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A Revised Update of the 2014 ASPIC Assessment of Redfish (*S. mentella and S. fasciatus*) in Divisions 3LN (*how the the stock is coping with the actual Management Strategy and its likely impact on the next coming years*)

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. Both species, occurring on Div. 3LN and managed as a single stock, don't belong to isolated local populations but, on the contrary, are part of a large Northwest Atlantic complex ranging from the Gulf of Maine to south of Baffin Island.

The present ASPIC assessment of this stock 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, for the first time, to all 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 within each series.

In order to proceed on the threshold of the new 2014 approach, and taking into account that since then no substantial changes appear to have occurred on the state of the stock, the main features of the previous input framework were kept, with MSY fixed at 1960-1985 average catch and the rest of the approved 2014 assessment framework updated. The 3L Spanish survey, the only ongoing survey so far outside the analysis, has now been successfully included on this assessment framework (relative inter-quartile range from bootstrap analysis for the last two assessments highlight the higher consistence of most of the 2016 assessment results when compared with the ones from 2014).

ASPIC assessment results confirm a stable stock from the 1960's to the first half of the 1980's, sustaining an average yield of 21 000t. Stock declined with a sudden rise of the catch over the late 1980's first half of the 1990, and increased since then, after catches fell to a residual level with the stock collapse. Assessment results also confirm that the maximum observed sustainable yield (*MSY*) of 21 000 t can be a long term sustainable yield if fishing mortality stands at 0.11/year, exploiting a correspondent B_{msy} at 190 000 t.

There is a very high probability that the stock was at the beginning of 2016 at or above B_{msy} , after crossing 2015 under a fishing mortality most likely at or below 50% F_{msy}.

There is also a very high probability that catch on 2016 at 10 400 t TAC and on 2017 and 2018 at the predicted increases approved in the 2014 Risk-Based Management Strategy for 3LN Redfish, will keep fishing mortality on 2018 below F_{msy} and biomass at the beginning of 2019 above B_{msy}.

Introduction

There are two species of the genus *Sebastes* with distribution overlapping in several areas of Northwest Atlantic, namely on the Gulf of St. Lawrence, Laurentian Channel, off Newfoundland and south of Labrador Sea: the deep sea redfish (*Sebastes mentella)*, with a maximum abundance at depths greater than 350m, and Acadian redfish (*Sebastes fasciatus*), preferring shallower waters of less than 300m (DFO, 2008). They have been commercially fished on the slopes of the Grand Bank, both on Div. 3LN (north-south east) and Div. 3O (south-west).

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.

Either redfish species occurring on Div. 3LN don’t belong to isolated local populations but, on the contrary, are part of a large Northwest Atlantic complex ranging from the Gulf of Maine to south of Baffin Island. This complex is centred on the Gulf of St. Laurence (GSL)- Laurentian Channel – western slope of the Grand Bank system, where the GSL is a main nursery area for *S.fasciatus* and *S. mentella* local populations, due to current patterns that favours larval drift from main regions of larval extrusion towards the gulf (Valentin, A. 2015).

As regards redfish occurring on the Gran Bank of Newfoundland, differences observed in the “state of the stock” 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 has been considered by NAFO Scientific Council as a management unit composed by the ensemble *S. mentella* –*S.fasciatus* aggregations overlapping on the north-south east parts of the Grand Bank.

Within this management unit, relative abundance of *S. mentella* –*S.fasciatus* may vary with the income and survival of juveniles from either species, though *S. fasciatus* tend to be more abundant in the south (Div. 3N) while *S. mentella* is more abundant in the northern division (3L). On recent years (2011-2015) most of Canadian spring and autumn surveys found larger redfish concentrations more frequent on Div. 3N (Rideout, R. 2016), despite the major proportion of the catch continue to be annually taken from Div. 3L. *S. mentella* dominates the commercial catch on either division.

Commercial Fishery

<u>Nominal catches and TAC’s</u>

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 rise 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 (450-3 000 t) until 2009.

The NAFO Fisheries Commission (FC) implemented a moratorium on directed fishing for this stock in 1998. In June 2009 the Scientific Council confirmed the upward trend of the stock as shown by spring and autumn surveys (NAFO, 2009) and Fisheries Commission reopen the fishery in 2010 with a TAC of 3 500 t. On

2011-2012 and 2013-2014 TAC's increased to 6 000t and 6 500t respectively, with FC following the Scientific Council recommendations based on $F_{statusquo}$ short term projections from the biannual analytical assessments (Ávila de Melo *et al.*, 2010b and 2012).

Catches increased with the reopening of the fishery in 2010 and were near 10 500t in 2015 (provisional, taken from NAFO Circ. Letter Ref. No.: GFS/16-067 Feb 2016), the highest level recorded since 1993 (Table 1, Fig. 1). From 2011 onwards catch corresponds to STATLANT 21A (extracted from NAFO Database).

The most recent perception of the stock status, with biomass at or above B_{msy} and fishing mortality below F_{msy}, justified the adoption by the FC on the 36th Annual Meeting – September 2014 of a Risk-Based Management Strategy (MS) for redfish in Divisions 3LN (Ávila de Melo *et al*., 2014; FC Working Paper 14/23). This MS is designed to reach 18 100 t of annual catch by 2019-2020 through a stepwise biannual catch increase of constant magnitude. That resulted on a TAC for 2015-2016 of 10 400t.

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. Since the reopen in 2010 Canada, followed by Russia and EU-Portugal are the main partners of a fishery increasingly deployed northwards, on Div. 3L.

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 rateseries for Div. 3LN is presented on Table 2 and Fig. 2 (standardized to zero mean and unit standard deviation 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 catch@length

Most of the commercial length sampling data available for the 3LN beaked redfish came, since 1990, from the Portuguese fisheries and have been annually included in the Portuguese research reports on the

NAFO SCS Document series (Vargas *et al.*, 2016). Taking into account that the majority of the length sampling was from depths greater than 250m, most of 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*., 2016; Fomin *et al*., 2016). The 1990-2015 per mille length composition of the Portuguese trawl catch was applied to the rest of the commercial catches (Table 3a). 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 1990-2015 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, apparent stable catch at length with no clear trends towards smaller or larger sizes, proportion 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 two digits proportions of small redfish in the catch occurred afterwards on most years between 2006 and 2015 (Table 3a, Fig. 3). Under a low exploitation regime such interlinked events should reflect an average level of recruitment on recent years well above the average low recruitment from the 1990's first half of the 2000's. Average proportion of small redfish in the commercial catch rose from 1.0% (1990-2005) to 13.9% (2006-2015).

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). No survey was carried out on Div. 3N in spring 2006 and autumn 2014. 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. 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) and since 2008 this "Power revised" 1984-1991 Russian survey series is incorporated in the input framework of the redfish 3LN ASPIC assessment (Ávila de Melo *et al.*, 2008). Between 1992 and 1994 the coverage of NAFO Sub area 3 by the Russian bottom trawl series became irregular and in 1995 was discontinued.

In 1995 EU-Spain started a new stratified-random bottom trawl spring (May-June) survey on NAFO Regulatory Area of Div. 3NO. All strata in the NRA were covered every year following the standard stratification, first till 732m and from 1998 onwards till the 1464 m depth contour. In 2003 the Spanish survey was extended northwards to some strata in Div. 3L, but it was only in 2006 that an adequate prospecting survey was first conducted in Division 3L with over 100 valid hauls (Róman *et al*, 2016).

Details on the two Canadian survey series, as well as on the Russian series and the two Spanish surveys can be found on previous assessments (Ávila de Melo *et al.*, 2014).

Survey biomass and female spawning biomass

All survey biomass series from stratified-random bottom trawl surveys used in the exploratory analysis preceding 2016 ASPIC assessment are presented in Table 4. The 1991-2015 spring and autumn female SSB survey indices for Div. 3LN combined are also presented on Table 4. In order to turn the survey series comparable and facilitate the detection of trends in 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 surveys in Div. 3L and Russian bottom trawl surveys in Div. 3LN suggests that stock size suffered a substantial reduction. Redfish bottom biomass from surveys in Div. 3LN remained well below average level until 1997 and started since then a discrete and discontinuous increase. A pronounced increase of survey biomass 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 2015, 100% of the biomass indices were above the average of their own series on 1978-1985, only 3% on 1986-2006, and 80% on 2007-2015.

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 1991-2015 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 2006-2015 3LN Spanish survey (González, *pers. comm.*, 2016). 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 1991-2015 spring and autumn standardized female SSB survey series for Div. 3LN combined have trends very similar to correspondent biomass series (Fig.4b).

<u>Abundance at length</u>

Spring and autumn survey abundance at length, for Div. 3LN combined, are presented in Table 5a and 5b. The overall 1991-2015 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 last line, Fig. 5a and 5b). During the first half of the 1990's, on both surveys, 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 time interval coupled, with systematic income of weak year classes. But after 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

<u>Brief history and background for the pre fixed *MSY* option</u>

A non-equilibrium surplus production model (ASPIC; Prager, 1994) is used to assess the status of the stock since 2008. The ASPIC operating model is a non-equilibrium implementation of Schaefer's and Pella-Tomlinson models, among others.

Until 2012 the model was adjusted to an array of Canadian, Russian and Spanish 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). However the model was showing an increasing unfitness to recent survey biomass increases observed on all ongoing surveys. The approved framework of the 2012 assessment ends up excluding the 3N Spanish survey and several inter annual biomass bumps from the Canadian surveys, either combined (spring) or separate (autumn) (Ávila de Melo *et al*, 2012).

On the next assessment (Ávila de Melo *et al*, 2014) the purpose was to reach an inclusive approach that would incorporate most, if not all, the surveys points available for the two divisions with no haircuts, and at the same time delivering a "realistic" output. In other words, resulting on key parameters and biomass and fishing mortality trajectories in line with the perception of stock and fishery dynamics one has from historical commercial and survey data. To achieve this goal two of the five input frameworks running on the exploratory analysis preceding the 2014 assessment were allowed run with maximum sustainable yield fixed at a user starting guess of 21 000 t. This *MSY proxy* is the average level of sustained catch for the 1960-1985 interval, when the stock experienced an apparent stability, suggested either by the STATLANT CPUE series or available surveys, and before declining in response to a sudden rise of catch level.

From exploratory analysis the better framework to run the 2014 assessment had MSY pre fixed at 1960-1985 average catch. This framework also kept negative correlated STATLANT CPUE series and all "outliers" in their respective survey series, while Canadian autumn surveys on Div. 3L and Div. 3N were assembled in a single 3LN Canadian autumn series.

Input series

All input series consist of annual observed values and were given equal weight in the analysis. Each Canadian series is referred by its season and division(s), while the Russian and Spanish series are also referred by their country name. The candidate input series to be included in this assessment are

I1 (Statlant CPUE and catch)	Statlant cpue for Div. 3LN,$_{1959\text{-}1994}$ & catch for Div. 3LN $_{1959\text{-}2015}$
I2 (3LN spring survey)	Canadian spring survey biomass for Div. 3LN, $_{1991\text{-}2005,\ 2007\text{-}2015}$
I3 (3LN autumn survey)	Canadian autumn survey biomass for Div. 3LN, $_{1991\text{-}2015}$
I4 (3LN Power russian survey)	Russian spring survey biomass for Div. 3LN , $_{1984\text{-}1991}$ (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, $_{1978\text{-}1979,\ 1981,1984\text{-}1985,\ 1990\text{-}1991\text{and }1993}$
I7 (3L autumn survey)	Canadian autumn survey biomass for Div. 3L, $_{1985\text{-}1986,\ 1990}$
$I8_a$ (3N spring spanish survey$_{long}$)	Spanish survey biomass for Div. 3N, $_{1995\text{-}2015}$
$I8_b$ (3N spring spanish survey$_{short}$)	Spanish survey biomass for Div. 3N, $_{1995\text{-}2005}$
I9 (3L summer spanish survey)	Spanish survey biomass for Div. 3L, $_{2006\text{-}2015}$
I10 (3LN spring/summer spanish survey)	Spanish survey biomass for Div. 3LN, $_{2006\text{-}2015}$

The CPUE series and the short survey series (Russian survey, Canadian summer, autumn and winter surveys on Div. 3L), reflect the stock dynamics from the early 1960's until the first half of the 1990's, while the spring and autumn Canadian surveys reflect the stock dynamics from the 1990's till nowadays. Trends within the two periods differ and overlap of series basically belonging to different intervals is short. The negative correlations found between "old" and "new" series are expected (and disqualified to halt the ASPIC assessment). Crescent unfitness between observed and estimated STATLANT CPUE series with is also expected, as the first lay over the first half of the assessment interval while the correspondent estimated STATLANT CPUE series continues to expand in line with the stock biomass estimated by the model. So this series is treated in the traffic light diagnostic rating just as any other series.

Basic assumptions on ASPIC fit mode

In this assessment the new ASPIC version 7.03 (Praguer, 2015) fit the logistic form of the production model (Schaefer, 1954). Being *K* the carrying capacity stock biomass, *r* the intrinsic rate of stock biomass increase, *C* the catch biomass, *MSY* and *Bmsy* the long term yield and biomass associated with *Fmsy*, the model basic assumptions are:

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

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

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

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

3) The biological reference points are

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

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.

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.

A detailed 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 and data series, all of them included in a single input file. On ASPIC 7.03 input format has changed, but the updated 2016 input files were still arranged on version 5 format and then converted to the new format using the utility program ASPIC5to7. Control parameters are kept from the 2014 assessment and line-by-line details of all input settings can be found on the correspondent SCR Doc. (Ávila de Melo *et al*, 2014). Starting guess for 3L Spanish summer survey catchability is the same as for the other 3L summer/autumn survey series. All data sets have 57 years length (1959-2015).

All 1959-2010 catches used in this assessment are the catches adopted by STACFIS for this stock. The 2011-2015 catches were taken from the NAFO STATLANT 21A data base. Last year catch (2015) is provisional and taken from the NAFO Circ. Letter Ref. No.: GFS/16-067 Feb 2016.

Input .a7inp file for the 2016 adopted framework is presented on Appendix 1.

Exploratory analysis

The 2014 assessment marks a rupture with previous "*MSY* model free estimate" assessments and a new approach to the available commercial and survey data series, aimed to surpass growing difficulties found on the fit of the model and at the same time provide consistent results. The underlying logistic Schaefer production model (1954) used in ASPIC operating model (Prager, 1994) was unable to absorb recent biomass increases observed in surveys unless providing unrealistic results, namely a too high *MSY* (well above the high level of catches on the late 1980's early 1990's that lead the stock to collapse) and a too low last year biomass relative to *Bmsy* (when all surveys indicate that the stock is now at or above the high level of the early 1980's). Avoiding an increasing number of "unpleasant" data (such as the Spanish survey on Div. 3N and the highs on the longer survey series) to get acceptable results was no longer a valid path, as recognized on the STACFIS research recommendation on this matter (NAFO, 2012).

In order to proceed on the threshold of the new 2014 approach, and taking into account that since then no substantial changes appear to have occurred on the state of the stock status, the main features of the previous assessment input are kept on all input options considered in the present exploratory analysis: MSY fixed at 1960-1985 average catch, the 1991-2015 Canadian autumn surveys on Div. 3L and Div. 3N assembled in a single 3LN Canadian autumn series, STATLANT CPUE series maintained and full length survey series used.

Having in mind the feasibility of the inclusion of the last survey series still out of the model fit, the Spanish summer survey on Div. 3L, three candidate frameworks were in contest for the input of the 2016 redfish 3LN ASPIC assessment:

ASPIC2016$_a$ standard (approved 2014 assessment framework): input MSY fixed at 1960-1985 average catch, keep CPUE
plus full length former survey series with all outlyers, plus 3N spanish survey
I1(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)+I7b (3L autumn survey, 1985-1986, 1990)+
I8 (3N spanish survey, 1995-2015)

ASPIC2016b plus 3LSpain: ASPIC 2016a standard plus 3L spanish survey
I1(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)+I7b (3L autumn survey, 1985-1986, 1990)+
I8a (3N spanish surveylong, 1995-2015)+I9 (3Lspanish survey, 2006-2015)

ASPIC2016c plus 3NSpainshort and 3LNSpain: ASPIC 2016a standard with 3N short spanish survey instead of 3N spanish full survey series
plus the combined 3LN spanish survey series
I1(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)+I7 (3L autumn survey, 1985-1986, 1990)+
I8b (3N spanish surveyshort, 1995-2005)+I10 (3LNspanish survey, 2006-2015)

Besides the correlation between ASPIC estimated and observed annual values for each data series, other criteria were used as diagnostics on the quality of the FIT runs with each of the three input frames considered. These criteria are thoroughly explained in previous assessments (Ávila de Melo *et al*, 2014).

The traffic light rating (from 0 a poor to 3 a good result of each diagnostic) presents two clear winners for best diagnostics (Table 6a), the approved 2014 assessment framework updated (**ASPIC2016$_a$** standard) and the same framework plus the 3L Spanish survey (**ASPIC2016$_b$** standard plus 3L Spanish survey). However, both end up with the same score, along with small biases when comparing key parameters from these two assessments with the ones from 2014 (1.5-1.7% bias, Table 6b), and very similar trajectories for relative biomass and fishing mortality (Fig's 6a and 6b).

Exploratory analysis went on just with the two input options giving better diagnostics on FIT, switching ASPIC7 to BOT mode. Main bootstrap results, summarized on Table 7, show very similar outputs, with a very high probability that the stock is at or above *Bmsy* under exploitation well below *Fmsy* (see the table results on bold). Nevertheless, looking to inter-quartile range, either as an absolute interval or relative to point estimate magnitude, all parameters showed narrower intervals for the bootstrap run with the input framework including the 3L Spanish survey (Table 7, two last columns on the far right). In other words, 50% variability width around point estimates shrinks if the assessment runs with the **ASPIC2016$_b$** input framework.

So, from the present exploratory analysis the better framework to run the redfish 3LN ASPIC 2016 assessment is the second candidate, **ASPIC2016$_b$**: with MSY fixed at 1960-1985 average catch and the rest of the approved 2014 assessment framework updated and engulfing the only ongoing survey so far outside the analysis, the 3L Spanish survey.

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 model results with the adopted framework for the 2016 assessment. 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 settings (either on the starting "region" used to initialize the minimization routine or on last year survey results). Eight input options, all of them considered in previous assessments, are presented on Table 8a and 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% *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 8b. 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). 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 position of the stock above B_{msy} (Table 8b, 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 higher last year surveys biomasses will press the stock downwards, closer to B_{msy} , in order to accommodate a faster rate of increase.
- A lower last year surveys biomasses will press 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 to zero mean and unit standard deviation) are plotted against the range of relative survey biomass for 2015.

Assessment results

ASPIC2016 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 ASPIC2016$_b$. Relative biomass and fishing mortality fit trajectories are plotted on Fig's 6a and 6b against 2014 and 2016a standard (2014 input framework) trajectories. These trajectories are also tabulated and plotted with their bias corrected 80% CL's on Table 9 and Fig's 9a and9b.

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 longer 3LN Canadian surveys (Appendix 2). With the exception of a worst unfit of the STATLANT CPUE index (previously justified in the *Input series* section), correlation in most input series continue to increase (from 2012 to 2014, and again to the 2016 assessment, see inserted columns right to R-squared in CPUE, on Appendix 2, with the 2012 and 2014 R's squares in brackets for comparison with the most recent ones). This is a remarkable feature in favour of the *fixed MSY* approach, taking into account not only that the assessment now incorporate all the "outliers" that have been forced to be strike out of previous input series, but include all ongoing surveys as well.

The assessment switched afterwards to bootstrap mode (1000 trials) to measure variability around parameter point estimates using bootstrap methods to calculate very high and high probability confidence limits here associated with 80% and 60% CL respectively. Estimates from bootstrap analysis are presented in Appendix 3. In each bootstrap trial and for each data series a set of observations is constructed by combining the predictions (from the original fit) with residuals randomly chosen from the original fit (more information at (Prager, 1994). Bias correction of an estimated parameter is based on the median of the sample distribution of the parameter estimates obtained after one bootstrap run with a prefixed number of bootstrap trials (Mainly, 1997). Being P the point estimate of a parameter and P_{m} the median value from that bootstrap distribution, then the bias corrected estimate P_{bc} of that parameter will be given as

$$P_{\mathrm{bc}} = P - (P_{\mathrm{m}} - P)$$

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 also unreliable. Therefore, the best available estimator of central tendency is the point estimate and being so, on the new ASPIC version 7.03 (Praguer, 2015), both estimated bias in point estimate ($P_{\mathrm{m}} - P$) and estimated relative bias have been removed from the bootstrap output summary table (Appendix 3) .

On the contrary, Prager kept the bias-corrected confidence limits in the new 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 limits shown on ASPIC BOT output (Appendix 3) are confidence intervals for the bias corrected point estimate and not for the point estimate, regardless the fact that the point estimate is also within those limits.

Bootstrap results confirm a stock at the beginning of 2016 with a very high probability to be at or above *Bmsy* and a fishing mortality in 2015 with a very high probability to be at or below 50% Fmsy (Appendix 3). Relative inter-quartile range tabulated on the two far right columns of this table with estimates from bootstrap analysis for the last two assessments (2014 in brackets) highlight the higher consistence of most of the 2016 assessment results when compared with the ones from 2014.

ASPIC assessment results suggest that the maximum observed sustainable yield (*MSY*) of 21 000 t can be a long term sustainable yield if fishing mortality stands at a level of 0.11/year. The correspondent B_{msy} for this stock is at the level of 190 000 t.

Catch versus surplus production trajectories are presented on Fig. 8. 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 well below to below surplus production levels since 1995.

ASPIC short term catch projection under the actual management strategy

Background for catch projection

The Risk-Based Management Strategy (MS) for 3LN Redfish adopted by the Fisheries Commission on the 36th Annual Meeting – September 2014 (Ávila de Melo *et al*., 2014; FC Working Paper 14/23), was designed to reach 18 100 t of annual catch by 2019-2020. It predicted a stepwise biannual catch increase, with the same amount of increase every two years, between 2015 and 2020 (18 100 t was the equilibrium yield in the 2014 given by the previous assessment, carried out under the assumption of an MSY of 21 000 t).

The present assessment evaluated the impact of the first year implementation of this new MS on the state of the stock and found 3LN redfish at the beginning of 2016 standing on its safe zone, with biomass at or above B_{msy} , after fishing mortality being kept well below F_{msy} during 2015.

A short term catch projection followed the assessment, in order quantify the likelihood of the stock sustain the approved 2016-2018 MS catches and arrive "still safe" to the beginning of 2019.

ASPIC projection framework

ASPICP, the ASPIC auxiliary program for projections, provided point estimates (with associated bias corrected 80% and 50% confidence limits) of biomass and fishing mortality for the assessment time interval,1959-2015, extended to the projection years, 2016-2018, under preset MS catch. ASPICP reads the results from the 1000 trials of the ASPIC $_{bot}$ 2016 assessment stored in a .bio file and project each of these runs three years ahead with the following 2016-2018 catch:

2016: 10 400 t
2017: 14 200 t
2018: 14 200 t

ASPICP read the specifications for this short term catch projection from a control file with a .ctl extension. This control file is presented and explained on Appendix 4. To run ASPICP the .ctl file was dragged and dropped to the available ASPICP shortcut. The 1959-2019 ASPICP results were stored in a .prj file and summarized on Table 9 and Fig. 9a and 9b.

Projection results

There is a very high probability that catch on 2016 at 10 400 t TAC and the approved increase on 2017 and 2018 will maintain biomass at the beginning of 2019 above B_{msy} while keeping fishing mortality till 2018 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. 10). The trajectory presented shows a stock within B_{msy} - 1.2 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). Fishing mortality dropped to well below F_{msy} in 1996, being kept at a low to very low level ever since. Biomass gradually approaches and surpasses B_{msy} several years after (2011-2012).

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 biomass corresponds to (roughly) 30% B_{msy}. The stock was at (or below) B_{lim} between 1993 and 2001.

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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	
2012	2781	1535	4316	6000	
2013	4446	1786	6232	6500	d
2014	4245	1450	5695	6500	d
2015	6037	2167	10467	10400	e
2016				10400	

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 2015.
e Provisional catch 2015 from year-to-date catches for December 2015 (NAFO Circ. Letter Ref. No.: GFS/16-067 Feb 2016)

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, 1990-2015.

Length	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
10													
11													
12	12												
13	6												
14	21												
15	28	28											
16	73	103	9									1	0.3
17	199	394	28			2				0.3	1	2	1
18	286	1034	412		5	2		0.01	1		1	1	1
19	445	2157	1291	5	6	3	1	0.3	2	16	4	4	3
20	720	3313	2375		16	14	4	2	13	47	6	18	14
21	1309	3780	2943	235	287	9		11	57	80	10	52	41
22	2081	**4922**	3600	714	683	65	6	17	**151**	150	26	102	81
23	3212	**7340**	**4358**	1141	594	64	17	34	**277**	128	46	118	101
24	**4164**	**7575**	**5552**	2565	708	99	9	64	**296**	120	85	114	132
25	**5216**	**6944**	**4981**	**5237**	**944**	100	9	**98**	**248**	178	**195**	114	154
26	**5560**	**5981**	**5145**	**5115**	**1297**	277	12	**118**	**221**	**318**	**364**	126	**204**
27	**5410**	**6197**	**4579**	**5433**	**1404**	**330**	35	**144**	**218**	**555**	**546**	**170**	**248**
28	**5217**	**5322**	**4063**	**5004**	**1182**	**300**	**75**	**114**	**173**	**712**	**943**	**188**	**289**
29	**4712**	**3354**	**4637**	**4437**	**1188**	**263**	**76**	**114**	**154**	**673**	**1003**	**179**	**289**
30	**4751**	**4043**	**3911**	**3283**	**1011**	**310**	**182**	**114**	**120**	**520**	**1027**	**236**	**294**
31	**4551**	2695	3711	**2964**	**912**	**313**	**197**	**154**	**129**	**413**	**564**	**289**	**295**
32	**3943**	2478	2187	2313	**944**	**309**	**98**	**146**	**119**	**434**	**315**	**303**	**276**
33	3082	1582	1355	2291	596	226	**67**	**131**	**110**	**383**	**237**	**298**	**216**
34	2737	1179	1569	1527	526	189	30	71	66	**268**	**217**	**218**	132
35	2100	928	1604	1059	363	182	35	24	19	141	129	**212**	83
36	1681	831	1895	923	202	106	23	19	18	89	60	121	37
37	1416	580	1571	766	196	160	7	14	11	82	78	82	18
38	1128	482	1303	807	158	171	5	10	8	51	50	55	11
39	729	363	1114	489	124	100	11	3	3	37	47	30	3
40	458	292	790	505	69	144	2	4	3	23	23	18	2
41	321	188	558	320	49	63	3	1	2	19	12	10	1
42	255	117	420	306	23	1	1	1	0	13	15	7	2
43	227	68	203	137	15	3	2	2	0	3	9	4	2
44	157	83	85	175	7	3	2	1	1	3	1	3	1
45	84	33	76	107	1	3	2	0.1			2	1	
46	58	8	32	9	3			0.1	0.02	0.2	1	1	
47	24		9	47	0.2						0.5	0.2	
48	11	2	8	5		3		0.1					
49	6		1		0.1								
50													
51	1	25			2								
52	2												
53	1												
54	2												
no ('000)	66410	74421	66375	47918	13517	3815	910	1411	2422	5457	6020	3076	2929
weight (tons)	29105	25815	27283	21308	5741	1989	451	630	899	2318	2617	1442	1216
mean weight (g)	438	347	411	445	425	521	496	446	371	425	435	469	415
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
length anomalies	1.70	-1.0	0.8	2.0	1.5	4.0	3.6	2.2	-0.2	2.3	2.5	3.2	1.9
%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%

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., 2005-2015)

Sebastes sp.	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
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
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

Table 3a (cont.): Length composition (absolute frequencies in '000s) of the 3LN redfish commercial catch and by-catch, 1990-2015.

Length	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
10						0.1			1	2	0.3		23
11	0.03					0.2	3	13	3	5	18	13	60
12	0.03					0.2	10	30	21	14	17	37	202
13	1					0.1	23	49	69	30	133	94	198
14	1			0.003		0.1	33	154	117	52	96	180	358
15	5			10		3	51	268	224	78	166	212	459
16	8			24		14	**362**	506	281	95	420	330	566
17	21	1	2	34		80	**670**	768	371	139	460	400	795
18	44	2	4	65	0.3	103	**747**	**935**	430	201	793	576	1321
19	90	6	9	99	43	96	**495**	**1383**	**766**	426	**1313**	907	2032
20	151	15	11	**182**	143	43	**357**	**1737**	**1253**	890	**2221**	1880	**3529**
21	**218**	28	13	**300**	77	**133**	**428**	**2284**	**1942**	**1564**	**3518**	2891	**5416**
22	**269**	35	11	**347**	149	**239**	**475**	**3084**	**2545**	**2235**	**4913**	3865	**8176**
23	**277**	41	16	**340**	212	**303**	**552**	**2188**	**1959**	**1778**	**3468**	3425	**8021**
24	**258**	54	35	**210**	170	**253**	**311**	**1183**	**1099**	**1231**	**2335**	2125	**4873**
25	**261**	85	61	**147**	**221**	**224**	268	831	593	992	**1605**	1510	**3485**
26	**309**	**157**	**138**	**111**	**206**	**138**	271	769	450	746	**1719**	1118	2558
27	**324**	**190**	**181**	99	**134**	81	193	584	371	670	1156	990	1534
28	**286**	**184**	**201**	88	**521**	32	194	580	462	646	1270	**1066**	1602
29	**245**	**184**	**223**	62	**425**	42	140	490	445	620	642	**916**	1477
30	**225**	**178**	**176**	60	**368**	44	96	416	434	714	691	**1159**	1757
31	**204**	**107**	**109**	35	**335**	31	64	296	608	691	864	**975**	1415
32	189	**108**	**91**	28	**594**	37	49	276	674	641	598	**862**	1207
33	196	95	83	19	**316**	58	40	242	535	681	517	673	843
34	149	73	71	17	**252**	83	37	215	223	392	304	438	539
35	112	51	63	10	124	62	11	208	170	265	141	345	511
36	62	36	56	5	110	39	13	137	85	157	167	222	315
37	41	17	31	2	4	31	2	70	46	101	70	123	153
38	22	10	15	1	2	12	1	69	54	105	48	122	91
39	14	9	8	0.014	23	9	2	32	19	40	16	57	25
40	7	5	8	0.320	22	1	0	17	17	33	5	48	29
41	2	2	4	0.003	0	1	0	7	10	20	6	26	33
42	3	1	2	0.003	0	0	0.567	3	5	11	4	10	4
43	2	2	6		0.5	3	0.019	0.1	5	7	4	2	4
44	2	1	3		0.1	0	0.233			2		1	3
45	0.1	1	1		0.1	1	0.3			1			
46	2	0.2	0.3				0.1			0.4			1
47	0.04	1	2										1
48			0.04										
49						1							
50												1	
51	0.3							0.03					
52													
53													
54	0.3												
no ('000)	3999	1681	1632	2295	4454	2199	5901	19825	16289	16274	29702	27598	53616
weight (tons)	1334	637	659	497	1664	597	1051	3948	3672	4316	6232	5695	10467
mean weight (g)	334	379	404	217	365	271	178	199	225	265	210	206	195
mean length	27.5	29.5	30.1	23.9	29.4	25.4	22.0	23.4	24.4	25.9	24.2	25.0	24.3
length anomalies	-0.1	1.8	2.5	-3.7	1.8	-2.2	-5.6	-4.3	-3.3	-1.7	-3.5	-2.7	-3.4
%lengths <20cm	4.2%	0.5%	0.9%	**10.1%**	1.0%	**13.5%**	**40.6%**	**20.7%**	**14.0%**	6.4%	**11.5%**	**10.0%**	**11.2%**

Table 3b (cont.): 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., 2005-2015)

Sebastes sp.	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
a	0.0095	0.0208	0.0208	0.0611	0.0207	0.0207	0.0207	0.0214	0.0214	0.0214	0.0360	0.0462	0.0116
b	3.1279	2.8851	2.8851	2.5597	2.8946	2.8946	2.8946	2.8659	2.8659	2.8659	2.6998	2.5880	3.0190

Table 4: Survey biomass ('000 t) from stratified bottom trawl surveys on Div. 3L and Div.3N included in the 2016 ASPIC framework, survey female SSB from spring and autumn Canadian surveys on Div. 3LN (1991-2015)

	Canadian				Russian				Spanish		
	Div. 3LN		Div. 3LN		Div. 3LN	Div. 3L	Div. 3L	Div. 3L	Div. 3N	Div. 3L	Div.3LN
	I2springcomb	I2springSSB	3autumncomb	I3autumnSSB	I4Powercomb	I5winter	I6summer	I7autumn	I8spring	I9summer	Spanishcomb
1978						311.2					
1979						227.8					
1980											
1981						261.4					
1982											
1983											
1984					215.9						
1985					94.0	277.7	161.0	98.2			
1986					63.0	36.6		17.1			
1987					70.3						
1988					44.9						
1989					12.3						
1990					8.4	18.2	92.8	20.7			
1991	10.6	1.5	37.9	4.7	18.7		37.6				
1992	10.1	1.8	*136.4*	15.4							
1993	22.6	4.3	19.2	3.6			20.8				
1994	4.2	0.6	31.8	5.9							
1995	5.9	0.8	90.7	15.9					46.1		
1996	22.8	11.6	16.0	2.6					6.6		
1997	14.9	1.8	70.7	10.7					4.8		
1998	59.4	11.5	112.2	14.5					22.5		
1999	61.5	15.2	72.0	12.6					46.5		
2000	87.8	17.3	100.5	16.6					68.9		
2001	41.6	7.0	132.6	13.8					53.9		
2002	31.0	5.8	50.1	9.4					7.6		
2003	27.7	3.7	71.9	9.6					11.0		
2004	79.6	26.2	49.9	11.4					27.0		
2005	66.5	8.8	58.6	11.2					146.9		
2006			91.9	12.9					87.8	70.1	157.9
2007	218.8	39.4	124.8	16.8					87.6	31.4	119.0
2008	144.0	23.4	198.5	27.4					68.1	75.6	143.6
2009	183.4	20.7	246.7	29.6					735.7	103.7	839.4
2010	165.3	21.5	461.5	55.5					359.5	266.8	626.3
2011	173.7	22.2	562.3	64.1					418.3	170.6	588.9
2012	322.0	45.5	596.0	89.7					265.2	481.5	746.7
2013	271.5	48.1	288.8	41.1					429.5	235.2	664.7
2014	271.7	38.3							178.1	216.4	394.5
2015	480.6	60.1	425.9	64.6					523.5	130.4	653.9

Table 5a: 3LN spring survey abundance at length, 1991-2015 (thousands).

Length	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
4													
5												62	
6						466		20	16	185	109	170	293
7						228		40	656	795	1511	472	2057
8						149	685	8	3280	378	1302	1073	1682
9	849					298	360	39	5877	89	483	1526	1524
10	1149			562		296	251	113	1343	166	240	2518	1197
11	798	381	122	355		478	730	533	309	403	116	1085	417
12	558	2988	1304	540		806	722	455	430	191	451	1645	1448
13	2524	7925	2396	500	108	920	540	172	517	412	345	838	1101
14	322	5192	5646	536	272	413	1871	561	369	353	1073	517	1278
15	699	2862	11059	1329	278	716	1859	896	175	2458	1738	766	2609
16	2250	382	13647	1790	966	846	1126	1506	774	2199	1681	1371	3559
17	3865	419	8796	3123	2847	1588	1201	2046	703	2157	3337	2580	6189
18	6226	1111	2719	3084	4285	4356	1860	2121	3455	3525	5257	6444	8643
19	7749	2480	2474	1403	5014	9476	3280	2849	2988	7017	8267	8161	15473
20	4522	2574	3839	829	2703	10910	4708	9472	5379	13198	9589	11326	21089
21	3482	3559	5754	922	1815	12119	6367	24848	16817	22002	14393	13958	23750
22	5148	1690	5301	783	1335	13844	7008	34265	31067	42769	15551	14932	19290
23	7253	1732	5708	1181	1257	16629	8191	31121	38232	53557	15590	15582	15120
24	6187	2721	4756	1498	1359	12502	10669	28376	45394	53956	14839	16034	10814
25	3366	2865	3398	1748	1004	8318	9469	21275	21482	34350	10166	12606	8036
26	1963	3250	3701	1564	1600	5649	7757	19512	30227	27846	10041	11224	6889
27	1426	2411	4478	1057	1693	5106	4047	16075	21654	21918	11330	8887	5102
28	953	1834	3283	803	1437	4901	2760	12716	15663	13775	10217	7496	3552
29	1038	1506	2876	731	1154	4264	1871	9632	14331	15612	10385	6419	2778
30	607	1048	2606	482	721	3323	1797	6120	6698	14650	9523	3741	2701
31	534	1014	2969	318	474	2231	1354	6513	5732	12804	10450	3588	2176
32	417	809	3087	244	548	1564	991	6157	4322	10277	8884	2235	2356
33	369	825	2621	138	264	762	640	5687	3259	6538	5183	1382	1972
34	399	540	2161	156	144	337	438	3287	2024	5043	3035	996	1009
35	251	544	1502	109	105	163	160	967	877	3301	990	455	640
36	190	366	880	135	113	105	77	660	534	895	296	227	227
37	222	216	696	127	151	118	42	402	273	709	378	93	82
38	159	219	669	82	101	28	88	82	102	396	116	43	35
39	130	300	726	31	70	55	4	82	67	186	155	59	35
40	118	220	483	46	62	28	0	216	79	183	23		94
41	45	77	371	0	15	15	0	15	51	16		15	
42	88	85	215	9	46	4	0	20	66	47	63	15	
43	69	85	83	49	27	35	15	201	0	31	28		15
44	45	77	189	29	31		31	12	27	31	28		
45	57	62				15	15	15		31	15		
46		46	51			15	46		31				
47		4	20		15		15						
48	11	31	31										
49		31											
50													
51													
52													
53													
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
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
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

Table 5a (cont.): 3LN spring survey abundance at length, 1991-2015 (thousands).

Length	2004	2005	2006[1]	2007	2008	2009	2010	2011	2012	2013	2014	2015
4		40									25	
5	31				416	46	258			146	183	
6	804	108		154	1966	479	137	559	41	695	1350	946
7	2400	540		3452	2942	974	562	781	1055	1772	968	8495
8	1236	950		9327	3135	954	936	858	1039	1106	826	5173
9	2209	2891		2625	3381	371	1361	1073	1596	1791	1039	673
10	4107	4892		886	4258	994	2423	1342	1921	1896	1266	249
11	2911	7296		1683	5317	1695	2902	2464	2178	2225	1377	812
12	1653	8756		2296	2432	3642	2871	1701	2852	1761	1610	1127
13	1330	9684		1908	1286	16098	2256	2458	2581	2303	1708	614
14	639	7710		1928	5396	12659	4892	3568	3658	1807	1527	333
15	1235	7437		3631	3841	11260	8481	4481	5998	4327	1149	285
16	1335	7357		5993	15866	75231	14345	8907	9617	2467	1438	928
17	2764	8647		14186	45719	197691	26140	17787	52512	3940	4388	125
18	3668	16472		24586	77478	325440	108928	56811	96670	12330	9410	13442
19	8995	31506		26943	50553	310284	219289	115709	194730	20116	63952	81532
20	11905	33702		26003	48021	164370	234599	144823	289679	103824	187959	388738
21	16956	33182		43665	49072	92564	178663	221969	398075	210629	323755	672239
22	16584	30967		68143	78864	60965	74436	128066	315995	237958	340216	734832
23	20423	30644		87375	88837	65881	72484	85379	190758	182210	246336	479788
24	17004	28561		96975	87288	76912	66508	62237	140353	147932	176273	291258
25	14657	24305		78847	61337	55777	61001	46547	94274	114790	78067	107567
26	24397	18438		90996	54230	30388	38296	44947	63492	62515	62684	41933
27	38936	20027		81118	34946	17043	18645	37756	45182	45089	33608	24506
28	43216	15249		36969	28227	14167	18908	32300	32808	40858	24604	23673
29	24426	11907		38023	19445	13076	11302	24988	33669	28454	15455	15087
30	18145	8832		30266	12314	8659	10701	16753	26246	25858	11811	23284
31	13713	5769		30137	10571	6011	4704	10141	18307	15530	9541	17648
32	9706	3036		21974	7018	4096	4110	8774	14817	14990	7287	16682
33	3487	2012		9163	7747	3448	2908	4925	5029	9922	4668	13284
34	5391	1617		8158	4329	2327	2565	2999	4685	9065	4326	11634
35	2249	832		7223	1860	1609	1804	1662	1757	10028	3835	6786
36	476	592		9422	1361	839	1035	1367	1276	5801	3451	4792
37	877	222		1894	786	312	394	788	958	3558	1381	1913
38	75	112		1945	386	235	197	848	548	1831	770	1486
39	43	86		193	325	90	31	224	897	1406	206	657
40	23	12		115	189	55	54	71	167	1275	174	199
41	4	15		59		28		119	81	865	11	81
42	15	8		24	53	50			15	1637	1256	29
43	15			8			76		48	463		552
44		15		23	60				97	12		12
45	8									417		
46					34					401		
47												
48						15						
49										401		
50												
51												
52										445		
53										401		
abundance (millions)	318.1	384.4		868.3	821.3	1576.7	1199.2	1096.3	2055.7	1337.3	1629.9	2993.4
mean length (cm)	25.7	22.2		25.1	22.9	20.3	21.6	22.6	22.5	24.1	23.1	22.8
length anomalies (cm)	2.6	-0.9		2.0	-0.3	-2.8	-1.5	-0.5	-0.7	1.0	0.0	-0.3

(1) Survey data only from Division 3L, no survey on Div. 3N

Table 5b: 3LN autumn survey abundance at length, 1991-2015 (thousands).

Length	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
4													
5				15	240	56	86	17		117	445	232	1090
6					256	359	330	0	251	481	937	915	2427
7	203				138	88	395	39	50	673	755	873	2185
8	1298				111	72	386	47	37	602	2114	1614	2714
9	1236				241	146	468	252	421	620	3146	1275	2095
10	7263		93	31	292	250	306	214	171	388	4323	1129	2855
11	22235	371	63	31	213	349	249	203	402	215	2846	2840	1839
12	62419	62	372		241	106	175	275	786	202	1266	2255	1123
13	109337	3189	457	335	304	274	366	596	868	320	1056	2072	1488
14	33876	27936	1775	551	513	1419	728	912	2472	587	445	2545	1451
15	14030	104298	1333	2362	967	722	1104	1768	1548	3635	407	1884	1929
16	7809	113966	3259	3697	1611	919	1405	4159	717	4671	11018	2159	8240
17	7860	106448	5283	12985	9645	825	1848	8155	1144	5480	31421	4694	15193
18	16191	95896	8707	28684	37932	2227	2095	12225	3185	7035	57695	9082	25813
19	32214	71577	6425	29295	72192	5062	8438	17373	6536	11926	74228	13661	38672
20	27189	113846	3906	15292	78316	6479	21672	46005	9068	31680	80538	12568	45262
21	15810	148628	5306	7701	43397	6621	47562	88726	15347	50184	65575	16481	42849
22	7915	153395	6375	5119	27652	6123	52500	124662	23121	66781	130029	20168	39683
23	6139	89704	6578	6494	20117	6743	44777	92991	29000	60123	118427	23529	39374
24	8377	28658	5164	5456	10296	4864	31865	56410	26969	52986	85149	25353	31785
25	8943	14222	3947	6808	12898	4429	24356	30123	29819	50534	64519	21326	21398
26	6602	13410	4120	8670	8517	4370	21375	23090	27515	40188	39693	19872	18032
27	4022	14699	4361	7830	17364	2890	21141	20596	25585	21851	33743	16470	17605
28	3776	8768	4240	8402	17495	2707	14031	18336	24801	17424	20396	10503	13962
29	2526	4855	3503	7625	16330	2678	8032	13397	16323	16387	14957	7230	7798
30	2110	3340	2765	6195	12717	2242	6138	7942	11346	12127	11093	5122	4910
31	1960	3229	1949	4553	16297	3409	4994	6250	7641	10199	9147	5109	3755
32	1314	2389	1901	2709	10628	2210	4035	5730	6315	7165	5261	4608	3523
33	1212	3299	1671	1603	7262	1220	2107	3878	5642	5026	4354	3862	3360
34	1117	1431	1286	916	3447	559	1673	4512	4545	3369	2776	2701	2182
35	1287	716	1044	610	1966	217	653	2048	3256	1303	1679	1451	1175
36	1184	595	800	297	1171	118	499	1080	1539	1092	675	560	506
37	1005	385	460	211	335	64	308	426	339	499	636	325	182
38	1166	401	427	257	398	14	243	247	184	329	282	85	111
39	787	228	308	274	572	22	176	85	272	227	215	67	115
40	662	93	237	119	75	22	164	17	67	151	180	136	
41	221	124	155	0	20	22	191	40	82	67	81		
42	135	77	132	15	24		45			67		17	
43	102	31	37	32	32			35	50		4	21	
44	128	46	99			42		17	50	4		17	
45	46	15	69	15	36	28		17	50	76		17	
46	24	46			12	14				18	17		
47	15	15	15	8		12			17				
48									17				
49		15											
50	15												
51													
52													
53													
abundance (millions)	422	1130	89	175	432	71	327	593	288	487	882	245	407
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
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

Table 5b (cont.): 3LN autumn survey abundance at length, 1991-2015 (thousands).

Length	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014(1)	2015
4												
5	34		84	234	31	96	1384	57	263	417		712
6	85	133	1418	512	641	624	1110	318	1405	4539		2832
7	61	162	1831	2222	2359	318	1405	727	926	2902		35136
8	620	908	466	2914	2745	871	3377	878	2332	4879		86942
9	1280	2236	829	8313	2359	3452	3788	2878	6976	5697		33864
10	1719	1574	1458	8498	4100	9932	4676	2265	9925	5439		5654
11	1046	3957	1709	7527	5543	5206	6612	1841	8539	8460		2409
12	1131	9942	3083	6352	4861	4025	7947	1925	6516	12917		1685
13	1436	11090	3970	5871	27297	9473	10315	3250	5463	12133		1763
14	1015	10309	8256	9046	28768	20311	11133	4187	6377	15089		2479
15	538	8461	13286	21881	23691	17750	8561	8268	5234	28083		3107
16	879	6083	20912	40243	116528	35720	12943	14606	3150	12974		3043
17	1984	5713	27177	51164	228751	138765	18474	46427	9778	15860		4208
18	5468	7248	23009	43358	221311	396982	77810	103647	24081	34943		4920
19	8222	10928	24342	35091	141084	421539	269160	432556	116751	92467		28086
20	9790	15982	26793	45870	78263	279787	459453	996936	315398	109915		96233
21	13134	25645	36447	55971	63995	138841	499979	1198226	664907	283174		285478
22	13632	23899	49628	61550	55482	67350	303473	587045	653151	454374		521322
23	16732	29785	71774	84212	89011	53177	261470	300782	501477	309498		455999
24	15458	20362	67361	81986	80398	65248	260734	126712	314858	193667		350489
25	13066	15824	34947	57418	66252	46806	165444	97731	203720	122411		221208
26	10432	12713	32335	39981	49866	39922	120859	82802	152183	64144		115600
27	9397	10857	19109	26128	48823	34957	95155	49339	135137	32163		95100
28	12135	12471	11651	19087	37469	24861	72543	35075	76038	23430		62113
29	13950	12659	10147	13206	21724	24372	38007	30904	67575	16618		44305
30	12267	9865	7475	7643	18374	14245	26788	35523	46137	14071		31552
31	9066	7347	9531	6404	11854	10895	15934	17230	29841	8793		35300
32	6787	5214	7469	4180	6793	7953	14869	11668	28059	8562		5061
33	4636	4905	4870	3623	6389	6675	9280	4838	18841	5790		8421
34	2959	3942	2096	2183	5268	3627	5875	2164	7507	2538		3360
35	1760	2720	1118	1067	2385	2538	1885	1869	4530	2229		1893
36	1259	1456	537	416	970	2183	2310	1332	2698	1220		1439
37	765	1298	444	847	784	1772	1299	817	5530	653		698
38	392	385	136	275	654	700	1374	138	5691	208		323
39	666	228	55	40		300	372	136	1938	257		479
40	308	60	116	17	391	250	389		954	375		63
41	76	85	61	103		129	208		1509			62
42	232	60			263	505	195		630			
43	99					92		45	571			
44									525			274
45				63	131	46	83		355			
46			16						216			
47									355			
48					62				77			
49									77			
50									77			
51												
52							1022					
53									77			
abundance (millions)	195	297	526	755	1456	1892	2797.7	4205.1	3448.4	1910.9		2553.6
mean length (cm)	25.4	23.0	22.8	21.9	20.8	20.6	22.7	21.8	23.4	22.6		23.0
length anomalies (cm)	2.7	0.2	0.1	-0.8	-1.9	-2.1	-0.1	-0.9	0.7	-0.2		0.2

(1) Survey data only from Division 3L, no survey on Div. 3N

Table 6a: A traffic light rating of diagnostics of 3 alternate frameworks of ASPICfit 2016 assessment.

		ASPIC2016a	rate	ASPIC2016b	rate	ASPIC2016c	rate
R squared in CPUE	I1	-0.31	1	-0.33	0	-0.03	2
	I2	0.60	1	0.62	2	0.46	0
	I3	0.66	1	0.67	2	0.54	0
	I4	0.27	2	0.27	2	0.23	0
	I5	0.42	2	0.42	2	0.40	0
	I6	0.75	1	0.76	2	0.68	0
	I7	0.25	2	0.25	2	0.23	0
	I8a	0.25	1	0.26	2		
	I8b					0.083	
	I9			0.157			
	I10					-0.312	
N restarts		31	2	36	1	119	0
contrast index (ideal = 1.0)		0.66	1	0.65	0	0.68	2
nearness index (ideal = 1.0)		1.00		1.00		1.00	
Total obj. function		53.06	1	56.43	0	48.28	2
B1/K (ideal = 0.5)		0.69	1	0.69	1	0.63	2
rate			**16**		**16**		**8**

(green)	good result	2
(yellow)	intermediate result	1
(red)	poor result	0

Table 6b: Key parameters of posible frameworks for ASPICfit 2016 assessment versus ASPICfit 2014 assessment:
How close is the 2016 assessment to Reference Points and state of stock given by previous assessment?

	MSY(1)	*B1/K*	*Fmsy*	*Flastyear/Fmsy*	*Ye(2)*	*Bmsy*	*B(3)/Bmsy*
ASPIC2016a	*21000*	0.6868	0.1113	0.3570	17380	188700	1.4150
ASPIC2016b	*21000*	0.6874	0.1116	0.3640	17820	188200	1.3890
ASPIC2016c	*21000*	0.6301	0.1016	0.3282	15100	206700	1.5300
ASPIC2014	*21000*	0.6764	0.1097	0.2136	18120	191500	1.3710

(1) fixed at the starting guess
(2) available in 2014 for ASPIC2014, available in 2016 for ASPIC 2016abc
(3) at the beginning of 2014 for ASPIC2014, at the beginning of 2016 for ASPIC 2016abc

Table 7: ASPIC2016a standard versus ASPIC 2016b plus 3LSpain: compairision of main results from bootstsrapp analysis

Param. name	ASPIC assessment	Point estimate	Bias-corrected approximate confidence limits 80% lower	80% upper	60% lower	60% upper	Inter-quartile range	Relative IQ range
B1/K	2016a standard	0.6868	0.5630	1.1080	0.5931	0.8971	0.230	0.334
	2016b plus3LSpain	0.6874	0.5616	0.9718	0.5883	0.8164	0.1761	0.2560
MSY	2016a standard	21000	NA	NA	NA	NA		
	2016b plus3LSpain	21000	NA	NA	NA	NA		
Ye Last year+1	2016a standard	17380	12660	20820	13860	20400	5486	0.3160
	2016b plus3LSpain	17820	13550	20890	15060	20510	4678	0.2630
Bmsy	2016a standard	188700	166800	230300	171900	215500	34290	0.1820
	2016b plus3LSpain	188200	168900	228700	174600	215000	32430	0.1720
Fmsy	2016a standard	0.1113	0.0912	0.1259	0.0975	0.1222	0.0197	0.1770
	2016b plus3LSpain	0.1116	0.0918	0.1244	0.0977	0.1202	0.0183	0.1640
B Last year+1/Bmsy	2016a standard	1.4150	**1.0100**	1.6330	**1.1410**	1.5850	0.3561	0.2520
	2016b plus3LSpain	1.3890	**0.9991**	1.5950	**1.1370**	1.5320	0.3289	0.2370
F Last year/Fmsy	2016a standard	0.3570	0.3064	**0.5059**	0.3165	**0.4467**	0.1014	0.2840
	2016b plus3LSpain	0.3640	0.3142	**0.5087**	0.3279	**0.4467**	0.0977	0.2680
Yield Last year+1/MSY	2016a standard	0.8278	0.6029	0.9912	0.6599	0.9716	0.2613	0.3160
	2016b plus3LSpain	0.8485	0.6455	0.9949	0.7170	0.9765	0.2228	0.2626

Table8a: Different random seed, seeds for key parameters and last year survey biomasses used on ASPICfit 2016 sensitivity analysis (differences in bold for each input set)

	Standard	-25%seed	+25%seed	25% Pessimistic	25% Optimistic	Last year-25%survB	Last year-10%survB	Last year+10%survB	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**	**6.2500E+05**	500000	500000	500000	500000
qcpue	9.0070E-06	9.0070E-06	9.0070E-06	**1.1259E-05**	**6.7553E-06**	9.01E-06	9.01E-06	9.01E-06	9.01E-06
q3LNspring	1.0000E+00	1.0000E+00	1.0000E+00	**1.2500E+00**	**7.5000E-01**	6.5800E-01	6.5800E-01	6.5800E-01	6.5800E-01
q3LNautumn	1.0000E+00	1.0000E+00	1.0000E+00	**1.2500E+00**	**7.5000E-01**	7.5900E-01	7.5900E-01	7.5900E-01	7.5900E-01
q3LNRussia	1.0000E+00	1.0000E+00	1.0000E+00	**1.2500E+00**	**7.5000E-01**	6.5800E-01	6.5800E-01	6.5800E-01	6.5800E-01
q3Lwinter	3.2200E-01	3.2200E-01	3.2200E-01	**4.0250E-01**	**2.4150E-01**	3.2200E-01	3.2200E-01	3.2200E-01	3.2200E-01
q3Lsummer	2.7500E-01	2.7500E-01	2.7500E-01	**3.4375E-01**	**2.0625E-01**	2.7500E-01	2.7500E-01	2.7500E-01	2.7500E-01
q3Lautumn	2.7500E-01	2.7500E-01	2.7500E-01	**3.4375E-01**	**2.0625E-01**	2.7500E-01	2.7500E-01	2.7500E-01	2.7500E-01
q3NSpain	7.5900E-01	7.5900E-01	7.5900E-01	**9.4875E-01**	**5.6925E-01**	7.5900E-01	7.5900E-01	7.5900E-01	7.5900E-01
q3LSpain	2.7500E-01	2.7500E-01	2.7500E-01	**3.4375E-01**	**2.0625E-01**	7.5900E-01	7.5900E-01	7.5900E-01	7.5900E-01
Random seed	3941285	**2955964**	**4926606**	3941285	3941285	3941285	3941285	3941285	3941285
3LNspring2015	4.805571E+05	4.805571E+05	4.805571E+05	4.805571E+05	4.805571E+05	**3.604178E+05**	**4.325014E+05**	**5.286128E+05**	**6.006964E+05**
3LNautumn2015	4.258580E+05	4.258580E+05	4.258580E+05	4.258580E+05	4.258580E+05	**3.193935E+05**	**3.832722E+05**	**4.684438E+05**	**5.323225E+05**
3Nspain2015	5.234608E+05	5.234608E+05	5.234608E+05	5.234608E+05	5.234608E+05	**3.925956E+05**	**4.711147E+05**	**5.758069E+05**	**6.543260E+05**
3Lspain2015	1.304180E+05	1.304180E+05	1.304180E+05	1.304180E+05	1.304180E+05	**9.781350E+04**	**1.173762E+05**	**1.434598E+05**	**1.630225E+05**

Table 8b: Compairision of main results from sensitivity analysis of ASPICfit 2016

	Standard	-25%seed	+25%seed	25% Pessimistic	25% Optimistic	Last year-25%survB	Last year-10%survB	Last year+10%survB	Last year+25%survB
K	376500	376500	376500	376500	376500	378600	377300	375700	374600
B1/K	0.6874	0.6874	0.6873	0.6873	0.6873	0.6831	0.6857	0.6891	0.6917
Bmsy	188200	188200	188200	188200	188300	189300	188600	187900	187300
Fmsy	0.1116	0.1116	0.1116	0.1116	0.1116	0.1109	0.1113	0.1118	0.1121
B2016/Bmsy	1.3890	1.3900	1.3890	1.3890	1.3890	1.4100	1.3970	1.3820	1.3740
F2015/Fmsy	0.3640	0.3639	0.3640	0.3640	0.3641	0.3583	0.3619	0.3659	0.3684
Ye2016	17820	17810	17820	17820	17820	17470	17690	17930	18070

Table 9: B/Bmsy and F/Fmsy point estimates and bias corrected trajectories from ASPICP 2016. 2016-2018 biomass projection under 2014 red 3LN MS for 2016-2018.

	Relative biomass trajectory and 2016-2019 projection under red 3LN MS			Relative F trajectory and 2016-2018 projection under red 3LN MS		
Year	Point estimate	Approx 80% lower CL	Approx 80% upper CL	Point estimate	Approx 80% lower CL	Approx 80% upper CL
1959	1.375	1.123	1.943	1.628	1.164	1.972
1960	1.239	1.022	1.719	1.036	0.757	1.247
1961	1.204	0.998	1.629	0.923	0.689	1.106
1962	1.188	0.993	1.575	0.862	0.657	1.029
1963	1.182	0.991	1.535	1.120	0.869	1.334
1964	1.145	0.963	1.466	0.417	0.329	0.495
1965	1.199	1.005	1.498	0.939	0.756	1.112
1966	1.182	0.999	1.458	0.679	0.555	0.802
1967	1.199	1.012	1.454	1.097	0.908	1.290
1968	1.163	0.990	1.397	0.719	0.602	0.843
1969	1.177	1.005	1.397	1.011	0.856	1.183
1970	1.154	0.988	1.357	0.587	0.502	0.685
1971	1.186	1.017	1.379	1.426	1.230	1.658
1972	1.112	0.958	1.286	1.264	1.095	1.466
1973	1.069	0.923	1.231	1.531	1.332	1.773
1974	1.004	0.866	1.152	1.061	0.925	1.230
1975	0.997	0.859	1.142	0.846	0.740	0.984
1976	1.014	0.871	1.158	0.963	0.844	1.121
1977	1.016	0.871	1.158	0.765	0.673	0.893
1978	1.040	0.889	1.181	0.539	0.475	0.630
1979	1.087	0.930	1.230	0.606	0.537	0.709
1980	1.123	0.960	1.263	0.673	0.600	0.786
1981	1.147	0.982	1.283	1.017	0.912	1.186
1982	1.127	0.968	1.255	0.912	0.821	1.062
1983	1.123	0.965	1.244	0.836	0.756	0.972
1984	1.128	0.971	1.244	0.615	0.559	0.714
1985	1.158	0.998	1.272	0.845	0.771	0.980
1986	1.158	1.000	1.266	1.858	1.704	2.145
1987	1.041	0.901	1.132	4.307	3.983	4.933
1988	0.730	0.642	0.786	4.020	3.749	4.554
1989	0.543	0.483	0.582	3.249	3.034	3.655
1990	0.447	0.398	0.479	3.430	3.196	3.863
1991	0.364	0.324	0.392	3.789	3.517	4.271
1992	0.288	0.254	0.311	5.533	5.065	6.273
1993	0.189	0.166	0.212	7.090	5.941	8.200
1994	0.106	0.087	0.133	2.712	2.065	3.407
1995	0.096	0.074	0.131	0.931	0.673	1.235
1996	0.107	0.079	0.150	0.182	0.129	0.247
1997	0.130	0.095	0.182	0.211	0.148	0.287
1998	0.156	0.113	0.221	0.251	0.176	0.348
1999	0.186	0.133	0.263	0.553	0.388	0.788
2000	0.214	0.148	0.308	0.657	0.450	0.962
2001	0.242	0.163	0.357	0.261	0.177	0.389
2002	0.285	0.189	0.418	0.186	0.127	0.282
2003	0.337	0.219	0.494	0.173	0.119	0.270
2004	0.397	0.253	0.576	0.070	0.049	0.110
2005	0.469	0.299	0.676	0.062	0.043	0.097
2006	0.550	0.350	0.779	0.040	0.028	0.062
2007	0.641	0.412	0.893	0.116	0.084	0.180
2008	0.732	0.468	0.994	0.036	0.027	0.057
2009	0.836	0.534	1.110	0.056	0.043	0.088
2010	0.940	0.610	1.219	0.199	0.156	0.305
2011	1.030	0.675	1.308	0.163	0.129	0.246
2012	1.121	0.745	1.396	0.177	0.143	0.261
2013	1.206	0.823	1.472	0.239	0.198	0.348
2014	1.278	0.886	1.526	0.206	0.175	0.295
2015	1.349	0.948	1.576	0.364	0.314	0.509
2016	1.389	0.999	1.595	0.352	0.309	0.483
2017	1.427	1.048	1.613	0.471	0.420	0.636
2018	1.442	1.079	1.607	0.467	0.422	0.618
2019	1.456	1.114	1.602			

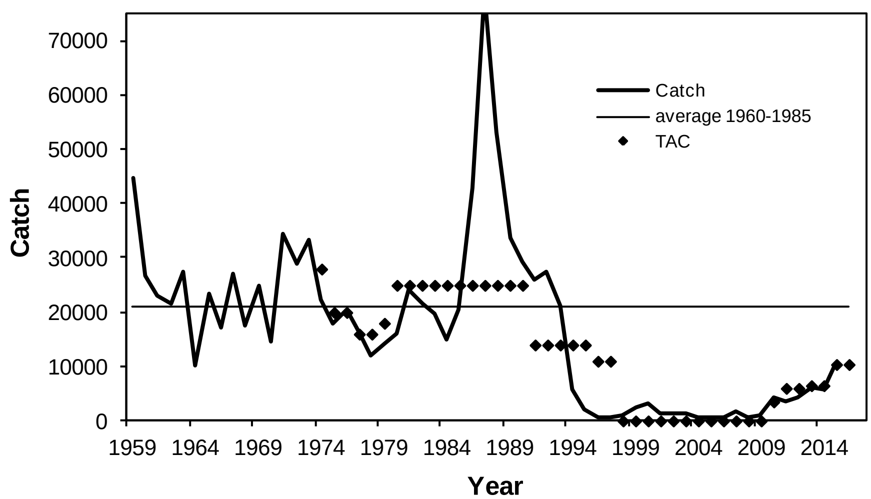

Fig. 1: redfish catch and TAC's in Div. 3LN

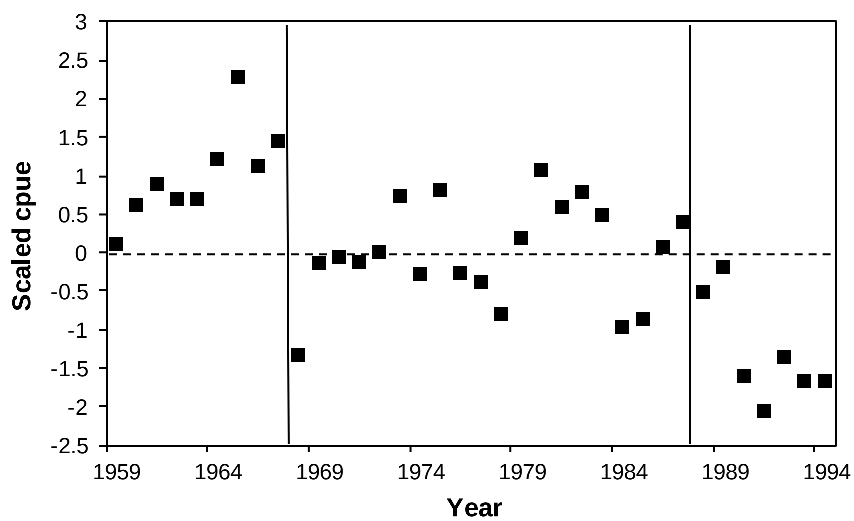

Fig. 2: Redfish Div. 3LN cpue 1959-1994

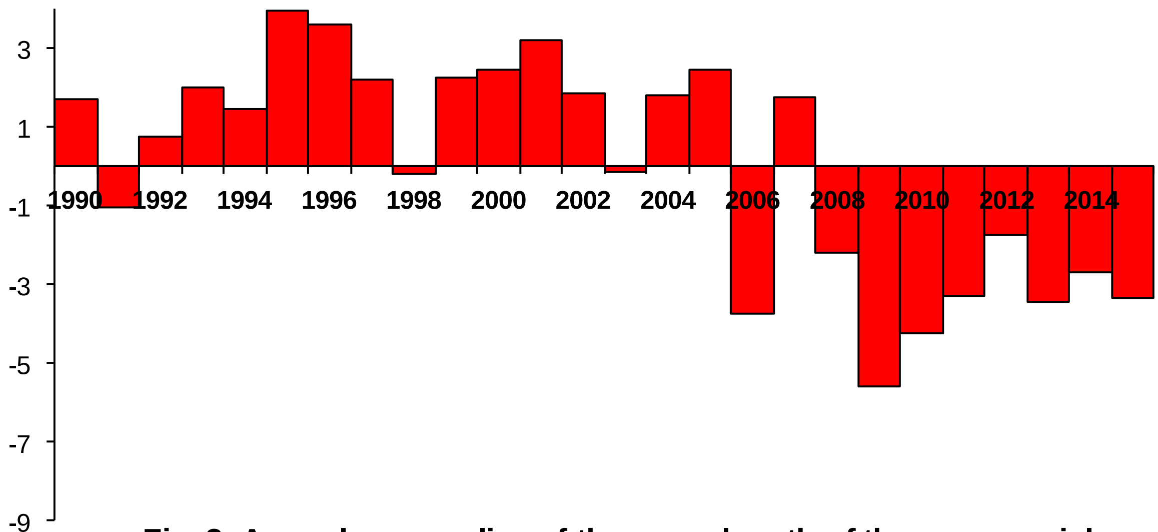

Fig. 3: Annual annomalies of the mean length of the commercial catch, 1990-2015

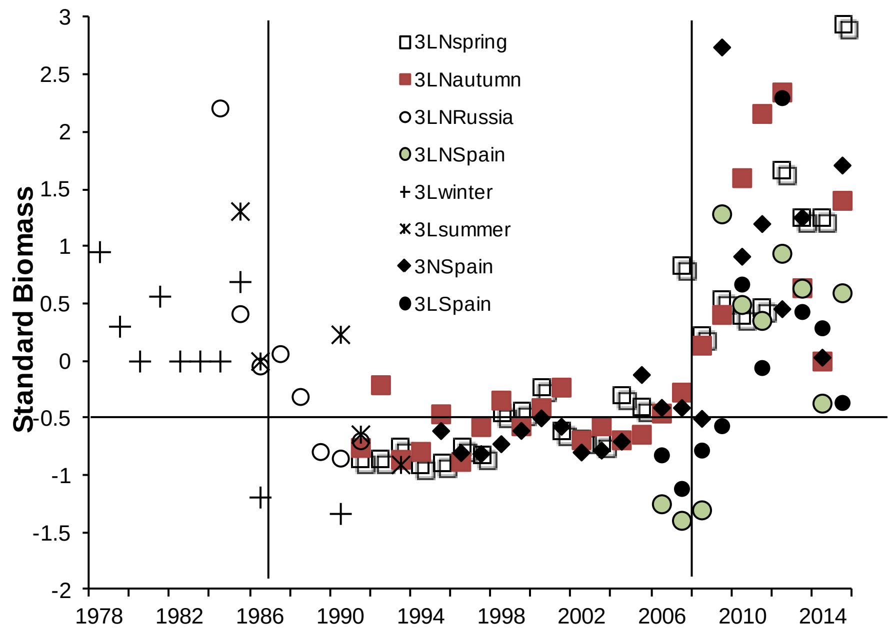

Fig. 4a: Standardized biomass from bottom trawl surveys included in ASPIC framework, 1978-2015

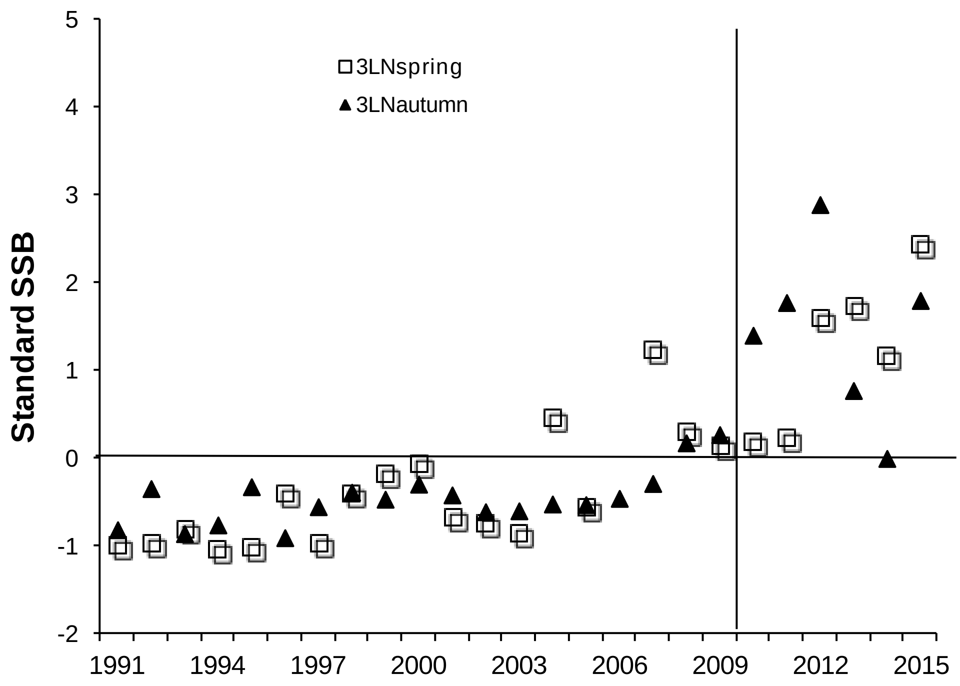

Fig. 4b: Standardized survey female SSB from spring and autumn Canadian surveys on Div. 3LN, 1991-2015

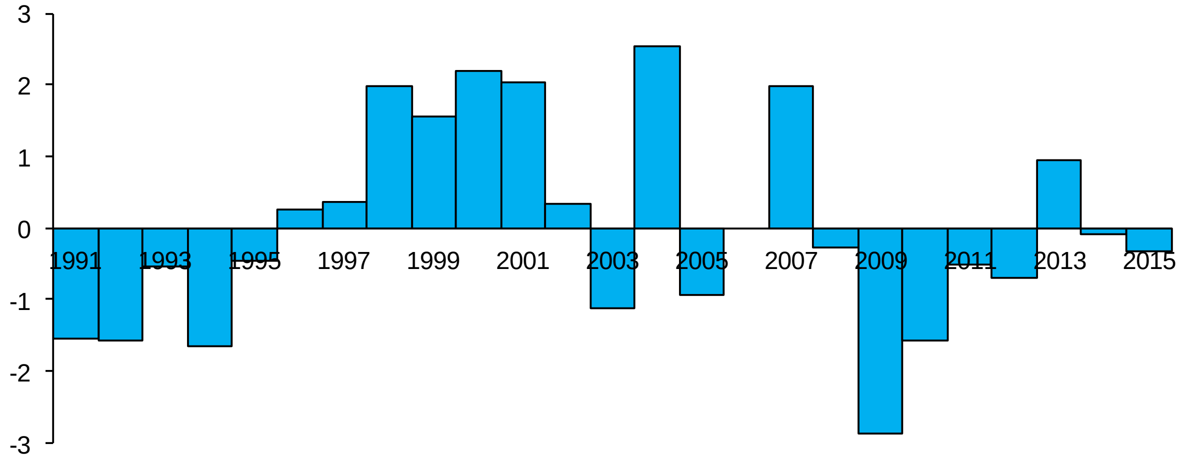

Fig. 5a: Annual annomalies of the mean length on the 3LN spring survey stock, 1991-2015

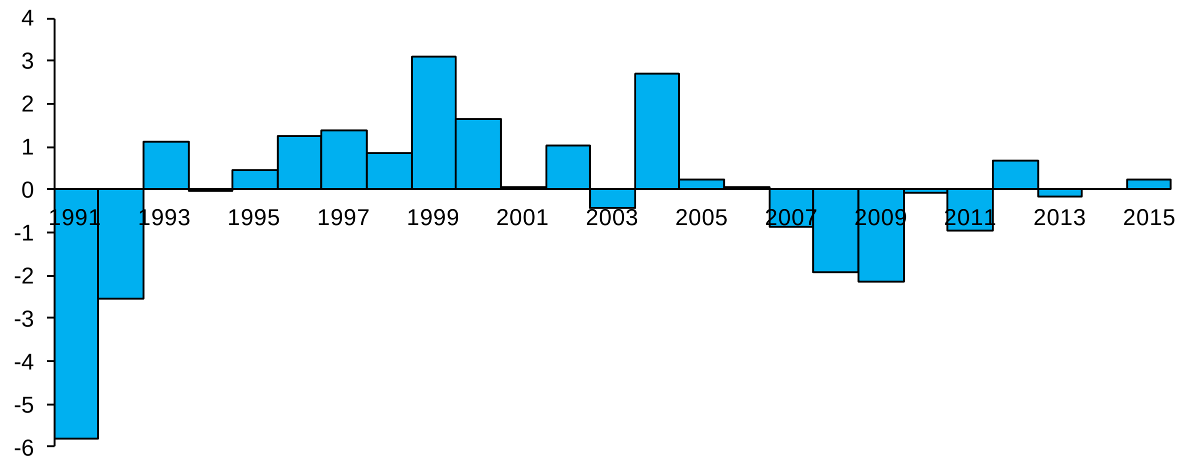

Fig. 5b: Annual annomalies of the mean length on the atumn survey stock, 1991-2015

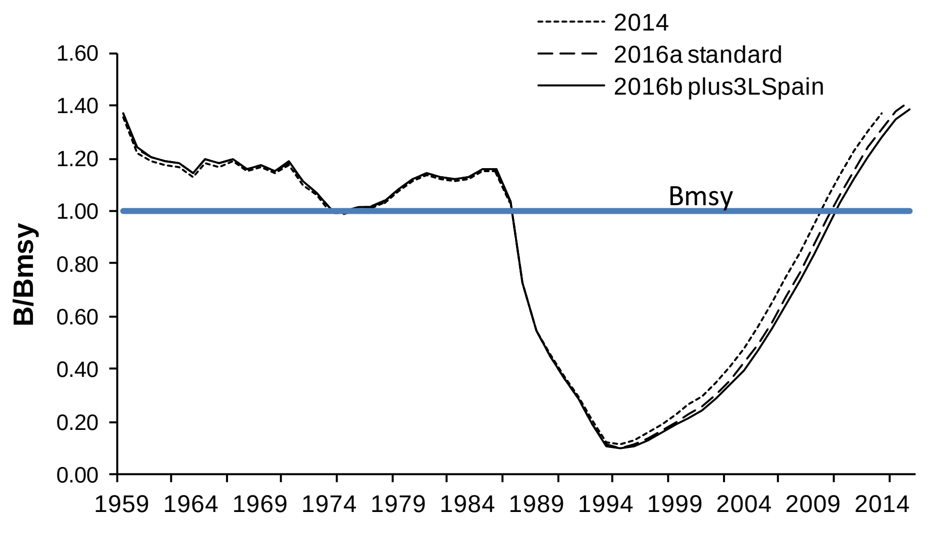

Fig 6a: B/Bmsy from 2014 *versus* 2016a and 2016b ASPICfit

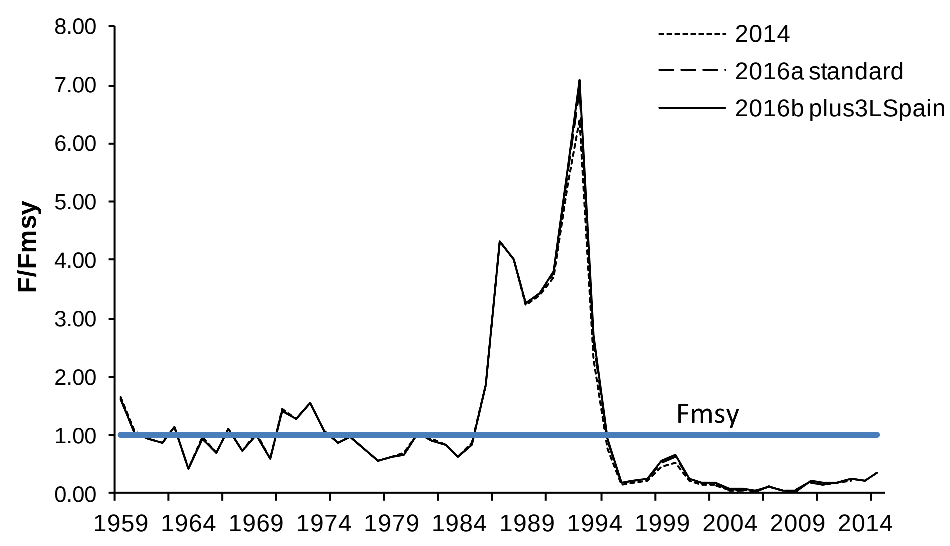

Fig. 6b: F/Fmsy from 2014 versus 2016a and 2016b ASPICfit

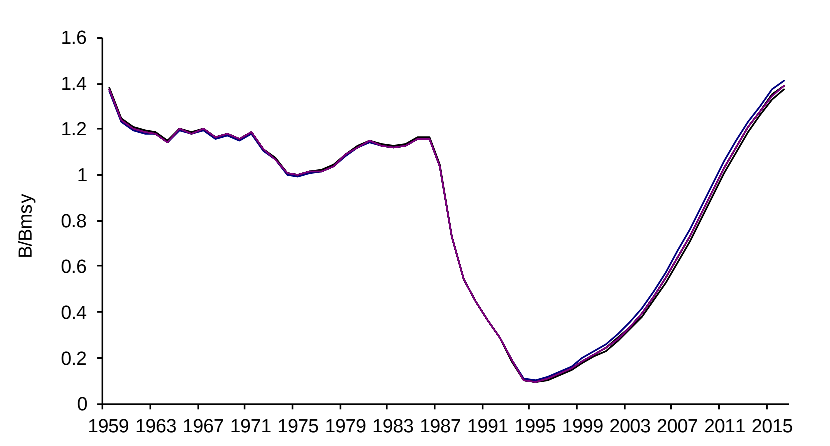

Fig. 7a: Impact of different sets of initial parameters and random seeds on ASPIC$_{fit}$ 2016 B/Bmsy trajectory

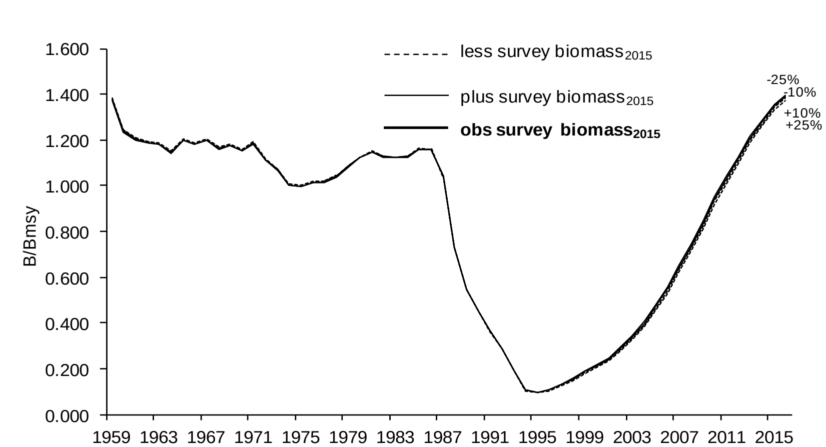

Fig. 7b: Impact of last year Canadian and Spanish survey results on ASPIC$_{fit}$ 2016 B/Bmsy trajectory

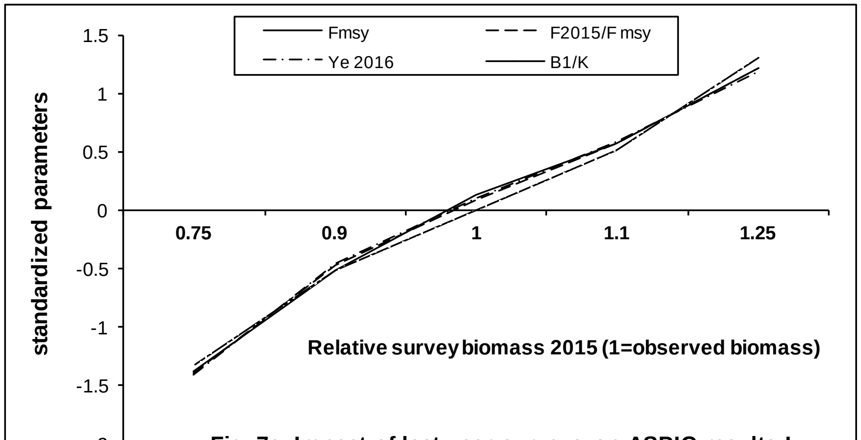

Fig. 7c: Impact of last year surveys on ASPIC results I (positive dependent parameters)

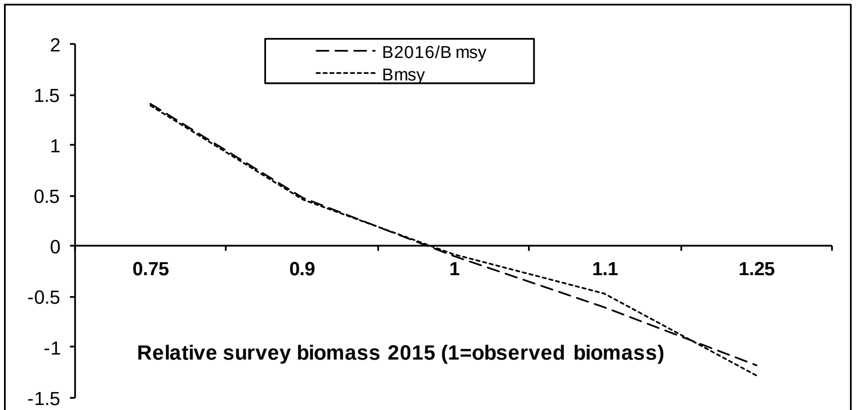

Fig. 7d: Impact of last year surveys on ASPIC results II (negative dependent parameters)

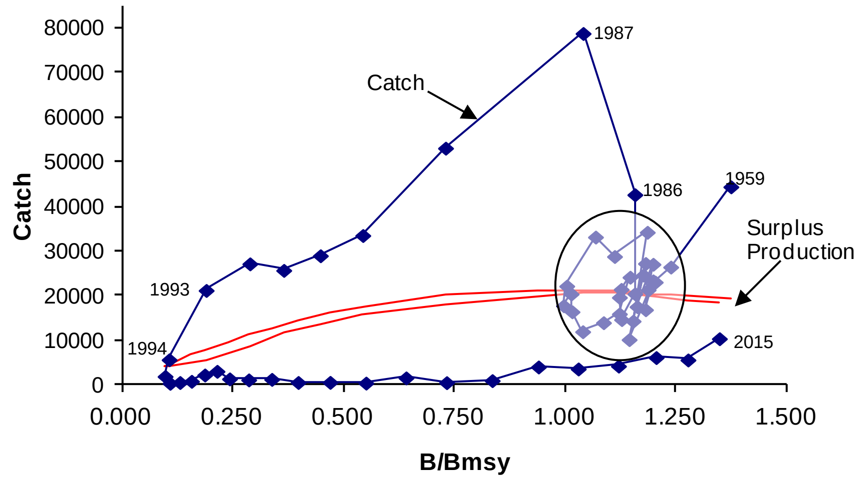

Fig. 8 : Catch versus Surplus Production from ASPIC$_{fit}$ 2016

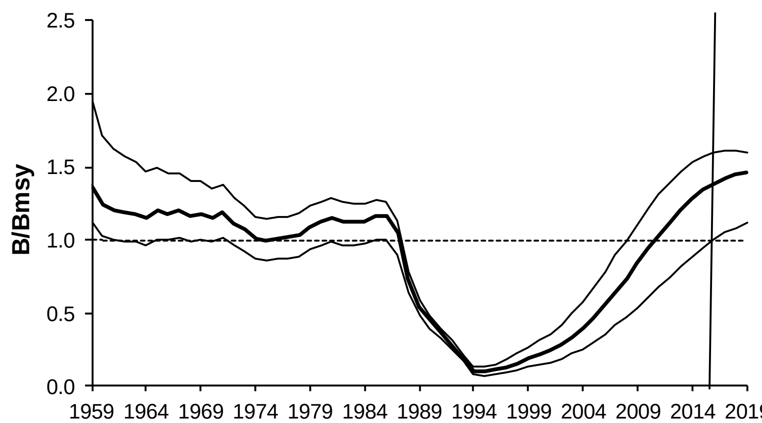

Fig. 9a : B/Bmsy 1959-2015 trajectory and 2016-2019 projection under 2014 red 3LN MS predicted catch (point estimates with approximate 80% bias corrected CL's)

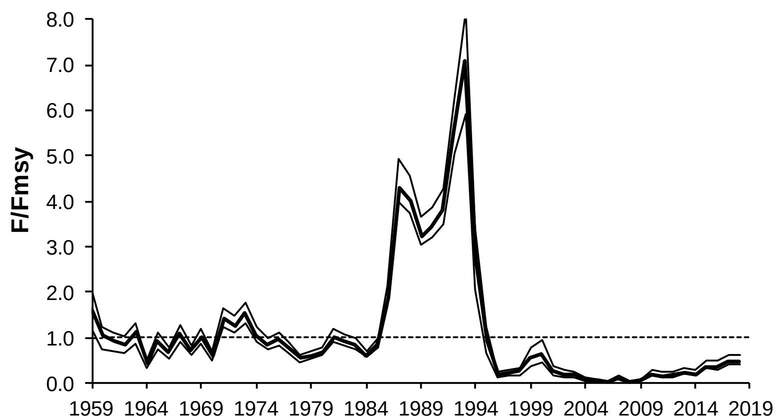

Fig. 9b: F/Fmsy 1959-2015 trajectory and 2016-2018 projection under 2014 red 3LN MS predicted catch (point estimates with approximate 80% bias corrected CL's)

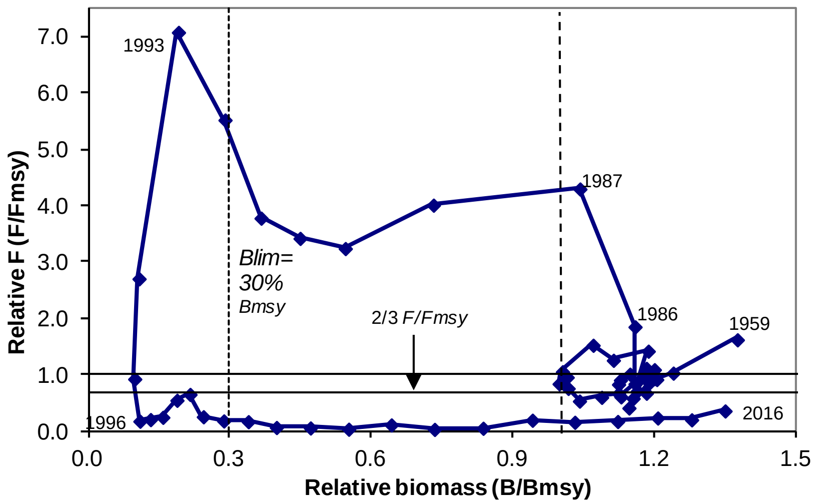

Fig. 10: Stock trajectory under a precautionary framework for ASPIC$_{fit}$ 2016

Appendix 1: Input .a7inp file of 2016 adopted framework

```
ASPIC-V7
# File generated by aspic5to7 v.0.62, at 2016-04-07 11:09:55
"3LN redfish"
# Program mode (FIT/BOT), verbosity, [if BOT] N bootstraps, [opt] user percentile:
FIT  2
# Model shape, conditioning (YLD/EFT), obj. fn. (SSE/LAV/MLE/MAP):
LOGISTIC  YLD  SSE
# N years, N series:
57  9
# Monte Carlo mode (0/1/2), N trials:
0  20000
# Convergence criteria (3 values):
1.00E-08  3.00E-08  1.00E-04
# Maximum F, N restarts, [gen. model] N steps/yr:
6.00E+00  18  24
# Random seed (large integer):
3941285
# Initial guesses and bounds follow:
# 'B1K', guess, estflag, min, max, ['penalty', penalty], or [priorname, prior params]
B1K    5.00E-01  1  5.00E-02  3.00E+00  penalty  0.00E+00
#B1K   5.00E-01  1  5.00E-02  3.00E+00  prior uniform  5.00E-02  3.00E+00
# 'MSY', guess, estflag, min, max, [if MAP] priorname, prior params
MSY    2.10E+04  0  5.00E+03  5.00E+04  prior uniform  5.00E+03  5.00E+04
# 'Fmsy', guess, estflag, min, max, [if MAP] priorname, prior params
Fmsy   8.40E-02  1  4.20E-03  8.40E-01  prior uniform  4.20E-03  8.40E-01
# q, guess, estflag, seriesweight, min, max, [if MAP] priorname, prior params
q      9.01E-06  1  1.00E+00  1.50E-07  9.01E-04  prior uniform  1.50E-07  9.01E-04
q      1.00E+00  1  1.00E+00  1.67E-02  6.00E+00  prior uniform  1.67E-02  6.00E+00
q      1.00E+00  1  1.00E+00  1.67E-02  6.00E+00  prior uniform  1.67E-02  6.00E+00
q      1.00E+00  1  1.00E+00  1.67E-02  6.00E+00  prior uniform  1.67E-02  6.00E+00
q      3.22E-01  1  1.00E+00  5.37E-03  1.20E+00  prior uniform  5.37E-03  1.20E+00
q      2.75E-01  1  1.00E+00  4.58E-03  1.20E+00  prior uniform  4.58E-03  1.20E+00
q      2.75E-01  1  1.00E+00  4.58E-03  1.20E+00  prior uniform  4.58E-03  1.20E+00
q      7.59E-01  1  1.00E+00  1.27E-02  4.55E+00  prior uniform  1.27E-02  4.55E+00
q      2.75E-01  1  1.00E+00  4.58E-03  1.20E+00  prior uniform  4.58E-03  1.20E+00
# Parameters for GENGRID or GENFIT go here.
DATA
# NOTE: Nominal CVs added by aspic5to7.
```

"Statlant CPUE"
CC

1959	1.4260E+00	4.4585E+04	3.0000E-01
1960	1.6020E+00	2.6562E+04	3.0000E-01
1961	1.6970E+00	2.3175E+04	3.0000E-01
1962	1.6310E+00	2.1439E+04	3.0000E-01
1963	1.6320E+00	2.7362E+04	3.0000E-01
1964	1.8120E+00	1.0261E+04	3.0000E-01
1965	2.1850E+00	2.3466E+04	3.0000E-01
1966	1.7810E+00	1.6974E+04	3.0000E-01
1967	1.8930E+00	2.7188E+04	3.0000E-01
1968	9.2200E-01	1.7660E+04	3.0000E-01
1969	1.3380E+00	2.4750E+04	3.0000E-01
1970	1.3670E+00	1.4419E+04	3.0000E-01
1971	1.3460E+00	3.4370E+04	3.0000E-01
1972	1.3870E+00	2.8933E+04	3.0000E-01
1973	1.6430E+00	3.3297E+04	3.0000E-01
1974	1.2900E+00	2.2286E+04	3.0000E-01
1975	1.6690E+00	1.7871E+04	3.0000E-01
1976	1.2920E+00	2.0513E+04	3.0000E-01
1977	1.2510E+00	1.6516E+04	3.0000E-01
1978	1.1060E+00	1.2043E+04	3.0000E-01
1979	1.4510E+00	1.4067E+04	3.0000E-01
1980	1.7610E+00	1.6030E+04	3.0000E-01
1981	1.5940E+00	2.4280E+04	3.0000E-01
1982	1.6610E+00	2.1547E+04	3.0000E-01
1983	1.5560E+00	1.9747E+04	3.0000E-01
1984	1.0490E+00	1.4761E+04	3.0000E-01
1985	1.0840E+00	2.0557E+04	3.0000E-01
1986	1.4130E+00	4.2805E+04	3.0000E-01
1987	1.5230E+00	7.9031E+04	3.0000E-01
1988	1.2080E+00	5.3266E+04	3.0000E-01
1989	1.3220E+00	3.3649E+04	3.0000E-01
1990	8.2500E-01	2.9105E+04	3.0000E-01
1991	6.6800E-01	2.5815E+04	3.0000E-01
1992	9.1200E-01	2.7283E+04	3.0000E-01
1993	8.0100E-01	2.1308E+04	3.0000E-01
1994	8.0200E-01	5.7410E+03	3.0000E-01
1995	-1.0000E-03	1.9890E+03	3.0000E-01
1996	-1.0000E-03	4.5100E+02	3.0000E-01
1997	-1.0000E-03	6.3000E+02	3.0000E-01
1998	-1.0000E-03	8.9900E+02	3.0000E-01
1999	-1.0000E-03	2.3180E+03	3.0000E-01
2000	-1.0000E-03	3.1410E+03	3.0000E-01
2001	-1.0000E-03	1.4420E+03	3.0000E-01
2002	-1.0000E-03	1.2160E+03	3.0000E-01
2003	-1.0000E-03	1.3340E+03	3.0000E-01
2004	-1.0000E-03	6.3700E+02	3.0000E-01
2005	-1.0000E-03	6.5900E+02	3.0000E-01
2006	-1.0000E-03	4.9600E+02	3.0000E-01
2007	-1.0000E-03	1.6640E+03	3.0000E-01
2008	-1.0000E-03	5.9700E+02	3.0000E-01
2009	-1.0000E-03	1.0510E+03	3.0000E-01
2010	-1.0000E-03	4.1200E+03	3.0000E-01
2011	-1.0000E-03	3.6720E+03	3.0000E-01
2012	-1.0000E-03	4.3160E+03	3.0000E-01
2013	-1.0000E-03	6.2320E+03	3.0000E-01
2014	-1.0000E-03	5.6950E+03	3.0000E-01
2015	-1.0000E-03	1.0467E+04	3.0000E-01

"3LN spring survey"
I1

1959	-1.0000E-03	3.0000E-01
1960	-1.0000E-03	3.0000E-01
1961	-1.0000E-03	3.0000E-01
1962	-1.0000E-03	3.0000E-01
1963	-1.0000E-03	3.0000E-01
1964	-1.0000E-03	3.0000E-01
1965	-1.0000E-03	3.0000E-01
1966	-1.0000E-03	3.0000E-01
1967	-1.0000E-03	3.0000E-01
1968	-1.0000E-03	3.0000E-01
1969	-1.0000E-03	3.0000E-01
1970	-1.0000E-03	3.0000E-01
1971	-1.0000E-03	3.0000E-01
1972	-1.0000E-03	3.0000E-01
1973	-1.0000E-03	3.0000E-01
1974	-1.0000E-03	3.0000E-01
1975	-1.0000E-03	3.0000E-01
1976	-1.0000E-03	3.0000E-01
1977	-1.0000E-03	3.0000E-01
1978	-1.0000E-03	3.0000E-01
1979	-1.0000E-03	3.0000E-01
1980	-1.0000E-03	3.0000E-01
1981	-1.0000E-03	3.0000E-01
1982	-1.0000E-03	3.0000E-01
1983	-1.0000E-03	3.0000E-01
1984	-1.0000E-03	3.0000E-01
1985	-1.0000E-03	3.0000E-01
1986	-1.0000E-03	3.0000E-01
1987	-1.0000E-03	3.0000E-01
1988	-1.0000E-03	3.0000E-01
1989	-1.0000E-03	3.0000E-01
1990	-1.0000E-03	3.0000E-01
1991	1.0642E+04	3.0000E-01
1992	1.0066E+04	3.0000E-01
1993	2.2573E+04	3.0000E-01
1994	4.1620E+03	3.0000E-01
1995	5.8560E+03	3.0000E-01
1996	2.2812E+04	3.0000E-01
1997	1.4928E+04	3.0000E-01
1998	5.9402E+04	3.0000E-01
1999	6.1496E+04	3.0000E-01
2000	8.7842E+04	3.0000E-01
2001	4.1573E+04	3.0000E-01
2002	3.0959E+04	3.0000E-01
2003	2.7700E+04	3.0000E-01
2004	7.9631E+04	3.0000E-01
2005	6.6462E+04	3.0000E-01
2006	-1.0000E-03	3.0000E-01
2007	2.1885E+05	3.0000E-01
2008	1.4398E+05	3.0000E-01
2009	1.8338E+05	3.0000E-01
2010	1.6535E+05	3.0000E-01
2011	1.7369E+05	3.0000E-01
2012	3.2198E+05	3.0000E-01
2013	2.7151E+05	3.0000E-01
2014	2.7175E+05	3.0000E-01
2015	4.8056E+05	3.0000E-01

"3LN autumn survey"
I2

1959	-1.0000E-03	3.0000E-01
1960	-1.0000E-03	3.0000E-01
1961	-1.0000E-03	3.0000E-01
1962	-1.0000E-03	3.0000E-01
1963	-1.0000E-03	3.0000E-01
1964	-1.0000E-03	3.0000E-01
1965	-1.0000E-03	3.0000E-01
1966	-1.0000E-03	3.0000E-01
1967	-1.0000E-03	3.0000E-01
1968	-1.0000E-03	3.0000E-01
1969	-1.0000E-03	3.0000E-01
1970	-1.0000E-03	3.0000E-01
1971	-1.0000E-03	3.0000E-01
1972	-1.0000E-03	3.0000E-01
1973	-1.0000E-03	3.0000E-01
1974	-1.0000E-03	3.0000E-01
1975	-1.0000E-03	3.0000E-01
1976	-1.0000E-03	3.0000E-01
1977	-1.0000E-03	3.0000E-01
1978	-1.0000E-03	3.0000E-01
1979	-1.0000E-03	3.0000E-01
1980	-1.0000E-03	3.0000E-01
1981	-1.0000E-03	3.0000E-01
1982	-1.0000E-03	3.0000E-01
1983	-1.0000E-03	3.0000E-01
1984	-1.0000E-03	3.0000E-01
1985	-1.0000E-03	3.0000E-01
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1987	-1.0000E-03	3.0000E-01
1988	-1.0000E-03	3.0000E-01
1989	-1.0000E-03	3.0000E-01
1990	-1.0000E-03	3.0000E-01
1991	3.7886E+04	3.0000E-01
1992	1.3641E+05	3.0000E-01
1993	1.9233E+04	3.0000E-01
1994	3.1757E+04	3.0000E-01
1995	9.0728E+04	3.0000E-01
1996	1.5968E+04	3.0000E-01
1997	7.0660E+04	3.0000E-01
1998	1.1222E+05	3.0000E-01
1999	7.1986E+04	3.0000E-01
2000	1.0046E+05	3.0000E-01
2001	1.3257E+05	3.0000E-01
2002	5.0123E+04	3.0000E-01
2003	7.1889E+04	3.0000E-01
2004	4.9907E+04	3.0000E-01
2005	5.8561E+04	3.0000E-01
2006	9.1883E+04	3.0000E-01
2007	1.2476E+05	3.0000E-01
2008	1.9849E+05	3.0000E-01
2009	2.4671E+05	3.0000E-01
2010	4.6149E+05	3.0000E-01
2011	5.6228E+05	3.0000E-01
2012	5.9599E+05	3.0000E-01
2013	2.8875E+05	3.0000E-01
2014	-1.0000E-03	3.0000E-01
2015	4.2586E+05	3.0000E-01

"3LN Power russian survey"
I1

1959	-1.0000E-03	3.0000E-01
1960	-1.0000E-03	3.0000E-01
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1962	-1.0000E-03	3.0000E-01
1963	-1.0000E-03	3.0000E-01
1964	-1.0000E-03	3.0000E-01
1965	-1.0000E-03	3.0000E-01
1966	-1.0000E-03	3.0000E-01
1967	-1.0000E-03	3.0000E-01
1968	-1.0000E-03	3.0000E-01
1969	-1.0000E-03	3.0000E-01
1970	-1.0000E-03	3.0000E-01
1971	-1.0000E-03	3.0000E-01
1972	-1.0000E-03	3.0000E-01
1973	-1.0000E-03	3.0000E-01
1974	-1.0000E-03	3.0000E-01
1975	-1.0000E-03	3.0000E-01
1976	-1.0000E-03	3.0000E-01
1977	-1.0000E-03	3.0000E-01
1978	-1.0000E-03	3.0000E-01
1979	-1.0000E-03	3.0000E-01
1980	-1.0000E-03	3.0000E-01
1981	-1.0000E-03	3.0000E-01
1982	-1.0000E-03	3.0000E-01
1983	-1.0000E-03	3.0000E-01
1984	2.1588E+05	3.0000E-01
1985	9.3996E+04	3.0000E-01
1986	6.2975E+04	3.0000E-01
1987	7.0298E+04	3.0000E-01
1988	4.4884E+04	3.0000E-01
1989	1.2268E+04	3.0000E-01
1990	8.3650E+03	3.0000E-01
1991	1.8680E+04	3.0000E-01
1992	-1.0000E-03	3.0000E-01
1993	-1.0000E-03	3.0000E-01
1994	-1.0000E-03	3.0000E-01
1995	-1.0000E-03	3.0000E-01
1996	-1.0000E-03	3.0000E-01
1997	-1.0000E-03	3.0000E-01
1998	-1.0000E-03	3.0000E-01
1999	-1.0000E-03	3.0000E-01
2000	-1.0000E-03	3.0000E-01
2001	-1.0000E-03	3.0000E-01
2002	-1.0000E-03	3.0000E-01
2003	-1.0000E-03	3.0000E-01
2004	-1.0000E-03	3.0000E-01
2005	-1.0000E-03	3.0000E-01
2006	-1.0000E-03	3.0000E-01
2007	-1.0000E-03	3.0000E-01
2008	-1.0000E-03	3.0000E-01
2009	-1.0000E-03	3.0000E-01
2010	-1.0000E-03	3.0000E-01
2011	-1.0000E-03	3.0000E-01
2012	-1.0000E-03	3.0000E-01
2013	-1.0000E-03	3.0000E-01
2014	-1.0000E-03	3.0000E-01
2015	-1.0000E-03	3.0000E-01

"3L winter survey"
I0

1959	-1.0000E-03	3.0000E-01
1960	-1.0000E-03	3.0000E-01
1961	-1.0000E-03	3.0000E-01
1962	-1.0000E-03	3.0000E-01
1963	-1.0000E-03	3.0000E-01
1964	-1.0000E-03	3.0000E-01
1965	-1.0000E-03	3.0000E-01
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1967	-1.0000E-03	3.0000E-01
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1970	-1.0000E-03	3.0000E-01
1971	-1.0000E-03	3.0000E-01
1972	-1.0000E-03	3.0000E-01
1973	-1.0000E-03	3.0000E-01
1974	-1.0000E-03	3.0000E-01
1975	-1.0000E-03	3.0000E-01
1976	-1.0000E-03	3.0000E-01
1977	-1.0000E-03	3.0000E-01
1978	-1.0000E-03	3.0000E-01
1979	-1.0000E-03	3.0000E-01
1980	-1.0000E-03	3.0000E-01
1981	-1.0000E-03	3.0000E-01
1982	-1.0000E-03	3.0000E-01
1983	-1.0000E-03	3.0000E-01
1984	-1.0000E-03	3.0000E-01
1985	9.0245E+04	3.0000E-01
1986	3.6568E+04	3.0000E-01
1987	-1.0000E-03	3.0000E-01
1988	-1.0000E-03	3.0000E-01
1989	-1.0000E-03	3.0000E-01
1990	1.8202E+04	3.0000E-01
1991	-1.0000E-03	3.0000E-01
1992	-1.0000E-03	3.0000E-01
1993	-1.0000E-03	3.0000E-01
1994	-1.0000E-03	3.0000E-01
1995	-1.0000E-03	3.0000E-01
1996	-1.0000E-03	3.0000E-01
1997	-1.0000E-03	3.0000E-01
1998	-1.0000E-03	3.0000E-01
1999	-1.0000E-03	3.0000E-01
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2002	-1.0000E-03	3.0000E-01
2003	-1.0000E-03	3.0000E-01
2004	-1.0000E-03	3.0000E-01
2005	-1.0000E-03	3.0000E-01
2006	-1.0000E-03	3.0000E-01
2007	-1.0000E-03	3.0000E-01
2008	-1.0000E-03	3.0000E-01
2009	-1.0000E-03	3.0000E-01
2010	-1.0000E-03	3.0000E-01
2011	-1.0000E-03	3.0000E-01
2012	-1.0000E-03	3.0000E-01
2013	-1.0000E-03	3.0000E-01
2014	-1.0000E-03	3.0000E-01
2015	-1.0000E-03	3.0000E-01

"3L summer survey"
I1

1959	-1.0000E-03	3.0000E-01
1960	-1.0000E-03	3.0000E-01
1961	-1.0000E-03	3.0000E-01
1962	-1.0000E-03	3.0000E-01
1963	-1.0000E-03	3.0000E-01
1964	-1.0000E-03	3.0000E-01
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1966	-1.0000E-03	3.0000E-01
1967	-1.0000E-03	3.0000E-01
1968	-1.0000E-03	3.0000E-01
1969	-1.0000E-03	3.0000E-01
1970	-1.0000E-03	3.0000E-01
1971	-1.0000E-03	3.0000E-01
1972	-1.0000E-03	3.0000E-01
1973	-1.0000E-03	3.0000E-01
1974	-1.0000E-03	3.0000E-01
1975	-1.0000E-03	3.0000E-01
1976	-1.0000E-03	3.0000E-01
1977	-1.0000E-03	3.0000E-01
1978	3.1116E+05	3.0000E-01
1979	2.2779E+05	3.0000E-01
1980	-1.0000E-03	3.0000E-01
1981	2.6138E+05	3.0000E-01
1982	-1.0000E-03	3.0000E-01
1983	-1.0000E-03	3.0000E-01
1984	2.7771E+05	3.0000E-01
1985	1.6104E+05	3.0000E-01
1986	-1.0000E-03	3.0000E-01
1987	-1.0000E-03	3.0000E-01
1988	-1.0000E-03	3.0000E-01
1989	-1.0000E-03	3.0000E-01
1990	9.2840E+04	3.0000E-01
1991	3.7572E+04	3.0000E-01
1992	-1.0000E-03	3.0000E-01
1993	2.0838E+04	3.0000E-01
1994	-1.0000E-03	3.0000E-01
1995	-1.0000E-03	3.0000E-01
1996	-1.0000E-03	3.0000E-01
1997	-1.0000E-03	3.0000E-01
1998	-1.0000E-03	3.0000E-01
1999	-1.0000E-03	3.0000E-01
2000	-1.0000E-03	3.0000E-01
2001	-1.0000E-03	3.0000E-01
2002	-1.0000E-03	3.0000E-01
2003	-1.0000E-03	3.0000E-01
2004	-1.0000E-03	3.0000E-01
2005	-1.0000E-03	3.0000E-01
2006	-1.0000E-03	3.0000E-01
2007	-1.0000E-03	3.0000E-01
2008	-1.0000E-03	3.0000E-01
2009	-1.0000E-03	3.0000E-01
2010	-1.0000E-03	3.0000E-01
2011	-1.0000E-03	3.0000E-01
2012	-1.0000E-03	3.0000E-01
2013	-1.0000E-03	3.0000E-01
2014	-1.0000E-03	3.0000E-01
2015	-1.0000E-03	3.0000E-01

"3L autumn survey"
I2

1959	-1.0000E-03	3.0000E-01
1960	-1.0000E-03	3.0000E-01
1961	-1.0000E-03	3.0000E-01
1962	-1.0000E-03	3.0000E-01
1963	-1.0000E-03	3.0000E-01
1964	-1.0000E-03	3.0000E-01
1965	-1.0000E-03	3.0000E-01
1966	-1.0000E-03	3.0000E-01
1967	-1.0000E-03	3.0000E-01
1968	-1.0000E-03	3.0000E-01
1969	-1.0000E-03	3.0000E-01
1970	-1.0000E-03	3.0000E-01
1971	-1.0000E-03	3.0000E-01
1972	-1.0000E-03	3.0000E-01
1973	-1.0000E-03	3.0000E-01
1974	-1.0000E-03	3.0000E-01
1975	-1.0000E-03	3.0000E-01
1976	-1.0000E-03	3.0000E-01
1977	-1.0000E-03	3.0000E-01
1978	-1.0000E-03	3.0000E-01
1979	-1.0000E-03	3.0000E-01
1980	-1.0000E-03	3.0000E-01
1981	-1.0000E-03	3.0000E-01
1982	-1.0000E-03	3.0000E-01
1983	-1.0000E-03	3.0000E-01
1984	-1.0000E-03	3.0000E-01
1985	9.8233E+04	3.0000E-01
1986	1.7119E+04	3.0000E-01
1987	-1.0000E-03	3.0000E-01
1988	-1.0000E-03	3.0000E-01
1989	-1.0000E-03	3.0000E-01
1990	2.0743E+04	3.0000E-01
1991	-1.0000E-03	3.0000E-01
1992	-1.0000E-03	3.0000E-01
1993	-1.0000E-03	3.0000E-01
1994	-1.0000E-03	3.0000E-01
1995	-1.0000E-03	3.0000E-01
1996	-1.0000E-03	3.0000E-01
1997	-1.0000E-03	3.0000E-01
1998	-1.0000E-03	3.0000E-01
1999	-1.0000E-03	3.0000E-01
2000	-1.0000E-03	3.0000E-01
2001	-1.0000E-03	3.0000E-01
2002	-1.0000E-03	3.0000E-01
2003	-1.0000E-03	3.0000E-01
2004	-1.0000E-03	3.0000E-01
2005	-1.0000E-03	3.0000E-01
2006	-1.0000E-03	3.0000E-01
2007	-1.0000E-03	3.0000E-01
2008	-1.0000E-03	3.0000E-01
2009	-1.0000E-03	3.0000E-01
2010	-1.0000E-03	3.0000E-01
2011	-1.0000E-03	3.0000E-01
2012	-1.0000E-03	3.0000E-01
2013	-1.0000E-03	3.0000E-01
2014	-1.0000E-03	3.0000E-01
2015	-1.0000E-03	3.0000E-01

"3N spanish survey"
I1

1959	-1.0000E-03	3.0000E-01
1960	-1.0000E-03	3.0000E-01
1961	-1.0000E-03	3.0000E-01
1962	-1.0000E-03	3.0000E-01
1963	-1.0000E-03	3.0000E-01
1964	-1.0000E-03	3.0000E-01
1965	-1.0000E-03	3.0000E-01
1966	-1.0000E-03	3.0000E-01
1967	-1.0000E-03	3.0000E-01
1968	-1.0000E-03	3.0000E-01
1969	-1.0000E-03	3.0000E-01
1970	-1.0000E-03	3.0000E-01
1971	-1.0000E-03	3.0000E-01
1972	-1.0000E-03	3.0000E-01
1973	-1.0000E-03	3.0000E-01
1974	-1.0000E-03	3.0000E-01
1975	-1.0000E-03	3.0000E-01
1976	-1.0000E-03	3.0000E-01
1977	-1.0000E-03	3.0000E-01
1978	-1.0000E-03	3.0000E-01
1979	-1.0000E-03	3.0000E-01
1980	-1.0000E-03	3.0000E-01
1981	-1.0000E-03	3.0000E-01
1982	-1.0000E-03	3.0000E-01
1983	-1.0000E-03	3.0000E-01
1984	-1.0000E-03	3.0000E-01
1985	-1.0000E-03	3.0000E-01
1986	-1.0000E-03	3.0000E-01
1987	-1.0000E-03	3.0000E-01
1988	-1.0000E-03	3.0000E-01
1989	-1.0000E-03	3.0000E-01
1990	-1.0000E-03	3.0000E-01
1991	-1.0000E-03	3.0000E-01
1992	-1.0000E-03	3.0000E-01
1993	-1.0000E-03	3.0000E-01
1994	-1.0000E-03	3.0000E-01
1995	4.6084E+04	3.0000E-01
1996	6.5580E+03	3.0000E-01
1997	4.7530E+03	3.0000E-01
1998	2.2540E+04	3.0000E-01
1999	4.6459E+04	3.0000E-01
2000	6.8928E+04	3.0000E-01
2001	5.3855E+04	3.0000E-01
2002	7.6200E+03	3.0000E-01
2003	1.1031E+04	3.0000E-01
2004	2.7016E+04	3.0000E-01
2005	1.4692E+05	3.0000E-01
2006	8.7830E+04	3.0000E-01
2007	8.7602E+04	3.0000E-01
2008	6.8059E+04	3.0000E-01
2009	7.3574E+05	3.0000E-01
2010	3.5954E+05	3.0000E-01
2011	4.1830E+05	3.0000E-01
2012	2.6524E+05	3.0000E-01
2013	4.2953E+05	3.0000E-01
2014	1.7805E+05	3.0000E-01
2015	5.2346E+05	3.0000E-01

"3L spanish survey"
I1

1959	-1.0000E-03	3.0000E-01
1960	-1.0000E-03	3.0000E-01
1961	-1.0000E-03	3.0000E-01
1962	-1.0000E-03	3.0000E-01
1963	-1.0000E-03	3.0000E-01
1964	-1.0000E-03	3.0000E-01
1965	-1.0000E-03	3.0000E-01
1966	-1.0000E-03	3.0000E-01
1967	-1.0000E-03	3.0000E-01
1968	-1.0000E-03	3.0000E-01
1969	-1.0000E-03	3.0000E-01
1970	-1.0000E-03	3.0000E-01
1971	-1.0000E-03	3.0000E-01
1972	-1.0000E-03	3.0000E-01
1973	-1.0000E-03	3.0000E-01
1974	-1.0000E-03	3.0000E-01
1975	-1.0000E-03	3.0000E-01
1976	-1.0000E-03	3.0000E-01
1977	-1.0000E-03	3.0000E-01
1978	-1.0000E-03	3.0000E-01
1979	-1.0000E-03	3.0000E-01
1980	-1.0000E-03	3.0000E-01
1981	-1.0000E-03	3.0000E-01
1982	-1.0000E-03	3.0000E-01
1983	-1.0000E-03	3.0000E-01
1984	-1.0000E-03	3.0000E-01
1985	-1.0000E-03	3.0000E-01
1986	-1.0000E-03	3.0000E-01
1987	-1.0000E-03	3.0000E-01
1988	-1.0000E-03	3.0000E-01
1989	-1.0000E-03	3.0000E-01
1990	-1.0000E-03	3.0000E-01
1991	-1.0000E-03	3.0000E-01
1992	-1.0000E-03	3.0000E-01
1993	-1.0000E-03	3.0000E-01
1994	-1.0000E-03	3.0000E-01
1995	-1.0000E-03	3.0000E-01
1996	-1.0000E-03	3.0000E-01
1997	-1.0000E-03	3.0000E-01
1998	-1.0000E-03	3.0000E-01
1999	-1.0000E-03	3.0000E-01
2000	-1.0000E-03	3.0000E-01
2001	-1.0000E-03	3.0000E-01
2002	-1.0000E-03	3.0000E-01
2003	-1.0000E-03	3.0000E-01
2004	-1.0000E-03	3.0000E-01
2005	-1.0000E-03	3.0000E-01
2006	7.0066E+04	3.0000E-01
2007	3.1410E+04	3.0000E-01
2008	7.5567E+04	3.0000E-01
2009	1.0368E+05	3.0000E-01
2010	2.6675E+05	3.0000E-01
2011	1.7063E+05	3.0000E-01
2012	4.8147E+05	3.0000E-01
2013	2.3516E+05	3.0000E-01
2014	2.1641E+05	3.0000E-01
2015	1.3042E+05	3.0000E-01

```
Appendix 2 ASPIC Fit 2016 results
3LN redfish                                                                                             Page 1
                                                                              Thursday, 07 Apr 2016 at 11:10:08
ASPIC -- A Surplus-Production Model Including Covariates (BETA Ver. 7.03)
                                                                                               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 program and user's guide
            surplus-production model.  Fishery Bulletin 92: 374-389.            available gratis at www.mhprager.com

CONTROL PARAMETERS (FROM INPUT FILE)     Input file: C:/...6/aspicfit16/ASPIC16b plus3LSpain/ASPIC16b plus3LSpain.a7inp
------------------------------------------------------------------------------------------------------------------------
Operation of ASPIC:  Fit logistic (Schaefer) model by direct optimization.
Number of years analyzed:                      57           Number of bootstrap trials:                          0
Number of data series:                          9           Objective function:                      Least squares
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:         18
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:     36
CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)
------------------------------------------------------------------------------------------------------------------------
```

		1	2	3	4	5	6	7	8	9
1	Statlant CPUE	1.000								
		36								
2	3LN spring survey	-0.019	1.000							
		4	24							
3	3LN autumn survey	0.700	0.766	1.000						
		4	23	24						
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	0.688	0.697	0.000	0.000	0.000	0.000	1.000	
		0	20	20	0	0	0	0	21	
9	3L spanish survey	0.000	0.236	0.772	0.000	0.000	0.000	0.000	0.121	1.000
		0	9	9	0	0	0	0	10	10

```
GOODNESS-OF-FIT AND WEIGHTING (NON-BOOTSTRAPPED ANALYSIS)
------------------------------------------------------------------------------------------------------------------------
Objective function component: label and            Weighted            Weighted      Current    Inv. var.    R-squared
source of variance                                      SSE     N           MSE       weight       weight      in CPUE

Loss(-1)  Unmatched yield                         0.000E+00
Loss(0)   Penalty on B1 > K                       0.000E+00     1           N/A    0.000E+00          N/A   2016    2014    2012
Loss(1)   Statlant CPUE                           7.550E+00    36     2.221E-01    1.000E+00    1.544E+00  -0.333 (-0.239) (0.019)
Loss(2)   3LN spring survey                       1.155E+01    24     5.251E-01    1.000E+00    6.528E-01   0.615 (0.625)  (0.612)
Loss(3)   3LN autumn survey                       8.964E+00    24     4.075E-01    1.000E+00    8.412E-01   0.671 (0.596)  (0.490)*
Loss(4)   3LN Power russian survey                3.430E+00     8     5.717E-01    1.000E+00    5.996E-01   0.267 (0.259)  (0.201)
Loss(5)   3L winter survey                        4.337E-01     3     4.337E-01    1.000E+00    7.903E-01   0.419 (0.413)  (0.366)
Loss(6)   3L summer survey                        7.385E-01     8     1.231E-01    1.000E+00    2.785E+00   0.756 (0.738)  (0.579)
Loss(7)   3L autumn survey                        1.464E+00     3     1.464E+00    1.000E+00    2.341E-01   0.253 (0.248)
Loss(8)   3N spanish survey                       1.896E+01    21     9.977E-01    1.000E+00    3.436E-01   0.258 (0.196)
Loss(9)   3L spanish survey                       3.340E+00    10     4.175E-01    1.000E+00    8.209E-01   0.157
                      *mean 2012 R-squared in 3L autumn survey and 3N autumn survey weighted by the number of years of each series)
............................................................................................
TOTAL OBJECTIVE FUNCTION, MSE, RMSE:         5.64293211E+01           4.479E-01    6.692E-01

Estimated contrast index (good=0.5, best=1.0):        0.6465 ..... Mean of B coverage proportions > and < Bmsy
Estimated nearness index (best=1.0):                  1.0000 ..... Proportional closeness of any B to Bmsy
```

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	User guess	2nd guess	Min bound	Max bound	Estim?
B1/K	Starting relative biomass (in 1959)	6.874E-01	5.000E-01	2.874E+00	5.000E-02	3.000E+00	1
MSY	Maximum sustainable yield	2.100E+04	2.100E+04	2.100E+04	2.100E+04	2.100E+04	0
Fmsy	Fishing mortality rate at MSY	1.116E-01	8.400E-02	1.029E-01	4.200E-03	8.400E-01	1
phi	Shape of production curve (Bmsy/K)	0.5000	0.5000	-----	-----	-----	0
q(1)	Statlant CPUE	8.305E-06	9.010E-06	5.320E-06	1.500E-07	9.010E-04	1
q(2)	3LN spring survey	7.995E-01	1.000E+00	4.980E-01	1.670E-02	6.000E+00	1
q(3)	3LN autumn survey	1.466E+00	1.000E+00	4.879E-01	1.670E-02	6.000E+00	1
q(4)	3LN Power russian survey	3.141E-01	1.000E+00	6.955E-01	1.670E-02	6.000E+00	1
q(5)	3L winter survey	2.469E-01	3.220E-01	1.711E-02	5.370E-03	1.200E+00	1
q(6)	3L summer survey	1.018E+00	2.750E-01	6.769E-02	4.580E-03	1.200E+00	1
q(7)	3L autumn survey	2.284E-01	2.750E-01	2.505E-01	4.580E-03	1.200E+00	1
q(8)	3N spanish survey	8.442E-01	7.590E-01	9.511E-01	1.270E-02	4.550E+00	1
q(9)	3L spanish survey	7.513E-01	2.750E-01	5.721E-02	4.580E-03	1.200E+00	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	1.882E+05	K/2	K*n**(1/(1-n))
K	Carrying capacity	3.765E+05	2*Bmsy	Bmsy/phi
n	Exponent in production function	2.0000	----	----
g	Fletcher's gamma	4.000E+00	----	[n**(n/(n-1))]/[n-1]
B./Bmsy	Ratio: B(2016)/Bmsy	1.389E+00	----	----
F./Fmsy	Ratio: F(2015)/Fmsy	3.640E-01	----	----
Fmsy/F.	Ratio: Fmsy/F(2015)	2.747E+00	----	----
Y.(Fmsy)	Approx. yield available at Fmsy in 2016	2.858E+04	MSY*B./Bmsy	MSY*B./Bmsy
	...as proportion of MSY	1.361E+00	----	----
Ye.	Equilibrium yield available in 2016	1.782E+04	4*MSY*(B/K-(B/K)**2)	g*MSY*(B/K-(B/K)**n)
	...as proportion of MSY	8.485E-01	----	----
--------- Fishing effort rate at MSY in units of each CE or CC series ---------				
fmsy(1)	Statlant CPUE	1.343E+04	Fmsy/q(1)	Fmsy/q(1)

3LN redfish
Page 3

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1	1959	0.182	2.588E+05	2.455E+05	4.458E+04	4.458E+04	1.903E+04	1.628E+00	1.375E+00
2	1960	0.116	2.332E+05	2.298E+05	2.656E+04	2.656E+04	1.997E+04	1.036E+00	1.239E+00
3	1961	0.103	2.266E+05	2.251E+05	2.317E+04	2.317E+04	2.019E+04	9.228E-01	1.204E+00
4	1962	0.096	2.236E+05	2.231E+05	2.144E+04	2.144E+04	2.028E+04	8.615E-01	1.188E+00
5	1963	0.125	2.225E+05	2.189E+05	2.736E+04	2.736E+04	2.044E+04	1.120E+00	1.182E+00
6	1964	0.046	2.156E+05	2.207E+05	1.026E+04	1.026E+04	2.037E+04	4.167E-01	1.145E+00
7	1965	0.105	2.257E+05	2.240E+05	2.347E+04	2.347E+04	2.024E+04	9.389E-01	1.199E+00
8	1966	0.076	2.225E+05	2.241E+05	1.697E+04	1.697E+04	2.024E+04	6.789E-01	1.182E+00
9	1967	0.122	2.257E+05	2.222E+05	2.719E+04	2.719E+04	2.031E+04	1.097E+00	1.199E+00
10	1968	0.080	2.188E+05	2.202E+05	1.766E+04	1.766E+04	2.039E+04	7.188E-01	1.163E+00
11	1969	0.113	2.216E+05	2.194E+05	2.475E+04	2.475E+04	2.042E+04	1.011E+00	1.177E+00
12	1970	0.065	2.172E+05	2.203E+05	1.442E+04	1.442E+04	2.039E+04	5.867E-01	1.154E+00
13	1971	0.159	2.232E+05	2.161E+05	3.437E+04	3.437E+04	2.053E+04	1.426E+00	1.186E+00
14	1972	0.141	2.094E+05	2.052E+05	2.893E+04	2.893E+04	2.083E+04	1.264E+00	1.112E+00
15	1973	0.171	2.013E+05	1.949E+05	3.330E+04	3.330E+04	2.097E+04	1.531E+00	1.069E+00
16	1974	0.118	1.889E+05	1.883E+05	2.229E+04	2.229E+04	2.100E+04	1.061E+00	1.004E+00
17	1975	0.094	1.877E+05	1.892E+05	1.787E+04	1.787E+04	2.100E+04	8.464E-01	9.969E-01
18	1976	0.107	1.908E+05	1.910E+05	2.051E+04	2.051E+04	2.100E+04	9.625E-01	1.014E+00
19	1977	0.085	1.913E+05	1.935E+05	1.652E+04	1.652E+04	2.098E+04	7.649E-01	1.016E+00
20	1978	0.060	1.957E+05	2.002E+05	1.204E+04	1.204E+04	2.091E+04	5.391E-01	1.040E+00
21	1979	0.068	2.046E+05	2.080E+05	1.407E+04	1.407E+04	2.077E+04	6.062E-01	1.087E+00
22	1980	0.075	2.113E+05	2.136E+05	1.603E+04	1.603E+04	2.062E+04	6.726E-01	1.123E+00
23	1981	0.113	2.159E+05	2.140E+05	2.428E+04	2.428E+04	2.061E+04	1.017E+00	1.147E+00
24	1982	0.102	2.122E+05	2.118E+05	2.155E+04	2.155E+04	2.067E+04	9.120E-01	1.127E+00
25	1983	0.093	2.113E+05	2.118E+05	1.975E+04	1.975E+04	2.067E+04	8.357E-01	1.123E+00
26	1984	0.069	2.123E+05	2.152E+05	1.476E+04	1.476E+04	2.057E+04	6.148E-01	1.128E+00
27	1985	0.094	2.181E+05	2.180E+05	2.056E+04	2.056E+04	2.047E+04	8.451E-01	1.158E+00
28	1986	0.207	2.180E+05	2.065E+05	4.280E+04	4.280E+04	2.078E+04	1.858E+00	1.158E+00
29	1987	0.480	1.960E+05	1.645E+05	7.903E+04	7.903E+04	2.050E+04	4.307E+00	1.041E+00
30	1988	0.449	1.374E+05	1.188E+05	5.327E+04	5.327E+04	1.808E+04	4.020E+00	7.301E-01
31	1989	0.362	1.022E+05	9.283E+04	3.365E+04	3.365E+04	1.559E+04	3.249E+00	5.431E-01
32	1990	0.383	8.417E+04	7.606E+04	2.910E+04	2.910E+04	1.353E+04	3.430E+00	4.472E-01
33	1991	0.423	6.860E+04	6.107E+04	2.582E+04	2.582E+04	1.140E+04	3.789E+00	3.644E-01
34	1992	0.617	5.419E+04	4.420E+04	2.728E+04	2.728E+04	8.687E+03	5.533E+00	2.879E-01
35	1993	0.791	3.559E+04	2.694E+04	2.131E+04	2.131E+04	5.568E+03	7.090E+00	1.891E-01
36	1994	0.303	1.985E+04	1.898E+04	5.741E+03	5.741E+03	4.020E+03	2.712E+00	1.055E-01
37	1995	0.104	1.813E+04	1.915E+04	1.989E+03	1.989E+03	4.055E+03	9.312E-01	9.632E-02
38	1996	0.020	2.020E+04	2.224E+04	4.510E+02	4.510E+02	4.669E+03	1.817E-01	1.073E-01
39	1997	0.024	2.441E+04	2.681E+04	6.300E+02	6.300E+02	5.554E+03	2.107E-01	1.297E-01
40	1998	0.028	2.934E+04	3.209E+04	8.990E+02	8.990E+02	6.548E+03	2.511E-01	1.559E-01
41	1999	0.062	3.499E+04	3.755E+04	2.318E+03	2.318E+03	7.541E+03	5.534E-01	1.859E-01
42	2000	0.073	4.021E+04	4.283E+04	3.141E+03	3.141E+03	8.468E+03	6.574E-01	2.136E-01
43	2001	0.029	4.554E+04	4.952E+04	1.442E+03	1.442E+03	9.592E+03	2.610E-01	2.419E-01
44	2002	0.021	5.369E+04	5.848E+04	1.216E+03	1.216E+03	1.102E+04	1.864E-01	2.852E-01
45	2003	0.019	6.349E+04	6.899E+04	1.334E+03	1.334E+03	1.257E+04	1.733E-01	3.373E-01
46	2004	0.008	7.472E+04	8.138E+04	6.370E+02	6.370E+02	1.422E+04	7.016E-02	3.970E-01
47	2005	0.007	8.831E+04	9.581E+04	6.590E+02	6.590E+02	1.593E+04	6.165E-02	4.691E-01
48	2006	0.004	1.036E+05	1.120E+05	4.960E+02	4.960E+02	1.754E+04	3.971E-02	5.502E-01
49	2007	0.013	1.206E+05	1.292E+05	1.664E+03	1.664E+03	1.892E+04	1.155E-01	6.408E-01
50	2008	0.004	1.379E+05	1.475E+05	5.970E+02	5.970E+02	2.000E+04	3.628E-02	7.324E-01
51	2009	0.006	1.573E+05	1.671E+05	1.051E+03	1.051E+03	2.072E+04	5.639E-02	8.355E-01
52	2010	0.022	1.769E+05	1.854E+05	4.120E+03	4.120E+03	2.098E+04	1.992E-01	9.400E-01
53	2011	0.018	1.938E+05	2.024E+05	3.672E+03	3.672E+03	2.087E+04	1.626E-01	1.030E+00
54	2012	0.020	2.110E+05	2.191E+05	4.316E+03	4.316E+03	2.042E+04	1.766E-01	1.121E+00
55	2013	0.027	2.271E+05	2.339E+05	6.232E+03	6.232E+03	1.975E+04	2.388E-01	1.206E+00
56	2014	0.023	2.406E+05	2.473E+05	5.695E+03	5.695E+03	1.892E+04	2.064E-01	1.278E+00
57	2015	0.041	2.538E+05	2.578E+05	1.047E+04	1.047E+04	1.813E+04	3.640E-01	1.349E+00
58	2016		2.615E+05						1.389E+00

3LN redfish
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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	2.039E+00	0.1816	4.458E+04	4.458E+04	0.35742	1.000E+00
2	1960	1.602E+00	1.909E+00	0.1156	2.656E+04	2.656E+04	0.17524	1.000E+00
3	1961	1.697E+00	1.870E+00	0.1030	2.317E+04	2.317E+04	0.09683	1.000E+00
4	1962	1.631E+00	1.853E+00	0.0961	2.144E+04	2.144E+04	0.12736	1.000E+00
5	1963	1.632E+00	1.818E+00	0.1250	2.736E+04	2.736E+04	0.10810	1.000E+00
6	1964	1.812E+00	1.833E+00	0.0465	1.026E+04	1.026E+04	0.01148	1.000E+00
7	1965	2.185E+00	1.861E+00	0.1047	2.347E+04	2.347E+04	-0.16073	1.000E+00
8	1966	1.781E+00	1.861E+00	0.0757	1.697E+04	1.697E+04	0.04411	1.000E+00
9	1967	1.893E+00	1.845E+00	0.1224	2.719E+04	2.719E+04	-0.02552	1.000E+00
10	1968	9.220E-01	1.829E+00	0.0802	1.766E+04	1.766E+04	0.68503	1.000E+00
11	1969	1.338E+00	1.822E+00	0.1128	2.475E+04	2.475E+04	0.30865	1.000E+00
12	1970	1.367E+00	1.830E+00	0.0655	1.442E+04	1.442E+04	0.29143	1.000E+00
13	1971	1.346E+00	1.795E+00	0.1591	3.437E+04	3.437E+04	0.28763	1.000E+00
14	1972	1.387E+00	1.704E+00	0.1410	2.893E+04	2.893E+04	0.20605	1.000E+00
15	1973	1.643E+00	1.619E+00	0.1708	3.330E+04	3.330E+04	-0.01478	1.000E+00
16	1974	1.290E+00	1.564E+00	0.1184	2.229E+04	2.229E+04	0.19245	1.000E+00
17	1975	1.669E+00	1.572E+00	0.0944	1.787E+04	1.787E+04	-0.06006	1.000E+00
18	1976	1.292E+00	1.587E+00	0.1074	2.051E+04	2.051E+04	0.20536	1.000E+00
19	1977	1.251E+00	1.607E+00	0.0853	1.652E+04	1.652E+04	0.25063	1.000E+00
20	1978	1.106E+00	1.663E+00	0.0601	1.204E+04	1.204E+04	0.40780	1.000E+00
21	1979	1.451E+00	1.727E+00	0.0676	1.407E+04	1.407E+04	0.17442	1.000E+00
22	1980	1.761E+00	1.774E+00	0.0750	1.603E+04	1.603E+04	0.00750	1.000E+00
23	1981	1.594E+00	1.777E+00	0.1135	2.428E+04	2.428E+04	0.10887	1.000E+00
24	1982	1.661E+00	1.759E+00	0.1017	2.155E+04	2.155E+04	0.05718	1.000E+00
25	1983	1.556E+00	1.759E+00	0.0932	1.975E+04	1.975E+04	0.12269	1.000E+00
26	1984	1.049E+00	1.787E+00	0.0686	1.476E+04	1.476E+04	0.53291	1.000E+00
27	1985	1.084E+00	1.811E+00	0.0943	2.056E+04	2.056E+04	0.51307	1.000E+00
28	1986	1.413E+00	1.715E+00	0.2072	4.280E+04	4.280E+04	0.19395	1.000E+00
29	1987	1.523E+00	1.366E+00	0.4805	7.903E+04	7.903E+04	-0.10874	1.000E+00
30	1988	1.208E+00	9.863E-01	0.4485	5.327E+04	5.327E+04	-0.20279	1.000E+00
31	1989	1.322E+00	7.709E-01	0.3625	3.365E+04	3.365E+04	-0.53929	1.000E+00
32	1990	8.250E-01	6.317E-01	0.3827	2.910E+04	2.910E+04	-0.26698	1.000E+00
33	1991	6.680E-01	5.072E-01	0.4227	2.582E+04	2.582E+04	-0.27546	1.000E+00
34	1992	9.120E-01	3.671E-01	0.6173	2.728E+04	2.728E+04	-0.91007	1.000E+00
35	1993	8.010E-01	2.237E-01	0.7910	2.131E+04	2.131E+04	-1.27545	1.000E+00
36	1994	8.020E-01	1.576E-01	0.3026	5.741E+03	5.741E+03	-1.62708	1.000E+00
37	1995	*	1.590E-01	0.1039	1.989E+03	1.989E+03	0.00000	1.000E+00
38	1996	*	1.847E-01	0.0203	4.510E+02	4.510E+02	0.00000	1.000E+00
39	1997	*	2.226E-01	0.0235	6.300E+02	6.300E+02	0.00000	1.000E+00
40	1998	*	2.665E-01	0.0280	8.990E+02	8.990E+02	0.00000	1.000E+00
41	1999	*	3.118E-01	0.0617	2.318E+03	2.318E+03	0.00000	1.000E+00
42	2000	*	3.557E-01	0.0733	3.141E+03	3.141E+03	0.00000	1.000E+00
43	2001	*	4.113E-01	0.0291	1.442E+03	1.442E+03	0.00000	1.000E+00
44	2002	*	4.857E-01	0.0208	1.216E+03	1.216E+03	0.00000	1.000E+00
45	2003	*	5.730E-01	0.0193	1.334E+03	1.334E+03	0.00000	1.000E+00
46	2004	*	6.759E-01	0.0078	6.370E+02	6.370E+02	0.00000	1.000E+00
47	2005	*	7.957E-01	0.0069	6.590E+02	6.590E+02	0.00000	1.000E+00
48	2006	*	9.299E-01	0.0044	4.960E+02	4.960E+02	0.00000	1.000E+00
49	2007	*	1.073E+00	0.0129	1.664E+03	1.664E+03	0.00000	1.000E+00
50	2008	*	1.225E+00	0.0040	5.970E+02	5.970E+02	0.00000	1.000E+00
51	2009	*	1.388E+00	0.0063	1.051E+03	1.051E+03	0.00000	1.000E+00
52	2010	*	1.540E+00	0.0222	4.120E+03	4.120E+03	0.00000	1.000E+00
53	2011	*	1.681E+00	0.0181	3.672E+03	3.672E+03	0.00000	1.000E+00
54	2012	*	1.820E+00	0.0197	4.316E+03	4.316E+03	0.00000	1.000E+00
55	2013	*	1.943E+00	0.0266	6.232E+03	6.232E+03	0.00000	1.000E+00
56	2014	*	2.054E+00	0.0230	5.695E+03	5.695E+03	0.00000	1.000E+00
57	2015	*	2.141E+00	0.0406	1.047E+04	1.047E+04	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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3LN redfish
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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     0.3574                                             |=======
1960     0.1752                                             |====
1961     0.0968                                             |==
1962     0.1274                                             |===
1963     0.1081                                             |==
1964     0.0115                                             |
1965    -0.1607                                          ===|
1966     0.0441                                             |=
1967    -0.0255                                            =|
1968     0.6850                                             |==============
1969     0.3087                                             |======
1970     0.2914                                             |======
1971     0.2876                                             |======
1972     0.2061                                             |====
1973    -0.0148                                             |
1974     0.1924                                             |====
1975    -0.0601                                            =|
1976     0.2054                                             |====
1977     0.2506                                             |=====
1978     0.4078                                             |========
1979     0.1744                                             |===
1980     0.0075                                             |
1981     0.1089                                             |==
1982     0.0572                                             |=
1983     0.1227                                             |==
1984     0.5329                                             |===========
1985     0.5131                                             |==========
1986     0.1939                                             |====
1987    -0.1087                                           ==|
1988    -0.2028                                         ====|
1989    -0.5393                                  ===========|
1990    -0.2670                                        =====|
1991    -0.2755                                       ======|
1992    -0.9101                           ==================|
1993    -1.2754                   ==========================|
1994    -1.6271            =================================|
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                                             |
2014     0.0000                                             |
2015     0.0000                                             |
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3LN redfish
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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	--	*	1.963E+05	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	1.838E+05	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	1.800E+05	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	1.783E+05	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	1.750E+05	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	1.765E+05	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	1.791E+05	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	1.792E+05	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	1.776E+05	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	1.761E+05	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	1.754E+05	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	1.761E+05	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	1.728E+05	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	1.641E+05	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	1.558E+05	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	1.505E+05	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	1.513E+05	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	1.527E+05	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	1.547E+05	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	1.601E+05	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	1.663E+05	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	1.708E+05	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	1.711E+05	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	1.693E+05	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	1.693E+05	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	1.721E+05	0.00000	1.000E+00
27	1985	0.000E+00	0.000E+00	--	*	1.743E+05	0.00000	1.000E+00
28	1986	0.000E+00	0.000E+00	--	*	1.651E+05	0.00000	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	1.315E+05	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	9.495E+04	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	7.422E+04	0.00000	1.000E+00
32	1990	0.000E+00	0.000E+00	--	*	6.081E+04	0.00000	1.000E+00
33	1991	1.000E+00	1.000E+00	--	1.064E+04	4.882E+04	-1.52340	1.000E+00
34	1992	1.000E+00	1.000E+00	--	1.007E+04	3.534E+04	-1.25579	1.000E+00
35	1993	1.000E+00	1.000E+00	--	2.257E+04	2.154E+04	0.04696	1.000E+00
36	1994	1.000E+00	1.000E+00	--	4.162E+03	1.517E+04	-1.29341	1.000E+00
37	1995	1.000E+00	1.000E+00	--	5.856E+03	1.531E+04	-0.96090	1.000E+00
38	1996	1.000E+00	1.000E+00	--	2.281E+04	1.778E+04	0.24902	1.000E+00
39	1997	1.000E+00	1.000E+00	--	1.493E+04	2.143E+04	-0.36167	1.000E+00
40	1998	1.000E+00	1.000E+00	--	5.940E+04	2.566E+04	0.83958	1.000E+00
41	1999	1.000E+00	1.000E+00	--	6.150E+04	3.002E+04	0.71712	1.000E+00
42	2000	1.000E+00	1.000E+00	--	8.784E+04	3.424E+04	0.94207	1.000E+00
43	2001	1.000E+00	1.000E+00	--	4.157E+04	3.959E+04	0.04883	1.000E+00
44	2002	1.000E+00	1.000E+00	--	3.096E+04	4.675E+04	-0.41225	1.000E+00
45	2003	1.000E+00	1.000E+00	--	2.770E+04	5.516E+04	-0.68878	1.000E+00
46	2004	1.000E+00	1.000E+00	--	7.963E+04	6.506E+04	0.20204	1.000E+00
47	2005	1.000E+00	1.000E+00	--	6.646E+04	7.660E+04	-0.14198	1.000E+00
48	2006	0.000E+00	0.000E+00	--	*	8.952E+04	0.00000	1.000E+00
49	2007	1.000E+00	1.000E+00	--	2.188E+05	1.033E+05	0.75108	1.000E+00
50	2008	1.000E+00	1.000E+00	--	1.440E+05	1.179E+05	0.19960	1.000E+00
51	2009	1.000E+00	1.000E+00	--	1.834E+05	1.336E+05	0.31688	1.000E+00
52	2010	1.000E+00	1.000E+00	--	1.653E+05	1.482E+05	0.10934	1.000E+00
53	2011	1.000E+00	1.000E+00	--	1.737E+05	1.619E+05	0.07056	1.000E+00
54	2012	1.000E+00	1.000E+00	--	3.220E+05	1.752E+05	0.60862	1.000E+00
55	2013	1.000E+00	1.000E+00	--	2.715E+05	1.870E+05	0.37265	1.000E+00
56	2014	1.000E+00	1.000E+00	--	2.717E+05	1.977E+05	0.31789	1.000E+00
57	2015	1.000E+00	1.000E+00	--	4.806E+05	2.061E+05	0.84669	1.000E+00

* Asterisk indicates missing value(s).

3LN redfish
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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    -1.5234               ==============================|
1992    -1.2558                    =========================|
1993     0.0470                                            |=
1994    -1.2934                   ==========================|
1995    -0.9609                          ===================|
1996     0.2490                                            |=====
1997    -0.3617                                      =======|
1998     0.8396                                            |=================
1999     0.7171                                            |==============
2000     0.9421                                            |===================
2001     0.0488                                            |=
2002    -0.4123                                     ========|
2003    -0.6888                               ==============|
2004     0.2020                                            |====
2005    -0.1420                                         ===|
2006     0.0000                                            |
2007     0.7511                                            |===============
2008     0.1996                                            |====
2009     0.3169                                            |======
2010     0.1093                                            |==
2011     0.0706                                            |=
2012     0.6086                                            |============
2013     0.3726                                            |=======
2014     0.3179                                            |======
2015     0.8467                                            |=================
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3LN redfish
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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	--	*	3.418E+05	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	3.321E+05	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	3.278E+05	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	3.261E+05	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	3.159E+05	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	3.307E+05	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	3.260E+05	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	3.308E+05	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	3.207E+05	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	3.247E+05	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	3.184E+05	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	3.271E+05	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	3.069E+05	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	2.950E+05	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	2.769E+05	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	2.750E+05	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	2.796E+05	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	2.803E+05	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	2.869E+05	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	2.998E+05	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	3.097E+05	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	3.164E+05	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	3.110E+05	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	3.097E+05	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	3.111E+05	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	3.196E+05	0.00000	1.000E+00
27	1985	0.000E+00	0.000E+00	--	*	3.195E+05	0.00000	1.000E+00
28	1986	0.000E+00	0.000E+00	--	*	2.872E+05	0.00000	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	2.014E+05	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	1.498E+05	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	1.234E+05	0.00000	1.000E+00
32	1990	0.000E+00	0.000E+00	--	*	1.005E+05	0.00000	1.000E+00
33	1991	1.000E+00	1.000E+00	--	3.789E+04	7.941E+04	-0.74007	1.000E+00
34	1992	1.000E+00	1.000E+00	--	1.364E+05	5.216E+04	0.96137	1.000E+00
35	1993	1.000E+00	1.000E+00	--	1.923E+04	2.909E+04	-0.41382	1.000E+00
36	1994	1.000E+00	1.000E+00	--	3.176E+04	2.657E+04	0.17833	1.000E+00
37	1995	1.000E+00	1.000E+00	--	9.073E+04	2.960E+04	1.12019	1.000E+00
38	1996	1.000E+00	1.000E+00	--	1.597E+04	3.578E+04	-0.80676	1.000E+00
39	1997	1.000E+00	1.000E+00	--	7.066E+04	4.299E+04	0.49680	1.000E+00
40	1998	1.000E+00	1.000E+00	--	1.122E+05	5.127E+04	0.78329	1.000E+00
41	1999	1.000E+00	1.000E+00	--	7.199E+04	5.893E+04	0.20016	1.000E+00
42	2000	1.000E+00	1.000E+00	--	1.005E+05	6.673E+04	0.40904	1.000E+00
43	2001	1.000E+00	1.000E+00	--	1.326E+05	7.868E+04	0.52174	1.000E+00
44	2002	1.000E+00	1.000E+00	--	5.012E+04	9.304E+04	-0.61857	1.000E+00
45	2003	1.000E+00	1.000E+00	--	7.189E+04	1.095E+05	-0.42083	1.000E+00
46	2004	1.000E+00	1.000E+00	--	4.991E+04	1.294E+05	-0.95286	1.000E+00
47	2005	1.000E+00	1.000E+00	--	5.856E+04	1.518E+05	-0.95242	1.000E+00
48	2006	1.000E+00	1.000E+00	--	9.188E+04	1.768E+05	-0.65430	1.000E+00
49	2007	1.000E+00	1.000E+00	--	1.248E+05	2.020E+05	-0.48212	1.000E+00
50	2008	1.000E+00	1.000E+00	--	1.985E+05	2.305E+05	-0.14943	1.000E+00
51	2009	1.000E+00	1.000E+00	--	2.467E+05	2.593E+05	-0.04978	1.000E+00
52	2010	1.000E+00	1.000E+00	--	4.615E+05	2.840E+05	0.48544	1.000E+00
53	2011	1.000E+00	1.000E+00	--	5.623E+05	3.092E+05	0.59798	1.000E+00
54	2012	1.000E+00	1.000E+00	--	5.960E+05	3.328E+05	0.58264	1.000E+00
55	2013	1.000E+00	1.000E+00	--	2.888E+05	3.526E+05	-0.19985	1.000E+00
56	2014	0.000E+00	0.000E+00	--	*	3.720E+05	0.00000	1.000E+00
57	2015	1.000E+00	1.000E+00	--	4.259E+05	3.832E+05	0.10543	1.000E+00

* Asterisk indicates missing value(s).

3LN redfish
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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    -0.7401                              ===============|
1992     0.9614                                             |===================
1993    -0.4138                                     ========|
1994     0.1783                                             |====
1995     1.1202                                             |======================
1996    -0.8068                             ================|
1997     0.4968                                             |==========
1998     0.7833                                             |================
1999     0.2002                                             |====
2000     0.4090                                             |========
2001     0.5217                                             |==========
2002    -0.6186                                 ============|
2003    -0.4208                                     ========|
2004    -0.9529                          ===================|
2005    -0.9524                          ===================|
2006    -0.6543                                =============|
2007    -0.4821                                   ==========|
2008    -0.1494                                          ===|
2009    -0.0498                                            =|
2010     0.4854                                             |==========
2011     0.5980                                             |============
2012     0.5826                                             |============
2013    -0.1999                                         ====|
2014     0.0000                                             |
2015     0.1054                                             |==
                   ------------------------------------------------------------------------------------
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3LN redfish
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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	--	*	7.709E+04	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	7.218E+04	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	7.070E+04	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	7.005E+04	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	6.876E+04	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	6.931E+04	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	7.036E+04	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	7.039E+04	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	6.978E+04	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	6.917E+04	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	6.889E+04	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	6.918E+04	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	6.786E+04	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	6.445E+04	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	6.122E+04	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	5.913E+04	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	5.943E+04	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	5.999E+04	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	6.078E+04	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	6.288E+04	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	6.532E+04	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	6.709E+04	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	6.721E+04	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	6.651E+04	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	6.652E+04	0.00000	1.000E+00
26	1984	1.000E+00	1.000E+00	--	2.159E+05	6.759E+04	1.16127	1.000E+00
27	1985	1.000E+00	1.000E+00	--	9.400E+04	6.847E+04	0.31682	1.000E+00
28	1986	1.000E+00	1.000E+00	--	6.298E+04	6.487E+04	-0.02963	1.000E+00
29	1987	1.000E+00	1.000E+00	--	7.030E+04	5.166E+04	0.30810	1.000E+00
30	1988	1.000E+00	1.000E+00	--	4.488E+04	3.730E+04	0.18520	1.000E+00
31	1989	1.000E+00	1.000E+00	--	1.227E+04	2.915E+04	-0.86556	1.000E+00
32	1990	1.000E+00	1.000E+00	--	8.365E+03	2.389E+04	-1.04930	1.000E+00
33	1991	1.000E+00	1.000E+00	--	1.868E+04	1.918E+04	-0.02632	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	1.388E+04	0.00000	1.000E+00
35	1993	0.000E+00	0.000E+00	--	*	8.460E+03	0.00000	1.000E+00
36	1994	0.000E+00	0.000E+00	--	*	5.959E+03	0.00000	1.000E+00
37	1995	0.000E+00	0.000E+00	--	*	6.013E+03	0.00000	1.000E+00
38	1996	0.000E+00	0.000E+00	--	*	6.985E+03	0.00000	1.000E+00
39	1997	0.000E+00	0.000E+00	--	*	8.419E+03	0.00000	1.000E+00
40	1998	0.000E+00	0.000E+00	--	*	1.008E+04	0.00000	1.000E+00
41	1999	0.000E+00	0.000E+00	--	*	1.179E+04	0.00000	1.000E+00
42	2000	0.000E+00	0.000E+00	--	*	1.345E+04	0.00000	1.000E+00
43	2001	0.000E+00	0.000E+00	--	*	1.555E+04	0.00000	1.000E+00
44	2002	0.000E+00	0.000E+00	--	*	1.837E+04	0.00000	1.000E+00
45	2003	0.000E+00	0.000E+00	--	*	2.167E+04	0.00000	1.000E+00
46	2004	0.000E+00	0.000E+00	--	*	2.556E+04	0.00000	1.000E+00
47	2005	0.000E+00	0.000E+00	--	*	3.009E+04	0.00000	1.000E+00
48	2006	0.000E+00	0.000E+00	--	*	3.517E+04	0.00000	1.000E+00
49	2007	0.000E+00	0.000E+00	--	*	4.056E+04	0.00000	1.000E+00
50	2008	0.000E+00	0.000E+00	--	*	4.632E+04	0.00000	1.000E+00
51	2009	0.000E+00	0.000E+00	--	*	5.247E+04	0.00000	1.000E+00
52	2010	0.000E+00	0.000E+00	--	*	5.822E+04	0.00000	1.000E+00
53	2011	0.000E+00	0.000E+00	--	*	6.358E+04	0.00000	1.000E+00
54	2012	0.000E+00	0.000E+00	--	*	6.882E+04	0.00000	1.000E+00
55	2013	0.000E+00	0.000E+00	--	*	7.347E+04	0.00000	1.000E+00
56	2014	0.000E+00	0.000E+00	--	*	7.768E+04	0.00000	1.000E+00
57	2015	0.000E+00	0.000E+00	--	*	8.095E+04	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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3LN redfish
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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     1.1613                                             |=======================
1985     0.3168                                             |======
1986    -0.0296                                            =|
1987     0.3081                                             |======
1988     0.1852                                             |====
1989    -0.8656                             =================|
1990    -1.0493                         =====================|
1991    -0.0263                                            =|
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                                             |
2014     0.0000                                             |
2015     0.0000                                             |
                   ------------------------------------------------------------------------------------
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3LN redfish
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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	--	*	6.389E+04	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	5.758E+04	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	5.595E+04	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	5.521E+04	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	5.493E+04	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	5.322E+04	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	5.571E+04	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	5.492E+04	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	5.572E+04	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	5.403E+04	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	5.470E+04	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	5.363E+04	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	5.511E+04	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	5.169E+04	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	4.969E+04	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	4.665E+04	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	4.633E+04	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	4.710E+04	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	4.722E+04	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	4.832E+04	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	5.051E+04	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	5.216E+04	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	5.330E+04	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	5.239E+04	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	5.217E+04	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	5.240E+04	0.00000	1.000E+00
27	1985	1.000E+00	1.000E+00	--	9.024E+04	5.384E+04	0.51660	1.000E+00
28	1986	1.000E+00	1.000E+00	--	3.657E+04	5.381E+04	-0.38638	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	4.838E+04	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	3.393E+04	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	2.524E+04	0.00000	1.000E+00
32	1990	1.000E+00	1.000E+00	--	1.820E+04	2.078E+04	-0.13246	1.000E+00
33	1991	0.000E+00	0.000E+00	--	*	1.693E+04	0.00000	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	1.338E+04	0.00000	1.000E+00
35	1993	0.000E+00	0.000E+00	--	*	8.786E+03	0.00000	1.000E+00
36	1994	0.000E+00	0.000E+00	--	*	4.901E+03	0.00000	1.000E+00
37	1995	0.000E+00	0.000E+00	--	*	4.476E+03	0.00000	1.000E+00
38	1996	0.000E+00	0.000E+00	--	*	4.986E+03	0.00000	1.000E+00
39	1997	0.000E+00	0.000E+00	--	*	6.027E+03	0.00000	1.000E+00
40	1998	0.000E+00	0.000E+00	--	*	7.243E+03	0.00000	1.000E+00
41	1999	0.000E+00	0.000E+00	--	*	8.637E+03	0.00000	1.000E+00
42	2000	0.000E+00	0.000E+00	--	*	9.927E+03	0.00000	1.000E+00
43	2001	0.000E+00	0.000E+00	--	*	1.124E+04	0.00000	1.000E+00
44	2002	0.000E+00	0.000E+00	--	*	1.325E+04	0.00000	1.000E+00
45	2003	0.000E+00	0.000E+00	--	*	1.567E+04	0.00000	1.000E+00
46	2004	0.000E+00	0.000E+00	--	*	1.845E+04	0.00000	1.000E+00
47	2005	0.000E+00	0.000E+00	--	*	2.180E+04	0.00000	1.000E+00
48	2006	0.000E+00	0.000E+00	--	*	2.557E+04	0.00000	1.000E+00
49	2007	0.000E+00	0.000E+00	--	*	2.978E+04	0.00000	1.000E+00
50	2008	0.000E+00	0.000E+00	--	*	3.404E+04	0.00000	1.000E+00
51	2009	0.000E+00	0.000E+00	--	*	3.883E+04	0.00000	1.000E+00
52	2010	0.000E+00	0.000E+00	--	*	4.368E+04	0.00000	1.000E+00
53	2011	0.000E+00	0.000E+00	--	*	4.784E+04	0.00000	1.000E+00
54	2012	0.000E+00	0.000E+00	--	*	5.209E+04	0.00000	1.000E+00
55	2013	0.000E+00	0.000E+00	--	*	5.606E+04	0.00000	1.000E+00
56	2014	0.000E+00	0.000E+00	--	*	5.940E+04	0.00000	1.000E+00
57	2015	0.000E+00	0.000E+00	--	*	6.267E+04	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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3LN redfish
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UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 5
                   -1       -0.75     -0.5      -0.25       0        0.25      0.5       0.75       1
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    ------------------------------------------------------------------------------------
1959     0.0000                                             |
1960     0.0000                                             |
1961     0.0000                                             |
1962     0.0000                                             |
1963     0.0000                                             |
1964     0.0000                                             |
1965     0.0000                                             |
1966     0.0000                                             |
1967     0.0000                                             |
1968     0.0000                                             |
1969     0.0000                                             |
1970     0.0000                                             |
1971     0.0000                                             |
1972     0.0000                                             |
1973     0.0000                                             |
1974     0.0000                                             |
1975     0.0000                                             |
1976     0.0000                                             |
1977     0.0000                                             |
1978     0.0000                                             |
1979     0.0000                                             |
1980     0.0000                                             |
1981     0.0000                                             |
1982     0.0000                                             |
1983     0.0000                                             |
1984     0.0000                                             |
1985     0.5166                                             |=====================
1986    -0.3864                              ===============|
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990    -0.1325                                        =====|
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                                             |
2014     0.0000                                             |
2015     0.0000                                             |
                   ------------------------------------------------------------------------------------
```

3LN redfish
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RESULTS FOR DATA SERIES # 6 (NON-BOOTSTRAPPED) 3L summer survey

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

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Statist weight
1	1959	0.000E+00	0.000E+00	--	*	2.498E+05	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	2.339E+05	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	2.290E+05	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	2.270E+05	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	2.228E+05	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	2.246E+05	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	2.280E+05	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	2.280E+05	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	2.261E+05	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	2.241E+05	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	2.232E+05	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	2.241E+05	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	2.199E+05	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	2.088E+05	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	1.983E+05	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	1.916E+05	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	1.926E+05	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	1.944E+05	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	1.969E+05	0.00000	1.000E+00
20	1978	1.000E+00	1.000E+00	--	3.112E+05	2.037E+05	0.42351	1.000E+00
21	1979	1.000E+00	1.000E+00	--	2.278E+05	2.116E+05	0.07351	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	2.174E+05	0.00000	1.000E+00
23	1981	1.000E+00	1.000E+00	--	2.614E+05	2.178E+05	0.18261	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	2.155E+05	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	2.155E+05	0.00000	1.000E+00
26	1984	1.000E+00	1.000E+00	--	2.777E+05	2.190E+05	0.23758	1.000E+00
27	1985	1.000E+00	1.000E+00	--	1.610E+05	2.218E+05	-0.32032	1.000E+00
28	1986	0.000E+00	0.000E+00	--	*	2.102E+05	0.00000	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	1.674E+05	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	1.208E+05	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	9.445E+04	0.00000	1.000E+00
32	1990	1.000E+00	1.000E+00	--	9.284E+04	7.739E+04	0.18198	1.000E+00
33	1991	1.000E+00	1.000E+00	--	3.757E+04	6.214E+04	-0.50306	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	4.497E+04	0.00000	1.000E+00
35	1993	1.000E+00	1.000E+00	--	2.084E+04	2.741E+04	-0.27413	1.000E+00
36	1994	0.000E+00	0.000E+00	--	*	1.931E+04	0.00000	1.000E+00
37	1995	0.000E+00	0.000E+00	--	*	1.948E+04	0.00000	1.000E+00
38	1996	0.000E+00	0.000E+00	--	*	2.263E+04	0.00000	1.000E+00
39	1997	0.000E+00	0.000E+00	--	*	2.728E+04	0.00000	1.000E+00
40	1998	0.000E+00	0.000E+00	--	*	3.265E+04	0.00000	1.000E+00
41	1999	0.000E+00	0.000E+00	--	*	3.820E+04	0.00000	1.000E+00
42	2000	0.000E+00	0.000E+00	--	*	4.358E+04	0.00000	1.000E+00
43	2001	0.000E+00	0.000E+00	--	*	5.039E+04	0.00000	1.000E+00
44	2002	0.000E+00	0.000E+00	--	*	5.950E+04	0.00000	1.000E+00
45	2003	0.000E+00	0.000E+00	--	*	7.020E+04	0.00000	1.000E+00
46	2004	0.000E+00	0.000E+00	--	*	8.280E+04	0.00000	1.000E+00
47	2005	0.000E+00	0.000E+00	--	*	9.749E+04	0.00000	1.000E+00
48	2006	0.000E+00	0.000E+00	--	*	1.139E+05	0.00000	1.000E+00
49	2007	0.000E+00	0.000E+00	--	*	1.314E+05	0.00000	1.000E+00
50	2008	0.000E+00	0.000E+00	--	*	1.501E+05	0.00000	1.000E+00
51	2009	0.000E+00	0.000E+00	--	*	1.700E+05	0.00000	1.000E+00
52	2010	0.000E+00	0.000E+00	--	*	1.886E+05	0.00000	1.000E+00
53	2011	0.000E+00	0.000E+00	--	*	2.060E+05	0.00000	1.000E+00
54	2012	0.000E+00	0.000E+00	--	*	2.230E+05	0.00000	1.000E+00
55	2013	0.000E+00	0.000E+00	--	*	2.380E+05	0.00000	1.000E+00
56	2014	0.000E+00	0.000E+00	--	*	2.517E+05	0.00000	1.000E+00
57	2015	0.000E+00	0.000E+00	--	*	2.623E+05	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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```
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     0.4235                                             |=================
1979     0.0735                                             |===
1980     0.0000                                             |
1981     0.1826                                             |=======
1982     0.0000                                             |
1983     0.0000                                             |
1984     0.2376                                             |==========
1985    -0.3203                                =============|
1986     0.0000                                             |
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990     0.1820                                             |=======
1991    -0.5031                         ====================|
1992     0.0000                                             |
1993    -0.2741                                  ===========|
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                                             |
2014     0.0000                                             |
2015     0.0000                                             |
                  -------------------------------------------------------------------------------------
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3LN redfish
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RESULTS FOR DATA SERIES # 7 (NON-BOOTSTRAPPED) 3L autumn survey

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

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Statist weight
1	1959	0.000E+00	0.000E+00	--	*	5.326E+04	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	5.176E+04	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	5.108E+04	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	5.081E+04	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	4.923E+04	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	5.154E+04	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	5.080E+04	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	5.155E+04	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	4.998E+04	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	5.060E+04	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	4.961E+04	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	5.098E+04	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	4.782E+04	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	4.597E+04	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	4.315E+04	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	4.286E+04	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	4.357E+04	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	4.368E+04	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	4.470E+04	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	4.673E+04	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	4.826E+04	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	4.930E+04	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	4.846E+04	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	4.826E+04	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	4.848E+04	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	4.980E+04	0.00000	1.000E+00
27	1985	1.000E+00	1.000E+00	--	9.823E+04	4.978E+04	0.67968	1.000E+00
28	1986	1.000E+00	1.000E+00	--	1.712E+04	4.475E+04	-0.96094	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	3.138E+04	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	2.335E+04	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	1.922E+04	0.00000	1.000E+00
32	1990	1.000E+00	1.000E+00	--	2.074E+04	1.567E+04	0.28072	1.000E+00
33	1991	0.000E+00	0.000E+00	--	*	1.237E+04	0.00000	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	8.128E+03	0.00000	1.000E+00
35	1993	0.000E+00	0.000E+00	--	*	4.533E+03	0.00000	1.000E+00
36	1994	0.000E+00	0.000E+00	--	*	4.140E+03	0.00000	1.000E+00
37	1995	0.000E+00	0.000E+00	--	*	4.612E+03	0.00000	1.000E+00
38	1996	0.000E+00	0.000E+00	--	*	5.575E+03	0.00000	1.000E+00
39	1997	0.000E+00	0.000E+00	--	*	6.700E+03	0.00000	1.000E+00
40	1998	0.000E+00	0.000E+00	--	*	7.990E+03	0.00000	1.000E+00
41	1999	0.000E+00	0.000E+00	--	*	9.183E+03	0.00000	1.000E+00
42	2000	0.000E+00	0.000E+00	--	*	1.040E+04	0.00000	1.000E+00
43	2001	0.000E+00	0.000E+00	--	*	1.226E+04	0.00000	1.000E+00
44	2002	0.000E+00	0.000E+00	--	*	1.450E+04	0.00000	1.000E+00
45	2003	0.000E+00	0.000E+00	--	*	1.706E+04	0.00000	1.000E+00
46	2004	0.000E+00	0.000E+00	--	*	2.017E+04	0.00000	1.000E+00
47	2005	0.000E+00	0.000E+00	--	*	2.365E+04	0.00000	1.000E+00
48	2006	0.000E+00	0.000E+00	--	*	2.755E+04	0.00000	1.000E+00
49	2007	0.000E+00	0.000E+00	--	*	3.149E+04	0.00000	1.000E+00
50	2008	0.000E+00	0.000E+00	--	*	3.592E+04	0.00000	1.000E+00
51	2009	0.000E+00	0.000E+00	--	*	4.041E+04	0.00000	1.000E+00
52	2010	0.000E+00	0.000E+00	--	*	4.426E+04	0.00000	1.000E+00
53	2011	0.000E+00	0.000E+00	--	*	4.818E+04	0.00000	1.000E+00
54	2012	0.000E+00	0.000E+00	--	*	5.186E+04	0.00000	1.000E+00
55	2013	0.000E+00	0.000E+00	--	*	5.495E+04	0.00000	1.000E+00
56	2014	0.000E+00	0.000E+00	--	*	5.797E+04	0.00000	1.000E+00
57	2015	0.000E+00	0.000E+00	--	*	5.972E+04	0.00000	1.000E+00

* Asterisk indicates missing value(s).

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3LN redfish
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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     0.6797                                             |===========================
1986    -0.9609       ======================================|
1987     0.0000                                             |
1988     0.0000                                             |
1989     0.0000                                             |
1990     0.2807                                             |===========
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                                             |
2014     0.0000                                             |
2015     0.0000                                             |
                   ------------------------------------------------------------------------------------
```

3LN redfish
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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	--	*	2.072E+05	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	1.940E+05	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	1.901E+05	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	1.883E+05	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	1.848E+05	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	1.863E+05	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	1.891E+05	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	1.892E+05	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	1.876E+05	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	1.859E+05	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	1.852E+05	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	1.860E+05	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	1.824E+05	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	1.733E+05	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	1.646E+05	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	1.590E+05	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	1.598E+05	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	1.613E+05	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	1.634E+05	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	1.690E+05	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	1.756E+05	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	1.804E+05	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	1.807E+05	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	1.788E+05	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	1.788E+05	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	1.817E+05	0.00000	1.000E+00
27	1985	0.000E+00	0.000E+00	--	*	1.841E+05	0.00000	1.000E+00
28	1986	0.000E+00	0.000E+00	--	*	1.744E+05	0.00000	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	1.389E+05	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	1.003E+05	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	7.837E+04	0.00000	1.000E+00
32	1990	0.000E+00	0.000E+00	--	*	6.422E+04	0.00000	1.000E+00
33	1991	0.000E+00	0.000E+00	--	*	5.156E+04	0.00000	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	3.732E+04	0.00000	1.000E+00
35	1993	0.000E+00	0.000E+00	--	*	2.274E+04	0.00000	1.000E+00
36	1994	0.000E+00	0.000E+00	--	*	1.602E+04	0.00000	1.000E+00
37	1995	1.000E+00	1.000E+00	--	4.608E+04	1.616E+04	1.04762	1.000E+00
38	1996	1.000E+00	1.000E+00	--	6.558E+03	1.878E+04	-1.05206	1.000E+00
39	1997	1.000E+00	1.000E+00	--	4.753E+03	2.263E+04	-1.56062	1.000E+00
40	1998	1.000E+00	1.000E+00	--	2.254E+04	2.709E+04	-0.18394	1.000E+00
41	1999	1.000E+00	1.000E+00	--	4.646E+04	3.170E+04	0.38223	1.000E+00
42	2000	1.000E+00	1.000E+00	--	6.893E+04	3.616E+04	0.64511	1.000E+00
43	2001	1.000E+00	1.000E+00	--	5.386E+04	4.181E+04	0.25319	1.000E+00
44	2002	1.000E+00	1.000E+00	--	7.620E+03	4.937E+04	-1.86862	1.000E+00
45	2003	1.000E+00	1.000E+00	--	1.103E+04	5.825E+04	-1.66398	1.000E+00
46	2004	1.000E+00	1.000E+00	--	2.702E+04	6.871E+04	-0.93342	1.000E+00
47	2005	1.000E+00	1.000E+00	--	1.469E+05	8.089E+04	0.59679	1.000E+00
48	2006	1.000E+00	1.000E+00	--	8.783E+04	9.454E+04	-0.07359	1.000E+00
49	2007	1.000E+00	1.000E+00	--	8.760E+04	1.090E+05	-0.21899	1.000E+00
50	2008	1.000E+00	1.000E+00	--	6.806E+04	1.245E+05	-0.60418	1.000E+00
51	2009	1.000E+00	1.000E+00	--	7.357E+05	1.411E+05	1.65172	1.000E+00
52	2010	1.000E+00	1.000E+00	--	3.595E+05	1.565E+05	0.83162	1.000E+00
53	2011	1.000E+00	1.000E+00	--	4.183E+05	1.709E+05	0.89500	1.000E+00
54	2012	1.000E+00	1.000E+00	--	2.652E+05	1.850E+05	0.36028	1.000E+00
55	2013	1.000E+00	1.000E+00	--	4.295E+05	1.975E+05	0.77686	1.000E+00
56	2014	1.000E+00	1.000E+00	--	1.780E+05	2.088E+05	-0.15941	1.000E+00
57	2015	1.000E+00	1.000E+00	--	5.235E+05	2.176E+05	0.87771	1.000E+00

* Asterisk indicates missing value(s).

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```
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     1.0476                                             |=====================
1996    -1.0521                        =====================|
1997    -1.5606              ===============================|
1998    -0.1839                                         ====|
1999     0.3822                                             |========
2000     0.6451                                             |=============
2001     0.2532                                             |=====
2002    -1.8686        =====================================|
2003    -1.6640            =================================|
2004    -0.9334                          ===================|
2005     0.5968                                             |============
2006    -0.0736                                            =|
2007    -0.2190                                         ====|
2008    -0.6042                                 ============|
2009     1.6517                                             |=================================
2010     0.8316                                             |=================
2011     0.8950                                             |==================
2012     0.3603                                             |=======
2013     0.7769                                             |================
2014    -0.1594                                          ===|
2015     0.8777                                             |==================
                   ------------------------------------------------------------------------------------
```

3LN redfish
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RESULTS FOR DATA SERIES # 9 (NON-BOOTSTRAPPED) 3L 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	--	*	1.844E+05	0.00000	1.000E+00
2	1960	0.000E+00	0.000E+00	--	*	1.727E+05	0.00000	1.000E+00
3	1961	0.000E+00	0.000E+00	--	*	1.691E+05	0.00000	1.000E+00
4	1962	0.000E+00	0.000E+00	--	*	1.676E+05	0.00000	1.000E+00
5	1963	0.000E+00	0.000E+00	--	*	1.645E+05	0.00000	1.000E+00
6	1964	0.000E+00	0.000E+00	--	*	1.658E+05	0.00000	1.000E+00
7	1965	0.000E+00	0.000E+00	--	*	1.683E+05	0.00000	1.000E+00
8	1966	0.000E+00	0.000E+00	--	*	1.684E+05	0.00000	1.000E+00
9	1967	0.000E+00	0.000E+00	--	*	1.669E+05	0.00000	1.000E+00
10	1968	0.000E+00	0.000E+00	--	*	1.655E+05	0.00000	1.000E+00
11	1969	0.000E+00	0.000E+00	--	*	1.648E+05	0.00000	1.000E+00
12	1970	0.000E+00	0.000E+00	--	*	1.655E+05	0.00000	1.000E+00
13	1971	0.000E+00	0.000E+00	--	*	1.623E+05	0.00000	1.000E+00
14	1972	0.000E+00	0.000E+00	--	*	1.542E+05	0.00000	1.000E+00
15	1973	0.000E+00	0.000E+00	--	*	1.464E+05	0.00000	1.000E+00
16	1974	0.000E+00	0.000E+00	--	*	1.415E+05	0.00000	1.000E+00
17	1975	0.000E+00	0.000E+00	--	*	1.422E+05	0.00000	1.000E+00
18	1976	0.000E+00	0.000E+00	--	*	1.435E+05	0.00000	1.000E+00
19	1977	0.000E+00	0.000E+00	--	*	1.454E+05	0.00000	1.000E+00
20	1978	0.000E+00	0.000E+00	--	*	1.504E+05	0.00000	1.000E+00
21	1979	0.000E+00	0.000E+00	--	*	1.563E+05	0.00000	1.000E+00
22	1980	0.000E+00	0.000E+00	--	*	1.605E+05	0.00000	1.000E+00
23	1981	0.000E+00	0.000E+00	--	*	1.608E+05	0.00000	1.000E+00
24	1982	0.000E+00	0.000E+00	--	*	1.591E+05	0.00000	1.000E+00
25	1983	0.000E+00	0.000E+00	--	*	1.591E+05	0.00000	1.000E+00
26	1984	0.000E+00	0.000E+00	--	*	1.617E+05	0.00000	1.000E+00
27	1985	0.000E+00	0.000E+00	--	*	1.638E+05	0.00000	1.000E+00
28	1986	0.000E+00	0.000E+00	--	*	1.552E+05	0.00000	1.000E+00
29	1987	0.000E+00	0.000E+00	--	*	1.236E+05	0.00000	1.000E+00
30	1988	0.000E+00	0.000E+00	--	*	8.921E+04	0.00000	1.000E+00
31	1989	0.000E+00	0.000E+00	--	*	6.974E+04	0.00000	1.000E+00
32	1990	0.000E+00	0.000E+00	--	*	5.714E+04	0.00000	1.000E+00
33	1991	0.000E+00	0.000E+00	--	*	4.588E+04	0.00000	1.000E+00
34	1992	0.000E+00	0.000E+00	--	*	3.320E+04	0.00000	1.000E+00
35	1993	0.000E+00	0.000E+00	--	*	2.024E+04	0.00000	1.000E+00
36	1994	0.000E+00	0.000E+00	--	*	1.426E+04	0.00000	1.000E+00
37	1995	0.000E+00	0.000E+00	--	*	1.438E+04	0.00000	1.000E+00
38	1996	0.000E+00	0.000E+00	--	*	1.671E+04	0.00000	1.000E+00
39	1997	0.000E+00	0.000E+00	--	*	2.014E+04	0.00000	1.000E+00
40	1998	0.000E+00	0.000E+00	--	*	2.411E+04	0.00000	1.000E+00
41	1999	0.000E+00	0.000E+00	--	*	2.821E+04	0.00000	1.000E+00
42	2000	0.000E+00	0.000E+00	--	*	3.218E+04	0.00000	1.000E+00
43	2001	0.000E+00	0.000E+00	--	*	3.720E+04	0.00000	1.000E+00
44	2002	0.000E+00	0.000E+00	--	*	4.393E+04	0.00000	1.000E+00
45	2003	0.000E+00	0.000E+00	--	*	5.183E+04	0.00000	1.000E+00
46	2004	0.000E+00	0.000E+00	--	*	6.114E+04	0.00000	1.000E+00
47	2005	0.000E+00	0.000E+00	--	*	7.198E+04	0.00000	1.000E+00
48	2006	1.000E+00	1.000E+00	--	7.007E+04	8.412E+04	-0.18280	1.000E+00
49	2007	1.000E+00	1.000E+00	--	3.141E+04	9.703E+04	-1.12792	1.000E+00
50	2008	1.000E+00	1.000E+00	--	7.557E+04	1.108E+05	-0.38278	1.000E+00
51	2009	1.000E+00	1.000E+00	--	1.037E+05	1.255E+05	-0.19110	1.000E+00
52	2010	1.000E+00	1.000E+00	--	2.667E+05	1.393E+05	0.64985	1.000E+00
53	2011	1.000E+00	1.000E+00	--	1.706E+05	1.521E+05	0.11505	1.000E+00
54	2012	1.000E+00	1.000E+00	--	4.815E+05	1.646E+05	1.07324	1.000E+00
55	2013	1.000E+00	1.000E+00	--	2.352E+05	1.758E+05	0.29118	1.000E+00
56	2014	1.000E+00	1.000E+00	--	2.164E+05	1.858E+05	0.15245	1.000E+00
57	2015	1.000E+00	1.000E+00	--	1.304E+05	1.936E+05	-0.39524	1.000E+00

* Asterisk indicates missing value(s).

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UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 9
                   -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     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    -0.1828                                         ====|
2007    -1.1279                      =======================|
2008    -0.3828                                     ========|
2009    -0.1911                                         ====|
2010     0.6499                                             |=============
2011     0.1150                                             |==
2012     1.0732                                             |=====================
2013     0.2912                                             |======
2014     0.1525                                             |===
2015    -0.3952                                     ========|
                   -------------------------------------------------------------------------------------
```

3LN redfish
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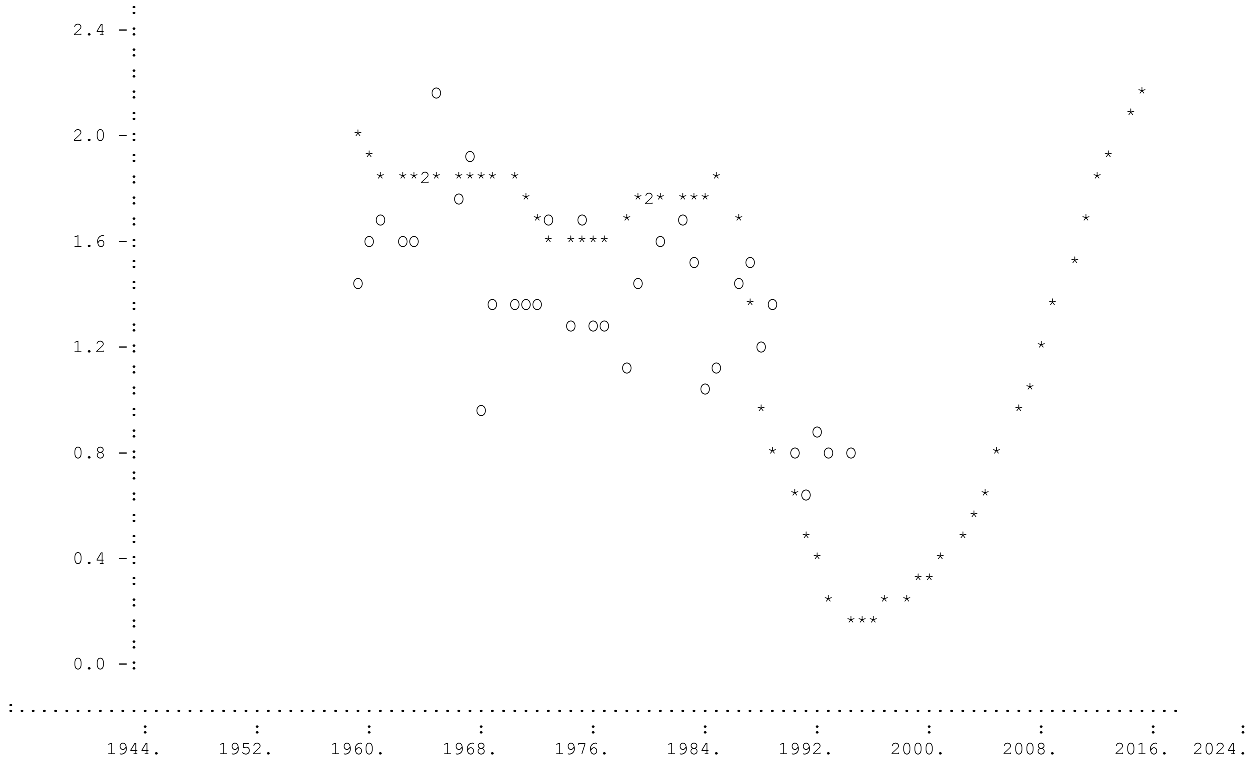
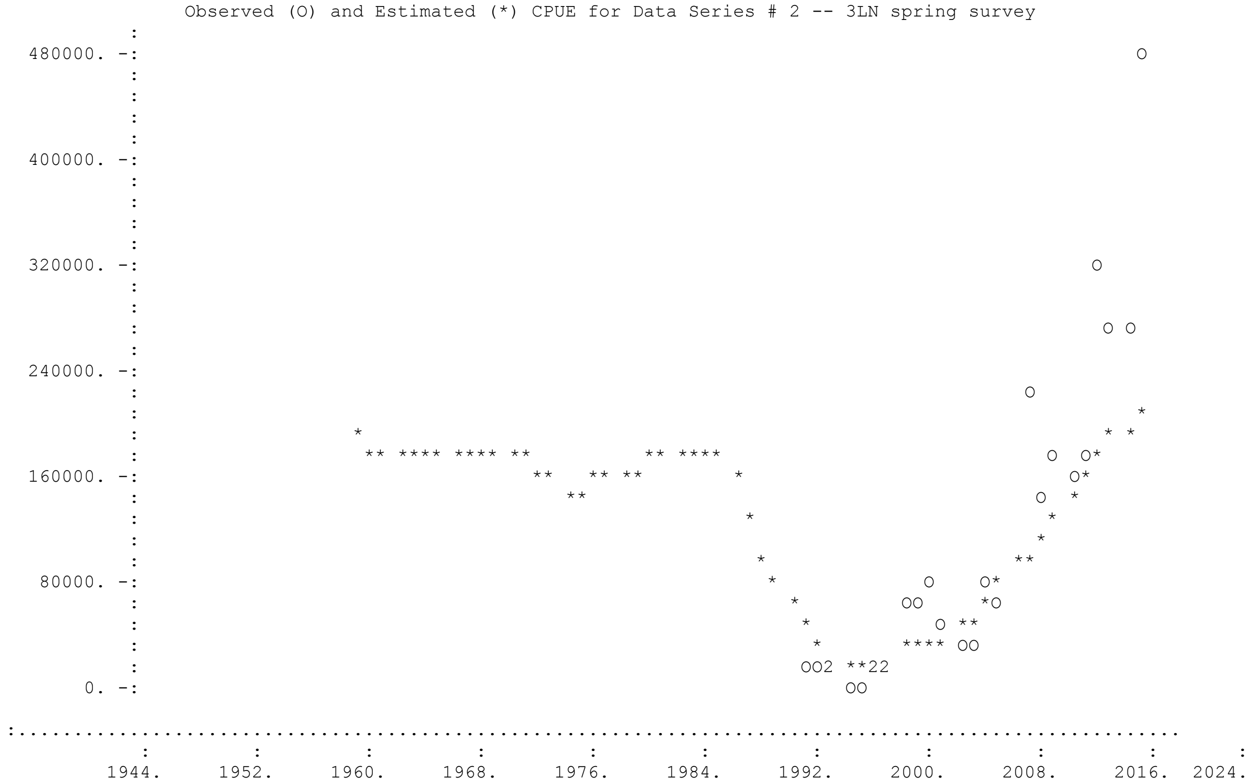
Observed (O) and Estimated (*) CPUE for Data Series # 1 -- Statlant CPUE



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



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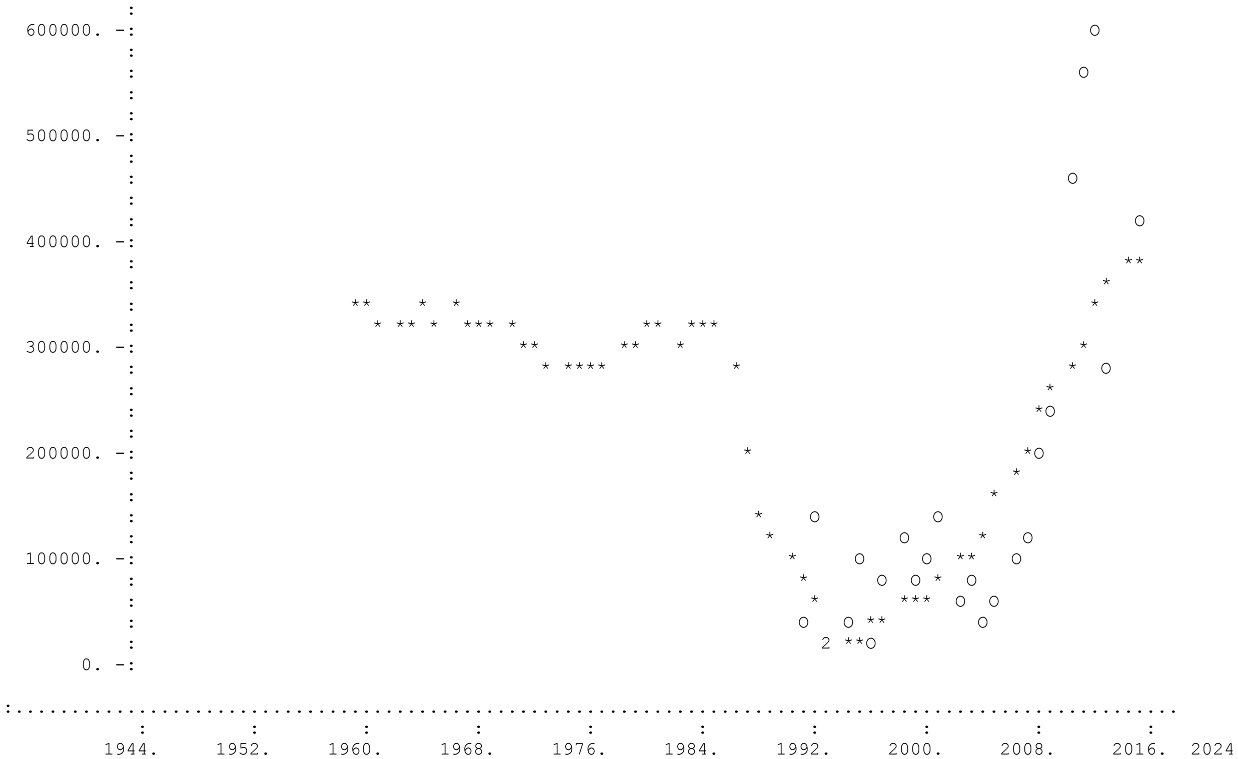
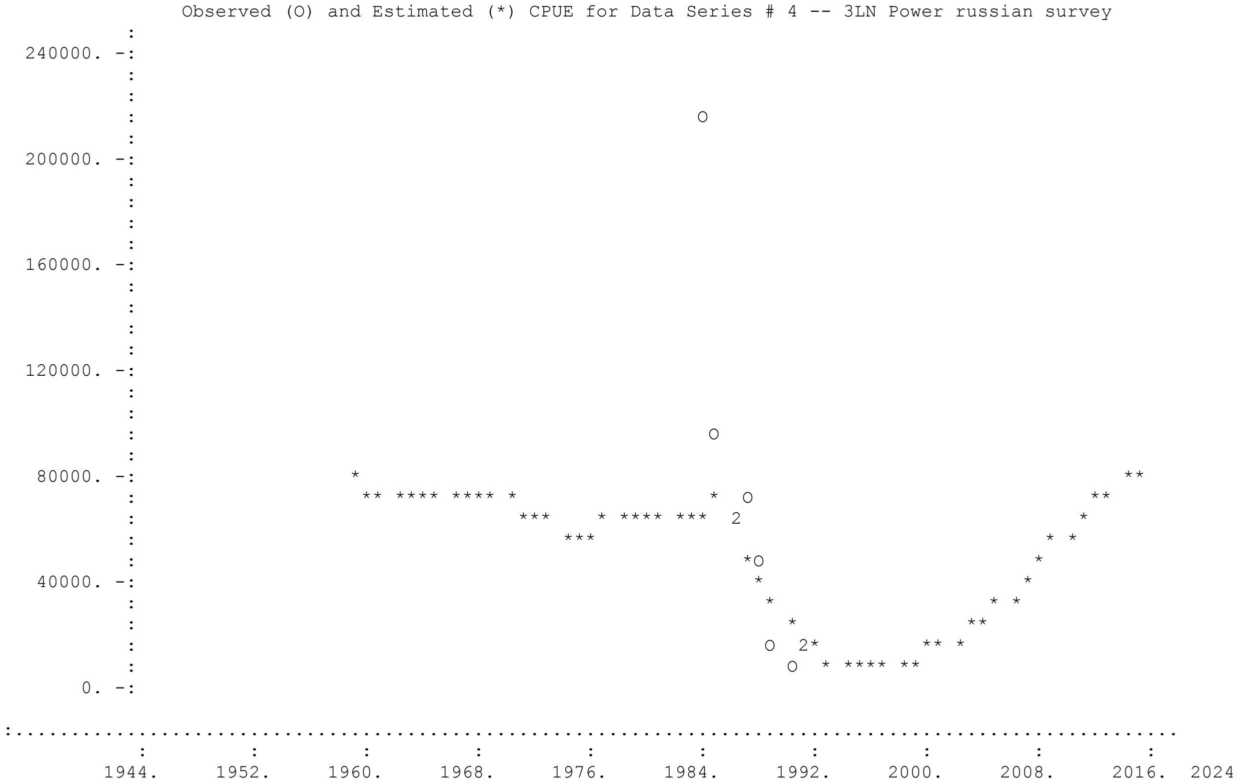
Observed (O) and Estimated (*) CPUE for Data Series # 3 -- 3LN autumn survey



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



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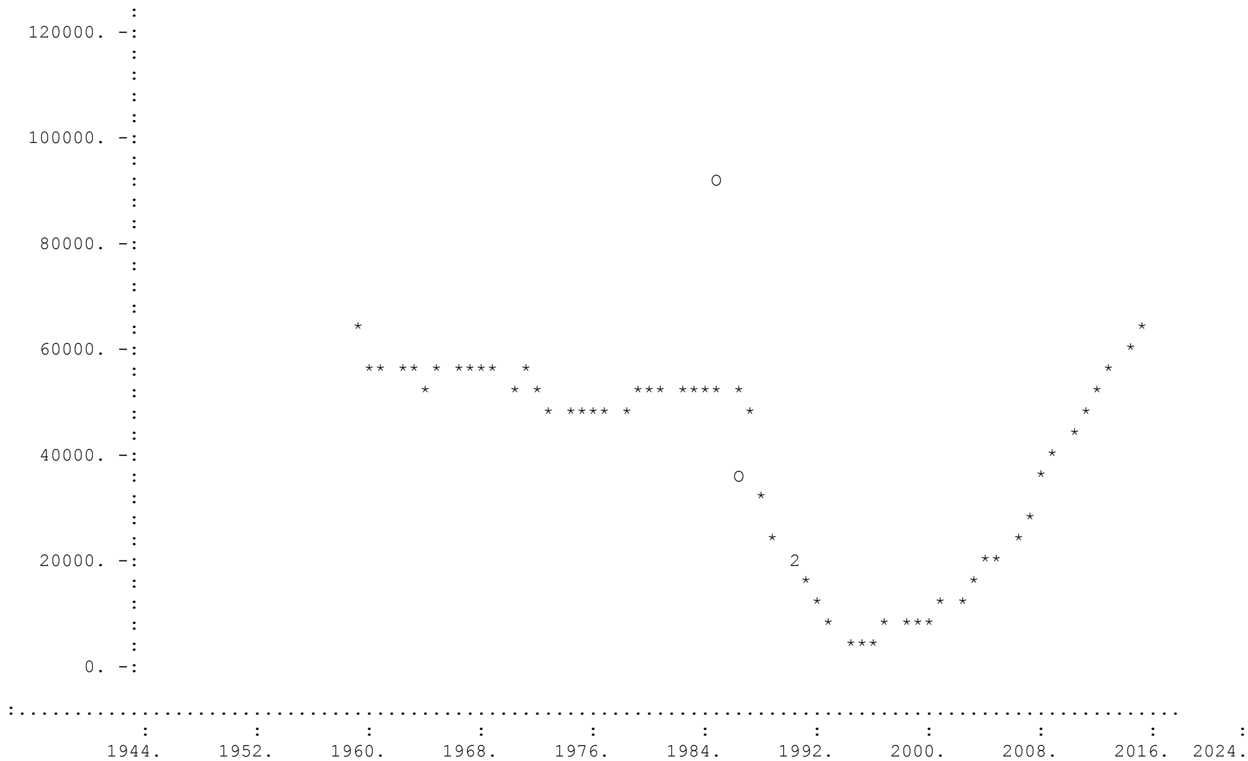
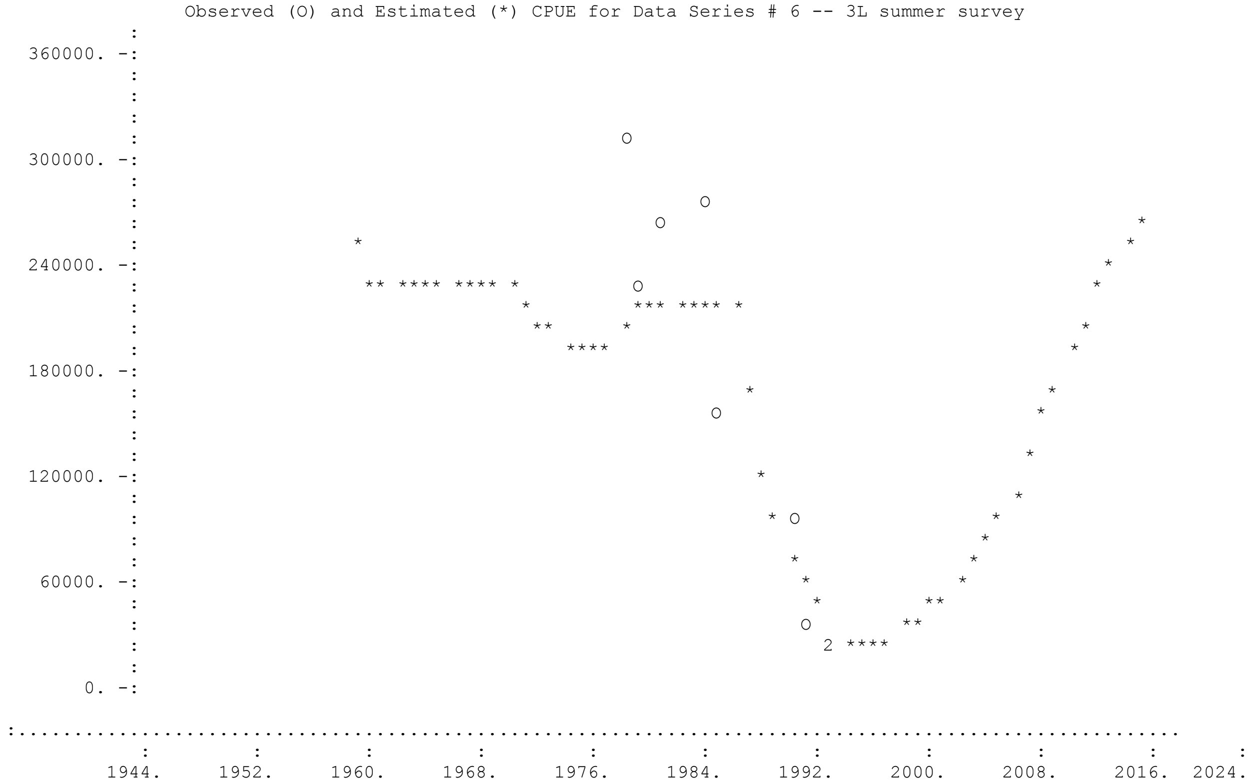
Observed (O) and Estimated (*) CPUE for Data Series # 5 -- 3L winter survey



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



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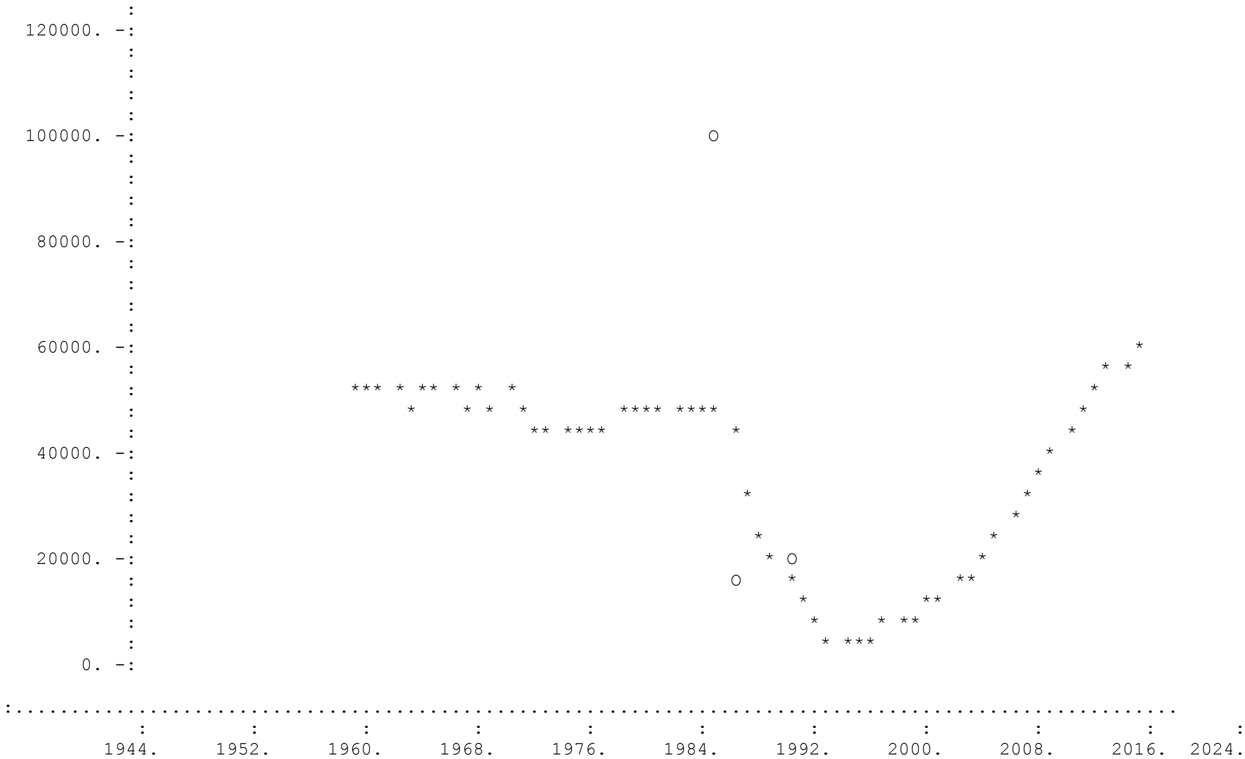
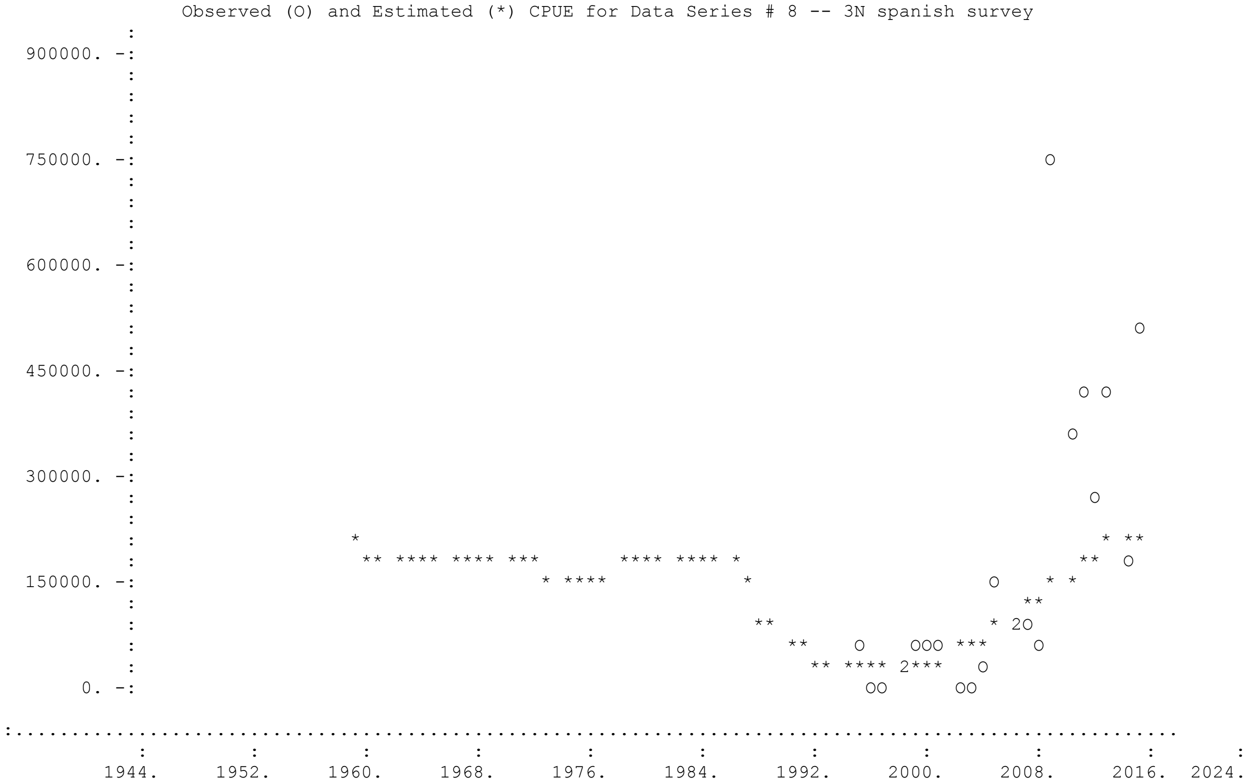
Observed (O) and Estimated (*) CPUE for Data Series # 7 -- 3L autumn survey



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



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3LN redfish
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                Observed (O) and Estimated (*) CPUE for Data Series # 9 -- 3L spanish survey
           :
  480000. -:                                                                                     O
           :
           :
           :
           :
  400000. -:
           :
           :
           :
           :
  320000. -:
           :
           :
           :                                                                                   O
           :
  240000. -:                                                                                      O
           :                                                                                        O
           :
           :                   *                                                                    **
           :                    **    * *                                                       O *
  160000. -:                       ***   *** ***        *** **** *                              **
           :                                    * **** *                                       *
           :                                                      *                          *       O
           :                                                                                *
           :                                                       *                       * O
   80000. -:                                                                              * O
           :                                                        * *                **  O
           :                                                           *             **
           :                                                            *       ****       O
           :                                                             * ****
       0. -:

:........................................................................................................
            :         :         :         :         :         :         :         :         :         :       :
         1944.     1952.     1960.     1968.     1976.     1984.     1992.     2000.     2008.     2016.  2024.


                                   Time Plot of Estimated F/Fmsy and B/Bmsy (dashed line = 1.0)
           :
      7.2 -:                                                             F
           :
           :
           :
           :
      6.0 -:
           :
           :                                                            F
           :
           :
      4.8 -:
           :
           :                                                      F
           :                                                       F
           :                                                           F
      3.6 -:
           :                                                        F F
           :
           :
           :                                                               F
      2.4 -:
           :
           :                                                     F
           :                   F
           :                   B              F F                                                    BB
      1.2 -:                    BB B2BB B2BB BB2        BBB BBBB B                               BB B
           :        ---- ---- --22 2--2 ---2 ---2 3332 2--2 2--2 -2-- ---- -2-- ---- ---- ---- 22-- ---- ---
           :                            F F          F  FF   FF    B              F        BBB
           :                         F       F         F            B BB         F     BB B          F
           :                                                            BB   F2 2BB2 22        FFFF F
      0.0 -:                                                               BBB         FF FFFF

:........................................................................................................
            :         :         :         :         :         :         :         :         :         :       :
         1944.     1952.     1960.     1968.     1976.     1984.     1992.     2000.     2008.     2016.  2024.

Elapsed time: 0 hours, 0 minutes,  3.869 seconds.
```

Appendix 3 ASPIC BOT 2016 results

```
3LN redfish                                                                                  Page 1
                                                                        Friday, 29 Apr 2016 at 13:41:31
ASPIC -- A Surplus-Production Model Including Covariates (BETA Ver. 7.03)
                                                                                       BOT 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 program and user's guide
            surplus-production model.  Fishery Bulletin 92: 374-389.          available gratis at www.mhprager.com

CONTROL PARAMETERS (FROM INPUT FILE)     Input file: C:/...6/aspicBOT16/ASPIC16b plus3LSpain/ASPIC16b plus3LSpain.a7inp
------------------------------------------------------------------------------------------------------------------------
Operation of ASPIC:  Fit logistic (Schaefer) model by direct optimization with bootstrap.
Number of years analyzed:                      57            Number of bootstrap trials:                        1000
Number of data series:                          9            Objective function:                       Least squares
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:          18
Maximum F allowed in fitting:               6.000
```

ESTIMATES FROM BOOTSTRAP ANALYSIS (Notation X. means terminal estimate of X)

Param name	Point estimate	Bias-corrected approximate confidence limits: 80% lower	80% upper	60% lower	60% upper	Inter-quartile range	Relative IQ range 2016	2014
B1/K	6.874E-01	5.616E-01	9.718E-01	5.883E-01	8.164E-01	1.761E-01	0.256	(0.295)
MSY	2.100E+04	NA	NA	NA	NA	NA	NA	
Fmsy	1.116E-01	9.180E-02	1.244E-01	9.767E-02	1.202E-01	1.831E-02	0.164	(0.190)
q(1)	8.305E-06	7.403E-06	9.949E-06	7.752E-06	9.506E-06	1.381E-06	0.166	(0.161)
q(2)	7.995E-01	5.823E-01	1.079E+00	6.529E-01	9.802E-01	2.669E-01	0.334	(0.371)
q(3)	1.466E+00	1.073E+00	2.076E+00	1.218E+00	1.836E+00	5.039E-01	0.344	(0.362)
q(4)	3.141E-01	2.277E-01	4.192E-01	2.543E-01	3.849E-01	1.057E-01	0.336	(0.329)
q(5)	2.469E-01	1.422E-01	3.968E-01	1.774E-01	3.367E-01	1.256E-01	0.509	(0.522)
q(6)	1.018E+00	8.484E-01	1.186E+00	9.352E-01	1.162E+00	1.841E-01	0.181	(0.204)
q(7)	2.284E-01	1.240E-01	3.334E-01	1.550E-01	2.978E-01	1.168E-01	0.511	(0.512)
q(8)	8.442E-01	5.769E-01	1.130E+00	6.538E-01	1.022E+00	2.873E-01	0.340	(0.401)
q(9)	7.513E-01	5.639E-01	1.063E+00	6.268E-01	9.775E-01	2.806E-01	0.373	
Ye(2016)	1.782E+04	1.355E+04	2.089E+04	1.506E+04	2.051E+04	4.678E+03	0.263	(0.271)
Y.(Fmsy)	2.858E+04	2.098E+04	3.237E+04	2.372E+04	3.123E+04	6.244E+03	0.218	(0.279)
Bmsy	1.882E+05	1.689E+05	2.287E+05	1.746E+05	2.150E+05	3.243E+04	0.172	(0.200)

ESTIMATES FROM BOOTSTRAP ANALYSIS (Notation X. means terminal estimate of X)

Param name	Point estimate	Bias-corrected approximate confidence limits 80% lower	80% upper	60% lower	60% upper	Inter-quartile range	Relative IQ range 2016	2014
fmsy(1)	1.343E+04	1.092E+04	1.642E+04	1.156E+04	1.530E+04	2.869E+03	0.214	
fmsy(2)	1.395E-01	9.262E-02	1.901E-01	1.047E-01	1.660E-01	4.973E-02	0.356	
fmsy(3)	7.612E-02	5.206E-02	1.084E-01	5.891E-02	9.548E-02	2.887E-02	0.379	
fmsy(4)	3.552E-01	2.671E-01	4.971E-01	2.920E-01	4.392E-01	1.198E-01	0.337	
fmsy(5)	4.519E-01	2.805E-01	7.953E-01	3.310E-01	6.356E-01	2.387E-01	0.528	
fmsy(6)	1.096E-01	8.192E-02	1.290E-01	8.790E-02	1.175E-01	2.292E-02	0.209	
fmsy(7)	4.885E-01	3.207E-01	8.723E-01	3.683E-01	7.087E-01	2.723E-01	0.557	
fmsy(8)	1.322E-01	9.056E-02	1.925E-01	1.029E-01	1.687E-01	5.248E-02	0.397	
fmsy(9)	1.485E-01	9.823E-02	2.079E-01	1.106E-01	1.859E-01	6.019E-02	0.405	
B./Bmsy	1.389E+00	9.991E-01	1.595E+00	1.137E+00	1.532E+00	3.289E-01	0.237	(0.296)
F./Fmsy	3.640E-01	3.142E-01	5.087E-01	3.279E-01	4.467E-01	9.767E-02	0.268	(0.345)
Ye./MSY	8.485E-01	6.455E-01	9.949E-01	7.170E-01	9.765E-01	2.228E-01	0.263	(0.271)
q2/q1	9.627E+04	6.652E+04	1.271E+05	7.512E+04	1.132E+05	3.112E+04	0.323	
q3/q1	1.765E+05	1.241E+05	2.370E+05	1.382E+05	2.115E+05	5.829E+04	0.330	
q4/q1	3.782E+04	2.651E+04	5.173E+04	2.972E+04	4.660E+04	1.335E+04	0.353	
q5/q1	2.973E+04	1.629E+04	4.756E+04	2.019E+04	3.979E+04	1.570E+04	0.528	
q6/q1	1.225E+05	9.753E+04	1.581E+05	1.086E+05	1.483E+05	3.269E+04	0.267	
q7/q1	2.750E+04	1.386E+04	4.076E+04	1.773E+04	3.541E+04	1.433E+04	0.521	
q8/q1	1.016E+05	6.967E+04	1.392E+05	7.814E+04	1.213E+05	3.419E+04	0.336	
q9/q1	9.046E+04	6.350E+04	1.255E+05	7.138E+04	1.118E+05	3.238E+04	0.358	

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

Unitless limit reference point in F (Fmsy/F.):	2.747
CV of above (from bootstrap distribution):	0.159

NOTES ON BOOTSTRAPPED ESTIMATES:

- Bootstrap results were computed from 1000 trials.
- Results are conditional on parameter bounds in the input file.
- If many trials were replaced, consider relaxing bounds and re-running.
- All bootstrapped intervals are approximate. The statistical literature recommends using at least 1000 trials for accurate 95% intervals. The default 80% intervals used by ASPIC should require fewer trials for equivalent accuracy. Using at least 500 trials is recommended.

Trials replaced for lack of convergence:	0	Trials replaced for MSY at bound or MSY >= K:	0
Trials replaced for q at bound:	429	Trials replaced for B1/K at bound:	13
Trials replaced for Fmsy at bound:	0		
Residual inflation factor:	1.0427		

Elapsed time: 0 hours, 23 minutes, 12.466 seconds.

Appendix 4 ASPIC.ctl file used in 2016-2018 catch projection

```
ASPICP-V4
"2016-2018 ASPIC16bot prj under red3LN HCR"
"ASPIC16b plus3LSpain.BIO"
0           "CV on MSY during projections"
BC  1       "bias corrected and smooth CI's"
0           "no years skipped from the start in plots"
1  1  1     "AGRAPH open to plot results; write a .prb file; write a R friendly version of the .prj file"
123456789   "random number seed only used when user CV of MSY is non zero"
10400  YABS "yield in same units as assessment"
14200  YABS
14200  YABS
%% END
```