ANNUAL MEETING - JUNE 1965Fishing Activity, Effort and Intensity in Subarea 1. 1952 - 1963.

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Although the definitions of fishing effort and fishing intensity are quite clear it is nearly always impossible to give fishing effort and fishing intensity in accurate figures. Actually most of the figures given as fishing effort are not really fishing effort as defined but fishing activity. In this paper it is tried to give figures for fishing activity, effort and intensity in the cod fisheries in Subarea 1 (West Greenland).

It has of course been necessary to introduce a lot of assumptions and theories of which some may not hold water. The most essential of these assumptions is that

... the catchability of cod to the various gears varies throughout the year (no doubt about that). In order to get a comparison between months or seasons of this changing catchability it is, however, supposed that the catchability of cod does not vary very much in the Portuguese dory fishery, and this is by no means an unambiguous supposition. The arguments for this theory are the facts that dories are fishing with two gears (hand line and long line), that dories are spread over a wide area round their mother vessel, and the fact that the catch per dory hour does not vary as much as the catch per hour trawled. It is, however, only a rather short season that dories are fishing (May - September), and it is thus impossible to compare dories with other vessels in the rest of the year. This gives raise to new assumptions.

When starting this work the author set out to get effort and intensity per month and division as such figures were needed when dealing with the great West Greenland tagging material. Such detailed figures, however, may not be of great interest to other ICNAF people, and the paper would be too heavy if the whole procedure of estimating and calculating the effort should be dealt with here. The tables in this paper are therefore given only as summaries of more detailed tables used by the author.

Consideration of space and time also forbids the author to go into details with all the assumptions and arguments. It may nevertheless be of interest to somebody to know the various steps and some of the arguments in the procedure. These steps are accordingly given here and it is hoped that they will show how reliable or rather unreliable the final figures are.

1. Only commercial sized cod are regarded.
2. All figures are based on catches given by weight (in estimating mortality it ought to be by number) and differences in length compositions of catch between gears or years are not regarded.

3. The catches given as division 1 NK are allocated to divisions from several points of view (e.g. number of Faroese motor boats in the various districts of Greenland. Within countries proportional to known allocated catches).
4. The fishing power of a Portuguese dory is regarded constant. (Mean fishing power of various fleets shown in Table 1).
5. The fishing power of Portuguese trawlers seems to be unchanged in the period looked at (according to "List of Vessels"). A "mean Portuguese trawler" is chosen as the standard fishing power. Time unit is one hour trawled.
6. Catch per dory hour is compared (per month) to catch per Portuguese trawler. The proportion between these catches varies between months. August is here chosen as the standard month because...

The relation "catch per dory hour/catch per hour trawled" is rather constant between divisions and areas (one hour trawled = 19.66 dory hours).

August is the only month in which all gears are operating to greater extent.

Cod are scattered over the grounds so that the density of cod within a division (and within borders of distribution) is rather uniform from area to area.

It is reasonable to believe that cod in August have the same catchability from division to division since phenomena as spawning, escape from cold water etc. do not occur.

7. Following 4, 5 and 6 the effort unit is defined as "the effort developed by a Portuguese mean trawler (1273 BRT, 1059 HP) in one effective trawling hour in August". The effort unit is hereinafter abbreviated to PTHA.
8. Following the basic assumption that catchability of cod does not vary very much in the dory fishery and that in August one trawling hour equals 19.66 dory hours it is possible to estimate the relative catchability of cod to Portuguese trawlers in other months where dories are fishing. This gives the relations shown in Table 2.  
The work started when the 1960 figures were the last figures available. The tables have now been supplemented with figures from 1961-63. This gives figures slight different from the previous figures, but because of the heavy work involved in the procedure and because of the desirability of uniform procedure from year to year the figures from the period 1954-60 have been maintained
9. The Portuguese catch per hour trawled is compared to the catch per unit time of other fleets (Table 3). For the period 1955-60 a Spanish trawler had an effect of 60.4 % of a Portuguese trawler (the figure for 1954 seems to be unreliable). For this period it was not possible to get reliable figures for other nations than Spain. In the period 1961-63

also German and U.K. fleets have been compared to Portuguese fleet. The means for Spain and U.K. are means weighted according to catch and fishing time. For Germany only those months have been regarded in which Germany has at least 10 days of fishing and Portugal at least 100 hours trawled.

From Tables 2 and 3 and from several arguments not given here the conversion factors given in Table 4 are estimated.

10. The effort based on conversion factors in Table 4 is raised to total effort (per month and division) by means of the corresponding catches. In many cases, however, it is not possible to use this procedure, and in such cases other ways of estimating effort have been used. Effort figures, catch and catch per effort are given in Table 7.
11. When fishery in a certain area is intensive and modern speedy vessels with electronic equipment are used and when gears can be used under nearly all bottom conditions then one can reasonably say, that fishery will take place over (all) where fish occur with some abundance - and only there. The cod fishery at West Greenland seems to be such a fishery and we therefore assume, that the distribution of commercial sized cod can be estimated from the distribution of the fishing activity. A picture of the distribution of the fishery is obtained by plotting recaptures of tagged cod (assuming that within divisions tagged cod are evenly distributed amongst the cod not tagged). All recaptures caught in the years 1955-58 have been used together with German and Portuguese recaptures from 1963 (Figs. 1 and 2). Some of the months show nearly the same picture and can be put together in longer periods. These periods are 1) January-April, 2) May, 3) June, 4) July-September and 5) October-December. Within each period cod seems to occur in certain depth intervals. Areas in these intervals are shown on Figs. 1 and 2. Their areas are measured by a planimeter (Table 5).
12. The scope of work mentioned in this paper was to estimate the relative possibility of a tagged cod to be caught in a certain area (division) at a certain time (month).

Assuming that tagged cod are evenly mixed with the stock of the division and assuming that tagged cod behave as untagged cod the relative possibility of a tagged cod to be caught can be measured by the fishing mortality coefficient ( $F$ ), which is proportional to the overall fishing intensity ( $\tilde{f}$ ).  $\tilde{f}$  is defined as the weighted mean effort per unit area, weighting factor being the density of cod in each area unit.

It is, however, very difficult to get adequate figures for  $\tilde{f}$  in this way. If fishing effort is distributed at random within the areas given in Table 5 we can, however, say that the possibility of a certain (tagged) cod to be caught is independent of the number of other cod present. Under this assumption the chance of this cod to be caught is

proportional to effort per unit area. This possibility of being caught is calculated per month and division. The summarized figures are given in Table 8.

#### THE FISHING ACTIVITY AND CATCH.

The fishing activity is recorded in various ways by various countries. Some of these records regard only the time spent fishing (fishing gear operating). It is a matter of fact, however, that the whole fishing procedure also consists of a searching for fish. To include this searching the author has chosen "days on grounds" as the unit for fishing activity. Days on grounds include also days of bad weather, and as weather conditions vary between months and years the figures may not be compared without remembering this source of error. When looking at the figures for fishing activity as given in Table 6 one should also bear in mind the changing fishing power as given in Table 1.

Although giving fishing activity Table 6 may very well give the most reliable picture of the variation in effort and fishing intensity. At any rate the figures in Table 6 are those of primary interest to people economically involved in fishery. The figures give (as previous figures) no ideas of variation in the mean size of fish, but to judge from various research reports it is a general feeling that the mean size of cod in landings has been decreasing in the last years.

The Portuguese dory vessels have a rather steady activity. Liners have an increase of activity in the years 1961-63 of about 40 % of the 1954 level, while trawlers' activity in 1963 is about  $2\frac{1}{2}$  times that of 1954.

#### THE FISHING EFFORT

The fishing effort is given in Table 7. Gears are combined according to conversion factors given in Table 4. The single figures may be inaccurate and suspicious, but as the procedure of estimating the figures do not vary very much between years the figures may nevertheless show the changes in fishing effort. Catch per unit effort should likewise show changes in the density of cod (measured by weight of catchable fish, not by number).

Total fishing effort in West Greenland waters was rather steady in the period 1952-57. In the period 1957-63 the effort has been about doubled. This has given a considerable higher total catch but also a general fall in catch per effort.

#### FISHING INTENSITY

Table 8 gives index of relative possibility of a certain (a tagged) cod to be captured in a division. The overall fishing intensity as defined also given in Table 8 is calculated from figures of Tables 7 and 5. The intensity ought to be based on monthly figures, but time has not permitted this. The

yearly mean area of each division is then calculated as a weighted mean, weighting factors being the catch in each month. The overall fishing intensity figures must therefore be taken with all possible reservations, but even so the figures seem to indicate that the intensity has been about doubled in the last five years.

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Table 1. Fishing power and mean "days on ground" of vessels over 50 gross tons fishing in Subarea 1.

Year		OTTER TRAWLERS	LINERS	PORTUGUESE DORY VESSELS
1953/54	Number of vessels	205	89	40
1956		170	113	49
1959		219	108	47
1962		226	94	35
1953/54	Mean tonnage (gross tons)	875	185	693
1956		926	178	765
1959		940	190	872
1962		1037	236	870
1953/54	Mean HP (trawlers) crew (liners) dories	1061	19.8	51
1956		1112	19.4	55
1959		1224	20.2	61
1962		1321	22.4	64
1953	Mean days on ground	30	96	73
1956		38	85	54
1959		40	154	72
1962		60	156	102

Table 2. Catch per hour trawled in per cent of catch per dory hour (Portuguese cod fishery, Subarea 1).

Month	5	6	7	8	9	7+8+9
Period						
1954-60	3613	4305	2172	1966	1930	2015
1954-63	3613	4305	2165	1899	2003	1973

Table 3. Cod Subarea 1. Different nations' catch per time unit as recorded in per cent of Portuguese trawlers' catch per hour as recorded. W = relative weight of the relations.

Year		Germany		Spain	U.K.		
		days fished	501-900	901-1800	hours trawled	501-900	901-1800
1954	%			17.5			
	W			68674			
1955	%			53.2			
	W			73851			
1956	%			76.3			
	W			155258			
1957	%			69.3			
	W			45323			
1958	%			66.7			
	W			70539			
1959	%			71.0			
	W			11495			
1960	%			77.8			
	W			1338			
1961	%	1502	1271	186.1	87.8	-	75.8
	W			63	326		354
1962	%	1178	1006	104.2	95.5	77.1	82.5
	W			2412	153	1087	2246
1963	%	497	1151	-	-	-	-
	W						
mean		-	-	60.4			
1954-60							
mean				106.3	90.3	77.1	81.6
1961-63							

Table 4. Conversion factors used to transform effort as recorded to standard effort (PTHA)

Years	Division		1A	LB	1C	
	Month	all			3-6	other
1954-60 1961-63	Portuguese trawlers (hours f.)	all	1.00	1.00	2.34	1.00
1954-60 1961-63	Spanish trawlers (hours f.)	all	0.69	0.69	1.61	0.69
1954-60 1961-63	German trawlers (days f.)	all	-	-	-	-
1954-60 1961-63	UK. trawlers (hours f.)	all	1.00	1.00	2.34	1.00
1954-63	Port. Dory Vessels	all	0.051	0.051	0.051	0.051

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cont/ Table 4.

1D		1E		1F	
2-5	6	2-6	other	2-6	other
2.00	3.57	2.80	1.00	2.00	1.00
2.00	3.57	2.80	1.00	2.00	1.00
1.38	2.46	1.93	0.69	1.38	0.69
2.00	3.57	2.80	1.00	2.00	1.00
-	-	-	-	-	-
26	26	26	13	26	13
-	-	-	-	-	-
2.00	3.57	2.80	1.00	2.00	1.00
0.051	0.051	0.051	0.051	0.051	0.051

Table: 5 Size of the offshore area occupied by the West Greenland cod Stock at different times of the year. Unit is square nautical mile. Figures in brackets are supposed to be minimum.

Division \ Month	Month				
	1 - 4	5	6	7 - 9	10 - 12
1A	o	o	o	1120	o
1B	( 1928 )	( 2725 )	7294	6058	4360
1C	5306	4932	6896	4675	5143
1D	1980	2494	3934	2957	2211
1E	1991	3607	3405	1327	2222
1F	4897	4413	3447	2448	4832
Total Subarea 1	16102	18171	24976	18585	18768

Table 6 Offshore fisheries, Subarea 1. Fishing activity expressed as "Days on Ground" or "1000 Doryhours". Figures in brackets are given in Stat. Bull. and these figures have been raised to total activity according to their proportional catch. Greenlanders' catch not included. Liners and dories have only very small quantities of fish other than cod.

Gear	Year	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
OT	Days o.g.	6080 (4601)	5325 (4656)	6376 (5896)	7614 (6707)	9781 (8469)	8864 (8014)	8286 (7534)	12618 (12137)	14165 (13629)	15519 (13949)
	tons cod	160890	131265	183343	139810	172683	109508	100813	171316	247186	244056
	tons total	173575	161570	194290	169111	191784	142561	147050	235582	317945	306128
	tons cod/day	26.5	24.7	28.8	18.4	17.7	12.4	12.2	13.6	17.5	15.7
	tons total/day	28.5	30.3	30.5	19.6	19.6	16.1	17.7	18.7	22.4	19.7
LL HL	Days o.g.	8539 (4706)	12898 (2585)	9592 (5283)	5147 (2263)	9707 (3859)	16679 (4761)	11691 (4747)	16087 (7176)	14625 (8508)	12728 (5808)
	tons cod	55623	56448	53161	29930	52558	47590	56064	74422	87399	76843
	tons cod/day	6.5	4.4	5.6	5.8	5.4	2.9	4.8	4.6	6.0	6.0
DV	Days o.g.	2912	3249	2633	3215	4257	3395	3017	3461	3553	3700
	1000 Doryhours	1040	961	993	1144	1486	1236	1344	1329	1339	1359
	tons cod	70664	60818	68713	74702	69078	49867	58936	65688	80693	61603
	tons cod/day	24.3	18.7	26.1	23.2	16.2	14.7	19.5	19.0	22.7	16.7
	kg cod/hour	67.9	63.3	69.2	65.3	46.5	40.3	43.8	49.4	60.3	45.3
Total Days o.g.		17531	21472	15968	15976	23745	28938	22994	32166	32343	31947

Table 2 Offshore cod fisheries Subarea I. Tons landed, effort(PTHA-units) and catch in tons per effort unit. Greenlander's catch and effort not included.

Year	1-A		1 B		1 C	
	tons landed	PTHA tons/PTHA	tons landed	PTHA tons/PTHA	tons landed	PTHA tons/PTHA
1952	7257	1.421	92520	1.685	19756	1.007
1953	4946	1.421	75580	1.687	14252	0.961
1954	5741	1.331	111008	1.367	29469	1.609
1955	1839	1.079	61820	1.091	42071	1.910
1956	73	1.259	68868	1.275	46762	2.475
1957	0	-	67142	1.257	36808	1.394
1958	168	0.889	70449	1.007	57893	1.333
1959	986	0.581	88462	1.012	15319	0.736
1960	107	0.877	71877	0.862	28506	0.871
1961	503	1.612	96048	0.954	57761	0.861
1962	1017	1.426	147025	1.265	93239	1.394
1963	66	0.680	88205	0.906	88254	1.274

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Table / continued.

	L-D		L-E		L-F		Total Subarea I			
	tons landed	PTHHA tons/PTHHA	tons landed	PTHHA tons/PTHHA	tons landed	PTHHA tons/PTHHA	tons landed	PTHHA tons/PTHHA		
102257	75015	1.363	5338	3620	1.475	37028	0.991	264508	195805	1.351
65060	46495	1.399	3128	2623	1.193	23096	1.130	189069	135345	1.397
121587	73211	1.661	4018	3128	1.285	15386	0.998	287177	195550	1.469
124310	71477	1.739	12502	8358	1.496	4508	1.329	248531	164731	1.509
164445	82649	1.990	16634	8649	1.923	2250	3.749	305217	166528	1.833
83696	72232	1.159	38770	31415	1.234	10715	1.682	244442	194185	1.259
104847	111918	0.937	30541	23223	1.315	29027	1.048	294319	277707	1.060
58119	88060	0.660	24958	31135	0.802	14729	1.298	206965	243864	0.849
63854	73601	0.868	28343	37845	0.749	22727	1.018	215813	250387	0.852
99919	108941	0.917	29216	43409	0.673	50332	0.556	311426	370766	0.840
100371	100348	1.000	39136	53167	0.736	39199	0.880	415278	376537	1.103
113410	120185	0.944	61464	63998	0.960	36396	0.855	382502	387334	0.988

Table 8. Relative possibility of a certain cod to be caught calculated per month and division as PTHA per square nautical mile and summarized to total figures given in this table. Overall fishing intensity (f) calculated as described in last chapter of the text.

Year	Division	I A	I B	I C	I D	I E	I F	Total Subarea I Sum.	f
1952		4.57	9.05	4.21	25.56	7.47	9.41	60.27	8.91
1953		3.11	7.37	2.58	15.03	7.90	6.71	42.70	6.65
1954		3.85	14.11	3.26	20.99	5.59	4.38	52.18	9.29
1955		1.53	9.57	3.94	22.23	3.76	1.37	42.40	7.20
1956		0.05	9.31	3.31	25.94	2.76	0.63	42.00	5.94
1957		-	9.11	4.50	23.75	9.42	2.95	49.73	7.99
1958		0.17	11.91	7.47	34.66	7.09	7.36	68.66	11.01
1959		1.51	14.50	4.09	30.04	9.09	3.30	62.53	9.79
1960		0.11	13.88	6.15	23.65	13.34	5.20	62.33	10.50
1961		0.27	18.32	12.56	37.26	19.03	13.00	100.44	16.95
1962		0.65	22.53	12.81	34.95	25.04	9.72	105.70	17.31
1963		0.08	19.04	13.28	40.56	26.94	8.48	108.38	18.04

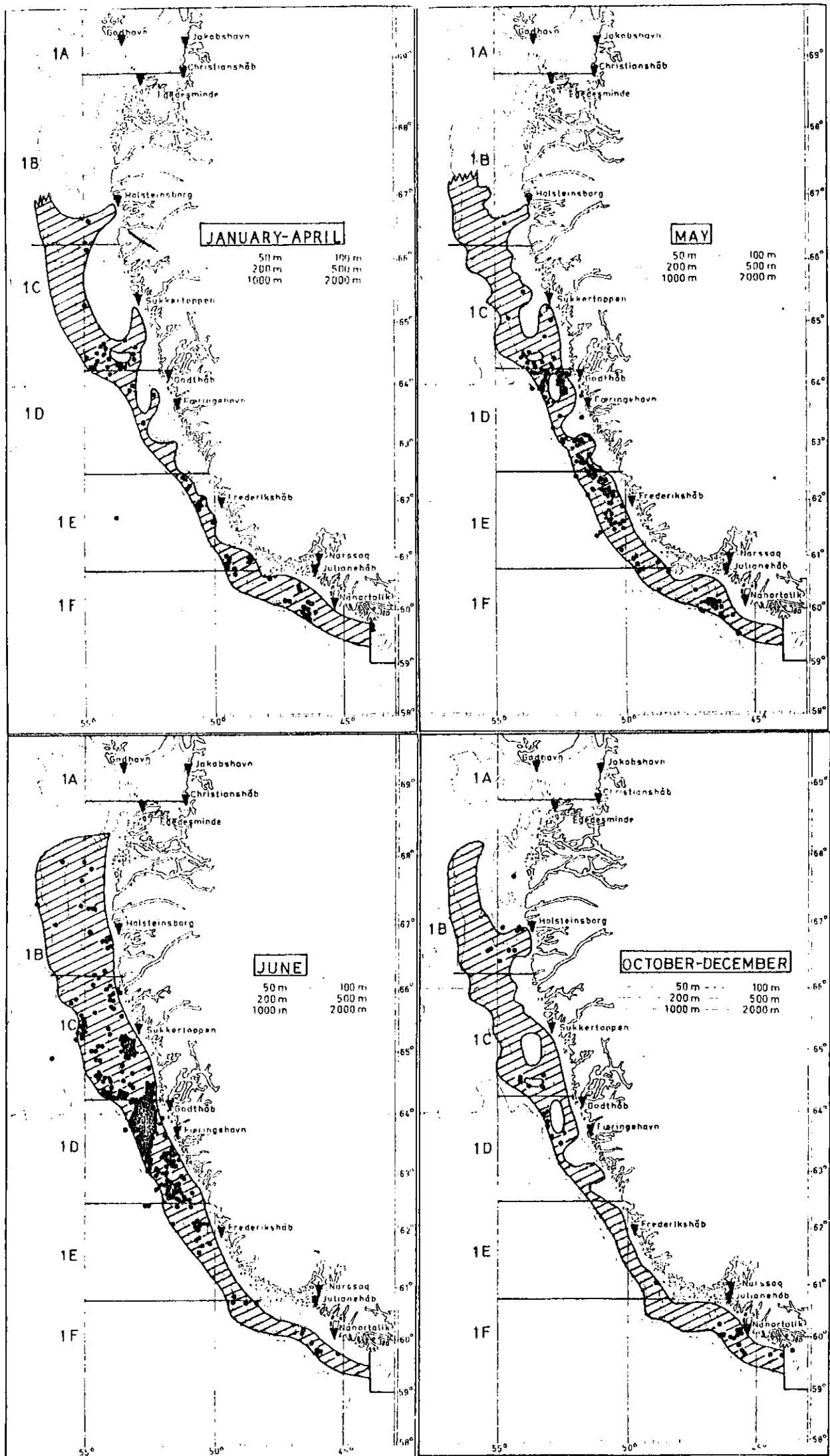


Fig.1. Distribution of cod fisheries and cod in West Greenland offshore waters. Each spot indicates a recaptured tagged cod.

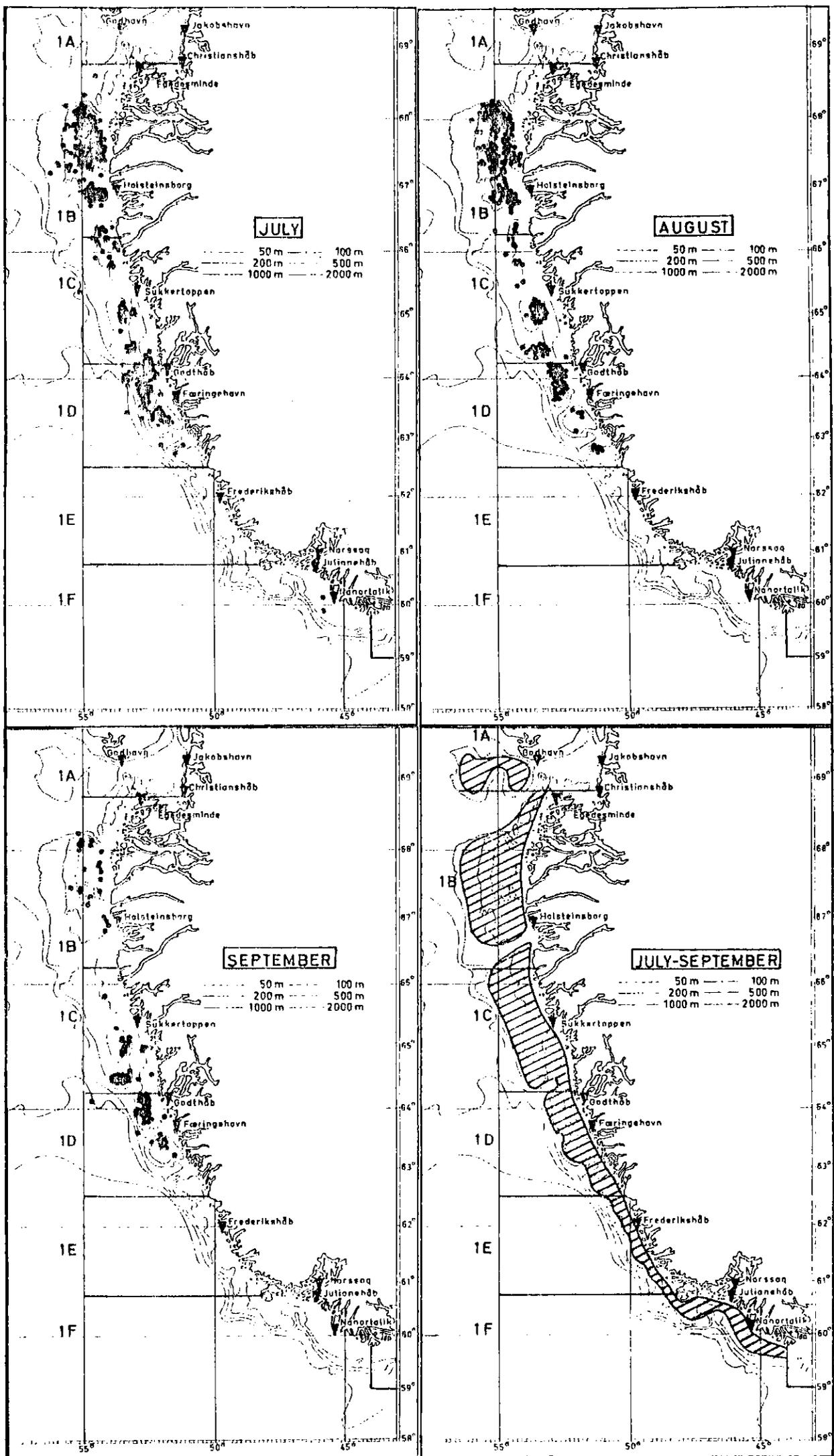


Fig.2. Distribution of cod fisheries and cod in West Greenland offshore waters. Each spot indicates a recaptured tagged cod.