The Abundance of Ringed Seals in the Beaufort Sea and Amundsen Gulf, 1983

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by

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ABSTRACT

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The third in a series of surveys to monitor the abundance and distribution of the ringed seal (*Phoca hispida*) was flown in the Beaufort Sea, Amundsen Gulf and Prince Albert Sound from 19 through 27 June 1983.

At the time of the survey, the Beaufort Sea was partially open, the fast ice was thin and appeared ready to break up, and the cover in the floe ice area was low. Amundsen Gulf and Prince Albert Sound were covered with fast ice.

Densities of seals in Amundsen Gulf and in Prince Albert Sound were similar to those of 1982. In the Beaufort Sea, the density of seals on the floe ice was similar to that estimated in 1981; the density on fast ice was higher, apparently absorbing an overflow from the lesser cover of floe ice. The total visible population has been similar over the three years.

Higher density in proximity to active industrial sites was indicated by results of regression analysis.

Key words: Ringed seal; *Phoca hispida*; Beaufort Sea; Amundsen Gulf; abundance; distribution; aerial survey.

RESUME

Kingsley, M.C.S. 1984. The abundance of ringed seals in the Beaufort Sea and Amundsen Gulf, 1983. Can. Manuscr. Rep. Fish. Aquat. Sci. 1778: iv + 8 p.

Du 19 au 27 juin 1983, le groupe chargé de la troisième d'une série d'études sur l'abondance et la répartition des phoques annulés (*Phoca hispida*) a été transporté par avion à la mer de Beaufort, au golfe Amundsen et au détroit de Prince-Albert.

Au moment de l'étude, la mer de Beaufort était partiellement dégagée, la banquise côtière était mince et paraissait sur le point de se briser, et les glaces flottantes ne couvraient qu'une petite surface de cette mer. Le golfe Amundsen et le détroit de Prince-Albert étaient couverts par la banquise côtière.

Les densités des populations de phoques dans le golfe Amundsen et le détroit de Prince-Albert étaient semblables à celles de 1982. Dans la mer de Beaufort, la densité des phoques sur les glaces flottantes étaient semblable à celle estimée en 1981; par contre, la densité des phoques de la banquise côtière était plus élevée. Il semble que le surplus de phoques, occasionné par la diminution des glaces flottantes, se soit réfugié sur la banquise côtière. La population totale visible ne semble pas avoir varié au cours des trois années.

Les résultats de l'analyse de la régression ont indiqué une plus forte densité à proximité des industries en exploitation.

Mots-clés: phoque annulé; *Phoca hispida*; mer de Beaufort; golfe Amundsen; abondance; répartition; enquête par photographies aériennes.

INTRODUCTION

An annual series of aerial surveys of seals in the Beaufort Sea was started in 1981. It was designed to monitor the populations of hauled-out ringed seals (Phoca hispida) and bearded seals (Erignathus barbatus) and to relate temporal and spatial variations in density to the distribution of industrial activity connected with hydrocarbon exploration and development. An area in Amundsen Gulf and Prince Albert Sound was also surveyed as a control area unaffected by industrial activity. The 1983 survey results are presented in this report, and are compared with those for the previous two years (Kingsley et al. 1982a; Kingsley and Lunn 1983).

METHODS

SURVEY DESIGN AND FLYING

The 1983 survey followed the same design as the 1981 and 1982 surveys (Kingsley and Lunn 1983). A strip transect design was employed, and all transects were oriented north-south. In the Beaufort Sea (Area 1), transects were spaced every 15' of longitude from 129° 15'W to 136° 30'W and were about 160 km long; the northwestern limit was 70° 40'N and the northeastern 71° 40'N. In the control area, comprising Amundsen Gulf (Area 2) and Prince Albert Sound (Area 3), transects were spaced every 20' of longitude from 114° 40' W to 123° 00' W; the southern limit was 70° 30' N in Area 2, and 70° 00' N in Area 3 (Fig. 1) (Kingsley et al. 1982a).

The transects were 0.8 km (0.5 miles) wide and were flown at 152 m (500 feet) in a Cessna 337 'Skymaster'. Data were collected continuously by two-minute intervals. Ringed and bearded seals were counted, and incidental sightings of white whales (Delphinapterus leucas), bowhead (Balaena mysticetus) and polar bear (Ursus maritimus) were recorded. Ice cover was estimated to the nearest eighth, and ice condition was recorded as 'fast', 'large floe', 'small floe' or 'rotten' (Kingsley et al. 1982b). Wind speed, cloud cover, and occurrence of fog or rain were also recorded for each two-minute interval.

DATA ANALYSIS

The data were analysed in the same way as in previous surveys, to give overall mean densities and estimates of the populations of visible seals by area (Kingsley et al. 1982a, b; Stirling et al. 1982). The Beaufort Sea area was divided into fast-ice and floe-ice subareas. The 20-m isobath is usually considered to approximate the seaward limit of the fast ice. However in the present study the 25-m isobath was used, because numerical information on its position in the survey area was readily available. Depths less than 25 m corresponded well, on average, with the 1981-1983 maximum fast ice area (Fig. 2). Ringed seal mean densities were computed for each subarea.

Stepwise multiple regressions were carried out to test for relationships between ringed seal density and ice type, weather, and water depth. The seal density in the two-minute intervals (the observational unit) was regressed on binary variables corresponding to these habitat and weather factors (Kingsley et al. 1982b). Seventeen industrial sites had been active at various times in the year before the survey. The distance from each two-minute interval to the nearest active site was calculated in kilometres. The reciprocal of the distance was used as a disturbance variable in the regression analyses. To avoid undue weighting by the large reciprocals of very small distances, 0.5 km was first added to the distance variable.

It seemed from the raw data that there were differences in seal densities between the days of survey, so binary dummy variables were created for dates and used in the regression analyses.

RESULTS AND DISCUSSION

SURVEY FLYING

The survey in the Beaufort Sea area was delayed and complicated by bad weather and aircraft malfunction. It took from 16 to 25 June to fly all the transects, and many were flown in cloudy, cold and windy conditions barely suitable for seal survey. On 25 June a large anticyclone moved into the region, and the survey of Amundsen Gulf and Prince Albert Sound went well and quickly and was completed on 27 June. The navigational system in the aircraft malfunctioned during the flying in Areas 2 and 3, and the element of error incurred by flying on dead reckoning is unknown: all the transects in Area 2 had one end offshore.

ICE CONDITIONS

The fast ice in the Beaufort Sea was thin, and appeared ready to break up, and cover was less than in 1981 or 1982. The shore lead was wide. The floe ice was thin and the cover was little more than half the 1981 value (Table 1).

In Amundsen Gulf there was nearly complete cover of fast or cracking ice, as there had been in 1982. However, the ice edge which ran from Cape Parry to Nelson Head was convex eastward, and the two westernmost transects in Amundsen Gulf were open water. Prince Albert Sound was fully ice-covered.

DENSITIES OF RINGED SEALS AND OF SEAL HOLES

Ringed seal densities in areas 2 and 3 were high and uniform, and similar to the 1982 values (Tables 2 and 3).

The overall mean density for Area 1 was slightly higher than in 1981, but half the 1982 value. Examination of the subarea mean densities and estimated visible populations showed a situation which could be approximately modelled by a constant visible population of about 5 400 seals, and a constant density on the floe ice (6/8+ cover) of about 0.21 seals/km^2, with the balance of the population moving to the fast ice to haul out. This model provides a summary of the three years' data, and is not advanced as a prediction of future distributions.

As in previous years, much difficulty was encountered in seeing seal holes in the muddy, puddled ice of the Beaufort Sea fast-ice subarea. As a result, counts good enough to analyze were not obtained, and holes in the floe ice subarea were not counted. Hole densities in Areas 2 and 3 were 5.7 and 5.3/km^2 (Table 3). These values gave a hole:seal ratio of about 2, a lower value than has been found in other studies (Alliston and McLaren 1981). It is suspected that some of the seals counted in Amundsen Gulf and Prince Albert Sound had moved in from earlier-open areas to the west, or that the winter social structure may be such that seals share the use of some holes. A more accurate survey technique for holes, perhaps using remote sensing, may help to resolve this.

HABITAT REGRESSIONS

The first regressions of ringed seal density revealed ice cover as the only significant variable, showing a general tendency for more seals to be seen in areas of higher ice cover. A similar result was obtained by Stirling et al. (1982). Seal densities were accordingly recalculated per square kilometre of ice, and reanalyzed. The variables entering the regression model (Table 4) were ice cover (2/8+), date (19 and 20 June), and cloud cover (broken or greater).

'Date = 19 June' entered with a positive coefficient, and 'date = 20 June' with a negative one. On 19 June the wind speed had been below 10 knots, cloud cover scattered and the outside air temperature at 500 ft 16-20°C; on 20 June it was windy (10-20 knots), overcast and cold (OAT 1-4°C). Even though the air temperature at 500 ft probably differs from that experienced by hauled-out seals, this variation in weather would affect seal behaviour. Outside air temperature should be recorded in future surveys.

When a disturbance variable was offered in the regression, it entered as significant, but with a positive coefficient, showing at least no negative effects of disturbance on density. A similar result was obtained in 1982 (Kingsley and Lunn 1983), who suggested, as a possible cause, greater intensity of industrial activity near to the offshore edge of the fast-ice, where seals would naturally tend to be more abundant.

CONCLUSIONS

The ringed seal system in the study area seems to have been stable over the three years of survey; fluctuations on the scale observed by Stirling et al. (1982) have not been observed. In the Beaufort Sea, the seals apparently distribute themselves between fast-ice and floe ice depending on the amount of floe ice available. When there is little, they move to the fast ice to haul out.

Densities and populations in Amundsen Gulf have also been stable. A count of seal holes in Amundsen Gulf and Prince Albert Sound again produced hole densities apparently too low to be comfortably inhabited by the seals counted in the area.

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Table 1. Ice cover and ice condition in Beaufort Sea (Area 1), Amundsen Gulf (Area 2) and Prince Albert Sound (Area 3) at time of survey, 1981-1983.

Area	Year	Survey area, $km^2.10^3$	Percentage area					
			Ice Cover			Ice surface	Ice condition[a]	
			0/8	6/8+	8/8		Fast[b]	Floe
1	1981	47.3	4.8	76.3	17.9	74.2	32.0	68.0
	1982	47.5	49.9	28.3	16.4	31.0	65.4	34.6
	1983	48.4	7.3	53.6	16.8	62.7	29.0	71.0
2	1981	21.0	74.3	21.6	11.4	22.2	58.9	41.1
	1982	21.3	0.0	100.0	100.0	99.9	100.0	0.0
	1983	21.0	8.0	89.1	85.6	90.1	98.9	1.1
3	1981	7.4	31.3	66.2	58.3	65.1	100.0	0.0
	1982	7.4	0.0	100.0	98.4	99.8	100.0	0.0
	1983	7.6	0.0	100.0	98.1	99.8	100.0	0.0

[a] As a percentage of area with any ice cover.

[b] Includes rotten and cracking ice.

Table 2. Ice cover, ringed seal densities, and estimated visible seal populations in the fast and floe ice subareas of the Beaufort Sea, 1981-1983.

	1981	1982	1983
Fast ice subarea			
Total extent ($km^2 . 10^3$)	15.4	15.7	16.4
Extent of fast ice ($km^2 . 10^3$)	10.1	11.7	10.4
Extent 6/8+ cover ($km^2 . 10^3$)	9.7	11.7	10.7
Mean seal density (per km^2)[a]	0.062	0.408	0.173
Std. error of density estimate	0.011	0.077	0.018
Est. visible population ($.10^3$)	0.60	4.77	1.85
Floe ice subarea			
Total extent ($km^2 . 10^3$)	31.9	31.7	32.1
Extent 6/8+ cover ($km^2 . 10^3$)	25.5	1.8	15.2
Mean seal density (per km^2)[a]	0.185	0.444	0.230
Std. error of density estimate	0.014	0.115	0.031
Est. visible population ($.10^3$)	4.72	0.80	3.50
Total estimated visible population in Beaufort Sea ($.10^3$)	5.32	5.57	5.35

[a] In ice cover 6/8 or more.

Table 3. Ringed seal and seal-hole densities, and estimated visible seal populations, Amundsen Gulf and Prince Albert Sound, 1981-1983.

	Ringed seal density (/km^2)	Seal hole density (/km^2)	Holes/seal	Estimated visible seal population (.10^3)
Amundsen Gulf (Area 2)				
1981	3.08 (0.66)[a]	3.74 (0.54)	1.21	14.0[b]
1982	2.61 (0.26)	3.60 (0.18)	1.38	54.9
1983	3.02 (0.15)	5.72 (0.22)	1.89	56.5
Pr. Albert Sd. (Area 3)				
1981	3.46 (0.67)	4.54 (0.65)	1.31	16.9
1982	2.03 (0.21)	3.61 (0.23)	1.78	15.0
1983	2.34 (0.13)	5.34 (0.35)	2.28	17.8
Areas 2 and 3 combined				
1981	3.28 (0.46)	4.25 (0.45)	1.30	30.9[b]
1982	2.46 (0.20)	3.60 (0.15)	1.46	70.5
1983	2.82 (0.11)	5.61 (0.19)	1.99	74.3

[a] Values in parentheses are standard errors.

[b] Estimates in 1981 were depressed by low ice cover in Amundsen Gulf; high seal densities did not compensate.

Table 4. Variables entering regressions[a] of ringed seal density.

a) Density as seals/km^2. Variables were offered for ice cover, ice type, and cloud cover.

Variable	Coefficient	Significance
Ice cover (eighths)[b]	0.0314	0.0001
Ice type = large floe	0.0604	0.0025
Cloud cover = scattered or heavier	-0.0978	0.0001
r^2 =	28.8%	

b) Density as seals/km^2 of ice. Variables were offered for ice cover and date.

Variable	Coefficient	Significance
Ice cover >=2/8	0.0129	0.0001
Date = 19 June	0.0103	0.0001
Date = 20 June	-0.0078	0.0006
r^2 =	23.5%	

c) Density as seals/km^2 of ice. Variables were offered for ice cover, cloud cover, disturbance, and date.

Variable	Coefficient	Significance
Ice cover >=2/8	0.0103	0.0001
Cloud cover >=broken	-0.0075	0.0003
Disturbance[b]	0.0849	0.0001
Date = 19 June	0.0105	0.0001
r^2 =	25.6%	

[a] All regressions were stepwise: variables could enter or leave at each step. Significance levels were 0.005 to enter, 0.01 to leave.

[b] These variables, and the response variable, were treated as continuous. All the others were binary.

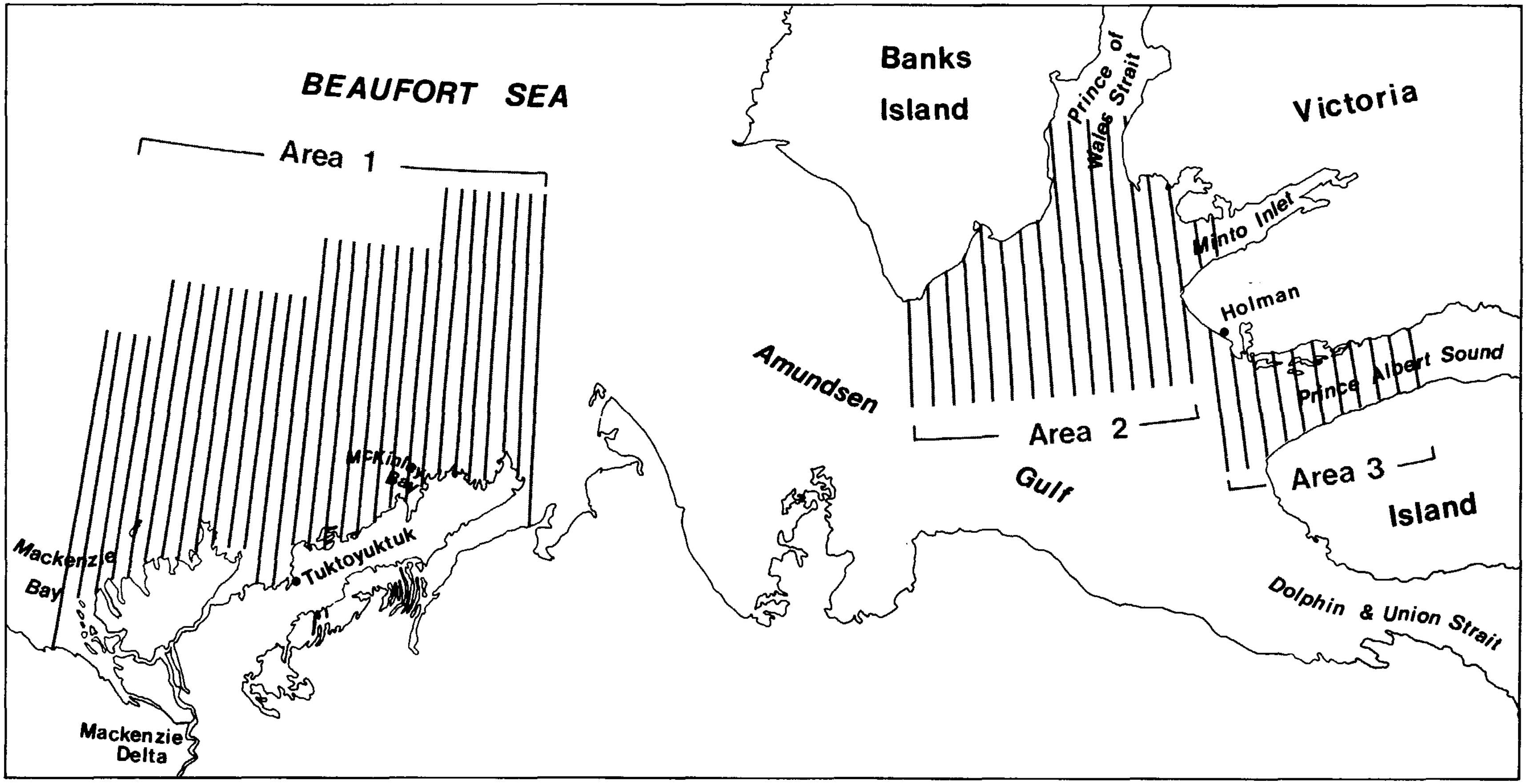

Fig. 1. Study area and transect lines, Beaufort Sea seal monitoring survey.

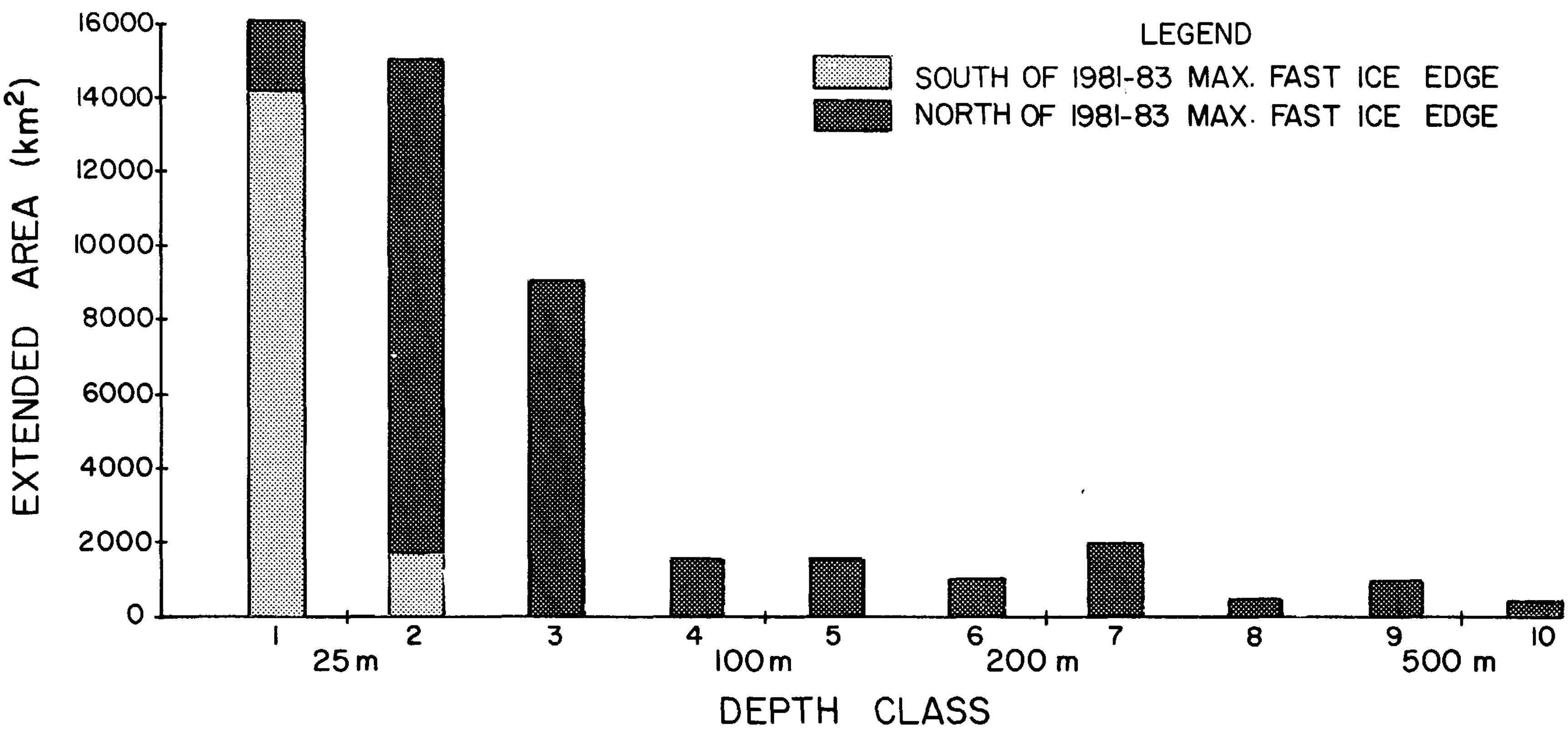

Fig. 2. Distribution of depth classes north and south of the 1981-1983 maximum fast-ice limit, Beaufort Sea seal survey area.