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An ASPIC Based Assessment of Redfish (*S. mentella and S. fasciatus*) in NAFO Divisions 3LN (*Is a Retrospective Biased Assessment Necessarily Useless in Terms of Scientific Advice?*)

by

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Abstract

There are two species of redfish in Divisions 3L and 3N, the deep-sea redfish (*Sebastes mentella)* and the Acadian redfish (*Sebastes fasciatus*) that have been commercially fished and reported collectively as redfish in fishery statistics. Redfish in Div. 3LN is regarded as a management unit composed of two Grand Bank populations from those two very similar redfish species. The present ASPIC assessment is based on the logistic form of a non-equilibrium surplus production model (Schaeffer, 1954; Prager, 1994, 2004 and 2007), adjusted to a standardized catch rate series (Power, 1997) and to most of the stratified-random bottom trawl surveys conducted by Canada and Russia in various years and seasons in Div. 3L and Div. 3N from 1978 onwards. These surveys were framed according to the input formulation previously adopted on the 2nd take of the ASPIC 2008 assessment (Ávila de Melo and Alpoim, 2010). The assessment was preceded by an exploratory analysis to check the response of the model to the inclusion of the Spanish spring survey series on Div. 3N (1995-2009), available for the first time to this assessment. The chosen input formulation run afterwards with different survey results and catch for 2009, different starting guesses for key parameters and different random number seeds, in order to test the robustness of ASPIC results to turbulence in the inputs used to initialize the model deterministic run. A 2010-2007 $ASPIC_{fit}$ retrospective analysis was also carried out to analyze the patterns of bias on relative biomass and fishing mortality in relation to the general increase on the still standing survey series, observed over the most recent years.

The assessment was carried out with ASPIC on both deterministic and bootstrap mode. Regardless the input formulations, the starting guess region, the mode of the ASPIC runs or the retrospective patterns, the 2010 assessment reiterates the main conclusion of the previous ones: the biomass of redfish in Div. 3LN is well above B_{msy} , while fishing mortality is well bellow F_{msy} . The status of the stock allows its exploitation and a low exploitation regime of 5 000 t will not prevent further increase of the stock size of redfish in Div. 3LN, already in its present safe zone, above the upper 80% confidence limit of B_{msy} as the given by the ASPIC $_{bot}$ 2010 assessment. At the same time fishing mortality rate will remain at a (very) low level, with a predicted fishing mortality on 2013 well bellow the lower 80% CL of F_{msy} as the given by the ASPIC $_{bot}$ 2010 assessment.

Introduction

There are two species of the genus *Sebastes* that have been commercially fished in Div. 3LN, the deep sea redfish (*Sebastes mentella)*, with a maximum abundance at depths greater than 300m, and Acadian redfish (*Sebastes fasciatus*), preferring shallower waters of less than 400m. Due to their external resemblance *S. mentella* and *S. fasciatus* are commonly designated as beaked redfish.

Beaked redfish are viviparous with the larvae eclosion occurring right before or after birth, long living and slow growing, with females attaining size of 50% maturity at 30-34cm (Power, 2001). Both species have pelagic and demersal concentrations as well as a long recruitment process to the bottom. Their external characteristics are very similar, making them difficult to distinguish. Therefore they are reported collectively as "redfish" in the commercial fishery statistics. *S. mentella* and *S. fasciatus* are also treated as a single species in the Grand Bank surveys carried out by Canada, Russia and more recently by EU-Spain.

This redfish assessment regards the beaked redfish in Div. 3LN as a management unit composed of two Grand Bank fish populations of two very similar species. Nevertheless, it is accepted that in this management unit *S. mentella* is the dominant population, representing almost 100% of the commercial catch and the major proportion of the exploitable redfish biomass in Divisions 3L and 3N.

A revised ASPIC model (Prager, 1994, 2004 and 2007) was evaluated at the June 2008 meeting (NAFO, 2008). The model incorporated most of the stratified-random bottom trawl surveys conducted by Canada and Russia in various years and seasons in Div. 3L and Div. 3N, from 1978 onwards. All input series consist of annual observed values and the ASPIC version 5.16 fit the logistic form of the production model (Schaefer, 1954).

STACFIS agreed that *the fitted biomass trajectory from the ASPIC revised model agreed with the input index series at a qualitative level. However, STACFIS had serious concerns about the results of the ASPIC model basically related with an unrealistically high B_{2008}/B_{msy} ratio (close to 1.9), and with the low correlations between model and input data. Therefore the ASPIC model was not accepted as a quantitative basis for the 2008 assessment of this stock.*

In 2010 we return to an ASPIC full assessment: avoiding the duplication of surveys in the input data sets, including for the first time the Spanish spring survey series on Div. 3N (1995-2009) in the exploratory analysis, relating adjustments in the model biomass trajectory to the most recent trends in surveys, and finally making retro projections till 2013 from the last four assessments (2010-2007). In brief, the present work aims to demonstrate that the 3LN redfish ASPIC based assessment is not a flaw assessment, despite the apparent poor fit of the model to the data and the (model induced) retrospective patterns back in time.

Commercial Fishery

<u>Nominal catches and TAC's</u>

Reported catches from Div. 3LN declined from 45 000 to 10 000 t on the first years of catch records (1959-1964) and oscillated afterwards (1965-1985) around an average level 21 000 tons. Catches increased sharply to a 79,000 t high in 1987 and fall steadily to 450 t, a minimum reached in 1996. From 1986 till 1993 reported catches were well above TAC's while on subsequent years were well bellow (1994-1997). Catch increased to 900 t in 1998, the first year under a moratorium on directed fishing, with a further increase to 2 600 t in 2000. Catches declined gradually and stabilized at 650 t level in 2004-2005. Catch returned to the historic low level in 2006 with 496 t, recorded an unexpected three times fold increase in 2007 with 1664 tons, drop in 2008 to 600 t but increase again in 2009 to 1051 t (Table 1, Fig. 1).

The NAFO Fisheries Commission implemented a moratorium on directed fishing for this stock in 1998. In June 2008 the Scientific Council recognized that there was enough evidence to allow a small amount of direct fishing (not exceeding 3 500 t in 2009), taking into account the high biomass and very low fishing mortality indices observed recently (NAFO, 2008). Despite this recommendation the Fisheries Commission decided to continue the ban on direct fishing for redfish in Div. 3LN in 2009 coupled with a 10% redfish by-catch rate in other fisheries. In June 2009 the Scientific Council confirmed that recent levels of catches have not altered the upward trend of the stock, as shown by both spring and autumn surveys (NAFO, 2009), and Fisheries Commission finally reopen the fishery with a TAC for 2010 of 3 500 t.

Description of the fishery

In the early 1980's the former USSR, Cuba and Canada were the primary fleets directing for redfish in Div. 3LN. The rapid expansion of the fishery was due to the entry of EU-Portugal in 1986 and South Korea in 1987, along with various re-flagged fleets. In the early 1990's Russia and the Baltic mid-water trawlers, together with South Korea and Portuguese bottom trawlers, were still responsible for the bulk of fishing effort, concentrated by that time on the "Beothuk Knoll" (Div. 3LMN border, southwest of the Flemish Cap).

South Korea left the area by the end of 1993 and from 1994 onwards the other fleets reduced effort substantially on Div. 3LN. The quick decline of redfish catch rates was the main reason for this reduction of redfish fishing effort, and justified its partial shift southwest to Div. 3O. Since 1994 most of the redfish catches in NAFO Divisions 3L and 3N were taken as by-catch of the Greenland halibut fishery pursued from the northern slopes of the Sackville Spur in Div. 3L through Flemish Pass till the canyons of southern Grand Bank in Div. 3N. The EU-Portugal and EU-Spain bottom trawl fleets have been the main fleets responsible for the 3LN redfish by-catch during the moratorium years. In 2009 there are records of a sporadic direct redfish fishery in Div. 3N conducted by Portuguese vessels.

Catch and Effort

On the 1997 assessment (Power, 1997) catch/effort data for Div. 3L and Div. 3N from 1959 to 1995 were analyzed with a multiplicative model (Gavaris, 1980) in order to derive a catch rate series for each division standardized for country-gear-tonnage class, NAFO division, month, and amount of by-catch associated with each observation. Both CPUE series shows much within year variability over time, with no statistically difference between the catch rates for most of the years. That assessment considered that *catch rate indices for Div. 3L and Div. 3N were not reflective of year to year changes in population abundance but they may be indicative of trends over longer periods of time.*

The present assessment recovers the predicted effort series in fishing hours for Div. 3L and Div. 3N from the 1997 multivariate analysis, in order to derive a single annual catch rate for Div. 3LN. For each year of the 1959-1994 interval this standardized catch rate is given by the ratio between the sum of Div. 3L and Div. 3N Statlant catch (thousand tons) and the sum of Div. 3L and Div. 3N predicted effort (fishing hours). The catch rates for Div. 3LN are presented on Table 2 and Fig. 2 (normalized to the mean in the figure). Catch rate for Div. 3LN increased on the first years of the time series, 1959 till 1967, oscillated around the average on the intermediate years and declined after 1987. On the final years of this CPUE series, 1990-1994, catch rates were stable at a minimum level.

Commercial fishery sampling

Most of the commercial length sampling data available for the 3LN beaked redfish came, since 1990, from the Portuguese fisheries and has been annually included in the Portuguese research reports on the NAFO SCS Document series (Vargas *et al.*, 2010). Taking into account that the majority of the length sampling was from depths greater than 400m, these data should represent *S. mentella* catches. Length sampling data from Spain and Russia were used to estimate the length composition of the commercial catches for those fleets in several years (González *et al*., 2009; Skryabin *et al*., 2010). The 1990-2009 per mille length composition of the Portuguese trawl catch was applied to the rest of the commercial catches (Table 3a). In all cases the 3LN beaked redfish length weight relationships used on the absolute length frequency vectors of the commercial catch were derived from the sampling on board of the Portuguese redfish by-catches on both Divisions 3L and 3N (Table 3b).

The overall mean length of the 1990-2009 catch (arithmetic mean of the annual mean lengths of the commercial catch) was used to derive length anomalies of the 3LN catch over this period (Table 3a, Fig. 3). The proportion of small redfish (less than 20cm) in the catch is presented as well in Table 3a. The purpose of the length anomalies was to detect eventual shifts in the length structure of the catch that could reflect changes in the exploitable stock structure. As for the proportion of small redfish, an important increase on the numbers of small redfish in the catch could reflect the one ore more good recruitments.

Above average mean lengths, an apparent stable length structure of the catch with no clear trends towards smaller or larger length groups and proportions in numbers of small redfish usually bellow 1%, are observed on most of the years of the 1990-2005 interval. However, well bellow average mean lengths occurred on 2006, 2008 and 2009, coupled with high proportions of small redfish in the catch (Table 3a, Fig. 3). It is obvious that, under a very low exploitation regime, such sudden drop on the mean lengths of the redfish by-catch in Div. 3LN on the most recent years can only reflect the income of above average year classes to the exploitable stock, from 4-5 years back in time.

Research Surveys

From 1978 till 1990 several stratified-random bottom trawl surveys have been conducted by Canada in various years and seasons in Div. 3L. However only since 1991 Canadian stratified-random surveys covered both Div. 3L and Div. 3N on a regular annual basis: a spring survey (May-Jun.) and an autumn survey (Sep.-Oct. 3N/Nov.-Dec. 3L for most years). The design of the Canadian surveys was based on a stratification scheme down to 732 m for Div. 3LN (Doubleday, 1981). From 1996 onwards the stratification scheme has been updated to include depths down to 1 464 m (800 fathoms) (Bishop, 1994), but only the autumn surveys have swept strata bellow 732 m depth, most on Div. 3L.

Up until the autumn of 1995 the Canadians surveys were conducted with an Engels 145 high lift otter trawl with a small mesh liner (29 mm) in the codend and tows planned for 30 minute duration. Starting with the autumn 1995 survey in Div. 3LN, a Campelen 1800 survey gear was adopted with a 12 mm liner in the codend and 15 minute tows. A comparison of the generated data with the original Engel data suggested overall trends in abundance were the same except that the relative measure of abundance estimated for the Campelen trawl conversions were higher (Power and Parsons, 1998).

All surveys on Div. 3L have Engel data converted into Campelen equivalents from 1985 onwards, with the exception of the spring survey (conversion since 1980). Abundance and biomass indices have been converted into Campelen equivalents since the start of Canadian surveys on Div. 3N, in 1991. Campelen equivalent data series extended till 1994 (autumn surveys in Div. 3L and Div. 3N) or 1995 (spring surveys in Div. 3L and Div. 3N) and are coupled with the original Campelen series starting since then. No spring survey was carried out in 2006 on Div. 3N. As regards Canadian surveys, only Campelen data and Engel data converted into Campelen equivalents are used in this assessment.

Since 1983 Russian bottom trawl surveys in NAFO Div. 3LMNO turn to stratified-random, following the above mentioned Canadian stratification for Sub area 3. On 1984 standard tows were set to half hour at 3.5 knots, with a standard gear. From 1984 till 1990, vessels conducting this survey were of the same tonnage class (the BRMT series) with the exception of 1985, when a vessel of smaller tonnage class (PST series) was employed. This smaller category was later employed on the 1991 and 1993 surveys. On 1992 and 1994 no survey was carried out in Div. 3N. On 1995 the Russian bottom trawl series in NAFO Sub area 3 was discontinued (Bulatova *et al.*, 1997).

On 1992 redfish results of the 1984-1991 stratified-random surveys in Div. 3LN by Russia were revised according to standard methodology (Power and Vaskov, 1992). Mean number and mean weight per standard tow were estimated from successful sets only, each tow being adjusted to 1.8 n mi. distance before analysis. Overall mean estimates by year and division were derived from the respective means by strata (weighted by the stratum area) and presented with associated 95% CI's. Survey abundance and survey biomass are finally tabulated by year and division. However in 1994, a Russian research document presents new figures for redfish bottom survey abundance and biomass from the same Russian survey series in Div. 3LN (1984-1991, plus the results of the 1993 survey) (Vaskov, 1994). No details are given regarding the method and the strata used to derive these new figures. The two series (Power, 1984-1991; Vaskov, 1984-1991 and 1993) are considered as alternate biomass indices for Div. 3LN combined. According to the results of the exploratory analysis preceding the 2008 ASPIC assessment (Ávila de Melo *et al.*, 2008), the model fits better to the "Power revised" 1984-1991 Russian survey series and since then this is the 3LN Russian series incorporated in the input.

In 1995 EU-Spain started a new stratified-random bottom trawl spring (May-June) survey on NAFO Regulatory Area of Div. 3NO. Despite changes on the depth contour of the survey, all strata in the NRA till 732m were covered every year following the standard stratification. From 1998 onwards the Spanish survey was extended to 1464 m (with the exception of 2001, with 1116m depth limit) and in 2004 expanded to the Regulatory Area of Div. 3L. From 1995 till 2000 the survey was carried out by the Spanish stern trawler *C/V Playa de Menduiña* using a *Pedreira* bottom trawl net. In 2001 the *R/V Vizconde de Eza* , trawling with a *Campelen* net, replaced the commercial stern trawler. In order to maintain the data series obtained since 1995, comparative fishing trials were conducted in spring 2001 to develop conversion factors between the two fishing vessel and gear combinations.

Former Div. 3NO redfish survey indices from C/V *Playa de Menduíña* have now been transformed to R/V *Vizconde de Eza* units (*González et al.*, 2010), and so, for the first time, the Div. 3N Spanish spring survey series (1995-2009) is included in the present assessment framework.

Survey biomass and female spawning biomass

All available survey biomass from stratified-random bottom trawl surveys are presented in Table 4. About 84% of the survey data are included in the exploratory analysis and 76% incorporated in the ASPIC assessment input. The 1991-2009 spring and autumn survey indices for Div. 3LN combined (biomass and female SSB) are also presented on Table 4. In order to turn the survey series comparable and facilitate the detection of trends within stock dynamics, the survey biomass series used in the assessment framework and the female SSB survey series were standardized and so presented on Figure 4a and 4b.

From the first half of the 1980s to the first half of the 1990s Canadian survey data in Div. 3L and Russian bottom trawl surveys in Div. 3LN suggests that stock size suffered a substantial reduction, as response to catches raising from an average of 21 000 tons (1965-1985) to 41 500 tons (1986-1992). Redfish survey bottom biomass in Div. 3LN remained well bellow average level until 1998 and start a discrete and discontinuous increase afterwards. A pronounced increase of the remaining biomass indices has been observed over the most recent years since 2006. Considering all available bottom trawl survey series occurring in Div. 3L and Div. 3N from 1978 till 2009, 100% of the biomass indices were above the average of their own series on 1978-1985, only 25% on 1986-2005, and 85% on 2006-2009.

In order to estimate spring and autumn female spawning survey biomass by division, Div. 3L and Div. 3N female maturity at length vectors (Power 2001; Ávila de Melo et al., 2005) were applied to the 1991-2009 female abundances at length of the spring and autumn surveys. Female spawners and stock abundance at length by division were used to calculate SOP female spawning and stock biomass for Div. 3L and Div. 3N, using sex combined length weight relationships derived from data collected on board of the Canadian autumn surveys, 1997-2004 (Power, *pers. comm.*, 2005). The SOP ratios (SSB/stock biomass) by division were then applied to the respective swept area survey biomasses to give the spring and autumn female SSB in Div. 3L and Div. 3N.

Both 1991-2009 spring and autumn standardized female SSB series for Div. 3LN combined showed very similar patterns to correspondent survey biomass series over the years, with all observations above average since 2006 (Fig.4b).

Abundance at length

Spring and autumn survey abundance at length, for Div. 3LN combined, are presented in Table 5a and 5b. The overall 1991-2009 mean length for each survey series (arithmetic mean of the annual mean lengths of the survey abundances at length) was used to derive the spring and autumn survey length anomalies for the stock over this period (Table 5a and 5b, Fig. 5a and 5b). During the first half of the 1990's on both survey series the length anomalies were negative or slightly positive. Mean lengths on most of the years between 1996 and 2004 were well above the mean, reflecting a shift on the stock length structure to larger individuals probably justified by a higher survival of the year classes through this interval. However since 2005 mean lengths generally fall to bellow-well bellow average, just as observed on the by-catch from the commercial fisheries (Fig 3). This most recent pattern on surveys and by catch at length seems to confirm the occurrence of one or more recent pulses on recruitment, the first to be detected on this stock since 1991-1992.

ASPIC assessment suite

A non-equilibrium surplus production model (ASPIC; Prager, 1994, 2004 and 2007) was used to assess the status of the stock. The model was adjusted to the updated surveys under the formulation adopted on the *"The 2nd Take of the 2008 Assessment of Redfish in NAFO Divisions 3LN,"* (Ávila de Melo and Alpoim, 2010) plus the Spanish spring survey on Div. 3N. The input series are summarized bellow:

I1 (Statlant CPUE)	Statlant cpue for Div. 3LN,$_{1959-1994}$ & catch for Div. 3LN $_{1959-2009}$
I2 (3LN spring survey)	Canadian spring survey biomass for Div. 3LN, $_{1991-2005,\ 2007-2009}$
I3 (3N autumn survey)	Canadian autumn survey biomass for Div. 3N, $_{1991,\ 1993-2009}$
I4 (3LN Power russian survey)	Russian spring survey biomass for Div. 3LN , $_{1984-1991}$ (Power and Vaskov,1992)
I5 (3L winter survey)	Canadian winter survey biomass for Div. 3L, $_{1985-1986 \text{ and } 1990}$
I6 (3L summer survey)	Canadian summer survey biomass for Div. 3L, $_{1978-1979,\ 1981, 1984-1985,\ 1990-1991 \text{and } 1993}$
I7 (3L autumn survey)	Canadian autumn survey biomass for Div. 3L, $_{1985-1986,\ 1990-1994,\ 1996-2009}$
I8 (3N spring spanish survey)	Spanish survey biomass for Div. 3N, $_{1995-2009}$ *versus* $_{1995-2008}$

All input series consist of annual observed values and were given equal weight in the analysis. On the rest of the analysis each Canadian series is referred by its season and division(s), while the Russian and Spanish series are referred by their country name. The model assumes that all catchability coefficients are constant over time. Because of the imprecision associated with the estimate of catchability for the various indices, absolute estimates of stock size and fishing mortality are normalized to the stock size and fishing mortality at MSY (B_{msy} and F_{msy} respectively). That is why normalized estimates are included in ASPIC output and used in the printer plots trajectories of biomass and fishing mortality. In a production model fishing mortality refers to catch/biomass ratio.

Basic assumptions

In this assessment the ASPIC version 5.16 fit the logistic form of the production model (Schaefer, 1954). Being K the carrying capacity stock biomass, r the intrinsic rate of stock biomass increase, C the catch biomass, MSY and $Bmsy$ the long term yield and biomass associated with $Fmsy$, the model basic assumptions are:

1) A logistic population growth over time of the unexploited stock (Schaefer, 1954)

$$dB_t / dt = rB_t - (r/K)B_t^2 \qquad (1)$$

2) For an exploited stock catch is also incorporated in the population growth

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

3) The biological reference points are

a. $MSY = rK/4$ (3)

b. $Bmsy = K/2$ (4)

c. $Fmsy = r/2$ (5)

Starting with user guesses (seeds) for the key parameters, Initial Biomass (as a ratio to *Bmsy*), *K*, *MSY* and catchability coefficients for each biomass index, ASPIC generate iteratively estimates of expected biomass indices for each series of observed indices. The key parameters of the model are found by a minimization routine for log squared residuals of *cpue* and biomass from each input survey series.

A summary of the ASPIC model (Prager, 1994) can be found on the 2003 assessment of redfish in Div. 3M (Ávila de Melo *et al.*, 2003).

Input file settings

The ASPIC Ver. 5.16 (Prager, 2007) requires from the user a set of initial definitions/starting guesses /constraints that have been specified in the input file as follows:

Line 1: Both `FIT` and `BOT` program modes were used. Starting guesses and minimum and maximum bounds were kept constant from FIT to BOT mode.
Line 2: Fit the `LOGISTIC` (Schaefer) model with condition fitting on `YLD` (yield) and `SSE` (sum of squared errors) as objective function.
Line 4: `1000` Number of bootstrap trials when running on BOT mode.
Line 11: `0d0` No penalty term in objective function for B1>K (biomass on the 1st year of the assessment greater than carrying capacity biomass).
Line 12: 8 (maximum number of) data series are to be analyzed as biomass index of the stock (Statlant CPUE, five Canadian, one Russian and one Spanish survey).
Line 13: `1d0 1d0 1d0 1d0 1d0 1d0 1d0 1d0` When computing the objective function the squared residuals of each one of the 8 data series have equal weight.
Line 14: `0.5d0` Starting guess for $B1/K$ = 0.5, the biomass on the 1st year of the assessment was assumed to be at B_{msy} level.
Line 15: `2.0d4` Starting guess for *MSY* = 20000 t. Between 1965 and 1985 catches oscillated with no trend around 21000, catch rates declined when catches were raised above that level.
Line 16: `2.000E+05` Starting guess for carrying capacity *K* = 200000 t, perhaps a rather conservative guess, roughly corresponding to the most recent high observed level of survey biomass (Table 5, spring and autumn survey biomasses on Div. 3LN) after more than a decade of fishing mortality close to 0. However even doubling the maximum observed biomass (2009, autumn survey on Div. 3LN), a starting guess of *K* = 500000 t would arrive to the same results.
Line 17: Catchability starting guess for

- STATLANT cpue, `9.007E-06` (*q* of Statlant CPUE for Div. 3M redfish ASPIC assessment, Ávila de Melo *et al.* 2003);
- spring survey on Div. 3LN combined, `0.658d0` (average 3LN spring survey/autumn survey biomass ratio, assuming that autumn survey biomass is a proxy of absolute stock biomass);
- autumn survey on Div. 3N, `0.759d0` (average autumn survey on Div. 3N/Div. 3LN biomass ratio);
- Russian survey on Div. 3LN combined, `0.658d0` (same as for the correspondent Canadian spring survey);
- winter survey in Div. 3L, `0.322d0` (average spring survey on Div. 3L/Div. 3LN ratio times average spring in Div. 3LN/autumn Div. 3LN ratio);
- summer and autumn survey in Div. 3L `0.275d0` (average autumn survey Div. 3L/Div. 3LN ratio);
- Spanish survey on Div. 3N `0.759d0` (the same as the correspondent Canadian autumn survey).

Line 18: `1 1 1 1 1 1 1 1 1 1 1` All key parameters of the model ($B1/K$, MSY, K, q_{cpue} , $q_{spring3LN}$, $q_{autumn3N}$, $q_{russiann3LN}$, $q_{winter3L}$, $q_{summer3L,}$ $q_{autumn3L}$ $q_{spanish3N}$) are estimated by the ASPIC program and not kept constant at the starting guess.
Line 19 and Line 20: minimum and maximum bounds on the estimate of *MSY* (5000-50000 t) and *K* (100000-500000 t) respectively. All $ASPIC_{fit}$ 2010 formulations gave estimates of these parameters far from either constraint.
Line 22: `51` Total number of years in the data sets included in the input file, from 1959 to 2009.

The rest of the settings of the input file were kept with the default options of the ASPIC Ver.5.16. The input file with all survey sets, including the Spanish survey on Div. 3N, is presented on Appendix 1. All 1959-2008 catches used in this assessment are the catches adopted by STACFIS for this stock. A catch of 482 t, taken from the NAFO Circular Letter of 10 February 2010 (Ref No GFS/10-61) with the *Recording of Provisional Catches for December 2009*, was used in this assessment as the redfish catch in Div. 3LN for 2009. Nevertheless in the sensitivity analysis presented further on is included an $ASPIC_{fit}$ run with the STACFIS catch for 2009 of 1051 t.

Exploratory analysis

The 2009 Spanish spring biomass index for Div. 3N has an enormously high magnitude, corresponding to more than a ten times fold increase from the previous year (Table 5). This jump has no parallel on the increases also observed from 2008 to 2009 on both Canadian spring and autumn surveys on Div. 3N (Table 5) and can only be compared to the isolated highs observed in autumn 1992 for Div. 3N and 1995 for Div. 3L, that have been considered outliers of the respective survey biomass series and excluded from the ASPIC framework (Ávila de Melo *et al.*, 2008 and 2010).

Due to the short time overlap between *cpue* and spring and autumn surveys in Div. 3L and Div. 3N (7 years for autumn survey on Div. 3L, 4 years for the rest of the other surveys, on a 51 years interval) the assessment assumes that the *cpue* series and the short survey series (Russian survey, summer and winter surveys on Div. 3L), basically represent the abundance of the stock during the former period prior to 1990, while the 3L and 3N autumn surveys and spring survey in Div. 3LN combined basically represent the abundance of the stock during the more recent period of the 1990's and 2000's. With such a short time overlap, the negative correlations occasionally found between "old" and "new" surveys have been disqualified to halt the ASPIC assessment. Therefore only negative correlations between the model and any of the input series of biomass indices, or between surveys overlapping most of the years, were considered a violation of the fundamental assumption of ASPIC that all indices reflect the abundance dynamics of the stock and should be correlated.

Three $ASPIC_{fit}$ 2010 options, corresponding to three possible arrangements related with the Spanish survey (ending in 2009, or in 2008, or the exclusion of this survey from the assessment), were used to test the goodness of fit of the model to the available survey data:

$ASPIC_{fit}$ 2010 without 3N Spain:

I1 (Statlant CPUE) + I2 (3LN spring survey) + I3 (3N autumn survey) + I4 (3LN Power Russian survey) + I5 (3L winter survey) + I6 (3L summer survey) + I7(3L autumn survey),

$ASPIC_{fit}$ 2010 with 3N Spain until 2008:

I1 (Statlant CPUE) + I2 (3LN spring survey) + I3 (3N autumn survey) + I4 (3LN Power Russian survey) +I5 (3L winter survey) + I6 (3L summer survey full series) + I7(3L autumn survey) + I8 (3N Spanish survey till 2008)

$ASPIC_{fit}$ 2010 with 3N Spain until 2009:

I1 (Statlant CPUE) + I2 (3LN spring survey) + I3 (3N autumn survey) + I4 (3LN Power russian survey) + I5 (3L winter survey) + I6 (3L summer survey) + I7(3L autumn survey) + I8 (3N Spanish survey till 2009)

Besides the correlation between ASPIC estimated and observed annual values for each data series (`R squared in CPUE`), other parameters were used as diagnostics of the FIT outputs for the three arrangements considered:

- `Number of restarts required for convergence`: The routine used in ASPIC to minimize the objective function can stop at a local minima. In order to find a true minimum of the objective function, which is kept constant regardless the initial values of the key parameters, ASPIC program has a restarting algorithm that requires the same solution to be found several times in a row before it is accepted (Prager, 2005). The shorter the number of restarts the quicker is the convergence and the better is the fit of the model to the data series.
- `Estimated contrast index (ideal = 1.0):  C* = (Bmax-Bmin)/K. A` wider contrast on the biomass trajectory reflects wider coverage by the stock exploitation history of the Yield/Biomass curve defined by the ASPIC underlying surplus production model.
- `Estimated nearness index (ideal = 1.0):  N* = 1 - |min(B-Bmsy)|/K.` Being a production model centred on *MSY*, the biomass trajectory given by ASPIC should pass at least once through B_{msy}.

- `TOTAL OBJECTIVE FUNCTION.` Measuring the overall size of the of *cpue* and survey residuals the least squares objective function points out how close model estimates are to observed data.

An overview of the exploratory analysis under a traffic light rating frame (quantifying the best, intermediate, worst and unacceptable results for the three survey data set options, see Table 6a) lead to the conclusion that so far the model will perform better without the Spanish survey on Div. 3N, and if this series is incorporated with its last point (2009) the main series supporting the older part of the stock dynamics (Statlant CPUE, 1959-1994) will cease to have a correlation with the model results.

The inclusion of the Spanish survey will increase the B_{msy} level. This upward revision maintain the stock trends but push the relative biomass trajectory down, bellow B_{msy} most of the years until 1986, followed by a deeper decline until 1995 and a slower increase afterwards. Biomass overcomes B_{msy} with all options, but later on by the assessment including the Spanish survey, which keeps 2010 biomass closer to B_{msy}. As a consequence of a higher B_{msy} and a lower relative biomass at the terminal year, both *MSY* and the equilibrium yield available in 2010 will be higher with the "Spanish survey assessment". All these features will be highlighted if the Spanish survey is extended till the last year (Table 6b, Fig. 6).

So, for the time being, the ASPIC 2010 assessment will run with the survey data sets previously adopted on the ASPIC 2008 assessment (2nd take, Ávila de Melo *et al.* 2010) and will not include the Spanish survey series on Div. 3N.

<u>Sensitivity analysis</u>

Different starting guesses for key parameters, different random number seeds, different estimates of the 2009 catch and different magnitudes of last year surveys were used to test the robustness of the $\text{ASPIC}_{\text{fit}}$ 2010 formulation. The purpose was not only to investigate how the model responds to changes (within a 50% range, from -25% to +25%) in some of the required inputs (either on the starting "region" used to initialize the minimization routine or on last year survey results) but also to confirm if the use of a smaller catch in 2009 would have an "visible" bias on the assessment results. Nine input options presented on Table 7a were tested against the standard option specified on Appendix 1:

- A 2009 STACFIS catch of 1051 t
- 25% above and bellow the default random number seed
- an "optimistic start" given by -25% *cpue* and survey catchabilities together with +25% *MSY*, *K* and *B1/K*,
- and a pessimistic start given by +25% cpue and survey catchabilities together with -25% *MSY*, *K* and *B1/K*,
- 10% and 25% reduction on last year surveys,
- 10% and 25% increase on last year surveys.

The FIT parameter solutions from each of these options are compared with the standard FIT solution on Table 7b. The catch and seed related options arrived to the same or very similar solutions, showing that the ASPIC results given by the chosen formulation are insensitive to either small changes on last year catch or first guess/default inputs chosen to initialize the assessment (Table 7b, Fig. 7a). However the assessment from the different hypothesis considered regarding the 2009 surveys show that the model is sensitive to the biomass indices available for the terminal year (Table 7b, Fig. 7b), and the response of the model is consistent with the underlying logistic model of biomass growth (Schaeffer, 1954) adopted in this ASPIC assessment. Under a *stock biomass above* B_{msy} */ fishing mortality bellow* F_{msy} scenario, such as the present one of the 3LN redfish stock, if biomass continue to grow it is expected that the available biomass indices will be a mirror of that growth:

- If the change in surveys between the last couple of years is positive and large, the model assumes that biomass should be growing fast which could only mean that the stock should be closer to B_{msy} and still far away of *K*. As a consequence ASPIC will under estimate biomass and over estimate fishing mortality,

- If the same change is negative or still positive but small, biomass should be growing slow which could only mean that the stock is already approaching K and have now leaved the B_{msy} zone well behind. Therefore ASPIC will over estimate biomass and under estimate fishing mortality.

This sensitivity of the model to last year surveys is well illustrated on Fig's 7c and 7d, were positive dependent (B_{msy} , MSY, $F_{last\ year}/F_{msy}$, Ye_{2010}) and negative dependent (B1/K, F_{msy}, $B_{last\ year}/B_{msy}$) parameters (previously standardized) are presented against the range o relative survey biomass for 2009.

Retrospective Analysis

A 2010-2007 $ASPIC_{fit}$ retrospective analysis was carried out in order to check for bias on relative biomass and fishing mortality. Going back in time the assessments present an over bias on biomass, intrinsic rate of stock biomass increase (and F_{msy}), and MSY, and present an under bias on fishing mortality, carrying capacity of stock biomass (and B_{msy}) and surplus production (Tab 8a, Fig. 8a and Fig. 8b). As discussed in the previous section, these retrospective patterns are the model response to the general increase of the still standing survey series, recorded over the most recent years (Fig. 8c).

The observed retrospective patterns don't jeopardize the perception of the stock history or of its present status. On the contrary from one year to the next more conservative assessments are putting the recent growth of the stock in line with the expected population growth of long-lived and slow-growing species such as redfish (namely reflected on lower estimates of intrinsic rate of stock biomass increase). Moreover, as time extends the remaining input series, correlations among input data and between model and input data increase, and the diagnostic fit improves. This is well illustrated with two traffic light rating frames similar to the one already used in the exploratory analysis, the first including the "R squared in CPUE" for all input series (Table 8b) and the second just for the long input series (Table 8c).

Assessment results

The updated $ASPIC_{2008}$ formulation runs on both deterministic (FIT) and bootstrap (BOT) mode with 1000 trials. Deterministic results are presented on Appendix 2, with a summary of diagnostics and parameters included on Table 6a and 6b under $ASPIC_{fit}$ $2010_{Without\ 3N\ Spain}$. Bootstrap results are presented on Appendix 3, with a summary on Table 9. Despite the "negative" correlations between STATLANT *cpue* and both spring survey biomass for Div. 3LN and 3N autumn survey, and between 3LN spring survey and 3L summer survey (conditioned by the very small number of pair-wise observations and not regarded as an assessment constraint), correlation among the rest of possible combinations of surveys is high ($r^2 > 0.7$), with the exception of the 3LN spring/3N autumn combo nevertheless with a relatively high $r^2 > 0.65$ (Appendix 2). The model has a relative poor fit to most input series (namely the Statlant CPUE index) due to the usual wide inter annual variability of redfish abundance indices, but correlations are increasing as regards the long up to date surveys from one year to the next (Table 8c). Residuals between observed and model generated values also seem to be more randomly distributed than on previous assessments (Appendix 2). Nevertheless these diagnostic features have little impact on the consistency of the assessment, taking into account the bootstrap results with generally small bias from the point estimates (< = 10%) for most parameters and the B/B_{msy} and F/F_{msy} bias corrected trajectories very close to their deterministic ones (Appendix 3, Table 9a, 9b and 9c, Fig. 9a and 9b).

The model results suggest a maximum sustainable yield (MSY) of 23 000 t that can be produced with a fishing mortality of 0.13 when stock biomass is at B_{msy} level. The magnitude of MSY matches the average level of catches taken from this stock over more than two decades (21 000 t, 1965-1985) along with an apparent stability of the stock. The magnitude of F_{msy} (0.13) is also consistent with the results of the yield per recruit analysis for redfish in Div. 3LN presented on the 1999 assessment of this resource, between $F_{0.1} = 0.12$ and $F_{max} = 0.22$ (Power and Parsons, 1999). Relative biomass was at or slightly above B_{msy} for most of the former years up to 1987, supporting an average level of catches just bellow MSY. Fishing mortality oscillated around F_{msy} most years until 1970, between 1971 and 1974 was above F_{msy}, declined afterwards, and vary bellow F_{msy} until 1985. Between 1986 and 1992 catches were higher than MSY (26000-79000 ton), pushing fishing mortality to well above F_{msy} from 1986 till 1993. Those eight years of heavy over-fishing determine the fall of biomass from B_{msy} in 1987 to 24% B_{msy} in 1994, when a minimum stock size is recorded. Long living/slow growing species such as redfish can not sustain over-fishing but for short periods of time: the quick decline of stock biomass through the second half of the 1980's – first half of the 1990's was followed by a drop on catch and fishing mortality. Since 1996 both were kept at low to very low levels. Over the moratorium years biomass was allowed to increase and is now well above B_{msy} (Table 9b and 9c, Fig. 9a and 9b).

Catch versus surplus production trajectories are presented on Table 9b and Fig. 9c. From 1960 till 1985 catches form a scattered cloud of points around surplus production curve. On 1986-1987 catches rise well above the surplus production and though declining continuously since then were still above equilibrium yield in 1993. Estimated catch has been well bellow surplus production levels since 1994.

ASPIC projections

Regardless the input formulations, the starting guess region, the mode of the ASPIC runs or the retrospective patterns, the 2010 assessment reiterates the main conclusion of the previous ones: the biomass of redfish in Div. 3LN is well above B_{msy} , while fishing mortality is well bellow F_{msy} . The status of the stock allows its exploitation, but the fact is that so far catches continue to be residual and the fishery didn't reopen yet (even on the small scale allowed by the 2010 TAC of 3 500 t). The real response of the stock to a real direct fishery is still to be seen and therefore any projection should be treated with caution.

<u>Underlying assumptions for the low catch option</u>

Redfish in Div. 3LN has been under moratorium over the past twelve years. A stepwise approach to direct fishery should start by a low exploitation regime in order to have a high probability that the stock biomass is kept within its present safe zone. This safe zone can be defined as above the upper 80% confidence limit of B_{msy} given by the ASPIC $_{bot}$ 2010 assessment.

An ASPIC medium term projection was carried out under constant (small) catch instead of constant fishing mortality. The reason for the constant catch option relates to the purpose of reopen the fishery keeping the biomass at its present level (well above B_{msy}), until future assessments confirms a positive answer of the stock to limited exploitation (as suggested by all recent assessments). This strategy turns useless the analysis of medium term projections under reference fishing mortalities such as 2/3 of F_{msy} (recommended by the PA surplus production framework for a stock above B_{msy} like this one), since this option will correspond to a rapid and very high increase of catch from its present very low level.

A 5 000 t catch as already been used in the projections from the 2008 assessments (1st and 2nd take, Ávila de Melo et al., 2008 and 2010). This is a figure large enough to accommodate a small scale redfish fishery and at the same time is a low catch for the actual size of this stock, not dependent of assessment results: as discussed previously, this is a retrospective biased assessment conditioned by increasing trends on surveys. Every next assessment will revise downwards recent relative biomass and upwards surplus production. At this transition stage *status quo catch* advice can not therefore be dependent on an increasing *last year plus one equilibrium yield* given by every last assessment, but rather on a constant and conservative figure with no negative impact on stock size (the bias corrected equilibrium yield for 2010 is 12 900 t, Appendix 3 and Table 9a).

<u>The ASPICP program</u>

ASPIC has an auxiliary program, ASPICP, to provide not only bias corrected estimates of biomass and fishing mortality on an annual basis for the assessment time interval (with associated 80% confidence limits) but also provides projections of these trajectories to the future. ASPICP reads the results from the 1000 trials of the ASPIC $_{bot}$ 2010 assessment stored in a .BIO file and project each of these runs a number of years ahead, under an annual $F_{status\ quo}$ multiplier or yield. These constraints are specified by the user in a .CTL file (Appendix 4) that controls the projection.

The ASPICP run with a 2010 *status quo* catch (the assumed 2009 level used in the assessment) and an annual catch of 5000 ton for the next couple of years, 2011-2012 (a longer projection may be misleading taking into account the retrospective nature of this assessment). Results are stored in a .PRJ file presented in Appendix 5.

Projection results

The bias corrected 1959–2013/ 2012 trajectories of biomass and fishing mortality (relative to B_{msy} and F_{msy}.), with associated 80% lower and upper CL's are presented in Table 10a and 10b, Appendix 5 and Fig. 10a and 10b. From the $ASPICP_{bot}$ 2010 bias corrected results, a low exploitation regime of 5 000 t will allow a further increase of the present biomass from 1.62 B_{msy} to 1.74 B_{msy} at the beginning of 2013. Fishing mortality will increase from 0.014 F_{msy} in 2009 to 0.128 F_{msy} in 2012. In other words, a catch level of 5 000 ton will allow a further increase in the stock size of redfish in Div. 3LN, already in its present safe zone. At the same time fishing mortality rate will remain at a (very) low level, with a predicted fishing mortality on 2013 well bellow the lower 80% CL of F_{msy} as the given by the ASPIC $_{bot}$ 2010 assessment.

In order to test if these results are robust, $ASPIC_{bot}$ & projections were performed back in time, every year till 2007 with all projections ending in 2013 and run with the *status quo* catch on the first year of each projection and a 5 000 t catch on the rest of the years. The bias corrected B/B_{msy} and F/F_{msy} trajectories from the consecutive 2007-2010 $ASPIC_{bot}$ assessments gave similar 2010-2013/2012 projections (Table 10a and 10b, Fig. 10c and 10d). Regardless the bias, all retrospective $ASPIC_{bot}$ & projections runs shown a stock keeping its high biomass and low fishing mortality several years after the reopening of a direct fishery at 5 000 t/year.

Stock and fishing mortality trajectory under a Precautionary Approach framework

The ASPIC bias corrected results were put under the precautionary framework (Fig. 11). The trajectory presented shows a stock around B_{msy} with an exploitation around F_{msy} trough 25 years on a row (1960-1985), rapidly declining afterwards to bellow B_{msy} when fishing mortality rises to well above F_{msy} (1986-1987), reproaching and surpassing B_{msy} when fishing mortality dropped (1993-1995) and is kept well bellow F_{msy}.

The NAFO SC Study Group recommendations from the meeting in Lorient in 2004 (SCS Doc. 04/12), as regards Limit Reference Points (LRP's) for stocks evaluated with surplus production models, considered F_{lim} at F_{msy} and F_{target} at 2/3 F_{msy}. The Study Group also considered that the biomass giving production of 50% *MSY* was a suitable B_{lim}. With the Schaeffer model used in the present ASPIC assessment this limit corresponds in this stock to (roughly) 30% B_{msy}. The stock was at (or bellow) B_{lim} between 1993 and 1996, prior to the implementation of the moratorium on this fishery in 1998.

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Table 1: Summary of catch and TAC's of redfish in Div. 3LN estimated from various sources

YEAR	3L	3N	TOTAL	TAC	
1959	34107	10478	44585		
1960	10015	16547	26562		
1961	8349	14826	23175		
1962	3425	18009	21439		a
1963	8191	12906	27362		a
1964	3898	4206	10261		a
1965	18772	4694	23466		
1966	6927	10047	16974		
1967	7684	19504	27188		
1968	2378	15265	17660		a
1969	2344	22356	24750		a
1970	1029	13359	14419		a
1971	10043	24310	34370		a
1972	3095	25838	28933		
1973	4709	28588	33297		
1974	11419	10867	22286	28000	
1975	3838	14033	17871	20000	
1976	15971	4541	20513	20000	
1977	13452	3064	16516	16000	
1978	6318	5725	12043	16000	
1979	5584	8483	14067	18000	
1980	4367	11663	16030	25000	
1981	9407	14873	24280	25000	
1982	7870	13677	21547	25000	
1983	8657	11090	19747	25000	
1984	2696	12065	14761	25000	
1985	3677	16880	20557	25000	
1986	27833	14972	42805	25000	
1987	30342	40949	79031	25000	b
1988	22317	23049	53266	25000	b
1989	18947	12902	33649	25000	b
1990	15538	9217	29105	25000	b
1991	8892	12723	25815	14000	b
1992	4630	10153	27283	14000	b
1993	5897	9077	21308	14000	bc
1994	379	2274	5741	14000	bc
1995	292	1697	1989	14000	
1996	112	339	451	11000	
1997	151	479	630	11000	
1998	494	405	899	0	
1999	518	1318	2318	0	b
2000	657	819	3141	0	bc
2001	653	245	1442	0	b
2002	651	327	1216	0	b
2003	584	751	1334	0	
2004	401	236	637	0	
2005	581	78	659	0	
2006	53	444	496	0	
2007	118	1546	1664	0	
2008	220	377	597	0	
2009			482	0	d
2009	57	994	1051		e

a Includes catch that could not be identified by division

b includes estimates of unreported catches

c Catch could not be precisely estimate due to discrepancies in figures from available sources: average of the range of the different catch estimates

d From NAFO circular letters. Used as 2009 catch in the ASPIC 2010 assessment

e STACFIS catch estimates for 2010

Table 2: Redfish STATLANT catch and predicted effort for Div. 3L and Div. 3N, 1959-1994 (Power, 1997). Standardized catch rate for Div. 3LN, 1959-1994.

	3L		3N		3LN		3LN
YEAR	STATLANT Catch	Predicted EFFORT	STATLANT Catch	Predicted EFFORT	STATLANT Catch	Predicted EFFORT	CPUE annual
1959	34107	22604	10478	8659	44585	31263	1.426
1960	10015	5690	16547	10892	26562	16582	1.602
1961	8349	3610	14826	10049	23175	13659	1.697
1962	3425	2049	18009	11090	21434	13139	1.631
1963	8191	3973	12906	8958	21097	12931	1.632
1964	3898	1491	4206	2981	8104	4472	1.812
1965	18772	8190	4694	2551	23466	10741	2.185
1966	6927	4615	10047	4915	16974	9530	1.781
1967	7684	3793	19504	10569	27188	14362	1.893
1968	2378	1446	15265	17684	17643	19130	0.922
1969	2344	1354	22356	17109	24700	18463	1.338
1970	1029	499	13359	10026	14388	10525	1.367
1971	10043	5207	24310	20320	34353	25527	1.346
1972	3095	1877	25838	18982	28933	20859	1.387
1973	4709	2078	28588	18186	33297	20264	1.643
1974	11419	11907	10867	5374	22286	17281	1.290
1975	3838	2443	14033	8265	17871	10708	1.669
1976	15971	11335	4541	4537	20512	15872	1.292
1977	13452	10461	3064	2738	16516	13199	1.251
1978	6318	5961	5725	4925	12043	10886	1.106
1979	5584	3517	8483	6176	14067	9693	1.451
1980	4367	2873	11663	6229	16030	9102	1.761
1981	9407	6020	14873	9216	24280	15236	1.594
1982	7870	4812	13677	8160	21547	12972	1.661
1983	8657	4960	11090	7734	19747	12694	1.556
1984	2696	1804	12065	12263	14761	14067	1.049
1985	3677	2104	16880	16858	20557	18962	1.084
1986	27833	15247	14972	15057	42805	30304	1.413
1987	34212	22369	44819	29517	79031	51886	1.523
1988	26267	19629	26999	24453	53266	44082	1.208
1989	19847	10567	13802	14884	33649	25451	1.322
1990	17713	16774	11392	18513	29105	35287	0.825
1991	8892	12329	12723	20052	21615	32381	0.668
1992	4630	2452	10153	13755	14783	16207	0.912
1993	5897	1576	9077	17116	14974	18692	0.801
1994	379	410	2274	2900	2653	3310	0.802

Table 3a: Length composition (absolute frequencies in '000s) of the 3LN redfish commercial catch and by-catch, 1990-2009.

Length	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
10																	
11														0.03			
12	12													0.03			
13	6													1			
14	21													1			0
15	28	28												5			10
16	73	103	9									1	0	8			24
17	199	394	28			2				0	1	2	1	21	1	2	34
18	286	1034	412		5	2		0	1		1	1	1	44	2	4	65
19	445	2157	1291	5	6	3	1	0	2	16	4	4	3	90	6	9	99
20	720	3313	2375		16	14	4	2	13	47	6	18	14	151	15	11	**182**
21	1309	3780	2943	235	287	9		11	57	80	10	52	41	**218**	28	13	**300**
22	2081	**4922**	3600	714	683	65	6	17	**151**	150	26	102	81	**269**	35	11	**347**
23	3212	**7340**	**4358**	1141	594	64	17	34	**277**	128	46	118	101	**277**	41	16	**340**
24	**4164**	**7575**	**5552**	2565	708	99	9	64	**296**	120	85	114	132	**258**	54	35	**210**
25	**5216**	**6944**	**4981**	**5237**	**944**	100	9	**98**	**248**	178	**195**	114	154	**261**	85	61	**147**
26	**5560**	**5981**	**5145**	**5115**	**1297**	277	12	**118**	**221**	**318**	**364**	126	**204**	**309**	**157**	**138**	**111**
27	**5410**	**6197**	**4579**	**5433**	**1404**	**330**	35	**144**	**218**	**555**	**546**	**170**	**248**	**324**	**190**	**181**	99
28	**5217**	**5322**	**4063**	**5004**	**1182**	**300**	**75**	**114**	**173**	**712**	**943**	**188**	**289**	**286**	**184**	**201**	88
29	**4712**	**3354**	**4637**	**4437**	**1188**	**263**	**76**	**114**	**154**	**673**	**1003**	**179**	**289**	**245**	**184**	**223**	62
30	**4751**	**4043**	**3911**	**3283**	**1011**	**310**	**182**	**114**	**120**	**520**	**1027**	**236**	**294**	**225**	**178**	**176**	60
31	**4551**	2695	3711	**2964**	**912**	**313**	**197**	**154**	**129**	**413**	**564**	**289**	**295**	**204**	**107**	**109**	35
32	**3943**	2478	2187	2313	**944**	**309**	**98**	**146**	**119**	**434**	**315**	**303**	**276**	189	**108**	**91**	28
33	3082	1582	1355	2291	596	226	**67**	**131**	**110**	**383**	**237**	**298**	**216**	196	95	83	19
34	2737	1179	1569	1527	526	189	30	71	66	**268**	**217**	**218**	132	149	73	71	17
35	2100	928	1604	1059	363	182	35	24	19	141	129	**212**	83	112	51	63	10
36	1681	831	1895	923	202	106	23	19	18	89	60	121	37	62	36	56	5
37	1416	580	1571	766	196	160	7	14	11	82	78	82	18	41	17	31	2
38	1128	482	1303	807	158	171	5	10	8	51	50	55	11	22	10	15	1
39	729	363	1114	489	124	100	11	3	3	37	47	30	3	14	9	8	0
40	458	292	790	505	69	144	2	4	3	23	23	18	2	7	5	8	0
41	321	188	558	320	49	63	3	1	2	19	12	10	1	2	2	4	0
42	255	117	420	306	23	1	1	1	0	13	15	7	2	3	1	2	0
43	227	68	203	137	15	3	2	2	0	3	9	4	2	2	2	6	
44	157	83	85	175	7	3	2	1	1	3	1	3	1	2	1	3	
45	84	33	76	107	1	3	2	0.1			2	1		0	1	1	
46	58	8	32	9	3			0.1	0.0	0.2	1	1		2	0.2	0	
47	24		9	47	0						0.5	0.2		0	1	2	
48	11	2	8	5		3		0.1								0.04	
49	6		1		0												
50																	
51	1	25			2									0.3			
52	2																
53	1																
54	2													0.3			
no ('000)	66410	74421	66375	47918	13517	3815	910	1411	2422	5457	6020	3076	2929	3999	1681	1632	2295
weight (tons)	29105	25815	27283	21308	5741	1989	451	630	899	2318	2617	1442	1216	1334	637	659	497
mean weight (g)	438	347	411	445	425	521	496	446	371	425	435	469	415	334	379	404	217
mean length	29.3	26.6	28.4	29.6	29.1	31.6	31.2	29.8	27.4	29.9	30.1	30.8	29.5	27.5	29.5	30.1	23.9
length anomalies	0.70	-2.0	-0.2	1.0	0.5	3.0	2.6	1.2	-1.2	1.2	1.5	2.2	0.9	-1.1	0.8	1.5	-4.7
%lengths <20cm	1.6%	**5.0%**	**2.6%**	0.0%	0.1%	0.2%	0.1%	0.0%	0.1%	0.3%	0.1%	0.2%	0.2%	**4.2%**	0.5%	0.9%	**10.1%**

Table 3b: length weight relationships from 3LN Sebastes sp. commercial sampling data used in the computation of 3LN catch parameters (Alpoim and Vargas, 2004; Vargas et al., 2005-2008)

Sebastes sp.	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
a	0.1115	0.1115	0.1115	0.1115	0.1115	0.1115	0.1115	0.1115	0.1115	0.0689	0.0979	0.0769	0.0447	0.0095	0.0208	0.0208	0.0611
b	2.4353	2.4353	2.4353	2.4353	2.4353	2.4353	2.4353	2.4353	2.4353	2.5588	2.4602	2.5298	2.6885	3.1279	2.8851	2.8851	2.5597

Table 4: Survey biomass ('000 t) from all stratified bottom trawl surveys on Div. 3L and Div.3N, 1978-2009 (shaded observations included in the ASPIC framework).
Survey female SSB ('000 t) from spring and autumn Canadian surveys on Div. 3LN, 1991-2009

	Canadian				Russian		Canadian							Spanish
	Div. 3LN		Div. 3LN		Div. 3LN	Div. 3LN	Div. 3L	Div. 3L	Div. 3L	Div. 3L	Div. 3N	Div. 3N	Div. 3N	Div. 3N
	$I2_{spring}$	$I2_{springSSB}$	$I3_{autumn}$	$I3_{autumnSSB}$	$I4_{Power}$	$I4_{Vaskov}$	$I5_{winter}$	$I6_{summer}$	$I7_{autumn}$	$I8_{spring}$	$I9_{spring}$	$I10_{autumn}$	$I11_{summer}$	$I12_{spring}$
1978								311.2						
1979								227.8						
1980										40.3				
1981								261.4						
1982														
1983														
1984					215.9	199.4		277.7						
1985					94.0	85.9	90.2	161.0	98.2	105.3				
1986					63.0	46.8	36.6		17.1					
1987					70.3	60.8								
1988					44.9	40								
1989					12.3	10.9								
1990					8.4	7.1	18.2	92.8	20.7					
1991	10.6	1.45	37.9	4.7	18.7	14.5		37.6	13.7	6.3	4.4	24.2	47.6	
1992	10.1	1.80	*136.4*	15.4					13.4	7.4	2.7	*123.0*		
1993	22.6	4.35	19.2	3.6		30.3		20.8	6.0	6.5	16.1	13.2	129.8	
1994	4.2	0.61	31.8	5.9					7.2	2.3	1.9	24.6		
1995	5.9	0.85	*90.7*	15.9					*50.1*	3.3	2.6	40.7		46.1
1996	22.8	11.65	16.0	2.6					4.7	16.8	6.0	11.3		6.6
1997	14.9	1.77	70.7	10.7					19.5	9.3	5.7	51.1		4.8
1998	59.4	11.50	112.2	14.5					18.5	27.6	31.8	93.7		22.5
1999	61.5	15.22	72.0	12.6					38.9	21.3	40.2	33.1		46.5
2000	87.8	17.27	100.5	16.6					24.9	36.2	51.7	75.5		68.9
2001	41.6	6.97	132.6	13.8					28.6	26.2	15.4	104.0		53.9
2002	31.0	5.79	50.1	9.4					11.9	9.1	21.8	38.2		7.6
2003	27.7	3.68	71.9	9.6					15.0	10.5	17.2	56.9		11.0
2004	79.6	26.25	49.9	11.4					9.3	14.4	65.3	40.6		27.0
2005	66.5	8.51	58.6	10.9					16.7	36.5	29.9	41.9		146.9
2006			91.9	12.9					27.2	35.3		64.7		87.8
2007	218.8	39.27	124.8	16.5					57.5	174.1	44.7	67.2		87.6
2008	144.0	22.93	198.5	26.7					53.3	38.5	105.5	145.2		68.1
2009	183.4	20.26	246.7	29.1					87.2	26.1	157.3	159.5		735.7

Table 5a: 3LN spring survey abundance at length, 1991-2009 (thousands).

Length	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006[(1)]
4															40	
5												62		31		
6						466		20	16	185	109	170	293	804	108	
7						228		40	656	795	1511	472	2057	2400	540	309
8						149	685	8	3280	378	1302	1073	1682	1236	950	602
9	849					298	360	39	5877	89	483	1526	1524	2209	2891	494
10	1149			562		296	251	113	1343	166	240	2518	1197	4107	4892	633
11	798	381	122	355		478	730	533	309	403	116	1085	417	2911	7296	1235
12	558	2988	1304	540		806	722	455	430	191	451	1645	1448	1653	8756	1344
13	2524	7925	2396	500	108	920	540	172	517	412	345	838	1101	1330	9684	1575
14	322	5192	5646	536	272	413	1871	561	369	353	1073	517	1278	639	7710	2903
15	699	2862	11059	1329	278	716	1859	896	175	2458	1738	766	2609	1235	7437	5776
16	2250	382	13647	1790	966	846	1126	1506	774	2199	1681	1371	3559	1335	7357	8062
17	3865	419	8796	3123	2847	1588	1201	2046	703	2157	3337	2580	6189	2764	8647	10733
18	6226	1111	2719	3084	4285	4356	1860	2121	3455	3525	5257	6444	8643	3668	16472	12772
19	7749	2480	2474	1403	5014	9476	3280	2849	2988	7017	8267	8161	15473	8995	31506	14610
20	4522	2574	3839	829	2703	10910	4708	9472	5379	13198	9589	11326	21089	11905	33702	19196
21	3482	3559	5754	922	1815	12119	6367	24848	16817	22002	14393	13958	23750	16956	33182	26687
22	5148	1690	5301	783	1335	13844	7008	34265	31067	42769	15551	14932	19290	16584	30967	30007
23	7253	1732	5708	1181	1257	16629	8191	31121	38232	53557	15590	15582	15120	20423	30644	23768
24	6187	2721	4756	1498	1359	12502	10669	28376	45394	53956	14839	16034	10814	17004	28561	19150
25	3366	2865	3398	1748	1004	8318	9469	21275	21482	34350	10166	12606	8036	14657	24305	10687
26	1963	3250	3701	1564	1600	5649	7757	19512	30227	27846	10041	11224	6889	24397	18438	5467
27	1426	2411	4478	1057	1693	5106	4047	16075	21654	21918	11330	8887	5102	38936	20027	6301
28	953	1834	3283	803	1437	4901	2760	12716	15663	13775	10217	7496	3552	43216	15249	2764
29	1038	1506	2876	731	1154	4264	1871	9632	14331	15612	10385	6419	2778	24426	11907	3259
30	607	1048	2606	482	721	3323	1797	6120	6698	14650	9523	3741	2701	18145	8832	2641
31	534	1014	2969	318	474	2231	1354	6513	5732	12804	10450	3588	2176	13713	5769	2039
32	417	809	3087	244	548	1564	991	6157	4322	10277	8884	2235	2356	9706	3036	1869
33	369	825	2621	138	264	762	640	5687	3259	6538	5183	1382	1972	3487	2012	1328
34	399	540	2161	156	144	337	438	3287	2024	5043	3035	996	1009	5391	1617	371
35	251	544	1502	109	105	163	160	967	877	3301	990	455	640	2249	832	263
36	190	366	880	135	113	105	77	660	534	895	296	227	227	476	592	139
37	222	216	696	127	151	118	42	402	273	709	378	93	82	877	222	31
38	159	219	669	82	101	28	88	82	102	396	116	43	35	75	112	46
39	130	300	726	31	70	55	4	82	67	186	155	59	35	43	86	
40	118	220	483	46	62	28	0	216	79	183	23		94	23	12	
41	45	77	371	0	15	15	0	15	51	16		15		4	15	46
42	88	85	215	9	46	4	0	20	66	47	63	15		15	8	31
43	69	85	83	49	27	35	15	201	0	31	28		15	15		46
44	45	77	189	29	31		31	12	27	31	28				15	
45	57	62				15	15	15		31	15			8		
46		46	51			15	46		31							
47		4	20		15		15									
48	11	31	31													
49		31														
abundance (millions)	66.0	54.5	110.6	26.3	32.0	124.1	83.0	249.1	285.3	374.5	187.2	160.5	175.2	318.1	384.4	217.2
mean length (cm)	21.6	21.6	22.6	21.5	22.7	23.4	23.5	25.1	24.7	25.3	25.2	23.5	22.0	25.7	22.2	21.9
length anomalies (cm)	-1.6	-1.6	-0.6	-1.7	-0.5	0.2	0.3	1.9	1.5	2.1	2.0	0.3	-1.2	2.5	-1.0	-1.3

(1) Survey data only from Division 3L

Table 5b: 3LN autumn survey abundance at length, 1991-2009 (thousands).

Length	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
4																
5				15	240	56	86	17		117	445	232	1090	34	0	84
6					256	359	330	0	251	481	937	915	2427	85	133	1418
7	203				138	88	395	39	50	673	755	873	2185	61	162	1831
8	1298				111	72	386	47	37	602	2114	1614	2714	620	908	466
9	1236				241	146	468	252	421	620	3146	1275	2095	1280	2236	829
10	7263		93	31	292	250	306	214	171	388	4323	1129	2855	1719	1574	1458
11	22235	371	63	31	213	349	249	203	402	215	2846	2840	1839	1046	3957	1709
12	62419	62	372		241	106	175	275	786	202	1266	2255	1123	1131	9942	3083
13	109337	3189	457	335	304	274	366	596	868	320	1056	2072	1488	1436	11090	3970
14	33876	27936	1775	551	513	1419	728	912	2472	587	445	2545	1451	1015	10309	8256
15	14030	104298	1333	2362	967	722	1104	1768	1548	3635	407	1884	1929	538	8461	13286
16	7809	113966	3259	3697	1611	919	1405	4159	717	4671	11018	2159	8240	879	6083	20912
17	7860	106448	5283	12985	9645	825	1848	8155	1144	5480	31421	4694	15193	1984	5713	27177
18	16191	95896	8707	28684	37932	2227	2095	12225	3185	7035	57695	9082	25813	5468	7248	23009
19	32214	71577	6425	29295	72192	5062	8438	17373	6536	11926	74228	13661	38672	8222	10928	24342
20	27189	113846	3906	15292	78316	6479	21672	46005	9068	31680	80538	12568	45262	9790	15982	26793
21	15810	148628	5306	7701	43397	6621	47562	88726	15347	50184	65575	16481	42849	13134	25645	36447
22	7915	153395	6375	5119	27652	6123	52500	124662	23121	66781	130029	20168	39683	13632	23899	49628
23	6139	89704	6578	6494	20117	6743	44777	92991	29000	60123	118427	23529	39374	16732	29785	71774
24	8377	28658	5164	5456	10296	4864	31865	56410	26969	52986	85149	25353	31785	15458	20362	67361
25	8943	14222	3947	6808	12898	4429	24356	30123	29819	50534	64519	21326	21398	13066	15824	34947
26	6602	13410	4120	8670	8517	4370	21375	23090	27515	40188	39693	19872	18032	10432	12713	32335
27	4022	14699	4361	7830	17364	2890	21141	20596	25585	21851	33743	16470	17605	9397	10857	19109
28	3776	8768	4240	8402	17495	2707	14031	18336	24801	17424	20396	10503	13962	12135	12471	11651
29	2526	4855	3503	7625	16330	2678	8032	13397	16323	16387	14957	7230	7798	13950	12659	10147
30	2110	3340	2765	6195	12717	2242	6138	7942	11346	12127	11093	5122	4910	12267	9865	7475
31	1960	3229	1949	4553	16297	3409	4994	6250	7641	10199	9147	5109	3755	9066	7347	9531
32	1314	2389	1901	2709	10628	2210	4035	5730	6315	7165	5261	4608	3523	6787	5214	7469
33	1212	3299	1671	1603	7262	1220	2107	3878	5642	5026	4354	3862	3360	4636	4905	4870
34	1117	1431	1286	916	3447	559	1673	4512	4545	3369	2776	2701	2182	2959	3942	2096
35	1287	716	1044	610	1966	217	653	2048	3256	1303	1679	1451	1175	1760	2720	1118
36	1184	595	800	297	1171	118	499	1080	1539	1092	675	560	506	1259	1456	537
37	1005	385	460	211	335	64	308	426	339	499	636	325	182	765	1298	444
38	1166	401	427	257	398	14	243	247	184	329	282	85	111	392	385	136
39	787	228	308	274	572	22	176	85	272	227	215	67	115	666	228	55
40	662	93	237	119	75	22	164	17	67	151	180	136		308	60	116
41	221	124	155	0	20	22	191	40	82	67	81			76	85	61
42	135	77	132	15	24		45			67		17		232	60	
43	102	31	37	32	32			35	50		4	21		99		
44	128	46	99			42		17	50	4		17				
45	46	15	69	15	36	28		17	50	76		17				
46	24	46			12	14				18	17					16
47	15	15	15	8		12			17							
48									17							
49		15														
50	15															
abundance (millions)	422	1130	89	175	432	71	327	593	288	487	882	245	407	195	297	526
mean length (cm)	16.9	20.2	23.9	22.7	23.2	24.0	24.1	23.6	25.8	24.4	22.8	23.8	22.3	25.4	23.0	22.8
length anomalies (cm)	-5.8	-2.5	1.1	0.0	0.4	1.2	1.4	0.8	3.1	1.6	0.1	1.0	-0.4	2.7	0.2	0.1

Table 6a: A traffic light rating of diagnostics for posible frameworks of ASPICfit 2010 assessment.

R squared in CPUE	$ASPIC_{fit}$ 2010 Without 3N Spain	rate	$ASPIC_{fit}$ 2010 With 3N Spain2008	rate	$ASPIC_{fit}$ 2010 With 3N Spain2009	rate
I_1	0.057	2	0.047	1	-0.067	-1
I_2	0.447	0	0.457	1	0.502	2
I_3	0.418	0	0.433	2	0.432	1
I4	0.212	2	0.205	1	0.197	0
I_5	0.379	2	0.370	1	0.358	0
I_6	0.602	2	0.590	1	0.566	0
I_7	0.365	0	0.394	1	0.437	2
N restarts	129	1	186	0	96	2
Contrast index (ideal = 1.0)	0.670	2	0.603	1	0.523	0
Total obj. function	29.64	1	41.13	0	0.396	2
Sum of rate		**12**		**9**		**8**

(green)	best result	2
(yellow)	intermediate result	1
(brown)	worst result	0
(black)	violation of a basic ASPIC basic ASPIC assumption	-1

Table 6b: Key parameters of posible frameworks for $ASPIC_{fit}$ 2010 assessment.

	B1/K	B_{msy}	B_{2010}/B_{msy}	*MSY*	F_{msy}	F_{2009}/F_{msy}	Ye_{2010}
$ASPIC_{fit}$ 2010 Without 3N Spain	0.5405	193500	1.564	22580	0.117	0.014	15390
$ASPIC_{fit}$ 2010 With 3N Spain2008	0.4809	214800	1.407	23040	0.107	0.015	19230
$ASPIC_{fit}$ 2010 With 3N Spain2009	0.3709	250000	1.198	25730	0.103	0.016	24720

Table7a: Different seeds for parameters and last year survey biomass used on $ASPIC_{fit}$ 2010 sensitivity analysis.

	Standard	STACFIS	-25%seed	+25%seed	25% Pessimistic	25% Optimistic	Last $year_{-25\%surv B}$	Last $year_{-10\%surv B}$	Last $year_{+10\%surv B}$	Last $year_{+25\%surv B}$
2009 catch	482	**1051**	482	482	482	482	482	482	482	482
B1/K	0.5d0	0.5d0	0.5d0	0.5d0	**0.375**	**0.625**	0.5d0	0.5d0	0.5d0	0.5d0
MSY	2.0d4	2.0d4	2.0d4	2.0d4	**15000**	**25000**	2.0d4	2.0d4	2.0d4	2.0d4
K	200000	200000	200000	200000	**150000**	**250000**	200000	200000	200000	200000
q_{cpue}	9.01E-06	9.01E-06	9.01E-06	9.01E-06	**1.13E-05**	**6.76E-06**	9.01E-06	9.01E-06	9.01E-06	9.01E-06
$q_{3LNspring}$	0.658	0.658	0.658	0.658	**0.823**	**0.494**	0.658	0.658	0.658	0.658
$q_{3Nautumn}$	0.759	0.759	0.759	0.759	**0.949**	**0.569**	0.759	0.759	0.759	0.759
$q_{3LNRussia}$	0.658	0.658	0.658	0.658	**0.823**	**0.494**	0.658	0.658	0.658	0.658
$q_{3Lwinter}$	0.322	0.322	0.322	0.322	**0.403**	**0.242**	0.322	0.322	0.322	0.322
$q_{3Lsummer}$	0.275	0.275	0.275	0.275	**0.344**	**0.206**	0.275	0.275	0.275	0.275
$q_{3Lautumn}$	0.275	0.275	0.275	0.275	**0.344**	**0.206**	0.275	0.275	0.275	0.275
Random seed	3941285	3941285	**2955964**	**4926606**	3941285	3941285	3941285	3941285	3941285	3941285
$3LNspring_{2010}$	183378	183378	183378	183378	183378	183378	**137533.5**	**165040.2**	**201715.8**	**229222.5**
$3Nautumn_{2010}$	159462	159462	159462	159462	159462	159462	**119596.5**	**143515.8**	**175408.2**	**199327.5**
$3Lautumn_{2010}$	87245	87245	87245	87245	87245	87245	**65433.75**	**78520.5**	**95969.5**	**109056.25**

Table 7b: Compairision of main results from sensitivity analysis of $ASPIC_{fit}$ 2010

	Standard	STACFIS	-25%seed	+25%seed	25% Pessimistic	25% Optimistic	Last $year_{-25\%surv B}$	Last $year_{-10\%surv B}$	Last $year_{+10\%surv B}$	Last $year_{+25\%surv B}$
K	387100	387300	385100	385100	385100	386800	363100	378200	394600	405900
B1/K	0.5405	0.5400	0.5442	0.5445	0.544	0.541	0.593	0.561	0.523	0.498
MSY	22580	22590	22570	22560	22560	22580	22460	22490	22710	22960
B_{msy}	193500	193600	192600	192600	192500	193400	181600	189100	197300	203000
F_{msy}	0.117	0.117	0.117	0.117	0.117	0.117	0.124	0.119	0.115	0.113
$B_{lastyear+1}/B_{msy}$	1.564	1.562	1.571	1.571	1.571	1.565	1.670	1.603	1.533	1.488
$F_{lastyear}/F_{msy}$	0.014	0.029	0.014	0.014	0.014	0.014	0.0131	0.0137	0.0142	0.0145
Ye_{2010}	15390	15470	15210	15210	15200	15360	12390	14320	16260	17480

Table 8a: Key parameters from 2010-2007 ASPIC assessments and bias between consecutive years.

	MSY	bias	*r*	*Fmsy*	bias	F_{2006}/F_{msy}	bias	Ye_{2007}	bias	*K*	*Bmsy*	bias	B_{2007}/B_{msy}	bias
ASPIC 2007	26570		0.433	0.217		0.0096		2742		245200	122600		1.947	
ASPIC 2008	25200	-5%	0.379	0.189	-14%	0.0105	8%	4461	39%	266200	133100	8%	1.896	-3%
ASPIC 2009	23110	-9%	0.289	0.145	-31%	0.0131	20%	11570	61%	319600	159800	17%	1.674	-13%
ASPIC 2010	22580	-2%	0.233	0.117	-24%	0.0177	26%	19890	42%	387000	193500	17%	1.297	-29%

Table 8b: A traffic light rating of retrospective $ASPIC_{fit}$ assessments 2010-2007, 1st take: R squared in CPUE for all input series

		$ASPIC_{fit}$ 2010	rate	$ASPIC_{fit}$ 2009	rate	$ASPIC_{fit}$ 2008	rate	$ASPIC_{fit}$ 2007	rate
R2 beteween series	I_2/I_3	0.665	3	0.534	2	0.382	0	0.434	1
	I_2/I_7	0.861	3	0.841	2	0.806	1	0.454	0
	I_3/I_7	0.798	3	0.667	2	0.502	0	0.559	1
R squared in CPUE	I_1	0.057	0	0.102	3	0.084	0	0.099	
	I_2	0.447	3	0.358	1	0.266	0	0.430	1
	I_3	0.418	3	0.259	2	0.160	0	0.237	2
	I_4	0.212	0	0.224	1	0.243	2	0.250	1
	I_5	0.379	0	0.393	1	0.412	2	0.419	3
	I_6	0.602	0	0.611	1	0.624	3	0.620	3
	I_7	0.365	3	0.207	2	0.107	1	0.036	2
Contrast index (ideal = 1.0)		0.670	0	0.750	1	0.782	3	0.773	2
Sum of rate			**18**		**18**		**12**		**16**

	best result	3
	1st interm. res	2
	2nd interm. res	1
	worst result	0

Table 8c: A traffic light rating of retrospective $ASPIC_{fit}$ assessments 2010-2007, 2nd take: R squared in CPUE for long input series only.

		$ASPIC_{fit}$ 2010	rate	$ASPIC_{fit}$ 2009	rate	$ASPIC_{fit}$ 2008	rate	$ASPIC_{fit}$ 2007	rate
R2 beteween series	I_2/I_3	0.665	3	0.534	2	0.382	0	0.434	1
	I_2/I_7	0.861	3	0.841	2	0.806	1	0.454	0
	I_3/I_7	0.798	3	0.667	2	0.502	0	0.559	1
R squared in CPUE	I_1	0.057	0	0.102	3	0.084	0	0.099	1
	I_2	0.447	3	0.358	1	0.266	0	0.430	2
	I_3	0.418	3	0.259	2	0.160	0	0.237	1
	I_7	0.365	3	0.207	2	0.107	1	0.036	0
Contrast index (ideal = 1.0)		0.670	0	0.750	1	0.782	3	0.773	2
Sum of rate			**18**		**15**		**5**		**8**

	best result	3
	1st interm. res	2
	2nd interm. res	1
	worst result	0

Table 9: Summary of the $ASPIC_{2010}$ results from bootstrapped analysis

Param. name	Point estimate	Bias corrected	Estimated bias in pt estimate	Estimated relative bias	Bias-corrected approximate confidence limits 80% lower	80% upper	50% lower	50% upper	Inter-quartile range	Relative IQ range
B1/K	0.541	**0.648**	0.108	19.90%	0.364	0.736	0.425	0.606	0.181	0.336
K	387100	**367720**	-19380	-5.01%	338600	487300	370100	464000	93910	0.243
MSY	22580	**23005**	425	1.88%	20640	24250	21430	23280	1848	0.082
Ye(2010)	15390	**12888**	-2502	-16.25%	9705	22970	13690	20750	7059	0.459
Bmsy	193500	**183810**	-9690.00	-5.01%	169300	243700	185100	232000	46960	0.243
Fmsy	0.117	**0.128**	0.012	9.96%	0.089	0.138	0.098	0.123	0.025	0.213
B./Bmsy	1.564	**1.623**	0.059	3.78%	1.138	1.769	1.282	1.645	0.363	0.232
F./Fmsy	0.014	**0.014**	0.000	-2.90%	0.012	0.021	0.013	0.018	0.004	0.318

Table 9b: B/Bmsy bias corrected trajectory from $ASPIC_{bot}$ 2010, catch verus surplus prodution from $ASPIC_{fit}$ 2010.

Year	Point estimate	Estimated bias	Bias corrected	Catch	Surplus prodution
1959	1.081	0.215	1.296	44585	22550
1960	0.967	0.176	1.144	26562	22540
1961	0.947	0.156	1.103	23175	22510
1962	0.943	0.143	1.086	21439	22520
1963	0.949	0.132	1.081	27362	22490
1964	0.924	0.122	1.045	10261	22530
1965	0.987	0.118	1.105	23466	22580
1966	0.982	0.110	1.092	16974	22580
1967	1.011	0.105	1.116	27188	22580
1968	0.987	0.097	1.084	17660	22580
1969	1.013	0.093	1.106	24750	22580
1970	1.002	0.087	1.089	14419	22570
1971	1.044	0.086	1.130	34370	22570
1972	0.983	0.077	1.060	28933	22560
1973	0.950	0.072	1.022	33297	22440
1974	0.894	0.067	0.961	22286	22330
1975	0.894	0.067	0.961	17871	22380
1976	0.917	0.069	0.986	20513	22450
1977	0.927	0.069	0.997	16516	22510
1978	0.958	0.071	1.029	12043	22570
1979	1.013	0.073	1.086	14067	22550
1980	1.057	0.073	1.130	16030	22460
1981	1.090	0.071	1.161	24280	22420
1982	1.080	0.067	1.147	21547	22430
1983	1.085	0.064	1.149	19747	22390
1984	1.098	0.061	1.159	14761	22270
1985	1.137	0.061	1.198	20557	22130
1986	1.145	0.058	1.203	42805	22380
1987	1.040	0.048	1.088	79031	22110
1988	0.746	0.028	0.773	53266	19830
1989	0.573	0.018	0.591	33649	17580
1990	0.490	0.016	0.506	29105	15850
1991	0.421	0.015	0.437	25815	14180
1992	0.361	0.015	0.376	27283	12140
1993	0.283	0.013	0.296	21308	9954
1994	0.224	0.012	0.237	5741	9313
1995	0.243	0.018	0.261	1989	10340
1996	0.286	0.027	0.313	451	11980
1997	0.346	0.039	0.384	630	13860
1998	0.414	0.052	0.466	899	15780
1999	0.491	0.067	0.558	2318	17570
2000	0.570	0.082	0.652	3141	19140
2001	0.652	0.095	0.747	1442	20550
2002	0.751	0.106	0.857	1216	21690
2003	0.857	0.113	0.970	1334	22380
2004	0.966	0.115	1.081	637	22550
2005	1.079	0.113	1.192	659	22150
2006	1.190	0.106	1.296	496	21220
2007	1.297	0.096	1.393	1664	19890
2008	1.391	0.084	1.475	597	18250
2009	1.482	0.072	1.554	482	16370
2010	1.564	0.059	1.623		

Table 9c: F/Fmsy bias corrected trajectory from ASPICbot 2010.

Year	Point estimate	Estimated bias	Bias corrected
1959	1.932	-0.184	1.748
1960	1.229	-0.109	1.120
1961	1.086	-0.091	0.995
1962	1.004	-0.080	0.924
1963	1.295	-0.099	1.196
1964	0.476	-0.035	0.440
1965	1.055	-0.076	0.979
1966	0.754	-0.053	0.701
1967	1.205	-0.081	1.124
1968	0.782	-0.051	0.730
1969	1.088	-0.070	1.018
1970	0.624	-0.039	0.585
1971	1.503	-0.092	1.411
1972	1.326	-0.078	1.248
1973	1.601	-0.092	1.509
1974	1.104	-0.062	1.042
1975	0.874	-0.050	0.824
1976	0.985	-0.056	0.928
1977	0.776	-0.045	0.731
1978	0.541	-0.031	0.510
1979	0.602	-0.035	0.567
1980	0.661	-0.038	0.624
1981	0.991	-0.055	0.936
1982	0.881	-0.047	0.834
1983	0.801	-0.042	0.759
1984	0.585	-0.030	0.554
1985	0.798	-0.040	0.758
1986	1.738	-0.083	1.655
1987	3.968	-0.174	3.794
1988	3.604	-0.142	3.462
1989	2.812	-0.106	2.706
1990	2.836	-0.109	2.727
1991	2.929	-0.115	2.814
1992	3.772	-0.143	3.629
1993	3.739	-0.109	3.630
1994	1.089	-0.025	1.064
1995	0.334	-0.010	0.324
1996	0.063	-0.003	0.061
1997	0.074	-0.004	0.070
1998	0.088	-0.005	0.083
1999	0.194	-0.011	0.182
2000	0.228	-0.014	0.214
2001	0.091	-0.005	0.086
2002	0.067	-0.004	0.063
2003	0.065	-0.004	0.061
2004	0.028	-0.001	0.026
2005	0.026	-0.001	0.025
2006	0.018	-0.001	0.017
2007	0.055	-0.002	0.053
2008	0.018	-0.001	0.018
2009	0.014	0.000	0.014

Table 10a: B/Bmsy bias corrected trajectory from ASPIC 2010 bootstrap and 2011-2013 biomass projection under status quo catch for 2010 and 5000 tons catch for 2011-2012. Comparison with similar results under the same level of projected catches from ASPIC2009-2007 bootstraps.

Year	Bias corrected ASPIC2010	Approx 80% lower CL	upper CL	Bias corrected ASPIC2009	Bias corrected ASPIC2008 2nd take	Bias corrected ASPIC2007
1959	1.296	0.728	1.471	1.450	1.689	1.801
1960	1.144	0.633	1.324	1.252	1.406	1.467
1961	1.103	0.614	1.290	1.200	1.335	1.385
1962	1.086	0.610	1.266	1.179	1.309	1.354
1963	1.081	0.614	1.254	1.173	1.305	1.349
1964	1.045	0.589	1.218	1.133	1.263	1.305
1965	1.105	0.640	1.268	1.204	1.349	1.393
1966	1.092	0.632	1.246	1.190	1.332	1.375
1967	1.116	0.662	1.259	1.218	1.365	1.407
1968	1.084	0.643	1.220	1.182	1.322	1.363
1969	1.106	0.664	1.237	1.208	1.354	1.394
1970	1.089	0.660	1.215	1.190	1.331	1.370
1971	1.130	0.709	1.251	1.236	1.385	1.425
1972	1.060	0.659	1.178	1.157	1.291	1.328
1973	1.022	0.633	1.138	1.117	1.248	1.284
1974	0.961	0.583	1.072	1.052	1.178	1.214
1975	0.961	0.585	1.076	1.058	1.195	1.233
1976	0.986	0.608	1.097	1.092	1.240	1.281
1977	0.997	0.618	1.103	1.108	1.262	1.305
1978	1.029	0.646	1.131	1.148	1.310	1.354
1979	1.086	0.699	1.180	1.213	1.383	1.427
1980	1.130	0.743	1.223	1.262	1.430	1.474
1981	1.161	0.780	1.255	1.294	1.457	1.498
1982	1.147	0.784	1.235	1.273	1.423	1.461
1983	1.149	0.793	1.228	1.271	1.414	1.451
1984	1.159	0.824	1.237	1.282	1.420	1.455
1985	1.198	0.872	1.271	1.322	1.460	1.495
1986	1.203	0.890	1.271	1.323	1.454	1.485
1987	1.088	0.823	1.147	1.189	1.294	1.320
1988	0.773	0.595	0.817	0.833	0.886	0.902
1989	0.591	0.459	0.625	0.634	0.668	0.682
1990	0.506	0.390	0.536	0.547	0.582	0.599
1991	0.437	0.332	0.463	0.479	0.518	0.540
1992	0.376	0.284	0.405	0.421	0.468	0.497
1993	0.296	0.218	0.331	0.342	0.394	0.431
1994	0.237	0.160	0.285	0.287	0.352	0.400
1995	0.261	0.163	0.316	0.332	0.432	0.500
1996	0.313	0.186	0.369	0.413	0.565	0.655
1997	0.384	0.213	0.445	0.521	0.732	0.843
1998	0.466	0.252	0.535	0.644	0.911	1.035
1999	0.558	0.296	0.633	0.777	1.088	1.217
2000	0.652	0.342	0.734	0.906	1.244	1.368
2001	0.747	0.391	0.847	1.030	1.375	1.491
2002	0.857	0.450	0.979	1.161	1.499	1.602
2003	0.970	0.520	1.111	1.283	1.604	1.692
2004	1.081	0.595	1.240	1.393	1.686	1.761
2005	1.192	0.684	1.359	1.495	1.756	1.817
2006	1.296	0.768	1.460	1.581	1.810	1.860
2007	1.393	0.867	1.551	1.656	1.853	1.893
2008	1.475	0.957	1.630	1.712	1.878	1.910
2009	1.554	1.049	1.708	1.765	1.898	1.902
2010	1.623	1.138	1.769	1.808	1.892	1.897
2011	1.683	1.215	1.812	1.819	1.889	1.895
2012	1.713	1.275	1.827	1.828	1.888	1.895
2013	**1.738**	1.335	1.840	**1.837**	**1.889**	**1.894**
retro bias between	**-5.7%** 2010-2009			**-2.8%** 2009-2008	**-0.3%** 2008-2007	
retro bias between	**-9.0%** 2010-2007					

Table 10b: F/Fmsy bias corrected trajectory from ASPIC 2010 bootstrap and 2011-2013 fishing mortality status quo catch fot 2010 and 5000 tons catch for 2011-2012. Comparison with similar results under the same level of projected catches from ASPIC2009-2007 bootstraps.

Year	Bias corrected ASPIC2010	Approx 80% lower CL	upper CL	Bias corrected ASPIC2009	Bias corrected ASPIC2008 2nd take	Bias corrected ASPIC2007
1959	1.748	1.503	2.512	1.555	1.280	1.212
1960	1.120	0.945	1.625	1.005	0.832	0.789
1961	0.995	0.845	1.447	0.892	0.738	0.700
1962	0.924	0.788	1.341	0.826	0.681	0.646
1963	1.196	1.019	1.739	1.070	0.879	0.833
1964	0.440	0.379	0.637	0.392	0.321	0.304
1965	0.979	0.844	1.384	0.869	0.711	0.674
1966	0.701	0.612	0.982	0.621	0.508	0.482
1967	1.124	0.988	1.561	0.995	0.814	0.774
1968	0.730	0.645	1.003	0.646	0.529	0.503
1969	1.018	0.910	1.386	0.900	0.737	0.702
1970	0.585	0.527	0.783	0.516	0.423	0.403
1971	1.411	1.279	1.872	1.245	1.024	0.977
1972	1.248	1.128	1.656	1.101	0.906	0.865
1973	1.509	1.364	2.020	1.332	1.092	1.041
1974	1.042	0.939	1.406	0.916	0.747	0.711
1975	0.824	0.746	1.105	0.721	0.584	0.555
1976	0.928	0.842	1.234	0.808	0.652	0.620
1977	0.731	0.667	0.970	0.634	0.510	0.485
1978	0.510	0.467	0.665	0.441	0.355	0.338
1979	0.567	0.520	0.731	0.490	0.396	0.378
1980	0.624	0.575	0.797	0.539	0.439	0.420
1981	0.936	0.870	1.186	0.812	0.666	0.638
1982	0.834	0.782	1.048	0.725	0.598	0.575
1983	0.759	0.710	0.950	0.661	0.548	0.527
1984	0.554	0.521	0.698	0.483	0.403	0.388
1985	0.758	0.710	0.954	0.662	0.555	0.534
1986	1.655	1.557	2.088	1.453	1.229	1.185
1987	3.794	3.577	4.719	3.362	2.894	2.794
1988	3.462	3.299	4.262	3.092	2.708	2.610
1989	2.706	2.564	3.314	2.411	2.114	2.025
1990	2.727	2.563	3.352	2.403	2.082	1.972
1991	2.814	2.612	3.516	2.438	2.066	1.928
1992	3.629	3.285	4.673	3.066	2.523	2.301
1993	3.630	3.087	4.939	2.945	2.316	2.036
1994	1.064	0.854	1.541	0.820	0.606	0.517
1995	0.324	0.258	0.495	0.240	0.167	0.142
1996	0.061	0.048	0.097	0.044	0.029	0.025
1997	0.070	0.055	0.113	0.049	0.032	0.028
1998	0.083	0.066	0.139	0.058	0.038	0.033
1999	0.182	0.146	0.311	0.127	0.083	0.073
2000	0.214	0.169	0.371	0.149	0.099	0.089
2001	0.086	0.068	0.152	0.060	0.041	0.037
2002	0.063	0.050	0.112	0.045	0.032	0.029
2003	0.061	0.049	0.107	0.045	0.032	0.030
2004	0.026	0.021	0.046	0.020	0.015	0.014
2005	0.025	0.020	0.042	0.019	0.015	0.014
2006	0.017	0.014	0.029	0.013	0.011	0.010
2007	0.053	0.045	0.087	0.043	0.035	0.034
2008	0.018	0.015	0.028	0.015	0.035	0.101
2009	0.014	0.012	0.021	0.014	0.103	0.101
2010	0.013	0.012	0.020	0.117	0.104	0.101
2011	0.131	0.118	0.191	0.116	0.104	0.101
2012	0.128	0.116	0.182	0.115	0.104	0.101
tro bias betwee	**10.1%**			**10.1%**	**2.2%**	
	2010-2009			2009-2008	2008-2007	
tro bias betwee	**20.9%**					
	2010-2007					

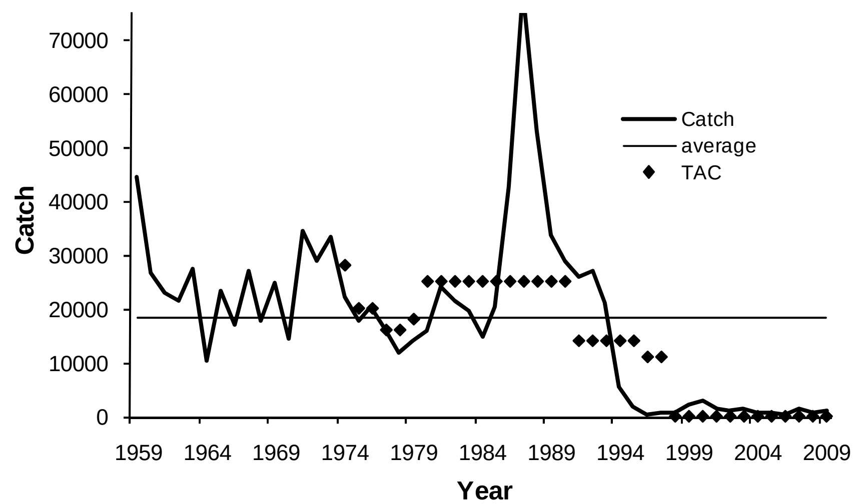

Fig. 1: redfish catch and TAC's in Div. 3LN

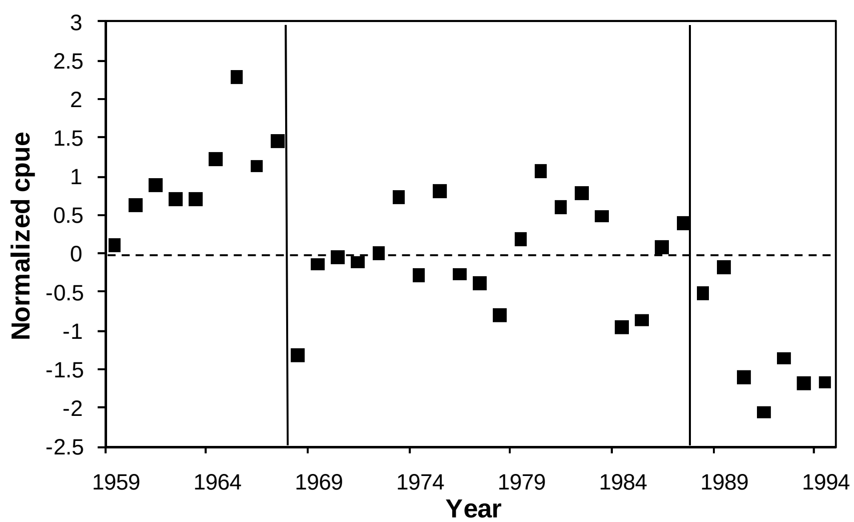

Fig. 2: Redfish Div. 3LN cpue 1959-1994

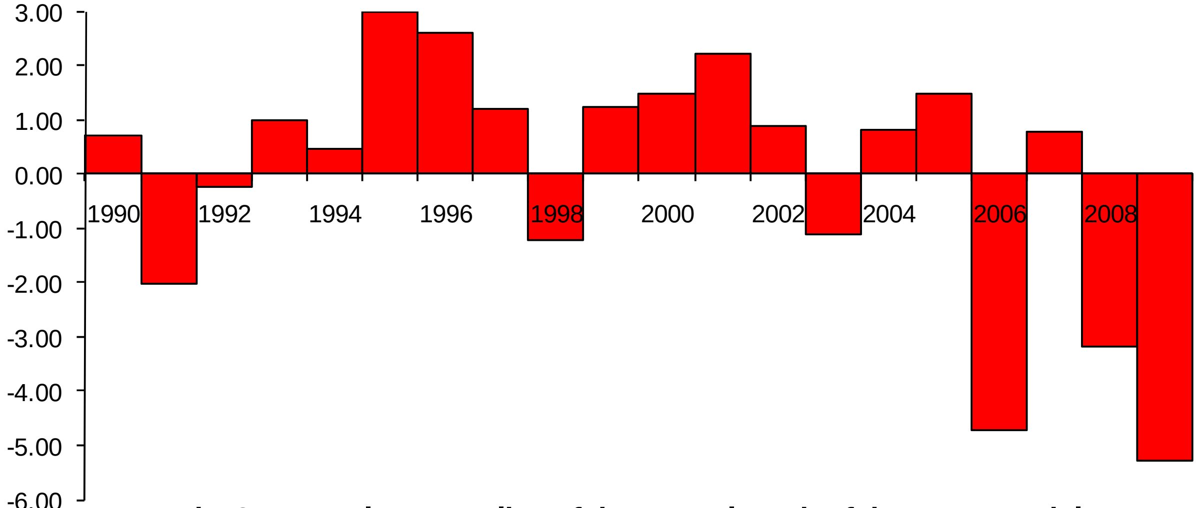

Fig. 3: Annual annomalies of the mean length of the commercial catch, 1990-2009

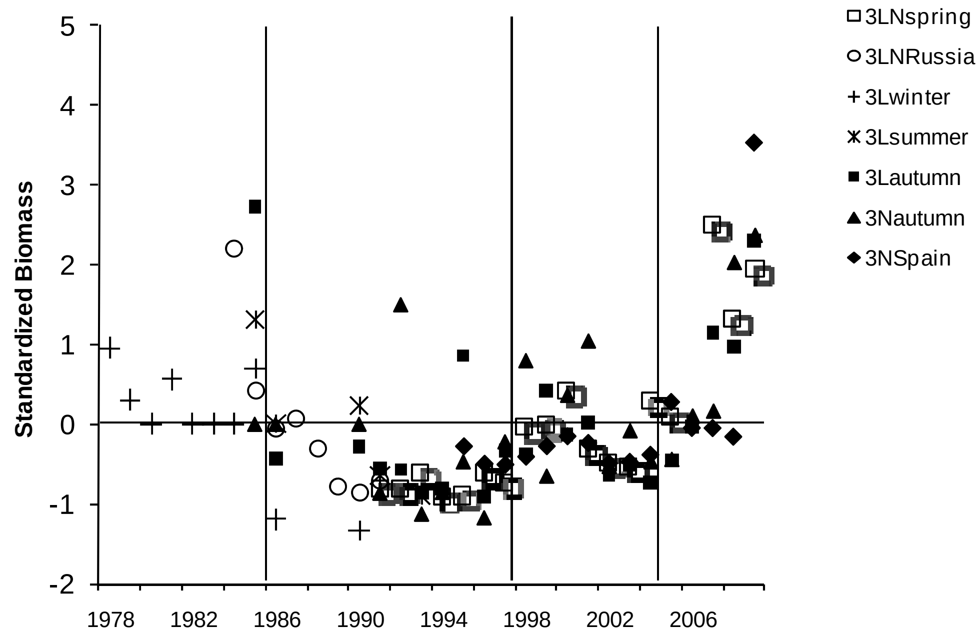

Fig. 4a: Standardized biomass from bottom trawl surveys included in ASPIC framework, 1978-2009

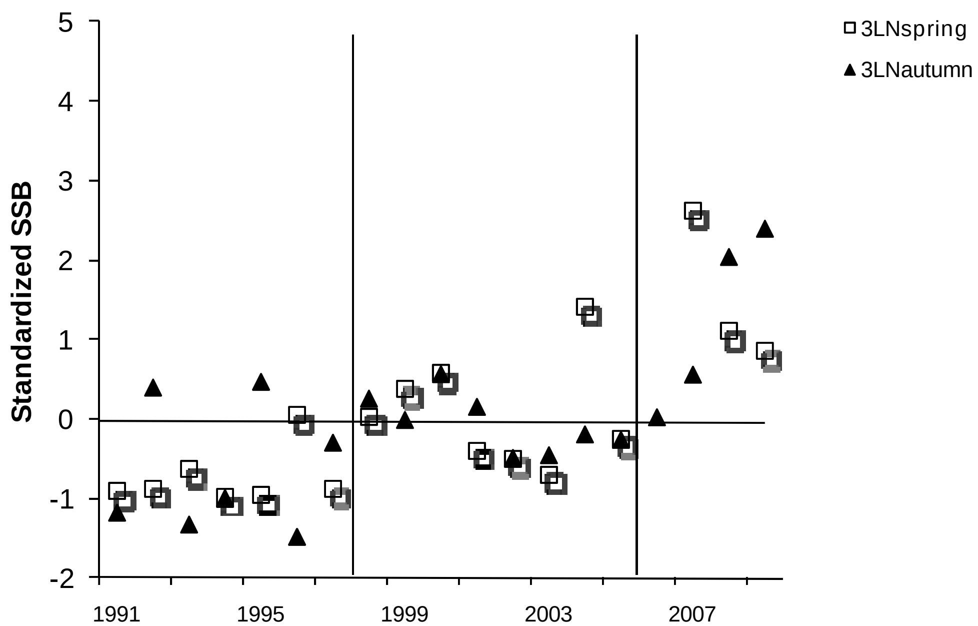

Fig. 4b: Standardized survey female SSB from spring and autumn Canadian surveys on Div. 3LN, 1991-2009

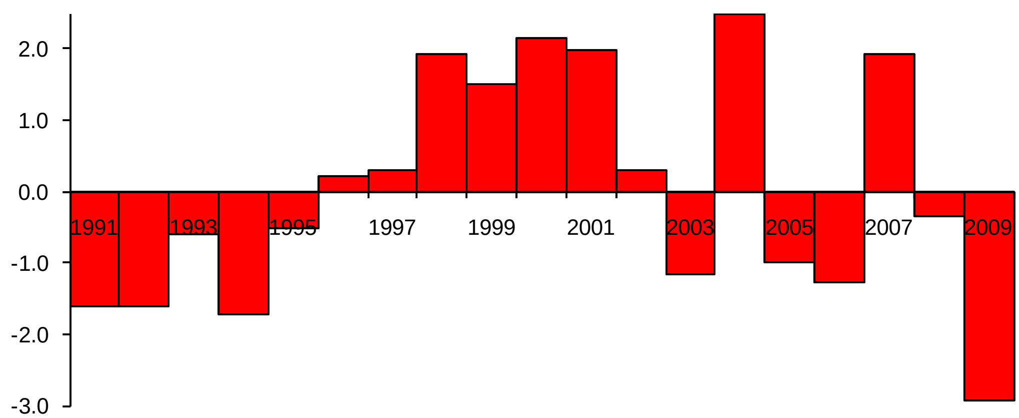

Fig. 5a: Annual annomalies of the mean length on the spring survey stock, 1991-2009

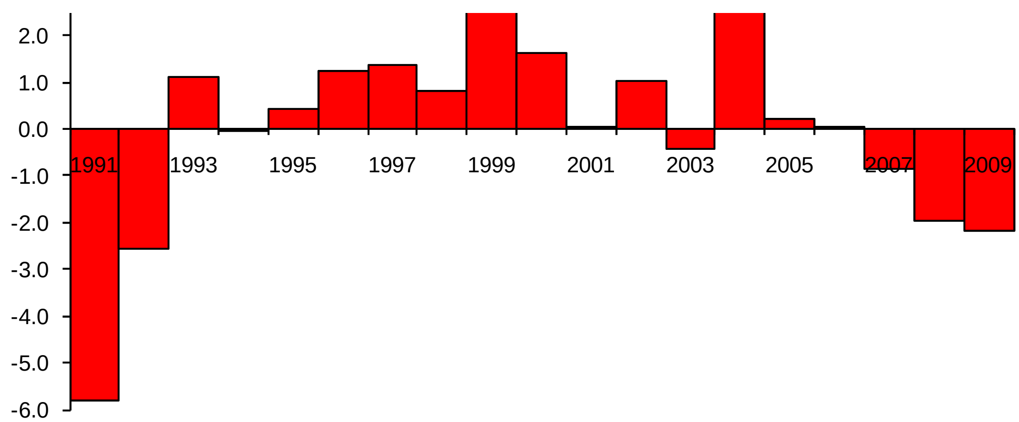

Fig. 5b: Annual annomalies of the mean length on the atumng survey stock, 1991-2009

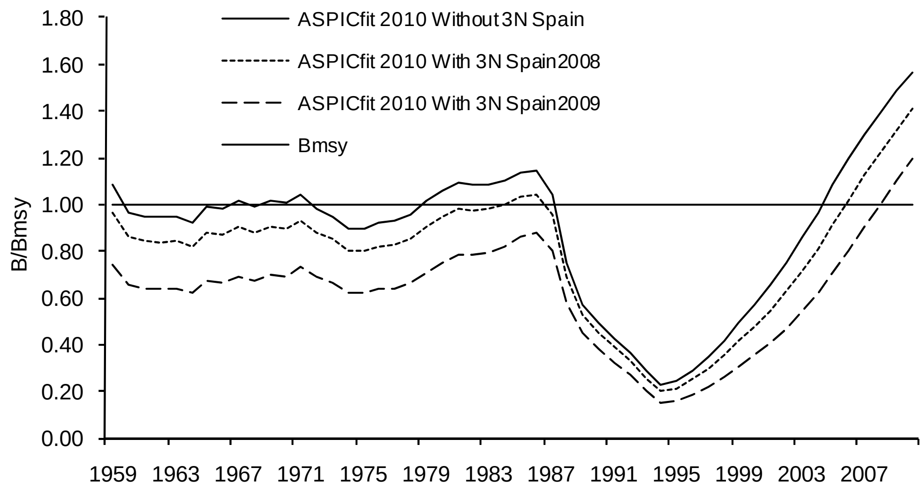

Fig. 6: B/Bmsy from ASPIC$_{fit}$ 2010, with and without the 3N Spanish survey (full series and ending in 2008)

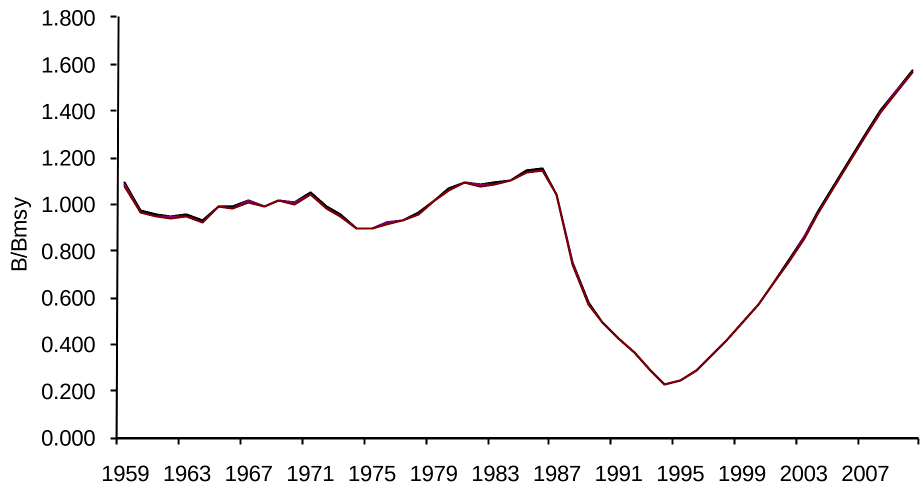

Fig. 7a: Impact of different 2009 catch, sets of initial parameters and random seeds on the B/Bmsy trajectory of ASPIC$_{fit}$ 2010

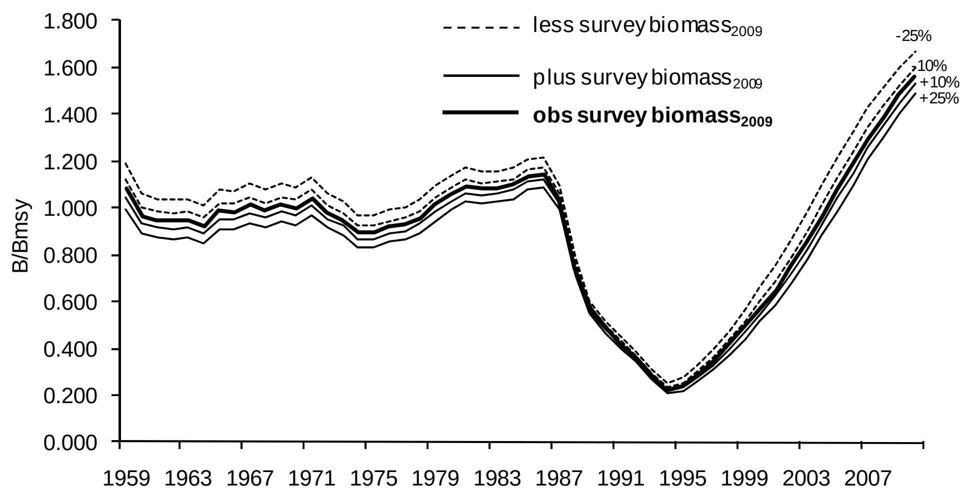

Fig. 7b: Impact of last year 3LN$_{spring}$/3L$_{autumn}$/3N$_{autumn}$ survey biomass on B/Bmsy trajectory of ASPIC$_{fit}$ 2010

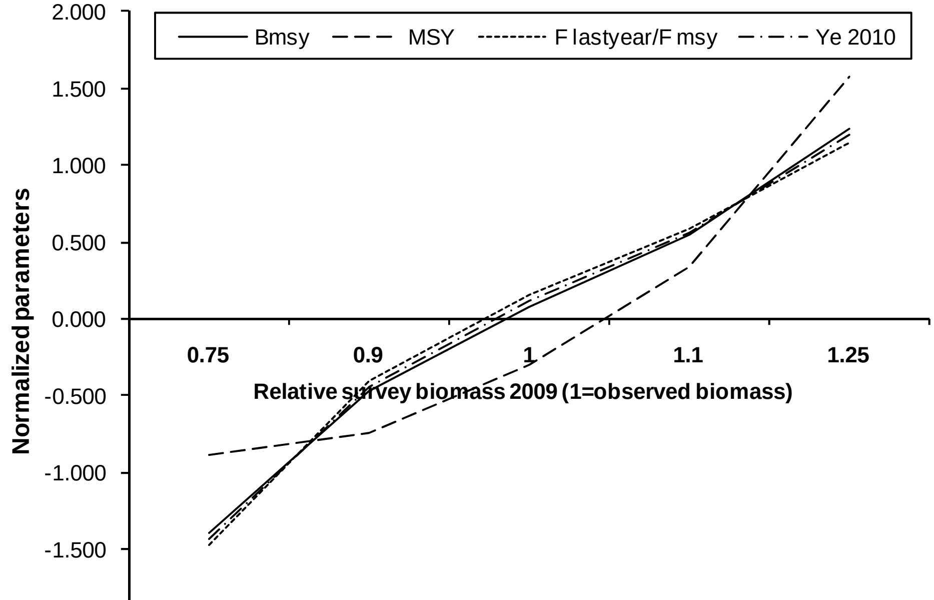

Fig. 7c: Impact of last year surveys on ASPIC results I (positive dependent parameters)

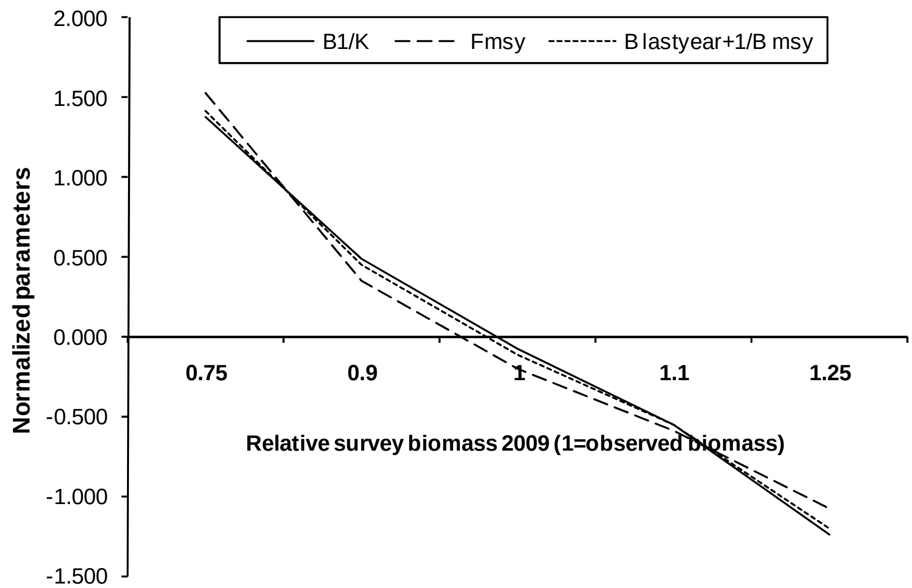

Fig. 7d: Impact of last year surveys on ASPIC results II (negative dependent parameters)

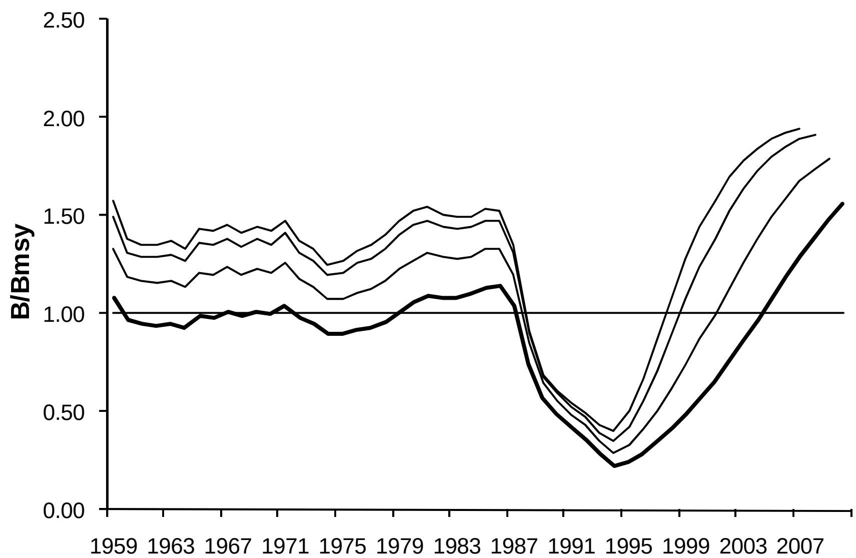

Fig. 8a: Retrospective B/Bmsy from $ASPIC_{fit}$, 2010-2007

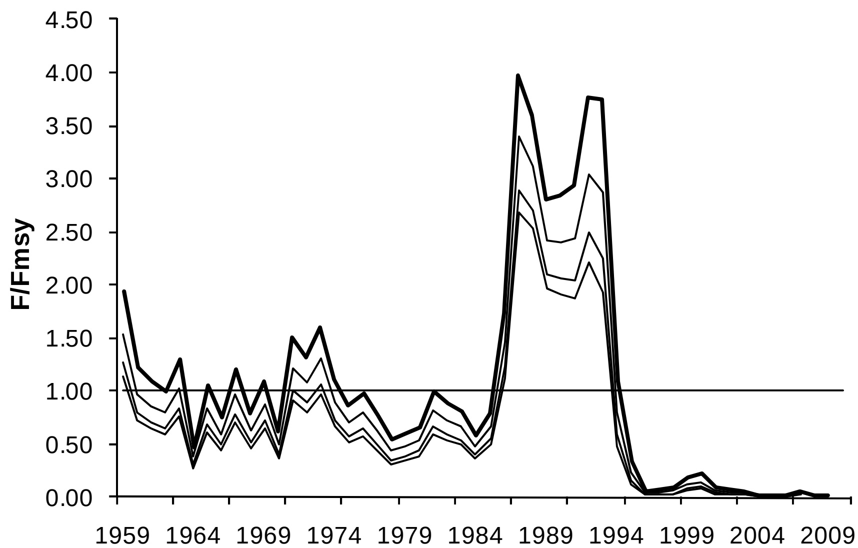

Fig. 8b: Retrospective F/Fmsy from $ASPIC_{fit}$, 2010-2007

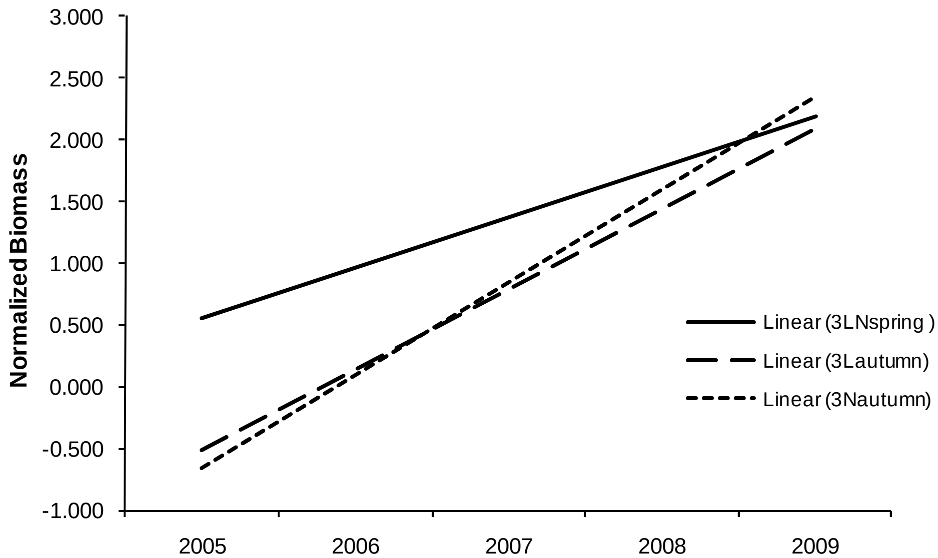

Fig. 8c: Recent trends from the actual surveys included in ASPIC framework

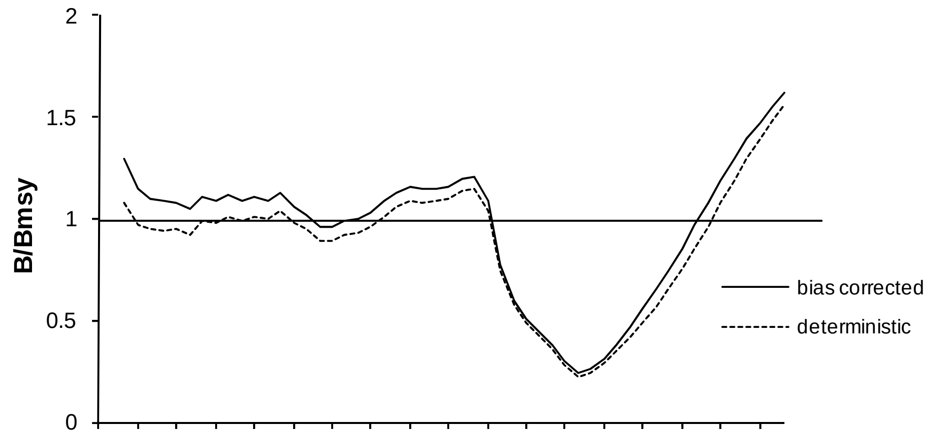

Fig. 9a: B/Bmsy deterministic and bias corrected trajectories for ASPIC2010, 1959-2010

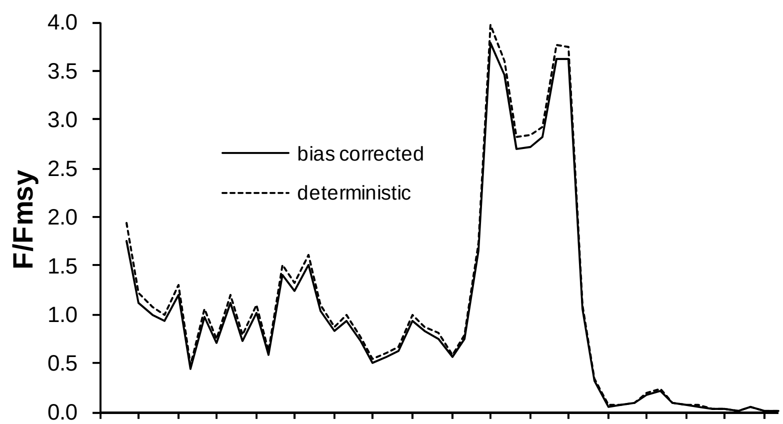

Fig. 9b: F/Fmsy deterministic and bias corrected trajectories for ASPIC2010

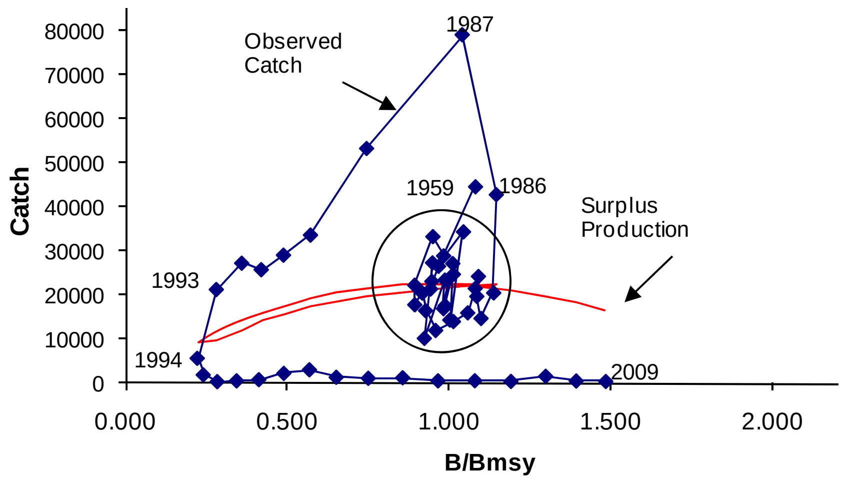

Fig. 9c: Catch versus Surplus Production from 1994 ASPICfit2010

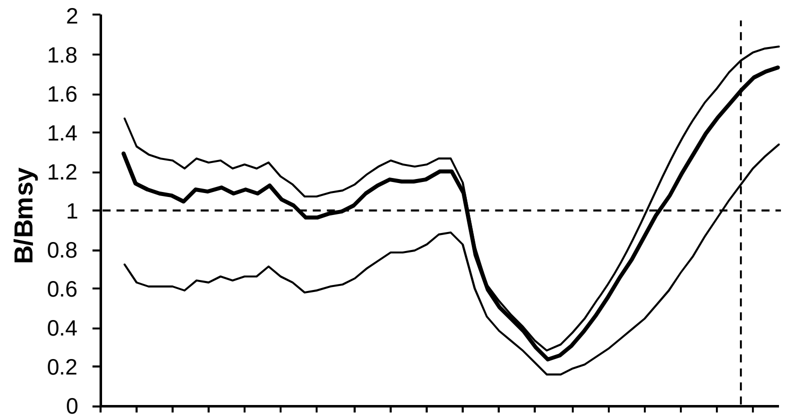

Fig. 10a: B/Bmsy trajectory and 2010-2013 projection under 5000 ton yield for ASPICbot 2010 (bias corrected point estimates with approximate 80% CL's)

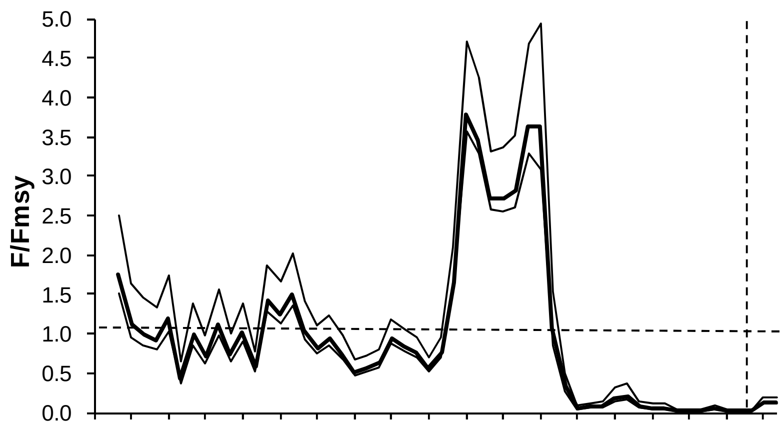

Fig. 10b: F/Fmsy trajectory and 2010-2012 projection under 5000 ton yield for ASPICbot 2010 (bias corrected point estimates with approximate 80% CL's)

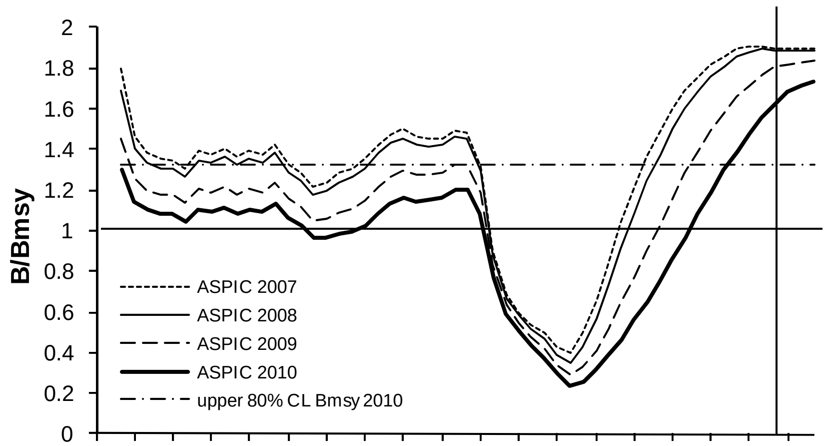

Fig. 10c: B/Bmsy bias corrected retro trajectories from ASPICbot 2010-2007 and last year+1-2013 retroprojections under 5000 ton yield

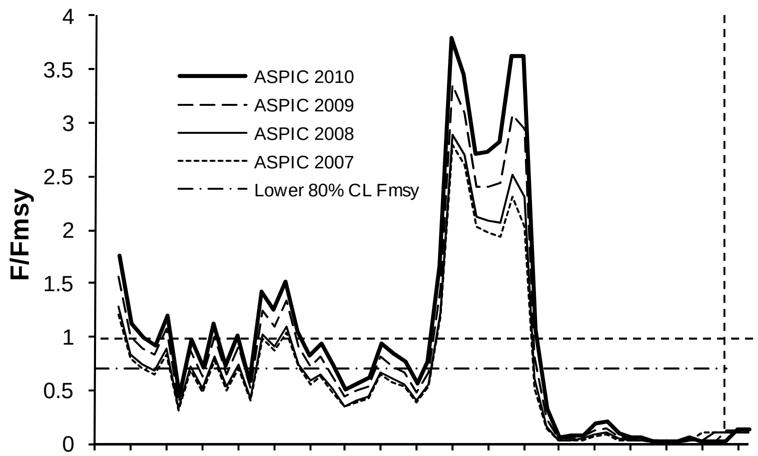

Fig. 10d: F/Fmsy bias corrected trajectories for ASPICbot 2010-2007 and last year+1-2012 retroprojections under 5000 ton yield

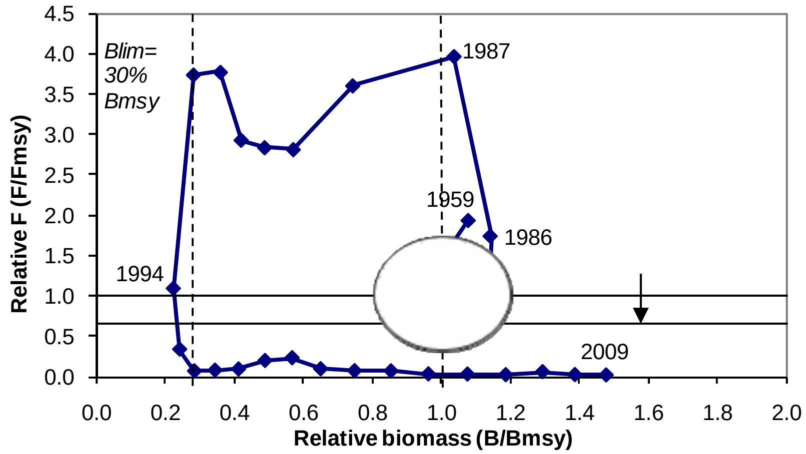

Fig. 11 : Stock trajectory under a precautionary framework for $ASPIC_{bot}$ 2010

Appendix 1: ASPIC 2010 input file including the complete series of each biomass index (Spanish survey on Div. 3N not used in the assessment).

```
FIT                                                     ## Run type (FIT, BOT, or IRF)
"3LN redfish"
LOGISTIC YLD SSE                                      ## See notes at end of this file
2                            ## Verbosity on screen (0-3); add 10 for SUM & PRN files
1000                                            ## Number of bootstrap trials, <= 1000
0 20000                        ## 0=no MC search, 1=search, 2=repeated srch; N trials
1d-8                                                  ## Convergence crit. for simplex
3d-8    6                                ## Convergence crit. for restarts, N restarts
1d-4    24                             ## Conv. crit. for F; N steps/yr for gen. model
6d0                                                   ## Maximum F when cond. on yield
0d0                              ## Stat weight for B1>K as residual (usually 0 or 1)
8                                                 ## Number of fisheries (data series)
1d0 1d0 1.d0 1.d0 1.d0 1.d0 1.d0 1.d0           ## Statistical weights for data series
0.5d0                                      ## B1/K (starting guess, usually 0 to 1)
2.0d4                                                         ## MSY (starting guess)
2.000E+05                                 ## K (carrying capacity) (starting guess)
9.007E-06 0.658d0 0.759d0 0.658d0 0.322d0 0.275d0 0.275d0 0.759d0
                                          ## q (starting guesses -- 1 per data series)
1 1 1 1 1 1 1 1 1 1 1                    ## Estimate flags (0 or 1) (B1/K,MSY,K,q1...qn)
0.5d4  5.0d4                                         ## Min and max constraints -- MSY
1.0d5  5.0d5                                           ## Min and max constraints -- K
3941285                                       ## Random number seed (large integer)
51                                                          ## Number of years of data
'Statlant CPUE'                                               ## Title for first series

'CC'
1959   1.426  44585
1960   1.602  26562
1961   1.697  23175
1962   1.631  21439
1963   1.632  27362
1964   1.812  10261
1965   2.185  23466
1966   1.781  16974
1967   1.893  27188
1968   0.922  17660
1969   1.338  24750
1970   1.367  14419
1971   1.346  34370
1972   1.387  28933
1973   1.643  33297
1974   1.290  22286
1975   1.669  17871
1976   1.292  20513
1977   1.251  16516
1978   1.106  12043
1979   1.451  14067
1980   1.761  16030
1981   1.594  24280
1982   1.661  21547
1983   1.556  19747
1984   1.049  14761
1985   1.084  20557
1986   1.413  42805
1987   1.523  79031
1988   1.208  53266
1989   1.322  33649
1990   0.825  29105
1991   0.668  25815
1992   0.912  27283
1993   0.801  21308
1994   0.802  5741
1995   -0.001 1989
1996   -0.001 451
1997   -0.001 630
1998   -0.001 899
1999   -0.001 2318
2000   -0.001 3141
2001   -0.001 1442
2002   -0.001 1216
2003   -0.001 1334
2004   -0.001 637
2005   -0.001 659
2006   -0.001 496
2007   -0.001 1664
2008   -0.001 597
2009   -0.001 482
```

'3LN spring survey'
'I1'

1959	-0.001
1960	-0.001
1961	-0.001
1962	-0.001
1963	-0.001
1964	-0.001
1965	-0.001
1966	-0.001
1967	-0.001
1968	-0.001
1969	-0.001
1970	-0.001
1971	-0.001
1972	-0.001
1973	-0.001
1974	-0.001
1975	-0.001
1976	-0.001
1977	-0.001
1978	-0.001
1979	-0.001
1980	-0.001
1981	-0.001
1982	-0.001
1983	-0.001
1984	-0.001
1985	-0.001
1986	-0.001
1987	-0.001
1988	-0.001
1989	-0.001
1990	-0.001
1991	10642.0
1992	10066.0
1993	22573.0
1994	4162.0
1995	5856.0
1996	22812.0
1997	14928.0
1998	59402.0
1999	61496.0
2000	87842.0
2001	41573.2
2002	30958.9
2003	27700.0
2004	79631.0
2005	66462.0
2006	-0.001
2007	218847.0
2008	143978.0
2009	183378.0

'3N autumn survey'
'I2'

1959	-0.001
1960	-0.001
1961	-0.001
1962	-0.001
1963	-0.001
1964	-0.001
1965	-0.001
1966	-0.001
1967	-0.001
1968	-0.001
1969	-0.001
1970	-0.001
1971	-0.001
1972	-0.001
1973	-0.001
1974	-0.001
1975	-0.001
1976	-0.001
1977	-0.001
1978	-0.001
1979	-0.001
1980	-0.001
1981	-0.001
1982	-0.001
1983	-0.001
1984	-0.001
1985	-0.001
1986	-0.001
1987	-0.001
1988	-0.001
1989	-0.001
1990	-0.001
1991	24221
1992	-0.001
1993	13222
1994	24584
1995	40650
1996	11277
1997	51116
1998	93703
1999	33125
2000	75544
2001	103997
2002	38261
2003	56882
2004	40614
2005	41911
2006	64665
2007	67212
2008	145210
2009	159462

'3LN Power russian survey'
'I1'

1959	-0.001
1960	-0.001
1961	-0.001
1962	-0.001
1963	-0.001
1964	-0.001
1965	-0.001
1966	-0.001
1967	-0.001
1968	-0.001
1969	-0.001
1970	-0.001
1971	-0.001
1972	-0.001
1973	-0.001
1974	-0.001
1975	-0.001
1976	-0.001
1977	-0.001
1978	-0.001
1979	-0.001
1980	-0.001
1981	-0.001
1982	-0.001
1983	-0.001
1984	215883.0
1985	93996.0
1986	62975.0
1987	70298.0
1988	44884.0
1989	12268.0
1990	8365.0
1991	18680.0
1992	-0.001
1993	-0.001
1994	-0.001
1995	-0.001
1996	-0.001
1997	-0.001
1998	-0.001
1999	-0.001
2000	-0.001
2001	-0.001
2002	-0.001
2003	-0.001
2004	-0.001
2005	-0.001
2006	-0.001
2007	-0.001
2008	-0.001
2009	-0.001

'3L winter survey'		'3L summer survey'		'3L autumn survey'	
'I0'		'I1'		'I2'	
1959	-0.001	1959	-0.001	1959	-0.001
1960	-0.001	1960	-0.001	1960	-0.001
1961	-0.001	1961	-0.001	1961	-0.001
1962	-0.001	1962	-0.001	1962	-0.001
1963	-0.001	1963	-0.001	1963	-0.001
1964	-0.001	1964	-0.001	1964	-0.001
1965	-0.001	1965	-0.001	1965	-0.001
1966	-0.001	1966	-0.001	1966	-0.001
1967	-0.001	1967	-0.001	1967	-0.001
1968	-0.001	1968	-0.001	1968	-0.001
1969	-0.001	1969	-0.001	1969	-0.001
1970	-0.001	1970	-0.001	1970	-0.001
1971	-0.001	1971	-0.001	1971	-0.001
1972	-0.001	1972	-0.001	1972	-0.001
1973	-0.001	1973	-0.001	1973	-0.001
1974	-0.001	1974	-0.001	1974	-0.001
1975	-0.001	1975	-0.001	1975	-0.001
1976	-0.001	1976	-0.001	1976	-0.001
1977	-0.001	1977	-0.001	1977	-0.001
1978	-0.001	1978	311163.0	1978	-0.001
1979	-0.001	1979	227788.0	1979	-0.001
1980	-0.001	1980	-0.001	1980	-0.001
1981	-0.001	1981	261384.0	1981	-0.001
1982	-0.001	1982	-0.001	1982	-0.001
1983	-0.001	1983	-0.001	1983	-0.001
1984	-0.001	1984	277711.0	1984	-0.001
1985	90245.0	1985	161038.0	1985	98233.0
1986	36568.0	1986	-0.001	1986	17119.0
1987	-0.001	1987	-0.001	1987	-0.001
1988	-0.001	1988	-0.001	1988	-0.001
1989	-0.001	1989	-0.001	1989	-0.001
1990	18202.0	1990	92840.0	1990	20743.0
1991	-0.001	1991	37572.0	1991	13665.0
1992	-0.001	1992	-0.001	1992	13424.0
1993	-0.001	1993	20838.0	1993	6011.0
1994	-0.001	1994	-0.001	1994	7173.0
1995	-0.001	1995	-0.001	1995	-0.001
1996	-0.001	1996	-0.001	1996	4691.0
1997	-0.001	1997	-0.001	1997	19544.0
1998	-0.001	1998	-0.001	1998	18522.0
1999	-0.001	1999	-0.001	1999	38861.0
2000	-0.001	2000	-0.001	2000	24917.0
2001	-0.001	2001	-0.001	2001	28568.7
2002	-0.001	2002	-0.001	2002	11888.0
2003	-0.001	2003	-0.001	2003	15007.0
2004	-0.001	2004	-0.001	2004	9293.0
2005	-0.001	2005	-0.001	2005	16650.0
2006	-0.001	2006	-0.001	2006	27218.4
2007	-0.001	2007	-0.001	2007	57546.0
2008	-0.001	2008	-0.001	2008	53276.0
2009	-0.001	2009	-0.001	2009	87245.0

```
'3N Spanish survey'
'I1'
1959   -0.001
1960   -0.001
1961   -0.001
1962   -0.001
1963   -0.001
1964   -0.001
1965   -0.001
1966   -0.001
1967   -0.001
1968   -0.001
1969   -0.001
1970   -0.001
1971   -0.001
1972   -0.001
1973   -0.001
1974   -0.001
1975   -0.001
1976   -0.001
1977   -0.001
1978   -0.001
1979   -0.001
1980   -0.001
1981   -0.001
1982   -0.001
1983   -0.001
1984   -0.001
1985   -0.001
1986   -0.001
1987   -0.001
1988   -0.001
1989   -0.001
1990   -0.001
1991   -0.001
1992   -0.001
1993   -0.001
1994   -0.001
1995   46084
1996   6558
1997   4753
1998   22540
1999   46459
2000   68928
2001   53855
2002   7620
2003   11031
2004   27016
2005   146918
2006   87830
2007   87602
2008   68059
2009   735743
```

Appendix 2: ASPIC2010 results on FIT mode

3LN redfish Page 1
Wednesday, 07 Apr 2010 at 16:41:57

ASPIC -- A Surplus-Production Model Including Covariates (Ver. 5.16)

FIT program mode
LOGISTIC model mode
YLD conditioning
SSE optimization

Author: Michael H. Prager; NOAA Center for Coastal Fisheries and Habitat Research
101 Pivers Island Road; Beaufort, North Carolina 28516 USA
Mike.Prager@noaa.gov

Reference: Prager, M. H. 1994. A suite of extensions to a nonequilibrium surplus-production model. Fishery Bulletin 92: 374-389.

ASPIC User's Manual is available gratis from the author.

CONTROL PARAMETERS (FROM INPUT FILE) Input file: aspic.inp

Operation of ASPIC: Fit logistic (Schaefer) model by direct optimization.

Number of years analyzed:	51	Number of bootstrap trials:		0
Number of data series:	7	Bounds on MSY (min, max):	5.000E+03	5.000E+04
Objective function:	Least squares	Bounds on K (min, max):	1.000E+05	5.000E+05
Relative conv. criterion (simplex):	1.000E-08	Monte Carlo search mode, trials:	0	20000
Relative conv. criterion (restart):	3.000E-08	Random number seed:		3941285
Relative conv. criterion (effort):	1.000E-04	Identical convergences required in fitting:		6
Maximum F allowed in fitting:	6.000			

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) error code 0

Normal convergence

WARNING: Negative correlations detected between some indices. A fundamental assumption of ASPIC is that all indices represent the abundance of the stock. That assumption appears to be violated.
Number of restarts required for convergence: 129

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

	1	2	3	4	5	6	7
1 Statlant CPUE	1.000						
	36						
2 3LN spring survey	-0.019	1.000					
	4	18					
3 3N autumn survey	-0.470	0.665	1.000				
	3	17	18				
4 3LN Power russian survey	0.108	0.000	0.000	1.000			
	8	1	1	8			
5 3L winter survey	0.178	0.000	0.000	0.908	1.000		
	3	0	0	3	3		
6 3L summer survey	0.733	-1.000	1.000	0.964	1.000	1.000	
	8	2	2	4	2	8	
7 3L autumn survey	0.326	0.861	0.798	0.794	0.959	0.930	1.000
	7	17	17	4	3	4	21

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)	Statlant CPUE	3.127E+00	36	9.197E-02	1.000E+00	2.074E+00	0.057
Loss(2)	3LN spring survey	8.160E+00	18	5.100E-01	1.000E+00	3.740E-01	0.447
Loss(3)	3N autumn survey	4.898E+00	18	3.061E-01	1.000E+00	6.230E-01	0.418
Loss(4)	3LN Power russian survey	3.890E+00	8	6.483E-01	1.000E+00	2.942E-01	0.212
Loss(5)	3L winter survey	4.759E-01	3	4.759E-01	1.000E+00	4.008E-01	0.379
Loss(6)	3L summer survey	1.616E+00	8	2.694E-01	1.000E+00	7.079E-01	0.602
Loss(7)	3L autumn survey	7.476E+00	21	3.935E-01	1.000E+00	4.847E-01	0.365

TOTAL OBJECTIVE FUNCTION, MSE, RMSE:	2.96430231E+01	2.906E-01	5.391E-01
Estimated contrast index (ideal = 1.0):	0.6700	C* = (Bmax-Bmin)/K	
Estimated nearness index (ideal = 1.0):	1.0000	N* = 1 - |min(B-Bmsy)|/K	

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	User/pgm guess	2nd guess	Estimated	User guess
B1/K	Starting relative biomass (in 1959)	.405E-01	5.000E-01	6.568E-01	1	1
MSY	Maximum sustainable yield	2.258E+04	2.000E+04	1.551E+04	1	1
K	Maximum population size	3.871E+05	2.000E+05	1.800E+05	1	1
phi	Shape of production curve (Bmsy/K)	0.5000	0.5000	----	0	1
--------- Catchability Coefficients by Data Series ---------------						
q(1)	Statlant CPUE	8.380E-06	9.007E-06	8.557E-04	1	1
q(2)	3LN spring survey	3.126E-01	6.580E-01	7.668E-01	1	1
q(3)	3N autumn survey	3.769E-01	7.590E-01	7.715E-01	1	1
q(4)	3LN Power russian survey	2.914E-01	6.580E-01	7.059E-01	1	1
q(5)	3L winter survey	2.351E-01	3.220E-01	9.626E-01	1	1
q(6)	3L summer survey	9.131E-01	2.750E-01	2.677E-01	1	1
q(7)	3L autumn survey	1.552E-01	2.750E-01	1.140E+00	1	1

MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Logistic formula	General formula
MSY	Maximum sustainable yield	2.258E+04	----	----
Bmsy	Stock biomass giving MSY	1.935E+05	K/2	K*n**(1/(1-n))
Fmsy	Fishing mortality rate at MSY	1.167E-01	MSY/Bmsy	MSY/Bmsy
n	Exponent in production function	2.0000	----	----
g	Fletcher's gamma	4.000E+00	----	[n**(n/(n-1))]/[n-1]
B./Bmsy	Ratio: B(2010)/Bmsy	1.564E+00	----	----
F./Fmsy	Ratio: F(2009)/Fmsy	1.400E-02	----	----
Fmsy/F.	Ratio: Fmsy/F(2009)	7.141E+01	----	----
Y.(Fmsy)	Approx. yield available at Fmsy in 2010	3.533E+04	MSY*B./Bmsy	MSY*B./Bmsy
	...as proportion of MSY	1.564E+00	----	----
Ye.	Equilibrium yield available in 2010	1.539E+04	4*MSY*(B/K-(B/K)**2)	g*MSY*(B/K-(B/K)**n)
	...as proportion of MSY	6.816E-01	----	----
--------- Fishing effort rate at MSY in units of each CE or CC series ---------				
fmsy(1)	Statlant CPUE	1.392E+04	Fmsy/q(1)	Fmsy/q(1)

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1	1959	0.225	2.092E+05	1.978E+05	4.458E+04	4.458E+04	2.255E+04	1.932E+00	1.081E+00
2	1960	0.143	1.872E+05	1.852E+05	2.656E+04	2.656E+04	2.254E+04	1.229E+00	9.673E-01
3	1961	0.127	1.832E+05	1.828E+05	2.318E+04	2.318E+04	2.251E+04	1.086E+00	9.465E-01
4	1962	0.117	1.825E+05	1.831E+05	2.144E+04	2.144E+04	2.252E+04	1.004E+00	9.431E-01
5	1963	0.151	1.836E+05	1.811E+05	2.736E+04	2.736E+04	2.249E+04	1.295E+00	9.486E-01
6	1964	0.055	1.787E+05	1.849E+05	1.026E+04	1.026E+04	2.253E+04	4.756E-01	9.235E-01
7	1965	0.123	1.910E+05	1.905E+05	2.347E+04	2.347E+04	2.258E+04	1.055E+00	9.869E-01
8	1966	0.088	1.901E+05	1.930E+05	1.697E+04	1.697E+04	2.258E+04	7.539E-01	9.823E-01
9	1967	0.141	1.957E+05	1.934E+05	2.719E+04	2.719E+04	2.258E+04	1.205E+00	1.011E+00
10	1968	0.091	1.911E+05	1.936E+05	1.766E+04	1.766E+04	2.258E+04	7.817E-01	9.874E-01
11	1969	0.127	1.960E+05	1.949E+05	2.475E+04	2.475E+04	2.258E+04	1.088E+00	1.013E+00
12	1970	0.073	1.939E+05	1.980E+05	1.442E+04	1.442E+04	2.257E+04	6.241E-01	1.002E+00
13	1971	0.175	2.020E+05	1.959E+05	3.437E+04	3.437E+04	2.257E+04	1.503E+00	1.044E+00
14	1972	0.155	1.902E+05	1.870E+05	2.893E+04	2.893E+04	2.256E+04	1.326E+00	9.828E-01
15	1973	0.187	1.838E+05	1.783E+05	3.330E+04	3.330E+04	2.244E+04	1.601E+00	9.499E-01
16	1974	0.129	1.730E+05	1.730E+05	2.229E+04	2.229E+04	2.233E+04	1.104E+00	8.938E-01
17	1975	0.102	1.730E+05	1.753E+05	1.787E+04	1.787E+04	2.238E+04	8.736E-01	8.940E-01
18	1976	0.115	1.775E+05	1.785E+05	2.051E+04	2.051E+04	2.245E+04	9.847E-01	9.173E-01
19	1977	0.090	1.795E+05	1.825E+05	1.652E+04	1.652E+04	2.251E+04	7.755E-01	9.273E-01
20	1978	0.063	1.855E+05	1.908E+05	1.204E+04	1.204E+04	2.257E+04	5.410E-01	9.583E-01
21	1979	0.070	1.960E+05	2.003E+05	1.407E+04	1.407E+04	2.255E+04	6.019E-01	1.013E+00
22	1980	0.077	2.045E+05	2.077E+05	1.603E+04	1.603E+04	2.246E+04	6.613E-01	1.057E+00
23	1981	0.116	2.109E+05	2.100E+05	2.428E+04	2.428E+04	2.242E+04	9.910E-01	1.090E+00
24	1982	0.103	2.091E+05	2.095E+05	2.155E+04	2.155E+04	2.243E+04	8.814E-01	1.080E+00
25	1983	0.093	2.099E+05	2.113E+05	1.975E+04	1.975E+04	2.239E+04	8.010E-01	1.085E+00
26	1984	0.068	2.126E+05	2.164E+05	1.476E+04	1.476E+04	2.227E+04	5.846E-01	1.098E+00
27	1985	0.093	2.201E+05	2.209E+05	2.056E+04	2.056E+04	2.213E+04	7.976E-01	1.137E+00
28	1986	0.203	2.217E+05	2.111E+05	4.280E+04	4.280E+04	2.238E+04	1.738E+00	1.145E+00
29	1987	0.463	2.012E+05	1.707E+05	7.903E+04	7.903E+04	2.211E+04	3.968E+00	1.040E+00
30	1988	0.421	1.443E+05	1.266E+05	5.327E+04	5.327E+04	1.983E+04	3.604E+00	7.456E-01
31	1989	0.328	1.109E+05	1.025E+05	3.365E+04	3.365E+04	1.758E+04	2.812E+00	5.729E-01
32	1990	0.331	9.480E+04	8.795E+04	2.910E+04	2.910E+04	1.585E+04	2.836E+00	4.898E-01
33	1991	0.342	8.155E+04	7.554E+04	2.582E+04	2.582E+04	1.418E+04	2.929E+00	4.213E-01
34	1992	0.440	6.992E+04	6.199E+04	2.728E+04	2.728E+04	1.214E+04	3.772E+00	3.612E-01
35	1993	0.436	5.477E+04	4.885E+04	2.131E+04	2.131E+04	9.954E+03	3.739E+00	2.830E-01
36	1994	0.127	4.342E+04	4.519E+04	5.741E+03	5.741E+03	9.313E+03	1.089E+00	2.243E-01
37	1995	0.039	4.699E+04	5.107E+04	1.989E+03	1.989E+03	1.034E+04	3.338E-01	2.428E-01
38	1996	0.007	5.534E+04	6.096E+04	4.510E+02	4.510E+02	1.198E+04	6.340E-02	2.859E-01
39	1997	0.009	6.687E+04	7.334E+04	6.300E+02	6.300E+02	1.386E+04	7.362E-02	3.455E-01
40	1998	0.010	8.010E+04	8.740E+04	8.990E+02	8.990E+02	1.578E+04	8.815E-02	4.139E-01
41	1999	0.023	9.498E+04	1.025E+05	2.318E+03	2.318E+03	1.757E+04	1.938E-01	4.908E-01
42	2000	0.027	1.102E+05	1.182E+05	3.141E+03	3.141E+03	1.914E+04	2.278E-01	5.696E-01
43	2001	0.011	1.262E+05	1.357E+05	1.442E+03	1.442E+03	2.055E+04	9.107E-02	6.523E-01
44	2002	0.008	1.454E+05	1.555E+05	1.216E+03	1.216E+03	2.169E+04	6.701E-02	7.510E-01
45	2003	0.008	1.658E+05	1.763E+05	1.334E+03	1.334E+03	2.238E+04	6.484E-02	8.568E-01
46	2004	0.003	1.869E+05	1.978E+05	6.370E+02	6.370E+02	2.255E+04	2.759E-02	9.655E-01
47	2005	0.003	2.088E+05	2.196E+05	6.590E+02	6.590E+02	2.215E+04	2.572E-02	1.079E+00
48	2006	0.002	2.303E+05	2.407E+05	4.960E+02	4.960E+02	2.122E+04	1.766E-02	1.190E+00
49	2007	0.006	2.510E+05	2.602E+05	1.664E+03	1.664E+03	1.989E+04	5.480E-02	1.297E+00
50	2008	0.002	2.692E+05	2.782E+05	5.970E+02	5.970E+02	1.825E+04	1.839E-02	1.391E+00
51	2009	0.002	2.869E+05	2.950E+05	4.820E+02	4.820E+02	1.637E+04	1.400E-02	1.482E+00
52	2010		3.028E+05						1.564E+00

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) Statlant CPUE

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	1959	1.426E+00	1.658E+00	0.2254	4.458E+04	4.458E+04	0.15045	1.000E+00
2	1960	1.602E+00	1.552E+00	0.1435	2.656E+04	2.656E+04	-0.03202	1.000E+00
3	1961	1.697E+00	1.532E+00	0.1267	2.318E+04	2.318E+04	-0.10214	1.000E+00
4	1962	1.631E+00	1.534E+00	0.1171	2.144E+04	2.144E+04	-0.06124	1.000E+00
5	1963	1.632E+00	1.518E+00	0.1511	2.736E+04	2.736E+04	-0.07263	1.000E+00
6	1964	1.812E+00	1.550E+00	0.0555	1.026E+04	1.026E+04	-0.15649	1.000E+00
7	1965	2.185E+00	1.597E+00	0.1232	2.347E+04	2.347E+04	-0.31365	1.000E+00
8	1966	1.781E+00	1.617E+00	0.0880	1.697E+04	1.697E+04	-0.09664	1.000E+00
9	1967	1.893E+00	1.620E+00	0.1406	2.719E+04	2.719E+04	-0.15552	1.000E+00
10	1968	9.220E-01	1.622E+00	0.0912	1.766E+04	1.766E+04	0.56513	1.000E+00
11	1969	1.338E+00	1.633E+00	0.1270	2.475E+04	2.475E+04	0.19953	1.000E+00
12	1970	1.367E+00	1.659E+00	0.0728	1.442E+04	1.442E+04	0.19370	1.000E+00
13	1971	1.346E+00	1.642E+00	0.1754	3.437E+04	3.437E+04	0.19876	1.000E+00
14	1972	1.387E+00	1.567E+00	0.1548	2.893E+04	2.893E+04	0.12178	1.000E+00
15	1973	1.643E+00	1.494E+00	0.1868	3.330E+04	3.330E+04	-0.09520	1.000E+00
16	1974	1.290E+00	1.450E+00	0.1288	2.229E+04	2.229E+04	0.11675	1.000E+00
17	1975	1.669E+00	1.469E+00	0.1019	1.787E+04	1.787E+04	-0.12759	1.000E+00
18	1976	1.292E+00	1.496E+00	0.1149	2.051E+04	2.051E+04	0.14658	1.000E+00
19	1977	1.251E+00	1.529E+00	0.0905	1.652E+04	1.652E+04	0.20091	1.000E+00
20	1978	1.106E+00	1.599E+00	0.0631	1.204E+04	1.204E+04	0.36845	1.000E+00
21	1979	1.451E+00	1.678E+00	0.0702	1.407E+04	1.407E+04	0.14560	1.000E+00
22	1980	1.761E+00	1.741E+00	0.0772	1.603E+04	1.603E+04	-0.01150	1.000E+00
23	1981	1.594E+00	1.759E+00	0.1156	2.428E+04	2.428E+04	0.09873	1.000E+00
24	1982	1.661E+00	1.756E+00	0.1028	2.155E+04	2.155E+04	0.05538	1.000E+00
25	1983	1.556E+00	1.771E+00	0.0935	1.975E+04	1.975E+04	0.12915	1.000E+00
26	1984	1.049E+00	1.813E+00	0.0682	1.476E+04	1.476E+04	0.54733	1.000E+00
27	1985	1.084E+00	1.851E+00	0.0931	2.056E+04	2.056E+04	0.53507	1.000E+00
28	1986	1.413E+00	1.769E+00	0.2028	4.280E+04	4.280E+04	0.22453	1.000E+00
29	1987	1.523E+00	1.431E+00	0.4630	7.903E+04	7.903E+04	-0.06265	1.000E+00
30	1988	1.208E+00	1.061E+00	0.4206	5.327E+04	5.327E+04	-0.12951	1.000E+00
31	1989	1.322E+00	8.593E-01	0.3281	3.365E+04	3.365E+04	-0.43078	1.000E+00
32	1990	8.250E-01	7.370E-01	0.3309	2.910E+04	2.910E+04	-0.11279	1.000E+00
33	1991	6.680E-01	6.330E-01	0.3417	2.582E+04	2.582E+04	-0.05382	1.000E+00
34	1992	9.120E-01	5.194E-01	0.4401	2.728E+04	2.728E+04	-0.56288	1.000E+00
35	1993	8.010E-01	4.093E-01	0.4362	2.131E+04	2.131E+04	-0.67138	1.000E+00
36	1994	8.020E-01	3.787E-01	0.1270	5.741E+03	5.741E+03	-0.75048	1.000E+00
37	1995	*	4.280E-01	0.0389	1.989E+03	1.989E+03	0.00000	1.000E+00
38	1996	*	5.108E-01	0.0074	4.510E+02	4.510E+02	0.00000	1.000E+00
39	1997	*	6.145E-01	0.0086	6.300E+02	6.300E+02	0.00000	1.000E+00
40	1998	*	7.324E-01	0.0103	8.990E+02	8.990E+02	0.00000	1.000E+00
41	1999	*	8.589E-01	0.0226	2.318E+03	2.318E+03	0.00000	1.000E+00
42	2000	*	9.901E-01	0.0266	3.141E+03	3.141E+03	0.00000	1.000E+00
43	2001	*	1.137E+00	0.0106	1.442E+03	1.442E+03	0.00000	1.000E+00
44	2002	*	1.303E+00	0.0078	1.216E+03	1.216E+03	0.00000	1.000E+00
45	2003	*	1.478E+00	0.0076	1.334E+03	1.334E+03	0.00000	1.000E+00
46	2004	*	1.658E+00	0.0032	6.370E+02	6.370E+02	0.00000	1.000E+00
47	2005	*	1.840E+00	0.0030	6.590E+02	6.590E+02	0.00000	1.000E+00
48	2006	*	2.017E+00	0.0021	4.960E+02	4.960E+02	0.00000	1.000E+00
49	2007	*	2.181E+00	0.0064	1.664E+03	1.664E+03	0.00000	1.000E+00
50	2008	*	2.331E+00	0.0021	5.970E+02	5.970E+02	0.00000	1.000E+00
51	2009	*	2.472E+00	0.0016	4.820E+02	4.820E+02	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1
                   -1       -0.75     -0.5      -0.25       0        0.25      0.5       0.75       1
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    ------------------------------------------------------------------------------------
1959     0.1505                                             |======
1960    -0.0320                                            =|
1961    -0.1021                                         ====|
1962    -0.0612                                           ==|
1963    -0.0726                                          ===|
1964    -0.1565                                       ======|
1965    -0.3136                                =============|
1966    -0.0966                                         ====|
1967    -0.1555                                       ======|
1968     0.5651                                             |=======================
1969     0.1995                                             |========
1970     0.1937                                             |========
1971     0.1988                                             |========
1972     0.1218                                             |=====
1973    -0.0952                                         ====|
1974     0.1167                                             |=====
1975    -0.1276                                        =====|
1976     0.1466                                             |======
1977     0.2009                                             |========
1978     0.3684                                             |===============
1979     0.1456                                             |======
1980    -0.0115                                             |
1981     0.0987                                             |====
1982     0.0554                                             |==
1983     0.1291                                             |=====
1984     0.5473                                             |======================
1985     0.5351                                             |=====================
1986     0.2245                                             |=========
1987    -0.0627                                          ===|
1988    -0.1295                                        =====|
1989    -0.4308                            =================|
1990    -0.1128                                        =====|
1991    -0.0538                                           ==|
1992    -0.5629                      =======================|
1993    -0.6714                  ===========================|
1994    -0.7505               ==============================|
1995     0.0000                                             |
1996     0.0000                                             |
1997     0.0000                                             |
1998     0.0000                                             |
1999     0.0000                                             |
2000     0.0000                                             |
2001     0.0000                                             |
2002     0.0000                                             |
2003     0.0000                                             |
2004     0.0000                                             |
2005     0.0000                                             |
2006     0.0000                                             |
2007     0.0000                                             |
2008     0.0000                                             |
2009     0.0000                                             |
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RESULTS FOR DATA SERIES # 2 (NON-BOOTSTRAPPED) 3LN spring 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	1959	0.000E+00	0.000E+00	--	*	6.184E+04	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	5.789E+04	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	5.717E+04	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	5.724E+04	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	5.663E+04	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	5.781E+04	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	5.958E+04	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	6.033E+04	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	6.046E+04	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	6.053E+04	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	6.095E+04	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	6.190E+04	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	6.126E+04	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	5.845E+04	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	5.573E+04	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	5.409E+04	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	5.481E+04	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	5.582E+04	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	5.706E+04	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	5.965E+04	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	6.262E+04	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	6.495E+04	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	6.564E+04	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	6.550E+04	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	6.606E+04	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	6.766E+04	0.00000	1.000E+00
27	1985	0.000E+00	0.000E+00	--	*	6.906E+04	0.00000	1.000E+00
28	1986	0.000E+00	0.000E+00	--	*	6.599E+04	0.00000	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	5.337E+04	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	3.960E+04	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	3.206E+04	0.00000	1.000E+00
32	1990	0.000E+00	0.000E+00	--	*	2.750E+04	0.00000	1.000E+00
33	1991	1.000E+00	1.000E+00	--	1.064E+04	2.362E+04	-0.79718	1.000E+00
34	1992	1.000E+00	1.000E+00	--	1.007E+04	1.938E+04	-0.65511	1.000E+00
35	1993	1.000E+00	1.000E+00	--	2.257E+04	1.527E+04	0.39075	1.000E+00
36	1994	1.000E+00	1.000E+00	--	4.162E+03	1.413E+04	-1.22216	1.000E+00
37	1995	1.000E+00	1.000E+00	--	5.856E+03	1.597E+04	-1.00314	1.000E+00
38	1996	1.000E+00	1.000E+00	--	2.281E+04	1.906E+04	0.17972	1.000E+00
39	1997	1.000E+00	1.000E+00	--	1.493E+04	2.293E+04	-0.42917	1.000E+00
40	1998	1.000E+00	1.000E+00	--	5.940E+04	2.733E+04	0.77651	1.000E+00
41	1999	1.000E+00	1.000E+00	--	6.150E+04	3.205E+04	0.65175	1.000E+00
42	2000	1.000E+00	1.000E+00	--	8.784E+04	3.694E+04	0.86619	1.000E+00
43	2001	1.000E+00	1.000E+00	--	4.157E+04	4.243E+04	-0.02036	1.000E+00
44	2002	1.000E+00	1.000E+00	--	3.096E+04	4.862E+04	-0.45147	1.000E+00
45	2003	1.000E+00	1.000E+00	--	2.770E+04	5.513E+04	-0.68825	1.000E+00
46	2004	1.000E+00	1.000E+00	--	7.963E+04	6.186E+04	0.25258	1.000E+00
47	2005	1.000E+00	1.000E+00	--	6.646E+04	6.866E+04	-0.03249	1.000E+00
48	2006	0.000E+00	0.000E+00	--	*	7.527E+04	0.00000	1.000E+00
49	2007	1.000E+00	1.000E+00	--	2.188E+05	8.137E+04	0.98941	1.000E+00
50	2008	1.000E+00	1.000E+00	--	1.440E+05	8.698E+04	0.50398	1.000E+00
51	2009	1.000E+00	1.000E+00	--	1.834E+05	9.223E+04	0.68730	1.000E+00

* Asterisk indicates missing value(s).

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3LN redfish                                                                                              Page 7

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 2
                   -2       -1.5       -1       -0.5        0        0.5        1        1.5        2
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    -------------------------------------------------------------------------------------
1959     0.0000                                             |
1960     0.0000                                             |
1961     0.0000                                             |
1962     0.0000                                             |
1963     0.0000                                             |
1964     0.0000                                             |
1965     0.0000                                             |
1966     0.0000                                             |
1967     0.0000                                             |
1968     0.0000                                             |
1969     0.0000                                             |
1970     0.0000                                             |
1971     0.0000                                             |
1972     0.0000                                             |
1973     0.0000                                             |
1974     0.0000                                             |
1975     0.0000                                             |
1976     0.0000                                             |
1977     0.0000                                             |
1978     0.0000                                             |
1979     0.0000                                             |
1980     0.0000                                             |
1981     0.0000                                             |
1982     0.0000                                             |
1983     0.0000                                             |
1984     0.0000                                             |
1985     0.0000                                             |
1986     0.0000                                             |
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990     0.0000                                             |
1991    -0.7972                             ================|
1992    -0.6551                                =============|
1993     0.3908                                             |========
1994    -1.2222                     ========================|
1995    -1.0031                         ====================|
1996     0.1797                                             |====
1997    -0.4292                                    =========|
1998     0.7765                                             |================
1999     0.6518                                             |=============
2000     0.8662                                             |=================
2001    -0.0204                                             |
2002    -0.4515                                    =========|
2003    -0.6882                               ==============|
2004     0.2526                                             |=====
2005    -0.0325                                            =|
2006     0.0000                                             |
2007     0.9894                                             |====================
2008     0.5040                                             |==========
2009     0.6873                                             |==============
                   -------------------------------------------------------------------------------------
```

RESULTS FOR DATA SERIES # 3 (NON-BOOTSTRAPPED) 3N autumn survey

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

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Statist weight
1	1959	0.000E+00	0.000E+00	--	*	7.056E+04	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	6.904E+04	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	6.879E+04	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	6.920E+04	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	6.736E+04	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	7.199E+04	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	7.165E+04	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	7.377E+04	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	7.203E+04	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	7.389E+04	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	7.307E+04	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	7.614E+04	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	7.170E+04	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	6.929E+04	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	6.520E+04	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	6.522E+04	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	6.692E+04	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	6.764E+04	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	6.990E+04	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	7.387E+04	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	7.707E+04	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	7.949E+04	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	7.879E+04	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	7.913E+04	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	8.012E+04	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	8.295E+04	0.00000	1.000E+00
27	1985	0.000E+00	0.000E+00	--	*	8.355E+04	0.00000	1.000E+00
28	1986	0.000E+00	0.000E+00	--	*	7.585E+04	0.00000	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	5.439E+04	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	4.179E+04	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	3.573E+04	0.00000	1.000E+00
32	1990	0.000E+00	0.000E+00	--	*	3.074E+04	0.00000	1.000E+00
33	1991	1.000E+00	1.000E+00	--	2.422E+04	2.635E+04	-0.08431	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	2.064E+04	0.00000	1.000E+00
35	1993	1.000E+00	1.000E+00	--	1.322E+04	1.636E+04	-0.21320	1.000E+00
36	1994	1.000E+00	1.000E+00	--	2.458E+04	1.771E+04	0.32794	1.000E+00
37	1995	1.000E+00	1.000E+00	--	4.065E+04	2.086E+04	0.66722	1.000E+00
38	1996	1.000E+00	1.000E+00	--	1.128E+04	2.520E+04	-0.80423	1.000E+00
39	1997	1.000E+00	1.000E+00	--	5.112E+04	3.019E+04	0.52653	1.000E+00
40	1998	1.000E+00	1.000E+00	--	9.370E+04	3.580E+04	0.96218	1.000E+00
41	1999	1.000E+00	1.000E+00	--	3.312E+04	4.155E+04	-0.22662	1.000E+00
42	2000	1.000E+00	1.000E+00	--	7.554E+04	4.758E+04	0.46226	1.000E+00
43	2001	1.000E+00	1.000E+00	--	1.040E+05	5.478E+04	0.64097	1.000E+00
44	2002	1.000E+00	1.000E+00	--	3.826E+04	6.250E+04	-0.49074	1.000E+00
45	2003	1.000E+00	1.000E+00	--	5.688E+04	7.043E+04	-0.21370	1.000E+00
46	2004	1.000E+00	1.000E+00	--	4.061E+04	7.869E+04	-0.66143	1.000E+00
47	2005	1.000E+00	1.000E+00	--	4.191E+04	8.679E+04	-0.72798	1.000E+00
48	2006	1.000E+00	1.000E+00	--	6.466E+04	9.460E+04	-0.38048	1.000E+00
49	2007	1.000E+00	1.000E+00	--	6.721E+04	1.015E+05	-0.41193	1.000E+00
50	2008	1.000E+00	1.000E+00	--	1.452E+05	1.081E+05	0.29490	1.000E+00
51	2009	1.000E+00	1.000E+00	--	1.595E+05	1.141E+05	0.33463	1.000E+00

* Asterisk indicates missing value(s).

```
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    ------------------------------------------------------------------------------------
1959     0.0000                                             |
1960     0.0000                                             |
1961     0.0000                                             |
1962     0.0000                                             |
1963     0.0000                                             |
1964     0.0000                                             |
1965     0.0000                                             |
1966     0.0000                                             |
1967     0.0000                                             |
1968     0.0000                                             |
1969     0.0000                                             |
1970     0.0000                                             |
1971     0.0000                                             |
1972     0.0000                                             |
1973     0.0000                                             |
1974     0.0000                                             |
1975     0.0000                                             |
1976     0.0000                                             |
1977     0.0000                                             |
1978     0.0000                                             |
1979     0.0000                                             |
1980     0.0000                                             |
1981     0.0000                                             |
1982     0.0000                                             |
1983     0.0000                                             |
1984     0.0000                                             |
1985     0.0000                                             |
1986     0.0000                                             |
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990     0.0000                                             |
1991    -0.0843                                          ===|
1992     0.0000                                             |
1993    -0.2132                                    =========|
1994     0.3279                                             |=============
1995     0.6672                                             |===========================
1996    -0.8042             ================================|
1997     0.5265                                             |=====================
1998     0.9622                                             |======================================
1999    -0.2266                                    =========|
2000     0.4623                                             |==================
2001     0.6410                                             |==========================
2002    -0.4907                         ====================|
2003    -0.2137                                    =========|
2004    -0.6614                   ==========================|
2005    -0.7280                =============================|
2006    -0.3805                              ===============|
2007    -0.4119                             ================|
2008     0.2949                                             |============
2009     0.3346                                             |=============
                   ------------------------------------------------------------------------------------
```

RESULTS FOR DATA SERIES # 4 (NON-BOOTSTRAPPED) 3LN Power 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	1959	0.000E+00	0.000E+00	--	*	5.764E+04	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	5.395E+04	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	5.328E+04	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	5.335E+04	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	5.278E+04	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	5.388E+04	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	5.553E+04	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	5.623E+04	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	5.635E+04	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	5.642E+04	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	5.680E+04	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	5.770E+04	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	5.710E+04	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	5.448E+04	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	5.195E+04	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	5.041E+04	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	5.109E+04	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	5.202E+04	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	5.318E+04	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	5.559E+04	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	5.837E+04	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	6.054E+04	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	6.118E+04	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	6.105E+04	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	6.157E+04	0.00000	1.000E+00
26	1984	1.000E+00	1.000E+00	--	2.159E+05	6.306E+04	1.23069	1.000E+00
27	1985	1.000E+00	1.000E+00	--	9.400E+04	6.437E+04	0.37864	1.000E+00
28	1986	1.000E+00	1.000E+00	--	6.298E+04	6.151E+04	0.02362	1.000E+00
29	1987	1.000E+00	1.000E+00	--	7.030E+04	4.974E+04	0.34584	1.000E+00
30	1988	1.000E+00	1.000E+00	--	4.488E+04	3.690E+04	0.19575	1.000E+00
31	1989	1.000E+00	1.000E+00	--	1.227E+04	2.988E+04	-0.89025	1.000E+00
32	1990	1.000E+00	1.000E+00	--	8.365E+03	2.563E+04	-1.11966	1.000E+00
33	1991	1.000E+00	1.000E+00	--	1.868E+04	2.201E+04	-0.16414	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	1.806E+04	0.00000	1.000E+00
35	1993	0.000E+00	0.000E+00	--	*	1.423E+04	0.00000	1.000E+00
36	1994	0.000E+00	0.000E+00	--	*	1.317E+04	0.00000	1.000E+00
37	1995	0.000E+00	0.000E+00	--	*	1.488E+04	0.00000	1.000E+00
38	1996	0.000E+00	0.000E+00	--	*	1.776E+04	0.00000	1.000E+00
39	1997	0.000E+00	0.000E+00	--	*	2.137E+04	0.00000	1.000E+00
40	1998	0.000E+00	0.000E+00	--	*	2.547E+04	0.00000	1.000E+00
41	1999	0.000E+00	0.000E+00	--	*	2.987E+04	0.00000	1.000E+00
42	2000	0.000E+00	0.000E+00	--	*	3.443E+04	0.00000	1.000E+00
43	2001	0.000E+00	0.000E+00	--	*	3.954E+04	0.00000	1.000E+00
44	2002	0.000E+00	0.000E+00	--	*	4.532E+04	0.00000	1.000E+00
45	2003	0.000E+00	0.000E+00	--	*	5.138E+04	0.00000	1.000E+00
46	2004	0.000E+00	0.000E+00	--	*	5.765E+04	0.00000	1.000E+00
47	2005	0.000E+00	0.000E+00	--	*	6.399E+04	0.00000	1.000E+00
48	2006	0.000E+00	0.000E+00	--	*	7.015E+04	0.00000	1.000E+00
49	2007	0.000E+00	0.000E+00	--	*	7.583E+04	0.00000	1.000E+00
50	2008	0.000E+00	0.000E+00	--	*	8.107E+04	0.00000	1.000E+00
51	2009	0.000E+00	0.000E+00	--	*	8.596E+04	0.00000	1.000E+00

* Asterisk indicates missing value(s).

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 4

```
                   -2       -1.5       -1       -0.5        0        0.5        1        1.5        2
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    ------------------------------------------------------------------------------------
1959     0.0000                                             |
1960     0.0000                                             |
1961     0.0000                                             |
1962     0.0000                                             |
1963     0.0000                                             |
1964     0.0000                                             |
1965     0.0000                                             |
1966     0.0000                                             |
1967     0.0000                                             |
1968     0.0000                                             |
1969     0.0000                                             |
1970     0.0000                                             |
1971     0.0000                                             |
1972     0.0000                                             |
1973     0.0000                                             |
1974     0.0000                                             |
1975     0.0000                                             |
1976     0.0000                                             |
1977     0.0000                                             |
1978     0.0000                                             |
1979     0.0000                                             |
1980     0.0000                                             |
1981     0.0000                                             |
1982     0.0000                                             |
1983     0.0000                                             |
1984     1.2307                                             |=========================
1985     0.3786                                             |========
1986     0.0236                                             |
1987     0.3458                                             |=======
1988     0.1957                                             |====
1989    -0.8902                           ==================|
1990    -1.1197                       ======================|
1991    -0.1641                                          ===|
1992     0.0000                                             |
1993     0.0000                                             |
1994     0.0000                                             |
1995     0.0000                                             |
1996     0.0000                                             |
1997     0.0000                                             |
1998     0.0000                                             |
1999     0.0000                                             |
2000     0.0000                                             |
2001     0.0000                                             |
2002     0.0000                                             |
2003     0.0000                                             |
2004     0.0000                                             |
2005     0.0000                                             |
2006     0.0000                                             |
2007     0.0000                                             |
2008     0.0000                                             |
2009     0.0000                                             |
                   ------------------------------------------------------------------------------------
```

RESULTS FOR DATA SERIES # 5 (NON-BOOTSTRAPPED) 3L winter survey

Data type I0: Abundance index (start 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	1959	0.000E+00	0.000E+00	--	*	4.919E+04	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	4.401E+04	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	4.306E+04	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	4.291E+04	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	4.316E+04	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	4.202E+04	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	4.490E+04	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	4.469E+04	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	4.601E+04	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	4.493E+04	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	4.609E+04	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	4.558E+04	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	4.749E+04	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	4.472E+04	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	4.322E+04	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	4.067E+04	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	4.068E+04	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	4.174E+04	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	4.219E+04	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	4.360E+04	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	4.608E+04	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	4.807E+04	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	4.958E+04	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	4.915E+04	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	4.935E+04	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	4.997E+04	0.00000	1.000E+00
27	1985	1.000E+00	1.000E+00	--	9.024E+04	5.174E+04	0.55631	1.000E+00
28	1986	1.000E+00	1.000E+00	--	3.657E+04	5.211E+04	-0.35418	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	4.731E+04	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	3.393E+04	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	2.606E+04	0.00000	1.000E+00
32	1990	1.000E+00	1.000E+00	--	1.820E+04	2.229E+04	-0.20246	1.000E+00
33	1991	0.000E+00	0.000E+00	--	*	1.917E+04	0.00000	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	1.644E+04	0.00000	1.000E+00
35	1993	0.000E+00	0.000E+00	--	*	1.288E+04	0.00000	1.000E+00
36	1994	0.000E+00	0.000E+00	--	*	1.021E+04	0.00000	1.000E+00
37	1995	0.000E+00	0.000E+00	--	*	1.105E+04	0.00000	1.000E+00
38	1996	0.000E+00	0.000E+00	--	*	1.301E+04	0.00000	1.000E+00
39	1997	0.000E+00	0.000E+00	--	*	1.572E+04	0.00000	1.000E+00
40	1998	0.000E+00	0.000E+00	--	*	1.883E+04	0.00000	1.000E+00
41	1999	0.000E+00	0.000E+00	--	*	2.233E+04	0.00000	1.000E+00
42	2000	0.000E+00	0.000E+00	--	*	2.592E+04	0.00000	1.000E+00
43	2001	0.000E+00	0.000E+00	--	*	2.968E+04	0.00000	1.000E+00
44	2002	0.000E+00	0.000E+00	--	*	3.417E+04	0.00000	1.000E+00
45	2003	0.000E+00	0.000E+00	--	*	3.898E+04	0.00000	1.000E+00
46	2004	0.000E+00	0.000E+00	--	*	4.393E+04	0.00000	1.000E+00
47	2005	0.000E+00	0.000E+00	--	*	4.908E+04	0.00000	1.000E+00
48	2006	0.000E+00	0.000E+00	--	*	5.414E+04	0.00000	1.000E+00
49	2007	0.000E+00	0.000E+00	--	*	5.901E+04	0.00000	1.000E+00
50	2008	0.000E+00	0.000E+00	--	*	6.329E+04	0.00000	1.000E+00
51	2009	0.000E+00	0.000E+00	--	*	6.744E+04	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 5
                   -1       -0.75     -0.5      -0.25       0        0.25      0.5       0.75       1
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    ------------------------------------------------------------------------------------
1959     0.0000                                             |
1960     0.0000                                             |
1961     0.0000                                             |
1962     0.0000                                             |
1963     0.0000                                             |
1964     0.0000                                             |
1965     0.0000                                             |
1966     0.0000                                             |
1967     0.0000                                             |
1968     0.0000                                             |
1969     0.0000                                             |
1970     0.0000                                             |
1971     0.0000                                             |
1972     0.0000                                             |
1973     0.0000                                             |
1974     0.0000                                             |
1975     0.0000                                             |
1976     0.0000                                             |
1977     0.0000                                             |
1978     0.0000                                             |
1979     0.0000                                             |
1980     0.0000                                             |
1981     0.0000                                             |
1982     0.0000                                             |
1983     0.0000                                             |
1984     0.0000                                             |
1985     0.5563                                             |======================
1986    -0.3542                               ==============|
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990    -0.2025                                     ========|
1991     0.0000                                             |
1992     0.0000                                             |
1993     0.0000                                             |
1994     0.0000                                             |
1995     0.0000                                             |
1996     0.0000                                             |
1997     0.0000                                             |
1998     0.0000                                             |
1999     0.0000                                             |
2000     0.0000                                             |
2001     0.0000                                             |
2002     0.0000                                             |
2003     0.0000                                             |
2004     0.0000                                             |
2005     0.0000                                             |
2006     0.0000                                             |
2007     0.0000                                             |
2008     0.0000                                             |
2009     0.0000                                             |
                   ------------------------------------------------------------------------------------
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RESULTS FOR DATA SERIES # 6 (NON-BOOTSTRAPPED) 3L summer 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	1959	0.000E+00	0.000E+00	--	*	1.806E+05	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	1.691E+05	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	1.670E+05	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	1.672E+05	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	1.654E+05	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	1.688E+05	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	1.740E+05	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	1.762E+05	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	1.766E+05	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	1.768E+05	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	1.780E+05	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	1.808E+05	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	1.789E+05	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	1.707E+05	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	1.628E+05	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	1.580E+05	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	1.601E+05	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	1.630E+05	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	1.667E+05	0.00000	1.000E+00
20	1978	1.000E+00	1.000E+00	--	3.112E+05	1.742E+05	0.58006	1.000E+00
21	1979	1.000E+00	1.000E+00	--	2.278E+05	1.829E+05	0.21951	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	1.897E+05	0.00000	1.000E+00
23	1981	1.000E+00	1.000E+00	--	2.614E+05	1.917E+05	0.30996	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	1.913E+05	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	1.929E+05	0.00000	1.000E+00
26	1984	1.000E+00	1.000E+00	--	2.777E+05	1.976E+05	0.34036	1.000E+00
27	1985	1.000E+00	1.000E+00	--	1.610E+05	2.017E+05	-0.22515	1.000E+00
28	1986	0.000E+00	0.000E+00	--	*	1.927E+05	0.00000	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	1.559E+05	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	1.156E+05	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	9.364E+04	0.00000	1.000E+00
32	1990	1.000E+00	1.000E+00	--	9.284E+04	8.031E+04	0.14499	1.000E+00
33	1991	1.000E+00	1.000E+00	--	3.757E+04	6.898E+04	-0.60751	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	5.660E+04	0.00000	1.000E+00
35	1993	1.000E+00	1.000E+00	--	2.084E+04	4.460E+04	-0.76100	1.000E+00
36	1994	0.000E+00	0.000E+00	--	*	4.126E+04	0.00000	1.000E+00
37	1995	0.000E+00	0.000E+00	--	*	4.664E+04	0.00000	1.000E+00
38	1996	0.000E+00	0.000E+00	--	*	5.566E+04	0.00000	1.000E+00
39	1997	0.000E+00	0.000E+00	--	*	6.697E+04	0.00000	1.000E+00
40	1998	0.000E+00	0.000E+00	--	*	7.981E+04	0.00000	1.000E+00
41	1999	0.000E+00	0.000E+00	--	*	9.360E+04	0.00000	1.000E+00
42	2000	0.000E+00	0.000E+00	--	*	1.079E+05	0.00000	1.000E+00
43	2001	0.000E+00	0.000E+00	--	*	1.239E+05	0.00000	1.000E+00
44	2002	0.000E+00	0.000E+00	--	*	1.420E+05	0.00000	1.000E+00
45	2003	0.000E+00	0.000E+00	--	*	1.610E+05	0.00000	1.000E+00
46	2004	0.000E+00	0.000E+00	--	*	1.807E+05	0.00000	1.000E+00
47	2005	0.000E+00	0.000E+00	--	*	2.005E+05	0.00000	1.000E+00
48	2006	0.000E+00	0.000E+00	--	*	2.198E+05	0.00000	1.000E+00
49	2007	0.000E+00	0.000E+00	--	*	2.376E+05	0.00000	1.000E+00
50	2008	0.000E+00	0.000E+00	--	*	2.540E+05	0.00000	1.000E+00
51	2009	0.000E+00	0.000E+00	--	*	2.694E+05	0.00000	1.000E+00

* Asterisk indicates missing value(s).

```
UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 6
                   -1       -0.75     -0.5      -0.25       0        0.25      0.5       0.75      1
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    ------------------------------------------------------------------------------------
1959     0.0000                                             |
1960     0.0000                                             |
1961     0.0000                                             |
1962     0.0000                                             |
1963     0.0000                                             |
1964     0.0000                                             |
1965     0.0000                                             |
1966     0.0000                                             |
1967     0.0000                                             |
1968     0.0000                                             |
1969     0.0000                                             |
1970     0.0000                                             |
1971     0.0000                                             |
1972     0.0000                                             |
1973     0.0000                                             |
1974     0.0000                                             |
1975     0.0000                                             |
1976     0.0000                                             |
1977     0.0000                                             |
1978     0.5801                                             |=======================
1979     0.2195                                             |=========
1980     0.0000                                             |
1981     0.3100                                             |============
1982     0.0000                                             |
1983     0.0000                                             |
1984     0.3404                                             |==============
1985    -0.2251                                    =========|
1986     0.0000                                             |
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990     0.1450                                             |======
1991    -0.6075                     ========================|
1992     0.0000                                             |
1993    -0.7610               ==============================|
1994     0.0000                                             |
1995     0.0000                                             |
1996     0.0000                                             |
1997     0.0000                                             |
1998     0.0000                                             |
1999     0.0000                                             |
2000     0.0000                                             |
2001     0.0000                                             |
2002     0.0000                                             |
2003     0.0000                                             |
2004     0.0000                                             |
2005     0.0000                                             |
2006     0.0000                                             |
2007     0.0000                                             |
2008     0.0000                                             |
2009     0.0000                                             |
                   ------------------------------------------------------------------------------------
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RESULTS FOR DATA SERIES # 7 (NON-BOOTSTRAPPED) 3L autumn survey

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

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Statist weight
1	1959	0.000E+00	0.000E+00	--	*	2.905E+04	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	2.843E+04	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	2.833E+04	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	2.849E+04	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	2.774E+04	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	2.964E+04	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	2.950E+04	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	3.037E+04	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	2.966E+04	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	3.042E+04	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	3.009E+04	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	3.135E+04	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	2.952E+04	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	2.853E+04	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	2.685E+04	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	2.685E+04	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	2.755E+04	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	2.785E+04	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	2.878E+04	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	3.042E+04	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	3.173E+04	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	3.273E+04	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	3.244E+04	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	3.258E+04	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	3.299E+04	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	3.416E+04	0.00000	1.000E+00
27	1985	1.000E+00	1.000E+00	--	9.823E+04	3.440E+04	1.04928	1.000E+00
28	1986	1.000E+00	1.000E+00	--	1.712E+04	3.123E+04	-0.60120	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	2.240E+04	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	1.721E+04	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	1.471E+04	0.00000	1.000E+00
32	1990	1.000E+00	1.000E+00	--	2.074E+04	1.266E+04	0.49409	1.000E+00
33	1991	1.000E+00	1.000E+00	--	1.366E+04	1.085E+04	0.23063	1.000E+00
34	1992	1.000E+00	1.000E+00	--	1.342E+04	8.500E+03	0.45698	1.000E+00
35	1993	1.000E+00	1.000E+00	--	6.011E+03	6.738E+03	-0.11416	1.000E+00
36	1994	1.000E+00	1.000E+00	--	7.173E+03	7.292E+03	-0.01650	1.000E+00
37	1995	0.000E+00	0.000E+00	--	*	8.589E+03	0.00000	1.000E+00
38	1996	1.000E+00	1.000E+00	--	4.691E+03	1.038E+04	-0.79402	1.000E+00
39	1997	1.000E+00	1.000E+00	--	1.954E+04	1.243E+04	0.45244	1.000E+00
40	1998	1.000E+00	1.000E+00	--	1.852E+04	1.474E+04	0.22834	1.000E+00
41	1999	1.000E+00	1.000E+00	--	3.886E+04	1.711E+04	0.82041	1.000E+00
42	2000	1.000E+00	1.000E+00	--	2.492E+04	1.959E+04	0.24042	1.000E+00
43	2001	1.000E+00	1.000E+00	--	2.857E+04	2.256E+04	0.23625	1.000E+00
44	2002	1.000E+00	1.000E+00	--	1.189E+04	2.573E+04	-0.77232	1.000E+00
45	2003	1.000E+00	1.000E+00	--	1.501E+04	2.900E+04	-0.65883	1.000E+00
46	2004	1.000E+00	1.000E+00	--	9.293E+03	3.240E+04	-1.24896	1.000E+00
47	2005	1.000E+00	1.000E+00	--	1.665E+04	3.574E+04	-0.76379	1.000E+00
48	2006	1.000E+00	1.000E+00	--	2.722E+04	3.895E+04	-0.35847	1.000E+00
49	2007	1.000E+00	1.000E+00	--	5.755E+04	4.178E+04	0.32014	1.000E+00
50	2008	1.000E+00	1.000E+00	--	5.328E+04	4.452E+04	0.17954	1.000E+00
51	2009	1.000E+00	1.000E+00	--	8.724E+04	4.699E+04	0.61887	1.000E+00

* Asterisk indicates missing value(s).

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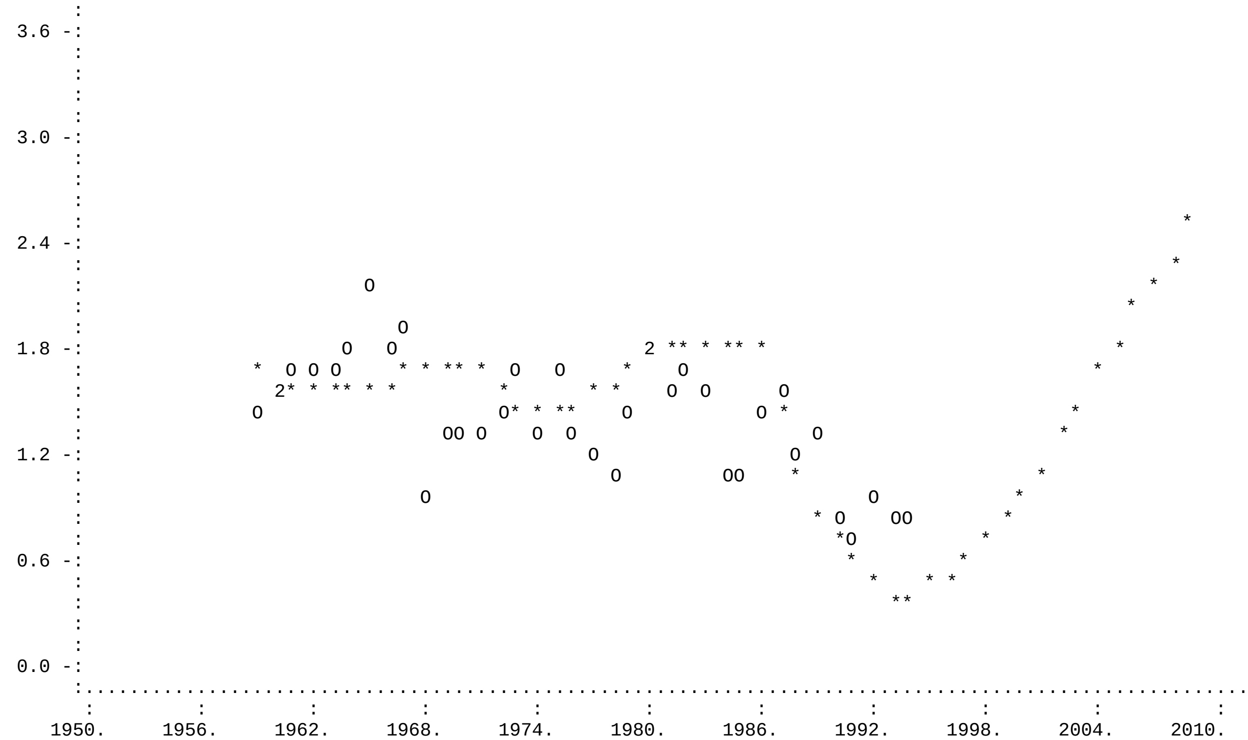
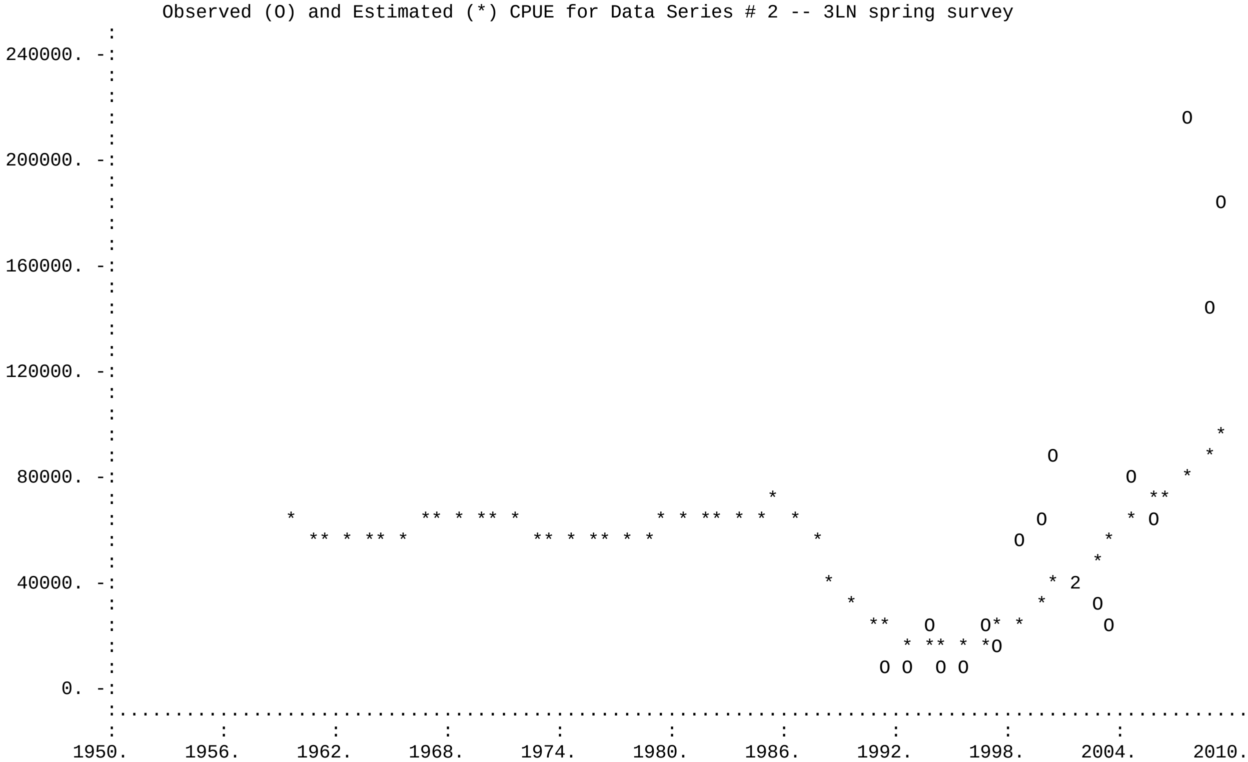
3LN redfish                                                                                             Page17

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 7
                   -2       -1.5       -1      -0.5        0        0.5        1        1.5        2
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    ------------------------------------------------------------------------------------
1959     0.0000                                             |
1960     0.0000                                             |
1961     0.0000                                             |
1962     0.0000                                             |
1963     0.0000                                             |
1964     0.0000                                             |
1965     0.0000                                             |
1966     0.0000                                             |
1967     0.0000                                             |
1968     0.0000                                             |
1969     0.0000                                             |
1970     0.0000                                             |
1971     0.0000                                             |
1972     0.0000                                             |
1973     0.0000                                             |
1974     0.0000                                             |
1975     0.0000                                             |
1976     0.0000                                             |
1977     0.0000                                             |
1978     0.0000                                             |
1979     0.0000                                             |
1980     0.0000                                             |
1981     0.0000                                             |
1982     0.0000                                             |
1983     0.0000                                             |
1984     0.0000                                             |
1985     1.0493                                             |=====================
1986    -0.6012                                 ============|
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990     0.4941                                             |==========
1991     0.2306                                             |=====
1992     0.4570                                             |=========
1993    -0.1142                                           ==|
1994    -0.0165                                             |
1995     0.0000                                             |
1996    -0.7940                             ================|
1997     0.4524                                             |=========
1998     0.2283                                             |=====
1999     0.8204                                             |================
2000     0.2404                                             |=====
2001     0.2363                                             |=====
2002    -0.7723                              ===============|
2003    -0.6588                                =============|
2004    -1.2490                    =========================|
2005    -0.7638                              ===============|
2006    -0.3585                                      =======|
2007     0.3201                                             |======
2008     0.1795                                             |====
2009     0.6189                                             |============
                   ------------------------------------------------------------------------------------
```

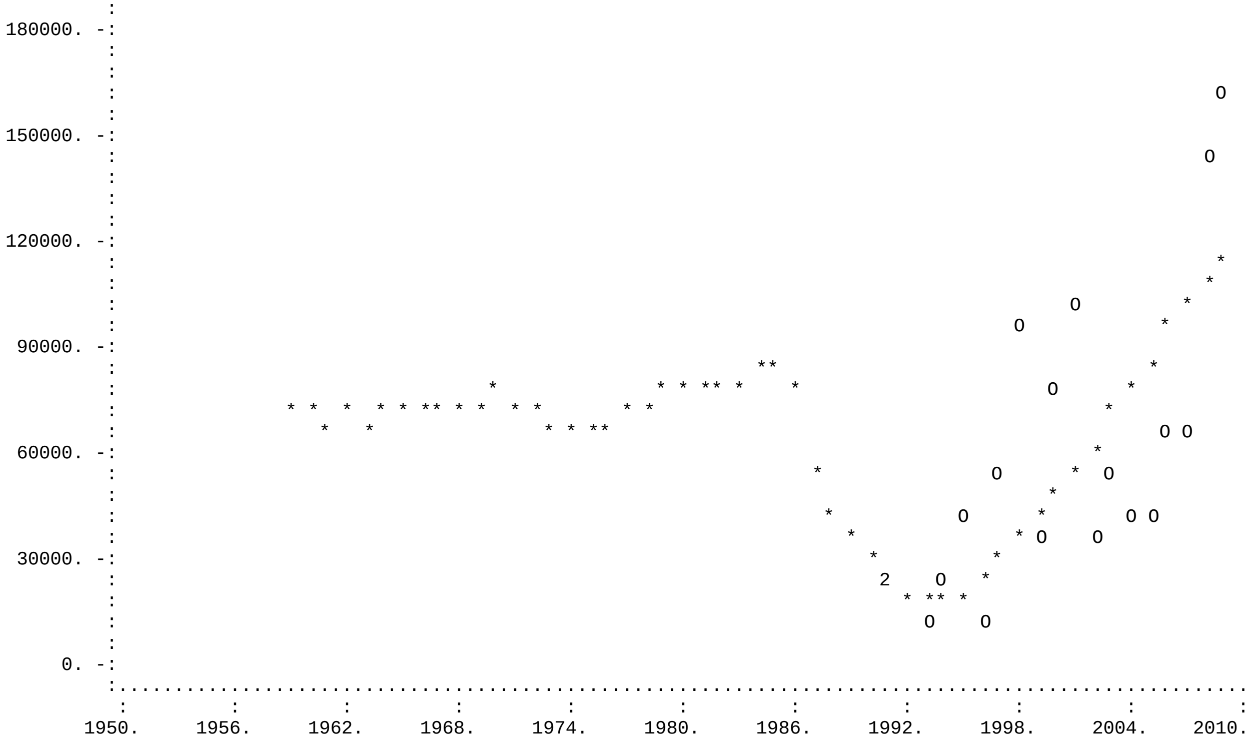
Observed (O) and Estimated (*) CPUE for Data Series # 1 -- Statlant CPUE



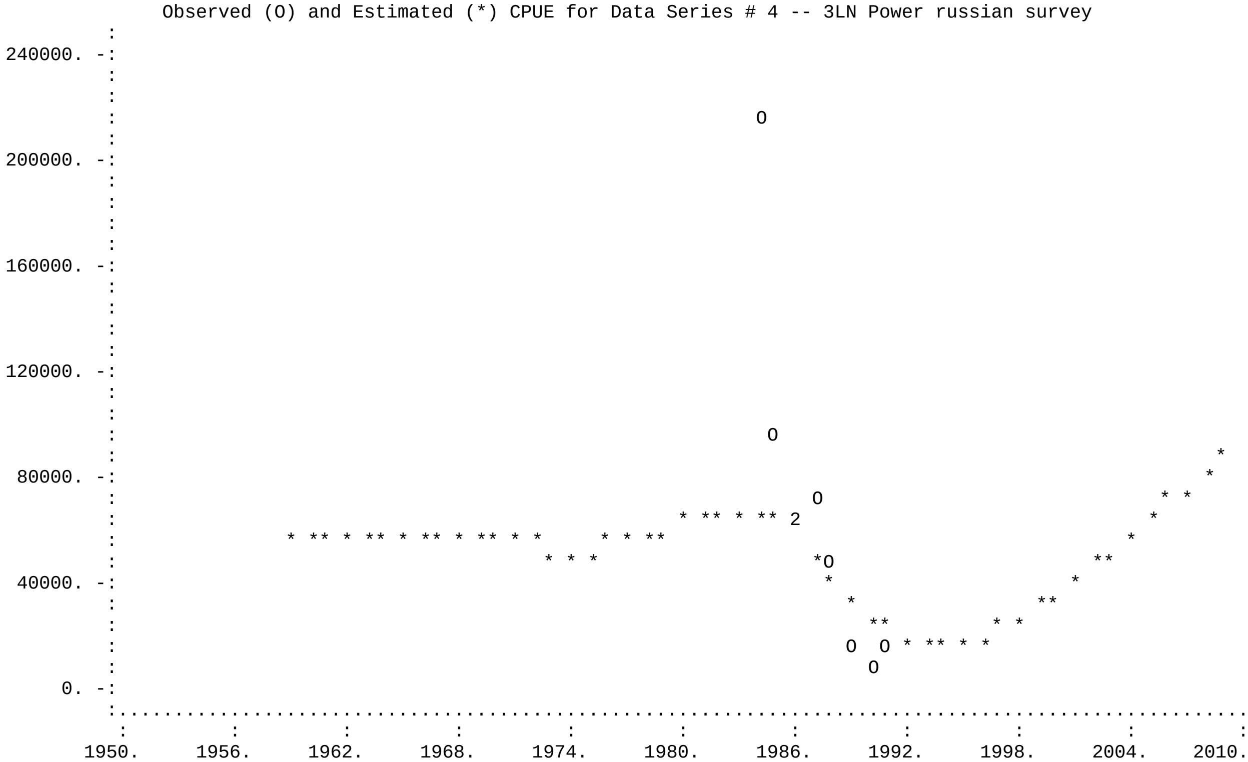
Observed (O) and Estimated (*) CPUE for Data Series # 2 -- 3LN spring survey



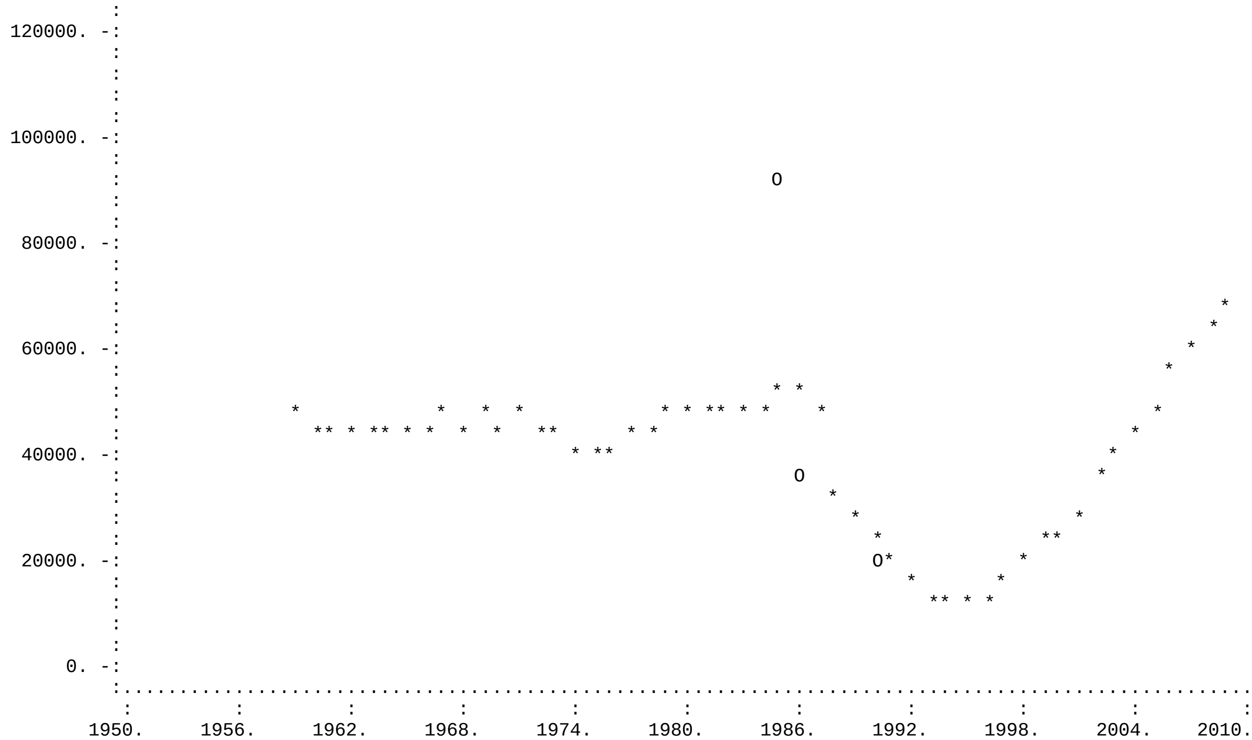
Observed (O) and Estimated (*) CPUE for Data Series # 3 -- 3N autumn survey



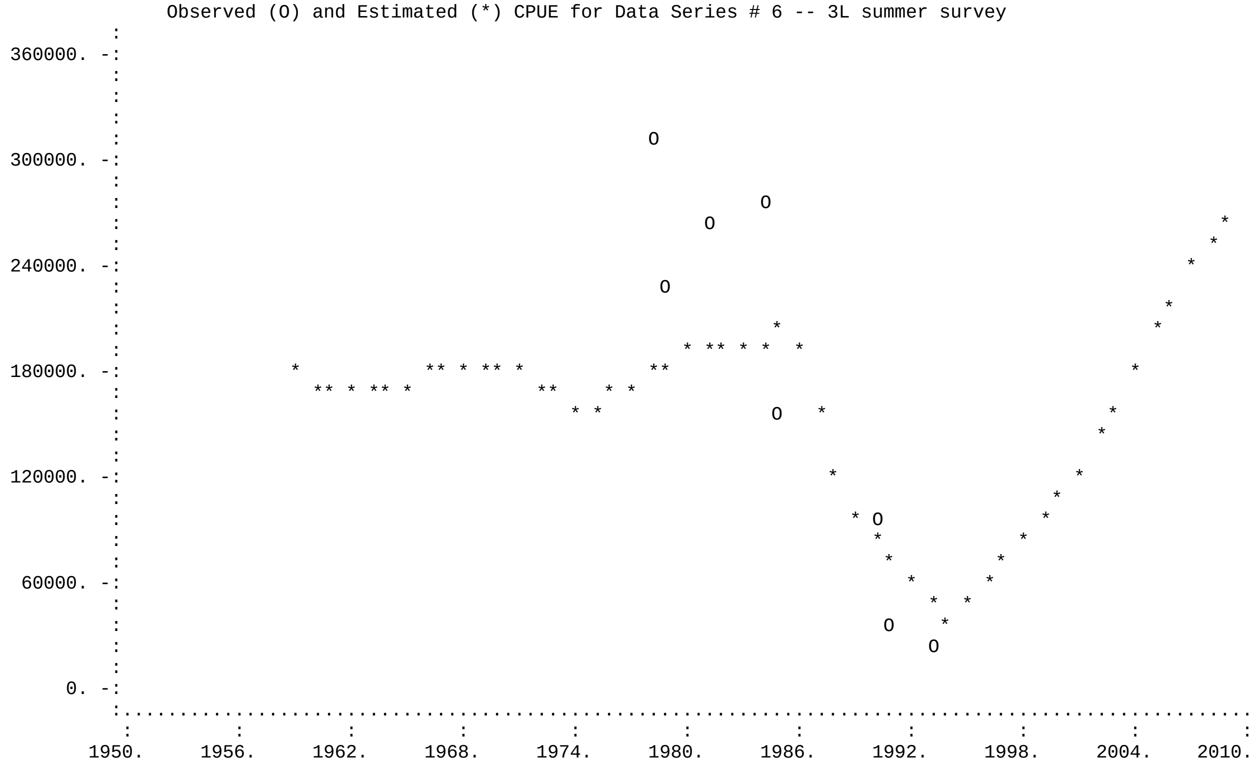
Observed (O) and Estimated (*) CPUE for Data Series # 4 -- 3LN Power russian survey



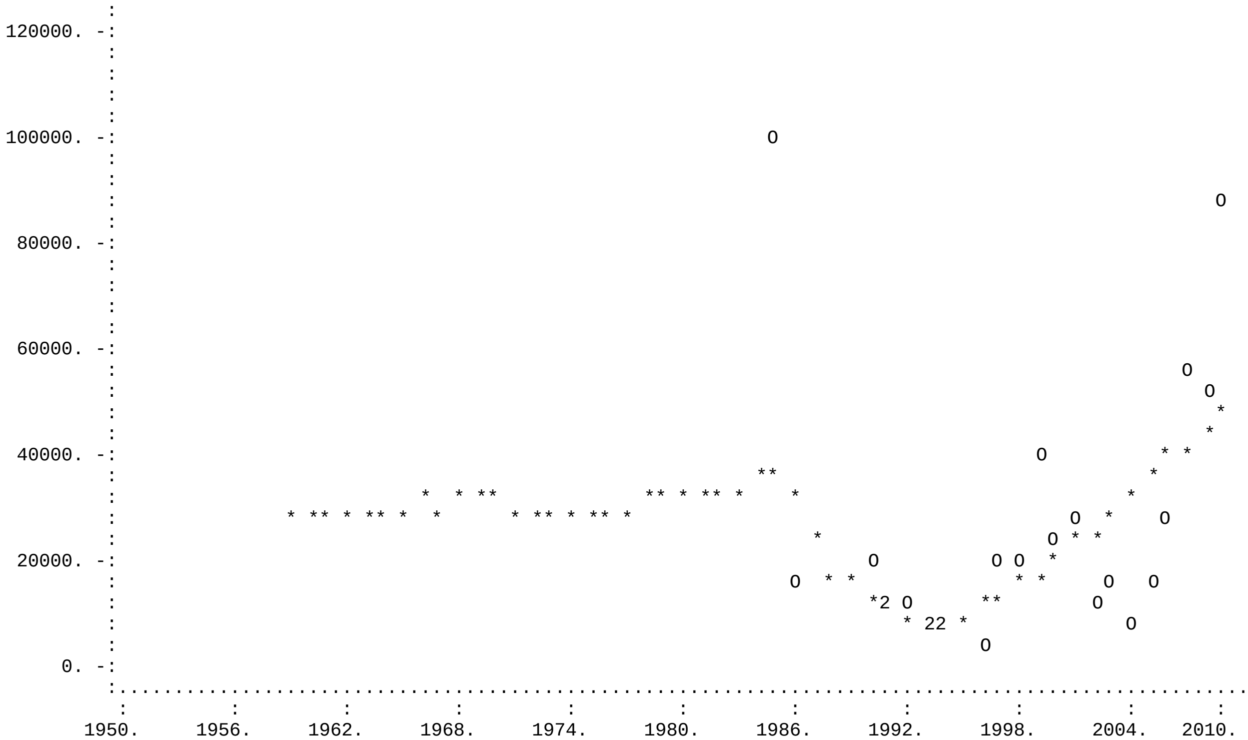
Observed (O) and Estimated (*) CPUE for Data Series # 5 -- 3L winter survey



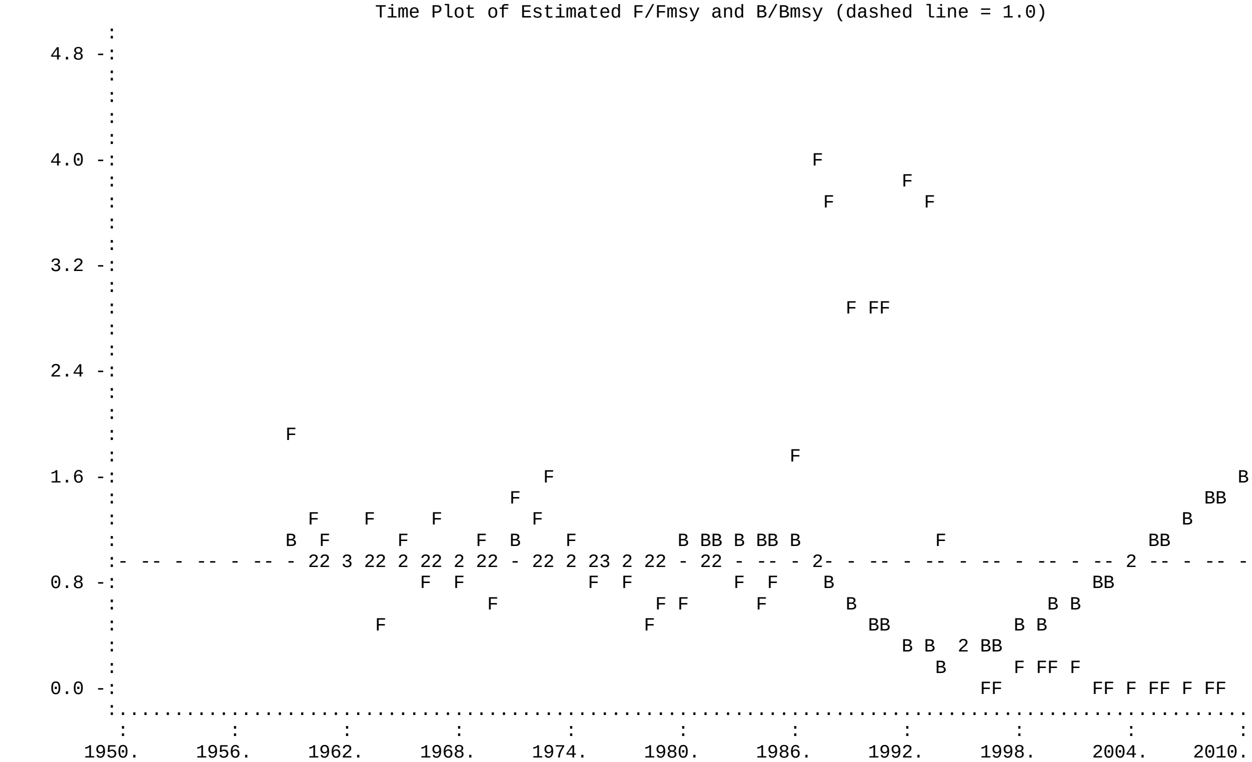
Observed (O) and Estimated (*) CPUE for Data Series # 6 -- 3L summer survey



Observed (O) and Estimated (*) CPUE for Data Series # 7 -- 3L autumn survey



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



Elapsed time: 0 hours, 0 minutes, 12 seconds.

Appendix 3: ASPIC2010 results on BOT mode

ESTIMATES FROM BOOTSTRAPPED ANALYSIS

Param name	Point estimate	Estimated bias in pt estimate	Estimated relative bias	Bias-corrected approximate confidence limits 80% lower	80% upper	50% lower	50% upper	Inter-quartile range	Relative IQ range
B1/K	5.405E-01	1.075E-01	19.90%	3.639E-01	7.355E-01	4.245E-01	6.059E-01	1.814E-01	0.336
K	3.871E+05	-1.938E+04	-5.01%	3.386E+05	4.873E+05	3.701E+05	4.640E+05	9.391E+04	0.243
q(1)	8.380E-06	2.107E-07	2.51%	6.836E-06	1.031E-05	7.410E-06	9.313E-06	1.903E-06	0.227
q(2)	3.126E-01	6.077E-03	1.94%	2.393E-01	3.980E-01	2.694E-01	3.490E-01	7.961E-02	0.255
q(3)	3.769E-01	8.998E-03	2.39%	2.931E-01	4.850E-01	3.279E-01	4.284E-01	1.005E-01	0.267
q(4)	2.914E-01	1.297E-02	4.45%	2.130E-01	3.627E-01	2.400E-01	3.217E-01	8.164E-02	0.280
q(5)	2.351E-01	2.244E-02	9.55%	1.519E-01	3.338E-01	1.796E-01	2.767E-01	9.715E-02	0.413
q(6)	9.131E-01	-2.432E-03	-0.27%	6.891E-01	1.106E+00	7.870E-01	1.025E+00	2.376E-01	0.260
q(7)	1.552E-01	3.377E-03	2.18%	1.240E-01	1.929E-01	1.373E-01	1.736E-01	3.633E-02	0.234
MSY	2.258E+04	4.253E+02	1.88%	2.064E+04	2.425E+04	2.143E+04	2.328E+04	1.848E+03	0.082
Ye(2010)	1.539E+04	-2.502E+03	-16.25%	9.705E+03	2.297E+04	1.369E+04	2.075E+04	7.059E+03	0.459
Y.@Fmsy	3.533E+04	2.147E+03	6.08%	2.374E+04	4.103E+04	2.828E+04	3.739E+04	9.108E+03	0.258
Bmsy	1.935E+05	-9.690E+03	-5.01%	1.693E+05	2.437E+05	1.851E+05	2.320E+05	4.696E+04	0.243
Fmsy	1.167E-01	1.162E-02	9.96%	8.910E-02	1.376E-01	9.798E-02	1.228E-01	2.485E-02	0.213
fmsy(1)	1.392E+04	1.213E+03	8.71%	1.075E+04	1.688E+04	1.196E+04	1.490E+04	2.945E+03	0.212
fmsy(2)	3.732E-01	4.631E-02	12.41%	2.309E-01	4.762E-01	2.761E-01	4.055E-01	1.294E-01	0.347
fmsy(3)	3.096E-01	3.725E-02	12.03%	1.895E-01	3.989E-01	2.258E-01	3.393E-01	1.135E-01	0.367
fmsy(4)	4.005E-01	3.278E-02	8.19%	3.064E-01	5.141E-01	3.414E-01	4.433E-01	1.020E-01	0.255
fmsy(5)	4.964E-01	4.608E-02	9.28%	3.201E-01	7.221E-01	3.765E-01	5.982E-01	2.217E-01	0.447
fmsy(6)	1.278E-01	1.627E-02	12.73%	9.418E-02	1.582E-01	1.046E-01	1.359E-01	3.130E-02	0.245
fmsy(7)	7.519E-01	8.234E-02	10.95%	4.955E-01	9.656E-01	5.823E-01	8.245E-01	2.422E-01	0.322
B./Bmsy	1.564E+00	5.907E-02	3.78%	1.138E+00	1.769E+00	1.282E+00	1.645E+00	3.633E-01	0.232
F./Fmsy	1.400E-02	-4.061E-04	-2.90%	1.194E-02	2.099E-02	1.316E-02	1.761E-02	4.451E-03	0.318
Ye./MSY	6.816E-01	-1.150E-01	-16.87%	4.107E-01	9.807E-01	5.863E-01	9.207E-01	3.344E-01	0.491
q2/q1	3.731E+04	6.134E+02	1.64%	2.837E+04	5.195E+04	3.253E+04	4.477E+04	1.223E+04	0.328
q3/q1	4.498E+04	1.028E+03	2.29%	3.378E+04	6.315E+04	3.912E+04	5.441E+04	1.529E+04	0.340
q4/q1	3.477E+04	1.273E+03	3.66%	2.535E+04	4.506E+04	2.917E+04	3.913E+04	9.957E+03	0.286
q5/q1	2.805E+04	2.592E+03	9.24%	1.761E+04	4.221E+04	2.177E+04	3.448E+04	1.271E+04	0.453
q6/q1	1.090E+05	-1.069E+03	-0.98%	8.444E+04	1.407E+05	9.670E+04	1.251E+05	2.841E+04	0.261
q7/q1	1.852E+04	3.632E+02	1.96%	1.390E+04	2.482E+04	1.602E+04	2.157E+04	5.554E+03	0.300

INFORMATION FOR REPAST (Prager, Porch, Shertzer, & Caddy. 2003. NAJFM 23: 349-361)

Unitless limit reference point in F (Fmsy/F.): 71.41
CV of above (from bootstrap distribution): 0.1874

NOTES ON BOOTSTRAPPED ESTIMATES:

- Bootstrap results were computed from 1000 trials.
- Results are conditional on bounds set on MSY and K in the input file.
- All bootstrapped intervals are approximate. The statistical literature recommends using at least 1000 trials for accurate 95% intervals. The default 80% intervals used by ASPIC should require fewer trials for equivalent accuracy. Using at least 500 trials is recommended.
- Bias estimates are typically of high variance and therefore may be misleading.

Trials replaced for lack of convergence: 0
Trials replaced for q out-of-bounds: 184
Trials replaced for K out-of-bounds: 237
Trials replaced for MSY out of bounds: 0
Residual-adjustment factor: 1.0479

Elapsed time: 3 hours, 41 minutes, 3 seconds.

Appendix 4: short term projection from ASPIC BOT 2010

```
'Projection with 5000 Y'   ## Projection title
'aspic.bio'                ## BIO file to read
'red3LN.prj'               ## Projection file to write
0d0                        ## Not used at present; set to 0d0
0                          ## Years to drop at start of plots
3                          ## Years of projections
482  Y                     ## Specification for projection year 1.
5000 Y                     ## Specification for projection year 2.
5000 Y                     ## Specification for projection year 3.
```

Note: the years of projection should have on each line:

1. A real number, the projected yield or effort.
   - If yield, it is in the same units as for the initial fit.
   - If effort, it is a unitless number: the multiple of the effort in the last year of the fit.
2. A character*1 indicator of whether the number is effort or yield.
   - This should be the capital letter 'Y' or 'F'.
3. Comments if desired may follow the letter, but must be delimited from it by at least one space.

Appendix 5: relative biomass and fishing mortality results from ASPIC BOT 2010 extended till 2013/2012 under a 2011-2012 catch of 5000 t

Results from ASPICP.EXE, version 3.16 12 Apr 2010 at 15:34.13
3LN redfish Page 1
Projection with 5000 Y

USER CONTROL INFORMATION (FROM INPUT FILE)

Control (CTL) file read was:	aspicp.ctl
Biomass (BIO) file read was:	aspic.bio
Output file (this file) written was:	aspicp.prj
Production-model type:	Logistic
Number of years of projections:	3
Type of confidence intervals:	Bias-corrected percentile
Confidence interval smoothing:	ON

Year	Input data	User data type
2010	4.820E+02	TAC
2011	5.000E+03	TAC
2012	5.000E+03	TAC

TRAJECTORY OF RELATIVE BIOMASS B/Bmsy (BOOTSTRAPPED)

Year	Point estimate	Estimated bias	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1959	1.081E+00	2.151E-01	19.89%	7.278E-01	1.471E+00	7.278E-01	1.471E+00	3.628E-01	0.336
1960	9.673E-01	1.762E-01	18.21%	6.333E-01	1.324E+00	6.333E-01	1.324E+00	3.437E-01	0.355
1961	9.465E-01	1.564E-01	16.53%	6.136E-01	1.290E+00	6.136E-01	1.290E+00	3.414E-01	0.361
1962	9.431E-01	1.427E-01	15.13%	6.097E-01	1.266E+00	6.097E-01	1.266E+00	3.353E-01	0.356
1963	9.486E-01	1.322E-01	13.94%	6.136E-01	1.254E+00	6.136E-01	1.254E+00	3.342E-01	0.352
1964	9.235E-01	1.216E-01	13.17%	5.891E-01	1.218E+00	5.891E-01	1.218E+00	3.293E-01	0.357
1965	9.869E-01	1.184E-01	11.99%	6.400E-01	1.268E+00	6.400E-01	1.268E+00	3.295E-01	0.334
1966	9.823E-01	1.101E-01	11.20%	6.320E-01	1.246E+00	6.320E-01	1.246E+00	3.292E-01	0.335
1967	1.011E+00	1.050E-01	10.39%	6.615E-01	1.259E+00	6.615E-01	1.259E+00	3.228E-01	0.319
1968	9.874E-01	9.687E-02	9.81%	6.427E-01	1.220E+00	6.427E-01	1.220E+00	3.159E-01	0.320
1969	1.013E+00	9.331E-02	9.21%	6.635E-01	1.237E+00	6.635E-01	1.237E+00	3.078E-01	0.304
1970	1.002E+00	8.742E-02	8.73%	6.603E-01	1.215E+00	6.603E-01	1.215E+00	3.002E-01	0.300
1971	1.044E+00	8.578E-02	8.22%	7.086E-01	1.251E+00	7.086E-01	1.251E+00	2.964E-01	0.284
1972	9.828E-01	7.716E-02	7.85%	6.585E-01	1.178E+00	6.585E-01	1.178E+00	2.823E-01	0.287
1973	9.499E-01	7.249E-02	7.63%	6.330E-01	1.138E+00	6.330E-01	1.138E+00	2.714E-01	0.286
1974	8.938E-01	6.742E-02	7.54%	5.832E-01	1.072E+00	5.832E-01	1.072E+00	2.627E-01	0.294
1975	8.940E-01	6.744E-02	7.54%	5.850E-01	1.076E+00	5.850E-01	1.076E+00	2.618E-01	0.293
1976	9.173E-01	6.901E-02	7.52%	6.076E-01	1.097E+00	6.076E-01	1.097E+00	2.631E-01	0.287
1977	9.273E-01	6.921E-02	7.46%	6.177E-01	1.103E+00	6.177E-01	1.103E+00	2.602E-01	0.281
1978	9.583E-01	7.056E-02	7.36%	6.463E-01	1.131E+00	6.463E-01	1.131E+00	2.589E-01	0.270
1979	1.013E+00	7.266E-02	7.17%	6.992E-01	1.180E+00	6.992E-01	1.180E+00	2.607E-01	0.257
1980	1.057E+00	7.272E-02	6.88%	7.426E-01	1.223E+00	7.426E-01	1.223E+00	2.594E-01	0.246
1981	1.090E+00	7.117E-02	6.53%	7.801E-01	1.255E+00	7.801E-01	1.255E+00	2.557E-01	0.235
1982	1.080E+00	6.651E-02	6.16%	7.837E-01	1.235E+00	7.837E-01	1.235E+00	2.430E-01	0.225
1983	1.085E+00	6.352E-02	5.86%	7.932E-01	1.228E+00	7.932E-01	1.228E+00	2.308E-01	0.213
1984	1.098E+00	6.142E-02	5.59%	8.235E-01	1.237E+00	8.235E-01	1.237E+00	2.266E-01	0.206
1985	1.137E+00	6.089E-02	5.35%	8.723E-01	1.271E+00	8.723E-01	1.271E+00	2.189E-01	0.193
1986	1.145E+00	5.779E-02	5.05%	8.901E-01	1.271E+00	8.901E-01	1.271E+00	2.085E-01	0.182
1987	1.040E+00	4.784E-02	4.60%	8.225E-01	1.147E+00	8.225E-01	1.147E+00	1.810E-01	0.174
1988	7.456E-01	2.752E-02	3.69%	5.949E-01	8.167E-01	5.949E-01	8.167E-01	1.204E-01	0.162
1989	5.729E-01	1.840E-02	3.21%	4.591E-01	6.247E-01	4.591E-01	6.247E-01	9.069E-02	0.158
1990	4.898E-01	1.631E-02	3.33%	3.896E-01	5.362E-01	3.896E-01	5.362E-01	7.913E-02	0.162
1991	4.213E-01	1.533E-02	3.64%	3.319E-01	4.630E-01	3.319E-01	4.630E-01	6.883E-02	0.163
1992	3.612E-01	1.500E-02	4.15%	2.838E-01	4.053E-01	2.838E-01	4.053E-01	6.376E-02	0.176
1993	2.830E-01	1.304E-02	4.61%	2.181E-01	3.305E-01	2.181E-01	3.305E-01	5.898E-02	0.208
1994	2.243E-01	1.221E-02	5.44%	1.601E-01	2.853E-01	1.601E-01	2.853E-01	6.435E-02	0.287
1995	2.428E-01	1.778E-02	7.32%	1.627E-01	3.159E-01	1.627E-01	3.159E-01	7.806E-02	0.322
1996	2.859E-01	2.668E-02	9.33%	1.860E-01	3.694E-01	1.860E-01	3.694E-01	9.822E-02	0.344
1997	3.455E-01	3.852E-02	11.15%	2.133E-01	4.446E-01	2.133E-01	4.446E-01	1.207E-01	0.349
1998	4.139E-01	5.238E-02	12.66%	2.518E-01	5.352E-01	2.518E-01	5.352E-01	1.481E-01	0.358
1999	4.908E-01	6.744E-02	13.74%	2.961E-01	6.332E-01	2.961E-01	6.332E-01	1.792E-01	0.365
2000	5.696E-01	8.201E-02	14.40%	3.418E-01	7.335E-01	3.418E-01	7.335E-01	2.077E-01	0.365
2001	6.523E-01	9.499E-02	14.56%	3.913E-01	8.466E-01	3.913E-01	8.466E-01	2.559E-01	0.392
2002	7.510E-01	1.060E-01	14.11%	4.503E-01	9.792E-01	4.503E-01	9.792E-01	2.913E-01	0.388
2003	8.568E-01	1.130E-01	13.19%	5.199E-01	1.111E+00	5.199E-01	1.111E+00	3.307E-01	0.386
2004	9.655E-01	1.152E-01	11.94%	5.946E-01	1.240E+00	5.946E-01	1.240E+00	3.567E-01	0.369
2005	1.079E+00	1.129E-01	10.47%	6.836E-01	1.359E+00	6.836E-01	1.359E+00	3.862E-01	0.358
2006	1.190E+00	1.063E-01	8.93%	7.677E-01	1.460E+00	7.677E-01	1.460E+00	3.974E-01	0.334
2007	1.297E+00	9.638E-02	7.43%	8.665E-01	1.551E+00	8.665E-01	1.551E+00	3.979E-01	0.307
2008	1.391E+00	8.412E-02	6.05%	9.565E-01	1.630E+00	9.565E-01	1.630E+00	3.880E-01	0.279
2009	1.482E+00	7.154E-02	4.83%	1.049E+00	1.708E+00	1.049E+00	1.708E+00	3.815E-01	0.257
2010	1.564E+00	5.907E-02	3.78%	1.138E+00	1.769E+00	1.138E+00	1.769E+00	3.633E-01	0.232
2011	1.636E+00	4.742E-02	2.90%	1.215E+00	1.812E+00	1.215E+00	1.812E+00	3.415E-01	0.209
2012	1.677E+00	3.585E-02	2.14%	1.275E+00	1.827E+00	1.275E+00	1.827E+00	3.085E-01	0.184
2013	1.711E+00	2.663E-02	1.56%	1.335E+00	1.840E+00	1.335E+00	1.840E+00	2.777E-01	0.162

NOTE: Confidence intervals are approximate.
At least 500 to 1000 trials are recommended when estimating confidence intervals.

Results from ASPICP.EXE, version 3.16 12 Apr 2010 at 15:34.13
3LN redfish Page 2
Projection with 5000 Y

TRAJECTORY OF RELATIVE FISHING MORTALITY RATE F/Fmsy (BOOTSTRAPPED)

Year	Point estimate	Estimated bias	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1959	1.932E+00	-1.843E-01	-9.54%	1.503E+00	2.512E+00	1.503E+00	2.512E+00	5.305E-01	0.275
1960	1.229E+00	-1.086E-01	-8.83%	9.451E-01	1.625E+00	9.451E-01	1.625E+00	3.625E-01	0.295
1961	1.086E+00	-9.082E-02	-8.36%	8.448E-01	1.447E+00	8.448E-01	1.447E+00	3.222E-01	0.297
1962	1.004E+00	-8.022E-02	-7.99%	7.876E-01	1.341E+00	7.876E-01	1.341E+00	2.930E-01	0.292
1963	1.295E+00	-9.852E-02	-7.61%	1.019E+00	1.739E+00	1.019E+00	1.739E+00	3.829E-01	0.296
1964	4.756E-01	-3.517E-02	-7.40%	3.787E-01	6.368E-01	3.787E-01	6.368E-01	1.351E-01	0.284
1965	1.055E+00	-7.610E-02	-7.21%	8.444E-01	1.384E+00	8.444E-01	1.384E+00	2.869E-01	0.272
1966	7.539E-01	-5.271E-02	-6.99%	6.122E-01	9.823E-01	6.122E-01	9.823E-01	1.975E-01	0.262
1967	1.205E+00	-8.141E-02	-6.76%	9.875E-01	1.561E+00	9.875E-01	1.561E+00	3.033E-01	0.252
1968	7.817E-01	-5.130E-02	-6.56%	6.449E-01	1.003E+00	6.449E-01	1.003E+00	1.902E-01	0.243
1969	1.088E+00	-6.959E-02	-6.40%	9.098E-01	1.386E+00	9.098E-01	1.386E+00	2.531E-01	0.233
1970	6.241E-01	-3.916E-02	-6.27%	5.268E-01	7.831E-01	5.268E-01	7.831E-01	1.365E-01	0.219
1971	1.503E+00	-9.157E-02	-6.09%	1.279E+00	1.872E+00	1.279E+00	1.872E+00	3.163E-01	0.210
1972	1.326E+00	-7.810E-02	-5.89%	1.128E+00	1.656E+00	1.128E+00	1.656E+00	2.818E-01	0.212
1973	1.601E+00	-9.153E-02	-5.72%	1.364E+00	2.020E+00	1.364E+00	2.020E+00	3.499E-01	0.219
1974	1.104E+00	-6.232E-02	-5.65%	9.386E-01	1.406E+00	9.386E-01	1.406E+00	2.459E-01	0.223
1975	8.736E-01	-4.973E-02	-5.69%	7.464E-01	1.105E+00	7.464E-01	1.105E+00	1.898E-01	0.217
1976	9.847E-01	-5.644E-02	-5.73%	8.421E-01	1.234E+00	8.421E-01	1.234E+00	2.125E-01	0.216
1977	7.755E-01	-4.468E-02	-5.76%	6.669E-01	9.698E-01	6.669E-01	9.698E-01	1.646E-01	0.212
1978	5.410E-01	-3.135E-02	-5.80%	4.665E-01	6.652E-01	4.665E-01	6.652E-01	1.116E-01	0.206
1979	6.019E-01	-3.474E-02	-5.77%	5.197E-01	7.309E-01	5.197E-01	7.309E-01	1.179E-01	0.196
1980	6.613E-01	-3.755E-02	-5.68%	5.746E-01	7.966E-01	5.746E-01	7.966E-01	1.276E-01	0.193
1981	9.910E-01	-5.480E-02	-5.53%	8.700E-01	1.186E+00	8.700E-01	1.186E+00	1.836E-01	0.185
1982	8.814E-01	-4.739E-02	-5.38%	7.818E-01	1.048E+00	7.818E-01	1.048E+00	1.586E-01	0.180
1983	8.010E-01	-4.216E-02	-5.26%	7.103E-01	9.499E-01	7.103E-01	9.499E-01	1.415E-01	0.177
1984	5.846E-01	-3.014E-02	-5.16%	5.207E-01	6.982E-01	5.207E-01	6.982E-01	9.829E-02	0.168
1985	7.976E-01	-4.001E-02	-5.02%	7.097E-01	9.538E-01	7.097E-01	9.538E-01	1.340E-01	0.168
1986	1.738E+00	-8.333E-02	-4.79%	1.557E+00	2.088E+00	1.557E+00	2.088E+00	2.852E-01	0.164
1987	3.968E+00	-1.737E-01	-4.38%	3.577E+00	4.719E+00	3.577E+00	4.719E+00	6.028E-01	0.152
1988	3.604E+00	-1.416E-01	-3.93%	3.299E+00	4.262E+00	3.299E+00	4.262E+00	5.108E-01	0.142
1989	2.812E+00	-1.061E-01	-3.77%	2.564E+00	3.314E+00	2.564E+00	3.314E+00	3.973E-01	0.141
1990	2.836E+00	-1.089E-01	-3.84%	2.563E+00	3.352E+00	2.563E+00	3.352E+00	4.300E-01	0.152
1991	2.929E+00	-1.154E-01	-3.94%	2.612E+00	3.516E+00	2.612E+00	3.516E+00	5.190E-01	0.177
1992	3.772E+00	-1.427E-01	-3.78%	3.285E+00	4.673E+00	3.285E+00	4.673E+00	7.957E-01	0.211
1993	3.739E+00	-1.087E-01	-2.91%	3.087E+00	4.939E+00	3.087E+00	4.939E+00	1.022E+00	0.273
1994	1.089E+00	-2.506E-02	-2.30%	8.542E-01	1.541E+00	8.542E-01	1.541E+00	3.710E-01	0.341
1995	3.338E-01	-9.977E-03	-2.99%	2.575E-01	4.949E-01	2.575E-01	4.949E-01	1.298E-01	0.389
1996	6.340E-02	-2.532E-03	-3.99%	4.847E-02	9.654E-02	4.847E-02	9.654E-02	2.740E-02	0.432
1997	7.362E-02	-3.585E-03	-4.87%	5.487E-02	1.133E-01	5.487E-02	1.133E-01	3.415E-02	0.464
1998	8.815E-02	-4.843E-03	-5.49%	6.590E-02	1.390E-01	6.590E-02	1.390E-01	4.181E-02	0.474
1999	1.938E-01	-1.135E-02	-5.86%	1.456E-01	3.105E-01	1.456E-01	3.105E-01	9.630E-02	0.497
2000	2.278E-01	-1.364E-02	-5.99%	1.691E-01	3.710E-01	1.691E-01	3.710E-01	1.132E-01	0.497
2001	9.107E-02	-5.427E-03	-5.96%	6.787E-02	1.515E-01	6.787E-02	1.515E-01	4.560E-02	0.501
2002	6.701E-02	-3.893E-03	-5.81%	5.017E-02	1.116E-01	5.017E-02	1.116E-01	3.300E-02	0.493
2003	6.484E-02	-3.585E-03	-5.53%	4.882E-02	1.073E-01	4.882E-02	1.073E-01	3.168E-02	0.489
2004	2.759E-02	-1.423E-03	-5.16%	2.124E-02	4.593E-02	2.124E-02	4.593E-02	1.265E-02	0.459
2005	2.572E-02	-1.214E-03	-4.72%	2.021E-02	4.235E-02	2.021E-02	4.235E-02	1.121E-02	0.436
2006	1.766E-02	-7.505E-04	-4.25%	1.411E-02	2.857E-02	1.411E-02	2.857E-02	7.069E-03	0.400
2007	5.480E-02	-2.066E-03	-3.77%	4.467E-02	8.680E-02	4.467E-02	8.680E-02	2.037E-02	0.372
2008	1.839E-02	-6.092E-04	-3.31%	1.534E-02	2.840E-02	1.534E-02	2.840E-02	6.361E-03	0.346
2009	1.400E-02	-4.061E-04	-2.90%	1.194E-02	2.099E-02	1.194E-02	2.099E-02	4.451E-03	0.318
2010	1.333E-02	-3.379E-04	-2.54%	1.156E-02	1.958E-02	1.156E-02	1.958E-02	3.886E-03	0.292
2011	1.336E-01	-2.932E-03	-2.19%	1.177E-01	1.913E-01	1.177E-01	1.913E-01	3.428E-02	0.257
2012	1.307E-01	-2.481E-03	-1.90%	1.162E-01	1.824E-01	1.162E-01	1.824E-01	2.955E-02	0.226

Note: no yield(s) were estimated in the projection.

NOTE: Confidence intervals are approximate.
At least 500 to 1000 trials are recommended when estimating confidence intervals.

Results from ASPICP.EXE, version 3.16 12 Apr 2010 at 15:34.13
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Projection with 5000 Y

TRAJECTORY OF ABSOLUTE BIOMASS (BOOTSTRAPPED)

Year	Point estimate	Estimated bias	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1959	2.092E+05	2.363E+04	11.29%	1.506E+05	2.949E+05	1.506E+05	2.949E+05	7.127E+04	0.341
1960	1.872E+05	1.867E+04	9.97%	1.298E+05	2.647E+05	1.298E+05	2.647E+05	6.779E+04	0.362
1961	1.832E+05	1.562E+04	8.52%	1.263E+05	2.556E+05	1.263E+05	2.556E+05	6.624E+04	0.362
1962	1.825E+05	1.330E+04	7.29%	1.269E+05	2.493E+05	1.269E+05	2.493E+05	6.353E+04	0.348
1963	1.836E+05	1.140E+04	6.21%	1.284E+05	2.445E+05	1.284E+05	2.445E+05	6.112E+04	0.333
1964	1.787E+05	9.870E+03	5.52%	1.253E+05	2.361E+05	1.253E+05	2.361E+05	5.899E+04	0.330
1965	1.910E+05	8.437E+03	4.42%	1.375E+05	2.448E+05	1.375E+05	2.448E+05	5.686E+04	0.298
1966	1.901E+05	7.046E+03	3.71%	1.385E+05	2.402E+05	1.385E+05	2.402E+05	5.389E+04	0.283
1967	1.957E+05	5.778E+03	2.95%	1.470E+05	2.433E+05	1.470E+05	2.433E+05	5.074E+04	0.259
1968	1.911E+05	4.671E+03	2.44%	1.444E+05	2.360E+05	1.444E+05	2.360E+05	4.847E+04	0.254
1969	1.960E+05	3.698E+03	1.89%	1.512E+05	2.384E+05	1.512E+05	2.384E+05	4.587E+04	0.234
1970	1.939E+05	2.817E+03	1.45%	1.521E+05	2.340E+05	1.521E+05	2.340E+05	4.338E+04	0.224
1971	2.020E+05	1.971E+03	0.98%	1.637E+05	2.421E+05	1.637E+05	2.421E+05	4.120E+04	0.204
1972	1.902E+05	1.284E+03	0.68%	1.539E+05	2.267E+05	1.539E+05	2.267E+05	3.888E+04	0.204
1973	1.838E+05	8.696E+02	0.47%	1.488E+05	2.180E+05	1.488E+05	2.180E+05	3.718E+04	0.202
1974	1.730E+05	6.613E+02	0.38%	1.393E+05	2.051E+05	1.393E+05	2.051E+05	3.557E+04	0.206
1975	1.730E+05	5.656E+02	0.33%	1.406E+05	2.036E+05	1.406E+05	2.036E+05	3.405E+04	0.197
1976	1.775E+05	4.386E+02	0.25%	1.462E+05	2.065E+05	1.462E+05	2.065E+05	3.230E+04	0.182
1977	1.795E+05	2.661E+02	0.15%	1.491E+05	2.070E+05	1.491E+05	2.070E+05	3.066E+04	0.171
1978	1.855E+05	3.347E+01	0.02%	1.562E+05	2.113E+05	1.562E+05	2.113E+05	2.903E+04	0.157
1979	1.960E+05	-3.435E+02	-0.18%	1.693E+05	2.207E+05	1.693E+05	2.207E+05	2.710E+04	0.138
1980	2.045E+05	-8.812E+02	-0.43%	1.803E+05	2.287E+05	1.803E+05	2.287E+05	2.490E+04	0.122
1981	2.109E+05	-1.516E+03	-0.72%	1.899E+05	2.348E+05	1.899E+05	2.348E+05	2.309E+04	0.109
1982	2.091E+05	-2.110E+03	-1.01%	1.904E+05	2.321E+05	1.904E+05	2.321E+05	2.255E+04	0.108
1983	2.099E+05	-2.610E+03	-1.24%	1.940E+05	2.326E+05	1.940E+05	2.326E+05	2.101E+04	0.100
1984	2.126E+05	-3.074E+03	-1.45%	1.982E+05	2.340E+05	1.982E+05	2.340E+05	1.987E+04	0.093
1985	2.201E+05	-3.577E+03	-1.63%	2.078E+05	2.424E+05	2.078E+05	2.424E+05	1.881E+04	0.085
1986	2.217E+05	-4.097E+03	-1.85%	2.100E+05	2.423E+05	2.100E+05	2.423E+05	1.748E+04	0.079
1987	2.012E+05	-4.339E+03	-2.16%	1.909E+05	2.214E+05	1.909E+05	2.214E+05	1.619E+04	0.080
1988	1.443E+05	-3.996E+03	-2.77%	1.348E+05	1.628E+05	1.348E+05	1.628E+05	1.480E+04	0.103
1989	1.109E+05	-3.401E+03	-3.07%	1.021E+05	1.281E+05	1.021E+05	1.281E+05	1.376E+04	0.124
1990	9.480E+04	-2.793E+03	-2.95%	8.684E+04	1.113E+05	8.684E+04	1.113E+05	1.262E+04	0.133
1991	8.155E+04	-2.183E+03	-2.68%	7.407E+04	9.782E+04	7.407E+04	9.782E+04	1.217E+04	0.149
1992	6.992E+04	-1.570E+03	-2.24%	6.230E+04	8.568E+04	6.230E+04	8.568E+04	1.161E+04	0.166
1993	5.477E+04	-9.824E+02	-1.79%	4.646E+04	7.006E+04	4.646E+04	7.006E+04	1.168E+04	0.213
1994	4.342E+04	-4.447E+02	-1.02%	3.397E+04	5.934E+04	3.397E+04	5.934E+04	1.302E+04	0.300
1995	4.699E+04	1.593E+02	0.34%	3.568E+04	6.410E+04	3.568E+04	6.410E+04	1.440E+04	0.306
1996	5.534E+04	9.630E+02	1.74%	4.137E+04	7.338E+04	4.137E+04	7.338E+04	1.599E+04	0.289
1997	6.687E+04	1.995E+03	2.98%	4.998E+04	8.672E+04	4.998E+04	8.672E+04	1.891E+04	0.283
1998	8.010E+04	3.208E+03	4.01%	6.008E+04	1.018E+05	6.008E+04	1.018E+05	2.281E+04	0.285
1999	9.498E+04	4.481E+03	4.72%	6.833E+04	1.170E+05	6.833E+04	1.170E+05	2.684E+04	0.283
2000	1.102E+05	5.644E+03	5.12%	7.974E+04	1.345E+05	7.974E+04	1.345E+05	3.038E+04	0.276
2001	1.262E+05	6.515E+03	5.16%	9.106E+04	1.531E+05	9.106E+04	1.531E+05	3.412E+04	0.270
2002	1.454E+05	6.896E+03	4.74%	1.048E+05	1.731E+05	1.048E+05	1.731E+05	3.805E+04	0.262
2003	1.658E+05	6.612E+03	3.99%	1.203E+05	1.935E+05	1.203E+05	1.935E+05	4.164E+04	0.251
2004	1.869E+05	5.595E+03	2.99%	1.382E+05	2.144E+05	1.382E+05	2.144E+05	4.332E+04	0.232
2005	2.088E+05	3.872E+03	1.85%	1.585E+05	2.342E+05	1.585E+05	2.342E+05	4.236E+04	0.203
2006	2.303E+05	1.562E+03	0.68%	1.825E+05	2.553E+05	1.825E+05	2.553E+05	3.596E+04	0.156
2007	2.510E+05	-1.137E+03	-0.45%	2.174E+05	2.815E+05	2.174E+05	2.815E+05	2.975E+04	0.119
2008	2.692E+05	-3.988E+03	-1.48%	2.458E+05	3.044E+05	2.458E+05	3.044E+05	2.884E+04	0.107
2009	2.869E+05	-6.796E+03	-2.37%	2.684E+05	3.350E+05	2.684E+05	3.350E+05	3.201E+04	0.112
2010	3.028E+05	-9.426E+03	-3.11%	2.852E+05	3.565E+05	2.852E+05	3.565E+05	3.701E+04	0.122
2011	3.167E+05	-1.177E+04	-3.72%	2.997E+05	3.794E+05	2.997E+05	3.794E+05	3.977E+04	0.126
2012	3.245E+05	-1.371E+04	-4.23%	3.088E+05	3.929E+05	3.088E+05	3.929E+05	4.595E+04	0.142
2013	3.312E+05	-1.523E+04	-4.60%	3.132E+05	4.014E+05	3.132E+05	4.014E+05	4.769E+04	0.144

NOTE: Confidence intervals are approximate.
At least 500 to 1000 trials are recommended when estimating confidence intervals.

Results from ASPICP.EXE, version 3.16 12 Apr 2010 at 15:34.13
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Projection with 5000 Y

TRAJECTORY OF ABSOLUTE FISHING MORTALITY RATE (BOOTSTRAPPED)

Year	Point estimate	Estimated bias	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1959	2.254E-01	-3.798E-03	-1.68%	1.599E-01	3.191E-01	1.599E-01	3.191E-01	8.336E-02	0.370
1960	1.435E-01	-1.144E-03	-0.80%	1.022E-01	2.079E-01	1.022E-01	2.079E-01	5.546E-02	0.387
1961	1.267E-01	-3.853E-04	-0.30%	9.204E-02	1.830E-01	9.204E-02	1.830E-01	4.838E-02	0.382
1962	1.171E-01	4.786E-05	0.04%	8.709E-02	1.686E-01	8.709E-02	1.686E-01	4.298E-02	0.367
1963	1.511E-01	6.475E-04	0.43%	1.139E-01	2.152E-01	1.139E-01	2.152E-01	5.406E-02	0.358
1964	5.549E-02	3.091E-04	0.56%	4.274E-02	7.809E-02	4.274E-02	7.809E-02	1.851E-02	0.334
1965	1.232E-01	7.979E-04	0.65%	9.667E-02	1.696E-01	9.667E-02	1.696E-01	3.783E-02	0.307
1966	8.797E-02	7.159E-04	0.81%	7.036E-02	1.196E-01	7.036E-02	1.196E-01	2.517E-02	0.286
1967	1.406E-01	1.438E-03	1.02%	1.135E-01	1.864E-01	1.135E-01	1.864E-01	3.801E-02	0.270
1968	9.121E-02	1.079E-03	1.18%	7.464E-02	1.194E-01	7.464E-02	1.194E-01	2.311E-02	0.253
1969	1.270E-01	1.663E-03	1.31%	1.050E-01	1.636E-01	1.050E-01	1.636E-01	2.984E-02	0.235
1970	7.282E-02	1.000E-03	1.37%	6.021E-02	9.077E-02	6.021E-02	9.077E-02	1.592E-02	0.219
1971	1.754E-01	2.724E-03	1.55%	1.469E-01	2.165E-01	1.469E-01	2.165E-01	3.642E-02	0.208
1972	1.548E-01	2.772E-03	1.79%	1.304E-01	1.910E-01	1.304E-01	1.910E-01	3.190E-02	0.206
1973	1.868E-01	3.698E-03	1.98%	1.574E-01	2.313E-01	1.574E-01	2.313E-01	3.873E-02	0.207
1974	1.288E-01	2.598E-03	2.02%	1.092E-01	1.592E-01	1.092E-01	1.592E-01	2.643E-02	0.205
1975	1.019E-01	1.896E-03	1.86%	8.719E-02	1.244E-01	8.719E-02	1.244E-01	1.975E-02	0.194
1976	1.149E-01	1.971E-03	1.72%	9.916E-02	1.387E-01	9.916E-02	1.387E-01	2.070E-02	0.180
1977	9.050E-02	1.435E-03	1.59%	7.899E-02	1.082E-01	7.899E-02	1.082E-01	1.508E-02	0.167
1978	6.312E-02	9.128E-04	1.45%	5.575E-02	7.395E-02	5.575E-02	7.395E-02	9.374E-03	0.149
1979	7.023E-02	9.788E-04	1.39%	6.269E-02	8.050E-02	6.269E-02	8.050E-02	9.212E-03	0.131
1980	7.716E-02	1.122E-03	1.45%	6.910E-02	8.668E-02	6.910E-02	8.668E-02	8.979E-03	0.116
1981	1.156E-01	1.866E-03	1.61%	1.041E-01	1.277E-01	1.041E-01	1.277E-01	1.254E-02	0.108
1982	1.028E-01	1.835E-03	1.78%	9.272E-02	1.121E-01	9.272E-02	1.121E-01	1.023E-02	0.099
1983	9.346E-02	1.776E-03	1.90%	8.466E-02	1.009E-01	8.466E-02	1.009E-01	8.800E-03	0.094
1984	6.821E-02	1.366E-03	2.00%	6.172E-02	7.259E-02	6.172E-02	7.259E-02	5.918E-03	0.087
1985	9.306E-02	2.007E-03	2.16%	8.493E-02	9.864E-02	8.493E-02	9.864E-02	7.399E-03	0.080
1986	2.028E-01	4.986E-03	2.46%	1.846E-01	2.137E-01	1.846E-01	2.137E-01	1.548E-02	0.076
1987	4.630E-01	1.441E-02	3.11%	4.151E-01	4.913E-01	4.151E-01	4.913E-01	3.960E-02	0.086
1988	4.206E-01	1.617E-02	3.85%	3.670E-01	4.532E-01	3.670E-01	4.532E-01	4.422E-02	0.105
1989	3.281E-01	1.351E-02	4.12%	2.813E-01	3.576E-01	2.813E-01	3.576E-01	3.950E-02	0.120
1990	3.309E-01	1.334E-02	4.03%	2.792E-01	3.631E-01	2.792E-01	3.631E-01	4.295E-02	0.130
1991	3.417E-01	1.322E-02	3.87%	2.817E-01	3.792E-01	2.817E-01	3.792E-01	4.992E-02	0.146
1992	4.401E-01	1.769E-02	4.02%	3.480E-01	5.010E-01	3.480E-01	5.010E-01	7.658E-02	0.174
1993	4.362E-01	2.182E-02	5.00%	3.304E-01	5.368E-01	3.304E-01	5.368E-01	1.026E-01	0.235
1994	1.270E-01	6.860E-03	5.40%	9.268E-02	1.639E-01	9.268E-02	1.639E-01	3.594E-02	0.283
1995	3.894E-02	1.586E-03	4.07%	2.909E-02	5.170E-02	2.909E-02	5.170E-02	1.140E-02	0.293
1996	7.398E-03	1.779E-04	2.40%	5.621E-03	9.868E-03	5.621E-03	9.868E-03	2.107E-03	0.285
1997	8.591E-03	8.230E-05	0.96%	6.649E-03	1.144E-02	6.649E-03	1.144E-02	2.450E-03	0.285
1998	1.029E-02	-1.244E-05	-0.12%	8.243E-03	1.404E-02	8.243E-03	1.404E-02	3.124E-03	0.304
1999	2.261E-02	-1.877E-04	-0.83%	1.849E-02	3.140E-02	1.849E-02	3.140E-02	6.826E-03	0.302
2000	2.658E-02	-3.196E-04	-1.20%	2.189E-02	3.678E-02	2.189E-02	3.678E-02	8.064E-03	0.303
2001	1.063E-02	-1.393E-04	-1.31%	8.877E-03	1.470E-02	8.877E-03	1.470E-02	3.204E-03	0.302
2002	7.819E-03	-9.204E-05	-1.18%	6.642E-03	1.083E-02	6.642E-03	1.083E-02	2.332E-03	0.298
2003	7.566E-03	-6.156E-05	-0.81%	6.529E-03	1.032E-02	6.529E-03	1.032E-02	2.070E-03	0.274
2004	3.220E-03	-8.616E-06	-0.27%	2.841E-03	4.299E-03	2.841E-03	4.299E-03	7.875E-04	0.245
2005	3.001E-03	1.245E-05	0.41%	2.699E-03	3.891E-03	2.699E-03	3.891E-03	5.931E-04	0.198
2006	2.060E-03	2.441E-05	1.18%	1.856E-03	2.501E-03	1.856E-03	2.501E-03	2.972E-04	0.144
2007	6.394E-03	1.277E-04	2.00%	5.706E-03	7.172E-03	5.706E-03	7.172E-03	7.013E-04	0.110
2008	2.146E-03	6.006E-05	2.80%	1.869E-03	2.316E-03	1.869E-03	2.316E-03	2.232E-04	0.104
2009	1.634E-03	5.810E-05	3.56%	1.392E-03	1.741E-03	1.392E-03	1.741E-03	1.814E-04	0.111
2010	1.555E-03	6.615E-05	4.25%	1.308E-03	1.653E-03	1.308E-03	1.653E-03	1.678E-04	0.108
2011	1.559E-02	7.653E-04	4.91%	1.291E-02	1.647E-02	1.291E-02	1.647E-02	1.875E-03	0.120
2012	1.525E-02	8.368E-04	5.49%	1.255E-02	1.609E-02	1.255E-02	1.609E-02	1.960E-03	0.129

NOTE: Confidence intervals are approximate.
At least 500 to 1000 trials are recommended when estimating confidence intervals.

```
Results from ASPICP.EXE, version 3.16                                                        12 Apr 2010 at 15:34.13
3LN redfish                                                                                                   Page 5
Projection with 5000 Y

                   Time Plot of B/Bmsy (#) with Bias-Corrected (BC) 80% Confidence Interval (^v)
                   (Dashed reference line is 1.0)

           :
           :
           :
           :
      2.2 -:
           :
           :
           :
           :
      2.0 -:
           :
           :
           :
           :                                                                                     vv
      1.8 -:                                                                                    v
           :                                                                                  v
           :                                                                                 v    #
           :                                                                                     #
           :                                                                                v   #
      1.6 -:
           :                                                                               v  #
           :
           :                   v                                                             #
           :                                                                             v
      1.4 -:                                                                                #
           :                                                                            v
           :                    v                                                                 ^
           :                     vv   v                        vv                          #     ^
           :                        v  v vvv  v          vvv vv                        v
      1.2 -:                         v      v           v                                #      ^
           :                                   v                #  v
           :                                    v    vv        #                      v       ^
           :                   #                 v vv     ## ##                        #
           :                                  #          #        #                          ^
      1.0 -:       - ---- ---- ---- --22 2222 -2-- ---- 2--- ---- ---- ---- ---- ---- ---- ---- ---- ---- --
           :                    ### #           #     #                             v  #    ^
           :                         #              ##
           :                                     # #           ^^                          ^
           :                                                  ^   ^                v  #
      0.8 -:                                              ^^ ^     v
           :                                             ^         #                #    ^
           :                   ^              ^                                   v
           :                             ^ ^^           ^                               ^
           :                    ^     ^^  ^    ^^     ^             v            v #
      0.6 -:                     ^^ ^^           ^ ^^^             ^                   ^
           :                                                        #             #
           :                                                         v         v      ^
           :                                                         # v         #
           :                                                        ^  #      v     ^
      0.4 -:                                                         ^  v      #   ^
           :                                                            #    v#   ^
           :                                                           ^ v  v
           :                                                            ^#v  #   ^
           :                                                              # #  ^
      0.2 -:                                                             ^   ^^
           :                                                              ^ ^
           :
           :
           :
      0.0 -:
           :........................................................................................................
            :         :         :         :         :         :         :         :         :         :         :
         1944.     1952.     1960.     1968.     1976.     1984.     1992.     2000.     2008.     2016.     2024.

         NOTE: Estimates beginning in 2011 depend on the user projection data listed on page 1.
```

Results from ASPICP.EXE, version 3.16 12 Apr 2010 at 15:34.13
3LN redfish Page 6
Projection with 5000 Y

```
                   Time Plot of F/Fmsy (#) with 80% Bias-Corrected (BC) Confidence Interval (^v)
                   (Dashed reference line is 1.0)

           :
           :
           :
           :
      5.5 -:
           :
           :
           :
           :
      5.0 -:
           :                                                             v
           :
           :                                                      v     v
           :
      4.5 -:
           :
           :                                                       v
           :
           :
      4.0 -:                                                      #
           :
           :                                                            #
           :                                                             #
           :                                                      ^#
      3.5 -:                                                           v
           :                                                         v
           :                                                       ^v   ^
           :
           :                                                             ^
      3.0 -:
           :                                                           #
           :                                                        ##
           :
           :                                                        ^^ ^
      2.5 -:                   v
           :
           :
           :
           :                                                    v
      2.0 -:                                    v
           :                   #              v
           :
           :                        v          v                #
           :                    v        v      #               ^
      1.5 -:                   ^              #                            v
           :                     v    v    v    ^v
           :                      v #           ^#
           :                    #        #          v     v
           :                     #    #    #   ^ # v                       #
      1.0 -:       - ---- ---- ---2 2--2 22-- ---- -22- --22 --2- ---- ---- ---- ---- ---- ---- ---- ---- --
           :                    ^          ^     ^ #      ^# v             ^
           :                     ^^   ^#  # v       ^#   v ^ # #
           :                                       ^ ^v v#   ^v^
           :                         v ^  ^ #           #^    #
      0.5 -:                         #      ^         2 ^     ^             v
           :                         ^                                          v
           :                                                                2    v
           :                                                                     #2v            vv
           :                                                             233 ^ 23 2    2    22
      0.0 -:                                                             ^        ^333 ^333
           :.........................................................................................................
            :         :         :         :         :         :         :         :         :         :         :
         1944.     1952.     1960.     1968.     1976.     1984.     1992.     2000.     2008.     2016.     2024.

         NOTE: Estimates beginning in 2010 depend on the user projection data listed on page 1.
```