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Assessment of Shrimp in Davis Strait (Subareas 0+1)

by

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1. INTRODUCTION

The shrimp fishery off West Greenland occurs in three main areas: the offshore area north of 71° N; the inshore area (primarily Disko Bay); and the offshore area south of 71° N (Fig. 1). STACFIS has provided advice on TAC (since 1977) for only the last area which includes the fishery off West Greenland in Subarea 1 (Divisions 1A to 1F) and the Canadian fishery in Division 0A (Table 1). No TAC's have been advised for the northern area or the inshore fishery but a cautious approach to exploitation has been advised in recent years for the former. Although treated separately for management purposes, sampling data suggest that the shrimp resources in these areas are parts of a single stock or stock complex.

STACFIS, at the 1992 June meeting, expressed concern for levels of recruitment and spawning biomass in the short term and recommended that the TAC's both for 1992 (current year) and 1993 not exceed 40,000 tons, a decrease of 10,000 tons, as a conservation measure. Neither Canada nor Greenland reduced its quotas in 1992. Greenland introduced a 55 mm cod end mesh size regulation on April 1, 1993, initiated an observers program and took steps towards reducing the size of the fleet. Canada has reduced its 1993 quota from 8500 to 6800 tons, pending the results of this meeting, and will also consider mesh size increases in 1993.

This paper presents the assessment of the status of the shrimp resource throughout the area by summarizing data from the various fisheries and research vessel surveys.

2. COMMERCIAL FISHERY (SCR Doc. 93/64, 93/xx, 93/xx)

2.1 History of the Fishery

The nominal catch in the offshore area south of 71°N increased from less than 1,000 tons before 1972 to almost 43,000 tons in 1976. Catches fluctuated in subsequent years but stabilized at a level about 44,000 tons from 1985 to 1988 and have since increased further to about 63,000 tons (preliminary) in 1992 (Table 1, Fig. 2). This figure includes 10,586 tons caught by Greenland in the TAC area, landed in a project allowing landings outside quotas of small shrimp that would otherwise have been discarded (see section 2.5).

The Canadian fishery in Div. 0A usually takes place from July to November whereas the Subarea 1 fishery occurs in all months. The location of fishing activity in the latter area is affected in the early part of the year by the presence of ice, confining the fleet to the southern grounds in Div. 1C, 1D and 1E. Catches in Div. 1A, 1B and 0A (Fig. 3) have been relatively stable since 1987 (except for a high catch in Div. 1B in 1988). Since 1987, catches have increased in Div. 1C and 1D and, for the 1990-1992 period, combined catch from these two divisions have exceeded those from Div. 1B. The catch from Div. 1E and 1F increased from less than 1,000 tons in 1988-91 to over 3,000 tons in 1992. Effort values show the same trends as the catch data.

The fishery in the offshore area north of 71°N, which is outside the area for which TAC's are advised, began in 1985 with a catch of about 4,300 tons. Catches increased to about 11,000 tons in both 1986 and 1987 but subsequently declined to 1,100 tons in 1991. Statistics show an increase to 2,647 tons in 1992. The fishery in this area usually occurs from June to November.

The West Greenland inshore fishery was relatively stable from 1972 to 1986 with estimated catches of 7,500 tons annually (except for 10,000 tons in 1974). Catches in recent years have increased from about 7,000 tons in 1987 to over 21,000 tons in 1992.

2.2 Trends in Catch Rates

Three catch rate indices are available for different offshore areas south of 71°N - the standardized catch rates of large (>8.5 g) shrimp for 27 Greenland trawlers from 1987 to 1992 in Div. 1B, a similar index for Div. 1CD (see Appendix I) and standardized catch rates for the Canadian fishery in Div. 0A from 1981 to 1992 (Fig. 4). The large shrimp index for the Greenland trawlers in Div. 1B showed a decrease from 1987 to 1989 followed by stability from 1989 to 1992. Catch rates in Div. 1CD fluctuated without trend over the period 1987-92. The Canadian series showed two periods of stable catch rates at similar levels: 1983 to 1986 and 1989 to 1992. These periods were separated by significantly higher catch in both 1987 and 1988. All three indices showed the same stability from 1989 to 1992.

2.3 Biological Data

Length frequency distributions obtained by observers were available from the commercial fishery in Div. 0A from 1981 to 1992 and in Subarea 1 from 1990 to 1992. The relative importance of the 1985 year class in Div. 0A was evident in 1990 as it recruited to the fishery and in 1991 when it clearly dominated the catches (Fig. 5). This year class was expected to change sex between 1991 and 1992, occurring as age 7 females in the 1992 catches. Although it contributed significantly as such in 1992, its occurrence was weaker than expected. Also evident was a strong component of large male shrimp, theoretically the 1986 year class. This year class, however, was considered to be weak during the 1992 assessment.

The data were separated into age classes by modal analysis and results showed that the trend in catch rates for female shrimp (age 7+) was similar to that from the commercial CPUE data. Males (ages 4, 5 and 6), on the other hand, indicated an increasing trend from 1981 to 1987, and fluctuated thereafter without trend.

CPUE at age:

	YEAR											
Age	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92
7+	1.0	1.0	0.7	0.6	0.7	0.6	0.9	0.8	0.7	0.6	0.6	0.6
4-6	1.0	2.0	1.7	3.0	1.5	2.7	3.4	3.2	2.3	3.3	2.8	2.8

Length frequency distributions obtained from the commercial fishery in Subarea 1 in 1990, 1991, and 1992, pooled by division and quarter or month, also showed the importance of the 1985 year class (Fig. 6). In 1990 this year class was dominating in the male group at 21.5 mm CL in samples from the second quarter in Div. 1B and from the third quarter in Div. 1A. In 1991 it generally dominated all available samples, in Div. 1C and 1D in June, and in Div. 1A and 1B in September. In 1992 it was expected to undergo sex transition and appear in the size group of smallest females, but a significant part of the year class may have remained as males with a slower than expected growth (see section 3.2).

2.5 Discards

In Div. 0A, discard rates increased from 1987 to 1991 and declined slightly in 1992, consistent with the growth and recruitment of the 1985 year class. Since 1981, the observed average discard rate has varied between 2.3 and 6.5%. These figures are underestimates of the actual discard rate.

A Greenland observer program, initiated in 1990 to estimate shrimp discarding practices in Subarea 1, was continued in 1991 and 1992. Levels of discards in SA1 were estimated at approximately 11,000 tons in 1990 and approximately 9,000 tons in 1991. In 1992 a discard of approximately 7,000 tons was estimated. This year, however, Greenland vessels were allowed in excess of vessels quotas to land about 10,000 tons of small shrimp - assumed otherwise to be discarded. Length frequency distributions obtained from the study showed that the 1985 year class was heavily discarded in both 1990 and 1991.

3. RESEARCH SURVEY DATA (SCR Doc. 93/70, 93/72)

3.1 Biomass Estimates

In July-August 1992, a stratified random trawl survey was carried out in the main area of shrimp distribution in Divisions 1A-1E and the adjacent part of Subarea 0. The area surveyed was the same as in 1990 and 1991 but extended beyond (south of) the areas covered in 1988 and 1989. Because shrimp densities in these southern areas appeared very low for the earlier years, the estimates from all five surveys are considered to be comparable.

The estimate of biomass for the area south of 69°30'N in 1992 was about 179,000 tons, compared to 171,000, 192,000, 175,000, and 119,000 tons in 1988, 1989, 1990 and 1991, respectively. Biomass in the area north of 69°30'N decreased from 22,000 tons in 1988 to 6,000 tons in 1991 and increased again in 1992 to the 1988 level (Table 2). In the main fishery area between 67° and 69°30'N, biomass was fairly stable around 115,000 tons from 1988 to 1990, decreased in 1991 to 70,000 tons, and increased again in 1992 to 100,000 tons. Biomass estimates in the southern grounds fluctuated between 30,000 and 46,000 tons except for 68,000 tons in 1989.

In September 1992 a stratified-random trawl survey was conducted in the inshore areas in Disko Bay and Vaigat. Biomass was estimated at 47,000 tons, close to the estimate from a similar survey in 1991.

3.2 Demographic Structure

The abundance of male shrimp increased significantly in 1989, when the 1985 year class entered the fishable stock, decreased in 1990 and 1991 and increased again in 1992 to the level of 1988. The recent increase is due to recruitment, especially of the 1987 year class, but may be influenced by the possible lack of sex change by a significant part of the 1985 year class in 1992. The number of female shrimp decreased from 1988 to 1989, increased in 1990, decreased in 1991 to the lowest number observed, and increased again in 1992 to the level of 1989.

Analysis of the research length frequency data (Fig. 7) show the predominance of the 1985 year class in 1989, 1990 and 1991 throughout the offshore area. In 1989, abundance was highest in shallower water, most animals being males of the 1985 year class. In subsequent years, abundance was higher to the north and in deeper water, reflecting the growth and behaviour of this strong year class. In 1992 recruitment of new year classes (primarily the 1987 year class) is indicated, especially in shallow water to the south.

In abundance at age estimates (Table 3) the 1985 year class is well identified up to 1991. In 1992 this year class was expected to undergo transition, but it cannot be identified with the expected strength in the first female group. At the same time results indicate that the 1986 year class, which was assumed almost absent in the length frequences from earlier years, appears strong.

The overall size composition of shrimp from the inshore survey in 1991 was similar to that for the offshore in relation to the occurrence of modes. In the inshore area, however, there was a higher proportion of younger male shrimp with a modal length of about 17 mm, likely representing the 1987 year class. In 1992, this group was found at 18.5 mm CL. Overall abundance of shrimp was similar in 1991 and 1992, but there was an evident shift between areas. In 1992, abundance of shrimp decreased in the southern parts of the Disko Bay and increased in the central areas and to the north in the Vaigat.

SUMMARY OF ALL INDICES

an overall increase in catches:

- overall increase from 1981 to 1992

short term variations in catches:

- catches north of 71°N decreased since 1987 and increased slightly in 1992
- catches in the inshore area increased since 1987
- catches offshore increased since 1988 (TAC exceeded)
- catches in division 0A have ranged between 6,000 and 7,500 tons from 1987 to 1992.

short term variations in effort:

- overall increase in effort from 1987 to 1991 and a slight decrease in 1992
- effort fluctuated in Div. 1A
- effort decreased in Div. 1B since 1988
- effort increased in Div. 0A

- effort increased in Div. 1C to 1990 and decreased to 1992
- effort increased in Div. 1D
- new fishing activity in Div. 1E in 1991 and 1992
- decreasing effort in Div. 1F since 1989

a shift in the fishery:

while catches fluctuated in the northern part of Davis Strait, the fishery (catches and effort) has increased in Div. 1D and 1E

trends in recent catch rates:

variations in division 0A:

- catch rates from 1989 to 92 stable but lower than 1987-88 variations in division 1B:
- decrease from 1987 to 89 followed by stability from 1989 to 92 variations in 1CD:
- variable without trend 1987 - 1992

composition of catches:

from division 0A:

- in general, years of high catch rates are associated with a dominance of females in the catches
- catch rates for females reflected the same trend as the overall commercial CPUE index while those for males increased to 1987 and have since stabilized throughout West Greenland offshore area:
- the relative importance of the 85 year class was evident in 1990 as it recruited to the fishery and in 1991 when it clearly dominated in the catches
- in 1992, it appeared that the 1985 year class did not change sex as expected and/or that the 1986 year class was stronger than previously thought. New year classes were evident in the fishery data in Div. 1A, 1D and 1E

discarding:

- the discard data show that the 85 year class was heavily discarded in 1990 and 1991 and, to a lesser extend in 1992.

- levels of discarding in SA1 were estimated at approximately 11,000 tons in 1990, 9,000 tons in 1991, and 7,000 tons in 1992

biomass estimates from research surveys:

- biomass in the area north of 69°30'N decreased from 1988 (22,000 tons) to 1991 (6,000 tons), and increased to 21,000 tons in 1992
- between 67°N and 69°30'N, biomass was stable at roughly 115,000 tons from 1988 to 1990 but decreased in 1991 to 70,000 tons, and increased in 1992 to 100,000 tons
- south of 67°N, biomass fluctuated between 30,000 and 46,000 tons except 1989 (68,000 tons)
- estimates of biomass of about 47,000 tons were obtained for 1991 and 1992 in the inshore area

demographic structure:

-proportion of males fairly constant from 1988 to 1992
- males: estimated number of males was highest in 1989 and lowest in 1991
- females: estimated number of females decreased from 1988 to 1991 and increased slightly in 1992
- the 85 year class dominated in 1989, 1990 and 1991 and the spatial distribution reflects the migration into deeper water of the year class as it grows. In 1992 the 1987 year class began recruiting to the survey and the commercial fishery especially to the south
- the 86 year class assumed to be poor up to 1991 appears strong in 1992, but may be superimposed by a component of the 85 year class not undergoing transition in 1992; uncertainty in the estimation of year class strength from trawl surveys was noted
- the size/age composition of shrimp from the inshore survey is similar in the occurrence of modes to the size composition of the offshore survey

STATUS OF THE RESOURCE

Indices from the commercial fishery show that the abundance in 1989-92 was stable but lower than the high 1987-88 level. The high level can be explained by the recruitment to the female component of at least two strong year classes. The decrease from the 87-88 level can be explained by mortality (fishing and natural) of these year classes. The stability since 1989 was maintained by recruitment of the strong 1985 year class.

The research survey index from 1988 to 1992 showed relative stability around a mean of approximately 180,000 tons. The higher level in 1989 was due, in part, to the 1985 year class which resulted in an increase in biomass in the southern areas and maintained the biomass level in the central areas. The low 1991 estimate might have been due to a decreased availability of shrimp to the research gear and/or survey area in that year, and therefore the previous concerns for the level of the spawning biomass are no longer valid.

The strong 1985 year class recruited to the fishery in 1990. It maintained catch rates in both 1991 and 1992 and should contribute significantly to the catches again in 1993. Data from both the 1992 survey and from commercial fishery in Div. 0A suggest that part of the 1985 year class did not change sex between 1991 and 1992. The reasons why the year class did not change sex as expected (if the assumption is correct) are not clear but could be due to overall population density or environmental factors. Accepting the former suggests the stock is healthy, a decrease in the age at sex inversion being generally considered a danger signal. If environmental factors apply, the implications are uncertain. However, it is not until we review the performance of the 1993 fishery and results of the 1993 reseach survey that evaluation of the status of the 1985 year class with respect to abundance, maturation and overall contribution to the 1994 fishery can be made.

Further, the prospects for recruitment do not appear to be as bleak as forecast in 1992. The 1987 year class shows some potential, and survey data in 1992 indicate the possibility of a strong 1989 year-class.

CONCLUSION

Given the success of the 1992 fishery and the stability in the estimates of shrimp biomass from the surveys, it is clear that previous concerns for the spawning biomass and recruitment were, in hind-sight, unwarranted. If the 1985 year class remains strong in 1993 and contributes as females, here on, there is less basis for concern for the level of the spawning stock. Also, no imminent recruitment failures are evident in the data. Therefore, the basis for the STACFIS advice in June 1992 for a reduction of the TAC in 1993 by 10,000 tons no longer applies, and it is proposed that the TAC in both 1993 and 1994 be maintained at 50,000 tons.

We are, however, concerned about the steady increase in catches over recent years. Continuation of this trend is not considered a cautious approach to resource management and could lead to overexploitation. Any increase in fishing pressure should only be done after a level has been maintained for several years with no negative effects on stock size and composition.

The sequence of events of the past year emphasizes the importance of having the most recent research and commercial data available for assessment meetings.

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Table 1. Nominal catches of shrimp (thousand tons) in Davis Strait 1982-92, and advised and effective TAC for SA0+1 in 1982-1993.

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
SA0+1	36.627	39.267	35.883	42.187	44.584	46.160	43.649	49.931	52.773	57.332	62.958	-
Inshore	7.500	7.500	7.500	7.500	7.500	6.921	10.233	13.224	15.386	17.891	21.148	-
N. of 71°	-	-	-	4.349	11.045	10.700	6.660	2.522	2.121	1.077	2.647	-
Total catch	44.327	46.767	43.383	54.036	63.129	63.781	60.542	65.677	70.280	76.300	86.753	-
Advised SA0+1 TAC	29.500	29.500	29.500	36.000	36.000	36.000	36.000	44.000	50.000	50.000	40.000	40.000
Effective SA0+1 TAC	34.800	34.625	34.925	42.120	42.120	40.120	40.120	45.245	45.245	46.225	44.200	48.900[1]

[1] Including 8300 tons north of 68°N

Table 2. Shrimp biomass estimates (thousand tons) obtained from stratified-random surveys in Davis Strait 1988-92.

Areas	1988	1989	1990	1991	1992
N1-N4	12.762	8.137	8.847	4.083	14.196
N5-N7	9.139	3.206	2.886	1.948	6.968
INSHORE	-	-	-	48.446	46.585
W1-W2	57.658	56.571	78.407	38.750	55.601
C1-C3	9.305	3.836	11.425	4.668	16.764
W3	42.706	51.806	35.693	26.655	27.738
W4	23.210	29.726	12.557	14.451	10.098
W5	16.758	38.422	17.149	15.467	36.301
W6	-	-	7.595	13.083	11.419
N1-N7	21.901	11.343	11.733	6.031	21.164
W1+W2+W3+C	109.669	112.213	125.525	70.073	100.103
W4+W5	39.968	68.148	29.706	29.918	46.399
Total offshore	171.538	191.704	174.559	119.105	179.085

Table 3. Abundance of shrimp (x10-6) at age estimated from Greenlandic trawl surveys, 1988 - 92.

Year	88	89	90	91	92
Age (yr)					
2	549	461	852	182	846
3	1122	4775	1076	726	2932
4	4534	16499	3227	1970	3753
5	9354	7212	11987	2529	6736
6	8304	3985	5289	8564	10610
7+	9970	6398	8146	5257	6459
Total	33832	39331	30556	19228	31336
Z (5+)		0.98	0.27	0.81	-0.04
Z (6+)		1.05	0.24	0.94	0.76

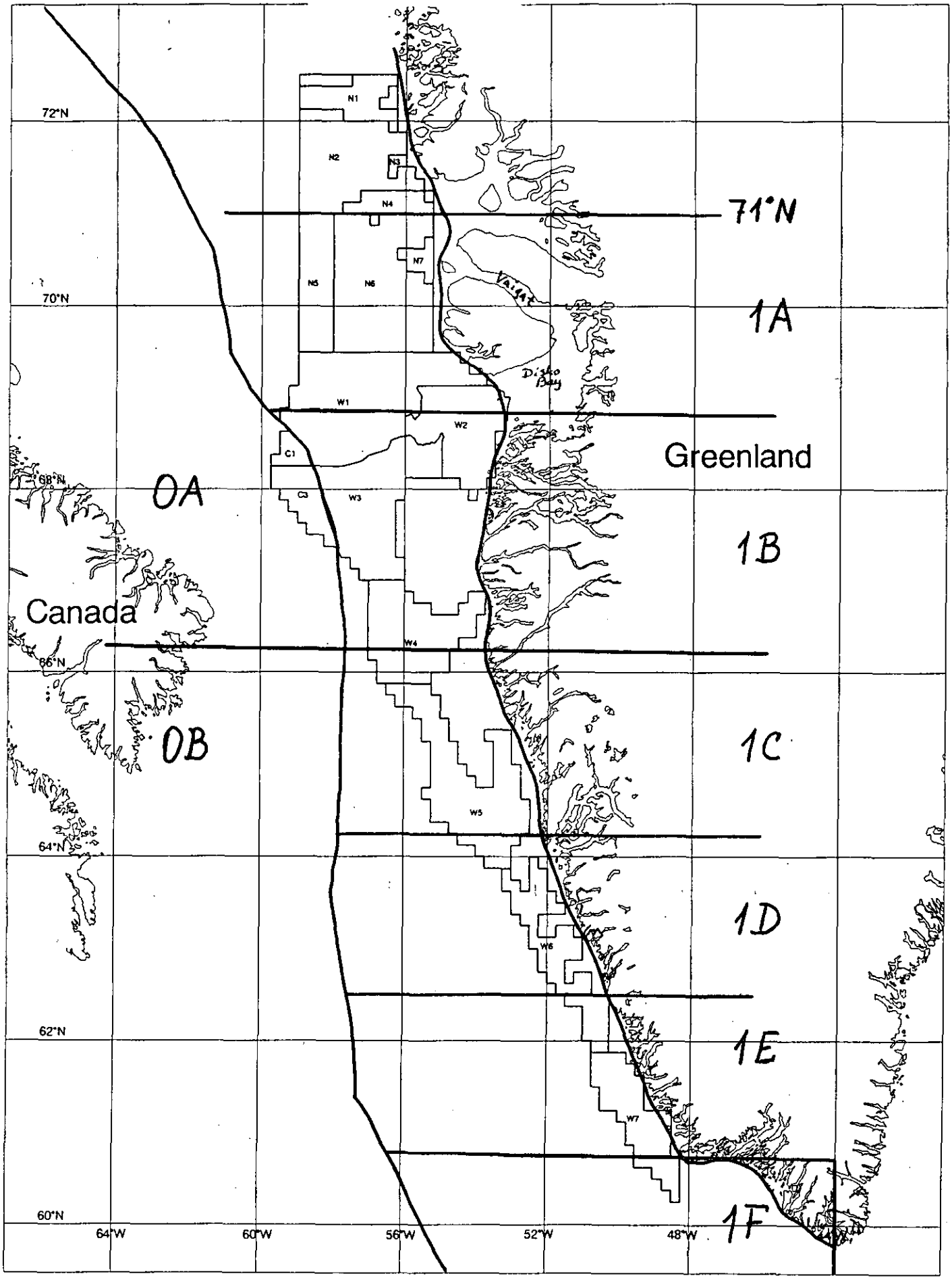


Figure 1. Map covering the Davis Strait fishing areas. NAFO Divisions and stratification scheme for the West Greenland shrimp survey are indicated, as is the limit between inshore and offshore areas.

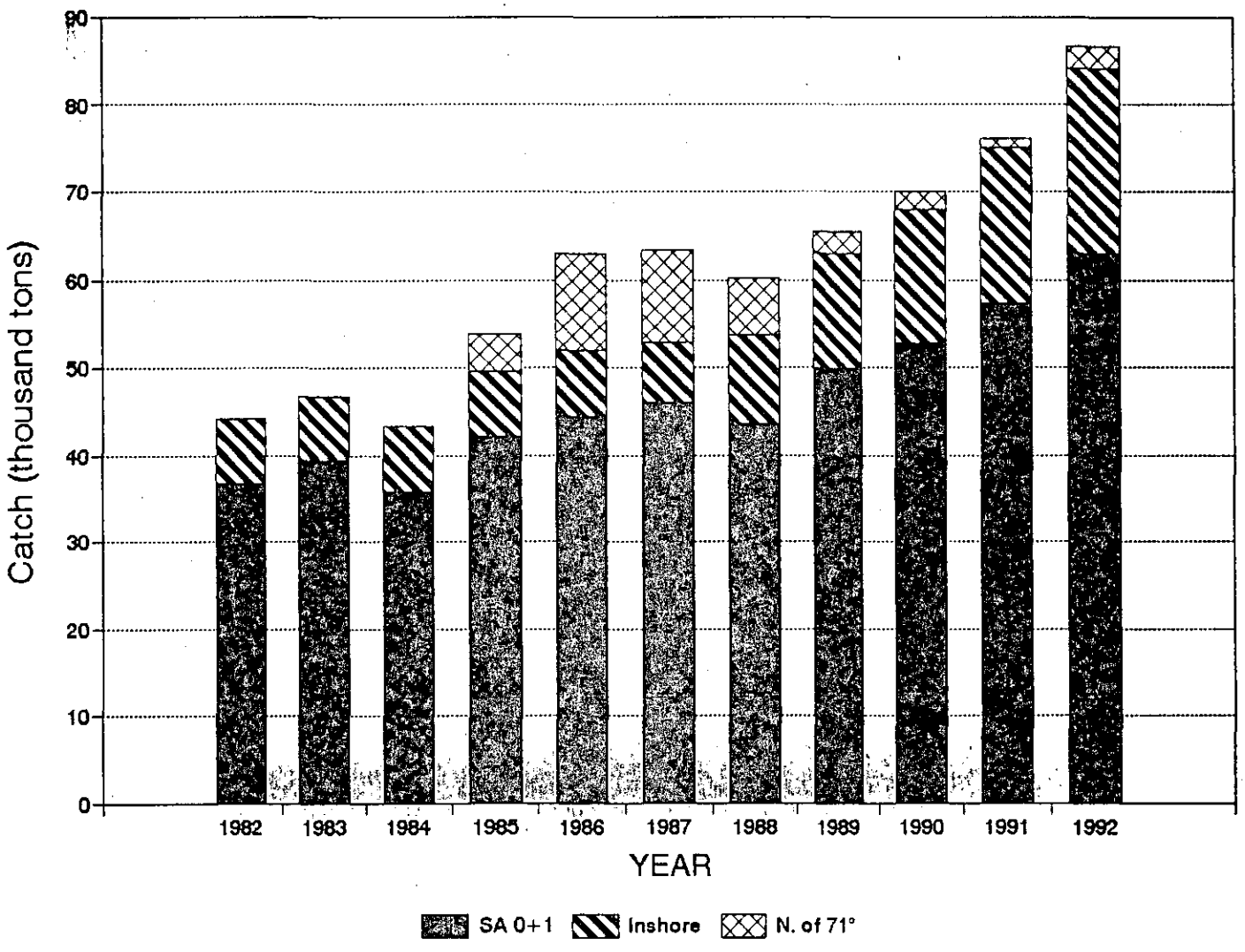


Figure 2. Nominal catches of shrimp (thousand tons) in Davis Strait 1982-92.

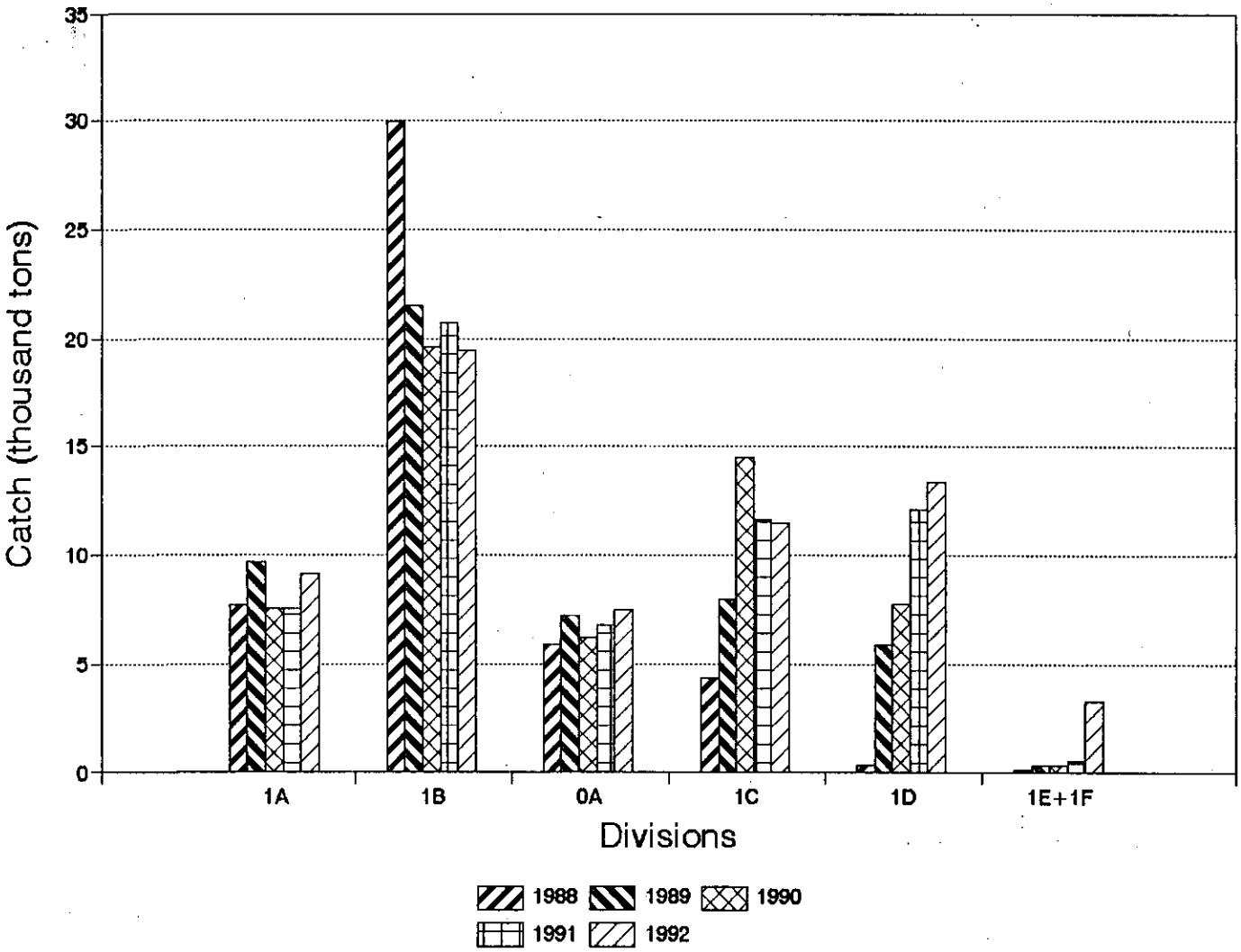
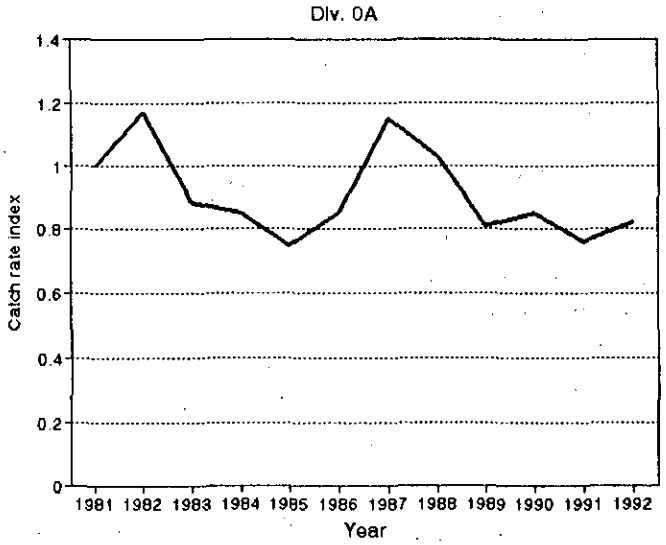
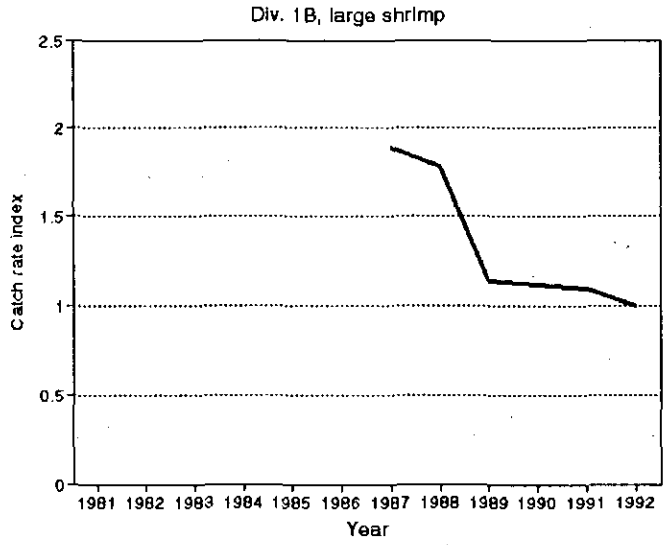


Figure 3. Nominal catches of shrimp, by Division, in 1988-92.





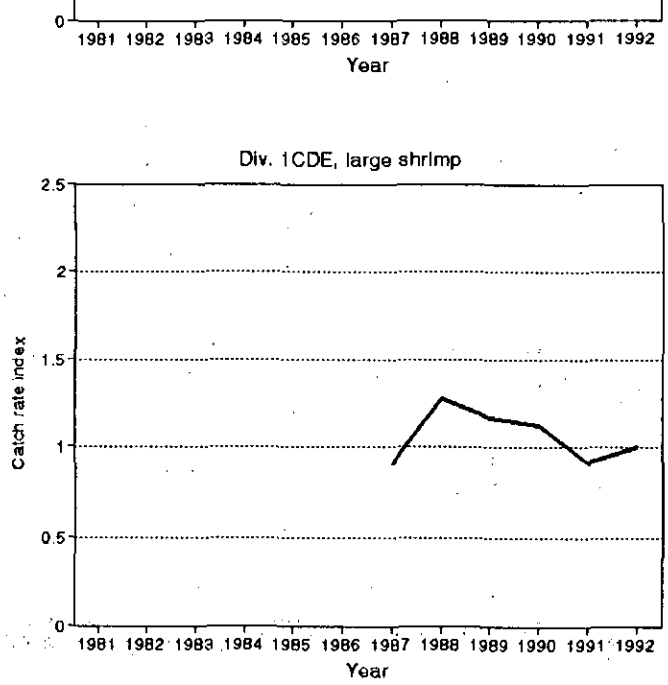


Figure 4. Catch rate indices for shrimp in Davis Strait.

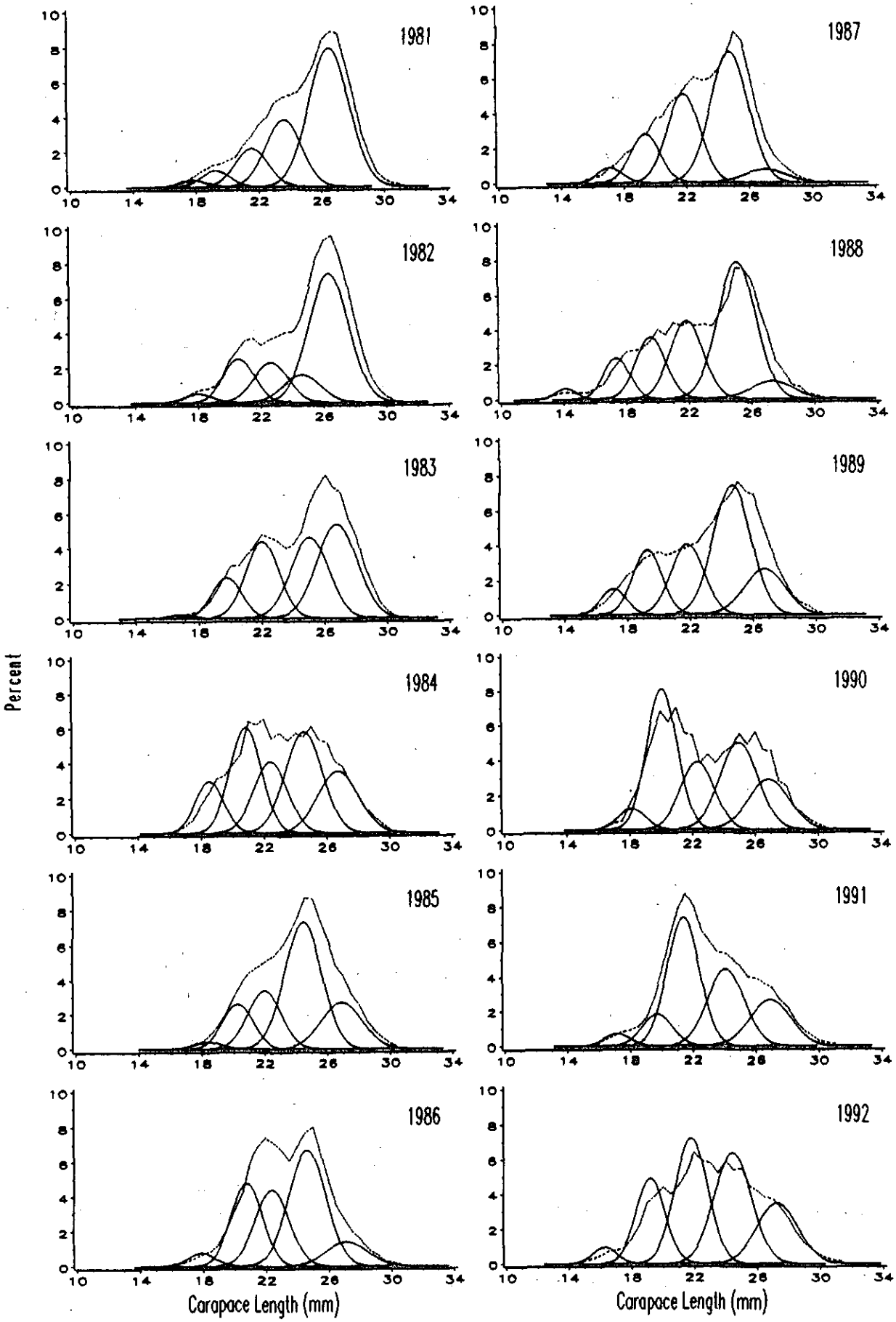


Figure 5. Seperation of ages from commercial length frequency data (broken line = commercial frequency). NAFO Div. 0A, 1981-92.

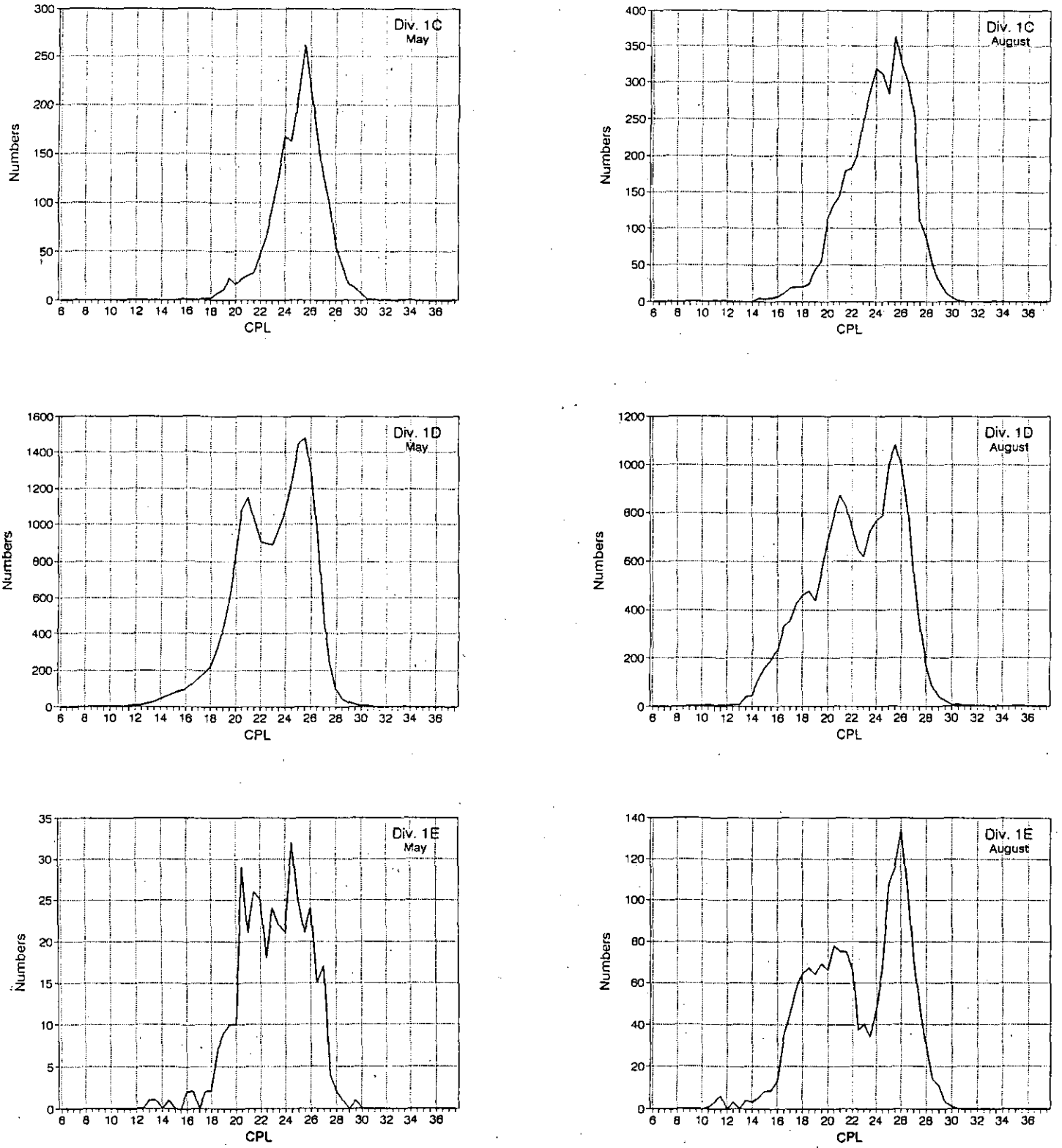


Figure 6. Commercial shrimp samples from May, August and November 1992, pooled by Division (1B, 1D and 1E) and month.

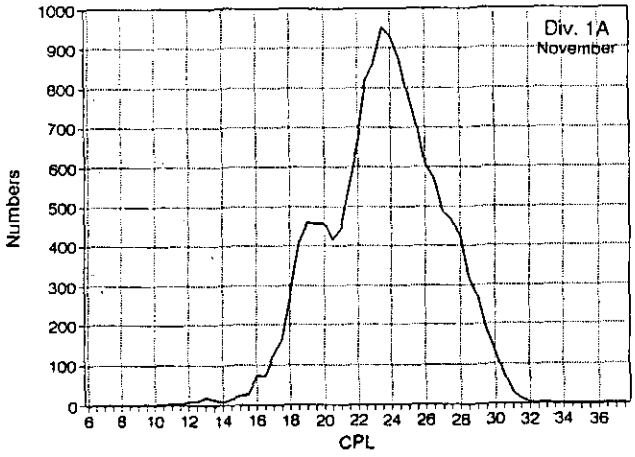
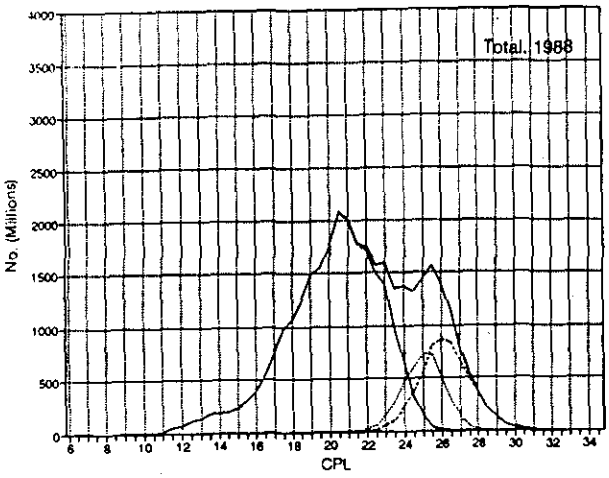
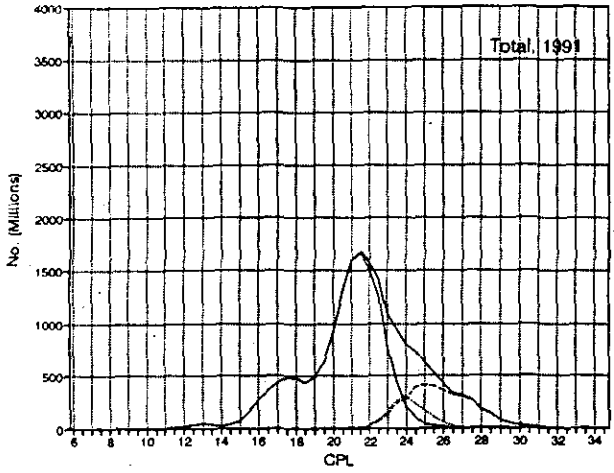
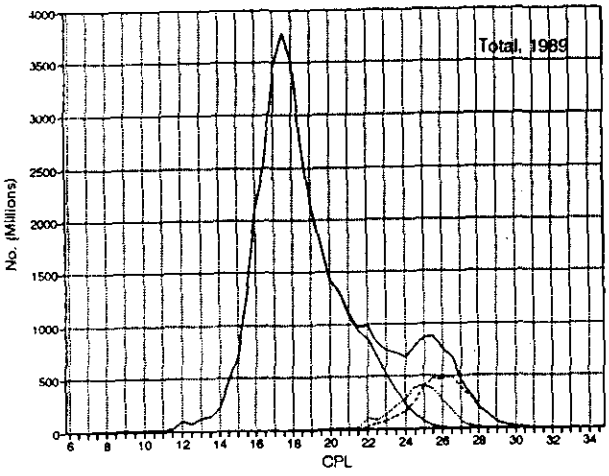
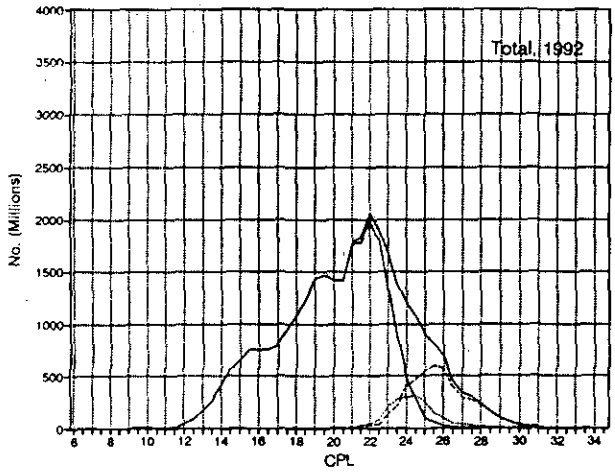


Figure 6 continued. Data from Division 1A.









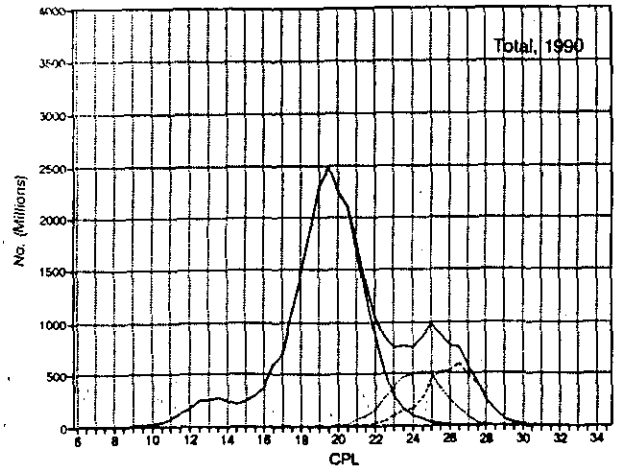


Figure 7. Numbers of shrimp by length group (CL) in the total survey area in 1988-92, based on pooling of samples weighted by catch and stratum area.

APPENDIX I.

Table 1. Estimation of parameters, standardization of CPUE for large shrimp in Div. 1B.

General Linear Models Procedure

Dependent Variable: LNCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	45	195.0654919	4.3347887	16.14	0.0001
Error	1145	307.5611383	0.2686123		
Corrected Total	1190	502.6266301			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.388092	9.865688	0.518278	5.25334116

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VESS	26	88.50484602	3.40403254	12.67	0.0001
YR	5	59.27819756	11.85563951	44.14	0.0001
MO	11	37.38050573	3.39822779	12.65	0.0001
AREA	3	9.90194257	3.30064752	12.29	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
VESS	26	71.75459966	2.75979229	10.27	0.0001
YR	5	53.73127180	10.74625436	40.01	0.0001
MO	11	39.73869131	3.61260830	13.45	0.0001
AREA	3	9.90194257	3.30064752	12.29	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		4.822715909 B	48.84	0.0001	0.09874193
VESS	OUIN	0.321462857 B	2.41	0.0163	0.13356542
	OUIQ	0.323785907 B	3.22	0.0013	0.10056597
	OUOQ	0.105074625 B	1.04	0.3000	0.10133031
	OUPJ	0.585569793 B	4.96	0.0001	0.11804296
	OUTM	0.338502904 B	3.45	0.0006	0.09805279
	OUWH	0.299607439 B	2.78	0.0056	0.10789013
	OUYM	0.141010491 B	1.40	0.1606	0.10043990
	OWDV	0.198623755 B	2.09	0.0369	0.09508443
	OWLQ	0.175690428 B	1.55	0.1213	0.11332159
	OWQU	0.979052240 B	9.15	0.0001	0.10698203
	OWSH	0.192978036 B	1.44	0.1510	0.13431149
	OWUD	0.112178947 B	1.06	0.2914	0.10628056
	OWUJ	-0.209576942 B	-1.91	0.0567	0.10988002
	OWVM	0.172593169 B	1.52	0.1281	0.11335605
	OWWP	0.691992231 B	7.08	0.0001	0.09779266
	OYBZ	0.391841027 B	3.06	0.0022	0.12788363
	OYCK	0.039647480 B	0.36	0.7225	0.11159938
	OYFF	0.659113108 B	6.02	0.0001	0.10943938
	OYHO	0.212373866 B	0.68	0.4942	0.31055065
	OYKK	0.336667664 B	3.17	0.0016	0.10619190
	OYNR	0.194345322 B	2.02	0.0437	0.09627144
	OYNS	0.300089179 B	2.63	0.0088	0.11431229
	OYRK	0.467978059 B	5.27	0.0001	0.08876478
	OYRT	0.546232715 B	4.74	0.0001	0.11532139
	OYXT	0.609778553 B	5.20	0.0001	0.11735599
	OZKQ	0.753945588 B	7.06	0.0001	0.10682198
	ZZZZ	0.000000000 B	.	.	.
YR	87	0.635841406 B	8.82	0.0001	0.07207619
	88	0.574691121 B	10.21	0.0001	0.05629396
	89	0.129037290 B	2.20	0.0283	0.05878142
	90	0.111642584 B	2.01	0.0451	0.05565929
	91	0.094603869 B	1.73	0.0831	0.05453483
	92	0.000000000 B	.	.	.
MO	1	0.021967493 B	0.17	0.8615	0.12592472
	2	-0.049427283 B	-0.18	0.8536	0.26775049
	3	-0.022214323 B	-0.20	0.8396	0.10972028
	4	0.258406189 B	3.26	0.0011	0.07915152
	5	-0.226689880 B	-3.17	0.0016	0.07161596
	6	-0.392468558 B	-5.57	0.0001	0.07045246
	7	-0.309321405 B	-4.34	0.0001	0.07121837
	8	-0.407020448 B	-5.59	0.0001	0.07281876
	9	-0.427205348 B	-5.50	0.0001	0.07763493
	10	-0.309502963 B	-3.94	0.0001	0.07860823
	11	-0.146277673 B	-2.02	0.0435	0.07237500
	12	0.000000000 B	.	.	.
AREA	3	0.259003180 B	2.74	0.0063	0.09460734
	4	0.056417968 B	1.37	0.1710	0.04118326
	5	0.227811400 B	5.36	0.0001	0.04246652
	6	0.000000000 B	.	.	.

NOTE: The X'X matrix has been found to be singular and a generalized inverse was used to solve the normal equations. Estimates followed by the letter 'B' are biased, and are not unique estimators of the parameters.

Table 2. Estimation of parameters, standardization of CPUE for large shrimp in Div. 1CD.

General Linear Models Procedure

Dependent Variable: LNCPUE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	44	134.5861918	3.0587771	17.05	0.0001
Error	1134	203.4386142	0.1793991		
Corrected Total	1178	338.0248060			

R-Square	C.V.	Root MSE	LNCPUE Mean
0.398155	7.990334	0.423555	5.30084655

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VESS	26	63.96546180	2.46021007	13.71	0.0001
YR	5	13.29637754	2.65927551	14.82	0.0001
MO	11	50.89447649	4.62677059	25.79	0.0001
AREA	2	6.42987598	3.21493799	17.92	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
VESS	26	76.47014489	2.94115942	16.39	0.0001
YR	5	10.13729612	2.02745922	11.30	0.0001
MO	11	50.97652989	4.63422999	25.83	0.0001
AREA	2	6.42987598	3.21493799	17.92	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		5.058856779 B	57.59	0.0	0.08784571
VESS	OUIN	0.170786418 B	1.75	0.0796	0.09732583
	OUIQ	0.109425996 B	1.16	0.2472	0.09450998
	OUOQ	-0.002645492 B	-0.03	0.9778	0.09512406
	OUPJ	0.099269362 B	0.95	0.3421	0.10444197
	OUTM	0.230627248 B	2.52	0.0119	0.09154824
	OUWH	0.086667336 B	0.94	0.3474	0.09219731
	OUYM	-0.053881531 B	-0.57	0.5677	0.09425895
	OWDV	0.074823561 B	0.83	0.4050	0.08982695
	OWLQ	-0.053288448 B	-0.53	0.5941	0.09997663
	OWQU	0.787201862 B	8.71	0.0001	0.09040564
	OWSH	0.261963448 B	2.59	0.0096	0.10102258
	OWUD	-0.108634854 B	-1.12	0.2625	0.09691082
	OWUJ	-0.421010477 B	-3.95	0.0001	0.10654877
	OWVM	-0.130395149 B	-1.27	0.2050	0.10282921
	OWWP	0.441378493 B	5.02	0.0001	0.08787196
	OYBZ	0.691093076 B	6.99	0.0001	0.09882476
	OYCK	0.069126974 B	0.70	0.4842	0.09877424
	OYFP	0.396141633 B	2.91	0.0036	0.13591305
	OYHO	0.200974529 B	0.89	0.3735	0.22572696
	OYKK	0.033605107 B	0.33	0.7441	0.10294290
	OYNR	-0.045798026 B	-0.49	0.6233	0.09320711
	OYNS	0.211438130 B	2.30	0.0218	0.09203711
	OYRK	0.235690734 B	2.72	0.0066	0.08661759
	OYRT	0.392361890 B	4.06	0.0001	0.09665069
	OYXT	0.572711209 B	5.64	0.0001	0.10146963
	OZKQ	0.578098157 B	6.28	0.0001	0.09206719
	ZZZZ	0.000000000 B	.	.	.
YR	87	-0.100331460 B	-1.01	0.3123	0.09925889
	88	0.245634348 B	3.33	0.0009	0.07383397
	89	0.153677153 B	3.31	0.0010	0.04639989
	90	0.117562445 B	3.22	0.0013	0.03651765
	91	-0.087638224 B	-2.63	0.0087	0.03335578
	92	0.000000000 B	.	.	.
MO	1	0.299023553 B	4.26	0.0001	0.07013721
	2	0.243397903 B	3.23	0.0013	0.07543013
	3	0.483933535 B	7.57	0.0001	0.06393195
	4	0.314463754 B	5.64	0.0001	0.05578397
	5	-0.186061128 B	-3.34	0.0009	0.05564305
	6	-0.031134816 B	-0.52	0.6011	0.05953276
	7	0.162850813 B	2.74	0.0062	0.05933282
	8	-0.082290006 B	-1.29	0.1962	0.06362566
	9	-0.282884232 B	-4.16	0.0001	0.06793521
	10	0.013140168 B	0.18	0.8609	0.07496168
	11	0.136242363 B	2.13	0.0334	0.06396957
	12	0.000000000 B	.	.	.
AREA	7	-0.005243487 B	-0.15	0.8788	0.03437698
	8	-0.156051716 B	-4.69	0.0001	0.03330536
	9	0.000000000 B	.	.	.

NOTE: The X'X matrix has been found to be singular and a generalized inverse was used to solve the normal equations. Estimates followed by the letter 'B' are biased, and are not unique estimators of the parameters.

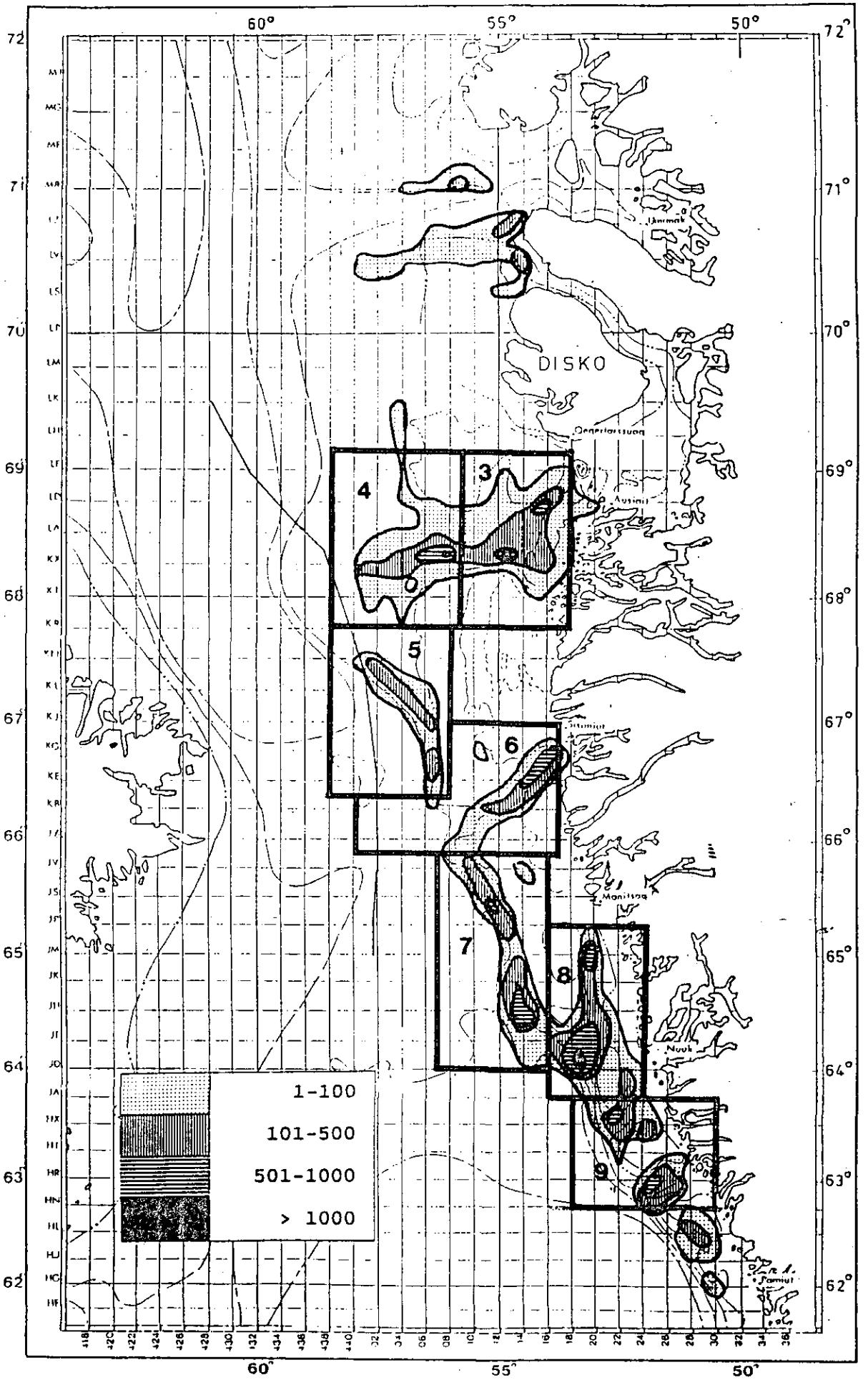


Fig. 1. Map showing areas in Div. 1B (3, 4, 5 and 6) and Div. 1CD (7, 8 and 9).

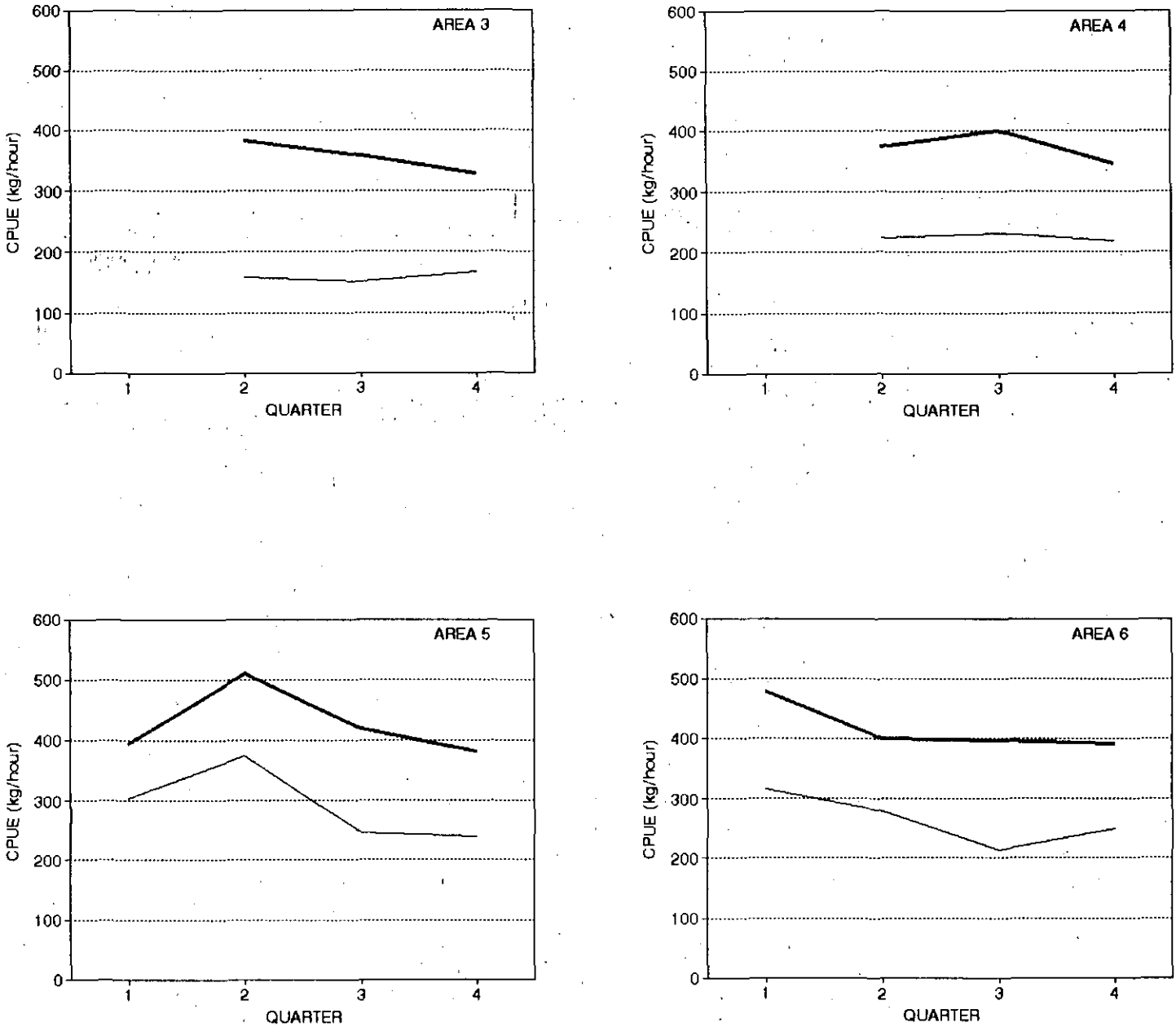


Fig. 2. Seasonality in CPUE of total catch and catch of larger shrimp in Div. 1B (by quarter).

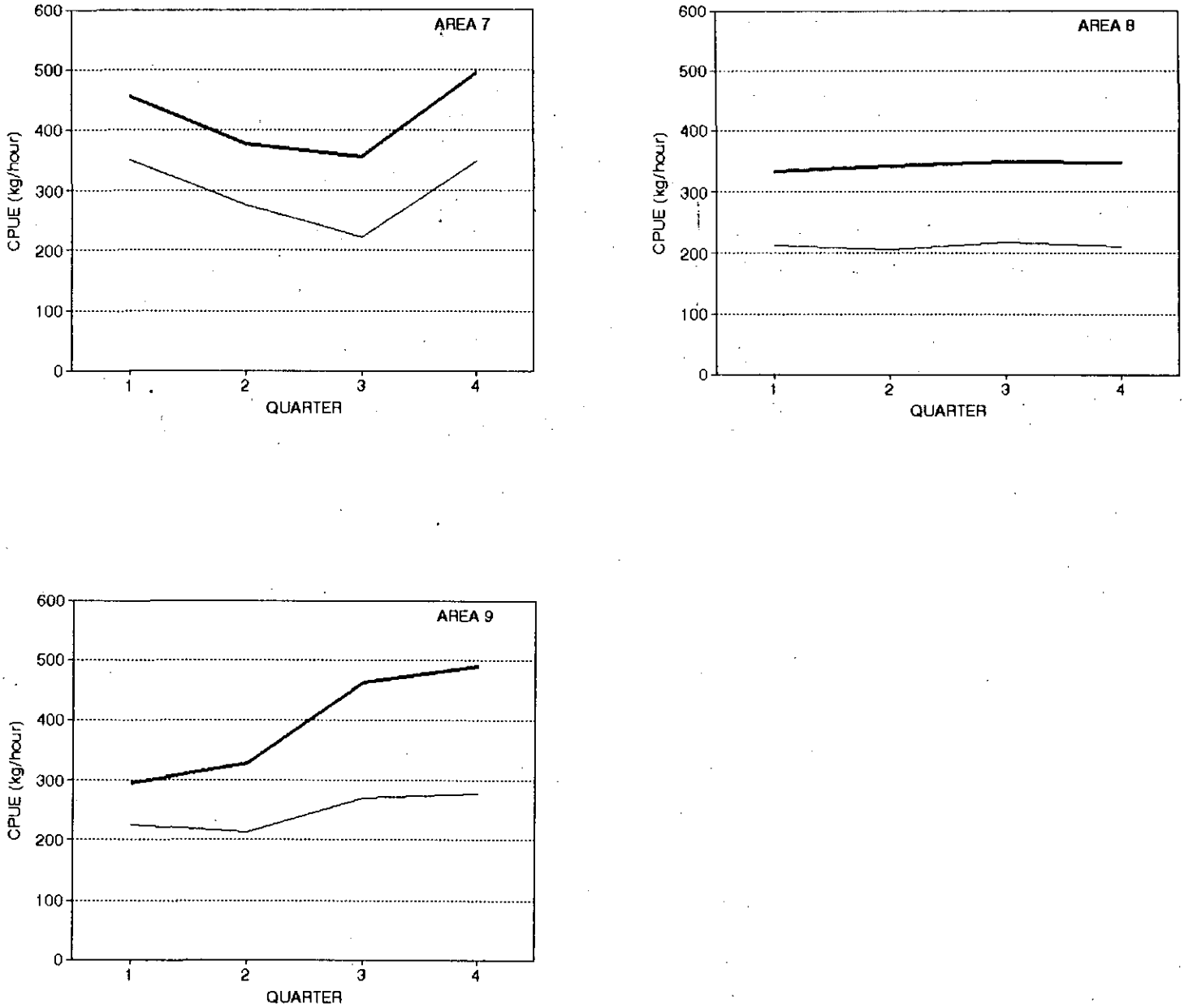


Fig. 3. Seasonality in CPUE of total catch and catch of larger shrimp in Div. 1CD (by quarter).