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Divisions 3LNO Yellowtail Flounder: Updated Survey and Catch Information for 2009 used in a Stock Production Model Incorporating Covariates (ASPIC)

by

Dawn Maddock Parsons

Northwest Atlantic Fisheries Center, Science Branch, Department of Fisheries and Oceans, Canada.
80 East White Hills Road, St. John's, Newfoundland Canada, AlC 5Xl.
Email: dawn.parsons@dfo-mpo.gc.ca

Abstract

The last assessment of 3LNO yellowtail flounder in 2008 included biological, survey and catch information and also incorporated recent and historical survey and catch indices in a surplus production model (ASPIC). For 2009, only the current update of the ASPIC model for this stock was presented. Canadian and Spanish surveys show the stock size has increased since the moratorium on directed fishing was declared in 1994. The 2007 and 2008 Canadian survey estimates of biomass are the highest in the series for the spring survey and in the fall survey, the 2007 biomass estimate is the highest in the series. Survey indices are updated, including estimates of biomass, abundance, mean numbers and mean weights per tow, length frequency data, and information on stock distribution. Another version of ASPIC (5.33) is compared to the accepted 2008 assessment (version 5.24) and no difference in model fit or output is evident. The 2009 assessment uses ASPIC version 5.33 with updated catch and survey biomass indices for 2008 to produce relative biomass and fishing mortality estimate. Projections in the short and medium term are also updated and results are presented in a precautionary approach framework.

Fishery and management

A. TAC Regulation

The stock has been under TAC regulation since 1973, when an initial level of 50 000 t was established. In 1976, the TAC was lowered to 9 000 t, following a series of high catches (Fig. 1; Table 1) and a reduction in stock size. From 1977 to 1988, the TAC varied between 12 000 t and 23 000 t and was unchanged at 15 000 t for the last 4 years of that period. The TAC was set at 5 000 t in 1989 and 1990, following sharp declines in stock size after the large catches in 1985 and 1986, then increased to 7 000 tons in 1991-94. However, NAFO Fisheries Commission decided that no directed fisheries would be permitted for this stock and some other groundfish fisheries (cod, American plaice and witch flounder) on the Grand Bank during 1994. From 1995 to 1997, the TAC was set at zero and a fishery moratorium was imposed. Following an increase in survey biomass, Scientific Council in 1997 recommended a re-opening of the yellowtail flounder fishery with a precautionary TAC of 4 000 t for the 1998 fishery. With the cessation of the moratorium, other management measures were imposed, such as delaying the re-opening until August of 1998 to allow the majority of yellowtail flounder spawning in that year to be completed, and restricting the fishery to Div. 3N and 3O. For the 1999 fishery, a TAC was set at 6 000 t and again restricted to Div. 3N and 3O, but there were no restrictions on the time period. A stock production model was used as the basis for Scientific Council's recommended TAC of 10 000 t for the 2000 fishery. Since then, the stock production model has continued to be the basis of TAC advice, which was set at 13 000 t in 2001-2002, increasing to 14 500 tons for 2003 and 2004, 15 000 tons for 2005-2006 and 15 500 tons for 2007 and 2008. In 2008, Scientific Council noted that this stock was well above B_{msy}, and recommended any TAC option up to 85% F_{msy} for 2009 and 2010. For 2009 the TAC was set at 17 000 tons.

B. Catch Trends

The nominal catch increased from negligible amounts in the early 1960s to a peak of 39 000 t in 1972 (Table 1; Fig. 1). With the exception of 1985 and 1986, when the nominal catch was around 30 000 t, catches were in the range of 10 000 to 18 000 t from 1976 to 1993, the year before the moratorium.

During the moratorium (1994-97), catches decreased from approximately 2 000 tons in 1994 to around 300 - 800 tons per year, as by-catch in other fisheries (Table 1). Since the fishery re-opened in 1998, catches have increased from 4 400 tons to a high of 14 100 tons in 2001. Overall, catches exceeded the TACs during 1985 to 1993 and again from 1998-2001, by about 10% in the latter period (Table 1; Fig. 1). Since 2002 the catches have been below the TAC. Both the 2004 and 2005 nominal catch estimates of 13 354 tons and 13 933 tons, respectively are below their respective TAC of 14 500 tons and 15 000 tons. In 2004, Canada caught 12 575 tons and in 2005 caught 13 137 tons. Corporate restructuring and labour disputes, in 2006, prevented the Canadian fleet from prosecuting the Yellowtail flounder fishery, and Canadian catch was only 177 tons. The nominal catch in that year was only 930 tons, well below the TAC of 15 500 tons. In 2007, the participation in the fishery increased by Canadian fleet, but was still low at 3 673 tons, and the nominal catch was 4 617 tons. Catch increased in 2008 to 11 400 tons.

In some years, small catches of yellowtail have been reported from the Flemish Cap, NAFO Div. 3M. STACFIS previously noted that these catches were probably errors in reporting or identification, as the reported distribution of yellowtail flounder does not extend to the Flemish Cap.

Table 2 shows a breakdown of the Canadian catches by year, division and gear. With the exception of 1991-1993, when Canadian vessels pursued a mixed fishery for plaice and yellowtail flounder in Div. 3O, the majority of catches have been taken in Div. 3N. The most important gear is otter trawl. The Canadian otter trawl catch in Div. 3L of 2 760 t in 2004 was the highest in this Division since 1986 but the catches declined by about 1 000 t in Div. 3N and 1 800 t in Div. 3O from 2003 to 2004. Although the Div. 3L and 3O catches were lower in 2005 when compared to 2004, Canada's highest catch of 10 572 t came from Div. 3N and represents the highest level from this division since 1981. In 2006, catch was negligible; with only 177 tons taken mainly in 3N (1 ton was taken in 3L). Canadian catch in 3L was only 5 tons in 2007 but increased to 985 tons in 2008. In 3N and 3O catches increased from 2006, and in 2007 were 2 053 tons and 1 615 tons respectively. Catch in 3N and 3O in 2008 was 10 210 tons, closer to the average for 2000-2005.

II. Research Survey Data

A. Canadian Stratified-random Surveys Spring and Fall Surveys

Stratified-random research vessel surveys have been conducted in the spring in Divs. 3L, 3N and 3O since 1984 and in the fall since 1990. Up until 1994, the surveys were conducted using an *Engel* 145' high-rise groundfish trawl whereas the 1995-2008 surveys were carried out with a much more efficient *Campelen 1800* shrimp trawl. All data presented here are now in *Campelen 1800* trawl catch equivalents for 1984-94 with the actual data for 1995-2008.

Abundance and biomass trends

Figures 2 and 3 and Tables 3 and 4 compare the population abundance and biomass estimates of yellowtail flounder in the Canadian spring and fall surveys. Detailed descriptions of survey trends in both series are contained in Maddock Parsons (2009). Survey indices show similar trends in both series, although the fall estimates were generally higher from 1992 to 2002, with the exception of 1996 and 1999. Since then, there has been no trend in biomass estimates between the surveys (Fig. 4). The fall survey indicates that the upward trend in stock size started in 1993 while the spring survey showed the trend starting in 1995.

Figure 4 shows the result of a regression of the biomass estimates from the spring and fall time series. A linear relationship is evident with 69% of the variation being explained by the model. Two time regimes are present: 1990-1995, when the stock was at its lowest and estimates were more in agreement, and 1996-2008, when the stock was increasing and the estimates were more variable. Catchability estimates from the stock production model indicate *q's* from the Campelen surveys are around 3, and therefore swept-area stock-size is likely being overestimated in the spring and fall surveys (see Appendix 1).

Size composition and growth

Figure 5 shows the length composition of survey catches from spring and fall surveys by year for Div. 3LNO (combined sexes). Size composition in most recent years generally showed one main peak in the length frequencies in the spring surveys and multi-modal peaks in the fall surveys. More small fish were present in the survey catches beginning in the fall of 1995 onward due to the increased efficiency of the new Campelen survey gear over the old gear. Annual shifts in modes could be evidence of year classes moving through the time series.

In the spring surveys in 1996, 1997, 1999 and 2000 there were bimodal distributions seen in the data which can be tracked from year to year. For example following the first mode, in 1998 its peak is at 27.5 cm; by 1999, the peak has moved to 31.5 cm where it stays for 2000; and by 2001 it has moved to 32.5 cm. Over the next two years, the peak remained strong but doesn't appear to move because growth was probably reduced considerably (see Dwyer *et al*., 2003). At this point, it is probably made up of a number of different age classes. However since 2000 there were no bimodal peaks evident in the data (Fig. 5).

In the fall surveys, multi-modal peaks are more common and unlike the spring surveys, were evident in surveys from 2001-2008 (Fig. 5). After 30-32 cm, growth slows and becomes almost negligible between years. This is consistent with the growth curves constructed using ages from thin-sectioned otoliths (Dwyer *et al*., 2003).

Figure 6A shows survey abundance less than 21 cm from Canada and Spain for the period 1995-2008 as a proxy for recruitment. At that size, yellowtail flounder are not recruited to any of the regulated fisheries. Population numbers at length for yellowtail flounder less than 22 cm (age 0-3 years) are plotted from the spring and fall Canadian surveys and total numbers caught from the spring Spanish surveys. The trends in spring and fall abundance < 22 cm are generally similar between series with the exception of the 2004 and 2005 Canadian fall surveys which had increased abundance of small fish compared to either the Canadian spring or Spanish spring surveys. In 2006-2008, however, the number of small fish in the Canadian fall survey, although higher than either of the spring surveys, is more in line with trends in the other surveys. Figure 6B shows that there was a relationship between 1996-2003 Canadian spring and fall estimates but no linear relationship exists between the entire time series.

B. Spanish Stratified-random Spring Surveys in the Regulatory Area, Div. 3NO (*SCR Doc. 09/09*)

Beginning in 1995, Spain has conducted stratified-random surveys for groundfish in the NAFO Regulatory Area (NRA) of Div. 3NO. These surveys cover a depth range of approximately 45 to 1 300 m. In 2003, after extensive comparative fishing between the vessel, C/V *Playa de Menduiňa* and Pedreira trawl with the replacement vessel, C/V *Vizconde de Eza*, using a Campelen 1800 shrimp trawl as the new survey trawl, all data have been converted to Campelen units (Paz *et al*., 2003, 2004). In 2006, an error in the estimation method was corrected and all survey estimates were re-calculated (González-Troncoso *et al*., 2006).

The biomass of yellowtail in the Div. 3NO of the NRA increased sharply up to 1999, and since then has shown a similar annual fluctuation pattern seen in the Canadian spring surveys of Div. 3LNO (Fig. 3 and 7). Most (83%) of the biomass comes from strata 360 and 376 similar to other years. Length frequencies in the 2008 Spanish survey showed a mode around 32-34 cm (Fig. 8). As in the Canadian spring surveys (Fig. 5), this survey showed a similar progression of the peak in the length frequencies from 1998 to 2005. There was no evidence of a recruitment pulse in recent years similar to the Canadian spring survey results.

C. Stock Distribution *(SCR Doc. 09/31)*

The 2008 distribution of yellowtail flounder in NAFO Divs. 3LNO are described in the results of the Canadian spring and fall surveys (Maddock Parsons, 2009). As in recent years, the stock continues to occupy more northern areas than in previous years with the increase in stock size.

Correlation of spatial distribution in the surveys to temperature has not been updated for this assessment.

In a previous assessment, a steady increase in the abundance of yellowtail flounder was seen to coincide with a northward expansion of the stock from 1995 up to 2005 and also coincided with increasing bottom temperatures (Walsh and Brodie, 2006). Small amounts of yellowtail were sometimes found in deepwater.

D. ASPIC Model Comparisons

In the 2008 assessment of this stock (SCR 08/45), both the version change of the stock production model incorporating covariance (ASPIC; Prager 1994, 1995, 2005) and input of various sources of data were investigated as applied to yellowtail flounder in NAFO Divs. 3LNO. The agreed assessment used ASPIC version 5.24, and the survey indices listed in Table 5. There is an updated version of ASPIC available for the 2009 assessment (version 5.33) that has some minor improvements to the estimation calculations, and comparison runs of the 2008 assessment formulation were undertaken to confirm that results in the new version are unchanged from version 5.24. Two other model specifications were also considered; the starting guess for *B1/K* (a parameter that is estimated, but requires a starting guess in the model input) and the Monte Carlo (MC) search which is used during fitting to help when a repeatable solution is otherwise difficult to find.

In the switch to the new version in 2008, the starting guess for *B1/K* was left at 2, but likely should have been set to 1 (biomass at the start of the series was thought to be around *K* (Walsh and Brodie, 2003)). As well, the assessment of this stock in 2006 (and held over in the 2008 assessment) utilized the MC search feature of ASPIC, but it is recommended to leave this search off unless it is definitely needed. A third comparison run was done, then, using the 2008 formulation, the starting guess for *B1/K*=1 and no MC search. Figure 9 shows the relative biomass and relative fishing mortality estimates for both the 2008 assessment and the same formulation in the version 5.33 of ASPIC, as well as the suggested model formulation to use in 2009 (using 2008 assessment formulation for comparison). Table 6 gives model diagnostics and parameter estimates for these three runs. Other than the difference in the beginning of the time series (which is generally more sensitive to model formulation, and is affected by the starting estimate for *B1/K*), there are no differences in the trends of relative biomass and relative fishing mortality and model results and diagnostics are very similar between the comparison runs.

E. Assessment Results

Surplus production model (ASPIC)

A non-equilibrium surplus production model incorporating covariates (ASPIC; Prager, 1994, 1995, 2005) was applied to nominal catch and survey biomass indices, as was done in the 2002, 2004, 2006 and 2008 assessments of this stock (Walsh *et al*., 2002; 2004;2006; Maddock Parsons *et al*., 2008). The Schaefer production model used assumes logistic population growth, in which the change in stock biomass over time (dB_t/dt) is a quadratic function of biomass (B):

$$dB_t/dt = rB_t - (r/K)B^2_t$$

where r is the intrinsic rate of population growth, and K is carrying capacity. For a fished stock, the rate of change is also a function of catch biomass (C):

$$dB_t/dt = rB_t - (r/K)B_t^2 - C_t$$

Biological reference points can be calculated from the production model parameters:

$$MSY = K\,r / 4; \quad B_{msy} = K / 2; \quad F_{msy} = r / 2$$

Initial biomass (expressed as the ratio: *B1/K*), *K*, *MSY*, and catchability coefficients for each biomass index (q_i) were estimated using non-linear least squares of survey residuals. Once a model formulation is accepted, a bootstrapped run can be made, in which survey residuals are randomly re-sampled 500 times to derive bias-corrected probability distributions for parameter estimates. This bootstrap analyses will be the basis for catch projections. In the model runs presented, and for all subsequent projections, it was assumed that the catch in 2009 would equal the TAC of 17 000 t, although catches in 2002-2005 and 2007 were estimated to be less than the TACs. In 2006, corporate restructuring and a labour dispute in the industry resulted in a near absence of yellowtail catch by the Canadian fleet. In 2007, catches increased marginally, while in 2008 catches were more normal, at 11 400 tons.

Because of differences in catchability among the various indices, relative (to *MSY* values) indices of biomass and fishing mortality rate were used instead of absolute values. Fishing mortality refers to yield (catch) /biomass ratio.

Input data/model formulation

To investigate the sensitivity of the ASPIC model to various input specifications (starting estimates for *B1/K*, *K*, *MSY* and the random number seed) several runs of the 2008 assessment formulation and data in ASPIC version 5.33 were run. The estimates of relative biomass (B/B_{msy}) and relative fishing mortality (F/F_{msy}) for these sensitivity runs are shown in Figure 10. With the exception of 2 of the runs, in which results in the early part of the time series are sensitive to the model specification, all other runs give estimates that overlay and the model does not appear to be sensitive to input specifications.

The survey indices and catch series that were used in the production model are included in Table 5. The catch and indices (scaled to the mean of each series) are shown in Figure 11.

ASPIC model runs comparing version 5.24 and 5.33 indicated no difference in estimates of relative biomass and fishing mortality (Table 7) or in the parameter estimates (*MSY*, *K*, F_{msy}, B_{msy} etc.) and model fit indicators (Table 6). The 2009 accepted model formulation was an update of the 2008 assessment formulation (adding the 2008 catch and indices; TAC in 2009 of 17 000 tons) with the exception of setting *B1/K* starting guess at 1 and turning off the Monte Carlo search feature. See Appendix 1 for the ASPIC input file. The 2009 assessment used the indices outlined in table 5 in ASPIC version 5.33.

For the accepted model in 2009, then, correlations among biomass indices varied (see Appendix 2). Of the five pair-wise correlations among the biomass indices included in the production analysis, all were high (>0.7). This excludes a sixth possible comparison involving only 2 data points (Russian *vs*. Canadian fall).

The model fit the data relatively well (Tables 6 and 8; Figs. 12 and 13). The majority of variance in survey indices was explained by the model, but fit varied among indices (r^2 ranged from 0.54 to 0.89). Residuals appeared to be randomly distributed for most of the survey indices (see Figure 13 and Appendix 2). The Spanish survey series, however, which covers only a portion of the stock area, showed negative residuals in the first 3 years followed by positive residuals. This indicates that the series increased faster than the model estimates in the latter period. In recent years, residuals have been smaller, and in 2007, the residual was negative.

ASPIC model estimates of relative biomass (B_t /B_{msy}) and fishing mortality rates (F_t /F_{msy}) are more precisely estimated than absolute values (Prager, 1995). Therefore the estimates of annual biomass (as of Jan 1) and fishing mortality rates were presented in relative terms.

The model results were very similar in trend to recent previous assessments, but parameter estimates were slightly higher. The model suggested that a maximum sustainable yield (*MSY*) of 19 540 (80% CL = 18 290, 20 440) tons can be produced when the total stock biomass (B_{msy}) is 78 550 (80% CL=72 580, 102 200) tons and the fishing mortality rate (F_{msy}) is 0.25 (80% CL = 0.21, 0.28) (Table 7; Appendix 2). Estimates of relative biomass and fishing mortality rates are given in Table 8 and shown in Fig. 14. Biomass showed a continuous decline from the late 1960s to the mid-1970s, stabilized through the mid-1980s, before declining further until about 1994, when the moratorium was imposed. The analysis showed that relative biomass (B_t /B_{msy}) was below the level at which *MSY* can be produced from 1973 to 1998, and at its minimum in 1994 the ratio was about 0.20, which is below the suggested B_{lim} reference point of 30% B_{msy} proposed by the SC Study Group on Limit Reference Points (NAFO 2004, SCS Doc. 04/12). Since 1994, the stock increased rapidly to a point where B_t /B_{msy} >1.0, and at the beginning of 2010, assuming a catch of 17 000 t in 2009, the relative bias corrected biomass B_t /B_{msy} is estimated to be 1.62 (80% CL = 1.55, 1.64).

The relative fishing mortality rate (F_t /F_{msy}) was high during most of the historical fishery (Fig 14), in particular during the mid to late 1980s to the early 1990s when landings were often double the TAC (Fig.1). Since the fishery re-opened in 1998, the fishing mortality rate gradually increased to the advised level of $2/3F_{msy}$, but in 2006, 2007, and 2008 the bias corrected *F*-ratios were considerably lower than $2/3F_{msy}$ at 0.32, 0.15, and 0.49 respectively. If the TAC of 17 000 tons is taken in 2009, the bias corrected *F*-ratio was calculated to be 0.53 (80% CL = 0.49, 0.59). Since the moratorium in 1994, the estimated yield from the stock had been below surplus production levels, until 2008 when the catch slightly exceeded the estimated surplus production. The stock is considered to be within the safe zone as defined in the Scientific Council Precautionary Approach Framework (NAFO, 2004).

Retrospective analysis

The surplus production model for the 2009 assessment was run with the same formulation, dropping out 5 years of data, one year at a time (2008-2004). The model parameter estimates and goodness of fit results are given in Table 9 and the relative biomass and fishing mortality estimates are plotted in Figure 15. There is very little retrospective pattern in the 2009 production model.

Projections

The accepted formulation for the 2009 assessment was used as the basis for projections in the short and medium term. Medium-term projections were carried out by extending the ASPIC bootstrap results forward to the year 2014 under an assumption of constant fishing mortality at 2/3 F_{msy}, 0.75 F_{msy} and 0.85 F_{msy}. All analyses assumed that the catch in 2009 would equal the TAC of 17 000 tons. Catch and biomass decrease slightly in the projections at 2/3 F_{msy}, 0.75 and 0.85 F_{msy} (Tables 10-12). At all levels of F_{msy} considered for medium term projections (2/3 F_{msy}, 75% F_{msy} and 85%F_{msy}), the probability that the biomass in 2010 is below B_{msy} is negligible. Plots of projection results are shown in Figure 21.

Summary

Yellowtail flounder on the Grand Bank declined in the late 1980s and early 1990s to its lowest observed level in 1994 (about 20% B_{msy}) following several years of excessive catch. The stock was under a directed-fishery moratorium from January 1, 1994 until Aug 1, 1998. The stock increased rapidly during and following the closure, as strong year classes produced in the early to mid-1990s (albeit at low SSB levels), benefited from 4+ years of reduced fishing mortality. Catches increased from about 4 400 tons in 1998 to around 15 000 tons 2004 and 2005, but was very low in 2006 (due to corporate restructuring/labour dispute in the Canadian industry) and again well below the TAC in 2007. Catches were nearer the recent average (2000-2005) in 2008 at 11 400 tons. Stock size estimates remain high, above B_{msy}. Fishing mortality is estimated to be below 2/3 F_{msy}, and well below the limit reference point ($F_{LIM} = F_{msy}$), and at levels of F between 2/3 F_{msy} and 85% F_{msy}, the stock is not projected to decrease below B_{LIM} in the medium term (to 2014).

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Table 1. Nominal catches by country and TACs (tons) of yellowtail in NAFO Divisions 3LNO.

Year	Canada	France	USSR/Rus.	S.Korea[a]	Other [b]	Total	TAC
1960	7	-	-	-	-	7	
1961	100	-	-	-	-	100	
1962	67	-	-	-	-	67	
1963	138	-	380	-	-	518	
1964	126	-	21	-	-	147	
1965	3075	-	55	-	-	3130	
1966	4185	-	2,834	-	7	7026	
1967	2122	-	6,736	-	20	8878	
1968	4180	14	9146	-	-	13340	
1969	10494	1	5,207	-	6	15708	
1970	22814	17	3,426	-	169	26426	
1971	24206	49	13087	-	-	37342	
1972	26939	358	11929	-	33	39259	
1973	28492	368	3,545	-	410	32815	50000
1974	17053	60	6,952	-	248	24313	40000
1975	18458	15	4,076	-	345	22894	35000
1976	7910	31	57	-	59	8057	9000
1977	11295	245	97	-	1	11638	12000
1978	15091	375	-	-	-	15466	15000
1979	18116	202	-	-	33	18351	18000
1980	12011	366	-	-	-	12377	18000
1981	14122	558	-	-	-	14680	21000
1982	11479	110	-	1,073	657	13319	23000
1983	9085	165	-	1,223	-	10473	19000
1984	12437	89	-	2,373	1836 [b]	16735	17000
1985	13440	-	-	4,278	11245 [b]	28963	15000
1986	14168	77	-	2,049	13882 [b]	30176	15000
1987	13420	51	-	125	2718	16314	15000
1988	10607	-	-	1,383	4166 [b]	16158	15000
1989	5009	139	-	3,508	1551	10207	5000
1990	4966	-	-	5903	3117	13986	5000
1991	6589	-	-	4156	5458	16203	7000
1992	6814	-	-	3825	123	10762	7000
1993	6747	-	-	-	6868	13615	7000
1994	-	-	-	-	2069	2069	7000 [d]
1995	2	-	-	-	65	67	0 [d]
1996	-	-	-	-	232	232	0 [d]
1997	1	-	-	-	657	658	0 [d]
1998	3739	-	-	-	647	4386	4000
1999	5746	-	96	-	1052 [b]	6894	6000
2000 [c]	9463	-	212	-	1486	11161	10000
2001 [c]	12238	-	148	-	1759	14145	13000
2002 [c]	9959	-	103	-	636	10698	13000
2003 [c]	12708	-	184	-	914 [e]	13806	14500
2004	12575		158	-	621	13354	14500
2005	13140	299	8	-	486	13933	15000
2006	177	-	1	-	752	930	15000
2007	3673	-	76	-	874	4623	15500
2008	10217	384	143		659	11403	15500
2009							17000

[a] South Korean catches ceased after 1992
[b] includes catches estimated from Canadian surveillance reports
[c] provisional
[d] no directed fishery permitted
[e] Includes catches averaged from a range of estimates

Table 2. Canadian catches (tons) of yellowtail flounder by division, from 1973 to 2008. Data from 2003-08 are from preliminary Canadian ZIF statistics and maybe slightly different from STATLANT data.

	OTTER TRAWL				
YEAR	**3L**	**3N**	**30**	**3LNO**	**OTHER GEARS**
1973	4188	21470	2827	28475	17
1974	1107	14757	1119	16983	70
1975	2315	13289	2852	18456	2
1976	448	4978	2478	7904	6
1977	2546	7166	1583	11295	0
1978	2537	10705	1793	15035	56
1979	2575	14359	1100	18034	82
1980	1892	9501	578	11971	40
1981	2345	11245	515	14105	17
1982	2305	7554	1607	11466	13
1983	2552	5737	770	9059	26
1984	5264	6847	318	12429	8
1985	3404	9098	829	13331	9
1986	2933	10196	1004	14133	35
1987	1584	10248	1529	13361	59
1988	1813	7146	1475	10434	173
1989	844	2407	1506	4757	252
1990	1263	2725	668	4656	310
1991	798	2943	2284	6025	564
1992	95	1266	4633	5994	820
1993	0	2062	3903	5965	782
1994	0	0	0	0	0
1995	0	0	0	0	2
1996	0	0	0	0	0
1997	0	1	0	1	0
1998	0	2968	742	3710	29
1999	0	5636	107	5743	3
2000	1409	7733	278	9420	43
2001	183	8709	3216	12108	130
2002	22	7707	2035	9764	195
2003	28	8186	4482	12696	1
2004	2760	7205	2609	12574	3
2005	284	10572	2283	13139	1
2006	-	176	-	176	1
2007	5	2053	1615	3672	1
2008	985	6976	2249	10210	6

Table 3. Estimates of abundance (millions), biomass ('000 tons), mean number and weight (kg) per tow for Spring surveys in NAFO Divisions 3LNO from 1984-2008.

	Spring Abundance (millions)				Spring Biomass ('000 tons)				Spring mean # per tow				Spring mean wt (kg) per tow			
	3L	3N	3O	3LNO	3L	3N	3O	3LNO	3L	3N	3O	3LNO	3L	3N	3O	3LNO
1984	45.4	435.3	63.5	544.2	21.9	167.7	28.2	217.7	22.1	189.7	25.8	79.9	10.7	73.1	11.4	32.0
1985	49.9	240.1	84.1	374.1	21.1	88.2	37.5	146.8	9.4	104.6	34.2	37.1	4.0	38.4	15.2	14.6
1986	26.9	229.5	70.1	326.5	12.6	95.1	30.5	138.2	5.3	100.0	28.5	33.3	2.5	41.5	12.4	14.1
1987	12.3	291.0	90.9	394.2	5.8	77.5	41.2	124.6	2.4	128.1	36.9	40.2	1.1	34.1	16.7	12.7
1988	8.1	135.3	59.7	203.1	3.7	51.4	25.8	81.0	1.6	58.9	24.2	20.7	0.7	22.4	10.5	8.2
1989	7.9	478.3	46.7	532.9	4.0	78.3	21.5	103.8	1.6	208.4	18.9	54.3	0.8	34.1	8.7	10.6
1990	4.7	305.5	57.3	367.4	2.2	75.7	25.1	103.1	0.9	133.1	23.9	37.7	0.4	33.0	10.5	10.6
1991	2.2	268.1	50.0	320.3	1.1	69.1	23.3	93.4	0.4	111.7	19.7	32.5	0.2	28.8	9.2	9.5
1992	0.3	189.2	28.0	217.4	0.2	49.6	11.6	61.4	0.1	79.3	11.0	21.2	0.0	20.8	4.6	6.0
1993	0.2	145.0	101.1	246.3	0.1	50.8	42.4	93.3	0.0	60.4	39.8	24.0	0.0	21.1	16.7	9.1
1994	0.1	126.4	21.9	148.4	0.0	46.3	9.2	55.6	0.0	51.5	8.5	14.1	0.0	18.9	3.6	5.3
1995	0.0	158.8	28.5	187.4	0.0	57.9	12.7	70.6	0.0	66.1	11.2	18.2	0.0	24.1	5.0	6.9
1996	2.5	475.3	161.7	639.4	1.1	103.9	70.6	175.6	0.5	198.0	63.3	62.1	0.2	43.3	27.6	17.1
1997	1.2	554.9	139.4	695.5	0.5	121.3	53.2	174.9	0.2	233.2	54.6	67.7	0.1	51.0	20.8	17.0
1998	1.6	577.2	154.5	733.3	0.5	143.7	58.0	202.2	0.3	240.4	60.5	69.9	0.1	59.8	22.7	19.3
1999	55.4	965.4	269.1	1289.9	28.5	238.5	98.7	365.7	9.6	402.1	105.4	120.4	5.0	99.3	38.7	34.1
2000	40.7	695.3	186.5	922.5	17.5	197.3	72.1	287.0	7.6	289.6	73.1	89.6	3.3	82.2	28.3	27.9
2001	11.5	1119.9	197.2	1328.5	4.4	297.9	63.6	366.0	2.1	466.4	77.3	126.6	0.8	124.1	24.9	34.9
2002	1.6	528.3	161.0	690.9	0.6	147.3	51.6	199.5	0.3	220.0	63.1	66.5	0.1	61.4	20.2	19.2
2003	92.0	914.9	243.2	1250.1	34.3	280.2	72.0	386.5	16.9	381.0	95.3	120.2	6.3	116.7	28.2	37.2
2004	38.7	690.1	237.9	966.7	15.3	216.7	75.8	307.9	7.0	287.4	93.2	92.0	2.8	90.3	29.7	29.3
2005	115.6	822.0	227.1	1164.8	43.6	263.7	81.5	388.8	21.7	342.4	89.0	113.2	8.2	109.8	31.9	37.8
2006	251.5	1035.0	295.9	1582.4	85.7	319.1	99.1	503.8	47.1	660.7	169.8	183.0	16.0	203.7	56.9	58.3
2007	177.5	953.5	309.7	1440.7	60.9	292.8	89.3	443.0	33.3	397.1	121.4	140.0	11.4	121.9	35.0	43.0
2008	115.3	1114.6	250.6	1480.4	43.2	330.4	83.3	456.9	21.6	464.2	98.2	143.8	8.1	137.6	32.6	44.4

Table 4. Estimates of abundance (millions), biomass ('000 tons), mean number and weight (kg) per tow for Fall surveys in NAFO Divisions 3LNO from 1990-2008.

	Fall Abundance (millions)				Fall Biomass ('000 tons)				Fall mean # per tow				Fall mean wt (kg) per tow			
	3L	3N	3O	3LNO	3L	3N	3O	3LNO	3L	3N	3O	3LNO	3L	3N	3O	3LNO
1990	4.4	148.5	39.5	192.5	2.1	46.5	17.3	65.8	0.8	65.9	16.1	19.3	0.4	20.6	7.0	6.6
1991	2.1	212.3	82.7	297.1	1.0	50.9	30.5	82.4	0.4	92.1	33.1	29.3	0.2	22.1	12.2	8.1
1992	2.0	158.0	55.8	215.9	0.9	44.1	19.4	64.5	0.4	86.4	22.7	22.4	0.2	24.1	7.9	6.7
1993	2.6	327.7	41.6	371.9	1.1	94.2	17.5	112.8	0.5	137.7	16.4	37.4	0.2	39.6	6.9	11.3
1994	0.1	259.3	28.5	287.9	0.0	95.5	10.9	106.4	0.0	108.0	11.2	28.0	0.0	39.8	4.3	10.3
1995	0.0	509.0	79.6	592.2	0.0	102.8	25.7	129.8	0.0	212.0	31.2	57.2	0.0	42.8	10.1	12.5
1996	6.7	516.3	56.2	579.1	2.2	113.2	18.9	134.3	1.1	215.0	22.7	51.6	0.4	47.1	7.6	12.0
1997	6.1	616.2	159.2	781.5	1.3	164.2	57.5	222.9	1.0	256.7	62.7	69.1	0.2	68.4	22.7	19.7
1998	13.1	632.1	183.0	828.2	5.2	173.6	52.8	231.6	2.1	241.2	69.0	71.1	0.8	66.3	19.9	19.9
1999	20.6	743.1	176.5	940.3	9.6	193.0	48.4	250.9	3.5	312.4	71.4	87.8	1.6	81.1	19.6	23.4
2000	37.9	860.3	254.1	1152.3	12.5	252.8	69.7	335.0	6.1	320.3	91.5	98.8	2.0	94.1	25.1	28.7
2001	74.5	1314.7	262.7	1651.9	25.5	368.9	81.4	475.8	11.7	489.5	95.3	139.8	4.0	137.3	29.5	40.3
2002	33.1	971.3	170.4	1174.8	13.6	272.7	53.5	339.7	5.2	361.7	61.4	99.3	2.1	101.5	19.3	28.7
2003	58.9	869.6	334.1	1262.6	18.6	252.0	97.7	368.3	9.2	364.8	127.1	110.9	2.9	105.7	37.2	32.3
2004	63.4	1158.6	209.1	1431.0	22.2	291.6	60.9	374.7	13.4	485.5	81.9	147.8	4.7	122.2	23.9	38.7
2005	38.8	1146.7	190.8	1376.3	14.1	261.5	67.1	342.7	6.6	446.1	68.7	122.7	2.4	101.7	24.2	30.6
2006	61.9	814.1	172.5	1048.5	21.2	232.3	52.0	305.5	10.2	339.1	68.1	95.4	3.5	96.7	20.5	27.8
2007	91.0	1414.2	252.0	1757.2	28.0	377.8	76.5	482.4	15.3	526.6	90.8	154.0	4.7	140.7	27.6	42.3
2008	81.9	787.1	300.2	1169.2	27.8	214.8	79.4	322.0	15.3	327.8	117.6	113.6	5.2	89.5	31.1	31.3

Table 5. Input indices used in the ASPIC production model for the 2009 assessment of Yellowtail flounder.

Year	Nominal catch (000 t)	Yankee survey (000 t)	Russian survey (000 t)	Campelen spring (000 t)	Campelen fall (000 t)	Spain survey (000 t)
1965	3.13					
1966	7.026					
1967	8.878					
1968	13.34					
1969	15.708					
1970	26.426					
1971	37.342	96.9				
1972	39.259	79.2				
1973	32.815	51.7				
1974	24.313	40.3				
1975	22.894	37.4				
1976	8.057	41.7				
1977	11.638	65.0				
1978	15.466	44.3				
1979	18.351	38.5				
1980	12.377	51.4				
1981	14.68	45.0				
1982	13.319	43.1				
1983	10.473					
1984	16.735		132.0	217.7		
1985	28.963		85.0	146.8		
1986	30.176		42.0	138.2		
1987	16.314		30.0	124.6		
1988	16.158		23.0	81.0		
1989	10.207		44.0	103.8		
1990	13.986		27.0	103.1	65.8	
1991	16.203		27.5	93.4	82.4	
1992	10.762			61.4	64.5	
1993	13.615			93.3	112.8	
1994	2.069			55.6	106.4	
1995	0.067			70.6	129.8	9.3
1996	0.232			175.6	134.3	43.3
1997	0.658			174.9	222.9	38.7
1998	4.386			202.2	231.6	122.6
1999	6.894			365.7	249.9	197.0
2000	11.161			287.5	335.0	144.7
2001	14.145			366.0	475.8	182.7
2002	10.698			199.5	339.7	148.5
2003	13.806			386.5	368.3	136.8
2004	13.354			307.9	374.7	170.0
2005	13.933			388.8	342.7	156.48
2006	0.930			★	305.5	160.1
2007	4.617			443.0	482.4	160.7
2008	11.403			456.9	322.0	160.1
2009	17.000					

notes: The Campelen fall survey values are corrected from the 2006 assessment (see SCR 07/57). The TAC in 2009 (17 000 t) is included in the catch series.

★ Survey coverage in 2006 was incomplete and results may not be compara years

Table 6.Parameter estimates and model diagnostics comparing the 2008 Assessment (version 5.24) with the same formulation in the newest version of ASPIC (5.33), a starting estimates of B1/K of 1, and the 2009 assessment (TAC in 201

	2008 Assessment ASPIC 5.24	2008 Formulation ASPIC 5.33	2008 Formulation ASPIC 5.33	2009 Assessment version 5.33
starting guess B1/K*	2	2	1	1
B1/K	0.868	0.814	0.432	0.494
K	147.200	152.400	162.100	157.100
MSY	18.820	18.590	19.790	19.540
Bmsy	73.580	76.220	81.060	78.550
Fmsy	0.256	0.244	0.244	0.249
B/Bmsy	1.637	1.619	1.647	1.619
Y(Fmsy)	30.800	30.090	32.590	31.620
Ye	11.190	11.470	11.500	12.060
F/Fmsy	0.494	0.506	0.468	0.527
q (1)	3.372	3.292	3.183	3.225
q (2)	0.997	0.929	0.994	1.001
q (3)	3.581	3.516	3.321	3.309
q (4)	1.176	1.132	1.144	1.157
q (5)	1.307	1.295	1.211	1.224
R^2 FC/Spring	0.873	0.873	0.870	0.891
R^2 Yankee	0.804	0.798	0.801	0.802
R^2 Can Fall	0.852	0.854	0.848	0.818
R^2 Russian	0.558	0.551	0.537	0.542
R^2 Spanish	0.616	0.603	0.610	0.617
Tot Obj Function	6.096	6.120	6.083	6.192
MSE	0.092	0.093	0.092	0.090

* This is an input to the model.

Table 7. Bootstrap results from the 2009 assessment of yellowtail flounder (ASPIC version 5.33).

				Bias-corrected approximate confidence limits					
	Point Estimate	Est. bias in pt est.	Est. rel. bias	80% Lower	80% Upper	50% Lower	50% Upper	IQ range	Rel IQ range
B1/K	0.49	0.011	2.30%	0.30	0.74	0.41	0.60	0.19	0.39
K	157.10	6.364	4.05%	145.20	204.30	149.90	174.10	24.17	0.15
q(1)	3.23	-0.031	-0.97%	2.85	3.64	3.03	3.48	0.45	0.14
q(2)	1.00	0.001	0.09%	0.84	1.15	0.91	1.09	0.18	0.18
q(3)	3.31	-0.023	-0.69%	2.75	3.68	3.05	3.49	0.44	0.13
q(4)	1.16	0.003	0.29%	0.95	1.34	1.04	1.25	0.20	0.18
q(5)	1.22	-0.020	-1.62%	1.08	1.44	1.15	1.35	0.20	0.17
MSY	19.54	0.380	1.95%	18.29	20.44	18.80	19.89	1.09	0.06
Ye(2010)	12.06	0.266	2.20%	11.80	13.09	11.88	12.46	0.58	0.05
Bmsy	78.55	3.182	4.05%	72.58	102.20	74.94	87.03	12.08	0.15
Fmsy	0.25	-0.002	-0.72%	0.21	0.28	0.23	0.26	0.04	0.15
fmsy(1)	0.08	0.001	0.66%	0.07	0.09	0.07	0.08	0.01	0.13
fmsy(2)	0.25	0.000	-0.14%	0.22	0.28	0.24	0.26	0.03	0.12
fmsy(3)	0.08	0.001	0.67%	0.07	0.09	0.07	0.08	0.01	0.14
fmsy(4)	0.22	0.000	-0.01%	0.19	0.26	0.20	0.23	0.03	0.14
fmsy(5)	0.20	0.004	1.98%	0.17	0.24	0.18	0.22	0.04	0.18
B./Bmsy	1.62	-0.003	-0.21%	1.55	1.64	1.59	1.63	0.05	0.03
F./Fmsy	0.53	-0.006	-1.13%	0.49	0.59	0.51	0.56	0.04	0.08
Ye./MSY	0.62	0.003	0.48%	0.58	0.69	0.60	0.66	0.06	0.09
q2/q1	0.31	0.005	1.66%	0.26	0.36	0.28	0.33	0.05	0.17
q3/q1	1.03	0.007	0.66%	0.90	1.16	0.96	1.10	0.14	0.13
q4/q1	0.36	0.007	1.84%	0.29	0.42	0.32	0.38	0.06	0.17
q5/q1	0.38	-0.001	-0.26%	0.33	0.44	0.35	0.41	0.06	0.15

Table 8. Estimates of relative F (F/F_{msy}) and relative B (B/B_{msy}) from ASPIC versions 5.24 and 5.33 using the 2008 assessment formulation and the 2009 assessment.

	F/F_{msy}				B/B_{msy}			
	2008 v5.24	2008 v5.33	2008 v5.33	2009 v5.33	2008 v5.24	2008 v5.33	2008 v5.33	2009 v5.33
	B1/K 2	B1/K 2	B1/K 1	B1/K 1	B1/K 2	B1/K 2	B1/K 1	B1/K 1
1965	0.09	0.10	0.16	0.15	1.74	1.63	0.86	0.99
1966	0.21	0.22	0.31	0.28	1.80	1.72	1.07	1.19
1967	0.26	0.27	0.35	0.33	1.80	1.74	1.22	1.34
1968	0.41	0.42	0.50	0.47	1.77	1.74	1.34	1.43
1969	0.50	0.51	0.57	0.55	1.71	1.68	1.38	1.46
1970	0.91	0.93	1.00	0.97	1.64	1.62	1.40	1.46
1971	1.52	1.55	1.62	1.59	1.46	1.45	1.29	1.33
1972	2.03	2.06	2.13	2.10	1.18	1.18	1.06	1.09
1973	2.21	2.22	2.30	2.27	0.90	0.90	0.82	0.84
1974	2.02	2.02	2.10	2.08	0.70	0.71	0.64	0.65
1975	2.31	2.27	2.39	2.37	0.59	0.60	0.54	0.55
1976	0.83	0.81	0.86	0.85	0.48	0.49	0.44	0.45
1977	1.05	1.04	1.09	1.08	0.56	0.58	0.51	0.53
1978	1.33	1.32	1.38	1.37	0.62	0.63	0.56	0.58
1979	1.61	1.59	1.68	1.66	0.62	0.64	0.57	0.58
1980	1.07	1.06	1.12	1.10	0.59	0.60	0.54	0.55
1981	1.20	1.19	1.25	1.24	0.64	0.65	0.58	0.60
1982	1.02	1.03	1.07	1.06	0.67	0.68	0.61	0.62
1983	0.73	0.73	0.76	0.75	0.72	0.72	0.65	0.67
1984	1.08	1.10	1.12	1.11	0.82	0.82	0.74	0.76
1985	2.05	2.08	2.11	2.09	0.84	0.83	0.77	0.79
1986	2.81	2.84	2.88	2.85	0.68	0.68	0.63	0.64
1987	1.90	1.91	1.94	1.92	0.48	0.48	0.45	0.46
1988	2.11	2.12	2.14	2.12	0.44	0.44	0.41	0.42
1989	1.37	1.38	1.39	1.38	0.38	0.39	0.36	0.37
1990	1.90	1.92	1.93	1.91	0.41	0.41	0.38	0.39
1991	2.57	2.59	2.58	2.56	0.38	0.38	0.35	0.36
1992	1.99	1.99	1.97	1.96	0.30	0.30	0.29	0.29
1993	3.06	3.05	2.97	2.95	0.28	0.28	0.27	0.27
1994	0.46	0.46	0.44	0.44	0.20	0.21	0.20	0.20
1995	0.01	0.01	0.01	0.01	0.28	0.28	0.28	0.28
1996	0.02	0.02	0.02	0.02	0.42	0.42	0.41	0.43
1997	0.05	0.05	0.05	0.05	0.62	0.60	0.59	0.61
1998	0.25	0.26	0.25	0.24	0.84	0.81	0.81	0.83
1999	0.33	0.35	0.33	0.32	1.04	1.00	0.99	1.02
2000	0.48	0.50	0.47	0.46	1.20	1.15	1.15	1.18
2001	0.58	0.60	0.56	0.56	1.28	1.24	1.25	1.27
2002	0.42	0.44	0.40	0.40	1.32	1.28	1.30	1.32
2003	0.52	0.54	0.50	0.50	1.40	1.36	1.38	1.40
2004	0.49	0.51	0.47	0.47	1.42	1.39	1.42	1.43
2005	0.51	0.53	0.48	0.49	1.45	1.42	1.45	1.46
2006	0.03	0.03	0.03	0.03	1.46	1.43	1.47	1.48
2007	0.15	0.15	0.14	0.14	1.63	1.60	1.63	1.64
2008	0.49	0.51	0.47	0.34	1.71	1.68	1.71	1.71
2009				0.53	1.64	1.62	1.65	1.69
2010								1.62

note: B1/K values in the table are starting guesses that are input into the model.

Table 9. Model outputs (ASPIC version 5.33) for retrospective analysis.

Model	2009 Assessment (1965-2008)	1965-2007	1965-2006	1965-2004	1965-2003	1965-2004
B1/K	0.494	0.466	0.468	0.629	0.491	0.687
K	157.100	159.600	159.600	152.000	157.400	149.600
MSY	19.540	19.620	19.610	19.140	19.540	19.090
Bmsy	78.550	79.800	79.780	76.010	78.720	74.780
Fmsy	0.249	0.246	0.246	0.252	0.248	0.255
B/Bmsy	1.619	1.705	1.628	1.463	1.445	1.427
F/Fmsy	0.527	0.141	0.036	0.500	0.478	0.511
Y(Fmsy)	31.620	33.450	31.920	28.000	28.240	27.240
Ye	12.060	9.864	11.880	15.040	15.670	15.600
q (1)	3.225	3.213	3.202	3.317	3.266	3.359
q (2)	1.001	0.993	0.994	0.997	0.999	1.007
q (3)	3.309	3.367	3.348	3.579	3.556	3.662
q (4)	1.157	1.149	1.149	1.166	1.158	1.177
q (5)	1.224	1.227	1.226	1.276	1.239	1.239
R^2 FC/Spring	0.891	0.871	0.842	0.845	0.812	0.816
R^2 Yankee	0.802	0.802	0.802	0.803	0.802	0.803
R^2 Can Fall	0.818	0.848	0.820	0.873	0.875	0.860
R^2 Russian	0.542	0.540	0.540	0.551	0.544	0.554
R^2 Spanish	0.617	0.611	0.602	0.589	0.570	0.533
Tot Obj Function	6.192	6.082	6.077	5.946	5.897	5.830
MSE	0.090	0.090	0.096	0.097	0.102	0.106

Table 10. Medium-term projections for yellowtail flounder. The 5, 50 and 95th percentiles of fishing mortality, biomass, yield and biomass /B_{msy}, are shown, for projected F of 2/3 F_{msy}, 75% F_{msy} and 85% F_{msy}. The results are derived from an ASPIC bootstrap run (500 iterations) with a catch constraint of 17 000 tons (TAC) in 2009. F_{msy}=0.2487

		F 2010-2014	Biomass					Yield					Relative Biomass (B/B_{msy})				
			2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
2/3 Fmsy	5	0.126	115.51	108.25	103.76	100.88	98.99	20.35	19.31	18.64	18.20	17.90	1.54	1.47	1.42	1.37	1.34
	50	0.168	125.91	118.74	113.94	110.79	108.58	20.49	19.51	18.86	18.42	18.13	1.62	1.53	1.47	1.43	1.40
	95	0.183	170.07	163.65	159.12	156.04	153.70	20.93	20.24	19.76	19.40	19.12	1.66	1.58	1.53	1.49	1.47
75% Fmsy	5	0.140	115.51	106.37	100.76	97.17	94.78	22.54	21.08	20.15	19.53	19.08	1.54	1.45	1.38	1.32	1.29
	50	0.188	125.91	116.78	110.78	106.78	103.95	22.71	21.33	20.41	19.80	19.39	1.62	1.50	1.43	1.38	1.34
	95	0.204	170.07	161.57	155.51	151.47	148.46	23.25	22.24	21.50	20.98	20.62	1.66	1.55	1.49	1.45	1.42
85% Fmsy	5	0.159	115.51	104.03	97.06	92.59	89.40	25.27	23.19	21.86	20.98	20.32	1.54	1.42	1.33	1.26	1.21
	50	0.213	125.91	114.36	106.87	101.82	98.44	25.47	23.49	22.21	21.35	20.75	1.62	1.47	1.38	1.32	1.27
	95	0.231	170.07	158.96	151.04	145.85	141.84	26.14	24.65	23.60	22.88	22.33	1.66	1.53	1.45	1.40	1.36

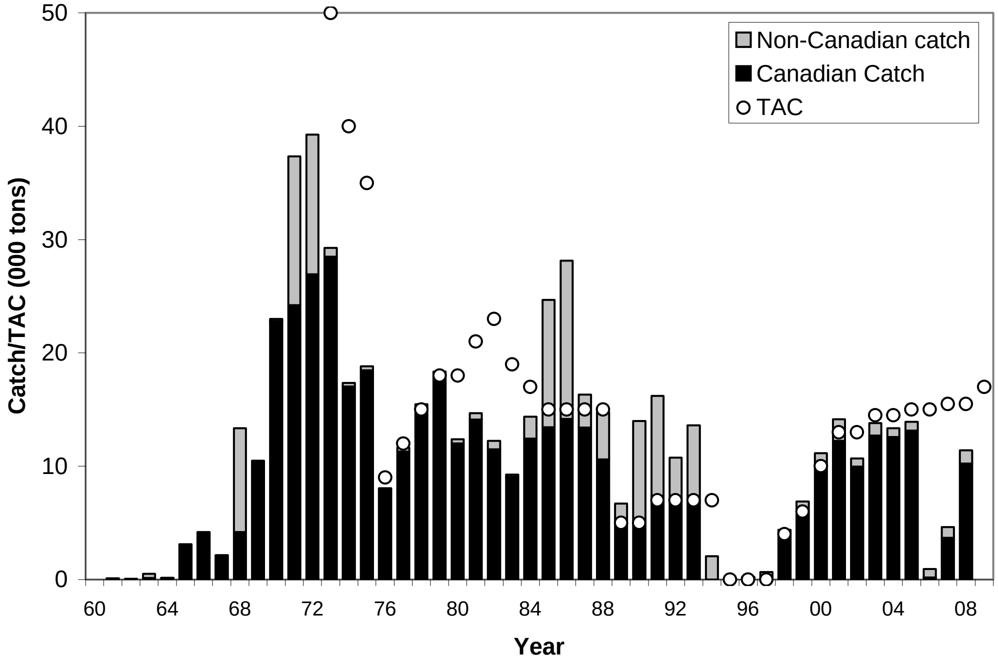

Figure 1. Catch (000 tons) and TAC of yellowtail flounder in NAFO Divisions 3LNO.

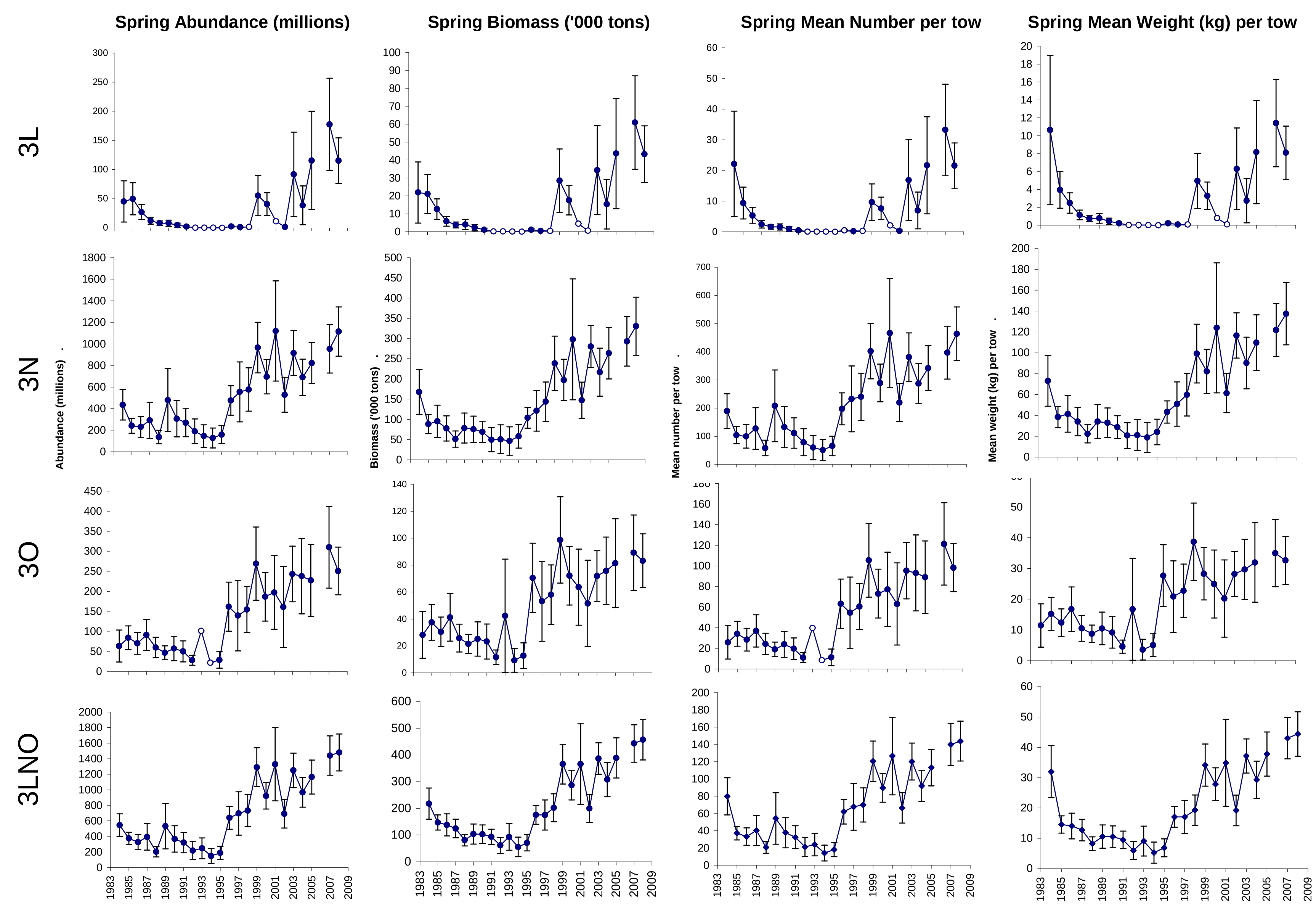

Figure 2. Abundance (millions), Biomass ('000 tons), Mean number and weight (kg) per tow for yellowtail flounder in spring surveys by NAFO division and for 3LNO combined from 1984-2008. Where lower 95% confidence limit is less than 0, error bars are omitted (hollow symbol)

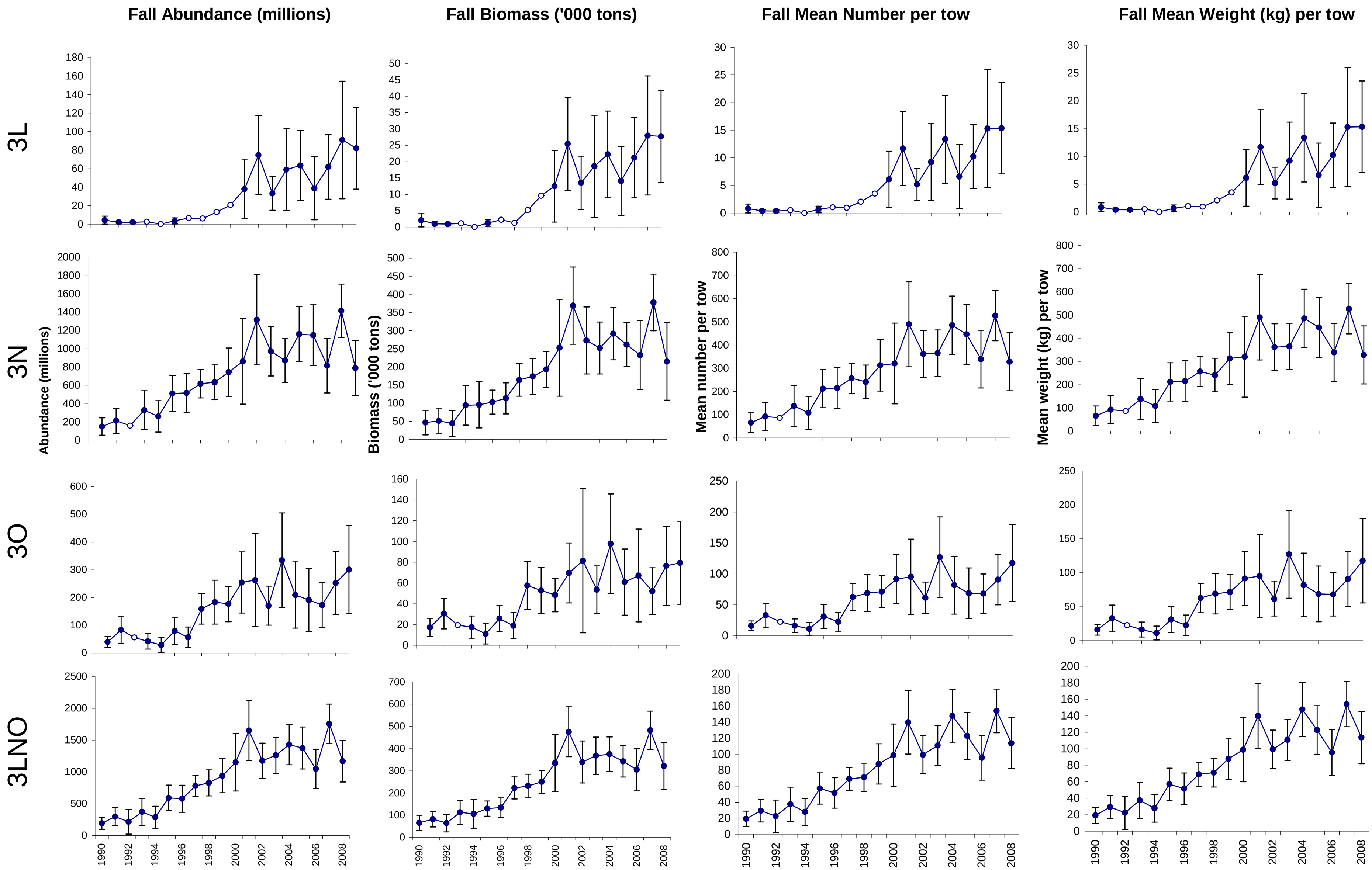

Figure 3. Abundance (millions), Biomass ('000 tons), Mean number and weight (kg) per tow for yellowtail flounder in fall surveys in NAFO divisions 3LNO from 1990-2008. Where lower 95% confidence limit is less than 0, error bars are omitted (hollow symbol)

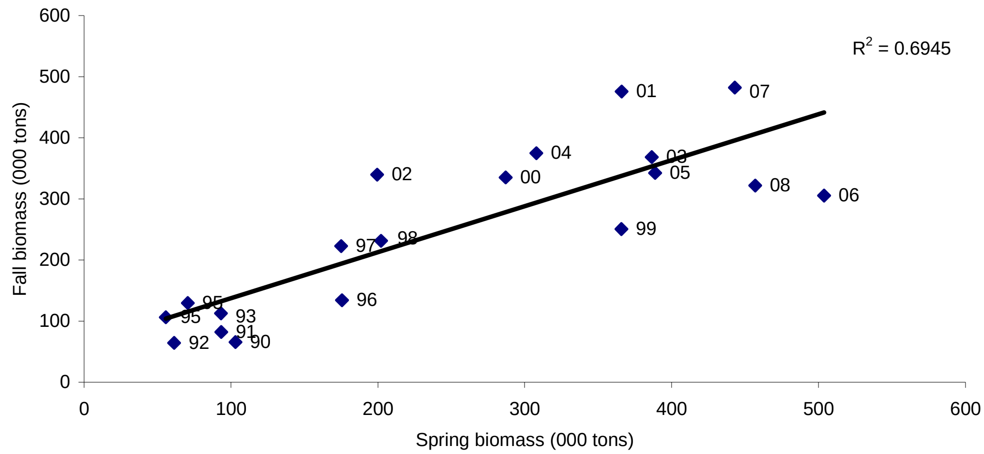

Fig. 4. Regression of Canadian spring and fall estimates of yellowtail flounder biomass in Div. 3LNO, 1990-2008.

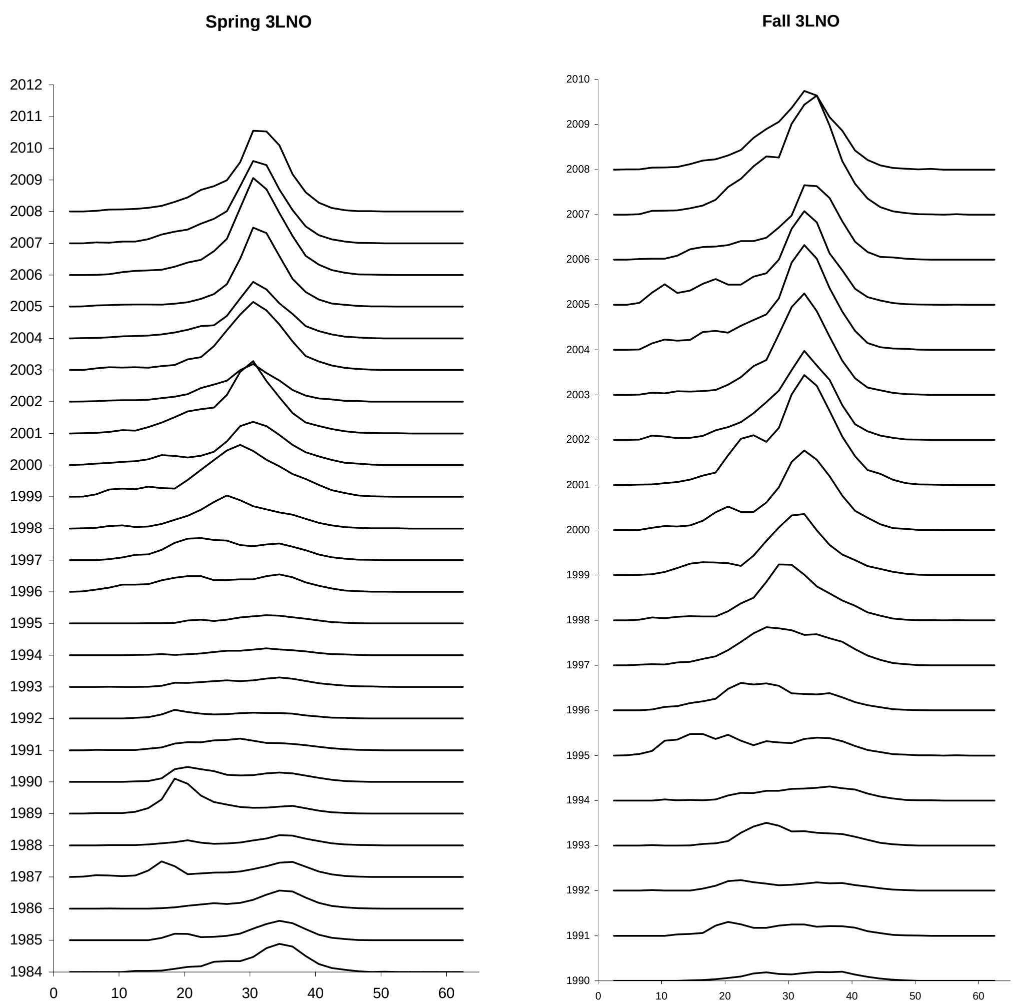

Figure 5. Abundance at length for 3LNO yellowtail flounder from Canadian spring (1984-2008) and fall (1990-2008) surveys.

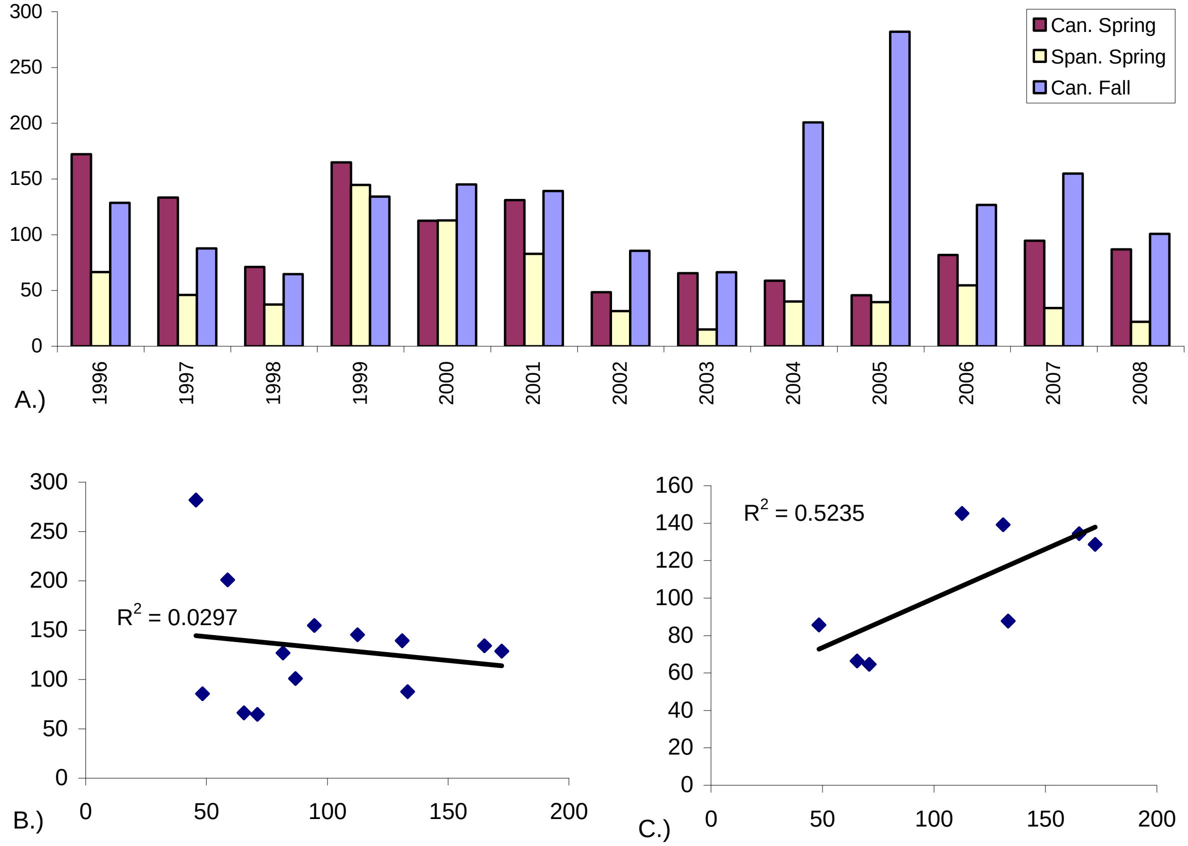

Figure 6. A. Population numbers of yellowtail flounder less than 22 cm in the Canadian and total numbers from Spanish surveys; B. regression of Canadian spring and fall estimates from 1996-2008; and C. regression of Canadian spring and fall estimates from 1996-2003.

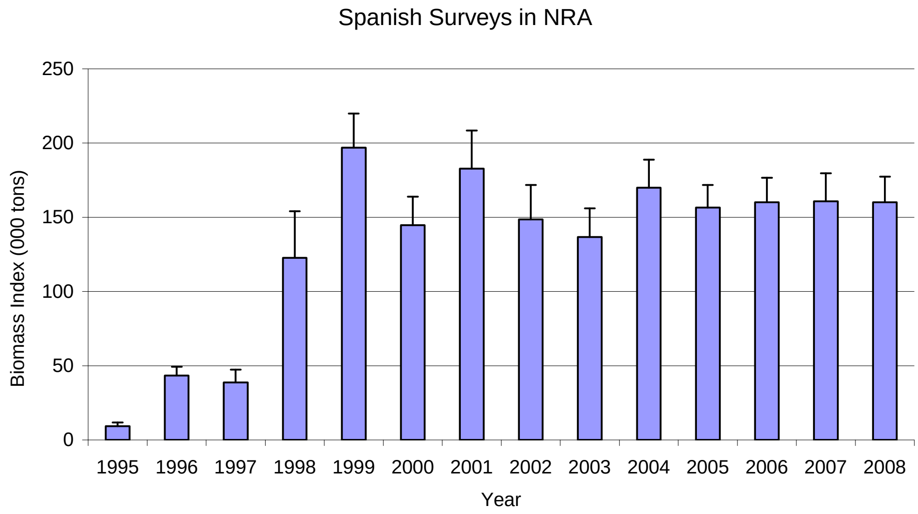

Figure 7. Converted biomass estimates from Spanish surveys in the NRA of Div. 3NO. Error bars are +1 SD.

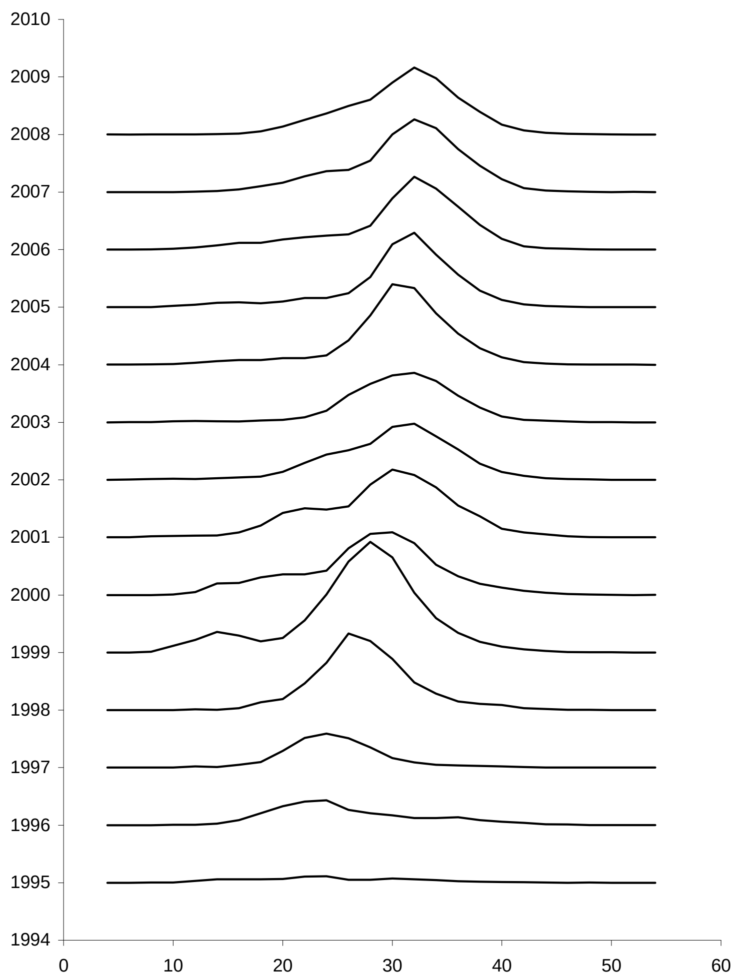

Figure 8 Length frequencies of yellowtail flounder in the Spanish spring surveys of NAFO Divs. 3LNO, 1995-2008 (sexes combined).

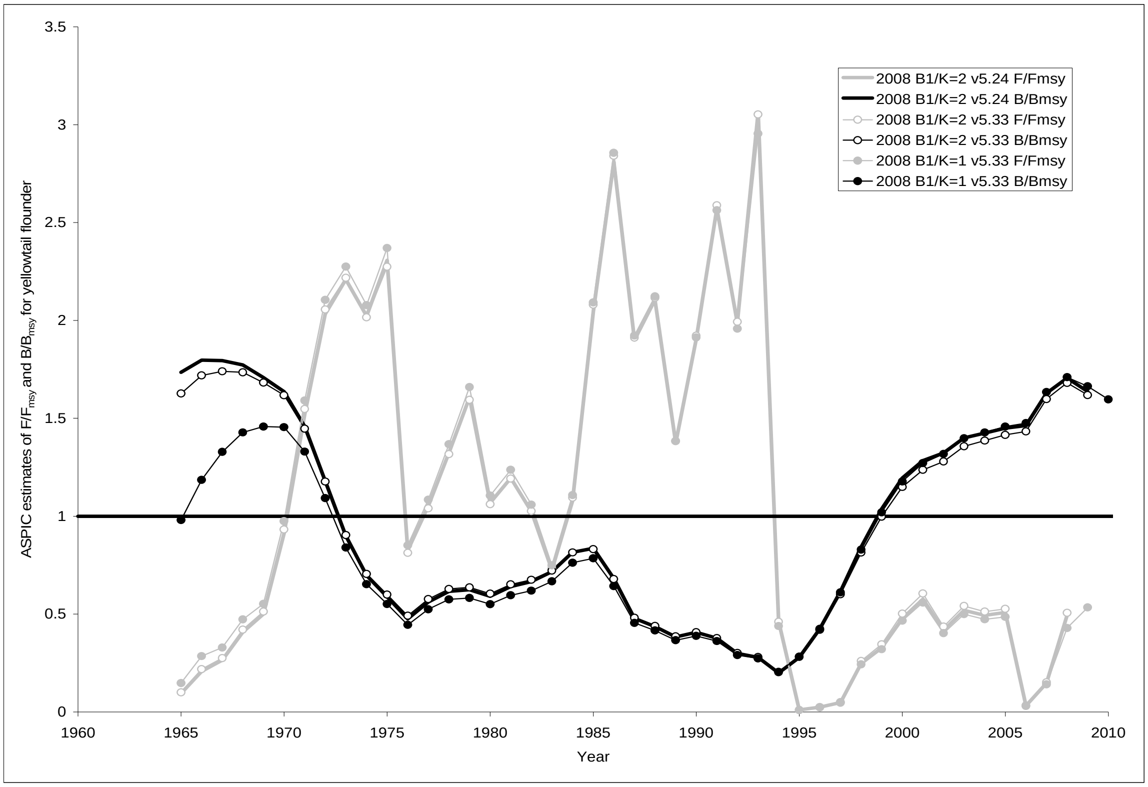

Figure 9. Relative fishing mortality (F/Fmsy) and relative biomass (B/Bmsy) estimates from 2 versions of ASPIC with 2 starting guesses for B1/K using 2008 assessment of yellowtail flounder in NAFO Divs. 3LNO.

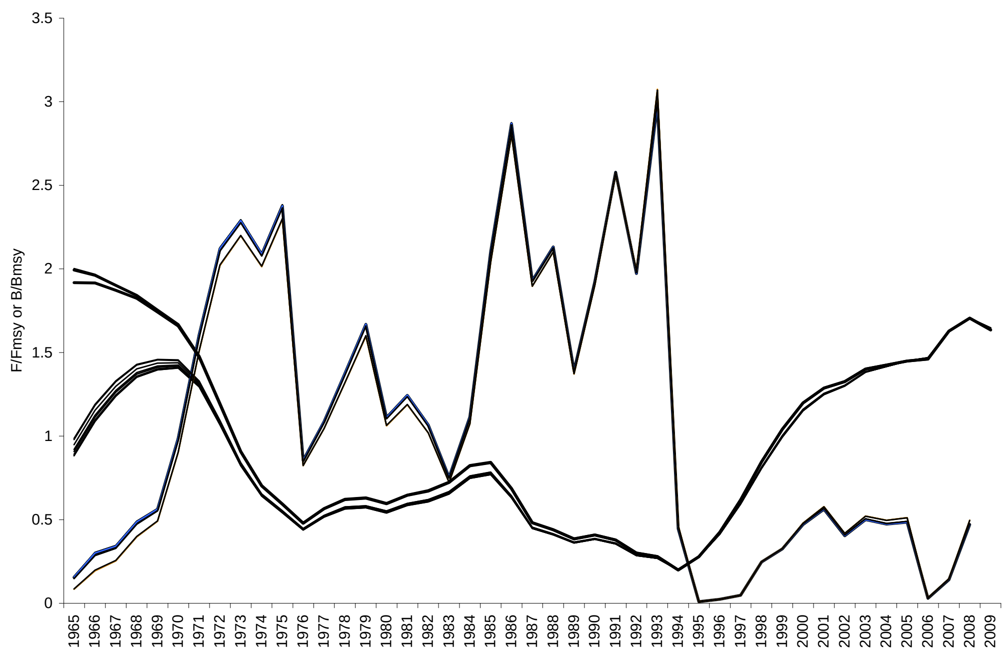

Figure 10. Relative fishing mortality and relative biomass estimates for a sensitivity analysis of the 2008 assessment for yellowtail flounder; each run changing one starting estimate of either B1/K, MSY, K or random number seed.

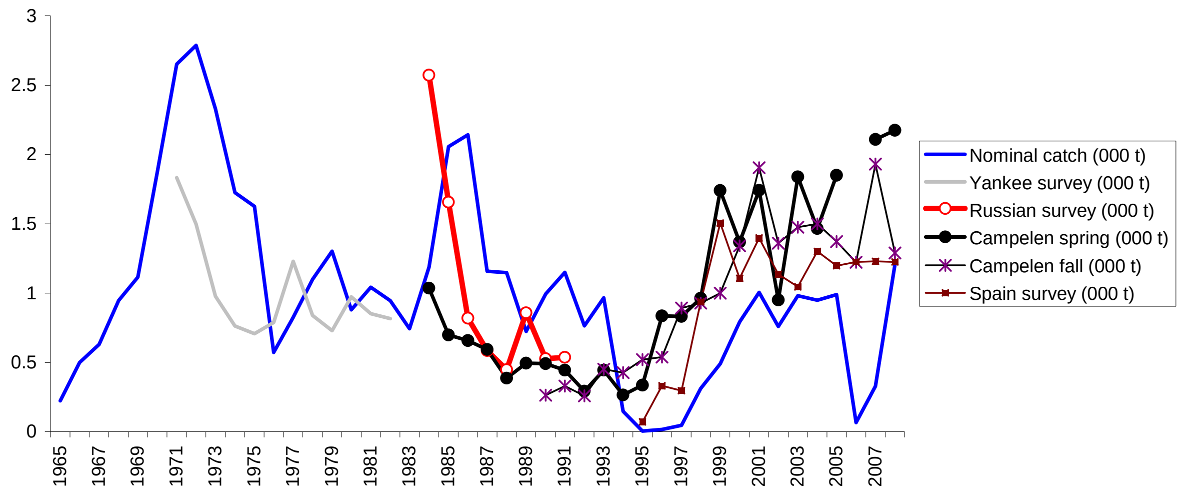

Figure 11. Nominal catch and survey series scaled to the mean in each series of the indices used in the 2009 assessment of yellowtail flounder.

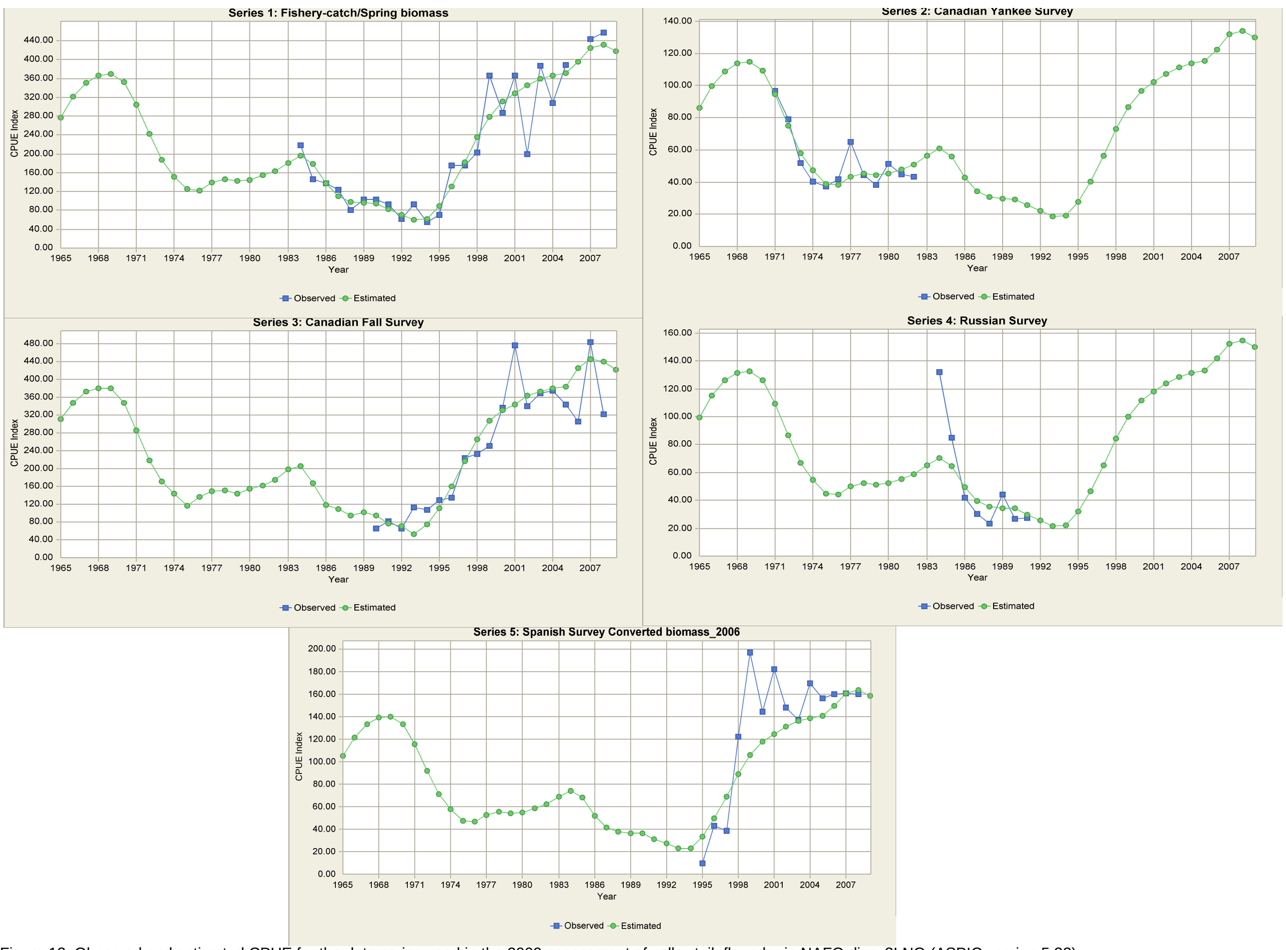

Figure 12. Observed and estimated CPUE for the data series used in the 2009 assessment of yellowtail flounder in NAFO divs. 3LNO (ASPIC version 5.33);

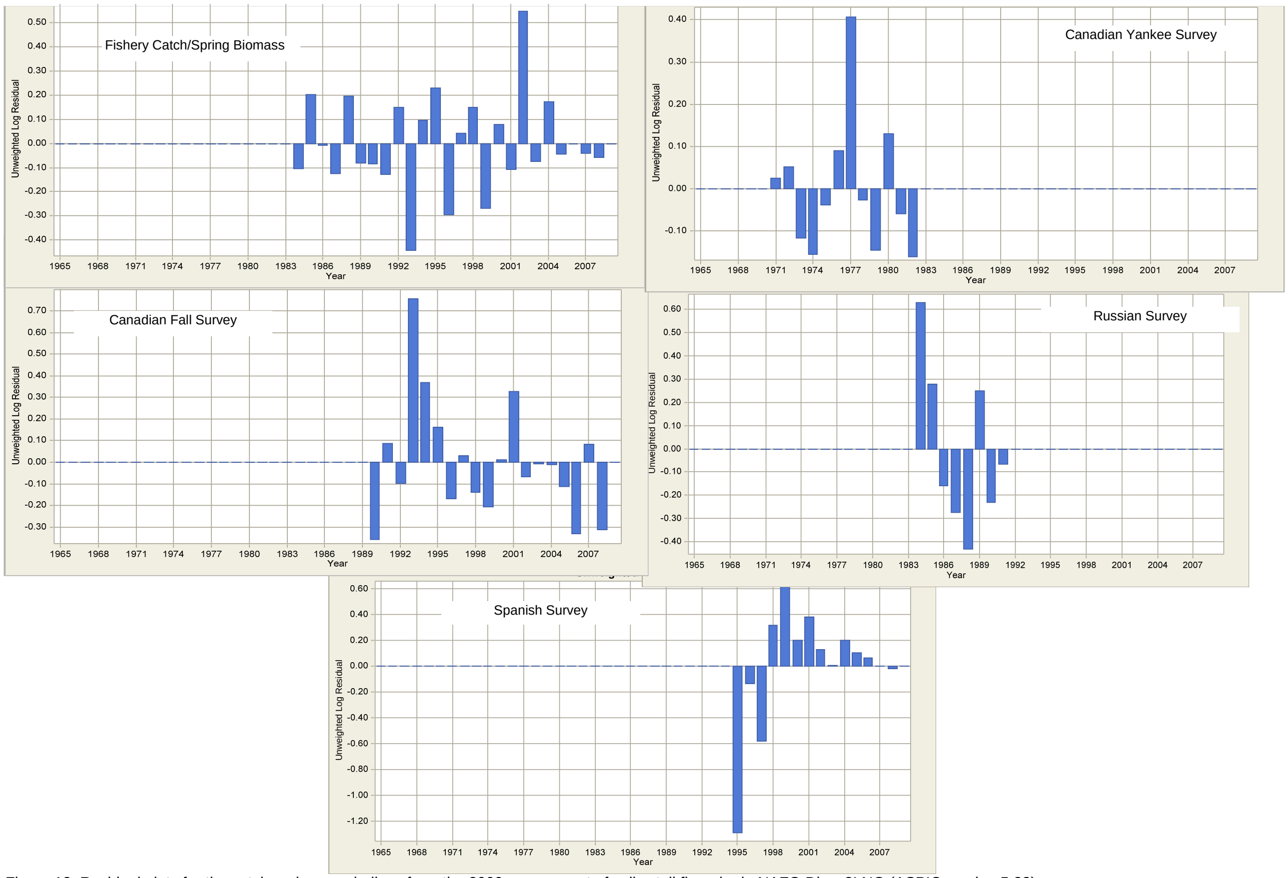

Figure 13. Residual plots for the catch and survey indices from the 2009 assessment of yellowtail flounder in NAFO Divs. 3LNO (ASPIC version 5.33).

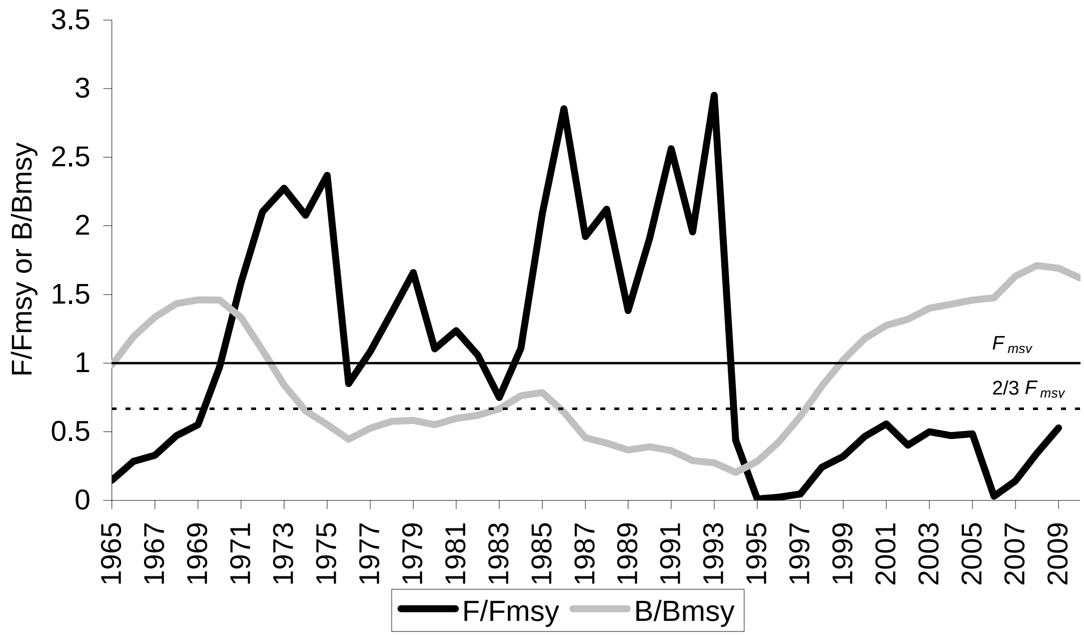

Figure 14. Yellowtail flounder in NAFO Divs. 3LNO: Relative fishing mortality (F/Fmsy) and relative biomass (B/Bmsy) estimates from the 2009 assessment (ASPIC version 5.33)

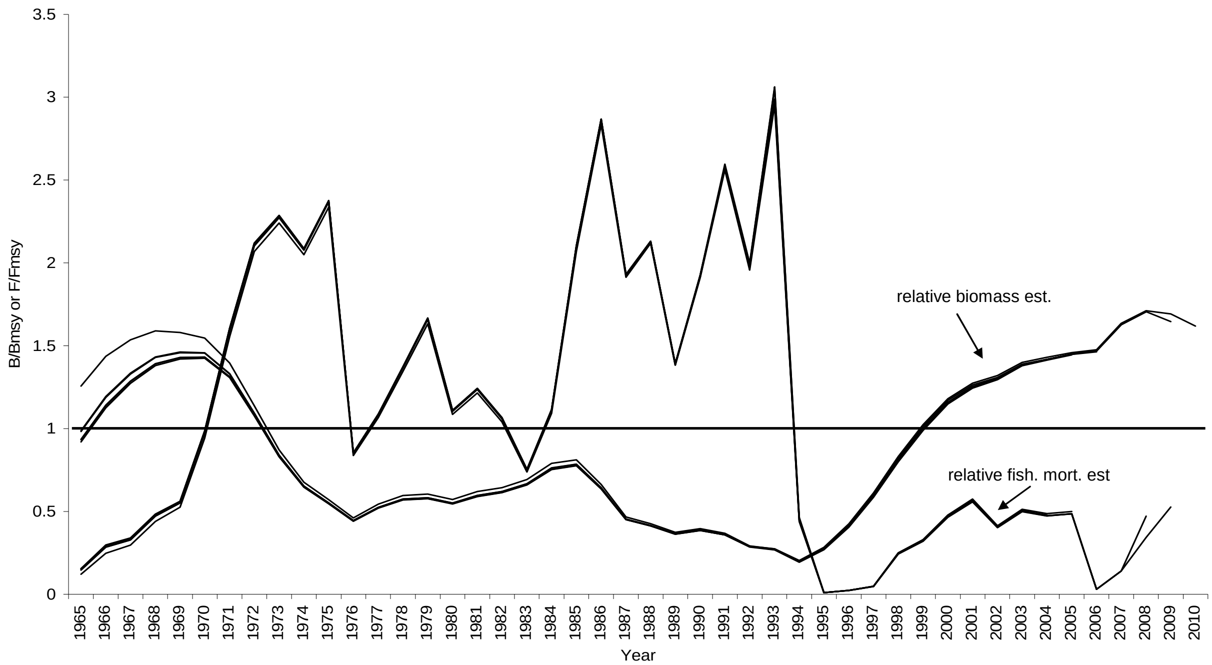

Figure 15. Retrospective view of the 2009 assessment of yellowtail flounder, dropping one year at a time 2009-2004.

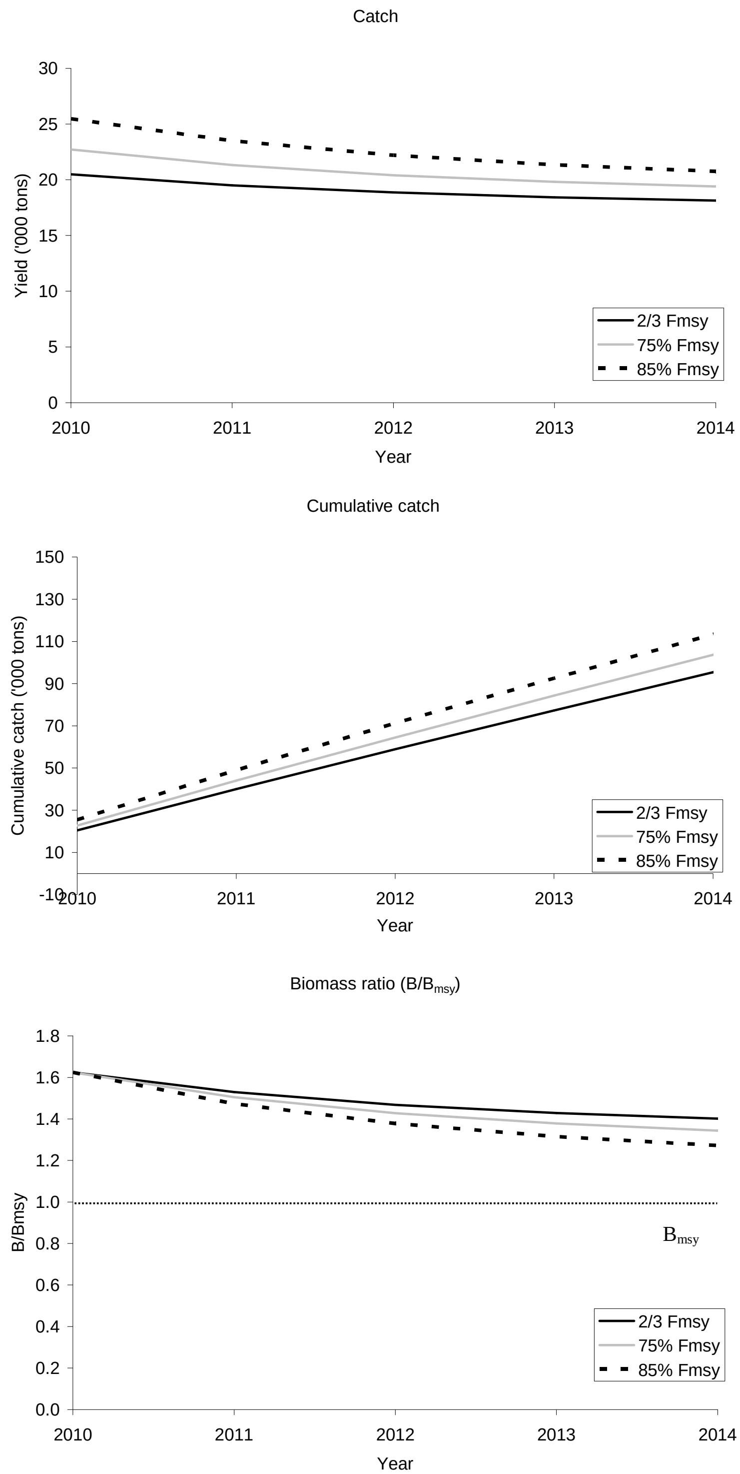

Figure 16. Yellowtail flounder in Div. 3LNO: medium term projections at 3 levels of F (2/3 Fmsy, 75% and 85% Fmsy). Top panel shows projected cumulative catch, middle panel gives projected catch, and lower panel is projected relative biomass ratios (B/Bmsy). Results are derived from an ASPIC bootstrap run (500 iterations) with a catch of 17 000 tons assumed in 2009.

APPENDIX 1.

```
FIT                     ## Run type (FIT, BOT, or IRF)
"3LNO Yellowtail SM version 5.33 (2008) 2009=TAC RUSSIA 1984-1991; 2006 Spring OUT"
LOGISTIC YLD SSE   ## Model type, conditioning type, objective function
2                       ## Verbosity
500                     ## Number of bootstrap trials, <= 1000
0 50000                 ## 0=no MC search, 1=search, 2=repeated srch; N trials
1.00000d-08             ## Convergence crit. for simplex
3.00000d-06   0         ## Convergence crit. for restarts, N restarts
1.00000d-02   24         ## Convergence crit. for estimating effort; N steps/yr
5.00000d00                     ## Maximum F allowed in estimating effort
1.00000d00              ## Weighting for B1 > K as residual (usually 0 or 1)
5                       ## Number of fisheries (data series)
1.00000d00  1.00000d00  1.00000d00  1.00000d00  1.00000d00 ## Statistical weights for data
series
1.00000d00             ## B1/K (starting guess, usually 0 to 1)
1.30000d01              ## MSY (starting guess)
4.00000d02              ## K (carrying capacity) (starting guess)
3.00000d00 1.00000d00 3.00000d00  1.00000d00 3.00000d00 # q (starting guesses -- 1 per data
series)
1 1 1 1 1 1 1 1               ## Estimate flags (0 or 1) (B1/K,MSY,K,q1...qn)
1.00000d00  5.00000d01            ## Min and max constraints -- MSY
1.00000d01  1.00000d03            ## Min and max constraints -- K
9114895                 ## Random number seed
45                      ## Number of years of data in each series
```

APPENDIX 2.

```
3LNO Yellowtail SM version 5.33 (2008) 2009=TAC RUSSIA 1984-1991; 2006 Spring OUT                              Page 1
                                                                                   Sunday, 07 Jun 2009 at 18:23:40
ASPIC -- A Surplus-Production Model Including Covariates (Ver. 5.33)
                                                                                                 FIT program mode
Author:     Michael H. Prager; NOAA Center for Coastal Fisheries and Habitat Research          LOGISTIC model mode
            101 Pivers Island Road; Beaufort, North Carolina  28516  USA                        YLD conditioning
            Mike.Prager@noaa.gov                                                                SSE optimization

Reference:  Prager, M. H. 1994. A suite of extensions to a nonequilibrium             ASPIC User's Manual is available
            surplus-production model.  Fishery Bulletin 92: 374-389.                           gratis from the author.

CONTROL PARAMETERS (FROM INPUT FILE)          Input file: g:\...009\ytail\aspic\2009 real assess\ytail_2009_assess.inp
-----------------------------------------------------------------------------------------------------------------------
Operation of ASPIC:  Fit logistic (Schaefer) model by direct optimization.
Number of years analyzed:                        45             Number of bootstrap trials:                          0
Number of data series:                            5             Bounds on MSY (min, max):       1.000E+00     5.000E+01
Objective function:                   Least squares             Bounds on K (min, max):         1.000E+01     1.000E+03
Relative conv. criterion (simplex):       1.000E-08             Monte Carlo search mode, trials:        0         50000
Relative conv. criterion (restart):       3.000E-06             Random number seed:                             9114895
Relative conv. criterion (effort):        1.000E-02             Identical convergences required in fitting:           5
Maximum F allowed in fitting:                 5.000

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS)                                                  error code   0
-----------------------------------------------------------------------------------------------------------------------
Normal convergence
Number of restarts required for convergence:     77

CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)
-----------------------------------------------------------------------------------------------------------------------
                                       |
 1  Fishery-catch/Spring biomass       |   1.000
                                       |      24
                                       |
 2  Canadian Yankee Survey             |   0.000   1.000
                                       |       0      12
                                       |
 3  Canadian Fall Survey               |   0.873   0.000   1.000
                                       |      18       0      19
                                       |
 4  Russian Survey                     |   0.933   0.000   1.000   1.000
                                       |       8       0       2       8
                                       |
 5  Spanish Survey Converted biomass...|   0.803   0.000   0.755   0.000   1.000
                                       |      13       0      14       0      14
                                       --------------------------------------------------
                                               1       2       3       4       5

GOODNESS-OF-FIT AND WEIGHTING (NON-BOOTSTRAPPED ANALYSIS)
-----------------------------------------------------------------------------------------------------------------------
                                                   Weighted             Weighted       Current     Inv. var.    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 B1 > K                      0.000E+00      1           N/A     1.000E+00           N/A
Loss(1)   Fishery-catch/Spring biomass            9.636E-01     24     4.380E-02     1.000E+00     1.321E+00        0.891
Loss(2)   Canadian Yankee Survey                  2.859E-01     12     2.859E-02     1.000E+00     2.024E+00        0.802
Loss(3)   Canadian Fall Survey                    1.307E+00     19     7.689E-02     1.000E+00     7.528E-01        0.818
Loss(4)   Russian Survey                          8.796E-01      8     1.466E-01     1.000E+00     3.948E-01        0.542
Loss(5)   Spanish Survey Converted biomass_2006   2.756E+00     14     2.296E-01     1.000E+00     2.521E-01        0.617
............................................................................................
TOTAL OBJECTIVE FUNCTION, MSE, RMSE:          6.19202210E+00          8.974E-02    2.996E-01
Estimated contrast index (ideal = 1.0):               0.7536          C* = (Bmax-Bmin)/K
Estimated nearness index (ideal = 1.0):               1.0000          N* = 1 - |min(B-Bmsy)|/K
```

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	User/pgm guess	2nd guess	Estimated	User guess
B1/K	Starting relative biomass (in 1965)	4.937E-01	1.000E+00	5.335E-01	1	1
MSY	Maximum sustainable yield	1.954E+01	1.300E+01	1.197E+01	1	1
K	Maximum population size	1.571E+02	4.000E+02	7.185E+01	1	1
phi	Shape of production curve (Bmsy/K)	0.5000	0.5000	----	0	1
---------	Catchability Coefficients by Data Series ---------------					
q(1)	Fishery-catch/Spring biomass	3.225E+00	3.000E+00	2.420E-01	1	1
q(2)	Canadian Yankee Survey	1.001E+00	1.000E+00	6.794E-01	1	1
q(3)	Canadian Fall Survey	3.309E+00	3.000E+00	1.438E-01	1	1
q(4)	Russian Survey	1.157E+00	1.000E+00	7.001E-01	1	1
q(5)	Spanish Survey Converted biomass_2006	1.224E+00	3.000E+00	2.747E-01	1	1

MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Logistic formula	General formula
MSY	Maximum sustainable yield	1.954E+01	----	----
Bmsy	Stock biomass giving MSY	7.855E+01	K/2	K*n**(1/(1-n))
Fmsy	Fishing mortality rate at MSY	2.487E-01	MSY/Bmsy	MSY/Bmsy
n	Exponent in production function	2.0000	----	----
g	Fletcher's gamma	4.000E+00	----	[n**(n/(n-1))]/[n-1]
B./Bmsy	Ratio: B(2010)/Bmsy	1.619E+00	----	----
F./Fmsy	Ratio: F(2009)/Fmsy	5.265E-01	----	----
Fmsy/F.	Ratio: Fmsy/F(2009)	1.899E+00	----	----
Y.(Fmsy)	Approx. yield available at Fmsy in 2010	3.162E+01	MSY*B./Bmsy	MSY*B./Bmsy
	...as proportion of MSY	1.619E+00	----	----
Ye.	Equilibrium yield available in 2010	1.206E+01	4*MSY*(B/K-(B/K)**2)	g*MSY*(B/K-(B/K)**n)
	...as proportion of MSY	6.174E-01	----	----
---------	Fishing effort rate at MSY in units of each CE or CC series ---------			
fmsy(1)	Fishery-catch/Spring biomass	7.711E-02	Fmsy/q(1)	Fmsy/q(1)

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	1965	0.036	7.757E+01	8.577E+01	3.130E+00	3.130E+00	1.930E+01	1.467E-01	9.875E-01
2	1966	0.071	9.374E+01	9.948E+01	7.026E+00	7.026E+00	1.812E+01	2.840E-01	1.193E+00
3	1967	0.082	1.048E+02	1.089E+02	8.878E+00	8.878E+00	1.661E+01	3.279E-01	1.335E+00
4	1968	0.117	1.126E+02	1.138E+02	1.334E+01	1.334E+01	1.561E+01	4.715E-01	1.433E+00
5	1969	0.137	1.148E+02	1.147E+02	1.571E+01	1.571E+01	1.541E+01	5.507E-01	1.462E+00
6	1970	0.242	1.145E+02	1.092E+02	2.643E+01	2.643E+01	1.654E+01	9.726E-01	1.458E+00
7	1971	0.395	1.046E+02	9.447E+01	3.734E+01	3.734E+01	1.862E+01	1.589E+00	1.332E+00
8	1972	0.523	8.592E+01	7.506E+01	3.926E+01	3.926E+01	1.935E+01	2.103E+00	1.094E+00
9	1973	0.565	6.602E+01	5.804E+01	3.281E+01	3.281E+01	1.811E+01	2.273E+00	8.404E-01
10	1974	0.517	5.131E+01	4.707E+01	2.431E+01	2.431E+01	1.636E+01	2.077E+00	6.532E-01
11	1975	0.589	4.336E+01	3.885E+01	2.289E+01	2.289E+01	1.450E+01	2.369E+00	5.520E-01
12	1976	0.212	3.497E+01	3.807E+01	8.057E+00	8.057E+00	1.434E+01	8.510E-01	4.452E-01
13	1977	0.269	4.125E+01	4.319E+01	1.164E+01	1.164E+01	1.557E+01	1.084E+00	5.251E-01
14	1978	0.340	4.518E+01	4.548E+01	1.547E+01	1.547E+01	1.607E+01	1.367E+00	5.752E-01
15	1979	0.413	4.579E+01	4.447E+01	1.835E+01	1.835E+01	1.585E+01	1.659E+00	5.829E-01
16	1980	0.275	4.329E+01	4.506E+01	1.238E+01	1.238E+01	1.598E+01	1.104E+00	5.511E-01
17	1981	0.307	4.689E+01	4.776E+01	1.468E+01	1.468E+01	1.653E+01	1.236E+00	5.969E-01
18	1982	0.263	4.874E+01	5.058E+01	1.332E+01	1.332E+01	1.705E+01	1.059E+00	6.204E-01
19	1983	0.186	5.247E+01	5.624E+01	1.047E+01	1.047E+01	1.795E+01	7.487E-01	6.679E-01
20	1984	0.275	5.994E+01	6.079E+01	1.673E+01	1.673E+01	1.852E+01	1.107E+00	7.631E-01
21	1985	0.520	6.173E+01	5.571E+01	2.896E+01	2.896E+01	1.782E+01	2.090E+00	7.859E-01
22	1986	0.710	5.058E+01	4.251E+01	3.018E+01	3.018E+01	1.534E+01	2.854E+00	6.440E-01
23	1987	0.478	3.574E+01	3.413E+01	1.631E+01	1.631E+01	1.328E+01	1.922E+00	4.550E-01
24	1988	0.528	3.271E+01	3.061E+01	1.616E+01	1.616E+01	1.224E+01	2.122E+00	4.164E-01
25	1989	0.344	2.879E+01	2.967E+01	1.021E+01	1.021E+01	1.197E+01	1.383E+00	3.666E-01
26	1990	0.476	3.056E+01	2.941E+01	1.399E+01	1.399E+01	1.188E+01	1.912E+00	3.890E-01
27	1991	0.637	2.845E+01	2.544E+01	1.620E+01	1.620E+01	1.058E+01	2.561E+00	3.622E-01
28	1992	0.487	2.282E+01	2.212E+01	1.076E+01	1.076E+01	9.448E+00	1.956E+00	2.906E-01
29	1993	0.734	2.151E+01	1.855E+01	1.362E+01	1.362E+01	8.111E+00	2.952E+00	2.738E-01
30	1994	0.109	1.601E+01	1.897E+01	2.069E+00	2.069E+00	8.288E+00	4.386E-01	2.038E-01
31	1995	0.002	2.223E+01	2.752E+01	6.700E-02	6.700E-02	1.126E+01	9.788E-03	2.829E-01
32	1996	0.006	3.342E+01	4.046E+01	2.320E-01	2.320E-01	1.488E+01	2.306E-02	4.254E-01
33	1997	0.012	4.807E+01	5.652E+01	6.580E-01	6.580E-01	1.792E+01	4.681E-02	6.120E-01
34	1998	0.060	6.533E+01	7.285E+01	4.386E+00	4.386E+00	1.937E+01	2.421E-01	8.317E-01
35	1999	0.080	8.032E+01	8.663E+01	6.894E+00	6.894E+00	1.929E+01	3.200E-01	1.023E+00
36	2000	0.116	9.271E+01	9.652E+01	1.116E+01	1.116E+01	1.850E+01	4.649E-01	1.180E+00
37	2001	0.139	1.000E+02	1.020E+02	1.414E+01	1.414E+01	1.780E+01	5.578E-01	1.274E+00
38	2002	0.100	1.037E+02	1.069E+02	1.070E+01	1.070E+01	1.696E+01	4.022E-01	1.320E+00
39	2003	0.124	1.100E+02	1.112E+02	1.381E+01	1.381E+01	1.616E+01	4.992E-01	1.400E+00
40	2004	0.118	1.123E+02	1.135E+02	1.335E+01	1.335E+01	1.565E+01	4.732E-01	1.430E+00
41	2005	0.121	1.146E+02	1.153E+02	1.393E+01	1.393E+01	1.525E+01	4.858E-01	1.459E+00
42	2006	0.008	1.159E+02	1.225E+02	9.300E-01	9.300E-01	1.339E+01	3.053E-02	1.476E+00
43	2007	0.035	1.284E+02	1.316E+02	4.617E+00	4.617E+00	1.062E+01	1.411E-01	1.635E+00
44	2008	0.085	1.344E+02	1.336E+02	1.140E+01	1.140E+01	9.933E+00	3.431E-01	1.711E+00
45	2009	0.131	1.329E+02	1.298E+02	1.700E+01	1.700E+01	1.121E+01	5.265E-01	1.692E+00
46	2010		1.271E+02						1.619E+00

RESULTS FOR DATA SERIES *# 1 (NON-BOOTSTRAPPED)* *Fishery-catch/Spring biomass*

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	Statist weight
1	1965	*	2.766E+02	0.0365	3.130E+00	3.130E+00	0.00000	1.000E+00
2	1966	*	3.209E+02	0.0706	7.026E+00	7.026E+00	0.00000	1.000E+00
3	1967	*	3.512E+02	0.0815	8.878E+00	8.878E+00	0.00000	1.000E+00
4	1968	*	3.670E+02	0.1173	1.334E+01	1.334E+01	0.00000	1.000E+00
5	1969	*	3.699E+02	0.1370	1.571E+01	1.571E+01	0.00000	1.000E+00
6	1970	*	3.524E+02	0.2419	2.643E+01	2.643E+01	0.00000	1.000E+00
7	1971	*	3.047E+02	0.3953	3.734E+01	3.734E+01	0.00000	1.000E+00
8	1972	*	2.421E+02	0.5230	3.926E+01	3.926E+01	0.00000	1.000E+00
9	1973	*	1.872E+02	0.5654	3.281E+01	3.281E+01	0.00000	1.000E+00
10	1974	*	1.518E+02	0.5166	2.431E+01	2.431E+01	0.00000	1.000E+00
11	1975	*	1.253E+02	0.5892	2.289E+01	2.289E+01	0.00000	1.000E+00
12	1976	*	1.228E+02	0.2117	8.057E+00	8.057E+00	0.00000	1.000E+00
13	1977	*	1.393E+02	0.2695	1.164E+01	1.164E+01	0.00000	1.000E+00
14	1978	*	1.467E+02	0.3401	1.547E+01	1.547E+01	0.00000	1.000E+00
15	1979	*	1.434E+02	0.4127	1.835E+01	1.835E+01	0.00000	1.000E+00
16	1980	*	1.453E+02	0.2747	1.238E+01	1.238E+01	0.00000	1.000E+00
17	1981	*	1.540E+02	0.3074	1.468E+01	1.468E+01	0.00000	1.000E+00
18	1982	*	1.631E+02	0.2633	1.332E+01	1.332E+01	0.00000	1.000E+00
19	1983	*	1.814E+02	0.1862	1.047E+01	1.047E+01	0.00000	1.000E+00
20	1984	2.177E+02	1.961E+02	0.2753	1.673E+01	1.673E+01	-0.10465	1.000E+00
21	1985	1.468E+02	1.797E+02	0.5199	2.896E+01	2.896E+01	0.20220	1.000E+00
22	1986	1.382E+02	1.371E+02	0.7099	3.018E+01	3.018E+01	-0.00792	1.000E+00
23	1987	1.246E+02	1.101E+02	0.4779	1.631E+01	1.631E+01	-0.12371	1.000E+00
24	1988	8.100E+01	9.874E+01	0.5278	1.616E+01	1.616E+01	0.19809	1.000E+00
25	1989	1.038E+02	9.569E+01	0.3440	1.021E+01	1.021E+01	-0.08134	1.000E+00
26	1990	1.031E+02	9.486E+01	0.4755	1.399E+01	1.399E+01	-0.08325	1.000E+00
27	1991	9.340E+01	8.205E+01	0.6370	1.620E+01	1.620E+01	-0.12961	1.000E+00
28	1992	6.140E+01	7.134E+01	0.4866	1.076E+01	1.076E+01	0.15004	1.000E+00
29	1993	9.330E+01	5.982E+01	0.7341	1.362E+01	1.362E+01	-0.44446	1.000E+00
30	1994	5.560E+01	6.118E+01	0.1091	2.069E+00	2.069E+00	0.09567	1.000E+00
31	1995	7.060E+01	8.877E+01	0.0024	6.700E-02	6.700E-02	0.22906	1.000E+00
32	1996	1.756E+02	1.305E+02	0.0057	2.320E-01	2.320E-01	-0.29690	1.000E+00
33	1997	1.749E+02	1.823E+02	0.0116	6.580E-01	6.580E-01	0.04142	1.000E+00
34	1998	2.022E+02	2.350E+02	0.0602	4.386E+00	4.386E+00	0.15022	1.000E+00
35	1999	3.657E+02	2.794E+02	0.0796	6.894E+00	6.894E+00	-0.26903	1.000E+00
36	2000	2.875E+02	3.113E+02	0.1156	1.116E+01	1.116E+01	0.07959	1.000E+00
37	2001	3.660E+02	3.289E+02	0.1387	1.414E+01	1.414E+01	-0.10700	1.000E+00
38	2002	1.995E+02	3.449E+02	0.1000	1.070E+01	1.070E+01	0.54757	1.000E+00
39	2003	3.865E+02	3.587E+02	0.1242	1.381E+01	1.381E+01	-0.07470	1.000E+00
40	2004	3.079E+02	3.660E+02	0.1177	1.335E+01	1.335E+01	0.17288	1.000E+00
41	2005	3.888E+02	3.719E+02	0.1208	1.393E+01	1.393E+01	-0.04434	1.000E+00
42	2006	*	3.950E+02	0.0076	9.300E-01	9.300E-01	0.00000	1.000E+00
43	2007	4.430E+02	4.244E+02	0.0351	4.617E+00	4.617E+00	-0.04286	1.000E+00
44	2008	4.570E+02	4.309E+02	0.0853	1.140E+01	1.140E+01	-0.05882	1.000E+00
45	2009	*	4.187E+02	0.1309	1.700E+01	1.700E+01	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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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    ------------------------------------------------------------------------------------
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     0.0000                                             |
1984    -0.1046                                         ====|
1985     0.2022                                             |========
1986    -0.0079                                             |
1987    -0.1237                                        =====|
1988     0.1981                                             |========
1989    -0.0813                                          ===|
1990    -0.0833                                          ===|
1991    -0.1296                                        =====|
1992     0.1500                                             |======
1993    -0.4445                           ==================|
1994     0.0957                                             |====
1995     0.2291                                             |=========
1996    -0.2969                                 ============|
1997     0.0414                                             |==
1998     0.1502                                             |======
1999    -0.2690                                  ===========|
2000     0.0796                                             |===
2001    -0.1070                                         ====|
2002     0.5476                                             |======================
2003    -0.0747                                          ===|
2004     0.1729                                             |=======
2005    -0.0443                                           ==|
2006     0.0000                                             |
2007    -0.0429                                           ==|
2008    -0.0588                                           ==|
2009     0.0000                                             |
                   ------------------------------------------------------------------------------------
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RESULTS FOR DATA SERIES *# 2 (NON-BOOTSTRAPPED)* *Canadian Yankee Survey*

Data type I1: Abundance index (annual average) Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Statist weight
1	1965	0.000E+00	0.000E+00	--	*	8.589E+01	0.00000	1.000E+00
2	1966	0.000E+00	0.000E+00	--	*	9.962E+01	0.00000	1.000E+00
3	1967	0.000E+00	0.000E+00	--	*	1.090E+02	0.00000	1.000E+00
4	1968	0.000E+00	0.000E+00	--	*	1.139E+02	0.00000	1.000E+00
5	1969	0.000E+00	0.000E+00	--	*	1.148E+02	0.00000	1.000E+00
6	1970	0.000E+00	0.000E+00	--	*	1.094E+02	0.00000	1.000E+00
7	1971	1.000E+00	1.000E+00	--	9.690E+01	9.461E+01	0.02391	1.000E+00
8	1972	1.000E+00	1.000E+00	--	7.920E+01	7.517E+01	0.05224	1.000E+00
9	1973	1.000E+00	1.000E+00	--	5.170E+01	5.813E+01	-0.11717	1.000E+00
10	1974	1.000E+00	1.000E+00	--	4.030E+01	4.714E+01	-0.15668	1.000E+00
11	1975	1.000E+00	1.000E+00	--	3.740E+01	3.891E+01	-0.03958	1.000E+00
12	1976	1.000E+00	1.000E+00	--	4.170E+01	3.812E+01	0.08974	1.000E+00
13	1977	1.000E+00	1.000E+00	--	6.500E+01	4.325E+01	0.40743	1.000E+00
14	1978	1.000E+00	1.000E+00	--	4.430E+01	4.554E+01	-0.02768	1.000E+00
15	1979	1.000E+00	1.000E+00	--	3.850E+01	4.453E+01	-0.14560	1.000E+00
16	1980	1.000E+00	1.000E+00	--	5.140E+01	4.512E+01	0.13024	1.000E+00
17	1981	1.000E+00	1.000E+00	--	4.500E+01	4.783E+01	-0.06096	1.000E+00
18	1982	1.000E+00	1.000E+00	--	4.310E+01	5.065E+01	-0.16147	1.000E+00
19	1983	0.000E+00	0.000E+00	--	*	5.633E+01	0.00000	1.000E+00
20	1984	0.000E+00	0.000E+00	--	*	6.088E+01	0.00000	1.000E+00
21	1985	0.000E+00	0.000E+00	--	*	5.579E+01	0.00000	1.000E+00
22	1986	0.000E+00	0.000E+00	--	*	4.257E+01	0.00000	1.000E+00
23	1987	0.000E+00	0.000E+00	--	*	3.418E+01	0.00000	1.000E+00
24	1988	0.000E+00	0.000E+00	--	*	3.066E+01	0.00000	1.000E+00
25	1989	0.000E+00	0.000E+00	--	*	2.971E+01	0.00000	1.000E+00
26	1990	0.000E+00	0.000E+00	--	*	2.945E+01	0.00000	1.000E+00
27	1991	0.000E+00	0.000E+00	--	*	2.547E+01	0.00000	1.000E+00
28	1992	0.000E+00	0.000E+00	--	*	2.215E+01	0.00000	1.000E+00
29	1993	0.000E+00	0.000E+00	--	*	1.857E+01	0.00000	1.000E+00
30	1994	0.000E+00	0.000E+00	--	*	1.900E+01	0.00000	1.000E+00
31	1995	0.000E+00	0.000E+00	--	*	2.756E+01	0.00000	1.000E+00
32	1996	0.000E+00	0.000E+00	--	*	4.052E+01	0.00000	1.000E+00
33	1997	0.000E+00	0.000E+00	--	*	5.660E+01	0.00000	1.000E+00
34	1998	0.000E+00	0.000E+00	--	*	7.296E+01	0.00000	1.000E+00
35	1999	0.000E+00	0.000E+00	--	*	8.676E+01	0.00000	1.000E+00
36	2000	0.000E+00	0.000E+00	--	*	9.666E+01	0.00000	1.000E+00
37	2001	0.000E+00	0.000E+00	--	*	1.021E+02	0.00000	1.000E+00
38	2002	0.000E+00	0.000E+00	--	*	1.071E+02	0.00000	1.000E+00
39	2003	0.000E+00	0.000E+00	--	*	1.114E+02	0.00000	1.000E+00
40	2004	0.000E+00	0.000E+00	--	*	1.136E+02	0.00000	1.000E+00
41	2005	0.000E+00	0.000E+00	--	*	1.155E+02	0.00000	1.000E+00
42	2006	0.000E+00	0.000E+00	--	*	1.226E+02	0.00000	1.000E+00
43	2007	0.000E+00	0.000E+00	--	*	1.318E+02	0.00000	1.000E+00
44	2008	0.000E+00	0.000E+00	--	*	1.338E+02	0.00000	1.000E+00
45	2009	0.000E+00	0.000E+00	--	*	1.300E+02	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 2
                   -1       -0.75     -0.5      -0.25       0        0.25      0.5       0.75       1
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual   ------------------------------------------------------------------------------------
1965     0.0000                                             |
1966     0.0000                                             |
1967     0.0000                                             |
1968     0.0000                                             |
1969     0.0000                                             |
1970     0.0000                                             |
1971     0.0239                                             |=
1972     0.0522                                             |==
1973    -0.1172                                        =====|
1974    -0.1567                                       ======|
1975    -0.0396                                           ==|
1976     0.0897                                             |====
1977     0.4074                                             |================
1978    -0.0277                                            =|
1979    -0.1456                                       ======|
1980     0.1302                                             |=====
1981    -0.0610                                           ==|
1982    -0.1615                                       ======|
1983     0.0000                                             |
1984     0.0000                                             |
1985     0.0000                                             |
1986     0.0000                                             |
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990     0.0000                                             |
1991     0.0000                                             |
1992     0.0000                                             |
1993     0.0000                                             |
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                                             |
2003     0.0000                                             |
2004     0.0000                                             |
2005     0.0000                                             |
2006     0.0000                                             |
2007     0.0000                                             |
2008     0.0000                                             |
2009     0.0000                                             |
                  ------------------------------------------------------------------------------------
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RESULTS FOR DATA SERIES *# 3 (NON-BOOTSTRAPPED)* *Canadian Fall Survey*

Data type I2: Abundance index (end of year) Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Statist weight
1	1965	0.000E+00	0.000E+00	--	*	3.102E+02	0.00000	1.000E+00
2	1966	0.000E+00	0.000E+00	--	*	3.469E+02	0.00000	1.000E+00
3	1967	0.000E+00	0.000E+00	--	*	3.725E+02	0.00000	1.000E+00
4	1968	0.000E+00	0.000E+00	--	*	3.800E+02	0.00000	1.000E+00
5	1969	0.000E+00	0.000E+00	--	*	3.790E+02	0.00000	1.000E+00
6	1970	0.000E+00	0.000E+00	--	*	3.463E+02	0.00000	1.000E+00
7	1971	0.000E+00	0.000E+00	--	*	2.843E+02	0.00000	1.000E+00
8	1972	0.000E+00	0.000E+00	--	*	2.185E+02	0.00000	1.000E+00
9	1973	0.000E+00	0.000E+00	--	*	1.698E+02	0.00000	1.000E+00
10	1974	0.000E+00	0.000E+00	--	*	1.435E+02	0.00000	1.000E+00
11	1975	0.000E+00	0.000E+00	--	*	1.157E+02	0.00000	1.000E+00
12	1976	0.000E+00	0.000E+00	--	*	1.365E+02	0.00000	1.000E+00
13	1977	0.000E+00	0.000E+00	--	*	1.495E+02	0.00000	1.000E+00
14	1978	0.000E+00	0.000E+00	--	*	1.515E+02	0.00000	1.000E+00
15	1979	0.000E+00	0.000E+00	--	*	1.432E+02	0.00000	1.000E+00
16	1980	0.000E+00	0.000E+00	--	*	1.552E+02	0.00000	1.000E+00
17	1981	0.000E+00	0.000E+00	--	*	1.613E+02	0.00000	1.000E+00
18	1982	0.000E+00	0.000E+00	--	*	1.736E+02	0.00000	1.000E+00
19	1983	0.000E+00	0.000E+00	--	*	1.983E+02	0.00000	1.000E+00
20	1984	0.000E+00	0.000E+00	--	*	2.043E+02	0.00000	1.000E+00
21	1985	0.000E+00	0.000E+00	--	*	1.674E+02	0.00000	1.000E+00
22	1986	0.000E+00	0.000E+00	--	*	1.183E+02	0.00000	1.000E+00
23	1987	0.000E+00	0.000E+00	--	*	1.082E+02	0.00000	1.000E+00
24	1988	0.000E+00	0.000E+00	--	*	9.528E+01	0.00000	1.000E+00
25	1989	0.000E+00	0.000E+00	--	*	1.011E+02	0.00000	1.000E+00
26	1990	1.000E+00	1.000E+00	--	6.580E+01	9.414E+01	-0.35814	1.000E+00
27	1991	1.000E+00	1.000E+00	--	8.240E+01	7.553E+01	0.08712	1.000E+00
28	1992	1.000E+00	1.000E+00	--	6.450E+01	7.118E+01	-0.09850	1.000E+00
29	1993	1.000E+00	1.000E+00	--	1.128E+02	5.296E+01	0.75601	1.000E+00
30	1994	1.000E+00	1.000E+00	--	1.064E+02	7.354E+01	0.36934	1.000E+00
31	1995	1.000E+00	1.000E+00	--	1.298E+02	1.106E+02	0.16029	1.000E+00
32	1996	1.000E+00	1.000E+00	--	1.343E+02	1.591E+02	-0.16923	1.000E+00
33	1997	1.000E+00	1.000E+00	--	2.229E+02	2.162E+02	0.03059	1.000E+00
34	1998	1.000E+00	1.000E+00	--	2.316E+02	2.658E+02	-0.13765	1.000E+00
35	1999	1.000E+00	1.000E+00	--	2.499E+02	3.068E+02	-0.20509	1.000E+00
36	2000	1.000E+00	1.000E+00	--	3.350E+02	3.311E+02	0.01181	1.000E+00
37	2001	1.000E+00	1.000E+00	--	4.758E+02	3.431E+02	0.32684	1.000E+00
38	2002	1.000E+00	1.000E+00	--	3.397E+02	3.639E+02	-0.06875	1.000E+00
39	2003	1.000E+00	1.000E+00	--	3.683E+02	3.717E+02	-0.00908	1.000E+00
40	2004	1.000E+00	1.000E+00	--	3.747E+02	3.793E+02	-0.01211	1.000E+00
41	2005	1.000E+00	1.000E+00	--	3.427E+02	3.836E+02	-0.11285	1.000E+00
42	2006	1.000E+00	1.000E+00	--	3.055E+02	4.249E+02	-0.32982	1.000E+00
43	2007	1.000E+00	1.000E+00	--	4.824E+02	4.447E+02	0.08130	1.000E+00
44	2008	1.000E+00	1.000E+00	--	3.220E+02	4.399E+02	-0.31194	1.000E+00
45	2009	0.000E+00	0.000E+00	--	*	4.207E+02	0.00000	1.000E+00

* Asterisk indicates missing value(s).

```
3LNO Yellowtail SM version 5.33 (2008) 2009=TAC RUSSIA 1984-1991; 2006 Spring OUT                             Page 9

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 3
                   -1       -0.75     -0.5      -0.25       0        0.25      0.5       0.75       1
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    ------------------------------------------------------------------------------------
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     0.0000                                             |
1984     0.0000                                             |
1985     0.0000                                             |
1986     0.0000                                             |
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990    -0.3581                               ==============|
1991     0.0871                                             |===
1992    -0.0985                                         ====|
1993     0.7560                                             |==============================
1994     0.3693                                             |===============
1995     0.1603                                             |======
1996    -0.1692                                      =======|
1997     0.0306                                             |=
1998    -0.1377                                       ======|
1999    -0.2051                                     ========|
2000     0.0118                                             |
2001     0.3268                                             |=============
2002    -0.0688                                          ===|
2003    -0.0091                                             |
2004    -0.0121                                             |
2005    -0.1128                                        =====|
2006    -0.3298                                =============|
2007     0.0813                                             |===
2008    -0.3119                                 ============|
2009     0.0000                                             |
                   ------------------------------------------------------------------------------------
```

RESULTS FOR DATA SERIES *# 4 (NON-BOOTSTRAPPED)* *Russian Survey*

Data type I1: Abundance index (annual average) Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Statist weight
1	1965	0.000E+00	0.000E+00	--	*	9.920E+01	0.00000	1.000E+00
2	1966	0.000E+00	0.000E+00	--	*	1.151E+02	0.00000	1.000E+00
3	1967	0.000E+00	0.000E+00	--	*	1.259E+02	0.00000	1.000E+00
4	1968	0.000E+00	0.000E+00	--	*	1.316E+02	0.00000	1.000E+00
5	1969	0.000E+00	0.000E+00	--	*	1.326E+02	0.00000	1.000E+00
6	1970	0.000E+00	0.000E+00	--	*	1.264E+02	0.00000	1.000E+00
7	1971	0.000E+00	0.000E+00	--	*	1.093E+02	0.00000	1.000E+00
8	1972	0.000E+00	0.000E+00	--	*	8.682E+01	0.00000	1.000E+00
9	1973	0.000E+00	0.000E+00	--	*	6.713E+01	0.00000	1.000E+00
10	1974	0.000E+00	0.000E+00	--	*	5.444E+01	0.00000	1.000E+00
11	1975	0.000E+00	0.000E+00	--	*	4.494E+01	0.00000	1.000E+00
12	1976	0.000E+00	0.000E+00	--	*	4.403E+01	0.00000	1.000E+00
13	1977	0.000E+00	0.000E+00	--	*	4.995E+01	0.00000	1.000E+00
14	1978	0.000E+00	0.000E+00	--	*	5.260E+01	0.00000	1.000E+00
15	1979	0.000E+00	0.000E+00	--	*	5.143E+01	0.00000	1.000E+00
16	1980	0.000E+00	0.000E+00	--	*	5.211E+01	0.00000	1.000E+00
17	1981	0.000E+00	0.000E+00	--	*	5.524E+01	0.00000	1.000E+00
18	1982	0.000E+00	0.000E+00	--	*	5.850E+01	0.00000	1.000E+00
19	1983	0.000E+00	0.000E+00	--	*	6.505E+01	0.00000	1.000E+00
20	1984	1.000E+00	1.000E+00	--	1.320E+02	7.031E+01	0.62992	1.000E+00
21	1985	1.000E+00	1.000E+00	--	8.500E+01	6.444E+01	0.27696	1.000E+00
22	1986	1.000E+00	1.000E+00	--	4.200E+01	4.917E+01	-0.15752	1.000E+00
23	1987	1.000E+00	1.000E+00	--	3.000E+01	3.948E+01	-0.27462	1.000E+00
24	1988	1.000E+00	1.000E+00	--	2.300E+01	3.541E+01	-0.43146	1.000E+00
25	1989	1.000E+00	1.000E+00	--	4.400E+01	3.431E+01	0.24865	1.000E+00
26	1990	1.000E+00	1.000E+00	--	2.700E+01	3.402E+01	-0.23103	1.000E+00
27	1991	1.000E+00	1.000E+00	--	2.750E+01	2.942E+01	-0.06751	1.000E+00
28	1992	0.000E+00	0.000E+00	--	*	2.558E+01	0.00000	1.000E+00
29	1993	0.000E+00	0.000E+00	--	*	2.145E+01	0.00000	1.000E+00
30	1994	0.000E+00	0.000E+00	--	*	2.194E+01	0.00000	1.000E+00
31	1995	0.000E+00	0.000E+00	--	*	3.183E+01	0.00000	1.000E+00
32	1996	0.000E+00	0.000E+00	--	*	4.679E+01	0.00000	1.000E+00
33	1997	0.000E+00	0.000E+00	--	*	6.537E+01	0.00000	1.000E+00
34	1998	0.000E+00	0.000E+00	--	*	8.426E+01	0.00000	1.000E+00
35	1999	0.000E+00	0.000E+00	--	*	1.002E+02	0.00000	1.000E+00
36	2000	0.000E+00	0.000E+00	--	*	1.116E+02	0.00000	1.000E+00
37	2001	0.000E+00	0.000E+00	--	*	1.179E+02	0.00000	1.000E+00
38	2002	0.000E+00	0.000E+00	--	*	1.237E+02	0.00000	1.000E+00
39	2003	0.000E+00	0.000E+00	--	*	1.286E+02	0.00000	1.000E+00
40	2004	0.000E+00	0.000E+00	--	*	1.312E+02	0.00000	1.000E+00
41	2005	0.000E+00	0.000E+00	--	*	1.334E+02	0.00000	1.000E+00
42	2006	0.000E+00	0.000E+00	--	*	1.416E+02	0.00000	1.000E+00
43	2007	0.000E+00	0.000E+00	--	*	1.522E+02	0.00000	1.000E+00
44	2008	0.000E+00	0.000E+00	--	*	1.545E+02	0.00000	1.000E+00
45	2009	0.000E+00	0.000E+00	--	*	1.502E+02	0.00000	1.000E+00

* Asterisk indicates missing value(s).

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 4

```
                   -1       -0.75     -0.5      -0.25       0       0.25      0.5       0.75        1
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    ------------------------------------------------------------------------------------
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     0.0000                                             |
1984     0.6299                                             |=========================
1985     0.2770                                             |===========
1986    -0.1575                                       ======|
1987    -0.2746                                  ===========|
1988    -0.4315                            =================|
1989     0.2486                                             |==========
1990    -0.2310                                    =========|
1991    -0.0675                                          ===|
1992     0.0000                                             |
1993     0.0000                                             |
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                                             |
2003     0.0000                                             |
2004     0.0000                                             |
2005     0.0000                                             |
2006     0.0000                                             |
2007     0.0000                                             |
2008     0.0000                                             |
2009     0.0000                                             |
                   ------------------------------------------------------------------------------------
```

RESULTS FOR DATA SERIES *# 5 (NON-BOOTSTRAPPED)* *Spanish Survey Converted biomass_2006*

Data type I1: Abundance index (annual average) Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Statist weight
1	1965	0.000E+00	0.000E+00	--	*	1.050E+02	0.00000	1.000E+00
2	1966	0.000E+00	0.000E+00	--	*	1.218E+02	0.00000	1.000E+00
3	1967	0.000E+00	0.000E+00	--	*	1.333E+02	0.00000	1.000E+00
4	1968	0.000E+00	0.000E+00	--	*	1.393E+02	0.00000	1.000E+00
5	1969	0.000E+00	0.000E+00	--	*	1.404E+02	0.00000	1.000E+00
6	1970	0.000E+00	0.000E+00	--	*	1.337E+02	0.00000	1.000E+00
7	1971	0.000E+00	0.000E+00	--	*	1.157E+02	0.00000	1.000E+00
8	1972	0.000E+00	0.000E+00	--	*	9.189E+01	0.00000	1.000E+00
9	1973	0.000E+00	0.000E+00	--	*	7.106E+01	0.00000	1.000E+00
10	1974	0.000E+00	0.000E+00	--	*	5.762E+01	0.00000	1.000E+00
11	1975	0.000E+00	0.000E+00	--	*	4.757E+01	0.00000	1.000E+00
12	1976	0.000E+00	0.000E+00	--	*	4.660E+01	0.00000	1.000E+00
13	1977	0.000E+00	0.000E+00	--	*	5.287E+01	0.00000	1.000E+00
14	1978	0.000E+00	0.000E+00	--	*	5.567E+01	0.00000	1.000E+00
15	1979	0.000E+00	0.000E+00	--	*	5.444E+01	0.00000	1.000E+00
16	1980	0.000E+00	0.000E+00	--	*	5.516E+01	0.00000	1.000E+00
17	1981	0.000E+00	0.000E+00	--	*	5.847E+01	0.00000	1.000E+00
18	1982	0.000E+00	0.000E+00	--	*	6.192E+01	0.00000	1.000E+00
19	1983	0.000E+00	0.000E+00	--	*	6.885E+01	0.00000	1.000E+00
20	1984	0.000E+00	0.000E+00	--	*	7.442E+01	0.00000	1.000E+00
21	1985	0.000E+00	0.000E+00	--	*	6.820E+01	0.00000	1.000E+00
22	1986	0.000E+00	0.000E+00	--	*	5.204E+01	0.00000	1.000E+00
23	1987	0.000E+00	0.000E+00	--	*	4.179E+01	0.00000	1.000E+00
24	1988	0.000E+00	0.000E+00	--	*	3.748E+01	0.00000	1.000E+00
25	1989	0.000E+00	0.000E+00	--	*	3.632E+01	0.00000	1.000E+00
26	1990	0.000E+00	0.000E+00	--	*	3.601E+01	0.00000	1.000E+00
27	1991	0.000E+00	0.000E+00	--	*	3.114E+01	0.00000	1.000E+00
28	1992	0.000E+00	0.000E+00	--	*	2.708E+01	0.00000	1.000E+00
29	1993	0.000E+00	0.000E+00	--	*	2.270E+01	0.00000	1.000E+00
30	1994	0.000E+00	0.000E+00	--	*	2.322E+01	0.00000	1.000E+00
31	1995	1.000E+00	1.000E+00	--	9.300E+00	3.369E+01	-1.28729	1.000E+00
32	1996	1.000E+00	1.000E+00	--	4.330E+01	4.953E+01	-0.13437	1.000E+00
33	1997	1.000E+00	1.000E+00	--	3.870E+01	6.919E+01	-0.58101	1.000E+00
34	1998	1.000E+00	1.000E+00	--	1.226E+02	8.918E+01	0.31823	1.000E+00
35	1999	1.000E+00	1.000E+00	--	1.970E+02	1.061E+02	0.61921	1.000E+00
36	2000	1.000E+00	1.000E+00	--	1.447E+02	1.182E+02	0.20263	1.000E+00
37	2001	1.000E+00	1.000E+00	--	1.827E+02	1.248E+02	0.38100	1.000E+00
38	2002	1.000E+00	1.000E+00	--	1.485E+02	1.309E+02	0.12599	1.000E+00
39	2003	1.000E+00	1.000E+00	--	1.368E+02	1.361E+02	0.00487	1.000E+00
40	2004	1.000E+00	1.000E+00	--	1.700E+02	1.389E+02	0.20193	1.000E+00
41	2005	1.000E+00	1.000E+00	--	1.565E+02	1.412E+02	0.10298	1.000E+00
42	2006	1.000E+00	1.000E+00	--	1.601E+02	1.499E+02	0.06569	1.000E+00
43	2007	1.000E+00	1.000E+00	--	1.607E+02	1.611E+02	-0.00239	1.000E+00
44	2008	1.000E+00	1.000E+00	--	1.601E+02	1.635E+02	-0.02128	1.000E+00
45	2009	0.000E+00	0.000E+00	--	*	1.589E+02	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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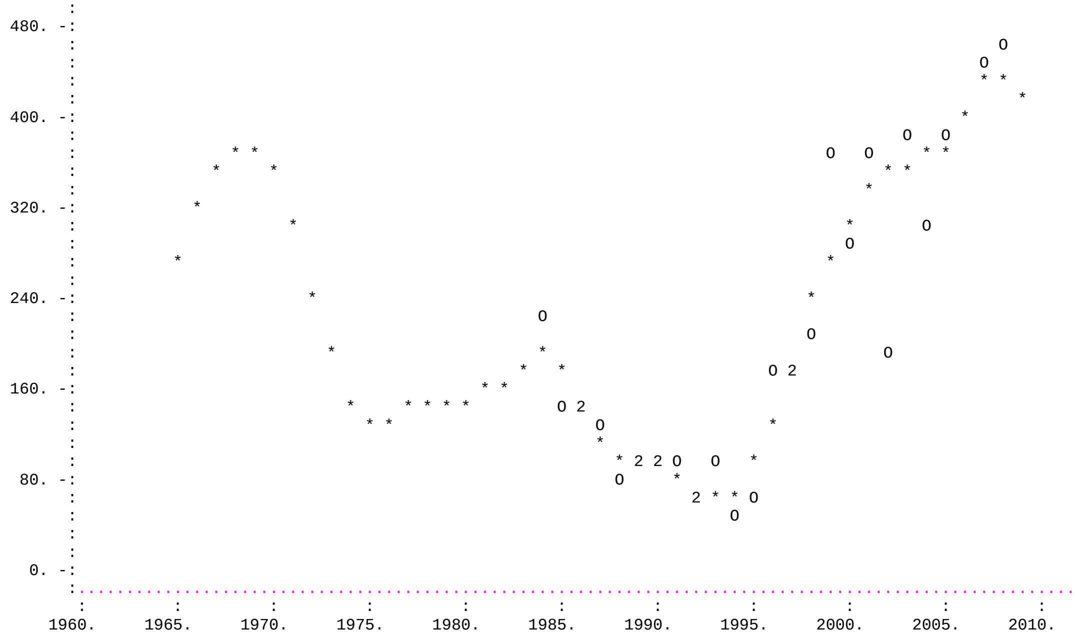
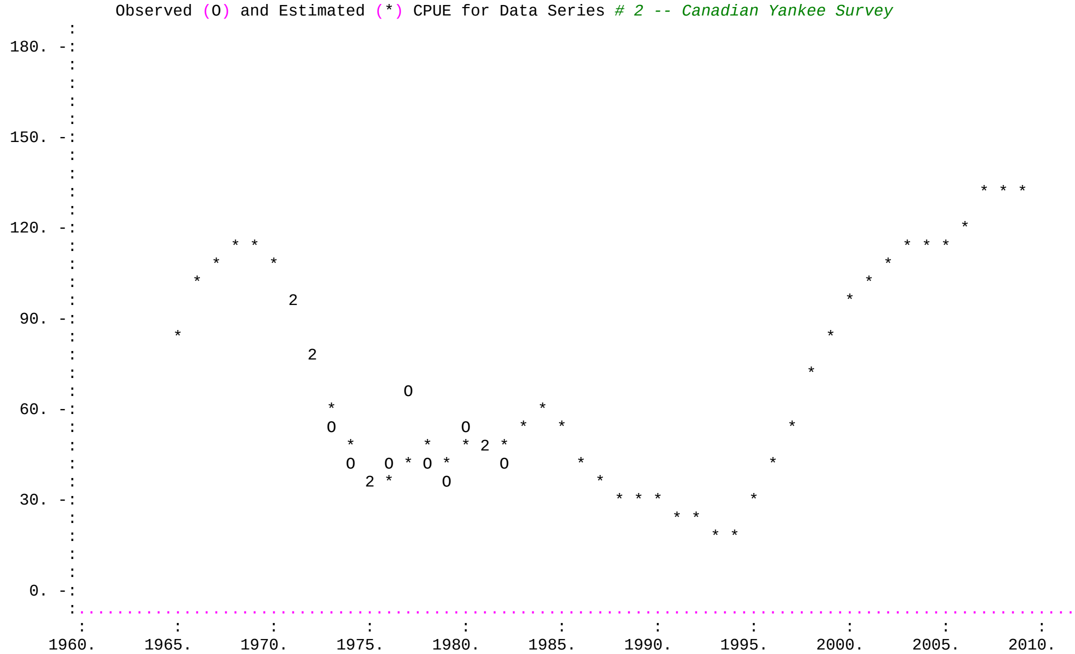
UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 5
                   -2      -1.5       -1      -0.5        0        0.5        1        1.5        2
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    ------------------------------------------------------------------------------------
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     0.0000                                             |
1984     0.0000                                             |
1985     0.0000                                             |
1986     0.0000                                             |
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990     0.0000                                             |
1991     0.0000                                             |
1992     0.0000                                             |
1993     0.0000                                             |
1994     0.0000                                             |
1995    -1.2873                   ==========================|
1996    -0.1344                                          ===|
1997    -0.5810                                 ============|
1998     0.3182                                             |======
1999     0.6192                                             |============
2000     0.2026                                             |====
2001     0.3810                                             |========
2002     0.1260                                             |===
2003     0.0049                                             |
2004     0.2019                                             |====
2005     0.1030                                             |==
2006     0.0657                                             |=
2007    -0.0024                                             |
2008    -0.0213                                             |
2009     0.0000                                             |
                   ------------------------------------------------------------------------------------
```

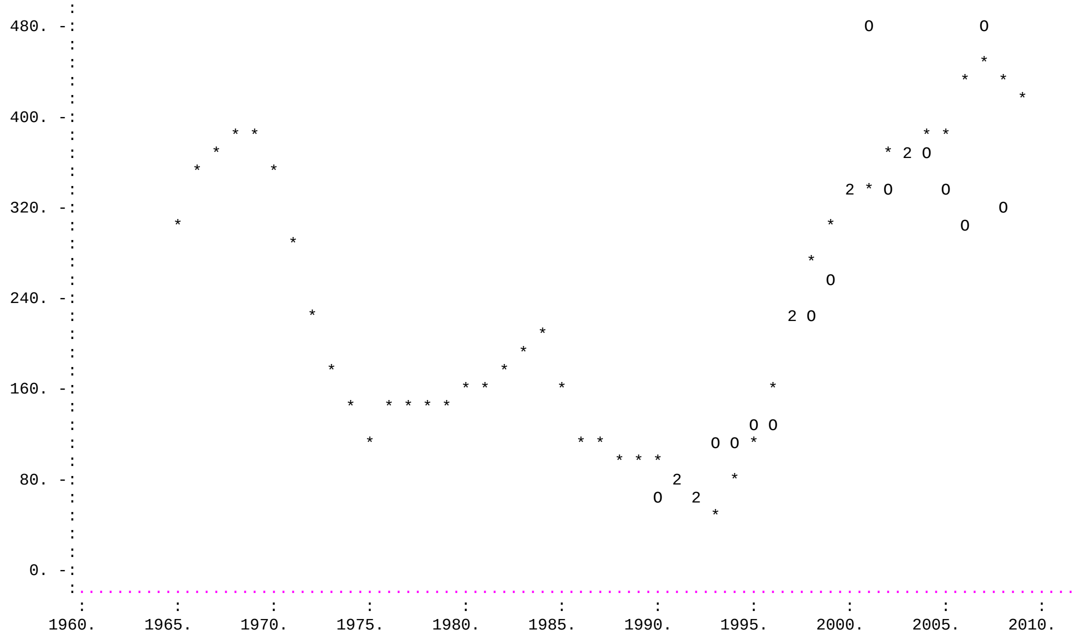
Observed (O) and Estimated (*) CPUE for Data Series *# 1 -- Fishery-catch/Spring biomass*



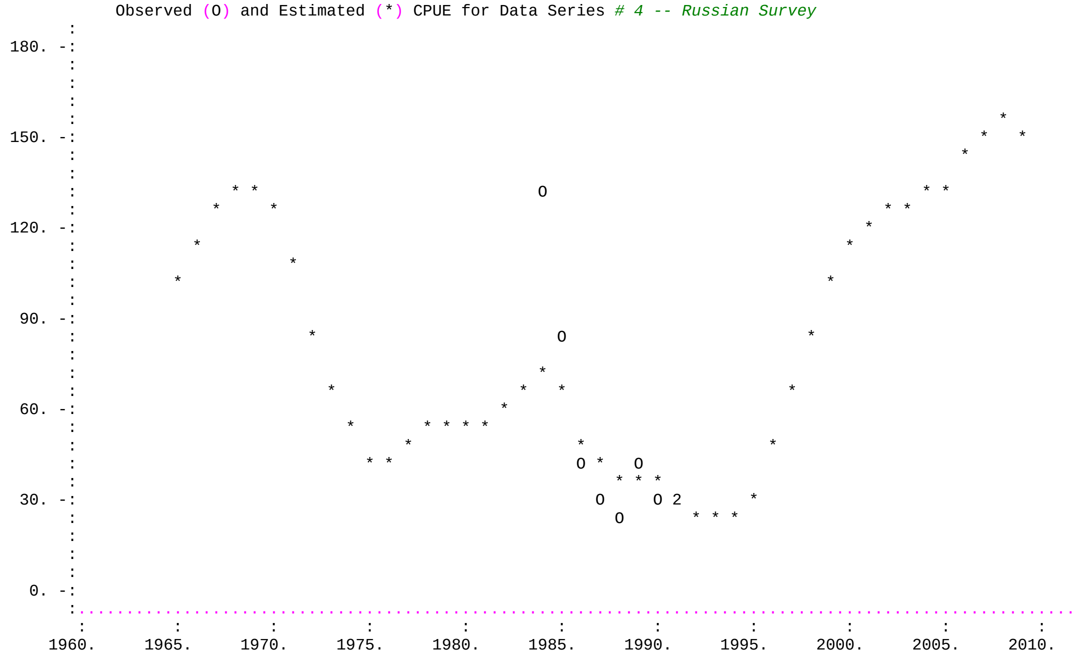
Observed (O) and Estimated (*) CPUE for Data Series *# 2 -- Canadian Yankee Survey*



Observed (O) and Estimated (*) CPUE for Data Series *# 3 -- Canadian Fall Survey*

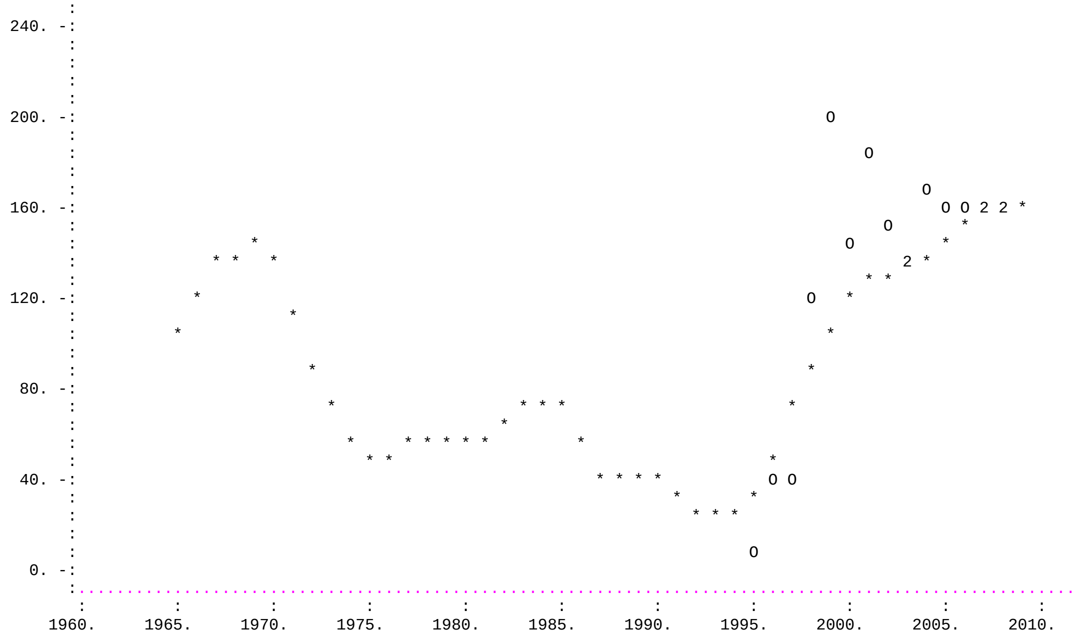


Observed (O) and Estimated (*) CPUE for Data Series *# 4 -- Russian Survey*



3LNO Yellowtail SM version 5.33 (2008) 2009=TAC RUSSIA 1984-1991; 2006 Spring OUT Page 16

Observed (O) and Estimated (*) CPUE for Data Series *# 5 -- Spanish Survey Converted biomass_2006*



Time Plot of Estimated F/Fmsy and B/Bmsy (dashed line = 1.0)