AGE, SEX AND REPRODUCTIVE STATUS OF PACIFIC WALRUS HARVESTED IN THE BERING STRAIT REGION OF ALASKA, 1997

BY

JOEL GARLICH-MILLER

U.S. Fish and Wildlife Service
Marine Mammals Management
1011 East Tudor Road
Anchorage, Alaska 99503

USFWS Summary Report
December 9, 1997

M:\WALRUS\REPORTS\HM97\HM97.DOC

Table of Contents

List of Tables

List of Figures

ABSTRACT

In 1997, a total of 859 harvested Pacific walrus were recorded during spring subsistence hunts in Alaska at the Native villages of Little Diomede, Gambell, Savoonga and Wales. The recorded harvest consisted of: 142 calves (16.5%), 11 yearlings (1.3%), 54 subadults (6.3%), 647 adults (75.3%), and 5 animals of unknown age class. The sex ratio of the harvest was approximately 1.2 females:male. Frequency distributions of age estimates indicated sex-linked differences in age structure of the harvest; the mean age of sampled females was lower than the mean age of sampled males. The age-sex composition of the harvest also varied between villages. Examination of sampled female reproductive tracts indicated that approximately 34 % of the mature females had ovulated in the most recent reproductive cycle. Approximately 49 % of the mature females samples examined had recently given birth to a calf.

INTRODUCTION

For thousands of years, walrus hunting has been an important component of the economy and culture of Native communities along the Bering and Chukchi Sea coasts (Ray 1975). Today, the Pacific walrus (*Odobenus rosmarus divergens*) remains a valuable resource to coastal Natives as a source of food and raw materials for traditional equipment and handicrafts. Each spring, as the pack ice recedes northward, hunters from coastal communities in the Bering Strait have access to herds of walrus as they migrate to their summer range. Harvest data indicate that approximately 80% of the annual reported walrus harvest in Alaska occurs in this region (Fay and Bowlby 1994).

With the passage of the Marine Mammal Protection Act (MMPA) in 1972, the U.S. Federal Government established, with certain exceptions, a moratorium on the taking (hunting, harassing, capturing or killing) of marine mammals in U.S. waters. Coastal Alaskan Natives were granted an exemption to this moratorium permitting them to take marine mammals for subsistence purposes. The MMPA allows for the subsistence harvest of walrus and other marine mammals to be carried out without regulation so long as populations are maintained within Optimum Sustainable Population (OSP) ranges (FWS 1994).

The U.S. Fish and Wildlife Service (FWS) is the agency responsible for managing Pacific walrus in the United States. As part of their management strategy, the FWS conducts a Walrus Harvest Monitoring Project (WHMP). Each spring, harvest monitors stationed at the primary walrus hunting villages in the Bering Strait region collect information on the size and demography of the walrus harvest. A key component of the WHMP is the collection and analysis of biological samples. Tooth samples are collected for age determination and female reproductive organs are collected to assess reproductive status. These life history data contribute to an assessment of the impact of the harvest on the population, and of population status relative to its OSP range.

This report summarizes the results of field and laboratory investigations of the age-sex composition and reproductive status of walrus harvested in the spring of 1997 from the four primary walrus hunting villages in Alaska: Inalik on Little Diomede Island (hereafter referred to as Diomede), Gambell and Savoonga on St. Lawrence Island, and Wales on the Seward Peninsula (Figure 1).

METHODS

Sample collection

Walrus harvest monitors stationed at each village met boats as they returned from walrus hunting trips to collect biological samples and harvest information (Dickerson et al. 1996). Harvest monitors attempted to identify and record the gender and age class of every walrus retrieved during the monitoring period. The gender and age class of walrus were determined based upon body and tusk morphology (Fay 1982; Stephensen et al. 1994).

Hunters were asked to voluntarily provide samples of teeth (usually the two lower canines) and female reproductive tracts (uterus and ovaries) from harvested walrus. Teeth were cleaned of blood and connective tissue and stored in labeled manila envelopes. Reproductive tracts were stored frozen. All samples were shipped to the FWS, Marine Mammals Management laboratory in Anchorage for analysis.

Age determination

When more than one tooth was provided, the best tooth was selected for analysis. Criteria for tooth selection included avoiding broken or partial teeth and selecting those teeth that would provide the best longitudinal section through the center core area. Unused teeth were archived as reference material.

A longitudinal thin section, 0.4-0.6 mm thick, was cut through the central core of each tooth using a lapidary saw, outfitted with water cooled, high concentration diamond wafering blades (Garlich-Miller 1997). Tooth sections were stored in a mixture of 35% ethanol, 5% glycerine and 60% water. Each tooth section was examined under reflected light using a variable-power stereoscopic dissecting microscope. Ages were estimated by counting incremental growth layer groups (GLG's) in the tooth cementum (Fay 1982; Garlich-Miller et al. 1993). One cemental GLG was assumed to represent one year of growth (Fay 1982).

Reproductive tract analysis

Reproductive status was investigated by macroscopic investigation of the reproductive organs (Garlich-Miller 1997). Each reproductive tract was examined for evidence of sexual maturity, reproductive maturity, recent ovulation and fecundity. The presence of corpora lutea or corpora albicantia in the ovaries was the criteria for sexual maturity (the ability to ovulate). The gross morphology of uterine horns and the presence or absence of placental scars or embryos in the uterus were used to assess reproductive maturity (the ability to produce a calf). An ovary with a newly formed corpus luteum was considered evidence of ovulation in the most recent reproductive cycle. Fecundity was assessed by examining the reproductive tracts for evidence of recent reproductive activity. The presence of an identifiable embryo or a nidation chamber in the uterus was the criterion for determining a new pregnancy. The presence of a newly formed corpus albicans in association with a greatly enlarged and thickened uterine horn, bearing an incompletely healed placental scar was considered evidence of recent parturition. Specimens lacking macroscopically visible evidence of pregnancy or recent parturition were described as quiescent. This category included all reproductively immature animals, as well as reproductively mature specimens with no evidence of pregnancy in the most recent reproductive cycle.

RESULTS

Age-sex composition of the sampled harvest

During the 1997 spring harvest, 859 walrus were recorded through the WHMP. The recorded harvest consisted of 448 females, 364 males, and 47 animals of unknown gender. For animals of known gender, the sex ratio was approximately 1.2 females:male. One hundred and forty two (16.5%) of the retrieved walrus were calves, 11 (1.3%) were yearlings, 54 (6.3%) were subadult animals, and 647 (75.3%) were adults. Five retrieved walruses of unknown age-class were also recorded (Table 1).

Walrus hunters contributed teeth from 44.8 % of all non-calf walrus of known gender (Table 2). Teeth were not collected from calf or yearling animals, for which age was estimated based on morphological characteristics (Fay 1982; Fay and Kelly 1989).

A total of 319 walrus teeth (females: n = 141, males: n = 175, unknown gender: n = 3) were processed for age determination. The mean age of sampled walrus is presented as an index for examining inter-village (Diomede, Gambell and Savoonga[1]) and sex-linked differences in the age structure of the sampled harvest (Table 3). Frequency distributions of age estimates for sampled walrus indicated sex-linked differences in age structure of the harvest (Figure 2; Figure 3). The mean age (years ± 1 SE) of all sampled females (15.7 ± 0.44) was significantly lower than the mean age of all sampled males (19.5 ± 0.55; $t = 5.79$, $df = 265$, $P < 0.0001$; Figure 3; Table 3).

There was a significant difference in the mean ages of male walrus sampled at the three villages (ANOVA: $F = 4.79$, $P = 0.0095$). Pair-wise multiple comparisons (Student-Newman-Keuls Method) indicated that all between village differences in the mean ages of sampled males were significant (Table 3, $P < 0.05$). On average, males sampled at Gambell were the oldest

---

[1]Only one tooth, collected from a 17 year old male walrus was returned from Wales. This sample was excluded from inter-village comparisons.

($\bar{x}$ = 23.4 ± 1.67), and males sampled at Diomede were the youngest (16.7 ± 1.19).

Analysis of variance indicated a significant difference in the mean ages of female walrus sampled from the three villages (ANOVA: F = 3.75, P = 0.0259). Pair-wise multiple comparisons revealed that the mean age of females sampled at Diomede (16.9 ± 0.63) was significantly older than for females sampled at Savoonga (13.7 ± 1.08; $P < 0.05$). All other between village differences in mean age were not significant at the P = 0.05 level.

Reproductive status of sampled females

During the 1997 spring harvest, hunters contributed a total of 83 female walrus reproductive tracts for analysis (Table 2). Most of the tracts were complete (consisting of paired uterine horns and ovaries), however missing reproductive material occasionally prevented a full assessment of reproductive status.

Sexual maturity

Macroscopic examination of the ovaries indicated that 82 of the 83 sampled females were sexually mature (having had at least one prior ovulation). These animals ranged in age from 8 to 23 years. The absence of a tooth sample precluded determining the age of the sexually immature animal.

Reproductive maturity

The uterine horns of one 8 year old, one 9 year old and two females of unknown age carried no evidence of past or present pregnancies. These animals were considered reproductively immature (never pregnant). All other reproductive tracts, collected from female walrus ranging in age from 9 to 23 years, were reproductively mature (n = 74), or were missing sufficient material to assess reproductive maturity (n = 5). One 12 year old female had recently given birth to her first calf.

Ovulation frequency

All ovaries were examined for evidence of recent ovulation (the presence of a corpus luteum). Of the 67 sexually mature reproductive tracts for which both ovaries were available, 23 (34 %) had ovulated in the most recent reproductive cycle.

Fecundity

The uterine horns of 74 reproductively mature female walrus were assessed for fecundity (Table 4). No evidence of new pregnancy was found in any of the uterine horns examined. It is important to note that these samples were collected at a time of the year normally associated with a phase of delayed implantation (Fay et al. 1984), and that un-implanted embryos are difficult to detect macroscopically (Fay 1982). Thirty six (49%) of the reproductively mature females carried a term fetus or had recently given birth to a calf.

DISCUSSION

Sample biases

The data presented in this study were obtained from harvested specimens and do not represent a random sample of the population. Biases associated with the harvest, which include hunter selection as well as the behavior and distribution of walrus, influence the age-sex structure of the harvest and preclude direct extrapolation of results to the entire population.

The influence of hunter selection biases on the composition of the harvest are difficult to quantify. Fay and Stoker (1982) note that hunters select for adult age classes of walrus, presumably for the valuable ivory tusks of mature animals. This is consistent with the results of the current study, in which juvenile age classes of walrus were poorly represented in the harvest.

Walrus often show a tendency to segregate into relatively homogeneous groups of animals of similar age, sex, or reproductive status. Volokhov (1991), reported that during a scientific cruise in the Bering Sea in the spring of 1991, most mature female walrus encountered in the vicinity of St. Lawrence Island were either pregnant or with a newborn calf. The segregation of different sex or reproductive classes of walrus is likely to affect the structure of the harvest at various geographical locations. For example, the relatively high proportion of females bearing calves taken by Gambell hunters may in part reflect the proximity of the community to areas frequented by pregnant females.

Age-sex composition of the sampled harvest

The sampled walrus harvest was dominated by newborn calves and adult animals, while yearling and subadult animals were poorly represented. This is consistent with reported hunter selection biases favoring calves and adult animals (Fay and Stoker 1982; Fay et al. 1986; Dickerson et al. 1996). In the present study, the sex ratio of the harvest favored females, and the mean age of sampled males was older than for sampled females. It is unclear to what extent the composition of the reported harvest can be attributed to sex-linked differences in sample selection biases, ageing errors, or survivorship. Field observations of the age-sex composition of walrus herds in the spring pack ice are required to quantify the relative proportions of various age and sex classes available to hunters.

Sexual and reproductive maturity

The poor representation of juvenile and adolescent age classes in the sample set made interpretation of the onset of sexual and reproductive maturity difficult. All but one of the samples examined, ranging in age from 8 to 23 years, were sexually mature (had previously ovulated). Ovulation does not always result in pregnancy; four of the sexually mature animals examined had never produced a calf. Increased sample sizes of young age classes are required to more accurately quantify the mean ages of sexual or reproductive maturity.

Reproductive rates

In the present study, the timing of sample collection (prior to implantation and development of the embryo) precluded a meaningful evaluation of pregnancy rates. Samples collected later in the reproductive cycle are necessary to quantify what proportion of the ovulated specimens had conceived.

Comparisons with previous studies

The mean ages of walrus sampled in the 1997 spring harvest were compared to data collected from previous years (Figure 4). In general, males were within the range of values reported over the past two decades, while the mean age of female walrus collected by the St Lawrence Island villages (Gambell and Savoonga) appear to have dropped over the past few years. It is unknown whether the apparent decline in mean age of female walrus taken near St. Lawrence Island is an artifact of sample biases, ageing errors, or represents a true change in the age structure of the herds available to hunters. This question warrants further investigation, because a shift in the age composition towards younger females may indicate that hunting pressure has removed older age classes of female walrus from the population (Fay et al. 1989).

ACKNOWLEDGMENTS

The author would like to thank the Native hunters at Diomede, Gambell, Savoonga and Wales for their voluntary contributions of sample material and harvest information to the harvest monitoring program. Harvest monitoring activities were coordinated by Larry Dickerson and Wells Stephensen. I would also like to acknowledge the hard work and dedication of the harvest monitors: Oopik Ahkinga, Carolyn Ahkvaluk, Larry Dickerson, John Iyapana Jr, and Don Kominick at Diomede; Harris Apassingok, Tony Fischbach, Sherry Nowpakahok, Teresa Okhtokiyuk, and James Walunga at Gambell; Calvin Akeya, Lance Imergan, Jenkins Noongwook, Jonathan Synder, and Reggie Wongittilin at Savoonga; Metrona Mazonna at Wales. Harris Apassingok, Susanne Kalxdorff, and Jonathan Snyder assisted with the laboratory analysis of reproductive organs and data entry.

LITERATURE CITED

Dickerson, L., D. Burn, J. Garlich-Miller, T. Fischbach, S. Rice, J. Bouchard, and B. Howard. 1996. 1995 Walrus harvest monitor project: annual summary. U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, AK. 26 p.

Fay, F.H. 1982. Ecology and biology of the Pacific walrus, *Odobenus rosmarus divergens* Illiger. North American Fauna No. 74. 279 p.

Fay, F.H., and C.E. Bowlby. 1994. The Harvest of Pacific walrus, 1931-1989. U.S. Fish and Wildlife Service, Marine Mammals Management, Technical report MMM 94-2. 43 p.

Fay, F.H. and B.P. Kelly. 1989. Development of a method for monitoring the productivity, survivorship, and recruitment of the Pacific walrus population. Final report 89-0012. Minerals Management Service, Anchorage, AK. 51 p.

Fay, F.H., B.P. Kelly, and J.L. Sease. 1989. Managing the exploitation of Pacific walruses: a tragedy of delayed response and poor communication. Marine Mammal Science 5(1): 1-16.

Fay, F.H., B.P. Kelly, and J.L. Sease. 1986. Determination of age of walrus taken in recent spring harvests in the Bering Strait region. Final report WR-0439-85. U.S. Fish and Wildlife Service, Anchorage, AK. 110 p.

Fay, F.H., G.C. Ray, and A.A. Kibal'chich. 1984. Time and location of mating and associated behavior of the Pacific walrus, *Odobenus rosmarus divergens* Illiger. *In* Soviet-American cooperative research on marine mammals. *Edited by* F.H. Fay and G.A. Fedoseev. Vol. 1- Pinnipeds, NOAA Technical report No. 12: 89-99.

Fay, F.H., and S.W. Stoker. 1982. Final report to the Eskimo Walrus Commission: reproductive success and feeding habits of walrus taken in the 1982 spring harvest, with comparisons from previous years. Final report, Eskimo Walrus Commission, Nome, AK. 91 p.

FWS. 1994. Conservation plan for the Pacific walrus in Alaska. U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, AK. 79 p.

Garlich-Miller, J.L. 1997. Age, Sex, and reproductive status of Pacific walrus harvested in the Bering Strait region, 1994-1996. U.S. Fish and Wildlife Service, Marine Mammals Management, Technical Report MMM 97-1. 26 p.

Garlich-Miller, J.L., R.E.A. Stewart, B.E. Stewart, and E.A. Hiltz. 1993. Comparison of mandibular with cemental growth-layer counts for ageing Atlantic walrus (*Odobenus rosmarus rosmarus*). Can. J. Zool. 71: 163-167.

Ray, D.J. 1975. The Eskimos of the Bering Strait, 1650-1898. Univ. Washington Press, Seattle, WA. 305 p.

Stephensen, W.D., D. Cramer, and D. Burn. 1994. Review of the Marine Mammal Marking and Reporting Program, 1988-1992. U.S. Fish and Wildlife Service, Marine Mammals Management, Technical Report MMM 94-1. 49 p.

Volokhov, V.I. 1991. Spring distribution and reproductive status of female Pacific walruses. Magadan, TINRO. 5 p.

Table 1. Summary of age class and sex of harvested walrus recorded by harvest monitors in 1997.

Village	Age Class	Female	Male	Unknown	Total
Diomede	Calf	10	4	4	18
	Yearling	0	0	0	0
	Subadult	4	6	0	10
	Adult	119	44	0	163
	Unknown	0	0	0	0
	Subtotal	**133**	**54**	**4**	**191**
Gambell	Calf	31	34	32	97
	Yearling	4	1	2	7
	Subadult	1	5	0	6
	Adult	221	53	0	274
	Unknown	0	0	1	1
	Subtotal	**257**	**93**	**35**	**385**
Savoonga	Calf	8	11	7	26
	Yearling	2	2	0	4
	Subadult	12	25	1	38
	Adult	31	177	0	208
	Unknown	4	0	0	4
	Subtotal	**57**	**215**	**8**	**280**
Wales	Calf	0	1	0	1
	Yearling	0	0	0	0
	Subadult	0	0	0	0
	Adult	1	1	0	2
	Unknown	0	0	0	0
	Subtotal	**1**	**2**	**0**	**3**
All Villages	Calf	49	50	43	142
	Yearling	6	3	2	11
	Subadult	17	36	1	54
	Adult	372	275	0	647
	Unknown	4	0	1	5
	Total	**448**	**364**	**47**	**859**

Table 2. Summary of walrus tooth and female reproductive tract samples collected at monitored villages in 1997.

Year	Non-calf Walrus	Tooth Samples	Teeth Sampled (%)	Adult & Subadult ♀ Walrus	Repro Samples	Repros Sampled (%)
Diomede	173	79	(45.7)	123	28	(22.8)
Gambell	287	74	(25.8)	222	48	(21.6)
Savoonga	250	165	(66.0)	43	7	(16.3)
Wales	2	1	(50.0)	1	0	-
Total	712	319	(44.8)	389	83	(21.3)

Table 3. Ages (years) of walrus sampled from monitored villages in 1997. Ages were determined by counts of cemental growth layer groups. Summary statistics do not include calves, yearlings, or animals of unknown gender. The number of tooth samples from Wales were too few for meaningful statistical comparisons.

	Males				Females			
Village	Sample Size	Range	Mean	Standard Error	Sample Size	Range	Mean	Standard Error
Diomede	24	6-28	16.7	1.19	55	5-28	16.9	0.63
Gambell	15	10-35	23.4	1.67	57	8-35	15.5	0.67
Savoonga	135	6-35	19.6	0.58	29	3-27	13.7	1.08
Wales	1	-	17	-	0	-	-	-
Total	175	6-35	19.5	0.51	141	3-35	15.7	0.44

Table 4. Fecundity of reproductively mature female walrus sampled from monitored villages in 1997.

Village	Sample Size	New embryo[a]	Term pregnancy or Recent birth	Quiescent[b]	Unknown[c]
Diomede	25	0	8	17	0
Gambell	43	0	24	19	0
Savoonga	6	0	4	2	0
Total	**74**	**0**	**36**	**38**	**0**

[a] Note: un-implanted blastocysts (evidence of pregnancy) are difficult to detect macroscopically.
[b] No visible embryo (see footnote [a]) , no evidence of recent birth.
[c] Missing reproductive material precluded determination of fecundity.

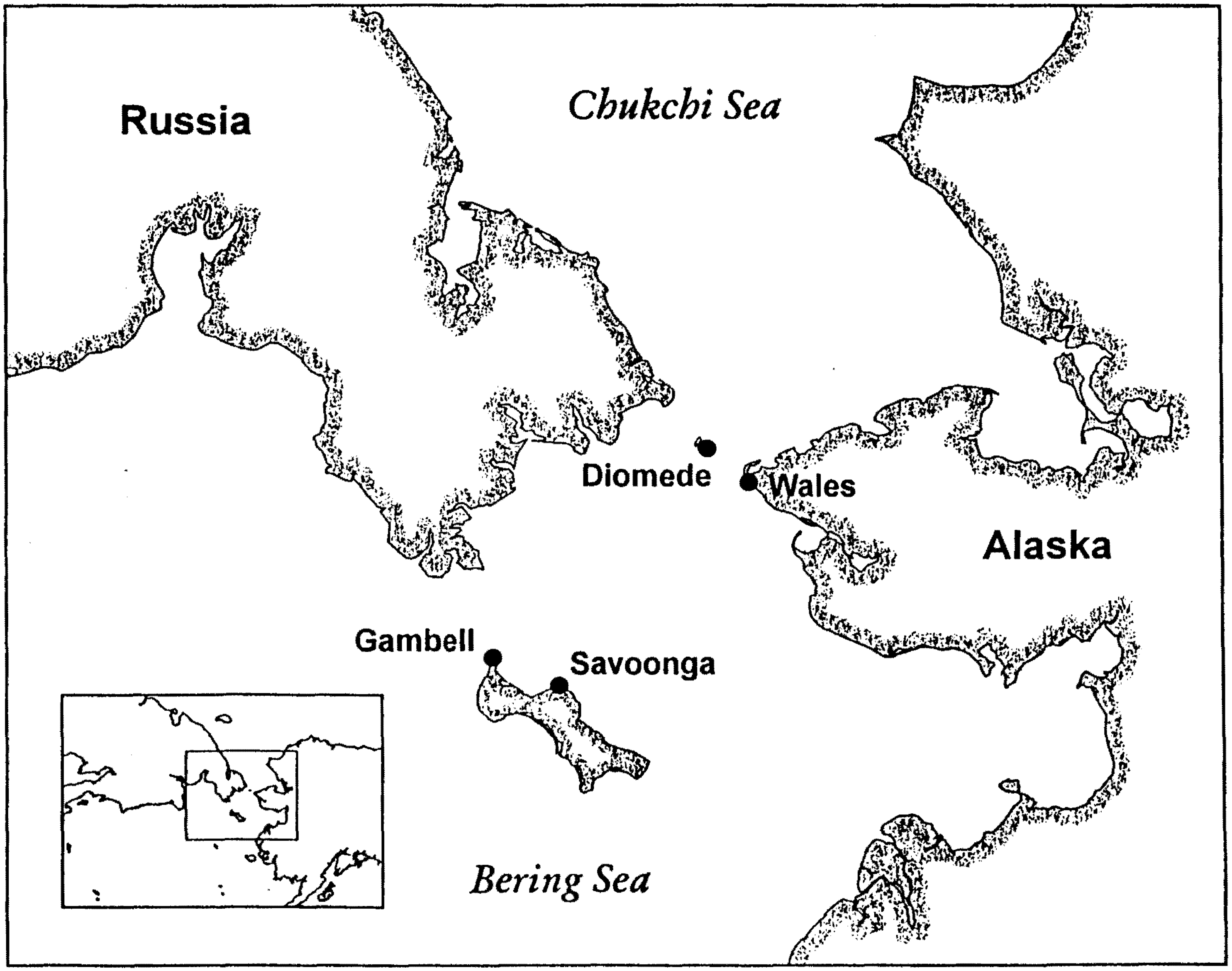

Figure 1. Location of Alaska villages where walrus harvest monitoring was conducted in 1997.

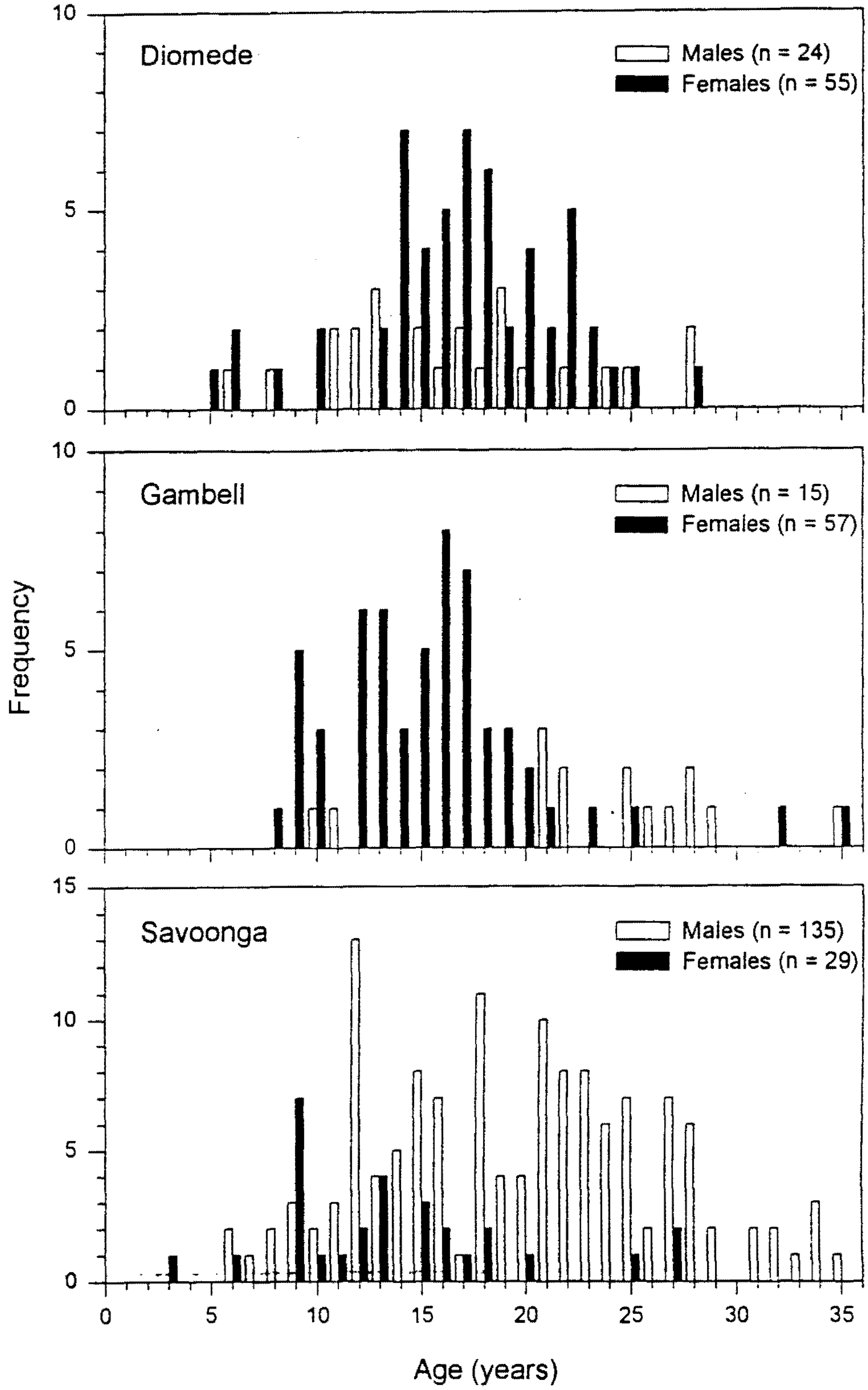

Figure 2. Age-sex composition of the 1997 spring walrus harvest at Diomede, Gambell, and Savoonga. Data does not include calf and yearling data, or animals of unknown gender.

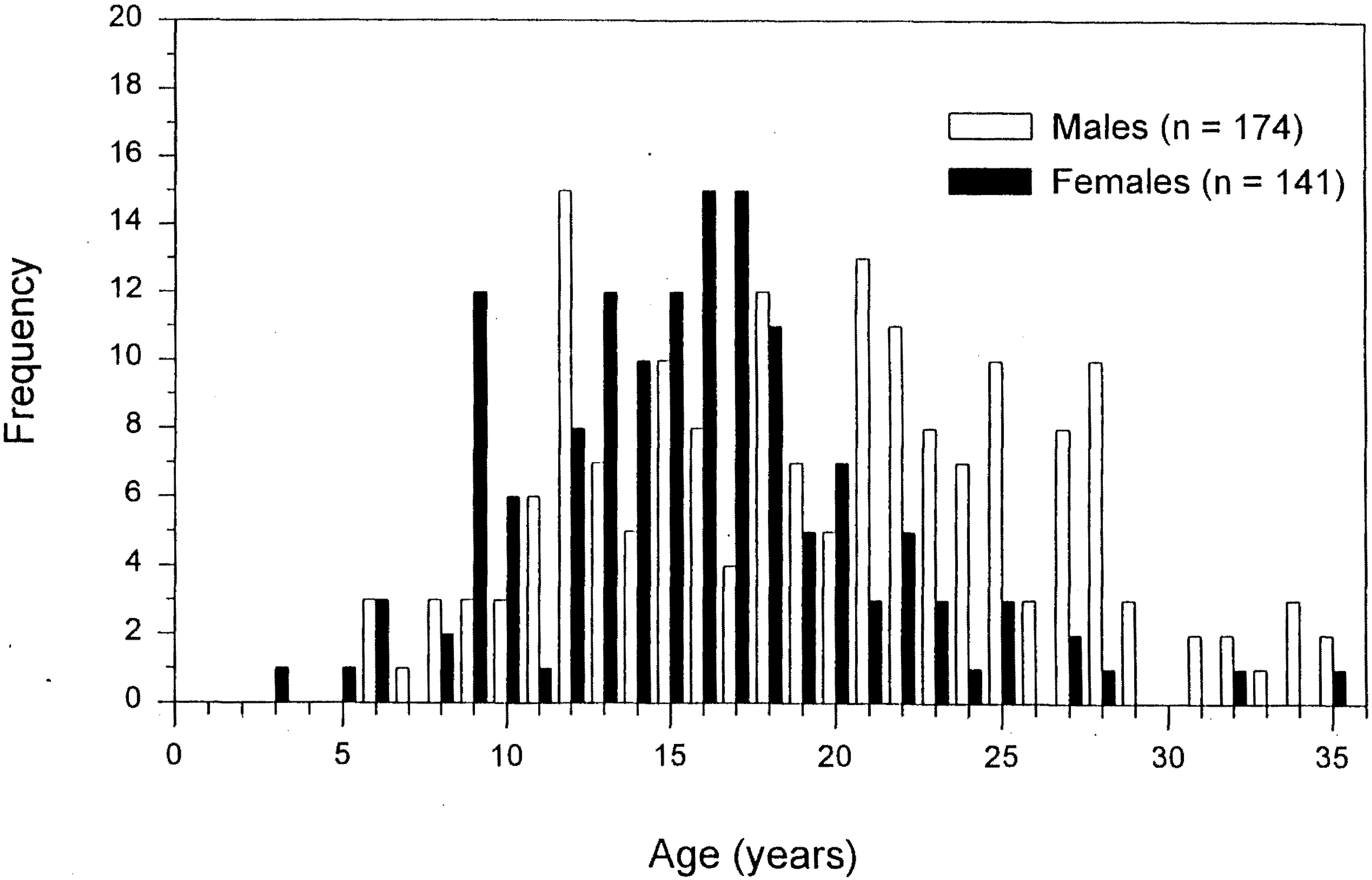

Figure 3. Age-sex composition of the 1997 spring walrus harvest at Diomede, Gambell, and Savoonga (combined). Data does not include calf and yearling data, or animals of unknown gender.

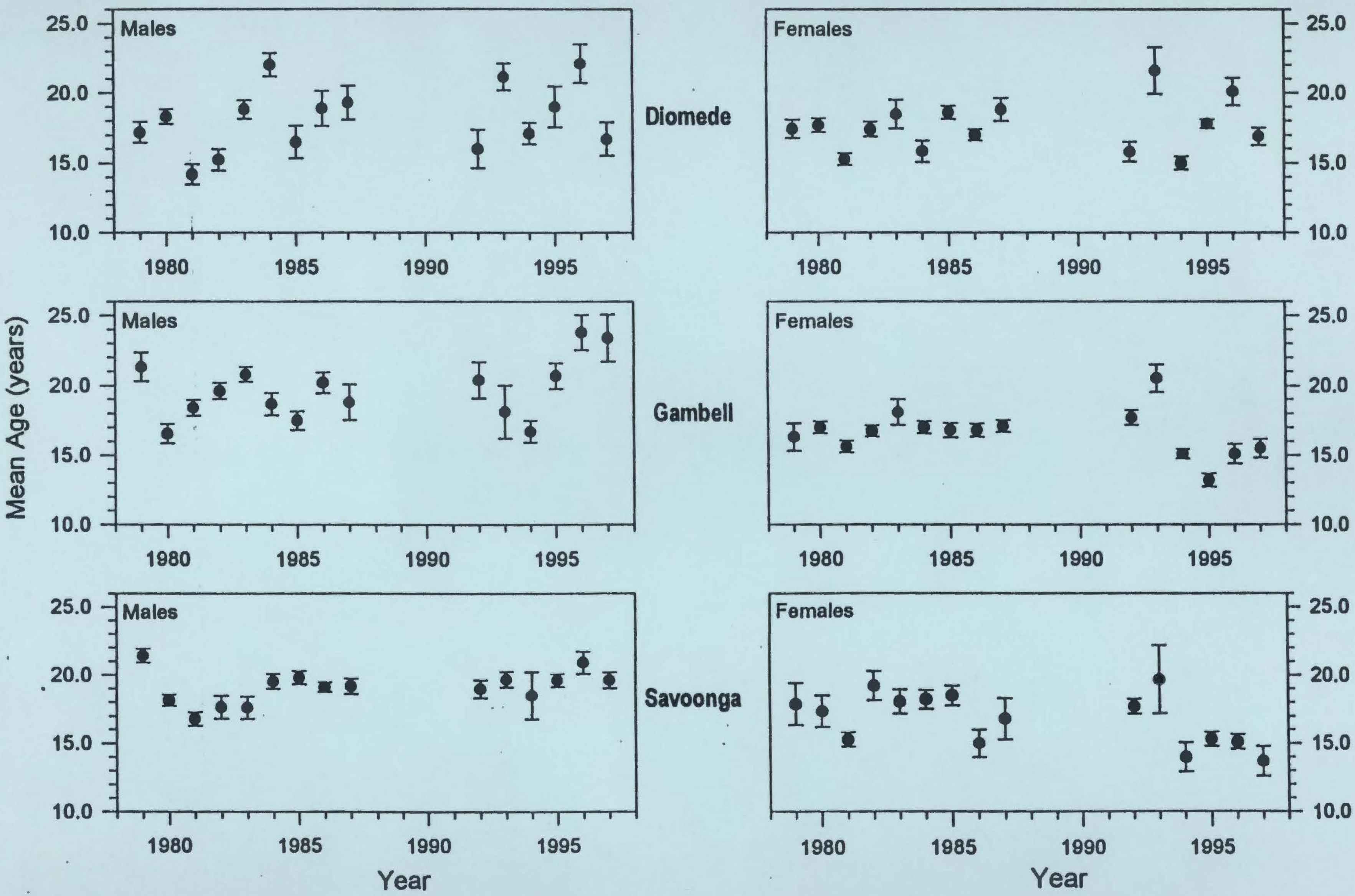

Figure 4. Mean ages and standard errors of spring harvested walrus from Diomede, Gambell, and Savoonga, from 1979 to 1997. Does not include calf and yearling data, or animals of unknown gender.