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AGEING THE CATCH AT SIZE FOR YELLOWFIN TUNA. A REVIEW NOTE ON ICCAT'S METHODS

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SUMMARY

This paper reviews the methods used by SCRS scientists to estimate the catch-at-age table for tropical tunas from the catch-at-size table. The method predominantly used was the simple monthly slicing of sizes, but recent work has shown some problems linked to the use of this method. The numbers of old fish estimated from slicing appear to be biased, because of the size overlapping of large fishes of different ages at given sizes. An improved method derived from the Kimura and Chikuni method have recently been used for yellowfin tuna and may help to reduce this problem, especially to estimate better the year-class strength variability. However, this use is limited by the absence of direct knowledge of the variability of ages at given sizes.

RESUME

Cet article fait une revue des méthodes utilisées par les scientifiques du SCRS pour estimer la matrice des prises par âges à partir du tableau des prises par âge. La principale méthode employée a été celle du découpage mensuel des fréquences au "hachoir", mais des travaux récents ont montré divers biais potentiels liés à cette méthode. Les nombres de vieux poissons estimés par cette méthode peuvent être biaisés par suite de la présence aux grandes tailles de poissons de divers âges. Une méthode améliorée dérivée de la méthode de Kimura et Chikuni a été proposée récemment et peut aider à réduire ces problèmes, en particulier en estimant mieux la variabilité du recrutement. Toutefois, l'emploi de ces méthodes améliorées est limité par l'absence de connaissances sur la variabilité des âges à une taille donnée.

RESUMEN

Este documento examina los métodos utilizados por los científicos del SCRS para estimar la matriz de las capturas por edad, basándose en la tabla de capturas por edad. El principal método empleado ha sido el corte ("filo de cuchillo") mensual de las frecuencias, si bien, algunos trabajos recientes han mostrado que este método contiene varios sesgos potenciales. Los números de peces viejos estimados por este método, podrían contener sesgos producidos por la presencia de peces de varias edades en el grupo de tallas grandes. Recientemente se ha propuesto un método mejorado derivado del método de Kimura y Chikuni, que podría contribuir a resolver en parte estos problemas, sobre todo, estimando de forma más exacta la variabilidad del reclutamiento. No obstante, el empleo de estos métodos más perfeccionados está limitado por la falta de conocimientos sobre la variabilidad de las edades a una determinada talla.

I-INTRODUCTION

The catch at age analysis have been conducted on yellowfin tuna since the early seventies (Fonteneau and Lenarz 1973). This analytical work was since conducted every year. This work was of major interest, because yellowfin was always exploited by several gears at variable efforts, each one having typical fishing patterns but age specific catchabilities, which are often variable with time. This variability was due to two major factors:

- the environmental changes which can produce during some years a high or a low age specific catchabilities for some gears.

- a general trend for an increase of fishing efficiency due to technological improvement of the fishing gears and of the fishing techniques.

The goal of the age specific analysis was first to evaluate the changes in fishing mortalities and, knowing the fishing efforts, to calculate the changes in fishing efficiencies. The final goal was to calculate the multigear yield per recruit of the fisheries.

A similar work was done on bigeye and skipjack tunas, using methods which were similar to the ones used for yellowfin.

The present short note will review this analytical work conducted on yellowfin (and other tropical species) in order to obtain the catch at age tables which the more basic and fundamental input of any SPA.

II-A BRIEF REVIEW OF YELLOWFIN LIFE HISTORY

The main biological characteristic of yellowfin tunas, at least in the eastern Atlantic were most studies have been conducted, are the following:

-M:

High natural mortality, assumed to be at a level of M=0.8 during 2 years, and then stable at M=0.6. An increase of M due to senescence was suspected, but never used in any analysis. The life expectation is approximately 6 years (at least in the catch at age tables...but direct age determinations are very rare)(An. ICCAT 1984).

-Spawning:

The spawning activities are mainly observed during one quarter, in the beginning of each year. This seasonality and the corresponding concentration of spawners is stable from one year to the other (and heavily exploited by the purse seine and longline fleets) (Bard and Capisano 1991). This is well shown by figure 1.

-Growth:

The growth pattern of yellowfin follows a rare two stanza growth curve (figure 2), which is probably due to ecological and physiological factors. This growth has been described and analyzed by many authors, among other by Fonteneau 1981, Bard and al 1991 or Gascuel and al. 1993. No direct reading of age are collected routinely by any laboratory.

-Males and females sex ratio and growth:

A significant difference was always observed for yellowfin tuna in the sex ratio by size (as shown by various authors, among others Capisano and Fonteneau 1991): most of the larger yellowfin are males, when females show a small average excess at intermediate sizes (see figure 3). This differential sex ratio is assumed to be related to a differential growth curve of the adult males and females, the asymptotic sizes of females being smaller than for males. As a consequence, the males are usually dominant in the total catches (figure 6).

III-A BRIEF REVIEW OF BUILDING OF THE CATCH AT SIZE

The catch at size is based on the samples taken at landing on most fleets. The size sampling for yellowfin has always been quite intensive, as most of the major fisheries have been well sampled, at least during recent years (about 50000 individuals were measured each year). The size samples are extrapolated by flag and gear. For most surface fleets, the extrapolations were conducted at a monthly level by geographical units of 5º squares. A limited number of strata substitutions are usually done (on approximately 10% of the catches during recent years) within the strata where no sample (or too small samples) was available. The sizes taken by the longliners are processed in a similar way, but using wider strata and more strata substitutions, as those fleets are usually less well sampled.

At the end of this data processing, monthly catch at size tables (by 2 cm intervals) are obtained, by area and for each gear. The total of this quarterly catch at age table (all gears) is used as the input of the ASP.

IV-A REVIEW OF PAST METHODS: SLICING THE CATCH AT SIZE

The present process used to built the catch at age from the catch at size tables was described by Fonteneau and Capisano 1991. This method is based on a monthly slicing of the catch at size table, using monthly fixed limits (given as a fixed table corresponding to the figure 3). The monthly fixed limits between ages are based on the analysis of the sizes taken by the fisheries (as described in Fonteneau and Capisano 1991). The use of constant limits, independent of the observed positions of modes, has been chosen because of the general stability of the modes (probably due to the relative constancy of the major spawning season). In general, those slicing limits works well on the modes observed for juvenile yellowfin, but are often inadequate for the large fishes at sizes where the modes of large fishes are usually overlapping. A table of quarterly catch at age is obtained (for each gear) using this method. Those quarterly catches at age are used for yellowfin VPA, because of the marked seasonalities observed for most of the fisheries: adults being caught in the first quarter, juvenile in the second half of the year.

V-A REVIEW OF PAST METHODS: SLICING THE CATCH AT SIZE

Some experiment of modal decomposition were unsuccessfully conducted by Capisano and Fonteneau 1991 using several methods: Battacharya (Pauly and Caddy 1985), Mix (Mac Donald and Pitcher 1979) and Multifan (Fournier and al 1990). The modes were easily separated for the small and medium sizes , but unsuccessfully separated for larger sizes, even during an intensive experimental analysis. Consequently the use of the slicing method was kept as the standard way to estimate catch at age from catch at age.

The major advantage of the present slicing method used for yellowfin was its simplicity and its flexibility, as it can easily be used in the assumption of the two stanza growth curve hypothesis. However it has always been obvious that this simple method could be inadequate and biased, especially for the large yellowfin. This inadequacy is due, among other factors, to the significant overlapping of the adjacent ages at large sizes: the mixing of ages at any given size is obvious for all large fishes. The differential growth between males and females probably increases those problems, as the larger modes of males (fishes greater than 150 cm) may have the same age as the modes of females at intermediate sizes (for instance 125 to 140 cm FL at sizes where the females are dominant in the catches). This problem have been explored by Garcia and Albaret 1977, but their results were never used in the building of a sex specific catch at age table.

VI-SOME PROSPECT OF AN IMPROVED AGEING: GASCUEL'S 1992 METHOD.

More recently, Gascuel 1992 proposed a paper (submitted to the Canadian Journal) developing an improvement of the present slicing method used for yellowfin.

This new method takes into account the variability of sizes at age and allows to correct the year to year variability of the year class strength. This model uses an algorithm similar to the one proposed by Kimura and Chikuni 1987. This new method provides better estimates of the year class strength estimated from the catch at age table (as the year to-year variability of the catches on each cohort are better taken into account. The traditional slicing method was able to estimate that the 1968 or 1983 cohort were both very low, but the catches upon each of those two cohorts was overestimated by "contaminated" catches from adjacent cohorts (for instance the very poor 1984 cohort being contaminated by caches from the very large 1983 cohort. The Gascuel's method was also used under the two stanza growth model, but the possible differential growth by sex was not taken into account (because the adequate data are still lacking).

CONCLUSION

To obtain a realistic catch at age table for yellowfin tuna is a necessity when scientists want to have a good understanding of the changes in the stock sizes and in their exploitation regime. The method used to obtain this catch at age from the catch at size tables are still fairly inadequate and provisional, even if some significant progresses in the methods have been proposed recently by Gascuel. The fundamental problem is that the real age of the large yellowfin remains fairly uncertain. Further researches should be developed in this very important field of ageing the adult yellowfin. This problem also applies to other tropical tuna species such as skipjack and bigeye tunas.

The exchange of experiences between scientists working on different species would be obviously of major interest.

BIBLIOGRAPHY

An. ICCAT 1984.- Report of the working group on juvenile tropical tunas. Rec. Doc. Scient. ICCAT Vol. 21 (2): 188 p.

BARD (F.X.) et CAPISANO (C.), 1991.- Actualisation des connaissances sur la reproduction de l'albacore (Thunnus albacares) en Océan atlantique. Rec. Doc. Scient. ICCAT, Vol. 36, pp. 158-181.

BARD (F.X.), CHABANNE (J.) et CAOUDER (N.), 1991.- Croissance du thon albacore (T. albacares) en Océan Atlantique estimée par marquages. Rec. Doc. Scient. ICCAT. Vol. 36 - pp. 182-264.

CAPISANO (C.) et FONTENEAU (A.), 1991.- Analyse des fréquences de longueur, du sex ratio et des zones de reproduction de l'albacore, Thunnus albacares de l'Atlantique. Rec. Doc. Scient. ICCAT Vol. 36, - pp. 241-279.

FONTENEAU (A.) and LENARZ (W.H.), 1974.- Cohort analysis of the eastern Atlantic fishery for yellowfin tuna. Rec. Doc. Scient. ICCAT, vol. 2, pp. 57-77.

FONTENEAU (A.), 1981.- Dynamique de la population d'albacore (Thunnus albacares) de l'Océan Atlantique. Thèse doctorat Université Paris 6. Nov. 1981 : 324 p.

FOURNIER (D.), SIBERT (J.), MAJKOWSKI (J.) and HAMPTON (J.), 1990.- Multifan, a likelihood-based method for estimating growth parameters and age composition from multiple length frequency samples with an application to southern bluefin tuna (Thunnus maccoyi). Can. J. Fish. Aquat. Sci., 47:301-317.

KIMURA (D.) and CHIKUNI (S.), 1987.- Mixtures of empirical distributions: an interative application of the age-length key. Biometrics, 43 : pp. 23-35.

GARCIA (S.) and ALBARET (J.J.) 1977. Utilisation de la relation sex-ratio/taille pour la décomposition par sexe des structures démographiques. Cah. ORSTOM, sér. Océanogr.,15:83-87.

GASCUEL (D.), 1992.- Une méthode simple d'ajustement des clés taille/âge. Application aux captures d'albacores (Thunnus albacares) de l'Atlantique est. Doc. SCRS 1992/37 (non publié dans Rec. Doc. Scient. ICCAT, soumis au Can. Journ.),.

GASCUEL (D.), FONTENEAU (A.) et CAPISANO (C.), 1992.- Modélisation d'une croissance en deux stances chez l'albacore (Thunnus albacares) de l'Atlantique est. Aq. Liv. Res., 1992, 5, pp 155-172.

MAC DONALD P.D.M. and PITCHER T.J., 1979.- Age groups from size frequency data : a versatile and efficient method of analyzing distribution mixtures. J. Fish. Res. Board Can. 36 : 987-1001.

PAULY (D.) and CADDY (J.F.), 1985.- A modification of Bathacharya's method for the analysis of mixtures of normal distributions. FAO Fish. Circ. (781) : 16 p.

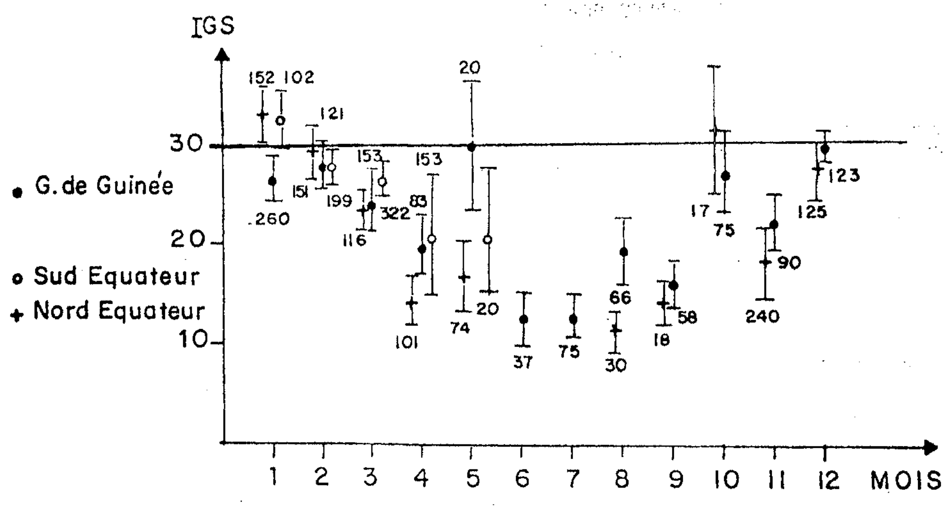

Figure 1: Seasonality of the eastern Atlantic yellowfin gonad indices (from Bard et Capisano 1991). A Gonad Index (GI) greater than 30 corresponds to a spawning activity).

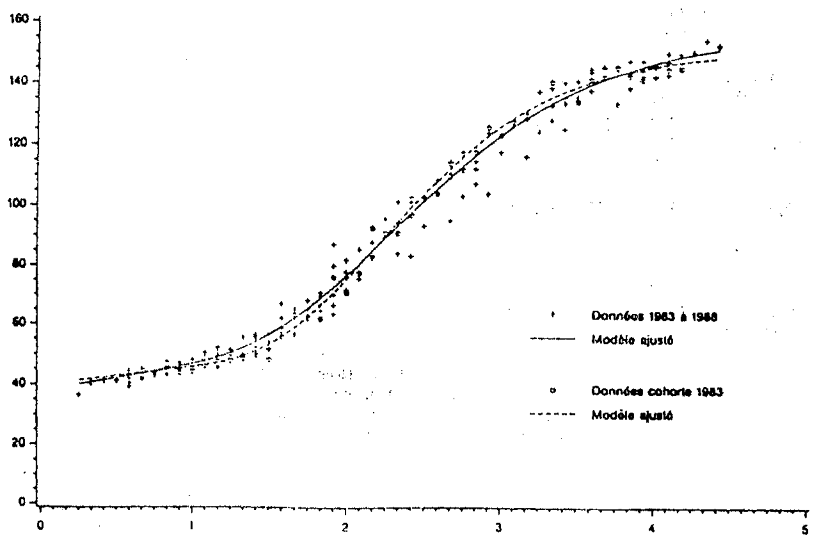

Figure 2 : The yellowfin growth model (from Gascuel et al 1992).

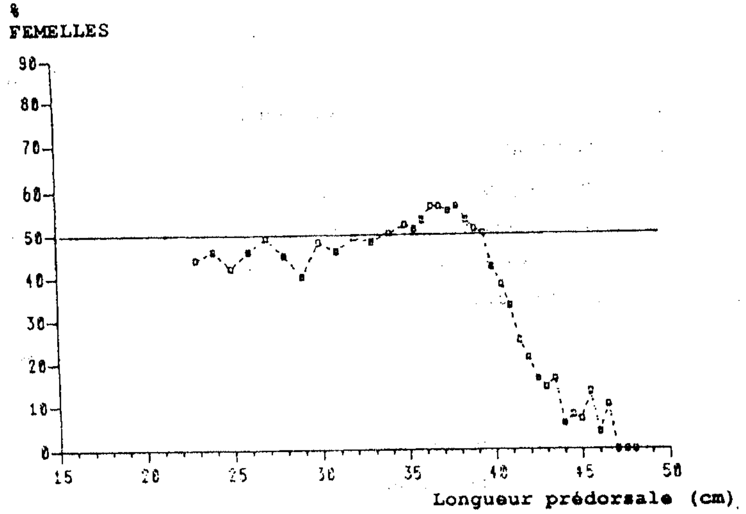

Figure 3 : Sex ratio observed for adult yellowfin in the eastern Atlantic (From Capisano and Fonteneau 1991).

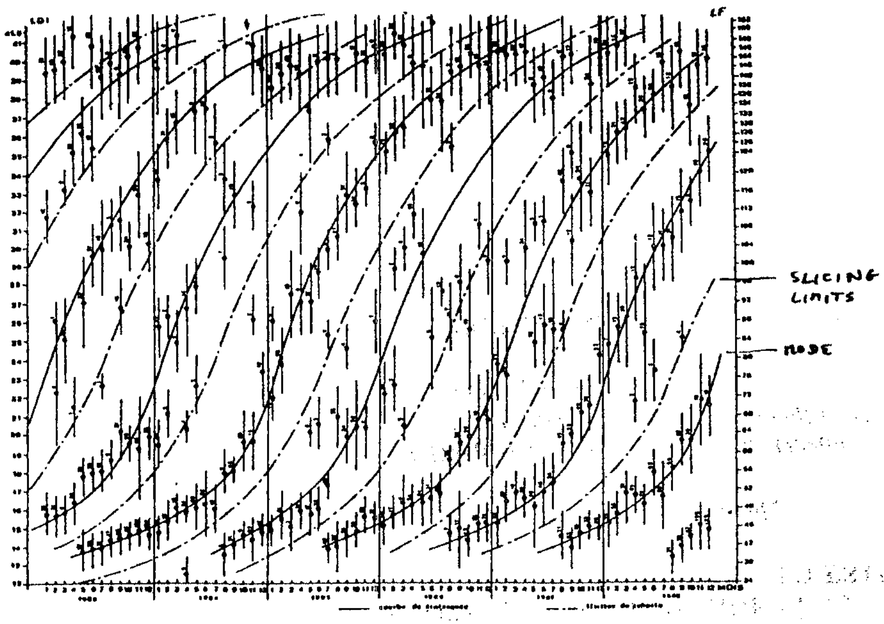

Figure 4 : Apparent modal progressions for yellowfin tuna and monthly slicing limits used by SCRS (From Capisano and Fonteneau 1991).

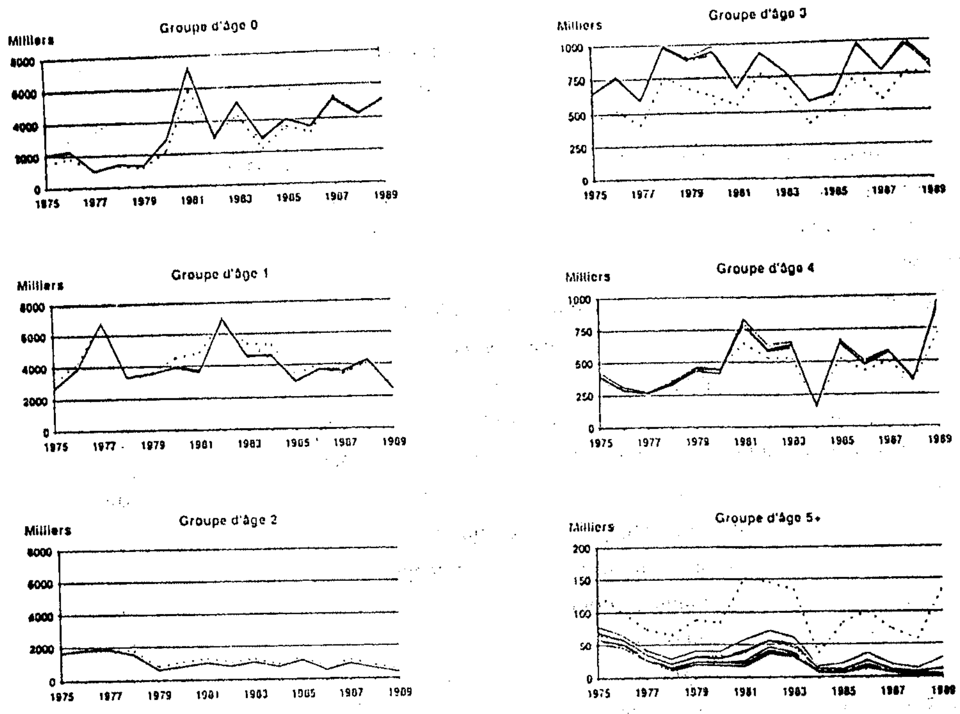

Figure 5 : Catch at age obtained by the slicing method (dotted lines) and by Gascuel 1992 method (from Gascuel 1992).

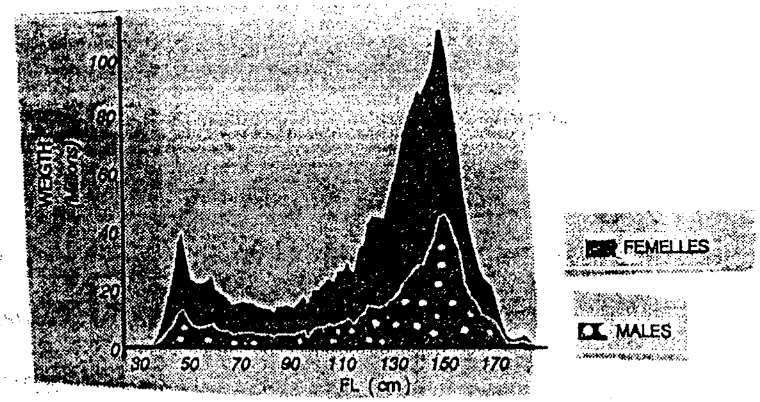

Figure 6 : Total average catches by sex of yellowfin tuna (average 1987-1991).(From ICCAT YFT WG 1993).