International Commission for the Northwest Atlantic Fisheries

ANNUAL MEETING - JUNE 1977

Cod stock evaluation - Div. 3NO

by

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Fishing mortality estimates were obtained using two methods. In the first (Table 1), available length frequencies and age/length keys were used to obtain total numbers at age, for the year, for Div. 3NO in 1974 and 1975. Catch per unit effort data in terms of numbers per hour (at age) were calculated. Effort data for the year was obtained by dividing catches per Division by an adjusted Spanish pair trawl CPUE for the Division. Values of Z were obtained by dividing 1975 CPUE by 1974 CPUE for age 7 and over and obtaining the natural log of the result (e.g. $10.08 \div 74.19$ gives a Z of $-2.00..$). By averaging the absolute values of Z, an F value of 0.74 for 1974-75 (M = 0.2) was obtained.

Method 2 used weighted F values (ICNAF Res.Doc. 73/4) and total effort data, as described in Method 1, to obtain a regression equation (Fig. 1) from which were obtained values of F for 1974 and 1975 (Table 2).

The high F values obtained support data presented in Res.Doc. 77/VI/17. Fishing pressure of this magnitude would be detrimental to an already depressed stock with a failing catch and CPUE.

Table 1. Fishing mortality (F) estimate for cod obtained from numbers at age data, 1974-75 in Div. 3NO.

Age	1974 Total for year[a]	CPUE	1975 Total for year[b]	CPUE	Z
2	–	–	–	–	–
3	891	7.08	–	–	–
4	9,020	71.70	1,791	16.28	–
5	22,497	178.83	645	5.86	–
6	9,334	74.19	562	5.11	–
7	2,727	21.68	1,109	10.08	2.00
8	1,101	8.75	457	4.16	1.65
9	1,049	8.34	330	3.00	1.07
10	734	5.83	397	3.61	0.84
11	210	1.67	435	3.96	0.39
12	105	0.83	232	2.11	0.51
13	420	3.34	225	2.05	0.90
14	420	3.34	165	1.50	0.80
15	315	2.50	172	1.56	0.76
16	–	–	172	1.56	0.47
17	210	1.67	337	3.06	–
18	–	–	457	4.16	0.91
	48,926		7,487		10.30

$$\bar{X} = 0.94$$

$$F = 0.74$$

	1974		1975		
Ave. wt (kg)	1.50		5.90		
Total catch	73,389		44,174		
Total effort (hrs)		125,804		109,981	

[a] Total catch adjusted using Can (N) Div. 3O (OT) - 1st quarter.
[b] Total catch adjusted using Can (N) Div. 3N (OT) - 2nd quarter.

Table 2. Total effort and F values for Div. 3NO cod.

Year	Total effort	Weighted F values
1960	41,225	0.45
1961	60,565	0.44
1962	37,350	0.27
1963	36,465	0.45
1964	37,645	0.50
1965	52,397	0.68
1966	62,123	0.50
1967	130,003	1.00
1968	92,751	1.10
1974	125,804	1.02[a]
1975	109,981	0.91[a]

[a] Values obtained from regression equation (Fig. 1).
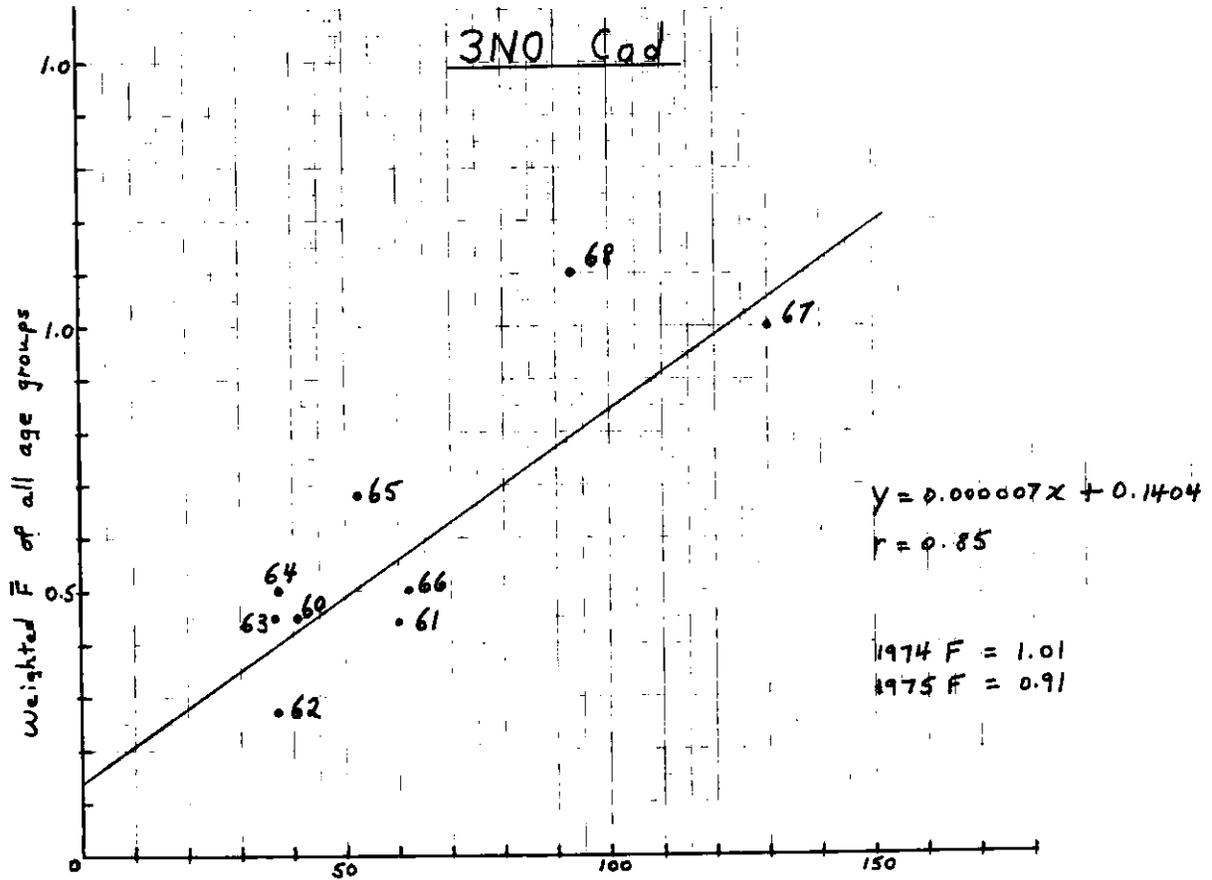
Fig. 1. Effort - total hours fished ('000 hrs).

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Sampling data for cod from subdivision 3NO during 1976 proved very scanty. Otter trawl samples were available for the 2nd and 3rd quarters from Can. (N) in Subdivision 3∅. With catches for those two quarters totalling only 1057 tons from a fishery directed toward species other than cod, there was little material available to provide a determination of total numbers at age.

Several methods involving evaluation of trends in the fishery were attempted to provide some indication of stock abundance changes. These methods essentially involved comparisons of different biomass estimates from stratified-random research cruises in Subdivision 3N (1971-76) with catch-per-unit-effort data from the Spanish pair trawler fishery (tons class 4; 151-500 tons) for the period 1971-75. The different methods used are as follows:

Method 1

For the years 1971-76 biomass estimates in numbers of fish were compared in strata with at least 3 years of data (Table 1). Strata which had continuous data(361,362) (for each of the 6 years) were used to obtain estimates for strata which had not been fished in a particular year. These estimates were obtained by; totalling the numbers in each stratum for which there was continuous data (Table 1.), totalling numbers from each incomplete stratum (eg. 845 + 639 + 4709 in stratum 359, Table 1) and dividing by the corresponding years total in the continuous data years (i.e. 18121 + 1870 + 1744) to obtain a ratio (eg..285 in stratum 359). This ratio was applied to the total per year obtained from strata with continuous data (eg. 9326 in 1971) to provide an estimate in that year for the stratum which had no data (i.e. 9326 X .285 = 2657, an estimate of biomass for stratum 359 in 1971). Estimates were thus obtained for all strata which had incomplete survey data (Table 2). An average number of fish per year for all these strata was obtained and this was compared with seasonally adjusted Spanish PT, catch-per-unit-effort from 1971-75 (Table 2; Fig. 1.)

Method 2

Using the same raw data as presented in Table 1, estimates of numbers present in strata where no fishing had been done were accomplished by using the areas (in sq. miles) involved with each strata (Table 3). For each year the totals for strata which had data (eg. 34606 in 1971; Table 1) were divided by the total area for the same strata. The ratios of numbers per unit area were used to obtain estimates for strata with missing data by multiplying the ratio by the stratum area for the particular year. (eg. ratio 1971=3.097; estimates for strata 359, 360, etc. = 1304, 9265 etc.) Estimates were thus obtained for all strata with missing data (Table 3.) Average numbers per year were obtained and this was compared with a seasonally adjusted Spanish PT. CPUE from 1971-75 (Fig. 2).

Method 3

     Average numbers of fish per year were obtained from strata which provided a continuous series of data from 1971-75. In this case only strata 361 and 362 could be used. These averages were plotted against Spanish PT - CPUE from 1971-75 (Fig. 3).

Method 4

     In this method all biomass estimates as shown in Table 1 were adjusted to a standard - that of strata 362. As such, determining values for strata with no data available in some years was not considered. Conversion factors obtained per stratum and the average values that resulted per year are shown in Table 2. Similarly these average values were plotted against Spanish PT - CPUE from 1971-75 (Fig. 4).

DISCUSSION

     Catch and catch-per-unit-effort data were also evaluated for the years 1960 to 1975. The total CPUE was calculated by adjusting Spanish PT - CPUE (T.C.4; 151-500) for 3NO to the total catch to obtain the total effort from which was obtained a total CPUE for each year (Table 4; Figure 5).

     The data would indicate that cod stocks remain depressed as compared to that in the late 60's. Biomass estimates although available only from recent years indicate a low but possibly stabilizing stock (Figs. 1 - 4). Spanish PT catch-per-unit-effort data shows a steady decline over the same period (Table 2). A linear regression analysis of Spanish PT-CPUE against different biomass estimates produced 'r' values as follows; method 1 - 0.74, method 2-0.82, method 3-0.61, and method 4 - 0.67. Catch and catch-per-unit-effort data from 1960 to 1975 shows a peak catch in 1968 and followed by a rapid decline associated with the same in CPUE. Indications are that the stock remains reduced and has not shown signs of any build up.

Table 1:

Biomass estimates (numbers in thousands) from stratified random cruises - Subdivisions 3NO. Also data obtained using method 4.

ICNAF	Strata	1971	1972	1973	1974	1975	1976	Conversion factor Method 4
3N	359		845	639			4709	2.292
	360		1559			2302	3425	1.868
	361	6894	5961	858	904	3624	723	0.977
	362	2432	12160	1012	1466	431	1021	1.000
	373	18511	3940	146	426		76	0.783
	374	1390	180	180	0	140		9.260
	375	3701	3936	410	1435	6617		1.087
	376		810	39		1294	113	6.482
	377		1096	147	613	413		6.641
	378	586	3778	472	1683			2.618
	380	12	139	756	80			17.295
	381	865	1259	1391	123	149		4.632
	382	146	5252	20	152		23	3.235
	383	69	1546	48	23		16	10.629
		34606	42461	6118	6905	14970	10106	
Ave. values Method 4.		5491	6853	2966	1453	3898	2519	

Table 2 Biomass estimates obtained from Method 1.

Biomass estimates obtained from Method 1.

359	2657	845	639	675	1155	4709
360	2841	1559	570	722	2302	3425
361	6894	5961	858	904	3624	723
362	2432	12160	1012	1466	431	1021
373	18511	3940	146	426	2802	76
374	1390	180	180	0	140	92
375	3701	3936	410	1435	6617	786
376	816	810	39	207	1294	113
377	801	1096	147	613	413	150
378	586	3778	472	1683	834	359
380	12	139	756	80	126	54
381	865	1259	1391	123	149	185
382	146	5252	20	152	678	23
383	69	1546	48	23	206	16
Ave.	2980	3033	478	608	1484	838

Sp (PT)
CPUE

151-500T

1.586	.977	.733	.430	.355

Table 3. Biomass estimates obtained using Method 4.

ICNAF	Strata	Area	1971	1972	1973	1974	1975	1976
3N	359	421	1304	845	639	258	540	4709
	360	2992	9265	1559	1387	1832	2302	3425
	361	1853	6894	5961	858	904	3624	723
	362	2520	2432	12160	1012	1466	431	1021
	373	2520	18511	3940	146	426	3233	76
	374	931	1390	180	180	0	140	717
	375	1593	3701	3936	410	1435	6617	1226
	376	1499	4642	810	39	918	1294	113
	377	100	310	1096	147	613	413	77
	378	139	586	3778	472	1683	178	107
	380	116	12	139	756	80	149	89
	381	182	865	1259	1391	123	149	140
	382	647	146	5252	20	152	830	23
	383	674	69	1546	48	23	865	16
	Ave.		3580	3033	536	708	1483	890

Table 4. Total catch (all countries) and total Catch-per-unit-effort (CPUE) data
for Subdivision 3NO (1971-75).

Yr.	Total Adj. C.P.U.E.	Total Catch
1960	1.298	79677
61	1.180	72724
62	.921	34984
63	1.856	69742
64	1.647	64461
65	1.826	99187
66	1.706	108919
67	1.706	226784
68	1.722	165511
69	1.499	117705
70	1.429	111561
71	1.493	126296
72	.924	103374
73	.769	80429
74	.583	73379
75	.402	44174

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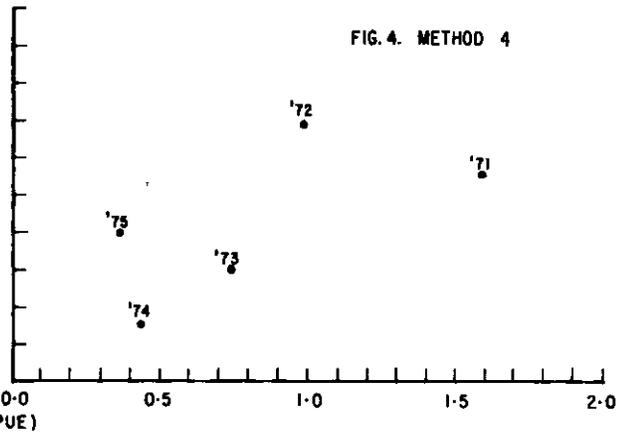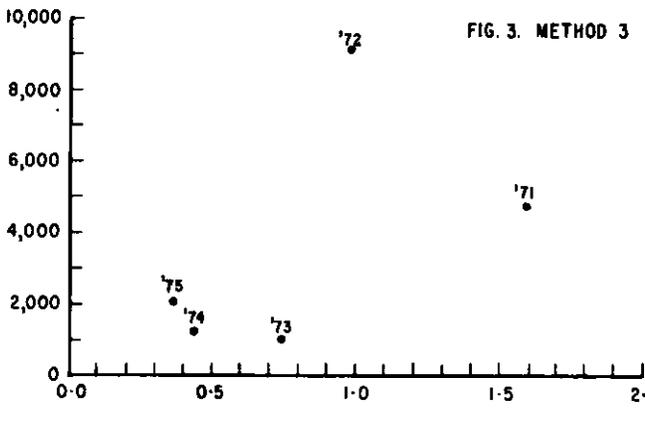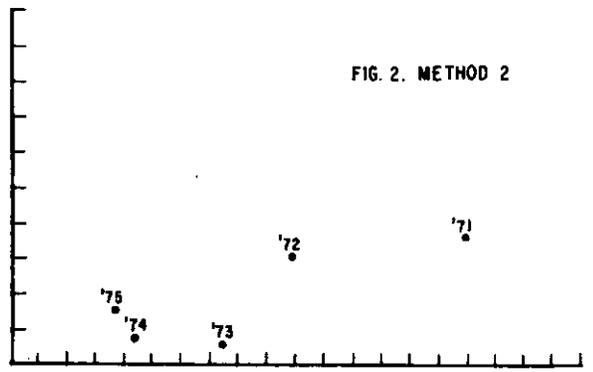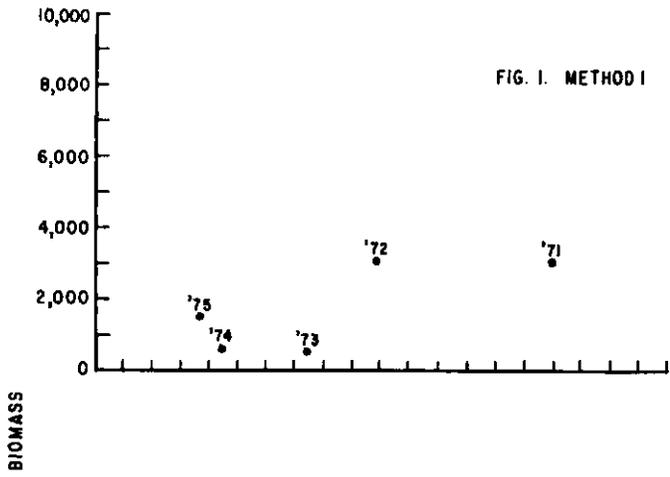
Figs. 1 to 4: Biomass estimates against Spain PT catch-per-unit-effort (CPUE) in metric tons/hour – 1971 to 1975.

Fig. 5 Total catch (all countries) and total catch-per-unit-effort (CPUE) data for Sub-division 3NO (1971-75).