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CATCH-AT-AGE ESTIMATION IN NORTH ATLANTIC ALBACORE

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SUMMARY

Age structure knowledge is necessary to apply analytical population analysis techniques in stock assessment. Several methods have been used to obtain catch-at-age data from the catch-at-size table for the northern albacore stock. Application of the mixture method shows a good performance to obtain the age frequency for young age groups. A brief description is presented in this paper.

RESUME

Les connaissances de la structure démographique est nécessaire pour appliquer les techniques d'analyse de la population analytique dans l'évaluation du stock. Plusieurs méthodes ont été utilisées pour obtenir les données de prise par âge tirées de la table de prise par taille du stock du germon nord. L'application de la méthode mixte indique une bonne performance pour obtenir la fréquence par âge des jeunes groupes d'âge. Une brève description est présentée dans ce document.

RESUMEN

El conocimiento de la estructura de edad es necesario para aplicar técnicas analíticas de análisis de población en evaluación de stock. Se han utilizado varios métodos para obtener datos de captura por clases de edad a partir de la tabla de captura por clases de talla para el stock del atún blanco del norte. La aplicación del método de mezclas muestra su buen rendimiento para obtener la frecuencia por edad de los grupos de edad juvenil. En este documento se presenta una breve descripción.

INTRODUCTION

A neccesary information for most population assesment models is a demographic description of the population. Therefore, the stablishment of age through measuring growth rate in relation with time variable is a prior parameter to estimate.

Often catch-at age distribution is derived from sampled length-frequency , the age relationship is described by either age-length keys (Fridikson,1934) or a growth curve , mostly the von Bertalanffy model (von Bertalanffy,1938).

Analysis of VPA, are supported by age structure information of catch data, obtained by those deterministic methods mentioned above. The use of these ageing methods include several types of biases (Powers,1983), then is important to choose an ageing technique whose estimation would include a reduction of errors, which always occur with existing methods (Bartoo and Parker,1983). Because the von Bertalanffy equation is a deterministic model it adds bias results. When using skeletical structures to derive an age-length key it is assumed another error when back-calculating the lentgh at annuli formation by changing age to dependent variable in growth equation.

Alternatively , another aproach to estimate age composition from size data is the analysis of the length frequency distributions. The basic idea inherent this technique is that clear modes appears in the catch size sampled and they may represent several cohorts. This principle was first pointed out by Petersen (1891), who separated age components of mixture by visual inspection.

Graphical methods to find mean lenghts at age , although widely used, they involve subjectivity (Cassie, 1954; Bhattacharya,1967) and are unreliable , unless the components are well identify (MacDonald, 1987).

Computer-assisted statistical methods, include the methods of moments, maximum likelihood, Bayesian methods and various minimum distance approaches (Titterington et al., 1985).

Different procedures have also been developed which combine both age-length-key (ALK) and length frequency analysis (Kimura and Chikuni, 1987; Martin and Cook, 1990).

For tuna stocks, catch-at-age tables as inputs in analitical models, are usually derived using deterministic "knife-edge" techniques, that implies number at length are converted into numbers at age, setting different boundaries in the length frequency distributions according to a growth curve equation. This technique shows two defficiencies; first it does not take into account the increase of length dispersion with age, and second, strong year classes and weak ones are not properly estimated.

The First ICCAT Albacore Workshop (Anon., 1990) discussed about this problem and recommended the investigation of the utility of stochastic methods for estimating the international albacore catch at age data. Santiago (1991) applied to albacore length data an stochastic method which contemplates the mean length and standard desviations in length for several age groups (Schnute and Fournier, 1980), demonstrating their good performance, at least to split younger age groups.

The Second ICCAT Albacore Workshop (Anon., 1991) recommended the use of stochastic methods to break down the 1975-1989 catch by size serie into age groups, working with the finest strata possible.

Different procedures have been developed to solve mixing of components in a size distribution.

BIOLOGY OF ALBACORE

Knowledge of poblational parameters and behaviour of albacore is a requirement when using structural models (Anon., ICCAT 1991; Anon., ICCAT 1993). Biological studies show:
-Natural Mortality
Assumed to be m=0.3 (Anon.,ICCAT 1990)
-Sexual Maturity
Not much knowledge on reproduction cycle is achieved. Spawning areas are located nearby Sargasson sea, in western Atlantic ocean and it takes place in Spring- Summer seasons (Bard, 1981). Sexual maturity is reached at a size superior to 85 cm fork length (4 or 5 years).
-Growth
Age and growth studies (Bard, 1980;Garcés and Fariña, 1983) using dorsal fin rays and estimated growth parameters from modal analysis (Beardsley, 1971) were reviewed by the Worshop held in 1989 (Anon., 1990). Size at age obtained by those methods were not in agreement. Trying to verify one of the growth curves, tag-recapture curve fit to von Bertalanffy function, was used. The best agreement was found with growth model fit by Bard (1980), which was adopted by SCRS for assesment purposes. However, ageing using hard parts has not been validated.

CATCH AT SIZE

Catch at length tables are updated in ICCAT files for North stock albacore. Collection of data are presented by gear and month (surface) or quarter (long-line) by ICCAT statistical areas.

CATCH -AT- AGE TABLE

Analysis of length frequency data serie applied in North Atlantic Albacore stock.

i) Slicing method.

Catch-at- age table were obtained by splitting the cath at size data set according to Bard (1981) growth equation, that was recommended by the Workshop held in 1989 (Anon. 1990). This method is well described in the report of the Second Albacore Workshop (Anon.1991). The results of applying this technique showed that it worked only for younger age groups (1 to 3), whose size distribution overlap less. For older age categories, where overlapping of adjacent ages is significant, the age-slicing technique, produces results which incorporate some degree of uncertainty and subjectivity.

Therefore, it was recommended to investigate the application of alternative distribution mixture methods for obtaining tne age frequency of commercial catch.

ii) Stochastic age-frequency estimation

First attempts of length frequency analysis were carried out with the application of the package Multifan ver 3.15 (Anon. 1992; Santiago, 1992). This computer package designed by Fournier and Sibert (Otter Research Ltd.) analyzes length frequency mixtures in order to get estimates of growth parameters and age composition. It uses a likelihood-based method that extends the model of Schnute and Fournier (1980) to simultaneously analyze several length frequency data sets, reducing the possibility of ambiguous results. It also introduces a new estimation method that reduces the subjectivity of the analysis. A detailed description of the mathematical basis of this method is given in Fournier and Sibert (1990).

The main assumptions of the basic model of MULTIFAN are:

- normality of the distributions of length at age;
- mean lengths at age follow a von Bertalanffy growth model;

Additional assumptions may also be included in the model:

- length dependence of standard deviations of length at age,
- size selectivity for the first age class; and
- seasonal component of growth.

DISCUSSION

Age calculated using a deterministic model as von Bertalanffy growth relationship, gives some bias. The quantification of error comitted is proportional to overlap in lengths-at-age and changes when analyzing data containing week or strong year classes. In the case of week year classes present in the data matrix, this model tends to disguise it in other year classes, consequentely variability of year class is underestimated and the recruitment stability is overestimated.

A stochastic model based on a matrix of length interval probabilities at age can reduce the bias in the results.

Length frequency methods like MULTIFAN provides reliable information on the age composition of the catches of North Atlantic albacore, specially for youngest ages (up to 4 years old group), representing an improvement with regard to the scilicing ("knife-edge") method, as concluded in Anon. (1992) and Santiago (1992).

Subsequently, the complete data set of North Atlantic albacore catch at size from 1975 to 1991 (on a quarterly basis) was analyzed using MULTIFAN Ver, 2 (Santiago, 1993) for second assesment of North Atlantic Albacore (Anon.,1993).

This technique has been adopted by the SCRS, as highly useful to obtained catch-at-age table with some feasibility, at least for younger age groups 1 to 4, although still remains the problem of separeting accurately older age groups present in the fishery.

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