ANNUAL SUMMARY: INFORMATION COLLECTED DURING THE 1993 SPRING WALRUS HARVEST IN ALASKA

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Region 7, Alaska
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INTRODUCTION

The Pacific walrus (*Odobenus rosmarus divergens*) has long been a vital part of the culture and survival of Native people living on the shores of the Bering and Chukchi Seas. Management responsibility for the Pacific walrus is shared by the United States (USA) and Russia. Since passage of the Marine Mammal Protection Act (MMPA) in 1972, Alaskan Natives (primarily Yupik and Inupiat) have continued to harvest walrus under an exemption to the MMPA's moratorium on the taking of marine mammals for subsistence and handicraft purposes, provided the taking is non-wasteful. The Pacific walrus provides meat for food, ivory for income and art, and hides for skin boats. Hunting primarily occurs in the spring as animals move north into the Chukchi Sea and, to a lesser extent, in the fall and winter on their southward migration back into the Bering Sea.

As the agency responsible for walrus management in the United States, the Fish and Wildlife Service (FWS) uses several approaches to monitor the size and structure of the harvest to determine its effect on the population. The Marking and Tagging Program (MTRP) collects statistics about the statewide total annual catch through reports of tagged tusks (see Stephensen *et al.* 1994 for a review). However, life history specimen material is not collected through the MTRP. These samples and more detailed statistics are required to determine more precisely how the harvest may affect the age/sex composition of the population, to assess recruitment and productivity, to monitor levels of contamination, to run statistically sensitive models used to identify and predict changes in population dynamics, and to develop appropriate and timely management responses (Fay *et al.* 1989, 1990).

With the cooperation and participation of Alaskan Native hunters, the FWS operates a Walrus Harvest Monitoring Project (WHMP) to collect the detailed harvest statistics and biological samples essential for management. Some form of walrus harvest monitoring program has been in place since 1959 when it was implemented by the State of Alaska. Between 1980 and 1989, the FWS assumed the lead for the task and began to monitor the spring harvest in six villages (Figure 1): Gambell and Savoonga on St. Lawrence Island, Ingalik on Little Diomede (henceforth referred to as "Diomede"), King Island, Wales, and Nome (Seagars *et al.* 1989). These villages and the monitoring period were selected because between 60-80% of the total annual statewide harvest occurred in these locales during the prior monitoring program conducted by the State. Due to funding constraints and other priorities, the FWS did not conduct a WHMP during the 1990 and 1991 seasons. During this period discussions where held by the Eskimo Walrus Commission (EWC), the State of Alaska, and the FWS to address ways to make the program a more cooperative one and to improve the quality and quantity of the data collected. Beginning in 1992 the FWS implemented a revised WHMP in Gambell, Savoonga, Diomede, and Wales that incorporated many of the recommendations coming out of these meetings.

There are four key elements to the revised program: 1) hunters' voluntary provision of specimen material from as many harvested walrus as possible; 2) phased implementation of a seasonally and geographically expanded sampling regime; 3) development of several local hire long-term Village Monitor positions; and 4) timely completion of data analysis and synthesis of these data into recommendations for cooperative management actions. Many of the key elements and following objectives can only be completely satisfied with the full implementation of the WHMP and complete cooperation of the hunting community. This implementation will involve monitoring in additional villages along the northwest Alaska coast and collection of additional sample material (i.e. teeth) in more southerly villages through the MTRP.

The objectives of the WHMP are:

1. Monitor the annual retrieved take of walrus from a representative sample of hunting villages.

2. Determine the age and sex structure of the retrieved take based on teeth and reproductive tracts collected from animals killed by the hunters. Incorporate data into population models.

3. Monitor "health" of the population and animal "fitness" by periodically collecting morphometrics, tissue samples for contaminants analysis, stomachs for food habits information, and through investigation of other possible indices of condition.

4. Establish a relationship between data collected in the Harvest Monitoring Program and the MTRP as a cross check on compliance and cooperation.

5. Develop and foster a partnership approach toward co-management of the walrus population through increased Native participation and Service responsiveness.

6. Coordinate and cooperate with Russian biologists conducting similar monitoring in the shore and (research) ship based harvests. Coordinate methods and exchange harvest data on a timely basis.

The stationing of FWS Walrus Program staff and seasonal MTRP Biological Technicians in the villages and employment of local residents as Village Monitors is the best mechanism available for acquiring biological samples and for establishing a positive long-term relationship between walrus hunters and FWS employees. Indirect benefits of this arrangement include an increased understanding of the needs of the Native community by the FWS and an increased role in resource study by hunters with management recommendations made jointly by the Eskimo Walrus Commission (EWC) and the FWS.

This report provides a summary of the information collected and analyzed from the spring 1993 walrus harvest. This report is intended to be used cooperatively by managers and hunters over time to recommend hunting levels and strategies to ensure the population is maintained within its Optimum Sustainable Population range, as required by the MMPA. More detailed analysis or data specific to individual animals can be obtained by contacting the authors.

METHODS

Preseason

In March 1993, FWS seasonal Biological Technicians and residents from Gambell, Savoonga, Diomede, and Wales contracted to work as Village Monitors on the WHMP met in Anchorage for a week-long training session. Topics addressed included: project objectives, specimen preparation and storage, and data collection, entry and storage. During training, the harvest monitoring teams learned about their responsibilities to FWS and their host villages. Information about cross-cultural differences, cooperation between FWS and village residents, and differences between rural and urban lifestyles was exchanged. The monitoring teams discussed employee and contractor expectations, rules of conduct, and administrative procedures. Also included were a four hour American Red Cross "Heartsaver" course and a four hour first aid class. The history and objectives of the WHMP and cooperation between FWS and village residents were discussed. In order to place the monitoring program in a larger context, walrus population biology and data gaps were addressed. Educational programs were prepared for presentation in village schools. The possibility of hiring assistants through the Resource Apprenticeship Program for Students (RAPS) program was discussed. Biological Technicians spent additional time acquiring and shipping equipment and supplies to their respective duty stations.

Harvest monitoring

FWS seasonal biological technicians arrived in Gambell and Savoonga on April 13 and in Diomede on May 6. The Village Monitors are year-round residents of these villages. The monitoring teams met with walrus hunters soon after their arrivals to discuss monitoring project plans for the spring season. The monitoring teams reviewed the WHMP with the hunters, discussed sampling methods, and gave them sampling kits. Each kit consisted of a 5-gallon bucket containing sample bags, grease pencils and trash bags; sampling directions were taped inside the lid of each bucket. To avoid mixing materials and contaminating samples, monitors asked hunters to put all samples, including teeth and reproductive tracts, in labelled bags as soon as possible. However, labelling and sample separation was often done at the beach when the boats returned. The date, sex of the animal collected, its reproductive status, the type of samples collected, and the name of the collector (hunter) were written on each sample bag. A tentative determination of age class was recorded following MTRP criteria: adult, subadult (visible tusk <12" for males, <8" for females), yearling (tusks present but not extending beyond lip), calf (recently born calf of year having no tusks), and unknown (Stephensen *et al.* 1994). Each bag contained a pair of temporary, white, pre-numbered tusk labels; these were placed on the tusks until replaced by the metal locking tags used by the MTRP. The labels were used to verify data collected by WHMP and MTRP.

Monitors asked hunters to donate two teeth from all animals and the reproductive tracts (ovaries and uterus) from all female walrus harvested. A lack of storage and processing facilities in Wales precluded collection of any samples except teeth. Hunters were encouraged to donate jaws, rather than teeth, to ensure that paired teeth were from the same animal. Once monitors had removed the sample teeth, the jaw and any remaining teeth were returned to the hunter. Liver and kidney samples were purchased in Gambell and Diomede for the analysis of heavy metals. Hunters were encouraged to donate additional heavy metal samples if possible.

Monitors met returning hunters on the beach and collected information about the location and duration of hunt, number of walrus and seals struck and lost, and attached temporary labels to tusks not labelled by hunters. Samples were collected on the beach and assigned numbers. Teeth were removed from jaws, cleaned, and placed in labelled envelopes. Reproductive tracts were rinsed with water and fixed in 10% formalin for up to two weeks. They were then stored in a solution of 5% formalin until subsequent analysis at the Marine Mammals Management laboratory in Anchorage. Samples collected for heavy metal analysis were subsampled for histological work; these subsamples were fixed in 10% formalin. The remainder of the liver and kidney samples were frozen and returned to Anchorage, where they were stored for subsequent heavy metal analysis by FWS-contracted laboratories.

Age determination

Hunters provided pairs of teeth from some of the harvested walrus so the estimated age of these animals could be determined. The best tooth from each pair of teeth was sectioned. Criteria for tooth selection included avoiding broken or partial teeth and selecting those that would provide the best cut through the central core. Sections through the central core provide the clearest view for precise readings (Fay *et al.* 1986). Unused teeth were re-packaged and kept in case additional cuts were necessary.

A pencil mark was drawn along the center line of the tooth, from crown to root apex, to assist in delineating a longitudinal section through the central core. Up to four teeth were positioned on an 18 cm x 3.8 cm x 3.8 cm wooden block with their penciled core lines perpendicular to the long axis of the block to facilitate cutting. Teeth were affixed to the wooden blocks using liberal amounts of hot glue; glued teeth were allowed to cure at least one day before cutting.

Wooden blocks with glued teeth were positioned on a rotary stage of a Felker 11-BR lapidary saw and secured with screw clamps (Figure 2). The stage was rotated so that the penciled lines on the teeth were aligned with the saw blades. A pair of diamond-tipped blades were secured together, separated by combinations of brass shims (Johnston *et al.* 1987). This allowed thin-sections to be produced with one cut. The 15 cm diameter blades rotated at 1100 rpm while teeth were advanced slowly into the water-cooled blades by an electric motor. Depending on its size, a typical tooth required 10-15 min for a complete cut. The resulting longitudinal thin-sections averaged 0.3 - 0.6 mm thick and were stored in individual vials in solution of 35% ethanol, 5% glycerine, and 60% water.

Two FWS biologists were trained by Dr. Francis H. Fay, University of Alaska Fairbanks, an internationally recognized expert in ageing walrus teeth. Age estimates were based on counts of the growth layer groups (GLGs) in the cementum (Figure 3). One GLG is assumed to appear in the tooth for each year of life (Fay *et al.* 1986). Tooth sections were examined under a 10 power binocular dissecting microscope. Sections were kept wet over a black-bottomed dish and read under reflected light. The entire length of each tooth section was examined and GLGs were counted on both right and left sides. The section was then flipped over and the process repeated. The side with the clearest view was used for age estimation.

To increase the accuracy of age determination, two independent replicate counts were compared to one another. Since teeth of female walrus are particularly difficult to interpret (Fay *et al.* 1986), teeth were segregated by gender and more time was allotted for reading teeth from female walrus. Readings were accepted by FWS as accurate if the following standards were met: 1) blind replicate counts were within two years of each other for teeth from females in the age category of 1-20 years; 2) replicate counts for female teeth in the age category over 20 years were within four years of each other; and 3) replicate counts of male teeth were within two years of each other for all age classes.

If replicate FWS counts differed by more than the above acceptance levels, the sections were sent to Dr. Fay for independent verification. An additional random sample of approximately 50% of previously accepted FWS readings were sent to Dr. Fay for quality control. Dr. Fay's counts were accepted as best and final. After final acceptance of tooth ages, tooth sections were archived in vials. Tooth pieces left after sectioning (essentially halves) were later returned to the EWC representative from the village which contributed the samples. Hunters had requested these pieces be returned to the villages so students could be taught carving techniques in local schools.

Female reproductive tract analysis

Reproductive tracts (uterus and ovaries) were examined to determine the reproductive status and history of each female walrus. Visual examination and dissection of reproductive tracts followed the methods of Fay and Stoker (1982). Reproductive tracts were soaked in water for at least 30 minutes prior to dissection to soften the tissues. Examination of each reproductive tract began with identification of dorsal and ventral surfaces as well as left and right sides (in situ perspective). The diameter and circumference of the uterine horns were recorded. Twisted horns, characteristic of juvenile animals, were measured with respect to diameter only (Figure 4, top). The procedure for dissection of each tract was to section and examine one ovary, its associated horn, the second ovary and the remaining horn. Observations were made and findings were recorded for each step.

Uterine horns were sectioned to expose the interior lining (lumen) of the horn (Figure 4, bottom). The color, texture, and width of placental scars in the lumen were recorded. Embryos and/or implantation sites were measured and recorded. Ovaries were sliced into 2-3 mm thick sections to the depth of the broad ligament (Figure 5) and were examined for follicular activity. *Corpora lutea* (CL) and *corpora albacantia* (CA) of the sectioned ovary were tallied and measured in relation to their maximum length and width. The length and width of the largest follicle in the ovary or of all follicles in the ovary greater than 9 mm in either length or width were recorded.

Following dissection, reproductive material was archived in a solution of 5% formalin. Based on examination of reproductive tracts and definitions developed by the Reproductive Working Group of the Walrus International Technical and Scientific Workshop (Stewart *et al.* 1993), reproductive maturity of females was designated as either juvenile, subadult, or adult. Reproductive status at the time of harvest was further defined for adults and subadults (Figure 6).

RESULTS

Harvest monitoring

FWS harvest monitors recorded a total of 726 walrus retrieved by hunters in the villages of Gambell, Savoonga, Diomede, and Wales during the 1993 spring walrus hunt (Table 1). The village of Gambell took 63.5% of the monitored harvest with a total of 461 walrus retrieved, followed by Savoonga (155 walrus retrieved), Diomede (93 walrus retrieved), and Wales (17 walrus retrieved). The composition (Table 2) of the monitored spring harvest by sex and age relative to results from previous years is shown in Figure 7.

The timing of the walrus harvest differed to some extent between the villages (Figure 8). Monitors observed 279 walrus hunting trips in Gambell on 18 hunting days. The largest catch occurred on May 11, 1993. In Savoonga, 142 walrus hunting trips were observed over 15 hunting days. The largest catch occurred on May 20, 1993. On Diomede, 70 walrus hunting trips were recorded over 19 hunting days. The largest catch occurred on May 29, 1993. Finally, in Wales, 25 hunting trips were observed over 12 hunting days.

All four villages provided samples for analysis (Table 3). The degree of participation in sample collection varied between villages. Most of the samples were collected as specified by the monitors; the reproductive material was in especially good condition. Savoonga provided the most material, with tooth samples donated from 68% of its adult animals and reproductive tracts from 42% of the adult female walrus.

Although some hunting trips were entirely unsuccessful, hunters were sometimes able to harvest seals in addition to or instead of walrus. A total harvest of 208 ice seals (bearded, *Erignathus barbatus*; ribbon, *Phoca fasciata*; ringed, *Phoca hispida*; and spotted seals, *Phoca largha*) were reported taken in the four villages over the monitoring period. The species and sex composition of the catch varied by village (Table 4). Although monitors recorded the number, species, and gender of ice seals caught, biological samples were not collected.

Age composition of the sampled catch

A total of 221 walrus teeth (96 females and 125 males) were read by FWS biologists from the 1993 spring harvest at Gambell, Savoonga, Diomede, and Wales. All female teeth were independently re-read by Dr. Francis Fay, due to the inherent difficulty in interpreting female ages. Dr. Fay's age estimates were used as the final count. Comparison of replicate counts of male teeth revealed that 42 did not meet FWS acceptance criteria. Those sections were sent to Dr. Fay for independent verification, with his age results used as the final count. A random sample (n=36) of male teeth that met FWS acceptance criteria were sent to Dr. Fay for quality control. Comparison of Dr. Fay's and FWS's readings revealed that 80.5% of the estimates for male teeth were within ± 2 years of each other.

The age and sex composition of the sampled spring harvest is shown in Figure 9. These values do not represent the mean age of the catch because the calculations exclude calves as well as any other animals from which teeth were not sampled. The largest age spread in retrieved catch occurred in Gambell, particularly for females. Older males were predominant in the Savoonga harvest, while Gambell and Diomede had younger males in the sample. The mean ages of sampled walrus appear in Table 5. Females were slightly older than the male catch. Small sample sizes contributed to the large standard errors.

Female reproductive status

Native hunters contributed a total of 46 reproductive tracts to the program. These represented 9% (n=20), 42% (n=5) and 34% (n=21) of the recorded harvest of adult female walrus (this category excludes yearlings and calves) during the monitored period in the villages of Gambell, Savoonga and Diomede, respectively. Reproductive tracts were intentionally not collected from Wales.

Most reproductive tissues were received in good condition. Thirty-nine of the tracts were complete, being composed of paired uterine horns and ovaries. Five of the seven remaining reproductive tracts were composed of both ovaries with one uterine horn, only. These tracts were from females who had recently given birth or were near term at the time of harvest; the grossly enlarged horn of pregnancy was not retrieved. The remaining two tracts were composed of one ovary with one horn and one ovary with two horns.

Evidence of recent-term or near-term pregnancy was found in 33% of all reproductive tracts. An additional 33% were found to contain evidence of a new ovulation. Nearly all of the remaining third of the reproductive tracts were defined as inactive, having neither evidence of a new ovulation or of term/near term pregnancy (Table 6). Although some of the inactive reproductive tracts may be representative of lactating females, the examiner had no means to distinguish lactating from non-lactating females in the sampled material.

Fifty percent of all reproductive tracts showed evidence of a past pregnancy (i.e., placental scar[s] other than a new scar present in either uterine horn). This number is considered a minimum reflection of past pregnancy since placental scars disappear after 4-5 years (Fay and Stoker 1982) and six of the females had only one uterine horn each collected for examination (often an indication of pregnancy as hunters remove the large horn of a pregnancy).

All but two of the reproductive tracts were accompanied by teeth from the animal. The reproductive tract of the youngest female (six years old) in the harvest sample showed distinctive juvenile features (Table 7). One female was designated reproductively as a subadult. The precise age of this animal could not be ascertained because the teeth from this animal and two other females were mixed. The three sets of teeth were aged as 19, 21 and 23 years old. Samples from all other females (19-40 years old) exhibited typically adult features of the reproductive tract.

One 16 year old female in the sample group was considered to be pregnant for the first time or "primiparous" (i.e. juvenile features of the opposing horn, only one large *corpus albicans* (CA) located in the ovary adjoining the horn which supported the pregnancy). A second female, aged at nine years, may also have been primiparous. However, this could not be confirmed because the ovary presumably associated with the pregnancy of the adjoining horn had both a large and a small CA. There were no CA's or *corpus luteum* (CL) in the opposing ovary.

Comparison of female status as determined by examination of the reproductive tract versus female status as reported to the monitor by the hunter after harvest revealed numerous inconsistencies. These included:

a. yearlings recorded as young of females whose reproductive tract indicated a birth in the current harvest season;

b. yearlings recorded as young of females that had not given birth in more than one year;

c. new calves recorded as young of females that had not given birth in the current harvest season.

Overall, there was less than 50% corroboration between female status as determined by examination of the reproductive tract versus female status as reported to or recorded by the harvest monitor. These inconsistencies could reflect errors in sample labeling, reporting, or in visual determination of the age of young animals (e.g. calling a young animal a yearling when it is actually a new calf of the year or a 2 year old). Finally, and perhaps most plausibly, these inconsistencies may occur because females and calves harvested in proximity are not necessarily related.

DISCUSSION

Harvest monitoring

For the seventh year, the harvest in the monitored villages was below the mean annual harvest level for the preceeding 13-year period (Table 8, Figure 10). The persistence of northeasterly winds during the winter of 1993 and an early northward movement of ice in the spring may have contributed to these lower harvest levels (Figure 11). In Gambell, hunters chose to continue whaling after the appearance of walrus near the village and may have missed most of the females and calves moving north at this time. The largest skin boat in Diomede was damaged by ice and was not able to be used for hunting. Some typically active hunters did not hunt because they were not living in Diomede during the 1993 spring season.

Age composition of the sampled catch

The mean age of the 1993 harvest was compared to previous years (Figure 12). Age data are currently unavailable for the years 1988, 1989, and 1992, because these teeth have not yet been read; the FWS is completing this work. Age data are unavailable from the 1990 and 1991 seasons because the FWS did not have a WHMP in 1990 and 1991.

The mean age of the sampled males was similar to that reported for previous years, but the mean age of sampled females taken in 1993 was noticeably higher. However, because of unanalyzed samples, small sample sizes, disjunct sample period, and large standard errors in the 1993 samples, no clear trend can be described at this time.

Female reproductive status analysis

Based on comparisons of female status as determined by reproductive tract examination versus female status as recorded by the monitor, the latter is not considered a reliable indicator of reproductive status at the time of harvest. Females and calves near to each other should not be assumed to be related. Assessment of female reproductive status must be determined from laboratory examination of reproductive material rather than from field observations. It is recommended the field sampling protocol drop the collection of visually determined reproductive status. Monitors should stop asking hunters for this information.

Sample size and future objectives

The low percentage of samples (especially reproductive material) returned by hunters is cause for concern. Samples may not have been returned for a variety of reasons, including: butchering and sample collection was conducted under difficult and dangerous conditions on the ice; sample collection took time away from further hunting; the reasons for sample collection may not have been well understood or accepted by hunters; some hunters did not perceive sample collection as providing a return benefit (either in terms of management information or financial reward).

A small sample size reduces the statistical validity of conclusions that can be drawn about the size and composition of the harvest and the reproductive status of the sampled females. Sampling a larger proportion of the harvest in a more consistent manner would help to alleviate some of these problems. The Pacific walrus is an important resource for Native Alaskans. It is in everyone's (the walrus, hunters, and the FWS's) best interest to have solid information about the status of the population and impact of the harvest. Only when statistically valid sample sizes are provided by hunters will it be possible for the FWS to provide hunters and their leaders with accurate and precise information on which they may develop valid recommendations and decisions about their hunting practices.

Some hunters and other members of the public have expressed frustration about the turnaround time between sample collection and reporting. Methods used by the WHMP for reporting back to hunters have varied. In the past, reports have been presented at spring village meetings as well as at biennial EWC meetings. However, putting the results into a meaningful context in a more timely manner should encourage more hunters to provide samples and thereby improve the quantity of data collected by this project. In an attempt to speed up the process of providing feedback to hunters and generally increase two-way communication between hunters and the FWS, additional village meetings were scheduled for the fall of 1993. The purpose of these meetings was to make preliminary information available to hunters about the previous spring's hunt. While an expanded effort was made to visit classrooms this season, proposed environmental education programs to translate scientific information into an understandable, real world context have not yet been initiated, but need to be developed. The results of these and other efforts will be monitored and discussed in future reports. More complete information, such as reports like this, will be disseminated by the FWS, WHMP, on an annual basis in time for the traditional spring EWC meeting. It is hoped this information will be used by hunters and their leaders to make informed recommendations about the coming season's harvest. The FWS looks forward to increasing these collaborative efforts which form important, basic steps toward a co-management regime for the Pacific walrus.

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The walrus hunters of Gambell, Savoonga, Diomede, and Wales collected the samples analyzed in this report. Their voluntary contributions, often made under adverse and dangerous conditions, are acknowledged. Such continued cooperation and support from hunters and the EWC will provide a foundation for conservation of the walrus population. The FWS especially recognizes Mr. Benjamin Nageak, Barrow, and the late Matthew Iya, Nome, for constructive comments and suggestions leading to significant changes in operation of the WHMP. Data and samples were collected from hunters by Village Monitors: Ruby Booshu, April James (Gambell), Steve Kraft, Crystal Merdock (Savoonga), John Iyapana, Jr. (Diomede), and Metronna Anungazuk (Wales) and Biological Technicians: Rebecca Boxer, Lynn Noonan (Gambell), Mary Brainard, Gary Henry (Savoonga), and Gay Sheffield (Diomede). Figure 2 was prepared by I. Levington. Constructive comments were made on a draft of this paper by Charlie Johnson (EWC), Carl Hild (Indigenous People's Council for Marine Mammals), Joel Garlich-Miller (FWS), and Thomas Evanse(FWS), and the late Francis H. Fay (UAF).

Use of trade names does not constitute endorsement by the FWS.

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Table 1. Summary of the 1993 spring walrus harvest in four villages participating in the Harvest Monitoring Program in northwestern Alaska. Percentages of totals shown in parentheses. Yearlings included in columns for males, females, or unknowns.

Village	Males	Females	Calves	Unknown	TOTAL
Gambell	146 (31.7)	239 (51.8)	67 (14.5)	9 (2.0)	461
Savoonga[a]	139 (89.7)	12 (7.7)	3 (1.9)	1 (0.6)	155
Diomede	22 (23.7)	61 (65.6)	6 (6.5)	4 (4.3)	93
Wales	5 (29.4)	10 (58.8)	1 (5.9)	1 (5.9)	17
TOTAL	312 (43.0)	322 (44.4)	77 (10.6)	15 (2.1)	726

[a] Total does not include an estimated 49 walrus reported taken at camps.

Table 2. Summary of walrus retrieved by age class and sex in four monitored villages in northwestern Alaska during the 1993 spring walrus harvest.

		Sex			
Village	Age Class	Male	Female	Unknown	TOTAL
Gambell	Adult	120	221	1	342
	Subadult	22	10	1	33
	Yearling	4	8	6	18
	Calf	21	32	14	67
	Unknown	0	0	1	1
	Subtotal	**167**	**271**	**23**	**461**
Savoonga	Adult	124	8	0	132
	Subadult	7	0	0	7
	Yearling	1	0	0	1
	Calf	1	0	2	3
	Unknown	7	4	1	12
	Subtotal	**140**	**12**	**3**	**155**
Diomede	Adult	21	57	1	79
	Subadult	1	3	3	7
	Yearling	0	0	0	0
	Calf	1	2	3	6
	Unknown	0	1	0	1
	Subtotal	**23**	**63**	**7**	**93**
Wales	Adult	3	10	0	13
	Subadult	0	0	0	0
	Yearling	1	0	1	2
	Calf	0	0	1	1
	Unknown	1	0	0	1
	Subtotal	**5**	**10**	**2**	**17**
TOTAL		335	356	35	726

Table 3. Summary of samples contributed by hunters in four villages participating in the 1993 Harvest Monitoring Program in northwestern Alaska. Percentages of totals shown in parentheses.

Village	Total Adults[a]	Teeth Samples	Adult Females[e]	Female Repro Samples
Gambell	385	75 (19.5)[c]	231	20 (8.7)
Savoonga	151 [b]	102 (67.5)[d]	12	5 (41.7)
Diomede	83	39 (46.0)	61	21 (34.4)
Wales	15	5 (33.3)	10	0[f]
TOTAL	634	221 (35.4)	314	46 (14.7)[g]

[a] Includes subadults and yearlings but not calves.
[b] Does not include an estimated 49 walrus reported taken at camps.
[c] About 63% of the tooth samples were taken from jaws provided by hunters.
[d] About 17% of the tooth samples were taken from jaws provided by hunters.
[e] Adult females does not include yearlings or calves.
[f] Reproductive samples not requested from Wales hunters.
[g] Percent calculation excludes Wales females.

Table 4. Summary of seals retrieved during the 1993 spring walrus harvest in four villages in northwestern Alaska. F = females, M = males, U = unknown sex. Hunting period monitored was 4/13/93 - 6/16/93 in Gambell, 4/13/93 - 6/17/93 in Savoonga, 5/6/93 - 6/26/93 in Diomede, and 4/22/93 - 6/18/93 in Wales.

	Bearded Seal			Ringed Seal			Spotted Seal			Ribbon Seal			Unident. Seal			Total Seals
Village	F	M	U	F	M	U	F	M	U	F	M	U	F	M	U	
Gambell	7	16	31	5	5	1	9	11	6	0	0	0	1	0	0	92
Savoonga	9	18	3	1	3	1	1	2	0	0	1	0	0	0	0	39
Diomede	0	6	33	1	5	1	3	3	3	0	0	0	0	0	1	56
Wales	2	10	0	0	0	0	2	7	0	0	0	0	0	0	0	21
TOTAL	18	50	67	7	13	3	15	23	9	0	1	0	1	0	1	208

Table 5. Mean age of retrieved adult and subadult walrus by village in the spring 1993 harvest (does not include calves, yearlings, or animals of unknown gender). Age determined from counts of cemental growth layer groups in teeth.

		Females			Males	
Village	Mean Age	Std. Error	n	Mean Age	Std. Error	n
Gambell	20.5	0.99	58	18.1	1.91	17
Savoonga	19.7	2.49	9	19.7	0.58	93
Diomede	21.6	1.67	25	21.1	0.97	14
Wales	22.0	2.27	4	6.0	0.00	1

Table 6. Reproductive status of adult females drawn from monitored villages during the 1993 spring walrus harvest as determined by examination of reproductive tracts. Reproductive tracts were not collected during harvest at the village of Wales.

Village	Term and postpartum	New ovulation	Inactive	Early Birth or abortion	Other	TOTAL
Gambell	6	8	5	0	1	20
Savoonga	2	0	3	0	0	5
Diomede	7	7	5	1	0	20
TOTAL	15	15	13	1	1	45

Table 7. Reproductive characteristics of sampled female walrus by age class.

Age Class	Sample size	With Cl's and/or CA's	With old placental scars	With new placental scar
6	1	0	0	0
9	1	1	1	1
12	2	2	1	1
15	2	2	1	2
16	4	4	2	2
17	3	3	3	2
18	3	3	3	0
19	2	2	2	1
20	1	1	1	1
21	1	1	1	0
22	2	2	1	1
23	4	4	3	1
24	3	3	1	2
25	1	1	0	1
26	2	2	1	0
27	1	1	1	0
30	1	1	0	0
32	1	1	1	0
33	1	1	1	0
36	1	1	0	0
37	2	2	2	0
40	1	1	0	0
TOTAL	40[a]	39	26	15

[a] Table does not include six females for which teeth samples were missing (3) or were inadvertently mixed (3).

Table 8. Numbers of walrus retrieved by Alaskan Natives in the spring 1980-1993 harvests as observed by the U.S. Fish and Wildlife Service Walrus Harvest Monitoring Project.

Year	Gambell	Savoonga	Diomede	Wales	Nome/ King Island	TOTAL
1980	556	456	709	68	500	2289
1981	961	662	808	128	759	3318
1982	942	167	558	119	717	2503
1983	642	624	166	67	637	2136
1984	1499	1011	1043	271	157	3981
1985	949	580	1208	521	271	3529
1986	816	609	759	131	336	2651
1987	1241	233	334	115	154	2077
1988	888	87	700	110	140	1925
1989	297	90	49	52	1	489
1990[a]						
1991[a]						
1992	276	392	147	6	[a]	821 [b]
Mean 1980-92	824	446	589	122		2338
1993	461	155	93	17	[a]	726 [b]

[a] Data not available.

[b] Totals do not include Nome or King Island.

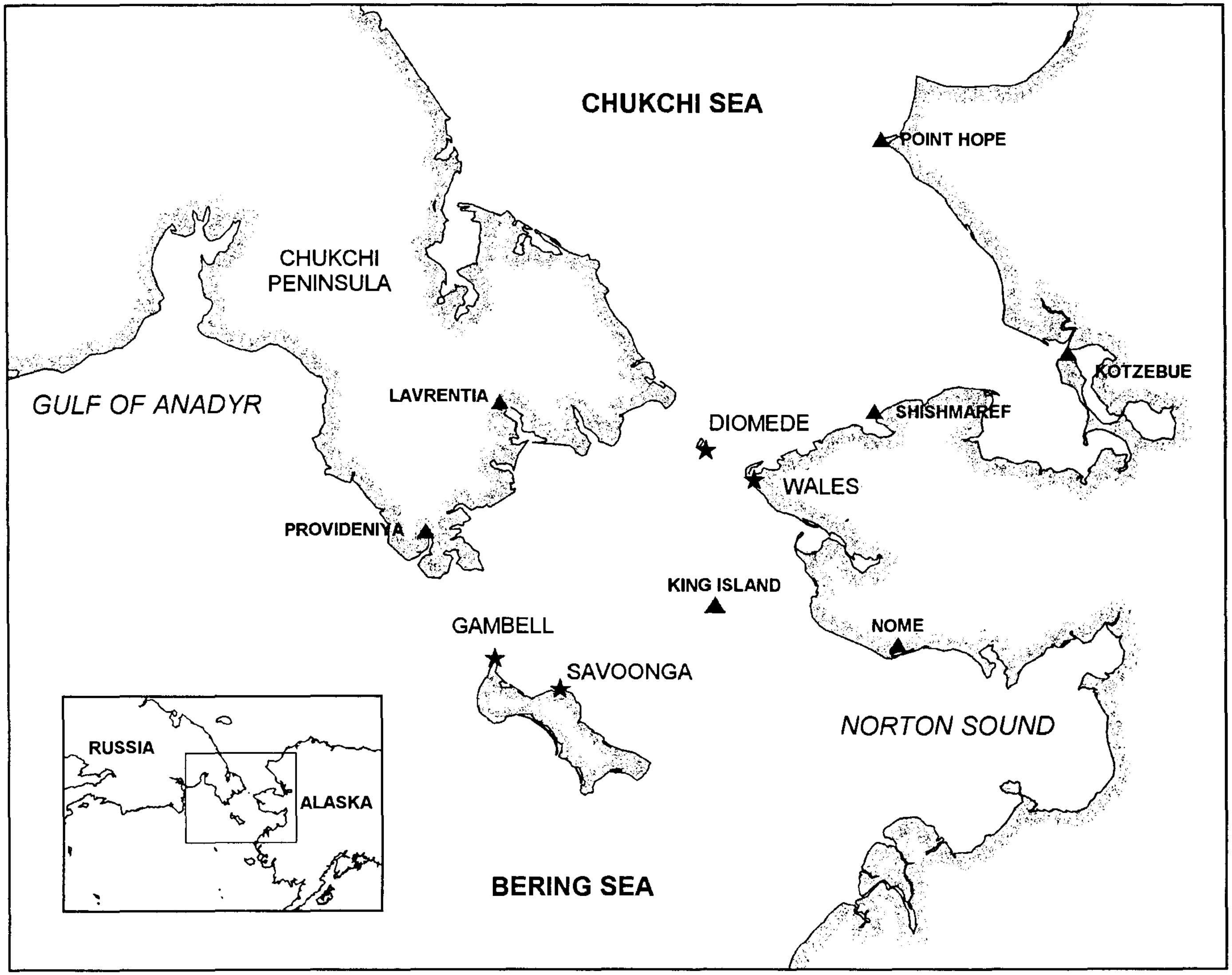

Figure 1. Location map showing the villages of Gambell, Savoonga, Diomede, and Wales (★).

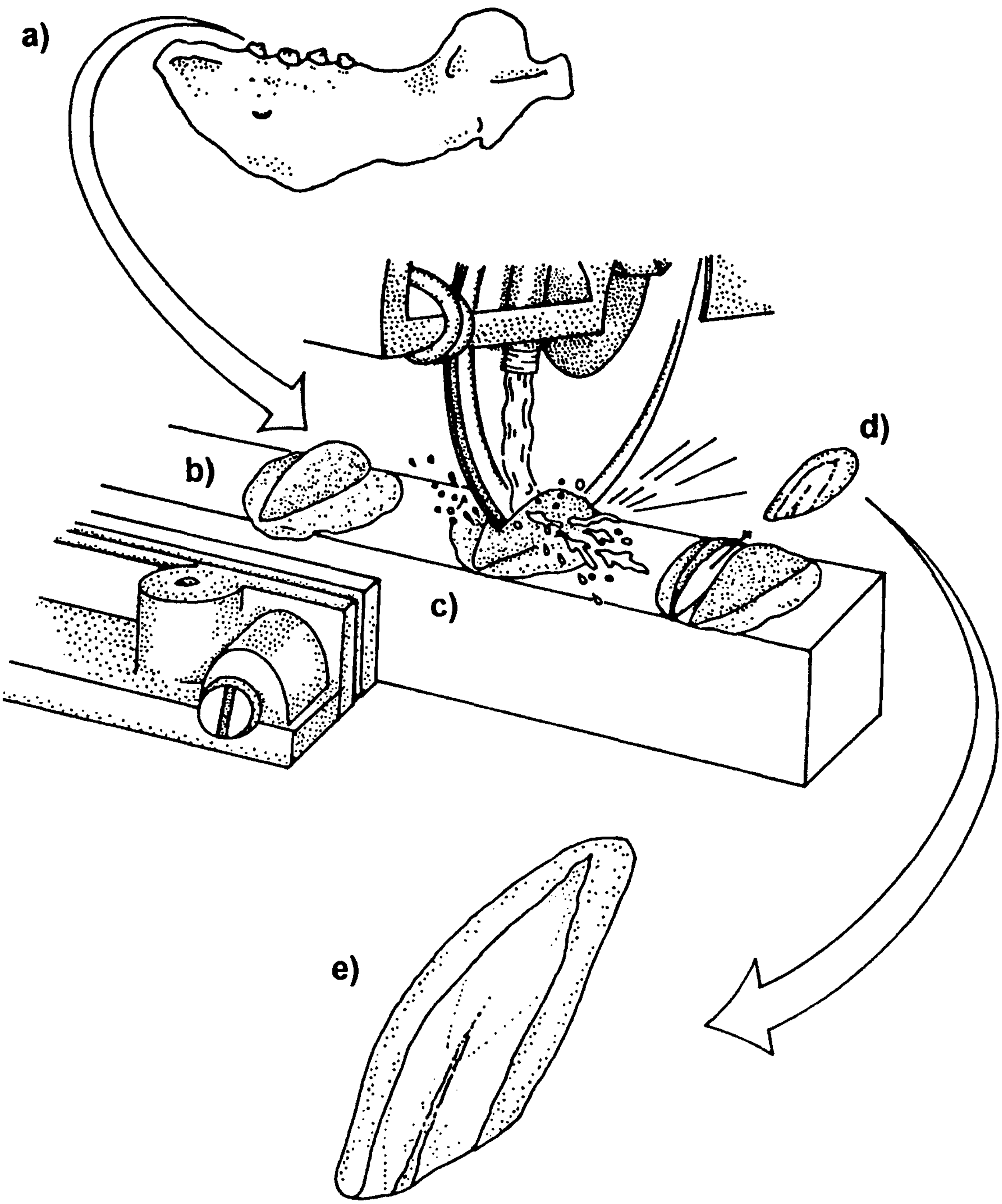

Figure 2. Diagram of tooth cutting process. a) Extraction of lower canine tooth from walrus jaw. b) Glue-mounting of tooth on wood block. c) Water-cooled, double-blade-saw cutting operation. d) Production of center-cut thin section of tooth (e).

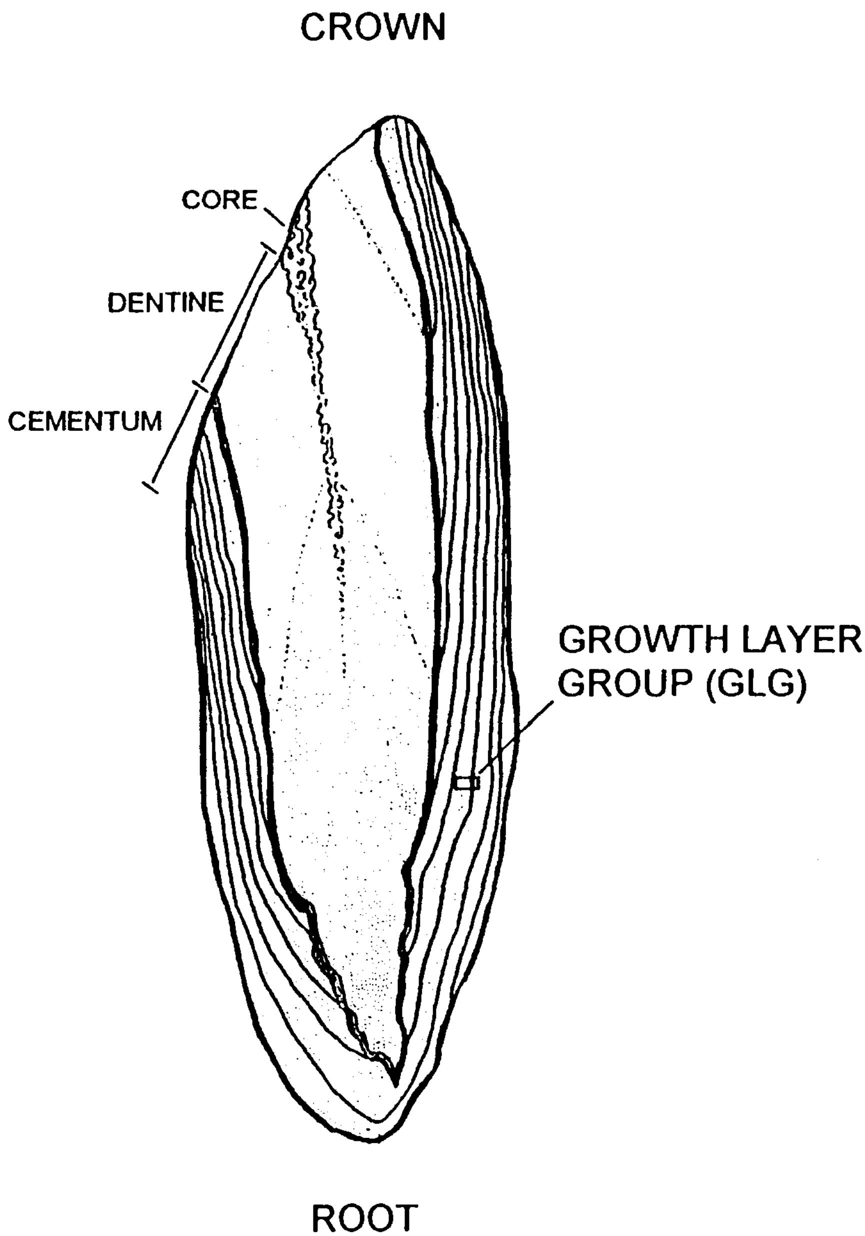

Figure 3. Diagrammatic longitudinal section of a walrus tooth showing growth layer groups (GLGs) of a nine-year-old walrus.

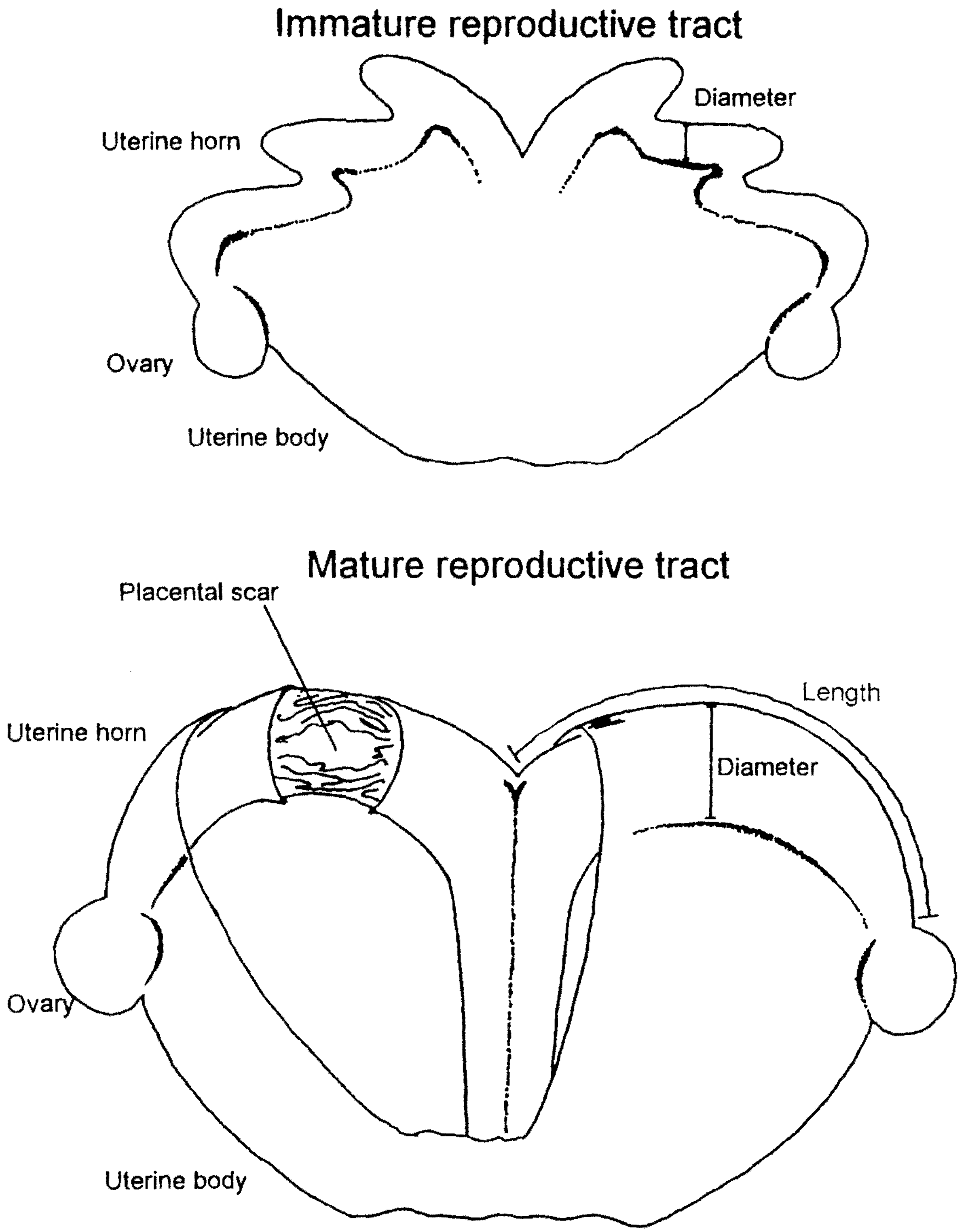

Figure 4. Female walrus reproductive tracts demonstrating the measurements taken.

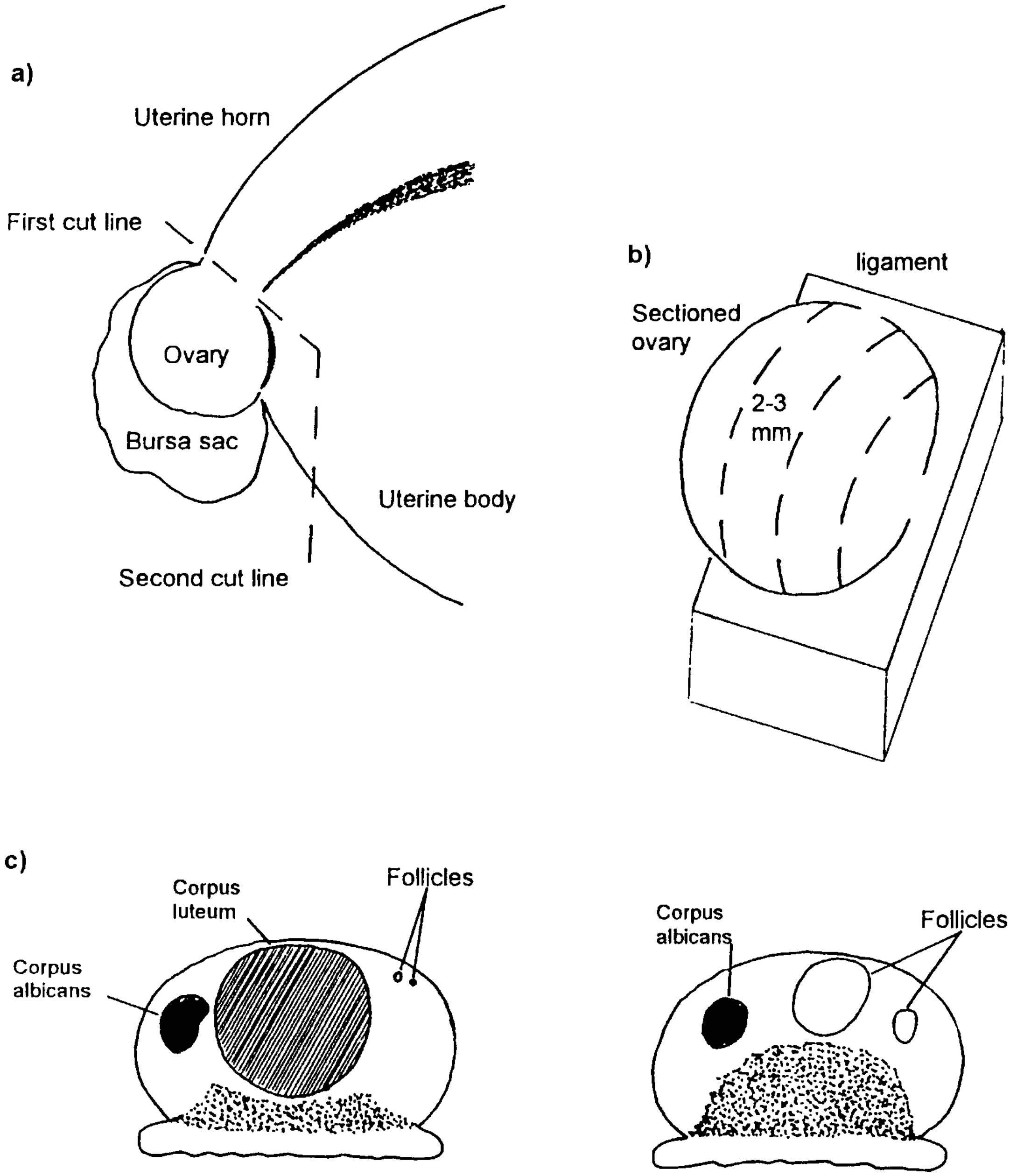

Figure 5. Ovary in situ (a), dissected ovary (b), and view of ovarian sections (c) with representative structures.

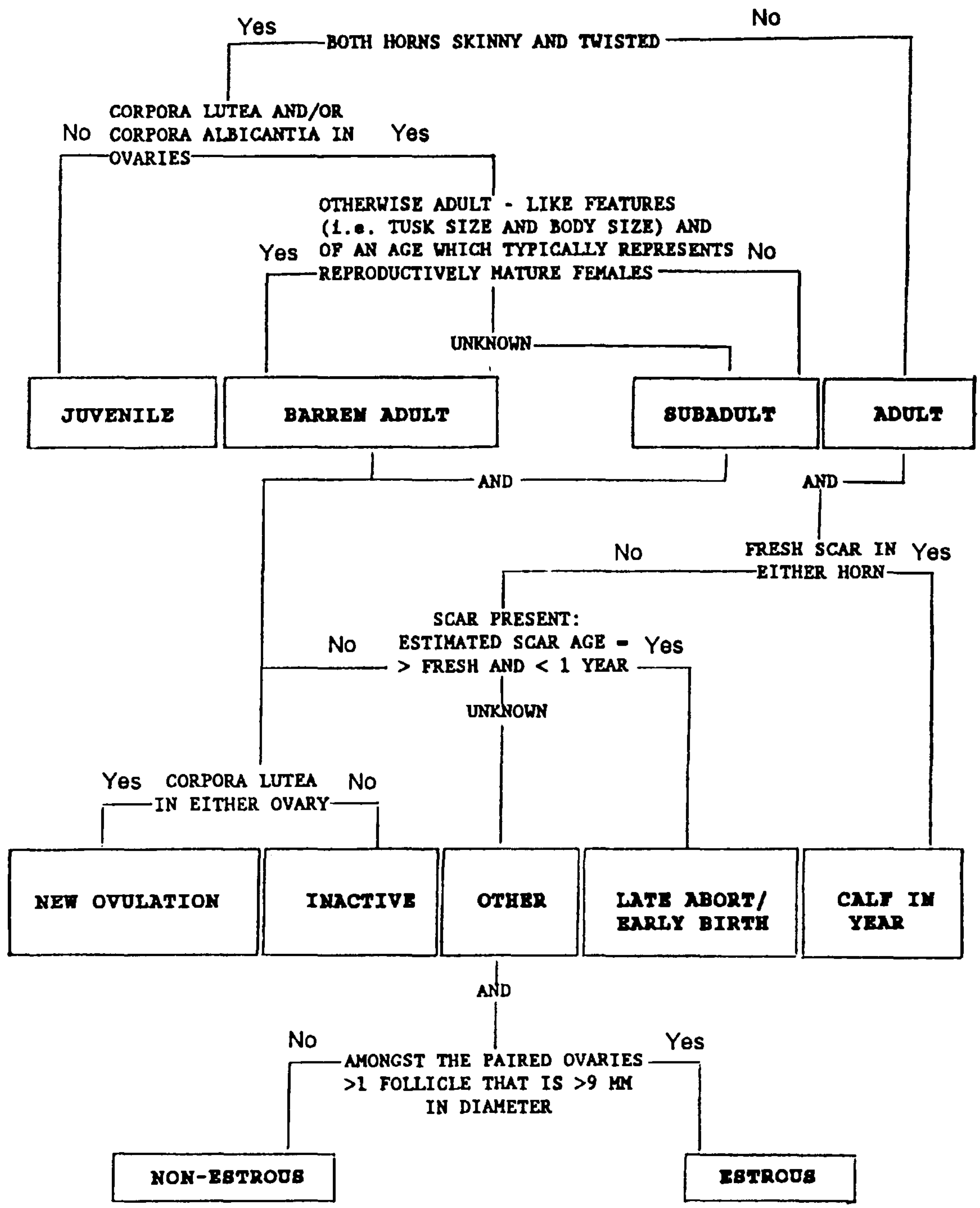

Figure 6. Method for assigning sexual maturity and reproductive status of complete reproductive tracts collected from the 1993 spring walrus harvest.

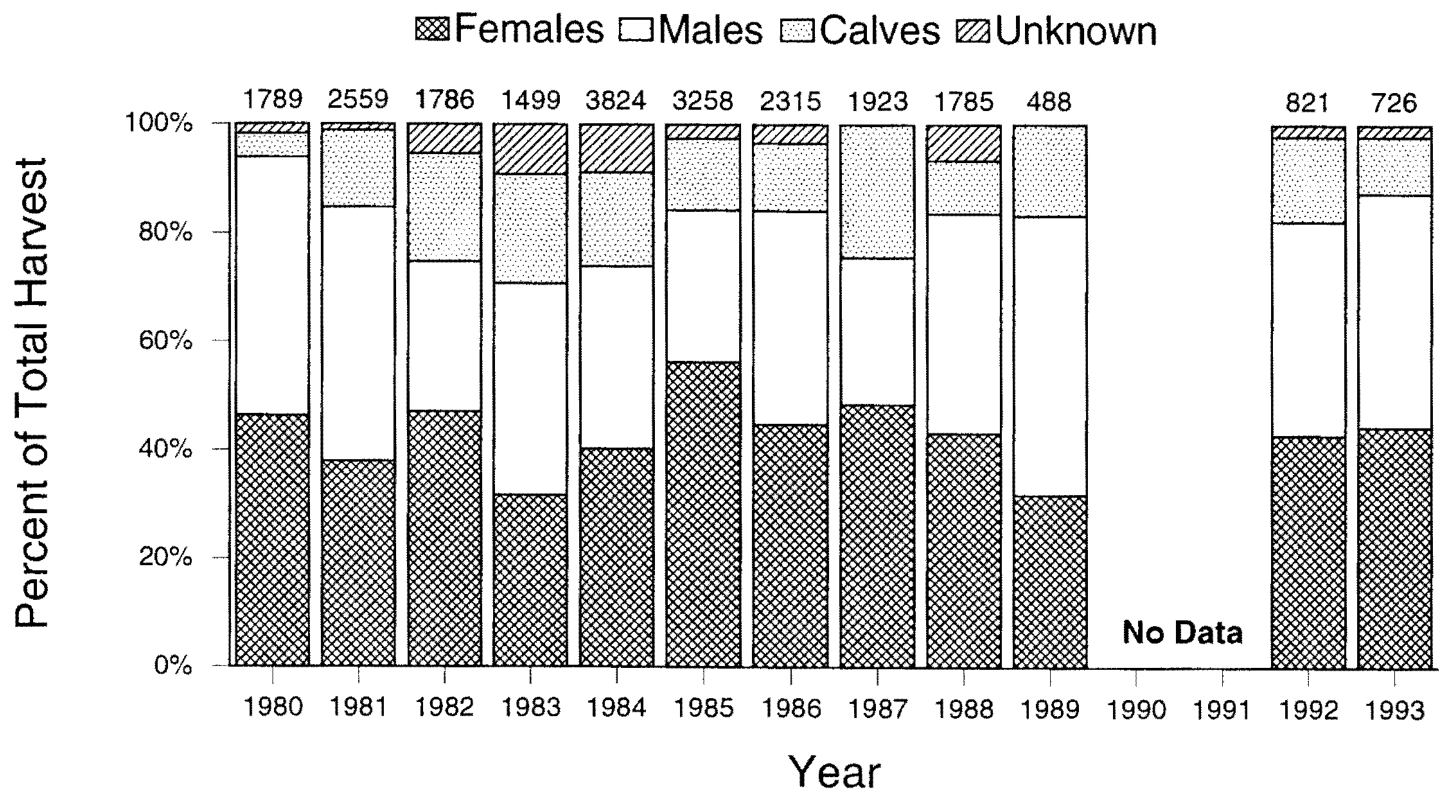

Figure 7. Composition of walrus retrieved in the spring walrus harvest in Gambell, Savoonga, Diomede, and Wales from 1980 to 1993. Sub-adults and yearlings incorporated with males and females as appropriate. Numbers at top are actual sample sizes.

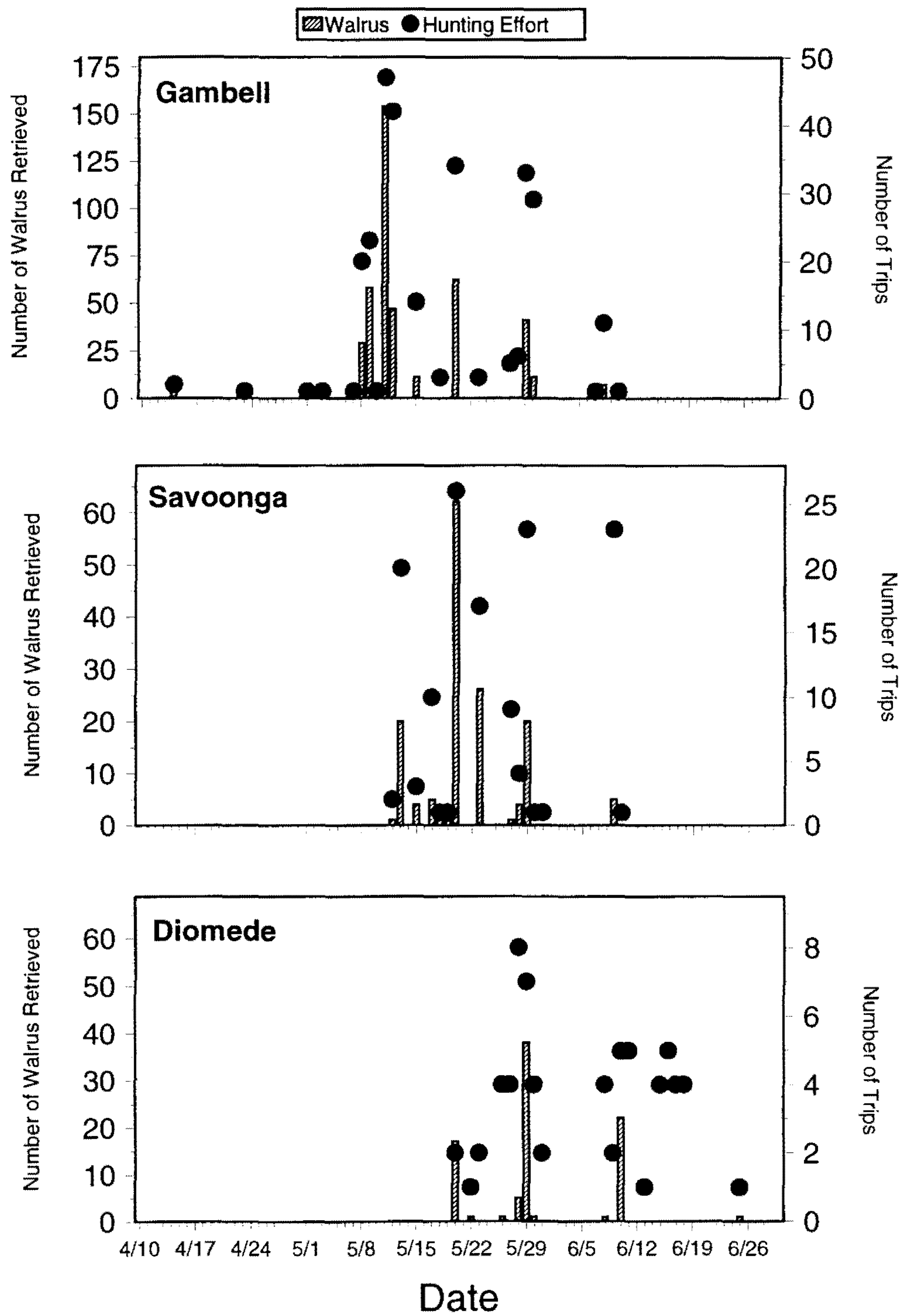

Figure 8. Number of walrus retrieved per day for three villages during the spring 1993 walrus harvest. Date shown is date hunters left the village.

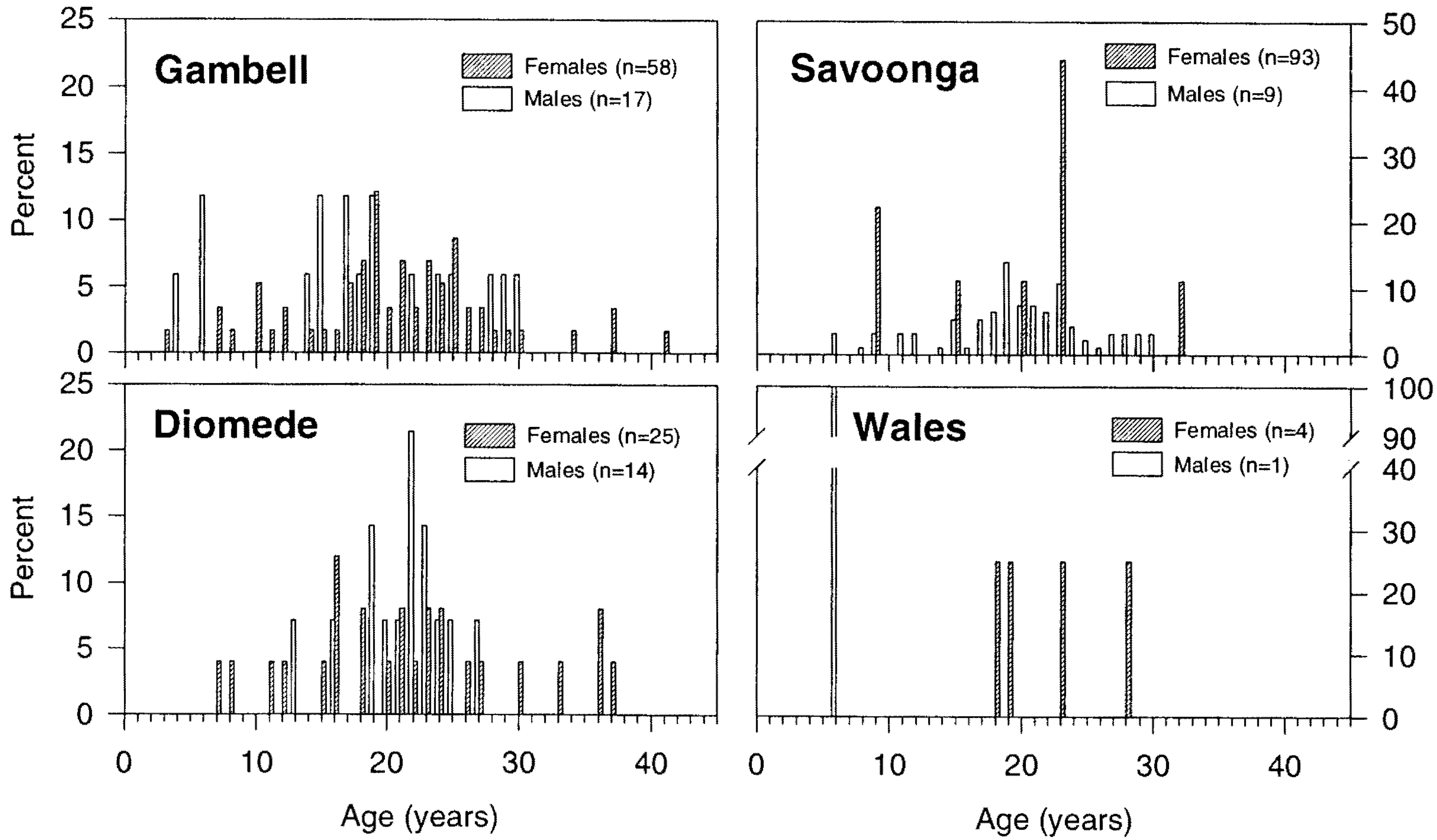

Figure 9. Age-sex composition of the 1993 spring catch of walrus in the Alaska villages of Gambell, Savoonga, Diomede, and Wales. Does not include calf and yearling data.

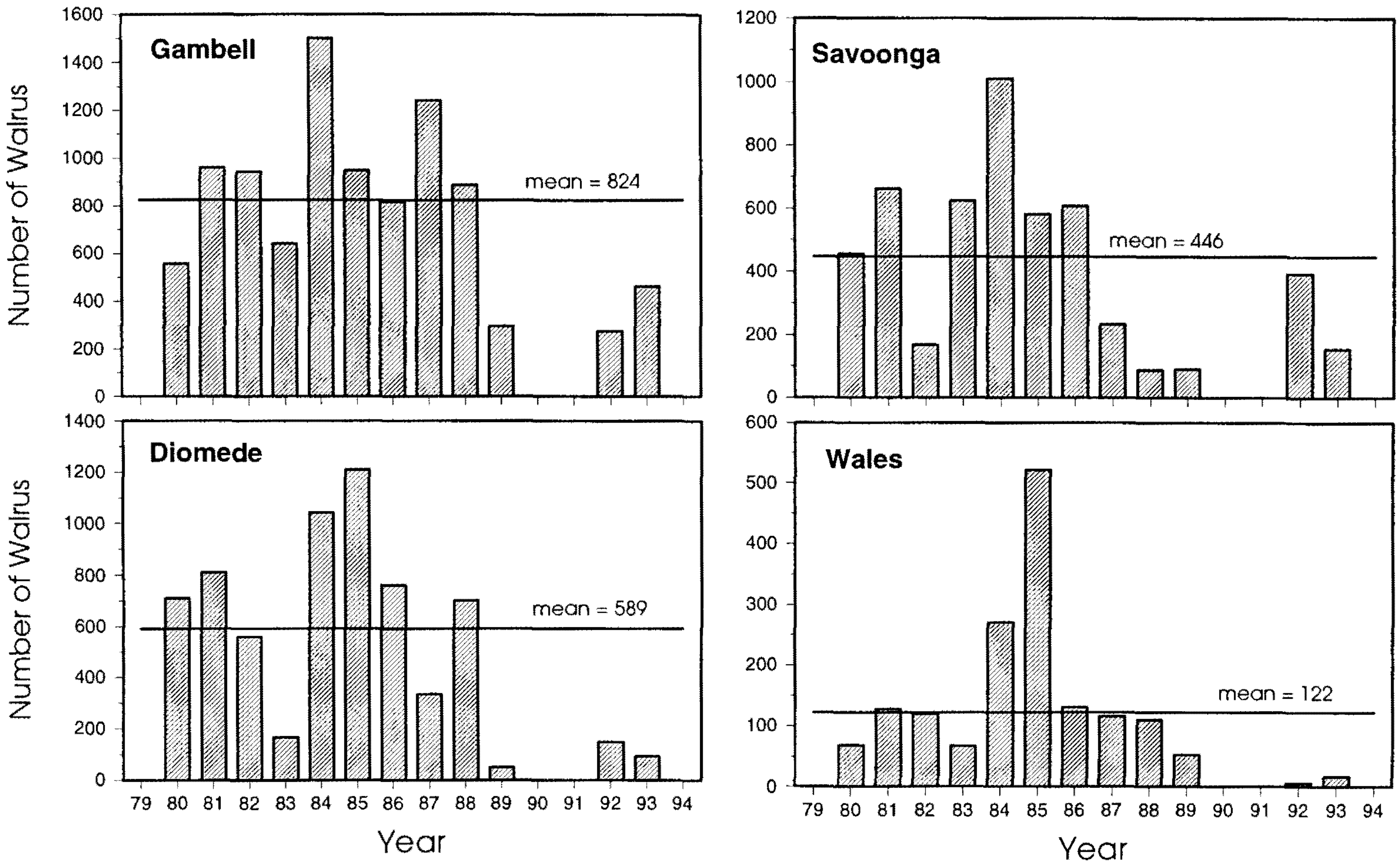

Figure 10. Number of walrus retrieved per year during the spring walrus harvest in Gambell, Savoonga, Diomede, and Wales from 1980-1993.

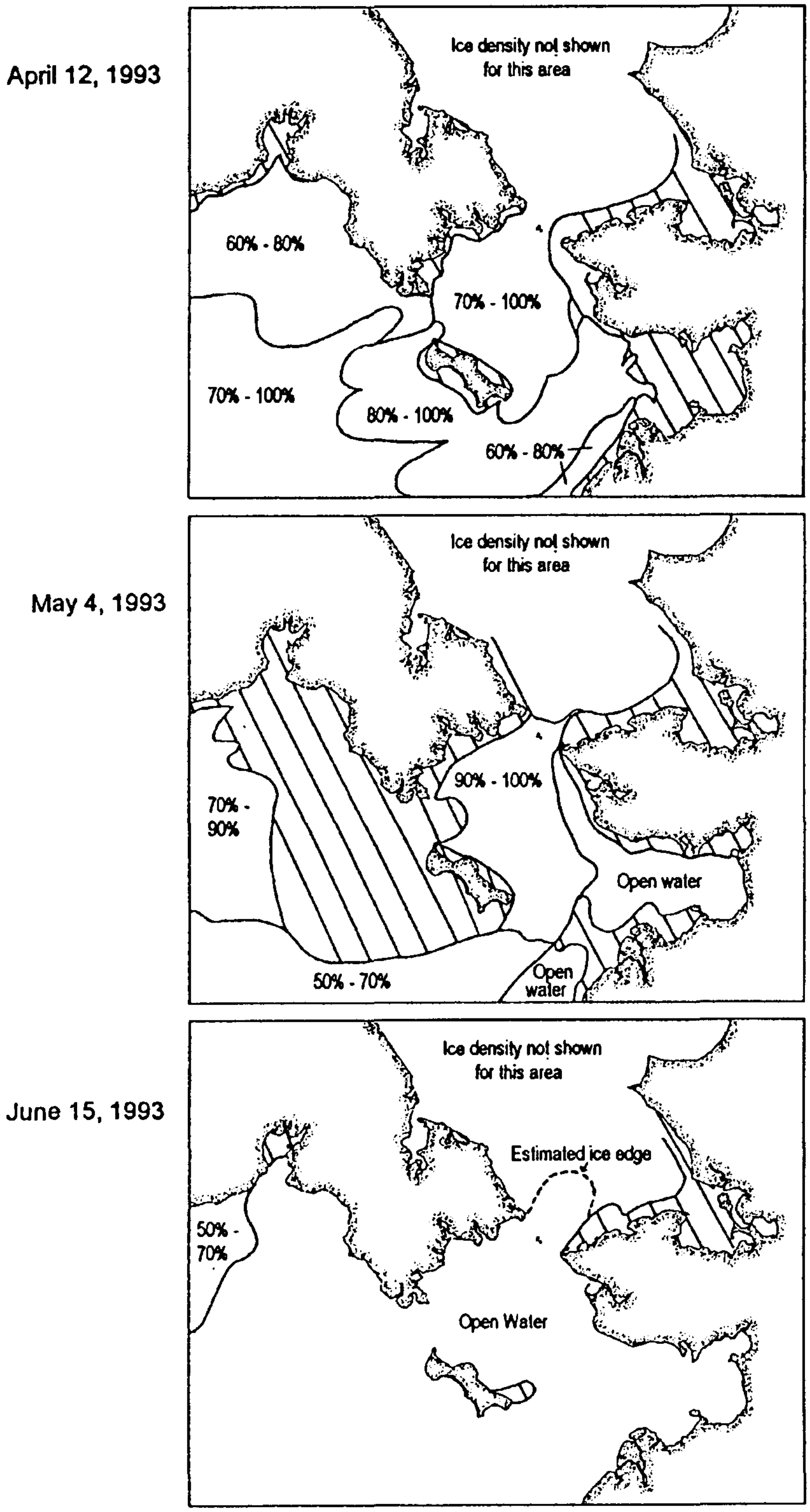

Figure 11. Ice density in the Bering Sea during the spring of 1993. Hatched areas denote shore ice or ice densities of less than 50%.

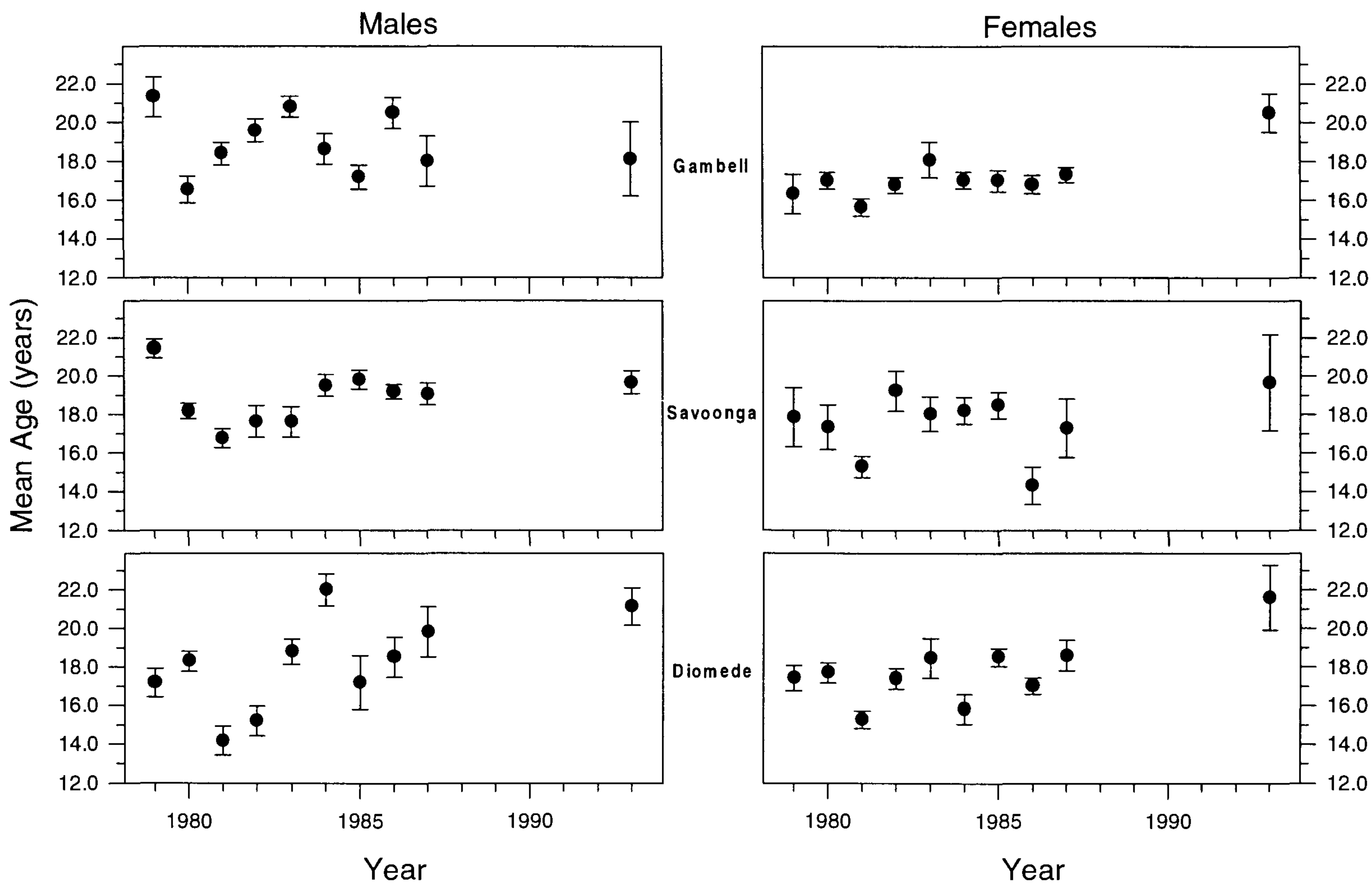

Figure 12. Mean age of spring harvested walrus from Gambell, Savoonga, and Diomede from 1980-1993. Vertical bars indicate standard errors about the means. Age determined by tooth analysis and do not include calf or yearling data.