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Impact of the 4Vn Winter Fishery on the Yield of the Southern Gulf of St. Lawrence Cod Stock

by

G.A. Chouinard and A.F. Sinclair

Science Branch, Gulf Region
Department of Fisheries and Oceans
P.O. Box 5030
Moncton, New Brunswick
E1C 9B6

ABSTRACT

The effect of the 4Vn winter fishery on the yield obtained for the 4TVn (Jan.-Apr.) cod stock was examined by reviewing discard studies and conducting simulations using modified catch equations. Observer information and previous studies found that discard rates were lower in area 4Vn than in area 4T. The simulations indicated that an increase of 3% in yield would occur if the fishery would be conducted in 4T only from May to December.

RESUME

Les effets de la pêcherie d'hiver du 4Vn sur le rendement pour l'ensemble du stock de morue du sud du Golfe du St. Laurent (4TVn (Jan.-Apr.)) ont été examinés en revisant les études de rejets et à l'aide de simulations utilisant les équations de captures modifiées. Les informations recueillies par les observateurs en mer et à partir d'études antérieures indiquent que la proportion de rejets à la mer est inférieure dans la zone 4Vn comparée à la zone 4T. Les résultats des simulations indiquent une augmentation de 3% dans le rendement global si la pécherie était uniquement exercée dans la zone 4T de mai à décembre.

INTRODUCTION

Commercial exploitation of the 4TVn (Jan.-Apr.) cod stock has traditionally been conducted in two distinct fisheries: the winter fishery conducted almost exclusively in 4Vn and the summer fishery in 4T. The winter fishery fleet is mainly comprised of large otter trawlers from France, Nova Scotia, and Newfoundland; while the summer fishery is conducted by smaller vessels (less than 30 m.), fishing with otter trawls, Danish, and Scottish seines and inshore vessels with fixed gears.

It has been argued by members of the industry that the winter fishery in 4Vn is detrimental to the fishery in 4T and the resource in general. More specifically, it is contended that large quantities of small cod are being discarded resulting in a loss of yield for the 4T fishery.

The objective of this study was to determine the impact of the 4Vn fishery on the 4T fishery by examining information on discard rates and comparing yields predicted by various scenarios.

DISCARD STUDIES

From 1980 to the present, information on discarding of cod at sea in area 4Vn is available from the International Observer Program (IOP) of the Department of Fisheries & Oceans (Scotia-Fundy Region). For the domestic fleet, observed discard rates by weight were respectively 0.6%, 0.03%, and 0.6% for 1984, 1985, and 1986. The French (Saint Pierre and Miquelon) fleet had a discard rate of 3.86% during the 1985 winter fishery (Chouinard and Nielsen, 1986). In general, French (Metropolitan) vessels do not discard fish as they have fish meal plants on board. Twenty-five (25) length frequencies of discards were available from the IOP file for the seven years. Since most of these were from the French fleet, the information was considered insufficient to allow calculation of catch at age of the discarded portion of the catch.

In NAFO 4T, three discard studies have been conducted in recent years. Studies by Cliche and Coté (1985) in 1980 and 1981 examined the discarding habits of the Québec otter trawler fleet. Chouinard and Metuzals (1985) conducted a similar study on seiners and trawlers from the Maritime Provinces in the fall of 1984. Discard rates by weight from these studies varied from 3.6 to 6.5%. Length frequencies indicated that the lengths of the discarded cod ranged from 20 to 50 cm. with modal length between 35 and 40 cm. The discard rate calculated from Québec observers samples (4) in 1985 was 7.9% (by weight). Although length frequencies were collected during these studies, the coverage in time, areas fished and across the various fleets is insufficient to separate the discards by age groups.

A summary of discarding rates obtained from these and other discard studies in 4T and 4Vn (Table 1) indicates high rates in 4T prior to 1959 when a minimum mesh size for codends of 4 1/8 in. (105 mm.) was instituted (Jean, 1963). The discard rates then decreased to 6% by 1961.

YIELDS

To examine the difference in yields with and without the 4Vn winter fishery, catch and weights at age for the two fisheries were used with modified catch equations. Because of ageing problems (Chouinard and Nielsen, 1986), catch and weights at age for 1983 to 1986 were uncertain; consequently, data for the years 1980-1982 was used in the analysis. Catch and weights at age used in the calculations are presented in Tables 2 and 3 and are representative of the landed portion of the catch only.

Partial recruitment (PR) vectors for each fishery were derived using a method described in Sinclair and Gavaris (1985). Fishing mortality (F) vectors for each fishery and each year were first calculated with the following modified catch equations. The period Jan. 1-Mar. 31 was used to represent the 4Vn fishery, and the period Apr. 1-Dec. 31 for the 4T fishery.

4Vn

$$N_{Apr} = N_{Beg}e^{-M \times 0.25} - C_{Beg-Apr}e^{-M \times 0.25 \times 0.5}$$

$$F_{Beg-Apr} = \ln (N_{Beg}/N_{Apr}) - M \times 0.25$$

4T

$$N_{End} = N_{Apr}e^{-M \times 0.75} - C_{Apr-End}e^{-M \times 0.75 \times 0.5}$$

$$F_{Apr-End} = 1.33 \ln (N_{End}/N_{Apr}) - M \times 0.75$$

Where

N_{Beg} = Beginning of year numbers (Chouinard and Nielsen, 1986)

N_{Apr} = Beginning of April numbers

N_{End} = End of year numbers

M = 0.2

Analysis of variance of the model

$$\ln F = a + b_1A + A + b_2Y \qquad \text{where A = age and Y = year}$$

was used for each fishery using the F values for ages 3 to 14 from above (APL function MULTPR). The resulting vectors were standardized to the mean of ages 7 to 11 for the 4Vn fishery, while ages 9 to 11 were used for 4T. The resulting PR vectors (Figure 1) are given below and indicate higher recruitment at a younger age for the winter fishery (4Vn).

	Age							
	3	4	5	6	7	8	9	10
4Vn	0.002	0.044	0.306	0.652	1.000	1.000	1.000	1.000
4T	0.005	0.046	0.192	0.360	0.562	0.734	1.000	1.000

	Age			
	11	12	13	14
4Vn	1.000	0.786	0.560	0.118
4T	1.000	0.670	0.536	0.118

Using these PR vectors for each fishery, a constant recruitment, a fishing mortality of 0.2, a natural mortality of 0.2, and the average weights at age for the years 1980 to 1982 (Table 4); simulation of the fishery under two different scenarios was conducted using modified catch equations.

The first scenario represented the status quo where the stock is fished in 4Vn in the winter and in 4T for the remainder of the year. The second assumed no fishery in 4Vn with the fishery in 4T being conducted from April to December. The starting population was composed of 10,000 fish in each age class. The projections were computed until equilibrium was attained (e.g. 12 years). The PR and average weight at age parameters for the two areas were interchanged to obtain some indication of the sensitivity of the analysis.

Results (Table 5) indicated an increase of 3% in the catch biomass if the fishery were entirely conducted in NAFO 4T. This increase is essentially attributable to growth. An increase of 10% in catch biomass occurred with a 4T only fishery and a PR similar to the 4Vn fishery.

DISCUSSION

Examination of discard studies indicated that discard rates were generally higher in area 4T; and therefore, discarding practices of cod in area 4Vn, as observed at sea, are considered no more damaging to the stock than in area 4T. Discard rates can be affected by several factors including selectivity of gear used, market conditions, and the size distribution of fish in the population. With similar fishing practices and market conditions, discard rates will vary due to variation of the proportion of small fish in the population. Selectivity of fishing gear is not an exact

process; and consequently, catches of small fish are usually unavoidable. Discard estimates were not used in the simulations, but since the levels of fish rejected are not considered high, they should not affect the results significantly.

Calculation of partial recruitment vectors was based on the years 1980-1982, and consequently do not reflect recent changes which may have occurred due to the reduction of the French fleet allocation in 4Vn in 1987. The different vectors obtained for the two fisheries were expected due to the difference in gear composition.

The results of the yield calculations indicate that a marginal increase in yield would occur if the fishery were entirely conducted in 4T. The 10% increase would only occur if the partial recruitment in 4T were similar to 4Vn, which is unlikely because of the proportion taken by fixed gear in 4T. The results of these simulations relied on the assumptions of similar exploitation patterns over the stock area and through the year. An exclusive 4T fishery may affect average weights, catch rates, and the level of $F_{0.1}$ which in turn would affect the resulting yield for the fishery. Due to the uncertainties of how an exclusive 4T fishery would be conducted, an increase in yield closer to 3% is more likely. An increase of this magnitude would be difficult to detect.

ACKNOWLEDGEMENTS

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Table 1. Summary of discard studies conducted on cod in NAFO Division 4T and Sub-division 4Vn.

A) 4T

Source	Year	Discard Rates by number (%)	Discard Rates by weight (%)
Jean (1963)	1956	25	9
Jean (1963)	1957	24	6
Jean (1963)	1958	16	7
Jean (1963)	1959	13	6
Jean (1963)	1960	10	4
Jean (1963)	1961	6	2
D.F.O. Unpubl. Study (1977)	1976	-	5.9
Cliche & Coté (1985)	1980	7.3	3.6
Cliche & Coté (1985)	1981	9.8	6.5
Chouinard & Metuzals (1985)	1984	14.2	6.0
Quebec Observers	1985	-	7.9

B) 4Vn (Jan.-Apr.)

Source	Year	Discard Rates by number (%)	Discard Rates by weight (%)
Quebec Observers	1984	-	3.9 (SPM fleet)
IOP Program	1984	-	0.6
	1985	-	0.03
	1986	-	0.6

Table 2. Catch at age in 4Vn and 4T cod fisheries.

	4Vn				4T		
AGE	1980	1981	1982	AGE	1980	1981	1982
3	72	0	4	3	242	96	368
4	347	503	224	4	1672	3259	1020
5	4125	1946	2326	5	10875	5331	7775
6	5018	6454	2040	6	9134	12387	7490
7	3173	3878	3014	7	6368	8985	9723
8	489	1369	1671	8	785	4657	5019
9	193	141	426	9	506	726	1731
10	104	52	160	10	216	380	166
11	18	21	56	11	106	169	54
12	13	9	11	12	11	55	47
13	3	4	4	13	13	77	2
14	2	1	2	14	6	1	1
15	2	0	2	15	9	14	0
16	-1	1	0	16	25	2	2

*Numbers are in thousands of fish.

Table 3. Average weight at age in 4Vn and 4T cod fisheries.

	4Vn				4T		
AGE	1980	1981	1982	AGE	1980	1981	1982
3	0.65	----	0.36	3	0.54	0.50	0.72
4	0.72	0.55	0.57	4	0.68	0.69	0.80
5	0.86	0.74	0.87	5	0.94	0.89	1.00
6	1.18	1.01	1.10	6	1.22	1.20	1.20
7	1.50	1.25	1.39	7	1.46	1.44	1.47
8	2.43	1.49	1.66	8	2.78	1.93	1,67
9	2.77	2.91	2.39	9	2.94	3.20	2.04
10	3.00	3.50	3.01	10	3.84	4.21	3.14
11	4.22	5.02	3.70	11	8.59	4.39	4.00
12	3.72	6.39	4.49	12	8.27	5.48	3.53
13	6.50	7.16	6.45	13	11.20	5.97	7.74
14	9.51	10.23	6.94	14	4.58	3.93	13.98
15	5.72	10.26	4.18	15	10.67	3.49	----
16	13.25	6.76	----	16	9.20	6.76	11.10

*Weights are in kilograms.

Table 4. Average weights at age (1980-1982 weighted by catch numbers) used in calculations of yield for the 4Vn and 4T fisheries.

	4Vn	4T
AGE	WEIGHT AT AGE	WEIGHT AT AGE
3	0.635	0.627
4	0.609	0.708
5	0.835	0.949
6	1.087	1.205
7	1.371	1.454
8	1.701	1.871
9	2.583	2.479
10	3.087	3.870
11	4.090	5.678
12	4.705	4.938
13	6.722	6.750
14	8.626	5.674

Table 5. Results of the simulations using a population of 10,000 fish at each age and parameters listed in text.

	Catch (number)	Yield (weight t)	% of status quo yield
Status quo fishery	2071	4724	100%
4T fishery only	2073	4867	103%
4T fishery with 4Vn PR	2535	5180	110%
4T fishery with 4Vn weights at age.	2535	4287	91%

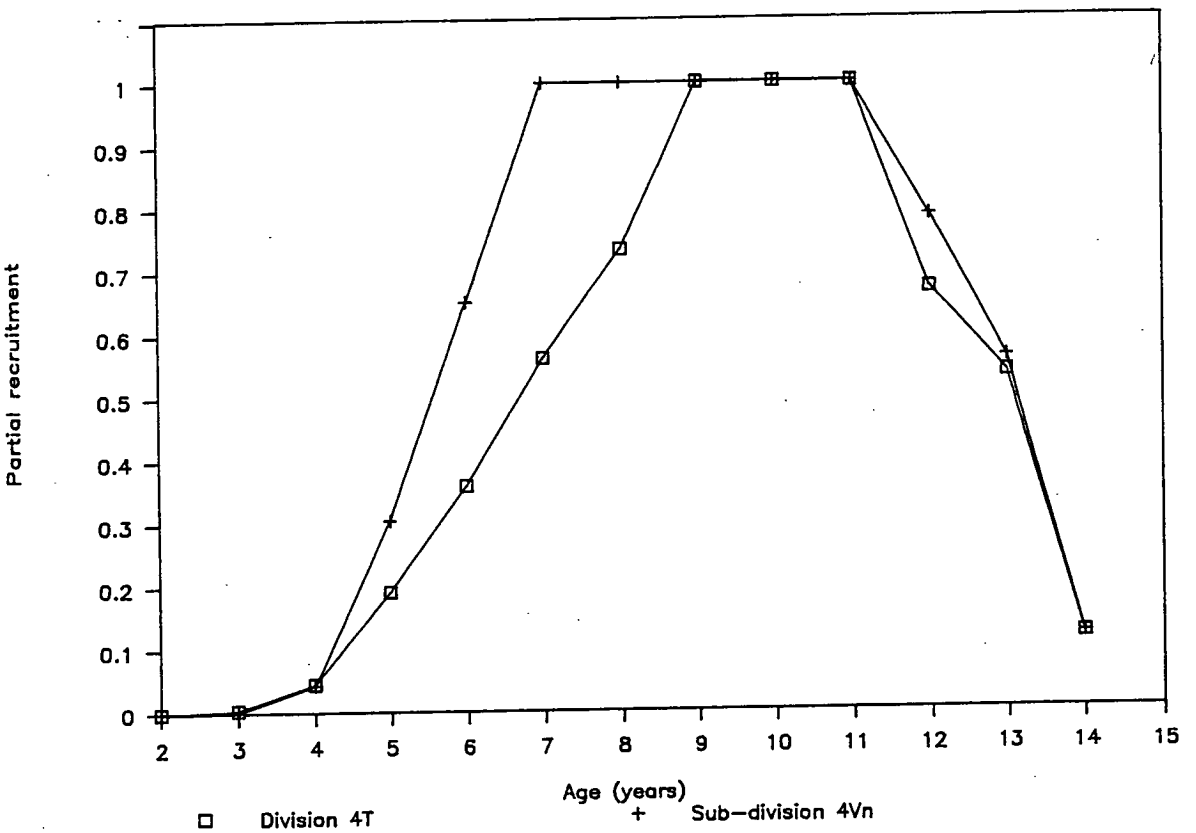

Figure 1. Partial recruitments for 4T and 4Vn used in the simulations.