International Commission for the Northwest Atlantic Fisheries

ANNUAL MEETING - JUNE 1976

Recent Developments in the 4VsW Cod Fishery

by

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The following table replaces Table 8 on page 8 of the original document.

Table 8
(Revised)

CATCH PROJECTION
4VsW COD

Age	Wt(kg)	Partial Recr'ts	1975 Stock(10^{-3})	1975 Catch(10^{-3})	1976 Stock(10^{-3})	1976 Catch(10^{-3})	1977 Stock(10^{-3})	1977 Catch(10^{-3})	F
1	0.14	0.03	36430	589	75000	1706	75000	676	0.01
2	0.31	0.25	28784	3642	29294	5083	59865	4677	0.09
3	0.70	0.50	16784	3962	20284	6390	19409	2906	0.18
4	1.08	0.75	9199	3044	10180	4383	10875	2266	0.26
5	1.61	1.0	10288	4249	4802	2521	4417	1189	0.35
6	2.11	1.0	5881	2429	4623	2426	1686	454	0.35
7	2.70	1.0	5666	2340	2643	1387	1623	437	0.35
8	3.60	1.0	1346	556	2546	1336	928	250	0.35
9	4.06	1.0	1123	464	605	317	894	241	0.35
10	4.71	1.0	1542	637	505	265	212	57	0.35
11	5.25	1.0	349	141	693	363	177	48	0.35

Calculated Wt.			33182		33200		12475
	F=0.6			F=0.847			
Corrected Wt.		.	29981		29997		11272

With F=0.30 calculated 11658
corrected 10532

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Introduction

A detailed assessment of the cod stock complex in ICNAF Subdiv. 4Vs and 4W was presented by Halliday (1975). Despite sparse sampling of commercial catches, a clear declining trend in the fishery in the 1970's was evident. In this paper, Halliday's analysis is extended using data on catch rates in 1974 and catch compositions and Research vessel cruises in 1975. His basic conclusions are upheld although the current situation appears more serious than was anticipated.

Research vessel surveys

Canada has conducted stratified random groundfish surveys in Subdiv. 4Vs and Div. 4W since 1970. Estimates of population numbers-at-age from these surveys are very variable (Table 1). Relative year class strengths appear more stable than absolute abundance estimates. The 1966, 1968, 1970 and 1971 year classes consistently appear strong in relation to neighbouring year classes. The 1972 and 1973 year classes appear to be weak.

The low estimated abundance for 1975, inconclusive by itself, is no cause for optimism concerning currently recruiting year classes.

Nominal Catches

Cod catches from Subdiv. 4Vs and Div. 4W averaged 60,000 tons from 1960-74 (Halliday 1975). In the period 1966-1973 catches fluctuated from 50,000 to 80,000 tons (Table 2). Catches declined to 44,000 tons in 1974 and 30,000 tons in 1975. The 1974 and 1975 catches were well below catch quotas of 60,000 tons for both years.

Estimated removals from the stocks

Estimated removals from 1966-1974 were taken from Table 8 of Halliday (1975). The 1975 estimates are derived from applying Canadian otter trawl age compositions to Spanish pair trawl catches and USSR 1974 age compositions to USSR 1975 catches. A mean weight of 0.372 kg per fish was adopted for 1975 USSR catches based on one sample. The composition of the Canadian catch was derived from samples of the otter trawl and long line fisheries.

The data are presented in Table (3).

Cohort Analysis

Cohort analysis was carried out on the data of Table 3 for ages 1-11 using a value of M = 0.2 and with F = 0.6 for fully recruited fish aged 5 and older in 1975. The use of F = 0.6 is likely to underestimate mortality rates in 1975 in view of the higher calculated average mortality rated for those age groups in 1973 and 1974 (0.75). F was assumed to be 0.45, 0.30, 0.15, and 0.02 for ages 4, 3, 2 and 1 respectively in 1975. For earlier years F for age 11 was taken to be the average of the calculated F's for ages 9 and 10. The results are presented in tables 4 and 5.

Fishing mortality rates, especially for fish aged 3 to 6 have shown a general increase in the late 1960's and the 1970's. Mortality rates on older fish have been more variable.

A very strong year class appears to have been produced in 1965. Year class sizes have declined steadily since 1966 and preliminary indications suggest that the 1972 and 1973 year classes are particularly weak.

Estimated stock biomasses for ages 2-11 increased from 260 x 10^3 mt in 1966 to 291 x 10^3 mt in 1968. Since 1968 biomass estimates have declined steadily to a 1974 value of 129 x 10^3 mt.

Catch Rates

Following Halliday (1975), catch rates of cod by Spanish pair trawlers of 151-500 gross tons from February to April in Subdiv. 4Vs and Div. 4W are considered as an index of cod abundance (Table 6).

Catch rates varied irregularly from 1.15 to 2.39 in the 1960's but have declined sharply and steadily from 1968 to 1974 (fig. 1). The mean of the Spanish pair trawler catch rates is closely related to estimates of cod biomass for ages 2-11 (fig. 2). The equation:

Biomass (10^{-4} mt) = 46.9 +202 Catch Rate (mt/hr) - 42.8 (Catch Rate)^2

with R^2 = 0.91 was fitted to the data.

The close relation between catch rates and biomass estimates supports the validity of the cohort analysis.

Cod and Silver Hake

The decline in year class size experienced in the 4VsW is not adequately explained by events in the fishery. The stock size appears to have been fairly stable from 1958 to 1970 in spite of average catches of 60,000 mt. Thus the poor year classes of the 1970's do not appear to be caused by the 4VsW cod fishery.

In view of the likelihood of predation of silver hake on juvenile cod, a relation between silver hake abundance and cod year class size might be expected. Table 7 shows catch rates of USSR otter trawlers >1800 gross tons of silver hake in Div. 4VWX in relation to estimates of population numbers of one-year-old cod. A statistically significant correlation of -0.734 exists between these variables and the line.

Cod abundance (10^{-6}) = 113.4 - 37.0 Catch Rate (mt/hr) was fitted (Fig. 3).

It is not clear whether this relation is entirely due to the predation of silver hake on cod or whether catch rates of juvenile cod which are discarded and not recorded from the USSR silver hake fishery are a factor. However, this relation gives no cause for optimism concerning cod year class sizes for 1970-1974.

Catch Projection

A catch projection (Table 8) was carried out using the results of the earlier cohort analysis and weights-at-age from Halliday (1975). It was assumed that the 1976 quota of 30,000 mt would be met. In 1977 the projected catch was based on F_{max} from the yield per recruit calculations of Halliday (1975). The 1974 and 1975 year classes were assumed to be 75 million fish at age one. The projected catch for 1977 was 15676 tons.

The projected catch is not sensitive to assumptions concerning the 1974 and 1975 year classes, but the projected population biomass is. With the hypothesised year class sizes, the stock biomass reaches a minimum in 1976 and recovers at a rate of about 15000 tons per year thereafter. If the 1974 and 1975 year classes are only 50 million, fish may recover at a rate of 8,000 tons per year.

The projection is sensitive to the estimated stock size in 1975. A 10% reduction in the 1975 stock results in a projected catch of 13,334 tons in 1977.

Discussion

Catch rates and analysis of the age composition of commercial catches indicate that the abundance of cod in Subdiv. 4Vs and Div. 4W decreased from over 250,000 mt in 1968 to 130,000 mt in 1974. Neither research vessel surveys nor commercial catch compositions show evidence of strong year classes about to enter the fishery.

In view of the history of the stock since 1958 (Halliday 1975), a stock biomass in the region of 200,000 mt is a reasonable management objective for this stock complex. In view of current trends and the absence of any indication of improved recruitment, drastic action is called for to preserve the spawning stock and especially to reverse current trends.

Acknowledgement

Special thanks are given to Dr. R. G. Halliday for his input into this analysis.

Reference

Halliday, R. G. (MS 1975) Eastern Scotian Shelf Cod: A Reconstruction of Possible Events in the Fishery in 1958 to 1974 and a Re-estimation of Potential Yield.
Int. Comm. Northwest. Atlant. Fish. Res. Doc. 75/IX/136.

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Table 1 .   Div. 4Vs - W cod - survey population estimates (nos. at age x 10⁻³ and mortality of fully recruited age groups).

Age	1970	1971	1972	1973	1974	1975
1	1,480	1,539	6,210	16,128	6,084	3,372
2	16,388	7,680	9,657	122,779	32,961	8,395
3	5,250	35,664	9,635	104,965	19,246	13,017
4	7,669	8,027	33,848	59,948	5,623	6,171
5	3,735	15,803	5,571	22,524	2,017	2,959
6	1,217	5,771	6,111	1,870	2,244	675
7	1,502	3,459	1,688	2,907	372	867
8	462	1,475	547	901	563	235
9	104	638	495	431	224	433
10+	711	471	153	910	340	234
Totals	38,518	80,531	73,915	333,363	69,574	36,358

$\bar{F}_{5+/6+}$ =	-0.62	0.92	0.53	1.67	0.64
$\bar{F}_{6+/7+}$ =	-0.61	1.21	0.37	1.41	0.52

	1970-75	1972-75
$\bar{F}_{5+/6+}$	0.67	1.02
$\bar{F}_{6+/7+}$	0.58	0.76

Table 2 .   Div. 4Vs-W Cod - Nominal Catches (mt)

Year	Canada	France	Portugal	Spain	USSR	Others	Total	Div. 4Vs	Div. 4W	Catch Quota
1966	17,690	1,494	-	43,157	5,473	356	68,170	27,163	41,007	-
1967	18,464	77	102	33,934	1,068	512	54,157	26,607	27,550	-
1968	24,888	225	-	50,418	4,865	29	80,425	48,781	31,644	-
1969	14,188	217	-	32,305	2,783	664	50,157	22,309	27,848	-
1970	11,818	420	296	41,926	2,521	446	57,427	28,632	28,795	-
1971	17,064	4	18	30,864	4,506	107	52,563	24,128	28,435	-
1972	19,987	495	856	28,542	4,646	7,119	61,645	36,533	25,112	-
1973	15,929	922	849	30,883	2,918	2,569	54,070	23,401	30,669	60,500
1974	10,700	34	1,464	27,384	3,097	1,060	43,740	19,610	24,130	60,000
1975ⱽ	9,975	780	301	15,590	2,957	378	29,981	-	-	60,000

1976 =   30,000

ⱽ Preliminary statistics.

Table 3 .   4Vs - W Cod.   Removals x10^3

Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	1055	206	938	536	486	869	896	533	557	654
2	6726	2057	6120	3420	3488	6025	8261	4763	3298	3643
3	10269	4858	10990	4010	5558	6634	8095	11111	8614	3947
4	12660	7733	16616	13055	14196	8065	12245	6792	9217	3044
5	10139	9370	15245	10026	13472	8449	9289	9441	7024	4249
6	4461	4338	8297	6073	4539	10262	8780	3818	2718	2429
7	3256	1467	3482	2144	1942	5160	3432	2979	944	2340
8	1590	1239	895	510	759	1849	1919	3717	1320	556
9	856	664	816	237	236	496	358	1164	413	464
10	496	647	361	50	72	114	393	273	369	637
11	666	325	152	95	137	131	79	299	15	144
12	24	65	211	58	56	72	2	3	5	123
13	14	16	33	12	9	98	37	7	-	30
14	-	5	17	7	12	12	-	5	-	8
15	2	7	1	2	4	51	1	5	-	8
16+	1	2	10	2	3	17	1	20	-	13
Totals	52215	32999	64184	40237	44969	48304	53788	44930	34494	22289

Table 4 .   4VsW Cod: Fishing Mortality Rates.

Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	.01	.00	.01	.01	.01	.01	.03	.02	.02	.02
2	.07	.02	.08	.07	.05	.13	.17	.19	.16	.15
3	.17	.07	.13	.07	.14	.14	.25	.37	.61	.30
4	.32	.19	.36	.22	.34	.32	.40	.34	.59	.45
5	.58	.42	.69	.38	.38	.35	.75	.62	.73	.60
6	.66	.53	.81	.66	.30	.56	.78	.83	.36	.60
7	.61	.47	1.17	.50	.45	.67	.37	.67	.49	.60
8	.53	.49	.60	.51	.33	1.10	.56	.89	.72	.60
9	.51	.43	.71	.31	.47	.38	.65	.82	.22	.60
10	.49	.94	.45	.08	.14	.44	.59	1.86	.67	.60
11	.50	.69	.58	.20	.33	.41	.62	1.34	.45	.60

Table 5 .   4VsW Cod: Estimated Population Numbers at Age

Age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	153159	113256	74298	91094	68957	71888	38384	29982	35773	36430
2	104629	124441	92540	59981	74096	56018	58070	30615	24065	28784
3	72245	79577	100022	70228	46014	57509	40412	40069	20756	16719
4	51209	49857	60756	71948	53869	32644	41082	25762	22752	9199
5	25372	30471	33822	34708	47093	31259	19429	22555	14946	10288
6	10201	11598	16469	13897	19345	26367	17948	7502	9924	5881
7	7907	4315	5571	5977	5883	11731	12302	6750	2688	5666
8	4299	3528	2205	1410	2953	3059	4936	6966	2831	1346
9	2382	2081	1767	996	693	1731	832	2305	2340	1123
10	1417	1176	1103	704	601	354	969	357	834	1542
11	1852	711	377	576	535	427	187	437	45	349

Table 6 .   Catch rates of Spanish pair trawlers in 4Vs and 4W and
estimated cod biomass ages 2-11 in 4VsW.

Year	Catch/hr 4Vs (mt/hr)	Catch/hr 4W (mt/hr)	Biomass 2-11(10^{-3} mt)
1966	1.70	1.59	260
1967	1.83	1.51	264
1968	2.36	2.39	291
1969	1.60	1.80	263
1970	1.61	1.45	234
1971	1.18	1.32	253
1972	1.12	0.68	219
1973	0.74	0.87	175
1974	0.58	0.43	129

Table 7 .   Year class size of 4VsW cod at age 1 from virtual population
analysis and catch rates of silver hake in 4VWX by USSR otter
trawlers > 1800 gt.

Year	Catch Rate (mt/hr)	Cod Yr. Class (10^{-3})
1966	0.15	153159
1967	0.29	113256
1968	0.15	74298
1969	0.98	91094
1970	1.58	68957
1971	1.13	71888
1972	1.26	38384
1973	2.62	29982
1974	1.16	35773

Table 8.

CATCH PROJECTION
4VsW COD

Age	Wt(kg)	Partial Recr'ts	1975 Stock(10^{-3})	1975 Catch(10^{-3})	1976 Stock(10^{-3})	1976 Catch(10^{-3})	1977 Stock(10^{-3})	1977 Catch(10^{-3})	F
1	0.14	0.03	36430	654	75000	1433	75000	789	
2	0.31	0.25	28784	3643	29235	3927	60110	4571	0.01
3	0.70	0.50	16784	3947	20283	5055	20402	2977	0.09
4	1.08	0.75	9199	3044	10140	3527	12065	2536	0.18
5	1.61	1.0	10288	4249	4803	2077	5141	1384	0.26
6	2.11	1.0	5881	2429	4623	1999	2075	559	0.35
7	2.70	1.0	5666	2340	2643	1143	1998	538	0.35
8	3.60	1.0	1346	556	2546	1102	1142	307	0.35
9	4.06	1.0	1123	464	605	262	1100	296	0.35
10	7.71	1.0	1542	637	505	218	261	70	0.35
11	5.25	1.0	349	144	693	299	218	59	0.35

Calculated Wt. 33195 27039 14158
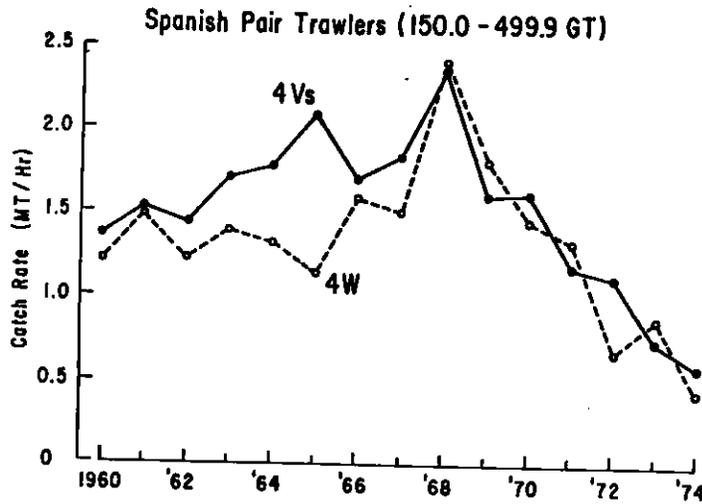Corrected Wt. 29981 29847 15676

Fig. 1.   Trends in catch rates of Spanish pair trawlers 150-500 gt in February to April 1 in ICNAF Subdiv. 4Vs and Div. 4W.

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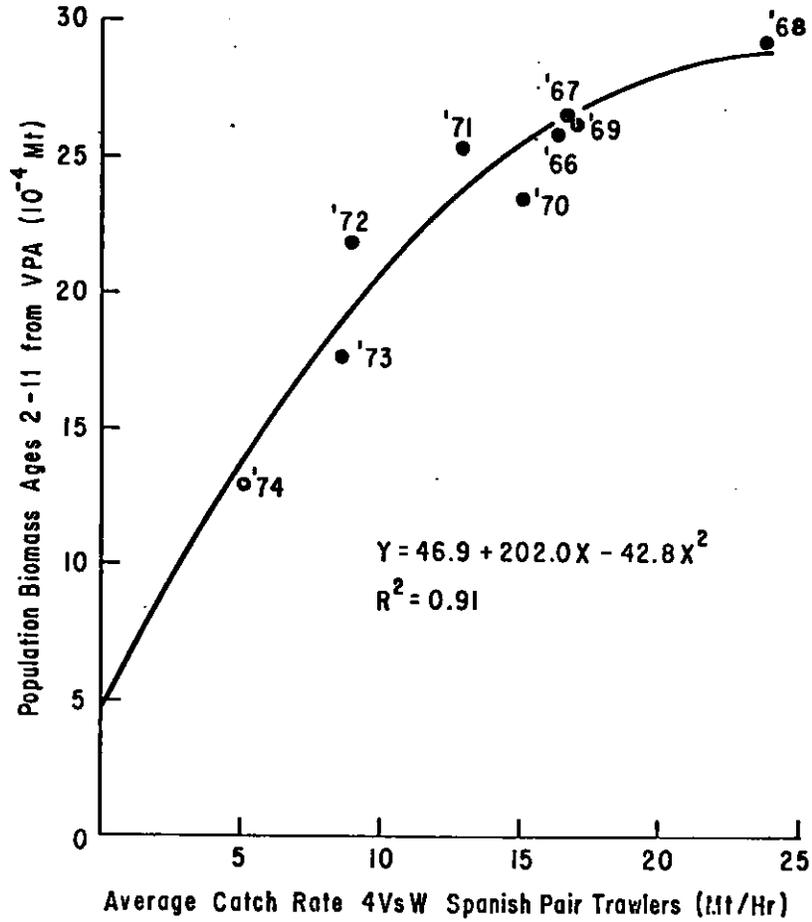
Fig. 2. Catch Rates of Spanish Pair Trawlers 150-500 gt
from February to April in relation to virtual
population estimates of stock biomass.

$$Y = 46.9 + 202.0X - 42.8X^2$$
$$R^2 = 0.91$$

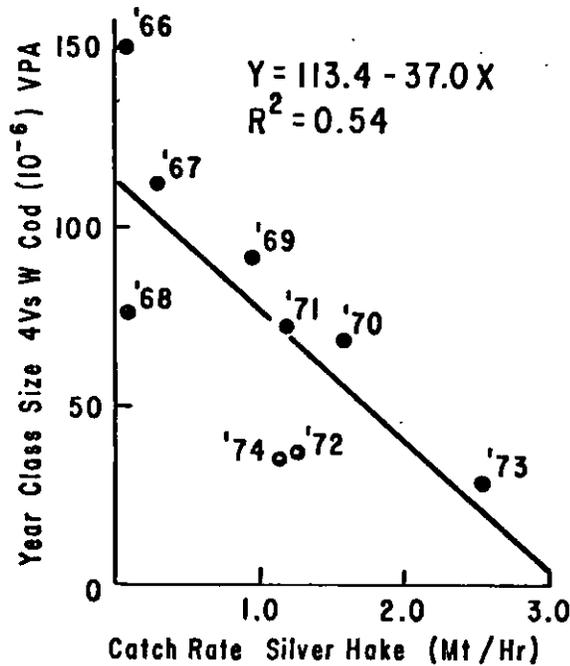$$Y = 113.4 - 37.0X$$
$$R^2 = 0.54$$

Fig. 3.   Relationship of catch rates of USSR >1800 gt
otter trawlers of silver hake in ICNAF Div. 4VWx
to virtual population estimates of cod year class size
in Subdiv. 4Vs and Div. 4W.