ALASKA DEPARTMENT OF FISH AND GAME
JUNEAU, ALASKA

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MARINE MAMMAL REPORT

by

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Project W-14-R-1 and 2, Work Plan F

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WORK PLAN SEGMENT REPORT

FEDERAL AID IN WILDLIFE RESTORATION

STATE: Alaska

PROJECT NO: W-14-R-1 and 2 TITLE: Marine Mammal Investigations

WORK PLAN: F TITLE: Walrus and Seals

JOB NO: 1 TITLE: Walrus Biology and Population

PERIOD COVERED: January 1, 1966 to December 31, 1966

ABSTRACT

Analysis of the age composition of 353 male walrus taken at Savoonga indicated an annual mortality rate of about 12 per cent for the year classes 14 through 28, and about 14 per cent for animals 14 through 33 years of age. These mortality rates are considered to be maximum estimates because of various factors resulting in under-representation of the older year classes in the harvest. By comparison with the age composition of previous harvests it is obvious that there is adequate recruitment to those year classes subject to the heaviest hunting pressure.

The size of the walrus population is apparently continuing to increase. The calculated rate of hunting mortality remained the same as in previous years even though the harvest was higher than usual. Although annual walrus harvests since 1961 have been composed of 65 to 70 per cent males, all indications are that there is a more than ample number of breeding bulls remaining. At present, the maximum mortality rate (due to hunting) in males is less than the birth rate. Bulls are sexually mature for several years before they enter the harvest in any significant numbers, and there is no indication that the rate of reproduction has decreased.

The average number of conceptions in 36 sexually mature females from which reproductive tracts were obtained was 4.9. Increased survival of female walrus is probably the result of the greater protection afforded them as the result of bag limits in effect during the past six years. However, we will need additional information during subsequent years to determine this with any degree of certainty.

Approximately 300 walrus were seen in Nushagak Bay during early May. During early June, approximately 3,000 walrus were in the vicinity of Round Island, in Bristol Bay. As far as could be determined, they were all males. Walrus were observed on the beaches of Big Diomede Island and the Punuk Islands during early December.

RECOMMENDATIONS

An extensive collection of female reproductive tracts, teeth and supporting data should be made in 1971 to determine if any significant changes in the annual rate of reproduction have occurred since the last major collections were obtained in 1965. More information is needed concerning the true proportion of older females in the population, and the significance of these animals with respect to reproduction.

The present bag limit of five adult females per hunter, per year, should remain in effect. Efforts should be continued to improve hunting techniques at all villages where walrus are taken.

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OBJECTIVES

The work objectives for this report period included a continuing effort to evaluate the present status and trend in the Pacific walrus population, and to determine the effects of recent harvests; to obtain information on herd composition and distribution throughout the year, and attempt to determine the various factors affecting distribution; to try and uncover the causes and significance of natural mortality, and the survival success of the younger cohorts in the population (especially orphaned calves); to investigate all phases of walrus biology that would enhance our present knowledge of the various aspects of reproduction; and to investigate the various aspects of social organization and behavior of walrus.

PROCEDURES

Investigation of the status and trend in the walrus population centered largely around obtaining information concerning the age composition and magnitude of the harvest. The long range walrus research program included an area wide collecting program, during 1967, to obtain lower canine teeth for walrus age determination. The last thorough analysis of the age composition of the walrus harvest is based on area wide collections obtained during 1962. It is felt that relatively complete samples, collected at five year intervals, would indicate any major changes in the size of the walrus population and/or the population trend, and provide a means for estimating the size of the population. Population estimations obtained in this manner will be compared with results obtained from aerial surveys. During the spring of 1966, a limited tooth collecting program was initiated at Savoonga. Both lower canine teeth were collected from 353 male walrus.

This sample amounted to 89 per cent of the total spring harvest of 397 males taken at Savoonga. Although the large scale collecting program will be undertaken during the coming spring, it was felt that a limited sample should be made during 1966 to provide information for comparison with the 1967 aerial survey in the event that the coming walrus hunting season is a poor one.

The collections were made at Savoonga because this is the site that consistently takes the greatest number of bulls, and it is also the site from which we have the greatest amount of previous information (starting with collections obtained by Dr. F. H. Fay, in 1953).

All teeth were longitudinally cross sectioned by Mr. Edward Muktoyuk. Sections from both teeth of each animal were examined. In this manner, all age determinations were double checked, and in a few cases where one tooth section was poor, the other one was usable.

In brief, age determinations were based on the number of cementum layers counted in the tooth sections. Sections were examined using low magnification with a binocular microscope. Either direct or refracted light was used, depending upon which proved most satisfactory with individual cross sections. In most instances, tooth sections did not require polishing. The rings or layers appeared as dark bands in refracted light, and light bands in direct light. It was found that the rings were more distinct if tooth sections were allowed to soak for several days before being examined. I used a mixture of 70 per cent alcohol and xylol.

For a more complete discussion of the use of teeth for determining age in Pacific walrus see Fay (1955), Harbo (1961) and Burns (1965).

Information was obtained concerning the magnitude and composition of the 1966 harvest at each village where walrus were taken (see seg. rpt. Job F-2). Department observers were stationed at the traditionally productive hunting sites to obtain specimens and data for the continuing biological studies, to enforce the hunting regulations, and to present the Department's walrus management program to the people actually involved in exploitation of this animal.

The extensive general collections of female reproductive tracts were discontinued last year, as adequate samples were obtained, and results of analysis were consistent with previous findings. However, during 1966 a limited amount of reproductive material was collected at Little Diomede Island in order to learn more about the reproductive performance of females older than 20 years of age, and to check field observations of the cow:calf ratio.

Reproductive history of those animals from which material was collected was obtained by examining ovaries for corpora lutea and/or corpora albicantia. No female reproductive tracts were obtained after June 10 so it was not possible to obtain additional information about the period of time during which implantation occurs.

All information concerning the movements, distribution, and areas where walrus were observed near or on land were recorded.

Field notes of Mr. Duff Kimsey (provided by Mr. Fred Woldstad, ADF&G, Anchorage) contained information about the numbers and activities of walrus on Round Island in Bristol Bay, during the period from May 27 to June 20.

FINDINGS

Analysis of the age composition of the walrus harvest at Savoonga does not necessarily yield findings that we can generally apply to all other areas in Alaska where walrus are taken. However, meaningful comparisons of many years' data obtained at the same location (in this case Savoonga) can be made, and it will indicate any major changes in the population.

Ricker (1948, 1958) describes in detail the procedure used to determine mortality and survival in fish populations, for which means of determining the age composition of the catch have been known for a long time.

Using the "catch curve" method described by Ricker (1948), Fay (1955) made the first estimate of annual hunting mortality in the Pacific walrus. This estimate was 11 per cent. Subsequent estimates by Fay (1960) indicated a mortality rate of 15 per cent, and Harbo (1961) indicated that annual hunting mortality was between 12 and 15 per cent. My results (Burns, 1965) based on data collected during 1961 and 1962 indicated a mortality rate of 13 per cent.

No collections of male walrus teeth were made between 1962 and 1966.

As was already pointed out, during the last spring hunting season (April and May, 1966) lower canine teeth were collected from 353 male walrus taken at Savoonga. From this sample, the annual rate of hunting mortality was calculated for two inclusive age categories: 1) males between the ages of 14 to 29 years, and 2) males from 14 to 33 years of age. The resulting mortality rates were about 12 and 14 per cent respectively (Figure 1).

The use of mortality rates derived from the male segment of the harvest rather than from either the entire harvest, or the female segment alone, is because of the extremely biased samples of females obtained. This bais results from the fact that hunters have greatest access to nursery herds which are composed of the younger, reproductively active females. On the other hand, males of all ages are distributed (and harvested) much more randomly.

However, in spite of more random sampling of males, at least two factors are operative, and result in calculated rates of mortality which are higher than the actual rates. These are: 1) selection by hunters for those animals with the best tusks (these are not necessarily the older bulls), and 2) the fact that there is some error involved in correctly determining the age of old animals. Some of the later cementum layers deposited in old animals are frequently hard to differentiate, and also, some layers are apparently lost through attrition and tooth wear.

However, these sources of bias are relatively constant so that although the rate of mortality due to hunting is lower than our calculated rates (actual hunting mortality in the male segment of the population is probably 10 to 12 per cent), mortality rates obtained during various years are directly comparable.

As can be seen in Figure 2, in spite of considerable variation in the annual harvests at Savoonga, the same year classes comprise the greatest segment of the kill. There is obviously adequate recruitment. The 1966 harvest shows a greater

Figure 1. Catch curve and derived mortality rate for male walrus taken at Savoonga during 1966. Age was determined on the basis of the number of cementum layers observed in sectioned canine teeth. The catch curve analysis follows the methods outlined by Ricker (1948, 1958).

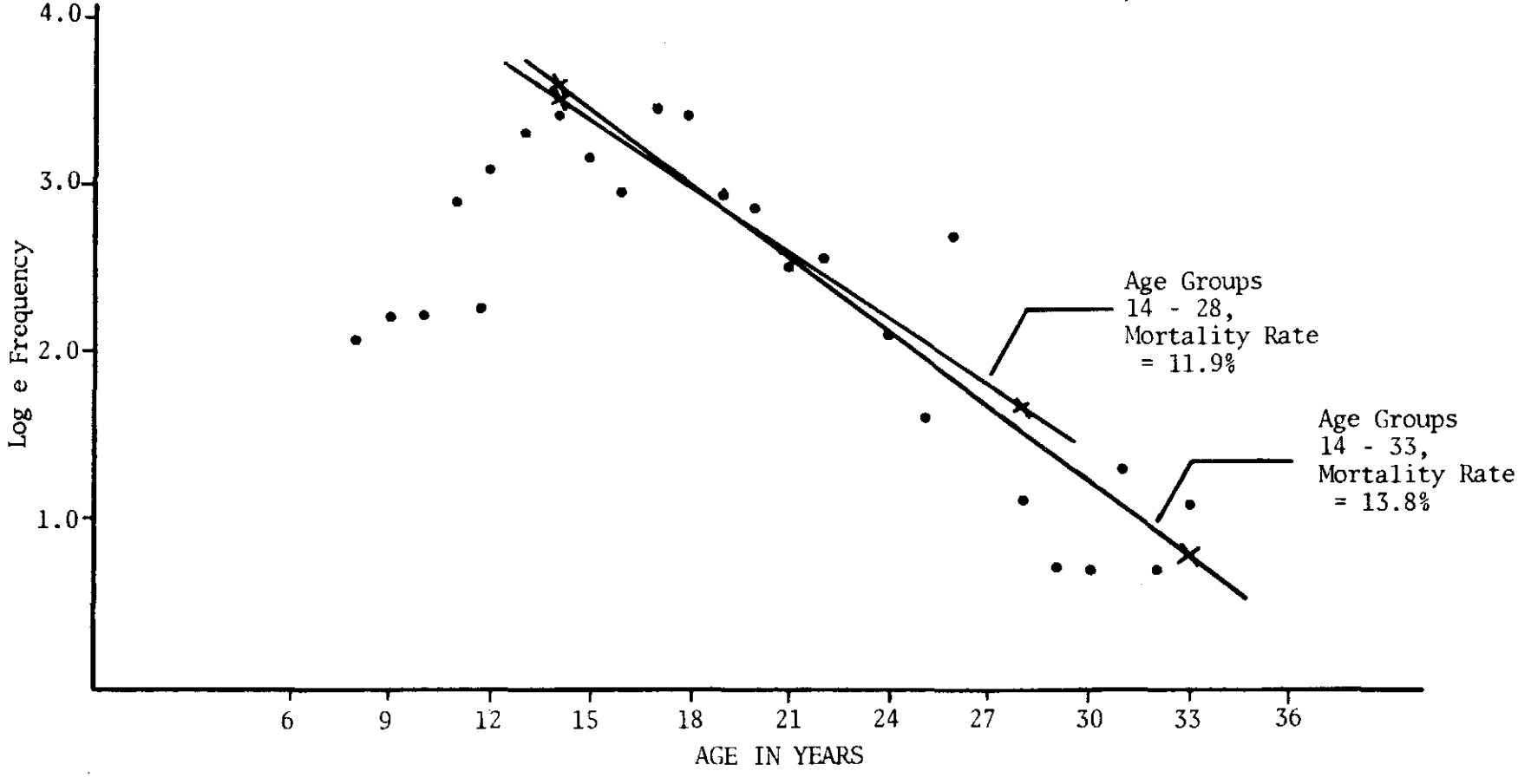
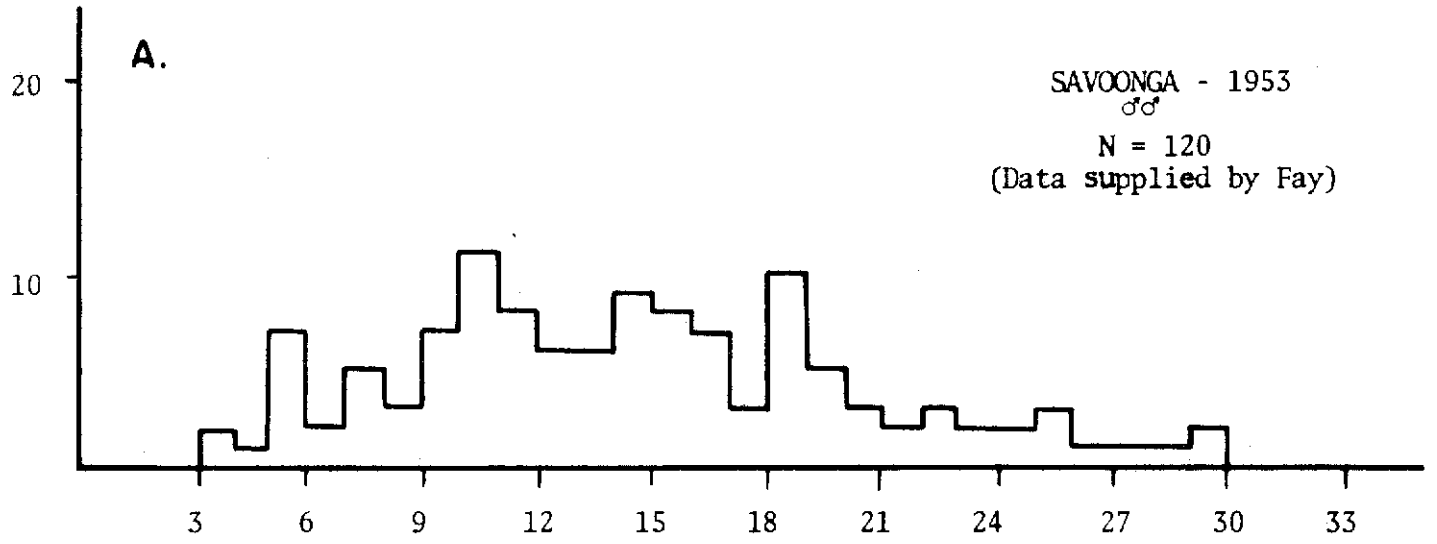


Figure 2. Age composition of the male segments of walrus harvests at Savoonga in (A) 1953, (B) 1956, (C) 1957, (D) 1960, (E) 1961, (F) 1962, (G) 1966.



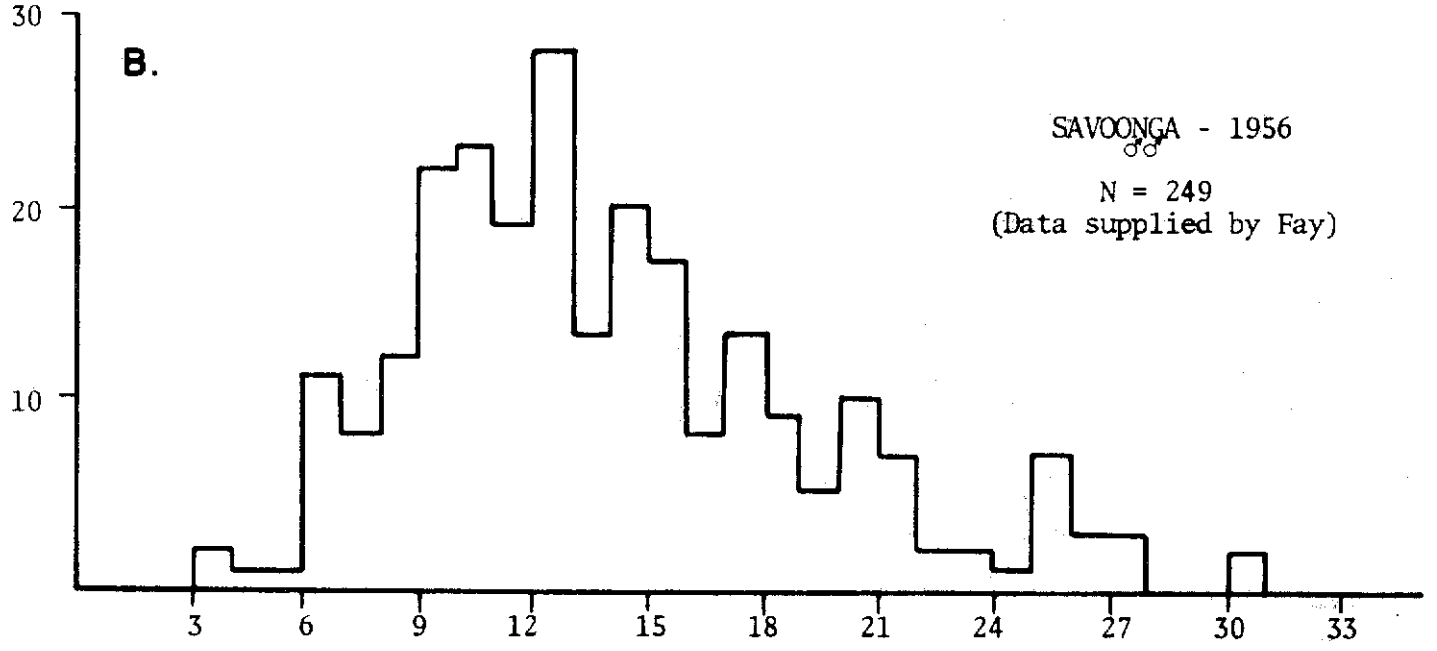
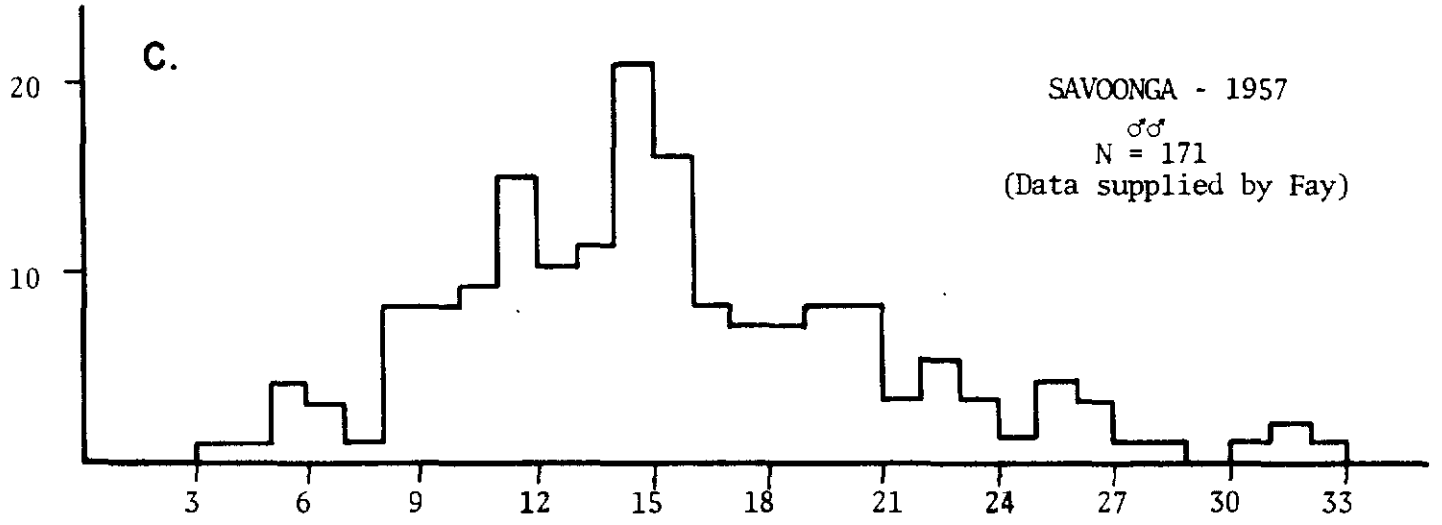
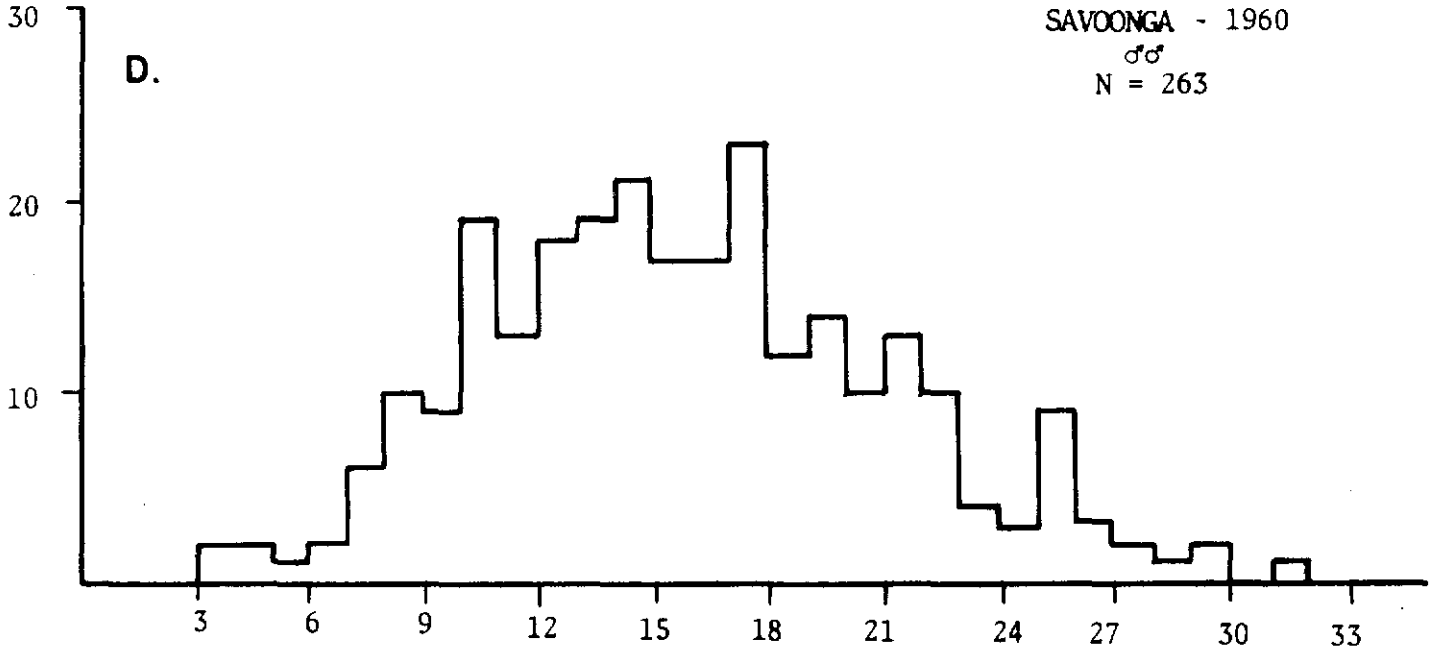


Figure 2. Age composition of the male segments of walrus harvests at Savoonga in (A) 1953, (B) 1956, (C) 1957, (D) 1960, (E) 1961, (F) 1962, (G) 1966. (Continued)





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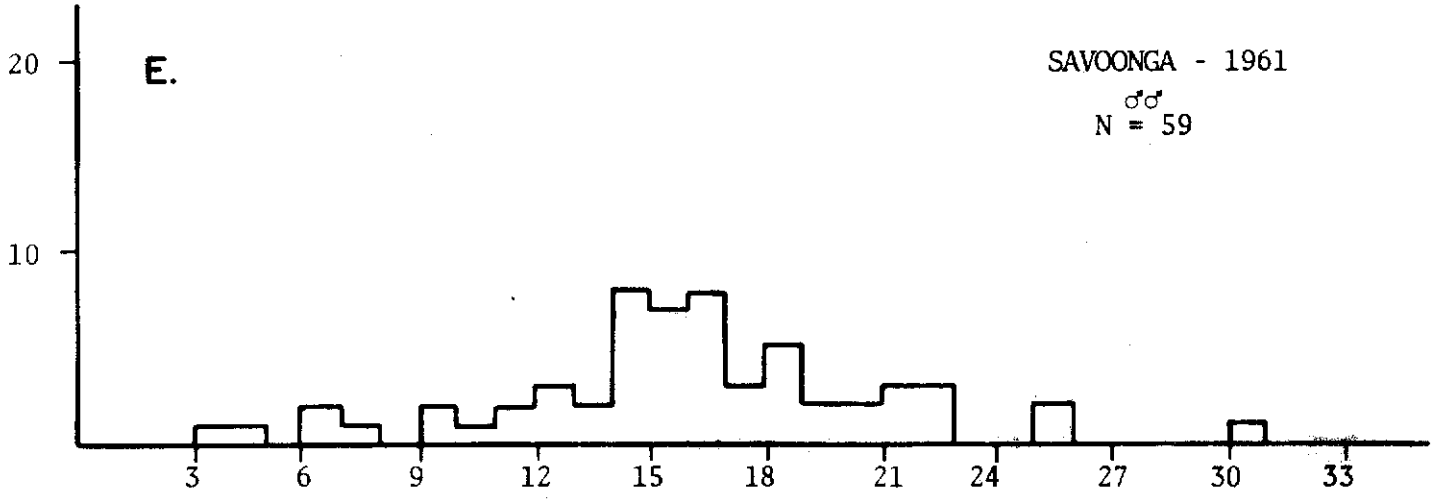

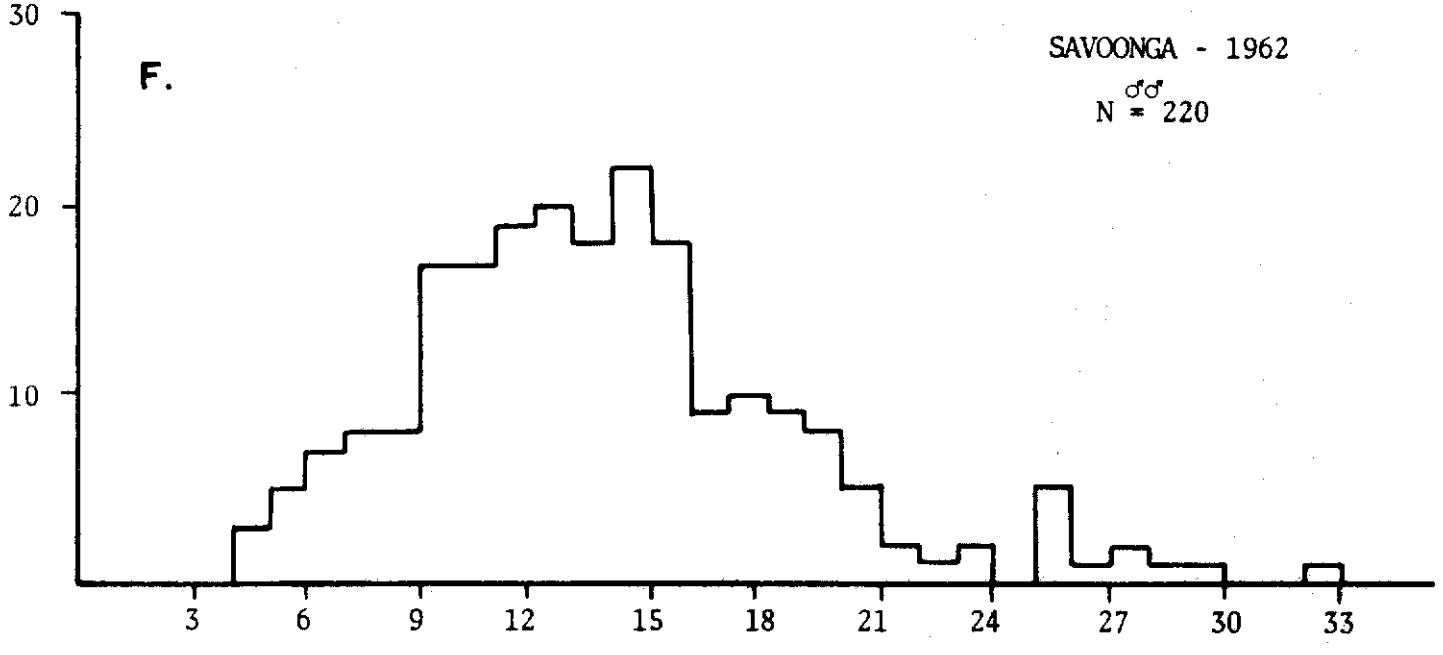

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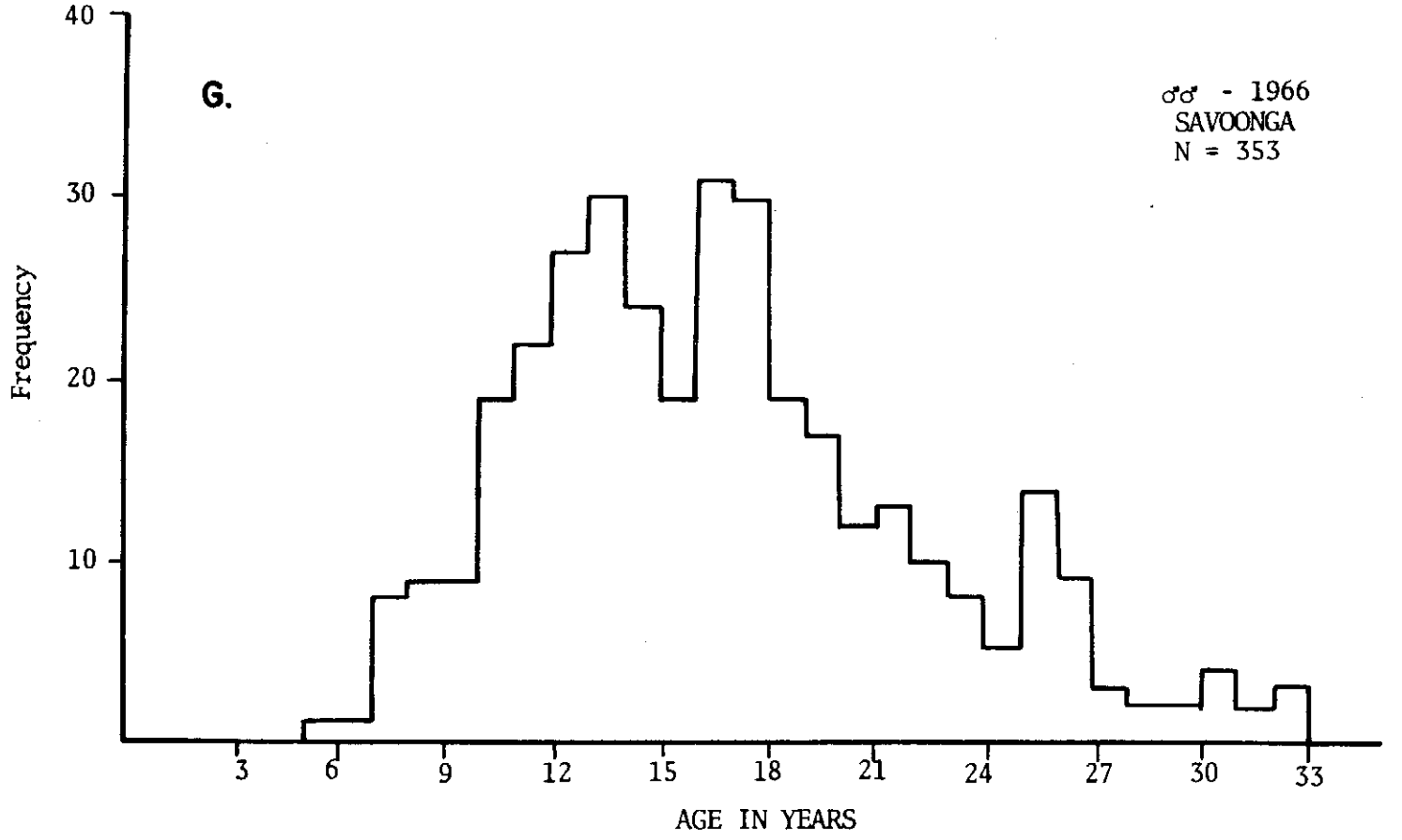

preponderance of animals older than 17 years (52 per cent) than any of the previous harvests, and the calculated mortality rates--12 to 14 per cent depending upon which age classes are included--were about the same as in previous years in spite of the fact that the harvest was much greater than usual. During the 1962 spring walrus harvest at Savoonga, 293 animals were taken. In 1966, 455 walrus were harvested.

In relating annual mortality due to hunting of the males to the walrus population as a whole it should be kept in mind that in all age classes other than calves, recent annual harvests have been comprised of only 30 per cent females. In other words, we have been calculating the maximum hunting mortality in the most heavily exploited segment of the population. At the present time all indications are that hunting mortality and deaths due to natural causes are less than the annual rate of increase, and the population is continuing to increase slowly.

The actual sex ratio of reproductively active walrus is unknown. Males are subject to the greatest hunting pressure. In view of this, the question arises as to how this situation is affecting the rate of reproduction at present, and ultimately, how many bulls per given number of cows are required to maintain normal rates of reproduction.

It will be difficult to determine the minimum ratio of males to females required for a normal rate of reproduction. At the present time, there is apparently a more than adequate number of bulls. This is based on their abundance and availability in the vicinity of various hunting sites, and the consistent findings with regard to various indices of reproduction in females (see Burns, 1965).

Also, with a maximum rate of exploitation in males of 12 to 14 per cent, and selection of animals usually older than 12 years (bulls are sexually mature for several years before they begin to enter the harvest in any substantial numbers), it does not appear that an excessive number of breeding bulls are being removed at present.

The limited amount of female reproductive material collected during 1966 included ovaries, teeth and supporting data taken at random from 34 animals killed at Little Diomede Island, and 4 taken at Savoonga.

Two of these animals (both from Diomede) were six years old, and neither had bred.

In the total sample of 36 sexually mature females, the average number of conceptions was 4.9. This is the highest average observed in any sample to date. Accordingly, the average age of these females was higher than that of previous samples (17+ years). Although this sample is not large enough to draw conclusions with any certainty, the increased survival of females may be due in part to the increased protection afforded the females during the past six years.

More females of all age classes are available, and the hunters can be more selective in taking those with the best tusks.

The calf:cow ratio in the nursery herds observed at King Island (Muktoyuk, personal communication) and Diomede were the same as in previous seasons, around 70:100. I did not have any opportunity to observe female walrus that were not associated with nursery herds.

From all indications it appears that the management program of the Department is effective, and if continued will result in greater numbers of Pacific walrus. The walrus population as a whole can continue to slowly increase if exploitation (almost all of which is the result of subsistence hunting activities) does not increase significantly. However, it is doubtful if the herds could withstand commercial exploitation.

Hunting methods can and should be improved to reduce the hunting loss that occurs at present. As has been pointed out many times, the average annual kills can be reduced without reducing the harvest. Improvement of hunting methods is one aspect of the management program that is receiving greater attention.

Records of interest concerning walrus in various parts of their range were sent in by several people.

Mr. Michael Nelson, ADF&G, Dillingham, reported that during the week of May 1, walrus were observed in Nushagak Bay. On May 3, 40 to 50 walrus were observed near Clark's Point. On May 4, the same number were off the mouth of Wood River. The largest number of animals were observed on May 5, when an estimated 300 were present in the bay (apparently between Clark's Point and Dillingham).

With regard to Round Island, in the Walrus Islands, field notes of Mr. Duff Kimsey indicate that walrus were present throughout the duration of his visit to the island, from May 27 to June 20.

His records indicate that the walrus occasionally leave the island during May and June for several days at a time.

The maximum number of walrus were present on May 28 and June 2. On May 28 there were 2,000 to 2,500 animals on the beach in one main herd, and many others were in the water and on other parts of the island. On June 2 there were between 2,000 and 3,000 animals resting on the beach in two large herds, and many others in the water.

Numerous walrus were feeding near the island on June 6, and Kimsey recorded that the peak of activity was from late morning until 10:00 p.m. On June 8 and 9 there were no walrus on the beach, and only three feeding in the water. However, on the evening of June 10, about 200 walrus were seen coming in from the sea and hauling out on the rocks, and by June 14, approximately 1,000 animals could be seen. As of June 20 there were apparently few walrus around the island.

As Kimsey pointed out, we do not know where the walrus go when they leave Round Island, or how often they return to it during the course of the summer. I have no records of the number of walrus in this area after June 20.

Some other sightings of interest were reported from both Little Diomede Island and eastern St. Lawrence Island.

At Little Diomede Island male walrus were numerous in the 2.7 mile wide channel that separates Big from Little Diomede. Several thousand (actual number not known) bulls were hauled out along the eastern side of the Russian island, on December 4, 5 and 6, and many walrus were observed in the water. At the time, very little ice was present.

During this same period, walrus were also numerous on and around the Punuk Islands, which lie about 8 miles off the southeastern tip of St. Lawrence Island. Hunters from the village at Northeast Cape informed me that on December 5, between 1,000 and 1,500 bull walrus were hauled out on the beach. As at Diomede Island, there was very little ice in the vicinity, and none that was heavy enough for the walrus to rest on.

Heavy drifting ice began moving south through Bering Strait on December 12 (this is almost three weeks to a month later than usual), and some female walrus and young began to appear at about the same time.

At Gambell, near the northwestern tip of St. Lawrence Island, the southward drifting sea ice did not begin to appear until December 16.

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WORK PLAN SEGMENT REPORT

FEDERAL AID IN WILDLIFE RESTORATION

STATE: Alaska

PROJECT NO: W-14-R-1 and 2 TITLE: Marine Mammal Investigations

WORK PLAN: F TITLE: Walrus and Seals

JOB NO: 2 TITLE: Walrus Harvest and Utilization

PERIOD COVERED: January 1, 1966 to December 31, 1966

ABSTRACT

The retrieved kill of walrus during 1966 was reported at 2,788 animals. This harvest was composed of 278 (10%) calves; 1,721 (62%) adult and sub-adult males, and 789 (28%) adult and sub-adult females. Very few sub-adults are taken due to selection for well tusked animals. The harvest of animals, exclusive of calves, was composed of 69 per cent males. Hunters from the four villages of Gambell, Savoonga, Diomede and King Island took about 80 per cent of the total harvest. Hunting loss at the various villages ranged from 20 to 60 per cent, averaging 50 per cent when all the villages are considered. The total kill of walrus was estimated at about 5,600 animals. The 1966 retrieved harvest, and total kill, probably ranks among the largest made by resident Alaskan hunters. Utilization of walrus meat at the various villages ranged from less than three per cent to almost 90 per cent depending upon the main objective of the hunts (ivory or meat). During 1966 there was an increase in the number of men going from mainland towns and villages to the productive walrus hunting sites for the hunting season. Greatest potential value of the 1966 walrus harvest was calculated at $691,900.

RECOMMENDATIONS

The present regulation imposing a bag limit of five cows per resident hunter, with no limit on bulls, should be continued. Attempts should be made to promote an exchange of information concerning the harvests of various pinnipeds by American and Soviet hunters.

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WORK PLAN: F TITLE: Walrus and Seals

JOB NO: 2 TITLE: Walrus Harvest and Utilization

PERIOD COVERED: January 1, 1966 to December 31, 1966

OBJECTIVES

To obtain current information about the magnitude, composition, utilization and value of the annual walrus harvest in Alaska. Also, to determine any changes in utilization and importance of walrus in a changing economy, and in view of both an increase in the human population of western Alaska, and growth or decline of various villages and towns.

PROCEDURES

The largest segment of the annual walrus harvest is obtained during April, May and early June, during the northward migration of these animals. This is also the period during which the majority of adult females and calves are taken.

As in past years, Department personnel were stationed at the most productive hunting sites. The men involved in field work during the period included in this segment report were Mr. Vernon Slwooko, who worked at Gambell from April 25 to June 4; and Mr. Keith Koontz, who was at Savoonga from April 20 to June 21. I worked at Little Diomede Island (and intermittently at Wales) from May 14 to June 25.

Only four hunters resided on King Island during the early spring of 1966, and no Department observer was stationed at that village. Ice conditions during June were such that three boats from Nome were able to reach King Island, and kill a substantial number of walrus.

Department personnel stationed at the various sites recorded the magnitude and composition of the harvest, enforced the game regulations, and collected specimen material (from both walrus and seals) used in the two other marine mammal jobs (Jobs F-1 and F-3). In addition, they recorded field observations, determined utilization of the harvest, and accumulated information concerning various measures of hunting effort and success. Records compiled by the Alaska Department of Economic Development and Planning, and the Bureau of Indian Affairs provided current information concerning numbers of people in the various villages.

Information concerning the harvest of walrus at King Island was obtained by interviewing the boat captains and men that hunted there, by conversation with a reporter and a photographer that accompanied the hunters, and from records kept by Mr. Edward S. Muktoyuk.

Magnitude and composition of the harvest at the less productive hunting sites were obtained by correspondence with resident clergymen, teachers, village leaders and by personal contact with villagers during their frequent travels through Nome.

FINDINGS

The retrieved and total kill of walrus, by village or area, is shown in Table 1. Since walrus are migratory, and available to hunters from various villages at different times of the year, the seasonal harvests are discussed below. During 1966 the hunting success was greater than usual at most of the traditionally productive hunting sites. The total 1966 harvest was 2,788 walrus of which 1,721 (62%) were bulls, 789 (28%) were cows, and 278 (10%) were calves. The harvest of sub-adults (exclusive of calves) and adults was 2,510 animals of which 69 per cent were bulls, and 31 per cent cows.

The total kill including those walrus retrieved, killed and sunk, obviously fatally wounded, and orphaned calves was estimated at 5,575.

In recent years the average annual harvests have been around 1,700 and the average total kills around 3,400 walrus.

Winter Harvest - January through mid-April, 1966

The winter harvest of walrus was slightly higher than normal, as the southward movement of ice was later than usual. Open water near the hunting sites in the northern Bering Sea area intermittently occurred throughout January and early February, and permitted hunters limited access to the herds. As usual, most of the animals taken during this period were males.

Information acquired over the past several years indicates that some male walrus (occasionally substantial numbers) winter much further north than the main groups of wintering animals. These bulls occur singly, or in small herds, and are occasionally found as far north as 70°, during late February.

The hunting success at various villages where walrus were taken during the period from January through mid-April was as follows:

Village	Total Winter Harvest	Males	Females	Calves of Either Sex
Diomede	22	19	3	0
Savoonga	38	38	0	0
Gambell	21	17	4	0
King Island	4	4	0	0
Other villages	11	11	0	0
TOTALS	96	89	7	0

Table 1. Retrieved and Total Kill of Walrus in Alaska During 1966.*

Location	Walrus Retrieved	Known Composition of Harvest ** Males No.	Males %	Females No.	Females %	Calves No.	Calves %	Percent Hunting Loss	Total Kill
Kuskokwim Area	45	45	(100)	0	(0)	0	(0)	40	75
Gambell	488	104	(21.3)	196	(40.2)	188	(38.5)	40	813
Savoonga	511	453	(88.6)	29	(5.7)	29	(5.7)	50	1,022
Northeast Cape	27	27	(100)	0	(0)	0	(0)	50	54
Nome	10	10	(100)	0	(0)	0	(0)	50	20
Brevig Mission	34	3	(8.8)	27	(79.4)	4	(11.8)	50	68
King Island	596	265	(44.5)	315	(52.8)	16	(2.7)	60***	1,490
Little Diomede Island	756	580	(76.7)	158	(20.9)	18	(2.4)	50	1,512
Wales	140	80	(57.1)	40	(28.6)	20	(14.3)	50	280
Point Hope	16	9	(56.3)	7	(43.7)	0	(0)	20	20
Wainwright	140	120	(85.7)	17	(12.2)	3	(2.1)	20	175
Barrow	12	12	(100)	0	(0)	0	(0)	50	24
Other Villages	13	13	(100)	0	(0)	0	(0)	40	22
TOTALS	2,788	1,721	(61.7)	789	(28.3)	278	(10.0)	50.0%	5,575

* Does not include the kill of walrus in the Bristol Bay area; estimated at 20 to 40 adult males.

** The columns "Males" and "Females" include all age groups with the exception of calves of the year.

*** Includes a high proportion of orphaned calves which apparently do not survive.

This winter harvest of 96 walrus was composed of 93 per cent males and 7 per cent females.

Spring Harvest - mid-April through June, 1966

Hunting success during late April, May and June was unusually high. During this period the walrus are moving northward with the receding pack ice. The area they occupy becomes more restricted as they approach Bering Strait, and the number of animals observed in single groups (herds) on the ice reaches the maximum.

Receding pack ice, extensive areas of open water, and movement of walrus past the villages, enable the hunters in the northern Bering Sea area to make their largest catches at this time of year.

From my records of walrus migration past Little Diomede Island, it appeared that many more animals moved north through the eastern part of the Strait (the American Sector) than through the western part. This is borne out by the occurrence of numerous walrus around King Island and along the mainland, and a reported scarcity of walrus along the Siberian mainland (Comm. Fish. Rev., 1967).

In Bering Strait the concentrated movement of animals began on May 28 and continued until July 4. An abundance of walrus during this extended period enabled the hunters from the villages in the northern Bering Sea to kill more animals than usual.

The spring harvest was as follows:

Village or Area	Total Spring Harvest	Males	Females	Calves of Either Sex
Kuskokwim Area	40	40	0	0
Gambell	460	80	192	188
Savoonga	455	397	29	29
Northeast Cape	22	22	0	0
Nome	10	10	0	0
Teller	1	1	0	0
Brevig Mission	34	3	27	4
King Island	591	260	315	16
Diomede Island	722	550	154	18
Wales	140	80	40	20
TOTALS	2,475	1,443	757	275

At Gambell, King Island and Little Diomede Island many of the herds to which the hunters had access, were nursery herds composed primarily of cows and new-born calves. Whenever possible, the Gambell hunters take both cows and calves, and few calves are orphaned. However, at Diomede and King Island, the hunters are primarily interested in adults. When a cow accompanied by a calf is killed, the calf is orphaned, and presumably it does not survive. The number of orphaned calves, determined through field observation of herd composition and by analysis of a series of female repo-tracts, is included in my estimate of the total kill (harvest + loss + orphaned calves). The number of orphaned calves at both King and Little Diomede Islands was approximately 330.

The villages of Gambell, Savoonga, King Island and Little Diomede Island have been, and continue to be, the most productive hunting sites. The spring harvest at these four villages alone was 2,223 walrus: 90 per cent of the total spring harvest, and 80 per cent of the total Alaskan harvest during 1966.

Records of hunting effort, return per unit of effort (walrus per boat hour) and utilization of the spring harvest are most complete for these four hunting sites, and are presented in Table 2.

During the spring of 1966 the first productive day for hunting walrus at Gambell was April 29, and the last day on which walrus were taken was June 6. Although there were 21 large skin boats at Gambell, the maximum number that went walrus hunting on any given day was 17. During the 39 days when walrus were passing Gambell (between the first and last successful days), hunters were able to go out on 19 of them. The total spring harvest of 460 walrus will be used by the 402 residents and 500 to 600 dogs. The spring harvest amounted to 5.4 walrus per hunter.

At Savoonga the spring harvest of 455 walrus was taken by about 86 men hunting with 19 skin boats. Walrus were killed from April 22 to June 16. During this 61 day period, boats were able to hunt on 31 days.

Unlike the concentrated movement of cows and calves near Gambell, the adult bulls (comprising most of the harvest at Savoonga) are found in smaller and more widely dispersed herds. Their migration is more protracted than that of the cows and calves, as they will remain in an area as long as suitable ice is present.

This harvest will be used by the 397 residents, and 539 dogs. It was interesting to learn that in May, 1965 there were 679 dogs in Savoonga. The decrease of 140 dogs is primarily due to an increase in the number of snow vehicles. During November, 1966 the number of dogs was even fewer, and will probably decrease to less than half of the number formerly kept by hunters.

The total spring harvest at Savoonga amounted to approximately 5.3 walrus per hunter.

Hunting success at Little Diomede Island was unusually high; 722 walrus being taken between April 15 and July 4. This harvest was made by 30 hunters using three large skin boats. Several older men and teenage boys went hunting only to obtain the legal limit of five female walrus per man. During most of the hunting season there were 26 regular hunters. Some of these included Diomede Islanders that now permanently reside in Teller, or Nome, and return to the island for the walrus hunting season.

A total of 154 adult female walrus were included in the spring harvest at Diomede. Most of them were taken in the early part of the season. From May 28 through June 1, 208 walrus were taken, of which 137 were females. From June 9 to July 4, 514 walrus were taken, of which 18 were females.

Without the bag limit of five adult female walrus per hunter, and the presence of a Department observer on the island, the harvest of females would probably have exceeded 1,100; as the cows were available to the hunters until June 20. The total harvest amounted to 24 walrus per man if the maximum number of 30 hunters is used, and 28 per man if the more realistic figure of 26 hunters is used.

What meat was salvaged from this harvest was used by the 94 residents of the Island. Since dog teams are seldom used at Little Diomede, the number of dogs is relatively small. During June there were between 25 and 30 on the Island.

A total of nine people including only four hunters spent the winter of 1965-1966 on King Island. However, ice conditions were such that three large skin boats were able to leave from Nome and reach King Island while walrus were still there in large numbers. A total of 41 men and older boys hunted from King Island. At first they used three large skin boats and one small one, and then just the three large boats.

As was mentioned previously, a Department observer was not stationed on King Island during the spring of 1966, as only four hunters were residing there. The favorable conditions which enabled the boats from Nome to make a successful crossing to the Island in time to hunt walrus, were not anticipated.

The walrus harvest at King Island was about 590 animals, of which 260 were adult bulls, 315 were adult cows, and 16 were calves.

The harvest of females amounted to 7.7 per man. The total harvest amounted to 14.4 walrus per hunter. Some walrus meat was returned to Nome, but this was only a small part of the total harvest.

In recent years, hunters from Wales have not killed any substantial number of walrus, and it has also been unusual for the hunters of Brevig Mission to take any. However, during June of 1966, walrus appeared very close to the coast near both of these villages, even entering Port Clarence. The combined harvest at these two sites was 174 animals.

The spring harvest as a whole was composed of 58.3 per cent bulls, 30.6 per cent cows, and 11.1 per cent calves.

Northward migrating walrus have usually passed through Bering Strait by the latter part of June, and are not available to Alaskan hunters in large numbers until the pack ice has receded north to between Icy Cape and Point Barrow (usually in late July or early August).

Summer Harvest - July through September, 1966

At only one village, Wainwright, were the hunters successful in making a substantial catch of walrus during the summer months of 1966. During early August the southern edge of the ice, and the walrus associated with it, had reached this northern village. Hunters from Wainwright took 140 walrus of which 120 were adult bulls, 17 cows and three calves. Nine skin boats and one inboard power launch, manned by approximately 36 men, participated in the hunts. The walrus will be used primarily for dog food, although the 290 residents do eat some walrus meat.

The total summer harvest of walrus was as follows:

Village	Total Summer Harvest	Males	Females	Calves of Either Sex
Kivalina	2	2	0	0
Point Hope	16	9	7	?
Wainwright	140	120	17	3
Barrow	12	12	0	0
TOTALS	170	143	24	3

This summer harvest was composed of 84 per cent males, 14 per cent females and two per cent calves of either sex.

Fall Harvest - October through December, 1966

After the walrus herds move away from the vicinity of Wainwright and Pt. Barrow, they are not generally available to the hunters until sometime in November or December; when they again start moving through Bering Strait on their way south. This southward fall migration is nothing like the more concentrated spring movements. In addition, hunting conditions are not very favorable. Quite frequently, walrus are near a village, but the hunters cannot reach them due to unfavorable ice.

The fall harvest is composed largely of male walrus and especially young males. These are the walrus that are found most frequently near, or on the beaches; and the hunters encounter them more often.

The fall and early winter of 1966 were unusually mild in the northern Bering Sea area. Heavy sea ice, moving down from the north, did not reach the northwestern tip of St. Lawrence Island until December 16.

Hunters from both Little Diomede Island, and Northeast Cape (eastern St. Lawrence Island) reported large concentrations of walrus hauled out on the beaches.

The hunters at Little Diomede Island reported that during early December, and especially on the 4th, 5th and 6th, several thousand bulls were hauled out on the east side of Big Diomede Island. The calls of those animals hauled out on the beach prompted a steady stream of animals coming from the north. The movement of walrus between these two islands (the channel is 2.7 miles wide) was reportedly quite spectacular. Most of the animals passed on the western side, near those walrus on the beach, and the hunters from the Alaskan Island did not willingly venture into Soviet Territorial waters.

At the same time as walrus were hauled out on Big Diomede Island, they were also numerous on and around the Punuk Islands near the southeastern tip of St. Lawrence Island.

Mr. Gregory Toolie, resident of Northeast Cape, informed me that on December 5, weather permitted the hunters to reach the Punuk Islands. They found between 1,000 and 1,500 animals hauled out on the beach. Many other walrus were in the water.

Since no suitable sea ice was in the vicinity of either the Diomedes or the Punuk Islands at the time the walrus were hauled out, it is probably safe to assume that the migrating walrus hauled out to rest. Those animals on the Punuk Islands were very reluctant to enter the water even after the hunters had shot two of them.

The total fall harvest was relatively poor. The number of animals, and the villages from which they were taken, are shown below:

Village	Total Fall Harvest	Males	Females	Calves of Either Sex
Diomede	12	11	1	0
Gambell	7	7	0	0
Savoonga	18	18	0	0
Northeast Cape	5	5	0	0
Kuskokwim Area	5	5	0	0
TOTALS	47	46	1	0

No residents returned to King Island during the fall of 1966. This is the first fall and winter that the island has been completely abandoned.

Hunting Effort at the Traditionally Productive Sites

In the previous discussions of the village by village harvests, one aspect of hunting effort--the number of men and craft involved in the hunts--was mentioned. The need for additional indices of effort and success, based on the limitations imposed by both weather and ice conditions, and changes in the number of men and craft engaged in walrus hunting, has been pointed out by several people working in other fields.

Additional measures of hunting effort and success at the sites traditionally realizing the greatest harvests are presented in Table 2. These indices include the number of hunting days, the number of boat-hours, and the number of boat-hours per walrus retrieved.

It should be kept in mind that these are measures of effort expended during the important and productive spring hunts. The value of this information lies in determining long term trends in availability of walrus to the hunters, and recognizing changes in actual hunting effort.

Utilization of the Harvest

An extensive discussion of the factors affecting walrus utilization at the various hunting sites was presented in a previous segment report (Burns, 1963). As would be expected, the proportion of walrus meat and skins salvaged is dependent upon magnitude of the harvest, the number of people and dogs for which it will be used, and weather and ice conditions at the time the walrus are killed. Without exception, utilization is greatly reduced once the actual needs of a village are met. However, at most villages (Wainwright is an exception) the hunters continue to pursue walrus as long as they are available.

Table 2. Comparative Hunting Effort and Success During the Spring Walrus Hunting Seasons in Alaska from 1961 to 1966. [1]

Measure of Effort		Gambell	Savoonga	King Island	Diomede Island
No. Hunting Days	1961	13 of 35	-----	-----	18 of 26
	1962	19 of 33	11 of 28	-----	8 of 16
	1963	14 of 20	-----	-----	11 of 37
	1964	27 of 48	-----	13 of 48	21 of 51
	1965	25 of 42	-----	6 of 18	16 of 28
	1966	19 of 39	31 of 61	?	24 of 43 [2]
Boat Hours	1961	910	---	---	399
	1962	947	537	---	140
	1963	810	---	---	320
	1964	1,714	---	199	502
	1965	2,157	---	93	408
	1966	---	2,397	?	538 [2]
Boat Hours per Walrus Retrieved	1961	5.10	----	----	.75
	1962	4.62	1.80	----	.58
	1963	4.74	----	----	1.20
	1964	29.55	----	1.14	17.31
	1965	5.74	----	.46	2.33
	1966	----	5.30	.40 to .80 [3]	1.13 [2]

[1] Data include only those hours expended, and walrus taken while an observer was at the respective villages.

[2] This information is incomplete in that walrus continued to be available to Diomede hunters after the observer had left. However, nursery herds and mixed herds had passed by.

[3] Determined by conversations with boat captains regarding success of daily hunts.

The 1966 spring harvest was one of the largest recorded in recent years. Accordingly, utilization was relatively poor.

Because of the unusual abundance of walrus at some areas, many of the hunters that normally utilize most of the animals they obtain, resorted to hunting walrus solely for their ivory. This situation occurred at Wales, Brevig Mission, and to some extent at Savoonga.

Traditionally, the primary interest of hunters at King and Diomede Islands is in ivory; a commodity on which they are very dependent for their necessary income. As would be expected, utilization of the animals they obtained was very low. They can obtain their ivory without adversely affecting the walrus population, by harvesting primarily bulls.

At villages where walrus are hunted for meat, utilization is very good.

Briefly, utilization of the 1966 harvest was as follows: in the Kuskokwim area, at Northeast Cape, Nome, Point Hope and Barrow, 80 to 90 per cent; at Gambell, 70 per cent; at Savoonga, Brevig Mission and Wales, 40 to 50 per cent; at Diomede Island, 3 to 5 per cent; and at King Island, 1 to 3 per cent. Utilization at Wainwright approached 90 per cent, as many walrus are landed on the beach before being butchered. As a result most of the usable parts of the carcasses are saved.

The number of people residing at both King and Little Diomede Islands has continued to decline; the major resettlement being in Teller and Nome. These people are still greatly dependent upon ivory carving as a source of income. During the spring hunting season many of these men return to their respective islands in order to renew their supply of raw ivory. This type of hunting is definitely on the increase. During May and June of 1966, 41 men went from Nome to King Island, and 5 men went from Nome or Teller to Little Diomede Island.

The amount of walrus meat that these hunters can salvage, and return to their homes on the mainland, is almost insignificant.

Value of the 1966 Harvest

The potential value of the 1966 walrus harvest was calculated in the same manner as outlined in previous Segment Completion Reports (Burns, 1963; 1965; 1966). It is based on the following values set forth by Fay (1958), and Harbo (1961):

Tusks of adult females valued at $10.00 per pair.
Tusks of adult males valued at $24.00 per pair.
Tusks, carved, either sex, valued at $125.00 per pair.
Bacula valued at $7.00 each.
Walrus meat valued at $ .10 per pound.
Skins of female walrus valued at $20.00 each.

During 1966 there was renewed interest on the part of commercial companies in the purchase of bull walrus skins. Approximately 60 of these hides were purchased from hunters at Savoonga, and 10 from the Gambell hunters; the purchase price was $75.00 for each skin. Unfortunately, at this time, the hunters are not especially interested in salvaging these skins. In this segment report, the potential value of bull walrus skins is included.

The estimated values of the component parts of the 1966 walrus harvest are presented in Table 3. The greatest potential value of the harvest was calculated to have been $691,899.

Changes in Size of the Villages that Traditionally Harvest Significant Numbers of Walrus

The population of villages and towns along the western and northwestern coast has been changing rather dramatically. Villages which are more or less isolated due to lack of suitable airfields (i.e. Diomede and King Islands), or to generally unfavorable weather conditions (i.e. Wales) are decreasing in size, as the people move to the larger population centers. On the other hand, villages situated near productive hunting areas, and where communication and transportation facilities are "relatively" good (i.e. Gambell and Savoonga) are undergoing a rapid population increase.

Population changes, and the economic base at a few villages and towns have a direct bearing on walrus management, as these factors determine both hunting effort, and the extent to which the walrus harvest will be utilized. Table 4 shows population changes at several of the walrus hunting villages in the northern Bering Sea area.

Of the annual harvests made by resident hunters, those obtained in 1960 (2,300 animals harvested and 4,600 killed), and 1966 (2,788 animals harvested and 5,575 killed), probably rank among the highest harvests ever made by resident Alaskan hunters.

Modern equipment such as effective high-powered rifles and outboards, walkie-talkies, and a general increase in the number of people in the walrus hunting villages of Bering Strait have contributed to increased hunting pressure at some locations, and increased efficiency at others.

At this point it is hard to determine what the future trend will be. An increase in the human population is almost a certainty. Most men will not pursue the life of a hunter unless forced to by a lack of other types of gainful employment.

In the immediate future, the trend will probably be toward a limited increase in the average annual harvests of walrus. According to Brooks (1954), annual harvests during the late 1930's, 1940's and early 1950's averaged around 1,300 walrus. From 1960 to 1965 the average annual harvest was around 1,700 walrus. It is expected that this will rise to around 2,000 walrus per year.

During the past five years there has been a general tendency toward increasing availability of walrus during the spring and summer hunts, and more hunting effort being expended. The main factors responsible for holding the harvest at the present level are the restrictions on the hunting of female walrus, and the self imposed bag limits at Gambell, Savoonga, and Wainwright.

Table 3. Potential Value of the 1966 Walrus Harvest in Alaska.

Location	Harvest			Value of Ivory		Bacula	Meat*	Value of Skins		Greatest Potential Value
	Males	Females	Calves	Raw	Carved			Males	Females	
Kuskokwim Area	45	0	0	$ 1,080	$ 5,625	$ 315	$ 4,500	$ 3,375	$ 0	$ 13,815
Gambell	104	196	188	4,456	37,500	728	23,382	7,800	3,920	73,330
Savoonga	453	29	29	11,162	60,250	3,171	47,229	33,975	580	145,205
Northeast Cape	27	0	0	648	3,375	189	2,700	2,025	0	8,289
Brevig Mission	3	27	4	342	3,750	21	1,946	225	540	6,482
King Island	265	315	16	9,510	72,500	1,855	45,504	19,875	6,300	146,034
Diomede Island	580	158	18	15,500	92,250	4,060	67,597	43,500	3,160	210,567
Wales	80	40	20	2,320	15,000	560	10,530	6,000	800	32,890
Wainwright	120	17	3	3,050	17,125	840	13,039	9,000	340	40,344
Other Areas	44	7	0	1,126	6,375	308	4,820	3,300	140	14,943
TOTALS	1,721	789	278	$49,194	$313,750	$12,047	$221,247	$129,075	$15,780	$691,899

* Utilizable weight is calculated on the basis of 1,000 lbs. for adult males, 600 for adult females and 65 for calves.

Table 4. Population Changes at Several Walrus Hunting Villages in Alaska

Village	Population 1940	1950	1960	1967	Number of Households - 1967
Gambell	296	309	377	402	71
Savoonga	209	249	374	397	60
Northeast Cape [1]	---	---	17	35	9
King Island [2]	205	220	270	320	?
Diomede Island	125 [3]	121	103	94	21
Wales	193	141	153	115	27
TOTALS	1,028	1,040	1,294	1,363	

1) Northeast Cape was established as a temporary camp during the 1950's, but is now composed of nine permanent and many temporary dwellings.

2) Information about King Island obtained from various sources including records of the King Island Native Store, and records of department personnel. The island was being slowly abandoned during the entire period in question. However, these people have remained as an identifiable group, residing in Nome, and are very much involved with walrus exploitation and utilization.

3) The exact 1940 census figure in unknown. Many of these people presently reside in Nome and Teller.

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WORK PLAN SEGMENT REPORT

FEDERAL AID IN WILDLIFE RESTORATION

STATE: Alaska

PROJECT NO: W-14-R-1 and 2 TITLE: Marine Mammal Investigations

WORK PLAN: F TITLE: Walrus and Seals

JOB NO: 3 TITLE: Seal Biology and Harvest

PERIOD COVERED: January 1, 1966 to December 31, 1966

ABSTRACT

The five main species of pinnipeds occurring in the northern Bering and Chukchi Seas (Pusa hispida, Erignathus barbatus, Phoca vitulina, Histriophoca fasciata and Odobenus rosmarus) are all dependent upon the presence of sea ice for the successful rearing of their young. Breeding animals of the various species are essentially segregated from each other at the time of pupping and breeding, by their requirements for particular ice conditions, by the capabilities of their young during the first few weeks of life, and by the ecological adaptations of the species.

Breeding ringed seals occupy the area of extensive land-fast ice along the mainland and around the larger islands. The use of birth lairs within this area affords protection from a variety of predators, during a period when these seals are most vulnerable. Ribbon and harbor seals occupy the southern edge of the drifting sea ice in an area essentially free of quadruped predators. Pups are born and nursed on top of the exposed floes. They are capable of protecting themselves from avian predators. Ringed, ribbon and harbor seal pups are all born during early April, as whitecoats. The dense coat of white hair is characteristic of young seals born on (or in) the ice, remaining there in a localized area for relatively long periods of time, and frequently left unattended. The dense coat (in this case white) is necessary for maintaining body temperature, for preventing the melting of snow and ice under the new born pups, and affords some protective coloration. However, white may be of more significant importance from the standpoint of factors other than protective coloration. Female walrus with calves occupy the area of drifting ice north of the major concentrations of ribbon and harbor seals. Walrus calves are born during late April and early May, and do not have a heavy wolly coat. They enter the water soon after birth. These calves are constantly attended by the female. The ability of calves to swim soon after birth is of selective advantage in allowing them to remain in close association with other walrus, particularly during periods of adverse weather. The mobility of calves also affords them a means of escape from such predators as polar bears, at least in some areas where walrus occur. Bearded seal pups are born mainly during late April. These seals are widely distributed on the drifting ice throughout the Chukchi and northern Bering Seas; greatest numbers occurring south of Bering Strait. Pups are born with a heavy coat (usually silver-grey in color) which is shed very rapidly. These pups enter the water within a few days of birth.

The main birth period in these five species of pinnipeds occurs within a span of six weeks, and coincides with the most favorable conditions for both birth and early independent life.

The 1966 harvest of seals in northwest Alaska was approximately 15,000 animals. A conservative estimate of the value of this harvest was $165,000.

RECOMMENDATIONS

The present regulations of no closed season and no limit should be continued in this area. Efforts should be made to determine the total harvest of all marine mammals in the Bering and Chukchi Seas, taken by both American and Soviet hunters. Work should be continued on the various aspects of life-history of each species, and a tagging program should be undertaken.

WORK PLAN SEGMENT REPORT

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OBJECTIVES

The objectives of work conducted during this report period were to investigate the interspecific relationships between the various species of phocid seals inhabiting the northern Bering and Chukchi Seas; to attempt to identify the environmental factors affecting abundance and distribution of ringed and bearded seals when they occupy their winter range; to obtain information on the life-history and general reproductive physiology of bearded, harbor and ribbon seals in western Alaska; to locate harbor seal population centers and determine patterns of dispersal; to investigate the apparent clinal differences in certain characteristics of reproduction; to maintain current information regarding the magnitude, characteristics and value of the harvest of various species of hair seals in western Alaska; and to assist in obtaining specimens of marine mammals for investigators working in other areas.

PROCEDURES

During the past two years the bearded seal has been the species most intensively investigated in western Alaska. A considerable amount of time during this report period was devoted to examination of specimen material collected since 1962, and to the writing of a comprehensive report dealing entirely with this seal (Burns, in press). As a result the effort devoted to studies of the harbor, ringed and ribbon seals was reduced; although specimen material was collected for examination at a later time.

Field work associated with the continuing study of walrus biology, harvest and utilization, provided the opportunity to obtain information and specimens from the various species of seals. This field work, undertaken primarily during the spring walrus hunting season, occurred on St. Lawrence Island, Little Diomede Island, and along the southern coast of the Seward Peninsula from Nome, west to Cape Prince of Wales. Assistants involved in these studies have already been mentioned in connection with job F-2. Fall and winter field work was undertaken by Edward Muktoyuk and myself, mostly in the vicinity of Nome.

Several other people cooperated by supplying seal specimens from various areas. These included Mr. Neal Shanahan, VISTA, Gambell; Mr. F. Patrick Fitzgerald, VISTA, Kivalina; Dr. Francis Fay, Arctic Health Research Center, Anchorage; and Mr. Edward Klinkhart, Alaska Department of Fish and Game, Anchorage.

A study of the comparative food habits of the four species of phocid seals of this area was initiated in order to gain an insight into some aspects of the interspecific relationships between these seals. Recent publications have provided comparative information from other areas. These include a paper by Kenyon (1962) dealing with phocid seals at Little Diomede Island, and a paper by Johnson, et al (1966) concerning the marine mammals of the Point Hope area. Records of the movements, distribution and abundance of the various seals were also compiled whenever the opportunity arose.

The problem of attempting to recognize physical factors of the environment affecting movements and distribution of seals has, for the present, centered around a review of available information concerning the oceanography of the Bering and Chukchi Seas, and compilation of records concerning the occurrence of seals in association with recognizable types of ice.

Specimens and supporting data including observations, weights, measurements, teeth, claws, reproductive tracts and fetuses provided the basic materials for determining such things as age of individual animals, age composition of the harvest, rates of exploitation, growth rates, age at reproductive maturity, age at physical maturity, rates of reproduction, chronology of various aspects of reproduction (breeding, implantation and birth dates), and fetal development.

Material including skulls, comments concerning general observations, and various Department reports have been supplied to interested parties working with marine mammals, upon request.

FINDINGS

Since most of the work accomplished during this report period concerned the bearded seal, and in view of the fact that a comprehensive report concerning the bearded seal study was recently completed, only a general resume of that work will be presented.

The main conclusions of the study were as follows:

1. Some adult Pacific bearded seals attain a weight during the winter in excess of 350 kg, and many are in excess of 270 kg during the summer months when they are in lean condition.

2. By age nine, most of the teeth are worn down to the gum line, and some are already missing.

3. The average weight of these seals at birth is 33 kg, and the average length is 131 cm. By the end of the brief nursing period (12 to 18 days) the average weight of pups has increased to 85 kg, and they have attained approximately 63 per cent of their adult length.

4. At physical maturity, the average length of these seals is about 233 cm. Females are slightly larger than males; a characteristic also observed in skull length.

5. Baculum length is a useful indicator of relative age in males.

6. There is some indication that certain food items may aid in the removal of stomach parasites. Food consists primarily of benthos.

7. The peak breeding period is from mid-April to mid-May, and male seals appear to be in breeding condition for a longer period of time than females. These seals are probably polygamous.

8. Implantation occurs during late July and early August, after a delay of approximately 2 1/2 months. By comparison with the findings of other investigators, the time of breeding and implantation is earlier in areas further south.

9. Birth of pups occurs from mid-March to early May with the peak of births occurring during late April.

10. Some female bearded seals begin to ovulate at three years of age, but reproductive maturity (the ability to successfully conceive) is not attained until age five or six. Males apparently achieve sexual maturity at age six or seven.

11. The incidence of pregnancy in adult females is approximately 85 per cent, based on both ovarian analysis and the frequency of fetuses in a limited sample of adults taken from late summer through winter.

12. The sex ratio of bearded seals at birth, and throughout the various age groups approximates 1:1; however, our samples consistently show slightly more females than males.

13. The estimated proportion of adult (sexually mature) seals in the population is between 55 and 60 per cent, and the rate of reproduction for the population as a whole is estimated at 22 to 25 per cent.

14. It appears that the age at sexual maturity is lower and the rate of reproduction is higher in the Pacific bearded seal, than in the Atlantic form. This is tentatively attributed to a higher rate of exploitation of the Pacific seals.

15. Distribution and migration of bearded seals in the Bering-Chukchi Sea area is affected primarily by the seasonal advance and retreat of the sea ice. Adult seals are almost always associated with ice although young seals will remain in ice free areas. Hunting success depends mainly upon availability of these seals during the seasonal migrations.

16. There is significant movement of bearded seals away from the coast during mid-winter and early spring. This coincides with an influx of mature ringed seals during the same period.

17. Although the responses of bearded seals to the presence of man are quite variable, these seals seem to possess acute senses of sight and hearing, and at least a good sense of smell.

18. During the breeding season male seals produce a distinct and very specific whistling sound under the water. These sounds are interpreted as a vocal proclamation or advertisement of a receptive male, in a specific breeding territory.

19. At the present time, all indications point toward increased exploitation of the seals available in commercial quantities. This exploitation may affect the bearded seals of the Bering and Chukchi Seas. The present harvest by Alaskan hunters is approximately 3,400 bearded seals, and the total kill is estimated at between 7,000 and 9,000 animals.

20. The effects of increased exploitation can be partially offset by reducing the high hunting loss. This can be accomplished through improvement of the presently employed hunting techniques.

21. It appears that direct census of bearded seals, using either aircraft or boats, is not satisfactory for obtaining population information other than a crude index of relative abundance in localized areas. Population size, status, and trends will have to be determined by indirect methods based on material collected from the hunters.

Some Aspects of Interspecies Relationships

There are five main species of pinnipeds found in the northern Bering and Chukchi Seas. These include the ringed seal (Pusa hispida), bearded seal (Erignathus barbatus), harbor seal (Phoca vitulina), ribbon seal (Histriophoca fasciata) and the walrus (Odobenus rosmarus).

Quite logically, each species is adapted to exploit a different ecological niche. However, before we can fully understand what parts of the total marine environment each animal actually utilizes, it is necessary to gain an insight into the life-history and ecology of each species. In the seals of this area there appear to be many areas of overlap, as well as many areas of specialization.

How much competition exists between the main species present in this area? Would population changes in one species directly affect another? Just what parts of the ecosystem does each species utilize? What conditions are most favorable during the critical period of pupping and breeding?

It will be a long time before these and other important questions will be resolved.

However, we can obtain a general picture of the spatial distribution of the seals and walrus during the early spring, the conditions in which they bear their young, and the capabilities of the young themselves. We can also logically explain the evolutionary significance of certain morphological and behavioral characteristics observed in the various species.

The information upon which this discussion is based, comes from many sources. Kenyon (1960a,b) provided information concerning the results of aerial surveys of walrus and other marine mammals in the eastern Bering Sea. Publications by Fay (1958; M.S.), and personal communications, have provided information on many aspects of walrus life-history. Papers by Krylov, et al (1964), and Tikhomirov (1964, 1966) provided information about the distribution of pinnipeds in the western Bering Sea, and along the southern edge of the pack ice.

My own work in the northern Bering Sea-Bering Strait area during the past six years has provided numerous opportunities to examine pups and adults of all species, to observe the seasonal movements of these animals, and to determine their distribution at different times of the year (Burns 1965a,b, 1966, in press). In addition to numerous point-to-point flights over the ice to various villages, two aerial surveys were made between Nome, King Island and Little Diomede Island. Both of these surveys were made during mid-April.

Polar bear hunters flying over the ice during March and April also provided information about marine mammals observed.

Of the five species of marine mammals with which we are concerned, all are dependent upon the presence of sea ice for the successful rearing of their progeny. There is a considerable amount of overlap with regard to the distribution of these marine mammals throughout the year. However, the reproductively active animals of certain species are basically segregated from the others, at the time of pupping and breeding, by requirements for certain ice conditions, by the capabilities of their young during the first few weeks of life, or by the ecological adaptations of the species.

The actual distribution of marine mammals in this area during any given spring depends a great deal upon the environmental conditions which have prevailed during the preceeding winter months. In some years sea ice extends much further south than in others. However, the general distribution of a species in relation to the other species remains the same.

The young of ringed, harbor and ribbon seals are all born as whitecoats. At the time of birth they are completely covered by a dense coat of long, curly white hair (lanugo). The young of these three species are frequently left unattended, and they do not willingly enter the water for at least three to four weeks after birth.

Ringed seal pups apparently remain out of the water for the longest period of time; almost until they are weaned, and have developed the sleek coat of hair they will possess throughout the rest of their first year. In the vicinity of Nome, the nursing period of ringed seals is between five and seven weeks. McLaren (1958) indicates that nursing often ceases with the destruction of the birth lair, a conclusion supported by my observations.

Ringed seal pups are born during early April, in (as opposed to on) the thick, stable land-fast ice, or under the heavy mantle of snow that covers it. The density of adult ringed seals during the late winter and spring months is greatest in areas of extensive land-fast ice. Birth lairs are excavated under a heavy cover of snow, or are natural cavities in rough ice (see McLaren, 1958, p. 56).

A limited amount of pupping occurs in the moving sea ice, as indicated by the occurrence of small numbers of whitecoats on the drifting ice near Nome, St. Lawrence Island, King Island, and Little Diomede Island. The extent of pupping in the pack ice is probably directly related to the extensiveness of suitable land-fast ice, and to the experience of the female seal. McLaren (op. cit.) presents evidence which suggests that the least experienced females (those bearing young for the first time) are often forced to have their pups in the more marginal areas. Premature destruction of the lair usually results in death of the pup, as the female deserts it.

Almost the entire area in which ringed seals remain long enough to successfully raise their young is frequented by various predators.

Ribbon and harbor seal pups are also born during the first part of April. However, these pups are born on top of the drifting sea ice, usually away from the land, along the southern edge of the pack ice. In this respect they are somewhat similar to the harp seals (Pagophilus groenlandicus) of the North Atlantic. The ribbon and harbor seals are apparently well inter-mixed, although the larger numbers of ribbon seals taken near the western end of St. Lawrence Island indicate that they are more numerous in the western part of Bering Sea.

Tikhomirov (1964) reported that along the southern edge of the ice in eastern Bering Sea, during 1962, harbor and ribbon seals constituted 80 per cent of the animals seen. The other species observed in substantial numbers were bearded seals--12 per cent, and sea lions (Eumatopias jubata)--8 per cent. Ringed seals were scarce. This cruise started in the vicinity of Bristol Bay, and it was probably in these lower latitudes that most of the sea lions were seen.

Ice at the southern edge of the pack is usually pretty loose, becoming widely disbursed during north winds, and more closely packed during south winds. The floes are relatively small and thin, as they are formed in Bering Sea during the winter months. The heavy ice that comes down through Bering Strait during the fall and winter months does not move this far south. Within the area covered by ice, seals in the southern region would be most affected by storms.

Ribbon and harbor seal pups nurse about four weeks. By the end of the lactation period they have acquired a sufficient blubber layer and the first year coat is essentially developed, although in some animals it may still be covered by patches of lanugo. Young seals still retaining some of their lanugo apparently spend a great deal of time on top of the ice, as this is the only place where I have observed them. During the past six spring seasons in Bering Strait, none of the hunters have reported the taking of a partially moulted pup in the water.

Ribbon and harbor seal pups are born in a region that is, at present, essentially unaffected by quadruped predators.

The walrus and bearded seals bear young that swim with the mother at a very early stage in their development. In the case of the walrus it is virtually from the moment they are born. In the bearded seal it is within a few days of birth. Neither the walrus nor the bearded seal possesses the dense white coat at birth, which is so characteristic of the other pinnipeds that bear young on the ice. However, both possess a white coat at some stage of their intrauterine development (Fay, M.S.; Burns, in press).

As far as I can determine, young walrus calves are never left unattended by their dams, and bearded seal pups are very closely attended.

The birth period of walrus and bearded seals is later than that of the other seals of the area. The peak period of pupping (in the northern Bering Sea area) in the bearded seal is between April 15 and 25, and in the walrus it is between April 20 and May 10.

The walrus is highly gregarious, the nursery herds being relatively large, and occurring in a comparatively restricted area. The walrus is the only pinniped of this area in which the animals bearing young are, to a large extent, essentially segregated from the adult males. This situation is not surprising in view of the fact that the ringed, harbor, ribbon, and a large proportion of bearded seals mate again within about four to six weeks of giving birth (so the adult males would be seeking out receptive females) while in the walrus the females do not breed until at least the February or March following the birth of a calf. During late April, the female walrus bearing calves are concentrated mainly near the western side of St. Lawrence Island. The bulls and other cows are less concentrated, and occur from north of Bering Strait to south of Nunivak Island; the largest concentrations occurring near eastern St. Lawrence Island.

Walrus calves are born on the ice floes in an area north of the harbor and ribbon seals. Calves possess a coat of hair that somewhat resembles that of the females, except that it is much more dense and darker.

The bearded seal shows little tendency toward gregariousness. During April it is widely distributed throughout the northern Bering and Chukchi Seas, the greatest density being in the Bering Sea. These seals also occur in the same general areas where walrus are found, but are not common around large groups of walrus.

Considering the circumpolar range of both walrus and bearded seals, these animals often bear young in areas where predators (primarily polar bears) are present.

A striking difference between the walrus and bearded seals is that walrus calves nurse for such a long period of time (18 to 24 months) and are small in relation to the size of the adult females. The weight of calves at birth is about seven per cent of the mother's weight. Bearded seals nurse for 12 to 18 days. At birth these pups are approximately 14 per cent of the weight of average adult females.

As has been shown, the various pinnipeds of the northern Bering and Chukchi Seas are to a large extent segregated from each other at the critical time during which the young are born, and breeding again takes place. The general distribution of breeding adults of the various species is shown in Figure 1. The ringed seals are ideally adapted to successfully utilize the narrow belt of relatively thick, stable, land-fast ice adjacent to the large land masses. Judging by the success with which the other seals raise their young, born on the exposed ice floes, protection from adverse climatic conditions is not the main cause responsible for development of the use of hidden lairs characteristic of ringed seals. Rather, the use of lairs in (as opposed to birth on top of) the ice or snow is an effective adaptation through which the ringed seals can utilize the extensive areas of land-fast ice, and be relatively safe from predators at a time of the year when they are most vulnerable. Predators throughout most of the areas where ringed seal pups are born include ravens, red foxes, white foxes, wolves, wolverines, polar bears, dogs and man.

The white coat--characteristic of young seals born on or in the ice, remaining there in a localized area for relatively long periods of time, and frequently left unattended--is an adaptation for maintaining body heat. Of equal importance this dense coat is insulation enough to prevent formation of a depression full of cold water in which the young seal would lie. The white hair no doubt affords some protective coloration, but it is a debatable question as to whether this is the main factor responsible for the evolution of a coat this color. What difference does color make, as far as predation is concerned, on a concealed ringed seal pup?

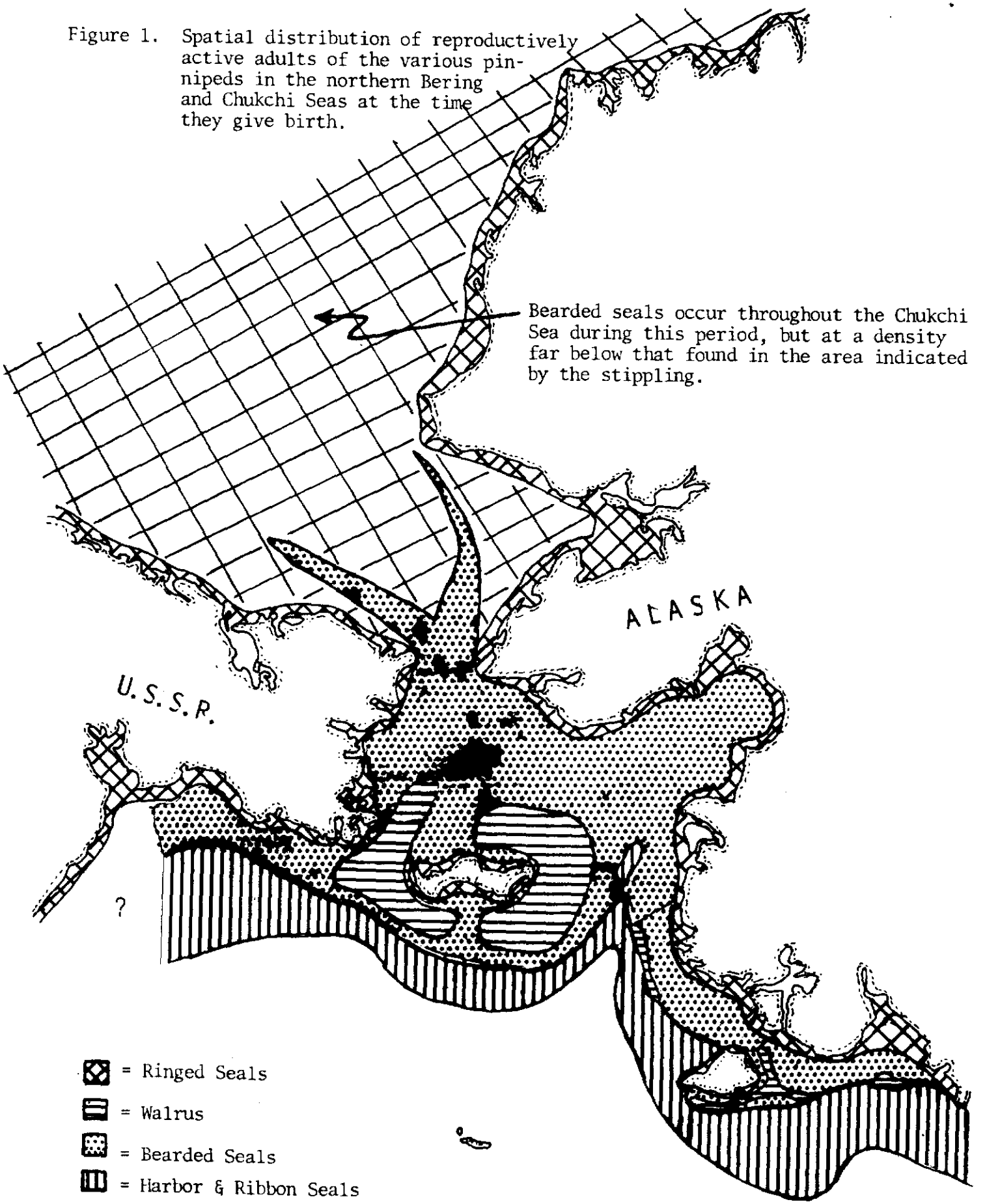
Ribbon and harbor seal pups are born in an area where predation by large carnivores is insignificant. The pups of both these species are quite belligerent, and a pup in good health can protect itself from sea-gulls which are numerous in the pupping areas. As whitecoats they will not enter the water, and can be easily caught and tagged (except that they bite like mad).

The walrus occupies the area of drifting ice north of the major concentrations of ribbon and harbor seals. In the areas where calving occurs, the ice is substantially thicker than near the southern terminus of the floes, and can support the weight of many adults and calves. At the time of calving, seasonally prevailing winds and currents have opened extensive leads of water.

Walrus calves do not possess the white coat as do the ringed, harbor and ribbon seals. Fay (personal communication) indicates that "brooding" by the adults is of major importance with regard to thermoregulation of the calves.

In the case of walrus calves, a dense coat of relatively long, curly hair is not necessary. In fact, it would be a disadvantage to young calves attempting to swim with the adults. The hair of whitecoats is bulky whereas a sleek coat is required. Bouyancy due to trapped air impedes diving. As it is, newborn calves are neither accomplished swimmers nor divers, and are frequently carried by the adults. The constant association of mother and calf has eliminated the need of a white coat for protective coloration, and lack of it may, in fact, insure the calf's safety from other walrus.

Figure 1. Spatial distribution of reproductively active adults of the various pinnipeds in the northern Bering and Chukchi Seas at the time they give birth.



The ability of calves to enter the water soon after birth is of selective advantage in permitting the calves to remain in association with other cows and calves; thus being able to form herds. The calves are protected against low temperatures and high winds, by huddling.

The bearded seal appears to be an intermediate between the other seals of this area and the walrus, with regard to the time of pupping, and the condition of pup.

Young bearded seals possess a coat of soft, grey (varying from silver-blue to brown) hair. This hair begins to shed almost immediately in pups born during the normal birth period, and is almost completely shed at birth in those pups born during late May.

The greatest density of these seals is found in the northern Bering Sea.

At birth the pups are extremely thin, being around 130 cm long, and weighing about 34 kg. These pups gain weight very rapidly, most of the gain resulting from an increase in the blubber layer. Within a few days of birth they weigh about 45 kg, and are about 85 kg by the time they are weaned.

The relatively dense coat is apparently important for thermoregulation during the first few days of life, until the rapidly increasing blubber layer is sufficient. Bearded seal pups enter the water within a few days of birth.

The main birth period in all the species of this area occurs within a span of six weeks (early April through mid-May). This is the period during which the conditions within each of the areas occupied by the various species, are most favorable. As Tikhomirov (1966) points out, birth at this time of the year in these pinnipeds is probably the result of selective parallel evolution.

Why are conditions at this time of the year most favorable?

Ringed, ribbon and harbor seals have their pups during early April. Birth in these seals coincides with the period of maximum snow accumulation, weakest ocean currents (Fedorova and Yankina, 1963), and the slowest ice movements. It does not necessarily coincide with the period of maximum ice extension which is usually in January or February (Wittman and MacDowell, 1964).

The most critical period for the young seals is during the first few months after weaning. By early May, when the young have attained independence, the ice pack is rapidly receding north. Climatic conditions are most favorable, and extensive areas of open water are present.

Since walrus and bearded seals enter the water soon after birth, they are not so dependent upon the presence of relatively stable ice. Birth in these animals is mainly during late April or early May. At this time numerous leads of water are present throughout the area, and the weather conditions are much more favorable than those of three weeks to a month earlier.

Spring Migration

The distribution of seals and walrus during the early spring has a direct bearing on the timing of their movements past the important hunting sites in the northern Bering Sea-Bering Strait area.

Young and non-breeding ringed seals are present near St. Lawrence, King and Little Diomede Islands throughout the winter and spring, as are bearded seals of all ages. At St. Lawrence Island both of these seals begin to appear in increasing numbers during early April, and constitute the vanguard of the spring migration. The main movement of walrus past this island usually occurs during the last part of April, and the first part of May. Cows and new-born calves move north mainly west of the island, while the bulls move up the eastern side. Bearded seals are still numerous when the walrus are present, but they are not associated with large concentrations of walrus. These seals continue moving past the island until almost all the sea ice has passed north. A small number of sub-adults remain after the ice is completely gone. Harbor and ribbon seals arrive last, usually in late May or early June. Harbor seals also move toward the Alaskan and Siberian mainland, and disburse along the ice free coast.

The appearance of these seals indicates that almost all of the sea ice has moved past the island.

At Little Diomede Island, in central Bering Strait, the pattern is the same but the timing is two to three weeks later. Also, there are two peaks in the walrus migration. The first occurs during late May and the first week of June. By this time the cows and calves which have moved north with the strong currents coming around the west side of St. Lawrence Island, are passing through the Strait. The main movement of bulls usually arrives during mid-June. As at St. Lawrence Island, the last seals to arrive are the harbor and ribbon seals. Compared to the harbor seals, relatively few ribbon seals pass through Bering Strait, indicating that they may be pelagic during the ice free months--remaining mostly south of the Strait.

In most years virtually no ice remains in Bering Strait after the first of July.

Vessels moving into the ice from the south would encounter the main concentrations of these seals in the reverse order; harbor and ribbon seals first, then walrus and bearded seals, and ringed seals mainly along the coast.

The 1966 Seal Harvest

The total harvest of hair seals (including ringed, bearded, harbor and ribbon) in western and northern Alaska was estimated at about 15,000 animals. This estimate is based on a recorded harvest of 12,418 seals (information obtained from seal bounty records), and reports from villages where seals are taken but not submitted for bounty. Also, as of this writing, some hunters have not submitted the scalps of seals killed during the last part of 1966.

Bounty records provided the means by which some measure of hunting effort, distribution of the kill, and the seasonal harvest could be determined for a large segment of the total kill.

The reported harvest of 12,418 seals was taken by 352 hunters; an average of about 35 seals per man. The largest segment of the harvest was taken during the months of April through June (the spring migration) when slightly over 40 per cent of the total kill was obtained. For the other periods the proportions were 23 per cent from January through March; 14 per cent from July through September; and 9 per cent from October through December. The exact season during which seals were taken could not be determined for about 14 per cent of the harvest.

An analysis of the total reported harvest of hair seals taken in western Alaska is presented in Table 1. Figure 2 illustrates the geographical distribution of this harvest.

Value of the Harvest

Estimates of the total value of the seal harvest in this area indicate only the cash value that could have been realized from the sale of skins, and the $3.00 bounty received for each seal scalp submitted. No arbitrary value has been established for the meat, although it should be realized that the meat is of major importance to the inhabitants of this area.

Seals are the mainstay of the economy of coastal Eskimos in this area. The primary objective of the hunt is to provide food for consumption by humans and sled dogs. Sale of skins is, at present, of secondary importance even though it is an important source of income. Unlike the situation in southern Alaska, hunting solely for skins is done only after the requirements of an ample food supply have been satisfied. The food requirements are seldom met as there is always someone in the villages that can use the meat.

On the basis of a $3.00 bounty for each seal scalp, and an average value of $8.00 per skin, the 1966 harvest in western Alaska is valued at $165,000.

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Figure 2. Distribution and magnitude of the reported 1966 hair seal harvest in western and northwestern Alaska. The numbers (1 through 28) correspond to the villages listed in Table 1.

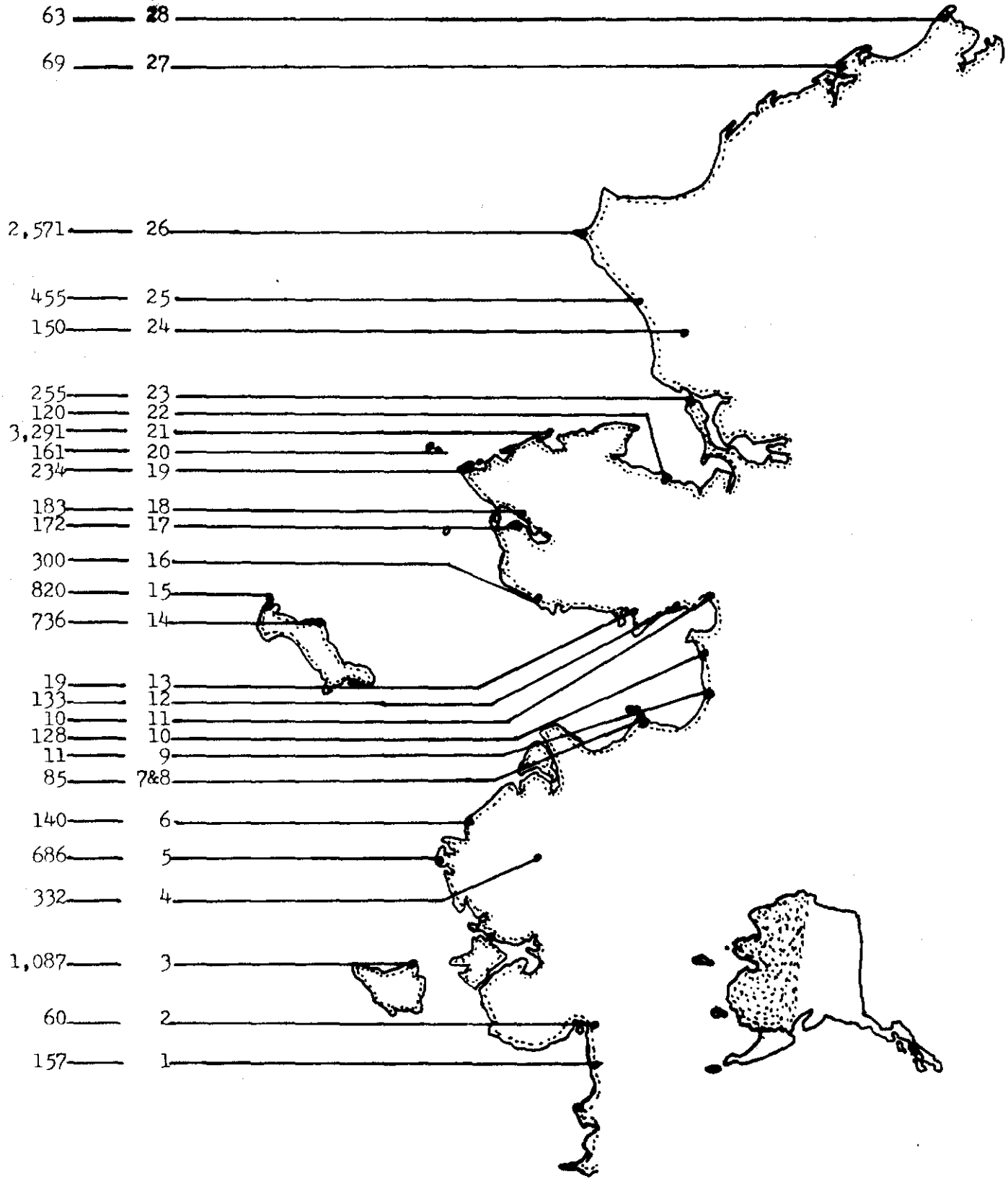

Table 1. The Reported Harvest of Hair Seals in Northwest Alaska during 1966, as Indicated by Bounty Records.[1]

Village	I.D. Number	Number of Hunters	Harvest of Seals by Season[2] Jan - Mar	April - June	July - Sept	Oct - Dec	Exact Season Unknown	Total Harvest
Quinhagak	1	10	12	145	0	0	0	157
Eek	2	3	0	58	2	0	0	60
Mekoryuk	3	32	20	691	257	119	0	1,087
Chevak	4	20	60	268	4	0	0	332
Hooper Bay	5	33	80	483	55	26	42	686
Scammon Bay	6	5	6	27	49	58	0	140
Stebbins	7	7	12	67	0	0	0	79
St. Michael	8	1	0	6	0	0	0	6
Unalakleet	9	1	11	0	0	0	0	11
Shaktoolik	10	7	110	18	0	0	0	128
Koyuk	11	1	0	10	0	0	0	10
Elim	12	6	14	32	5	5	77	133
Golovin	13	1	19	0	0	0	0	19
Savoonga	14	33	168	149	113	115	191	736
Gambell	15	35	159	109	136	120	296	820
Nome	16	19	25	60	6	7	202	300
Teller	17	8	0	11	70	43	48	172
Brevig Mission	18	5	73	52	0	0	58	183
Wales	19	9	22	127	0	0	85	234
Diomede	20	11	67	87	0	0	7	161
Shismaref	21	33	572	1,153	807	607	152	3,291
Deering	22	5	0	18	0	0	102	120
Kotzebue	23	5	10	125	0	0	120	255
Noatak	24	2	0	75	0	0	75	150
Kivalina	25	12	177	170	2	0	96	445
Point Hope	26	42	1,125	996	229	0	221	2,571
Wainwright	27	3	27	27	15	0	0	69
Barrow	28	3	32	10	21	0	0	63
TOTALS		352	2,801	4,974	1,771	1,100	1,772	12,418

[1]The total harvest of seals in northwest Alaska approximated 15,000 animals. The discrepancy results from failure of hunters to submit scalps for bounty--especially bearded seals. As examples, the reported harvests from Barrow, Wainwright, Kotzebue, Koyuk, Unalakleet, St. Michael, Tununak and Eek are far below the actual harvests.

[2]The term "seals" applies to all species of hair seals found in this region.

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