Study and Report Title: Monitoring Distribution and Abundance of Ringed Seals in Northern Alaska
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Background

Minerals Management Service (MMS)has sponsored studies of the biology and ecology of ringed seals since 1975 in recognition of the ecological importance of this species and the possibility that they might be impacted by industrial activities. In 1984, MMS began monitoring overall ringed seal distribution and abundance in the Beaufort and Chukchi Sea OCS planning areas. Ringed seal aerial surveys were flown during May-June 1985-1987. There was substantial intra- and inter-annual as well as regional variability. The investigators concluded that careful timing of surveys and fairly broad geographic coverage would be critical if surveys were to be used for determining either long or short term trends in abundance. Ten years later, MMS decided to sponsor a second series of Beaufort Sea ringed seal surveys.

Objectives

The objectives of this study were to: 1)review and refine aerial survey protocol for monitoring ringed seal distribution and abundance; 2)estimate relative abundance and density of ringed seals on fast ice in the Beaufort Sea during 1996-1999 and compare with data collected during 1985-1987; and 3)correlate ringed seal densities on fast ice with environmental variables.

Description

Aerial surveys were conducted during late May-early June 1996-1999. Surveys were conducted on sea ice within 40 km of shore from Barrow to Kaktovik. Univariate and Poisson regression analyses were used to investigate the effects of environmental factors on seal distribution and abundance and to examine whether there had been a change in seal abundance since

the 1980s. A subset of data from these and surveys conducted by ADF&G in 1985-1987 was used in these analyses.

We evaluated the effects of water depth, ice deformation, distance from the fast ice edge, longitude, time of day, weather, and melt water on observed and modeled densities. Power analysis was conducted to predict the ability of surveys to identify trends in abundance. Power was compared for 50 and 65 transects, 5 and 10 years, negative and positive population trends, and raw *vs.* Poisson modeled seal densities.

Study Results

The dataset for 1985-1987 included 223 transect lines covering 7,156 km^2 of ice habitat, on which we counted 2,189-3,867 ringed seals per year. Total survey effort during 1996-1999 included 366 transect lines covering 11,143 km^2 of sea ice habitat on which we counted 1,111-3,796 seals per year. Observed densities for all ice combined in the 1980s ranged from 1.01 seals/km^2 in 1985 to 1.85 seals/km^2 in 1987. Observed densities for the 1990s were similar to 1985 and somewhat lower than in 1986 and 1987, ranging from 0.81-1.17 seals/km^2. Poisson regression modeled densities for 1985-1999 ranged from 2.25 –0.64 seals/km^2.

Habitat-related variables water depth, ice deformation and distance from the fast ice edge significantly effected seal densities. Observed and modeled densities were highest in water 5-35 m deep, when <20% of the ice surface was deformed, and near the fast ice edge. The effects of weather and time of day were inconsistent and annually variable.

Power analysis indicated that almost no power was gained by increasing survey coverage by 30%. Power did increase when the survey period was increased from 5 to 10 years, and for modeled compared to raw densities. Power to detect a 20% annual decline with 10 years of surveys was moderate (0.53-0.73), but power to detect an annual trend of 5% was very low (8%-32%).

Trend analyses based on an ANOVA comparison of raw density estimates suggested a marginally significant (p=0.09) but substantial decline of 31% between the 1980s and 1990s. The Poisson regression model indicated highly significant ($p<0.001$) declines of 72% on fast ice and 43% on pack ice over the 15-year period. Because surveys in the 1990s were conducted several days earlier than those in the 1980s, the apparent decline between the 1980s and 1990s could be an artifact of survey timing rather than an actual decline in abundance. However, if warmer temperatures in the 1990s resulted in comparably earlier basking, the decline in seal numbers could be real. We think it is likely that ringed seal abundance in the Beaufort Sea has already or will change in the future due to increased predation and competition caused by increases in polar bear and bowhead

whale populations, and changes in habitat and prey populations caused by global warming.

Significant Conclusions

The statistical power to detect trend was low for all combinations of sample size, years, and population change and for both raw and modeled densities. This suggests that current survey methods must be modified if surveys are to be useful for detecting trends in abundance.

Poisson regression analysis to model the effects of environmental covariates improved the statistical power to detect trend. However, the model did not account for all of the observed variability. This was partly due to the nature of the sighting data (*e.g.* occasional sightings of large groups) and also to substantial date-related effects on ice characteristics and seal behavior that we could not model.

We had hoped, by narrowing the survey window and conducting surveys before breakup occurred, that we could minimize the effect of date. However, recent information from tagged seals indicates the change from hauling out in lairs to basking in the open is rapid and annually variable, and may significantly affect on the number of seals counted. Future efforts to improve abundance estimates and detect trend must include quantification of the effects of date on seal distribution and behavior.

Temporal variability in ice conditions and hauling out behavior preclude clear conclusions about the trend of ringed seals in the central Beaufort Sea between the 1980s and 1990s, even though raw and modeled densities were lower for the 1990s than for the 1980s. To improve interpretation of surveys and facilitate trend analysis in the future, studies are needed on ways to predict the onset of basking behavior in seals.

Study Products

Annual reports were submitted in 1997-1999. Investigators presented study results at MMS information transfer meetings in 1997-2001. An annotated bibliography with more than 200 ringed seal references was provided to MMS in 1999. A draft final report was submitted in March 2002 and a revised final version in September 2002. All survey data are in digital format and will be provided to the National Marine Mammal Laboratory and the National Oceanographic Data Center.

Study findings were presented in poster format at the 13th Biennial Conference on the Biology of Marine Mammals in 1999 and as an oral presentation at the 14th Biennial Conference on the Biology of Marine Mammals in 2001. A technical manuscript describing surveys results will be submitted in 2002.

Figure 1. Map of the Beaufort Sea showing sectors used in analysis of ringed seal survey data. Dashed line is the 20 m depth contour.