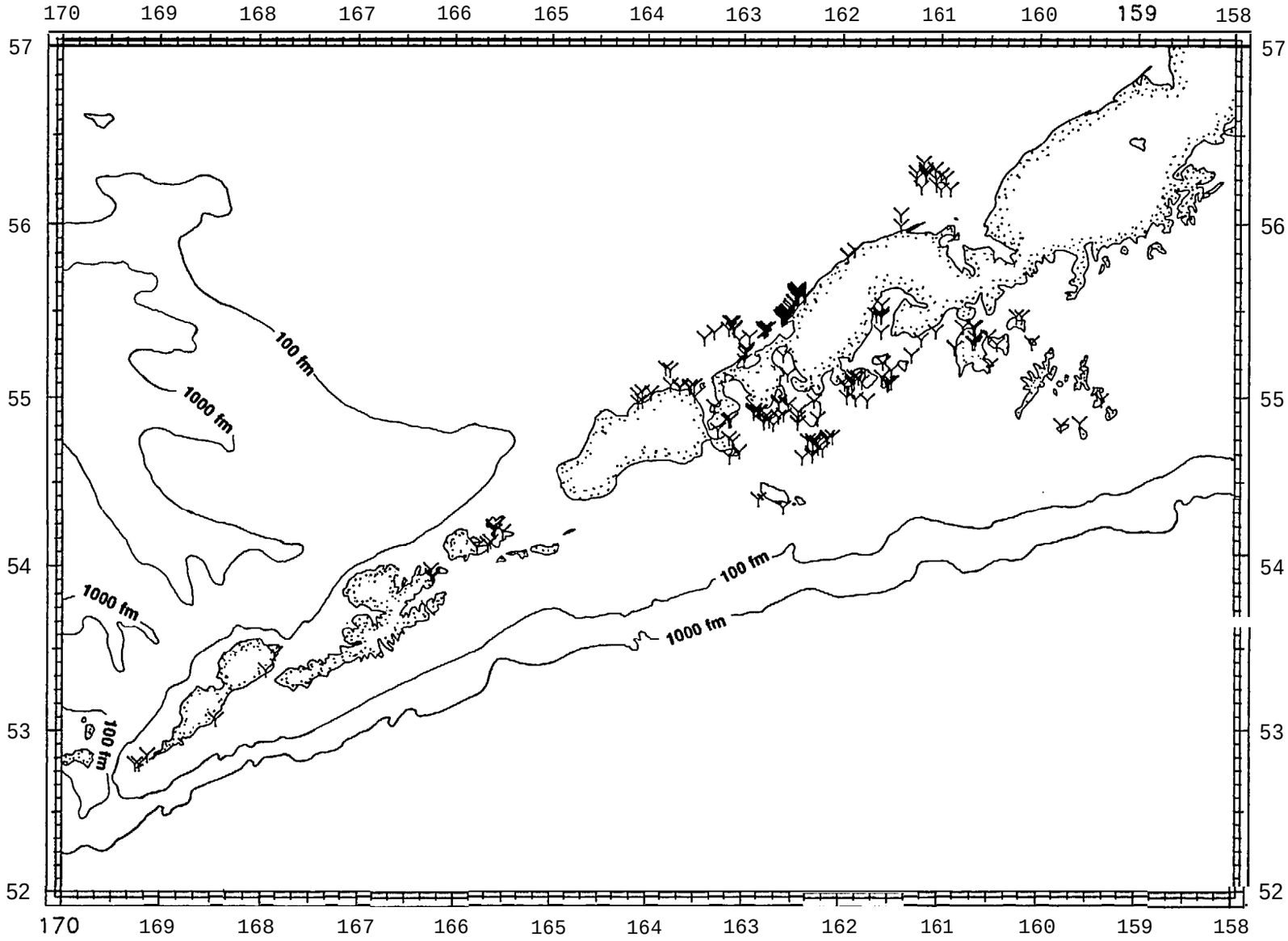

Figure 11b. Locations of sea otter rafts (groups 210 individuals) observed in the study area during June/July 1986.

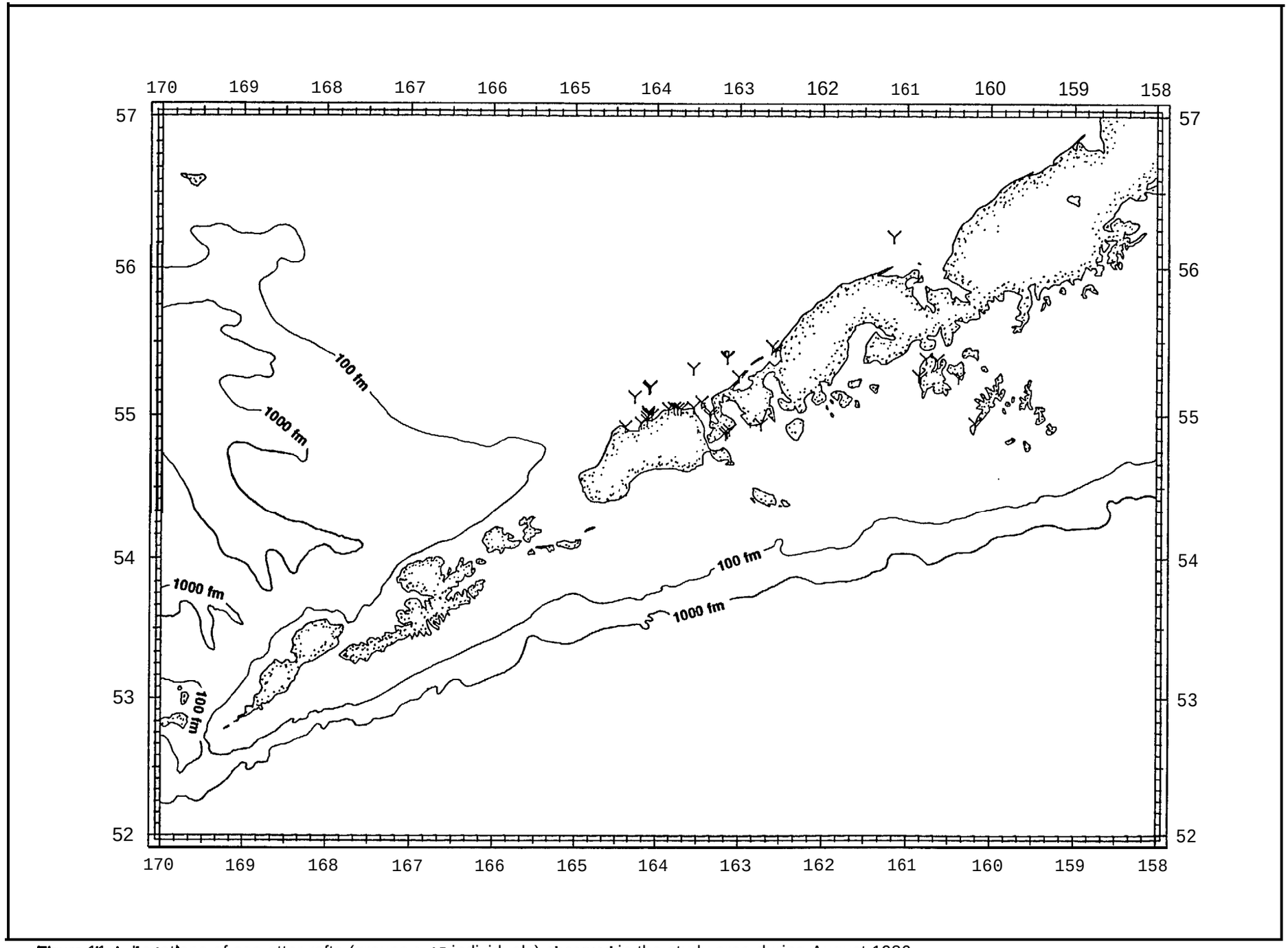

Figure 11 c. Locations of sea otter rafts (groups ≥ 10 individuals) observed in the study area during August 1986,

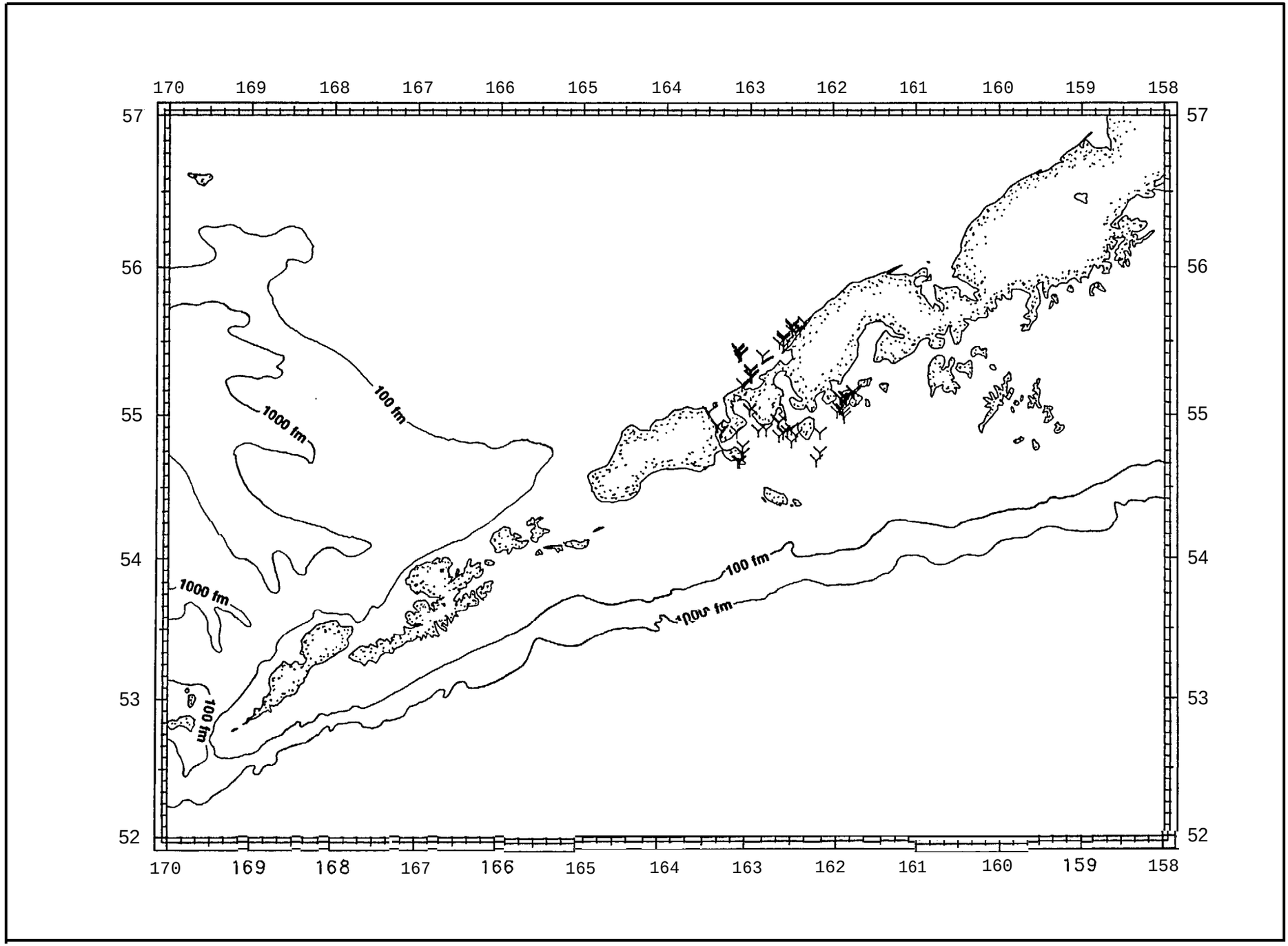

Figure **11d. Locations of sea otter rafts (groups ≥ 10 individuals)** observed **in the study** area during October 1986.

No rafts were observed in water >33 fm (60 m). These results suggest that rafts of males seasonally concentrate in relatively shallow water near Moffet Lagoon and near Cape Mordvinof on Slime Bank.

There were 69 rafts of 1,312 otters observed in the Shumagin Planning Area during systematic surveys (Table 9, Appendix Table B-7). Raft sizes averaged 17-21 animals per survey period. There was no difference in numbers of rafts observed by season ($X^2 = 2.43$, 3 df). Rafts were not uniformly distributed ($P < 0.05$) in the area west of the Shumagin Island complex. While the rafts were widespread, 41 percent were observed west of Deer Island and south of Cold Bay between longitudes 162°20'W and 162°39'W. This area was used consistently for three surveys periods. An additional 20 rafts were observed in the Shumagin Islands. Rafts occurred at 8 of the 13 islands. Seventy percent of the rafts were observed at Unga Island, where they were recorded during all three surveys. No rafts were observed in the Pavlof Islands.

Fourteen rafts were observed in the Fox Islands: five at Akun, two at Akutan, two on the east end of Unalaska, three at Umnak, and two at Samalga Island (Table 9).

Consequently, rafts of otters occurred throughout the three planning areas, with some areas of seasonal concentrations.

4.4 ABUNDANCE

Sea otter abundance estimates were determined for the North Aleutian Basin, Shumagin, and St. George Basin planning areas. Estimates were derived by selecting the most suitable strip width, visibility and sea state conditions, and period of sea otter activity. Strip width was determined by comparing the probability of detecting a group of sea otters at three right angles distance intervals from the aircraft: 0.0-0.125, 0.125-0.25, and 0.25-0.5 nm (Table 10). The probability of

Table 10. Observed and expected number of sea otter groups in each survey band.

Survey Period		Distance from flight track (rim) 0.0-0.125	0.125-0.250	0.250-0.500	X^2
1	Observed	1,059	260	70	2,045
	Expected	347	347	695	
2	Observed	1,397	314	160	2,537
	Expected	468	468	935	
3	Observed	654	205	58	1,142
	Expected	229	229	459	
4	Observed	881	403	178	1,149
	Expected	366	366	730	

detection was not uniform ($P < 0.001$) across the three distance intervals. Since substantially more sea otters *were* observed than expected in the 0.0-0.125 nm interval only, this was the strip width used to determine sea otter abundance. Estimates were based on the full interval of distance because bubble windows in the aircraft provided observers unobstructed downward visibility.

Visibility and sea states dramatically affect the probability of detecting sea otters. Kenyon (1969), Estes (1974), Schneider (1976), and others report that calm seas and unhindered viewing conditions are required to accurately count sea otters. We selected sea states defined as O-1 by the Beaufort Wind Scale (no whitecaps) with good to excellent visibility conditions and a 2 sea state with very good visibility conditions with little or no glare for estimating sea otter abundance. Chi-square analysis showed that sea otter detectability was not uniformly ($P < 0.05$) distributed across visibility and sea state conditions. Expected number of sea otter groups exceeded the observed for viewing conditions worse than these conditions indicating a decrease in detectability.

The most suitable period of the day for surveying sea otters is during their resting period (Garshelis, 1983). Garshelis and Garshelis (1984) reported that 99 percent of the sea otters they studied in Prince William Sound rested between 0930 and 1330 local sun time. Garshelis (1983) reported that approximately 80 percent were resting between 0830 and 1430. Estes (1977) reported that the resting peak of otters off Amchitka Island was between 0830 and 1430 local sun time, when 60 percent were inactive. Surveys conducted during these time intervals provide the most accurate counts because most otters are resting on the surface of the water. We derived our estimates from effort accomplished and sea otters observed between 0830 and 1430 local sun time (Alaska Standard Time minus 2 hours). This selection process reduced the total effort and counts by over 50 percent to 1,603 otter groups for 7,640 nm of effort.

Abundance was estimated two ways. The strip transect method was used to estimate sea otter abundance in the North Aleutian Basin and the open water and reef areas of the Shumagin Planning Area. These estimates were based on the process described above for selecting the best data. Sea otter abundance in the Shumagin, Pavlof, Sanak, and Fox (St. George Basin) Island complexes was determined from the highest count. The numbers of otters associated with the season having the highest count for each island were summed for all islands to determine abundance for each complex. This procedure was followed because the irregular shape of the islands precluded conducting strip transect surveys accurately. The island counts were combined with the strip transect estimates to determine sea otter abundance.

Sea otter abundance was highest in the Shumagin Planning Area, lowest in the St. George Basin, and intermediate in the North Aleutian Basin. The abundance estimate for the Shumagin Planning Area was derived by combining the single count of otters for the island complexes with each of the three seasonal estimates for the open water area west of these island complexes between 161°00'W and 165°00'W (Table 11). There were 1,877 sea otters counted in the Sanak (13 animals), Pavlof (620), and Shumagin (1,244) island complexes. An additional 13,469 to 15,958 sea otters were estimated for the waters west of the islands to Unimak Pass. This range of estimates was based on the three seasonal surveys conducted in March, June-July, and October; a survey was not conducted in August. The three estimates are within 16 percent of each other and each estimate falls within the range of confidence intervals. The closeness of the estimates suggests there was no major movement from the Shumagin Planning Area by sea otters. These estimates combined with the island counts provide a total abundance estimate of 15,346 to 17,835 sea otters.

The estimated sea otter abundance for the North Aleutian Basin ranged between 9,061 and 13,091 animals (Table 12). These estimates were derived by separating the Basin into two areas and summing the two estimates to obtain a single value. The one area (B), from Cape Seniavin to Cape Lieskof (160°W - 162014), had low otter densities while

Table 11. Sea otter abundance estimates for Shumagin Planning Area [a/]

Survey Period	Area Surveyed (nm^2)	No. Groups	Mean Group Size	Estimated Density (No./nm^2)	Estimated Abundance	95 percent CI	Island Counts			Totals
							Sanak	Pavlof	Shumagin	
Spring	124	347	2.206	6.1949	15,958	+ 9,771	13	620	1,244	17,835
Summer	60	139	2.243	5.2286	13,469	± 8,956	13	620	1,244	15,346
Fall	100	243	2.383	5.8148	14,979	+ 11,856	13	620	1,244	16,856

a/ Abundance estimates and 95 percent confidence intervals were developed for area from Unimak Pass to 161°00'W, west of the Shumagin Island complex. Abundance estimate was developed for Sanak, Pavlof, and Shumagin island complexes by summing the seasonal high count for each island; a confidence interval could not be calculated for the islands.

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Table 12. Sea otter abundance estimates for the North Aleutian Basin

Survey Period	Area Surveyed (nm^2)	No. Groups	Mean Group Size	Estimated Density (no. /nm^2)	Estimated Abundance	95 percent CI
Spring						
A a/	102	190	2.262	4.2137	9,207	± 5,109
B b/	-- c/	--	--	--	--	--
Total	NA	NA	NA	NA	NA	NA
Summer						
A	177	350	2.294	4.5295	9,897	± 4,667
B	123	100	2.060	1.6811	3,194	± 741
Total	300	450	NA	3.2047	13,091	± 5,408
Fall						
A	100	196	1.816	3.5675	7,795	± 2,822
B	67	38	1.179	0.6663	1,266	± 222
Total	167	234	NA	2.2181	9,061	± 3,044

a/ "A" equals area west of 162°00'W comprising 2,185 nm2.

b/ "B" equals area east of 162°00'W comprising 1,900 nm^2.

c/ Insufficient effort to estimate abundance.

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the second area (A), from Cape Lieskof to Unimak Pass (162°W - 165°W), had high otter densities. Abundance estimates were calculated for each of the areas for each season except March. The effort in March was insufficient to estimate abundance in the Cape Seniavin-to-Cape Lieskof area. The June/July and August counts were pooled to increase the sample size for estimating summer abundance. Densities were over 2.5 times higher in the Cape Lieskof-to-Unimak Pass area than in the Cape Lieskof-to-Cape Seniavin area. Abundance estimates for the former area dropped from 9,207 in the spring and 9,897 animals in the summer to 7,795 animals in the fall. While these values suggest a movement of otters from the Basin in the fall, the fall estimate lies within the confidence intervals of the spring and summer estimate. Therefore, sampling variation alone may account for the drop in values. An estimated 1,266 to 3,194 sea otters were in the Cape Lieskof-to-Cape Seniavin area.

Lastly, the abundance estimate for the St. George Basin was 858 sea otters. This estimate was derived from a single count of otters on the islands comprising the Fox Island complex.

The total abundance, calculated by pooling the sea otters estimated in the three planning areas, was between 26,775 and 29,295 animals (Table 13). These estimates were based on the assumption that: 1) the counts used for the Shumagin and St. George island complexes were constant in the spring, summer, and fall, and 2) no movements of otters occurred among the planning areas to cause double counting of animals. The relatively short survey period (<15 days) for each season and the relatively consistent estimates suggest that major movements did not occur in a given season to cause duplicate counting errors. In addition, islands which were surveyed during multiple seasons had relatively consistent counts which suggests that the numbers of otters associated with the island complexes were probably stable.

The estimates of total sea otter abundance that we provide are conservative. The actual number may be 15-30 percent higher, since our estimates were based on data selected for the time of day that Estes

Table 13. Estimated abundance of sea otters in Project Area.

Season	North Aleutian Basin	Shumagin		St. George Basin	Total
	All Areas	Open Water	Islands	Islands	
Spring	9,207 ± 5,109	15,958 ± 9,771	1,877	858	27,900
Summer	13,091 ± 5,408	13,469 ± 8,956	1,877	858	29,295
Fall	9,061 ± 3,044	14,979 ± 11,856	1,877	858	26,775

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(1977) and Garshelis (1983) reported 70-85 percent of the otters were either resting or feeding at the surface and the remainder were underwater and unavailable for observation. If their findings apply to our study area, then the total abundance would be between 30,791 and 33,689 sea otters when applying a 15 percent correction factor for missed animals, or it would be between 34,808 and 38,084 sea otters when applying a 30 percent correction factor. Total abundance may be even higher since the estimates don't account for the number of otters missed on the surface by observers. Simultaneous aerial and ground counts conducted by Geibel and Miller (1984) *in* California show that an estimated 30 to 40 percent of otters on the surface are missed by aerial observers in the area visible below the aircraft. Consequently, the total sea otter abundance in our study area may be closer to 50,000 animals.

5.0 DISCUSSION

The primary purpose of this study was to determine the current population status of sea otters in the North Aleutian Basin, Shumagin, and St. George Basin planning areas and to investigate the possibility of a major sea otter migration between the North Aleutian Basin and Shumagin planning areas through False Pass. Cimberg et al. (1984) set forth the migration hypothesis after they reported dramatic seasonal differences in otter abundance observed during surveys conducted along the north side of the Alaska Peninsula during 1982 and 1983. The differences in Cimberg et al. 's abundance estimates were approximately seven-fold between August (10,325) and March (1,454) or October (1,880), which they attributed to a summer influx of otters from the Pacific Ocean side of the Alaska Peninsula.

Our results do not confirm the hypothesis by Cimberg et al. (1984) of a sea otter migration through False Pass. In contrast, our abundance estimates for the North Aleutian Basin were relatively constant over the spring, summer, and fall seasons (Table 12). Numbers were also relatively constant among seasons in the Shumagin Planning Area (Table 11), which would not be expected if 90 percent of the north side population moves through False Pass each spring and fall (Cimberg, et al. 1984). We suspect that major differences between our results and those of Cimberg et al. (1984) can be attributed to differing survey conditions. Although they do not provide specific environmental data in their report, a significant amount of their survey effort occurred during winds exceeding 10 kt and in many cases greater than 20 kt (R. Cimberg, pers. comm.). The results from studies conducted by Kenyon (1969) and Estes (1974) confirm our findings that sea otter detectability greatly decreases when winds exceed 10 kt. Wind conditions in the study area are typically worse during fall and spring when the estimates made by Cimberg et al. (1984) were lowest. Consequently, the seasonal change *in* sea otter densities reported by Cimberg et al. (1984) may have been due to sighting conditions during the surveys.

Our results, however, do not preclude the existence of a major migration through False Pass. Movements may have occurred during the winter months when we did not survey. The advance of landfast ice along the north side of the Peninsula may temporarily alter the range of sea otters and, in extreme ice years, possibly force otters to move to the south side during late February and March. In 1986, landfast ice reached its maximum coverage during our March survey (NOAA-Navy, 1986), but our abundance estimates *were* not substantially different from estimates for the other seasons.

Our data indicated that there were local movements within the planning areas. Otter use in the North Aleutian Basin shifted seasonally between the Izembek-Moffet Lagoon vicinity and Slime Bank, west of False Pass. Otter use in the Shumagin Planning Area also shifted seasonally between Sandman Reefs and Morzhovoi Bay. Moreover, otters in both planning areas displayed high seasonal use of the areas north and south of the bays bordering False Pass. Otters in the Shumagin Planning Area showed high use of the bay entering False Pass during the summer while otters in the North Aleutian Basin showed high use north of False Pass during summer and fall. These shifts did not appear to be related to migration between the two sides of the Peninsula since abundance estimates were reasonably constant during each season. The shifts may be due to breeding activity, prey availability, or some other factor that we presently lack the data to explain. It is likely, however, that some exchange occurs between otters in the North Aleutian Basin and Shumagin planning areas through False Pass.

Observed otter densities in the study area were generally lower than reported for other areas in Alaska. The highest density, 6.2 otters/nm^2, occurred in the Shumagin Planning Area during March. In contrast, Estes (1974) calculated a density of 63 otters/nm^2 at Amchitka Island in 1972, a 10-fold difference from our data. Kenyon (1969) stated that a growing population may reach 40 otters/nm^2 and then drop precipitously, and finally stablize at an optimum of 10-15

otters/nm² after depleted food resources have recovered. Consequently, our data suggest that otter densities in each of the three planning areas were suboptimum.

Otter densities we estimated for the North Aleutian planning area were below estimates reported from previous surveys (Schneider, 1976). Our observed sea otter density for the summer period in the North Aleutian Basin was 3.2 otters/nm². This is less than half the density of 7.9 otters/nm² (2.3 otters/km²) observed by Schneider (1976) in the same area in 1976. Schneider (1981) believed that the total population and densities of sea otters in this area were even higher in the 1960s before their range and numbers were reduced by severe sea-ice conditions in the early 1970's (Schneider and Fare, 1975). If so, the population on the north side may be steadily declining. However, use of the Port Moller area has apparently increased substantially since 1976. Our abundance estimates for this area ranged between 3,194 during the summer and 1,266 during the fall based upon sightings of 206 and 45 otters (100 and 38 groups), respectively, while Schneider (1976) observed none along 72 nm of trackline flown in this area. Cimberg et al. (1984) reported otter use of the Port Moller area was high during the summer and fall of 1982, although their conclusion was based upon sightings of only 18 and 17 otters, respectively.

Schneider's (1976) summer otter densities by water depth were also considerably higher than our densities, except for water depths greater than 33 fm (60 m) where they were similarly low. Schneider's densities (no per nm²) were 10.6, 19.9, 1.7, and 0.1 for the 0-11 fm (0-20 m), 12-22 fm (21-40 m), 23-33 fm (41-60 m), and over 33 fm (60 m) water depth classes, respectively. In comparison, our densities (no per nm²) for the same depth classes were 3.9, 1.1, 1.0, and 0.5. We observed a similar pattern of high otter densities in the shallower depth classes in the spring and fall, but the fall densities were effected by the land fast ice which concentrated otters in the 12-22 fm (21-40 m) depth class. Schneider (1976) did not conduct surveys during these seasons. These results show that we observed a similar distribution of otter by depth class, but lower densities than

Schneider (1976), which further suggests that current sea otter population size may be lower than previous estimates of abundance for the north side of the Alaska Peninsula.

Sea otter numbers in the Sanak, Pavlof, Shumagin, and Fox islands have apparently changed dramatically since surveys in the late 1950s, 1960s, and mid 1970s. The most dramatic change has probably occurred in the Fox Islands. Kenyon (1960, 1965) observed only 17 otters at two islands in 1960 and 43 otters at three islands in 1965 (Table 14). During 1986, we observed 858 otters at six islands, four of which yielded 146 or more sightings. The most apparent increases were at Akun, Akutan, and Unalaska islands where we observed a total of 549 otters compared to 10 otters reported by Schneider and Faro (1969) in 1969.

Dramatic increases were also observed in the Pavlof Islands and the northern Shumagin Islands. Other than four otters observed at Outer Illiask Island in both 1957 and 1960 (Kenyon, 1969), few otters were thought to exist in the Pavlof's until 122 animals were observed by Schneider and Faro (1970) in 1970 (Table 15). Combining the high counts for each island in 1986, we observed 620 otters. This count represents a significant increase since 1970, even though the latter surveys were conducted under poor to fair conditions.

Few otters were observed in the four northern Shumagin Islands in 1957 and 1962 when surveys were conducted by Lensink (1958) and Kenyon (1969), respectively (Table 16). The highest count was five animals in 1957. By 1969-1970 Schneider and Faro (1969, 1970) had counted a total of 357 otters, although they surveyed during fair to poor visibility conditions. Our highest count was 772 otters at the four northern islands during June-July, which was a two-fold increase since 1970. Seventy-four percent of the otters we observed were at Unga Island. This increase in otters in the northern Shumagin Islands appears to have coincided with a decrease in the nine southern Shumagin Islands. Our data indicates that there has been a four-fold decrease in otter numbers since 1957 and a three-fold decrease since 1962 in the southern

Table 14. Numbers of sea otters recorded in the Fox Islands, 1960-1986.

Islands	Year Surveyed [a] March 1960		May 1965		April 1969		August 1975		July 1986	
	No.	Vis. [b]	No.	Vis.	No.	Vis.	No.	Vis.	No.	Vis.
Ugamak	0	FA-EX	0	FA-PO	0	FA-GO	5	FA-PO	---	---
Tigalda	11	FA-EX	32[c]	FA-PO	49	FA-GO	73	FA-PO	0[c]	EX
Avatanak	0	FA-EX	2[c]	FA-PO	0	FA	4	FA-PO	---	---
Rootok	0	FA-EX	0[c]	FA-PO	2	FA	1	FA-PO	15	EX
Akun	0	FA-EX	---[d]	--	3	FA	3	FA-PO	226	VG-EX
Akutan	0	FA-EX	0[c]	FA-PO	1	FA	0	FA-PO	146[c]	VG-EX
Unalga	0	FA	- -- -- -		0	FA-GO	0	FA-PO	7	EX
Unalaska	0	GO	0[c]	FA-PO	6[c]	FA-GO	4	FA-PO	177[c]	GO-EX
Umnak/Samalga	6	GO-EX	9[c]	FA-PO	36[c]	FA-GO	174	FA-PO	287	GO-EX
Total	17		43		97		264		858	

[a] Sources: 1960, 1965 (Kenyon, 1960, 1965); 1969 (Schneider and Fare, 1969); 1975 (Schneider, 1976); 1986 (This study).
[b] Visibility conditions during survey: EX . Excellent, VG = Very Good, GO = Good, FA = Fair, and Po = Poor.
[c] Incomplete survey of island.
[d] Dash signifies no survey.

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Table 15. Numbers of sea otters recorded in the Sanak and Pavlof islands, 1957-1986.

Islands	Year Surveyed [a] July 1957		April 1962		March 1970		March-October 1986	
	No.	Vis. [b]	No.	Vis.	No.	Vis.	No.	Vis.
Sanak/Caton	251	EX	548	EX	239	FA-PO	13	FA-VG
Total	251		548		239		13	
Pavlof Islands [c]								
Dolgoi	0	EX	0	EX	67	FA-PO	185	VG
Goloi	0	EX	0	EX	2	FA-PO	113	EX
Inner Illiask	0	EX	0	EX	2	FA-PO	77	GO
Outer Illiask	4	EX	4	EX	16	FA-PO	82	VG
Wosnesenski	0	EX	0	EX	4	FA-PO	29	GO-VG
Ukoloi	0	EX	0	EX	2	FA-PO	54	GO
Poperechnoi	0	EX	0	EX	29	FA-PO	80	EX
Total	4		4		122		620	

[a] Sources: 1957, 1962 (Kenyon, 1969); 1971 (Schneider and Fare, 1970); 1986 (This study).
[b] Visibility conditions during survey: EX = Excellent, VG . Very Good, GO = Good, FA = Fair, and PO = Poor.
[c] 1957 and 1962 surveys of Pavlof Islands were incomplete.

-Table 16. Numbers of sea otters recorded in the Shumagin Islands, 1957-1986,

Islands	Year Surveyed [a]									
	July 1957		Apri 1 1962		April 1 9 6 9		March 1970		March-August 1986	
	No.	Vis. [b]	No.	Vis.	No.	Vis.	No.	Vis.	No.	Vis.
Northern Islands										
Unga	2	EX	4	EX	---	---	184	FA-PO	568	VG-EX
Popof	2	EX	--	--	----	--	52	FA-PO	72	EX
Korovin	--[c]	EX	----	--	----	--	46	FA-PO	101	VG-EX
Andronica	1	EX	----	--	75	PO-FA	---	---	31	EX
Subtotal	5		4		75		282		772	
Southern Islands										
Nagai	149	EX	338	EX	232	PO-GO	---	---	184	GO-EX
Big Koniuji	220	EX	222	EX	296	PO-FA	---	---	52	EX
Turner					6	FA	---	---	6	VG-EX
Bendel	268[d]	EX	105[d]	EX	27	FA	---	---	35	VG-EX
Spectacle					8	FA	---	---	17	VG
Little Koniuji	430	EX	255	EX	232	PO-FA	---	--	65	EX
Simeonof	455	EX	294	EX	329	PO-FA	---	---	13	GO-VG
Chernabura	132	EX	79	EX	6	PO	---	---	20	VG
Bird	160	EX	38	EX	76	PO	---	---	80	VG
Subtotal	1,814		1,331		1,212		---		472	
Total	1,819		1,335		1,287		282		1,244	

[a] Sources: 1957 (Lensink, 1958); 1962 (Kenyon, 1969, 1970 (Schneider and Faro, 1969, 1970); 1986 (This study).
[b] Visibility conditions during survey: EX = Excellent, VG = Very Good, GO = Good, FA = Fair, and PO = Poor.
[c] Dash signifies no survey.
[d] Value applies to Turner, Bendel, and Spectacle islands combined.

Shumagin Islands (Table 16; Figure 12). The southern Shumagins are apparently an area where sea otters survived commercial harvest (Kenyon 1969), and one of the first places where there was rapid population growth. The decline we report since the 1950s may be related to overharvesting of food resources by the otters over a rather long occupation period. Sanak Islands is another area where a remnant sea otter population survived to protection (Kenyon, 1969). In 1962, 548 sea otters were observed here by Kenyon (1969) while our 1986 counts yielded only 13 otters (Table 15).

In summary, the sea otter populations in the study area have apparently expanded into areas which were not occupied since the days of commercial harvest. These areas include the Fox, Pavlof, and northern Shumagin islands. Otters also appear to be reestablishing themselves in the Port Moller region where their numbers dropped following the severe sea-ice conditions in the early 1970s. Sea otters have long been established in the North Aleutian Planning Area between Cape Mordvinof and Cape Lieskof. They have also been long established in the Shumagin Planning Area in the vicinity of Sanak and Caton islands and in the southern Shumagin Islands. Otters in these two planning areas may possibly have survived as isolated seed populations. Presently, these areas are experiencing declines in numbers, especially near Sanak and Caton islands, possibly indicating a decrease in the habitat carrying capacity from the effects of several decades of high sea otter abundance. The proposed existence of a major seasonal sea otter migration through False Pass could not be confirmed.

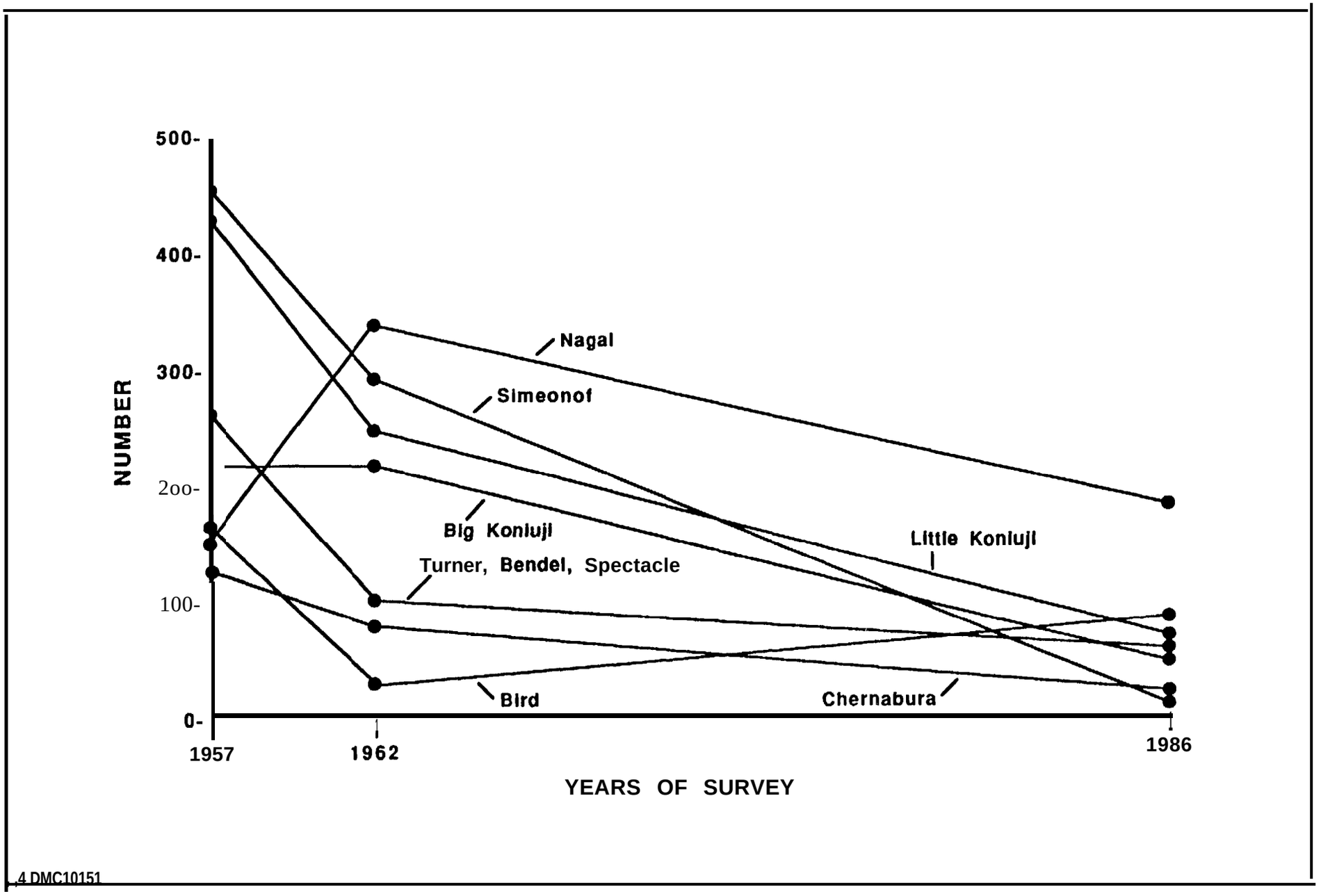

Figure 12. Change in numbers of sea otters counted in the southern Shumagin Islands from 1957-1986. The 1957 and 1962 data from Kenyon (1969).

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APPENDIX A

Table A-1. Criteria used to determine relative visibility.

Visibility	Highest Allowed Beaufort Sea State	Descriptors
Excellent	1	Calm and clear
Very Good	2	Surface ripple, some glare.
Good	4	Light chop, glare, fog
Fair	5	Chop, glare, shadows, fog but all animals on line visible
Poor	5	Same as Fair only some animals on line obscured
Unacceptable	--	Survey tract obscured

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Table A-2. Criter a used to classify glare.

Glare Number	Percent area obscured by sun reflection, fog, or moisture on window surface
1	1 - 10 percent
2	11 - 25 percent
3	26 - 50 percent
4	51 - 75 percent
5	76 - 100 percent

6378a

Table B-1. Numbers and groups of sea otters observed by 20 minute segments of longitude in the North Aleutian Planning Area under selected survey conditions, March-October 1986.[a/]

Longitude	Survey 1 Effort[b/]	Survey 1 No	Survey 1 Groups	Survey 2 Effort	Survey 2 No.	Survey 2 Groups	Survey 3 Effort	Survey 3 No.	Survey 3 Groups	Survey 4 Effort	Survey 4 No.	Survey 4 Groups	Total Effort	Total No.	Total Groups
Area B															
158°40'-160019'	32	0	0	24	0	0	0		--	0	--	--	56	0	0
160"20'-160°39'	71	12	12	142	4	4	0	--	--	211	69	58	424	85	74
160"40'-160°59'	41	11	10	238	111	56	46	1	1	174	11	8	499	134	75
161"00'-161"19'	4	0	0	235	165	87	133	61	25	98	2	1	470	228	113
161°20'-161"39'	0	--[c/]	--	251	76	48	81	12	5	86	4	2	418	92	55
161°40'-161059'	0	--	--	112	15	9	0	--	--	83	7	7	195	22	16
Subtotal	148	23	22	1,002	371	204	260	74	31	652	93	76	2,062	561	333
Area A															
162"00'-162"19'	36	43	18	177	64	29	0	--	--	101	49	25	314	156	72
162"20'-162°39'	138	216	61	307	931	187	118	56	24	273	520	178	836	1,723	450
162"40'-162"59'	142	20	13	154	78	42	176	82	47	190	72	34	662	252	136
163"00'-163"19'	330	467	186	63	72	33	172	40	31	101	36	27	666	615	277
163"20'-163°39'	303	206	105	94	41	37	228	232	130	373	435	216	998	914	488
163"40'-163"59'	182	58	53	120	77	35	119	102	55	27	15	11	448	252	154
164°00'-164019'	51	5	5	126	24	14	195	471	180	35	0	0	407	500	199
164"20'-164°59'	11	1	1	64	14	13	54	58	44	0	--	--	128	73	58
Subtotal	1,193	1,016	442	1,105	1,301	390	1,062	1,041	511	1,100	1,127	491	4,460	4,485	1,834
Total	1,341	1,039	464	2,107	1,672	594	1,322	1,115	542	1,752	1,220	567	6,522	5,046	2,167

a/ Selected survey conditions are the following Beaufort sea state and visibility combinations: OEX, 0 VG, 0 GO, 1 EX, 1 VG, 1 GO, and 2 VG.

b/ Effort in nautical miles,

c/ Dashes signify no data.

8221a

Table B-2. Numbers and groups of sea otters observed by 20 minute segments of longitude in the Shumagin Planning Area under selected survey conditions, March-October 1986.?/

	Survey 1			Survey 2			Survey 3			Survey 4			Total		
Longitude	Effort[b]	No.	Groups	Effort	No.	Groups	Effort	No.	Groups	Effort	No.	Groups	Effort	No.	Groups
161°00'-161019'	36	0	0	185	119	36	0	--[c]	--	0	--	--	221	119	36
161″20'-161°39'	40	7	6	209	169	71	0	--	--	0	--	--	249	176	77
161″40'-161°59'	171	249	148	180	101	57	0	--	--	148	154	76	499	504	281
162°00'-162019'	228	86	66	74	14	12	0	--	--	189	269	166	491	369	244
162″20'-162″39'	224	453	117	89	142	45	22	1	1	321	556	205	656	1,152	368
162″40'-162°59'	141	81	40	220	223	85	40	17	15	94	15	12	495	336	152
163°00'-163″19'	124	192	48	132	226	79	9	10	3	212	119	57	477	547	187
163°20'-165”00'	47	14	11	153	12	11	2	1	1	57	14	10	259	41	33
Total	1,011	1,082	436	1,242	1,006	396	73	29	20	1,021	1,127	526	3,447	3,244	1,378

a/ Selected survey conditions are the following Beaufort sea state and visibility combinations: OEX, OVG, OGO, 1 EX, 1 VG, 1 GO, and2 VG.

b/ Effort in nautical miles.

c/ Dashes signify no data.

8221a

Table B-3. Number of sea otter pups observed by 20 minute segments of longitude in the North Aleutian Basin Planning Area under selected survey conditions, March-October 1986.[a/]

Longitude	Survey 1 Effort[b/]	Survey 1 Pups	Survey 2 Effort	Survey 2 Pups	Survey 3 Effort	Survey 3 Pups	Survey 4 Effort	Survey 4 Pups	Total Effort	Total Pups
Area B										
158°40′-160″19′	32	0	24	0	0	--	0	--	56	0
160°20′-160039′	71	0	142	0	0	--	211	0	424	0
160″40′-160°59′	41	0	238	2	46	0	174	0	499	2
161°00′-161″19′	4	0	235	1	133	1	98	0	470	2
161°20′-161″39′	0	--[c/]	251	1	81	0	86	0	418	1
161″40′-161°59′	0	--	112	1	0	--	83	0	195	1
Subtotal	148	0	1,002	5	260	1	652	0	2,062	6
Area A										
162°00′-162″19′	36	0	177	1	0	--	101	1	314	2
162″20′-162″39′	138	0	307	4	118	0	273	1	836	5
162″40′-162″59′	142	0	154	2	176	5	190	2	662	9
163°00′-163019′	330	5	63	0	172	6	101	1	666	12
163°20′-163039	303	0	94	0	228	18	373	1	998	19
163°40′-163059′	182	0	120	2	119	7	27	2	448	11
164″00′-164°19′	51	0	126	1	195	10	35	0	407	11
164°20′-164059′	11	0	64	0	54	1	0	--	129	1
Subtotal	1,193	5	1,105	10	1,062	47	1,100	8	4,460	70
Total	1,341	5	2,107	15	1,322	48	1,752	8	6,522	76

a/ Selected survey conditions are the following Beaufort sea state and visibility combinations: 0 EX, OVG, 0 GO, 1 EX. 1 VG. 1 GO, and 2 VG.
b/ Effort in nautical miles.
c/ Dashes signify no data.

Table B-4. Number of sea otter pups observed by 20 minute segments of longitude in the Shumagin Planning Area under selected survey conditions, March-October 1986.[a/]

Longitude	Survey 1		Survey 2		Survey 3		Survey 4		Total	
	Effort[b/]	Pups	Effort	Pups	Effort	Pups	Effort	Pups	Effort	Pups
161″00′-161°19′	36	0	185	2	0	--[c1]	0	--	221	2
161°20′-161039′	40	0	209	3	0	--	0	--	249	3
161°40′-161059′	171	3	180	6	0	--	148	1	499	10
162°00′-162019′	228	3	74	0	0	--	189	4	491	7
162°20′-162039′	224	2	89	3	22	0	321	5	656	10
162″40′-162°59′	141	0	220	0	40	1	94	1	495	2
163°00′-163019′	124	0	132	4	9	0	212	2	477	6
163″20′-165°00′	47	0	153	0	2	0	57	0	259	0
Total	1,011	8	1,242	18	73	1	1,021	13	3,447	40

a/ Selected survey conditions are the following Beaufort sea state and visibility combinations: OEX, OVG, OGO, 1 EX, 1 VG, 1 GO, and 2VG.

b/ Effort in nautical miles.

c/ Dashes signify no data.

Table B-5. Number of sea otter pups observed in various depth cla ses in the North Aleutian Planning Area under selected survey conditions, March-October 1986.[a/]

Depth Class (fro)	Survey 1		Survey 2		Survey 3		Survey 4		Total	
	Effort (rim)	Pups	Effort (rim)	Pups	Effort (rim)	Pups	Effort (rim)	Pups	Effort (rim)	Pups
0-11 (0-20 m)	634	0	747	5	474	28	513	4	2,368	37
12-22 (21-40 m)	377	3	629	6	315	5	554	3	1,875	17
23-33 (41-60 m)	210	1	663	4	445	15	583	1	1,901	21
>33(>60 m)	124	1	68	0	88	0	110	0	390	1
Total	1,345	5	2,107	15	1,322	48	1,760	8	6,534	76

a/ Selected survey conditions are the following Beaufort sea state and visibility combinations: OEX, OVG, OGO, 1 EX, 1 VG, 1 GO, and 2 VG.

8221a

Table B-6. Numbers of sea otter rafts (groups > 10 individuals) anti numbers of individuals comprising rafts observed in the North Aleutian Planning Area under selected survey-conditions, March - October 1986.[a/]

Longitude	Survey 1 Effort[b/]	Survey 1 Rafts No.	Survey 1 Rafts Ind.	Survey 2 Effort	Survey 2 Rafts No.	Survey 2 Rafts Ind.	Survey 3 Effort	Survey 3 Rafts No.	Survey 3 Rafts Ind.	Survey 4 Effort	Survey 4 Rafts No.	Survey 4 Rafts Ind.	Total Effort	Total Rafts No.	Total Rafts Ind.
Area B															
158″40′-160″19′	32	0	0	24	0	0	0	--	--	0	--	--	56	n	0
160°20′-160039′	71	0	0	142	0	0	0	--	--	211	0	0	424	0	0
160°40′-160059′	41	0	0	238	1	14	46	0	0	174	0	0	499	1	14
161°00′-161019′	4	0	0	235	0	0	133	1	15	98	0	0	470	1	15
161°20′-161039′	0	--[c/]	- ·	251	1	12	81	0	0	86	0	0	418	1	12
161°40′-161059′	0	--	--	112	0	0	0	--	--	83	0	0	195	0	0
Subtotal	148	0	0	1,002	2	26	260	1	15	652	0	0	2,062	3	41
Area A															
162″00′-162°19′	36	1	25	177	0	0	0	--	--	101	0	0	314	1	25
162°20′-162039′	138	5	117	307	24	604	118	2	28	273	12	217	836	43	966
162″40′-162°59′	142	0	0	154	1	12	176	0	0	190	1	25	662	2	37
163″00′-163°19′	330	8	152	63	2	35	172	0	0	101	0	0	666	10	187
163″20′-163°39	303	3	50	94	0	0	228	2	36	373	6	134	998	11	220
163°40’-163059’	182	0	0	120	1	10	119	1	15	27	0	0	448	2	25
164°00’-164019’	51	0	0	126	0	0	195	8	184	35	0	0	407	8	184
164°20’-164059’	11	0	0	64	0	0	54	0	0	0	--	--	129	0	0
Subtotal	1,193	17	344	1,105	28	661	1,062	13	263	1,100	19	376	4,46o	77	1,644
Total	1,341	17	344	2,107	30	687	1,322	14	278	1,752	19	376	6,522	80	1,685

a/ Selected survey conditions are the following Beaufort sea state and visibility combinations: O EX, 0 VG, OGO, 1 EX, 1 VG, 1 GO, and 2 VG.
b/ Effort in nautical miles.
c/ Dashes signify no data.

Table B-7. Numbers of sea otter rafts (groups ≥ 10 individuals) and numbers of individuals comprising the rafts observed in the Shumagin Planning Area (excluding island surveys) under selected survey conditions, March - October 1986.[a/]

Longitude	Survey 1			Survey 2			Survey 3			Survey 4			Total		
	Effort[b/]	Rafts No.	Rafts Ind.	Effort	Rafts No.	Rafts Ind.	Effort	Rafts No.	Rafts Ind.	Effort	Rafts No.	Rafts Ind.	Effort	Rafts No.	Rafts Ind.
161″00′-161°19′	36	0	0	185	3	62	0	--[c/]	--	0	--	--	221	3	62
161°20′-161″39′	40	0	0	209	5	64	0	--	--	0	--	--	249	5	64
161″40′-161°59′	171	3	60	180	2	25	0	--	--	148	3	55	499	8	140
162°00′-162″19′	228	0	0	74	0	0	0	--	--	189	3	43	491	3	43
162″20′-162″39′	224	13	272	89	4	65	22	0	0	321	11	258	656	28	595
162°40′-162059′	141	1	10	220	6	99	40	0	0	94	0	0	495	7	109
163°00′-163″19′	124	7	129	132	6	127	9	0	0	212	2	43	477	15	299
163°20′-165″00′	47	0	0	153	0	0	2	0	0	57	0	0	259	0	0
Total	1,011	24	471	1,242	26	442	73	0	0	1,021	19	399	3,447	69	1,312

a/ Selected survey conditions are the following Beaufort sea state and visibility combinations: 0 EX, OVG, 0 GO, 1 EX, 1 VG, 1 GO, and 2 VG.

b/ Effort in nautical miles.

c/ Dashes signify no data.

8221a

Table B-8. Numbers of sea otter rafts (groups ≥ 10 individuals) and numbers of individuals comprising the rafts observed in the North Aleutian Planning Area under selected survey conditions, March - October 1986.[a/]

Depth Class (fro)	Survey 1			Survey 2			Survey 3			Survey 4			Total		
	Effort (rim)	Rafts No.	Rafts Ind.	Effort (nm)	Rafts No.	Rafts Ind.	Effort (nm)	Rafts No.	Rafts Ind.	Effort (nm)	Rafts No.	Rafts Ind.	Effort (nm)	Rafts No.	Rafts Ind.
0-11 (0-20 m)	634	9	175	747	11	274	474	6	94	513	9	189	2,368	35	732
12-22 (21-40 m)	377	6	142	629	18	403	315	1	70	554	10	187	1,875	35	802
23-33 (41-60 m)	210	2	27	663	1	10	445	7	114	583	0	0	1,901	10	151
> 32 (> 60 m)	0	0	0	68	0	0	88	0	0	110	0	0	390	0	0
Total	1,345	17	344	2,107	30	687	1,322	14	278	1,760	19	376	6,534	80	1,685

a/ Selected survey conditions are the following Beaufort sea state and visibility combinations: 0 EX, 0 VG, 0 GO, 1 EX, 1 VG, 1 GO, and 2 VG.

8221a

APPENDIX C

OTHER MARINE MAMMALS

This section summarizes the relative abundance, distribution among planning areas, and period of occupancy of marine mammal species other than sea otters. Population estimates or detailed analyses were not developed for these species, since they were recorded incidentally to counts of sea otters. Moreover, the number of observations were generally too small to permit more than a general summary. Eight species of marine mammals were observed during the four survey periods in addition to the sea otter (Table C-l).

There were five cetacean and three pinniped species observed during the surveys. The cetaceans included 124 groups of 195 animals represented by 89 harbor porpoises, 46 Dan's porpoises, 22 gray whales, 11 killer whales, 9 minke whales, and 18 unidentified cetaceans. The pinnipeds included 1,205 groups of 23,320 animals represented by 18,825 northern sea lions, 4,491 harbor seals, and 4 northern fur seals. Species composition and relative abundance were generally highest during the midsummer survey when effort was greatest. The only endangered species encountered was the gray whale.

Use of the three planning areas by these species was variable (Table C-l). Species composition was highest in the North Aleutian Basin, lowest in the St. George Basin, and intermediate in the Shumagin planning areas. All eight species were observed in the North Aleutian Basin, whereas all species but the killer whale, Dan's porpoise, and northern fur seal were observed in the Shumagin area. Only the Dan's porpoise, northern sea lion, and harbor seal were recorded in the St. George Basin. The northern sea lion and harbor seal were the only species observed in all three planning areas. Relative abundance of the eight species among the planning areas followed a similar pattern as composition, except for the northern sea lion which was most abundant in the Shumagin Planning Area. The observed difference in marine mammal use among the planning areas were partly attributable to

Table C-1. Species composition and number of other marine mammals observed in the three planning areas, March-October 1986.

Species	North Aleutian Basin (9,020 nm)[a/] Individuals	North Aleutian Basin (9,020 nm)[a/] Groups	Shumagin (8,099 nm) Individuals	Shumagin (8,099 nm) Groups	St. George Basin (704 nm) Individuals	St. George Basin (704 nm) Groups	Total (17,823 nm) Individuals	Total (17,823 nm) Groups
Cetacea								
Mysticeti								
Minke whale (*Balaenoptera acutorostrata*)	5 (1)[b/]	5(1)	0 (3)	0 (3)	0	0	5 (4)	5 (4)
Gray whale (*Eschrichtius robustus*)	7 (9)	7 (7)	5 (1)	2 (1)	0	0	12 (lo)	9 (8)
Identified baleen	8 (1)	8(1)	1	1	0	0	9(1)	9 (1)
Odontoceti								
Killer whale (*Orcinus orca*)	11	4	0	0	0	0	11	4
Harbor porpoise (*Phocoena phocoena*)	71	38	18	13	0	0	89	51
Dall's porpoise (*Phocoenoides dalli*)	42 (2)	25 (1)	0	0	2	2	44 (2)	27 (1)
Unidentified porpoise	8	5	0	0	0	0	8	5
Subtotal	152 (13)	92 (10)	24 (4)	16 (4)	2	2	178 (17)	110 (14)
Pinnipedia								
Otariidae								
Northern sea lion (*Eumetopias jubatus*)	5,183 (405)	192 (12)	4,983 (4,601)	293 (32)	3,653	171	13,819 (5,006)	656 (44)
Northern fur seal (*Call orhinus ursinus*)	4	4	0	0	0	0	4	4
Phocidae								
Harbor seal (*Phoca vitulina*)	2,360 (572)	151 (14)	1,016 (1)	206 (1)	542	129	3,918 (573)	486 (15)
Subtotal	7,547 (977		347 (26)999 (4,602)	499 (33)	4,195	300	17.741 (5,579)	1,146 (59)
TOTAL	7,699 (990)	439 (36)	6,023 (4,606)	515 (37)	4,197	302	17,919 (5,596)	1,256 (73)

a/ Effort.

b/ Additional number or groups of animals on deadhead survey tracklines.

survey effort which was highest (9,020 nm) in the North Aleutian Basin, lowest (704 nm) in the St. George Basin, and intermediate (8,099 nm) in the Shumagin area. The relatively high abundance of sea lions in the Shumagin Planning Area was probably due to the prevalence of islands for use as haul out sites.

The frequency that the eight species were observed during the four survey periods was variable (Tables C-2, C-3, C-4, C-5). Three species were encountered during all four periods, four during three periods, and one during two periods. The harbor porpoise, northern sea lion, and harbor seal were recorded each period, confirming these species were resident from early spring to late fall. The pattern of temporal use was similar between the North Aleutian Basin and Shumagin area. The gray, minke, and killer whales, and Dan's porpoise were recorded during three periods, suggesting these species were also resident. Smaller numbers of these species probably contributed to having one period with no observations as well as fewer corroborating patterns of occurrence among planning areas. Low numbers of gray whales appeared to summer in the nearshore areas of the North Aleutian Basin and Shumagin area as also reported by Brueggeman et al. (1987) in these areas during 1985. Lastly, fur seals were observed during two periods in March and October which approximately corresponds to the migration period to and from the Pribilof Islands. These results show that the study area provides important feeding areas and migration corridors for these species.

Table C-2. Species composition and number of other marine mammals observed in the three planning areas, March 1986.

Species	North Aleutian Basin (1,966 nm)[a]		Shumagin (3,162 nm)		St. George Basin (0 nm)		Total (5,128 nm)	
	Individuals	Groups	Individuals	Groups	Individuals	Groups	Individuals	Groups
Cetacea								
Mysticeti								
Gray whale (*Eschrichtius robustus*)	1	1	4	1	---[b]	---	5	2
Odontoceti								
Killer whale (*Orcinus orca*)	3	1	0	0	---	---	3	1
Harbor porpoise (*Phocoena phocoena*)	34	12	8	5	---	---	42	17
Subtotal	38	14	12	6	---	---	50	20
Pinnipedia								
Otariidae								
Northern sea lion (*Eumetopias jubatus*)	2,088	92	1,791	111	---	---	3,879	203
Northern fur seal (*Callorhinus ursinus*)	1	1	0	0	---	---	1	1
Phocidae								
Harbor seal (*Phoca vitulina*)	6	5	248	67	---	---	254	72
Subtotal	2,095	98	2,039	178	---	---	4,134	276
TOTAL	2,133	112	2,051	184	---	---	4,184	296

a/ Effort.

b/ Not surveyed.

Table C-3. Species composition and number of other marine mammals observed in the three planning areas, June-July 1986.

Species	North Aleutian Basin (2,969 nm)[a/]		Shumagin (2,607 nm)		St. George Basin (704 nm)		Total (6,280 nm)	
	Individuals	Groups	Individuals	Groups	Individuals	Groups	Individuals	Groups
Cetacea								
Mysticeti								
Minke whale (Balaenoptera acutorostrata)	3 (1)[b/]	3 (1)	0	0	0	0	3 (1)	3 (1)
Gray whale (Eschrichtius robustus)	4 (9)	4 (7)	1 (1)	1 (1)	0	0	5 (lo)	5 (R)
Unidentified baleen	6 (1)	6(1)	1	1	0	0	7(1)	7 (1)
Odontoceti								
Killer whale (Orcinus orca)	3	1	0	0	0	0	3	1
Harbor porpoise (Phocoena phocoena)	27	18	2	2	0	0	29	20
DalI's porpoise (Phocoenoides dalli)	39 (2)	23 (1)	0	0	2	2	41 (2)	25 (1)
Unidentified porpoise	8	5	0	0	0	0	8	5
Subtotal	90 (13)	60 (10)	4(1)	4(1)	2	2	96 (14)	66 (11)
Pinnipedia								
Otariidae								
Northern sea lion (Eumetopias jubatus)	119 (405)	50 (12)	2,943 4,601)	121 (32)	3,653	171	6,715 (5,006)	342 (44)
Phocidae								
Harbor seal (Phoca vitulina)	1,547 (572)	78 (14)	594 1)	86 (1)	542	129	2,683 (573)	293 (15)
Subtotal	1,666 (977)	128 (26)	3,537 (4,602)	207 (33)	4,195	300	9,398 (5.579)	635 (59)
TOTAL	1,756 (990)	188 (36)	3,541 (4,603)	211 (34)	4,197	302	9,494 (5,593)	701 (70)

a/ Effort.

b/ Additional number or groups of animals on deadhead survey tracklines.

Table C-4. Species composition and number of other marine mammals observed in the three planning areas, August 1986.

Species	North Aleutian Basin (1,790 nm)[a/]		Shumagin (1,013 nm)		St. George Basin (0 nm)		Total (2,803 nm)	
	Individuals	Groups	Individuals	Groups	Individuals	Groups	Individuals	Groups
Cetacea								
Mysticeti								
Minke whale (*Balaenoptera acutorostrata*)	1	1	0	0	---[b/]	---	1	1
Gray whale (*Eschrichtius robustus*)	2	2	0	0	---	---	2	2
Odontoceti								
Harbor porpoise (*Phocoena phocoena*)	3	3	0	0	---	---	3	3
Dall's porpoise (*Phocoenoides dalli*)	2	1	0	0	---	---	2	1
Subtotal	8	7	0	0	---	---	8	7
Pinnipedia								
Otariidae								
Northern sea lion (*Eumetopias jubatus*)	1,178	26	230	49	---	---	1,408	75
Phocidae								
Harbor seal (*Phoca vitulina*)	703	34	160	45	---	---	863	79
Subtotal	1,881	60	390	94	---	---	2,271	154
TOTAL	1,889	67	390	94	---	---	2,279	161

a/ Effort.

b/ Not surveyed.

Table C-5. Species composition and number of other marine mammals observed in the three planning areas, October 1986.

Species	North Aleutian Basin (2,295nm) [a/]		Shumagin (1,317 nm)		St. George Basin (0 nm)		Total (3,612 nm)	
	Individuals	Groups	Individuals	Groups	Individuals	Groups	Individuals	Groups
Cetacea								
Mysticeti								
Minke whale (Balaenoptera acutorostrata)	1	1	0 (3)[b/]	0 (3)	---[c/]	---	1 (3)	1 (3)
Unidentified baleen	2	2	0	0	---	---	2	2
Odontoceti								
Killer whale (Orcinus orca)	5	2	0	0	---	---	5	2
Harbor porpoise (Phocoena phocoena)	7	5	8	6	---	---	15	11
Dan's porpoise (Phocoenoides dalli)	1	1	0	0	---	---	1	1
Subtotal	16	11	8 (3)	6 (3)	---	---	24 (3)	17 (3)
Pinnipedia								
Otariidae								
Northern sea lion (Eumetopias jubatus)	1,798	24	19	12	---	---	1,817	36
Northern fur seal (Callorhinus ursinus)	3	3	0	0	---	---	3	3
Phocidae								
Harbor seal (Phoca vitulina)	104	34	14	8	---	---	118	42
Subtotal	1,905	61	33	20	---	---	1.938	81
TOTAL	1,921	72	41 (3)	26 (3)	---	---	1,962 (3)	98 (3)

a/ Effort.

b/ Additional number or groups of animals on deadhead survey tracklines.

c/ Not surveyed.