An Aerial Survey Estimate of Pup Production of Hooded Seals (Cystophora cristata) in the Gulf of St. Lawrence during March 1986

by

G. B. Stenson and D. Wakeham
Science Branch
Department of Fisheries and Oceans
P. O. Box 5667
St. John's, Newfoundland A1C 5X1

Abstract

An aerial survey was conducted off the coast of Prince Edward Island in March, 1986 to estimate the pup production of hooded seals, Cystophora cristata, in the southern Gulf of St. Lawrence. An area of 62.77 km^2 was systematically surveyed using spot aerial photography. Pup production was estimated at 239 with 95% confidence limits of 118-363. This estimate is negatively biased because no adjustment was made for the number of pups which had already left the ice or were yet to be born. On the day of the survey, a second whelping patch was located and was visually estimated to contain 200 families.

Résumé

En mars 1986, on a effectué une enquête par photographies aériennes au large des côtes de l'Ile-du-Prince-Edouard afin de déterminer combien il y avait de phoques à capuchon nouveaux-nés (Cystophora cristata) dans la partie sud du golfe du Saint-Laurent. Les photographies aériennes ont permis d'examiner une surface de 62,77 km^2 et d'estimer le nombre de nouveaux-nés à 239, avec une limite de confiance de 95% (de 118 à 363). Cette estimation est toutefois faussée parce qu'on n'a pas tenu compte du nombre de nouveaux-nés qui avaient déjà quitté la glace, ni des naissances prochaines. Le jour de l'enquête, on a repéré une autre aire de mise bas où semblaient se trouver environ 200 familles.

Introduction

Hooded seals, Cystophora cristata, whelp in three locations in the Northwest Atlantic: at the 'Front' off Newfoundland and Labrador, in Davis Strait and in the Gulf of St. Lawrence. The majority of animals whelp in the first two locations and recently pup production has been reliably estimated in both of these populations by the use of aerial survey techniques (Hay et al. 1985; Bowen et al. 1987). The Gulf population however, is much smaller and has never been accurately surveyed; previous estimates have been based primarily on visual sightings (Sergeant 1966; Sergeant and Hoek, in press). However, the reliability of these estimates is unknown as visual estimates of abundance are often inaccurate and imprecise (LeResche and Rausch 1974; Wartzok and Ray 1975; Lavigne et al. 1977; Scott et al. 1985).

Historically, the Gulf of St. Lawrence supported a large population of hooded seals; Sergeant and Hoek (in press) estimate that as many as 4,000 hooded seals may have been taken in the Gulf in 1894 by a single ship. If this estimate is indicative of historical abundance, the population declined dramatically during this century. Sealing was banned in the Southern Gulf in 1964 and this ban was extended to the entire Gulf in 1965. However, how the population has responded to this closure is unknown. Due to the imprecise nature of visual estimates only large changes in abundance can be recognized while smaller, steady increases would not be identified. Therefore, a reliable estimate of abundance is necessary before the status of the hooded seals in the Gulf can be determined. The purpose of this study is to estimate pup production in a major whelping patch in the Gulf of St. Lawrence based upon a spot photographic survey.

Methods

Survey design

To determine the total pup production, an aerial survey was conducted on March 18, 1986. The patch surveyed was located at 46°40'N 62°17'W, approximately 40 n mi south of the Magdalen Islands (Fig. 1). After the limits of the patch were determined, east-west transects were flown across it during which spot photographs were taken at 0.18 km (5 sec) intervals. The photographic sequence began when the observer first encountered seals and ended when no seals were present on the horizon. Transects were spaced 0.93 km (0.5 n mi) apart and helicopter position was recorded at the beginning and end of each photographic sequence to allow for calculation of transect length. The survey was carried out at a flying altitude of 153 m and at a velocity of 117 km/hr.

Helicopter and camera specifications

A Bell 206 B helicopter was used for the survey. Flight altitude was maintained by means of a barometric altimeter and accurate navigation along flight lines was ensured by the use of a Loran C 20 navigational system. Vertical photographs (5.5 cm X 5.5 cm) were taken using a 70 mm format Hasselblad camera equipped with a 80 mm lens. The camera was mounted to the floor of the helicopter in front of the

forward passenger seat and photographs were taken through a hole cut in the bubble. Kodak Ektachrome color positive film (Type 5017) was used for all photographs.

Examination of aerial photographs

The number of attended and solitary pups in each photograph was recorded from the photographs. The film was viewed over a light table and examined with a hand-lens (7-8X magnification) to facilitate reading. The reader (DW) had considerable experience in identifying hooded seals from photographs and no difficulties were encountered in identifying pups.

The transects were plotted on a hydrographic chart (1:300,000) of Mercator projection. The transect end points were connected and the total area surveyed was determined by planimetry. The single photo area was determined from the survey altitude, the print size and the calibrated length of the camera lens.

Statistical methods

The number of hooded seals present was estimated by multiplying the area surveyed by the average density of seals, as determined from the spot photographs. Since the data indicated a clumped distribution of pups, confidence limits for the density estimates were obtained using a bootstrap resampling procedure; a histogram was produced of the mean density of 2000 random draws of the observed data with replacement (Efron 1979).

Results

A summary of the results of the photo-transects is given in Table 1. Figure 2 shows the location of the transects flown. A total of 379 photographs were taken and the survey covered an area of 62.77 km^2. A total of 17 pups were identified on the photographs, an observed density 3.815 pups/km^2. The resulting estimate of total pup production is 239 pups. The 95% confidence limits for this estimate are 118-363 (Fig. 3).

Discussion

This study provides the first aerial survey estimate of hooded seal pup production in a Gulf of St. Lawrence whelping patch. Prior estimates were based upon visual estimates of the number of families present or on the number of pups tagged in a whelping patch (Sergeant 1966; Sergeant and Hoek, in press). However, the use of visual estimates pose many problems and the results can be affected by a variety of factors. These include observer experience, motivation, fatigue, ambient weather and condition of the terrain (Caughley 1974; Lavigne et al. 1977; Norton-Griffiths 1976). Although the influence of these factors upon survey results has been estimated in studies in which individual animals are counted (see LeResche and Rausch 1974; Caughley et al. 1976; Briggs et al. 1985), their influence upon visual estimates of

aggregations of animals are less understood. Such estimates have been found to be inaccurate causing the actual population to be overestimated or underestimated depending upon the species and the observers (Lavigne et al. 1977; Wartzok and Ray 1975; Scott et al. 1985). Also, visual estimates of aggregations are often imprecise, even among experienced observers (Lavigne et al. 1977; Wartzok and Ray 1975).

The behaviour of the animal surveyed will also affect the accuracy of a visual estimate. Female hooded seals tend to be scattered widely throughout poorly defined whelping patches and in the Gulf, seals were spread over more than 62 km^2 at very low densities. This tendency to scatter widely makes it difficult to estimate the total area used and the density of seals present thus greatly increasing the difficulty of making an accurate population estimate.

A visual estimate of the whelping patch surveyed was made by two observers, one of which had considerable experience estimating populations of hooded seals. The pup production was estimated to be between 200 and 500. Although the survey estimate is included in this range, accepting the mean of the visual estimate would result in a population level significantly greater than that of the aerial survey. Sergeant (1976) noted a similar tendency to estimate a larger population visually. An aerial survey of a whelping patch in the Davis Strait resulted in an estimated of 4,200 hooded seals while the visual estimate was between 5,000 and 10,000 animals.

Along with the inaccurate nature of visual estimates, an additional difficulty is the large range of such estimates. Usually, the range of these estimates are so large that they are of little use in identifying population changes. Although the confidence intervals of this aerial survey were also large (118-363) the present estimate provides a statistical basis for future surveys. Also, improvements in survey design can decrease the interval in future surveys.

This study provides a minimum estimate of pup production only. The estimate of 239 pups is negatively biased because it is not corrected for the distribution of births in the population. The lactation period of hooded seals is very short, averaging four days (Bowen et al. 1985). However, in the Gulf pups may whelp over a period exceeding three weeks (Sergeant and Hoek, in press). Therefore, some pups may be missed on the day of the survey if they had left the ice or had not been born yet. The amount of correction necessary for these pups is unknown although it may be as large as 50% (Bowen et al. 1987). However, this survey was conducted at a time when the maximum number of pups were likely present on the ice (Sergeant, pers. comm.) and therefore, the amount of bias was minimized.

Unfortunately, the total population of hooded seals in the Gulf cannot be accurately estimated. On the day of this survey, a second whelping patch was located at 46°42'N 61°10'W, near Cape Breton Island (Fig. 1). This patch was visually estimated to consist of approximately 200 families (R. Langford, pers. comm.). If we assume that this estimate is reasonably accurate (not necessarily a valid assumption) the resulting total pup production between these two patches is 400-450 seals. As mentioned previously, this estimate is negatively biased since it does not include a correction for the distribution of births in the patches. This estimate may also be

increased due to the presence of females that give birth outside of the main whelping patches. At the Front, these 'scattered' females may account for as much as 20% of the pup production (Bowen et al. 1987). The proportion of pup production which occurs outside of the whelping patches in the Gulf of St. Lawrence is unknown although small number of scattered hooded seals have been observed among whelping harp seals (Hoek, pers. comm.).

If the maximum corrections for the distribution of births and for scattered females are applied to the estimate of production in the two patches, the total production would be in the order of 700-800 pups. However, this would be a maximum estimate and pup production may in fact be considerably smaller. Naturally, this estimate assumes that all of the existing whelping patches were discovered. This assumption is considered to be valid as the majority of the area historically occupied by hooded seals was overflown during various reconnaissance flights and no other hooded seals were observed.

Based on visual estimates and the number of pups tagged, Sergeant (pers. comm.) estimated that production in the Gulf during 1984 exceeded 500 pups but was not greater than 1000. The results presented here suggest a similar level of production. Population estimates have not varied significantly since hunting ceased in 1964 and this observation lead Sergeant and Hoek (in press) to suggest that the population of hooded seals in the Gulf may be stable. Due to the imprecise nature of the available estimates however, it is impossible to determine if the population size of hooded seals has changed during this period. Until proper aerial surveys covering the entire expanse of heavy ice in the southern Gulf are conducted, it will be impossible to determine the status of hooded seals in this area. Although this study does not encompass the entire Gulf population, it does provide an initial attempt to estimate pup production in the Gulf based upon a technique which is statistically reliable for determining future trends in abundance.

Acknowledgements

We would like to thank W. Hoek for his help during the aerial survey. Our pilot K. Miller ensured that the survey was completed efficiently, R. Langford provided information concerning DFO reconnaissance flights, R. Myers assisted with the bootstraps and I-H. Ni reviewed a draft of this manuscript.

References

Briggs, K. T., W. B. Tyler, and G. B. Lewis. 1985. Comparison of ship and aerial surveys of birds at sea. J. Wildl. Manage. 49: 405-411.

Bowen, W. D., O. T. Oftedal, and D. J. Boness. 1985. Birth to weaning in 4 days: remarkable growth in the hooded seal, Cystophora cristata. Can. J. Zool. 63: 2841-2846.

Bowen, W. D., R. A. Myers, and K. Hay. 1987. Abundance estimation of a dispersed, dynamic population: hooded seals (Cystophora cristata) in the Northwest Atlantic. Can. J. Fish. Aquat. Sci. 44: in press.

Caughley, G. 1974. Bias in aerial survey. J. Wildl. Manage. 38: 921-933.

Caughley, G., R. Sinclair, and D. Scott-Kemmis. 1976. Experiments in aerial survey. J. Wildl. Manage. 40: 290-300.

Efron, B. 1979. Computing and theory of statistics: thinking the unthinkable. SIAM (Soc. and Appl. Math) Review. 21: 460-480.

Hay, K., G. B. Stenson, D. Wakeham, and R. A. Myers. 1985. Estimation of pup production of hooded seals (Cystophora cristata) of Newfoundland during March 1985. CAFSAC Res. Doc. 85/96.

Lavigne, D. M., N. A. Øritsland, and A. Falconer. 1977. Remote sensing and ecosystem management. Norsk Polarinstitutt Skrifter NR 166. 51 p.

LeResche, R. E., and R. A. Rausch. 1974. Accuracy and precision of aerial moose censusing. J. Wildl. Manage. 38: 175-182.

Norton-Griffiths, M. 1976. Further aspects of bias in aerial census of large mammals. J. Wildl. Manage. 40: 368-371.

Scott, M. D., W. L. Perryman, and W. G. Clark. 1985. The use of aerial photographs for estimating schools sizes of cetaceans. Inter-American Trophical Tuna Commission Bull. 18: 383-404.

Sergeant, D. E. 1966. Canadian research report on harp and hood seals in the northwest Atlantic. ICNAF Res. Doc. 66-61.

1976. Research on hooded seals Cystophora cristata Exleben in 1976. ICNAF Res. Doc. 76/XI/126.

Sergeant, D. E., and W. Hoek. In press. The hooded seals whelping in the Gulf of St. Lawrence. In: Øritsland, T., P. F. Brodie and G. H. Winters [ed.] Proceedings of the Hooded Seal Workshop. Bergen, Norway, 7-11 November, 1983.

Wartzok, D., and G. C. Ray. 1975. A comparison of the accuracy and precision of visual and photographic aerial censuses of ice-inhabiting marine mammals: results of a simulated flight. Proceedings of the Workshop on Remote Sensing of Wildlife, Quebec, Canada, 17-20 November 1975. 20 p.

Table 1. Summary of results of spot-photo survey of hooded seals carried out in the Gulf during March 1986. (Total area surveyed = 62.77 km; single photo area = 0.01185 km^2; interval between transects = 0.926 km; survey altitude = 153.8 m).

Transect no.	Length (km)	No. photos taken	No. of hooded seal pups counted			Frequency of photos with no. of pups equal to		
			Family	With mother	Total	0	1	2
1	5.4	26	0	0	0	26	-	-
2	4.7	29	1	1	2	28	-	1
3	7.6	36	1	2	3	34	1	1
4	8.4	49	1	1	2	47	2	-
5	8.4	40	0	2	2	38	2	-
6	6.5	39	1	2	3	36	3	-
7	7.1	36	2	0	2	34	2	-
8	6.4	38	1	0	1	37	1	
9	6.5	55	1	0	1	54	1	-
10	5.9	28	1	0	1	27	1	-
TOTALS	66.9	376	9	8	17	361	13	2

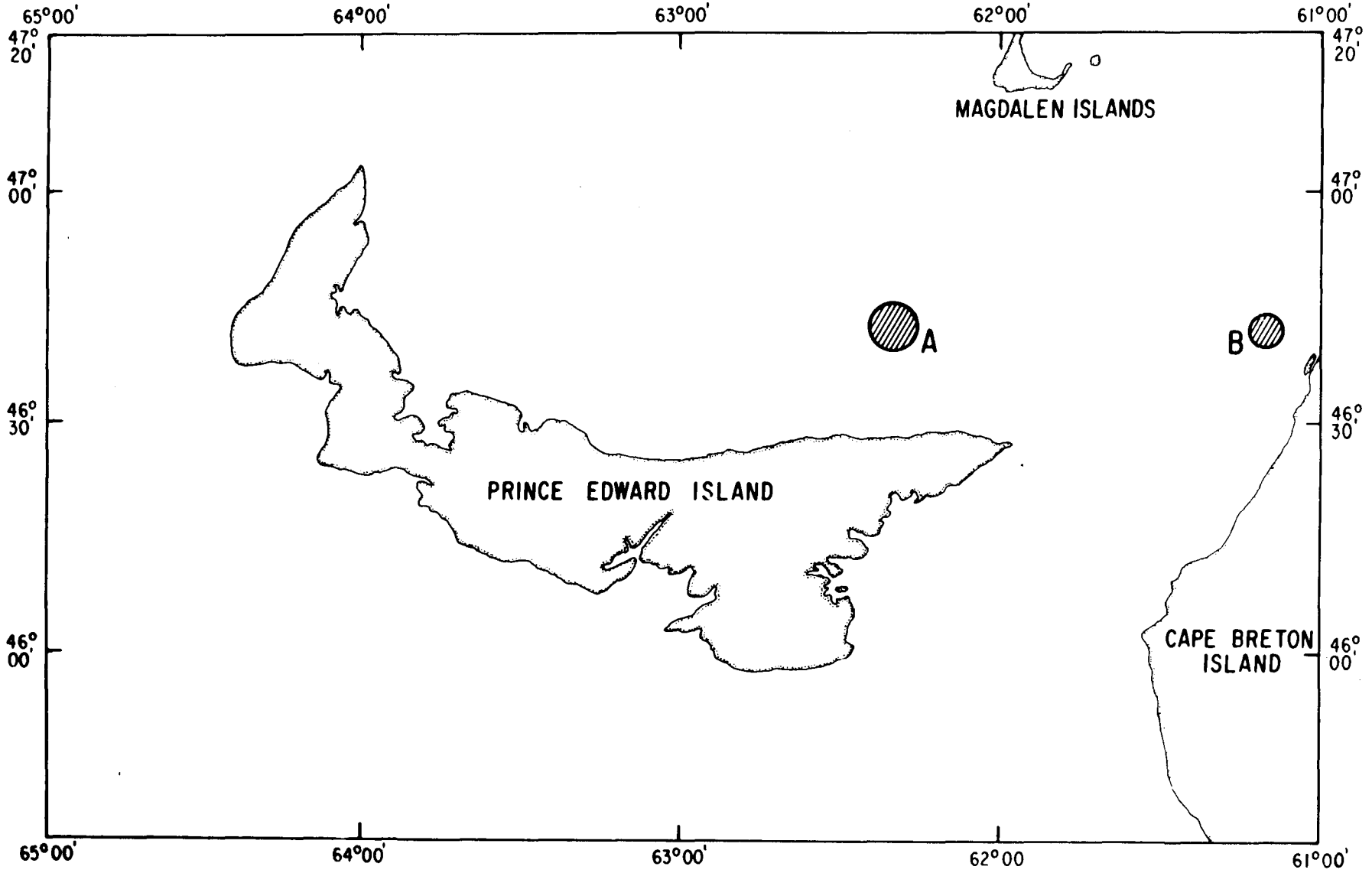

Fig. 1. Location of known whelping patches of hooded seals in the Gulf of St. Lawrence on March 18, 1986. Patch A was initially located on March 14 and surveyed on March 18. Patch B was located on March 18 and only a visual estimate of population is available.

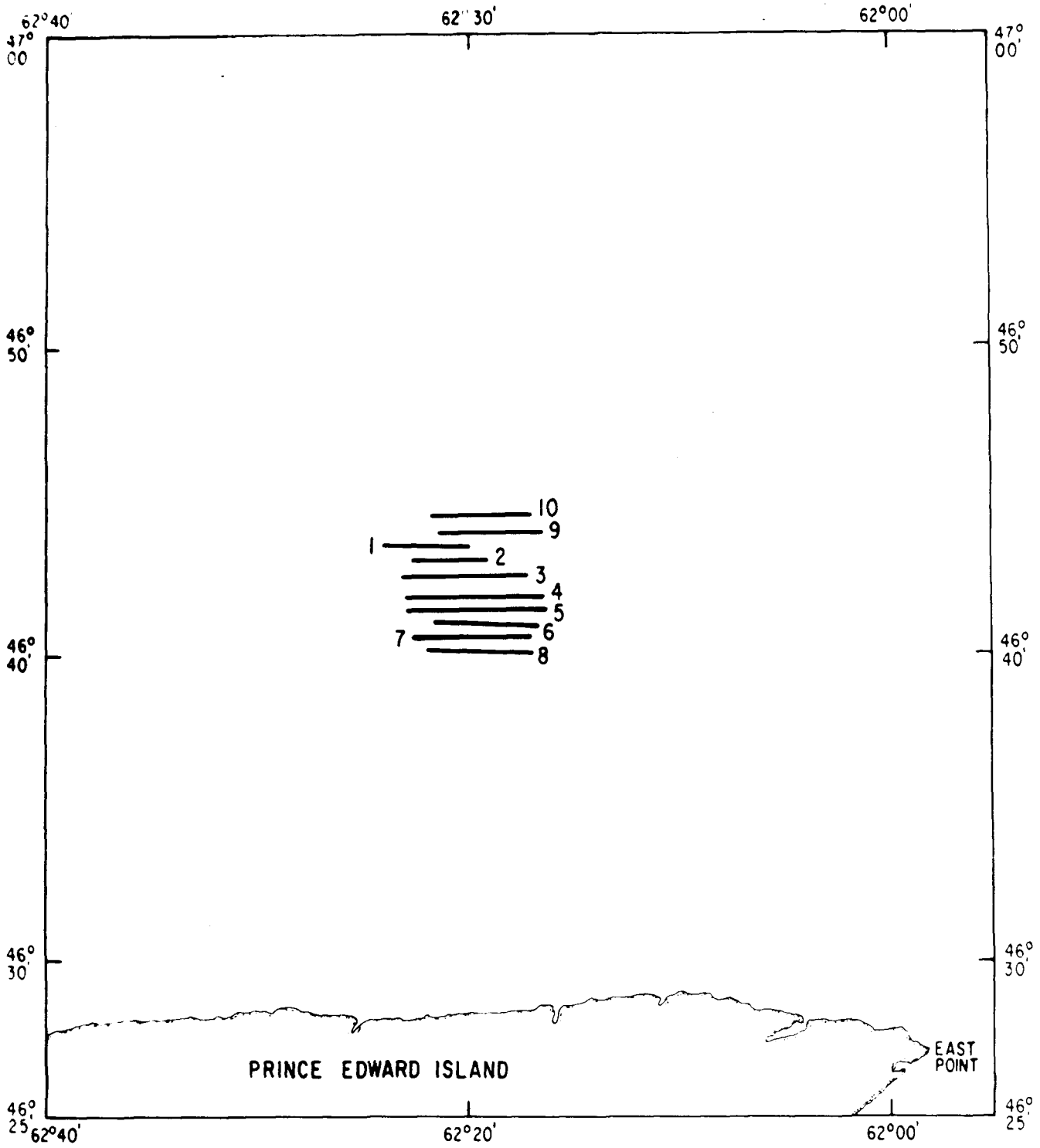

Fig. 2. Photo-transects flown in the Gulf of St. Lawrence March 18, 1986. Transects are identified by number at the end of the lines.

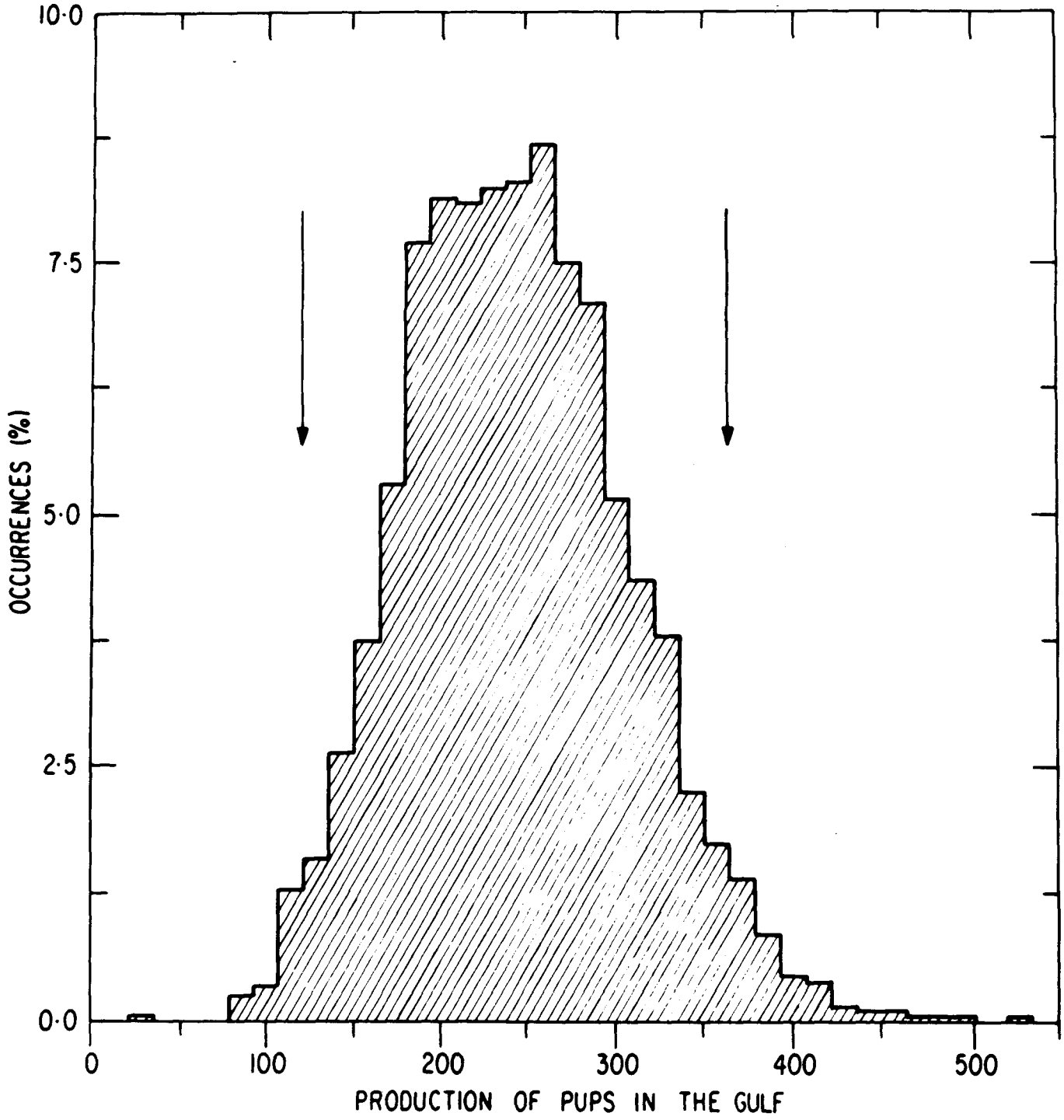

Fig. 3. Histogram of 2000 bootstrap simulations of the data collected during an aerial survey of hooded seals in the Gulf of St. Lawrence during March 1986. The 95% confidence limits are indicated by arrows.