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The Canadian Fishery for Northern Shrimp (*Pandalus borealis*) in NAFO Division 0A and Subarea 1, 1979-1997

by

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INTRODUCTION

Quota reports, to the end of October, 1997, show that only 20 t of shrimp were taken by Canadian vessels in Div. 0A from an allocation of 8500 t. The total shrimp catch for 1996 was approximately 2600 t, 31% of the quota. Four vessels have participated in the fishery to date in 1997, compared to 10 in 1996. The number of northern shrimp licences for this area has remained at 17 since 1991.

Daily vessel hails provided preliminary information on fleet activity and performance in 1997 and 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. Sampling data were obtained at sea by fishery 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, from vessel logs and daily hails for 1996 and from hails only up to late October, 1997. The data were summarized by year, month and vessel (n = 616). Annual, unstandardized CPUE's (kg/hr) were calculated by dividing the catch reported in vessel logs/hails from 1979 to 1997 by the corresponding effort. Standardized CPUE's for 1996 and 1997 were calculated using the multiplicative model for Div. 0A derived by Hvingel et al. (1996). Annual estimates from 1981 to 1997 are presented here and incorporated in the single time series index which is assumed to reflect the development of the stock since 1976 (see Hvingel et al. this meeting).

Size compositions from the catches sampled by observers during the 1981 - 1996 period were used to calculate the total numbers caught in each year. No samples were available from the limited 1997 fishery. Catches at length and age were estimated as described by Parsons and Veitch (1991, 1996). For each age, mean lengths, proportions, numbers caught and numbers caught per hour (standardized and unstandardized) were tabulated by year.

RESULTS

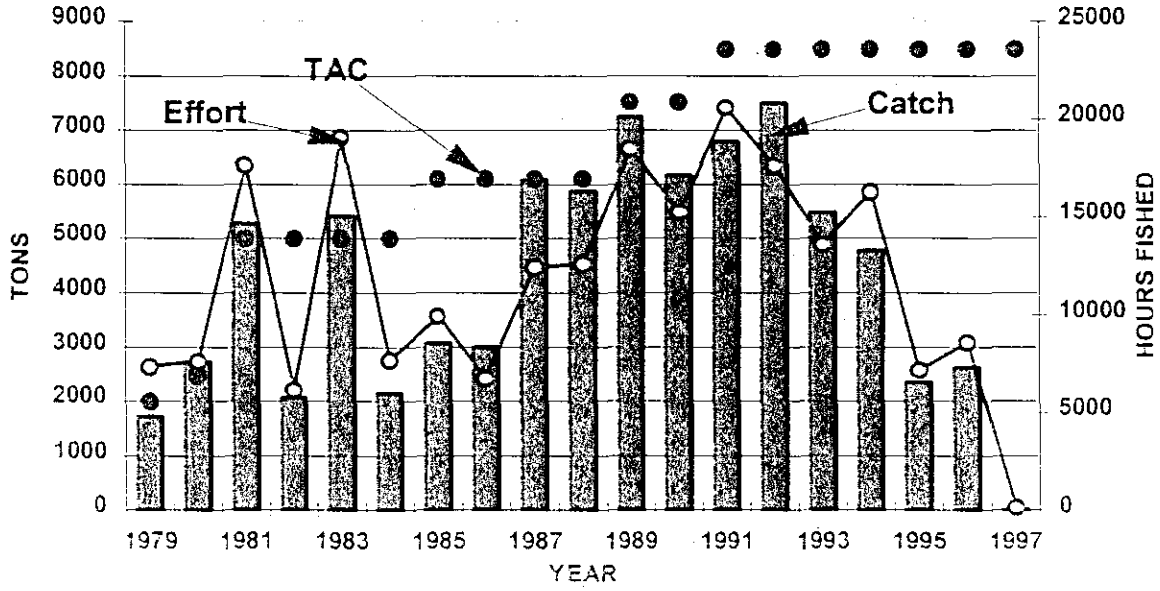
Location of fishing

Since 1981, the Canadian fishery has been restricted to Div. 0A in an area extending from about 67° 20' to 68° 45' N and 58° to 59° 30' W, between the international boundary to the east and approximately the 500 m depth contour to the west. 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. By 1989, virtually all the available grounds were fished and extensive coverage of the area also was achieved in 1990 and 1991. However, since 1992, effort has concentrated in the western and southern regions where catch rates were highest (Parsons and Veitch, 1996). Fishing locations in 1996 and 1997 are shown in Figure 1.

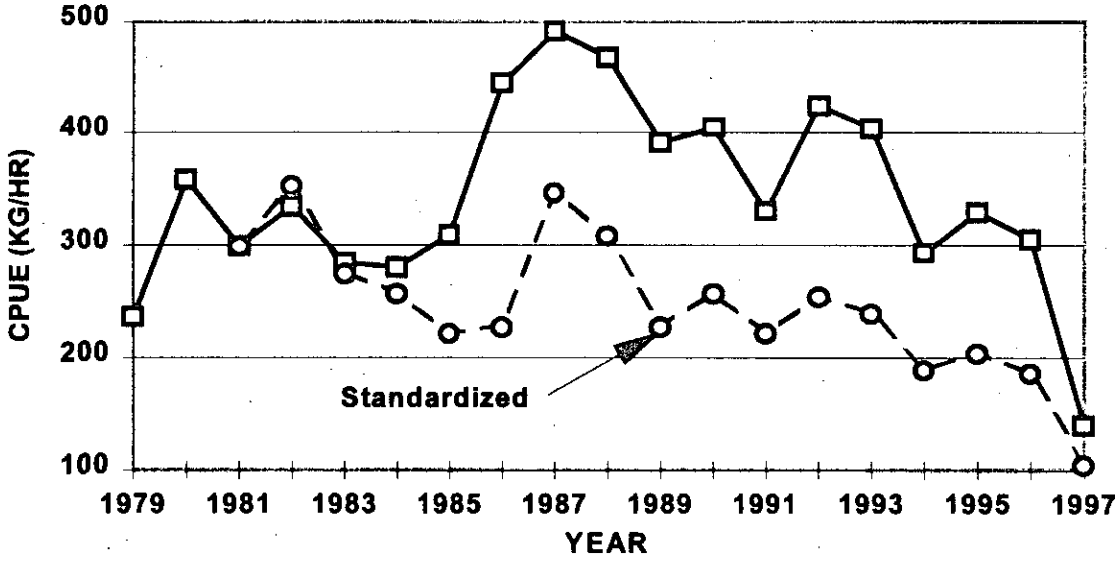
Catch, effort and CPUE

The fishery usually begins in late June - early July and continues into late November. However, most of the catch and effort occurs in the August to October period (Tables 1 and 2). Seasonality in fishery performance is evident in the monthly CPUE data (Table 3). In most years, catch rates (unstandardized) were relatively high during the June - July period, declined during August - September and either stabilized or increased in October and November.

Total catches fluctuated between 1700 and 5400 tons during 1979 to 1983, increased from about 2100 tons in 1984 to 7500 tons in 1992 and declined, thereafter, to about 2500 tons in 1995 and 1996 and only 20 tons, to date, in 1997. Unstandardized effort (hours fished) showed approximately the same trend, over time, as catch. It is anticipated that the final catch and effort estimates for 1997 will be the lowest recorded for the area.



Annual unstandardized catch rates 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. Standardized CPUE's (see Hvingel et al., this meeting) showed a decline from 1982 to 1985 and a large increase between 1986 and 1987. The trend from 1987, onward, is similar to the unstandardized series.



Historical TAC, catch, effort and CPUE for the Canadian fishery are given in Table 4.

Length distributions

Length frequencies from catches sampled in 1996 (Fig. 2) showed four prominent size groups at modal lengths of 14, 18, 21.5 (males) and 25 mm CL (females). Primiparous females were unimodal at 25 mm and multiparous at 25.5 mm. Ovigerous females, taken later in the season, formed a single mode at 24.5 mm. Males comprised 72% of the catch in numbers and females 28%. Based on samples taken during the period prior to spawning, females were split evenly between primiparous and multiparous groups.

Compared to previous years (Parsons and Veitch, 1996), the distribution in 1996 was unique due to the substantial component of males at 14 mm in addition to the prominent modes at 18, 21.5 and 25 mm.

Age composition

Results of the catch-at-age analysis for the 1981 - 1996 period are presented in Tables 5 through 9 and Fig. 3. Estimated mean lengths at age (Table 5) 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 1996 (Table 6) 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 and only 28% in 1996. 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). Age 3 males with modes at roughly 14 mm also were evident each year from 1993 to 1996. About 9% of shrimp caught in 1996 were estimated to be age 3, the highest in the time series.

The proportions in Table 6 were applied to the total estimated catch numbers to derive a catch-at-age matrix (Table 7) which was subsequently divided by both the unstandardized and standardized fishing effort to produce age-specific indices of abundance (Tables 8 and 9 and Fig. 3). 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 increased slightly to about 1987 but varied without trend, thereafter. There were indications that relatively strong year classes were produced in 1981, 1985 and 1990. 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.

DISCUSSION

Observations from the Canadian fishery for northern shrimp in Div. 0A 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. The 1997 CPUE is not reliable because of the low effort level.

- Further analyses showed that the decline in CPUE since 1987 was associated with a gradual reduction in the catch rates of female shrimp while those for males varied without trend over the same period.

- The 1996 fishery data from Div. 0A suggested that the 1993 year class was strong. Further speculation on the strength of this year class based on 1997 data is not yet possible.

- The lack of a sustained fishery in Div. 0A in 1997 is due, in part, to indications of low catch rates and small shrimp in the area but also to increased quotas in southern areas, some of which were allocated to the offshore fleet.

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Table 1. Catch(t) by month/year from vessel logbooks - NAFO Div. 0A+SA 1, 1979-1997

Year	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	Sum
Month																				
4	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	0
6	.	.	347	.	17	.	290	309	144	42	509	.	.	.	.	.	31	.	1	1690
7	.	54	756	373	752	379	924	603	505	763	2105	890	1003	963	286	385	311	78	1	11131
8	.	.	665	650	1241	354	604	363	1157	1284	1280	1200	1591	1776	1377	1388	624	668	11	16233
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**	**5314**	**5295**	**7432**	**5377**	**4642**	**1512**	**2180**	**14**	**65887**
%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**	**83.1**	**70**	

Table 2. Effort (hrs) by month/year from vessel logbooks - NAFO Div. 0A+SA 1, 1979-1997

Year	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	Sum
Month																				
4	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	4
6	.	.	746	.	33	.	597	471	166	59	937	.	.	.	.	.	64	.	13	3086
7	.	121	1804	617	1928	845	2502	1340	519	1188	5391	2079	1906	1847	505	779	941	323	11	24646
8	.	.	2170	1836	4100	1360	2412	995	2341	3237	3738	3745	5482	4460	3770	4647	2106	2172	77	48648
9	81	.	1968	1504	3151	1641	1784	731	2714	2595	1734	1826	3028	5773	4150	3430	922	2459	.	39491
10	325	.	3229	1248	3995	1370	1804	577	4944	2197	3210	3089	3233	3582	2769	4072	328	1435	.	41407
11	1072	.	2980	953	1074	129	827	1191	3	1167	1423	2370	2377	1806	2056	2958	239	769	.	23394
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**	**7158**	**101**	**181586**

Table 3. CPUE by month/year from vessel logbooks - NAFO Div. 0A+SA 1, 1979-1997

Year	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
Month																			
4	.	.	.	.	.	122	.	.	.	.	.	.	.	.	.	.	.	.	.
6	.	.	466	.	508	.	486	656	868	720	543	.	.	.	.	.	488	.	109
7	.	445	419	604	390	448	369	450	973	642	391	428	526	521	565	494	331	387	109
8	.	.	306	354	303	260	250	365	494	397	342	321	290	398	365	299	296	347	148
9	513	.	297	304	253	243	232	330	436	381	382	466	261	512	386	280	395	267	.
10	218	.	258	268	248	236	323	419	456	589	394	393	381	339	453	306	293	268	.
11	231	.	249	261	239	311	308	507	522	455	426	488	285	290	397	223	356	339	.
12	140	306	149	.	.	.	.	.	.	130	.	.	.	93	742	.	.	.	.

Table 4. Data from the Canadian fishery for shrimp in SA 0+1, 1979 - 1997.

			UNSTANDARDIZED			STANDARDIZED		
YEAR	TAC (T)	CATCH [1] (T)	CPUE (KG/H)	INDEX	EFFORT [2] (HR)	CPUE [3] (KG/H)	INDEX [4]	EFFORT [2] (HR)
1979	2000	1732	236		7339			
1980	2500	2726	358		7615			
1981	5000	5284	299	1.00	17672	299	1.00	17672
1982	5000	2064	335	1.12	6161	353	1.18	5850
1983	5000	5413	284	0.95	19060	275	0.92	19678
1984	5000	2142	280	0.94	7650	257	0.86	8330
1985	6120	3069	309	1.03	9932	221	0.74	13871
1986	6120	2995	445	1.49	6730	227	0.76	13180
1987	6120	6095	491	1.64	12413	347	1.16	17573
1988	6120	5881	468	1.57	12566	308	1.03	19096
1989	7520	7235	391	1.31	18504	227	0.76	31839
1990	7520	6177	405	1.35	15252	257	0.86	24022
1991	8500	6788	330	1.10	20570	221	0.74	30679
1992	8500	7493	425	1.42	17631	254	0.85	29483
1993	8500	5491	404	1.35	13592	239	0.80	22956
1994	8500	4766	292	0.98	16322	188	0.63	25301
1995	8500	2361	329	1.10	7176	203	0.68	11612
1996	8500	2623	305	1.02	8600	185	0.62	14149
1997	8500	20	139	0.46	144	105	0.35	191

[1] Catches (tons) from 1979 - 1989 as reported in MacDonald and Collins (1990). Catches from 1990 to 1996, inclusive, are *not official* statistics and 1997 are incomplete (to Oct. 31). Division 0A only from 1981 onward.

[2] Effort calculated from total catch/CPUE. CPUE calculated from vessel logs.

[3] Scaled to 299 kg/hr in 1981 from unstandardized series.

[4] CPUE index from Hvingel et al.(1996) rescaled to 1.00 in 1981.

Table 5. Mean carapace length (mm) at age for shrimp in NAFO Division 0A, 1981 - 1996.

YEAR	_81	_82	_83	_84	_85	_86	_87	_88	_89	_90	_91	_92	_93	_94	_95	_96
AGE																
3	-	-	-	-	-	-	-	14.62	-	-	-	-	14.51	13.75	14.12	14.5
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	17.91
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	20.04
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	21.94
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	24.69
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	26.36

Table 6. Proportion of shrimp caught at age as determined from commercial length frequency distributions - NAFO Division 0A, 1981 - 1996.

YEAR	_81	_82	_83	_84	_85	_86	_87	_88	_89	_90	_91	_92	_93	_94	_95	_96
AGE																
3	0	0	0	0	0	0	0	0.02	0	0	0	0	0.026	0.015	0.016	0.092
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	0.088
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	0.14
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	0.403
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	0.139
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	0.139
TOTAL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 7. Number (x10-3) of shrimp caught at age by year in Div. 0A, 1981 - 1996.

Year/Age	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
3	0	0	0	0	0	0	0	14842	0	0	0	0	19832	9968	5354	36112
4	10185	5727	5227	29642	7042	12095	29070	68271	54333	37565	27551	29309	79328	71107	15394	34569
5	25193	31393	65626	67170	47888	87594	107865	117991	153631	280921	83542	177805	205186	108986	121479	55129
6	67540	31605	137640	48678	67607	87227	219554	164742	187355	149443	366162	296017	130434	213321	54214	158762
7+	433111	143390	372267	126453	229581	179586	408509	376235	541457	348701	411488	473822	327993	261169	138212	109069
TOTAL	536029	212115	580760	271943	352118	366502	764998	742081	936776	816630	888743	976953	762774	664551	334654	393640

Table 8. Number of shrimp caught per hour (unstandardized) at age in Div. 0A, 1981 - 1996.

Year/Age	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
3	0	0	0	0	0	0	0	1181	0	0	0	0	1459	611	746	4199
4	576	930	274	3875	709	1797	2342	5433	2936	2463	1339	1662	5836	4357	2145	4020
5	1426	5095	3443	8780	4822	13015	8690	9390	8303	18419	4061	10085	15096	6677	16929	6410
6	3822	5130	7221	6363	6807	12961	17687	13110	10125	9798	17801	16790	9596	13070	7555	18461
7+	24508	23274	19531	16530	23115	26684	32910	29941	29262	22863	20004	26874	24131	16001	19260	12682
TOTAL	30332	34429	30470	35548	35453	54458	61629	59055	50626	53542	43206	55411	56119	40715	46635	45772
Effort (hrs)	17672	6161	19060	7650	9932	6730	12413	12566	18504	15252	20570	17631	13592	16322	7176	8600

Table 9. Number of shrimp caught per hour (standardized) at age in Div. 0A, 1981 - 1996.

Year/Age	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
3	0	0	0	0	0	0	0	777	0	0	0	0	864	394	461	2552
4	576	979	266	3558	508	918	1654	3575	1706	1564	898	994	3456	2810	1326	2443
5	1426	5366	3335	8064	3452	6646	6138	6179	4825	11694	2723	6031	8938	4308	10462	3896
6	3822	5403	6995	5844	4874	6618	12494	8627	5884	6221	11935	10040	5682	8431	4669	11221
7+	24508	24511	18918	15180	16551	13626	23246	19702	17006	14516	13413	16071	14288	10322	11903	7709
TOTAL	30332	36259	29513	32646	25385	27807	43533	38861	29422	33995	28969	33136	33228	26266	28820	27821
Effort (hrs)	17672	5850	19678	8330	13871	13180	17573	19096	31839	24022	30679	29483	22956	25301	11612	14149

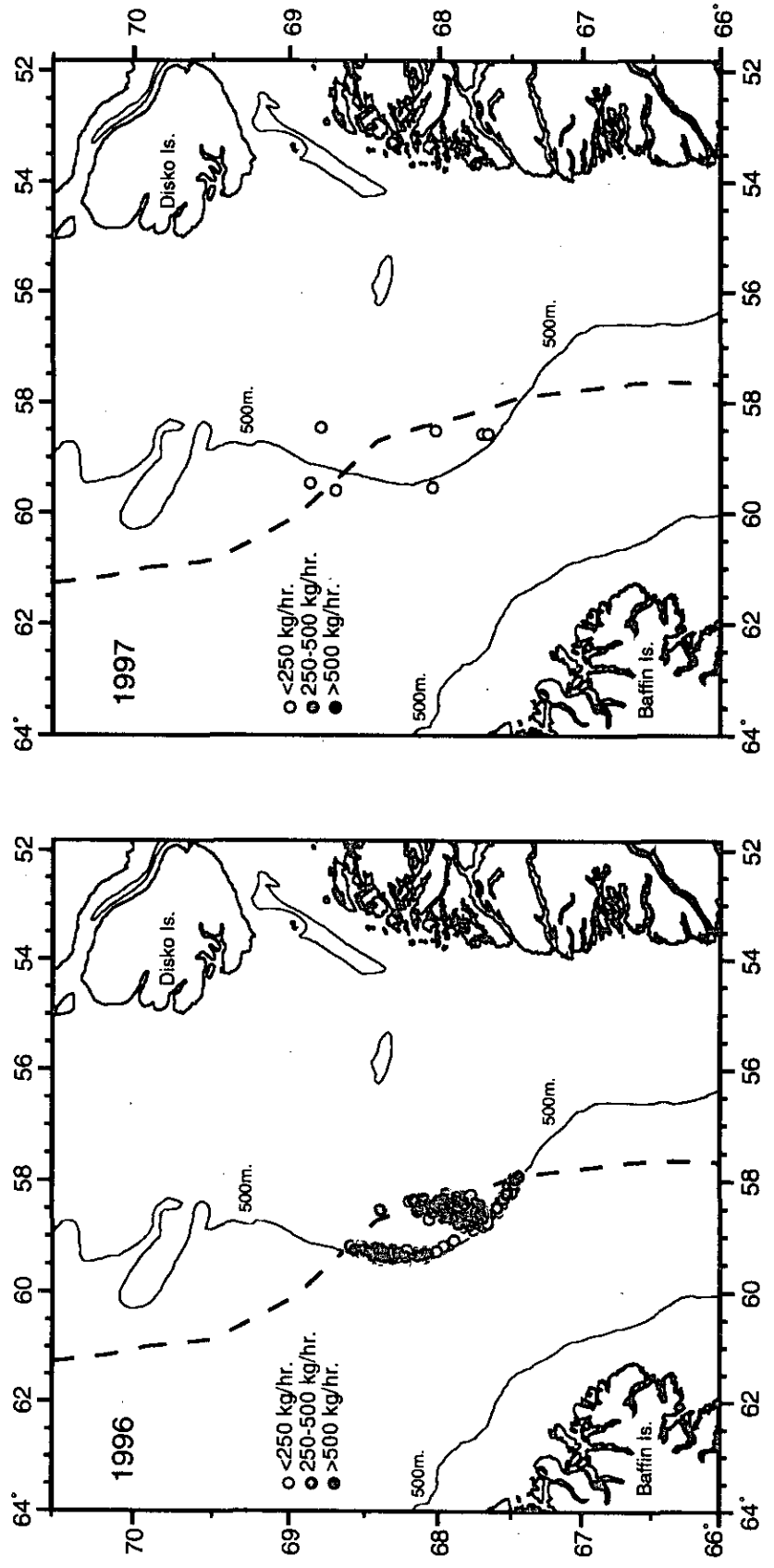

Fig. 1. Northern shrimp fishing locations with CPUE indices in Div. 0A, 1996-1997.

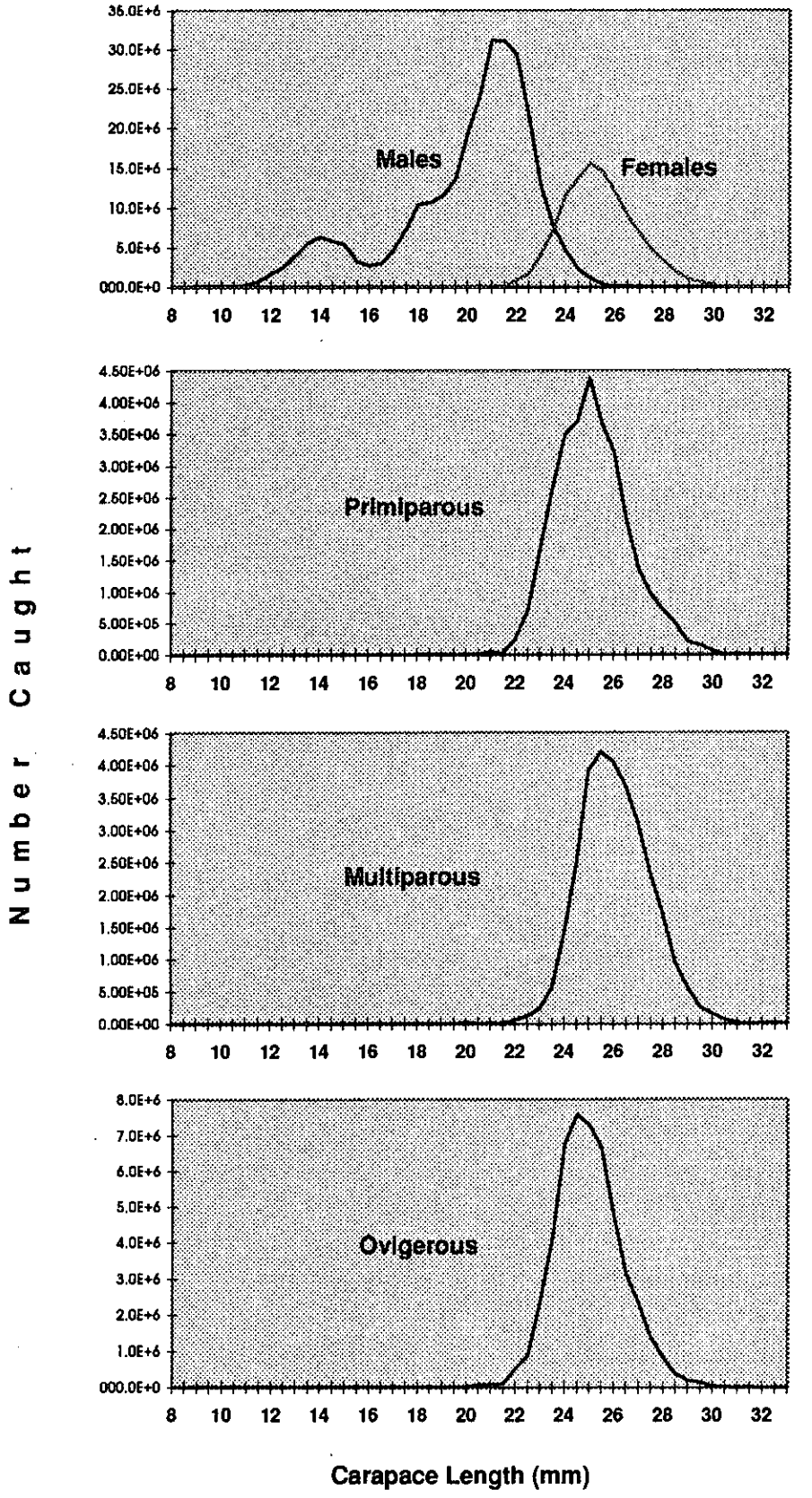

Figure 2. Commercial length frequencies from Div. 0A, 1996

Figure 3a. Number caught per hour (unstandardized) at age - Div. 0A, 1981 - 1996

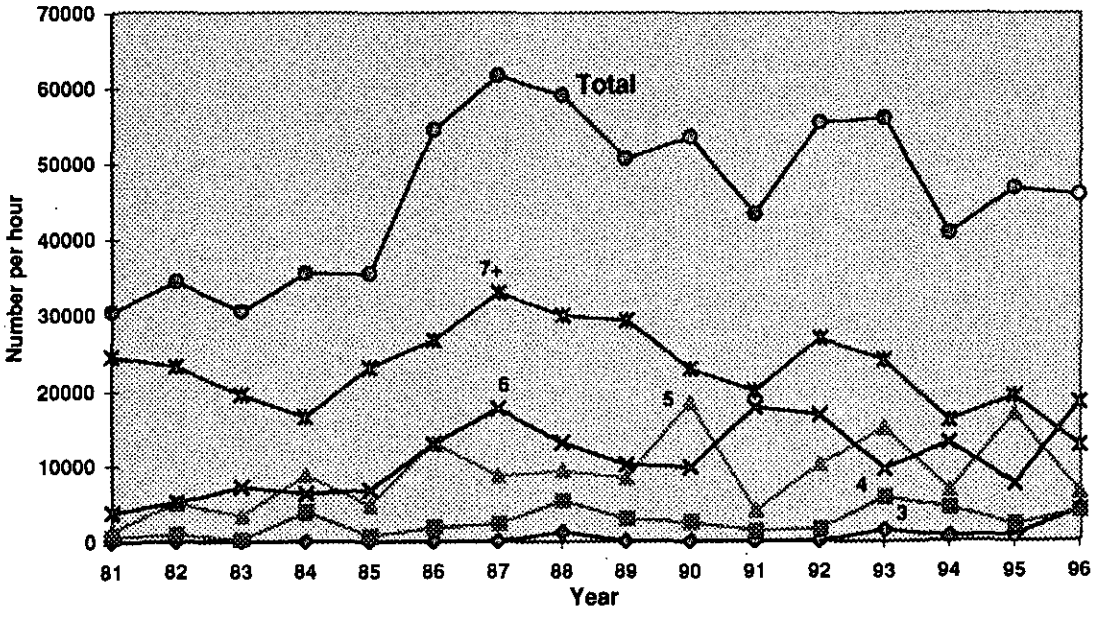

Figure 3b. Number caught per hour (standardized) at age - Div. 0A, 1981 - 1996