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STOCK ASSESSMENT DIAGNOSTICS FOR SOUTH ATLANTIC SWORDFISH

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SUMMARY

Catch and catch per unit effort are used to fit a biomass dynamic stock assessment model. A variety of diagnostics are then used to check for violations of model assumptions and to explore the information in the data. Potential problems are identified and ways to overcome or avoid them discussed.

RÉSUMÉ

La capture et la capture par unité d'effort sont utilisées pour ajuster un modèle d'évaluation des stocks dynamique de la biomasse. Divers diagnostics sont ensuite utilisés afin de détecter le non-respect des postulats du modèle et d'explorer les informations dans les données. Les problèmes potentiels sont identifiés et les façons de les surmonter sont discutées.

RESUMEN

La captura y la captura por unidad de esfuerzo se usan para ajustar un modelo de evaluación de stock de dinámica de biomasa. A continuación se utilizan diferentes diagnósticos para comprobar infracciones de los supuestos del modelo y explorar información en los datos. Se identifican posibles problemas y se discuten formas de superarlos o evitarlos.

KEYWORDS

Swordfish, ASPIC, Assessment, Biomass Dynamic, Diagnostics, South Atlantic, Likelihood Profiles, Surplus Production

1. Introduction

A range of stock assessment models are used by the SCRS, from biomass dynamic models using catch and effort data with only a few parameters to statistical catch-at-size models with potentially 1000s of parameters. Despite these differences the methods are being used for the same purpose i.e. to estimate population parameters from fisheries dependent data. Therefore the Stock Assessment Methods Working Group (WGSAM) recommended that a common framework be developed to help ensure some consistency across assessment packages when decisions are being made about model choices. Therefore a set of common diagnostics were presented at the working group on stock assessment to help stock assessment working groups compare fits within and between stock assessment packages. In this paper we apply these diagnostics as part of the North Atlantic swordfish biomass dynamic assessment. The same diagnostics were used for the Northern and Southern Atlantic albacore and the Northern swordfish stocks. The paper is intended to an example of what to look at, how to do it, potential problems, consequences and how to overcome and avoid them. It is not intended to provide strict guidelines but to present methods that can be used for a range of stock assessment models that use indices of abundance such as Catch Per Unit Effort (CPUE) for fitting.

2. Materials and methods

2.1. Stock assessment assumptions

A Stock Production Model Incorporating Covariates (ASPIC) is a non-equilibrium implementation of a biomass dynamic model based on surplus production model. ASPIC uses time series of indices of abundance and catch biomass to estimate stock status and uses bootstrapping to construct sampling distribution for a statistic of interest, e.g. stock status, the biomass that would provided the maximum sustainable yield (B_{MSY} and MSY). The model was fit to five time series of catch and catch per unit of effort (CPUE) fisheries data covering 15 distinct fishing fleets. The main assumptions of ASPIC are that population dynamics are surplus production function e.g. Pella and Tomlinson (1969). Where biomass of a stock next year (Bt+1) as the sum of the biomass this year Bt less the catch (Ct) plus the surplus production (Pt) where (r) is the intrinsic rate of increase, (K) the carry capacity (p) the shape of the surplus production function. If $p < 1$ then the curve is skewed to the left.

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The dynamics i.e. productivity and reference points and the response of the stock to perturbations, are determined by r and the shape of the production function p; if p = 1 then MSY is found halfway between 0 and K, as p increases MSY shifts to the right.

It is assumed that catches and catch per unit effort (CPUE) is proportional to stock abundance and catches are from a single homogeneous stock. The data used are those compiled from the last stock assessment. If there are zero or negative correlations between the indices, then this means that a basic assumption of ASPIC is violated, either because factors other than stock abundance are determining catch rates or that the indices are fishing different stock components.

2.2. Methods

A non-equilibrium production model was fitted to the input data from the last assessment using ASPIC (A Stock Production Model Incorporating Covariates, Prager, 1992). ASPIC uses time series of indices of abundance and catch biomass to estimate stock status and uses bootstrapping to construct sampling distribution for a statistic of interest, e.g. stock status, the biomass that would provided the maximum sustainable yield (BMSY and MSY).

We fitted the data using ASPIC by fixing the values of K and MSY over a grid, plots of the residual sum of squares were then used to compare the plausibility of the different values of K and MSY given the data.

3. Results

Two indices of abundance are available, i.e. the long-line fleets of Uruguay and Spain, **Figure 1**. ASPIC assumes that CPUE time series provide information on trends in abundance. Therefore if there is no correlation or a negative correlation between the indices then there will be problems when fitting ASPIC, therefore the two indices are plotted against each other in **Figure 2.**

It was not possible to estimate both MSY and K due to the conflicting information in the CPUE time series. Fixing MSY and estimating K caused K to hit an the upper bound; fixing K caused MSY to hit the lower bound. Therefore instead first MSY and K were both fixed and the residual sum of squares estimated for a grid of MSY and K. The profiles for the residual sum of squares for MSY are plotted in **Figure 3** and for K in F**igure 4**, the lines represent fixed values of K in the MSY plot and MSY in the K plots.

In F**igure 5** a profile is plotted for MSY for single value of K, while in F**igure 6** the profile is plotted for K for single value of MSY These plots showed that there is little information in the CPUE data to allow MSY and K to be estimated and catch alone is insufficient to determine MSY and K.

By looking at the results from other ASPIC assessments it can be seen that using catch alone allows the relationship between r and K to de determined but not for either to be estimated independently.

In F**igures 7 and 8** r is plotted against K on the log scale. **Figure 8** is from the North Atlantic Albacore assessment, where points are the 7 scenarios (points) used by the group. While **Figure 7** is based on the profiling of North Atlantic swordfish, i.e. by fixing K at a range of values (points).

4. Discussion and conclusions

The assessment had problems in finding a solution (i.e. it did not converge); K tending to infinity and MSY to 0. The analysis also showed that the two fleets give alternative stock hypotheses, i.e. one suggests that MSY is very low and K very high and that catches are explainable by mining of the stock; the other suggests the stock is very productive. The catch data alone appeared to fix the relationship between r and K, however it insufficient alone to estimate either parameter. To find a solution requires an informative index of abundance, to fix parameters are use Bayesian priors.

Bibliography

Pella, J. and Tomlinson, P. (1969). A generalized stock production model. Inter-American Tropical Tuna Commission.

M. Prager. Aspic-a surplus-production model incorporating covariates. Coll. Vol. Sci. Pap., Int. Comm. Conserv. Atl. Tunas (ICCAT), 28:218{229, 1992.

SCRS/2009/016, Collect. Vol. Sci. Pap. ICCAT, 65(1): 1-123 (2010) REPORT OF THE 2009 ATLANTIC SWORDFISH STOCK ASSESSMENT SESSION (Madrid, September 7 to 11, 2009).

L. Kell, I. Mosqueira, P. Grosjean, J. Fromentin, D. Garcia, R. Hillary, E. Jardim, S. Mardle, M. Pastoors, J. Poos, *et al*. Flr: an open-source framework for the evaluation and development of management strategies. ICES Journal of Marine Science: Journal du Conseil, 64(4):640, 2007.

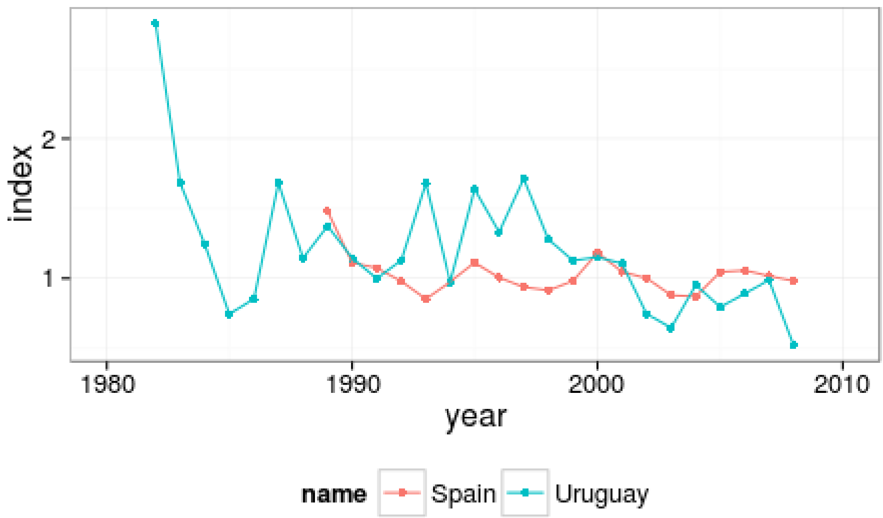

Figure 1. Indices of abundance.

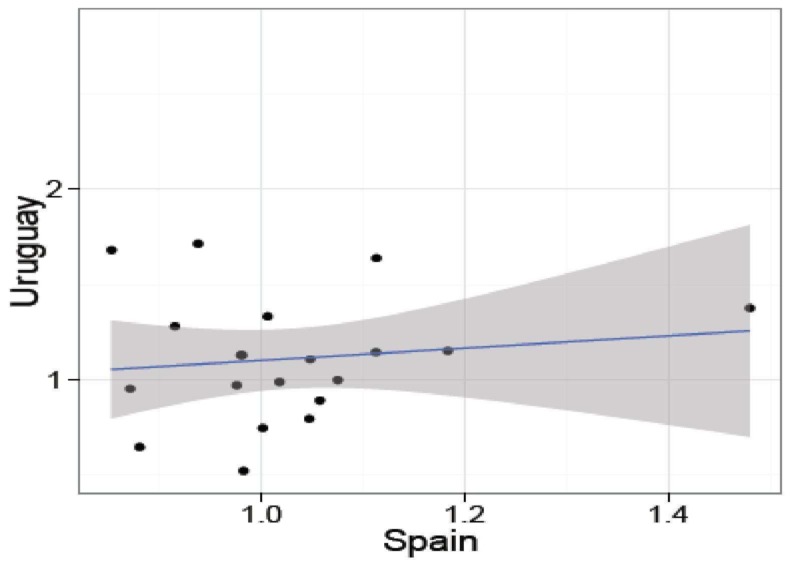

Figure 2. Correlation between indices.

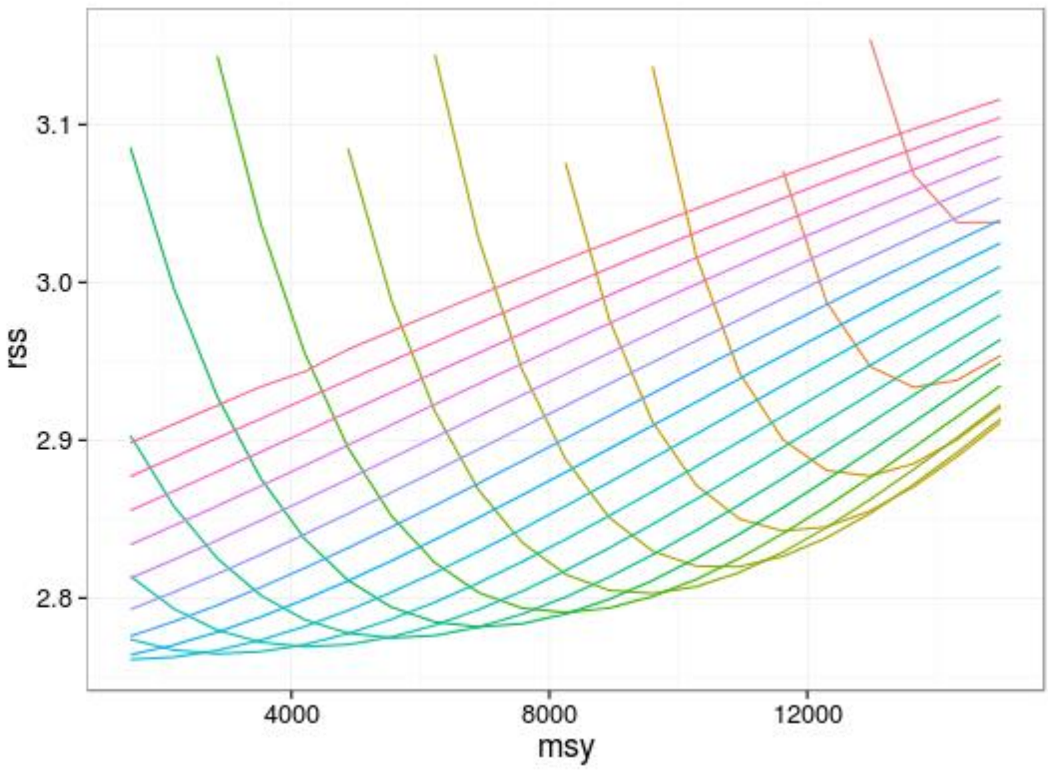

Figure 3. Profiles of residual sum of squares for MSY.

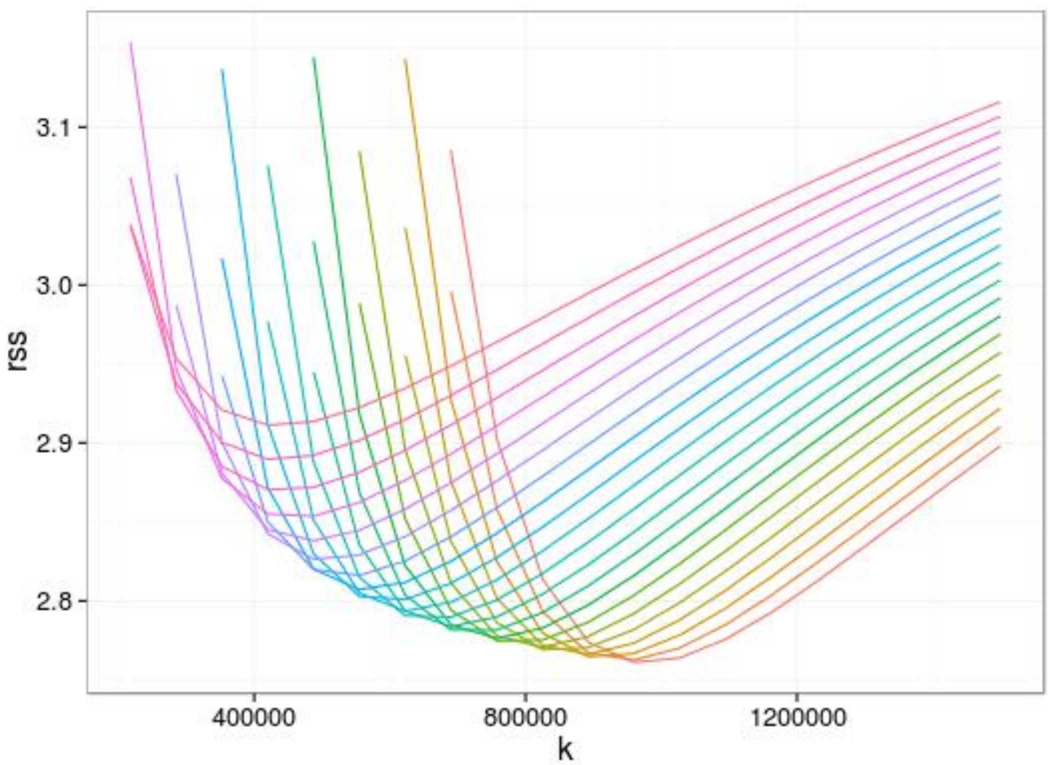

Figure 4. Profiles of residual sum of squares for K.

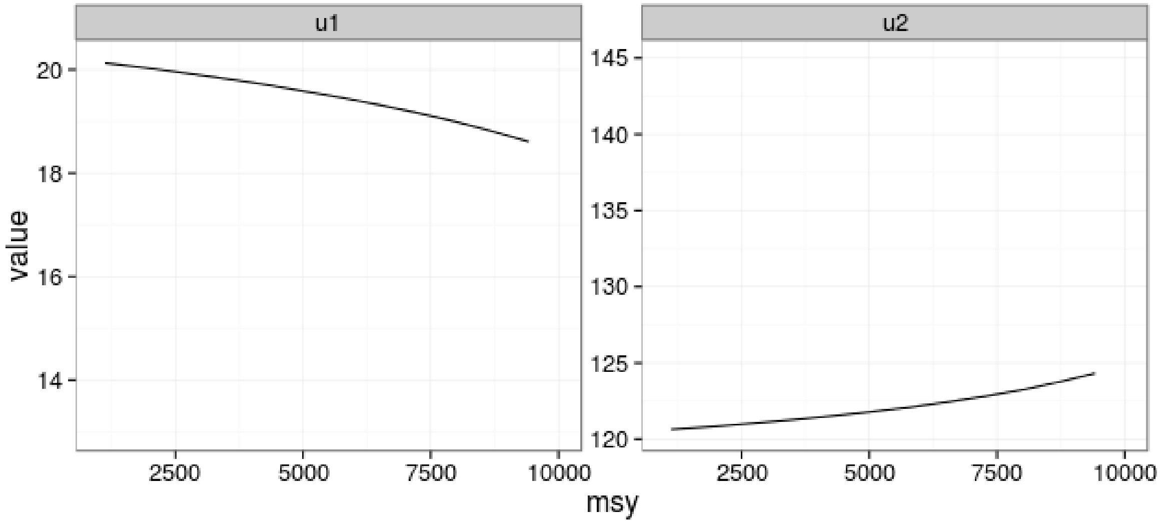

Figure 5. Profiles of residual sum of squares by index for MSY.

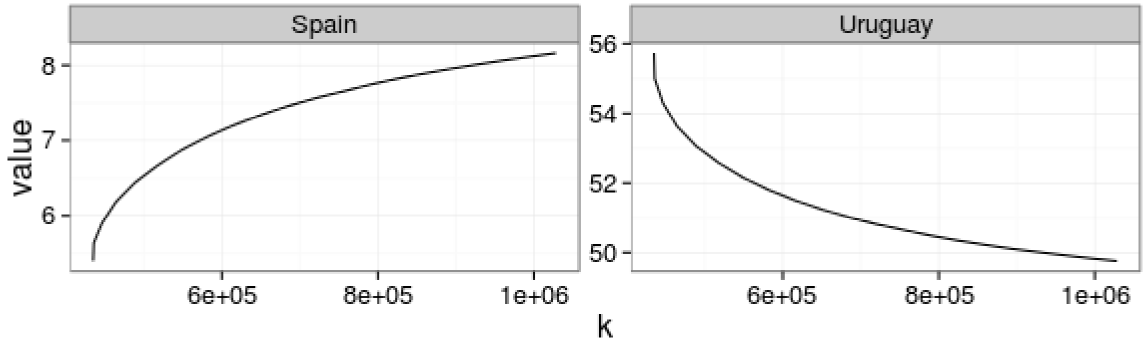

Figure 6. Profiles of residual sum of squares by index for K.

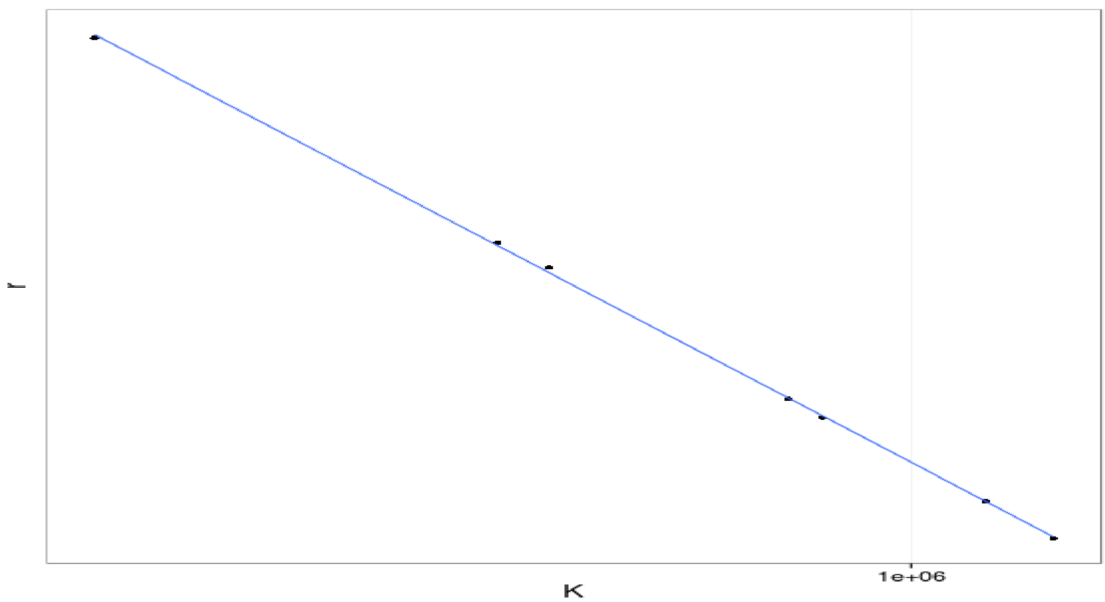

Figure 7. Plot of r verse K on the log scale from the North Atlantic Albacore assessment, points are the 7 scenarios used by the group.

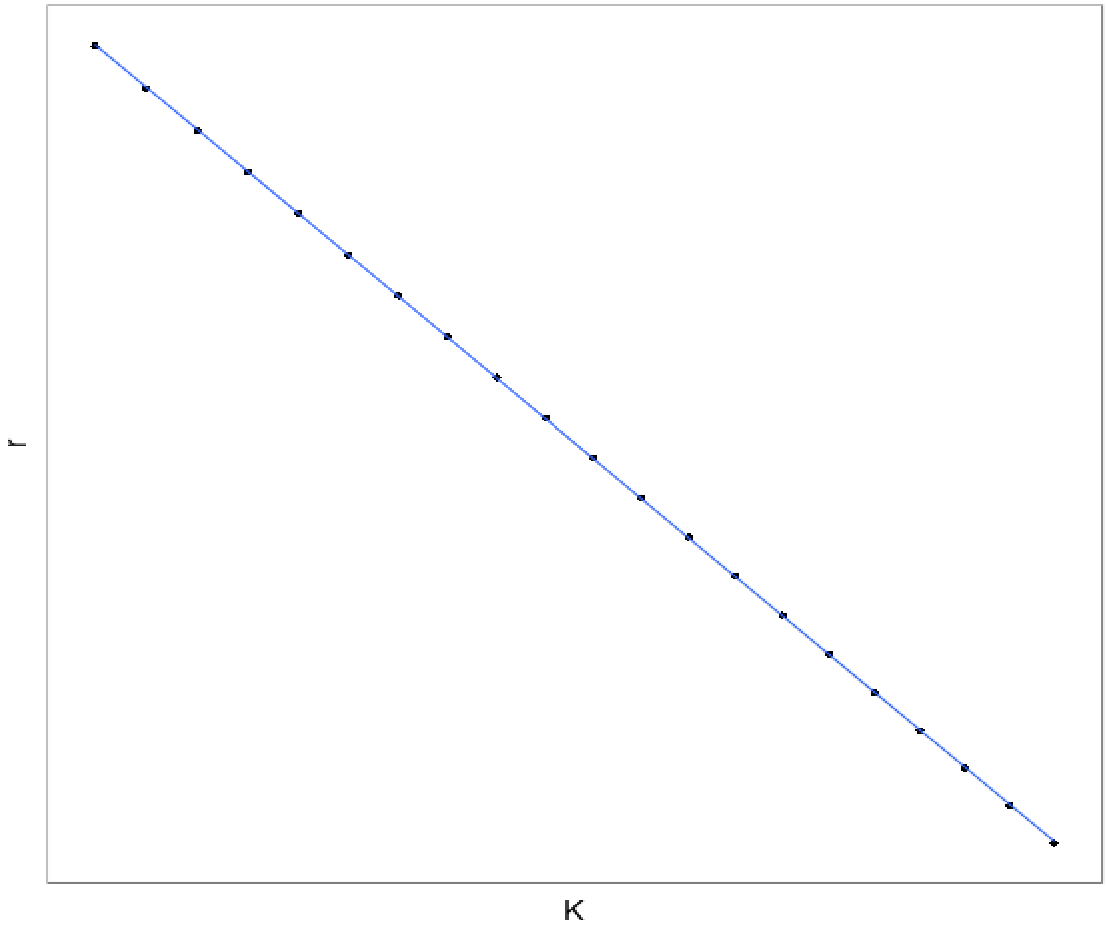

Figure 8. Plot of r verse K on the log scale from the likelihood profiling of K for North Atlantic swordfish, points are the fixed values of K.