

# Age Structure of Northwest Atlantic Harp Seal Catches, 1952-80

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## Abstract

Annual age compositions of harp seal, *Pagophilus groenlandicus*, catches in the Northwest Atlantic are presented for the 1952-80 period. For the Labrador-Newfoundland and Gulf of St. Lawrence areas, these were estimated from available age samples of catches by different hunting methods, with appropriate adjustments to reduce a bias in previous analyses which led to overestimation of the catches of mature animals. Age compositions of catches at West Greenland are also presented, but very little information was available for the Canadian Arctic. Except for the Canadian Arctic, biological sampling and estimates of actual catches have gradually improved over the period, and consequently the age compositions for the 1970's are considered to be more reliable than those for the 1960's and 1950's.

## Introduction

Sound management of commercially harvested animal populations depends on accurate knowledge of the age structure of removals from the stocks. In the Northwest Atlantic, harp seals, *Pagophilus groenlandicus*, have been hunted commercially since the late 1700's, but it is only since the early 1950's that detailed information on the age structure of catches has been recorded.

Determining the age structure of harp seal catches is difficult because several methods are used to hunt these animals in the Northwest Atlantic, each with different hunting selectivities. Seals captured in nets along the coasts of southern Labrador and Quebec and in the vicinity of St. Anthony, Newfoundland, are mainly mature animals, whereas seals shot from small boats and larger vessels up to 20 m in length are generally immature animals, called bedlamers. The large vessel (offshore) catches taken from breeding concentrations prior to 1965 and from molting patches throughout the sampling period consist of a mixture of immature and mature animals. For this reason, the age structure of the total annual catches of seals (age 1 and older) must take into account the age compositions of catches by different hunting methods in their proper proportions.

Lett and Benjaminsen (1977) produced the first comprehensive age structure of total annual harp seal catches in the Northwest Atlantic for 1952-75. In this paper, the data base is updated to 1980, certain inconsistencies in the previous analysis are corrected, and an attempt is made to remove a bias in age composition of inshore catches which led to overestimation of the kill of mature animals, particularly in recent years.

## Age Sampling of Catches

Biological sampling of harp seal catches began in 1952 and has continued to the present. Age frequencies used to produce the age compositions of catches of age 1+ (age 1 and older) animals in the "Front" (Labrador and northern Newfoundland) and "Gulf" (Gulf of St. Lawrence) areas are given in Appendix Table A. The data were obtained from the following sources: Sergeant and Fisher (1960), Sergeant (1971, MS 1976, MS 1977, MS 1978, pers. comm.), Øritsland (1971, pers. comm.), and Benjaminsen and Øritsland (MS 1975). Age samples of net catches by landsmen (inshore fishermen) were available for one or more of three localities (St. Anthony, Newfoundland; La Tabatière, Quebec; and southern Labrador) for the entire period. Age samples of seals shot by landsmen from small boats and larger vessels up to 20 m in length have been collected annually since 1974. Age samples from large vessel catches were collected in 1952-54, 1958, and regularly since 1961.

Age frequencies of West Greenland catches of harp seals were obtained from Kapel (MS 1977, MS 1979, pers. comm.) (see Appendix Table B). Only two age samples were available for the 1952-71 period, one taken in 1953 and the other in 1962. Kapel used these samples with data on the relative frequency of pelage types from the Greenland "List of Game" to construct separate composite age frequencies of harp seals for the 1954-62 and 1963-71 periods. West Greenland catches have been sampled annually since 1972.

Age samples of harp seal catches in the Canadian Arctic (Appendix Table C) were available only for 1967, 1969, 1976 and 1977 (D. E. Sergeant, pers. comm.; R. E. A. Stewart, pers. comm.).

## Harp Seal Catches

The annual catches of harp seals in the Northwest Atlantic (except Canadian Arctic) were compiled from statistics reported to the International Commission for the Northwest Atlantic Fisheries for 1952-78 (ICNAF, 1970, 1971-1980) and to the Northwest Atlantic Fisheries Organization for 1979 and 1980 (NAFO 1981, MS 1980), supplemented by updated estimates of West Greenland catches (F. O. Kapel, pers. comm.) (Table 1). Estimates of Canadian Arctic catches were obtained from Smith and Taylor (1977) and Sergeant (pers. comm.).

The annual catches of age 1+ seals in the Front and Gulf areas were reported by three hunting categories: vessels >150 GRT (gross registered tons), vessels <150 GRT, and landsmen who hunt from small boats (<10 GRT). Age 1+ seals taken by the first two categories are shot, whereas the landsmen's catches usually consist of shot and netted animals. The age structure of shot animals by landsmen hunting from small boats tends to be similar to that for vessels <150 GRT, but the

age structure of netted seals is generally quite different. Hence, it was necessary to obtain estimates of netted seal catches in order to utilize the existing time series of age frequencies for this hunting category.

The estimates of netted seal catches were obtained from fishermen of the St. Anthony area in northern Newfoundland, from fishery officers and the Economics and Intelligence Branch of the Canadian Department of Fisheries and Oceans, and from statistics provided by the Government of Quebec. From these sources, it was assumed that annual averages of 5,000, 2,500 and 2,000 age 1+ seals were taken in the St. Anthony area in the 1950's, 1960's and 1970's respectively, actual statistics being available only for 1978-80. Net catches of seals by Quebec fishermen along the north shore of the Gulf for 1967-80 varied greatly (1,000-8,000 animals) but showed no trend over this period (Fig. 1), and consequently a mean value of 4,034 was used as the estimate of the yearly harvest during 1952-66. No estimates of net catches along the coast of Labrador were available, and, as only a few hundred seals are thought to be taken annually, they have not been considered in this analysis.

TABLE 1. Harp seal catches in the Northwest Atlantic, 1952-80.

Year	Front and Gulf regions (Subareas 2, 3 and 4)							Canadian Arctic <sup>a</sup>		West Greenland (Subarea 1)		All Northwest Atlantic areas		
	Vessels ≥150 GRT		Vessels <150 GR		Landsmen		Nets	(Subarea 0)						Total
	Pups	Age 1+	Pups	Age 1+	Pups	Age 1+	Age 1+	Pups	Age 1+	Pups	Age 1+	Pups	Age 1+	
1952	172,185	98,378			25,878	1,667	9,000	60	1,724	9,676	6,724	207,799	117,493	325,292
1953	147,090	66,811			50,885	—	8,100			9,676	6,724	207,711	83,359	291,070
1954	125,353	83,939			49,681	—	5,443			11,160	7,753	186,254	98,859	285,113
1955	231,700	75,671			20,597	—	5,401			9,118	6,337	261,475	89,133	350,608
1956	299,745	42,585			41,652	—	5,428			6,430	4,468	347,887	54,205	402,092
1957	137,721	76,437			27,717	—	3,605			7,565	5,257	173,063	87,023	260,086
1958	80,430	137,227			60,566	10,563	9,000			9,859	6,849	150,915	165,363	316,278
1959	227,212	77,304			11,620	—	3,998			5,219	3,626	244,111	86,652	330,763
1960	131,649	114,534			24,519	—	6,648			9,428	6,551	165,656	129,457	295,113
1961	154,286	13,170			14,533	—	5,877			7,013	4,873	175,892	25,644	201,536
1962	164,625	99,513			42,463	6,888	6,500			4,952	3,442	212,100	118,067	330,167
1963	207,818	57,094			62,601	8,029	6,500			5,803	4,200	276,282	77,547	353,829
1964	210,089	60,348			56,293	8,433	6,500			5,302	3,838	271,744	80,843	352,587
1965	121,398	33,757	5,225	748	56,135	10,490	6,500			5,365	3,886	188,183	57,105	245,288
1966	209,145	59,364	2,665	470	39,325	5,670	6,500			4,078	2,951	255,273	76,679	331,952
1967	252,837	41,361	542	2,945	24,371	5,800	6,500			2,446	1,769	280,256	60,099	340,355
1968	125,236	30,328	6,083	924	25,139	—	4,986			4,076	2,950	160,594	40,912	201,506
1969	202,685	44,940	2,717	555	27,938	1,692	8,285			3,702	2,681	237,102	59,877	296,979
1970	184,192	26,255	11,999	862	21,240	3,046	9,931			3,583	2,595	221,074	44,383	265,457
1971	169,426	14,343	10,106	811	31,047	625	4,608			3,214	2,326	213,853	24,437	238,290
1972	104,109	1,646	4,295	2,535	8,406	5,774	3,118			3,392	2,560	120,262	17,357	137,619
1973	63,369	15,081	10,717	1,731	24,249	5,282	3,403			5,039	4,123	103,434	31,344	134,778
1974	85,387	21,828	5,194	1,904	24,244	4,365	4,713			4,479	2,520	119,364	37,054	156,418
1975	109,832	10,992	15,107	9,027	15,699	4,503	9,203			3,780	2,220	144,478	37,669	182,147
1976	93,939	4,576	17,181	17,789	20,965	3,865	6,687			4,836	2,964	136,981	37,605	174,586
1977	92,904	2,048	18,970	15,525	15,108	7,555	3,033			7,850	2,088	134,892	31,973	166,865
1978	63,669	3,523	11,188	16,640	41,333	16,304	9,066			5,500	7,000	121,750	54,257	176,007
1979	96,926	1,011	8,799	9,838	26,733	13,522	4,274			4,797	6,903	137,315	37,272	174,587
1980	91,577	1,563	19,868	17,868	20,976	10,926	6,979			3,936 <sup>b</sup>	5,664 <sup>b</sup>	136,417	44,724	181,141

<sup>a</sup> Average of available data: annual average of 1,768 seals in 1962-71 (Smith and Taylor, 1977), and catches of 1,117, 2,513, 2,017 and 1,508 seals in 1974-77 respectively (Sergeant, pers. comm.)

<sup>b</sup> Provisional estimates assuming the same proportion of pups as in 1979.

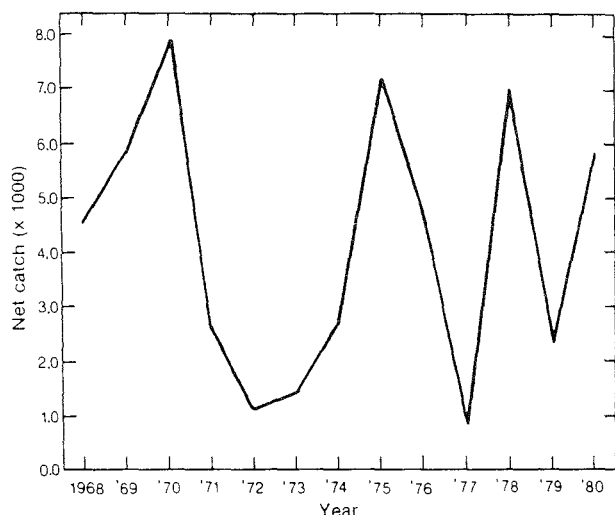


Fig. 1. Estimates of the Quebec northshore net catch of age 1+ harp seals from 1968 to 1980.

## Age Composition of Catches

### Front and Gulf (Subareas 2-4)

The age compositions of total annual catches of harp seals in the Front and Gulf areas by large vessels, landsmen with nets, and small vessels are given in Table 2 for the 1952-80 period. These were determined by applying the relevant age frequencies (Appendix Table A) to the harp seal catches given in Table 1 for the three major hunting categories, after making certain assumptions about the age structure of catches in years when no biological sampling was carried out.

The age compositions of large vessel (>150 GRT) catches were based on Canadian, Norwegian, or both when available, research samples of molting harp seals. Such age samples were not available for 1955, 1956, 1957, 1959 and 1960, and the unweighted mean of 1952-54 and 1958 age frequencies was used to prorate the large vessel catches for these years. The unweighted mean was used because no trend was evident in the proportions of age 1-4 seals in the available samples obtained during 1952-62, and hence there was little advantage in using a more complex procedure of estimation. However, it should be noted that the use of average values may introduce error, as Lett and Benjaminsen (1977) have previously pointed out, because the catches of age 1+ seals by large vessels during that early period represented 87-96% of the total annual catches of age 1+ seals. The age samples of the large vessel catch in 1972 was small (135 seals), but only 1,646 age 1+ animals (9% of total catch) were taken by large vessels in that year, and the effect of biased sampling on the age structure of the overall catch of age 1+ seals is relatively unimportant. No age sample of the large vessel catch was available for 1980, and the age frequency for 1979 was used.

Samples of the age structure of netted seals were available for one or more localities over the entire period: southern Labrador (D), St. Anthony area, Newfoundland (E), and La Tabatiere, Quebec (F) (see Appendix Table A). Shot samples from small boats in the St. Lawrence River estuary (G) were also included when available because it was not possible to estimate the relative proportions of netted and shot seals caught along the north shore of the Gulf. Age samples comprising less than 100 seals from landsmen's catches were combined with other similar samples and are not listed separately in Appendix Table A (e.g. 1971, D-F). The netted component of the harp seal catches was sampled quite well during 1952-80. No net sample was available for 1957, but a sample of 234 seals were taken by hook and line near Magdalen Islands in the Gulf of St. Lawrence. The age composition of this sample was similar to those of net samples in adjacent years and was therefore used to represent the total netted catch in 1975.

The age compositions of shot seals by small vessels (<150 GRT) and landsmen (Table 2) were determined from samples of small vessel catches in White Bay and Notre Dame Bay, Newfoundland (C) for the 1974-80 period (Appendix Table A). No significant error is thought to be introduced by combining these two categories, as age frequencies of samples from small vessel catches in 1979 and 1980 did not differ from those from landsmen's catches. In the absence of age samples prior to 1974 and as the selectivity pattern of the 1974-80 samples showed no trend over time, the unweighted average age frequency was used to prorate the catches prior to 1974. Unfortunately, the available samples of shot seals were all taken after the introduction of conservation measures in 1971. Prior to 1971, bedlamers (the focus of this hunt) likely constituted a smaller proportion of the population, and recent age frequencies may therefore not be fully representative of catches in the earlier period.

In previous analyses (Lett and Benjaminsen, 1977; Lett *et al.*, 1979), the landsmen's catches included seals caught in nets and those shot from small boats and larger vessels (<150 GRT). However, as indicated previously, netted catches consisted mainly of mature seals whereas shot catches consisted primarily of immature seals. Consequently, the use of netted age samples to prorate the entire landsmen's catches results in overestimation of the numbers of age 1+ animals killed. During 1952-61, most of the age 1+ catches of seals were taken by nets (Table 1), and no serious bias results from using net samples alone. However, the small vessel proportion of the landsmen's catch increased to 88% of the total in certain years between 1962 and 1980 and regularly comprised 50-75%, and the use of net samples only for this period introduces significant bias in the catch-at-age data.

TABLE 2. Estimated age compositions of harp seal catches by different hunting methods in the Front and Gulf areas, 1952-80.

Age (yr)	1952			1953			1954			1955			1956		
	Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels	
		Nets	Other		Nets	Other		Nets	Other		Nets	Other		Nets	Other
0	172,185	—	25,878	147,090	—	50,885	125,353	—	49,681	231,700	—	20,597	299,745	—	41,652
1	4,353	221	766	20,523	79		31,494	151		21,286	514		11,979	89	
2	10,447	941	370	6,074	256		12,163	424		7,673	825		4,318	477	
3	6,530	1,051	198	5,094	659		3,517	432		4,972	1,029		2,798	501	
4	4,788	1,080	126	2,988	756		4,868	757		3,882	439		2,185	444	
5	5,659	1,136	61	3,037	1,000		2,434	500		3,367	622		1,895	299	
6	10,883	720	42	2,351	872		3,240	469		3,277	375		1,844	283	
7	7,400	664	24	2,106	719		2,837	492		2,792	321		1,571	338	
8	7,400	499	15	2,351	531		2,703	333		2,853	418		1,605	436	
9	5,224	526	4	2,302	475		1,754	257		2,459	139		1,384	364	
10	6,094	471	13	1,910	420		2,703	205		2,792	150		1,571	267	
11	5,224	388	6	2,498	353		1,083	167		2,490	128		1,401	186	
12	1,306	471	8	1,371	372		2,434	189		1,907	128		1,073	242	
13	1,306	166	6	1,078	292		2,434	99		1,544	11		869	129	
14	2,176	—	6	833	189		1,217	99		1,120	43		630	218	
15	3,918	166	7	1,616	207		1,620	212		2,179	43		1,226	105	
16	1,306	111	4	1,812	177		2,166	30		2,058	22		1,158	163	
17	2,175	56	2	1,274	134		949	68		1,332	32		749	121	
18	1,741	56	1	784	122		269	68		696	43		392	186	
19	871	111	2	588	85		1,083	38		757	11		426	145	
20	5,224	166	1	2,449	92		537	294		2,331	43		1,312	193	
21	871	—	2	1,567	97		269	38		1,271	32		715	24	
22	—	—	1	882	55		269	15		757	22		426	33	
23	435	—	—	588	36		680	38		605	11		341	48	
24	1,306	—	—	441	12		134	8		515	—		290	56	
25+	1,741	—	2	294	110		1,082	60		756	—		427	81	
Total	270,563	9,000	27,545	413,901	8,100	50,885	209,292	5,443	49,681	307,371	5,401	20,597	342,330	5,428	41,652

Age (yr)	1957			1958			1959			1960			1961		
	Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels	
		Nets	Other		Nets	Other		Nets	Other		Nets	Other		Nets	Other
0	137,721	—	27,717	80,430	—	60,566	227,212	—	11,620	131,649	—	24,519	154,286	—	14,533
1	21,502	154		19,267	205	4,856	21,746	136		32,218	336		4,883	152	
2	7,751	231		7,220	249	2,348	7,838	347		11,615	1,057		1,360	617	
3	5,022	308		9,148	909	1,254	5,079	379		7,525	1,995		1,001	950	
4	3,921	354		9,630	1,423	802	3,966	273		5,877	662		1,201	1,198	
5	3,401	185		8,667	1,041	384	3,440	348		5,097	464		440	370	
6	3,310	154		5,296	1,026	267	3,347	394		4,959	612		520	494	
7	2,821	247		5,296	616	151	2,853	379		4,226	405		601	408	
8	2,882	246		4,335	660	97	2,914	333		4,318	187		361	256	
9	2,484	200		4,335	454	24	2,512	318		3,722	138		320	266	
10	2,821	169		9,148	440	82	2,853	257		4,226	178		681	228	
11	2,515	247		5,296	410	39	2,543	152		3,768	128		400	142	
12	1,926	154		6,741	293	54	1,948	106		2,886	119		120	190	
13	1,559	154		3,852	278	39	1,577	76		2,336	59		161	152	
14	1,131	185		2,889	220	39	1,144	136		1,695	89		240	66	
15	2,201	108		8,667	103	43	2,226	121		3,299	40		40	114	
16	2,079	92		5,778	44	24	2,103	46		3,115	49		200	48	
17	1,345	77		2,889	88	10	1,361	61		2,016	30		161	28	
18	703	77		482	73	5	711	30		1,054	30		80	19	
19	764	62		1,444	44	10	773	46		1,145	—		120	—	
20	2,356	62		5,296	73	5	2,381	30		3,528	40		80	66	
21	1,284	16		2,889	—	10	1,299	—		1,924	—		—	—	
22	764	31		2,407	14	5	773	—		1,145	10		80	—	
23	611	—		963	44	—	618	15		916	—		40	19	
24	520	15		1,922	44	—	526	—		779	—		—	9	
25+	764	77		3,370	249	15	773	15		1,145	20		80	85	
Total	214,158	3,605	27,717	217,657	9,000	71,129	304,516	3,998	11,620	246,183	6,648	24,519	167,456	5,877	14,533

TABLE 2. (continued).

Age (yr)	1962			1963			1964			1965			1966		
	Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels	
		Nets	Other		Nets	Other		Nets	Other		Nets	Other		Nets	Other
0	164,625	—	42,463	207,818	—	62,601	210,089	—	56,293	121,398	—	61,360	209,145	—	41,990
1	26,147	190	3,166	5,070	258	3,690	1,424	384	3,877	6,468	77	5,165	10,522	184	2,822
2	31,870	475	1,531	5,527	791	1,784	2,850	528	1,875	2,626	259	2,497	8,769	518	1,365
3	7,935	658	818	4,842	821	952	3,802	896	1,001	2,626	662	1,333	3,420	752	729
4	7,286	915	523	2,512	721	609	5,227	694	640	3,031	1,017	853	3,507	818	466
5	5,073	849	251	2,101	621	292	3,325	701	307	4,648	911	409	3,946	818	223
6	2,211	292	174	2,786	452	203	5,705	593	213	4,446	807	284	3,946	919	155
7	1,951	439	98	3,060	235	115	2,850	405	120	1,414	519	161	3,858	618	88
8	2,081	424	63	3,016	270	74	2,378	333	78	405	461	103	2,718	317	56
9	2,211	307	16	2,878	200	18	2,378	238	19	405	211	26	1,315	301	14
10	781	248	54	3,289	235	63	3,802	238	66	1,009	134	88	1,491	167	48
11	1,041	176	25	3,197	223	30	1,901	210	31	203	144	42	2,017	184	23
12	1,691	146	35	2,329	176	41	1,901	188	43	1,414	173	57	1,491	84	31
13	781	160	25	2,603	118	30	1,424	188	31	—	221	42	1,315	117	23
14	1,171	153	25	2,558	182	30	1,424	174	31	1,009	144	42	1,491	117	23
15	1,561	322	28	1,918	194	33	2,378	79	34	810	173	46	1,228	117	25
16	520	124	16	2,466	141	18	1,901	94	19	405	115	26	1,228	134	14
17	1,561	95	7	1,645	141	8	2,378	116	8	203	96	11	877	84	6
18	650	110	3	1,096	76	4	3,802	51	4	608	58	5	1,491	17	3
19	520	51	7	822	94	8	1,901	101	8	608	96	11	877	50	6
20	1,171	117	3	822	118	4	—	58	4	203	38	5	964	33	3
21	130	22	7	776	64	8	1,901	44	8	405	48	11	701	17	6
22	520	81	3	548	76	4	947	36	4	203	20	5	263	33	3
23	—	29	—	411	82	—	947	36	—	—	20	—	614	17	—
24	130	22	—	365	47	—	1,424	14	—	—	29	—	351	—	—
25+	520	95	10	457	164	11	2,378	101	12	608	67	16	964	84	8
Total	264,138	6,500	49,351	264,912	6,500	70,630	270,437	6,500	64,726	155,155	6,500	72,598	268,509	6,500	48,130

Age (yr)	1967			1968			1969			1970			1971		
	Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels	
		Nets	Other		Nets	Other		Nets	Other		Nets	Other		Nets	Other
0	252,837	—	24,913	125,236	—	31,222	202,685	—	30,655	184,192	—	33,239	169,426	—	41,153
1	9,951	150	4,019	5,189	132	426	19,059	1,025	1,033	6,535	435	1,796	6,761	271	660
2	3,964	440	1,944	3,578	411	205	1,937	378	500	5,708	809	869	1,867	382	319
3	991	523	1,038	2,132	558	110	1,761	831	267	1,213	903	464	1,216	705	171
4	1,034	506	664	1,113	469	71	1,365	817	171	1,296	836	297	538	408	109
5	2,068	731	318	1,113	324	34	1,806	772	82	1,296	925	142	509	486	52
6	2,930	805	221	1,019	462	23	1,409	497	57	745	519	99	311	297	36
7	2,542	755	125	1,729	388	13	1,628	601	32	910	360	56	283	211	21
8	1,853	473	80	1,826	396	9	2,201	594	21	938	627	36	227	206	13
9	1,206	341	20	1,280	242	2	1,628	423	5	771	657	9	480	189	3
10	1,034	299	68	1,280	242	7	1,276	438	18	1,103	680	30	425	292	11
11	1,551	207	32	970	176	3	1,145	379	8	716	453	14	283	176	5
12	1,034	166	45	710	198	5	749	253	11	745	364	20	311	172	8
13	819	133	32	734	117	3	924	230	8	496	320	14	198	172	5
14	1,249	191	32	995	117	3	1,012	163	8	469	240	14	56	107	5
15	1,293	158	36	807	139	4	1,012	208	9	525	325	16	113	107	6
16	862	83	20	758	125	2	616	163	5	662	266	9	113	82	3
17	1,121	100	9	616	139	1	1,100	163	2	275	262	4	56	82	1
18	1,249	91	4	1,019	81	—	704	104	1	358	178	2	85	65	1
19	1,293	83	9	876	73	1	836	75	2	358	187	4	85	52	1
20	819	75	4	640	37	—	704	52	1	275	207	2	29	60	1
21	517	58	9	379	37	1	484	62	2	249	97	4	29	30	1
22	389	33	4	522	51	—	308	27	1	194	67	2	56	17	1
23	474	8	—	285	14	—	396	15	—	139	63	—	29	17	—
24	258	33	—	212	7	—	176	15	—	84	49	—	—	9	—
25+	860	58	12	546	51	1	704	—	3	165	102	5	283	13	2
Total	294,198	6,500	33,658	155,564	4,986	32,146	247,625	8,285	32,902	210,417	9,931	37,147	183,769	4,608	42,588

TABLE 2. (continued).

Age (yr)	1972			1973			1974			1975			1976		
	Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels	
		Nets	Other		Nets	Other		Nets	Other		Nets	Other		Nets	Other
0	104,109	—	12,701	63,369	—	34,966	85,387	—	29,438	109,832	—	30,806	93,939	—	38,146
1	146	134	3,820	1,629	65	3,224	6,911	74	3,427	4,112	1,393	7,271	2,137	1,315	11,123
2	110	312	1,847	2,206	153	1,559	4,357	165	1,240	1,976	1,408	2,786	783	857	5,444
3	110	223	986	1,748	175	832	1,650	82	405	905	1,008	1,193	437	823	2,663
4	293	356	627	1,657	98	529	1,249	138	338	594	669	398	266	675	1,657
5	110	189	302	2,784	120	255	1,286	266	248	506	778	290	172	480	236
6	121	200	210	754	120	177	1,688	735	248	506	677	254	100	435	58
7	159	100	118	633	175	100	404	303	90	247	771	361	129	343	58
8	110	123	76	792	164	67	404	442	68	203	512	72	93	332	119
9	73	67	19	391	229	16	692	332	23	257	244	72	79	148	—
10	73	78	65	363	185	55	384	322	—	151	292	361	50	274	—
11	50	167	31	437	262	26	230	239	23	247	221	37	36	160	119
12	61	145	45	252	294	36	365	229	45	151	213	145	36	103	119
13	24	78	31	298	240	26	384	212	45	177	237	72	50	92	—
14	13	167	31	160	229	26	248	174	23	133	213	—	29	92	58
15	49	89	34	214	196	29	230	165	—	133	118	—	36	183	—
16	36	45	19	167	164	16	192	212	23	115	110	72	36	57	—
17	24	89	8	84	120	7	192	156	23	115	63	37	36	69	—
18	24	111	4	47	109	3	153	101	—	88	126	—	22	45	—
19	—	56	8	103	65	7	116	82	—	71	47	72	14	45	—
20	36	155	4	112	65	3	39	64	—	55	31	—	7	57	—
21	—	100	8	—	33	7	39	74	—	44	24	37	7	11	—
22	12	56	4	—	142	3	76	64	—	63	—	—	14	11	—
23	—	45	—	18	—	—	39	37	—	44	24	—	7	34	—
24	—	33	—	18	—	—	96	18	—	55	16	—	—	23	—
25+	12	—	12	214	—	10	404	27	—	44	8	—	—	23	—
Total	105,755	3,118	21,010	78,450	3,403	41,979	107,215	4,713	35,707	120,824	9,203	44,336	98,515	6,687	59,800

Age (yr)	1977			1978			1979			1980		
	Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels		Large vessels	Landsmen and small vessels	
		Nets	Other		Nets	Other		Nets	Other		Nets	Other
0	92,904	—	34,078	63,669	—	52,521	96,926	—	35,532	91,577	—	40,844
1	576	475	6,400	519	1,135	14,199	310	609	12,940	481	458	13,300
2	303	629	4,649	605	1,268	8,158	153	823	4,923	236	562	5,814
3	236	519	4,376	532	1,533	3,986	92	598	2,061	141	1,061	3,202
4	194	325	3,227	435	1,387	2,616	85	485	1,145	131	853	1,602
5	189	240	1,477	378	1,215	1,370	74	438	801	114	842	1,046
6	92	150	820	206	703	1,058	49	309	458	75	624	905
7	50	130	547	105	292	250	47	175	229	72	479	557
8	42	140	273	125	299	435	38	99	115	59	385	349
9	77	60	55	105	232	—	16	95	115	25	218	315
10	25	30	164	89	239	250	18	65	—	28	104	138
11	20	35	164	36	100	62	27	61	—	42	146	246
12	25	20	109	44	100	62	22	69	—	34	135	246
13	37	40	109	44	53	125	14	69	—	22	104	174
14	42	45	273	44	93	—	7	30	115	11	94	277
15	22	35	328	40	40	125	9	34	115	14	125	208
16	32	25	109	36	73	—	9	30	—	14	135	173
17	22	5	—	44	60	—	7	53	—	11	114	138
18	13	25	—	36	40	62	11	50	—	17	10	—
19	7	5	—	24	46	—	5	38	—	8	21	69
20	5	25	—	16	33	62	5	19	—	8	104	35
21	10	5	—	16	13	62	5	19	—	8	73	—
22	5	15	—	4	13	62	—	30	—	—	73	—
23	12	25	—	20	13	—	4	8	—	6	10	—
24	7	15	—	8	13	—	—	11	—	—	10	—
25+	5	15	—	12	73	—	4	57	343	6	239	—
Total	94,952	3,033	57,158	67,192	9,066	85,465	97,937	4,274	58,892	93,140	6,979	69,638

The age compositions of the annual catches of harp seals in the Front and Gulf areas during 1952-80 are summarized in Table 3. The exclusion of Canadian Arctic and West Greenland catches makes these age compositions comparable with those given in Table 3

of Lett and Benjaminsen (1977). The effect of treating the landsmen's catches of shot and netted seals separately is a change in the age compositions toward higher proportions of younger seals. For example, relative to the analysis of Lett and Benjaminsen (1977),

TABLE 3. Age compositions of harp seal catches in the Front and Gulf area, 1952-80 (summarized from Table 2).

Age	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
0	198,063	197,975	175,034	252,297	341,397	165,438	140,996	238,832	156,168	168,819
1	5,340	20,602	31,645	21,800	12,068	21,656	24,328	21,882	32,554	5,035
2	11,758	6,330	12,587	8,498	4,795	7,982	9,817	8,185	12,672	1,977
3	7,779	5,753	3,949	6,001	3,299	5,330	11,311	5,458	9,520	1,951
4	5,994	3,744	5,625	4,321	2,629	4,275	11,855	4,239	6,539	2,399
5	6,856	4,037	2,934	3,989	2,194	3,586	10,092	3,788	5,561	810
6	11,645	3,223	3,709	3,652	2,127	3,464	6,589	3,741	5,571	1,014
7	8,088	2,825	3,329	3,113	1,909	3,068	6,063	3,232	4,631	1,009
8	7,914	2,882	3,036	3,271	2,041	3,128	5,092	3,247	4,505	617
9	5,754	2,777	2,011	2,598	1,748	2,684	4,813	2,830	3,860	586
10	6,578	2,330	2,908	2,942	1,838	2,990	9,670	3,110	4,404	909
11	5,618	2,851	1,250	2,618	1,587	2,762	5,745	2,695	3,896	542
12	1,785	1,743	2,623	2,035	1,315	2,080	7,088	2,054	3,005	310
13	1,478	1,370	2,533	1,555	998	1,713	4,169	1,653	2,395	313
14	2,182	1,022	1,316	1,163	848	1,316	3,148	1,280	1,784	306
15	4,091	1,823	1,832	2,222	1,331	2,309	8,813	2,347	3,339	154
16	1,421	1,989	2,196	2,080	1,321	2,171	5,846	2,149	3,164	248
17	2,233	1,408	1,017	1,364	870	1,422	2,987	1,422	2,046	189
18	1,798	906	337	739	578	780	560	741	1,084	99
19	984	673	1,121	768	571	826	1,498	819	1,145	120
20	5,391	2,541	831	2,374	1,505	2,418	5,374	2,411	3,568	146
21	873	1,664	307	1,303	739	1,300	2,899	1,299	1,924	—
22	1	937	284	779	459	795	2,426	773	1,155	80
23	435	624	718	616	389	611	1,007	633	916	59
24	1,306	453	142	515	346	535	1,966	526	779	9
25+	1,743	404	1,142	756	508	841	3,634	788	1,165	165
Total	307,108	272,886	264,416	333,369	389,410	245,480	297,786	320,134	277,350	187,866

Age	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	207,088	270,419	266,382	182,758	251,135	277,750	156,458	233,340	217,431	210,579
1	29,503	9,018	5,685	11,710	13,528	14,120	5,747	21,117	8,766	7,692
2	33,876	8,102	5,253	5,382	10,652	6,348	4,194	2,815	7,386	2,568
3	9,411	6,615	5,699	4,621	4,901	2,552	2,800	2,859	2,580	2,092
4	8,724	3,842	6,561	4,901	4,791	2,204	1,653	2,353	2,429	1,055
5	6,173	3,014	4,333	5,968	4,987	3,117	1,471	2,660	2,363	1,047
6	2,677	3,441	6,511	5,537	5,020	3,956	1,504	1,963	1,363	644
7	2,488	3,410	3,375	2,094	4,564	3,422	2,130	2,261	1,326	515
8	2,568	3,360	2,789	969	3,091	2,406	2,231	2,816	1,601	446
9	2,534	3,096	2,635	642	1,630	1,567	1,524	2,056	1,437	672
10	1,083	3,587	4,106	1,231	1,706	1,401	1,529	1,732	1,813	728
11	1,242	3,450	2,142	389	2,224	1,790	1,149	1,532	1,183	464
12	1,872	2,546	2,132	1,644	1,606	1,245	913	1,013	1,129	491
13	966	2,751	1,643	263	1,455	984	854	1,162	830	375
14	1,349	2,770	1,629	1,195	1,631	1,472	1,115	1,183	723	168
15	1,911	2,145	2,491	1,029	1,370	1,487	950	1,229	866	226
16	660	2,625	2,014	546	1,376	965	885	784	937	198
17	1,663	1,794	2,502	310	967	1,230	756	1,265	541	139
18	763	1,176	3,857	671	1,511	1,344	1,100	809	538	151
19	578	924	2,010	715	933	1,385	950	913	549	138
20	1,291	944	62	246	1,000	898	677	757	484	90
21	159	848	1,953	464	724	584	417	548	350	60
22	604	628	987	228	299	426	573	336	263	74
23	29	493	983	20	631	482	299	411	202	46
24	152	412	1,438	29	351	291	219	191	133	9
25+	625	632	2,491	691	1,056	930	598	707	272	298
Total	319,989	342,042	341,663	234,253	323,139	334,356	192,696	288,812	257,495	230,965

TABLE 3. (continued).

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980
0	116,810	98,335	114,825	140,638	132,085	126,982	116,190	132,458	132,421
1	4,100	4,918	10,412	12,776	14,575	7,451	15,853	13,859	14,239
2	2,269	3,918	5,762	6,170	7,084	5,581	10,031	5,899	6,612
3	1,319	2,755	2,137	3,106	3,923	5,131	6,051	2,751	4,404
4	1,276	2,284	1,725	1,661	2,598	3,746	4,438	1,715	2,586
5	601	3,159	1,800	1,574	888	1,906	2,963	1,313	2,002
6	531	1,051	2,671	1,437	593	1,062	1,967	816	1,604
7	377	908	797	1,379	530	727	647	451	1,108
8	309	1,023	914	787	544	455	859	252	793
9	159	636	1,047	573	227	192	337	226	558
10	216	603	706	804	324	219	578	83	270
11	248	725	492	505	315	219	198	88	434
12	251	582	639	509	258	154	206	91	415
13	133	564	641	486	142	186	222	83	300
14	211	415	445	346	179	360	137	152	382
15	172	439	395	251	219	385	205	158	347
16	100	347	427	297	93	166	109	39	322
17	121	211	371	215	105	27	104	60	263
18	139	159	254	214	67	38	138	61	27
19	64	175	198	190	59	12	70	43	98
20	195	180	103	86	64	30	111	24	147
21	108	40	113	105	18	15	91	24	81
22	72	145	140	63	25	20	79	30	73
23	45	18	76	68	41	37	33	12	16
24	33	18	114	71	23	22	21	11	10
25+	24	224	431	52	23	20	85	404	245
Total	129,883	123,832	147,635	174,363	165,002	155,143	161,723	161,103	169,757

the present analysis indicates increases in the catches of age 1-4 seals of 14.1% in 1972, 17.5% in 1973, 2.9% in 1974 and 9.2% in 1975.

#### West Greenland (Subarea 1)

The age compositions of catches of harp seals at West Greenland for 1952-78 (most recent available data) are given in Table 4. They are based on the composite age frequencies developed by Kapel (pers. comm.) for the 1954-62 and 1963-71 periods and annual age samples for 1972-78 (see Appendix Table B).

#### Canadian Arctic (Subarea 0)

The size and age composition of harp seal catches in the Canadian Arctic are poorly documented. Smith and Taylor (1977) estimated the average annual harvest to have been 1,768 seals during 1962-71. The annual catch varied from 1,117 to 2,513 seals during 1974-77 (Sergeant, pers. comm.), the unweighted average of all estimates for 1962-77 being 1,784 seals. Age samples were available for only 4 years (1967, 1968, 1976 and 1977) of the entire period. These samples were combined and the resulting age frequency was applied to the assumed average catch of 1,784 seals to obtain the average age structure of Canadian Arctic catches during 1952-80 (Table 5). In contrast to catches at West Greenland which consisted mainly of young immature seals, the Canadian Arctic catch consisted mainly of mature animals.

#### Discussion

The age compositions of harp seal catches presented here differ in several respects from those produced by Lett and Benjaminsen (1977). A major departure is the way of treating the landmen's catches by applying different age frequencies to separate estimates of the catches of shot and netted seals. This effectively reduces the bias associated with overestimation of the kill of mature seals, particularly in recent years, when only net samples are used to prorate the landmen's catches of both shot and netted animals. Another difference is that age 26 and older animals are included in the age compositions, whereas Lett and Benjaminsen (1977) truncated the age frequencies at 25 years and assumed a constant proportion of older animals in the catches. Furthermore, the data base is expanded to include the best available estimates of harp seal catches at West Greenland.

It is important to note that biases most likely still exist in these data. Recent work by Doubleday and Bowen (MS 1980) indicated that there is substantial error associated with age determination of harp seals in that estimates of age, based on a single examination of the teeth, are unreliable for animals older than 12 years. Furthermore, the absence of age samples of seals shot by landmen during 1952-73 and the small samples used to estimate age compositions of other components of the hunt have led to assumptions which may have introduced bias.



TABLE 4. Estimated age compositions of harp seal catches at West Greenland, 1952-79.

Age	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
0	9,676	9,676	11,160	9,118	6,430	7,565	9,859	5,219	9,428	7,013	4,952	5,803	5,302	5,365
1	2,624	2,624	3,026	2,473	1,743	2,052	2,674	1,416	2,557	1,902	1,343	1,100	1,005	1,018
2	820	820	946	773	545	641	835	442	799	594	420	700	640	648
3	656	656	756	618	436	513	668	354	639	475	335	400	366	370
4	492	492	567	463	327	386	501	265	479	356	252	300	274	278
5	328	328	378	309	218	256	334	177	319	238	166	300	274	278
6	328	328	378	309	218	256	334	177	319	238	166	200	183	185
7	164	164	189	155	109	128	167	88	160	119	84	200	183	185
8	164	164	189	155	109	128	167	88	160	119	84	100	91	92
9	164	164	189	155	109	128	167	88	160	119	84	100	91	92
10	164	164	189	154	109	128	167	88	160	119	84	100	91	92
11+	820	820	946	773	545	641	835	443	799	594	420	700	640	648
Total	16,400	16,400	18,913	15,455	10,898	12,822	16,708	8,845	15,979	11,886	8,394	10,003	9,140	9,251

Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
0	4,078	2,446	4,076	3,702	3,583	3,214	3,392	5,039	4,479	3,780	4,836	7,850	5,500	4,797
1	774	464	773	702	680	609	714	2,016	1,330	1,380	1,716	994	3,500	2,808
2	492	295	492	447	432	388	476	732	560	420	624	399	1,500	1,755
3	281	169	281	255	247	222	238	366	70	120	312	199	750	585
4	211	126	211	191	185	166	298	92	140	60	156	99	250	351
5	211	126	211	191	185	166	119	183	—	—	—	99	250	117
6	140	84	140	128	124	111	119	92	70	—	—	—	250	234
7	140	84	140	128	124	111	119	—	—	60	—	99	—	117
8	70	42	70	64	62	55	60	92	—	—	—	—	125	234
9	70	42	70	64	62	55	—	—	—	60	—	—	—	117
10	70	42	70	64	62	55	—	—	—	60	156	199	375	585
11+	492	295	492	447	432	388	417	550	350	60	—	—	—	—
Total	7,029	4,215	7,026	6,383	6,178	5,540	5,952	9,162	6,999	6,000	7,800	9,938	12,500	11,700

TABLE 5. Average age composition of harp seal catches in the Canadian Arctic, based on samples in 1967, 1969, 1976 and 1977.

Age	Catch	Age	Catch
0	60	14	40
1	117	15	73
2	212	16	34
3	236	17	38
4	160	18	28
5	95	19	30
6	87	20	46
7	93	21	22
8	67	22	18
9	49	23	16
10	79	24	18
11	55	25+	20
12	57		
13	34	Total	1,784

Equal confidence cannot be placed in all parts of the data set. Biological sampling of catches has progressively improved over time, particularly after 1966, and estimates of the actual catches from various components of the hunt have steadily become more accurate. Consequently, the estimated age compositions of catches from 1952 to about 1965 are the least reliable, whereas considerable confidence may be placed on the data from 1974 onwards. The period from 1966 to 1973 may be considered as a period of gradual improvement in the quality of the estimates.

The Canadian Arctic component of the harp seal hunt is still poorly understood, as there is little information on age composition and the level of catches in the area. Also, there are no reliable estimates of the sinking loss of shot seals, although such losses are believed to be as high as 50% of the landed catch in the northern areas. Future research should attempt to fill these gaps in our knowledge of the harp seal hunt.

### Acknowledgements

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APPENDIX TABLE A. (continued).

Year	Sample Source		Age (years)																							Total		
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23		24	25+
1980	Vessels <150	C	382	167	92	46	30	26	16	10	9	4	7	7	5	8	6	5	4	—	2	1	—	—	—	—	—	827
	Landsmen	E	35	33	45	49	46	25	26	23	15	8	6	10	9	8	11	10	9	1	2	8	7	7	1	—	17	411
		G	9	21	57	33	35	35	20	14	6	2	8	3	1	1	1	3	2	—	—	2	—	—	—	—	1	6
	E+G		44	54	102	82	81	60	46	37	21	10	14	13	10	9	12	13	11	1	2	10	7	7	1	1	23	671

<sup>a</sup> The type of sample is defined as follows: A = Canadian shot sample of molting seals; B = Norwegian shot sample of molting seals; C = shot samples from small vessels in White Bay and Notre Dame Bay, Nfld.; D = netted seals from Labrador; E = netted seals from St. Anthony, Nfld.; F = netted seals from La Tabatiere, Que.; G = shot sample from small boats in St. Lawrence River estuary; H = seals captured by hook and line near Magdalen Islands, Gulf of St. Lawrence.

APPENDIX TABLE B. Percentage age composition of harp seal catches at West Greenland, 1954-78.

Year	Age (years)											Total	
	0	1	2	3	4	5	6	7	8	9	10		11+
1954-62 <sup>a</sup>	59	16	5	4	3	2	2	1	1	1	1	5	100
1963-71 <sup>a</sup>	58	11	7	4	3	3	2	2	1	1	1	8	101
1972	57	12	8	4	5	2	2	2	1	—	—	7	100
1973	55	22	8	4	1	2	1	—	1	—	—	6	100
1974	64	19	8	1	2	—	1	—	—	—	—	5	100
1975	63	23	7	2	1	—	—	1	—	1	1	1	100
1976	62	22	8	4	2	—	—	—	—	—	—	2	100
1977	79	10	4	2	1	1	—	1	—	—	—	2	100
1978	44	28	12	6	2	2	2	—	1	—	—	3	100

<sup>a</sup> F. O. Kapel (pers. comm.)

APPENDIX TABLE C. Age samples of harp seal catches in the Canadian Arctic, 1967-77.

Year	Age (years)																									Total	
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		25+
1967 <sup>a</sup>	—	5	11	25	13	9	17	20	14	10	14	9	14	8	10	12	7	7	6	2	5	4	3	2	1	2	230
1969 <sup>a</sup>	—	9	23	11	19	23	12	17	14	9	19	14	11	9	8	17	5	6	5	5	10	3	1	3	6	4	263
1976 <sup>b</sup>	24	25	46	61	28	7	10	6	3	4	4	1	1	—	—	6	3	4	—	3	4	—	1	1	—	—	242
1977 <sup>b</sup>	6	19	25	20	19	8	4	3	2	1	2	3	3	—	2	1	2	2	3	5	4	4	4	2	2	4	149
Total	30	58	105	117	79	47	43	46	33	24	39	27	28	17	20	36	17	19	14	15	23	11	9	8	9	10	884

<sup>a</sup> D. E. Sergeant (pers. comm.)

<sup>b</sup> R. E.A. Stewart (pers. comm.)

