Canadian Atlantic Fisheries
Scientific Advisory Committee

Comité scientifique consultatif des
pêches canadiennes dans l'Atlantique

CAFSAC Research Document 83/46

CSCPCA Document de recherche 83/46

An assessment of the cod stock in NAFO division 4RS 3Pn

by

Dominique Gascon
Direction de la Recherche sur les pêches
Ministère des Pêches et Océans
C.P. 15 500
901 Cap Diamant
Québec, Québec G1K 7Y7

ABSTRACT

The nominal catches of cod from the 4RS 3Pn stock have increased in recent years from 74,000 T in 1977 to 103,000 T in 1982 (preliminary statistics). Standardized catch rate indices have also increased in the same interval from 0.666 T/hour to 1.577 T/hour. Catch rates were standardized to Canadian-Maritime otter trawler TC4 using the multiplicative model combining catch rate data for country-year, months, divisions and years. Population estimates from cohort analysis (using a constant instantaneous rate of natural mortality of 0.2) provided the best relationship with catch rate series when a fully recruited fishing mortality of 0.3 was assumed for 1982. Projections for 1984 at $F_{0.1}$ indicated a catch of 96,370 T assuming that the TAC of 100,000 T will be taken in 1983.

RESUME

Les captures nominales de morue provenant du stock de 4RS-3Pn ont augmenté au cours des dernières années de 74 000 T en 1977 à 103 000 T en 1982 (données préliminaires). Les taux de captures standardisés ont aussi augmenté au cours de la même période de 0.666 T/heure à 1.577 T/heure. Les taux de captures ont été standardisés sur les chalutiers (TC4) canadiens des Provinces maritimes en utilisant le modèle multiplicatif qui permet de combiner des données provenant de pays-engins, mois, divisions et années différentes. La meilleure relation entre les taux de capture et les estimés de population produit par des analyses de cohorte (avec un taux instantané constant de mortalité naturelle de 0.2) a été obtenue quand une mortalité par pêche F_T = 0.3 a été utilisée en 1982 sur les ages pleinement recrutés. Une prise de 96 370 T a été projetée pour 1984 en supposant que le TPA de 100 000 T va être pris en 1983.

INTRODUCTION

The cod fishery in NAFO divisions 4RS 3Pn has been prosecuted historically in two distinct components: a winter fishery concentrated in divisions 3Pn and southern 4R and a summer fishery in divisions 4R and 4S (Table 1). The fishery has been dominated historically by Canada which took 53% of the reported catches between 1959 and 1976; French, Portuguese and other foreign fleets (mostly Spanish) took respectively 23%, 5% and 9% of the reported catch in the same period (Table 2). Since 1977, the French component of the catch has been limited to 15% while the remainder was caught in a 2 to 1 proportion by Newfoundland- and Québec-based vessels. Catches by Maritime-based vessels have been relatively small. Historically, the catches have been equally divided between the inshore and offshore component of the fishery (Table 3), the winter fishery being predominantly offshore, while the summer fishery is predominantly inshore.

NOMINAL CATCHES

Nominal catch statistics for 1982 (Table 4) of cod from the 4RS 3Pn stock for Newfoundland- and Maritime-based vessels were obtained from the Economic and Statistic Branches of the Department of Fisheries and Oceans while those from the French fleet (Metropolitan and St.Pierre) were obtained from the Canadian Atlantic Fisheries Directorate. Preliminary data from Québec-based vessels were unavailable at the time of writing; they were estimated on a quarterly basis from the weekly quota-reports (Table 5). The total catch in 1982 was estimated at 103,427 T exceeding the TAC by 10,127 T. The 1982 catch represents an increase of 5,371 T relative to 1981. All quotas for the inshore component of the fleet were exceeded (131% for Jan.-Sept. period and 119% for the Oct.-Dec. period) and closures were imposed. Similarly, quotas were rapidly reached by all components of the offshore fleet, with the exception of trawlers in 4S which did not catch their quota (mostly Québec-based).

CATCH AND EFFORT DATA

Historical commercial catch and effort data, with the exception of Quebec-based vessels, were obtained from the NAFO Statistical Bulletin. Catch and effort data for Québec-based vessels (from 1975 onward) were obtained from the Direction de la recherche, ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (J.-P. Lussiaà Berdou: personal communication). Effort data for Maritime- and Newfoundland-based vessels for 1982 were obtained with the nominal catch statistics.

The catch rate data were analyzed using the Multiplicative model (Tables 6, 7, 8) (Gavaris, 1980). In previous work on this stock, (Gavaris and Bishop, 1982) the data series was divided into two segments: the 1959-1977 period and the 1977-present series, in order to account for qualitative differences between the two sequences. Preliminary analysis indicated that these qualitative differences did not affect the catch rate estimates produced by the model. Consequently the data series was analyzed as a single unit. A weighting factor, estimated from the residuals of an unweighted regression (at 4 levels of fishing effort) was applied to the catch effort data (Gavaris, personal communication). A strong seasonal pattern in catch rate is apparent (Table 7). The catch rates are highest in January and decline steadily through the year. Catch rates were standardized for Canada-Maritime and Québec Otter trawlers fishing 3Pn in January. There has been a steady increase in catch rates since the mid 1970's (Table 8 and Figure 1).

CATCH AT AGE

Biological sampling data of the catch in 1982 were obtained from the Newfoundland Region's Commercial Sampling Section for Canadian landings and the Foreign Observer Program for the catch by the French fleet (Table 9). Coverage for the offshore component of the catch was very good, especially in the first two quarters, whereas the coverage was less satisfactory for the inshore component of the catch.

Quarterly catches at age with their variance (Gavaris personal communication) were calculated for the main components of the fishery. Quarterly length-frequencies (across all three Division) were obtained by combiniing monthly length-frequencies for each Country-Province and gears. The Country-Province length frequencies were then combined to give gear specific quarterly length frequencies. Finally, quarterly length-frequencies for inshore gears were combined into general quarterly inshore-gear length-frequencies, since no gear-specific age-length keys were available for the inshore component of the catch. The combined length frequencies were calculated as the weighted averages (by nominal catch) of individual length frequencies. Age-length keys were applied to these quarterly length frequencies, providing 4 quarterly gear-specific catch at age vectors (Table 10). Catch at age for 1982 was obtained by combining these quarterly catch at age vectors and by applying the result to the whole catch (Table 11). Average weights at age were obtained by applying the following length-weight relationship to the length data.

$$W_{kg} = 6.1575 \times 10^{-6}\ FL_{cm}^{3.087855}$$

(Hodder, 1964).

In recent years, there has been an increase in the average weights of partially recruited age groups, which may be the result of a greater selectivity by the fishermen and processing plants.

SEQUENTIAL POPULATION ANALYSIS

Cohort analysis (Pope, 1972) was performed using the catch at age matrix shown in Table 12. Based on age specific fishing mortalities from preliminary runs of SPA, cod in NAFO divisions 4RS 3Pn appear to be fully recruited to the fishery from age 7 onward. The partial recruitment for age 4 to 6 in 1982 was estimated as the average of the partial recruitments from 1974 to 1980 (Table 13). Partial recruitment estimates for 1981 appeared anomalously large and were thus eliminated. Historical partial recruitments for age 4 to 6 were calculated by dividing fishing mortality at age by the average fully recruited fishing mortality age 7 to 11. This was obtained from the survival rate of fish age 7 to 10 in one year and 8 to 11 in the following year. In the cohort analysis the fishing mortality for the oldest age group was estimated as the fully recruited fishing mortality for age 7 to 11.

Results of the regression analyses between fishing mortality and fishing effort, standardized catch per unit effort and total biomass and exploitable biomass (obtained from the average weights at age matrix in Table 12) for values of $F_t = 0.2$ to $F_t = 0.5$ are presented in Table 14. The discriminatory power of the correlation coefficient was weak as values varied little between terminal F's of 0.2 and 0.5. Further, the regressions were highly dependent upon the last 2 points, imposing some reservation about the discriminatory abilities of regression analysis. Nevertheless, a fishing mortality of $F = 0.3$ on the fully-recruited age groups in 1982 provided a relationship between the estimate of exploitable biomass and catch per unit effort passing closest to the origin (Fig. 2). Further, the distribution of residuals about the regression line was approximatively even, adding some weight to the use of $F_T = 0.3$. Results of cohort analysis are presented in Table 15.

CATCH PROJECTIONS

The 1982 population size at age 4 appears to be substantially larger than average (Table 15), but the estimate from sequential population analysis in 1982 is doubtful due to uncertainties about partial recruitment at age 4; further, the unsatisfactory nature of the relationship between age 4 catch per unit effort and the age 4 biomass estimate from the sequential population analysis (Fig. 3), which is entirely dependent upon one point (1981) prevented

the use of this relationship, as done in previous years (Gavaris & Bishop, 1982) as a means of estimating age 4 population size. Hence, age 4 population size in 1979 (16×10^7), the second largest estimated year class, was used as the best estimate of age 4 population size in 1982. Projections were made using this estimate of age 4 population size and age 5-15 population numbers from the sequential population analysis (Table 16). Recruitment at age 4 in 1983 and 1984 was estimated as the geometric mean of age 4 population size between 1974 and 1980. The 1981 value was excluded as it represents an anomalously large year class which could produce a significant overestimate in the projections. Assuming that the TAC of 100,000 T is taken in 1983, fishing at the $F_{0.1}$ level ($F = 0.2$) would result in a catch of 96,370 T in 1984 (Table 16).

REFERENCES

Gavaris, S., 1980. Use of multiplicative model to estimate catch rate and effort from commercial data. Can. J. Fish. Aquatic Sci. 37: 2272-2275.

Gavaris, S. and C.A. Bishop, 1982. Assessment of the cod stock in 4RS 3Pn. CAFSAC Research Document 82/27.

Hodder, V.M., 1964. Assessments of the effects of fishing and of increases in the mesh size of trawls on the major commercial fisheries of the Newfoundland area (ICNAF Subarea 3). Fish. Res. Board Canada. Manuscript Report no 801, 116 p.

Pope, J.G., 1972. An investigation of the accuracy of virtual population analysis using Cohort analysis. ICNAF Res. Bull. 9: 65-74.

Table 1. Historical monthly catch statistics for the 4RS 3Pn cod stock for the period 1961-1982. The pre-1961 data for 3Pn are too incomplete to allow monthly estimates for the stock as a whole.

MONTHS / YEARS	J	F	M	A	M	J	J	A	S	O	N	D	NK	TOTAL
1961*	364	12,375	44,543	8,745	1,473	5,761	14,341	6,752	2,490	1,408	1,305	453		100,010
1962*	316	12,903	24,720	4,656	1,565	6,951	16,717	11,738	3,513	1,535	1,016	291		85,921
1963*	649	7,661	13,336	2,478	1,623	17,419	14,870	10,698	3,104	1,916	692	300		74,746
1964	1,104	24,423	15,761	6,058	3,106	10,350	12,527	5,853	2,153	1,385	863	651		84,234
1965	792	12,506	21,171	3,698	2,216	5,267	10,422	5,945	3,636	1,359	927	990		68,929
1966	1,965	22,817	8,929	2,516	1,638	8,371	7,482	4,744	2,490	1,146	1,779	1,208		65,085
1967	7,872	7,028	14,792	8,447	2,017	7,525	12,664	5,232	7,154	3,315	1,356	1,909	1	79,312
1968	725	7,980	22,799	9,061	3,087	10,717	17,216	9,400	4,914	1,781	1,172	819		89,671
1969	875	4,654	9,675	4,220	5,192	10,958	12,103	8,639	7,866	3,557	2,035	1,366		71,140
1970	1,637	25,487	18,115	27,995	4,803	6,020	8,974	3,897	2,130	3,170	1,936	1,301		105,465
1971	845	44,590	7,580	5,250	2,338	5,839	8,420	3,039	2,374	1,616	1,004	915		83,810
1972	1,494	14,961	5,337	7,400	7,334	4,594	6,818	3,296	2,365	1,406	994	212	2,026	58,237
1973	16,472	10,556	7,586	4,826	3,235	5,860	5,125	4,145	2,365	1,459	1,016	567	2,593	65,805
1974	12,995	10,753	5,959	5,665	6,231	5,021	6,235	5,396	2,214	1,331	1,009	479	3,148	66,436
1975	8,232	19,486	2,702	2,616	5,316	5,122	5,042	4,488	2,767	1,267	819	704	1,672	60,233
1976	15,637	15,204	3,610	3,437	7,071	6,930	6,978	4,310	3,348	2,286	1,537	578	6,055	76,981
1977	11,143	8,603	3,790	11,312	10,057	7,368	8,133	5,780	3,361	1,751	1,814	454		73,566
1978	20,754	6,307	5,161	3,156	6,717	9,796	13,255	7,000	2,836	1,979	1,309	236		78,506
1979	15,543	4,273	6,475	6,647	8,517	12,890	12,085	8,660	2,971	2,449	1,816	451		82,777
1980	5,280	8,965	9,925	8,087	7,147	14,096	23,158	10,719	5,687	2,773	1,311	431		97,579
1981	9,156	15,368	3,170	3,763	12,835	17,257	16,344	10,343	5,676	2,550	1,172	277		97,911
1982+	1,846	10,354	11,918	4,247	9,550	12,023	18,503	5,711	5,439	1,591	433	32	21,780	103,427

* Incomplete data. Some statistics reported for div. 3P only.

\+ Preliminary statistics.

Table 2. Historical catch statistics for the 4RS 3Pn cod stock by division for the major participants involved in the fishery during the period 1954-1982.

3Pn

COUNTRIES / YEARS	CAN-N	CAN-M	CAN-Q	FR-M	FR-SPM	SPAIN	PORT.	OTHERS	TOTAL
1954									NK
1955									NK
1956									NK
1957									NK
1958									NK
1959*	4,901			651		59	1,162		6,773
1960*	5,181		2	3,694		1,428	976		11,281
1961*	5,728		42	8,515		15,551	8,282	100	38,218
1962*	8,022		3	3,807		9,310	3,506		24,648
1963*	8,076		65	2,148		5,764	4,139	12	20,204
1964	8,502			2,015		1,663	2,116	836	15,132
1965	8,344		2	5,206	277	1,466	1,009	431	16,735
1966	6,876		2	3,470	450	1,675	559	592	13,624
1967	4,546			6,622		2,512	1,273	5,475	20,428
1968	5,640			3,207	13	2,223	680	146	11,909
1969	4,763			47	5	102			4,917
1970	4,930			90	1	184			5,205
1971	6,661				26	167	990		7,844
1972	6,521			2,687	3	269	877		10,357
1973	5,885			1,008		515	3,841	51	11,300
1974	2,941		8	3,913	557	1,507	4,149	938	14,013
1975	2,758		18	2,612	295		538	12	6,233
1976	6,041		56	1,452	280			636	8,465
1977	7,109		247	167	42				7,565
1978	6,271		34	497					6,802
1979	10,208	151		557					10,916
1980	8,150	174		271	204				8,799
1981	11,191	60	3	2,869	1,006				15,130
1982+	14,824	153	(3)	382					(15,362)

* Incomplete data. Some statistics reported from div. 3P only.

\+ Preliminary statistics (Québec catch is estimated).

4R

COUNTRIES / YEARS	CAN-N	CAN-M	CAN-Q	FR-M	FR-SPM	SPAIN	PORT.	OTHERS	TOTAL
1954		16,571		14,050			1,598	7	32,226
1955	15,631	252		20,642		46	9,628	35	46,234
1956	15,635	4,076		10,568		14	8,737	32	39,062
1957	25,133	1,974		13,512			7,252	1	47,872
1958	18,832	7,139		30,037		314	15,334		71,656
1959	26,099	7,174		7,099		392	166		40,930
1960	17,302	5,937		21,970	4	7,331	13,418	604	66,566
1961	15,737	2,904		18,706		2,374	7,626		47,347
1962	21,984	3,482		7,043		5,451	10,142		48,102
1963	26,799	2,984		1,628		3,019	7,936		42,366
1964	20,162	3,197		16,264	38	6,806	12,492	1	58,960
1965	20,037	1,715		10,084	70	219	11,714		43,839
1966	21,202	1,813		9,735		1,097	10,361		44,208
1967	22,398	3,511		10,460	1	3,806	6,180	3,585	49,941
1968	32,810	4,415		22,963	169	2,779	6,905		70,041
1969	27,342	8,784		16,318	165	2,693	1,330		56,632
1970	23,337	11,337		30,303	120	8,053	17,993	3	91,146
1971	17,095	2,237		24,363	68	5,451	17,144	4	66,362
1972	11,664	3,348		10,608	3	1,357	8,144	2,459	37,583
1973	13,222	1,086		16,525	109	502	11,232	418	43,094
1974	16,348	5,538		11,679	395		5,302	184	39,446
1975	14,897	2,727		13,206	625		9,879	235	41,569
1976	20,004	6,648		15,392	918		9,034	4,034	56,030
1977	9,907	25,568		15,815	2,097				53,387
1978	35,376	6,290		13,252	2,022				56,940
1979	37,096	4,423	1,038	11,040	2,171				55,768
1980	52,358	2,822	582	8,275	646				64,683
1981	49,479	2,291	775	7,466	1,167				61,178
1982+	51,086	2,024	(765)	11,659					(65,534)

\+ Preliminary statistics (Québec catch is estimated).

Table 2. Continued.

4S

COUNTRIES / YEARS	CAN-N	CAN-M	CAN-Q	FR-M	FR-SPM	SPAIN	PORT.	OTHERS	TOTAL
1954		2,928							2,928
1955	1	4,487		30			717		5,235
1956	11	2,318		319					2,648
1957	23	5,417		254			119		5,813
1958	157	7,597		38			20		7,812
1959	7	10,224				126			10,357
1960		16,057		18		428			16,503
1961	1	13,814		495		74	61		14,445
1962		13,171							13,171
1963	22	11,794					360		12,176
1964	45	10,077		18			2		10,142
1965	108	7,241					1,006		8,355
1966	88	6,777		57			331		7,253
1967	50	6,859		22			1,092	920	8,943
1968	146	7,558			17				7,721
1969	307	9,241			1	42			9,591
1970	443	8,175				198	298		9,114
1971	182	9,161			1	259		1	9,604
1972	189	9,130		27		338	613		10,297
1973	434	7,942					911	2,124	11,411
1974	366	8,976		86	4		1,474	2,077	12,983
1975	381	7,808		401	16		2,400	1,425	12,431
1976	726	9,231		22	23		1,099	1,385	12,486
1977	171	12,426		10	7				12,614
1978	229	14,535							14,764
1979	47	851	15,194		1				16,093
1980	1,437	1,417	21,243						24,097
1981	336	229	21,038						21,063
1982+	131	1,388	(21,012)						(22,531)

+ Preliminary statistics (Québec catch is estimated).

TOTAL

COUNTRIES / YEARS	CAN-N	CAN-M	CAN-Q	FR-M	FR-SPM	SPAIN	PORT.	OTHERS	TOTAL
1954									NK
1955									NK
1956									NK
1957									NK
1958									NK
1959*	31,007	17,398		7,750		577	1,328		58,060
1960*	22,483	21,996		25,682	4	9,187	14,394	604	94,350
1961*	21,466	16,760		27,716		17,999	15,969	100	100,010
1962*	30,006	16,656		10,850		14,761	13,648		85,921
1963*	34,897	14,843		3,776		8,783	12,435	12	74,746
1964	28,709	13,274		18,297	38	8,469	14,610	837	84,234
1965	28,489	8,958		15,290	347	1,685	13,729	431	68,929
1966	28,166	8,592		13,262	450	2,772	11,251	592	65,085
1967	26,994	10,370		17,104	1	6,318	8,545	9,980	79,312
1968	38,596	11,973		26,170	199	5,002	7,585	146	89,671
1969	32,412	18,025		16,365	171	2,837	1,330		71,140
1970	28,710	19,512		30,393	121	8,435	18,291	3	105,465
1971	23,938	11,398		24,363	95	5,877	18,134	5	83,810
1972	18,374	12,478		13,322	6	1,964	9,634	2,459	58,237
1973	19,541	9,028		17,533	109	1,017	15,984	2,593	65,805
1974	19,655	14,516		15,678	956	1,507	10,925	3,199	66,436
1975	18,036	10,553		16,219	936		12,817	1,672	60,233
1976	26,771	15,935		16,866	1,221		10,133	6,055	76,981
1977	17,187	38,241		15,992	2,146				73,566
1978	41,876	20,859		13,749	2,022				78,506
1979	47,351	5,425	16,232	11,597	2,172				82,777
1980	61,945	4,413	21,825	8,546	850				97,579
1981	61,006	2,580	21,816	10,335	2,173				97,911
1982+	66,041	3,565	21,780	12,041					103,427

* Incomplete data. Some statistics reported for div. 3P only.

+ Preliminary statistics (Québec catch is estimated).

Table 3. Historical catch statistics for the 4RS 3Pn cod stock broken down into gear categories for the period 1954-1982 (DV, dory vessels; T, traps; GN, gill nets; HL hand lines; LL, long lines; IN MISC, inshore miscellaneous; DS danish seines; PT, pair trawls; ST, shrimp trawls; OT, otter trawls.)

3Pn

GEARS / YEARS	DV	T	GN	HL	LL	IN. MISC.	DS	PT	ST	OT	TOTAL
1954											NK
1955											NK
1956											NK
1957											NK
1958											NK
1959*				1,016		3,885				1,872	6,773
1960*				1,246		3,934				6,101	11,281
1961*					2,083	3,645		15		32,475	38,218
1962*					2,988	5,005		29		16,626	24,648
1963*	53				3,062	4,922				12,167	20,204
1964	558				3,416	4,875		178		6,105	15,132
1965	113				2,702	4,815		142		8,963	16,735
1966	16				2,499	2,854		559		7,696	13,624
1967					657	3,463	27	33		16,248	20,428
1968	33				85	5,031	12	306		6,442	11,909
1969			444	270	3,630	39	10	24		500	4,917
1970		46	643	675	3,378		5	62		396	5,205
1971			364	217	5,574	134		52		1,503	7,844
1972	17	10	181	98	5,593	20	545	176		3,717	10,357
1973	1,405		175	110	5,431	97	174	356		3,552	11,300
1974	128		297	52	2,460	915	58	1,507		8,596	14,013
1975			61	152	2,418	12	6			3,584	6,233
1976		9	163	225	4,467	636	163			2,802	8,465
1977		37	73	163	5,679		119			1,494	7,565
1978		7	34	103	5,323		17			1,318	6,802
1979		25	40	116	7,338		181			3,216	10,916
1980			13	83	6,443		18			2,242	8,799
1981		4	3	72	7,560		28			7,463	15,130
1982+		1	12	121	7,765		13			7,450	15,362

* Incomplete data. Some statistics reported for div. 3P only.

\+ Preliminary statistics.

4R

GEARS / YEARS	DV	T	GN	HL	LL	IN. MISC.	DS	PT	ST	OT	TOTAL
1954						16,413				15,813	32,226
1955	55					15,620				30,559	46,234
1956	3,057					15,316				20,689	39,062
1957	581			196		25,034				22,061	47,872
1958	2,619			2,261		18,075				48,701	71,656
1959	2,183			575		25,809				12,363	40,930
1960				108		17,135				49,323	66,566
1961					113	15;640	71			31,523	47,347
1962					104	21,486	105			26,407	48,102
1963					55	26,620	181			15,510	42,366
1964					123	18,789	185			39,863	58,960
1965					152	16,766	145		26,776		43,839
1966					201	15,532	53	38	28,384		44,208
1967					207	21,015	47		28,672		49,941
1968			289		1,138	26,130	60	508	41,916		70,041
1969		3,943	10,905	1,622	4,405	2,646	198	5	32,908		56,632
1970	184	2,340	4,319	1,673	5,489	1,962	239	225	5	74,710	91,146
1971		3,786	3,718	1,295	3,076	436	247		224	53,580	66,362
1972		1,606	2,835	1,107	1,115	2,851	16	24	168	27,861	37,583
1973		2,007	3,154	1,007	2,564	3,050	120	84	545	30,563	43,094
1974		1,789	5,182	1,714	1,358	666	223		28,514		39,446
1975		2,032	6,462	1,413	978	490	221		29,973		41,569
1976		1,572	7,671	1,445	527	4,238	155		40,422		56,030
1977		2,414	7,866	1,591	1,429	147	147		39,793		53,387
1978		4,103	13,235	1,749	2,462		233		35,158		56,940
1979		3,071	11,479	3,138	5,031		311		32,738		55,768
1980		8,354	11,607	2,380	7,768		467		34,107		64,683
1981		5,408	5,796	2,096	8,936	327	384		38,231		61,178
1982+		7,418	9,414	2,121	7,128	330	335		38,788		65,534

\+ Preliminary statistics.

Table 3. Continued.

48

GEARS / YEARS	DV	T	GN	HL	LL	IN. MISC.	DS	PT	ST	OT	TOTAL
1954						2,892				36	2,928
1955						4,423				812	5,235
1956						2,197				451	2,648
1957						5,217				596	5,813
1958				107		7,114				591	7,812
1959				434		9,368				555	10,357
1960				5,159		2,037				9,307	16,503
1961		1,133			2,229	3,830	5			7,248	14,445
1962		2,777	80	3,974	2,057		24			4,259	13,171
1963		3,197		3,570	432		15			4,962	12,176
1964					486	6,166				3,490	10,142
1965		3,950	24		320		1		4,060		8,355
1966		1,656	973		441	798			3,385		7,253
1967		2,470	1,618	710	305				3,840		8,943
1968		3,070	1,127	623	333				2,568		7,721
1969		2,312	1,960	607	262				4,450		9,591
1970	21	1,789	846	771	251				215	5,221	9,114
1971		2,410	963	503	565			1	309	4,853	9,604
1972		2,040	1,418	511	511				242	5,575	10,297
1973		885	1,774	470	402	2,248			477	5,155	11,411
1974		200	2,326	402	976	2,064			7,009		12,977
1975		579	2,072	2,337	136	1,425			5,882		12,431
1976		992	2,900	353	46	1,385			6,810		12,486
1977		861	4,089	303	36		2		7,323		12,614
1978		2,178	3,626	194	28		2		8,736		14,764
1979		1,043	6,578	467	148				7,857		16,093
1980			1,376		1,796	11,658			9,267		24,097
1981		3	364		2,678	12,554		51	5,953		21,603
1982+		13	1		4	15,422			7,071		22,531

+ Preliminary statistics.

TOTAL

GEARS / YEARS	DV	T	GN	HL	LL	IN. MISC.	DS	PT	ST	OT	GRAND TOTAL
1954											NK
1955											NK
1956											NK
1957											NK
1958											NK
1959*											NK
1960*				6,513		23,106				64,731	94,350
1961*		1,133			4,425	23,115	76	15		71,246	100,010
1962*		2,777	80	3,974	5,149	26,491	129	29		47,292	85,921
1963*	53	3,197		3,570	3,549	31,542	196			32,639	74,746
1964	558				4,025	29,830	185	178		49,458	84,234
1965	113	3,950	24		3,174	21,581	146	142	39,799		68,929
1966	16	1,656	973		3,141	19,184	53	597	39,465		65,085
1967		2,470	1,618	710	1,169	24,478	74	33	48,760		79,312
1968	33	3,070	1,416	623	1,556	31,161	72	814	50,926		89,671
1969		6,255	13,309	2,499	8,297	2,685	208	29	37,858		71,140
1970	205	4,175	5,808	3,119	9,118	1,962	244	287	220	80,327	105,465
1971		6,196	5,045	2,015	9,215	570	247	53	533	59,936	83,810
1972	17	3,656	4,434	1,716	7,219	2,871	561	200	410	37,153	58,237
1973	1,405	2,892	5,103	1,587	8,397	5,395	294	440	1,022	39,270	65,805
1974	128	1,989	7,805	2,168	4,794	3,645	281	1,507	44,119		66,436
1975		2,611	8,595	3,902	3,532	1,927	227		39,439		60,233
1976		2,573	10,734	2,023	5,040	6,259	318		50,034		76,981
1977		3,312	12,028	2,057	7,144	147	268		48,610		73,566
1978		6,288	16,895	2,046	7,813		252		45,212		78,506
1979		4,139	18,097	3,721	12,517		492		43,811		82,777
1980		8,354	12,996	2,463	16,007	11,658	485		45,616		97,579
1981		5,415	6,163	2,168	19,174	12,881	463		51,647		97,911
1982+		7,432	9,427	2,242	14,897	15,752	348		53,329		103,427

* Incomplete data. Some statistics reported for div. 3P only.

+ Preliminary statistics.

Table 4. Preliminary catch statistics for cod in NAFO divisions 3Pn, 4R and 4S in 1982.
*estimated from weekly quota reports

Subdivision 3Pn
CANADA - NEWFOUNDLAND

GEAR TYPE	J	F	M	A	M	J	J	A	S	O	N	D	NK	TOTAL
TRAPS	0	0	0	0	0	0	1	0	0	0	1	0		1
FIXED GILL NETS	0	0	0	0	0	6	2	0	3	0	1	0		12
HAND LINES	1	0	10	9	57	8	19	7	3	3	1	3		121
LINE TRAWLS	203	796	1697	1267	681	375	364	962	674	451	249	0		7719
DANISH SEINES	0	0	0	0	6	0	2	3	0	2	0	0		13
OTTER TRAWLS	6	411	6267	206	14	12	10	5	7	1	16	3		6958
TOTAL	210	1207	7974	1482	758	401	398	977	687	457	267	6		14824

CANADA - MARITIME

GEAR TYPE	J	F	M	A	M	J	J	A	S	O	N	D	NK	TOTAL
LINE TRAWLS	0	9	37	0	0	0	0	0	0	0	0	0		46
OTTER TRAWLS	0	0		103	0	1	1	0	1	0	1	0		107
TOTAL	0	9	37	103	0	1	1	0	1	0	1	0		153

CANADA - QUEBEC*

GEAR TYPE	J	F	M	A	M	J	J	A	S	O	N	D	NK	TOTAL
OTTER TRAWLS													3	3
TOTAL													3	3

FRANCE

GEAR TYPE	J	F	M	A	M	J	J	A	S	O	N	D	NK	TOTAL
OTTER TRAWLS	0	77	119	186	0	0	0	0	0	0	0	0		382
TOTAL	0	77	119	186	0	0	0	0	0	0	0	0		382
DIVISION TOTAL	210	1293	8130	1771	758	402	399	977	688	457	268	6	3	15362

Table 4. continued.

Division 4R
CANADA - NEWFOUNDLAND

GEAR TYPE	J	F	M	A	M	J	J	A	S	O	N	D	NK	TOTAL
TRAPS	0	0	0	1	22	2092	4308	967	28	0	0	0		7418
FIXED GILL NETS	14	1	0	18	805	1272	5252	1036	684	308	24	0		9414
HAND LINES	0	0	2	0	130	499	661	511	167	104	35	12		2121
LINE TRAWLS	19	66	10	86	517	1405	1029	1749	1733	443	69	2		7128
DANISH SEINES	0	0	0	0	25	69	138	31	39	29	4	0		335
OTTER TRAWLS	0	1614	1481	531	5765	6081	6682	339	1994	171	9	3		24670
TOTAL	33	1681	1493	636	7264	11418	18070	4633	4645	1055	141	17		51086

CANADA - MARITIME

GEAR TYPE	J	F	M	A	M	J	J	A	S	O	N	D	NK	TOTAL
OTTER TRAWLS	26	543	98	347	950	19	7	16	2	3	11	0		2024
TOTAL	26	543	98	347	952	19	7	16	2	3	11	0		2024

CANADA - QUEBEC *

GEAR TYPE	J	F	M	A	M	J	J	A	S	O	N	D	NK	TOTAL
MISCELLANEOUS INSHORE													330	330
OTTER TRAWLS													435	435
TOTAL													765	765

FRANCE

GEAR TYPE	J	F	M	A	M	J	J	A	S	O	N	D	NK	TOTAL
OTTER TRAWLS	1559	6500	2083	1420	97	0	0	0	0	0	0	0		11659
TOTAL	1559	6500	2083	1420	97	0	0	0	0	0	0	0		11659
DIVISION TOTAL	1618	8724	3674	2403	8313	11437	18077	4649	4647	1058	152	17	765	65534

Table 4. continued.

Division 4S
CANADA - NEWFOUNDLAND

GEAR TYPE	J	F	M	A	M	J	J	A	S	O	N	D	NK	TOTAL
TRAPS	0	0	0	0	0	13	0	0	0	0	0	0		13
FIXED GILL NETS	0	0	0	0	0	1	0	0	0	0	0	0		1
LINE TRAWLS	0	0	0	0	0	0	0	0	2	0	0	0		2
OTTER TRAWLS	0	113	0	0	0	1	0	0	1	0	0	0		115
TOTAL	0	113	0	0	0	15	0	0	3	0	0	0		131

CANADA - MARITIME

GEAR TYPE	J	F	M	A	M	J	J	A	S	O	N	D	NK	TOTAL
LINE TRAWLS						2								2
OTTER TRAWLS	18	224	114	73	479	167	27	85	101	76	13	9		1386
TOTAL	18	224	114	73	479	169	27	85	101	76	13	9		1388

CANADA - QUEBEC *

GEAR TYPE	J	F	M	A	M	J	J	A	S	O	N	D	NK	TOTAL
MISCELLANEOUS INSHORE													15442	15442
OTTER TRAWLS													5570	5570
TOTAL													21012	21012
DIVISION TOTAL	18	337	114	73	479	184	27	85	104	76	3	9	21012	22531

Table 5. Commercial landings in 1982 in NAFO area 3Pn, 4RS by Quebec based vessels estimated from the weekly quota reports.

Qtr	Fixed gear	Mobile gear	Total
1	0	0	0
2	254	3015	3269
3	10406	2226	12632
4	5112	767	5879
Total	15772	6008	21780

Table 6: Results of the ANOVA from the regression of ln catch rate of cod on dummy variables in NAFO divisions 4RS 3Pn. For type definition, see Table 7.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R.....0.864
MULTIPLE R SQUARED.....0.747

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	1.569E2	1.569E2	
REGRESSION	41	8.379E2	2.044E1	77.807
TYPE 1	8	1.644E2	2.055E1	78.243
TYPE 2	8	9.881E1	1.235E1	47.023
TYPE 3	2	2.370E1	1.185E1	45.121
TYPE 4	23	4.823E1	2.097E0	7.983
RESIDUALS	1081	2.839E2	2.627E-1	
TOTAL	1123	1.279E3		

Table 7. Regression coefficients for grouped categories from the Multiplicative model (Gavaris, 1980) for Cod in NAFO area 3Pn, 4RS.

TYPE 1:	Country-gear	ln power	Std. error	No obs.
	Intercept	-0.471	0.102	1123
	Can M OT-4 + Can Q OT-4	0.000	0.000	197
	Can M OT-5	0.399	0.064	120
	Can N OT-4	-0.201	0.057	238
	Can N OT-5	0.127	0.074	93
	Port OT-6 + Spain OT-6	0.676	0.065	264
	Port OT-7	0.974	0.095	41
	Span OT-4	0.495	0.144	40
	Can Q OT-2	-1.268	0.088	51
	Can Q OT-3	-0.861	0.082	79
TYPE 2:	Month	ln power	Std. error	No obs.
	January	0.000	0.000	108
	February	-0.016	0.067	192
	March	-0.157	0.072	152
	April	-0.349	0.070	179
	May	-0.407	0.072	137
	June-August	-0.593	0.079	119
	July-Sept.	-0.687	0.081	104
	Oct.-Dec.	-0.792	0.089	85
	November	-0.766	0.104	47
TYPE 3:	Division	ln power	Std. error	No obs.
	3Pn	0.000	0.000	243
	4R	0.279	0.049	583
	4S	0.107	0.067	297

Table 8: Mean catch rates indices of cod in NAFO divisions 4RS 3Pn relative to 1977 (ie. 1977 = 1.0, under heading relative power) and standardized to Can. M-Q/OT4/January/3Pn (heading catch rate) and their respective standard errors. The proportion (Prop.) of the total catch that was used to compute catch rates is also indicated.

YEAR	TOTAL CATCH	PROP.	RELATIVE POWER MEAN	RELATIVE POWER S.E.	CATCH RATE MEAN	CATCH RATE S.E.	EFFORT
1959	58060	0.347	1.051	0.202	0.708	0.072	81998
1960	94350	0.021	1.343	0.175	0.747	0.150	126354
1961	100010	0.237	1.752	0.211	0.954	0.139	104829
1962	85921	0.423	1.618	0.201	1.245	0.162	69002
1963	74746	0.385	1.933	0.250	1.149	0.160	65042
1964	84234	0.251	1.726	0.215	1.373	0.197	61331
1965	68929	0.345	1.721	0.192	1.226	0.171	56237
1966	65085	0.293	1.538	0.165	1.222	0.155	53240
1967	79312	0.256	1.274	0.124	1.093	0.132	72571
1968	89671	0.210	1.520	0.143	0.906	0.099	99006
1969	71140	0.296	1.343	0.126	1.080	0.120	65875
1970	105465	0.138	1.257	0.110	0.954	0.107	110539
1971	83810	0.500	0.885	0.087	0.893	0.097	93844
1972	58237	0.508	0.986	0.096	0.629	0.073	92600
1973	65805	0.267	0.881	0.094	0.700	0.083	93978
1974	66436	0.260	1.230	0.114	0.626	0.075	106099
1975	60233	0.335	0.918	0.086	0.874	0.095	68912
1976	76981	0.209	0.937	0.075	0.652	0.073	118041
1977	73566	0.150	1.000	0.000	0.666	0.069	110490
1978	78506	0.208	0.940	0.079	0.668	0.069	117592
1979	82777	0.159	1.103	0.103	0.784	0.084	105618
1980	97579	0.119	1.179	0.100	0.837	0.089	116561
1981	97911	0.077	1.838	0.189	1.306	0.150	74943
1982	103427	0.078	2.220	0.219	1.577	0.185	65597

AVERAGE C.V. FOR THE MEAN:0.102

AVERAGE C.V. FOR THE MEAN:0.122

Table 9. Commercial sampling for 4RS, 3Pn cod in 1982.

Gear	Qtr	Country	Month	Div.	Length meas.	Otoliths
A) Mobile gear						
OT	1	Fra (M)	Feb.	3Pn	124	51
		Fra (M)	March	3Pn	1544	
		Can (N)	March	3Pn	493	25
		Fra (P)	March	3Pn	208	93
		Fra (M)	Jan.	4R	4146	280
		Fra (M)	Feb.	4R	13589	
		Fra (P)	Feb.	4R	1546	92
		Can (M)	Feb.	4R	646	--
		Can (N)	Feb.	4R	1732	451
		Can (N)	March	4R	2504	
		Can (M)	Feb.	4S	305	--
	2	Fra (P)	April	3Pn	206	--
		Fra (M)	April	4R	4125	--
		Fra (P)	April	4R	1748	184
		Can (M)	April	4R	729	--
		Can (M)	May	4R	800	--
		Can (N)	May	4R	5421	253
		Can (M)	June	4S	353	150
	3	Can (M)	July	4S	640	
		Can (M)	Aug.	4S	102	41
		Can (M)	Sep.	4S	209	
	4	Can (M)	Oct.	4S	200	--
ST	2	Can (M)	May	4R	800	--
		Can (N)	May	4R	1759	113
		Can (M)	May	4S	214	--
		Can (M)	June	4S	600	--
MT	2	Can (M)	April	4R	400	--
		Can (M)	May	4S	400	--

Table 9. (cont'd).

Gear	Qtr	Country	Month	Div.	Length meas.	Otoliths
B) Fixed gear						
LT	2	Can (N)	March	3Pn	3557	363
		Can (N)	March	4R	1680	689*
	3	Can (N)	June	4R	596	484*
	4	Can (M)	Sep.	4S	216	66
GN	2	Can (N)	May	4R	2192	689*
	3	Can (N)	June	4R	2785	484*
HL	3	Can (N)	June	4R	582	484*

*Combined LT, GN and HL.

Table 10: Age specific catch ($x10^6$), variance of catch and average weights (kg) of commercial landings of cod in NAFO divisions 4RS 3Pn grouped by gear and quarters.

	Inshore - 2			Inshore - 3			Otter trawl - 1			Otter trawl - 2, 3, 4		
Age	Weight	Catch	Var (catch)	Weight	Catch	Var (catch)	Weight	Catch	Var (catch)	Weight	Catch	Var (catch)
3	0.391	10	18.016	0.428	4	17.988	0.340	27	46.133	0.500	79	499.118
4	0.601	198	484.709	0.902	2120	104109.021	0.562	521	4436.837	0.831	906	24526.947
5	1.010	917	4295.278	1.091	5845	230048.502	0.961	4812	78082.810	1.130	7065	166218.246
6	1.364	821	5578.529	1.506	3849	200565.615	1.241	3694	86085.473	1.413	3522	138351.832
7	1.697	1109	6394.873	1.799	2825	123464.488	1.627	3575	60493.228	1.751	4683	143664.941
8	2.053	922	4876.522	2.416	1731	59976.444	2.018	1739	27080.100	2.085	2736	81078.888
9	2.579	411	2034.881	3.265	931	24936.077	2.426	532	6766.170	2.599	828	20342.496
10	3.160	262	1056.531	4.387	665	14521.099	3.711	136	450.517	3.305	414	8631.268
11	3.643	77	256.534	5.738	302	3222.239	4.052	42	130.112	5.012	45	243.317
12	6.253	11	9.005	7.634	93	702.448	4.336	24	55.139	5.822	31	139.207
13	4.905	9	10.203	7.265	78	592.112	8.782	2	1.084	3.939	8	55.466
14	7.156	12	14.840	6.838	58	437.000	4.470	4	7.655	3.954	5	23.339
15	7.651	6	4.265	6.897	6	39.749	6.358	3	3.450	6.219	13	71.334
16	4.945	6	8.007	9.749	23	170.052						
17	7.623	1	1.015	9.706	28	212.406				6.219	6	41.353
18	7.235	1	0.878	14.931	16	78.713	7.894	2	4.126			
19				16.624	7	0.006						
20	1.897	1	0.488				17.930	1				

Table 11: Age specific catch ($x10^6$), variance of catch and average weights (kg) of commercial landings of cod in NAFO divisions 4RS 3Pn during 1982.

AGE	WEIGHT	CATCH	VAR(CATCH)	STD.ERROR	COEF.VAR
2	0.107				
3	0.453	131	692.247	26.31	0.20
4	0.821	4088	159060.746	398.82	0.10
5	1.068	20340	570043.593	755.01	0.04
6	1.388	12970	512802.349	716.10	0.06
7	1.721	13305	397799.241	630.71	0.05
8	2.145	7779	206049.138	453.93	0.06
9	2.791	2949	64406.301	253.78	0.09
10	3.804	1612	29368.210	171.37	0.11
11	5.169	508	4587.793	67.73	0.13
12	6.691	173	1078.765	32.84	0.19
13	6.776	106	784.678	28.01	0.26
14	6.611	87	575.033	23.98	0.28
15	6.682	30	141.482	11.89	0.40
16	8.707	32	212.059	14.56	0.46
17	9.003	39	303.423	17.42	0.45
18	13.601	22	99.703	9.99	0.46
19	16.624	8	0.007	0.08	0.01
20	13.361	2	0.582	0.76	0.42

Table 12: Catch at age ($x10^6$) and average weights (kg) at age matrices used in the sequential population analyses of cod in NAFO divisions 4RS 3Pn.

4RS 3PN COD CATCH AT AGE 7/ 6/83

	1974	1975	1976	1977	1978	1979	1980	1981	1982
4	1471	2924	1984	3141	3134	4110	2620	13173	4088
5	5121	4380	14724	10292	11159	16209	15975	10711	20340
6	11537	6446	7570	15321	17601	13751	20475	21606	12970
7	7353	9048	3775	7653	10346	12890	10821	14094	13305
8	10987	3392	5867	2882	2432	4669	6029	5088	7779
9	3902	5808	2016	3041	1164	1416	1262	1988	2949
10	2722	1647	2584	949	1188	643	398	682	1612
11	704	815	1717	612	460	473	217	162	508
12	273	870	600	292	382	252	268	98	173
13	147	64	196	171	194	112	68	76	106
14	48	52	90	49	106	83	88	42	87
15	40	150	27	11	17	28	24	37	30

4RS 3PN COD AVERAGE WEIGHTS AT AGE 7/ 6/83

	1974	1975	1976	1977	1978	1979	1980	1981	1982
4	0.57	0.57	0.57	0.57	0.68	0.55	0.52	0.72	0.82
5	0.86	0.86	0.86	0.86	0.87	0.89	0.82	0.96	1.07
6	1.30	1.30	1.30	1.30	1.30	1.32	1.29	1.31	1.39
7	1.79	1.79	1.79	1.79	1.84	1.78	1.76	1.78	1.72
8	2.43	2.43	2.43	2.43	2.56	2.41	2.37	2.22	2.15
9	3.06	3.06	3.06	3.06	3.01	3.15	3.42	2.76	2.79
10	3.60	3.60	3.60	3.60	2.88	3.57	4.17	3.96	3.80
11	4.06	4.06	4.06	4.06	3.23	3.79	4.43	5.33	5.17
12	4.48	4.48	4.48	4.48	3.96	4.51	3.78	6.97	6.69
13	4.89	4.89	4.89	4.89	4.12	5.23	4.98	6.20	6.78
14	5.30	5.30	5.30	5.30	5.84	4.74	3.93	7.80	6.61
15	5.71	5.71	5.71	5.71	9.33	5.43	7.00	3.91	6.68

Table 13. Historical partial recruitment estimates for age 4-6 cod in NAFO area 3Pn, 4RS

Age \ Year	1974	1975	1976	1977	1978	1979	1980	1981	Mean 74-80
4	0.06	0.07	0.04	0.05	0.04	0.06	0.08	0.16	0.06
5	0.33	0.26	0.48	0.22	0.29	0.31	0.38	0.32	0.32
6	0.56	0.74	0.66	0.70	0.65	0.58	0.75	0.97	0.67

Table 14. Results of the regression analyses of fishing mortality vs effort and biomass and exploitable biomass versus standardized catch rates for cod in NAFO areas 4RS 3Pn using years 1974-1982.

Terminal F	0.200	0.250	0.300	0.350	0.400	0.450	0.500
F vs Effort							
R :	0.550	0.557	0.621	0.642	0.650	0.634	0.630
Intercept :	0.072	0.099	0.160	0.209	0.262	0.314	0.370
Slope x 10^{-6} :	3.423	3.340	3.080	2.790	2.450	2.090	1.630
1982 residual:	0.096	0.069	0.062	0.043	0.023	0.014	0.023
Total Biomass vs CPUE							
R :	0.953	0.951	0.948	0.945	0.903	0.935	0.910
Intercept :	-288996	-162370	-77933	-17604	51893	62885	91072
Slope :	823915	617726	480260	161979	126712	251127	205301
1982 residual:	39829	28334	20663	15172	4243	7819	5227
Exploitable Biomass vs CPUE							
R :	0.951	0.947	0.940	0.928	0.909	0.880	0.830
Intercept :	-100369	-39439	1146	30139	51893	68113	373557
Slope :	274830	208999	161979	126712	99287	77353	23107
1982 residual:	15571	10543	6947	4243	2132	434	1

Table 15: Results from the cohort analysis for cod in NAFO divisions 4RS 3Pn using a fishing mortality $F_T = 0.3$ for the fully recruited ages (7+).

4RS3PN COD POPULATION NUMBERS 7/ 6/83

	1974	1975	1976	1977	1978	1979	1980	1981	1982
4	51482	95705	114533	109467	160815	164419	134205	313530	252765
5	34642	40819	75711	91977	86782	128829	130896	107507	244777
6	48253	23729	29456	48664	65992	60954	90810	92714	78327
7	20896	29067	13595	17267	25980	38103	37462	55822	56358
8	27692	10455	15611	7715	7212	11909	19533	20880	32950
9	10955	12731	5490	7473	3709	3705	5525	10537	12491
10	5917	5439	5168	2671	3366	1983	1752	3382	6828
11	2474	2381	2963	1893	1328	1681	1042	1074	2152
12	584	1388	1212	872	996	671	949	657	733
13	344	231	350	450	450	470	321	534	449
14	579	149	132	109	213	193	283	202	369
15	104	431	75	26	45	79	83	152	127
4+	203922	222525	264296	288583	356888	412995	422861	606991	688327
5+	152441	126820	149762	179116	196072	248576	288656	293461	435562
6+	117798	86001	74052	87139	109291	119747	157760	185954	190784
7+	69545	62272	44595	38475	43299	58794	66950	93240	112457

4RS3PN COD MEAN BIOMASS 7/ 6/83

	1974	1975	1976	1977	1978	1979	1980	1981	1982
4	26188	48631	58621	55681	98077	80862	62589	199970	186231
5	24804	29953	52627	67309	63605	96755	90782	88463	226706
6	49209	23652	29668	46986	66011	63701	92754	95674	89693
7	26988	38747	18578	20616	33191	49469	49928	77227	76282
8	46783	18730	26843	13291	13479	20033	34543	36249	55749
9	24106	25670	11973	15758	8297	8213	14933	23595	27426
10	13984	14674	11739	6919	6990	5221	5777	10774	20419
11	7630	7029	6940	5672	3109	4852	3697	4758	8755
12	1707	3374	3444	2857	2774	2142	2728	3808	3858
13	1140	865	1009	1549	1250	1929	1279	2766	2396
14	2657	570	347	382	788	616	830	1260	1917
15	417	1785	307	103	296	308	438	467	668
4+	225614	213682	222097	237123	297866	334102	360278	545010	700099
5+	199426	165051	163476	181442	199789	253241	297690	345040	513868
6+	174622	135098	110849	114133	136184	156486	206908	256577	287162
7+	125413	111445	81181	67147	70173	92784	114153	160903	197467

4RS3PN COD FISHING MORTALITIES 7/ 6/83

	1974	1975	1976	1977	1978	1979	1980	1981	1982
4	0.032	0.034	0.019	0.032	0.022	0.028	0.022	0.048	0.018
5	0.178	0.126	0.242	0.132	0.153	0.150	0.145	0.117	0.096
6	0.307	0.357	0.334	0.428	0.349	0.287	0.287	0.298	0.201
7	0.492	0.422	0.367	0.673	0.580	0.468	0.385	0.327	0.300
8	0.577	0.444	0.537	0.532	0.466	0.568	0.417	0.314	0.300
9	0.500	0.702	0.521	0.597	0.426	0.549	0.291	0.234	0.300
10	0.710	0.407	0.804	0.499	0.494	0.444	0.289	0.252	0.300
11	0.378	0.475	1.023	0.442	0.483	0.372	0.262	0.182	0.300
12	0.726	1.179	0.792	0.462	0.551	0.536	0.374	0.180	0.300
13	0.638	0.365	0.967	0.545	0.648	0.306	0.266	0.171	0.300
14	0.096	0.488	1.410	0.688	0.797	0.646	0.420	0.262	0.300
15	0.547	0.480	0.502	0.611	0.537	0.493	0.383	0.310	0.300
7+	0.541	0.501	0.559	0.600	0.539	0.490	0.381	0.307	0.300

Table 16: Projections of population abundance and biomass and catch biomass assuming a catch of 100,000 T (the TAC) in 1983 and $F_{0.1}$ = 0.2 in 1984.

POPULATION NUMBERS

	1982	1983	1984
4	160000	112000	112000
5	244777	127306	90604
6	78327	182062	97768
7	56378	52452	130366
8	32950	34199	35159
9	12491	19985	22924
10	6828	7576	13396
11	2152	4141	5078
12	733	1305	2776
13	449	445	875
14	369	272	298
15	127	224	183
4+	595581	541968	511428
5+	435581	429968	399428
6+	190804	302662	308824
7+	112477	120600	211056

POPULATION BIOMASS (AVERAGE)

	1982	1983	1984
4	117285.17	82757.93	82757.93
5	226706.04	119719.74	85204.98
6	89692.45	215141.32	115531.14
7	76313.97	74356.65	184810.24
8	55748.58	60602.16	62303.44
9	27424.57	45956.07	52715.22
10	20418.16	23727.98	41957.00
11	8755.49	17646.81	21639.64
12	3859.14	7197.27	15306.79
13	2395.62	2484.62	4889.38
14	1919.82	1483.66	1623.73
15	667.54	1232.78	1005.06
4+	631186.55	652307.01	669744.57
5+	513901.38	569549.07	586986.63
6+	287195.34	449829.33	501781.66
7+	197502.89	234688.02	386250.51

CATCH BIOMASS

	1982	1983	1984
4	3352	1193	993
5	21764	9160	5440
6	18028	34239	15281
7	22885	17555	35970
8	16725	14308	11965
9	8228	10850	10124
10	6126	5602	8058
11	2626	4166	4156
12	1157	1699	2940
13	719	587	939
14	575	350	312
15	200	291	193
4+	102385	100000	96370
5+	99033	98807	95377
6+	77269	89647	89937
7+	59241	55408	74656

FISHING MORTALITY

	1982	1983	1984
4	0.029	0.014	0.012
5	0.096	0.077	0.064
6	0.201	0.161	0.134
7	0.300	0.241	0.200
8	0.300	0.241	0.200
9	0.300	0.241	0.200
10	0.300	0.241	0.200
11	0.300	0.241	0.200
12	0.300	0.241	0.200
13	0.300	0.241	0.200
14	0.300	0.241	0.200
15	0.300	0.241	0.200
4+	0.130	0.129	0.121

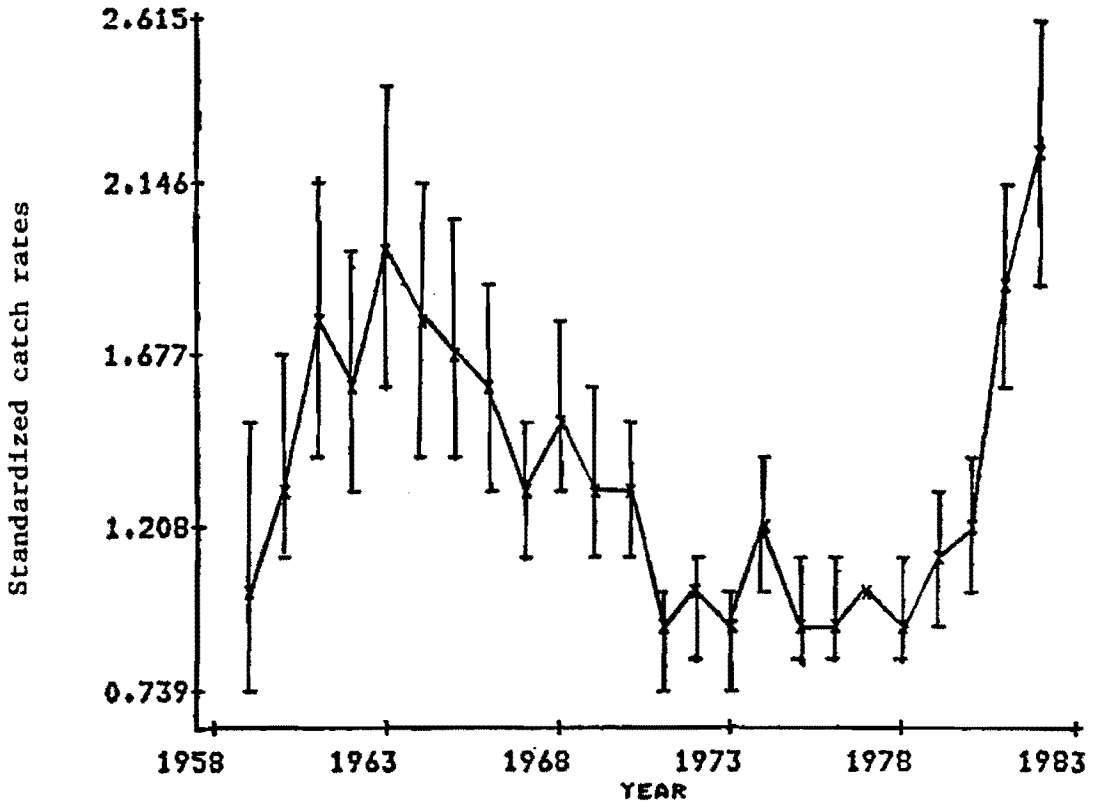
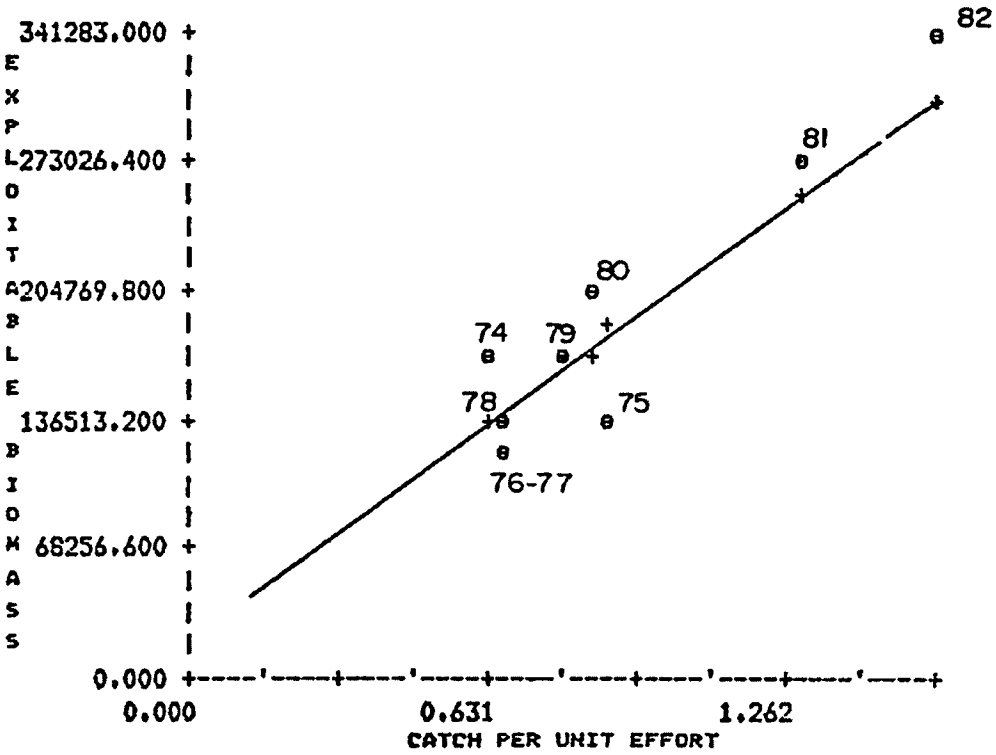


Figure 1: Relative (to 1977) catch rate indices of cod in NAFO divisions 4RS 3Pn (± 90% confidence limits) from 1959 to 1982.

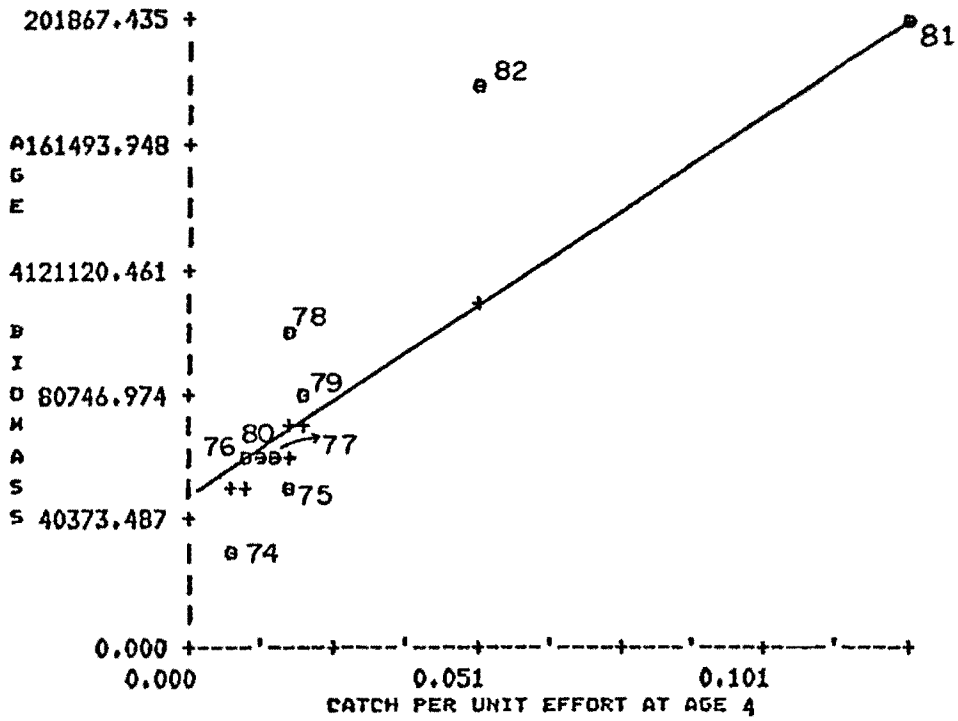
Figure 2: 4RS 3PN COD REGRESSION ANALYSIS OF EXPLOITABLE BIOMASS VS CATCH PER UNIT EFFORT AT TERMINAL F_T =0.3, AGES CONSIDERED: 4 TO 15.
OBSERVED = θ, PREDICTED = +



RESULTS OF THE REGRESSION ANALYSIS 7/ 6/83

YEARS	INDEPENDENT	ALL YEARS OBSERVED	ALL YEARS PREDICTED	ALL YEARS RESIDUALS	1982 EXCLUDED OBSERVED	1982 EXCLUDED PREDICTED	1982 EXCLUDED RESIDUALS
1974	0.626	167891	131980	¯35911	167891	134757	¯33135
1975	0.874	139795	183812	44017	139795	180807	41012
1976	0.652	121416	137414	15998	121416	139584	18168
1977	0.666	123507	140340	16833	123507	142184	18677
1978	0.668	140639	140758	119	140639	142555	1917
1979	0.784	171278	165002	¯6276	171278	164095	¯7183
1980	0.837	209104	176079	¯33025	209104	173936	¯35168
1981	1.306	265311	274100	8789	265311	261023	¯4288
1982	1.577	341283	330739	¯10544	341283	311344	¯29939
R:			9.40^{E-1}			8.47^{E-1}	
INTERCEPT:			1.15^{E3}			1.85^{E4}	
SLOPE:			2.09^{E5}			1.86^{E5}	

Figure 3: 4RS 3PN COD REGRESSION ANALYSIS OF AGE 4 BIOMASS VS CATCH PER UNIT EFFORT AT AGE 4 AT TERMINAL F_T =0.3, AGES CONSIDERED: 4 TO 4,
OBSERVED = θ, PREDICTED = +



RESULTS OF THE REGRESSION ANALYSIS 7/ 6/83

YEARS	INDEPENDENT	ALL YEARS OBSERVED	ALL YEARS PREDICTED	ALL YEARS RESIDUALS	1982 EXCLUDED OBSERVED	1982 EXCLUDED PREDICTED	1982 EXCLUDED RESIDUALS
1974	0.009	26188	59532	33344	26188	53827	27639
1975	0.019	48631	73758	25127	48631	66651	18020
1976	0.010	58621	61353	2732	58621	55468	¯3152
1977	0.015	55681	68545	12864	55681	61952	6271
1978	0.017	98077	71367	¯26710	98077	64496	¯33582
1979	0.021	80862	76128	¯4733	80862	68787	¯12074
1980	0.012	62589	63684	1096	62589	57570	¯5018
1981	0.127	199970	223764	23793	199970	201867	1897
1982	0.051	186231	118719	¯67512	186231	107179	¯79052

	ALL YEARS	1982 EXCLUDED
R:	8.62E¯1	9.37E¯1
INTERCEPT:	4.74E4	4.29E4
SLOPE:	1.39E6	1.26E6