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Studies on harp seals of the western North Atlantic population in 1976

by

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Introduction

The major tasks remaining in 1976 in an analysis of harp seal production and yield were (a) to calculate production (b) estimate mortalities of immature year classes (c) recalculate fertility rates up to date. All these tasks have been addressed in the present study either by analysis of past data or by study of new data, or both, with varying success.

1. New Data, 1976

From April 10-19, 1976 M/V Carino was chartered for a voyage to the Front icefields in order primarily to study selectivity of catching of moulting seals due to shooting. A patch or patches of moulting seals were worked E. of St. Anthony, Newfoundland (ca 51°30'N, 54°W) between April 12 and 17. From the barrel using binoculars seals were categorised to small bedlamers[1], large bedlamers, dark saddlers and light saddlers. Photos were taken with a telephoto lens for later analysis to confirm percentages of different categories. The gunners of the ship then shot a sample of about 50 seals which were worked up on deck for age, pelt type and reproductive status. This procedure was repeated through the day and on successive days as the seals allowed. The total sample was of 320 moulting animals.

Previously, on April 1 and 7 two graduate students on board M/V Arctic Explorer had collected age and reproductive samples from a total of 325 moulting harp seals from the same general area.

[1]spotted, largely immature, harp seals

Age samples of harp seals were also obtained by purchase from four types of shore fisheries from five areas between December 1975 and April 1976. They were:

1) Labrador coast net fishery, southward migrants, Dec. 1975. 90 seals.
2) La Tabatière net fishery, N. Quebec, southward migrants into Gulf, Dec. 1975-Jan 1976. 130 seals.
3) St. Anthony, Nfld. net and shoot fishery of migrants and wintering seals, Dec. 1975 to April 1976. 325 seals.
4) Little Bay Is. and Point Leamington, Notre Dame Bay, Nfld. Shoot fishery for bedlamer (immature) seals Feb. to April 1976. 700 seals of which 400 analysed.

Locations of all samples are shown in Figure 1.

The migration patterns of harp seals of the western stocks are described by Sergeant (1965). Early migrants, taken in the shore net fisheries, lack many of the younger immatures, which tend to remain late in the arctic. Many of them when they arrive move into Notre Dame Bay, where they are selectively taken by shore shoot fisheries. Moulters taken by ships at first consist of heterogeneous samples of immatures and adults (mostly males) more or less separately, the adults arriving from the whelping patches and the immatures from their wintering field. The patches become more homogeneous through April, and gain the bulk of the adult females late in the month.

2. Mortality Rates of Immatures

2a. Selection of Immatures due to Tameness

Overall results of sampling from the *Carino* cruise are shown in Table 1. It can be seen that there is a considerable selection toward bedlamers (immatures), and towards small bedlamers over large ones. This set of measurements quantifies a well-known observation; the young immatures are tame, the adults wild.

Observations were made over an eight-hour period on April 14 when a large patch of seals stayed on the ice under bright sunny weather and with several killer whales (*Orcinus orca*) observed in the vicinity.

Figure 2 shows the percentage of bedlamers observed in counts through the day. The points fall into a straight line with an increasing percentage of bedlamers observed with elapsed time. Observation showed that disturbance of adults was brought about by the ship's presence as well as by the shooting. That this was not a diel rhythm was shown by a large percentage of adults (not quantified) on first arrival by the ship to the seal patch at 1800 hrs on April 11.

A single attempt at pelt-typing from colour transparencies (shown in Fig. 2) shows good agreement with direct counting.

Analysis of selection was carried out as shown in Table 2. Calculated directly, selection in favour of bedlamers over adults is X 3·7; calculated by multiplying the selection of large bedlamers over adults, and small bedlamers, over large bedlamers, for slightly smaller data, it is 2.1 X 1.6 = 3.4 which is quite good agreement. The analysis shows continually increasing tameness with decreasing age.

2b. Application to Age Sample.

The total age sample from Carino is shown in Figure 3(1). Over half the animals shot were one-year-olds.

From the ages of individual animals, pelt type can be related to age and sex (Table 3).

From Table 3 males change from the arbitrary category of "small spotted" to "large spotted" at 2 years, females at 2-3 years, suggesting that females are slightly smaller.

Males change from the spotted (bedlamer) pelage to the dark saddle rapidly at 6 years, some animals going through a "smutty harp" category at 4 or 5 years. This is the age at sexual maturity. Females change from the spotted category to a light saddled pelage at about 10 years and to a dark saddled pelage at about 13 years. None of these observations is, of course, new but they must be delimited for the analysis.

Table 4 shows that the number of spotted animals corresponds well with age-groups 1-5 for males. Some females are excluded using this age limit but the overall error is small because of the small number of adult females present in moulting patches at this date.

Table 3 shows that the age change from the arbitrary "small spotted" to "large spotted" categories can be computed from the numbers or percentages of each category in each age type, reading horizontally. This analysis is performed in Tables 5 and 6.

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The result of the analysis is shown in Table 7 and Figure 3(2). There is still a marked surplus of one-year-olds in this sample from what could be expected, considering the similarities in catch of year-classes 1-4 taken in the quota fishery since 1972 (Table 8).

As suggested to me by Dr. G. H. Winters, the remaining excess of young immatures is probably due to the cross-migration of these animals which is known to occur from the Gulf to the Front. Since these animals winter mainly in Notre Dame Bay, they would be taken by our sampling, at the period when they were joining the moulting Front herds.

3. Calculation of Cross-over from Gulf to Front.

A large number of tags were recovered of tagged harp seals in the wintering areas from tagging in the Gulf from 1966 to 1970, and of brands and/or tags from animals marked in the Gulf from 1972 to 1975. [Only one tagging experiment has been carried out on the Front during this period, in 1973, and there is one recovery from this experiment of an animal entering the Gulf at nearly 4 years of age. This is a unique event to date; although it indicates some degree of mixing of the two herds, the loss of Front animals to the Gulf is too low to be significant and is ignored here.]

Table 9 shows the degree of crossover of Gulf animals to the Front by age, from shoremen's recoveries only. It would be difficult to correct these data from the very varied shore fisheries, which vary annually in catch, and select various age categories. No attempt has been made to make such corrections here and the raw data are used, implying equal catching effort for the young age categories east and west of the great northern peninsula of Newfoundland.

A correction must however be made for the relative production of harp seals in the Gulf and on the Front. Use of aerial photographic survey of the relative numbers of adults at whelping patches over the same time period as the marking (Table 10) produces a figure of about 38% of animals whelping in the Gulf if each year is considered as of equal value.

The final result is entered in the last column of Table 7 and shown in Figure 3(3).

Mortality from ages 1 to 4 can validly be compared because of the relatively steady catch of young under quota during the period 1972 to 1975

(Table 8). Mean annual mortality indicated for immature year classes is about 0·4. This still seems high. It seems possible that not all adults had entered this patch of seals. This conclusion is supported by the low maximal age (19 years) found in this sample.

Two samples were collected in the same area from Arctic Explorer on April 1 and 7. At the second date a sample not unlike that from Carino was collected, (Figure 4), but on the first date a sample was collected having a larger number of older animals (up to 25 years). Had this sample been larger, it would have been useful to apply the process above, since presumably in any shot sample, the selection towards immature seals occurs. It would seem likely that the Arctic Explorer sample of April 7 represents immatures almost unmixed, resembling samples of immatures wintering in Notre Dame Bay (Fig. 4, lower) Carino's sample represents partial mixing with adults (chiefly males at this date), and Arctic Explorer April 1 represents rather full mixing.

4. Calculation of Production up to 1972-73.

Sergeant (in press, Fig. 8) gives gross age samples collected over two periods: just before the quota, in 1970 and 1971, and after the quota, in 1974 and 1975. The individual samples in each year represent, by chance, a blend of selectivity both towards immatures (spring shore samples, moulting samples), and against immatures (net samples in the fall), as well as relatively neutral samples (winter net/shoot sample, St. Anthony), and in relatively equal numbers. See Sergeant (in press, Fig. 7 for details in the year - 1970. These two figures are reproduced here as Figs 5 and 6.) Therefore the gross or totalled sample in each year gives an approximate representation of the population.

Figure 5 shows immediately on inspection that the more recent samples only have a good representation of younger year classes and that these are the age-classes of 1972 and later years. That this is not an artefact of sampling is shown by Fig. 6e. In 1970, a moulting sample showed plenty of one and two year olds, the one-year-olds increased by selectivity as shown above, the two-year-olds an abundant year-class in fact. However, the 1969 year class was reduced to lower levels when selectivity was reduced or reversed by adding in the fall net samples (Fig. 5). This did not occur for 1973 and 1974 year classes.

In further refinement, bias was avoided, or at least made uniform, by taking the 1975 sample as standard and using equivalent percentages of each type of sample with respect to the "neutral" winter net/shoot sample in other years. The working is shown in Table 11. The samples (4) and (5) with selectively taken immatures roughly neutralise samples (1) and (2) in which immatures are selected against, while sample (3) is neutral. Samples for 1974 (Table 12) are smaller but sufficiently similar in balance to those of 1975 as not to be worth tampering with.

Important large samples for 1970 (Table 13) include a large percentage of shore fisheries which are rather heavily biased against one year-olds. Balance is achieved by including only samples 2, 5 and 6; 5 is neutral and 2 and 6 balance each other numerically. The result (Table 15) gives 10·4 percent one year olds as compared with 7·6% if the entire sample is used.

A similar operation is performed in table 14 and 15 for similar large samples for 1967. The result is a calculation of 12·4% one year olds. Samples for 1971 contain no ships' catches or spring shore-catches, and the bias of large shore catches against one year olds cannot be neutralised. Consequently, this year's samples were not used.

In 1976 the reverse bias is dominant: a great excess of spring ship and shore catches over early winter net catches (Table 16). The bias is removed in Table 17. The result is 27·8% one year olds.

It is possible that bias has been over-corrected. The excess of shore caught animals in pre-quota years (1967, 1970), the shift to neutrality in 1974 and 1975, and the excess of spring caught animals in 1976 may be due to chance climatic conditions affecting the various fisheries from which samples were derived. On the other hand, it may reflect relative availability of the year-classes to hunting. Thus, recent samples show a disappearance of older age classes, and an abundance of immatures. The balance is therefore bound to shift against net fisheries taking adults, and in favour of fisheries taking immatures. It is therefore possible that the analysis has over-corrected for bias.

Nevertheless, the ultimate reduction of the data is shown in Table 18 and graphically in Figure 7. An estimate of production of 350,000 is given for the median year of about 1971.

An earlier analysis using uncorrected data (total samples) for sample years 1970, 1971, 1974 and 1975 had given an estimate of about 275,000 for median year about 1972 (Table 19 and Figure 8).

Previous estimates of production are shown in Figure 9. These are in the main obtained from Sergeant (1975, Figures 203, 204 and 205) for a variety of samples. Figure 203 gives an estimate for median years 1961-2 for all samples, Figure 205 omits dates of samples from La Tabatiere but the year-classes represented at age 4 were from 1950 to 1966, giving a median year of 1958. Figure 204 had a number of curves. Those for total population are relevant and those for 1966-69 give estimates for median years 1967-68. Use of these three data sets in Figure 9 gives a declining trend of from 350,000 young in about 1960 to about 300,000 in 1967-68. Use of the total data of Figure 8 would extend this decline to about 275,000 pups born in median year 1972 whereas use of the selected data of Figure 7 suggests an increase to about 350,000 again (or no decline) up to 1971. In view of catch levels at the time, this seems improbable. Moreover new estimates of fertility discussed below suggest a decrease because of the increased reproductive rates found.

A decline to about 275,000 in 1972 would fit exactly with R. L. Allen's most optimistic population projection (Allen 1975, Figure 221 and Table 76 parameter set (2)). Figure 9 also includes this population projection. It would indicate a pup production of 265,000 in 1976, the lowest point, under a quota management which has followed quite closely Allen's assumptions of a harvest of 126,000 pups and 10,000 older seals after 1972. (The actual catch (Table 8) has averaged 118,000 pups and 26,000 older seals up to 1975, and may have been lower in 1976).

5. Recalculation of Fecundity.

Samples of ovary pairs from females of known age were obtained from catches of both Arctic Explorer and Carino between April 1 and 17, 1976. These samples therefore refer to newly pregnant females and give excellent information on age at sexual maturity but will tend to over-estimate fecundity of mature females, as compared with samples taken from shore catches in late pregnancy (January). Data are shown in Table 20, where they are compared with data obtained from the Front in 1968 and from St. Anthony in 1970. (Data for 1968-70 were deficient for critical age 5 because of a shortage of this age in samples). These ages should be raised by one year to show age at first parturition.

Median age at first maturity on the Front has dropped from approximately 5 years in 1968-70 to less than 4 years in 1976. This could not have occurred without some further thinning of the herds. The lag effect would be from birth to maturity, or about 5 years and 4 years respectively, so that events up to 1963 and 1972 approximately are being compared. The curve of attainment of sexual maturity is very similar to that obtained for female harp seals in the White Sea in 1958-1964 by Soviet authors (Sergeant, 1973, Text fig 1, Table 1). The White Sea population was then at low numbers with few older age classes among reproducing females (Nazarenko and Timoshenko, 1974, Figure 1), a situation which prevails among age samples collected at the Front in 1976 (Table 16).

A corollary of the high reproductive rates found in 1976 will of course be a maximal rate of production of pups. Thus an estimated 67% of female pups born in 1972 will themselves produce pups in 1977 when they will attain 5 years of age. The curve of increase of production from 1977 onward will therefore be steeper than predicted by Allen (1975), who assumed no age-specific increase in fecundity.

Discussion

The evidence from 1976 samples - high reproductive rate, low proportion of older animals, high numbers of young age classes - is all indicative of a youthful population producing at near maximal capacity. There seems little doubt therefore that high catches up to 1971 have reduced numbers, and that a decline to an estimated 275,000 pups in 1972 is realistic.

Models must now be reconstructed using the new fecundity rate, but in view of the large cohorts of immature animals of relatively low reproductive value escaping the fishery (many of them of Gulf origin) it seems very unlikely that present catches are excessive, even though it has been reported that landsmen's catches again considerably exceeded the allowance in 1976. Indeed, it may be possible to start increasing the quota again at or shortly after 1977 to take account of increasing production. But this conclusion must await firm catch figures for 1976, as well as a recalculated model of population turnover rates.

Summary

1. From study of selectivity of animals of different sizes and pelt types taken in the shooting of moulting seals, an attempt was made to correct the age frequency of the sample obtained. A further correction was applied from the age-specific cross-over of young immature harp seals from the Gulf to the Front, as determined from accumulated recaptures of marked animals. For the specific age sample, correction appears still to be incomplete, suggesting that heterogeneity of sample as between bedlamers and adult seals still occurred. The method however appears valid for homogeneous samples.

2. Age-specific fecundity of Front animals in 1976 reached the highest value (lowest ages of first reproduction) yet measured. Values approximated those found in the White Sea immediately before protection of herds there. Considering the time lag of 4-5 years to first maturity, the finding suggests continued thinning of herds to 1971 or 1972, which is in accord with the only published model for the western harp seals, that of Allen (1975).

3. Attempts at quantification of production up to 1972-3 based on catch and survival are complicated by biases of most samples either towards selection of young immature animals or against their catch. Crude analysis suggests a production of about 275,000 young in 1972-3 which is in accord with Allen's most optimistic assessment (Allen 1975, Fig. 221 and Table 16, parameter set (2).

4. All evidence obtained: that of high reproductive rates, of a low percentage of older adults in the population, and of high catches of immature age classes by the spring shore fishery and at the ships' moulting catch, suggests a youthful population with a high capacity for increase. The impending maturation of the first age class of females protected by the quota, that of 1972 in 1977, suggests that production will begin to increase rapidly in 1977.

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Table 1. Counts and shot samples from M/V Carino April 12-17, 1976.

1. Counts

Date	Time[1]	Pelt Category: Dk Saddle	Lt Saddle	Large Bedl	Small Bedl	% Bedl
April 12	0930	73		186		
	1550	41	12	9	6	22.8
April 14	0900	59	33	57	28	48.2
	1345	66	27	80	84	63.8
	1710	14	15	51	44	76.6
	1600[2]	89		233		72.4
April 16	1100	55	8	28	28	52.9
	1420	37	6	46	31	64.2
April 17	0830	38	6	44	35	64.2
Total April 14-17		310	107	315	256	
April 12-17		490		657		57.3

[1]Nfld. Standard Time. Midpoint of sampling.
[2]Counted from photos.

Table 3. Pelt type related to age and sex. Percentages of bedlamer pelt type in each age class in parentheses.

Age in years	Males Sm.Sp.	Males L.Sp.	Males Sm.	Males Dk.S.	Ratios Sm.Sp./Large	Ratios L.Sp./S.	Females Sm.Sp.	Females L.Sp.	Females Lt.S.	Females Dk.S.	Ratios Sm.Sp./L. Sp.
1	71 (91)	2 (8)					45 (78)	4 (11)			
2	7 (9)	7 (29)			50		10 (17)	5 (14)			67
3		9 (38)					3 (5)	7 (19)			
4		3 (13)	1					8 (22)			
5		2 (8)	1			50		4 (11)			
6		1 (4)		3				1 (2)			
7				1				5 (14)			
8				3					1		
9				1				2 (6)			
10				4							
11											
12				1					1		
13				3					1	1	
14 and over				10						1	
N	78	24	2	26			58	36	3	2	
		130						99			
					229						

Table 4. Ratio Spotted animals to Saddlers (from Table 3).

	Sp.[1]	S.	1-5 yrs.	6 and up
Males	104	26	103	27
Females	94	5	86	13

[1]including "smutties"

Table 1. (Continued)

2. Shot Samples

Pelt Category

Date	Time							
April 12	0930	6		3	27		26	65.5
April 14	1000	10		1	16		30	80.7
	1430	1		-	11		40	98.1
April 16	1300	8		2	26		40	86.8
April 17	0930	3		1	16		46	93.9
Total		28		7	96		182	
"			35			278		88.8

Table 2. Analysis of selectivity due to ship disturbance and shooting.

Saddlers and Bedlamers

Counts show ·59 bedlamers = ·41 adults

Kills show ·89 bedlamers = ·11 adults

Selection is $\frac{\cdot 41}{\cdot 11}$ = 3·72 X in favour of bedlamers

Large and Small Bedlamers

Counts show 315:256 = ·45 small = ·55 large

Kills show 96:182 = ·66 small = ·34 large

Selection is $\frac{\cdot 55}{\cdot 34}$ = 1·6 X in favour of small

All Saddlers to large Bedlamers

Counts show ·57 Saddlers

Kills show ·27 Saddlers

Selection = $\frac{\cdot 57}{\cdot 27}$ = 2·1 X in favour of large bedlamers

Therefore, selection factors are:

Saddlers		Large Bedlamers		Small Bedlamers
	2·1		1·6	
		3·4		
		3·7		

Table 5. Age frequency <u>Carino</u> corrected for selectivity due to shooting
1. Males (Sm.Sp. =(Small spotted, L.Sp. = large spotted,
S = Saddlers)

Age (Yrs)	Freq. by age	Frequency by class %[1]		Frequency by class No.		Selectivity	Corrected Frequency			
		Sm.Sp.	L.Sp.	Sm.Sp.	L.Sp.	Sm.Sp./ L.Sp.	Sm.Sp.	L.Sp.	S.	Total
1	104	97	3	101	3		63	3		66
2	22	50	50	11	11	÷1·6	7	11		18
3	17		100		17			17		17
4	4		100		4			4		4
		L.Sp.	S.	L.Sp.	S.					
5	3	100		3		S/L.Sp.		3		3
6	3	25	75	1	2	X 2·1		1	4	5
7	1		100		1				2	2
8	3				3				6	6
9	1				1				2	2
10	4				4				8	8
11	1				1				2	2
12	1				1				2	2
13	3				3				6	6
14										
15	2				2				4	4
16	4				4				8	8
17	2				2				4	4
18	1				1				2	2
19	1				1				2	2
20										
N	177									161

[1] from Table 3

Table 6. Age frequency Carino corrected for selectivity due to shooting 2. Females. Abbreviations as in Table 5.

Age (Yrs)	Freq. by age	Frequency by class %[1] Sm.Sp.	L.Sp.	S.	No. Sm.	L.Sp.	S.	Select-ivity Sm.Sp./L.Sp.	Corrected Frequency Sm.Sp.	L.Sp.	S.	Total
1	75	92	8		69	6		÷ 1·6	43	6		49
2	24	67	33		16	8			10	8		18
3	15	30	70		5	10			3	10		13
4	11		100			11				11		11
5	5		100			5				5		5
6	2		100			2				2		2
7	5		100			5				5		5
8	1			100			1	S/L.Sp.			2	2
9	3		100			3		X 2·1		3		3
10	1			(100)			1				2	2
11												
12	1			100			1				2	2
13	1						1				2	2
14	1						1				2	2
15	1						1				2	2
16												
17												
18												
19												
20												
N	146											118

[1]from Table 3

Table 7. Age frequencies, Carino; by sexes and together; raw and corrected for selectivity (from Tables 5 and 6) corrected for Gulf animals.

Age in yrs	Raw frequency ♂	♀	Total	Corrected frequency ♂	♀	Total	Percent of[1] Gulf animals crossing to Front	Percent[2] corrected for Gulf pop. (X·38)	Reduction	Corrected freq.
1	104	75	179	66	49	115	.69	.26	-30	85
2	22	24	46	18	18	36	.42	.16	-6	30
3	17	15	32	17	13	30	.11	.04	-1	29
4	4	11	15	4	11	15	0			15
5	3	5	8	3	5	8	0			8
6	3	2	5	5	2	7	(0)			7
7	1	5	6	2	5	7				7
8	3	1	4	6	2	8				8
9	1	3	4	2	3	5				5
10	4	1	5	8	2	10				10
11	1		1	2		2				2
12	1	1	2	2	2	4				4
13	3	1	4	6	2	8				8
14		1	1		2	2				2
15	2	1	3	4	2	6				6
16	4		4	8		8				8
17	2		2	4		4				4
18	1		1	2		2				2
19	1		1	2		2				2
20										
N	177	146	323	161	118	279				232

[1] from Table 9

[2] from Table 10, divide by .38

Table 8. Catches of young and of all older harp seals (in thousands) 1972-1975 under fishery with quota of 150,000 harp seals. Data from ICNAF statistics

Year	Young	Older	Total	Total Landsmen
1972	117	13	130	24
1973	98	25	124	45
1974	114	32	146	40
1975	140	34	174	53
Mean	118	26	144	41

Table 9. Harp seals tagged or branded in the Gulf of St. Lawrence and recovered in winter and spring in the Gulf (ICNAF subarea 4) or the Front (subareas 2 and 3).

Year of marking	Year of Recovery 1		2		3		4		5		6	
	G	F	G	F	G	F	G	F	G	F	G	F
1966	7	12	1	1	-	-			1	-	2	-
1968	3	7	-	1	1	-						
1969	2	10	2	-	2	-						
1970	2	1	-	1	-	-						
1972	-	1	-	-	4	1	2	-				
1973	-	1	-	-	1	-						
1974	2	2	1	-								
1975	1	3										
Total	17	37	4	3	8	1	2	-	1	-	2	-
Percent crossover		.69		.42		.11		0		0		0

Table 10. No. of Adults Gulf and Front. [Indices giving relative numbers]

	Gulf		Front	Total
1959	148,725	48.8	155,790	304,515
1964	93,076	45.1	96,140	189,216
1970	64,000	35.6	115,503	179,503
1972	114,320	53.0	101,373	215,693
1973	15,041	16.2	77,756	92,797
1974	25,768	38.0	41,979	67,747
1975	23,226	24.7	70,750	93,956
Overall		37.3	62.7	

Table 11. Combined samples of harp seals for 1975. Taken as standard.

Age (yrs)	(1)	(2)	(3)	(4)	(5)	Total
1	20	-	157	146	55	378
2	55	1	123	30	47	256
3	56	12	61	13	20	162
4	19	26	40	1	10	96
5	8	62	29	4	4	107
6	4	57	25	2	5	93
7	5	71	22	1	9	108
8	4	50	11		2	67
9	3	21	7		2	33
10	-	19	18		10	47
11	-	14	14		1	29
12	2	14	11		4	31
13		10	20	1	1	32
14		9	18			27
15		5	10			15
16		7	7		2	16
17		1	7		1	9
18		7	9			16
19		2	4		2	8
20		-	4			4
21		-	3		1	4
23 or +		1	5			6
N	176	390	607	198	176	1,547
Percent total	11.4	25.2	39.2	12.8	11.4	100

Key to samples

(1) Port Hope Simpson, Labrador. Net, Dec. 1974.

(2) La Tabatière, Que Net, Jan 1975.

(3) St. Anthony, Nfld. Net and shoot, Dec 1974 to Apr 1975.

(4) Little Bay Is., Notre Dame Bay, shoot, Jan to May 1975.

(5) Pt. Leamington, NDB, as above (4).

Table 12. Samples of Harp seals for 1974.

Age (yrs)	(1)	(2)	(3)	(4)	Total
1		8	106	46	160
2		18	22	33	73
3	2	7	7	11	27
4	5	10	5	10	30
5	17	12	6	5	40
6	61	19	4	7	91
7	20	13	1	3	37
8	30	18		3	51
9	19	17		1	37
10	15	20			35
11	8	18	1		27
12	11	14		2	27
13	6	17		2	24
14	2	17		1	20
15	2	16			18
16	2	21	1		24
17	4	13		1	18
18	1	10			11
19	2	7			9
20	1	6			7
21		8			8
22		7			7
23 or +	2	7			9
N	210	303	153	124	790
%	26.5	38.3	19.4	15.7	100.0

(1) La Tabatière

(2) St. Anthony

(3) Pt. Leamington

(4) Little Bay Is.

Table 13. Age samples of 1970.

Age (yrs)	1	2	3	4	5	6	Total
1	21	5	-	31	41	122	220
2	60	8	4	69	41	111	193
3	67	27	5	89	15	14	217
4	63	42	13	45	25	17	205
5	68	61	16	40	23	23	231
6	44	26	12	16	19	14	131
7	24	24	11	8	14	17	98
8	22	40	24	12	43	11	152
9	25	40	26	8	49	17	165
10	24	48	34	8	39	20	173
11	13	36	25	4	24	15	117
12	8	27	15	4	28	22	104
13	8	27	10	1	26	12	84
14	5	17	13	-	19	6	60
15	10	24	8	2	29	11	84
16	2	15	12	1	30	14	74
17	9	18	12	-	20	8	67
18	6	13	8	1	12	11	51
19	6	9	8	1	18	8	50
20	6	10	6	3	22	7	54
21	1	5	5	1	10	4	26
22	1	7	2		5	5	20
23 or +	4	21	6		17	10	58
N	497	550	275	344	569	499	2,734
%	18.1	20.1	10.0	12.6	20.8	18.3	100.0

1) Southern Labrador

2) La Tabatière

3) Netagamu R. (near La Tabatière)

4) Tadoussac, St. Lawrence R. estuary

5) St. Anthony

6) Ships:-
<u>Theron</u>
Apr 5, 18, 25
<u>Kvitfjell</u>
Apr 5-6, 8

Table 14. Age samples for 1967.

Age (yrs)	1	2	3	4	5	6	Total
(0)						(5)	
1	6	12	17	104	72	11	222
2	11	42	14	25	36	25	153
3	17	46	1	9	9	13	95
4	24	38	9	7	11	9	98
5	30	58	11	6	23	17	145
6	25	72	17	29	20	20	184
7	27	64	26	8	32	14	171
8	14	44	21	11	19	10	119
9	10	31	26	10	13	14	104
10	9	27	16	6	10	9	77
11	11	14	21	7	16	14	83
12	5	15	14	7	11	8	60
13	6	10	16	7	7	10	56
14	7	16	15	5	14	12	69
15	7	12	13	6	14	7	59
16	6	4	17	5	9	7	48
17	3	9	12	4	14	6	48
18	4	5	9	5	15	2	46
19	6	4	8	6	15	5	39
20	4	5	11	7	8	4	39
21	4	3	3	3	5	3	21
22	-	4	2	4	4	2	16
23 or +	7	5	12	6	13	3	47
N	243	540	315	275	399	232	2,141

Samples

1) Port Burwell, N. Labrador, Nov. 1966

2) La Tabatière, Que. Jan 1967

3) St. Anthony, Nfld. Jan-Apr 1967

4) Brandal Gulf, Apr 1967

5) Polarhav, Theron, Front, Apr 1967

6) Cumberland Sound summer 1967

Table 15. Selected samples of 1970 and 1967.

	1970				1967				
Age (yrs)	2	5	6	Total	2	3	4	5	Total
1	5	41	122	168	12	17	104	72	205
2	8	41	111	160	42	14	25	36	117
3	27	15	14	56	46	1	9	9	65
4	42	25	17	84	38	9	7	11	65
5	61	23	23	107	58	11	6	23	98
6	26	19	14	59	72	21	17	29	139
7	24	14	17	55	64	26	8	32	130
8	40	43	11	94	44	21	11	19	95
9	40	49	17	106	31	26	10	13	80
10	48	39	20	107	27	16	6	10	59
11	36	24	15	75	14	21	7	16	58
12	27	28	22	77	15	14	7	11	47
13	27	26	12	65	10	16	7	7	40
14	17	19	6	42	16	15	5	14	50
15	24	29	11	64	12	13	6	14	45
16	15	30	14	59	4	17	5	9	35
17	18	20	8	46	9	12	4	14	39
18	13	12	11	36	5	9	5	15	34
19	9	18	8	35	4	8	6	15	33
20	10	22	7	39	5	11	7	8	31
21	5	10	4	19	3	3	3	5	14
22	7	5	5	17	4	2	4	4	14
23 and +	21	17	10	48	5	12	6	13	36
N	550	569	499	1,618	540	315	275	399	1,529

Table 16. Age samples of 1976. Localities given in Table 17.

Age (yrs)	1	2	3	4	5	6	7	8	Total
1	-	27	88	31	88	179	75	113	601
2	-	18	57	17	46	46	34	58	276
3	1	26	45	9	20	32	20	25	178
4	13	9	37	8	14	15	11	17	124
5	16	4	22	10	6	8	2	2	70
6	15	3	20	5	4	5	1		53
7	19	1	10	12		6	1		49
8	13	-	16	7	2	4	2		44
9	9	1	3	7		4			24
10	14	1	9	2		5			31
11	8		6	2	2	1	2		21
12	4		5	3		2	2		16
13	5		3	3		4			15
14	4		4	3		1	1		13
15	3		13	2		3			21
16	1		4	1		4			10
17	1		5	3		2			11
18			4	2		1			7
19			4	1		1			6
20			5	1					6
21			1	1					2
22			1	2					3
23 or +			7	1					8
N	126	90	369	133	182	323	151	215	1,589

Table 17. Location of samples of 1976 and removal of bias.

Location of samples

1) La Tabatière, Jan 1976
2) Southern Labrador, Dec 1975
3) St. Anthony, Nfld. Jan-Apr 1976
4) *Arctic Explorer* Apr 1, 1976
5) *Arctic Explorer* Apr 7, 1976
6) *Carino*, Apr 12-17, 1976
7) Little Bay Is. NDB Nfld., Feb-Apr 1976
8) Pt. Leamington, NDB Feb-Apr 1975

Age (yrs)	1-4	8	Total
1	146	113	259
2	92	58	150
3	81	25	106
4	67	17	84
5	52	2	54
6	43		43
7	42		42
8	36		36
9	20		20
10	26		26
11	16		16
12	12		12
13	11		11
14	11		11
15	18		18
16	6		6
17	9		9
18	6		6
19	5		5
20	6		6
21	2		2
22	3		3
23 or +	8		8
N	718	215	933

Table 18. Harp seals sampled in 1967, 1970, 1974, 1975 and 1976. Analysis of year class strength at age one from selected samples.

Year of sample	Total	One year		Year of catch	Catch of young ($X10^{-3}$)	Bias removed
		No.	Percent			
1976	933	259	27.8	1975	141	Excess spring
1975	1,547	378	24.4	1974	114	Standard
1974	790	160	20.2	1973	95	Standard
1970	1,619	168	10.4	1969	222	Excess winter
1967	1,529	205	13.4	1966	264	Excess winter

Table 19. Harp seals sampled in 1970, 1971, 1974 and 1975. Analysis of year class strength at age one from total samples.

Year of sample	Total	One year No.	One year Percent	Year of catch	Catch of young (000's)
1975	1,547	378	24.4	1974	114
1974	790	160	20.2	1973	95
1971	1,356	70	5.2	1970	222
1970	2,682	205	7.6	1969	235

Table 20. Age-specific fecundity of Front animals.

	1968-70			1976		
Age	Total No.	Mature No.	Mature %	Total No.	Mature No.	Mature %
1	27	-	0	34	-	0
2	30	-	0	11	-	0
3	17	-	0	10	1	10
4	5	1	20	12	8	67
5	3	2	(67)	11	10	91
6	9	7	78	5	5	100
7	11	11	100	14	14	100
8	9	9	100	8	8	100

Adults	Total No.	Infertile No.	Infertile %	Total No.	Infertile No.	Infertile %
	135	3	2.2	65	3	4.6[1]

[1]or less. Some follicles may not have luteinised at the early date of sampling and confusion with cystic follicles was possible.

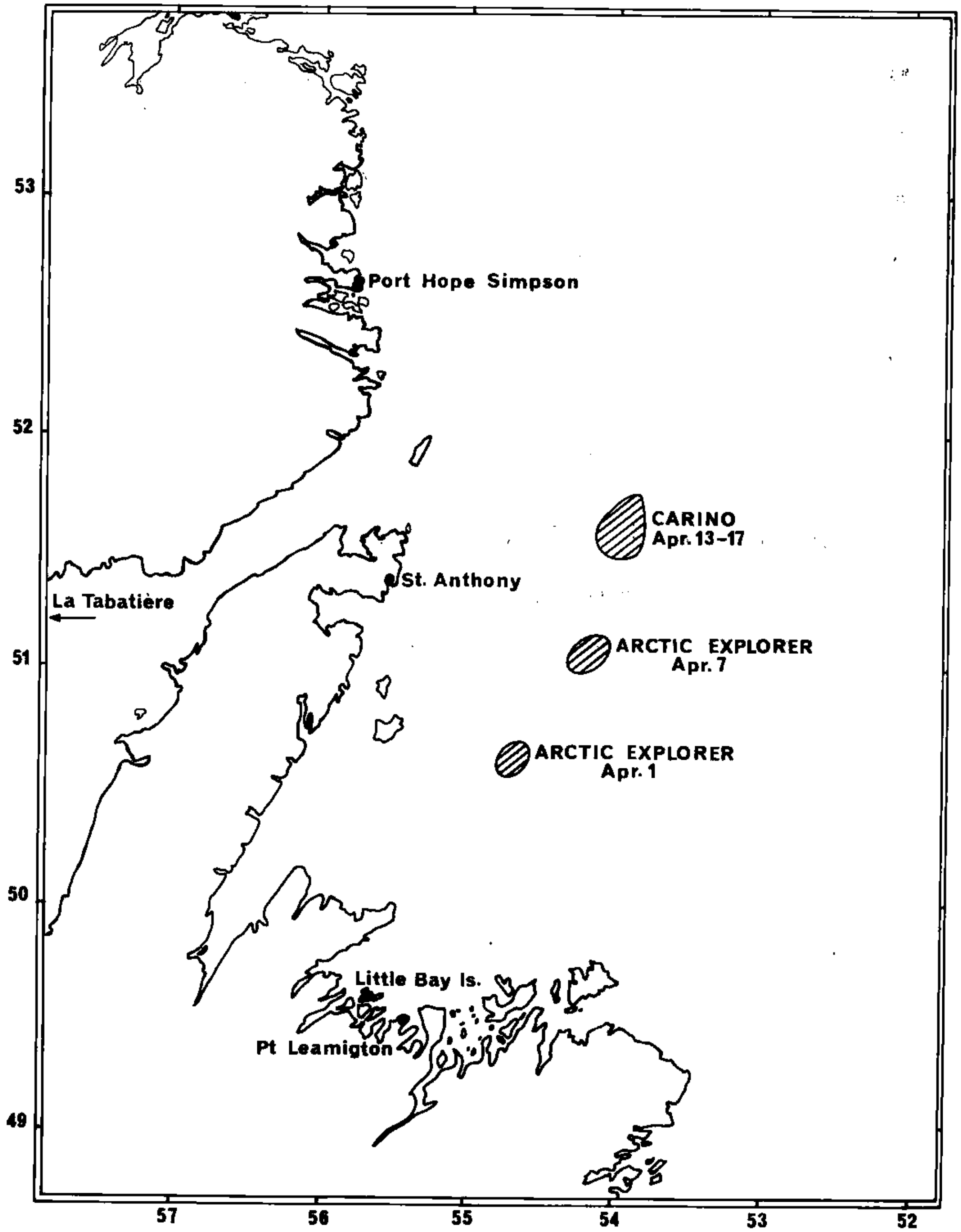

Fig. 1. Map of sampling areas (1975) - 1976.

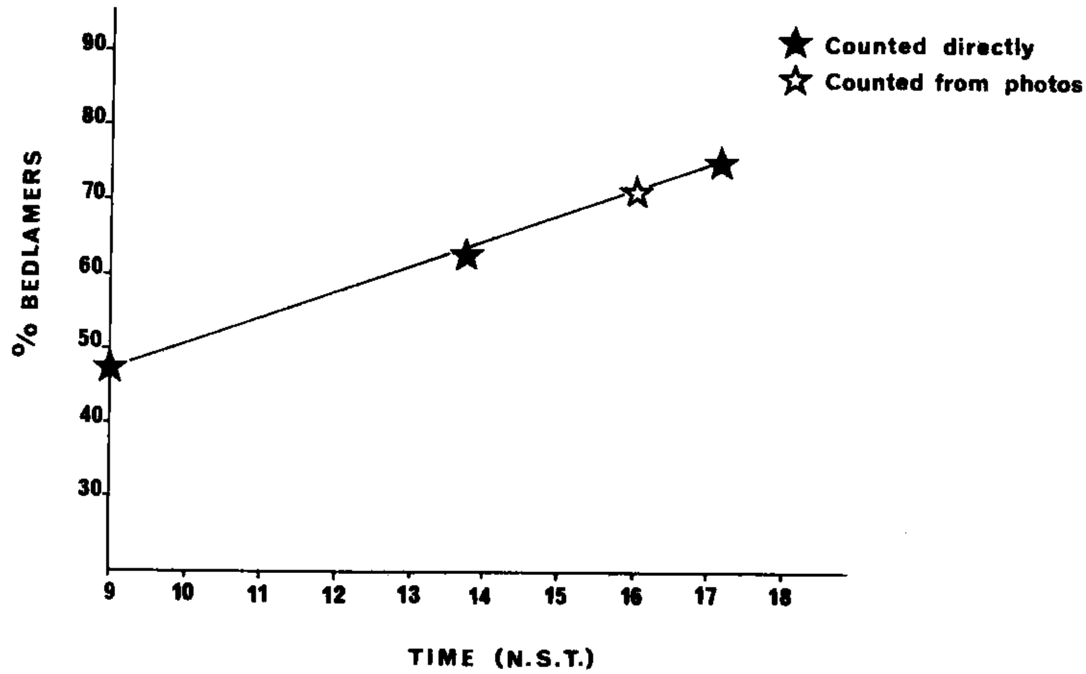

Fig. 2. Percent bedlamer harp seals in patch of 14 April 1976.

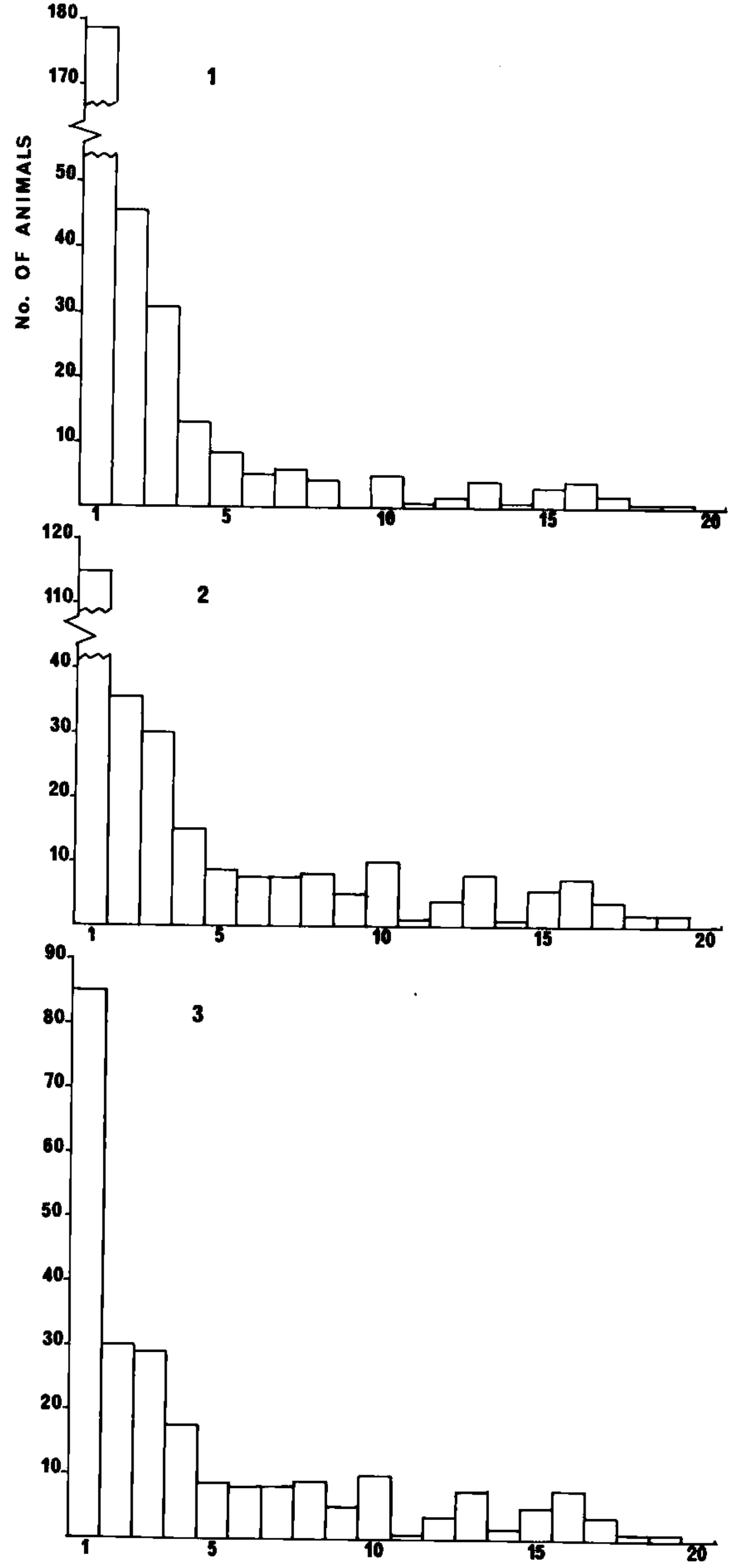

Fig. 3. Age samples from Carino, 12-17 April 1976.
(1) Raw
(2) Corrected for selectivity due to hunting
(3) Further corrected for selectivity due to Immigration of Gulf bedlamers

E 14

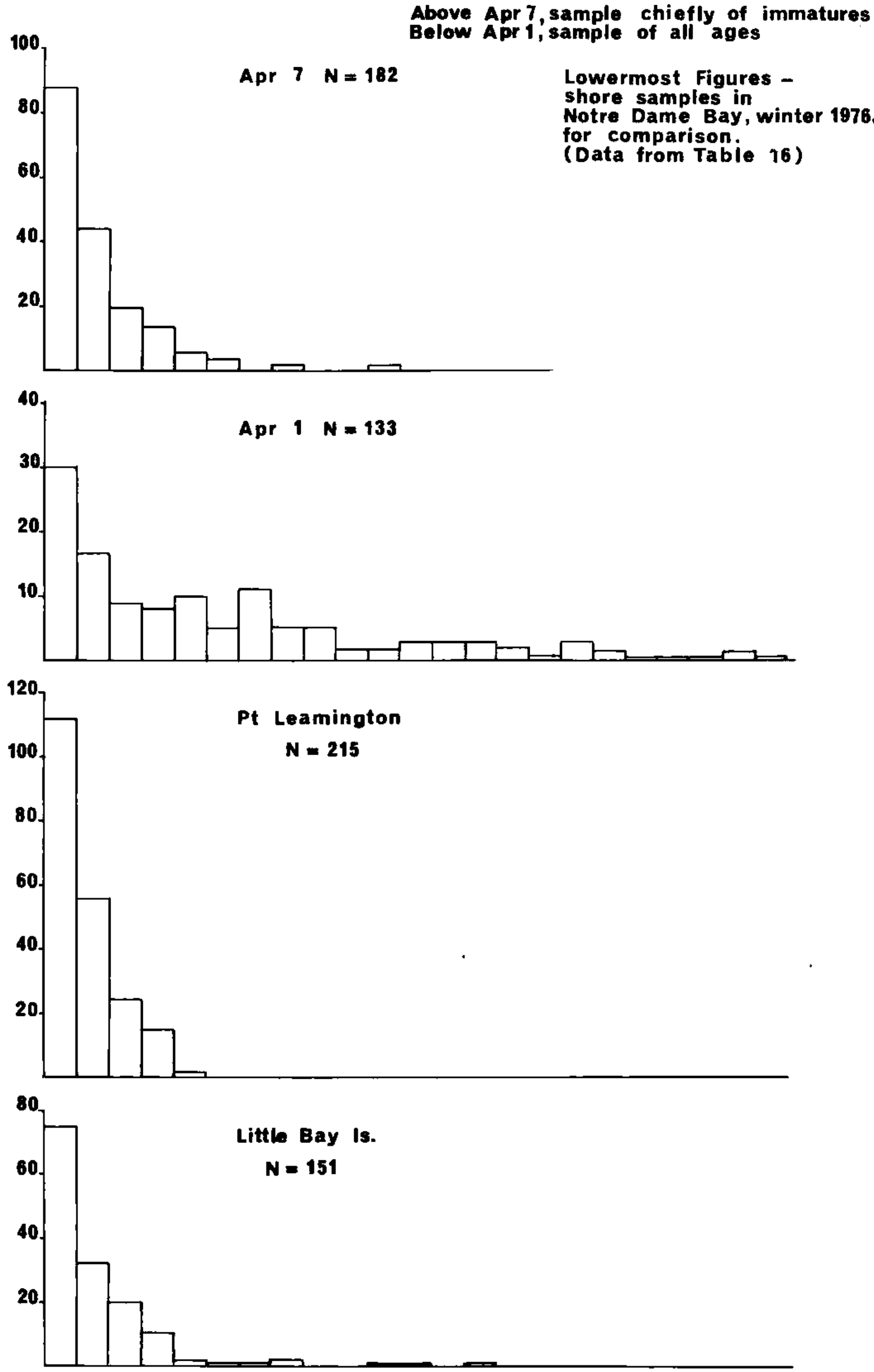

Fig. 4. Samples of moulting harp seals from Arctic Explorer, 1976.

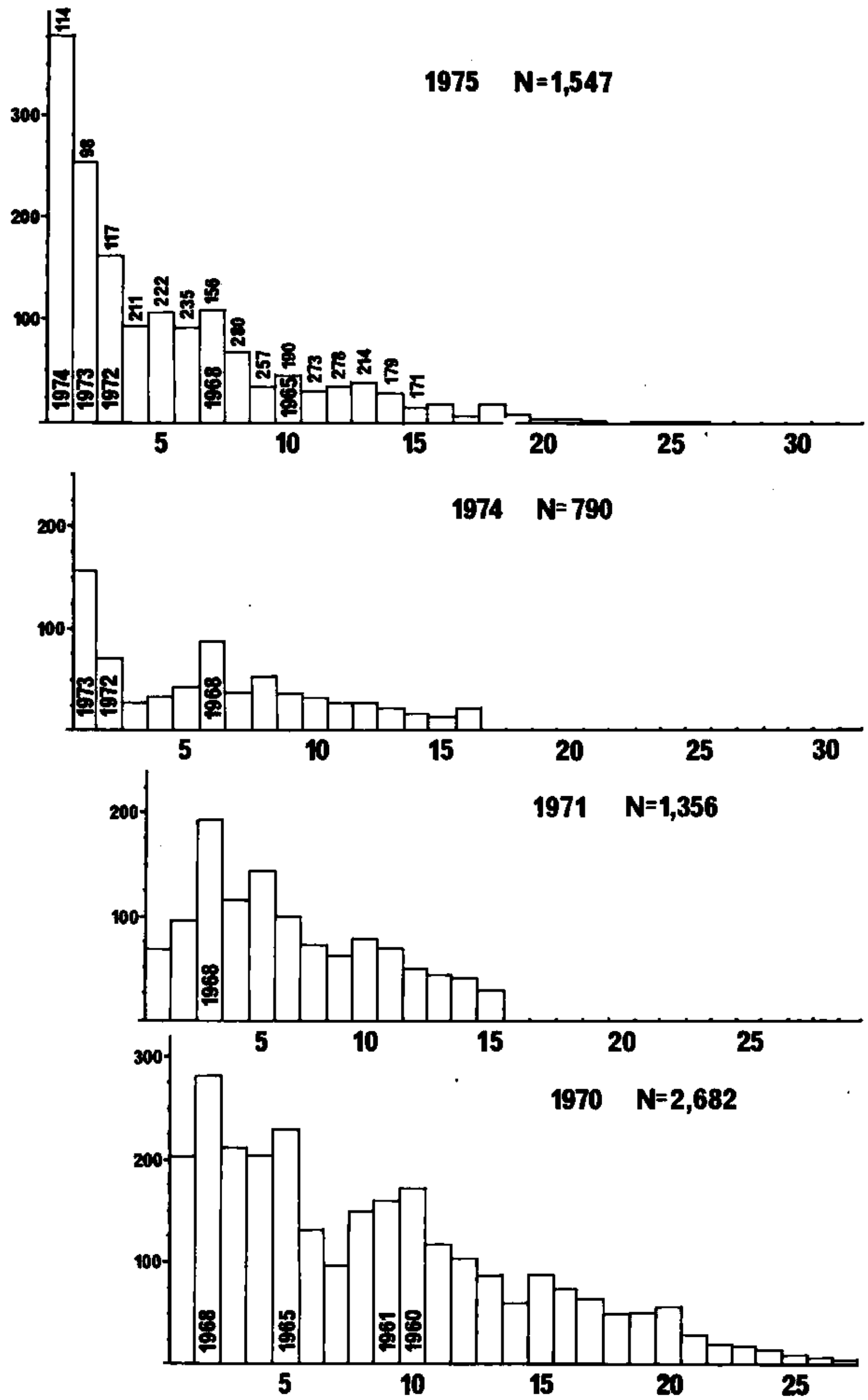

Fig. 5. Pooled age samples of harp seals from eastern Canada over four years.

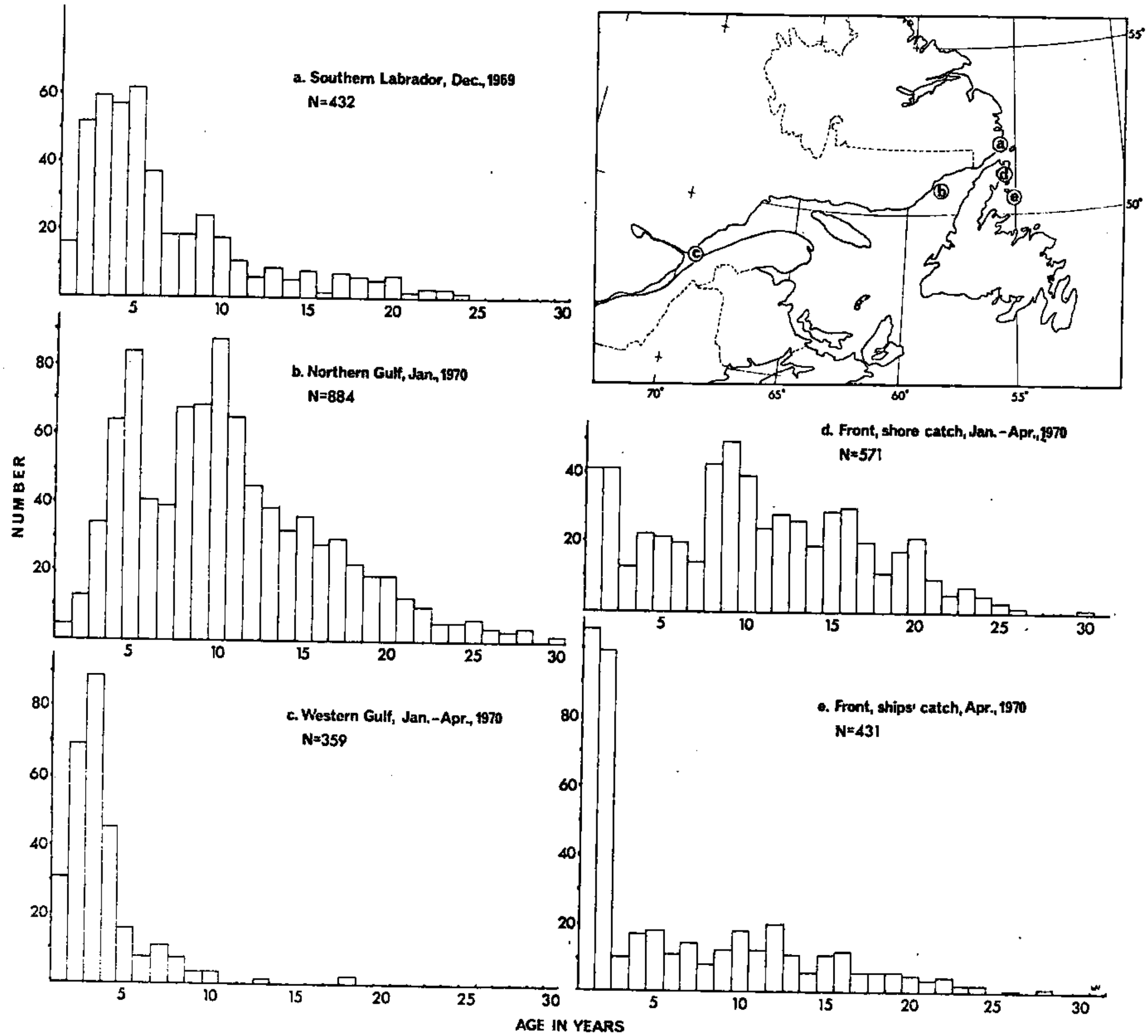

Fig. 6. A series of age samples taken in winter 1969-70 from localities shown in map.

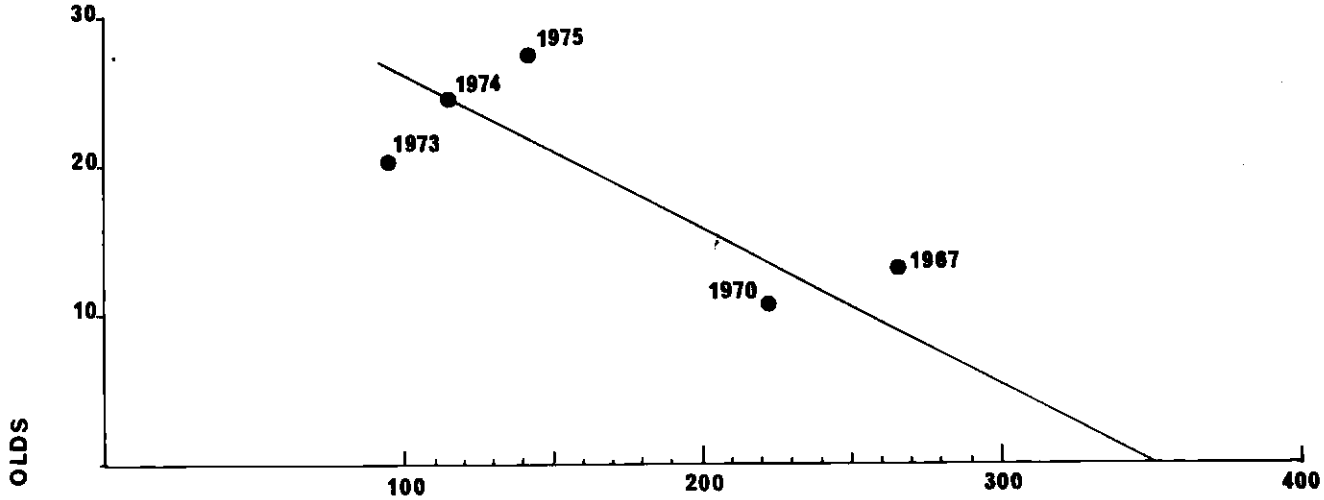

Fig. 7. Population estimate for years 1967-1975 (median 1971).

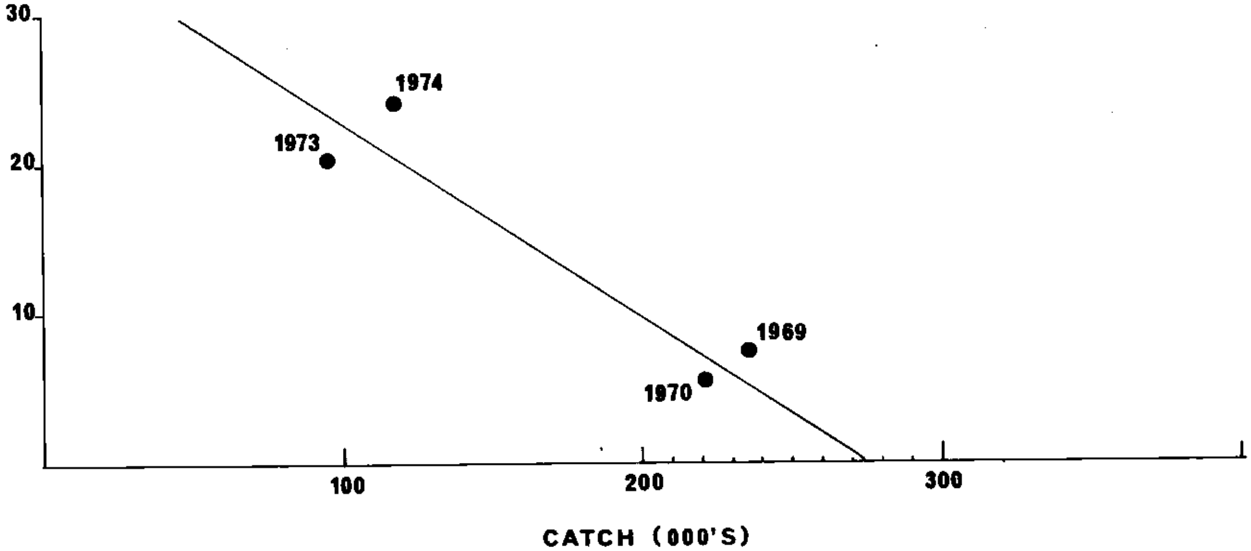

Fig. 8. Same for 1969-1974 (median 1972).

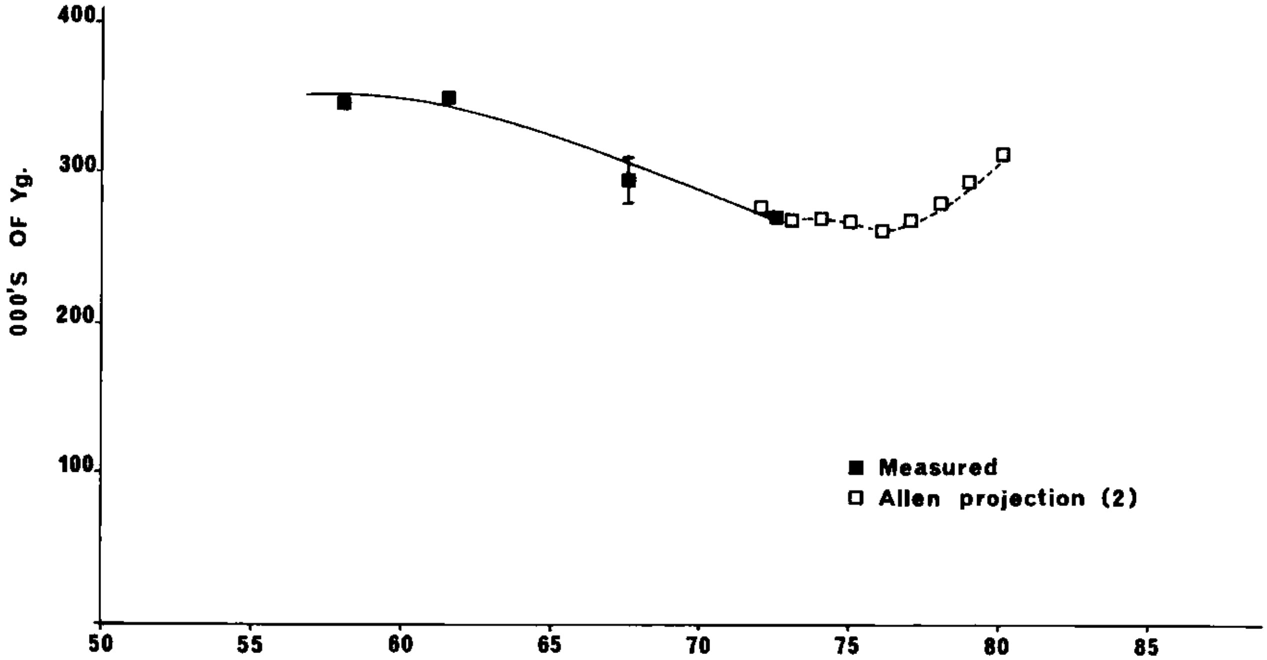

Fig. 9. Estimates of production.