1982 East Coast Newfoundland Herring Assessment

by

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ABSTRACT

This paper provides an update of the annual assessments of the four east coast Newfoundland herring stock complexes: 1) White Bay-Notre Dame Bay, 2) Bonavista Bay, 3) Trinity Bay, and 4) Conception Bay-Southern Shore. Landings decreased from 9,200 t in 1981 to 2,500 t in 1982 due to a reduction in the TAC. Samples taken from the 1982 commercial fishery indicated that the 1968 year-class continued to support the fishery. However, samples from a research gillnet program indicated some recruitment of younger age groups, particularly the 1979 year-class. Catch rate information was available from both the commercial gillnet fishery and the research gillnet program. Total mortality coefficients ($\bar{Z}$) were calculated and estimates of terminal fishing mortality (F_t) were derived from trial runs of cohort analysis for each of the $\bar{Z}$'s calculated. Management considerations are provided for 1983 and 1984.

RESUME

L'article qui suit contient une mise à jour des évaluations annuelles des quatre complexes de stocks de harengs de la côte est de Terre-Neuve: 1) baie Blanche - baie Notre-Dame, 2) baie de Bonavista, 3) baie de la Trinité et 4) baie de la Conception - côte sud. Les débarquements ont diminué, passant de 9 200 t en 1981 à 2 500 t en 1982, à la suite d'une réduction du TPA. Des échantillons prélevés à même les prises commerciales de 1982 indiquent que la classe d'âge de 1968 continue d'alimenter cette pêche. Cependant, des échantillons examinés au cours d'un programme de pêche expérimentale aux filets maillants montrent un certain recrutement de plus jeunes groupes d'âge, particulièrement de la classe d'âge de 1979. Il existe des données sur les taux de capture des filets maillants, à la fois commerciaux et expérimentaux. Les coefficients de mortalité totale (Z) ont été calculé, et des estimations de mortalité par pêche de dernière année (F_t) dérivées de passages d'essai d'analyse des cohortes pour chaque Z calculé. Nous examinons divers aspects de la gestion en 1983 et 1984.

INTRODUCTION

1) Historical Fishery

Prior to the 1970's, the herring fishery along the east coast of Newfoundland, from Cape Norman to Cape Race, was primarily a fixed gear fishery, with landings averaging between 1000-2000 t annually (Winters and Moores, 1977). The area took on added importance in the early 1970's as demand for food herring increased due to the decline of the northeast Atlantic herring stocks (Burd, 1974). The east coast represented one of the last relatively unexploited, unregulated areas along the Atlantic coast. This was reflected in the catch, as landings increased from 1300 t in 1970 to 26,300 t in 1979 (Wheeler and Winters, 1980).

The large (> 65 ft. LOA*) purse seine fleet dominated the fishery throughout the mid 1970's; however, in 1977 they were excluded from the area. This was due to the introduction of the ring net in 1974 and the ensuing expansion of a fleet of small (< 65 ft. LOA) local east coast ring net vessels. By 1978, this fleet included approximately 100 vessels and took the major proportion of the catch (Table 1). Purse seines and ring nets were placed under quota control in 1977. Inshore gears, primarily gillnets, which were not regulated, took an increasing proportion of the catch, reaching a peak of 13,000 t in 1979. All gears came under quota regulation in 1980. TAC's and catches ($x10^3$t) are listed below for 1977-81 time period:

*Length overall

	1977	1978	1979	1980	1981
TAC	22.0	17.4	20.8	9.8	7.0
Catch	25.7	23.4	26.4	12.4	9.2

2) Stock Delineation

Approximately 100,000 tags were applied to herring in 31 experiments conducted along the east coast between 1975 and 1981. After preliminary analysis of the tagging data, Winters and Moores (1979) defined four east coast stock complexes (Fig. 1) for assessment purposes: 1) White Bay - Notre Dame Bay (Area A&B); 2) Bonavista Bay (Area C); 3) Trinity Bay (Area D); and, 4) Conception Bay - Southern Shore (Area E&F). Migratory patterns result in a substantial intermix between White Bay and Notre Dame Bay herring and also between herring from Conception Bay and the Southern Shore; therefore, these areas were combined for stock assessment purposes. Detailed examination of recaptures by area (Wheeler and Winters, unpublished) tends to confirm the preliminary conclusions. It also shows that similar intermixing occurs between Bonavista and Trinity Bays but to a lesser degree.

3) The 1982 Fishery

Although CAFSAC recommended a closure of the fishery in 1982, a TAC of 2,030 t was set and divided between the four stock areas. This TAC,

was allocated to fixed gears only. The reported landings of 2,568 t represented a 27% overrun of the TAC.

	A&B	C	D	E&F
TAC	1230	300	350	150
Catch	1968	386	108	74

The overruns occurred in the two more northerly stock complexes: 1) White Bay - Notre Dame Bay and 2) Bonavista Bay. Quotas were not caught in the other two stock areas: 3) Trinity Bay and 4) Conception Bay - Southern Shore.

4) 1982 Research Charters

Two commercial purse seine (< 65 ft LOA) vessels were chartered for a three week period in October/November, 1982. Over 1,100 miles of cruise track were covered in Notre Dame and Bonavista Bays. Small herring (7-11 cm; 1982 year-class) were caught in 20 out of 25 successful purse seine sets. Large herring (primarily 1968 year-class) were caught in the remaining five sets. This was the first time significant concentrations of small fish were caught during a research survey along the east coast. Subsequently, there have been reports by fishermen of similar size herring in Trinity and St. Mary's Bays.

Input Data and Assessment Parameters

1) Age Compositions

The number of samples collected from the commercial fishery in 1982 was reduced from previous years due to the reduction in catch (Table 2). Consequently, age distributions from the 1982 commercial catch (Fig. 2) are suspect. They show the continuing domination of the 1968 year-class in all areas with little or no recruitment.

Age compositions of samples from the experimental fixed gear program (Figs. 3 to 7) show a somewhat different trend over the past three years. Although the 1968 year-class continues to dominate in most areas, there is evidence of recruitment of younger age groups. In 1982, the 1979 year-class represented approximately 20% of the catch in White Bay (Fig. 4) and 40% in Bonavista Bay (Fig. 6). Although there were no samples obtained from Notre Dame Bay in 1982 (Fig. 5), the 1976 year-class did appear to be of moderate strength in 1980 (25%) and 1981 (15%).

2) Age Specific Weights

Mean weights-at-age (Table 3) normally derived from biological samples taken in the first two quarters of the year, were unchanged from those used in last year's assessment since the number of samples taken in 1982 was too small to accurately reflect any real changes.

3) Partial Recruitment Rates

Similarly, partial recruitment rates were unchanged from last year's assessment as recruitment of the younger age groups appeared low from commercial samples.

4) Abundance Indices

A) Commercial gillnet fishery:

Catch rates were obtained from the commercial gillnet fishery in each area by examining purchase slips of individual fishermen, contacting them to determine the number of nets they fished, and then calculating catch per net per landing (Table 5). This information was combined with data from last year's assessment to extend this time series. In all areas, catch rates either increased from the previous year (Area C and E&F) or remained the same (Area A&B and D). Changes in number of gillnets fished per fisherman were calculated for the period 1977-82 (Table 6). Fleet sizes increased from 1977 to 1981 but decreased in 1982.

B) Fall research gillnet program:

The research gillnet program, which was initiated in the fall of 1980, was continued in 1982. Ten fishermen were originally contracted to fish the nets; however, two were unable to do so due to illness. Catch rates (total number of herring caught per day) were determined for each fisherman (Table 7). Weighted averages by area, for consistent fishermen over the three years, and also for all fishermen, were calculated. Due to a change in the depth of nets provided to certain fishermen in 1981 and 1982, total catch and hence catch rates had to be adjusted to allow for comparisons. Results varied even within stock areas. For Area A&B, Westport catch rate increased three-fold from 1981 to 1982; Hillgrade catch rate dropped from 134 in 1981 to 0 in 1982. Similarly, for Area C, Centreville and Salvage catch rates increased in 1982 while Portland decreased. In Area D, Hickmans Harbour catch rate remained relatively constant, although the numbers involved (4.1 in 1981 and 5.1 in 1982) are very small.

C) Abundance index problems:

There are inherent problems with both sources of catch rate data. The purchase slips are not designed for the calculation of

catch rates. The fundamental question is whether each slip represents a landing? Other questions include: a) how much fish is sold without a purchase slip?, b) if fish is sold under one partner's name, is it his share or both combined?, c) when partners change from year to year, how can comparisons be made?

The research gillnet program is better in that total landings and the unit of effort are known each year. However, sample sizes are small and probably do not reflect trends over the entire area.

5) Calculation of Total Mortality (Z)

The linear formula of Paloheimo (1961) was used to calculate total mortality coefficients (Z) for age groups (5+) for 1981-82 and 1980-82 based upon both commercial and research gillnet catch rates (Table 5 and 7). Effort values calculated from the commercial gillnet data were adjusted, similar to last year (Wheeler and Winters, 1982) to account for gillnet selectivity. The method, as derived by Olsen (1959) adjusts the landings for gillnet selectivity. The most important aspect of this correction factor occurs in the older age groups (11+) where the standard commercial gillnet is not as effective. This is important along the east coast where so many of the herring are in these age classes. Effort values from the research gillnet data represent number of days fished since the gear remains constant from year to year.

Trial runs of cohort analysis were made to obtain the best estimates of terminal fishing mortality (F_t) for each of the Z's calculated. These data are summarized in Table 8. It becomes obvious that in most areas there is no trend and hence is impossible to choose "a best estimate" of F_t.

6) 5+ Biomass vs CPUE and F_5^+ vs Effort

The relationships between 1) CPUE and 5+ biomass and 2) F_5^+ and effort from the commercial gillnet fishery were examined for the period 1977-81 (Figs 8 to 11). Linear regression analyses were performed for a range of F_t's in each area. Correlation coefficients of these regressions are presented in Table 9. Significant correlations were obtained for Area A&B (Fig. 8) and Area E&F (Fig. 11). Predicted values of F for 1982 from these regressions are 0.08 and 0.40, respectively.

Results of the Assessment

Cohort analysis was carried out for each stock area using F_t's from 0.10 to 0.40. Results have not been included as it has not been possible to accurately define the 1982 fishing mortality from the available CPUE data. This is possibly due to the low biomass levels of the stocks. Previous

assessments (Wheeler and Winters, 1981; 1982) have shown that stock sizes are extremely low, less than 10% of the maximum levels observed during the 1970's.

Although there is some evidence of recruitment in Area A&B and C from the research gillnet samples, there is little or no such evidence from commercial samples. The concentrations of small herring (1982 year-class) in all areas during the fall of 1982 (as evidenced during the purse seine charter and reports from fishermen) may provide some hope for the long term. However, the biological advice for the short term (1983 and 1984) should remain the same as last year ie. closure.

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Table 1. East Coast herring landings (t) by area and gear, 1973-82.

Year	Gear	A	B	C	D	E&F	Total
1973	Inshore	816	1,658	504	544	1,098	4,620
	Ringnet	-	-	-	-	-	-
	Purse seine	1	1	5	156	211	374
	TOTAL	817	1,659	509	700	1,309	4,994
1974	Inshore	1,423	2,588	642	1,223	536	6,412
	Ringnet	8	6	-	428	2,107	2,549
	Purse seine	-	-	-	-	48	48
	TOTAL	1,431	2,594	642	1,651	2,691	9,009
1975	Inshore	1,584	1,852	450	743	893	5,522
	Ringnet	-	108	-	1,790	2,596	4,494
	Purse seine	828	1,183	1,559	1,370	13	4,953
	TOTAL	2,412	3,143	2,009	3,903	3,502	14,969
1976	Inshore	773	3,184	491	914	737	6,099
	Ringnet	487	3,412	3,052	1,054	1,748	9,753
	Purse seine	1,724	2,908	2,812	1,614	-	9,058
	TOTAL	2,984	9,504	6,355	3,582	2,485	24,910
1977	Inshore	552	4,893	2,808	1,145	461	9,859
	Ringnet	1,227	4,922	6,204	1,548	1,716	15,617
	Pair trawl	-	-	236	-	-	236
	TOTAL	1,779	9,815	9,248	2,693	2,177	25,712
1978	Inshore	1,704	6,476	1,473	1,282	714	11,649
	Ringnet	1,254	3,980	4,239	1,055	1,231	11,759
	TOTAL	2,958	10,456	5,712	2,337	1,945	23,408
1979	Inshore	1,051	11,843	2,755	2,350	451	18,450
	Ringnet	832	1,968	3,490	1,181	442	7,913
	TOTAL	1,883	13,811	6,245	3,531	893	26,363
1980	Inshore	1,352	3,518	1,973	754	158	7,755
	Ringnet	747	913	1,714	964	319	4,657
	TOTAL	2,099	4,431	3,687	1,718	477	12,412
1981	Inshore	690	2,743	2,280	788	245	6,746
	Ringnet	223	1,383	1,708	434	-	3,748
	TOTAL	913	4,126	3,988	1,222	245	10,494
1982	Inshore (TOTAL)	451	1,549	386	108	74	2,568

1982 figures are provisional (no ringnet fishery)

Table 2. Samples from commercial fishery, by area and gear, 1980-82.

Year	Area	Gear type				Total # sampled	Comm. catch (t)
		Bar seine	Ringnet	Gillnet	Squid trap		
1980	A	-	-	191	-	191	2099
	B	394	-	735	-	1129	4431
	C	650	1462	100	-	2212	3687
	D	650	788	149	-	1587	1718
	E&F	-	294	100	-	394	477
1981	A	-	-	-	-	-	913
	B	498	1369	549	-	2416	4126
	C	450	1545	500	-	2495	3988
	D	398	350	200	-	948	1222
	E&F	-	-	-	-	-	245
1982	A	-	-	-	196	196	452
	B	150	-	1000	-	1150	1549
	C	-	-	850	-	850	386
	D	-	-	-	-	-	108
	E&F	-	-	100	-	100	74

Table 3. Average weight-at-age (cm) of Newfoundland East Coast herring used in 1982.

	Area			
Age	A & B	C	D	E & F
2	90	60	90	95
3	138	149	182	126
4	197	242	248	250
5	233	270	314	280
6	264	300	340	310
7	290	305	345	325
8	300	310	365	330
9	305	334	370	337
10	306	341	375	350
11	345	352	378	380

Table 4. Age specific selectivity patterns for each defined stock, used to initiate cohort analysis.

	Area			
Age	A & B	C	D	E & F
2	0.10	0.15	0.15	0.30
3	0.35	0.40	0.25	0.45
4	0.55	0.70	0.40	0.60
5	1.00	1.00	0.65	0.80
6	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00

Table 5. CPUE indices, by area and season, obtained from gillnet purchase slips (sample size in parenthesis) and calculation of instantaneous total mortality (Z).

	Area	Season	1977	1978	1979	1980	1981	1982
Catch per net per landing (kg)	A&B	Spring	70 (8)	57 (28)	58 (36)	38 (38)	58 (37)	64 (15)
		Fall	63 (1)	64 (7)	33 (12)	41 (5)	52 (9)	49 (9)
		Combined *	70 (9)	58 (35)	51 (48)	39 (43)	56 (46)	58 (24)
	C	Spring	104 (1)	29 (2)	76 (9)	88 (14)	71 (14)	104 (14)
	D	Spring	26 (2)	36 (2)	119 (14)	57 (16)	40 (16)	39 (13)
	E&F	Spring	70 (3)	45 (7)	37 (10)	27 (13)	25 (13)	38 (10)
Effort	A&B	Spring	20329	80491	115621	64500	33431	16000
		Fall	12349	21906	39727	12659	15385	15224
		Combined *	31443	103276	157196	76154	48911	30517
	C	Spring	1279	33241	15079	9114	9972	3567
	D	Spring	2308	6278	5269	5684	8500	1564
	E&F	Spring	2500	8489	6216	3889	8440	1658
Instantaneous total mortality (Z)	A&B	Spring	0.30	0.02	0.47	-0.39	2.06	
		Fall	2.05	-0.03	0.47	0.53	-0.20	
		Combined *	1.03	0.03	0.41	-0.17	0.70	
	C	Spring	1.23	-0.91	0.01	0.13	-0.40	
	D	Spring	-0.23	-1.13	0.74	0.36	-0.02	
	E&F	Spring	0.49	0.28	0.17	0.15	-0.18	

*weighted average.

Table 6. Changes in average number of gillnets fished per fisherman. (A.N.N. - average number of nets, n - sample size, and A.F. - adjustment factor)

	A&B			C			D			E&F			Average		
Year	A.N.N.	n	A.F.	A.N.N.	n	A.F.	A.N.N.	n	A.F.	A.N.N.	n	A.F.	A.N.N.	n	A.F.
1977	9.1	20	1.10	7.8	5	1.00	10.5	2	1.00	10.7	3	1.00	9.1	30	1.02
1978	8.3	71	1.00	10.8	11	1.38	10.5	2	1.00	12.3	6	1.15	8.9	90	1.00
1979	10.4	87	1.25	10.2	29	1.31	10.6	13	1.01	13.2	10	1.23	10.6	139	1.19
1980	11.1	87	1.34	11.4	34	1.46	12.7	15	1.21	15.0	13	1.40	11.7	149	1.31
1981	15.8	47	1.90	14.5	22	1.86	14.3	17	1.36	16.4	13	1.53	15.3	99	1.72
1982	16.5	24	1.99	11.8	12	1.51	13.0	13	1.24	15.4	10	1.44	14.6	59	1.64

Table 7. CPUE indices (total number of herring caught per day) from the experimental fixed gear program and calculation of instantaneous total mortality (Z).

Area	Community	Catch rates			f			Z80-81	Z81-82	Z80-82
		1980	1981	1982	1980	1981	1982			
A&B	Westport	61.7	43.4	122.8	53	36	29	0.42	-0.93	-0.50
	Brents Cove	-	-	685.0	-	-	29			
	La Scie	364.9	167.0	-	26	23	-	0.86		
	Harrys Hr.	-	83.3	-	-	29	-			
	Leading Tickles	-	135.6	-	-	26	-			
	Hillgrade	1017.5	134.1	0.0	57	31	31	2.49		
	Average (1)	557.0	85.4	59.3	110	67	60	2.19	0.63	2.33
	(2)	520.3	106.9	263.2	136	145	89	1.54	-0.79	0.60
C	Centreville	29.5	41.8	54.0	51	30	26	-0.30	0.03	-0.27
	Salvage	199.5	9.9	371.8	32	35	31	2.57	-2.63	-0.06
	Portland	-	247.6	105.5	-	26	29		1.56	
	Average (1)	95.0	24.6	226.8	83	65	57	1.10	-1.41	-0.31
	(2)	95.0	88.3	185.9	83	91	86	-0.10	0.01	-0.12
D	Port Rexton	-	-	56.6	-	-	30			
	Hickmans Hr.	77.3	4.1	5.1	42	30	30	2.97	-0.22	2.75
	Average (1)	77.3	4.1	5.1	42	30	30	2.97	-0.22	2.75
	(2)	77.3	4.1	30.9	42	30	60	2.97	-2.00	0.97

(1) weighted averages; only those communities consistent over three years

(2) weighted averages; all communities

Table 8. Summary of total mortality coefficient values (Z) and resultant estimates of terminal fishing mortality (F_t) calculated from the various sources of catch rate data.

Area	Z	F_t	Catch rate source
A & B	2.06	1.91	(Z81-82) commercial spring gillnet fishery
	-0.20	-	(Z81-82) commercial fall gillnet fishery
	0.70	0.56	(Z81-82) commercial spring & fall gillnet fishery
	1.88	0.85	(Z80-82) commercial spring gillnet fishery
	-0.64	-	(Z80-82) commercial fall gillnet fishery
	0.39	0.11	(Z80-82) commercial spring & fall gillnet fishery
	-0.93	-	(Z81-82) Westport research gillnets
	0.63	0.47	(Z81-82) research gillnets - consistent communities
	-0.79	-	(Z81-82) research gillnets - all communities
	2.33	1.19	(Z80-82) research gillnets - consistent communities
	0.60	0.19	(Z80-82) research gillnets - all communities
C	-0.40	-	(Z81-82) commercial spring gillnet fishery
	-0.26	-	(Z80-82) commercial spring gillnet fishery
	0.03	-	(Z81-82) Centreville research gillnets
	-2.63	-	(Z81-82) Salvage research gillnets
	1.56	1.40	(Z81-82) Portland research gillnets
	-0.27	-	(Z80-82) Centreville research gillnets
	-0.06	-	(Z80-82) Salvage research gillnets
	-1.41	-	(Z81-82) research gillnets - consistent communities
	0.01	-	(Z81-82) research gillnets - all communities
	-0.31	-	(Z80-82) research gillnets - consistent communities
	-0.12	-	(Z80-82) research gillnets - all communities
D	-0.02	-	(Z81-82) commercial spring gillnet fishery
	0.35	0.02	(Z80-82) commercial spring gillnet fishery
	-0.22	-	(Z81-82) research gillnets - consistent communities
	-2.00	-	(Z81-82) research gillnets - both communities
	2.75	0.85	(Z80-82) research gillnets - consistent communities
	0.97	0.13	(Z80-82) reserach gillnets - both communities
E & F	-0.18	-	(Z81-82) commercial spring gillnet fishery
	-0.05	-	(Z80-82) commercial spring gillnet fishery

Table 9. Correlation coefficients for the relationships between 5+ biomass and CPUE and F_{5+} and effort assuming various F_t's, by area, from the commercial gillnet fishery for the period 1977-81.

Area	F_t	r^2	
		5+ Biomass vs CPUE	F_{5+} vs Effort
A&B	0.01	0.54	0.83
	0.05	0.55	0.90
	0.10	0.56	0.78
	0.20	0.57	0.49
	0.30	0.57	0.30
C	0.10	0.03	0.07
	0.20	0.03	0.06
	0.30	0.03	0.06
	0.40	0.03	0.05
D	0.10	0.05	0.42
	0.20	0.05	0.56
	0.30	0.05	0.60
	0.40	0.05	0.61
E&F	0.10	0.98	0.13
	0.20	0.98	0.58
	0.30	0.98	0.60
	0.40	0.98	0.53

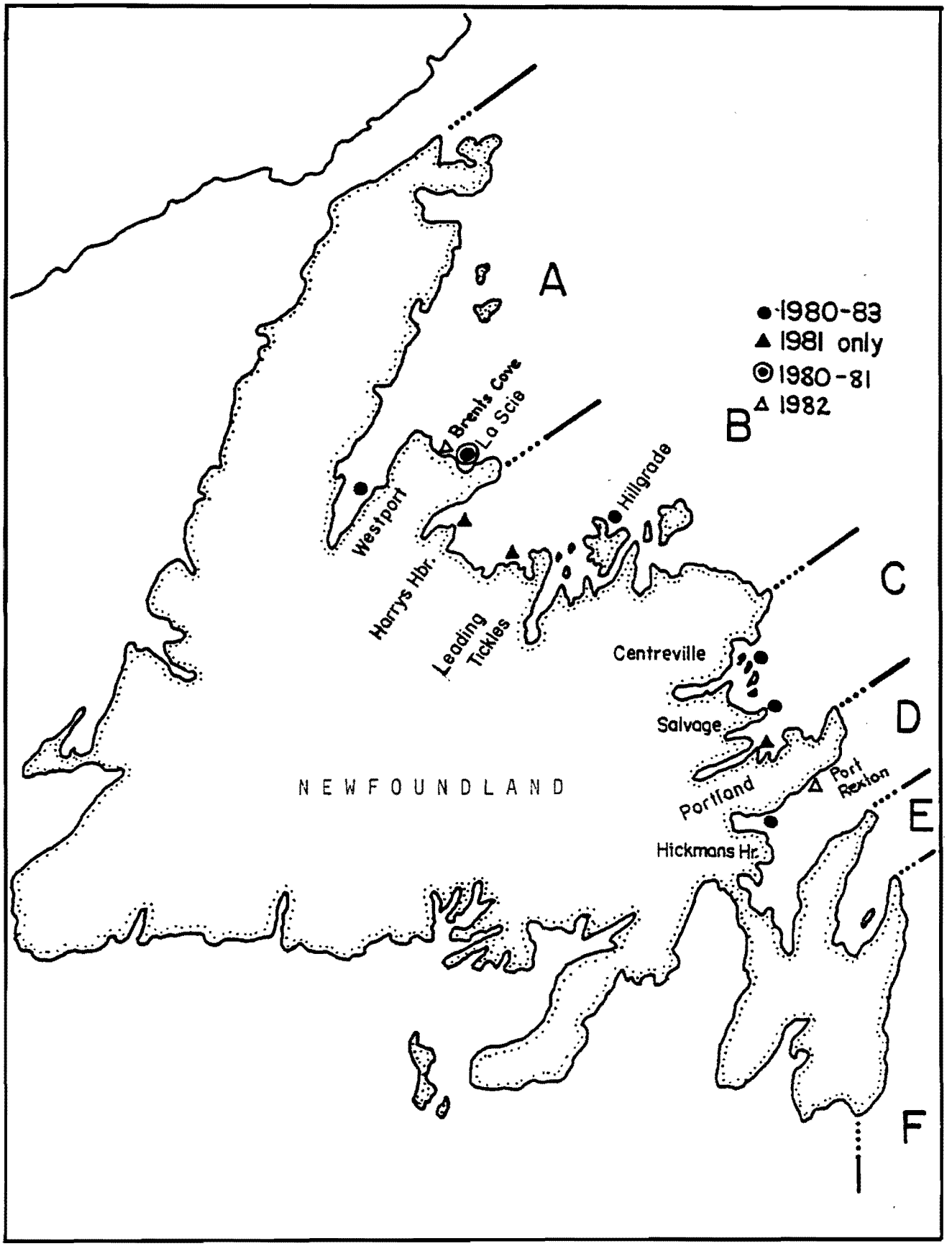


Fig.1 . Area map of the four east coast Newfoundland stock complexes and locations of the experimental fixed gear program.

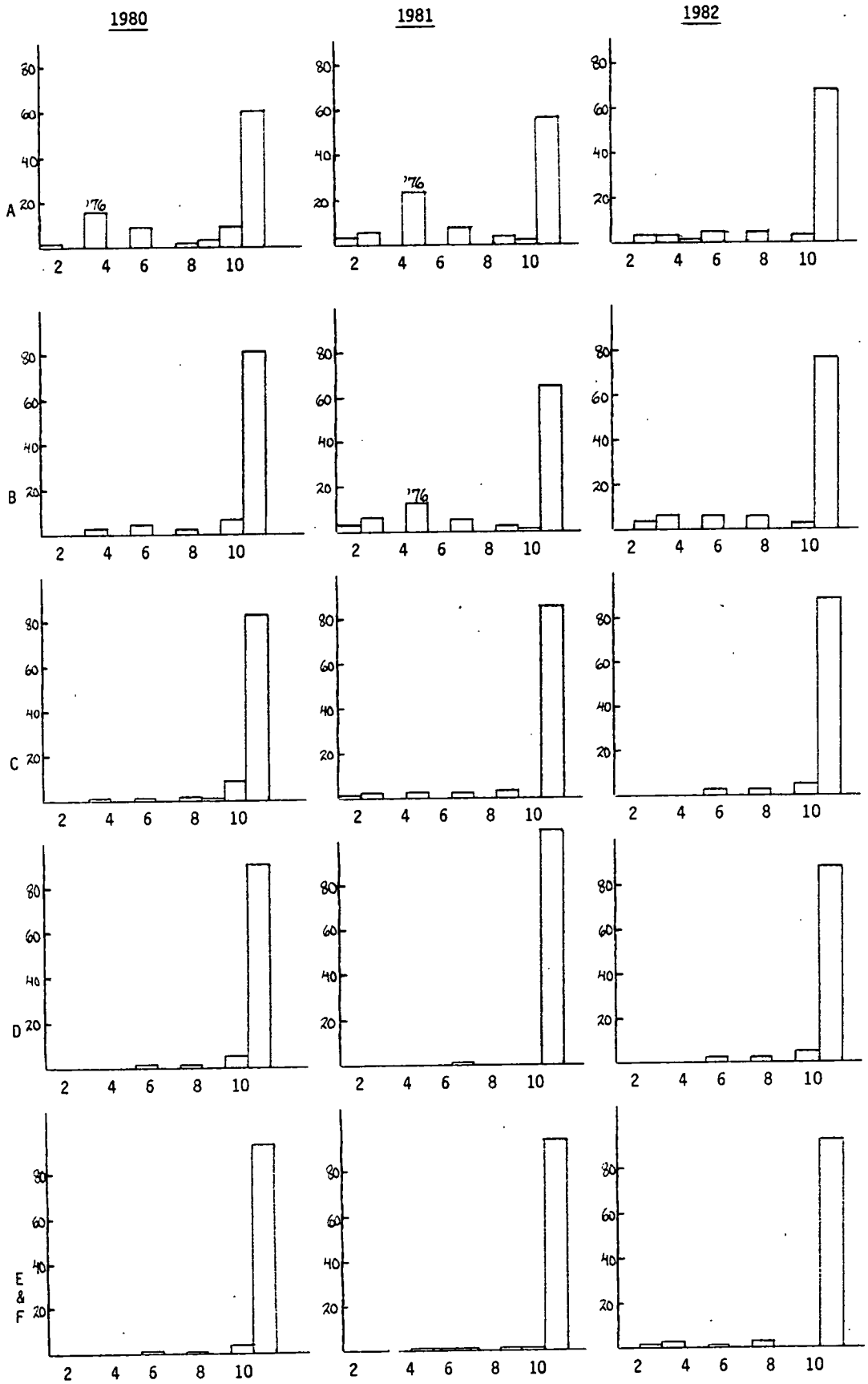


Fig. 2.. Age distribution of herring in the commercial landings from east coast Newfoundland herring stocks, 1980-82. (x axis - age; y axix - percentage).

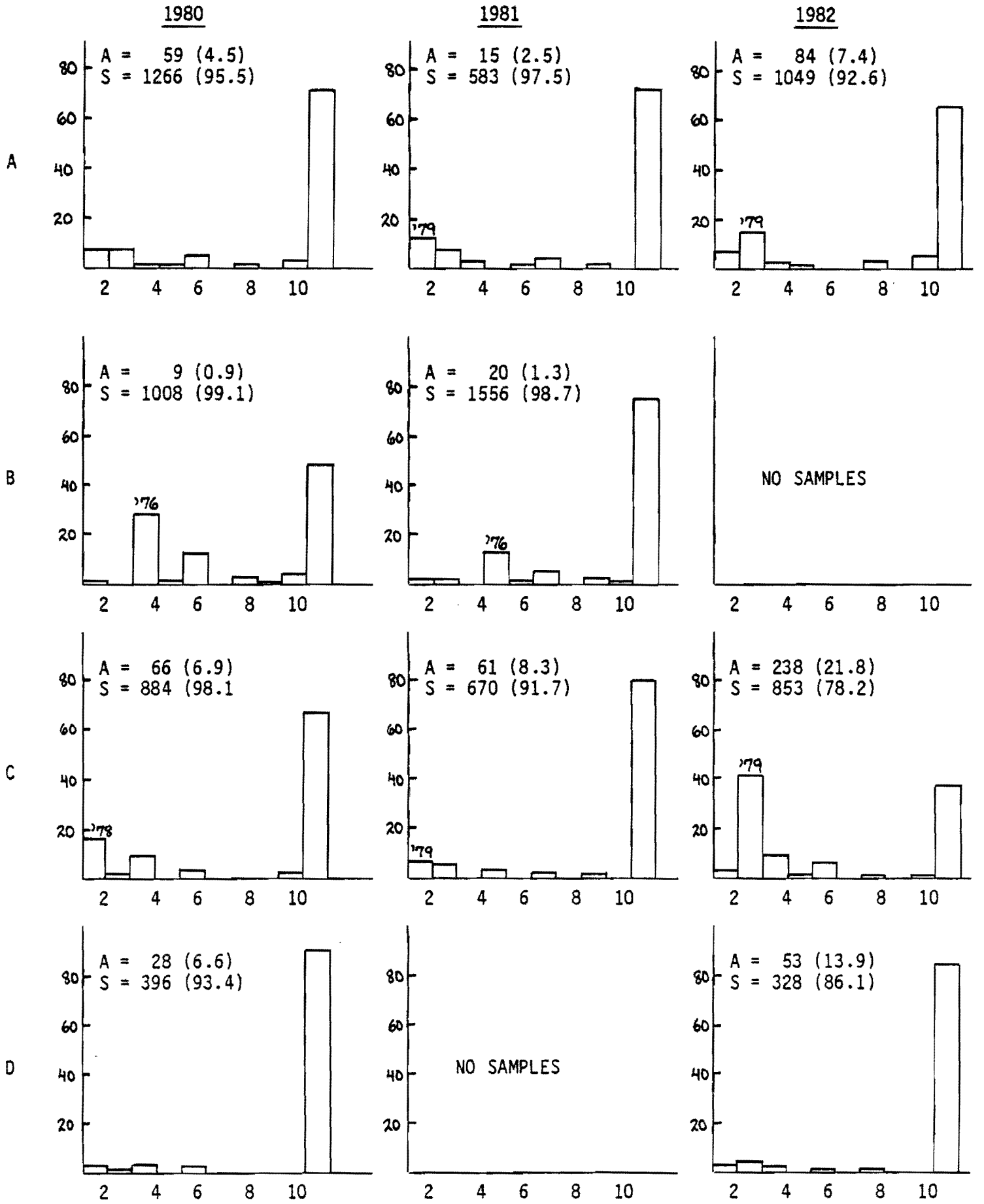


Fig. 3. Age composition of herring samples, by year and area, from the experimental fixed gear program (x axis - age, y axis - percentage).

AREA A

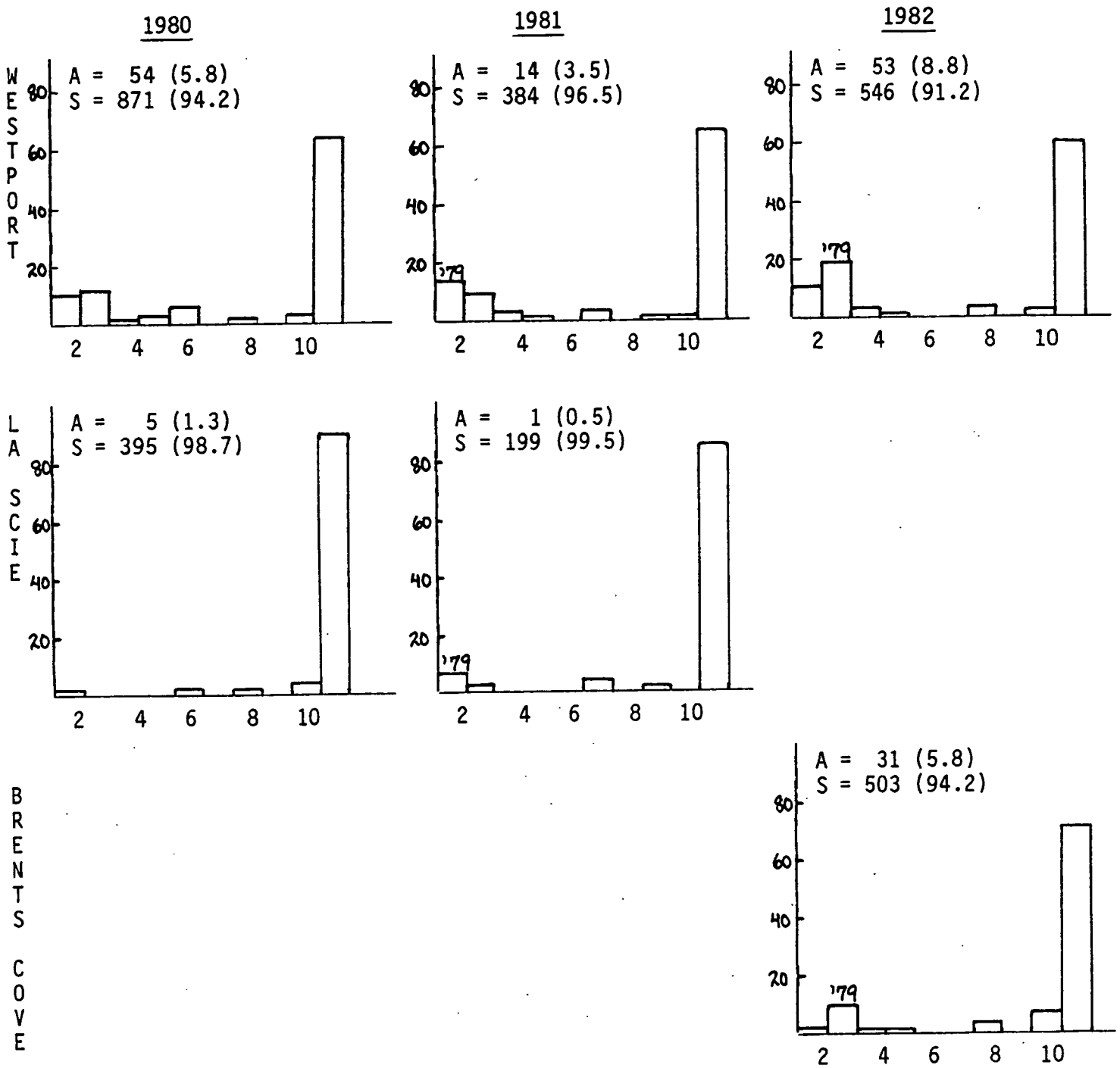


Fig.4 . Age composition of herring - Area A, by year and community, from the experimental fixed gear program (x axis - age, y axis - percentage).

Area B

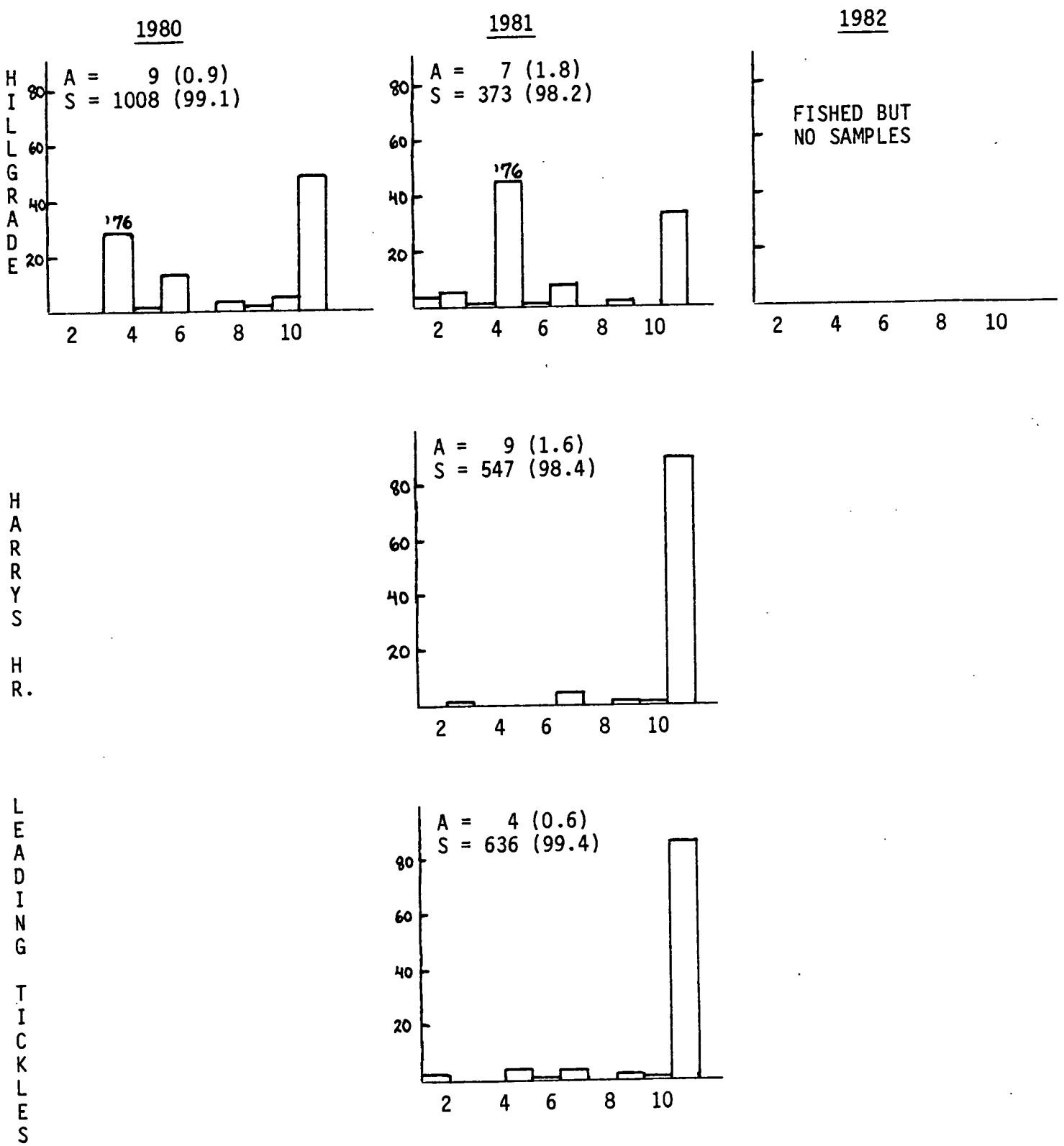


Fig. 5. Age composition of herring - Area B, by year and community, from the experimental fixed gear program (x axis - age, y axis - percentage).

Area C

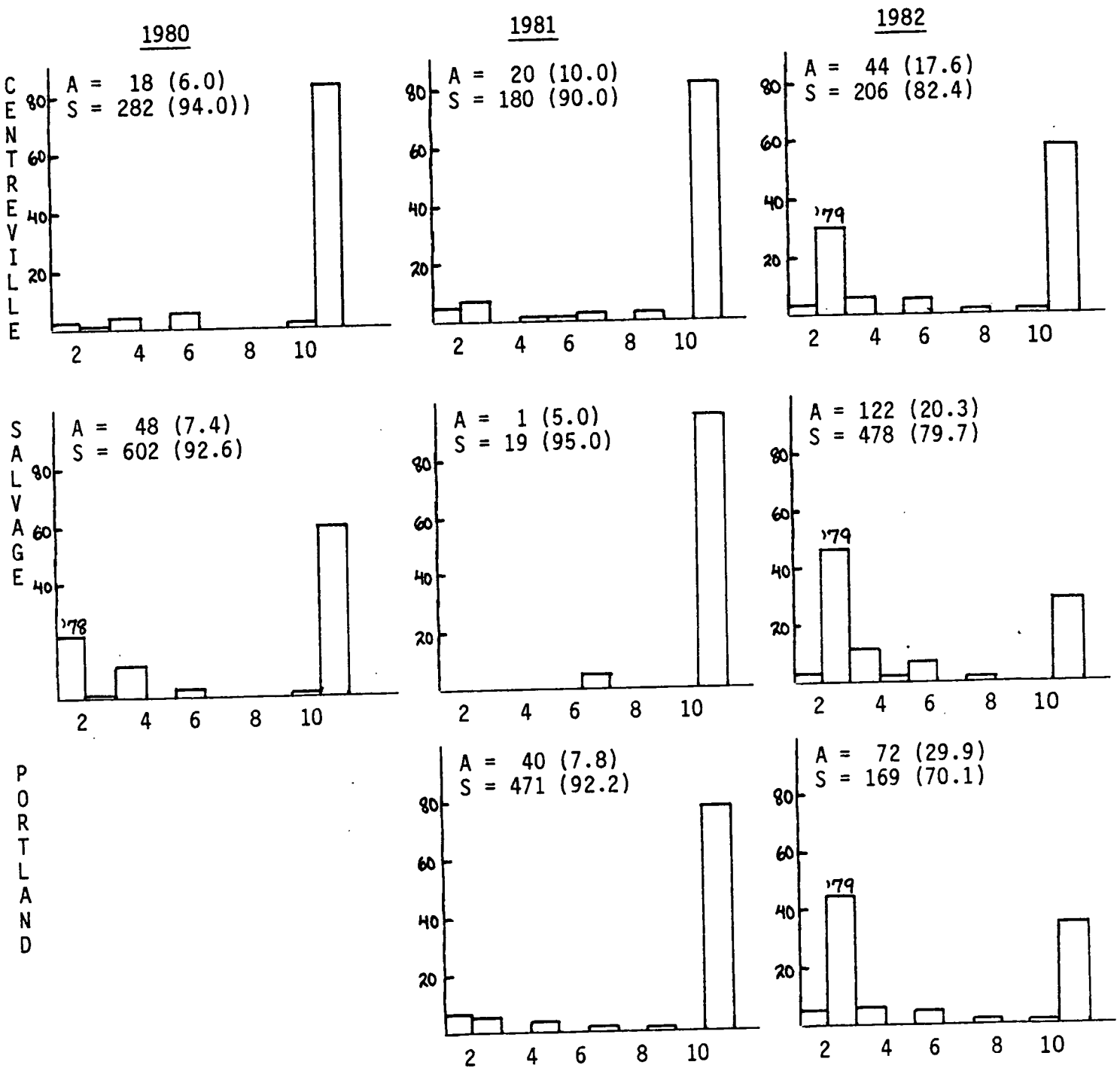


Fig. 6. Age composition of herring - Area C, by year and community, from the experimental fixed gear program (x axis - age, y axis - percentage).

Area D

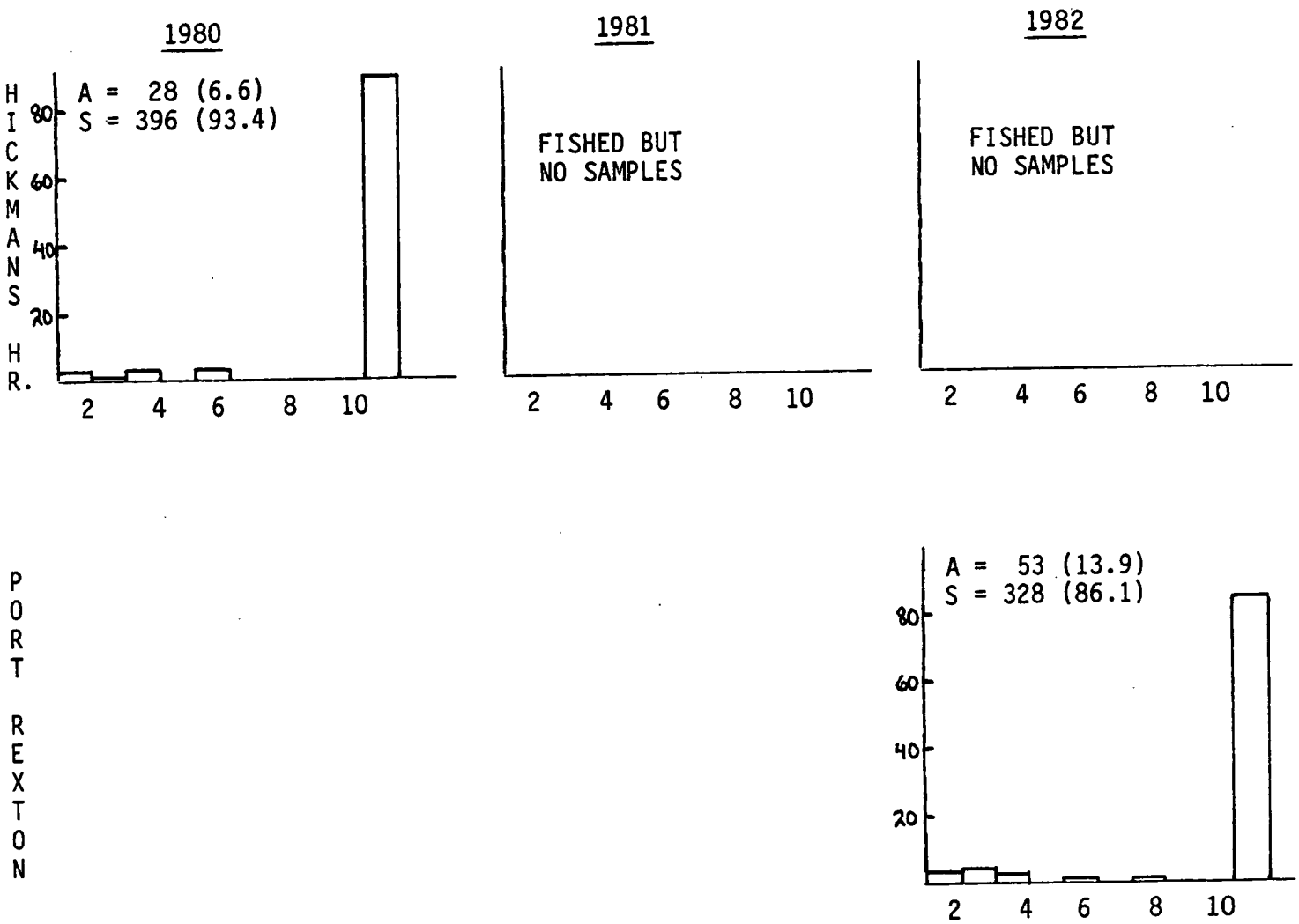
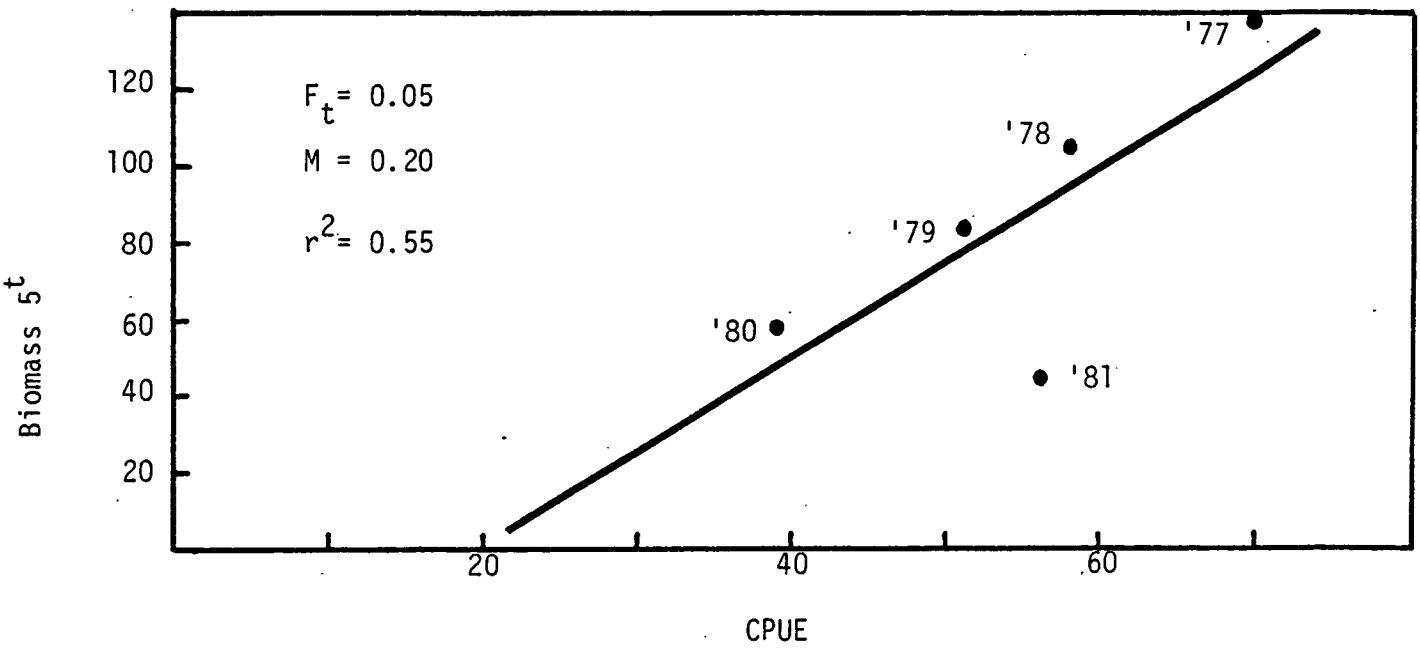


Fig.7 . Age composition of herring - Area D, by year and community, from the experimental fixed gear program (x axis - age, y axis - percentage).



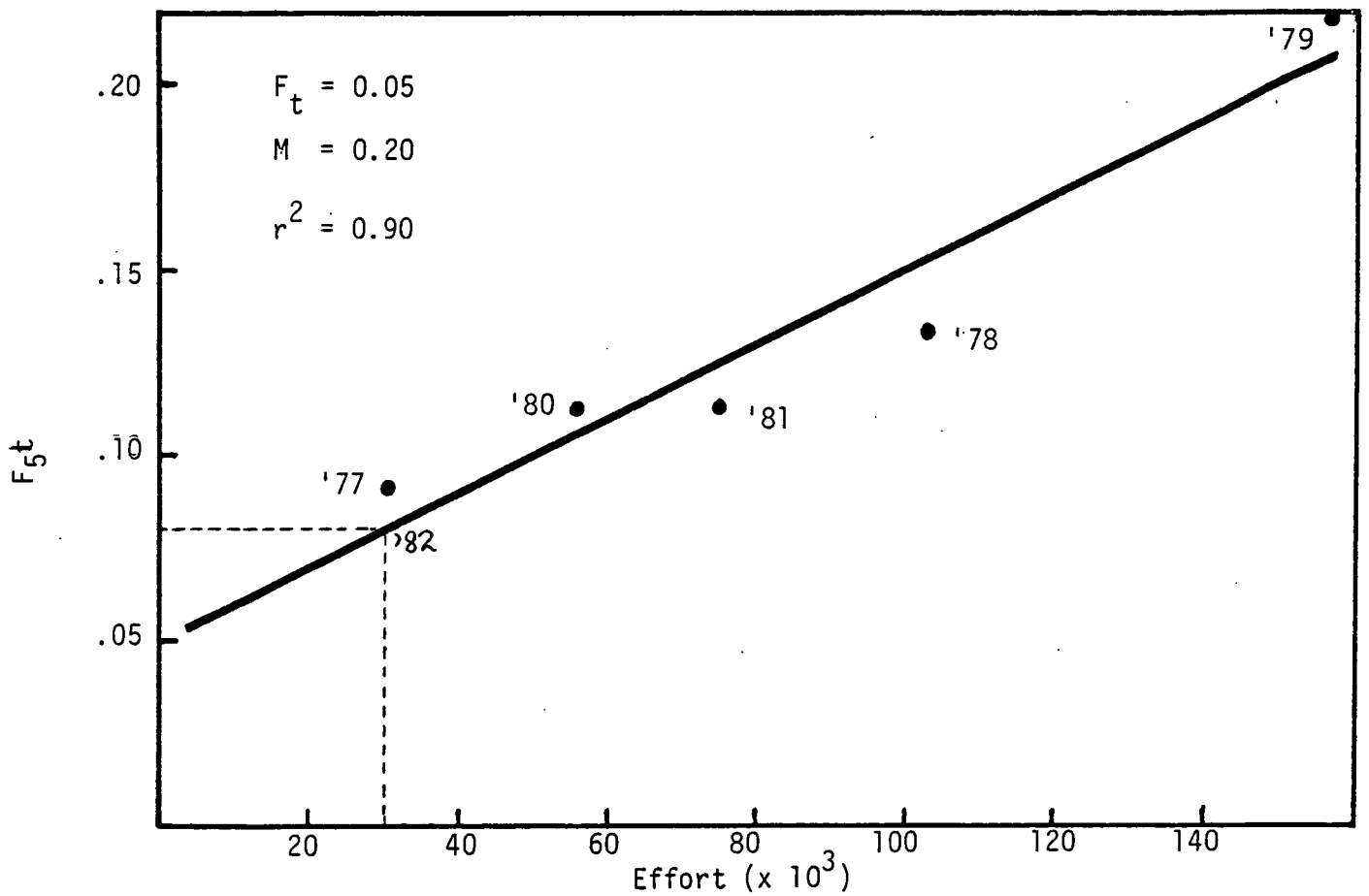


Fig. 8 . Relationships between A) CPUE and 5+ biomass and B) Effort and F_{5+} from the combined spring and fall commercial gillnet fishery in Area A&B (F_t = 0.05, M = 0.20).

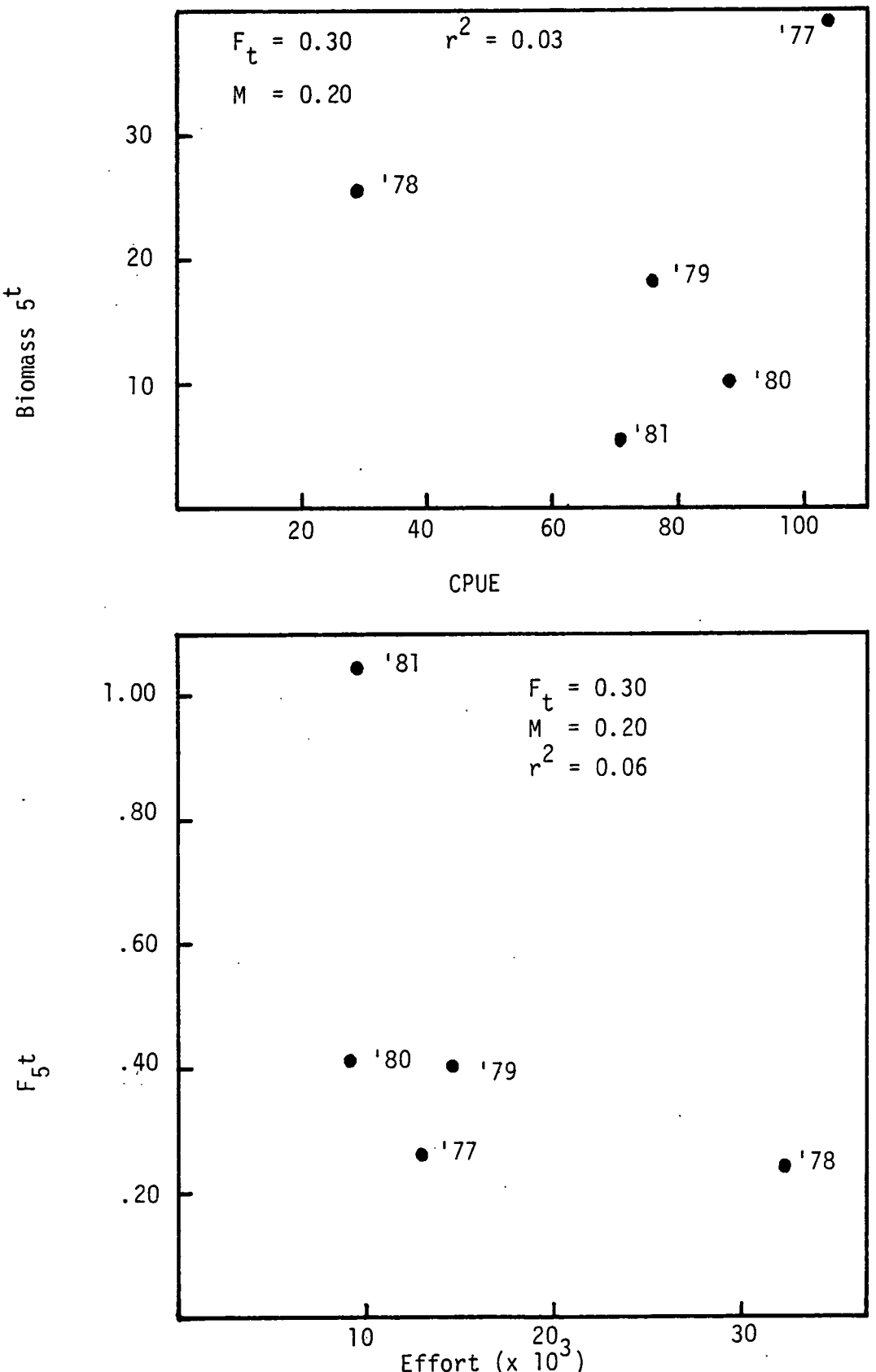


Fig. 9 . Relationships between A) CPUE and 5+ biomass and B) Effort and F_{5+} from the spring commercial gillnet fishery in Area C (F_t = 0.30, M = 0.20).

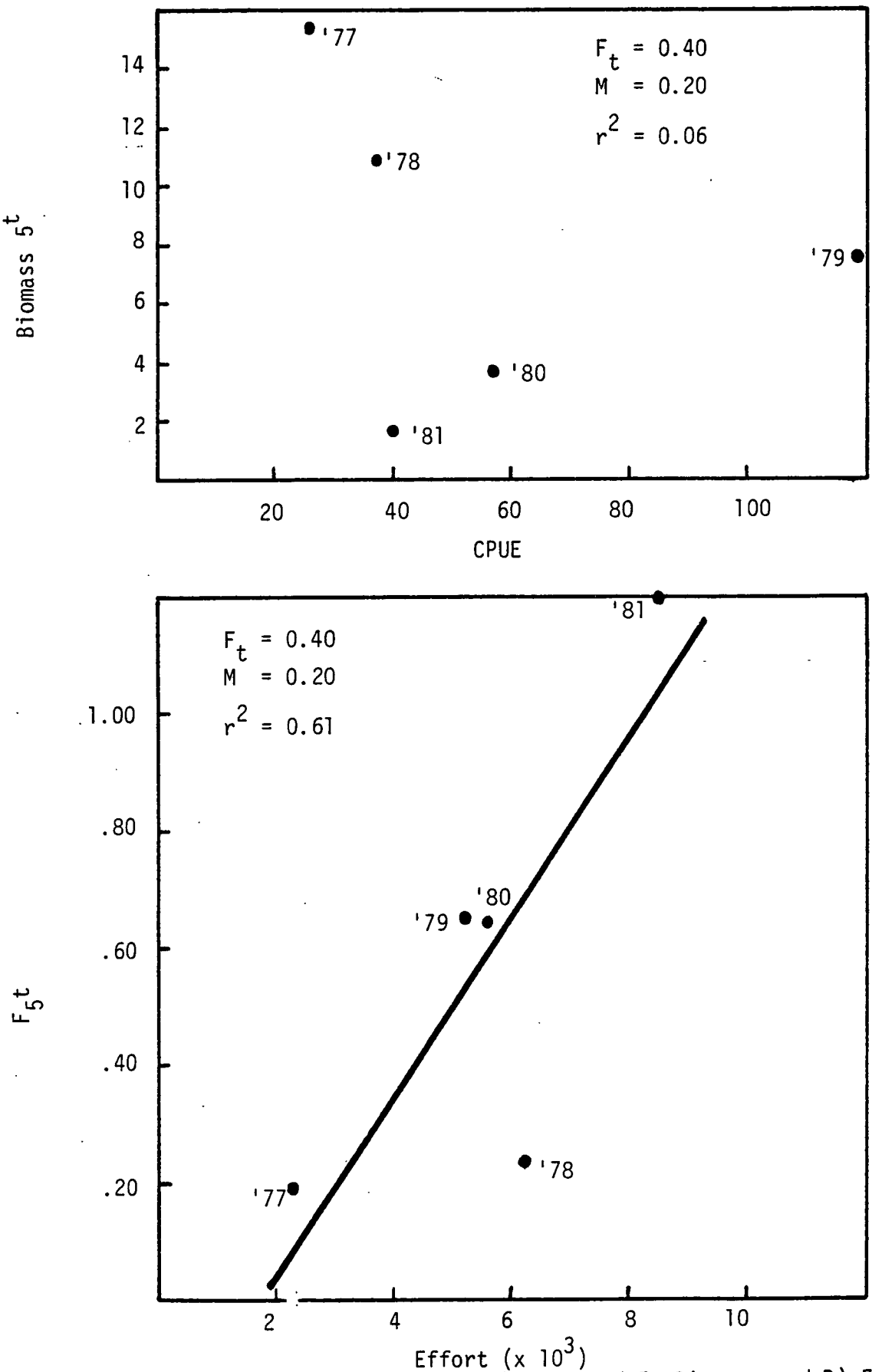


Fig. 10. Relationships between A) CPUE and 5+ Biomass and B) Effort and F_{5+} from the spring commercial gillnet fishery in Area D (F_t = 0.40, M = 0.20).

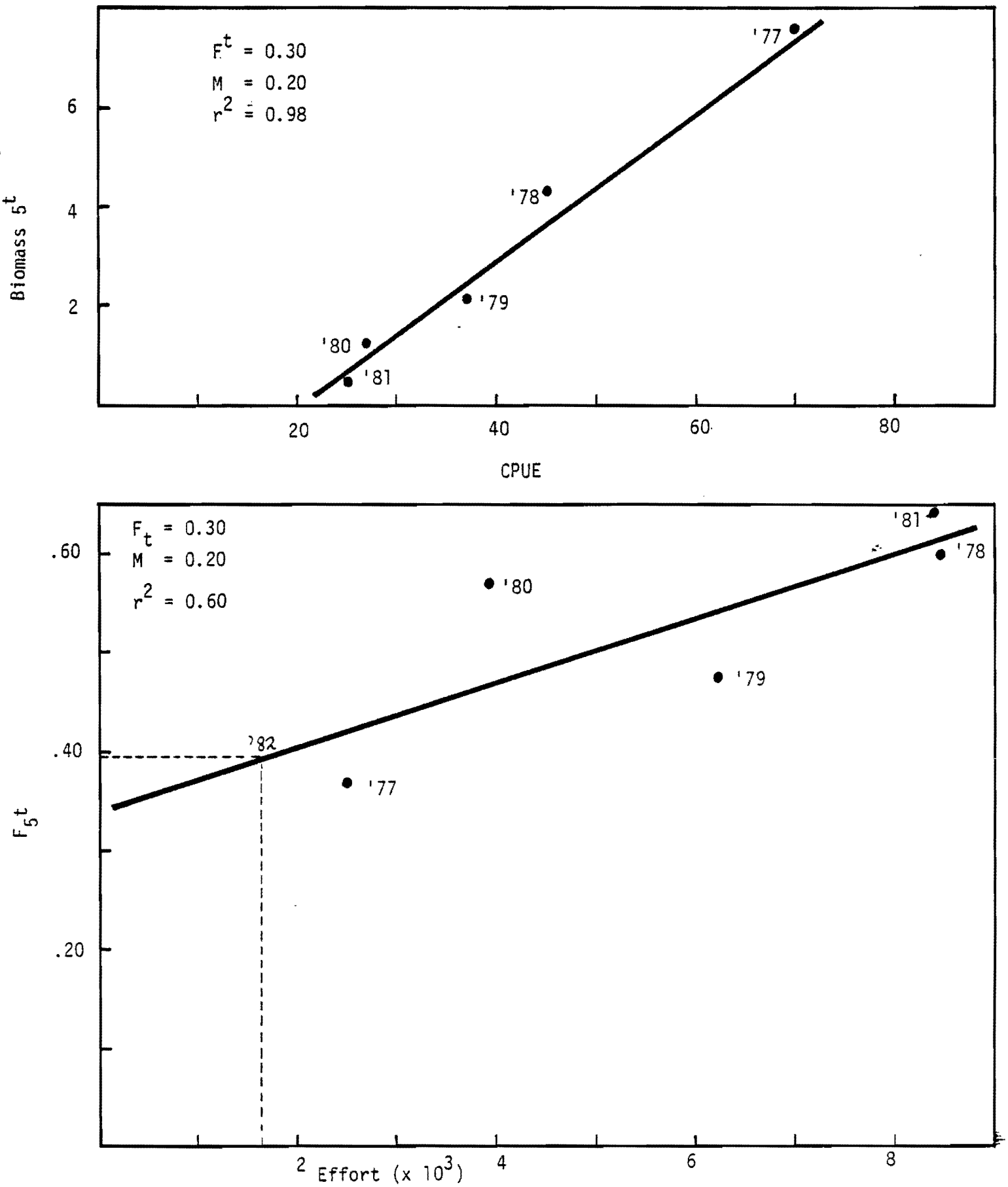


Fig. 11. Relationships between A) CPUE and 5+ Biomass and B) Effort and F_{5+} from the spring commercial gillnet fishery in Areas E&F (F_t = 0.30, M = 0.20).