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Biomass Indices and Geographical Distribution Patterns of Survey Catches for Shrimp (*Pandalus borealis*) off West and East Greenland, 1982-96

by

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Abstract

The present paper describes the trend in biomass indices and geographical distribution patterns for shrimp since 1982 as derived from by-catches taken during the annual German groundfish survey off West and East Greenland. The biomass estimates show no significant trend and should be considered hardly representative for the stock status. The geographical distribution patterns of the survey catches indicate a southward shift of the stock biomass off West Greenland. These findings are consistent with observations of the shrimp directed fishing effort which is recently extended to southern areas.

Introduction

After the collapse of the formerly productive cod and redfish stocks off Greenland, the exploitation of the shrimp stocks off West and East Greenland became recently the most important marine resource in terms of economic value. Therefore, any information on the historical and recent stock status are considered to be relevant. The present paper describes the trend in biomass indices and geographical distribution patterns since 1982 as derived from by-catches taken during the annual German groundfish survey off West and East Greenland.

Materials and Methods

Estimates of biomass indices and geographical distribution patterns of catches were derived from annual groundfish surveys covering shelf areas and the continental slope off West and East Greenland. Surveys commenced in 1982 and were primarily designed for the assessment of cod. Because of favourable weather and ice conditions and to avoid spawning concentrations, autumn was chosen for the time of the surveys. These were carried out by the research vessel (R/V) WALTHER HERWIG (II) throughout most of the time period. In 1984 R/V ANTON DOHRN was used and she was replaced by the new R/V WALTHER HERWIG III since 1994, respectively.

The fishing gear used was a standardized 140-feet bottom trawl, its net frame rigged with heavy ground gear because of the rough nature of the fishing grounds. A small mesh liner (10mm) was used inside the cod end. The horizontal distance between wing-ends was 25 m at 300 m depth, the vertical net opening being 4 m. In 1994, smaller Polyvalent doors (4.5 m^2, 1,500 kg) were used for the first time to reduce net damages due to overspread caused by bigger doors (6 m^2, 1,700 kg), which have been used earlier. All calculations of

abundance and biomass indices were based on the 'swept area' method using 22 m horizontal net opening as trawl parameter, i. e. the constructional width specified by the manufacturer. The towing time was normally 30 min. at a speed of 4.5 knots. Trawl parameters are listed in Table 1. Hauls which received net damage or became hangup after less than 15 minutes were rejected. Some hauls of the 1987 and 1988 surveys were also included although their towing time had been intentionally reduced to 10 minutes because of the expected large cod catches as observed from echo sounder traces.

The surveys were primarily designed for the assessment of cod. In order to reduce the error of abundance estimates, the subdivision of shelf areas and the continental slope into different geographic and depth strata was required due to a pronounced heterogeneity of cod distribution (Rätz, 1996 a, b). The survey area was thus split into seven geographic strata. Each stratum was itself subdivided into two depth strata covering the 0-200 m and 201-400 m zones. Figure 1 and Table 2 indicate the names of the 14 strata, their geographic boundaries, depth ranges and areas in nautical square miles (nm^2). All strata were limited at the 3 mile offshore line.

The applied strategy was to distribute the sampling effort according both to the stratum areas and to cod abundance. Consequently, fifty percent of the hauls were allocated proportionally to strata by stratum area while the other fifty percent were apportioned on the basis of a review of the historical mean cod abundance/nm^2, all hauls being randomly distributed within trawlable areas of the various strata. Non-trawlable areas were mainly located inshore. During 1982-96, 2,343 successful sets were carried out, the numbers of valid sets by year and stratum being listed in Table 3. Apart from stratum 7.2 (Dohrn Bank), East Greenland strata were not covered adequately in 1984, 1992 and 1994 due to technical problems. In 1995, the survey area off West Greenland was incompletely covered for the first time again due to technical problems. Only 50 % of the strata of West Greenland were covered, namely the southern strata 3.1, 3.2, 4.1, and 4.2. Stratum 7.1 has a very low area and therfore never been covered. In 1996, the entire survey area was covered.

The weight of by-catches of shrimp (*Pandalus borealis*) was recorded on a regular basis when the catch exceeded 20 kg while smaller catches remained often unrecorded due to the time-consuming sorting procedure. Stratified biomass estimates were calculated from these catch-per-tow data using the stratum areas as weighting factor (Cochran, 1953; Saville, 1977). Strata with less than five valid sets were rejected from the calculation. The coefficient of catchability was set arbitrarily at 1.0, implying that estimates are merely indices of biomass. Respective confidence intervals (CI) were set at the 95% level of significance of the stratified mean.

Results and Discussion

During the period 1982-96, the total recorded by-catch of shrimp amounted to 3,650 kg. Biomass indices by stratum and year are listed in Table 4 and illustrated in Fig. 2. These indices were also aggregated to the total off West, East Greenland and the overall total. These estimates should be considered hardly representative for the stock biomass since neither the applied survey strategy nor the gear was designed for shrimp catches. Furthermore, the incomplete coverage of the survey area in some years and the irregular recording of shrimp by-catches less than 20 kg contributed to the very high confidence intervalls of biomass estimates. Since 1982, the indices of biomass show no significant trend but indicate that the shrimp was more abundant off West Greenland where the biggest catches were observed. The geographical distribution patterns of the survey catches are illustrated in Fig. 3 and 4 for the periods 1982-89 and 1990-96, respectively. However, these Figures as well as the biomass estimates listed in Table 4 indicate a southward shift of the stock biomass off West Greenland. Since 1991, no big catches were observed in the northern strata 1.1 and 1.2. In previous years, shrimp were found to be most abundant in the northernmost survey areas. These findings are consistent with observations of the behaviour of the shrimp fleet off West Greenland. Recently, the effort distribution was extended to southern areas where more effort was applied (Hvingel, 1996; Hvingel et al., 1996). A likely adverse effect of this change in shrimp directed effort to groundfish stocks could not be assessed due to unknown by-catches. However, the demersal fish assemblage off West Greenland remained severely depleted without any signs of recovery since 1991 (Rätz, 1997).

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Table 1 Trawl parameters of the survey.

Gear	140-feet bottom trawl
Horizontal net opening	22 m
Standard trawling speed	4.5 kn
Towing time	30 minutes
Coefficient of catchability	1.0

Table 2 Specification of strata.

Stratum	geographic boundaries south	north	east	west	depth (m)	area (nm^2)
1.1	64°15'N	67°00'N	50°00'W	57°00'W	1-200	6805
1.2	64°15'N	67°00'N	50°00'W	57°00'W	201-400	1881
2.1	62°30'N	64°15'N	50°00'W	55°00'W	1-200	2350
2.2	62°30'N	64°15'N	50°00'W	55°00'W	201-400	1018
3.1	60°45'N	62°30'N	48°00'W	53°00'W	1-200	1938
3.2	60°45'N	62°30'N	48°00'W	53°00'W	201-400	742
4.1	59°00'N	60°45'N	44°00'W	50°00'W	1-200	2568
4.2	59°00'N	60°45'N	44°00'W	50°00'W	201-400	971
5.1	59°00'N	63°00'N	40°00'W	44°00'W	1-200	2468
5.2	59°00'N	63°00'N	40°00'W	44°00'W	201-400	3126
6.1	63°00'N	66°00'N	35°00'W	41°00'W	1-200	1120
6.2	63°00'N	66°00'N	35°00'W	41°00'W	201-400	7795
7.1	64°45'N	67°00'N	29°00'W	35°00'W	1-200	92
7.2	64°45'N	67°00'N	29°00'W	35°00'W	201-400	4589
Σ						37463

Table 3 Numbers of valid hauls by stratum, West, East Greenland and total, 1982-96.

Year	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2	7.1	7.2	Σ West	Σ East	Σ
1982	20	11	16	7	9	6	13	2	1	10	3	12	1	25	84	52	136
1983	26	11	25	11	17	5	18	4	3	19	10	36	0	18	117	86	203
1984	25	13	26	8	18	6	21	4	5	4	2	8	0	5	121	24	145
1985	10	8	26	10	17	5	21	4	5	21	14	50	0	28	101	118	219
1986	27	9	21	9	16	7	18	3	3	15	14	37	1	34	110	104	214
1987	25	11	21	4	18	3	21	3	19	16	13	40	0	18	106	106	212
1988	34	21	28	5	18	5	18	2	21	8	13	39	0	26	131	107	238
1989	26	14	30	9	8	3	25	3	17	18	12	29	0	11	118	87	205
1990	19	7	23	8	16	3	21	6	18	19	6	15	0	13	103	71	174
1991	19	11	23	7	12	6	14	5	8	11	10	28	0	16	97	73	170
1992	6	6	6	5	6	6	7	5	0	0	0	0	0	6	47	6	53
1993	9	6	9	6	10	8	7	0	9	6	6	18	0	14	55	53	108
1994	16	13	13	8	10	6	7	5	0	0	0	0	0	6	78	6	84
1995	0	0	3	0	10	7	10	5	8	6	6	17	0	12	35	49	84
1996	5	5	8	5	12	5	10	5	7	9	5	13	0	9	55	43	98
Σ	267	146	278	102	197	81	231	56	124	162	114	342	2	241	1358	985	2343

Table 4 Biomass indices (1,000 t) by year, stratum, West and East Greenland and total for shrimp (*Pandalus borealis*), 1982-96. Confidence intervals (CI) are given at the 95% level of significance in per cent of the stratified mean. Incomplete survey coverage off East Greenland in 1984, 1992 and 1994!

Year	1.1	1.2	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.1	6.2	7.1	7.2	Σ West	Σ East	Σ Total	CI
1982	191	58	0	136	0	0	0			0		0		0	385	0	385	123
1983	211	6	0	90	0	0	0			0	0	0		0	306	0	306	145
1984	755	615	31	1337	0	0	0		0			0		0	2738	0	2738	43
1985	1552	451	204	774	0	0	0		0	0	0	125		0	2981	125	3106	64
1986	0	1360	0	1160	0	278	0			0	0	0		0	2797	0	2797	82
1987	1123	767	0		0		0		0	0	0	0		0	1890	0	1890	112
1988	374	837	0	0	0	0	0		0	0	0	0		0	1211	0	1211	72
1989	0	0	0	0	0		0		0	0	0	0		0	0	0	0	0
1990	0	173	3403	0	0		0	0	0	0	0	0		0	3576	0	3576	87
1991	0	0	611	327	0	0	0	0	0	0	0	0		0	938	0	938	146
1992	0	0	0	0	0	232	0	0						0	232	0	232	200
1993	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0
1994	0	0	0	0	0	0	0	0						0	0	0	0	0
1995					0	147	0	0	0	975	0	0		0	147	975	1122	173
1996	0	0	0	1166	845	194	0	0	0	0	0	0		0	2205	0	2205	112

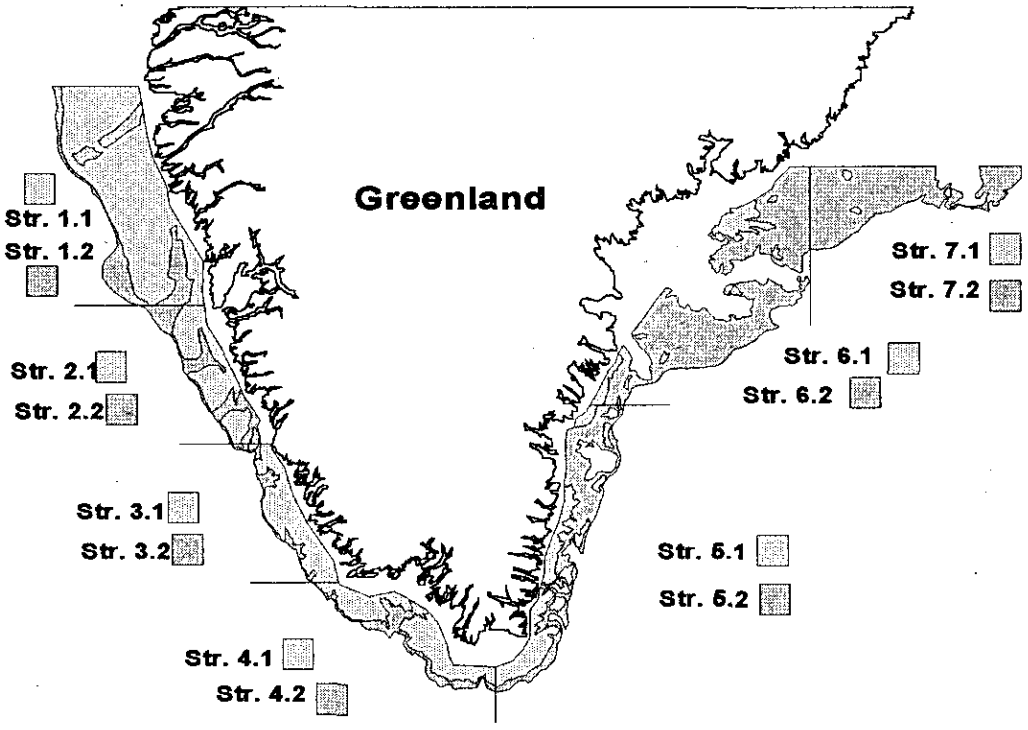

Fig. 1 Stratification scheme of the survey area as specified in Table 2.

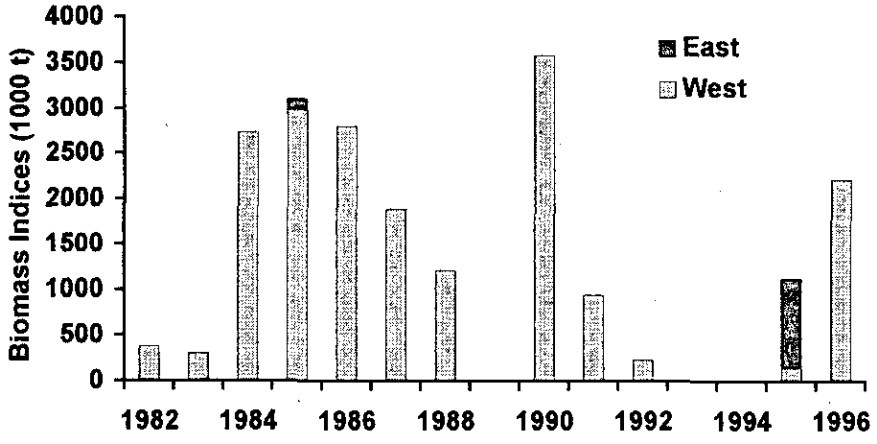

Fig. 2 Biomass indices off West, East Greenland, and total for shrimp as listed in Table 6, 1982-96. Incomplete survey coverage off East Greenland in 1984, 1992 and 1994!

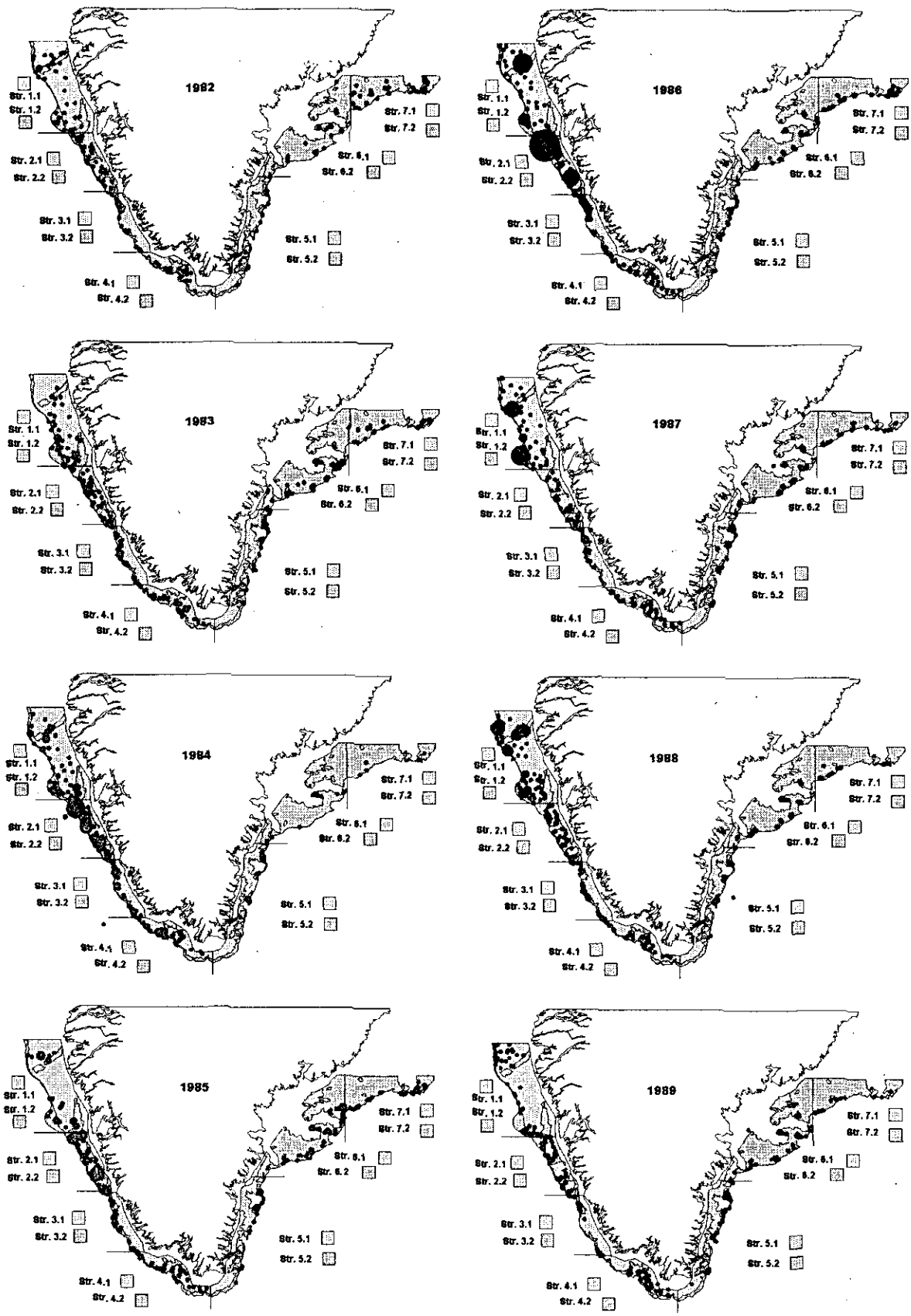

Fig. 3 Geographical distribution patterns of shrimp catches, 1982-89. The catches are linearely scaled from 0 to the maximum of 280 kg/30 min observed in 1990.

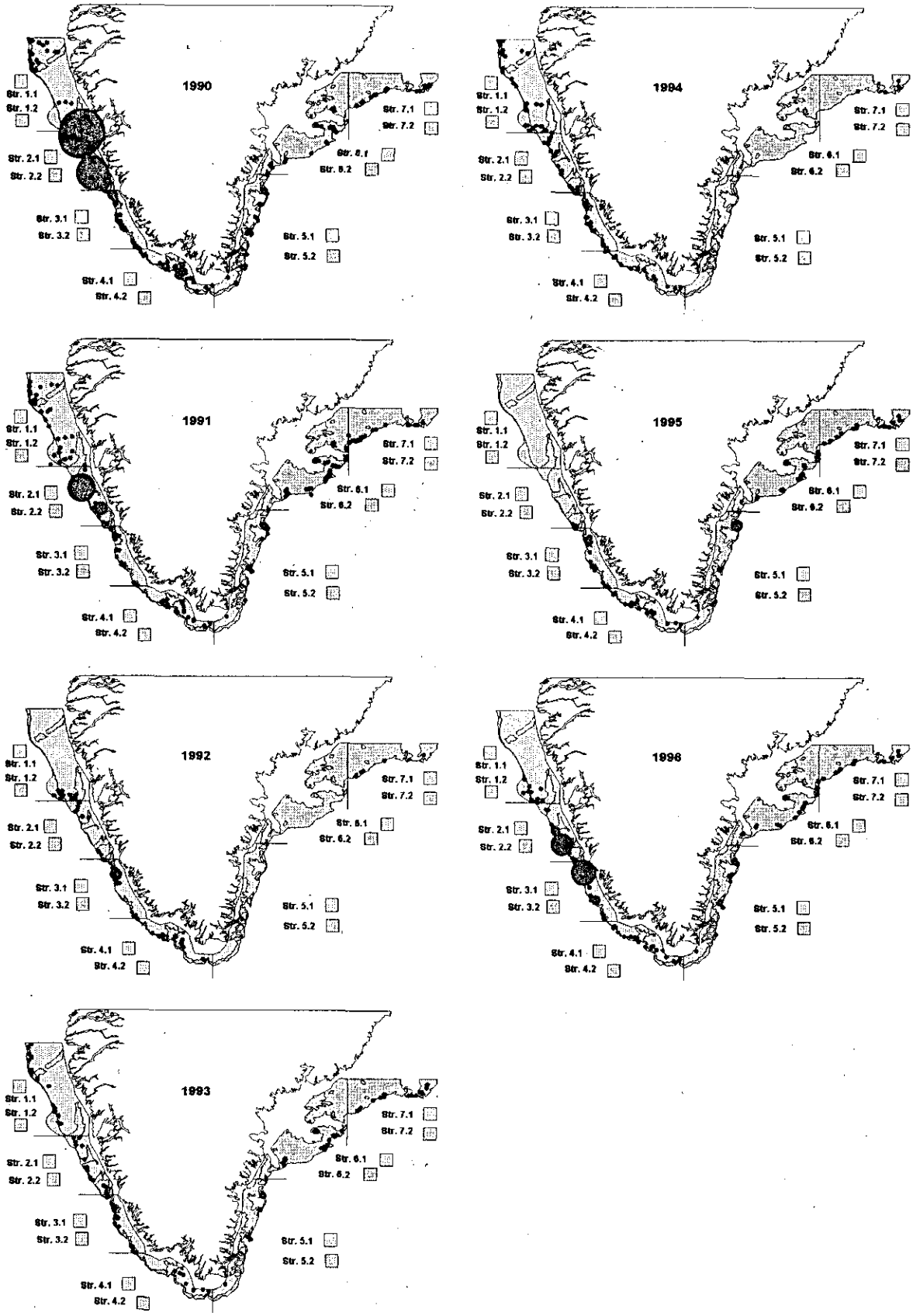

Fig. 4 Geographical distribution patterns of shrimp catches, 1990-96. The catches are linearely scaled from 0 to the maximum of 280 kg/30 min observed in 1990.