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SEA OTTER REPORT

By
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Volume II
Project Progress Report
Federal Aid in Wildlife Restoration
Project W-17-4, Jobs 8.9R and 8.11R (2nd half) and
Project W-17-5, Jobs 8.9R and 8.11R (1st half)

(Printed September, 1973)

JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperator: Karl B. Schneider

Project Nos.: W-17-4 & W-17-5 Project Title: Marine Mammal Investigations

Job No.: 8.9R Job Title: Sex and Age Segregation of Sea Otters

Period Covered: January 1, 1972 to December 31, 1972

SUMMARY

Information on sex and age segregation in sea otter populations was gathered incidentally during a series of distribution and abundance counts made from shore and a helicopter at Amchitka Island and during a transplant capture operation in Prince William Sound.

The effectiveness of using pup/adult ratios obtained from shore counts for classifying male and female areas was demonstrated.

All areas around Amchitka Island that had not been studied previously were classified. It appears that all male areas around the island have been identified. Those on the northwestern half of the island are over 20 miles apart while those on the southeastern half averaged 10 miles apart. There are a total of six male areas around Amchitka, which occupy less than 8 percent of the shoreline. Female areas occupy most of the remaining habitat, however, a few areas of marginal habitat do not have the characteristics of either male or female areas.

Superficial evidence indicates that sexual segregation occurs in areas outside of the Aleutian Islands, but it may be manifested in different ways. The composition of sea otters caught in certain Prince William Sound areas was typical of Aleutian female areas except that the percentage of adult males was higher. Discrete male areas may not exist in areas such as Prince William Sound where areas of good quality habitat are separated by stretches of marginal habitat.

CONTENTS

BACKGROUND

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

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

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

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

Schneider (1972) presented more detailed information on the location of male and female areas and the changes in sex and age composition on these areas throughout the year.

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

OBJECTIVES

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

PROCEDURES

No field work was conducted specifically for this project in 1972; however, some pertinent information was gathered in the course of other activities.

A series of visual counts of sea otters were made at Amchitka Island in cooperation with James Estes, University of Arizona, and Carl Abegglen, Bureau of Sport Fisheries and Wildlife. These counts were designed to determine the distribution and abundance of sea otters around Amchitka Island.

The coastal waters of Amchitka Island were divided into 45 helicopter count units (Fig. 1). Sea otters were counted by two observers in an Alouette II helicopter. A third man recorded the numbers seen in each count unit and made notes on viewing conditions and presence of pups in certain areas.

Four areas, labeled A, B, C and D, were selected for shore counts (Fig. 1). Each area was divided into from five to nine subareas, each of which could be counted from a single point on shore. Usually these subareas coincided with helicopter count units. Sea otters were counted in each subarea from a preselected high point of land with the aid of 10 x 50 binoculars and a 15 to 60X spotting scope. Pups were recorded separately from other animals.

Count areas A, B, C and D should not be confused with similarly labeled harvest areas used by Schneider (1972). There is no relationship between the two systems.

In July, 1972, 60 sea otters were captured for a transplant in the vicinity of Green Island and the Port Chalmers area of Montague Island in Prince William Sound. Each capture net location was marked on a chart and the sex and weight of each sea otter caught at each location were recorded. This information was used to provide a rough indication of the sex and age composition of sea otters in a particular area. Similar data, less specific to area, were extracted from 1965 and 1966 transplant records.

FINDINGS

Amchitka

The percentage of pups counted during shore counts may be used to separate male areas from female areas. Male areas are characterized by large numbers of single animals. Small pups are rarely found in these

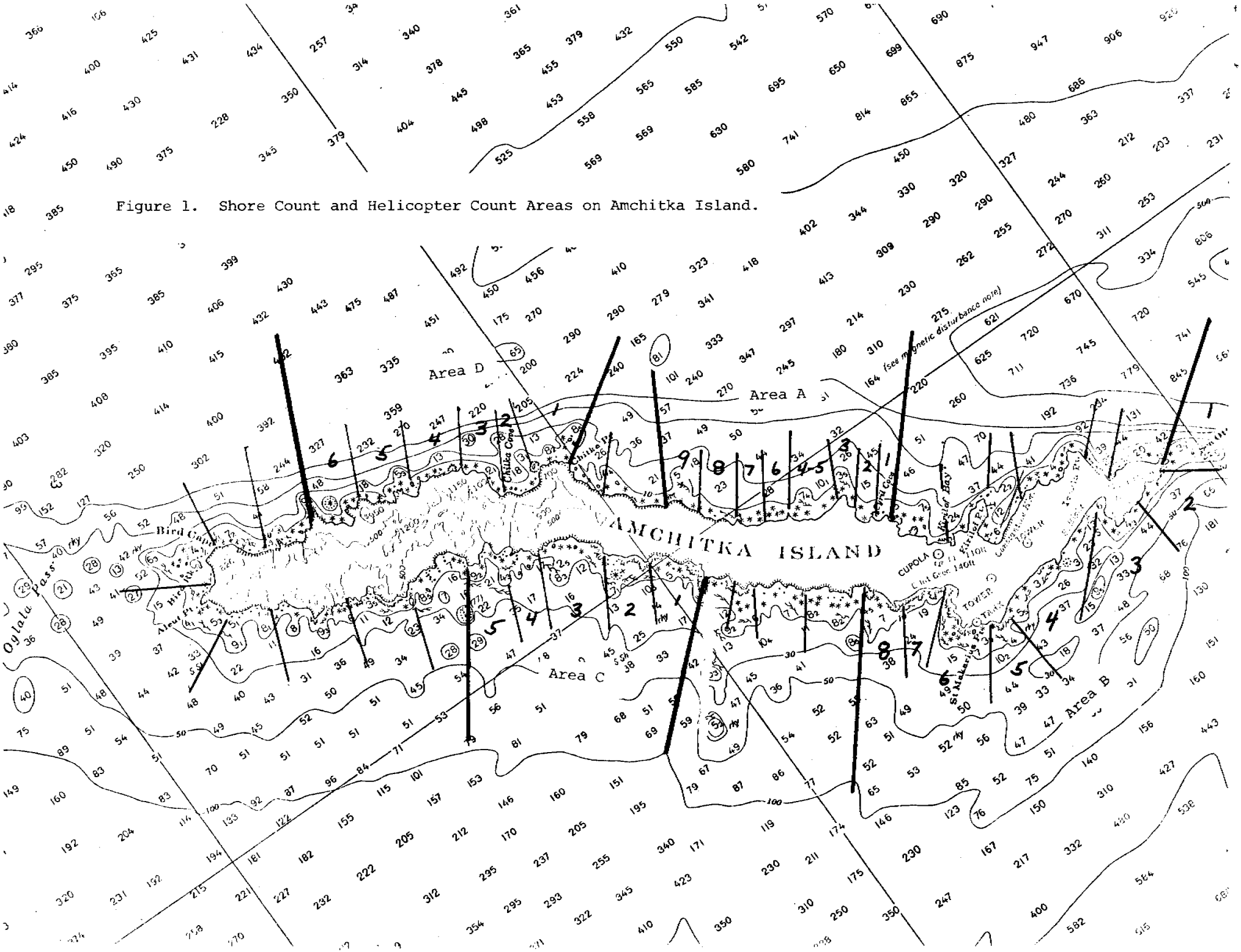

Figure 1. Shore Count and Helicopter Count Areas on Amchitka Island.

areas. Some areas of marginal habitat will also have few pups, but support much lower densities of sea otters than male areas. The best month to identify areas on the basis of pup distribution is June when the number of very small pups is at a maximum. For example, shore count Area A is known to include two male areas. These are in subareas 3 and 9 (Fig. 2). The remaining subareas are known to be in typical female areas. While the number of pups identified can vary greatly with viewing conditions, all shore counts made in late May and early June showed a lower percentage of pups in subareas containing male areas than in subareas lying entirely in female areas (Table 1). The only reason any pups were seen in subareas 3 and 9 is that each subarea also includes portions of female areas as well as the male area. If the subareas were smaller, the differences between male and female areas would be even greater. The existing subareas are small enough to distinguish male areas from female areas, regardless.

High percentages of pups were counted in all subareas of shore count areas C and D (Table 2), demonstrating that both lie entirely within female areas. This confirms conclusions drawn from the 1970 harvest (Schneider, 1972). No usable counts were made in Area B, but the composition of that area is already known from previous studies (Kenyon, 1969).

Only the extreme northwest end of Amchitka and a portion of the area between shore count areas B and C have not been classified into male and female areas by either collection of animals or shore counts. Particular attention was given to these areas during helicopter counts. Aleut Point appears to be a typical male area. Large numbers of single animals, but no pups, were seen there on helicopter surveys. A search from shore with binoculars under fair conditions confirmed this. All of the remaining area between shore count areas C and D contained pups, including the Bird Cape-Bird Rock Area. Juxta Point, just southeast of Area C, appears to be a male area, however sea otters may be up to six miles offshore directly off the point, making shore counts ineffective.

It appears that all male areas on Amchitka Island have been identified. This gives us a complete picture of sexual segregation in an entire, relatively isolated population for the first time. Fig. 3 shows the locations of the major male and female areas. Unmarked areas contain poorer quality habitat which supports low densities of sea otters. Generally these areas can be considered female areas, but they may be used by subadult males and transient animals of any sex or age class also.

The six male areas around Amchitka Island include less than 8 percent of the point to point shoreline. The percentage of sea otter habitat used by nonbreeding males is more difficult to measure because males may feed in relatively deep water. The area shown in Fig. 3 covers only those areas where sea otters are commonly seen.

The nature of segregation around the northwestern half of Amchitka Island does not appear significantly different from that described by Kenyon (1969) and Schneider (1972) around the southeastern half. The

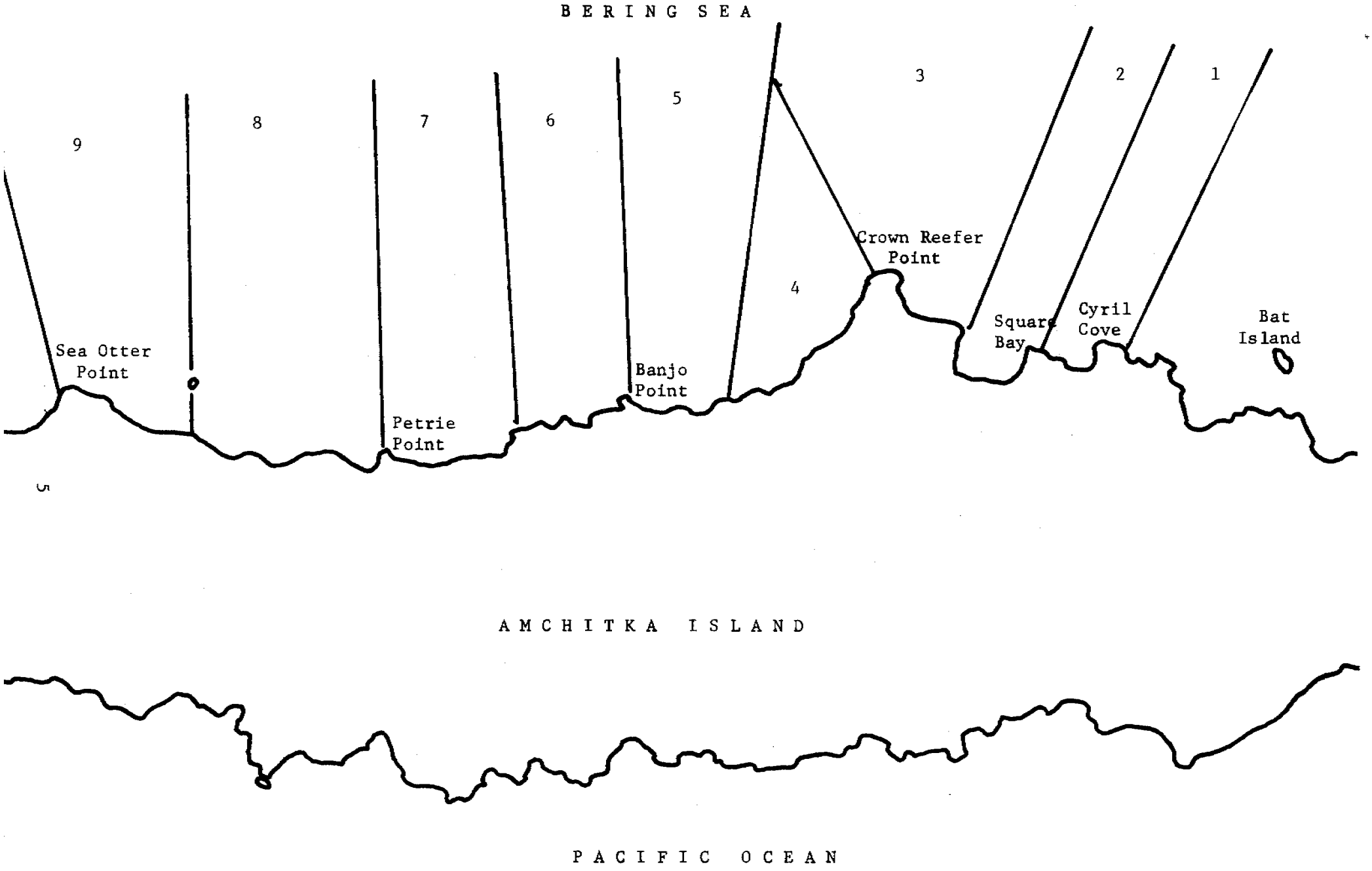

Figure 2. Shore Count Area A, Amchitka Island

Table 1. Shore counts of sea otters - Amchitka Island.

Area A	Subarea									
5/25/72	1	2	3	4-5	6	7	8	9	Total	Conditions
Adults	17	41	106	24	9	8	19	104	328	Very good in kelp at 9, fair to poor all other areas.
Pups	3	6	1	2	1	1	1	3	18	
Total	20	47	107	26	10	9	20	107	346	
5/27/72										
Adults	26	44	70	35	14	13	42	108	352	Good in kelp, poor offshore.
Pups	7	9	2	4	2	3	2	1	30	
Total	33	53	72	39	16	16	44	109	382	
5/29/72										
Adults	30	74	103	43	26	13	44	81	414	Good, but otters in area 9 scattered beyond scope range.
Pups	8	8	1	11	2	3	3	2	38	
Total	38	82	104	54	28	16	47	83	452	
6/7/72										
Adults	12	57	90	59	31	20	38	82	389	Very good.
Pups	5	12	2	11	9	7	15	0	61	
Total	17	69	92	70	40	27	53	82	450	

Table 2. Shore counts of sea otters - Amchitka Island.

Area C			Subarea				
5/26/72	1	2	3	4	5	Total	Conditions
Adults	77	39	104	52	42	314	Fair to poor.
Pups	12	5	8	5	4	34	
Total	89	44	112	57	46	348	
Area D							
5/21/72	1	2	3	4	5	6	Total	Conditions
Adults	136	54	70	75	94	116	545	
Pups	29	9	17	11	13	17	96	
Total	165	63	87	86	107	133	641	
5/25/72								
Adults	72	84	39	61	61	60	377	Poor offshore, choppy, windy
Pups	11	15	4	5	5	3	43	
Total	83	99	43	66	66	63	420	
5/29/72								
Adults	184	56	67	52	75	96	530	Very good to excellent in Areas 1-3, fair to good in 4-6, otter scattered offshore
Pups	24	8	9	11	8	12	72	
Total	208	64	76	63	83	108	602	

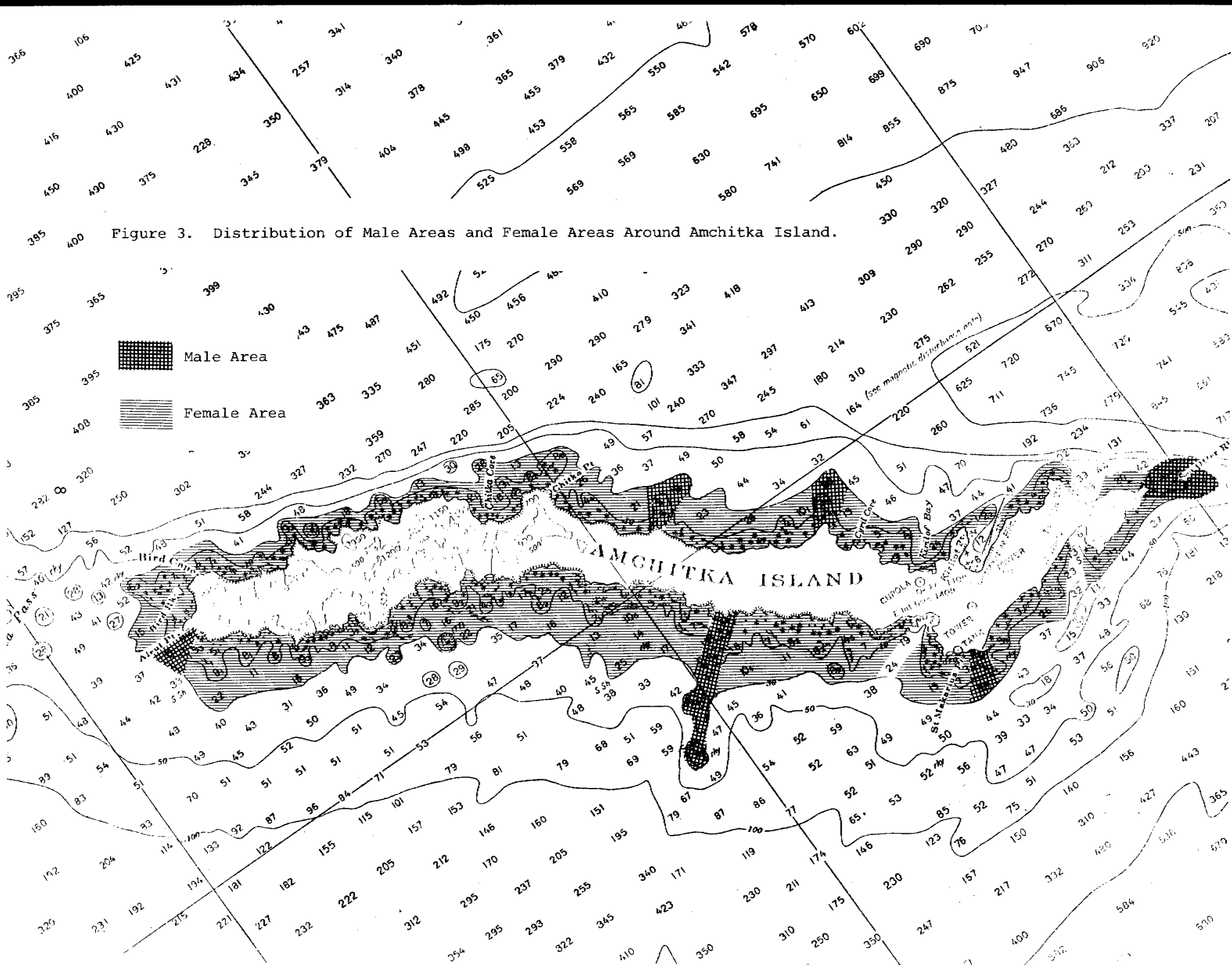

Figure 3. Distribution of Male Areas and Female Areas Around Amchitka Island.

main difference is the greater distances between male areas. Aleut Point is over 20 miles from the two closest male areas, while the remaining areas average about 10 miles apart. This spacing is probably a function of the topography of the coastline and ocean floor. Male areas are usually found where shallow water extends farther offshore than normal. This may be near an exposed point of land or a pass between islands. Points with water sheltered by numerous rocks and islets are more often used by females.

The spacing of male areas on the northwestern half of Amchitka is similar to that found on Tanaga and Kanaga islands (Schneider, 1972) and is probably more typical than that found on the southeast end.

Other Areas

Little is known about sex and age segregation in sea otter populations outside of the Aleutian Islands. Available information indicates that some form of segregation occurs, but that it may differ in nature between areas.

On June 2, 1970, over 2,150 sea otters in seven pods, each containing from 30 to 1,071 individuals, were photographed by John Vania in a small area near Amak Island in southwestern Bristol Bay. Resolution of the photographs was such that it was possible to determine whether most of the otters had pups or not. No pups could be identified even though the number of small pups in the population should have been high at that time of year. The size of the individuals varied considerably indicating a mixture of subadults and adults. This may or may not have been a case of sexual segregation, but at least one segment of the population (i.e. females with young pups) was excluded from the concentration.

Prince William Sound

Sex and age composition data from otters captured for transplants in certain areas at Hinchinbrook Island in 1965 (Fig. 4) and in the Green Island-Port Chalmers area adjacent to Montague Island in 1966 and 1972 (Fig. 5) are summarized in Tables 3 and 4.

Sample sizes are too small for concrete conclusions; however, these data and field observations indicate that the composition of sea otters in all of the capture areas is similar. Field observations indicate that sea otters move freely throughout the area inscribed by the 30-fathom curve around the Green Island-Port Chalmers area (Fig. 5) in response to food availability and changing weather conditions. All areas contained adult females, including those with pups, and adult males. Subadult males appeared to be virtually absent, indicating that some form of sexual segregation exists.

In general, the composition of the animals in these areas was similar to that found in female areas in the Aleutians. A major difference was that the percentage of males in these areas (33 to 41 percent) exceeded that found in Aleutian female areas at the same time of year (13 to 27 percent) and even exceeded that found near the peak of breeding

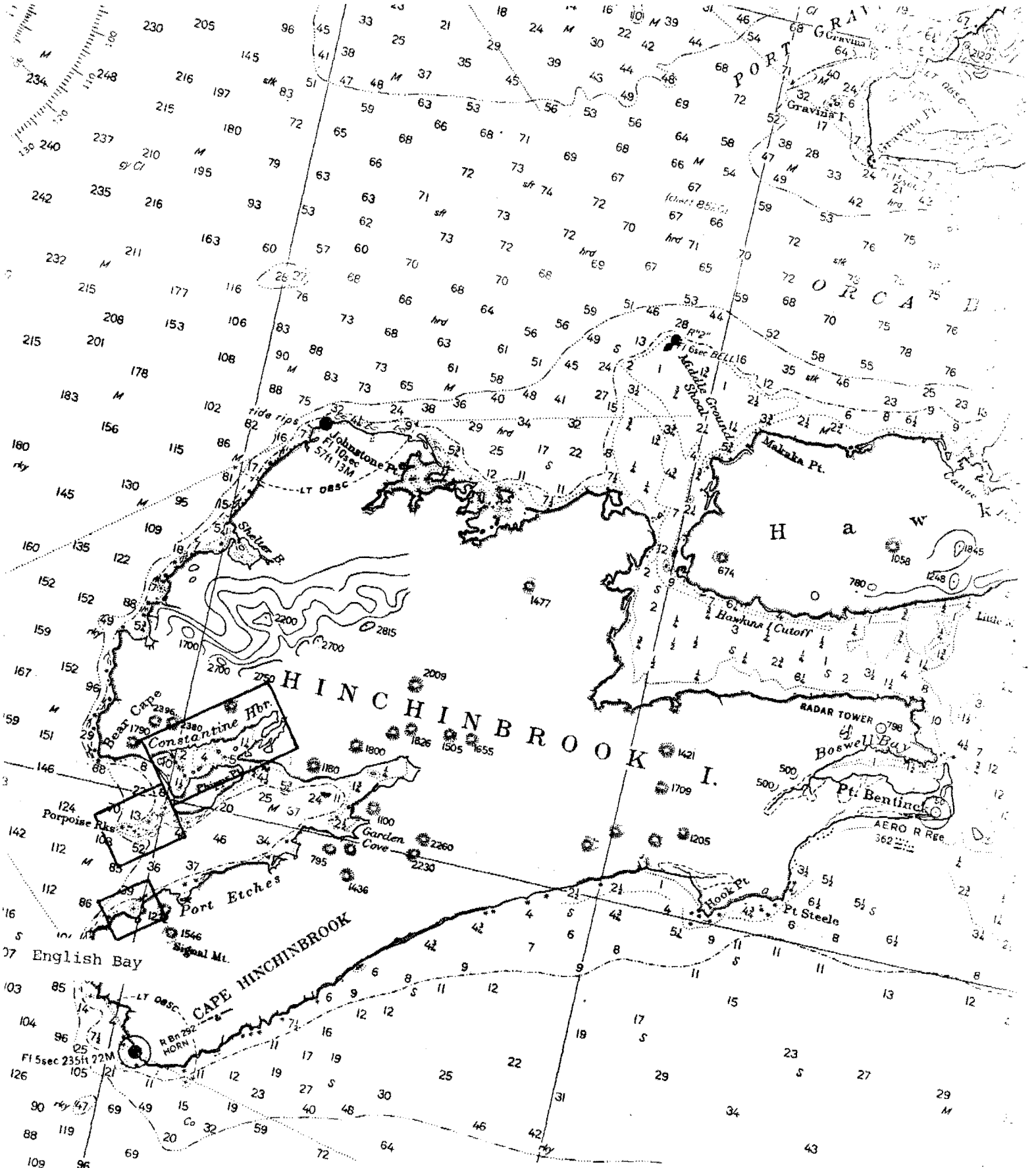

Figure 4. 1965 Transplant Capture Areas on Hinchinbrook Island.

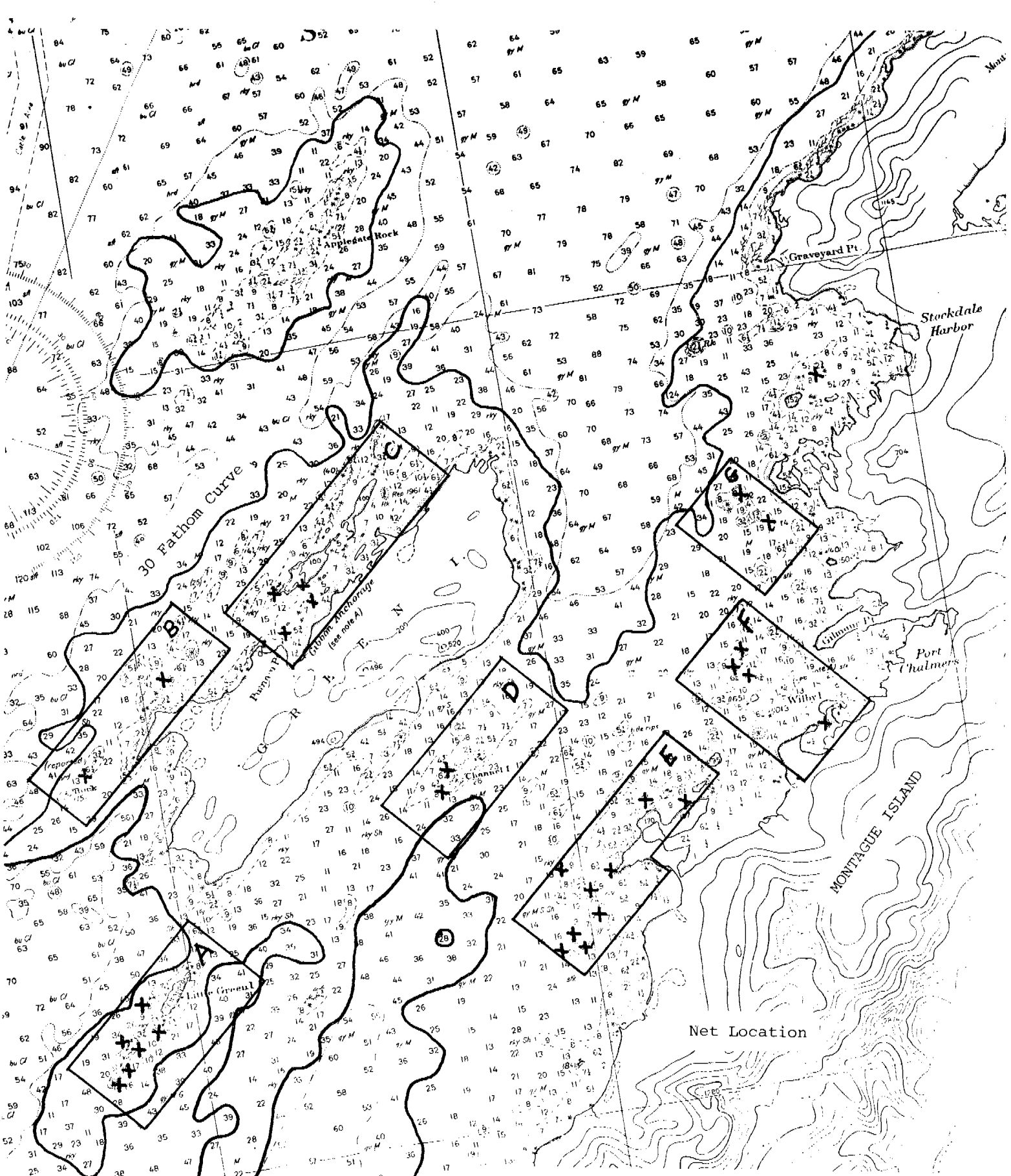

Figure 5. 1972 Transplant Capture Areas, Green Island - Port Chalmers Area.

Table 3. Sex and age composition of sea otters captured in Prince William Sound, 1965-1966. (Ages estimated from weights.)

	Adults		Subadults		Pups			All Ages		
	M	F	M	F	M	F	?	M	F	?
August 5-31, 1965										
Hinchinbrook Island										
Constantine Harbor	11	9	0	3	2	3	-	13	15	-
Porpoise Rocks	2	6	0	0	0	0	1	2	6	1
English Bay	1	4	0	3	0	0	-	1	4	-
Total Number	14	19	0	0	2	3	1	16	25	1
Percent	42	58	0	100	33	50	17	38	60	2
August 19-Sept. 2, 1966										
Green Island-Montague Island										
Number	13	19	0	2	2	1	-	15	22	-
Percent	41	59	0	100	67	33	-	41	59	-

Table 4. Sex and age composition of sea otters captured in the Green Island-Port Chalmers area of Prince William Sound, July 4-15, 1972. (See Fig. 5 for area designations. Ages estimated from weights.)

Area	Adults		Subadults		Pups			All Ages		
	M	F	M	F	M	F	?	M	F	?
A	4	10	1*	0	2	3		7	13	
B	0	1	0	0	0	0		0	1	
C	1	1	0	0	1	0		2	1	
D**	0	0	0	0	0	0		0	0	
E	5	11	0	1	2	2		7	14	
F	0	3	0	1	0	0	2	0	4	2
G	3	3	0	1	1	1		4	5	
Total No.	13	29	1*	3	6	6	2	20	38	2
Percent	31	69	25	75	43	43	14	33	63	3

* 33 lb. may have been a large pup.

**While no otters were caught at Channel Island in 1972, females and pups were caught there in 1966 and 1970.

(20 to 34 percent) (Schneider, 1972). Pups observed and caught in Prince William Sound in summer appeared to be larger and probably older than those in the Aleutians. It is possible that the peaks of pupping and breeding occur several months earlier in Prince William Sound. If the peak of breeding occurs in July and August, the high percentage of adult males in what appears to be typical female areas would be at least partially explained.

Male areas have never been reported in the Prince William Sound area. It is safe to conclude that none occur within the area shown in Fig. 5. All areas of prime sea otter habitat are known to have the characteristics of female areas.

There is considerable doubt as to whether male areas, as we know them in the Aleutians, exist in Prince William Sound. The topographical features common to Aleutian male areas do not exist in most parts of Prince William Sound. In the Rat and Andreanof islands of the Aleutians, sea otter habitat tends to be uniformly good over large areas (Fig. 3). Habitat in Prince William Sound is variable. Areas of excellent habitat are separated by long stretches of apparently marginal habitat. These latter areas are usually where the area of shallow water near shore is narrow. There are also some broad, shallow areas, such as those south of Hinchinbrook Island (Fig. 4) and off the southwest tip of Montague Island, which may be good habitat but aren't known to support high densities of sea otters. It is possible that nonbreeding males are dispersed throughout these areas, rather than concentrated in small discrete "male areas". If this is the case, we would expect discrete male areas to occur only where there is severe competition for long expanses of good habitat. We would also expect to find some areas in the Aleutians, where nonbreeding males occur, that are not typical male areas. Subadult males are known to frequent certain bays containing marginal habitat (Schneider, 1972). The north sides of such islands as Adak, Tanaga and Kanaga, where steep-sided volcanoes meet the water, may also be such areas. Limited observations indicate that few pups occur in these areas. We would not expect to find discrete male areas in populations that are substantially below carrying capacity, but would expect to find nonbreeding males in the sparsely populated portions of the area, particularly at the fringes of expanding concentrations. Possible support for this theory is the fact that single animals are usually the first to repopulate an area (Kenyon, 1969).

Until more areas are studied, we cannot be certain of the variety of ways in which sexual segregation may be manifested. Findings from one area should be applied to another area with caution.

RECOMMENDATIONS

Future studies should be directed at determining the extent and nature of sexual segregation in such areas as Prince William Sound. This can be best done at Montague Island where the most background information is available. Counts of pups and adults should be made along the northwest shore from Zaikof Point to Hanning Bay, including

the Applegate Rock and The Needles areas. These counts would be best done from a skiff but a helicopter might prove satisfactory. Particular effort should be made to determine the sex of animals in areas where no pups are seen. It may be necessary to selectively collect a few animals to accomplish this.

The following questions should be answered.

1. Do discrete male areas exist in Prince William Sound?

2. If male areas do not exist, where are the nonbreeding males in the population?

3. Does the distribution of pupping and breeding times in Prince William Sound differ from that found in the Aleutian Islands?

4. Does the number of adult males in female areas such as the Green Island-Port Chalmers area fluctuate throughout the year?

Studies in the Aleutian Islands should be directed at determining the changes in numbers of sea otters inhabiting male areas throughout the year. This should be done by repetitive shore counts in male areas that have adequate observation points. Crown Reefer Point and Sea Otter Point on Amchitka Island are suitable, but are still influenced by the reduction in numbers from the nuclear test "Cannikin".

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

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Project Nos.: W-17-4 & W-17-5 Project Title: Marine Mammal Investigations

Job No.: 8.11R Job Title: Reproduction in the Female Sea Otter

Period Covered: January 1, 1972 to December 31, 1972

SUMMARY

Seventy female sea otter reproductive tracts were examined. Fifty of these were sexually mature females collected in late June, 1971. A preliminary analysis of how this sample affects previous conclusions on the annual pattern of reproductive activity was made.

The major pupping period is more distinct than previously believed. It begins in early to mid-April, reaches a peak in mid-May and is over by late June. The peak breeding period probably is of similar duration and magnitude but is centered around October 1.

The mean gestation period is about 7.5 months. The blastocyst remains unimplanted for about half of this time.

Superficial evidence indicates that the timing and distribution of births and breeding may vary between widely separated areas.

Females classed as post-partum have usually given birth within the previous 1.5 months.

Females lactate as long as they are accompanied by a pup. They only occasionally become pregnant when they are still lactating.

A preliminary examination of the ages of nulliparous females indicates that most females enter their first estrus when 4 years old, but a few may do so when between 3 and 4 years old. This first estrus may not result in a successfull pregnancy.

CONTENTS

BACKGROUND

The first observations of sea otter (*Enhydra lutris*) reproduction were made by Steller (1751). Very little new information was collected over the next 200 years. A number of isolated observations were summarized by Lensink (1962). The first extensive studies of sea otter reproduction were initiated after the Alaska Department of Fish and Game harvested sea otters in 1962 and 1963, making relatively large numbers of reproductive tracts available. Studies of the morphology of the reproductive tract and histological changes associated with the reproductive cycle were accomplished using these specimens (Sinha, 1965; Sinha et al., 1966; Sinha and Mossman, 1966; and Sinha and Conaway, 1968). Kenyon (1969) made the first real attempt to determine the rates and timing of reproduction on a population-wide basis. These studies were based on fairly large samples from winter and early spring. Unfortunately very little information was available for other times of year.

In 1967, the Alaska Department of Fish and Game resumed harvesting and large samples from other times of year became available. The Department began accumulating data at that time and preliminary findings were reported by Vania et al. (1968). Collection of reproductive tracts continued until 1971. Preliminary analysis of data collected between 1967 and 1970 was presented by Schneider (1972).

OBJECTIVES

To gather basic information on reproduction in the female sea otter and to determine the rates and timing of reproduction for sea otter populations.

PROCEDURES

Seventy female sea otter reproductive tracts collected in 1971 and 1972 were examined using procedures outlined by Schneider (1972). Fifty of these tracts were from sexually mature females collected between June 24 and 28, 1971 at Amchitka Island. Previous summer samples had been collected from animals that died during transplants and were biased in favor of pregnant females with large fetuses. These samples distorted our understanding of the distribution of pupping throughout the year. The annual reproductive cycle was reevaluated using the 1971 sample in place of the transplant samples.

The age of sexual maturity of female sea otters was determined by comparing the ages of nulliparous and multiparous animals. Ages were estimated from cementum layers using the techniques described by Schneider (1972).

FINDINGS

The reproductive status of 1178 sexually mature sea otters from all samples large enough for meaningful comparison is summarized in Table 1. The June, 1971 sample was collected by randomly shooting all available animals in female areas. The difference between this sample and the transplant mortality samples is striking. The 1971 sample contained more anestrous and post-partum animals and fewer pregnant animals with large fetuses. This confirms that sea otters with large fetuses are more likely to die during transplants, and probably also reflects the fact that females with small pups are less likely to be caught in nets than single animals. The bias in these transplant samples made it appear that the peak pupping period extended through the summer (Schneider, 1972).

Seasonal changes in the reproductive cycle are shown graphically in Figs. 1, 2 and 3. The January and March information is from Kenyon (1969). Summer samples collected from transplant mortalities were not used. The curves were subjectively fitted to the data.

Basically the annual fluctuations in reproductive status within sea otter populations are similar to those reported by Schneider (1972). However, the new information from the June, 1971 sample indicates that more abrupt changes occur between May and June.

The changes in the anestrus and implanted pregnant curves between May and June are exaggerated. All of the samples except those from June were from harvests where hunters tended to avoid shooting females with pups. This reduced the number of anestrous females and consequently increased the percentage of pregnant animals in the samples. The bias may amount to 10 to 15 percent of the mature females in May (Schneider, 1972), but is probably considerably lower in fall and winter when most pups are larger and less obvious to the hunter. Animals were shot as randomly as possible without regard for size, sex or reproductive status during the June, 1971 collection. The composition of this sample probably comes closest to that found in the population.

Table 1. Reproductive condition of sexually mature sea otters.

Dates	Location	Inactive Ovaries			Active Ovaries			Fetus Weight Class*					Total
		Anestrous	Post-Partum	Resorption	Preestrus + Estrus	Unimpl. Preg.	Impl. Preg.	1	2	3	4	5	
May 4-8, 1970	Tanaga I.	51 (16.8)	41 (13.5)	10 (3.3)	10 (3.3)	88 (28.9)	104 (34.2)	17 (5.6)	8 (2.7)	10 (3.3)	35 (11.4)	33 (10.9)	304
May 9, 1970	Delarof Is.	18 (23.4)	14 (18.2)	1 (1.3)	4 (5.2)	13 (16.9)	27 (35.0)	10 (13.0)	0	3 (3.9)	6 (7.8)	8 (10.4)	77
May 10-12, 1970	Amchitka I.	34 (24.6)	18 (13.0)	3 (2.2)	8 (5.8)	27 (19.6)	48 (34.8)	5 (3.6)	6 (4.3)	2 (1.4)	23 (16.7)	12 (8.7)	138
June 24-28, 1971	Amchitka I.	28 (56.0)	9 (18.0)	0	0	6 (12.0)	7 (14.0)	1 (2.0)	1 (2.0)	2 (4.0)	1 (2.0)	2 (4.0)	50
June 23 - August 13, 1968	**Amchitka I.	17 (38.6)	2 (4.5)	1 (2.3)	2 (4.5)	4 (9.0)	18 (40.9)	1 (2.3)	2 (4.5)	3 (6.8)	5 (11.3)	7 (15.8)	44
July 6 - August 8, 1969	**Amchitka I.	17 (36.9)	1 (2.2)	0	4 (8.6)	14 (30.4)	10 (21.9)	0	1 (2.2)	1 (2.2)	2 (4.3)	6 (13.2)	46
Sept. 10-17, 1967	Adak I.	72 (43.9)	5 (3.1)	0	16 (9.8)	31 (18.9)	40 (24.4)	6 (3.7)	6 (3.7)	8 (4.9)	9 (5.5)	11 (6.7)	164
Sept. 25 - Oct. 6, 1967	Amchitka I.	55 (47.8)	6 (5.2)	0	18 (15.7)	19 (16.5)	17 (14.8)	4 (3.5)	0	0	10 (8.7)	3 (2.6)	115
Oct. 12-15, 1968	Kanaga I.	58 (41.3)	6 (4.3)	1 (0.7)	13 (9.3)	31 (22.2)	31 (22.2)	4 (2.9)	4 (2.9)	7 (5.0)	11 (7.8)	5 (3.6)	140
Oct. 18-20, 1968	Adak I.	46 (46.0)	6 (6.0)	0	11 (11.0)	24 (24.0)	13 (13.0)	2 (2.0)	3 (3.0)	0	4 (4.0)	4 (4.0)	100

Numbers in parenthesis are percent of sexually mature females.

* Fetus weight class 1 = 0-1g, 2 = 1-10g, 3 = 10-100g, 4 = 100-1000g, 5 = 1000+g.
**Transplant mortalities (all other samples from harvests).

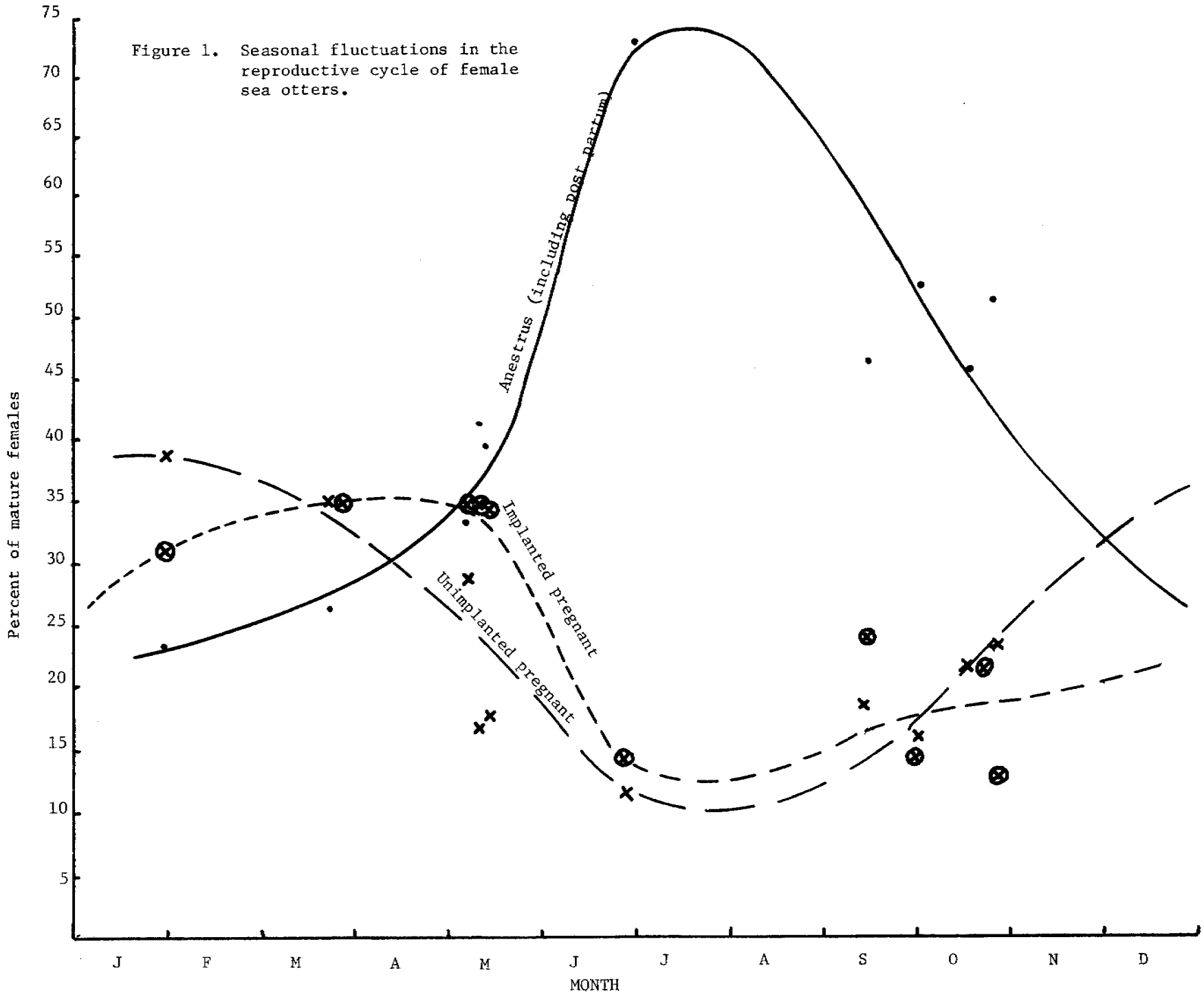


Figure 1. Seasonal fluctuations in the reproductive cycle of female sea otters.

Figure 2. Seasonal fluctuations in the reproductive cycle of female sea otters.

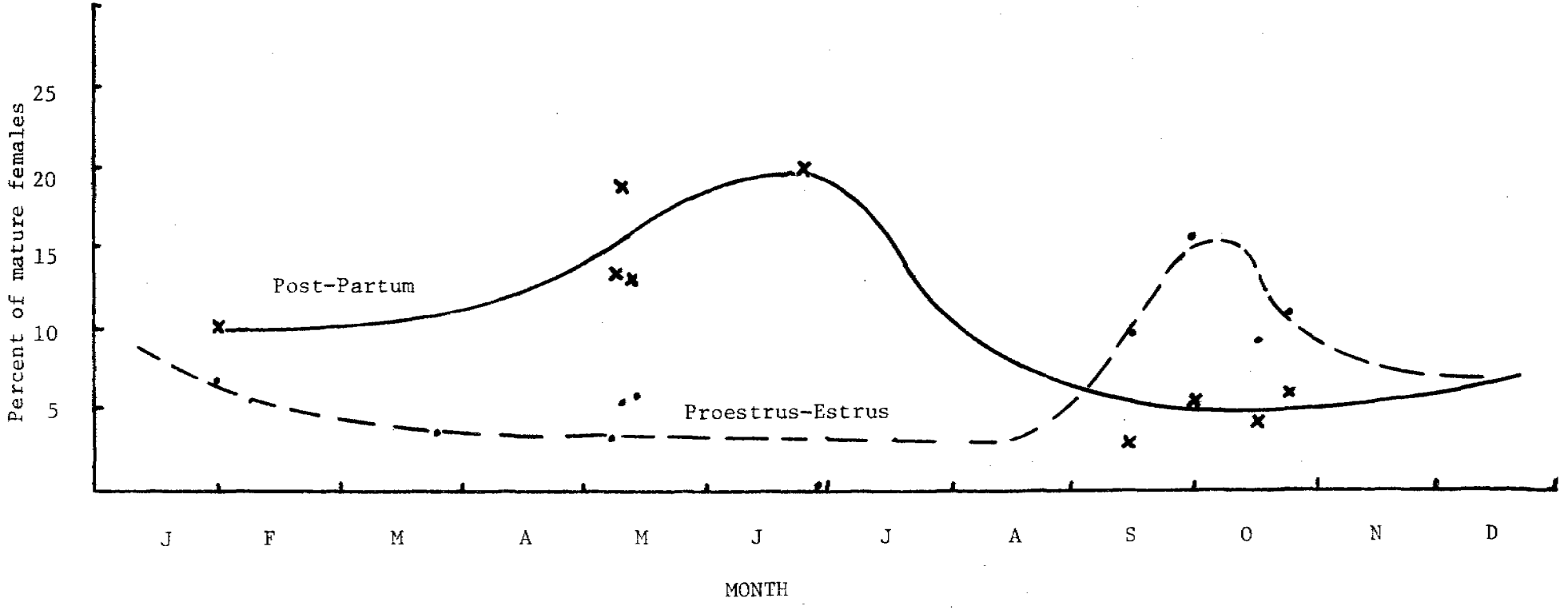
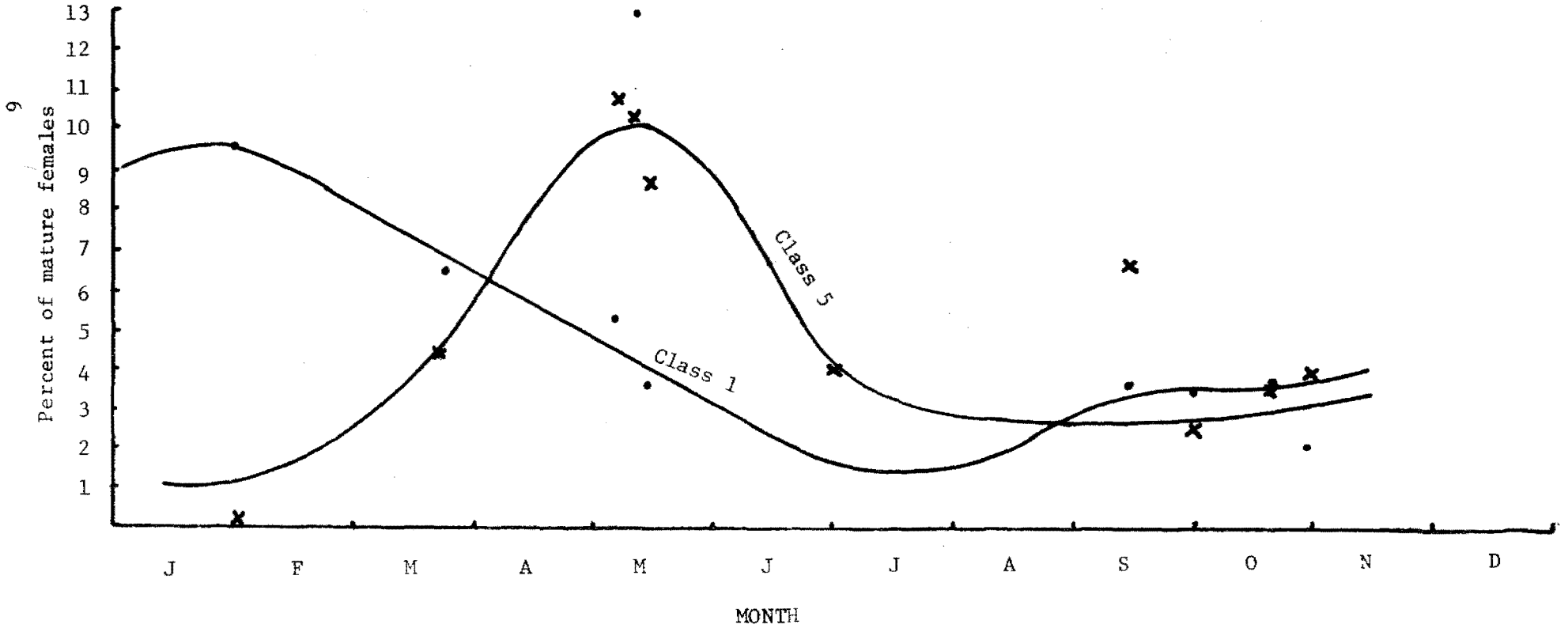


Figure 3. Percent of mature females with weight class 1 and 5 fetuses.



Peak Pupping Period

The peak period of pupping is more restricted than previously believed. We do not have information clearly defining the beginning of this period, however. The relatively high percentage of post-partum animals collected in May indicates that large numbers of pups are born in April. The number of class 5 fetuses rises rapidly during April (Fig. 3) indicating that the rate of birth is considerably lower than the rate at which fetuses are entering class 5. If the fetus remains in class 5 for three weeks (Schneider, 1972), those entering that class in April would be born in May. This evidence indicates that, although the birth rate increases significantly sometime in April, the greatest number of births occurs in May. The anestrus curve (Fig. 1) rises abruptly between early May and late June while the implanted pregnant curve drops abruptly. At the same time, the number of post-partum females reaches a peak (Fig. 2) and the number of class 5 fetuses drops (Fig. 3). By late June, the number of anestrous females has reached a peak and the number of implanted pregnant females is at its lowest point of the year. These changes indicate that there is a high rate of birth between early May and late June and that the peak period of pupping is over by late June. Therefore the peak pupping period appears to extend from early or mid-April to mid-June with the birth rate reaching its peak in mid-May. This distribution of births closely matches that estimated from fetal weights (Schneider, 1972).

Breeding

No females in the June, 1971 collection were in proestrus or estrus. One female that died during the June, 1971 transplant was in proestrus and small numbers of females in proestrus and estrus have been found in earlier transplants (Table 1). Therefore we can assume that the lack of such animals in the June 1971 collection is a result of inadequate sample size and that at least a low level of breeding occurs throughout the summer. Field observations of copulating pairs also confirm this.

In previous analyses of the peak breeding period, it had been assumed that differences in percent of mature females in proestrus and estrus in the four September and October samples (Fig. 2) were due to random variability, rather than actual changes in the population. We have found the pupping peak to be sharply defined. If the peak breeding period is of equal duration and magnitude, it is possible that some of this variability is due to real changes in the population. When the shape of the proestrus-estrus curve is adjusted accordingly (Fig. 2), we find a sharp peak of breeding around the first of October. At the same time, the unimplanted pregnant curve begins to rise sharply.

Gestation Period

The time between the peak of breeding, October 1, and the peak of pupping, mid-May, should roughly equal the average gestation period. This would be about 7.5 months or 227 days. This is slightly shorter than previously estimated.

Schneider (1972) estimated that the blastocyst remained unimplanted for 48 percent of the total gestation period. This estimate was based in part on the two transplant mortality samples (Table 1). We have shown that the transplant samples were biased in favor of implanted pregnancies. If we replace those samples with the June 1971 sample, we get a new estimate of 50 percent. Because this is an unweighted average and some of the samples are small, this estimate should be considered only approximate.

The unimplanted and implanted periods would each average about 114 days. This is only slightly shorter than the 120-day implanted period that Kenyon (1969) estimated by plotting the cube roots of term fetus weights of various species of otters. The rate of fetal growth would be slightly faster than estimated by Schneider (1972).

Timing of the Reproductive Cycle in Other Areas

The preceeding discussion is based entirely on sea otters from the western Aleutian Islands and may not apply to populations in other areas. Observations of other workers indicate that the timing and distribution of birth in California are different. Murie (1940) found very few small pups in California in July. This and recent unpublished work by others indicate that California sea otters may have a more distinct pupping season which occurs in late fall or early winter. Superficial evidence indicates that the breeding season in Prince William Sound, Alaska, may occur earlier than in the Aleutian Islands (see Job 8.9, this report). However, the variability in sizes of pups captured there during transplants (Table 2) indicates that there is not a discrete pupping season. The preponderance of larger pups in the sample may be, in part, due to selectivity of the capture technique, but field observations indicate that in July and August there are fewer very small pups in Prince William Sound than in western Aleutian Islands.

Recovery of the Uterus After Parturition

During the June, 1971 collection a relatively large number of mother-pup pairs were shot together and immediately marked. The size and age of these pups are compared with the condition of the mother's uterus in Table 3. The size of pups accompanying post-partum females is somewhat variable. The age class is more consistent. Class I pups may be from 0 to 1.5 months old. Therefore, females with an enlarged uterine horn and a fresh, rough-looking placental scar probably have given birth within the previous month and a half.

Early Mortality of Pups

Four out of 10 post-partum females were not accompanied by a pup and were not lactating. These may have aborted or the pup may have been lost shortly after birth. This mortality coincided with a period of high predation by bald eagles (*Haliaeetus leucocephalus*) on very young sea otter pups (Estes and Smith, 1973).

Table 2. Weights of sea otter pups captured in Prince William Sound.

	Males	Females
August 5-17, 1965		34 pounds
		16 pounds
August 19 - Sept. 2, 1966	26 pounds	32 pounds
	28 pounds	
July 3-15, 1972	30 pounds	24 pounds
	25 pounds	16 pounds
	10 pounds	7 pounds
	21 pounds	12 pounds
	10 pounds	26 pounds
	26 pounds	27 pounds

Table 3. Size and age class of pups accompanying post-partum and anestrous females collected June 1971.

Sex	Weight (pounds)	Total Length (cm)	Age Class*
Post-partum			
F	4.2	54	I
M	4.6	56	I
F	6.0	63	I
F	6.75	64	I
Post-partum - Anestrous			
M	7.5	68	I
Anestrous			
F	6.5	69	II
M	7.5	65	II
F	7.75	75	II
M	8.13	71	--
M	10.0	76	II
F	10.0	80	III
F	11.0	73	III
F	11.0	78	III
F	11.0	86	III
M	13.0	87	III
F	15.0	86	--
F	25.0	101	--
M	37.0	113	--

*From Lensink (1962).

Frequency of Breeding

Twenty-four females collected in June 1971 were known to be lactating. Sixteen of these were known to be accompanied by a pup. The other eight are assumed to have had pups, either at the time of collection or shortly before. Six of the eight were collected at one spot where there was considerable confusion as to which pup went with which female. As a result many pups were not matched with females. The other two were killed near pups which were not matched with females. Most or all cases where a lactating female was not recorded to have a pup were due to errors in recording and not because the female did not have a pup.

Four females were accompanied by small pups but were not recorded to be lactating. Therefore, a total of 28 females were known or believed to have a pup at the time of collection. Twenty-one of these were judged to be anestrous, six post-partum and one appeared to be supporting a normal, early, unimplanted pregnancy. This is a lower percentage of active ovaries for such animals than found in previous samples (3.5 percent vs. 13.4 percent). This may be partly due to sample size, but also reflects the relatively low level of breeding in June and the high number of females that have had pups in the previous three months. The unimplanted pregnancy is one of the very few recorded incidences of pregnancy in a lactating female sea otter. Unfortunately, this female could not reliably be matched with a pup when collected. Therefore we do not have any indication of when she last gave birth, but it is probable that the interval between the last birth and the next birth would have been less than the normal two years.

The length of the nursing period is not known. Two pups collected in June 1971 with lactating females were large (Table 3). Normally, pups do not remain with the female after they reach a weight of 25 to 30 pounds. The 37-pound male may be the largest pup known to still be with its mother. We do not know its age. It appears that females continue to lactate as long as they are accompanied by a pup.

Age of Sexual Maturity

An examination of the estimated ages of 76 nulliparous females collected in 1968 indicates that most female sea otters become sexually mature after their fourth year. All less than 3 years old (44 of 44) were anestrous, having immature ovaries contianing no follicles exceeding 2 mm. Two of 16 nulliparous females, estimated to be between 3 and 4 years old, showed signs of sexual maturity. One of these was in estrus and the other had a regressing corpus luteum or luteinized attritic follicle. Nine of 10 females, estimated to be 4 years old, were becoming mature. Eight of these were in either proestrus or estrus and one was supporting an unimplanted pregnancy. No females estimated to be 5 years old or older were immature. Two 5-year-olds, one 6-year-old and one 7-year-old were in proestrus or estrus but had not previously been pregnant. One 5-year-old and one 6-year-old each had either a corpus albicans or remnant of a large attritic follicle and a nulliparous appearing uterus. When this information is combined with that from other sexually mature females collected at the same time (Schneider, 1972), it appears that a

few females may enter their first estrus when they are between 3 and 4 years old, but most do not until they are about 4 years old. This first estrus may not result in a successful pregnancy and some females may be 7 or 8 years old before they bear their first pup.

RECOMMENDATIONS

The age of sexual maturity and age of weaning for pups should be investigated further.

Information on the timing and distribution of breeding and pupping should be obtained from areas outside of the Aleutians. Initially this could be done with a series of pup counts, however, it will probably be necessary to make at least one or two collections of a minimum of 50 mature females to establish the approximate magnitude of any difference between populations.

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