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The Canadian Fishery for Northern Shrimp (Pandalus borealis) in NAFO Division 0A and Subarea 1, 1979-1996

by

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INTRODUCTION

Weekly quota reports, to the end of October, 1996, show that about 2100 t of shrimp have been taken by Canadian vessels in Div. 0A from an allocation of 8500 t. The total shrimp catch for 1995 was approximately 2360 t, 28% of the quota. Ten vessels have participated in the fishery to date in 1996, compared to 11 in 1995. The number of northern shrimp licences has remained at 17 since 1991.

Log book records and daily vessel hails provided preliminary information on fleet activity and performance in 1996. Data from previous years have been updated as much as possible in the present analysis. Catch, effort, catch per unit effort (CPUE) and size composition of shrimp from the commercial catches are compared over time and information is provided on shrimp discards. Sampling data were obtained at sea by fisheries observers assigned to each vessel in the fleet.

MATERIALS AND METHODS

Catch (kilograms) and effort (hours fished) were compiled from vessel logs for the period 1979 to 1995 and from available logs and daily hails up to late October, 1996. The data were summarized by year, month and vessel (n = 606). Since 1981, fishing effort has been confined to NAFO Div. 0A in an area extending from about 67° 20' to 68° 45' N and 58° to 59° 30' W (Fig. 1).

Annual CPUE's (kg/hr) were calculated two ways:

1. The catch reported in vessel logs/hails from 1979 to 1996 was divided by the corresponding effort, providing a series of unstandardized, weighted, annual catch rates.

2. Data from 1981 to 1996 were analyzed for year, month and vessel effects using SAS multiple regression procedures, producing a predicted, annual catch rate series. The catch and effort data set was selected for CATCH > 0 and MONTH > 5 and the CPUE variable (catch/effort) was log (base e) transformed for standardization. Seven observations were deleted from the total of 588 after examination of the studentized residuals from an initial run of the regression analysis revealed them as outliers (i.e. data were retained for a second run if -3.00 < STUDENT < 3.00). The annual log CPUE values, estimated from the final analysis, were retransformed to their original units of kg/hr.

Both unstandardized and standardized catch rates were indexed to 1981.

Available size compositions from the catches sampled by observers during the 1981 - 1996 period were used to calculate the total numbers caught in each year. Catch at length was estimated in three steps: 1. the number in the sample was adjusted (by ratio of weight) to the number caught in the set; 2. numbers from all sets for the month were totalled and adjusted (by weight) to the monthly catch reported in vessel logs; 3. the numbers from all months were totalled and adjusted (by weight) to the total catch for the year.

The numbers caught at 0.5 mm carapace length (CL) intervals for each year up to 1995 were converted to catch at age by modal analysis (Macdonald and Pitcher, 1979) of the annual length frequency distributions. The number of age components in the catch and initial estimates of their mean lengths were based on the findings of Savard et al. (1994). Final runs were made with all coefficients of variation held fixed at an average value of 0.048. The rationale for this constraint is described in Parsons and Veitch (1991). Proportions of female ages for recent years were constrained to the values estimated by observers for primiparous and multiparous females. For each age, mean lengths, proportions, numbers caught and numbers per hour (standardized and unstandardized) were tabulated.

Estimates of the proportions of discarded shrimp by month and year also were derived from the observer data.

RESULTS

Location of fishing

Over the past 16 years, the Canadian fishery has been restricted to Div. 0A, between the international boundary to the east and the 500 m depth contour to the west (Fig. 1). Parsons and Veitch (1995) noted changes in the distribution of effort over time. From 1981 to 1987, most activity occurred from about 67° 30' to 68° 10'N and 58° to 59° W but, beginning in 1988, substantially more effort was expended north of 68° N and west of 59° W. High densities of shrimp (as represented by catch rates > 500 kg/hr) generally occurred throughout the area fished each year.

By 1989, virtually all the available grounds were fished and extensive coverage of the area also was achieved in 1990 and 1991. However, beginning in 1992, effort was displaced to the western and southern regions where catch rates were highest (Parsons and Veitch, 1995). Although the 1996 data are incomplete (Fig. 1 - insert), they show the same tendencies as the previous four years.

Catch, effort and CPUE

Catch, effort and CPUE for shrimp by month and year as derived from the available vessel logs (supplemented with hails in 1996) are given in Tables 1, 2 and 3, respectively. The fishery usually begins in late June - early July and continues into late November. However, most of the catch is taken and most of the effort expended in the August to October period. Total catches fluctuated during the late 70's and early 80's, increased from about 2100 tons in 1984 to 7500 tons in 1992 and declined, thereafter, to 1995 (Fig. 2). Unstandardized effort (Fig. 3a) showed approximately the same trend, over time, as catch. It is anticipated that the final catch and effort estimates for 1996 will be about the same as those of 1995.

The seasonality of the fishery is further evident in the monthly CPUE data (Table 3). In most years, catch rates were relatively high during the June - July period, declined during August - September and either stabilized or increased in October and November. This pattern was evident in 1996. Annual, unstandardized catch rates (Fig. 4a) were fairly stable up to 1985, increased to a substantially higher level from 1986 to 1988 and subsequently declined to 1991. Some improvement occurred in 1992 and 1993 but catch rates from 1994 to 1996 returned to the level observed in the early 1980's.

The results of the multiple regression analysis to standardize the catch rates (Table 4a) showed that the model explained 68% of the total variation and that all three class variables (YEAR, MONTH and VESSEL) were highly significant. T-values indicated that catch rates for most years were significantly ($P < 0.05$) higher than the 1996 estimate. Although 1996 was the lowest in the series, the 1994 and 1995 estimates were not significantly higher ($P > 0.10$).

Standardized effort (Fig. 3b) showed roughly the same trends as the unstandardized series except the increase from 1984 was more pronounced and continued to 1992. The log CPUE values were retransformed (Table 4b) to provide standardized estimates in the original units (kg/hr). The interpretation of these predicted catch rates differs from the unstandardized values. Except for the high CPUE's in 1981/82 and 1987/88, the standardized series indicated relative stability (Fig. 4b) up to 1993. However, the values predicted for recent years (1994 to 1996) were the lowest in the sixteen year period.

A summary of TAC, catch, effort and CPUE for the Canadian fishery is given in Table 5.

Length distributions

Length frequencies from catches sampled in 1996 (Fig. 5) showed three prominent size groups at modal lengths of 14, 21 (males) and 24-25 mm CL (females). Other components are evident at 18 mm (males) and 22 mm (females). Within the female group, there are clearly two primiparous components (22 and 24 mm) and one multiparous (25.5 mm). Males of all sizes comprised 71% of the catch in numbers, 21% were primiparous females and 8% multiparous.

Compared to previous years (Fig. 6), the distribution in 1996 is unique due to the substantial component of males at 14 mm in addition to the dominance of the mode at 21 mm. The latter is consistent with the strong presence of males around 19 - 20 mm in 1995.

Data on sizes of shrimp caught during the 1996 fishery in Div. 0A are lacking. The late start and long trips resulting from low catch rates delayed the delivery of length frequencies for processing. Those presented here represent only 415 tons, less than 20% of the total catch to date and one trip for each of two vessels.

Age composition

Due to insufficient data for the 1996 fishery in Div. 0A, a quantitative catch-at-age analysis was not attempted. The 1995 data have been updated and reanalyzed, however, and the results for the 1981 - 1995 period are presented in Tables 6 through 10 and Fig. 6.

Observations worth noting for 1996 are the indication that part of the 1990 year class has already undergone sex inversion (i.e. primiparous females at 22 mm) and, particularly, the presence of a relatively strong 1993 year class (i.e. prominent mode at 14 mm). These observations need to be corroborated by data from other components of the 1996 fishery in SA 1 and the research trawl survey.

Ageing of commercial length distributions (Fig. 6) followed the procedures of Parsons and Veitch (1991). Since 1993, the analyses have included constraining the proportions of primiparous and multiparous females (mainly ages 7 and 8+) to those determined from the observer sampling data. Estimated mean lengths at age (Table 6) agreed well with those from the previous ageing study by Savard et al. (1994) and showed consistency from year to year.

The estimated proportions at age of the numbers of shrimp caught from 1981 to 1995 (Table 7) showed that the relative contribution of ages 7+ (females) to the catches declined from over 80% in 1981 to 47% in 1984, increased to 65% in 1985 and, from 1986 to 1993, varied between 43 and 58%. About 40% was estimated in this plus group both in 1994 and 1995. Three-year-old male shrimp did not contribute substantially to the catch up to 1987 but formed an identifiable mode at 14.6 mm in the 1988 length distribution (the 1985 year class). Modes at roughly 14 mm also were evident in 1993, 1994 and 1995. Age 3 males in the 1996 samples accounted for 17.5% of the total numbers. Despite the preliminary nature of these data, it is noted that the highest percentage at age 3 in previous years was 2.6% in 1993.

The proportions in Table 7 were applied to the total estimated catch numbers to derive a catch-at-age matrix (Table 8) which was subsequently divided by both the unstandardized and standardized fishing effort to produce age-specific indices of abundance (Tables 9, 10 and Fig. 7). Female ages are combined as 7+ in this analysis.

Age 3 males occurred only in low numbers in the years indicated above and no interpretation of the catch rates was made. Catch rates for males at age 4 showed substantial variation within an overall increasing trend. CPUE's for males aged 5 and 6 also increased over time with indications (peaks) that relatively strong year classes were produced in 1981, 1985, 1990 and possibly 1988. Ages 7+, representing the female component of the stock, are targeted by the fishery and the numbers caught per hour for these animals showed a decreasing trend since 1987, similar to the catch rate series from the vessel log data.

Shrimp discards

The percentages of shrimp discards determined by observers declined in recent years from a high of 6.5% in 1991 to 1% in 1996, the lowest level achieved during the 1981 - 1996 period.

Shrimp discards (% of total shrimp catch) in Div. 0A, 1981 - 96, estimated by observers.

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Month																
May								0.7								
Jun	2.9		0.5		4.2	2.4	1.9	1.3	2.3						1.6	
Jul	2.7	2.6	1.6	6.9	3.1	2.4	1.8	1.8	1.9	9.6	8.2	3.7	2.6	2.2	1.3	
Aug	4.6	3.5	3	5.4	3.6	2.6	3.5	1.6	3.1	4.8	7.8	3.5	2.3	1.7	1.2	1.1
Sep	5.8	3.6	3.6	6.1	3.2	2.2	1.6	2.5	6.2	5.2	8	4.8	2.8	1.6		1
Oct	5.8	3.7	5.2	3.3	4	2	2.1	3.3	3.5	2.4	5.6	3.5	2.5	1.5		
Nov	3.6	3.3	5.8	6.7	2.4	2.3	2	4.2	3.6	2.2	3.8	4.7	2	1.5		
Dec	3.3							1.2								
Mean	**4.31**	**3.3**	**3.41**	**5.54**	**3.48**	**2.31**	**2.24**	**2.57**	**3.26**	**4.36**	**6.54**	**4.1**	**2.47**	**1.63**	**1.35**	**1.04**

DISCUSSION

The Canadian fishery for northern shrimp in Davis Strait has existed since the late 1970's and the data collected are considered useful in the interpretation of stock status. Important observations include:

- Catch rate indices (unstandardized and standardized) have declined since 1987 and, for the 1994 - 1996 period, are at a lower level than observed from 1989 to 1993.

- Further analyses showed that the decline was associated with a gradual reduction in the catch rates of female shrimp while catch rates for males varied without trend.

- Although recruitment of a few relatively strong year classes raised standardized CPUE's in the early and late 1980's over the "base level" observed from 1983 to 1986, the strong 1985 year class only maintained catch rates in the early 1990's near a similar "base level". The 1990 year class, which appeared strong relative to adjacent year classes, also failed to improve the CPUE in 1996.

- The 1996 fishery data from Div. 0A suggest that the 1993 year class is strong. Given the lack of sampling data, this needs to be investigated further from other sources of information.

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Table 1. Catch(t) by month/year from vessel logbooks - NAFO Div. 0A+SA 1, 1979-1996

Year	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	Sum
Month																			
4	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	0
6	.	.	347	.	17	.	290	309	144	42	509	.	.	.	.	.	31	.	1689
7	.	54	756	373	752	379	924	603	505	763	2105	890	1003	963	286	385	311	78	11130
8	.	.	665	650	1241	354	604	363	1157	1284	1280	1200	1591	1776	1377	1388	624	668	16222
9	42	.	585	458	798	398	414	241	1183	989	662	852	792	2956	1602	960	364	528	13824
10	71	.	833	335	992	324	582	242	2252	1294	1264	1214	1233	1214	1255	1248	96	371	14820
11	248	.	743	249	257	40	255	604	2	531	607	1157	676	524	816	661	85	.	7455
12	16	62	72	.	.	.	.	.	.	7	.	.	.	0	42	.	.	.	199
Sum	376	116	4001	2064	4057	1495	3069	2362	5244	4910	6427	6314	6295	7432	5377	4642	1512	1645	65338
%Total	21.7	4.3	75.7	100	74.9	69.8	100	78.9	86	83.5	88.8	86	78	99.2	97.7	97.4	64	78.3	

Table 2. Effort (hrs) by month/year from vessel logbooks - NAFO Div. 0A+SA 1, 1979-1996

Year	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	Sum
Month																			
4	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	4
6	.	.	746	.	33	.	597	471	166	59	937	.	.	.	.	.	64	.	3073
7	.	121	1804	617	1928	845	2502	1340	519	1188	5391	2079	1906	1847	505	779	941	166	24478
8	.	.	2170	1836	4100	1360	2412	995	2341	3237	3738	3745	5482	4460	3770	4647	2106	1932	48331
9	81	.	1968	1504	3151	1641	1784	731	2714	2595	1734	1826	3028	5773	4150	3430	922	1967	38999
10	325	.	3229	1248	3995	1370	1804	577	4944	2197	3210	3089	3233	3582	2769	4072	328	1377	41349
11	1072	.	2980	953	1074	129	827	1191	3	1167	1423	2370	2377	1806	2056	2958	239	.	22625
12	114	203	483	.	.	.	.	.	.	50	.	.	.	4	56	.	.	.	910
Sum	1592	324	13380	6158	14281	5349	9926	5305	10687	10493	16433	13109	16026	17472	13306	15886	4600	5442	179769

Table 3. CPUE by month/year from vessel logbooks - NAFO Div. 0A+SA 1, 1979-1996

Year	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
Month																		
4	.	.	.	.	.	122	.	.	.	.	.	.	.	.	.	.	.	.
6	.	.	466	.	508	.	486	656	868	720	543	.	.	.	.	.	488	.
7	.	445	419	604	390	448	369	450	973	642	391	428	526	521	565	494	331	470
8	.	.	306	354	303	260	250	365	494	397	342	321	290	398	365	299	296	346
9	513	.	297	304	253	243	232	330	436	381	382	466	261	512	386	280	395	268
10	218	.	258	268	248	236	323	419	456	589	394	393	381	339	453	306	293	269
11	231	.	249	261	239	311	308	507	522	455	426	488	285	290	397	223	356	.
12	140	306	149	.	.	.	.	.	.	130	.	.	.	93	742	.	.	.

TABLE 4A. STANDARDIZATION OF CPUE - MULTIPLICATIVE, YEAR-MONTH-VESSEL MODEL, 1981 - 1996

General Linear Models Procedure

Dependent Variable: LNCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	67	61.21613659	0.91367368	16.18	0.0001
Error	513	28.96352350	0.05645911		
Corrected Total	580	90.17966009			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.678824	4.075187	0.23761126	5.83068360

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	15	21.88008696	1.45867246	25.84	0.0001
MONTH	6	11.94897113	1.99149519	35.27	0.0001
VESSEL	46	27.38707850	0.59537127	10.55	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	15	9.23754608	0.61583641	10.91	0.0001
MONTH	6	7.52247559	1.25374593	22.21	0.0001
VESSEL	46	27.38707850	0.59537127	10.55	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		5.230789123 B	67.72	0.0001	0.07724619
YEAR	81	0.473285123 B	5.24	0.0001	0.09026487
	82	0.626515101 B	6.13	0.0001	0.10217288
	83	0.350918980 B	4.21	0.0001	0.08342366
	84	0.310152788 B	2.90	0.0039	0.10689239
	85	0.179921821 B	1.66	0.0974	0.10835644
	86	0.292286348 B	3.18	0.0016	0.09200249
	87	0.621821415 B	8.30	0.0001	0.07493612
	88	0.516083945 B	7.16	0.0001	0.07207757
	89	0.278598871 B	4.13	0.0001	0.06748243
	90	0.341733019 B	5.05	0.0001	0.06766674
	91	0.241915199 B	3.58	0.0004	0.06753784
	92	0.304293431 B	4.71	0.0001	0.06463205
	93	0.290099499 B	4.40	0.0001	0.06586003
	94	0.010227006 B	0.16	0.8734	0.06415735
	95	0.108015694 B	1.52	0.1285	0.07093786
	96	0.000000000 B	.	.	.

TABLE 4B. RETRANSFORMED ANNUAL CATCH RATES FROM MULTIPLE REGRESSION.

	LN TRANSFORM			RETRANSFORMED		
SUMMARY	YHAT	YHATVAR	STDERR	MEAN	VARIANCE	STDERR
INTRCPT	5.2307891	0.005967	0.0772462	191.72929	219.11855	14.802654
1981	5.7040742	0.0048524	0.0696589	307.94707	459.93394	21.446071
1982	5.8573042	0.0069513	0.0833742	358.56373	892.34062	29.872071
1983	5.5817081	0.0039292	0.0626831	272.60511	291.98433	17.087549
1984	5.5409419	0.0078301	0.0884877	261.20455	533.17603	23.090605
1985	5.4107109	0.0084701	0.0920334	229.23604	444.07932	21.07319
1986	5.5230755	0.0069035	0.0830871	256.69833	454.21096	21.312226
1987	5.8526105	0.0039521	0.0628655	357.42131	504.86172	22.469128
1988	5.7468731	0.0038051	0.0616857	321.58162	393.52292	19.837412
1989	5.509388	0.0037647	0.061357	253.60719	242.14657	15.561059
1990	5.5725221	0.0037468	0.0612108	270.13712	273.43626	16.535908
1991	5.4727043	0.0038632	0.0621544	244.46046	230.86916	15.194379
1992	5.5350826	0.0041705	0.0645791	260.15506	282.2199	16.799402
1993	5.5208886	0.0044655	0.0668245	256.45061	293.59796	17.1347
1994	5.2410161	0.0040859	0.0639214	193.88278	153.57782	12.392652
1995	5.3388048	0.0055967	0.0748114	213.63855	255.22487	15.975759
1996	5.2307891	0.005967	0.0772462	191.72929	219.11855	14.802654

Table 5. Data from the Canadian fishery for shrimp in NAFO SA 0+1, 1979 - 1996.

			UNSTANDARDIZED			STANDARDIZED		
YEAR	TAC (T)	CATCH * (T)	CPUE (KG/H)	INDEX	EFFORT ** (HR)	CPUE (KG/H)	INDEX	EFFORT ** (HR)
1979	2000	1732	236		7339			
1980	2500	2726	358		7615			
1981	5000	5284	299	1.00	17672	308	1.00	17156
1982	5000	2064	335	1.12	6161	359	1.17	5749
1983	5000	5413	284	0.95	19060	273	0.89	19828
1984	5000	2142	280	0.94	7650	261	0.85	8207
1985	6120	3069	309	1.03	9932	229	0.74	13402
1986	6120	2995	445	1.49	6730	257	0.83	11654
1987	6120	6095	491	1.64	12413	357	1.16	17073
1988	6120	5881	468	1.57	12566	322	1.05	18264
1989	7520	7235	391	1.31	18504	254	0.82	28484
1990	7520	6177	405	1.35	15252	270	0.88	22878
1991	8500	6788	330	1.10	20570	244	0.79	27820
1992	8500	7493	425	1.42	17631	260	0.84	28819
1993	8500	5491	404	1.35	13592	256	0.83	21449
1994	8500	4766	292	0.98	16322	194	0.63	24567
1995	8500	2361	329	1.10	7176	214	0.69	11033
1996	8500	2100	302	1.01	6954	192	0.62	10938

* Catches (tons) from 1979 - 1989 as reported in MacDonald and Collins (1990).
Catches from 1990 to 1995, inclusive, are not official statistics and 1996 incomplete (to Oct. 31).
Division 0A only from 1981 onward.

** Effort calculated from total catch/CPUE. CPUE calculated from vessel logs.
Reference month for standardization of CPUE is August.

Table 6. Mean carapace length (mm) at age for shrimp in NAFO Division 0A, 1981 - 1995.

YEAR	_81	_82	_83	_84	_85	_86	_87	_88	_89	_90	_91	_92	_93	_94	_95
AGE															
3	-	-	-	-	-	-	-	14.62	-	-	-	-	14.51	13.75	14.12
4	18.32	18.48	17.43	19.03	18.86	18.38	17.59	17.87	17.51	18.63	17.66	16.74	17.94	17.61	17.44
5	19.73	21.08	20.23	21.33	20.76	21.26	19.85	20.05	19.76	20.58	20.2	19.7	20.63	19.7	20.15
6	22.03	23.13	22.51	22.92	22.47	22.87	22.3	22.34	22.31	22.83	21.85	22.32	22.83	22.04	22.29
7	24.06	25.09	25.53	25.04	24.92	25.11	25.25	25.56	25.17	25.47	24.58	24.94	24.86	24.88	24.78
8+	26.97	26.82	27.27	27.22	27.38	27.61	27.54	27.8	27.22	27.36	27.39	27.77	27.77	26.04	26.49

Table 7. Proportion of shrimp caught at age as determined from commercial length frequency distributions - NAFO Division 0A, 1981 - 1995.

YEAR	_81	_82	_83	_84	_85	_86	_87	_88	_89	_90	_91	_92	_93	_94	_95
AGE															
3	0	0	0	0	0	0	0	0.02	0	0	0	0	0.026	0.015	0.016
4	0.019	0.027	0.009	0.109	0.02	0.033	0.038	0.092	0.058	0.046	0.031	0.03	0.104	0.107	0.046
5	0.047	0.148	0.113	0.247	0.136	0.239	0.141	0.159	0.164	0.344	0.094	0.182	0.269	0.164	0.363
6	0.126	0.149	0.237	0.179	0.192	0.238	0.287	0.222	0.2	0.183	0.412	0.303	0.171	0.321	0.162
7	0.242	0.112	0.285	0.279	0.465	0.398	0.482	0.445	0.418	0.264	0.279	0.302	0.284	0.179	0.226
8+	0.566	0.564	0.356	0.186	0.187	0.092	0.052	0.062	0.16	0.163	0.184	0.183	0.146	0.214	0.188
TOTAL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 8. Number (x10-3) of shrimp caught at age by year in Div. 0A, 1981 - 1995.

Year/Age	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
3	0	0	0	0	0	0	0	14842	0	0	0	0	19832	9968	5354
4	10185	5727	5227	29642	7042	12095	29070	68271	54333	37565	27551	29309	79328	71107	15394
5	25193	31393	65626	67170	47888	87594	107865	117991	153631	280921	83542	177805	205186	108986	121479
6	67540	31605	137640	48678	67607	87227	219554	164742	187355	149443	366162	296017	130434	213321	54214
7+	433111	143390	372267	126453	229581	179586	408509	376235	541457	348701	411488	473822	327993	261169	138212
TOTAL	536029	212115	580760	271943	352118	366502	764998	742081	936776	816630	888743	976953	762774	664551	334654

Table 9. Number of shrimp caught per hour (unstandardized) at age in Div. 0A, 1981 - 1995.

Year/Age	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
3	0	0	0	0	0	0	0	1181	0	0	0	0	1459	611	746
4	576	930	274	3875	709	1797	2342	5433	2936	2463	1339	1662	5836	4357	2145
5	1426	5095	3443	8780	4822	13015	8690	9390	8303	18419	4061	10085	15096	6677	16929
6	3822	5130	7221	6363	6807	12961	17687	13110	10125	9798	17801	16790	9596	13070	7555
7+	24508	23274	19531	16530	23115	26684	32910	29941	29262	22863	20004	26874	24131	16001	19260
TOTAL	30332	34429	30470	35548	35453	54458	61629	59055	50626	53542	43206	55411	56119	40715	46635
Effort (hrs)	17672	6161	19060	7650	9932	6730	12413	12566	18504	15252	20570	17631	13592	16322	7176

Table 10. Number of shrimp caught per hour (standardized) at age in Div. 0A, 1981 - 1995.

Year/Age	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
3	0	0	0	0	0	0	0	813	0	0	0	0	925	406	485
4	594	996	264	3612	525	1038	1703	3738	1907	1642	990	1017	3698	2894	1395
5	1468	5461	3310	8184	3573	7516	6318	6460	5394	12279	3003	6170	9566	4436	11011
6	3937	5497	6942	5931	5045	7485	12860	9020	6578	6532	13162	10272	6081	8683	4914
7+	25245	24942	18775	15408	17130	15410	23927	20600	19009	15242	14791	16441	15292	10631	12527
TOTAL	31244	36896	29290	33135	26274	31449	44807	40631	32888	35695	31946	33900	35562	27051	30332
Effort (hrs)	17156	5749	19828	8207	13402	11654	17073	18264	28484	22878	27820	28819	21449	24567	11033

Fig.1 Northern shrimp fishing locations and density indices in Div. 0A, 1981-1996.

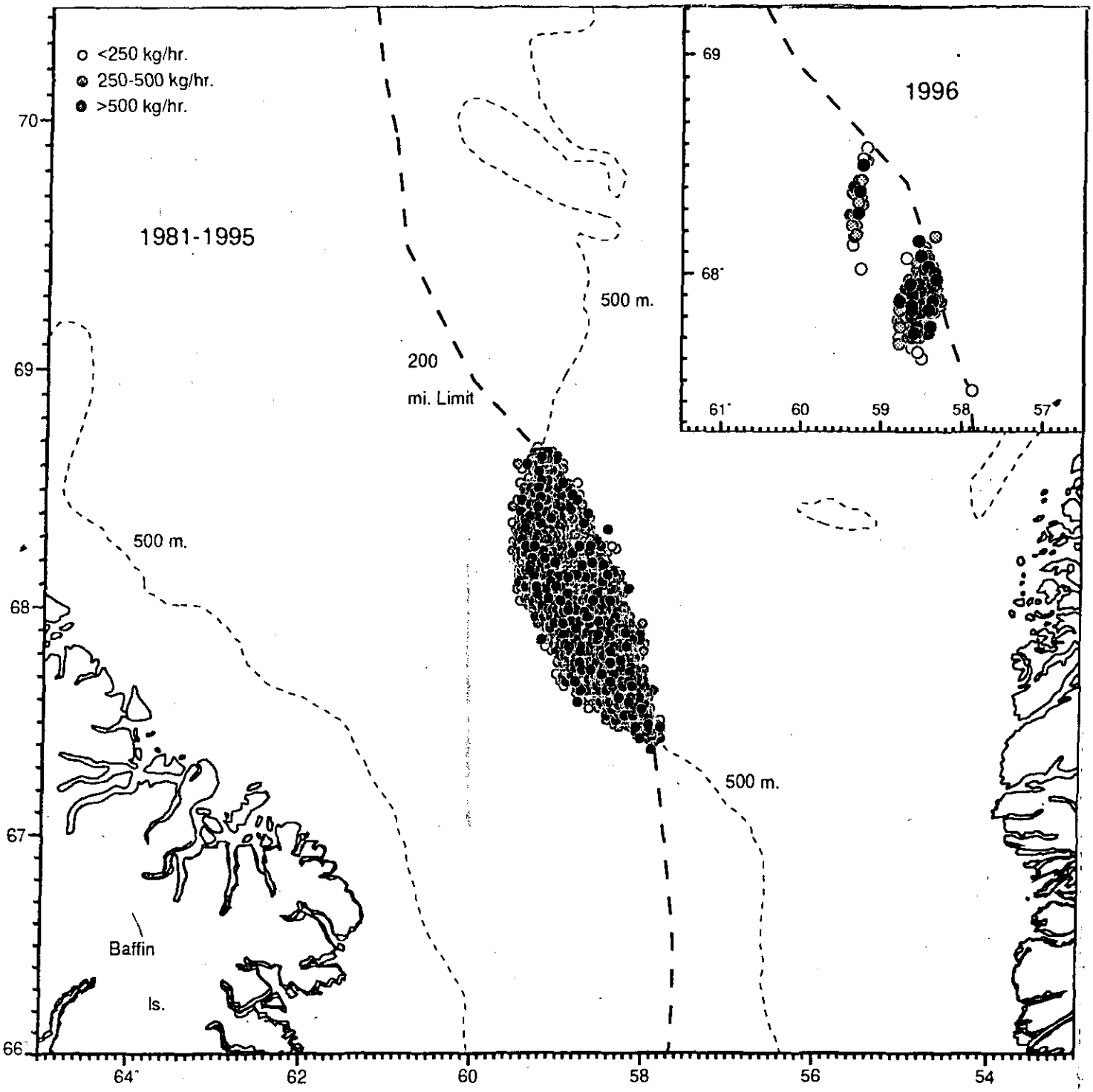


Fig. 2. Shrimp catches by Canada in SA 0+1, 1979 -1996

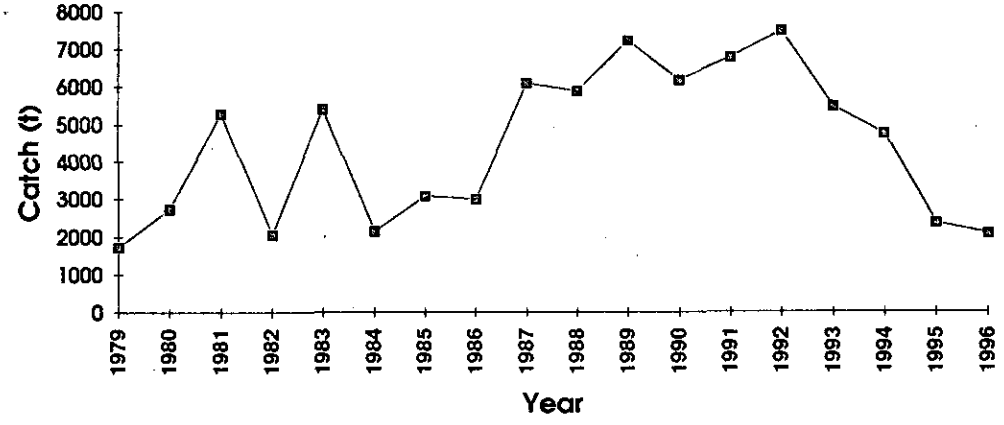


Fig. 3a. Unstandardized effort SA 0+1, 1979 - 1996

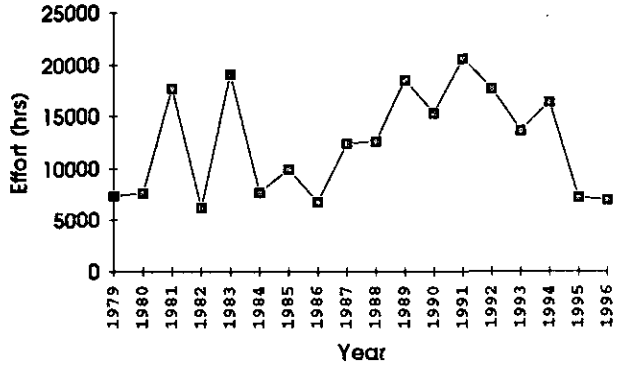


Fig. 3b. Standardized effort - Div. 0A, 1981 -1996

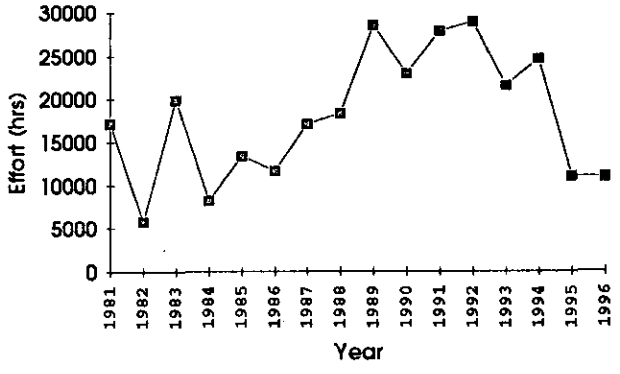


Fig. 4a. Unstandardized CPUE SA 0+1, 1979 - 1996

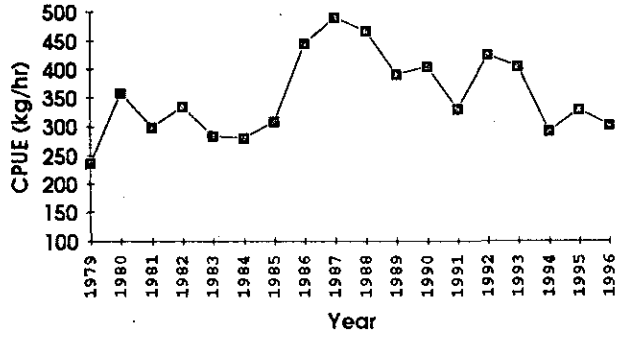
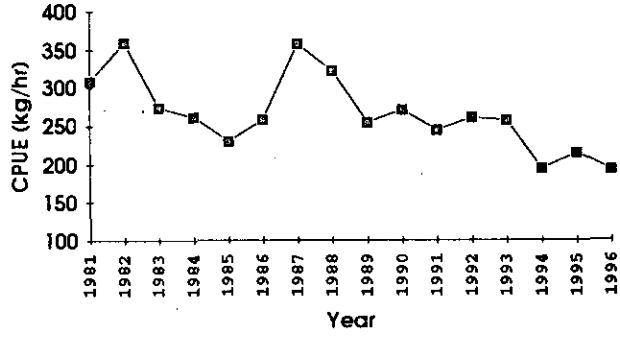


Fig. 4b. Standardized CPUE - Div. 0A, 1981 - 1996



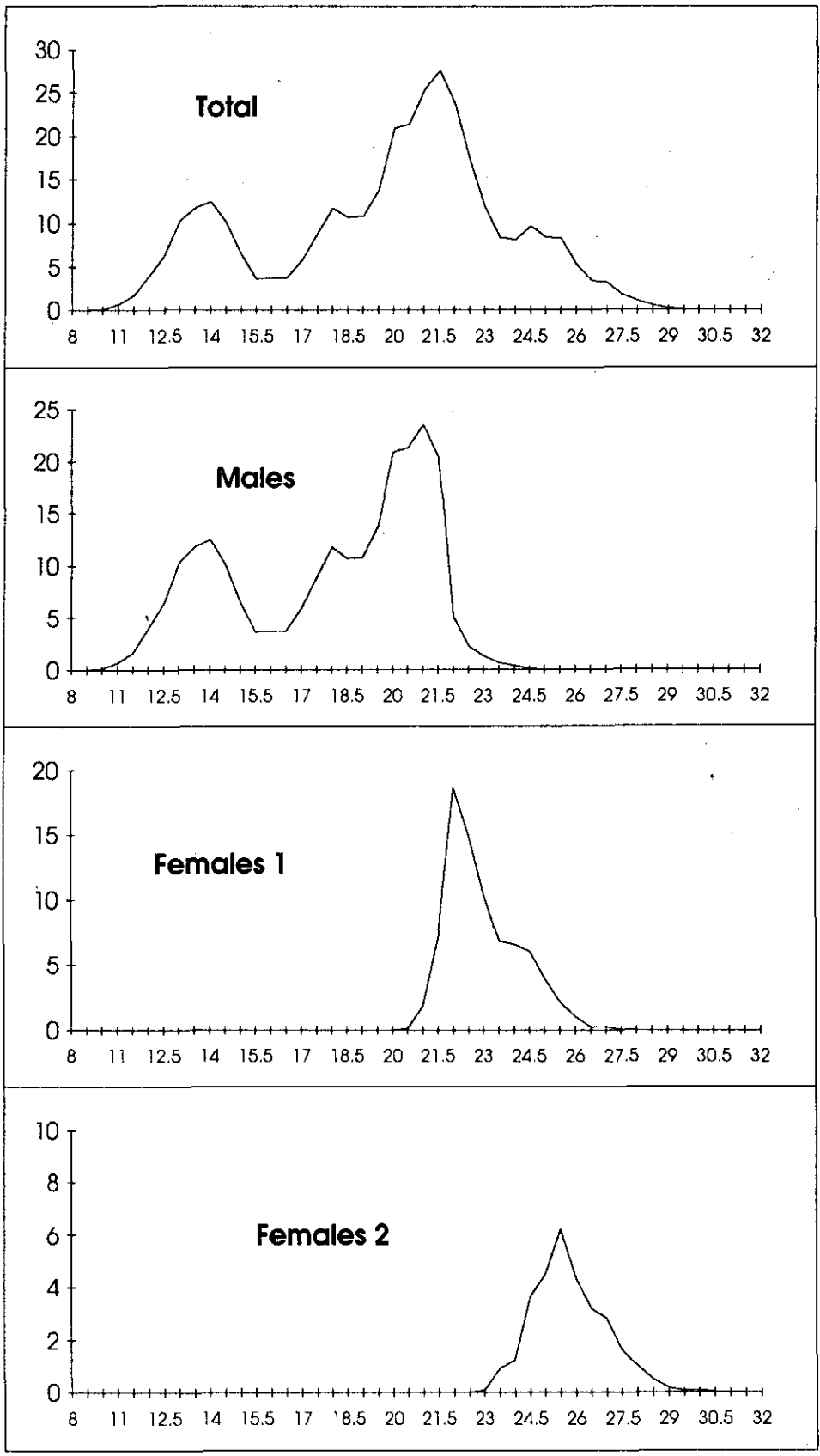


Figure 5. Commercial length frequencies from Div. 0A, 1996.

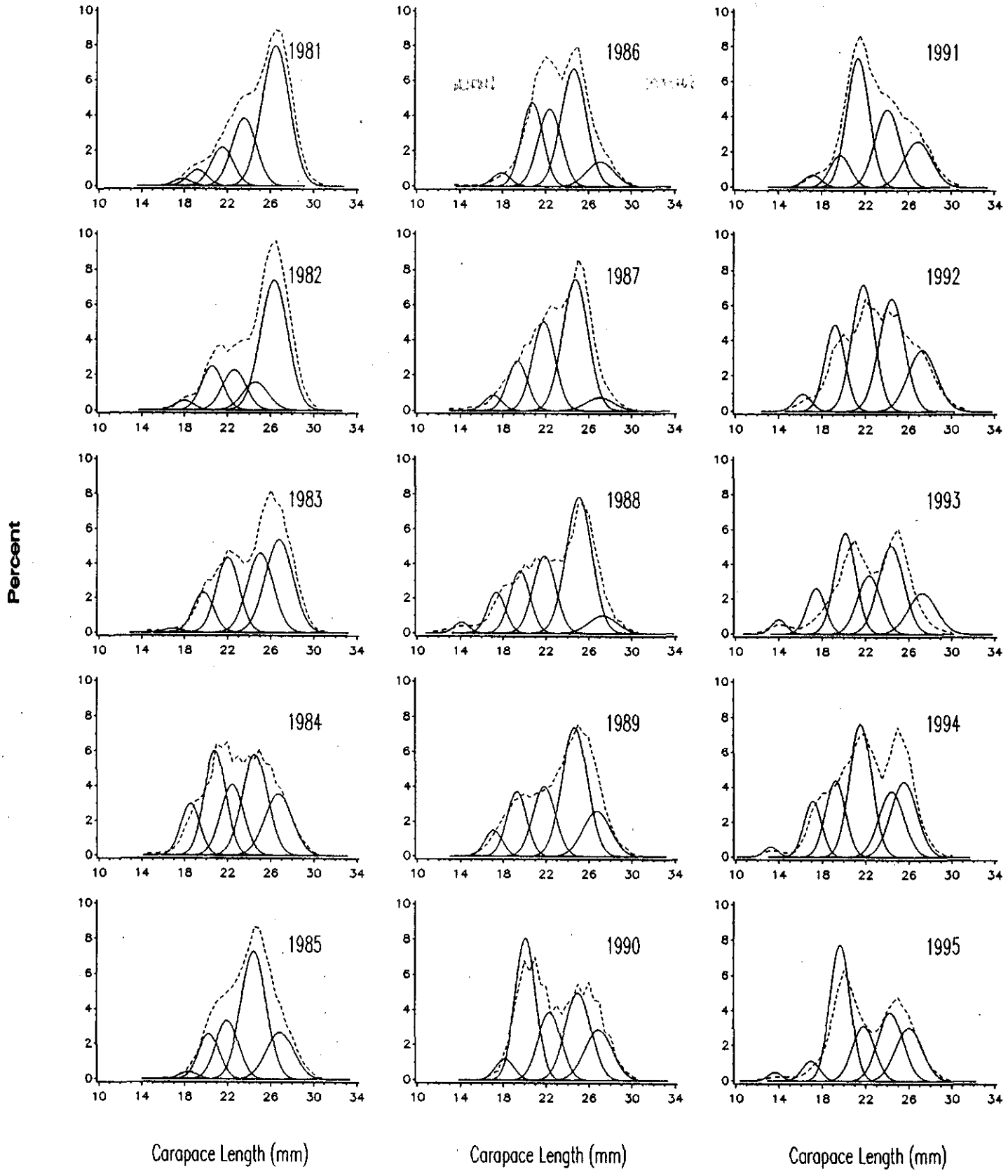


Fig. 6. Separation of ages from commercial length frequency data (broken line = commercial frequency), NAFO Div. 0A, 1981-1995.

Figure 7a. Number caught per hour (unstandardized) at age
Div. 0A, 1981 - 1995

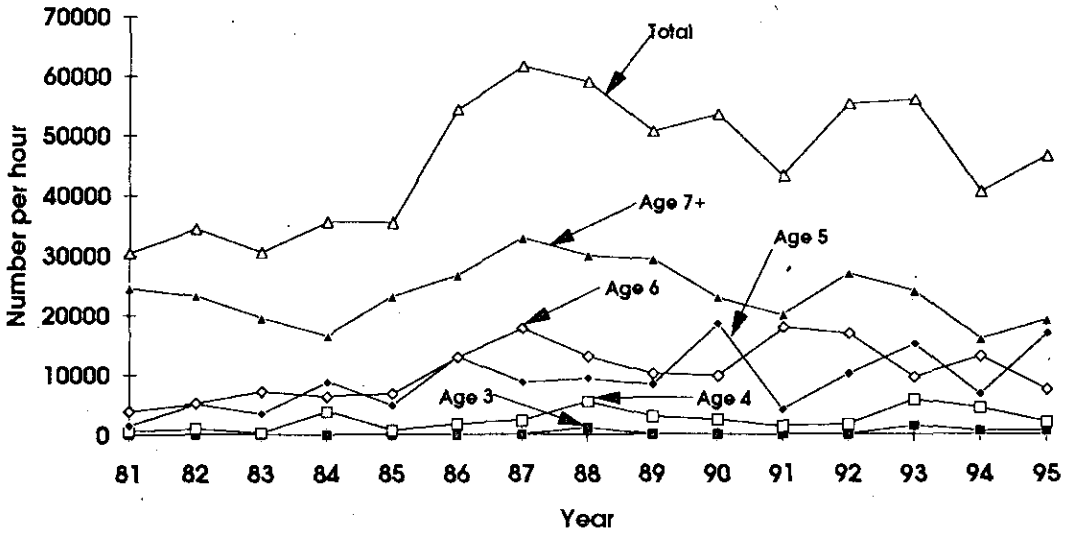


Figure 7b. Number caught per hour (standardized) at age
Div. 0A, 1981 - 1995