Northwest Atlantic Fisheries Organization

Serial No. N6317 **NAFO SCR Doc. 14/022**

SCIENTIFIC COUNCIL MEETING – JUNE 2014

An ASPIC Based Assessment of Redfish (*S. mentella and S. fasciatus*) in NAFO Divisions 3LN (*assuming that the highest apparently sustained historical average level of catch is a sound proxy to MSY*)

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), adjusted to a standardized catch rate series (Power, 1997) and to most of the stratified-random bottom trawl surveys conducted in various years and seasons in Div. 3L and Div. 3N from 1978 onwards. Both CPUE and surveys were used with all observations of each series.

This assessment is not a follow up of the previous ones (Ávila de Melo *et al.*, 2012 and 2010). The logistic Schaefer production model (1954) incorporated in ASPIC operating model (Prager, 1994) can not cope anymore with the most recent biomass increases observed in both spring and (mainly) autumn Canadian 3LN surveys, unless it is allowed to provide unrealistic assessment results. And continuing to strip off the highs of each one of these series, in order to get a picture in line to what is the perception of the stock history from commercial and survey data trends, is no longer a valid option, as reflected on the last STACFIS research recommendation on this matter (NAFO, 2012).

Being so, input has been reframed opening room to a new combination of Canadian autumn 3L and 3N surveys. The inclusion of the Spanish spring survey on Div. 3N and the removal of the historical CPUE series have also been considered. Two selected frameworks options have finally run with MSY kept constant at an initial starting guess, instead of being estimated by the model. Before entering the latest (2013) ASPIC Suite flow, the input selected from exploratory analysis was submitted to a sensitivity test in order to evaluate the robustness of the new framework against variability on random number seed, start user guesses for key model parameters and last year survey biomass.

The consistency of the new ASPIC assessment with their predecessors was checked by comparison of biomass and fishing mortality fit trajectories against previous ones from the 2012 and 2010 assessments. A 2014-2012 retrospective analysis was also performed with good results (small retro bias on relative biomass and fishing

mortality in response to the general increase of the still standing survey series), and the assessment pursued successfully to bootstrap mode (again good consistency with previous results) and projections.

A medium term management plan is finally proposed, based on bi-annual increases of the catch from the present TAC level of 6 500 t up to target catch/TAC of 18 100 t, the 2014 equilibrium yield from the present assessment, that should be in place by 2019-2020. This management plan allows, with a very high probability, that biomass is kept above B_{msy} and fishing mortality below F_{msy}.

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.

Most studies NAFO Scientific Council has reviewed in the past have suggested a closer connection between Div. 3LN and Div. 3O, for both species of redfish. However, differences observed in population dynamics between Div. 3O and Div. 3LN suggests that it would be prudent to keep Div. 3LN as a separate management unit. Being so beaked redfish in Div. 3LN is regarded in the present work as a management unit composed of two Grand Bank fish populations of two very similar species. 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.

Commercial Fishery

Nominal catches and TAC’s

Between 1959 and 1960 reported catches drop from 44 600 to 26 600 t, oscillating over the next 25 years (1960-1985) around an average level of 21 000 t. Catches jump afterwards to a 79 000 t high in 1987 and fall steadily to a 450 t minimum reached in 1996. Catches were kept at a low level since then (450-3 000 t), until 2009.

The NAFO Fisheries Commission implemented a moratorium on directed fishing for this stock in 1998. During the moratorium years, redfish from divisions 3L and 3N was primarily taken as by-catch in the Greenland halibut fishery pursued by EU-Portugal and EU-Spain. In June 2008 the Scientific Council recognized that there was enough evidence to allow a small amount of direct fishing in 2009 (not exceeding 3 500 t), taking into account the high biomass and very low fishing mortality indices observed (NAFO, 2008). Despite this recommendation the Fisheries Commission decided to continue the ban on direct fishing in 2009 but allowed an increase to 10% redfish by-catch rate in other fisheries. In June 2009 the Scientific Council confirmed that the levels of catches have not altered the upward trend of the stock, as shown by spring and autumn surveys (NAFO, 2009), and Fisheries Commission finally reopen the fishery with a TAC for 2010 of 3 500 t. Next year the Fisheries Commission endorsed the Scientific Council recommendation from the 2010 analytical assessment and set the TAC for 2011 and 2012 at 6 000 t. Based on the main conclusions from the 2012 assessment (Ávila de Melo *et al.*, 2012) Scientific Council recommended that fishing mortality in 2013 and 2014 should be kept around $F_{statusquo}$, but didn’t specify a TAC. Fisheries Commission set the 2013-2014 TAC at 6 500 t, slightly above the average 2013-2014 projected catch at $F_{statusquo.}$

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Catches increased with the reopening of the fishery in 2010 and have reached just over 6 000 t in 2013 (provisional, taken from NAFO Circ. Letter Ref. No.: GFS/14-070 Feb 2014), the highest level recorded on 20 years (Table 1, Fig. 1). For 2011 and 2012 catch corresponds to STATLANT 21A (extracted from the NAFO Database, last update 9th September 2013).

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. EU-Portugal and EU-Spain bottom trawl fleets were the main fleets responsible for the 3LN redfish by-catch during the moratorium years. Catches from EU-Portugal, Russian and Canadian fleets justified most of the recent increase on the redfish catch observed on divisions 3L and 3N between 2010 and 2013.

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*.

ASPIC assessments recovered 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.*, 2014). 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*., 2013; Fromin *et al*., 2014). The 1990-2013 per mille length composition of the Portuguese trawl catch was applied to the rest of the commercial catches (Table 3a). The commercial length weight relationships used to get catch numbers at length were derived from redfish sampling on board of Portuguese vessels fishing on divisions 3L and 3N (Table 3b).

The overall mean length of the 1990-2013 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 on the bottom of Table 3a. The purpose of the length anomalies was to detect possible shifts in the length structure of the catch that could reflect changes in the length structure of the exploitable stock. An important increase on the numbers of small redfish in the catch could reflect the income of one ore more good recruitments.

Above average mean lengths, an apparent stable catch at length distribution with no clear trends towards smaller or larger length groups and proportions in numbers of small redfish usually below 1%, are observed on most of the years of the 1990-2005 interval. However, well below average mean lengths coupled with unusually high proportions of small redfish in the catch occurred afterwards on several years (Table 3a, Fig. 3). Under a low exploitation regime such interlinked events should reflect the sequential recruitment of above average year classes into the exploitable stock between 2008 and 2013.

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 below 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 Doubleday 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 tow were estimated from successful sets only, each tow being adjusted to 1.8 nm 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 starting in 1995, comparative fishing trials were conducted in spring 2001 to develop conversion factors between the two fishing vessel and gear combinations. Former Div. 3N and Div. 3O redfish survey indices from C/V *Playa de Menduíña* have been transformed to R/V *Vizconde de Eza* units (González *et al.*, 2010), and so the complete Div. 3N Spanish spring survey series is included since 2010 in the assessment framework (González *et al.*, 2014).

The Spanish survey in Div. 3L of NAFO Regulatory Area (Flemish Pass) was initiated by Spain in 2003. The Research vessel *"Vizconde de Eza"* has carried out the entire surveys series following the same procedures and using the same bottom trawl gear *Campelen 1800*. In 2003, the survey was carried out in spring (June) and it did not cover all strata adequately (69% of the total area prospected in 2006-2012). In 2004, the survey was carried out in August for a period of nine days with a minimal coverage of 96% of the swept area. In 2005, it was not possible to perform the survey due to problems with the winch of the ship; and in 2006, for the first time, an adequate prospecting survey was conducted in Division 3L with over 100 valid hauls (Róman *et al*, 2014).

Survey biomass and female spawning biomass

All available survey biomass from stratified-random bottom trawl surveys are presented in Table 4. About 85% of all survey data are used in the exploratory analysis and rearranged to be included in the 2014 ASPIC assessment input. The 1991-2014 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 to zero mean and unit standard deviation 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. Redfish survey bottom biomass in Div. 3LN remained well below average level until 1997 and started since then a discrete and discontinuous increase. A pronounced increase of the remaining biomass indices has been observed over the most recent years, 2007 onwards. Considering all available bottom trawl survey series occurring in Div. 3L and Div. 3N from 1978 till 2013, 100% of the biomass indices were above the average of their own series on 1978-1985, only 4% on 1986-2006, and 89% on 2007-2013.

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 1991-2013 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 female and sex combined length weight relationships derived from data collected on board of the Canadian 3LN autumn surveys, 1997-2004 (Power, *pers. comm.*, 2005), of the 3N Spanish survey, 2005, and of the 2006-2013 3LN Spanish survey (González, *pers. comm.*, 2014). 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 1991-2014 spring and autumn standardized female SSB series for Div. 3LN combined showed very similar patterns to correspondent survey biomass series (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 1991-2013 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 2007 (spring survey) or 2006 (autumn survey) were above the mean, reflecting a shift on the stock length structure to larger individuals probably justified by a higher survival of the main year classes crossing the stock through this interval. But since 2008 mean lengths generally fall to below average, just as observed on the commercial catch at length (Fig 3). This most recent pattern on the length structure of both surveys and commercial catch seems to confirm the occurrence of recent good recruitments, after a low productivity regime that prevailed for more than 15 years.

ASPIC assessment suite

A non-equilibrium surplus production model (ASPIC; Prager, 1994) is used to assess the status of the stock. The ASPIC operating model is a non-equilibrium implementation of Schaefer's and Pella-Tomlinson models, among others.

So far the model was adjusted to an array of surveys series arranged under the formulation adopted on the *"The 2nd Take of the 2008 Assessment of Redfish in NAFO Divisions 3LN,"* (Ávila de Melo and Alpoim, 2010a). The 2012 input series considered in the exploratory analysis preceding the assessment were as follows:

I1 (Statlant CPUE)	Statlant cpue for Div. 3LN,$_{\text{1959-1994}}$ & catch for Div. 3LN $_{\text{1959-2011}}$
I2 (3LN spring survey)	Canadian spring survey biomass for Div. 3LN, $_{\text{1991-2005, 2007-2011}}$
I3 (3N autumn survey)	Canadian autumn survey biomass for Div. 3N, $_{\text{1991, 1993-2011}}$
I4 (3LN Power russian survey)	Russian spring survey biomass for Div. 3LN , $_{\text{1984-1991 (Power and Vaskov,1992)}}$
I5 (3L winter survey)	Canadian winter survey biomass for Div. 3L, $_{\text{1985-1986 and 1990}}$
I6 (3L summer survey)	Canadian summer survey biomass for Div. 3L$_{\text{, 1978-1979, 1981,1984-1985, 1990-1991and 1993}}$
I7 (3L autumn survey)	Canadian autumn survey biomass for Div. 3L, $_{\text{1985-1986, 1990-1994, 1996-2011}}$
I8 (3N spring spanish survey)	Spanish survey biomass for Div. 3N, $_{\text{1995-2011}}$

However the model shown an increasing unfitness to recent increases observed from the second half of the 2000's onwards on all the ongoing surveys. The approved framework of the 2012 assessment ends up excluding the whole Spanish survey and several recent inter annual biomass jumps from both Canadian surveys, either for Div. 3LN (spring) or Div. 3L and N separately (autumn) (Ávila de Melo *et al*, 2012).

Our goal at present was to search for an inclusive approach that would incorporate most, if not all, of the surveys historically available for these divisions, grouping the two divisions whenever it is feasible in order to get most series with a single index for a single management unit, with no haircuts and still preserving the general perception that one has of the stock history. Not only given by previous assessments, but from the observed trends of commercial and survey data as well. To achieve this goal the input was reframed and allowed to accommodate three alternate options that so far have not been considered:

1. Exclude the Statlant CPUE for Div. 3LN on the first series, taking into account the chronically poor fit of this index.

2. Couple Div. 3L and Div. 3N Canadian autumn surveys, providing the assessment with a second long survey series (191-2013) representative of the whole distribution area. A single series with a single catchabilty to fit, avoiding two series with two catchabilities that should be constant within each division, but may vary over time due to most likely temporal changes of redfish concentrations between Div. 3L and Div. 3N. The three early points left of the Canadian autumn survey on Div. 3L prior to 1991 were assembled in a short survey series.

   This assemblage of the two divisions was not applied to the Spanish surveys on Div. 3N and Div. 3L. The substantial difference between the lengths of the two series (a long 3N survey *versus* a short 3L survey, taking into account the difficulties found on the 3 former years of the last series) would imply that 11 of the 19 points of the Spanish 3N survey will have to be removed in order to join the two series. Furthermore the two different seasons where the two surveys are carried out also discourage the Spanish combo.

3. Keep maximum sustainable yield fixed at the user starting guess, 21 000 t, the average level of catch for the 1960-1985 period, when the stock experienced an apparent stability suggested either by the Statlant CPUE series or the available surveys and before declining in response to a sudden and important increase on catch.

The several options regarding the candidates to be included this year in the 2014 adopted ASPIC framework were:

I1a (Statlant CPUE and catch), *or*	Statlant cpue for Div. 3LN, $_{1959\text{-}1994}$ & catch for Div. 3LN $_{1959\text{-}2013}$
I1b (Catch)	Catch for Div. 3LN $_{1959\text{-}2013}$
I2 (3LN spring survey)	Canadian spring survey biomass for Div. 3LN, $_{1991\text{-}2005,\ 2007\text{-}2013}$
I3a (3N autumn survey) *or*	Canadian autumn survey biomass for Div. 3N, $_{1991,\ 1993\text{-}2010,\ 2012\text{-}2013}$
I3b (3LN autumn survey)	Canadian autumn survey biomass for Div. 3LN, $_{1991\text{-}2013}$
I4 (3LN Power russian survey)	Russian spring survey biomass for Div. 3LN , $_{1984\text{-}1991\ \text{(Power and Vaskov,1992)}}$
I5 (3L winter survey)	Canadian winter survey biomass for Div. 3L, $_{1985\text{-}1986\ \text{and}\ 1990}$
I6 (3L summer survey)	Canadian summer survey biomass for Div. 3L, $_{1978\text{-}1979,\ 1981,1984\text{-}1985,\ 1990\text{-}1991\text{and}\ 1993}$
I7a (3L autumn survey) *or*	Canadian autumn survey biomass for Div. 3L, $_{1985\text{-}1986,\ 1990\text{-}1994,\ 1996\text{-}2009,\ 2011\text{-}2013}$
I7b (3L autumn survey)	Canadian autumn survey biomass for Div. 3L, $_{1985\text{-}1986,\ 1990}$
I8 (3N spring spanish survey)	Spanish survey biomass for Div. 3N, $_{1995\text{-}2013}$

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 used in the trajectories of biomass and fishing mortality. In a production model fishing mortality refers to catch/biomass ratio.

<u>Basic assumptions on ASPIC fit mode</u>

In this assessment the latest ASPIC version 5.56 (Praguer, 2013) 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 *Bms*y 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. $$MSY = rK/4 \qquad (3)$$

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

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

Starting with user guesses (seeds) for the key parameters and catchability coefficients, ASPIC fit generate iteratively an expected series for each observed series of the input framework. Key parameters of the model are found by a minimization routine that gathers all sums of log squared residuals found within each series.

A summary of the ASPIC model (Prager, 1994) is available at the 2003 assessment of redfish in Div. 3M (Ávila de Melo *et al.*, 2003).

Input file settings

ASPIC model requires from the user a set of initial definitions/starting guesses/constraints that need to be 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 50 or 60 Number of bootstrap trials when running on BOT mode, bias corrected approximate confidence limits of point estimates (50% or 60%) besides the standard 80% CL.
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 (Statlant CPUE with catch or just catch, 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 With an MSY fixed at the average catch of the former years, 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 for three of the five formulations tested on the next exploratory analysis, where *MSY* is estimated by the ASPIC program, as on previous assessments. *MSY* is fixed at a starting guess of 21000 t on the two other runs considered in the exploratory analysis. Between 1960 and 1985 catches oscillated with no trend around 21000. Commercial and survey catch rates declined when catches were raised above that level.
Line 16: 5.000E+05 Starting guess for carrying capacity *K* = 500 000 t, perhaps a rather conservative guess, roughly corresponding to the highest observed level of survey biomass after more than15 years of very low fishing mortality (Table 4, 2011-2012 autumn survey biomass on Div. 3LN).
Line 17: all catchability starting guesses were kept unchanged from the ASPIC2012 assessment just on the ASPIC2014 *statusquo* run, which is just an update. On the other four runs all three survey series for the 3LN ensemble had 1 as their catchability starting guess and so for these runs Line 17 stayed as follows:

- 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, 1.0000E+;
- autumn survey on Div. 3LN, 1.0000E+00;
- Russian survey on Div. 3LN combined, 1.0000E+00;
- winter survey in Div. 3L, 0.322d0 (average 1991-2009 3L/3LN spring survey biomass ratio times average 1991-2009 spring 3LN/autumn 3LN survey biomass ratio);
- summer and autumn survey in Div. 3L 0.275d0 (average 1991-2009 3L/3LN autumn survey biomass ratio);
- Spanish survey on Div. 3N 0.759d0 (the same as the correspondent Canadian autumn survey).

Line 18: 1 1 (or 0) 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, with the exception of two exploratory runs where *MSY* is fixed at a starting guess of 21000 t.
Line 19: 5.0000E+03 5.0000E+05 minimum and maximum constraints for *MSY*, on the three runs that it is estimated by ASPIC. Due to the logistic biomass growth underlying the Schaeffer model the recent increases recorded on several ongoing surveys place the actual biomass well beyond B_{msy} and lead to *MSY* estimates well above the highest catches recorded for this stock. That is the reason for such high maximum constraint allowed this year for *MSY*. Or,
Line 19: 5.0000E+03 5.0000E+04 minimum and maximum constraints for *MSY* on the two runs that it is fixed at the user starting guess of 21000 t. Under this option this line is obviously useless.

Line 20: `1.0000E+05 6.0000E+06` minimum and maximum bounds on the estimate of *K*, for all exploratory runs. For the same reason as stated above *K* can also reach unexpectedly high levels when *MSY* is estimated by the model.
Line 22: `55` Total number of years in the data sets included in the input file, from 1959 to 2013.

The rest of the settings of the input file were kept with the default options of ASPIC 5.56. The selected input file is presented on Appendix 1. All 1959-2010 catches used in this assessment are the catches adopted by STACFIS for this stock. The 2011 and 2012 catches were taken from the NAFO STATLANT 21A data base (as the latest update on September 13th 2013). The 2013 catch is provisional and it was taken from the NAFO Circ. Letter Ref. No.: GFS/14-070 Feb 2014.

Exploratory analysis

On 2012 the outcome of the exploratory analysis was a selected framework with the Canadian spring and autumn series purged of their bumpy surveys and a Spanish 3N survey still off the assessment despite its longevity. This make up was necessary in order to preserve an ASPIC run with results still in line with their predecessors and also still in line with overall picture one takes of this stock from the available time series of abundance related data.

On most occasions the survey bumps causing the crescent unfitness of the model are justified by one or two large redfish hauls within few strata that represent a large proportion of the swept area biomass (Power, *pers. comm.*). The likelihood of their occurrence is expected to increase as stock gets bigger and this was confirmed on the next 2012 and 2013 Canadian surveys.

On this year exploratory analysis three categories were set of candidate frameworks corresponding to three different approaches to this assessment:

1. A *status quo* category, with the update of the framework adopted in 2012 but keeping all the 2012-2013 new points.
2. An *MSY* model free estimate category, were *MSY* is estimated by the model along with the other key parameters. All the three frameworks in this category have a joint 1991-2013 Canadian autumn 3LN survey series and a short 1985-1986 and 1990 Canadian autumn 3L survey series. All points included in all series.
3. An *MSY* user fixed category, were an empirical approach to *MSY* is assumed as an input constant, based on 21000 t average catch level of the 1960-1985 interval. The two framework in this category have the same arrangement of the Canadian autumn surveys as on the previous category. All points included in all series.

The CPUE series and the short survey series (Russian survey, Canadian summer, autumn and winter surveys on Div. 3L), basically represent the abundance of the stock during the former period until 1990, while the Canadian spring and autumn survey on Div. 3LN combined and the Spanish 3N survey basically represent the abundance of the stock during the more recent period of the 1990’s and 2000’s. The negative correlations occasionally found between “old” and “new” surveys have been disqualified to halt the ASPIC assessment. The unavoidable negative correlation between the estimated and the observed Statlant CPUE series (due to the lack of observed values covering the last half of the time interval, when estimated series grows in line with the biomass increase estimated by the model) has also been disqualified to invalidate the assessment. Its value is treated in the traffic light diagnostic rating just as the one from any other series.

The five ASPIC 2014 framework options, distributed by the three approaches to this assessment described above, were:

Category 1

ASPIC 2014 1: 2012 status quo without 3N Spain, 3LN spring but 2007, 3L autumn but 2010 and 3N autumn but 2011

I1a(Statlant CPUE and catch)+I2 (3LN spring survey 1991-2005, 2008-2013)+I3a (3N autumn survey 1991, 1993-2010, 2012-2013)+I4 (3LN Power russian survey)+ I5 (3L winter survey)+I6 (3L summer survey)+I7a (3L autumn survey, 1985-1986, 1990-1994,1996-2009,2011-2013)

Category 2

ASPIC 2014 2: **with 3LN autumn survey and 3N Spain survey** full length survey series with all previous outlyers included, option b for I3 and I7

I1a(Statlant CPUE and catch)+I2 (3LN spring survey)+I3b (3LN autumn survey)+I4 (3LN Power russian survey)+

I5 (3L winter survey)+I6 (3L summer survey full series)+I7b (3L autumn survey, 1985-1986, 1990)+I8 (3N spanish survey)

ASPIC 2014 3: **strike out CPUE keep autumn 3LN survey and 3N Spain survey** full length catch and survey series with all previous outlyers included, option b for I1, I3 and I7

I1b (Catch)+I2 (3LN spring survey)+I3b (3LN autumn survey)+I4 (3LN Power russian survey)+

I5 (3L winter survey)+I6 (3L summer survey full series)+I7b (3L autumn survey, 1985-1986, 1990)+I8 (3N spanish survey)

Category 3

ASPIC 2014 4: **input MSY fixed at 1960-1985 average catch, strike out CPUE, keep autumn 3LN survey and 3N Spain survey**

full length catch and survey series with all previous outlyers included, option b for I1, I3 and I7

I1b (Catch)+I2 (3LN spring survey)+I3b (3LN autumn survey)+I4 (3LN Power russian survey)+

I5 (3L winter survey)+I6 (3L summer survey full series)+I7b (3L autumn survey, 1985-1986, 1990)+I8 (3N spanish survey)

ASPIC 2014 5: **input MSY fixed at 1960-1985 average catch, keep CPUE** full length survey series with all previous outlyers included, option b for I3 and I7

I1a(Statlant CPUE and catch)+I2 (3LN spring survey)+I3b (3LN autumn survey)+I4 (3LN Power russian survey)+

I5 (3L winter survey)+I6 (3L summer survey full series)+I7b (3L autumn survey, 1985-1986, 1990)+I8 (3N spanish survey)

Besides the correlation between ASPIC estimated and observed annual values for each data series (R squared in CPUE), other criteria were used as diagnostics of the FIT outputs for the five frameworks 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, 2004). 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}. Otherwise the ASPIC will set B_{msy} at the first guess given by the user.

- 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.

- B1/K (ideal = 0.5). At the beginning, and over the first 25 years, biomass from all previous assessments has been in the vicinity of B_{msy}. This time, and in line with these former results, the two last options kept *MSY* constant at the average catch for those years and if so the nearness of that biomass ratio to 0.5 (= B_{msy}/K) is added as a new diagnostic to evaluate the fit of the candidate frameworks.

An overview of the exploratory analysis under a traffic light rating frame (quantifying from 1 the worst to 5 the best of the five results of each diagnostic, see Table 6a) lead to the conclusion that both *MSY* fixed candidates (Category 3) shown a much better performance than the status quo or the three *MSY* free estimate candidates, namely for the diagnostics other than the r^2 *in CPUE*.

All *MSY* free estimate runs gave depressed (first half) biomass trajectories well below B_{msy}, and B_{msy}'s estimates at magnitudes well above all magnitudes estimated in the past. *MSY* and the equilibrium yield available in 2014 are also at much higher levels (Table 6b) than the highest level observed of catch (41600 t, 1986-1992), occurring at a time when all available indices for this stock declined. The model fit each estimated survey series to the big jumps observed on the correspondent survey, the final outcome being a stock increasing at an increasing speed from the second half of the 1990's onwards. The underlying logistic production model has no option but to assume that such a stock should still be in nowadays climbing towards B_{msy}.

The traffic light rating presents two clear winners for best diagnostics (Table 6a) but the difference between the two *MSY* fixed options, excluding or keeping the Statlant CPUE series, is marginal in favour of the second (ASPIC 2014 5). However the comparison to the 2012 key parameters, including how close *B1* can get to B_{msy}, in other words *B1/K* to 0.5, and B/B_{msy} to 2012 and 2010 relative biomass trajectories (Table 6b, Fig. 6a and 6b) confirms that, in terms of consistency with *MSY* assumption, previous assessments, and past history of 3LN redfish fishery and surveys, the ASPIC 2014 5 option has the better data framework on contest.

So, from exploratory analysis the better framework to run the redfish 3LN ASPIC 2014 assessment is the fifth candidate, ASPICfit 2014 5: with MSY fixed at 1960-1985 average catch, with the 1991-2013 Canadian autumn surveys on Div. 3L and Div. 3N assembled in a single 3LN Canadian autumn series, keeping the Statlant CPUE series and with all survey series having all points included.

Sensitivity analysis

Different starting guesses for key parameters, different random number seeds and different magnitudes of last year surveys were used to test the robustness of the $ASPIC_{fit}$ 2014 formulation. The purpose was to investigate if the model stands still in its response 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). Eight input options presented on Table 7a were tested against the standard adopted input option:

- 25% above and below the default random number seed,
- an "optimistic" start given by -25% *CPUE* and survey catchabilities, together with +25% *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 seed related options and both "optimistic" and "pessimistic" starts arrived to visual undistinguishable solutions (Fig. 7a), confirming that the ASPIC results given by the chosen formulation are almost insensitive to first guess/default inputs chosen to initialize the assessment (Table 7b). Un-skew very light turbulence is induced on the trajectories of relative biomass and fishing mortality by variability on last year surveys, in line with the logistic model chosen for biomass growth and the with actual level of the stock above B_{msy} (Table 7b, Fig. 7b).

If the stock is in the safe zone, with biomass above B_{msy} and fishing mortality below F_{msy}, such as the 3LN redfish stock at present,

- A change in the surveys between the last couple of years higher than expected will pull the stock downwards, closer to B_{msy}, in order to accommodate a faster rate of increase.
- A change in the surveys between the last couple of years smaller than expected will push the stock upwards, closer to *K*, in order to accommodate a slower rate of increase.

The response of the model to variability on last year surveys is well illustrated on Fig's 7c and 7d, were positive dependent (F_{msy} , $F_{last\ year}/F_{msy}$, Ye_{2014} and *B1/K*) and negative dependent (B_{msy}, and $B_{last\ year+1}/B_{msy}$) parameters (previously standardized) are plotted against the range of relative survey biomass for 2013.

Retrospective Analysis

A 2014-2012 ASPICFIT retrospective analysis (the actual framework with last year of each assessment one year less, from 2013 back to 2011) checked for retro bias on relative biomass and fishing mortality (Table 8, Fig. 8a and 8b). From one year to the next ASPIC assessments over estimate biomass (and B_{msy}) and under estimate fishing mortality (and F_{msy}) with a small bias (1%-5%). As discussed in the previous section, these retrospective patterns are the model response to the general increase of the still standing survey series the past decade (Fig. 8c).

The observed retrospective biases don't change the perception of the stock related trajectories (biomass and fishing mortality) over time or its present position in relation to B_{msy} and F_{msy}. But from one year to the next more conservative assessments are slowing down the estimated growth of the stock, more in line with a lower rate of intrinsic stock biomass increase, which one would expect from a long-lived/slow-growing species such as redfish.

Assessment results

$ASPIC_{2014}$ run first on deterministic (FIT) mode. Results are presented on Appendix 2, with a summary of diagnostics and parameters included on Table 6a and 6b under $ASPIC_{fit}$ 2014 5. Relative biomass and fishing mortality trajectories are plotted on Fig's 6b and 6c.

Despite the "negative" correlations between series with a very small number of pair-wise observations, correlation among the majority of possible combinations of surveys is high ($r^2 > 0.65$), namely between the two long 3LN Canadian surveys (Appendix 2). With the exception of a (previously justified) worst unfit of the Statlant CPUE index and a poor fit of the "new" Spanish 3N survey, correlations between observed and estimated series increase from last assessment, which is a remarkable feature in favour of this new approach, taking into account that this assessment incorporates all the "outliers" that have been progressively forced to be strike out of the input framework on previous assessments in sake of model fit.

The ASPIC package is used afterwards for a second assessment, this time on bootstrap mode (1000 trials), regarded as the first step towards projections@risk. Both parametric and non-parametric parameter estimates can be computed, and associated variability estimates can be computed as well, by bootstrap methods. Our choice for a frequentist framework (such as the one provided by $ASPIC_{bot}$) alternate to a Bayesian framework, relies on our belief that, once the parameters distributions are computed through the residuals resampling, such as in $ASPIC_{bot}$, it is unnecessary to assume '*a priori*' distributions based on empirical knowledge (or simply based on the user assumption, when this empirical knowledge does not exist). Although the Bayesian approach is the only option for dealing with uncertainties in many cases, when feasable, the frequentist way to deal with this problem by using the frequency as a measure for the uncertainty reduces to a much lesser extent the human touch within the process.

In each bootstrap trial a set of observations is constructed by combining the predictions (from the original fit) with residuals from the original fit (more information at (Prager, 1994)). Bias of an estimated parameter are computed as follows: a) compute the median estimation bias as the difference between the parameter median value (from the bootstrap runs) and the parameter estimator; b) correct the bias by a bias-corrected estimator obtained as the difference of the parameter estimator and the parameter estimated bias computed at a). Note that bias correction is done in terms of the median rather the mean, since mean correction can have extremely high variance, so it is unreliable. But even so, and according to Michael Prager (*pers. comm.*, 2014), bias correction of point estimate using the median from bootstrapping may also have an extremely high variance, so it is unreliable. Therefore, the best estimator of central tendency is the point estimate.

Prager also developed bias-corrected confidence intervals (as it appears within ASPIC outputs). A description of how these intervals are computed can be found in (Prager, 1994) and in (Efron, 1982). However, the bias-corrected confidence intervals shown on ASPIC output are confidence intervals for the point estimate and not for the bias corrected point estimate.

Bootstrap results are presented on Tables 9a and 9b and Fig's 9a to 9e. The $ASPIC_{bot}$ 2014 main results and bias corrected trajectory for relative biomass are presented with the results of the previous $ASPIC_{bot}$ 2012 and 2010 assessment (Ávila de Melo *et al.* 2012 and 2010b). The three assessments gave similar results and similar stock dynamics over the last 50 years, despite the expected upwards/downwards shifts of biomass and fishing mortality trajectories from one assessment to the next.

The robustness of the $ASPIC_{bot}$ 2014 results is also confirmed by:

- small bias between the bias corrected and the point estimates (< 10%) for most key parameters (Table 9a),
- B/B_{msy} and F/F_{msy} point estimate trajectories sticking to their bias corrected ones (Table 9b, Fig.'s 9b and 9c),
- while keeping their point estimated biomass and fishing mortality tracks far from their own 80% CL's boundaries (Fig's 9d and 9e).

The model results suggest that the maximum observed sustainable yield (*MSY*) of 21000 t can be a long term sustainable yield if fishing mortality stands at a long term level of 0. 11. The correspondent stock biomass is considered this stock B_{msy} (191500 t). The magnitude of *MSY* is given by the average level of catches over more than 25 years (21 000 t, 1965-1985) coping with an apparent stability of stock biomass. The magnitude of F_{msy} (0.11) is of the some order of magnitude than $F_{0.1}$ = 0.12 given by a previous yield per recruit analysis for redfish in Div. 3LN (Power and Parsons, 1999). Relative biomass was slightly above B_{msy} for most of the former years up to 1985, under a fishing mortality in the vicinity of F_{msy}. Between 1986 and 1992 catches were higher than *MSY* (26 000 t - 79 000 t), pushing fishing mortality well above F_{msy} from 1986 till 1993. Those eight years of heavy over-fishing determine the fall of biomass, from B_{msy} in 1986 to 12% B_{msy} in 1994-1995, 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 1995 both were kept at low to very low levels. Over the moratorium years biomass was allowed to increase and at the beginning of 2014 the probability to be at or above B_{msy} is high to very high (Table 9a and Fig. 9d).

Catch versus surplus production trajectories are presented on Fig. 10. From 1960 till 1985 catches form a scattered cloud of points around surplus production curve. On 1986-1987 catch rises well above the surplus production and though declining continuously since then was still above equilibrium yield in 1993. Catch has been below to well below surplus production levels since 1995.

ASPIC medium term projection under a precautionary management strategy proposal

Background rational

Regardless the input formulations, the starting guess region, the mode of the ASPIC runs or the retrospective patterns, the 2014 assessment reiterates the main conclusion of the previous ones: the biomass of redfish in Div. 3LN is above B_{msy}, while fishing mortality is well below F_{msy}. The status of the stock allows an increase in its exploitation the question is how far and how fast should be this increase on the threshold to *MSY*. In sake of precaution the following caveats should be taken into consideration when setting a management strategy (MS) for redfish in Div. 3LN:

1. *MSY* is given by empirical evidence from a more or less distant past. It is uncertain that the productivity regime which supported 21000 t over the 1960's up to the first half of the 1980's still prevails.
2. So, before moving to *MSY* the MS should confirm that the stock size nowadays can accommodate a substantial increase of catch and still stand where it is: at or above a level of biomass that was able to sustain a long term catch of 21000t. This substantial increase should correspond to the estimated equilibrium yield for 2014 (Ye_{2014}) of 18100 t.
3. In practical terms the MS should first drive the stock to a sustained exploitation under Ye_{2014} within a foreseeable future, 2015-2020. If Ye_{2014} is accepted as a preliminary catch target within a prefixed time frame, the steps to achieve this goal should be catch steps.

4. MS control should go along with the assessment time frame and focus on the impact of those catch steps on biomass and fishing mortality in relation to their own reference points. If over the next coming years (2015-2020) the actual perception of stock status change, the MS should be reviewed in accordance with the newest assessment results.
5. The actual perception of the stock status is that biomass is at or above B_{msy} and fishing mortality below F_{msy} with a high (60% confidence interval) to very high (80% confidence interval) probability.

The medium term management strategy proposal

The purpose of this MS proposal is to reach 18100 t annual catch by 2019-2020 through a stepwise biannual catch increase, with the same amount of increase every two years between 2015 and 2020.

The medium term ASPIC projection objective

To predict if the MS proposal is able to be implemented with a very high probability of keeping biomass at or above B_{msy} , and fishing mortality below F_{msy}.

ASPIC projection framework

ASPICP, the ASPIC auxiliary program for projections, provide point estimates (with associated 80% and 50% confidence limits) and bias corrected estimates of biomass and fishing mortality for the assessment time interval extended to the projection years, in this case under user preset catch. ASPICP reads the results from the 1000 trials of the ASPIC $_{bot}$ 2014 assessment stored in a .BIO file and project each of these runs seven years ahead under the following gradient for 2014-2020 catch:

Catch 2014	6500
Catch 2015	10400
Catch 2016	10400
Catch 2017	14200
Catch 2018	14200
Catch 2019	18100
Catch 2020	18100

This catch sequence is input on a .CTL file that will guide the medium term projection. Results are stored in .PRJ files and summarized on Table 10 and Fig 11a and 11b.

Projection results

There is a high probability that the proposed gradual increase of the catch on the next coming years towards the present equilibrium yield of 18100 t, will maintain biomass at the beginning of 2021 above B_{msy} while keeping fishing mortality until 2020 below F_{msy} .

Stock and fishing mortality trajectory under a Precautionary Approach framework

The ASPIC point estimate results were put under the precautionary framework (Fig. 12). The trajectory presented shows a stock slightly above B_{msy} under exploitation around F_{msy} through 25 years in a row (1960-1985). The stock rapidly declined afterwards to well below B_{msy} when fishing mortality rises to well above F_{msy} (1987-1994). Biomass gradually aproaches and finally surpasses B_{msy} after fishing mortality dropped to well below F_{msy} (1994-1996) being kept at a low to very low level ever since.

The NAFO SC Study Group recommendations from the meeting in Lorient in 2004 (NAFO, 2004), 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 below) B_{lim} between 1993 and 2001, justifying the implementation of the moratorium on this fishery in 1998.

Acknowledgements

This assessment is part of a EU research project supported by the European Commission (DG Mare, Program for the Collection of Data in Fisheries Sector), IPMA (EU-Portugal) and IEO (EU-Spain). The authors would like to thank Don Power (Science, Oceans and Environment Branch, DFO, St. John's, NL, Canada) for the early submission of the 2012 and 2013 data from the spring and autumn Canadian surveys on Div. 3L and Div. 3N. We also would like to express our gratitude to Barb Marshall of the NAFO Secretariat (Dartmouth, NS, Canada) for her work on the edition of this research document.

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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	57	994	1051	0	
2010	260	3688	4120	3500	
2011	2418	1254	3672	6000	d
2012	2781	1535	4316	6000	d
2013			6003	6500	e
2014				7000	

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 STATLANT 21A catches as updated on September 2013.
e Provisional catch 2013 from year-to-date catches for December 2013 (NAFO Circ. Letter Ref. No.: GFS/14-070 Feb 2014)

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
	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, 1990-2013.

Length	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
10																			0.09			1	2	1
11														0.03					0.21	3	13	3	5	35
12	12													0.03					0.23	10	30	21	14	32
13	6													1					0.09	23	49	69	30	330
14	21													1			0		0.09	33	154	117	52	222
15	28	28												5			10		3	51	268	224	78	207
16	73	103	9									1	0	8			24		14	**362**	506	281	95	479
17	199	394	28			2				0	1	2	1	21	1	2	34		80	**670**	768	371	139	628
18	286	1034	412		5	2		0	1		1	1	1	44	2	4	65	0	103	**747**	**935**	430	201	909
19	445	2157	1291	5	6	3	1	0	2	16	4	4	3	90	6	9	99	43	96	**495**	**1383**	**766**	426	**1930**
20	720	3313	2375		16	14	4	2	13	47	6	18	14	151	15	11	**182**	143	43	**357**	**1737**	**1253**	890	**2786**
21	1309	3780	2943	235	287	9		11	57	80	10	52	41	**218**	28	13	**300**	77	**133**	**428**	**2284**	**1942**	**1564**	**3925**
22	2081	**4922**	3600	714	683	65	6	17	**151**	150	26	102	81	**269**	35	11	**347**	149	**239**	**475**	**3084**	**2545**	**2235**	**5725**
23	3212	**7340**	**4358**	1141	594	64	17	34	**277**	128	46	118	101	**277**	41	16	**340**	212	**303**	**552**	**2188**	**1959**	**1778**	**3343**
24	**4164**	**7575**	**5552**	2565	708	99	9	64	**296**	120	85	114	132	**258**	54	35	**210**	170	**253**	**311**	**1183**	**1099**	**1231**	**2362**
25	**5216**	**6944**	**4981**	**5237**	**944**	100	9	**98**	**248**	178	**195**	114	154	**261**	85	61	**147**	**221**	**224**	268	831	593	992	**1532**
26	**5560**	**5981**	**5145**	**5115**	**1297**	277	12	**118**	**221**	**318**	**364**	126	**204**	**309**	**157**	**138**	**111**	**206**	**138**	271	769	450	746	**1564**
27	**5410**	**6197**	**4579**	**5433**	**1404**	**330**	35	**144**	**218**	**555**	**546**	**170**	**248**	**324**	**190**	**181**	99	**134**	81	193	584	371	670	896
28	**5217**	**5322**	**4063**	**5004**	**1182**	**300**	**75**	**114**	**173**	**712**	**943**	**188**	**289**	**286**	**184**	**201**	88	**521**	32	194	580	462	646	986
29	**4712**	**3354**	**4637**	**4437**	**1188**	**263**	**76**	**114**	**154**	**673**	**1003**	**179**	**289**	**245**	**184**	**223**	62	**425**	42	140	490	445	620	594
30	**4751**	**4043**	**3911**	**3283**	**1011**	**310**	**182**	**114**	**120**	**520**	**1027**	**236**	**294**	**225**	**178**	**176**	60	**368**	44	96	416	434	714	573
31	**4551**	2695	3711	**2964**	**912**	**313**	**197**	**154**	**129**	**413**	**564**	**289**	**295**	**204**	**107**	**109**	35	**335**	31	64	296	608	691	651
32	**3943**	2478	2187	2313	**944**	**309**	**98**	**146**	**119**	**434**	**315**	**303**	**276**	189	**108**	**91**	28	**594**	37	49	276	674	641	440
33	3082	1582	1355	2291	596	226	**67**	**131**	**110**	**383**	**237**	**298**	**216**	196	95	83	19	**316**	58	40	242	535	681	346
34	2737	1179	1569	1527	526	189	30	71	66	**268**	**217**	**218**	132	149	73	71	17	**252**	83	37	215	223	392	239
35	2100	928	1604	1059	363	182	35	24	19	141	129	**212**	83	112	51	63	10	124	62	11	208	170	265	119
36	1681	831	1895	923	202	106	23	19	18	89	60	121	37	62	36	56	5	110	39	13	137	85	157	128
37	1416	580	1571	766	196	160	7	14	11	82	78	82	18	41	17	31	2	4	31	2	70	46	101	65
38	1128	482	1303	807	158	171	5	10	8	51	50	55	11	22	10	15	1	2	12	1	69	54	105	42
39	729	363	1114	489	124	100	11	3	3	37	47	30	3	14	9	8	0	23	9	2	32	19	40	16
40	458	292	790	505	69	144	2	4	3	23	23	18	2	7	5	8	0	22	1	0	17	17	33	5
41	321	188	558	320	49	63	3	1	2	19	12	10	1	2	2	4	0	0	1	0	7	10	20	6
42	255	117	420	306	23	1	1	1	0	13	15	7	2	3	1	2	0	0	0	0.567	3	5	11	4
43	227	68	203	137	15	3	2	2	0	3	9	4	2	2	2	6		0.5	3	0.019	0	5	7	4
44	157	83	85	175	7	3	2	1	1	3	1	3	1	2	1	3		0.1	0	0.233			2	
45	84	33	76	107	1	3	2	0.1			2	1		0	1	1		0.1	1	0			1	
46	58	8	32	9	3			0.1	0.0	0.2	1	1		2	0.2	0				0			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														1					
50																								
51	1	25			2									0.3							0			
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	4454	2199	5901	19825	16289	16274	31123
weight (tons)	29105	25815	27283	21308	5741	1989	451	630	899	2318	2617	1442	1216	1334	637	659	497	1664	597	1051	3948	3672	4316	6003
mean weight (g)	438	347	411	445	425	521	496	446	371	425	435	469	415	334	379	404	217	365	271	178	199	225	265	193
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	29.4	25.4	22.0	23.4	24.4	25.9	23.4
length anomalies	1.48	-1.2	0.5	1.8	1.2	3.8	3.4	2.0	-0.4	2.0	2.3	3.0	1.7	-0.3	1.6	2.3	-3.9	1.6	-2.4	-5.8	-4.5	-3.5	-2.0	-4.4
%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%**	1.0%	**13.5%**	**40.6%**	**20.7%**	**14.0%**	6.4%	**15.3%**

Table 3b: length weight relationships from 3LN Sebastes sp. Portuguese commercial sampling data used in the computation of 3LN catch at length (Alpoim and Vargas, 2004; Vargas et al., 2005-2014)

Sebastes sp.	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
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	0.0207	0.0207	0.0207	0.0214	0.0214	0.0214	0.0360
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	2.8946	2.8946	2.8946	2.8659	2.8659	2.8659	2.6998

Table 4: Survey biomass from all stratified bottom trawl surveys on Div. 3L and Div.3N, 1978-2013. Survey female SSB from spring and autumn Canadian surveys on Div. 3LN, 1991-2013
(shaded indices included in the 2014 ASPIC framework; *values in italic not validated as survey indices*)

	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. 3L	Div. 3N
	I2spring	I2springSSB	I3autumn	I3autumnSSB	I4Power	I4Vaskov	I5winter	I6summer	I7autumn	I8spring	I9spring	I10autumn	I11summer		I12spring
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		*81.8*	11.0
2004	79.6	26.25	49.9	11.4					9.3	14.4	65.3	40.6		*30.8*	27.0
2005	66.5	8.51	58.6	11.2					16.7	36.5	29.9	41.9			146.9
2006			91.9	12.9					27.2	35.3		64.7		70.1	87.8
2007	218.8	39.27	124.8	16.8					57.5	174.1	44.7	67.2		31.4	87.6
2008	144.0	22.93	198.5	27.4					53.3	38.5	105.5	145.2		75.6	68.1
2009	183.4	20.26	246.7	29.6					87.2	26.1	157.3	159.5		103.7	735.7
2010	165.3	20.57	461.49	53.9					324.4	36.5	128.9	137.1		266.8	359.5
2011	173.7	21.86	562.3	64.1					71.4	59.9	113.8	490.9		170.6	418.3
2012	322.0	45.47	596.0	89.7					215.4	58.9	263.1	380.6		481.5	265.2
2013	271.5	48.14	288.8	41.1					61.9	146.4	125.1	226.9		235.2	429.5

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]	2007	2008	2009	2010	2011	2012	2013
4															40								
5												62		31				416	46	258			146
6						466		20	16	185	109	170	293	804	108		154	1966	479	137	559	41	695
7						228		40	656	795	1511	472	2057	2400	540	309	3452	2942	974	562	781	1055	1772
8						149	685	8	3280	378	1302	1073	1682	1236	950	602	9327	3135	954	936	858	1039	1106
9	849					298	360	39	5877	89	483	1526	1524	2209	2891	494	2625	3381	371	1361	1073	1596	1791
10	1149			562		296	251	113	1343	166	240	2518	1197	4107	4892	633	886	4258	994	2423	1342	1921	1896
11	798	381	122	355		478	730	533	309	403	116	1085	417	2911	7296	1235	1683	5317	1695	2902	2464	2178	2225
12	558	2988	1304	540		806	722	455	430	191	451	1645	1448	1653	8756	1344	2296	2432	3642	2871	1701	2852	1761
13	2524	7925	2396	500	108	920	540	172	517	412	345	838	1101	1330	9684	1575	1908	1286	16098	2256	2458	2581	2303
14	322	5192	5646	536	272	413	1871	561	369	353	1073	517	1278	639	7710	2903	1928	5396	12659	4892	3568	3658	1807
15	699	2862	11059	1329	278	716	1859	896	175	2458	1738	766	2609	1235	7437	5776	3631	3841	11260	8481	4481	5998	4327
16	2250	382	13647	1790	966	846	1126	1506	774	2199	1681	1371	3559	1335	7357	8062	5993	15866	75231	14345	8907	9617	2467
17	3865	419	8796	3123	2847	1588	1201	2046	703	2157	3337	2580	6189	2764	8647	10733	14186	45719	197691	26140	17787	52512	3940
18	6226	1111	2719	3084	4285	4356	1860	2121	3455	3525	5257	6444	8643	3668	16472	12772	24586	77478	325440	108928	56811	96670	12330
19	7749	2480	2474	1403	5014	9476	3280	2849	2988	7017	8267	8161	15473	8995	31506	14610	26943	50553	310284	219289	115709	194730	20116
20	4522	2574	3839	829	2703	10910	4708	9472	5379	13198	9589	11326	21089	11905	33702	19196	26003	48021	164370	234599	144823	289679	103824
21	3482	3559	5754	922	1815	12119	6367	24848	16817	22002	14393	13958	23750	16956	33182	26687	43665	49072	92564	178663	221969	398075	210629
22	5148	1690	5301	783	1335	13844	7008	34265	31067	42769	15551	14932	19290	16584	30967	30007	68143	78864	60965	74436	128066	315995	237958
23	7253	1732	5708	1181	1257	16629	8191	31121	38232	53557	15590	15582	15120	20423	30644	23768	87375	88837	65881	72484	85379	190758	182210
24	6187	2721	4756	1498	1359	12502	10669	28376	45394	53956	14839	16034	10814	17004	28561	19150	96975	87288	76912	66508	62237	140353	147932
25	3366	2865	3398	1748	1004	8318	9469	21275	21482	34350	10166	12606	8036	14657	24305	10687	78847	61337	55777	61001	46547	94274	114790
26	1963	3250	3701	1564	1600	5649	7757	19512	30227	27846	10041	11224	6889	24397	18438	5467	90996	54230	30388	38296	44947	63492	62515
27	1426	2411	4478	1057	1693	5106	4047	16075	21654	21918	11330	8887	5102	38936	20027	6301	81118	34946	17043	18645	37756	45182	45089
28	953	1834	3283	803	1437	4901	2760	12716	15663	13775	10217	7496	3552	43216	15249	2764	36969	28227	14167	18908	32300	32808	40858
29	1038	1506	2876	731	1154	4264	1871	9632	14331	15612	10385	6419	2778	24426	11907	3259	38023	19445	13076	11302	24988	33669	28454
30	607	1048	2606	482	721	3323	1797	6120	6698	14650	9523	3741	2701	18145	8832	2641	30266	12314	8659	10701	16753	26246	25858
31	534	1014	2969	318	474	2231	1354	6513	5732	12804	10450	3588	2176	13713	5769	2039	30137	10571	6011	4704	10141	18307	15530
32	417	809	3087	244	548	1564	991	6157	4322	10277	8884	2235	2356	9706	3036	1869	21974	7018	4096	4110	8774	14817	14990
33	369	825	2621	138	264	762	640	5687	3259	6538	5183	1382	1972	3487	2012	1328	9163	7747	3448	2908	4925	5029	9922
34	399	540	2161	156	144	337	438	3287	2024	5043	3035	996	1009	5391	1617	371	8158	4329	2327	2565	2999	4685	9065
35	251	544	1502	109	105	163	160	967	877	3301	990	455	640	2249	832	263	7223	1860	1609	1804	1662	1757	10028
36	190	366	880	135	113	105	77	660	534	895	296	227	227	476	592	139	9422	1361	839	1035	1367	1276	5801
37	222	216	696	127	151	118	42	402	273	709	378	93	82	877	222	31	1894	786	312	394	788	958	3558
38	159	219	669	82	101	28	88	82	102	396	116	43	35	75	112	46	1945	386	235	197	848	548	1831
39	130	300	726	31	70	55	4	82	67	186	155	59	35	43	86		193	325	90	31	224	897	1406
40	118	220	483	46	62	28	0	216	79	183	23		94	23	12		115	189	55	54	71	167	1275
41	45	77	371	0	15	15	0	15	51	16		15		4	15	46	59		28		119	81	865
42	88	85	215	9	46	4	0	20	66	47	63	15		15	8	31	24	53	50			15	1637
43	69	85	83	49	27	35	15	201	0	31	28		15	15		46	8			76		48	463
44	45	77	189	29	31		31	12	27	31	28				15		23	60				97	12
45	57	62				15	15	15		31	15			8									417
46		46	51			15	46		31									34					401
47		4	20		15		15																
48	11	31	31																15				
49		31																					401
50																							
51																							
52																							445
53																							401
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	868.3	821.3	1576.7	1199.2	1096.3	2055.7	1337.3
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	25.1	22.9	20.3	21.6	22.6	22.5	24.1
length anomalies (cm)	-1.5	-1.5	-0.5	-1.6	-0.4	0.3	0.4	2.0	1.6	2.2	2.1	0.4	-1.1	2.6	-0.9	-1.2	2.0	-0.3	-2.8	-1.5	-0.5	-0.7	1.0

[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	2007	2008	2009	2010	2011	2012	2013
4																						0	0
5				15	240	56	86	17		117	445	232	1090	34	0	84	234	31	96	1384	57	263	417
6					256	359	330	0	251	481	937	915	2427	85	133	1418	512	641	624	1110	318	1405	4539
7	203				138	88	395	39	50	673	755	873	2185	61	162	1831	2222	2359	318	1405	727	926	2902
8	1298				111	72	386	47	37	602	2114	1614	2714	620	908	466	2914	2745	871	3377	878	2332	4879
9	1236				241	146	468	252	421	620	3146	1275	2095	1280	2236	829	8313	2359	3452	3788	2878	6976	5697
10	7263		93	31	292	250	306	214	171	388	4323	1129	2855	1719	1574	1458	8498	4100	9932	4676	2265	9925	5439
11	22235	371	63	31	213	349	249	203	402	215	2846	2840	1839	1046	3957	1709	7527	5543	5206	6612	1841	8539	8460
12	62419	62	372		241	106	175	275	786	202	1266	2255	1123	1131	9942	3083	6352	4861	4025	7947	1925	6516	12917
13	109337	3189	457	335	304	274	366	596	868	320	1056	2072	1488	1436	11090	3970	5871	27297	9473	10315	3250	5463	12133
14	33876	27936	1775	551	513	1419	728	912	2472	587	445	2545	1451	1015	10309	8256	9046	28768	20311	11133	4187	6377	15089
15	14030	104298	1333	2362	967	722	1104	1768	1548	3635	407	1884	1929	538	8461	13286	21881	23691	17750	8561	8268	5234	28083
16	7809	113966	3259	3697	1611	919	1405	4159	717	4671	11018	2159	8240	879	6083	20912	40243	116528	35720	12943	14606	3150	12974
17	7860	106448	5283	12985	9645	825	1848	8155	1144	5480	31421	4694	15193	1984	5713	27177	51164	228751	138765	18474	46427	9778	15860
18	16191	95896	8707	28684	37932	2227	2095	12225	3185	7035	57695	9082	25813	5468	7248	23009	43358	221311	396982	77810	103647	24081	34943
19	32214	71577	6425	29295	72192	5062	8438	17373	6536	11926	74228	13661	38672	8222	10928	24342	35091	141084	421539	269160	432556	116751	92467
20	27189	113846	3906	15292	78316	6479	21672	46005	9068	31680	80538	12568	45262	9790	15982	26793	45870	78263	279787	459453	996936	315398	109915
21	15810	148628	5306	7701	43397	6621	47562	88726	15347	50184	65575	16481	42849	13134	25645	36447	55971	63995	138841	499979	1198226	664907	283174
22	7915	153395	6375	5119	27652	6123	52500	124662	23121	66781	130029	20168	39683	13632	23899	49628	61550	55482	67350	303473	587045	653151	454374
23	6139	89704	6578	6494	20117	6743	44777	92991	29000	60123	118427	23529	39374	16732	29785	71774	84212	89011	53177	261470	300782	501477	309498
24	8377	28658	5164	5456	10296	4864	31865	56410	26969	52986	85149	25353	31785	15458	20362	67361	81986	80398	65248	260734	126712	314858	193667
25	8943	14222	3947	6808	12898	4429	24356	30123	29819	50534	64519	21326	21398	13066	15824	34947	57418	66252	46806	165444	97731	203720	122411
26	6602	13410	4120	8670	8517	4370	21375	23090	27515	40188	39693	19872	18032	10432	12713	32335	39981	49866	39922	120859	82802	152183	64144
27	4022	14699	4361	7830	17364	2890	21141	20596	25585	21851	33743	16470	17605	9397	10857	19109	26128	48823	34957	95155	49339	135137	32163
28	3776	8768	4240	8402	17495	2707	14031	18336	24801	17424	20396	10503	13962	12135	12471	11651	19087	37469	24861	72543	35075	76038	23430
29	2526	4855	3503	7625	16330	2678	8032	13397	16323	16387	14957	7230	7798	13950	12659	10147	13206	21724	24372	38007	30904	67575	16618
30	2110	3340	2765	6195	12717	2242	6138	7942	11346	12127	11093	5122	4910	12267	9865	7475	7643	18374	14245	26788	35523	46137	14071
31	1960	3229	1949	4553	16297	3409	4994	6250	7641	10199	9147	5109	3755	9066	7347	9531	6404	11854	10895	15934	17230	29841	8793
32	1314	2389	1901	2709	10628	2210	4035	5730	6315	7165	5261	4608	3523	6787	5214	7469	4180	6793	7953	14869	11668	28059	8562
33	1212	3299	1671	1603	7262	1220	2107	3878	5642	5026	4354	3862	3360	4636	4905	4870	3623	6389	6675	9280	4838	18841	5790
34	1117	1431	1286	916	3447	559	1673	4512	4545	3369	2776	2701	2182	2959	3942	2096	2183	5268	3627	5875	2164	7507	2538
35	1287	716	1044	610	1966	217	653	2048	3256	1303	1679	1451	1175	1760	2720	1118	1067	2385	2538	1885	1869	4530	2229
36	1184	595	800	297	1171	118	499	1080	1539	1092	675	560	506	1259	1456	537	416	970	2183	2310	1332	2698	1220
37	1005	385	460	211	335	64	308	426	339	499	636	325	182	765	1298	444	847	784	1772	1299	817	5530	653
38	1166	401	427	257	398	14	243	247	184	329	282	85	111	392	385	136	275	654	700	1374	138	5691	208
39	787	228	308	274	572	22	176	85	272	227	215	67	115	666	228	55	40	0	300	372	136	1938	257
40	662	93	237	119	75	22	164	17	67	151	180	136		308	60	116	17	391	250	389	0	954	375
41	221	124	155	0	20	22	191	40	82	67	81			76	85	61	103		129	208	0	1509	0
42	135	77	132	15	24		45			67		17		232	60			263	505	195	0	630	0
43	102	31	37	32	32			35	50		4	21		99					92		45	571	0
44	128	46	99			42		17	50	4		17										525	0
45	46	15	69	15	36	28		17	50	76		17					63	131	46	83		355	0
46	24	46			12	14				18	17					16						216	0
47	15	15	15	8		12			17													355	0
48									17									62				77	0
49		15																				77	0
50	15																					77	0
51																						0	0
52																				1022		0	0
53																						77	0
abundance (millions)	422	1130	89	175	432	71	327	593	288	487	882	245	407	195	297	526	755	1456	1892	2797.7	4205.1	3448.4	1910.9
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	21.9	20.8	20.6	22.7	21.8	23.4	22.6
length anomalies (cm)	-5.8	-2.5	1.1	0.0	0.5	1.3	1.4	0.9	3.1	1.6	0.1	1.1	-0.4	2.7	0.2	0.1	-0.8	-1.9	-2.1	-0.1	-0.9	0.7	-0.2

Table 6a: A traffic light rating of diagnostics of 5 alternate frameworks of ASPICfit 2014 assessment.

		ASPICfit 2014 1	rate	ASPICfit 2014 2	rate	ASPICfit 2014 3	rate	ASPICfit 2014 4	rate	ASPICfit 2014 5	rate
R squared in CPUE	I1a	-0.095	5	-0.283	3					-0.239	4
	I1b										
	I2	0.759	3	0.836	5	0.829	4	0.734	2	0.625	1
	I3a	0.717									
	I3b			0.705	4	0.708	5	0.678	3	0.596	2
	I4	0.136	2	0.125	1	0.146	3	0.292	5	0.259	4
	I5	0.290	3	0.269	1	0.288	2	0.438	5	0.413	4
	I6	0.466	3	0.380	1	0.410	2	0.805	5	0.738	4
	I7a	0.500									
	I7b			0.161	2	0.176	3	0.268	5	0.248	4
	I8			0.343	4	0.351	5	0.295	3	0.196	2
N restarts		2013	2	3769	1	1418	3	49	4	43	5
contrast index (ideal = 1.0)		0.2007	2	0.1443	1	0.2464	3	1.5822	4	0.6270	5
nearness index (ideal = 1.0		0.7519	2	0.6507	1	0.7576	3	1.0000	5	1.0000	5
Total obj. function		31.83457	5	44.68636	2	42.16328	4	43.16644	3	51.09520	1
B1/K (ideal = 0.5)		0.05790	3	0.02516	2	0.06186	4	1.62300	1	0.67640	5
rate			30		28		41		45		46

(green)	good result
(yellow)	intermediate result
(red)	poor result

ASPIC $_{fit}$ 2014 formulations:

ASPIC$_{fit}$ 2014 1 update 2012 approved assessment framework

I1a(Statlant CPUE and catch)+I2 (3LN spring survey 1991-2005, 2008-2013)+I3a (3N autumn survey 1991, 1993-2010, 2012-2013)+I4 (3LN Power russian survey)+I5 (3L winter survey)+I6 (3L summer survey)+
I7a (3L autumn survey, 1985-1986, 1990-1994,1996-2009,2011-2013)

ASPIC$_{fit}$ 2014 2 with 3LN autumn survey and 3N Spain survey full length survey series, all previous outliers included, option b for I3 and I7

I1a(Statlant CPUE and catch)+I2 (3LN spring survey)+I3b (3LN autumn survey)+I4 (3LN Power russian survey)+I5 (3L winter survey)+I6 (3L summer survey full series)+
I7b (3L autumn survey, 1985-1986, 1990)+I8 (3N spanish survey)

ASPIC$_{fit}$ 2014 3 strike out CPUE, full length catch and all survey series, all previous outliers included, option b for I1, I3 and I7

I1b (Catch)+I2 (3LN spring survey)+I3b (3LN autumn survey)+I4 (3LN Power russian survey)+I5 (3L winter survey)+I6 (3L summer survey full series)+I7b (3L autumn survey, 1985-1986, 1990)+
I8 (3N spanish survey)

ASPIC$_{fit}$ 2014 4 MSY fixed at 1960-1985 average catch, strike out CPUE, keep full length catch and all survey series, all previous outliers included, option b for I1, I3 and I7

I1b (Catch)+I2 (3LN spring survey)+I3b (3LN autumn survey)+I4 (3LN Power russian survey)+I5 (3L winter survey)+I6 (3L summer survey full series)+I7b (3L autumn survey, 1985-1986, 1990)+
I8 (3N spanish survey)

ASPIC$_{fit}$ 2014 5 MSY fixed at 1960-1985 average catch, keep full length CPUE and all survey series, all previous outliers included, option b for I3 and I7

I1a(Statlant CPUE and catch)+I2 (3LN spring survey)+I3b (3LN autumn survey)+I4 (3LN Power russian survey)+I5 (3L winter survey)+I6 (3L summer survey full series)+I7b (3L autumn survey, 1985-1986, 1990)+
I8 (3N spanish survey)

Table 6b: Key parameters of posible frameworks for ASPICfit 2014 assessment versus ASPICfit 2012 assessment:

How close is the 2014 assessment to the perception of the state of stock given by previous assessments?

	MSY	*B1/K*	*Fmsy*	*F2013/Fmsy*	*Ye2014*	*Bmsy*	*B2014/Bmsy*
ASPICfit 2014 1	117300	0.0579	0.0812	0.1257	79410	1444000	0.4319
ASPICfit 2014 2	267300	0.0252	0.0925	0.0803	136900	2889000	0.3015
ASPICfit 2014 3	112900	0.0619	0.0992	0.1105	59580	1138000	0.5152
ASPICfit 2014 4	*21000(1)*	1.6230	0.1285	0.2104	17450	162300	1.4040
ASPICfit 2014 5	*21000(1)*	0.6764	0.1097	0.2136	18120	191500	1.3710
	MSY	*B1/K*	*Fmsy*	*F2011/Fmsy*	*Ye2012*	*Bmsy*	*B2012/Bmsy*
ASPICfit 2012	23700	0.4434	0.1053	0.1683	18360	225100	1.4750

(1) fixed at the start user guess: average catch 1960-1885

Table7a: Different random seed, seeds for key parameters and last year survey biomasses used on ASPICfit 2014 sensitivity analysis (differences in bold for each input set)

	Standard	-25%seed	+25%seed	25% Pessimistic	25% Optimistic	Last year-25%sur	Last year-10%surv	Last year+10%sur	Last year+25%survB
B1/K	0.5d0	0.5d0	0.5d0	**0.375**	**0.625**	0.5d0	0.5d0	0.5d0	0.5d0
K	500000	500000	500000	**375000**	**625000**	500000	500000	500000	500000
qcpue	0.0000	0.0000	0.0000	**0.0000**	**0.0000**	0.0000	0.0000	0.0000	0.0000
q3LNspring	1.0000	1.0000	1.0000	**1.2500**	**0.7500**	0.6580	0.6580	0.6580	0.6580
q3LNautumn	1.0000	1.0000	1.0000	**1.2500**	**0.7500**	0.7590	0.7590	0.7590	0.7590
q3LNRussia	1.0000	1.0000	1.0000	**1.2500**	**0.7500**	0.6580	0.6580	0.6580	0.6580
q3Lwinter	0.3220	0.3220	0.3220	**0.4025**	**0.2415**	0.3220	0.3220	0.3220	0.3220
q3Lsummer	0.2750	0.2750	0.2750	**0.3438**	**0.2063**	0.2750	0.2750	0.2750	0.2750
q3Lautumn	0.2750	0.2750	0.2750	**0.3438**	**0.2063**	0.2750	0.2750	0.2750	0.2750
q3NSpain	0.7590	0.7590	0.7590	**0.9488**	**0.5693**	0.7590	0.7590	0.7590	0.7590
Random seed	3941285	**2955964**	**4926606**	3941285	3941285	3941285	3941285	3941285	3941285
3LNspring2013	271514	271514	271514	271514	271514	**203636**	**244363**	**298665**	**339393**
3LNautumn2013	288754	288754	288754	288754	288754	**216566**	**259879**	**317629**	**360943**
3Nspain2013	429532	429532	429532	429532	429532	**322149**	**386579**	**472485**	**536915**

Table 7b: Compairision of main results from sensitivity analysis of ASPICfit 2014

	Standard	-25%seed	+25%seed	25% Pessimistic	25% Optimistic	Last year-25%sur	Last year-10%surv	Last year+10%sur	Last year+25%survB
K	383000	383100	383100	383100	383100	385600	384100	382100	380900
B1/K	0.6764	0.6763	0.6763	0.6763	0.6763	0.6718	0.6744	0.6783	0.6806
Bmsy	191500	191500	191500	191500	191500	192800	192000	191000	190500
Fmsy	0.1097	0.1096	0.1096	0.1096	0.1096	0.1089	0.1094	0.1099	0.1103
B2014/Bmsy	1.3710	1.3710	1.3700	1.3700	1.3710	1.3890	1.3770	1.3650	1.3570
F2013/Fmsy	0.2136	0.2136	0.2136	0.2136	0.2136	0.2105	0.2126	0.2145	0.2159
Ye2014	18120	18120	18120	18120	18120	17820	18020	18200	18330

Table 8 : Compairision of key parameters for ASPIC 2014-2012 retrospective assessment.

Last year	*Fmsy*	bias between consecutive years	*F last year/Fmsy*	bias between consecutive years	*Bmsy*	bias between consecutive years	*B last year+1/Bmsy*	bias between consecutive years
2011	0.1065		0.1362		197200		1.3230	
2012	0.1085	2%	0.1428	5%	193500	-2%	1.2660	-4%
2013	0.1097	1%	0.1479	4%	191500	-1%	1.2260	-3%

Table 9a: Compairision of ASPIC2014 with ASPIC2012 and ASPIC 2010 summaries of bootstrap analysis results.

Param. name	ASPIC assessment	Point estimate	Estimated bias in pt estimate	median	point estimate bias corrected	Estimated relative bias	Bias-corrected approximate confidence limits of point estimates: 80% lower	80% upper	60% lower	60% upper	50% lower	50% upper	Inter-quartile range	Relative IQ range
B1/K	2014	**0.6764**	0.1682	0.845	0.508	**24.87%**	0.5491	1.042	0.5785	0.8381	0.589	0.7887	0.1997	0.295
	2012	0.4434	0.064	0.507	0.380	14.37%	0.241	0.643			0.315	0.519	0.204	0.460
	2010	0.5410	0.050	0.591	0.491	9.25%	0.312	0.832			0.411	0.658	0.247	0.456
K	2014	**383000**	7837	390837	375163	**1.53%**	337100	478500	350800	443900	356700	433500	76800	0.200
	2012	450300	16210	466510	434090	3.60%	351100	747600			398800	608400	209700	0.466
	2010	386700	27970	414670	358730	7.23%	316300	606000			345000	471600	126600	0.327
MSY	2014	**21000**		21000	21000									
	2012	23700	1099	24799	22601	4.64%	21360	31580			22430	26430	4002	0.169
	2010	22580	1326	23906	21254	5.87%	20400	24630			21310	23180	1871	0.083
Ye Last year+1	2014	**18120**	-869	17252	18989	**-4.79%**	12920	20930	14620	20670	15530	20430	4906	0.271
	2012	18360	-718	17642	19078	-3.91%	10640	32820			14670	26200	11530	0.628
	2010	15350	352	15702	14998	2.29%	7152	25890			10590	20850	10260	0.668
Bmsy	2014	**191500**	2931	194431	188569	**1.53%**	168500	239200	175400	221900	178400	216800	38400	0.200
	2012	225100	8103	233203	216997	3.60%	175600	373800			199400	304200	104800	0.466
	2010	193300	13990	207290	179310	7.23%	158100	303000			172500	235800	63310	0.327
Fmsy	2014	**0.110**	0.000122	0.110	0.110	**0.11%**	0.088	0.125	0.095	0.120	0.097	0.118	0.021	0.19
	2012	0.105	0.006	0.111	0.100	5.50%	0.082	0.131			0.090	0.116	0.027	0.253
	2010	0.117	0.004	0.121	0.113	3.27%	0.090	0.149			0.100	0.132	0.032	0.273
B Last year+1/Bmsy	2014	**1.371**	-0.048	1.323	1.419	**-3.51%**	**0.915**	**1.626**	**1.058**	**1.562**	1.119	1.524	0.405	0.296
	2012	1.475	-0.005	1.470	1.480	-0.35%	0.950	1.761			1.164	1.637	0.473	0.321
	2010	1.566	-0.049	1.517	1.615	-3.15%	1.060	1.831			1.289	1.726	0.437	0.279
F Last year/Fmsy	2014	**0.210**	0.021	0.231	0.189	**9.87%**	**0.178**	**0.325**	**0.186**	**0.280**	0.191	0.265	0.074	0.345
	2012	0.168	0.00196	0.170	0.166	1.16%	0.139	0.241			0.153	0.204	0.050	0.299
	2010	0.014	0.00042	0.014	0.014	2.97%	0.011	0.020			0.013	0.017	0.005	0.327

Table 9b: Bias corrected trajectories from $ASPIC_{bot}$ 2014assessment.

Year	B/Bmsy			F/Fmsy		
	Point estimate	Estimated bias	Bias corrected	Point estimate	Estimated bias	Bias corrected
1959	1.353	0.336	1.017	1.654	-0.120	1.774
1960	1.221	0.227	0.994	1.051	-0.069	1.120
1961	1.187	0.177	1.010	0.936	-0.055	0.990
1962	1.172	0.145	1.027	0.873	-0.045	0.918
1963	1.167	0.122	1.045	1.135	-0.052	1.187
1964	1.131	0.104	1.027	0.422	-0.017	0.439
1965	1.184	0.090	1.094	0.950	-0.032	0.983
1966	1.168	0.077	1.091	0.687	-0.020	0.707
1967	1.186	0.067	1.119	1.109	-0.029	1.138
1968	1.150	0.058	1.092	0.726	-0.016	0.743
1969	1.165	0.051	1.114	1.022	-0.020	1.042
1970	1.143	0.045	1.098	0.593	-0.010	0.602
1971	1.174	0.039	1.135	1.439	-0.020	1.459
1972	1.102	0.034	1.068	1.275	-0.017	1.292
1973	1.060	0.031	1.029	1.544	-0.019	1.563
1974	0.996	0.028	0.968	1.069	-0.013	1.082
1975	0.989	0.026	0.963	0.853	-0.009	0.862
1976	1.006	0.025	0.981	0.970	-0.008	0.978
1977	1.008	0.023	0.985	0.771	-0.005	0.776
1978	1.031	0.021	1.010	0.544	-0.002	0.546
1979	1.078	0.019	1.059	0.611	-0.001	0.612
1980	1.113	0.016	1.097	0.678	0.000	0.678
1981	1.137	0.013	1.124	1.025	0.002	1.023
1982	1.118	0.011	1.107	0.919	0.003	0.916
1983	1.114	0.009	1.105	0.842	0.004	0.838
1984	1.119	0.007	1.112	0.620	0.004	0.616
1985	1.150	0.005	1.145	0.852	0.006	0.845
1986	1.150	0.003	1.147	1.870	0.015	1.855
1987	1.035	0.001	1.034	4.323	0.032	4.291
1988	0.729	0.001	0.728	4.016	0.026	3.990
1989	0.545	0.001	0.545	3.228	0.018	3.210
1990	0.451	0.001	0.450	3.385	0.017	3.368
1991	0.371	0.001	0.369	3.702	0.017	3.685
1992	0.297	0.002	0.295	5.288	0.026	5.262
1993	0.201	0.002	0.199	6.412	0.090	6.322
1994	0.122	0.003	0.119	2.292	0.089	2.203
1995	0.117	0.003	0.113	0.764	0.044	0.719
1996	0.132	0.004	0.127	0.148	0.010	0.138
1997	0.159	0.005	0.154	0.172	0.012	0.160
1998	0.190	0.006	0.184	0.206	0.015	0.190
1999	0.227	0.008	0.219	0.453	0.038	0.415
2000	0.261	0.009	0.253	0.536	0.051	0.484
2001	0.298	0.010	0.288	0.213	0.023	0.190
2002	0.350	0.011	0.339	0.153	0.017	0.135
2003	0.411	0.012	0.399	0.143	0.017	0.126
2004	0.479	0.011	0.468	0.058	0.007	0.051
2005	0.560	0.010	0.550	0.052	0.006	0.046
2006	0.649	0.008	0.642	0.034	0.004	0.030
2007	0.746	0.003	0.743	0.100	0.012	0.088
2008	0.843	-0.002	0.845	0.032	0.004	0.028
2009	0.948	-0.009	0.957	0.050	0.006	0.044
2010	1.052	-0.017	1.069	0.179	0.020	0.159
2011	1.139	-0.026	1.165	0.148	0.016	0.132
2012	1.226	-0.034	1.260	0.162	0.017	0.146
2013	1.305	-0.042	1.347	0.214	0.021	0.193
2014	1.371	-0.048	1.419			

Table 10: B/Bmsy medium term projection with 80% lower CL's under a 2015-2020 bi-annual stepwise approach of a target catch at the actual Ye (18100 t).
F/Fmsy medium term projection with 80% lower CL's for a 2015-2020 bi-annual stepwise approach of a target catch at the actual Ye (18100 t).
A catch at the *status quo* TAC is assumed for 2014, point estimates instead of bias corrected estimates

Year	Yield	B/Bmsy	80% lower CL	F/Fmsy	80% upper CL
2014	6500	1.371	0.931	0.221	0.321
2015	10400	1.429	0.997	0.343	0.485
2016	10400	1.462	1.045	0.335	0.462
2017	14200	1.493	1.092	0.452	0.608
2018	14200	1.501	1.120	0.449	0.594
2019	18100	1.509	1.150	0.574	0.745
2020	18100	1.496	1.161	0.578	0.739
2021		1.485	1.170		

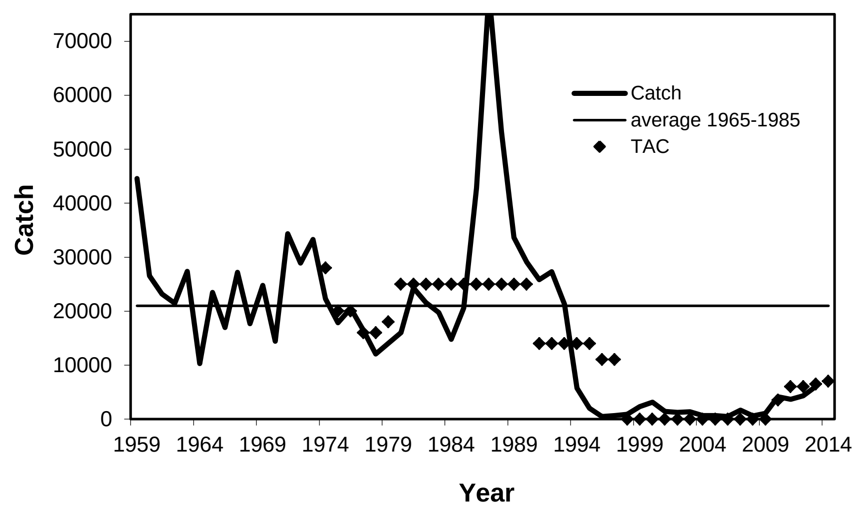

Fig. 1: redfish catch and TAC's in Div. 3LN

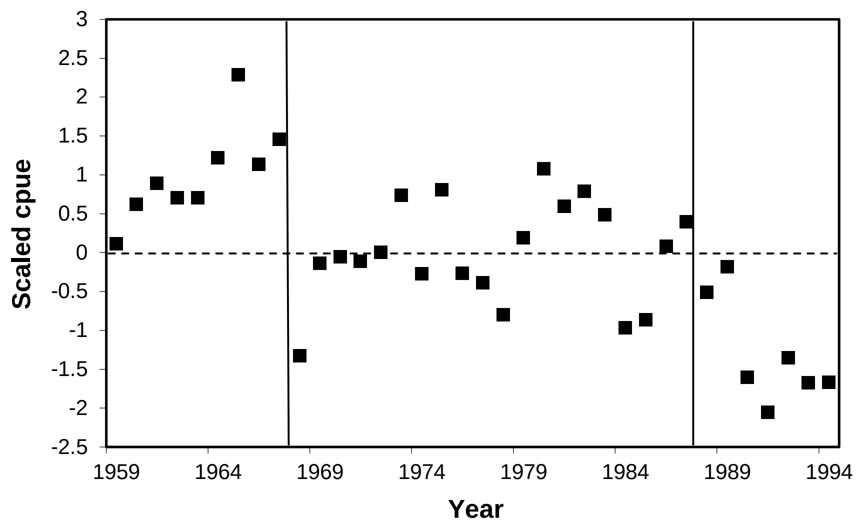

Fig. 2: Redfish Div. 3LN cpue 1959-1994

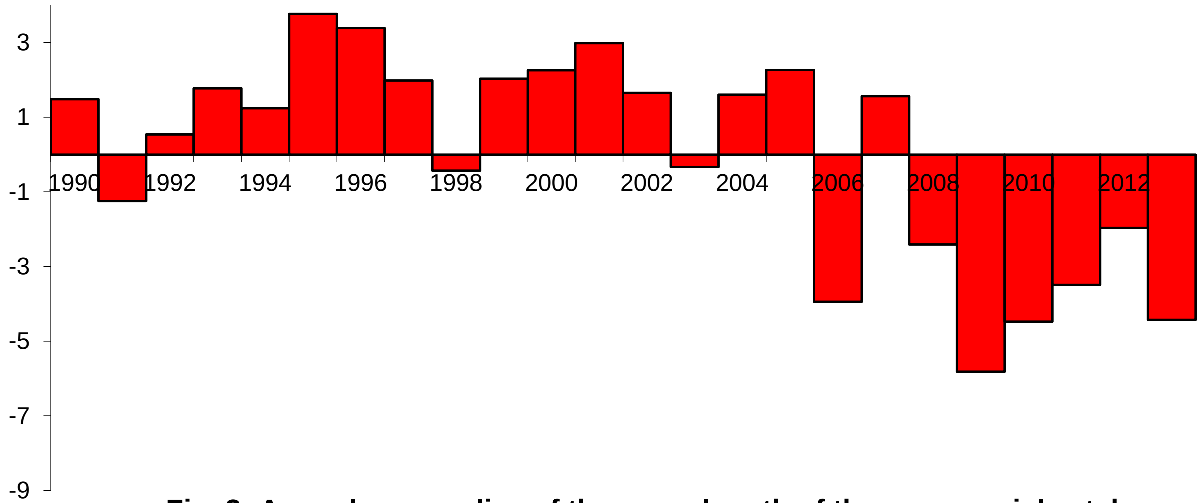

Fig. 3: Annual annomalies of the mean length of the commercial catch, 1990-2013

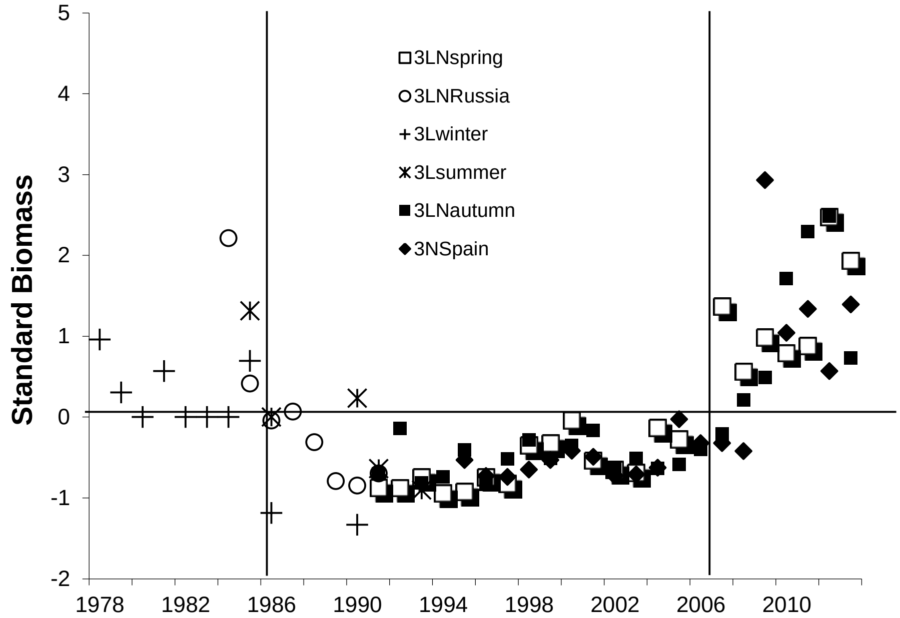

Fig. 4a: Standardized biomass from bottom trawl surveys included in ASPIC framework, 1978-2013

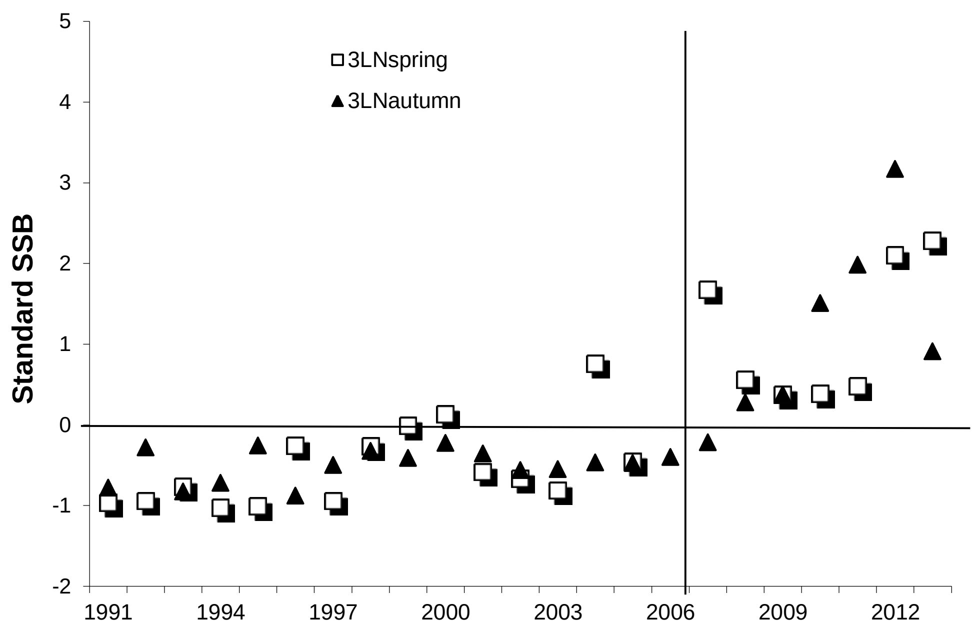

Fig. 4b: Standardized survey female SSB from spring and autumn Canadian surveys on Div. 3LN, 1991-2013

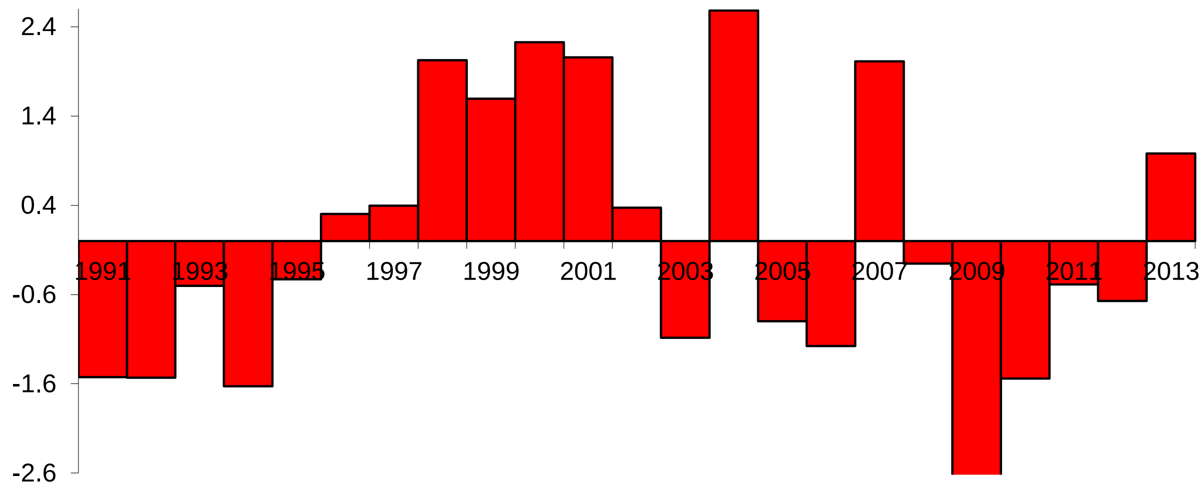

Fig. 5a: Annual annomalies of the mean length on the spring survey stock, 1991-2013

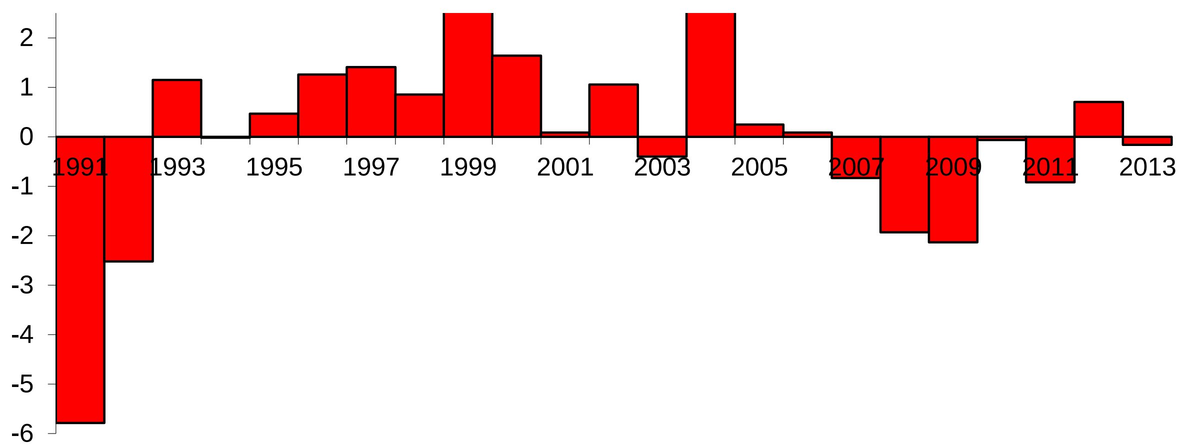

Fig. 5b: Annual annomalies of the mean length on the atumng survey stock, 1991-2013

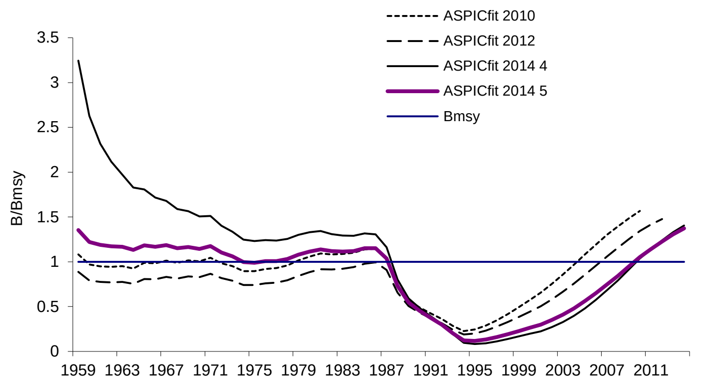

Fig. 6a: B/Bmsy from 2010, 2012 and 2014 ASPIC$_{\text{fit 4 and 5}}$

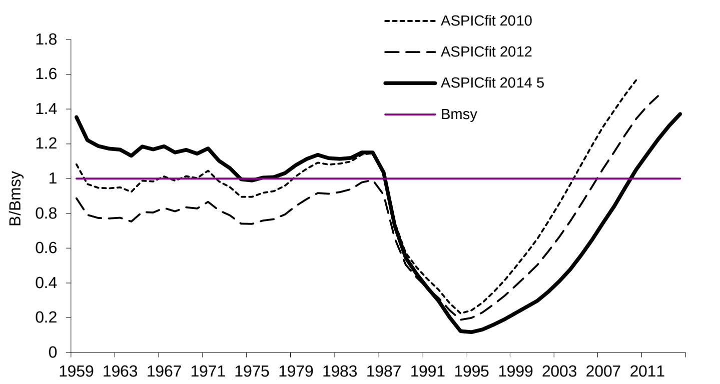

Fig. 6b: B/Bmsy from 2010, 2012 and 2014 ASPIC$_{\text{fit 5}}$

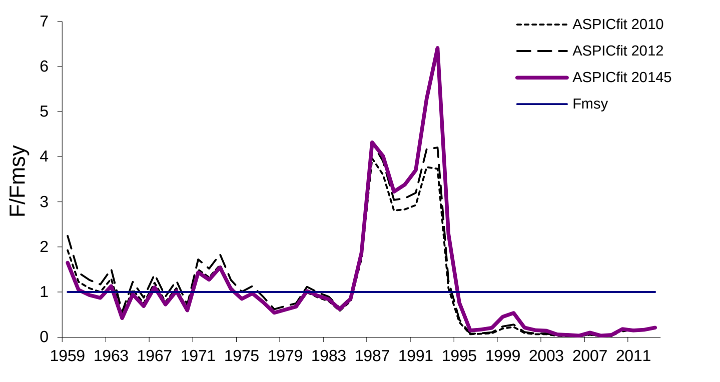

Fig. 6c: F/Fmsy from 2010, 2012 and 2014 ASPIC$_{\text{fit 5}}$

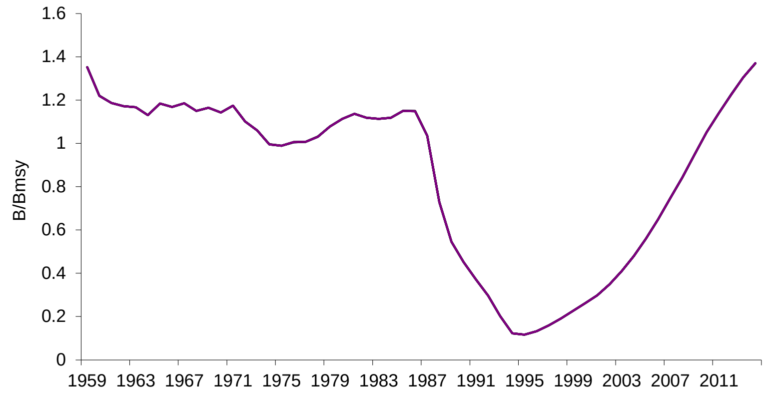

Fig. 7a: Impact of different sets of initial parameters and random seeds on the B/Bmsy trajectory of ASPIC$_{fit}$ 2014

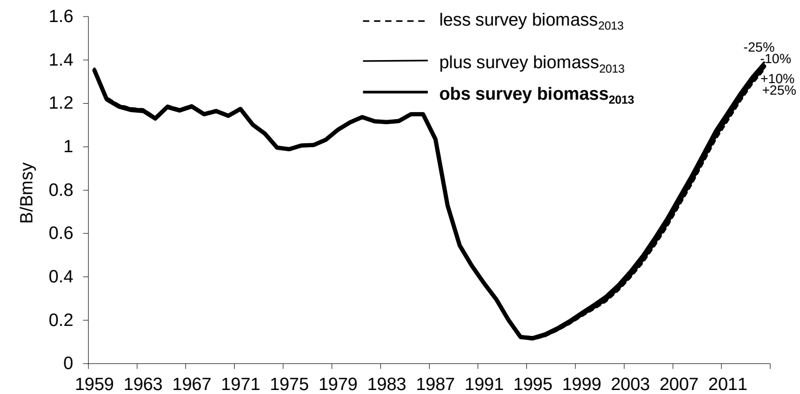

Fig. 7b: Impact of last year 3LN$_{spring}$ and 3L$_{autumn}$ survey biomass on B/Bmsy trajectory of ASPIC$_{fit}$ 2014

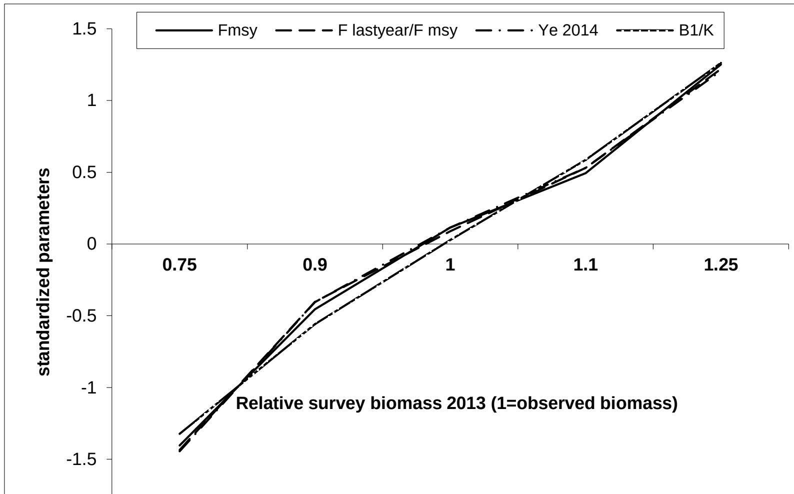

Fig. 7c: Impact of last year surveys on ASPIC results I (positive dependent parameters)

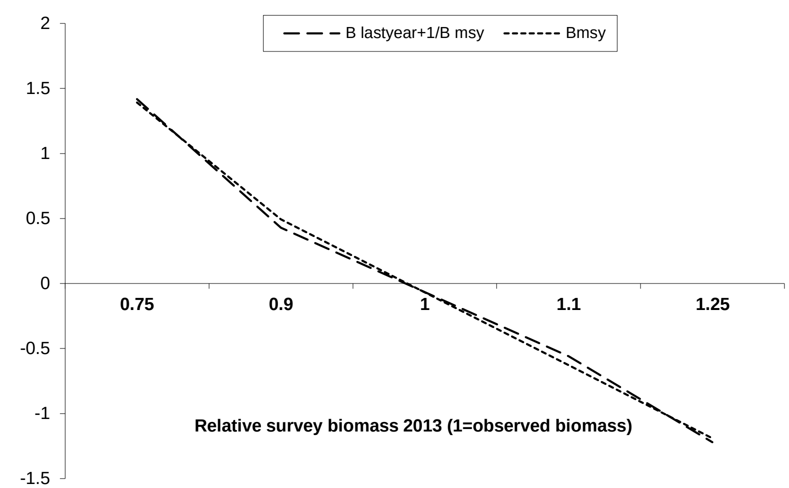

Fig. 7d: Impact of last year surveys on ASPIC results II (negative dependent parameters)

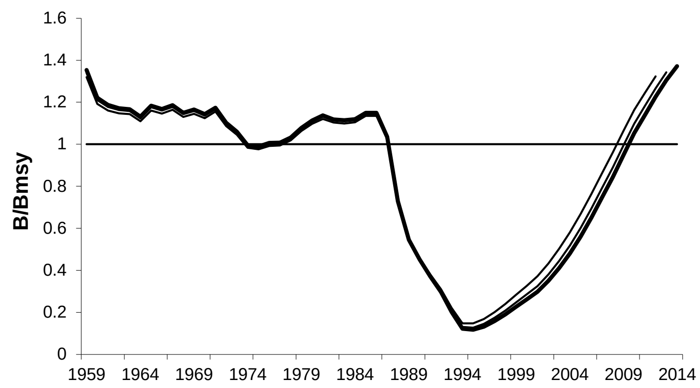

Fig. 8a: B/Bmsy trajectories from retrospective ASPIC last year 2013-2011

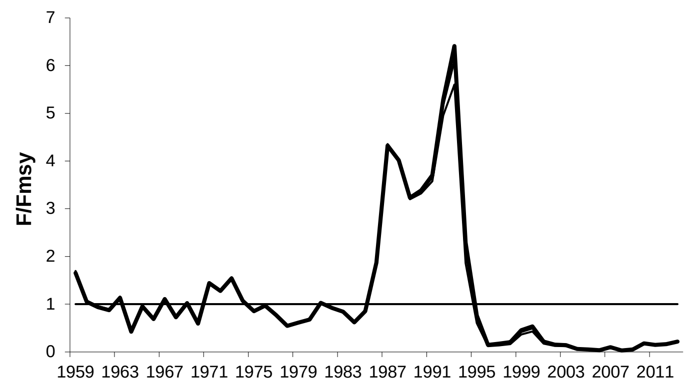

Fig. 8b: F/Fmsy trajectories from retrospective ASPIC last year 2013-2011

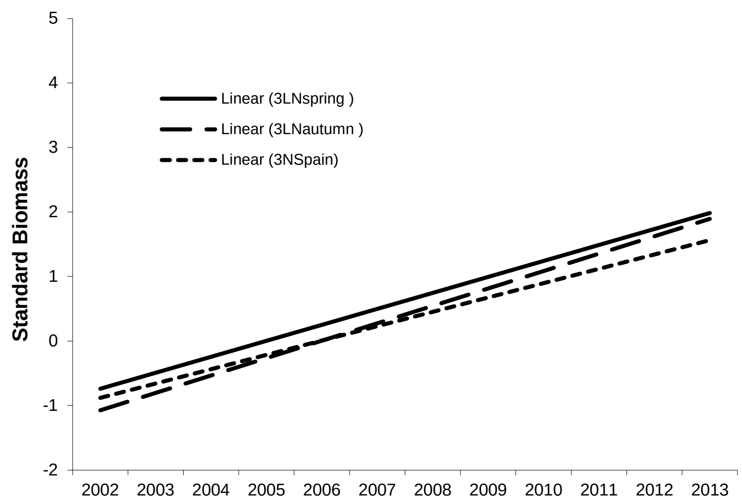

Fig. 8c: Linear trends from the actual bottom trawl surveys included in ASPIC framework, 2002-2013

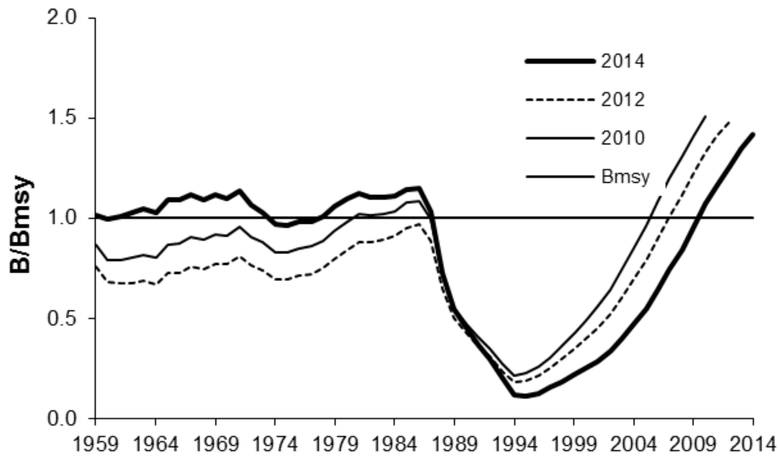

Fig. 9a: B/Bmsy bias corrected trajectories from ASPIC$_{bot}$ 2014 and 2012 assessments

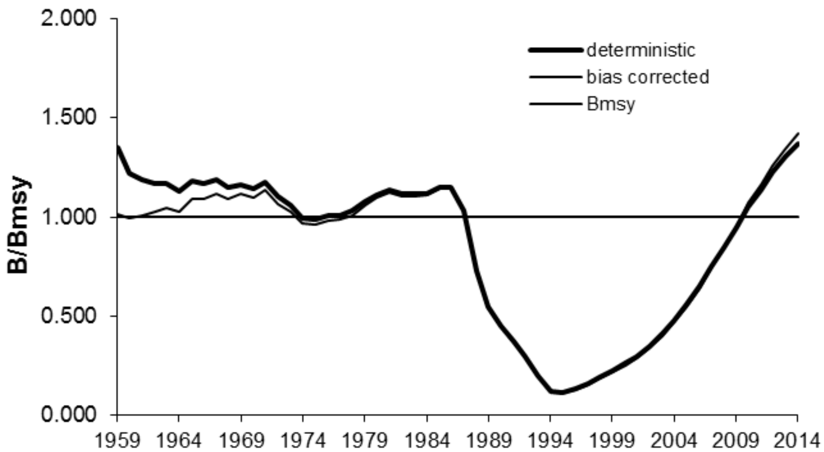

Fig. 9b: B/Bmsy deterministic and bias corrected trajectories for ASPIC$_{bot}$ 2014

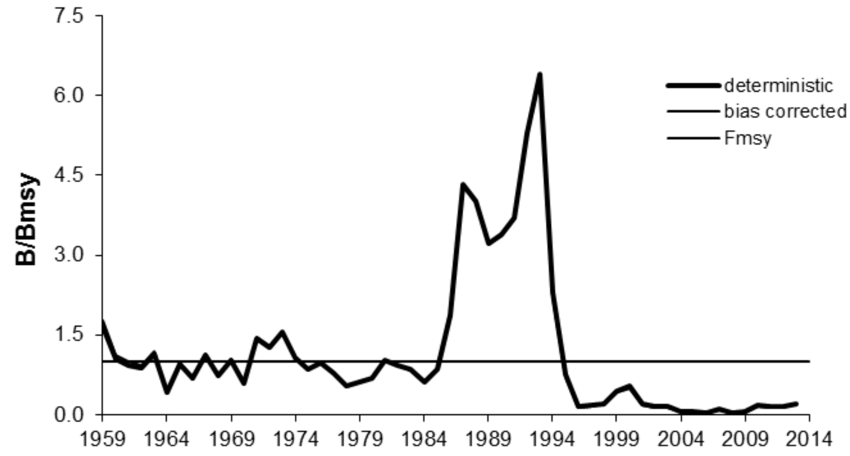

Fig. 9c: B/Bmsy deterministic and bias corrected trajectories for $ASPIC_{bot}$ 2014

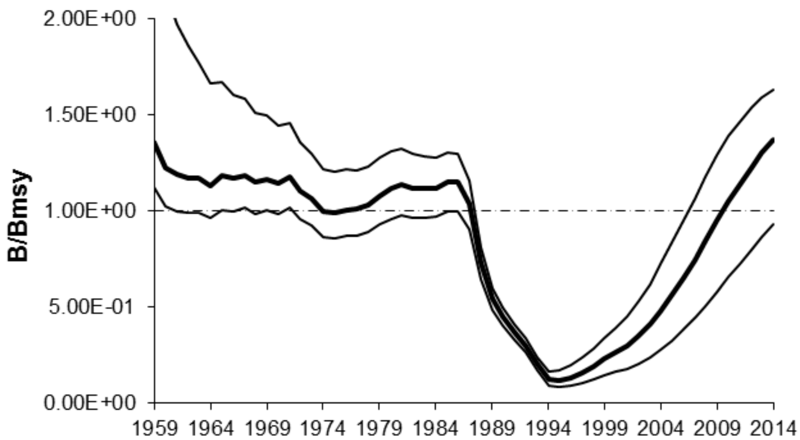

Fig. 9d: B/Bmsy trajectories for $ASPIC_{bot}$ 2014 (point estimates with approximate 80% CL's)

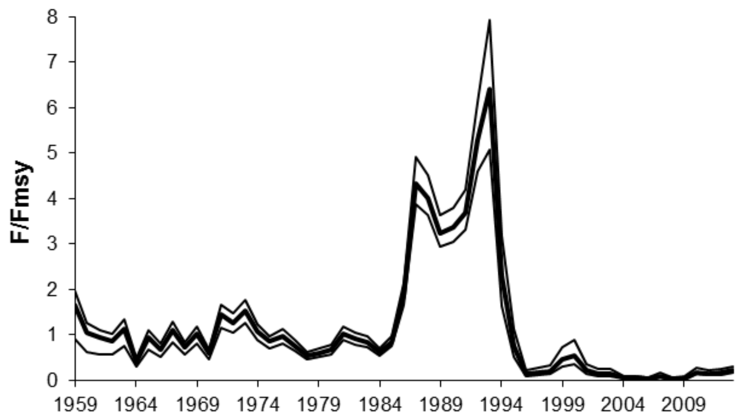

Fig. 9e: F/Fmsy trajectories for $ASPIC_{bot}$ 2012 (point estimates with approximate 80% CL's)

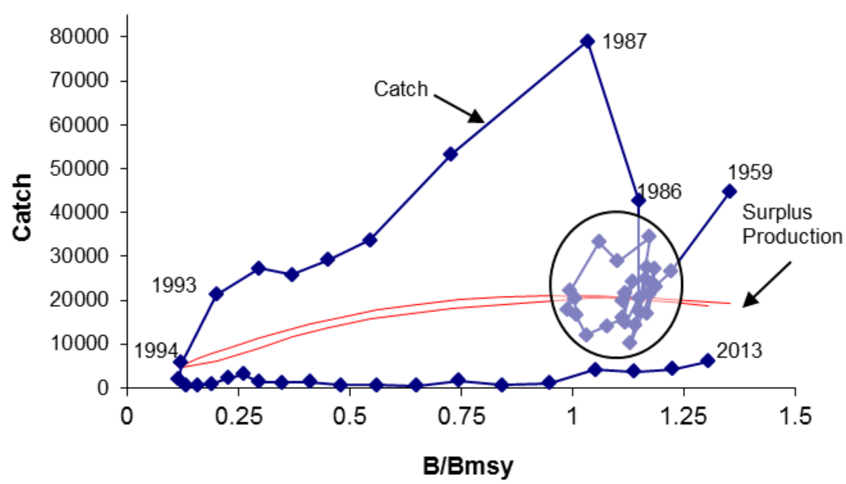

Fig. 10: Catch versus Surplus Production from $ASPIC_{fit}$ 2014

1994

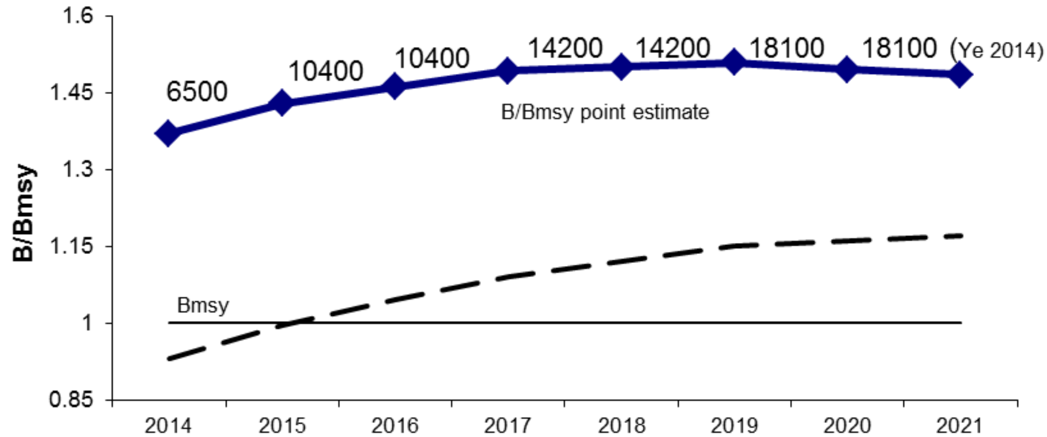

Fig. 11a: 2014-2021 B/Bmsy and lower 80% CL trajectories under a stepwise approach to Ye 2014 of 18100t.

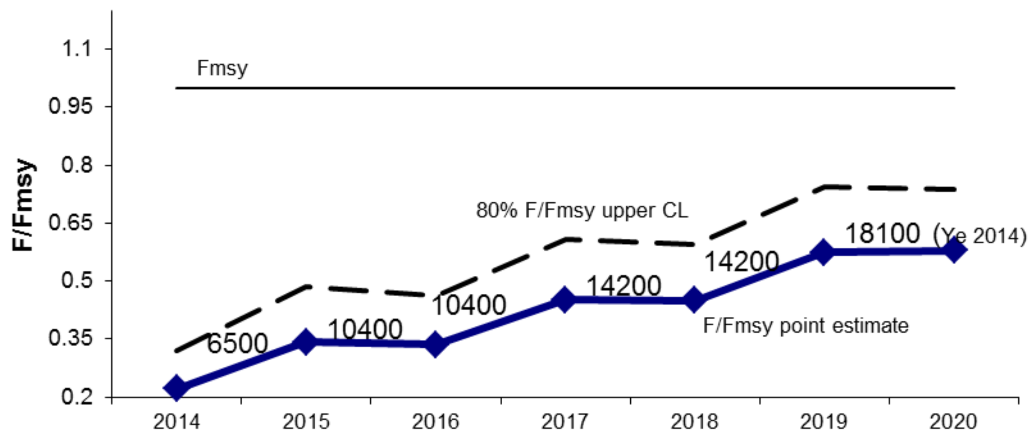

Fig. 11b: 2014-2020 FFmsy and upper 80% CL trajectories for a stepwise approach to Ye 2014 of 18100t.

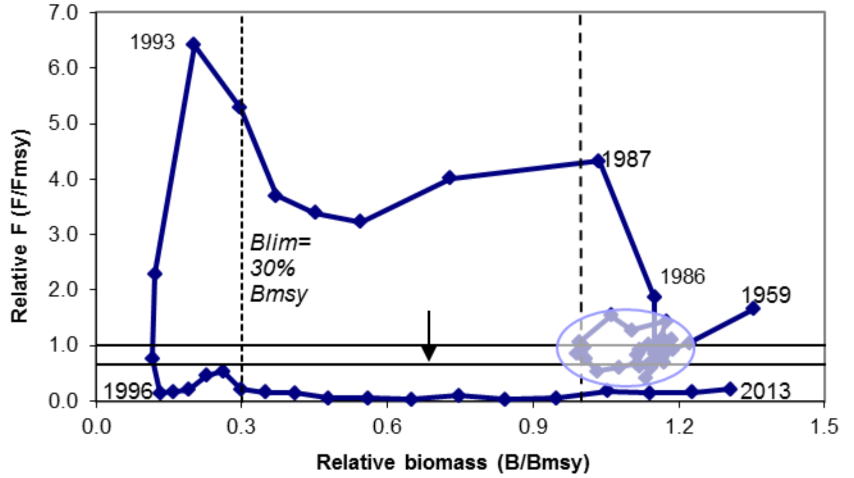

Fig. 12: Stock trajectory under a precautionary framework for $ASPIC_{bot}$ 2014

Appendix 1: input file of selected 2014 framework

```
FIT  ## Run type (FIT, BOT, or IRF)
"3LN redfish"
LOGISTIC  YLD    SSE
2  ## Verbosity
1000  50  ## Number of bootstrap trials, <= 1000
0  20000  ## 0=no MC search, 1=search, 2=repeated srch; N trials
1.0000E-08  ## Convergence crit. for simplex
3.0000E-08  6  ## Convergence crit. for restarts, N restarts
1.0000E-04  24  ## Conv. crit. for F; N steps/yr for gen. model
6.0000  ## Maximum F when cond. on yield
0.0  ## Stat weight for B1>K as residual (usually 0 or 1)
8  ## Number of fisheries (data series)
1.0000E+00  1.0000E+00  1.0000E+00  1.0000E+00  1.0000E+00
1.0000E+00  1.0000E+00  1.0000E+00    ## Statistical weights for
data series
0.5000  ## B1/K (starting guess, usually 0 to 1)
2.1000E+04  ## MSY (starting guess)
5.0000E+05  ## K (carrying capacity) (starting guess)
9.0070E-06  1.0000E+00  1.0000E+00  1.0000E+00  3.2200E-01
2.7500E-01  2.7500E-01  7.5900E-01    ## q (starting guesses --
1 per data series)
1  0  1  1  1  1  1  1  1  1  1    ## Estimate flags (0 or 1)
(B1/K,MSY,K,q1...qn)
5.0000E+03  5.0000E+04  ## Min and max constraints -- MSY
1.0000E+05  6.0000E+06  ## Min and max constraints -- K
3941285  ## Random number seed
55  ## Number of years of data in each series
"Statlant CPUE"
                                CC
               1959     1.426000E+00     4.458500E+04
               1960     1.602000E+00     2.656200E+04
               1961     1.697000E+00     2.317500E+04
               1962     1.631000E+00     2.143900E+04
               1963     1.632000E+00     2.736200E+04
               1964     1.812000E+00     1.026100E+04
               1965     2.185000E+00     2.346600E+04
               1966     1.781000E+00     1.697400E+04
               1967     1.893000E+00     2.718800E+04
               1968     9.220000E-01     1.766000E+04
               1969     1.338000E+00     2.475000E+04
               1970     1.367000E+00     1.441900E+04
               1971     1.346000E+00     3.437000E+04
               1972     1.387000E+00     2.893300E+04
               1973     1.643000E+00     3.329700E+04
               1974     1.290000E+00     2.228600E+04
```

1975	1.669000E+00	1.787100E+04
1976	1.292000E+00	2.051300E+04
1977	1.251000E+00	1.651600E+04
1978	1.106000E+00	1.204300E+04
1979	1.451000E+00	1.406700E+04
1980	1.761000E+00	1.603000E+04
1981	1.594000E+00	2.428000E+04
1982	1.661000E+00	2.154700E+04
1983	1.556000E+00	1.974700E+04
1984	1.049000E+00	1.476100E+04
1985	1.084000E+00	2.055700E+04
1986	1.413000E+00	4.280500E+04
1987	1.523000E+00	7.903100E+04
1988	1.208000E+00	5.326600E+04
1989	1.322000E+00	3.364900E+04
1990	8.250000E-01	2.910500E+04
1991	6.680000E-01	2.581500E+04
1992	9.120000E-01	2.728300E+04
1993	8.010000E-01	2.130800E+04
1994	8.020000E-01	5.741000E+03
1995	-1.000000E-03	1.989000E+03
1996	-1.000000E-03	4.510000E+02
1997	-1.000000E-03	6.300000E+02
1998	-1.000000E-03	8.990000E+02
1999	-1.000000E-03	2.318000E+03
2000	-1.000000E-03	3.141000E+03
2001	-1.000000E-03	1.442000E+03
2002	-1.000000E-03	1.216000E+03
2003	-1.000000E-03	1.334000E+03
2004	-1.000000E-03	6.370000E+02
2005	-1.000000E-03	6.590000E+02
2006	-1.000000E-03	4.960000E+02
2007	-1.000000E-03	1.664000E+03
2008	-1.000000E-03	5.970000E+02
2009	-1.000000E-03	1.051000E+03
2010	-1.000000E-03	4.120000E+03
2011	-1.000000E-03	3.672000E+03
2012	-1.000000E-03	4.316000E+03
2013	-1.000000E-03	6.003000E+03

"3LN spring survey"

	I1
1959	-1.000000E-03
1960	-1.000000E-03
1961	-1.000000E-03
1962	-1.000000E-03
1963	-1.000000E-03
1964	-1.000000E-03

1965	-1.000000E-03
1966	-1.000000E-03
1967	-1.000000E-03
1968	-1.000000E-03
1969	-1.000000E-03
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1980	-1.000000E-03
1981	-1.000000E-03
1982	-1.000000E-03
1983	-1.000000E-03
1984	-1.000000E-03
1985	-1.000000E-03
1986	-1.000000E-03
1987	-1.000000E-03
1988	-1.000000E-03
1989	-1.000000E-03
1990	-1.000000E-03
1991	1.064200E+04
1992	1.006600E+04
1993	2.257300E+04
1994	4.162000E+03
1995	5.856000E+03
1996	2.281200E+04
1997	1.492800E+04
1998	5.940200E+04
1999	6.149600E+04
2000	8.784200E+04
2001	4.157300E+04
2002	3.095900E+04
2003	2.770000E+04
2004	7.963100E+04
2005	6.646200E+04
2006	-1.000000E-03
2007	2.188470E+05
2008	1.439780E+05
2009	1.833780E+05
2010	1.653460E+05
2011	1.736920E+05

```
 2012     3.219790E+05
 2013     2.715140E+05
"3LN autumn survey"
         I2
 1959    -1.000000E-03
 1960    -1.000000E-03
 1961    -1.000000E-03
 1962    -1.000000E-03
 1963    -1.000000E-03
 1964    -1.000000E-03
 1965    -1.000000E-03
 1966    -1.000000E-03
 1967    -1.000000E-03
 1968    -1.000000E-03
 1969    -1.000000E-03
 1970    -1.000000E-03
 1971    -1.000000E-03
 1972    -1.000000E-03
 1973    -1.000000E-03
 1974    -1.000000E-03
 1975    -1.000000E-03
 1976    -1.000000E-03
 1977    -1.000000E-03
 1978    -1.000000E-03
 1979    -1.000000E-03
 1980    -1.000000E-03
 1981    -1.000000E-03
 1982    -1.000000E-03
 1983    -1.000000E-03
 1984    -1.000000E-03
 1985    -1.000000E-03
 1986    -1.000000E-03
 1987    -1.000000E-03
 1988    -1.000000E-03
 1989    -1.000000E-03
 1990    -1.000000E-03
 1991     3.788600E+04
 1992     1.364140E+05
 1993     1.923300E+04
 1994     3.175700E+04
 1995     9.072800E+04
 1996     1.596800E+04
 1997     7.066000E+04
 1998     1.122250E+05
 1999     7.198600E+04
 2000     1.004610E+05
 2001     1.325657E+05
```

2002	5.012260E+04
2003	7.188900E+04
2004	4.990700E+04
2005	5.856100E+04
2006	9.188340E+04
2007	1.247580E+05
2008	1.984860E+05
2009	2.467072E+05
2010	4.614912E+05
2011	5.622814E+05
2012	5.959870E+05
2013	2.887540E+05

"3LN Power russian survey"

	I1
1959	-1.000000E-03
1960	-1.000000E-03
1961	-1.000000E-03
1962	-1.000000E-03
1963	-1.000000E-03
1964	-1.000000E-03
1965	-1.000000E-03
1966	-1.000000E-03
1967	-1.000000E-03
1968	-1.000000E-03
1969	-1.000000E-03
1970	-1.000000E-03
1971	-1.000000E-03
1972	-1.000000E-03
1973	-1.000000E-03
1974	-1.000000E-03
1975	-1.000000E-03
1976	-1.000000E-03
1977	-1.000000E-03
1978	-1.000000E-03
1979	-1.000000E-03
1980	-1.000000E-03
1981	-1.000000E-03
1982	-1.000000E-03
1983	-1.000000E-03
1984	2.158830E+05
1985	9.399600E+04
1986	6.297500E+04
1987	7.029800E+04
1988	4.488400E+04
1989	1.226800E+04
1990	8.365000E+03
1991	1.868000E+04

```
1992    -1.000000E-03
1993    -1.000000E-03
1994    -1.000000E-03
1995    -1.000000E-03
1996    -1.000000E-03
1997    -1.000000E-03
1998    -1.000000E-03
1999    -1.000000E-03
2000    -1.000000E-03
2001    -1.000000E-03
2002    -1.000000E-03
2003    -1.000000E-03
2004    -1.000000E-03
2005    -1.000000E-03
2006    -1.000000E-03
2007    -1.000000E-03
2008    -1.000000E-03
2009    -1.000000E-03
2010    -1.000000E-03
2011    -1.000000E-03
2012    -1.000000E-03
2013    -1.000000E-03
"3L winter survey"
        I0
1959    -1.000000E-03
1960    -1.000000E-03
1961    -1.000000E-03
1962    -1.000000E-03
1963    -1.000000E-03
1964    -1.000000E-03
1965    -1.000000E-03
1966    -1.000000E-03
1967    -1.000000E-03
1968    -1.000000E-03
1969    -1.000000E-03
1970    -1.000000E-03
1971    -1.000000E-03
1972    -1.000000E-03
1973    -1.000000E-03
1974    -1.000000E-03
1975    -1.000000E-03
1976    -1.000000E-03
1977    -1.000000E-03
1978    -1.000000E-03
1979    -1.000000E-03
1980    -1.000000E-03
1981    -1.000000E-03
```

```
1982    -1.000000E-03
1983    -1.000000E-03
1984    -1.000000E-03
1985     9.024500E+04
1986     3.656800E+04
1987    -1.000000E-03
1988    -1.000000E-03
1989    -1.000000E-03
1990     1.820200E+04
1991    -1.000000E-03
1992    -1.000000E-03
1993    -1.000000E-03
1994    -1.000000E-03
1995    -1.000000E-03
1996    -1.000000E-03
1997    -1.000000E-03
1998    -1.000000E-03
1999    -1.000000E-03
2000    -1.000000E-03
2001    -1.000000E-03
2002    -1.000000E-03
2003    -1.000000E-03
2004    -1.000000E-03
2005    -1.000000E-03
2006    -1.000000E-03
2007    -1.000000E-03
2008    -1.000000E-03
2009    -1.000000E-03
2010    -1.000000E-03
2011    -1.000000E-03
2012    -1.000000E-03
2013    -1.000000E-03
"3L summer survey"
        I1
1959    -1.000000E-03
1960    -1.000000E-03
1961    -1.000000E-03
1962    -1.000000E-03
1963    -1.000000E-03
1964    -1.000000E-03
1965    -1.000000E-03
1966    -1.000000E-03
1967    -1.000000E-03
1968    -1.000000E-03
1969    -1.000000E-03
1970    -1.000000E-03
1971    -1.000000E-03
```

```
1972    -1.000000E-03
1973    -1.000000E-03
1974    -1.000000E-03
1975    -1.000000E-03
1976    -1.000000E-03
1977    -1.000000E-03
1978     3.111630E+05
1979     2.277880E+05
1980    -1.000000E-03
1981     2.613840E+05
1982    -1.000000E-03
1983    -1.000000E-03
1984     2.777110E+05
1985     1.610380E+05
1986    -1.000000E-03
1987    -1.000000E-03
1988    -1.000000E-03
1989    -1.000000E-03
1990     9.284000E+04
1991     3.757200E+04
1992    -1.000000E-03
1993     2.083800E+04
1994    -1.000000E-03
1995    -1.000000E-03
1996    -1.000000E-03
1997    -1.000000E-03
1998    -1.000000E-03
1999    -1.000000E-03
2000    -1.000000E-03
2001    -1.000000E-03
2002    -1.000000E-03
2003    -1.000000E-03
2004    -1.000000E-03
2005    -1.000000E-03
2006    -1.000000E-03
2007    -1.000000E-03
2008    -1.000000E-03
2009    -1.000000E-03
2010    -1.000000E-03
2011    -1.000000E-03
2012    -1.000000E-03
2013    -1.000000E-03
"3L autumn survey"
        I2
1959    -1.000000E-03
1960    -1.000000E-03
1961    -1.000000E-03
```

1962	-1.000000E-03
1963	-1.000000E-03
1964	-1.000000E-03
1965	-1.000000E-03
1966	-1.000000E-03
1967	-1.000000E-03
1968	-1.000000E-03
1969	-1.000000E-03
1970	-1.000000E-03
1971	-1.000000E-03
1972	-1.000000E-03
1973	-1.000000E-03
1974	-1.000000E-03
1975	-1.000000E-03
1976	-1.000000E-03
1977	-1.000000E-03
1978	-1.000000E-03
1979	-1.000000E-03
1980	-1.000000E-03
1981	-1.000000E-03
1982	-1.000000E-03
1983	-1.000000E-03
1984	-1.000000E-03
1985	9.823300E+04
1986	1.711900E+04
1987	-1.000000E-03
1988	-1.000000E-03
1989	-1.000000E-03
1990	2.074300E+04
1991	-1.000000E-03
1992	-1.000000E-03
1993	-1.000000E-03
1994	-1.000000E-03
1995	-1.000000E-03
1996	-1.000000E-03
1997	-1.000000E-03
1998	-1.000000E-03
1999	-1.000000E-03
2000	-1.000000E-03
2001	-1.000000E-03
2002	-1.000000E-03
2003	-1.000000E-03
2004	-1.000000E-03
2005	-1.000000E-03
2006	-1.000000E-03
2007	-1.000000E-03
2008	-1.000000E-03

```
 2009    -1.000000E-03
 2010    -1.000000E-03
 2011    -1.000000E-03
 2012    -1.000000E-03
 2013    -1.000000E-03
"3N spanish survey"
         I1
 1959    -1.000000E-03
 1960    -1.000000E-03
 1961    -1.000000E-03
 1962    -1.000000E-03
 1963    -1.000000E-03
 1964    -1.000000E-03
 1965    -1.000000E-03
 1966    -1.000000E-03
 1967    -1.000000E-03
 1968    -1.000000E-03
 1969    -1.000000E-03
 1970    -1.000000E-03
 1971    -1.000000E-03
 1972    -1.000000E-03
 1973    -1.000000E-03
 1974    -1.000000E-03
 1975    -1.000000E-03
 1976    -1.000000E-03
 1977    -1.000000E-03
 1978    -1.000000E-03
 1979    -1.000000E-03
 1980    -1.000000E-03
 1981    -1.000000E-03
 1982    -1.000000E-03
 1983    -1.000000E-03
 1984    -1.000000E-03
 1985    -1.000000E-03
 1986    -1.000000E-03
 1987    -1.000000E-03
 1988    -1.000000E-03
 1989    -1.000000E-03
 1990    -1.000000E-03
 1991    -1.000000E-03
 1992    -1.000000E-03
 1993    -1.000000E-03
 1994    -1.000000E-03
 1995     4.608400E+04
 1996     6.558000E+03
 1997     4.753000E+03
 1998     2.254000E+04
```

1999	4.645900E+04
2000	6.892800E+04
2001	5.385500E+04
2002	7.620000E+03
2003	1.103100E+04
2004	2.701600E+04
2005	1.469180E+05
2006	8.783000E+04
2007	8.760200E+04
2008	6.805900E+04
2009	7.357430E+05
2010	3.595360E+05
2011	4.183050E+05
2012	2.652380E+05
2013	4.295322E+05

Appendix 2 APIC Fit 2014 results

```
3LN redfish                                                                                        Page 1
                                                                              Tuesday, 29 Apr 2014 at 15:09:01
ASPIC -- A Surplus-Production Model Including Covariates (Ver. 5.56)
                                                                                            FIT program mode
Author:     Michael H. Prager                                                            LOGISTIC model mode
            Prager Consulting                                                               YLD conditioning
            http://www.mhprager.com                                                         SSE optimization

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

CONTROL PARAMETERS (FROM INPUT FILE)           Input file: C:/...steps/aspic14 msy3LN springautumn 3Lautumn 3NSpain.inp
------------------------------------------------------------------------------------------------------------------------
Operation of ASPIC:  Fit logistic (Schaefer) model by direct optimization.
Number of years analyzed:                   55             Number of bootstrap trials:                            0
Number of data series:                       8             Bounds on MSY (min, max):       5.000E+03     5.000E+04
Objective function:                  Least squares         Bounds on K (min, max):         1.000E+05     6.000E+06
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 should be checked.
Number of restarts required for convergence:     25


CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)
------------------------------------------------------------------------------------------------------------------------
                                       |
 1  Statlant CPUE                      |   1.000
                                       |      36
                                       |
 2  3LN spring survey                  |  -0.019   1.000
                                       |       4      22
                                       |
 3  3LN autumn survey                  |   0.700   0.786   1.000
                                       |       4      22      23
                                       |
 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                   |  -0.108   0.000   0.000   0.751   0.959   1.000   1.000
                                       |       3       0       0       3       3       2       3
                                       |
 8  3N spanish survey                  |   0.000   0.659   0.659   0.000   0.000   0.000   0.000   1.000
                                       |       0      18      19       0       0       0       0      19
                                       ---------------------------------------------------------------------------------
                                               1       2       3       4       5       6       7       8


GOODNESS-OF-FIT AND WEIGHTING (NON-BOOTSTRAPPED ANALYSIS)
------------------------------------------------------------------------------------------------------------------------
                                                    Weighted             Weighted      Current      Inv. var.    R-squared
Loss component number and title                          SSE      N           MSE       weight         weight      in CPUE

Loss(-1)  SSE in yield                             0.000E+00
Loss(0)   Penalty for B1 > K                       0.000E+00      1           N/A    0.000E+00            N/A
Loss(1)   Statlant CPUE                            6.582E+00     36     1.936E-01    1.000E+00      1.660E+00       -0.239
Loss(2)   3LN spring survey                        1.027E+01     22     5.135E-01    1.000E+00      6.258E-01        0.625
Loss(3)   3LN autumn survey                        9.031E+00     23     4.301E-01    1.000E+00      7.473E-01        0.596
Loss(4)   3LN Power russian survey                 3.495E+00      8     5.825E-01    1.000E+00      5.517E-01        0.259
Loss(5)   3L winter survey                         4.386E-01      3     4.386E-01    1.000E+00      7.328E-01        0.413
Loss(6)   3L summer survey                         8.324E-01      8     1.387E-01    1.000E+00      2.317E+00        0.738
Loss(7)   3L autumn survey                         1.453E+00      3     1.453E+00    1.000E+00      2.212E-01        0.248
Loss(8)   3N spanish survey                        1.899E+01     19     1.117E+00    1.000E+00      2.877E-01        0.196
............................................................................................
TOTAL OBJECTIVE FUNCTION, MSE, RMSE:           5.10952034E+01           4.562E-01    6.754E-01

Estimated contrast index (good=0.5, best=1.0):        0.6270           Mean of B coverage proportions > and < Bmsy
Estimated nearness index (best=1.0):                  1.0000           Proportional closeness of B to Bmsy
```

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	User/pgm guess	2nd guess	Estimated	User guess
B1/K	Starting relative biomass (in 1959)	6.764E-01	5.000E-01	6.568E-01	1	1
MSY	Maximum sustainable yield	2.100E+04	2.100E+04	1.467E+04	0	1
K	Maximum population size	3.830E+05	5.000E+05	1.280E+06	1	1
phi	Shape of production curve (Bmsy/K)	0.5000	0.5000	----	0	1
---------	Catchability Coefficients by Data Series ---------------					
q(1)	Statlant CPUE	8.146E-06	9.007E-06	1.034E-05	1	1
q(2)	3LN spring survey	6.429E-01	1.000E+00	2.869E-01	1	1
q(3)	3LN autumn survey	1.234E+00	1.000E+00	1.678E-01	1	1
q(4)	3LN Power russian survey	3.080E-01	1.000E+00	4.006E-01	1	1
q(5)	3L winter survey	2.429E-01	3.220E-01	5.463E-01	1	1
q(6)	3L summer survey	9.881E-01	2.750E-01	1.520E-01	1	1
q(7)	3L autumn survey	2.241E-01	2.750E-01	5.821E-01	1	1
q(8)	3N spanish survey	6.796E-01	7.590E-01	1.734E-01	1	1

MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Logistic formula	General formula
MSY	Maximum sustainable yield	2.100E+04	----	----
Bmsy	Stock biomass giving MSY	1.915E+05	K/2	K*n**(1/(1-n))
Fmsy	Fishing mortality rate at MSY	1.097E-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(2014)/Bmsy	1.371E+00	----	----
F./Fmsy	Ratio: F(2013)/Fmsy	2.136E-01	----	----
Fmsy/F.	Ratio: Fmsy/F(2013)	4.682E+00	----	----
Y.(Fmsy)	Approx. yield available at Fmsy in 2014	2.823E+04	MSY*B./Bmsy	MSY*B./Bmsy
	...as proportion of MSY	1.344E+00	----	----
Ye.	Equilibrium yield available in 2014	1.812E+04	4*MSY*(B/K-(B/K)**2)	g*MSY*(B/K-(B/K)**n)
	...as proportion of MSY	8.627E-01	----	----
---------	Fishing effort rate at MSY in units of each CE or CC series ---------			
fmsy(1)	Statlant CPUE	1.346E+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	0.181	2.591E+05	2.459E+05	4.458E+04	4.458E+04	1.928E+04	1.654E+00	1.353E+00
2	1960	0.115	2.338E+05	2.305E+05	2.656E+04	2.656E+04	2.013E+04	1.051E+00	1.221E+00
3	1961	0.103	2.273E+05	2.259E+05	2.317E+04	2.317E+04	2.032E+04	9.357E-01	1.187E+00
4	1962	0.096	2.245E+05	2.239E+05	2.144E+04	2.144E+04	2.040E+04	8.731E-01	1.172E+00
5	1963	0.124	2.234E+05	2.199E+05	2.736E+04	2.736E+04	2.054E+04	1.135E+00	1.167E+00
6	1964	0.046	2.166E+05	2.218E+05	1.026E+04	1.026E+04	2.047E+04	4.219E-01	1.131E+00
7	1965	0.104	2.268E+05	2.252E+05	2.347E+04	2.347E+04	2.035E+04	9.502E-01	1.184E+00
8	1966	0.075	2.237E+05	2.254E+05	1.697E+04	1.697E+04	2.034E+04	6.867E-01	1.168E+00
9	1967	0.122	2.271E+05	2.236E+05	2.719E+04	2.719E+04	2.041E+04	1.109E+00	1.186E+00
10	1968	0.080	2.203E+05	2.217E+05	1.766E+04	1.766E+04	2.048E+04	7.264E-01	1.150E+00
11	1969	0.112	2.231E+05	2.209E+05	2.475E+04	2.475E+04	2.050E+04	1.022E+00	1.165E+00
12	1970	0.065	2.189E+05	2.219E+05	1.442E+04	1.442E+04	2.047E+04	5.925E-01	1.143E+00
13	1971	0.158	2.249E+05	2.178E+05	3.437E+04	3.437E+04	2.059E+04	1.439E+00	1.174E+00
14	1972	0.140	2.111E+05	2.070E+05	2.893E+04	2.893E+04	2.086E+04	1.275E+00	1.102E+00
15	1973	0.169	2.031E+05	1.967E+05	3.330E+04	3.330E+04	2.098E+04	1.544E+00	1.060E+00
16	1974	0.117	1.907E+05	1.901E+05	2.229E+04	2.229E+04	2.100E+04	1.069E+00	9.960E-01
17	1975	0.094	1.895E+05	1.910E+05	1.787E+04	1.787E+04	2.100E+04	8.531E-01	9.892E-01
18	1976	0.106	1.926E+05	1.928E+05	2.051E+04	2.051E+04	2.100E+04	9.701E-01	1.006E+00
19	1977	0.085	1.931E+05	1.953E+05	1.652E+04	1.652E+04	2.099E+04	7.711E-01	1.008E+00
20	1978	0.060	1.975E+05	2.020E+05	1.204E+04	1.204E+04	2.093E+04	5.436E-01	1.031E+00
21	1979	0.067	2.064E+05	2.098E+05	1.407E+04	1.407E+04	2.081E+04	6.113E-01	1.078E+00
22	1980	0.074	2.132E+05	2.155E+05	1.603E+04	1.603E+04	2.067E+04	6.783E-01	1.113E+00
23	1981	0.112	2.178E+05	2.160E+05	2.428E+04	2.428E+04	2.066E+04	1.025E+00	1.137E+00
24	1982	0.101	2.142E+05	2.138E+05	2.155E+04	2.155E+04	2.072E+04	9.193E-01	1.118E+00
25	1983	0.092	2.134E+05	2.138E+05	1.975E+04	1.975E+04	2.071E+04	8.421E-01	1.114E+00
26	1984	0.068	2.143E+05	2.173E+05	1.476E+04	1.476E+04	2.062E+04	6.195E-01	1.119E+00
27	1985	0.093	2.202E+05	2.202E+05	2.056E+04	2.056E+04	2.053E+04	8.515E-01	1.150E+00
28	1986	0.205	2.202E+05	2.087E+05	4.280E+04	4.280E+04	2.081E+04	1.870E+00	1.150E+00
29	1987	0.474	1.982E+05	1.667E+05	7.903E+04	7.903E+04	2.048E+04	4.323E+00	1.035E+00
30	1988	0.440	1.396E+05	1.210E+05	5.327E+04	5.327E+04	1.809E+04	4.016E+00	7.290E-01
31	1989	0.354	1.044E+05	9.507E+04	3.365E+04	3.365E+04	1.566E+04	3.228E+00	5.453E-01
32	1990	0.371	8.644E+04	7.841E+04	2.910E+04	2.910E+04	1.366E+04	3.385E+00	4.514E-01
33	1991	0.406	7.100E+04	6.360E+04	2.582E+04	2.582E+04	1.162E+04	3.702E+00	3.707E-01
34	1992	0.580	5.681E+04	4.706E+04	2.728E+04	2.728E+04	9.036E+03	5.288E+00	2.966E-01
35	1993	0.703	3.856E+04	3.031E+04	2.131E+04	2.131E+04	6.110E+03	6.412E+00	2.013E-01
36	1994	0.251	2.336E+04	2.284E+04	5.741E+03	5.741E+03	4.711E+03	2.292E+00	1.220E-01
37	1995	0.084	2.233E+04	2.375E+04	1.989E+03	1.989E+03	4.886E+03	7.636E-01	1.166E-01
38	1996	0.016	2.523E+04	2.775E+04	4.510E+02	4.510E+02	5.644E+03	1.482E-01	1.317E-01
39	1997	0.019	3.042E+04	3.336E+04	6.300E+02	6.300E+02	6.678E+03	1.722E-01	1.589E-01
40	1998	0.023	3.647E+04	3.985E+04	8.990E+02	8.990E+02	7.828E+03	2.057E-01	1.904E-01
41	1999	0.050	4.340E+04	4.667E+04	2.318E+03	2.318E+03	8.986E+03	4.530E-01	2.266E-01
42	2000	0.059	5.007E+04	5.348E+04	3.141E+03	3.141E+03	1.009E+04	5.356E-01	2.614E-01
43	2001	0.023	5.702E+04	6.188E+04	1.442E+03	1.442E+03	1.137E+04	2.125E-01	2.977E-01
44	2002	0.017	6.695E+04	7.268E+04	1.216E+03	1.216E+03	1.291E+04	1.526E-01	3.496E-01
45	2003	0.016	7.864E+04	8.511E+04	1.334E+03	1.334E+03	1.451E+04	1.429E-01	4.106E-01
46	2004	0.006	9.181E+04	9.944E+04	6.370E+02	6.370E+02	1.613E+04	5.842E-02	4.794E-01
47	2005	0.006	1.073E+05	1.157E+05	6.590E+02	6.590E+02	1.770E+04	5.194E-02	5.603E-01
48	2006	0.004	1.243E+05	1.335E+05	4.960E+02	4.960E+02	1.906E+04	3.387E-02	6.493E-01
49	2007	0.011	1.429E+05	1.521E+05	1.664E+03	1.664E+03	2.009E+04	9.979E-02	7.462E-01
50	2008	0.003	1.613E+05	1.714E+05	5.970E+02	5.970E+02	2.075E+04	3.177E-02	8.425E-01
51	2009	0.005	1.815E+05	1.915E+05	1.051E+03	1.051E+03	2.098E+04	5.006E-02	9.477E-01
52	2010	0.020	2.014E+05	2.098E+05	4.120E+03	4.120E+03	2.079E+04	1.791E-01	1.052E+00
53	2011	0.016	2.181E+05	2.265E+05	3.672E+03	3.672E+03	2.029E+04	1.479E-01	1.139E+00
54	2012	0.018	2.347E+05	2.424E+05	4.316E+03	4.316E+03	1.951E+04	1.624E-01	1.226E+00
55	2013	0.023	2.499E+05	2.563E+05	6.003E+03	6.003E+03	1.859E+04	2.136E-01	1.305E+00
56	2014		2.625E+05						1.371E+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	2.003E+00	0.1813	4.458E+04	4.458E+04	0.33975	1.000E+00
2	1960	1.602E+00	1.877E+00	0.1153	2.656E+04	2.656E+04	0.15850	1.000E+00
3	1961	1.697E+00	1.840E+00	0.1026	2.317E+04	2.317E+04	0.08078	1.000E+00
4	1962	1.631E+00	1.824E+00	0.0957	2.144E+04	2.144E+04	0.11189	1.000E+00
5	1963	1.632E+00	1.791E+00	0.1244	2.736E+04	2.736E+04	0.09320	1.000E+00
6	1964	1.812E+00	1.806E+00	0.0463	1.026E+04	1.026E+04	-0.00305	1.000E+00
7	1965	2.185E+00	1.835E+00	0.1042	2.347E+04	2.347E+04	-0.17484	1.000E+00
8	1966	1.781E+00	1.836E+00	0.0753	1.697E+04	1.697E+04	0.03046	1.000E+00
9	1967	1.893E+00	1.821E+00	0.1216	2.719E+04	2.719E+04	-0.03867	1.000E+00
10	1968	9.220E-01	1.806E+00	0.0796	1.766E+04	1.766E+04	0.67232	1.000E+00
11	1969	1.338E+00	1.800E+00	0.1120	2.475E+04	2.475E+04	0.29635	1.000E+00
12	1970	1.367E+00	1.808E+00	0.0650	1.442E+04	1.442E+04	0.27944	1.000E+00
13	1971	1.346E+00	1.774E+00	0.1578	3.437E+04	3.437E+04	0.27615	1.000E+00
14	1972	1.387E+00	1.686E+00	0.1398	2.893E+04	2.893E+04	0.19521	1.000E+00
15	1973	1.643E+00	1.602E+00	0.1693	3.330E+04	3.330E+04	-0.02506	1.000E+00
16	1974	1.290E+00	1.548E+00	0.1172	2.229E+04	2.229E+04	0.18250	1.000E+00
17	1975	1.669E+00	1.556E+00	0.0935	1.787E+04	1.787E+04	-0.07005	1.000E+00
18	1976	1.292E+00	1.571E+00	0.1064	2.051E+04	2.051E+04	0.19529	1.000E+00
19	1977	1.251E+00	1.591E+00	0.0846	1.652E+04	1.652E+04	0.24047	1.000E+00
20	1978	1.106E+00	1.646E+00	0.0596	1.204E+04	1.204E+04	0.39740	1.000E+00
21	1979	1.451E+00	1.709E+00	0.0670	1.407E+04	1.407E+04	0.16382	1.000E+00
22	1980	1.761E+00	1.756E+00	0.0744	1.603E+04	1.603E+04	-0.00311	1.000E+00
23	1981	1.594E+00	1.759E+00	0.1124	2.428E+04	2.428E+04	0.09850	1.000E+00
24	1982	1.661E+00	1.741E+00	0.1008	2.155E+04	2.155E+04	0.04712	1.000E+00
25	1983	1.556E+00	1.742E+00	0.0923	1.975E+04	1.975E+04	0.11283	1.000E+00
26	1984	1.049E+00	1.770E+00	0.0679	1.476E+04	1.476E+04	0.52311	1.000E+00
27	1985	1.084E+00	1.793E+00	0.0934	2.056E+04	2.056E+04	0.50340	1.000E+00
28	1986	1.413E+00	1.700E+00	0.2051	4.280E+04	4.280E+04	0.18506	1.000E+00
29	1987	1.523E+00	1.358E+00	0.4741	7.903E+04	7.903E+04	-0.11475	1.000E+00
30	1988	1.208E+00	9.853E-01	0.4403	5.327E+04	5.327E+04	-0.20377	1.000E+00
31	1989	1.322E+00	7.744E-01	0.3539	3.365E+04	3.365E+04	-0.53484	1.000E+00
32	1990	8.250E-01	6.387E-01	0.3712	2.910E+04	2.910E+04	-0.25599	1.000E+00
33	1991	6.680E-01	5.180E-01	0.4059	2.582E+04	2.582E+04	-0.25427	1.000E+00
34	1992	9.120E-01	3.833E-01	0.5798	2.728E+04	2.728E+04	-0.86688	1.000E+00
35	1993	8.010E-01	2.469E-01	0.7031	2.131E+04	2.131E+04	-1.17703	1.000E+00
36	1994	8.020E-01	1.861E-01	0.2513	5.741E+03	5.741E+03	-1.46105	1.000E+00
37	1995	*	1.935E-01	0.0837	1.989E+03	1.989E+03	0.00000	1.000E+00
38	1996	*	2.260E-01	0.0163	4.510E+02	4.510E+02	0.00000	1.000E+00
39	1997	*	2.718E-01	0.0189	6.300E+02	6.300E+02	0.00000	1.000E+00
40	1998	*	3.246E-01	0.0226	8.990E+02	8.990E+02	0.00000	1.000E+00
41	1999	*	3.801E-01	0.0497	2.318E+03	2.318E+03	0.00000	1.000E+00
42	2000	*	4.356E-01	0.0587	3.141E+03	3.141E+03	0.00000	1.000E+00
43	2001	*	5.040E-01	0.0233	1.442E+03	1.442E+03	0.00000	1.000E+00
44	2002	*	5.920E-01	0.0167	1.216E+03	1.216E+03	0.00000	1.000E+00
45	2003	*	6.932E-01	0.0157	1.334E+03	1.334E+03	0.00000	1.000E+00
46	2004	*	8.099E-01	0.0064	6.370E+02	6.370E+02	0.00000	1.000E+00
47	2005	*	9.425E-01	0.0057	6.590E+02	6.590E+02	0.00000	1.000E+00
48	2006	*	1.088E+00	0.0037	4.960E+02	4.960E+02	0.00000	1.000E+00
49	2007	*	1.239E+00	0.0109	1.664E+03	1.664E+03	0.00000	1.000E+00
50	2008	*	1.396E+00	0.0035	5.970E+02	5.970E+02	0.00000	1.000E+00
51	2009	*	1.560E+00	0.0055	1.051E+03	1.051E+03	0.00000	1.000E+00
52	2010	*	1.709E+00	0.0196	4.120E+03	4.120E+03	0.00000	1.000E+00
53	2011	*	1.845E+00	0.0162	3.672E+03	3.672E+03	0.00000	1.000E+00
54	2012	*	1.974E+00	0.0178	4.316E+03	4.316E+03	0.00000	1.000E+00
55	2013	*	2.088E+00	0.0234	6.003E+03	6.003E+03	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1
                   -2       -1.5       -1      -0.5        0        0.5        1       1.5        2
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year  Residual     ------------------------------------------------------------------------------------
1959     0.3397                                             |=======
1960     0.1585                                             |===
1961     0.0808                                             |==
1962     0.1119                                             |==
1963     0.0932                                             |==
1964    -0.0030                                             |
1965    -0.1748                                          ===|
1966     0.0305                                             |=
1967    -0.0387                                            =|
1968     0.6723                                             |=============
1969     0.2964                                             |======
1970     0.2794                                             |======
1971     0.2761                                             |======
1972     0.1952                                             |====
1973    -0.0251                                            =|
1974     0.1825                                             |====
1975    -0.0701                                            =|
1976     0.1953                                             |====
1977     0.2405                                             |=====
1978     0.3974                                             |========
1979     0.1638                                             |===
1980    -0.0031                                             |
1981     0.0985                                             |==
1982     0.0471                                             |=
1983     0.1128                                             |==
1984     0.5231                                             |==========
1985     0.5034                                             |==========
1986     0.1851                                             |====
1987    -0.1148                                           ==|
1988    -0.2038                                         ====|
1989    -0.5348                                  ===========|
1990    -0.2560                                        =====|
1991    -0.2543                                        =====|
1992    -0.8669                            =================|
1993    -1.1770                     ========================|
1994    -1.4611                =============================|
1995     0.0000                                             |
1996     0.0000                                             |
1997     0.0000                                             |
1998     0.0000                                             |
1999     0.0000                                             |
2000     0.0000                                             |
2001     0.0000                                             |
2002     0.0000                                             |
2003     0.0000                                             |
2004     0.0000                                             |
2005     0.0000                                             |
2006     0.0000                                             |
2007     0.0000                                             |
2008     0.0000                                             |
2009     0.0000                                             |
2010     0.0000                                             |
2011     0.0000                                             |
2012     0.0000                                             |
2013     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	--	*	1.581E+05	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	1.481E+05	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	1.452E+05	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	1.439E+05	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	1.414E+05	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	1.426E+05	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	1.448E+05	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	1.449E+05	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	1.437E+05	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	1.425E+05	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	1.420E+05	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	1.427E+05	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	1.400E+05	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	1.331E+05	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	1.264E+05	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	1.222E+05	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	1.228E+05	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	1.239E+05	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	1.256E+05	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	1.299E+05	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	1.349E+05	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	1.385E+05	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	1.388E+05	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	1.374E+05	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	1.375E+05	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	1.397E+05	0.00000	1.000E+00
27	1985	0.000E+00	0.000E+00	--	*	1.415E+05	0.00000	1.000E+00
28	1986	0.000E+00	0.000E+00	--	*	1.342E+05	0.00000	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	1.072E+05	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	7.776E+04	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	6.111E+04	0.00000	1.000E+00
32	1990	0.000E+00	0.000E+00	--	*	5.040E+04	0.00000	1.000E+00
33	1991	1.000E+00	1.000E+00	--	1.064E+04	4.088E+04	-1.34583	1.000E+00
34	1992	1.000E+00	1.000E+00	--	1.007E+04	3.025E+04	-1.10022	1.000E+00
35	1993	1.000E+00	1.000E+00	--	2.257E+04	1.948E+04	0.14730	1.000E+00
36	1994	1.000E+00	1.000E+00	--	4.162E+03	1.468E+04	-1.26068	1.000E+00
37	1995	1.000E+00	1.000E+00	--	5.856E+03	1.527E+04	-0.95838	1.000E+00
38	1996	1.000E+00	1.000E+00	--	2.281E+04	1.784E+04	0.24592	1.000E+00
39	1997	1.000E+00	1.000E+00	--	1.493E+04	2.145E+04	-0.36233	1.000E+00
40	1998	1.000E+00	1.000E+00	--	5.940E+04	2.561E+04	0.84120	1.000E+00
41	1999	1.000E+00	1.000E+00	--	6.150E+04	3.000E+04	0.71784	1.000E+00
42	2000	1.000E+00	1.000E+00	--	8.784E+04	3.438E+04	0.93810	1.000E+00
43	2001	1.000E+00	1.000E+00	--	4.157E+04	3.977E+04	0.04423	1.000E+00
44	2002	1.000E+00	1.000E+00	--	3.096E+04	4.672E+04	-0.41142	1.000E+00
45	2003	1.000E+00	1.000E+00	--	2.770E+04	5.471E+04	-0.68057	1.000E+00
46	2004	1.000E+00	1.000E+00	--	7.963E+04	6.392E+04	0.21984	1.000E+00
47	2005	1.000E+00	1.000E+00	--	6.646E+04	7.438E+04	-0.11257	1.000E+00
48	2006	0.000E+00	0.000E+00	--	*	8.583E+04	0.00000	1.000E+00
49	2007	1.000E+00	1.000E+00	--	2.188E+05	9.775E+04	0.80594	1.000E+00
50	2008	1.000E+00	1.000E+00	--	1.440E+05	1.102E+05	0.26769	1.000E+00
51	2009	1.000E+00	1.000E+00	--	1.834E+05	1.231E+05	0.39877	1.000E+00
52	2010	1.000E+00	1.000E+00	--	1.653E+05	1.349E+05	0.20374	1.000E+00
53	2011	1.000E+00	1.000E+00	--	1.737E+05	1.456E+05	0.17655	1.000E+00
54	2012	1.000E+00	1.000E+00	--	3.220E+05	1.558E+05	0.72582	1.000E+00
55	2013	1.000E+00	1.000E+00	--	2.715E+05	1.647E+05	0.49961	1.000E+00

* Asterisk indicates missing value(s).

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UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 2
                   -2       -1.5       -1       -0.5        0        0.5        1        1.5        2
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    -----------------------------------------------------------------------------------
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    -1.3458                  ===========================|
1992    -1.1002                       ======================|
1993     0.1473                                             |===
1994    -1.2607                    =========================|
1995    -0.9584                          ===================|
1996     0.2459                                             |=====
1997    -0.3623                                      =======|
1998     0.8412                                             |=================
1999     0.7178                                             |==============
2000     0.9381                                             |===================
2001     0.0442                                             |=
2002    -0.4114                                     ========|
2003    -0.6806                               ==============|
2004     0.2198                                             |====
2005    -0.1126                                           ==|
2006     0.0000                                             |
2007     0.8059                                             |================
2008     0.2677                                             |=====
2009     0.3988                                             |========
2010     0.2037                                             |====
2011     0.1765                                             |====
2012     0.7258                                             |===============
2013     0.4996                                             |==========
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RESULTS FOR DATA SERIES # 3 (NON-BOOTSTRAPPED) 3LN 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	--	*	2.885E+05	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	2.806E+05	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	2.771E+05	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	2.758E+05	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	2.674E+05	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	2.800E+05	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	2.761E+05	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	2.803E+05	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	2.719E+05	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	2.754E+05	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	2.701E+05	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	2.776E+05	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	2.606E+05	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	2.506E+05	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	2.354E+05	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	2.338E+05	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	2.377E+05	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	2.383E+05	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	2.438E+05	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	2.548E+05	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	2.631E+05	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	2.688E+05	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	2.644E+05	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	2.634E+05	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	2.645E+05	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	2.718E+05	0.00000	1.000E+00
27	1985	0.000E+00	0.000E+00	--	*	2.717E+05	0.00000	1.000E+00
28	1986	0.000E+00	0.000E+00	--	*	2.446E+05	0.00000	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	1.723E+05	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	1.289E+05	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	1.067E+05	0.00000	1.000E+00
32	1990	0.000E+00	0.000E+00	--	*	8.764E+04	0.00000	1.000E+00
33	1991	1.000E+00	1.000E+00	--	3.789E+04	7.012E+04	-0.61563	1.000E+00
34	1992	1.000E+00	1.000E+00	--	1.364E+05	4.760E+04	1.05293	1.000E+00
35	1993	1.000E+00	1.000E+00	--	1.923E+04	2.884E+04	-0.40504	1.000E+00
36	1994	1.000E+00	1.000E+00	--	3.176E+04	2.757E+04	0.14155	1.000E+00
37	1995	1.000E+00	1.000E+00	--	9.073E+04	3.114E+04	1.06932	1.000E+00
38	1996	1.000E+00	1.000E+00	--	1.597E+04	3.755E+04	-0.85513	1.000E+00
39	1997	1.000E+00	1.000E+00	--	7.066E+04	4.502E+04	0.45084	1.000E+00
40	1998	1.000E+00	1.000E+00	--	1.122E+05	5.357E+04	0.73953	1.000E+00
41	1999	1.000E+00	1.000E+00	--	7.199E+04	6.180E+04	0.15258	1.000E+00
42	2000	1.000E+00	1.000E+00	--	1.005E+05	7.038E+04	0.35592	1.000E+00
43	2001	1.000E+00	1.000E+00	--	1.326E+05	8.263E+04	0.47265	1.000E+00
44	2002	1.000E+00	1.000E+00	--	5.012E+04	9.707E+04	-0.66092	1.000E+00
45	2003	1.000E+00	1.000E+00	--	7.189E+04	1.133E+05	-0.45518	1.000E+00
46	2004	1.000E+00	1.000E+00	--	4.991E+04	1.325E+05	-0.97611	1.000E+00
47	2005	1.000E+00	1.000E+00	--	5.856E+04	1.535E+05	-0.96356	1.000E+00
48	2006	1.000E+00	1.000E+00	--	9.188E+04	1.764E+05	-0.65224	1.000E+00
49	2007	1.000E+00	1.000E+00	--	1.248E+05	1.991E+05	-0.46768	1.000E+00
50	2008	1.000E+00	1.000E+00	--	1.985E+05	2.240E+05	-0.12103	1.000E+00
51	2009	1.000E+00	1.000E+00	--	2.467E+05	2.486E+05	-0.00774	1.000E+00
52	2010	1.000E+00	1.000E+00	--	4.615E+05	2.692E+05	0.53898	1.000E+00
53	2011	1.000E+00	1.000E+00	--	5.623E+05	2.897E+05	0.66311	1.000E+00
54	2012	1.000E+00	1.000E+00	--	5.960E+05	3.085E+05	0.65862	1.000E+00
55	2013	1.000E+00	1.000E+00	--	2.888E+05	3.240E+05	-0.11516	1.000E+00

* Asterisk indicates missing value(s).

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UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 3
                   -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    -0.6156                                 ============|
1992     1.0529                                             |=====================
1993    -0.4050                                     ========|
1994     0.1415                                             |===
1995     1.0693                                             |=====================
1996    -0.8551                            =================|
1997     0.4508                                             |=========
1998     0.7395                                             |===============
1999     0.1526                                             |===
2000     0.3559                                             |=======
2001     0.4726                                             |=========
2002    -0.6609                                =============|
2003    -0.4552                                    =========|
2004    -0.9761                         ====================|
2005    -0.9636                          ===================|
2006    -0.6522                                =============|
2007    -0.4677                                    =========|
2008    -0.1210                                           ==|
2009    -0.0077                                             |
2010     0.5390                                             |===========
2011     0.6631                                             |=============
2012     0.6586                                             |=============
2013    -0.1152                                           ==|
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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	--	*	7.573E+04	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	7.098E+04	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	6.956E+04	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	6.897E+04	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	6.774E+04	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	6.831E+04	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	6.937E+04	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	6.942E+04	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	6.886E+04	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	6.829E+04	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	6.804E+04	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	6.835E+04	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	6.708E+04	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	6.375E+04	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	6.059E+04	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	5.854E+04	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	5.884E+04	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	5.939E+04	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	6.016E+04	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	6.223E+04	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	6.463E+04	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	6.638E+04	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	6.651E+04	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	6.584E+04	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	6.586E+04	0.00000	1.000E+00
26	1984	1.000E+00	1.000E+00	--	2.159E+05	6.692E+04	1.17117	1.000E+00
27	1985	1.000E+00	1.000E+00	--	9.400E+04	6.781E+04	0.32659	1.000E+00
28	1986	1.000E+00	1.000E+00	--	6.298E+04	6.429E+04	-0.02064	1.000E+00
29	1987	1.000E+00	1.000E+00	--	7.030E+04	5.134E+04	0.31420	1.000E+00
30	1988	1.000E+00	1.000E+00	--	4.488E+04	3.726E+04	0.18628	1.000E+00
31	1989	1.000E+00	1.000E+00	--	1.227E+04	2.928E+04	-0.86993	1.000E+00
32	1990	1.000E+00	1.000E+00	--	8.365E+03	2.415E+04	-1.06020	1.000E+00
33	1991	1.000E+00	1.000E+00	--	1.868E+04	1.959E+04	-0.04742	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	1.449E+04	0.00000	1.000E+00
35	1993	0.000E+00	0.000E+00	--	*	9.334E+03	0.00000	1.000E+00
36	1994	0.000E+00	0.000E+00	--	*	7.035E+03	0.00000	1.000E+00
37	1995	0.000E+00	0.000E+00	--	*	7.316E+03	0.00000	1.000E+00
38	1996	0.000E+00	0.000E+00	--	*	8.547E+03	0.00000	1.000E+00
39	1997	0.000E+00	0.000E+00	--	*	1.028E+04	0.00000	1.000E+00
40	1998	0.000E+00	0.000E+00	--	*	1.227E+04	0.00000	1.000E+00
41	1999	0.000E+00	0.000E+00	--	*	1.437E+04	0.00000	1.000E+00
42	2000	0.000E+00	0.000E+00	--	*	1.647E+04	0.00000	1.000E+00
43	2001	0.000E+00	0.000E+00	--	*	1.906E+04	0.00000	1.000E+00
44	2002	0.000E+00	0.000E+00	--	*	2.238E+04	0.00000	1.000E+00
45	2003	0.000E+00	0.000E+00	--	*	2.621E+04	0.00000	1.000E+00
46	2004	0.000E+00	0.000E+00	--	*	3.062E+04	0.00000	1.000E+00
47	2005	0.000E+00	0.000E+00	--	*	3.564E+04	0.00000	1.000E+00
48	2006	0.000E+00	0.000E+00	--	*	4.113E+04	0.00000	1.000E+00
49	2007	0.000E+00	0.000E+00	--	*	4.684E+04	0.00000	1.000E+00
50	2008	0.000E+00	0.000E+00	--	*	5.278E+04	0.00000	1.000E+00
51	2009	0.000E+00	0.000E+00	--	*	5.897E+04	0.00000	1.000E+00
52	2010	0.000E+00	0.000E+00	--	*	6.462E+04	0.00000	1.000E+00
53	2011	0.000E+00	0.000E+00	--	*	6.975E+04	0.00000	1.000E+00
54	2012	0.000E+00	0.000E+00	--	*	7.466E+04	0.00000	1.000E+00
55	2013	0.000E+00	0.000E+00	--	*	7.894E+04	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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3LN redfish                                                                                                    Page11

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     1.1712                                             |=======================
1985     0.3266                                             |=======
1986    -0.0206                                             |
1987     0.3142                                             |======
1988     0.1863                                             |====
1989    -0.8699                            =================|
1990    -1.0602                        =====================|
1991    -0.0474                                            =|
1992     0.0000                                             |
1993     0.0000                                             |
1994     0.0000                                             |
1995     0.0000                                             |
1996     0.0000                                             |
1997     0.0000                                             |
1998     0.0000                                             |
1999     0.0000                                             |
2000     0.0000                                             |
2001     0.0000                                             |
2002     0.0000                                             |
2003     0.0000                                             |
2004     0.0000                                             |
2005     0.0000                                             |
2006     0.0000                                             |
2007     0.0000                                             |
2008     0.0000                                             |
2009     0.0000                                             |
2010     0.0000                                             |
2011     0.0000                                             |
2012     0.0000                                             |
2013     0.0000                                             |
                   ------------------------------------------------------------------------------------
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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	--	*	6.291E+04	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	5.677E+04	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	5.521E+04	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	5.451E+04	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	5.426E+04	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	5.260E+04	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	5.508E+04	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	5.432E+04	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	5.514E+04	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	5.350E+04	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	5.418E+04	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	5.315E+04	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	5.462E+04	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	5.127E+04	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	4.931E+04	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	4.632E+04	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	4.601E+04	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	4.677E+04	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	4.689E+04	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	4.797E+04	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	5.013E+04	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	5.177E+04	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	5.289E+04	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	5.201E+04	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	5.181E+04	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	5.205E+04	0.00000	1.000E+00
27	1985	1.000E+00	1.000E+00	--	9.024E+04	5.347E+04	0.52342	1.000E+00
28	1986	1.000E+00	1.000E+00	--	3.657E+04	5.346E+04	-0.37981	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	4.812E+04	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	3.390E+04	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	2.536E+04	0.00000	1.000E+00
32	1990	1.000E+00	1.000E+00	--	1.820E+04	2.099E+04	-0.14261	1.000E+00
33	1991	0.000E+00	0.000E+00	--	*	1.724E+04	0.00000	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	1.380E+04	0.00000	1.000E+00
35	1993	0.000E+00	0.000E+00	--	*	9.364E+03	0.00000	1.000E+00
36	1994	0.000E+00	0.000E+00	--	*	5.674E+03	0.00000	1.000E+00
37	1995	0.000E+00	0.000E+00	--	*	5.423E+03	0.00000	1.000E+00
38	1996	0.000E+00	0.000E+00	--	*	6.127E+03	0.00000	1.000E+00
39	1997	0.000E+00	0.000E+00	--	*	7.388E+03	0.00000	1.000E+00
40	1998	0.000E+00	0.000E+00	--	*	8.857E+03	0.00000	1.000E+00
41	1999	0.000E+00	0.000E+00	--	*	1.054E+04	0.00000	1.000E+00
42	2000	0.000E+00	0.000E+00	--	*	1.216E+04	0.00000	1.000E+00
43	2001	0.000E+00	0.000E+00	--	*	1.385E+04	0.00000	1.000E+00
44	2002	0.000E+00	0.000E+00	--	*	1.626E+04	0.00000	1.000E+00
45	2003	0.000E+00	0.000E+00	--	*	1.910E+04	0.00000	1.000E+00
46	2004	0.000E+00	0.000E+00	--	*	2.230E+04	0.00000	1.000E+00
47	2005	0.000E+00	0.000E+00	--	*	2.606E+04	0.00000	1.000E+00
48	2006	0.000E+00	0.000E+00	--	*	3.020E+04	0.00000	1.000E+00
49	2007	0.000E+00	0.000E+00	--	*	3.471E+04	0.00000	1.000E+00
50	2008	0.000E+00	0.000E+00	--	*	3.918E+04	0.00000	1.000E+00
51	2009	0.000E+00	0.000E+00	--	*	4.408E+04	0.00000	1.000E+00
52	2010	0.000E+00	0.000E+00	--	*	4.892E+04	0.00000	1.000E+00
53	2011	0.000E+00	0.000E+00	--	*	5.296E+04	0.00000	1.000E+00
54	2012	0.000E+00	0.000E+00	--	*	5.700E+04	0.00000	1.000E+00
55	2013	0.000E+00	0.000E+00	--	*	6.069E+04	0.00000	1.000E+00

* Asterisk indicates missing value(s).

```
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     0.5234                                             |=====================
1986    -0.3798                              ===============|
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990    -0.1426                                       ======|
1991     0.0000                                             |
1992     0.0000                                             |
1993     0.0000                                             |
1994     0.0000                                             |
1995     0.0000                                             |
1996     0.0000                                             |
1997     0.0000                                             |
1998     0.0000                                             |
1999     0.0000                                             |
2000     0.0000                                             |
2001     0.0000                                             |
2002     0.0000                                             |
2003     0.0000                                             |
2004     0.0000                                             |
2005     0.0000                                             |
2006     0.0000                                             |
2007     0.0000                                             |
2008     0.0000                                             |
2009     0.0000                                             |
2010     0.0000                                             |
2011     0.0000                                             |
2012     0.0000                                             |
2013     0.0000                                             |
                   ------------------------------------------------------------------------------------
```

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	--	*	2.430E+05	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	2.277E+05	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	2.232E+05	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	2.213E+05	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	2.173E+05	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	2.191E+05	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	2.225E+05	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	2.227E+05	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	2.209E+05	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	2.191E+05	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	2.183E+05	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	2.193E+05	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	2.152E+05	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	2.045E+05	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	1.944E+05	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	1.878E+05	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	1.888E+05	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	1.905E+05	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	1.930E+05	0.00000	1.000E+00
20	1978	1.000E+00	1.000E+00	--	3.112E+05	1.996E+05	0.44384	1.000E+00
21	1979	1.000E+00	1.000E+00	--	2.278E+05	2.074E+05	0.09401	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	2.130E+05	0.00000	1.000E+00
23	1981	1.000E+00	1.000E+00	--	2.614E+05	2.134E+05	0.20291	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	2.112E+05	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	2.113E+05	0.00000	1.000E+00
26	1984	1.000E+00	1.000E+00	--	2.777E+05	2.147E+05	0.25730	1.000E+00
27	1985	1.000E+00	1.000E+00	--	1.610E+05	2.175E+05	-0.30075	1.000E+00
28	1986	0.000E+00	0.000E+00	--	*	2.063E+05	0.00000	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	1.647E+05	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	1.195E+05	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	9.394E+04	0.00000	1.000E+00
32	1990	1.000E+00	1.000E+00	--	9.284E+04	7.748E+04	0.18090	1.000E+00
33	1991	1.000E+00	1.000E+00	--	3.757E+04	6.284E+04	-0.51434	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	4.649E+04	0.00000	1.000E+00
35	1993	1.000E+00	1.000E+00	--	2.084E+04	2.995E+04	-0.36263	1.000E+00
36	1994	0.000E+00	0.000E+00	--	*	2.257E+04	0.00000	1.000E+00
37	1995	0.000E+00	0.000E+00	--	*	2.347E+04	0.00000	1.000E+00
38	1996	0.000E+00	0.000E+00	--	*	2.742E+04	0.00000	1.000E+00
39	1997	0.000E+00	0.000E+00	--	*	3.297E+04	0.00000	1.000E+00
40	1998	0.000E+00	0.000E+00	--	*	3.937E+04	0.00000	1.000E+00
41	1999	0.000E+00	0.000E+00	--	*	4.611E+04	0.00000	1.000E+00
42	2000	0.000E+00	0.000E+00	--	*	5.285E+04	0.00000	1.000E+00
43	2001	0.000E+00	0.000E+00	--	*	6.114E+04	0.00000	1.000E+00
44	2002	0.000E+00	0.000E+00	--	*	7.181E+04	0.00000	1.000E+00
45	2003	0.000E+00	0.000E+00	--	*	8.410E+04	0.00000	1.000E+00
46	2004	0.000E+00	0.000E+00	--	*	9.825E+04	0.00000	1.000E+00
47	2005	0.000E+00	0.000E+00	--	*	1.143E+05	0.00000	1.000E+00
48	2006	0.000E+00	0.000E+00	--	*	1.319E+05	0.00000	1.000E+00
49	2007	0.000E+00	0.000E+00	--	*	1.503E+05	0.00000	1.000E+00
50	2008	0.000E+00	0.000E+00	--	*	1.693E+05	0.00000	1.000E+00
51	2009	0.000E+00	0.000E+00	--	*	1.892E+05	0.00000	1.000E+00
52	2010	0.000E+00	0.000E+00	--	*	2.073E+05	0.00000	1.000E+00
53	2011	0.000E+00	0.000E+00	--	*	2.238E+05	0.00000	1.000E+00
54	2012	0.000E+00	0.000E+00	--	*	2.395E+05	0.00000	1.000E+00
55	2013	0.000E+00	0.000E+00	--	*	2.532E+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     0.4438                                             |==================
1979     0.0940                                             |====
1980     0.0000                                             |
1981     0.2029                                             |========
1982     0.0000                                             |
1983     0.0000                                             |
1984     0.2573                                             |==========
1985    -0.3007                                 ============|
1986     0.0000                                             |
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990     0.1809                                             |=======
1991    -0.5143                        =====================|
1992     0.0000                                             |
1993    -0.3626                              ===============|
1994     0.0000                                             |
1995     0.0000                                             |
1996     0.0000                                             |
1997     0.0000                                             |
1998     0.0000                                             |
1999     0.0000                                             |
2000     0.0000                                             |
2001     0.0000                                             |
2002     0.0000                                             |
2003     0.0000                                             |
2004     0.0000                                             |
2005     0.0000                                             |
2006     0.0000                                             |
2007     0.0000                                             |
2008     0.0000                                             |
2009     0.0000                                             |
2010     0.0000                                             |
2011     0.0000                                             |
2012     0.0000                                             |
2013     0.0000                                             |
                   ------------------------------------------------------------------------------------
```

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	--	*	5.239E+04	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	5.095E+04	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	5.031E+04	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	5.008E+04	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	4.855E+04	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	5.083E+04	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	5.014E+04	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	5.089E+04	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	4.937E+04	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	5.000E+04	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	4.905E+04	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	5.041E+04	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	4.732E+04	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	4.551E+04	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	4.275E+04	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	4.246E+04	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	4.316E+04	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	4.327E+04	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	4.427E+04	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	4.627E+04	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	4.778E+04	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	4.881E+04	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	4.800E+04	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	4.782E+04	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	4.803E+04	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	4.935E+04	0.00000	1.000E+00
27	1985	1.000E+00	1.000E+00	--	9.823E+04	4.934E+04	0.68861	1.000E+00
28	1986	1.000E+00	1.000E+00	--	1.712E+04	4.441E+04	-0.95327	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	3.129E+04	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	2.341E+04	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	1.937E+04	0.00000	1.000E+00
32	1990	1.000E+00	1.000E+00	--	2.074E+04	1.591E+04	0.26509	1.000E+00
33	1991	0.000E+00	0.000E+00	--	*	1.273E+04	0.00000	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	8.642E+03	0.00000	1.000E+00
35	1993	0.000E+00	0.000E+00	--	*	5.236E+03	0.00000	1.000E+00
36	1994	0.000E+00	0.000E+00	--	*	5.005E+03	0.00000	1.000E+00
37	1995	0.000E+00	0.000E+00	--	*	5.654E+03	0.00000	1.000E+00
38	1996	0.000E+00	0.000E+00	--	*	6.818E+03	0.00000	1.000E+00
39	1997	0.000E+00	0.000E+00	--	*	8.174E+03	0.00000	1.000E+00
40	1998	0.000E+00	0.000E+00	--	*	9.727E+03	0.00000	1.000E+00
41	1999	0.000E+00	0.000E+00	--	*	1.122E+04	0.00000	1.000E+00
42	2000	0.000E+00	0.000E+00	--	*	1.278E+04	0.00000	1.000E+00
43	2001	0.000E+00	0.000E+00	--	*	1.500E+04	0.00000	1.000E+00
44	2002	0.000E+00	0.000E+00	--	*	1.762E+04	0.00000	1.000E+00
45	2003	0.000E+00	0.000E+00	--	*	2.058E+04	0.00000	1.000E+00
46	2004	0.000E+00	0.000E+00	--	*	2.405E+04	0.00000	1.000E+00
47	2005	0.000E+00	0.000E+00	--	*	2.787E+04	0.00000	1.000E+00
48	2006	0.000E+00	0.000E+00	--	*	3.203E+04	0.00000	1.000E+00
49	2007	0.000E+00	0.000E+00	--	*	3.616E+04	0.00000	1.000E+00
50	2008	0.000E+00	0.000E+00	--	*	4.068E+04	0.00000	1.000E+00
51	2009	0.000E+00	0.000E+00	--	*	4.514E+04	0.00000	1.000E+00
52	2010	0.000E+00	0.000E+00	--	*	4.888E+04	0.00000	1.000E+00
53	2011	0.000E+00	0.000E+00	--	*	5.260E+04	0.00000	1.000E+00
54	2012	0.000E+00	0.000E+00	--	*	5.601E+04	0.00000	1.000E+00
55	2013	0.000E+00	0.000E+00	--	*	5.883E+04	0.00000	1.000E+00

* Asterisk indicates missing value(s).

```
UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 7
                   -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     0.6886                                             |============================
1986    -0.9533       ======================================|
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990     0.2651                                             |===========
1991     0.0000                                             |
1992     0.0000                                             |
1993     0.0000                                             |
1994     0.0000                                             |
1995     0.0000                                             |
1996     0.0000                                             |
1997     0.0000                                             |
1998     0.0000                                             |
1999     0.0000                                             |
2000     0.0000                                             |
2001     0.0000                                             |
2002     0.0000                                             |
2003     0.0000                                             |
2004     0.0000                                             |
2005     0.0000                                             |
2006     0.0000                                             |
2007     0.0000                                             |
2008     0.0000                                             |
2009     0.0000                                             |
2010     0.0000                                             |
2011     0.0000                                             |
2012     0.0000                                             |
2013     0.0000                                             |
                   ------------------------------------------------------------------------------------
```

RESULTS FOR DATA SERIES # 8 (NON-BOOTSTRAPPED) 3N spanish survey

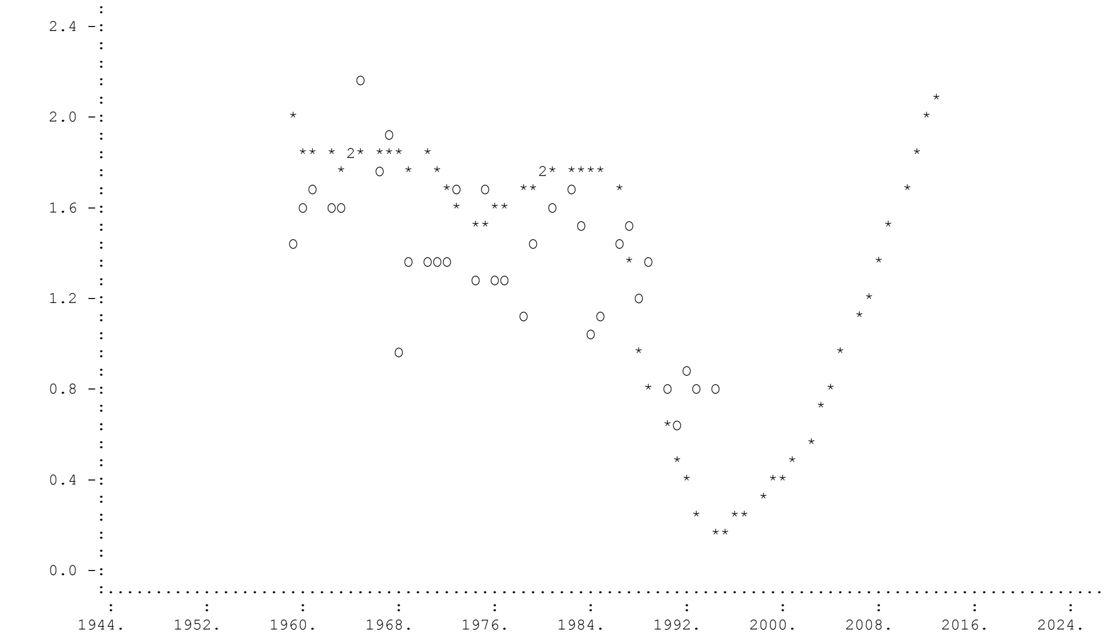
Data type I1: Abundance index (annual average) Series weight: 1.000

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	--	*	1.671E+05	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	1.566E+05	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	1.535E+05	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	1.522E+05	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	1.495E+05	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	1.507E+05	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	1.531E+05	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	1.532E+05	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	1.519E+05	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	1.507E+05	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	1.501E+05	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	1.508E+05	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	1.480E+05	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	1.407E+05	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	1.337E+05	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	1.292E+05	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	1.298E+05	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	1.310E+05	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	1.327E+05	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	1.373E+05	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	1.426E+05	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	1.465E+05	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	1.468E+05	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	1.453E+05	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	1.453E+05	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	1.477E+05	0.00000	1.000E+00
27	1985	0.000E+00	0.000E+00	--	*	1.496E+05	0.00000	1.000E+00
28	1986	0.000E+00	0.000E+00	--	*	1.419E+05	0.00000	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	1.133E+05	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	8.221E+04	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	6.461E+04	0.00000	1.000E+00
32	1990	0.000E+00	0.000E+00	--	*	5.329E+04	0.00000	1.000E+00
33	1991	0.000E+00	0.000E+00	--	*	4.322E+04	0.00000	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	3.198E+04	0.00000	1.000E+00
35	1993	0.000E+00	0.000E+00	--	*	2.060E+04	0.00000	1.000E+00
36	1994	0.000E+00	0.000E+00	--	*	1.552E+04	0.00000	1.000E+00
37	1995	1.000E+00	1.000E+00	--	4.608E+04	1.614E+04	1.04895	1.000E+00
38	1996	1.000E+00	1.000E+00	--	6.558E+03	1.886E+04	-1.05636	1.000E+00
39	1997	1.000E+00	1.000E+00	--	4.753E+03	2.267E+04	-1.56247	1.000E+00
40	1998	1.000E+00	1.000E+00	--	2.254E+04	2.708E+04	-0.18351	1.000E+00
41	1999	1.000E+00	1.000E+00	--	4.646E+04	3.172E+04	0.38176	1.000E+00
42	2000	1.000E+00	1.000E+00	--	6.893E+04	3.635E+04	0.63995	1.000E+00
43	2001	1.000E+00	1.000E+00	--	5.386E+04	4.205E+04	0.24740	1.000E+00
44	2002	1.000E+00	1.000E+00	--	7.620E+03	4.939E+04	-1.86898	1.000E+00
45	2003	1.000E+00	1.000E+00	--	1.103E+04	5.784E+04	-1.65697	1.000E+00
46	2004	1.000E+00	1.000E+00	--	2.702E+04	6.758E+04	-0.91682	1.000E+00
47	2005	1.000E+00	1.000E+00	--	1.469E+05	7.864E+04	0.62500	1.000E+00
48	2006	1.000E+00	1.000E+00	--	8.783E+04	9.075E+04	-0.03269	1.000E+00
49	2007	1.000E+00	1.000E+00	--	8.760E+04	1.033E+05	-0.16531	1.000E+00
50	2008	1.000E+00	1.000E+00	--	6.806E+04	1.165E+05	-0.53728	1.000E+00
51	2009	1.000E+00	1.000E+00	--	7.357E+05	1.301E+05	1.73242	1.000E+00
52	2010	1.000E+00	1.000E+00	--	3.595E+05	1.426E+05	0.92484	1.000E+00
53	2011	1.000E+00	1.000E+00	--	4.183E+05	1.539E+05	0.99980	1.000E+00
54	2012	1.000E+00	1.000E+00	--	2.652E+05	1.647E+05	0.47628	1.000E+00
55	2013	1.000E+00	1.000E+00	--	4.295E+05	1.742E+05	0.90262	1.000E+00

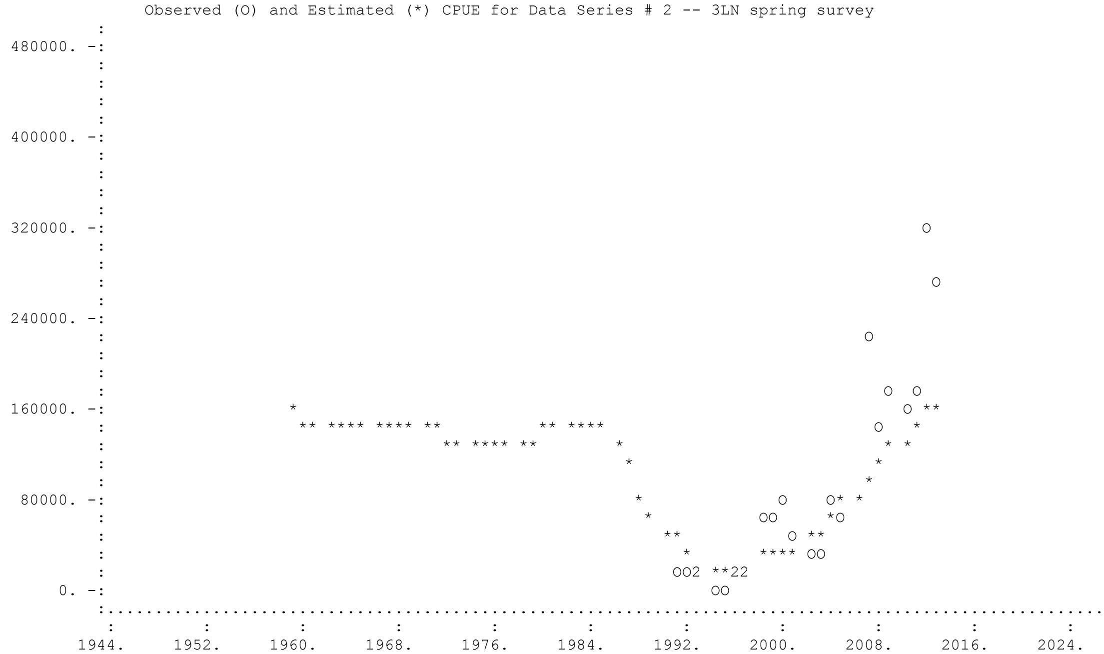
* Asterisk indicates missing value(s).

```
UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 8
                   -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     0.0000                                             |
1992     0.0000                                             |
1993     0.0000                                             |
1994     0.0000                                             |
1995     1.0489                                             |=====================
1996    -1.0564                        =====================|
1997    -1.5625              ===============================|
1998    -0.1835                                         ====|
1999     0.3818                                             |========
2000     0.6399                                             |=============
2001     0.2474                                             |=====
2002    -1.8690        =====================================|
2003    -1.6570            =================================|
2004    -0.9168                           ==================|
2005     0.6250                                             |============
2006    -0.0327                                            =|
2007    -0.1653                                          ===|
2008    -0.5373                                  ===========|
2009     1.7324                                             |===================================
2010     0.9248                                             |==================
2011     0.9998                                             |====================
2012     0.4763                                             |==========
2013     0.9026                                             |==================
                   ------------------------------------------------------------------------------------
```

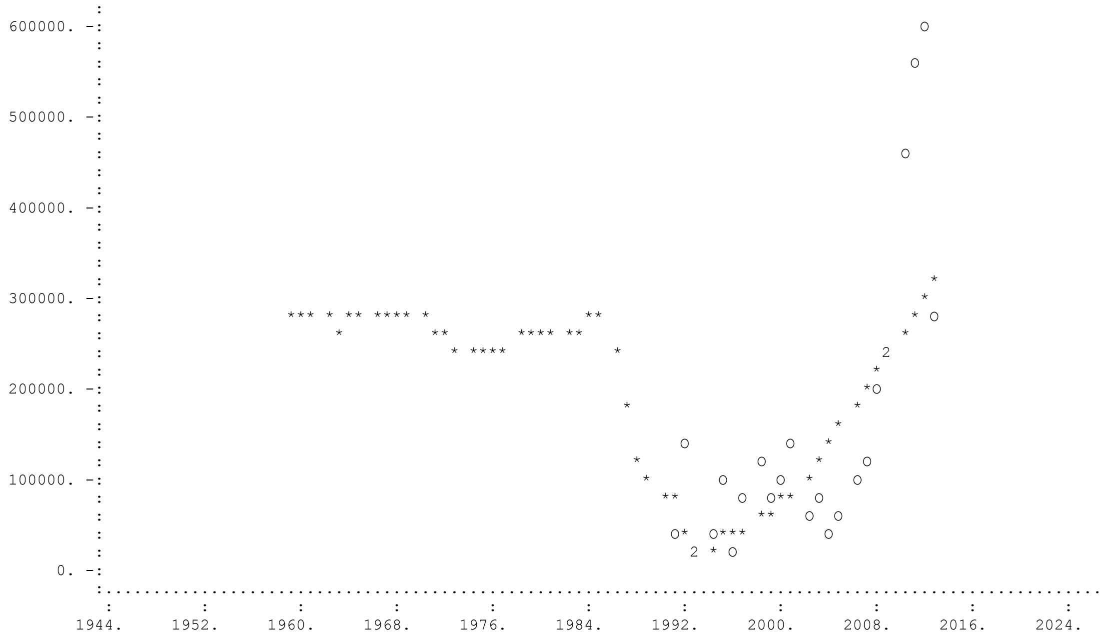
Observed (O) and Estimated (*) CPUE for Data Series # 1 -- Statlant CPUE



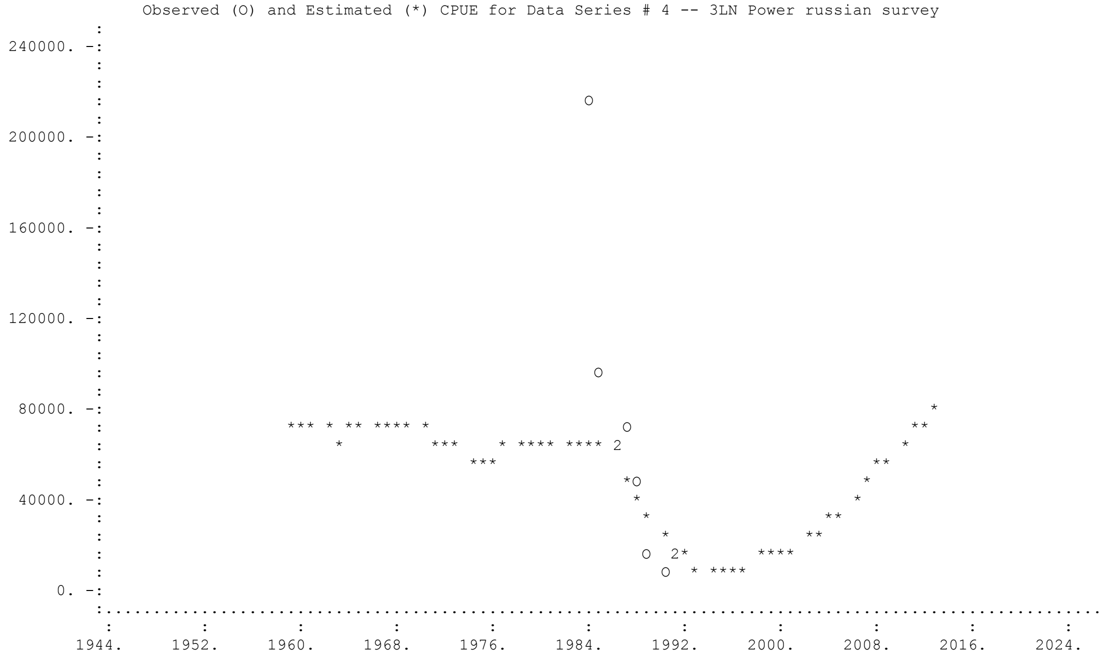
Observed (O) and Estimated (*) CPUE for Data Series # 2 -- 3LN spring survey



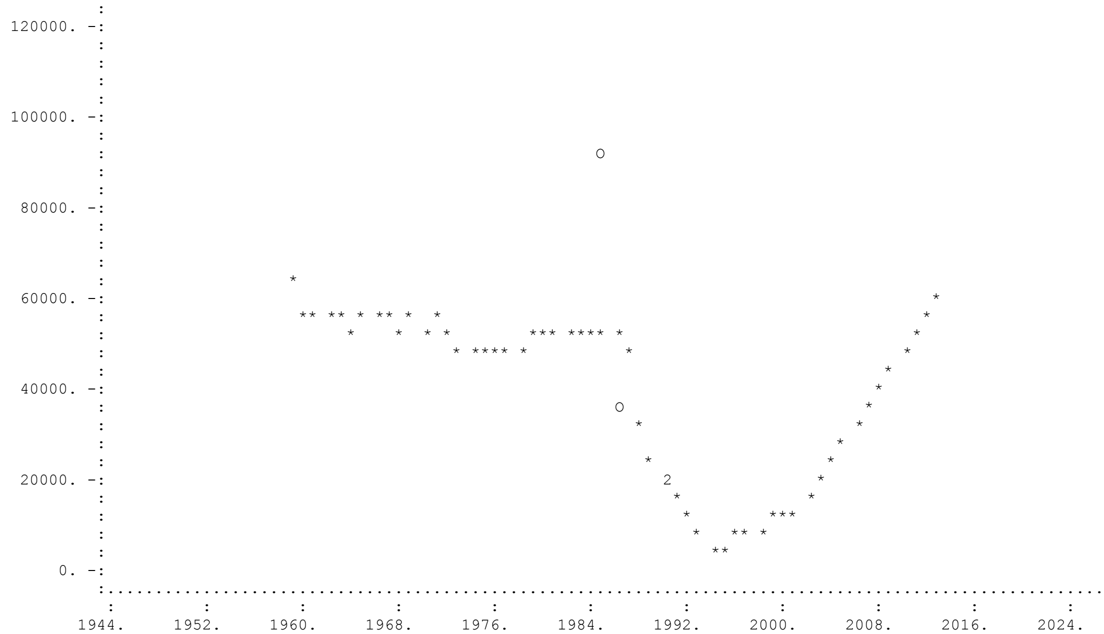
Observed (O) and Estimated (*) CPUE for Data Series # 3 -- 3LN autumn survey



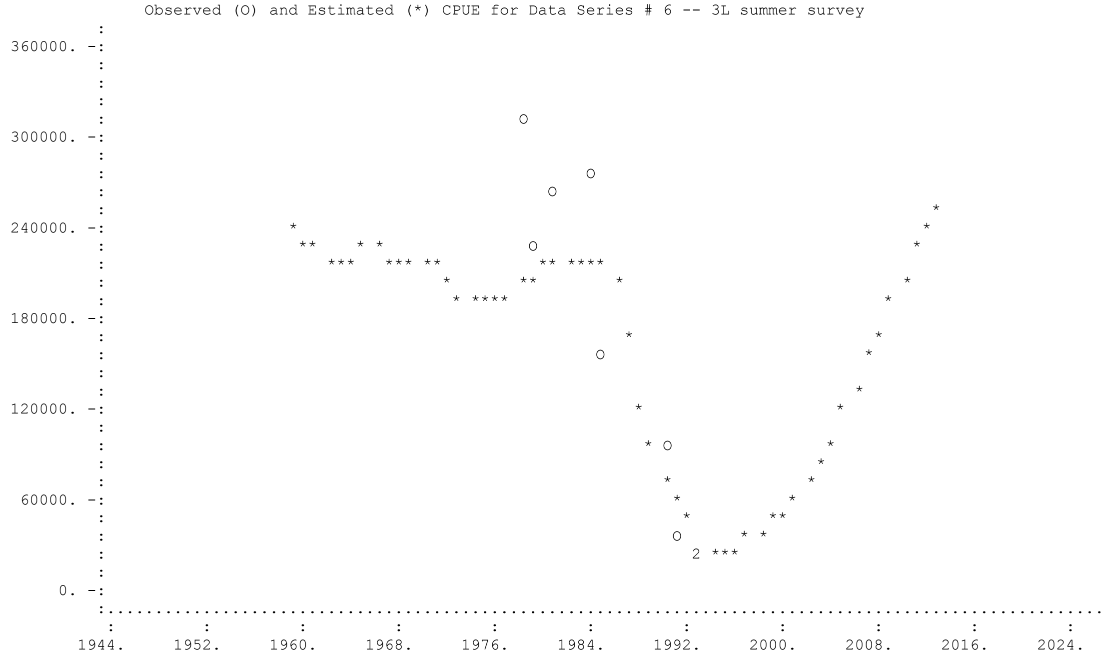
Observed (O) and Estimated (*) CPUE for Data Series # 4 -- 3LN Power russian survey



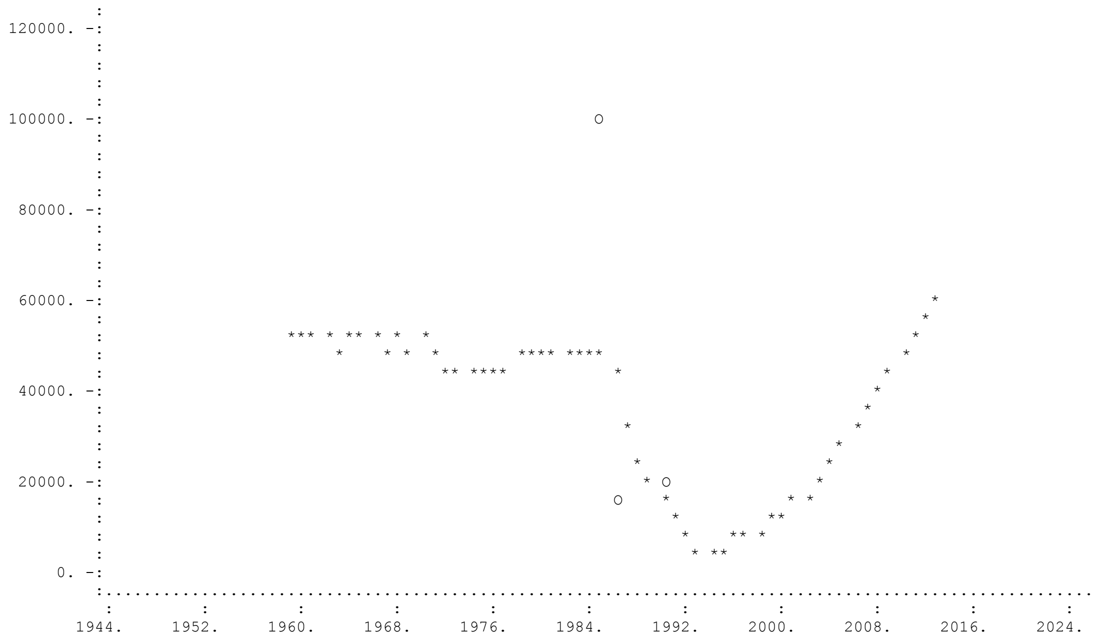
Observed (O) and Estimated (*) CPUE for Data Series # 5 -- 3L winter survey



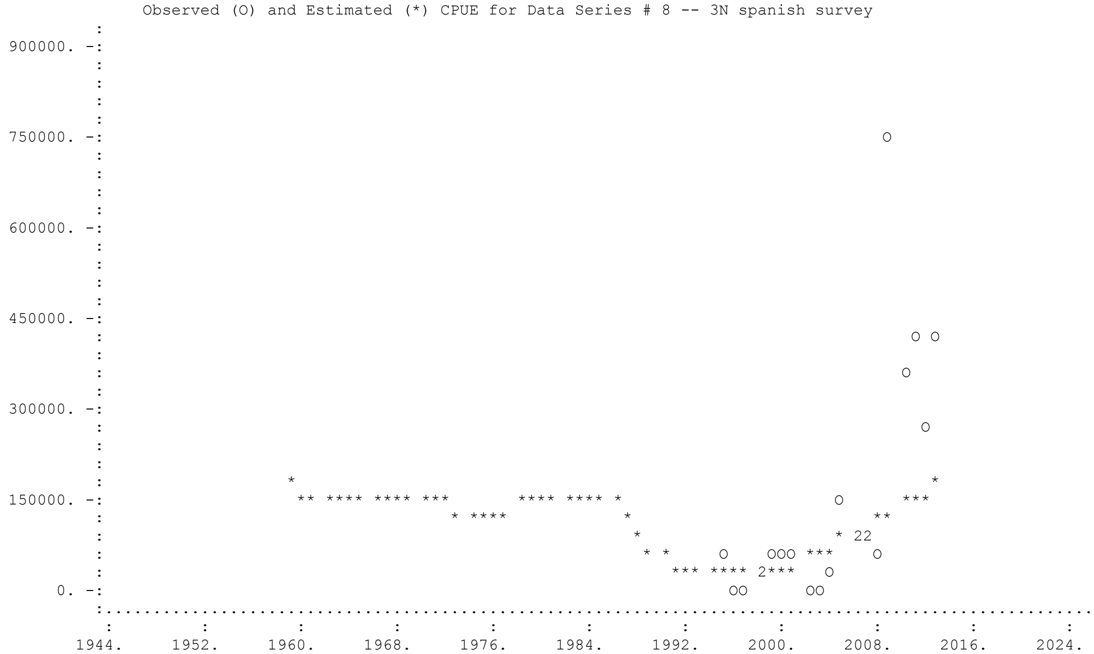
Observed (O) and Estimated (*) CPUE for Data Series # 6 -- 3L summer survey



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



Observed (O) and Estimated (*) CPUE for Data Series # 8 -- 3N spanish survey



```
3LN redfish                                                                                                    Page 24

                                   Time Plot of Estimated F/Fmsy and B/Bmsy (dashed line = 1.0)
           :
      7.2 -:
           :
           :
           :                                                             F
           :
      6.0 -:
           :
           :
           :                                                            F
           :
      4.8 -:
           :
           :                                                      F
           :                                                       F
           :
      3.6 -:                                                           F
           :                                                          F
           :                                                        F
           :
           :
      2.4 -:                                                               F
           :
           :                                                     F
           :                   F
           :                   B              F F                                                   B
      1.2 -:                    BB B2BB B2BB BB2         BB BBBB B                              BBB
           :        ---- ---- --22 2--2 ---2 ---2 3332 22-2 22-2 -2-- ---- ---- ---- ---- --22 2--- ---- ---
           :                            F F          F  FF    F    B        F             BB
           :                         F       F         F            B BB         FF   BBB
           :                                                            BB B 22 2BB2 2F        FFFF
      0.0 -:                                                                B          FF FFFF
           :........................................................................................................
            :         :         :         :         :         :         :         :         :         :         :
         1944.     1952.     1960.     1968.     1976.     1984.     1992.     2000.     2008.     2016.     2024.
```

Elapsed time: 0 hours, 0 minutes, 3.292 seconds.