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An Assessment of the Status of the Redfish in NAFO Division 3O

by

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Abstract

There are two species of redfish, the deep sea redfish (*Sebastes mentella)* and the Acadian redfish (*Sebastes fasciatus*) that have been commercially fished and reported collectively in fishery statistics in Div. 3O. Nominal catches have ranged between 3 000 tons and 35 000 tons since 1960 (Table 1, Fig. 1). Up to 1986 catches averaged 13 000 tons, increased to 27 000 tons in 1987 with a further increase to 35 000 tons in 1988, exceeding TACs by 7 000 tons and 21 000 tons respectively. Catches declined to 13 000 tons in 1989, increased gradually to about 16 000 tons in 1993 and declined further to about 3 000 tons in 1995, partly due to reductions in foreign allocations within the Canadian zone since 1993. Catches increased to 14 000 tons by 1998, declined to 10 000 tons in 2000 and increased to 20 000 in 2001. The 2002 catch was at 17 000 tons. Assessment of this stock has been primarily based on research data due to variable commercial indices and fleets prosecuting different areas of the stock. It is difficult to reconcile year to year changes in seasonal research vessel (RV) surveys, but generally, the spring survey biomass index suggests the stock may have increased since the early-1990s, fluctuated over 100 000 tons from 1994 to 1999 and declined to 2002. The autumn surveys, while more stable in the early-1990s, generally supports this pattern. RV surveys do not adequately sample fish greater than 25 cm which up to 1997 have generally comprised the main portion of the fishery, which, makes it is difficult to interpret survey estimates in relation to what is happening to the stock as a whole. The fishery since 1998 appeared to target the relatively strong 1988 year-class that has grown sufficiently to exceed the small fish protocol of 22 cm. There is concern that there has been little sign in recent surveys of size groups smaller than 17 cm despite using a shrimp trawl, which is very effective at catching small fish.

Introduction

There are two species of Sebastes that have been commercially fished in Div. 3O, the deep sea redfish (*Sebastes mentella)* and the Acadian redfish (*Sebastes fasciatus*). The external characteristics are very similar, making them difficult to distinguish, and as a consequence they are reported collectively as "redfish" in the commercial fishery statistics. Redfish in Div. 3O have been subject to management regulation since 1974 within Canada's 200 mile Exclusive Economic Zone (EEZ). About 8% of the inhabitable redfish area within Div. 3O lies within the NAFO Regulatory Area (NRA) which is currently only regulated by mesh restrictions. In addition to Catch regulation within Canada, a small fish protocol at 22 cm was implemented in 1995.

Nominal Catches and TACs

Nominal catches have ranged between 3 000 tons and 35 000 tons since 1960 (Table 1, Fig. 1). Up to 1986 catches averaged 13 000 tons, increased to 27 000 tons in 1987 with a further increase to 35 000 tons in 1988, exceeding TACs by 7 000 tons and 21 000 tons, respectively. Catches declined to 13 000 tons in 1989, increased gradually to about 16 000 tons in 1993 and declined further to about 3 000 tons in 1995, partly due to reductions in foreign allocations within the Canadian zone since 1993. Catches increased to 14 000 tons by 1998, declined to 10 000 tons in 2000 and increased to 20 000 in 2001. The 2002 catch was at 17 000 tons

The large catches in 1987 and 1988 were due mainly to increased activity in the NRA by South Korea and non-Contracting parties (NCPs), primarily by Panama. There hasn't been any activity in the NRA by NCPs since 1994. Estimates of under-reported catch have ranged from 200 tons to 23 500 tons. There have also been estimates of over-reported catch in recent years. These have ranged from 1 800 tons to 2 800 tons.

A TAC of 16 000 tons was first implemented by Canada within its 200-mile limit in 1974. The TAC was increased in 1978 to 20 000 tons and generally remained at that level through to 1987. The TAC for 1988 was reduced to 14 000 tons and remained unchanged until 1994 when it was reduced to 10 000 tons as a precautionary measure and maintained at that level to 2003. During 1999 a shift was implemented from a calendar year based TAC to a fiscal year based TAC currently in effect from April 1, 2000 to March 31, 2001 at 10 000 tons. To facilitate this temporal shift in TAC, the 1999 calendar year TAC was extended to March 31, 2000 and increased from 10 000 tons to 10 200 tons to accommodate the extension.

Description of the Fishery

Russia predominated in this fishery up until 1993 (Table 2) and generally caught its share (about 50%) of the total non-Canadian allocation, which accounted for about 2/3 of the TAC. From 1987 to 1993 Russian catches ranged from 3 800 tons to 7 200 tons Russia and Cuba, impacted by the reduction and eventual elimination of foreign allocations by Canada, ceased directed fishing in 1994. Russia resumed directed fishing in 2000 rapidly increasing their catch from 2 200 tons to about 11 000 tons in 2001 and 2002. Portugal began fishing in 1992 averaged about 1 800 tons between 1992 to 1998. Their reported catches escalated to 5 500 tons in 1999 and have averaged about 4 200 tons to 2002. Spain, who had taken less than 50 tons before 1995, increased catches from 1 200 tons in 1997 to a peak of 4 500 tons in 1999 with a subsequent decline to 700 tons in 2002.

Canada has had limited interest in a fishery in Div. 3O because of small sizes of redfish encountered in areas suitable for trawling. Canadian landings were less than 200 tons annually from 1983-1991. In 1994, Canada took 1 600 tons due to improved markets related to lobster bait, but declined to about 200 tons in 1995. Between 1996 and 1999 Canadian catches have alternated between levels of about 8 000 tons and 2 500 tons based on market acceptability for redfish near the 22 cm size limit. From 2000-2002 Canada has averaged about 3 400 tons.

In general, the fishery has occurred primarily from May to October since 1990 (Table 3a). The prominent means of capture from the mid-1970s to the early 1980s was the bottom otter trawl. The use of mid-water trawls from 1990 to 1993 (Table 3b) was primarily by Russia and Cuba. Canadian, Portuguese and Spanish fleets primarily use bottom trawling.

Commercial Fishery Data

Catch and Effort

Catch and effort data for 1959 to 1999 were extracted from ICNAF/NAFO Statistical Bulletins and were combined with provisional 2000-2001 NAFO data and Canadian regional data compiled by various Department of Fisheries and Ocean regional statistics branches. Initially selected from this database were observations where redfish comprised more than 50% of the total catch and were therefore considered to be redfish directed.

These data were analysed with a multiplicative model (Gavaris, 1980) to derive a standardized catch rate index for hours fished. The effects included in the model were a combination country-gear-tonnage class category type (CGT), month, and a category type representing the amount of bycatch associated with each observation. For this effect five groups were arbitrarily established : (>50% <=60%), (>60% <=70%), (>70% <=80%), (>80% <=90%) and (>90%) where each group corresponds to the percentage of redfish relative to the total catch associated with each observation. In the usual manner, catch or effort data of less than 10 units were eliminated prior to analysis in addition to any categories with less than five samples except in the year category type. A second standardization was conducted for days fished due to missing hours-fished data from two major fleets, EU-Portugal since 1992 and EU-Spain since 1995. For the "days fished" model the only difference in was that observations with effort less than 5 days fished were eliminated prior to analysis. For all analyses an unweighted regression was run because of unknown percentages of prorating prior to 1984.

Previous catch rate analyses of this stock (Power *et al*., 1995) suggested different trends in the catch rate series derived for Canada only and for countries that have only fished outside the EEZ. Accordingly, separate standardizations of available catch rate data were conducted as follows: (i) All fleets, (ii) Canada only, (iii) countries which have fished both inside and outside the EEZ (Russia, Cuba and Japan) and (iv) countries which have only fished outside the EEZ (Poland, Portugal, South Korea, Spain and Russia and Japan since 1994).

For the "hours fished" standardization with all fleets, the regression was significant ($p < 0.05$), explaining 57% of the variation in catch rates (Table 4). There was a significant year effect but only the one year was significantly different from the reference year. The catch rate index (Table 5, Fig. 2 upper left panel) shows much within year variability, particularly prior to 1969 and since 1994. Although there are interannual fluctuations, the index shows an increase from 1969 to 1979 followed by a decrease to the lowest level in 1993. There was a 400% increase in 1994 and a decline to the 1993 level by 1997. The index again sharply by 250% in 1998 and has increased to the second highest rate in the series in 2002.

For the "days fished" standardization with all fleets, the regression was significant ($p < 0.05$), explaining 60% of the variation in catch rates (Table 6). There was a significant year effect but the regression coefficients and their standard errors indicate no year was significantly different from the reference year. The catch rate index (Table 7, Fig. 2 upper right panel) shows much within year variability and fluctuation, particularly prior to 1979 and again in the recent period since 1998. The series generally sugggests an decrease from 1960 to 1965 followed by an increase to one of the highest rates in the series in 1979. A period of stability followed to 1983, which was followed by a decline to 1989. Another period of stability occurred to 1994 and then a dramatic 40% decline to the lowest rate on record in 1995. The index stayed at this level until 1997 and then increased by 120% in 1998. The index declined in 1999 but has since increased in the vicinity of the highest rate in the series in 2002.

The analysis of catch rates separately by fleet category (Fig. 2, lower panels) suggests different trends over the time period from 1960 to 1990, particularly since the mid-1970s in both hours fished and days fished models. The Canadian fleet generally shows an increase over the period while the fleets fishing inside and outside show a decrease. The trends are generally in agreement since 1993. This suggests these fleets should be analysed separately for a historic perspective.

In summary, the analysis of catch rates by the Canadian fleet are not considered indicative of overall trends in the resource. Canada has not accounted for a major portion of the reported catches from Div. 3O and has only fished within the 200 mile EEZ. The recent dramatic fluctuations cannot be accounted for by the biology of redfish. Market conditions have determined the Canadian activity in Div. 3O. There are fleets that search for larger sized fish rather than simply maximizing catch rate. The trend in the two foreign fleet catch rate series are similar where comparisons can be made (since and indicate a general decline since the early- to mid-1980s to the more recent period. The catch rates of the fleets that have fished outside is probably indicative of a decline in the proportion of the stock outside the EEZ where most of the effort occurs.

Commercial fishery sampling

Sampling of redfish conducted by Portugal (Vargas *et al*., MS 2003), Spain (Gonzalez *et al*., MS 2003) and Russia (Vaskov *et. al*., MS 2003) from the 2002 trawl fishery (Fig. 3). The Portuguese fleet fished between 200m-300m while the Russian fleet fished from 300m-600m. Sampling was also available from the Canadian fleet.

The compilation of annual catch at length as number per thousand suggested fish between 21 cm-25 cm generally dominated the catches. Lengths between 21 cm-24 cm (range 15 cm-43 cm) dominated the Portuguese catch. The dominant mode in the Spanish catch was between 19 cm-21 cm (range 14 cm-31 cm) and the Russian fleet modal catch occurred between 23 cm-25 cm (range 11 cm-52 cm), which was sampled for total length.

A compilation of catch at length from various fleets from 1995 to 2002 suggests that the size composition has changed over the time period with fleets catching a larger portion of fish >25 cm prior to 1998.

Research Survey Data

Abundance Indices

Stratified random groundfish surveys have been conducted in the spring and autumn in Div. 3O since 1991, with coverage of depths to 730 m. In addition, a summer survey was conducted in 1993. From 1991 to spring 1995 an Engel 145 otter trawl was used (1.75 n. mi. standard tow) and from autumn 1995 onwards a Campelen 1800 shrimp trawl (0.75 n. mi. standard tow). The 1991 to spring 1995 Engel 145 data were converted into Campelen 1800 trawl equivalent data. Details of the comparative fishing trials and data modelling can be found in Power and Atkinson (MS 1998).

The series of mean weight per standard tow for spring (Table 8) and autumn (Table 9) exhibits large fluctuations in estimates between seasons and years for some strata, not uncommon for bottom trawl surveys for redfish. This is usually accounted for by the influence of one or two large sets on the survey. It is difficult to reconcile year to year changes in the indices, but generally, the spring survey biomass index (Fig. 4) suggests the stock may have increased since the early-1990s, fluctuated over 100 000 tons from 1994 to 1999 and declined to 2002. The low 1997 value is considered a sampling anomaly. The autumn surveys, while more stable in the early-1990s, generally supports this pattern. It should also be noted that the 1996 autumn estimate does not include important strata unsampled due to problems on the survey.

In most surveys, stratum by stratum density estimates in the NAFO Regulatory Area (denoted in Tables 8 and 9 as strata 354, 355, 356, 721, 722) were generally lower than inside, although there is a portion of these strata that actually occurs inside. Estimates of percentages of survey biomass have ranged from 3% to 53% with an average of the values being 18% for the spring surveys. For the autumn surveys estimates range from 7% to 37% with an average of the values being 20%.

Recruitment

Size distribution in terms of mean number per tow at length from the spring surveys (Fig. 5) indicates a bimodal distribution in 1991 with modes at 11 cm and 20 cm corresponding to about the 1988 and 1984 year-classes respectively. The 20 cm mode progresses at about a cm per year up to 1994 (at 23 cm) and cannot be traced any further. The 11-cm mode progresses at about 2-3 cm per year until it reaches 21 cm in 1996. From 1996 to 1998 the mode remains at 21 cm but is dominant. It appears to have increased to 22cm in 1999 and 23 cm in the 2000 survey. This mode remains dominant and at 22 cm or 23 cm from 2001-2003. A pulse of recruitment was detected in the 1999 survey but has since diminished.

Size distribution from the autumn surveys (Fig. 6) indicates a bimodal distribution in 1991, similar to the spring survey, with modes at 13 cm and 21 cm. The 21-cm mode only progresses to 23 cm by 1994 after which it is no longer discernible. The 13-cm mode progresses to a 17-cm mode in 1992 but only increments to 19 cm up to the 1995 survey. The mode increases about 1 cm per year to 23 cm by 1999 and remains at that length until the 2000 survey. In the 2001-2002 surveys the dominant mode is at 21 cm or 22 cm. The pulses of recruitment detected in the spring of 1999 were also detected in the autumn survey, but both were diminished by 2002. There has been no prospect in the surveys of size groups smaller than 17cm since 1995.

The size distributions of the survey catches indicate only a narrow range of sizes caught each year in Div. 3O. Generally fish smaller than about 10 cm and larger than about 25 cm are absent in survey catches from 1991-2000 which cover strata down to 732 m (400 fathoms). It is well documented that the Engel survey gear (e.g. Power MS 1995) and the Campelen survey gear (e.g. Power and Atkinson, MS 1998b) can catch both smaller (than 10 cm) and larger (than 25 cm) redfish. Length sampling from the commercial fisheries in the mid-1990s reveals a higher proportion of fish greater than 25 cm compared to the survey catches. Therefore, it appears that fish sizes outside this range, especially fish greater than 25 cm, are generally unavailable to the gear in this area. The reasons for this are unknown but may be related to distribution relative to trawlable bottom.

Stratified random groundfish surveys have been conducted in the spring in Div. 3O from 1973 to 1990, with coverage of depths to 367 m. The surveys used a Yankee 41.5 trawl with a liner from 1973-1982 and an Engel 145 trawl with a liner from 1983-1990. Size distributions were plotted to get an indication of historical recruitment pattern and size range in depths from 93 m-367 m, which is considered the shallower end of redfish distribution. It is clear from the varied scales on the y-axis (Fig. 8) that estimates of abundance from these surveys fluctuated greatly from year to year. In general, the upper limit of the size range was 29 cm in this depth range. The 1990 survey shows a dominant mode at 24 cm. This mode could be followed back to the 1981 survey at 9 cm. The next tractable pulse of recruitment occurred in the 1975 survey at 9-10 cm.

Estimation of Stock Parameters

A Non-equilibrium stock production model incorporating covariates (ASPIC)

The catch and CPUE series from the days fished catch rate standardization were utilized in a non-equilibrium logistic production model (Prager, 1994 and 1995). Covariate information used were the Canadian spring survey biomass index used as a beginning of year index (B0), the Canadian autumn survey index used as an end of year index (B2) and the Russian Spring/Summer Biomass Index from Vaskov (MS 2003) used as an average year index (B1). Starting values were those as suggested by Prager (1995) for a long-lived species such as redfish. Initially, all indices were run simultaneously with no penalty constraint on the ratio of Stock Biomass at the beginning of the series to B_{msy}.

The initial run was terminated because of a negative correlation with the Canadian Spring Index. This was subsequently dropped and secondary runs were performed on each individual covariate index. The Canadian autumn index was also dropped because of negative correlation. A run with the Russian Spring/Summer index ran to convergence. The results, presented in Annex 1, suggest a relatively good correlation with the Catch/CPUE index (0.633). There were large negative loq q residuals with the Russian series for 1987 and 1991 due to the inherently noisy nature of bottom trawl surveys. The residual pattern with the NAFO CPUE in days fished was not disturbing, however, this series used was a standardisation of all fleets which was shown to have different trends over time. Given these caveats, it is suggested that the results of this model be considered illustrative and further investigations into model input be considered.

Catch/Biomass ratio

A fishing mortality proxy was derived by simple catch to biomass ratios. In deriving a fishing mortality proxy, and because most of the catch is taken in the last three quarters of the year, the catch in year “n” was divided by the average of the Canadian Spring (year = n) and Autumn (year = n-1) survey biomass estimates to better represent the relative biomass at the time of the year before the catch was taken. Survey catchability (q) for redfish is not known but assumed less than one. All fish sizes were included in the survey biomass estimate. The results (Fig. 9) suggest that relative fishing mortality decreased rapidly from the highest in the series in 1992 to the lowest in 1995 but has since increased to the highest estimate in the series in 2002.

Size at Maturity

Recent size at maturity data for redfish (Power and Atkinson, MS 1998) suggests L_{50} is about 28 cm for females and 21 cm for males.

State of the Stock

It is still not possible to determine current fishing mortality rate. It is difficult to accept the CPUE series as representative of the whole stock area given the conflicting trends between fleets. RV surveys do not adequately sample fish greater than 25 cm which up to 1997 have generally comprised the main portion of the fishery. This makes it is difficult to interpret survey estimates in relation to what is happening to the stock as a whole. It is also difficult to accept the proxy fishing mortality rate as an indication of trend in fishing mortality because there is extremely high variability around the survey estimates and are therefore not considered to be reflective of year to year changes in stock abundance. Accepting this caveat and the observation that Canadian spring and autumn survey estimates of Div. 3O redfish are either stable or decreasing in the last few years, the increase in catches in Div. 3O in recent years, particularly in 2001 and 2002 at about 20 000 tons, suggests that fishing mortality has increased beginning in 2001. Before 1998, the surveys tracked a relatively strong year class which in recent years has become more targeted by the fishery. There is concern, however, about the poor sign of subsequent recruitment (less than 17 cm). It is also important to consider that length at which 50% of males are mature is about 21cm, whereas 50% of females do not reach maturity until about 28 cm.

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Table 1. Nominal catches (t) and TACs (within the Canadian 200 mile limit) redfish in Div. 3O.

Year	Canada	Others	Total [a]	TAC
1960	100	4,900	5,000	
1961	1,000	10,000	11,000	
1962	1,046	6,511	7,557	
1963	2,155	7,025	9,180	
1964	1,320	14,724	16,044	
1965	203	19,588	19,791	
1966	107	15,198	15,305	
1967	645	18,392	19,037	
1968	52	6,393	6,445	
1969	186	15,692	15,878	
1970	288	12,904	13,192	
1971	165	19,627	19,792	
1972	508	15,609	16,117	
1973	133	8,664	8,797	
1974	91	13,033	13,124	16,000
1975	103	15,007	15,110	16,000
1976	3,664	11,684	15,348	16,000
1977	2,972	7,878	10,850	16,000
1978	1,841	5,019	6,860	16,000
1979	6,404	11,333	17,737	20,000
1980	1,541	15,765	17,306	21,900
1981	2,577	10,027	12,604	20,000
1982	491	10,869	11,360	20,000
1983	7	7,133	7,340	20,000
1984	167	9,861	16,978	20,000
1985	104	8,106	12,860	20,000
1986	141	10,314	11,055	20,000
1987	183	12,837	27,170	20,000
1988	181	11,111	34,792	14,000
1989	27	11,029	13,256	14,000
1990	155	8,887	14,242	14,000
1991	28	7,533	8,461	14,000
1992	1,219	12,149	15,268	14,000
1993	698	12,522	15,720	14,000
1994	1,624	3,004	5,428	10,000
1995	177	2,637	3,214	10,000
1996	7,255	2,390	9,845	10,000
1997	2,554	2,558	5,112	10,000
1998	8,972	4,380	14,052	10,000
1999	2,344	10,249	12,593	10,200
2000	2,206	10,584	10,003	10,000
2001	4,893	17,203	20,307	10,000
2002	3,000	16,452	17,234	10,000

[a] Totals since 1983 may include adjustments for estimated catches from various sources

Table 2. Nominal reported catches (t) of redfish in Div. 3O by country and year since 1990.

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Canada (M)	27	4	27	21	779	4	2124	693	2851	317	1326	336	12
Canada (N)	128	24	1192	677	845	173	5131	1861	6121	2027	880	4557	2988
France (SPM)	-	-	-	-	-	-	-	134	266	-	-	-	-
Japan	1406	226	125	159	-	264	417	285	355	-	-	-	-
Portugal	83	3	1468	4794	2918	1935	1635	894	1875	5469	4555	3537	4610
Spain	4	-	-	-	26	22	338	1245	1884	4549	3747	2314	659
Russia	3811	4427	5845	6887	60	416	-	-	-	231	2233	11343	11182
Cuba	2750	2748	2776	665	-	-	-	-	-	-	-	-	-
Estonia	-	-	-	-	-	-	-	-	-	-	49	9	
Lithuania	-	-	-	-	-	-	-	-	-	-	-	-	1
Korea(S)	833	129	1935	17	-	-	-	-	-	-	-	-	-
EU	-	-	-	-	-	-	-	-	-	-	-	-	
OTHER *	5200	900	1900	2500	800	400	200	-	700	-	-	-	-
Total	9042	7561	13368	13220	4628	2814	9645	5112	13352	12593	12790	22096	19452
TAC	14000	14000	14000	14000	10000	10000	10000	10000	10000	10200	10000	10000	10000

* Estimates of catch from other sources

Table 3a. Nominal reported catches (t) of redfish in Div. 3O by month and year since 1990.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Unk	Total
1990	108	23	257	26	1220	2474	1534	1571	1002	686	28	113		9042
1991	17	47	96	1	713	2054	2346	1118	830	338	-	1		7561
1992	0	57	14	10	635	3262	2520	1808	896	1261	797	2108		13368
1993	226	14	754	817	2089	1601	1887	2068	1809	829	630	496		13220
1994	60	93	742	1609	236	83	-	68	1000	540	19	178		4628
1995	7	125	145	2	45	28	56	765	645	879	107	10		2814
1996	0	0	89	119	166	46	773	882	1685	2864	1539	1482		9645
1997	4	0	10	34	86	417	1298	909	622	1274	409	49		5112
1998	40	193	216	279	1329	2723	1924	953	1280	1964	2275	176		13352
1999	100	139	262	463	527	942	1644	2513	2298	2056	1434	215		12593
2000	80	92	943	739	1077	1844	1088	1254	1545	2068	1814	246		12790
2001	29	10	950	1383	1710	2522	1128	956	1978	3785	3318	2013	2314	22096

Table 3b. Nominal reported catches (t) of redfish in Div. 3O by gear since 1990.

	Otter Trawls				
Year	Bottom	Midwater	Gillnets	Misc	Total
1990	5501	3537	-	4	9042
1991	4625	2936	-	-	7561
1992	10046	3292	1	29	13368
1993	11997	1214	-	9	13220
1994	3085	1498	26	19	4628
1995	2221	525	26	42	2814
1996	9303	335	7	-	9645
1997	5091	10	2	9	5112
1998	13352				13352
1999	11623	970			12593
2000	12750	39		1	12790
2001	21467	629			22096

Table 4. ANOVA results and regression coefficients from a multiplicative model utilized to derive a standardized catch rate series for Redfish in Div. 3O. Effort is HOURS FISHED. Analysis is for all fleets. (2002 based on preliminary Canadian data).

REGRESSION OF MULTIPLICATIVE MODEL
MULTIPLE R............. 0.756
MULTIPLE R SQUARED..... 0.571

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARE	F-VALUE
INTERCEPT	1	3.05E1	3.05E1	
REGRESSION	83	2.24E2	2.70E0	10.274
Cntry|Gear|TC(1)	27	9.08E1	3.36E0	12.791
Month(2)	11	7.91E0	7.19E²1	2.733
Bycatch(3)	4	2.90E1	7.25E0	27.551
Year(4)	41	3.83E1	9.35E²1	3.555
RESIDUALS	640	1.68E2	2.63E²1	
TOTAL	724	4.23E2		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VAR #	REG. COEF	STD. ERR	NO. OBS
Cntry|Gear|TC	20127	INT	1.072	0.316	724
Month	8				
Bycatch	95				
Year	60				
(1)	2114	1	²1.086	0.175	16
	2125	2	²0.818	0.142	18
	3114	3	²1.011	0.093	77
	3121	4	²1.041	0.197	12
	3123	5	²1.545	0.144	37
	3124	6	²0.978	0.139	41
	3125	7	²1.119	0.100	52
	3154	8	²1.081	0.280	5
	3155	9	²0.660	0.169	16
	4127	10	²0.039	0.136	19
	4157	11	²0.079	0.114	32
	9114	12	²1.589	0.247	6
	14124	13	²0.336	0.189	9
	14125	14	²0.550	0.244	5
	14126	15	²0.461	0.140	18
	14127	16	²0.315	0.110	34
	16127	17	²0.648	0.247	6
	17126	18	²0.631	0.207	8
	20114	19	²1.439	0.169	14
	20157	20	²0.140	0.088	55
	25126	21	²0.282	0.149	17
	25127	22	²0.172	0.124	29
	27123	23	²2.174	0.210	9
	27125	24	²0.674	0.124	36
	34126	25	²0.324	0.259	5
	34127	26	0.058	0.218	14
	34157	27	²0.739	0.275	5
(2)	1	28	²0.249	0.133	20
	2	29	²0.200	0.131	22
	3	30	²0.115	0.097	48
	4	31	²0.380	0.101	42
	5	32	²0.035	0.091	56

CATEGORY	CODE	VAR #	REG. COEF	STD. ERR	NO. OBS
	6	33	²0.114	0.082	75
	7	34	0.007	0.077	93
	9	35	0.068	0.077	90
	10	36	0.067	0.082	76
	11	37	²0.108	0.090	57
	12	38	²0.154	0.096	48
(3)	55	39	²0.759	0.101	39
	65	40	²0.454	0.091	48
	75	41	²0.473	0.083	53
	85	42	²0.432	0.057	122
(4)	61	43	0.090	0.376	6
	62	44	²0.065	0.343	11
	63	45	²0.076	0.338	13
	64	46	0.053	0.374	6
	65	47	²0.209	0.387	5
	66	48	²0.016	0.488	2
	67	49	0.173	0.358	7
	69	50	²0.433	0.354	9
	70	51	²0.259	0.347	10
	71	52	²0.016	0.337	14
	72	53	²0.344	0.330	17
	73	54	0.031	0.352	9
	74	55	²0.404	0.352	9
	75	56	²0.524	0.370	6
	76	57	²0.076	0.324	23
	77	58	²0.146	0.324	23
	78	59	²0.317	0.322	24
	79	60	0.146	0.319	33
	80	61	0.008	0.322	26
	81	62	0.097	0.325	23
	82	63	0.147	0.325	25
	83	64	0.004	0.333	17
	84	65	²0.084	0.324	25
	85	66	²0.064	0.327	21
	86	67	²0.120	0.333	18
	87	68	²0.072	0.321	33
	88	69	²0.123	0.324	30
	89	70	²0.292	0.327	26
	90	71	²0.235	0.327	24
	91	72	²0.636	0.351	10
	92	73	²0.387	0.331	31
	93	74	²0.494	0.362	17
	94	75	1.036	0.406	5
	95	76	0.094	0.391	6
	96	77	²0.068	0.339	18
	97	78	²0.539	0.337	21
	98	79	0.455	0.332	34
	99	80	0.238	0.340	23
	100	81	0.480	0.345	17
	101	82	0.418	0.341	22
	102	83	0.567	0.346	22

Table 5. Standardized catch rate index for Redfish in Div. 3O from a multiplicative model utilizing HOURS FISHED as a measure of effort. Index is for all fleets (2002 based on preliminary Canadian data).

	PREDICTED CATCH RATE					
	LN TRANSFORM		RETRANSFORMED			
YEAR	MEAN	S.E.	MEAN	S.E.	CATCH	EFFORT
1960	1.0722	0.0996	3.171	0.977	5000	1577
1961	1.1622	0.0686	3.524	0.908	11000	3122
1962	1.0069	0.0384	3.063	0.595	7557	2467
1963	0.9961	0.0344	3.036	0.559	9180	3024
1964	1.1248	0.0599	3.409	0.823	16044	4706
1965	0.8633	0.0728	2.608	0.692	19791	7588
1966	1.0559	0.1550	3.034	1.151	15305	5044
1967	1.2456	0.0474	3.871	0.833	19037	4917
1969	0.6392	0.0400	2.119	0.420	15878	7494
1970	0.8131	0.0360	2.526	0.475	13192	5222
1971	1.0565	0.0287	3.234	0.545	19792	6119
1972	0.7277	0.0233	2.334	0.354	16117	6904
1973	1.1030	0.0353	3.377	0.629	8797	2605
1974	0.6680	0.0370	2.184	0.416	13124	6009
1975	0.5483	0.0528	1.923	0.436	15110	7859
1976	0.9957	0.0173	3.061	0.401	15348	5014
1977	0.9257	0.0191	2.852	0.392	10850	3805
1978	0.7554	0.0183	2.406	0.324	6860	2851
1979	1.2182	0.0156	3.827	0.477	17737	4634
1980	1.0801	0.0157	3.333	0.416	17306	5192
1981	1.1693	0.0173	3.641	0.477	12604	3461
1982	1.2190	0.0155	3.831	0.475	11360	2966
1983	1.0765	0.0210	3.313	0.477	7340	2216
1984	0.9879	0.0164	3.039	0.387	16978	5587
1985	1.0087	0.0196	3.097	0.432	12860	4152
1986	0.9524	0.0219	2.925	0.431	11055	3780
1987	1.0000	0.0142	3.079	0.366	27170	8824
1988	0.9494	0.0146	2.927	0.352	34792	11888
1989	0.7805	0.0172	2.468	0.323	13256	5370
1990	0.8368	0.0174	2.611	0.343	14242	5454
1991	0.4365	0.0307	1.738	0.302	8461	4868
1992	0.6856	0.0208	2.241	0.322	15268	6813
1993	0.5781	0.0432	1.990	0.410	15720	7899
1994	2.1079	0.0775	9.032	2.468	5428	601
1995	1.1664	0.0639	3.547	0.883	3214	906
1996	1.0041	0.0278	3.071	0.508	9845	3206
1997	0.5332	0.0271	1.918	0.314	5112	2665
1998	1.5269	0.0220	5.195	0.767	14052	2705
1999	1.3100	0.0278	4.170	0.691	12593	3020
2000	1.5521	0.0306	5.304	0.921	10003	1886
2001	1.4899	0.0282	4.990	0.833	20307	4069
2002	1.6388	0.0317	5.782	1.022	17234	2981

Table 6. ANOVA results and regression coefficients from a multiplicative model utilized to derive a standardized catch rate series for Redfish in Div. 3O. Effort is DAYS FISHED. Analysis is for all fleets. (2002 based on preliminary Canadian data).

REGRESSION OF MULTIPLICATIVE MODEL
MULTIPLE R............. 0.773
MULTIPLE R SQUARED..... 0.597

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARE	F-VALUE
INTERCEPT	1	4.27E3	4.27E3	
REGRESSION	81	1.67E2	2.07E0	9.964
Cntry|Gear|TC(1)	26	6.23E1	2.40E0	11.551
Month(2)	11	4.65E0	4.23E²1	2.037
Bycatch(3)	4	2.00E1	5.00E0	24.111
Year(4)	40	2.26E1	5.66E²1	2.725
RESIDUALS	544	1.13E2	2.08E²1	
TOTAL	626	4.55E3		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VAR #	REG. COEF	STD. ERR	NO. OBS
Cntry|Gear|TC	20127	INT	3.525	0.501	626
Month	8				
Bycatch	95				
Year	60				
(1)	2114	1	²1.139	0.190	13
	2125	2	²0.774	0.142	14
	3114	3	²0.924	0.093	55
	3121	4	²1.169	0.194	9
	3123	5	²1.412	0.143	29
	3124	6	²0.890	0.138	32
	3125	7	²0.981	0.105	36
	3154	8	²0.958	0.253	5
	3155	9	²0.632	0.180	10
	4127	10	²0.548	0.133	16
	4157	11	²0.348	0.111	29
	9114	12	²1.325	0.245	5
	14124	13	²0.541	0.191	7
	14125	14	²0.700	0.221	5
	14126	15	²0.410	0.152	12
	14127	16	²0.319	0.129	18
	17126	17	²0.723	0.115	77
	19105	18	0.021	0.219	8
	20114	19	²1.504	0.179	12
	20157	20	²0.249	0.089	41
	25126	21	²0.517	0.186	8
	25127	22	²0.337	0.141	16
	27123	23	²1.555	0.200	8
	27125	24	²0.495	0.134	21
	34126	25	²0.259	0.164	16
	34127	26	²0.421	0.165	16
(2)	1	27	²0.118	0.127	17
	2	28	²0.170	0.137	15
	3	29	²0.062	0.097	40
	4	30	²0.224	0.095	38
	5	31	0.063	0.085	51
	6	32	²0.080	0.077	72
	7	33	0.055	0.075	77
	9	34	0.134	0.075	78
	10	35	0.089	0.079	67
	11	36	²0.003	0.089	45
	12	37	²0.054	0.090	43
(3)	55	38	²0.696	0.100	36
	65	39	²0.418	0.086	46
	75	40	²0.487	0.075	54
	85	41	²0.369	0.054	116
(4)	61	42	0.052	0.494	7
	62	43	0.017	0.510	6
	63	44	²0.319	0.505	11
	64	45	²0.140	0.548	4
	65	46	²0.507	0.611	2
	67	47	0.089	0.523	5
	69	48	²0.257	0.536	5
	70	49	²0.512	0.527	7
	71	50	²0.257	0.519	7
	72	51	²0.417	0.506	13
	73	52	0.250	0.566	3
	74	53	²0.298	0.537	5
	75	54	²0.203	0.561	3
	76	55	²0.061	0.505	21
	77	56	²0.086	0.504	20
	78	57	²0.431	0.503	17
	79	58	0.056	0.503	27
	80	59	²0.064	0.503	22
	81	60	0.068	0.506	21
	82	61	²0.006	0.508	18
	83	62	0.063	0.512	13
	84	63	²0.018	0.514	12
	85	64	²0.051	0.511	15
	86	65	²0.161	0.513	15
	87	66	²0.181	0.507	23
	88	67	²0.141	0.509	20
	89	68	²0.202	0.507	22
	90	69	²0.221	0.512	16
	91	70	²0.212	0.522	9
	92	71	²0.170	0.511	21
	93	72	²0.163	0.515	25
	94	73	²0.140	0.525	11
	95	74	²0.627	0.527	10
	96	75	²0.552	0.513	20
	97	76	²0.706	0.512	22
	98	77	0.079	0.510	38
	99	78	²0.116	0.515	25
	100	79	²0.082	0.515	29
	101	80	0.036	0.511	40
	102	81	0.214	0.522	15

Table 7. Standardized catch rate index for Redfish in Div. 3O from a multiplicative model utilizing DAYS FISHED as a measure of effort. Index is for all fleets (2002 based on preliminary Canadian data).

PREDICTED CATCH RATE

YEAR	LN TRANSFORM MEAN	LN TRANSFORM S.E.	RETRANSFORMED MEAN	RETRANSFORMED S.E.	CATCH	EFFORT
1960	3.5255	0.2511	33.237	15.674	5000	150
1961	3.5773	0.0553	38.614	8.962	11000	285
1962	3.5427	0.0505	37.389	8.302	7557	202
1963	3.2065	0.0327	26.952	4.839	9180	341
1964	3.3858	0.0729	31.601	8.389	16044	508
1965	3.0183	0.1430	21.129	7.720	19791	937
1967	3.6148	0.0529	40.134	9.119	19037	474
1969	3.2683	0.0484	28.447	6.190	15878	558
1970	3.0138	0.0410	22.136	4.443	13192	596
1971	3.2689	0.0419	28.556	5.791	19792	693
1972	3.1080	0.0238	24.533	3.765	16117	657
1973	3.7756	0.0766	46.581	12.662	8797	189
1974	3.2274	0.0533	27.238	6.211	13124	482
1975	3.3228	0.0782	29.594	8.126	15110	511
1976	3.4649	0.0150	35.209	4.305	15348	436
1977	3.4398	0.0174	34.297	4.507	10850	316
1978	3.0946	0.0188	24.268	3.317	6860	283
1979	3.5817	0.0151	39.570	4.851	17737	448
1980	3.4614	0.0143	35.100	4.193	17306	493
1981	3.5933	0.0153	40.026	4.942	12604	315
1982	3.5199	0.0159	37.183	4.672	11360	306
1983	3.5889	0.0212	39.736	5.755	7340	185
1984	3.5070	0.0224	36.587	5.456	16978	464
1985	3.4749	0.0208	35.460	5.093	12860	363
1986	3.3649	0.0212	31.760	4.603	11055	348
1987	3.3446	0.0148	31.222	3.788	27170	870
1988	3.3841	0.0168	32.447	4.191	34792	1072
1989	3.3230	0.0163	30.534	3.883	13256	434
1990	3.3047	0.0188	29.940	4.093	14242	476
1991	3.3136	0.0279	30.073	4.989	8461	281
1992	3.3558	0.0205	31.486	4.487	15268	485
1993	3.3623	0.0234	31.643	4.816	15720	497
1994	3.3858	0.0350	32.210	5.975	5428	169
1995	2.8987	0.0359	19.781	3.716	3214	162
1996	2.9735	0.0230	21.453	3.238	9845	459
1997	2.8199	0.0233	18.397	2.797	5112	278
1998	3.6045	0.0196	40.391	5.633	14052	348
1999	3.4097	0.0256	33.144	5.271	12593	380
2000	3.4432	0.0250	34.283	5.392	10003	292
2001	3.5616	0.0210	38.668	5.579	20307	525
2002	3.7391	0.0328	45.906	8.253	17234	375

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.181

Table 8. Mean number (upper panel) and weight (kg., lower panel) per standard tow from Canadian SPRING surveys in Div. 3O covering strata to 732 m (400 ftm.). Dashes (---) represent unsampled strata. Number of successful sets in brackets. Data from 1991-1995 are Campelen trawl equivalent units (see text). Data from 1996 to present are actual Campelen data. G=GadusAtlantica, W=Wilfred Templeman, A=Alfred Needler.

Stratum	Depth Range (M)	Area sq mi	% Area within NRA	May3-11 1991-Q2 W105	May2-13 1992-Q2 W119-20	May5-18 1993-Q2 W136-7	May14-22 1994-Q2 W153	May13-27 1995-Q2 W168-69	May22-30 1996-Q2 W188	May-Jun 1997-Q2 W204	May-Jun 1998-Q2 W221-2	May-Jun 1999-Q2 W238	May-Jun 2000-Q2 W315-16	May-Jun 2001-Q2 W365,367	May 2002-Q2 W419,421	May 2003-Q2 W479
329	093-183	1721	0.00	13.3 (9)	0.0 (8)	0.0 (6)	169.6 (5)	19.6 (5)	0.0 (6)	33.5 (6)	0.0 (7)	0.3 (6)	0.0 (5)	0.0 (5)	0.0 (5)	80.0 (5)
332	093-183	1047	0.00	35.5 (6)	1.4 (5)	0.0 (4)	0.0 (4)	1177.8 (4)	181.8 (4)	7.3 (3)	348.0 (4)	899.0 (4)	43.5 (4)	44.0 (3)	23.7 (3)	79.7 (3)
337	093-183	948	0.00	607.2 (5)	6.5 (4)	3.0 (2)	0.0 (3)	3462.8 (4)	5.0 (3)	2.0 (3)	703.5 (4)	339.0 (3)	207.5 (4)	48.7 (3)	2.7 (3)	429.7 (3)
339	093-183	585	0.00	0.0 (3)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.5 (2)	0.0 (2)
354	093-183	474	0.52	0.0 (3)	0.0 (2)	2537.0 (2)	0.0 (2)	0.0 (3)	2.5 (2)	0.0 (2)	422.9 (2)	1006.5 (2)	4.5 (2)	81.1 (2)	0.0 (2)	3.0 (2)
333	185-274	151(147)	0.00	1089.0 (2)	3240.0 (2)	8184.5 (2)	50275.0 (2)	979.5 (2)	870.1 (2)	231.9 (2)	4321.3 (2)	5502.4 (2)	1355.9 (2)	1525.5 (2)	941.5 (2)	572.0 (2)
336	185-274	121	0.00	187.5 (2)	688.5 (2)	4496.5 (2)	9955.5 (2)	83150.0 (2)	1360.6 (2)	139.1 (2)	34839.0 (2)	1682.7 (2)	1714.3 (2)	1742.0 (2)	1048.0 (2)	1456.5 (2)
355	185-274	103	0.72	119.5 (2)	111.0 (2)	7307.0 (2)	5829.0 (2)	1928.0 (2)	36488.9 (2)	306.2 (2)	5152.0 (2)	2191.6 (2)	4161.1 (2)	407.5 (2)	515.2 (2)	1408.6 (2)
334	275-366	92(96)	0.00	733.0 (2)	223.0 (2)	837.0 (2)	1179.0 (2)	159.0 (2)	1206.8 (2)	286.2 (2)	733.5 (2)	2515.2 (2)	3960.3 (2)	730.9 (2)	916.5 (2)	3344.5 (2)
335	275-366	58	0.00	39.7 (3)	265.3 (3)	582.5 (2)	6992.0 (2)	2267.0 (2)	15196.4 (2)	531.6 (2)	5796.0 (2)	8671.3 (2)	957.6 (2)	4730.6 (2)	4291.9 (2)	1612.3 (2)
356	275-366	61	0.77	444.0 (2)	805.5 (2)	2552.5 (2)	883.0 (2)	3980.0 (2)	4347.0 (2)	133.6 (2)	3990.2 (2)	9384.4 (2)	24603.5 (2)	503.2 (2)	2020.9 (2)	586.5 (2)
717	367-549	93(166)	0.00	1461.5 (2)	324.0 (2)	279.0 (2)	1269.0 (2)	312.5 (2)	597.0 (2)	3398.6 (2)	483.6 (2)	3239.6 (2)	740.9 (2)	139.5 (2)	242.0 (2)	584.0 (2)
719	367-549	76	0.00	277.0 (2)	88.5 (2)	497.5 (2)	1985.0 (2)	331.0 (2)	440.5 (2)	374.3 (2)	1098.0 (2)	1487.6 (2)	1685.1 (2)	1755.4 (2)	208.8 (2)	602.5 (2)
721	367-549	76	0.76	176.0 (2)	4369.0 (2)	449.0 (2)	108.0 (2)	7596.5 (2)	575.5 (2)	262.6 (2)	543.0 (2)	3263.2 (2)	687.8 (2)	541.1 (2)	94.7 (2)	342.5 (2)
718	550-731	111(134)	0.00	56.5 (2)	17.5 (2)	174.0 (2)	349.0 (2)	15.5 (2)	47.8 (2)	60.8 (2)	79.3 (3)	35.4 (3)	369.0 (3)	22.5 (2)	79.0 (2)	0.0 (2)
720	550-731	105	0.00	35.5 (2)	113.0 (2)	24.0 (2)	34.5 (2)	40.0 (2)	284.6 (2)	63.2 (2)	35.6 (2)	221.3 (2)	53.6 (2)	52.1 (2)	93.1 (2)	32.0 (2)
722	550-731	93	0.76	186.5 (2)	79.0 (2)	76.0 (2)	327.5 (2)	17.0 (2)	80.0 (2)	91.8 (2)	334.0 (2)	47.5 (2)	640.2 (2)	447.9 (2)	86.7 (2)	78.5 (2)
	Total:	6011	8.25													
Upper (95% CI)				465.3	495.8	1955.9	3238.5	4318.0	8884.4	1255.6	10277.2	1348.6	895.5	288.5	234.6	508.6
Weighted mean (by area)				190.987	180.3	698.4	1748.5	2662.6	953.2	141.7	1250.0	869.5	571.3	204.7	149.3	277.0
Lower (95% CI)				-83.3	-135.1	-559.1	258.6	1007.2	-6978.1	-972.1	-7777.3	390.4	247.1	121.0	64.1	45.4
SURVEY ABUNDANCE(x10[6])				155.4	146.7	568.3	1445.8	2201.7	788.2	117.2	1033.6	719.0	472.4	169.3	123.5	229.0
ABUNDANCE within NRA				7.3	42.0	181.1	69.1	106.1	405.0	7.0	100.2	143.6	213.3	18.8	19.9	21.7
% within NRA				4.7	28.6	31.9	4.8	4.8	51.4	6.0	9.7	20.0	45.2	11.1	16.1	9.5
				Campelen Trawl Equivalent 1991-1995					Campelen Trawl 1996-Present							
329	093-183	1721	0.00	0.3 (9)	0.0 (8)	0.0 (6)	11.2 (5)	0.5 (5)	0.0 (6)	1.0 (6)	0.0 (7)	0.0 (6)	0.0 (5)	0.0 (5)	0.0 (5)	3.0 (5)
332	093-183	1047	0.00	0.7 (6)	0.2 (5)	0.0 (4)	0.0 (4)	148.5 (4)	11.9 (4)	0.3 (3)	49.1 (4)	238.5 (4)	1.7 (4)	2.3 (3)	3.1 (3)	10.3 (3)
337	093-183	948	0.00	16.0 (5)	1.5 (4)	0.9 (2)	0.0 (3)	335.0 (4)	0.1 (3)	0.1 (3)	75.9 (4)	29.5 (3)	14.5 (4)	4.7 (3)	0.0 (3)	58.3 (3)
339	093-183	585	0.00	0.0 (3)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)
354	093-183	474	0.52	0.0 (3)	0.0 (2)	284.6 (2)	0.0 (2)	0.0 (3)	0.0 (2)	0.0 (2)	109.4 (2)	28.7 (2)	0.1 (2)	8.4 (2)	0.0 (2)	0.7 (2)
333	185-274	151(147)	0.00	120.8 (2)	404.0 (2)	1339.7 (2)	5428.5 (2)	113.5 (2)	120.4 (2)	20.2 (2)	696.3 (2)	797.6 (2)	236.2 (2)	225.7 (2)	154.9 (2)	76.3 (2)
336	185-274	121	0.00	11.6 (2)	81.2 (2)	630.9 (2)	1032.9 (2)	8543.1 (2)	161.8 (2)	7.7 (2)	5068.7 (2)	198.9 (2)	226.1 (2)	222.9 (2)	133.7 (2)	202.3 (2)
355	185-274	103	0.72	2.7 (2)	2.8 (2)	972.9 (2)	608.3 (2)	178.4 (2)	4916.3 (2)	7.5 (2)	741.6 (2)	314.7 (2)	502.8 (2)	44.2 (2)	78.3 (2)	184.3 (2)
334	275-366	92(96)	0.00	103.3 (2)	36.5 (2)	202.9 (2)	171.1 (2)	29.4 (2)	220.0 (2)	33.9 (2)	140.3 (2)	478.9 (2)	733.0 (2)	146.4 (2)	142.3 (2)	476.2 (2)
335	275-366	58	0.00	4.3 (3)	54.3 (3)	118.3 (2)	1210.4 (2)	263.7 (2)	2445.8 (2)	58.7 (2)	1053.9 (2)	1460.3 (2)	138.7 (2)	741.6 (2)	740.4 (2)	229.1 (2)
356	275-366	61	0.77	26.6 (2)	113.0 (2)	462.4 (2)	135.8 (2)	468.0 (2)	515.8 (2)	7.5 (2)	651.6 (2)	1600.5 (2)	4317.8 (2)	73.3 (2)	302.7 (2)	74.5 (2)
717	367-549	93(166)	0.00	452.4 (2)	74.3 (2)	83.2 (2)	395.3 (2)	91.4 (2)	191.2 (2)	534.7 (2)	143.1 (2)	670.0 (2)	310.6 (2)	30.2 (2)	45.3 (2)	135.8 (2)
719	367-549	76	0.00	33.7 (2)	12.3 (2)	150.0 (2)	669.7 (2)	71.8 (2)	79.5 (2)	59.6 (2)	291.6 (2)	289.0 (2)	326.3 (2)	366.5 (2)	52.4 (2)	113.0 (2)
721	367-549	76	0.76	24.7 (2)	183.6 (2)	110.5 (2)	22.0 (2)	1220.5 (2)	68.2 (2)	20.9 (2)	153.0 (2)	651.6 (2)	129.6 (2)	90.7 (2)	17.2 (2)	48.4 (2)
718	550-731	111(134)	0.00	42.2 (2)	7.5 (2)	87.7 (2)	156.0 (2)	7.3 (2)	27.2 (2)	15.0 (2)	35.5 (3)	16.7 (3)	174.5 (3)	7.4 (2)	18.1 (2)	0.0 (2)
720	550-731	105	0.00	11.7 (2)	57.7 (2)	9.7 (2)	15.9 (2)	14.6 (2)	129.1 (2)	21.0 (2)	14.5 (2)	103.6 (2)	17.7 (2)	18.2 (2)	30.9 (2)	5.9 (2)
722	550-731	93	0.76	118.4 (2)	12.6 (2)	33.2 (2)	126.1 (2)	6.3 (2)	25.4 (2)	12.2 (2)	137.0 (2)	19.7 (2)	261.0 (2)	114.2 (2)	26.6 (2)	17.9 (2)
	Total:	6011	8.25													
Upper (95% CI)				100.7	104.2	277.6	848.6	451.0	1081.0	189.5	1504.1	268.3	145.8	45.7	37.4	78.7
Weighted mean (by area)				18.8	19.6	103.1	208.3	283.8	124.2	19.0	192.7	148.2	101.0	31.7	24.3	37.7
Lower (95% CI)				-63.2	-65.0	-71.5	-431.9	116.6	-832.6	-151.5	-1118.8	28.1	56.2	17.6	11.3	-3.2
SURVEY BIOMASS(tons)				15278	15961	83874	172264	234648	102695	15699	159313	122550	83508	26183	20126	31202
BIOMASS within NRA				1553	2347	23733	8478	14641	54177	410	18024	19914	36624	3048	3151	2940
% within NRA				10.2	14.7	28.3	4.9	6.2	52.8	2.6	11.3	16.2	43.9	11.6	15.7	9.4

3O Spring

Table 9. Mean number (upper panel) and weight (kg., lower panel) per standard tow from Canadian AUTUMN surveys in Div. 3O covering strata to 732 m (400 ftm.). Dashes represent unsampled strata. Number of successful sets in brackets. Data from 1991-1995 are Campelen trawl equivalent units (see text). Data from 1996 to present are actual Campelen data. G=GadusAtlantica, W=Wilfred Templeman, A=Alfred Needler.

Stratum	Depth Range (M)	Area sq mi	% Area within NRA	Oct27-Nov18 1991-Q4 W113-4	Oct26-Nov5 1992-Q4 W128-9	Nov1-12 1993-Q4 W144-5	Oct29-Dec13 1994-Q4 W160-61	Sep28-Oct26 1995-Q4 W176-77	Nov25-Dec13 1996-Q4 W290 A253, T42	Oct-Dec 1997-Q4 W212-13	Sep-Oct 1998-Q4 W229-230	Sep-Oct 1999-Q4 W246-247	Sep-Oct 2000-Q4 W319-320 T338	Sep-Oct 2001-Q4 W372 T357	Sep-Oct 2002-Q4 W427 T411
329	093-183	1721	0.00	1.1 (7)	0.0 (3)	0.0 (5)	0.0 (6)	47.8 (5)	0.2 (5)	421.4 (5)	0.8 (5)	0.0 (5)	0.0 (5)	746.8 (5)	405.8 (5)
332	093-183	1047	0.00	0.0 (4)	88.3 (3)	49.7 (3)	118.0 (3)	403.0 (3)	11.5 (2)	89.0 (3)	45.3 (3)	32.0 (3)	65.5 (3)	8.7 (3)	12.8 (3)
337	093-183	948	0.00	175.5 (4)	667.5 (2)	35.3 (3)	41.5 (2)	515.0 (2)	0.0 (2)	149.3 (3)	273.8 (3)	28.7 (3)	50.6 (3)	37.3 (3)	61.9 (3)
339	093-183	585	0.00	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (3)	0.0 (2)	0.0 (2)		1.0 (2)	1.0 (2)	0.5 (2)
354	093-183	474	0.52	0.0 (2)	628.0 (2)	0.0 (2)	0.0 (2)	8100.0 (3)	427.3 (2)	6357.5 (2)	226.5 (2)	695.5 (2)	0.0 (2)	272.5 (2)	150.9 (2)
333	185-274	151(147)	0.00	314.5 (2)	1365.0 (2)	479.0 (2)	2073.0 (2)	923.5 (2)	---	217.0 (2)	155.2 (2)	230.5 (2)	488.8 (2)	320.7 (2)	31.6 (2)
336	185-274	121	0.00	364.5 (2)	2760.0 (2)	3298.5 (2)	3807.0 (2)	450.0 (2)	161.5 (2)	918.0 (2)	691.7 (2)	3481.0 (2)	882.0 (2)	131.0 (2)	87.5 (2)
355	185-274	103	0.72	9957.0 (2)	6381.0 (2)	1317.5 (2)	2310.5 (2)	2317.3 (2)	391.4 (2)	215.0 (2)	124.5 (2)	2333.5 (2)	1020.5 (2)	879.1 (2)	614.5 (2)
334	275-366	92(96)	0.00	8774.0 (2)	3290.0 (2)	2603.7 (3)	975.0 (2)	3474.0 (2)	---	1670.0 (2)	1110.5 (2)	178.1 (2)	378.7 (2)	1441.2 (2)	106.2 (2)
335	275-366	58	0.00	3853.0 (2)	5346.0 (2)	2541.5 (2)	5648.0 (2)	1667.0 (2)	2895.5 (2)	8352.5 (2)	2459.5 (2)	2748.0 (2)	2403.4 (2)	740.5 (2)	781.7 (2)
356	275-366	61	0.77	678.5 (2)	3828.0 (2)	568.5 (2)	2671.0 (2)	3637.1 (2)	868.4 (2)	735.5 (2)	5602.0 (2)	3452.9 (2)	5888.0 (2)	2481.2 (2)	692.0 (2)
717	367-549	93(166)	0.00	---	---	6079.5 (2)	1172.5 (2)	2247.5 (2)	---	13031.5 (2)	8428.5 (2)	603.2 (2)	5420.1 (2)	1401.5 (2)	488.9 (2)
719	367-549	76	0.00	813.5 (2)	---	4854.0 (2)	2715.5 (2)	2892.6 (2)	5015.5 (2)	5311.5 (2)	1953.0 (2)	3604.0 (2)	8284.0 (3)	2407.5 (2)	6420.9 (2)
721	367-549	76	0.76	315.5 (2)	---	543.5 (2)	82.5 (2)	9846.8 (2)	575.5 (2)	3882.0 (2)	1872.5 (2)	905.6 (2)	1582.7 (2)	1970.5 (2)	4210.8 (2)
718	550-731	111(134)	0.00	---	---	520.0 (2)	1051.5 (2)	863.8 (2)	---	95.0 (2)	12.5 (2)	169.5 (2)	102.0 (2)	289.5 (2)	545.3 (2)
720	550-731	105	0.00	---	---	147.0 (2)	306.0 (2)	43.2 (2)	1598.6 (2)	---	471.0 (2)	103.5 (2)	160.0 (2)	88.4 (2)	12.7 (2)
722	550-731	93	0.76	11.5 (2)	---	371.5 (2)	56.5 (2)	365.5 (2)	324.0 (2)	13.8 (2)	278.0 (2)	15.0 (2)	156.4 (2)	282.3 (2)	336.4 (2)
764	732-914	105	1.00	---	---	---	---	---	---	---	5.0 (2)	---	4.5 (2)	0.0 (2)	0.5 (2)
768	732-914	99	0.00	---	---	---	---	---	---	---	0.5 (2)	---	0.0 (2)	0.0 (2)	0.0 (2)
772	732-914	135	0.00	---	---	---	---	---	---	---	0.0 (2)	---	6.3 (2)	---	0.6 (2)
	Total:	6350	9.46												
Upper (95% CI)				3059.2	1217.7	587.0	672.0	9437.2	445.6	7592.4	3138.3	686.7	515.7	1000.7	618.7
Weighted mean (by area)				436.0	572.0	371.5	388.6	1233.7	203.8	1304.5	455.7	359.5	411.0	416.0	317.1
Lower (95% CI)				-2187.1	-73.7	156.0	105.2	-6969.8	-25.1	-4983.5	-2226.9	32.3	306.3	-168.7	15.5
SURVEY ABUNDANCE(x10^6)				336.3	421.8	302.3	321.3	1020.1	153.3	1059.8	398.0	268.3	359.0	355.6	300.9
ABUNDANCE within NRA				108.4	111.0	25.1	42.0	404.2	31.8	253.2	62.9	77.0	62.0	52.7	52.7
% within NRA				32.2	26.3	8.3	13.1	39.6	20.8	23.9	15.8	28.7	17.3	14.8	17.5
				Campelen Trawl Equivalent 1991-1994				Campelen Trawl 1995-Present							
329	093-183	1721	0.00	0.0 (7)	0.0 (3)	0.0 (5)	0.00 (6)	1.0 (5)	0.0 (5)	22.6 (5)	0.0 (5)	0.0 (5)	0.0 (5)	42.1 (5)	32.2 (5)
332	093-183	1047	0.00	0.0 (4)	13.3 (3)	2.7 (3)	15.59 (3)	31.5 (3)	0.2 (2)	7.7 (3)	2.7 (3)	0.8 (3)	0.8 (3)	0.1 (3)	1.7 (3)
337	093-183	948	0.00	30.8 (4)	64.7 (2)	7.0 (3)	5.04 (2)	55.5 (2)	0.0 (2)	17.9 (3)	34.6 (3)	1.9 (3)	12.7 (3)	2.9 (3)	3.9 (3)
339	093-183	585	0.00	0.0 (2)	0.0 (2)	0.0 (2)	0.00 (2)	0.0 (2)	0.0 (3)	0.0 (2)	0.0 (2)		0.2 (2)	0.2 (2)	0.1 (2)
354	093-183	474	0.52	0.0 (2)	171.5 (2)	0.0 (2)	0.00 (2)	785.3 (3)	15.6 (2)	915.0 (2)	31.5 (2)	69.0 (2)	0.0 (2)	35.2 (2)	10.9 (2)
333	185-274	151(147)	0.00	27.1 (2)	168.0 (2)	46.5 (2)	257.7 (2)	107.0 (2)	---	26.5 (2)	20.0 (2)	18.0 (2)	24.4 (2)	31.0 (2)	3.9 (2)
336	185-274	121	0.00	18.5 (2)	374.3 (2)	378.8 (2)	357.8 (2)	49.7 (2)	9.1 (2)	117.4 (2)	103.8 (2)	548.7 (2)	98.9 (2)	13.5 (2)	9.0 (2)
355	185-274	103	0.72	352.2 (2)	450.7 (2)	77.9 (2)	264.2 (2)	237.0 (2)	37.9 (2)	25.9 (2)	11.9 (2)	387.8 (2)	127.8 (2)	119.0 (2)	64.2 (2)
334	275-366	92(96)	0.00	1317.9 (2)	480.7 (2)	380.5 (3)	171.1 (2)	506.8 (2)	---	289.5 (2)	188.3 (2)	22.6 (2)	54.6 (2)	188.8 (2)	13.7 (2)
335	275-366	58	0.00	512.6 (2)	850.9 (2)	351.8 (2)	877.1 (2)	187.7 (2)	332.2 (2)	1114.4 (2)	382.1 (2)	443.2 (2)	355.4 (2)	89.0 (2)	82.5 (2)
356	275-366	61	0.77	59.4 (2)	684.6 (2)	60.1 (2)	303.8 (2)	387.6 (2)	145.5 (2)	106.1 (2)	914.5 (2)	592.9 (2)	881.6 (2)	370.6 (2)	96.4 (2)
717	367-549	93(166)	0.00	---	---	1391.3 (2)	340.4 (2)	588.8 (2)	---	2281.8 (2)	1834.0 (2)	135.7 (2)	1143.7 (2)	229.2 (2)	75.9 (2)
719	367-549	76	0.00	268.9 (2)	---	930.5 (2)	536.2 (2)	414.0 (2)	656.4 (2)	880.2 (2)	321.3 (2)	691.0 (2)	1313.7 (3)	373.6 (2)	889.9 (2)
721	367-549	76	0.76	53.7 (2)	---	100.4 (2)	16.57 (2)	1666.7 (2)	87.3 (2)	732.5 (2)	410.5 (2)	177.5 (2)	230.2 (2)	319.2 (2)	762.0 (2)
718	550-731	111(134)	0.00	---	---	169.3 (2)	442.1 (2)	409.4 (2)	---	37.1 (2)	4.4 (2)	48.0 (2)	24.8 (2)	79.5 (2)	118.0 (2)
720	550-731	105	0.00	---	---	50.0 (2)	118.7 (2)	16.5 (2)	572.6 (2)	---	162.6 (2)	21.3 (2)	52.3 (2)	16.1 (2)	2.9 (2)
722	550-731	93	0.76	7.7 (2)	---	164.0 (2)	22.71 (2)	125.8 (2)	103.9 (2)	4.0 (2)	108.6 (2)	5.3 (2)	34.9 (2)	125.2 (2)	68.1 (2)
764	732-914	105	1.00	---	---	---	---	---	---	---	1.6	---	2.6 (2)	0.0 (2)	0.4 (2)
768	732-914	99	0.00	---	---	---	---	---	---	---	0.3	---	0.0 (2)	0.0 (2)	0.0 (2)
772	732-914	135	0.00	---	---	---	---	---	---	---	0.0	---	2.2 (2)	---	0.1 (2)
	Total:	6350	9.46												
Upper (95% CI)				306.5	147.4	105.2	109.0	972.0	86.2	1182.1	664.3	106.8	83.3	75.6	68.1
Weighted mean (by area)				44.9	76.3	63.6	64.5	151.9	30.5	190.3	86.6	56.4	68.7	43.6	38.9
Lower (95% CI)				-216.7	5.2	22.1	20.0	-668.2	-25.1	-801.5	-491.0	6.0	54.0	11.6	9.7
BIOMASS(tons)				34618	56247	51782	53324	125578	22974	154622	75676	42100	60004	37286	33976
BIOMASS within NRA				4473	14818	3584	5008	46022	3565	37798	11459	11585	8700	8567	8396
% within NRA				12.9	26.3	6.9	9.4	36.6	15.5	24.4	15.1	27.5	14.5	23.0	24.7

3O Autumn

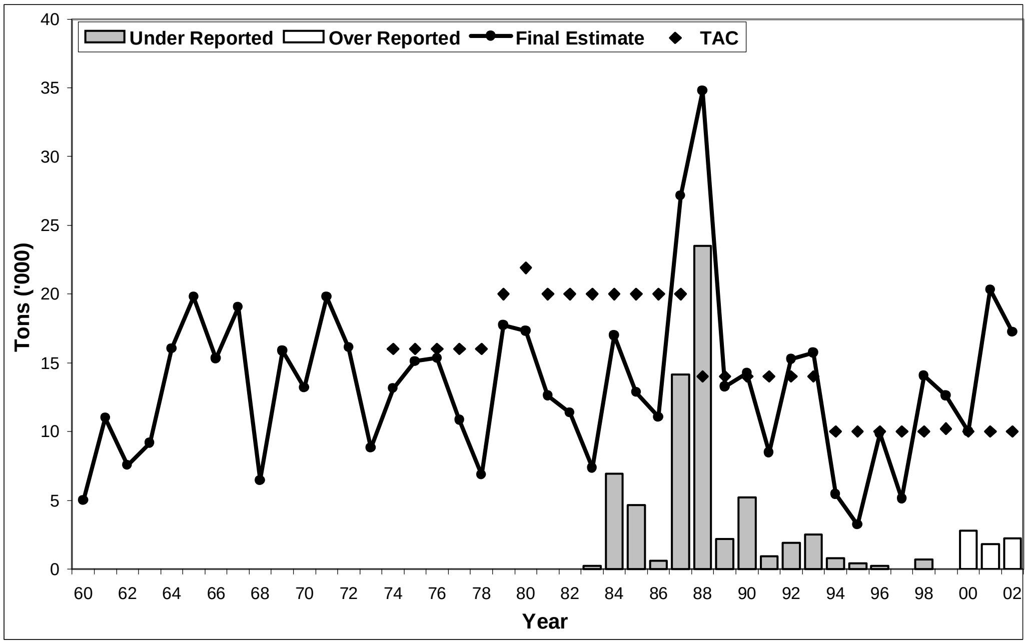

Fig. 1: Nominal catches and TACs of redfish in Div. 3O.

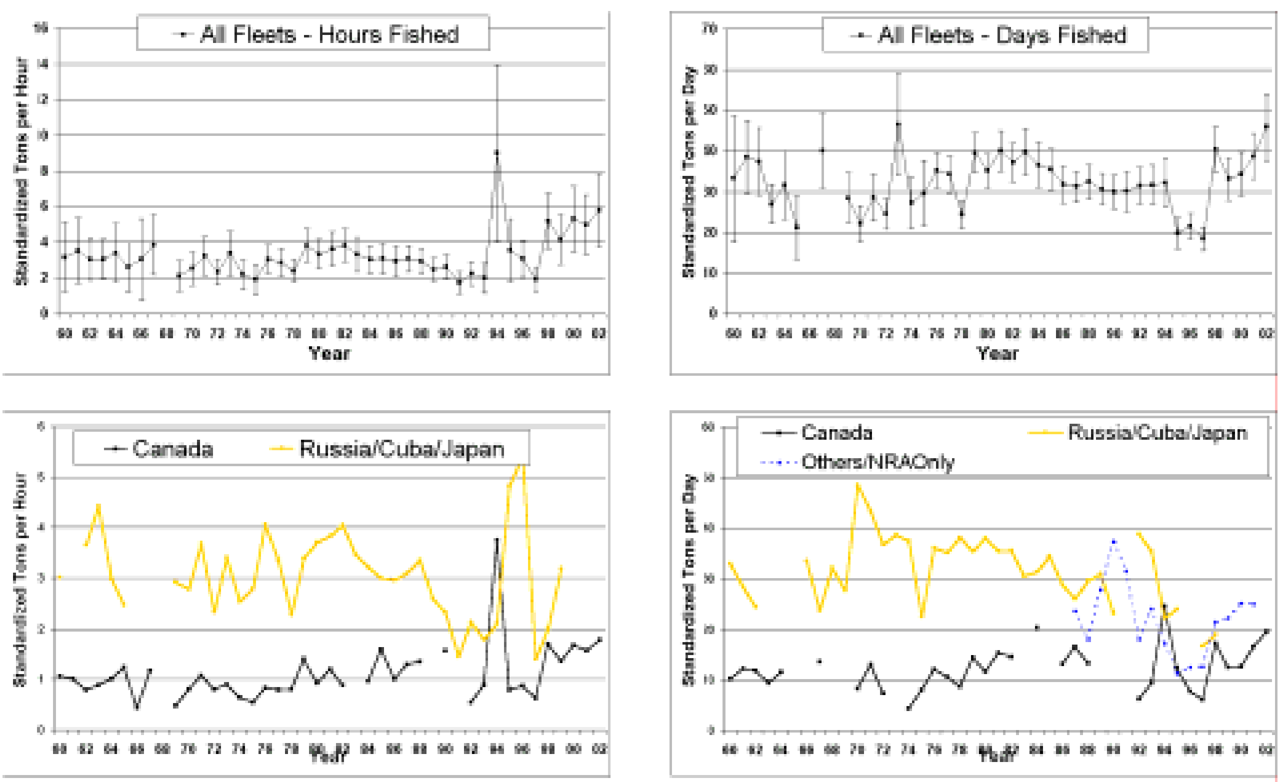

Fig. 2. Standardized Mean CPUE ± 2 standard errors for Redfish in Div. 3O from 1960-2002 utilizing effort in HOURS fished (left panel) and DAYS fished (right panel). Lower panels denote standardizations separately by fleets that have fished only inside the 200-mile limit (Canada), fleets that have fish inside and in the NRA (Russia, Cuba) and fleets that have only fished in the NRA .

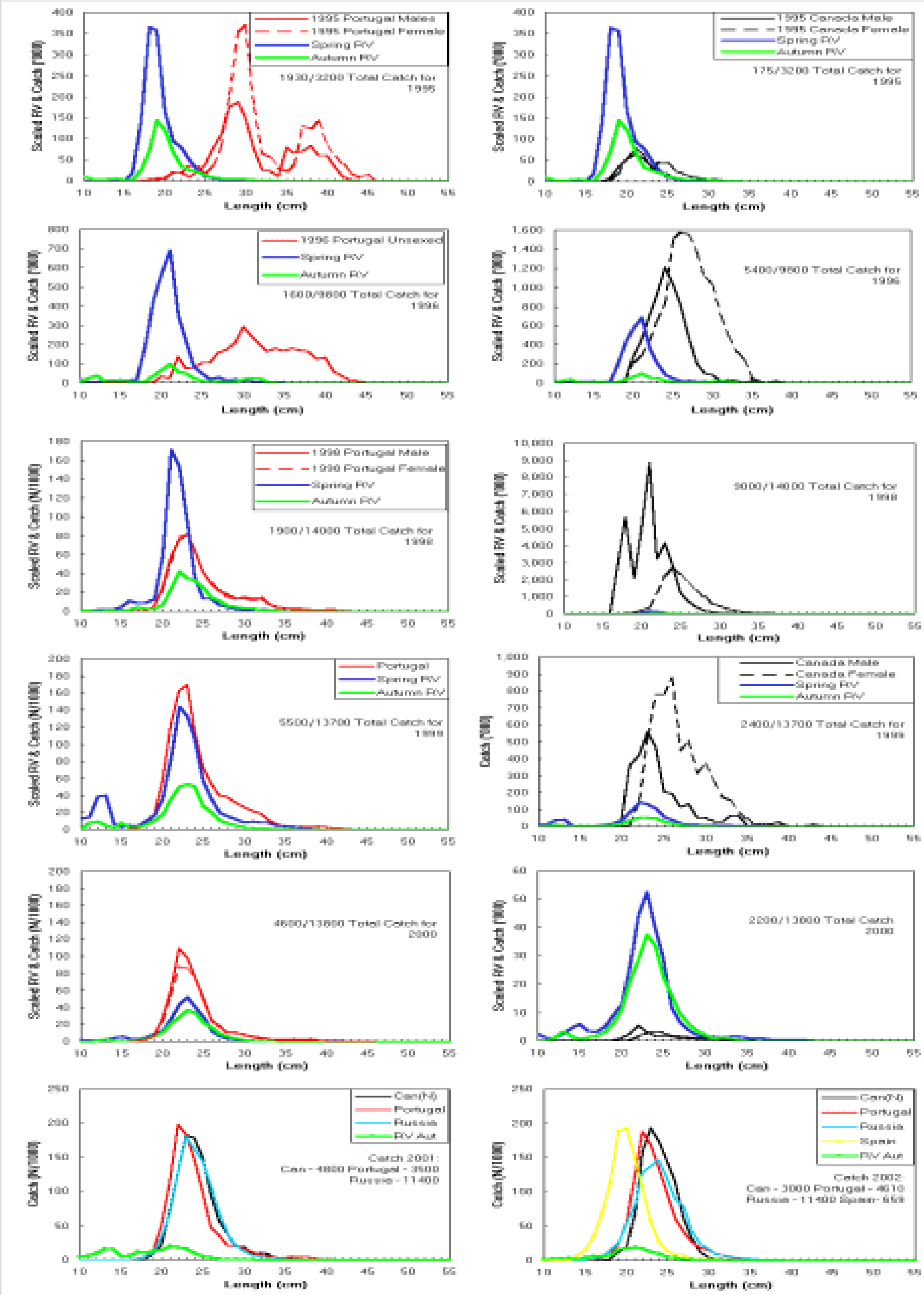

Fig. 3. Commercial catch-at-length for Div. 3O compared with RV catch-at-length.

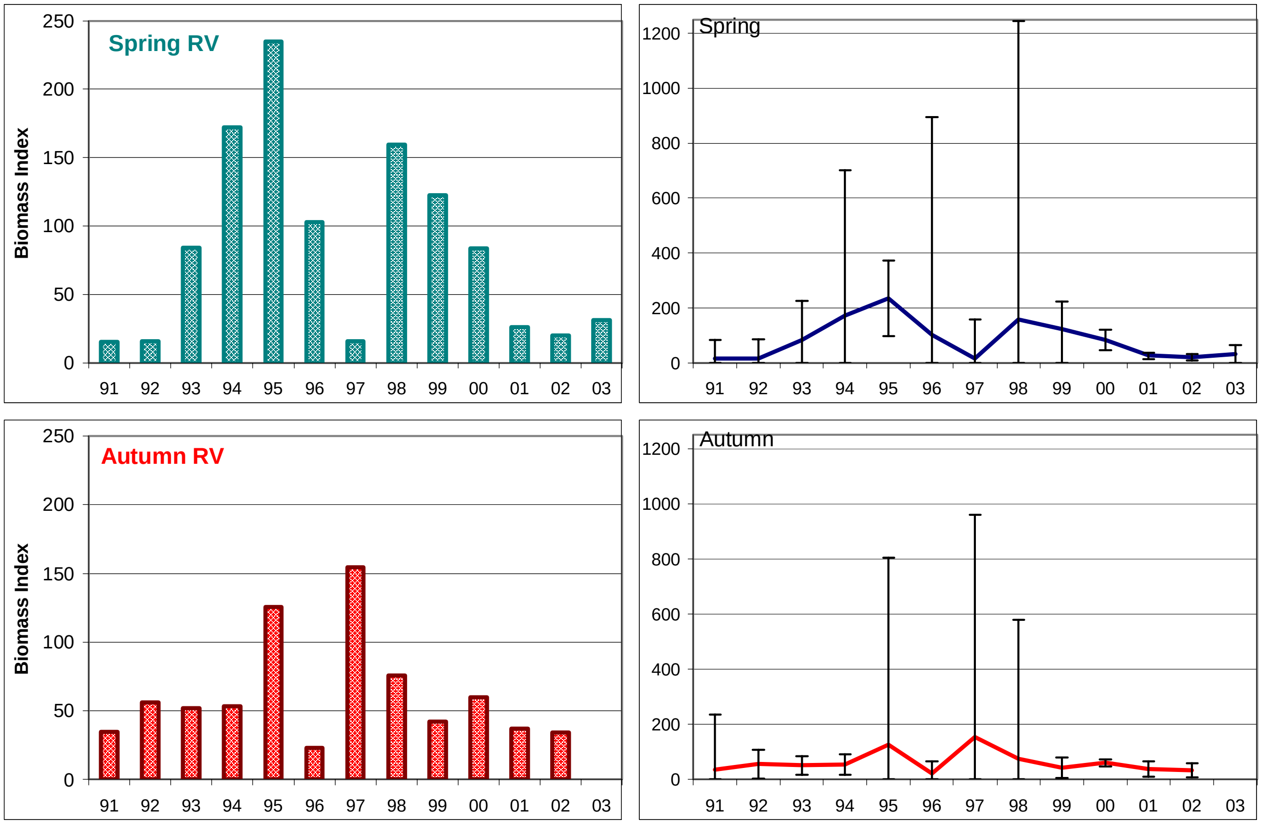

Fig. 4. Survey biomass for redfish in Div. 3O for spring and autumn surveys from 1991-2002 (upper panel) with 95% CI (lower panels). Surveys prior to autumn 1995 utilized an Engel trawl. Estimates were converted into Campelen equivalents based on comparative fishing trials.

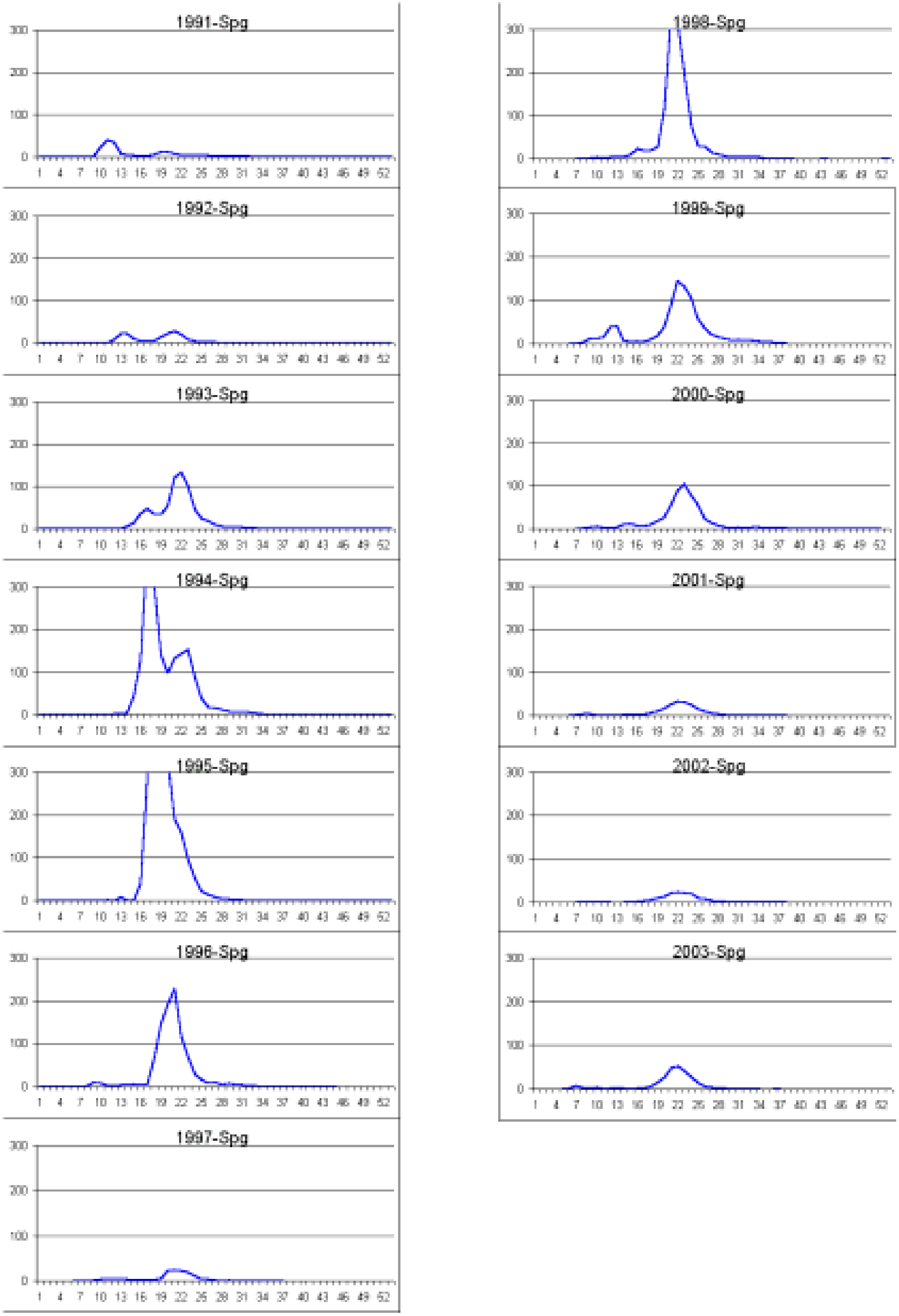

Fig. 5. Length distributions from RV surveys to Div. 3O in SPRING from 1991-2003. Plotted are mean per standard tow. The 1991-1995 data are convertions into Campelen equivalents based on a comparative fishing experiments.

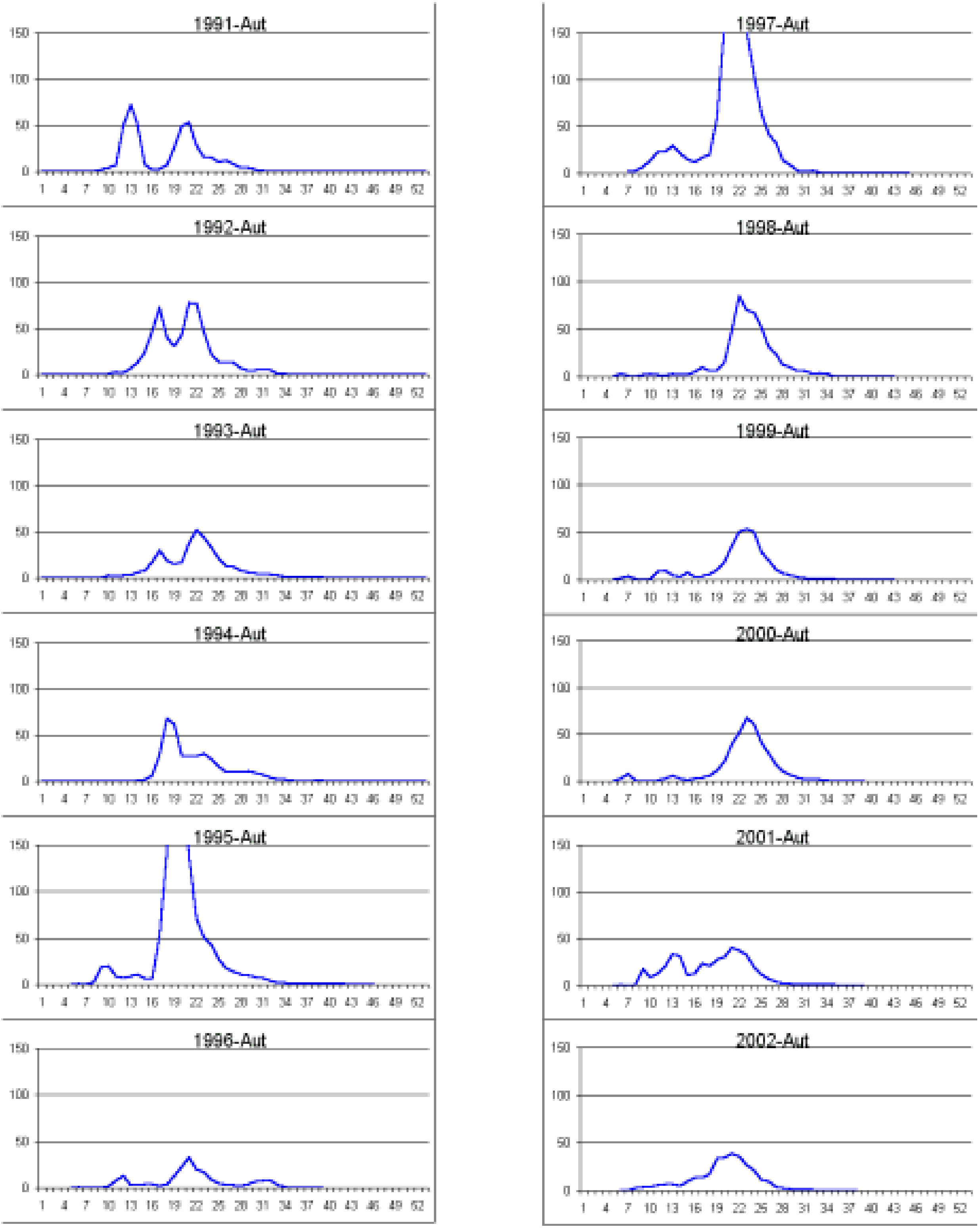

Fig. 6. Length distributions from RV surveys to Div. 3O in AUTUMN from 1991-2002. Plotted are mean per standard tow. The 1991-1994 data are convertions into Campelen equivalents based on a comparative fishing experiments.

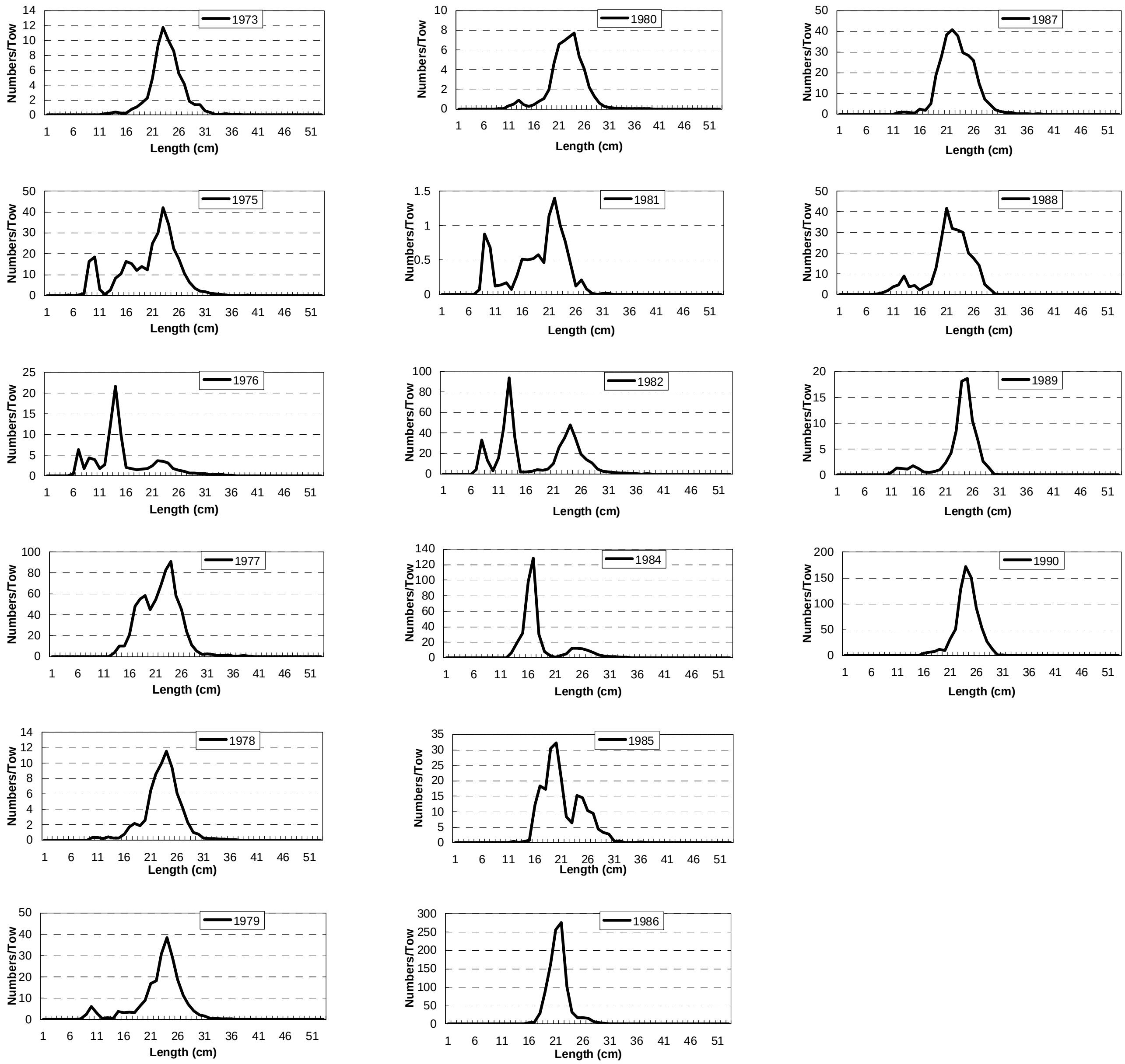

Fig. 7. Length distributions from RV surveys to Div. 3O in spring from 1973-1990. Plotted are mean per standard tow. The surveys covered depths to 200 fathoms.

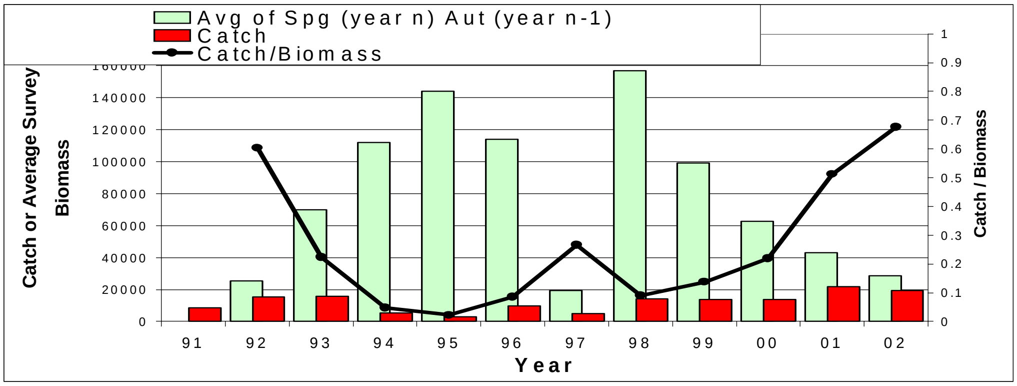

Fig. 8. Catch/Biomass ratios for Div. 3O. Plotted are average survey biomass between spring (n) and autumn (n-1) for year (n) in which catch was taken.

APPENDEX 1

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ASPIC 3.81 3O Redfish with NAFO Cpue series 1960-2002 in days fished
Page 1
                                                                                                                    13 Jun 2003 at
17:04.36
ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.81)
FIT Mode

Author: Michael H. Prager; NOAA/NMFS/S.E. Fisheries Science Center                                         ASPIC
User's Manual
        101 Pivers Island Road; Beaufort, North Carolina  28516  USA                                        is
available gratis
                                                                                                                       from the
author.
Ref:    Prager, M. H.  1994.  A suite of extensions to a nonequilibrium
        surplus-production model.  Fishery Bulletin 92: 374-389.


CONTROL PARAMETERS USED (FROM INPUT FILE)
------------------------------------------------------------------------------------------------------------------
Number of years analyzed:                       43            Number of bootstrap trials:
0
Number of data series:                           2            Lower bound on MSY:
2.000E+03
Objective function computed:             in effort            Upper bound on MSY:
5.000E+05
Relative conv. criterion (simplex):      1.000E-08            Lower bound on r:
2.000E-03
Relative conv. criterion (restart):      3.000E-08            Upper bound on r:
5.000E+00
Relative conv. criterion (effort):       1.000E-04            Random number seed:
2345678
Maximum F allowed in fitting:                8.000            Monte Carlo search mode, trials:            2
10000


PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS)
code  0
------------------------------------------------------------------------------------------------------------------
Normal convergence.


CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)
------------------------------------------------------------------------------------------------------------------
                                       |
 1  NAFO CPUE series                   |   1.000
                                       |      41
                                       |
 2  Russian 30 Spring series           |   0.633   1.000
                                       |      10      10
                                       --------------------------------------------------
                                               1       2


GOODNESS-OF-FIT AND WEIGHTING FOR NON-BOOTSTRAPPED ANALYSIS
------------------------------------------------------------------------------------------------------------------
                                                     Weighted          Weighted      Current    Suggested
R-squared
Loss component number and title                           SSE    N          MSE       weight       weight
in CPUE

Loss(-1)  SSE in yield                              0.000E+00
Loss( 0)  Penalty for B1R > 2                       0.000E+00    1          N/A    1.000E+00          N/A
Loss( 1)  NAFO CPUE series                          2.395E+00   41    6.141E-02    1.000E+00    1.225E+00
-0.173
Loss( 2)  Russian 30 Spring series                  7.582E+00   10    9.477E-01    1.000E+00    7.934E-02
-0.038
TOTAL OBJECTIVE FUNCTION:                      9.97672540E+00

Number of restarts required for convergence:                8
Est. B-ratio coverage index (0 worst, 2 best):         0.5342               < These two measures are defined
in Prager
Est. B-ratio nearness index (0 worst, 1 best):         1.0000               <     et al. (1996), Trans. A.F.S.
125:729
```

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Starting guess	Estimated	User guess
B1R	Starting biomass ratio, year 1960	9.502E-01	1.500E+00	1	1
MSY	Maximum sustainable yield	1.445E+04	2.000E+05	1	1
r	Intrinsic rate of increase	4.019E-01	3.000E-01	1	1
....	Catchability coefficients by fishery:				
q(1)	NAFO CPUE series	3.875E-04	5.000E-05	1	1
q(2)	Russian 30 Spring series	5.279E-03	5.000E-05	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	Related quantity
MSY	Maximum sustainable yield	1.445E+04	Kr/4	
K	Maximum stock biomass	1.438E+05		
Bmsy	Stock biomass at MSY	7.190E+04	K/2	
Fmsy	Fishing mortality at MSY	2.010E-01	r/2	
F(0.1)	Management benchmark	1.809E-01	0.9*Fmsy	
Y(0.1)	Equilibrium yield at F(0.1)	1.430E+04	0.99*MSY	
B-ratio	Ratio of B(2003) to Bmsy	1.208E+00		
F-ratio	Ratio of F(2002) to Fmsy	9.685E-01		
F01-mult	Ratio of F(0.1) to F(2002)	9.292E-01		
Y-ratio	Proportion of MSY avail in 2003	9.567E-01	2*Br-Br^2	Ye(2003) = 1.382E+04
....	Fishing effort at MSY in units of each fishery:			
fmsy(1)	NAFO CPUE series	5.186E+02	r/2q(1)	f(0.1) = 4.667E+02

ASPIC 3.81 3O Redfish with NAFO Cpue series 1960-2002 in days fished
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ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1	1960	0.068	6.832E+04	7.309E+04	5.000E+03	5.000E+03	1.442E+04	3.404E-01	9.502E-01
2	1961	0.138	7.774E+04	7.943E+04	1.100E+04	1.100E+04	1.429E+04	6.891E-01	1.081E+00
3	1962	0.090	8.103E+04	8.434E+04	7.557E+03	7.557E+03	1.401E+04	4.459E-01	1.127E+00
4	1963	0.102	8.748E+04	8.974E+04	9.180E+03	9.180E+03	1.355E+04	5.091E-01	1.217E+00
5	1964	0.177	9.185E+04	9.051E+04	1.604E+04	1.604E+04	1.348E+04	8.821E-01	1.278E+00
6	1965	0.230	8.928E+04	8.617E+04	1.979E+04	1.979E+04	1.387E+04	1.143E+00	1.242E+00
7	1966	0.185	8.336E+04	8.275E+04	1.531E+04	1.531E+04	1.412E+04	9.204E-01	1.159E+00
8	1967	0.239	8.218E+04	7.968E+04	1.904E+04	1.904E+04	1.427E+04	1.189E+00	1.143E+00
9	1968	0.079	7.741E+04	8.137E+04	6.445E+03	6.445E+03	1.418E+04	3.942E-01	1.077E+00
10	1969	0.189	8.515E+04	8.418E+04	1.588E+04	1.588E+04	1.402E+04	9.386E-01	1.184E+00
11	1970	0.158	8.330E+04	8.374E+04	1.319E+04	1.319E+04	1.406E+04	7.839E-01	1.159E+00
12	1971	0.244	8.416E+04	8.123E+04	1.979E+04	1.979E+04	1.420E+04	1.213E+00	1.171E+00
13	1972	0.208	7.857E+04	7.765E+04	1.612E+04	1.612E+04	1.435E+04	1.033E+00	1.093E+00
14	1973	0.110	7.680E+04	7.961E+04	8.797E+03	8.797E+03	1.427E+04	5.499E-01	1.068E+00
15	1974	0.159	8.228E+04	8.279E+04	1.312E+04	1.312E+04	1.412E+04	7.888E-01	1.144E+00
16	1975	0.183	8.327E+04	8.276E+04	1.511E+04	1.511E+04	1.412E+04	9.086E-01	1.158E+00
17	1976	0.188	8.228E+04	8.167E+04	1.535E+04	1.535E+04	1.418E+04	9.351E-01	1.144E+00
18	1977	0.131	8.111E+04	8.280E+04	1.085E+04	1.085E+04	1.411E+04	6.521E-01	1.128E+00
19	1978	0.078	8.438E+04	8.790E+04	6.860E+03	6.860E+03	1.372E+04	3.884E-01	1.174E+00
20	1979	0.199	9.124E+04	8.908E+04	1.774E+04	1.774E+04	1.362E+04	9.909E-01	1.269E+00
21	1980	0.203	8.712E+04	8.536E+04	1.731E+04	1.731E+04	1.394E+04	1.009E+00	1.212E+00
22	1981	0.149	8.375E+04	8.448E+04	1.260E+04	1.260E+04	1.400E+04	7.425E-01	1.165E+00
23	1982	0.131	8.515E+04	8.644E+04	1.136E+04	1.136E+04	1.385E+04	6.540E-01	1.184E+00
24	1983	0.081	8.765E+04	9.079E+04	7.340E+03	7.340E+03	1.344E+04	4.023E-01	1.219E+00
25	1984	0.185	9.375E+04	9.184E+04	1.698E+04	1.698E+04	1.333E+04	9.200E-01	1.304E+00
26	1985	0.142	9.010E+04	9.043E+04	1.286E+04	1.286E+04	1.349E+04	7.077E-01	1.253E+00
27	1986	0.120	9.073E+04	9.191E+04	1.106E+04	1.106E+04	1.333E+04	5.985E-01	1.262E+00
28	1987	0.316	9.300E+04	8.591E+04	2.717E+04	2.717E+04	1.386E+04	1.574E+00	1.294E+00
29	1988	0.507	7.969E+04	6.863E+04	3.479E+04	3.479E+04	1.432E+04	2.523E+00	1.108E+00
30	1989	0.222	5.922E+04	5.962E+04	1.326E+04	1.326E+04	1.403E+04	1.107E+00	8.237E-01
31	1990	0.238	5.999E+04	5.989E+04	1.424E+04	1.424E+04	1.404E+04	1.183E+00	8.344E-01
32	1991	0.135	5.979E+04	6.271E+04	8.461E+03	8.461E+03	1.420E+04	6.715E-01	8.317E-01
33	1992	0.235	6.554E+04	6.505E+04	1.527E+04	1.527E+04	1.432E+04	1.168E+00	9.115E-01
34	1993	0.246	6.459E+04	6.383E+04	1.572E+04	1.572E+04	1.427E+04	1.225E+00	8.983E-01
35	1994	0.080	6.313E+04	6.765E+04	5.428E+03	5.428E+03	1.438E+04	3.993E-01	8.781E-01
36	1995	0.041	7.208E+04	7.771E+04	3.214E+03	3.214E+03	1.432E+04	2.058E-01	1.003E+00
37	1996	0.115	8.319E+04	8.531E+04	9.845E+03	9.845E+03	1.394E+04	5.743E-01	1.157E+00
38	1997	0.056	8.729E+04	9.152E+04	5.112E+03	5.112E+03	1.336E+04	2.779E-01	1.214E+00
39	1998	0.148	9.553E+04	9.496E+04	1.405E+04	1.405E+04	1.296E+04	7.364E-01	1.329E+00
40	1999	0.133	9.444E+04	9.465E+04	1.259E+04	1.259E+04	1.300E+04	6.621E-01	1.314E+00
41	2000	0.104	9.485E+04	9.629E+04	1.000E+04	1.000E+04	1.278E+04	5.169E-01	1.319E+00
42	2001	0.216	9.763E+04	9.382E+04	2.031E+04	2.031E+04	1.309E+04	1.077E+00	1.358E+00
43	2002	0.195	9.041E+04	8.855E+04	1.723E+04	1.723E+04	1.367E+04	9.685E-01	1.258E+00
44	2003		8.685E+04						1.208E+00

ASPIC 3.81 3O Redfish with NAFO Cpue series 1960-2002 in days fished
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RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) NAFO CPUE series

Data type CC: CPUE-catch series Series weight: 1.000

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Resid in yield
1	1960	3.324E+01	2.832E+01	0.0684	5.000E+03	5.000E+03	-0.15997	0.000E+00
2	1961	3.861E+01	3.078E+01	0.1385	1.100E+04	1.100E+04	-0.22666	0.000E+00
3	1962	3.739E+01	3.268E+01	0.0896	7.557E+03	7.557E+03	-0.13453	0.000E+00
4	1963	2.695E+01	3.478E+01	0.1023	9.180E+03	9.180E+03	0.25485	0.000E+00
5	1964	3.160E+01	3.507E+01	0.1773	1.604E+04	1.604E+04	0.10426	0.000E+00
6	1965	2.113E+01	3.339E+01	0.2297	1.979E+04	1.979E+04	0.45771	0.000E+00
7	1966	*	3.207E+01	0.1850	1.531E+04	1.531E+04	0.00000	0.000E+00
8	1967	4.013E+01	3.088E+01	0.2389	1.904E+04	1.904E+04	-0.26214	0.000E+00
9	1968	*	3.153E+01	0.0792	6.445E+03	6.445E+03	0.00000	0.000E+00
10	1969	2.845E+01	3.262E+01	0.1886	1.588E+04	1.588E+04	0.13699	0.000E+00
11	1970	2.214E+01	3.245E+01	0.1575	1.319E+04	1.319E+04	0.38260	0.000E+00
12	1971	2.856E+01	3.148E+01	0.2437	1.979E+04	1.979E+04	0.09739	0.000E+00
13	1972	2.453E+01	3.009E+01	0.2076	1.612E+04	1.612E+04	0.20422	0.000E+00
14	1973	4.658E+01	3.085E+01	0.1105	8.797E+03	8.797E+03	-0.41199	0.000E+00
15	1974	2.724E+01	3.209E+01	0.1585	1.312E+04	1.312E+04	0.16378	0.000E+00
16	1975	2.959E+01	3.207E+01	0.1826	1.511E+04	1.511E+04	0.08036	0.000E+00
17	1976	3.521E+01	3.165E+01	0.1879	1.535E+04	1.535E+04	-0.10654	0.000E+00
18	1977	3.430E+01	3.209E+01	0.1310	1.085E+04	1.085E+04	-0.06664	0.000E+00
19	1978	2.427E+01	3.406E+01	0.0780	6.860E+03	6.860E+03	0.33910	0.000E+00
20	1979	3.957E+01	3.452E+01	0.1991	1.774E+04	1.774E+04	-0.13653	0.000E+00
21	1980	3.510E+01	3.308E+01	0.2027	1.731E+04	1.731E+04	-0.05932	0.000E+00
22	1981	4.003E+01	3.274E+01	0.1492	1.260E+04	1.260E+04	-0.20100	0.000E+00
23	1982	3.718E+01	3.350E+01	0.1314	1.136E+04	1.136E+04	-0.10432	0.000E+00
24	1983	3.974E+01	3.518E+01	0.0808	7.340E+03	7.340E+03	-0.12164	0.000E+00
25	1984	3.659E+01	3.559E+01	0.1849	1.698E+04	1.698E+04	-0.02766	0.000E+00
26	1985	3.546E+01	3.504E+01	0.1422	1.286E+04	1.286E+04	-0.01179	0.000E+00
27	1986	3.176E+01	3.562E+01	0.1203	1.106E+04	1.106E+04	0.11465	0.000E+00
28	1987	3.122E+01	3.329E+01	0.3163	2.717E+04	2.717E+04	0.06421	0.000E+00
29	1988	3.245E+01	2.659E+01	0.5070	3.479E+04	3.479E+04	-0.19891	0.000E+00
30	1989	3.053E+01	2.310E+01	0.2224	1.326E+04	1.326E+04	-0.27889	0.000E+00
31	1990	2.994E+01	2.321E+01	0.2378	1.424E+04	1.424E+04	-0.25466	0.000E+00
32	1991	3.007E+01	2.430E+01	0.1349	8.461E+03	8.461E+03	-0.21315	0.000E+00
33	1992	3.149E+01	2.521E+01	0.2347	1.527E+04	1.527E+04	-0.22242	0.000E+00
34	1993	3.164E+01	2.474E+01	0.2463	1.572E+04	1.572E+04	-0.24620	0.000E+00
35	1994	3.221E+01	2.622E+01	0.0802	5.428E+03	5.428E+03	-0.20592	0.000E+00
36	1995	1.978E+01	3.011E+01	0.0414	3.214E+03	3.214E+03	0.42024	0.000E+00
37	1996	2.145E+01	3.306E+01	0.1154	9.845E+03	9.845E+03	0.43240	0.000E+00
38	1997	1.840E+01	3.547E+01	0.0559	5.112E+03	5.112E+03	0.65645	0.000E+00
39	1998	4.039E+01	3.680E+01	0.1480	1.405E+04	1.405E+04	-0.09310	0.000E+00
40	1999	3.314E+01	3.668E+01	0.1330	1.259E+04	1.259E+04	0.10139	0.000E+00
41	2000	3.428E+01	3.732E+01	0.1039	1.000E+04	1.000E+04	0.08478	0.000E+00
42	2001	3.867E+01	3.636E+01	0.2165	2.031E+04	2.031E+04	-0.06163	0.000E+00
43	2002	4.591E+01	3.431E+01	0.1946	1.723E+04	1.723E+04	-0.29104	0.000E+00

* Asterisk indicates missing value(s).

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ASPIC 3.81 3O Redfish with NAFO Cpue series 1960-2002 in days fished
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UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1
                   -1       -0.75     -0.5      -0.25       0        0.25      0.5       0.75       1
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    ------------------------------------------------------------------------------------
1960    -0.1600                                       ======|
1961    -0.2267                                    =========|
1962    -0.1345                                        =====|
1963     0.2548                                             |==========
1964     0.1043                                             |====
1965     0.4577                                             |==================
1966     0.0000                                             |
1967    -0.2621                                   ==========|
1968     0.0000                                             |
1969     0.1370                                             |=====
1970     0.3826                                             |===============
1971     0.0974                                             |====
1972     0.2042                                             |========
1973    -0.4120                             ================|
1974     0.1638                                             |=======
1975     0.0804                                             |===
1976    -0.1065                                         ====|
1977    -0.0666                                          ===|
1978     0.3391                                             |==============
1979    -0.1365                                        =====|
1980    -0.0593                                           ==|
1981    -0.2010                                     ========|
1982    -0.1043                                         ====|
1983    -0.1216                                        =====|
1984    -0.0277                                            =|
1985    -0.0118                                             |
1986     0.1146                                             |=====
1987     0.0642                                             |===
1988    -0.1989                                     ========|
1989    -0.2789                                  ===========|
1990    -0.2547                                   ==========|
1991    -0.2131                                    =========|
1992    -0.2224                                    =========|
1993    -0.2462                                   ==========|
1994    -0.2059                                     ========|
1995     0.4202                                             |=================
1996     0.4324                                             |=================
1997     0.6564                                             |==========================
1998    -0.0931                                         ====|
1999     0.1014                                             |====
2000     0.0848                                             |===
2001    -0.0616                                           ==|
2002    -0.2910                                 ============|
                   ------------------------------------------------------------------------------------
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ASPIC 3.81 3O Redfish with NAFO Cpue series 1960-2002 in days fished
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RESULTS FOR DATA SERIES # 2 (NON-BOOTSTRAPPED) Russian 30 Spring series

Data type B1: Year-average biomass estimates Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed biomass	Model biomass	Resid in log B	Resid in biomass
1	1960	0.000E+00	0.000E+00	0.0	*	7.309E+04	0.00000	0.0
2	1961	0.000E+00	0.000E+00	0.0	*	7.943E+04	0.00000	0.0
3	1962	0.000E+00	0.000E+00	0.0	*	8.434E+04	0.00000	0.0
4	1963	0.000E+00	0.000E+00	0.0	*	8.974E+04	0.00000	0.0
5	1964	0.000E+00	0.000E+00	0.0	*	9.051E+04	0.00000	0.0
6	1965	0.000E+00	0.000E+00	0.0	*	8.617E+04	0.00000	0.0
7	1966	0.000E+00	0.000E+00	0.0	*	8.275E+04	0.00000	0.0
8	1967	0.000E+00	0.000E+00	0.0	*	7.968E+04	0.00000	0.0
9	1968	0.000E+00	0.000E+00	0.0	*	8.137E+04	0.00000	0.0
10	1969	0.000E+00	0.000E+00	0.0	*	8.418E+04	0.00000	0.0
11	1970	0.000E+00	0.000E+00	0.0	*	8.374E+04	0.00000	0.0
12	1971	0.000E+00	0.000E+00	0.0	*	8.123E+04	0.00000	0.0
13	1972	0.000E+00	0.000E+00	0.0	*	7.765E+04	0.00000	0.0
14	1973	0.000E+00	0.000E+00	0.0	*	7.961E+04	0.00000	0.0
15	1974	0.000E+00	0.000E+00	0.0	*	8.279E+04	0.00000	0.0
16	1975	0.000E+00	0.000E+00	0.0	*	8.276E+04	0.00000	0.0
17	1976	0.000E+00	0.000E+00	0.0	*	8.167E+04	0.00000	0.0
18	1977	0.000E+00	0.000E+00	0.0	*	8.280E+04	0.00000	0.0
19	1978	0.000E+00	0.000E+00	0.0	*	8.790E+04	0.00000	0.0
20	1979	0.000E+00	0.000E+00	0.0	*	8.908E+04	0.00000	0.0
21	1980	0.000E+00	0.000E+00	0.0	*	8.536E+04	0.00000	0.0
22	1981	0.000E+00	0.000E+00	0.0	*	8.448E+04	0.00000	0.0
23	1982	0.000E+00	0.000E+00	0.0	*	8.644E+04	0.00000	0.0
24	1983	1.000E+00	1.000E+00	0.0	2.126E+05	9.079E+04	0.85091	1.218E+05
25	1984	1.000E+00	1.000E+00	0.0	8.410E+04	9.184E+04	-0.08802	-7.738E+03
26	1985	1.000E+00	1.000E+00	0.0	1.573E+05	9.043E+04	0.55369	6.689E+04
27	1986	1.000E+00	1.000E+00	0.0	1.221E+05	9.191E+04	0.28425	3.022E+04
28	1987	1.000E+00	1.000E+00	0.0	2.053E+04	8.591E+04	-1.43141	-6.538E+04
29	1988	1.000E+00	1.000E+00	0.0	9.048E+04	6.863E+04	0.27641	2.185E+04
30	1989	1.000E+00	1.000E+00	0.0	2.764E+04	5.962E+04	-0.76866	-3.198E+04
31	1990	1.000E+00	1.000E+00	0.0	9.866E+04	5.989E+04	0.49918	3.877E+04
32	1991	1.000E+00	1.000E+00	0.0	1.349E+04	6.271E+04	-1.53620	-4.921E+04
33	1992	0.000E+00	0.000E+00	0.0	*	6.505E+04	0.00000	0.0
34	1993	1.000E+00	1.000E+00	0.0	1.854E+05	6.383E+04	1.06649	1.216E+05
35	1994	0.000E+00	0.000E+00	0.0	*	6.765E+04	0.00000	0.0
36	1995	0.000E+00	0.000E+00	0.0	*	7.771E+04	0.00000	0.0
37	1996	0.000E+00	0.000E+00	0.0	*	8.531E+04	0.00000	0.0
38	1997	0.000E+00	0.000E+00	0.0	*	9.152E+04	0.00000	0.0
39	1998	0.000E+00	0.000E+00	0.0	*	9.496E+04	0.00000	0.0
40	1999	0.000E+00	0.000E+00	0.0	*	9.465E+04	0.00000	0.0
41	2000	0.000E+00	0.000E+00	0.0	*	9.629E+04	0.00000	0.0
42	2001	0.000E+00	0.000E+00	0.0	*	9.382E+04	0.00000	0.0
43	2002	0.000E+00	0.000E+00	0.0	*	8.855E+04	0.00000	0.0

* Asterisk indicates missing value(s).

```
ASPIC 3.81 3O Redfish with NAFO Cpue series 1960-2002 in days fished
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UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 2
                   -2      -1.5        -1      -0.5         0        0.5         1        1.5         2
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    ------------------------------------------------------------------------------------
1960     0.0000                                             |
1961     0.0000                                             |
1962     0.0000                                             |
1963     0.0000                                             |
1964     0.0000                                             |
1965     0.0000                                             |
1966     0.0000                                             |
1967     0.0000                                             |
1968     0.0000                                             |
1969     0.0000                                             |
1970     0.0000                                             |
1971     0.0000                                             |
1972     0.0000                                             |
1973     0.0000                                             |
1974     0.0000                                             |
1975     0.0000                                             |
1976     0.0000                                             |
1977     0.0000                                             |
1978     0.0000                                             |
1979     0.0000                                             |
1980     0.0000                                             |
1981     0.0000                                             |
1982     0.0000                                             |
1983     0.8509                                             |=================
1984    -0.0880                                           ==|
1985     0.5537                                             |===========
1986     0.2842                                             |======
1987    -1.4314                ============================|
1988     0.2764                                             |======
1989    -0.7687                              ===============|
1990     0.4992                                             |==========
1991    -1.5362              ===============================|
1992     0.0000                                             |
1993     1.0665                                             |=====================
1994     0.0000                                             |
1995     0.0000                                             |
1996     0.0000                                             |
1997     0.0000                                             |
1998     0.0000                                             |
1999     0.0000                                             |
2000     0.0000                                             |
2001     0.0000                                             |
2002     0.0000                                             |
                   ------------------------------------------------------------------------------------
```

```
ASPIC 3.81 3O Redfish with NAFO Cpue series 1960-2002 in days fished
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                Observed (O) and Estimated (*) CPUE for Data Series # 1 -- NAFO CPUE series
           :
      56. -:
           :
           :
           :
           :
      48. -:
           :                          O                                                         O
           :
           :
           :
      40. -:              O                       O   O   O                             O
           :  O                                                                               O
           :    O                                       O   O                           * * * *
           :      * *                       O     * O     * * 2 *                     *
           :O         *                       O *   *   *         *                 *     O O   *
      32. -:    *   O   *   * * * *     * * * *       *         O O O       O O O
           :  *           *         * *                               O O O       *
           :*                 O   O       O
           :      O                     O                           *
           :                                                                *   *
      24. -:                        O           O                       * *   *
           :                    O                                     *
           :          O                                                             O
           :                                                                      O
           :                                                                          O
      16. -:
           :
           :
           :
           :
       8. -:

:........................................................................................................
            :         :         :         :         :         :         :         :         :         :
:
         1960.     1965.     1970.     1975.     1980.     1985.     1990.     1995.     2000.     2005.
2010.

                Observed (O) and Estimated (*) CPUE for Data Series # 2 -- Russian 30 Spring series
           :
  240000. -:
           :
           :
           :                                              O
           :
  200000. -:
           :
           :                                                                  O
           :
           :
  160000. -:                                                  O
           :
           :
           :
           :
  120000. -:                                                    O
           :
           :
           :                                                            O               * * * *
           :    * * * *       *                 * * * * * * 2 * * * O               * *         *
   80000. -:  *         * * *   * * * * * * * *                                   *
           :*                                                       *
           :                                                              * * * *
           :                                                          * *
           :
   40000. -:
           :
           :                                                      O   O
           :                                                              O
           :
       0. -:

:........................................................................................................
            :         :         :         :         :         :         :         :         :         :
:
         1960.     1965.     1970.     1975.     1980.     1985.     1990.     1995.     2000.     2005.
2010.
```

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ASPIC 3.81 3O Redfish with NAFO Cpue series 1960-2002 in days fished
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                                   Time Plot of Estimated F-Ratio and B-Ratio
           :
      3.0 -:
           :
           :
           :
           :
      2.5 -:                                                        F
           :
           :
           :
           :
      2.0 -:
           :
           :
           :
           :                                                      F
      1.5 -:
           :                                                                                  B
           :        B                             B         B B B B                     B B B   B
           :      B   B B F   B B 2       B     B   B B B B             F   F F     B B           B
           :  B B     F   B B       B B B   B B                     B F                       F
      1.0 -:2 - - - - - - - - - - - 2 - - - - - - 2 2 - - - - - - - - - - - - - - 2 - - - - - - 2 - - - - - - -
-
           :        F   F     F           F F               F               B B B
           :                    F       F                             B B B
           :  F                               F       F F     F           F             F F
           :                                                    F                   F
      0.5 -:      F                   F                                                     F
           :    F           F                   F         F                     F
           :F                                                                         F
           :                                                                      F
           :
      0.0 -:

:........................................................................................................
            :         :         :         :         :         :         :         :         :         :
:

         1960.     1965.     1970.     1975.     1980.     1985.     1990.     1995.     2000.     2005.
2010.
```