

CHAPTER 3 TRAWL SURVEY: CATCH DISTRIBUTION AND COMPOSITION AND SWEEPED-AREA BIOMASS ESTIMATES OF DEMERSAL FISH

The composition of the fish fauna in the catches was studied by dividing the shelf into two parts: an inner shelf, down to 70 m depth and an outer shelf, from 70 to 200 m. In addition, a slope area from 200 m and downwards has been grouped separately. The locations of the trawl stations are shown in Fig. 1. Pooled length distributions (weighted by the catch) of main species are shown in Annex II and records of the catches are presented in Annex III.

In the swept-area biomass estimates for the shelf down to 200 m the depth strata 0-50m, 50-100m and 100-200 m have been applied. In the catch rate analysis and biomass estimates of the slope species the area has been divided into depth zones 100-200 m, 200-300 m, 300-400 m, 400-500m, 500-600 m and 600-800 m. Mean densities by depth strata of the main species, the incidence and the catch distributions are shown in Annex I.

3.1 CABINDA - LUANDA

In this region, 73 swept-area trawl stations were successfully performed, and 51 of them were dayhauls. Due to safety reasons, no trawl hauls were made closer to the shore than 10 nm. This factor should be taken into account when comparing the results from this survey with previous surveys. Another factor is the new type of bottom trawl gear used in the new 'Dr. Fridtjof Nansen', that has proven to be more efficient in catching demersal species living very close to the bottom. The hauls were distributed as follows: 0-50 m : 9; 50-100 m : 11; 100-200 m : 12 and 200-800 m : 41.

Table 1 shows the catch rates by main species groups for the inner shelf, the outer shelf and the slope. "Demersal" comprises the families Sciaenidae, Haemulidae (=Pomadasyidae), Serranidae, Sparidae, Lutjanidae and Merluccidae, while "Pelagic" includes Engraulidae, Clupeidae, Carangidae, Scombridae, Sphyraenidae and Trichiuridae (the latter family is actually mainly benthopelagic). The catch rates of both these groups were highest on the inner shelf, and the demersal group had higher catch rates in all three depth zones. Compared with similar analysis from survey I and II in 1989, the catch rates obtained during the present survey of demersal and pelagic species are somewhat higher (25-100%) on the inner shelf and slightly lower

(15-25%) on the outer shelf. Sharks and shrimps were most abundant on the slope, while cephalopods occurred in highest catch rates on the inner shelf. The catch rates of the latter group were 5 times higher than in any of the surveys in 1989, *Illex coindetii*, *Todaropsis eblanae* and *Sepia* sp. being most abundant. Fig. 11 shows the distribution of total cephalopods. They were found all over the shelf and most of the slope, but in few concentrations.

Table 1. CABINDA-LUANDA. Catch rates (kg/hour) by main groups in swept area bottom trawl hauls for the shelf and the slope.

INNER SHELF 0-70 M

ST.NO.	DEP.	Demersal	Pelagic	Sharks	Shrimps	Cephalopod	Other
118	54	111.54	477.68		5.86	1.40	110.38
119	42	1160.10	34.20			0.72	46.80
127	70	177.76	339.06			142.30	44.88
128	47	60.26	721.44			29.08	8.26
129	24	882.20	159.00			33.00	206.00
130	21	236.14	22.68			43.34	39.12
131	58	274.80				5.16	20.48
145	31	5.94	1.02			70.20	24.00
146	39	122.58				2.16	79.32
160	52	84.78	85.44			1.38	17.28
170	61	81.48	758.18			14.72	25.94
171	38	537.72	90.90			6.70	47.66
172	37	390.10	102.78			4.20	19.98
180	46		2.40			0.12	0.46
MEAN		294.67	199.63		0.42	25.32	49.33

OUTER SHELF 70-200 M

ST.NO.	DEP.	Demersal	Pelagic	Sharks	Shrimps	Cephalopod	Other
108	89	82.00	237.18		0.26	0.34	166.18
109	184	144.16	74.72		8.50	0.54	272.48
117	93	203.56	115.70	36.34	8.26	2.46	202.66
120	121	130.58	6.00			9.68	79.86
126	120		181.54			0.35	0.07
132	80	77.52	4.06	3.40		7.12	46.76
133	142	396.12	77.58		0.24	16.08	264.90
142	151	95.92	173.40			9.56	159.88
143	110	118.40	83.86			9.86	24.62
147	84	113.54	669.06			18.76	66.36
148	141	321.85	2.85			3.70	213.05
158	146	84.52	35.64			8.08	61.45
159	80	134.83	19.18			29.16	23.97
161	107	153.96	22.92				78.00
168	195	5.72	60.88		27.90	5.29	244.94
169	105	158.79	38.37			13.83	163.50
173	78	40.88	97.92		10.72	28.62	421.24
179	122	69.78	188.56			1.80	465.64
MEAN		129.56	116.08	2.21	3.10	9.18	164.20

Table 1. Cont. SLOPE 200-800 m

ST.NO.	DEP.	Demersal	Pelagic	Sharks	Shrimps	Cephalopod	Other
110	299	44.68	1.50	1.50	7.68	1.58	108.70
111	416	69.00	11.00	718.60	32.72	1.04	54.28
112	571			49.10	22.56		57.66
113	798			1.16	15.34		98.96
114	486	3.96		19.02	45.66		221.28
115	312	150.00	12.48	6.00	27.78	8.16	166.24
116	214	254.00	23.40	4.14	7.82	2.34	315.30
121	554			1.26	106.08	0.30	26.52
122	709				1.20	0.78	124.08
123	445	38.00		2.84	2.98		71.32
124	335	94.63	3.63		12.20	27.36	258.18
125	215	36.30	92.94		1.42	10.34	572.32
134	241	59.20	57.98	30.00	7.68	13.40	699.04
135	344	38.26	11.00		13.70	4.76	219.76
136	491	12.60	31.80	22.60	11.12	1.36	143.08
137	615	6.54		3.19	8.15	1.35	220.94
138	769				1.52		164.22
139	527	13.50		0.40	34.90	1.20	223.38
140	326	129.71	46.59		3.63	5.57	348.11
141	269	149.23	37.55		9.59	4.63	1236.13
144	410	69.18	3.80	3.92		33.24	21.30
149	204	53.01	114.25	77.42	19.16	16.75	998.35
150	246	149.04	72.54		21.54	6.58	730.20
151	315	344.18	15.18		10.04	5.84	1610.04
152	376	331.86	29.32	60.00	0.92	4.72	130.68
153	456	111.29	1.55	29.61	1.36		80.98
154	563	41.80	0.46	2.18	260.38	0.66	191.38
155	706						183.20
156	397	12.60	1.72	21.00	313.84		32.26
157	264		104.70		10.62		228.06
162	224	5.90	58.18		26.60	1.90	166.40
163	359	66.98	2.16	0.34	224.40	2.44	40.42
164	484	74.10	0.54	3.30	206.42		39.84
165	581	13.66	0.92	1.76	241.04		46.72
166	495	24.20		6.00	537.60		35.90
167	355	172.40		0.40	11.28	5.64	84.90
174	354	69.36	2.82	20.64	94.14	15.74	82.34
175	553	5.08		12.00	386.20		27.20
176	666			4.32	34.92	3.60	413.64
177	453	55.00		9.48	183.96	1.80	54.74
178	253	272.48	29.08	40.22	46.31	1.56	217.27
MEAN		72.48	18.71	28.11	73.28	4.50	262.10

Catch rates of pelagic groups broken down to families (Table 2) are presented just to give some indication of the forms present. Carangids dominated both the inner and outer shelf, *Trachurus trecae* being the most important species. The catch rates on the inner shelf were much higher than those obtained in 1989, and a little lower on the outer shelf. The length distribution and mean length (27 cm) were similar to those found in 1992, while in 1989 mainly juvenile horse mackerel (15 cm) was found. Hairtails were the second most important pelagic family, with *Trichiurus lepturus* as the only species. The catch rates were quite similar to those obtained during survey II 1989.

Hairtail was the dominating pelagic species in the bottom trawl hauls on the slope (not shown in Table 2). Clupeids were much more common in 1989, especially on the inner shelf. During the present survey *Sardinella aurita* only occurred in one catch on the outer shelf and *Ilisha africana* in one haul on the inner shelf. Barracudas were also more common on the inner shelf in 1989, while scombrids were slightly more abundant on the outer shelf in 1994.

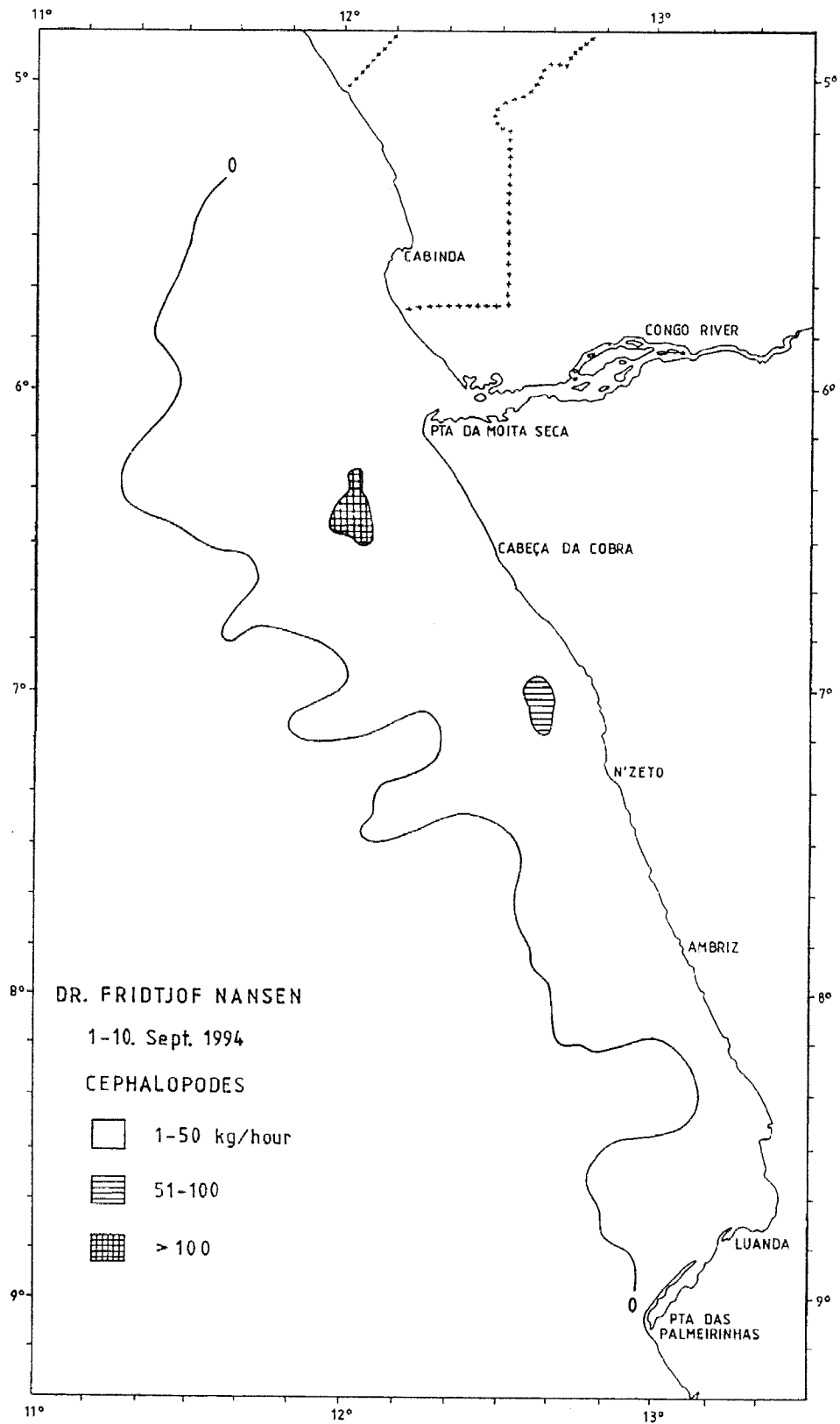


Figure 11. Cabinda - Luanda. Distribution of cephalopods (kg per hour trawling).

Table 2. CABINDA-LUANDA. Catch rates (kg/hour) of main pelagic families in swept-area bottom trawl hauls for the shelf.

INNER SHELF, 0-70 M

ST.NO.	DEP.	Clupeids	Carangids	Barracudas	Scombrids	Hairtails	Other
118	54		289.66	20.16	17.16	150.70	229.18
119	42		0.30	33.90			1207.62
127	70		295.10	4.40	2.70	36.86	364.94
128	47		692.04	4.48		24.92	97.60
129	24	33.60	46.80	7.60		71.00	1121.20
130	21		13.80	6.36		2.52	318.60
131	58						300.44
145	31		1.02				100.14
146	39						204.06
160	52		82.92			2.52	103.44
170	61		745.50	2.24	7.14	3.30	122.14
171	38		29.70			61.20	592.08
172	37		52.98			49.80	414.28
180	46					2.40	0.58
MEAN		2.40	160.70	5.65	1.93	28.94	369.74

OUTER SHELF 70-200 M

ST.NO.	DEP.	Clupeids	Carangids	Barracudas	Scombrids	Hairtails	Other
108	89	19.46	159.46		12.40	45.86	248.78
109	184		0.06			74.66	425.68
117	93		27.68			88.02	453.28
120	121		0.94		0.84	4.22	220.12
126	120		178.36			3.18	0.42
132	80		1.52			2.54	134.80
133	142		56.58			21.00	677.34
142	151		58.40			115.00	265.36
143	110		62.16		5.70	16.00	152.88
147	84		646.52			22.54	198.66
148	141		2.85				538.60
158	146				0.29	35.35	154.05
159	80		0.89			18.29	187.96
161	107		0.06		22.86		231.96
168	195					60.88	283.85
169	105		11.37			27.00	336.12
173	78		21.42			76.50	501.46
179	122		182.70		5.86		537.22
MEAN		1.08	78.39		2.66	33.95	308.25

Table 3 shows the catch rates of the most important demersal families. Both on the inner and outer shelf, seabreams were the most common, followed by grunts on the inner shelf and croakers on the outer shelf. The mean catch rate of sparids on the inner shelf was substantially higher than in 1989, but at about the same level on the outer shelf. *Dentex angolensis*, *D. canariensis*, and *Pagellus bellottii* (red pandora) were the most abundant species. Mean lengths were about the same as observed in previous surveys, but the length distributions were somewhat "broader".

Table 3. CABINDA-LUANDA. Catch rates (kg/hour) of main demersal families in swept-area bottom trawl hauls for the shelf.

INNER SHELF, 0-70 M

ST.NO.	DEP.	Seabreams	Grunts	Croakers	Groupers	Hakes	Other
118	54		67.10	44.44			595.32
119	42	1094.28	2.92	5.90	57.00		81.72
127	70	97.90		49.36	30.50		526.24
128	47	60.26					758.78
129	24	77.20	729.00	76.00			398.00
130	21	212.32	9.52		14.30		105.14
131	58	233.00			41.80		25.64
145	31	5.60			0.34		95.22
146	39	122.58					81.48
160	52	40.02	38.70		6.06		104.10
170	61	45.66	14.92		20.90		798.84
171	38	6.60	454.00	71.74	5.38		145.26
172	37	141.06	199.80	10.20	37.90	1.14	126.96
180	46						2.98
MEAN		152.61	108.28	18.40	15.30	0.08	274.69

OUTER SHELF 70-200 M

ST.NO.	DEP.	Seabreams	Grunts	Croakers	Groupers	Hakes	Other
108	89	15.78		66.12		0.10	403.96
109	184	22.58		87.78	33.80		356.24
117	93	23.52		180.04			365.42
120	121	120.00		9.80	0.78		95.54
126	120						181.96
132	80	77.52					61.34
133	142	74.82		321.30			358.80
142	151	75.00		19.48	1.44		342.84
143	110	106.24		12.16			118.34
147	84	110.74		2.80			754.18
148	141	244.00	3.50	66.30	8.05		219.60
158	146	74.58			9.94		105.17
159	80	134.83					72.31
161	107	15.96			138.00		100.92
168	195	3.23				2.49	339.01
169	105	140.55		18.24			215.70
173	78	37.46		3.42			558.50
179	122	51.16		16.06		2.56	656.00
MEAN		73.78	0.19	44.64	10.67	0.29	294.77

The catch rates of grunts were similar to those in 1989 on the inner shelf, but on the outer shelf this group only occurred on one station in 1994. Like in previous investigations *Brachydeuterus auritus* (big-eye grunt) was very abundant. The mean catch rate of croakers on the inner shelf was about 2/3 of that observed in 1989, while it was almost the double on the outer shelf. The most common croakers were *Miracorvina angolensis* and *Umbrina canariensis*. The catch rates of groupers were also higher than in 1989, *Epinephelus aeneus* being the most abundant.

Table 4. CABINDA-LUANDA. Catch rates (kg/hour) of main demersal families/species in swept-area bottom trawl hauls for the slope.

SLOPE 200-800 M

ST.NO.	DEP.	Seabreams	Hakes	Rose shr.	Str. shr.	Spid.shr.	Other
110	299		39.46	6.68	0.94		118.56
111	416		69.00		2.32	30.40	784.92
112	571				22.52		106.80
113	798				9.54		105.92
114	486		3.96		0.66	45.00	240.30
115	312	62.40	87.60	26.58	1.20		192.88
116	214	89.90		7.82			509.28
121	554				7.68	98.40	28.08
122	709				0.96		125.10
123	445		38.00		0.96	1.06	75.12
124	335		94.63	12.20			289.17
125	215	36.30		1.42			675.60
134	241	52.52	6.68	7.68			800.42
135	344		38.26	10.90			238.32
136	491		12.60		8.36	2.76	198.84
137	615		6.54		1.90	5.71	226.02
138	769				1.52		164.22
139	527		13.50		19.90	15.00	224.98
140	326		129.71	1.16			402.74
141	269	19.74	114.54	8.28			1294.57
144	410	63.50					67.94
149	204	53.01		19.16			1206.77
150	246	74.68	69.14	21.54			814.54
151	315		344.18	10.04			1631.06
152	376		329.66			0.92	226.92
153	456		111.29		0.97		112.53
154	563		41.80		0.56	259.82	194.68
155	706						183.90
156	397		12.60		2.88	310.96	54.98
157	264			10.62			332.76
162	224	3.50	2.40	26.60			226.48
163	359		66.84	0.84	0.42	223.14	45.50
164	484		74.10		16.64	189.30	44.16
165	581		13.66		1.20	239.76	49.48
166	495		24.20		6.60	531.00	41.90
167	355		172.40	11.28			90.94
174	354		69.36	49.58		44.28	121.82
175	553		5.08		6.20	380.00	39.20
176	666				13.32	21.60	421.56
177	453		55.00		21.36	162.60	66.02
178	253	196.46	43.52	46.31			320.63
MEAN		15.90	50.97	6.80	3.62	62.48	319.41

Table 4 presents the most important forms present on the slope. The mean catch rates are not directly comparable with those obtained in 1989 because more hauls were done deeper than 600 m during the present survey and for the earlier mentioned differences in gear type. The catch rates of hake, however, are somewhat lower than in 1989. Sparids, on the other hand, were more common in deepwater hauls in 1994, and *D. angolensis* was the dominating sparid found in deepwater stations. The mean catch rate of total shrimp (see Table 1) was at the same level as in 1989. *Nematocarcinus africanus* (spider shrimp) made up 85% of the catches of shrimp, and its mean catch rate actually exceeded that of hake. The commercially important species *Parapenaeus longirostris* (rose shrimp) and *Aristeus varidens* (striped red shrimp) had mean catch rates of about 10 and 5 % respectively of that of the spider shrimp, and *Plesiopenaeus edwardsianus* (scarlet shrimp) was only found in one haul at 709 m depth. Catch rates and biomass estimates of hake and commercially important shrimp species will be further dealt with in section 4.

In Annex I-A swept-area estimates of mean densities based on 32 random bottom trawl hauls are presented for demersal species on the shelf, to 200 m. Most pelagic species are not included in the estimates shown, but separate runs including important pelagic groups have been done in order to make comparisons with previous estimates of these groups. Like in previous surveys (1989,91,92) *B. auritus* was the species with the highest density in the 0-50 m zone, followed by *Dentex* species and *P. bellottii*. In the 50-100 m zone *Synagrops microlepis* (thinlip splitfin) had the highest density, followed by *Pentheroscion mbizi* (blackmout croaker), *P. bellottii* and *Dentex* species. Also in 1992 *S. microlepis* had the highest density in this zone, while in many previous investigations *B. auritus* was the dominating species found here. If pelagic groups are included, *T. trecae* and *T. lepturus* had the highest densities in the 50-100 m zone. In the deepest shelf zone (100-200 m) *Chlorophthalmus atlanticus* (Atlantic greeneye) had the highest density, closely followed by *D. angolensis*, *U. canariensis* and *S. microlepis*. In previous investigations *C. atlanticus* had been of less importance and *S. microlepis* more abundant in this zone.

The mean density of demersal species on the shelf was about 12 tonnes/nm², if major pelagic groups are included the mean density increased to 17 tonnes/nm². This result is about the same as what was found in 1989 and 1992, and somewhere in the middle of the result of the two surveys in 1991.

At the bottom of Annex I-A summed densities of the most important species by main groups are presented. Seabreams had the highest mean density, more than the double of grunts. These are followed by croakers, squids and groupers. In most previous investigations grunts have been the dominating group, followed by seabreams and croakers. The mean density of squids is the highest reported for this area, while that of so called "commercial shrimps" is higher than in 1992, in the middle of the results from 1991 and substantially lower than in 1989.

In Table 5 the densities in each depth zone of some important species and groups are multiplied by the area of the three shallowest depth zones. The results from some previous investigations are also given. This year estimates may be a little biased by the relatively low number of inner shelf trawl hauls, including one large catch of seabreams. The total biomass of demersal valuable groups is about 30% higher than in the two previous surveys, mainly due to a 100% increase in the biomass of seabreams. The present estimate of seabreams is the second largest since the surveys started in 1985, only passed by survey 4/85 (41 800 tonnes). The sum of valuable groups is the third highest in the time series. Groupers and grunts excluding bigeye grunt had about the same biomass as in 1992, while the estimate of croakers is only half of what was found in the two previous surveys and one of the lowest in the time series.

Table 5. Cabinda-Luanda. Mean densities of main groups and biomass estimates for the shelf to 200 m by year/period of investigation.

Group/ species	Mean density 1994 (t/nm ²)	Biomass (tonnes)		
		1994	1992	1991/II
Seabreams	3.79	32 700	16 000	16 500
Grunts*	0.10	900	1 000	2 900
Croakers	1.19	8 500	14 000	15 600
Groupers	1.71	3 500	3 000	940
Sum dem. val.	6.79	45 600	34 000	35 940
Bigeye grunt	1.61	17 100	21 000	19 700
Horse mackerel	2.42	18 500	20 000	12 000
Other carangids	1.49	13 300	4 000	860
Barracudas	0.08	820	1 000	
Hairtail	1.19	8 900	7 000	8300

* excluding big-eye grunt

The estimated biomasses of bigeye grunt, horse mackerel, barracuda and hairtail are similar to those obtained in 1992, while the estimates of other carangids are 3 times higher. *Decapterus rhonchus* and *Selene dorsalis* were the dominating species in this group.

Fig. 12 presents the distribution (kg/hour trawling) of the summed valuable demersal groups. Catch rates of more than 100 kg/hour were obtained from the middle of the inner shelf to the outer part of the shelf, from Cabinda to just north of Luanda, with the highest rates between Cabinda and N'zeto.

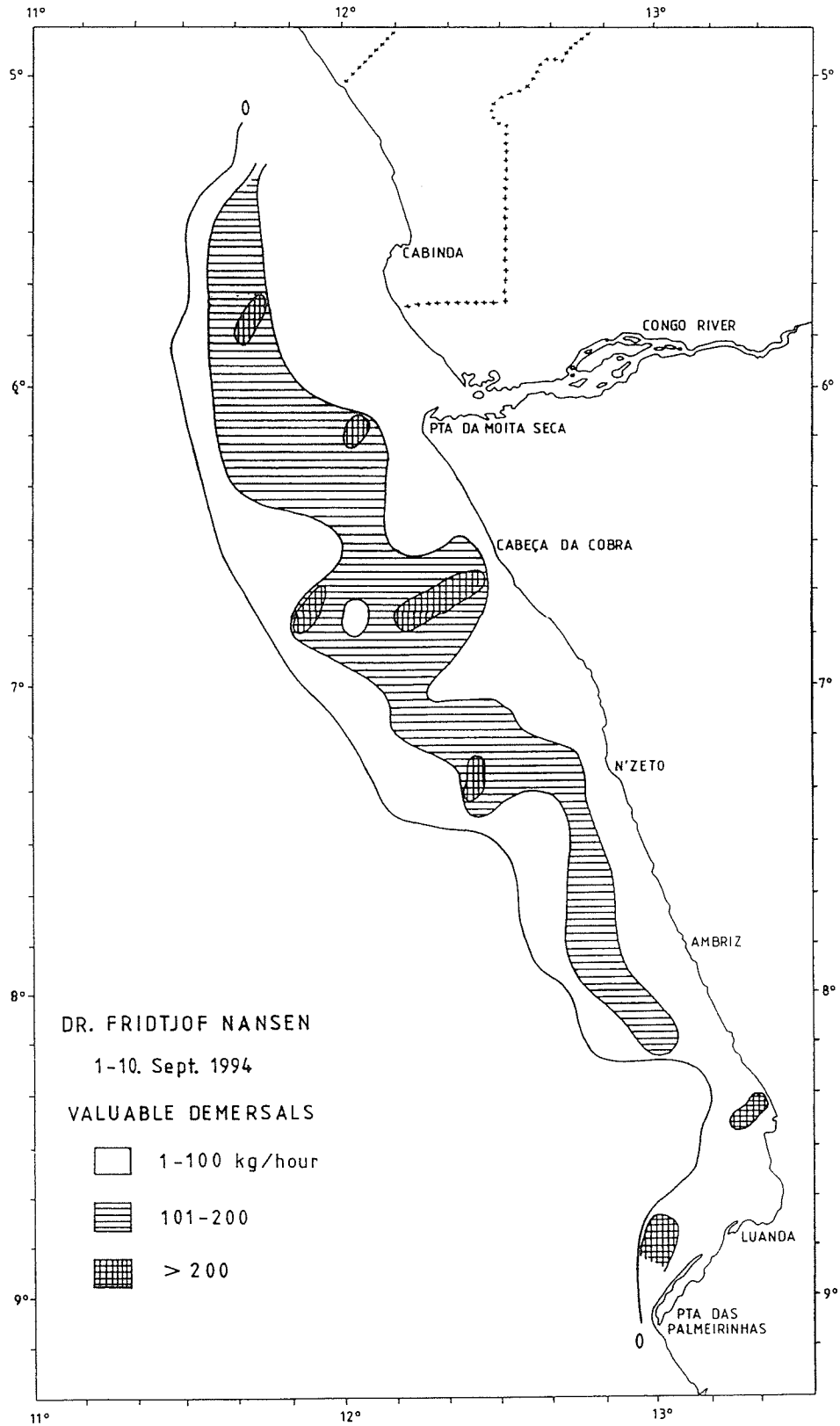


Figure 12. Cabinda - Luanda. Distribution of demersal valuable species (kg per hour trawling).

3.2 Luanda - Benguela

All together 72 swept-area hauls were made in the Luanda-Benguela shelf area. The hauls were distributed as follows: 0-50 m: 11 hauls; 50-100 m: 13 hauls; 100-200 m: 14 hauls and 200-800 m: 34 hauls.

Table 6 presents the catch rates by main groups for the inner shelf, outer shelf and the slope. In contrast with the Cabinda-Luanda region, the pelagic group had the highest catch rates both on the inner and outer shelf, and the catch rates were much higher than in the north. The mean catch rate of the demersal group on the inner shelf was only about 1/5 of that in north, while on the outer shelf it was more than 4 times higher. On the slope, the demersal group was the dominating, and the mean catch rate was about 100 % higher than in the northern region. Compared with similar analysis from survey I and II in 1989, the catch rate of the demersal group is much lower on the inner shelf and at about the same level (II/89) on the outer shelf, while the pelagic group in 1994 had higher catch rates on both shelf areas, especially on the outer. Like in the north cephalopods had the highest catch rate on the inner shelf, and the rates were about the double of those in the north and much higher than the rates obtained in 1989. *Sepia officinalis hierredda* was most abundant on the inner shelf, *Illex coindetii* and *Todaropsis eblanae* on the outer shelf. Fig. 13 shows the distribution of total cephalopods. They were found over most of the region, and with a few more concentrations than in the north. Sharks and shrimps were most abundant on the slope, with somewhat lower catch rates than found in the north.

Catch rates of the most important pelagic families are presented in Table 7. Carangids dominated both the inner shelf, outer shelf and the slope (not shown in the table), and *Trachurus trecae* was the most important species. The catch rates were much higher than in the northern region, especially on the outer shelf, and they were also much higher than the rates obtained in 1989. Like in 1992 both juvenile and adult horse mackerel were caught, with a mean length of 26 cm. In 1989 the catches mainly consisted of juvenile fish. Hairtails were the second most important pelagic family. The catch rates of *Trichiurus lepturus* were lower than in the north on the inner shelf, but much higher on the outer shelf. Compared with 1989, the catch rates were also lower on the inner shelf and substantially higher on the outer shelf. *T. lepturus* also occurred in most hauls on the slope. Scombrids were found in a couple of hauls on the inner shelf and in some more on the outer shelf. The catch rates were low, but higher than those obtained in 1989. *Scomber japonicus* was the dominating species. Like in the Cabinda-Luanda region, clupeids and barracudas were more common in 1989. During the present survey *Sardinella aurita* and *Sphyræna guachancho* were only found in a few hauls on the inner shelf.

Table 6. LUANDA-BENGUELA. Catch rates (kg/hour) by main groups in swept area bottom trawl hauls for the shelf and the slope.

INNER SHELF, 0-70 M

ST.NO.	DEP.	Demersal	Pelagic	Sharks	Shrimps	Cephalopod	Other
186	41	8.48	80.26			6.26	2.88
187	13	7.64	0.44			395.00	5.84
188	68	386.56	1911.26			18.66	136.50
199	41	261.27	312.23			0.55	166.54
200	26	28.12	165.58			27.58	7.12
201	14	12.27	124.62			13.44	10.83
202	55	33.98	375.26			0.40	45.26
218	50	6.64	4.62			5.06	1.14
219	28	10.30	3.00				0.44
220	44	78.60	51.00		33.00		137.60
221	55	25.00	322.08			10.08	33.12
233	63	82.02	114.68		8.70	7.56	47.88
234	20	7.34	6.82			96.52	10.98
235	44	17.64	1474.80			78.00	
245	44		26.00			0.94	15.30
246	61	44.40	24.98		0.32	8.56	13.28
MEAN		63.14	312.35		2.63	41.79	39.67

OUTER SHELF 70-200 M

ST.NO.	DEP.	Demersal	Pelagic	Sharks	Shrimps	Cephalopod	Other
184	159	302.86	67.38		17.03	4.75	294.44
185	88	143.88	476.16			34.78	53.58
189	112	347.10	45.20			2.20	669.06
196	162	231.43	70.85	12.69		92.19	134.66
197	112	228.66	910.38			38.88	260.76
198	72	361.02	32.44	8.00		9.42	4.44
204	118	1518.08	983.06			8.10	262.80
205	192	137.86	48.32		6.50	34.20	563.74
215	192	142.02		36.60	0.48	3.36	370.92
216	110	145.92	7.56	16.80		5.64	44.88
217	80	403.70	8696.38				899.88
222	90	564.71	1323.83				484.04
223	115	1146.00	2552.00			48.00	45.20
224	190	2232.00	63.36		6.24	7.20	910.56
232	103	169.63	175.86			0.38	338.45
236	75	373.76	15.52			39.92	22.08
243	131	1306.50	474.30			20.70	155.63
244	71	233.70	310.00			37.60	39.30
247	106	42.76	7.60	4.36		2.26	18.74
251	192	1050.34	104.05		13.24	51.56	314.70
252	89	369.68	257.06				70.66
MEAN		545.31	791.49	3.74	2.07	21.01	283.74

SLOPE 200-800 M

ST.NO.	DEP.	Demersal	Pelagic	Sharks	Shrimps	Cephalopod	Other
181	740	8.12	14.70		25.76	6.30	340.76
182	571	31.50	13.00	0.66	11.80	1.90	66.00
183	457	73.24	14.32	28.97	30.35	0.87	157.04
190	292	43.30	0.37	68.87	1.73	1.90	496.58
191	340	92.37	6.41		8.69	3.95	153.50
192	551	40.20	0.84	9.72	39.24	5.76	218.28
193	450	129.60		31.18	33.72	12.36	147.42
194	340	160.36	34.36	78.27	57.33	9.16	986.84
195	257	100.99	114.63		88.61	5.31	339.08
206	268	250.00	247.50		4.75	15.00	1186.50
207	362	26.10	5.62		20.80		63.38
208	453	53.74	1.40	50.60	78.10	3.10	105.76
209	555	50.80	7.40	24.40	31.64	2.72	95.68
210	771	10.88	25.60		2.72		167.28
211	541	63.20	11.70	7.02	442.28		85.72
212	451	90.30	43.54	65.70	97.88	4.90	45.74
213	345	65.80	2.10	1.48	52.30	3.78	248.32
225	248	1930.40	46.40		14.00		1749.20
226	352		2.24		2.40	0.04	3.74
227	449	115.80	3.12	1.08	132.24	0.60	83.04
228	549	75.50		6.70	148.40	4.10	29.70
229	475	9.92		4.32	57.12		335.68
230	347	84.00		6.56	8.82	1.88	70.30
231	202	89.28	231.20		12.16		163.20
237	201	338.98	443.24		10.48	4.98	960.92
238	377	34.80		11.44	49.60	0.72	113.44
239	483		0.54	11.38	90.23		265.97
240	601			1.20	21.68		202.60
241	393	28.40		7.70	11.00		199.60
242	206	116.24	239.40		103.65	7.32	940.63
248	234	1212.28	197.24		11.14	18.72	757.22
249	334	8.94		1.24	4.35	0.50	358.76
250	471	42.19		39.87	28.57		92.14
MEAN		162.95	51.72	13.89	52.53	3.51	340.30

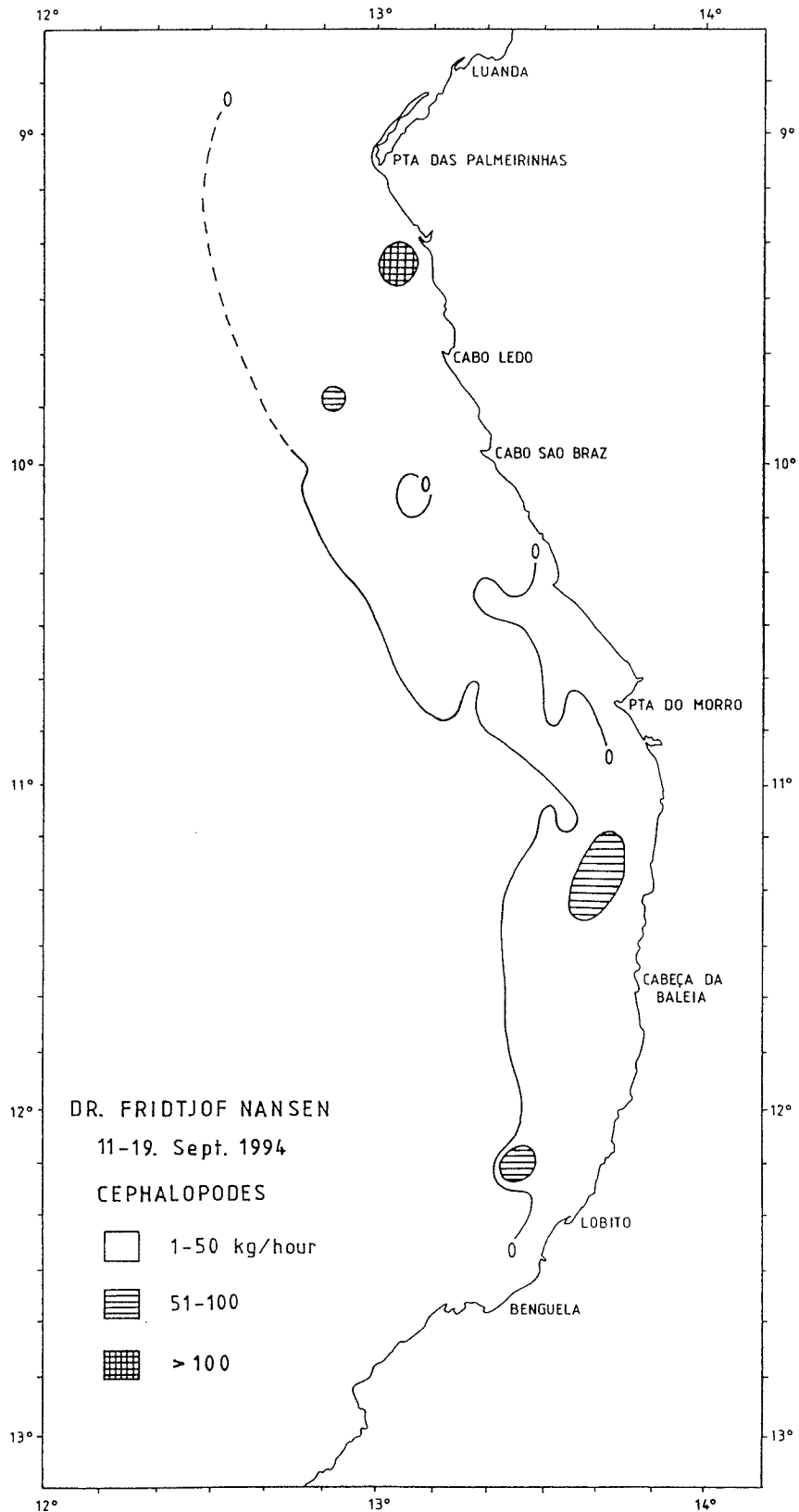


Figure 13. Luanda - Benguela. Distribution of cephalopods (kg per hour trawling).

Table 7. LUANDA-BENGUELA. Catch rates (kg/hour) of main pelagic families in swept-area bottom trawl hauls for the shelf.

INNER SHELF, 0-70 M

ST.NO.	DEP.	Clupeids	Carangids	Barracudas	Scombrids	Hairtails	Other
186	41		79.26	0.90		0.10	17.62
187	13		0.44				408.48
188	68		1844.88		39.72	26.66	541.72
199	41		305.31			6.92	428.36
200	26		130.98			34.60	62.82
201	14	2.33	1.28	114.47		6.54	36.54
202	55	2.10	334.66			38.50	79.64
218	50		4.62				12.84
219	28		3.00				10.74
220	44		24.00		12.20	14.80	249.20
221	55		318.12			3.96	68.20
233	63		102.80			11.88	146.16
234	20	1.18	2.46			3.18	114.84
235	44		1474.80				95.64
245	44		26.00				16.24
246	61		1.28			23.70	66.56
MEAN		0.35	290.87	7.21	3.25	10.68	147.23

OUTER SHELF 70-200 M

ST.NO.	DEP.	Clupeids	Carangids	Barracudas	Scombrids	Hairtails	Other
184	159		4.98			62.40	619.08
185	88		470.50		4.12		233.78
189	112		30.76			14.44	1018.36
196	162		57.38		6.05	7.42	470.97
197	112		867.30		43.08		528.30
198	72		16.36			16.08	382.88
204	118		934.88		48.18		1788.98
205	192		10.04		1.38	36.90	742.30
215	192						553.38
216	110		2.48			5.08	213.24
217	80		3752.42			4943.96	1303.58
222	90		1257.93			65.90	1048.75
223	115		2416.00			136.00	1239.20
224	190					63.36	3156.00
232	103		146.02			29.84	508.46
236	75		15.52				435.76
243	131		472.50			1.80	1482.83
244	71		277.00			33.00	310.60
247	106		7.60				68.12
251	192		104.05				1429.84
252	89		257.06				440.34
MEAN			528.61		4.90	257.91	855.94

Table 8. LUANDA-BENGUELA. Catch rates (kg/hour) of main demersal families in swept-area bottom trawl hauls for the shelf.

INNER SHELF, 0-70 M

ST.NO.	DEP.	Seabreams	Grunts	Croakers	Groupers	Snappers	Other
186	41	7.90	0.58				89.40
187	13	7.02			0.62		401.28
188	68	301.52	80.24	4.80			2066.42
199	41	186.46	3.55			71.26	479.32
200	26	23.58	4.54				200.28
201	14	1.80	3.21	7.26			148.89
202	55	6.42	23.30	4.26			420.92
218	50	0.64	0.70				16.12
219	28		0.98		1.86		10.90
220	44		75.50	3.10			221.60
221	55	4.56	13.44		7.00		365.28
233	63	75.36		6.48			179.00
234	20	7.34					114.32
235	44		13.44		4.20		1552.80
245	44						42.24
246	61	37.98	5.02	1.40			47.14
MEAN		41.29	14.03	1.71	0.86	4.45	397.24

OUTER SHELF 70-200 M

ST.NO.	DEP.	Seabreams	Grunts	Croakers	Groupers	Hakes	Other
184	159	271.71		23.86		7.29	383.60
185	88	143.88					564.52
189	112	218.78		124.08	3.06	1.18	716.46
196	162	231.43					310.39
197	112	172.26		16.20	40.20		1210.02
198	72	355.66		0.88	4.48		54.30
204	118	822.08		679.50	16.50		1253.96
205	192	92.48		15.76		29.62	652.76
215	192	100.80		7.20	14.70	19.32	411.36
216	110	141.96			3.96		74.88
217	80		403.70				9596.26
222	90	398.38		166.33			1807.87
223	115	1124.40		21.60			2645.20
224	190			1670.40		561.60	987.36
232	103	127.58		32.50	9.55		514.69
236	75	361.92		11.84			77.52
243	131	1306.50					650.63
244	71	217.30	5.30	4.80	6.30		386.90
247	106	42.76					32.96
251	192	952.10		26.94		71.30	483.55
252	89	301.16		68.52			327.72
MEAN		351.58	19.48	136.69	4.70	32.87	1102.04

Table 8 presents the catch rates of the most important demersal families. Like in the northern region seabreams were the most common both on the inner shelf and outer shelf. The catch rates of seabreams on the inner shelf were only about 25% of those in the north, while on the outer shelf the mean rate was almost 5 times higher in the south. Compared with 1989, the catch rates on the inner shelf are comparable to those obtained in 1989, while the rate on the outer shelf was 3 times as high in 1994. *Pagellus bellottii* and *Dentex canariensis* were the most abundant species on the inner shelf, while *Dentex macrophthalmus* dominated on the outer shelf (75% of the seabream catches), followed by *D. angolensis* and *P. bellottii*. Mean lengths and length distributions were similar to those observed in previous surveys.

Brachydeuterus auritus (big-eye grunt) was most abundant on the inner shelf and was only caught in two hauls on the outer shelf. The catch rates on the inner shelf were lower than in the northern region, and much lower than those found in 1989, both on the inner and outer shelf.

The most common croakers were *Umbrina canariensis*, on the inner shelf, and *Pentheroscion mbizi* and *Atractoscion aequidens* on the outer shelf.

Groupers were less abundant than in the Cabinda - Luanda region, and the catch rates were lower than in 1989. *Epinephelus aeneus* and *E. goreensis* were the most abundant groupers. Snappers (*Litjanus goreensis* and *L. endecacanthus*) only occurred on one station on the inner shelf.

Table 9 presents the most important forms on the slope. More deep-water hauls (> 600m) were done during the present survey than in 1989, so the results are not directly comparable. Furthermore, differences in the bottom trawl now used, more efficient in catching those species very close to the bottom, should also be taken into account when comparing present and earlier results. Seabreams, mainly *D. macrophthalmus*, occurred in stations shallower than 250 m. The catch rates were similar to those obtained in survey I 1989. Benguela hake (*M. polli*) was caught in most of the slope stations. The mean catch rate was 40% higher than in the north, but somewhat lower than in both 1989 surveys. Total shrimp (see Table 6) had a lower mean catch rate than in the north, while the rate was at the same level as in survey II 1989. *Nematocarcinus africanus* made up over 60% of the shrimp catches. The more important *Parapenaeus longirostris* and *Aristeus varidens* had mean catch rates of about 35 and 28% respectively of that of the spider shrimp. Small catches (< 5 kg/h) of *Plesiopenaeus edwardsianus* were obtained in a few stations from 350 m and downwards at similar rates as in survey III 1989. Hake and important shrimps are further described in section 4.

Table 9. LUANDA-BENGUELA. Catch rates (kg/hour) of main demersal families/species in swept-area bottom trawl hauls for the slope.

ST.NO.	DEP.	Seabreams	Hakes	Rose shr.	Str. shr.	Spid. shr.	Other
181	740		8.12		25.34		362.18
182	571		31.50		4.30	7.00	82.06
183	457		73.24		30.35		201.20
190	292		43.30		0.63		568.82
191	340		92.37	5.31	2.15		165.09
192	551		40.20		21.84	17.40	234.60
193	450		129.60		33.06		191.62
194	340		160.36	57.33			1108.63
195	257	22.36	78.63	88.61			459.02
206	268			4.75			1699.00
207	362		26.10	0.90		19.90	69.00
208	453		53.74		48.60	29.00	161.36
209	555		50.80		3.64	28.00	130.20
210	771		8.40		2.00		196.08
211	541		63.20		4.82	436.80	105.10
212	451		90.30		28.92	68.96	159.88
213	345		65.80	52.30			255.68
225	248		12.40	14.00			3713.60
226	352			0.30		2.02	6.10
227	449		115.80		10.08	121.80	88.20
228	549		75.50		39.40	109.00	40.50
229	475		9.92			57.12	340.00
230	347		84.00	6.02			81.54
231	202	42.88	46.40	12.16			394.40
237	201	140.00	12.24	10.48			1595.88
238	377		34.80		3.20	46.40	125.60
239	483				2.85	86.03	279.24
240	601				3.76	17.52	204.20
241	393		26.90			6.50	213.30
242	206	30.89	85.35	100.80		2.85	1187.35
248	234	479.78	708.96	11.14			996.72
249	334		8.94	4.10		0.25	360.50
250	471		42.19		28.57		132.01
MEAN		21.69	69.06	11.16	8.89	32.02	482.08

In Annex I-B swept-area estimates based on 37 bottom trawl hauls are presented for demersal species on the shelf. In the 0-50 m zone *Sepia officinalis hierredda* had the highest density, followed by *Dentex canariensis*, *Synagrops microlepis* and *Brachydeuterus auritus*. In the northern area, as well as in most previous investigations, *B. auritus* was the dominating species in the shallowest zone. *S. microlepis* had the highest density between 50 and 100 m, followed by *D. macrophthalmus*, *P. bellottii* and *B. auritus*. Also in 1992 *S. microlepis* had the highest density in this zone, while in earlier investigations *B. auritus* was the dominating demersal species. *D. macrophthalmus* had the highest density in the deepest shelf zone, almost three times higher than *Pentheroscion mbizi*, which came second. Then followed *Chlorophthalmus atlanticus*, *Umbrina canariensis* and *S. microlepis*.

In previous investigations *S. microlepis* often had the highest density in the 100-200 m zone, but *D. macrophthalmus* has normally been abundant. If pelagic species are included, *T. trecae* had the highest density in all three shelf zones, and *T. lepturus* came second in the 50-100 m zone.

The mean density of demersal species on the shelf was about 18 tonnes/nm², which is somewhere in the middle of the results of survey I and II in 1989 and 50% higher than the mean density for

the Cabinda-Luanda region. If pelagic groups are included, the mean density increases to almost 38 tonnes/nm². This is almost exactly the same as found in 1992, and about 25% higher than the results of the two surveys in 1991.

Summed densities of the most important species by main groups are presented at the bottom of Annex I-B. Like in the northern region seabreams had the highest density, more than the double of croakers. Then came squids, grunts and groupers. In most previous investigations grunts has been the dominating group, followed by seabreams and croakers. The mean density of squids is the highest reported, more than the double of what was found in 1992. "Commercial shrimp" had lower mean density than in 1989, but higher than in 1991 and 1992.

Table 10 summarizes the mean densities of some important groups, and biomass estimates for 1994 and some previous investigations are also presented.

Table 10. Luanda-Benguela. Mean densities and biomass estimates by main groups over the shelf to 200 m by year of investigation.

Group/ species	Density (t/nm ²) 1994	Biomass (tonnes)		
		1994	1992	1991
Seabreams	7.30	28 730	28 000	24 580
Grunts*	0.02	120	2 000	5 500
Croakers	2.65	9 250	2 000	19 000
Groupers	0.11	400	1 000	1 000
Sum dem. val.	10.08	38 500	33 000	50 080
Bigeye grunt	0.55	2 990	52 000	18 500
Horse mackerel	13.74	65 100	75 000	48 500
Other carangids	0.46	2 790	1 640	290
Barracudas	0.12	740		
Hairtail	5.02	26 200	1 300	4100

* excluding big-eye grunt

The estimated total biomass of demersal valuable groups is 17% higher than in 1992. Seabreams made up more than 70% of the biomass of demersal valuable groups, and their biomass was the highest measured in the time series, slightly higher than in 1992. *D. macrophthalmus* contributed almost 70% to the biomass of seabreams.

Croakers had less than half of the biomass found in 1991, but much higher than in 1992. The biomass estimates of groupers and grunts excluding big-eye grunt were lower than in the two previous investigations, that of grunts is the lowest in the time series.

The estimated biomass of big-eye grunt is also the lowest in the time series. A big haul of about 25 tonnes was not included in the swept-area estimates because it was difficult to bring the catch on deck for precise registration. Big-eye grunt made up over 70% of the total catch, and including this haul, it would have increased the biomass estimate to about 250.000 tonnes.

The biomass estimate of Cunene horse mackerel in the bottom layer is somewhat lower than in 1992 but well above the result from 1991. Hairtail came out with the highest biomass estimated in the time series. A catch of 5 tonnes contributed 90% to the hairtail biomass. Other carangids and barracudas were also more abundant than in previous investigations.

Fig. 14 shows the distribution of the summed demersal valuable groups. Catches of more than 100 kg/hour were obtained from the middle of the inner shelf to the beginning of the slope (250m) over most of the region. There were also large areas with catch rates > 200 kg/hour.

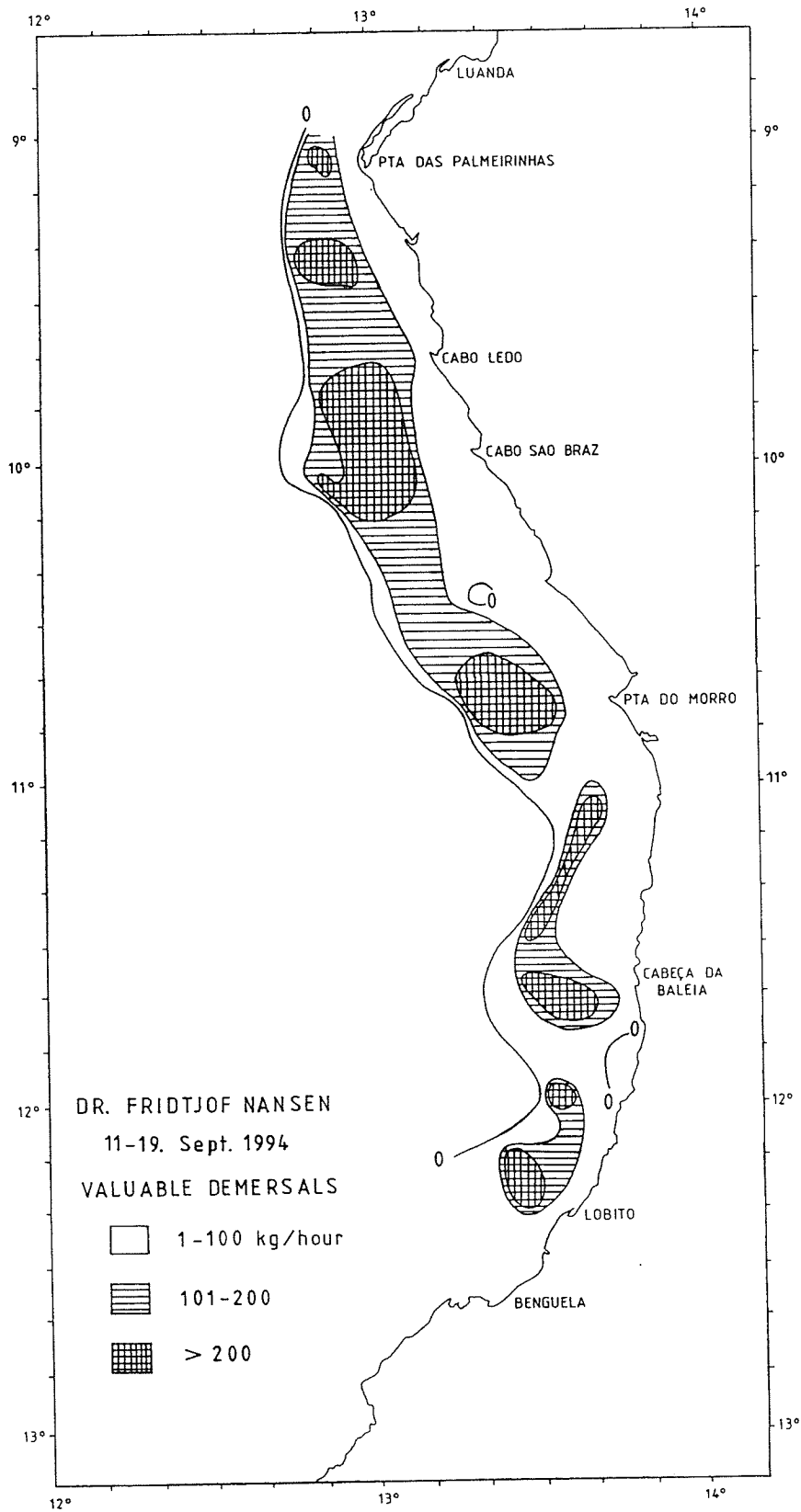


Figure 14. Luanda - Benguela. Distribution of demersal valuable species (kg per hour trawling).

3.3 Review of results

In the category high-value demersal fish we include species of seabreams, croakers, grunts (excluding the bigeye grunt), groupers etc. that constitute the most valuable food fish. Table 11 shows the results of present and previous surveys. The present estimate for the Benguela - Cabinda region is one of the highest in the time series, about 25% higher than the 1992 estimate. However, the difference in the bottom trawl gear used in the new 'Dr. Fridtjof Nansen', probably more efficient than the one previously used, might be critical. Tests on the differences between the two gear types are planned for the near future and present results and comparisons should be evaluated again in the light of the information gained from the calibration experiments.

Table 11. Valuable demersal fish. Mean biomass estimates (1000 tonnes) by survey and region.

Survey	Cunene-Benguela	Benguela-Luanda	Luanda-Cabinda	Benguela-Cabinda	Total
1/85-4/85	N.S.	N.S.	48.8	-	-
1/86-2/86	15.6	21.2	38.3	59.5	78.4
1/89-2/89	28.2	17.9	25.5	43.4	75.1
3/89	N.S.	N.S.	31.7	-	-
Nov/89					68.0*
1/91	26.4	15.0	15.9	30.9	57.3
2/91	36.4	50.1	35.9	86.0	122.4
1/92	47.7	33.0	34.0	67.0	114.7
1/94	N.S.	38.5	45.6	84.1	-

* From GOA survey, seabreams only.