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Northwest Atlantic Fisheries Organization

Serial No. N5918 **NAFO SCR Doc. 11/033**

SCIENTIFIC COUNCIL MEETING – JUNE 2011

Assessment of NAFO Div. 3LNO Yellowtail Flounder

by

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Abstract

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 were the highest in the series for the spring survey and in the fall survey, the 2007 biomass estimate was the highest in the series. In 2009, estimates of biomass and abundance declined in both Canadian spring and autumn surveys, but 2010 estimates were again near the highest in the series. The 2009 and 2010 Spanish spring survey estimates were also near the highest in the series. The 2011 assessment uses ASPIC version 5.34 with updated catch and survey biomass indices for 2009 and 2010 to produce relative biomass and fishing mortality estimates. 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 and 2009, Scientific Council noted that this stock was well above B_{msy}, and recommended any TAC option up to 85% F_{msy} for 2009, 2010 and 2011. For 2009 and 2010 the TAC was set at 17 000 tons each year.

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. 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. Catches in 2009 and 2010 were low with only 6 200 tons and 4 200 tons, respectively, taken of the 17 000 ton TACs. Reduction in the effort by the Canadian fleet in the recent two years was the result of market conditions.

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. In 2009 and 2010, catch was predominantly from Div. 3N, at 3 228 tons and 5 582 tons respectively.

C. The 2009-2010 Fisheries by Non-Canadian Vessels (SCS Doc. 10/ 5,6; 11/ 5, 7)

Sampling of size composition from commercial catches of yellowtail flounder in 2009 and 2010 was available from the fisheries for Greenland halibut and skate in the NRA of Div. 3NO, and in the Canadian directed fishery for yellowtail, length frequencies were available for 2009 and 2010. Available length frequencies from the Canadian and Spanish catches for 2009 and 2010 are plotted together in Figure 2. The minimum codend mesh size in the Canadian fleet is 145 mm while Spain uses a minimum of 130 mm mesh size when fishing for Greenland halibut. In 2009, the mode in the Spanish yellowtail by-catch was 28-34 cm, lower than that seen in years prior to 2006, or in fisheries by Canada and Portugal which had similar modes in the length frequencies of 36-38cm. In 2009 and 2010, skate fisheries of Portugal and Spain, where a minimum codend mesh size of 280 mm is used, there were two modes of size selected at 26 cm and 32 cm in the 2010 catch by Portugal while the mode in the 2010 catch by Spain was 36 cm.

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 1995-2010.

Abundance and biomass trends

Figures 3 and 4 and Tables 3 and 4 compare the population abundance and biomass estimates of yellowtail flounder in the Canadian spring and autumn surveys. Detailed descriptions of trends in yellowtail flounder from both surveys are contained in Maddock Parsons (2011a). 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. 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 5 shows the result of a regression of the biomass estimates from the spring and fall time series. A linear relationship is evident with 70% 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 2).

Size composition and growth

Figure 6 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. 6). Smaller peaks of fish around 18cm are evident from about 2006 or 2007-2009 and then merge into the modal peak by 2010.

In the fall surveys, multi-modal peaks are more common and unlike the spring surveys, were evident in surveys from 2001-2010 (Fig. 6). 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 7A shows survey abundance less than 22 cm from Canada and Spain for the period 1995-2010 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 2006-2009, 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. In 2001 catches of small fish in the Canadian autumn survey were above average and can also be seen as a mode in the survey abundance at length plot (Fig. 6). Figure 7C shows that there was a relationship between 1996-2003 Canadian spring and fall estimates but no linear relationship exists between the entire time series (Fig. 7B).

B. Spanish Stratified-random Spring Surveys in the Regulatory Area, Div. 3NO (*SCR Doc. 11/06*)

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 8). Most (85%) of the biomass comes from strata 360 and 376 similar to other years. Length frequencies in the 2009 Spanish survey showed a mode around 32-34 cm (Fig. 9). As in the Canadian spring surveys (Fig. 6), this survey showed a similar progression of the peak in the length frequencies from 1998 to 2003. From 2007-2010, there was is some evidence of a recruitment pulse in recent years similar to the Canadian spring survey results.

C. Stock Distribution *(SCR Doc. 11/37)*

Distribution of yellowtail flounder in NAFO Divs. 3LNO are described for the Canadian spring (1984-2010) and autumn (1990-2010) survey series (Maddock Parsons, 2011b). The stock continues to occupy more northern areas, and while still more northerly than when the stock was under moratorium, the proportion of yellowtail north of 45 degree latitude had declined in the past couple of years (see Maddock Parsons 2011a).

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. Biological Studies

Maturity

Maturity at size by year was estimated using Canadian spring research vessel data from 1984-2010. Estimates were produced using a probit model with a logit link function and a binomial error structure (SAS, 1989). L_{50} declined in males, by about 7 cm from around 30 cm in the mid-1980's to 23 cm in 1999. Although there have been short term fluctuations there has been little overall trend since 2000, with L_{50} averaging just under 25 cm. Female L_{50} has been generally declining since about 2002 and each of the last 8 years which have all been estimated below the long term average of 33 cm (Fig. 10). There was significant inter-annual variation in the proportion mature at length for both males and females (generalized linear models: males χ^2=477.7, df=26, p<0.0001, females χ^2=509, df=26, p<0.0001). In general for males, years prior to 1992 were significantly different from years since 2002. For females, all years except 2008 are significantly lower than 2010.

Weight at length

Log length – log weight regressions were fit for females for each year from the Canadian spring survey data from 1990-2010. The specific length weight relationships are given in Table 5. Annual length weight relationships were unavailable prior to 1990 so for those years a relationship produced using data from 1990-1993 is given. There seems to have been a slight down ward trend in weight at length since 1996. This can be best seen in the largest size range plotted, the 50.5 cm grouping. For this size group weight has declined by about 0.15 kg since 1996 (Fig. 11).

Female SSB

Estimates of female proportion mature at length, population numbers at length, and annual length weight relationships were used to produce an index of female SSB from the spring survey. Female SSB declined from 1984 to 1992 (Fig. 12). Since 1995 it has increased substantially. The average index over the 1996-1998 period was 66 000 t, similar to levels in the mid-1980's. There was a large increase in the index in 1999 consistent with the large increase in the overall survey abundance index for that year. Overall the SSB index has been increasing since 1995. The 2005 to 2010 average is 194 000 t, substantially higher than that of the mid-1980's. In general the female SSB index mirrors the trend in the total survey biomass index.

E. 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 in 2008 used ASPIC version 5.24, and the survey indices listed in Table 5. There was 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. Other than differences in the output describing 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 were no differences in the trends of relative biomass and relative fishing mortality and model results and diagnostics were very similar between the comparison runs. In 2011 there was yet another version of ASPIC available and a run comparing the results of the 2009 model formulation in the previous version (5.33) and the newest version (5.34) confirmed that the new version of ASPIC was nearly identical in output (Table 9). Results of the ASPIC version comparison (v5.33 vs 5.34) suggested that the penalty option for B1/K should be switched off, as estimation in the early part of the time series has been known to be poorly understood by the model and if the penalty term was assessed, slightly worse model fit resulted. For the 2011 assessment, then, the penalty term was disabled.

E. Assessment Results

CPUE analysis

A multiplicative model (Gavaris, 1980) was used to analyze the catch and effort data for this stock as in assessments prior to the moratorium (Brodie et al. 1994), and in recent years (Maddock Parsons 2008; 2009). Logbook data from the Can (N) fleet identifying yellowtail as the directed species from 1965 to 1993, along with 1998-2005 and 2007-2010 data
were utilized to derive a standardized catch rate series. This logbook data provides the longest series available because data from NAFO Statistical Bulletins exist only from 1974 onward in a format that identifies yellowtail as a main (directed fishery) species. The Can (N) fleet has taken the majority of the catch over the time period from this stock and provided the only source of CPUE data, particularly the late 1970's and also since 1998. The data from 2006 was not included in the standardization because only 177 tons were taken by the Can(N) fleet trawlers due to labour problems within the industry.

Ln (CPUE) was the dependent variable in the model. Independent variables (category types) were: (1) a combination country-gear-tonnage-class category type (CGT), (2) NAFO Division, (3) month and (4) Year. Consistent with previous catch rate standardizations (e.g. Maddock Parsons 2008), individual observations with catch less than 10 tons or effort less than 10 hours were eliminated prior to analysis. Subsequently, within each independent variable, categories with arbitrarily less than five observations were also eliminated, with the exception of the variable "year", which is the purpose of the standardization. The percentage of otter trawl catch with reported hours fished effort utilized in the analysis, after the selection criteria were applied, ranged from 33% in 1966 to 100% in 2005, and averaged 68% since 1965. The advantage of running the Gavaris model is that the derived index is retransformed into the original units of fishing effort and can be computed for any chosen combination of the main factors. Plots of residuals from a preliminary run indicated data with higher levels of catch and effort tended to be less variable, therefore a weighted regression was conducted.

Tables 6 and 7 show the ANOVA and regression results of the CPUE analysis and Fig 13 shows the standardized series from 1965 to 2010. In Fig. 13A, the catch per unit of effort declined steadily from 1965 to 1976 then increased marginally to a relatively stable level from 1980 to 1985. The index again declined to the lowest level in the series in 1991. The catch rate in 1998, after more than four and a half years of moratorium, was at a level comparable to the late 1960's then remained stable to 2002 followed by an increase to the highest on record in 2008. Catch rate declined marginally in 2009 and remained at the same level in 2010. Monthly coefficients (Table 6) indicated that CPUE was highest during the fall period (September – October) and the best catch rates are in 3N. Data from the Canadian fleet indicate that by-catch of American plaice has been problematic in this fishery since the moratorium but no attempt has been made to account for this factor in the CPUE analyses.

Standardizations of the data separately for Div. 3N and Div. 3O (Fig. 13B) showed that, overall, the historical trends were the same, although the catch rate is generally lower in Div. 3O than in Div. 3N. Large fluctuations tend to occur more frequently in Div. 3O, primarily before 1985. In the period since the resumption of the directed fishery in 1998 catch rates showed opposite trends within each division between 1998 and 2001 and again in 2004 and 2007. Nevertheless, both series indicate recent catch rates are amongst the highest in the time series.

As noted previously, e.g. Brodie et al. (2004), the fluctuations in the combined index from 1990 to 1993 was due primarily to the switch in effort of the fleet to Div. 3O. A substantial part of the effort labeled 'directed' for one species or the other in this Division was actually effort directed at a mixed fishery for American plaice and yellowtail flounder during 1991-1993. Given this major shift in the fishery from the 1965-90 to 1991-93, some caution must be used in comparison of catch rates between these periods. Nonetheless, it is reasonable to interpret the 1991-1993 values for CPUE as another indication that the stock was low at that time. Since the resumption of the fishery in 1998, there has been a by-catch restriction of 5% for both American plaice and cod which directly affected the fishing pattern of the Canadian fleet. The vessels spent additional time searching for good catches of yellowtail with low by-catches of both restricted species, which they found mainly in the central and northern areas of Div. 3N. Avoidance of yellowtail too small for filleting machines (less than about 35 cm) has also been a factor in the fishery in recent years. The by-catch limits were increased to 13% in 2009 and to 15% in 2010. Once again, caution should be used in comparing post-moratorium catch rates with other fishery periods. However, the overall CPUE has increased since 1998, under the constraint of 5% by-catch limitations for most years, and suggests that the stock size has increased to a relatively high level, in agreement with survey indices (Maddock Parsons 2011; Gonzalez-Troncoso et al. 2011).

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, 2008 and 2009 assessments of this stock (Walsh *et al*., 2002; 2004;2006; Maddock Parsons *et al*., 2008; 2009). 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. In the model run presented it was assumed that the catch in 2011 would equal the TAC of 17 000 t, although catches in 2002-2005 and 2007-2010 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. In 2009 and 2010, however, catches were lower once more, partly due to market conditions.

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

The survey indices and catch series that were used in the production model are included in Table 8. The catch and indices (scaled to the mean of each series) are shown in Figure 14.

The 2011 accepted model formulation was an update of the 2009 assessment formulation (adding the 2010 catch and indices; TAC in 2011 of 17 000 tons) with the exception of turning off the b1/K penalty term. See Appendix 1 for the header data which outlines the input to the ASPIC model. The 2011 assessment used the indices outlined in table 8 in ASPIC version 5.34.

For the accepted model in 2011, 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 (Table 9; Figs. 15 and 16). The majority of variance in survey indices was explained by the model, but fit varied among indices (r^2 ranged from 0.55 to 0.85). Residuals appeared to be randomly distributed for most of the survey indices (see Figure 16 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 2010, the residual was near zero.

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 8 910 (80% CL = 17 650, 19 540) tons can be produced when the total stock biomass (B_{msy}) is 74 160 (80% CL=69 560, 86 320) tons and the fishing mortality rate (F_{msy}) is 0.26 (80% CL = 0.22, 0.28) (Table 10; Appendix 2). Estimates of relative biomass and fishing mortality rates are given in Table 11 and shown in Fig. 17. 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 1974 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 2012, assuming a catch of 17 000 t in 2011, the relative bias corrected biomass B_t /B_{msy} is estimated to be 1.63 (80% CL = 1.59, 1.65).

The relative fishing mortality rate (F_t /F_{msy}) was high during most of the historical fishery (Fig 17), 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 since 2006 the bias corrected *F*-ratios were considerably lower than $2/3F_{msy}$. If the TAC of 17 000 tons is taken in 2011, the bias corrected *F*-ratio was calculated to be 0.54 (80% CL = 0.51, 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 2011 assessment was run with the same formulation, dropping out 5 years of data, one year at a time (2011-2007). The model parameter estimates and goodness of fit results are given in Table 12 and the relative biomass and fishing mortality estimates are plotted in Figure 18. There is very little retrospective pattern in the 2011 production model.

Projections

The accepted formulation for the 2011 assessment was used as the basis for projections in the short and medium term with 2011 catch=TAC (17 000 t). A second 2011 catch scenario was also considered. The accepted model formulation (with TAC of 17 000 assumed taken in 2011) was projected, as was a scenario of catch in 2011 equal to the average of 2008-2010 (8 979 t). Model results for the ASPIC run used to project this scenario were nearly identical to the 2011 catch=TAC (17 000t) run and are included in Table 9. Medium-term projections for both 2011 catch scenarios were carried out by extending the ASPIC bootstrap results forward to the year 2016 under assumptions of constant fishing mortality at F_{2010}, 2/3 F_{msy}, 0.75 F_{msy}, 0.85 F_{msy}, and F_{msy}. Catch and biomass decrease slightly in the projections at 2/3 F_{msy}, 0.75 and 0.85 F_{msy} (Table 13). At all levels of F_{msy} considered, and for both catch scenarios examined, medium term projections indicated that the probability of the biomass in 2012 and 2013 being below B_{msy} is negligible. Plots of projection results are shown in Figure 19.

Precautionary Approach Framework

The surplus production model outputs indicate that the stock is presently above B_{msy} and F is below F_{msy} (Fig. 20). 30% B_{msy} is considered a suitable limit reference point (B_{lim}) for stocks where a production model is used. At present, the risk of the stock being below B_{lim} = 30% B_{msy} is approximately zero. The stock is, therefore, in the safe zone as defined in the NAFO Precautionary Approach Framework.

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, 2009 and 2010. 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 2016).

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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	5416	87	3		662	6168	17000
2010	8057	580	101	-	628	9366	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 2010. Data from 2003-10 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
2009	224	3228	1958	5410	0
2010	114	5,582	2,358	8,054	0

Table 3. Estimates of abundance (millions), biomass ('000 tons), mean number and weight (kg) per tow for Spring surveys in NAFO Divisions 3LNO from 1984-2010.

	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
2009	47.0	751.6	117.9	916.4	13.2	213.5	44.4	271.2	8.8	313.0	46.2	89.0	2.5	88.9	17.4	26.3
2010	110.3	950.9	272.2	1333.3	28.6	276.9	89.2	394.7	21.0	396.0	106.7	130.8	5.5	115.3	35.0	38.7

Table 4. Estimates of abundance (millions), biomass ('000 tons), mean number and weight (kg) per tow for Fall surveys in NAFO Divisions 3LNO from 1990-2010.

	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	3.6	509.0	79.6	592.2	1.2	102.8	25.7	129.8	0.7	212.0	31.2	57.2	0.2	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
2009	45.1	709.9	145.0	900.0	16.5	180.7	40.7	237.8	7.6	282.7	52.6	80.2	2.8	72.0	14.7	21.2
2010	135.7	1335.9	184.7	1656.3	35.9	336.4	44.9	417.2	22.0	558.5	72.4	149.1	5.8	140.6	17.6	37.5

Table 5. Length weight relationships used to produce an index of female SSB from the spring survey. The relationships are of the form log(weight)=(*a**log(length))+*b*)

Year	*a*	*b*
prior to 1990	3.1	-5.19
1990	3.19	-5.33
1991	3.05	-5.12
1992	3.02	-5.06
1993	3.11	-5.2
1994	3.09	-5.19
1995	3.1	-5.2
1996	3.09	-5.15
1997	3.09	-5.17
1998	3.05	-5.11
1999	3.15	-5.27
2000	3.17	-5.32
2001	3.09	-5.2
2002	3.08	-5.2
2003	3.09	-5.22
2004	3.12	-5.24
2005	3.17	-5.32
2006	3.09	-5.21
2007	3.25	-5.46
2008	3.22	-5.42
2009	3.14	-5.3
2010	3.1	-5.23

Table 6. ANOVA results and regression coefficients from a multiplicative model utilized to derive a standardized catch rate series for Yellowtail flounder in NAFO Div. 3LNO (2010 based on preliminary data).

REGRESSION OF MULTIPLICATIVE MODEL
MULTIPLE R............. 0.792
MULTIPLE R SQUARED..... 0.628

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARE	F-VALUE
INTERCEPT	1	3.88E1	3.88E1	
REGRESSION	56	1.27E1	2.26E-1	32.044
Cntry|Gear|TC	3	7.87E-1	2.62E-1	37.200
Division	2	8.65E-1	4.33E-1	61.307
Month	11	3.76E-1	3.42E-2	4.843
Year	40	8.57E0	2.14E-1	30.346
RESIDUALS	1064	7.51E0	7.06E-3	
TOTAL	1121	5.90E1		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VAR #	REG. COEF	STD. ERR	NO. OBS
Cntry|Gear|TC (1)	3125	INT	0.088	0.114	1121
Division (2)	34				
Month (3)	10				
Year (4)	65				
(1)	3114	1	-0.299	0.033	162
	3124	2	-0.223	0.033	153
	3126	3	-0.071	0.039	104
(2)	32	4	-0.202	0.027	219
	35	5	-0.236	0.024	278
(3)	1	6	-0.089	0.070	27
	2	7	-0.199	0.064	33
	3	8	-0.155	0.055	45
	4	9	-0.173	0.046	78
	5	10	-0.108	0.039	146
	6	11	-0.151	0.039	150
	7	12	-0.193	0.041	134
	8	13	-0.097	0.042	129
	9	14	0.013	0.042	117
	11	15	-0.087	0.044	85
	12	16	-0.023	0.048	67
(4)	66	17	-0.052	0.144	11
	67	18	-0.118	0.153	12
	68	19	-0.262	0.142	14
	69	20	-0.430	0.134	20
	70	21	-0.420	0.120	42
	71	22	-0.450	0.118	41
	72	23	-0.557	0.119	45
	73	24	-0.428	0.118	50
	74	25	-0.851	0.121	37
	75	26	-0.862	0.120	38
	76	27	-0.918	0.130	26
	77	28	-0.783	0.122	38
	78	29	-0.739	0.119	51
	79	30	-0.723	0.119	47
	80	31	-0.612	0.124	30
	81	32	-0.616	0.125	30
	82	33	-0.713	0.128	24
	83	34	-0.555	0.127	24
	84	35	-0.597	0.127	28
	85	36	-0.546	0.125	30
	86	37	-0.895	0.125	30
	87	38	-0.829	0.126	30
	88	39	-0.907	0.128	26
	89	40	-0.941	0.137	17
	90	41	-0.779	0.138	16
	91	42	-1.400	0.130	24
	92	43	-1.220	0.134	21
	93	44	-0.901	0.131	23
	98	45	-0.266	0.145	11
	99	46	-0.204	0.142	12
	100	47	-0.109	0.129	24
	101	48	-0.314	0.128	20
	102	49	-0.379	0.130	19
	103	50	-0.183	0.123	34
	104	51	-0.012	0.124	30
	105	52	0.076	0.123	32
	107	53	0.042	0.135	17
	108	54	0.146	0.123	35
	109	55	-0.001	0.125	27
	110	56	0.028	0.126	27

LEGEND FOR AVOVA RESULTS:

CGT CODES: 3114 = Can(NFLD) TC 4 Side Trawler
3124 = " TC 4 Stern Trawler
3125 = " TC 5 "
3126 = " TC 6 "

DIVISION CODES: 32 = 3L, 34 = 3N, 35 = 3O

Table 7. Standardized catch rate index for Yellowtail flounder in NAFO Div. 3LNO
from a multiplicative model utilizing HOURS FISHED as a measure of effort. (2010 based on preliminary data).

	PREDICTED CATCH RATE						
	LN TRANSFORM		RETRANSFORMED				% OF CATCH IN
YEAR	MEAN	S.E.	MEAN	S.E.	CATCH	EFFORT	THIS ANALYSIS
1965	0.0878	0.0131	1.089	0.124	3075	2825	39.5
1966	0.0356	0.0109	1.034	0.108	4185	4046	32.7
1967	-0.0301	0.0139	0.967	0.114	2122	2194	44.0
1968	-0.1744	0.0093	0.839	0.081	4180	4982	52.6
1969	-0.3417	0.0069	0.711	0.059	10494	14768	30.8
1970	-0.3324	0.0035	0.719	0.042	22814	31751	54.4
1971	-0.3625	0.0031	0.697	0.039	24206	34713	58.4
1972	-0.4689	0.0031	0.627	0.035	26939	42970	53.9
1973	-0.3405	0.0028	0.713	0.038	28492	39964	74.4
1974	-0.7631	0.0035	0.467	0.028	17053	36514	82.0
1975	-0.7745	0.0032	0.462	0.026	18458	39968	72.1
1976	-0.8305	0.0054	0.436	0.032	7910	18134	60.5
1977	-0.6956	0.0039	0.500	0.031	11295	22609	44.4
1978	-0.6516	0.0031	0.522	0.029	15091	28897	61.5
1979	-0.6353	0.0031	0.531	0.030	18116	34129	73.0
1980	-0.5239	0.0047	0.593	0.041	12011	20258	65.1
1981	-0.5287	0.0045	0.590	0.039	14122	23929	73.6
1982	-0.6252	0.0051	0.536	0.038	11479	21429	48.2
1983	-0.4676	0.0046	0.627	0.042	9085	14483	50.3
1984	-0.5095	0.0048	0.601	0.042	12437	20678	54.7
1985	-0.4583	0.0042	0.633	0.041	13440	21223	50.6
1986	-0.8068	0.0041	0.447	0.029	14168	31700	62.5
1987	-0.7411	0.0043	0.477	0.031	13420	28119	66.4
1988	-0.8192	0.0049	0.441	0.031	10607	24037	57.1
1989	-0.8532	0.0072	0.426	0.036	5009	11758	40.0
1990	-0.6909	0.0074	0.501	0.043	4969	9917	45.8
1991	-1.3126	0.0054	0.269	0.020	6589	24464	48.3
1992	-1.1318	0.0064	0.323	0.026	6814	21126	59.3
1993	-0.8133	0.0057	0.444	0.033	6747	15206	68.4
1998	-0.1787	0.0093	0.835	0.081	3739	4476	91.3
1999	-0.1164	0.0083	0.890	0.081	5746	6459	94.2
2000	-0.0213	0.0051	0.980	0.070	9463	9658	98.7
2001	-0.2266	0.0047	0.798	0.055	12238	15332	96.5
2002	-0.2917	0.0053	0.748	0.054	9959	13320	98.0
2003	-0.0954	0.0036	0.911	0.054	12708	13956	99.4
2004	0.0763	0.0037	1.081	0.066	12575	11632	99.4
2005	0.1635	0.0037	1.180	0.072	13140	11139	100.9
2007	0.1303	0.0066	1.139	0.092	3673	3223	99.9
2008	0.2334	0.0036	1.265	0.076	10217	8076	99.7
2009	0.0865	0.0039	1.092	0.068	5416	4959	99.6
2010	0.1156	0.0044	1.124	0.075	8057	7168	96.5

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.072

Table 8. Input indices used in the ASPIC production model for the 2011 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	6.168			271.2	237.8	183.4
2010	9.366			394.7	417.2	189.7
2011	17.000					

notes: The Campelen fall survey values are corrected from the 2006 assessment (see SCR 07/57). The TAC in 2010 (17 000 t) is included in the catch series.

★ Survey coverage in 2006 was incomplete and results may not be comparable to other years

Table 9. Parameter estimates and model diagnostics comparing the 2009 assessment formulation in the newest version of ASPIC (5.34), a starting estimates of B1/K of 1, and the 2011 assessment (TAC in 2011).

	2009 Assessment version 5.33	2011 Assessment v 5.34 catch in 2011 TAC (17 000 t)	2011 Assessment v5.34 catch in 2011 mean (2008-2010)
starting guess B1/K*	1	1	1
B1/K	0.494	0.784	0.684
K	157.100	148.300	150.500
MSY	19.540	18.910	19.040
Bmsy	78.550	74.160	75.240
Fmsy	0.249	0.252	0.253
B/Bmsy	1.619	1.634	1.727
Y(Fmsy)	31.620	28.810	30.370
Ye	12.060	11.300	8.984
F/Fmsy	0.527	0.533	0.273
q (FC/Spring)	3.225	3.230	3.197
q (Yankee)	1.001	0.998	0.997
q (Can Fall)	3.309	3.295	3.255
q (Russian)	1.157	1.167	1.161
q (Spanish)	1.224	1.286	1.269
R^2 FC/Spring	0.891	0.851	0.850
R^2 Yankee	0.802	0.804	0.804
R^2 Can Fall	0.818	0.754	0.753
R^2 Russian	0.542	0.551	0.547
R^2 Spanish	0.617	0.660	0.659
Tot Obj Function	6.192	6.783	6.786
MSE	0.090	0.090	0.905

* This is an input to the model.

In 2011 assessment, penalty for B1>K was turned off…

Table 10. Bootstrap results from the 2011 assessment of yellowtail flounder (ASPIC version 5.34).

				as-corrected approximate confidence lim					
	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	0.78	0.018	2.30%	0.47	1.25	0.72	0.91	0.19	0.24
K	148.30	5.677	3.83%	139.10	172.60	142.30	156.80	14.44	0.10
q (FC/Spring)	3.23	-0.046	-1.41%	2.82	3.61	3.04	3.42	0.39	0.12
q (Yankee)	1.00	-0.003	-0.27%	0.81	1.14	0.90	1.08	0.17	0.17
q (Can Fall)	3.30	-0.048	-1.47%	2.83	3.68	3.11	3.54	0.43	0.13
q (Russian)	1.17	0.000	0.02%	0.98	1.35	1.08	1.27	0.18	0.16
q (Spanish)	1.29	-0.015	-1.18%	1.11	1.45	1.21	1.38	0.16	0.13
MSY	18.91	0.248	1.31%	17.65	19.54	18.26	19.20	0.94	0.05
Ye(2010)	11.30	0.113	1.00%	11.13	11.34	11.21	11.30	0.09	0.01
Bmsy	74.16	2.839	3.83%	69.56	86.32	71.16	78.38	7.22	0.10
Fmsy	0.26	-0.004	-1.52%	0.22	0.28	0.24	0.27	0.03	0.13
fmsy (FC/Spring)	0.08	0.000	0.27%	0.07	0.09	0.07	0.08	0.01	0.11
fmsy (Yankee)	0.26	-0.001	-0.54%	0.23	0.29	0.24	0.28	0.03	0.12
fmsy (Can Fall)	0.08	0.000	0.53%	0.07	0.09	0.07	0.08	0.01	0.13
fmsy (Russian)	0.22	-0.002	-0.70%	0.19	0.26	0.21	0.24	0.03	0.14
fmsy (Spanish)	0.20	0.001	0.41%	0.17	0.23	0.18	0.21	0.03	0.16
B./Bmsy	1.63	0.000	0.01%	1.59	1.65	1.62	1.64	0.03	0.02
F./Fmsy	0.54	-0.005	-0.92%	0.51	0.59	0.52	0.56	0.04	0.07
Ye./MSY	0.60	-0.001	-0.12%	0.58	0.65	0.59	0.62	0.03	0.05
q2/q1	0.31	0.005	1.63%	0.26	0.35	0.28	0.33	0.05	0.17
q3/q1	1.02	0.002	0.21%	0.90	1.12	0.95	1.07	0.12	0.12
q4/q1	0.36	0.007	1.93%	0.30	0.42	0.33	0.39	0.06	0.17
q5/q1	0.40	0.002	0.56%	0.35	0.45	0.37	0.42	0.05	0.12

Table 11. Estimates of relative F and B from the 2009 assessment (ASPIV v5.33) and the 2011 assessment (ASPIC v5.34).

	F/F_{msy}		B/B_{msy}	
	2009 v5.33 B1/K 1	2011 v5.34 B1/K 1	2009 v5.33 B1/K 1	2011 v5.34 B1/K 1
1965	0.15	0.10	0.99	1.57
1966	0.28	0.22	1.19	1.68
1967	0.33	0.27	1.34	1.72
1968	0.47	0.42	1.43	1.72
1969	0.55	0.51	1.46	1.67
1970	0.97	0.92	1.46	1.61
1971	1.59	1.53	1.33	1.44
1972	2.10	2.04	1.09	1.17
1973	2.27	2.22	0.84	0.89
1974	2.08	2.03	0.65	0.69
1975	2.37	2.32	0.55	0.58
1976	0.85	0.83	0.45	0.47
1977	1.08	1.06	0.53	0.56
1978	1.37	1.33	0.58	0.61
1979	1.66	1.61	0.58	0.62
1980	1.10	1.07	0.55	0.59
1981	1.24	1.20	0.60	0.64
1982	1.06	1.03	0.62	0.66
1983	0.75	0.73	0.67	0.71
1984	1.11	1.08	0.76	0.81
1985	2.09	2.05	0.79	0.83
1986	2.85	2.81	0.64	0.68
1987	1.92	1.90	0.46	0.48
1988	2.12	2.10	0.42	0.44
1989	1.38	1.37	0.37	0.38
1990	1.91	1.89	0.39	0.41
1991	2.56	2.53	0.36	0.38
1992	1.96	1.93	0.29	0.30
1993	2.95	2.92	0.27	0.29
1994	0.44	0.43	0.20	0.21
1995	0.01	0.01	0.28	0.30
1996	0.02	0.02	0.43	0.45
1997	0.05	0.05	0.61	0.65
1998	0.24	0.24	0.83	0.88
1999	0.32	0.32	1.02	1.08
2000	0.46	0.46	1.18	1.23
2001	0.56	0.56	1.27	1.32
2002	0.40	0.41	1.32	1.35
2003	0.50	0.51	1.40	1.42
2004	0.47	0.49	1.43	1.44
2005	0.49	0.50	1.46	1.47
2006	0.03	0.03	1.48	1.48
2007	0.14	0.15	1.64	1.64
2008	0.34	0.35	1.71	1.71
2009	0.53	0.19	1.69	1.69
2010		0.29	1.62	1.73
2011		0.54		1.73
2012				1.63

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

Table 12. Model outputs (ASPIC version 5.34) for retrospective analysis.

Model	2011 Assessment (1965-2011)	1965-2010	1965-2009	1965-2008	1965-2007	1965-2006
B1/K	0.784	0.738	0.733	0.489	0.446	0.544
K	148.300	149.200	148.900	157.500	161.000	155.200
MSY	18.910	18.970	19.000	19.550	19.720	19.340
Bmsy	74.160	74.590	74.450	78.760	80.490	77.610
Fmsy	0.252	0.254	0.255	0.248	0.245	0.249
B/Bmsy	1.634	1.726	1.734	1.692	1.706	1.629
Y(Fmsy)	28.810	30.230	30.390	30.700	31.200	29.430
Ye	11.300	8.970	8.767	10.190	9.902	11.690
F/Fmsy	0.533	0.286	0.189	0.343	0.140	0.031
q (FC/Spring)	3.230	3.214	3.220	3.222	3.194	3.252
q (Yankee)	0.998	0.999	1.003	1.000	0.995	0.996
q (Can Fall)	3.295	3.278	3.278	3.301	3.340	3.416
q (Russian)	1.167	1.165	1.168	1.154	1.148	1.158
q (Spanish)	1.286	1.278	1.264	1.222	1.217	1.250
R2 FC/Spring	0.851	0.851	0.840	0.890	0.870	0.845
R2 Yankee	0.804	0.804	0.803	0.802	0.802	0.803
R2 Can Fall	0.754	0.754	0.735	0.818	0.848	0.822
R2 Russian	0.551	0.549	0.549	0.540	0.539	0.546
R2 Spanish	0.660	0.660	0.638	0.616	0.610	0.603
Tot Obj Function	6.783	6.784	6.761	6.192	6.083	6.077
MSE	0.090	0.090	0.094	0.897	0.092	0.096

Table 12.1. Medium-term projections for yellowtail flounder. The 5th, 50th and 95th percentiles of projected biomass, catch and relative biomass B/B_{msy} are shown, for projected F values of status quo F, 2/3 F_{msy}, 75% F_{msy} and 85%F_{msy}. The results are derived from an ASPIC bootstrap run (500 iterations) with catch constraints in 2011 of 17 000 tons (TAC) F_{msy} =0.255 and 8 979 t (mean catch 2008-2010) F_{msy} =0.2531.

		Projections with catch in 2011 = 17 000 t (TAC)														
		Projected Biomass					Projected Catch (000 tons)					Projected Relative Biomass (B/B_{msy})				
		2012	2013	2014	2015	2016	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016
F_{2010}	5	113.65	115.74	117.06	117.89	118.40	8.85	8.98	9.06	9.11	9.14	1.59	1.62	1.65	1.66	1.67
	50	121.27	123.48	124.92	125.83	126.44	8.87	8.99	9.07	9.13	9.16	1.64	1.67	1.69	1.70	1.70
	95	157.98	160.81	162.61	163.74	164.51	8.92	9.04	9.14	9.21	9.26	1.67	1.69	1.71	1.72	1.73
2/3 F_{msy}	5	113.65	106.49	102.03	99.26	97.46	19.82	18.80	18.14	17.67	17.35	1.59	1.50	1.44	1.40	1.36
	50	121.27	113.96	109.25	106.03	103.87	19.89	18.88	18.23	17.80	17.51	1.64	1.54	1.48	1.43	1.41
	95	157.98	150.85	145.87	142.33	139.76	20.19	19.39	18.86	18.46	18.17	1.67	1.58	1.53	1.49	1.47
75% F_{msy}	5	113.65	104.50	98.87	95.35	93.06	22.15	20.69	19.74	19.08	18.61	1.59	1.48	1.40	1.34	1.30
	50	121.27	111.91	105.90	101.86	99.17	22.24	20.80	19.86	19.24	18.83	1.64	1.51	1.43	1.38	1.34
	95	157.98	148.68	142.24	137.67	134.35	22.63	21.47	20.69	20.12	19.71	1.67	1.56	1.49	1.45	1.41
85% F_{msy}	5	113.65	102.17	95.21	90.83	87.95	24.86	22.79	21.45	20.52	19.87	1.59	1.45	1.35	1.28	1.23
	50	121.27	109.51	102.04	97.11	93.67	24.97	22.93	21.62	20.75	20.15	1.64	1.48	1.38	1.31	1.27
	95	157.98	146.14	138.03	132.28	128.10	25.47	23.82	22.72	21.90	21.33	1.67	1.53	1.45	1.39	1.35
F_{msy}	5	113.65	98.93	90.18	84.70	80.97	28.60	25.51	23.55	22.19	21.21	1.59	1.40	1.28	1.19	1.13
	50	121.27	106.22	96.77	90.57	86.25	28.76	25.72	23.78	22.50	21.61	1.64	1.43	1.31	1.23	1.17
	95	157.98	142.60	132.22	124.88	119.80	29.43	26.95	25.28	24.09	23.24	1.67	1.50	1.39	1.31	1.26

		Projections with catch in 2011 = 8 979 t (mean catch 2008-2010)														
		Projected Biomass					Projected Catch (000 tons)					Projected Relative Biomass (B/B_{msy})				
		2012	2013	2014	2015	2016	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016
F_{2010}	5	119.85	119.28	118.95	118.75	118.64	9.39	9.36	9.34	9.33	9.32	1.67	1.67	1.67	1.68	1.68
	50	129.92	129.56	129.32	129.18	129.09	9.42	9.40	9.38	9.38	9.37	1.73	1.72	1.72	1.72	1.72
	95	169.06	169.21	169.34	169.44	169.48	9.49	9.52	9.54	9.56	9.57	1.75	1.75	1.74	1.74	1.74
2/3 F_{msy}	5	119.85	109.88	104.11	100.52	98.29	20.89	19.49	18.63	18.05	17.64	1.67	1.55	1.47	1.41	1.37
	50	129.92	119.80	113.43	109.29	106.49	21.00	19.64	18.78	18.21	17.83	1.73	1.59	1.51	1.46	1.42
	95	169.06	158.88	152.25	147.58	144.04	21.31	20.23	19.51	19.00	18.68	1.75	1.64	1.56	1.52	1.49
75% F_{msy}	5	119.85	107.94	101.07	96.82	94.16	23.24	21.36	20.21	19.42	18.86	1.67	1.52	1.43	1.36	1.31
	50	129.92	117.78	110.20	105.25	101.93	23.37	21.55	20.39	19.64	19.13	1.73	1.57	1.47	1.40	1.36
	95	169.06	156.75	148.69	142.83	138.50	23.75	22.30	21.31	20.68	20.20	1.75	1.61	1.53	1.47	1.43
85% F_{msy}	5	119.85	105.58	97.40	92.38	89.12	26.07	23.53	21.96	20.89	20.13	1.67	1.49	1.38	1.30	1.24
	50	129.92	115.32	106.31	100.44	96.44	26.23	23.76	22.20	21.18	20.49	1.73	1.54	1.42	1.34	1.29
	95	169.06	154.11	144.24	137.13	131.87	26.72	24.72	23.40	22.52	21.86	1.75	1.58	1.48	1.42	1.37
F_{msy}	5	119.85	102.16	92.16	86.03	81.86	30.15	26.47	24.20	22.66	21.54	1.67	1.45	1.30	1.20	1.13
	50	129.92	111.74	100.72	93.53	88.63	30.36	26.79	24.55	23.07	22.05	1.73	1.49	1.34	1.25	1.19
	95	169.06	150.29	137.84	129.12	122.80	31.03	28.11	26.22	24.88	23.96	1.75	1.54	1.42	1.34	1.28

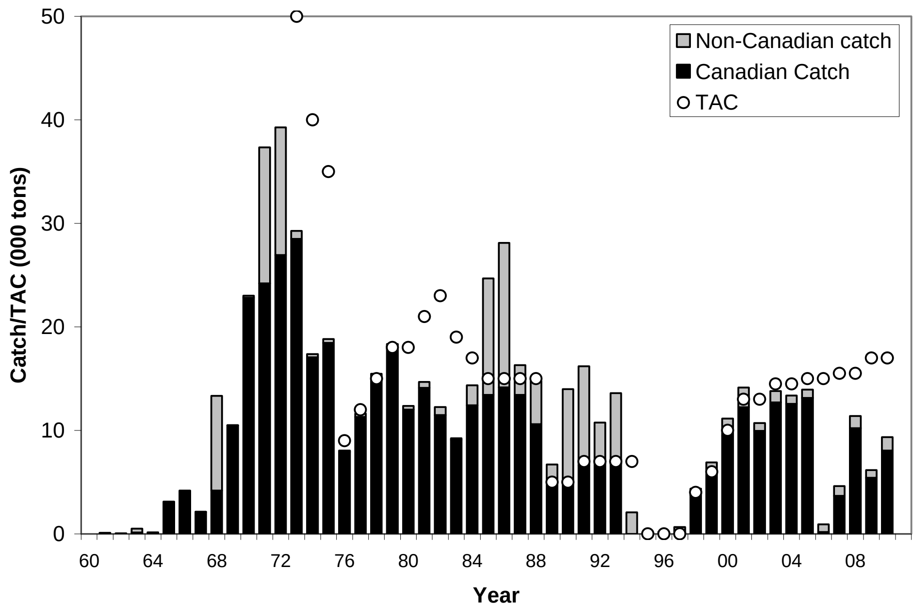


Figure 1. Catch (000 tons) and TAC of yellowtail flounder in NAFO Divisions 3LNO.

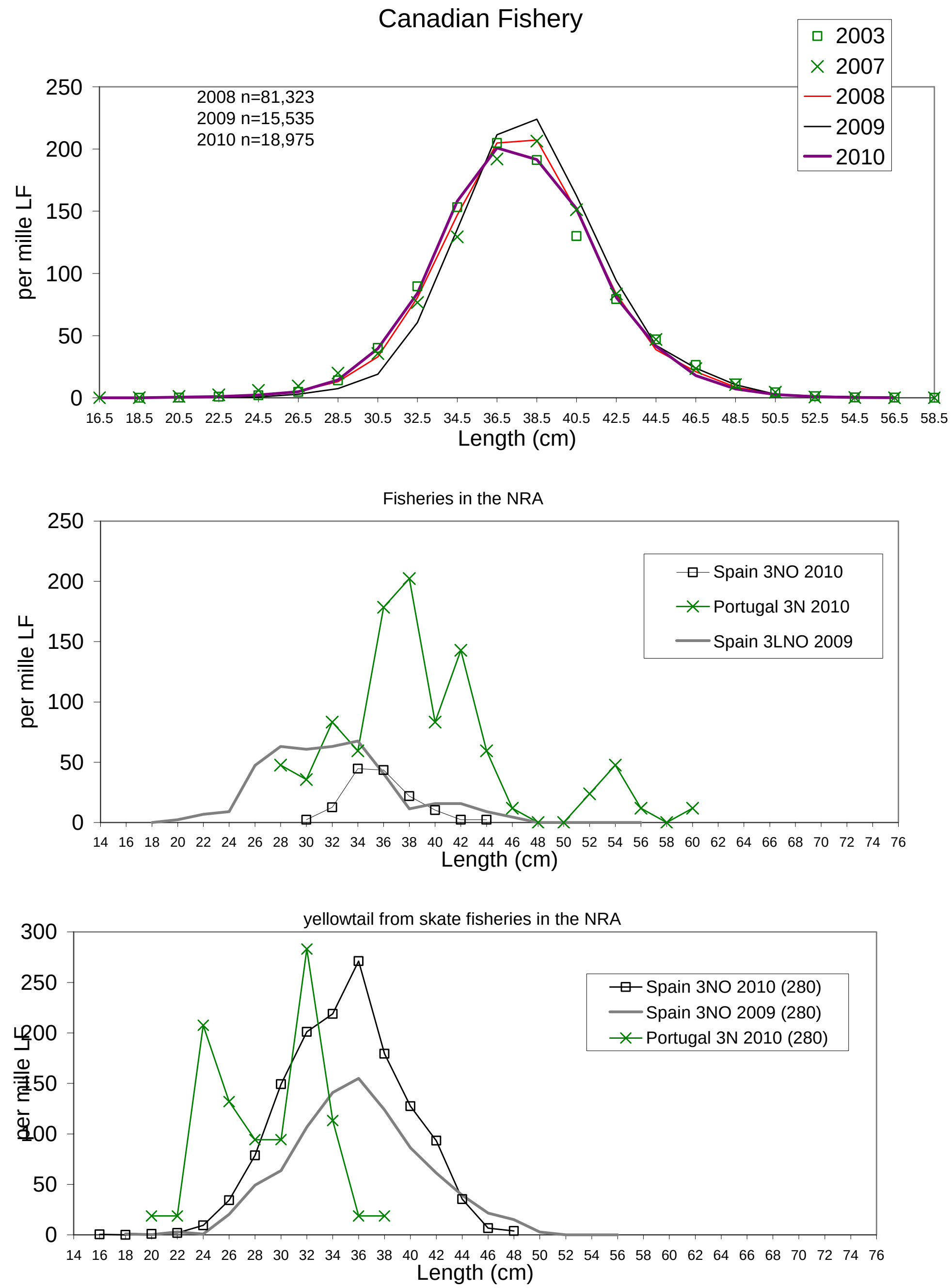


Figure 2. Length frequencies of yellowtail flounder in NAFO Divs. 3LNO from the Canadian (upper panel), Portuguese and Spanish fisheries middle panel), and by-catch in skate fisheries (lower panel).

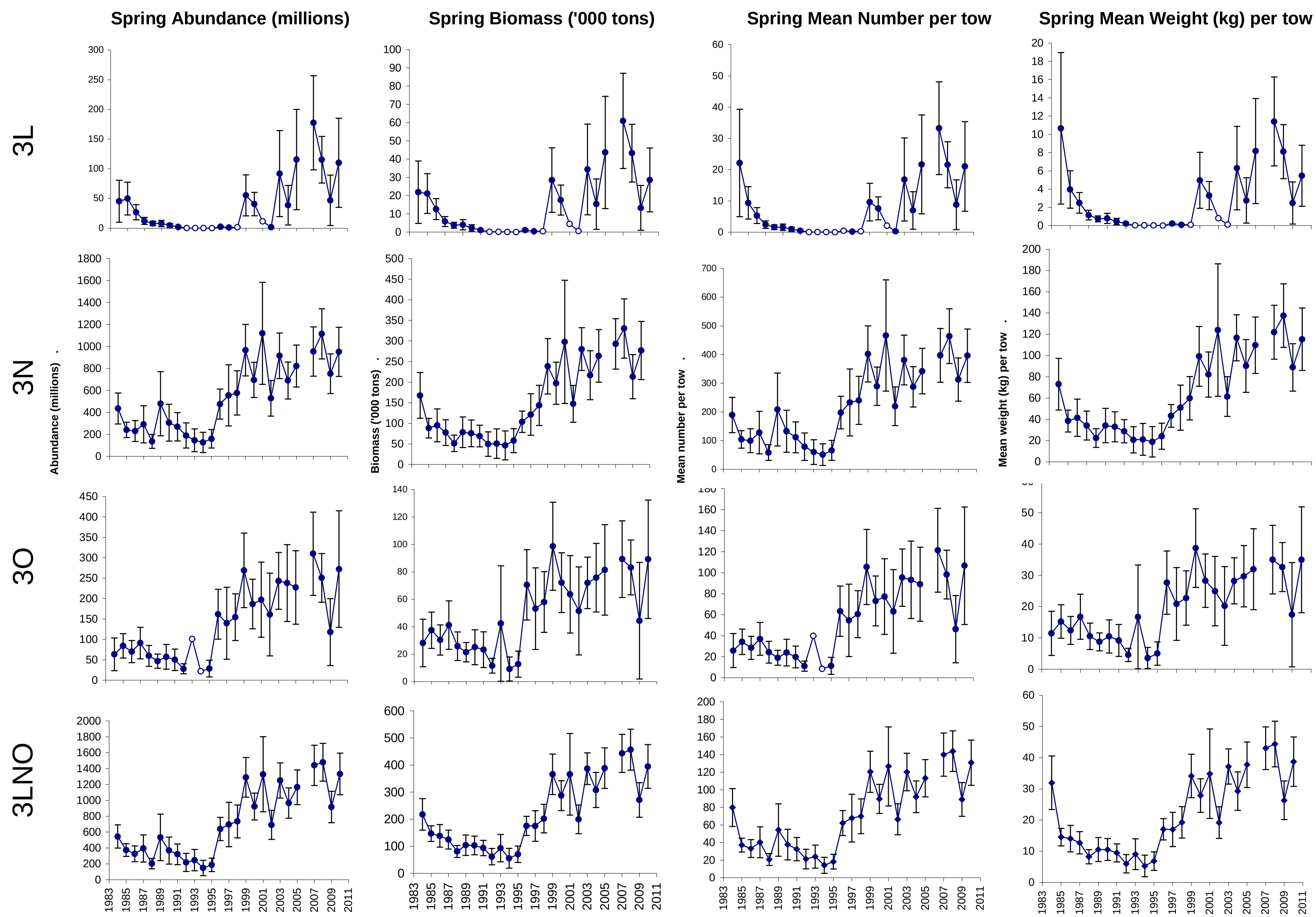


Figure 3. Abundance (millions), Biomass ('000 tons), Mean number and weight (kg) per tow for yellowtail flounder in spring surveys by NAFO division and for 3LNO combined from 1984-2010. Where lower 95% confidence limit is less than 0, error bars are omitted (hollow symbol)

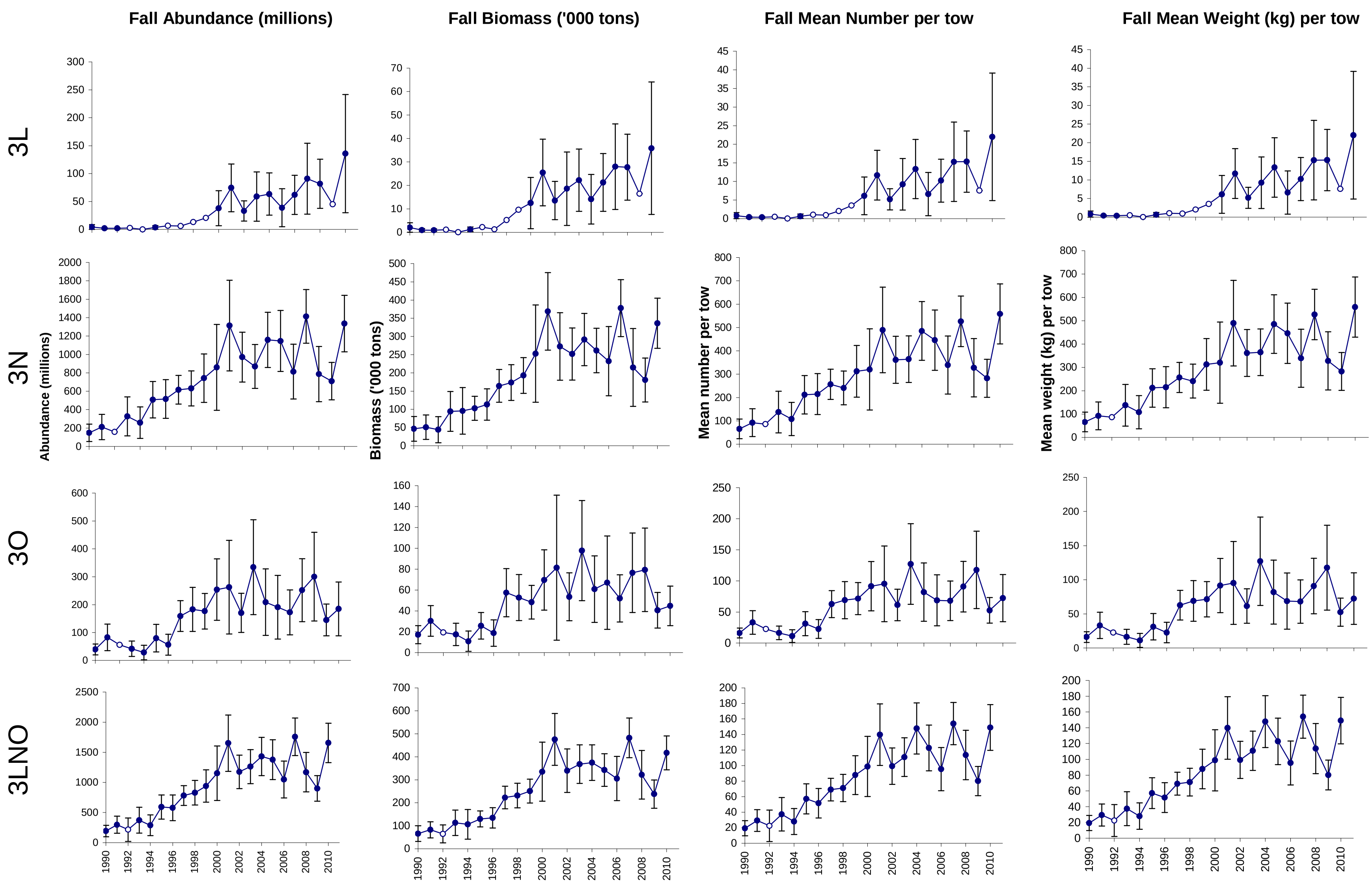


Figure 4. Abundance (millions), Biomass ('000 tons), Mean number and weight (kg) per tow for yellowtail flounder in fall surveys in NAFO divisions 3LNO from 1990-2010. Where lower 95% confidence limit is less than 0, error bars are omitted (hollow symbol)

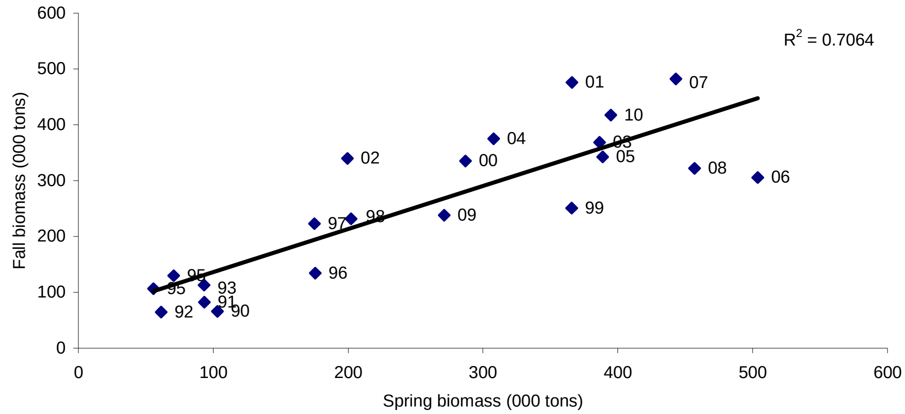


Fig. 5. Regression of Canadian spring and fall estimates of yellowtail flounder biomass in Div. 3LNO, 1990-2010.

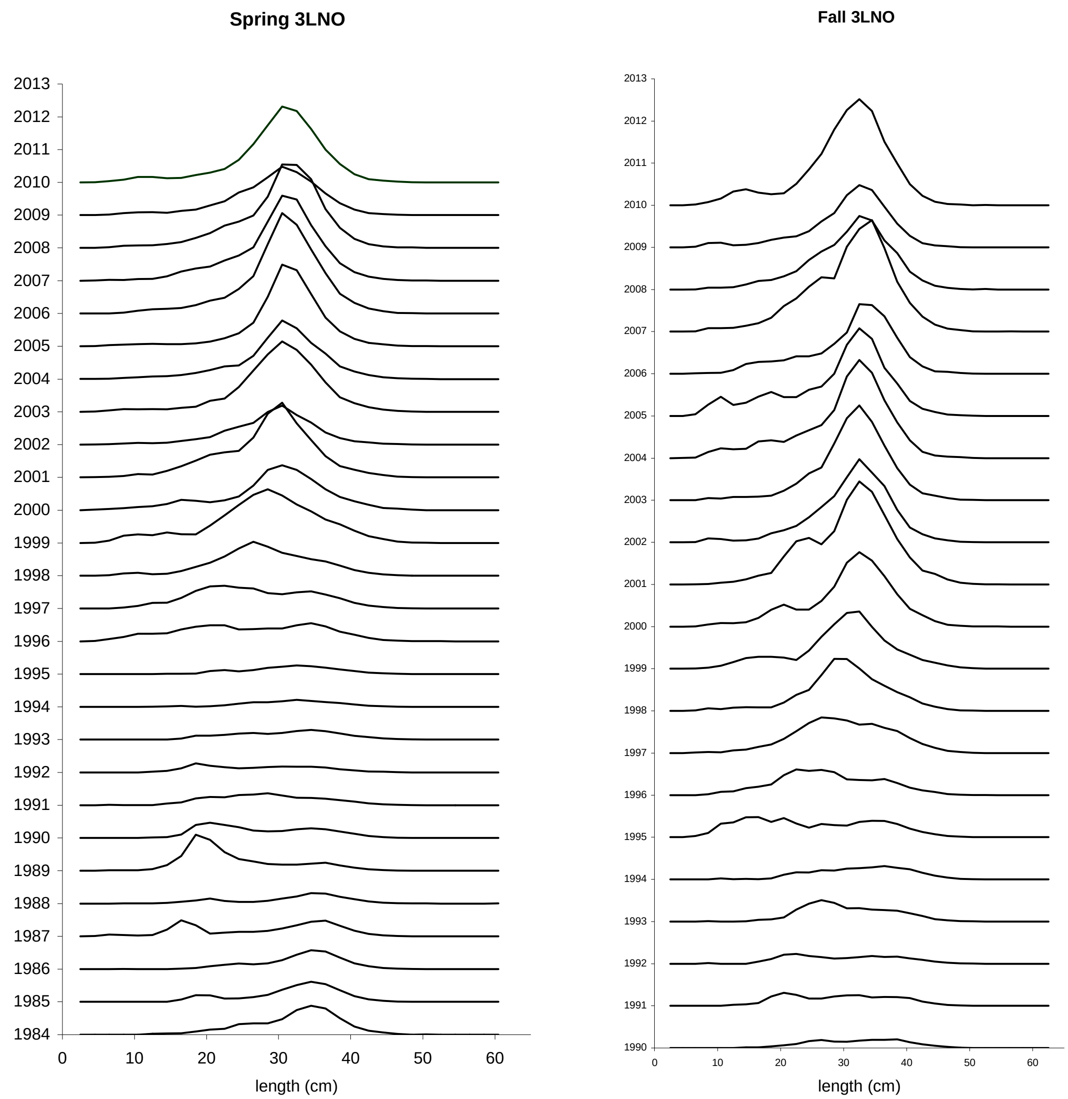


Figure 6. Abundance at length for 3LNO yellowtail flounder from Canadian spring (1984-2010) and fall (1990-2010) surveys.

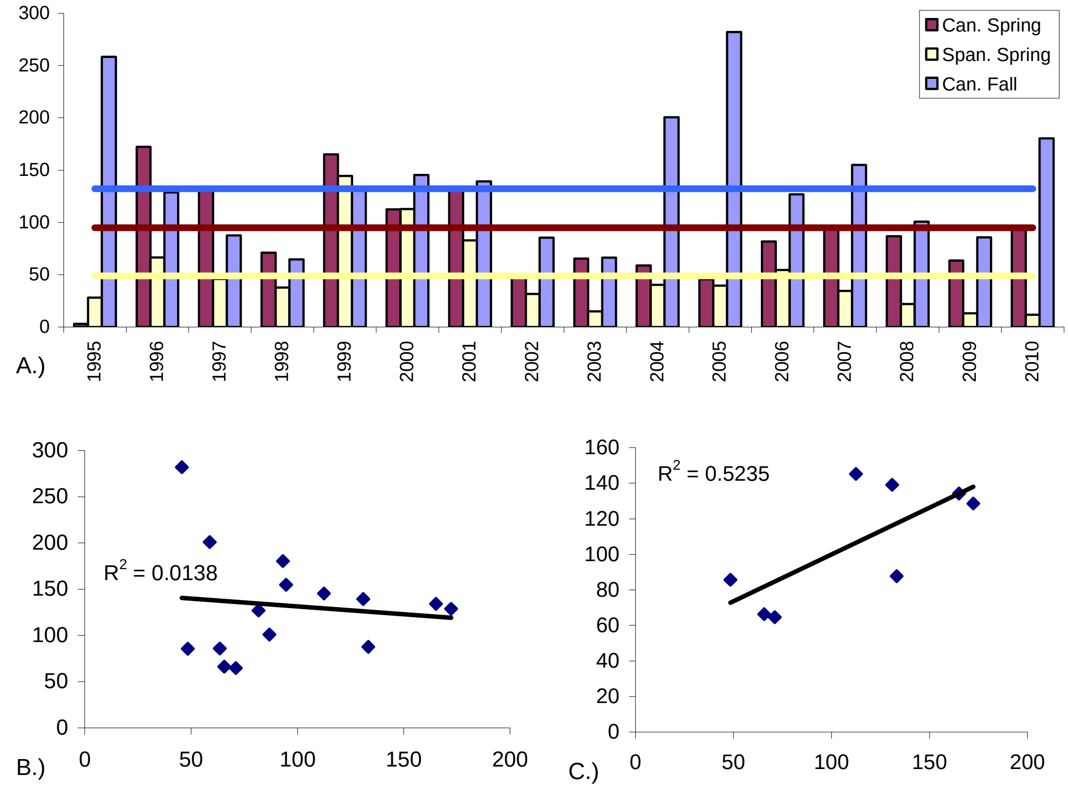


Figure 7. A. Population numbers of yellowtail flounder less than 22 cm in the Canadian and total numbers from Spanish surveys; B. regression of Canadian spring and fall estimates from 1996-2010; and C. regression of Canadian spring and fall estimates from 1996-2003.

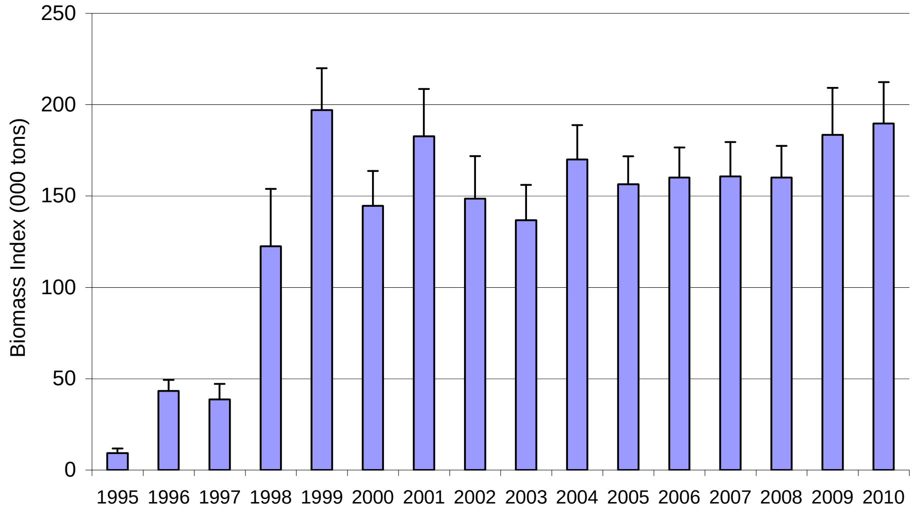


Figure 8. Converted biomass estimates from Spanish surveys in the NRA of Div. 3NO. Error bars are +1 SD.

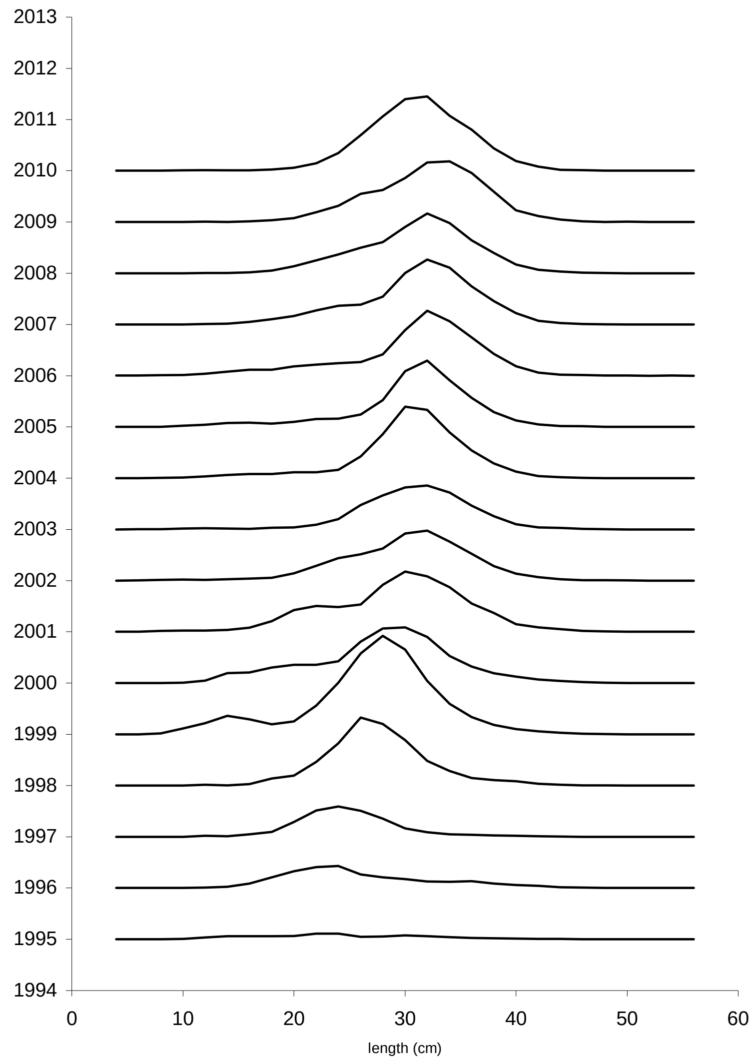


Figure 9. Length frequencies of yellowtail flounder in the Spanish spring surveys of NAFO Divs. 3LNO, 1995-2010 (sexes combined).

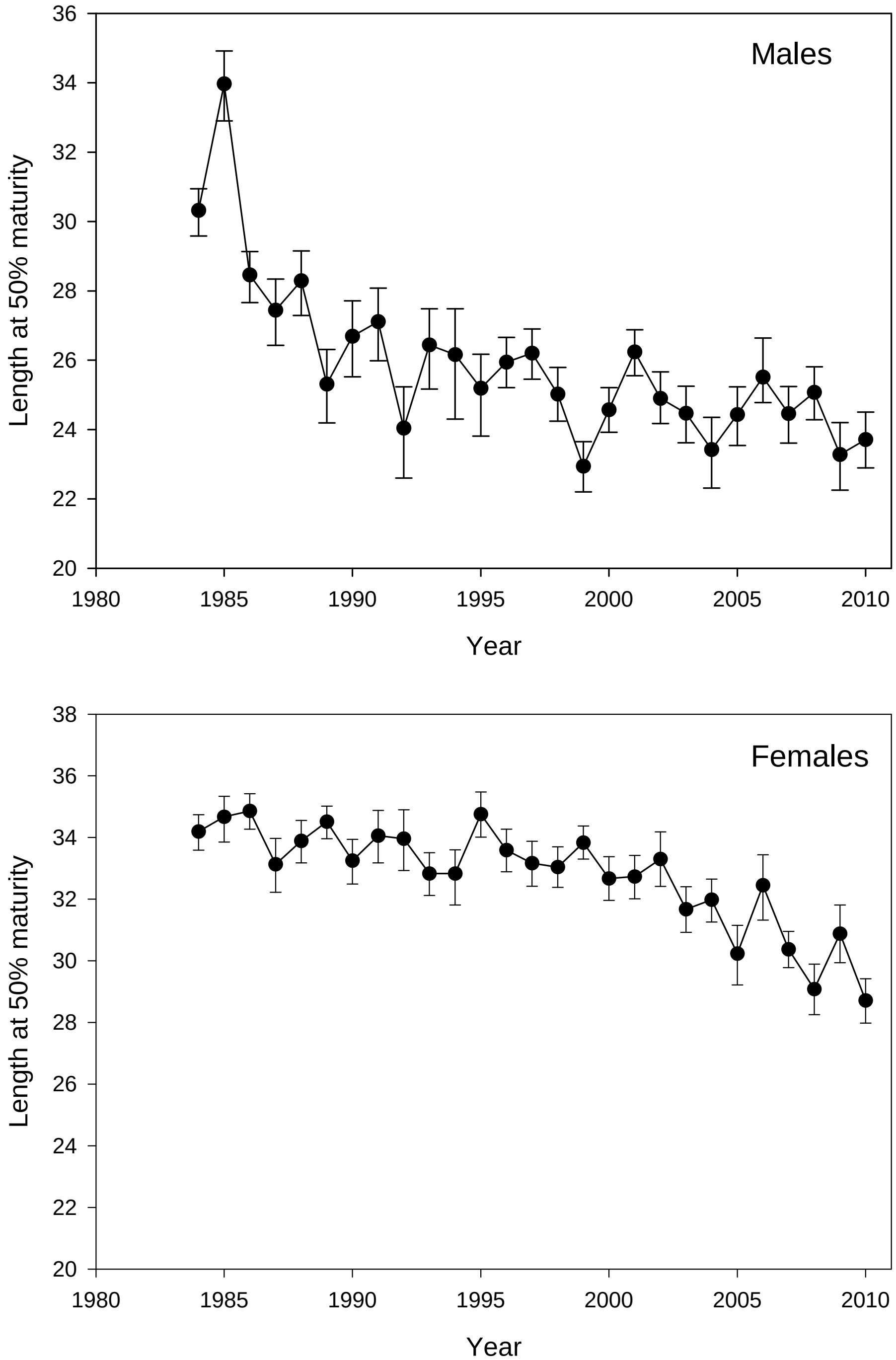


Figure 10. Length at 50% maturity of male and female yellowtail flounder from annual Canadian research vessel surveys of Div. 3LNO from 1984 to 2010.

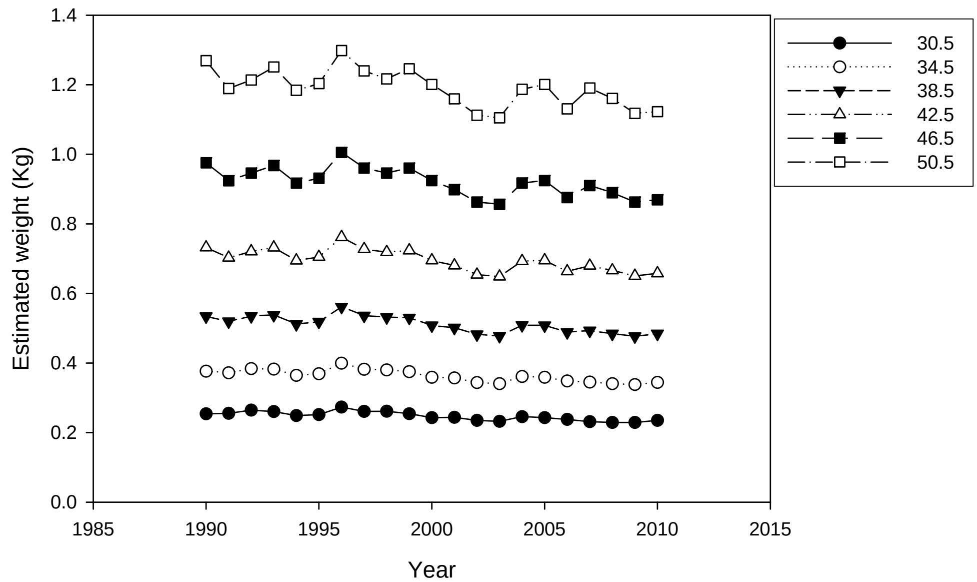


Figure 11. Estimated weight (Kg) at length (cm) for selected length groups for female yellowtail flounder in Div. 3LNO from Canadian spring surveys from 1990-2010.

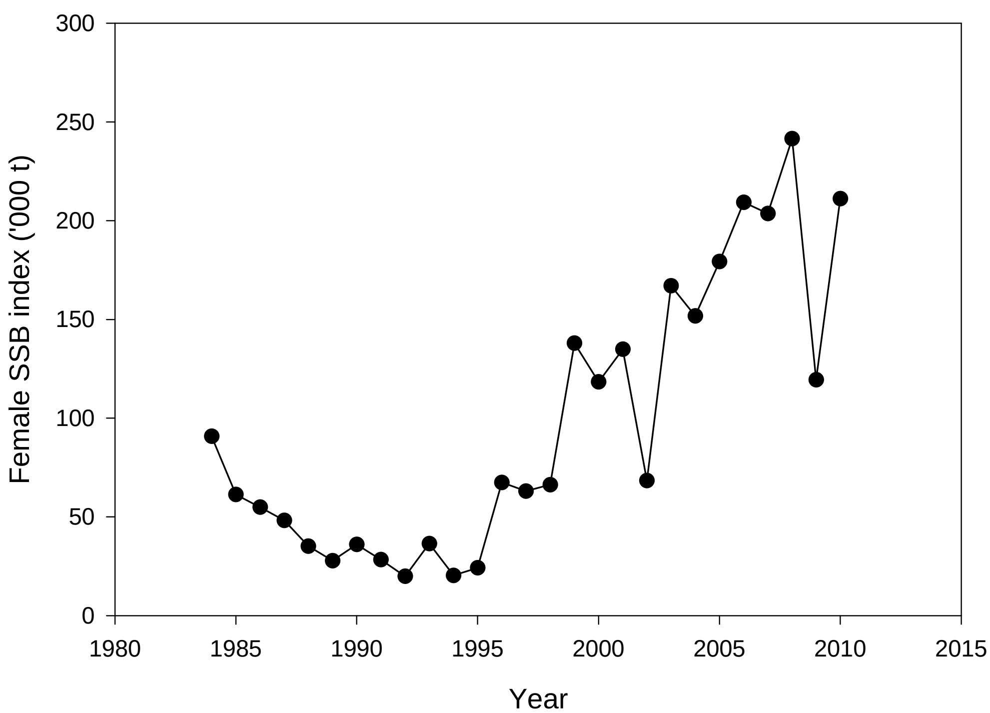
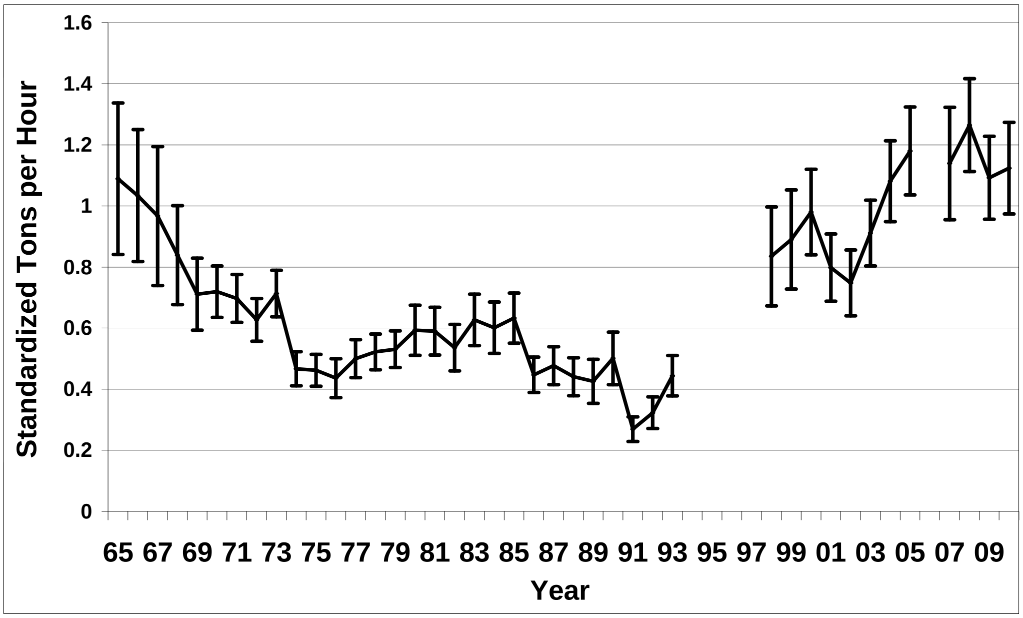


Figure 12. Index of female spawning stock biomass ('000t) for Div. 3LNO yellowtail flounder as calculated from Canadian spring research vessel surveys from 1984-2010.

A) Div. 3LNO from 1965-1993,1998-2005, 2007-2010



B) Div 3N and 3O separately from 1965-1993,1998-2005, 2007-2010

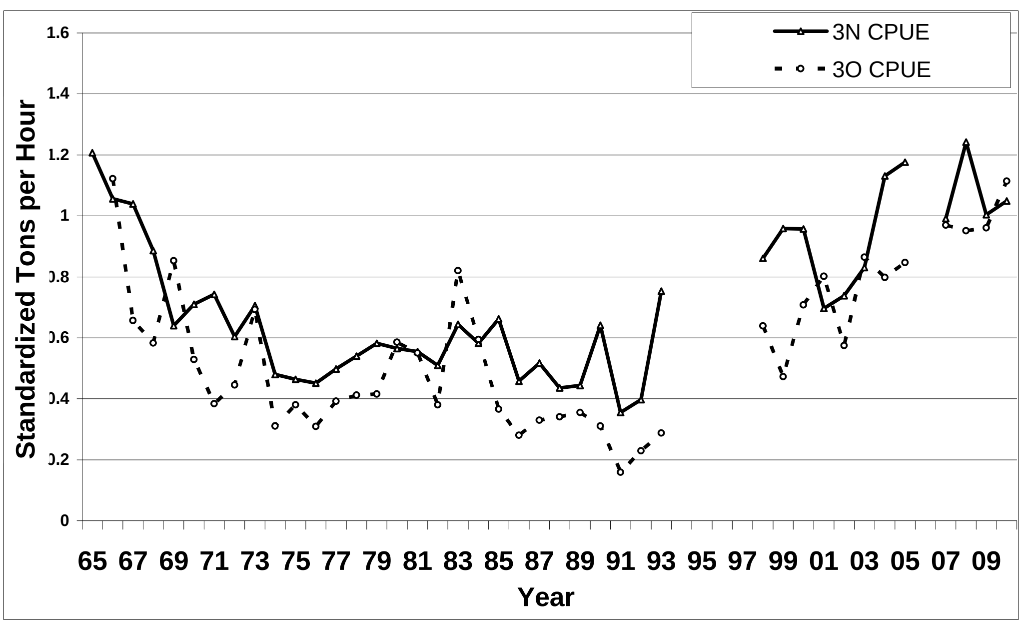


Fig 13. Standardized CPUE ± 2 s.e. for Yellowtail in Div. 3LNO from 1965-1993, 1998-2005 and 2007-2010 (preliminary) under different treatments of the database. From 1991-1993 the fishery was a mixed fishery with American plaice. There was no directed fishery from 1994-1997.

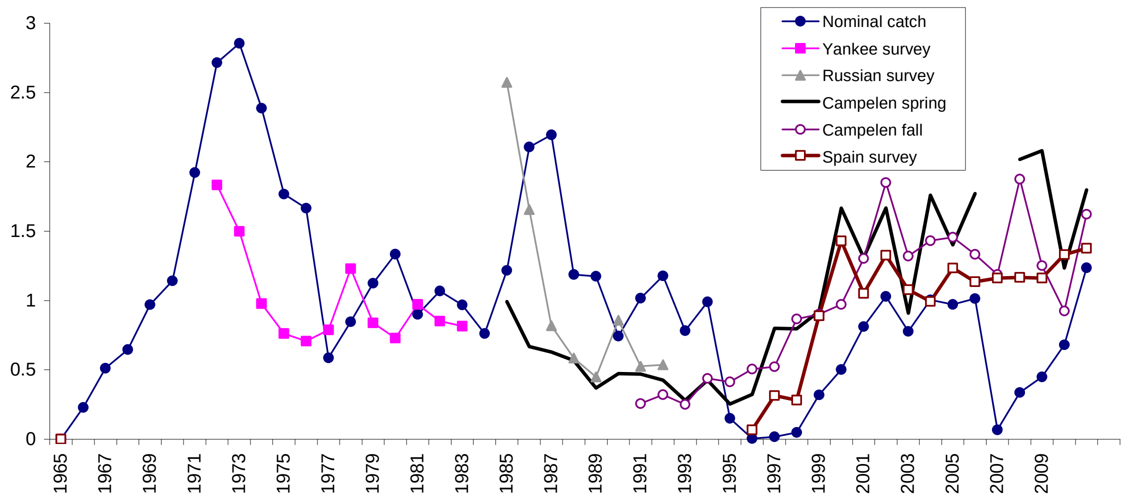


Figure 14. Nominal catch and survey series scaled to the mean in each series of the indices used in the 2011 assessment of yellowtail flounder.

Figure 15. Observed and estimated CPUE for the data series used in the 2011 assessment of yellowtail flounder in NAFO divs. 3LNO (ASPIC version 5.34);

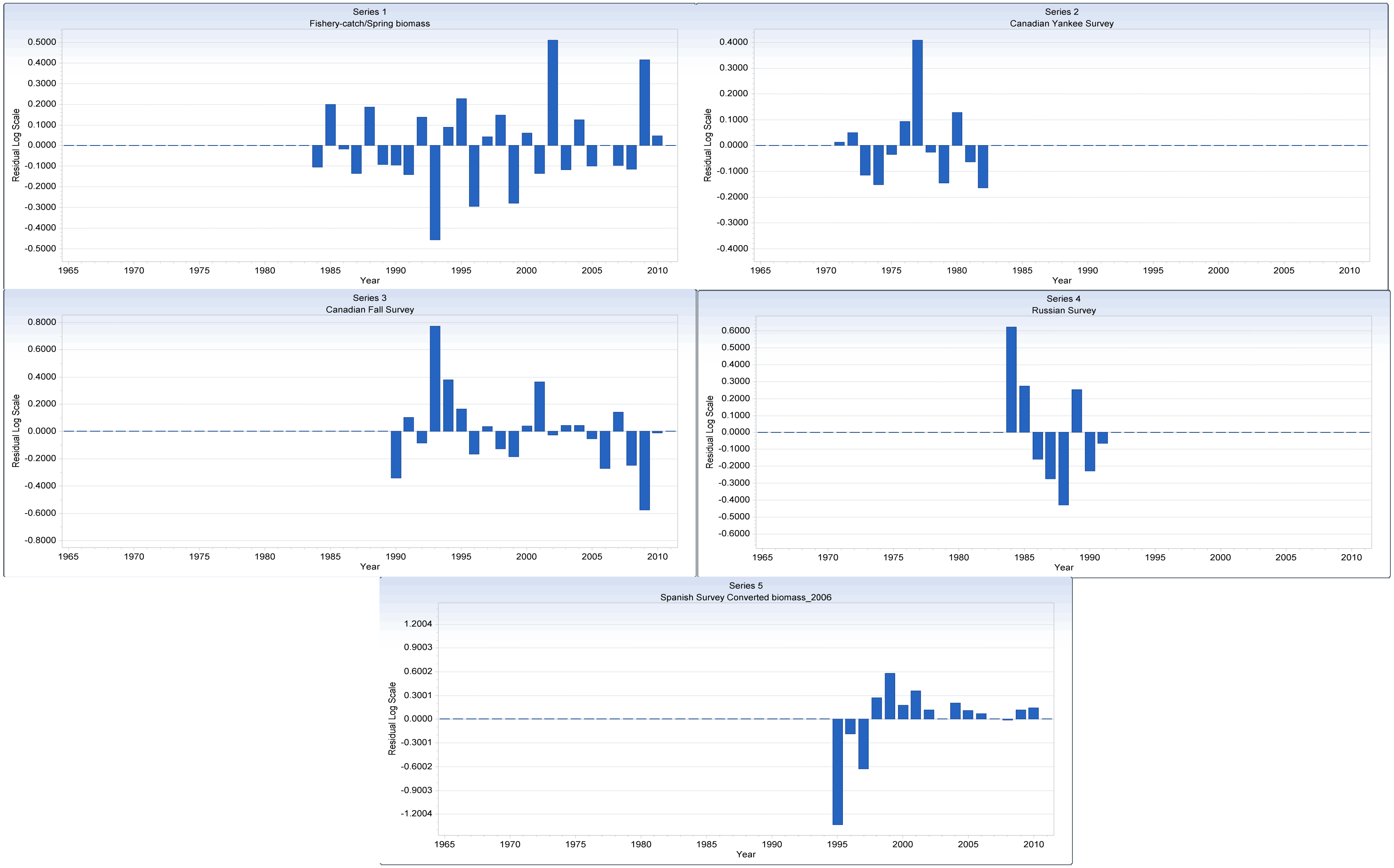


Figure 16. Residual plots for the catch and survey indices from the 2011 assessment of yellowtail flounder in NAFO Divs. 3LNO (ASPIC version 5.34).

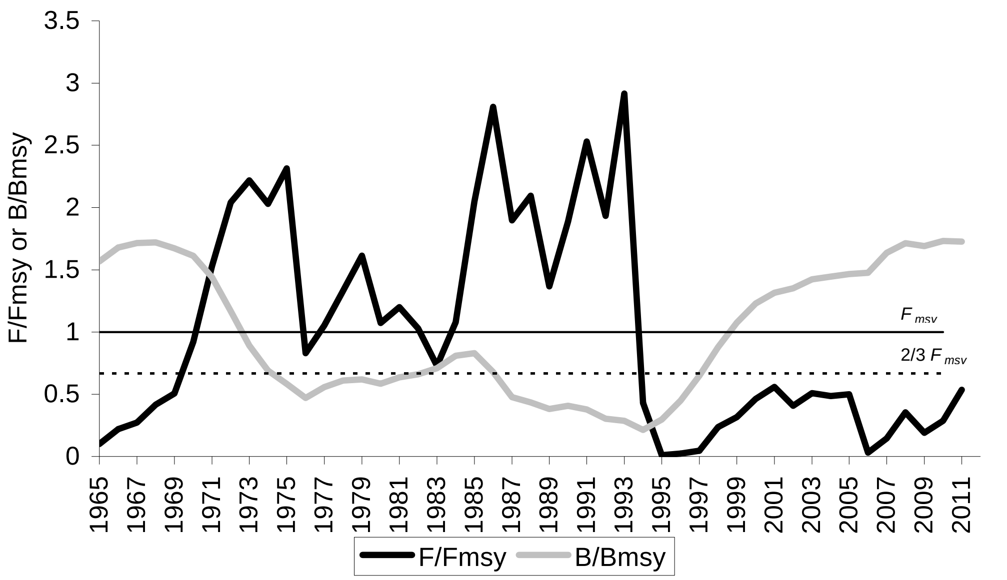


Figure 17. Yellowtail flounder in NAFO Divs. 3LNO: Relative fishing mortality (F/Fmsy) and relative biomass (B/Bmsy) estimates from the 2011 assessment (ASPIC version 5.34)

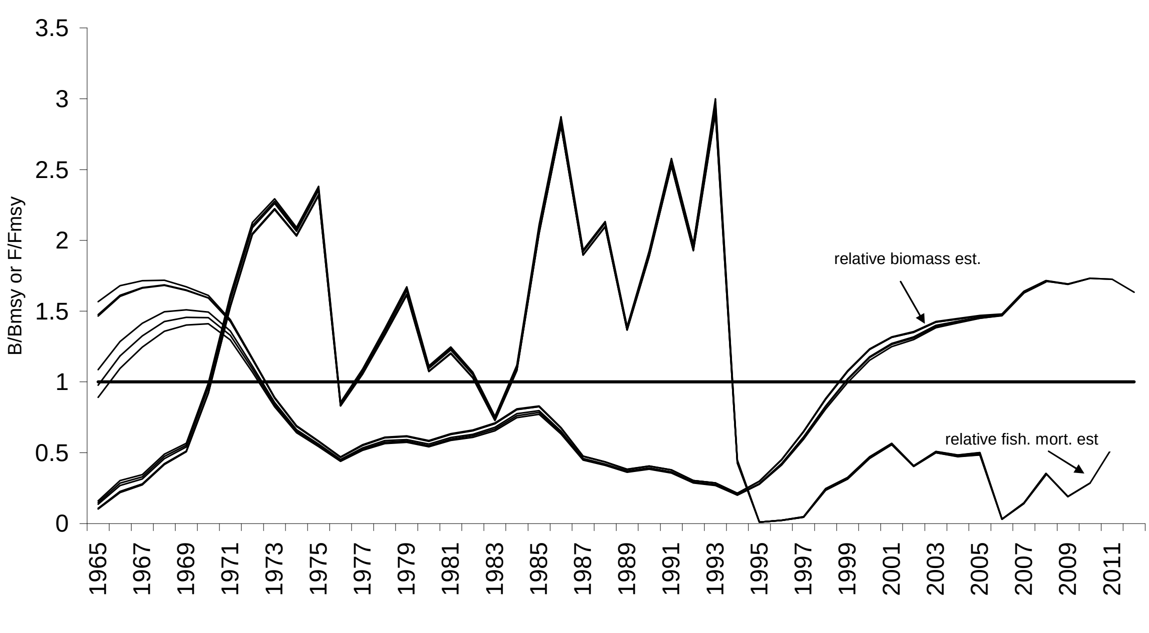


Figure 18. Retrospective view of the 2011 assessment of yellowtail flounder, dropping one year at a time 2011-2007.

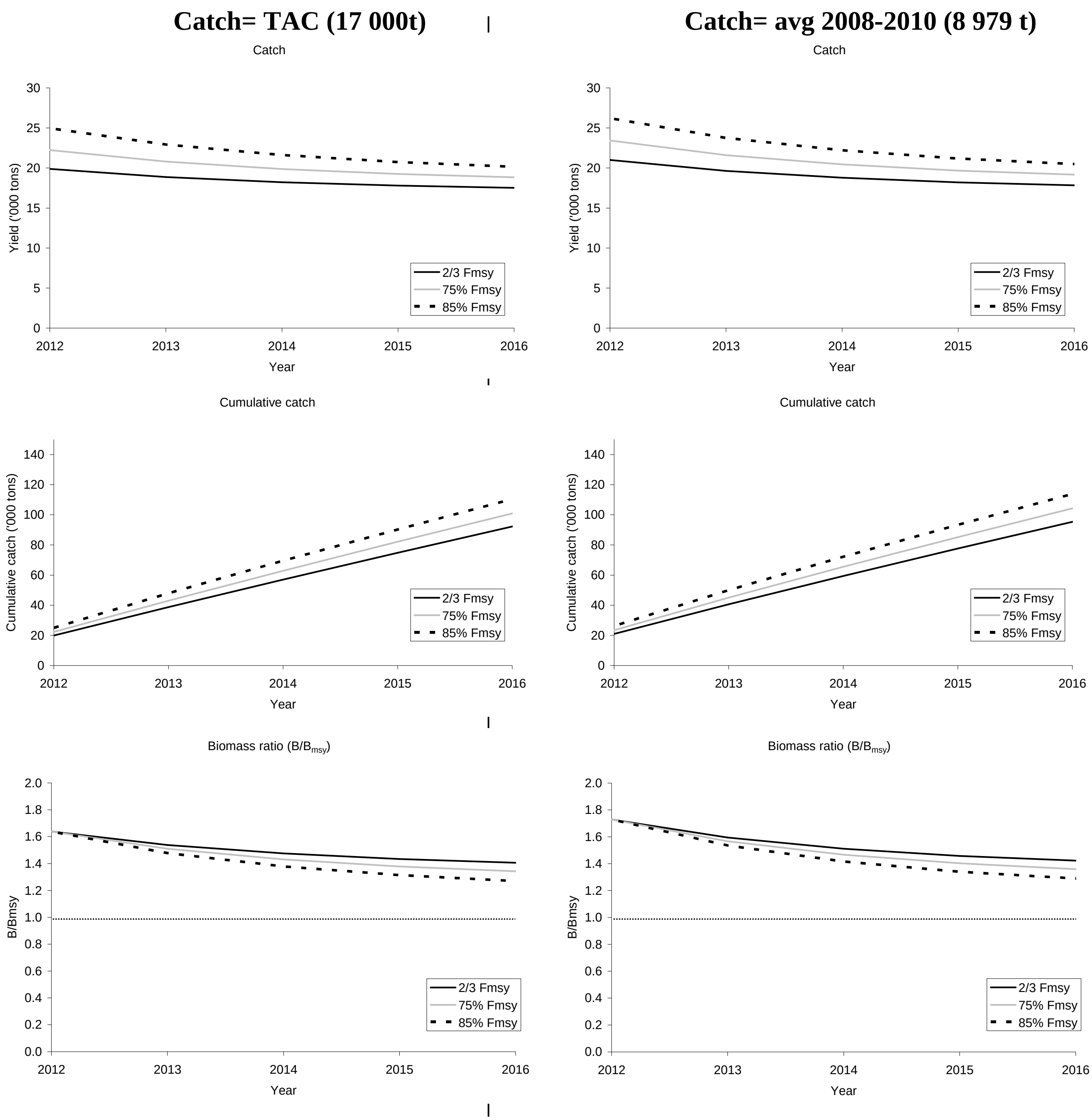


Figure 19. Yellowtail flounder in Div. 3LNO: medium term projections at 3 levels of F (2/3 Fmsy, 75% and 85% Fmsy) under two catch scenarios. Top panels show projected cumulative catch, middle panels give projected catch, and lower panels are projected relative biomass ratios (B/Bmsy). Results are derived from ASPIC bootstrap runs (500 iterations) with catches of 17 000 tons (left column) and 8 979 t (mean 2008-1010; right column) assumed in 2011.

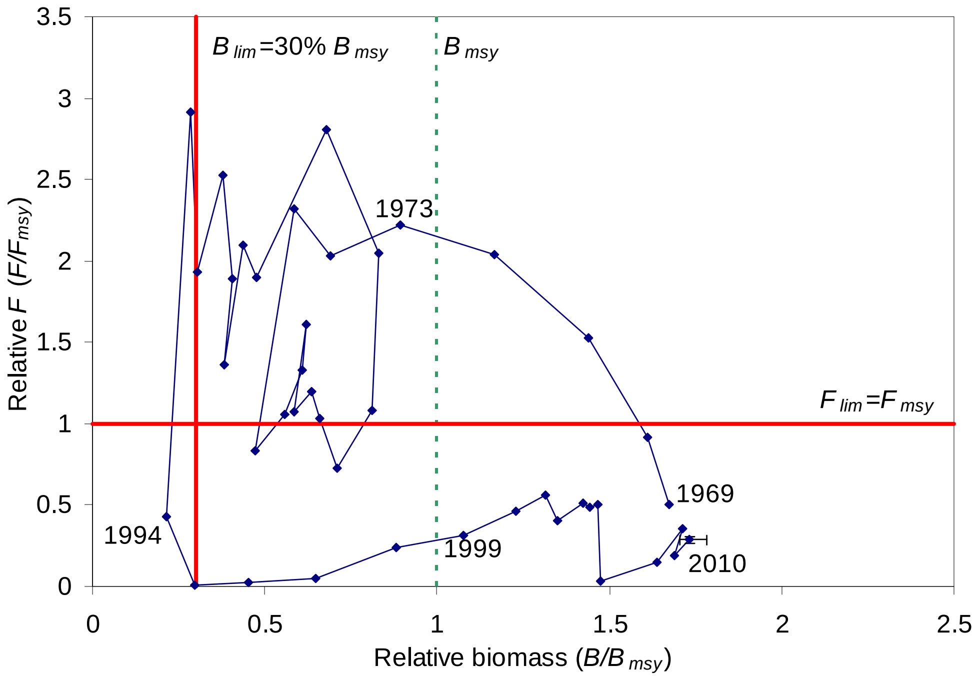


Figure 20. Yellowtail flounder in Div. 3LNO: stock trajectory estimated in the surplus production analysis, under a precautionary approach framework.

APPENDIX 1.

```
FIT  ## Run type (FIT, BOT, or IRF)
"3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006
Spring OUT"
LOGISTIC  YLD    SSE
12  ## Verbosity
500  50  ## Number of bootstrap trials, <= 1000
0  50000  ## 0=no MC search, 1=search, 2=repeated srch; N trials
1.0000E-08  ## Convergence crit. for simplex
3.0000E-06  0  ## Convergence crit. for restarts, N restarts
1.0000E-02  24  ## Conv. crit. for F; N steps/yr for gen. model
5.0000  ## Maximum F when cond. on yield
0.0  ## Stat weight for B1>K as residual (usually 0 or 1)
5  ## Number of fisheries (data series)
1.0000E+00  1.0000E+00  1.0000E+00  1.0000E+00  1.0000E+00    ## Statistical
weights for data series
1.0000  ## B1/K (starting guess, usually 0 to 1)
1.3000E+01  ## MSY (starting guess)
4.0000E+02  ## K (carrying capacity) (starting guess)
3.0000E+00  1.0000E+00  3.0000E+00  1.0000E+00  3.0000E+00    ## 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)
1.0000E+00  5.0000E+01  ## Min and max constraints -- MSY
1.0000E+01  1.0000E+03  ## Min and max constraints -- K
9114895  ## Random number seed
47  ## Number of years of data in each series
"Fishery-catch/Spring biomass"
```

APPENDIX 2.

```
3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
Page 1
                                                                                                     Sunday, 05 Jun 2011
at 08:37:28
ASPIC -- A Surplus-Production Model Including Covariates (Ver. 5.34)
                                                                                                                    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: n:\...011\ytail\aspic534\ytail2011_no
b1kpenalty_notboot.inp
-------------------------------------------------------------------------------------------------------------
-----------
Operation of ASPIC:  Fit logistic (Schaefer) model by direct optimization.
Number of years analyzed:                       47            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: 176

CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)

		1	2	3	4	5
1	Fishery-catch/Spring biomass	1.000 26				
2	Canadian Yankee Survey	0.000 0	1.000 12			
3	Canadian Fall Survey	0.880 20	0.000 0	1.000 21		
4	Russian Survey	0.933 8	0.000 0	1.000 2	1.000 8	
5	Spanish Survey Converted biomass...	0.777 15	0.000 0	0.702 16	0.000 0	1.000 16

GOODNESS-OF-FIT AND WEIGHTING (NON-BOOTSTRAPPED ANALYSIS)

Loss component number and title		Weighted SSE	N	Weighted MSE	Current weight	Inv. var. weight	R-squared in CPUE
Loss(-1)	SSE in yield	0.000E+00					
Loss(0)	Penalty for B1 > K	0.000E+00	1	N/A	0.000E+00	N/A	
Loss(1)	Fishery-catch/Spring biomass	1.134E+00	26	4.726E-02	1.000E+00	1.299E+00	0.851
Loss(2)	Canadian Yankee Survey	2.849E-01	12	2.849E-02	1.000E+00	2.155E+00	0.804
Loss(3)	Canadian Fall Survey	1.611E+00	21	8.477E-02	1.000E+00	7.240E-01	0.754
Loss(4)	Russian Survey	8.620E-01	8	1.437E-01	1.000E+00	4.272E-01	0.551
Loss(5)	Spanish Survey Converted biomass_2006	2.891E+00	16	2.065E-01	1.000E+00	2.972E-01	0.660
TOTAL OBJECTIVE FUNCTION, MSE, RMSE:		6.78292526E+00		9.044E-02	3.007E-01		
Estimated contrast index (ideal = 1.0):		0.7594		C* = (Bmax-Bmin)/K			
Estimated nearness index (ideal = 1.0):		1.0000		N* = 1 - |min(B-Bmsy)|/K			

3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
Page 2

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	User/pgm guess	2nd guess	Estimated	User guess
B1/K	Starting relative biomass (in 1965)	7.836E-01	1.000E+00	5.335E-01	1	1
MSY	Maximum sustainable yield	1.891E+01	1.300E+01	1.175E+01	1	1
K	Maximum population size	1.483E+02	4.000E+02	7.048E+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	3.230E+00	3.000E+00	2.288E-01	1	1
q(2)	Canadian Yankee Survey	9.984E-01	1.000E+00	6.665E-01	1	1
q(3)	Canadian Fall Survey	3.295E+00	3.000E+00	1.370E-01	1	1
q(4)	Russian Survey	1.167E+00	1.000E+00	6.867E-01	1	1
q(5)	Spanish Survey Converted biomass_2006	1.285E+00	3.000E+00	2.558E-01	1	1

MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Logistic formula	General formula
MSY	Maximum sustainable yield	1.891E+01	----	----
Bmsy	Stock biomass giving MSY	7.416E+01	K/2	K*n**(1/(1-n))
Fmsy	Fishing mortality rate at MSY	2.550E-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(2012)/Bmsy	1.634E+00	----	----
F./Fmsy	Ratio: F(2011)/Fmsy	5.362E-01	----	----
Fmsy/F.	Ratio: Fmsy/F(2011)	1.865E+00	----	----
Y.(Fmsy)	Approx. yield available at Fmsy in 2012	2.881E+01	MSY*B./Bmsy	MSY*B./Bmsy
	...as proportion of MSY	1.523E+00	----	----
Ye.	Equilibrium yield available in 2012	1.130E+01	4*MSY*(B/K-(B/K)**2)	g*MSY*(B/K-(B/K)**n)
	...as proportion of MSY	5.976E-01	----	----
---------	Fishing effort rate at MSY in units of each CE or CC series ---------			
fmsy(1)	Fishery-catch/Spring biomass	7.896E-02	Fmsy/q(1)	Fmsy/q(1)

3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
Page 3

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	0.026	1.162E+02	1.206E+02	3.130E+00	3.130E+00	1.146E+01	1.017E-01	1.567E+00
2	1966	0.056	1.246E+02	1.260E+02	7.026E+00	7.026E+00	9.676E+00	2.187E-01	1.680E+00
3	1967	0.070	1.272E+02	1.274E+02	8.878E+00	8.878E+00	9.175E+00	2.733E-01	1.715E+00
4	1968	0.106	1.275E+02	1.256E+02	1.334E+01	1.334E+01	9.806E+00	4.164E-01	1.719E+00
5	1969	0.129	1.240E+02	1.215E+02	1.571E+01	1.571E+01	1.119E+01	5.067E-01	1.672E+00
6	1970	0.235	1.195E+02	1.126E+02	2.643E+01	2.643E+01	1.379E+01	9.200E-01	1.611E+00
7	1971	0.390	1.068E+02	9.579E+01	3.734E+01	3.734E+01	1.717E+01	1.529E+00	1.440E+00
8	1972	0.521	8.664E+01	7.541E+01	3.926E+01	3.926E+01	1.875E+01	2.041E+00	1.168E+00
9	1973	0.565	6.613E+01	5.803E+01	3.281E+01	3.281E+01	1.792E+01	2.217E+00	8.917E-01
10	1974	0.518	5.123E+01	4.696E+01	2.431E+01	2.431E+01	1.633E+01	2.030E+00	6.908E-01
11	1975	0.591	4.325E+01	3.877E+01	2.289E+01	2.289E+01	1.456E+01	2.316E+00	5.832E-01
12	1976	0.212	3.492E+01	3.806E+01	8.057E+00	8.057E+00	1.442E+01	8.301E-01	4.708E-01
13	1977	0.269	4.128E+01	4.324E+01	1.164E+01	1.164E+01	1.562E+01	1.055E+00	5.566E-01
14	1978	0.339	4.526E+01	4.557E+01	1.547E+01	1.547E+01	1.610E+01	1.331E+00	6.103E-01
15	1979	0.411	4.590E+01	4.460E+01	1.835E+01	1.835E+01	1.590E+01	1.613E+00	6.189E-01
16	1980	0.274	4.345E+01	4.525E+01	1.238E+01	1.238E+01	1.603E+01	1.073E+00	5.859E-01
17	1981	0.306	4.710E+01	4.799E+01	1.468E+01	1.468E+01	1.655E+01	1.200E+00	6.351E-01
18	1982	0.262	4.897E+01	5.081E+01	1.332E+01	1.332E+01	1.703E+01	1.028E+00	6.603E-01
19	1983	0.186	5.268E+01	5.640E+01	1.047E+01	1.047E+01	1.781E+01	7.281E-01	7.104E-01
20	1984	0.276	6.002E+01	6.074E+01	1.673E+01	1.673E+01	1.828E+01	1.080E+00	8.093E-01
21	1985	0.523	6.156E+01	5.543E+01	2.896E+01	2.896E+01	1.763E+01	2.049E+00	8.302E-01
22	1986	0.717	5.023E+01	4.211E+01	3.018E+01	3.018E+01	1.529E+01	2.810E+00	6.774E-01
23	1987	0.484	3.535E+01	3.374E+01	1.631E+01	1.631E+01	1.328E+01	1.896E+00	4.766E-01
24	1988	0.535	3.231E+01	3.022E+01	1.616E+01	1.616E+01	1.225E+01	2.096E+00	4.358E-01
25	1989	0.348	2.841E+01	2.930E+01	1.021E+01	1.021E+01	1.199E+01	1.366E+00	3.831E-01
26	1990	0.481	3.019E+01	2.906E+01	1.399E+01	1.399E+01	1.191E+01	1.887E+00	4.072E-01
27	1991	0.645	2.811E+01	2.511E+01	1.620E+01	1.620E+01	1.061E+01	2.530E+00	3.791E-01
28	1992	0.493	2.252E+01	2.184E+01	1.076E+01	1.076E+01	9.494E+00	1.932E+00	3.037E-01
29	1993	0.743	2.126E+01	1.831E+01	1.362E+01	1.362E+01	8.162E+00	2.915E+00	2.866E-01
30	1994	0.110	1.580E+01	1.880E+01	2.069E+00	2.069E+00	8.365E+00	4.315E-01	2.131E-01
31	1995	0.002	2.210E+01	2.745E+01	6.700E-02	6.700E-02	1.137E+01	9.570E-03	2.980E-01
32	1996	0.006	3.341E+01	4.049E+01	2.320E-01	2.320E-01	1.495E+01	2.247E-02	4.505E-01
33	1997	0.012	4.813E+01	5.652E+01	6.580E-01	6.580E-01	1.776E+01	4.565E-02	6.490E-01
34	1998	0.060	6.523E+01	7.251E+01	4.386E+00	4.386E+00	1.884E+01	2.372E-01	8.796E-01
35	1999	0.081	7.968E+01	8.558E+01	6.894E+00	6.894E+00	1.842E+01	3.158E-01	1.075E+00
36	2000	0.118	9.121E+01	9.450E+01	1.116E+01	1.116E+01	1.748E+01	4.631E-01	1.230E+00
37	2001	0.143	9.753E+01	9.892E+01	1.414E+01	1.414E+01	1.680E+01	5.607E-01	1.315E+00
38	2002	0.104	1.002E+02	1.030E+02	1.070E+01	1.070E+01	1.604E+01	4.074E-01	1.351E+00
39	2003	0.130	1.055E+02	1.063E+02	1.381E+01	1.381E+01	1.535E+01	5.091E-01	1.423E+00
40	2004	0.124	1.071E+02	1.079E+02	1.335E+01	1.335E+01	1.499E+01	4.851E-01	1.444E+00
41	2005	0.128	1.087E+02	1.091E+02	1.393E+01	1.393E+01	1.471E+01	5.007E-01	1.466E+00
42	2006	0.008	1.095E+02	1.158E+02	9.300E-01	9.300E-01	1.292E+01	3.150E-02	1.476E+00
43	2007	0.037	1.215E+02	1.244E+02	4.617E+00	4.617E+00	1.021E+01	1.455E-01	1.638E+00
44	2008	0.090	1.271E+02	1.261E+02	1.140E+01	1.140E+01	9.628E+00	3.545E-01	1.713E+00
45	2009	0.049	1.253E+02	1.270E+02	6.168E+00	6.168E+00	9.318E+00	1.905E-01	1.689E+00
46	2010	0.073	1.284E+02	1.282E+02	9.366E+00	9.366E+00	8.877E+00	2.866E-01	1.732E+00
47	2011	0.137	1.279E+02	1.243E+02	1.700E+01	1.700E+01	1.025E+01	5.362E-01	1.725E+00
48	2012		1.212E+02						1.634E+00

3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
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RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) Fishery-catch/Spring biomass

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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	*	3.897E+02	0.0259	3.130E+00	3.130E+00	0.00000	1.000E+00
2	1966	*	4.069E+02	0.0558	7.026E+00	7.026E+00	0.00000	1.000E+00
3	1967	*	4.114E+02	0.0697	8.878E+00	8.878E+00	0.00000	1.000E+00
4	1968	*	4.057E+02	0.1062	1.334E+01	1.334E+01	0.00000	1.000E+00
5	1969	*	3.926E+02	0.1292	1.571E+01	1.571E+01	0.00000	1.000E+00
6	1970	*	3.638E+02	0.2346	2.643E+01	2.643E+01	0.00000	1.000E+00
7	1971	*	3.094E+02	0.3898	3.734E+01	3.734E+01	0.00000	1.000E+00
8	1972	*	2.436E+02	0.5206	3.926E+01	3.926E+01	0.00000	1.000E+00
9	1973	*	1.874E+02	0.5655	3.281E+01	3.281E+01	0.00000	1.000E+00
10	1974	*	1.517E+02	0.5177	2.431E+01	2.431E+01	0.00000	1.000E+00
11	1975	*	1.252E+02	0.5905	2.289E+01	2.289E+01	0.00000	1.000E+00
12	1976	*	1.229E+02	0.2117	8.057E+00	8.057E+00	0.00000	1.000E+00
13	1977	*	1.397E+02	0.2691	1.164E+01	1.164E+01	0.00000	1.000E+00
14	1978	*	1.472E+02	0.3394	1.547E+01	1.547E+01	0.00000	1.000E+00
15	1979	*	1.441E+02	0.4114	1.835E+01	1.835E+01	0.00000	1.000E+00
16	1980	*	1.462E+02	0.2735	1.238E+01	1.238E+01	0.00000	1.000E+00
17	1981	*	1.550E+02	0.3059	1.468E+01	1.468E+01	0.00000	1.000E+00
18	1982	*	1.641E+02	0.2621	1.332E+01	1.332E+01	0.00000	1.000E+00
19	1983	*	1.822E+02	0.1857	1.047E+01	1.047E+01	0.00000	1.000E+00
20	1984	2.177E+02	1.962E+02	0.2755	1.673E+01	1.673E+01	-0.10394	1.000E+00
21	1985	1.468E+02	1.790E+02	0.5225	2.896E+01	2.896E+01	0.19858	1.000E+00
22	1986	1.382E+02	1.360E+02	0.7165	3.018E+01	3.018E+01	-0.01581	1.000E+00
23	1987	1.246E+02	1.090E+02	0.4836	1.631E+01	1.631E+01	-0.13405	1.000E+00
24	1988	8.100E+01	9.762E+01	0.5347	1.616E+01	1.616E+01	0.18660	1.000E+00
25	1989	1.038E+02	9.463E+01	0.3484	1.021E+01	1.021E+01	-0.09252	1.000E+00
26	1990	1.031E+02	9.386E+01	0.4813	1.399E+01	1.399E+01	-0.09384	1.000E+00
27	1991	9.340E+01	8.112E+01	0.6452	1.620E+01	1.620E+01	-0.14096	1.000E+00
28	1992	6.140E+01	7.054E+01	0.4928	1.076E+01	1.076E+01	0.13880	1.000E+00
29	1993	9.330E+01	5.916E+01	0.7434	1.362E+01	1.362E+01	-0.45560	1.000E+00
30	1994	5.560E+01	6.073E+01	0.1101	2.069E+00	2.069E+00	0.08819	1.000E+00
31	1995	7.060E+01	8.867E+01	0.0024	6.700E-02	6.700E-02	0.22793	1.000E+00
32	1996	1.756E+02	1.308E+02	0.0057	2.320E-01	2.320E-01	-0.29465	1.000E+00
33	1997	1.749E+02	1.826E+02	0.0116	6.580E-01	6.580E-01	0.04290	1.000E+00
34	1998	2.022E+02	2.342E+02	0.0605	4.386E+00	4.386E+00	0.14696	1.000E+00
35	1999	3.657E+02	2.764E+02	0.0806	6.894E+00	6.894E+00	-0.27979	1.000E+00
36	2000	2.875E+02	3.053E+02	0.1181	1.116E+01	1.116E+01	0.05993	1.000E+00
37	2001	3.660E+02	3.195E+02	0.1430	1.414E+01	1.414E+01	-0.13581	1.000E+00
38	2002	1.995E+02	3.325E+02	0.1039	1.070E+01	1.070E+01	0.51096	1.000E+00
39	2003	3.865E+02	3.435E+02	0.1298	1.381E+01	1.381E+01	-0.11798	1.000E+00
40	2004	3.079E+02	3.486E+02	0.1237	1.335E+01	1.335E+01	0.12423	1.000E+00
41	2005	3.888E+02	3.524E+02	0.1277	1.393E+01	1.393E+01	-0.09819	1.000E+00
42	2006	*	3.739E+02	0.0080	9.300E-01	9.300E-01	0.00000	1.000E+00
43	2007	4.430E+02	4.019E+02	0.0371	4.617E+00	4.617E+00	-0.09725	1.000E+00
44	2008	4.570E+02	4.072E+02	0.0904	1.140E+01	1.140E+01	-0.11526	1.000E+00
45	2009	2.710E+02	4.101E+02	0.0486	6.168E+00	6.168E+00	0.41430	1.000E+00
46	2010	3.950E+02	4.140E+02	0.0731	9.366E+00	9.366E+00	0.04689	1.000E+00
47	2011	*	4.015E+02	0.1368	1.700E+01	1.700E+01	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
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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    -0.1039                                         ====|
1985     0.1986                                             |========
1986    -0.0158                                            =|
1987    -0.1341                                        =====|
1988     0.1866                                             |=======
1989    -0.0925                                         ====|
1990    -0.0938                                         ====|
1991    -0.1410                                       ======|
1992     0.1388                                             |======
1993    -0.4556                           ==================|
1994     0.0882                                             |====
1995     0.2279                                             |=========
1996    -0.2947                                 ============|
1997     0.0429                                             |==
1998     0.1470                                             |======
1999    -0.2798                                  ===========|
2000     0.0599                                             |==
2001    -0.1358                                        =====|
2002     0.5110                                             |====================
2003    -0.1180                                        =====|
2004     0.1242                                             |=====
2005    -0.0982                                         ====|
2006     0.0000                                             |
2007    -0.0973                                         ====|
2008    -0.1153                                        =====|
2009     0.4143                                             |=================
2010     0.0469                                             |==
2011     0.0000                                             |
                   ------------------------------------------------------------------------------------
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3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
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RESULTS FOR DATA SERIES # 2 (NON-BOOTSTRAPPED) Canadian Yankee Survey
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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	--	*	1.204E+02	0.00000	1.000E+00
2	1966	0.000E+00	0.000E+00	--	*	1.258E+02	0.00000	1.000E+00
3	1967	0.000E+00	0.000E+00	--	*	1.272E+02	0.00000	1.000E+00
4	1968	0.000E+00	0.000E+00	--	*	1.254E+02	0.00000	1.000E+00
5	1969	0.000E+00	0.000E+00	--	*	1.213E+02	0.00000	1.000E+00
6	1970	0.000E+00	0.000E+00	--	*	1.124E+02	0.00000	1.000E+00
7	1971	1.000E+00	1.000E+00	--	9.690E+01	9.563E+01	0.01315	1.000E+00
8	1972	1.000E+00	1.000E+00	--	7.920E+01	7.528E+01	0.05072	1.000E+00
9	1973	1.000E+00	1.000E+00	--	5.170E+01	5.794E+01	-0.11388	1.000E+00
10	1974	1.000E+00	1.000E+00	--	4.030E+01	4.689E+01	-0.15137	1.000E+00
11	1975	1.000E+00	1.000E+00	--	3.740E+01	3.870E+01	-0.03427	1.000E+00
12	1976	1.000E+00	1.000E+00	--	4.170E+01	3.800E+01	0.09304	1.000E+00
13	1977	1.000E+00	1.000E+00	--	6.500E+01	4.317E+01	0.40916	1.000E+00
14	1978	1.000E+00	1.000E+00	--	4.430E+01	4.550E+01	-0.02667	1.000E+00
15	1979	1.000E+00	1.000E+00	--	3.850E+01	4.453E+01	-0.14548	1.000E+00
16	1980	1.000E+00	1.000E+00	--	5.140E+01	4.517E+01	0.12912	1.000E+00
17	1981	1.000E+00	1.000E+00	--	4.500E+01	4.791E+01	-0.06261	1.000E+00
18	1982	1.000E+00	1.000E+00	--	4.310E+01	5.072E+01	-0.16288	1.000E+00
19	1983	0.000E+00	0.000E+00	--	*	5.631E+01	0.00000	1.000E+00
20	1984	0.000E+00	0.000E+00	--	*	6.064E+01	0.00000	1.000E+00
21	1985	0.000E+00	0.000E+00	--	*	5.534E+01	0.00000	1.000E+00
22	1986	0.000E+00	0.000E+00	--	*	4.204E+01	0.00000	1.000E+00
23	1987	0.000E+00	0.000E+00	--	*	3.368E+01	0.00000	1.000E+00
24	1988	0.000E+00	0.000E+00	--	*	3.017E+01	0.00000	1.000E+00
25	1989	0.000E+00	0.000E+00	--	*	2.925E+01	0.00000	1.000E+00
26	1990	0.000E+00	0.000E+00	--	*	2.901E+01	0.00000	1.000E+00
27	1991	0.000E+00	0.000E+00	--	*	2.507E+01	0.00000	1.000E+00
28	1992	0.000E+00	0.000E+00	--	*	2.180E+01	0.00000	1.000E+00
29	1993	0.000E+00	0.000E+00	--	*	1.828E+01	0.00000	1.000E+00
30	1994	0.000E+00	0.000E+00	--	*	1.877E+01	0.00000	1.000E+00
31	1995	0.000E+00	0.000E+00	--	*	2.741E+01	0.00000	1.000E+00
32	1996	0.000E+00	0.000E+00	--	*	4.042E+01	0.00000	1.000E+00
33	1997	0.000E+00	0.000E+00	--	*	5.643E+01	0.00000	1.000E+00
34	1998	0.000E+00	0.000E+00	--	*	7.239E+01	0.00000	1.000E+00
35	1999	0.000E+00	0.000E+00	--	*	8.544E+01	0.00000	1.000E+00
36	2000	0.000E+00	0.000E+00	--	*	9.435E+01	0.00000	1.000E+00
37	2001	0.000E+00	0.000E+00	--	*	9.876E+01	0.00000	1.000E+00
38	2002	0.000E+00	0.000E+00	--	*	1.028E+02	0.00000	1.000E+00
39	2003	0.000E+00	0.000E+00	--	*	1.062E+02	0.00000	1.000E+00
40	2004	0.000E+00	0.000E+00	--	*	1.078E+02	0.00000	1.000E+00
41	2005	0.000E+00	0.000E+00	--	*	1.089E+02	0.00000	1.000E+00
42	2006	0.000E+00	0.000E+00	--	*	1.156E+02	0.00000	1.000E+00
43	2007	0.000E+00	0.000E+00	--	*	1.242E+02	0.00000	1.000E+00
44	2008	0.000E+00	0.000E+00	--	*	1.259E+02	0.00000	1.000E+00
45	2009	0.000E+00	0.000E+00	--	*	1.268E+02	0.00000	1.000E+00
46	2010	0.000E+00	0.000E+00	--	*	1.279E+02	0.00000	1.000E+00
47	2011	0.000E+00	0.000E+00	--	*	1.241E+02	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
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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     0.0131                                             |=
1972     0.0507                                             |==
1973    -0.1139                                        =====|
1974    -0.1514                                       ======|
1975    -0.0343                                            =|
1976     0.0930                                             |====
1977     0.4092                                             |================
1978    -0.0267                                            =|
1979    -0.1455                                       ======|
1980     0.1291                                             |=====
1981    -0.0626                                          ===|
1982    -0.1629                                      =======|
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                                             |
2010     0.0000                                             |
2011     0.0000                                             |
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3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
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RESULTS FOR DATA SERIES # 3 (NON-BOOTSTRAPPED) Canadian Fall Survey

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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	--	*	4.105E+02	0.00000	1.000E+00
2	1966	0.000E+00	0.000E+00	--	*	4.192E+02	0.00000	1.000E+00
3	1967	0.000E+00	0.000E+00	--	*	4.202E+02	0.00000	1.000E+00
4	1968	0.000E+00	0.000E+00	--	*	4.086E+02	0.00000	1.000E+00
5	1969	0.000E+00	0.000E+00	--	*	3.937E+02	0.00000	1.000E+00
6	1970	0.000E+00	0.000E+00	--	*	3.520E+02	0.00000	1.000E+00
7	1971	0.000E+00	0.000E+00	--	*	2.855E+02	0.00000	1.000E+00
8	1972	0.000E+00	0.000E+00	--	*	2.179E+02	0.00000	1.000E+00
9	1973	0.000E+00	0.000E+00	--	*	1.688E+02	0.00000	1.000E+00
10	1974	0.000E+00	0.000E+00	--	*	1.425E+02	0.00000	1.000E+00
11	1975	0.000E+00	0.000E+00	--	*	1.151E+02	0.00000	1.000E+00
12	1976	0.000E+00	0.000E+00	--	*	1.360E+02	0.00000	1.000E+00
13	1977	0.000E+00	0.000E+00	--	*	1.492E+02	0.00000	1.000E+00
14	1978	0.000E+00	0.000E+00	--	*	1.513E+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	--	*	1.614E+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	--	*	1.978E+02	0.00000	1.000E+00
20	1984	0.000E+00	0.000E+00	--	*	2.029E+02	0.00000	1.000E+00
21	1985	0.000E+00	0.000E+00	--	*	1.656E+02	0.00000	1.000E+00
22	1986	0.000E+00	0.000E+00	--	*	1.165E+02	0.00000	1.000E+00
23	1987	0.000E+00	0.000E+00	--	*	1.065E+02	0.00000	1.000E+00
24	1988	0.000E+00	0.000E+00	--	*	9.363E+01	0.00000	1.000E+00
25	1989	0.000E+00	0.000E+00	--	*	9.951E+01	0.00000	1.000E+00
26	1990	1.000E+00	1.000E+00	--	6.580E+01	9.265E+01	-0.34222	1.000E+00
27	1991	1.000E+00	1.000E+00	--	8.240E+01	7.423E+01	0.10443	1.000E+00
28	1992	1.000E+00	1.000E+00	--	6.450E+01	7.005E+01	-0.08255	1.000E+00
29	1993	1.000E+00	1.000E+00	--	1.128E+02	5.208E+01	0.77287	1.000E+00
30	1994	1.000E+00	1.000E+00	--	1.064E+02	7.283E+01	0.37912	1.000E+00
31	1995	1.000E+00	1.000E+00	--	1.298E+02	1.101E+02	0.16469	1.000E+00
32	1996	1.000E+00	1.000E+00	--	1.343E+02	1.586E+02	-0.16633	1.000E+00
33	1997	1.000E+00	1.000E+00	--	2.229E+02	2.150E+02	0.03627	1.000E+00
34	1998	1.000E+00	1.000E+00	--	2.316E+02	2.626E+02	-0.12564	1.000E+00
35	1999	1.000E+00	1.000E+00	--	2.499E+02	3.006E+02	-0.18472	1.000E+00
36	2000	1.000E+00	1.000E+00	--	3.350E+02	3.214E+02	0.04140	1.000E+00
37	2001	1.000E+00	1.000E+00	--	4.758E+02	3.302E+02	0.36541	1.000E+00
38	2002	1.000E+00	1.000E+00	--	3.397E+02	3.478E+02	-0.02349	1.000E+00
39	2003	1.000E+00	1.000E+00	--	3.683E+02	3.529E+02	0.04284	1.000E+00
40	2004	1.000E+00	1.000E+00	--	3.747E+02	3.582E+02	0.04492	1.000E+00
41	2005	1.000E+00	1.000E+00	--	3.427E+02	3.608E+02	-0.05146	1.000E+00
42	2006	1.000E+00	1.000E+00	--	3.055E+02	4.003E+02	-0.27027	1.000E+00
43	2007	1.000E+00	1.000E+00	--	4.824E+02	4.187E+02	0.14155	1.000E+00
44	2008	1.000E+00	1.000E+00	--	3.220E+02	4.129E+02	-0.24862	1.000E+00
45	2009	1.000E+00	1.000E+00	--	2.380E+02	4.233E+02	-0.57573	1.000E+00
46	2010	1.000E+00	1.000E+00	--	4.172E+02	4.217E+02	-0.01062	1.000E+00
47	2011	0.000E+00	0.000E+00	--	*	3.994E+02	0.00000	1.000E+00

* Asterisk indicates missing value(s).

```
3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
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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    -0.3422                           ==============|
1991     0.1044                                         |====
1992    -0.0825                                      ===|
1993     0.7729                                         |==============================
1994     0.3791                                         |===============
1995     0.1647                                         |=======
1996    -0.1663                                  =======|
1997     0.0363                                         |=
1998    -0.1256                                    =====|
1999    -0.1847                                  =======|
2000     0.0414                                         |==
2001     0.3654                                         |===============
2002    -0.0235                                        =|
2003     0.0428                                         |==
2004     0.0449                                         |==
2005    -0.0515                                       ==|
2006    -0.2703                               ===========|
2007     0.1416                                         |======
2008    -0.2486                                ==========|
2009    -0.5757                    ======================|
2010    -0.0106                                         |
2011     0.0000                                         |
                   ----------------------------------------------------------------------------------
```

3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
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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	--	*	1.408E+02	0.00000	1.000E+00
2	1966	0.000E+00	0.000E+00	--	*	1.471E+02	0.00000	1.000E+00
3	1967	0.000E+00	0.000E+00	--	*	1.487E+02	0.00000	1.000E+00
4	1968	0.000E+00	0.000E+00	--	*	1.466E+02	0.00000	1.000E+00
5	1969	0.000E+00	0.000E+00	--	*	1.419E+02	0.00000	1.000E+00
6	1970	0.000E+00	0.000E+00	--	*	1.315E+02	0.00000	1.000E+00
7	1971	0.000E+00	0.000E+00	--	*	1.118E+02	0.00000	1.000E+00
8	1972	0.000E+00	0.000E+00	--	*	8.803E+01	0.00000	1.000E+00
9	1973	0.000E+00	0.000E+00	--	*	6.775E+01	0.00000	1.000E+00
10	1974	0.000E+00	0.000E+00	--	*	5.483E+01	0.00000	1.000E+00
11	1975	0.000E+00	0.000E+00	--	*	4.526E+01	0.00000	1.000E+00
12	1976	0.000E+00	0.000E+00	--	*	4.443E+01	0.00000	1.000E+00
13	1977	0.000E+00	0.000E+00	--	*	5.049E+01	0.00000	1.000E+00
14	1978	0.000E+00	0.000E+00	--	*	5.320E+01	0.00000	1.000E+00
15	1979	0.000E+00	0.000E+00	--	*	5.207E+01	0.00000	1.000E+00
16	1980	0.000E+00	0.000E+00	--	*	5.282E+01	0.00000	1.000E+00
17	1981	0.000E+00	0.000E+00	--	*	5.602E+01	0.00000	1.000E+00
18	1982	0.000E+00	0.000E+00	--	*	5.931E+01	0.00000	1.000E+00
19	1983	0.000E+00	0.000E+00	--	*	6.584E+01	0.00000	1.000E+00
20	1984	1.000E+00	1.000E+00	--	1.320E+02	7.092E+01	0.62132	1.000E+00
21	1985	1.000E+00	1.000E+00	--	8.500E+01	6.471E+01	0.27269	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	3.938E+01	-0.27216	1.000E+00
24	1988	1.000E+00	1.000E+00	--	2.300E+01	3.528E+01	-0.42785	1.000E+00
25	1989	1.000E+00	1.000E+00	--	4.400E+01	3.420E+01	0.25194	1.000E+00
26	1990	1.000E+00	1.000E+00	--	2.700E+01	3.393E+01	-0.22832	1.000E+00
27	1991	1.000E+00	1.000E+00	--	2.750E+01	2.932E+01	-0.06405	1.000E+00
28	1992	0.000E+00	0.000E+00	--	*	2.550E+01	0.00000	1.000E+00
29	1993	0.000E+00	0.000E+00	--	*	2.138E+01	0.00000	1.000E+00
30	1994	0.000E+00	0.000E+00	--	*	2.195E+01	0.00000	1.000E+00
31	1995	0.000E+00	0.000E+00	--	*	3.205E+01	0.00000	1.000E+00
32	1996	0.000E+00	0.000E+00	--	*	4.727E+01	0.00000	1.000E+00
33	1997	0.000E+00	0.000E+00	--	*	6.598E+01	0.00000	1.000E+00
34	1998	0.000E+00	0.000E+00	--	*	8.465E+01	0.00000	1.000E+00
35	1999	0.000E+00	0.000E+00	--	*	9.992E+01	0.00000	1.000E+00
36	2000	0.000E+00	0.000E+00	--	*	1.103E+02	0.00000	1.000E+00
37	2001	0.000E+00	0.000E+00	--	*	1.155E+02	0.00000	1.000E+00
38	2002	0.000E+00	0.000E+00	--	*	1.202E+02	0.00000	1.000E+00
39	2003	0.000E+00	0.000E+00	--	*	1.241E+02	0.00000	1.000E+00
40	2004	0.000E+00	0.000E+00	--	*	1.260E+02	0.00000	1.000E+00
41	2005	0.000E+00	0.000E+00	--	*	1.274E+02	0.00000	1.000E+00
42	2006	0.000E+00	0.000E+00	--	*	1.352E+02	0.00000	1.000E+00
43	2007	0.000E+00	0.000E+00	--	*	1.453E+02	0.00000	1.000E+00
44	2008	0.000E+00	0.000E+00	--	*	1.472E+02	0.00000	1.000E+00
45	2009	0.000E+00	0.000E+00	--	*	1.482E+02	0.00000	1.000E+00
46	2010	0.000E+00	0.000E+00	--	*	1.496E+02	0.00000	1.000E+00
47	2011	0.000E+00	0.000E+00	--	*	1.451E+02	0.00000	1.000E+00

* Asterisk indicates missing value(s).

3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
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```
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     0.6213                                             |=========================
1985     0.2727                                             |===========
1986    -0.1575                                       ======|
1987    -0.2722                                  ===========|
1988    -0.4279                            =================|
1989     0.2519                                             |==========
1990    -0.2283                                    =========|
1991    -0.0640                                          ===|
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                                             |
2010     0.0000                                             |

2011     0.0000                                             |
                   -------------------------------------------------------------------------------------
```

3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
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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	--	*	1.551E+02	0.00000	1.000E+00
2	1966	0.000E+00	0.000E+00	--	*	1.619E+02	0.00000	1.000E+00
3	1967	0.000E+00	0.000E+00	--	*	1.637E+02	0.00000	1.000E+00
4	1968	0.000E+00	0.000E+00	--	*	1.615E+02	0.00000	1.000E+00
5	1969	0.000E+00	0.000E+00	--	*	1.562E+02	0.00000	1.000E+00
6	1970	0.000E+00	0.000E+00	--	*	1.448E+02	0.00000	1.000E+00
7	1971	0.000E+00	0.000E+00	--	*	1.231E+02	0.00000	1.000E+00
8	1972	0.000E+00	0.000E+00	--	*	9.693E+01	0.00000	1.000E+00
9	1973	0.000E+00	0.000E+00	--	*	7.459E+01	0.00000	1.000E+00
10	1974	0.000E+00	0.000E+00	--	*	6.037E+01	0.00000	1.000E+00
11	1975	0.000E+00	0.000E+00	--	*	4.983E+01	0.00000	1.000E+00
12	1976	0.000E+00	0.000E+00	--	*	4.892E+01	0.00000	1.000E+00
13	1977	0.000E+00	0.000E+00	--	*	5.559E+01	0.00000	1.000E+00
14	1978	0.000E+00	0.000E+00	--	*	5.858E+01	0.00000	1.000E+00
15	1979	0.000E+00	0.000E+00	--	*	5.733E+01	0.00000	1.000E+00
16	1980	0.000E+00	0.000E+00	--	*	5.816E+01	0.00000	1.000E+00
17	1981	0.000E+00	0.000E+00	--	*	6.168E+01	0.00000	1.000E+00
18	1982	0.000E+00	0.000E+00	--	*	6.531E+01	0.00000	1.000E+00
19	1983	0.000E+00	0.000E+00	--	*	7.250E+01	0.00000	1.000E+00
20	1984	0.000E+00	0.000E+00	--	*	7.808E+01	0.00000	1.000E+00
21	1985	0.000E+00	0.000E+00	--	*	7.125E+01	0.00000	1.000E+00
22	1986	0.000E+00	0.000E+00	--	*	5.413E+01	0.00000	1.000E+00
23	1987	0.000E+00	0.000E+00	--	*	4.336E+01	0.00000	1.000E+00
24	1988	0.000E+00	0.000E+00	--	*	3.885E+01	0.00000	1.000E+00
25	1989	0.000E+00	0.000E+00	--	*	3.766E+01	0.00000	1.000E+00
26	1990	0.000E+00	0.000E+00	--	*	3.735E+01	0.00000	1.000E+00
27	1991	0.000E+00	0.000E+00	--	*	3.228E+01	0.00000	1.000E+00
28	1992	0.000E+00	0.000E+00	--	*	2.807E+01	0.00000	1.000E+00
29	1993	0.000E+00	0.000E+00	--	*	2.354E+01	0.00000	1.000E+00
30	1994	0.000E+00	0.000E+00	--	*	2.417E+01	0.00000	1.000E+00
31	1995	1.000E+00	1.000E+00	--	9.300E+00	3.529E+01	-1.33353	1.000E+00
32	1996	1.000E+00	1.000E+00	--	4.330E+01	5.205E+01	-0.18399	1.000E+00
33	1997	1.000E+00	1.000E+00	--	3.870E+01	7.265E+01	-0.62986	1.000E+00
34	1998	1.000E+00	1.000E+00	--	1.226E+02	9.320E+01	0.27413	1.000E+00
35	1999	1.000E+00	1.000E+00	--	1.970E+02	1.100E+02	0.58260	1.000E+00
36	2000	1.000E+00	1.000E+00	--	1.447E+02	1.215E+02	0.17493	1.000E+00
37	2001	1.000E+00	1.000E+00	--	1.827E+02	1.272E+02	0.36244	1.000E+00
38	2002	1.000E+00	1.000E+00	--	1.485E+02	1.323E+02	0.11523	1.000E+00
39	2003	1.000E+00	1.000E+00	--	1.368E+02	1.367E+02	0.00079	1.000E+00
40	2004	1.000E+00	1.000E+00	--	1.700E+02	1.387E+02	0.20320	1.000E+00
41	2005	1.000E+00	1.000E+00	--	1.565E+02	1.403E+02	0.10946	1.000E+00
42	2006	1.000E+00	1.000E+00	--	1.601E+02	1.488E+02	0.07313	1.000E+00
43	2007	1.000E+00	1.000E+00	--	1.607E+02	1.600E+02	0.00463	1.000E+00
44	2008	1.000E+00	1.000E+00	--	1.601E+02	1.621E+02	-0.01221	1.000E+00
45	2009	1.000E+00	1.000E+00	--	1.834E+02	1.632E+02	0.11667	1.000E+00
46	2010	1.000E+00	1.000E+00	--	1.897E+02	1.647E+02	0.14108	1.000E+00
47	2011	0.000E+00	0.000E+00	--	*	1.598E+02	0.00000	1.000E+00

* Asterisk indicates missing value(s).

3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
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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    -1.3335                  ===========================|
1996    -0.1840                                         ====|
1997    -0.6299                                =============|
1998     0.2741                                             |=====
1999     0.5826                                             |============
2000     0.1749                                             |===
2001     0.3624                                             |=======
2002     0.1152                                             |==
2003     0.0008                                             |
2004     0.2032                                             |====
2005     0.1095                                             |==
2006     0.0731                                             |=
2007     0.0046                                             |
2008    -0.0122                                             |
2009     0.1167                                             |==
2010     0.1411                                             |===
2011     0.0000                                             |
                   ------------------------------------------------------------------------------------
```

3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
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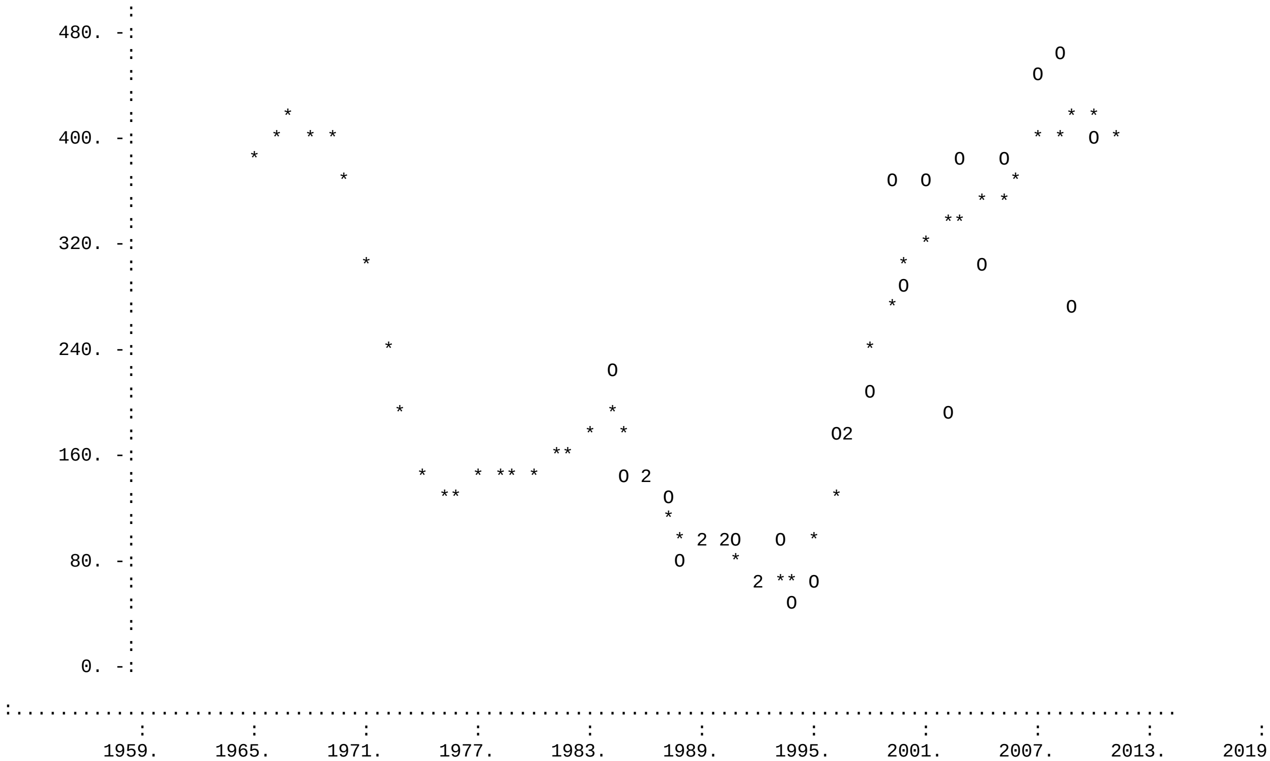
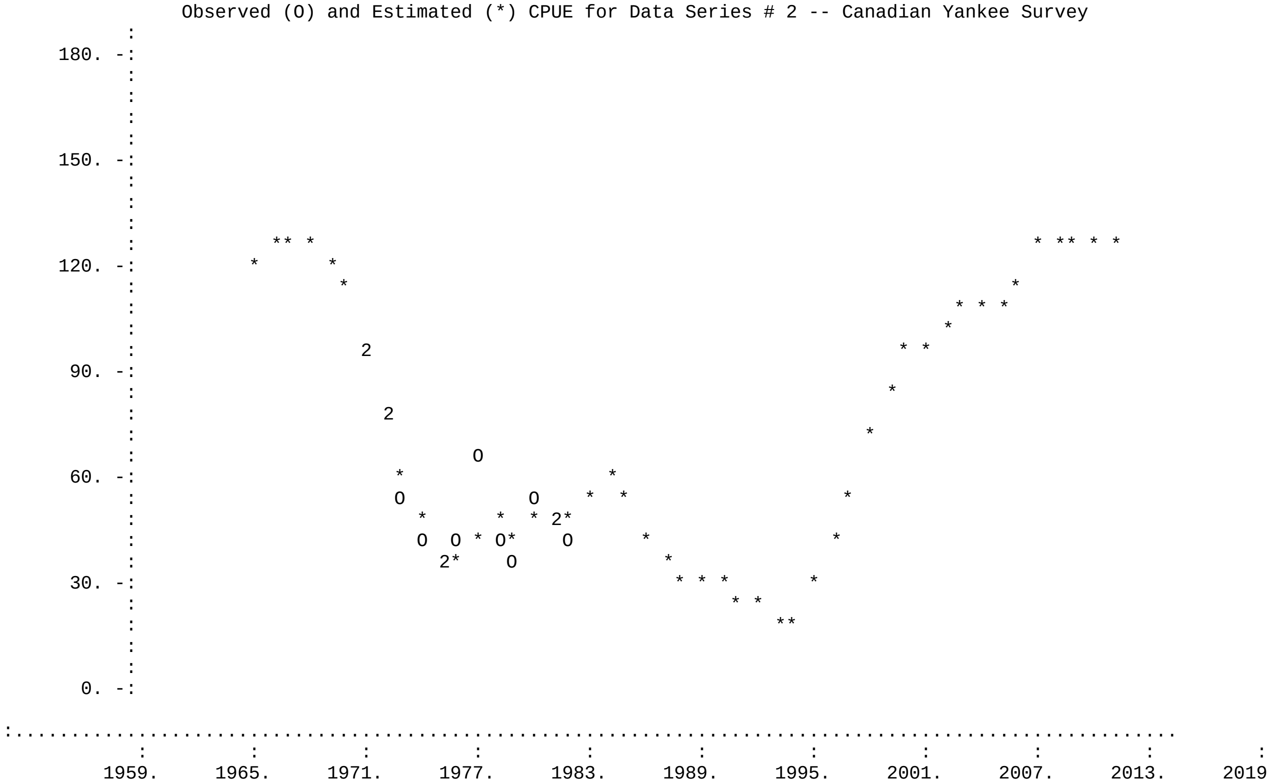
Observed (O) and Estimated (*) CPUE for Data Series # 1 -- Fishery-catch/Spring biomass



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



3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
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```
                Observed (O) and Estimated (*) CPUE for Data Series # 3 -- Canadian Fall Survey
           :
     480. -:                                                                      O         O
           :
           :
           :
           :          * ** *                                                                * ** 2
     400. -:                 *                                                            *        *
           :

           :                                                                         O O *
           :                  *                                                     ** *
           :                                                                    O * O    O
     320. -:                                                                    *             O
           :                                                                   *          O
           :                    *
           :
           :                                                                 * O
     240. -:                                                                                   O
           :                      *                                        O O
           :                                          *                    *
           :                                        *
           :                       *              *
     160. -:                                   * *     *                  *
           :                         *  * * **
           :                                                            O O
           :                           *                 * *         OO *
           :                                                * * *
      80. -:                                                     2    *
           :                                                    O  2
           :                                                         *
           :
           :
       0. -:
:........................................................................................................
            :         :         :         :         :         :         :         :         :         :         :
         1959.     1965.     1971.     1977.     1983.     1989.     1995.     2001.     2007.     2013.     2019.
```

```
                Observed (O) and Estimated (*) CPUE for Data Series # 4 -- Russian Survey
           :
     180. -:
           :
           :
           :
           :
     150. -:            **                                                                    ** *
           :               * *                                                              *      *
           :          *                                                                   *
           :                  *                       O
           :                                                                         * * *
     120. -:                                                                        *
           :                    *                                                 *
           :                                                                    *
           :                                                                   *
           :
      90. -:                      *
           :                                           O                     *
           :
           :                                          *
           :                       *                *  *                   *
           :                                      *
      60. -:                         *      ** * *
           :                           *  *              *                *
           :                            *                O *  O
           :                                                * * *
      30. -:                                               O    O2      *
           :                                                O      * **
           :
           :
           :
       0. -:
:........................................................................................................
            :         :         :         :         :         :         :         :         :         :         :
         1959.     1965.     1971.     1977.     1983.     1989.     1995.     2001.     2007.     2013.     2019.
```

3LNO Yellowtail SM version 5.34 (2011) 2011=TAC RUSSIA 1984-1991; 2006 Spring OUT
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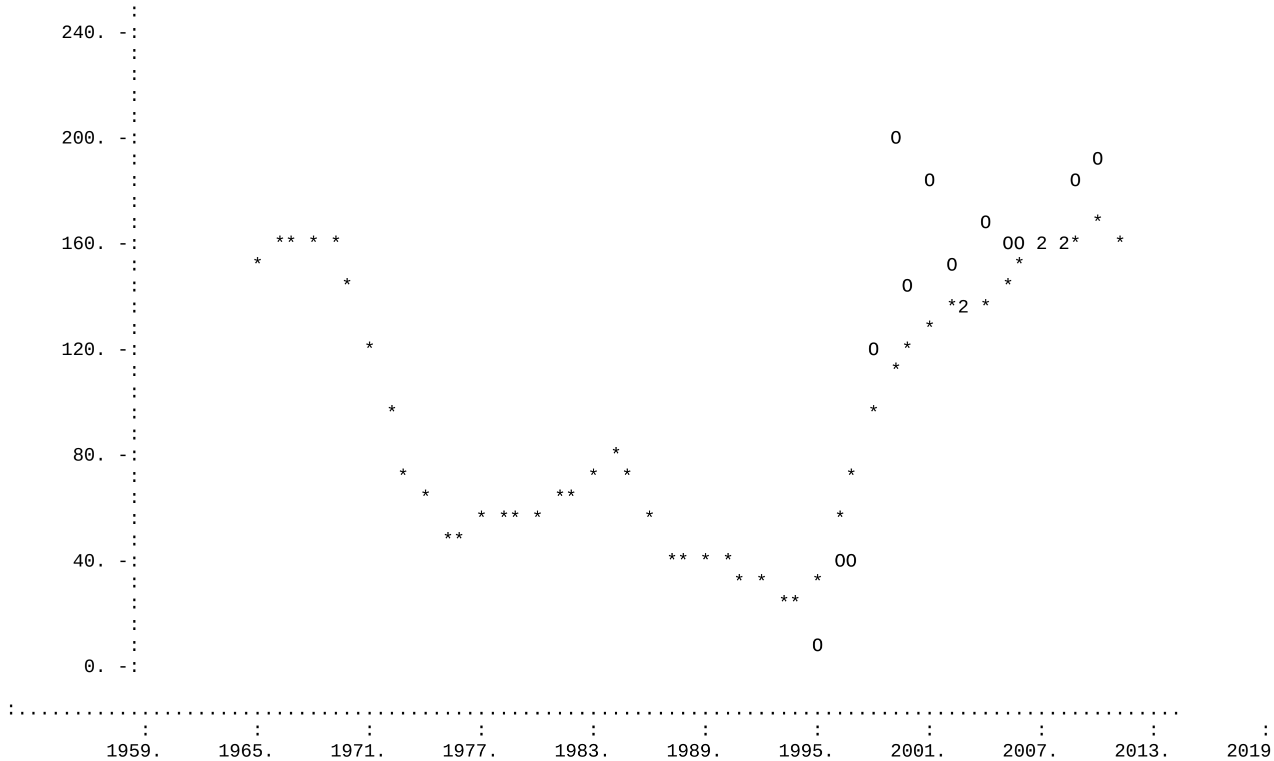
Observed (O) and Estimated (*) CPUE for Data Series # 5 -- Spanish Survey Converted biomass_2006



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