NOT TO BE CITED WITHOUT PRIOR
REFERENCE TO THE AUTHOR(S)

Northwest Atlantic Fisheries Organization

Serial No. N4669 **NAFO SCR Doc. 02/57**

SCIENTIFIC COUNCIL MEETING – JUNE 2001

An Update on the Status of the Cod stock in NAFO Divisions 3NO.

by

B. P. Healey, D. E. Stansbury, E. F. Murphy, and P. A. Shelton

Department of Fisheries & Oceans, Science, Oceans & Environment Branch
NW Atlantic Fisheries Centre, P.O. Box 5667
St. John's, NF, Canada, A1C 5X1

Abstract

This report provides a interim monitoring report of all 2001 catch and survey information on the NAFO Div. 3NO cod stock since the last full assessment. All abundance and biomass indices were either stable or decreasing. Mean numbers per tow from Canadian spring and fall surveys decreased for the second consecutive year. Catches from this stock have increased steadily during the six years of moratoria, from a total of 172 t in 1995 to 1309 t in 2001. There are no indications of stock recovery. Estimates of fully recruited fishing mortality for 2001 are quite high for a stock under moratorium.

Introduction

In the last assessment of this stock (Stansbury et al, 2000), it was concluded that "*…recruitment has been almost non-existent since the 1990 year-class*", and "*Low spawner biomass, low recruitment and high fishing mortality on age 4 and 5 point to poor prospects for this stock in the medium term. Recovery will require a number of relatively strong year-classes that survive to maturity, rebuilding the spawner biomass. It will also require that by-catch mortality should be kept at an extremely low level.*". In this paper we review the data pertinent to this fishery that has become available since the last assessment of the stock.

Since this assessment, additional surveys have been completed, and catch statistics from the 2001 fishery are available.

Nominal catch and catch at age

Catches from this stock peaked at 227,000 t in 1967, mainly by the former USSR and Spain, but declined steadily thereafter to 15,000 t in 1978. From 1979 to 1991, catches ranged from 20,000 to 50,000 t (Table 1, Fig. 1a). Continued reduction in the recommended TAC reduced catches to a level of about 10,000 t in 1993. The directed fishery on this stock was suspended in February 1994 and the stock has been under NAFO moratorium since that time. In 1998 the Scientific Council Report recommended that there should be no directed fishing for cod in Div. 3N and 3O, and that by-catches in fisheries targeting other species should be kept at the lowest possible level.

Landings since 1994 (Figure 1a), which include Canadian surveillance and NAFO Scientific Council estimates (Table 1) have been increasing since the moratorium began from 170 t in 1995 to 1309t in 2001 (Figure 1b). In comparison to 2000, Canadian and Russian catches increased in 2001, whereas the landings by the Spanish and

Portuguese fleets have decreased. The increase in the Canadian catch from 207 t in 2000 to 560 t in 2001 can be attributed to increased by-catches taken in the directed yellowtail fishery (Table 2, Figures 2a, 2b). The catch at age matrix has not been updated.

Research vessel survey data

Canadian research surveys are conducted in the spring and fall of each year. Details of the survey design and the Engels to Campelen gear conversion can be found in Stansbury et al (2001).

Abundance and biomass estimates for these surveys are summarized in Tables (3-6) and plotted for the index strata (strata with depths < 200 fathoms) in Figures (3-10). Abundance and biomass have been extremely low in both Div. 3N and Div. 3O from 1994 onwards. The swept area biomass estimates from index strata surveyed in 3N and 3O combined for 2000 spring and fall were 96,899 t and 55,107 t respectively. In the 2001 surveys, these biomass indices decreased to 45,068 t and 44,610 t, respectively. Comparing the biomass and abundance indices from the Canadian Spring and Fall Surveys, each of the biomass and abundance indices were either stable or have decreased from 2000 to 2001.

The mean numbers per tow at age for the index strata are given in Table 7 for the spring survey and Table 8 for the fall survey, and are plotted in Figure 11 (age aggregated). Both the spring and fall indices have been extremely low in all years after 1993.

Estimates of F_{2001}

By direct calculation, we can compute 2001 fully recruited values of fishing mortality. Given estimates of survivors from the VPA in the last assessment, an assumed PR, catch weights, natural mortality and a fully recruited F, we can compute a projected 2001 yield. The value of F that produces a yield that matches that taken by the 2001 fishery (1309 t) is an approximation to the fully recruited fishing mortality.

Applying a fully-recruited F-value of 0.263 to the PR used in the last assessment, the 2001 "projected yield" will equal 1309t. Similarly, applying a fully-recruited F-value of 0.344 to the PR computed by averaging the 1999 and 2000 fishing mortalities from the last assessment produces the catch taken in 2001.

Such levels of fishing mortality are cause for concern for a stock under moratorium.

Conclusion

Nearly all of the abundance and biomass indices observed in the Canadian Fall and Spring surveys are declining, with no evidence of any strong year-classes since the 1989 cohort. Removals from this stock have increased steadily despite a moratorium on directed fishing. High levels of fishing mortality indicate poor prospects for this stock in the near future.

References

Stansbury, D.E., P.A. Shelton, E.F. Murphy, B.P. Healey and J. Brattey. 2001. An Assessment of the Cod Stock in NAFO Divisions 3NO. NAFO SCR Doc. 01/72, Ser. No. N4450.

Table 1 - Annual Catches of Cod (t) in NAFO Divisions 3NO, 1953-2001.

Year	Canada	Spain	Portugal	USSR	Others	Total	TAC
1953	39884	12633	7919		5761	66197	
1954	17392	88674	24045		4650	134761	
1955	6053	64987	27711		15605	114356	
1956	5363	42624	15505		1390	64882	
1957	9641	51990	21740		6819	90190	
1958	4812	29436	11608		2195	48051	
1959	3687	39994	17730	48	2911	64370	
1960	3408	33972	14347	24204	3746	79677	
1961	5428	32284	9059	22854	3099	72724	
1962	3235	17413	3653	7971	2712	34984	
1963	5079	37632	10004	10184	6843	69742	
1964	2882	37185	8095	9510	6789	64461	
1965	4229	64652	1692	17166	11448	99187	
1966	6501	52533	5070	39023	5792	108919	
1967	3446	77948	9703	118845	16842	226784	
1968	3287	69752	6752	78820	6900	165511	
1969	3664	71160	4940	29173	8768	117705	
1970	4771	67034	3185	28338	8233	111561	
1971	2311	89915	6589	19307	8174	126296	
1972	1736	76324	11537	12198	1579	103374	
1973	1832	42403	7759	27849	586	80429	103000
1974	1360	38338	6602	26911	178	73389	101000
1975	1189	16616	5560	20785	24	44174	88000
1976	2065	9880	2620	8992	726	24283	43000
1977	2532	8827	1742	4041	462	17604	30000
1978	6246	5813	641	1819	199	14718	15000
1979	9938	13782	1140	2446	545	27851	25000
1980	5589	8999	1145	3261	997	19991	26000
1981	6096	13299	1091	3187	671	24344	26000
1982	10185	14361	2466	3985	608	31605	17000
1983	11374	12320	1109	3238	778	28819	17000
1984	8705	13590	1071	3306	431	27103	26000
1985	18179	13682	608	3968	462	36899	33000
1986	18035	23395	6890	1181	1144	50645	33000
1987	18652	15788	4108	764	2307	41619	33000
1988	19727	15889	3927	2973	634	43150	40000
1989	13433	17904	913	108	857	33215	25000
1990	10620	4678	2145	18	11385	28846	18600
1991	12056 [2]	5448	1063	61	10824 [3]	29454 [3]	13600
1992	7859	1927	449	68	2449 [3]	12752 [3]	13600
1993 [1]	5370	3764	525	287	700 [3]	10646 [3]	10200
1994 [1]	47	1783	50		822 [3]	2702 [3]	6000 [4]
1995 [1]	64	29			79 [3]	172 [3]	0 [4]
1996 [1]	99		33		42 [3]	174 [3]	0 [4]
1997 [1]	286	1	96			383	0 [4]
1998 [1]	396		95		56	547	0 [4]
1999 [1]	568	3	322	26		919	0 [4]
2000 [1]	207	200	500	137	6	1050 [3]	0 [4]
2001 [1]	560	87	392	227	44	1309 [5]	0 [4]

[1] Provisional
[2] Figure is 4000 t higher than Canadian Statistics as this is an amount deemed to be misreported as 3L catch.
[3] Includes Canadian Surveillance Estimates and NAFO Scientific Council Estimates
[4] The fishery for cod was suspended in February 1994 and has been under a NAFO moratorium since then.
[5] Includes Scientific Council & NAFO Observer Estimates

Table 2 - Canadian (N) Catches by Directed Species in 2000 & 2001.*

Year	Directed Species	Cod Catch (t)
2000	White Hake	10.591
	Skate	19.809
	G. Halibut	21.425
	Yellowtail	105.704
	Others	14.395
Total		171.924
2001	White Hake	36.127
	Redfish	46.373
	Yellowtail	391.773
	Others	34.381
Total		508.654

*Totals differ slightly from STATLANT 21A data – these totals were updated using a different data source.

Table 3 - Canadian 3N Spring Survey Indices (from index strata only).

Year	Abundance	SE	Biomass	SE
1984	455890	157039	193824	29836
1985	202159	27576	154549	18270
1986	90915	35654	137124	33801
1987	328729	91793	248503	37740
1988	85784	15324	98880	12640
1989	40584	5543	89211	12355
1990	46693	7693	113356	13694
1991	17156	4176	29535	8520
1992	38173	5808	11543	2748
1993	29421	20213	18630	9845
1994	1120	520	715	287
1995	1182	651	432	118
1996	3285	787	1682	553
1997	7905	6106	5090	3438
1998	5328	1582	1720	497
1999	11138	1967	9459	3022
2000	4577	11	2669	1362
2001	8866	3107	6529	1995

Table 4 - Canadian 3O Spring Survey indices (from index strata only).

Year	Abundance	SE	Biomass	SE
1984	190427	23492	200758	26557
1985	85023	12072	150013	18667
1986	163306	92856	180686	57045
1987	549997	118784	545446	107416
1988	143763	39030	181076	34873
1989	67215	10972	114780	32407
1990	68515	10310	113664	14933
1991	785821	669240	96783	35395
1992	63667	22549	61399	21352
1993	537522	271901	215824	92888
1994	20100	13845	25964	11823
1995	5967	1800	14127	3094
1996	21202	4574	21696	4742
1997	6412	1513	8990	3056
1998	31110	12293	80199	36701
1999	69803	14900	61139	11992
2000	73688	14847	94231	47545
2001	24416	3171	38539	6458

Table 5 - Canadian 3N Fall Survey Indices (from index strata only).

Year	Abundance	SE	Biomass	SE
1990	91783	29227	92723	25023
1991	670348	355442	249323	64135
1992	443490	286249	164303	91007
1993	17924	4041	28741	7956
1994	11729	3576	26189	7249
1995	14478	3221	17781	4298
1996	3359	1328	3290	1185
1997	4092	757	7988	1681
1998	9562	2228	8265	3200
1999	33895	9200	20754	5781
2000	25058	7551	21196	5346
2001	26992	4853	19841	4203

Table 6 – Canadian 3O Fall Survey Indices (from index strata only).

Year	Abundance	SE	Biomass	SE
1990	81735	17121	72817	11789
1991	85767	15463	71915	12726
1992	25185	6229	20254	4404
1993	32193	7605	26845	7412
1994	5957	2162	10531	3158
1995	13741	2367	27681	6346
1996	2496	562	3021	1387
1997	4663	916	11555	2467
1998	8388	1598	10177	1753
1999	31880	5651	39849	15974
2000	38743	6086	33912	6737
2001	28424	3443	24769	4051

Table 7- Mean Numbers per Tow from Canadian Spring RV Survey in NAFO Divs. 3NO.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.16	0.37	0.38	5.00	0.18	0.38	0.90	0.57	0.00	0.00	0.00	0.00	0.10	0.06	1.71	4.69	2.15	0.15
2	53.39	9.88	12.77	54.15	26.45	4.77	7.25	147.62	10.07	1.17	0.22	0.76	1.35	0.24	0.16	4.71	6.46	1.88
3	41.57	29.27	3.63	14.13	12.91	10.39	6.77	15.44	9.66	58.27	0.91	0.20	1.65	1.67	0.51	4.55	4.58	2.91
4	21.35	16.14	17.87	19.67	1.02	2.40	3.80	1.59	0.24	53.63	1.63	0.04	0.44	0.58	1.23	0.38	0.69	1.01
5	7.17	2.76	11.53	50.35	0.47	0.34	1.46	0.47	0.11	1.25	1.05	0.15	0.24	0.16	0.52	0.70	0.10	0.26
6	5.04	0.90	2.11	26.41	1.10	0.31	0.25	0.16	0.09	0.68	0.07	0.10	0.57	0.03	0.17	0.30	0.20	0.01
7	1.51	1.03	0.82	7.38	1.13	0.61	0.41	0.07	0.03	0.46	0.12	0.01	0.56	0.09	0.13	0.11	0.29	0.06
8	0.72	0.66	0.58	1.71	0.66	0.52	0.52	0.06	0.03	0.22	0.07	0.02	0.05	0.07	1.35	0.12	0.07	0.07
9	1.36	0.84	0.42	1.63	0.67	0.36	0.61	0.14	0.08	0.05	0.07	0.05	0.04	0.01	1.61	0.42	0.06	0.01
10	1.15	1.18	0.61	0.54	0.75	0.40	0.46	0.12	0.11	0.08	0.02	0.01	0.03	0.02	0.15	0.84	0.57	0.01
11	0.61	0.88	1.02	0.70	0.35	0.51	0.34	0.11	0.13	0.17	0.04	0.01	0.02	0.03	0.03	0.07	1.10	0.16
12	0.25	0.48	0.51	0.60	0.44	0.33	0.34	0.09	0.14	0.12	0.05	0.02	0.00	0.02	0.01	0.03	0.13	0.40
13	0.10	0.23	0.31	0.68	0.69	0.27	0.16	0.12	0.12	0.07	0.07	0.05	0.00	0.01	0.03	0.03	0.02	0.04
14	0.03	0.14	0.15	0.23	0.55	0.39	0.37	0.13	0.10	0.07	0.02	0.02	0.03	0.00	0.00	0.02	0.00	0.02
15	0.05	0.08	0.08	0.21	0.21	0.21	0.44	0.12	0.09	0.09	0.03	0.03	0.02	0.01	0.02	0.01	0.01	0.00
16	0.08	0.08	0.04	0.12	0.11	0.11	0.22	0.18	0.09	0.05	0.01	0.02	0.00	0.00	0.01	0.00	0.02	0.01
17	0.05	0.03	0.04	0.00	0.11	0.09	0.14	0.07	0.06	0.02	0.00	0.00	0.01	0.00	0.00	0.02	0.00	0.00
18	0.01	0.01	0.03	0.01	0.04	0.04	0.06	0.04	0.01	0.01	0.03	0.00	0.00	0.01	0.00	0.00	0.00	0.00
19	0.00	0.02	0.03	0.02	0.03	0.03	0.05	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1+	134.60	64.98	52.93	183.54	47.87	22.46	24.55	167.10	21.17	116.42	4.42	1.49	5.11	3.01	7.64	17.00	16.45	7.00

Table 8 - Mean Numbers per Tow from Canadian Fall RV Survey in NAFO Divs. 3NO.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.07	0.06
1	18.89	14.87	0.41	1.30	0.00	1.15	0.08	0.03	1.67	4.44	2.12	0.34
2	6.15	129.66	49.65	0.72	0.62	1.02	0.74	0.10	0.29	5.01	3.77	2.64
3	3.25	4.36	65.00	3.63	0.28	0.46	0.29	0.40	0.20	2.52	4.75	4.70
4	3.56	2.19	4.70	3.59	0.96	0.20	0.06	0.33	0.32	0.13	1.81	2.55
5	1.73	2.73	1.02	0.30	1.32	0.94	0.01	0.14	0.11	0.37	0.20	0.98
6	0.37	1.33	0.61	0.27	0.16	1.64	0.02	0.06	0.06	0.30	0.24	0.07
7	0.29	0.37	0.18	0.18	0.04	0.11	0.02	0.28	0.01	0.08	0.11	0.16
8	0.38	0.31	0.03	0.10	0.06	0.05	0.01	0.28	0.16	0.04	0.03	0.06
9	0.40	0.53	0.03	0.02	0.01	0.06	0.00	0.05	0.22	0.12	0.01	0.02
10	0.24	0.37	0.07	0.02	0.01	0.05	0.00	0.04	0.03	0.55	0.03	0.02
11	0.20	0.45	0.00	0.06	0.03	0.00	0.00	0.00	0.01	0.04	0.24	0.00
12	0.09	0.33	0.06	0.04	0.03	0.02	0.00	0.00	0.00	0.00	0.01	0.05
13	0.15	0.27	0.12	0.04	0.02	0.02	0.01	0.00	0.00	0.00	0.01	0.01
14	0.07	0.21	0.03	0.05	0.06	0.00	0.01	0.01	0.00	0.02	0.00	0.00
15	0.16	0.12	0.03	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.21	0.38	0.02	0.02	0.03	0.00	0.01	0.01	0.00	0.02	0.00	0.00
17	0.07	0.16	0.03	0.01	0.02	0.00	0.00	0.00	0.00	0.03	0.00	0.00
18	0.02	0.06	0.08	0.02	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00
19	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.01		0.01	0.00	0.00
1+	36.26	158.70	122.07	10.43	3.67	5.72	1.26	1.74	3.09	13.68	13.33	11.60

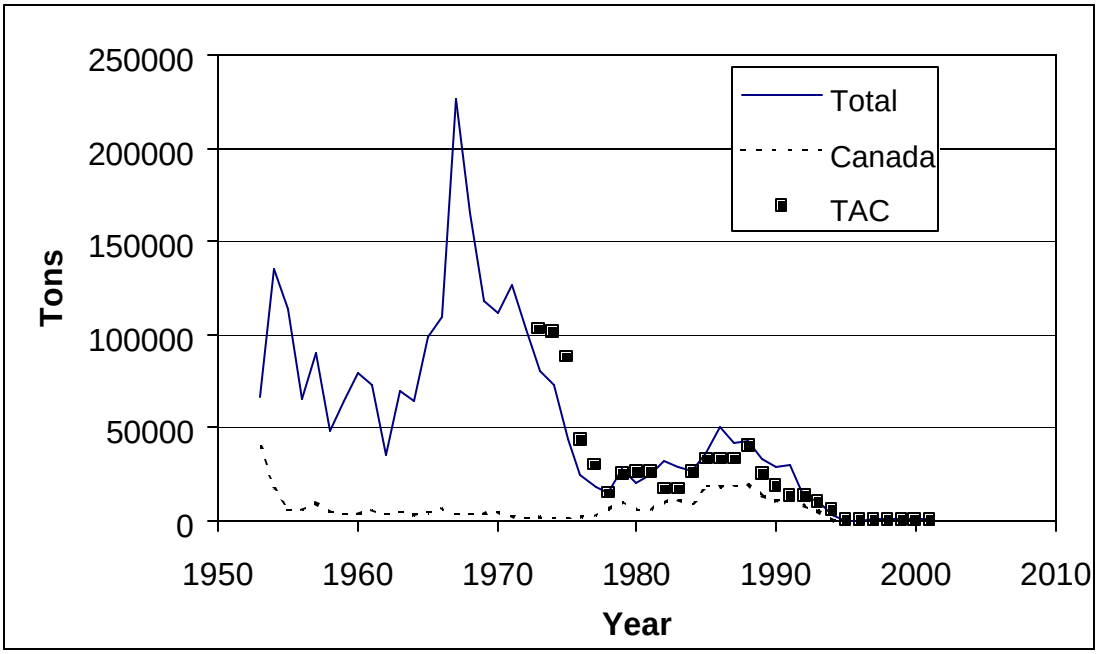

Figure 1a- Landings of Cod (t) in NAFO Divisions 3NO from 1953-2001.

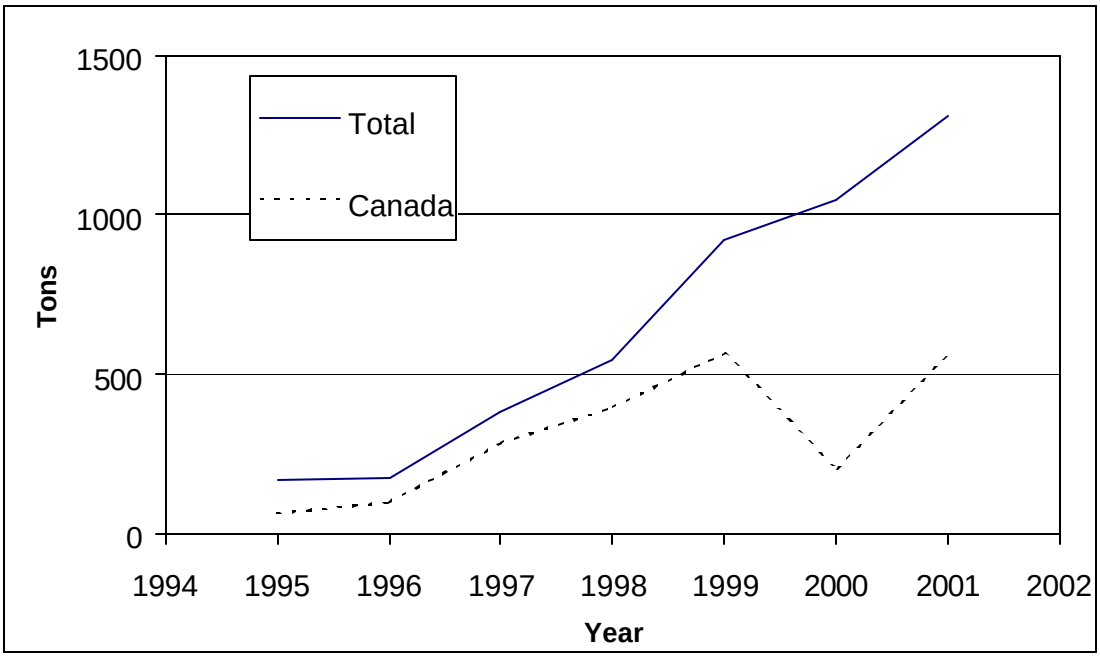

Figure 1b- Landings of Cod (t) in NAFO Divisions 3NO during NAFO moratorium (declared July 1994).

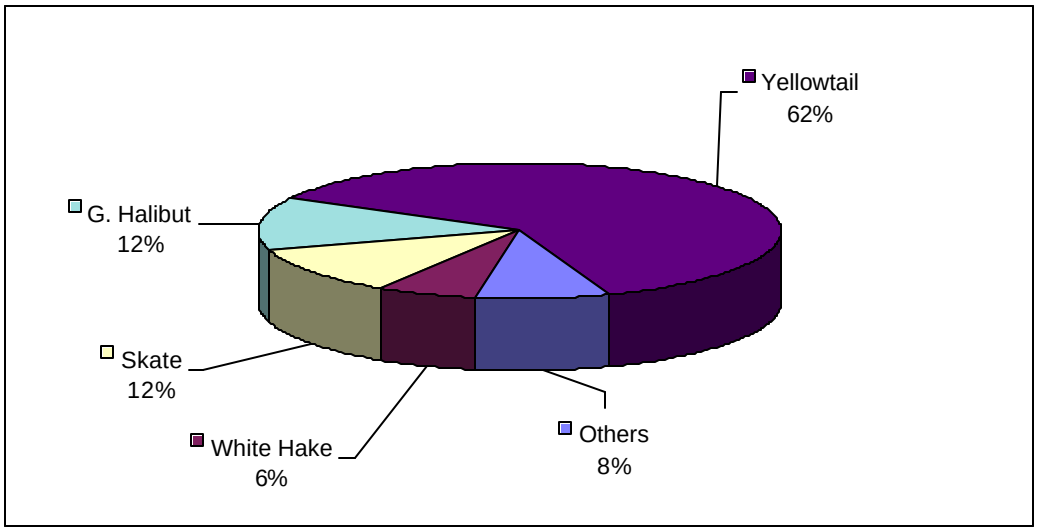

Figure 2a - Canadian (N) catches by directed species in 2000.

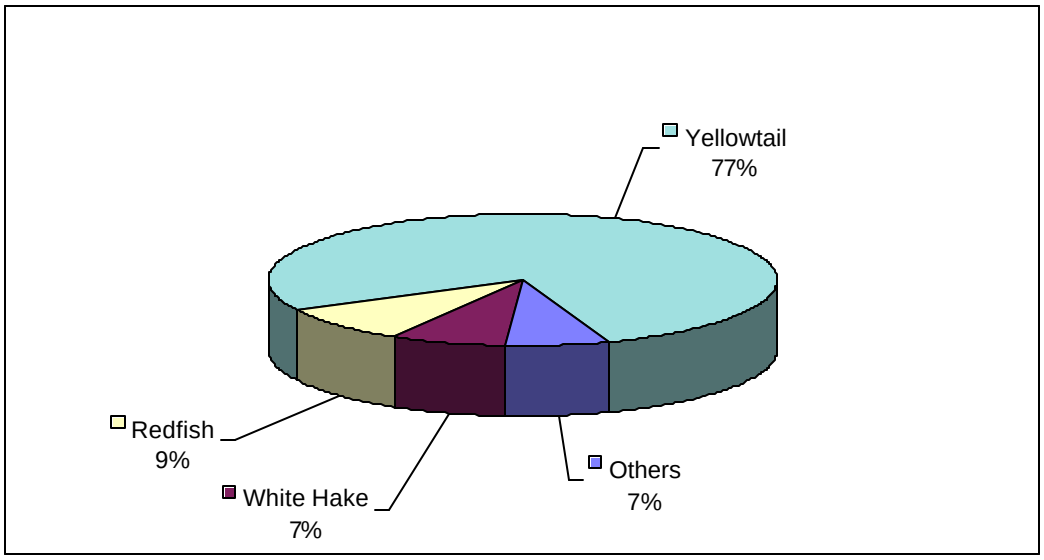

Figure 2b - Canadian (N) catches by directed species in 2001.

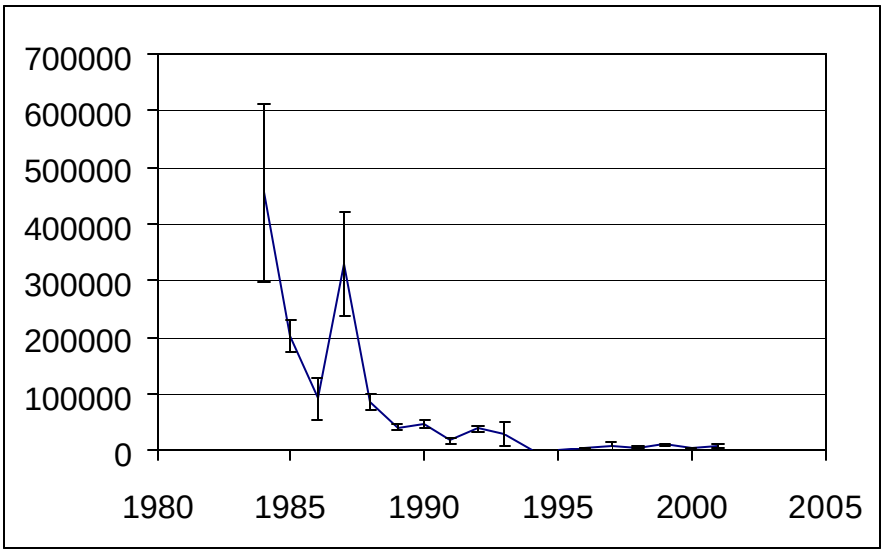

Figure 3 - 3N Spring Abundance Index.

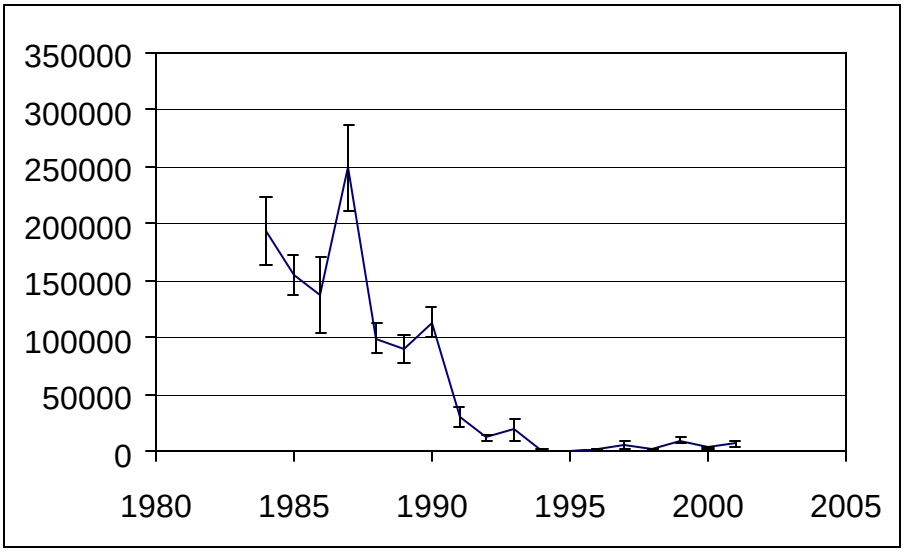

Figure 4 - 3N Spring Biomass Index.

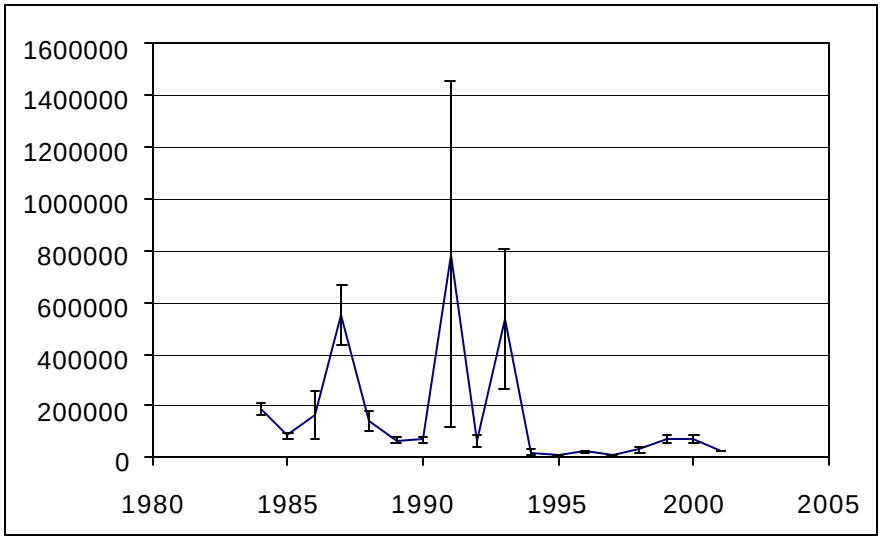

Figure 5 - 3O Spring Abundance Index.

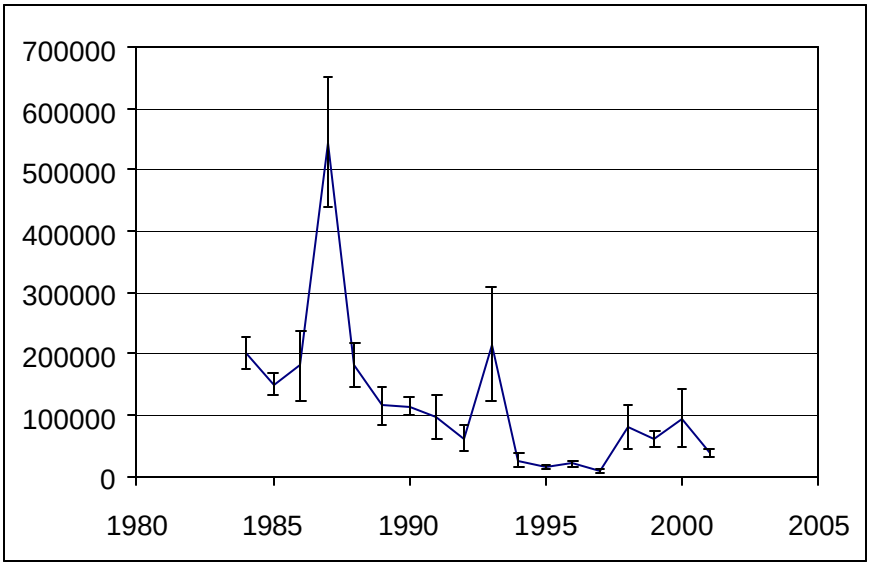

Figure 6 - 3O Spring Biomass Index.

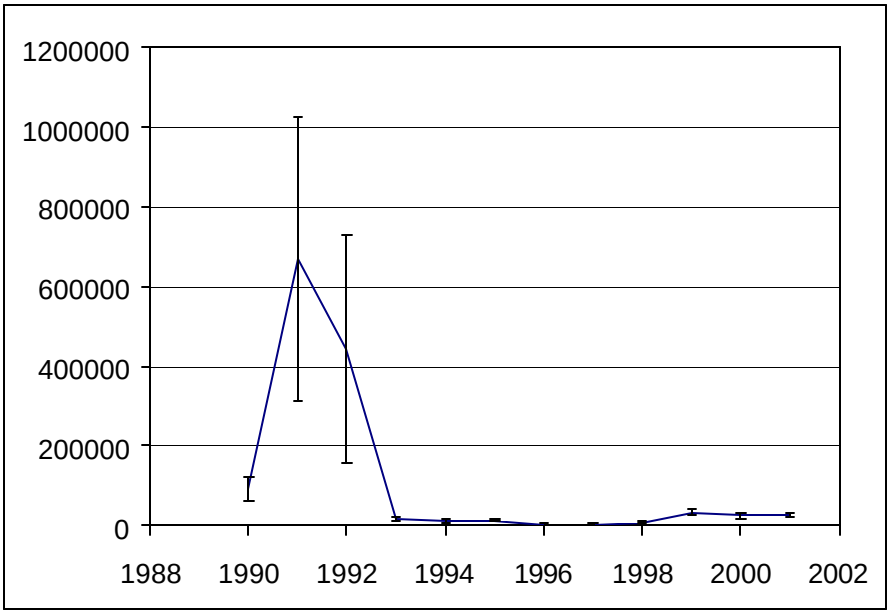

Figure 7 - 3N Fall Abundance Index.

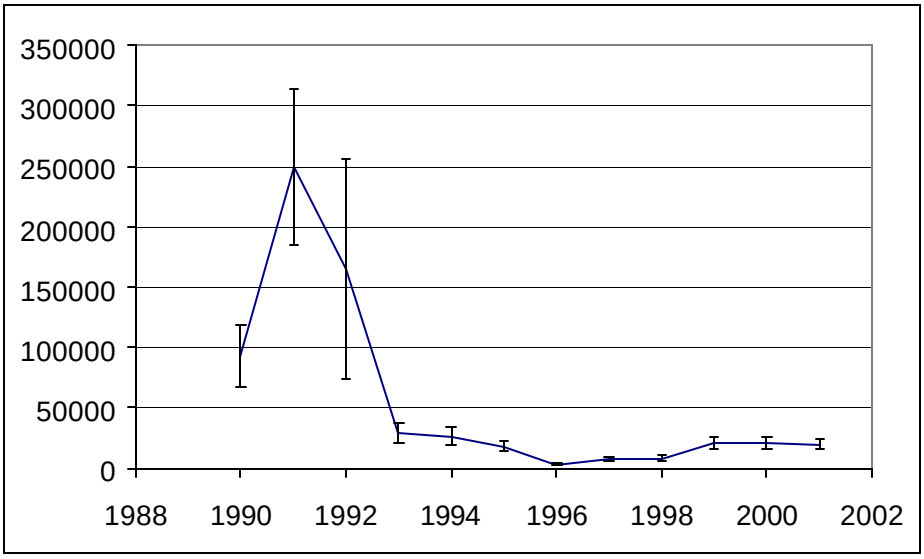

Figure 8 - 3N Fall Biomass Index.

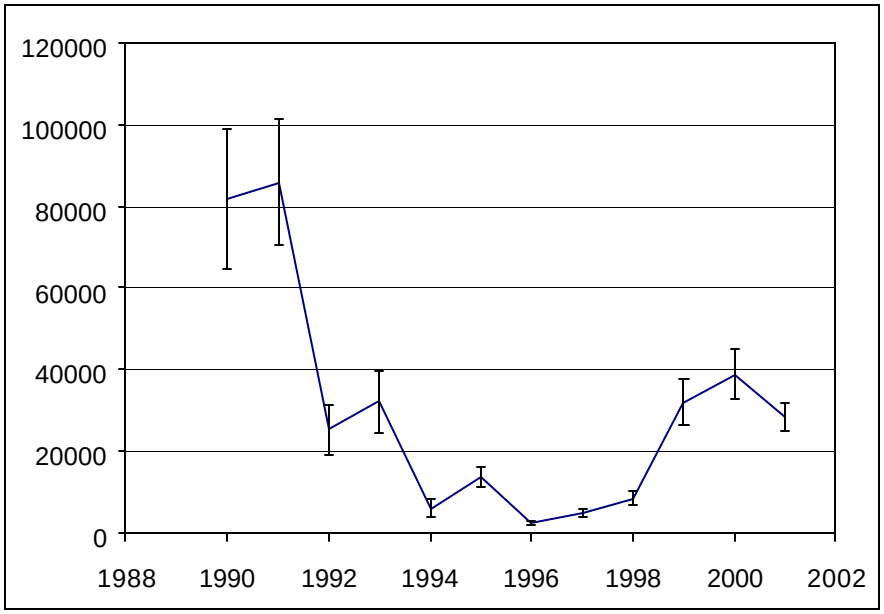

Figure 9 – 3O Fall Abundance Index.

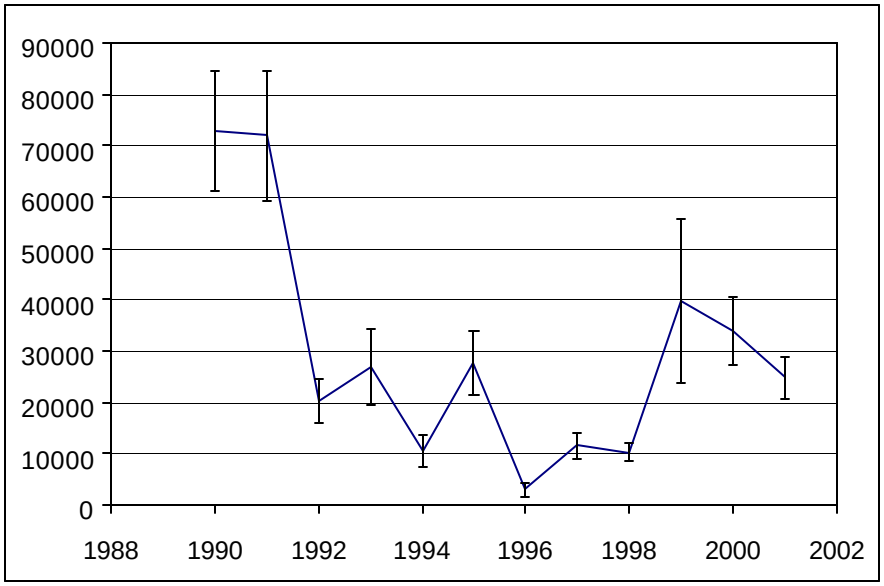

Figure 10 – 3O Fall Biomass Index.

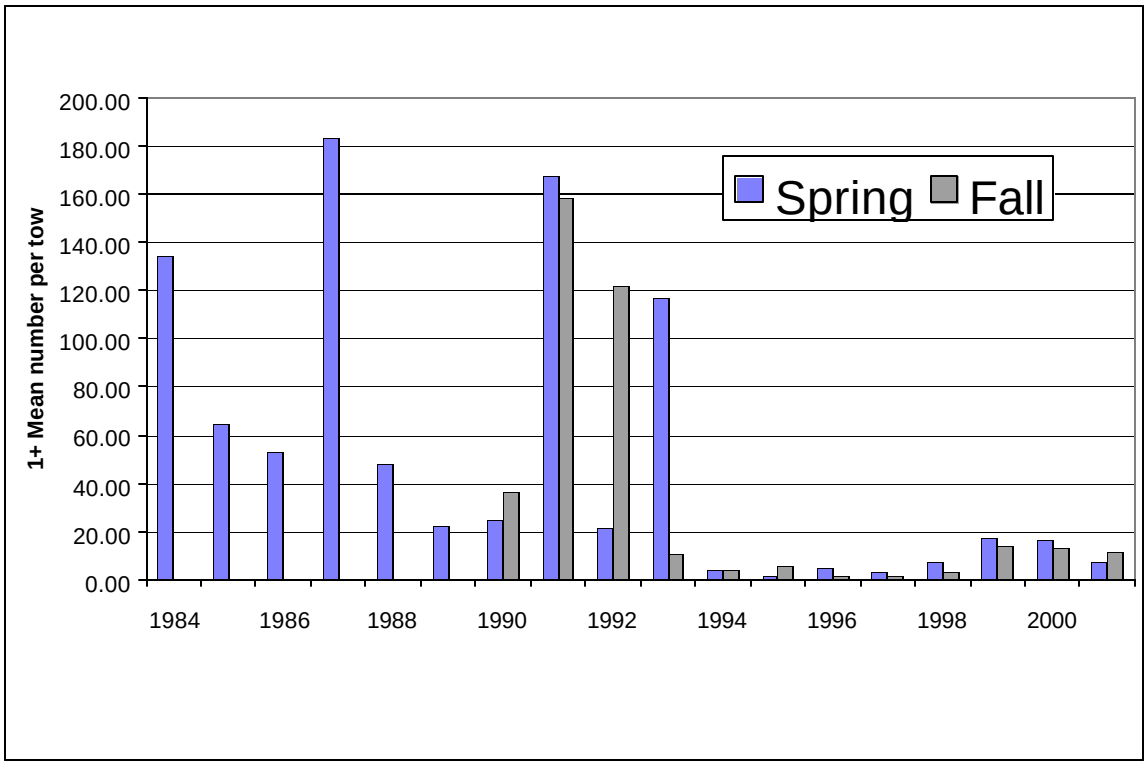

Figure 11 - Mean Numbers per Tow from Canadian RV Surveys in NAFO Divs. 3NO.