Progress Report, 1981
Walrus Harvest, Health/Welfare Study
Gambell, Alaska.

by
Kae S. Lourie

Information presented as the author's interpretation of the walrus harvest during a particular time for a specific village. Primary use of this report is to provide insight to resource managers on the current walrus harvest. The document is restricted to internal U.S.F.W.S. use.

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

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Abstract

Spring walrus harvest data and biological samples (177 pairs of teeth for aging, corresponding sternal skin/blubber thickness and tusk length measurements for health studies, and tissue samples for contaminant analysis) were collected in Gambell, Alaska from 22 April through 6 June 1981. Analysis of biological samples is in progress. Retrieved harvest consisted of 961 walruses (36% males, 39% females, and 25% calves). An average of 8.3 walruses were retrieved per hunter. Loss rates for animals shot in the water were between 6-18% for animals shot on the ice. Loss rates were highest for males and lowest for calves. Total harvest (including possible sunk and lost) was estimated to be between 1118 and 1301 animals.

An estimated average of 55% of the walruses harvested were utilized solely for their ivory and an average of 45% were utilized for other parts along with the ivory. Percent utilization of specific walrus parts varied highly by the type of part but was highest for calves (100%) and lowest for vibrissae (1%).

Herd size was found to affect an animal's vulnerability in being harvested. Animals in herds of 1-2 were most vulnerable (90-100% retrieved). Vulnerability dropped as herd size increased and males (in all male herds) were found to be less vulnerable than females (in female/young herds). Of all factors, wind velocity affected hunting occurrence and success the most, followed by ice conditions, and then by weather (fog, rain, snow).

During the migration male walruses predominated to the E and NE of Gambell and to the NW close to the Siberian coastline. Females, sub-adults, and calves predominated to the N and NW (in the middle of Anadyr Strait). The height of the harvest and probably the migration occurred between 12 and 23 May. The ice pack was substantially broken up by this time, allowing hunters better access to walrus and allowing walrus an open path through Bering Strait.

assist in the return of management to the State. The Fish and Wildlife Service is also developing a walrus management plan that will be beneficial to both the State of Alaska and the federal government.

1980 Fish and Wildlife Service Walrus Program

In 1980 the Fish and Wildlife Service carried out a walrus research project which was partially designed to continue research the State of Alaska had been involved in prior to 1979.

Project achievements included estimation of the total walrus population by aerial surveys and collection of walrus biological samples and documentation of harvest information at the major Eskimo walrus hunting communities (Nome, Gambell, Savoonga, Wales and Little Diomede). Biological samples collected included the two lower canine teeth for age, stomach contents for food habits, and ovaries from females (along with accompanying teeth) for reproductive status. Analysis of these samples was contracted out to Dr. Francis Fay of the Institute of Marine Sciences, University of Alaska, Fairbanks and is currently underway.

1981 Fish and Wildlife Service Walrus Program

Goals and Data Collection

1981 project goals were to continue walrus harvest and health studies at the major Eskimo walrus hunting communities of Nome, Gambell, Savoonga, Wales and Little Diomede. Data and biological samples included estimates of the native

INTRODUCTION

Background

The passage of the Marine Mammal Protection Act (MMPA) of 1972 gave the Department of the Interior responsibility for walruses, polar bears, sea otters, manatees, and dugongs. The Fish and Wildlife Service was made responsible for managing the marine mammals in the Department of the Interior and for enforcing the moratorium on taking the importing marine mammals and marine mammal parts.

In 1973 the State of Alaska requested return of management for walrus from the Fish and Wildlife Service. Management was returned in 1976.

The People of Togiak v. United States (No. 77-0264, D.D.C. Apr. 3, 1979, and Jan. 29, 1981 determined that because of the "Native Exemption" portion of the MMPA of 1972, the State of Alaska could not manage subsistence take of walrus by indigenous people unless the walrus population was depleted. In 1979 the State returned walrus management to the Fish and Wildlife Service because "Native Exemption" language violated the State of Alaska Constitution which states that no preference may be made over wildlife resource utilization due to race.

The Fish and Wildlife Service has had management authority of walrus since July 1, 1979. At present Congress has passed amendments to the MMPA which will facilitate return of management to the State of Alaska. Fish and Wildlie Service's role at this time is to continue to monitor walrus harvest and health of the population until the State of Alaksa resumes management, and to

1981 Fish and Wildlife Service Walrus Program Evaluation and Recommendations

Field Preparation

The 1981 walrus project got a late start due to President Reagan's January federal hiring freeze. Two people (Tim Smith and the author), were hired in mid-March and two people were loaned from departments within the Service (Elizabeth Halpin from Habitat Evaluation Procedures and Chuck Adsit from Realty) to collect the spring walrus harvest information. A good effort was made by all to get ready for the field season in a short time.

Preliminary meetings were held to pass out field gear, go over program goals, and discuss sampling techniqus. More time should be spent informing the field workers of Fish and Wildlife Service walrus management goals, past and present projects of the program, current political undertones with the native people and/or Alaska Department of Fish and Game, and their causes, the status of any legislative matters affecting marine mammals, and backgrund on other marine mammal issues. The people in native villages do not distinguish between Alaska Department of Fish and Game, National Marine Fisheries Service, or Fish and Wildlife Service. It would be beneficial to be well versed in marine mammal issues concerning these three agencies as village people tend to barrage field workers with questions.

Field Work and Logistics

Field work in Gambell took place from 22 April - 6 June. Initiation of field work was 9 days earlier than last year due to the earlier completion of the whaling season. Gambell struck and lost 2 bowhead whales on 5 and 12 April

subsistence take, collection of 20 pairs of the lower front teeth of walrus per village, measuring tusk length and blubber thickness, and collecting blubber, liver and kidney samples.

By monitoring the subsistence take, the Fish and Wildlife Service can better estimate walrus population levels and determine trends. Age data from walrus teeth will help determine more about the sex and age compositon of the population. Blubber thickness will be used as an indication of walrus health. Tusk length and age of the animal will be analyzed to see if there is a correlation with tusk length and food availability. As part of the National Marine Mammal Pesticide Monitoring Program blubber samples will be analyzed for P.C.B.'s and organic chlorines (DDT, DDE, and DDD), liver for mercury, and kidney for cadmium, lead, and arsenic.

The National Marine Mammal Pesticide Monitoring Program is an international program, whose major United States participants are the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. These agencies are obtaining baseline data on contaminant levels world-wide by using the hair seal as an indicator species. The detection of concentrations of pollutants in hair seals may assist in the identification of marine areas which have received large quantities of these compounds. In the future, periodic monitoring of pollutant levels in hair seals will be done to determine pollution problem areas in the marine environment.

Due to the possibility of future development of offshore oil and mining in the Bering Sea, the Fish and Wildlife Service is proposing that walrus be used as an indicator species for pollutant levels of that area. Baseline information is being collected to determine the natural level of heavy metals in the environment and what levels of P.C.B.'s and organic chlorines already exist.

It would be advantageous to arrive in Gambell about a week before walrus hunting begins or while the hunters are butchering their last bowhead whale. This added time would allow the biologist to mingle with the people, re-establish rapport, set up the walrus hunters' meeting when the most people could attend, and gradually ease into the situation. Hunter data (size of boats, etc.) could also be gathered at this time. By being there during the completion of whaling the biologist could direct questions concerning bowhead whales to the bowhead whale observer who would still be in town. This would hopefully alleviate some of the confusion on walrus and whale management.

The first day of spring walrus hunting was 21 April. Up until then Gambell hunters were busy whaling. There were 25 days of walrus hunting due to ice and weather limitations. Hunting tapered off by 28 May with one hunter incidentally taking 3 bull walruses 2 June while bird hunting. The ice moved far off shore by 30 May making it hazardous to cross the large expanse of open and often rough water to find game. Soon the point of diminishing returns had been reached and people began turning their attention to processing their meat and walrus hides, and getting ready to move to their summer camps. By 6 June it was apparent that the spring hunt was over. Gambell's harvest was monitored for 45 total days (6 days of which, 9 May - 14 May, were monitoried solely by Abraham Kaningok, walrus harvest assistant).

Food and lodging were provided by the Antoghame family (Tom, Shirley, Kimberlie 9, Ryan 4, and Leon 2). There are advantages and disadvantages to staying wih a family while in Gambell. The advantages are safety from assault, the day-to-day logistics are provided (meals, hauling water, honey bucket, transportation), and the family is a source of information (general goings on, and CB interpretation). The disadvantages having to contend with

and landed 1 whale on 14 April. Savoonga struck and lost 1 whale on 13 April and landed 2 whales on 14 and 21 April. The 1981 EWC bowhead whale quota was 3 strikes for Gambell, and 3 strikes for Savoonga.

A walrus hunter's meeting was held on 23 April. Although advertised over KNOM radio station and by a sign posted in the Gambell Native Store only about 7 people attended. Most of the hunters had gone hunting that day and had come home tired.

The meeting was useful in instructing hunters of sample collection techniques and provided an opportunity to explain the rationale behind the 1981 program. The current program and the reason stomachs and ovaries were not going to be collected were explained. It was emphasized that there was no walrus harvest quota, but that Fish and Wildlife Service needed to know the harvest levels and collect biological data to successfully maintain the health of the walrus population for future generations. The hunters seemed receptive to the program and especially interested in the contaminant program, although disgruntled about the reduced collection program and therefore reduced available cash income.

Another meeting was scheduled for those hunters that missed the first meeting but only 2 people attended. It was therefore necessary to explain sampling techniques to people on the beach as they prepared to leave for or returned from hunting. People were generally in a rush, so there was some confusion in the sampling methods and little chance to explain program goals. After repeated explanations people were soon bringing in the correct samples.

children while trying to get work done, household chores and baby-sitting expectations at extremely busy times, and no place to go to get away from the Eskimo culture. All in all, if the field biologist is a woman it is wise to remain with a family. If male, livig alone may be advantageous.

Transportation is required while doing field work in Gambell. The north and west beaches are too far apart to get adequate harvest data on foot. A snowmachine is useful during the first half and a three-wheeler was used during the entire 1981 season and, although it got stuck occasionally, the machine proved adequate. A couple of plastic sleds and tow ropes are convenient to have along. They make it feasible to haul specimens and to help out with hauling water, etc.

Logistical Support

This year no attempt was made to put up radio antennaes for radio contact with the Anchorage office. Telephone communication proved to be adequate and wasn't limited to established radio times.

Scott Schliebe served as the logistic go-between. He did an excellent job in obtaining items, offering support, encouragement, advice, and keeping the other field biologists posed on what was going on in the office and in the field.

Walrus Data Collection Assistant

Because Gambell is split between the use of two beaches, two people are needed to adequately meet returning hunters. The assistant helps monitor harvest at

the second beach, collects samples and other information, and assists in processing samples. Abraham was rehired this year because he was already familar with the program and there wasn't enough time to recruit a new helper.

Contracts for Payment

Kawerak was not contracted to supply the walrus data collection assistant, to issue payment to the Eskimo hunters, nor to supply housing for the field biologist during the 1981 program as it had done in 1980. The Fish and Wildlife Service established contracts directly with individuals to supply housing, to act as assistants, and with each village native store to cash the hunters' receipts received in return for teeth samples.

In Gambell, food and lodging were contracted out to Tom Antoghame at a rate of $40.00 per day. A total of $1,640.00 was paid for 41 days of food and lodging. Three-wheeler rental was also contracted out to Tom Antoghame at a rate of $20.00 per day, and the total spent was $820.00 for 41 days. One final billing was sent for each of these contracts to CGS at the end of the field season. It would be better to have a partial payment halfway through the season. This would enable the family to stock up on food supplies for an additional person, at least halfway through the season, rather than having their personal stores completely depleted.

Abraham Kaningok was hired as the walrus data collection assistant. He was paid $40.00 for each day worked with a total of $1200.00 being spent. One final billing was sent to CGS at the end of the field season. This did not seem to be a problem for Abraham, but might be for someone with a limited cash flow. It might be better to make at least one partial payment during the field season.

The Gambell Native Store was contracted to cash the hunters' receipts received in return for teeth samples. The hunters received $10.00 per pair of teeth for which the tusk could also be measured. The store was paid an additional $2.00 per pair for handling the monetary exchange. A total of 177 pairs of teeth were bought with a total of $1,770.00 paid to the hunters and $354.00 paid to the Gambell Native Store. See the following table for a summary of money spent in Gambell by USFWS:

Income to Gambell from USFWS, Spring 1981.

Biological Samples

177 pairs of teeth:	
@ $10.00 per pair to the hunters	$1,770.00
@ $2.00 per pair to the Gambell Native Store	$ 354.00
Total	$2,124.00

Room and Board Contract (with Tom Antoghame)

41 days @ $40.00 per day	$1,640.00

Transportation Contract (with Tom Antoghame)

Three wheeler rental:	
41 days @ $20.00 per day	$ 820.00

Field Support Items Purchased at the Gambell Native Store

Gas - Three wheeler (10.3 total gallons)	$ 32.79
Honda parts (spark plugs, oil)	$ 7.10
Specimen supplies	$ 14.49
Total	$ 54..38

Field Assistant (Abraham Kaningok)	
30 days @ $40.00 per day	$1,200.00
Total spent in Gambell	$5,838.38

Billing paperwork was completed occasionally throughout the hunting season so that partial payments could be made to the store by CGS. There was some confusion in the method of submitting billings early in the season, but was straightened out with CGS during a trip to Anchorage. Otherwise, this system worked well, its success being largely due to the cooperation of Leonard Apangalook, the Gambell Native Store manager. Leonard liked the partial payments and his reception remained good. Thi would be a good system to follow next year since it offers direct capital to the village.

Data Collection

Gambell hunters were familiar with most of the sampling techniques used this year from previous cooperation with the Alaska Department of Fish and Game in their data collection program and last year with the Fish and Wildlife Service. The hunters were very adept at providing viable teeth samples but sometimes tried to sell 2 broken teeth in a pair. It is prudent to check the samples to make sure they are viable and are acompanied with all the required information.

There was some confusion over new sampling methods. Hunters in the beginning were often switching the ends of the blubber/skin measurement sticks, holding the X on the end of the stick rather than placing it on the sternum bone. Generally it took a number of explanations to clear up the confusion, but then things ran smoothly.

The largest confusion developed over the teeth buying limitations. Teeth were bought from walruses of alternate sexes and limited to 5 pairs per boat per day in an effort to spread the 20 pair sample size over the entire spring season. The result was a communication nightmare. Signs were posted in the Gambell Native Store to inform the hunters whether teeth were being bought and from what sex of animal. Halfway through the season hunters ignored the signs resulting in more confusion. The biologist resorted to calling each boat captain each time a change was made and informing boat crews on the beach.

Many hunters were bothered by the teeth sample limitations but some appreciated the limit per boat because it gave them a better chance to sell their walrus teeth, especially if they came in late. Spreading the sampling out over the season also spread the cash reward out more fairly to hunters that were unsuccessful in hunting on some days but were more successful on others.

It is difficult to devise a standard method of sample limitation since hunting is sporadic. Probably the best way would be to limit it to 2-3 pairs per boat per day and divide the collection period into 3-4 parts spread over the season (beginning, middle, end, etc.) to insure total coverage. A limit per boat would also allow the biologist enough time to adequately measure tusks and collect the corresponding harvest numbers, herd composition, stomach contents, and other general biological data. Some method of limitation needs to be devised that will not bias the sample.

A few hunters were asked to assist in the collection of tissue samples for contaminant analysis. Although a few hunters were interested in knowing what pollutant levels occurred in walrus it was difficult to find volunteers to collect samples because there was no monetary reward.

The hunters also viewed obtaining the samples as too much trouble. One hunter inquired why the samples weren't taken during the joint Soviet-American walrus research cruise in March, where cranes were available to hoist the animals and freezers to process the samples immediately. It was rather embarrassing to explain that the department requesting the samples didn't know about the Soviet-American cruise. To an Eskimo in a tight community where everyone knows what everyone else is doing, it's difficlt to understand lack of communication within an agency.

The whole data collection program (including collecting verbal data) should be analyzed and revamped to determine what information is important to collect and how it should be collected. Hunters are usually in a hurry before and after hunting and don't appreciate a barrage of questions. For the data collection to be more effective, forms containing columns for all pertinent data should be provided and collection techniques standardized.

Specimen Payments

Hunters were paid for pairs of walrus teeth only if at least one tooth was perfectly whole and unchipped and if the tusk from the same animal could be measured. Skin/blubber measurements were requested but not mandatory.

In collectijng specimens all parts should be made mandatory. As soon as hunters knew a portion of the data was optional it was difficult to obtain. It would be better to keep things in a package deal, and not pay more and more each year for the same items. The $10.00 per pair of teeth with tusk measurements and skin/blubber thickness was a fair price. In the future however, if only teeth are bought they should command a lower price with the explanation that the other data are not included.

People generally don't want to contribute biological specimens unless they are paid. It was difficult, for example, to obtain the contaminant samples. It would be good to demonstrate how cooperation will benefit the users by helping to maintain resources for future use.

A prevalent attitude was that the parts collection was designed to be a walrus hunters' relief fund. Some people expect and depend upon the money from specimens to purchase gas, shells, etc. There was much grumbling because ovaries and stomachs (the big money makers) weren't bought this year. During intervals when teeth weren't bought, people also asked how they were expected to buy gas. It needs to be stressed that the monetary reward is to offset the inconvenience of obtaining specimens and that the program is not designed to fund hunting.

Attitudes

There was more antagonism towards the Fish and Wildlife Service walrus program this year than last year. This took many forms, was due to a variety of factors, and continued thoughout the season.

Upon arrival in Gambell contact was made with boat captains and hunters to re-establish rapport and inform them of the walrus program. Two hunters related that they weren't going to report how many walrus they brought in each day because the government was trying to stop them from hunting. This was baffling since a walrus harvest quota had not been established. After being reminded of this fact, they still remained skeptical.

One hunter stated that white people never learn. "Don't you know what a walrus looks like yet?", he asked. When infomed of the walrus hunters' meeting he said he wasn't going and from now on they (Gambell hunters) were going to do it (walrus hunting) their own way. "We're tired of you coming around and trying to control us," he said. When informed that a walrus quota was not established last year nor this year he responded that he knew that, but that there were too many meetings, too many white people around. "We just want to do things on our own," he said.

Most other people that were approached didn't react so strongly. Some were friendly, others listened quietly and nodded but didn't say much in response.

The strong reactions came as a surprise. Last year people related that they preferred Fish and Wildlife Service having walrus management because subsistence use was upheld in the Marine Mammal Protection Act. Instead of becoming more receptive of the program durng its second year, people were more skeptical and antagonistic.

One hunter threw some light on the situation. He said that there were a number of things that had affected people's attitudes. One of which was the whaling quota. The people watch the whales go by and yet they're not allowed to hunt after they've used up their quota. People are getting angry because things are changing. The regulations change, inflation keeps going up, cost of living goes up, and they don't understand why they can't hunt bowhead whales when they see lots of whales going by. They perceive biologists collecting data as government intervention. They do not distinguish between ADF&G and USFWS or NPFS; it's all white people and government intervention to them. The people feel that they can take care of the management of animals themselves and that they're tired of the government telling them what to do. They're tired of questions and studies.

Direct antagonism generally decreased during the season. People were either getting used to the program again or were keeping their feelings to themselves. Occasional outbursts of skepticism and antagonism were a constant reminder of underlying feelings.

Some people were threatened by note-taking while being interviewed about the day's harvest. People are generally upset over the bad publicity they have received in the past about their walrus use and are nervous about what is recorded. It is best to avoid writing notes in front of hunters remembering the details and jotting them down between crews. People were apprehensive of any notice given to the amount of meat brought back and questions concerning hours spent hunting. It is best not to ask direct questions on these topics but to acquire the information through conversation. Some people were threatened by the biologist meeting their boats as they returned from the hunt. This was especially apparent when the hunter didn't have any walrus and also when specimens weren't being purchased. The investigative nature of the program makes them feel as if the federal government is always looking over their shoulder. This threat can be reduced somewhat by a casual friendly greeting, an effort not to be nosey and not asking a lot of direct questions, and helping to pull in the boat.

Direct antagonism continued with some people. One hunter in particular always made snide remarks. He never listened to explanations. One hunter switched from verbal antagonism to silence. One man, who wasn't even hunting walrus this year, angrily accused the biologist of making fun of Gambell residents and stated that he was tired of white people coming to Gambell.

Overall there remained a lot of confusion over marine mammal management. A lot of questions were raised about the bowhead whale issue. People didn't understand that the National Marine Fisheries Service was a seperate agency, with jurisdiction over the bowhead, and that the Fish and Wildlife Service wasn't involved. To them, NMFS, USFWS, and ADF&G were all the same and that the "government" (for which all the aforementioned agencies were rolled into one) was trying to stop them entirely from hunting bowhead whales. This sentiment often stretched over to walrus and the whole "subsistence" lifestyle. People's attitudes over the bowhead issue was probably the largest factor affecting peoples' attitudes toward the Fish and Wildlife Service.

Although people were very skeptical and antagonistic towards the federal government, a change of attitude often occurred if the person was visited at his home. Visiting provided an opportunity to explain the rationale behind the walrus program. It also gave the person a chance to ask questions in the safety of his own home away fom the critical eyes and ears of his peers. It gave the biologist and the hunter an opportunity to get to know one another and to see each other as individuals . Visiting is probably one of the best ways to find out what issues are troubling the people, what their attitudes and concerns are, and a chance to develop trust in what the walrus data collection program is trying to achieve. Generally hunters were more cooperative in offering information after they had been visited. They could then see the reasons for all the questions.

One word of caution about dealing with Eskimos: they are very literal people and take everything the biologist says literally. It took all season to try and erase the effect of one sarcastic joke.

Information and Education

I&E work in Gambell and the other villages involved in the walrus program is badly needed. The majority of people don't distinguish between the Fish and Wildlife Service, Alaska Department of Fish and Game, or the National Marine Fisheries Service. They need to be informed of what the Service does and how it differs from the other 2 agencies in jurisdiction and scope. It would also be prudent to present the Service's management and research plans and show the people how research of walrus biology will benefit them.

More information also needs to be disseminated on walrus biology. People had questions concerning walrus gestation, breeding cycles, and delayed implantation. Answering these questions will not only further their knowledge but will hopefully make the Service more credible in their eyes.

People were also interested in the Service's international involvement with the Soviet Union concerning walrus. A slide show and talk about the Soviet reseach cruise last March would broaden their horizons in the multi-faceted issue of walrus management.

METHODS

Data Collection

1981 spring walrus harvest data and biological samples were collected in Gambell from 22 April through 6 June, a total of 45 days. Two observers, each at one of the two beaches, met returning hunters to collect data.

Harvest estimates, number of sunk and lost, walrus herd composition, direction of hunting, and weather and ice conditions were attained by interviewing hunters. The reported harvest was cross-checked by the number of pairs of tusks present. When possible, the number and type of walrus parts kept by hunters was also recorded.

Biological samples included the two lower front walrus teeth, corresponding skin/blubber thickness and tusk length measurements, and a small number of skin/blubber, liver, and kidney tissue samples for contaminant analysis.

A sample size of 200 pairs of teeth was established for each village. A total of 177 pairs (84 males and 93 females) were collected at Gambell. Teeth were bought in intervals, sex of the sample alternated, and a sample limit set for each boat per day in an effort to extend the data collection over the entire spring hunting season. See Table for the schedule used to buy teeth.

Teeth were removed from the skull by the hunter in the field. The tooth was loosened by gentle tapping with a hammer. In most cases this produced a viable sample, at times however the tooth broke in half. The pair of teeth were bagged and attached with the skin/blubber measurement stick to a tusk from that animal with a rubber band. Some hunters tied the bag through the nasal passage. Either of these methods proved to be adequate in keeping the correct samples together.

Skin/blubber measurements were also taken in the field. A slit was made over the sternum on the walrus and a wooden tongue depressor inserted until it hit the bone (Appendix). One line was marked wth a grease pencil for the skin/subcutaneous fat (blubber) interface and one for the outside of the skin.

Upon the crew's return to Gambell the two lower front walrus teeth were bought from boat captains if the corresponding tusk measurement was available and at least one of the two teeth was whole and not badly chipped. The longest tusk of each animal was measured along the frontal curve from the gum line to the tip of the tusk to the nearest 0.5 cm. Fractured or deformed tusks were noted (left or right tusk: from the animal's perspective). A number code was used to indicate shape of tusks from head on and from the side (Table 21). Skin and blubber measurements were not mandatory, but when available, were measured as marked on the sticks, to the nearest millimeter. Herd composition, stomach contents, and the presence of fetuses or calves with females was also noted for each sample when possible.

A few hunters were requested to voluntarily bring in skin/blubber, liver, and kidney tissue samples for contaminant analysis along with the corresponding two lower front teeth and skin/blubber meausrement stick, from animals older than 10 years. As soon as possible after receiving the tissues a 10 gram or greater sample was cut off from within the larger sample, away from all exposed edges, with a sterilized knife. Care was taken not to contaminate samples by contact with other organs or with oils or other compounds. Each smaller sample was foil wrapped, placed in a zip-lock bag, and all samples from the same animal placed in one larger bag, and frozen.

1980-81 fall and winter walrus harvest estimates were attained by interviewing hunters and relying on their memory of their walrus taken. Eleven out of 39 boat captains were interviewed.

Data Analysis

Sunk and lost data were anlayzed to determine a minimum and maximum percent sunk and lost rate. Minimum percent sunk and lost was calculated by averaging the known sunk and lost data from 16 May to 2 June from all animals taken during that period. This period was used as a sample period because hunters were asked more consistently than at other times whether or not they lost animals. Minimum percent lost was calculated for males, females and calves by substrate (ice, water, or unknown). These percentages were then applied to harvest data from the rest of the season (besides those animals with known sunk and lost data), to estimate total numbers of animals lost. The estimated number of lost animals was then added to the known harvest totals to produce an estimated minimum harvest total.

Maximum percent sunk and lost was calculated by totaling all known sunk and lost data including data from those captains that reported seeing no animals, seeing only the animals they retrieved, not being able to reach the animals they saw because of ice conditions, those that reported sinking no animals, and those that reported the number of animals they did lose. Maximum percent lost was determined for males, females, and calves, by substrate (ice, water, or unknown). These percentages were then applied to the harvest in which sunk and lost data was unknown to determine an estimated maximum harvest total.

Vulnerability or retrieved take correlated to sex compositon and herd size was determined by analyzing percent animals retrieved from herds consisting of all males, all females, all females and young, and mixed herds (males, females, and sub-adults) by herd size. For males, herd sizes consisted of 1, 2, 3, 4, 5, 6-10, 11-15, 16-20, 21-30, 51-100, and 100. For females, herd sizes

consisted of 1 lone female, 2 (1 female and 1 calf), 2 (both females), 3 (all females), 4 (2 females, 2 calves), 5 (all females), 11-15 (3 calves included), and 21-30 (1 calf included). Mixed herds also included some groups with calves. This sub-dividing of herd size categories by calf presence was done so that the percent retrieved take could be compared by the total number of adults present versus groups with calves. Percent retrieved was determined for adults, calves, and total animals in the herd along with corresponding percent escaped or lost. Average number of killed animals to average herd size for each category was also determined.

Weather factors affecting hunting were analyzed by tallying total days with fog, rain, snow, versus favorable weather (clear or overcast) by their effect on hunting (favorable - no effect, slight weather - no effect, unfavorable - hunters returned due to weather, extreme - weather prevented hunting, and favorable weather - but no hunting due to other factors). Effect on hunting categories were further subdivided into successful (at least 1 walrus retrieved) and unsuccessful (zero walrus retrieved) categories. Sums were calculated for total weather days (measured in full days or partial days if shared by another weather type). Percentages were calculated for each weather extremity (slight, unfavorabel and extreme) within each weather type (fog, rain and snow), for total days each weather type occurred during the total observed days, and for the total number of unfavorable weather days compared to favorable weather days out of the total observed days.

Wind velocity and direction were subjectively estimated each day during the field season at Gambell. Total number of days were tallied by estimated velocity (unknown, 0-5, 6-10, 11-15, 16-20, and 20 mph) within directions (unknown, calm, SW, W, NW, N, NE, E, and SE). If two conditions (different

velocities and directions) occurred during the same day they were each given 1/2 day totals. Percentages were calculated for each wind velocity and direction and for total days by direction. Total days by velocity were also tallied and percent of total days at velocities calculated.

The effect of estimated wind speed on hunting was analyzed by tallying the number of full or partial days of wind velocities (unknown, 0-5, 6-10, 11-15, 16-20, and 20 mph) within hunting categores (favorable - hunting successful; unfavorable - hunters returned due to wind; extreme - too windy to hunt; and unsuccessful or no hunting - due to other factors). Percentages were calculated for each velocity correlated to hunting conditions out of the total observed days, for each velocity within each hunting category, and for total days each hunting condition occurred out of the total observed days.

Ice conditions were subjectively described for each day during the field season and later compared with chronological satellite photoprints of ice conditions supplied by the National Oceanic and Atmospheric Administration.

Ice conditions affecting hunting were anlyzed by tallying total days with unknown, favorable, slightly consolidated, dangerously consolidated, extremely consolidated, ice far offshore, and no ice conditons by their effect on hunting (successful, unsuccessful, no hunting, or unsuccessful/no hunting due to other factors). Percentages were calculated for hunting effect by ice type, and for occurrence of each ice type out of the total 45 observed days.

The relative effect of weather, wind velocity, and ice conditions on hunting were summarized by tallying the total days with successful, unsuccessful, or no hunting by the condition(s) causing those effects (unknown, favorable

wind/weather/ice, unfavorable ice, dangerous ice, no ice, unfavorable fog/rain/snow, extreme weather, unfavorable wind velocity, extreme wind velocity, no game, and other). Percentages were calculated for the affecting factor by hunting effect type (successful, unsuccessful, or no hunting), each hunting effect out of the total (45) observation days, and for successful days versus unsuccessful/no hunting days out of the total observed days.

Hunter reported grouping data of harvested herds was used to analyze sex and age composition of retrieved take by direction, and sex and age composition of harvested herds within directions. Herds were classified as all males, all females and young, and mixed (males, females, and subadults). Directions included N, NE, E, SE, S, SW, W, NW, and unknown. Percentages were calculated for number of total herds, number of total animals, total male herds, female/young herds, total female/young animals, total mixed herds, and total mixed animals within directions.

Walrus parts utilization data was collected during 12 of the 25 hunting days (from 24 April through 2 May and from 16 May through 27 May). Data was only used if all meat parts kept by the hunters could be seen and counted. Applicable data was available from 102 out of 136 (75.0%) of the total successful hunting occurrences. The sample harvest was made up of 240 males, 178 females, and 132 calves with an overall total of 550 (57.2% o the retrieved harvest).

Total number of walrus parts used from the sample harvest were tallied over the sample data days. Two types of percentages were then calculated. Percent utilization of parts based on preference was determined by what parts are actually used based on sex of the animal and characteristic number of parts

used for certain cases. Both male and female walruses are utilized for briskets, hearts, intestines, and vibrissae. Generally just males are utilized for kidneys, livers, and stomach contents. Females are utilized for mammary glands, hides for boats, and usually ribs. A maximum of 2 pieces of flank meat and 4 pieces of mungoona (skin/blubber) are generally utilized per animal from both males and females.

Percent utilization of parts based on total animals available was calculated without regard to preference and based on the assumption that all adult walruses are potential sources of food or other parts if they possess that part (obviously male walruses did not have mammary glands, etc.).

Number of animals harvested with some meat retrieved versus those with just ivory being utilized was also estimated. Sample days were the same as for the walrus parts utilization analysis. Low and high figures of animals with only ivory utilized versus animals with some parts utilized were determined by counting the total parts utilized by type and estimating the minimum and maximum number of animals of the retrieved take that parts could have originated from. Percent ranges were calculated for the low and high figures for both categories. An average figure and a corresponding average percent were determined for number of adults with just ivory being utilized and number of adults with some walrus parts being utilized.

For the total average animals with some parts being utilized (188), percent utilizaiton based on total parts available (without regard to preference) was also calculated. These figures were compared to percent total utilization overall, from the preceding walrus parts utilization analysis.

Walrus migration was analyzed by correlating the chronological spring break up of the ice pack with the daily harvest totals. General observations were compared to findings in the literature.

To analyze herd composition by direction, number of herds and total number of animals per herd, were tallied by direction (N, NE, E, SE, S, SW, W, and NW) in which animals had been harvested. Herds were classified as males, females and young, and mixed (male, females, and young). Percentages of herds and total animals by sex were calculated within directions.

The period of calving was estiamted by computing the percentage of fetuses to born calves per hunting day.

Skin and blubber thicknesses were tallied, a range of low and high measurements determined, and an average thickness calculated for both male and female walruses.

Tusk length in cm and tusk shape were tallied, range of low and high tusk measurements determined, and an average tusk length and shape calculated for both male and female walruses.

RESULTS

Harvest and Hunting Data

1980-81 Fall and Winter Walrus Harvest

Twenty eight percent (11 out of 39) of the total boat captains were interviewed concerning their 1980-81 fall and winter walrus harvest. Only 5

of 11 stated how many walrus they harvested. Table 1 shows the number of walrus taken by hunter by season and corresponding comments.

1981 Spring Walrus Harvest

Known walrus harvest and sex composition of the harvest is shown in Table 2. Daily retrieved harvest is presented in Graph 1 - 1981 Spring Daily Retrieved Walrus Harvest, Table 3 - Minimum and Maximum Percent Lost, Table 4 - Estimated Minimum and Maximum Harvest, and Table 5 - Total Estimated Harvest extrapolates sunk and lost data to estimate total possible harvest.

Hunter Data

Table 6 - Known 1981 Spring Walrus Harvest by Boat Crew shows hunting success as it relates to individaul boat crews. A summary of hunter data is presented in Table 7 - Hunter Data.

Vulnerability

The number of retrieved animals and percent retrieved correlated to herd size is shown in Table 8 - Vulnerability: Proportion of Retrieved Animals to Herd Size.

Factors Affecting the Hunt

Weather and Wind Factors

Correlation of hunting success to weather type and extremity is shown in Table 9 - Effect of Weather on Hunting. Table 10 - Wind Velocity and Direction, presents the number of days and percent of total days exhibiting wind directions at different velocities. Table 11 - Effect of Wind velocity on Hunting, correlates wind speed to hunting occurrence and hunting success

Ice Factors

Table 12 - Beaching/Landing Access gives the number of days and the percentage of total observed days that the north beach, west beach or both beaches were open and the number of days with no access or unknown access.

A chronological record of ice movements for the field season and the correlation of accessible hunting directions to ice conditons is given in Table 13 - Correlation of Hunting Directions and Harvest to Ice Movements.

The effect of various types of ice on hunting success is presented in Table 14 - Effect of Ice Type on Hunting.

Comparison of Factors Affecting the Hunt

An overall comparison of factors affecting hunting is given in Table 15 - Summary of Factors Affecting the Success of the Hunt.

Walrus Parts Utilization

Sample data of number of walrus parts utilized and percent of total available based on preference or upon total possible is shown in Table 16 - 1981 Gambell Walrus Parts Utilization.

affecting the overall harvest total (missed crews, incomplete data for 21 April, possible missed data during 9 May through 15 May, and incomplete sunk and lost data) could only add to the total harvest.

Minimum percent lost and maximum percent lost (Table 3) were calculated to extrapolate known sunk and lost data to harvest with unknown sunk and lost (Table 4) in order to determine a minimum and maximum estimate harvest (Table 5).

The minimum percent lost figures (Table 3) are low estimates because they are based on the assumption that all hunters from 16 May through 2 June stated how many animals they lost when in actuality an unknown number of hunters did not. Those who made no mention of losing animals were assumed to have lost no animals. Since some of these hunters probably lost animals the average number is low.

The maximum percent lost estimates could either be high or low. These numbers are based on data in which sunk and lost figures were known, but fail to include an unknown number of hunters that didn't lose any animals. If all known sunk data are true figures and were not underestimated by the hunters then the maximum percent lost is high since data in which no animals were lost wasn't averaged in. If, however, hunters underestimated the number of lost animals and if the actual number lost was far above the number reported then the maximum percent lost estimates are low. These figures could also be close to the actual percent lost if all the above factors balance each other out.

Males and females show similar minimum and maximum percent lost figures which were many times higher than the overall calf loss rate (Table 3). This is due

to the larger size of the adult animals which are harder to handle by the hunters, especially if shot in the water. Adults shot on the ice were also lost by falling hard when hit, breaking through the ice; or if wounded, may escape in the water to die and sink later. A hunter related that people who lost walrus in the water are afraid to get in close and harpoon the animal. Many hunters voiced reluctance to approach walrus in the water for fear of being attacked. Younger males were especially aggressive. Calves on the other hand are small and relatively light and offer little, if any, threat to safety. Percentages for calves do not include fetuses since fetuses are only lost if the mother sinks.

A higher percentage of animals (males, females, and calves alike) were lost in the water than on the ice (Table 3). As was previously stated this was probably due to difficulty of handling animals shot in the water, reluctance of hunters in approaching walrus shot in the water, and the occasions of walrus falling into the water after they'd been shot and killed on the ice. Walrus sink rapidly when killed, retrieval being higher for wounded animals.

A higher percentage of males were lost in the water compared to females. This was probably due to the higher fear of males attacking boats while in the water than females, and also to the larger bulk and therefore difficulty in handling males.

The spring retrieved harvest climaxed during the 2nd and 3rd week of May (Graph 1). The four most successful hunting days occurred on 12 May, 16 May, 20 May, and 23 May with totals of 137, 161, 151, and 150 animals harvested respectively.

Sex Composition of the Harvest

Percent sex composition of the known harvest is shown in Table 2. Percent figures are very similar for both males and females (retreived, sunk and lost animals). This similarity could either be representative of the sex composition of the walrus population, could have been brought about by selection by hunters for a particular sex, or could have been affected by the available hunting directions and therefore predominate sex available.

The sex ratio for walrus at birth is 1:1 but may be disproportionate for animals of breeding age as much as 1 male per 3 females (Fay and Ray, 1979). It is therefore possible that hunters were selecting male walruses over female walruses in order to harvest the two sexes about equally when females predominate in the population.

This selection could have taken place due to a number of factors. Hunters could have selected males for some physical characteristic such as larger tusks, preference for male livers for food, etc. Females, however, are also selected for their fine grain tusks, their hides for boats, and ribs, mammary glands, and fetuses for eating. It appers then that selection would be approximately equal due to these factors.

Another factor could have been that the teeth sampling quota used (Table 22) biased the sex composition of the harvest. Walrus teeth were bought for alternate sexes and limited to 5 pairs per crew per day throughout the season in an effort to spread the 200 pair sample limit over the entire spring harvest. Harvest data was unbiased when no quota existed during the periods 26 April, from 8 May through 15 May and from 17 May through 22 May (Table 22).

Ice conditions determined the direction of the hunt from 27 April through 5 May (Table 22), and therefore had a greater effect on the sex of animal harvested than the teeth quota during that time. A higher percentage of herds made up of females, subadults, and calves are found to the NW, W, and SW than male herds unless hunters approach the Gulf of Anadyr where a large number of male herds predominate (Table 17). More males than females (both in number of animals and number of herds) are found to the NE and E (towards Savoonga) especially early in the hunting season (Table 17). The sex ratio of the harvest during each day of this period was consistent with the direction of the hunt for that particular day and therefore doesn't appear to have been affected by the teeth buying schedule.

A teeth quota consisting of both males and females was established on 16 May, and from 23 May through 2 June. Roughly the same number of pairs of teeth were needed from both males and females on 16 May. Therefore, there was no effect on the harvest of males versus females on that day.

By 23 May a greater number of male teeth were needed than female pairs (25 and 5 pairs respectively since there was an overall limit of 100 pairs of male teeth and 100 pairs of female teeth). The ice had moved offshore quite a distance by 23 May, thereby offering unlimited hunting directions for the remainder of the season. It is possible that the number of male teeth needed could have affected the selection for males on 23 May and 25 May through 27 May. These days had a high harvest ratio of males to females (Table 22). The high ratio of males to females taken to the NE and E were consistent with the prevailent sex composition found in those directions. The ratio of males to females taken to the N and NW was high. Some of these males were taken close

to the Gulf of Anadyr where a high preportion of males reside. It is possible, however, that males were being selected over females in all directions. The direction the number chose to hunt could have also been affected by the higher number of male teeth needed over females to fulfill the quota.

On 2 June, 3 male walruses were taken incidentally to bird hunting and therefore weren't affected by the teeth buying schedule.

Upon analysis of this information it is apparent only 4 out of 26 hunting days could have been affected by the teeth sample quota and therefore had little effect on the sex ratio of the harvest. The nearly equal sex ratio of he harvest was probably a result of the available hunting directions during the season. As previously stated, a higher percentage of females and sub-adults are encountered to the N and NW and a higher percentage of males to the E and NE (Table 17). A higher percentage of males are also found to the N and NW close to the Siberian coast. The harvest of males versus females by direction also corresponds to this (Table 18). A higher number of males was harvested to the E and NE whereas a higher number of females was harvested to the SW and W. Males and females were taken about equally to the N and NW, although the predominate sex of these directions is female (Table 17). This can be explained by the incidence of hunting close to the Siberian coast where large numbers of males were encountered. The number of hunting occurrences by direction and the relative numbers of males to females taken by direction therefore balances out (20.5% of all males harvested were taken to the E and NE, 36.0% to the N and NW, the majority close to Siberia, and only 2.0% to the SE, etc.) (Table 18).

Hunter Data

Known walrus harvest by boat crew (Table 6) are reliable minimum harvest totals and percentages of the total harvest. Harvest totals were unknown for only 4 hunting occurrences of 3 crews (D.O., E.O., and G.O. twice). One boat captain (B.O.) may have been mistaken for another (G.O.) during 16 hunting days. The number of times B.O. hunted during this time was unknown. Boat landing, however, was limited to one area so an accurrate total harvest was attained for the sum of the two crews.

Vulnerability (Retrieved Take Correlated to Sex Composition and Herd Size)

Vulnerability is defined here as the retrieved walrus harvest correlated to sex composition and size of herds. Males in herds of 1 and 2 males are highly vulnerable (Table 8). Percent retrieval of male and therefore vulnerability drops to 61% for herds of 3 males, to 50% for herds of 4 males, and keeps dropping as herd size increases, to a low of 15% retrieval for herds of 21-30 males. The one sample size for herds of 51-100 males and per herds of greater than 100 males are too small to be representative.

Females are also highly vulnerable in herd sizes of 1, for herds of 1 female and 1 calf, and for herds of 2 females. It is interesting to note that herds made up of 2 females have the same vulnerability as 1 female accompanied by a calf. One would think that a female in the company of a calf would be more vulnerable than 2 adult females due to the ease of harpooning the calf. When vulnerability is calculated based on total number of animals in each herd rather than adult females then herds of 2 (1 female and 1 calf) are shown to

be more vulnerable (94% retrieved) than herds of 2 females (90% retrieved). Vulnerability drops to 78% retrieved for herds of 2 females and 2 calves. Sample sizes for herds of 3, 5, 11-13, and 21-30 animals are too small to be representative.

Mixed herds also show the same trend of high vulnerability for smaller herds but sample sizes are rather small to offer much comparison.

Males appear to be less vulnerable than females for the same herd sizes based on number of adults. Vulnerability also decreased faster with increasing herd size for males than females.

Calf vulnerability remains high throughout all herd sizes.

Weather, Wind, Ice, and Other Factors Affecting the Hunt

The major factors affecting the spring walrus hunt were the weather, wind velocity, and ice conditions. These parameters dictated whether or not hunting took place and to a large extent determied the success of the hunt.

Weather

Of the typical weather types experience at Gambell, favorable weather (clear, partly cloudy, or overcast) was observed during the majority of the 45 days (Table 9). Of these 25 days a combined 32% were successful hunting days. Twelve percent of the 25 days proved to be unsuccessful. A high percentage (56%) was unsuccessful due to other factors. Five of the clear days had wind

velocities too extreme to hunt (20%). Eight of the overcast days also had extreme wind velocities and one day no hunting occurred due to dangerous ice conditions (a combined total of 36%).

Fog, rain, and snow were observed for 33.3% of the total days (Table 9). Fog occurred most often (15.6% of the total 45 days) followed by rain (13.3%) and then snow (4.4%).

Fog is common at St. Lawrence Island in the spring. Heavy fog obscures visibility making it hard to locate walrus. Out of the 7 days experiencing fog the largest percentage (35.7%) only reduced visibility slightly and did not deter hunting (Table 9). The total 2.5 days actually represent 4 days in which fog occurred. Three of these days were given half day values because they were shared by snow (2 half days) and rain (1 half day) which added to reduce visibility but whose partial effects on hunting are totalled in the respective snow and rain columns.

Two days of fog reduced visibility enough to cause hunters to return to Gambell (one was a successful hunting day and the other was not). Fog extremely reduced visibilty and deterred hunting during 2 days. Hunters were able, however, to hunt in the afternoon when the fog dissipated. Although visibility had improved the second day extreme wind velocity made hunters return. No hunting occurred during one day with fog at the end of the hunting season since the ice had already dissappeared.

Of the 7 days with fog 64.3% were successful hunting days, 21.4% were unsuccessful, and 14.3% were unsuccessful due to factors other than fog (i.e., no ice remained).

Rain reduces visibility, hurting people's eyes as they travel in their boats. It rained for 6 days out of the 45 observed days (Table 9). Twenty five percent of these days had slight rain and were successful hunting days. The total 1.5 days actually represent 2 days in which rain occurred, but one of the days was shared with fog so was given one half day value. One day with rain deterred hunting but for only part of the day. Of the 6 days with rain 41.7% were successful hunting days while 58.3% were unsuccessful due to extreme wind velocity.

Snow also obscures visibility. It snowed for two days out of the observed 45 days. Twenty five percent were slight but didn't deter hunting, and 25% caused hunters to return. Of the 2 days, 50% were successful hunting days and 50% were unsuccessful due to other factors (extreme wind velocity, and fog).

Wind Velocity

Wind velocity is one of the most important factors affecting hunting. The degree that wind makes the water choppy and rough is dependent on the ice conditions. Broken up ice tends to shelter the water reducing the effect of the wind, whereas areas of open water tend to be rougher. As the ice pack breaks up, dissipates, and eventually dissappears winds of lesser velocities produce the same effect that only a very strong wind could create when ice was present.

Of the total 45 observed days 51.1% had unfavorable (causing hunters to return) or extreme (deterred hunting) winds (Table 11). Favorable hunting wind speeds occurred for 35.6% of the time. Only 13.3% of the unsuccessful or nonhunting days could be attributed to other factors.

Of the 23 days with unfavorable or extreme winds 40% completely deterred hunting (Table 11). Of these 18 days wind velocities ranged from 11-15 mph to greater than 20 mph with the majority (44.4%) being in the 16-20 mph range. The pack ice had already left the area during 5 of the days and 1 day also had dangerous broken shore ice conditions. During 3 of the days with 11-15 mph winds the ice was far offshore or gone altogether, and 2 days had dangerous ice conditions.

Four of the 23 days (8.9%) had unfavorable winds that caused hunters to return but were still successful hunting days, whereas 1 day (2.2%) out of the 23 days was not successful (Table 11). A majoriy (50.0%) of the unfavorable yet successful days had winds of 11-15 mph. The ice was far offshore during one of these days. Days with unfavorable wind that were successful hunting days probably either started with low wind speeds and later increased or the wind speed became more critical out in hunting areas with open water. Only one of the unfavorable wind days proved to be unproductive.

Days with favorable wind velocities and successful hunting made up 35.6% of the total 45 days (Table 11). Wind velocities ranged from calm to 11-15 mph, with the majority being in the 0-5 mph wind speed range.

Only 13.3% of the total 45 days were unsuccessful or hunting was deterred due to other factors. Disruptive factors included whaling (helping Savoonga residents butcher their bowhead whale during 1 day), dissipation of weather regimes and fog.

It is apparent (Table 11) that wind does not deter hunting at velocities of calm to 5 mph, but can cause hunters to return due to rough water at 6-10 mph

but more often at 11-15 mph and greater. Hunting at these unfavorable wind velocities may still be successful, however. Often wind velocities increase after hunters have already left Gambell or become more critical in areas of open water depending on the ice conditions. Wind velocities of 11-15 mph but more often 16-20 mph and greater usually deter hunting entirely. During 3 of the 5 days with 11-15 mph winds in which hunting was deterred, the pack ice was either far offshore or gone entirely. Two of the 5 days had dangerous ice conditions that coupled with the wind could trap or crush boats. All days in which factors other than wind velocity (whaling, no ice, dangerous ice conditions, poor ice, no game, or fog) created unsuccessful or no hunting conditions had calm to 11-15 mph wind speeds, with the majority being 0-5 mph. This implies that wind is an important determinant of hunting occurrence and success.

Ice

Ice conditions affect hunting by determining whether crews are able to launch or beach their boats, what hunting directions are available, and accessibility to walrus.

Gambell's launching and beaching accessibility are among the best anywehre on St. Lawrence Island. The geographical orientation and ocean currents around Northwest Cape serve to keep at least one beach (north or west) open most of the time (Fig.). Gambell has far better accessibility compared to Savonnga which is ice locked by north winds and opens up only with southerly winds.

At no time during the 45 observed days were both north and west beaches inaccessible due to ice conditions (Table 12). During 57.8% of the observed days both beaches were open. The north or west beaches were solely open about the same amount of time (17.8% and 11.1% respectively). Beach accessibility was unknown for 15.6% of the observed days. When one or the other beach was closed, hunters simply towed their boats by snow machines to the accessible beach and launched from there.

Wind direction and current are the factors determining whether beach or whether either beach is closed off by ice. Both beaches remained open during generally light winds (10 mph SW winds for the first day, but the west beach closed by the second day, 5-10 mph NE; N and NW winds; 1-4 mph W winds; and 15 mph E winds) when the pack ice was close to shore, or later during higher velocities (5-25 mph) of all directions when the ice pack moved far offshore.

North and NE winds of 5 mph or greater piled ice up against the north beach when the ice pack was close offshore. It usually took a few days of steady north wind if the ice pack was any distance offshore before the north beach was inaccessible. The spring northerly current of 7 knots helped to counteract the effect of the wind and after the wind abated would act to move the ice out again. The spring diurnal tide also moved ice in or out to a certain degree. The flood sets northwestward and the ebb sets eastward during the navigable months of the year (U.S. Coast Pilot, 1964).

The west beach remained open during N, NE, E, and SE winds but was clogged with ice by W, NW, and SW winds of 5 to 25 mph winds if the ice pack was near shore or if the wind blew for a few days when the ice was far offshore. The spring current and tide changes usually helped to move the ice out of the area.

Ice conditions determined what hunting directions were accessible. A chronological record of ice movements for the field season and the correlation of accessible hunting directions to ice conditions is given in Table 13.

Spring walrus hunting started on 21 April. At least 17 hunters hunted on that day. Although a field biologist was not present until 22 April it is apparent from the satellite ice photos (Table 13, photo) that the north shore of St. Lawrence Island was completely blocked by largely compacted ice but that hunting could have occurred to the NW, W, andSW.

On 22 April the ice pack to the west of Gambell started moving toward the east (photo). No hunting occurred during that day even though conditions were favorable. Gambell hunters were assisting Savoonga hunters in butchering their second bowhead whale.

By 23 April a definite eastward movement of the ice pack was evident (photo). This probably occurred due to the absence of a strong N or NW wind which allowed the predominantly northeasterly ocean current between St. Lawrence Island and the Siberian coast (Fig.) to carry the ice towards the northeast. Nine crews hunted in unknown directions on that day. Available hunting direction appear to have been from the SW to the NE with ice unfavorably compacted to the W.

Ice continued to move eastward on 24 April due to the absence of strong N-NW winds. Twenty-four crews hunted in unknown directions. Available directions were from the SW to th NE. Hunters reported that winds were from the W out on the water which compacted the ice together.

The combination of the northeasterly ocean current and the moderate NW winds on 25 April created dangerous ice conditions that deterred hunting.

SW winds dominated from 26 April through 2 May eventually closing off access to the W with compacted ice (by 28 April) but opening up the north side of St. Lawrence Island by pushing the ice further offshore. Crews hunted to W, NW, and NE on 26 April and to the W, NE, and E on 27 April but by 30 April through 2 May were limited to hunting to the E and NE. The SW wind had clearly pushed the ice pack far offshore to the north of the island on those days (photos through).

Although the wind direction changed to the N-NW on 3 May, the effect of the previous SW wind remained. Possible hunting diretions were to the N, NE, and E with ice still consolidated to the NW, W, and SW.

The effect of the N wind was apparent by 4 May having pushed the ice pack up against the N shore of the island but opening up access somewhat to the W and SW (photo).

On 5 May the wind changed directions to the W but access remained open to the S-SW.

The wind shifted to the SW on 6 May and by 7 May the ice pack appeared to be compacting in against the W shore (photo). Access was virtually closed off to the NE, N, NW, and W with access remaining open to the SW.

Although on 8 May the ice pack surrounded the whole W end of the island up to the SW, W, and N shores, the ice pack appears in photo to be largely broken up and dispersed allowing hunting in all directions. A more compacted band of ice existed to the W, arching to the N.

N-NE winds predominated from 9 May through 5 June with 1 occurrence of SE wind (22 May) and 1 occurrence of SW wind (25 May). The dispersed nature of the ice pack during this period, up until the ice completely disappeared, no longer deterred hunting in any direction. Although the ice pack was dispersed, hunting directions were chosen by the different crews on the basis of what directions had good ice and might therefore produce walrus. Due to the dispersed nature of the ice, wind velocity deterred hunting more than ice conditions.

The N-NE winds pushed the ice pack that existed to the north and south of St. Lawrence Island towards the south and southeast. This had the effect of extending period of access to ice to the north by keeping it close to St. Lawrence Island but pushed the ice to the south further offshore. This trend was especially apparent from 9 May through 18 May (photos through). By 18 May the whole N side of the island was compacted with ice.

Satellite photos were unreadable from 19 May through 22 May. By 23 May most of the pack ice had either been carried north by the current or had melted. One area of compacted pack ice was visible (photos through) north of St. Lawrence Island from 23 May through 28 May but was gone by 30 May. The waters surrounding St. Lawrence Island were thereafter ice free save for the remaining shorefast ice on the north side. Hunting ended by 28 May with one incidental harvest occurring on 2 June.

The type of ice may also affect hunting by encouraging or discouraging access to walrus, creating dangerous boating conditions, and determining walrus presence.

In the early part of the season as the ice around the island breaks up the ice pack is usually compacted together making it difficult for a boat to maneuver amongst the flows. Often the walrus are to the inside of the pack where they can't be reached. Hunters complained of poor hunting due to consolidated ice conditions between 23 Apjril and 7 May. From the satellite ice photographs (Table 13, photos through) it is apparent that a lot of open water existed to the W of Gambell on 21 April but that ice started to move in from the W on 22 April. From 23 April to 7 May the ice to the W and N of Gambell was pretty consolidated.

West, NW, and N winds also have the tendency to consolidate the ice against the northeasterly ocean current. On 25 May hunters complained of consolidated ice conditions due to the N wind.

Slightly compacted conditions where hunting was possible, although poor to mediocre, occurred during 28.9% of the 45 observed days (Table 14). Of these 13 days 53.8% were successful hunting days. Only 1 day (7.7%) was unsuccessful. A little less than half (38.5%) were unsuccessful for other reasons (3 had unfavorable wind, 1 no game was sighted, and 1 hunters returned due to fog).

Dangerous boating conditions result when the ice is close together and wind and current cause the flows to butt up against each other. A boat could

easily be crushed or its route back to land cut off. A NW wind and the northeasterly ocean current can work together to cause such a situation just off the northwest corner of Northwest Cape (Fig.). North, NE, W, and SW winds can all create dangerous boating conditions if ice is close to shore by closing off access back to land with ice. East and SE winds however, push the ice offshore and open up the distance between flows.

There were 4 hunting days where hunters commented on the dangerous ice conditions. Seven additional days had compacted ice conditions and were potentially dangerous. Only one day was considered too dangerous to attempt to hunt and hunters returned early on one day due to dangerous ice conditions, a combined total of 6.6% of the 45 observed days (Table 14). Although conditions were considered favorable on 8 May, 1 crew was trapped in the ice. They were able to return to Gambell the next day. Although dangerous, not many people get caught in the ice because they watch conditions constantly and know when to come back.

Favorable conditions occur when the ice pack degrades and disperses to allow boats free passage in amongst the flows and yet remains close to shore. A few favorable days occurred early in the season (22 and 24 April) probably due to favorable wind conditions that dispersed the ice. The ice pack only really started to spread out from 8 May on (Table 13, photos through).

Favorable ice conditions occurred during 20.0% of the total 45 observed day (Table 14). Of the 9 days 55.6% were successful hunting days and 44.4% were unsuccessful or no hunting occurred due to other factors (1 day hunters were at southwest Cape butchering Savoonga's second bowhead whale, and 3 days had unfavorable wind).

As the ice pack further degrades and more open water occurs between flows the wind has more effect on the open water making it rough. The added space between flows also allows the wind to have a greater effect on pushing the pack ice further offshore. Once offshore it takes stronger northerly winds of longer duration to counteract the northeasterly ocean current and push the ice pack up against the island.

On 11 May the ice pack moved offshore to the west and north (photos through). A change in wind direction on 16 May to the NE brought the pack ice closer to shore until 22 May when a SE wind blew the pack ice far offshore until the pack ice left the area by 30 May (photos through).

During 24.4% of the 45 total observed days the ice pack was far offshore. Of these 11 days 54.5% offered successful hunting and 45.5% were unsuccessful or no hunting occurred due to unfavorable winds.

The spring hunt ends when the walrus follow the retreating pack ice north and the distance across open water to any remaining ice is too far and dangerous to travel. The pack ice left the area by 30 May (photo). Of the observed 45 days 15.6% had no ice (Table 14). No hunting occurred during 6 of these 7 days (85.7%). One hunter incidentally harvested 3 walruses while bird hunting on one day out of the 7.

Other minor factors affecting the spring hunt include competition with Savoonga hunters and killer whales scaring away game. When ice to the north of St. Lawrence Island breaks up, Savoonga hunters are able to hunt. This year Savoonga had an earlier season. There were some comments and grumbling from Gambell hunters about competition with Savoonga for available walrus in

that direction. Hunters complained about competition on 30 April and 25 May. Hunters stated that Savoonga hunters either got the available walrus first and/or scared them off by their hunting efforts. Competition probably also occurred on 26 May and other days where hunting occurred to the northeast and east.

Hunters reported that when killer whales are in the area they scare the walrus and other game up on to the ice. The walrus flee close to shore. This makes it easier to hunt walrus if close to St. Lawrence Island or more difficult if they flee towards Siberia. Hunters commented on killer whales being in the area on 19, 20, and 26 May. One hunter reported seeing a pod of killer whales attacking a gray whale on 24 May.

Comparison of Factors Affecting the Hunt

No hunting occurred or hunting was unsuccessful during 55.6% of the total 45 observed days. Hunting was successful during 44.4% of the observed days (Table 15). Of the 25 unsuccessful/nonhunting days, no hunting occurred during the majority (21 days).

The biggest factor deterring hunting during the 21 days was the incidence of extreme wind velocity (69.0%). Six days (each given 1/2 day value) of extreme wind velocities were shared with the incidence of no ice. One day (given 1/2 day value) was combined with dangerous ice conditions that together with the wind could trap boats.

Incidence of no ice was the second largest factor deterring hunting (19.0%) followed by dangerous ice conditions (7.1%). Only one day with favorable conditions occurred in which no hunting took place (Gambell hunters were assisting in butchering Savoonga's second bowhead whale).

Of the 4 unsuccessful hunting days the largest percentage (37.5%) were due to no game being sighted. This was especially apparent during the early part of the season when compacted ice conditions discouraged access to walrus and before the height of the migration had occurred.

Unfavorable weather (fog, snow, and rain) and unfavorable wind velocities were equal (25.0%) in their effect on deterring hunting success. Unfavorable ice conditions combined with lack of game were responsible for 12.5% of the unsuccessful hunts.

Hunting was successful during 44.4% of the total 45 observed days (Table 14). Of the 20 successful hunting days the largest percentage (40.0%) had favorable wind, weather, and ice conditions. Two of these days (each given 1/2 day value) were shared with conditions where the ice was far offshore. Hunting was successful even with unfavorable ice conditions during 20.0% of the 20 days (one day had dangerous ice conditions, 1 day had consolidated ice, 1 day was shared with poor visibilty due to weather, and 3, 1/2 days, the ice was far offshore and were shared with 1 day of unfavorable wind and 2 days of favorable conditions). The same percentage of successful hunting days occurred despite unfavorable weather and wind (17.5%). Only 1 successful hunting day occurred when no ice was present.

Walrus Parts Utilizationa

There are two ways percent utilization can be analyzed. Total possible percent utilization is based on the premise that all walruses (regardless of sex and age) are available as sources for the particular item. An example would be to consider all livers as potential food from all walruses. In the case of items like mammary glands, it is obvious that this item is only available from females.

Another way of analyzing percent utilization is based on preference. Preference affects what is actually "available" by determining what is actually used. For example, theoretically all walrus hides are available for use for boats but only female hides are actually used. Male hides are too thick and often too scarred to be adequate. Ribs are best from females, livers from older bulls, and the list goes on. Condition of the animal also determines if the meat is useable. Meat from diseased animals is not used, whereas fatter animals are preferred sources of food.

Table 16 presents two sets of percent utilization data, preference percent, and total possible percent. Both percentages are the same when parts are utilized for both males and females.

Briskets were utilized from 10.3% of the total sample retrieved male and female walruses. Briskets from older and fatter bulls are best but people use briskets from both males and females.

One hundred percent of the retrieved calves were utilized. Aged and then dried calves are a delicacy and in high demand. Each family tries to acquire

and prepare enough walrus calves for their own use plus enough to share. Relatives from Savoonga and the mainland put in requests and some are also traded or donated to people who don't have hunters in the family.

Utilization of flank meat was hard to estimate. Pieces came in different sizes and were easily confused with mukluk (bearded seal) meat. Front flack meat by the neck is best from older males and females. A maximum of 2 pieces were brought in per animal. If 2 peices are considered to be the maximum available then percent utilization was 1.1%. Actual percent utilization is much lower if the total possible flank meat per walrus is considered.

Since there are 4 flippers per animal and all are possible food 3.8% were utilized from the total sample. Although flippers from both sexes are used the more tender flippers from females of all ages are preferred.

Hearts are available from all walruses except one year olds which are too small to bother with. Hearts were utilized from 20.3% of the total sample walruses. Generally the heart from older bulls are considered to be the best.

Intestines are also available from both males and females, although males are thought to be best. Intestine utilization was 4.1% of the total available walruses.

Kidneys are generally taken from males only and since there are two available per animal the preference percent utilization was 2.9%. The total possible percent utilizaton was 1.7% (for both males and females).

People prefer livers from old bulls. If they tear when poked they are very tender. Female livers are rarely used. Percent utilization of male livers was 24.2%. If both male and female livers are considered available then the percent utilization was 13.9%.

Mammary glands known to the Eskimos as "milk" were utilized 6.7% of the available 4 glands per female. This is based on the total female sample harvest. It appears that only lactating females are used which would increase the percent utilization based on number of available lactating females.

Mungoona (skin with subcutaneous fat attached) is utilized from all animals regardless of age or sex. The maximum number counted from one animal was four pieces. If 4 pieces are available per animal then the percent utilization was 4.8% of the amount available. If the whole body covering of skin and fat is considered to be available then the corresponding percent utilization would be lower. Mungoona from any part of the walrus is good but it is best right over the sternum area with the sternum meat attached. Older males are better because their mungoona is thicker but females are good too.

Ribs from females are the most tender but if a male has ribs with a lot of meat they are also good. Of the total walrus ribs from both male and females, 1.7% were used. If ribs from females are considered to be the only ones available then the percent utilization was 3.9%.

Only female skins are used for skin boats. The percent utilization is therefore 6.7% of the available female skins. Percent utilization of both males and females skins is 2.9%.

Hunters stated that females rarely feed during the spring migration and that males are therefore the available source for stomcah clams which when fresh are considered a delicacy. If available, stomcah contents of clams are usually brought home. Actual percent utilization would be close to 100% of the actual available. If all males are considered available the 7.9% of their stomachs produced useable clams, or that amount was used. Stomachs were used from 4.5% of both male and female animals.

Vibrissae and the walrus face pads may be only used for craft items and/or toothpicks. It is unknown whether people eat the face pads. For whatever purpose 0.7% of male and female face pads were utilized.

Table 16 also shows the estimated number of adults harvested, (the same sample animals used for the parts utilization analysis) with just ivory utilized versus those with some parts being utilized (meat, etc.). High and low figures are used because it was difficult to determine how many animals were represented by at least one body part. The average number and average percent gives the best estimation of the number of animals and percentage of animals being utilized solely for ivory. Percent utilization of walrus parts is also presented for the average estimated animals returning with some part utilization taking place. These figures offer an interesting comparison to the overall sample utilization data.

Biological Data

Spring Walrus Migration

The spring walrus migration is dependent on the chronology of the spring break up of the Bering Sea ice pack.

By mid-to-late April there is a reduction in ice deformation pressure and more frequent occurrence of leads and polynyas in the Bering Sea ice pack (Burns, Shapiro, and Fay; 1977). As the pack ice loosens, walruses wintering around St. Lawrence Is. start moving westward towards the Soveit Gulf of Anadyr and north toward Bering Strait (Kelley). Animals migrating from wintering areas in the Bristol Bay region further to the south begin appearing with increasing frequency in the eastern Gulf of Anadyr, Chirikov Basin, Bering Strait, and the area north of Nunivak Is. (Burns, et al; 1977).

From a satellite photograph of the ice pack on 15 April (Fig.) it is apparent that the ice pack around St. Lawrence Island was still pretty consolidated at that time. By 21 April (Table 13, photo) the ice was more degraded around the island but the pack ice within Bering Straits was still relatively solid.

On 23 April a hunter stated that the walrus being hunted at that time were still the winter walrus but that some on the south side of the island were moving north. The harvest remained relatively small during the last two weeks of April (Graph 1) partly due to the consolidated ice conditions and partly due to the early time frame of the migration.

By May the entire Bering Sea pack is rapidly degraded (Burns, et al; 1977). The ice melts in the same area it reached by the end of April during its winter southward movement (Burns, et al; 1977).

From 4 May thourgh 8 May (photos through) the pack ice to the west, north and within Bering Straits is visibly degraded. Harvest was still low during this time, however (Graph 1).

Calving

On 21 April all interviewed hunters reported bringing in only fetuses and that born calves were not yet available (Graph 2). It appears that calving started shortly after 21 April and by 24 April was well underway. The absence of data on 22 and 23 April and from 27 April through 7 May makes it unfeasible to determine when the height of calving occurred. By 8 May the majority (85%) had already calved. From then on the percentage of calves was 96-100% out of the total.

Biological Samples

Age composition of animals harvest is determined by what is preferred by the hunter for whatever reason (food, hides for skin boats, tusk size, etc.). There was some bias of teeth samples created, however, by hunters retaining the larger, older bull teeth for carving, while selling the smaller female and younger male teeth to the biologist. This bias was probably small since most hunters preferred the ready cash provided by the sample program over carving the teeth, and because the limit of 5 pairs of teeth purchased per crew per day allowed them plenty of extra teeth anyway.

Hunters were given tongue depressors on which they marked skin and blubber thickness measurements from harvested animals. There was a lot of variability inherent in this system. Hunters weren't as careful as perhaps a field biologist would have been in making sure the depressor hit the sternum bone and marking skin/blubber interface and outside surface of the skin lines accurately. A good deal of distortion was also possible from pressing the

stick up against the incision wall. Skin and blubber thickness measurements are therefore, crude measurements that should be used only a rough indicators of walrus health trends.

The range of skin thickness and average skin thickness are similar for males and females (Table 19). The range of blubber thickness measurements and average blubber thickness are higher for females than males. Correlation of skin and blubber thicknesses to sex and age classes will be determined later when age data from tooth sectioning is available.

Tusk lengths were measured by the field biologist and are accurate within 0.5 cm. The average length for males exceeded the average length for females by 8.1 cms (Table 20). Correlation of tusk length to sex and age classes will be determined later when age data from tooth sectioning is available.
Reliability of teeth samples matching the correct tusks was dependent upon the hunter. Gambell hunters were very careful about following sampling instructions. Most teeth were not only bagged and attached to a tusk but matched each other in shape and size. It was possible that a hunter could have broken both teeth from 1 animal and thrown in a couple of teeth from another animal to qualify for payment. More often the hunter tried to sell the two broken teeth rather than exchange them. Since the number of pairs bought was limited to 5 per boat, hunters often had a chance to obtain another pair of teeth and corresponding tusks for measurement. There was one case where the hunter sold a pair of teeth (GW-158) that he had to locate out of a can full of teeth, and had to rely on his memory to pick the correct ones out. For the most part hunters processed the teeth as they hunted thereby attaching the correct teeth to the correct tusk.

The predominant tusk shape for both males and females was a 5/10 with males also having 6/10 equally as often as the 5/10 (Table 21). Shape was subjectively analyzed by the field biologist and matched to the corresponding code for both degree of divergence or convergence, and curve as viewed laterally.

The level of existing contaminants in walrus issues will be available at a later date after analysis is complete. Three hunters cooperated in supplying 4 contaminant samples. All 4 samples were delivered after 11 hours had passed, and one was at least 18 hours old. This time factor and its effect on the break down of the contaminants in the walrus tissue samples will need to be considered upon analysis of the results.

Appendix I. Eskimo Observation on Walrus Biology

Walrus Population

Gambell residents have been observing a rise in the walrus population over the years. One hunter stated that 40 years ago they'd be lucky if they got 5 walrus in a day, but that now there are lots of walrus. Hunters also commented that there were more walrus this year than last. One hunter, however, remarked that 3-4 years ago there were a lot more walrus than now, so many that during the fall migration it looked like a city floating by.

Food and Health

Hunters stated that walrus were thin during the last 3 years but that this year they appeared to be fat and healthy. People found crabs, shrimp, and

needlefish in the walruses' stomachs during the lean years but this year found mostly clams. One hunter said that there was a very large siphoned clam bed out approximately 20 miles to the W-NW that the walruses utilize.

Abnormal/Sick Walrus

Hunters reported having seen:

1) A blind bull walrus with cataracts and small eyes, and a bent oosik (slight at the tip). This walrus wasn't a rogue walrus however.

2) Walrus with malformed tusks:

   a) A female with 2 seperate tusks on each side, not fused together (Fig.). The hunter couldn't remove the tusks after boiling. The same hunter had found another walrus of unknown sex with 4 tusks a few years earlier.

   b) A walrus of unknown sex with 1 deformed twisted tusk (Fig.).

   c) A female with 2 really curved tusks (Fig.).

Rogue Walrus

Hunters stated that rogue walrus haul out at Southwest Cape on the north side of St. Lawrence Is. between Savoonga and Gambell, and on the Punuk Islands.

Walrus Ice Preference

Walruses, being large animals, must haul out on ice flows thick enough to support their weight (Fay). They prefer thick, pressure-ridged (highly deformed) flows for haul out areas, (Burns, et al. 1977). Eskimos report that during the winter the north wind blows ice over to Siberia where it pressure ridges. In the spring when it breaks up and comes over towards St. Lawrence Island the walrus haul out on it during their northward migration. This ice is good ice for hunting. Hunters would also travel far to the northwest, close to Siberia, and would find large herds of predominately males on this type of ice. They said that these were Siberian walruses and from conjecture could have originated from the Gulf of Anadyr.

Shorefast ice although pressure ridged and highly deformed was not found to produce walrus. This ice would break off from shore and would float around but did not originate out to sea where walrus would utilize it for haul out areas. The hunters easily distinguished between the two forms.

Appendix II. Logistics of Walrus Hunting

Season/Walrus Migration

Walrus hunting obviously centers around times when walrus are available. Although the main thrust of the hunt is during the spring and fall migrations, walruses are hunted all year round.

Walrus cluster around and especially to the southwest of St. Lawrence Is. during January, February, and March (Kelley). This wintering population is available to hunters by foot over the ice, or by boat if open water exists and is not too rough. Hunters drag their boats over the shorefast ice when conditions allow. Southeast winds cause the water to warm up and push the ice out enough to offer boat all the way to Savoonga. Hunting during this time is difficult on foot since the walrus prefer areas of thin ice. New ice can start forming in the morning and be thick enough to walk on by afternoon. People usually take a boat with them when they are out on the ice in case the ice blows away from shore. The south current will usually hold the ice in towards the shore for 4 hrs. before the north current takes it out. Hunters watch the current closely. Although walrus are fatter than during migration, considered very good eating, and the fresh meat is a welcome change from preserved food, walrus take during the winter is small.

The surrounding island pack ice begins to loosen with the warmer weather in April (Kelley). As the bowhead whale migrates north, hunters turn their efforts to whaling. Walrus are not hunted during whaling so as not to frighten the whales away with rifle shots.

As the pack ice loosens in April, walruses wintering around St. Lawrence Is. start moving westward towards the Soveit Gulf of Anadyr and north toward Bering Strait (Kelley).

After the bowhead whale quota has been reached hunters begin hunting walrus. This year the quota was reached early and so consequently walrus hunting started earlier, (by 21 April). Hunting is generally slow this early. On 23

April one of the hunters stated that walrus being hunted at that time were still the winter walrus but that some on the south side of the island were moving north and that the major part of the migration would occur later.

More rapid melting and decreased southward movement of the Bering Sea ice takes place during May (Muench and Ahlnas, 1976). The eastern Chukchi flaw also opens widely at this time (Kelley). A large proportion of walruses concentrated between St. Lawrence Is. and Bering Strait, but also occur around the whole island (Kelley). Hunting swings into full gear during the 2nd and 3rd weeks of May with the highest number of walrus being taken at this time of year. Villagers hunt intensely during this short season filling their meat racks and stock piling ivory for carving during the winter.

In June most of the walrus population moves northward through Bering Strait, but several thousand animals, mainly males, remain for the summer in the Gulf of Anadyr (Kelley). Towards the tail end of the spring season hunters concentrate their hunting efforts towards the predominantly male populations to the east over by Savoonga and towards the northwest near the Gulf of Anadyr.

The spring season tapers off as the distance to the ice pack increases and the predominantly open water gets too rough for boating.

Throughout July, August, and much of September the population north of Bering Strait continues its northward movement out of St. Lawrence Islanders' range as the pack ice recedes (Kelley). Some animals remain in the waters around St. Lawrence Island allowing an incidental harvest to take place. An estimate of the summer harvest is not available. Southward migration begins in the

latter part of September with some migrating animals reaching St. Lawrence Is. by late September. Herds in the Gulf of Anadyr leave their summer haulout areas usually at this time (Kelley).

With the advance of the Chukchi pack ice in October large herds of walrus are forced out of the Chukchi Sea and appear around St. Lawrence and the Punuk Islands (Kelley). As herds of animals move into the area Gambell hunters switch from summer activities to the fall hunt. Boats are used to hunt the walrus in the water. Fall harvest can be as high as 50 animals per crew, this estimate is crude, however. Herds of several thousand walruses remain around St. Lawrence and the Punuk Islands at least through November (Kelley). Hunting is said to peak around Thanksgiving. As the area around St. Lawrence Is. freezes and congests with pack ice walrus congregate in areas of thin ice where food is available to the southwest of St. Lawrence Island.

Beach Use

In the beginning of the spring hunting season the majority of hunters store their boats at the west beach and launch and land their boats from that side. The north beach usually has an extensive shorefast ice shelf that during spring of 1981 extended 1/4 mi. out from shore until 7 May, when it started to break up and was totally gone by 20 May. Usually this shorefast ice is not used to store boats on as it may go out at any time.

Due to predominately west winds early in the 1981 season and closed access to the west beach, a lot of hunters moved their boats to the northeast corner of

the shorefast ice and launched and landed from there, pulling their boats across the ice to store them on the beach after each hunt. This condition lasted from 26 April through 2 May.

As soon as conditions improved on the west side, boats were hauled back to their old storing places. The majority of hunters then utilized the west beach, until the ice and snow melted leaving gravel. About half of the hunters started using the still snow covered north beach at this time as it's easier to pull boats up over snow and ice rather than gravel. The other half remained at the west beach probably because of easy access from their homes.

Equipment

All but two hunters in Gambell use aluminum boats for hunting walrus. Most boats are 14-18' long skiff or fisherman type boats. The major brand used is Lund but other brands include Smokercraft, Starcraft or Sears boats. The 18' boats are large enough to carry up to 4 people including gear, but limit the amount of walrus meat that can be brought back. One hunter uses s homemade 18' wood boat and another hunter uses a 23' uniak (skin boat).

Outboard motor brands used include Evinrude, Johnson, and Mariner. Horsepower ranges from 25 up to 70 with the majority having 40-50 horsepower.

Most people use 5 gallon gas cans, but some use the large 15-20 gallon containers. Gas capacity per boat ranges from 15 to 35 gallons.

A hand winch is included to haul walrus up onto the ice for butchering. The winch is anchored onto the ice, a line hooked into the walrus, and the walrus inched up.

Binoculars are included to sight game, a compass to navigate, a CB for emergency communication as well as to swap information with other hunters, and of course rifles to shoot the animal.

If shot in the water, a harpoon and float system are used to keep the animal from sinking. Harpoons are made by attaching a commercial harpoon head onto a 2 x 2 that has had the edges rounded off. Harpoon line is made from walrus calf hide and attached to either a homemade seal skin poke or a commercial plastic float.

Paddles or oars and flares are the only other emergency gear included besides a CB. Hunters generally don't carry floatation devices, tents, or sleeping bags. If trapped in the ice overnight they solely depend on the clothes on their backs and a thermos of hot tea or coffee.

Meat hooks are made from a rounded 2 x 2 and metal hook. They are used to help hoiset walrus up onto the ice, for turning the animal over, and especially for unloading meat when they return home.

Navigation

Fog by reducing visibility makes navigation difficult. Most, if not all hunters, have compasses to aid in navigation, but it is an easier task with the aid of visual landmarks. Hunters use the Siberian mountains on the Chukchi Peninsula, the Southwest Cape bluffs, Sevuokok Mountain, and Kookooligit Mountains (Map) to aid in determining directions. They also know how far offshore they are by how much of Sevuokuk or the other mountains are showing above the horizon.

Even without fog, hunters constantly watch their compasses and the time to correct for the surface ocean current. During the spring the current runs north at about 7 knots per hour in the middle of Anadyr Strait. The water close to shore may travel south with the tide change but the current isn't affected much offshore.

If hunters get lost in the fog north of the island they head south or southwest in order to hit the Northwest Cape. If they head southeast they usually miss the Cape and end up somewhere on the north side of the island. In the fog the shore ice on that side can confuse them into thinking that they are on the south side of the island. Hunters, therefore, always keep track of their location to counteract the ocean current, and in case of fog.

Weather and Ice Trends

Hunters related that the ice will go quickly in the spring if the ice during the previous winter remained thin and didn't build up a lot due to pressure ridging southeast storms bring swells and warmer weather which break up the ice and cause it to melt faster. Southeast winds also speed up the northward movement of the ice.

North winds help hold the ice back against the northerly ocean current keeping the ice around St. Lawrence Island longer and therefore extending the spring hunting season. A lot of north wind, however, blows the ice to the south of St. Lawrence Island where it is then picked up by the current running northward on the east side of the island by passing the west entirely.

West winds bring ice from the Siberian side making walrus from that area available. Too much west wind consolidates the ice up against the west shore, deterring launching and landing and preventing hunting in that direction.

East, NE, and SE winds blow the ice off of the west shore allowing launching and landing from that side and spreads the ice out allowing hunters to manuever amongst the flows with their boats.

A lot of hunters stated that the spring break-up was earlier this year and predicted a short hunting season.

Crews

Most crews are made up of family members (brothers, sons, nephews, uncles, etc.). Cross family crews occur due to preference for a certain person outside of the family, or if there aren't enough men in the family who are old enough or care to go. Women crew memebers are rare. The only women crew members observed were daughters of boat captains. Only one woman was part of the regular crew.

Generally one crew member, usually the boat captain, will be in charge of running the boat. One or more will shoot, and usually one is in charge of the CB.

As was stated earlier the boat captain either pays for all expenses himself or takes an extra ivory share to cover them. Whether expenses are shared or not,

the crew is expected to help in the maintenance chores of the equipment. This includes re-riveting and patching the boat, maintaining and repairing the outboard motors, etc.

Support Workers

Most hunting crews radio home on the way back from the hunt to let their families know approximately when they'll beach. Various members of the family act as support workers in meeting the boat, helping to pull the boat in, and hauling meat and ivory home. Often they bring down the family snowmachines or three-wheeler, if a vehicle isn't already on the beach. Support workers consist of wives, children that are too young to hunt but old enough to help out, elders too old to hunt, and generally anyone else in the family that didn't go hunting. Sometimes no one meets a crew and they are left to do all the work themselves.

Hunting Scenario

Each day of the spring season starts with the boat captain or a crew member waking up early to check the weather. If the weather looks favorable the person calls the remainder of the crew and meets them at the beach to either check the ice conditions or go ahead and go hunting.

If the weather looks unfavorble the crew waits to see if it will improve. Often hunters meet at the store or on the beach and discuss the weather or wait together. If the weather doesn't look like it will improve people go off to work on their equipment, perhaps carve ivory for more gas and rifle money, or rest.

When conditions look favorable hunters quickly depart in hopes of getting to the walrus before they are spooked by other crews. Groups of boats usually hunt together or keep tabs on each other by way of CB. They also discuss weather and ice conditions, where the walrus are located, and relative hunting success.

Some of the old men that can't hunt anymore sit at the beach and listen to the hunters talk over the CB. Families often leave the CB on all day so that they can also keep track of what is going on.

When the hunters return they radio home to let their families know so that someone will be at the beach to help them pull in the boat and haul the ivory, meat and equipment home.

Hunters keep track of who is already back and often ask the biologist who has come in. If someone is still out after all the boats are in a few hunters stay up and listen to the CB and talk them in. By the volume of the responding voice the lost crew can tell if they are getting closer to Gambell. Sometimes people light flares on the beach to help the lost crew locate Gambell. This hunter support system is important as the dangers while hunting are many (changing ice can trap boats, crews can get disoriented and lost in the fog, and one boat, this year, lost its boat plug and started to sink, etc.).

Appendix III. Increasing Technology and Demands and Their Corresponding Affect on Walrus Hunting

Increasing technology and demands affect the amount of money needed and therefore the number of walrus taken.

The pre-white contact ancestors of present day Gambell residents made all of their own hunting gear. Their boats, harpoons, floats, etc. came from their surroundings. With European contact cam guns and new hunting technology. Through the years the Eskimos of St. Lawrence Island have taken advantage of the "new ways" to make their subsistence life style easier. They still hunt and derive a lot of their sustenance and income fromthe plants and animals around them, but in most cases they use modern devices to do so.

Technology

Walrus hunting has evolved from a large crew paddling a walrus skin boat around, killing a few animals, and bringing everything back, to a small crew (2-6 men) using aluminum boats and outboard motors, to kill a lot more animals, and bringing less meat back. The "overhead" of walrus hunting has changed from that of the amount of time needed to make and repair one's hunting gear to that of a cash outflow to buy gear and then maintain it. Modern walrus hunting equipment now includes: aluminum boats, outboard motors, gas cans, rifles, binoculars, CB's, compasses, winches, etc.

Changes in hunter gear have occurred within the last year, increasing the Gambell residents "potential" walrus harvest capability (Fig.). Last year 6.3% of the boats had 25 hp outboards (2 out of 32), approximately 75% had 35

hp outboards (24 out of 32), 9.4% (3 out of 32) had 40 hp motors and only 9.4% had 50 hp or larger outboards. During the 1981 spring harvest 3.3% of the boats (1 out of 30) had 25 hp outboards, 27.7% (8 out of 30) had 35 hp, 20% (6 out of 30) had 40 hp, and 50% (5 out of 30) had 50 hp or larger outboards, (including one hunter who had two 35 hp outboards side by side, giving him a total of 70 hp).

A hunter related that 40 hp is maximum for a 16' Lund and 55 hp for an 18" boat. This same hunter stated that next year he was going to buy an 18' Lund and 55 hp outboard (he already had a 16' Lund and 40 hp outboard).

The boats with 50 hp or larger outboards have the advantage of getting to the game first. Boats with 35-40 hp outboards end up having to go beyond the 50-55 hp boats to find game. They are often passed by the faster boats coming and going. The competition between hunters is forcing them to increase their horsepower and get larger boats.

Boat length is difficult to judge, but if boat size estimates were correct over the past two years, there were more 15-16' boats during 1980 and more 18' boats during 1981. Since the larger boat motors can only be accomodated on larger boats it is probable that people bought larger boats as they increased their outboard horsepower. From 1980 estimates there were 6.9% - 14', 65.5% - 15', 3.4% - 16', and 24.1% - 18' boats. During 1981 there were 3.3% - 15', 3.3% - 16', 63.3% - 18', and 26.7% - 15-18' boats. The 15-18' boats are boats that were estimated as 15' during 1980 and 18' during 1981. Since the outboard size didn't change on these boats the wrong size may have been estimated.

Two hunters had new boats this year, with styrofoam flotation units and with huge capacity, it took 50 hp outboards just to push the boat in the water. The boats were very heavy, requiring larger crews (generally 5).

Number of gas cans, or gas carrying capacity also increased. During 1980 gas cans were counted for 10 crews. Forty percent had 10 gallon gas capacity, 50% had 15, and 10% had 20 gallon capacity. During 1981 gas cans were counted for 30 different crews. A total of 3.3% had 15 gallon gas capacity, 36.7% had 20, 46.7% had 25, 6.7% had 35 gallon gas capacity.

As bigger and bigger boat and correspondingly larger outboards are bought, and other new hunting technology develops, it seems to follow that the number of walrus taken will have to increase to cover the cost of new equipment and increasing inflation.

Another factor affecting walrus take is the increased demand for materialistic goods and services that require money. As the native people become more acclimated to the white culture they become aware of and require some of the anemities of that culture. Clothes and hair styles to a certain extent are just as modern as found in Anchorage. A mixture of old and new remain.

Snow machines and three-wheelers lighten work. As new models come out new demands are created. Television has increased the materialistic trend, advertising everything from tooth paste, to new automobiles, to sex appeal. One woman stated that she'd like to get one of the new video television recorders so her kids wouldn't miss the cartoons in the mornings. Next will be computer games.

Consumption of white food varies from household to household but on the whole has also increased over the years. The Gambell Native store offers everything from fresh pineapple, to pizza, to smoked turkey. A lot of families eat at least 50% native food as they say if they eat too much white food they get indigestion.

Transportation to and from the mainland is another demand that is becoming more accessible. A few people related that they were leaving Gambell for a few days for a change of pace.

Drinking is a very expensive habit in Gambell. A fifth of whiskey costs as much as $100.00 One fellow spent $400.00 in 4 days on a drunk. Bootleggers from Nome have a very profitable racket going. While in Gambell, news came that the Gambell bootlegger had been caught and sentenced to 30 days in jail. A Nome merchant was also apprehended trading whiskey for raw ivory. Some of the people in Gambell complain about the use of cash from ivory to fly to Nome to get drunk or the buying of bootleg liquor. They see it as a real waste of resources.

In summary, as cost of necessities rise due to inflation, demand for materialistic goods and services increases, and hunting technology improves, there will follow an increasing demand on the walrus resource. Although, not necessarily a function of the Fish and Wildlife Service, it is imperative that action be taken or encouraged to find other means of commercially utilizing walrus parts besides that of ivory carving in order to prepare for the day when the number of walrus needed to support people in native communities exceeds a safe harvest level.

Unemployment

Preliminary 1980 population figures show 441 residents in Gambell and 105 separate households. Dividing the total population by households gives an average of 4.2 people per household. If there is one bread winner per household and there are a total of 60 full-time and part-time jobs then 57% of the breadwinners are employed (Environmental Services, 1980). There are a few more jobs available but the number is unknown. Head Start hires a few, an unknown number of men belong to the Air National Guard, and G&E enterprises hire a few clerks plus provide income for the owner. If there are a total of 10 more jobs available than 66.7% are employed at least part-time. This leaves 33.3% of the total bread winners unemployed.

Alternative Money Sources

A few alternative methods of earning money to that of being employed exist in Gambell. One family provides food and lodging for bird watching groups that come to Gambell each spring. Approximately 3 bird watching tour companies from "out-of-state" bring 20-50 people per company per visit. Last year over 100 bird watchers visited Gambell. The family provides food and lodging at the rate of $40-$50 per person per day. Around 7 villagers are also hired to assist in cooking.

People dig in old village sites around Gambell and all over St. Lawrence Island for artifacts and old ivory in the summer. This option is open to everyone young and old, male and female alike. Overhead is low, just something to dig with. A lot of women and old people dig to help supplement the family income. Artifacts re sold to tourists, as well as buyers that come

to Gambell from as far away as New York state in the fall and winter. Some very rare pieces are found such as ivory dolls that may be sold for thousands of dollars (one sold for $20,000). Other less rare pieces range from a few dollars for a button or toggle, to a hundred dollars for a stone uluq, to a few hundred for something moderately rare. Residents stated that some villagers make as much as $30,000 a year form selling artifacts alone. This type of business is very dependent on being in the right place at the right time. Old ivory, which is stained from the ground, is also found while digging. These pieces along with old sled runners are also carved or used as bases for carvings.

Walrus Products and Handicrafts

Walrus hunting and the subsequent production of items out of walrus products provides the largest alternative income to that of being employed in Gambell. There are 39 boat captains and at least 70 crew members, with 1 to 4 crew members per boat (depending on size and preference). If the average crew size is 3 then the total number of crew members would be 117. Between 109 and 156 men, therefore, derive some income from walrus hunting each spring. If only the 39 boat captains are counted as bread winners then 37% of the 105 estimated bread winners obtain part of their income from walrus hunting. A number of crew members are also bread winners so the percentage is much higher than this.

A lot of men that do have jobs hunt walrus. They hunt when their work schedule permits them to take leave. These hunters appear to take a smaller fraction of the total take and usually bring back a high percentage of the meat. They either carve or sell the ivory to the Gambell Native store for $15-$18 per pound. They are less dependent on the cash income the walrus provides.

Ivory carving is the mainstay of the unemployed or self-employed population. A large proportion of the men in the village carve ivory. Some women and youngsters also carve. Quality ranges from poor to exquisitely detailed and artistic. Prices range from $35.00 for 1-1/2 to 2 inch carvings to $1,000.00 or more for ornately carved tusks. Common subjects include: seals, sea lions, whales, polar bears, walruses, river otters, cormorants, puffins, crested auklets, other seabirds, owls, ptarmigan, swans, eagles, brown bears, kayaks, whaling ships, etc.

Gift store buyers come to Gambell to buy carvings just before big selling times such as Christmas and the summer tourist season. Some bring trade items such as power carving tools, carving bits, and houseware items which they deduct from the amount they owe the carver. Complaints were voiced that buyers only come at certain times of the year and buy carvings only from the really good carvers. This makes it hard for the less skillful carvers to find markets and also for people to obtain cash in the off times of year. Money often runs out during the middle of winter when the stove oil is getting low.

The Presbyterian Church buys carvings from heads of households with the deacons' fund to help provide cash at hard times of the year. Dean Hickox, the pastor, pays the asking price of the carver and then sends the cavings to his daughters, one whom lives in Anchorage and the other in Portland, Oregon. The daughter in Anchorage has a clientele she sells the carvings to at a 10% mark-up. The other daughter in Portland marks them up 15%. This is an incredibly low mark-up compared to the 100% mark-up by the gift shops. According to a friend of Pastor Hickox, the church is losing money because some of the carvers inflate their price, and the carvings can't compete with

the same carvings in the gift shops. Some of the Gambell people hold the attitude that the church is cheating them because Pastor Hickox' daughters mark up the carvings when they sell them. This is interesting since the gift stores mark them up 100% and complaints weren't heard about this.

Another cash source is selling raw ivory to the Gambell Native store. Last winter the store bought ivory from the hunters at $15 per pound and then sold it back to the carvers for $25 a pound. The spring resell price was $18 a pound. The store bought a total of 600 pounds during the winter. This form of exchange serves to provide a cash flow in the village. The hunter receives cash from the raw ivory in the spring, or later when he needs it, and then can buy a little back at a time in the winter to carve, sell the carvings for a profit, buy more ivory and the necessities of life, etc.

The store just started buying ivory carvings during the spring with a $5,000.00 per month limit. Carvers can only trade the value of the carving for store items that came on the North Star freighter. Such items include bulk items like sugar, flour, canned goods, stove oil, and gas. The North Store is a BIA freighter made available to native villages in order to help them cut living costs. The store sells the carvings in the ANICA gift shop in Anchorage at a 100% mark-up. They also sell carvings to tourists who come to Gambell at cost.

People in the village say that there is a lot of illegal trafficking of raw ivory occurring. The buyers come out in the middle of the winter when cash is low and people start running out of stove oil. Even though people know that they may be hurting the ivory carving market by selling raw ivory they feel they have little choice when money is short.

Besides selling carvings and raw ivory, there is also a market for head mounts. The general concensus is that tusks that touch at the tips make the best mounts, but odd ball or deformed tusks also sell well. People sometimes rework the tusk cavity to change diverging tusks into straight or touching tusks.

Generally people can make more money per tusk by carving rather than selling head mounts. Some people, however, figure that considering the time, effort, and skill involved in carving, they can get about the same amount of money for a head mount with a whole less effort, especially if they are slow carvers. One interviewed hunter was working on a mount with tusks of about arm length. Ater he boiled the skull and whitened it with chlorox, he sanded the skull till it was smooth then buffed it. He then etched the tusks and skull with animal designs. He said he could probably get $2,500.00 for them. He makes about 5 mounts a year.

Walrus teeth are carved into seals, faces, earrings, and other small things, or sectioned and made into bracelets and earrings, or sold as is to gift shops. One carver makes elaborate two-sided faces which he sells for up to $50.00. Prices vary for other items by size and intricacy.

Other handicrafts made from walrus parts include drums made from walrus stomach mesentary, vibrissae tooth picks, carved rookery bases from broken up skulls, sewing decorations made from dried stomach mesentary, and carved and/or polished oosiks.

Non-walrus handicraft items are also sold for income. Some of these include whale bone carvings, polished and/or scrimshawed baleen, baleen boats, dolls, sealskin hats, mittens, and vests, mukluks, game balls, uluqs, yo-yo's, etc. A craft cooperative does not exist to market items, but some of the ivory carving buyers buy them, or people send orders if they've obtained someone's name. The Gambell Native store doesn't offer space for consignment items either. People have expressed an interest in developing a cooperative market.

Family Earning Structure

When it comes to supporting the family, generally the whole family pitches in. The father and sons may carve, the wife and daughters may sew fur handicrafts (mittens, hats, dolls), even the live-in mother-in-law and/or father-in-law helps out by making something to sell. Different family members might have a full or part-time job or work for a construction company as carpenters, laborers, or cooks. Some men seek temporary summer employment as fire-fighters, etc. Some women hold health-aid alternates, or washeteria jobs. Generally the family members make up the walrus hunting crew also. It appears that when there aren't enough males in the family, cross family crews develop.

Cost of Living

Store Prices

Living in Gambell is expensive. Appendix gives a list of Gambell Native store items and corresponding prices on May 7, 1981. Although the North Star

freighter helps cut costs on certain items, the Native Store brings in a lot of food by air freight. Prices are double to triple compared to Anchorage prices. The privately owned store, G&E Enterprises, often matches the Gambell Native Store prices. People are generally disgruntled about high costs. Since ANICA runs the Native Store, people mentioned that they think the ANICA bureaucracy is sponging off the potential savings to the people. One hunter said he hoped another private store would come in to offer competition to the existing 2 stores and thereby, cause a lowering of prices. He believes that the ANICA bureaucracy, although intended to be non-profit yet self-supported, is inefficient because it is a government endeavor and that a private store could offer reduced prices by being more efficient. A lot of people increase their food buying power by receiving food stamps.

Subsistence

Most people depend highly on subsistence hunting. The degree of dependency depends on the family. Some eat mostly native foods, a lot eat 50-50 (native and white food). Even people with full-time jobs make an effort to acquire a certain portion of native food.

Walrus, bowhead whales, and gray whales are hunted in the fall and spring. People hunt birds, gather eggs, gather sedentary seafood, fish, crab, and harvest greens, blackberries, salmonberries and cranberries in the summer. In the winter people hunt seal, fish and crab on the ice. One can see drying racks all over the village in the spring to attest to the large use of wild meat.

Housing

Housing consists of old wood frame houses along the west beach, 30 houses built in 1976 by the BIA and Department of Housing and Urban Development (HUD), 30 houses built in 1978-80 by a joint HUD/Bering Straits Regional Housing Authority project, and some provately built homes. People living in the two building projects pay a certain proportion of their mortgage based on their income.

Utilities

Utilities available in Gambell include electricity provided by three AVEC generators (75 kw, 175 kw, and 250 kw) at $.51 per kilowatt/hour, and heat from fuel oil (Environmental Services, 1980). Oil is delivered annually on the BIA North Star III and sold through the Gambell Native Store (Environmental Services, 1980). Stove oil costs approximately $130 per 55 gallon barrel.

Some people burn drift wood in wood stoves to supplement their heat.

Transportation

Snow machines and 3 wheeler hondas provide the majority of land transportation. Just a few dog teams are left. Gasoline cost $2.50 per gallon in May. One hunter related that he wanted to get a dog team started again to save gas.

Sanitation

Showers at the new washeteria cost $1.50 and washer and dryer cost around $2.00 a load.

Walrus Hunting Costs

The economics of walrus hunting itself affects walrus hunting. Walrus hunting is an expensive endeavor. Not many people can afford to purchase the necessary gear to become a boat captain. Some poeple work on construction crews or other temporary or permanent jobs, or carve a lot of ivory to do so.

Initial Gear Costs

The initioal cost starts with the purchase of a boat. People can use uniaks (walrus skin boats) but these are slow and are the last ones to get to the walrus. Only one family still uses an uniak and they often come back unsuccessful. Last spring 15'-18' Lund boats cost $2,800.00 ($1,000.00 of which covered freight). An outboard motor must then be bought. Fifty-five hp Evinrudes were advertised at the Gambell Native Store on sale for $2,191.13 and were originally $2,921.51. Rifles, gas cans, binoculars, a CB, a winch, and a compass must also be bought. Often a smaller back up outboard is included. Other gear includes harpoons (homemade except for the head), line made out of walrus calf hide, and harpoon floats (either large red commercial fishing floats or homemade seal pokes), a couple of paddles, and meat hooks.

Often boat captians own more than 1 boat and outboard motor. As a boat gets worn a captain might buy a new one and use the older one for reserve in case something happens to the new one, or store it at another place on the island. Some people rent them out to captains who don't have a boat. One hunter had a boat at Southwest Cape and when weather and ice conditions weren't good at Gambell he travelled overland and hunted out of there. Likewise, as people obtain bigger or better outboards, they take the older one along as an emergency back up or keep it at home as a reserve in case they need to work on the new outboard.

Operating Costs

Besides the initial gear costs, the boat captain often supplies the gas and rifle shells. Gasoline costs approximately $2.50 a gallon during the spring or $142.00 per 55 gallon barrel from the Gambell Native store. Some boat captains buy their gas in bulk before the spring season starts, as it is cheaper this way. Others have to buy it daily from the store since they can't afford such a large cash outlay. One of the more active hunters buys 10 barrels of gas and all his rifle shells before the season starts. He estimated that he spent $1,,500.00 during the 1981 spring season on gas and shells alone.

Some boat captains supply their crew members with rifles, shells, binoculars, and other gear, besides initially buying the boat and outboard, and buy all the gas. These captains split the ivory tusks equally between themselves and their crew. Most captains, however, take an extra share to cover expenses. In the old days, boat captains would supply everything (sometimes supporting crew member's families with food, clothing and housing). One of the captains told me that if this was not done (in the old days) the crew members would go work for someone else.

Gear Loss

Another cost in the economics of walrus hunting is that of losing gear. Harpoons, seal pokes, and line are easy to lose since a wounded walrus that's been harpooned can dive under the ice, die, and become inaccessible. Binoculars and rifles are often ruined by the elements. Outboards sometimes burn out due to too heavy a load, and boats can develop a leak and sink, or be battered so badly by the ice and pounding of the waves to be irreparable.

Maintenance Costs

Maintenance is also a cost factor. When the weather and/or ice conditions preclude hunting, hunters often repair outboard motors, clean guns and other equipment, or re-rivet boats and patch leaks. The salt water, rough weather, and ice leave their toll on the life of equipment. A continuous maintenance program is essential to hunting.

Summary

In conclusion, walrus is a very important factor in the economics of living at Gambell. As was previously stated walrus provides primary income to at least 33.3% of the heads of households and secondary income to an unknown percentage. Between 109 and 156 men derive some food and income for their families from walrus hunting. These and other economic factors should be considered when devising walrus management plans.

Appendix V. Eskimo Views on Walrus Management

It appeared that the majority of Gambell hunters would prefer there be no State or federal management of walrus. Many hunters stated that they managed walrus take in earlier years by maintaining a quota of 5 walrus per boat, and that they would be capable of managing walrus harvest themselves if there was a need. Some felt it a direct threat to their livelihood and lifestyle by a government "official" overseeing the harvest.

A few people were concerned over the walrus waste that they observed, and hoped to see a walrus harvest quota established. One person stated that he understood the problem of having enough cash income to live, but that he objected to people using cash from ivory to buy bootleg alcohol or take trips to Nome to get drunk. It seemed that the people most concerned over walrus waste and those that wanted direct management and a walrus harvest quota were people who had another source of cash income other than ivory carving. Only one hunter stated that he would like to see a quota reinstated because he didn't like seeing "wanton waste".

If given a choice between federal or State management, a lot of people voiced that they preferred federal management. Some people stated that they preferred the federal government because it was far away, upheld subsistence use, didn't allow selling of raw ivory through a sealing program, and didn't establish a walrus quota. Supporters of these views were generally ivory carvers who depended on a variable amount of walrus meat for subsistence, an

ample amount of ivory for carving, and who believed they would be hurt by competition with factory made ivory carvings if raw ivory were legally available. Some people stated that a walrus quota would be good if the walrus population declined but not while the population is high. They also felt that if a quota were established it should be based on what people's needs were.

Other people wanted to see the State get management back. These were mostly hunters that had assistant guiding licenses and wanted sport hunting opened. One hunter wanted the State to have management so that a quota would be reinstated.

Still other people didn't know which agency had management, and didn't distinguish between ADF&G, USFWS, or NMFS. These people were generally against government control of any kind. They viewed the walrus as their animals and didn't understand the need for international agreements on walrus management with the Soviet Union or that one must also consider the total take from all Alaska villages besides just Gambell. As far as they were concerned the "government" was trying to stop their form of lifestyle.

Generally people respected scientists, like John Burns and Bud Fay, who worked on walrus biology. They weren't threatened by research and respected the effort being made to maintain the health of the walrus population. They also appreciated the added income from the purchase of specimens.

Many people were concerned about the sale of illegal raw ivory. Part of illegal trafficking stems from a lack of cash flow in the village especially during the middle of the winter. Most people felt that a State financed ivory bank would help solve the problem. The Gambell Native store doesn't have enough capital to buy up unlimited amounts of ivory from hunters. If the State could finance the store then hunters could get cash from the ivory in the spring and buy it back to carve in the winter. Some people felt that a raw ivory permit system where a non-native could apply for a permit to buy 100 lbs. of raw ivory would also help provide cash, and yet wouldn't allow too much raw ivory out on the market to compete with Eskimo carvers.

A number of ideas arose when asked for opinions on ways to utilize more of the walrus meat from animals taken primarily for their ivory. Some people thought freezers would be good to store the extra meat for human food and dog food. This would also allow a market to be developed in Nome and elsewhere for human food. Nome Eskimos do get a lot of their own walrus meat, however. Another suggestion was to have a mother ship collect walrus meat. One person thought that people would probably want to hunt traditionally in spring but that the ship could be used to follow the walrus as they migrated north allowing for an even bigger harvest. People were very interested in developing a meat market with the Soviets, having them come over with the factory ships and buy meat directly from the village. Other suggestions included building a dog food factory or fox farms.

Appendix VI. Subsistence

Seasonal Use

In the winter Gambell residents trap arctic foxes on the island and hunt for ringed, spotted, bearded, and ribbon seals, walrus, and polar bears out on the pack ice. Walrus may occasionally be hunted by boat when open water is present. People also fish and crab on the shorefast ice. Bullheads, various rock fish, and crabs are caught by jigging a pixie lure or bright object on the end of some fishing line. The line is jigged until a bite is felt and then quickly wrapped around the person's arms to pull the fish or crab up.

People related that a commercial crab boat came from Kodiak or Bristol Bay to St. Lawrence Island around 3 years ago and harvested approximately $150,000 worth of crab. They claim that crabbing around Gambell has never been the same since and that the number and size of crab caught has greatly decreased.

With spring breakup comes the bowhead whale migration and the spring whaling season. Uniaks and sails are used to silently approach the whale. Whale shares are distributed by boat crews with the most shares going to the boat crew that struck the whale. After the whale quota is reached spring walrus hunting begins. Seals are also hunted at this time both providing fresh food and food to store for the next winter. Fishing and crabbing on the shorefast ice continues until the ice breaks away and moves offshore. Spring birds are also hunted as they migrate north or come to the island to breed.

As the ice pack moves north and the existing ice melts, people turn their attention to preparing for their summer camps. Gambell residents have camps on the north or south side of the island. Available resources depend upon the location of the camp. King, silver, and chum salmon, dolly varden, grayling, and whitefish fishing is available in lagoons, lakes, or some streams. Seal hunting is available on both the north and south sides of the island, while sea peaches (a sedentary marine organism) are only available on the north side. A piece of metal with hooks attached is drug by line on the sea floor to obtain them. Egging is available in June and July and bird snaring during the summer at the rookery cliffs at Southwest Cape and other seabird colonies. Greens, roots, bark, blackberries, salmonberries, and cranberries are available throughout the island. Gray whale hunting also takes place in the waters offshore.

With fall comes the fall walrus migration. Walrus are hunted till the migration passes and the ice closes off the open water. Fall storms often throw up living seafood such as clams, fish, and sedentary marine organisms of the beaches, which people gather.

Walrus Uses and Preparation

Walrus provides a number of subsistence products. (See the section on walrus utilization for percentage figures of walrus usage by part.)

Many parts of walrus are utilized for food. Walrus calf is probably the most favored and sought after food that walrus provides. It is usually aged first for about 12 days and then butchered and hung to dry. Some people butcher and hang their calves without aging. Once dry the meat is stored by freezing or kept in a cool place. It is eaten dried or boiled. Calf heads are also eaten. The heads are often stored in barrels with walrus fat (that turns to oil) and allowed to ferment. The heads are then boiled and the head meat, brains, and eyes are eaten.

Brisket is eaten boiled fresh or after it's been aged. People also take the meat off the bone and dry it. Generally older fatter bulls are preferred, but all sexes and ages can be used.

Hunters stated that flank meat was primarily used for sled dog food in the past because of its toughness. Some flank meat, however, is used for human consumption. The front area by the neck is best from both males and females of older animals and is either boiled, fried, or dried.

Flippers are either aged and boiled or boiled fresh. Female flippers are usually the most tender.

Heart valves are eaten raw and the heart muscle is eaten boiled. Older bulls are best but females are good too.

Intestines from bulls are cut into one foot sections, boiled till rubbery, sliced and eaten. People also age them till they smell, turn them inside out and dry them, or dry them fresh. They can also be frozen raw and boiled at a later date.

Livers are sliced thin, dipped in flour, and fried; or frozen, sliced thin, dipped in oil and eaten raw; or aged in oil and eaten raw or cooked. Old bulls have very tender livers. Females are rarely used. Liver may be stored in the freezer up to 6 months, and perhaps longer. "Milk" or mammary glands from lactating females, and kidneys from bulls are boiled and eaten.

Mungoona or the skin/blubber layer may be taken from any area of the walrus, but is best right over the sternum area with the sternum meat attached. Mungoona may be used from all walruses but it is best from older males becauseit is thicker. Mungoona may be eaten freshly boiled (sliced thin to eat), or may be aged and then boiled. Both aged and fresh mungoona may be frozen and eaten raw. Mungoona may also be used to make "meat balls". A one foot by two foot piece is cut from the breast area, then brisket, hip, or other walrus meat is placed on one half. The other half is folded over and the sides laced up together with rope forming a meat-packed pillow. This is then placed in an underground cellar with shorefast ice and allowed to ferment from May to fall. It may also be stored over the whole winter.

Ribs from females are generally more tender than males, but if the male ribs have a lot of meat on them they are good. People boil or dry the ribs.

Emmonak or clams are often found in bull walrus stomachs. The clams are still fresh if the green sheathes are still intact and if they are firm and white. They are still edible if firm, even after the sheathing has been digested. People eat them raw after the stomach juices have been rinsed off, or dipped in hot water, or make chowder out of them.

Tongue may be boiled or fried. Tongues from females are the best. The outer skin is cut off and the meat is simmered for about three hours.

The walrus face pads are aged and eaten by some people.

Young walruses (1-4 year olds) are boiled fresh, or hung and dried like walrus calves. The mungoona and organ meats are also used. All parts may be fermented.

Washed up walrus are also utilized for their mungoona which is cut off and boiled.

Walrus is also a source for subsistence items other than food. Rope is made from hides from calves, yearlings, or 2 1/2 - 3 year old females. The line is cut in a circle around the body from the navel to the neck. It is allowed to ferment for a few days until the hair slips off, then stretched between 2 posts outside and dried.

Female hides are used for uniak coverings. The blubber is removed and the hide is folded and placed in a warm area (for about a week) until the hair slips off. The hide is then split, stretched, and dried. Before sewing can take place, the hide must be soaked in water until pliable. Two skins are draped over the wooden boat frame and stitched together with a special folded water proof seam. Whale tail sinew is used for thread since it is pliable, gives, and also swells when wet (further aiding in waterproofing the seam). After the skin is lashed in place to the frame and allowed to dry the boat is painted with a marine enamel which keeps the boat from getting waterlogged. This protection extends the life of the vessel up to 3 years, (unpainted boats only last one or two years).

Walrus stomachs are used to make drums and storage containers. The outside muscle layer is cut away from the inside mesentery layer and the stomach lining is scraped away. The remaining stomach mesentery is then soaked in ice water till it is white then blown up with air and dried outside. The stomach shape is still retained and when one end is cut open produces a container or bag that may be used to store food or collect berries, etc.

Walrus vibrissae are used for toothpicks; teeth for fishhooks, etc; bones for tool handles, net sinkers, harpoon parts, and carvings; and tusks for carvings, boat keel runners and tools, etc.

Other Plant and Animal Uses and Preparation

Mukluk or bearded seal (Erignathus barbatus) is heavily depended on for food. Of all seals, mukluk (both calves and adults) were harvested the most during the 1981 spring season (Table). Mukluk is very tender and is eaten raw, frozen,, boiled, fried or dried (all either fresh or aged). Young mukluk may be butchered similarly to walrus calf and also dried. All seal blubber may be rendered into oil and used as a food dip.

Mukluk intestines are cut into one foot lengths, turned inside out, aged or dried fresh. They may also be boiled. Intestines are also used to make waterproof rain parkas or snow shirts. The outside muscle layer is peeled off and the inside absorptive layer is scraped away leaving the mesentery layer. The blood is then soaked out and the intestines blown up with air and allowed to dry. Intestines dried in the summer are made into waterproof rain coats whereas intestines dried in the winter are made into breathable snow shirts.

Other seals utilized for food include adult and calf ringed seals (Pusa hispida), spotted seals (Phoca vitulina), and occasionally ribbon seals (Histriophoca fasciata). Their harvested numbers during the 1981 spring season and relative percentages are presented in Table . Spotted seals are utilized slightly more than ringed seals, and ribbon seals are taken rarely.

Small to medium sized seals are used to make pokes. Pokes serve as storage containers or floats. The seal skin is peeled off of the animal from its tail over its head, scraped, blown up with air and allowed to dry. Seal skin is

also used for kamaq (boot) uppers, hats, mittens, pants, guspuqs (parkas), and rifle cases. Mukluk skins are used to make boot soles and also rifle cases and packs.

Bowhead whale meat and muktuk (skin/blubber) are eaten and baleen is sold to gift stores and tourists, or used to make sleds and tool parts. Gray whales are also utilizd for their meat and muktuk.

A vast array of migratory birds are utilized when available. See Table for known 1981 spring harvest information. Cormorant adult breasts, legs, and wings are fried or boiled. Young cormorant chicks are also eaten. Murre breasts are dried and eaten raw dipped in seal oil, boiled, or deep fat fried. Auklets are boiled fresh or aged with blubber and eaten raw, dipped in seal oil. Cranes, eiders, geese, and other waterfowl are also eaten. The brains, eyes, hearts, livers, lungs, and other organs except the intestines are eaten from most birds.

Bird eggs are collected in June and July on the slopes of Sevuokuk Mt. and at Southwest Cape. People eat them raw or cooked, or store them either raw or cooked in the shell in seal oil for later use.

People collect green shoots as soon as they appear and dig for roots in the spring. The greens are eaten fresh or allowed to ferment in seal oil. They can be frozen for use in the winter. Willow bark is also collected and eaten.

Storage Methods

Storage methods include drying, freezing, storing in seal oil, or keeping food cool in meat cellars. Cellars are dug into the permafrost and filled with chunks of shorefast ice left on the beaches in the spring. Meat of all kinds is stored and allowed to slowly ferment in the cool but unfrozen conditions.

Appendix VII.

Gambell, The Village

Included is an excellent write-up and map of Gambell prepared by Environmental Services Limited under contract with the Alaska Department of Community and Regional Affairs, Division of Community Planning, September 1980. This write-up sums up so many aspects about Gambell that it would be redundant to write about the same things. There are aspects that aren't covered that are worth mentioning.

Resident Non-Native People

Six BIA grammar school teachers and 4 REAA high school teachers are hired outside of Gambell and live there seasonally. A Presbyterian minister and his wife and a Seventh-Day Adventist minister and his wife also live in Gambell. The only other non-native residents are a few spouses that have married native residents.

Non-Native Visitors

Various health workers visit Gambell regularly as well as a Postal Supervisor. Construction crews came out to build housing, and AVEC maintenance personnel come out occasionally. Tourists visit Gambell during the Whale Festival and in the spring to observe migrating birds. Wytcliff Bible Translators have two full-time staff (a married couple) that come out to Gambell from Nome in their work translating the New Testament into Siberian Yupik.