SCRS/1994/031 Col.Vol.Sci.Pap. ICCAT, 43 : 325-329 (1996)

UPDATED ASPIC ANALYSES FOR NORTH ATLANTIC ALBACORE THROUGH 1992[1]

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ABSTRACT

The non-equilibrium stock production analytical model, ASPIC (Prager 1991, 1992, 1993a, 1994) was fitted to updated catch and effort data for the north Atlantic albacore tuna stock for the final Albacore Research Program meeting. Directed fishing effort statistics for the Spanish baitboat and troll fisheries and for the Japanese longline fishery (1968-1992) were available for updating the ASPIC results. Results were similar to trials made using ASPIC for the 1993 ICCAT SCRS meeting. Results indicated that several of the data series used in the model contained large variation and that the abundance trends from the separate series were not always in agreement. More in-depth examinations of the individual series of albacore CPUE data are needed to clarify the observed disparities between series before use in production model. The multiple series of indices currently available are useful in exploratory analyses of the individual CPUE trends.

RESUME

Le modèle analytique non-équilibré de production du stock, l'ASPIC (Prager 1991, 1992, 1993a, 1994) a été ajusté à des données actualisées de capture et d'effort sur le stock de germon nord-atlantique pour les besoins de la réunion finale du Programme de Recherche sur le Germon (PSG). Des statistiques sur l'effort des canneurs et ligneurs espagnols et des palangriers japonais visant directement cette espèce (1968-92) étaient disponibles pour actualiser les résultats de l'ASPIC. Les résultats étaient semblables aux essais effectués au moyen de l'ASPIC pour la réunion de 1993 du SCRS de l'ICCAT. Les résultats indiquaient que plusieurs séries de données utilisées dans le modèle contenaient une forte variation, et que les tendances d'abondance des différentes séries ne concordaient pas toujours. Il faut mener un examen plus approfondi des séries individuelles de données de CPUE du germon, afin d'élucider les divergences observées entre les séries avant leur utilisation dans le modèle de production. Les nombreuses séries d'indices dont on dispose à l'heure actuelle sont utiles pour les analyses d'exploration des tendances individuelles de la CPUE.

RESUMEN

Con destino a la reunión final del Programa Atún Blanco, el modelo analítico, de no equilibrio, de producción del stock ASPIC (Prager 1991, 1992, 1993a, 1994) se ajustó a los datos actualizados de captura y esfuerzo del stock de atún blanco en el Atlántico norte. Para actualizar los resultados de ASPIC se disponía de estadísticas de esfuerzo de pesca dirigido de las pesquerías españolas de barcos de cebo y arrastre y de la pesquería japonesa de palangre (1968-1992). Los resultados obtenidos eran similares a los ensayos realizados usando ASPIC, destinados a la reunión del SCRS de ICCAT en 1993. Estos resultados indicaban que varias de las series de datos utilizadas en el modelo tenían una amplia variación y que las tendencias de la abundancia de las series separadas no concordaban en todos los casos. Es necesario examinar más a fondo las series individuales de datos de CPUE de atún blanco, con el fin de esclarecer las disparidades observadas entre las series, antes de aplicarlas en el modelo de producción. Las múltiples series de índices que están disponibles en la actualidad son útiles para llevar a cabo análisis exploratorios de las tendencias individuales de la CPUE.

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1. METHOD

ASPIC is a program that fits a non-equilibrium logistic production model to catch and effort data (Prager 1993b). The method requires a time series of catch (yield) and fishing effort data (*CE*). The effort data should be effort that is directed towards the species being investigated. If only catch per unit effort (*CPUE*) exists then effort values can be derived by dividing catch by *CPUE*. The ASPIC program can also incorporate into the tuning procedure information on the level of the stock auxiliary to catch and effort data, such as, an estimate of the biomass (*B*) and/or an index of the biomass (*I*). At least one series of the data series however must be a *CE* type series. In the fitting process the program contains flexibility to separate fisheries (gears) and to partition individual fisheries by time series thus providing capability of examining changes in catchability with gear or time. The latter capability adds the important function of exploratory analysis to the ASPIC procedure.

In addition to the above data requirements the program requires the user provide starting guesses for the estimated parameters. These include r, the intrinsic rate of population increase; K the carrying capacity or the maximum stock size; B_1, the biomass at the beginning of the first year of the data; and q, the catchability coefficient of each fishery specific data series, ASPIC provides from the "FIT" application mode estimates of the basic parameter estimates above and output on the performance of the fit of the model to the data. Initial fits usually begin with all time series (i.e. fisheries and or time periods) weighted equally. Through the FIT mode the user can obtain results regarding the relative weights of each data series in the overall fitting. This output is supplied to the user to evaluate the overall results and to examine what the separate sets are indicating in the fit. A recent utility provide by ASPIC is a correlation matrix among all input series of the *CPUE* observations or estimates if *CPUE* was estimated.

ASPIC provides from the "BOT" application mode the above information output from "FIT" as well as estimates of precision of the parameters. Once a satisfactory analysis data set is selected that models the yield and effort reasonably the user can calculate the stock yield through time using a separate ASPIC utility.

Parameter estimation by ASPIC was specifically covered in Prager (1991 and 1992, 1993a). ASPIC assumes in model fitting that errors in yield or effort are multiplicative with constant standard deviation (Prager 1993b). The method allows residuals of the fit to be accumulated in effort or in yield. In the trials performed here, residuals were accumulated in effort because yield is more often the quantity known with more accuracy than is effort. Further, for data series where missing effort exists in one or more years estimation of these unknown values is possible.

2. AVAILABLE DATA TO UPDATE THE PREVIOUS ANALYSIS

Three sources of catch and effort statistics for the north Atlantic albacore surface and longline fisheries for 1968-1992, were used in the updated ASPIC trials. The fleet specific catch and effort data included the French baitboat, troll, midwater trawl, and driftnet fisheries, the Spanish baitboat and troll fisheries, the Japanese longline fisheries, and the Taiwanese longline fisheries. The primary input catch (yield) and effort statistics used were nearly identical to those of SCRS 93. The exceptions included 1) adding the 1992 year in all data sets, 2) replacing the nominal effort data of the Spanish baitboat and troll fisheries with standardized fishing effort data calculated from *CPUE* in weight standardized using general linear model (GLM) theory as suggested by the albacore working group at the 1993 SCRS meeting, and 3) replacing the nominal effort of the Japanese longline fishery with effective effort and with effort computed from standardized *CPUE* in weight as suggested by the albacore working group during the 1993 SCRS meeting.

Statistics for the French surface fleets were taken from ICCAT Statistical Bulletins and from the 1993 SCRS Albacore Working Group meetings. As in the previous ASPIC trials fishery statistics for the French fleets assume: 1) only nominal fishing effort statistics existed for French fisheries; 2) each individual fishery was entered into the analysis as a separate data set in the analysis yielding four data series, 3) the time series included were baitboat (1968-1976), troll (1968-1987), midwater trawl and driftnet (1988-1992). No other partitioning (i.e. year) was made for the French fisheries and only nominal effort data were available for analyses. The baitboat and troll fleets were not included in the analysis post 1976 and 1987 respectively. This decision was made by the Albacore Assessment Group during the 1993 SCRS working group meeting. These years mark the point in time when these fisheries are thought to not have been targeting albacore and when other surface fleets became more important in the albacore fishery.

Statistics for the Spanish surface fleets were taken from the ICCAT Statistical Bulletins and from unpublished results of GLM *CPUE* analyses provided by Spanish national scientist. Three data series were input into the ASPIC analyses for Spanish fisheries. These included 1) baitboat catch and nominal effort (1968-1980), 2) troll catch and nominal effort (1968-1980), and 3) troll and baitboat combined catch and standardized *CPUE* (1981-1992). Standardized *CPUE*, expressed as kg/1000 fishing days, was used to calculate a measure of standardized effort for the troll and baitboat fisheries combined for 1981-1992.

Fishery yield and effort statistics for the Taiwanese longline fleet was taken directly from SCRS/92/104 (Hsu *et al.*, 1993) Fishing effort values used in these analyses were selected from the printed output of GLM analyses. The 1992 effort value was calculated from a regression using the 1968-1991 statistics.

Fishery yield and effort statistics for the Japanese longline fishery were taken from information presented by national scientists at the 1993 SCRS working group meeting and from unpublished analysis results from GLM analyses. Effective effort was used as the measure of fishing time directed towards albacore in Trial 1 and fishing effort calculated from GLM values of *CPUE* in weight were used in Trial 2. In addition in trial 2 the Japanese longline fishery statistics were input as two separate series, 1968-1974 and 1975-1992, corresponding to periods in time when this fishery underwent changes in target species.

3. ASPIC TRIALS

Two trials were made to examine effects of the updated multiple series of total catch and effort statistics and incorporation of new GLM standardized values of effort on ASPIC program results for the north Atlantic albacore resource. In trial 1 fishing effort for the Japanese longline fishery was measured as effective effort while in Trial 2 effort for the Japanese longline fishery was calculated as discussed earlier using the GLM values of standardized *CPUE* in weight. In Trial 1, effective effort for the Japanese longline fishery was available only for 1975-1992 so effort for 1968-1974 was estimated through the ASPIC program. In both Trial 1 and 2 effort for the Spanish baitboat and troll fisheries (combined) for 1981-1992 was computed from GLM standardized CPUE in weight. Spanish baitboat and troll effort for 1968-1980 was nominal effort as described above in the Data Section and was entered separately for each fishery. As in the 1993 SCRS analysis, Taiwanese longline effort included was from standardized GLM analyses. Fishing effort statistics for all French fisheries was input as nominal effort as described above.

4. RESULTS

Results of fitting the 10 different data series to the north Atlantic albacore catch and fishing effort data are shown in Table 1. Detailed results from the fits are available on computer disk from the author. The observations from fitting are similar to previous results from fitting ASPIC to the albacore data in that annual trends in *CPUE* show large variations for the surface fisheries and are very different between fisheries. This observation is not surprising since the different fisheries target different segments of the stock. That the individual fisheries show large variation within a fishery over time is not un-expected because the importance of certain gears to the total catch has not remained constant over the entire time period of the analysis, 1968-1992. The amount of agreement between the catch and effort series was also measured by the correlation between individual sets measured as *CPUE*. When all of the data series were entered into the analysis together correlation factors between many sets were observed to be negative. In general very few data series showed a positive correlation greater than 0.5 (Table 2a and 2b).

The fitting results of the ten different data series gave values of *MSY* ranging from 102,600 t - 140,900 t. Trials 1 and 2 represent analyses using the catch (yield) and effort data from all of the surface fleets and from the longline fleets entered together in the ASPIC program. Results from trial 1, in which all 10 data sets were modelled over the time period 1968-1992 and, in which the effort of the Japanese longline fishery was measured as effective effort gave a predicted *MSY* of 140,900 t. Trial 2, also including all ten data series for 1968 -1992 and included the Japanese longline fishing effort as standardized effort, gave an *MSY* of 102,600 t. Results for Trial 2 yielding an *MSY* of 102,600 t can be compared with that of SCRS 1993 that gave values of 51,240 t to 64,970 t. This comparison provides some information on effects of including standardized effort into the analysis. Trial 2 was considered more realistic over trial 1 because the number of observations having negative correlation in *CPUE* were fewer for trial 2 and the agreement in observed *CPUE* was higher for trial 2 for observations that were positively correlated.

5. COMMENTS

Results of the two trials were quite variable as regards parameter estimates. It was not possible to incorporate directed effort for all the fisheries that are known to exploit the albacore stock because that information is not available. If the nominal effort statistics used for the French surface fleet statistics are not representative of directed effort on albacore then a bias in results would exist. An additional complicating factor recognized by the author occurring in these analyses here and in the previous analyses of SCRS/93/105 (Cummings-Parrack, 1994) is that of the disagreement of the basic data series being input into the ASPIC model. This was observed in the trials conducted in this study by the large negative correlation (in *CPUE*) between individual data points of the separate series. The ASPIC model is flexible in the ability to incorporate different series (fisheries) of varying time-lengths. When the trends between individual data series are vastly different and/or the amount of variability in the input observations is extremely large the results may be not realistic. In addition, violations of the basic production model occurs if the different series are not representative of the same age groups of the stock. For that reason population trajectories were not evaluated from the results of the trials.

These observations suggest other points that have importance to the use of multiple series of indices in production models analysis for the north Atlantic albacore stock. First, negative correlations between many of the individual sets of catch and effort data suggest that many of the data series are not in agreement with each other in terms of trends in abundance. The low correlations further suggest that the data series are giving disparate trends in abundance. This observation emphasizes the need for a closer look as to why several series are indicating differing abundance trends even though they are targeting similar age groups of the stock. It is unknown whether the individual sets of surface indices are tracking different portions of the stock or if trend results are due to differences in analyses methods. Second, several of the data series (e.g. Spanish and French surface fleets) also represent fleets fishing localized components of the stock; and *CPUE* trends from these fisheries may not be representative of the total stock. This should be considered in context of other analyses in which these surface indices are used as indicators of total stock abundance (i.e. virtual population analyses). In fact, it is believed by some, that the Spanish surface boats do not target the age 1 fish and actually avoid this age group. Third, whether the indices calculated using nominal effort (i.e. French) are representative of directed fishing effort is not known also and introduces further bias into results. This concern has been significantly improved recently for the north Atlantic albacore stock as many of the *CPUE* series have been treated using one or more of the commonly used standardization type methods. Fourth, the surface fisheries represent the major fisheries currently targeting albacore but these fleets target only young fish less than five years of age so these indices alone can not be used to model total stock production. In the 1993 SCRS ASPIC analysis, one of the runs include the multiple sets of catch and effort data from the surface fleet (some nominal and some standardized) together with the total catch as the input. This approach was not considered valid for these analyses here as the surface fisheries alone would only provide information on young fish. Likewise, the indices from the longline fleets taken together with the total catch were evaluated during the 1993 SCRS meeting and by previous albacore scientists prior to that. However, indices from the longline fisheries cannot alone be used to model total stock production because these fleets target only the adult component. Fifth, including multiple series of *CPUE* from fleets fishing localized groups of young fish together (i.e. surface) with indices catching only the adult stock (i.e. longline) probably introduces further violations to the basic production model analysis since all indices are not tracking the same component of the stock. Six, a change in selectivity occurred in the albacore fishery as thought to by some familiar with the fishery, the fraction of the stock available to the fishery may change and again violations to basic production model theory.

In summary, the analyses were improved by the addition of standardized effort for two fisheries, the Japanese longline (1968-1992) and the Spanish baitboat and troll (1981-1992). The usefulness of the results are presently limited due to the unique characteristics of the multiple indices. Further analyses of the *CPUE* indices should incorporate measures of directed albacore fishing effort for the remaining surface fisheries that are developed through similar standardization methods as for these fisheries (i.e. GLM, Homma, etc.). In addition, because the individual data sets contain a great deal of variability in *CPUE* both within and between data series two avenues of research should be pursued. First, the raw data used in *CPUE* standardization analyses should be carefully reviewed and the methods used to arrive at a final model rigorously by the albacore working group perhaps in a workshop forum. Secondly, the individual data sets could be analyzed externally to ASPIC via a GLM framework for the purpose of calculating a separate index of *CPUE* obtained across all fisheries as suggested by Prager (personal communication). This separate index of *CPUE* could be entered into the ASPIC analyses with the total yield to examine stock production.

Table 1. Results of ASPIC Analyses for North Atlantic Albacore for Two Trials

Trial	Estimated *MSY* (MT) *MSY* (MT)	*K*	*r*	$Biomass_{1993}$ /$Biomass_{1969}$	B_{1993}	B_{1993}/K	Data Series Used
1	140,900	251,900	2.24	1.04	239,000	0.95	1-9
2	102,600	122,000	3.36	1.42	113,400	0.93	1, 3-11

Table 2a. Correlation among input series for Trial expressed as CPUE (number of pairwise observations is given under each value)

Index Set	Correlation								
1. #1,TAi LL, 100 hooks, standardized	1.000								
	25								
2. #2 Jap LL effective effort	'0.681	1.000							
	18	18							
3. #3, Spain BB, 1000 fishing days	0.479	-0.809	1.000						
	13	6	13						
4. #4, Spain Troll, 1000 days, nominal	0.205	-0.812	0.427	1.000					
	13	6	13	13					
5. #5, Spain TROL+BB (CPUE=standardized)	0.105	-0.593	0.000	0.000	1.000				
	12	12	0	0	12				
6. #6, French BB, 1000 days, nominal	0.453	-1.000	0.982	-0.417	0.000	1.000			
	9	2	9	9	0	9			
7. #7,French Troll, 1000 days, nominal	0.350	0.232	0.172	0.46	0.005	0.164	1.000		
	20	13	13	13	7	9	20		
8. #8, French DNT 1000 days, nominal	-0.632	-0.904	0.000	0.000	-0.067	0.000	0.000	1.000	
	5.	5	0	0	5	0	0	5	
9. #9, French MWT, 1000 days, nominal	-0.01	-0.096	0.000	0.000	0.647	0.000	0.000	-0.255	1.000
	5	5	0	0	5	0	0	5	5
	1	2	3	4	5	6	7	8	9

Table 2b. Correlation among input series for Trial 2 expressed as CPUE (number of pairwise are given under each value).

Index Set	Correlation									
1 #1,Tai LL,100 hooks,standardized	1.000									
	25									
2 #2 Jap LL effort=c/std cpue	-0.193	1.000								
	7	7								
3 #2a Jap LL effort=c/std cpue	0.496	0.000	1.000							
	18	0	18							
4 #3, Spain Bb,1000 fishing days,	0.479	0.070	-0.444	1.000						
	13	7	6	13						
5 #4 Spain troll,1000 days,nominal	0.205	-0.822	-0.660	0.427	1.000					
	13	7	6	13	13					
6 #5,Spain tr+bb (cpue = stdzed	0.105	0.000	-0.380	0.000	0.000	1.000				
	12	0	12	0	0	12				
7 #6,French bb, 1000 days, nominal	0.453	-0.038	1.000	0.982	-0.417	0.000	1.000			
	9	7	2	9	9	0	9			
8 #7,French troll,1000 days, nominal	0.350	-0.066	0.079	0.172	0.460	0.005	0.164	1.000		
	20	7	13	13	13	7	9	20		
9 #8,French dnt 1000 days, nominal	-0.623	0.000	-0.851	0.000	0.000	-0.067	0.000	0.000	1.000	
	5	0	5	0	0	5	0	0	5	
10 #9,French mwt,1000 days,nominal	-0.010	0.000	0.308	0.000	0.000	0.647	0.000	0.000	-0.255	1.000
	5	0	5	0	0	5	0	0	5	5
	1	2	3	4	5	6	7	8	9	10