

## Analysis of the Current Status of Fortune Bay Herring Stock

by

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### INTRODUCTION

The Fortune Bay herring stock has been under management control since 1973. During this period catches have varied from 3,254 mt in 1973 to 462 mt in 1976. This compares to peak landings of 15,000 mt taken in both 1968 and 1971. A TAC of 1000 mt was set for both 1978 and 1979 with the TAC being taken in 1978 and slightly exceeded in 1979 with a provisional catch of 1,170 mt (Table 1).

Prior to 1976 the mobile purse seine fleet was the dominant component in the Fortune Bay herring fishery. However, with reductions in the TAC level the proportion allocated to purse seiners declined such that since 1976 bar seines have been the major contributor to the catch accounting for 70% of the 1979 catch.

Tagging Results and Stock Definition: The Fortune Bay management unit (Newfoundland Statistical Area I - Fig. 1) is defined as the area from Point May to Pass Island. This unit was originally defined based on meristic, morphometric, parasite (Parsons and Hodder 1971, Parsons 1973) and internal tagging data. Recent external tagging experiments in Fortune Bay (Table 2) have shown no movement to adjacent bays while experiments conducted in the St. Mary's-Placentia area (Winters and Moores this meeting) show movement to Fortune Bay from only one experiment. It, therefore, appears that the definition of the stock area is reasonable.

Catch Composition: This stock is composed primarily of spring spawners with autumn spawners representing only 2% of the catch. Since 1977 the 1974 year-class has been the major contributor to the fishery and represented 87% of the catch of spring spawners in 1979 (Fig. 2). Unlike other Newfoundland areas the 1968 year-class has been of little significance in Fortune Bay in recent years primarily due to its heavy exploitation as 2- and 3-year olds. Among the fall spawning component the 1973 year-class is dominant representing 49% of the 1979 catch of that component.

Assessment Parameters: The analysis was performed for spring spawners only. Partial recruit rates and average weights remained unchanged from 1978 (Table 3). Cohort analysis was performed at a range of  $F_T$  values from .05 to .40 with M assumed to be 0.20.

Selection of Terminal F: Due to a paucity of independent data regarding stock abundance in Fortune Bay for recent years the determination of a terminal F value for 1979 was difficult. Four approaches were employed as follows:

(1) Effort vs F: Effort data were available for the purse seine fleet for the period 1967-73 (Table 4). Taking into account the large contribution of young age-groups to the fishery a weighted F value was calculated for each year. The best correlation between F and effort (with 1979 as the terminal year) was achieved at  $F_T = 0.05$  ( $R = 0.96$ ) (Fig. 3). While this gives  $F_{5+}$  values close to the  $F_T$  values used in 1977 (Winters and Moores 1977) and 1978 (Winters and Moores 1978), the resultant size of the 1974 year-class is larger than the strong 1968 year-class. This may imply that the 1974 year-class because of its dominance in the catch composition in 1979 has a much higher selection factor than the older age-groups.

(2) Strength of 1974 year-class at level assumed in 1977 and 1978: In 1977 the strength of the 1974 year-class at age 2 was estimated, based on historical partial recruit rates, at  $44.3 \times 10^{-6}$  individuals (Winters and Moores 1977) and at  $38.2 \times 10^{-6}$  individuals in 1978 (Winters and Moores 1978) for an average of  $41.3 \times 10^{-6}$  individuals. This level is approximated by a run with  $F_T = 0.25$  in 1979.

(3) Estimation of strength of 1974 year-class from regression: If it is assumed that general environmental conditions have a major influence on determining year-class strength (Moores and Winters 1978) estimates of year-class size can be made from known levels in adjacent stocks. Using year-class strengths at age 2 from Placentia-St. Mary's Bay (Winters and Moores 1979) regression analysis was performed for the year-classes 1966-73 ( $R = .98$ ) (Fig. 4). A value for the 1974 year-class in Fortune Bay was predicted to be  $29.8 \times 10^{-6}$  individuals. This value was brought forward to age 5 in 1979 and was used to generate a 5+ population structure in 1979 based on 5+ catch composition with a resultant  $F_{5+}$  value of .40 in 1979.

(4) Effort vs F 1966-73: Due to a lack of effort data since 1973 the use of F on effort (Method 1) to establish  $F_T$  in 1979 is tenuous. A series of cohort runs were performed for the period 1966-73 using partial recruit rates for 1973 calculated by comparing numbers-at-age in the purse seine catch to numbers-at-age in the total catch. The best correlation of F on effort was achieved at a terminal F in 1973 of .50. This age structure was then projected to 1979. An estimate of the 1974 year-class in 1979 was then derived utilizing the ratio of 11+ numbers in the population to the 11+ numbers in the catch assuming a constant selectivity pattern for ages 5+.

This gave an estimate of the 1974 year-class numbers-at-age 5 of  $89.8 \times 10^{-6}$ . This corresponds roughly to the estimate from the 1966-79 cohort runs at  $F_T = 0.05$ .

Results of Assessment and Catch Projection: The analyses performed do not provide any definite level of terminal  $F$  for 1979. Although perhaps a greater degree of confidence can be placed in the estimate of the 1974 year-class from relative comparison with the St. Mary's-Placentia Bay stock. Nevertheless, catch projections were performed for each option of  $F_T$  in 1979 at a  $F_{0.1}$  of 0.30 (Winters and Moores 1977).

The levels of 1974 year-class strength at age 2 and the 1980 projected catches for each level of  $F_T$  in 1979 (.05-.40) are shown in Fig. 5 and Fig. 6, respectively.

### CONCLUSIONS

The stock situation in Fortune Bay at present is very unclear and will probably remain so until independent means of estimating either stock size or year-class strength are devised. The 1974 year-class is the most significant factor in the stock and the 1980 TAC will depend largely upon the size agreed to for this year-class. The 1974 year-class in all other areas, except the Gulf of St. Lawrence, does not appear to be exceedingly large and would suggest that it should be of only moderate size in Fortune Bay.

### ACKNOWLEDGMENTS

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## REFERENCES

- Moores, J.A. and G.H. Winters. 1978. Growth patterns in Newfoundland herring stock. CAFSAC Res. Doc. 78/43.
- Parsons, L.S. 1973. Meristic characteristics of Atlantic herring (Clupea harengus harengus L.) stocks in Newfoundland and adjacent waters. ICNAF Res. Bull. 10:37-52.
- Parsons, L.S. and V. Hodder. 1971. Variations in the incidence of larval nematodes in herring from Canadian Atlantic waters. ICNAF Res. Bull. 8: 5-14.
- Winters, G.H. and J.A. Moores. 1977. Analysis of stock size and yield of Fortune Bay herring. CAFSAC Res. Doc. 77/29.
1978. Prognosis of yield and abundance of southeast Newfoundland herring for 1979. CAFSAC Res. Doc. 78/34.

Table 1. Fortune Bay herring landings (mt) by gear 1976-79.

Year	Gear				Total
	Purse seine	Gillnet	Bar seine	Trap	
1976	109	43	310	-	462
1977	188	22	364	5	579
1978	105	42	853	-	1000
1979*	286	73	814	1	1174

\* provisional figures to June

Table 2. Results of Fortune Bay tagging experiments.

Area	Recaps.	Total tagged	Yr. recap.	I
(I) Bay de l'East May 76	2	339	76	1
			77	1
(I) Stone's Cove April 77	18	1000	77	13
			78	5
(I) Dog Cove May 77	15	4000	77	8
			78	6
			79	1
(G) SMB April 74	109	11000	75	
			76	5
			77	

Table 3. Partial recruit rates and average weights used in the Fortune Bay herring assessment.

Area	2	3	4	5	6	7	8	9	10	11+
PR rate	.05	.50	.80	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Ave. wgt. (gm)	70	138	206	240	276	310	335	345	360	390

Table 4. Effort and CPUE data for Fortune Bay herring 1967-73 (from Winters and Moores 1977).

Year	CPUE (tons/day)	Effort (days)
1967	63.7	89
1968	69.2	213
1969	53.7	128
1970	62.2	151
1971	49.5	303
1972	33.7	314
1973	24.8	131

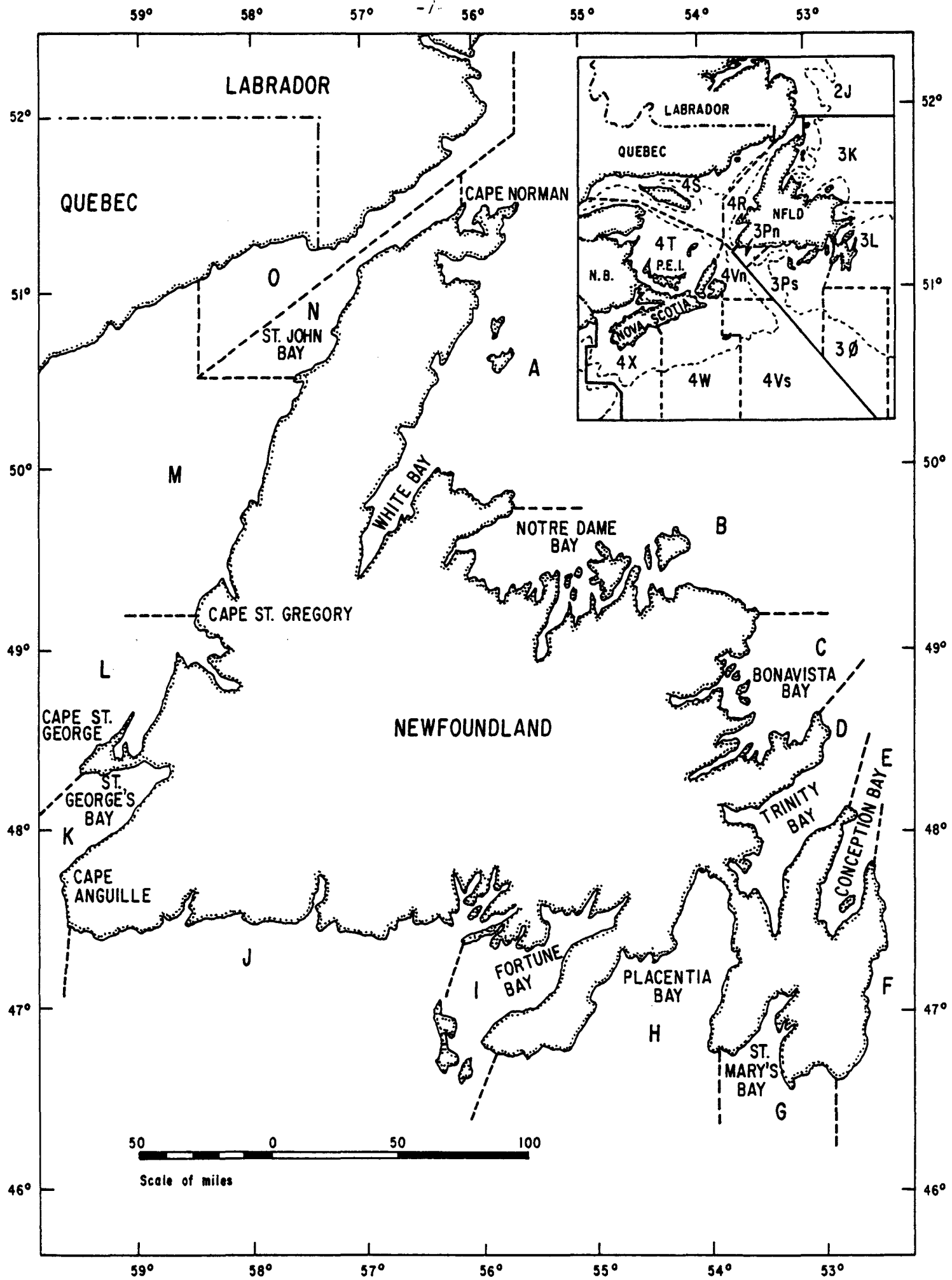


Fig. 1. Area map of Newfoundland.

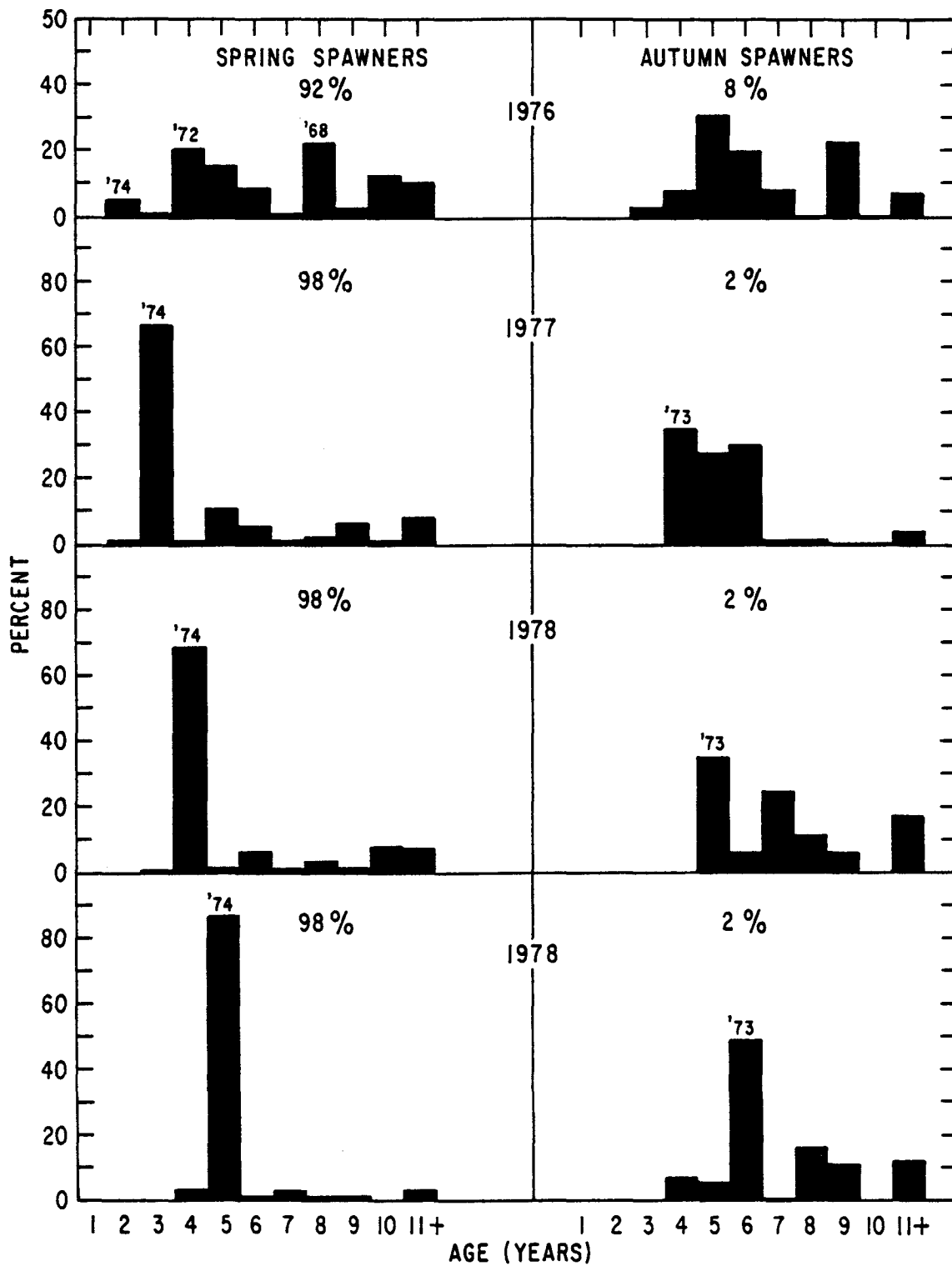


Fig. 2. Age frequency distribution of Fortune Bay herring 1976-79.



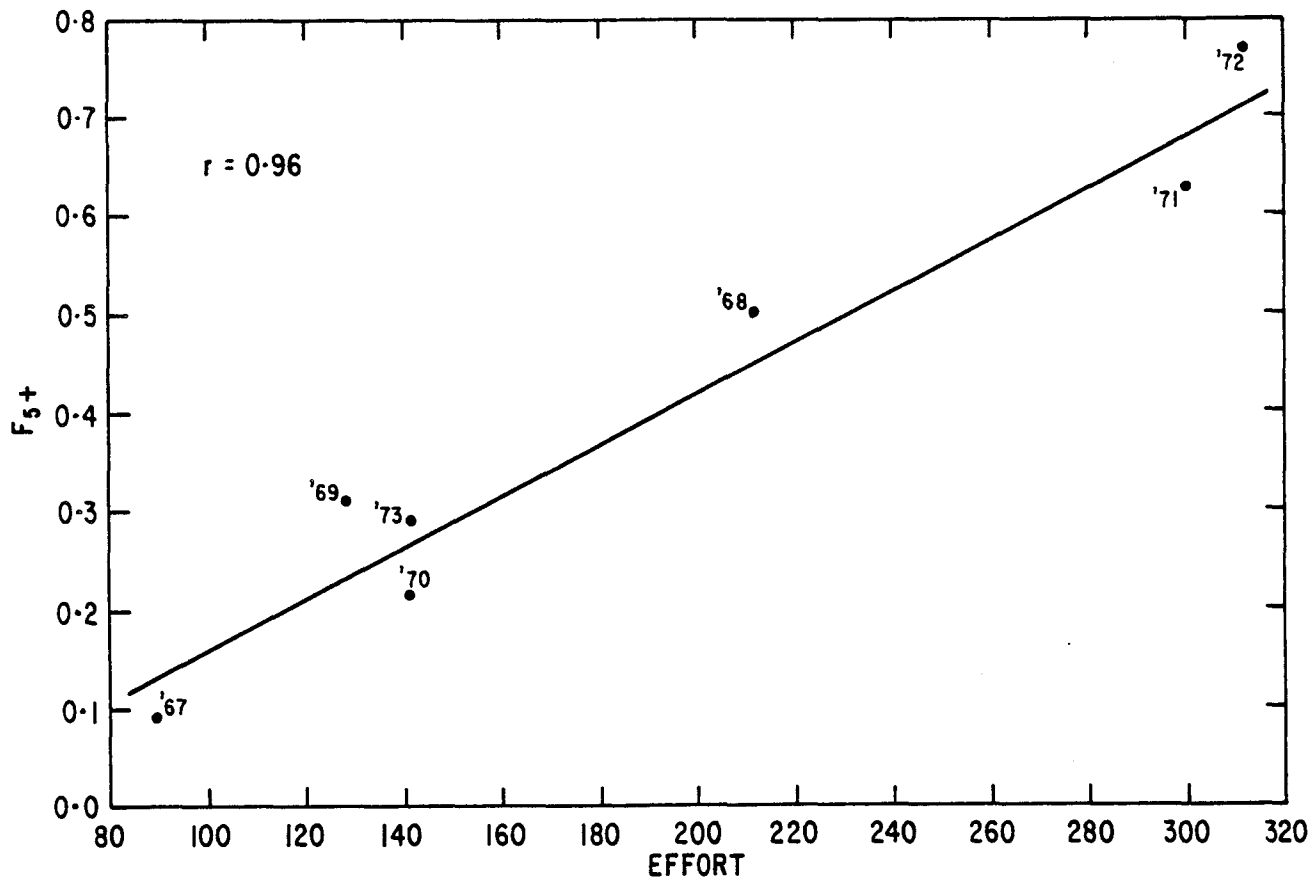


Fig. 3. Relationship between effort and fishing mortality estimates of Fortune Bay herring derived from cohort runs 1966-79.

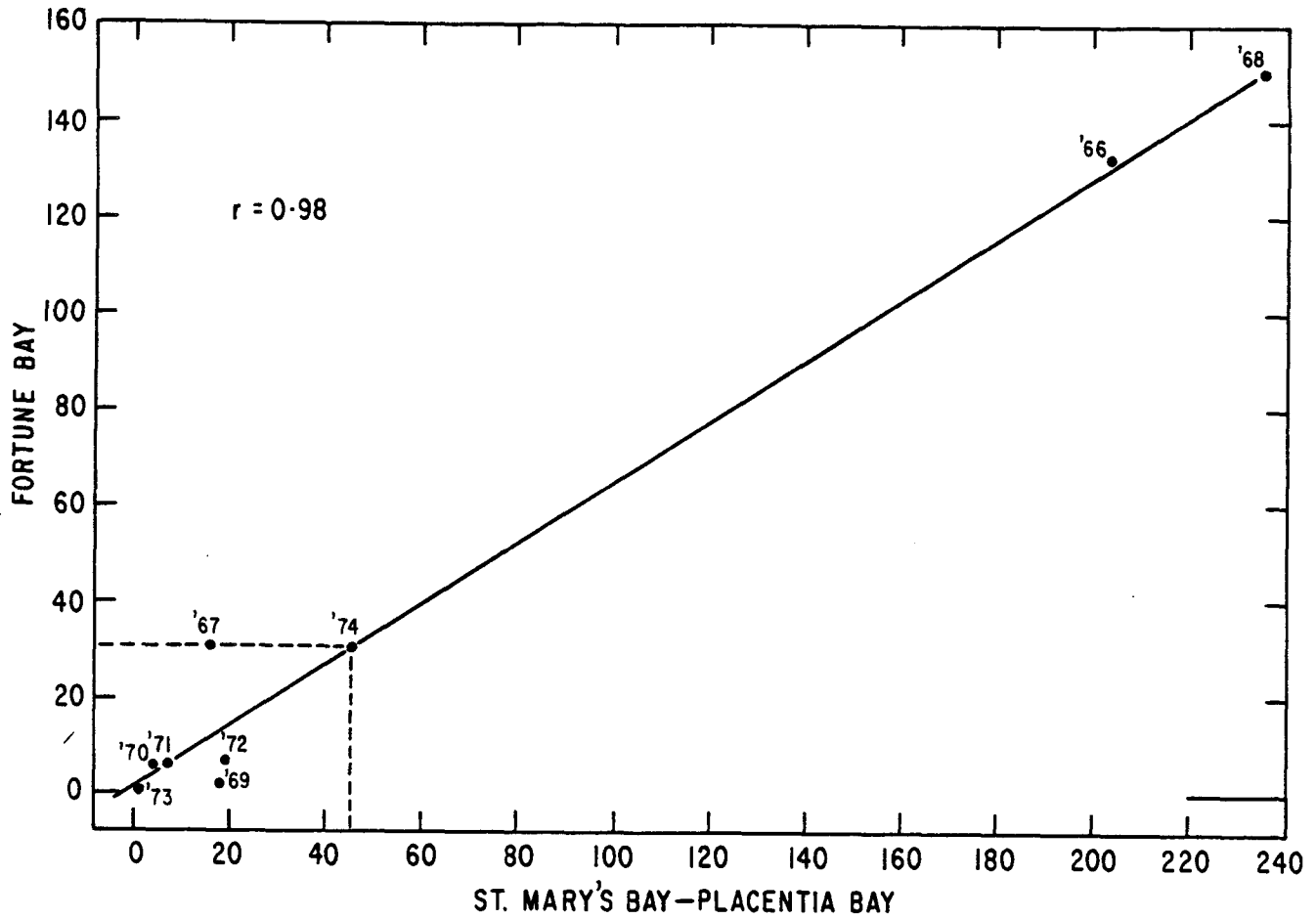


Fig. 4. Year-class size (age 2) St. Mary's-Placentia compared to year-class size (age 2) Fortune Bay for year-classes 1966-73.

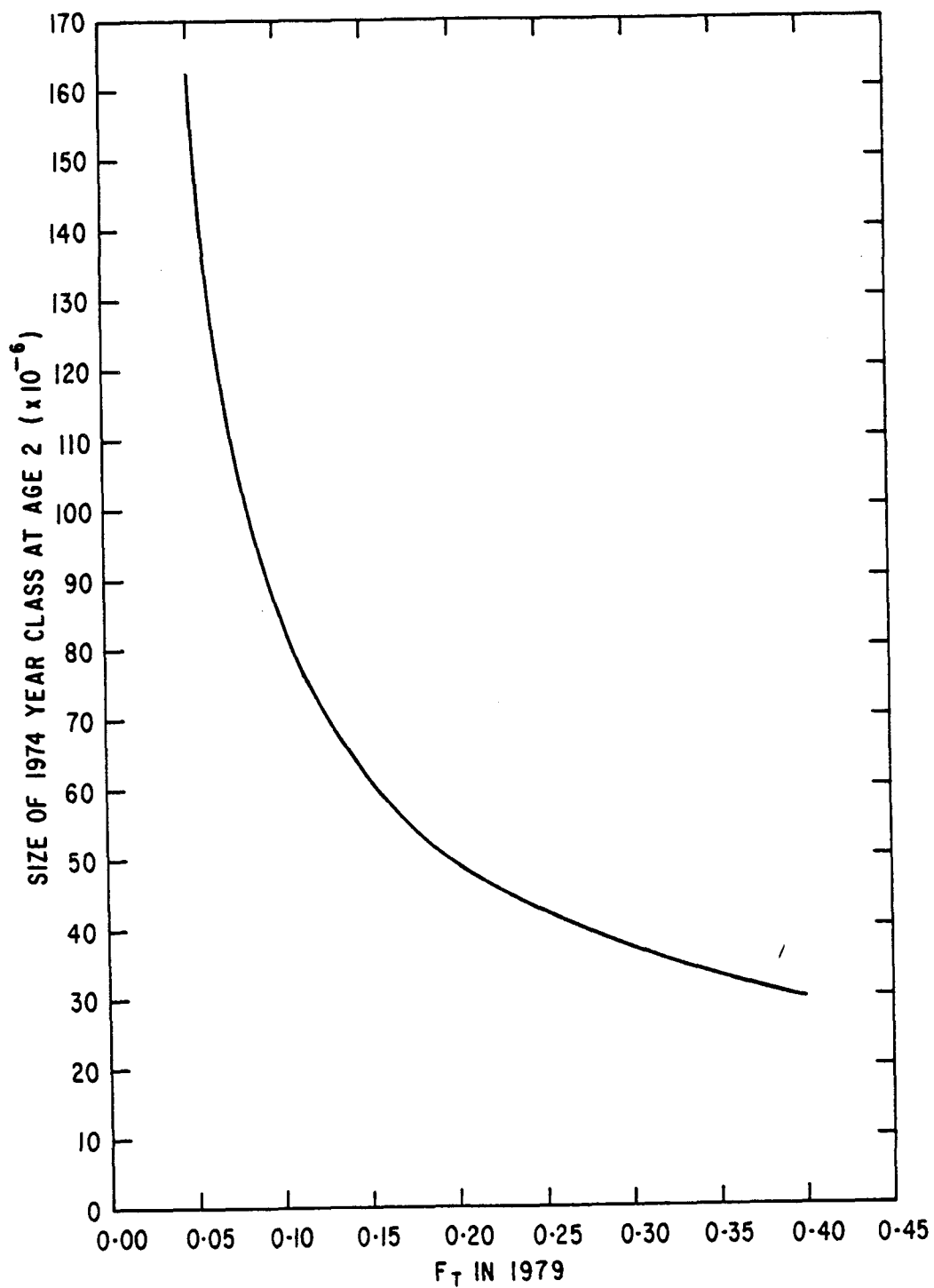


Fig. 5. Size of 1974 year-class under various options of terminal F in 1979.

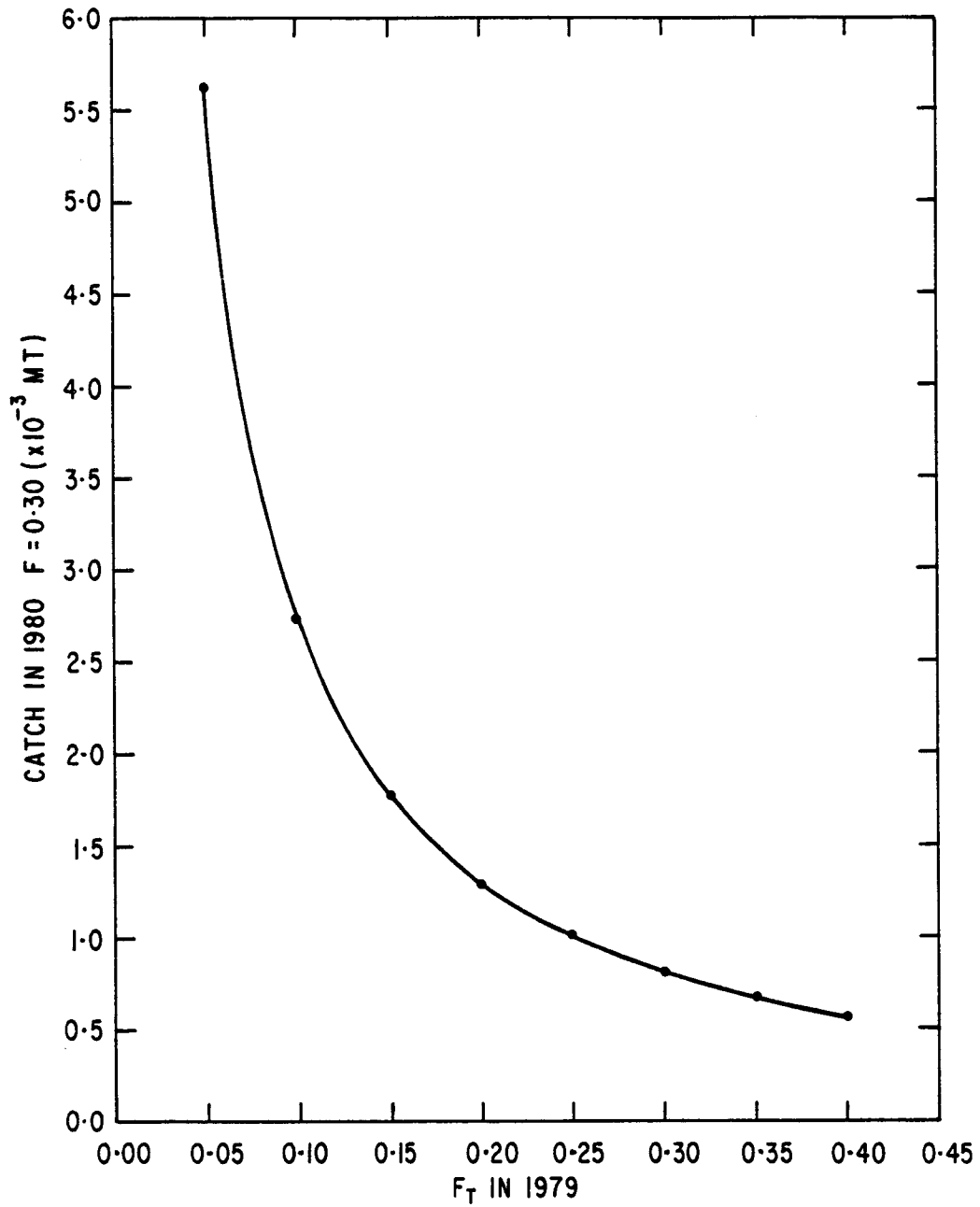


Fig. 6. Catch projection for 1980 ( $F_{0.1} = 0.30$ ) at different levels of terminal  $F$  in 1979.

HERRING FORTUNE BAY SS  
POPULATION NUMBERS

F<sub>T</sub>-0-25

AGE/YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	3204.	5444.	131899.	29477.	145892.	1564.	5442.	6294.	4742.	356.
3	216547.	2622.	4456.	102064.	23667.	81097.	1123.	3065.	3145.	3530.
4	2198.	177986.	2066.	3533.	72719.	12141.	44595.	684.	1674.	1369.
5	2178.	1788.	122578.	1405.	2815.	50097.	4227.	18437.	499.	879.
6	6059.	1763.	1422.	56417.	981.	2226.	18977.	800.	9964.	299.
7	7424.	4879.	1399.	969.	34393.	632.	728.	5641.	244.	4019.
8	4868.	6019.	3613.	1033.	623.	21542.	337.	273.	3036.	94.
9	3229.	3904.	4520.	2406.	610.	292.	9145.	176.	153.	1473.
10	159.	2618.	2732.	3004.	1345.	485.	115.	2600.	99.	117.
11	1139.	129.	1820.	1405.	709.	890.	258.	63.	1415.	63.
12	28.	917.	92.	931.	350.	453.	492.	139.	38.	891.
13	22.	22.	640.	52.	226.	229.	229.	279.	83.	26.
14	17.	17.	17.	332.	20.	146.	122.	113.	176.	58.
15	13.	13.	13.	13.	87.	14.	76.	66.	61.	127.
16	10.	10.	10.	10.	10.	58.	10.	40.	39.	39.
17	7.	7.	7.	7.	7.	7.	32.	7.	23.	28.
18	5.	5.	5.	5.	5.	5.	5.	20.	5.	15.

AGE/YEAR	1976	1977	1978	1979
2	41562.	1717.	13.	89.
3	290.	33954.	1380.	9.
4	2638.	224.	25887.	1092.
5	594.	1872.	161.	18746.
6	618.	280.	1236.	75.
7	166.	390.	79.	795.
8	1942.	126.	295.	25.
9	62.	1285.	64.	114.
10	1077.	19.	880.	5.
11	76.	713.	12.	422.
12	42.	49.	457.	5.
13	585.	28.	31.	219.
14	19.	387.	19.	15.
15	42.	14.	248.	10.
16	95.	31.	9.	119.
17	26.	72.	23.	5.
18	20.	20.	55.	15.

HERRING FORTUNE BAY SS  
FISHING MORTALITIES

AGE/YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	.000	.000	.056	.019	.387	.131	.374	.494	.095	.006
3	.001	.038	.032	.139	.467	.398	.296	.405	.632	.091
4	.007	.168	.186	.027	.173	.855	.683	.115	.444	.635
5	.011	.029	.576	.159	.035	.771	1.465	.415	.312	.152
6	.017	.031	.184	.295	.239	.918	1.013	.987	.708	.387
7	.010	.100	.103	.241	.268	.430	.781	.420	.754	.527
8	.021	.086	.207	.322	.557	.657	.448	.380	.523	.200
9	.010	.157	.209	.381	.029	.730	1.058	.376	.067	.113
10	.014	.164	.465	1.244	.213	.429	.409	.408	.253	.233
11	.017	.138	.470	1.189	.248	.392	.419	.307	.263	.193
12	.040	.160	.376	1.216	.226	.483	.367	.315	.158	.221
13	.051	.051	.456	.767	.236	.428	.505	.261	.158	.134
14	.067	.067	.067	1.136	.119	.451	.422	.419	.127	.121
15	.088	.088	.088	.088	.211	.168	.450	.314	.246	.091
16	.119	.119	.119	.119	.119	.392	.119	.365	.152	.187
17	.167	.167	.167	.167	.167	.167	.277	.167	.217	.128
18	.250	.250	.250	.250	.250	.250	.250	.250	.250	.250
AGE/YEAR	1976	1977	1978	1979						
2	.002	.018	.092	.012						
3	.059	.071	.034	.125						
4	.143	.132	.123	.200						
5	.552	.215	.568	.250						
6	.262	1.065	.242	.250						
7	.076	.077	.957	.250						
8	.213	.487	.750	.250						
9	1.013	.178	2.349	.250						
10	.213	.272	.535	.250						
11	.228	.245	.648	.250						
12	.201	.253	.538	.250						
13	.212	.216	.547	.250						
14	.124	.244	.436	.250						
15	.111	.176	.534	.250						
16	.072	.113	.436	.250						
17	.087	.080	.217	.250						
18	.250	.250	.250	.250						

C A T C H M A T R I X

AGE/YEAR	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
2	1.	1.	6549.	515.	42383.	174.	1536.	2220.	389.	2.
3	230.	89.	128.	11984.	7997.	24094.	260.	924.	1333.	279.
4	13.	24764.	317.	85.	10433.	6314.	19975.	67.	543.	582.
5	22.	46.	48563.	187.	87.	24357.	2941.	5671.	121.	112.
6	90.	49.	216.	13038.	189.	1210.	10937.	454.	4574.	87.
7	66.	422.	124.	188.	7312.	200.	357.	1749.	117.	1490.
8	90.	450.	610.	261.	241.	9385.	110.	78.	1119.	16.
9	28.	513.	770.	690.	16.	137.	5402.	50.	9.	142.
10	2.	358.	920.	1935.	234.	153.	35.	788.	20.	22.
11	17.	15.	617.	884.	141.	261.	80.	15.	296.	10.
12	1.	123.	26.	593.	64.	157.	137.	34.	5.	160.
13	1.	1.	212.	25.	43.	72.	82.	58.	11.	3.
14	1.	1.	1.	204.	2.	48.	38.	35.	19.	6.
15	1.	1.	1.	1.	15.	2.	25.	16.	12.	10.
16	1.	1.	1.	1.	1.	17.	1.	11.	5.	6.
17	1.	1.	1.	1.	1.	1.	7.	1.	4.	3.
18	1.	1.	1.	1.	1.	1.	1.	4.	1.	3.

AGE/YEAR	1976	1977	1978	1979
2	82.	28.	1.	1.
3	15.	2114.	42.	1.
4	318.	25.	2705.	180.
5	228.	328.	63.	3774.
6	129.	166.	240.	15.
7	11.	26.	44.	160.
8	337.	44.	141.	5.
9	36.	190.	52.	23.
10	187.	4.	330.	1.
11	14.	140.	5.	85.
12	7.	10.	172.	1.
13	101.	5.	12.	44.
14	2.	76.	6.	3.
15	4.	2.	93.	2.
16	6.	3.	3.	24.
17	2.	5.	4.	1.
18	4.	4.	11.	3.

Table 1. Percent mature at age for the period 1967-73.

Year	Age			
	2	3	4	5
1967	0	79	99	100
1968	0	25	80	100
1969	0	38	80	100
1970	0	50	98	100
1971	0	40	84	100
1972	0	54	100	100
1973	0	52	85	100



Table 2. Biomass and population numbers Fortune Bay ( $F_T = 0.25$ ).

Year-class	Age 2 ( $\times 10^{-3}$ )	Population number ( $\times 10^{-3}$ )		Biomass ( $\times 10^{-3}$ mt)	
		5+	spawning <sup>1</sup>	5+	spawning
66	131,899	25,056	178,917	7,743	59,710
67	29,477	22,017	199,168	7,142	80,761
68	145,892	138,816	141,583	34,994	45,781
69	1,564	67,954	109,565	19,527	42,351
70	5,442	42,160	125,258	13,054	57,835
71	6,294	77,065	119,702	21,024	41,407
72	4,742	34,749	79,950	10,263	29,257
73	356	28,654	30,829	7,766	9,110

<sup>1</sup> based on maturity ogives

