**SHORT-TERM CONTRACT FOR MODELLING APPROACHES: SUPPORT TO BFT**

**ASSESSMENT (GBYP 07/2017) OF THE ATLANTIC-WIDE RESEARCH PROGRAMME ON**

**BLUEFIN TUNA (ICCAT-GBYP – Phase 7)**

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**Progress Report 6 including workplan**

**Executive summary**

Progress from September 2016 – February 2017. The previous contract saw the development of a fully functional R package for developing and testing MPs for various Atlantic bluefin tuna operating models including full documentation and tutorials.

Progress from May 2017 – July 2017. Prior to the assessment meeting the priority has been updating the various data and fitting the latest operating models accounting for the recommendations of the CMG report.

Status of MSE framework. MSE development in terms of functionality is the same as September 2016 and requires two principal inputs from a wider group: **management objectives** (performance metrics) and **management procedures** (Figure 1)

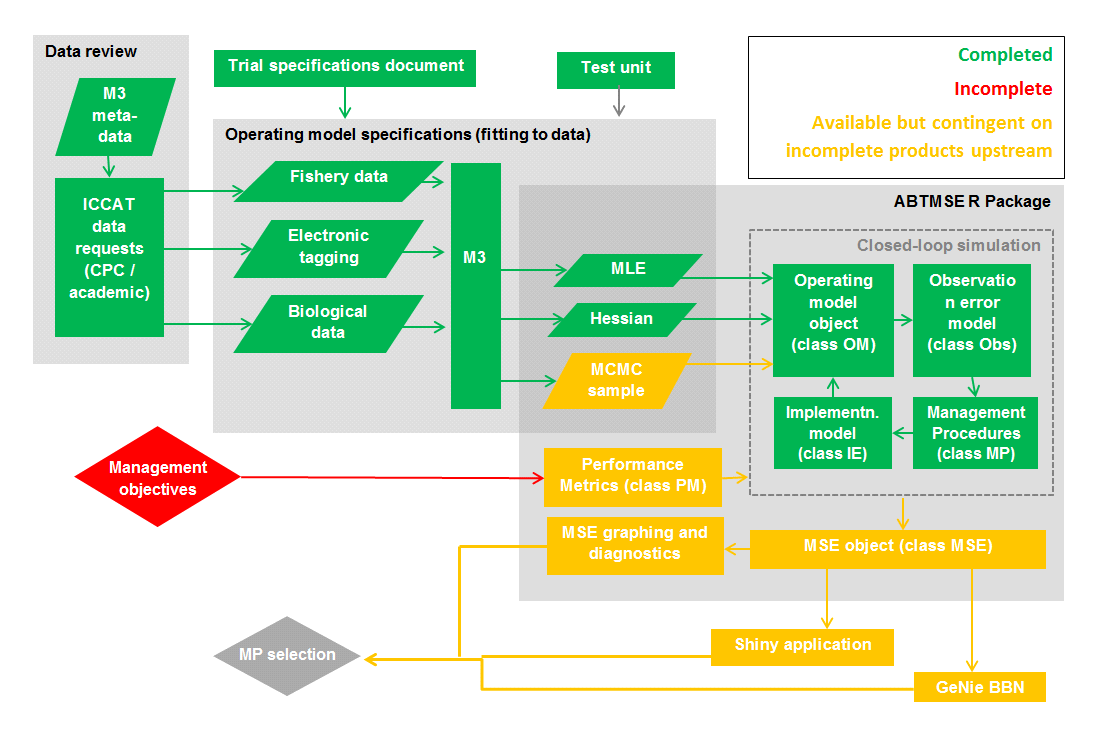


Figure 1. MSE status

**Progress in previous contract since Progress Report 5 (Sept 2016 - Feb 2017)**

***Data***

- Following the data preparatory meeting the fleet structure and data formats were finalized and the meta-database was updated.

- The fishery, survey, tagging and stock of origin data were formatted for the operating model

- [A draft SCRS paper](https://drive.google.com/open?id=0B0HYOP0BN5RPN3VxTmo4SVZqQUE) was written that provides a full account of the derivation of the ‘master index’ that is central to the operational modelling.

- The online [meta-data summary](https://drive.google.com/open?id=13pFaM3BTnzQ1BNQGoYn4O2n1IeD18V3VTbN9Hv7139U) was linked to the corresponding sources of data in the GitHub repository.

***Operational modelling***

- A final operating model structure ([M3 v1.4](https://drive.google.com/open?id=0B0HYOP0BN5RPYkJ4X0QydjZUNGM)) was designed following feedback from the Core Modelling Group including a new model initialization by stock reduction analysis to account for catches before 1960

- The new operating model was simulation tested to check for coding errors, identifiability and to establish suitable data weightings

- The trial specifications document was updated following feedback from the core modelling group

***MSE development***

- The 18 reference operating models were fitted to data and reproducible [R scripts](https://drive.google.com/open?id=0B0HYOP0BN5RPUThxcWJ1b1p2dHM) are available that describe this process.

- A [standard operating model fitting report](https://drive.google.com/open?id=0B0HYOP0BN5RPYXNWVHdxSjNTa2s) was developed in R markdown and these were generated for each reference operating model.

- A comprehensive set of R functions were developed to allow for the simple and rapid design of operating models, fitting of operating models to data, design of management procedures, specification of performance metrics and the running of Management Strategy Evaluation

- All of the R code, data and objects were compiled into a single R package ([ABTMSE](https://drive.google.com/open?id=0B0HYOP0BN5RPeDJYVE5mT0FGSTg)) with complete documentation for all functions, objects and data to be used in MSE analyses.

- The raw data, R scripts, Reports, help documentation and the R package were assembled in a single directory which can be downloaded from the [ICCAT GitHub repository](https://github.com/ICCAT/abft-mse).

***Documentation***

- An extensive user guide was developed in R markdown that describes the file structure, the project and guides users through the various functions of the R package including worked examples of the 7 steps of MSE development (of Punt and Donovan, 2007)([Appendix 4](https://drive.google.com/open?id=0B0HYOP0BN5RPV1BXOGk0cEwyTGM)).

- A fully documented website was produced using ‘pkgdown’ that can act as the front page of the ICCAT abft-mse repository and has links to various documentation including all the functions and objects of the R package ([Appendix 5](https://drive.google.com/open?id=0B0HYOP0BN5RPS0l6Q2cwb1FpVU0))

- Software design documentation for the M3 assessment model, ABTMSE R package and an M3 guide.

**Progress in current contract since Progress Report 5 (May 2017 - July 2017)**

***MSE documentation updates***

- Trial specifications document

- Updated standard operating model report

***Data update for OM conditioning***

- Latest PSAT tagging data (provided by M. Lauretta)

- Master index recalculated to include assessment CPUE indices (additional trend information, spatial and seasonal distribution still determined by Task II CPUE)

- 2017 Assessment compatibility

* Fishery CPUE indices
* Updated fleet definitions
* Spawning biomass indices
* New mortality at age schedule
* New maturity (spawning fraction) at age schedule
* New growth model (with length based variability calculation)
* Latest CATDIS data
* Latest Task II CPUE
* Updated size composition dataset

***Operating model structure updates***

- Move to annual recruitment estimates

- Initialization by master index but then F modification by season and area (allowing for seasonal shifts in spatial distribution to fit electronic tags and stock of origin data). Essentially 40 additional parameters have been added (10 areas x 4 seasons) to allow greater flexibility to fit existing data and rely less on the structure imposed by the master index.

- Stock reduction initialization moved up from 1960 to 1981 to avoid attempting fit to inconsistent fishery composition data.

***Fixes to ensure model stability***

- To avoid generation of spatially cryptic biomass, stock of origin data for stock-specific areas were invented. For example 100 observations of Eastern fish in the South East Atlantic but no observations of Western fish. Similarly, 100 observations of Western fish in the Caribbean but no observations of Eastern fish.

- Given that the electronic tag and stock of origin data do not cover all age classes, areas and seasons the gaps can lead to cryptic biomass in areas/seasons where there are no catches. This creates instability in model predictions of the magnitude of the two stocks. To prevent the optimization from exploring these parameter vectors, a weak prior on the eastern to western stock ratio of 8:1 was included.

**Current status of deliverables and actions required to achieve them**

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| --- | --- | --- |
| **Deliverable 1 July 20, 2016 (100%)** | | |
|  | i | Workplan outlining the actions required to complete the final deliverables |
|  | ii | Presentation and short report summarizing current status of deliverables and actions required to achieve them |
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The workplan (deliverable i) is included in Section 5 below. The purpose of Progress report 5 and accompanying presentations was to address deliverable ii.

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| **Deliverable 2 September 23, 2017 (0%)** | | |
|  | i | Updated presentations and short report summarizing current status of deliverables and actions required to achieve them |
|  | ii | Examples based on agreed trials, to include output statistics and fully OM conditioning diagnostics |
|  | iii | Draft papers on application of MSE |
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| **Deliverable 3 November 3, 2017 (0%)** | | | |
|  | i | Updated presentations and short report summarizing current status of deliverables and actions required to achieve them |
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| **Deliverable 4 February 21, 2018 (0%)** | | |
|  | i | Updated **Repository** with full tracking including version control for software development  <https://github.com/ICCAT/abft-mse> containing the OM |
|  | ii | Update of **SDP** (Software Development Plan) that will be reviewed by external experts, as agreed at Monterey meeting |
|  | iii | **Test Unit** so that code can be validated |
|  | iv | **Meta Database** summarizing all parameters and assumptions used  https://github.com/ICCAT/GBYP-MetaDB |
|  | v | Evaluation of **Management Procedures** implementation by 3rd parties.  Written up as SCRS papers and code available in repository |
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**Current status of objectives**

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| **Objective** | | | **Tasks (bold are completed)** |
|  | **i**  (100%) | Ensure the Operational Model (OM) implements the trials as specified by the 2016 CMG report. | **Added (M3 v1.0):**  **age-based movement, plus group, model initialization at equilibrium estimated F, recruitment predicted from SSB in previous year, a prior for depletion to allow the model to fit specified depletion.** |
|  | **ii**  (100%) | Us the test unit to validate the age-based movement model | **Test unit is being updated to match developments in the operating model** |
|  | **iii**  (0%) | Work with third parties to add MPs to the MSE framework including empirical control rules and simple stock assessment methods | Reach out to national scientists, members of the BFT WG (possibly leverage the chairs of Eastern and Western WGs) and the CMG to develop new MPs or to incorporate existing MPs (e.g. CCSBT) |
|  | **iv**  (0%) | Run the MSE in collaboration with BFT Species group | Requires a dedicated meeting following finalization of the TS, fitting of the appropriate OMs and integration of these into the R ABT-MSE framework. |
|  | **v**  (50%) | Collaborate with the SCRS and others (e.g. rRFMOs) to develop interactive web based graphics to communicate MSE results to decision makers and stakeholders. |  |
|  | **vi**  (100%) | Work with other to update and maintain the meta database of the available bluefin data and knowledge <https://github.com/ICCAT/GBYP-MetaDB> | **The meta database has been made publically available and editable** [https://docs.google.com/spreadsheets/d/ 13pFaM3BTnzQ1BNQGoYn4O2n1IeD18V3VTbN9Hv7139U/ edit#gid=1352276725](https://docs.google.com/spreadsheets/d/%2013pFaM3BTnzQ1BNQGoYn4O2n1IeD18V3VTbN9Hv7139U/%20edit) |
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**Workplan for achieving deliverables**

Following the data preparatory meeting, it was clear that the data for the operating models would become available earlier than scheduled under the previous workplan of report 4 (see Figure 2 for the latest workplan and changes from previous version). The meta-database update was completed in light of the data preparatory meeting however it is subject to ongoing updates as data become available or are refined (finalization of maturity, growth model and inverse age-length key derivation).

A demonstration MSE is a part of deliverable 3 and should include user-specified MPs, and performance metrics that have been subject to review by stakeholders. However, the previous workplan did not acknowledge a prior, more cursory demonstration MSE that is part of deliverable 2 which is now reflected in the updated Gantt chart (Demonstration MSEs 1 and 2).

* **Repository with version control (Complete, August 2016)**

The most recent version of the M3 model is the first to be simulation tested and fitted to the operating models of the trial specifications document. This constitutes a first beta, a working example that is fit for purpose (v1.0). The ICCAT MSE GitHub repository is now linked with local repositories and will be updated on a regular basis to reflect changes in code and software documentation moving forwards.

* **Software development plan (October 2016)**

A manual and software design document are available for the latest version of the M3 operating model (/Manuals and design documents/). A software design document and manual is currently being drafted for ABT-MSE R framework.

* **Test unit (Complete, Jul 2016)**

The test unit is essentially complete for v1.0 of the M3 operating model but requires more sophisticated observation error models, potentially for new sources of information such as close-kin genetics analysis and standard gene tagging.

* **Meta database (TBD depending on feedback, simple Excel version September 2016 following data preparatory meeting)**

Carruthers (2015c) describe a cursory attempt to develop a meta database describing the types, availability and ownership of various data for condition OMs. This simple excel worksheet may not provide sufficient detail and flexibility to accommodate all data. The current version has been updated and is available as a public (and editable) google document at: [https://docs.google.com/spreadsheets/d/13pFaM3BTnzQ1BNQGoYn4O2n1IeD18V3VTbN9Hv7139U/edit#gid=1352276725](https://docs.google.com/spreadsheets/d/13pFaM3BTnzQ1BNQGoYn4O2n1IeD18V3VTbN9Hv7139U/edit%23gid=1352276725)

There are two options: continue to update and expand the current google worksheet. The other option is a wholesale overhaul and redevelopment to a more dedicated and powerful data base engine. This should be a topic for discussion of the CMG members at the September species group meeting.

* **User-defined MPs (Prior to Jan 2017)**

The current ABT-MSE R framework allows for rapid design and incorporation of user-specified MPs. The precursor to this is clear documentation (the ABT-MSE R framework manual is under development and will be finalized once OM and TS have been finalized). Additionally a tutorial and potential a demo video could also help prospective MP designers become acquainted with the simulation framework and outputs.

* **Other outstanding issues**
* **Provision of electronic tagging data in requirement format**

A large number of potentially informative electronic tags were provided by the Stanford lab, but without covariate length / age data with which to assign tags to age classes (e.g. age class one: 0-3 years, age class 2: 3-8 years, age class 3: 9+ years). These data are currently not used in the conditioning of operating models despite their potential value.

* **Development of inverse age-length keys**

Inverse age-length keys (probability of a fish being of length class L given age class A) were derived by me using a very naïve approach (i.e. superimposing a 10% coefficient of variation around the maximum likelihood fit of the Richards growth curve following Allioud et al.). Time – varying iALKs are accepted by the M3 operating model that may be better derived empirically from the raw age-length data.

* **Changes to operating model structure**

The modelling and estimation of recruitment deviations prior to the initial model year was deemed of secondary importance following the guidance of the core modelling group in Monterey (January 2016). However on examining the fit of the M3 model to the master abundance indices it is apparent that without the estimation of historical recruitment the model cannot fit initial ‘bumps’ in abundance that are inferred by indices. Incorporating these changes is reasonably trivial (a few days) and a priority following the September species group meeting.

* **Derivation of a master relative abundance index**

Currently a master relative abundance index is derived in an ad-hoc manner using coarse task II catch and effort data by me the technical assistant. This index is very important to the conditioning of operating models because it infers the temporal trajectory and spatial distribution of both stocks combined. Given its importance, this index should be derived by more detailed data (trip level data) and subject to careful review by a range of stakeholders.