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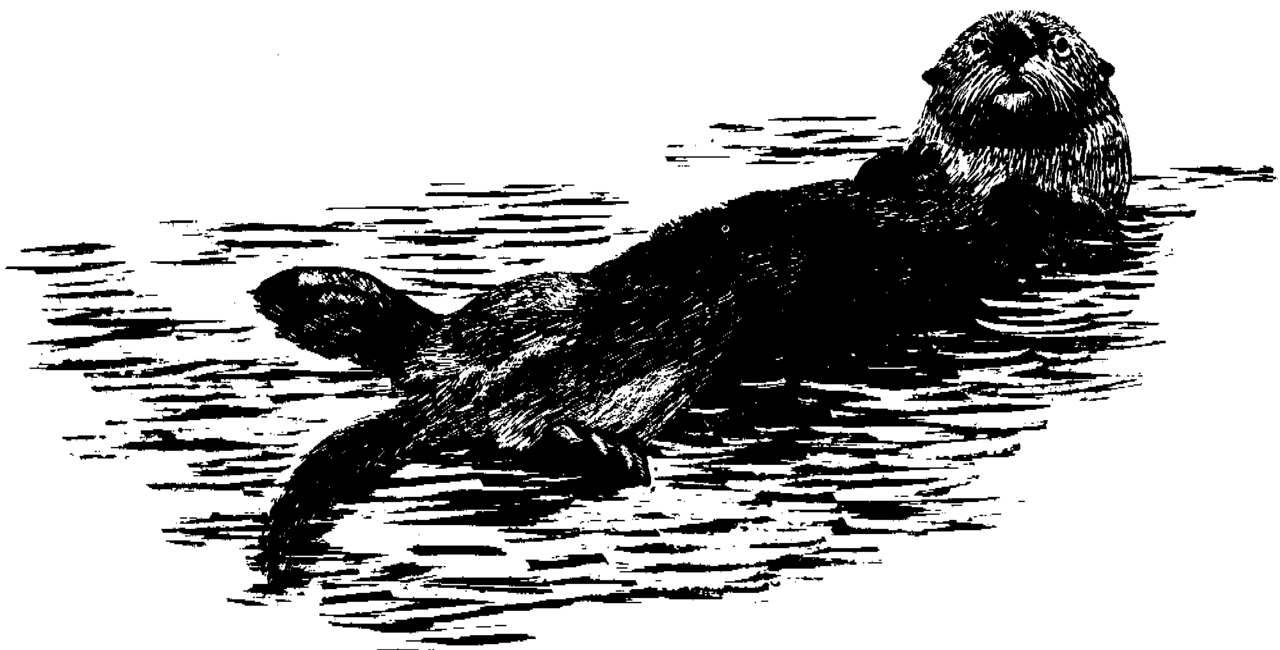
ALASKA DEPARTMENT OF FISH AND GAME
JUNEAU, ALASKA

SEX AND AGE SEGREGATION OF SEA OTTERS

By Karl B. Schneider



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Federal Aid in Wildlife Restoration
Projects W-17-4 through W-17-8
Job 8.9R

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Job Title: Sex and Age Segregation of Sea Otters

Period Covered: July 1, 1971 to June 30, 1976

SUMMARY

Knowledge of patterns of geographical segregation of sea otters by sex and age is essential to any active conservation and management program on that species. The sexes and ages of sea otters harvested or captured from several Alaskan populations were examined by specific location and season to determine patterns of segregation.

All populations contained large female areas where most adult females and dependent pups in the population were found. The number of sexually mature males over 5 years old in female areas fluctuated seasonally and was positively correlated with the number of estrous females. Sexually immature males between the ages of 1 and 6 years appeared to be actively excluded from female areas. Where high densities of sea otters were continuous and range expansion had ceased, many adult males and most immature males concentrated in geographically discrete male areas. Permanently established male areas did not exist in some populations where areas of high sea otter density were separated by areas of low density or where the population was expanding into vacant habitats. Areas of low sea otter density and the fringes of expanding concentrations appeared to function as male areas in these populations.

Topography, habitat quality, population density and male breeding behavior appeared to influence patterns of sex and age segregation. Segregation may influence survival, productivity, population composition and vulnerability to natural events and human activities.

CONTENTS

BACKGROUND

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

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

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

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

Wild and Ames (1974) found concentrations of males near fronts of the expanding California population and speculated that more traditional male areas existed in the center of the population.

An understanding of the degree of sexual segregation is important for the management of sea otter populations. During experimental harvests the Alaska Department of Fish and Game found it necessary to direct hunting effort to specific geographic areas to avoid exerting undue pressure on any segment of the population. Similarly, selective placement of nets was required to capture sea otters of the desired sex for transplants. Estes and Smith (1973) used their knowledge of sexual segregation to evaluate the effects of an underground nuclear explosion on the sea otter population of Amchitka Island. Such knowledge would be of equal importance in evaluating the effects of other localized disturbances. Oil spills killing the same number of sea otters could have varying impacts on a population if they occurred in areas supporting different segments of that population.

Portions of this report were presented in a paper titled Sex and Age Segregation in Alaskan Sea Otter Populations at the Second Conference on the Biology of Marine Mammals, San Diego.

OBJECTIVE

To determine the degree of geographical segregation of sex and age classes of sea otters.

PROCEDURES

A total of 2556 sea otters were collected by the Alaska Department of Fish and Game during an experimental harvest program conducted in the western Aleutian Islands between 1962 and 1971. Kenyon (1969) discussed the distribution by sex and age of 491 of these sea otters collected in 1962 and 1963. Sex, total curvilinear length, weight and collection location were recorded for each sea otter collected. Ages of most of the animals collected after 1963 were estimated on the basis of tooth cementum layers or skull characteristics (Schneider 1973a). Reproductive tracts were collected from most females and examined for evidence of sexual maturity and stage of the annual reproductive cycle (Schneider 1972 and 1973b). A small sample of testes was collected in 1967, weighed and the epididimal fluid was examined for presence of sperm.

Location of capture, sex and weight of 1081 sea otters captured for transplant at Amchitka Island and Prince William Sound were recorded.

All sea otters captured or collected were classified as adults, subadults or pups, using the criteria presented in Table 1. Adults were defined as sexually mature animals, subadults as sexually immature animals not attended by a female and pups as all animals attended by a female.

Pups and independent sea otters (adults and subadults) were counted from shore, boat and helicopter at Amchitka Island, Kanaga Island, and Tanaga Island in the Aleutians and in Prince William Sound and Southeast Alaska.

FINDINGS

Most of the quantitative information for this and previous studies of geographical sex and age segregation in sea otters was obtained from Aleutian Island populations that had completely repopulated all immediately available habitat. In most cases these populations had already rapidly

Table 1. Criteria used for age classification of sea otters. Criteria numbered in order of preference of use. When possible #1 criteria were used. Number 2 criteria were used only when data on #1 criteria were not available and #3 criteria were used only when data on #1 and #2 criteria were not available.

Pups

1. Attended by a female.
2. Less than 1 year old.
3. Weighed less than 30 lb.

Subadults

1. Independent of mother but ovaries immature or testes weight. less than 13 g.
2. Females 1 to 3 years old
   Males 1 to 5 years old
3. Females - weighed 30 to 39 lb.
   Males - weighed 30 to 49 lb.

Adults

1. Ovaries mature or testes weight over 13 g.
2. Females over 4 years old.
   Males over 6 years old.
3. Females - weighed over 40 lb.
   Males - weighed over 50 lb.

increased, reached their peak and then declined to more moderate levels. Most appeared to be regulated by food availability. Therefore, the following discussion of male and female areas concerns populations that are at or near "carrying capacity" in high quality habitat and may not apply to other presently expanding populations.

Characteristics of Male Areas

Classical Aleutian male areas are usually small and very discrete. They tend to be located near exposed points of land where shallow water and kelp beds extend 4 to 12 km from shore. They often are found in shallow passes between major islands. Male areas rarely contain offshore rocks or islets that could provide significant shelter. They frequently have the roughest sea conditions in the vicinity, often experiencing large waves, strong currents and tide rips. Most include between 400 and 800 m of shoreline that contains hauling areas. The hauling areas are usually rocky beaches or intertidal rocks but occasionally include vegetated areas above the storm tide line. Male areas are usually 10 to 40 km apart and consequently include only a small fraction of the shoreline available to the population.

Sea otter densities are usually highest in male areas, suggesting that these areas are highly productive of sea otter food species. Male areas frequently contain favored hauling areas for harbor seals (*Phoca vitulina*).

The boundaries of male areas are very discrete and almost visible. The composition of sea otters caught in nets set 250 m from a representative male hauling area and only 100 m from the edge of the area frequented by males was typical of that for female areas, and only males were caught directly offshore from the hauling area. No transition zone adjacent to the male area was evident within 800 m of shore. Boundaries of male areas may be less discrete far offshore although depth contours would tend to confine the movements of males in many areas.

Characteristics of Female Areas

Female areas are much less discrete, larger and more variable than male areas. Kenyon (1969) used the term in conjunction with hauling areas favored by females. Collections of animals over large areas indicate that this term can be applied to any densely populated area that is not a male area. Where high quality sea otter habitat is continuous, female areas comprise the entire area between male areas.

Female areas generally are more protected from heavy seas than male areas are; often containing many offshore rocks and islets and bays. Nevertheless, many are exposed to the open ocean and receive heavy seas during storms. They may even include completely unprotected offshore portions of otter habitat.

There are many areas that do not clearly fit the concept of either male or female areas. Usually such areas support low densities of sea otters and casual observation indicates that they contain lower densities of sea otter food species as well. Often they contain large expanses of sandy bottom. Many of the sea otters using these areas appear to be transient. The areas are usually poorly defined and are situated adjacent to female areas. They probably represent the low end of a continuum in quality of sea otter habitat found outside of the very discrete male areas. Classical female areas would represent the other extreme of this continuum. There is evidence that the sex and age composition of sea otters varies with habitat characteristics. Therefore, it should be recognized that the term "female area" can not be as precisely defined as the term "male area."

In the following discussion "female area" means any portion of sea otter habitat which supports moderate to high otter densities but is not a male area. Areas of apparently marginal habitat supporting low densities of sea otters were not included.

Composition of Female Areas

Sex and age composition of sea otters collected or captured in female areas (Table 2) varied by season. Although samples are not strictly comparable (see footnotes in Table 2), it is evident that males older than pups occur in relatively low numbers throughout the year. If the highly biased June-August transplant samples are excluded, there appears to be a seasonal pattern of occurrence of adult males in female areas. Adult male:adult female ratios remained relatively stable at a low level from March through August then increased sharply in September and October and declined in mid winter.

There also appeared to be a seasonal pattern in the sex ratio of subadults in female areas, although this is confused by biases in two of the samples. At the time of the March-April collection the number of small pups normally would be low and this is about the time when many pups born the preceeding spring would be weaned. This is also the time of year when juvenile mortality is highest (Kenyon 1969) and likely many subadults were in poor condition. Because classification of pups and subadults in this sample was based exclusively on weights, many subadults may incorrectly have been classified as pups. The unbalanced sex ratio of "pups" lends validity to this explanation and indicates that more females than males were erroneously classified as pups. Perhaps this occurred because the criteria used did not allow for sexual dimorphism.

The June-August transplant sample was biased by the fact that the majority of animals were captured in an area that in effect was being overharvested. Proportionately more subadults were caught after the initial intensive trapping effort, indicating that younger age classes were more likely to immigrate from adjoining areas to fill vacant habitat.

This artificial modification of the age structure of sea otters in the capture area may also have influenced the sex ratio of subadults in that sample. Therefore, the apparent increase in the subadult male:subadult female ratio indicated in Table 2 may be exaggerated. Regardless, the May sample is believed to be comparable to the September-October sample. If this assumption is correct a seasonal change in the sex ratio of subadults in female areas does exist.

Table 2. Sex and age distribution of sea otters collected or captured in female areas - by season.

Months	Collection Method	Males			Females			Adult ♂ / 100 Adult ♀	Subadult ♂ / 100 Adult ♀
		Adults	Subadults	Pups	Adults	Subadults	Pups		
Jan-Feb	Harvest[1]	8	1	11	79	19	10	10.1	1.3
Mar-Apr	Harvest[1]	7	11	8[5]	118	29	36[5]	5.9	9.3[5]
May	Harvest[1]	29	8	29	433	38	31	6.7	1.8
Jun-Aug	Transplant[2]	69	45	20	328	105	22	21.0	13.7
June	Harvest[3]	2	0	9	50	8	18	4.0	0
Aug	Harvest[4]	1	0	0	18	1	0	5.6	0
Sep-Oct	Harvest[1]	114	6	48	415	127	40	27.5	1.4

1. Hunters tended to collect larger animals without pups - biased toward males
2. Age structure of area altered by overharvest. Highly mobile animals more likely to be caught - biased toward subadults and adult males
3. All animals shot indiscriminantly - relatively unbiased
4. Hunters attempted to collect males only
5. Separation of subadults and pups uncertain. Collection made near time of weaning and period of highest mortality.

Ages for most sea otters in the May and September-October samples were determined, permitting a more detailed comparison of the sex and age composition of sea otters in female areas at those times of the year (Figs. 1 and 2). The most striking characteristics of these sex and age distributions are the scarcity of males between the ages of 1 and 5 years and the seasonal variation in numbers of males 6 years old and older. Females between the ages of 1 and 4 in the May sample and 1 and 2 in the September-October sample were also poorly represented, but not to the same degree as young males. These scarcities can not be explained by hunter selectivity, because single animals were generally taken in favor of females with pups and pups. Consequently selectivity should have favored subadults of both sexes and adult males. Therefore, the low occurrence of subadults in the areas sampled is real and may be even more pronounced than indicated by the data (Figs. 1 and 2).

Composition of Male Areas

Kenyon (1969) found only two females among 102 sea otters collected in male areas during the 1962 and 1963 harvests. Information on the location of collection from the 1967-1970 harvests and transplants was often less precise. Although the samples suggested that more females occupied male areas, most of these probably came from adjacent female areas. Two of 30 sea otters known to have been collected or captured in male areas were females. General observations indicate that an insignificant number of females occupy male areas and that those that do tend to remain on the fringes and may be transient. Most appear to be subadults. Females with pups are rarely seen in male areas but they may occur immediately adjacent to them.

The lack of precision in recording location of collection makes it impossible to determine the age structure of sea otters in male areas from the available data. However, some insight is possible from examination of samples from areas that included male areas (Fig. 3). These samples came from male areas and immediately adjacent portions of female areas. The proportion collected in the male areas is unknown but interviews with the hunters indicated that a substantial percentage of the animals came from the male areas. The high percentages of males in the samples substantiate this.

The data in Fig. 3 do not permit determination of sex ratios or seasonal changes. Differences between the sex and age distributions in Fig. 3 and Figs. 1 and 2 should reflect the animals collected in male areas. The most important differences are the occurrence of substantial numbers of subadult males between the ages of 1 and 5 and the higher ratio of adult males to adult females in the Fig. 3 samples.

These differences indicate that male areas contain males of all ages except pups, which are known from field observation to rarely occur there.

Composition of Other Areas

Few data are available on the composition of sea otters in marginal areas that by definition are neither male nor female areas. Nevertheless,

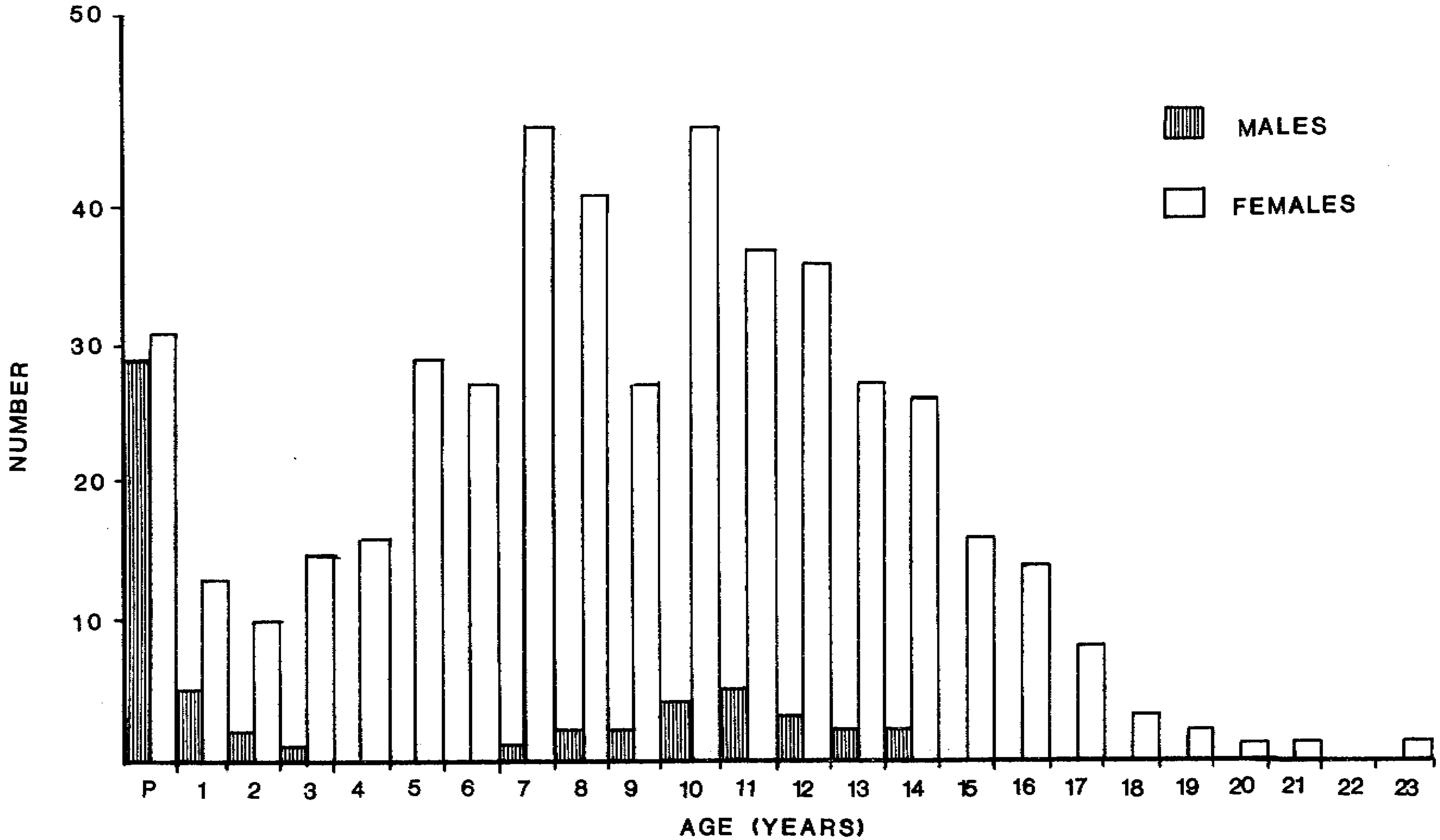

FIG. 1 SEX AND AGE COMPOSITION OF SEA OTTERS COLLECTED IN FEMALE AREAS - - MAY

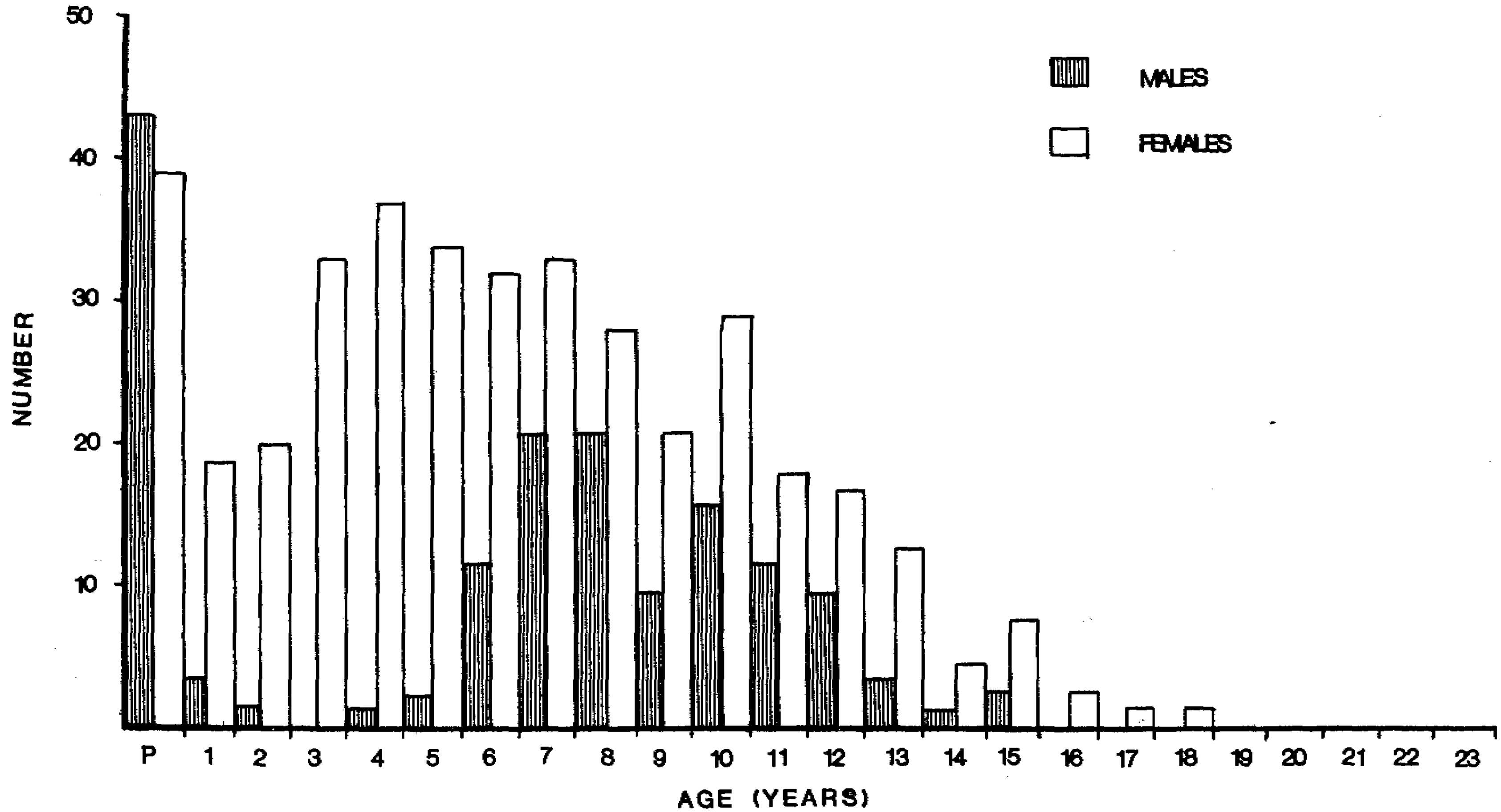

FIG. 2 SEX AND AGE COMPOSITION OF SEA OTTERS COLLECTED IN FEMALE AREAS - - SEPTEMBER-OCTOBER

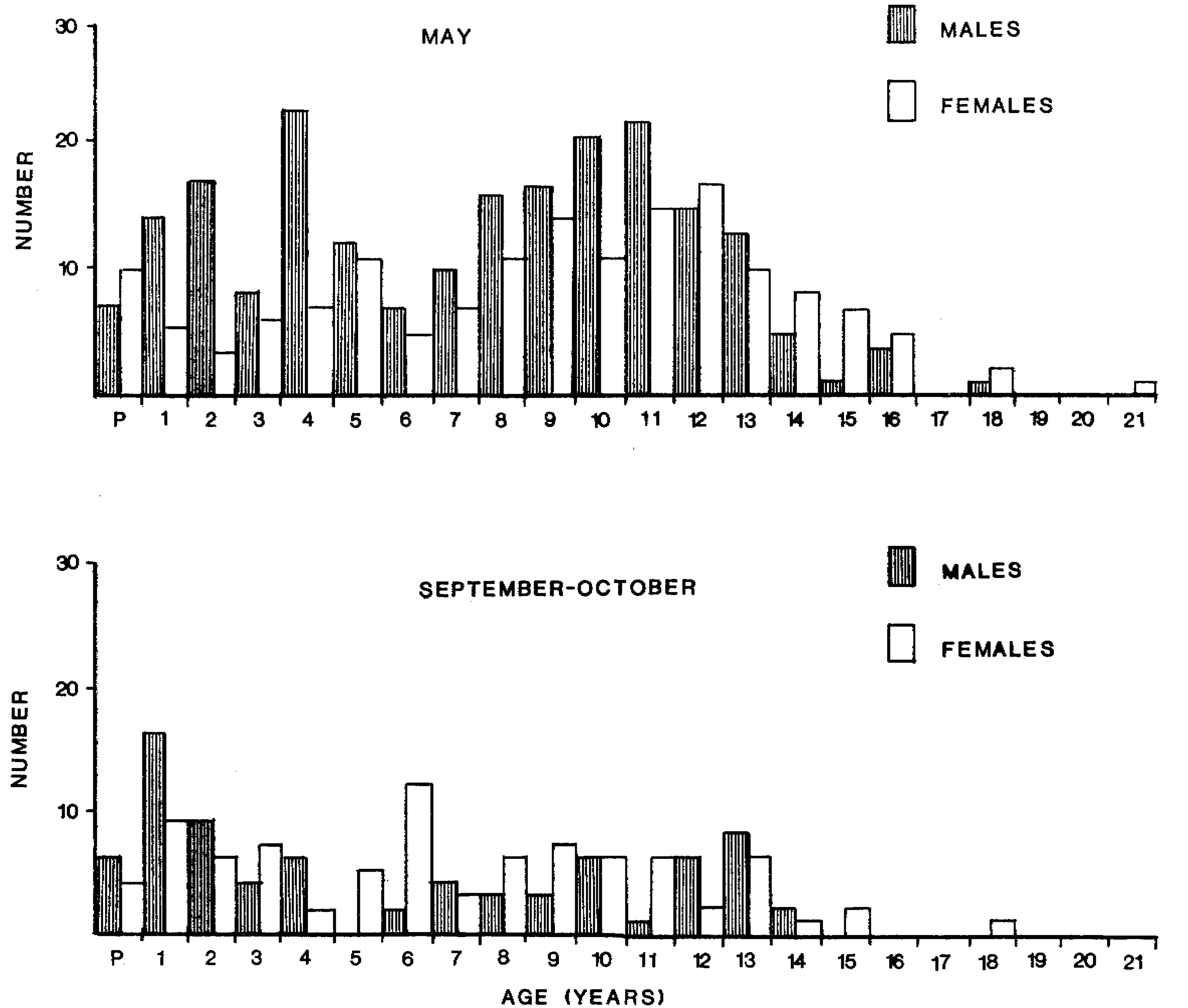

FIG. 3 SEX AND AGE COMPOSITION OF SEA OTTERS COLLECTED IN AREAS CONTAINING BOTH MALE AND FEMALE AREAS

observations and limited collecting indicate that subadults are predominant and that many are males.

In summary, female areas contain females of all ages, although subadult females are there in smaller numbers than would be expected in the population as a whole. Pups of both sexes are present in approximately equal numbers. Subadult males between the ages of 1 and 5 years occur in very small numbers in female areas, perhaps as transients. The number of males over 6 years old fluctuates seasonally (reaching a peak in fall) but is always lower than the number of adult females.

Male areas contain males of all ages over 1 year, with high proportions of subadults. Females occur only occasionally in male areas and those that are found there are usually subadults.

Data on the proportions of each sex and age class in various areas are inadequate. However, it appears that virtually all sexually mature females and all pups are in female areas at all times of year. Adult males occur in both male areas and female areas, with regular seasonal shifts between areas. Most subadult males occur in male areas although some occur in marginal habitat not frequented by adult females and small numbers occur in female areas perhaps as transients. The location of subadult females is less clear but many are in female areas. The remainder probably occupy the periphery of female areas, perhaps spending considerable time offshore or in pockets of less desirable habitat not favored by adult females.

Sex and Age Segregation in Non-Aleutian Areas

Although some form of sex and age segregation seems to occur in all sea otter populations, classical male areas have only been described in the western Aleutian Islands and Commander Islands. Few other areas have been studied in detail but the available data indicate that sex and age segregation is not always manifested in the same manner.

Wild and Ames (1974) described male areas at or near the fringes of the expanding California populations. Similar concentrations of males have been found or suspected to exist in most expanding Alaskan populations. I have not considered these classical male areas as they are usually temporary. They likely serve the same function, however. Wild and Ames (1974) described female areas that appeared similar to those in the Aleutians but they had no data that would indicate whether male areas existed in the center of the population.

Through transplant captures, pup/adult counts and field observation we have collected enough information to examine sex and age segregation in Prince William Sound populations (Table 3). In most respects this composition is similar to that found in Aleutian female areas; numerous adult females, few subadult males, pups of both sexes, etc. The most striking difference is the relatively high ratio of adult males to adult females. Both areas have been carefully examined by field observation and review of the composition of sea otters caught in each net location. No concentrations of males could be found within the capture areas, and both areas can be considered true female areas.

The high proportion of adult males may reflect, in part, the sampling procedures used. Data presented in Table 2 indicate that our transplant capturing technique took a higher percentage of adult males than our harvest techniques. This would partly be due to rapid replacement of captured males and the longer duration of most capture operations. However, this would not explain completely, differences between transplant samples from the Aleutians and Prince William Sound. The Aleutian operations lasted longer and one of the highest adult male:adult female ratios was obtained during the 1970 Prince William Sound operation which lasted only 3 days. Habitat differences might have contributed to the difference. Males are more mobile than females making them more vulnerable to stationary nets. Most sea otters were caught near resting areas or along travel routes. The geography of both Prince William Sound areas made trapping along travel routes particularly effective and the two highest male:female ratios (Table 3) were obtained when this technique was used extensively.

It does not seem likely that these capturing technique biases could account for the entire difference between Aleutian and Prince William Sound transplant capture samples. The possibility that a real difference exists in the proportion of adult males in female areas during summer should be considered. Possible reasons for this difference will be discussed later.

Even if more males in Prince William Sound are in female areas most subadult males and some adult males must be somewhere else. A search for male areas was conducted during two helicopter surveys, a boat survey and numerous informal aerial and boat surveys conducted during other activities. The entire shoreline of Prince William Sound was covered. Knight, Latouche, Evans, Elrington, Bainbridge, Montague, Green and Hinchinbrook Islands, Applegate Rock and Simpson, Sheep and Gravina Bays have been covered particularly thoroughly. Only one area having the characteristics of a male area (high densities of sea otters but no pups) was located. This was in the Sheep and Gravina Bay area. The presence of many males in this area has been confirmed by Ancel Johnson (pers. comm.) through field observation and limited capturing. However, this area is characteristic of an expanding fringe of a large population rather than a classical permanent male area. Sea otters first appeared there regularly in the late 1960's, and a rapid increase has been documented since 1970 (Pitcher 1975, Ancel Johnson pers. comm.). During the past year several hundred have moved into the Port Fidalgo-Bligh Island area further demonstrating that this is an area of range expansion.

The only other portion of Prince William Sound that could contain a large concentration of males is the area south of Hinchinbrook and Hawkins Islands. This too is an area of range expansion. There are also extensive areas of perhaps poor quality habitat where sea otter densities are low and few females with pups are seen. Subadult males might use these areas much as they do the much smaller pockets of marginal habitat found in the Aleutian Islands. The evidence strongly supports the conclusion that permanent classical male areas of the type found in the western Aleutian Islands do not exist in Prince William Sound at the present time. Instead subadult males either move to sparsely populated

Table 3. Sex and age distribution of sea otters captured in Prince William Sound.

	Males			Females			Unknown	Adult ♂ /	Subadult ♂ /
Month-Year	Adults	Subadults	Pups	Adults	Subadults	Pups	Pups	100 Adult ♀	100 Adult ♀
Green I. - Port Chalmers									
August 1966	13	0	2	19	2	1	0	68	0
July 1970	12	2	2	17	9	3	2	71	11.8
July 1972	13	1	6	29	3	6	2	45	3.4
Total	38	3	10	65	14	10	4	58	4.6
Port Etches									
August 1965	14	0	2	19	3	3	1	74	0
Total Both Areas									
	52	3	12	84	17	13	5	62	3.6

areas or to the fringes of the population.

We have had the opportunity to observe the early stages of sexual segregation in transplanted sea otter populations in Southeast Alaska. More casual observations indicate that a similar pattern has occurred in naturally occurring populations of the same size such as those in the eastern Aleutian Islands.

Between 1965 and 1969 a total of 412 sea otters were released at various locations in Southeast Alaska. Small groups soon became established at several locations including Khaz Bay on Chichagof Island and Surge Bay on Yakobi Island. It appears that many of the otters scattered after release then gradually joined these concentrations. As a result the groups grew more rapidly than possible through reproduction alone.

At first no particular population structure was evident, although females with pups appeared to favor certain locations. When the populations reached 30 to 40 countable animals (1969-1970) a definite structure was noticed. Most of the otters concentrated in very small areas, often forming pods of 20 or more animals. Most feeding activity occurred very close to these resting areas. These groups contained most of the females with pups and appeared to contain most of the adult females in the population. Several adult males were evident in and around these pods. Scattered individuals occurred within a few miles of the concentration. Most of these were adult males or subadults of unknown sex.

Neither area was surveyed between 1972 and 1974. By 1975 both populations had grown considerably, with a minimum of 100 otters at Khaz Bay and 250 at Surge Bay. At Khaz Bay the area south of Black Island formerly occupied by the concentration that included females with pups was inhabited by a concentration of single animals including at least some males. A new concentration containing 49 adults and subadults and 19 pups was found a short distance away in an area that had supported only scattered animals until 1971.

At Surge Bay the concentration containing females with pups remained in the same area in 1975 as in 1971. New podding areas containing females with pups were found and a pod of 110 sea otters with no pups was found a short distance away.

It appeared that each area had developed a concentration of animals that were predominately males, in effect a male area, adjacent to a concentration that included females, all of the pups and a few adult males, in effect a female area. Scattered animals, many of them subadults, occupied habitat adjacent to the concentrations.

In 1975 two other transplanted populations in the Maurelle Islands and at Coronation Island had structures similar to those at Khaz Bay and Surge Bay prior to 1971. Both had concentrations which included pups surrounded by scattered individuals some of which were males. No concentrations without pups were found. Another small population (21 sea otters counted in 1975) at the Barrier Islands appeared to be less structured.

All of the areas previously discussed have represented what is generally considered typical sea otter habitat, nearshore shallow areas that usually contain offshore rocks, islets and kelp beds. The distribution of sea otters in these areas appears to be strongly influenced by the configuration of the shoreline and offshore surface features. There are several other areas in Alaska with few surface features where sea otters lead a more pelagic existance. The most notable of these areas lies north of Unimak Island and the Alaska Peninsula. In this area an estimated 17,000 sea otters inhabit a 10,000 km^2 area of open water containing few surface features (Schneider 1976). These otters range over 50 km from shore, rarely haul out and use land for protection in only a few parts of their range. The distribution of the population appears fluid. At times several thousand have been seen within a few kilometers of shore while at other times most of the population is far offshore.

There is little definitive information on sex and age segregation in this and similar populations. In 1970 a total of 2,157 sea otters were counted in photographs of several pods clustered in one small area. No pups were visible in the photographs even though the resolution should have permitted identification of pups being held by their mothers. Substantial numbers of females with pups have been observed in other pods in or near the same area on other occasions. Segregation does appear to exist in this population, but there is a question as to whether geographically discrete male areas and female areas occur there.

Segregation by Reproductive Condition

It is evident even to the casual observer that some form of segregation occurs within female areas. Most obvious are the concentrations of females with pups that regularly occupy certain areas.

While harvesting around Tanaga Island in May 1970, a large number of pregnant females with large fetuses were collected at one time. Most of these came from a well protected area near Tidgituk Island. This raised the possibility that females may segregate according to reproductive condition. The numbers of females in each stage of the reproductive cycle around Tanaga Island are presented in Table 4 by area. More pregnant animals were collected near South Bay, and within that area most of the females with fetuses weighing over 100 g were collected near Tidgituk Island. This concentration also was evident in pup counts made in June 1968, when a very high percentage of pups was observed in the same area. Most females with large fetuses in May would have had pups by June. Marakov (1965) mentioned a bay on Medny Island that was preferred by pregnant females and females with pups.

Although there is no indication that all females go to specific areas to pup there may be a tendency for those nearing parturition or with young pups to move to areas that provide some degree of protection from storms.

The high number of resorptions found in animals taken between Cape Sudak and Twin Bays (Table 4) is probably a reflection of habitat quality rather than selection of an area by animals in a particular reproductive

Table 4. Reproductive Stage of Sexually Mature Sea Otters Harvested on Tanaga Island - By Area - May 1970.

Area	Nonpregnant	Unimplanted Pregnant		Implanted Pregnant		Fetus Weight Class*					Resorption	Total
		No.	%	No.	%	1	2	3	4	5		
Cape Sudak-Pendant Point	12	7	26	8	30	0	2	0	3	2	2	27
Barnes Point-Hot Springs Bay	12	7	24	10	36	3	0	1	4	2	2	29
Barnes Point-Trunk Point	11	6	25	7	29	0	3	1	3	0	2	24
Trunk Point-Twin Bays	7	9	39	7	30	2	1	1	1	2	2	23
Hazard Point-Twin Bays	4	3	27	4	36	0	0	1	1	2		11
Twin Bays-Herd Rock	12	8	28	9	31	1	1	1	4	2		29
Twin Bays-South Bay	2	9	45	9	45	3	0	1	1	4	1	20
South Bay-Lash Bay	6	9	29	16	51	1	0	0	9	6	1	31
South Bay-Harem Rock	17	14	31	14	31	2	0	1	5	6		45
Lash Bay-Inferno Reef	4	1	9	6	55	2	1	1	0	2		11
Harem Rock-Kulak Point	12	6	29	3	14	1	0	1	1	0		22
Kulak Point-S.E. Bight	13	9	28	10	31	2	0	1	2	5		32

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

Brackets indicate overlapping areas

condition.

Factors Influencing Sex and Age Segregation

No studies of the causes of sex and age segregation in sea otters have been conducted. Several factors that influence it can be suggested, however.

Adult females generally occupy densely populated areas which are presumably areas of high quality habitat. Classical male areas also support high densities of sea otters but they usually lack protected areas that might be favored by females with pups. Males and subadult females are more likely to occur in sparsely populated habitats that are probably of lower quality. Concentrations of males at expanding fronts are usually replaced by adult females as the population grows. This suggests that adult females are able to successfully compete with other sex and age classes for habitat that best suits their requirements.

When large numbers of sea otters were removed from the densely populated female areas between Crown Reefer Point and Ivakin Point at Amchitka Island in 1968, there was an increase in the ratio of subadult females to 100 adult females from 38 in 1968 (n=235) to an average of 62 over the next 3 years (n=149). Subsequent collecting in an adjacent area showed lower ratios than expected (12.5 subadult females/100 adult females). This indicates that subadult females are more likely to move into vacant niches than adult females, suggesting that they are less well established and are seeking space in more desirable habitat. This supports the view that subadult females tend to be excluded from dense female areas by some density related mechanism such as competition for food or space.

The distribution of males in the population appears to be regulated by a strong mechanism. The data show that males less than 6 years old, except dependent pups, are almost entirely exluded from female areas and that the number of older males fluctuates seasonally. These fluctuations coincide with fluctuations in the number of estrous females observed in the same samples (Schneider 1972 and 1973b), strongly suggesting that the presence of adult males in female areas is related to breeding activity. To examine this relationship, the distribution of conceptions was compared to the adult male:adult female ratio in female areas throughout the year (Fig. 4). The distribution of conceptions was estimated by backdating the distribution of births estimated from fetal weights by 7.5 months, (Schneider 1972) the estimated gestation period of sea otters (Schneider 1973b). Adult male:adult female ratios and conception rates based on all samples except that from June were adjusted for hunter bias under the assumption that hunters avoided approximately 15 percent of the animals because they were females accompanied by pups. This assumption was based on field counts made under conditions similar to those encountered by hunters. Although this adjustment brings the estimates closer to the actual compostion of the population it does not significantly affect conclusions drawn from the estimates.

There was a significant correlation between the adult male:adult female ratio and the estimated number of conceptions occurring in a

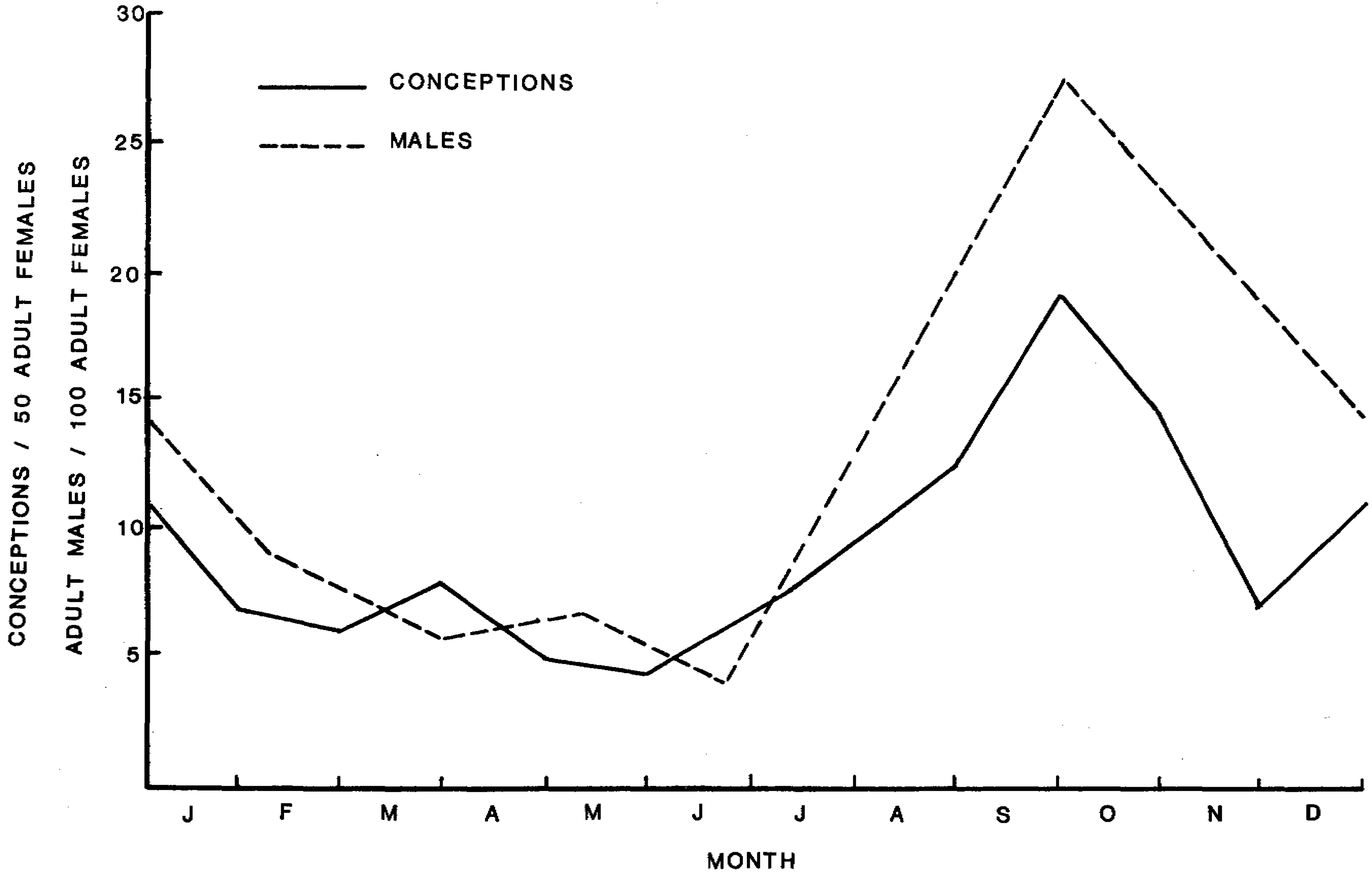

FIG. 4 COMPARISON OF NUMBER OF ADULT MALES IN FEMALE AREAS WITH NUMBER OF CONCEPTIONS

particular month ($r=0.947$, $P < 0.02$, $df=3$). The latter presumably reflects the number of females in estrus and the number of breeding encounters, even though some estrous females may not conceive and some resorptions occurred. The implication of this correlation and the age composition of males shown in Figs. 1 and 2 is that adult males are attracted to female areas by estrous females. It also appears that some mechanism which is influenced by the number of estrous females limits the density of adult males and tends to exclude younger males except those not yet weaned.

The most likely mechanism limiting the density and ages of male sea otters in female areas is territoriality. Territoriality in male sea otters has been documented (Vandevere 1970, Calkins and Lent 1975), however, many males seeking estrous females are highly mobile (Kenyon 1969). Mobile males in close proximity may in effect have moving territories. The geographical area influenced by these moving territories would be smaller when the male is engaged with a receptive female than when he is searching for one. As the density of estrous females increases males become less mobile and their area of influence is reduced. This would permit other, perhaps less dominant, males to enter the area increasing the density of adult males.

Kenyon (1969) observed no agonistic behavior in sea otters but Vandevere (1970) and Calkins and Lent (1975) reported active defense of geographically discrete territories. I have observed aggressive encounters between males in male areas and in captivity. Therefore, it appears that agonistic behavior does occur in the sea otter but it is not commonly observed. The degree of exclusion of sub adult and adult males not actively participating in breeding activities suggests that it is a strong force even if it is not always overtly displayed.

In the Aleutian populations studied, most males excluded from female areas concentrated in discrete, permanently established male areas while in the other populations studied they tended to scatter over large areas of sparsely populated, probably marginal, habitat or concentrated at the fringes of expanding populations. Although these differences could be related to inherent behavioral differences they more likely reflect the distribution of high quality habitat.

Those regions where classical male areas were not found were either adjacent to vacant or sparsely populated habitat or contained large areas of apparently poor quality habitat not favored by adult females. Classical male areas occurred only where high densities of sea otters were continuous and no vacant habitat was available nearby. Therefore it appear that non-breeding males will move to any habitat not occupied by high densities of adult females and territorial males. If such areas are not readily available they become concentrated in small areas which are less attractive to females.

Differing adult male:adult female ratios in animals caught in Prince William Sound and at Amchitka during summer are not easily explained. There is evidence, however, that the annual distribution of births in sea otters in California is different from that in Aleutian otters. Therefore it is possible that more females come into estrous in summer in Prince William Sound than do in the Aleutians. If this were the case, more males would occur in Prince William Sound female areas in summer but perhaps fewer would in fall.

The female areas studied in Prince William Sound did not support uniform densities of sea otters at all times, and frequent shifts in distribution were observed. At any given time portions of the area supported very low densities. It is possible that "surplus" males were able to remain in female areas by avoiding concentrations of females and subsequent encounters with actively breeding males. More subadults of both sexes would be expected in the samples if this occurred, however.

Mobility of an individual probably influenced susceptibility to capture. If for some reason Prince William Sound males were relatively more mobile than Amchitka males, more would have been caught.

In California some males rested in a male area and foraged in an adjacent female area (Shimek and Monk 1977) while other males remained in the female area for periods of at least 5 months (Loughlin 1976). It seems unlikely that such a pattern would occur where female areas are far from male areas, but this does illustrate another variation in the patterns of sex segregation. Studies of other areas, particularly detailed studies of small areas, will probably reveal other variations.

In summary, many factors probably influence patterns of sex and age segregation. Adult females and their pups appear to select habitat most suitable for their needs. Subadult females tend to be forced into adjacent habitat of lower quality perhaps through competition for food or space. These subadults are most likely to pioneer sparsely populated or uninhabited habitats. Sexually active adult males compete for space, although not necessarily a geographic territory, in female areas. Those males not able to successfully compete move to any available habitat away from concentrations of adult females or concentrate in discrete male areas. Competition for food, space and breeding opportunities is probably the primary cause of sex and age segregation. Geography, the distribution of food and population status are the most likely causes of differences in patterns of sex and age segregation between areas.

Implications of Sex and Age Segregation

The patterns of sex and age segregation observed have a number of implications for sea otter populations.

1. Survival Patterns

Segregation clearly could influence patterns of survival. If adult females were able to select habitat that best suited their needs it would enhance their chances for survival and the survival of their dependent pups. Subadult females forced into marginal habitat would tend to have higher mortality rates. Subadult males might be expected to have even higher mortality rates than females of the same age because they would have fewer options, being forced into marginal habitat or crowded male areas.

Survival of subadults of both sexes would be enhanced in expanding populations; they would be able to select better quality habitat not yet dominated by adult females. In fact, the majority of beach dead otters found in areas of expanding populatons are old animals while those found where populations have ceased to expand are mostly subadults and a disproportionate number are males (Kenyon 1969).

Effects of segregation on the survival of adult males are less obvious. Possibly those restricted to male areas would have different mortality rates than those inhabiting female areas.

Males occupying large areas of marginal habitat might also have different survival rates than those confined to discrete male areas. Certainly the vulnerability of the male segment to localized disturbances and habitat changes would differ between such areas.

2. Population Composition

The sex and age structure of the population would be strongly influenced by different survival rates among sex and age classes. Therefore, considerably different sex and age structures could occur among areas where segregation was expressed differently.

Because "surplus" males tend to die earlier or emigrate from the center of expanding populations where possible, the sex ratio of the core of most populations would tend to be skewed in favor of females. Although this has not been demonstrated quantitatively, crude calculations suggest that as many as 70 percent of the sea otters older than pups at Amchitka Island were females. More females than males are born in Aleutian sea otter populations (Schneider 1973b) and factors other than segregation might cause different survival rates for the sexes. Nevertheless, segregation could be a significant contributing factor.

3. Population Productivity

Patterns of sex and age segregation favor the survival of those animals contributing the most to the immediate reproducive effort of the population (adult females and possibly actively breeding males), altering the composition of the population in their favor. This should lead to increased production of pups. Because the survival of pups remaining under the care of their mothers would also be enhanced, the production of pups to the age of weaning would be maximized also.

Maximum production of pups to weaning age would be of little value when some population regulating factor such as food availability was limiting population growth. In such cases pups would suddenly enter the most vulnerable age classes and die in large numbers. However, the population would be able to respond immediately if the limiting factors were moderated. Therefore, a population could quickly recover after being depressed during a year of severe storms or even after catastrophic events such as oil spills.

This strategy would appear to be particularly effective in a long-lived species with a low reproductive rate such as the sea otter.

4. Range Expansion

Patterns of range expansion would tend to be influenced by segregation. Males and to a lesser extent subadult females would tend to move to the fringes of expanding populations where high quality habitat not dominated by adult females is available. Concentrations of males have been identified at the fringes of a number of expanding populations.

5. Male Reproduction

If males that are not actively breeding tend to be excluded from female areas, the age distribution of males shown in Figs. 1 and 2 should reflect the age structure of the male breeding component of the population. It appears that few males less than 6 years old actively breed. The fact that 6-to 8-year-olds were more abundant in fall during the peak breeding period could indicate that sea otters of these ages are less able to compete for space in female areas than older males, however, it may merely reflect sampling error.

Several questions are raised. Are males younger than 6 physically mature but unable to compete for places in female areas? Are all males in female areas actively breeding? Are sexually mature males fertile all year so a reservoir of potential breeding males is always available? Do some males remain in female areas all year or do all periodically return to male areas? These questions are important in assessing the importance of specific animals to the population. It is obvious that a surplus of males is produced in most populations. Some of this surplus is removed through increased mortality or emigration. What additional males can be removed without influencing the productivity of the population? Males in female areas appear to be playing an important immediate role. How much of a reservoir of males outside female areas is needed to meet peak breeding demands and replace active breeders removed from the population? Are all of the adult males in this reservoir capable of assuming an active breeding role at any time? If the age structure of males becomes skewed toward younger classes are younger males capable of assuming an active breeding role? In other words, how important are male areas?

Although only limited investigations into male reproduction have been made, Lensink (1962) found abundant sperm in all epididymides examined between February and August. Kenyon (1969) found that spermatozoa were produced when testes reached a weight of 13 to 14 g. All older males were actively producing sperm but two showed signs of lowered fertility. This suggested that males generally remained fertile after a certain age but raised the possibility of a mild periodicity in fertility. Ages of males in both of these studies were not precisely known and no comparison between those collected in male areas and those collected in female areas was made. However, both of Kenyon's males showing reduced fertility were collected in male areas.

Only a small number of testes were collected during this study, but because estimates of age were made, some new information was obtained. The epididymal fluid of 31 males was examined for the presence of sperm. Sperm was present in epididymides of all testes weighing more than 13 g and absent in all weighing less than 13 g. This confirmed Kenyon's (1969) findings that sexual maturity is attained when the testes reach 13 to 14 g. Although sample sizes in the younger age classes were small it appears when testes weights are plotted against age (Fig. 5), that most males become sexually mature around age 5 or 6 years.

The age distributions of males in female areas (Figs. 1 and 2) indicate that males do not become fully active breeders until a year or two after physiological maturity, although they may be active during the peak breeding period when more males enter female areas. This suggests that younger, sexually mature males may be excluded from female areas by purely behavioral mechanisms.

Unfortunately the testes of relatively few older males collected in male areas have been examined for presence of sperm. Three such animals in my samples were fertile, including one 11-year-old. The absence of infertile adult males in Lensink's (1962) Kenyon's (1969) and the present study indicates that any periodicity in male fertility is subdued.

These meager data indicate that a reservoir of fertile males exists outside of female areas even during the peak breeding period when these testes were collected. This reservoir is comprised in part of younger males but also contains older males.

A more comprehensive study of male reproductive activity and how this activity influences sex and age segregation is needed. At the present time it appears that a substantial surplus of males remains in the population even when higher mortality and emigration rates reduce their numbers. Sexually mature, fertile males are available to replace actively breeding males that might be removed from female areas. However, not all males outside of female areas are surplus. Some are needed to meet peak breeding demands and younger males are needed to provide recruitment to the pool of sexually mature animals. If a significant periodicity in fertility occurs it is likely that all males spend a portion of each year outside of female areas. Therefore, a reproductively functioning segment of the population would reside outside of female areas. The areas in which this segment reside, whether classical male areas, marginal habitat or even expanding fronts, are important if not critical to maintenance of the population.

6. Movements

Patterns of sex and age segregation and the forces that control these patterns probably strongly influence sea otter movements.

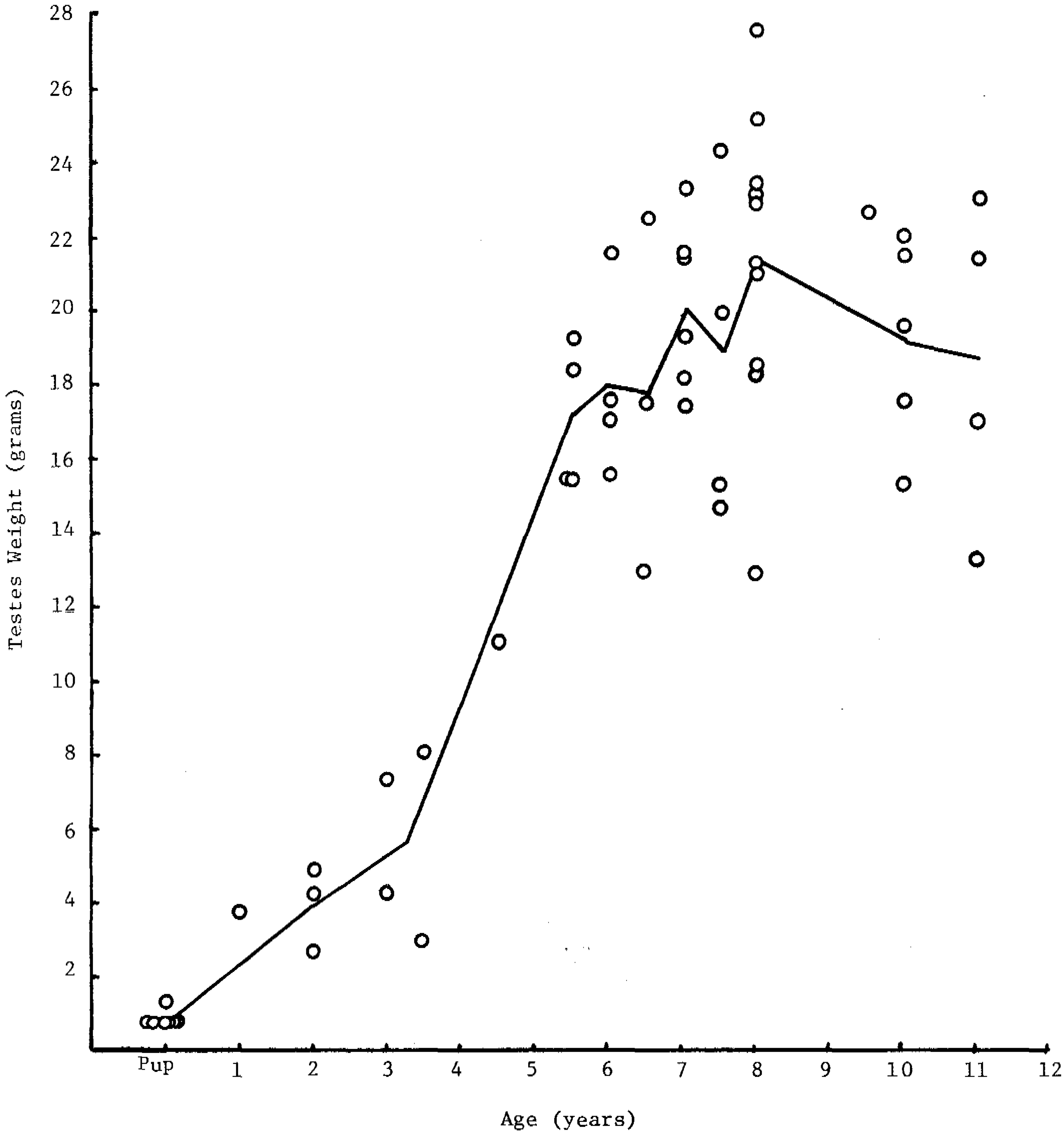

Figure 5. Weights of sea otter testes (epididymis removed).

The first comprehensive studies of movements have recently been initiated in California and Alaska. Consideration of sex and age segregation patterns will be necessary to interpret the results of these studies. Although the relationship between segregation and movement patterns will not be clear until several movement studies in different areas are completed, it is possible to suggest several general relationships that might be found.

Sea otters that are able to occupy favorable habitats would be expected to move less and be more consistent in their movement patterns than those seeking more desirable habitat. If this were true, adult females would be the most sedentary sex and age class. Dominant adult males would move less or at least more predictably than less dominant males which would be searching for breeding opportunities. Subadults of both sexes in populations near carrying capacity would be expected to actively search for more desirable habitat and would be more mobile and erratic in their movements.

It might be expected that subadult males would remain in male areas and move little until reaching sexual maturity. However, small numbers are found in female areas and they often appear in small pockets of little used, probably poor quality habitat for a few days then disappear. It is possible that these subadult males are transients unable to establish themselves in a specific area. If so, they may be the most mobile of all sex and age classes.

At least some adult males make seasonal movements between male and female areas in response to changing numbers of estrous females. Six male areas at Amchitka Island are separated by an average distance of 24 km and three areas at Tanaga Island are an average of 26.5 km apart. The longest known distance between male areas is 39 km between Sea Otter Point and Aleut Point at Amchitka Island. The two known male areas at Kanaga Island are over 60 km apart but it is possible that another exists between them. Therefore, some portions of female areas are almost 20 km from the nearest male area, and this would be the minimum distance that some males would be expected to travel seasonally. Many males likely travel further and may move from one male area to another. The degree of fidelity of males to a specific male area and a portion of a female area could influence movements.

Females, particularly adults, appear to avoid male areas. Therefore, male areas may serve as partial barriers to female movements. If so, the normal movements of females would tend to be confined. This could affect population recovery when the number of sea otters in a female area bounded by two male areas was seriously reduced, as occurred during the nuclear test "Cannikin" at Amchitka.

Subadult females are occasionally found in male areas indicating that male areas may be less of a barrier to them than to older females. When large numbers of sea otters were removed from the female areas east of the Crown Reefer Point male area at Amchitka Island, changes in the proportion of subadult females collected or captured on either side of the point indicated that a number of subadult females moved through this male area.

7. Vulnerability

The patterns of sex and age segregation strongly influence the vulnerability of a sea otter population to site-specific events, particularly catastrophic events such as oil spills. The sex and age composition of sea otters affected by similar events in different areas would vary greatly. The loss of 100 animals from a female area would probably have a greater and longer lasting impact on the population than the loss of 100 animals from a male area. Therefore some knowledge of segregation patterns is necessary for impact prediction and assessment.

In some cases of long term alteration or loss of habitat the patterns of segregation might change. For example, if a male area is lost it is possible that another would be formed accomodating the displaced males. This could in turn result in the displacement of females. Therefore the impact of an event may not always be predictable.

A major concern is that development of the marine environment might retard repopulation of vacant sea otter habitat. Sea otter populations usually build to high densities before range expansion occurs (Kenyon 1969). Maintenance of high densities near the fringes of expanding populations appears necessary for expansion to occur. Reduction of densities by an oil spill or similar event could prevent range expansion at least temporarily. Chronic pollution could have a long term effect.

In such cases it is natural to become most concerned about the concentration of sea otters at the edges of the population's range. However, these concentrations are often comprised of "surplus" males and perhaps some subadult females. Although these animals are contributing to the competition for food which probably strongly influences range expansion, they probably contribute little to the growth of the population. Therefore, the female areas behind the "expanding fronts" are probably more important than the fronts themselves.

CONCLUSIONS

Sex and age segregation occurs in all sea otter populations. The patterns of segregation vary among areas depending on a number of factors including the topography of the habitat, distribution and availability of food, densities of sea otters and status of the population. Patterns of segregation tend to be more rigid in areas where densities are high and the population is being naturally limited and less rigid where densities are low or the population is expanding. This variability makes it difficult to apply findings from one area to another, particularly when dealing with small areas in a heterogeneous environment. The basic causes of segregation appear to be common to all sea otter populations, however. This allows the formulation of some general statements that may be of value.

Two major causes of segregation appear to be competition for specific areas of habitat among all sea otters (food availaiblity may be the most important factor in that habitat) and competition for breeding opportunities among males. Adult females seem to be most successful in competing for space and tend to congregate in areas of highest quality habitat. This creates "female areas" which exist in one form or another in all sea otter populations. These female areas are well defined and easily recognized in areas of high sea otter densities and are poorly defined in areas of low densities.

Subadult females will attempt to maintain a place in the same areas of high quality habitat occupied by adult females. If sea otter densities are naturally limited by food, subadults may be unable to successfully compete with adult females and be forced into less desirable areas or into vacant range.

Males also attempt to occupy female areas probably for both better feeding and breeding opportunities found there. However, competition for breeding opportunities limits the number and age structure of males in these areas through territorial mechanisms. Where adult female densities are high, almost all subadult males and many adult males are excluded. The density of adult males in these areas may fluctuate in response to changes in numbers of estrous females.

Males that are excluded from female areas will seek opportunities to survive away from areas where competition with more dominant males is too great. The options open to these less dominant males vary greatly from area to area. This variation in options and the ways in which males exploit them contributes greatly to the differences in segregation patterns among areas.

When possible, surplus males will congregate in high quality habitat adjacent to a concentration of females. This occurs where populations are expanding into high quality range. If all of the highest quality habitat is occupied by females and more dominant males, they may occupy less desirable habitat in the immediate area. These areas vary greatly and often do not fit any commonly used definitions of male area or female area. Some males may migrate relatively long distances to the fringes of the population or beyond. When the above options are not available, e.g. in areas of continuous high density where there is no room for range expansion, males will congregate in small areas which may provide abundant food but provide little shelter and are less attractive to adult females than the surrounding areas. These are the classical "male areas" described in certain Aleutian populations.

In more heterogeneous habitats the variety of options available to less dominant sea otters is greater and the patterns of segregation are likely to be more complex and more difficult to predict. In homogeneous, high quality habitat the patterns should be more predictable and probably would be similar to those described for Aleutian populations.

Sex and age segregation is an integral part of the reproductive strategy of the sea otter. When limiting forces of the type likely to occur in nature are exerted on the population, the least productive segment of the population tends to be sacrificed first. When these forces are lifted the population is skewed in favor of the most productive segments and can respond quickly.

Unfortunately this strategy which is so effective in nature may be detrimental in an environment influenced by modern man. The most productive segments of a sea otter populaton tend to be concentrated. Man often exerts influences on the marine environment that are concentrated and equally detrimental to all sex and age classes of sea otters. The most obvious example is an oil spill which would have a longer term impact on the population if it struck a female area in a segregated population than if it impinged on the same area in a population where the sex and age classes were randomly distributed. There are also less obvious examples of the lack of "flexibility" of the sea otter to some of man's activities. Female areas support the highest densities within most populations. Where male areas support equal or higher densities they tend to be less accessible to man. It is likely that fur hunters of the 18th and 19th centuries concentrated their initial efforts on female areas where the higher densities and calmer waters increased hunting success. Therefore the tendency for sea otters to segregate probably contributed to the hunters' ability to quickly eliminate certain sea otter populations.

The recovery of the sea otter from overexploitation demonstrated that the species is capable of withstanding considerable abuse from man, at least when permanent habitat degradation does not occur. If sex and age segregation allows the sea otter to better withstand certain abuses of nature, then man should be able to use knowledge of segregation patterns to conduct his activities in a manner that is more compatible with the survival strategy of the species.

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APPENDIX

Mapping of Sea Otter Sex and Age Segregation Patterns

In the course of our sea otter studies it has been possible to classify portions of the Alaska coastline as being sea otter male areas or female areas. These classifications have proved useful in the conduct of studies, direction of harvest and capture operations and in prediction and evaluation of impacts. The available information is summarized here in the hope that it will be useful in the future and will be updated and expanded as more detailed studies are carried out in new areas. More detailed information on which these summaries were based is on file in the Anchorage office of the Alaska Department of Fish and Game.

Several methods were used to classify sea otter habitat. The reliability of the information depends largely on the method used. Classifications based on the sex and age composition of sea otters that were captured or killed were most reliable. Those based on pup/adult ratios during counts from shore or boat where sea otter densities were high usually proved correct when later confirmed through collection of animals. Classifications based on pup/adult ratios where sea otter densities were low or where observations were made from a helicopter were least reliable.

1. Amchitka Island

Sex and age segregation has been studied more intensively at Amchitka Island than any other area. It appears that all classical male areas and major female areas around the island have been identified (Fig. A-1). The classification of most of these areas has been confirmed through the collection and capture of large samples of sea otters. No collecting or capturing has been done at the extreme northwest end or in the central portion of the southwest side of the island, however, visual observations of pups have been made in these areas from shore and helicopter.

Virtually all sea otter habitat around Amchitka not in an identified male area can be considered typical female areas. Within these female areas there are a few small pockets of low quality habitat that are frequented by subadult males. However, these areas are scattered and small. Constantine Harbor is perhaps the largest such area.

Six discrete male areas have been identified around Amchitka (Fig. A-1), East Cape, Crown Reefer Point and St. Makarius Pt. East were identified by Lensink (1962) and Kenyon (1969) and their existence has been confirmed in subsequent studies. Sea otter Point was identified as a male area by Jim Estes during counts and this identification was confirmed during subsequent collecting by the Alaska Department of Fish and Game. Estes also located a male hauling area at Juxta Point and no pups were seen in the shallow area extending 12 km offshore from the point. No pups have been seen near Aleut Point on repeated helicopter surveys and observations from shore. No collecting or capturing has been done at either

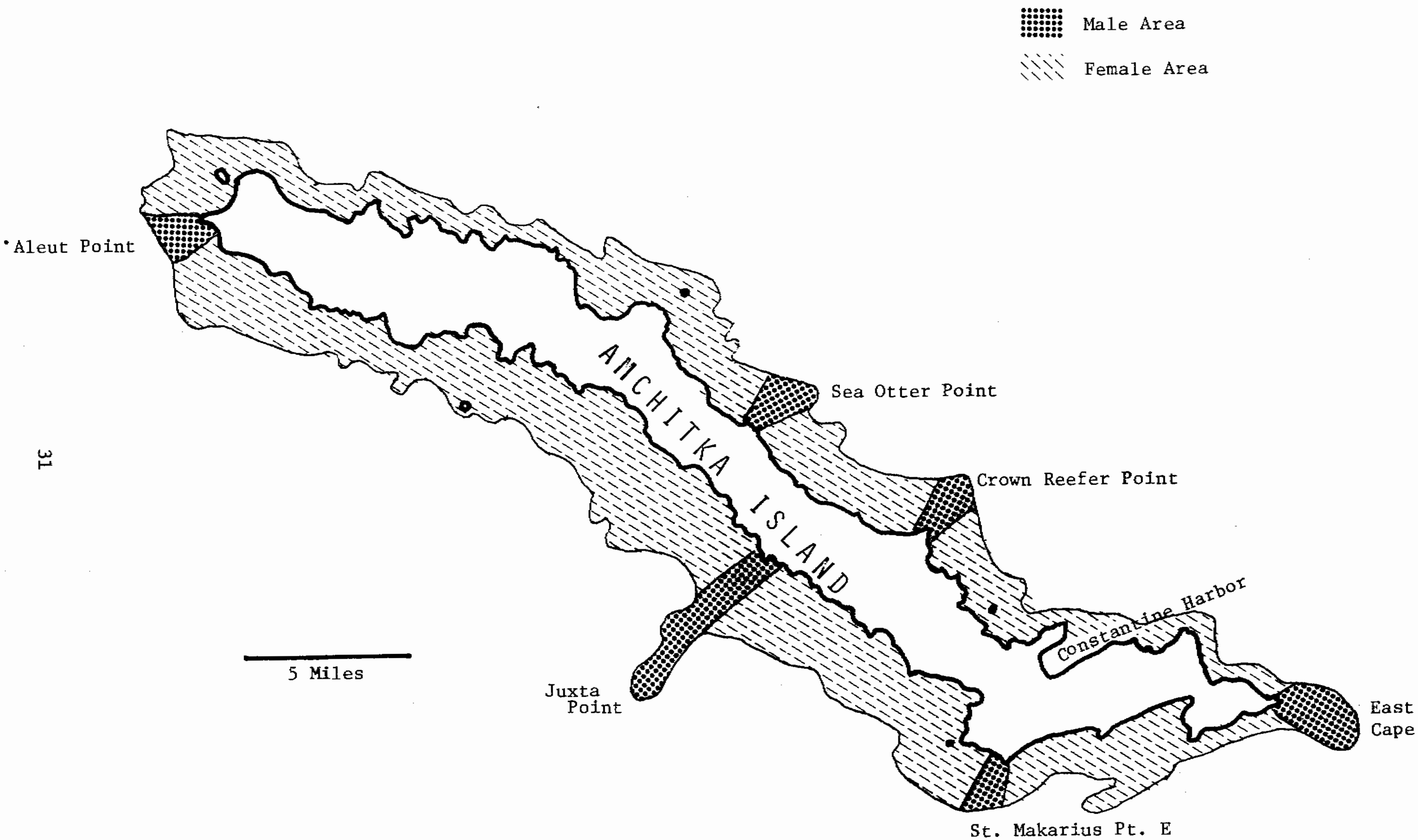

Figure A-1. Locations of known sea otter male and female areas around Amchitka Island.

Juxta Point or Aleut Point. It is possible that the shallow portions of Oglala Pass serve as an extension of the Aleut Point male area. The area around Bird Rock is clearly a female area, however.

It is highly unlikely that any unidentified male areas exist on Amchitka Island. Although some exchange of sea otters between Amchitka Island and adjacent islands, particularly Rat Island, probably occurs, the group of sea otters around Amchitka probably has most of the characteristics of a discrete population. Therefore Figure A-1 can be considered to represent the distribution of male and female areas within an entire population. No other population or subpopulation has been completely mapped.

2. Delarof Islands

Sea otters were harvested around Ogluiga, Skagul and a portion of Ulak Island in 1970. The composition of animals taken indicated that most of the areas hunted were female areas but one male area was almost certainly encountered. Lack of precision in recording exact locations makes it impossible to determine the exact location of this male area but it was somewhere south or southeast of Skagul Island (Figure A-2).

3. Tanaga Island

The entire southern shoreline of Tanaga Island between Cape Sudak and Tanaga Bay was classified during a skiff count in 1968. These classifications were confirmed through extensive harvesting in 1970. The reliability of this classification is exceeded only by that for the southeast half of Amchitka Island. Most of this portion of the shoreline is composed of high quality female areas (Figure A-3). Three definite male areas were identified, Cape Sudak, Kanaga Pass and Cape Amagalik. It is unlikely that other male areas exist in the area classified. No data are available from the remainder of the island, however, there is a strong possibility that the precipitous coastline around the foot of Tanaga Volcano supports a high percentage of males. This assumption is based on observations in similar areas where there are no large concentrations of sea otters and pups are rarely seen. If this area does function as a broad, diffuse male area there appears to be little "need" for other male areas around Tanaga Island.

4. Kanaga Island

The shoreline of Kanaga Island from Ship Rock to Kanaga Pass and from Kanaga Pass to Round Head was tentatively classified during a skiff survey in 1968. The classification of the areas between Round Head and Cape Tusik and the extreme western tip of the island was confirmed during harvesting operations in 1969. Because harvesting was less extensive at Kanaga than at Tanaga the reliability and completeness of the classification is poorer.

Two male areas were identified. Shoal Point and Kanaga Pass.

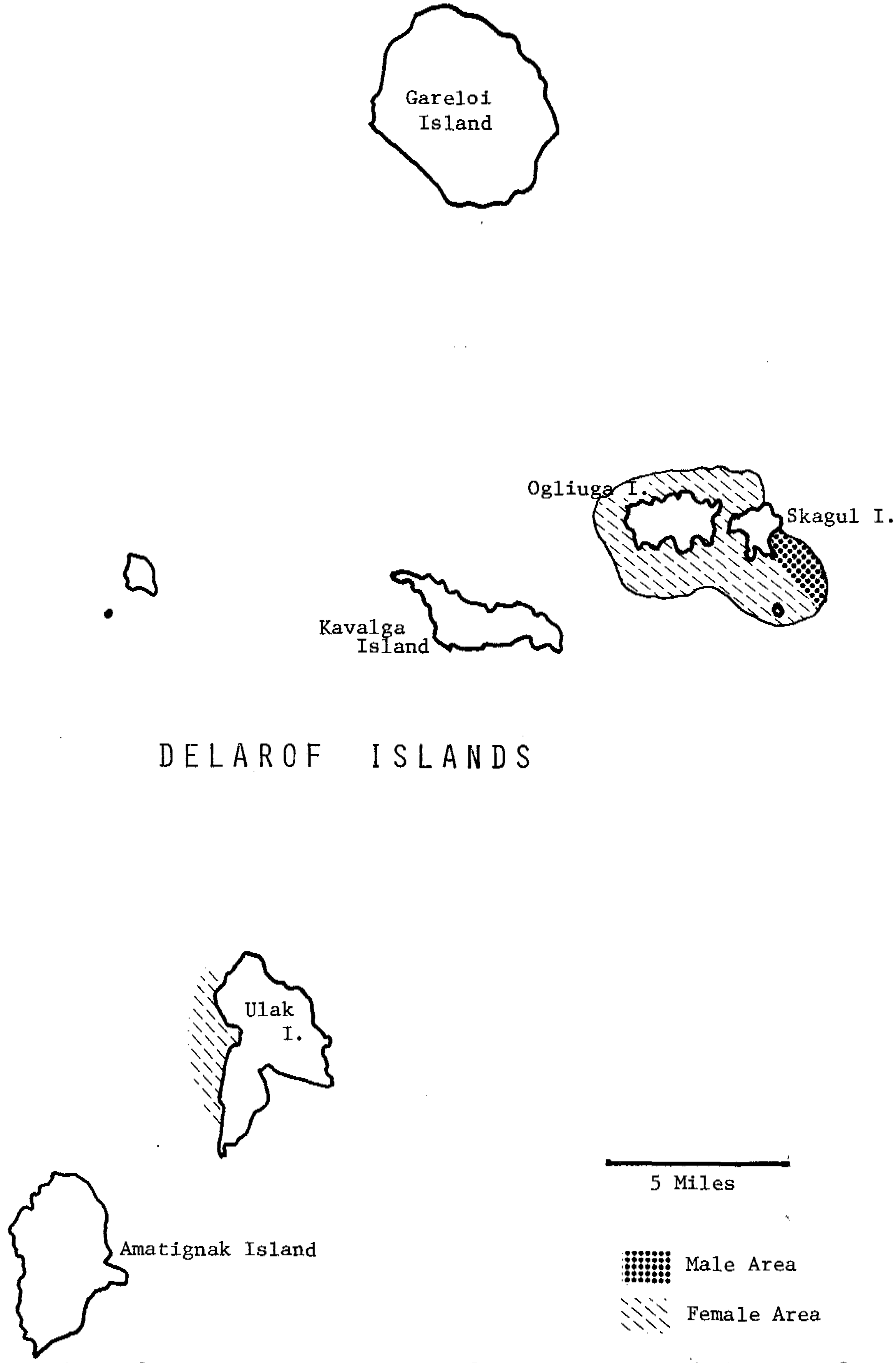

Figure A-2. Locations of known sea otter male and female areas around the Delarof Islands (exact location of the male area is uncertain).

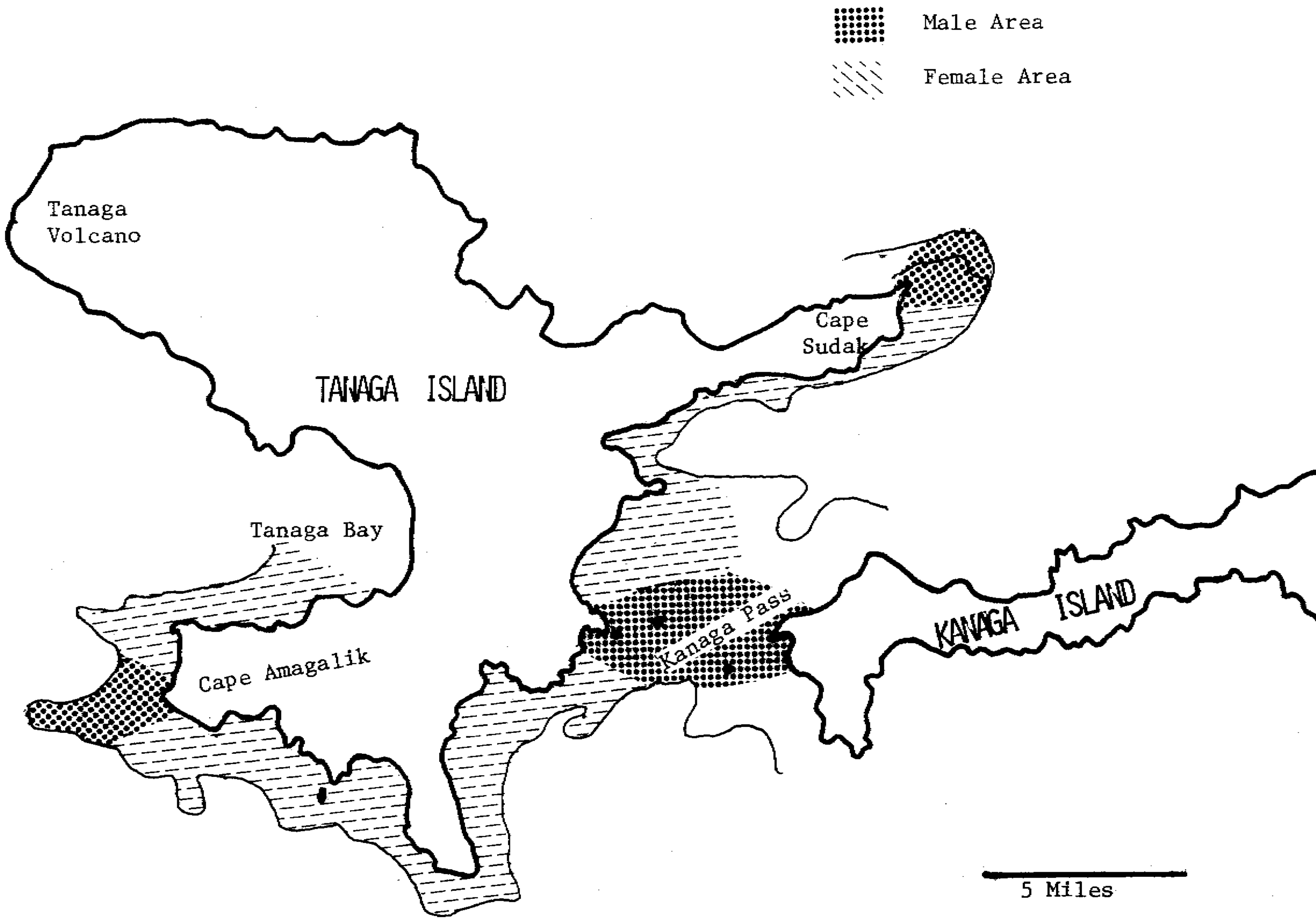

Figure A-3. Locations of known sea otter male and female areas around Tanaga Island.

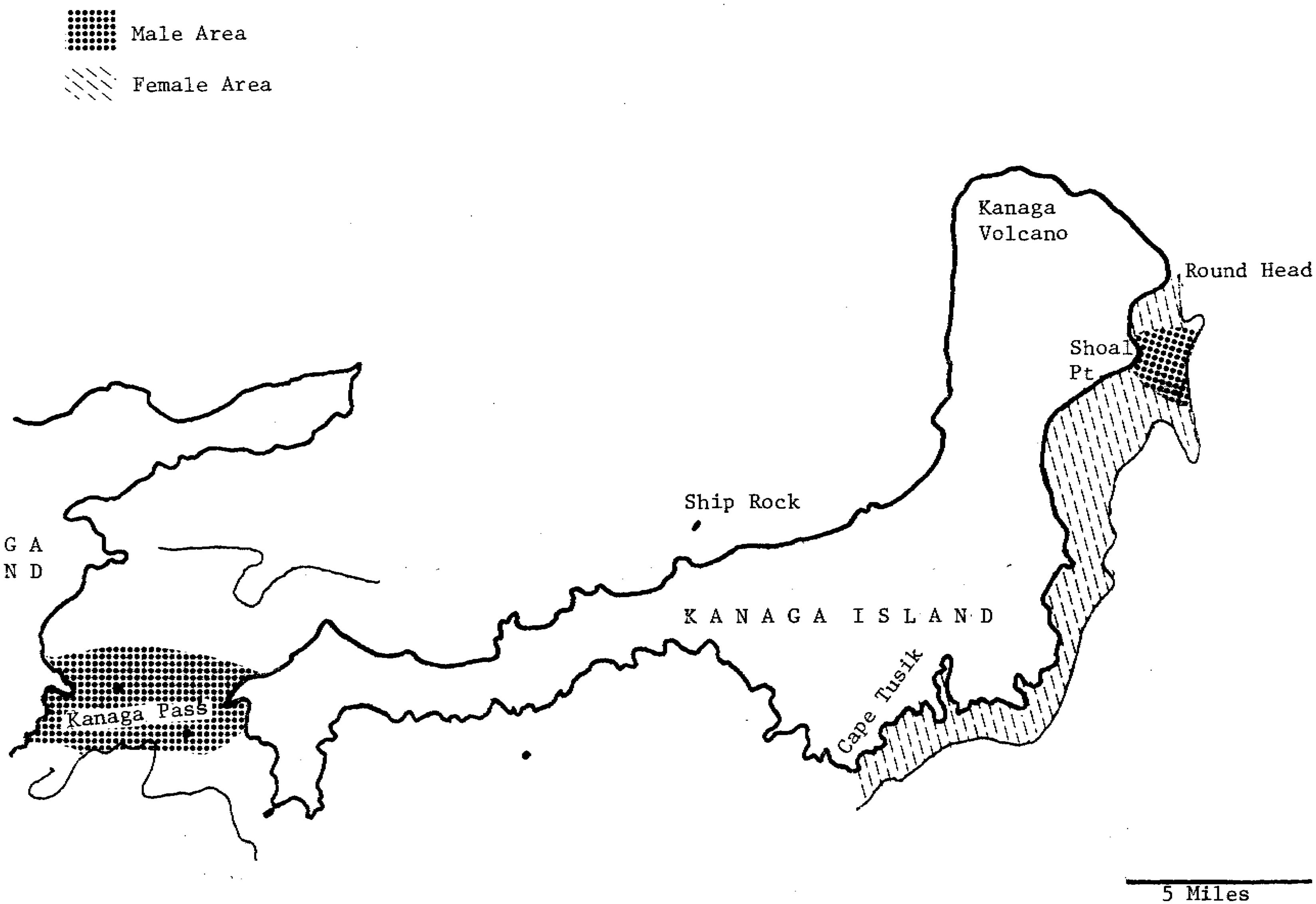

Figure A-4. Locations of known sea otter male and female areas around Kanaga Island.

Kanaga Pass is shallow, forming a bridge of sea otter habitat between Kanaga and Tanaga Islands. In effect the two islands share a common male area.

The remainder of the classified portions of Kanaga Island appeared to be female areas, however, at least one other male area probably exists on the south side of the island. Shoal Point and Kanaga Pass are farther apart than male areas in any similar population. The area around Cape Tusik appears to be the most likely male area even though data from the 1968 count do not show this.

The precipitous area around the base of Kanaga Volcano may also serve as a male area.

5. Adak Island

Only three small areas around Adak Island have been classified and all of these were typical female areas (Figure A-5). The classification of these areas is based on samples of harvested animals and is considered reliable.

No male areas have been identified at Adak, however, no pups were seen during a boat trip around Cape Moffett suggesting that this area, which is similar to the bases of the Kanaga and Tanaga Volcanoes, is inhabitated by males.

6. Afognak and Shuyak Islands

A dense and rapidly expanding sea otter population inhabits the waters around Afognak and Shuyak Islands. Most of the population presently occurs around the north side of Afognak Island from Marmot Strait to Ban Island. Lesser densities occur in Marmot Bay on the east side of the Kodiak Archipelago and along most of the west side.

Pup counts made from a skiff indicate that the area from Foul Bay to Dark Passage, Perenosa Bay, Seal Bay and the northwest tip of Marmot Island are female areas (Fig. A-6). No male areas have been identified but the nature of the habitat and continuous high densities of sea otters suggest a high probability that at least one classical male area of the type described for the Aleutian Islands exists there. Two areas should be examined more closely. Latax Rocks has many of the characteristics of a male area, being exposed to rough seas and tide rips, and there is evidence of a heavily used hauling area there.

The other area worthy of further examination is the vicinity of Sea Otter Island. In May 1977 a pod of 200 sea otters with no pups was seen on the west side of Sea Otter Island. Pups were present around the rocks immediately to the east, however.

No pups have been seen in Marmot Bay or south of Malina Bay. This fits the typical pattern of an expanding population where most of the animals pioneering new habitat are males.

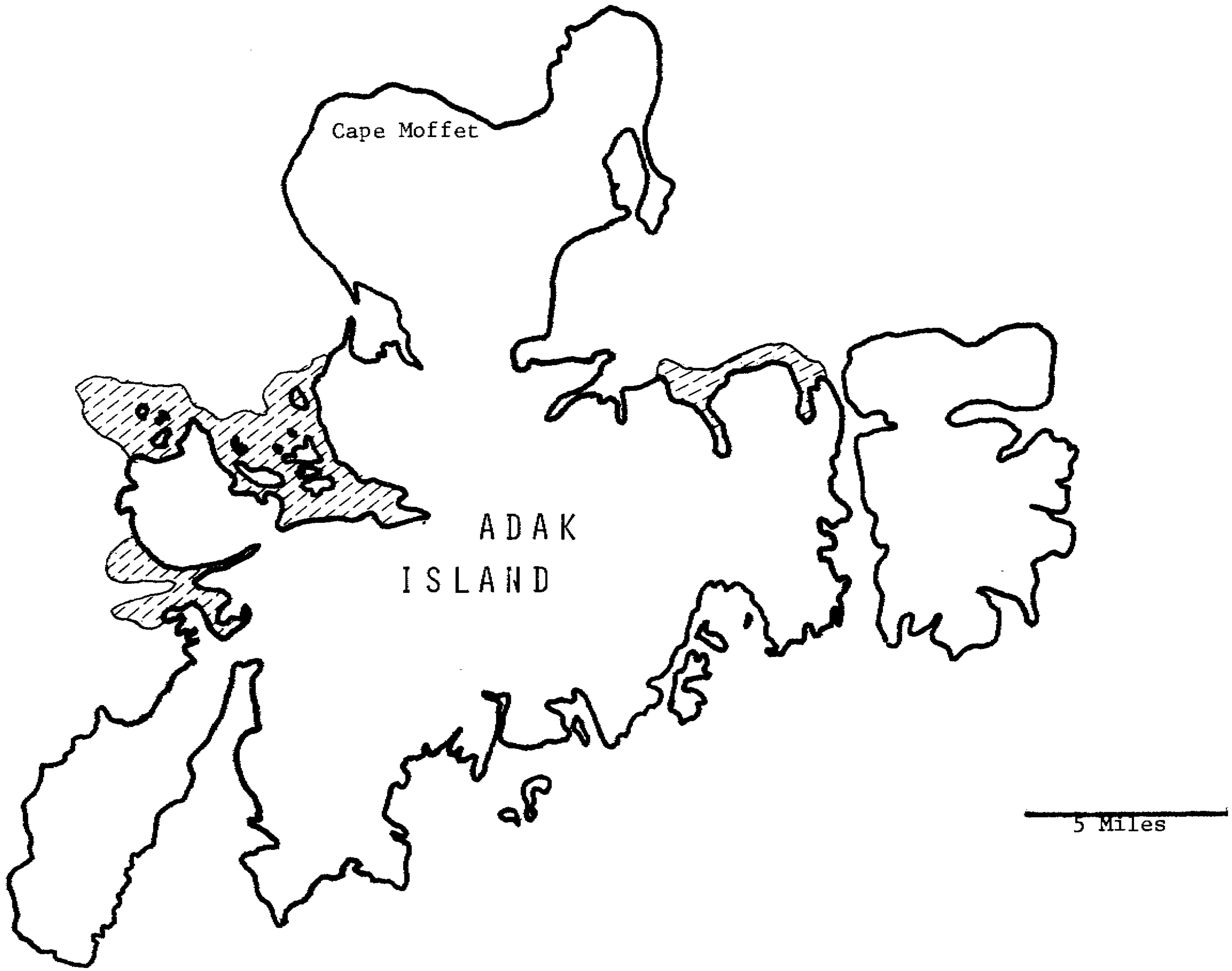

Figure A-5. Locations of known sea otter female areas around Adak Island.

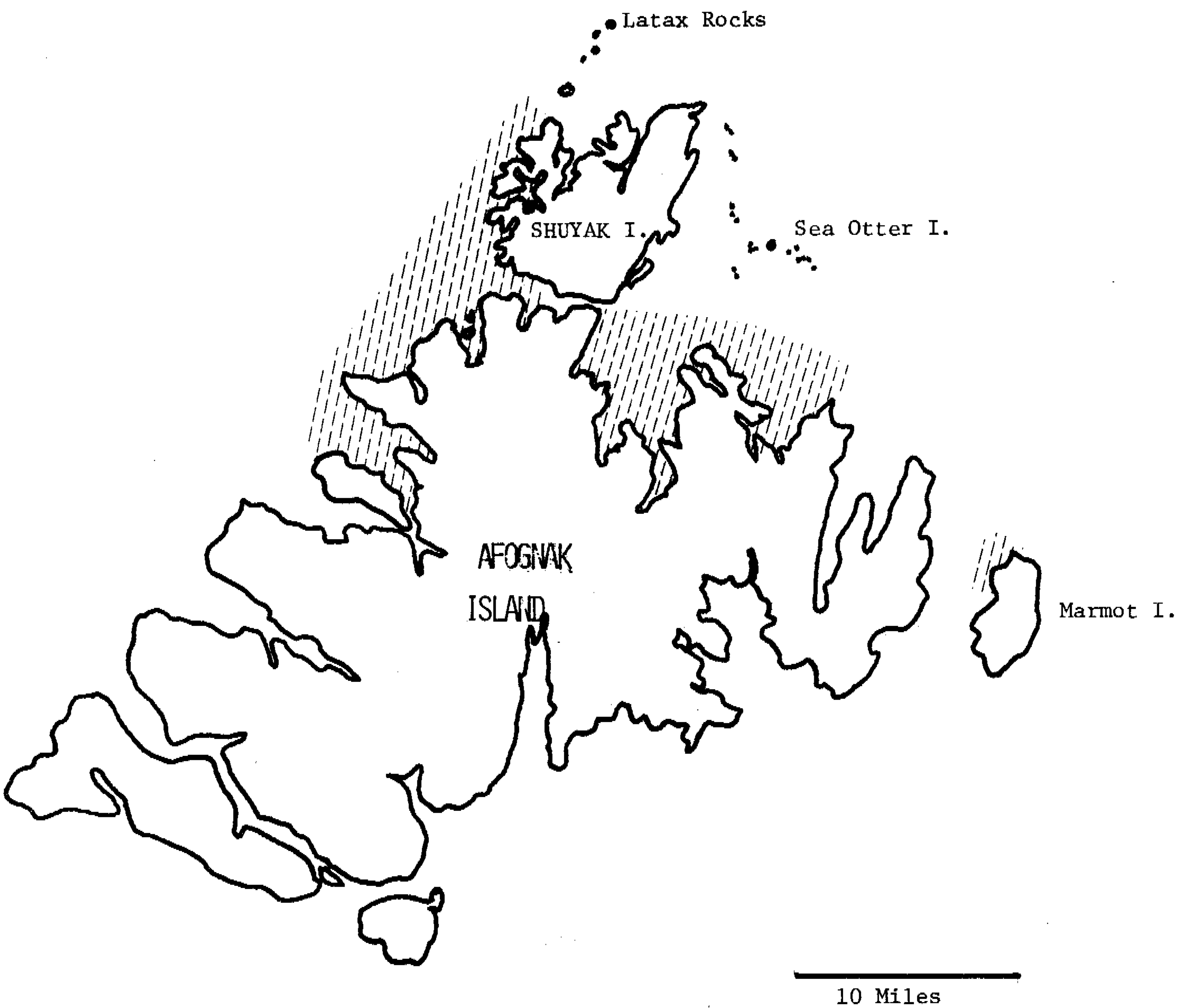

Figure A-6. Locations of known sea otter female areas around Afognak Island.

7. Prince William Sound

The most extensively studied area in Prince William Sound lies around Green Island and Port Chalmers on Montague Island. Classification of this area is based on the composition of sea otters captured for transplant and extensive observations from boats and helicopters. The entire area supporting high densities of sea otters is a female area (Figure A-7). Lower density areas along the west shore of Montague Island are suspected to be inhabitated by males.

The Constantine Harbor-Porpoise Rocks area of Hinchinbrook Island has also been classified as a female area on the basis of captured animals.

Much of the shorelines of Latouche, Evans, Elrington and Knight Islands were surveyed from a boat in 1974. No particular pattern of segregation was evident in the counts. Sea otter densities are low in most of these areas and it may be possible for non breeding males to remain scattered throughout the area. The concept of female areas and male areas is probably oversimplified and of less value in low density areas such as these.

A large number of sea otters occupy Sheep Bay, Gravina Bay and Port Fidalgo. This group is rapidly expanding its range in both directions along the east side of Prince William Sound. All evidence indicates that the majority of these animals are males although some females with pups occur there. This group fits the concept of an expanding front even though it is relatively isolated from the rest of the population. The composiiton of sea otters inhabiting this area will almost certainly change and much of the area will become female areas.

8. Southeast Alaska

Five small concentrations of sea otters in Southeast Alaska have reached a size where sex and age segregation is becoming visible. Since these populations have been and probably will continue to be surveyed regularly, they present a unique opportunity to observe the development of segregation patterns. Some changes, described in the main body of this report, have already occurred. Results of the 1975 survey of these populations are presented in detail in Figures A-8 through A-12 to serve as a basis for future comparison.

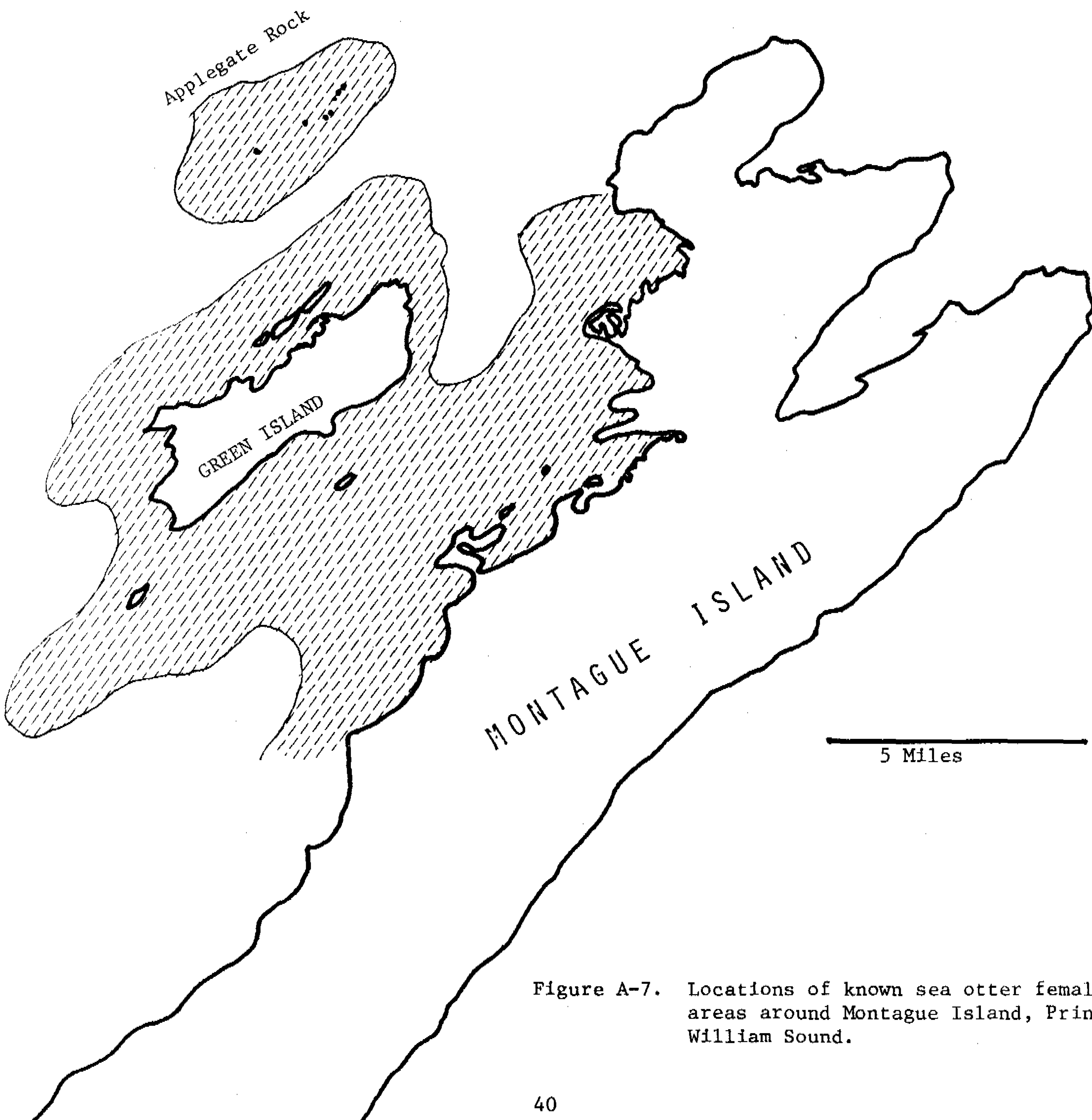

Figure A-7. Locations of known sea otter female areas around Montague Island, Prince William Sound.

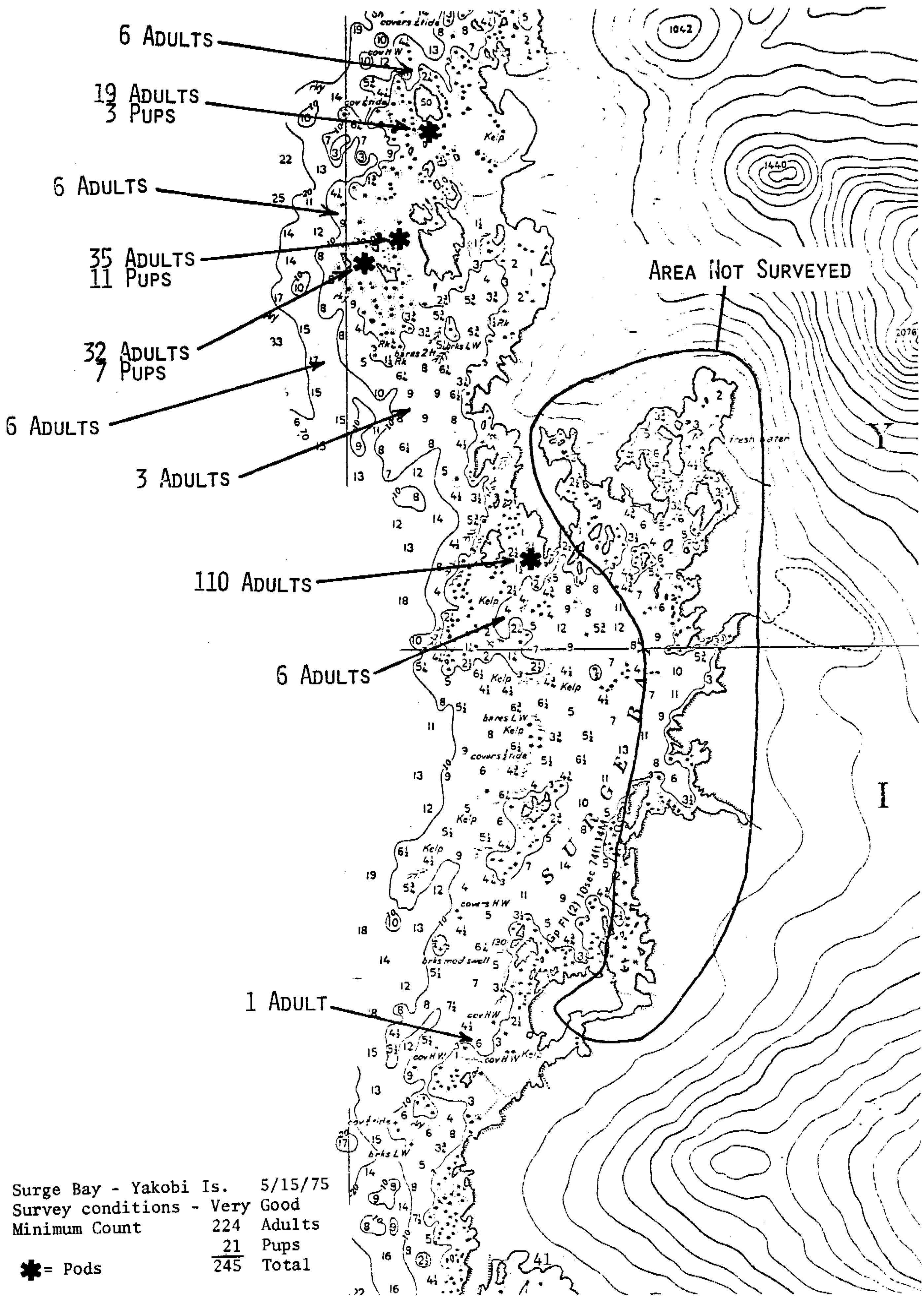

Fig A-8 Surge Bay - Yakobi Is. 5/15/75
Survey conditions - Very Good

Minimum Count	224	Adults
	21	Pups
	245	Total

✱ = Pods

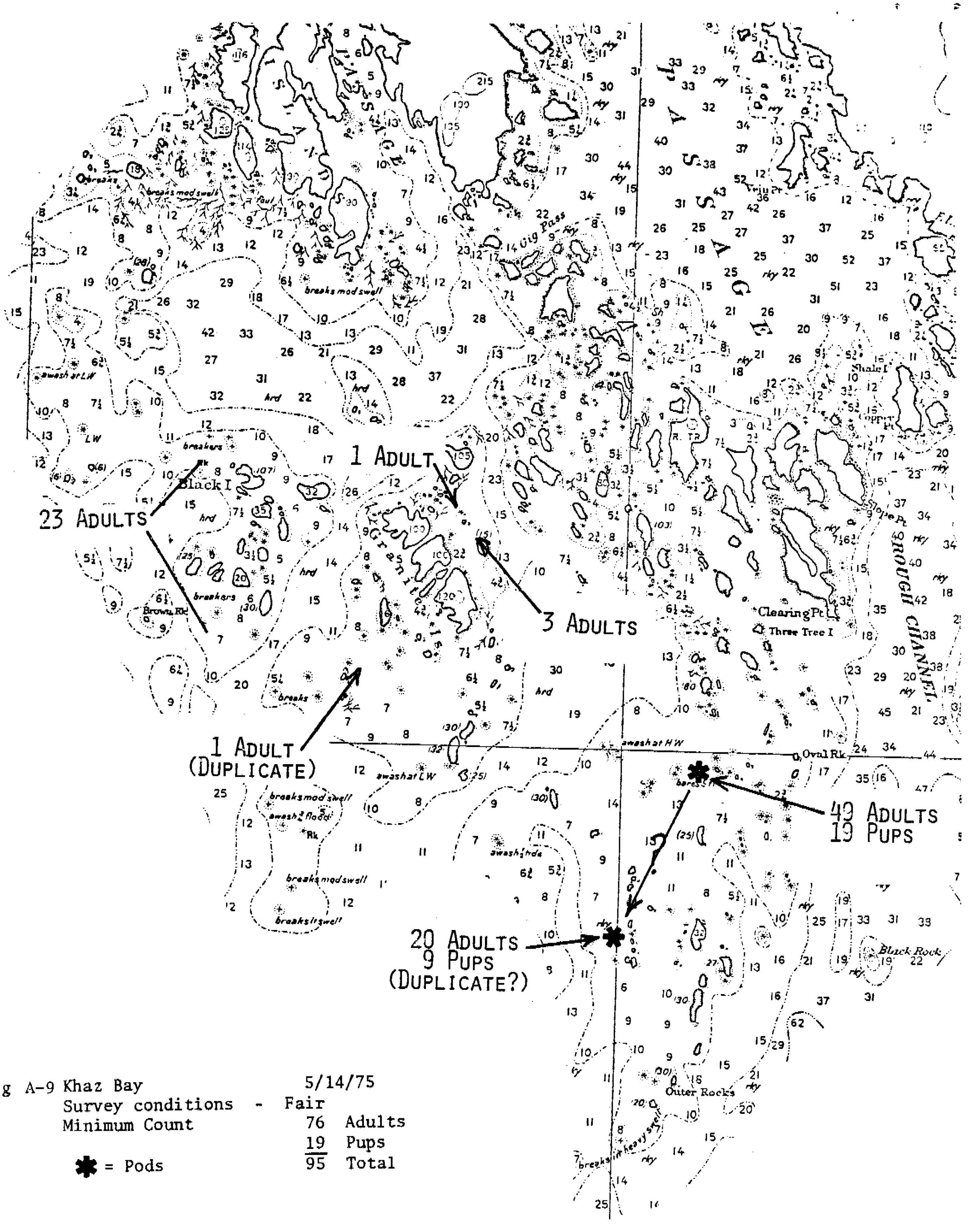

Fig A-9 Khaz Bay 5/14/75

Survey conditions - Fair

Minimum Count

	76	Adults
	19	Pups
✱ = Pods	95	Total

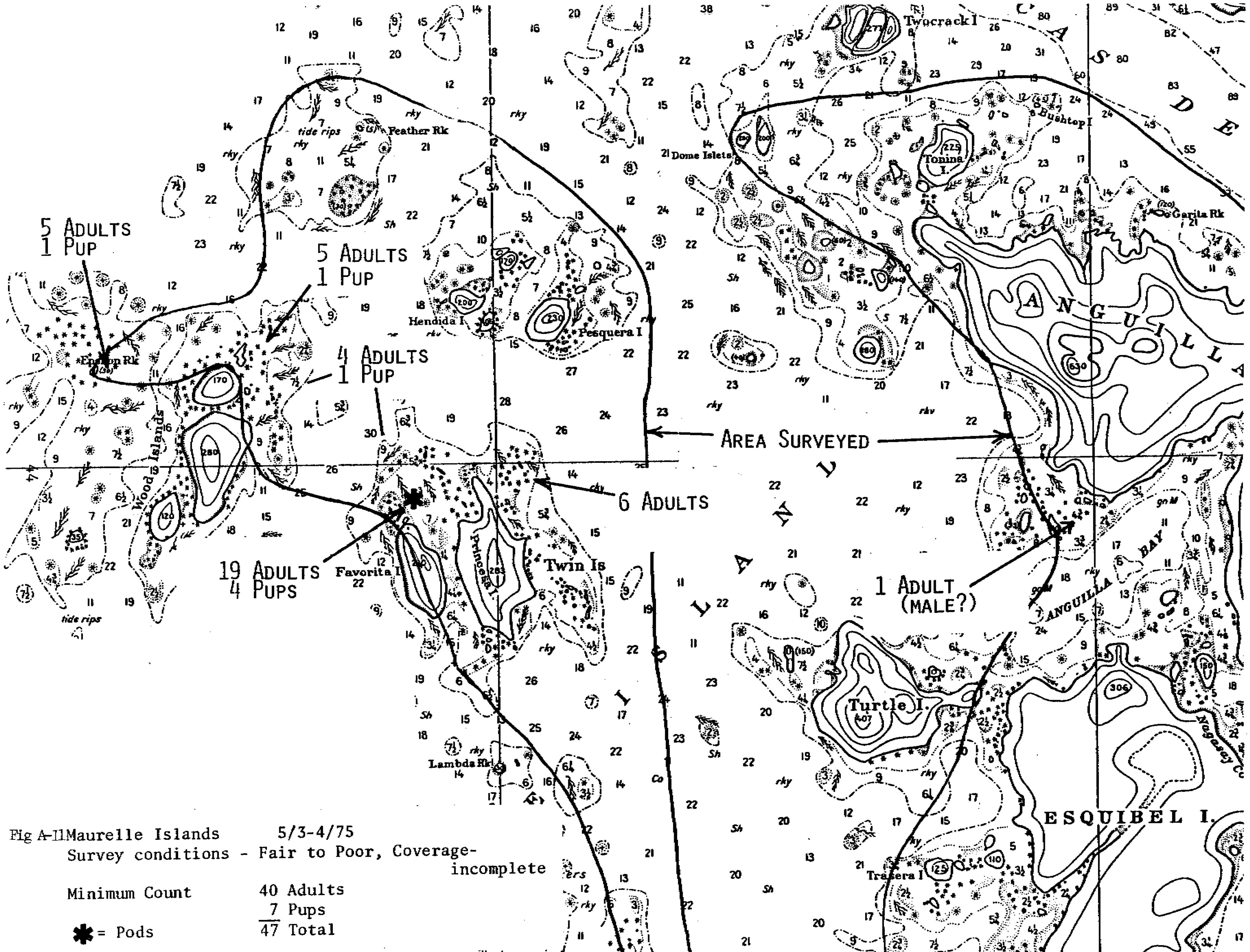

Fig A-11 Maurelle Islands 5/3-4/75
Survey conditions - Fair to Poor, Coverage-incomplete

Minimum Count 40 Adults
7 Pups
47 Total

✱ = Pods

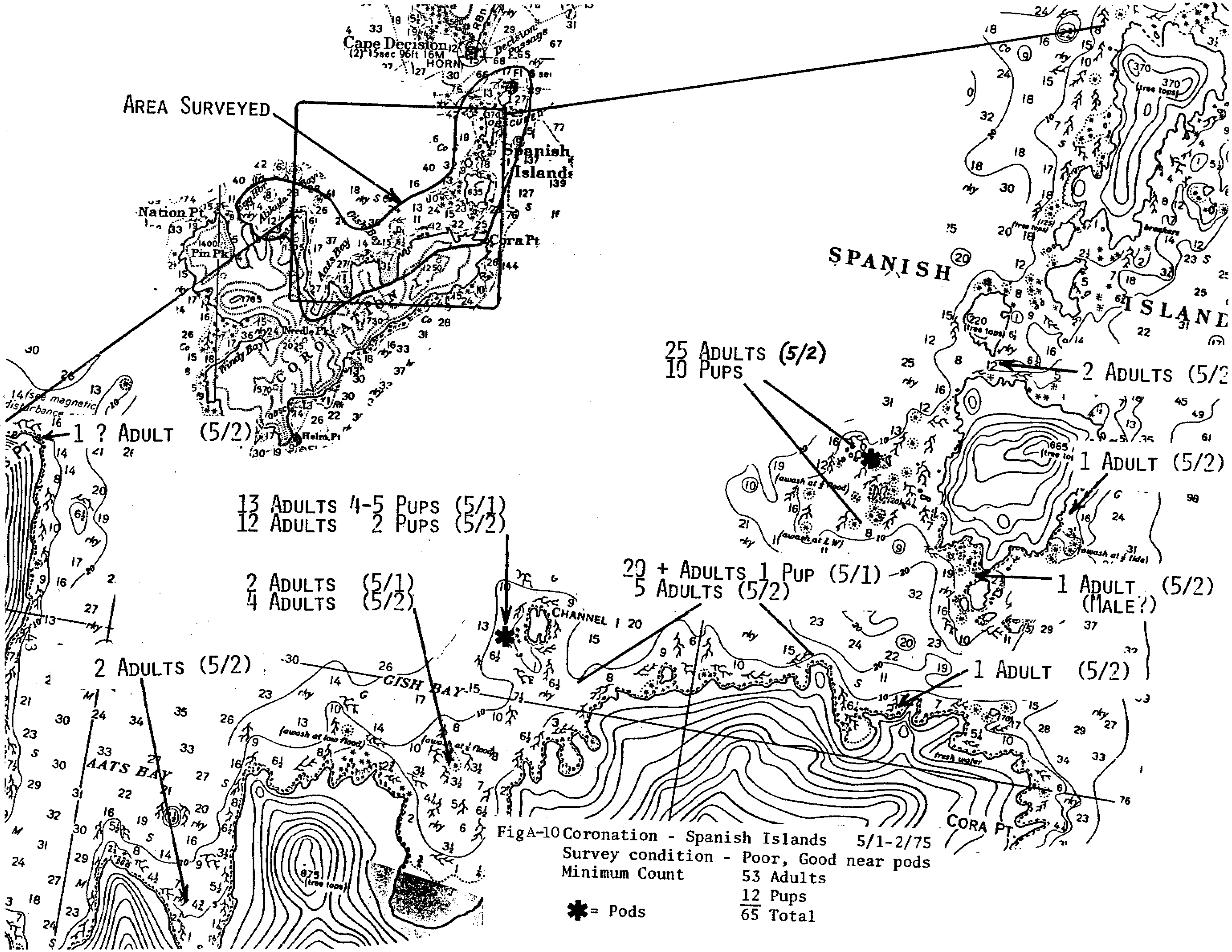

Fig A-10 Coronation - Spanish Islands 5/1-2/75
Survey condition - Poor, Good near pods
Minimum Count 53 Adults
12 Pups
65 Total

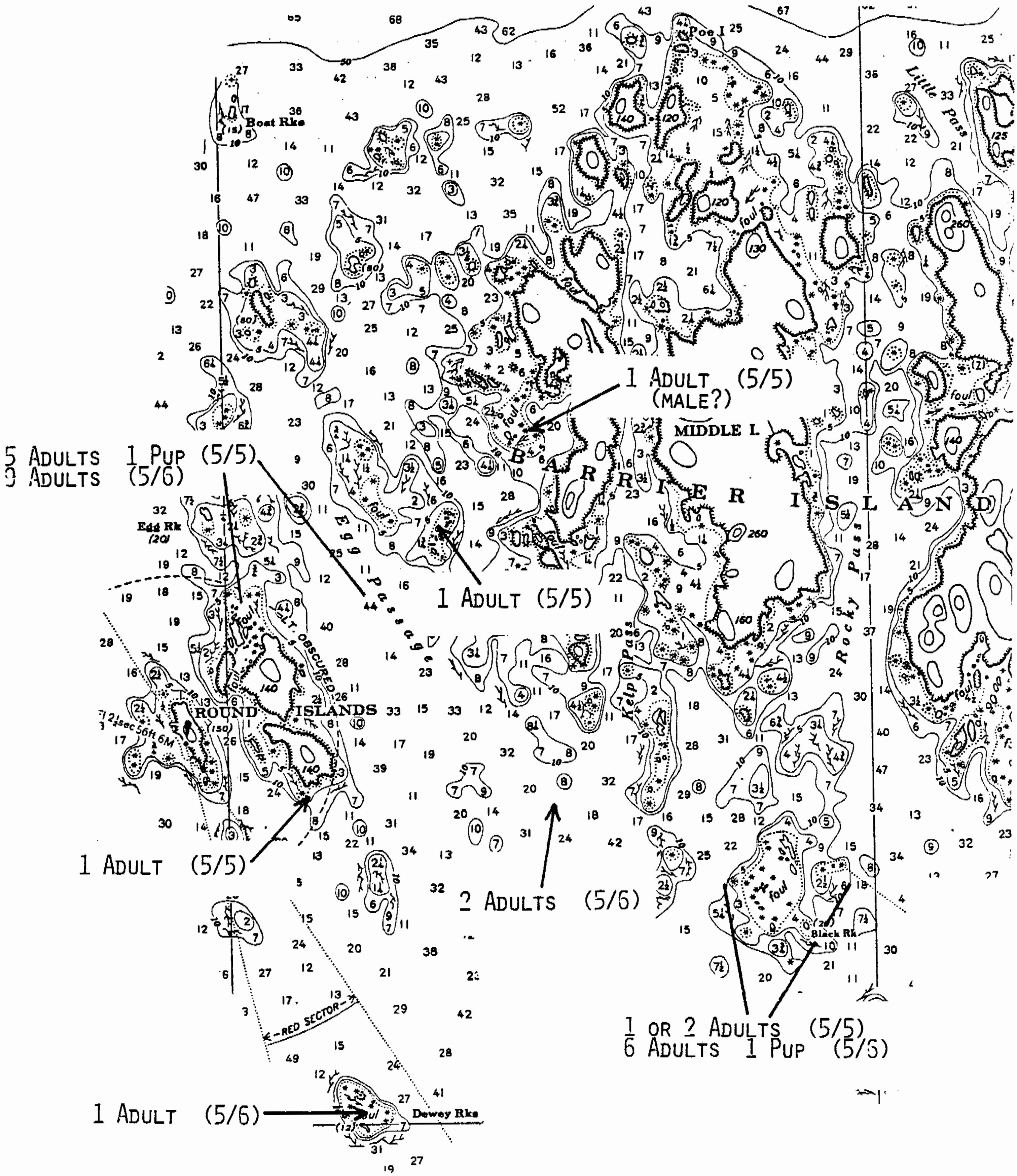

Fig A-12Barrier Islands 5/5-6/75
Survey conditions - Very Good, but otter scattered
Minimum Count 19 Adults
2 Pups
21 Total