### 2024 Report of the ICCAT Albacore Year Programme (ALBYP)

#### Background and programme objectives

Since 2010, the Albacore Species Group (ALB SG) has designed a research programme to address key uncertainties that would allow for the improvement of the scientific advice for management of the species. The research programme has now been developed for both the northern and the southern stocks of Atlantic albacore and has been revised on several occasions according to new knowledge, priorities and cost estimates. The research plan is focused on three main research areas: biology and ecology, monitoring stock status, and Management Strategy Evaluation (MSE) for northern albacore. Funds for this research programme have become available since 2021, and were used to develop some of the key research topics as described below. In 2024 it was recommended that the Mediterranean stock be integrated into the ALBYP.

## 2024 activities

Since 2021, the Albacore Species Group has prioritized the following research topics: a reproductive biology study to improve knowledge on maturity and fecundity, an electronic tagging study to better understand the life cycle and habitat use, and the MSE following the MSE schedule agreed by the Commission. The first two research items are being pursued for both the North and the South Atlantic stocks, while the third one is, for now, specific to the northern stock. The following are the cumulative ALBYP activities conducted up to 2024.

#### Reproductive biology of North Atlantic albacore

ICCAT funds were used to issue a contract to a consortium to undertake this project to improve knowledge of: a) the reproduction and maturity for the northern Atlantic albacore stock, b) sex-specific maturity ogives, c) spatial and temporal spawning grounds, and d) L<sub>50</sub> and size/age related fecundity.

The project consortium is led by Dr Alex Hanke and Dr Dheeraj Busawon (Department of Fisheries and Oceans, DFO, Canada), assisted in the coordination of activities by Pablo Quelle and Dr Victoria Ortiz de Zárate (EU-Spain, Instituto Español de Oceanografía - Consejo Superior de Investigaciones Científicas (IEO-CSIC). Other scientists involved in the project include: Dr Freddy Arocha (Instituto Oceanográfico de Venezuela (IOV), Universidad de Oriente (UDO), Venezuela), Dr Nan-Jay Su (National Taiwan Ocean University, Chinese Taipei), Dr David Macías (EU-Spain, IEO-CSIC) and Dr Kadra Benhalima (DFO, Canada).

Albacore samples were collected from February 2023 to January 2024 by the Chinese Taipei (February to August 2023) and the Venezuelan (November 2023 to January 2024) fleets. Late shipping of 207 samples out of 276 samples collected by the Chinese Taipei fleet, did not allow these to be analysed. On the other hand, all the 50 samples from Venezuela were analysed.

Dorsal fin rays were processed and read using the methodology described in Ortiz de Zárate and Babcock (2016). Two readers made independent estimations of age of each sample and final age was determined by agreement. This analysis was completed in the first semester of 2024. Albacore ages ranged from 4 to 9 years for females and 4 to 11 years for males.

In order to determine maturing stage, gonads were also collected from albacore specimens. Oocytes were classified into one of 6 classes according to their different developmental stages using similar terminology to that of Brown-Peterson *et al.* (2011). To determine the maturity stage and ovarian phase of each female, a microscopic maturity scale was applied to identify the Most Advanced Group of Oocytes (MAGO) in the ovary, the post ovulatory follicles (POF) and vitellogenic oocytes development (Farley *et al.*, 2013 and 2016; and Schaefer, 2001). To estimate fecundity parameters the following two approaches were used: the Weibel method for fecundity estimates (Weibel and Gómez, 1962; Weibel, *et al.*, 1966; Weibel, 1969) and a new dissector method (Sterio, 1984).

The Chinese Taipei fleet collected 201 fish, 144 females and 57 males, caught in sub-areas 1, 2 and 4. A total of 96 females and 9 males between February and August were classified as being in the spawning stage (gonad stage IV). Out of the total analysed samples, 34 corresponded to spawning capable fish (stage III) (27 males and 7 females), 10 fish (2 males and 2 females) in the regenerating phase (Vb), and 52 fish in developing stage (IIb). No fish immature (Stage I), developing (Stage IIa), and regressing (Va) stages were observed.

Venezuela samples were collected in areas 3 to 5. All the fish analysed were mature, mainly in regenerating stage (N=40). Histological analysis confirmed these results as spawning females were found from April to September (2021 and 2022 data) in fishing areas 1, 2, 3 and 4.

Batch fecundity (BF) was estimated for 11 samples with sizes ranging from 97 to 107 cm straight fork length (SFL) (ages 5 to 9). The mean BF was 1.01 million oocytes, ranging from 0.30 to 2.15 million. The average relative batch fecundity (BFrel) was 54 oocytes per gram of body weight, ranging from 13 to 108 oocytes per gram of body weight. In order to determine factors affecting batch fecundity, such as the size, body weight, gonad weight and season, samples from all years should be re-analysed together.

Microscopic analysis of the maturity status indicated that most fishes (N=248) were mature. However, only 3 fish (2 males and 1 female) were "developing" (Stage II). Therefore, it was impossible to adjust the logistic curve to obtain the ogive. In this context, any estimates of L50 cannot be done unless new immature specimens of smaller length (< 80 cm SFL length) can be sampled in the Atlantic Ocean.

## Reproductive biology of South Atlantic albacore

Dr Paulo Travassos, a national scientist from Brazil, is the project leader for this short-term contract, with research activities being conducted with the participation and support of scientists from Brazil (Dr Paulo Almeida, Dr Mariana Rego, Dr Maria Lúcia Araújo, Dr Joaquim Evêncio Neto and Dr Luis Gustavo Cardoso), Uruguay (Dr Andrés Domingo and Dr Rodrigo Forselledo), South Africa (Dr Wendy West, Dr Denham Parker, Dr Sven Kerwath), Namibia (Charmaine Jagger) and Chinese Taipei (Dr Nan-Jay Su).

Important gaps in scientific knowledge remain for albacore in the South Atlantic Ocean that need to be filled in. Thus, the objective of this research is to determine the spawning areas, spawning season, the age-size at maturity, and the fecundity of the southern Atlantic albacore, using samples/measurements provided by participating CPCs. This work is expected to generate information for the conservation of the species and the management of fisheries in the South Atlantic.

To achieve these objectives, biological sampling is being carried out in the three main areas in the South Atlantic (2 oceanic areas off Brazil/Uruguay and 1 off Namibia/South Africa). From September 2021 to date, samples have been collected in a joint effort by the partner countries with the aim of sampling on the largest possible space-time scale. Only samples collected by the Brazilian (237 gonads) and the Chinese Taipei tuna fleets (300 gonads) have been included in the study so far. Samples from the Namibia/South Africa area are being collected and will soon (2025) be sent for analysis.

Samples were collected from three different areas along de Brazilian coast: one located in the North (around 4°-6°S Recife fleet), the second located around 22°-27°S and the third area around 33°-34°S. Upon examining the frequency distribution of albacore caught in these areas, it was observed that there was a gradient in length composition based on latitude. Larger fish have been caught at low latitudes with fork length sizes ranging from 91-125 cm. With increasing latitude, a decrease in size of the fish caught was observed, ranging from 99-111 cm around 22°-27°S and from 81-111 cm further south (around 33°-34°S).

The assessment of maturation stages according to catch-location revealed that at higher latitudes there is a predominance of immature individuals. As latitude decreases, the percentage of stages indicating reproductive activity becomes more significant. Based on the data generated for fish classified as capable of spawning and active, the spawning area of the species in the South Atlantic is probably located between latitudes 10°S and 25°S, where many active females were caught.

The size at first maturity ( $L_{50}$ ) was re-estimated based on a review of the previously established maturation stages for both males and females. The  $L_{50}$  for females was determined to be 89.7 cm fork length (FL) (confidence interval: 86.1–91.5 cm), while for males it was 88.0 cm FL (confidence interval: 86.8–90.5 cm). The  $L_{95}$  was 94.0 cm for both females and males. However, to obtain a more accurate and precise  $L_{50}$ , it is necessary to include smaller individuals, making it essential to analyze samples from Namibia and South Africa. For the fecundity estimate, there was no new analysis, and the values already presented are considered here. The average weight of the ovaries used for estimating fecundity was 328.1 g (±164.6 std. dev.), while the fork length of the females ranged from 97.7 to 109.0 cm. The batch fecundity varied from 0.08 to 1.46 million oocytes, and the frequency of hydrated oocytes per 0.5 g batch ranged from 176 to 398.

A total of 288 first dorsal fin spines were collected, from fish measuring between 91 and 125 cm FL. Of this total, a small portion was blocked and analysed. The range of the number of rings in the analyzed spine sections was 7 to 8 rings, but the number of years is likely higher as the initial rings are not visible due to the vascularization zone of the spine. Eighty (80) otoliths were also collected so far from fish caught by the Brazilian longline fleet based in Recife, measuring more than 95 cm FL. These otoliths have been processed and stored for analyses, which should begin soon.

In this context, the species breeds in low latitudes after its migratory journey to tropical areas in the western South Atlantic. The study suggests that the younger members of the species remain in the subtropical and temperate zones on both sides of the South Atlantic Ocean, while the adults carry out their reproductive migration to warm tropical waters and then return to high latitudes of cold waters.

# Movements and habitat use of North Atlantic albacore

This project is led by Dr Haritz Arrizabalaga (AZTI, EU-Spain), in collaboration with scientists from EU-Spain (AZTI and IEO), and additional support from scientists from different CPCs involved in communication of tagging recoveries and rewards (EU-France, EU-Ireland, EU-Portugal, Japan and Chinese Taipei).

ICCAT funds are used mainly to purchase tags and to cover some of the deployment and satellite transmission costs, while other costs (additional tags, personnel, travel, etc.) are provided as in-kind contributions by participating institutions involved in tagging and analyses activities.

Since 2019, several tagging surveys have been conducted off the Canary Islands and in the Bay of Biscay. The surveys off the Canary Islands were conducted onboard baitboats and charter vessels targeting large individuals during the winter/spring. So far, 39 MiniPATs have been implanted (5 in 2019, 10 in 2020, 14 in 2022, 6 in 2023 and 4 in 2024). In the Bay of Biscay, surveys were conducted onboard baitboats used for the bluefin tuna acoustic survey, as well as on recreational and charter vessels using trolling gear, targeting small to medium size individuals during summer and autumn. So far, 154 internal archival tags (Lotek LAT 2810L) and 2 pop-up satellite archival tag (PSATs) have been implanted in 2020-2024.

In order to increase the chances of recovering internal archival tags, posters announcing  $\notin$ 1,000 rewards were produced in Spanish, French, English, Portuguese, Japanese and Mandarin Chinese and distributed through collaborating ALB SG participants from different CPCs. To date, we have collected data from 34 of the PSATs deployed. Of the internal archival tags, 14 tags were recovered, nine of them with times at liberty above one full year. Unfortunately, two of them were recovered with the antenna broken. Another one is still being analyzed, but the others provided full year tracks. These recoveries (up to 439 days at liberty), to our best knowledge, are the longest recoveries obtained ever for albacore tuna in the Atlantic Ocean. These tracks cover more than a year in the life of a juvenile albacore that visited shallow waters of the Bay of Biscay in subsequent summers, while inhabiting deeper waters in the central and western Atlantic during the winter, as well as travelling south to the Canary Islands before returning to the Bay of Biscay. Updates of the results obtained thus far were presented to the Albacore Species Group during the Species Group meetings held in September 2024 (Cabello de los Cobos *et al.*, 2023 and 2024). In the near future, we will continue deploying the remaining purchased tags, estimating all the tracks and analyzing the information provided by the tags.

## Movements and habitat use of South Atlantic albacore

The project leaders for this study are Dr Paulo Travassos and Dr Andrés Domingo, national scientists from Brazil and Uruguay, respectively. The main purpose of this study is to provide information about movement patterns and habitat use of albacore in the South Atlantic Ocean, to contribute to the assessment and management of the southern stock of the species.

A total of 13 miniPAT (WildLife Computers) tags have been made available by ICCAT (10 for tagging in Brazil and 3 in South Africa). Taking the opportunity of an expedition to tag yellowfin tuna around the Fernando de Noronha archipelago (Protuna Project, national research supported by the Brazilian government; CNPq Process No. 445810/2015-7), an attempt to tag albacore in this area was conducted from 23-27 May 2022. However, no albacore were caught during this cruise and thus no fish were tagged.

After that, no tagging cruises were carried out and the tags recently had to be sent back to the manufacturer (WildLife Computers) to change the tagware and battery. The expectation is that these tags will be delivered back by May/June 2025, so that the tagging work can be planned, with the first tagging cruise scheduled for the South Atlantic in spring 2025.

## Management strategy evaluation (MSE) of North Atlantic albacore

ICCAT funds were used for a short-term contract with AZTI, coordinated by Dr Gorka Merino and Dr Agurtzane Urtizberea, to accomplish the technical tasks required to follow the MSE schedule adopted by the Commission in 2021. According to this schedule, after adoption of the first ICCAT Management Procedure (MP) in 2021 (following adoption of a harvest control rule in 2017), the existence of exceptional circumstances must be evaluated on a yearly basis (indicators depending on the year). In addition, a new benchmark stock assessment using Stock Synthesis 3 (SS3) was developed in 2023, which will serve as a basis for conditioning new operating models for the second round of the MSE framework. This new MSE is expected to be delivered in 2026 to allow the Commission to revise the MP if it wishes to do so. Moreover, the *Recommendation by ICCAT on conservation and management measures, including a management procedure and Exceptional Circumstances Protocol, for North Atlantic albacore* (Rec. 21-04) requires testing alternatives to the adopted MP.

With regards to the operating model (OM) development in the new MSE model framework for North Atlantic albacore, interested members of the ALB SG have worked together with the ICCAT Secretariat and the contractors on the new model structure since 2021. The definition of the fleets, catch, catch per unit effort (CPUE) and size data for the SS3 model was adopted at the 2023 North Albacore Data Preparatory Meeting (including MSE) (ICCAT, 2023). In 2023, the SS3 model was developed and discussed at the 2023 North Albacore Data Preparatory Meeting (including MSE) (Urtizberea *et al.*, 2023a) and the 2023 ICCAT Atlantic Albacore Stock Assessment Meeting (Urtizberea *et al.*, 2023b). At the 2023 Albacore Species Group meeting, the refined model (Urtizberea *et al.*, 2023c) was presented together with a set of model diagnostics, incorporating the suggestions by the ALB SG. This model produced very similar results to the model used to provide stock status in the 2023 stock assessment but showed a better performance with regards to diagnostics performance. The ALB SG accepted this model as a reference case to structure the OMs for the new MSE.

In 2024, the SS3 reference case was used for conditioning new operating models for the second round of the MSE framework, expected to be delivered in 2026. The contractors started the elaboration of a grid of reference OMs based on Stock Synthesis as part of the new MSE, and tested the currently adopted MP on this new reference grid. In addition, they developed a new Observation Error Model by incorporating statistical properties of CPUE residuals in both the historical and future parts of the time series. They also produced the necessary plots for the Albacore Species Group to discuss the detection of exceptional circumstances, as requested by the Exceptional Circumstances Protocol contained in the Recommendation by ICCAT on conservation and management measures, including a Management Procedure and Exceptional Circumstances Protocol, for North Atlantic albacore (Rec. 21-04).

## 2025 Plan and activities

#### Reproductive biology and aging of North Atlantic albacore

Sampling activities will continue in 2025 to cover small individuals to allow estimation of  $L_{50}$ . Additional fecundity analyses on existing samples will allow to finalize the study on reproductive biology of northern albacore. The analyses will be done using the same methods as previously used to estimate maturity stage and fecundity. The corresponding spine samples will be aged to determine the age of fish sampled for the reproductive staging and fecundity study.

In order to estimate the maximum age of albacore tuna to inform hypotheses about natural mortality, additional samples for aging (spines and otoliths) of large individuals (>100 cm SFL) are required (100-200 individuals per stock). A sample of spines, already aged, is available, and additional samples are and will be available to complete this study.

## Reproductive biology and aging of South Atlantic albacore

Given that only samples collected by the Brazilian and Chinese Taipei tuna fleets have thus far been analyzed during the project, priority will be given to collecting samples from the other partner countries (mainly Namibia and South Africa). Samples are already being collected by partners in these two countries and will be sent to Brazil for analysis in early 2025.

Paired (otolith and spine) samples of large albacore will also be collected in order to verify natural mortality assumptions based on maximum age.

## Movements and habitat use of North Atlantic albacore

During 2025, we plan to continue deploying additional tags using different tagging opportunities (commercial, research, charter and recreational vessels) with the intention to better characterize the life cycle of North Atlantic albacore and consider stock structure assumptions. Following the experience of recent years, deployments are planned by AZTI scientists in the Bay of Biscay and the Canary Islands but may be expanded to other areas if opportunities arise, especially in the western Atlantic if suitable tagging platforms are identified. We also plan to perform additional analyses on the information collected so far in order to complete the tracks for all recovered tags.

# Movements and habitat use of South Atlantic albacore

The tagging expedition, which was scheduled to take place in Brazil in January/February 2025, had to be suspended due to the need to send the tags to WildLife Computers for tagware and battery revision. The expectation is that these tags will be delivered back by May/June so that the tagging work can be planned, with the first tagging cruise scheduled for the South Atlantic in spring 2025.

## Management strategy evaluation of North Atlantic albacore

In 2025 the plan is to finalize the Reference and Robustness set of OMs using the reference case SS3 model developed in 2023. Another key development expected in 2025 is the finalization of the observation error model considering the statistical properties of each abundance index in the projections. Empirical and model-based MPs will be developed and evaluated. At least one of the MPs considered will be the one adopted in Rec. 21-04.

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