INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS

COMMISSION INTERNATIONALE POUR LA CONSERVATION DES THONIDES DE L'ATLANTIQUE

ICCAT CICTA CICAA

COMISIÓN INTERNACIONAL PARA LA CONSERVACIÓN DEL ATÚN ATLÁNTICO

ATLANTIC-WIDE RESEARCH PROGRAMME FOR BLUEFIN TUNA

(ICCAT GBYP)

PHASE 7

EC GRANT AGREEMENT SI2.752957

GBYP SCIENTIFIC AND TECHNICAL FINAL REPORT FOR PHASE 7

20 April 2018

ICCAT – Calle Corazón de Maria 8, 6° - 28002 Madrid – España

ATLANTIC-WIDE RESEARCH PROGRAMME FOR BLUEFIN TUNA (ICCAT GBYP)

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FINAL REPORT

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ICCAT ATLANTIC-WIDE RESEARCH PROGRAMME FOR BLUEFIN TUNA (GBYP)

FINAL REPORT FOR PHASE 7 (2017-2018)

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EXECUTIVE SUMMARY

The Phase 7 of GBYP activities began on 21 February 2017 and ended on 20 February 2018, including (a) continuation of data recovery, including data mining and elaboration, (b) aerial survey for bluefin tuna spawning aggregations, (c) biological studies, (d) tagging, including awareness and rewarding campaign, and (e) further steps of the modelling approaches in support of bluefin tuna stock assessment and MSE.

As regards data recovery activities, recent datasets from Italian long line fleet were recovered, for the period 2011-2016, representing aa total catch of more than 20,000 bluefin tuna specimens, which means more than 1000 tons. In addition, individual weight and length was provided for more than 8000 fish. The datasets were incorporated into the ICCAT database for Task 1 and Task 2 and the SCRS was informed of this progress.

The aerial survey on bluefin tuna spawning aggregations was resumed after being stopped in Phase 6, in order to provide at least a time series enough to be usable both for the assessment and the MSE process. It was carried out on four overlapping areas (Balearic Sea, southern Tyrrhenian Sea, central-southern Mediterranean Sea and Levantine Sea) which had been defined and standardised in the previous analyses, Thanks to a new strategy adopted by the GBYP coordination team, based on an almost real time analysis of the data provided by the observers on a weekly basis it was possible to get the results report just two weeks after the conclusion of the field activities,, therefore allowing the results to be presented SCRS Bluefin tuna Assessment Session. For the very first time, the time series of the ICCAT GBYP aerial survey data were used in the MSE and the OM, while the BFT SG considered that this time series was still too short for its use in the assessment. The results obtained by the ICCAT GBYP aerial survey in 2017 confirm the suitability of the methodology, constituting a good reference for continuing the survey in the following years.

The tagging activities directly promoted by GBYP were focused on the electronic tagging, while the activities related to conventional tagging were limited to the logistic support to entities that had asked for GBYP help for carrying out such activities, by providing tags and advice on tagging methods. A total of 58 electronic pop-up tags were deployed in Portuguese traps and in Skagerrak, where they were implanted on specimens caught by rod and reel and hand line. Most of the results are already available, since the mean time on fish of these tags has been of 40 days. The preliminary results were communicated to SCRS and data from processed tracks were provided to the specialists in charge of exploitation of electronic tags data for OM-MSE. In addition, a database of GBYP electronic tags was developed, along with a Shiny application for visualisation of tracks and associated temperature and depth data, which was presented to SCRS. The tag recovery activities were carried out continuously along the whole Phase, as usual. The total number of recovered tags in Phase 7 was slightly lower than in the previous one.

Biological studies, involving a great number of scientific institutions, have continue providing samples whose analysis have provided relevant results. The sampling of adult bluefin tuna was carried out on various sites, including farms and it was very

successful, while sampling for juveniles encountered various problems, due to a very peculiar spatial distribution attributable to a special hydrographic scenario. Nevertheless, a high number of various types of samples (tissues, spines, otoliths) was collected in different areas and the targets were reached. In addition, a Shiny application has been developed to facilitate the inspection of available samples in the GBYP Tissue Bank and their selection following different criteria. Due to the budget constraints, biological analyses were reduced in this Phase. Thus, otolith micro constituents analysis was restricted to bluefin tuna caught in 2016 in Moroccan traps, indicating that all the fish were of Eastern origin, which taking into account previous results confirm that mixing of the Eastern and Western population in Moroccan traps occurs at variable rate in successive years. Genetic studies were limited to the analysis of transcriptomic and genomic data exploiting previous available data for defining the genomic variability of the species and experimental trials for developing genetic tests for sex assignment. Age determination analysis were successfully performed on a great number of samples (2000), in order to further populate and improve the age-length-key. In addition, GBYP convened a first workshop on bluefin tuna reproductive biology aiming at reviewing the current knowledge and identifying research priorities and experts, setting the basis for a larger workshop on this topic that will be held on Phase 8..

As concerns the modelling approaches, modelling expert assistant successfully continued the work already initiated in previous Phases, focusing on the production of a fully documented working MSE framework including all finalized operating models (both reference and robustness) to allow stakeholders to develop and test their own Management Procedures. As concerns the operational modelling, the M3 model was updated from 1.3 through to 1.7, in order to accommodate the requirements of the reference and robustness operating models. The Trial Specifications and the meta-data base were also updated to include new OM definitions, performance metrics and data sources. Regarding MSE development, the ABT-MSE R-package is now complete and ready for use by stakeholders. The ICCAT GBYP Core Modelling MSE Group held three meetings in Phase 7, providing its feedback for development of MSE and updating the trial specification document. The Group has already used all GBYP electronic tag data, the relevant results from the GBYP biological studies and the index developed by aerial survey.

In conclusion, the GBYP has been highly successful in improving the information required for the BFT stock assessment and provision of management advice. It has demonstrated the need, achievability and value of having coordinated, dedicated and centralized research and data gathering programs. Several of the accomplishments of the program are essential for improving the stock assessment and hence need to become structural tasks which requires continuous long-term commitments. There is also a critical need to continue the research component of the GBYP as there is still much to learn about the biology and behaviour of bluefin tuna for improving the stock assessments. A dedicated multi-year effort and continuity in the process is required to address these research needs. If the Commission commits itself to support reliable and robust stock assessments and management advice for BFT, it needs to decide on how to proceed to guarantee the continuity of GBYP outputs, and hence the development of long-term structural and funding arrangements should be a high priority of the Commission.

KEYWORDS

bluefin tuna, historical data, biological analyses, sampling, aerial survey, tagging, genetics, microchemistry, modelling, Mediterranean Sea, Atlantic Ocean

1. Introduction

The ICCAT Atlantic-wide Research Programme for Bluefin Tuna was officially adopted by SCRS and the ICCAT Commission in 2008, and it started officially at the end of 2009, with the objective to:

a) Improve basic data collection, including fishery independent data;

b) Improve understanding of key biological and ecological processes;

c) Improve assessment models and provision of scientific advice on stock status.

Since the beginning, the Programme was conventionally identified with the acronym GBYP (Grand Bluefin Year Programme), for showing the ideal continuation of the previous multi-year ICCAT BYP.

The total budget of the programme officially approved by the ICCAT Commission in 2008 was 19,075,000 Euro in six years, with the engagement of the European Union and some other ICCAT Contracting Parties to contribute to this programme in 2009 and in the following years. The initial year (October 2009-December 2010) had costs for 653,864 Euro (against the original approved figure of 890,000 Euro), the second Phase (January 2011-April 2012) had costs for 2,318,849 Euro (against the original figure of 3,390,000 Euros), while the third Phase (June 2012 to January 2013) had costs for 1,769,362 Euro (against the original approved figure of 5,845,000 Euro). The fourth Phase (March 2013-February 2015) had a total budget of 2,875,000 Euros (against the original approved figure of 5,195,000 Euros) and final costs for 2,819,556 Euro. At the end of this Phase, coinciding with the first six years period from the adoption of the program by ICCAT Commission, in spite that only four Phases had been implemented, taking into account the above reported figures, the GBYP Steering Committee (documents SCRS/2014/194 and SCI 005/2014) and the SCRS recommended extending the GBYP activities up to 2021 and this proposal was endorsed by the Commission during its meeting on November 2014, along with the SCRS report. A new plan for the GBYP activities to be done during these additional years was approved along with the extension. Thus, the program continued with a fifth Phase (February 2015-February 2016, which had a total budget of 2,125,000 Euros (against the original approved figure of 3,345,000 Euros), being its final costs of 1,995,786 Euros. The sixth Phase (February 2016-February 2017) had a total budget of 2,125,000 Euros (against the original approved figure of 410,000 Euros) and the final costs were 1,945,137 Euros. The seventh Phase have had a total budget of 1,808,985 Euros, with final costs of 1,587,639 €. The overall ICCAT GBYP operating budget for the first seven Phases, covering eight years (a total of 13,090,195 Euros) is about 68.62% of what it was supposed to be (the 19,075,000 Euros approved by the Commission) for just six years. Several private or public entities[1] provided few additional funds or in kind support (see Section 11 of this report for the details). These budget reductions had an impact on all activities carried out so far.

[1] Additional financial contributions to GBYP were provided by Asociación de Pesca, Comercio y Consumo Responsable de Atún Rojo (SP) and by Grupo Ricardo Fuentes e Hijos s.a. (SP). In kind contributions were provided by Aquastudio Research Institute (IT), Balfegó Grup (SP), Carloforte Tonnare PIAMM (IT), Federcoopesca (IT), Ph.D. Jean Marc Fromentin (France), IEO–Fuengirola (SP); INRH –Tangier (MO), Maromadraba SARL and Es Sahel (Fuentes Group) (MO), Oceanis srl (IT), Ph.D. Molly Lutcavage (US), Mr. Roberto Mielgo Bregazzi (SP), the Stanford University (USA), Unimar (IT), the University of Cagliari (IT), Wildlife Computers Inc. (USA), the WWF Mediterranean Programme and the GBYP Coordinator.

For the purpose of independently reviewing the work carried out to date within the scope of ICCAT GBYP and evaluating the effectiveness of this complex research programme, as required by the Commission in 2015, a large comprehensive review of the first five Phases of ICCAT GBYP was carried out at the beginning of the Phase 6 and the results were presented to the SCRS 2016 Plenary (document SCRS/2016/192) and to the Commission at its 2016 Special Meeting.

Phase 1 (EU Grant agreement SI2.542789) and Phase 2 (EU Grant agreement SI2.585616) activities were jointly committed by the European Community (80%), Canada, Croatia, Japan, Libya, Morocco, Norway, Turkey, United States of America, Chinese Taipei and the ICCAT Secretariat. Other CPCs (Albania, Algeria, Egypt, Iceland, Korea, Popular Republic of China and Tunisia) joined the first funders in the following Phases, while Phase 7 was co-funded by European Union, Libya, USA, Japan, Tunisia, Turkey, Kingdom of Morocco, Canada, Norway, ICCAT Secretariat, Chinese Taipei, Popular Republic of China and Iceland, in order of contribution. Some CPCs did not pay their contribution (even requested or committed), further limiting the use of available funds, because the EU has a maximum percentage of contribution of 80% under the firm condition to duly obtain the remaining 20%.

The third Phase (7 months) officially initiated on June 20, 2012, after the signature of the Grant Agreement for co-financing the GBYP Phase 3 (SI2.625691) by the European Commission. Phase 3 officially expired on January 19, 2013, but closing the administrative issues took more time than scheduled, due to a delay of one contractor in providing the necessary documents. The GBYP activities up to the first part of Phase 3 were presented to the SCRS and the ICCAT Commission in 2012 and they have been approved, while the last part was present to the SCRS and the Commission in 2013 (documents SCRS/2013/144) and therefore approved.

The fourth Phase of GBYP officially initiated on March 6, 2013, after the signature of the Grant agreement for co-financing the GBYP Phase 4 (SI2.643831) by the European Commission and then it was extended for a total of about 23 months, ending on 23 February 2015. The partial results were presented to SCRS and the Commission in 2013 and 2014 (documents SCRS/2013/144 and SCRS/2014/051) and they have been approved, while the final results were presented to the SCRS and the Commission in 2015 (documents SCRS/2015/144 and SCI/2015/APP.5), they were approved by the SCRS and endorsed by the Commission.

The fifth Phase of GBYP was officially initiated on February 24, 2015 after the signature of the Grant agreement with the European Union for co-financing the GBYP Phase 5 (SI2.702514) by the European Commission and ended on 23 February 2016. The partial results were presented to the SCRS and the Commission in 2015 (documents SCRS/2015/144) and they have been approved. The final report for Phase 5 has been officially approved by the European Union, while the final results were presented to the SCRS and the Commission in 2016 (documents SCRS/2016/193) and were therefore approved.

The sixth Phase of the ICCAT GBYP officially started on 21 February 2016 following the signature of the Grant agreement for the co-financing of the ICCAT GBYP Phase 6 (SI2.727749) by the European Commission and expired on 20 February 2017. The Grant agreement was revised on February 6, 2017, taking into account the modification of the activities as recommended by the Steering Committee. A first report of the GBYP activities in Phase 6 up to September 2016 was provided to the SCRS and the Commission (document SCRS/2016/193) and they have been approved. The final report of Phase 6 has been officially approved by the European Union, while the final results were presented to the SCRS and the Commission in 2017 (document SCRS/2017/139) and were therefore approved.

The seventh Phase of the ICCAT GBYP officially started on 21 February 2017 following the signature of the Grant agreement for the co-financing of the ICCAT GBYP Phase 7 (SI2.752957) by the European Commission and ended on 20 February 2018. The amendment of the Grant agreement submitted in December 2017 was finally accepted in March 2018, taking into account the modification of the activities as recommended by the Steering Committee and the incremented costs of Coordination due to staff changes. A first report of the GBYP activities in Phase 7 up to September 2017 was provided to the SCRS and the Commission (**Annex 1b, documents no. 1 and 11**); the activities were approved by the SCRS (**Annex 1a, document no. 50)** and endorsed by the Commission. The final report of Phase 7 activities will be submitted to SCRS and at the Commission in their respective meetings in 2018.

All final reports of all GBYP activities in Phase 7 have been provided to the ICCAT GBYP Steering Committee and published on the ICCAT GBYP web pages (http://www.iccat.int/GBYP/en/)

The ICCAT GBYP activity is being supported by a twin programme carried out by NOAA-NMFS, which focuses its research activities on the western Atlantic Ocean.

2. Coordination activities

In the first part of the Programme, the staff was composed by the GBYP Coordinator, the Coordinator assistant (from March 2011 to March 2014) and one contracted technician for data management (from October 2011 to December 2013). In the second part of Phase 4 the staff was reduced to the Coordinator only, while the previous staff level was resumed from May 2015. Due to retirement of Dr. Antonio Di Natale at the end of Phase 7, the new Coordinator Dr. Francisco Alemany was appointed, who assumed the responsibility from 15th January 2018. The GBYP staff history is showed on **Table 1**. The ICCAT Secretariat provided the necessary support for the GBYP activities.

Table 1. ICCAT GBYP staff over the different years of the programme.

GBYP STAFF		2010	2011	2012	2013	2014	2015	2016	2017	18
name	role	M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F
Francisco ALEMANY	coordinator									
Stasa TENSEK	assistant									
Alfonso PAGÁ GARCÍA	data expert									
Antonio DI NATALE	coordinator									
M'Hamed IDRISSI	assistant									
Ana JUSTEL RUBIO	data expert									

A total of **63 reports** were produced in the framework of ICCAT GBYP in Phase 7 (**Annex 1a**). Several additional documents and reports have been also provided by GBYP for the needs of the Steering Committee for its meetings. A total of **33 scientific papers**[2] have been produced in Phase 7 (list in **Annex 1b**), while others will be published in the following months. So far, the GBYP produced in total, over the first 7 Phases, **310 activity reports** and **242 scientific papers**.

A total of 7 Calls for Tenders, 2 official invitations and 1 request for offers were released in Phase 7. A total of 17 contracts have been awarded to various entities (**Annex 2**) and 2 purchase orders. In total, the number of contracts provided by GBYP in the first 7 Phases is 128, including 95 entities, localised in 24 different countries; many hundreds of researchers and technicians have been working so far in the various GBYP activities; this large and open participation to ICCAT GBYP activities is considered to be one of the best results of this research programme. The coordination staff participated in 14 meetings in Phase 7 (**Annex 3**).

As usual, the administrative and desk work behind all these duties was huge and heavy and it was carried out in continuous and constructive contact with the ICCAT Secretariat and the Administrative Department, which had to face an important additional workload caused by GBYP activities since the beginning of this programme.

A particular coordination effort was necessary for assisting the contractors engaged in the aerial survey activities and for assisting them for the many permits required, getting directly in touch with the relevant Authorities of the various CPCs concerned. A continuous assistance, 7/7 days 24/24h, was necessary for solving various problems,

[2] Including 12 scientific papers which were presented on Bluefin Tuna Data Preparatory Meeting (6-11 March 2017) have already been included in the Final Report of GBYP Phase 6

emergencies and operational difficulties.

Furthermore, the GBYP coordination is providing scientific support to all the national initiatives which are potentially able to increase the effectiveness of the GBYP and its objectives. For this reason, since 2010 the Coordinator joined the Steering Committee for the Bluefin tuna programmes of the NOAA, together with some members of the GBYP Steering Committee; in this function he participated to the evaluation session of the US domestic research programmes for Bluefin tuna also in period 2013-2017.

The budget items included under the GBYP Coordination activity in Phase 7 were: Coordination staff salaries and benefits, Travel and subsistence (including SC), Computer hardware and software, Consumables and supplies, Contract for external SC member, contracts for the external review, ICCAT Secretariat overhead and ICCAT staff. The original budget for the Coordination activity was 357,985 euro and it was increased to 415,745 euro after the amendment.

In conformity with the Atlantic-Wide Bluefin Research Programme (GBYP) adopted by the SCRS and the Commission for Phase 7 in 2016, as it was modified by the GBYP Steering Committee in 2018, the following research initiatives have been conducted or initiated (see also **Annex 2**).

3. Data mining and data recovery

3.1. Objectives of the data recovery and data mining

The objective of data recovery and data mining activities is to fill the many gaps existing in several data series currently present in the ICCAT data base, concerning both recent and historical data, which causes a large amount of substitutions in the assessment process, increasing uncertainties. At the same time, data mining activities should provide reliable data series, longer that those currently available, recovering data from many sources, including archives having difficulties for the access. The data mining activity can include also the recovery of old genetic and biological data. This activity allows for a better understanding of the long-time catch series by gear, improving the data available for the assessment and possibly for replacing substitutions used for data gaps; old data will allow also for a better understanding and for improving our knowledge about Atlantic bluefin tuna.

The total budget for data mining and data recovery was 600,000 euro for activities in 3 years; so far, the total expenditures have been 550,173 euro for 8 years of activities (91.7 % of the original budget), recovering much more data that it was set at the beginning). This amount represents 4.14 % of the total GBYP funds received so far. Therefore, the GBYP objectives set for data recovery and data mining in these first Phases have been largely accomplished.

The data recovered so far in all ICCAT GBYP Phases are showed in **Table 2** and **Table 3**, according to the last data and revision. The GBYP was also very active for organising the SCRS BFT Data Preparatory meeting in 2017 (**Annex 1a, document no. 47**), cooperating with the ICCAT Secretariat.

Table 2. Total data recovered by GBYP from Phase 1 to Phase 7.

TOTAL PHASES 1 to 7	origin	data	total data
# Records	OG	102,011	500,080
	TP	36,557	
	TAMD	311,415	
	FARM	49,364	
	HGEN	733	
BFT (no.)	OG	80,589	30,355,240
	TP	29,220,326	
	TAMD	1,004,228	
	FARM	49,364	
	HGEN	733	
BFT (tons)	OG	123,043	1,705,688
	TP	1,501,762	
	TAMD	80,408	
	FARM	475	
	HGEN	-	
# BFT sampled (size and/or weigth or historical genetics)	OG	114,116	997,288
	TP	7,610	
	TAMD	825,485	
	FARM	49,364	
	HGEN	713	
Legend: OG = Other Gear; TP = Trap; TAMD = Trade, Auction and Market Data; FARM = Farmed tunas; HGEN = Historical Genetic samples;			

Table 3. Total data recovered by GBYP from Phase 1 to Phase 7 by century (<1500-1900) and by decade (1900 onwards).

TOTAL PHASES 1 to 7																		
DATA TYPE	Year	<1500	1500	1600	1700	1800	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
	source																	
# Records	OG						9	10	222	13,518	105	15,822	30,212	18,264	1,905	1,174	10,197	10,573
	TRAP		352	1,220	844	6,265	3,005	4,360	6,727	2,301	1,188	1,021	1,040	2,032	780	3,868	1,554	
	TAMD																249,132	62,283
	FARM															851	18,492	30,021
	HGEN	145						110	155			2			30			291
BFT (no.)	OG													204	42	9,937	28,199	42,207
	TRAP		4,216,840	5,239,018	1,370,723	4,548,109	1,613,889	1,883,967	2,971,685	2,013,583	1,002,661	1,787,209	1,566,956	614,611	70	204,806	186,199	
	TAMD														178,743		660,388	165,097
	FARM															851	18,492	30,021
	HGEN	145						110	155			2			30			291
BFT (tons)	OG						44	163	601	2,497	6,056	6,057	29,059	14,492	17,880	17,086	26,848	2,260
	TRAP		21,784	454,322	157,638	154,439	40,327	72,010	76,801	83,592	127,009	86,204	111,417	71,873	8,761	19,568	15,306	711
	TAMD																64,326	16,082
	FARM															207	268	
	HGEN																	
# BFT sampled (size and/or weigth or historical genetics)	OG												18,614	18,548	804	18,569	34,365	23,216
	TRAP							153	170							2,225	5,062	
	TAMD																660,388	165,097
	FARM															851	18,492	30,021
	HGEN	145						110	155			2			10			291
Legenda: OG = Other Gear; TRAP = Tuna Trap; TAMD = Trade, Auction and Market Data; FARM = Farmed tunas; HGEN = Historical Genetic samples																		

3.2 Data recovery in Phase 7

ICCAT GBYP issued one Call for Tenders under this activity at the beginning of the Phase 7, in order to recover existing datasets which are not currently incorporated in the ICCAT database on Bluefin tuna, to support the improvement of the assessment analytical work and the MSE process. As a priority for the data mining in Phase 7, ICCAT GBYP Steering Committee identified the recovery of the recent or historical catch datasets.

Respective to this Call, three offers were received, one of which was later withdrawn and two remaining were awarded a contract. Both contract were for recovering recent data from the Italian long-line fisheries. The datasets include catches by vessel, area and day, partly with effort data (no. of hooks/day) and were provided on the Excel forms, in the format used by the ICCAT Statistical Department.

One contract provided recovery of the LL datasets for the years 2014-2016 and is related to a total catch of 4,958 Bluefin tunas and a total weight of 231,719 kg. In addition 4,958 Bluefin tunas have individual length or weight or both. The other contract provided the recovery of additional LL datasets for the years 2011, 2012 and 2016, which included a total catch of 15,744 Bluefin tunas and a total weight of 844,850 kg, out of which 3,172 individuals were sampled and their individual weigh or length data were provided.

The final reports of these activities are attached in **Annex 1a** as **document no. 45.** and **document no. 46.** The summary of the data recovered in the Phase 7 is shown by **Table 4**. The details on the data recovery in the last part of the Phase 6 and in the first part of Phase 7 and are presented in paper SCRS/2017/191 (**Annex 1b, document no. 19**).

In addition to these data recovery activities, the GBYP provided an additional key for interpreting the historical trap data, using the history of the Sicilian traps (the most documented in the Mediterranean area) for exemplifying the various problems over the centuries (**Annex 1b, document no. 32,** submitted as SCRS/2017/043). Furthermore, an updated bibliography for the Bluefin tuna traps, including also video and audio documents, for a total of 2,245 titles, was made available to the SCRS Bluefin Tuna Species Group (**Annex 1b, document no. 8,** submitted as SCRS/2017/119).

Table 4. Data recovered in Phase 7 from historical traps (TRAP) and Italian longliners (LL).

Fishing period	Gear	Fishing area/ Trap name	ICCAT CPC	BFT total catch (n)	BFT total catch (tons)	Individual fish data (size or weight)	number of vessels
1599-1817	TRAP	Favignana	EU-IT	17,750	1,331		
1599-1818	TRAP	Formica	EU-IT	23,541	1,766		
1599-1823	TRAP	Bonagia	EU-IT	3,171	238		
1592-1705	TRAP	Pula	EU-IT	12,526	940		
1591-1595	TRAP	Carbonara	EU-IT	505,582	85,949		
1594-1602	TRAP	Pixini	EU-IT	210,637	13,691		
1595-1654	TRAP	Porto Scuso	EU-IT	54,999	3,575		
1595-1654	TRAP	Porto Palla	EU-IT	12,894	838		
1597-1654	TRAP	Santa Caterina Pittinuri	EU-IT	5,208	339		
1598-1654	TRAP	Le Saline	EU-IT	21,819	1,418		
1604-1654	TRAP	Cala Vignola	EU-IT	148,895	9,678		
1603-1606	TRAP	San Marco	EU-IT	28,443	1,849		
1606-1608	TRAP	Porto Pi	EU-IT	9,143	594		
1604-1608	TRAP	Capo Bianco	EU-IT	11,345	1,929		
1611-1654	TRAP	Cala Agustina	EU-IT	611,914	104,026		
1632-1640	TRAP	Argentiera	EU-IT	331,454	56,347		
1702-1705	TRAP	Isola Piana	EU-IT	9,743	738		
1588-1613	TRAP	Ursa	EU-IT	8,203	533		
1583-1646	TRAP	Xàbia	EU-SP	14,643	952		
1612-1659	TRAP	Palmar	EU-SP	180,085	11,706		
1602	TRAP	Hospitalet Infant	EU-SP	329,708	21,431		
1580-1589	TRAP	Benidorm	EU-SP	50,339	3,272		
TOTAL TRAP DATA				**2,602,042**	**323,139**		
2011-2012, 2016	LL	Adriatic Sea	EU-IT	6942	234	163	9
2014-2016	LL	Ionian Sea	EU-IT	2463	116	2463	13
2016	LL	Sardinia	EU-IT	253	11	243	3
2011-2012, 2016	LL	Strait of Sicily	EU-IT	7062	433	2492	22
2011-2012, 2014-2016	LL	Tyrrhenian Sea	EU-IT	3982	283	2769	33
TOTAL LL DATA				**20,702**	**1,077**	**8,130**	
total PH 6 and 7				**2,622,744**	**324,216**	**8,130**	

Following a specific request provided by the ICCAT Statistical Department before the 2017 SCRS Bluefin tuna data preparatory meeting, the GBYP made all possible efforts for recovering the available additional Bluefin tuna fishery data from the Black Sea. Therefore, in 2017, the GBYP carried out an extensive analysis of the available literature, trying to get any possible numerical information about those fisheries but the final result was limited to a series of Bulgarian historical catches, that were reported to the ICCAT Statistical Department and to the SCRS Bluefin tuna data preparatory meeting in March 2017, with the document SCRS/2017/039 (attached in **Annex 1b, document no. 28)**.

The GBYP data were used also for two additional papers (attached in **Annex 1b, document no. 18**, presented as SCRS/2017/166 and **Annex 1b, document no. 15**, presented as SCRS/2017/169), which were presented to the SCRS Bluefin Tuna Assessment Session (20-28 July 2017).

3.3 BFT Data Preparatory Meeting

A Bluefin tuna data preparatory meeting was organised by the SCRS, with the support of GBYP, in Madrid on 6-

11 March 2017. The meeting was attended by around 40 scientists (plus the ICCAT Secretariat staff), including most of the members of the GBYP Steering Committee and several members of the GBYP Core Modelling MSE Group.

The GBYP support to the Meeting has been substantial, directly providing 7 papers (documents SCRS/2017/013, SCRS/2017/031, SCRS/2017/039, SCRS/2017/40, SCRS/2017/041, SCRS/2017/042 and SCRS/2017/043). Furthermore, the GBYP data have been used for the papers SCRS/2017/019, SCRS/2017/027, SCRS/2017028 and SCRS/2017/045.

Since the scientific papers presented during the meeting direct were direct results of the work carried out in Phase 6, they have already been included in the Final Report for Phase 6, even though the meeting was formally outside of the GBYP Phase 6, which ended on 20 February 2017. The final report of the meeting is attached in **Annex 1a, document no. 47**.

4. Aerial Survey on Bluefin Tuna Spawning Aggregations

4.1 Objectives and overview of the aerial survey for bluefin tuna spawning aggregations

ICCAT GBYP Aerial Survey on Bluefin spawning aggregations was initially identified by the Commission as one of the three main research objectives of the Programme, in order to provide fishery-independent trends on the minimum SSB. The original GBYP programme included only a total of three annual surveys over a maximum of three different areas, but this plan was later modified by the Steering Committee and the statistical study revealed that under the best possible conditions a very minimum of six surveys will be necessary for detecting a trend with an acceptable CV level. The total original budget, set for 3 surveys in 3 areas, was 1,200,000 euro; the costs for carrying out the first 5 surveys in much more areas (up to 4 main "internal" areas and 7 "external" areas) have been about 2,025,621 euro (169 % of the original budget, but with much more than the double of the activities initially planned). This amount represents 15.47% of the total GBYP funds used so far. Therefore, the GBYP objectives initially set for the aerial survey on spawning aggregations in these first Phases have been largely accomplished.

Two surveys on four selected areas were carried out in GBYP Phase 1 and Phase 2, with many transect replicates. In Phase 2 the protocols were partly changed by the Steering Committee and it was made mandatory the use of bubble windows on all aircrafts. The aerial survey activity was suspended in Phase 3, following the recommendation by the GBYP Steering Committee, because it was requested an extended survey all over the potential Mediterranean spawning areas, which covers about 90% of the Mediterranean Sea surface, and because sufficient funds were not made available.

The extended survey was conducted in 2013 and the results were presented to the SCRS and the Commission. This was the first extended aerial survey conducted over more than 60% of the Mediterranean Sea, under very difficult

situations, and using a budget that was not proportionally increased for keeping the same effort realised in previous surveys on the four main areas; therefore, the replicates in the main areas (defined as "inside") were much less, while they were reduced to the minimum in the additional areas (identified as "outside"). Even in this survey, security and permits problems were serious constraints also.

Due to severe budget constraints, it was impossible to carry out any aerial survey in 2014, during the extension period of Phase 4.

The GBYP Steering Committee, in September 2014, included again an extended aerial survey within the activities of Phase 5; this survey included 7 extended areas and 4 main areas. In the very last part of Phase 4, after the meeting of the GBYP Steering Committee in February 2015, a further analysis of the previous data was requested, for better assessing any variance possibly induced by the use of bubble windows since 2011 and the various types of aircrafts, and the study was included in the final report of GBYP Phase 4 for the EU. The possible use of a calibration exercise was discussed at the same meeting and a first draft on a SWOT analyses was presented by the GBYP coordination (document SCRS/2015/143). This preliminary document was therefore discussed by mail with some well-known experts in aerial survey (Phil Hammond and Greg Donovan), who shared the contents, and therefore revised and presented to SCRS at the 2015 BFT Species Group meeting. The main results of the SWOT analysis indicates that a calibration for an aerial survey which uses so many pilots and spotters of different nationalities is not feasible, also taking into account the many legal constraints. Furthermore, a calibration limited to the rotation of scientific spotters (when feasible) would concern only one of the many variance factors which can bias an aerial survey. The GBYP Steering Committee, after many discussions, finally confirmed the agreement to include again the extended aerial survey in the activities of Phase 5.

The surface in 2015 was about 1,284,859 km^2 (312,491 km^2 of "inside" areas and 972,368 km^2 for "outside" areas), representing about 54.35% of the whole surface of the Mediterranean Sea, a surface never covered by any other scientific survey in the Mediterranean so far. Furthermore, that survey covered about 87.6% of the total potential areas where spawning of Bluefin tuna may even occasionally occur. The total length of transects was 25,493 km (14,404 km in "inside" areas and 11,079 km in "outside" areas.

Strong winds, scarce visibility, Bluefin tunas travelling well below the surface (many purse-seiners got most of the catches by fishing with sonar in 2015) due to abnormal extreme oceanographic conditions[3] and military activities have been operative and environmental constraints that caused troubles for the survey in some areas.

The survey revealed that most of the school sightings were concentrated in the areas initially selected by GBYP for conducting the surveys in 2010 and 2011 (which were also the "inside" areas of the extended survey), confirming the full validity of the initial choice based on scientific knowledge and recent fishery data obtained by

[3] See document SCRS/2015/154, considering that July 2015 was the hottest so far in the Mediterranean Sea in the history of oceanographic records.

a VMS analyses of the purse-seiners activities from 2007 to 2009. Only very few sightings were made in other areas where spawners usually travel not so close to the surface.

Additionally, during Phase 5, an analysis on overlapping "inside" areas over the four surveys (**Figure 1**) was carried out, because it was supposed that looking at the same areas over the differ years may possibly provide a more homogenous and standardised comparison, even if further standardisation might be necessary, because the number of replicates or coverage was different in the various surveys. It was noticed a large inter-annual variability as well as geographical variability (variable concentrations in variable areas) among the various surveys. Overall, pooling all areas together, there is again a strong interannual variability both in terms of total weight and density of animals (and taking into account that sub-area G was not surveyed in 2011, the variability may be even larger). In 2010 the total weight (density of animals not being available due to the lack of information on cluster size on that year) was almost half as that in 2011, but still much larger than in 2013; in 2015 the highest total weight of all years was observed, much larger than in 2011. In terms of abundance of animals, 2011 has the largest estimate (and even more considering that area G was not surveyed that year), decreasing to around one third in 2013 (considering only A, C and E) but increasing again to less than two thirds in 2015.

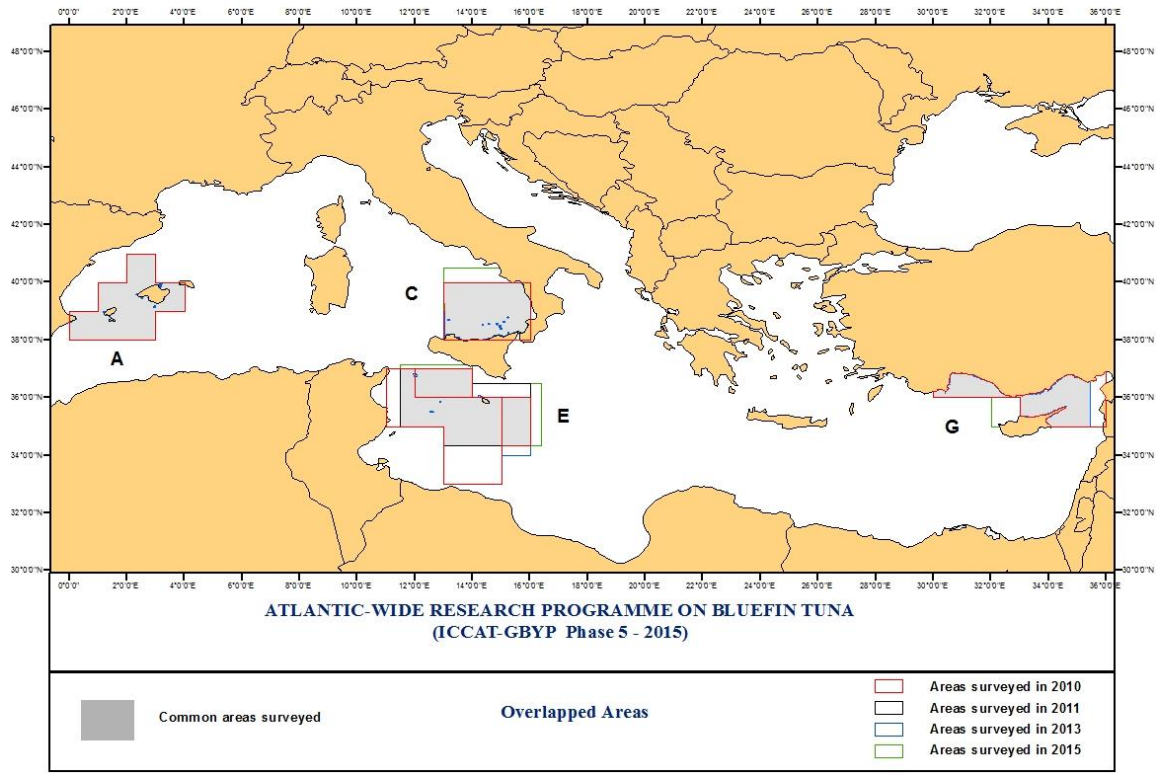


Figure 1. Overlapped areas for four GBYP aerial surveys.

Clearly, these are the "normal" variance factors when carrying out an extended survey in a fixed period (which was set according to the peak of Bluefin tuna spawning in June, as it is known since a couple of centuries. This effect shold be smoothed in a sufficiently long series of surveys if oceanographic conditions get close to the usual average over most of these years.

In the last part of Phase 5, a power analysis and a cost benefit analysis for the aerial survey on spawning aggregations was done in order to have a more focused overview of the works carried out so far within the GBYP and have further details for adopting the best research strategy in Phase 6. The analysis showed that the average cost per km on effort in the GBYP survey was quite low (between 10.14 and 11.23 euro/km) when the survey was carried out only over the main spawning areas, while it increased in a considerable manner when the strategy was turned toward an extended survey covering most of the Mediterranean Sea (from 17.91 to 18.81 euro/km). This relevant increase in the last two extended surveys was due almost exclusively to the extremely complex logistic for surveying the "outside" areas, something that no other survey had faced so far. The comparison of costs with other aerial surveys that have been carried out for which cost data were made available showed that the GBYP costs (even if the effective transect length was the highest) are the lowest among all recent aerial surveys carried out in the European or Mediterranean area for various marine species.

The main recommendation coming out from the power analysis is that a reduction of the coefficients of variation, at several levels (encounter rates, school size, detection function and additional variances) is required to be able to detect trends in population abundance within an acceptable time frame. Furthermore, increased coverage in terms of kilometers of tracks (which means several replicates) on effort should be necessary. Tables of different cost analysis and power analysis have been provided for the purpose of evaluating the level of power (and therefore coverage) that could be achieved in the future aerial surveys, in correlation with the available level of financial resources.

According to the decision of the ICCAT GBYP Steering Committee adopted by e-mail, the aerial survey for the spawning aggregations was suspended again in the year 2016. The Steering Committee based the decision on the assumption that the financial resources are not sufficient for carrying out an adequate survey (i.e. in terms of survey effort that would be required to achieve a reasonable CV) again on the entire or in most of the area in the Mediterranean Sea where spawners/adults may occur. Additionally, it pointed out large logistical, political and administrative constraints that would more than likely prevent such an extended survey from being adequately implemented, even if very much larger financial resources were available.

Later, the Steering Committee identified the potential alternative to conduct a comprehensive survey restricted to relatively limited areas within the Mediterranean that can be adequately surveyed with the available resources. In order for this approach to provide a useful index of abundance, the proportion of the adult stock within the survey areas during the survey needs to be relatively constant. This is essential so that changes and trends in the actual size of the population can be distinguished from inter-annual variability in the utilization of the areas being surveyed. It also reiterated the request that a sort of calibration should be useful. The SC considered the recommendation that this alternative be adopted and the surveys be restricted to the four core overlapping areas that had been included in all the four previous surveys (**Figure 1**), which will provide standardised results and short series possibly usable both for the assessment and the MSE process.

The external reviewers of the GBYP, in Phase 6, also acknowledged the many efforts and the low cost of the GBYP aerial survey, along with the constraints and limits. They also recommended to continue the survey on the four main areas as the only possible alternative to a future Close-kin Genetic Tagging for providing a fishery-independent index.

4.2 Aerial survey in Phase 7

Following a specific request from the European Union, the leading financial contributor of the GBYP, and the recommendation of the Steering Committee, the aerial survey was resumed in Phase 7 on the four overlapping areas (Balearic Sea, southern Tyrrhenian Sea, central-southern Mediterranean Sea and Levantine Sea) which have been already defined and standardised in previous analyses, in order to provide at least a short series possibly usable both for the assessment and the MSE process. Due to the very tight schedule, it was recommended to monitor the survey data in real time, for detecting any possible bias or problem, immediately correcting the survey reporting and have the final report, as well as the index of abundance available for the SCRS BFT Stock Assessment Session. The budget originally planned for the aerial survey in 2017 was only 388,000 euro, well below the usual necessary level, due to a general budget restriction for Phase 7.

A first call of tenders was released at the very beginning of the Phase 7, for obtaining the Aerial Survey 2017 design, the revision of both the protocol and the sighting forms, the assistance to the training course and the survey data analyses. Only one bid was received, from the company that has already participated in this activity in the previous phases of the Programme (Alnilam Investigation and Conservation Ltd), and the contract was awarded.

The 2017 aerial surveys for Bluefin tuna in the Mediterranean Sea, as well as the ones in previous years, was designed using the software DISTANCE, the "industry standard" software for line and point transect distance sampling, based on: the four defined survey areas (survey areas A, C, E and G, see **Figure 2**), target survey time available (equivalent to about 32,000 km), time for circling over detected schools to estimate their size (set at 10%), and time for flying in between lines (set between 10 and 15% depending on the line separation in each block). The survey was designed as equal spaced parallel lines (transects), which were placed mostly in a north-south direction to be approximately perpendicular to the coast in most blocks (**Figure 3**). According to the design, each area had four replicates, while extra additional replicates were included in the design in case of time or budget availability. The comprehensive ICCAT GBYP aerial survey design for 2017 attached in **Annex 1a**, **document no. 1.**

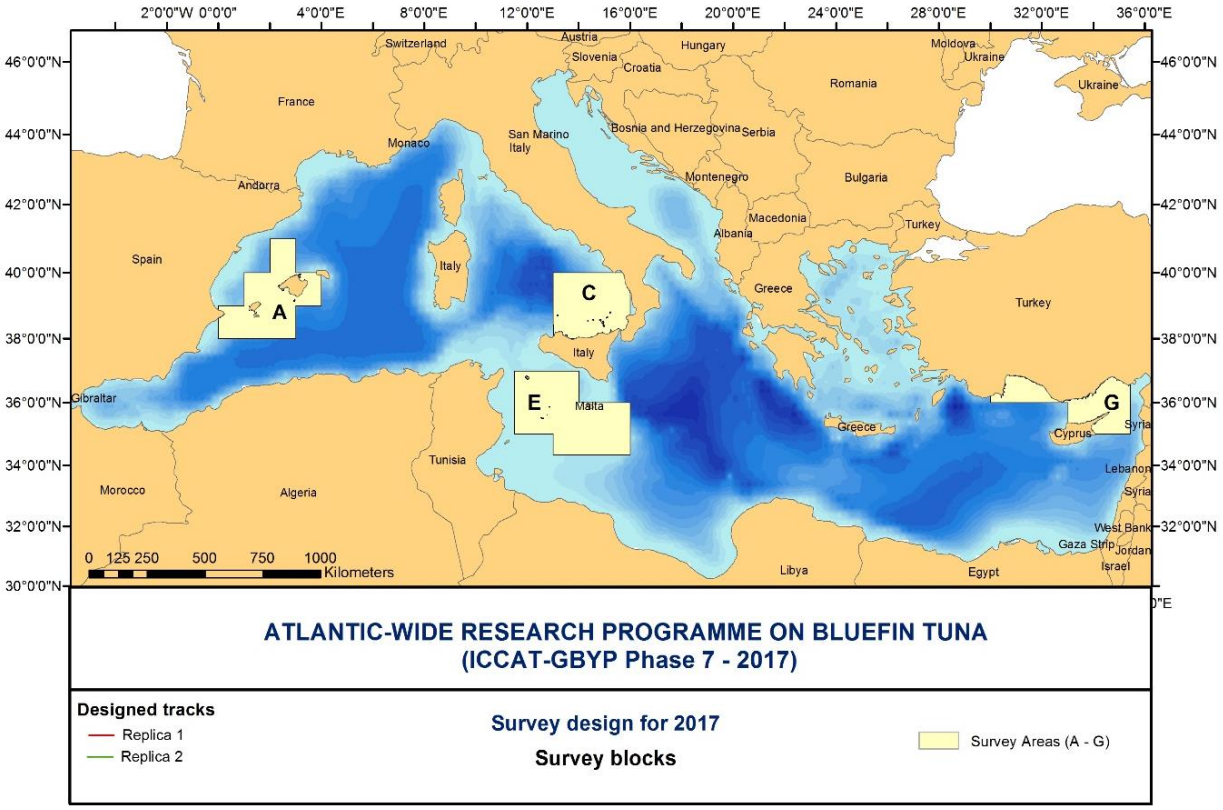


Figure 2. Four areas identified for the aerial survey in 2017. They correspond to the overlapping areas in all previous surveys and to the most important Bluefin tuna spawning areas in the Mediterranean Sea.

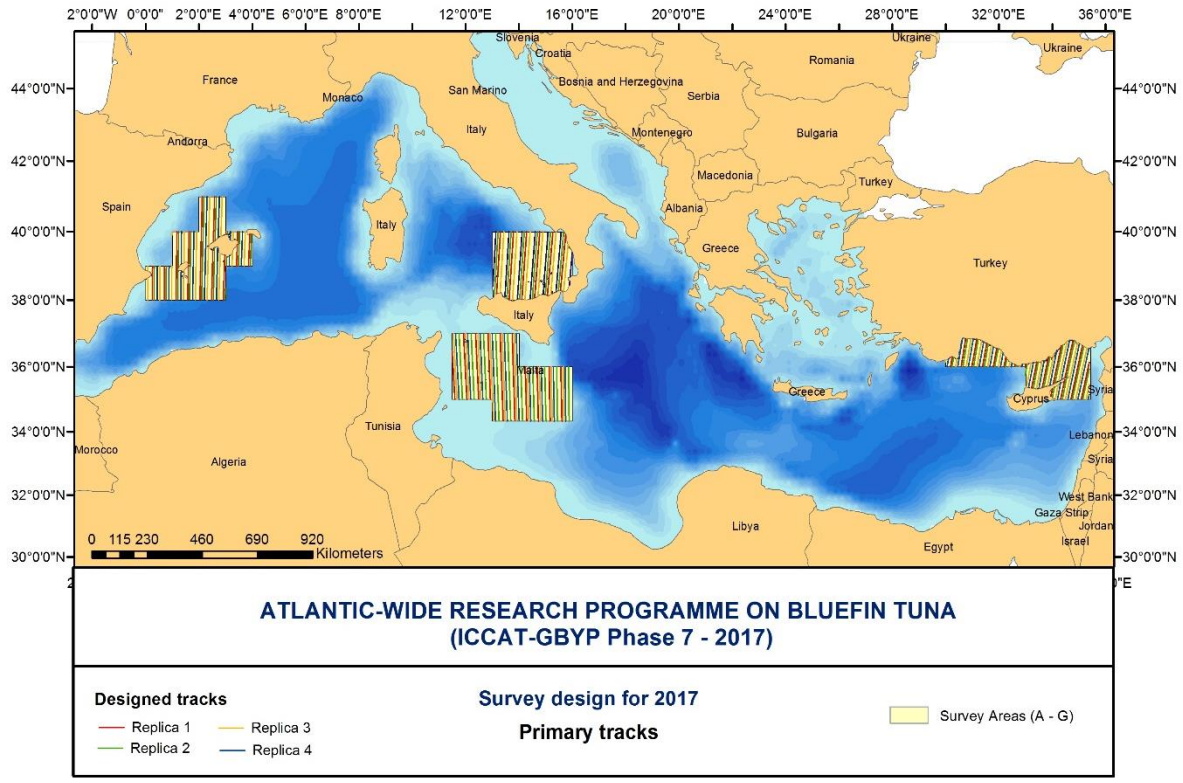


Figure 3. The transect design for the four areas to be surveyed by GBYP in 2017. Each area has four replicates, while extra replicates are not showed on this figure.

Following the drafting of the aerial survey design, another Call for tenders was released, for carrying out the survey in the four areas. Three companies were awarded the contracts: a Spanish company (Grup AirMed) was awarded for area A (Balearic Sea) and area E (southern-central Mediterranean Sea), two Italian companies working together (Unimar and Aerial Banners) for areas C (southern Tyrrhenian Sea) and a French company (Action Air Environnement/Action Communication) for area G (Levantine Sea).

Once awarded the contracts, the ICCAT Secretariat immediately informed all concerned CPCs and assisted all contractors in all procedures for getting the necessary permits. This work needed a continuous assistance by the GBYP Coordination, because of the many delicate aspects concerned and many daily difficulties encountered for various reasons. All companies received the necessary permits, even if some permits had to follow a complex procedure, due to some peculiar situations.

A training course for pilots, professional spotters and scientific observers was organised at the ICCAT Secretariat in Madrid, on 15 May 2017; it was attended by 22 fellows (for the first time, including the Turkish national observer), trained by an external expert (Dr. J.A. Vázquez) and by the GBYP Coordinator. The list of participants is attached **Annex 1a**, as **document no. 7.** During the training course, the GBYP Coordination carried out an independent assessment of the estimation and identification capacities of each participant, using a visual tool specifically developed by GBYP. The updated ICCAT GBYP Protocol for Aerial Survey for Bluefin Tuna Spawning Aggregation, the details for filling the sighting forms and the instructions for the administrative parts were circulated among the contractors immediately after the course. The presentations exposed during the Training course are attached in **Annex 1a**, as **documents no. 4-6.**

The updated protocol (attached in **Annex 1a**, as **document no. 2**) and forms (attached in **Annex 1a**, as **document no. 3)** were developed in cooperation with the GBYP Coordination Team. The updated form now has 51 fields, with a total of 172 entries and it is considered possibly the most complete available among all aerial surveys for marine animals.

4.2.1 Aerial survey activities

This year, due to the reduced budget, it was necessary again to fit the survey effort with the available budget. Therefore, the transect length was initially set at 32,000 km, potentially allowing a maximum of four replicates in each area; according to the previous experience, this could have resulted either in more replicates if the stand-by days are nil or in less replicates if the stand-by days are higher than the forecast (max 25%). This design transect length was much higher than the effective average of the previous surveys (2010, 2011, 2013, 2015) of 21,180 km.

The schedule for beginning the aerial survey was set on 29 May 2017 and the 1st of July was set as the limit for concluding the field activities. As a matter of fact, the aerial survey field activities initiated on 29 May in area E, on 30 May in areas A and C, and on June 6 in area G, due to the complexity of the permit procedures and the travel

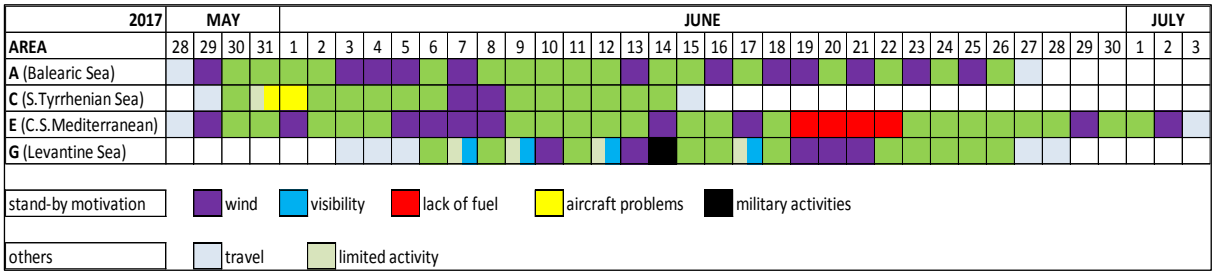
days. The survey ended on June 14 in area C, on June 26 in areas A and G and on July 2 in area E (both the initial and ending dates do not include the days needed for reaching the base airport in each area and those for returning to the home airport). Therefore, the total number of days for effectively carrying out the survey were different in each area: 29 in area A, 16 in area C, 34 in area E and 21 area G.

The aircrafts were a Partenavia P68V (GBYP ID: ICCAT 1) in area A, a Partenavia P68V (ICCAT ID: ICCAT 2), and a Partenavia P68C-TC (GBYP ID: ICCAT 6) in area C, a Partenavia P68C (GBYP ID: ICCAT 3)[4] in area E and a CESSNA 337 Sky-master push-pull (GBYP ID: ICCAT 4) in area G. Therefore, we had three areas A, C and E) covered by high-wings twin side engines aircrafts and one area (G) covered by a high-wings push-pull engines aircraft. All aircrafts have been equipped with bubble windows, two additional GPS connected to the computer and declinometers. Each crew had a professional pilot who was also a professional observer, then a professional observer and two scientific observers (except in area G where a scientific observer was substituted by the Turkish national observer).

The factors affecting the survey in each area were different and **Table 5** graphically shows the activities in each area, including the days on stand-by and the motivations. In total, over 101 days of activities (29 in area A, 16 in area C, 35 in area E and 21 in area G), the number of days in stand-by was 35, equal to 34.6% against a preliminary estimation of 25%; including the days with partial activity, then the total reaches 37.5 days, equal to 37.1%. The percentage of stand-by days by area was 41% in area A, 19% in area C, 41% in area E and 29% in area G. This high number of days in stand-by was caused by many factors but mostly by the wind (30% in total), that affected several areas during this period (mostly the Balearic area and the central-southern Mediterranean Sea). This problem affected also the stabilisation of the thermocline in some parts of these areas, particularly when the wind continued over several days. Other motivations for the stand-by have been the lack of fuel in area E (a well-known recurrent problem in Malta over the years which is difficult to solve, due to the lack of Avgas in several airports close to the area or to the need of a higher rank pilot licence to land in Pantelleria, another airport where Avgas is available), accounting for 4%, the military activities in area G and some problem to the aircraft in area C (both accounting for 1% each). As a matter of fact, there was another motivation that only partly appears in **Table 5**, and this was the poor visibility in area G, which induced also to adopt a different approach for the strip size; this limited visibility, generated by a peculiar environmental situation, caused 19% of days of limited operational activity in the survey in area G. The final reports are attached in **Annex 1a**, as **document no. 8** (for the areas A and E), **document no. 9** (for area C) and **document no. 10** (for area G).

[4] Due to a problem in the fuel reservoir in the first part of the survey in area C, it was necessary to substitute the aircraft with the reserve one.

Table 5. General overview of the aerial survey field activities by area, including the motivations for stand-by.



In general, in 2017, the aerial survey worked much better than in all previous years, from all points of view and besides the usual problems. At the beginning it was necessary to discuss and solve the problems with the national authorities concerned; the problems were related to the permits in three FIRs, the potential security risks in three areas, the potential problems linked to possible interferences with rescue of migrants in one area and with military activities and operations in two areas, but at the end everything was solved by the GBYP Coordination working together side-by-side with the contracted companies concerned and with the extremely supportive local authorities. The problems during the field activities were discussed and solved in real time.

4.2.2 Aerial survey results

In previous ICCAT GBYP aerial surveys, the data analyses were available usually at the end of the year. For the very first time and thanks to the new strategy adopted by the GBYP Coordination, it was possible to get the data elaboration report in real time, therefore allowing the results and a paper (document SCRS/2017/149, attached in **Annex 1b, document no. 9**.) to be presented SCRS Bluefin tuna Assessment Session just two weeks after the conclusion of the field activities.

The coverage was very good in all areas (**Table 6**), for a total of 265,626 km^2, even if it was not possible to reach the total length of the transects set at the beginning, due to several motivations. As a matter of fact, at the end the final effective transect length was 21,178 km, equal to the average in previous surveys. This evidence confirms again the right choice of limiting the survey to the four overlapping areas for getting comparable and standardised results. In 2017, according to the parameters and diagnostics of the detection function, the effective strip width was defined at 1.4 km in all areas, due to the limited visibility in area G.

Table 6. Areas, number and total length of transects and number of sightings of Bluefin tuna for each surveyed sub-area.

Area	Area (km^2)	Number of transects	Length of transects on effort (km)	Number of observations (after truncation) Detection Function	Number of observations (after truncation) Abundance estimate
A	61,933	26	4,981	40	22
C	53,868	25	4,911	16	15
E	93,614	30	6,705	10	9
G	56,211	55	4,581	61	45
Total	265,626	136	21,178	127	91

The results for all the aerial surveys carried out so far in the overlapping areas are shown in **Table 7** (for Balearic Sea), **Table 8** (for Southern Tyrrhenian Sea), **Table 9** (for central-southern Mediterranean Sea) and **Table 10** (for Levantine Sea). The summary table showing combined results of all overlapping areas for all 5 years of aerial survey performed by ICCAT GBYP is given in the **Table 11**.

Table 7. Survey details for the surveys carried out so far in Area A (Balearic Sea). All data are only related to the same overlapping surface and to on-effort results, excluding the off-effort data.

Year	**2010**	**2011**	**2013**	**2015**	**2017**	**Total (sum)**	**Total (mean)**
Survey area (km^2)	61,933	61,933	61,933	61,933	61,933	309,665	61,933
Transect length (km)	6,118	7,838	6,807	4,109	4,981	29,852	5,970
Effective strip width x2 (km)	2.96	1.36	3.00	3.9	1.4		2.52
Area searched (km^2)	18,130	10,660	20,398	15,961	7,017	72,166	14,433
% coverage	29.3	17.2	32.9	25.8	11.3		23.3
Number of schools ON effort	8	10	10	6	22	56	11.2
Abundance of schools	25	58	30	23	95	231	46
%CV abundance of schools	55.4	35.9	36.1	43.4	30.8		
Encounter rate of schools	0.0013	0.0013	0.0015	0.0014	0.0044		0.00198
%CV encounter rate	54.5	33.8	35.1	41.1	25.9		
Density of schools (1000 km^{-2})	0.402	0.938	0.490	0.372	1.531		0.747
%CV density of schools	55.4	35.9	36.1	43.4	30.8		
Mean weight (t)	131.25	122.43	194.1	160.7	133.9		148.462
%CV weight	6.2	19.2	23.8	11.7	34.9		
Mean cluster size (animals)		678.1	611	825	754		717
%CV abundance		27.9	26.0	11.0	33.6		
Density of animals (km^{-2})		0.636	0.299	0.307	1.155		0.599
%CV density of animals		45.4	44.5	44.7	39.7		
Total weight (t)	**3,587**	**4,371**	**3,539**	**4,712**	**12,693**		**5,780**
%CV total weight	56.5	46.2	40.6	42.0	40.9		
L 95% CI total weight	1,251	1,807	1,624	2,132	5,848		
U 95% CI total weight	10,285	10,577	7,710	10,414	27,551		
Total abundance (animals)		**39,399**	**18,542**	**19,002**	**71,520**		**37,116**
%CV total abundance		45.4	44.5	44.7	39.7		
L 95% CI total abundance		16,540	7,913	8,195	33,620		
U 95% CI total abundance		93,850	43,445	44,060	152,141		

Table 8. Survey details for the surveys carried out so far in Area C (southern Tyrrhenian Sea). All data are only related to the same overlapping surface and to on-effort results, excluding the off-effort data.

Year	**2010**	**2011**	**2013**	**2015**	**2017**	**Total (sum)**	**Total (mean)**
Survey area (km^2)	53,868	53,868	53,868	53,868	53,868	269,340	53,868
Transect length (km)	8,487	8,826	2,791	2,739	4,911	27,754	5,550
Effective strip width x2 (km)	2.96	1.36	3.00	3.9	1.4		2.52
Area searched (km^2)	25,150	12,004	8,364	10,640	6,918	63,076	12,615
% coverage	46.7	22.3	15.5	19.8	12.8		23.4
Number of schools ON effort	6	10	10	3	15	44	8.8
Abundance of schools	12	45	64	13	57		38
%CV abundance of schools	45.7	33.4	34.3	62.0	28.8		
Encounter rate of schools	0.0007	0.0011	0.0036	0.0009	0.0031		0.0016
%CV encounter rate	44.6	31.2	33.1	60.5	23.6		
Density of schools (1000 km^{-2})	0.217	0.833	1.196	0.239	1.058		0.709
%CV density of schools	45.7	33.4	34.3	62.0	28.8		
Mean weight (t)	124.17	38.87	173.5	190.0	202.5		145.808
%CV weight	5.6	44.4	22.1	19.9	21.9		
Mean cluster size (animals)	733	291	1,285	1,533	1,453		1,059
%CV abundance	36.5	30.7	17.0	19.0	17.2		
Density of animals (km^{-2})	0.182	0.242	1.536	0.366	1.539		0.773
%CV density of animals	59.2	45.3	38.3	64.9	33.3		
Total weight (t)	**1,596**	**1,917**	**11,370**	**2,665**	**11,547**		**4,387**
%CV total weight	46.9	54.9	40.8	65.1	35.5		
L 95% CI total weight	652	661	5,161	802	5,829		
U 95% CI total weight	3,904	5,557	25,049	8,856	22,874		
Total abundance (animals)	**9,797**	**13,059**	**82,763**	**19,708**	**82,886**		**41,643**
%CV total abundance	59.2	45.3	38.3	64.9	33.3		
L 95% CI total abundance	3,187	5,446	39,399	5,958	43,597		
U 95% CI total abundance	30,016	31,317	173,860	65,192	157,580		

Table 9. Survey details for the surveys carried out so far in Area E (central-southern Mediterranean Sea). All data are only related to the same overlapping surface and to on-effort results, excluding the off-effort data.

Year	2010	2011	2013	2015	2017	Total (sum)	Total (mean)
Survey area (km^2)	93,614	93,614	93,614	93,614	93,614	468,070	93,614
Transect length (km)	13,137	10,192	4,381	2,566	6,705	36,981	7,396
Effective strip width x2 (km)	2.96	1.36	3.00	3.9	1.4		2.52
Area searched (km^2)	38,930	13,862	13,129	9,969	9,446	85,335	17,067
% coverage	41.6	14.8	14.0	10.6	10.1		18.2
Number of schools ON effort	29	45	20	3	9	106	21.2
Abundance of schools	63	304	135	20	44		113
%CV abundance of schools	31.5	24.1	34.8	58.0	36.4		
Encounter rate of schools	0.0022	0.0044	0.0046	0.0008	0.0013		0.0029
%CV encounter rate	29.9	21.0	33.6	56.3	32.4		
Density of schools (1000 km^{-2})	0.678	3.246	1.447	0.213	0.466		1.210
%CV density of schools	31.5	24.1	34.8	58.0	36.4		
Mean weight (t)	110.14	118.05	11.0	50.2	102.3		78.338
%CV weight	33.9	19.2	66.0	99.5	51.2		
Mean cluster size (animals)	1,015	1,715	361	507	848		889
%CV abundance	19.0	21.5	67.3	97.9	33.2		
Density of animals (km^{-2})	0.787	5.566	0.522	0.108	0.395		1.476
%CV density of animals	37.8	32.3	75.7	113.8	49.9		
Total weight (t)	**7,681**	**37,851**	**1,517**	**1,093**	**4,457**		**10,520**
%CV total weight	47.1	32.2	74.6	115.2	63.4		
L 95% CI total weight	3,155	20,342	390	75	1,413		
U 95% CI total weight	18,698	70,432	5,899	15,857	14,062		
Total abundance (animals)	**73,676**	**521,085**	**48,884**	**10,126**	**36,927**		**138,140**
%CV total abundance	37.8	32.3	75.7	113.8	49.9		
L 95% CI total abundance	35,741	279,620	12,363	727	14,559		
U 95% CI total abundance	151,880	971,060	193,280	141,020	93,662		

Table 10. Survey details for the surveys carried out so far in Area G (Levantine Sea). All data are only related to the same overlapping surface and to on-effort results, excluding the off-effort data.

Year	2010	2011	2013	2015	2017	Total (sum)	Total (mean)
Survey area (km^2)	56,211		56,211	56,211	56,211	224,844	56,211
Transect length (km)	3,790		2,081	859	4,581	11,311	2,827
Effective strip width x2 (km)	2.96		3.00	3.9	1.4		2.81
Area searched (km^2)	11,231		6,236	3,335	6,453	27,256	6,814
% coverage	20.0		11.1	5.9	11.5		12.1
Number of schools ON effort	33		12	2	45	92	23
Abundance of schools	150		108	22	191		118
%CV abundance of schools	28.1		39.7	70.9	23.5		
Encounter rate of schools	0.0087		0.0058	0.0015	0.0098		0.0081
%CV encounter rate	26.3		38.7	69.5	16.6		
Density of schools (1000 km^{-2})	2.674		1.924	0.399	3.398		2.099
%CV density of schools	28.1		39.7	70.9	23.5		
Mean weight (t)	63.621		4.0	9.0	16.5		23.280
%CV weight	12.7		40.2	66.7	31.5		
Mean cluster size (animals)			336	600	809		582
%CV abundance			36.7	66.7	31.9		
Density of animals (km^{-2})			0.646	0.239	2.756		1.214
%CV density of animals			54.1	97.3	40.1		
Total weight (t)	**10,507**		**440**	**220**	**3,157**		**3,581**
%CV total weight	32.1		56.5	97.3	39.3		
L 95% CI total weight	5,643		151	25	1,495		
U 95% CI total weight	19,561		1,285	1,965	6,669		
Total abundance (animals)			**36,316**	**13,448**	**154,939**		**68,234**
%CV total abundance			54.1	97.3	40.1		
L 95% CI total abundance			12,995	1,506	72,366		
U 95% CI total abundance			101,490	120,070	331,731		

Table 11. Results for all ICCAT GBYP aerial surveys in all overlapping areas combined.

Year	2010	2011	2013	2015	2017	Total (sum)	Total (mean)
Survey area (km^2)	265,627	209,416	265,627	265,627	265,627	1,288,135	265,627
Transect length (km)	31,532	26,856	16,060	10,272	21,178	105,898	21,173
Effective strip width x2 (km)	2.96	1.36	3.00	3.9	1.4		2.52
Area searched (km^2)	93,442	36,525	48,127	39,904	29,834	166,041	33,208
% coverage	35.2	17.4	18.1	15.0	11.2		12.89
Number of schools ON effort	76	65	52	14	91	298	59.6
Abundance of schools	250	388	338	78	387		288
%CV abundance of schools	22.8	19.9	21.5	38.9	20.2		
Encounter rate of schools	0.0024	0.0024	0.0032	0.0014	0.0043		0.0028
%CV encounter rate				20.2	11.6		
Density of schools (1000 km^{-2})	0.942	1.852	1.274	0.295	1.457		1.086
%CV density of schools	22.8	19.9	21.5	38.9	23.4		
Mean weight (t)	87.9	101.1	22.6	272.2	82.3		113.212
%CV weight	16.8	27.5	51.0	41.4	19.2		
Mean cluster size (animals)	791	1,275	582	1,548	895		1018
%CV abundance	18.6	37.3	18.5	40.5	17.0		
Density of animals (km^{-2})		**2.7388**	**0.702**	**0.234**	**1.304**		**1.245**
%CV density of animals		29.9	29.4	39.1	25.9		
Total weight (t)	**23,371**	**44,139**	**16,866**	**8,690**	**31,855**		**24,984**
%CV total weight	25.6	28.7	30.3	35.3	26.7		
L 95% CI total weight	14,243	25,315	9,343	4,398	19,018		
U 95% CI total weight	38,347	76,964	30,447	17,169	53,355		
Total abundance (animals)		**573,543**	**186,505**	**62,284**	**346,272**		**292,151**
%CV total abundance		29.9	29.4	39.1	25.9		
L 95% CI total abundance		321,620	105,320	28,766	209,816		
U 95% CI total abundance		1,022,800	330,270	134,860	571,473		

The weather and oceanography conditions are extremely important for the aerial survey, particularly in the Mediterranean Sea, where oceanography factors are essential components for the spawning activities. The general geography of the Mediterranean area, with so many different coasts and hundreds of isles, naturally creates many different meteorological situations, over the more that 2.5 million Km^2 of the Mediterranean; these conditions may clearly affect the operational side of the survey. At the same time, the oceanography is quite complex as well, with effects on the distribution, the reproductive biology and behaviour of the Bluefin tuna, and this year it revealed a further interesting change in the distribution and concentration of the Bluefin tuna schools (a lower concentration in area E), which was mirrored by the adaptive strategy of the purse-seine fishing fleets. Some of the data collected during ICCAT GBYP aerial survey were used for elaboration of the paper on habitat modelling (Cañadas et al., 2018, attached in **Annex 1b**, as **document no. 3).**

The combined data for the four areas surveyed in 2017 are shown on **Table 12** and it is very clear that the aerial survey in 2017 was very successful, even taking into account the reduced budget availability, which imposed a reduced number of replicas compared to years when the budget was much higher, and considering also the unfavourable weather conditions in some areas, which limited both the operations and the effective strip width. Besides the practical problems, most of which are unpredictable but always within the usual *alea* of a wide field activity, the activity this year has been a win-win one.

Table 12. Results for all ICCAT GBYP aerial surveys in all overlapping areas and in total in 2017.

Year	**A**	**C**	**E**	**G**	**Total (sum)**	**Total (mean)**
Survey area (km^2)	61,933	53,868	93,614	56,211	265,627	
Transect length (km)	4,981	4,911	6,705	4,581	21,178	
Effective strip width x2 (km)	1.4	1.4	1.4	1.4		1.4
Area searched (km^2)	7,017	6,918	9,446	6,453	29,834	
% coverage	11.3	12.8	10.1	11.5	11.2	
Number of schools ON effort	22	15	9	45	91	22.8
Abundance of schools	95	57	44	191	387	96.8
%CV abundance of schools	30.8	28.8	36.4	23.5	20.2	
Encounter rate of schools	0.0044	0.0031	0.0013	0.0098		0.0043
%CV encounter rate	25.9	23.6	32.4	16.6		11.6
Density of schools (1000 km^{-2})	1.531	1.058	0.466	3.398		1.457
%CV density of schools	30.8	28.8	36.4	23.5		23.4
Mean weight (t)	133.9	202.5	102.3	16.5		82.3
%CV weight	34.9	21.9	51.2	31.5		19.2
Mean cluster size (animals)	754	1,453	848	809		895
%CV abundance	33.6	17.2	33.2	31.9		17.0
Density of animals (km^{-2})	1.155	1.539	0.395	2.756		**1.304**
%CV density of animals	39.7	33.3	49.9	40.1		25.9
Total weight (t)	**12,693**	**11,547**	**4,457**	**3,157**	**31,855**	
%CV total weight	40.9	35.5	63.4	39.3	26.7	
L 95% CI total weight	5,848	5,829	1,413	1,495	19,018	
U 95% CI total weight	27,551	22,874	14,062	6,669	53,355	
Total abundance (animals)	**71,520**	**82,886**	**36,927**	**154,939**	**346,272**	
%CV total abundance	39.7	33.3	49.9	40.1	25.9	
L 95% CI total abundance	33,620	43,597	14,559	72,366	209,816	
U 95% CI total abundance	152,141	157,580	93,662	331,731	571,473	

The results show that the total survey area was equal to 265,627 km^2, for a final effective transect length of 21,178 km and a total effective area searched of 29,834 km^2. This last number is just the result of the reduced effective strip width (1.4 km, imposed mostly by the reduced visibility in one area), because, as a matter of fact, the searched area was much larger. The number of Bluefin tuna schools detected on effort (91) has been the highest so far, confirming a good presence of the species. The map showing the distribution of the Bluefin tuna sightings by area,

on effort and off effort, during the survey in 2017, is provided by **Figure 4**.

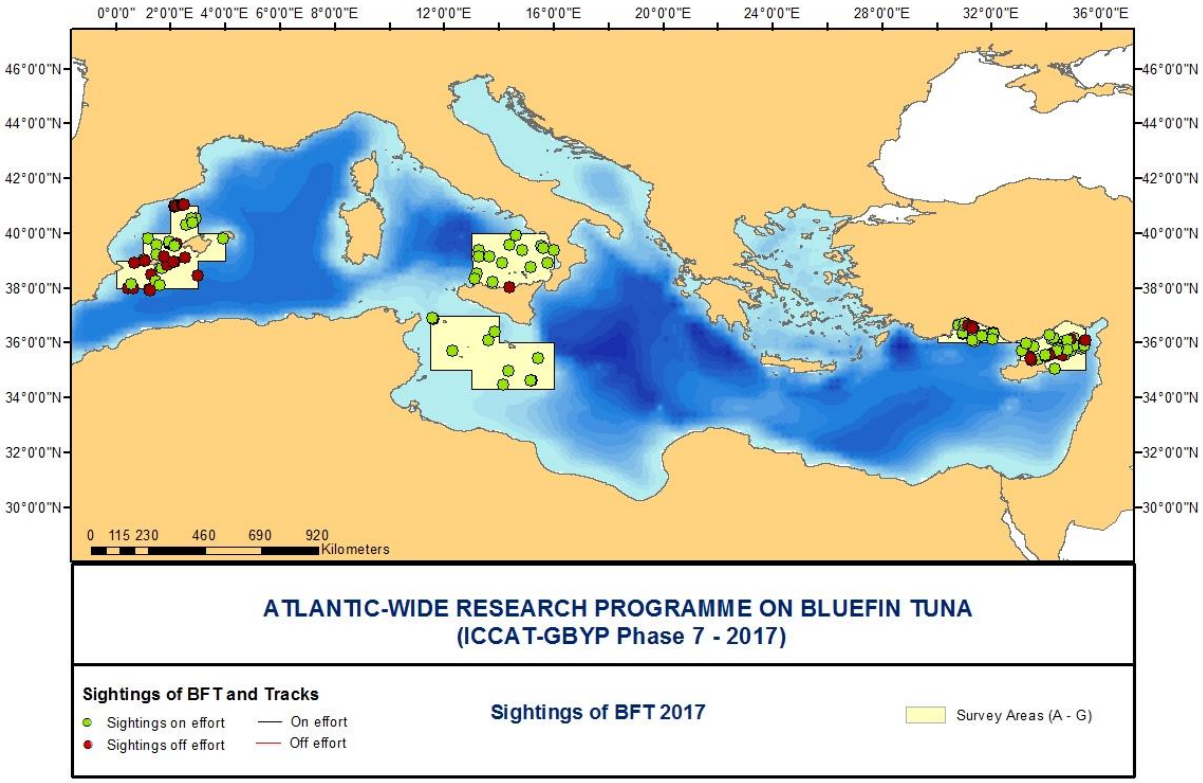


Figure 4. Distribution of the sightings of Bluefin tuna on and off effort during the ICCAT GBYP Aerial Survey for spawning aggregations in 2017.

The abundance of schools (387) was one of the highest so far, almost the same than the highest value (388) registered in 2011 and much higher than the average. The encounter rate of schools (0.0043) was the highest so far, about the double than the average. The density of schools (1.457/1000 km^2) has been the second highest so far, well over the average. The mean weight of the schools was 82.3 tons, below the average, for a high presence of young spawners. The density of animals (1.304 km2) has been the second highest, even in this case over the average. The main parameters, the total weight (31,855 tons) and the total abundance of fish (n=346,272) have been both the second highest so far, well over the average (**Figure 5** graphically shows the results in all surveys for the density of fish and schools, the total abundance and the total weight).

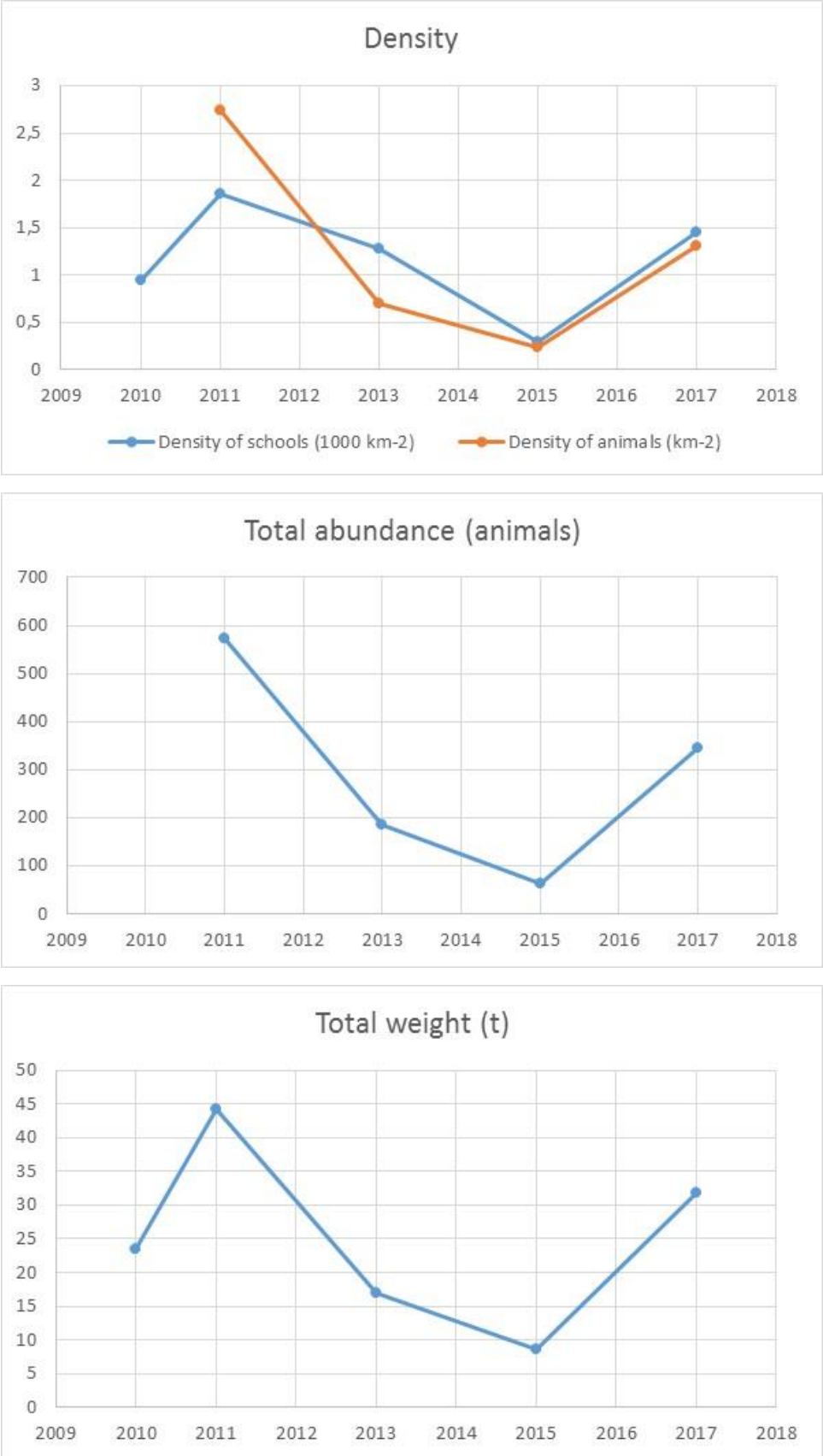


Figure 5. Graphic plots of the main results of the five ICCAT GBYP Aerial surveys on Bluefin tuna spawning aggregations for the density of schools and animals (top), the total abundance of fish (middle) and the total weight in tons (bottom).

The detailed results of the ICCAT GBYP survey are attached in **Annex 1a**, as **document no. 16.** As mentioned earlier, these results have already been presented in the paper SCRS/2017/149 (**Annex 1b, document no. 9**), submitted for the Bluefin Tuna Stock Assessment Meeting. For the very first time, the series of the ICCAT GBYP aerial survey data was used in the MSE and the OM, while the BFT SG considered that it is still limited in number of years for its use in the assessment. The results obtained by the ICCAT GBYP aerial survey in 2017 confirm the validity of the methodology.

5. Tagging

According to the general programme, after the adoption of the ICCAT GBYP Tagging Design and GBYP Tagging Manual in Phase 1, it was planned to begin the tagging activity in GBYP Phase 2 and continue it in the following Phases. The tag awareness and recovery programme was also launched in Phase 2 and continued in the following Phases, including a new tag rewarding policy.

5.1 Objectives

The specific objectives of the GBYP tagging activity on the medium term were set as follows:

a) Validation of the current stock status definitions for populations of bluefin tuna in the Atlantic and Mediterranean Sea. If the hypothesis of two stock units (eastern and western stocks) holds, the tags should provide estimates of mixing rates between stock units by area and time strata (ICCAT main area definitions and quarter at least). It is also important to consider possible sub-stock units and their mixing or population biomass exchange, particularly in the Mediterranean Sea (this point included both conventional and electronic tagging).
b) Estimate the natural mortality rates (M) of bluefin tuna populations by age or age-groups and/or total mortality (Z) (this point was related to conventional tagging).
c) Estimate tagging reporting rates for conventional tags, by major fishery and area, also using the observer programs currently deployed in the Mediterranean fisheries (ICCAT ROP-BFT).
d) Evaluate habitat utilization and large-scale movement patterns (spatio-temporal) of both the juveniles and the spawners (this point was mostly related to electronic tagging but not only).
e) Estimate the retention rate of various tag types, due to contrasting experiences in various oceans.

Electronic Pop-up tags should provide data over a short time frame, while conventional tags, internal archival tags and PIT tags should provide data over a longer period of time, always depending on the reporting rate.

The initial, short-term GBYP objective was to implant 30,000 conventional tags and 300 electronic tags in three years in the eastern Atlantic, with a total budget of 9,765,000 euro; the absolutely necessary tagging design study and protocol, as well as the tag awareness and rewarding campaigns, were not included in this initial budget. So far, with only 50 % of the funds (a total of 4,885,229 euro, equal to 37.32% of the total GBYP funds received so far), GBYP deployed so far 88.4 % of the conventional tags (26,519) and 129.7 % of the electronic tags (389 in total; 331 mini PATs, 50 internal archival tags and 8 acoustic tags); furthermore, the tagging design and protocols,

the awareness and rewarding campaigns were included in the activity carried out so far, while they were not included in the initial activities. It is very clear that the general objectives sets for the tagging activities in these first Phases were largely accomplished so far, even without considering the proportion of the available budget.

The updated situation of the tagging activities in Phase 7 is shown on **Table 13**. In total, up to 21 February 2018, the total number of bluefin tuna tagged so far in all Phases of GBYP are 19,140, and a total of 26,908 tags of various types have been implanted (**Table 14**). 41.6% of the tagged fish were double tagged (against an objective of 40%).

Table 13 – Details on the number of Bluefin tuna tagged with various types of tags in Phase 7 and on the number of the various types of tags implanted in the various areas (updated on 21 February 2018)

Phase 7

	ALL FISH TAGGED	FISH SINGLE TAGGED					FISH DOUBLE TAGGED						
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic	Double Tags - Conventional	Mini-PATS + Conv.	Mini-PATS + 2Conv.	MiniPAT+Acoustic+Conv.	Archivals + Conv.	Archivals + 2Conv.	Acoustic + Conv.
Canada	1	0	1	0	0	0	0	0	0	0	0	0	0
Bay of Biscay (a)	0	0	0	0	0	0	0	0	0	0	0	0	0
Morocco*	0	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	46	6	0	40	0	0	0	0	0	0	0	0	0
Strait of Gibraltar***	0	0	0	0	0	0	0	0	0	0	0	0	0
West Med. **	18	18	0	0	0	0	0	0	0	0	0	0	0
Central Med. ****	292	216	76	0	0	0	0	0	0	0	0	0	0
East Med.	0	0	0	0	0	0	0	0	0	0	0	0	0
North Sea	19	1	0	3	0	0	0	15	0	0	0	0	0
		241	**77**	**43**	**0**	**0**	**0**	**15**	**0**	**0**	**0**	**0**	**0**
GRAND TOTAL	**376**	**SUBTOTAL = 361**					**SUBTOTAL = 15**						

	TOTAL NUMBER OF TAGS	TAGS IMPLANTED				
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic
Canada	1	0	0	0	0	0
Bay of Biscay (a)	0	0	0	0	0	0
Morocco*	0	0	0	0	0	0
Portugal	46	6	0	40	0	0
Strait of Gibraltar	0	0	0	0	0	0
West Med. **	18	1	0	0	0	0
Central Med.	292	134	39	0	0	0
East Med.	0	0	0	0	0	0
North Sea	34	16	0	18	0	0
	391	**157**	**39**	**58**	**0**	**0**

Table 14. Details on the number of Bluefin tuna tagged with various types of tags in all Phases of GBYP and on the number of the various types of tags implanted in the various areas (updated on 21 February 2018)

All GBYP Phases (2, 3, 4, 5 ,6 & 7) (up to 21/02/2018)

	ALL FISH TAGGED	FISH SINGLE TAGGED					FISH DOUBLE TAGGED						
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic	Double Tags - Conventional	Mini-PATS + Conv.	Mini-PATS + 2Conv.	MiniPAT+Acoustic+Conv.	Archivals + Conv.	Archivals + 2Conv.	Acoustic + Conv.
Canada	823	0	818	0	0	0	0	5	0	0	0	0	0
Bay of Biscay (a)	7701	4173	1	3	0	0	3493	18	0	0	13	0	0
Morocco*	369	129	48	45	0	0	121	14	0	7	0	0	1
Portugal	280	23	39	64	0	0	154	0	0	0	0	0	0
Strait of Gibraltar***	5561	2254	43	0	0	0	3212	22	5	0	23	2	0
West Med. **	1734	972	377	28	0	0	352	5	0	0	0	0	0
Central Med.	2607	989	1081	32	0	0	479	15	0	0	12	0	0
East Med.	50	0	0	50	0	0	0	0	0	0	0	0	0
North Sea	19	1	0	3	0	0	0	15	0	0	0	0	0
		8541	**2407**	**225**	**0**	**0**	**7811**	**94**	**5**	**7**	**48**	**2**	**1**
GRAND TOTAL	**19140**	**SUBTOTAL = 11173**					**SUBTOTAL = 7968**						

	TOTAL NUMBER OF TAGS	TAGS IMPLANTED					
		FT-1-94	FIM-96 or BFIM-96	Mini-PATs	Archivals	Acoustic	% by area
Canada	828	0	822	5	0	0	**3,1%**
Bay of Biscay	11225	7697	3494	21	13	0	**41,7%**
Morocco*	515	258	183	66	0	8	**1,9%**
Portugal	434	145	225	64	0	0	**1,6%**
Strait of Gibraltar***	8618	5491	3075	27	25	0	**32,0%**
West Med. **	2090	1308	732	33	0	0	**7,8%**
Central Med.	3114	1386	1550	47	12	0	**11,6%**
East Med.	50	0	0	50	0	0	**0,2%**
North Sea	34	16	0	18	0	0	**0,1%**
TOTAL	**26908**	**16301**	**10081**	**331**	**50**	**8**	**100,0%**
%	**99%**	**60,6%**	**37,5%**	**1,2%**	**0,2%**	**0,0%**	

The final reports of all electronic tagging activities in Phase 7 are in the **Annex 1a (documents no. 60 and 62)**. The overview of the ICCAT GBYP tagging activities in the Phase 7 was presented within the document SCRS/2017/139 (**Annex 1b, document no. 11**).

5.2 Tags and correlate equipment

At first, ICCAT GBYP acquired a considerable amount of tags during these first Phases of the programme, allowing both the tag delivery to all stakeholders who have a bluefin tagging activity (either opportunistic or institutional) and to the GBYP contractors. During the Phase 7, GBYP acquired some additional electronic tags MiniPATs manufactured by Wildlife Computers, with the aim of deploying them during tagging activities. Since it was not possible to deploy all, the ones that remained are going to be used in Phase 8. In addition, in this Phase, a total of 10,000 conventional tags have been purchased, which are to be deployed in following phases.

5.3 Tagging in Phase 7

As recommended by the Steering Committee, the tagging activities in the Phase 7 were limited again to the deployment of electronic tags, keeping the deployment of conventional tags only as a complimentary activity.

The attention for the first part of the tagging programme in the Phase 7 was focused in the northern Atlantic and in the North Sea. Only one contract was awarded, for the deployment of 20 PSATs in waters near Sweden and 20 in water near Denmark. Due to some logistical problems and unfavourable weather conditions, only 18 tags were deployed – 4 in Denmark and 14 in Sweden. The tags were deployed during September and the fishing gear used for tagging was rod and reel, while an auxiliary boat that was chartered and used for moving the tagging team within the tagging area. Adult Bluefin tunas were tagged on board or along the side of the boat by expert taggers.

The bluefin tuna was first spotted again in the Norwegian waters in 2012, after decades of absence, and the GBYP had the opportunity to get the first information in real time, thanks to a fish tagged by our team in Morocco. The reasons for the return of Bluefin tuna in the Nordic waters are currently unknown, but it is important to note that mackerels were quite abundant in these last years in the same waters. In 2016, the Bluefin tuna was noticed also in the Swedish waters, not far from the coast. It is suspected that the bluefin tuna going to the North Sea is almost exclusively of eastern origin. The tagging will possibly help understanding these migration patterns and specific behaviour, because this is the first time bluefin was tagged in the waters around Denmark and Sweden[5]. The information from the released tags will possibly provide the complementary data to the current electronic tags database and extend its coverage to new northern areas. Up to 16 March 2018, a total of 13 of these tags have already popped off, while 5 are still deployed. The available tracks from the tags deployed in Skagerrak in 2017 are shown in the **Figure 6** in blue colour.

Following the recommendation of the Steering Committee, a second call for tenders was released, for the tagging activities in the Portuguese traps and in the Strait of Messina. Only one contract was awarded, for tagging 40 Bluefin tunas in the Portuguese traps. These traps capture mostly tunas moving into the Atlantic after spawning in the Mediterranean Sea, but in 2017 they got also incoming fish. As reported above, tagging has already been done there in 2016, but the results were suboptimal, given the high number of premature releases, mostly due to the

[5] Not all electronic tags tracks have been available yet

technical failure of the electronic tags. Nevertheless, although the deployments were short, they showed that from Portuguese traps, the majority of tagged individuals moved towards northern Atlantic, while one moved towards the Azores. As concerns the deployments in 2017, all the electronic tags have already popped off and all off their tracks are already available. The tracks from the tags deployed in Portugal in 2017 are shown in the **Figure 6** in magenta colour.

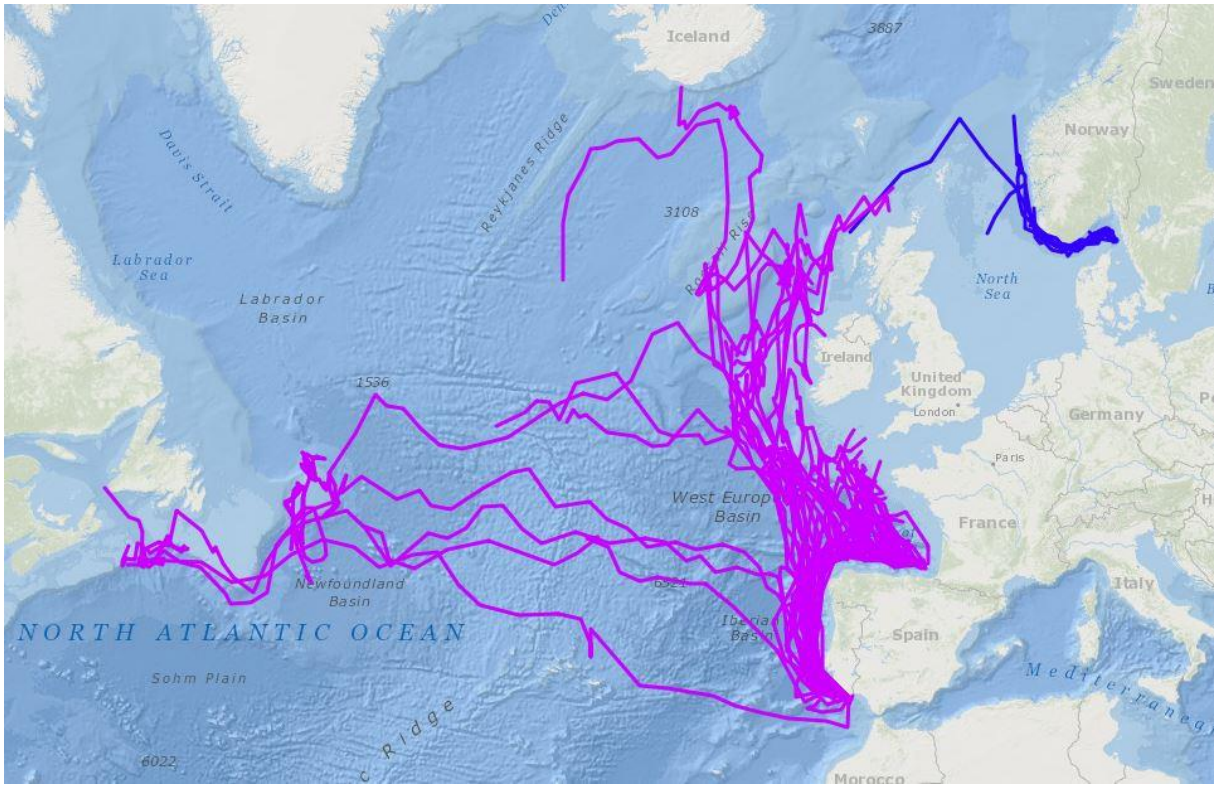


Figure 6. Available tracks from the electronic tags deployed within GBYP Phase 7

The total duration of the tags implanted so far by GBYP (= days at liberty) was 782 days in average (min. 1, max 2102 days) for the conventional tags and 49 days in average for the electronic tags (min 1, max 360 days).

Following the request of the Bluefin Species Group expressed during the SCRS Bluefin Tuna Data Preparatory Meeting in March 2017, a brief study was performed in order to get a deeper insight into the migratory patterns of the Bluefin entering the Mediterranean and the results are presented in the document SCRS/2017/131 (**Annex 1b, document no. 7**). This paper shows the distribution of both conventional tags and electronic tags that were deployed in the Atlantic Ocean and in the Strait of Gibraltar when they have been recovered or popped-off in the Mediterranean Sea. For better understanding the geographical distribution of those migrant fish, it was decided to divide the Mediterranean in five different areas and then asses the presence. Most of the tags are reported from the Strait of Gibraltar, while the percentage in other areas (Med Gate, Balearic and Central Med) is lower. The lowest percentage is in the eastern Mediterranean, due to many factors, including the W-E "filter" which accounts for the accumulation of fishing activities and the low tag reporting rate. It is confirmed that migrant fish are able to reach

every part of the Mediterranean Sea, possibly with different abundance and with interannual variability. Further analyses of the tag data will be necessary, as well as a better reporting of natural marks, which inform us about the migration from the central-southern Atlantic.

The first electronic tag data base has been developed in Phase 7, along with the Shiny application which allows for the visualization of the tracks and temperature and depth parameters. It was presented as SCRS/2017/192 (**Annex 1b, document no. 21**).

5.4 Tag awareness campaign

This activity is considered essential for improving the very low tag reporting rate existing so far in the Eastern Atlantic and the Mediterranean Sea. The tag awareness material was produced in 12 languages, considering the major languages in the ICCAT convention area and those of the most important fleets fishing in the area: Arabic, Croatian, English, French, Greek, Italian, Japanese, Mandarin, Portuguese, Russian, Spanish and Turkish. In total, more than 15,750 posters of various sizes (A1, A3 and A4) and more than 18,000 stickers were produced so far; two posters and all stickers were revised in 2014. All posters are also available on the ICCAT-GBYP web page http://www.iccat.int/GBYP/en/AwCamp.asp. A capillary distribution of the tag awareness material was carried out directly by GBYP, sending copies to all stakeholders such as: Government Agencies, scientific institutions, tuna scientists, tuna industries, fishers, sport fishery federations and associations, the RFMOs and RACs concerned; the coverage was complete in the ICCAT Convention area, including also non-ICCAT countries and entities fishing in the area. The map clearly shows the distribution effort (**Figure 7**). The ICCAT-GBYP web page has the full list of contacts http://www.iccat.int/GBYP/images/mapamunditicks.jpg .

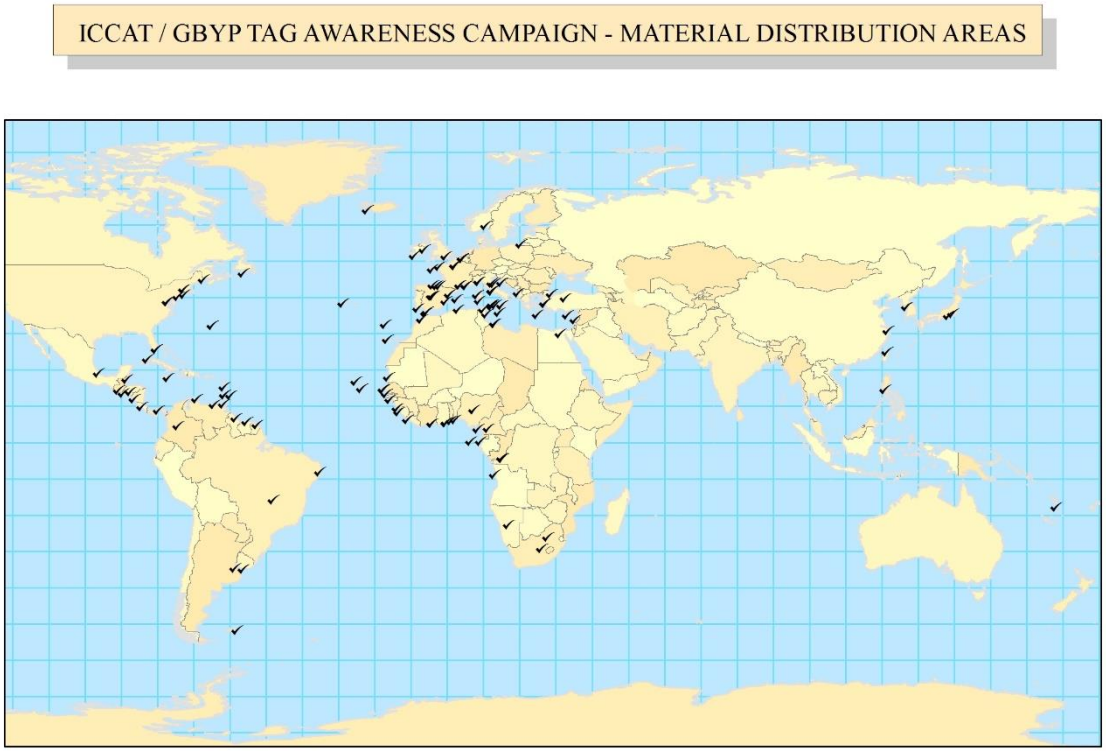


Figure 7. ICCAT GBYP Tag awareness campaign- material distribution locations

Posters are now present in most of the ports where bluefin tuna are usually or potentially landed, in tuna farms, tuna traps, industries, sport fishers clubs, fishers associations, bars where fishers are usually going, local port authorities and on many fishing vessels. Some articles were also promoted and they have been published on newspapers and magazines.

A short propaganda video on ICCAT GBYP tagging activities, along with a spot, were produced in Phase 6. The videos and spots were translated in 8 languages and were already presented at the SCRS meeting in September 2016. While it is now available for free download, it is envisaged to develop the ICCAT GBYP Bluefin tuna tagging visibility campaign and use these video materials for this purpose, by distributing them to main TV stations and other media in Mediterranean CPCs. Some CPCs had already used the videos on national television channels. All videos are uploaded on YouTube as a preview (https://www.youtube.com/channel/UCK25VrRxTajo-7I0AQbNQxw) and their download in the high quality is easily available on request. For better informing all ICCAT CPCs and scientists about the possibility to freely use these videos and spots, the ICCAT Secretariat released the Circular no. 0361/2017 (on 1 March 2017), with all the details. So far, the GBYP videos had 3,762 visualisations in 87 countries.

5.5 Tag reward policy

Following the recommendations made by SCRS and the GBYP Steering Committee, the ICCAT GBYP tag reward

policy was considerably improved since the beginning, with the purpose of increasing the tag recovery rate which was extremely and unacceptably low. The current strategy includes the following rewards: 50€/ or a T-shirt for each spaghetti tag; 1000 € for each electronic tag; annual ICCAT GBYP lottery (September): 1000 € for the first tag drawn and 500 € each for the 2nd and 3rd tag drawn. According to the recovery data, this policy (along with the strong tag awareness activity) was very useful for considerably improving the tag reporting.

In Phase 7, additional 900 T-shirts have been purchased for replenishment of the reward T-shirt stock.

5.6 Tag recovery and tag reporting

This activity is the final result of the activities listed in previous points. For further improving the results, meetings with ICCAT ROPs were organised in earlier years, further informing them about the ICCAT GBYP tag recovery activity and asking them to pay the maximum attention to tags (and to natural marks) when observing harvesting in cages or any fishing activity at sea. Special information forms have been provided to ICCAT ROPs.

While examining the results of the ICCAT GBYP tag recovery/reporting activities, it is very important to consider that about 90% of the conventionally tagged fish in Phases 2-4 were juveniles (age 0-3); about 70% were surely immature fish (age 0-2) and then it is difficult for these fish to be caught by most of the fisheries, particularly taking into account the ICCAT minimum size regulation and the fact that the baitboat fishery in the Bay of Biscay in the last years was almost nil, because fishermen sold their quota to other fisheries. Furthermore, the institutional GBYP conventional tagging campaign was suspended from Phase 5 and only the complimentary conventional tagging activities were continued.

Since the first year of the GBYP and up to 21 February 2018, there have been 725 tags recovered by GBYP. The GBYP recoveries are summarized as follows:

- 434 Conventional “Spaghetti” tags (59.9% of the total)
- 234 Conventional “Double-barb” (two types) tags (32.3% of the total)
- 33 External Electronic “mini-PATs” tags (4.6% of the total)
- 16 Internal Electronic “Archivals” tags (2.2% of the total)
- 4 Acoustic tags (0.6 % of the total)
- 4 Commercial “Trade” bluefin tuna tag (0.6% of the total)

The distribution of tag recovered by area and fishery[6] is showed on **Table 15** and **Table 16**.

[6] For comparison purposes, but also because the data were not previously reported, we included in the table also the tags recovered by ICCAT between 2002 and 2009, before GBYP. These tags were only 7 (4 spaghetti, 1 double barb spaghetti and 2 internal archival).

Table 15. Geographical distribution of the areas where the tag recoveries occurred, in numbers and percent, by type of tag (up to 21 February 2018)

Fishing Area / Tags	Spaghetti Tags	Double BarbTags	External Elec. Tags	Internal Elec. Tags	Acoustic Tags	Commercial Tags	Grand Total	%
East Atl	85	46	13	1		1	146	20,14
Med	316	144	11	14	4		489	67,45
North Atl	23	20	5			2	50	6,90
West Atl	10	24		1		1	36	4,97
Unknown			4				4	0,55
Grand Total	434	234	33	16	4	4	725	100
%ge	59,9%	32,3%	4,6%	2,2%	0,6%	0,6%	100,0%	

The number of tags reported by two important commercial activities in the Eastern Atlantic and in the Mediterranean Sea (purse-seiners/cages and tuna traps) is surprisingly very low. The purse-seine fishery is historically the most productive in the last decades, reaching over 70% of the total catch in some years; since 1999, almost all purse-seine catches (and, in recent years, also most of the trap catches) are moved to cages and then to fattening farms and these activities are strictly monitored by ICCAT observers (ROPs). Consequently, the GBYP was supposed to have a high tag recovery and reporting rate from purse-seiners/farms, but the data are showing a different reality: the farms had recovered 94 tags, of various types (63 single-barb spaghetti, 18 double-barb spaghetti, 8 internal, 1 PSAT and 4 acoustic), while 34 were recovered from purse-seiners (22 single-barb spaghetti, 10 double-barb spaghetti, 1 PSAT and 1 internal). Even considering that most of the last conventional tagging activities were targeting juveniles, the recovery and reporting rate is unrealistically too low (12.97% of the total reported tags for the farms and 4.69% for the purse-seiners, which means 17.66% for the PS activities in total). The same conclusions can be stated for the traps, because they have reported only 17 tags to ICCAT within the period taken into account (8 single-barb spaghetti, 7 double-barb spaghetti, 2 internal archival). Even in this case, the recovery and reporting rate (2.34% of the total recovered tags) is unrealistically too low. A similar consideration is applicable even to the long-line fishery; including both the bluefin tuna targeted fishery and the many long-liners targeting other pelagic species having the bluefin tuna as a by-catch (69 tags in total, 42 single-barb spaghetti, 25 double-barb spaghetti and 2 internal, equal to 9.52% of the total). The possible reasons for the low reporting rates from all these relevant fisheries have been already discussed at the document SCRS/2013/177.

Table 16. Details of tag reported to ICCAT GBYP by fishery, in numbers and percent, up to 21 February 2018

Fishery -Gear / Tags	Spaghetti Tags	Double BarbTags	External Elec. Tags	Internal Elec. Tags	Acoustic Tags	Commercial Tags	Grand Total	%
BB	200	101					301	41,52
FARM	63	18	1	8	4		94	12,97
HAND	34	20	1				55	7,59
LL	42	25		2			69	9,52
LLHB	2	2					4	0,55
NF			13			4	17	2,34
PS	22	10	1	1			34	4,69
RR	16	34		2			52	7,17
SPOR	11	1					12	1,66
TN	1	1					2	0,28
TRAP	8	7		2			17	2,34
TROL	13	5					18	2,48
UNCL	22	10	17	1			50	6,90
Grand Total	434	234	33	16	4	4	725	100

Table 17. BFT tags reported by year to GBYP (yellow shading means tags reported to ICCAT prior to GBYP).

Recovery Year / Tags	Spaghetti Tags	Double BarbTags	External Elec. Tags	Internal Elec. Tags	Acoustic Tags	Commercial Tags	Grand Total	%
2002	1	1		1			3	
2006	1			1			2	
2008	1						1	
2009	1						1	
TOT 2002-2009	4	1	0	2	0	0	7	
2010	3						3	0,41
2011	8		1				9	1,24
2012	36	7	6	1		1	51	7,03
2013	60	28	9	2		1	100	13,79
2014	72	30	1	3		2	108	14,90
2015	68	46	3	3	1		121	16,69
2016	99	56	4	3	1		163	22,48
2017	78	63	5	3	2		151	20,83
2018	10	4	2	1			17	2,34
Undefined (2012 or 2013)			2				2	0,28
Grand Total	434	234	33	16	4	4	725	100

The important tag reporting improvement registered after the beginning of the tagging and tag awareness activities by ICCAT GBYP is impressive (**Table 17** and **Figure 8**): the average ICCAT recovery for the period 2002-2009 was only 0.88 tags per year, while during GBYP tag recovery activities the average was 90.63 tags per year. The first significant increase in the rate of the tag recoveries was recorded from 2012. Such a success should probably be attributed, not only to the recent tagging activities, but to the settled tag awareness campaign as well. In the year 2017, a total of 151 tags were recovered, in spite of the fact that, due to recommendation of the Steering Committee, from 2014 onward, conventional tagging was limited to the complimentary tagging only. In the year 2018, up to the 21 February, 17 tags have been recovered. We have to note that, for the first time in ICCAT bluefin tuna tagging activities, the number of tags recovered and reported from the Mediterranean Sea is higher than any other area. Considering that reported tags from the Mediterranean were almost nil before GBYP, this is the clear evidence that GBYP tag awareness campaign is producing positive effects.

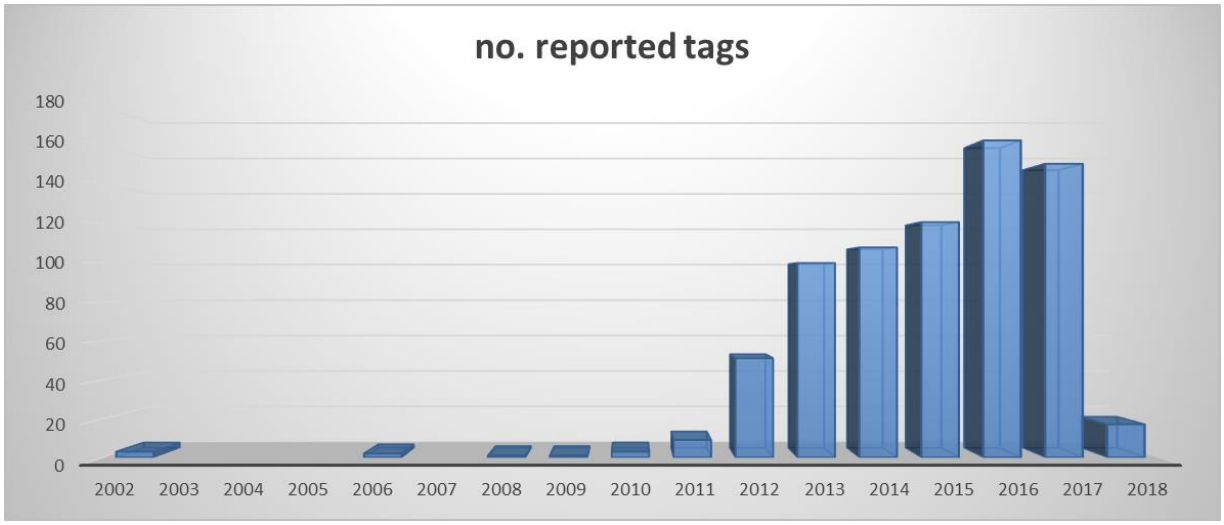


Figure 8. Number of bluefin tuna tags reported to ICCAT by year, up to 21 February 2018

It is extremely difficult and almost impossible at the moment to define a recovery rate for GBYP conventional tagging activities, taking into account that most of the conventionally tagged tunas were juveniles and they will be

possibly available in most of the fisheries within the ICCAT Convention area only in future years. Whenever we consider, as a preliminary exercise, the number of tags recovered so far in comparison with the number of GBYP tags deployed, the provisional recovery rate is 2.69 %, but this rate is clearly negatively biased by the juvenile ages of about 90% of the tagged fish. At the same time, it is impossible assessing the recovery rate of tags which were not deployed by ICCAT GBYP, because ICCAT does not have the insight in the total number of implanted tags by each tagging entity in the ICCAT area.

Interesting information is still coming from the double tagged tunas (**Table 18**): up to 21 February 2017, tags were recovered from 226 double tagged fish and both tags have been recovered from 130 fish (57.52% of the double tagged fish recoveries). 45 fish had only the billfish (double-barb) tag on, while other 51 fish had only the single barb spaghetti on. According to these first data, it seems that both types of tags (single barb and double barb) are more or less equally resistant, with the slight better resilience for the single barb. The tag recovery rate for all double tagged fish by GBYP is currently 2.83%.

Table 18. BFT tag recoveries from double tagged fish by type (up to 21 February 2018)

Release	Spaghetti tag only	Double Barb Tag only	Both	TOTAL FISH	TOTAL TAGS
2011	2	5	5	12	17
2012	12	11	44	67	111
2013	30	16	65	111	176
2016	1	1	1	3	4
2017	6	12	15	33	48
Total	51	45	130	226	**356**
%	22,57	19,91	57,52	100	

RcCode: 2conv	both recovered							
	Year of Recovery							
Year of Release	2012	2013	2014	2015	2016	2017	2018	TOTAL FISH D/T
2011	1	3	2	0	0	3	0	9
2012	5	15	10	3	7	9	0	49
2013	0	6	15	17	19	13	1	71
2014	0	0	0	1	0	0	0	1
2016	0	0	0	0	1	0	0	1
2017	0	0	0	0	0	0	0	0
TOTAL	6	24	27	21	27	25	1	131
%	4,58	18,32	20,61	16,03	20,61	19,08	0,76	100,00

Reiterating what it was said in the first part of the ICCAT GBYP, the extreme importance of having all tag release data related to all tagging activities carried out on bluefin tuna (but also on all other species under the management of ICCAT) concentrated in the ICCAT tag data base should be mandatory. This is essential because recoveries can be logically reported to ICCAT at any time and it is not always easy, rather time/effort consuming, finding the entity which implanted the tags if data are not properly stored. As usual, the GBYP staff had experienced a lot of difficulties in recovering the tag release data in several cases, with an important additional workload. At the moment this tag release communication is not mandatory, but it should be, because it has a general interest, including for the various entities and institutions carrying out this activity.

5.7 Complementary study on catch and release

As a complimentary activity in Phase 7, the Steering Committee decided to include the study on biological response of bluefin tuna to recreational fishing by catch and release method. The study was done by Croatian Institute of Oceanography and Fisheries (IZOR) and it was completely funded by Croatian Sport Sea Fishing Association. Although the Study didn't suppose any financial implication for GBYP, the incidental mortality occurred within was accounted against GBYP Research Mortality Allowance, in line with the provisions of the Rec.11-06. The total RMA used for this activity was 838.55 kg.

The goal of this study was to determine mortality rate, behaviour and sub-lethal wounds of juvenile tuna caught with different types of fishing tools and subsequently released in controlled cage conditions, in order to observe their recovery and behaviour during 29 days of intensive feeding. Based on gathered, analysed and interpreted results of research, series of recommendations will be defined for sports and recreation fishermen and for organizers of BGF competitions so that the idea of C&R tuna fishing grants positive effect to the survival of released fish.

After the experimental fishing and the feeding trial, 152 tunas were released from the cage. Conducted research showed that hooking damages range from superficial injuries, most often on peripheral parts of jaw, skin and operculum to serious wounds. It is believed that the place of hooking is the primary factor that affects the mortality of the fish caught by this method. However, the severity of the injury proved to be directly influenced by type and characteristics of hook used. Straight J-shaped hook, with point of hooking that is parallel to the arm of the hook, contributed to higher caught fish mortality rate due to serious injury, while the use of circle hooks resulted in highest number of jaw hooking and superficial injuries to skin and operculum. This confirms earlier results which state that barbless circle hooks have important role in fish preservation.

The results of this study might be taken advantage of in future GBYP tagging activities, in those cases where the fish is caught by handline or rod and reel. The study resulted in several conclusions and recommendation which might be implemented with a view to reduce premature mortality in early days posterior to implementing the tag. In this way, the risk of losing valuable equipment could be reduced, which might eventually improve tagging results. The final report of this study is attached in **Annex 1a**, as **document no. 63.**

5.8 Close-kin genetic tagging

As a possible alternative to the conventional tagging or as additional tagging approach, the ICCAT GBYP Steering Committee recommended to explore and evaluate the close-kin genetic tagging (Close Kin Mark Recapture, CKMR) at the end of Phase 5. It was a new approach to estimate the SSB abundance and other important population parameters that is currently applied for some fish species (including sharks), some marine mammals species, for the southern Bluefin tuna and that will be possibly applied also for the Pacific Bluefin tuna. CKMR uses information on the frequency and distribution in space and time of closely genetically related individuals in samples of tissue from live or dead animals.

For the purpose of obtaining the advice on close-kin tagging of Atlantic bluefin tuna, a feasibility study was done by The Commonwealth Scientific and Industrial Research Organisation (CSIRO) from Australia.

When the revised report for the first part of the feasibility study was provided by CSIRO along with the report for programming the workshop on CKMR genetics, the CSIRO also stated its unavailability for carrying out the second part of the feasibility study in Phase 7 (as it was planned), due to a considerable workload but also to the need to further check the CKMR technique applied to tunas. At the same time, due to the same reasons, they proposed to move at least to Phase 8 both the second part of the feasibility study and the workshop

Given that it was not possible for the contractor to provide a realistic costing for the CKMR study in this primary stage, the GBYP Steering Committee decided anyway to start collecting the necessary samples as much as possible, also for practically assessing the feasibility and the real costs for carrying out a CKMR study for EBFT, starting from Phase 6. An enhanced sampling was done within the Biological studies for both juveniles and adults in the major spawning areas, also for testing the sampling problems and not only the real costs.

In the Phase 7, the enhanced sampling for adults and juveniles was continued, but no other activities regarding CKMR were carried out.

6. Biological Studies

The initial, short-term ICCAT GBYP objective approved by the Commission in 2008 was to collect samples from 12,000 fish (including western Atlantic and the Japanese catches and markets) and carry out ageing and genetic studies, and micro-constituent analyses in three years in the eastern Atlantic and Mediterranean, with a total budget of 4,350,000 Euros. So far, with only about 59.1 % of funding (2,570,728 euro, equal to 19.64 % of the total funds received so far), the ICCAT GBYP collected samples 14,906 fish, equal to 124 % of the initial target (12,000 fish). Furthermore, the GBYP carried out aging, aging calibration, genetic and micro-constituent analyses; also, the sampling design and protocols, and the otolith shape analyses were included in the activity carried out so far, even if they were not included in the initial plan. It is very clear that the general objectives sets for the biological studies in these first Phases were largely accomplished so far, a result which is even more important when taking into account the proportion of the available budget.

The GBYP biological sampling design was the one provided by the Institut National de Recherche Haulieutique (INRH - Morocco) on March 2011. The final approved version is available on the ICCAT-GBYP web site (http://www.iccat.int/GBYP/Documents/BIOLOGICAL%20STUDIES/PHASE%202/Rapport%20final%20design%20echantillonnage%20biologique%20ICCAT-GBYP.pdf).

A new stratification was agreed in 2016 and then updated in 2017 (attached in **Annex 1a document no. 17**)

All the activities carried out in previous Phases and the first part of Phase 7 concerning the biological sampling and analyses have already been presented to SCRS and the Commission in 2017 (SCRS/2017/139 in **Annex 1b document no. 11**), while the activities carried out in the second part of Phase 7 will be presented at the SCRS meetings in 2018.

6.1 Objectives

The main objective of this task was to improve understanding of key biological and ecological processes through broad scale biological sampling of live fish to be tagged and dead fish landed (e.g. gonads, muscles, otoliths, spines, etc.), histological analyses to determine bluefin tuna reproductive state and potential, and biological and genetics analyses to investigate mixing and population structure, namely to define the population structure of Atlantic bluefin tuna (*Thunnus thynnus*), with a particular attention to the age structure and the probable sub-populations identification.

6.2 Biological Studies in Phase 7

The activities in previous GBYP Phases have been clearly able to accomplish their objectives. Of course, the activities in following Phases of GBYP are set for completing and improving the preliminary results and for better defining some issues, such as mixing between the two current stocks and the sub-population hypothesis, which may require several years of data and many analyses, depending on the available budget.

Due to the reduced overall budget for the Phase 7, not all the activities already initiated in the previous phases of the biological studies could be continued. The Steering Committee identified the priorities to be carried out within Phase 7, while other activities were postponed.

Pursuant to the inputs of the SCRS BFT Species Group and the specific recommendation of the Steering Committee, taking into account that the Call for tenders issued in Phase 6 for ageing many otoliths received no bids, the invitation for improving the ageing capacities of the ICCAT GBYP has been directed to the Fish Ageing Services ltd from Australia, a well-reputed institution. The Fish Ageing Services accepted the invitation and the contract was awarded for ageing of 2000 otoliths previously stored in the ICCAT GBYP tissue bank that haven't been aged so far.

Another invitation was sent for sampling for adult Bluefin tuna in farms. This activity represents the continuation of the activity already initiated in the Phase 6, which was recommended by the Steering Committee in order to complement the feasibility study for the close-kin genetic tagging and provide enough samples for the development of an annual ALK. While YOY were successfully sampled in some areas in previous years, sampling of adults from spawning areas has been sometimes problematic. As regards the sampling of the adults in farms the experience from the previous year demonstrated that it can be a useful strategy for obtaining the needed adult samples from the spawning areas. Thus, in Phase 7 the invitation for sampling was sent to tuna farms in Spain,

Malta and Turkey, but no positive answer was received from Turkey. Three offers were received from the other areas, from the same companies that have already been engaged in this activity in the Phase 6, and were all awarded a contract. AquaBioTech Ltd from Malta was contracted for providing samples from at least 300 specimens from the southern Tyrrhenian Sea and at least 300 specimens from the central/southern Mediterranean Sea. Taxon Estudios Ambientales SL was contracted for providing samples from 170 specimens and Balfegó & Balfegó for providing samples from 150 specimens, both from the Balearic Sea.

The Call for tenders for biological studies was released afterwards and it included a broad list of activities including maintaining the GBYP Tissue Bank, sampling, analyses and even a special research study of reproductive biology of tuna in the Slope Sea (NW Atlantic). Given the budget limitations, some activities could not be funded in this Phase and the contracts were awarded on the base of single activity or even by the individual component of the activity. In total, three contracts were awarded. One contract was awarded to a consortium headed by AZTI for sampling, maintenance of the tissue bank and YOY ageing. The other contract was awarded to a consortium headed by University of Bologna for complementary sampling and some limited and very specific genetic analyses. The third contract was awarded to the Social and Environmental Entrepreneurs (Project Tag a Tiny) for BFT reproductive studies in the Slope Sea.

Following the request of the ICCAT SCRS BFT Species Group and the ICCAT GBYP Steering Committee, the GBYP finalized an agreement with the Company (MRAG) in charge of the ICCAT-ROP for the opportunistic sampling to be performed by ROP observers, covering just the costs for the sampling material. This activity was initiated in the Phase 7 as a trial to assess the feasibility and the possible cost per year. ROPs have been engaged in collecting small tissue samples of all accessible Bluefin tuna individuals at the harvesting in farms or when dead Bluefin tunas were taken on board of vessels having an ICCAT observer on duty.

Following the request coming from the SCRS BFT Species Group and the recommendation made by Steering Committee, a first limited workshop on the reproductive biology of the Atlantic Bluefin Tuna was held within Phase 7. One of the objectives of the Workshop was identifying the feasible priorities of biological studies which could be carried out within the GBYP, especially in Phase 8, while the other one was preparing the larger biological workshop in Phase 8, including the agenda drafting and the identification of the most adequate experts to participate as invited speakers.

6.3. Maintenance and management of the ICCAT GBYP Tissue Bank

The ICCAT GBYP tissue bank is stored in the AZTI laboratory since the beginning of the GBYP biological sampling activities. In Phase 7, as detailed in the previous paragraph, AZTI was awarded a contract for the maintenance and management of the sample bank, in continuation with the activity in previous years. This task included the appropriate storage of all samples already collected and new ones that arrived in Phase 7, their delivery to the entities in charge of the analysis and the posterior receipt. Also, it included the eventual relabelling of the samples according to the protocol and the management and the regular update of the samples database.

In addition to maintenance of the Bank, during Phase 7, Shiny application (**Figure 9**) has been developed to facilitate the inspection of available samples in Bank and to aid sample selection following different criteria to help better design future experiments and analyses. The application allows the user to interactively visualize and filter the database of available samples, and download the data associated to the selection.

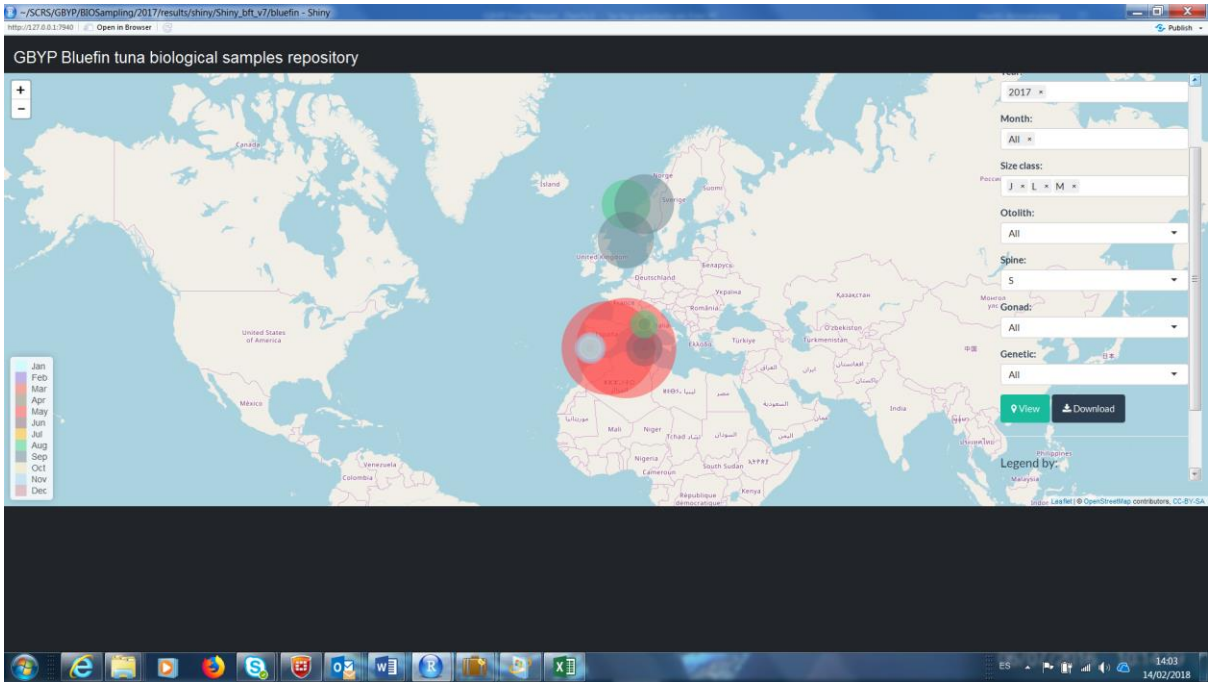


Figure 9. Shiny application developed to visualize available biological samples in the GBYP Tissue Bank

6.4. Sampling

Sampling in Phase 7 has been performed by the various entities that operate under different contracts – the Consortium headed by AZTI, the Consortium headed by UNIBO, Balfegó & Balfegó, Taxon Estudios Ambientales and AquaBioTech. In addition, opportunistic tagging was done by ICCAT-ROPs and tagging teams. YOY and adult Bluefin tuna from the main spawning areas in the Mediterranean (Balearic Sea, southern Tyrrhenian Sea, southern central Mediterranean Sea and Levantine Sea) have been the priority for the collection of otoliths, spines and genetic samples. A special attention has been devoted for the collection of samples by size classes and strata that had been under-represented in the samples from previous years, with the goal of collecting at least 10 samples for each 10 cm length class and stratum. It was envisaged to collect samples for more than 2000 individuals. GBYP sampling strata and sampling needs for Biological studies in Phase 7 are attached in **Annex 1a**, as **document no. 17.**

Around 3600 bluefin tuna individuals have been sampled in Phase 7[7]. From these, 1562 individuals were collected

[7] As some sampling activities took place rather later in the Phase, some samples are yet to be verified before

by the Consortium, while others individuals were sampled under the additional contracts, mainly the ones for sampling adults on farms. All the data on samples collected this year have already been merged with the general samples database and stored in tissue bank. **Table 19** shows the number of bluefin tuna sampled in each strata (area/size class combination).

Table 19. Number of bluefin tuna sampled in Phase 7 by area and size class (the amounts are not final and are indicative only)

		Age 0	**Juveniles**	**Medium**	**Large**	Total
		<3 kg	**3-25 kg**	**25-100 kg**	**>100 kg**	
Eastern Mediterranean	Levantine Sea	358		130	248	736
Central Mediterranean	East Sicily and Ionian	52				52
	Malta	2			435	437
Western Mediterranean	Balearics		1	19	887	907
	Ligurian Sea	17	2	29		48
	Sardinia		1	80	135	216
	Tyrrhenian Sea	83			187	270
Gibraltar	Gibraltar	100		109	3	212
Northeast Atlantic	Portugal (Algarve)				30	30
Central North Atlantic	Central and North Atlantic				384	384
North Sea	Norway				241	241
	TOTAL	**612**	**4**	**367**	**2550**	**3533**

In the Eastern Mediterranean, 154% of the target number of individuals (YOY and adults) has been sampled. The sampling for YOY in the Levantine Sea was above the original plan, and it was carried out mostly in the area near the Turkish-Syrian border. The sampling of adult individuals was also above target. Sampling done by ROPs was especially successful in this area with 275 adult individuals collected. Like in previous phases, the success rate of getting otoliths from these fish is very low, due to the way they kill them (bullets use to break them into many pieces).

As for the Central Mediterranean, the targets for sampling adults were reached, while sampled YOY individuals were well below target, due to their apparent disappearance from this area.

In the Western Mediterranean, the total targets for sampling individuals were reached, including fish from all sizes,

integrating them into the database and therefore the final numbers of collected samples is still not available

but predominantly YOY. The sampling of adult individuals in Sardinia was successful. The individuals were tracked during the processing of their heads in order to sample their otoliths. However, the sampling of YOY in the Tyrrhenian was below the target. The sampling of YOY in the Ligurian Sea was also below the target, but this was compensated with samples from larger individuals (mostly medium sized).

In the area around Gibraltar, the targets for medium sized fished were reached. In addition, 100 YOY were sampled in the Atlantic part of the Strait of Gibraltar, despite this was not planned originally, because it is not common to find YOYs in that area. Sampling in Portugal was also successful.

In the Central Atlantic, the number of samples is by far beyond the original expectation, all belonging to large size fish, which will potentially allow for interesting insights into mixing of stocks and their interannual variability. Furthermore, as in Phase 6, unexpected samples from Norway were obtained again, since the Institute of Marine Research provided samples from 248 large individuals that were collected using their own funds.

The final reports of the sampling activities are attached in **Annex 1a**, as **document no. 21** (sampling on farms done by Taxon Estudios Ambientales), **document no. 25** (sampling on farms done by Balfegó & Balfegó), **document no. 29** (sampling on farms done by AquaBioTech), **document no. 32** (sampling done by the Consortium headed by AZTI) and **document no. 36** (sampling done by the Consortium headed by the University of Bologna).

The unusual presence of very small bluefin tuna YOYs was noticed in 2017 in the areas where this is not common. It was firstly noticed in the second part of August in some areas where these small sizes are not present, like in the southern part of the Iberian Peninsula (both in Atlantic Spain and Portugal), in the Canary Islands and in the central-northern Adriatic Sea. The exact natal origin of this very young fish is unknown, but the GBYP has been able to collect some samples, which will be analysed in the future. The possible reasons for this phenomenon might be specific oceanographic and climatological conditions in 2017, as presented in the scientific paper SCRS/2017/216 (**Annex 1b document no. 10**).

6.5. Analyses

As has already been mentioned, due to the limited budget, this year the main priority has been given to activities different than the usual genetic and microchemical analyses. Therefore, the activities already initiated in earlier phases of the ICCAT GBYP, like microchemical analyses on otoliths for stable isotopes and genetic analyses using RAD-seq methodology and SNPs have been postponed to the following phase. Nevertheless, the budget allowed contracting some additional genetic analyses, that hasn't been done so far on Bluefin tuna. These activities includes the analysis of transcriptomic and genomic data exploiting previous available data for defining the genomic variability of the species and experimental trials for developing a genetic test for sex assignment.

The age determination analyses were performed on 2000 otoliths that had not been read before. In addition, reading and counting of daily rings was carried out on 20 YOY to establish their birthdate.

6.5.1 Otolith chemistry analyses

Although initially it was not planned to carry out this task due to the lack of funds, given that some sampling activities couldn't be completed anyway, the contract with the Consortium headed by AZTI was amended in order to include some otolith chemistry analyses instead. These analyses were limited to 50 otoliths, which were analyses for stable carbon and oxygen isotopes ($\delta^{13}C$ and $\delta^{18}O$).

The results from previous phases suggested that western origin contributions were negligible in the Mediterranean Sea, Bay of Biscay and Strait of Gibraltar, but mixing rates could be important in the central North Atlantic, Canary Islands and western coast of Morocco. To assess the spatial and temporal variability of mixing proportions, in the Phase 6, the otoliths collected in Moroccan coast in 2016 were analysed.

$\delta^{13}C$ and $\delta^{18}O$ were measured in the otolith cores of bluefin tuna from Atlantic coast of Morocco and compared to baseline populations from the Mediterranean Sea and Gulf of Mexico. Mixed-stock analyses using MLE procedure indicated that catches in 2016 were comprised entirely by the Mediterranean population (100% of eastern origin fish). Mixing rate estimates in the coast of Morocco using this methodology varied considerably in preceding years, with catches in 2011 and 2014 dominated by the western population and catches in 2012, 2013 and 2015 dominated by the Mediterranean population (**Figure 10**). The results for 2016 confirm that mixing of the two populations occurs at variable rate, but Mediterranean bluefin tuna may be the principal contributors to the fishery in Moroccan traps. The final report of these analyses is attached in **Annex 1a document no. 32.**

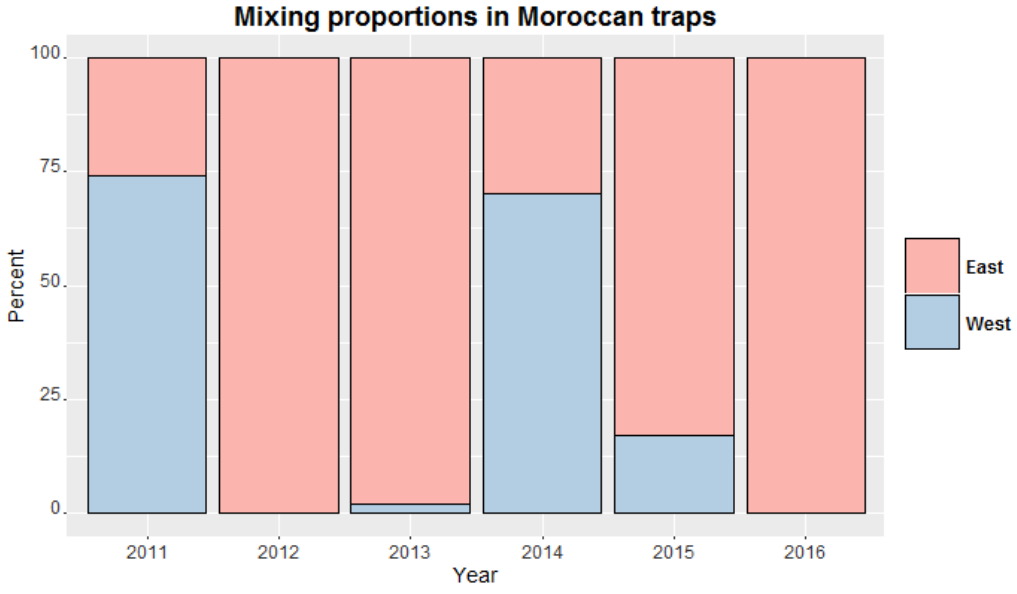


Figure 10. Interannual variation of the mixing proportions in the western African coast (Moroccan traps) estimated by Maximum Likelihood Estimator (HISEA program)

6.5.2 Genetic analyses

Due to limited budget in Phase 7, these activities were limited to the analysis of transcriptomic and genomic data exploiting previous available data for defining the genomic variability of the species and experimental trials for genetic sex assignment, which were carried out by the Consortium headed by the University of Bologna.

Annotation and comparison of bluefin tuna reference against other tuna genomes will allow better functional characterisation of tuna genomes. Moreover, the genomic reference will be used for the mapping and positioning of current and future genomic markers, allowing comparison between markers dataset and analyses and the validation of population structure results. These genomic resources could be ultimately translated to improve the current management and exploitation of the species, with a special focus on rearing conditions in fattening cages, eventual reproduction in captivity and broodstock management.

Within this activity, a genome-wide annotation of protein-coding genes has been performed and 41,508 protein-coding genes were identified. The quality of the annotation was enhanced by incorporating transcriptomic data, obtained from different sources, into the gene prediction pipeline to guide and support the identification of candidate gene. The resulting gene annotations have been assessed by comparison of predicted protein sequence with proteins from other species, showing a high rate of similarity with those of other fishes (97% of predicted proteins mapped to Teleostei Uniref90 reference clusters), supporting the good quality of these gene annotations. All the 41,508 predicted BFT proteins were subjected to functional annotation and 63% of the candidate sequences (26,151 protein) were associated to functions assigned by accurate homology-based approaches according to the standard catalogue of Gene Ontology (GO), covering, with different proportions, the three ontology aspects: biological process (**Figure 11**), molecular function (**Figure 12**) and cellular component (**Figure 13**), with a total of 13,915 different GO terms. Moreover, sequence analysis tools were adopted to complement functional annotation with protein features (secretory signal peptides, mitochondrial-targeting peptides and/or transmembrane domains) and annotations of GO cellular component terms.

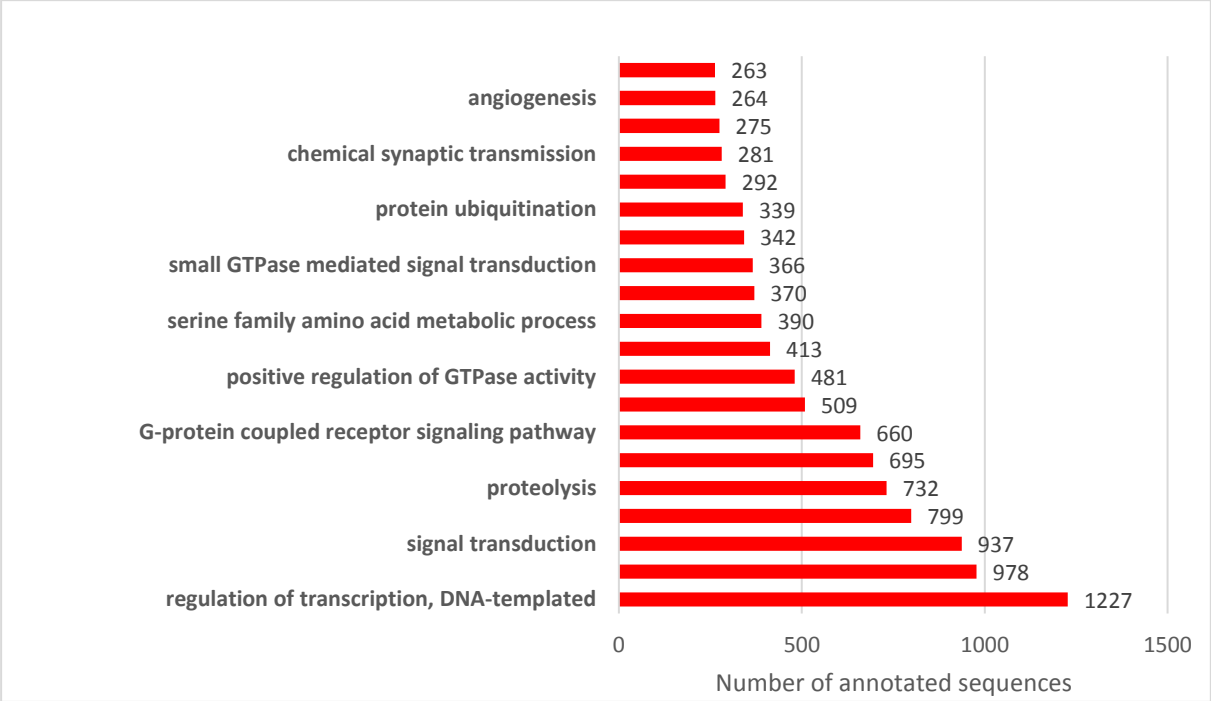


Figure 11. Distribution of the 20 most abundant GO biological processes annotated on BFT protein sequences using homology-based approaches.

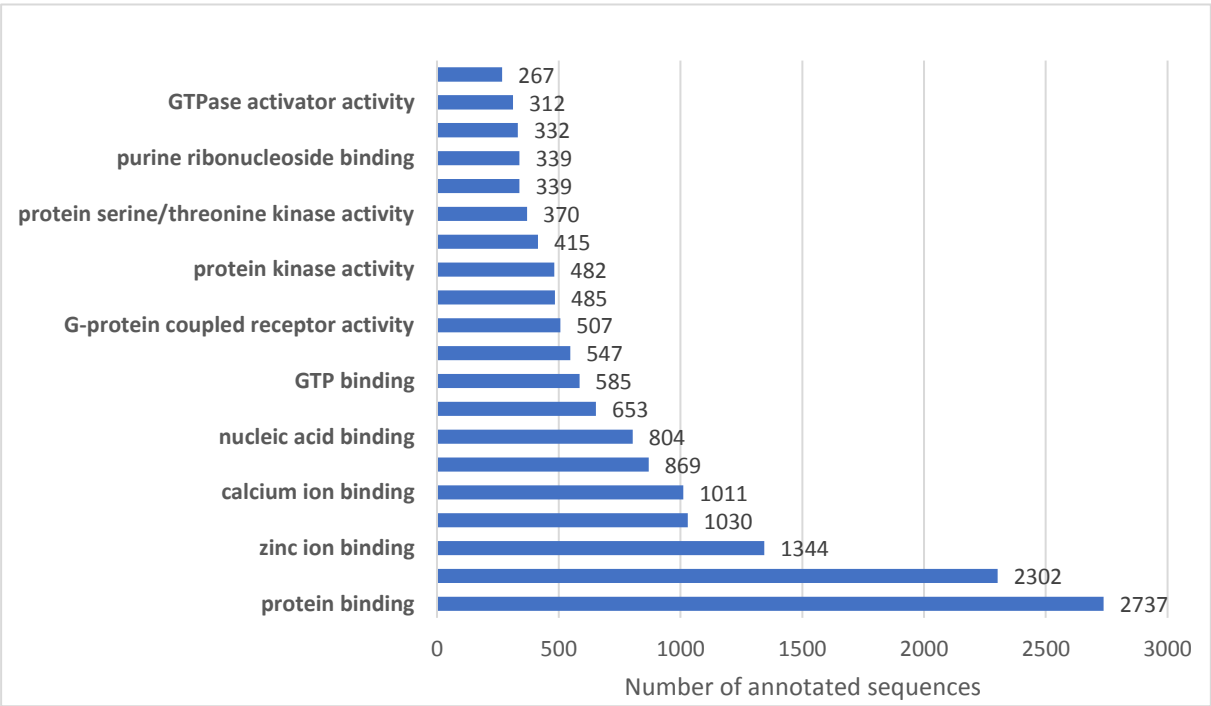


Figure 12. Distribution of the 20 most abundant GO molecular functions annotated on BFT protein sequences using homology-based approaches.

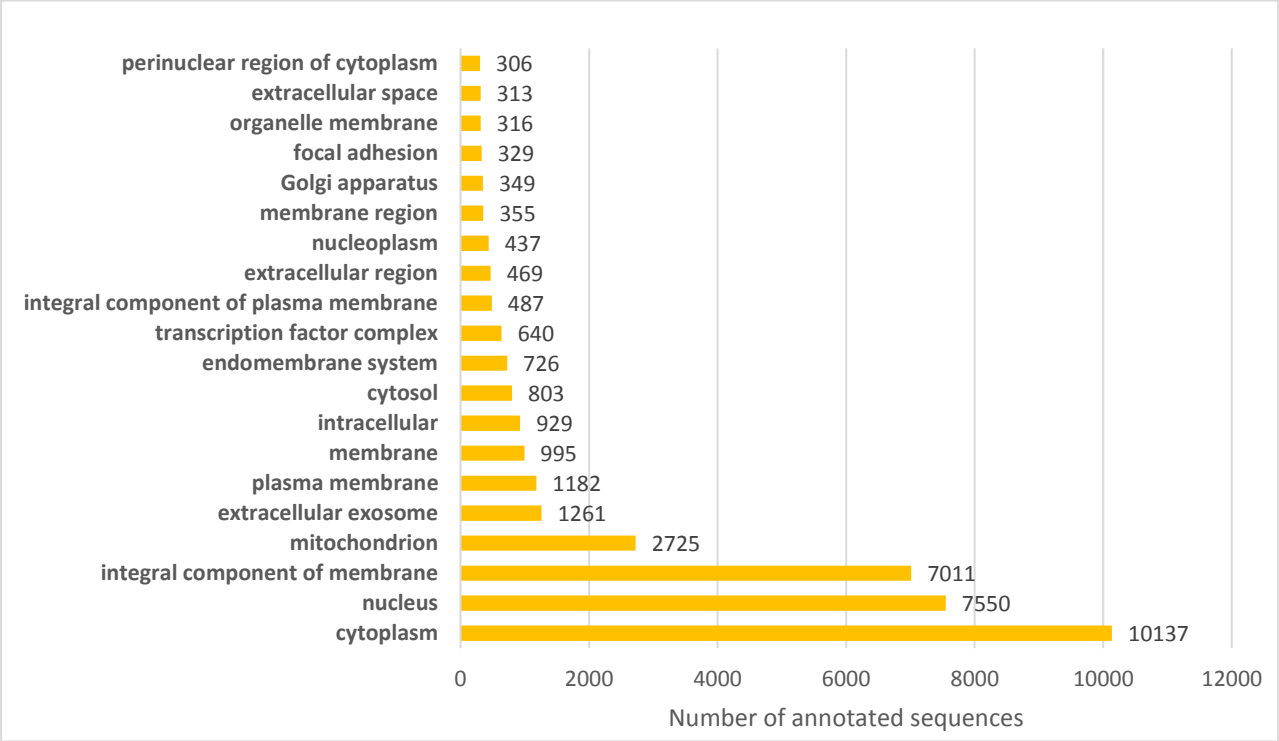


Figure 13. Distribution of the 20 most abundant GO cellular components annotated on BFT protein sequences either by homology-based approaches or predictive tools.

Within the genetic tasks, special attention was paid to investigating in the bluefin tuna genome the presence of candidate genes for sex-related traits. The presence of candidate genes and markers for sex-related traits was investigated in the BFT genome by searching for sequence similarity with candidate sex-determining genes characterized in previous studies in *T. orientalis* and other bony fishes (as zebrafish, cod, medaka, Patagonian pejerrey, fugu, rainbow trout, turbot, Yellowtail). Only 3 out of the 35 candidate genes and markers did not find a match on the assembled BFT genome. All other sequences were located each in different scaffolds, not supporting the identification of a well-defined sex-determining region in the BFT genome. However, these results provide a first preliminary identification of putative regions prone to be further investigated using data from BFT individuals of known sex. To develop a test for sex identification, further work, based on known sex individuals, should be carried out. The final report of these analyses is attached in **Annex 1a document no. 36.**

6.5.3 Age determination analyses

Due to the problems encountered so far for ageing large quantities of otoliths, it was decided to dedicate a special effort in Phase 7 for ageing a total of 2000 Bluefin tuna otolith samples of various size classes, previously stored in the ICCAT GBYP tissue bank that haven't been aged so far. The ageing was done by Fish Ageing from Australia.

Figure 14. Example of an image of an otolith section with the first Apex indication and zones marked

The otoliths were prepared for age reading by single section cut on low speed saw. This method, although more expensive, allows preserving the section and keeping it useful for further micro-chemical analyses. The ageing was carried out by two different readers for all samples, while a third expert reader provided reading of 10% of the otoliths for a quality control. An image of each otolith section was provided with zones marked, by using Leica M80 with 20 times magnification. Both sides (dorsal and ventral lobes) were used to come up with an interpretation. Opaque zones were counted and measurements were marked and measured on the ventral arm along a transect from the first Apex and the ventral tip close to the distal edge of the otolith. (**Figure 14**). Opaque zones were marked at end of the zones. Finally, the age-length-key was developed (**Figure 15**).

Row Labels	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Grand Total
15	1																					1
20	4																					4
25	9																					9
30	10																					10
35	5																					5
40	33	1																				34
45	19																					19
50	21																					21
55	8	43	1																			52
60		44	1																			45
65		6	1																			7
70		5	3																			8
75		12	17																			29
80		9	21	1		1																32
85			14	1																		15
90			9	1																		10
95			11	6																		17
100			16	27	3																	46
105			4	27	4																	35
110			5	21	7	1																34
115			1	18	22	11	2	1														55
120				8	11	17	3	1														40
125				1	10	12	4		4													31
130				1	9	14	11	1	1													37
135				1	2	8	4							1								16
140				1	3	5	2	4		1												16
145					10	8			3													21
150					7	7	2	1				1										18
155					7	13	3	1	1													25
160					1	5	3	3	2	1												15
165						1	5	1	2													9
170						2		4	2													8
175						1	1	4	2			1										9
180							1	9	4				1									15
185							1	17	15	1												34
190							2	9	23	5	2	2	1									44
195							1	7	20	25	9	2										64
200								5	27	22	12	9	1		2							78
205								3	21	26	26	12	7	2								97
210					1				6	29	30	21	6	3		2						98
215								1	6	28	28	23	9	3	1							99
220								1	5	27	31	26	23	5	3		2					123
225									2	15	31	42	29	9	2	2						132
230									2	6	17	44	37	18	7							131
235									2	6	11	28	57	12	4	2						122
240										3	10	27	31	9	4	4	1	2				91
245											5	8	21	9	2	2						47
250										1	4	6	8	11	2	3	1					36
255											1	1	3	2	2	5		1	2			17
260													3		3		2		1		1	10
265											1			1			1					3
270																			1			1
275												1										1
Grand Total	110	120	104	114	97	106	45	73	150	196	218	254	237	85	32	20	7	3	4		1	1976

Figure 15. Age length key developed by reading of 1976 otoliths by Fish Ageing Services

6.5.4 Daily ageing

The analysis was performed on 20 YOYs caught in Mediterranean in 2016, for which the SCRS requested the reading of daily increments, with the objective to better understand the age of the most extreme components in this atypical year class. The size of these fish was larger than expected size suggested that they might have been born before the assumed spawning season (before mid-May). The study was done by the Consortium headed by AZTI.

Daily age reading was carried out using a transversal section of the otolith, as shown in **Figure 16.** The methodology is laborious, since the section is obtained essentially by sanding the otolith until the daily rings around the nucleus and border of the otolith are visible in a thin section. In young individuals this can be obtained in a

single plain, but in larger individuals it might require sequential sanding and reading to cover the complete life history of the individual. Each otolith was read at least two times, and sometimes up to 3 or 4 times. Two final values were given for each otolith, and the final age assigned to each individual was the average of the available estimates.

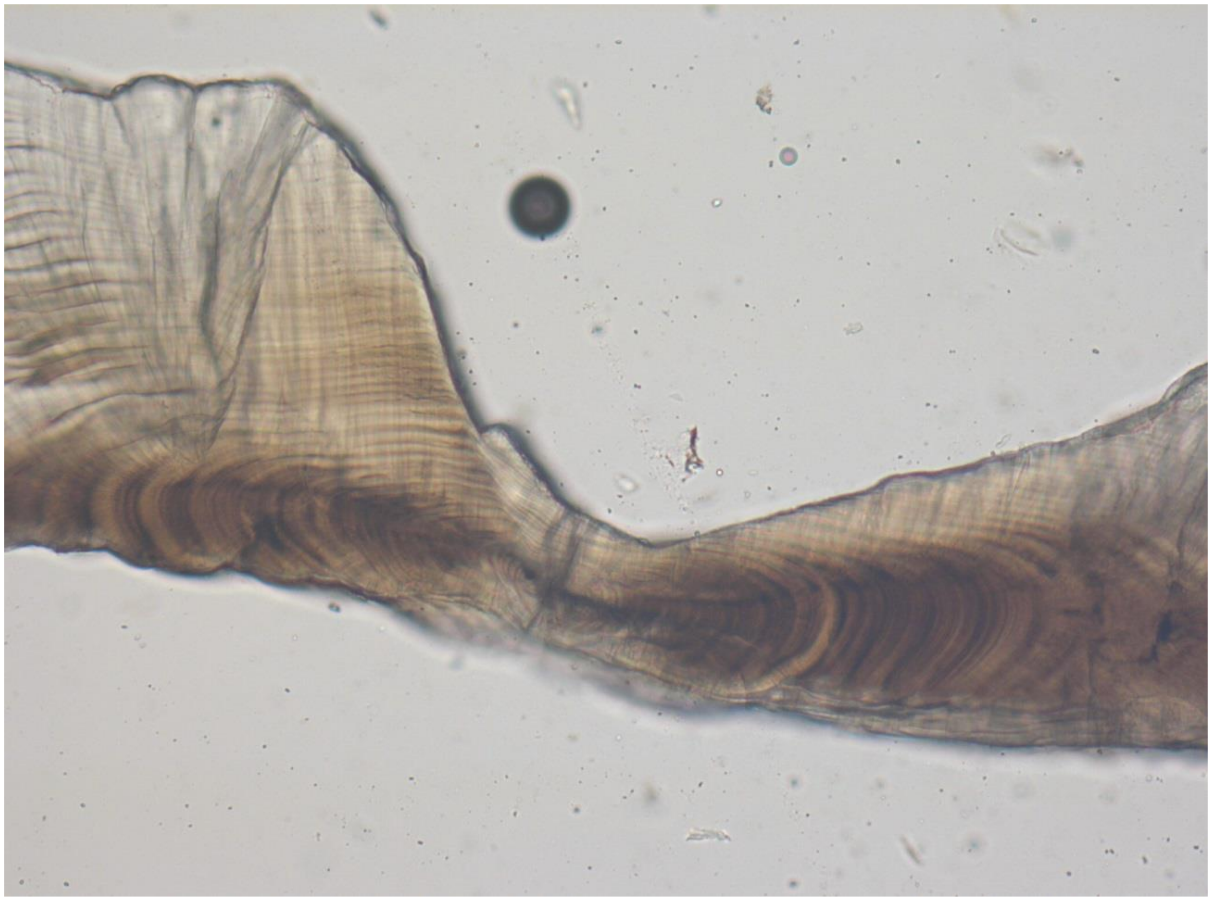


Figure 16. Transversal section of the YOY otolith with visible daily rings.

The results of otolith daily rings reading indicate that all these fish were born in June-July period, rejecting the original hypothesis, although confirming that the growth rates can vary a lot between individuals born in the same season. Specifically, one group of individuals sampled in August in the Tyrrhenian presented an apparently abnormal quick growth.

6.5.5 Study in the Slope Sea

In Phase 7, the Steering Committee recommended giving priority, among other activities, to the special research activity which includes studies for trying to fill knowledge gaps in Bluefin tuna reproductive biology in the NW Atlantic (i.e. Slope Sea and surroundings); with the expectation that the results might add additional evidence to the existence of a further spawning area in this part of the Atlantic Ocean. This study was designed to include, in particular, conventional histology (microscopic inspection of gonads) combined with new endocrine immunoassays (measuring of the quantity of pituitary gonadotropins in the tissue of Bluefin tuna) for the Bluefin

tuna captured in the NW Atlantic. The study was done by the Social and Environmental Entrepreneurs (Project Tag a Tiny).

Some previous analyses indicated that the endocrine profiles of the fish sampled in the Slope Sea (spawning in the late summer) might be different from those from GOM (spawning earlier). The intention in this study was to obtain endocrine profile (gonadotrophins quantity in the pituitary gland, hypothalamus and liver) of the BFT sampled in SW Nova Scotia in order to identify the spawning period, consistent with the presence of larvae in the North Slope Sea. However, due to logistic constraints the sampling targets were not reached and the study has not been completed out. Anyhow, the other main objective of this activity, to create a collection of slides for histological analysis from gonads samples available in LPRC and NOAA Panama, have been accomplished. The analysis of these samples is still pending and will be finished in the forthcoming months, as envisaged. The final report of these tasks is attached in **Annex 1a document no. 40.**

6.6 Workshop on bluefin tuna reproductive biology

The ICCAT GBYP Workshop on Atlantic bluefin tuna reproductive biology was held during 14 and 15 February 2018, at ICCAT Headquarters in Madrid. It included participation of 7 scientists, apart from Steering Committee members. One of the objectives of the meeting was identifying the feasible priorities of studies related to reproductive biology which could be carried out within the GBYP, especially in Phase 8, while the other one was preparing the larger biological workshop in Phase 8, including the agenda drafting and the identification of the most adequate experts to participate as invited speakers.

The participants of the workshop identified seven research activities to be possibly done within the framework of the GBYP in Phase 8, which were suggested to the Steering Committee for their consideration. As regards the extensive workshop on bluefin tuna reproductive biology that is going to be held in Phase 8, the participants recommended that it should be conceived in such a way that it should answer or provide inputs on the following topics: 1) planning of the activities to be carried out within the GBYP biological studies in Phase 9, 2) affirming or rejecting the hypothesis of substantial differences in bluefin tuna reproductive biology between the eastern and western stocks and 3) identifying methods for estimation of the percentage of individuals contributing to spawning by age and area. In addition, they drafted a tentative agenda for the Workshop to be held in Phase 8, identifying the principal topics and recommended a list of scientist to participate as invited speakers. In order to address the controversy on the reproductive parameters currently used for the assessment of the bluefin tuna eastern and western stocks, the participants recommended that a reference report be elaborated by independent experts, reviewing the available information and drawing conclusions on this issue. It was envisaged to carry out this activity within the framework of GBYP and such a report drafted prior to the Workshop in Phase 8. The report of this activity is presented as document SCRS/2018/013 (**Annex 1a, document no. 41**).

7. Modelling approaches

The initial, short-term ICCAT GBYP objective which was approved by the Commission in 2008 was to carry out operating modelling studies from year 4, with a total budget of 600,000 Euros. So far, with 103.8 % of the funds (a total of 622,748 Euros, equal to 4.76 % of the total GBYP funds received so far), the ICCAT GBYP carried out many modelling activities since Phase 2 (in 7 years of activities so far), following the recommendations of the Steering Committee and the SCRS. It is very evident that the general objectives set for the modelling studies in these first Phases were largely accomplished so far, but the amount of effort for this activity was clearly underestimated when the GBYP was conceived. Furthermore, the modelling plan was fully revised and now it has been extended up to 2021 as recommended by the GBYP Core Modelling MSE Group, by the SCRS and as it was endorsed by the Commission.

7.1 Objectives

Under the GBYP the modelling programme addresses objective 3: "Improve assessment models and provision of scientific advice on stock status through improved modelling of key biological processes (including growth and stock-recruitment), further developing stock assessment models including mixing between various areas, and developing and use of biologically realistic operating models for more rigorous management option testing".

In addition, in 2012 the Commission requested the SCRS (Doc. No. PA2-617A/2012 COM) to conduct a stock assessment in 2015 and to:

a) Develop a new assessment model allowing the inclusion of the last updated knowledge on the biology and ecology of bluefin tuna, in particular life-history parameters, migration patterns, and aiming at identifying and quantifying uncertainties and their consequences on the assessment results and projections.

b) Release a stock status advice and management recommendations, supported by a full stock assessment exercise, based on the new model, additional information and statistical protocols mentioned in points above and on which basis all actions may be adopted and updated by the Commission through the management plan to further support the recovery.

The GBYP activities in the first Phases were consistent with the objectives, within the timeframe set by the Modelling MSE Core Group.

7.2 Modelling in Phase 7

7.2.1 Modelling technical assistant

Following the recommendation of the GBYP Steering Committee, a contract for developing the Operating Model and MSE framework and related code was extended to Dr. Thomas Robert Carruthers (under a contract to Blue Matter Science), who initiated this work in Phase 4.

The objectives for modelling activities under GBYP Phase 7 were the following:

i) Ensure the Operational Model (OM) implements the trials as specified by the 2016 CMG report.

ii) Use the test unit to validate the age-based movement model.

iii) Work with third parties to add Management Plans (MPs) to the MSE framework including empirical control rules and simple stock assessment methods

iv) Run the MSE in collaboration with BFT Species group.

v) Collaborate with SCRS and others (e.g. tRFMOS) to develop interactive web based graphics to communicate MSE results to decision makers and stakeholders.

vi) Work with others to update and maintain the meta database of the available Bluefin data and knowledge https://github.com/ICCAT/GBYP-MetaDB

The focus of the work in Phase 7 was the production of a fully documented working MSE framework including all finalized operating models (both reference and robustness) to allow stakeholders to develop and test their own Management Procedures. In this regard, a number of major milestones were achieved in this Phase. The final report of this activity is attached in **Annex 1a document no. 58.**

As concerns the operational modelling, the M3 model was updated from 1.3 through to 1.7, in order to accommodate the requirements of the reference and robustness operating models. The Trial Specifications and the meta-data base were also updated to include new OM definitions, performance metrics and data sources. All reference operating models were fitted to data and presented to the core modelling group. The summary was presented on the document SCRS/2017/223 (**Annex 1b, document no. 6**). The principal robustness operating models were fitted to data and are to be summarized in a 2018 SCRS paper. The 36 reference and 4 robustness operating models were included in the ABT-MSE R package (v2.3.0) for use in MP testing. Finally, a functionality was added to specify the operating models of the R package using the MCMC posterior samples of the fitted M3 models (a better characterization of parameter uncertainty and cross-correlation).

Regarding MSE development, the R package was updated with the performance table function and an MSE performance metrics plot to standardize the outputs of user MSE runs, consistent with the performance metrics of the updated trial specifications document. In addition, standardized operating model fitting reports were updated following feedback from the Core Modelling Group including a new, additional OM comparison report. All of the latest R code, data and objects were into the R package (ABTMSE v2.3.0) with complete documentation for all functions, objects and data to be used in MSE analyses (**Figure 17**). The raw data, R scripts, Reports, help documentation and the R package were assembled in a single directory which can be downloaded from either the ICCAT GitHub repository or a Google drive.

As regards documentation, a paper SCRS/2017/224 (**Annex 1b, document no. 5**) was presented, showing the design and implementation of new MPs in the R package. In addition, other paper was drafted, introducing the ABT-MSE R package and its capabilities, which was presented as document SCRS/2017/225 (**Annex 1b, document no. 4**). Other peer-review paper on description and testing a multi-stock, multi-index management

procedure designed specifically for Atlantic bluefin tuna was drafted as well, but it is currently available only as draft. The user guides for M3 (v1.7) and ABT-MSE R package (v2.3) have been updated with new tutorials and examples of MP development. The user guide was developed in R markdown that describes the file structure, the project and guides users through the various functions of the R package including worked examples of the 7 steps of MSE development. Finally, software design documentation was updated for the latest version of the ABT-MSE R package (v2.3.0).

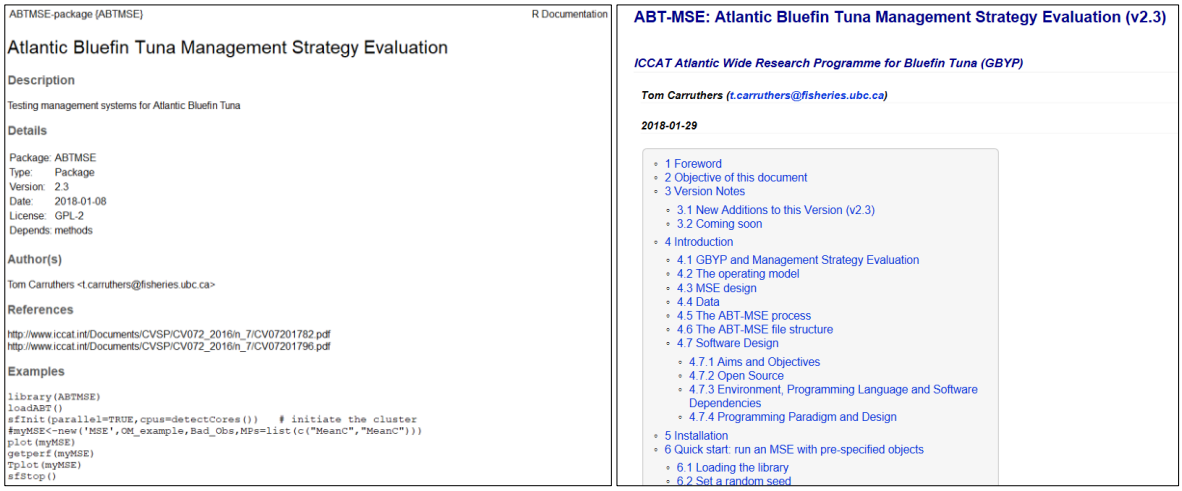


Figure 17. (a) Complete R package for MP testing ABT-MSE with (b) Package ABT-MSE user guide

It is important for the BFT Species Group and the Commission to gain experience in conducting of MSE. Major interactions with decision makers and stakeholders will best be conducted using results from stocks of interest to illustrate trade-offs, so that they can choose between tangible options on the basis of actual projections rather than abstract concepts. The initial MP design and performance statistics, however, should be few, informative and based axes such as ‘stock status’, 'safety', 'stability' and 'yield'.

The ABT-MSE Package is now complete and ready for use by Stakeholders in the development and testing of Management Procedures. The next phase of the MSE process will see stakeholders develop and test custom management procedures. Due to diversity in their skillset, background and experience each user is likely to require different levels and types of technical support. In order to promote the work of stakeholders in developing management procedures it may be helpful to support or provide tools to aid in the production of SCRS papers documenting their research. This provides a transparent and citeable account of the project research that may also benefit other users.

The ICCAT GBYP Core Modelling MSE Group, in its 6th meeting, recommended the contract of the external modelling expert to be continued in GBYP Phase 8 and 9.

7.2.2 ICCAT GBYP Core Modelling MSE Group

There were institutional replacements in the membership of the ICCAT GBYP Core Modelling and MSE Group

(ex ICCAT GBYP Core Modelling Group) in the last years, taking into account the two GBYP Core Modelling and MSE Coordinators, the new SCRS Chair and the new rapporteurs. The Group in Phase 7 had the following members: Tom Carruthers (expert and MSE Technical Assistant), Polina Levontin, Richard Hillary, Toshihide Kitakado, Haritz Arrizabalaga, Doug Butterworth and *ex-oficio* members: David Die (SCRS Chair), Clay Porch (ABFT Chair), Gary Melvin (WBFT Rapporteur), Ana Gordoa (EBFT Rapporteur), Laurie Kell (ICCAT Population Dynamics Specialist), Paul De Bruyn (ICCAT Research and Statistics Coordinator), Antonio Di Natale (ICCAT GBYP Coordinator) and Miguel Neves dos Santos (ICCAT Assistant Executive Secretary).

A fourth meeting of the Group was held in Madrid on 11 March 2017, back to back with the SCRS Bluefin tuna data preparatory session. It was decided to call an *ad horas* meeting of a Group for preparing a proposal for taking the current MSE work forward and use the opportunity to inform about it the scientists that were already been attending the other meeting. The future schedule was also proposed. The report of this meeting is attached in **Annex 1a, document no. 51**.

A fifth meeting of the Group was held on various occasions back-to-back with SCRS Bluefin tuna Stock assessment session (in Madrid, 19-23 July 2017, then extended to the 28th). During the meeting, the importance to use the various sets of GBYP data in the OM was pointed out. The Group, revising what it was discussed at the Monterey meeting, decided to make publically accessible the software developed by the MSE expert, using Github. The public can now access the software on https://github.com/ICCAT/abft-mse/wiki. It was confirmed that the 5-year GBYP aerial survey index will be included in the OM, being the last report already available, as agreed. Carruthers was asked to review the various points according to the notes provided by the Group and present the updated runs and the new documents. The Group recommended to use OM7 as the best case run. The report of this meeting is attached in **Annex 1a, document no. 52**.

A sixth meeting of the Core Modelling MSE Group was held in Madrid on 25-26 September 2017, back-to-back to the SCRS Bluefin tuna Species Group meeting. The group discussed MSE trial specifications and updated them according to the decisions. The report on refined conditioning of OMs was considered as well. Conducted conditioning was confirmed as adequate, the models to be used to generate future abundance index data were approved and it was decided to revise and refine procedures for conditioning robustness trials. Finally, the Group discussed future plans. It also discussed the need to involve specialists from different CPCs in the CMMG particularly from geographical areas which are not currently represented in the Group, so enhance the likely acceptance of a final MP proposed through extending "ownership" of the proposal. The necessity of securing a number of candidate MP developers to work using the package developed towards proposing CMPs to the planned 2018 intersessional meeting was stressed. The Group recommended that Tom Carruthers be one of those developers. Participants in the meeting indicated the likely availability of such developers from a number of CMPs. The report of this meeting is attached in **Annex 1a, document no. 53**.

The Group developed an updated schedule for the next activities:

1) About April 2018 the various developers of CMPs meet to compare results and agree on refinements to take their CMPs further.
2) The September 2018 bluefin session narrows the set of CMPs based on their performance across the various OMs.
3) A first stakeholder-scientist interaction takes place during a Panel 2 intersessional meeting in about February 2019 to discuss desired MP properties and performance, informed by results from this first set of CMPs.
4) A subsequent meeting of the CMMG takes place to consider the results of CMP amendments informed by that stakeholder-scientist interaction.
5) If needed, a second stakeholder-scientist interaction takes place during a further Panel 2 intersessional meeting in about July 2019.
6) A meeting of the CMMG takes place before the September 2019 bluefin session to finalise a small number on CMPs to present to the Commission
7) A proposed set of CMPs is presented to the Commission at its 2019 meeting for a selection there of a final MP.

7.2.3 Technical meeting and workshop on modelling/MSE

Within the framework of the Phase 7, a technical meeting was organized on modelling and MSE. It was held in Madrid in a week of 15-19 May 2017 and it included a working group to develop SAM Assessment for East Atlantic and Mediterranean Bluefin Tuna**.** This group was formed by Laurie Kell, population dynamics expert in ICCAT Secretariat and two external participants: Anders Nielsen and Abdelouahed Ben Mhamed.

The assessment of the Mediterranean and Atlantic bluefin tuna has always been conducted using the VPA approaches. The uncertainties around the estimates of such approaches make difficult the provision of scientific advice. In this meeting the working group used a state-space stock assessment model SAM as a new approach to evaluate the impact of uncertainty. Additionally, a comparison of the results of VPA and SAM was conducted, based on the 2014 datasets and the preliminary 2017 datasets. To evaluate the robustness of SAM a range of diagnostics and scenarios was ran according the 2017 Bluefin data preparatory meeting. The summary of the meeting and its findings were provided by the document SCRS/2017/146 (**Annex 1b, document no. 54**).

7.2.4 Use of GBYP data in the BFT Stock Assessment, in the MSE and in the OM

One of the principal objectives of the GBYP is to improve the basic data for their use in the various assessment and modelling approaches. At the beginning the data collected under the various activities by the GBYP suffered several delays before finally entering into the ICCAT system, but later, after refining the procedures for incorporating the data in the ICCAT Statistical department, most of the data were duly incorporated and several size and effort data were used in the 2014 stock assessment.

Table 20. Details about the use of GBYP data up to the first part of Phase 7 in the stock assessment, in the MSE and in the OM.

USE OF ICCAT GBYP DATA UP TO THE FIRST PART OF PHASE 7		
Activity	**use in the BFT Stock Assessment**	**use in the BFT MSE and OM**
Data mining and data recovery	size data, historical trap data, BB data, historical maturity data, non-GBYP electronic tagging data recovered by GBYP	size data, LL CPUE, historical trap data, BB data, non-GBYP electronic tagging data recoverd by GBYP, historical genetic data
Aerial survey on BFT spawning aggregation	data available, but not used so far (5 surveys, too short series)	yes
Tagging	conventional tag data, growth data from tagging, GBYP electronic tag data	conventional tag data, electronic tag data, mixing determination by area
Biological studies	genetic and microchemical data (mixing), ALK, reproductive characterististics, L/W correlation	genetic and microchemical data (mixing by area), ALK, reproductive characteristics, L/W correlation
Modelling approaches	SAM application, VPA training course	MSE and OM development, Modelling Multi-Year Plan

In the following Phases, the data were moved into the system almost in real time, after being accepted by the ICCAT SCRS Subcomstat, while others were provided directly to the specialist identified by the SCRS BFT Species Group. In the first part of Phase 7, the great majority of the GBYP data were used in the 2017 Bluefin Assessment, in the MSE and in the OM. **Table 20** shows the details. The report of the Bluefin Tuna Stock Assessment Meeting is attached in **Annex 1a, document no. 48 and documents no.49.**

GBYP data were used for drafting following scientific papers in connection with bluefin tuna stock assessment: SCRS/2017/124 (attached in **Annex 1b, document no. 13**), SCRS/2017/177 (attached in **Annex 1b, document no. 14**), SCRS/2017/190 (attached in **Annex 1b, document no. 16**), SCRS/2017/178 (attached in **Annex 1b, document no. 17**), SCRS/2017/170 (attached in **Annex 1b, document no. 20**),

8. Legal framework

The enforcement of the ICCAT Rec. 11-06, which allows for a "research mortality allowance" of 20 tons/year for GBYP and for the use of any fishing gear in any month of the year in the ICCAT Convention area for GBYP research purposes, finally helped GBYP in carrying out both tagging and biological sampling activities. The ICCAT Secretariat, on 22 May 2012, issued a first circular (no. 2296/2012), establishing the rules and the details for the enforcement of Rec.11-06, including the official form for reporting the RMA and the first list of authorized institutions (20 entities). For the purpose of covering all the activities of GBYP Phase 7, it was updated on 19 June 2017 (no. 0964/2017), with the list of 39 entities and then again on 12 September 2017 (no. 1386/2017) with the list of 43 entities.

A total of 328 ICCAT GBYP RMA certificates have been issued from 2012 to February 2018, using 12,662.02 kg of bluefin tuna (equal to 2110 fish). 52 RMA certificates were issues in Phase 7, using a total of 1,245.47 kg corresponding to 328 fish. RMA used quantities in previous years (5,039.49 kg in 2012, 4,392.76 kg in 2013, 887.78 kg in 2014, 324.71 kg in 2015, 874.86 kg in 2016 and 1,142.42 kg) were officially communicated to ICCAT

Statistical Department for the inclusion in the official ICCAT BFT catch table. The use of GBYP RMA up to the first part of 2017 was given in the document SCRS/2017/208 (attached in **Annex 1b, document no. 12**).

The ICCAT CPCs, in general, supported from a practical point of view the GBYP field activities, as established by the Commission. Only few exceptions were noticed about the late issuing of the permit for carrying out biological sampling activities in some areas.

9. Cooperation with the ICCAT ROP

The GBYP coordination, together with the ICCAT Secretariat, is maintaining and improving the contacts with the ICCAT ROP observers, for strengthening the cooperation and providing opportunities. The ICCAT ROP observers are engaged for directly checking bluefin tuna at the harvesting for improving the tag recovery and reporting, but also for noticing and reporting any natural mark. Specific forms were provided to ROP. The GBYP Coordinator regularly participated to the ICCAT ROP observers training courses, specifically training them for the tag recovery and reporting, up to Phase 5. ICCAT GBYP tag awareness material is regularly provided to ICCAT ROPs.

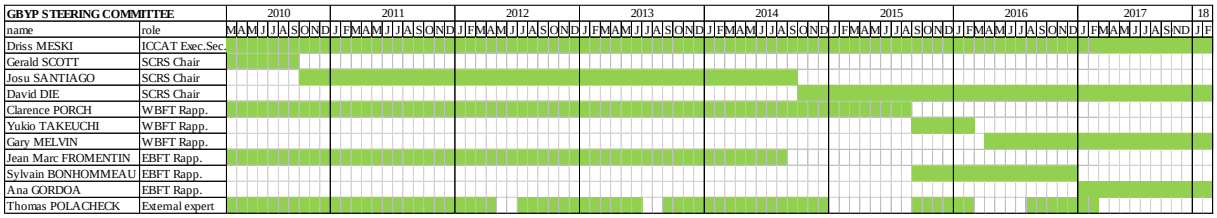
The contacts between ICCAT ROPs and ICCAT GBYP are usually in real time, always through the ICCAT Secretariat, which is duly informed of all contacts and procedures. ICCAT ROPs are also helping for identifying the right persons for providing the rewards for the recovered tags.

ICCAT ROPs are improving their tag reporting year after year and this cooperation was extended also to genetic sampling in Phase 7, after assessing both their availability and the good-will of the tuna farm owners.

10. Steering Committee Activities

The GBYP Steering Committee in the Phase 7 was composed by the Chair of SCRS, Ph.D. David Die, the BFT-W Rapporteur, Ph.D. Gary Melvin, the BFT-E Rapporteur, Ph.D. Ana Gordoa and the ICCAT Executive Secretary, Mr. Driss Meski. **Table 21** shows the different composition of the ICCAT GBYP Steering Committee since the beginning of the programme (according to the official contracts for the external member only). The changes in the SC members, which are logical according to the current institutional components, sometimes created different views for some GBYP activities.

Table 21. Composition of the ICCAT GBYP Steering Committee since the beginning of the programme.



The Steering Committee members have been constantly informed by the GBYP about all the initiatives and they are regularly consulted by e-mail on many issues. A monthly report was provided to the Steering Committee by the GBYP Coordinator. The activity of the Steering Committee included continuous and constant e-mail contacts with the GBYP coordination, which provided the necessary information.

In Phase 7 the Steering Committee held two meetings. The first one was held on 7-8 March 2017, discussing various aspects of the programme, providing guidance and opinions for adapting the plan for Phase 7. The other meeting was held on 15-16 February 2018 and it was dedicated on the review of the activities carried out in the Phase 7 and planning of the future activities for Phase 8. The finalised reports of the GBYP Steering Committee meeting are available on http://www.iccat.int/GBYP/en/scommittee.htm and attached in **Annex 1a**, as **document no. 42** and **document no. 43**.

11. Funding, donations and agreements

The Atlantic-wide Research Programme for Bluefin Tuna, according to the Commission decision in 2009, is voluntary funded by several ICCAT CPCs. The annual budgets are on http://www.iccat.int/GBYP/en/Budget.htm

So far, up to the first seven Phases, GBYP received and used only 68.62 % of the funds originally approved for the six-years period (13,091,190 euro against 19,075,000 euro). In Phase 7, the budget had the following funders (in order of contribution already received):

European Union (grant agreement)	Euro	1,447,188.00
Japan (donation according to quota)	Euro	57,024.88
Tunisia (donation according to quota)	Euro	53,447.40
Turkey (donation according to quota)	Euro	52,972.61
United States of America (donation)	Euro	50,000.00
Kingdom of Morocco (donation)	Euro	50,000.00
Libya (donation according to quota)	Euro	41,406.40
Canada (grant agreement)	Euro	20,448.50
Norway (donation)	Euro	20,000.00
Chinese Taipei (donation according to quota)	Euro	3,000.00
Popular Republic of China (donation according to quota)	Euro	1,931.09

Iceland (donation according to quota) Euro 1,566.12

Further amounts were residuals of previous GBYP Phases and they were used for better balancing the EU contribution and for compensating costs which were not covered by the EU funding in various Phases. Additional eventual residuals from the amounts provided in Phase 7 will be used for the following Phases of GBYP. Contributions for the current and previous GBYP Phases are still pending from some ICCAT CPCs.

The lack of a stable and reliable multi-year funding system is one of the major problems for GBYP, because this fact prevents a proper planning of all activities and contracts at the beginning of each Phase. The GBYP Steering Committee and the SCRS several times recommended the adoption of a more stable funding system, but all proposals submitted so far by the ICCAT Secretariat or some CPCs to the Commission (i.e.: scientific quota, contribution proportional to quota, etc.) were discussed but they were never approved. The uncertainties linked to the funding at each Phase are creating operational problems since the beginning of the programme, because it is difficult to plan all activities and provide all necessary contracts when the effective funding will be certain and confirmed only at the very end of each Phase. This fact implies a continuous attention to the effective budget availability at each step of the programme by the Coordination and the impossibility to operate with multi-year contracts for multi-year activities.

The Atlantic-wide Research Programme for Bluefin Tuna is a very complex programme and its activities concern all stakeholders. When it was approved by the Commission, the reason was that this programme is necessary for improving the scientific knowledge about this species and this is the difficult and challenging work that GBYP is carrying on, following the strategy recommended yearly by the Steering Committee and the SCRS, but also by the Commission. As a consequence, the GBYP needs the cooperation of all stakeholders and all countries to fulfil its duties in the best possible way. This need was perfectly identified by SCRS and the Commission during the preliminary evaluation of the Programme and then reinforced by the mid-term evaluation and by the second external review. Therefore, GBYP is managing to work with all stakeholders, keeping them aware of the programme and its activities and getting them directly involved when necessary.

Here following is the list of donors to GBYP, in alphabetic order:

- ✓ Aquastudio Research Institute, donation in kind of 1 miniPAT, estimated value 3,500 euro (2014).
- ✓ Asociación de Pesca, Comercio y Consumo Responsable de Atún Rojo (SP): Euro 6,000.00 (for GBYP in Phase 1).
- ✓ Association Marocaine de Madragues, donation in kinds of a social dinner in Tangier; estimated value not defined (for the Symposium on Trap Fishery).
- ✓ Carloforte Tonnare PIAMM, donation in kind of several tunas for biological sampling and tagging; estimated value not defined (Phase 4).
- ✓ COMBIOMA, University of Cagliari, donation in kind for tagging underwater and logistics in Sardinian traps; estimated value not defined (Phase 4).

- ✓ Departement de la Pêche Maritime, DPMA/DPRH, Rabat (MO), essential administrative and logistic support for tagging in Moroccan traps in Phase 2, 3, 4 and 5.
- ✓ Federcoopesca, Roma, donation in kind, providing 5 extra days of a purse-seiner time for tagging; estimated value not defined (Phase 4, 2013) and donation in kind of the electronic and conventional tagging activity in Phase 5 (estimated value to be defined).
- ✓ Fromentin Jean-Marc, Ph.D., IFREMER: a collection of tuna trap data from 1525 to 2000, estimated value not defined (for Data Recovery and Data Mining, Phase 4).
- ✓ Grup Balfegó (SP), donation in kinds of tuna heads prepared for sampling otoliths; estimated value: Euro 300,00 (for the GBYP Operational Meeting on Biological Sampling in Phase 2).
- ✓ Grupo Ricardo Fuentes e Hijos S.A. (SP): Euro 10,000.00 (for the Symposium on Trap Fishery in Phase 2) and the practical support for tagging in Moroccan traps in Phase 2, 3, 4 and 5.
- ✓ Hopkins Marine Station of the Stanford University, donation in kind of 7 acoustic tags and 8 miniPATs analysis and logistics in Morocco; estimated value not defined (Phase 4, 2013 and 2014).
- ✓ Institute National de Recherche Haulieutique (INRH), Tangier (MO), donation in kinds of logistic support and staff assistance for tagging in Morocco: estimated value to be defined (for GBYP Tagging in Phase 2, 3, and 4).
- ✓ Instituto Español de Oceanografia, Fuengirola, donation in kinds of staff assistance for tagging in Morocco: estimated value not defined (for GBYP Tagging in Phase 2).
- ✓ Lutcavage Molly, Ph.D.,Scool of Environment, University of Massachusetts (USA), donation of data from 697 e-tags; estimated value not defined (for GBYP Modelling in Phase 6).
- ✓ Maromadraba SARL and Es Sahel (Fuentes Group), donation in kind of divers working time, vessels support and sailors, for tagging in Morocco; estimated value: Euro 6,000.00 (for GBYP Tagging in Phase 2, 3, 4 and 5).
- ✓ Mielgo Bregazzi Roberto (SP), donation in kinds of many thousands of individual tuna data from auctions, estimated value: 50,000.00 Euros (for GBYP Data Recovery in Phase 2) and 300,000 Euros (for GBYP Data Recovery in Phase 3).
- ✓ National Institute of Fishery Science, Busan (Republic of Korea), donation of the output data from 12 electronic tags (2 miniPATs and 10 SPATs) to be deployed in Phase 7, estimated value not defined.
- ✓ National Research Institute for Far Seas Fisheries, Shimizu (JP), donation of many hundreds Bluefin tuna samples from the central Atlantic fishery: estimated value not defined (for GBYP biological and genetic analyses in Phase 2, 3, 4 and 5); complimentary support for travel and accommodation costs for several Japanese scientists for participating in various GBYP meetings and activities.
- ✓ Oceanis srl, donation in kind for tagging underwater and logistics in Maltese cages and Sardinian traps; estimated value not defined (Phase 4).
- ✓ UNIMAR, Rome (IT), donation of data sets from 9 e-tags (for GBYP Modelling in Phase 5).
- ✓ Wildlife Computers Inc., donation in kind of additional 25 miniPATs for compensating the problems created by the pin-broke.
- ✓ WWF Mediterranean Programme (WWF MedPO), donation in kinds of 24 miniPATs, analysis and

logistics in Morocco; estimated value: Euro 80,400.00 (for GBYP Tagging in Phase 2 and 3). Donation in kind of 6 miniPATs and 2 experimental e-tags; estimated value 40,000 euro (for tagging in the Strait of Messina in Phase 6).

- ✓ WWF Netherlands, complimentary support for the costs of an additional tagger during the tagging activities in the North Sea, estimated value not defined (Phase 7).
- ✓ Former GBYP Coordinator, donation of many thousands of old catch data; estimated value not defined (Phases 3, 4 and 5).

The list does not include other entities which provided complimentary tagging activities for conventional tags.

12. GBYP web page

The ICCAT GBYP web page, which was created in the last part of Phase 1, is usually regularly updated with all documents produced by GBYP; in some cases, due to the huge workload, some set of documents are posted all together. Documents are posted only after their revision and the final approval. The texts of the GBYP pages were revised, improved and updated on February 2018. The webpage is available at the following link http://www.iccat.int/GBYP/en/index.htm.

The update of the contents and the design of the GBYP web page is currently ongoing, in line with the requirements and style of the new ICCAT web page.

The ICCAT Secretariat provided all the necessary support for the ICCAT GBYP web pages.

Annex 1. List of reports and scientific papers in GBYP Phase 7

Annex 1a. List of deliverables produced within the framework of GBYP contracts and activities in Phase 7 (interim reports and software products will not be included in the final copies and they are marked in yellow; technical interim reports and draft final reports are not listed; interim reports cannot be published):

1) Aerial Survey – 17 March 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Aerial survey design. Alnilam Research and Conservation Ltd: 1-68.
2) Aerial Survey – 16 May 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Aerial Survey Protocol 2017. Alnilam Research and Conservation Ltd: 1-17.
3) Aerial Survey – 16 May 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Aerial Survey Forms 2017. Alnilam Research and Conservation Ltd: 1-3.
4) Aerial Survey – 15 May 2017: ICCAT GBYP Administrative rules for the Aerial survey, Presentation for the Training Course. ICCAT GBYP Coordination: 1-29.
5) Aerial Survey – 15 May 2017: ICCAT GBYP Aerial Survey objectives and approach, Presentation for the Training Course. ICCAT GBYP Coordination: 1-49.
6) Aerial Survey – 15 May 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Power Point presentation for the Aerial Survey Training Course 2017. Alnilam Research and Conservation Ltd: 1-90.
7) Aerial Survey – 15 May 2017: Training Course for the ICCAT GBYP Aerial survey for bluefin spawning aggregations, List of participants. ICCAT GBYP Coordination: 1-2.
8) Aerial Survey – 17 July 2017: Short term contract for the aerial survey for bluefin spawning aggregations (ICCAT GBYP 02/2017a), Final Report for Areas A and E. Grup Air-Med: 1-65.
9) Aerial Survey – 19 July 2017: Short term contract for the aerial survey for bluefin spawning aggregations (ICCAT GBYP 02/2017b), Final Report for Area C. Unimar and Aerial Banners: 1-26.
10) Aerial Survey – 17 July 2017: Short term contract for the aerial survey for bluefin spawning aggregations (ICCAT GBYP 02/2017c), Final report for Area G. Action Air Environnement: 1-42.
11) Aerial Survey – 06 June 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Weekly report 1. Alnilam Research and Conservation Ltd: 1-3.
12) Aerial Survey – 13 June 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Weekly report 2. Alnilam Research and Conservation Ltd: 1-4.

13) Aerial Survey – 20 June 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Weekly report 3. Alnilam Research and Conservation Ltd: 1-7.
14) Aerial Survey – 27 June 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Weekly report 4. Alnilam Research and Conservation Ltd: 1-7.
15) Aerial Survey – 04 July 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Weekly report 5. Alnilam Research and Conservation Ltd: 1-5.
16) Aerial Survey – 18 July 2017: Short term contract for aerial survey design, training course, real-time monitoring of the data and real-time survey data analysis (ICCAT GBYP 01/2017), Final report. Alnilam Research and Conservation Ltd: 1-25.
17) Biological studies – May 2017. Sampling strata and needs for Biological studies in Phase 7. GBYP Coordination: 1-2.
18) Biological studies – 28 June 2017. Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017a), Short report.Taxon Estudios Ambientales SL: 1-7.
19) Biological studies – 11 October 2017. Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017a), Short report.Taxon Estudios Ambientales SL: 1-9.
20) Biological studies – 14 December 2017. Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017a), Short report.Taxon Estudios Ambientales SL: 1-9.
21) Biological studies – 2 February 2018. Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017a), Final report.Taxon Estudios Ambientales SL: 1-50.
22) Biological studies – 04 July 2017: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017b), Short report. Balfegó & Balfegó SL: 1-2.
23) Biological studies – 18 September 2017: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017b), Short report. Balfegó & Balfegó SL: 1-3.
24) Biological studies – 29 January 2018: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017b), Short report. Balfegó & Balfegó SL: 1-3.
25) Biological studies – 6 February 2018: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017b), Final report. Balfegó & Balfegó SL: 1-3.
26) Biological studies – 16 June 2017: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017c), Short report. AquaBiotech Ltd: 1.
27) Biological studies – 15 September 2017: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017c), Short report. AquaBiotech Ltd: 1-3.
28) Biological studies –21 November 2017: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017c), Short report. AquaBiotech Ltd: 1.
29) Biological studies –7 February 2018: Short term contract for biological studies-sampling for adults (ICCAT GBYP 05/2017c), Final report. AquaBiotech Ltd: 1-9.

30) Biological studies – 19 September 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-1), Short report. Consortium represented by AZTI: 1-7.
31) Biological studies –6 November 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-1), Short report. Consortium represented by AZTI: 1-8.
32) Biological studies –15 February 2018. Short term contract for biological studies (ICCAT GBYP 08/2017-1), Final report. Consortium represented by AZTI: 1-36.
33) Biological studies – 31 August 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-2), Short report. Consortium represented by University of Bologna: 1-8.
34) Biological studies –20 September 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-2), Short report. Consortium represented by University of Bologna: 1-19.
35) Biological studies –7 November 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-2), Short report. Consortium represented by University of Bologna: 1-21.
36) Biological studies –8 February 2018. Short term contract for biological studies (ICCAT GBYP 08/2017-2), Final report. Consortium represented by University of Bologna: 1-33.
37) Biological studies – 29 September 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-3), Short report. Social and Environmental Entrepreneurs [Tag a Tiny Programme]: 1-4.
38) Biological studies – 6 November 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-3), Short report. Social and Environmental Entrepreneurs [Tag a Tiny Programme]: 1-6.
39) Biological studies – 6 November 2017. Short term contract for biological studies (ICCAT GBYP 08/2017-3), Short report. Social and Environmental Entrepreneurs [Tag a Tiny Programme]: 1-6.
40) Biological studies – 12 February 2018. Short term contract for biological studies (ICCAT GBYP 08/2017-3), Final report. Social and Environmental Entrepreneurs [Tag a Tiny Programme]: 1-9.
41) Biological studies – 15 February 2018. Report of the ICCAT GBYP Planning Workshop on the Bluefin Tuna Reproductive Biology, provided as SCRS/2018/013, Anon.: 1-12.
42) Coordination –08 March 2017: ICCAT GBYP Steering Committee Meeting, Report, 1-5.
43) Coordination –15 February 2018: ICCAT GBYP Steering Committee Meeting, Report, 1-14.
44) Data recovery – 23 May 2017: Short term contract for the data recovery plan (ICCAT GBYP 03/2017a), Preliminary short report. Necton: 1-1.
45) Data recovery – 4 July 2017: Short term contract for the data recovery plan (ICCAT GBYP 03/2017a), Final report. Necton: 1-4.
46) Data recovery – 7 July 2017: Short term contract for the data recovery plan (ICCAT GBYP 03/2017b), Final report. Ricerca Mare Pesca: 1.
47) Meetings – March 2017, ICCAT Bluefin tuna data preparatory meeting 2017, Report, Anon: 1-60.
48) Meetings – July 2017, ICCAT Bluefin tuna stock assessment meeting, Report, Anon: 1-106.
49) Meetings – July 2017, ICCAT Bluefin tuna stock assessment meeting, Addendum to the Report, presented as SCRS/2017/188. Anon: 1-6.
50) Meetings – October 2017, Standing Committee on Research and Statistics (SCRS), Report, Anon: 1-465.

51) Modelling approaches – 11 March 2017: ICCAT GBYP Core Modelling and MSE Group, Fourth Meeting, Report. Anon: 1:4.
52) Modelling approaches – July 2017: ICCAT GBYP Core Modelling and MSE Group, Fifth Meeting, Report. Anon: 1:7.
53) Modelling approaches – September 2017: ICCAT GBYP Core Modelling and MSE Group, Sixth Meeting, Report. Anon: 1:39.
54) Modelling approaches – May 2017: Eastern Bluefin Tuna Stock Assessment Using SAM, Report of the Technical Meeting and Workshop on modelling/MSE, provided as SCRS/2017/146. Ben Mhamed, A. *et.al*: 1-19.
55) Modelling approaches– 17 July 2017: Short term contract for modelling approaches: Support to BFT Assessment (ICCAT GBYP 07/2017), Progress report 6 including workplan. Tom Carruthers: 1-6.
56) Modelling approaches– 9 October 2017: Short term contract for modelling approaches: Support to BFT Assessment (ICCAT GBYP 07/2017), Progress report 7. Tom Carruthers: 1-4.
57) Modelling approaches– 17 November 2017: Short term contract for modelling approaches: Support to BFT Assessment (ICCAT GBYP 07/2017), Progress report 8. Tom Carruthers: 1-4.
58) Modelling approaches– 17 November 2017: Short term contract for modelling approaches: Support to BFT Assessment (ICCAT GBYP 07/2017), Final report. Tom Carruthers: 1-13.
59) Tagging – 17 August 2017: Short term contract for the Tagging programme 2017 (Area A) (ICCAT GBYP 07/2017), Progress report. Tunipex, S.A: 1-21.
60) Tagging – 19 October 2017: Short term contract for the Tagging programme 2017 (Area A) (ICCAT GBYP 07/2017), Final report. Tunipex, S.A: 1-21.
61) Tagging – 17 September 2017: Short term contract for the Tagging programme 2017 (Area C) (ICCAT GBYP 04/2017), Progress report. The consortium represented by the Technical University of Denmark, S.A: 1-3.
62) Tagging – 29 November 2017: Short term contract for the Tagging programme 2017 (Area C) (ICCAT GBYP 04/2017), Final report. The consortium represented by the Technical University of Denmark, S.A: 1-18.
63) Complementary activities - 14 February 2018: Biological response of bluefin tuna (*Thunnus thynnus*) to recreational sport fishing by catch and release. Institute of Oceanography and Fisheries (IZOR): 1-6.

Annex 1b. List of Scientific Papers – Phase 7 (Documents marked in yellow were not included in the final copies and comprise: 1. Deliverables that were presented as scientific documents have already been included in the Annex 1a; 2. Scientific Papers which were presented on Bluefin Tuna Data Preparatory Meeting, 6-11 March 2017, that have already been included in the Final Report of GBYP Phase 6):

1) Anonymous, 2017, Report of the ICCAT Atlantic-Wide Research Programme for Bluefin Tuna (ICCAT GBYP), Activity report for the last part of Phase 6 and the first part of Phase 7 (2016-2017), including a general overview of the activities up to 2017. SCI-037/2017
2) Ben Mhamed, A., Nielsen, A., Kell, L., 2017, Eastern bluefin tuna stock assessment using SAM. SCRS/2017/146
3) Cañadas, A., Cañadas, A., Aguilar de Soto, N., Aissi, M., Arcangeli, A., Azzolin, M., B-Nagy, A., Bearzi, G., Campana, I., Chicote, C., Cotte, C., Crosti, R., David, L., Di Natale, A., Fortuna, C., Frantzis, A., Garcia, P., Gazo, M., Gutierrez-Xarxa, R., Holcer, D., Laran, S., Lauriano, G., Lewis, T., Moulins, A., Mussi, B., Notarbartolo di Sciara, G., Panigada, S., Pastor, X., Politi, E., Pulcini, M., Raga, J.A., Rendell, L., Rosso, M., Tepsich, P., Tomás, J., Tringali, M., Roger, Th., 2018, The challenge of habitat modelling for threatened low density species using heterogeneous data: The case of Cuvier's beaked whales in the Mediterranean. In Ecological Indicators, Volume 85, 2018, Pages 128-136, ISSN 1470-160X, https://doi.org/10.1016/j.ecolind.2017.10.021.(http://www.sciencedirect.com/science/article/pii/S1470160X17306581)
4) Carruthers, T., Butterworth, D., 2017, ABT-MSE: An R package for Atlantic bluefin tuna management strategy evaluation. SCRS/2017/225
5) Carruthers, T., Butterworth, D., 2017, Performance of example management procedures for Atlantic bluefin tuna. SCRS/2017/224
6) Carruthers, T., Butterworth, D., 2017, Summary of the reference set of conditioned operating model for Atlantic bluefin tuna. SCRS/2017/223
7) Carruthers, T., Di Natale, A., Lauretta, M., Pagá García, A., Tensek, S., 2017, Migratory behaviour of Atlantic bluefin tuna entering the Mediterranean. SCRS/2017/131
8) Di Natale, A., 2017, An updated bibliography on bluefin tuna trap fishery. SCRS/2017/119
9) Di Natale, A., Cañadas, A., Vázques-Bonales, J.A., Tensek, S., Pagá García, A., 2017, Report of the ICCAT GBYP Aerial survey for bluefin spawning aggregations in 2017. SCRS/2017/149
10) Di Natale, A., Lino, P.G., López Gonzalez, J.A., Neves dos Santos, M., Pagá García, A., Piccinetti, C., Tensek, S., 2017, Unusual presence of small bluefin tuna YOY in the Atlantic ocean and in other areas. SCRS/2017/216
11) Di Natale, A., Tensek, S., Pagá García, A., 2017, ICCAT Atlantic-Wide Research Programme for Bluefin Tuna (GBYP) Activity report for the last part of Phase 6 and the first part of the Phase 7. SCRS/2017/139
12) Di Natale, A., Tensek, S., Pagá García, A., 2017, Report on the use of Research Mortality Allowance by ICCAT GBYP in 2012-2016 and the first part of 2017. SCRS/2017/208
13) Kell, L., Ben Mhamed, A., Rouyer, T., Kimoto, A., 2017, An evaluation of bias and prediction skill for the east Atlantic bluefin stock assessment. SCRS/2017/124

14) Kerr, L.A., Morse, M.R., Cadrin, S.X., Galuardi, B., 2017, Application of an Atlantic bluefin tuna operating model to generate pseudodata for stock assessment testing. SCRS/2017/177
15) Macias, D., Palma, C., Rodriguez-Marín, E., 2017, Revision of Atlantic bluefin tuna Task I nominal catches from Spain. SCRS/2017/169
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Annex 2. GBYP contracts issued in Phase 7.

ICCAT-GBYP CONTRACTS (PHASE 7)								
ICCAT GBYP DATA RECOVERY								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule**		**COST €**	**NOTES**
					initial date	**final date**		
7	2017-2018	03/2017	*Data recovery plan* - Necton Soc.Coop. A r.l. - Italy	Antonio Celona, e-mail: info@necton.it	21/06/2017	07/07/2018	6.500,00 €	
		03/2017	*Data recovery plan* - Ricerca Mare Pesca s.c.a.r.l. - Italy	Marcello Bascone, e-mail: marcellobascone@libero.it	02/06/2017	07/07/2018	17.500,00 €	
ICCAT GBYP AERIAL SURVEY								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule**		**COST €**	**NOTES**
					initial date	**final date**		
7	2017-2018	01/2017	*Aerial survey design* - Alnilam - Spain	Ana Cañadas, e-mail: anacanadas@alnilam.com.es	24/04/2017	31/07/2017	25.000,00 €	
		02/2017	*Aerial Survey* - Grup Air-Med - Spain	Francisco Javier Hevia Bousoño, e-mail: javier@grupairmed.com	16/05/2017	19/07/2017	164.398,03 €	
		02/2017	*Aerial Survey* - Unimar-Italy and Aerial Banners-Italy	Adriano Mariani, e-mail: a.mariani@unimar.it	19/05/2017	19/07/2017	71.779,41 €	
		02/2017	*Aerial Survey* - Action Air Environnement - France	Alexis Giordana, e-mail: agiordana@action-air.net	15/05/2017	19/07/2017	119.699,18 €	
		cost reimbursement	*Aerial Survey Training Course*		15/05/2017	15/05/2017	8.521,28 €	
ICCAT GBYP TAGGING PROGRAMME								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule**		**COST €**	**NOTES**
					initial date	**final date**		
7	2017-2018	04/2017	*Tagging programme* - Technical University of Denmark, as leader of a Consortium including 2 more institutions (1 Sweden, 1 Netherlands)	Brian MacKenzie, e-mail: brm@aqua.dtu.dk	28/06/2017	04/12/2017	60.282,89 €	
		07/2017	*Tagging programme (Area B)* - Tunipex S.A. - Portugal, as leader of consortium including one more Portuguese institution	Alfredo Poço, e-mail: alfredo@tunipex.eu	11/07/2017	28/12/2017	43.500,00 €	
		purchase order	*Tagging awareness campaign* - Refurbishment of T-shirts - Fun Fashion - Spain	Juan Carlos Vázquez, e-mail: funfashiont@gmail.com	14/12/2017	15/02/2018	3.582,00 €	
		purchase order	*Tagging programme* - Purchase of conventional tags - Floy Tag & Manufacturing - USA	Betsy Amick, e-mail: betsy@floytag.com	15/12/2017		5.896,54 €	Original cost $ 6.725
ICCAT GBYP BIOLOGICAL SAMPLING AND ANALYSES								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule**		**COST €**	**NOTES**
					initial date	**final date**		
7	2017-2018	05/2017	*Sampling for BFT adults* - AquaBioTech Ltd - Malta, as the leader of consortium including three more Maltese institution	Simeon Deguara, e-mail:dsd@aquabt.com	02/06/2017	10/02/2018	95.940,66 €	
		05/2017	*Sampling for BFT adults* - Balfegó & Balfegó S.L. - Spain	Begonya Mèlich Bonancia, e-mail: bmelich@grupbalfego.com	29/06/2017	10/02/2018	34.745,20 €	
		05/2017	*Sampling for BFT adults* - Taxon Estudios Ambientales S.L. - Spain, as a leader of consortium including one more Spanish institution	Antonio Belmonte Ríos, e-mail: antonio.belmonte@taxon.es	24/05/2017	10/02/2018	40.000,00 €	
		09/2017	Ageing 2000 otoliths - Fish Ageing Services - Australia	Kyne Krusic Golub, e-mail: kyne.krusicgolub@fishageingservices.com	12/06/2017	10/02/2018	66.343,10 €	Original cost AU$ 97.580
		08/2017	*Biological studies* - Fundación AZTI - Spain, as leader of a Consortium including 9 more institutions (2 Italy, 1 Malta, 1 Turkey, 1 Spain, 1 USA (w/o budget), 1 Ireland (w/o budget), 1 Japan (w/o budget), 1 France (w/o budget) (+ 4 subcontracts: 1 Turkey, 1 Portugal, 1 Italy, 1 Spain)	Haritz Arrizabalaga, e-mail: harri@azti.es	10/07/2017	15/02/2018	132.470,32 €	
		08/2017	*Biological studies* - Social and Environmental Entrepreneurs - Tag a Tiny Programme - USA	Molly Lutcavaga, e-mail: melutcavage@gmail.com	10/07/2017	15/02/2018	109.369,25 €	
		08/2017	*Biological studies* - University of Bologna - Italy, as leader of a Consortium including 1 more institution (Italy)	Alessia Cariani, e-mail: alessia.cariani@unibo.it	10/07/2017	15/02/2018	42.104,38 €	
		cost reimbursement	*ICCAT GBYP Planning Workshop on BFT Reproductive Biology*		14/02/2018	15/02/2018	11.688,11 €	
ICCAT GBYP MODELLING APPROACHES								
PHASE	**YEAR**	**CALL FOR TENDERS or ACTIVITY**	**RETAINED PROPOSAL**	**main contact**	**working schedule**		**COST €**	**NOTES**
					initial date	**final date**		
7	2017-2018	06/2017	*Modelling Approaches: Support to Bluefin Tuna Stock Assessment* - Blue Matter Science - Canada	Thomas Robert Carruthers, e-mail: t.carruthers@fisheries.ubc.ca	24/04/2017	21/02/2018	83.000,00 €	
		cost reimbursement	*External expert assistance for DPM and assessment* - Abdelouahed Ben Mhamed and Anders Nielsen		15/05/2017	19/05/2017	3.602,12 €	
		cost reimbursement	*ICCAT GBYP Core Modelling and MSE group* meeting		19/07/2017	23/07/2017	4.382,80 €	

Annex 3. List of meetings and activities attended by GBYP coordination staff in Phase 7

DATE	VENUE	MEETING
06-11/03/2017	Madrid, Spain	Bluefin Tuna Data Preparatory Meeting
07-08/03/2017	Madrid, Spain	ICCAT GBYP Steering Committee Meeting
11/03/2017	Madrid, Spain	*Ad horas* meeting of the ICCAT GBYP Core Modelling and MSE Group (IV)
15-19/05/2017	Madrid, Spain	Technical Working Group to develop SAM Assessment for East Atlantic and Mediterranean Bluefin Tuna
15/05/2017	Madrid, Spain	Training course for crew members of the Aerial Survey for Bluefin Spawning Aggregations
19/07/2017 and 23/07/2017	Madrid, Spain	Meeting of the ICCAT GBYP Core Modelling and MSE Group (V)
20-28/07/2017	Madrid, Spain	Bluefin Tuna Stock Assessment Meeting
7-9/09/2017	Isla Cristina (Huelva), Spain	Arráez & Sotarráez - XVI Encuentro de Capitanes de Almadraba*
25-26/09/2017	Madrid, Spain	Meeting of the ICCAT GBYP Core Modelling and MSE Group (VI)
25-26/09/2017	Madrid, Spain	Meeting of the SCRS Sub-Committee on Statistics
27-29/09/2017	Madrid, Spain	SCRS Bluefin Tuna Species Group Meeting
02-06/10/2017	Madrid, Spain	Meeting of the Standing Committee on Research and Statistics (SCRS)
14-15/02/2018	Madrid, Spain	ICCAT GBYP Workshop on BFT Reproductive Biology
15-16/02/2018	Madrid, Spain	ICCAT GBYP Steering Committee Meeting

* non-official participation; the meeting was attended on personal behalf and without costs for the programme.