SECOND REVIEW OF THE ICCAT ATLANTIC-WIDE RESEARCH PROGRAMME ON BLUEFIN TUNA (ICCAT GBYP PHASE 6-2016)

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SUMMARY

The "take home message"[2] from the 2016 external review of the GBYP is: The GBYP should be continued. Advances in biological methods to determine spawning ground origin of bluefin tuna are particularly successful. It is time to transition successful research into operational data for mixed stock management. A method to measuring abundance of bluefin tuna remains a challenge. Aerial surveys and close kin mark and recapture are the leading candidates for future investments. Good progress is being made in the development of Management Strategy Evaluation for mixed stock management. The approach should also be used to set science priorities. Tagging is the most expensive component of the GBYP. However estimating population size and mortality rates from tagging is problematic. Other methods may be more practical than tagging for information on mixing. There is a need for more consistent guidance from a re-constituted Steering Committee, a realistic budget outlook, and harmonisation of efforts across the Atlantic. The Commission should consider the challenges that will come with scientific advice on management of mixed spawning stocks of bluefin fisheries.

RÉSUMÉ

L'essentiel du message[3] à retenir de l'examen externe du GBYP réalisé en 2016 est le suivant : Le GBYP devrait se poursuivre. Les progrès accomplis en matière de méthodes biologiques visant à déterminer la zone de frai d'origine du thon rouge sont particulièrement louables. Il est temps de transposer les programmes de recherche fructueux en données opérationnelles pour la gestion des stocks mixtes. Trouver une méthode permettant de mesurer l'abondance du thon rouge relève du défi. Les prospections aériennes et le marquage et la récupération de spécimens étroitement apparentés sont les principaux candidats aux futurs investissements. De bons progrès sont réalisés dans le développement de l'évaluation de la stratégie de gestion pour la gestion des stocks mixtes. L'approche devrait également être utilisée pour définir les priorités scientifiques. Le marquage est le composant le plus coûteux du GBYP. Cependant, l'estimation par marquage de la taille de la population et des taux de mortalité est problématique. D'autres méthodes pourraient être plus pratiques que le marquage pour obtenir des informations sur le mélange. Il existe un besoin d'orientations plus cohérentes de la part d'un comité directeur reconstitué, d'une perspective budgétaire réaliste et d'une harmonisation des efforts à travers l'Atlantique. La Commission devrait examiner les défis qui accompagneront les avis scientifiques sur la gestion des stocks reproducteurs mixtes des pêcheries de thon rouge.

RESUMEN

El principal "mensaje» [1] de la revisión externa del GBYP de 2016 es: el GBYP debería continuar. Los avances en los métodos biológicos para determinar la zona de desove de origen del atún rojo han sido un éxito. Es el momento de realizar una transición desde la investigación de éxito a datos operativos para la gestión de los stocks mezclados. Continúa siendo un desafío hallar un método para medir la abundancia de atún rojo. Las prospecciones aéreas y el marcado y recaptura de ejemplares estrechamente emparentados son los principales candidatos para futuras inversiones. Se están haciendo progresos en el desarrollo de una evaluación de la estrategia de ordenación para una gestión de los stocks mezclados. El enfoque debería utilizarse también para establecer prioridades en cuanto a ciencia. El marcado es el componente más

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[2] See Section 1 (Overview of the Second Review of the GBYP) for an expanded description of the "message".
[3] *Cf.* Section 1 (Aperçu du deuxième examen du GBYP) pour obtenir une description détaillée du "message".
[1] Véase la sección 1 (visión general de la Segunda revisión del GBYP) para una descripción más amplia del "mensaje".

amplio del GBYP. Sin embargo, estimar el tamaño de la población y las tasas de mortalidad a partir del marcado es problemático. Otros métodos podrían ser más prácticos que el marcado para obtener información sobre la mezcla. Es necesario contar con orientaciones más coherentes de un Comité directivo reconstituido, una perspectiva presupuestaria realista y realizar una armonización de los esfuerzos en todo el Atlántico. La Comisión debería considerar los desafíos que se plantearán con el asesoramiento científico sobre una ordenación de los stocks reproductores mixtos de las pesquerías de atún rojo.

KEYWORDS

Programme review, GBYP, Bluefin tuna, Tagging, Aerial Survey, Data recovery, Biological Sampling, Modelling

1 Overview of the Second Review of the GBYP

1.1 Background

The Atlantic-wide research programme for bluefin tuna was officially adopted by the ICCAT Commission in 2008. The SCRS, in 2009, identified the priorities of the Research Plan as:

"1. Improve basic data collection through data mining ...

2. Improve understanding of key biological and ecological processes …

3. Improve assessment models and provision of scientific advice …"

An External Peer Review of the Programme was conducted in 2013. This document is the report of the Second External Peer Review of the Programme.

1.2 Brief Description of Programme Components

The GBYP is organized into six Programme components. The cumulative budget for the first 5 phases (March 2010-February 2016) of the Programme was € 9,557,329.

Data Recovery and Data Mining (4% of the cumulative budget): This component supports projects to recover fishery data from the Eastern Atlantic Bluefin tuna (BFT) fishery. Such data is potentially valuable for filling gaps from the recent decade when a large portion of the catch in the Mediterranean was difficult to sample. Lengths for millions of fish have been recovered to date.

There have also been projects to extend indices of abundance from trap fisheries further back in time. One trap index has now been extended back to 1525 AD. There are also interesting results from recovery of evidence of bluefin tuna fisheries of ancient times.

In addition, the GBYP has sponsored workshops and a symposium and data preparation meetings. Recently, the Programme has considered the potential for using market data to recover information about catches and size frequency, particularly for the periods of greatest concern about the possibility of under reporting and under sampling the catch.

The Commission now requires that stereoscopic video camera systems (SVCS) be used to monitor the transfer of fish from purse seine fisheries to fish farms in the Mediterranean Sea. This technology has the potential to provide an unprecedented amount of data on catches and length frequencies.

Biological Studies (15 % of the cumulative budget): This component develops methods for determining the age and spawning stock origin of bluefin tuna. Workshops have been conducted on aging methods and to calibrate age determinations. A manual for biological sampling has been prepared.

Methods to determine the spawning stock origin of fish have been successfully developed. The methods are based on genetics, otolith microchemistry and otolith shapes. It is now feasible to prepare annual age-length-stock origin (A-L-S) keys to be applied to biological samples from the catch as input to age structured mixed stock fishery models. Age length stock keys should be updated annually.

Aerial surveys (17 % of the cumulative budget): This component was initiated with a workshop to consider aerial survey design and methodology. Since then, Mediterranean Sea surveys have been conducted in 2010, 2011, 2013, and 2015. However, the survey design has varied between years (in terms of sampling intensity and area sampled).

A power analysis indicates that it is feasible to use aerial surveys to monitor relatively small changes (the order of 10%) over the course of several years (i.e., about 6). However, doing so depends on the degree of standardization of surveys and inter-calibration of survey aircraft and survey observers, which is challenging for the relatively large number of aircraft and observers participating in these surveys. As noted, survey design has varied between years and inter-calibration (in respect of the large number of spotters and planes used) has not occurred. In addition, the potential for reliably monitoring changes in abundance depends on the amount of inter-annual variability resulting from several factors that cannot be controlled. A second power analysis that considered more sources of uncertainty was much more pessimistic. There are also serious logistic challenges. In light of these concerns, the fifth aerial survey of the Mediterranean Sea in 2016 was cancelled.

In addition to aerial survey efforts for the Mediterranean Sea, there is a separate aerial survey project for the Western Atlantic that uses underwater acoustic sensors on ship in association with aerial surveys to address the proportion of fish close enough to the surface to be detected.

Given concerns about aerial surveys, ichthyoplankton (eggs and larvae) surveys will also be considered (see section 3.3). A workshop is planned. However, there are difficulties with ichthyoplankton indices including timing of spawning relative to the timing of surveys, large inter-annual variability in egg and larvae survival rates and some logics problems that are similar to the problems faced by aerial surveys (e.g. security).

Tagging (42% of the cumulative budget): This is by far the most expensive component. The Programme has conducted tagging workshops, prepared a tagging manual, paid rewards for tag returns, and conducted a tag awareness campaign to encourage returns. About 18,000 fish have been tagged with conventional tags (about 45% double tagged), and over two hundred have been tagged with electronic satellite tags (i.e., tags that transmit data to researchers via satellite). Tag return rates for conventional tags have been lower than expected. The Programme has also assembled data from other electronic tagging programmes and it now has a total of 781 electronic tagging records. It is attempting to obtain a substantial (the exact number is unknown, but it is probably around 450) number of additional records from other programmes.

Tagging can provide (a) estimates of population size and mortality rates, (b) information on fish movements for use in models of mixing, (c) data for fitting growth rate functions, and (d) behaviour information. However, the low rate of tags returns (about 1.5%) and an unknown reporting rate of tags recoveries, undermine population estimates (a) Efforts to collect data to estimate reporting rates have been unsuccessful. Data from tags is useful for estimating parameters of mixing models, (b) but it has limitations and data from biological methods for determining the spawning stock origin of fish (discussed above) can also be used. Tagging data provides information on growth, (c) but so do age determinations using the methods developed under the biological studies component of the Programme. The value of behavioural information (d) for preparing scientific advice is unclear. An attempt by the GBYP to undertake collection of data for estimating reporting rates was made but this could not be effectively implemented and conventional tagging was suspended for this reason.

The GBYP is now considering a novel type of tagging study that uses natural genetic tags to estimate population size. This method is known as close kin mark and recapture (CKMR) analysis. The method makes use of genetic technology that is analogous to a paternity test. Applying CKMR analyses will be difficult for Atlantic bluefin tuna because of the size of the population and complexity in stock structure. However, recent advances in technology should help. The GBYP is funding feasibility/design studies.

Modelling (4 % of the cumulative budget): The GBYP is advancing the development of new modelling approaches for management strategy evaluation (MSE). A key part of MSE is the development of a so called "operating model" that reflects a broad range of plausible scenarios about how fishery systems (e.g. fish populations, fishing activity, fishery management procedures or rules) functions.

MSE can be used to test options for managing fisheries that are robust to all of the uncertainty captured by the operating model. They can also be used to evaluate the value (in terms of fishery management performance) of various types and amounts of data.

The GBYP supports a core modelling group, modelling meetings, and modelling coordinators and external experts. It has contracted for the development of an operating model and good progress is being made. An alternative modelling effort is being funded by the USA. It is unclear if these modelling efforts will be harmonised, and how two separate efforts will be used for scientific advice to support fishery management.

Coordination (18% of the cumulative budget): This component supports a Programme Coordinator and two Programme staff in the Secretariat. It also provides a stipend for the external member of the steering committee and expenses for meeting travel. In addition to GBYP funded staff dedicated to supporting the Programme, other secretariat staff make valuable scientific and administrative contributions to the Programme.

The Secretariat staff (both those funded by the Programme and other staff) add scientific and technical expertise to the Programme. They issue and advertise calls for tenders and invitations, participate in evaluation panels and communication with bidders, prepare the contracts, plan activities, revise documents and reports; help developing databases and protocols, etc. The Secretariat staff add scientific expertise to the Programme. They help with logistics of some field work and they prepare databases and data for input to the scientific advice preparation process. They also prepare grant proposals for funding, manage contracts including communication with bidders, organise workshops and Steering Committee meetings, and prepare progress and completion reports, etc.

The Scientific Steering Committee is composed of the General Secretary, SCRS Chair, Eastern and Western Bluefin tuna Rapporteurs, and one external (independent) scientist. It usually meets annually and it works by e-mail correspondence between meetings.

1.3 Discussion

The justification of the GBYP is in Commission and SCRS documents. However, as far as we know, the GBYP lacks a needs based Strategic Plan. Identification of Programme needs is useful to evaluate programme effectiveness and therefore we have identified the following needs based on our own experiences, and from discussions with Programme staff, analysis of the Steering Committee reports and email responses from those involved with the Programme in various capacities. From the perspective of the reviewers, the most important needs are to:

Take account of mixing - There are spawning areas in the Mediterranean Sea and the Gulf of Mexico. Fisheries are managed as Eastern and Western Management units, but fish from both spawning areas mix. There is a risk of unknowingly overfishing if mixing is ignored.

Address gaps in Eastern Atlantic bluefin tuna fisheries data- The fishery in the Mediterranean Sea changed in the late 1900s - early 2000s with the advent of purse seining and fish farming. Catches were under-reported and biological samples of length frequencies are limited during this period. Catch reporting has improved, but missing or limited data from this period hinders scientific advice and management and therefore the time series of catches either needs to be populated from other data sources or an estimated time series agreed based on the best available information.

Develop a reliable measure of abundance for the Eastern Atlantic - Most of the catch from the Mediterranean Sea is by purse seine fishing, for which standardisation of catch per unit effort (CPUE) is notoriously difficult. CPUE indices based on fish trap data are useful, but they have limitations. Without a reliable abundance measure(s), fishery management (especially setting TACs) may be unreliable.

Enhance understanding of the carrying capacity for Eastern and Western Atlantic - There are two competing hypotheses about the carrying capacity of the Western Atlantic management unit (referred to as the high and low recruitment scenarios). Similar uncertainty about the Eastern Atlantic management unit has been reflected in recent SCRS reports. This uncertainty impedes the Commission's ability to determine the status of stocks (are they overfished or not?) and the ability to project the long term outlook for the fishery.

1.3.1 Performance relative to scientific needs

The GBYP has successfully advanced methods for determining the stock origin (eastern or western spawning grounds) of bluefin tuna found throughout the Atlantic Ocean. It has retrieved data that give a historical perspective (including ancient history) on fisheries and improved some time series of data that are used in stock assessments. Model development is going well such that it is reasonable to expect mixed spawning stock BFT fisheries advice in the future (thus addressing need 1 on mixing). Modelling can and should be used to guide future research priorities and to quantify data collection priorities and requirements (i.e. inform costs and organisation), in this way modelling exercises should be conducted before any expensive future activities as the modelling exercises can be much cheaper and can provide advice as to what data are actually needed and may prevent the collection of data that is of no practical use. Successful modelling justifies the GBYP and the potential for transitioning the models into operational data collection streams to support future scientific advice and management is reason enough for continuing the programme.

Progress has also been made addressing the other three scientific needs given above. However, the future direction of the Programme with respect to measures of abundance is challenging and role of tagging is unclear and challenging.

The GBYP has made a considerable investment in the development of fishery independent indices because fishery dependent indices of abundance have well known limitations and weaknesses. Most of the investment has been in aerial surveys, but larval surveys (which are used for the Western Atlantic) are being considered. Recently, close kin mark and recapture analysis (CKMR) has been under consideration.

While aerial surveys have been used successfully for some populations, they have been problematic for Eastern Atlantic bluefin tuna. There are logistic problems because of the spatial scale of the surveys, exacerbated by geopolitical complexity and instability (e.g. military conflicts) for some areas where Bluefin tuna are found. It may not be feasible to adequately standardize and calibrate surveys such that they provide reliable results with sufficient statistical power to detect meaningful changes in abundance. As a result the future of aerial surveys is in doubt.

If not aerial surveys, then what method(s) should be used to enhance abundance measures in the East? Larval surveys will have some of the logistic difficulties of aerial surveys, and they have additional limitations (e.g. variable egg and larval survival). CKMR is potentially a useful approach, but having multiple spawning stocks and spawning areas makes the method more difficult and expensive, though results suggest that CKMR can accommodate the multiple stock and spawning area hypotheses more so then aerial or larval surveys. Cost wise CKMR may not be more costly than an adequately sizes aerial survey or conventional tagging programme. The costs of data collection and sampling can be spread over several years to reduce the cost of the programme,

However, there are advances in technology that are encouraging. Tagging (discussed below) is another method with the potential for estimating abundance, but it does not look like it will work in this case. Conventional tagging has been discontinued. So far, there has been little or no effort to develop a relative abundance index (CPUE) for purse fishing. Given the difficulty with fishery independent methods, purse seine CPUE may merit further consideration. While it will be difficult to develop a CPUE index for purse seiners, the need is great and there is an unprecedented amount of new data from observer programmes that might allow a breakthrough.

The bottom line is that a measure of abundance of Eastern Atlantic bluefin tuna is needed. It is time (i.e., during phase 6) to decide on the approach with the greatest likelihood of success and to apply enough effort and resources to make it work. Our judgement is that (1) aerial surveys focused on known areas of consistent spawning concentrations (similar to the initial design of aerial surveys) with as much standardization and inter-calibration as possible or (2) CKMR, are the best candidates.

Tagging has been the most expensive component of the GBYP. It has the potential to provide several types of important information (as discussed above), but most of this potential is unlikely to be realised because of the low recovery rate and unknown reporting rate for tags (NB: it has not been possible to implement a data collection programme that would allow for estimating reporting rates) and the difficulties the Programme encountered in estimating the rate. Some other types of information can be obtained from other components of the GBYP.

It is time to rethink tagging to clarify objectives in terms inputs to scientific advice for management, taking account of costs and alternative ways of obtaining comparable information. As noted, conventional tagging has already been discontinued, but electronic tagging also needs to be critically evaluated in terms of expected contributions to scientific advice, cost and alternatives. Future tagging should be evaluated using the models being developed by the Programme.

Funds now budgeted for tagging could be redirect to CKMR analyses (NB: commenced in Phase 5) or to supplement aerial survey efforts to improve their likelihood of success.

Probable under reporting of catches from the Mediterranean Sea during the early years of purse seining for fish farming (late 1990s-mid 2000s) remains a problem for stock assessments and scientific advice. In addition, data on the size composition of catches is limited. Data mining has recovered, and probably will recover, some information on size composition. However, little progress has been made quantifying the magnitude of under reporting. There may be information in market data, but so far the GBYP has chosen not to pursue this approach but due to the potential value of these data we would recommend that the GBYP investigate the analysis of market and auction data for this purpose. We are aware of sensitivities about using market data to address potential under reporting, but from a scientific point of view, we are not aware of reasons not to use it to better address this problem. To date, Eastern Atlantic bluefin tuna assessments have addressed likely under reporting as sensitivity analysis to indicate the robustness of advice. Advances in modelling should allow more comprehensive and reliable robustness trials in the future.

While we understand that catch reporting for the Mediterranean Sea has greatly improved in recent years, information on the size composition of the catch remains an issue. Stereoscopic video camera systems (SVCS) are used to count and measure fish when they are transferred from purse seine fisheries into fish farms. SVCS data is potentially valuable (necessary unless there is an alternative source of data) for stock assessments and scientific advice. We expect the counts to be reasonably accurate. However, the reliability of the size data needs to be critically evaluated under the range of situations that occur in the fishery. If the data are reliable, protocols need to be developed for processing of images and delivery of data in a timely manner for input to stock assessments. We do not know if this work is the GBYP's responsibility, but it is recommended that ICCAT (within or outside of the GBYP) should verify the reliability of these data and assure it is available for scientific purposes.

The GBYP could provide estimates on carrying capacity. Data mining could provide evidence about the abundance of bluefin tuna prior to industrial fishing (particularly for the Mediterranean Sea). Evidence already exists, from one fish trap relative abundance index extending back to the 1500s. Such information is highly relevant to the carrying capacity. It is recommended that modelling (e.g. through MSE and development of operating models) should also be used to design more robust fishery management strategies in the face of uncertainty about carrying capacity. Thus, although the GBYP does not have programme components that directly address the issue of carrying capacity, it has the potential to produce useful information.

A potentially important consideration about the past, present and future carrying capacity of Atlantic bluefin tuna is spawning outside of the two well documented spawning areas in the Mediterranean Sea and the Gulf of Mexico. An opportunistic plankton survey off the northeast continental shelf of North America discovered bluefin tuna larvae in concentrations comparable to the known spawning ground of the Gulf of Mexico. The spawning stock origin of the larvae is unknown. Bluefin tuna of both Eastern and Western Atlantic origin are known to be in the area where the larvae were found. It is also possible that the larvae are genetically different from fish of either Mediterranean Sea or Gulf of Mexico origin. In addition to stock origin, it is also important to know if spawning off the northeast continental shelf of North America is a consistent (annual) or occasional event. It is recommended at this time that this should be considered by the SC and appropriate methods to collect spawning data in this area determined.

It is also noteworthy that some of the highest catches in the history of fishing for Atlantic bluefin tuna occurred off Brazil in the 1960s. The spawning stock origin of these fish is unknown although they were from what's now designated as the Western Atlantic management unit. There are reports or speculation (we are not clear which it is) about other spawning activity outside of the two well documented spawning grounds. It seems appropriate for the GBYP to consider options for investigating alternative spawning areas to determine their significance and implications for management. For historic events (e.g. fishery off Brazil), data mining might be an option. Are there archived plankton samples or museum specimens that might be informative?

1.3.2 Programme Coordination

Coordination of a programme as large and complex as the GBYP is challenging. Proposal preparation, contract management, logistics for some field programs (e.g. aerial surveys) and reporting result in large Secretariat workload (for both GBYP funded staff and other Secretariat staff). Fortunately, it seems to be coping well. A more serious management challenge concerns budget uncertainty. Most funding for the Programme is year to year. With yearly budget decisions near the beginning of the year, it is sometimes difficult to issue contracts for field work (mostly in the summer) in a timely manner. Multiyear planning is also difficult unless there is a realistic multiyear budget outlook. The problem of multiyear planning is exacerbated by instability in advice from the Steering Committee. Another problem is coordination of efforts between the Eastern and Western Atlantic.

We realize that some of these programme coordination issues are beyond the control of the GBYP. One aspect of programme coordination that is within the control of the GBYP is the Steering Committee. Our concern is that Steering Committee guidance for the programme is sometimes vague, inconsistent or piecemeal. Given the size and complexity of the Programme, we believe a larger Steering Committee with more external scientists is merited. This mirrors the recommendation of the SC though this has not been approved by the Commission. The Committee should meet more regularly (perhaps some meeting via internet conference). It should be provided with background documents in advance of meetings to prepare it to make decisions, and it needs to strive for explicit decisions that are well documented. In this way discussions could be effectively facilitated and clear decisions made that are able to be justified with available evidence. This will mean work for the Secretariat, but we believe it is necessary. The role of the Steering Committee relative to SCRS, the Bluefin Species Group and the Secretariat also needs to be clarified.

1.3.3 Implications of Programme Success

We have a closing thought about the implications of the GBYP's success. With the Programme's success, the Commission should anticipate advice on management of mixed stock fisheries. If mixing is ignored, there is a risk of unknowingly overfishing one or the other stock. One approach to avoid this risk is to restrict fishing to spawning grounds during spawning seasons when mixing is likely to be minimal. However, this approach is unlikely to be acceptable for many reasons. Another approach is to use mixing models to take account of the stock composition of catch by area, season and fishing method, and to allocate portions of the TAC accordingly. This approach will be challenging for the Commission, because inevitably, it will require rethinking current allocations by CPCs for fishing east and west of the current stock boundary. There are alternative approaches, but they will probably require forgoing some potential catch to prevent one other of the spawning stocks from being overfished. It is not too soon for a dialogue among managers and with scientists about the implications of the GBYP successfully addressing question mixing amongst the different spawning stocks of BFT.

2 Background

2.1 Background to the Review

A previous External Peer Review of the Programme was conducted in 2013 (Fonteneau, Suzuki, and Payne, 2014). It made 27 recommendations for the future direction of the Programme. Comments on the recommendations are in Annex 4 of the report of the GBYP Steering Committee meeting on 28-29 September 2013. Based on our review of the report and the comments, it is not clear to us that the 2013 review had much impact, although a number of recommendations have been implemented e.g. observers to collect catch and effort (Point 1)and catch at size data from all tuna farms (Point 3). Some are still in progress e.g. creation of a single database of electronic tag return information (Point 23), which is being completed slowly over time but requires data from all those tagging bluefin tuna with electronic tags. Some of these recommendations are repeated and strengthened here e.g. Close Kin study on BFT (Point 28) and the administrative functioning issues (Points 32-34) others are not such as the continuation on the aerial survey (Point 16) which was in 2013 seen as one of the bug successes of the programme. An earlier review of a programme plan for the GBYP was conducted under the auspices of the International Council for Exploration of the Sea (ICES, Sissenwine, 2011) in response to a request by the European Union. Among other things, the ICES review recommended research on otolith microchemistry for direct determination of stock origin of bluefin tuna and close kin genetics for population estimation. GBYP has successfully pursued the former and the latter is now under consideration.

This document is the report of the Second External Peer Review of the GBYP. A second review was recommended by the Commission in 2015 (full Terms of Reference can be found in Annex 2).

The Terms of Reference for the science element of the review are as follows:

- For each of the scientific component, review the progress made to date relative to the detailed objectives for that component.

- Review the appropriateness and adequacy of the design of various experiments and scientific studies, including their implementation and the results obtained to date.

- Suggest possible modifications or additions to each research component that may improve the accuracy, precision, robustness and / or cost-efficiency of the information being obtained.

- Provide guidance on the timeframe and resources required to complete remaining detailed objectives.

- Describe trade-offs between the need to complete current studies and any new studies of modified versions of current studies.

- Provide an overview of the interrelationships, priorities and reasonable timeframes to achieve detailed objectives of the various scientific components. Prioritization should be based on the relative contribution of each component to the improvement of the stock assessments the provision of management advice and the broad scientific knowledge on bluefin tuna.

The Terms of Reference for the coordination element of the review are as follows:

- Review the administrative and logisitic constraints that the programme has operated under and how these have affected the implementation of the research activities, their continutity and the ability of the GBYP to meet its primary objectives.

    - Link such constraints to the previous terms of reference and propose possible imporvements in the implementation, efficiency and the cost effectiveness of the work undertaken.

    - Provide comments on te current funding system for GBYP and suggestions for its improvement.

The reviewers approached the review independently based on their own perspectives on research and programme coordination. They were open minded about the possibility that they might not agree on all aspects of the review and that these differences would be identified in this report. The initial report outline included sections where they would give their individual perspectives. However, these sections were not necessary since the reviewers agreed on all major aspects of the report.

The total duration of the review was approximately two months (from the award of the contract to the report due date). This time constraint combined with the large amount of information to be considered limited the evaluation to a review of written documents primarily available on the ICCAT GBYP website and a three day site visit with the Secretariat staff responsible for the Programme. The Programme staff were available throughout the review, and they were very responsive to requests for documents and other sources of information. The reviewers also solicited input from other members of the ICCAT community associated with the Programme by e-mail or phone as described below. In addition, the reviewers brought decades of experience worldwide with scientific programmes of similar (or greater) scale and purpose to the GBYP to the review, as well as knowledge about of Atlantic bluefin tuna scientific and management issues based on ICCAT involvement through to around 2010.

The review considered previous Programme related documents and it compares the initial objectives established at the beginning of the Programme and if those objectives have been achieved so far (fully, partially or not completed). The reviewers have taken into account the results from the first five phases of the Programme that have already been conducted. This includes previous reviews including the mid-term review and associated reports, cost/benefit analyses (tagging programmes and aerial surveys) and other relevant documents. Any limitations or effects on the achievement of these objectives caused by reported budgetary and logistical constraints out of the control of the Programme have been noted and considered as part of the evaluation.

A single set of documents relating to GBYP has been collated by the two reviewers to ensure consistency and avoid repetition with additional documents provided during the programme review meeting held with the GBYP Programme staff at the ICCAT Secretariat in Madrid. A list of the references and documents examined during this study can be found in 0 In addition to the documents listed in the references, most of the documents posted on the GBYP website were consulted, although it was not possible to examine all of them in detail.

A structured email (see **Annex 6**) was sent to solicit views on the importance of the GBYP, its successes and disappointments, the future direction of the GBYP and how well it has been managed. It was sent to current and former members of the Programme Steering Committee and Programme funders. Upon request, some members of the ICCAT community were interviewed by phone. A list of the scientists consulted during the review, along with their contact details and summary of communications, is in **Annex 1** .

2.2 Constraints on the Review

The total contract duration was two months. This time limit constrained the review.

Contact with other members of the ICCAT community associated with the GBYP was limited due to time constraints. They only had a two week window to respond to the structured e-mail soliciting their input. It is recommended that future reviews include provisions (e.g. sufficient time) for scientists to present their own work and for a dialogue with funders and managers to be established. They are the experts on Atlantic bluefin tuna and are in the best place to recognise the short and long term needs for research to support management. The conclusions and recommendations in this report should be given serious consideration based on their merit, but the reviewers acknowledge that there are legitimate alternative perspectives, such that this report should not be treated as a rigid prescription or dictate.

2.3 Programme History

The ICCAT Atlantic-wide Research Programme for Bluefin Tuna (GBYP) was adopted by SCRS and endorsed by the Commission in 2008, after a long process. The Atlantic-wide research programme on bluefin tuna (GBYP) officially began in October 2009, with implementation of the programme starting in March 2010.The programme was created in response to repeated requests by the ICCAT scientific committee (SCRS) for a dedicated programme to improve the stock assessment and management advice. The SCRS noted that the Atlantic bluefin stock assessment suffered from lack of knowledge and reliable data on the biology and on fisheries and the absence of fishery independent measures of abundance, lead to a high degree of uncertainty. The main objective of the GBYP therefore was to improve knowledge and understanding of the Atlantic bluefin tuna (*Thunnus thynnus*) stocks and populations to improve stock assessments and management advice.

During the Commission Meeting in 2009, a number of Contracting Parties expressed a willingness to make extra-budgetary contributions to such a Programme. The Programme was initiated in March 2010. The three original Programme objectives were:

a) *Improve basic data collection* through data-mining (including information from traps, observers and VMS); developing methods to estimate sizes of fish caged; elaborating accurate CPUE indices for Mediterranean purse seine fleets; development of fisheries-independent abundance surveys and implementing a large scale experiment with congenital marks and genetic tags.

b) *Improve understanding of key biological and ecological processes* through electronic tagging experiments to determine habitat and migration routes; implementing a broad scale biological collection of samples from live tagged fish and dead landed fish (e.g. gonads, liver, otoliths, spines etc.); conducting histological analyses to determine bluefin tuna reproductive state and potential; biological; and genetics analyses to investigate mixing and population structure; and review predator-prey relationships.

c) *Enhance assessment models and provision of scientific advice on stock status* through improved modelling of key biological process (including growth and stock-recruitment); further developing of stock assessment models, including mixing between various areas; and developing and use of biologically realistic operating models for evaluation of management strategies.

The Programme was conceived as a multiyear effort to be conducted in six phases. Phase 5 was completed in February 2016. Funding has been provided for phase 6. Continuation of the Programme to 2021 is under consideration.

2.4 Programme staff and steering committee

The Scientific Steering Committee is composed of the General Secretary, SCRS Chair, Eastern and Western Bluefin tuna Rapporteurs, and one external (independent) scientist.

The programme is led within the ICCAT Secretariat by a Programme Coordinator (Antonio di Natale). The Programme Coordinator has been with the programme from the start, which has shown to be an important consistent element throughout all six phases and noted by a number scientists related to the programme. The Programme Coordinator is supported by an Assistant Programme Coordinator and a Data Expert. The Assistant Programme Coordinator Role was held by M'Hamed Idrissi between 2011 and 2014 and by Stasa Tensek (2015 to date). The Data Expert role was held by Ana Justel Rubio (2011-2013) and by Alfonso Pagá Garcia (2015 to date). The gaps in coverage of these two roles were due to funding issues for a year of the programme.

The Assistant Programme Coordinator is critical in supporting the Programme Coordinator. The number of tenders and contracts issued by GBYP during the six phases of the programme require a great deal of administration in terms of development and implementation, often in challenging circumstances e.g. the difficulties in implementing aerial surveys.

The Data Expert role has been shown to be critical in validating data sets on bluefin tuna particularly those related to the data mining and recovery. With the variety and volume of datasets related to Atlantic bluefin tuna, the role of Data Expert has been critical in ensuring the quality and availability of data to the Programme.

A Steering Committee (SC) consisting of the current SCRS Chair, the ICCAT Executive Secretary (or his/her Assistant), the two bluefin tuna rapporteurs and an external expert with substantial experience in similar research undertakings for other tuna RFMOs, was established t09o guide and refine the Programme as necessary The. GBYP Coordinator regularly consults the SC on Calls for Tenders. The Steering Committee is required to meet not less than once a year to review and usually meets annually and works between meetings by email. That SC is tasked to, review and refine the Programme activities and actions for prepare the budget for SCRS.

It should also be noted that ICCAT Secretariat staff additional to the GBYP staff above add scientific and technical expertise to the Programme. Secretariat staff revise all call for tenders and invitations; advertises the announcements; participate in evaluation panels and communication with bidders; prepare the contracts, plan activities; revise documents and reports; help developing databases and protocols, coordinate logistics of field work and prepare data for input to the scientific advice preparation process. ICCAT Secretariat staff are also available for the preparation of grant proposals for funding, manage contracts, organizes workshops and Steering Committee meetings, and prepare progress and completion reports etc.

2.5 Programme Components

Six programme elements were developed during the implementation of the Programme to address the three initial objectives (given above). These six programme components are:

- Coordination;
- Data Mining and Recovery;
- Aerial Surveys;
- Biological Studies;
- Modelling; and
- Tagging.

Objective (a) to *improve basic data collection* addressed through the data mining and recovery and aerial survey (now fishery independent indices) programme components along with genetic tagging aspects of the biological studies component.

Objective (b) to *improve understanding of key biological and ecological processes* is addressed through the tagging and biological studies programme components.

Objective (c) to enhance assessment models and provision of scientific advice on stock status is addressed through the modelling programme component with data provided by the data mining, biological studies, aerial survey and tagging components.

All the objectives are under-pinned by the programme coordination component.

2.6 Budget

The cumulative funding through the first 5 phases of the Programme (March 2010-February 2016) by component is shown in **Table 1**.

3 Analysis of Programme Components

Each of the Programme components is discussed relative to the appropriate task in the Terms of Reference. A strategic approach to addressing and analysing each of the programme components is presented here identifying how the components and objectives frame the requirements for each in terms of objectives and activities that have occurred. It should be noted that the strategic review by SCRS 2015-2020 will obviously go into more detail for the future but for the purposes of framing and our analysis of the existing programme we have presented a structured approach. NB: The requirement for such as structured (logical framework) approach is also a recommendation of this review (see Section 3.6.2) to better structure the needs and guide the SC in their recommendations.

3.1 Data mining and recovery

The data-mining component addresses the need to fill the gaps in the history of the Atlantic bluefin tuna fishery. The largest gap in the data series correspond to the IUU fishing related gaps in the Mediterranean Sea purse seine fishery. The probable under-reporting of catches from the Mediterranean Sea during the early years of purse seining for bluefin tuna farming (from the late 1990s to the mid-2000s) remains a significant problem for stock assessments and the provision of scientific advice with bluefin tuna data used in the assessments being officially classified as "unreliable" by the SCRS. Data on the size composition of catches is also limited for this period. This underlines the importance of data mining and recovery programme component.

Information from the trap fishing in the Mediterranean Sea was seen as a source of a potential CPUE index for the Eastern Atlantic bluefin tuna stock and one of the first activities conducted under this programme component was to hold a "Trap Symposium" at the start of GBYP in 2011[4] on the recommendation of SCRS to attempt to collate, review and standardise information from the trap fishery (including information from traps, observers and VMS). In addition, GBYP has sponsored other related workshops and data preparation meetings to help recover data to populate the time series.

Data mining has recovered, and will probably recover over time, more information on size composition but data from purse seine fisheries are scarce and data cannot be back-calculated form fish harvested from farms as the rates of growth of bluefin tuna from farms after fattening, are too uncertain to allow these data to be used in stock assessments. Market data have also been requested from the Japanese market to verify catch data and size frequency of wild-caught and farmed fish. Analysis of market data has, so far, been problematic, with many datasets holding data for grouped fish and different product types and presentations (e.g. gilled and gutted, headed gilled and gutted and fillets of a number of different grades), although some analyses have managed to estimate levels of under-reported in the Eastern bluefin tuna fisheries of up to 57% (Gagern, van den Bergh, and Sumaila 2013).

Wide-ranging datasets related to bluefin tuna have since been provided from universities to church archives (related to tax records) but many are difficult to read, recover and interpret, with a wide variety of quality between data sources. There have also been projects to extend indices of abundance from trap fisheries further back in time. Data mining could in this way provide evidence about the abundance of bluefin tuna prior to industrial fishing (particularly for the Mediterranean Sea). One trap index has now been extended back to 1525.

3.1.1 Review of appropriateness and adequacy

A summary of the objectives, the needs addressed, activities and a summary of the appropriateness and adequacy for the data mining and recovery component can be found in **Table 2**.The data mining and recovery component directly addresses the first objective of the GBYP through three areas of activity to "Improve basic data collection through data-mining (including information from traps, observers and vessel monitoring systems (VMS); developing methods to estimate sizes of fish caged; elaborating accurate CPUE indices for Mediterranean purse seine fleets…".

[4]https://www.iccat.int/Documents/CVSP/CV067_2012/Presentations/Session_05_Last_Day_Synthesis_&_Summary_for_04Sessions_BFT_Trap_Fisheries_Symposium/S5_01_Last_Day_Synthesis_&_Summary_DiNatale_&_Idrissi.pdf

Critically, when considering appropriateness and adequacy, data have not just been added to existing databases. Incoming data are checked to ensure quality and to prevent duplication. Where data are not reported by weight but are only reported as numbers of fish, these data are converted to a catch weight using all available average weight data. This is done through highly detailed and verified methods (Pagá Garcia *et al.* 2016).

3.1.1.1 Improve basic data collection through data-mining

The most appropriate and useful element of the data mining and recovery component has been the data mining related to the fisheries in the Mediterranean. The most successful aspect of this has been the recovery of data relating to the trap fisheries, with much less success in the larger purse seine fishery for which catch, effort and size frequency data are still limited. Although highly educational and valuable in terms of the history of the bluefin tuna fishery, the value of some these datasets in the development of operational stock assessments and management advice appears to be unclear and limited. This may be linked to the lack of a clear purpose and specific objectives for the programme and the data requirements for simulation modelling carried out before the programme. However, information on the historic abundance of bluefin tuna prior to intense fishing is relevant and appropriate to an understanding the carrying capacity of the stock (discussed later in the report).

Limited progress has been made quantifying the magnitude of under-reported catches. There may be valuable information available from market data, but the BFT species group were divided as to the use of this data and so far the GBYP has chosen not to pursue this approach. We understand there are sensitivities about using market data to estimate the degree of under reporting, but we are not aware of any scientific reason not to pursue this approach. It has proven useful in other fisheries. To date, Eastern Atlantic bluefin tuna assessments have addressed likely under reporting through sensitivity analysis to indicate of the robustness of advice. Advances in modelling should allow more comprehensive and reliable robustness trials in the future. This is potentially a valuable Programme contribution with respect to the need to address probable catch under-reporting and as data mining has proved quite a cost-effective methods for providing data it is recommended that a proposal for an exercise to attempt to recover these data is prepared.

3.1.1.2 Developing methods to estimate sizes of fish caged

The data mining programme component has been successful in providing data on bluefin tuna numbers, catch weight and sampling over the first five phases of the Programme and it is anticipated that it will continue to do so. During the first five phases of the Programme, records of the catch over 26 million individual bluefin tuna were made, relating to over 1.19 million tonnes and over 3 million individual samples (for length, weight or genetics) were recovered (GBYP Pers. Comm.) (Di Natale, Idrissi, and Justel Rubio 2013; Di Natale, Idrissi, and Justel Rubio 2014).

Data mining and recovery from market data has resulted in only a small highly verified dataset being available for analysis from what was potential a much larger dataset. Similarly outputs generated from purse seine operations have been shown to be based on a small highly biased (towards small fish) historical dataset. This has resulted in a possibility that there was a serious error in size composition inputs to recent Eastern Atlantic assessments. If nothing else the data recovery on this aspect has highlighted problems and gaps in the datasets required and where potential bias had been introduced into the models.

3.1.1.3 Elaborating accurate CPUE indices for Mediterranean purse seine fleets

The data mining and recovery component was also tasked with "elaborating accurate CPUE indices for Mediterranean purse seine fleets". This is a challenging task. So far, it seems little effort has been expended on developing a purse seine CPUE abundance index. This topic is much more complex than for many other gears (e.g. bottom trawls or longlines). Purse seiners only attempt to set on schools above a certain size and the majority of fishing time is spent searching for schools of bluefin tuna. A simple equation based on catch divided by the number of days fished will not represent a good indicator of population size (or density). The basic indicator of effort in terms of number of sets is also an inadequate measure of effort, since it will be directly proportional to landings and the level of fish caged for many purse seine operations. An appropriate measure of effort that is most meaningful will include both search time as well as actual fishing time, although this will need to be adjusted based on fleet operations with numbers of boats acting together to search with the catches being made by a smaller number of vessels within the fleet. The level of catch is also unlikely to be available due to misreporting during the period of concern.

3.1.2 Suggestions for possible modifications / additions

The main gaps that may still be filled using data mining and recovery concern potential under reporting of catch and under reporting of size frequencies during the early years of purse fishing to supply fish farms. These data are being sought within the Programme and if available should be validated and verified and added to the data for assessment. It is likely, given the problems with the CPUE indices described in section 3.1.1.3 that the true level of catch and effort, particularly from the Mediterranean purse seine fishery will never be available. It may not be possible or realistic to achieve. It is recommended that an agreed best estimate of the time series is developed along with appropriate confidence intervals. Where these data are required for analysis moving forwards then sensitivity analyses should be performed, until a point in time is reached where a good time series for the most recent years is available that the unknowns in the data have little or no effect on the model outputs.

Looking forward, data collection for a number of elements is shifting towards the CPCs to provide as standards rather than a GBYP responsibility to ensure collection. For example, once the setup and standardisation of the low-cost (to the programme and ICCAT) collection of accurate number and size frequency data from the stereoscopic video camera systems (as defined in ICCAT Recommendations 12-03 and 13-08) starts providing consistent data to the Programme from CPCs, this could provide comprehensive accurate size frequency data moving forward for purse seine fisheries that supply fish to farms. However, the validity of size data, data processing requirements and access to these data needs to be address if this technology is to fulfil its potential (see elaboration in the section 0 of this report). Apparently, responsibility for validation of stereoscopic video data and for making it accessible is not clear. We have no view on this organizational issue, but it is important that ICCAT as an institution assure that data is valid and accessible for both scientific and management purposes.

The SCRS 2015-2020 Strategic Plan[5] plans to list "specific data elements that are lacking for each stock over a 5-year span". It is recommended that any such data elements that are identified for GBYP within the strategic plan will need to be included in the appropriate areas of the GBYP or run in parallel to them although it should be likely that these have already been identified for GBYP and are in place to be collected.

The recommended focus for the overall Programme moving forward as stated is to move towards an operational approach for collection of data to management of the bluefin tuna fishery. It is recommended therefore that data mining and recovery continues to allow essential data to be provided where those data feed into the stock assessment models, but it is unlikely that any new additions will be made to this programme component.

3.1.3 Guidance on timeframe and resources

The period of the GBYP has been critical period for adding data to the time series to populate the stock assessment models. It will continue to be a critical period until operational models for the management of bluefin tuna are in place, with appropriate data collection procedures in place to meet the management needs.

It is recommended that where significant gaps still exists in recent history for data that feed into these models, e.g. size frequency of the catch, then these gaps should be prioritised. It is recommended that a lower priority should be given to the funding of further historical data recovery that do not feed into the provision of data for the operational management of the fishery.

3.1.4 Interrelationships, priorities and timeframes to achieve objectives relative to stock assessments, management advice and broad scientific knowledge

Data mining and recovery has the potential to provide data for the biological studies and modelling components. Where data sets have the potential to do this they may provide a cost-effective solution for data collection to fill gaps and allow other objectives to be achieved. Where data sets are available for the critical data relating to recent years these should be prioritised.

3.1.5 Trade-offs between need to complete current studies and modified studies

The data mining a recovery component of GBYP has only been small budget component at 4% of the total programme budget but recent historical data to fill the gaps have been important.

[5]http://www.iccat.int/Documents/SCRS/STRATEGIC-PLAN_EN.pdf

The biggest data gap has been the data for the early purse seine fishery for caging and investigations into recovery of data sets from this period should be continued along with ensuring the provision of accurate catch and effort data from all bluefin tuna fisheries looking forward.

There are few trade-offs necessary for this programme component as we recommend the continuation of current studies to continue time series of data that feed into current models.

3.2 Biological Studies

The biological studies component of GBYP addresses the second objective of the programme to "Improve understanding of key biological and ecological processes. This objective aims to provide a base level of knowledge on bluefin tuna through "a broad scale biological collection of samples from live tagged fish and dead landed fish (e.g. gonads, liver, otoliths, spines etc.); conducting histological analyses to determine bluefin tuna reproductive state and potential; biological and genetic analyses to investigate mixing and population structure; and review predator-prey relationships". A target of 12,000 fish to be sampled was set by the Commission in 2008. In 2011, a sampling design study was conducted (Abid *et al.* 2011) and while the initial objective of sampling 12,000 fish seems arbitrary (at least no statistical basis can be found), the design study that followed is probably sound.

3.2.1 Review of appropriateness and adequacy

The initial design of the Biological Studies component of the Programme served the following needs:

- Expand biological sampling of fisheries that was more representative of all fleets, fishing methods, areas and seasons with biological collection of samples from live tagged fish and dead landed fish (e.g. gonads, liver, otoliths, spines etc.);
- Develop and improve basic inputs to current assessments (e.g. size at age, weight at length, maturity and reproductive data) including conducting histological analyses to determine bluefin tuna reproductive state and potential;
- Conduct biological and genetic analyses to investigate mixing and population structure and develop methods for determining the stock origin of samples collected from the fishery; and
- Review predator-prey relationships

These needs are addressed below and summarised in **Table 3**.

3.2.1.1 Expand biological sampling of fisheries

Undoubtedly biological sampling has been greatly expanded and gaps have been filled. Basic inputs to assessments have been greatly improved. Three methods for identifying the stock origin of fish have been shown to be reasonably precise and reliable. In this regard, the design of the biological studies component of the GBYP was adequate and appropriate for the research oriented phases of the Programme. In order to meet any future criteria for appropriateness and adequacy to feed into on ongoing operational model, we would recommend clear identification of the requirements for biological data collection needs to be made, alongside a standardisation of data collection, storage and analysis, with adequacy defined as an identification of what would constitute sufficient data in terms of quality and quantity to provide the relationships and data to populate the stock assessment and any other models.

3.2.1.2 Develop and improve basic inputs to current stock assessments

Basic biological data have been collected to provide data and relationships that are used in stock assessment models such as a clear understanding of the length-weight relationship (e.g. Cort *et al.* 2015) and biological samples of a variety of types have also been taken to contribute to determination of the age of bluefin tuna (e.g. Rodriguez-Marin *et al.* 2014; Rodriguez-Marin *et al.* 2015) and therefore contribute to the age component of age-length keys (ALK). By the close of phase 5 a total of 9183 fish had been sampled (76.53% of the 12,000 target). As a result, annual updated age-length keys (ALK) have been developed for use in assessments. **Figure 1** (SCRS 2015-040) compares the age-length function resulting from GBYP studies with previous functions. While the curves are similar, the potential to produce annual age-length keys in the future should allow assessments to realistically account for both within year and between year variability in growth. The "cohort slicing" methodology commonly used in ICCAT assessments does not reflect this variability.

Workshops have been conducted on biological sampling (2011), aging methods and to calibrate the age determinations. A manual for standardised biological sampling has been prepared so that comparisons can be made without concerns relating to different methods of data collection used between different sampling locations (Abid *et al.* 2011). There has been a clear level of organisation throughout GBYP in that there is a shared and centralised storage of samples and data (at AZTI), previously original GBYP samples had been stored in Miami (although technically still belonging to ICCAT).

Data collection targets for biological sampling from phase 5 onwards has on the recommendation of the SCRS and SC been stratified by age and area to ensure the correct level of coverage, and these have in most cases been met or exceeded. In no case was the collection rate less than 70% of the target.

While we understand that catch reporting for the Mediterranean Sea has greatly improved in recent years, information on the size composition of the catch remains an issue. Stereoscopic video camera systems (SVCS) are now used to monitor the transfer of purse seine caught fish into cages to both count and measure fish. ICCAT Recommendations 12-03[6] and 13-08[7] states that "*A programme using stereoscopical cameras systems or alternative techniques that provide the equivalent precision shall cover 100% of all cagings in order to refine the number and weight of the fish in each caging operation*". Normal cameras are also used but can only produce counts of numbers.

The stereoscopic video camera data are not only needed for compliance monitoring (i.e. monitoring catch against quota), but they are potentially valuable (required unless there is an alternative source of data) for estimates of numbers and size distribution (length and therefore weight) for scientific advice. The SC has noted that "These data are potentially highly informative for providing estimates of the size distribution of the purse seine catches". This technology has, if the video tapes can be analysed, the potential to provide an unprecedented amount of data on catches and length frequencies, across the whole purse seine / caging operation. A preliminary review of the stereoscopic camera data collected and submitted was completed and documented in(Ortiz, 2014). However, the reliability of the data for size composition and the algorithms for estimating size, need to be critically evaluated under the range of situations that occur in the fishery (e.g. the difference in the size of fish in Croatia). We are only aware of a limited amount of testing. If the data are reliable, standardised protocols need to be developed for processing of images and the delivery of data in a timely manner for input to stock assessments, which would need the agreement of industry as at the moment these data are fully confidential. This was confirmed by the SC in 2015 who stated "The SC considered that there was a critical need to develop detailed specification and protocols for the use of the stereoscopic camera systems, the analyses of the data obtained from these systems and the required data that should be provided with the submission of video tapes".

3.2.1.3 Conduct biological and genetic analyses to investigate mixing and population structure and develop methods for determining the stock origin of samples collected from the fishery

Good progress has been made throughout the GBYP to develop methods for identifying spawning stock origin of bluefin tuna with a number of methods to determine the spawning stock origin of bluefin tuna successfully developed during the period of the programme. The methods are based on three differing techniques genetic (historical samples, larvae and adults), otolith microchemistry and otolith shape e.g. (Fraile, Arrizabalaga, and Rooker 2015; Rooker *et al.* 2014).These methods are already yielding new insights about population structure and mixing. Otolith microchemistry has enabled over 1300 individuals to be assigned by natal origin and this work has enabled stock specific "age-length-stock origin" keys to be applied to biological samples from the catch to provide data inputs to age structured mixed stock fishery models for scientific advice on mixing. Analysis of otoliths through Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICPMS) has the potential to determine transit of individual bluefin tuna between ocean regions, and preliminary results indicate that barium was the most important discriminating element, and the overall discrimination capacity between the two water masses was of 78%. A combination of trace element and stable isotope analysis of bluefin tuna otoliths has also allowed the origin of adult fish back to their nursery grounds to be identified for some areas but a high degree of overlap exists. Discrimination between the nursery areas in western (Balearic Sea), central (Tyrrhenian Sea), and eastern (Levantine Sea) was 80 %, 73% and 85% respectively. If this technique can be developed further it could allow a better understanding of the relative contribution of various nursery grounds to the adult stock.

However, at least one important new issue has emerged in recent years. An opportunistic plankton survey off the northeast continental shelf of North America discovered bluefin tuna larvae in concentrations comparable to the known spawning ground of the Gulf of Mexico (Richardson *et al.* 2016). The spawning stock origin of the larvae

[6]https://www.iccat.int/Documents/Recs/compendiopdf-e/2012-03-e.pdf
[7]http://www.iccat.int/Documents/Recs/compendiopdf-e/2013-08-e.pdf

is unknown. Bluefin tuna of both Eastern and Western Atlantic origin are known occur in the area where the larvae were found. It is also possible that the larvae are genetically different from fish of both Mediterranean Sea and Gulf of Mexico origin. In addition to stock origin, it is also important to know if spawning off the northeast continental shelf of North America and in other areas (e.g. off Morocco) outside of the Mediterranean Sea and Gulf of Mexico spawning grounds are consistent (annual) or occasional events.

It is also noteworthy that some of the highest catches in the history of fishing for Atlantic bluefin tuna occurred of Brazil in the 1950s. The spawning stock origin of these fish is unknown. It seems appropriate for the GBYP to consider options for investigate alternative spawning areas to determine their significance and implications for management.

A need to better understand the reproductive parameters and behaviour of bluefin tuna (e.g. age at first maturity) has also been identified as a critical information need. These parameters are used in stock assessment for calculation of spawning stock biomass and substantial uncertainties are still associated with these estimates e.g. reproductive potential, spawning period duration etc. (e.g. Corriero, A. *et al.* 2003; Corriero A. *et al.* 2005). There are clear differences between the estimated age of maturity between the eastern and western stocks (the western stock being estimated to be higher although this is suggested to be an over-estimate (Richardson *et al.* 2016)) and there is evidence that a proportion of the mature spawning stock biomass may not spawn every year (i.e. skip spawning) (Secor 2007). The variation and range of the values used to populate stock assessment models must be clearly understood to ensure outputs of the models are the best possible.

Historic biological samples have also been uncovered as part of the data-mining and recovery. For example the discovery of documents relating to Turkish tuna traps at the University of Istanbul also revealed a large number of boxes of bluefin tuna bones including vertebrae from which genetic analysis has been able to be conducted showing some small differences to the current genetic make-up of the stocks but not to the degree of showing any genetic erosion that would lead us to believe the stock had at any time reached the critical levels of diversity that could lead to that state (Puncher *et al.* 2015).

The biological studies programme element has been appropriate and adequate in meeting the overall objective of "provide a base level of knowledge on bluefin tuna". Biological samples have been collected to allow bluefin tuna reproductive state and potential to be estimated. Otolith and genetic samples have been analysed through a variety of techniques to investigate mixing and population structure and origin. Techniques are relatively advanced but decisions on standardisation are needed.

3.2.1.4 Review predator-prey relationships

The proposed review of Atlantic bluefin tuna predator-prey relationships, does not appear to have been a priority activity and we cannot find any evidence of a review having been conducted under the GBYP or within the wider research community since the work of Chase (2002) and Newlands, Lutcavage, and Pitcher (2004). It is considered that this will not have any large scale implications on the success of the Programme.

3.2.2 Suggestions for possible modifications / additions

We recommend that biological studies evolve from a research mode to an operational mode to provide basic information on the age composition and stock origin of catches. This will require the design and development of an ongoing biological sampling programme (e.g. year after year reporting analogous to routine reporting on fisheries) to prepare inputs such as annual Age-Length-Stock (A-L-S) keys to mixed stock assessment models and fishery advice. As these keys are still being developed and populated with data it is recommended that they are updated and expanded annually for the next few years at least and if necessary this may need to continue as part of an annual cycle of data collection. Annual updates of the ALS keys annual would be useful in ensuring that years with strong and weak recruitment can be identified and the recruitment level estimated. The data collection programme should follow a statistical design that will result in estimates of age and stock composition with an adequate level of precision. Simulation testing to evaluate the level of precision and the impact of these inputs to assessments based on the precision of assessments need to be conducted. The design of a sampling scheme should be conducted in concert with the modelling component of the Programme and the development of an operating model.

The Steering Committee should decide if the review of predator-prey relationships is still a priority and decide if this should be included in any future work plans. At this point in time, it seems unlikely that trophic relationships will be included in the operating model and it is we think it is unlikely it will have a significant influence of management advice. This aspect of the biology of bluefin tuna could be removed from the GBYP and left to more academic research teams to investigate.

Clearly, information on size and age at maturity is necessary to calculate the size of spawning stocks, but this does not necessarily make it a priority for scientific advice for fisheries management. In essence, this information scales the spawning stock axis of a spawner-recruit (S-R) function. It might also help explain some of the variability. Scaling of the S-R function is important if some common assumptions about the function are made (e.g., about the slope at the origin or B_{MSY} relative to the biomass of an unfished stock). However, if S-R functions are derived empirically from estimates of stock size from the assessment, the advice should be robust to uncertainty in size at maturation, unless size at maturity changes with trend. While we are generally supportive of data collection to provide a reliable understanding of size at maturity, the specific priority and design of sampling for this purpose within the GBYP should be considered in the context of the operating model.

3.2.2.1 Expand biological sampling of fisheries

Continual data collection will be required to a standard to ensure ongoing requirements for operational model are met.

It is recommended that where possible low level cost-effective data collection by fishers and observers is introduced or expanded upon. Fishing vessels and farms are often reluctant to allow biological sampling to occur, but the basic set of biological parameters should be feasible (i.e. length, weight, sex, maturity) along with genetic and aging material (i.e. flesh samples and otoliths). This may be achieved by the observers in conjunction with vessels and farms themselves given appropriate training. We understand that collecting otoliths from farmed BFT is problematic as the current method of killing bluefin tuna on farms is by shotgun which leads to otoliths being destroyed, damaged or lost. However, these samples are important enough for scientists and industry to work together to design a sampling scheme that may fulfil scientific needs with minimal impact on businesses. Hopefully, a cooperative approach can overcome the problem of destroying otoliths renders it almost impossible to find them, without onerous regulations.

Identification of larvae, as an indicator of spawning events may require a series of ichthyoplankton surveys in candidate areas to help identify those areas. It is recommended that where possible ICCAT CPCs work with their respective fishing industries to identify when a fishing vessel is likely to be fishing in a particular candidate area and to provide them with the necessary plankton nets to conduct some sampling. This may not be of the level of scientific rigour that would be expected of a dedicated survey but with these large voids in understanding, any information will be very useful and may help future targeting of expensive dedicated surveys.

3.2.2.2 Improve basic inputs to current stock assessments

It is recommended that the best method for age determination and stock identification be identified and used throughout ICCAT. Methods for data collection should be standardised and disseminated (with training if required) across all ICCAT bluefin tuna fisheries (e.g. by individual CPC laboratories or shared facilities specializing in the specific method of processing). The standardisation of methods should also ensure that all data produced have both the required data and meta-data to identify and utilise the data appropriately. A short-term effort on the development of a standard and related training and dissemination will provide benefits in the long term. It is probably more appropriate though for an ongoing programme for preparing ALS keys to be conducted by individual CPCs with coordination by a group under the auspices of SCRS rather than continuing under a Secretariat office. This approach will ensure data collection protocols and standards are maintained, data will be maintained in a single central database allowing ease and speed of definition, aggregation and publications of ALS keys for the wider BFT community. The GBYP programme moving into an operational phase can facilitate this along with the actual aging process by collating and forwarding samples to specific establishments for aging. The EU Data Collection Framework (DCF)[8] that supports fisheries data collection by EU Member States might be a model for operationalising results of Biological Studies from the GBYP. To be successful, there would need to be a commitment from non-EU CPCs to fulfil an appropriate share of a sampling design and processing protocols agreed by ICCAT.

[8]http://ec.europa.eu/fisheries/cfp/fishing_rules/data_collection/index_en.htm

3.2.2.3 Methods for determining the spawning stock origin

It is recommended that otolith microchemistry approaches to identification of movements of bluefin tuna between regions and in particular identifying spawning stock origin and nursery grounds be continued to be elaborated for Atlantic bluefin tuna as these may prove very useful in understanding the movement of juvenile tuna. An analysis of the cost-benefit of these approaches should be considered. Similarly, it is recommended that SCRS determine the best method or combination of methods for genetic identification to be used within the Programme. There may be a similar trade-off to aging between cost and availability i.e. can all ICCAT parties conduct this research or is it more a data collection and standardisation exercise with samples provided to a central sampling facility where a decision on which samples need to be prioritised can be taken.

3.2.2.4 Predator-prey relationships

It is the recommendation of the reviewers, given our advice to move towards an operational management model that research of this type is not critical and could be pursued by more academic researchers outside GBYP.

3.2.3 Guidance on timeframe and resources

The transition from a research to an operations phase for biological data collection will take several years. As detailed above, a sampling scheme will need to be designed and arrangements will need to be made for processing of the various sample types. This will require assumptions about the past spatial distribution of fish of Mediterranean Sea and Gulf of Mexico origin and about past growth rates, but making these assumptions based on current A-L-S information should be an improvement over the implicit assumptions of current assessments.

Meanwhile, biological sampling of basic data (length, weight, sex maturity etc.) should continue into the future, with links to stock and age data to allow the provision of age-length-stock keys for input into the stock assessment models. A-L-S keys for stock assessments should provide yearly data once the data collection and analysis has commenced. Such keys should be applied as soon as they are available refining the keys as time progresses.

It is hard to estimate the cost of an operational programme to produce ALS keys before a sampling design, processing protocols and funding arrangements are decided. The cost of an operational programme will probably be greater than the Biological Studies component of the GBYP, but there may be synergies with current sampling activity of CPCs carried out to fulfil existing ICCAT obligations.

Low cost data collection where appropriate can be started immediately once data requirements and appropriate data collection forms (translated into the necessary languages) have been prepared. It should be noted that data collection need not wait for the decision on aging / genetic identification methods to be agreed, only that more and varied samples may need to be taken until such a point is reached.

It is recommended that the methods for age determination and genetic identification should be decided within one or two years after discussion within the bluefin species group, the Steering Committee and the GBYP programme staff.

3.2.4 Trade-offs between need to complete current studies and modified studies

Biological sampling should never end and the sampling programme will never be complete. In this view, more data equals a better (i.e. more accurate and precise) estimates of true biological and population parameters which may change over time. With the requirements for age-length-stock keys for the various stocks and sub-stocks possible samples will be required to meet the requirements of the models. However, since the initial objectives of the Biological Studies component of the GBYP have mostly been accomplished (e.g. relationships established), the trade-offs between completing current studies and transitioning successful research to the operational delivery of data for stock assessments should not be a concern.

The models themselves need to take account of the complex biology of bluefin tuna and will need to include the potential for multiple spawning areas and mixing of stocks. Although this will complicate current models and require modification, the nature of the number of potential spawning locations and mixing between Eastern and Western stocks will require it.

3.2.5 Interrelationships, priorities and timeframes to achieve objectives relative to stock assessments, management advice and broad scientific knowledge

The priority for biological studies should be to transition successful research into an operational programme to produce ALS keys as input to stock assessments and management advice. This transition will probably take several years, but it should be achieved within the time frame under consideration for extension of the GBYP (through 2021).

3.3 Aerial Survey / Fishery Independent Indices

This component of the Programme is intended to provide fishery independent indices of abundance. The aerial survey component of the Programme was initiated with a workshop to consider survey design and methodology. Since then, Mediterranean Sea surveys have been conducted in 2010, 2011, 2013, and 2015. However, the survey design has varied between years (in terms of sampling intensity and area sampled). **Figure 2** indicates the locations where aerial surveys have sighted bluefin tuna. The areas enclosed by red lines indicate the four common areas surveyed in all years. Most of the survey effort was within these areas.

A summary of the results from the four surveys is given in **Table 4**.

Note that the confidence intervals for abundance estimates all overlap (i.e., differences in estimates are not statistically significant) even though the estimates vary by more than a factor of 2. In a sense, it is reassuring that the differences in estimates are not statistically significant, because it seems very unlikely that population abundance could actually change so rapidly. Thus it is not surprising that power analyses indicated it will take many years to detect changes in population abundance using aerial surveys. These results confirm that aerial surveys are only potentially useful to indicate long term trends, not year to year changes.

An initial power analyses indicated that it is feasible to use aerial surveys to monitor relatively small changes (the order of 10%) over the course of several years (i.e., about 6). However, doing so depends on the degree of standardization of surveys and inter-calibration of survey aircraft and survey observers. As noted, the survey design has varied between years and at this point in time inter-calibration has not occurred, because of the large number of different spotters and planes that are used in any given year and the differences in estimates of school size and sighting efficiencies between the different spotters and planes are likely to be large and not correctable or able to be standardised without calibration. There is also concern that conducting inter-calibration studies may not be feasible and some members of the Steering Committee question the value of aerial surveys without inter-. In addition, the potential for reliably monitoring changes in abundance depends on the (a) degree of inter-annual variability in timing of spawning relative to the timing of surveys, (b) spatial distribution of fish particularly, if the distribution changes as a function of population size, and (c) behavioural factors such as time fish spend near the surface where they can be seen from aircraft.

In addition, there are serious logistic challenges with aerial surveys. For example, surveying some areas originally included in the survey design is not feasible because of security concerns in areas near military conflicts. There have also been problems obtaining authorisations to survey within the airspaces of some Mediterranean CPCs, sometimes causing delays that adversely impact field programmes. In light of some or all of these concerns, the fifth aerial survey of the Mediterranean Sea in 2016 was cancelled.

A second power analysis and cost-benefit analysis, was conducted recently in phase 5 of the GBYP (See **Tabel 5**). The analysis is based on data from the four surveys conducted so far (i.e. 2010, 2011, 2013 and 2015). It is a sophisticated analysis that we believe provides a rigorous basis for evaluating the future potential of aerial surveys as a measure of bluefin tuna abundance in the Mediterranean Sea.

The second power analysis considers process error (caused by some of the factors discussed above) as well as sampling variability (which was considered in the first power analysis). In reality, aerial surveys (as are most research surveys of living marine resources) are considerably more uncertain than indicated by sampling error alone. Thus, the second power analysis is much less optimistic about the potential to monitor changes in abundance with aerial surveys, as indicated in **Table 5**.

The analysis indicates that there is a 22.3% chance of detecting a trend of 25% annual population increase with 10 years of surveying. However, in this analysis "detection" means estimating the trend with a 95% confidence interval that is entirely within 20% of the actual trend. 95% confidence is a demanding statistical criteria for detecting a trend. **Figure 3** Anon, 2016) is (presumably) also from the second power analysis (although not

presented in Cañadas and Ben Mhamed 2016). It is based on a less demanding detection criteria: 60% probability of detecting a change in abundance. It indicates that it will take almost 10 years to detect a change in abundance if the population growth rate is 0.25 and with a survey coefficient of variation (CV) of 0.40. A CV of 0.40 is probably as good as can be expected (the CV could be a lot worse) if all sources of variability (within and between surveys) are taken into account.

The second power analysis is accompanied by a cost analysis that indicates that the cost per distance surveyed is relatively low for GBYP aerial surveys. It also indicates the trade-off between the cost and precision for additional survey transect sampling within areas that have been covered by all four of the GBYP surveys. Increasing sampling quickly reaches a point of diminishing returns where additional cost results in a relatively small improvement in precision.

Given concerns about the viability of using aerial surveys for a fishery independent measure of abundance, some consideration is being given to ichthyoplankton (eggs and larvae) surveys as an alternative. A workshop on this matter is planned. This methodology has been applied in the Gulf of Mexico and the index is used in the Western Atlantic bluefin tuna assessment. However, there are difficulties with ichthyoplankton indices of abundance including timing of spawning relative to the timing of surveys, large inter-annual variability in egg and larval survival rates, and some logics problems that are similar to the problems faced by aerial surveys (e.g. security).

In addition to aerial survey efforts for the Mediterranean Sea, there is a separate aerial survey project for the Western Atlantic that uses underwater acoustic sensors on ship in association with aerial surveys to address the proportion of fish close enough to the surface to be detected.

The Aerial Survey component of the Programme is discussed below relative to its Terms of Reference:

3.3.1 Appropriateness and adequacy of the design

The design of aerial surveys has changed over the short period of the surveys in terms of the area covered and sampling intensity. This is understandable given the overall duration of the aerial surveys conducted and the difficulties encountered. The degree of standardisation and inter-calibration between spotters and aircraft that is required for the first power analysis to have been meaningful has not occurred. *Clearly, the design of the surveys that were actually conducted was not adequate or appropriate to address the need for fishery independent surveys of abundance* (See **Table 6**).

3.3.2 Possible modifications or additions to research to improve information obtained

If aerial surveys are to be resumed, there needs to be agreement on a survey design that will be rigorously applied. A key design consideration is the size of the areas to be surveyed.

The initial survey design concentrated survey effort in areas of known concentrations of spawning fish during the spawning season. Later, the survey design was expanded to cover a much larger area beyond these previously identified spawning areas. We refer to these two survey approaches as a focused approach and a broad area approach, respectively.

The advantage of a focused approach is that it is easier (in terms of cost and logistics) to conduct enough sampling to achieve a relatively small within survey CV. The focused approach is likely to have fewer logistic problems and standardization of methods.

The disadvantage of a focused approach is that there may be a high between survey variance (analogous to the process error considered in the phase 5 power analysis discussed above) as a result of inter-annual variability in the proportion of the population in the areas surveyed. Some of this inter-annual variability may be a result of environmentally related differences in the timing of spawning between years or behaviour (e.g. time fish spend close enough to the surface to be spotted). The amount of between survey variance cannot be estimated from individual surveys, but it can be estimated from a time series of surveys (e.g. the method described by Collie and Sissenwine 1983, uses Kalman filters, to address between survey variance) and an approach for this was conducted in recent aerial survey cost benefit analysis.

The advantage of a broad area approach is that some (but not all) of the between survey variance is captured within survey CV. The disadvantages are greater costs and logistic problems.

With a focused survey approach (where some of the population may be present outside of the survey area), the objective is an index to track trends in abundance. As discussed above, inter-annual variability in the proportion of fish in the survey area during the spawning season adds uncertainty (variance), but it does not necessarily affect the accuracy of the index in terms of tracking trends. However, if the spatial distribution of the fish is a function of population size, then the index will be inaccurate relative to population trends. For example, if fish become more concentrated in favourable spawning habitat which corresponds to the focused survey areas as population size decreases, and vice versa, the index will lag trends in abundance. The potential impact of alternative scenarios for a non-linear relationship between an aerial survey index and population abundance can be addressed within a management strategy evaluation (MSE) as a series of simulation scenarios (without data only subjective weighting) as part of the Modelling component of the GBYP. Ultimately it will be necessary to subjectively weight scenarios, but this is usually the case for stock assessment sensitivity analysis.

The results of the four surveys that have been conducted indicate that most bluefin tuna were in the areas of known concentrations (i.e., spawning grounds) during the spawning season (see **Figure 2**), although this partially reflects a concentration of sampling effort in these area. Nevertheless, this information supports the focused survey approach that was initially planned by the GBYP *if additional aerial surveys are to be conducted.* As a practical matter, the cost and logistic problems associated with a broad areas survey probably rule them out.

3.3.3 Guidance on timeframe and resources to complete objectives

The objective of a relative abundance index means that the time frame for aerial surveys is indefinite (i.e., surveys will need to be conducted routinely unless and until they are replaced by a better method for tracking population abundance). However, the most recent power analysis is pessimistic about the prospects for an aerial survey time series having enough power to detect trends with confidence, especially within the current time horizon under consideration for the GBYP (through 2021). Conducting additional focused aerial surveys during this period should contribute greatly to refining expectations about the long term value of aerial surveys. If it is decided to continue with aerial surveys until the end of the GBYP, then their cost effectiveness should be fully evaluated and a decision on whether they should be continued or not can be made. If they are assessed to be appropriate and costs effective then a continual operational programme may be justified. The funding level of the Aerial Survey component of the GBYP is probably sufficient for a focused aerial survey approach.

In the long term, surveys under an operational programme, could be conducted by CPCs according to a standardised plan agreed by the Commission in the form of an ICCAT Recommendation agreed by all CPCs rather than being organised and managed by the Secretariat under the GBYP. However, sharing responsibility for aerial surveys between CPCs will require a commitment to standardization and inter-calibration. The approach would be analogous to international bottom trawl surveys of the North Sea conducted by individual countries under the auspices of an international design developed by ICES, with European Union members receiving some financial support from the EU Data Collection Framework.

It is recommended that an evaluation of alternative fisheries independent surveys (as detailed below) to aerial surveillance is conducted before committing resources.

3.3.4 Trade-offs between the need to complete current studies and new or modified studies

The purpose of aerial surveys is to produce a much needed Eastern Atlantic bluefin tuna measure of abundance. If a decision was made not to continue with aerial surveys to produce this measure of abundance, this would potentially free up funds to develop an alternative abundance measure. Some alternatives are:

- **Ichthyoplankton surveys**- Such surveys are being considered. However, many of the challenges facing aerial surveys also apply to ichthyoplankton surveys. In addition, variability in the survival rate of eggs and larvae add uncertainty to abundance measures based on icthyoplankton surveys. Hauser and Sissenwine (1991) use simulation models to investigate this source of uncertainty.

- **Scientific fishing surveys**- Scientific longline surveys of large pelagic species (including tunas and sharks) were conducted off the east coast of the USA. Conceptually, such surveys are analogous to trawl surveys that are used worldwide to track abundance of demersal species.

- **Catch per unit effort**- CPUE is the most common measures of abundance used to assess large pelagic fish stocks (including bluefin tuna) worldwide. However, most CPUE indices are based on longline fishing. The dominant fishing method in the Mediterranean Sea is purse seining. Interpreting purse

seine CPUE is particularly difficult for many reasons, including ambiguity about the definition of fishing effort (e.g. how should search time be counted?). However, with unprecedented amounts data collected by observers on purse seiners, it might be possible to find a useful index of abundance.

- **Tagging**- Mark and recapture studies based on tagging data are widely used to estimate mortality rates and population size. There are many factors that bias estimates, but there are also well developed methods to taking account of these factors. Most methods requires estimating the rate of reporting of tag recaptures. However, Eastern Atlantic bluefin tuna tagging studies have not been able to collect the data that would allow for estimation of the reporting rate and tagging studies have been deemed to be unreliable for mortality rate and population size estimation (see discussion under tagging).

- **Close kin genetic analysis**- This is a form of mark and recapture study using natural genetic tags. It has been used successfully for Southern bluefin tuna. It is being considered for Atlantic bluefin tuna. Initial considerations indicate it will be more difficult for Atlantic bluefin tuna than for Southern bluefin tuna (see discussion under tagging), but advances in are encouraging.

So when it comes to trade-offs between continuing aerial surveys and developing an alternative method for measuring abundance, there are several possible alternatives, but it is not clear that any of them have a better chance of success. It is our judgment that close kin mark and recapture is the best candidate, but we believe more critical evaluation is needed before coming to a firm conclusion. The GBYP contract with the Australian scientists that pioneered the method for Southern bluefin tuna will be an important part of the critical evaluation that is needed.

3.3.5 Interrelationships, priorities and timeframes to achieve objectives relative to stock assessments, management advice and broad scientific knowledge

The GBYP should select the method for measuring abundance with the best chance of success and applying enough resources to demonstrate the reliability and usefulness of the method for stock assessments and management advice within the period under consideration for extension of the GBYP.

3.4 Tagging

This component of the Programme accounts for more than 40% of the budget and it is more than twice the cost of the next largest Programme component. The Programme has conducted tagging workshops, prepared a tagging manual, paid rewards for tag returns, and conducted a tag awareness campaign to encourage returns. About 18,000 fish have been tagged with conventional tags (about 45% double tagged).

Table 7 (obtained from the Secretariat) indicates the number tagged by area and type of tags. About 90% of the fish that have been tagged were juveniles. The recovery rate of conventional tags has been low (1.6% according to the Report to the EU on phase 5). In part, the low rate of returns reflects the large proportion of juveniles tagged since most of these fish were too small to be legally retained until recently growing to legal size. However, the low return rate probably also reflects an unknown but variable rate of reporting of fish that are recaptured. The trajectory of all tag returns in the ICCAT tagging data base (most were not tagged as part of the GBYP) is indicated in **Figure 4** (from the Report to the EU on phase 5).

Our understanding is that 234 satellite (reporting) electronic tags have been deployed by the GBYP (Righton *et al.* 2015). According to the Secretariat, the GBYP has also assembled an impressive database of records from 781 satellite (reporting) electronic tags (including the 234 GBYP tags), although most of the records were from fish that were not tagged by the Programme. It is attempting to obtain a substantial (the exact number is unknown, but it is probably around 450) number of additional records from other satellite electronic tagging programmes.

Tracks from satellite electronic tags applied by the GBYP in the Mediterranean Sea and the Eastern Atlantic are shown in **Figure 5** (from the Report to the EU on phase 5).

During Phase 5 of the GBYP, a cost-benefit analysis of the tagging component was conducted by Righton *et al.* (2015). It is a comprehensive review of the strengths and weaknesses of the tagging component of the GBYP. We think that the review conducted by CEFAS was excellent with a lot of information and insights about the tagging. The review credits the GBYP with tagging a large number of fish with conventional tags, developing a tagging manual and improving tagging methodology, fostering awareness of the tagging programme to enhance reporting of tag recoveries, assembling a large number of satellite electronic tag records, and developing a

modelling and assessment framework for analysis of tagging data. The latter was actually an accomplishment of the modelling component of the GBYP. The review by Righton *et al.* (2015) concludes that the cost per tag is reasonable or low relative to comparable tagging programmes.

We agree that the tagging component of the GBYP has been an impressive accomplishment, but from our point of view, we think the tagging component of the Programme should be evaluated in terms of its expected contribution to stock assessments and management advice. This is the perspective we apply in our discussion of the tagging component of the Programme relative to the Terms of Reference for this review.

Appropriateness and adequacy of the design

Tagging (of various types) can provide the following types of information:

- Estimates of population size and mortality rates;
- Information on fish movements for use in models of mixing;
- Data for fitting growth rate functions; and
- Behavioural information, such as time fish spend close enough to the sea surface to be spotted from an aircraft.

This list of uses for tagging data is consistent with the objectives of the tagging component of the GBYP given in the review by Righton *et al.* (2015). We discuss the appropriateness and adequacy of the design of the tagging component for each of these potentially valuable uses of tagging data. These needs are addressed below and summarised in **Table 8.**

3.4.1.1 Estimation of population size and mortality

We have not evaluated quantitative aspects of the tagging design (e.g. number of fish to be tagged, expected number of tag returns) in terms of the estimation of population size and mortality rates, but it is apparent that it is not appropriate or adequate. The main problem is that the tag return rate is very low and although the actual tag return rate is known the rate of reporting of recovered tags is unknown and probably highly variable between fisheries and years. Plans to conduct studies to estimate reporting rates were not able to be implemented and tagging data are not used in stock assessments for population size or mortality rate estimation. The targeted tagging of juvenile bluefin tuna has also been mentioned during the review as not the best focus of conventional tagging effort with the potential long interval until recapture and lack of effective returns being quoted as the two main reasons.

3.4.1.2 Information on fish movements for use in models of mixing

Tagging data from both conventional tagging and satellite electronic tagging can be used in mixing models as the basis for mixed stock fisheries advice. The review by Righton *et al.* (2015) describes modelling approaches that are available for using this data. The review points out that parameter estimates from conventional tag returns requires the assumption that the reporting rate is constant over time and the same for all fisheries that recovered tags. These assumptions are highly unlikely to be true. Other assumptions could be made, but they are no more likely to be true. Therefore, implementation of conventional tagging studies was inadequate and inappropriate for estimating parameters of mixing models. It is unclear if the design would have been adequate if studies to estimate reporting rates included in the design had been successfully conducted, but they were not.

Reporting rate is not an issue with using records from satellite electronic tags to estimate mixing parameters. However, it is unclear how many electronic tags will be necessary and when and where fish should be tagged to maximize the value of electronic tagging. Also, the stock origin of fish is usually unknown, and the current technology only allows fish to be tracked for about a year. The appropriateness and adequacy of design of electronic tagging should be evaluated within the modelling framework that will be used to estimate movement parameters of mixing models.

3.4.1.3 Growth rate functions

If the size of fish is recorded when fish are tagged and when they are recaptured, the difference in size indicates the fish's growth rate. Such data can and have been used to fit growth models so long as the tag returns cover a wide range of fish sizes and if recaptures in the purse seine fishery are recorded prior to caging. We doubt that the design of the tagging programme was optimized for estimating growth, but it is probably adequate for this purpose.

3.4.1.4 Behavioural information

Electronic tags provide a tremendous amount of behaviour information, including the amount of time bluefin tuna spend near the surface, such that they can be spotted from aircraft during aerial surveys and for understanding a component of uncertainty in aerial survey indices of abundance. **Figure 6** below indicates the amount of time (during day light) electronically tagged bluefin tuna spent within 5m of the surface.

These data are potentially valuable for understanding the amount of variability in aerial survey indices of abundance resulting from variability in the vertical distribution of fish but would require additional information. In this form the data provide no information as to whether they can explain the inter-annual variability in the survey estimates as there will also be inter-variability in the surfacing behaviour of bluefin tuna related to the environmental conditions during the survey.

In summary, the design and implementation of conventional tagging is adequate for fitting growth functions, but it is inadequate for estimating population size and mortality rates and is not useful for estimating parameters of mixed spawning stock models, although it might help to bound the range of parameters.

The design of electronic tagging is probably appropriate for estimating parameters of mixing models and to evaluate a behavioural source of uncertainty in aerial surveys. However, the adequacy of the design (in terms of sample size, the number of fish tagged, the spatial and seasonal distribution of tags and length of tracks and lack of knowledge of the stock origin of fish tagged) of electronic tagging is unknown and it should be assessed within the framework of the models that will use the data**.**

A summary of the appropriateness and adequacy of the tagging component can be found in **Table 8**.

Possible modifications or additions to research to improve information obtained

In light of difficulties encountered with aerial surveys and conventional tagging to estimate population size, the GBYP is now considering a novel type of tagging study that uses genetic natural tags to estimate population size. The method is known as close kin mark and recapture (CKMR) analysis and it has been successfully applied to Southern bluefin tuna. The method makes use of genetic technology that is analogous to a paternity test. Genetic samples are collected from spawning fish, and genetic samples for juveniles are tested to see if they are the offspring of any of the spawning fish that were sampled. The greater the number of matches, the lower the estimate of the size of the spawning population.

The targeted tagging of juvenile BFT was not possible to be implemented due to unexpected restrictions. This provided a gap in the programme that tagging was not able to fill.

3.4.2 Guidance on timeframe and resources to complete objectives

It now seems that tagging component of the GBYP will not be able to estimate population size or mortality rates from conventional tagging due to the low level and uneven level of tag returns.

Based on the discussion above, we have doubts about the benefits of more time and resources being spent on the conventional tagging component of the Programme. Our understanding is that this is the conclusion of the Steering Committee and the conventional tagging programme has been suspended.

3.4.3 Trade-offs between the need to complete current studies and new or modified studies

As noted, the tagging component of the GBYP is the most expensive single component. If current studies are not completed, we recommend that there should be more resources applied to transitioning biological studies into operations and where possible expanding them (e.g. to produce annual (?) ALS keys as inputs to future assessments and mixing models). The resources freed from tagging might also be invested in making aerial surveys successful and / or applying CKMR analysis to estimating population size.

3.4.4 Interrelationships, priorities and timeframes to achieve objectives relative to stock assessments, management advice and broad scientific knowledge

Conventional tag data is useful for growth rate models, but the biological studies component of the Programme provides an alternative source of growth rate information through otolith analysis.

As discussed above, we are pessimistic about achieving some of the objectives of the tagging component of the GBYP. Estimating population size and mortality rates seems unlikely. In the case of information on stock mixing relative to stock assessments and management advice, there are alternative sources of information as a result of successful studies carried out under the biological studies component. Growth rate information is also provided by results from the biological studies component. Behavioural information is potentially useful, but the need is unclear, especially if aerial surveys are not pursued in the future.

3.5 Modelling

Models have been used to integrate data in the preparation of scientific advice for management of bluefin tuna since the early years of ICCAT. However, the GBYP is advancing the development of relatively new modelling approaches for management strategy evaluation MSE). MSE is gaining popularity as the scientific basis for fishery management worldwide. A key part of MSE is the development of a so called “operating model” that reflects a broad range of plausible scenarios about how fishery systems (e.g. fish populations, fishing activity, fishery management procedures or rules) function. Operating models can be used to integrate large, complex and diverse types of information. They do not require scientists to decide between multiple competing hypotheses when there is insufficient data to reject any of the hypotheses.

MSE can be used to test options for managing fisheries that are robust to all of the uncertainty captured by the operating model. They can also be used to evaluate the value (in terms of fishery management performance) of various types and amounts of data.

The GBYP has supports a core modelling group, modelling meetings, a modelling coordinator and a modelling technical assistant. The modelling technical assistant is primarily developing an operating model for MSE. Support for the modelling coordinator has been terminated.

During phase 5 of the GBYP (according to the GBYP report to the EU on phase 5), a spatial, multi-stock statistical catch-at-length operating model (M3) was developed and a metadata summary was constructed to identify all sources of data that could be used to fit operating models for Atlantic bluefin tuna. The M3 operating model was simulation tested and conditioned on preliminary data to reveal possible model mis-specification and future data processing needs. The model was further updated for estimation. Trial specifications for numerous operating models have been described and a several management procedures MPs) have been tested in a preliminary MSE.

The short-term priorities (i.e. planned activities) for the modelling component of the GBYP (according to the GBYP report to the EU of activities through phase 5) are:

a) Obtaining new spatial, age-structured data, (e.g. stock of origin by age class, electronic tagging by age class, indices of spawning stock biomass by stock, and analyses to identify the correct fleet disaggregation (time and gear type));
b) Simulation test M3 operating model to identify coding errors, possible biases and correct weighting of various data sources;
c) Fitting the M3 model to data;
d) Finalizing Trial Specifications and carrying out alternative M3 model fits
e) Updating online tools; and
f) Assisting in experimental design of data collection programs (for instance, estimation of stock biomass using close-kin genetic tagging).

This is an ambitious set of priorities. We note the importance of priority (f). We think that much, if not most, of the components of the GBYP would benefit from their designs being optimized (in terms of their potential contribution to stock assessments and management advice) by simulation testing within the framework of an operating model.

An alternative modelling effort is being funded by the USA. It applies the MAST model (a multi-stock age structured tag integrated assessment model) developed by Taylor *et a*l. (2011). The model uses conventional and satellite electronic tagging data to estimate mixing parameters. However, the model assumes that reporting rates for recovered tags are constant over time, space and fleet. It is clear that this assumption is violated for conventional tags, thus compromising results from the model (Righton *et al*.. 2015). Perhaps this is one of the issues being addressed in the current USA modeling project.

It is unclear how these modelling efforts will be harmonized, and used for scientific advice to support fishery management. Multiple modelling efforts may be advantageous to test various approaches to see which one works best. Alternatively, model averaging is sometime used as a robust approach when no one models is clearly superior to all the others though care needs to be taken if a model averaging approach is taken to ensure that action is taken where necessary and potential problems are not ignored by the averaging process. However, it also makes sense to pool resources (intellectual as well as financial) to solve important, challenging problems like MSE for a complex fishery with complex stock dynamics.

This component of the Programme is discussed relative to its Terms of Reference Below:

3.5.1 Review of appropriateness and adequacy:

Our judgement is that the modelling components' emphasis on developing an operating model to support Management Strategy Evaluation is appropriate. The models that are being developed by the Programme are the vehicle for assimilating and integrating much of the data collected by other components of the Programme to advance stock assessments and mixed stock fishery management advice. The amount of value added by modelling is potentially immense, and without the modelling much of the potential value of the GBYP will be foregone (see **Table 9**).

In this sense the design of the modelling component of the Programme is adequate, but an even larger investment might be needed if modelling is to play the prominent role in the design of sampling strategies for other components of the Programme that it should.

3.5.2 Suggestions for possible modifications / additions:

We suggest better coordination and harmonisation of modelling activities funded through the Secretariat and the USA.

3.5.3 Guidance on timeframe and resources:

Good progress is being made such that management strategy evaluation to support mixed stock management should be available within the timeframe under consideration for extension of the GBYP, but not by the completion of phase 6. The modelling component of the Programme is relatively modest. It is important enough to receive a larger share of Programme funding based on the merits of technical proposals to advance and/or accelerate the modelling effort.

3.5.4 Trade-offs between need to complete current studies and modified studies:

We do not recommend any trade-offs relating to modelling. We agree with the short term priorities (a-f) given above.

3.5.5 Interrelationships, priorities and timeframes to achieve objectives relative to stock assessments, management advice and broad scientific knowledge:

As discussed above, we think the modelling component of the GBYP is on track to contribute to stock assessments and management advice over the next few years. The current planning horizon for the GBYP is realistic for the completion of management strategy evaluation of management procedure options to support mix stock

management of Atlantic bluefin tuna. There may be substantial interrelationships for the modelling component with a potential lack of data from aerial surveys, tagging studies and basic CPUE data to inform the models.

3.6 Coordination

At the start of the Programme the Programme Coordinator (Antonio di Natale) was appointed, joined in the second year by an Assistant Coordinator (M'Hamed Idrissi) and later that year by a Data Expert (Ana Justel Rubio). At the start of 2014, due to budget constraints (absence of EU funding) both the Assistant Coordinator and Data Expert roles were discontinued until mid-2015 when the roles were again filled with a new Assistant Coordinator (Stasa Tensek) and Data Expert (Alfonso Pagá Garcia). A summary of the programme staff over time is provided in **Table 10**.

The Programme is supported and guided by a Steering Committee (SC) , established in 2009, and consists of the ICCAT Executive Secretary, the Chair of the SCRS, the two bluefin tuna rapporteurs and an external member from outside the ICCAT membership. The SC Members are paid for by their own CPCs to contribute to the SC with the exception of the external member that is contracted through GBYP. A summary of the SC membership over time is provided in **Table 11**. Management plans for ICCAT species are initially determined by ICCAT CPCs at the Commission level, this feeds down to the scientific requirements developed by SCRS and down to the SC. Requirements for activities are defined by the SC and passed by the Secretariat to the SCRS for approval. Implementation of the activities defined is the responsibility of the GBYP programme staff at the Secretariat. This is a long process involving a number of different bodies and the necessary timescales to include them all effectively in the process reduces the effectiveness of the activities.

The composition of the SC was stable for the first four years of the programme based on **Table 11** with only one change but since 2014 a number of changes to the composition of the SC, with the exception of the ICCAT Executive Secretary and the external member have occurred. These changes in membership and in the actual composition of SC members at meetings (determined by their individual availability) or the response of SC members to requests for their opinions, appears with the changes in SCRS Chair and BFT rapporteurs to have led to number of changes over time in the priorities and direction of the research recommended by the SC for the GBYP.

The change in design of aerial surveys during the Programme and the decision to cancel a planned aerial survey illustrate our concern about the clarity and consistency of SC guidance. The suspension was based on concerns about the likelihood of success of aerial surveys, and a lack of resources for adequately funding all research components that the SC was recommending and a preference for concentrating resources on fewer elements rather than commit to inadequate coverage of a number of research elements. Information provided regarding the logistic constraints on the indicated that the survey would not be able to address some of the major issues (e.g. large process error, calibration, survey areas). The recommendation to resume the aerial survey was contingent on at least some of these being able to be addressed (e.g. calibration and survey area) but in fact this was not achievable.

There was however, strong external pressure from CPs to resume the aerial survey irrespective of the scientific merits based on the information and opinion provided by the Secretariat member of the SC. This changing of approach should be avoided and has been criticised as limiting the potential successes of the programme. Our major concern here is that the Steering Committee guidance to the Programme may sometimes become vague, inconsistent or piecemeal. Responses from SC Members and other individuals contacted have noted that the SC has a difficult position, having to perform complex planning decision making processes with detailed recommendations in a very short period in an *ad hoc* manner, and a method for making decisions more aligned to the requirements of the SC is required. The SC should be provided with the time and resources to perform their role and the request by the SC for a dedicated 2.5 day meeting appears reasonable.

Given the overall size and complexity of the Programme, we believe a larger steering committee with more external scientific input is merited. The SC is required to make rapid decisions on complex planning issues that require detailed recommendations. This process is not assisted by the funding cycle and its impacts on programme planning. A better process is needed. The SC should "meet" more regularly (perhaps meeting virtually over the Internet) and it needs to strive for well documented explicit and justified decisions responding to a structured programme approach.

In order to address the *ad hoc* and planning process that is regarded as not being ideally structured for a multi-year programme and requiring increased transparency, it is suggested that a structured logical framework (LOGFRAME) approach[9] (alternatively known as Goal Oriented Project Planning (GOPP) or Objectives Oriented Project Planning (OOPP)), or similar, is adopted for the Programme. This approach would introduce a structured approach with a defined purpose, goals, specific objectives and activities, each with objectively verifiable indicators to ensure all required aspects are considered. A structured framework allows progress to be indicated in a simpler manner and also allow the Programme Coordinator to provide accountability within the programme and to funders (i.e. ICCAT CPCs making voluntary contributions).

The overarching purpose of the GBYP would be clearly identified, with a number of clearly defined subsidiary goals which when met will achieve the purpose of the Programme. Each of these goals, will themselves have one or more specific objectives that will enable their achievement. Similarly, for each objective there would be a number of activities i.e. physical actions that can be assessed, evaluated and monitored

As an example a simple interpretation of the collection of biological material within a structured framework could be organised as follows:

Purpose:	Provide ICCAT Commission, SCRS and bluefin species group with best available information to enable effective stock management.	
Goal:	1.	To provide information on the biological parameters of Atlantic bluefin tuna updated on a regular basis.
Objectives	1.1	Collect length and weight data to update length-weight relationships.
	1.2	Collect otoliths and genetic samples from length-weight sampled fish to provide age-length-stock keys.
	1.3	Collect sex and maturity data to update L_{MAT50}, information on spawning location and timing.
Activities:	1.0.1	Define sampling strategy for biological parameters.
	1.1.1	Collect L-W data as defined in 1.0.1
	1.1.2	Update length-weight relationships (by stock / region where appropriate).
	1.2.1	Collect biological samples as defined in 1.0.1.
	1.2.2	Commission otolith aging and genetic analysis of samples collected.
	1.2.3	Update age-length-stock keys based on analysed data.
	1.3.1	Collect sex and maturity data as defined in 1.x.1.
	1.3.2	Update maturity ogives.
	1.3.3	Provide update on identified spawning locations and timings observed.

Here the collection of biological material addresses the goal "*To provide information on the biological parameters of Atlantic bluefin tuna updated on a regular basis*". Within this goal three example objectives are presented for length-weight (1.1), otolith and genetic sampling (1.2) and sex and maturity data collection (1.3).

Each objective has one or more activities related to it. For example for length-weight (1.1), there are two activities, 1.1.1 – "Collect L-W data" and 1.1.2 – "Update length-weight relationships (by stock / region where appropriate)".Each of the activities would have an indicator to indicate the activity has reach the required level.

[9] https://www.bond.org.uk/data/files/resources/49/The-logical-framework-approach-How-To-guide-December-2013.pdf

Indicators should follow the SMART methodology[10] for indicators to ensure they are correct in their definition and application.

Currently, the Programme Coordinator provides a monthly worksheet summary of the progress in implementing the workplan. The SC noted and the reviewers agree (SCRS/2014/194) that this has proved "highly valuable and such monthly reports should be maintained". It would be ideal to report in a structured manner on an objective and activity level as described above within such a report.

It is recommended that the role of the each of the groups and their responsibilities relative to each other needs to be clarified. This includes the GBYP itself, the Steering Committee, SCRS, the bluefin species group and the ICCAT Secretariat. The Steering Committee in particular has evolved since the creation of the GBYP and has adjusted its own priorities and functions to meet needs rather than having a clear direction and goal towards which it can "steer" the Programme.

3.6.1 Administrative and Logistic Constraints

The stability provided by having consistent Programme Coordinator throughout the Programme, now into its seventh year, cannot be underestimated. The experience of dealing with specific contractors and the large number of interested parties CPCs, NGOs and industry and maintained good relations with each is important. Having effectively implemented the tender process a number of times for programme activities such as the aerial surveys clearly increases the efficiency of the process and the cost effectiveness of the tendering and logistical aspects of the Programme.

Given the nature of the Programme being highly fragmented in terms of tendering and also the fishery itself, geographically, number of CPCs prosecuting the fishery and the high profile nature of the bluefin tuna fishery with NGOs, the size and composition of the Programme team within the Secretariat can be considered reasonable although additional short-term assistance may be required and is recommended at specific busy periods. The fragmented approach to tendering that has been observed occurs on both a physical and a time-related basis, i.e. one tender for design, a second for implementation and a third for analysis, and these tenders may need to be put out annually. The difficulties and constraints of this process has been noted by the reviewers and by a number of persons contacted during the review. Each phase will be tendered for separately with the results that three different organisations may conduct each phase within a single year. The lack of consistency in approach may limit the usefulness of results and increases the time taken to complete each individual topic.

Ideally, gaps in the staffing should not occur as this would add to the burden of other staff, with a minimal crossover in terms of time where staff are required to be replaced to ensure an effective handover of skills and experience. The gap in staffing highlighted in **Table 10** was caused by budgetary instability from the reduction in available funding for a year of the programme, and long-term funding options as recommended in section 3.6.3, would have insulated the programme from this sort of changes.

Severe logistical constraints exist to both the aerial surveys and tagging operations, also noting again that these are the two most expensive components of the programme. Programme staff have been involved in assisting the aerial survey and tagging contractors in obtaining the necessary permits to fly in the airspace of or conduct tagging operations in the waters of various ICCAT CPCs. For instance it was noted that problems exist in flying non-EU aircraft in EU airspace, though the tender opportunities put forward by ICCAT mean they must be open to all. It is noted that the Programme team were required to assist these activities on a 24/7 basis during the implementation phase.

[10] https://en.wikipedia.org/wiki/SMART_criteria

3.6.2 Possible improvements to implementation, efficiency and cost-effectiveness

Efficiency and cost-effectiveness could be increased within the Programme by allowing a level of increased independence from the Secretariat in terms of approval for budgetary expenditure (up to a reasonable maximum) to the Programme Coordinator or Assistant Programme Coordinator. While all administrative matters are a direct responsibility of the Executive Secretary, though the Executive Secretary may be able to delegate some of these to the Deputy Executive Secretary or for some to the Programme Coordinator. This may increase cost-effectiveness and efficiency with the programme and Secretariat.

Long-term contracts (multi-year) as detailed above would increase efficiency and cost-effectiveness for all contracted work. This is however, dependent on the introduction of longer-term guaranteed financial provisions, though the difficulties in implementing this are clear.

One of the two most expensive programme components as noted is tagging. The value and cost-effectiveness of the tagging programme as highlighted (see section3.4) is severely undermined by the tag return rate being so low due to the non-return of recovered tags by industry. The current planned tag awareness programme should therefore be given high priority and visibility wherever possible to ensure the money already spent on tagging is not wasted. This may provide a slightly better estimate of tag returns although details related to growth and migration would have been lost.

3.6.3 Institutional funding

The issue of institutional funding of the GBYP is critical for long-term planning and efficient and cost-effective implementation. The current system relies on a series of annually approved voluntary budget contributions from ICCAT CPCs. This annual system has created a management problem for the GBYP with activities that should ideally be managed and contracted on a multi-year basis (e.g. tagging, aerial surveillance and biological sampling) have been fragmented into multiple single year contracts. This could be compared to the more recent ICCAT Atlantic Ocean Tuna Tagging Programme (AOTTP) that has a longer-term budget funded as an External Action of the European Union (DCI-FOOD/2015/361-161), with other ICCAT CPCs and Contributors, allowing more freedom over planning and implementation.

The annual budget cycle has three significant impacts on the potential success of the GBYP. Firstly, there is the increased administrative requirement on the programme administration, as new tenders and contracts have been required to be raised, evaluated and awarded every year, and this work takes more time from the programme team that could be more effectively spent on other work. Secondly, each of these contracts, as they are issued annually are unlikely to be cost-effective compared to a multi-annual contract issued to one supplier. A single supplier would be able to develop a clear pattern of operation over a number of years, with consistent staff and experience and the capacity to negotiate critical elements such as port or airspace access which will enable them to be addressed quickly and effectively. Finally, a single contract issued to a single supplier over a multi-annual period would allow consistency of sampling or search effort (e.g. aerial surveillance from the same supplier with the same aircraft and possibly crew) allowing any estimates derived from the work to be more useful in management terms. This fragmentation of contracts has resulted in 62 individual calls for tender being issued, evaluated and awarded during the six phases of the Programme so far (See **Annex 5** for details).

The funding primarily rests with the voluntary grant from the EU that stands at approximately 80% of total funding with other voluntary contributions from other ICCAT CPCs and NGOs. (A full breakdown of contributions can be found in **Table 12** (by year) and **Table 13** (by phase)). The simple fact that these contributions are voluntary and may be stopped or reduced at any time by a CPC is of concern for the long-term sustainability of the programme. It is also within the current format of funding allocation, beyond the control of the major funder (EU) to issue multiyear grants. We would therefore recommend that alternative mechanisms such as those provided to AOTTP be investigated for funding of future GBYP activities.

The annual cycle of funding is also of concern and is described in **Figure 7.** The annual cycle of funding for a BFT year (February to February) starts in the previous July, when an informal indication of the EU contribution is released. In the weeks preceding the annual SCRS meeting the SC will meet either side of the WG (BFT) (September) to develop the components and specific activities that will require funding during the coming year to be formulated in the grant. This review of the focus of the GBYP creates additional work for the Programme Coordinator and team, redrafting the requirements programme every year in a very short period. These are then discussed and modified if necessary by the SCRS (October) and formally approved by the Commission (November). The cycle of funding makes it very difficult to plan activities for the following year whilst at the

same time establishing a budget estimate when the overall budget figure is not available at the earliest until the end of November. Strategic choices and decisions are then having to be taken to reduce or even remove certain activities from the plan for the following year. This appears to leave the Programme somewhat disjointed in direction between years.

A draft proposal for the grant from the EU is then submitted, which is then reviewed and feedback provided by the EU, with an official resubmission of the draft grant proposal (November). This is followed by approval by DG MARE typically in December.

Problems may arise where EU funding is not available such as in phase 3 of GBYP where EU funding was not available to GBYP and the contribution to the programme dropped. For a main purse seine fishing season that starts in June the administration to provide aerial surveillance for example will not start until the grant has been approved and received. This may not occur until April, which given an annual requirement to retender for services requires a six week (minimum) tender process (3 weeks for tenders to be received and 3 weeks for evaluation, selection and putting contracts in place). This will only leave 2-3 weeks once approved for the organisation of the implementation e.g. in the example of aerial surveys - training, approval for flight and airport permits (see section3.3) and deployment of aircraft and crew to the necessary locations. The tender process may also extend into August where tenders may still be sent out and responses received. It has been noted by the reviewers during this review, that this shortened tender process also potentially leads to inadequate responses to calls for tenders. Some possible respondents may not be able to respond in the time period allowed, others may not wish to commit to a single year, or there is a risk associated which results in increased costs in the response.

The programme funding cycle also, as noted by the Programme's own Steering Committee, makes it is "very difficult to properly plan the activities in the following year" and "…annual funding cycle of the programme has made the process of issuing call for tenders and awarding contracts difficult, especially in regards to timing contracts so as they can match the natural cycle of BFT and the seasonal cycle of its fisheries" (SC Report February, 2015). This was clear even after the first year of operation when the Steering Committee reported "Following the first year experience, it is clear that the programme could better work if proper ICCAT rules will be in place, to provide the necessary support from all the CPCs concerned…. a) A stable system to ensure the regular funding of the Atlantic-wide Research Programme for Bluefin Tuna (GBYP) should be adopted by STACFAD and forwarded to the ICCAT Commission, in order to avoid yearly incertitude, to support the regular follow-up of the programme and provide all CPCs concerned a methodology to calculate their voluntary contribution." (Di Natale, 2011). There is also a restriction on the "carry-over" of funds between years. In the event that due to the short-term planning cycle an event funded and planned cannot be implemented, these funds cannot be used to implement the same activity in the following year when the planning and implementation would be feasible. These funds will in all likelihood be lost to the Programme and will have to be requested from voluntary contributions again the next year when it is likely that the same set of problems may occur. This short-sighted planning leads to an inability to plan effectively into the future, without multi-year funding a number of significant contingencies would need to be put in place to successfully implement multi-year programme.

When a particular activity requires additional funding to meet the requirements of the Commission (e.g. the aerial survey for spawning aggregations), because this has not been able to be identified early enough (funding levels already established back in July) the lack of available funding may lead to the cancellation of the entire activity stream for that year. This leads to gaps in the time series of data collected, loss of experience from Programme and external staff (e.g. air crew). The SC also noted "some new domestic rules for providing funds abroad which are creating additional problems for activities similar to GBYP" which lead to them and the reviewers to recommend that the Commission considers long-term funding sources for GBYP.

The potential for funding outside the establishment mechanism i.e. grants from CPC, has been discussed within the SC at various times (i.e. from industry, private organisations, NGOs, etc.). This would provide a mechanism to ensure a certain level of funding could be held in reserve for periods where funds were not available through voluntary contributions to support critical elements of the Programme (e.g. GBYP programme staff, biological sampling (though not analysis) etc.).

Other options such as the proposal made by the SCRS Chair (2010), to have a special provision by ICCAT of a specific GBYP quota, that could be auctioned off to be used for funding the Programme have not been feasible or practical. Alternative funding opportunities should be investigated.

4 Discussion

The overall performance of the GBYP has been good. A tremendous amount of data has been collected as a result of new field programs and data recovery. A large number of fish have been tagged and an unprecedented collection of satellite electronic tagging records have been assembled. Ambitious aerial surveys (in terms of intensity and spatial coverage) have been undertaken. Biological parameters used in stock assessments have been improved (e.g., size at age) and pioneering methods for determining the spawning stock origin of Atlantic bluefin tuna have been developed and validated. Advanced modelling in support of Management Strategy Evaluation is underway. One piece of evidence of the good performance of the GBYP is its productivity in terms of reports and scientific publications. This productivity is summarised in **Table 14.**

The ICCAT scientific community and the ICCAT Secretariat, including the small hardworking GBYP staff, deserve credit for the Programme's good performance. The Commission and Programme donors also deserve credit for their recognition of the importance of long term investment in science to support sound conservation and management of a valuable and iconic living marine resource.

In terms of numerical objectives of the Programme (e.g., number of fish to be tagged, length samples to be collected, aerial surveys to be conducted), the Programme has generally fulfilled its objectives in spite of being funded at about 50% of the planned funding level.

Justification for the GBYP is provided in Commission and SCRS documents. However, we think it is useful to evaluate the Programme in terms of the scientific problems that need to be solved to improve management of Atlantic bluefin tuna. While the scientific problems are well known (especially by the ICCAT scientific community), we think it is useful to identify them explicitly as a framework for evaluating Programme effectiveness. From the perspective of the reviewers, the most important scientific needs concern:

1. Take mixing into account- There are major bluefin tuna spawning areas in the Mediterranean Sea and the Gulf of Mexico. Fish that spawn in these areas are known to be sufficiently reproductively isolated to constitute separate stocks for fishery management purposed. Since the early 1980s, bluefin tuna fisheries have been managed as Eastern and Western Management units with a stock boundary at 45 degrees west. However, it is clear that fish from both spawning stocks mix in many fishing areas and seasons. Taking account of this mixing is a major challenge for both scientists and managers. If it is ignored (which is more or less the current situation although SCRS often comments on its importance), there is a risk that one or the other stocks will be unknowingly overfished.

2. Address gaps in Eastern Atlantic bluefin tuna fisheries data- The fishery for bluefin tuna in the Mediterranean Sea changes dramatically in the late 1900s-early 2000s with the advent of purse seining and fish transfers to fish farms. Apparently, catches were under-reported and biological samples of length frequencies of catch are limited or missing during this period. We understand that catch reporting has improved, but missing or limited data hinders scientific advice and management. Furthermore, biological sampling is an ongoing concern. Scientific advice, particular on Total Allowable Catches (TACs), relies on these types of data.

3. Develop a reliable measure of abundance for the Eastern Atlantic- For fisheries for large pelagic species, like bluefin tuna, the most common measure of abundance world-wide is standardized longline catch per unit effort (CPUE). However, most of the catch from the Mediterranean Sea is by purse seine fishing, for which standardization of CPUE is notoriously difficult. CPUE indices based on fish trap data are useful, but they have limitations. A fishery independent survey of larval in the Gulf of Mexico has been used in assessments of the Western management unit, but there are no fishery independent indices for the Eastern management unit. Without a reliable abundance measure(s), fishery management (especially setting TACs) may be unreliable and overly dependent on intuition (or guesses) subject to political pressure.

4. Enhance understanding of the carrying capacity for Eastern and Western Atlantic - There is broad scientific agreement that bluefin tuna were much more abundant in the Western management area in the 1960 until the mid-1970s than they have been since. This situation has led to two competing hypotheses about the carrying capacity of the Western Atlantic management unit (referred to as the high and low recruitment scenarios). So far, SCRS has not been able to confirm or reject either hypothesis. Similar uncertainty about the Eastern Atlantic management unit has been reflected in recent SCRS reports. This uncertainty impedes the Commission's ability to determine the status of stocks (are they overfished or not?) and the ability to project the long term outlook for the fishery.

There are strategies for managing bluefin tuna fisheries without knowing carrying capacity, which might be why this topic receives minor attention in the GBYP. However, there are some components of the Programme that could contribute knowledge about carrying capacity.

There are many other topics worthy of research, but we consider these four topics are "grande" enough to merit the extraordinary expense and commitment necessary for the GBYP.

So, how well has the GBYP done relative to these needs? After discussing the performance of the GBYP relative to these identified needs, we comment on coordination of the GBYP and implications or the Programme's success.

Take Mixing into Account*:* This need is addressed primarily by the Biological Studies Component and the Modeling Component of the GBYP. The Data Mining Component and the Tagging Component also provides some useful data.

GBYP has successfully advanced methods for determining the stock origin (eastern or western spawning grounds) of bluefin tuna found throughout Atlantic Ocean. These direct stock identification methods include genetics, otolith microchemistry, and otolith shape. Combined with advances in methods to determine the age of fish, it is now feasible to prepare annual age-length-stock (A-L-S) keys to be applied to biological samples collected by season, area, fishery type (which could be defined by gear type, CPC or other factors), to estimate the age and stock origin of the catch.

In addition, conventional tagging and satellite electronic tagging from the Tagging Component provides information on mixing. The movements of tagged fish can be used to estimate the probability of a fish transiting from one area to another.

Information on mixing (from methods that determine stock origin or individual fish or tagging) is most useful when it is integrated in models from the Modeling Component that can be used to assess stocks and inform advice on management of mixed stock fisheries. Most models that are suitable for scientific advice on management of mixed stock fisheries partition the Atlantic distribution of bluefin tuna fisheries into spatial grids or boxes, as indicated in **Figure 8**.

Tagging data is used to estimate the probability of fish transiting between boxes. Two limitations of this data are that the spawning stock origin of the fish is usually unknown and that the estimates are inaccurate unless the probability of recovering a fish is equal for all areas and over time. This is unlikely to be true for conventional tags.

With direct determination of the stock origin of fish caught in each box, parameters of a spatial (by box) and temporal (by month or season) distribution matrix can be estimate. This requires representative sampling of the catch, which is also required for size distribution data even for assessment models that ignore mixing. The operating model that is being developed under the Modeling Component of the GBYP should be suitable to use both types of information on mixing.

Thus, the GBYP has conducted the research and is developing the models necessary to conduct mix stock assessments and give mix stock management advice in the future. It is our judgment that direct determination of stock identification is a more practical way of collecting information on mixing on an ongoing basis (indefinitely into the future). Doing so will require a representative sampling programme, which is also necessary for size information, so that annual A-L-S keys can be applied. While ongoing sampling of the fishery will be challenging, sampling lengths and tissues (e.g. otoliths or tissue samples for genetics) is done routinely for fisheries worldwide.

The same sampling programme should also be able to provide some of the biological samples needed for CKMR if such analyses are to be pursued, but these will need to be augmented as sample size requirements are likely greater than previous and also require sampling of a component of the population that is not currently a major component of the fishery.

Address gaps in Eastern Atlantic bluefin tuna fisheries data- This need is primarily addressed by the Data Mining and Recovery Component of the GBYP. The component has made some progress recovering length samples from the Eastern Atlantic fishery, which is a valuable contribution in terms of improving the accuracy of future stock assessments. It is recommended that market and auction data may be useful to better elucidate the magnitude of

under reporting of Eastern Atlantic catch during the early era of purse seining and fish farming in the Mediterranean Sea. This approach has been used for Southern bluefin tuna.. We understand that there are sensitivities about using market data to address potential under-reporting, but we are not aware of any scientific reason not to explore this approach. It has been useful in other for other fisheries. At this point (without new information that might come from market analyses), it appears that the best option is to consider missing catch data in sensitivity analyses within stock assessments to indicate the robustness of scientific advice (i.e. the current approach used in assessments).

We understand that the problem of under-reporting of catches has been addressed, but obtaining representative samples of the size composition of fish entering fish farms (a large portion of the catch from the Eastern Atlantic management unit) remains a challenge. Size information after grow-out (e.g., at the time of sale or from markets) will be hard to interpret because of variable growth rates in farms, but some data are available on the growth rates on a number of farms.

Stereoscopic video camera monitoring of the transfer of fish from purse seiners (actually from towing cages) to fish farms is now required in order to count fish and to estimate their sizes. This method was developed for Southern bluefin tuna farms in Australia, but doubts about its accuracy with respect to size estimates continue to delay its use. Limited testing has been conducted for Atlantic bluefin tuna entering fish farms in the Mediterranean Sea as indicated in
Figure 9.

These results are encouraging. However, we suspect that more testing over a wide range of conditions and situations is needed. If testing confirms that stereo video monitoring does produce data that are useful in stock assessments, arrangements need to be made so that images are processed and the results are routinely accessible for scientific purposes.

Develop a reliable measure of abundance for the Eastern Atlantic*:* This need is addressed by the Aerial Survey Component of the GBYP. The Tagging Component and the Data Mining Component also have the potential to address the need.

Fishery dependent indices of abundance have well known limitations and weaknesses. Reliable indices for purse seine fisheries are particularly difficult, and this is the most important fishing method for today's Eastern Atlantic bluefin tuna fishery. This is why GBYP has made a considerable investment in the development fishery independent indices. Most of investment has been in aerial surveys. However, a fifth aerial survey planned for 2016 (phase 6) was cancelled because of concerns about the viability of aerial surveys as a reliable measure of abundance.

There are several potential alternatives to aerial surveys including ichthyoplankton surveys, scientific fishing surveys (e.g. longline surveys), intense examination of observer data from purse seine fishing in search of a breakthrough in their use for CPUP an index of abundance, artificial tagging for mark and recapture analyses, and close kin mark and recapture analyses using genetic natural tags. All of these are discussed above. None of them should be entirely ruled out at this stage, but we are not optimistic about several of them.

With respect to aerial surveys, an important design consideration is the geographic scale of the surveys. One option is a narrow focus on known areas of consistent spawning. This approach allows more intense sampling within the survey area. However, there will be added variance because of inter-annual variability in the spatial distribution of bluefin tuna and the timing of spawning (and arrival on the spawning grounds where the surveys occur) relative to the timing of surveys. The other approach is to conduct broad area surveys covering as much of the Mediterranean Sea as practical. This approach should capture some of the variance resulting from inter-annual variability in spatial distributions and timing of spawning. However, the sample variance within surveys will probably be higher and board areas surveys are likely to be more challenging in terms of cost and logistics. Conceptually, we favour broad area surveys, but as a practical matter, they are probably not realistic. One advantage of focused surveys is that survey standardization and inter-calibration is more realistic (although still challenging) than for broad area surveys. Standardization and inter-calibration should offset some of the added variance that is inherent with focused surveys, but the degree of trade-off is unknown. In part it will depend on how well focused surveys can be standardized and inter-calibrated.

We realize that GBYP aerial survey design called for standardization and inter-calibration, but it has not occurred. We have heard that some knowledgeable people associated with the Programme do not think that standardization and inter-calibration is feasible because of the large number of spotters and aircraft necessary to survey the

Mediterranean Sea. If they are right, then we doubt aerial surveys will be reliable. However, we think that standardized and inter-calibrated is important enough to critically examine this view before abandoning aerial surveys.

Inter-calibration and standardization has implications for two different uses of the data. One is for comparisons between areas. Unless aircraft and spotters sampling different areas are inter-calibrated, comparisons between areas are not useful. However, if the same aircraft and spotters using standardized methods survey the same area year after year, comparisons between years for the area may be useful. Similarly, comparisons of annual surveys of the Mediterranean Sea, if each sub-area is surveyed using standardized methods and the same aircraft and spotters, may be useful for monitoring temporal trends. Inter-annual variability in the distribution fish will add variance, just as it does for almost all survey methods. If the goal is to monitor temporal trends for the whole Mediterranean Sea, rather than compare areas within the Sea, the challenge of inter-calibration and standardization for each team surveying portions of the Mediterranean Sea may be comparable to the challenge of standardization and inter-calibration of smaller aerial surveys, such as the southern bluefin tuna aerial survey of the South Australian Bight.

Table 15 below illustrates the potential for using surveys that are standardize and inter-calibrated within areas for monitoring temporal trends, even if inter-calibration between areas is not feasible.

Even with large differences between areas in (a) the probability of observing a BFT and (b) the proportion of the population in the area, the number of BFT observed by hypothetical surveys is proportional to total population size in numbers.

Mark and recapture studies using conventional tagging was intended to provide a measure of abundance, but this approach has not been successful and releases of tagged fish has been abandoned, recovery of tagged fish will continue as normal. However, mark and recapture estimates of population size and mortality rates using natural genetic tags (CKMR) is now being considered. The method has been applied successfully to Southern bluefin tuna (SBT). Results have an important influence on stock assessments (they are fully integrated into models) and management of the stock. Application of CKMR to Atlantic bluefin tuna will be more challenging because of the size of the population and the complexity of the stock structure. However, there have already been important advances in the methodology since the application to SBT, which should reduce the sample size that will be required for Atlantic bluefin tuna. It is reasonable to expect advances in technology to further reduce the cost of processing samples. If CKMR is pursued, it should be practical to obtain part of the genetic samples from the same sampling scheme that will be required for A-L-S keys and mixing models, though this may accrue additional costs.

The bottom line is that a measure of Eastern Atlantic bluefin tuna is needed. It is time (i.e., during phase 6) to decide on the approach with the greatest likelihood of success and to apply enough resources to make it work. Our judgement is that (1) aerial surveys focused on known areas of consistent spawning concentrations (similar to the initial design of aerial surveys) with as much standardization and inter-calibration as possible or (2) CKMR, are the best candidates.

In terms of trade-offs, the budget for tagging studies is the most likely source of funds for a renewed effort to measure abundance of bluefin tuna in the Eastern Atlantic. It is time to rethink electronic tagging to clarify objectives in terms inputs to scientific advice for management, taking account of costs and alternative (perhaps more cost effective) ways of obtaining comparable information.

Enhance understanding of the carrying capacity for Eastern and Western Atlantic*:* None of the Components of the GBYP were designed to address this need, but Data Mining, Biological Studies and Modelling Components have the potential to contribute useful information.

Data mining could provide evidence about the abundance of bluefin tuna prior to industrial fishing (particularly for the Mediterranean Sea). It already has for one fish trap relative abundance index extending back to the 1500s. Such information is highly relevant to the carrying capacity (e.g. how much more abundant might bluefin tuna be with light fishing pressure). Modelling might also be used to design more robust fishery management strategies in the face of uncertainty about carrying capacity. Thus, although the GBYP does not have programme components that directly address the issue of carrying capacity, it has the potential to produce useful information.

One aspect of uncertainty about carrying capacity is the unprecedented magnitude of the fishery of Brazil in the 1960. Catches off Brazil during the 1960s were the largest reported catches in the history of the fishery. Nothing like this fishery has occurred since, as indicated by the comparison of spatial distribution of catch in the 1960s to recent catches (see **Figure 10** and **Figure 11**).

Catches off Brazil in the 1960s came from the western Atlantic management unit of bluefin tuna (although Eastern and Western Atlantic management units were not created until the 1980s). Although these catches do not influence the assessment of the Western Atlantic bluefin tuna management unit because the assessment begins with data from the 1970s, they are relevant to the carrying capacity of the western Atlantic stock if the fish off Brazil were of Western Atlantic origin. However, the stock origin of these fish is unknown. They might have been of Eastern Atlantic origin or perhaps even genetically different from both known spawning stocks.

An opportunistic plankton survey off the northeast continental shelf of North America has further complicated the picture when it comes to spawning grounds and spawning stocks. It discovered bluefin tuna larvae in concentrations comparable to the known spawning ground of the Gulf of Mexico to be in the area, though it is not known if this is a consistent (annual) or occasional event. It is recommended at this time that this should be considered by the SC and appropriate methods to collect spawning data in this area determined. As these areas are outside the main fishing areas data collection may not be simple or may be expensive.

The mysteries of a large fishery off Brazil during the 1960s and of spawning off the Northeast continental shelf of North America are intriguing and they could be important from a management perspective, depending on the genetic origin of the fish and the persistence or frequency of spawning outside of the Gulf of Mexico and Mediterranean Sea. There are other historic references and speculation about spawning outside of the well document areas. It seems appropriate for the GBYP to consider options for investigate alternative spawning areas to determine their significance and implications for managing. Data mining might be an option. Are there archived plankton samples or museum specimens that might be informative?

Coordination: For a programme as large and complex as the GBYP, coordination is challenging. Proposal preparation, contract management, logistics for some field programmes (e.g. aerial surveys) and reporting result are large workloads for a small programme staff. We were impressed by their dedication and the thoughtful way they approach a heavy workload. Fortunately, they seem to be coping well.

A more serious management challenge concerns budget uncertainty. Most funding for the Programme is year to year. With yearly budget decisions near the beginning of the year, it is sometimes difficult to issue contracts for field work (mostly in the summer) in a timely manner. This year to year funding challenge has probably exacerbated logistic problems encountered with aerial surveys. We understand that the major funding organizations have internal controls that will not allow them to make multiyear funding commitments, but it should be possible to come to agreement with the GBYP on realistic budget planning horizons. The GBYP programme should also consider issuing calls for tender, contingent on availability of funds, in advance of final commitments by Programme funders.

Another factor that exacerbates multiyear planning is inconsistency in advice from the Steering Committee. We understand that changes in survey design between surveys were at least in part a response to evolving guidance from the Steering Committee based on the results of previous work. We are also concerned that Steering Committee guidance is sometimes too vague or piecemeal, and that the Steering Committee does not meet long enough or often enough for a programme as large and complex as the GBYP. The Steering Committee works by correspondence, but we understand that some members are simply too busy to devote enough time to all of the issues and problems that arise.

Coordination of effort between the Eastern and Western Atlantic is also a concern. There is the potential for redundancies or inconsistencies in aerial surveys, electronic tagging, modelling and close kin mark and recapture analyses.

Given the size and complexity of the Programme, we believe a larger steering committee with more external scientists is merited. The Committee should meet more regularly (perhaps some meeting via internet conference) and it needs to strive for well documented explicit decisions. A larger Steering Committee with more meeting time and communications between meetings should be able to improve coordination between Eastern and Western Atlantic GBYP activities, as well as enhancing planning and programme design in the Eastern Atlantic. The role of the Steering Committee relative to SCRS, the Bluefin Species Group and the Secretariat needs to be clarified.

Implication of the GBYP's success: With the Programme's success, the Commission should anticipate advice on management of mixed stock fisheries. If mixing is ignored (more or less the current situation although it is generally agreed that mixing occurs and SCRS sometimes comments on mixing implications), there is a risk of unknowingly overfishing one or the other or both stocks.

Mixed stock assessment models should be able to produce advice on the total allowable catch from each spawning stock (e.g. Eastern and Western) to prevent overfishing or rebuild stocks. Current stock assessments give such advice. The difference is that not all of the catch of the Eastern stock occurs in the Eastern management area, and similarly, not all of the catch from the Western stock occurs in the Western management area. The catch of each stock in the other management area needs to be considered in managing the stocks to avoid overfishing.

There are at least three general approaches:

1. Spawning ground fisheries: This approach restricts fishing to spawning grounds during spawning seasons. The available evidence is that mixing will be minimal if the fishery concentrates on spawners.

2. Optimal spatial and temporal design of fishing: The stock composition of the catch depends on when and where fishing occurs. The mixed stock fishery models that are being developed partition the Atlantic Ocean (including the Mediterranean Sea and Gulf of Mexico) into around 10 spatial grids (see **Figure 10** and **11** The stock composition of the catch from each grid area will probably vary by season or on an even finer temporal scale (e.g. monthly). The stock composition of the catch may also depend on the fishing method or the CPC conducting the fishing. Taking account of all of these factors that affect the stock composition of the catch, there will be an optimal allocation of catch by grid area, season, and other factors to maximize the catch from both stocks within the constraint of not overfishing either stock.

3. Forego potential yield from one stock to prevent overfishing of the other: This approach retains the current Eastern and Western management units (although the boundary between the units might be changed to improve separation of the stocks). The TAC for one or the other management area will have to be reduced, such that the total Atlantic wide catch will be less than it would be with either of the other two approaches, in order to prevent one or the other stock from being overfished.

The spawning ground fishery approach is conceptually simple, but it is unlikely to be acceptable for many reasons. The approach that applies an optimal spatial and temporal design is complex. It will require rethinking allocation protocols between CPCs and current management areas. We suspect that most Commissioners would dread the task of negotiating new allocation schemes that partition catch between CPCs, around 10 areas, seasons, and fishing methods. The approach of foregoing potential yield is relatively straightforward to implement from a management perspective. It remains to be seen if the amount of yield that is foregone is sufficient enough to merit a more complex approach. There may be additional approaches. It is not too soon for a dialogue among managers and with scientists about the implications of the GBYP successfully addressing mixing.

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Table 1. GBYP Budget Overview by Programme Component.

Component	Cumulative Amount (Euros)
Coordination	1,701,370 (18%)
Data Recovery	395,462 (4%)
Aerial Survey	1,619,624 (17%)
Tagging	4,021,643 (42%)
Biological Studies	1,460,983 (15%)
Modelling	358,247 (4%)
Total	9,557,329

Data Source: (GBYP Pers. Comm.)

Table 2. Data mining and recovery – Appropriateness and adequacy.

Objective	Need addressed	Activities relevant under this component (and timescale = phase 1-6)	Appropriate to need	Adequate to address need?	Gaps
Improve data and understanding of Atlantic bluefin tuna fisheries	Improve basic data collection through data-mining (including information from traps, observers and vessel monitoring systems (VMS));	Trap Symposium 2011	Yes. Attempt to fill gaps in CPUE through standard source of data.	Partial	Data gaps still exist from under-reported catches from purse seine fishery
		Market data analysis conducted to fill gaps in data (catch and size frequency	Yes (missing data not available and market data may be able to bridge a gap)	Partial	Data gaps still exist from under-reported catches from purse seine fishery.
		Basic data collection of 26 million individual bluefin tuna, records and over 3 million individual samples (for length, weight or genetics) recovered	Yes. Clear need for basic data to provide inputs to stock assessment and management models	Yes. Though regular updates to check parameters have not changed will need to be made.	Continual monitoring required.
		Incoming data are checked to ensure quality and to prevent duplication. Data are converted to a catch weight using all	Yes – Quality control is essential and also to avoid duplication.	Yes. Critical and shown to be working well.	Needs to be continued at current high standards for all new data.

Objective	Need addressed	Activities relevant under this component (and timescale = phase 1-6)	Appropriate to need	Adequate to address need?	Gaps
		available average weight data.			
		Historic catch data collected.	Yes - for estimating carrying capacity but not for more immediate need of populating a working model.	Possibly – Though utility for an operational model may not be so high.	
	Developing methods to estimate sizes of fish caged	Stereoscopic cameras now tested and 100% implemented.	Yes	Yes. Data is available to the BFT working group.	Provision of data to GBYP needs to be ensured by Secretariat as not GBYP's role to chase farms and CPCs.
	Elaborating accurate CPUE indices for Mediterranean purse seine fleets;	No clear progress has been made	No	No – Has not been possible so far.	CPUE not available. Models that are not reliant on CPUE data series may need to be used.

Table 3. Biological Studies – Appropriateness and adequacy.

Objective	**Need addressed**	**Activities relevant under this component (and timescale = phase 1-6)**	**Appropriate to need**	**Adequate to address need?**	**Gaps**
Improve understanding of key biological and ecological processes	Broad scale biological collection of samples from live tagged fish and dead landed fish (e.g. gonads, liver, otoliths, spines etc.)	A target of 12,000 fish to be sampled was set by the Commission in 2008. In 2011, a sampling design study was conducted (Abid *et al.* 2011) L-W relationship updated ALSK developed	Y - Expanded biological sampling to be representative of all fleets, fishing methods, areas and seasons. 12,000 fish seems arbitrary (at least no statistical basis can be found), the design study that followed is probably sound	Yes – Number, scope and data collected appear to be adequate. Basic inputs to assessments have been greatly improved. Data collection targets for biological sampling from phase 5 onwards has on the recommendation of the SCRS and SC been stratified by age and area to ensure the correct level of coverage	Continual data collection may be required to a standard to ensure ongoing requirements for operational model are met.
	Conduct histological analyses to determine bluefin tuna reproductive state and potential	Basic knowledge expanded but substantial uncertainties are still associated with these estimates e.g. reproductive potential, spawning period duration.	Partial – Still need more data on a stock origin basis	Partial – Mixing of stocks and possible new origins has increased the problem,	Mixing remains one of the critical and not clearly understood aspects of Atlantic bluefin tuna biology.
	Biological; and genetics analyses to investigate mixing and population structure	Develop methods for determining the stock origin of samples collected from the fishery.	Yes - methods to determine the spawning stock origin of bluefin tuna have been successfully developed.	Yes - But most cost-effective and accurate methods must be determined.	Increased sampling in cost effective manner to expand the understanding of population structure and mixing.

Objective	Need addressed	Activities relevant under this component (and timescale = phase 1-6)	Appropriate to need	Adequate to address need?	Gaps
	Review predator - prey relationships	No confirmed activities	n/a	No - No activities, though likely to be low priority.	Still to be completed.

Table 4. Assessment of bluefin tuna spawning aggregations in the four main areas ("inside"), after the revised calculation for the overlapping surfaces.

All sub-areas				
Year	**2010**	**2011**	**2013**	**2015**
Survey area (km^2)	265,627	209,416	265,627	265,627
Transect length (km)	29,967	26,247	14,862	12,046
Effective strip width x2 (km)	2.96	1.36	3.00	3.03
Area searched (km^2)	88,803	35,697	44,539	36,556
% coverage	33.4	17.0	16.8	13.8
Number of schools ON effort	76	65	52	24
Abundance of schools	328	420	397	147
%CV abundance of schools	23.3	20.6	22.0	33.0
Encounter rate of schools	0.0025	0.0025	0.0035	0.0020
%CV encounter rate				20.2
Density of schools (1000 km^{-2})	1.236	2.004	1.494	0.553
%CV density of schools	23.3	20.6	22.0	33.0
Mean weight (t)	87.9	101.1	52.5	272.2
%CV weight	1.7	2.8	1.8	41.4
Mean cluster size (animals)		1,275	582	1,548
%CV abundance		37.3	18.5	40.5
Density of animals (km^{-2})		**2.8363**	**0.789**	**1.556**
%CV density of animals		30.0	30.4	46.9
Total weight (t)	**26,882**	**45,639**	**17,818**	**70,256**
%CV total weight	25.6	28.7	30.1	49.4
L 95% CI total weight	14,243	26,133	9,902	26,420
U 95% CI total weight	38,347	79,703	32,061	186,820
Total abundance (animals)		**593,968**	**209,486**	**413,410**
%CV total abundance		30.0	30.4	46.9
L 95% CI total abundance		332,640	116,000	165,000
U 95% CI total abundance		1,060,600	378,330	1,035,800

Source: GBYP Scientific and Technical Final Report for Phase 5 (2016).

Table 5. Results of power analysis for aerial surveys.

No. of years	% annual change	Power to detect a trend $\beta \pm 0.2\beta$
10	+25	0.223
5	+25	0.087
3	+25	0.051
10	-25	0.18
5	-25	0.042
3	-25	0.032

Source: Cañadas and Ben Mhamed (2016).

Table 6. Aerial Survey – Appropriateness and adequacy.

Objective	Need addressed	Activities relevant under this component (and timescale = phase 1-6)	Appropriate to need	Adequate to address need?	Gaps
Development of fisheries-independent abundance surveys	Development of a reliable measure of abundance of bluefin tuna in the Eastern and Western Atlantic	Aerial surveys designed workshop conducted and survey methodology selected. Aerial surveys conducted in 2011, 2012, 2013, and 2015. Two power analyses conducted. Ichthyoplankton survey workshop planned.	No. A consistent survey design has not been maintained. Inter-calibration studies have not been conducted. . Power analyses are informative although the first was unrealistically optimistic. The second is pessimistic, but this is in part due to the high statistical standard chosen for detecting a trend. An ichthyoplankton workshop is appropriate, but we are not optimistic about the approach.	Partial – Some of the logistic challenges of conducting aerial surveys could not be anticipated. The aerial survey effort to date has been adequate in the sense that ICCAT now has a more realistic appreciation for these challenges and the limitations they put on the design of aerial surveys.	More rigorous or structured evaluation of the alternative survey designs (e.g., focused or broad area) and of alternative methods for measuring abundance.

Table 7. Summary of Atlantic bluefin tuna tagged (by type and location) during the GBYP.

	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.	% by area
Canada	295	0	290	0	0	0	0	5	0	0	0	0	0	**1.7%**
Bay of Biscay (a)	7701	4173	1	3	0	0	3493	18	0	0	13	0	0	**43.5%**
Morocco*	341	129	24	46	0	0	121	13	0	7	0	0	1	**1.9%**
Portugal	116	17	11	0	0	0	88	0	0	0	0	0	0	**0.7%**
Strait of Gibraltar***	5561	2254	43	0	0	0	3212	22	5	0	23	2	0	**31.4%**
West Med. **	1675	932	358	28	0	0	352	5	0	0	0	0	0	**9.5%**
Central Med.	1966	773	691	5	0	0	479	7	0	0	12	0	0	**11.1%**
East Med.	30	0	0	30	0	0	0	0	0	0	0	0	0	**0.2%**
		8278	**1418**	**112**	**0**	**0**	**7745**	**70**	**5**	**7**	**48**	**2**	**1**	
GRAND TOTAL	**17685**	**SUBTOTAL = 9808**					**SUBTOTAL = 7878**							**100.0%**

Table 8. Tagging – Appropriateness and adequacy.

Objective	Need addressed	Activities relevant under this component (and timescale = phase 1-6)	Appropriate to need	Adequate to address need?	Gaps
Improve understanding of key biological and ecological processes	Estimation of population size and mortality	Large number of conventional tagged bluefin tuna released. Tag awareness and reward campaign to encourage returns.	No – Small returns and unable to estimate reporting rate for tag recoveries. Plans to conduct studies to estimate reporting rates have been abandoned. The targeted tagging of juvenile bluefin tuna was not the best focus of conventional tagging effort as unanticipated regulation restrict catching these small fish.	No – Large number of missing conventional tags shown by the low expected return rate and non-compliance by industry means tagging data are not adequate for population size or mortality estimates	Reliable estimates of reporting rates by CPC, fishing method and year. In particular, there would need an increase cooperation by the farming industry.
	Information on fish movements for models of mixing	Conventional tagging and satellite electronic tagging to demonstrate movement and mixing of bluefin tuna.	No for conventional tags. The data is not reliable unless the reporting rate of tag returns is known by area, season, year, CPC and fishing method. Such information is probably not obtainable.	No for conventional tags. Estimates of tag recapture reporting rates are inadequate or non-existent. Unknown for satellite electronic tags. The adequacy of the data should be evaluated within the models that used the data. While there is a large amount of data, we have doubts about the	Unclear how many electronic tags will be necessary and when and where fish should be tagged to maximize the value of electronic tagging. Requires input from modelling. Lack of information on the stock

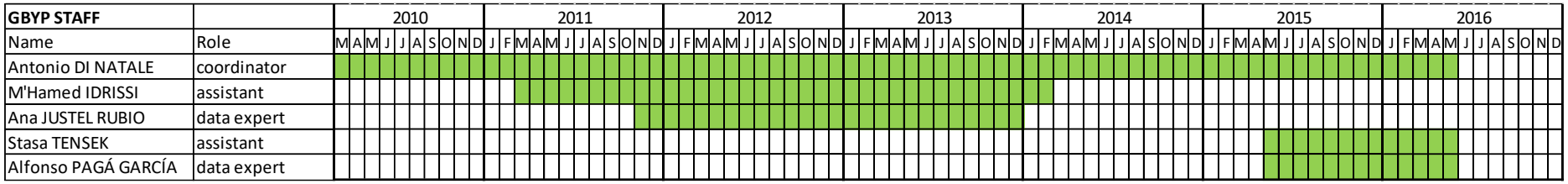
Objective	Need addressed	Activities relevant under this component (and timescale = phase 1-6)	Appropriate to need	Adequate to address need?	Gaps
			Yes for satellite electronic tags. Satellite tag movement data is used to estimate parameters of mixing models.	representativeness of the behaviour of several hundred (optimistically maybe a thousand) fish for estimating numerous mixing parameters to account for10 spatial grids, seasons, stock origins and years.	origin of many satellite electronic tagged fish limits the use of the data.
	Growth rate functions	Collect data from conventional tags to identify the rate of growth of Atlantic bluefin tuna.	Yes – Sufficient data are available, though differences in reporting by region must be noted.	Yes – Growth estimates have been possible from the returned tagging data.	It is unclear if growth information from tagging is representatives of all sizes, areas, years and stock origins. However, there are alternative sources of such information.
	Behavioural information	Use data from satellite electronic tags to characterise the behaviour of bluefin tuna	Allows a factor to be applied to population estimates from aerial surveys.	Yes – Much better understanding of the behaviour of schooling bluefin tuna.	Unclear if the available data on time fish spend near enough to the surface to be spotted by aerial surveys is representative of all of the areas, environmental conditions where and when surveys occur.

Table 9. Modelling – Appropriateness and adequacy.

Objective	Need addressed	Activities relevant under this component (and timescale = phase 1-6)	Appropriate to need	Adequate to address need?	Gaps
Enhance assessment models and provision of scientific advice on stock status	Improved modelling of key biological process (including growth and stock-recruitment)	Obtaining new spatial, age-structured data, (e.g. stock of origin by age class, electronic tagging by age class, indices of spawning stock biomass by stock, and analyses to identify the correct fleet disaggregation (time and gear type))	Yes- The M3 model being developed under the auspice of the GBYP is appropriate. Our judgement is that state of the art modelling approaches are being applied to develop a model that is capable of assimilating vast amounts of complex data from many sources. It will be flexible enough to use potential new types of data (e.g., CKMR data).	Probably yes. The conceptual design is adequate. More resources might be applied to accelerate development, but the availability of suitable experts that can work synergistically may limit the pace of development.	The most important gap in terms of the modelling component delivering on its objectives and the needs is probably data.
	Further developing of stock assessment models, including mixing between various areas				Modelling should play a more prominent role in the design of data collection.
		Assisting in experimental design of data collection programs (for instance, estimation of stock biomass using close-kin genetic tagging)			
	Developing and use of biologically realistic operating models for evaluation of management strategies	Simulation test M3 operating model to identify coding errors, possible biases and correct weighting of various data sources	M3 has the potential to be a stock assessment model for improved representation of key biological processes, mixed stock assessment advice and an operating model for MSE.		
		Fitting the M3 model to data			
		Finalizing Trial Specifications and carrying			

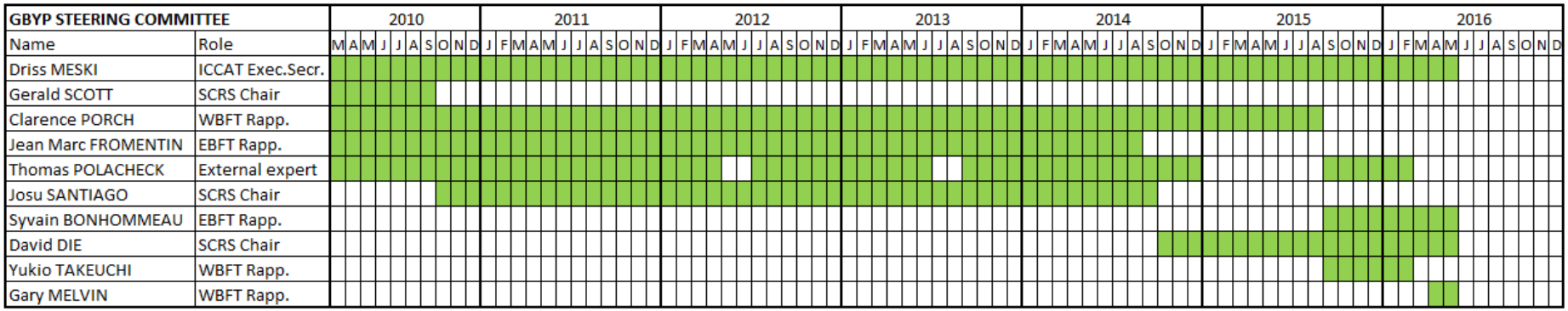
Objective	Need addressed	Activities relevant under this component (and timescale = phase 1-6)	Appropriate to need	Adequate to address need?	Gaps
		out alternative M3 model fits			
		Updating online tools			

Table 10. Summary of GBYP staff 2010 to date.



Data Source: GBYP Programme.

Table 11. Summary of GBYP Steering Committee Members 2010 to date.



Data Source: GBYP Programme.

Table 12. Voluntary Contributions (€) by Source and Year to GBYP.

Source of Funding	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***TOTAL***
Albania								5143.59	5143.59
Algeria				7177.05			11919.81		19096.86
Canada		15000.00	22000.00	22000.00	22110.85	17494.75	23000.00	18994.52	140600.12
Croatia	7000.00			19518.90	18077.61				44596.51
Egypt					4267.25	-622.51	622.51		4267.25
European Union	480000.00		1643091.29	1343856.21	1803081.18	210000.00	1620430.32	1190000.00	8290459.00
Iceland					1433.38	1205.99	2000.00	1708.54	6347.91
Japan	10000.00	42398.00		43704.08	52741.61	44957.92	73000.00	62860.40	329662.01
Kingdom of Morocco			30000.00	64732.08	59993.00	49828.27	62089.10	53324.00	319966.45
Libya		50000.00						54068.52	104068.52
Norway	20000.00	20000.00		20000.00	20000.00	19614.86	20000.00	20000.00	139614.86
People's Republic of China				1609.81		1000.00	767.54		3377.35
Republic of Korea					3727.16	-727.16	727.16	4442.65	8169.81
Tunisia						39397.30	70011.98	58336.51	167745.79
Turkey		22500.00	75060.00	27836.23	25763.81	18099.59	41730.49	57138.43	268128.55
United States of America	71200.00	177700.07		187500.00	193693.34	4600.00	106131.41	8233.59	749058.41
Chinese Taipei	3000.00		3000.00	3000.00	3000.00	1000.00	5000.00	3000.00	21000.00
ICCAT BYP		26723.66							26723.66
Other monetary incomes	15.50	7635.63	27601.41	5513.70	6305.00	85.49	129.37		47286.10
TOTAL	**591215.50**	**361957.36**	**1800752.70**	**1746448.06**	**2214194.19**	**405934.50**	**2037559.69**	**1537250.75**	**10695312.75**

Data source: GBYP Programme

Table 13. Voluntary Contributions (€) by Source and Phase to GBYP.

Source of Funding	2009	2010	2011	2012	2013	2014	Total
Albania						5143.59	5143.59
Algeria			7177.05		11919.81		19096.86
Canada	15000.00	22000.00	22000.00	39605.60	23000.00	18994.52	140600.12
Croatia	7000.00		19518.90	18077.61			44596.51
Egypt				3644.74	622.51		4267.25
European Union	523091.29	1853688.23	1293249.16	2240430.32	1190000.00	1190000.00	8290459.00
Iceland				2639.37	2000.00	1708.54	6347.91
Japan	10000.00	42398.00	43704.08	97699.53	73000.00	62860.40	329662.01
Kingdom of Morocco		30000.00	64732.08	109821.27	62089.10	53324.00	319966.45
Libya		50000.00				54068.52	104068.52
Norway	20000.00	20000.00	20000.00	41614.86	18000.00	20000.00	139614.86
People's Republic of China			1609.81	1000.00	767.54		3377.35
Republic of Korea				3000.00	727.16	4442.65	8169.81
Tunisia				39397.30	70011.98	58336.51	167745.79
Turkey	22500.00	75060.00	27836.23	43863.40	41730.49	57138.43	268128.55
United States of America	71200.00	177700.07	187500.00	198293.34	106131.41	8233.59	749058.41
Chinese Taipei	3000.00	3000.00	3000.00	4000.00	5000.00	3000.00	21000.00
ICCAT BYP	26723.66						26723.66
Other monetary incomes	1443.97	39180.10	142.17	6390.49	129.37		47286.10
Total	**699958.92**	**2313026.40**	**1690469.48**	**2849477.83**	**1605129.37**	**1537250.75**	**10695312.75**

Data source: GBYP Programme

Table 14. Summary of reports and publications (GBYP) by phase.

GBYP Phase	Reports	Scientific Papers
1	20	9
2	73	50
3	17	20
4	44	58
5	42	34
Total	**196**	**171**

Source: ICCAT Secretariat

Table 15. Description of example parameters of standardised and inter-calibrated surveys.

Parameter	Area 1	Area 2	Total area
Spatial distribution by area	0.8	0.2	
Probability of observing a BFT	0.2	0.5	
# in each area for N=500	400	100	
# observed for N=500	80	50	130
# in each area for N=1000	800	200	
# observed for N=1000	160	100	260

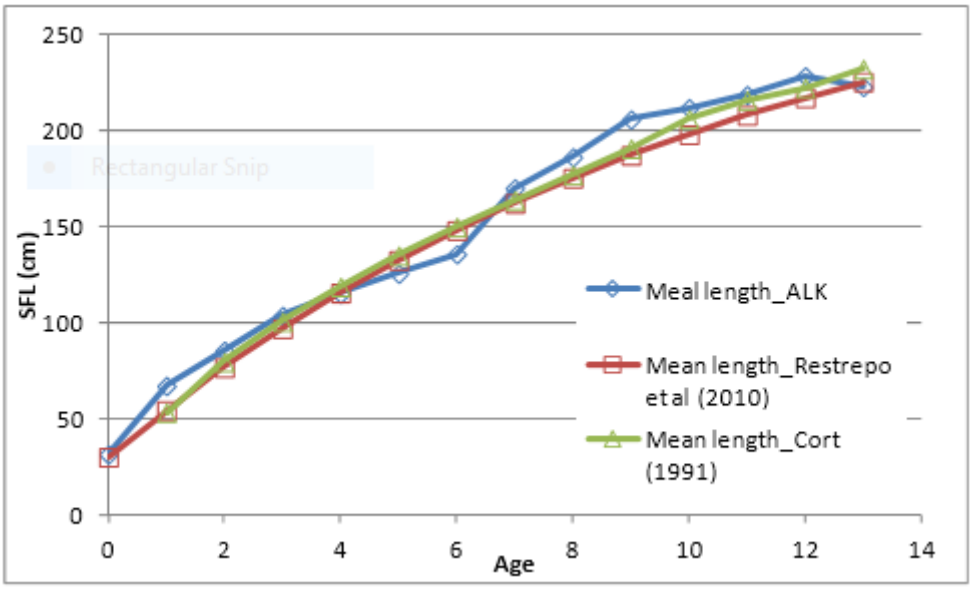


Figure 1. Comparison of size at age data.

Data Source: (Rodriguez-Marin *et al.* 2015)

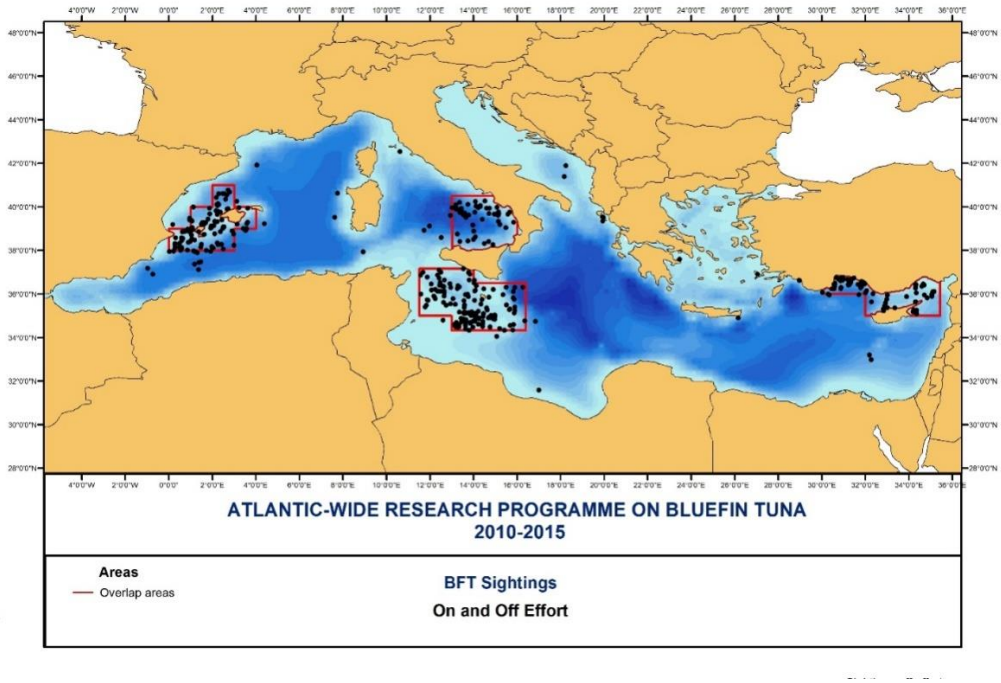


Figure 2. Map showing locations where aerial surveys have sighted bluefin tuna.

Source: Pers. Comm. GBYP Programme Coordinator.

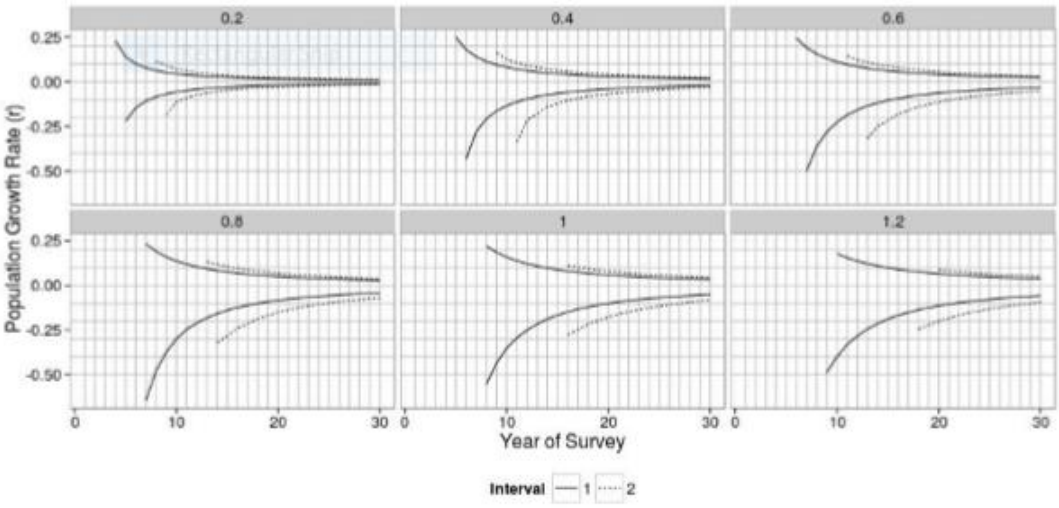


Figure 3. ICCAT GBYP aerial survey on spawning aggregations power analysis.

NB: Contours correspond to a probability of 0.6 that the null hypothesis i.e. no change in population will be rejected when the null hypothesis is false.

Source: (Anon., 2016)

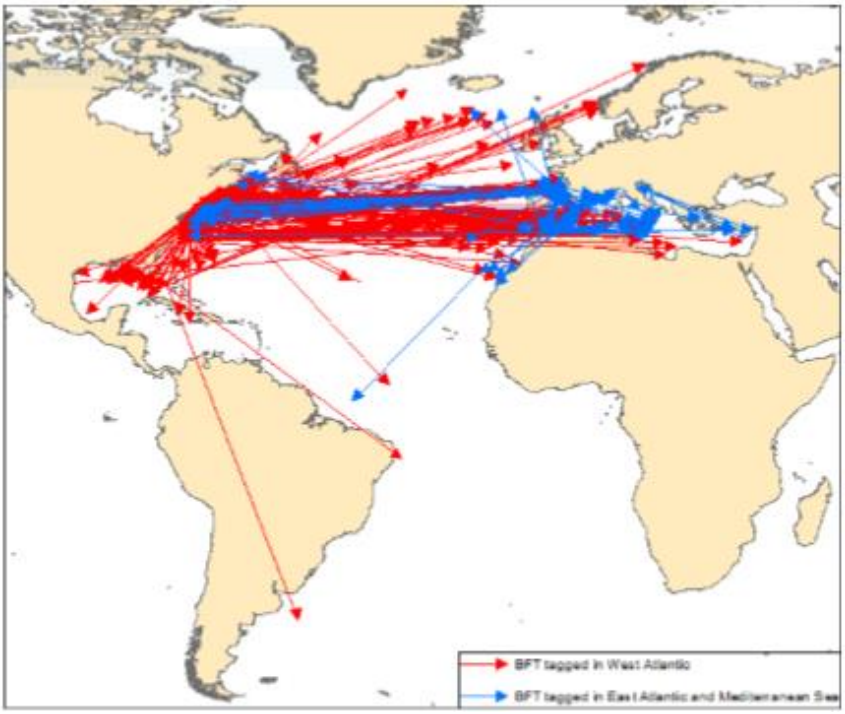


Figure 4. Displacements of bluefin tunas tagged on both sides of the Atlantic and in the Mediterranean (n=5428) by various entities and programmes for which tags were reported to ICCAT up to 23 February 2016.

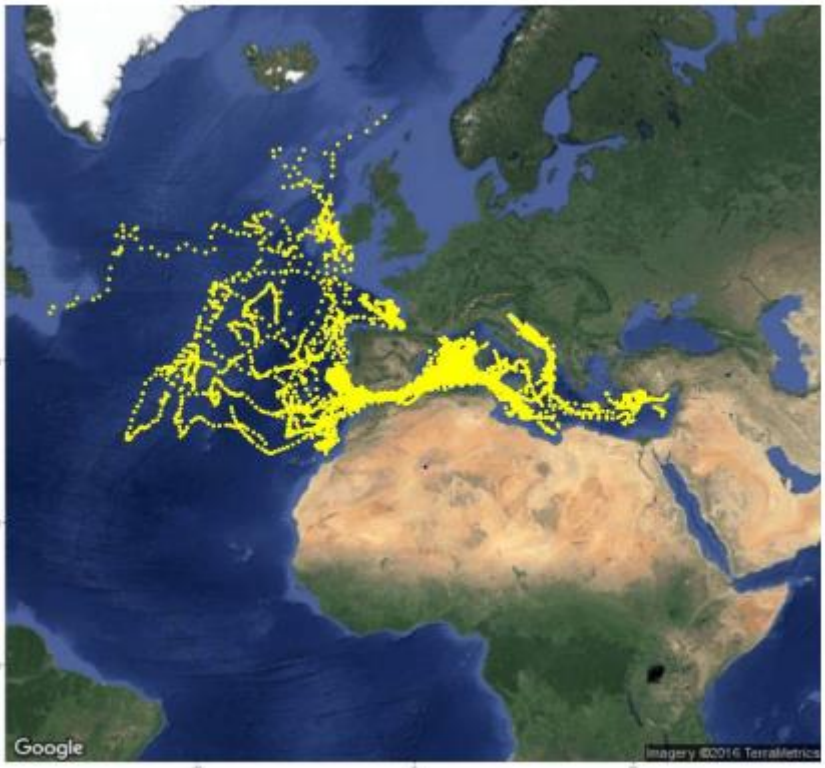


Figure 5. Cumulative tracks of a satellite data received so far from all PSATs deployed in the various Phases by ICCAT GBYP in Eastern Atlantic and in the Mediterranean.

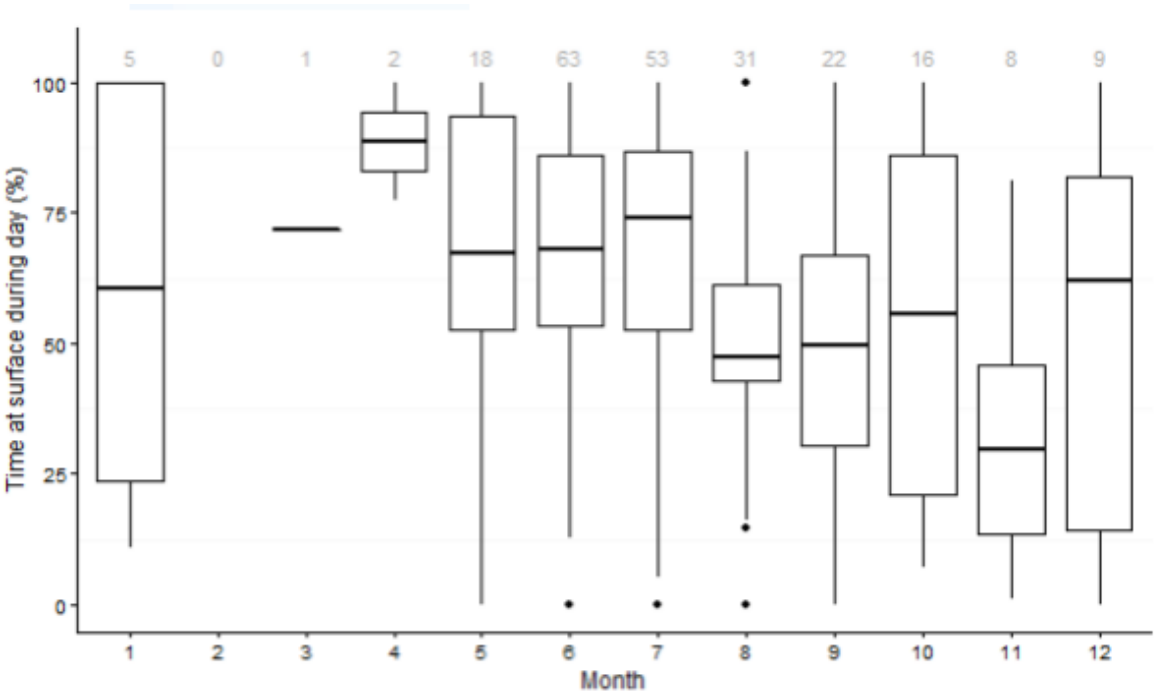


Figure 6. Time spent by bluefin tuna within 5m of the seas surface by month. Numbers above each box indicated the number of datasets used in the calculations.

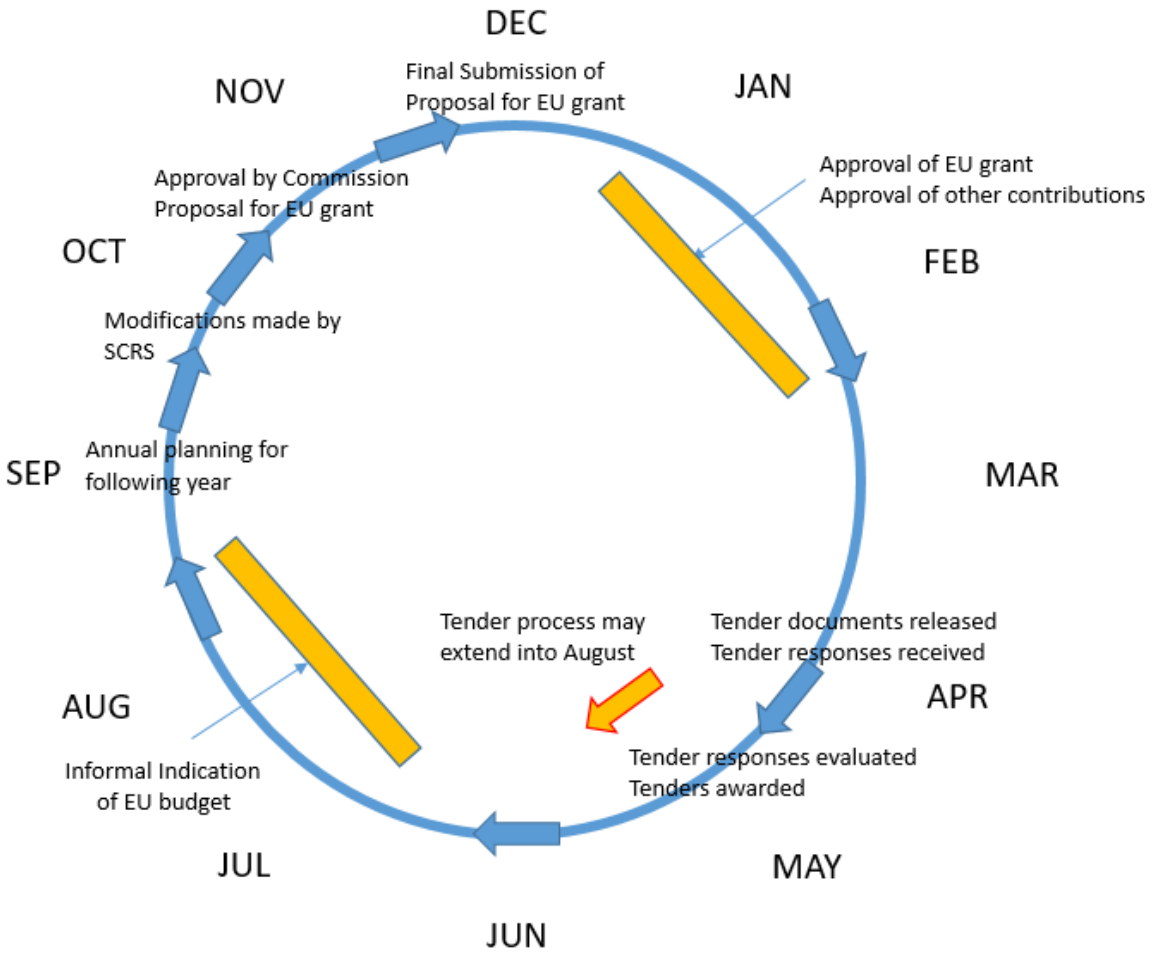


Figure 7. Indicative annual cycle of GBYP funding.

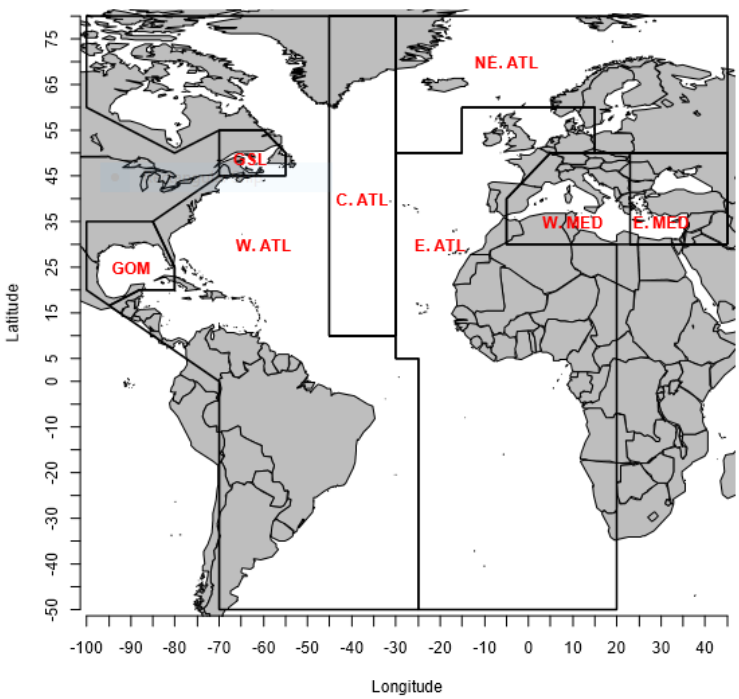


Figure 8. Spatial allocation of Atlantic bluefin tuna.

Source: (ICCAT 2015. Report of the 2015 ICCAT bluefin data preparatory meeting. Available at: https://www.iccat.int/Documents/Meetings/Docs/BFT_DATA_PREP_2015_eng.pdf, accessed 16 June 2016).

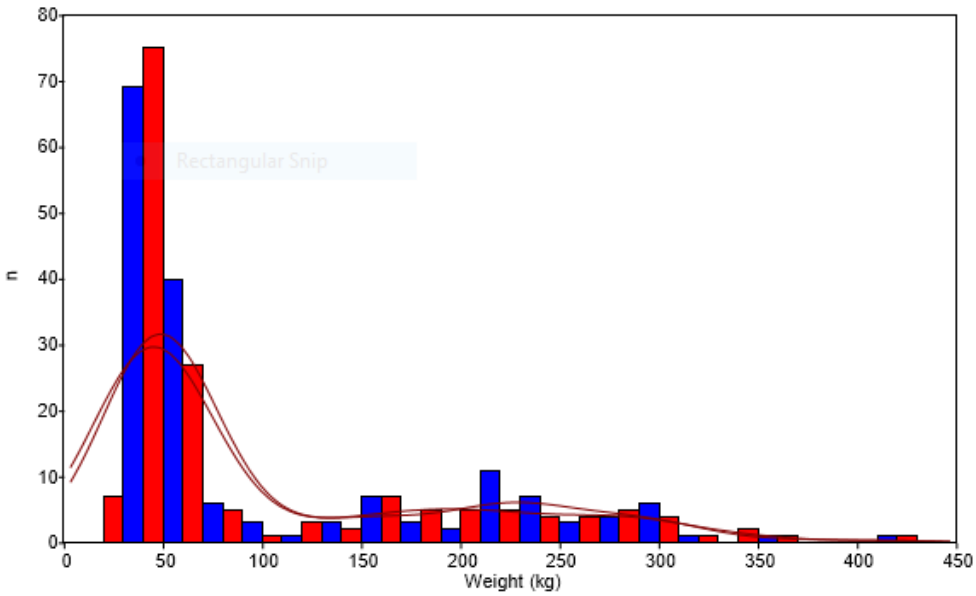


Figure 9. Measured (blue) and assessed (red) weight distributions.

Source: (Mariani *et al*. 2014)

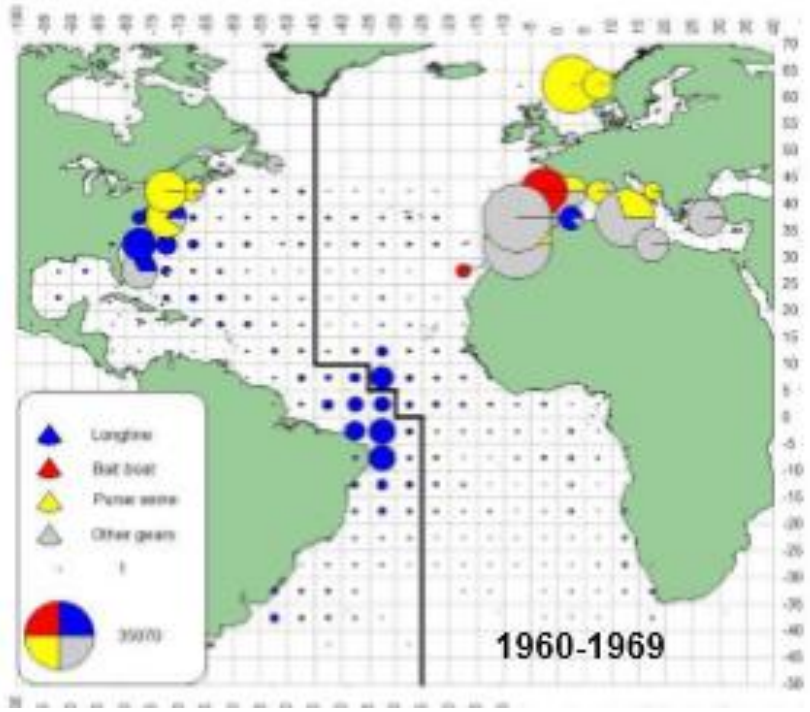


Figure 10. Catches of bluefin tuna by gear in 1960-1969.

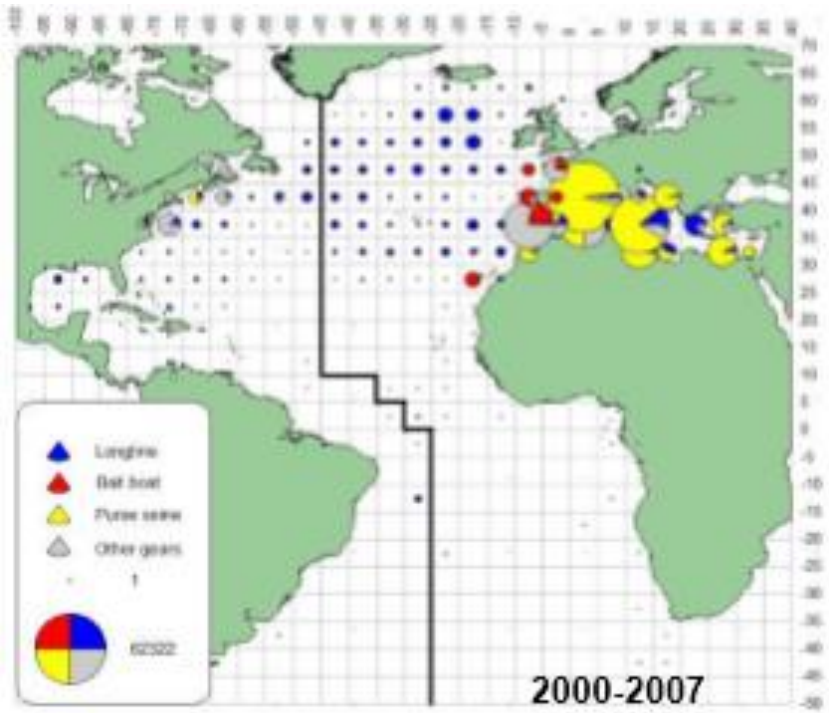


Figure 11. Catches of bluefin tuna by gear in 2000 - 2007.

Annex 1 Persons contacted as part of the study.

Name	Organisation	Contact	Notes
Antonio Di Natale	ICCAT Secretariat	Interview in person	antonio.dinatale@iccat.int
Stasa Tensek	ICCAT Secretariat	Interview in person	stasa.tensek@iccat.int
Alfonso Pagá	ICCAT Secretariat	Interview in person	alfonso.paga@iccat.int
Miguel Neves dos Santos	ICCAT Secretariat	Interview in person	miguel.santos@iccat.int
Driss Meski	ICCAT Secretariat	Email and phone	driss.meski@iccat.int
Francesca Arena	DG MARE, EU	Teleconference (03/06/2016)	francesca.arena@ec.europa.eu
Antonio Cervantes	DG MARE, EU		antonio.cervantes@ec.europa.eu
Ziro Suzuki	National Research Institute of Far Seas Fisheries, Japan	Email	zsuzuki@affrc.go.jp
Alain Fonteneau	IRD	Email	alain.fonteneau@ird.fr
Henri Farrugio	Ex-IFREMER, France	Email	farrugio.fisheries@gmail.com
Corrado Piccinetti	University of Bologna, Itlay	Email	corrado.piccinetti@unibo.it
Jose Luis Cort Basilio	IEO,Spain	Email	jose.cort@st.ieo.es
Haritz Arrizabalaga'	AZTI, Spain	Email	harri@azti.es
Joseph Powers	LSU College of the Coast and Environment	Email	j.powers.fish@gmail.com
Craig Brown	NOAA, USA	Email	Craig.Brown@noaa.gov
Noureddine Abid	Institut National de Recherche Halieutique, Morocco	Email	noureddine.abid65@gmail.com
João Gil Pereira	Universidade dos Açores	Email	pereira@uac.pt
Andy Payne	CEFAS, UK	Email	andy.payne@cefas.co.uk
David Die	RSMAS, Univ. of Miami, USA	Email	ddie@rsmas.miami.edu
Sylvain Bonhommeau	IFREMER, France	Email	sylvain.bonhommeau@ifremer.fr
Gary D. Melvin	DFO, Canada	Email	Gary.Melvin@dfo-mpo.gc.ca
Tom Polacheck		Email	runningtide.tom@gmail.com
Clay Porch	NOAA, USA	Email and phone	clay.porch@noaa.gov
Josu Santiago	AZTI, Spain	Email	jsantiago@azti.es
Jean-Marc Fromentin	IFREMER, France	Email	Jean.Marc.Fromentin@ifremer.fr
Yukio Takeuchi	SPC	Email	yukiot@spc.int
Jerry Scott	Independent	Email	gpscott_fish@hotmail.com

Annex 2 Terms of Reference

The following Terms of Reference are as detailed in the Call for Tenders (ICCAT GBYP CIRCULAR# 0270/16) dated 9 March 2016.

ICCAT is seeking an independent evaluation of the success of the GBYP in achieving its objectives based on the following terms of reference:

For each of the scientific components, review the progress made to date relative to the detailed objectives for that component.

- Review the appropriateness and adequacy of the design of various experiments and scientific studies, including their implementation and the results obtained to date.
    - Suggest possible modifications or additions to each research component that may improve the accuracy, precision, robustness and/or cost-efficiency of the information being obtained.
    - Provide guidance on the timeframe and resources required to complete remaining detailed objectives.
    - Describe trade-offs between the need to complete current studies and any new studies of modified versions of current studies.
    - Provide an overview of the interrelationships, priority and reasonable timeframes to achieve detailed objectives of the various scientific components. Prioritization should be based on the relative contribution of each component to the improvement of the stock assessments, the provision of management advice and the broad scientific knowledge on bluefin tuna.

- Review the administrative and logistic constraints that the programme has operated under and how these have affected the implementation of the research activities, their continuity and the ability of the GBYP to meet its primary objectives.
    - Link such constraints to the previous terms of reference and propose possible improvements in the implementation, efficiency and the cost effectiveness of the work undertaken.
    - Provide comments on the current funding system for GBYP and suggestions for its improvement.

Job Description

The evaluators shall do their evaluation by comparing the initial objectives established at the beginning of the programme with those achieved, by considering effects of any reported budgetary and logistical constraints out of the control of the programme.

The reviewers shall take into account the final results from the first five phases of the Programme, including two cost/benefits analyses (for the tagging activities and the aerial survey) which were carried out in the very last part of GBYP Phase 5, as recommended by the GBYP Steering Committee, the SCRS and the Commission.

The review is to be conducted by **two independent experts** (i.e., individuals not directly engaged in GBYP activities or who do not have a direct vested interest in the results of the Programme).

The reviewers shall have an extensive documented experience and understanding of large-scale research programs for fishery resources (preferably related to large pelagic fish and ideally in relation to bluefin or other tuna resources) and its application to stock assessments and the provision of scientific advice for fishery management purposes. International experience will be highly preferred.

The reviewers shall have an excellent working knowledge of one of the three official languages of ICCAT (English, French and Spanish). *A* high level of knowledge of English is highly desirable.

Each reviewer will undertake an independent assessment of the GBYP against the above Terms of Reference.

The two reviewers will then produce a combined report of their findings and conclusions. The report shall identify items where there is consensus between the two reviewers and items were there is not.

The GBYP Coordinator will provide the reviewing team all the relevant GBYP and related ICCAT documents. The reviewing team will have access via oral and/or written consultations to selected ICCAT Secretariat staff involved in the project, relevant GBYP contractors, GBYP Steering Committee members and BFT WG members. The GBYP Coordinator will assist, as needed, with the facilitation of any such consultations and any other information the reviewers may require.

The reviewers shall provide a list and summary of all such contacts made as an appendix to their report.

The reviewers may be requested to provide additional comments to the SCRS and/or the Commission after their report is considered.Such input will incur additional costs that need not to bet included in the budget for this task but will be reimbursed by ICCAT through a future addendum to the contract.

Annex 3 Brief Biographies of Reviewers

Michael Sissenwine

Dr Michael Sissenwine is a Visiting Scholar of the Woods Hole Oceanographic Institution, Distinguished Senior Scientist at the School for Marine Science and Technology of the University of Massachusetts, and an independent marine science consultant with projects worldwide. He serves as a member of the New England Fishery Management Council (2013-present). He was President (2004-2006) of the International Council for Exploration of the Sea (ICES) and chair (2008-20010) of its Advisory Committee. ICES coordinates marine science and advises European governments (including the European Union) on marine ecosystems. He was the Director of Scientific Programs and Chief Science Advisor for the U.S. National Marine Fisheries Service (2002-2005). He was responsible for about 25 Laboratories, research on eight offshore research vessels and 1,400 staff throughout the USA. His organization's mission was to provide the scientific basis for conservation and management of marine living resources and their ecosystems. He also led eleven NOAA programs, funded at a total of about one billion dollars annually that supported the Agency's stewardship mission (2002-2004). From 1996-2002, he served as Director of the Northeast Fisheries Science Center, comprised of five laboratories and approximately 300 staff. Previously, Dr Sissenwine served almost six years as the Senior Scientist of the National Marine Fisheries Service, overseeing the Agency's scientific programs throughout the USA.

Dr Sissenwine is a US Commissioner to the North Atlantic Fisheries Organization and a former Scientific Council member; a former US delegate to the Pacific Science Association (PSA) and former chair of the National Academy of Sciences' National Committee for PSA; a former member of the scientific steering committee for the US Global Ecosystem Dynamics program (GLOBEC) and a former co-director of GLOBEC; past member of the Fishery Resources Commission of the World Humanity Action Trust of the UK; the former chair of the Advisory Committee on Fisheries Research of the United Nations Food and Agricultural Organization (FAO); participant in FAO "Expert Consultations" on Fisheries Management Techniques, the Precautionary Approach, Indicators of Sustainability, and Ecosystem Approaches to Fisheries; and past member of several National Research Council Panels and Committees, including the Ocean Studies Board and the National Academies of Sciences' Board on International Scientific Organizations. He served as the chair of the Interagency Working Group of the National Oceanographic Partnership Program. He served as an advisor to the Pew Foundation Conservation Fellows Program. He was a member of the President's panel on Ocean Exploration. He serves on many other advisory and scientific review groups and he has advised on research and resource management problems worldwide. Throughout Dr. Sissenwine's career, he has provided scientific advice to policy makers and managers. He was a member of the Scientific and Statistical Committees of the New England and Caribbean Fishery Management Councils (NEFMC and CFMC) before being appointed to the NEFMC. Dr Sissenwine has about 40 years of experience conducting, planning, and directing an evaluating research on marine fisheries and related topics. His career has been focused on the science policy makers need, and formulating objective advice based on this science to inform decision makers. He has no current involvement in Atlantic bluefin tuna research, but as former Director of Scientific Programs of the US National Marine Fisheries Service, he had responsibility for all US scientific contributions to ICCAT, including bluefin tuna research and assessments. He personally participated in numerous ICCAT meetings concerning Atlantic bluefin tuna in the past, including playing an instrumental role in preparation of the ICCAT rebuilding plan for the Western Atlantic management unit. As a current member of the (a) Advisory Committee to the US Highly Migratory Species Division of the US National Marine Fisheries Service and (b) a member of a panel of advisors to the US Commissioners to ICCAT, he is keenly aware of current scientific issues that are important for conservation and management of Atlantic bluefin tuna. In addition, Dr Sissenwine's recent experience as a participant in scientific committee meetings of the Commission for Conservation of Southern Bluefin Tuna, positions him to bring a global perspective to a review of Atlantic bluefin tuna research.

Dr Sissenwine received a Presidential Rank Award, Silver Medal, and Distinguished Career Award from the US Government. The American Fisheries Society honoured him with three awards for career excellence named in honour of William Ricker, Elton Sette and Dwight Webster. In 2011, he received Outstanding Achievement Awards from both ICES and the American Institute of Research Fishery Biologist. He holds a Ph.D. in Oceanography from the University of Rhode Island (1975), from whom he received the 2009 Dean's List Award for distinguished alumni.

John Pearce

John Pearce is one of the Principal Consultants at MRAG Ltd. He has over twenty years' experience in fisheries management and analysis. He has particular experience in the development and review of monitoring, control and surveillance activities, risk analysis and assessment and fisheries management systems.

Mr Pearce is an expert in illegal, unreported and unregulated (IUU) fishing and related monitoring, control and surveillance systems including the integration of related data into the decision making processes within fisheries management. Mr Pearce is an expert in illegal, unreported and unregulated (IUU) fishing and related monitoring, control and surveillance systems including the integration of related data into the decision making processes within fisheries management. He was the project leader on a recent FAO project quantifying the level of IUU in the Indian and Pacific Oceans and as a team member on a similar EU funded project implemented by MRAG Asia Pacific for the South Pacific region. He was a key member of the team that developed the global estimate of IUU fishing (Agnew *et al.* 2009).

He has implemented and conducted a number of reviews of large European Union projects and programmes. Mr Pearce was the Team Leader reviewing the use of data and their related information systems for fisheries control in all 22 (now 23) EU maritime States and reviewed the systems and developed a methodology and framework for the transparent assessment and reporting on the performance of the European Union Joint Deployment Plans for the Community Fisheries Control Agency (CFCA now EFCA). He also recently was part of the team that completed the ex-post evaluation of European Union financial measures for the implementation of the Common Fisheries Policy (2007-2013).

Mr Pearce has a wide experience in the systems analysis, design, development and use of databases for fisheries and is responsible for the verification and submission of national data for fisheries (e.g. STATLANT), observers and research surveys for the United Kingdom (on behalf of the Overseas Territories) to CCAMLR, ICCAT and IOTC. He has occupied a key role in many fisheries worldwide defining and reviewing data collection systems for data entry, validation (both database rule and interface led) and production of standardised reporting formats for export and analysis to ensure efficient and accurate data are provided to stock assessment teams

Mr {Pearce's experience covers a wide variety of fisheries including tuna fisheries in the Atlantic, Pacific and Indian Oceans, fisheries in the Antarctic and high seas deep water fisheries. In this capacity he has worked as part of the UK delegation or as an invited expert to IOTC, ICCAT, WCFPC, the British Seychelles Fisheries Commission, the British Mauritian Fisheries Commission and the Marine Technical Advisory Group of the International Commission for Land Use and Ecosystems at which he chaired the Illegal, Unregulated and Unreported Fishing subgroup. Mr Pearce is also a certified MSC Team Leader.

Annex 4 Summary of Steering Committee Recommendations

Year	Month	Ref	Activity	Action/Recommendations
2010	7	SC-07/11	TAG	Contract (Call for Tenders) for a short time contract for analyzing the PIT tagging issue and create a report for the SCRS;
2010	9	SC-09/10		c(1) The Steering Committee recommended that an individual (P2) with previous experience in tagging experiments be included in the coordination part of the GBYP whose primary responsibility would be to undertake the required liaison work for tag recovery activities.
2010	9	SC-09/10	AS	b(1) - The Steering Committee recommended that future aerial surveys should continue to focus on spawners aggregations, leaving CPCs the freedom to complementary conduct aerial surveys on juveniles or adult surveys in additional areas.
2010	9	SC-09/10	AS	b(2) - Information on the extent that individual fish move between spawning areas is important if an area time dependent approach were to be adopted. Otherwise, a common period should be defined taking into account the total period of spawning in all of the areas to develop a robust design.
2010	9	SC-09/10	AS	b (3) - The Steering Committee decided to support the Coordinator's request to organize a 2 days training course at the ICCAT Secretariat before the 2011 survey, to improve the consistency among all the staff in implementing the survey protocols.
2010	9	SC-09/10	AS	b(3) - The Steering Committee also recommended hiring a professional figure (P1) within the GBYP Coordination staff to help ensure the consistency of the survey implementation in the various areas.
2010	9	SC-09/10	AS	b(4) - It was recommended to provide opportunities for a direct participation in the aerial surveys for local scientists. A recommendation will be forwarded to SCRS and the Commission for providing the necessary support.
2010	9	SC-09/10	AS	b(5) - Standardized protocols should be developed for distinguishing primary and secondary sightings during the surveys. The question of secondary sightings is one question that should be considered by the Workshop proposed under b7 below.
2010	9	SC-09/10	AS	b(6) - The Steering Committee recommended that consideration should be given to both of these but this needs to be done taking into account the underlying assumptions and ensuring that such designs would be able to provide a robust long term index. The Coordinator mentioned the issue of the difficulty in terms of contracts and flight permits for this adaptive survey design. The Steering Committee considered that this question this question should be considered by the proposed Workshop in b8 below.
2010	9	SC-09/10	AS	b(7) - The GBYP recommended that these analyses by conducted by the contractor in charge of analysing the aerial survey data The Steering Committee also recommended the design workshop include both individuals with first-hand knowledge of aerial sighting of adults in the Mediterranean and experts in the design, implementation and analysis of line transect aerial surveys.
2010	9	SC-09/10	AS	b(8) - The budget for the aerial survey in 2010 was clearly not sufficient to cover the full need of the survey design and the survey design itself was not included. The budget was increased taking into account the major cost of fuel and flight hour occurred in the first year. The budget figures are 605,000.00 Euros for 2011 (including intercalibration, workshop and training course) and 463,080.00 Euros in 2012.

Year	Month	Ref	Activity	Action/Recommendations
2010	9	SC-09/10	BIOL	f - The Steering Committee recommends that sampling commences as soon as possible. The strategy should be mostly focused on otoliths sampling for micro-constituents analysis in the first year. This will continue in the second year together with genetic sampling.
2010	9	SC-09/10	BIOL	f(1) - The Steering Committee suggests identifying in advance some storage places for long term archiving of the samples, possibly in Government institutions able to ensure a long-term storage.
2010	9	SC-09/10	BIOL	f(2) - The Steering Committee decided that it is necessary to get a genetic sampling design (including storage protocols) before going on with the genetic sampling and analysis. The sampling in 2011 should be limited at a minimal level, while it would be increased in 2012, possibly taking advantage of the biological sampling and then reducing the sampling costs.
2010	9	SC-09/10	BIOL	f(3) - The Steering Committee decided to postpone to the following years the studies on the reproductive biology.
2010	9	SC-09/10	BIOL	f(4) - Proposal related to growing in cages study will be discussed, eventually may be restructured to align with high priority needs of and included in GBYP.
2010	9	SC-09/10	COORD	Propose to the Commission to have a larger Steering Committee, including two external members, to improve the functionality, taking into account more broad views and experiences.
2010	9	SC-09/10	COORD	Encourage the GBYP Coordinator to increase the number of contacts and propose possible MOUs with industries and NGOs interested in cooperating and contributing to the GBYP, either with funds or in kind support.
2010	9	SC-09/10	COORD	The Steering Committee recommended hiring an administrative support (G2-1), and hiring two new professional figures to support the growing scientific activities and to ensure a constant monitoring and reporting of the main research activities. The professionals to be hired should be a P1 (mostly for the aerial survey monitoring and for helping in improving the tag reporting) and a P2 (mostly for monitoring the tagging activities and the biological sampling).
2010	9	SC-09/10	COORD	It was agreed to develop a dedicated GBYP web page, within the ICCAT site, in order to post all the products of the Programme.
2010	9	SC-09/10	DM	g(1) - The Steering Committee recommended continuation of the data recovery and data retrieval exercise, particularly for very old data sets (before 1950) and for data concerning fisheries on juveniles. The Steering Committee also stressed the importance to get the data and analyses of these from the Japanese market (particularly from auction of individual fish).
2010	9	SC-09/10	DM	g(1) - The Steering Committee also recommended that a specific call should be released for proposals to provide actual data on the small scale and recreational fishery on juveniles in the Mediterranean Sea, allocating about 25,000 to 30,000 euro per year in the next two years, because the information on these fisheries is entirely missing in the ICCAT data base. These calls might imply also a job to be done in two years.
2010	9	SC-09/10	DM	g(2) - The Steering Committee agreed about the additional information on the most important fisheries which the analysis of the VMS data is potentially able to provide. An external contract (under a confidentiality agreement) could be released.
2010	9	SC-09/10	DM	g(3) - The Steering Committee agreed about the need to analyse the aerial survey data at the end of each season and present the yearly data to SCRS. The Steering Committee recommends

Year	Month	Ref	Activity	Action/Recommendations
				prolonging the contract to the same team contracted in 2010, with the objective to better use the first year experience.
2010	9	SC-09/10	DM	The Steering Committee also considers that the proposal to organize a Bluefin tuna trap fishery symposium, proposed by scientists from various CPCs is potentially able either to improve the standardization and analysis of the tuna trap fishery data and to better use the sampling and tagging opportunities provided by the traps. The Steering Committee recommended that this proposal should be considered within the data recovery activities, if the budget will allow the cover the costs.
2010	9	SC-09/10	EGG	e(1) - The Steering Committee decided to postpone the eggs and larval survey campaign by one year because of budget constraints and the priority provided for this activity, leaving 2011 for the survey design and developing the survey in 2012 and possibly in the following years.
2010	9	SC-09/10	EGG	e(2) - The Steering Committee decided to postpone this decision to a next meeting, waiting for the development of the US BFT Program in the West.
2010	9	SC-09/10	EGG	e(3) - See e(1)
2010	9	SC-09/10	GEN	ICCAT Secretariat as a matter of urgency issue a circular to all CPCs, reminding the GBYP agreed needs and asking for a clear identification of the contribution to be expected from each CPCs concerned. *This information is crucial for planning of effective future activities and effective utilization of the funds received.*
2010	9	SC-09/10	GEN	The Steering Committee recommended that the ICCAT Secretariat explore the possibility of improving the operational part of the observer's contract with MRAG, taking into account these needs.
2010	9	SC-09/10	MOD	g(1) - The Steering Committee agreed that it is necessary to anticipate this item as much as possible, because of the complex work to be done and suggested to organise a modelling workshop in 2011 (taking advantage of the Working Group on Stock Assessment Methods) and then to begin the modelling activities in 2012. The Steering Committee considers these two years as the transition to a more adequate modelling approach.
2010	9	SC-09/10	TAG	c(1) The Steering Committee endorsed the Coordinator's proposal to include the communication and awareness strategy within the overall design of the tagging experiment.
2010	9	SC-09/10	TAG	c(2) - The Steering Committee recognized the importance of have an individual with extensive knowledge of tuna tagging having the role to monitor the implementation of the tag release component of the tagging experiment according to the agreed protocols and recommended that such a person (P2) be recruited as part of the coordination activities of the GBYP.
2010	9	SC-09/10	TAG	c(3) - The Steering Committee recommended delaying deployment of electronic tags to the third year of GBYP (2012), contingent on sufficient funds be available.
2010	9	SC-09/10	TAG	c(4) - The Steering Committee decided not to recommend the implanted archival tagging at this stage due to budget constraints, low return rates and the potential data they can provide relative to the main objectives of the program during its life.
2010	9	SC-09/10	TAG	c(5) - For this reason, the Steering Committee decided to include PITs in the tagging strategy for 2011 and 2012.

Year	Month	Ref	Activity	Action/Recommendations
2010	9	SC-09/10	TAG	The Steering Committee discussed about the meetings hold with tenders according to the calendar set in the previous meeting. The proposal concerning the tagging design should be revised and the ICCAT Secretariat is recommended to ask for this revision to the tender, in order to have a proposal including the following points: a) a tagging design for the Eastern Mediterranean and the Mediterranean Sea, for traditional tags and PITs; b) a workshop to be organized with the purpose to identify the opportunities and best practices to carry out the tagging activities in tuna traps, particularly taking advantage of fish to be released, with the participation of trap owners or their associations; c) a workshop to be organized with the purpose to identify the opportunities and best practices to carry out the tagging activities from tuna purse seines, with the participation of purse-seiner owners or their associations; d) an operational tagging manual including the operational details and protocols for the two types of tags required and for the various tagging activities.
2010	9	SC-09/10	TAG	As concerns the proposal to carry out growth studies in tuna cages in Malta, the Steering Committee hold a meeting with the tender and requested the proposal to be fully revised, with the aim to double tagging the fish and find the best technical ways to estimate both size composition of tuna going to cages and their growth for various year classes. The proposal should also include fishes to be released in the wild after aging.
2011	7	SC-07/11	AS	(a) The SC recommended informing the Commission of the serious difficulties encountered, particularly those due to the lack of collaboration by some ICCAT CPCs since it is essential that all CPCs concerned better cooperate with the GBYP aerial survey and are conscious of the serious implications linked to this lack of cooperation, from a scientific as well as from an economic point of view.
2011	7	SC-07/11	AS	(b) The SC recommended extending the contract provided in Phase 1 for the aerial survey data elaboration and analysis, thereby avoiding a new Call for Tenders, taking into consideration the good work done by the Contractor. In this way, GBYP would have the same analysis for the data collected in Phase 2, including the analysis of the individual capacity of the observers (after the requested rotation procedure) and the different effects of the flat windows used in Phase 1 vs the bubble windows adopted in Phase 2 (as defined during the Workshop in February and the Training Course in May, 2011).
2011	7	SC-07/11	AS	(c) The SC recommended organizing a second ICCAT-GBYP Workshop in early 2012 (possibly late January of early February). Before the Workshop, two short-term contracts should be awarded to specialists in aerial surveys on marine animals, for the purpose of providing: 1) a revision of the GBYP Aerial Survey Protocol, taking into account the first two years of experience and the forms that have been used so far; the contract should include a procedure for the calibration (rotating the crew, excluding the pilots, from one area to the other); and, 2) a preliminary assessment of the aerial survey scenario adopted by the SCRS and the Commission for Phase 3.
2011	7	SC-07/11	AS	(d) The SC recommended organizing a second Training Course for the Aerial Survey crew in 2012 after the Workshop and prior to the Aerial Survey

Year	Month	Ref	Activity	Action/Recommendations
2011	7	SC-07/11	AS	(e) The SC recommended Informing all the CPCs concerned by the Aerial Survey, as soon as the final design is approved and immediately after contracting the company(s), recalling the ICCAT endorsement of the Aerial Survey method to provide fishery-independent data for the assessment, the consequent engagement of each CPC, and requesting the maximum support and cooperation for the GBYP aerial survey activities.
2011	7	SC-07/11	BIOL	After this first year, the Steering Committee decided the following points concerning the biological sampling activity on Phase 3 of the GBYP: a. The biological and genetic sampling activity shall be continued under the same sampling design scheme, possibly covering larger areas; b. A second GBYP Operational Meeting on Biological and Genetic Sampling shall be organized in early 2012, for the purpose of better refining the field activities in 2012 considering the experience in 2011. c. The Call for tenders for the biological and genetic sampling and analysis shall be released by ICCAT in early 2012, for the purpose of allowing the field activity starting in March 2012. If the work done by the contractor in Phase 2 is considered satisfactory, the SC recommended extending the previous contract for efficiency reasons and with the possibility of negotiating extensions to more areas.
2011	7	SC-07/11	COORD	Due to the need for data entry resulting from the huge amount of data collected under the GBYP Data Recovery and mining activity, the SC recommended that support should be provided by the GBYP to the ICCAT Department of Statistics ant that a support staff person for this purpose be hired as soon as possible, initially under a temporary contract, in order to provide the data to SCRS. The SC recommended that this position should be extended with a regular contract in Phase 3 to ensure that all that data recovered will be available for analyses by the SCRS.
2011	7	SC-07/11	DATA	The SC considered that the amount of data already recovered by the GBYP though the data calls in Phase 1 and Phase 2 possibly represents a majority of the recoverable data existing on the bluefin tuna fishery. Work in the near future should focus on any potential sources of data which are not yet covered. Taking this fact into account, the SC recommends that this item ("Data mining and data recovery") should have a reduced budget in Phase 3 compared to that in the annual budgets in Phases 1 and 2.
2011	7	SC-07/11	DATA	The Steering Committee recommended the GBYP Coordinator to contact the Convener of ICCAT Sub-Committee on Statistics in order to initiate an exercise among all CPCs for establishing a minimum level of sampling for the provision of Task II data on bluefin (eventually this exercise could be extended to all species under the competence of ICCAT) and for eventually defining, in agreement with the scientists concerned, a minimum level of sampling coverage to be officially adopted by the ICCAT.
2011	7	SC-07/11	DATA	The SC recognized the value of additional environmental data, as was revealed during the Symposium in Tangier. This could help in better standardising the historical trap data; help explain fluctuations in trap catch and to provide an important trap CPUE series for the assessment. The SC recommended that the Coordinator prepare a specific provision for this need in Phase 3, after preliminary investigations indicated that there were sufficient years of such data to make such an exercise worthwhile.

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2011	7	SC-07/11	DATA	The SC was informed that SST data, as they were obtained in Phase 1, are available for ten years up to 2010; these data sets were used for the elaboration of the aerial survey data, providing interesting correlations. Updated data at the appropriate spatial and temporal scales are now required before the elaboration of the aerial survey data collected in Phase 2. The SC agreed on the need for the SST data and recommended that the Coordinator try to acquire a free data set from the provider (CLS) or, if this fails, to buy the 2011 SST data from the same provider.
2011	7	SC-07/11	TAG	(a) The SC recommended that ToR and a Call for tenders for GBYP related tools is issued.
2011	7	SC-07/11	TAG	(c) Direct and regular contact is made. This "communication" role should be vested mainly by the GBYP Assistant Coordinator and, depending on the time availability, also by the Coordinator.
2011	7	SC-07/11	TAG	(d) A proactive role shall be attributed mainly to the GBYP Coordinator to develop the necessary contacts with all the various stakeholders organizations at higher level, including the national fishers associations, various advisory bodies where tuna stakeholders are concerned, the RFMOs operating in the ICCAT Convention area (CGPM, CECAF, etc.), taking all the best opportunities to participate in local meetings to disseminate the awareness about the tagging activity. Contacts with national organizations in USA, Canada and South American countries shall be maintained.
2011	7	SC-07/11	TAG	The SC decided the following points concerning the tagging activity on Phase 3 of the GBYP: a. The conventional tagging activity shall be continued under the same tagging design scheme, possibly covering larger areas; b. Electronic tagging (using miniPATs) shall be initiated. Depending on the budget available, between 50 and 100 tags should be deployed, sharing the tags between pre-spawners in various areas and post-spawners only in the eastern Mediterranean. c. PIT tags should be also implanted, according to the previous discussion in the last paragraph of point 5.3; the PIT tagging should eventually be able to provide reliable estimates of the reporting rates and, in this regard, an experiment should be conducted in 2-3 cages, where PITs will be implanted in 10 fish which are also tagged with conventional tags at the beginning of the caging season, to estimate the reporting rates by the ROP observers. d. A second GBYP Operational Meeting on Tagging shall be organized in early 2012 for the purpose of refining the field activities in 2012 considering the experience in 2011. e. Promotional and awareness activities shall be continued and possibly improved in GBYP Phase 3, with a particular attention to the direct contacts with stakeholders in various locations.
2011	7	SC-07/11	TAG	The SC recommended that two possible strategies might be feasible for some of the current juvenile fisheries, (i) comparing recovery rates with and without observers and (ii) seeding of tags into the catch prior to processing, to enable estimation of reporting rates.
2011	9	SC-09/11	AS	The SC recommended continuing the GBYP aerial survey only if sufficient guaranties of obtaining all flight permits are provided by all CPCs concerned and if sufficient budget is available for surveying a much larger area than the current one, at least for a total length of 100,000 km.

Year	Month	Ref	Activity	Action/Recommendations
2011	9	SC-09/11	AS	The SC also proposed to explore the possibility of shifting the target of the aerial survey to juvenile bluefin tuna, particularly in the Western Mediterranean, the Gulf of Lion, the Gulf of Gabes and the Adriatic Sea.
2011	9	SC-09/11	BIOL	The SC recommended improving sampling for maturity studies and possibly reallocating some budget for satisfying this need.
2011	9	SC-09/11	COORD	The SC recommended to revise the budget according to the various proposal for improving the activities and requested the coordinator to provide options to be discussed at the SCRS in the following week for selecting the most adequate to be proposed to the Commission in November 2011.
2011	9	SC-09/11	COORD	The SC recommended that the scientific results obtained by the GBYP must be better highlighted and strengthened.
2011	9	SC-09/11	TAG	The SC recommends strictly monitoring the tagging activity carried out under GBYP.
2011	9	SC-09/11	TAG	The SC also recommended to change and improve the reward strategy, given the expanded nature of the GBYP tagging programme and the extremely low reporting rates in the past. The SC, after reiterating these recommendations, also recalled the need to activate as soon as the communication material will be ready the contacts with stakeholders and local Authorities in the Convention area; in a preliminary phase, the GBYP Coordination staff should be empowered to establish all the necessary contacts and travel to the various areas where the bluefin tuna fishery is carried out.
2012	2	SC-02/12	DM?	Develop. Standards for Videoing Transfer to towing cages
2012	2	SC-02/12	Gen	Long term plan for extension of GBYP
2012	2	SC-02/12	Gen	Strategy for multi-year funding
2012	9	SC-09/12	Coor	Explore the possibility of making the administrative procedure requested by the current EC Grant simpler
2012	12	SC-12/12	AS	Feasibility study for an extended work over the Med.
2012	12	SC-12/12	AS	Call for Tenders, awarding of contracts (7 areas covering the Med.), and negotiating permits
2012	12	SC-12/12	BIOL	Find solution to the transfer of biological samples collected in Libya to the Consortium
2012	12	SC-12/12	BIOL	Determine whether ROP and national observers could collect biological samples as routine activities
2012	12	SC-12/12	BIOL	Ensure that samples for genetics are collected and archived whenever hard parts are collected as part of the ongoing biological sampling programme
2012	12	SC-12/12	BIOL	Call for Tenders, awarding of contract,
2012	12	SC-12/12	BIOL	Provision of the complete set of age-at-length data one month prior to the SCRS biological data meeting
2012	12	SC-12/12	BIOL	Written report with the preliminary results of genetic stock structure analysis be presented to GBYP modelling meeting
2012	12	SC-12/12	COOR	Development a draft of ToRs for Mid-Term GBYP Review
2012	12	SC-12/12	COOR	Call for tenders and awarding of contracts for mid-term GBYP review
2012	12	SC-12/12	COOR	Completion of ToRs for recommended GBYP activities ASAP (even before funds have been received

Year	Month	Ref	Activity	Action/Recommendations
2012	12	SC-12/12	COOR	Establishment of MoU with Italian fishing industry for their offer of 40-hour flight
2012	12	SC-12/12	COOR	Early holding of a 3-day Phase-V SC planning meetings (preferably prior to SCRS)
2012	12	SC-12/12	DM	Final report on Ottoman Archives, expected in January 2013
2012	12	SC-12/12	DM	Contract for Data recovery from Ottoman Archives
2012	12	SC-12/12	DM	Meeting in Istanbul to clarify information & develop a future plan
2012	12	SC-12/12	DM	Contract for the Analysis of Market data
2012	12	SC-12/12	DM	Analysis of VMS data
2012	12	SC-12/12	DM	Analysis of data from farms for size composition in total catch
2012	12	SC-12/12	MOD	Completion of Data Imputation Contract
2012	12	SC-12/12	MOD	Completion of ALK Contract
2012	12	SC-12/12	MOD	Completion of detail draft multi-year proposal for the modelling work
2012	12	SC-12/12	MOD	Formation of a group to develop an operating model for BFT and produce a written design to be presented at the 3-day modelling in May 2013
2012	12	SC-12/12	MOD	Call for tenders and awarding of contracts for management procedures and external expert assistance with OM development
2012	12	SC-12/12	TAG	Exploration of alternative approaches to tagging in the East Med
2012	12	SC-12/12	TAG	Tag recovery: arrangement for access to observers data for rates of recovery and reporting (cartch data)
2012	12	SC-12/12	TAG	Tag recovery: briefing with observers about tag recovery
2012	12	SC-12/12	TAG	Tag recovery: debriefing with observers about tag recovery
2012	12	SC-12/12	TAG	Recontact individuals who had been sent promotional material
2012	12	SC-12/12	TAG	Promotion of tag recovery using recreational and small-scale fishery broadcast and print media
2012	12	SC-12/12	TAG	Promotion of tag recovery in local media
2012	12	SC-12/12	TAG	Improve coordination with other institutions on tag recovery data
2012	12	SC-12/12	TAG	Purchase and deployment of electronic tags in Phase 4
2013	12	SC-09/13	AS	The SC recommended that the aerial survey should be continued for 2014 (assuming same conditions regarding the ability to obtain flight permits), but noted that the design could be made more cost effective based on what has been learned from 2013 and previous years.
2013	12	SC-09/13	AS	The SC recommended maintaining broad coverage to ensure the robustness of the survey design to the spatial variability of spawning aggregations.
2013	12	SC-09/13	AS	The SC recommended adjustments to the areas that should be surveyed.

Year	Month	Ref	Activity	Action/Recommendations
2013	12	SC-09/13	AS	It is also recognized that it is important to perform the aerial surveys with the same companies and spotters to the extent possible so as to avoid introducing excessive variations due repetitive changes in spotters. The SC recommends taking into account this issue when selecting the companies that will be awarded. Cost alone should not be the primary consideration; priority should also be given to companies that have already performed aerial surveys for GBYP in the past.
2013	12	SC-09/13	AS	Three specific technical concerns should be addressed for the next survey. First, the problems in the detection function noticed for various companies in the three years in some areas should be better analysed, properly addressing them in future activities. Second, it is important that the protocols for identifying and using secondary (offline) sightings should be reviewed and applied consistently among aircraft/spotters. Third, the estimates of school size should be calibrated among observers.
2013	12	SC-09/13	BIOL	The Steering Committee was informed of some administrative issues that delayed processing of the contract. Those issues have been discussed and resolved. However, the delay in processing the contract might make it difficult for the Consortium to complete the genetic analyses by the date indicated in the proposal and a delay of about 3 months would be reasonable. It was also noted that the current proposal does not include a component for aging (reading the hard parts sampled). The Steering committee agreed that these samples need to be aged, but noted that it is most important to continue collecting samples and to complete the genetic analyses. Therefore, the SC recommended the proposal be accepted as submitted and to move forward with signing the contract as soon as possible.
2013	12	SC-09/13	BIOL	The SC recommended that the biological sampling be continued at similar levels to those in phase 4.
2013	12	SC-09/13	BIOL	In addition to continuing the biological sampling, priority should be given in 2014 to establishing a reference collection for otoliths and spines and developing standardized and validated aging techniques. The SC recommended supporting the participation of invited experts to a workshop of bluefin tuna larval biology standardized and validated aging techniques. At least 50 otoliths and 50 spines (one otolith and one spine from the same fish), covering a range of sizes, should be prepared and mounted. The SC recommended that funds should be allocated from the GBYP to help sponsor this process, including a workshop, during Phase 5.
2013	12	SC-09/13	BIOL	The SC recommended supporting the participation of invited experts to a workshop of bluefin tuna larval biology.
2013	12	SC-09/13	COORD	The SC recommended that coordination with other National Research Programs be improved; particularly with the national programs in place in the western Atlantic.
2013	12	SC-09/13	DATA	The SC recommended going ahead with the proposal for phase 4, provided the tenders include, for all records, flags with codes that designate the reliability of each record based on well-defined criteria. The flag codes should include text describing any differences in opinion among the investigators.
2013	12	SC-09/13	DATA	The SC recommended that, as part of phase 5, an in-depth analysis of these data should be conducted for producing estimates (including uncertainty) of total catch, size composition, and growth rates in cages.

Year	Month	Ref	Activity	Action/Recommendations
2013	12	SC-09/13	FUTURE	The SC agrees with previous SCRS recommendations to the Commission regarding the possibility of establishing a "scientific TAC" for bluefin tuna (SCRS 2012).
2013	12	SC-09/13	FUTURE	The SC agreed that a draft document addressing the future of the program should be prepared in advance of the Steering Committee meeting planned for September 2014.
2013	12	SC-09/13	MOD	The SC agreed with the recommendations from the Bluefin Methods meeting in Gloucester, MA, in that the priority for this year (phase 4) is to develop and implement a detailed multi-annual work plan that includes objectives, deliverables and responsibilities, for presentation at the SCRS for agreement and finalisation (based on the outline established at the 2013 Bluefin Tuna Stock Assessment meeting in Gloucester, Ma). A core modelling steering group should be established to oversee the development and subsequent implementation of the plan, the chair of which should be an external expert contracted for about 3 months per year (beginning in phase 4) to serve as the program coordinator .
2013	12	SC-09/13	MOD	The SC recommends that the program Coordinator continue to manage the project in phase 5 and 6 (approximately 3 months per year), assisted by the Secretariat's relevant expertise in modelling.
2013	12	SC-09/13	MOD	The SC further recommended an external expert be contracted full-time during phase 5 and 6 to develop the computer code and run the operating model based on the mathematical equations and model scenarios recommended by the modelling steering group.
2013	12	SC-09/13	TAG	The SC recommended to continue the various tagging enterprises. Depending on the amount of funds available, highest priority should be given to the three pilot studies on adult fish (traps in Morocco and Sardinia and purse seine in the Tyrrhenian Sea) and the tagging of juveniles (ages 1-3) in the Adriatic Sea using purse-seines and cages. The next highest priority should be given to extending the pilot study in the Tyrrhenian Sea for tagging adults to include juveniles.
2013	12	SC-09/13	TAG	The SC further recommended to continue the tagging and recovery of juveniles (ages 1-3) in the Bay of Biscay and Strait of Gibraltar, respectively.
2013	12	SC-09/13	TAG	The SC also recommended that further development of novel methods for tagging be encouraged.
2013	12	SC-09/13	TAG	The SC also recommended, at a somewhat lower priority than the aforementioned projects, a call for a short-term contract to review the literature on PIT tagging programs and identify the health issues that have arisen, if any, in regards to food safety.
2013	12	SC-09/13	TAG	The SC recommends the GBYP Coordinator explore the feasibility of tagging in the Eastern Mediterranean for Phase 6.
2013	12	SC-09/13	TAG	The SC also recommends that the recovery of tags be formally included as a high priority task for BFT National and ROP observers.
2013	12	SC-09/13	TAG	The SC recommended that full use be made of the residuals of funds still available for Phase 4 (approx. 114,000 euro). Approximately 50,000 – 60,000 euros will likely be spent on the contracts relating to the modelling coordinator and PIT tagging review. The SC recommended that any remaining funds be spent on a combination or archival and mini-PAT tags.
2014	9	SC-09/14	AS	C3) Aerial survey activity: the SC recognized that the budget originally set for this item was underestimated and recommended

Year	Month	Ref	Activity	Action/Recommendations
				the Coordinator to improve the budget up to the best estimated amount, without going over a maximum of 600,000 euro.
2014	9	SC-09/14	AS	C4) Calibration: the SC, even recognizing the serious difficulties for carrying out a calibration with many different pilots and observers, recommended the Coordinator to keep this budget item, improving the budget as necessary, taking into account that the available estimation was in the order of 90,000 euro.
2014	9	SC-09/14	BIOL	The SC recommends collecting samples of young of the year (YOY) at least in Turkey, Spain, Italy and Morocco. Due to the fact that the contract with the Consortium was already expired, the SC recommends immediately releasing contracts o the institutions or individual scientists already involved in the previous contract which will be able to provide the necessary samples within the very short time available. The GBYP Coordinator is requested to investigate as soon as possible the availabilities and the necessary budgets, within the limits of the available funds for this budget item.
2014	9	SC-09/14	BIOL	the SC, taking into account the information provided by Mr. Porch on a close-kin genetic tagging study being conducted for western Atlantic bluefin tuna, recommends developing a preliminary appraisal of the costs of a similar program for eastern Atlantic and Mediterranean Bluefin tuna. This should be done in collaboration with experts having local knowledge of the eastern Atlantic and Mediterranean populations. A short-term contract is needed to facilitate this collaboration and to support travel costs for a meeting in the USA..
2014	9	SC-09/14	BIOL	E1) Ageing calibration: the SC acknowledged the good results provided by the first exercise carried out in 2014 (SCRS/2014/150) and recommends continuing the efforts for improving the technique, keeping this budget item for Phase 5.
2014	9	SC-09/14	COORD	A(1) - The SC recommends hiring two staff, one for data analyses and data assistance (with GIS use capabilities) and one as support and assistance for the many duties of the Coordinator;
2014	9	SC-09/14	COORD	A(1) - The SC recommended the Coordinator to check the possible level options with the ICCAT Secretariat and adjust the budget accordingly.
2014	9	SC-09/14	COORD	A(2) - The budget for travels should be slightly improved, taking into account the following point.
2014	9	SC-09/14	COORD	A(5) - The SC recommends improving the support from external members, asking for a second external member. Therefore, the budget should be revised and set at 40,000 euro per year, in total. The SC recommends taking the necessary steps for having the formal approval from the Commission.
2014	9	SC-09/14	DM	B(1)a - The SC acknowledge the discovery of a high quantity of bluefin tuna vertebras, recovered by the University of Istanbul and reported to SCRS (doc. SCRS/2014/167) and covering a period of 8 centuries, starting from IV a.C.; these samples can provide very useful genetic data on the old eastern Mediterranean/Black Sea population components. The SC recommends the Coordinator to assess the budget and include this item in Phase 5.
2014	9	SC-09/14	DM	B1b) Data recovery: The SC discussed about the need to acquire SST data to be used for updating the prediction model which uses the aerial survey data; Mr. Bonhommeau informed the SC that these data can be made available to GBYP for free by his team, without any need to use funds for this item.

Year	Month	Ref	Activity	Action/Recommendations
2014	9	SC-09/14	DM	B2a) Data standardization and basic analyses: The SC notes that this budget item covered the short-time contract previously used for an external assistance; taking into account the previous point A1), the SC recommends the Coordinator to check with the ICCAT Secretariat the best way for dealing with this need and set the budget accordingly.
2014	9	SC-09/14	DM	B2c) Market data analyses: the SC considered the outcomes provided by the SCRS BFT Data Preparatory Meeting in May 2014 and then recommended the Coordinator to remove this budget item from Phase 5 budget.
2014	9	SC-09/14	MODEL	F7) External expert assistance: the SC discussed this budget item and recommended the Coordinator to keep the budget at the level already agreed.
2014	9	SC-09/14	TAG	Due to the lack of juveniles in this time of the year in two areas where there was the plan for tagging several fish (the information was communicated to GBYP by the two institutions who carried out the tagging in the same areas in 2013 and it seems caused by an anomalous oceanographic and climate situation), and to the difficulties for putting in place a tagging activity in another area, the SC recommends to use the available funds for acquiring the maximum possible number of electronic tags. The GBYP Coordinator is requested to check with the EC Project Officer which formal steps (if any) are necessary for this change
2014	9	SC-09/14	TAG	D2) Tagging trials with purse seiners and tuna traps: the SC recommended to put tagging in the eastern Mediterranean as first priority, dedicating efforts for tagging in this area using both electronic (on adults or juveniles) and conventional tags (on juveniles), with the objective to implant about 50 miniPATs. The SC recommended the Coordinator to arrange all necessary actions, within the budget already set for this item.
2014	9	SC-09/14	TAG	D4) Tag rewards: taking into account the improved number of reported tags noticed in the last two years, the SC recommends the Coordinator to slightly improve this budget item up to 20,000 euro.
2015	2	SC-02/15	AS	The SC confirmed it previous recommendation about the area to be covered by the survey based on the map developed last year (Figure 3 in Di Natale 2014). It recommended that the current contract is extended to provide the survey design (i.e. tracklines and coverage by area) and for the basic analyses of the survey results.

Year	Month	Ref	Activity	Action/Recommendations
2015	2	SC-02/15	AS	It noted that one successful approach for this attempted in other surveys has been to have each of the professional spotters within a plane when the survey is being conducted to make independent estimates of school and fish sizes for each sighting made during a survey. Such data can then be used to calibrate the estimate of one spotter relative to another. By rotating spotters during the course of a survey, one is then able to calibrate estimates across a large number of spotters. Using this approach, calibration experiments can be done with minimal additional cost to the overall survey. However, it is essential that the estimates made by the two spotters are truly independent (e.g. without discussion between them or subsequent feedback on the estimates made). The data collected by scientific spotters are critical for ensuring that this does in fact occur. The SC recommended that this approach be utilized in the aerial survey in Phase 5. It recognized that there may be considerable logistic problem in achieving this. It recommended that the following approach be used for structuring the contracts for the aerial survey in order to achieve this. One call for tenders would be made for companies to supply aircrafts with a profession spotter pilot to undertake the survey work in the various areas to be surveyed. The TOR for this contract would specified that the plane would also be required to carry an additional spotter and one or two scientific spotters that would be supplied independently under a separate contract) and that the spotter these spotters could be changed during the course of the survey (the names and rotational plans for these spotters would need to be set prior to survey in order to obtain the requisite permits).
2015	2	SC-02/15	AS	The SC agreed that the GBYP plans for the aerial survey in Phase 6 should be reassessed in light of the cost-benefit analysis and, if necessary, that the corresponding budget should be reallocated for improving other budget items, even if this will necessarily implies an amendment to the EU Grant Agreement that will be signed before the beginning of Phase 6.
2015	2	SC-02/15	BIOL	The SC recommended that the terms of reference for the biological sampling in Phase V need to be explicit in stating that sampling needs to be conducted to ensure that otolith and genetic samples are collected by fishery over the size range of fish actually captured by that fishery.
2015	2	SC-02/15	BIOL	The SC recommended to have the bluefin tuna larvae workshop that was moved from Phase 5 to Phase 6 and to allocate about 20.000 euro for that purpose.
2015	2	SC-02/15	COORD	The SC recommends that remaining funds originally budgeted for coordination and not spent because of the transfer of the GBYP research assistant to another ICCAT position should be allocated to the purchase of additional electronic tags and urged the program coordinator to attempt to purchase such tags before the deadline of expenditure of these funds is reached
2015	2	SC-02/15	COORD	The SC re-iterated its previous recommendation for the need for additional assistance both in coordinating the GBYP activities and in ensuring that all data collected by the GBYP were appropriately included within the general ICCAT database system.
2015	2	SC-02/15	COORD	The SC recommended that as a general principle that contracts for activities related to a single and specific component of the GBYP should be included within the work and budget for that activity and that the activities included within the Coordination component should be those directly related to the general implementation and administration of the overall program.

Year	Month	Ref	Activity	Action/Recommendations
2015	2	SC-02/15	DM	The SC confirmed it previous recommendation that the historical genetic analyses be continued under Phase 5 with a budget of 20,000 euro. It also recommended that this work be undertaken as an extension to the previous contract and that there was no need for a new call for tenders for this work.
2015	2	SC-02/15	DM	It was decided to continue processing data from ancient traps, using the ICCAT methodology as agreed with the SCRS BFT Species Group and the Subcomstat. As soon as this work will be fully completed and verified, then it will be possible to cross check these data sets with the already existing GBYP trap data base, for eliminating duplicates, filling holes and verify and resolve any possible discrepancy, for finally incorporate this long list of data in the ICCAT BFT data base as agreed. New trap data from 1950 on will be agreed with national scientists when necessary.
2015	2	SC-02/15	DM	The GBYP Coordinator informed the SC of a new data set found in the Canary Islands which might be interesting for the project and might provide a new insight on tuna catches for a fishery which escaped from any previous statistics. Furthermore, it seems that additional size/weight data sets, concerning some recent years of Mediterranean BFT LL can be successfully recovered, as well as few additional historical trap data sets that were previously not available. Considering that these data sets can be useful for further improving the data collected so far, the SC agreed to recommend recovering them, setting a budget level for Phase 6 close to the one used in Phase 5.
2015	2	SC-02/15	MODEL	The SC decided to improve the budget allocation set for the Modelling MSE meeting (logistic, travels and accommodation) up to 40.000 euro. Furthermore, the SC allocated a maximum of 40,000 euro for the overall power analysis. The budget for other budget items will be revised by the GBYP Coordinator according to the effective costs.
2015	2	SC-02/15	TAG	The SC noted its discussion above to re-recommend a short term review to evaluate the extent of PIT use in other fisheries practice, and any associated documented health problems and review any risks that may have been identified (or the lack of risks). It agreed that this was important to determine whether recommencing conventional tagging could be considered as an options in latter phases of the program.
2015	2	SC-02/15	TAG	The GBYP Coordinator informed the SC that the full data sets for some electronic tags which remained at sea for less than 19 days in previous GBYP Phases can now be processed according to improved software by CLS. The number of these tags is still to be exactly defined, but it will be very limited; at the same time, the amount requested by CLS for processing these data will be much lower than a normal amount, but it will depend by the total number of tags. The SC agreed to get all detailed data during the last part of Phase 5 and include these costs under the budget item for Tagging.
2015	9	SC-09/15	COORD	The GBYP Coordinator proposed intensifying the activity by making a short video spot which would be distributed to coastal countries TV stations for free, translated in many languages, but the cost for this production should be assessed. The SC agreed about this proposal and asked the GBYP Coordinator to get a preliminary assessment of the cost and include it on the provisional budget for Phase 6 if it is within a reasonable amount.

Year	Month	Ref	Activity	Action/Recommendations
2015	9	SC-09/15	MODEL	As concerns the close-kin genetic study, the SC recommended to possibly release the contract for the second part of the close kin genetic study (definition of genetic markers and related budget for performing the necessary activities) within Phase 6, to the same expert(s) already awarded for carrying out the first part of the study in Phase 5. The decision about any activation of the close-kin genetic field activity in Phase 6 will be taken after the full feasibility study will be available along with a budget
2015	9	SC-09/15	MODEL	The SC strongly supported the continuation of ongoing MSE modelling activity and decided to allocate to this activity a similar budget as in the previous phase. As well, it considered crucial the prolonged contract arrangements of the MSE key experts (Joe Powers and Tom Carruthers). In order to ensure continuity, it was recommended to extend the contracts of the key experts and possibly sign a new contract with them in strict continuity, avoiding any time hole.
2015	9	SC-09/15	TAG	. The SC recommended to provisionally include in the budget only the electronic tagging activities, a sufficient number of tags and the related services. More details about the activities to be carried out will be set before presenting the final plan of the activities for Phase 6 for funding.

Annex 5 Summary of Calls for Tender Issued by GBYP by phase and by year.

Activity	Year	Phase	Call Date	Offer submission deadline	Award date	Notes
Data recovery	2010	1	11/06/2010	30/06/2010	30/07/2010	
Data recovery - Supply of SST data and maps	2010	1			26/10/2010	Contract based on SC recommendation.
Data recovery	2011	2	26/01/2011	11/03/2011	24/03/2011	
Trap symposium - organisation	2011	2	09/03/2011	16/05/2011	16/05/2011	
Data recovery	2011	2	20/12/2011	13/02/2012	19/04/2012	
Data recovery	2012	3	08/10/2012	23/10/2012	24/10/2012	
Data recovery	2013	4	04/07/2013	18/07/2013	25/07/2013	
Data recovery	2013	4	30/04/2013	31/05/2013	extended	
Data recovery	2015	5			07/05/2015	
Data recovery	2016	6	14/03/2016	01/04/2016	12/04/2016	
Data recovery - electronic tags	2016	6	25/04/2016	09/05/2016		Invitation to 3 entities
Aerial survey design	2010	1	23/03/2010	30/03/2010	07/04/2010	
Aerial survey design	2011	2			21/03/2011	Extension of previous contract (SC Rec)
Aerial survey design	2013	4			15/04/2013	Extension of previous contract (SC Rec)
Aerial survey design	2015	5			11/03/2015	Extension of previous contract (SC Rec)
Aerial survey	2010	1	06/04/2010	20/04/2010	29/04/2010	
Aerial survey	2011	2	05/04/2011	22/04/2011	extended	
Aerial survey	2011	2	25/04/2011	28/04/2011	04/05/2011	
Aerial survey	2013	4	19/04/2013	06/05/2013	17/05/2013	
Aerial survey	2015	5	08/04/2015	27/04/2015	06/05/2015	
Aerial survey data elaboration	2010	1	30/06/2010	30/07/2010	06/08/2010	
Aerial survey data elaboration (+SST)	2010	1	29/03/2010		29/10/2010	Call for expression of interest
Aerial survey data elaboration	2013	4			13/08/2013	Extension of previous contract (SC Rec)
Aerial survey data elaboration	2015	5			04/08/2015	Extension of previous contract (SC Rec)
Aerial survey power analysis	2012	3			21/12/2012	Extension of previous contract (SC Rec)
Aerial survey power analysis	2015	5	25/11/2015	13/12/2015	18/12/2015	
Aerial survey new protocols and training course	2015	5			21/05/2015	
Biological sampling scheme	2011	2	11/03/2011	20/03/2011	28/03/2011	

Activity	Year	Phase	Call Date	Offer submission deadline	Award date	Notes
Biological sampling and analyses	2011	2	27/04/2011	13/05/2011	27/05/2011	
Biological sampling and analyses	2012	3	26/03/2012	27/04/2012	extended	
Biological sampling and analyses	2012	3	03/05/2012	10/05/2012	07/06/2012	
Biological sampling and analyses	2013	4	06/03/2013	25/03/2013	07/10/2013	
Biological sampling and analyses	2015	5	29/04/2015	11/05/2015	extended	
Biological sampling and analyses	2015	5	09/06/2015	22/06/2015	06/07/2015	
Biological sampling (adults)	2016	6	18/05/2016	15/06/2016		
Tagging design	2010	1	28/07/2010	13/08/2010	29/10/2010	
Tag awareness and reward campaign	2011	2	28/07/2011	01/09/2011	03/09/2011	
Field Tag awareness activities	2014	4	02/04/2014	28/04/2014	13/05/2014	
Tag awareness activities	2016	6	09/05/2016	25/05/2016		Under selection
Tagging	2011	2	12/05/2011	05/06/2011	extended	
Tagging	2011	2	16/06/2011	26/06/2011	11/07/2011	
Tagging	2012	3	26/03/2012	27/04/2012	extended	
Tagging	2012	3	03/05/2012	10/05/2012	21/06/2012	
Tagging	2013	4	06/03/2013	25/03/2013	10/04/2013	
Tagging	2015	5	22/04/2015	04/05/2015	08/05/2015	
Tagging	2016	6	19/04/2016	08/05/2016	17/05/2016	
Tagging cost/benefit analysis	2015	5	25/11/2015	13/12/2015	22/12/2015	
Tagging: Close kin feasibility	2015	5	16/06/2015	26/06/2015	no bids selected	(1 bid, not selected)
Tagging: Close kin feasibility	2015	5	14/10/2015	26/10/2015	12/11/2015	Invitation to 10 entities (SC Rec)
Modelling: Coordinator	2014	4	10/01/2014		24/01/2014	Call for expression of interest (SC Rec)
Modelling: Coordinator	2015	5			21/04/2015	Direct contract (SC Rec)
Modelling: Risk assessment	2012	3	06/09/2012	16/09/2012	19/09/2012	
Modelling: Support to stock assessment	2011	2	15/03/2011	01/04/2011	06/04/2011	
Modelling: Support to stock assessment	2011	2	13/10/2011	28/10/2011	02/11/2011	
Modelling: Support to stock assessment	2012	3	06/09/2012	30/09/2012	16/10/2012	
Modelling: Support to stock assessment	2013	4	19/04/2013	28/04/2013	30/04/2013	
Modelling: Support to stock assessment	2013	4	09/12/2013	10/01/2014	24/03/2014	
Modelling: Support to stock assessment	2014	4	04/04/2014	28/04/2014	19/05/2014	

Activity	Year	Phase	Call Date	Offer submission deadline	Award date	Notes
Modelling: Support to stock assessment	2015	5			19/05/2015	Extension of previous contract (SC Rec)
Modelling: Support to stock assessment	2016	6			30/05/2016	Extension of previous contract (SC Rec)
GBYP review - mid term	2013	4	27/06/2013	15/07/2013	29/07/2013	
GBYP review - second	2016	6	09/03/2016	27/03/2016	11/04/2016	

Annex 6 Email request for feedback on GBYP from interested parties.

The standard email below was sent out to the contacts listed in **Annex** 1 to enable the reviewers to collect their views on the GBYP programme.

Dear Colleagues

Following the recommendation at the 2016 ICCAT Commission meeting to conduct a review of the GBYP prior to the extension of the programme, MRAG Ltd (through John Pearce and Michael Sissenwine) have been contracted to conduct a second external review of the programme.

Unfortunately it is not feasible (mainly because the limited time available for the review) to convene a program review meeting in which key scientists and sponsors could present their scientific work and/or perspective, respectively. Nevertheless, we would like your input to help us address the Terms of Reference of this review, we would like to allow you as a key contributor to the programme, through Based on your involvement in the Steering Committee or Species Working Group, it would be very helpful to get to your views in response to a few broad questions.

Due to the short timeframe for this review we would ask that responses if possible are provided by the 11th June 2016, and would hope that this does not inconvenience you too much.

In responding to the questions we would also wish to know if you would:

(a) – Prefer your responses to remain anonymous;
(b) – Note that you had responded to the questions but responses would not be attributed to yourself (NB: If only one person responds on a particular question this would be treated as anonymous); or
(c) – Allow your responses to be openly cited.

Question 1: Importance of the GBYP – Please describe how you understand the GBYP has been important in developing the understanding and management of Atlantic bluefin tuna and how the objectives of the programme have contributed to this.

Question 2: Successes – Please describe positive outcomes that you would like to highlight of the GBYP to date (e.g. the success of any particular component that has contributed to the better understanding of Atlantic bluefin tuna or the benefit of a dedicated programme enabling the better organisation of particular research themes).

Question 3: Disappointments – Please describe disappointing aspects of the GBYP that have occurred during the programme (e.g. inability to implement particular studies, planning issues).

Question 4: Future of GBYP – Where do you see the focus of the GBYP firstly between 2016 and the projected end in 2021 and secondly potentially beyond?

Question 5: Management – How satisfied are you with the management of the GBYP and what, if anything, would you suggest could be improved?

If you have any questions please do not hesitate to contact me.

Best regards

John Pearce