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The natural history and ecology of the bearded seal (Erignathus barbatus) and the ringed seal (Phoca (Pusa) hispida)

Principal Investigators:

John J. Burns - bearded seal
Marine Mammals Biologist
Alaska Department of Fish and Game
1300 College Road
Fairbanks, Alaska 99701

Thomas J. Eley, Jr. - ringed seal
Marine Mammals Biologist
Alaska Department of Fish and Game
1300 College Road
Fairbanks, Alaska 99701

Assisted by: Bonnie Friedman, Carol Nielsen, Carl Grauvogel, Edward Muktoyuk, Harry Reynolds and Glenn Seaman.

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I. Summary of Objectives, Conclusions and Implications with Respect to OCS Oil and Gas Development

In view of scheduled field work involving committments of ship and aircraft time, this report is based on work accomplished through February 1976. Unfortunately, this conflict has directly affected the completeness of various analyses and reflects a lesser data base than has actually been acquired.

Ringed seals, Phoca hispida and bearded seals, Erignathus barbatus are major components of the marine mammal fauna of the Bering, Chukchi and Beaufort Seas. They have been chosen as target species for investigation based upon criteria including their significance in the ecosystem, importance to people residing along the coast and considerations of timeliness, feasibility and applicability to OCS requirements. This does not overlook the significance of other marine mammal species of the region, some of which are the subjects of other investigations (i.e. walrus, spotted seals, bowhead whales), and some which suggest a lower probability of successful achievement of important task objectives (i.e. ribbon seals or grey whales). All of the marine mammal species of the area will be included in certain kinds of analyses such as that of distribution.

The broad objectives of this project are to obtain baseline information about the natural history and ecology of ringed and bearded seals. These species occupy vastly different ecological niches within the ice dominated marine systems in question.

The ringed seal is a small, widely distributed and very abundant species which mainly occurs in areas of extensive, relatively thick and stable sea ice. It is the only species within our study area that occupies the land fast ice. It is the species taken in largest numbers by Eskimo seal hunters. Ringed seals feed mainly on zooplankton, the smaller shrimp and demersal fishes.

In marked contrast, bearded seals are the largest of our nothern seals. They are also widely distributed, but occur in the drifing ice. They feed almost exclusively on benthic organisms. Annual harvests of bearded seals are much lower than those of ringed seals. However, due to the great difference in size, the amount of usable protein obtained is almost the same. Bearded seals are preferred by coastal residents.

Our intent in selecting these species for investigation was to examine simultaneously the biology of two species which are of significant importance to man, and which depend on vastly different habitats within the marine ecosystem.

The implications with respect to oil and gas development are basically that we will be able to recognize how, when, where and why certain activities may have proximal or ultimate effects on these two important species. As examples, how does seismic exploration in areas of land fast ice affect ringed seals which breed there? What food organisms are these seals utilizing? Are there differences in the susceptibility of prey species to oil pollution--or, which of the seals is most susceptible to significant indirect effects of oil development? How much disturbance will the seals tolerate? Will they avoid areas of intensive human activity? Are there critical migration routes, etc. Answers to almost all of the questions concerning the potential effects of oil and gas development on these seals depend on an understanding of their natural history and ecology.

II. Introduction

Bearded and ringed seals constitute two of the five pinniped species associated with the ice dominated habitat of the Bering, Chukchi and Beaufort Seas. By virtue of numbers and distribution they are of great significance to coastal residents of northern Alaska and Siberia; providing reliable sources of food and usable byproducts. Their importance as significant, functioning elements of the marine environment is not adequately known. Both species occur throughout the seasonally ice covered regions. However, differences in habitat requirements (including food habits) result in an ecological partitioning of the marine system in question. Proposed OCS lease areas in the Bering and Beaufort Seas fall directly within the habitat of these two species.

The primary emphasis of our ecological studies responds to OCSEAP tasks A-1, A-2 and A-3. Information required for accomplishment of objectives A-6 and A-31 is being obtained. Our study (as well as many others) are required in order to eventually achieve objective E-1.

Information required to meet the task objectives include, but are not limited to, such things as natality, mortality, population size, population structure, trophic relationships, detailed understanding of factors determining density, distribution, seasonal movements, critical habitat requirements, relationship to ice habitats, behavior and other biological processes. Historical events indicate that marine mammals, as intelligent, irritable (in the physiological sense) and ecologically specialized organisms have almost always been adversely affected by the activities of man. The proposed exploitation of outer continental shelf resources poses the real threat of habitat alteration. Adverse impacts can be lessened if there is an adequate understanding of the ecosystem and its component parts and types of pertubation that can be anticipated.

Our study of bearded and ringed seals is one of moderate duration which will require about five years to complete. The specific task objectives are:

V. Sources and Methods

A. Schedule

Dates	Location	Activity
April to June 1975	Bering Sea and Bering Straits	Collection of specimens from native hunters - ADF&G funded.
June 1975	Barrow	Aerial survey of ringed seal - ADF&G and OCS funded.
August 1975-January 1976	Fairbanks	Office and laboratory analyses of data.
January 1976	Nome	Collection of specimens and field natural history observations.
February 1976	Fairbanks	Office and laboratory analyses of data.
February 1976	St. Lawrence Island	Collection of specimens and field natural history observations.
March 1976	Cape Lisburne and Surveyor Cruise	Collection of specimens and field natural history observations.

B. Methods

This project is dependent upon a sampling program which is to continue, intermittently, throughout the year. It involves acquisition of biological specimens for laboratory analysis and field observation of undisturbed seals. In anticipation of project approval a major sampling program was conducted at Eskimo hunting sites in the Yukon-Kuskokwim region, St. Lawrence Island and Bering Strait (funded by Alaska Department of Fish and Game). Methods of analysis during this first project year are as follows:

1. Existing literature and unpublished data are being reviewed and summarized in the traditional manner including abstracting pertinent papers and reports, and analyzing data already in hand (dating back to at least 1962). An OASIS search was conducted in an attempt to obtain additional references.

2. Acquisition of large amounts of specimen material required for an understanding of the natural history and ecology of these two species is continuing at major hunting

1. Summarization and evaluation of existing literature and available unpublished data on reproduction, distribution, abundance, food habits and human dependence on bearded and ringed seals in the target areas.

2. Acquisition of large amounts of specimen material required for an understanding of food habits in these two species.

3. Acquisition of additional data on productivity and fetal growth rate.

4. Acquisition of baseline data on mortality and morbidity (including parasitology, diseases, predation and human harvest) of ringed and bearded seals.

5. Determination of population structure of bearded and ringed seals as indicated by composition of harvest taken by Eskimo subsistence hunters.

6. Initial assessment of regional differences in density and distribution of ringed and bearded seals in relation to geographic areas and, to a lesser extent, in relation to major habitat conditions.

7. Acquisition of additional information on seasonal migrations.

III. Current State of Knowledge

A considerable amount of general background information concerning bearded and ringed seals is presently available and is being summarized under our task objective 1. Almost all of this information relates to general understanding of aspects such as reproduction, age and growth, gross physical characteristics, general seasonal movements, general distribution and food habits. However, the knowledge presently available remains inadequate for purposes of understanding the dynamic processes of these two species, their impact on and role in the northern marine environment and the probable effects of disturbance both to the species themselves and the environment on which they depend.

IV. Study Area

Beaufort, Chukchi (including Kotzebue Sound) and Bering (including Norton Sound) Seas.

villages. We have emphasized the collection of jaws and claws (for age determination), reproductive tracts, and stomachs. When possible weights and all standard measurements are taken (Table 1). In addition, selective collection by the PI's is utilized to collect animals under specific environmental, temporal or behavioral conditions. Selective collection provides additional data that cannot be obtained from the animals taken at the Eskimo hunting sites (Table 2).

3. The preliminary analysis of food habits of bearded and ringed seals will involve volumetric measurement of total stomach contents, separation and identification of major food items, and determination of frequency of occurrence and volume of prey species (Project RU# 232).

4. The sex of a specimen is determined by examination of the external genitalia or reproductive organs in those cases where the intact animal is not presented.

5. Examination of the claws provides a rapid and accurate means of age determination for seals up to six years of age, as growth rings or ridges are formed on the claw annually. After six years the claws are usually worn so that the initial ring ("constriction of birth") and subsequent rings are worn off.

   The ages of all seals are initially estimated by claw examination. A canine tooth is sectioned for each seal over six years old and the age is determined by enumerating the dentine or cementum annuli (Smith 1973 and Benjaminsen 1973).

6. Fetal, pup and adult growth rates are being based on weight and length measurements correlated with specimen age and date of collection.

7. Species productivity is being determined through laboratory examination of reproductive tracts and correlation of these data with the age of each specimen.

   Testes are weighed to the nearest 0.1g with and without epididymides. Length and width at the middle of the testes are measured to the nearest mm. Testes volume is determined by water displacement. Bacula are cleaned by boiling, air dried and then measured (nearest mm) and weighed (nearest 0.1g).

   The presence of sperm in the epididymides is used to ascertain breeding condition. The epididymides are sliced and a drop of fluid is squeezed onto a slide and examined under 78X or 300X magnification. Sperm presence or absence in the epididymal fluid is quantified as: none found, trace or abundant.

Table 1. Field data collected from seal specimens.

Species

Sex

Date of collection

Location of collection

Gross weight

Curvilinear (zoological) length - measured over curvature of body from tip of nose to end of tail, with head and neck in a natural position.

Standard Length - measured along a straight line on a flat surface, from tip of nose to end of tail, with head and neck in a natural position.

Axillary girth - taken around the body immediately behind foreflippers.

Maximum girth - the largest circumference around the abdomen.

Front flipper length - the distance along the anterior border of the forelimb, from axilla to tip of longest digit (not claw).

Front flipper width - the straight line distance from the tips of the first and last digits (not claws) of the spread flipper.

Hind flipper width - the straight line distance from the tips of the first and last digit (not claws) of the spread flipper.

Naval to anus length - the distance along the curvature of the body from the center of the umbilical scar to the anterior notch of the anus in males and to the vestibule in females.

Penis to anus length - measured along the body contour from the center of the penile orifice to the anterior notch of the anus.

Tail length - measured from the externally visible base of the tail to the end of the tail flesh (not hair).

Blubber thickness - over sternum.

Specimens

Jaw

Claws

Stomach

Reproductive organs

Tissue samples

Table 2. Additional field data collected during selective collections and as possible from seals taken by Eskimo hunters.

Time of collection
Habitat type and ice type
Behavior at time of collection
Group size and composition
Tidal stage
Water depth
Selected organ weights and/or measurements
Hide and blubber weight
Heart weight
Lung weight
Liver weight
Kidney weight
Spleen weight
Diaphragm weight
Small intestine length
Large intestine length
Tissue samples
Blubber
Blood serum
Heart
Skeletal muscle
Kidney
Liver
Diaphragm and tongue
Large intestine contents
Small intestine contents

Ovaries are weighed to the nearest 0.1g and then cut into 2mm longitudinal sections. The sections are left joined at the base to preserve their relative position. The sections are examined macroscopically for corpora lutea, corpora albicantia, follicles and ovarian masses or abnormalities. The largest diameter of corpora lutea, corpora albicantia and largest follicle are measured to the nearest mm. Drawings are made of each ovary for later reference. The presence or absence of a fetus is noted at necropsy.

8. All specimens are examined macroscopically for gross pathological conditions. We attempt to conduct a complete necropsy on each seal selectively collected. Time and conditions do not allow complete necropsies of all the specimens obtained in the various villages but we endeavor to examine, at least partially, as many as possible. The following necropsy procedure is used:

   a. The heart is opened so that all four chambers are visible, and the condition of the musculature, valves and pericardium are observed macroscopically.

   b. The pulmonary artery and aorta are opened and examined distally for about 10cm beyond their origins.

   c. The trachea is opened and examined from larynx to bifurcation.

   d. Both aspects of the lungs and their visceral pleura are observed and the organs are palpated to detect any consolidated areas. The primary and secondary bronchi are opened and examined from the tracheal bifurcation to 10-15cm beyond the hibus.

   e. The diaphragm is examined macroscopically and a small sample (about 25cm^2) is cut out and air dried at room temperature. These dried tissues will be subjected to a digestion procedure to recover possible encysted Trichinella spiralis larvae.

   f. Both aspects of the liver and spleen are observed macroscopically and the organs are sliced at 2cm intervals to allow examination of the parynchyma.

   g. The kidneys are both examined macroscopically, then sliced longitudinally through the hibus in the dorso-ventral plane, and the exposed cortex and medulla are examined.

h. The gall bladder is carefully removed from its attachments to the liver together with any remaining parts of the attached bile ducts and is examined macroscopically. In most cases at least half of the bile duct is missing and in several cases the contents of the gall bladder and bile duct have leaked away.

i. The esophagus is opened from larynx to cardia, the mucosa examined and any parasites (primarily ascarids regurgitated from the stomach) are collected.

j. The stomach is tied at the cardiac and pyloric sphincters, severed near these ties, injected with 10 percent formalin and placed entire (and unopened) in a 10 percent formalin solution. Upon subsequent examination the organ is opened, and the contents removed and washed with water onto sieves. The mucosa is also washed to remove any adhering matter. The washed mucosa is then examined.

Larger parasites (primarily anasakids and diphyllobothriids) are washed in 9-mesh (openings 2.00mm) and 16-mesh (openings 1.00mm) sieves and separated from the other stomach contents by workers in conjunction with the food habits study. Water and small suspended materials which pass through the larger mesh sieves are passed through a 60-mesh (openings 0.250mm) sieve and tiny helminths are recovered.

k. The duodenum, small intestine and large intestine are opened separately, the mucosa grossly examined and their contents suspended in saline or water. A small fecal sample may be removed from the distal portion of the large intestine and preserved in 2.5 percent potassium dichromate.

l. Samples (about $125cm^3$) of heart, liver, kidney, skeletal muscle and skin and blubber are wrapped in aluminum foil, labeled and frozen. These tissue samples will be provided to other investigators for microbiological, hydrocarbon, pesticide and heavy metal analyses.

m. The teeth of ringed seal specimens are examined for wear or chipping and those conditions are quantified according to the tooth wear index of Stirling (1969) (Table 3). In addition, ringed seal skulls in museum collections are examined and tooth wear quantified to determine the frequency, severity and ontogeny of oral pathology in Alaskan ringed seals.

Table 3. Tooth wear index.

Description	Score
Tooth chipped or worn	1 point per tooth
Tooth chipped or worn to pulp cavity	2 points per tooth
Abscess in bone <5mm in diameter	2 points per abcess
Abscessed jaw in cheek teeth row	3 points per abcess

9. Tissue and serum samples are being provided to other investigators for microbiological, heavy metal, and hydrocarbon determination.

10. Aerial, ship and ground surveys are being used to determine the distribution and densities of ringed and bearded seals killed by polar bears (Ursus maritimus), wolves (Canis lupus) and Arctic fox (Alopex lagopus). These dead seals are being examined to determine cause of death, physical condition, amount consumed by predator. Specimens are collected for laboratoty analyses. In addition, the geographic location, specific habitat (breathing hole, lead, lair, etc.) and ice type are noted. Standard measurements are made on all seals.

    Teeth and claws are collected to determine the age of the prey. Reproductive tracts are examined for sex and reproductive condition following standard techniques. Blubber, selected organs and tissues, stomach and digestive tract of prey species will be examined for parasites, diseases or pathologic conditions and food habits, and will be provided to cooperators for analyses for pesticides, heavy metals and petro-chemicals.

    Several ecological and behavioral parameters will be investigated to determine factors affecting prey availability and selection and hunting success of predators. For example, polar bears tend to take seals hauled out on the ice or in lairs, therefore, these factors influence hunting success of bears. The numbers and kinds of seals seen on the ice during surveys will be related to ice conditions, weather and seal biology data to obtain environmental and natural history correlates to hauling out behavior.

VI-VII. Results and Preliminary Discussion - Ringed Seal

1. Literature Review

Approximately 250 literature citations concerning ringed seals have been recovered thus far from our searches and those of OASIS and about 100 of these citations have been reviewed and summarized. OASIS searches were not as effective in finding new references as were our own because the OASIS searches did not extend back past 1972 for Biological Abstracts and 1964 for Oceanic Abstracts and Government Report Announcements.

Few studies of ringed seals have been conducted in Alaskan waters (Kenyon 1962; Johnson et al. 1966; Burns 1970; Burns and Harbo 1972). Most of the information presently available on Alaskan ringed seals is in the form of unpublished observations and extrapolations or hypotheses based on research conducted in Canada. Quantitative data are definitely lacking in the ringed seal literature. A summary of the literature is presented in the following paragraphs and a partial bibliography is presented in the References section of this report.

A. Distribution and Migration

Ringed seals have a circumpolar distribution in Arctic and Subarctic seas, and they are the most abundant seal found in the Arctic. Polar bears, arctic foxes and ringed seals are the only mammals that have been recorded north of 85°N latitude.

In Alaska, ringed seals inhabit the shorefast and moving pack ice of the northern Bering, Chukchi and Beaufort Seas. Stragglers have been collected at Unalaska Island in the Aleutian Islands (John Burns unpublished data) and on the Pribilof Islands.

The general distribution of ringed seals is limited by the distribution and quality of sea ice; however, some ringed seals are seen during ice-free periods in the Bering and Chukchi Seas. Seals appear at various coastal locations with the formation of shorefast ice in the Fall and then disappear in the Spring with the ice breakup. Seals which winter in the Bering Sea may appear to move farther and are more widely distributed than adult ringed seals. The density of ringed seals varies greatly with the area and the season, but chiefly depends on the stability of shorefast ice for reproduction.

In addition to man, predators of ringed seals include polar bears (the chief predator), Arctic and red foxes (Vulpes vulpes), dogs, wolves and ravens (Corvus corax).

11. Population structure of ringed and bearded seals is being assessed through sex and age determination of samples obtained at coastal hunting sites and in the course of shipboard work. Eskimo collectors have been established in various villages, with hopes of obtaining jaws and claws and other specimen material from seals killed by the villagers. The collector also maintains a log of dates, species and sex of kills.

12. Regional differences in seal density and distribution are being assessed through aerial and shipboard surveys. Aerial survey techniques that are being used are discussed in detail by Burns and Harbo (1972). Shipboard survey techniques are being developed by us.

    The first aerial survey was conducted in June 1975 from Barrow and was jointly funded by Alaska Department of Fish and Game and OCSEAP. An aerial survey of Norton and Kotzebue Sounds and adjacent areas will be conducted in June 1976 and one or two flights will be flown over the ice near Barrow to recheck seal densities. The Barrow flights will be in June, concurrent with the Norton and Kotzebue Sound survey.

    A shipboard survey will be conducted at the ice edge in the Bering Sea from 13 March to 25 April 1976 aboard the Surveyor.

13. Seasonal migration patterns are being determined through observations at coastal hunting sites, and from shipboard and aerial surveys.

14. Natural history and behavioral observations are obtained from several sources: (1) field observations by the principal investigators, (2) unpublished field observations of other reliable investigators, (3) reports from Eskimos, and (4) observation of captive animals.

    The bulk of the natural history and behavioral observations are recorded by the principal or other investigators while they are on the sea ice, or aboard ships, skin boats or aircraft. These observations are usually made with the aid of field glasses or spotting scopes and are recorded as field notes with appropriate ecological and behavioral conditions.

    Because of the amount of time they spend on the ice pursuing marine mammals, Eskimo hunters can provide a wealth of information concerning behavior and natural history. However, this information is accepted with caution. Interview of several hunters may be required to separate facts from legends, or information given just to please the investigators. Rarely has information been given which is intended to mislead the investigators.

B. General Characteristics

Ringed seals are the smallest of all pinnipeds (seals, sea lions and walruses) with adults in Alaska rarely exceeding 155cm in standard length. There is little difference in size between males and females. Adult ringed seals seldom exceed 90kg in Alaskan waters, however, the weight of the individual varies with the season. Heaviest weights are achieved in the winter and early spring when the seal has a thick layer of fat or blubber under the skin. The blubber provides insulation and is an energy source during the breeding and pupping seasons. The weights of ringed seals appear to decline with the decrease in feeding during the reproductive and molting season.

The color of ringed seals is quite variable, but the basic pattern is a gray back with black spots and a light belly. The black spots on the back are ringed with light marks from which comes the seal's name.

C. Etymology

The generic name Pusa is derived from the name used for seals by the people of Greenland. The specific name hispida is Latin for rough or bristly and appears to refer to the adult pelage (King 1964).

The Inupiat Eskimos refer to the ringed seal as "natchek" and to the Yupik-speaking Eskimos of the Bering Straits it is "niksik".

D. Food Habits

Ringed seals eat a variety of invertebrates and fish. The species eaten appears to depend on availability, depth of water and distance from shore. The important food species are Arctic cod, sculpins and crustaceans (particularly shrimp, mysids, amphipods and euphausiids).

E. Biology

Biology: Females give birth to a single, white coated pup in ice dens (lairs) on both land-fast and drifting pack ice during March and April. The female seals build the lairs on ice pressure ridges or under snow in refrozen leads for protection from predators and severe weather. Lairs are about 10 feet (305cm) long with an entrance from the water located at one end.

There is some evidence that females lacking maternal experience give birth in marginal habitat--drifing pack ice--and may be more subject to polar bear predation. The more experienced females give birth in better habitat, land-fast ice, and may have higher reproductive success.

At birth the average weight of pups is 10 pounds (4.5kg) and the average length is about 24 inches (61 cm). Females nurse pups for about 2 months during which the pup doubles its birth weight, to about 20 pounds (9.0 kg). This gain is due to an increase in blubber thickness which provides the pup insulation to reduce heat loss to the cold water, air and ice, and provides an energy reserve. Weaning usually takes place at ice breakup.

Most females breed again within a month after the birth of the pup. Implantation of the new fetus is delayed 3-1/2 months and occurs in mid-July or early August. Pregnancy lasts about 11 months. The incidence of pregnancy in adult females is about 85 to 90 percent, and a fetal sex ratio of 1:1 has been found in Alaskan specimens. Female ringed seals first ovulate at five or six years of age but successful conception does not appear to take place until the female is seven years old. Males become sexually mature at seven or eight years of age.

Ringed seals have been reported to live to an age of 36 to 40 years in the wild, however, very few animals exceed 10 to 15 years of age.

F. Vocalizations

Until recently the ringed seal has been considered a silent species unlike many of its relatives which produce very melodious and complex "songs." Recent studies have found that ringed seals do emit several types of vocalization underwater and that these vocalizations are not readily audible above water or ice. Although these vocalizations are "heard" all year, if one uses a hydrophone (underwater microphone), the number of vocalizations increases during the breeding season. This may mean that the vocalizations are used to maintain social organization or to defend territories.

G. Behavior

The behavior of ringed seals is poorly understood since both males and females spent the greater part of the year in lairs or in the water. From May and June until ice breakup, ringed seals "haul out" on the shorefast ice on sunny and warm days and undergo a molt (shedding and regrowth of the hairs). Apparently the warmth and rest are required for rapid regrowth of the hairs.

H. Hunting

Ringed seals are hunted by Alaskan coastal residents from Mekoryuk to Kaktovik for human and dog food and skin for clothing, equipment and crafts. The annual harvest for subsistence purposes has ranged from 20,000 in 1964 to 5,000 in 1973, which was the first year after the passage of the Marine Mammal Protection Act.

I. Parasites

Twenty-six parasites have been reported from ringed seals throughout its range (Table 3). However, ringed seal parasites and their associated pathologies have not been intensely investigated in Alaskan waters.

Table 3. Parasites reported from the ringed seal.

Trematoda
Orthosplanchnus articus Odhner, 1905
Phocitrema fusiforme Goto and Ozaki, 1930
Pseudamphistomum truncatum (Rud., 1819) Luhe, 1908
Anophryocephalus anophrys Baylis, 1922
Trigonocotyle skrjabini Krotov et Delymure, 1955
Cestoda
Diphyllobothrium fasciatus Krabbe, 1865
Diphyllobothrium hians Diesing, 1850
Diphyllobothrium latum (L., 1758) Luhe, 1910
Diphyllobothrium lanceolatum Krabbe, 1865
Diphyllobothrium tetrapterus Siebold, 1848
Pyramicocephalus phocarum (Fabricius, 1780) Monticelli, 1890
Schistocephalus solidus Muller, 1776
Nematoda
Contracaecum sp.
Contracaecum osculatum (Rud, 1802) Baylis, 1920
Terranova decipiens (Krabbe, 1878) Baylis, 1916
Phocascaris netsiki Lyster, 1940
Otostrongylus circumlitus (Railliet, 1899) Bruyn, 1933
Dipetalonema spirocauda (Leidy, 1858) Anderson, 1959
Trichinella spiralis (Owen, 1835) Railliet, 1895
Acanthocephala
Bolbosoma nipponicum Yamaguti, 1939
Corynosoma sp.
Corynosoma reductum Linstow, 1905
Corynosoma semerme (Forsell, 1904) Luhe, 1911
Corynosoma strumosum (Rud., 1802) Luhe, 1904
Corynosoma wegeneri Heinze, 1934
Anoplura
Echinophthirius horridus (Olfers, 1816) Fahrenholz, 1919

2. Specimens

During the 1975 hunting season 520 ringed seals were collected from seven villages (Table 4). Measurements, jaws, claws, stomachs or reproductive tracts were obtained from most specimens. Partial data are available from about 600 additional specimens collected from 1962 to 1974. In 1976, 31 specimens have been collected from 2 villages so far. All of these specimens are being processed as rapidly as possible.

Table 4. Ringed seal specimens collected by Eskimo hunters, 1975.

Location	Male	Female	Unknown	Total
Mekoryuk	9	19		28
Nome	11	6		17
Gambell	1		1	2
Savoonga	209	133		342
Diomede	35	29		64
Shishmaref	17	8		25
Wainwright	17	15		32
Barrow	8	1	1	10
Total	307	211	2	520

3. Food Habits

See Annual Report of "Trophic relationships among ice inhabiting phocid seals" (RU# 232).

4. Productivity and Growth Rates

A knowledge of the factors affecting the productivity of the ringed seal is needed to assess, and, hopefully, lessen possible adverse impacts of outer continental shelf development. Productivity of a species is determined ultimately by fecundity (number of viable ova produced, which is influenced by an array of synergestic parameters) and mortality. On a proximal level we are interested in the various factors which affect: 1) fertility, the number of pups produced; 2) pup survival to breeding age; and 3) mortality and morbidity of the breeding segment of the population.

A. Fetal Growth Rates

The embryonic and fetal development of the ringed seals is one of the parameters that influences fertility. Embryological development is usually considered as a continuous process of growth and differentiation from the formation of the zygote to parturition. Growth and differentiation appear continuous, albeit slow during the 3-1/2 month delay before implantation, but the factors that affect the rate of growth and differentiation are unknown.

Female ringed seals appear to be impregnated in mid-April soon after the birth of the pup. Impregnation is followed by a delay of up to 3-1/2 months before implantation, approximately in August. Additional seal specimens are required from August and September to demonstrate the precise period of implantation and to determine early fetal growth rates.

Thus far, 44 ringed seal fetuses have been examined and measured. A 1:1 fetal sex ratios (22 males and 22 females) has been found. The fetal growth curve for length (Fig. 1) closely resembles those from ringed seals in Canada (McLaren 1958). The growth curve for weight is similar to those for most mammals (Fig. 2). The relative growth of length and weight is more rapid in mid-pregnancy with relative growth rates leveling off in late pregnancy (Fig. 3). No differences in growth rates of males and females were detected, however the sample size was small.

B. Pup Growth Rates

Weights of 44 ringed seal pups (23 male and 20 female and 1 sex unknown) have been obtained thus far (Fig. 4). Ringed seal pups weigh about 4kg at birth. A live pup, two or three days old weighed 5kg while the mean weight of eight full-term fetuses was 3.4kg.

Pup weights increase steadily from birth and appear to level out in August or September. However, our sample size of pups collected after July is very small.

The mean weights of male and female pups collected during specific periods generally do not differ. However, there is more variation in the weights of males than in the females.

Blubber thickness over the sternum increases from a trace at birth to 1.8cm in May. During June and July the blubber thickness decreases to 1.5cm and this decrease in thickness is probably associated with the loss of weight immediately after weaning in late May. By

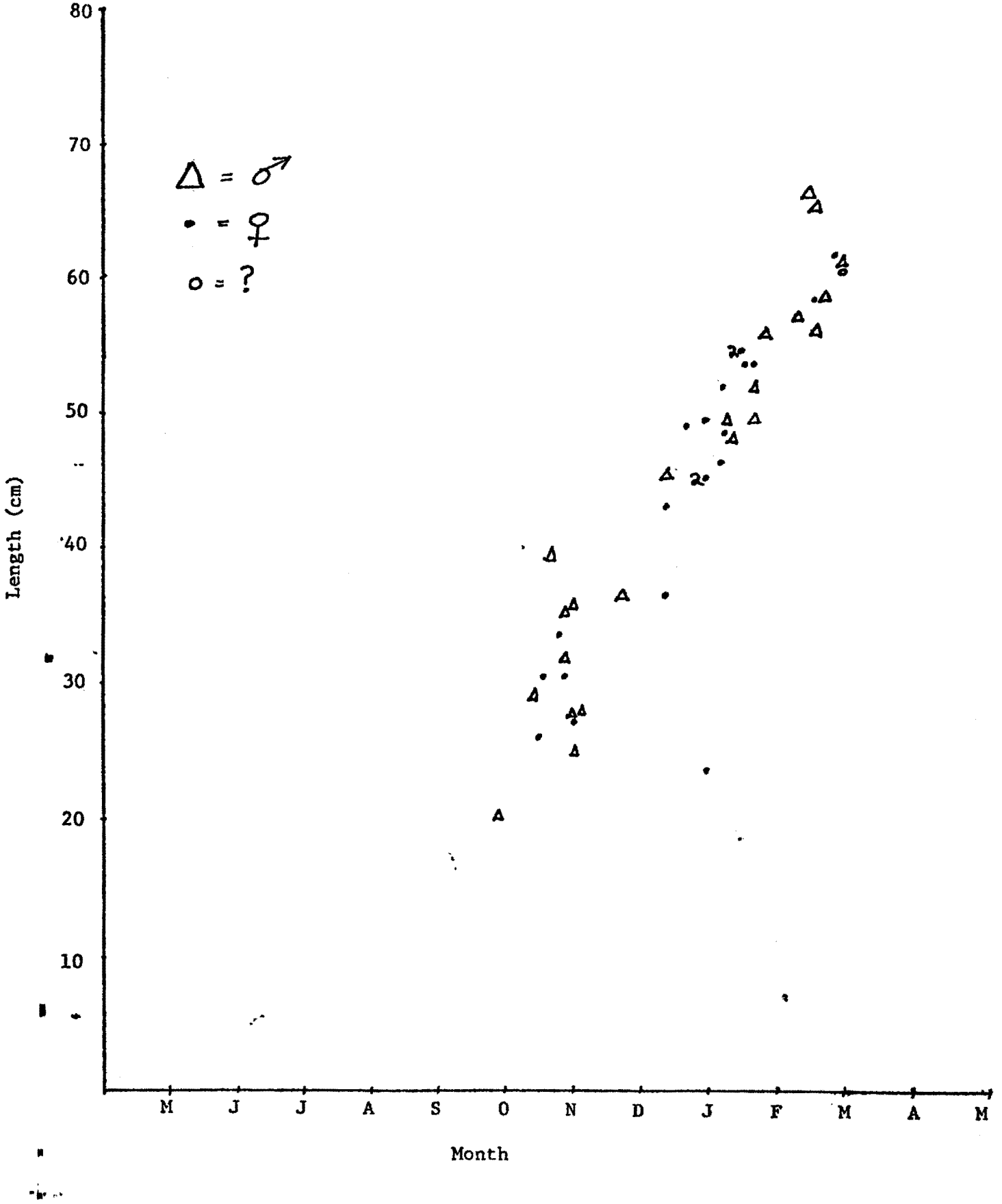

Figure 1. Fetal growth, length in relation to month of collection.

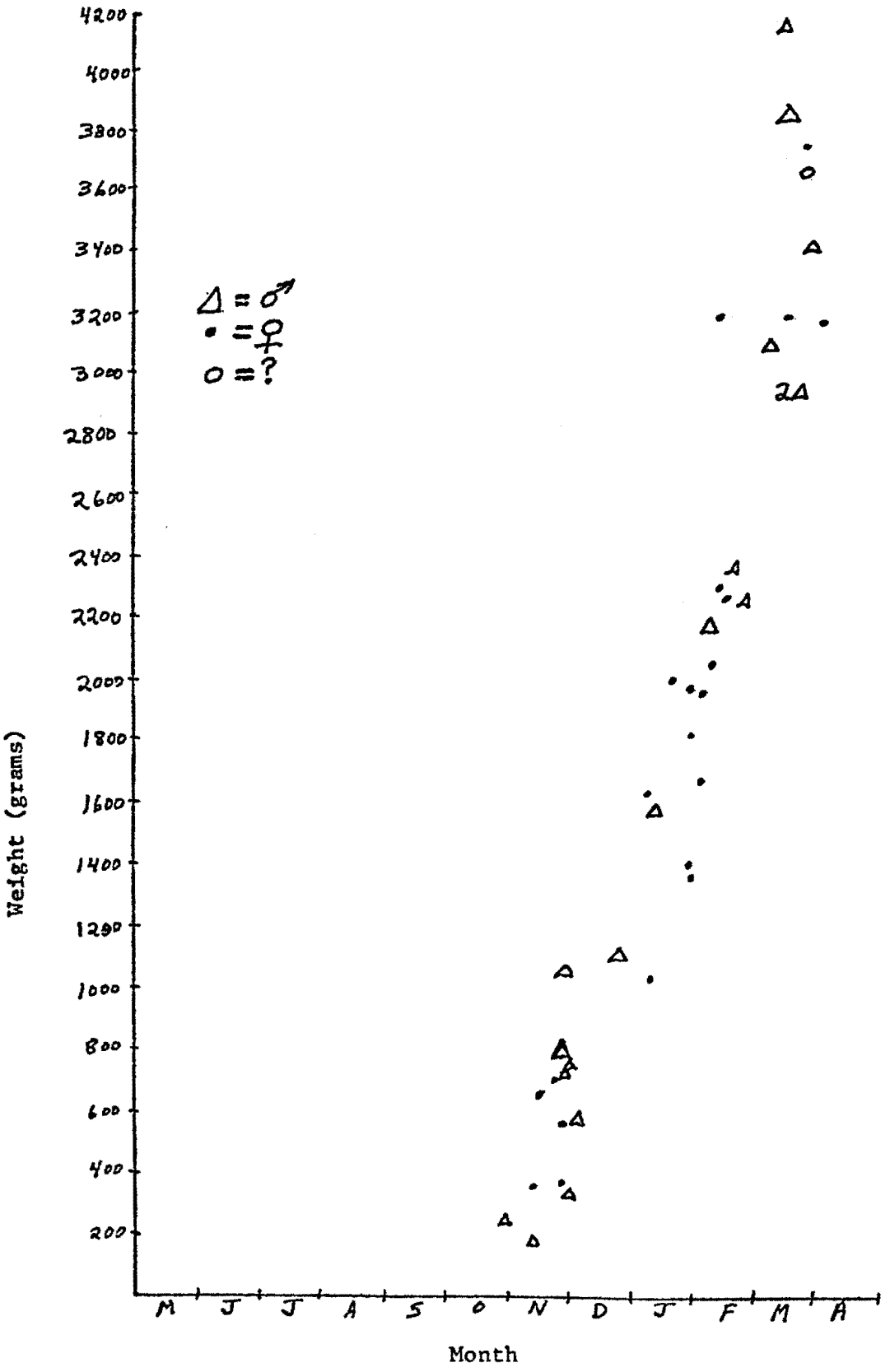

Figure 2. Fetal growth , weight in relation to month of collection.

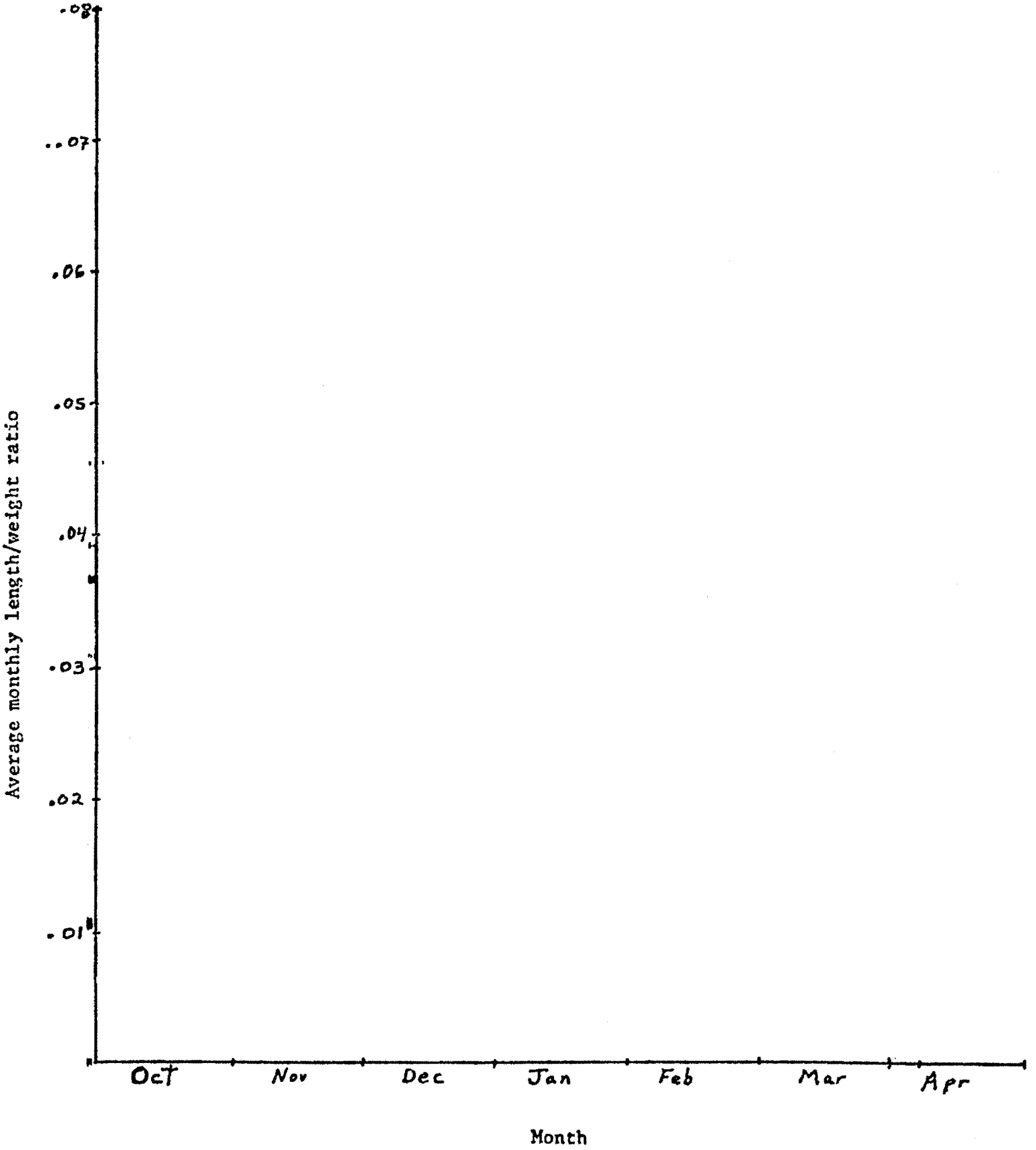

Figure 3. Fetal growth , length in relation to weight.

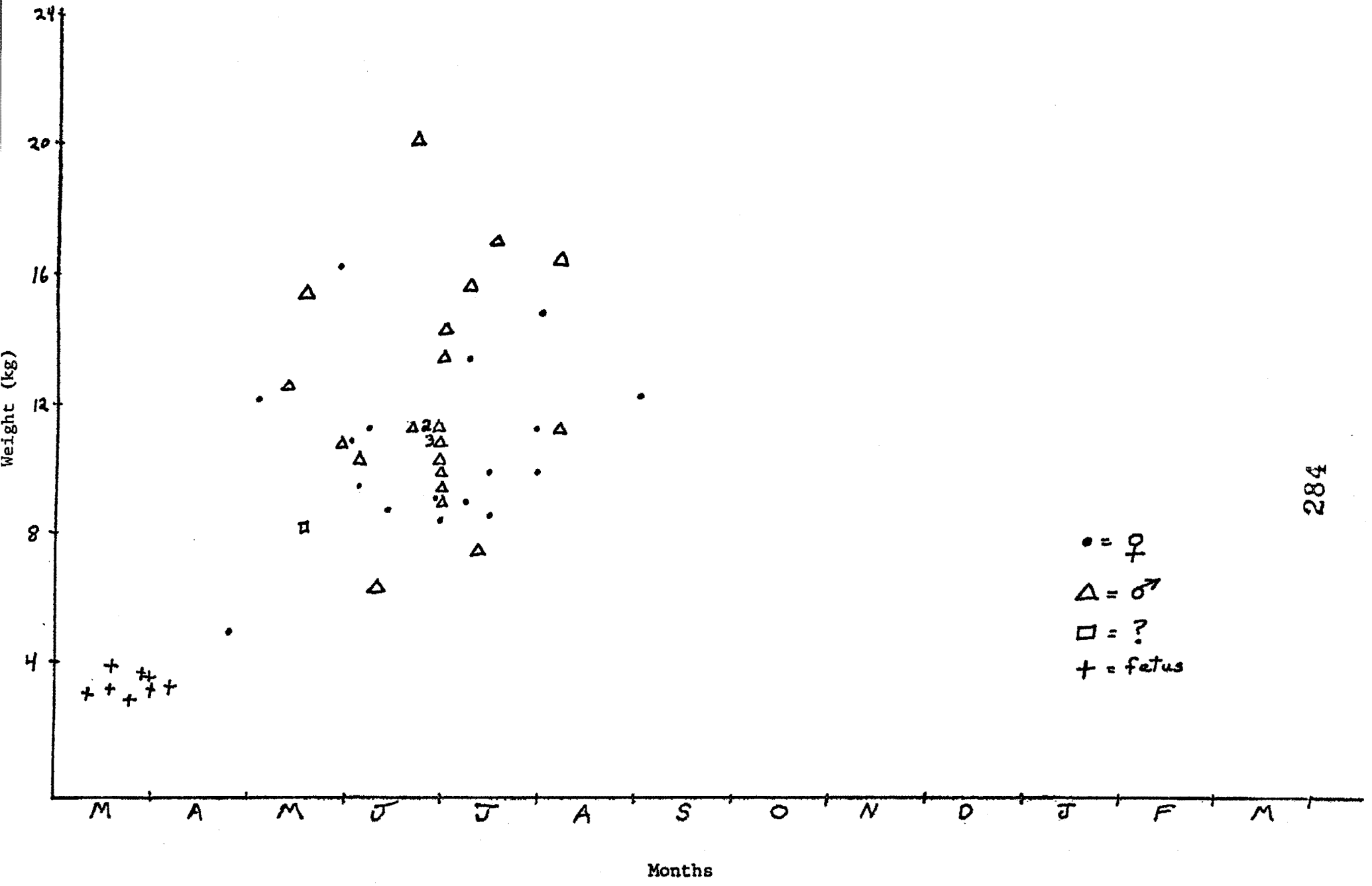

Figure 4. Pup growth , weight in relation to month of collection.

August the mean blubber thickness is about 1.8cm and then increases to 2.5cm in September and 3.1cm in February. There appears to be no difference in blubber thickness between male and female pups.

C. Reproduction

The epididymides of 94 males (representing all age classes and collected during all months) have been examined for the presence of sperm. Active spermatogenesis has been detected only in males seven years old and older and collected during March, April, May and June (Table 5). A trace of sperm was detected in a male collected in July.

Table 5. Sperm presence in the epididymides of males seven years old and older.

Month	Number Examined	Sperm Presence		
		Abundant (Number)	Trace (Number)	None (Number)
January	3	-	-	3
February	1	-	-	1
March	5	5	-	-
April	6	6	-	-
May	8	8	-	-
June	10	4	4	2
July	5	-	1	4
August	0	-	-	-
September	0	-	-	-
October	2	-	-	2
November	11	-	-	11
December	12	-	-	12

Analyses of the female reproductive tracts have not begun.

5.. Parasitology and Diseases - Ringed Seals

A total of 17 ringed seals were necropsied by the Principal Investigators and/or Mrs. Carol Nielsen. The specimens collected from these seals for later laboratory analyses and study are presented in Table 6. Dipetalonema spirocauda was collected from the heart of the Nome specimen, and this appears to be the first record from ringed seals in Alaskan waters (Margolis and Dailey 1972).

The stomachs of 47 additional ringed seals were examined in conjunction with food habits studies. These stomachs were from seals collected at Barrow, Wainwright, Diomede, Savoonga, Gambell and Mekoryuk during spring and summer 1975. For the 45 ringed seals, the stomachs were processed as described previously, using the 60-mesh sieve to recover tiny helminths. However, for two animals only the larger helminths were recovered (i.e. only those helminths retained in the 9-mesh sieve).

All helminths recovered from the seal stomachs were placed initially in 10 percent formalin and later removed to AFA (alcohol-formalin-acetic acid solution with glycerine). After examination and classification, nematodes and acanthocephala were removed to 70 percent ethanol with glycerine while cestodes were replaced in AFA.

Table 6. Ringed seal necropsy specimens by location and date.

Specimens	Wainwright July-Aug. 1975 n = 6	Barrow Dec. 1975 n = 9	Nome Jan. 1976 n = 1
A. Normal tissue			
Blubber and skin	-	8	1
Heart	-	8	1
Lung	1	8	1
Liver	6	8	1
Kidney	-	8	1
Striated muscle	-	8	1
Duodenum mucosa	1	-	-
B. Pathological tissue			
Diaphragm	6	8	1
Liver	4	-	-
Duodenum mucosa	1	1	-
Small intestine mucosa	1	1	1
Large intestine mucosa	2	1	1
C. Parasite specimens			
Mouth and esophagus	1	-	-
Duodenum	4	1	1
Small intestine	4	2	1
Large intestine	6	3	1
Fecal specimen from rectum	6	2	1
Heart	-	-	1

Parasitology and Diseases - Bearded Seals

A total of 44 bearded seals were examined for parasites and/or diseases. Seals were collected by Eskimo hunters from the villages of Barrow, Wainwright, Diomede, Savoonga, Gambell and Mekoryuk between April and August 1975. Complete necropsies were conducted on nine of the Wainwright seals by J. Burns and Carol Nielsen, ADF&G parasitologist. Only the stomachs of the remaining 35 animals were examined. These stomachs were available in conjunction with the food habits studies. Stomachs were processed as described in methods section 8j. However, eight stomachs were examined for larger helminths only, using a 2.0mm, 9-mesh sieve. All helminths recovered from bearded seals stomachs were preserved as described in the ringed seal section of these results.

Examination and classification of the parasites recovered, nematodes and acanthocephala, is presently underway. Parasitological work on bearded seals is being conducted by C. Nielsen.

6. Population Structure

Ringed seals comprise about 65 percent of the seal harvest by Eskimo hunters in Alaskan waters. The preponderance of ringed seals in the harvest does not necessarily reflect preference by the hunters, rather it indicates the ready availability of ringed seals. Ringed seals can be hunted during almost every month except for late summer in those years when the ice moves far north of Barrow.

The sex composition of our specimens collected under the aegis of OCS (Table 4) and other samples (Burns, unpubl. data; Eley, unpubl. data; Grauvogel, unpubl. data) are weighted towards males. Males constituted 59.3 percent of our sample. Grauvogel (unpubl. data) found that male ringed seals comprised 57.0 percent and 55.6 percent of the 1973 and 1974, respectively, ringed seal harvest in the northern Bering Sea and Bering Straits area.

The predominance of males in the harvest may indicate the true sex ratio. More likely, however, the males may be more mobile due to searching for females or defense of a territory, therefore more likely to expose themselves to a hunter. However, Mech (1973) found a predominance of males in a wolf population at a high density and a preponderence of female wolves in populations that had been heavily exploited. In future studies we will investigate the relationship of age, season and geographic location to the sex ratio.

7. Geographic Variation in Densities

See Annual Report of "The relationship of marine mammal distribution, densities and activities to sea ice" (RU #248/249).

VIII. Conclusion - Ringed Seal

Ringed seals and associated data have been gathered by the Department of Fish and Game personnel since 1962. However, this annual report covers examinations and analyses conducted between 8 September 1975 and 1 March 1976. Most of our sampling and analyses are incomplete at this time and of an on-going nature. Therefore the results and their preliminary interpretation are considered tentative and are not to be quoted without permission of the Principal Investigators.

Adult ringed seals are mainly associated with the shorefast ice of the Bering, Chukchi and Beaufort Seas. By virtue of their nearshore habits and numbers, they are important to the coastal residents as a source of food and usable products. Proposed OCS lease areas in the Bering and Beaufort Seas are within the habitat of the ringed seal and pose a real threat to this species. The objective of our studies are to develop a baseline of ecological and behavioral data in order to prevent or lessen adverse impacts of outer continental shelf development.

1. A literature review is underway and about 250 citations pertaining to ringed seals has been recovered.

2. Few citations pertain specifically to ringed seals in Alaskan waters.

3. A summary of the literature reviewed thus far is presented.

4. Over 500 specimens have been examined under the aegis of OCSEAP but not all of the desired kinds of data could be collected from each one.

5. Specimens from the fall and winter are lacking in our samples.

6. Preliminary analyses of fetal growth rates have begun but our sample is not yet large enough to investigate geographic variation in growth rates.

7. No difference in the growth of male and female fetuses was detected and the sex ratio was 1:1.

8. Preliminary analyses of pup growth rates indicates little difference in the growth rates of male and female pups. However, male pups show greater variation in weights.

9. Active spermatogenesis has been detected only in males seven years old and older and collected during March, April, May and June.

10. Parasitological examinations have begun but identifications of parasites recovered are incomplete.

11. Dipetalonema spirocanda was collected from the heart of a seal taken in Nome and this appears to be the first recorded from ringed seals in Alaskan waters.

12. Ringed seals comprise about 65 percent of the seal harvest by Eskimo hunters.

13. The sex composition of ringed seals in the harvest is weighted towards males.

Bearded Seals

Information and specimens were obtained from 162 bearded seals collected at hunting sites from Nunivak Island in the Bering Sea to Wainwright in the northern Chukchi Sea. Analyses of data from these seals and examination of specimens was not completed by the time this report was prepared. The results of analyses and summary of findings will be presented in the next report.

IX. Needs for Further Study - Ringed and Bearded Seals

Our first need for futher work is the examination of additional specimens, especially from the fall and winter and from the Beaufort Sea, so that we can fully address our task objectives.

Secondly we perceive the need, and plan the development, of a behavioral basis for the management of ringed and bearded seals. To accomplish this objective requires, in part, answering some specific questions.

1. What are the "normal" behavioral and activity patterns (including feeding, social organization and migration) of Pusa and Erignathus and how do these patterns change with varying environmental, temporal, seasonal and geographic conditions?

2. Under what environmental, behavioral or physiological conditions are these animals hauled out on sea ice where they may be assessed by visual or remote sensing techniques?

3. What alterations to normal behavioral and activity patterns are caused by human disturbance and what are the effects of these alterations on the population dynamics, ecology and physiology of these seals?

The acquisition of these behavioral data will allow us to more fully assess the impact of outer continental shelf development on ringed and bearded seals. Adverse impacts may be lessened if we have an understanding of the ecosystem and the suite of factors that directly effect its component parts.

X. Summary of 4th Quarter Operations - Ringed and Bearded Seals

A. Field and laboratory activities

1. Schedule

Dates	Location	Activity
January 1976	Fairbanks	Office and laboratory analyses of data and prepration of data management plans.
January 1976	Nome	Collection of specimens and field natural history observation.
February 1976	Fairbanks	Office and laboratory analyses of data.
February 1976	St. Lawrence Island	Collection of specimens and field natural history observation.
March 1976	Fairbanks	Preparation of annual report.
March 1976	Cape Lisburne and Surveyor cruise	Collection of specimens and field natural history observation.

2. Scientific Party

Names	Affiliation	Role
John J. Burns	ADF&G	Bearded seal natural history
Thomas J. Eley	ADF&G	Ringed seal natural history
Lloyd F. Lowry	ADF&G	Ice pinniped trophic relationships
Kathryn Frost	ADF&G	Ice pinniped trophic relationships

Carol Nielsen	ADF&G	Marine mammal parasitology and pathology
Bonnie F. Friedman	ADF&G	Natural history technician
Glenn Seaman	ADF&G	Natural history technician
Harry Reynolds	ADF&G	Area Biologist - Barrow
Carl Grauvogel	ADF&G	Area Biologist - Nome
Edward Muktoyuk	ADF&G	Marine mammal technician

3. Methods

See Annual Report.

4. Sample Localitities

Bering (including Norton Sound), Chukchi and Beaufort Seas.

5. Data Collected or Analyzed

It must be remembered that this report of fourth quarter activities covers only two months (January and February) of the fourth quarter and our major field activities begin in mid-March. In addition, approximately three weeks of this quarter has been taken up with OCSEAP required meetings, particularly data management, and preparation of the Annual Report.
These two activities have severely reduced the time available for completion of work required under the terms of the contract.

The bulk of our analyses consisted of laboratory, graphical or statistical examination of specimens or data collected during the spring and summer of 1975., we emphasized sex composition of the harvest, male reproductive condition, age determination, parasitological collection, pup and fetal growth and literature review. In addition, more samples were obtained from several villages.

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