1950

International Commission for the Northwest Atlantic Fisheries

1970

RESTRICTED

Serial No.2400
(D.c.11)

ICNAF Res.Doc.70/61

ANNUAL MEETING - JUNE 1970

RESULTS OF RESEARCH ON HARP SEALS IN 1969-70

by

D. E. Sergeant
Fisheries Research Board of Canada
Arctic Biological Station
Ste. Anne de Bellevue, Que.

CONTENTS

1. Introduction

The important questions in present management of the herds of harp seals in the western Atlantic are: how much mixing is there between the populations whelping in the Gulf (ICNAF Subarea 4) and on the Front (Subareas 2 and 3), and what is the total sustainable yield of young?

2. Mixing of stocks

This problem remains intractable because of the difficulty of obtaining direct tagging results over a number of years. Almost all seal tags so far developed have dropped off after three years, before maturity is reached at 4 to 5 years. Tagging of adult females in adequate numbers has proved infeasible. It will probably be necessary to brand moulted pups, which can be done in years when limited catches of young are taken early in the season; and to develop very intensive advertising to offset the lack of information on a brand as compared with a tag. However the results will be slow to accrue.

In the absence of direct information, indirect clues must be sought. These are discussed below.

The null hypothesis requires that the animals whelping in the Gulf and on the Front are completely mixed each year. However, in view of the highly developed migratory abilities of harp seals, it seems likely that the animals have some ability to "home." The converse hypothesis, that all animals return annually to the same whelping area, presumably the area of birth, seems improbable and there is plenty of evidence from tagging that immatures at least do not do this. Therefore it seems best to assume that there is a degree of mixing, though this cannot yet be quantified.

a. Evidence from whelping

In 1965 I wrote (Sergeant, 1965) "The segregation of Gulf and Front herds as breeding stocks is based on the following evidence: (1) About the same relative catch is taken out of the two areas annually, so that the relative stock sizes appear to be constant, at about 2:1 between Front and Gulf herds. (2) The seals whelp in the Gulf even in exceptional years when pack ice is virtually non-existent, using ice drifted against the shore... (3) Breeding in the Gulf is on average some 3 days earlier than on the Front." Moreover tagging, carried out largely on the Front up to 1965, had shown no movement of immatures into the Gulf.

Statement (1) still appears to be true. From an aerial survey of both areas carried out in March 1970, I estimate the relative numbers of whelping seals to have been about 5:3 between Front and Gulf. This evidence, however, could equally well support either total annual mixing or totally separate stocks. Statements (2) and (3) need modifying in the light of recent observations.

In 1969, it was apparent by January that very little ice would form in the Gulf by the time of seal whelping in late February. Catch figures and survey flights in March, 1969, showed that probably no more than 50,000 animals had whelped in the southern Gulf, and there was no ice elsewhere in the Gulf. Moreover, careful enquiry showed no evidence of mass mortality of pups on beaches in the southern Gulf of St. Lawrence. Delayed pupping occurred, but this has occurred in several recent years. I conclude that probably all other whelping animals, some 50,000 to 100,000 or more, moved to the Front, probably along the southern coast of Labrador where scattered whelping was reported, and possibly to the ice around George's Island, Hamilton Inlet, where the main mass of Front animals whelped.

It was also evident, from collections made in January, 1969, on the Quebec North Shore, that southward migrating animals had entered the Gulf in usual numbers. Catch results in January-March in the lower St. Lawrence River, around Tadoussac, were reported even better than usual because the absence of ice allowed more hunting from boats.

I therefore suppose that animals entering the Gulf in January normally whelp in the Gulf. Probably, the majority choose the nearest large fields of good ice in the Magdalen Shallows, while other animals move north and whelp in the northern Gulf ("Meccatina patch"); while if either or both areas have poor ice, the seals pass through the Strait of Belle Isle and whelp off the Labrador coast. It is only necessary to assume that the females seek ice some days before the normal whelping date, a behavioural pattern which has been observed.

If such a distribution of whelping ice can occur, then it is necessary to ignore the division of catch into two areas, and to regard the total catch of young in the northwest Atlantic as the important figure.

However, the attempt of many animals to whelp in 1969 in the normal region of the southern Gulf shows some degree of homing. The normal patterns of ice and whelping apparently occurred for 15 consecutive years, 1954 to 1968, with abnormal years in 1951, 1953, and 1969. For the majority of years having stable spring ice, the number of animals in each area may well have been reasonably constant. Unfortunately there is no information on the constancy of entry of individual animals to the Gulf in January.

Whelping in the Gulf in past years was apparently earlier than on the Front since starting dates of commercial sealing were based on average whelping dates. During the 1960's late whelping in the Gulf, observed up to March 12-15, could have been due to aircraft disturbance which ended in 1970. However, in 1970 whelping occurred in the Gulf between about February 27 and March 17. Of three groups, one whelped early, one at intermediate dates and one, probably the largest group, whelped between about March 5 and 17. Most animals on the Front had whelped by March 14. Therefore, whatever the significance of late whelping in the Gulf, a mean difference in whelping dates does not now exist between Gulf and Front animals.

b. Evidence from age composition

Assuming a rather constant natural mortality of younger age groups, a closer inverse relationship between survival in the Gulf and catch in the Gulf would support the idea of homing; a closer inverse relationship between survival in the Gulf and total catch (Gulf + Front) would support the idea of extensive mixing. Table 1 shows catch figures for young harp seals by area from 1950 to 1969; Table 2 shows the tested relationships, which require a lapse of 4 years before the year-class is fully shown in the net fisheries of the Gulf (Figure 1b). The results are inconclusive. There is actually a higher inverse relation between total catch and Gulf survival than between Gulf catch and Gulf survival, but the difference is probably not significant. In most years, the catches (Table 1) in the two areas are themselves positively correlated. For years when they are not, in 1959 and 1960 a relatively high Gulf catch and low Front catch led to excellent Gulf survival, which argues for mixing. In 1965, under the same conditions, Gulf survival was not good, which argues either for lack of mixing, or a higher natural mortality in 1965 of Front animals. (This point is brought in because extensive but unquantifiable mortality of Front young due to ice rafting was observed in 1965.) In 1957, with low Gulf and high Front catches, survival in the Gulf was the highest recorded, which argues for separateness of stocks. The limitation of this data is the delay of 4 years between catch and survival information. Probably the most that can be obtained from it is that the degree of mixing seems to be variable from year to year.

c. Evidence from maturity status

I have claimed (Sergeant, 1966) that samples of Gulf and Front females showed differing median ages at sexual maturity. In fact, the cited samples show a decline in median age from about 5 1/2 to 4 1/2 years in each region (Table 3). This evidence is therefore in favour of mixing.

Numerous later samples have been taken from the Gulf (Sergeant, MS, 1969) which show annual variations about a median age at sexual maturity of 4.8 years between 1965 and 1969 (Table 4). Samples from the Front in this time period are not adequate for close comparison, but small samples taken at the Front by Norway in 1964 and 1967 (T. Øritsland, unpublished data) and by Canada in 1968 (Sergeant, MS, 1969) suggest a median age close to 5 years, which is therefore not significantly different from the Gulf. The question cannot be settled without larger samples from the Front.

At this point an error in Sergeant (MS, 1969, Appendix Table p. 18) needs to be corrected.

In a sample from moulting animals in the Gulf taken in April, 1966, maturity was achieved in March, 1966. However in netted samples taken in January, 1966, maturity was achieved in April, 1965. The maturity status of the April 1966 sample should have been compared with that taken in January 1967. When this is done, the agreement is improved, maturity in each case having been achieved at 4.7 years (Table 4). Similarly, the single available Front sample of moulters (Sergeant, MS, 1969, Table 2) taken in April 1968 should be compared with the Gulf sample taken in January 1969. Agreement is good, with maturity in the Front sample at about 5 years, in the Gulf at 5.0 years (Table 4).

Therefore available data on median age at maturity do not invalidate the hypothesis that the stocks are mixed. In summary all that can be said is that median age at maturity declined from the early 1950's to the early 1960's from about 5 1/2 to 4 1/2 years, and may have risen slightly thereafter to about 5 years again.

In 1969, I showed (Sergeant, MS, 1969, Fig. 7) that median age at female sexual maturity in the Gulf varied inversely with the previous catch of young of the same year-class. Figure 2 of the present document shows that this inverse correlation is higher with Gulf catch of young than with total catch of young for the maturation years of 1952 and 1963 to 1968. (Correlation coefficients: for young caught in the Gulf, -0.94; for young caught in Gulf and on Front, -0.61.) If median age at sexual maturity varies inversely with density of the young in the first spring of life, before they leave the Gulf, then the results suggest constancy of return to the Gulf during the period of sampling up to and including 1967. It will be interesting to see whether the divergence shown in 1968 continues.

Another question we may ask is: do variations in density affect survival, as distinct from reproductive rate? Apparently not. Table 5 shows that for two years when catches of young seals in the Gulf were at a ratio of 3:2, the survival rates to one year of young seals, tagged with the same disc tags, were almost the same.

d. Evidence from tagging

Table 6 shows recaptures by Subarea, after one year, of seals tagged as young in the Gulf (Subarea 4). There is a marked cross-over of tagged seals to Subareas 2 and 3 in the first spring, even when the returns are weighted for much greater catches in these subareas, especially by ships in spring. Exact weighting is not easy since, for instance, the landsmen's catches in the two areas are of different types.

What do these cross-overs mean? While we have been unable so far to tag large numbers of young on the Front and ensure their good survival, nevertheless no Front tags have yet been recovered in the Gulf. Apparently, the movement is going in one direction only, from Gulf to Front.

Two other observations are important. First, on the southward migration, the animals first enter the Gulf of St. Lawrence, being caught on the Quebec North Shore in late December (Christmas to New Year), but not arriving at St. Anthony, Newfoundland, until about January 15, even though the distance is less.

Second, the age composition of the southward migrants at the Quebec North Shore localities is younger than on the northeast Newfoundland coast (Fig. 1b, 3a-c).

These observations are explained if the animals keep close to the coast, when they will enter the Gulf first. The younger adult animals, on balance, must lead the migration, so explaining the younger age at the Quebec North Shore localities. As ice forms off the southern Labrador coast, and blocks the Strait of Belle Isle, the later migrating, mostly older animals are forced to pass east of Belle Isle and arrive at the coast in White Bay. We do not have any evidence that they normally pass beyond Fogo Island, until ice drives the immatures south to its southern fringes in April.

Last of all come the great majority of the non-breeding immatures which, as we know from tag recoveries and the structure of age samples, remain very late in the arctic. When these come south between late January and March the Strait of Belle Isle is blocked, so that they remain east of Newfoundland. That is why the majority of tags from one-, two- and three-year-olds--the only tags we recover--are taken from Subarea 3. Only the relatively few early-migrating immatures can have entered the Gulf, unless they migrate right round the island of Newfoundland.

We must now ask if these immatures, when they reach maturity, reenter their ancestral home in the Gulf. We have no direct evidence, but clearly if they did not, the Gulf stock would be impoverished and would die out. We must therefore assume that as they grow older and follow the main stream of migration, they reenter the Gulf.

While the animals taken at the Gulf net fisheries are mostly the younger adults, the older adults must also enter the Gulf, presumably at a later date, when ice has started to form along the shore and the nets have been lifted. This is shown by a comparison of frequencies of pelage patterns among female harp seals (Table 7). In January 1965, at the net fisheries at La Tabatière, Mr. B. Beck recorded pelage patterns of animals sampled. Taking animals 5 years and older to be adults, the percentage of spotted females, which are the younger animals, in the net fishery was 50%. However, among whelping females in the southern Gulf in March 1964, Dr. A. W. Mansfield with a tagging party recorded only 7% of spotted females. This is similar to a figure of 13% spotted females among whelping patches on the Front in 1962 given by Popov and Timoshenko (1965).

There are difficulties in the way of this hypothesis. If the younger mature animals lead the migration, and enter first the Gulf, and if these animals stay to whelp in the region which they enter, then the age-composition of Gulf whelpers will be younger than that of Front whelpers, which is not true judging from the data in Table 7. Therefore there must be considerable mixing of animals into and out of the Gulf between entry in January and whelping in March.

3. Estimate of sustainable yield

In the absence of reliable total counts of young, the best data on present production come from age-frequencies. There now exist long series of age samples drawn from two sources: migrant Gulf entrants, and moulting animals usually taken at the Front (Fig. 4). The latter samples come from the last ten years, in order of appearance from Soviet, Canadian, and Norwegian sampling. They seem to show good agreement in age determination, based on similarity of age-class representation in comparable samples. We are interested in ages of 1 to 8 years. Recently, samples from winter catches from the Gulf North Shore (shot samples), the Newfoundland area and the Canadian arctic have added to the data (Fig. 1, 3).

The Gulf samples have been dealt with before (Sergeant, MS, 1967) where I concluded that Gulf catches of 90,000 young or less led to good survival. However, this conclusion was based on the assumption that the Gulf stock is separate.

If it is assumed that full mixing of stocks occurs, then the data on catch (Table 1) and Gulf survival (Table 2) can be used to calculate the total sustainable yield of young. Good survival (over 15.0% of 4-year-olds in netted Gulf samples) occurred in 5/6 samples after total catches of 175,000 young or less. Fair and poor survival show less clear relationship to catch, but always occurred after catches of 183,000 young or more. Fair survival (10.1 - 13.5% of 4-year-olds) occurred after catches of 183,000 to 266,000 young; poor survival (6.6 - 10.0%) after catches of 198,000 to 341,000 young.

In summary, the netted Gulf age samples can as well be used to suggest a sustainable yield of about 175,000 young seals from both areas, as a yield of 90,000 young seals from the Gulf, assuming in the first case full mixing of the two stocks, and in the second, no mixing.

The Front samples (Fig. 4) are of very different sizes and more weight should be attached to the larger samples among them. Weighting should also act against ages 1 and 2 years in case of doubt, because these age groups are strongly selected from among early-season moulting catches. Therefore one method of analysis is to use a single large sample (e.g. 1968 in Fig. 4) to assess the survival of each year-class; the other, adopted here, to sum assessments of survival of the same year-class through all available samples, weighting against the smaller samples if there is doubt. The results are shown in Table 8.

Assuming full mixing of subpopulations, survival has been consistently good after combined catches of young harp seals of 156,000 in 1960 and 1968; nearly always good after a catch of 169,000 in 1961; consistently fair after a catch of 183,000 in 1965. It was usually poor after a catch of 207,000 in 1962, usually fair after a catch of 239,000 in 1959, and fair to poor after a catch of 266,000 in 1964. Survival was consistently poor after catches of 252,000 in 1966, and 270,000 in 1963. Therefore, based on age samples from the Front, at present a conservative estimate of sustainable yield would be 156,000, a median estimate 180,000, and a liberal one 239,000. An attempt to obtain an absolute figure of production follows.

4. Estimate of production

Two sets of three-year series of data from the Front come from the shore fishery at St. Anthony, and from moulters, in the years 1967, 1968, and 1969 (Fig. 3). (Addition of Norwegian data would improve the sample of moulters in 1969.) These data allow a quantification of production. The analysis is shown in Tables 9 and 10.

In Table 9, the ratios between catch in different years are calculated for Front and total young, as well as ratios of their survival, based on the strength of the one-year-old age-class in each sample. These calculations are made only within samples of the same type, where the effect of selectivity can be ignored. (There is clearly selectivity either in the winter samples or among moulters, because of the very different ratios of one-year-old to total seals in the same year.) Since the catches of young in 1966 and 1967 were almost identical the ratios are calculated between the mean of 1966 and 1967, and 1968.

In Table 10, production is calculated from this information. If for the first year, catch = x, then survival of the same year-class = 1-x. For the second year catch is y and survival, 1-y. But from Table 9, we know the ratio x/y and 1-x/1-y. Hence values of x and y can be calculated. Thus, for Front production and St. Anthony survival, comparing 1966-67 as x and 1968 as y, x = 1.84y, and 1-y = 8.76 (1-x), hence x = 0.944 and y = 0.5133. Production is then calculated from the catch of either year, e.g. it is 98,000/0.5133 or 192,714.

The results agree within small limits to suggest a Front production of about 200,000. This seems realistic since no recent catches there have exceeded 200,000 young.

The estimate of total production by this method is about 300,000, which gives an estimate of Gulf production of 100,000 young. Insofar as Gulf animals are not represented in sampling at St. Anthony and among Front moulters, this is presumably an underestimate.

A similar operation cannot be done for the Gulf where as yet only one year's sample of shot animals has been analysed (Fig. 1c), but in future such a calculation will be possible. Note that in 1969 the percentage of one-year-old seals was high in samples from both areas (Tables 9 and 11), but since 1968 catches were equally low in both areas no light is thrown on mixing from this data.

5. Summary

The evidence on mixing of Gulf and Front stocks of harp seals is equivocal, and the degree of mixing cannot yet be quantified. Possibly the degree of mixing varies from year to year.

Considering the catch of young harp seals in both areas and assuming full mixing of stocks, catches of 175,000 young seals or less are almost invariably followed by good survival of the same year-class in subsequent years, catches of 180,000 to 200,000 young are usually followed by fair survival, and catches exceeding 200,000 young are usually followed by poor survival. Consequently an estimate of sustainable yield is about 175,000 young seals from both areas, Gulf and Front.

An estimate of annual production of young from age samples, by comparison of survival rates from year to year, is 200,000 for the Front and 300,000 for both areas.

6. References

Khuzin, R. Sh. 1963. Materialy po biologii i promysly grenlandskogo tyulenya (Pagophilus groenlandicus Erxl. 1777) u Nyufaundlenda. Trudy PINRO 15: 235-249.

Øritsland, T. 1969. Additional results of Norwegian research on seals, 1964, 1967, 1968 and 1969. ICNAF Doc. 69/28, 10 p.

Popov, L. A., and Ju. K. Timoshenko. 1965. Nekotorye dannye o grenlandskom tyulenye Nyufaundlenskogo stada. (Some data on harp seals of the Newfoundland stock.) In: Morskie Mlekopitayushchie, Moskva, p. 158-170.

Sergeant, D. E. 1965. Migrations of harp seals Pagophilus groenlandicus (Erxleben) in the Northwest Atlantic. J. Fish. Res. Bd. Canada 22(2): 433-464.

1966. Reproductive rates of harp seals, Pagophilus groenlandicus (Erxleben). J. Fish. Res. Bd. Canada 23(5): 757-766.

MS. 1967. Canadian research on harp seals in 1967, with further results from 1966 and previous years. ICNAF Serial No. 1952, Hamburg 12 Oct. 1967, 22 p.

MS. 1969. On the population dynamics and size of stocks of harp seals in the Northwest Atlantic. ICNAF Doc. 69/31, 25 p.

Table 1. Catches of young harp seals $X10^{-3}$.

Year	Gulf	Front	Total
1950	31	195	226
1951	90	229	319
1952	63	135	198
1953	32	166	198
1954	74	101	175
1955	94	158	252
1956	93	248	341
1957	74	91	165
1958	90	51	141
1959	62	177	239
1960	85	71	156
1961	41	128	169
1962	89	118	207
1963	110	160	270
1964	84	182	266
1965	90	93	183
1966	84	168	252
1967	92	188	280
1968	57	99	156
1969	33	187	220

Table 2. Relationship between survival of year-classes, after 4 years, in netted samples entering the Gulf of St. Lawrence, and catch of young (data from Table 1). The expected inverse relationship is indicated by a ✓.

				Relationship with catch of young	
Year-class	Sample size	Survival as % sample	Index (1960=100)	Gulf with Gulf	Gulf with Total
1950	345	16.5	100	✓	✓
1951	507	8.1	49	✓	✓
1952	673	8.2	50	X	X
1953	---	---	---	---	---
1954	624	15.4	93	✓	✓
1955	265	6.8	41	✓	✓
1956	673	10.0	61	✓	✓
1957	619	20.0	121	✓	✓
1958	621	15.3	93	X	✓
1959	672	13.4	77	X	✓
1960	381	16.5	100	X	✓
1961	459	15.7	93	✓	✓
1962	347	12.7	76	✓	✓
1963	546	6.6	41	✓	✓
1964	479	11.2	69	✓	✓
1965	645	10.7	64	✓	X
				11	13

Table 3. Maturity status Gulf and Front, 1951 to 1954; Gulf, 1965 and Front, 1961-1962.

	Front 1951-1954 April			Gulf 1951-1954 January		
	Number		%	Number		%
Age (yrs)	Total	Mature	Mature	Total	Mature	Mature
3	18	-	0	16	-	0
4	16	1	6.25	13	2	15.4
5	24	8	33.3	5	2	40.0
6	15	12	80.0	7	5	71.4
7	11	10	90.9	21	18	85.7
8	8	8	100.0	8	8	100.0
	Front 1961-1962			Gulf 1965		
3	8	1	12.0	25	2	8.0
4	14	7	50.0	34	4	11.8
5	10	6	60.0	33	21	63.7
6	9	8	88.8	34	27	79.4
7	11	11	100.0	32	31	96.9
8	No Data		-	14	14	100.0

Table 4. Median age of maturation of female harp seals compared (in the Gulf) with catch of young of the year-class taken four years before year of maturation.

Year of maturation	Sample size (3-8 yrs)	Area	Median age	Catch of young $X10^{-3}$ Gulf	Catch of young $X10^{-3}$ Total
1951-54	70	G	5.3		
1951-54	92	F	5.4		
1961-62	52	F	4-5		
1963	35	G	ca 5	33	220
1964	172	G	4.7	85	178
1965	57	G	5.4	41	174
1966	191	G(2)	4.7	89	252
1967	113	G	4.3	110	307
1968	(137	G	5.0)	84	262
	(41	F	ca 5)		

Table 5. Survival rate at one year of age from tag returns.

Year of tagging	Gulf catch of young $X10^{-3}$	Number tagged	Less tags recovered at quota fishery	Surviving tags	Recovered first spring	Corrected for fishing effort(1)	Percent recovery
1966	84	1345	----	1345	29	35	2.62
1968	57	2219	1055	1164	28	28	2.41

(1)From data in Table 6.

Table 6. Recoveries, after one year, of disc tags from young harp seals tagged in the Gulf of St. Lawrence (Subarea 4) in 1966 and 1968.

Year	Recovered in ICNAF Subarea	Recoveries by			Catches of adult and immature harp seals by		
		Landsmen	Ships	Both	Landsmen	Ships	Both
1967	4	5	6	11	2,090	2,111	4,201
	3	12	6	18	5,501	36,341	41,842
1969	4	3	-	3	5,269	-	5,269
	3	6	19	25	6,046	44,360	50,406
Both	4	8	6	14	7,359	2,111	9,470
	3	18	25	43	11,547	80,701	92,248
		26	31	57	18,906	82,812	101,718

Table 7. Distribution of pelage pattern in adult female harp seals:
a--Gulf entrants, January 1965, females 5 years and up;
b--whelping near Magdalen Islands, March 1964;
c--whelping off Labrador coast, March 1962, from Popov and Timoshenko (1965).

	Spotted		Faint saddle		Dark saddle		
	Number	%	Number	%	Number	%	N
a	81	50	38	24	42	26	161
b	56	7	91	12	632	81	779
c	?	13	?	23	?	64	?

Table 8. Analysis of survival of recent age-classes on the Front.

Year-class	Assessments of survival			Summation	Catch $X10^{-3}$ young
	Good	Fair	Poor		
1959	2	5	1	Fair in 5/8	239
1960	8			Good in 8/8	156
1961	5	1		Good in 5/6	169
1962		2	3	Poor in 3/5	207
1963			4	Poor in 4/4	270
1964		2	2	Fair-poor in 4/4	266
1965		3		Fair in 3/3	183
1966			3	Poor in 3/3	252
1967			3	Poor in 3/3	280
1968	3			Good in 3/3	156

Table 9. Survival at one year of age expressed as percentage of total sample for samples from (a) St. Anthony and (b) the Front icefields.

	Catch $X10^{-3}$		Survival in sample from					
			St. Anthony			Front Icefields		
Year-class	Front	total	1 yr	total	%	1 yr	total	%
1966	180	264	18	315	5.7	77	405	19.0
1967	184	276	7	201	3.5	84	576	14.5
1968	98	155	87	205	42.4	62	107	57.9
Ratio: $\frac{1966\text{-}67}{1968}$	1.84	1.74			$\frac{1}{8.76}$			$\frac{1}{3.54}$

Table 10. Calculation from Front and total production using ratios of catch and survival for 1966-67/1968.

	Front				Total			
	St. Anthony		Front Icefields		St. Anthony		Front Icefields	
	1966 -67	1968	1966 -67	1968	1966 -67	1968	1966 -67	1968
Catch	94.44	51.33	84.77	46.10	94.81	54.44	85.66	49.24
Survival	5.56	48.67	15.23	53.90	5.19	45.46	14.34	50.76
Production	192,714		215,767		284,780		315,166	

Table 11. Age composition of North Shore sample, January-March, 1969. Animals were shot in the water.

		Number		Percent
Year-class	Gulf catch $X10^{-3}$	1 yr	Total	1 yr
1968	57	37	153	24.2

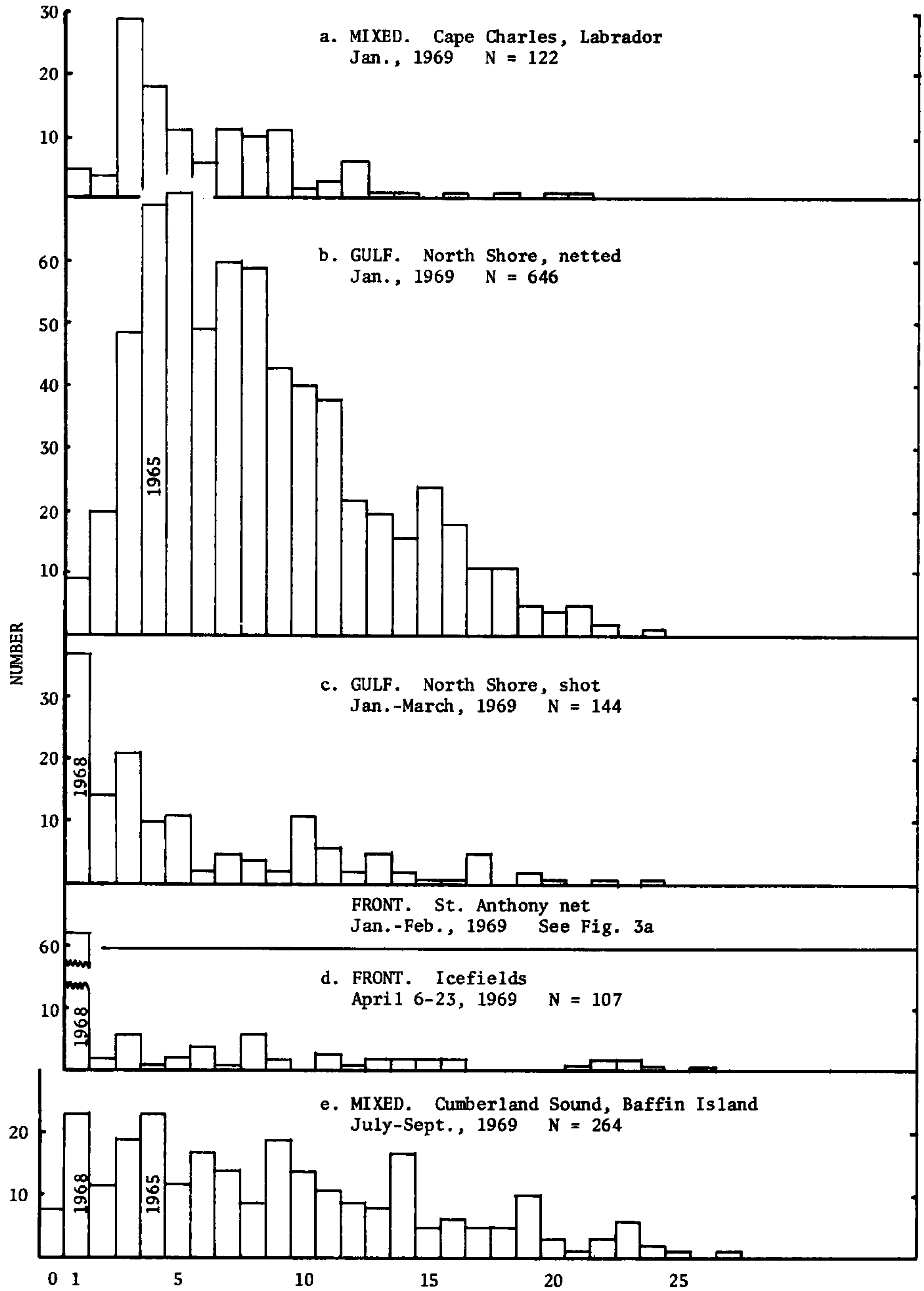

Figure 1. Canadian age samples of harp seals in 1969.

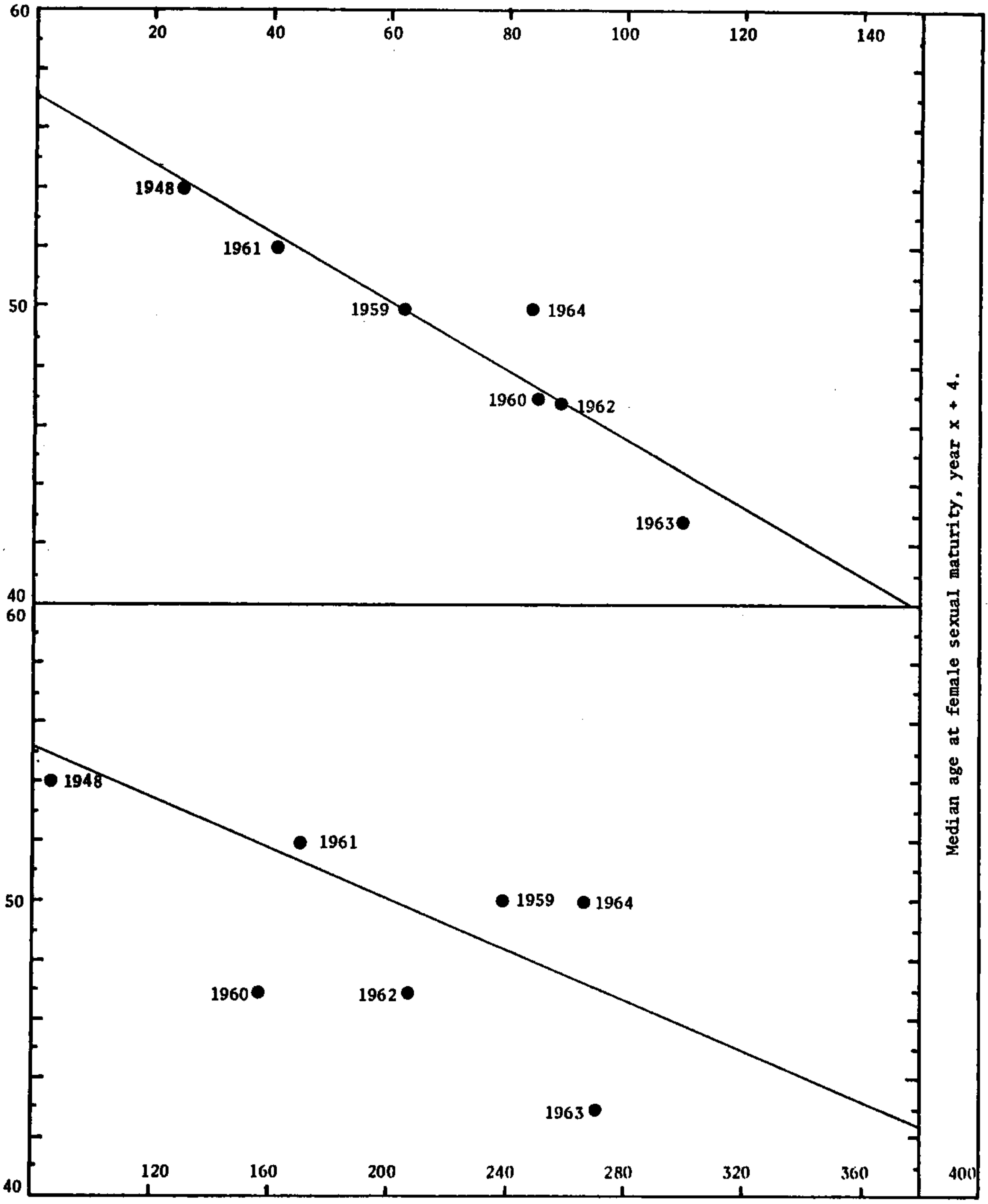

Fig.2. Correlation of Gulf median age at female maturity with Gulf catch of young (above) and total catch of young (below) four years previously.

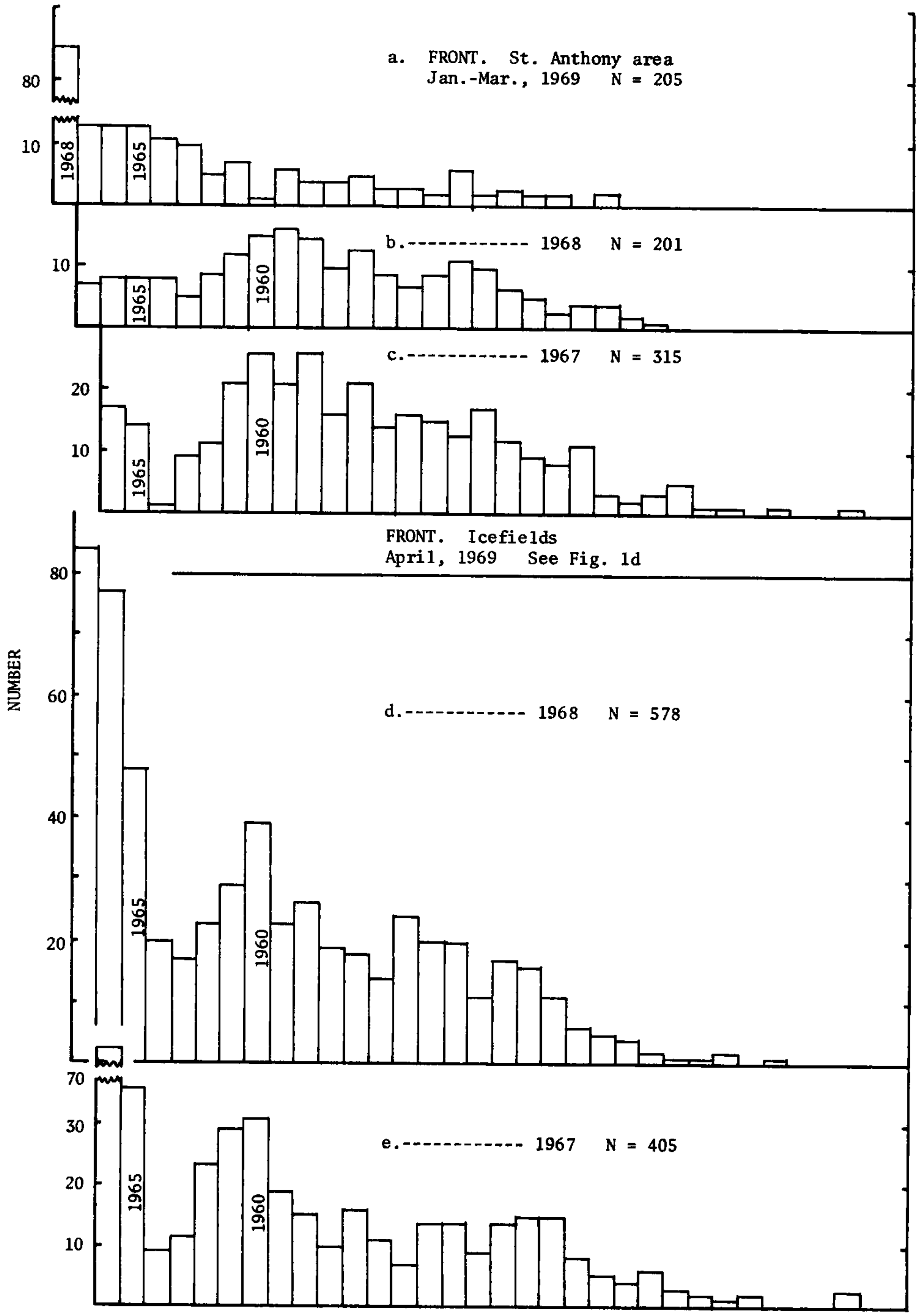

Figure 3. Age samples for three consecutive years from shore fisheries from St. Anthony, Newfoundland (above) and Front moulting seals (below).

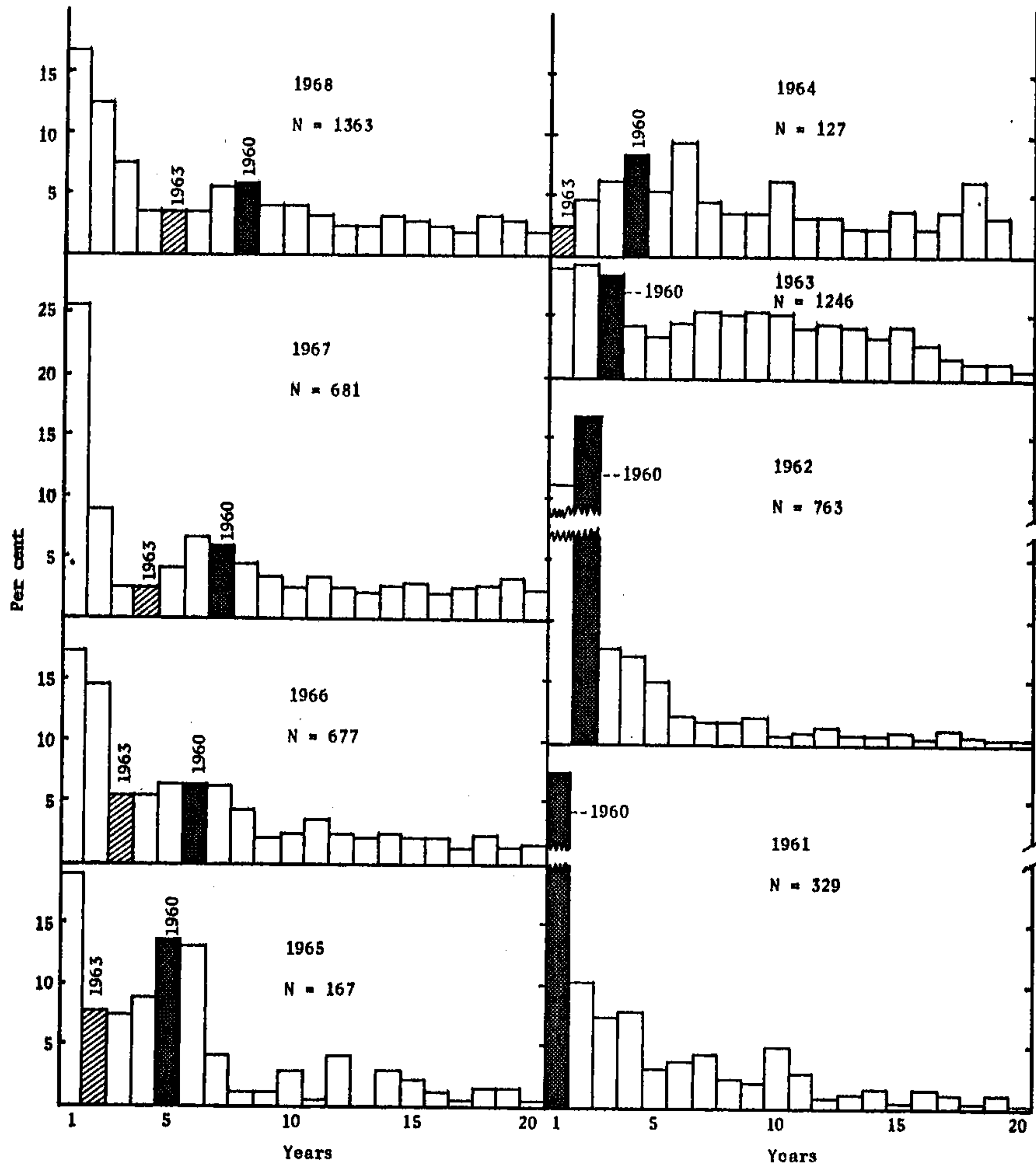

Fig. 4. Age samples of moulting seals from the Front. Original data plus age frequencies from Khuzin (1963), Øritsland (MS,1969) and Popov and Timoshenko (1965).