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**DISTRIBUTION AND ABUNDANCE OF YOUNG COD AND WHITING IN THE
SOUTH-EASTERN NORTH SEA IN THE PERIOD 1980 - 1982.**

by

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Summary.

In the period 1980 - 1982 twelve successive surveys were carried out in the south-eastern part of the North Sea. Seasonal changes in distribution and abundance of 0-, I- and II-group cod and whiting are discussed. The poor correlation between IYFS abundance index for cod and VPA year class strength is probably related to the coastal distribution of one year old cod during the winter. A young fish survey in either November or May is likely to yield more reliable indices of abundance than the IYFS.

Introduction.

Since 1960 International Young Fish Surveys are carried out annually in February/March in order to collect information on distribution and abundance of several commercially important species in the North Sea. The primary aim of the IYFS is to obtain an index of abundance of the youngest two year classes in the sea, which can be used in catch predictions. The correlation between VPA recruitment figures and IYFS estimates vary from highly significant (haddock) to just or not significant (cod). The problems encountered in cod are probably related to the fact that the main nurseries of cod lie along the Danish-German-Dutch coast, which is evident from the long term averages (ANON., 1974; DAAN, 1980).

Recently, the validity of the standard IYFS abundance indices has been questioned (ANON., 1982) and attempts have been made to improve these indices for cod (BURD, 1981; BURD & PARNELL, 1982).

The IYFS presents only data for the first quarter of the year. In 1980 a national sampling program for cod stomachs was started by The Netherlands Institute for Fishery Investigations in the south-eastern North Sea, covering that part of the North Sea with the highest abundance of young cod.

From the first results it appeared that the distribution of I-group cod changed markedly in the course of the year and that the timing of the IYFS might not be optimal in order to derive good indices of year class strength for this species. For example, the underestimation of the 1979 cod year class by the IYFS in 1980 was explained by changes in the distribution pattern (ANON., 1981b).

In this paper results are presented of 12 surveys, one in each quarter, during the years 1980 - 1982 and the distribution pattern and abundance of cod and whiting in the course of three years is discussed. Data from the surveys in the first quarter have already been published as these surveys formed part of the IYFS (DAAN & KUITER, 1981; HEESSEN & KUITER, 1982).

Material and methods.

The study area (figure 1) comprises 33 ICES rectangles in the south-eastern part of the North Sea. The area forms the major part of Roundfish Area 6, except for three of the most western rectangles (34/36 F2) which belong to Roundfish Area 5.

The data for the first quarter are extracted from the IYFS data base and for information about the ships participating in the IYFS in 1980 - 1982 reference is made to CORTEN (1980, 1982) and CORTEN & KUITER (1981).

The surveys in the other quarters of 1980 and 1982 formed part of a national Dutch sampling programme for cod stomachs. The 1981 surveys formed part of the North Sea Stomach Sampling Project 1981 (ANON., 1980).

During these "extra" surveys the area was fished by the Dutch research vessel "Tridens" (5 times) or by the chartered commercial trawler "Rose Marie" (KW 34, 4 times). In the third quarter of 1981 the English research vessel "Cirolana" also fished a number of stations in this area, which have been included in the analysis. The number of rectangles fished and the total number of hauls per survey is given in table I.

The gear used was the standard IYFS GOV trawl, a high opening (Grande Ouverture Verticale) bottom trawl with a 1 cm codend. The gear and the method of fishing are described in ANON. (1981a).

Results.

Distribution:

The mean number per hour per rectangle of 0-, I- and II-group of both species during each of the surveys is given in Appendix I.

For each survey the contribution of each rectangle to the total catch of a certain age group was calculated. Missing data were estimated from other years. In figure 2 and 3 the distribution of cod and whiting is given as a mean of this contribution (per rectangle and per quarter) over three years. The distribution of I- and II-group cod during the first quarter has been well established by the IYFS: high concentrations are found particularly in the inshore area. The mean over 1974/1979 (figure 4) does not differ substantially from the mean over the period 1980/1982.

In the course of the year a marked difference exists between the distribution during the first and the third quarter. In the third quarter the I- and II-group cod have left the coastal area almost completely and have moved out of that area to the central part of the North Sea. In quarter 3 also the first demersal 0-group cod are caught, in particular along the coast of Denmark and Schleswig-Holstein. The distribution in quarter 2 and 4 is approximately intermediate between the two extremes in quarter 1 and 3.

For whiting the situation is different. Areas of high abundance are more variable from year to year and a seasonal pattern or cycle as for cod is not observed. Whereas a large proportion of young cod is restricted to a relatively small number of rectangles, whiting is in general more evenly distributed. The inshore area seems to be less important for whiting than for cod.

Abundance:

Figure 5 and 6 show the changes in abundance of different year classes of both species from the third quarter as 0-group up till the fourth quarter as II-group. The oldest year class shown in these figures is year class 1978, caught as II-group in 1980. The youngest year class is year class 1982. Arrows under the X-axis indicate the abundance found

during the IYFS in the first quarter. The resemblance between both figures is remarkable. Both for cod and whiting year class 1979 was the strongest year class in the south-eastern North Sea, 1980 the poorest one and 1981 was intermediate.

For all year classes the abundance as I-group in the second quarter is much higher than in the first quarter, whereas in the fourth quarter the abundance of I-group is still higher or at the same level as in the first. The general pattern is rather consistent, perhaps with the exception of year class 1980. The abundance of the cod year class 1980 in the fourth quarter as 0-group was slightly lower than the abundance one quarter later during the IYFS. However, in the 1981 IYFS in one rectangle in the German Bight more I-group cod was caught than in all other rectangles together. Eliminating this one rectangle changes the abundance from 50.0 to only 18.8.

Also for whiting holds that especially during the survey in the second quarter of the year substantially more I-group fish are caught than during the IYFS.

Discussion.

The seasonal changes in distribution pattern of I- and II-group cod are very similar: they aggregate in the coastal zone during the winter period and disperse over the deeper north-westerly part of the area in summer. This is in good agreement with the results of recent English tagging experiments off the Dutch coast and in the German Bight (RILEY & PARNELL, 1983). Except for quarter 3 the inshore area in the German Bight is very important for both I- and II-group cod. These changes in distribution present also a good explanation for the apparent changes in abundance: the decrease from the fourth quarter as 0-group till the first quarter as I-group and a strong increase in I-group abundance in the second quarter suggests that an unknown quantity of the one year old cod is missed during the IYFS, because they have moved inshore, where they cannot be fished with the standard gear.

However, if in each year the same proportion of I-group cod was missed, this would not influence the relative abundance index. The proportion available apparently varies between years, possibly as a result of differences in water temperature and/or salinity (see also BURD, 1981 and BURD & PARNELL, 1982) and this may affect the relation between IYFS abundance index and VPA year class strength.

Although for cod the concentration in the coastal zone during the winter period can provide an explanation for the increase of I-group between quarter 1 and 2, the reason why there is also such an increase in the catches of whiting from the first to the second quarter is less clear since the distribution of I-group whiting is not very different in both quarters. A higher catchability due to growth seems unlikely, because 0-group abundance in the fourth quarter is also in whiting sometimes very much higher than I-group abundance during the IYFS. The existence of an other and still unknown common factor affecting catchability, and thus estimated abundance during the winter of both cod and whiting cannot be excluded.

For both species the level of abundance between I- and II-group differs considerably. Except for the influence of the fishery, for cod certainly the dispersion over a greater part of the North Sea will play a role. As a consequence of its migration pattern, cod appears to be more available to the gear during the fourth quarter as 0-group as well as during the second quarter as I-group than during the IYFS. An additional survey, even if limited to a restricted area (as in this study), seems

to be desirable. When the abundance is taken into account the second quarter should be preferred, but that time of the year is probably too late for the results of such a survey to be used in the Assessment Working Group.

However, possibilities for a supplementary survey in the fourth or second quarter should be investigated.

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TABLE I - Number of rectangles fished during each survey and the total number of hauls in the whole study area (between brackets).

Year	1980	1981	1982
Quarter 1	32 (112)	33 (93)	33 (115)
2	27 (27)	32 (35)	33 (33)
3	31 (31)	32 (55)	33 (33)
4	31 (31)	24 (24)	30 (30)

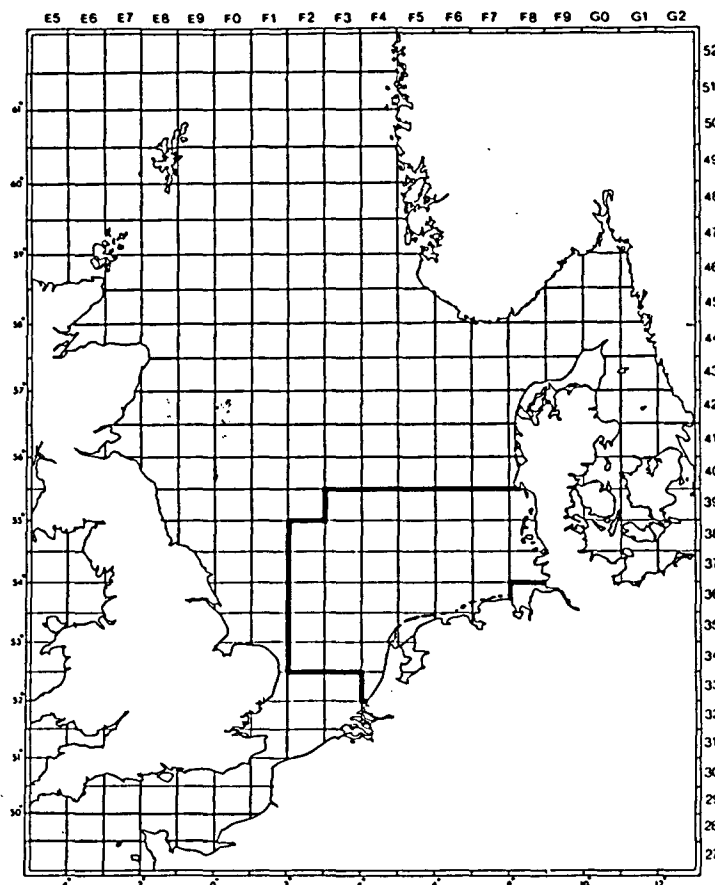


Figure 1 - The study area.

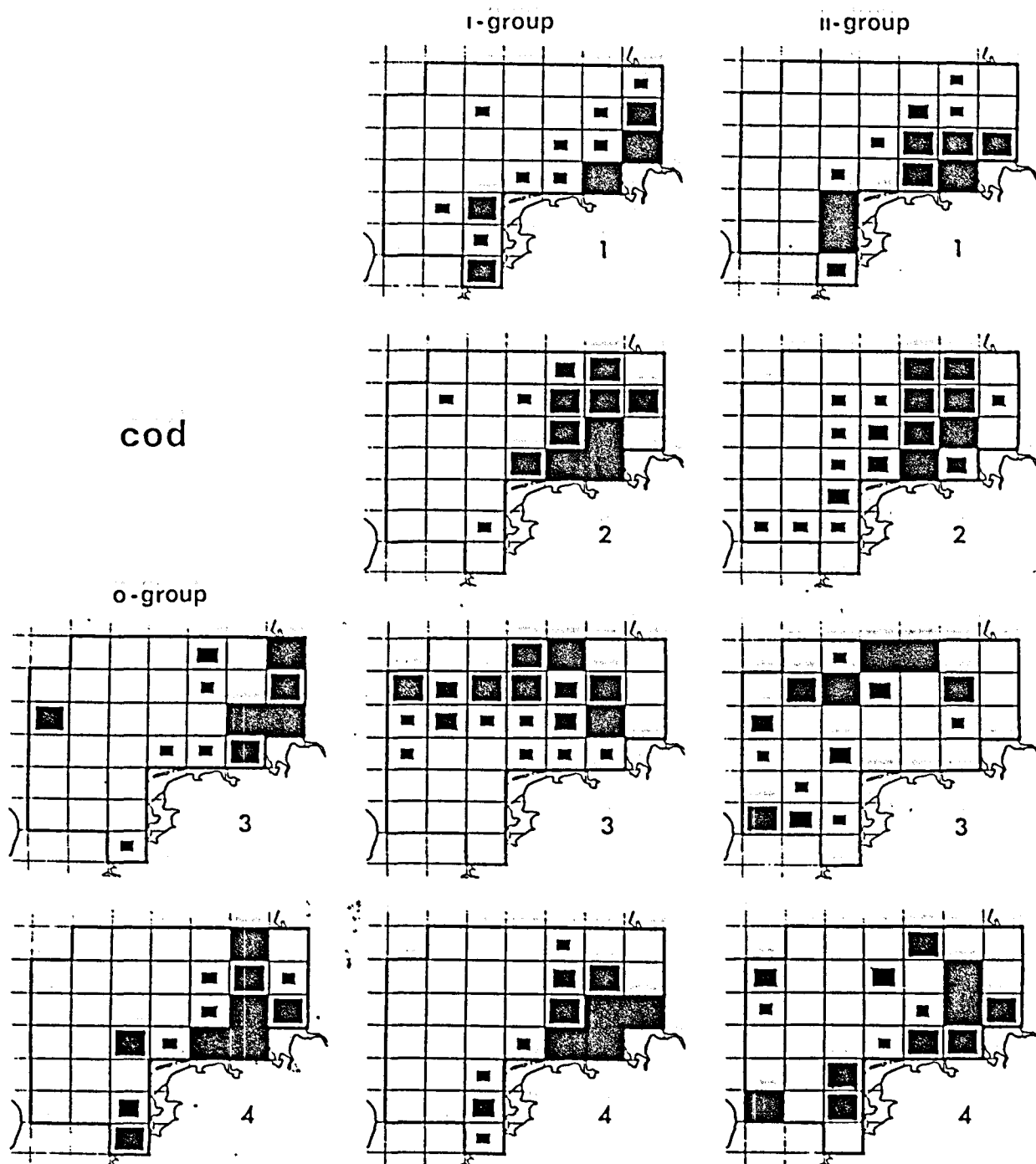


Figure 2 - Distribution of 0-, I- and II-group cod per quarter as mean percentage over the years 1980/1982 of the contribution per rectangle to the total catch

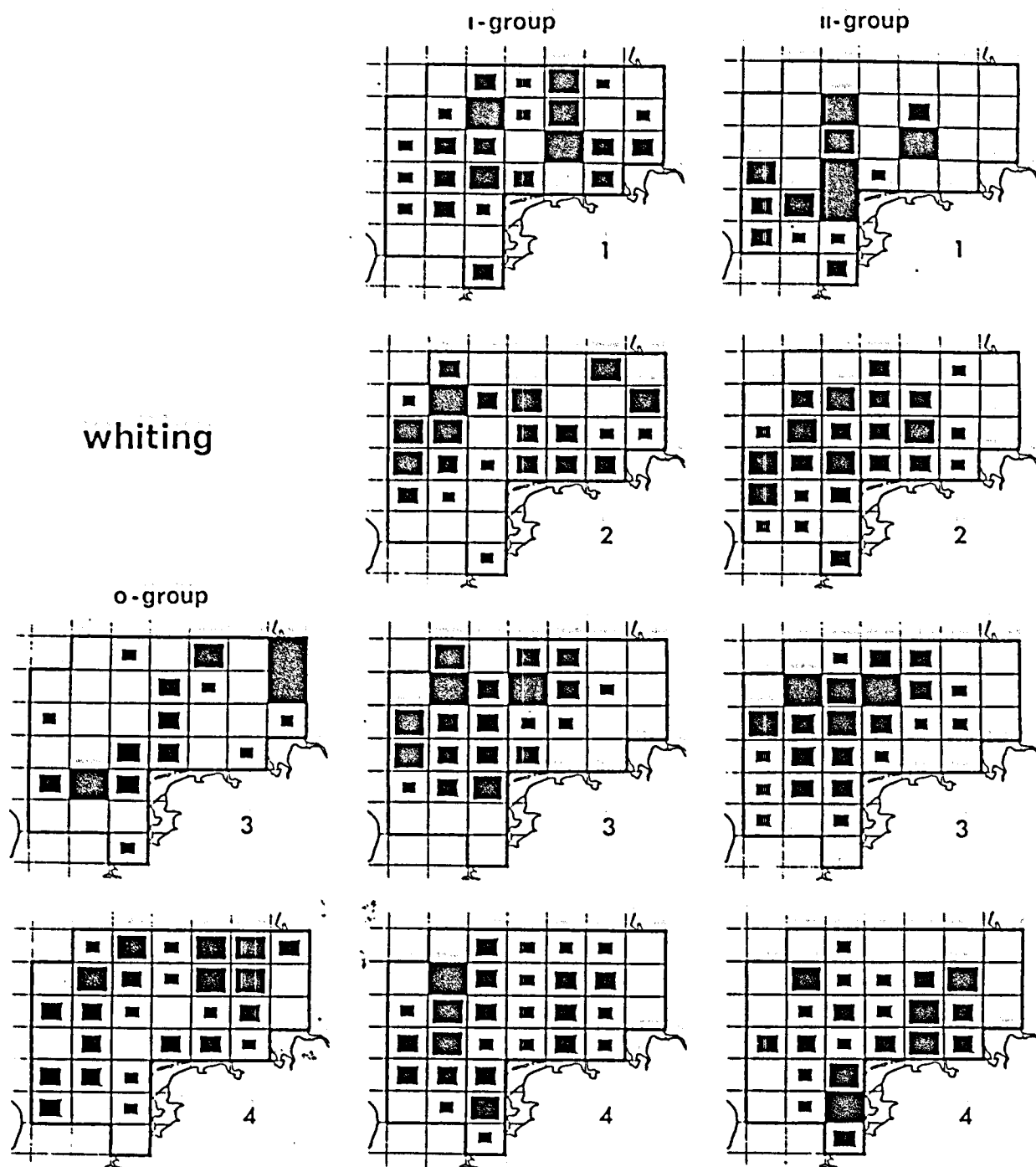


Figure 3 - Distribution of 0-, I- and II-group whiting per quarter as mean percentage over the years 1980/1982 of the contribution per rectangle to the total catch.

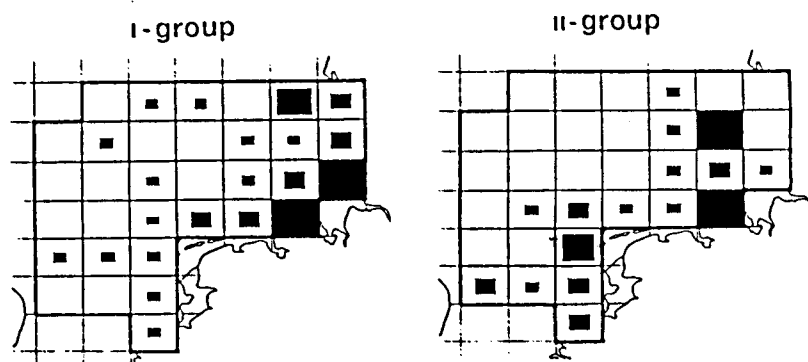


Figure 4 - Distribution of I- and II-group cod during IYFS 1974-1979 (after DAAN, 1980). Contribution per rectangle to the total catch.

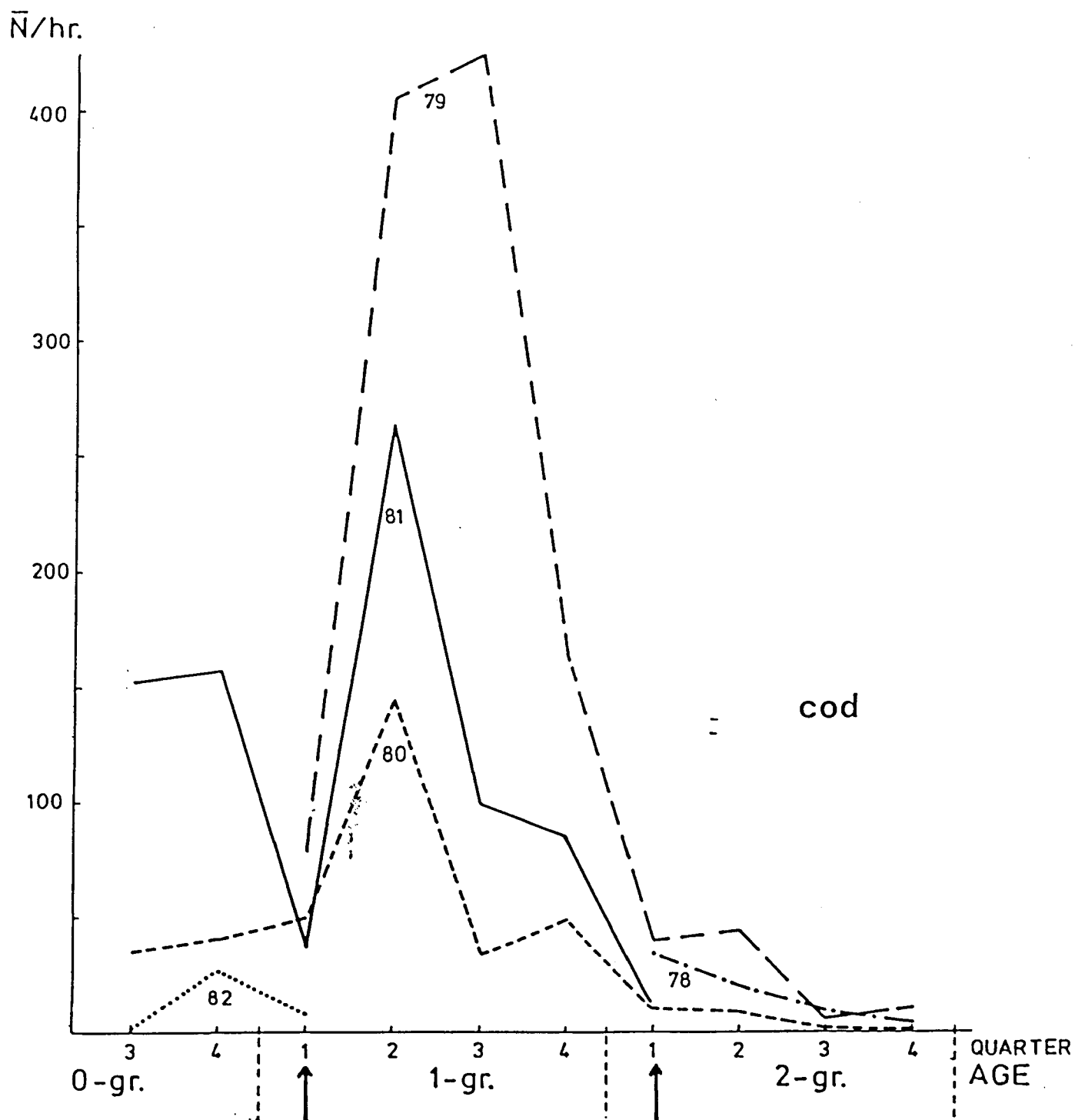


Figure 5 - Abundance of different year classes of cod from the third quarter as 0-group up till the fourth quarter as II-group. Preliminary values for the 1983 IYFS are also included. Arrows indicate the abundance during the IYFS.

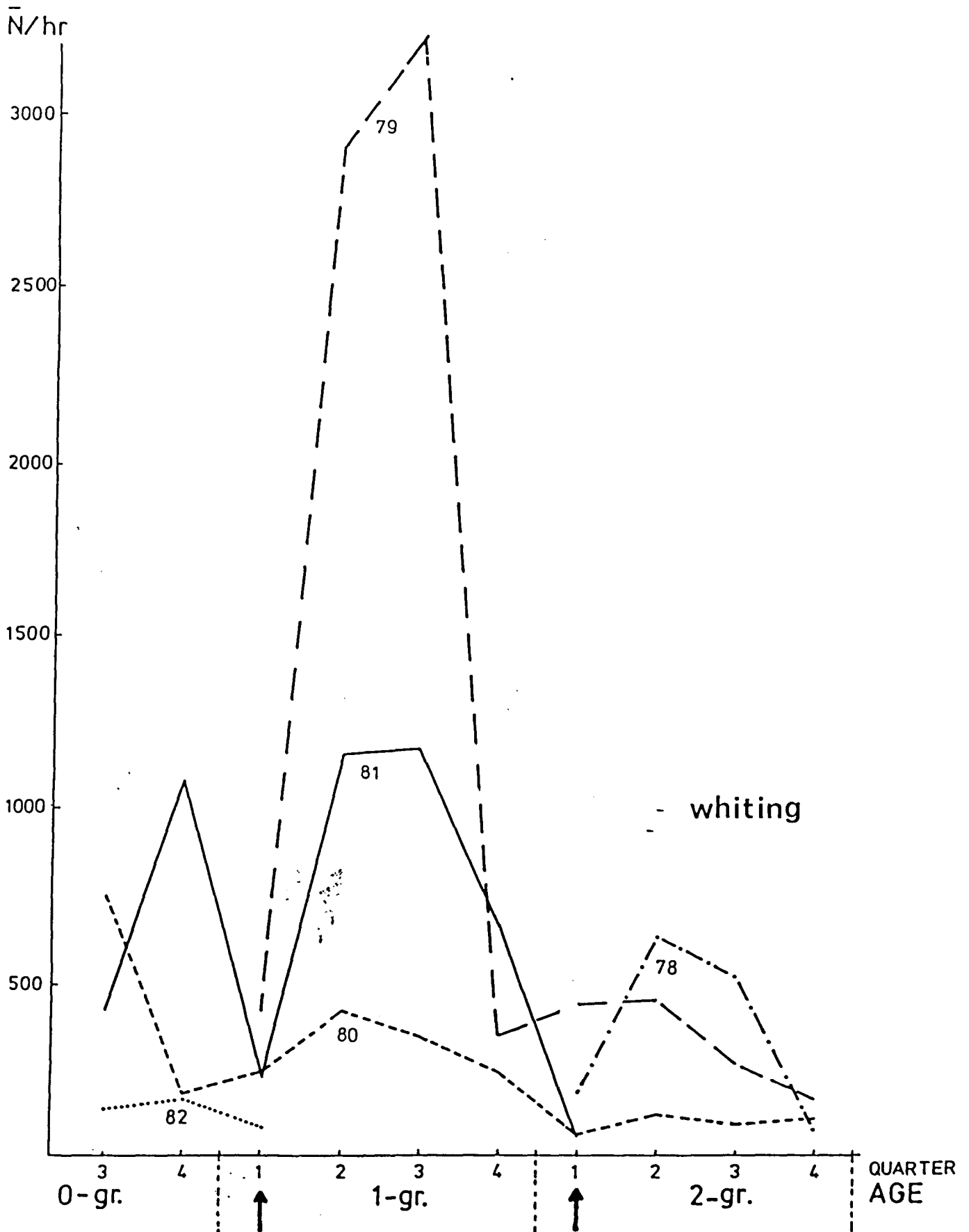


Figure 6 - Abundance of different year classes of whiting from the third quarter as 0-group up till the fourth quarter as II-group. Preliminary values for the 1983 IYFS are also included. Arrows indicate the abundance during the IYFS.

	F3	F4	F5	F6	F7	F8	
	0 0 0 8 2 0	0 2 0 6 12 0	0 0 0 0 2 0	134 99 0 2 - 9	10 0 0 100 - 163	320 2080 24 13 - 4	39
F2	0 0 0 - 20 0	0 0 0 2 6 0	0 0 0 3 2 0	0 0 0 16 - 0	90 0 0 13 - 36	40 0 0 70 - 88	38
	0 1027 0 0 120 0	0 0 0 0 10 0	12 0 0 0 2 0	10 0 0 0 6 0	28 25 0 32 20 4	112 1457 6 420 154 34	37
	0 0 0 2 4 -	0 6 0 0 4 0	8 6 0 0 0 126	102 0 0 1 335 0	66 0 0 64 1762 0	200 45 0 500 633 67	36
	0 0 0 0 - -	2 1 0 0 4 0	0 0 0 0 82 0				35
	0 4 0 0 - -	0 3 0 0 40 0	0 0 0 6 417 2				34
			0 2 0 77 158				33

COD 0

APPENDIX I - Mean number of fish per hour during each of the surveys.
 Per rectangle the figures represent the three years (3 columns) and the respective quarters (4 rows).
 For both 0-groups only the means for quarter 3 and 4 are given.

			F3			F4			F5			F6			F7			F8			
			3	3	8	37	7	1	6	4	2	24	12	10	0	23	3	-	39	22	39
			38	26	8	27	0	4	2	2	0	685	71	154	2835	260	244	-	-	0	
			88	6	0	168	8	4	1457	8	338	417	234	524	12	2	38	0	0	2	
			4	8	4	18	0	40	4	0	33	74	-	29	28	-	9	5	-	0	
F2																					
2	0	5	16	0	6	36	11	23	7	0	5	21	6	4	35	49	7	122	267	37	38
124	0	4	483	14	29	54	10	38	225	41	249	390	565	317	1056	416	360	-	851	0	
0	0	792	769	46	38	549	88	387	430	70	276	1281	19	122	679	201	180	-	1	0	
-	0	4	11	0	6	7	2	2	0	-	8	203	-	94	1048	-	6	-	-	0	
16	0	4	5	1	5	7	7	14	34	1	12	62	10	38	103	8	19	102	1050	13	37
71	2	16	46	8	0	20	2	0	48	8	203	1334	64	526	1001	567	1174	-	0	4	
456	8	0	367	0	164	103	0	90	344	13	12	304	17	140	4480	306	28	-	0	12	
2	0	4	0	4	6	4	3	12	14	4	16	609	23	40	961	307	181	174	337	149	
3	0	0	13	0	0	16	7	10	146	8	8	71	9	14	1169	118	484				36
88	11	6	42	1	2	117	14	29	1677	196	250	178	305	3046	-	1139	1898				
471	0	4	16	0	10	182	2	31	524	6	22	238	46	0	996	3	0				
0	10	-	2	0	6	0	0	2	26	50	4	696	61	464	972	261	1299				
0	0	0	2	2	48	94	5	236													35
15	0	2	14	4	12	81	4	38													
14	0	0	29	0	2	26	12	2													
2	-	-	7	0	8	66	18	36													
0	0	1	21	3	5	43	1	29													34
-	1	20	16	5	9	291	20	80													
98	2	22	67	5	10	120	0	0													
8	-	-	58	0	10	68	62	79													

			F3			F4			F5			F6			F7			F8			39					
			1	3	0	2	1	0	0	2	0	6	10	0	26	27	2	-	1	0						
			4	2	0	5	7	2	6	3	2	72	3	19	71	44	2	-	-	0						
			0	1	0	2	4	1	43	11	17	84	43	0	0	0	0	0	0	0						
			0	0	0	0	0	0	0	0	1	10	-	2	0	-	0	0	-	0						
F2			0	0	0	0	4	3	1	6	1	1	3	3	24	41	11	18	23	5	0	18	0	38		
			0	0	0	7	2	1	28	7	0	23	15	4	30	163	17	48	108	27	-	41	0			
			0	0	0	12	30	0	39	8	13	2	18	0	3	1	0	9	35	0	-	0	0			
			-	0	2	0	0	0	0	0	0	0	-	2	0	-	0	34	-	2	-	-	0			
			0	2	0	2	1	1	0	15	4	3	9	16	159	109	9	56	79	16	1	208	1	37		
			1	2	0	0	23	2	18	30	2	31	28	5	66	62	27	64	245	36	-	0	0			
			0	18	0	1	0	0	3	0	0	0	1	0	4	0	0	0	9	0	-	0	0			
			0	0	2	0	0	0	0	1	0	0	0	0	7	4	0	25	68	9	2	73	0			
			1	7	0	0	0	0	7	25	3	7	2	5	172	140	2	490	485	6	36					
			0	9	0	4	9	0	7	36	2	20	99	0	2	183	102	-	131	2						
			13	0	0	0	1	0	2	2	3	4	0	0	0	2	0	0	0	0						
			0	3	-	0	0	0	0	0	0	3	39	0	18	5	4	16	6	6						
			0	0	0	0	8	1	17	11	127	35			COD II											
			3	2	2	0	0	0	23	76	0															
			0	3	0	3	9	0	2	0	0															
			0	0	-	0	2	0	7	75	0															
			1	2	2	2	28	2	10	36	131	34														
			-	39	5	2	51	2	18	5	0															
			30	15	2	21	3	0	9	0	0															
			18	-	-	2	0	0	6	29	3															
						85	14	10	33																	
						-	0	0																		
						0	-	0																		
						0	7	0																		

	F3	F4	F5	F6	F7	F8	
	0 0 24 201 2 36	18 433 15 934 1115 102	126 4 22 244 138 24	704 1167 438 268 - 710	0 0 2 420 - 469	11776 6656 496 354 - 40	39
F2	0 0 1 - 6 0	0 0 6 257 1423 1028	40 0 0 353 1199 41	350 220 216 162 - 0	1068 77 0 280 - 654	0 0 0 422 - 307	38
	0 620 12 6 3135 6	96 0 58 72 1974 225	70 8 0 27 1016 144	2043 716 32 32 448 51	120 32 7 49 1334 144	56 2 4 308 837 256	37
	0 120 84 29 16 -	32 255 15 79 3577 157	1920 14 32 4 499 69	1975 507 8 56 3365 40	104 0 0 105 1384 36	560 26 39 126 516 8	36
	16 438 400 216 - -	1064 313 1296 65 547 320	392 207 240 10 477 180	WHITING O			35
	30 143 24 157 - -	0 25 0 53 359 10	0 5 0 2 1188 0				34
							33
		520 - 3 35 735 0					

F2			F3			F4			F5			F6			F7			F8			
			34	36	101	330	429	101	133	82	92	1104	744	334	19	225	9	-	87	41	
			272	833	764	85	22	225	392	46	76	230	11	294	21600	258	83	-	-	16	
			18312	75	4	500	2	114	3640	58	1296	395	581	1303	629	0	18	0	208	10	39
			100	0	12	726	90	1129	44	0	626	145	-	685	159	-	242	30	-	0	
38	101	22	109	209	79	889	157	2796	232	82	27	1170	546	69	81	62	34	95	228	55	
836	313	254	14856	3050	571	560	1580	88	13824	40	512	1020	171	210	1012	69	39	-	1086	2488	
36	0	118	6384	4110	584	3507	289	2136	11533	1555	5130	4760	37	2502	1064	401	66	-	0	50	38
-	1	45	4753	990	42	729	157	189	319	-	276	651	-	420	337	-	882	-	-	19	
315	1	183	136	380	142	267	414	345	272	20	42	1059	1721	222	377	305	75	313	589	143	
3462	100	8854	2983	1981	384	640	185	18	1088	649	770	2620	411	2456	53	10	2410	-	303	76	
13104	295	601	5633	9	3213	2907	18	1785	1898	287	1078	940	519	323	1010	63	365	-	8	5	37
41	147	620	347	663	2201	218	277	638	106	54	467	341	139	764	213	88	385	16	22	341	
132	156	74	1250	42	20	1420	539	425	898	43	194	132	25	78	493	230	503				
1626	79	8480	1403	866	1148	1280	231	1673	4420	183	923	776	170	2785	-	238	3482				
2856	865	3382	245	494	2258	3492	36	1682	5408	289	727	387	28	133	466	34	127				36
68	451	-	186	591	3074	14	162	358	80	293	384	307	461	922	202	87	383				
260	96	26	440	76	490	315	135	53													
2024	189	2993	123	285	1090	112	95	505													
2177	256	803	5436	237	2689	1028	64	5246													
298	-	-	60	302	616	84	295	866													
265	17	51	21	99	82	94	1	63													
-	4	273	532	67	220	898	12	330													
2004	54	80	79	27	150	96	2	429													
36	-	-	86	165	160	17	227	2819													
						622	1	207													
						-	59	1258													
						37	-	97													
						33	150	258													

WHITING I

			F3			F4			F5			F6			F7			F8			39	
			0	3	0	5	32	1	1	2	9	15	38	17	0	3	0	-	1	0		
			124	186	22	2	3	9	2394	16	17	123	3	78	20	430	8	-	-	0		
			0	19	0	627	5	3	1414	106	46	152	573	65	19	0	0	0	0	0		
			6	0	2	19	11	63	5	0	28	24	-	30	17	-	6	0	-	0		
F2			0	0	1	2	2	2	6	506	1341	15	26	2	148	568	107	0	1	0	38	
			96	3	2	944	360	191	98	2394	6	942	52	82	490	681	31	240	164	16		
			4	0	1	2576	2713	155	1119	616	316	3477	881	272	1134	34	109	140	505	11		
			-	1	3	353	318	5	84	22	17	49	-	54	153	-	41	354	-	33		
			9	22	2	9	7	0	128	1606	94	49	23	1	832	2983	7	12	163	4	37	
			370	66	31	769	2381	45	800	820	5	971	438	119	1920	231	132	170	22	208		
			149	1369	5	672	22	225	1066	78	360	1153	195	88	187	245	26	305	54	45		
			3	29	8	5	147	82	19	229	58	54	33	25	340	188	104	135	114	24		
			13	2515	9	30	73	0	723	3235	24	209	11	15	21	6	0	45	84	23	36	
			1281	1609	300	624	747	207	2880	106	275	546	516	101	239	292	417	-	116	148		
			472	161	38	118	166	227	272	10	262	113	163	47	37	24	9	29	8	4		
			4	341	-	4	110	333	2	117	26	31	346	85	146	367	224	122	99	67		
			694	0	0	261	532	179	1097	1389	18	WHITING II									35	
			164	532	633	211	418	94	312	829	211											
			34	107	107	382	223	200	15	120	280											
			13	-	-	16	122	113	34	605	226											
			605	201	24	34	441	31	125	24	64	34									33	
			-	152	70	55	461	10	108	136	44											
			100	202	33	5	114	49	16	6	133											
			8	-	-	60	74	49	6	242	1397											
						490	43	17													33	
						-	319	238														
						1	-	36														
						22	243	102														