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MARINE MAMMAL REPORT

by

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Annual Project Segment Report
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WORK PLAN SEGMENT REPORT

FEDERAL AID IN WILDLIFE RESTORATION

STATE: Alaska

PROJECT NO.: W-14-R-3 & W-17-1 TITLE: Marine Mammal Investigations

WORK PLAN: F TITLE: Walrus and Seals

JOB NO.: 1 and TITLE: Walrus Biology and Populations

2 TITLE: Walrus Harvest and Utilization

PERIOD COVERED: January 1, 1968 to December 31, 1968

ABSTRACT

The 1968 retrieved harvest of walruses in northwest Alaska was 1,436 animals. Of these, 932 (64.9 percent) were bulls, 330 (23.0 percent) were cows and 174 (12.1 percent) were calves of either sex. Considering adults only, 74 percent were bulls and 26 percent cows. Estimated total kill (including hunting loss and orphaned calves) was 2,600 animals. Little Diomede Island was the most successful hunting site, accounting for 565 animals. Various indicators and comparisons of hunting effort and success are discussed.

Greatest potential value of the 1968 harvest was estimated at $353,600 of which an estimated $200,000 was actually realized.

Comparison of age composition of harvests at selected locations since 1956 indicate no significant change in population structure. It appears that recruitment of harvestable animals has remained good and the population is at present, not being over-exploited. Several reasons for biased sampling are discussed. The occurrence of walrus hauling out on Round Island in Kuskokwim Bay and on Big Diomede Island, as well as their appearance in Herendeen Bay is documented.

RECOMMENDATIONS

The present bag limit of five adult female walrus per resident hunter, per year, should remain in effect. Resident sport hunters not actually dependent upon the resource should be limited to one bull per year as are non-resident sportsmen. Efforts should be continued to improve hunting techniques at all villages where walruses are taken.

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OBJECTIVES

Objectives of the work undertaken during this report period included assessment of walrus population status and trend; accumulation of data concerning present hunting effort, success, harvest composition, utilization and value; enforcement of current regulations pertaining to walrus; and reporting on the phase of investigations concerning walrus population structure, dynamics and trend.

PROCEDURES

The acquisition of information concerning walrus hunting, magnitude of the harvest and utilization was obtained primarily by Department employees working at the major walrus hunting sites during these periods when walrus were available to hunters. These employees included Vernon Slwooko who recorded the spring and fall harvests at Gambell, Alexander Akeya who provided the same services at Savoonga, Sam Stoker who worked on Little Diomede Island during April-June, and Robert Pegau and Edward Muktoyuk, both of whom accompanied hunters to King Island during June.

The importance of these four villages, as far as walrus hunting is concerned, is indicated by the fact that 83 percent of the total annual walrus harvest was taken at these locations.

These men were also responsible for enforcing the current game regulations and conducting field work in conjunction with Jobs F-1 and F-3.

Magnitude and composition of the harvest at less productive hunting sites were determined by correspondence with resident clergyman, teachers, village leaders, and by personal contact with villagers during their frequent travels through Nome. I am especially indebted to Raymond Aguvaluk of Wainwright, John High of Barrow and Rae Baxter of Bethel.

Work on biology and population status of walrus was limited to participation in an extensive aerial survey of Bering Sea, examination of reproductive material from a few selected specimens, and partial analysis of age composition of hunter-killed walrus.

The aerial survey was sponsored and largely financed by the U. S. Fish and Wildlife Service. Mr. Karl Kenyon was in charge of the survey and acted as an observer, Dr. Richard Manville was recorder, Mr. Ray Trembley, pilot, and Mr. Theron Smith, navigator. I represented the Alaska Department of Fish and Game and acted as an observer. The Department also provided financial assistance when it became obvious that a complete survey would not be possible due to a shortage of budgeted funds. The aerial survey was made during April 15-23, and included Norton Sound, Bering Strait, Central Bering Sea, Gulf of Anadyr, Kuskokwim Bay and northwest Bristol Bay. Results of this survey will be published by the Fish and Wildlife Service personnel.

FINDINGS

The retrieved harvest of walrus in Alaska during 1968 was 1,436 animals. The total kill (retrieved harvest + hunting loss, including orphaned calves) is estimated at about 2,600 animals. Table 1 presents a summary of 1968 harvest data including success at various villages, composition of the kill, estimated hunting loss and total kill.

Approximately 87 percent (1,252 walrus) of the total annual harvest was taken at five villages in the Bering Strait area: Gambell, Savoonga, King Island, Diomede and Wales. The village of Little Diomede accounted for 39.4 percent of the annual harvest.

Composition of the retrieved kill was 932 adult males (64.9%), 330 adult females (23.0%) and 174 calves of either sex (12.1%). Due to selectivity of the hunters, there are very few sub-adult walrus taken. Hunters from St. Lawrence Island prefer females accompanied by calves. At other localities the preference is either cows or bulls with well developed tusks (refer to age composition data). Considering the sex ratio of all animals other than calves, 73.9 percent were males and 26.1 percent were females.

The chronological aspect of the harvest is important from the standpoint of raw ivory supply to carvers, storage, preservation and utilization of meat and the availability of animals.

Seasonal harvests and comments concerning conditions that prevailed at different locations are indicated as follows.

Table 1. Retrieved and total kill of walrus in Alaska during 1968.

Location	Walrus Retrieved	Composition of Harvest*						Percent Hunting Loss	Total Kill
		Males		Females		Calves			
		No.	%	No.	%	No.	%		
Mekoryuk	5	5	(100)	0	(0)	0	(0)	40	8
Kuskokwim Area	32	29	(90.6)	3	(9.4)	0	(0)	20	40
Gambell	466	160	(34.3)	172	(36.9)	134	(28.8)	40	777
Savoonga	117	83	(70.9)	27	(23.1)	7	(6.0)	50	234
Northeast Cape	14	14	(100)	0	(0)	0	(0)	50	28
King Island	37	35	(94.6)	0	(0)	2	(5.4)	50	74
Wales	66	47	(71.2)	14	(21.2)	5	(7.6)	50	132
Diomede	565	451	(79.8)	88	(15.6)	26	(4.6)	50**	1,130
Pt. Hope	21	19	(90.5)	2	(9.5)	0	(0)	20	26
Wainwright	85	63	(74.1)	22	(25.9)	0	(0)	20	106
Barrow	16	14	(87.5)	2	(12.5)	0	(0)	30	23
Other Areas	12	12	(100)	0	(0)	0	(0)	40	20
Totals	1,436	932	(64.9)	330	(23.0)	174	(12.1)	44.7	2,598

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

**Includes loss due to orphaning of calves.

Winter Harvest - January through mid-April 1968

Walrus hunting during the winter months is usually poor due to unfavorable weather and ice conditions, short days, and inaccessibility of walrus even though they may be near a village.

Most of the limited number of walruses taken during this period are shot by seal hunters who happen to be in a favorable location when the animals surface near the shore ice.

The winter harvest was as follows:

Village	Winter Harvest	Males	Females	Calves
Mekoryuk	1	1	0	0
Gambell	9	9	0	0
Savoonga	7	7	0	0
Northeast Cape	1	1	0	0
Diomede	5	2	3	0
Totals	23	20	3	0

The 1968 winter harvest amounted to 1.5 percent of the total annual harvest.

Spring Harvest - mid-April through June 1968

During the spring hunting period a combination of factors including the northward retreat of the pack ice, extensive areas of open water, favorable weather and availability of walrus, enable hunters to make their largest catches. Unlike winter hunting, the effort is organized and concerted, with boat crews usually interested only in walrus. If none are available, they will then seek other game.

Ice conditions were favorable at most of the traditional hunting sites, with the exceptions of Savoonga and Northeast Cape on eastern St. Lawrence Island. Frequent southwest winds during April and May, which brought pack ice and walrus to Gambell, Diomede and Wales, caused the ice to be far out from Savoonga and Northeast Cape. In addition, several Northeast Cape hunters were employed and did not take part in the hunts.

Hunters at Little Diomede Island had relatively poor success during the early part of the season when females and calves were passing north through Bering Strait. Accordingly, the harvest of

cows and calves was lower than in some previous years. In addition, regulations imposing a limit on females, as well as changing attitudes of the hunters, helped to keep the harvest of females down. Success during early June, when bulls were available, was very high.

Hunting success in the Kuskokwim Bay area was greater than usual. According to Rae Baxter of Bethel, there were an estimated 500 walrus hauled out on the offshore sand bars south of the village of Kwigillingok and other animals were available in the Kuskokwim Bay area.

The walrus harvest at King Island was very poor because hunters were unable to get to King Island until most of the walrus had passed north. The village at King Island is now abandoned, and the men must travel from Nome to the island. Frequently, unfavorable ice conditions prevent a crossing in time to intercept the main migration of walrus. This was the case during 1968.

The total spring harvest was as follows:

Village or Area	Spring Harvest	Males	Females	Calves
Mekoryuk	3	3	0	0
Kuskokwim Area	24	21	3	0
Gambell	400	105	161	134
Savoonga	57	40	10	7
Northeast Cape	8	8	0	0
King Island	37	35	0	2
Wales	64	45	14	5
Diomede	537	430	81	26
Other Areas	3	3	0	0
Totals	1,133	690	269	174

Diomede hunters took 47.4 percent of the total spring harvest and hunters from Gambell accounted for 35.3 percent. The spring harvest was composed of 60.9 percent bulls, 23.7 percent cows and 15.4 percent calves of either sex. This was the only season during which calves were taken. The spring harvest was 79 percent of the total 1968 harvest.

Summer Harvest - July through September 1968

Bering Strait is usually clear of the last remnants of seasonal pack ice by the first week of July. Accordingly, very few walrus are available to Bering Sea hunters after that period and until the fall advance of the ice. Exceptions are the animals which occur in Bristol Bay (protected by regulation) and the few stray individuals which haul out on the beaches.

After passing through Bering Strait, walrus are usually not available to Alaskan hunters until late July and early August when they are in the vicinity of Wainwright and Barrow. These are the only northern villages that consistantly take walrus in any substantial numbers. The summer walrus harvest was as follows:

Village	Summer Harvest	Males	Females	Calves
Makoryuk	1	1	0	0
Pt. Hope	3	3	0	0
Wainwright	83	61	22	0
Barrow	16	14	2	0
Other Areas	5	5	0	0
Totals	108	84	24	0

Walrus were available to hunters at Barrow. However, most able and willing men were employed and did not participate in the hunt.

The summer harvest represented 7.5 percent of the annual harvest and was composed of 77.8 percent bulls and 22.2 percent cows.

Fall Harvest - October through December 1968

Walrus, especially bulls, begin to pass south through Bering Strait in small numbers during early October, fully two months before the ice comes down. At this time they haul out on beaches and are occasionally available to hunters. Walrus were taken at Little Diomede and St. Lawrence Island during October and November. During mid-November a large number of walrus (2,000-3,000) hauled out on the east side of Big Diomede and were present until the ice arrived in early December. Arriving animals were continuously attracted to this herd and drawn from within the range of Little Diomede hunters which were only 2.7 miles away, across the International Date Line. The walruses were not molested by the Soviets on Big Diomede Island. This was the fourth year in succession

that walruses frequented the beaches of Big Diomede Island. Apparently it is again being used as a traditional hauling area.

During the early fall, hunters from Point Hope also had access to southward migrating walruses and secured 18 animals.

Residents at both Gambell and Savoonga, on St. Lawrence Island, hunted walrus during December using boats and on foot. Details of some of the hunts on foot are stories of high adventure. The fall walrus harvest was as follows:

Village or Area	Fall Harvest	Males	Females	Calves
Kuskokwim Area	8	8	0	0
Gambell	57	46	11	0
Savoonga	53	36	17	0
Northeast Cape	5	5	0	0
Wales	2	2	0	0
Diomede	23	19	4	0
Point Hope	18	16	2	0
Wainwright	2	2	0	0
Other Areas	4	4	0	0
Totals	172	138	34	0

This fall harvest amounted to 12 percent of the total annual harvest and was composed of 80.2 percent males and 19.8 percent females.

Hunting Effort During the Spring Season

Various measures of hunting effort and success have been used as general indicators of long term trends in avilability of walrus to hunters, changes in hunting effort and dependence of people on the marine mammal resource, and differences in availability of walrus due to limitations imposed by weather and ice conditions.

Hunting effort has remained consistantly high at three major walrus hunting sites, considering the limitations imposed by vagaries of weather and ice conditions. These locations are Gambell, Savoonga and Little Diomede Island. However, at King Island, formally a very important hunting site, the effort has become minimal although the success is relatively high.

As mentioned previously, this is due to the fact that hunters no longer reside on King Island, and few are willing to make the long and sometimes arduous trip from Nome knowing that at best they can only intercept the last of the migrating walrus. In 1968 only two boats, manned by 14 hunters (including three boys) went to the island and remained there for eight days. The number of hunting days, boat hours expended and boat hours per walrus retrieved for this and other important sites are presented in Table 2.

At Savoonga there were 18 boats participating in the spring hunt, with a maximum of 15 boats out on any given day. Conditions in general were not very favorable for waltus hunting at Savoonga.

Nineteen boats (one more than last year) hunted for walrus at Gambell during the most favorable days, and this represented the maximum number of boats with crews.

At Little Diomede Island there were four boats manned by 28 regular hunters. There were sometimes a few older men and boys on weekends. The four boats at Diomede retrieved 537 walrus during the spring season. Using the figure of 28 regular hunters, the retrieved harvest amounted to approximately 19 walrus per man.

The total spring harvest at the four villages included in Table 2 amounted to 72 percent of the 1968 statewide walrus harvest.

Utilization of walruses harvested was as follows: at Mekoryuk, the Kuskokwim area, Savoonga, Northeast Cape, Point Hope, Wainwright and Barrow, 85 to 95 percent; at Gambell and Wales, 50 to 60 percent; at Little Diomede and King Islands, 7 to 10 percent.

Value of the 1968 Harvest

The potential value of the 1968 walrus harvest was calculated in the same manner as outlined in previous segment reports. 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 cents per pound
Skins of females valued at $20.00 each
Also included is the value of male skins which are marketed at $75.00 each.

The estimated values of the component parts of the 1968 harvest are presented in Table 3. Greatest potential value of the harvest was calculated to have been $353,564. Actual realized

Table 2. Comparative hunting effort and success during the spring walrus hunting seasons in Alaska from 1961-1968.[1]

Measure of Effort	Year	Gambell	Savoonga	King Island	Diomede Island
Number of 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
	1967	30 of 50	29 of 59	5 of 12	33 of 59
	1968	32 of 56	19 of 48	2 of 8	26 of 50
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
	1967	-	1,894	65	795
	1968	-	-	32	730
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[2]	1.13
	1967	-	10.41	.50	1.39
	1968	-	-	.80	1.35

[1]Data include only those hours expended and walrus taken while an observer was at the respective villages.
[2]Determined by conversations with boat captains regarding success of daily hunts.

Table 3. Potential value of the 1968 walrus harvest in Alaska.

Location	Harvest ♂	Harvest ♀	Harvest Calves	Value of Ivory Raw	Value of Ivory Carved	Bacula	Meat*	Value of Skins ♂	Value of Skins ♀	Greatest Potential Value
Mekoryuk	5	0	0	120	625	35	500	375	0	1,535
Kuskokwim Area	29	3	0	726	4,000	203	2,990	2,175	60	9,428
Gambell	160	172	134	5,560	41,500	1,120	27,191	12,000	3,440	85,251
Savoonga	83	27	7	2,262	12,500	581	9,965	6,225	540	29,811
Northeast Cape	14	0	0	336	1,750	98	1,400	1,050	0	4,298
King Island	35	0	2	840	4,375	245	3,513	2,625	0	10,758
Wales	47	14	5	1,268	7,625	329	5,572	3,525	280	17,331
Diomede	451	88	26	11,704	67,375	3,157	50,549	33,825	1,760	156,666
Pt. Hope	19	2	0	476	2,625	133	2,020	1,425	40	6,243
Wainwright	63	22	0	1,732	10,625	441	7,620	4,725	440	23,851
Barrow	14	2	0	356	2,000	98	1,520	1,050	40	4,708
Other Areas	12	0	0	288	1,500	84	1,200	900	0	3,684
Totals	932	330	174	25,668	156,500	6,524	114,040	69,900	6,600	353,564

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

value to hunters and other walrus "consumers" is estimated at around $200,000. This includes income derived from the carving industry, sale of bacula, home utilization of meat and use of some female skins. The actual income from meat and hides was minimal due to poor utilization.

Harvest Composition

During May and June 1967, lower canine teeth were collected from 719 males walruses taken at Savoonga, King Island and Little Diomede Island. This sample amounted to 93 percent of the entire spring harvest at these locations. The job of sectioning and age determination of this large sample was completed during 1968. This information, as well as age composition data from as far back as 1953, have been partially analyzed primarily to uncover the significant sources of bias which affect estimations of natality, hunter caused mortality and population size.

A thorough and meaningful analysis of these data is not possible at the present time due to the limitations of facilities and techniques available to this writer. However, complete statistical analysis of all age composition data will be accomplished during the coming months.

Several important differences are obvious in samples obtained during years of high and low harvests at various villages. During seasons when walruses are available to hunters in large numbers and substantial harvests are obtained, young middle-aged animals comprise a very high proportion of the harvest (animals 10-20 years of age). Good availability of walrus is an indication that concentrations of animals were within range of the hunters. Young and middle-aged animals form the largest herds, and hunter selectivity is toward the latter. Accordingly, in years of large harvests, representation of middle-aged animals is very high, and age composition of the harvest does not represent age composition of the total population.

Older walruses (23+ years) tend to occur in much smaller herds which are less concentrated. They are often solitary. During the March 1968 cruise of the R/V Alpha Helix, many solitary walruses and animals in groups of two to five individuals were encountered far south of the major walrus concentrations. Judging by body conformation, size and condition of the tusks, almost all were old bulls.

Older animals form a larger proportion of walrus harvests during those years when general availability to hunters is poor. The reason for this is because hunters have much less choice as to which groups of animals they pick to attack, and are forced to take whatever is present, including solitary animals and sub-adults.

Examples of the above comments are evident in analysis of age composition of the 1967 spring harvests at Diomede and King Island. At Diomede the spring harvest was very good and 572 walruses were taken. Teeth were obtained from 493 of the 499 males included in this harvest. Of these, only 15 percent were 21+ years of age. At King Island 129 walruses were harvested, which amounts to a rather poor season. However, 22 percent of the males harvested were 21+ years of age.

Review of past records shows this same general tendency: better representation of the various age classes when hunting success is poor, and disproportionate representation of middle-aged animals when it is high (see data presented by Burns, 1967).

At least two factors in addition to biased availability of walruses during different years have an effect on harvest composition and analysis. These were previously recognized by Harbo (1961) and Burns (1967) as being: 1) selection by hunters for those animals with the best tusks (not necessarily the older bulls), and 2) the fact that there is some error involved in correctly determining the age of old animals. It also appears that old animals, especially males, form the largest portion of late migrants. Limited ice cover, extensive open water and the fact that these animals are frequently swimming rather than passively moving with the ice, greatly reduces their vulneratility to hunters.

As far as possible, all sources of bias will be considered in the complete analysis of age composition data. For the present, I will attempt to analyze age composition information to determine whether any major changes in walrus population structure have occurred during the past twelve years.

Fig. 1 illustrates the age composition of male walruses harvested at Savoonga during four spring hunting seasons in which the hunters had fair to good success. Data for 1956 were kindly provided by Dr. Francis H. Fay, Arctic Health Research Center, Fairbanks. Several facts are obvious from the data included. Calculated overall mortality rates were similar in all four years (14 to 17 percent). Also in general there appears to be little proportional difference in representation of the age categories which comprise the major portion of the harvests (10-20 years). On the basis of information from Savoonga, there is no indication that hunter caused mortality has adversely affected the overall population structure during the last twelve years.

Fig. 2 presents data from the 1967 spring harvest at Diomede, King Island and Savoonga. The influence of the large harvest at Diomede is obvious in the calculated estimate of hunter caused mortality for the combined total sample in age groups 13-35. A mortality rate in the total sample of 19 percent is greatly in excess of the actual mortality rate. However, it is reasonably

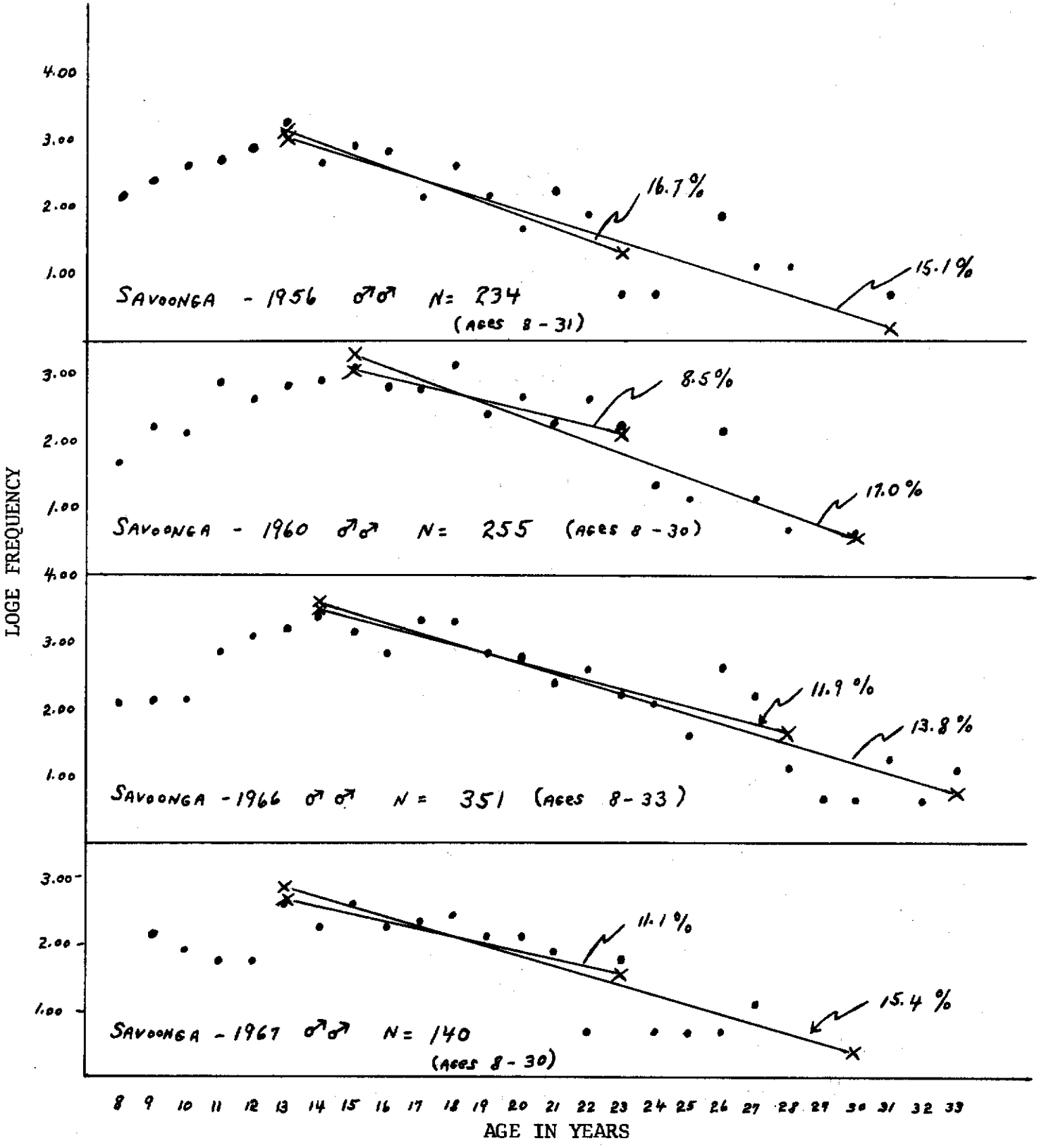

Fig. 1. Comparative age composition and calculated mortality rates for male walruses taken at Savoonga during 1956, 1960, 1966 and 1967. Data for 1956 was provided by Dr. Francis H. Fay. Solid lines indicate calculated mortality rates for age classes they transect.

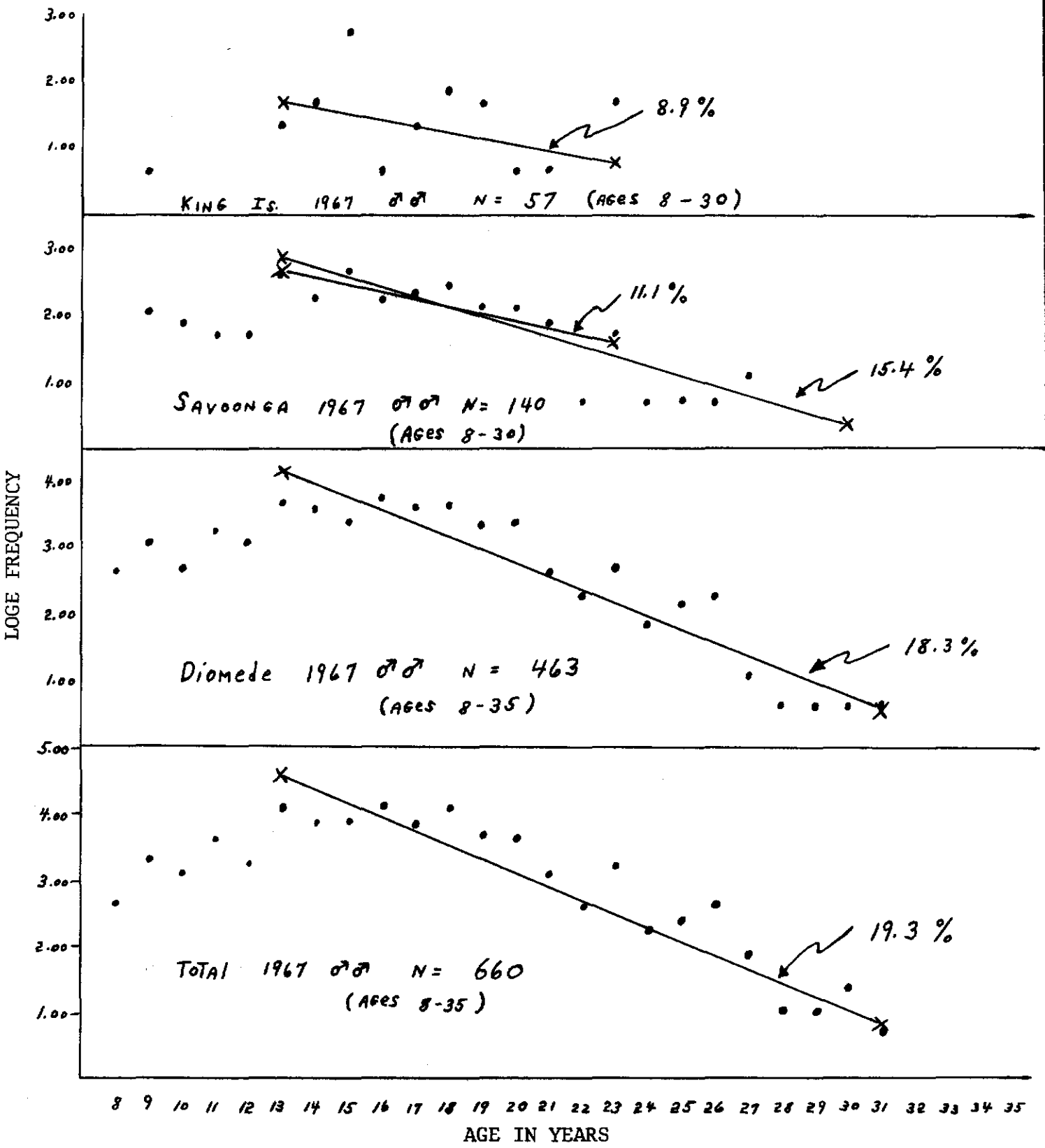

Fig. 2. Comparative age composition and calculated mortality rates for male walruses taken in northern Bering Sea during 1967. Solid lines indicate calculated mortality rates for the age classes they transect.

consistent with previous estimates for this age group, indicating that that over-exploitation is not occurring at the present level of hunting effort. Harbo (1961) calculated a mortality rate in his combined 1960 sample of males (age groups 13-31) of 18.1 percent.

Estimates of mortality for animals between 13 and 23 years of age are probably closer to the actual level of hunter caused mortality. The estimate for the total 1967 sample of males in these age groups was about 10 percent. Considering each village separately, these estimates were 11 percent at Savoonga, 8 percent at King Island and 10 percent at Diomede. Harbo (1961) estimated the mortality rate in his 1960 sample of males to be 8.3 percent for animals 13 to 20 years and 12.3 percent in 15 to 24 year olds. Comparison of these figures also indicates that there has been no dramatic shift in population structure and that recruitment has remained good.

Miscellaneous Observations

Several reports and observations of interest concerning the occurrence of walrus were recorded during 1968. The significance of walrus appearing on the margin of their normal range is debatable; however, we are interested in learning of reoccurrence of animals in formally used areas and on hauling grounds. These observations may indicate an increasing walrus population.

On April 20, 1968, the crab fishing boat North Beach was laying inside Herendeen Bay, near Port Moller on the Alaska Peninsula. The captain and crew reported the presence of between 500 and 1,000 walrus which remained in the bay for several days. Numerous photos of these animals were taken. All animals included in the photos I examined were males, as were two dead walruses found by the vessel's crew.

At about the same time the aerial survey crew, including Karl Kenyon and I, observed an estimated 1,000 walruses hauled out on Round Island in northern Bristol Bay. The island was surveyed on April 23. To my knowledge this is the earliest date that a concentration of walruses was observed on any of the Walrus Island group, and most available information indicates that they usually begin to appear in late May or early June.

At the time of our survey, seasonal pack ice extended to just north of Cape Newhenham. The walruses at Round Island and Herendeen Bay were reasonably close to the pack ice and concentrations of other walruses, but for unknown reasons were disassociated from them.

Rae Baxter, Alaska Department of Fish and Game, Bethel, reported a reasonably successful spring walrus hunting season in the

Kuskokwim Bay area. During June he stated that about 500 walruses were hauled out on the outer sand bars south of Kwigillingok. Although walruses frequent Kuskokwim Bay, there are no previous reports of a hauling area. In addition, the sand bars utilized as a hauling area are not at all like the typical areas which are usually narrow beaches at the foot of a precipitous island or land-head.

One other hauling area was reported by many of the residents of Little Diomede Island. In late October walruses began to appear in the narrow channel separating Big and Little Diomede Islands. The animals began hauling out on a narrow strip of rocky beach on the east side of Big Diomede Island. The number of walruses using this beach increased until by mid-November an estimated 2,000-3,000 animals occupied most of the available beach. They continued frequenting Big Diomede Island until early December when heavy ice moved in from the north. This was the fourth year in succession that Big Diomede was utilized as a hauling area. Since the Soviet residents of Big Diomede do not harass these animals, it seems likely that the island is a re-established hauling ground. This situation could not occur on Little Diomede Island due to activity of the resident hunters.

During July-September, two U. S. Coast Guard icebreakers, the Northwind and Staten Island were operating in the Arctic Ocean and portions of the East Siberian Sea. Marine mammal observation forms were provided to each ship for reporting sightings of polar bears, seals, walruses and whales.

The Northwind reported the largest number of walrus sightings between August 2 and 8, in the vicinity of Point Barrow. On August 13, 111 walruses were recorded at 74° 22' N and 165° 00' W. This position is well into the Arctic Ocean at water depths in excess of 50 fathoms. Northwind made the deepest penetration of the Arctic ice on the following day (August 14) when she reached the position of 75° 48' N, 167° 00' W.

During late August the Staten Island passed through Long Strait into the East Siberian Sea. The cruise track and daily positions while in this region are considered classified information and were not provided to me. Substantial numbers of walruses were encountered when the ship entered Long Strait on August 27, and on each day that she worked in the pack ice of the East Siberian Sea. As would be expected, few walruses were recorded on those days when the ship was operating in open water.

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WORK PLAN SEGMENT REPORT

FEDERAL AID IN WILDLIFE RESTORATION

STATE: Alaska

PROJECT NO.: W-14-R-3 & W-17-1 TITLE: Marine Mammal Investigations

WORK PLAN: F TITLE: Walrus and Seals

JOB NO.: 3 TITLE: Seal Biology and Harvest

PERIOD COVERED: January 1, 1968 to December 31, 1968

ABSTRACT

The primary research effort during 1968 was devoted to a life history study of the ribbon seal (Histriophoca fasciata).

Two methods were used for determining age of individual animals: examination of canine teeth and of claws. Gworth rates were determined and indicate little difference between sexes. Pups average 62 percent of adult length, one year olds 70.4 percent, two year olds 86.6 percent and three year olds 92.4 percent. The oldest animal included in the sample (N=314) was 23. As indicated by females, the breeding season occurs during late April and early May. Defining sexual maturity as the age of initial conception, some females mature at two years of age (38 percent) and most are sexually mature by age four. A discussion of ribbon seal distribution, description and general growth of female reproductive organs is also included.

Analysis of 1968 seal bounty records indicates a harvest of only 6,273 hair seals in northwest Alaska. Several reasons for the inaccuracy of these records are discussed. The actual 1968 harvest of seals is estimated at between 10,000-11,000 animals.

RECOMMENDATIONS

Present regulations of no closed season and no limit should remain in effect for resident Alaskan hunters. A continuing effort should be made to determine magnitude of the total kill by both Soviet and Alaskan hunters in order to initiate appropriate steps to insure perpetuation of all species, especially ribbon seals taken on the high seas. Continued effort should be directed at biological studies which will shed light on individual species' life histories and the interrelationships among species and within the total marine environment they occupy.

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OBJECTIVES

The objectives of work conducted during this report period included: continued assessment of the magnitude, geographical distribution and characteristics of the hair seal (including Erignathus, Phoca, Pusa and Histriophoca) harvest in northwest Alaska; continuation of the life-history study of Histriophoca including accumulation of material, writing and publication of completed studies; to continue investigation of interspecific relationships among the ice inhabitating phocids; and to acquire the data and specimens necessary for initiation of a study of ice inhabitating spotted seals (genus Phoca).

PROCEDURES

Assessment of the 1968 hair seal harvest is based on an analysis of bounty records, reports from hunters, and observations recorded by Department biologists at various villages during the year. During 1968, no attempt was made to identify the species of seal taken on the basis of scalps submitted for bounty.

Specimen collections were limited mainly to Phoca and Histricphoca taken during phases I and II of the R/V Alpha Helix Bering Sea Expedition, animals taken during the spring hunting season at Little Diomede Island, and some spotted seals taken during the fall near Nome.

Emphasis was devoted primarily to the processing of specimens and data from Histriophoca and Phoca, and to the reporting of findings concerning the former.

Persons instrumental in completing certain phases of these investigations included Mrs. Mark Kaminsky who did the lab work associated with preparation of seal teeth for age determinations, Mr. Edward Muktoyuk who served as a field assistant throughout the year,

Mr. Sam Stoker who worked on Little Diomede Island during May and June 1968, and Mr. Robert Pegau who served as a field and lab assistant, compiled the bounty records and helped with the statistical analysis of data.

Description of specific procedures for age determination and reproductive status in Histriophoca will be discussed in the appropriate sections below.

FINDINGS

The following is a partial resume of the ribbon seal life-history data compiled to date. Additional parts of this study (e.g. reproduction in males, food habits, parasites, physiology, comparative anatomy, taxonomy, etc.) are not yet completed, and will be included in a comprehensive report.

Introduction

The ribbon seal, Histriophoca fasciata (Zimmermann), is one of five pinnipeds of common occurrence in the northern Bering and Chukchi Seas; the four others being walrus (Odobenus), beared seals (Erignathus), ringed seals (Pusa), and spotted seals (Phoca). All species are traditionally used by coastal residents of Alaska and Siberia. In recent years the level of commercial exploitation has markedly increased to the point where there is concern on the part of American and Soviet investigators about the status of some species, including the ribbon seal.

Pinnipeds are of vital importance to the residents of coastal areas in western and northern Alaska. All species are utilized depending upon their availability. Since 1959 the Alaska Department of Fish and Game has been involved in a broad study of Bering Sea pinnipeds in order to determine factors affecting abundance, distribution and seasonal movements; general life history; ecology; reproductive physiology; growth rates; interspecific relationships; comparative behavior; and mortality.

Greatest concentrations of ribbon seals occur in the north central Bering Sea, usually away from the major coastal settlements. Accordingly, even though the seals are reasonably abundant, the frequency with which they are taken by Alaskan residents is low during most years. Since 1960, the Alaska Department of Fish and Game has stationed biologists at the major hunting sites. From 1961 through 1966 these biologists were able to acquire specimens and/or data from only 23 ribbon seals, and as of 1966 it did not appear likely that an intensive investigation of ribbon seals would be feasible.

However, the winter of 1966-67 was an unusual one during which temperatures were above normal, and storms with accompanying prevailing winds from the south were frequent.

Sea ice conditions which prevailed during March through June of 1967 were accordingly atypical. The seasonal sea ice in Bering Sea was unusually fragmented and the ice edge was several hundred miles north of its normal position during late winter.

An aerial survey was made on April 20, 1967 in order to determine the influence of these unusual conditions on the distribution of pinnipeds. Large concentrations of seals, including ribbon seals were observed in the northeastern part of Bering Sea from the region of St. Lawrence Island to Bering Strait and it seemed obvious that a great number would be taken by Alaskan hunters. During the following months of May and June, ribbon seals were available to hunters in the Bering Strait region in unprecedented numbers and approximately 1,100 were taken. Data and specimens were obtained from as many seals taken by resident hunters as was possible within the limitations imposed by time and the demands of our primary investigations of walrus.

Collections and observations made during 1967 form the main body of information included in this report.

The ribbon seal study was continued during 1968, as the result of my participation in two phases of an expedition by ship into the ice-covered regions of the eastern Bering Sea. These expeditions were undertaken in an effort to study the physiology and natural history of a wide variety of animals including the ribbon seal. During the first cruise the U. S. Coast Guard Cutter Northwind and the R/V Alpha Helix, operated by Scripps Institute, worked in the ice from March 7 to 27. From May 25 to June 2 the Alpha Helix worked in an area bounded roughly by St. Lawrence Island, St. Matthew Island, and Nunivak Island. These ship-board expeditions provided the opportunity to move into areas in which ribbon seals were abundant, and to remain there utilizing the ships as base of operations and as floating laboratories. Helicopters were used for reconnaissance flights from the Northwind, and for selective sampling. Two ribbon seal fetuses, obtained by Caesarean section were kept alive on the Alpha Helix in late March and early April.

The second phase of the Alpha Helix expedition provided ample opportunity to study both living and dead ribbon seals, and to determine comparative differences between this and other pinnipeds of the Bering Sea. Five adult ribbon seals were kept aboard the Alpha Helix for periods of time ranging from four days to almost two weeks. During this same period other pinnipeds were maintained alive including four spotted seals, two fur seals and six sea lions.

One of the major problems with regard to material utilized in this report is that except for a few ribbon seals taken during November, the remainder of the information comes from animals killed during only four months - March, April, May and June. Unfortunately, this shortcoming cannot be remedied without a great financial

investment and the use of large, ice-reinforced vessels operating in very unfavorable conditions during the late fall and mid-winter months.

General Description

For the sake of general description, we will concern ourselves with characteristics of the ribbon seal that can be easily observed or determined without dismembering the animal.

The most striking and obvious difference between this and the other phocids is the distinctive coloration of adults which is indicated by the scientific name as follows (from King, 1964, p. 142):

> Histrio - Latin, A stage player, + phoca, which is Greek for seal. A reference to the striking color pattern.
>
> Fasciata - from the Latin fascia, a band or ribbon, referring to the white band-like markings on the coat.

All ribbon seals older than pups of the year exhibit this banded pattern of coloration. Indistinct white bands begin to appear in some young ribbon seals as early as twelve weeks after birth, but are usually not obvious until they molt at the end of their first year of life. These white bands increase in contrast in males to sexual maturity, after which the adult male is essentially dark brown or black (dark brown before the spring molt and shiny black after it) with white bands. There are four white bands, one encircling the neck or head, one encircling the body at or behind the level of the naval, and one on each side of the body encircling the foreflippers. Width of the bands is quite variable, and they sometimes coalesce. Adult females have similar markings but they are much less distinct due to the lighter background color of grey rather than dark brown or black.

The bands on skins kept in museum collections almost invariably turn yellow due to oxidation, giving a false impression of their color on living seals.

Markings of ribbon seal pups do not resemble those observed on older animals. At birth they are completely covered by a dense coat of white lanugo except for a slightly darker colored snout. Pups normally shed this coat completely by six weeks of age, revealing a coat of short sleek hair which is neither banded nor spotted. In color it is a blue-grey on the undersides. The muzzle is black. Pups in this condition appear very similar to young hooded seals (Cystophora cristata). This stage of pelage development has thus far not been mentioned in the literature.

The facial region of adult ribbon seals is always black in males and grey in females. Mystical vibrissa are relatively long

and beaded as in all phocids except bearded and monk seals. Superciliary vibrissa, usually six to twelve in number, are prominent behind and mediad of the eyes. They are arranged in a semicircle. In addition to the typical mystical vibrissae which occur on the fleshy nose pads and are well innervated, there are four short whiskers on top of the nose, behind the nostrils. These are arranged with two whiskers on each side of the nose and are directed upward rather than out away from the face as are the mystical vibrissa.

The eyes are uniformly dark (sometimes appearing green in direct light) and are larger in comparison to those of other Bering Sea phocids. In five adult ribbon seals, greatest diameter of the eye ranged from 43.9 to 48.0 mm ($\bar{x}$=45). Limited data from other adult phocids of this region show an eye diameter of about 43.5 mm in Pusa, 39 mm in Erignathus, and 38.5 mm in Phoca.

Adult ribbon seals are generally more slender in relation to their length than are the other northern phocids. Maximum girth, expressed as a proportion of length for adult phocids of Bering Sea is roughly 68 percent in Histriophoca, 70 percent in Phoca, 73 percent in Erignathus, and 90 percent in Pusa.

As in all phocids, with the exceptions of Erignathus and Monachus, the number of mammary teats is two.

On the foreflippers there is a gradation in length of the digits, the first one being longest and the fifth shortest. This is also the case in Pusa and Phoca. In Erignathus the third digit is longest, giving the distal edge of the flipper a slightly rounded appearance. The foreclaws of Histriophoca are relatively long and slender. Claws on the hind flippers are short and the fleshy part of the flipper extends beyond the claws. The third digit of the hind flipper is shortest; digits one and five, and two and four are equal length with the former pair being slightly longer.

They are fast swimmers and seem to maneuver very easily. The hind flippers provide almost all of the power during swimming; foreflippers being held against the body except when turning, banking, coming to a stop, or maintaining a stationary position.

Ribbon seals have a very flexible neck which can be extended to a greater degree than in the other phocids of this area. It may have been this long neck which let Inukai (1940) to mention that attachment of the foreflippers in Histriophoca is almost at the middle of the body, while in the other phocids of the Okhotsk and Bering Sea, attachment is about one-third of the way along the body.

After watching ribbon seals under various conditions, it appears obvious that both the neck and foreflippers are much more

flexible than in Erignathus, Pusa or Phoca, and that the apparent position of foreflipper attachment to the trunk depends upon the attitude of the seal.

Locomotion over a solid substrate such as ice is surprisingly rapid, and is accomplished in a manner unlike that observed in the other phocids of this region.

In Erignathus, Pusa and Phoca, locomotion over a solid substrate is accomplished by wriggling movements resembling the progression of a caterpiller. Weight of the forward part of the body is supported by the sternum or sometines both foreflippers, and the rear end brought forward. The forepart of the body is again extended and the process repeated. Since the hind limbs cannot be rotated forward, they are not used on land or ice. Occasionally, especially on slippery ice, Phoca is able to move rapidly by a swimming motion in which the hind end of the body supplies the power.

When ribbon seals are moving across ice or snow, the head and neck are extended forward close to the surface, the foreflippers are alternately extended and drag the body forward when each is retracted, and the torso and hind flippers are vigorously moved from side to side as if swimming.

Movement of the torso and flippers seems to counterbalance the alternate extension and retraction of the foreflippers. Moving in this manner, the ribbon seal does not hunch its back, but slides on its chest, stomach and abdomen. On a smoth ice flow ribbon seals can easily outdistance a man.

Distribution and Seasonal Movements

The distinction between total range and effective range of animals, as pointed out by Davies (1958) is pertinent to a discussion of ribbon seal distribution. Total range includes those areas far from an animal's normal habitat, where it has occasionally been found. Effective range is the area in which most individuals of a given species usually occur. The difference between the two is sometimes very extensive, especially in pinnipeds which can move great distances from the effective range to a degree usually not equalled in land mammals.

The effective range of Histriophoca includes the Okhotsk, Bering and Chukchi Seas, and the bays and straits contiguous with them.

Von Schrenck (in Allen 1880, p. 681) reported these seals from the Gulf of Tartary (Tarter Strait), the southern coast of the Okhotsk Sea and the eastern coast of the Kamchatka Peninsula.

Rass et al (1955) indicated that these seals occurred all along the coast of Siberia from Bering Strait to the Kurile Islands and the shores of the Okhotsk Sea. Bobrinski (1944) reported their occurrence in the eastern part of the East Siberian Sea.

On the American side, the effective range extends from the vicinity of Point Barrow (Bee and Hall, 1956; Morgan, pers. comm.) to Unalaska Island in the Aleutian Islands (Scammon, in Allen, 1880).

Their range, although restricted in the vicinity of the southeastern Kamchatka Peninsula and Kurile Islands, is continuous from the Bering to the Okhotsk Sea. At the present time ribbon seals from both areas are considered to be the same.

Extreme dispersal of ribbon seals within their effective range is associated with years of unusual ice conditions. The formation of extensive ice in the Bering and Okhotsk Seas results in the occurrence of these seals further south of areas where they normally occur. The reverse is also true.

Inukai (pers. comm.) indicated that along the northern coast of Hokkaido, ribbon seals occur in greatest numbers during those years of heavy ice formation. In our region, the ribbon seals drift south with ice coming down from the Okhotsk Sea during the spring.

The factors affecting ribbon seal distribution are, at the present time, very poorly understood. These seals are associated with sea ice during the late winter, spring and early summer, but their distribution and activities during the late summer and fall are virtually unknown. They are especially dependent upon the presence of sea ice on which to give birth to their pups, and for hauling out to molt. However, after the main molting period is over in mid- to late June, they are apparently no longer dependent upon the presence of sea ice. Circumstantial evidence indicates that they become largely pelagic, living in the open sea.

Concentrations of both spotted (Phoca) and ribbon seals can be located in central Bering Sea during April and May. However, by the time the ice edge is receding north through Bering Strait, there are only a small number of ribbon seals associated with it, although spotted seals are numerous.

In the Okhotsk Sea, there is no permanent ice pack. The various pinnipeds there must become either totally pelagic during the ice-free months, or resort to coastal rookeries. Except for occasional individuals, ribbon seals do not haul out on land.

As stated previously, all of the Bering Sea phocids are found in association with sea ice at one time or another during the year.

This does not imply that sea ice of any type is suitable for all species, nor that all species are randomly intermixed. On the contrary, each species occurs in greatest abundance within different geographical regions and, therefore, within different ice zones. Sea ice within the various regions differs greatly in size and thickness of the floes, and surface area of the sea actually covered by ice, and thickness of the accumulated snow cover.

Ribbon seals do not normally occur within the limits of the heavy seasonal ice pack. During late winter through early summer, they are concentrated in the extensive ice edge zone which extends along the southern edge of seasonal ice. This ice edge zone is characterized by small floes usually less than 20 m across, separated by water or slush ice, with little or no snow cover, and subject to rapid dispersal or compaction by winds and ocean currents. During late March 1968, the ice edge zone in central Bering Sea was approximately 85 miles wide. Ribbon seals were most numerous along the inner edge of this zone and were gradually replaced by spotted seals towards the southern edge of ice.

On March 25 and 26, 1968, the R/V Alpha Helix and USCG Cutter Northwind encountered concentrations of ribbon seals at approximately 59° N and 172° 50' W in edge zone ice of .7 to .9 coverage. The edge of the seasonal ice pack at this time extended north from approximately 57° 30' N, and except for some extensive leads in the vicinity of St. Lawrence Island and the Gulf of Anadyr, the seasonal ice pack was essentially continuous north of this point.

By June 1, 1968, ice conditions had changed dramatically. The area south of St. Lawrence Island was essentially free of ice except for a band of scattered floes starting near Nunivak Island in the east and extending in an arc southwest and then northwest into the Gulf of Anadyr.

At this time walruses, bearded seals and ringed seals were of common occurrence north of St. Lawrence Island, and a large proportion of these animals had already migrated north through Bering Strait. The belt of scattered floe ice far to the south of this region was occupied primarily by ribbon seals and a lesser number of spotted seals. Several hundred ribbon seals were observed from the R/V Alpha Helix on June 1, in an area approximately 60° 20' N, 169° 24' W. I have no idea of the probable numbers of ribbon seals in the area, as visibility from the ship was very poor due to fog.

The occurrence of a disjunct band or remnant of seasonal ice far south of the normally receding ice edge may be a normal annual occurrence, perhaps resulting from seasonal ocean currents, prevailing winds, etc.

Several things suggest this, including the fact that during most years ribbon seals are not abundant in northeastern Bering Sea. Also, the structure and formation of ice found in this wide band during June 1968 indicated that it was not formed as a normal part of the seasonal ice pack, but in fact probably came from some coastal area, pushed by the irregular currents. During years of unusual meteorological and oceanographic conditions, which result in only limited formation of the seasonal pack ice, the separated band of sea ice does not form, and accordingly, ribbon seals occur much further north of their normal spring range.

Age determination

Age of individual ribbon seals was determined by two methods: counting the number of growth ridges on claws, and counting cementum layers on decalcified sections of canine teeth. Both methods have been discussed at length in the literature.

Age determinations based on the number of observed bands or ridges of seal claws was discussed by Plekanov (1933), Doutt (1942), Laws (1953), McLaren (1958a, b), and Burns (1967). Usefulness of claws varies greatly among the different species, depending primarily upon distinctness of bands and rate of claw wear. Laws (loc. cit.) indicated that in Mirounga leonina wear was so great that claws were useful only on animals up to four or five years old. In Pusa Hispida, McLaren (1958b) found that claws were not useful beyond about the tenth year. Bands or ridges on claws of Erignathus barbatus are obvious, but there is a great deal of individual variation in wear. In a sample of 390 bearded seals from Bering Sea (Burns, loc. cit.), it was found that ridges persist for at least nine years and frequently as long as 16 years. McLaren (1958a) also found this to be the case in bearded seals of the eastern Canadian Arctic. Ridges are also obvious in ice inhabiting forms of Phoca vitulina from Bering Sea, and they persist for between nine and 15 years. However, they are not discernable on spotted seals obtained from the Aleutian Islands, the Gulf of Alaska, or southeastern Alaska. In addition, claws of spotted seals from these areas are commonly worn due to climbing on rocky shores.

Among the Bering Sea phocids, claws from ribbon seals are the easiest from which to determine age. The foreclaws are long, and dark (almost black) ridges are distinct and they persist for between 15 and 21 years. Negligible wear of the claws is attributed to this seal's more pelagic habits and their seasonal occurrence in the edge zone ice rather than in the heavier pack.

Two claws were obtained from each seal and handled as individual specimens. They were soaked in a solution of 50 percent isopropyl alcohol and xylol at least two days prior to examination. Age was determined while the claws were wet. Soaking

greatly increased contract and made the bands or ridges more distinct.

Formation of a band or ridge is apparently associated with any one or all of several periods of physiological stress, all of which occur during the spring and early summer. These include: birth, lactation, breeding, decreased feeding activity and molting.

In determining age, each band including the constriction of birth was counted. Pups of the year showing only the constriction of birth were thus in age class I indicating they were in their first year of life, but had not attained their first birthday.

Age determinations based on claws were made for 314 ribbon seals.

Results of age determinations based on claws were compared with those obtained from examination of transverse sections of canine teeth. In most cases where comparisons could be made, the results were identical. When inconsistancies occurred, differences were (except in one case) within two years of each other. Some differences were the result of counting indistinct rings in the canine teeth.

Preparation of tooth sections was accomplished as follows: teeth were removed from Loess' solution in which they were stored after extraction. A dilute solution of 3 percent HCl was used for decalcification. Teeth were decalcified until they were "rubbery" and could be cut with a razor blade. The time required for decalcification varied depending upon density of indivisual teeth. Decalcified teeth were then rinsed in continuously flowing tap water for three-four hours.

After thorough rinsing, teeth were cut with a razor blade at a point approximately two-thirds of the way up the root. The root end was clamped into a microtome and frozen with a commercial preparation of flourinated hydrocarbons (Cyrokuik). Sections were cut at an average thickness of 40 micron.

Laboratory preparations of Ehrlich's hematoxylin were used initially for staining but the results were variable and sometimes poor. Commercially prepared alum hematoxylin (Paragon C. & C. Co., Inc., 190 Willow Ave., Bronx, New York 10454) was then used and produced a vivid stain with consistent results. Sections were stained for about ten minutes and rinsed in tap water. Time required for penetration of the 40 micron sections resulted in over staining. Excess stain was removed by placing sections in a dilute solution of sulfuric acid (7 drops/250 ml water) until they appeared light red. They were then transferred to a dilute solution of lithium carbonate and allowed to re-blue to desired intensity and rinsed in water.

Stained sections were placed on a slide, excess water blotted off, and dried overnight. Alcholic dehydration was thus avoided. A few drops of xylene solution and a cover slip were added, avoiding the problem of xylene clearing.

Use of layers in the dentine or cementum for age determination has been applied to various animals with a high degree of success since Laws (1953) published results of his studies.

Use of layers in the dentine is possible in those species in which the teeth have an open pulp cavity throughout all or most of their lives. Retention of an open pulp cavity permits the formation of dentine. Mirounga leonina retains an open pulp cavity throughout life, and dentinal layers have proven to be an accurate means of estimating age in animals of known age (Carrick and Ingham, 1962). Scheffer and Kraus (1964) report that fur seals have an open pulp cavity for 20 years. The tusks (upper canine teeth) of walrus retain an open cavity and continue growing during the animal's entire life. However, in the other teeth of a walrus the root apex is completely closed between five to eight years of age.

In many pinnipeds the pulp cavity becomes filled with dentine when the animal is still relatively young. When this occurs, dentine deposition is reduced, and dentinal layers are not usable as a means of determining age.

However, cementum continues to be deposited on the tooth root and the characteristics of its deposition provide a very accurate method of age determination. The accuracy of this method as a means of age determination has been reported for a wide variety of animals, including white-tailed deer (Ransom, 1966; Gilbert, 1966; Sauer, et al, 1966), caribou (McEwan, 1963), bison (Novakowski, 1965), grizzly bear (Mundy and Fuller, 1964) and coyotes (Linhart and Knowlton, 1967).

In pinnipeds, Hewer (1960) was able to support the hypothesis that layers in the cementum were deposited annually by counting 25-26 rings in a grey seal known to have died at 26 1/2 years of age. Similarly, Mansfield and Fisher (1960) identified 18-20 layers in a spotted seal known to be 19 1/2 years old.

At the present time I have no ribbon seals older than pups which are of known age and am basing the accuracy of age determination using cementum layers on its successful application in other species of seals. It is noteworthy that there were no discrepancies in determining age of pups, which were easily identifiable by other methods, and also, age determinations based upon cementum layers agreed very well with those based on examination of claws.

Cementum layers in most ribbon seal teeth are fairly distinct and easy to count. However, there were a few specimens in which the cementum was unusually thin and the rings were so indistinct that no age determination was possible.

In pups of the year (all obtained during May and June) there was little or no cementum and no ring was obvious. The first dense layer of cementum (the ring) forms during the spring following birth and is obvious on the outer margin of cementum. In all specimens this marginal ring was counted.

Because of the comparative ease of determining age on the basis of claws, this method was used on the majority of pups, and on most specimens from which no reproductive tracts were obtained. In all other cases, age determinations based on both claws and canine teeth were used.

Age and Growth

Material included in this duscussion of age and growth consists of two near-term fetuses, 155 seals for which both age and weight data are available, and 156 seals for which standard length and age are known.

The length and weight of ribbon seals at birth has not been reported and I have no data from new born pups. However, two near-term fetuses were obtained, one on March 25 and the second on March 26. The first, female number AH-17-68, weighed 8.4 kg. with a standard length of 85.7 cm. The second, male number AH-20-68, weighed 7.3 kg. and was 75.3 cm long. These fetuses were obtained by Caesarian section and kept alive for almost two weeks. They were within seven to fourteen days of being born naturally. The length measurements of these fetuses ($\bar{x}$=80.5 cm) approximates actual size at birth, and are both within the range of lengths observed in weaned pups.

Although these term fetus lengths apply to new born pups, the weights are less than that expected in pups born seven to fourteen days later. Data from ringed and bearded seal fetuses shows an increase primarily in weight near the end of pregnancy. This is primarily in girth (therefore weight). I would estimate weight of ribbon seal pups at birgh to range from 8.0 to 12.0 kg.

At the present time my data is not sufficient to plot rate of growth during the nursing period other than to state that weight is doubled from an estimated average of 10.0 kg. at birth to 21.3 kg. in weaned pups ($\bar{x}$=62).

All measurements taken of ribbon seals showed great variation within each age class. In pups of the uear variation in weight was as much as 51 percent (15.0 - 30.9 kg., $\bar{x}$=62). Differences in

standard length were as large as 42 percent (74.0 - 127.8 cm, $\bar{x}$=62). The range in these parameters was not as great in older age classes.

In my samples there was no significant size difference between males and females. The value for "t" in pups was 2,385 (d.f. = 60); in two year olds, those in the third year of life, "t" was 1.71 (d.f. = 9). However, larger samples within older age classes are necessary for valid comparisons. The largest animal obtained was a pregnant, 23 year old female, number AH-18-68, obtained on March 26, 1968. This seal was 179.7 cm long, girth was 114.3 cm, blubber thickness was 6.1 cm, and it weighed 148.2 kg. She was supporting the term fetus which weighed 7.3 kg.

Fig. 1 shows the progressive increase in length, and Fig. 2 shows the weight increase.

The growth rate in ribbon seals is very rapid in comparison to that observed in Pusa and Erignathus. To obtain an estimate of average length in adult ribbon seals, all animals seven years or older were considered. Average length of this sample (N=28) was 151cm. Using this value as the average size of adults, proportional length within each age class was as follows: pups (N=62) 61 percent; one year (N=14) 70.4 percent; two years (N=11 86.6 percent; three years (N=17) 92.4 percent; and six years (N=7) 98 percent.

Laws (1956) discussed growth and sexual maturity in marine mammals and found the average length of females at puberty to be about 86 percent of the adult length. McLaren (1958b) confirmed this for Pusa in which ovulation begins at about age six; at which time they have attained approximately 88 percent of their adult size.

In Erignathus proportional size at sexual maturity was higher. Female bearded seals from Bering Sea became sexually mature starting at age five, after attaining approximately 92 percent of their adult length (Burns, 1967) McLaren (1958a) reported that female bearded seals in the eastern Canadian Arctic achieve puberty at age six, and have attained 91 percent of adult length.

If either of these values apply to Histriophoca, the onset of reproductive maturity in females would be expected at age two to three.

Reproduction

Birth in ribbon seals begins during the last few days of March and reaches its peak during the second week of April (Tikhomirov, 1966). The nursing period lasts for three to four weeks, based upon the work of Tikhomirov (loc. cit.), and the

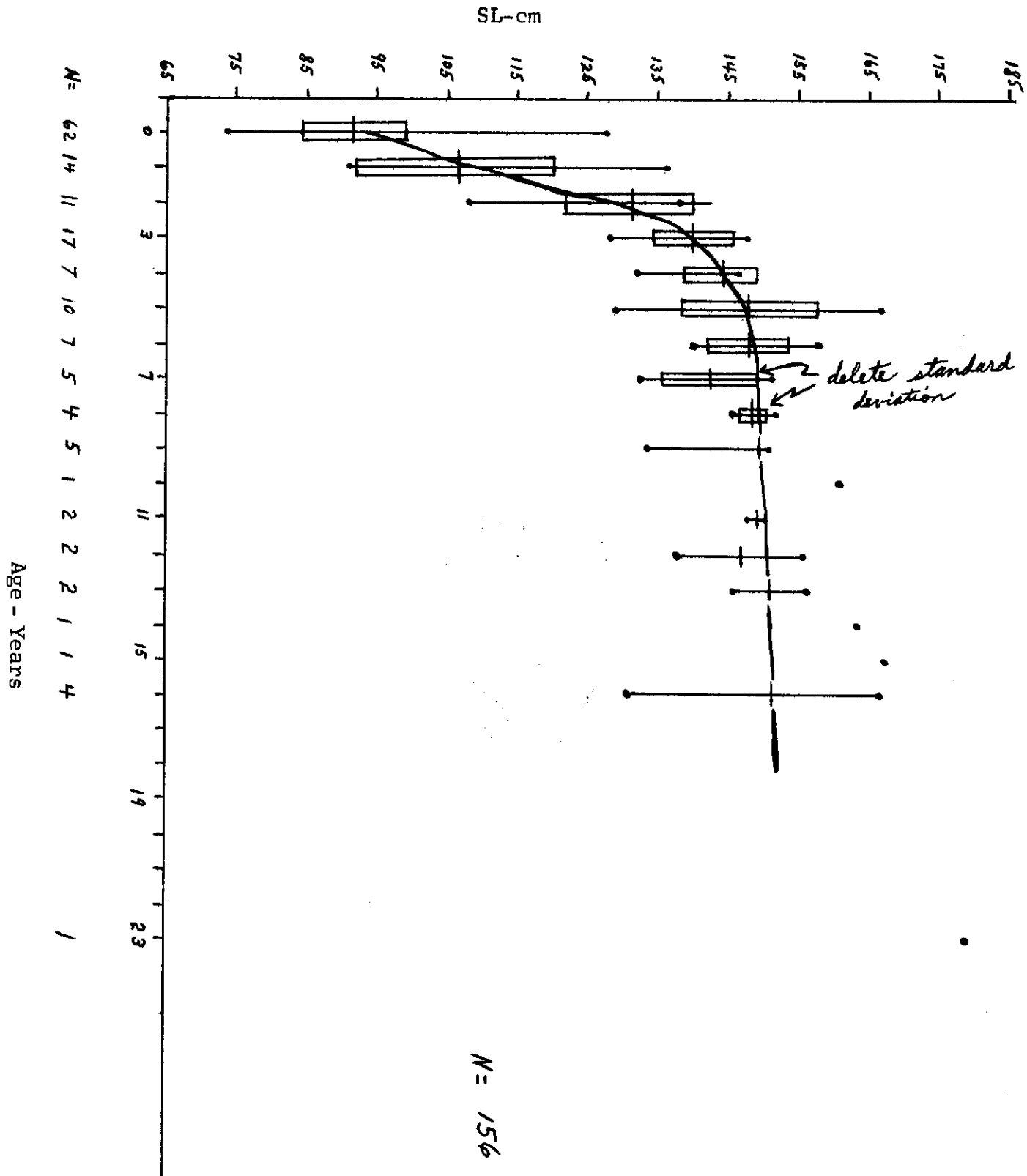

Fig. 1. Correlation of standard length and age in ribbon seals. Illustrated are range, mean and standard deviation; the latter calculated for age groups including six or more individuals.

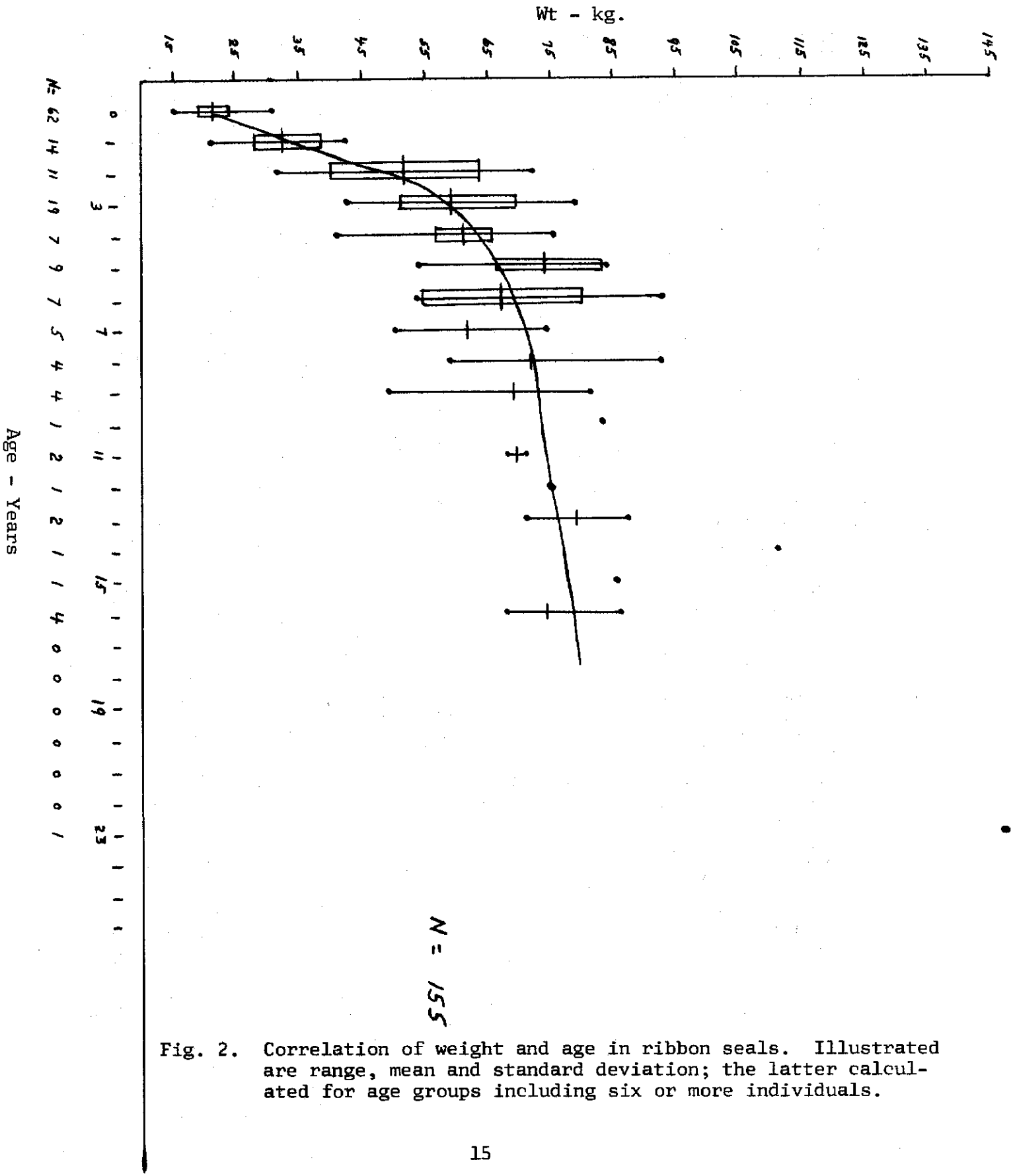

Fig. 2. Correlation of weight and age in ribbon seals. Illustrated are range, mean and standard deviation; the latter calculated for age groups including six or more individuals.

appearance of independent pups during late April and early May at Alaskan hunting sites. These occurrences mark the end of the annual reproductive cycle and are a reference point with regard to various aspects of reproduction in both sexes.

Interpretation of the cronology and sequence of events concerning reproduction in female ribbon seals is reasonably uncomplicated. Conclusions concerning reproductive status, age at sexual maturity, breeding season and the incidence of pregnancy are based on a combination of: 1) gross appearance, size and conformation of reproductive organs; 2) macroscopic examination of sectioned ovaries, and 3) examination of uterine horns for placental scars. Specimens were obtained from 99 animals. The date of capture is known for each animal and age was determined for 93 of these females. Unfortunately, the hunter selectivity towards pups resulted in poor representation of older age classes. However, the sample does provide a basic insight into the reproductive process in females.

The Breeding Season as Indicated by Females

Except for one specimen, AH-18-68, taken on March 26 and supporting a term fetus, the 98 remaining specimens were taken between April 28 and June 13. This period is during and just after the breeding season. Only two mature females had not yet ovulated at the time of their capture. These were: SS-9-67, taken on April 28, containing an unshed follicle measuring 12 x 7 mm; and SS-18-67, taken on April 30, containing an unshed follicle measuring 15 x 8 mm. Eight additional females were taken in which a corpus luteum was not yet completely formed, indicating recent ovulation. Specimen SS-33-67 taken on May 9 had just ovulated. A small bloody scar was obvious on the surface of the ovary, and the developing corpus luteum (17 x 8 mm) was mostly filled with bloody fluid. Ovulation had probably occurred during the preceding day or two. The remaining seven females can be divided into two groups, those in which the corpus luteum was less than half formed, and those in which it was more than half but less than completely formed. Females in group one were taken on the following dates: May 8, one specimen; May 15, one specimen; May 16, two specimens. Three females are included in the latter group, one taken on May 16 and two on May 18. Sexually mature females taken after May 18 had completely formed corpora lutea. I am assuming that the corpus luteum is completely formed within two weeks of ovulation.

From my sample of 44 sexually mature females it appears that ovulation (and conception) occur mainly during late April and early May, and probably not much after mid-May.

Age at Sexual Maturity

Age at sexual maturity is comonly defined in one of three ways: the age at which first ovulation takes place (e.g. Tikhomirov, 1966); the age at which initial pregnancy occurs (Burns, 1967); or the age at which a female's fertility rate is at least equal to the population mean (Fay, ms). In this discussion sexual maturity is attained at the age of initial pregnancy, which in some cases does not occur at the first ovulation. It has been found in walruses (Burns, 1965) and bearded seals (Burns, 1967) that young females may ovulate without becoming pregnant and are therefore not sexually mature. Infertile ovulation in immature animals, with subsequent formation of a corpus luteum spuria and corpus albicans has also been reported in the fur seal, Callorhinus ursinus (Craig, 1964); fin whale, Balaenoptera physalus (Wheeler, 1930); and blue whale, Balaenoptera musculus (Laurie, 1937).

A similar situation prevails in some young female ribbon seals in which a corpus albicans is present but the uterine horns obviously had never supported a fetus. Another indication of infertile ovulation is the occurrence of a regressing corpus luteum spuria which has a different size and appearance than a corpus luteum vera, especially in females taken after mid-May. Table 1 illustrates the reproductive status of 93 females of known age. Some female ribbon seals achieve sexual maturity by two years of age. Some female ribbon seals achieve sexual maturity by two years of age, and almost all females have bred at least once by age four.

Findings presented in Table 1 generally substantiate the conclusions of Tikhomirov (1966) regarding the age at sexual maturity. However, since our respective criterion are somewhat different (age at first ovulation vs. age at initial pregnancy) the proportion of mature animals within age classes two to five will be consistently lower in my samples, regardless of sample size. As an example, Tikhomirov (1966: Table 2) concluded that 86 percent of 28 three year old females had attained sexual maturity. In my small sample of six females in this age category only three were considered sexually mature. It appears obvious that additional specimens in age classes two through five are needed.

Growth of Reproductive Organs

Since conclusions of reproductive status are based in part on the size and appearance of reproductive organs, it is desirable to determine their development in relation to age. In my sample of females, length of each uterine horn, weight of ovaries, and comments regarding gross appearance were noted prior to internal examination. All material was preserved in 10 percent formalin.

Measurements of uterine horn length were taken from the external bifurcation, along the dorso-medial margin, to the

Table 1. Breeding status of female ribbon seals according to age class. N = 93.

Age	Nulliparous #	Nulliparous %	Primaparous #	Primaparous %	Multiparous #	Multiparous %	Total in Age Class
Pup	39	100	0	0	0	0	39
1	8	100	0	0	0	0	8
2	5	62	3	38	0	0	8
3	3	50	3	50	0	0	6
4	0	0	2	33	4	66	6
5	0	0	1	25	3	75	4
6	0	0	0	0	1	100	1
7	0	0	0	0	4	100	4
7+	0	0	0	0	17	100	17
	55		9		29		93

constriction just posteriad of the ovary. Uterine horns of females which had not carried a fetus were smooth and relatively straight. Length of uterine horns in pups ranged from 2.5 to 6.2 cm ($\bar{x}$=4.1). The youngest pups frequently had the largest uterine horns (and ovaries) within this age class. This hypertrophy of gonads has been attributed to the recent influence of placental hormones and has been reported in fur seals (Craig, 1964), bearded seals (Burns, 1967) and several other animals (Parkes, 1954). Uterine horn length in nulliparous females was greatest in two year olds, the maximum being 7.8 cm with an average of 6.9 cm.

Uterine horn length in all females, plotted by age class and general reproductive status is illustrated in Fig. 3a. Greatest variation was observed in multiparous females and is attributed to the repeated enlargement and contraction associated with pregnancy and post-partum recovery.

Combined ovary weight (Fig. 3b) from animals taken between April 28 and June 15 also increased with age and general reproductive status. Mean weight in pups was 1.9 g. This decreased to 1.6 g in one year olds, and steadily increased to 4.1 g in nulliparous three year olds. Both ovaries were approximately the same size in these sexually immature animals.

Primaparous females which occurred in age classes two through five usually had one ovary which was significantly larger and heavier than the other, and contained a corpus luteum vera. Weight ranged from a mean of 4.4 g in two year olds to 6.4 g in a single five year old.

In multiparous females both ovaries were once again fairly similar in size and weight with the one containing the corpus luteum vera usually slightly heavier than the other. Weight ranged from a mean of 6.9 g in four year olds to 7.4 in animals older than seven years.

One specimen was not included in this sample because it was not taken in the period April 28 to June 13. This was AH-18-68 taken on March 26 and supporting a term fetus. Weight of both ovaries was 13.9 g and one contained a corpus luteum vera measuring 25 x 14 mm. From this specimen it appears that both ovaries increase in weight throughout pregnancy, and that the corpus luteum reaches its maximum size near the end of pregnancy.

1968 Seal Harvest in Western Alaska

During the past few years bounty records have provided a reasonably accurage means for determining the harvest of hair seals in western and northern Alaska, the number of men engaged in seal hunting, and the general cronology of the harvest. This was not the case in 1968.

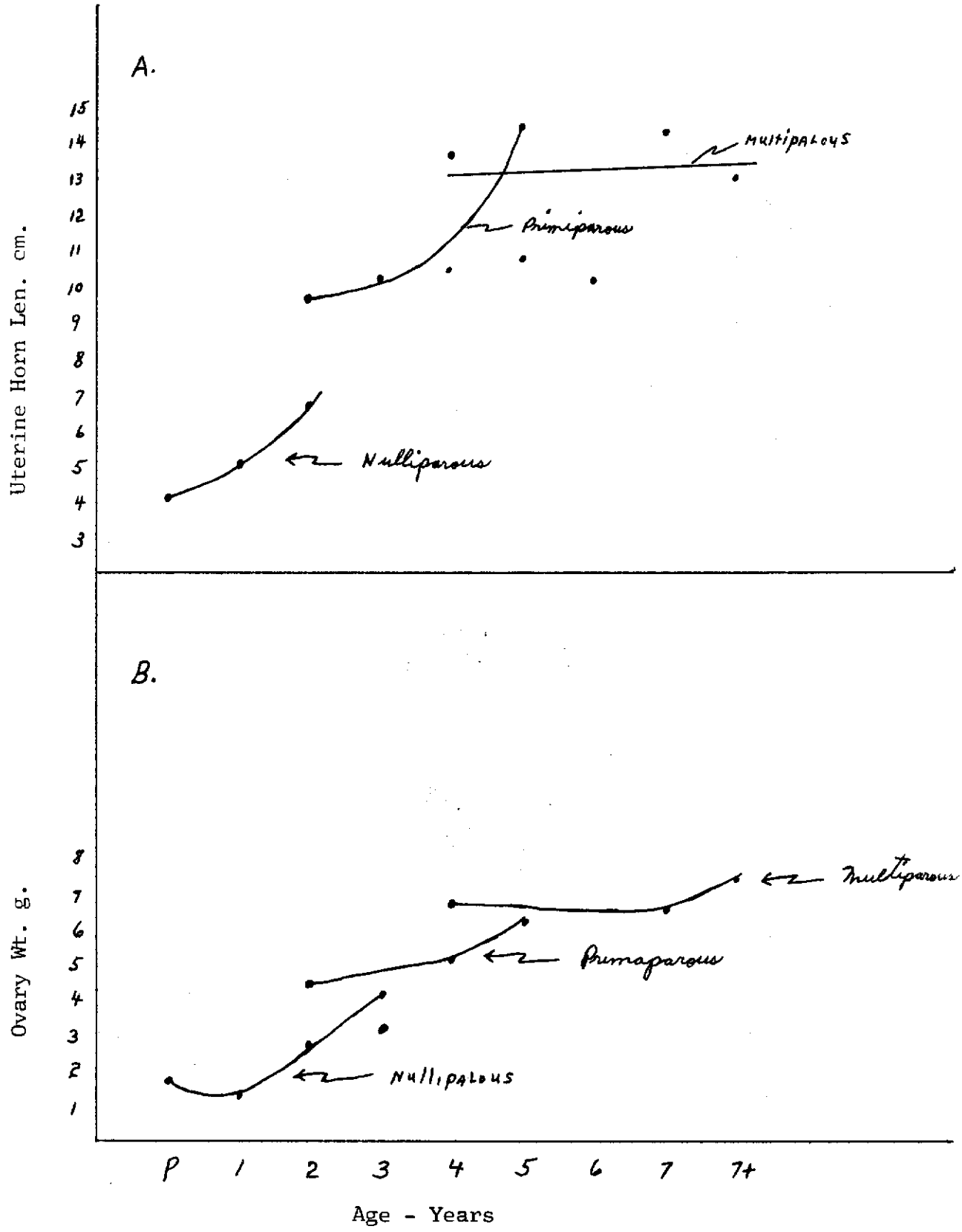

Fig. 3. Correlation of female reproductive organ development with age; A) uterine horn length in relation to age and general reproductive status, and B) ovary weight (both ovaries combined) in relation to age and general reproductive status.

At the 1968 session of the Alaska State Legislature there were several discussions of bounties and the bounty system. Publicity appearing in local newspapers and aired by radio conveyed the idea that bounty payments would be stopped. The net result was confusion in the minds of many local seal hunters, and a general impression that the seal bounty was no longer in effect. In addition to this, seal hunting was poor in some areas, and hunters did not submit the few scalps they had.

As a result, the number of seal scalps submitted for bounty was the lowest since 1962, and is a poor reflection of the total 1968 seal harvest. The harvest of hair seals during 1968 as indicated by bounty records was 6,273 seals. The reported harvest in 1967 was 11,125 seals.

The actual seal harvest during 1968 in western and northern Alaska is estimated to have been between 10,000-11,000 seals. This is based on the known seasonal harvest in some villages, and comparisons with information from previous years in others.

In spite of the major shortcoming of bounty records for 1968, they still provide a general idea of hunting success by region, the minimal number of hunters involved, and some indication of the proportion of seals taken in each season.

Table 2 is a summary of the 1968 seal harvest as indicated by bounty records. The recorded 1967 harvest is also included for comparison.

Table 2. The Reported Harvest of Hair Seals in Northwest Alaska During 1968, as Indicated by Bounty Records.[1]

Village	Number of Hunters	Harvest of Seals by Season[2] Jan.-Mar.	April - June	July - Sept.	Oct.-Dec.	Exact Season Unknown	Total Harvest
Quinhagak	4	0	64	0	0	0	64
Eek	0	0	0	0	0	0	0
Chefornak	1	0	8	0	0	0	8
Tuntutuliak	2	0	12	0	0	0	12
Mekoryuk	17	69	292	0	0	46	407
Chevak	12	12	161	9	0	39	221
Hooper Bay	33	0	541	0	0	121	662
Scammon Bay	2	0	0	0	0	26	26
Stebbins	0	0	0	0	0	0	0
St. Michael	0	0	0	0	0	0	0
Unalakleet	0	0	0	0	0	0	0
Shaktoolik	2	0	22	0	0	28	50
Koyuk	0	0	0	0	0	0	0
Elim	1	0	21	0	0	0	21
Golovin	1	0	0	0	0	42	42
White Mountain	0	0	0	0	0	0	0
Savoonga	21	103	84	112	42	98	439
Gambell	20	24	51	95	73	215	458
Northeast Cape	0	0	0	0	0	0	0
Nome	12	0	56	20	4	83	163
Teller	4	0	23	0	96	21	140
Brevig Mission	9	34	73	66	88	320	581
Wales	9	59	46	0	20	141	266
Diomede	15	62	142	0	0	10	214
Shishmaref	28	179	569	121	573	216	1,658
Candle	1	0	0	0	0	28	28
Kotzebue	0	0	0	0	0	0	0
Noatak	0	0	0	0	0	0	0
Kivalina	12	352	55	0	0	0	407
Point Hope	13	51	40	0	34	139	264
Wainwright	5	26	0	0	7	7	40
Barrow	4	54	25	0	23	0	102
TOTALS	228	1,025	2,285	423	960	1,580	6,273

[1]The total harvest of seals in northwest Alaska was between 10,000-11,000 during 1968. Discrepancy between recorded and total harvest results from failure of hunters to submit scalps for bounty - especially bearded seals. Also, it was thought that the bounty was abolished so scalps were not saved. As examples, the reported harvests from Eek, Scammon Bay, Stebbins, Unalakleet, Northeast Cape, Kotzebue, Wainwright and Barrow were far below the actual harvests. Barter Island bountied no seals although hunters there are active.

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

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