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REPORT OF THE WORKSHOP ON THE STATUS OF NORTHERN FUR SEALS ON THE PRIBILOF ISLANDS, ALASKA

Held

November 14-16, 1983

Seattle, Washington

Edited by

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0.0 Introduction

As shown in Figure 1, a decline has been observed in the estimated number of northern fur seal pups born on the Pribilof Islands since the 1950's. The degree to which the population has been reduced, the causes of the decline and future prospects are of concern in view of both domestic legislation and international agreements. To address the issue of the status of the Pribilof stocks of northern fur seals a workshop was held in Seattle, Washington on November 14-16, 1983. Participants (Appendix I) were invited to review the NMML data base, published papers, and background materials (Appendix II). The agenda for the meeting is included as Appendix III.

Considerable progress has been made since 1983, along a number of fronts, using the results and suggestions from the 1983 workshop as guidelines. A number of the papers used in draft form in 1983 are now in final form as background papers for the North Pacific Fur Seal Commission (NPFSC) or are published.

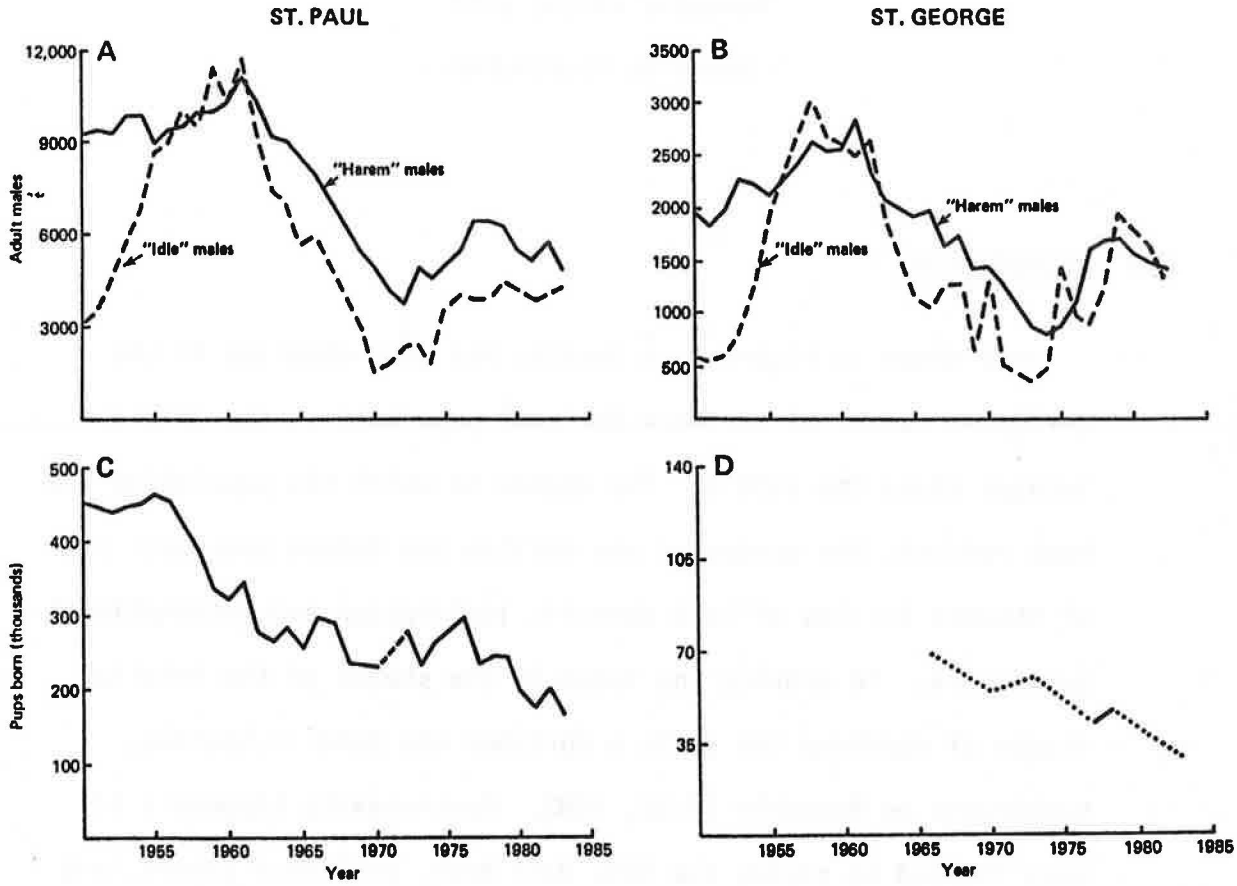

Figure 1. Historical records of male abundance, based on counts conducted in July, and estimated pup numbers at birth for each of the Pribilof Islands since 1950(from Fowler 1982).

The published forms are indicated in Appendix II. On at least two occasions the text of this report contains editorial note of differences between what the report indicates and what has been determined from subsequent analysis. The conclusions of the group, however, were left as they were on the basis of information available at the time of the workshop and in response to reviews.

The editorial process involved several steps as each section of this report was written by a volunteer workshop participant. First, the reports generated for each section by the individuals responsible were collected, collated, and edited for flow and transition between sections. The resulting first draft was then circulated to all participants for review. Using their comments the current version of this report was produced to best reflect the view of the group at that time (early 1984). A concensus was not always possible. Differences of opinion, therefore, are noted.

The objectives of the workshop were to:

1) examine data relative to the status of northern fur seals (in 1983);
2) examine the potential causes and identify the most likely cause(s) of the decline; and
3) determine the directions in which research might progress to further clarify issues related to objectives 1 and 2.

1.0 Review of trends in the numbers of northern fur seals on the Pribilof Islands

Several segments of the northern fur seal population of the Pribilof Island have been monitored through counting or other estimating techniques for a long period of time. These include counts of adult males, counts or estimates of the number of pups born, counts of dead pups, and the total number of animals taken in the harvest. Since 1912, when fur seals were protected from pelagic sealing, all data suggest that the population increased until it reached a high level by at least the early 1950's and possibley as early as the early 1940's. The harvest of males increased as was expected and reached a high exceeding 60,000 per year in the 1950's. Harvests of the 1950's and 1960's were characterized by rather large fluctuations. With the fur seal population at high levels, counts of dead pups increased suggesting that the population might be above the level that could produce a maximum sustainable yield (MSY). Along with these changes came reductions in body size compared to the early 1900's. For these and other reasons, the harvest policy of taking only subadult males was changed, beginning in 1956 to kill also a substantial number of females. It was thought that this reduction of the number of females would reduce the population to a more productive and stable level.

The reduction of the female herd continued until 1963 with more modest female kills from 1964 to 1968. The population did not respond to this reduction in the expected way; the number of animals available and included in the harvest is less than expected, the count of adult males has declined and the recent declines in the number of pups born was unexpected. In fact, the data suggest that the population of the early 1980's was about 50% of the mid-1950's level, which is lower than the level estimated to provide MSY. The present trend is downward. Therefore it was essential that all available data be evaluated to determine if they reliably indicate the present population trend and size, and to determine what is causing the current declining trend.

1.1 Counts of Adult Males

Adult males have been counted nearly every year on both St. Paul and St. George Islands since the early 1900's. The males are classified into "harem males" (territorial males with females) and idle males (other adult males). Determining the number of harem males is straightforward and readily apparent, however classifying males as idle males requires a subjective determination regarding whether or not they are adult. Size may be used but requires judgment and the potential for error exists. Work by Johnson (1968) shows that few males reach adult size before age 7 and nearly all harem males are

age 9 or older. However, full recruitment to the breeding male population is not achieved until about age 10, an age that is difficult to separate from 9-year-olds on size alone. Territoriality is the most often used criteria. If a male can be moved from its territory, it is not considered territorial.

The female herd reduction program that was begun in 1956 was also accompanied by changes in the male harvest--increases in the length of the season and in the size range of subadult males permitted to be killed. Since the number of harem males depends on the total number of adult males and the number of females, and possibly other abiotic factors, it was not surprising that beginning about 1960, i.e. after an appropriate time lag, counts of both categories of adult males dropped sharply. The counts reached a low point in the early 1970's and increased thereafter for some years but are currently declining. Both categories of adult males have shown essentially the same pattern but the count of idle males on St. George Island has been more variable.

Clearly while the counts of adult males in the two identified categories must indicate gross changes in the total adult male population (a decline in this case), changes in the rate of escapement and possible changes in counting methods complicate the interpretation of these counts. Therefore it cannot be assumed that trends in the harem and idle bull counts will accurately reflect changes in the adult male population. Thus, although a decline is indicated, the extent of the decline, or the rate of decline, may be difficult to estimate with bull numbers.

1.2 Estimates of the number of pups born

Several techniques have been used to develop estimates of the number of pups born. Techniques have changed through time and during the period when the population was at its maximum size in the late 1940's and early 1950's, few completely reliable estimates are available. Chapman (1964) developed estimates based on the recovery of marked males in the harvest for this period and later developed estimates using the size of the male kill, estimates of pregnancy rates and other parameters (often referred to as "accumulative estimates"). York (1985) developed an estimate of the number of pups born in 1940 from the harem male count and the pups counted on one rookery. Since the early 1960's the number of pups has been estimated for several years using shearing and sampling techniques (Chapman and Johnson, 1968). After a review of the estimates and strong points or shortcomings of the estimates, the majority of the workshop participants agreed that the number of pups born each year during the early to mid-1950's was probably in excess of 400,000. Several participants argued that the variability inherent in these estimates might preclude such a conclusion.

Beginning in the early 1960's a method of marking and sampling (shearing and sampling) during the year of birth was developed and tested. In 1963 this technique was used for the first time. In the next several years it became standardized and was used to estimate the number of pups born most years on St. Paul Island and several

years on St. George Island. An extension and modification of the shearing and sampling technique used in recent years takes advantage of pup to bull ratios which are observed to be consistent among rookeries within eyars (Kozloff, 1981). Collectively these estimates suggest that there was an initial decline in the number of pups born on St. Paul from about 400-450,000 in the mid-1950's to 230-300,000 in the mid-1970's. The intentional harvest of females was the primary cause of the initial portion of this decline (York and Hartley, 1981). Since 1978 the estimates for St. Paul Island suggest the population is again declining and in 1983 the number of pups born was estimated to be 166,000. The estimates from St. George Island suggest similar changes on that island.

A number of factors that may bias estimates using any of these techniques were identified and discussed. It was concluded that estimates developed prior to the 1960's were of lowest confidence and estimates since 1963 were more reliable. However, the majority of the group felt that there was little question that the number of pups born has declined and estimates since 1980 suggest the decline has resumed. Also, most of the group agreed that there was little doubt that the number of pups born in 1983 is 50 percent (or less) of the number born in the mid-1950's.

1.3 Harvest

The number of males harvested each year provides one of the most complete records in the fur seal data base. The methods of harvesting have been relatively constant through time. However, there are several changes that have been made that have probably had an effect on the proportion of animals that are taken in the harvest. Changes thought to have a significant effect include: changes in length limits; the number of people in sealing crews; motivational factors (such as pay per hour vs. pay per pelt); changes in the dates and duration of the season; and the number of times the hauling grounds are driven during a season. Thus, it was agreed that the number of males killed cannot reliably indicate the size of the subadult male population, though the decline in the harvest certainly does reflect a general decrease in this population component.

1.4 Other Trend Indicators

Some quantitative data are available, primarily from St. George Island, that show the number of animals hauling out on rookeries and hauling grounds has declined. Casual observations on St. Paul Island suggest a similar decline. The declines on rookeries are most obvious at the periphery. These observations lend support to the conclusion that the population has declined since it is unlikely that the actual proportion of the animals hauling out has changed.

2.0 Comparison of current population levels with those of the 1940's and early 50's.

2.1 Adult males

There was substantial discussion of the effect of the number of females and of the sex ratio on the ratio of harem to idle bulls. It was stated that the ratio of the number of pups to harem bulls has decreased on both islands in recent years (since the early 1970's) but more so on St. George Island than St. Paul Island. It was also noted that each year the "idle bull count" is conducted over a period of only one or two days and hence does not necessarily reflect the seasonal dynamics of the two components of the adult males, i.e., either the interchange between idle and harem bull categories or the interchange between being hauled out on land or being away at sea.

The question of whether it is necessary to consider both the harem and idle bull counts was posed. It was argued that to make relative statements or comparisons, the best index should be used and this is the harem bull count (at least for adult males). It must be kept in mind, however, that during the 1950's there was a several-fold increase in the count of idle males; during the same period the counts of harem bulls increased only a fraction.

In summary, the workshop group agreed that there has been a substantial drop in the number of adult male fur seals in recent years and their numbers are much less than observed in the late 1940's and early 1950's.

2.2 Pups

There was a discussion of the methods used in pup estimation and the evolution of such methods, e.g., the so-called shearing/sampling procedure which was different in 1961, 1962 than in later years. There was also a discussion of the biases of the estimates produced through tagging studies and how these biases might have changed over the period from the initiation of tagging in 1947 to the late 1960's. It was noted that Paper 17 (see Appendix II) provides a corrected tagging estimate for the period 1947-52 using a comparison of tagging and shearing estimates from the 1960's. This led to a discussion of early (i.e. 1947-52) pup population estimates, including that for 1940 based on a count on one rookery and extrapolation to the whole island using the harem bull/pup ratio. There are a number of such extrapolations that could be used to improve the population estimations.

The group discussed the accumulation or cohort estimates that have been used for the period 1950-1960. It was agreed that these need to be recalculated taking into account that the mean age for idle males should have been 7-9 rather than 6-8 (as used by Chapman, 1964; and followed by Polachek and Smith, Document 17).

In any case it seems clear that the pup population has fallen more than 50 percent from the early 1950's to current levels; that the decline occurred over two periods from 1956 to the late 1960's with another decline occurring from the late 1970's to the present.

Between the mid-1960's and late 1970's the population may have begun to recover but not at rates observed for the population growth observed in the number of pups counted in the early 1900's.

2.3 Harvest

The group again noted the difficulties inherent in relating harvest trends to population trends. As noted during discussions concerning trends, the factors that can be involved in changing the escapement rate include (1) changes in number of working days, (2) changes in hours per day and in number of workers, (3) changes in intensity of effort (particularly in areas harvested), (4) changes in incentives of working, (5) effect of changes in the length limits. Though some of these factors may be investigated, they have not been. As noted in Section 1.3 above while the harvest is not an exact reflection of the subadult population, there has certainly been a substantial decline in the population between the historical period and recent years.

3.0 Review of trends within the population

3.1 Pup mortality on land

It was noted that the analysis of pup mortality on land is complicated because the numbers of dead pups counted or estimated appears in both numerator and denominator of the mortality ratio. Though there are problems with the data due to the variety of methods used to estimate the number of pups born, it was agreed that as pup population has decreased so has mortality rate on land.

3.2 Mortality in first 20 months after leaving land

There are two methods to estimate mortality for this period, one produced by Lander (1975) and one produced by Smith and Polachek (Document 17) extending a procedure used earlier by Chapman (1964). Both involve some assumptions, but appear to give similar results though a full comparative analysis has not been carried out. A simulation study of the Lander method using contrived data without sampling error or bias was considered. The results indicate that there is some bias in estimating survival from age 0 to age 2, but the estimates of survival to age 3 are quite robust.

In any case it was agreed that mortality in the first 20 months after leaving land is highly variable. Although analyses with earlier data indicated that this mortality was density dependent, it is not possible to show a relationship with population size with the current data (1983). Part of the variability may be due to exogenous factors such as sea temperatures and weather. Other biological factors may include diseases. (Editor's note: subsequent work has shown density dependence in multiple regression models using entanglement rates as an independent variable along with pup numbers; Fowler (in press).)

3.3 Mortality of subadults

While some tagging of subadults took place in the late 1960's which provided some information on mortality of subadult males (older than 5-6 years), no comparable experiments have been carried out recently. There are two potential sources of information from the St. George studies: the longitudinal studies of branded animals (one problem with these is that the animals involved are in general not of known age) and a 1980 tagging study. The results of these studies were not available to the workshop participants. The group agreed that no data currently are available to demonstrate trends in the mortality of subadults between recent years and the early 1950's.

3.4 Mortality of adults

An unpublished study of adult female mortality rates as determined from pelagic samples was discussed. In this work comparisons of mortality rates were made between the period 1958 to 65 and the period 1966 to 1974. The comparison was based on the age composition of the animals sampled for two periods. The difference between the two periods was not found to be significant. There are no pelagic data since 1974. Completion of this work is necessary for further consideration.

Two other sources of data are available - longitudinal records of marked females on St. George Island and the ages of salvaged dead adult animals. Analyses of these data have not been completed.

There is, therefore, insufficient information to evaluate trends in adult male mortality rates.

3.5 Growth/size (length, weight, tooth weight)

A summary of Document #12, on changes in length, weight and tooth weight was presented. This paper contains an examination of lengths and weights of animals taken pelagically and in the land harvest as well as tooth weights of subadult males. It was shown that body size has increased as the population declined from the 1950's to the present as based on all measures or indices of size. Potential problems inherent in the individual analyses were noted, and it was suggested by the group that additional statistical analyses be conducted specifically taking into account spatial and temporal factors.

It was noted that a study of male teeth (Antonelis, York and Kajimura, 1982) from 1951, 1961 and 1971 year classes (taken from kills of 3-year-males in 1954, 1963 and 1974 respectively) confirm the growth changes shown in Document 12. There was also a discussion of the Robbin Island data and of skin size both of which show similar trends. It was agreed that the combined analyses show changes in growth in both length and weight that are density dependent. Further analyses of the data are needed, however, since some of the assumptions of the existing work need to be tested. A specific suggestion was made to test for changes in asymptotic size of the fur seals over the past 20 years.

3.6 Age of Maturation

York (Document 4) summarized the estimates of average age of first parturition derived from pelagic samples by three methods (two of these are basically the same). It was also noted that there is a low correlation between the estimates. If there is a trend in the age of maturation data, which is uncertain, it seems to be the reverse of that expected (i.e. a decline in age at first reproduction with a decline in the population size). It was noted that the female harvest may have had an effect on the apparent age at maturity or in the structure of the samples used for producing the estimates. It was noted that more recent estimates are not available though the observation of marked animals on St. George may provide more new information when those data are analyzed.

There was also a discussion of the Japanese pelagic data included in part, in Document #17. It was agreed that it would be useful to extend this work with more recent data though it was also pointed out that in view of the fact that the samples come from a mixed stock, any conclusions are difficult to interpret.

3.7 Reproduction

The pregnancy rate estimates, as based on pelagic samples, have been examined for trend with no significant results. It was noted that pelagic sampling terminated in 1974 and thus no recent estimates are available. Some information may become available from

longitudinal studies on St. George Island. Work on estimating age at first pregnancy using the teeth of Arctocephalus was discussed as it might relate to existing fur seal data and tooth samples. This method appears promising for the northern fur seal though the problem of obtaining future samples and the possibility of biases was not addressed. Work along these lines is under progress.

3.8 Diseases/parasites

Information concerning several diseases and parasites was reviewed regarding mortality on land. It was suggested that the so-called emaciation syndrome may have higher frequency in years of high dead pup counts. However there is a large variability in the incidence of various causes of death, some of which appear to be density dependent. The most convincing case of this is hookworm disease. Further work is needed to substantiate any such relationship.

3.9 Feeding Cycle

Several studies of the length of the female feeding cycle were discussed. These involve earlier work as well as the current St. George studies. It was noted that the length of the feeding cycle increases with time following parturition. Also feeding cycles are shorter for St. George Island females than St. Paul Island females.

None of the data available shows any changes in length cycles that might be due to fisheries impacting resources that support fur seals. The general lack of understanding of interactions involving changes in the fur seal population and in the level of fisheries removals was discussed, particularly with respect to its complicating any interpretation of feeding cycle data. However it was noted that there was an increase in feeding cycles (time at sea) at San Miguel Island in 1983 over that of previous years (attributed to poor feeding conditions due to the El Nino phenomenon). This does seem to suggest that the feeding cycle is in part environmentally determined, at least under extreme conditions, and may be flexible. Some workshop participants argued that this preliminary information indicates that the availability of food is to some degree reflected in feeding cycle length. To the extent that it is, the lack of change over time could be interpreted as a carrying capacity which is declining with the population. Others did not agree with this interpretation, however, and it was agreed that we do not have information on feeding cycles for the Pribilof Island seals that can be used to make definitive statements at this time.

4.0 Review of Information Concerning Current Carrying Capacity (K) in Comparison to Historic Levels

The purpose of this review was to determine if there is evidence to test the hypothesis that reduction of carrying capacity, particularly food resources, is responsible for the observed and

on-going decline of the Pribilof Island fur seal population(s). Two categories of information were considered: (1) fishery and food habit data; and (2) correlations between fur seal density and various population parameters.

4.1 Fishery and food habit data

This discussion was initiated by a presentation of a summary of information contained in Document 18. During the presentation and subsequent discussions, workshop participants noted that fur seals from the Pribilof Island breeding population(s) migrate as far south as California-Mexico boundary, California in the winter months. Studies have included pelagic sampling conducted in various parts of the fur seal's range from 1958 to 1974 to determine distribution patterns, food habits, and other characteristics of the population. The resulting data indicate that female and juvenile fur seals migrate further south than do adult male fur seals. Fifty-three species of fish and ten species of squid have been identified in the stomach contents of fur seals collected from 1958 to 1974, some remain unidentified. The broad spectrum of species found in stomach contents suggest that fur seals are opportunistic predators which eat whatever species they encounter in an "acceptable" size range. Commercial fisheries in the eastern Bering Sea take walleye pollock, Pacific herring, Greenland turbot, Atka mackeral, and two genera of oceanic squid as species also fed upon by fur seals. Although the

pollock population in the eastern Bering Sea remains relatively large, the abundance of older fish has been reduced and catches since the early 1970's have been mainly young fish. Pelagic collections of fur seals in the vicinity of the Pribilof Islands in 1973 and 1974 indicate that pollock was the principle fur seal prey species in the vicinity of the Pribilof Islands. Pollock found in fur seal stomach samples generally were small, ranging in length from 10 to 35 cm, with majority in sub-commercial size, averaging about 19 to 21 cm.; the sizes of pollock taken depended upon the area sampled. Since fur seals tend to eat pollock of smaller size than those taken by the fishery, and pollock are cannibalistic, the fishery conceivably could have resulted in an increase in pollock of the size eaten by fur seals (Document 8). Pelagic sampling of fur seals in the eastern Bering Sea was stopped in 1974 and there consequently is no basis for determining whether there have been any changes or trends in fur seal diet since 1974.

There have been no detectable changes in the duration of feeding cycles of post-parturient females on St. Paul and St. George Islands, suggesting either that fisheries or other factors have not made it more difficult (time consuming) for these seals to obtain food in the vicinity of the Pribilof Islands in recent years or that the population has been at a constant fraction of its carrying capacity. However as discussed earlier, in 1983, there was a significant

increase in the average duration of the feeding cycle of post-parturient females on San Miguel Island, possibly due to local changes in fish distribution or abundance caused by increased water temperatures (El Nino). This suggested that duration of feeding cycles may in fact be a sensitive indicator of relative food availability in the vicinity of pupping/breeding colonies. The welfare and productivity of the Pribilof fur seal population(s) may be affected as much or more by the relative availability and quality of food in "overwintering areas" than by the availability or quality of food in the vicinity of pupping/breeding colonies. The benefits of the annual migration and the relative importance of feeding at different times and in different areas is not known. It was noted that the herring fishery off British Columbia collapsed in the late 60's but recovered by the mid-1970's. Also the anchovy catch in southern California was down in 1981 and 1982; the squid fishery in central California was down in 1983 and the foreign fishery for hake (Pacific Whiting) along the California coast was stopped in 1977 following passage of the Magnuson Fishery Conservation and Management Act.

The workshop participants concluded that existing information on fisheries is insufficient to determine whether or not they have caused or contributed to a decline in fur seal carrying capacity and abundance in the Northeast Pacific.

4.2 Density-dependent correlations

The workshop participants noted that, if carrying capacity has remained more or less constant as the Pribilof Island fur seal population(s) declined, the number of animals per unit of space, food, or other limiting resources would have declined and it would be reasonable to expect corresponding density-dependent changes in growth rates, age at first reproduction, pregnancy rates, survival rates, or other variables. Detection of such changes would suggest that the population is below the largest level supportable by available habitat (i.e., below carrying capacity) and that the population decline probably has not been caused by undetected degradation or destruction of habitat.

The workshop participants considered existing information concerning possible density-dependent changes in relevant individual and population characteristics (see sections 3.0 to 3.9 above) and concluded that on-land pup mortality appears to be the variable most clearly correlated with density. Available data concerning pup production (particularly in the late 1940's and 1950's), growth rates, and other variables show similar trends but need to be analyzed in more detail. Given the available data and analyses, some participants argued that it is not possible to clearly determine how the Pribilof fur seal population currently relates to carrying capacity levels; whether carrying capacity has changed significantly in the last two or three decades; or whether the observed population

decline is due to declining carrying capacity, increased mortality, or some combination of both. Others interpreted the data on density dependence to indicate that the population is currently below carrying capacity and that existing conditions are consistent with little if any change in carrying capacity. Further work on this issue was encouraged.

5.0 Review of possible explanations for population decline

5.1 Harvest (sex ratio)

The sustained harvest of male seals since 1918 has maintained the number of male seals in the Pribilof Island population at lower levels than would be observed in the absence of a harvest. The population has been able to sustain high levels of male seal harvest for several generations, and increased during the early 1900's (1911-1940) while being harvested, evidence that the resulting altered sex ratio is tolerable to the population. However, three possible effects of changes in the ratio of males to females that have occurred as the male harvest varied were identified: (1) decreased pregnancy rates with decreased numbers of males; (2) decreased pup survival rates with increased numbers of males; and (3) genetic changes in the size of male seals due to high selective pressure owing to the taking of larger seals in the harvest.

(1) The pelagic samples collected from 1958 to 1974 revealed no major changes in pregnancy rates during the 1960's, when the numbers of harem males declined markedly (Document 17: Figure 2, p. 32; Table 10, p. 24; page 50). There was a possible decrease in the pregnancy rate for five- and six-year-old seals (Document 17, Figure 12, p. 48). There was a similar decline in the proportion of the female seals captured pelagically from the western Pacific, but this appears to have been associated with a marked decline in the proportion of the seals sexually mature for these ages (Document 17, Figure 14, p. 52). None of these changes were thought by the workshop group to represent changes due to changes in numbers of male seals.

Mention was made of a report from the Soviet Union indicating fecundity may have decreased as the ratio of males to females (number of males per female) decreased on Robben Island. However, it was not known if this work was based on data, or was merely assumed as part of a population model. A careful review of this work was recommended to see if data supporting this relationship exist.

Evidence for changes in the ages of breeding males was discussed. Johnson (1968) conducted a study in the mid-60's on the Pribilofs showing that the breeding bulls were age 10 and older. Males as young as 5-years-old have been observed to copulate on San Miguel Island, and, in fact, males between 5 and 7 years of age were responsible for 50% of the copulations there between 1969 and 1972.

These males returned to San Miguel to hold territories with females for an average of 5 to 7 years, compared to about 1.5 years for males on the Pribilofs. There are no data which show any changes on the Pribilof Islands.

(2) Swartzman (1984) conducted correlation analyses utilizing the variables logarithm of number of dead pups over the total estimated number of pups born, the total number of pups born and the ratio of pups born to the total number of harem and idle bulls counted. These multivariate analyses permit the determination of the effect of the sex ratio on survival with the effect of density eliminated. The results showed that the sex ratio has a small but statistically significant effect on pup survival as measured by the dead pup count. There remain unresolved questions both in the statistical analyses and as to the extent to which survival to recruitment is reflected in the ratio of dead pups to estimated total pups. Currently pup survival is quite high compared to that in the next two years at sea.

Observations from one rookery on St. George Island, relating to social interactions as the number of male seals have increased were discussed. It was suggested that a ring of "buffer males" was becoming established around the breeding areas. These males hold territories, but do not breed and do not move. The presence of this stable group may reduce the level of disturbance on the breeding

areas, and thereby may act opposite to the disturbing effect of larger numbers of non-breeding males reported by Parker (1918) and others. It was pointed out that such males have been present to varying degrees on both islands.

The group thought that there was some basis for assuming that pup survival was adversely affected by increasing numbers of males, but that the effect was slight at best, and, given the magnitude of the effect, is certainly out-weighed by most other factors. It seems influenced more by population size than bull numbers and is less influential in determining recruitment than is the survival of the first two or three years at sea.

(3) No substantive data were presented on the question of genetic changes in the fur seal population. Considerable discussion followed about any likelihood of any selection being severe enough to be important. The existence of sufficient genetic diversity (blood samples might be analyzed here) and the relative direction of such selection was questioned. For instance, in addition to size at age, selection might also be against seals that were slower on land. The relation of speed on land to overall fitness was questioned.

Selection for size was discussed in relation to the existence of seasonal trends of arrival time on the islands. Although it is known that older seals tend to arrive on the islands earlier, it is not known if larger seals of the same age also arrive earlier. An unsuccessful study of the size of the harvested animals by harvesting rounds (which addressed this point) was discussed. There were

demonstrable changes, but the quality of the data prevented conclusive determinations. Additional study of these data and perhaps collection of new data are needed to address the question of changes in size selection over the harvest season.

The rate of harvest of young male seals is not known precisely, leaving some uncertainty as to the force of any selection that might be operating. The exploitation rates implied by the existing data on harem and idle males, and the number of pups born suggests that the fraction of three-year-old male seals that ultimately escape the harvest has varied from 0.04 to 0.29 (Document 17, Table 8, p. 84).

The group felt that some uncertainties about genetic effects should be cleared up to help determine the likelihood of genetic selection being important. Research is needed to understand the role of genetics, if any, in the current decline.

5.2 Changes in mortality

A model was discussed showing the possibility that the estimated numbers of pups born in recent decades could be simulated using age specific reproductive and survival estimates from data collected since 1950. The fit of the model to the estimated numbers of pups born could be improved markedly by assuming juvenile survival to be related to the cohort specific harvest rates. Conversely, Appendix III of Document 17 presents calculations suggesting that a model assuming a self-regulating population could not be made consistent

with the observed rate of increase of the population from 1911 to 1924 (8%) and, also with estimates of pups born more recently. However, assuming a slight decrease in the survival rates substantially improved the fit of the model to the recent population history (Document 17, p. 120).

Preliminary data from tagged pups that were resighted on the study areas on St. George were presented. Of 2,000 pups tagged, some 156 had been resighted. This was thought to be low, perhaps suggesting that the survival of young seals had decreased markedly. It was noted that of 19,183 pups tagged in 1947, 2,386 were eventually recaptured as three or four-year-olds (Kenyon et al., 1954). By this proportion, the return to St. George would be about 63% of that observed earlier. Numerous differences in the procedures used in these different experiments were noted, and direct comparison was not thought valid. However, the group felt that this was an example of one way the early tagging data might be usefully reanalyzed.

To explore the possibility that the recent declines in the numbers of pups born are due to changes in survival rates, four possible causes of changes in mortality rates were considered: (1) predation, (2) entanglement, (3) climatic change, and (4) diseases or parasites. Few data were available for these, although it is clear that any single factor was potentially sufficient to induce the relatively small changes that are required to cause a decline in model calculations.

(1) Information was present on the predation on fur seal pups at the end of their first summer by sea lions, killer whales, and sharks. In 1974 and 1975, 3% to 6% of the pups alive in August on St. George Island were thought to have been killed by sea lions. However, the sea lions were not observed to change their behavior to concentrate on the pups, and the number of sea lions born in this area was estimated to have declined from 3,000 to 300 in the last few decades. More anecdotal information was presented showing that both killer whales and sharks do prey on fur seals, but the magnitude of this and the changes on abundance of these predators is not known.

(2) The percent of the male seals killed in the annual harvest that are entangled in debris has increased from less than 0.25% before 1970 to around 0.40% (Document 9, Fig. 1, p. 2). This has been interpreted as effecting the survival rate of young fur seals which may have declined by 5% or 6% and possibly more (Document 14). Simulation studies suggest that changes of this magnitude would be sufficient to account for the observed decline if animals of both sexes are involved.

The argument in Document 9 from a doubling of what is a very small observed entanglement rate before 1970 to a major decrease in the overall survival rate involves a series of assumptions for which there is only limited data. More data are required for adequate testing. While the group did not review these calculations in detail, the participants did believe that several of the assumptions

could be tested through further research. The problems of the persistence of net fragments (in the water column or on the surface), the possible differences in the investigative behavior of male and female fur seals, the small numbers of observed entangled fur seals, the interpretation of parallel observations on the western Pacific island populations, and the possible ability of the seals to extricate themselves from larger net fragments were all discussed.

The workshop group thought that while increased mortality due to entanglement was a possible explanation of the recent history of the population, other explanations could not be eliminated at this time. The argument suggesting this possibility depended on too many assumptions, which are not yet fully tested.

(3) It was suggested that pup survival in the summers following exceptionally cold preceding winters appeared to be lower than average, perhaps related to changes in the distribution of food resources. The available data and the expected relationships were discussed. It was noted that a multiple regression analysis along this line was conducted earlier (North Pacific Fur Seal Commission Report on Investigations from 1907 through 1972) but although significant regressions were found, the results were not easily interpretable. The group thought that a review of this approach would be useful.

(4) Data on the incidence of diseases and parasites in pups during their first summer was discussed. The numbers of pups dying on the islands due to several factors were presented for the years

1964 to 1979 (Document 22). The percentages showed no obvious trends. The group thought that the explanation of the recent history was not likely to be explained by changes in the disease rates, especially those prevalent on land.

5.3 Contaminants

Document 6 presented some data on heavy metal residues in male fur seal tissues. The levels were generally low, although cadmium and mercury levels may be high enough to be of concern. There was no information that the levels were increasing, and it was noted that the source of these contaminants may be natural rather than industrial. Given the possibly high levels, and the lack of data for females, the group thought that further monitoring would be justified.

5.4 Resource levels

Because fishing activity in the Bering Sea and elsewhere in the North Pacific where fur seals range has increased since the mid-1960's, the possibility that the food supply has decreased to the detriment of the fur seals was considered. Several of the documents listed in Appendix II describe the likely changes to the exploitable biomass of several fish stocks of importance to fur seals. However, the main question remained unanswered: If such

changes do occur, would they have any direct effect on the seals' foraging abilities, either during the summer around the Pribilofs Islands or at other times of the year?

It was noted, again, that the average duration of foraging by nursing females had not changed in recent years although this may not change in response to altered resource levels except in extreme circumstances (Section 3.9). The weight of pups at the end of the summer have shown an increase although there was some uncertainty about the comparability of the data for pup weights (editor's note: see Kozloff, 1986). The group was reminded that the duration of the foraging periods by nursing fur seals on San Miguel Island were about 2 days longer in 1983 (7.5 days) than in previous years (5.6 in 1982), and that the average pup weight at the end of September was 6.6 kg compared to 11.0 kg in 1982 . This decline is apparently an effect of the El Nino situation, and it was suggested that foraging time and pup weight probably serve as sufficient indicators of change if significant changes occur in food availability. It was noted that the Galapagos fur seals had suffered complete pup mortality, and heavy adult mortality in the 1983 breeding season as a result of the same El Nino condition. Little data are yet available on how the forage species in these areas were affected, although the California squid fishery did not develop to its usual levels in 1983.

5.5 Changes in birth rate

The pelagic data collected from 1958 to 1974 did not suggest any major changes. However, there is no recent information. Naturally occurring disease, like leptospirosis, may contribute to reduced pregnancy rates. Further research in this area is needed.

5.6 Other

Several other possible factors were discussed, including emigration of seals to other areas, human disturbance on the rookeries, incidental take in fishing gear, competition with other species, and other factors which might have changed at sea. The habits and activities of fur seals at sea are little known, and are very difficult to study.

The levels of incidental take by fisheries is thought to be low, with a fair amount of data available. The existing information may contain biases, however, and should be examined and interpreted with care. The largest problem is thought to be with the salmon gill net fishery, with estimated kills of a few thousand at the very most.

A stranding of 30 to 40 animals on the Washington coast was noted. This stranding was thought to involve a naturally occurring neurotoxin. Affected seals recovered with cure and gave birth to healthy pups. Such normal birth would not have been expected if the problem had involved heavy metals or pesticides. Since the cause is not definitely known, further study should be encouraged if additional future strandings occur.

6.0 Development of topics of importance for further research

At the end of the workshop, all participants were asked to name a research project they felt would be important for the fur seal group of the National Marine Mammal Laboratory to undertake. Projects were mentioned until time ran short. In all, 80 ideas were generated (Table 1). Then, all participants (23 persons) were asked to choose 10 items in decreasing order of importance--that is, what they thought to be the most important of the 80 items was chosen as number 1, second most important number two, etc.

The results of this survey are presented in several ways: Table 2 shows the frequency that the most listed items were chosen (order of preference not considered). Rank scores were then computed for each item by scoring each first choice 10 points, each second choice 9 points, ..., each 10th choice 1 point. A weighted value was assigned for each item and was calculated as $n_i(11-i)$, where n_i is the number of ith place votes for that item. Scores for each item were then computed by adding all such values for each item.

Table 3 shows the rank scores for the top six items. Since many of the items of the list of 80 were related, they were organized into 17 sub-groups or categories. Category names, subject description, and codes of items within the groups (corresponding to item numbers in Table 1) appear in Table 4. The grouping was subjective and it was often difficult to assign an item to only one category since there was considerable overlap among the categories.

Table 4 shows the results of this analysis as the frequency with which each category was selected. Category 113 (future tagging studies) scored the highest with 32 votes. Category 109 (food related questions) was second with 29 votes, followed by category 108 (reliability and variance studies of the estimators) with 24 votes and category 101 (entanglement questions) with 23 votes. Since each category does not have an equal number of items, the number of persons that chose at least 1 item in the category were calculated. These are presented in column 7 of Table 4. In addition the raw score (column 5 in Table 4) was divided by the number of items in the category (column 4); these numbers are in column 6 of Table 4.

Table 4 also presents the popularity of each category by taking into account the order of preference of each group. Scores were computed for each group in the same way as for individual items above; that is, 10 points for each first place vote, 9 for each second place vote, etc. These numbers appear in column 8 of Table 4. Category 113 (Future Tagging) has the largest score (204), followed by category 101 (Entanglement) (152), category 109 (Food) (127), category 108 (Statistics of Vital Parameters) (115), category 116 (Continuation of present work)(110) and category 104 (Pregnancy rates)(100). When these scores are divided by their group size, the results are somewhat different (Column 9): category 116 (36.7) scores highest, followed by 104 (33.3), 113 (29.1) and 101 (25.3).

While all voters did not agree on the relative importance of various categories, and all the ranking methods were not consistent, 6 or 7 categories were favorites: Continuation of the present programs and monitoring, conduct studies to determine pregnancy rates, resume tagging studies, entanglement studies, food habits studies (pelagic research).

7.0 Summary

The group agreed that the Pribilof portion of the northern fur seal population shows a declining trend. Current levels appear to be less than 50% of levels observed in the early 1950's.

No explanation for the decline has been clearly demonstrated. One possibility, a decline in the carrying capacity through changes attributed to commercial fisheries, is inconsistent with much of the information reviewed but cannot be conclusively ruled out because of remaining uncertainty in the data. Mortality due to entanglement is one possibility supported by some of the existing data but which, it was agreed, has not conclusively been demonstrated to be a major cause. Other possibilities include reduced pregnancy rates (birth rates), mortality due to predation, problems with toxic materials, and incidental take by commercial fisheries.

In view of the uncertainty surrounding potential explanations of the decline and the extent of the decline, it is important that research effort be focused on the problem. Explicit focus for this work was provided by consideration of direction for future research. The directions important to the group were resource/ fisheries questions, the role of entanglement, and reproductive rates. Other potential problems need to be addressed but the information reviewed seemed to result in concerns that brought these issues out as being of major concern.

8.0 Acknowledgements

To all of the participants goes the gratitude of the staff of the Fur Seal Program of the National Marine Mammal Laboratory. We are particularly grateful to Doug Chapman, Doug DeMaster, Bob Hofman, Ancel Johnson, and Tim Smith for their efforts in writing the first version of this report. The comments received from the review were very helpful in clarifying the final version and we thank the participants for their help.

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TABLE 1.--Research items proposed during a workshop on the fur seal population, November 18, 1983.

1. Comparative studies with other fur seals.
2. Determine net entanglement in Aug/Sept for females.
3. Clean up data base and make accessible.
4. Determine current pregnancy rates.
5. Evaluate Lander's survival estimate.
6. Resume pup marking at an appropriate magnitude.
7. Follow up San Miguel Island fur seal reproductive failure.
8. Pilot study on reproductive history of female based on teeth collected in 1983.
9. Maintain current monitoring.
10. Expand marking (#6) to yearlings and 2-yr-olds.
11. Repair cat walks.
12. Systematize weighing procedures devised to evaluate food resources.
13. Investigate abundance of prey species outside Bering Sea.
14. Evaluate pelagic pup weights and relate to evironmental parameters.
15. Resume pelagic research.
16. Mark females to assess population size and to determine pregnancy rates.
17. Develop tagging data base to include age of female, date of birth, day of weaning, wt. at weaning, etc.
18. Determine types, quantities, size, distribution, and movements of net fragments in Eastern Bering Sea.
19. Analyze year/season effects on existing growth data.
20. Analyze number of pups born in 50's and 60's from tagging data.
21. Sonic tracking of fur seals to feeding areas.
22. Analyze current tooth collections to determine reproductive histories of females.
23. Evaluate evidence of food limitation for other species that utilize similar prey.
24. Determine adult female mortality from tag/weights.
25. Quantify changes in rookery size with aerial photos.
26. Evaluate differences in composition of different classes of animals over time by rookery.
27. Map breeding areas used for each rookery.
28. Evaluate St. George studies to determine if pregnancy rates can be estimated without pelagic sampling.
29. Evaluate total disturbance effects due to humans.
30. Analyze historical tag data base for evidence of emigration.
31. Monitor levels of cadmium.
32. Determine if risk of entanglement is same for young females and males at sea.
33. Analyze tooth collection and include condition index (girth, wgts, blubber thickness, etc.).
34. Examine escapement rate of entangled animals from nets.
35. Determine spatial and temporal distribution of fur seals.

TABLE 1.--continued.

36. Test assumption that nets on shore are a representative sample of the nets at sea.
37. Do electropheretic work on fur seal tissues to assess genetic changes.
38. Inventory population for currently marked animals.
39. Characterize and monitor oceanographic conditions and fish populations.
40. Collect standard morphological characters on a seasonal and area specific basis.
41. Compute variances of pup estimate, survival estimates, and weight estimates.
42. Track net fragments by satellite.
43. Quantitative description of fouling and sinking of net fragments.
44. Assess character of net fragments in beach cast animals and compare with net fragments on live animals.
45. Continue work in foraging of female and males with TDR's.
46. Simulate effects of changing effort of harvest by using movement data model.
47. Inject females and pups with tetracycline to investigate natural "check" marks on teeth and relate to behavior.
48. Evaluate possibility of Bering Sea climatic changes.
49. Use St. George data to determine percentage of idle males actually counted.
50. Assess mortality rate and morbidity schedule of entangled males.
51. Analysis of longitudinal tagging studies to estimate vital rates and evaluate their potential use.
52. Analyze tagging data, pup weight, and tag recovery data to determine if there is a weight related survival effect.
53. Evaluate probability/occurrence of entanglement in the eastern North Pacific.
54. Determine escapement rate of sub-adult males from the harvest.
55. Map all rookeries where fur seals occur to detect population changes.
56. Continue to monitor population at Bogoslov Island.
57. Coordinate with other fur seal groups on tagging, analysis, etc.
58. Extend modelling work to incude the male segment of the population.
59. Conduct St. George type behavior work at St. Paul.
60. Compare entanglement rates from Robben, Commander, and Pribilof Islands for both males and females.
61. Replicate counts of harem and idle males on rookeries at same rookery and day.
62. Conduct Chapman type estimates of pup numbers for years not done for comparison.
63. Determine maximum range of foraging effort and relate to food availability.
64. Examine future pelagic samples for disease and parasites.
65. Use radio tags to determine island or origin of seals foraging at sea.

TABLE 1.--continued

66. Hire 1 or 2 field biologists.
67. Determine if male kill is related to population size.
68. Explore use of reproductive success of marine birds to evaluate forage availability.
69. Assess relation of San Miguel SLV to emaciation syndrome in pups and pelagic juvenile survival.
70. Determine if female kill in 50's can account for decline, with emphasis to check for internal consistency.
71. Standardize research monitoring techniques and harvest to facilitate data interpretation.
72. Initiate on-islands studies in October, November and December to observe killer whale, etc., predation.
73. Determine distribution of males at sea.
74. Switch harvest from St. Paul to St. George to test if St. George reaction was unique.
75. Monitor dead pups and their weights to document weights in living pups.
76. Ground truth pup esitmation procedure with exhaustive counts at a number of large rookeries.
77. Conduct simualtion study on when genetic selection would result in a population decline.
78. Determine seasonal haul-out patterns by size, age and sex.
79. Conduct hydro-acoustic survey for net fragments to determine distribution and abundance.
80. Analyze existing data on counts of sub-adult males to determine magnitude of trends.

TABLE 2.--Suggested research activities occurring on five or more lists of the most important in order by the frequency of occurrence on lists.

Item number	Description	Number of times listed
6	Resume tagging	15
2	Female entanglement	9
4	Determine current pregnancy rates	8
15	Resume pelagic sampling	8
22	Analyze tooth collection for reproductive rates	8
9	Maintain current monitoring	7
18	Describe types of net fragments in Bering Sea	6
25	Quantify rookery size	6
76	Verify pup estimation procedure	6
32	Risk of entanglement for females	5
45	TDR work on both sexes	5
56	Monitor Bogoslof population	5
60	Compare entanglement rates among all islands	5

TABLE 3.--An ordered listing of potential fur seal research items as determined by rank scoring items listed by workshop participants.

Item number	Description	Rank score
6	Resume tagging	115
2	Determine Aug/Sept entanglement rates of females	83
15	Resume pelagic research	72
4	Determine current pregnancy rates	56
9	Maintain current monitoring	56
22	Analyze tooth collection	41

TABLE 4.--Grouped research items, research items in groups (Numbers correspond to Table 1) numbers of items in the group, and various preferences scores (see text).

Group (1)	Subject (2)	Items (codes correspond to those of Table 1) (3)	Number items in group (4)	Raw score (5)	Raw score wtd (5)/(4) (6)	No. persons choosing category (7)	Rank score (8)	Rank score wtd.by sp.size (9)
101	Entanglement	2,32,34,50,53,60	6	23	3.8	17	152	25.3
102	Nets	18,36,42,43,44,79	6	15	2.5	10	84	14.0
103	Diseases and pollutants	31,64,69	3	3	1.0	3	8	2.7
104	Pregnancy rates	4,7,28	3	15	5.0	14	100	33.3
105	Genetic effects	37,77	2	1	0.5	1	8	4.0
106	Weather	14,48	2	4	2.0	4	16	8.0
107	Harvest	46,54,67,74	4	9	2.3	7	42	10.5
108	Reliability and variance of vital parameters	5,19,41,49,57,61,62 71,76,80	10	24	2.4	14	115	11.5
109	Food	12,13,14,21,23,39,45, 63,65,68	10	29	2.9	16	127	12.7
110	Pelagic Research	15,35,40,73	4	11	2.8	9	78	19.5
111	Distribution (Land)	25,26,27,55,78	5	12	2.4	10	60	12.0
112	Tagging (analy past data)	20,30,52	3	8	2.7	7	34	11.3
113	Tagging (future)	6,10,17,38,16,24,51	7	32	4.6	18	204	29.1
114	Tooth work	8,22,33,47	4	15	3.8	11	76	19.0
115	Nuts and bolts	11,66	2	4	2.0	2	22	11.0
116	Continuation	3,9,56	3	16	5.3	11	110	36.7
117	Other	1,29,58,59,72,75	6	9	1.5	7	29	4.8

APPENDIX I
List of Participants

The following attended the Workshop on Status of Northern Fur Seals, Pribilof Islands (Nov. 14-16, 1983) in Seattle, Wash. as invited participants from outside the National Marine Mammal Laboratory:

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APPENDIX I (continued)

In addition, the following, from the National Marine Mammal Laboratory, also participated in the workshop:

1. Mr. George Antonelis
2. Dr. Robert DeLong
3. Dr. Charles Fowler
4. Dr. Roger Gentry
5. Mr. Michael Goebel
6. Dr. Hiroshi Kajimura
7. Dr. Mark Keyes
8. Mr. Patrick Kozloff
9. Dr. Thomas Loughlin
10. Dr. Robert Miller
11. Ms. Anne York

APPENDIX II
List of Background Documents

1. Report of Workshop on population trends of northern fur seals, 1-2 April of 1982, Ottawa, Canada. From North Pacific Fur Seal Commission, Proceedings of the 25th Annual Meeting.

2. Report of Workshop on population trends of northern fur seals, March 28-29, 1983, Washington, D.C. From North Pacific Fur Seal Commission, Proceedings of the 26th Annual Meeting.

3. Pup production following harvest of female northern fur seals, A. E. York and J. R. Hartley, 1981. Can. J. of Fish. and Aquat. Sci. 38:84-90.

4. Average age at first reproduction of the northern fur seal (Callorhinus ursinus). A. E. York. Can. J. of Fish. and Aquat. Sci. 40:121-127.

5. Chlorinated hydrocarbons in the tissues of northern fur seals from St. Paul Island, Alaska. J. Calambokidis and J. Peard. Contract report, April, 1982.

6. Heavy metals in northern fur seals (Callorhinus ursinus) from the Pribilof Islands, Alaska. C. J. Goldblatt and R. G. Anthony. (1983) Alaska J. Environ. Qual. 12(4):478-482.

7. Interactions of northern fur seals and commercial fisheries. C. Fowler 1982. Trans. 47th N. Am. Wildl. and Nat. Res. Conf. p. 278-292.

8. Interactions between fur seal populations and fisheries in the Bering Sea. G. L. Swartzman, and R. T. Haar. Fish. Bull. 81:121-132.

9. Entanglement as an explanation for the decline in northern fur seals of the Pribilof Islands. C. W. Fowler, 1982. Background paper for NPFSC, Ottawa, Can.

10. Status of northern fur seals in the Pribilof Islands. Background paper submitted to 26th meeting of NPFSC, Washington, D.C.

11. Population dynamics as related to rate of increase per generation time. C. W. Fowler (In prep.).

12. Density dependent body size in northern fur seals (Callorhinus ursinus). Fowler, C. W. Background paper presented at 27th annual meeting of the North Pacific Fur Seal Commission, Moscow, U.S.S.R., March 29-April 9, 1984.

13. The effects of net entanglement on the drag and power output of swimming sea lions. Feldkamp, S. D. Contract report Nov. 1983.

APPENDIX II - continued

14. Entanglements in fishing debris as a contribution factor in the decline of northern fur seals on the Pribilof Islands. C. W. Fowler. Background paper presented at 27th annual meeting of the North Pacific Fur Seal Commission, Moscow, U.S.S.R., March 29-April 9, 1984.

15. Reexamination of the life table of northern fur seals with implications about population regulatory mechanisms. Smith, T. D. and T. Polacheck, 1981. (p. 99-120 in Fowler and Smith, Dynamics of Large Mammal Populations, John Wiley and Sons.)

16. Population dynamics of the Pribilof fur seals. L.L. Eberhardt. 1981. (p. 197-220 in Fowler and Smith, Dynamics of Large Mammal Populations, John Wiley and Sons.)

17. The population dynamics of the Alaska fur seal: What do we really know? Tim Smith and Tom Polacheck. NWAFC processed report 84-15. July 1984.

18. A review of fishery resources and commercial catch of fish important to northern fur seals. H. Kajimura. Background paper presented at 27th annual meeting of the North Pacific Fur Seal Commission, Moscow, U.S.S.R., March 29-April 9, 1984.

APPENDIX III
Agenda for

Workshop on Status of Northern Fur Seals
Pribilof Islands

November 14-16, 1983
Seattle, Washington

Section of Report	
	Call to order/Logistics/Agenda/Assignments for Report
	Introduction/Background/Objectives
1.0	Review of trends in northern fur seal numbers
1.1	° Counts of adult males
1.2	° Estimates of pup numbers
1.3	° Harvest
1.4	° Others
2.0	Comparison of current levels with historic level
2.1	° Males
2.2	° Pups
2.3	° Harvest
3.0	Review of trends within the population
3.1	° Pup mortality on land
3.2	° Mortality in first 20 months after leaving land
3.3	° Mortality of subadults
3.4	° Mortality of adults
3.5	° Growth/size (length, weight, tooth weight)
3.6	° Age at maturation
3.7	° Reproduction
3.8	° Diseases/parasites
3.9	° Feeding cycles
4.0	Review of information concerning current carrying capacity in comparison to historic levels
4.1	° Fisheries
4.2	° Density-dependent correlations (Mortality, growth)
5.0	Review of possible explanations for population decline
5.1	° Harvest (sex ratio)
5.2	° Changes in mortality 1) Predation 2) Entanglement 3) Diseases/parasites
5.3	° Contaminants
5.4	° Resource levels
5.5	° Changes in birth rate
5.6	° Others
6.0	Development of list of topics of importance for further research
	° Prioritization of research needs and other unfinished business