

LITHOBY,
FISHERIES RESEARCH BOARD OF CANADA
BIOLOGICAL STATION
ST. JOHN'S, NEWFOUNDLAND, CANADA

Censusing and Estimating the Size of Ringed Seal Populations

by T. G. Smith

FISHERIES RESEARCH BOARD OF CANADA

TECHNICAL REPORT NO. 427

1973



JAN 24 1974

FISHERIES RESEARCH BOARD OF CANADA

Technical Reports

FRB Technical Reports are research documents that are of sufficient importance to be preserved, but which for some reason are not appropriate for primary scientific publication. No restriction is placed on subject matter and the series should reflect the broad research interests of FRB.

These Reports can be cited in publications, but care should be taken to indicate their manuscript status. Some of the material in these Reports will eventually appear in the primary scientific literature.

Inquiries concerning any particular Report should be directed to the issuing FRB establishment which is indicated on the title page.

FISHERIES RESEARCH BOARD OF CANADA

TECHNICAL REPORT NO. 427

CENSUSING AND ESTIMATING THE SIZE OF
RINGED SEAL POPULATIONS

by

T. G. Smith

FISHERIES AND MARINE SERVICE

Arctic Biological Station

Ste. Anne de Bellevue, Que.

November 1973

ABSTRACT

Methods and survey design for censusing ringed seals on the sea ice are discussed. Factors affecting the final population estimate include seal behavior, weather conditions, age structure of the population, diurnal variation in the number of hauled-out seals and the proportion of seals under the ice. A higher number of seals are seen along complex coastlines and different densities are observed in closely adjacent ice areas with different stability and snow cover. The latter appears to be directly related to the suitability of the ice as birth lair habitat.

INTRODUCTION

Ringed seals, Phoca (Pusa) hispida for the greater part of the year, are solitary animals rarely seen with other seals. Most of their time is spent in the water and for the greater part of the year under the land-fast sea ice. During the spring, from early May until breakup, they haul out on the ice to bask in the sun. This hauling-out period is associated with the annual moult and a long fasting period. The hauling-out period reaches its peak around the end of June or early July just before the ice break-up in most mid arctic localities. This appears to be the best time for aerial counts.

A number of investigators have attempted to derive population estimates of ringed seals using aerial surveys. McLaren (1966) surveyed areas in the Frobisher Bay region of eastern Baffin Island in late June. Johnson et al. (1966) surveyed the coast of Alaska between Point Hope and CapeThompson at various times between January and June. Smith (1973) surveyed the complex fiord-indented coastline in the Home Bay and Cumberland Sound areas of eastern Baffin Island. Burns and Harbo (1972) flew a number of surveys along the Alaskan coast between Point Lay and Barter Island during early June. McLaren (1961) also suggests the use of a ship transect count in the open-water season from boats or freighter canoes.

The present paper outlines and evaluates the methods used in aerial censusing and points out some important factors that must be considered before these figures are used in a final estimate of population size. Data used here are from aerial surveys and behavioural observations made in the Home Bay area on the east coast of Baffin

Island in 1968 and 1969 (Smith, 1973) as well as similar work on the west coast of Victoria Island and the Amundsen Gulf region in 1972 (Fig. 1).

SURVEY METHODS

Although single-engine aircraft have been used (McLaren, 1966; Burns and Harbo, 1972) it is probably better to use twin-engine aircraft such as the Piper Apache or Aztec. These have a long range and are necessary for flying over the areas of open water which are numerous and quite extensive in late June.

The specific approach to counting seals on the ice depends mainly on the topography of the coastline.

In general it is felt that for flying in areas of deep fiords and around islands, where the boundaries of the survey area can be delimited by landmarks, the lower the altitude flown, the greater is the visibility of the seals. It appears that the silhouette of the seal against the horizon makes it much more visible than when it is viewed from directly overhead, especially against a surface of water-mottled ice. Under such conditions it was found that seals could easily be picked out up to three miles on either side of the aircraft when flying at altitudes of 50-100 feet (Smith, 1973). An air speed of 130-135 mph is great enough so that seals were not scared down until the plane was over or past them.

On very simple coastlines such as seen on the Alaskan coast between Point Bay and Barter Island (Burns and Harbo, 1972) the only

possible approach to counting seals is to fly transects of known widths. This is also used to count offshore areas in regions with complex coastlines.

For the western Victoria Island survey which lasted from 20 to 23 June 1972, angles of sight were established for altitudes of 300 and 500 feet by flying over a strip two miles long by one mile wide made of 45-gal gas drums set out on the sea ice. Constant sighting angles were maintained by the use of marks on the windscreen and side windows. Two observers, one in the passenger seat and one behind the pilot count all seals out to one half mile on each side of the aircraft. Although Banfield (1955) states that to effectively cover an area of one half mile from the plane it is necessary to fly at altitudes in excess of 1000 feet, it was found that objects the size of ringed seals could be picked out consistently from the 300-foot altitude.

During the survey, records are kept of all changes in altitudes or headings. Seal counts are recorded every two minutes and real time noted every 30 minutes. One observer takes care of the timing device so that the counts from each observer are from the same quadrat. Detailed notes are made on the extent and quantity of ice, number of leads crossed, pressure ridges and snow cover. All seals counted along leads or in the water are recorded separately. Pups and suckling pairs are also recorded. Notes are made on changes in cloud cover, presence of fog and precipitation during the survey. Separate notes are made on bearded seal, polar bear and fox sightings.

General Survey Design

Aerial surveys flown by us have been spread over a period of 10 days during late June and early July. There is a fair amount of fog during this time of year, just prior to the ice breakup, and we know we can count on approximately 50 percent good flying weather. No more than eight hours of flying is undertaken each day. Using a Piper Aztec or Apache which have ranges of 6 and 5 hours respectively it is usually possible during a five-day period to cover approximately 5400 square miles of sea ice.

The survey design must seek to provide data on a number of points: (1) location of areas of high ringed seal density around hunting communities; (2) longer ranging flights to estimate densities in offshore areas and along uninhabited coastlines; (3) information on the patterns of distribution with respect to distance from shore, distance from open water, densities in bays and fiords, around islands and in different ice types.

The use of time quadrats within a strip transect provides a useful structure by which the survey results can be tested statistically. Regression analysis can be used to test variation in density with distance from open water or shore (Burns and Harbo, 1972) or with increased numbers of leads and open water areas (Siniff, Cline and Erikson, 1970). Various tests exist based on the transect and quadrat design to determine randomness or aggregation in the seal distribution (Andrewartha, 1961; Greig-Smith, 1964; Siniff, et al., 1970). The survey design should include replicate transects to test the

variation in density from day to day and within similar areas. Tests can be made of differences in the visual acuity of different observers by separating out variation from other causes and by using a third observer as a check.

RESULTS

McLaren (1958) states that complex coastlines because of greater ice stability are more productive than simple coastlines. He divided his ice areas arbitrarily into 3 categories described by their distance from shore and assigned decreasing seal densities to these areas as distance from shore increased. My surveys in the complex coastal areas of Home Bay on east Baffin Island and along the simple coastline of west Victoria Island do indicate that coastal complexity is correlated with high production (Table 1 and 2). This is also borne out by the low densities obtained by Burns and Harbo (1972) along the simple Alaskan coast between Point Lay and Barter Island.

Both of my surveys indicated the presence of very low and highly productive areas within the same region. On east Baffin deep fiords and areas around islands had the highest densities (Table 1). The few transects flown indicated a sharp drop in densities in ice 15 to 20 miles offshore. Results from the survey on western Victoria Island and the Amundsen Gulf region did not show this clear pattern of density with different ice categories (Table 2). Two large bays near Holman did have quite different numbers of seals. Prince Albert Sound to the south of the village of Holman was quite

productive with a mean density of 7.29 seals/square nautical mile. Minto Inlet to the north almost as large and with the same east-west orientation was significantly less densely occupied with a mean of 0.61 seals/square nautical mile.

A regression was done on the density of seals with distance from shore on one transect running out from Holman on a heading of 275° for 103 miles. The regression was not significant ($F = 1.13$, d.f. = 21). From these limited data it appears that a fairly constant number of seals are found in areas off the western Victoria Island coast as far out as the middle of the Amundsen Gulf. The two longest transects in areas far off shore yielded similar mean densities of 3.68 and 4.58 seals per square nautical mile. Areas 15, 10, and 3 miles offshore along the coast near Holman had similar densities of 3.26, 2.36 and 2.77 seals per square nautical mile.

Factors Affecting the Final Population Estimate

A large number of factors will affect the estimate of the true population size based on an aerial count of seals in the fast ice. These can be divided into two types; those associated with the census itself and those involving the behaviour of the seals.

Included in the first category are timing of the survey and underestimation of seals on the ice. It appears that the optimum time for counting hauled-out seals is in the 2-3 weeks prior to the actual break-up of fast ice. In most mid arctic areas where ringed seal censuses have been made this occurs during the first two weeks of July.

It is variable however from one year to the next and plans for survey work should be flexible enough to take this into consideration. The objective of aerial surveys should be to count the number of seals resident in the fast ice. The peak of the haul-out period has been shown by both McLaren (1958) and Smith (1973) to occur near the end of June on the east Baffin coast. The present study on the western coast of Victoria Island at approximately the same latitude of 70°N indicates a similar peak (Fig. 2). It should also be pointed out that counts made on the fast ice of bays after much of the fast ice has been broken up will sometimes lead to obvious overestimation of population densities. Thus McLaren (1958, 1966) appears to have grossly overestimated densities by extrapolation from peak counts obtained late in the season in Ney Harbour, an area containing only 3.6 square miles of fast ice.

A significant error may be introduced by the observers missing seals present in the census area during the survey. This is caused mainly by flying at too great an altitude. Ground controls conducted during previous surveys have shown that significant numbers of seals are missed when flying at an altitude of 1000 feet compared to altitudes of approximately 100 feet (Smith, 1973). When flying transects of one-half mile wide at 300 feet of altitude a slight error may be caused by missing seals at the extreme edge of the transect, because they are hauled out in collapsed birth lairs, which are somewhat below the surface of the ice.

Data derived from studies on ringed seal behaviour and

population structure must be used as correction factors on aerial counts to derive estimates of the real population size. A number of different observation periods in areas of high seal densities during the peak of haul-out have provided information on the diurnal regime of hauling-out and the proportion of seals under the ice. Smith (1973) from studies made in Ekalugad fiord on east Baffin Island showed the diurnal peak of haul-out at various dates through the month of June. Similar data during five continuous observation days from 12 to 16 June on the west coast of Victoria Island in 1972 are shown in Fig. 3. The diurnal peak of haul-out appears to cover the period from approximately 900 to 1500 hours. During this time indirect calculation indicate that a maximum of 50 percent of the seals are under the ice (Smith, 1973).

Climatic conditions also play an important role in determining the number of seals hauled up on a particular day. Table 3 shows the maximum number of seals on the fast ice per day in the west Victoria Island study area and the weather conditions existing at the time. Negative correlation of -0.669 and -0.575 were found for seal numbers with wind and percent overcast. Both coefficients showed a significant departure from $H_0 = r = 0$ at the 95 percent level of confidence. Observational data both in Ekalugad fiord and on the west coast of Victoria Island also indicates that moulted pups still accompanying their hauled-out mothers, spend a proportionately larger part of their time in the water than do the adult females. It is also evident that suckling pups are not easily visible during aerial counts and a

large proportion of them might be missed.

Information on the age structure of the population at the time of aerial counts has been obtained from Eskimo catches on the east Baffin coast (Smith, 1973) and from a sample of animals shot on the ice near the study area on the west coast of Victoria Island (Fig. 4). In both cases the adolescent portion of the catch was grossly under-represented when compared to the catch curve considered most representative of the whole population age structure obtained from catches during the open water season.

CONCLUSIONS

Large differences in seal densities appear to be associated with different coastal topography. Mean densities per square nautical mile of 8.83, 6.53 and 5.02 for fiords, around islands and in the offshore ice of the complex coastal areas on the east Baffin survey are compared to densities of 4.58 - 2.36 for ice at various distances from the western Victoria Island coastline. Burns and Harbo (1972) found even lower densities of 1.68 and 1.83 and 2.15 along the simple Alaskan coast between Point Lay and Barter Island.

Intensive aerial censusing of areas around hunting communities provides important data for estimation of local stock size. This has also shown that areas of ice which at first appear similar contain very different densities of seals. Certain fiords in the Home Bay area had constantly higher numbers of seals than neighbouring fiords which were of roughly the same dimensions and orientation. A comparison of

Minto Inlet and Prince Albert Sound on western Victoria Island shows vastly different densities of 0.61 and 7.29 seals per nautical square mile, respectively. The local Inuit hunters from Holman state that this is a constant feature of these two areas. A closer examination from the ground reveals that there are differences in the ice surface and snow cover between these two areas. Prince Albert Sound which is the larger of the two is dotted with ice hummocks formed by the pressuring of the ice early in the fall. It also contains four or five large pressure ridges which cross the Sound completely at the seaward end. Once the fast ice is formed it is very stable and does not break up until about mid July each year. The ice hummocks and pressure ridges act as wind breaks where snow accumulates on the lee and windward side. These areas are selected by the ringed seal for building birth lairs. Minto Inlet appears to freeze over with very little pressuring, consequently there are no ice hummocks and few pressure ridges. It appears thus that suitable snow cover and rough ice is needed for breeding lair habitat and that this is related to seal densities obtained in aerial counts. There are also indications from stomach contents of seals collected at the birth lairs that plankton and fish productivity under the ice and bottom topography might have an influence on the selection of fast ice areas by seals.

Better quantitative data on the proportion of seals under the ice during aerial counts, on the age structure of the hauled-out seals,

on the diurnal density changes, are all necessary to refine population estimates based on aerial censuses.

REFERENCES

- Andrewartha, H. 1961. Introduction to the study of animal populations
Univ. Cambridge Press, 281 pp.
- Banfield, A. 1955. An aerial survey technique for northern big game.
Trans. 20th North Amer. Wildl. Confl: 519-532.
- Burns, John J., and Samuel J. Harbo, Jr. 1972. An aerial survey of
ringed seals, northern coast of Alaska. Arctic 25: 279-290.
- Greig-Smith, P. 1964. Quantitative plant ecology. Butterworths,
London, 256 pp.
- Johnson, M. L., C. H. Fiscus, B. T. Ostenson, and M. L. Barbour. 1966.
Marime mammals, Chapter 33 In Normal J. Wilimovsky [Ed.],
Environment of the Cape Thompson region, Alaska. U.S.A.E.C.,
Div. Tech. Inf. Ext., Oak Ridge, Tennessee.
- McLaren, I. A. 1958. The biology of the ringed seal (Phoca hispida
Schreber) in the Canadian arctic. Fish. Res. Board Can. Bull. 118:
97 p.
1961. Methods of determining the numbers and availability
of ringed seals in the eastern Canadian arctic. Arctic 14: 162-175.
1966. Analysis of an aerial census of ringed seals.
J. Fish. Res. Board Can.: 770-774.

- Siniff, D. B., Cline, D. R. and A. W. Erikson, 1970. Population densities of seals in the Weddell Sea, Antarctica, in 1968. Vol. I p. 377-394. In M. W. Holgate ed., Antarctic Ecology. Academic Press, London and New York.
- Smith, T. G. 1973. Population dynamics of the ringed seal in the Canadian eastern arctic. Fish. Res. Board Can. Bull. 181: 55 p.

LIST OF TABLES

- Table 1. Density of ringed seals per nautical square mile in different types of ice (from Smith, 1973).
- Table 2. Density of ringed seals per nautical square mile from transects flown out of Holman, on western Victoria Island, 21 and 23 June 1972.
- Table 3. Maximum number of ringed seals on the fast ice in relation to weather conditions, on the west coast of Victoria Island May to June 1972.

Table 1. Density of ringed seals per nautical square mile in different types of ice (from Smith, 1973).

<u>Type of coastline</u>	<u>Ice description</u>	<u>Mean density</u>	<u>S.E.</u>
Complex	Fiords	8.42	1.16
"	Fiords	8.83	3.39
"	Heads of fiords and around islands	5.89	1.18
"	Heads of fiords and around islands	6.53	0.87
"	Offshore to 18 miles	5.02	
"	Offshore to 27 miles	7.98	
"	Offshore 18 to 33 miles	1.02	
"	Offshore 27 to 33 miles	0.19	

Table 2. Density of ringed seals per square nautical mile from transects flown out of Holman, on western Victoria Island, 21 and 23 June 1972.

Track description	Area covered (sq. naut. miles)	Number of 2 minute quadrats	Mean number per 2 minute quadrat (seals on leads excluded)	S.E.	Mean number per 2 minute quadrat (seals on leads included)	Density per naut. sq. mile
275° out of Holman across Amundsen Gulf	117.0	26	14.9	1.05	16.58	3.68
At least 10 miles offshore from Cape Parry to 10 miles offshore Holman	112.5	25	20.6	1.87	20.64	4.58
15 miles offshore western Victoria Is.	76.5	17	12.8	1.46	14.70	3.26
10 miles off coast western Victoria Is.	49.5	11	9.5	1.24	10.63	2.36
3 miles off coast western Victoria Is.	54.0	12	9.8	1.74	12.49	2.77
George Is. to Nunungiak in Prince Albert Sound	108.0	24	30.0	3.97	32.83	7.29
Minto Inlet	99.0	22	2.8		2.77	0.61

Table 3. Maximum number of ringed seals on the fast ice in relation to weather conditions, on the west coast of Victoria Island May to June 1972.

<u>Date</u>	<u>Maximum number of seals</u>	<u>Mean daily wind velocity (mph)</u>	<u>Mean percent overcast</u>
May 31	10	1.6	75
June 1	12	7.9	68
2	11	16.6	91
3	0	24.0	70
4	4	14.3	59
5	10	9.0	60
6	18	8.3	100
7	24	5.0	68
8	9	13.7	37
9	32	10.0	100
10	14	18.8	50
11	6	22.5	62
12	48	3.5	25
13	50	1.8	25
14	41	1.8	0
15	42	7.9	14
16	36	3.7	25

LIST OF FIGURES

- Fig. 1. A map of the survey area out of Holman on western Victoria Island. Arrow points to the area where behavioural observations were made.
- Fig. 2. Daily maximum number of ringed seals observed in the study area on the coast of western Victoria Island during May and June 1972
- Fig. 3. Diurnal haul-out regime of ringed seals in study area on the coast of western Victoria Island.
- Fig. 4. Age structure of seals shot on the ice near the study area on western coast of Victoria Island.

Fig. 1. A map of the survey area out of Holman on western Victoria Island. Arrow points to the area where behavioural observations were made.

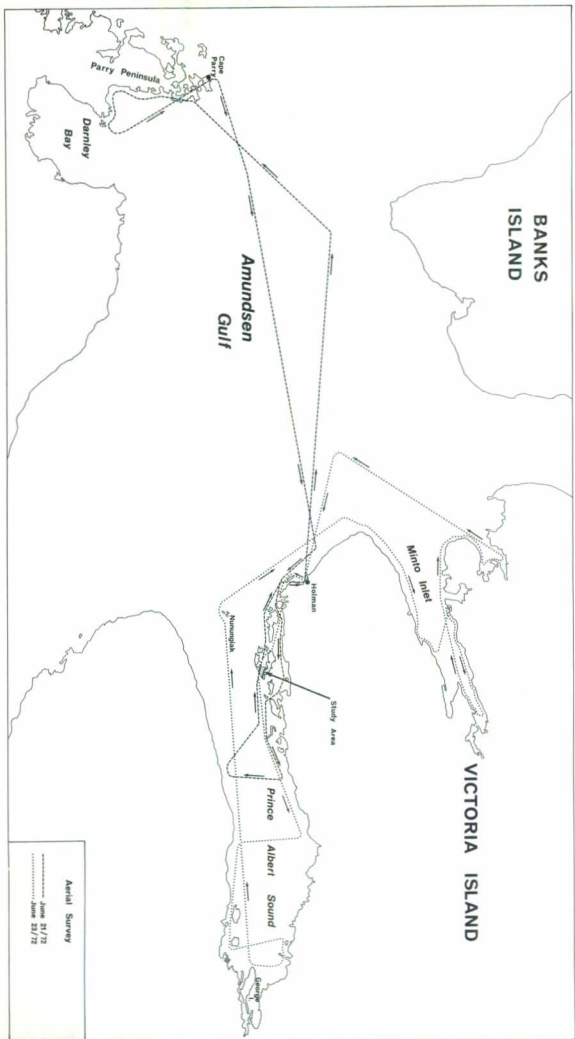


Fig. 2. Daily maximum number of ringed seals observed in the study area on the coast of western Victoria Island during May and June 1972.

MAXIMUM NUMBER OBSERVED

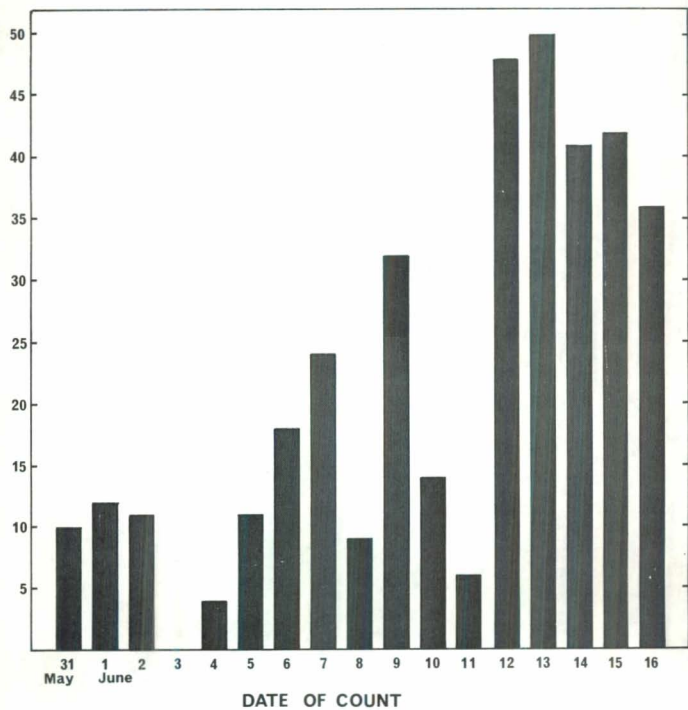


Fig. 3. Diurnal haul-out regime of ringed seals in study area on the coast of western Victoria Island.

NUMBER OF SEALS

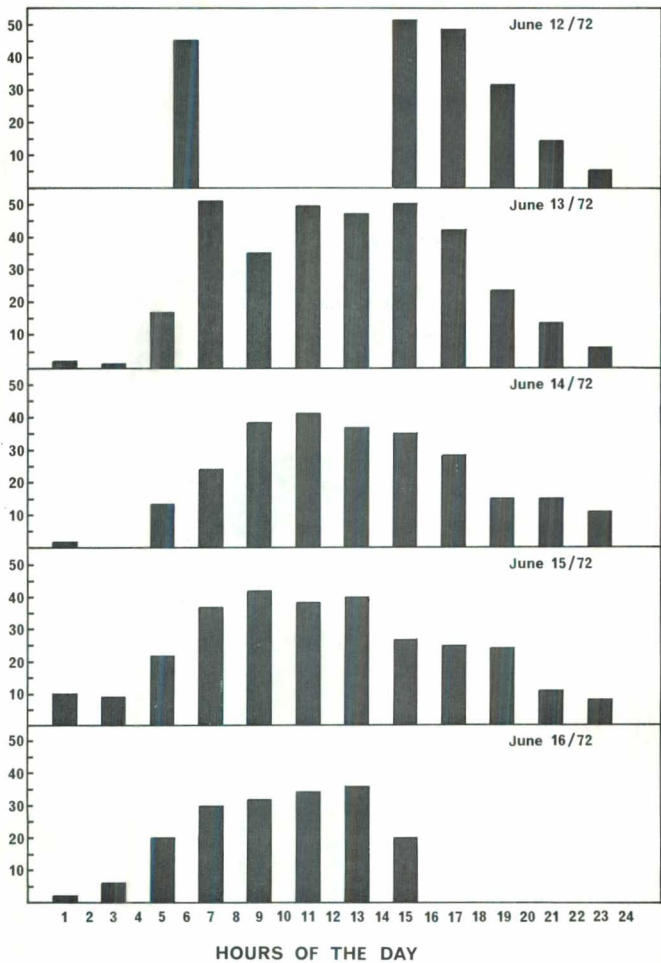


Fig. 4. Age structure of seals shot on the ice near the study area on western coast of Victoria Island.

