REPORT OF THE 2019 THIRD INTERSESSIONAL MEETING OF THE ICCAT BLUEFIN TUNA MSE TECHNICAL GROUP

(*Madrid, Spain, 19-21 September 2019*)

"The results, conclusions and recommendations contained in this Report only reflect the view of the Bluefin MSE Technical Group. Therefore, these should be considered preliminary until the SCRS adopts them at its annual Plenary meeting and the Commission revise them at its Annual meeting. Accordingly, ICCAT reserves the right to comment, object and endorse this Report, until it is finally adopted by the Commission."

1. Opening, adoption of agenda and meeting arrangements

The meeting was held at the ICCAT Secretariat in Madrid, September 19 to 21, 2019. Drs Doug Butterworth (Professor Emeritus, University of Cape Town) and Gary Melvin (SCRS Chair), the Bluefin MSE Technical Group ("the Group") Rapporteurs and meeting Chairs, opened the meeting. The ICCAT Executive Secretary, Mr. Camille Jean Pierre Manel, welcomed the participants and highlighted the importance of ICCAT's Atlantic bluefin tuna Management Strategy Evaluation (MSE) process. He thanked the participants for their work so far and emphasized the importance of this work for the Commission. The Chairs proceeded to review the Agenda, which was adopted with a small change (**Appendix 1**). Due to the time constraints, the Group focused only on the main outputs from the meeting in compiling this report.

The List of Participants is included in **Appendix 2**. The List of Documents presented at the meeting is attached as **Appendix 3**. The abstracts of all SCRS documents and presentations provided at the meeting are included in **Appendix 4**. The following served as Rapporteurs:

Sections	Rapporteur
Items 1, 8	A. Kimoto
Items 2-7	M. Lauretta, C. Fernandez, D. Butterworth, G. Melvin, J. Walter

2. Review of July Meeting results regarding Operating models (OMs)

The co-chair and the Contractee gave two presentations (SCRS/P/2019/062) updating the progress in OM developments since the meeting held in St. Andrews in July 2019. This intersessional work proceeded along the priority lines indicated in the July MSE meeting report (Section 12 of that report: Anon., 2019a), focusing particularly on the top three priorities, i.e.

- Check changes made to OM conditioning code during the July MSE meeting, and update the Trials Specification Document to include the revised selectivity specifications
- Investigate how re-weighting of contributions to the penalised log-likelihood affects model fit
- Investigate options for modeling selectivity in response to points raised at the July MSE meeting

Regarding the first bullet point, the changes made to the code were checked and no errors were found. The issue of not being able to estimate the biomass scale of the West and East areas realistically, detected at the July MSE meeting after the code changes, remained unresolved. This inability to determine scale is a consequence of failure to fit many of the abundance indices reasonably.

Regarding the third bullet point above, a revised fleet definition splitting the Japanese longline fishing fleet CPUE into an earlier series (before 2010) and a recent series (2010 and afterwards) was implemented. Therefore, 18 fishing fleets, instead of 17, are now reflected in the OMs. The selectivity of the two Japanese (East and West) longline CPUE indices corresponding to the year 2010 and onwards was modified accordingly. The selectivity of the Canadian rod and reel fishing fleet is now assigned an asymptotic shape.

The most complex investigations concerned the second bullet point, i.e. the investigation of how the weightings of different contributions to the penalised log-likelihood impacted on the model fits. The process followed to address this was:

1. First develop a better-based baseline (default) weighting approach from which to investigate sensitivities to alternative weightings.
2. Also use the analysis as a basis to understand what informs biomass scale, and whether appropriate weighting might re-establish that scale through improved fits to abundance indices.

The new default weighting scheme developed assigns weights equal to 1 for all datasets except for the catch length composition data, which are assigned weights smaller than 1 (to allow for the lack of independence across lengths). Priors are also assigned weights equal to 1, whereas catches (disaggregated by year, quarter, fleet and region) are assigned weights smaller than 1. Initial broad-scale findings were:

- The default weighting does not achieve a reasonable biomass scale (at least for the OMs without past regime shifts in recruitment)
- Upweighting the Gulf of Mexico (GOM) larval index (relative to the default weighting) can get biomass scale in the West area (and also in the East area for a very high weighting)
- Upweighting the MED (Mediterranean) larval index (relative to the default weighting) can get biomass scale in the East area
- Data conflicts detected:
  Increases in abundance in the East area (implied especially by the MED larval index) imply increases in abundance the West area because of the numbers of eastern fish which the stock of origin (SOO) data then suggest to be there; however, the West area abundance indices for locations where these eastern fish are expected to be present do not show as much increase as the first two sources of data suggest.
- Alternative weightings (upweighting or downweighting different data sources in turn) have impacts on estimates of both biomass trend and magnitude, as well as on the "Superman effect" (a strong recent rate of increase in East biomass).

The Group requested that individual data series log-likelihood components be presented to better understand their influence compared to the sum of log-likelihoods by data type.

A sub-group reviewed the Trial Specification Document's (TSD) Table 2.1, 2.2, and 3.1 and cross-referenced the information in these tables with the data file used in the operating model (M3.dat file). Tables were also reviewed for accuracy in the correct quarter (Q), strata (the 7 areas of the operating model), fleet assignment, relationships with abundance for fishery independent indices, and size range for selectivities, among others (see details in **Appendix 5**). A major change was made regarding the Canadian acoustic survey, which is to be assumed to be proportional to the eastern and western combined stock abundance in numbers of fish >159 cm (ageclasses[1] 2 and 3) in quarter 3 in the Gulf of St. Lawrence (GSL) stratum only. Originally it had been assumed to be proportional to the spawning stock biomass (SSB) of western stock for all strata combined. This change was made because the data in recent years show that the GSL has a mix of eastern and western origin fish (Anon., 2017), and the unit for this index is number of fish rather than biomass. Furthermore, the relationships of the Western MED Larval survey, USA Larval Survey, and GBYP Aerial survey indices should be to the SSB in the stratum where and the quarter when the survey has taken place. Some minor changes were made to the USA rod and reel size range of selectivites that were established during the July MSE meeting.

3. Compile candidate reference and robustness sets Oms

After discussing the results from the presentations on OM developments (SCRS/P/2019/062), the Group agreed on the following actions:

1. Further investigate the causes and robustness of the estimated large increase in eastern stock biomass in the most recent years of the model (i.e. the Superman effect). Try to identify what data series cause this effect, and if possible, group individual series that produce similar and produce contrary effects to create alternative scenarios for candidate management procedure (CMP) testing. Showing the table with log-likelihood values separated by individual indices of abundance (for both fishery-dependent and fishery-independent indices) could help interpret the results. The Contractee presented the

[1]Ageclass 1 refers to ages 0 to 4, ageclass 2 refers to ages 5 to 8, and ageclass 3 refers to ages 9+.

outcomes of downweighting the individual indices on estimated biomass trend and scale. The MED larval survey and GSL fishery index were found to be influential in producing the Superman effect, and the Group considered that alternative runs with these indices downweighted might produce desired alternative scenarios in stock trend and absolute biomass. It was noted that it is more appropriate to downweight individual series than completely remove them, so that the statistical properties of the indices remain estimated which in turn allows these indices to still be projected and hence utilised by CMPs. The decision as to whether to include these trials as part of the reference set of models or robustness tests will be evaluated by the Group after model refitting and evaluation of results. The next step is to evaluate the suite of models that do not result in a Superman effect, evaluate their convergence, and determine if they give consistent trends and provide biomass scale.

2. Examine the effect of differentially weighting the two components of SOO data (microchemistry and genetics). Conduct a sensitivity run assigning a weight of 1/3 (of the default) to the genetics SOO dataset, and one run with the same downweighting of the microchemistry SOO dataset. The microchemistry data were found to be in some contradiction with most data sources, while genetics data impact in the opposite direction and have little influence on the overall objective function or biomass estimates. The Contractee noted that the SOO data were highly influential and a major source of conflict with the indices of abundance for the West area mixed stock fisheries. The Group noted that the microchemistry data have a larger effect on the model fit due to higher effective samples sizes and the longer time series for these data (which go back to the 1970s) compared to the more recent genetic data. Although downweighting the SOO data did not have a large effect on the stock trend or biomass scale, the effect on other aspects of model fit had yet to be considered, and the measure of influence is best evaluated by the effect on performance of candidate management procedures. A need identified was to determine alternative weights for the SOO data.

3. A subgroup was formed to further consider issues connected with movement, in particular, if there is additional information that could be usefully incorporated in the model (for example, via the prior distribution for the movement parameters) (see details in **Appendix 6**). The Group noted that previously movement restrictions identified had been implemented in the package, including exclusion of GOM-origin fish migration into the MED and MED-origin fish migration into the GOM, no residency of fish in the GOM during Q3, and no fish present in the GSL during Q1. The Group initially identified two additional movement constraints that should be parameterized in the model:

   1) the biomass of GOM-origin ageclass 3 fish should be greatest in the GOM during the spawning season (Q2), and
   2) the biomass of MED-origin ageclasses 2 and 3 should be greatest in the MED during the spawning season (also Q2); ageclass 1 was not included because most of the juveniles remain in the MED and hence should not be used to estimate seasonality effects in the MED.

These dynamics were based on the knowledge of the fishery seasonality and catch histories, and supported by electronic tagging observations. The recommendations were agreed upon by the Group, and incorporated into the OMs as specified in more detail below; this is because it was important to capture the known biology of the stock accurately.

- The seasonality of the GOM spawning biomass was estimated from a joint U.S.-Mexico longline CPUE analysis conducted during the workshop in Mexico City (Walter *et al*. 2017). The quarterly distribution of spawning biomass (ageclass 3) in the GOM was estimated therefrom to be Q1: 31% Q2: 61% Q3: 7% and Q4: 1%.
- The preferred approach is to use quarterly coefficients estimated from an index standardization model using the Spanish longline data operating in the MED during the 1990s; however, this will first require consultation with the Spanish scientists to confirm that those data are available. In the interim, the nominal catch rates in the MED from the Spanish longline fleet operating during the 1990s were considered to be the best available appropriate information. The quarterly biomass distribution (ageclasses 2 and 3) was estimated therefrom to be Q1: 11% Q2: 63% Q3: 22% and Q4: 4%.
- The movement of the fish between strata from one quarter to the next will be restricted to movements that have been observed from conventional tag returns or electronic tag tracks (**Table 1**).

The Contractee agreed to run the MSE with each of the proposed revisions (seasonality of spawning residency, restrictions on regional transitions, and fleet modifications). The results will be reviewed during the 2019 Bluefin Species Group meeting prior to final acceptance of these revisions.

4. Develop plausibility weighting scenarios

There was insufficient time to address this item.

5. Develop graphical presentation of CMP results

There was insufficient time to address this item.

6. Other matters

Workplan and schedule 2020

An initial draft roadmap (see **Appendix 7**) was outlined as to how to advance the MSE process in 2020, such that TAC advice could be provided from an MP potentially adopted by the Commission in October 2021. To accomplish this, a series of meetings was proposed, which included 1) a small technical group meeting to develop proposals for the final operating models parameterizations and performance, 2) a Bluefin MSE Technical Group meeting (as part of the bluefin stock assessment data preparatory meeting) to review and adopt the final operating models, 3) a meeting of candidate management procedure developers to compare and evaluate their proposed procedures, 4) a final Bluefin MSE Technical Group meeting to evaluate and select management procedure candidates for initial presentation to the Commission in October 2020, and 5) meetings between scientists and stakeholders to review and revise, as necessary, the management procedure candidates over the October 2020 to October 2021 period.

An important milestone that must be met in order to remain on Schedule for an MP adoption in October 2021 is to have OMs adopted by April 2020 at the latest. One possibility raised was to have a pre-workshop webinar to evaluate the OMs prior to or during December 2019, so that model performance, diagnostics, and any necessary revisions could be communicated and addressed in advance of 2020 workshops.

A final roadmap will need more detail; this will best be developed following discussions in the Bluefin Species Group on assessment plans for 2020.

The Group reviewed the details of advances in the MSE process made at this meeting, as provided in **Appendix 8**. As regards the set of proposed robustness tests, additional tests were identified to span the range of uncertainties in the data and model assumptions; these are listed in **Appendix 8**. It was noted that it is highly desirable to have a range of OMs that range across the results of the stock assessments in terms of absolute biomass of both the stocks as well as the stock status estimates.

A need was identified to review the set of reality checks (2019 Intersessional Meeting of the ICCAT Bluefin Tuna Species Group in February: Anon. (in press) for screening OMs by the Bluefin MSE Technical and Bluefin Species Groups. It was recommended that this revised set of diagnostics be developed during the Bluefin Species Group meeting.

7. Recommendations

The Group recommended that the Contractee implement the changes identified above.

8. Adoption of the report and closure

The report was adopted during the meeting. The meeting was adjourned.

References

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A. Kimoto, T. Carruthers, J. F. Walter, C. Mayor, A. Hanke, N. Abid, H. Arrizabalaga, E. Rodríguez-Marín, C. Palma, and M. Ortiz. (in press). Summary of input data (catch, size and indices) used in the Atlantic bluefin tuna operating models (version 5.2.3). Document SCRS/2019/133: 21 p.

Walter J., Lauretta M., Kimoto A., Hanke A., Ramirez K., and Melvin G. 2017. Report of the Working Group on Multi-National Pelagic Longline Index for Western Atlantic Bluefin Tuna. ICCAT Col. Vol. Sci. Papers, 74 (6): 2784-2808.

Teo SLH, Boustany A, Dewar H, Stokesbury MJW, Weng KC. 2007. Annual migrations, diving behavior, and thermal biology of Atlantic bluefin tuna, *Thunnus thynnus*, on their Gulf of Mexico breeding grounds. Mar. Biol. 151: 1–18.

Table 1. Movements between spatial strata by stock and quarter used to restrict the movement of fish based on conventional tag returns or electronic tag tracks in the OMs. These are possible movements present in a particular stratum (row) that move to a stratum (column) in the following quarter for all ageclasses. The left panel applies to the Western Stock (i.e. excludes the MED), and the right panel to the Eastern Stock (i.e. excludes the GOM). Insertions are 1 if at least one such movement has been observed, and 0 if none have been observed.

West stock (all age classes) **Possible: 64%**

Quarter 1

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	1	1	0	0	0	0	0
WATL	1	1	1	1	1	1	0
GSL	1	1	1	1	1	1	0
SATL	0	1	0	1	1	1	0
NATL	0	1	0	1	1	1	0
EATL	0	1	0	1	1	1	0
MED	0	0	0	1	0	1	0

Quarter 2

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	1	1	1	1	0	0	0
WATL	1	1	1	1	1	1	0
GSL	0	0	1	0	0	0	0
SATL	1	1	1	1	1	1	0
NATL	1	1	1	1	1	1	0
EATL	1	1	1	1	1	1	0
MED	0	0	0	1	0	0	0

Quarter 3

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	1	1	1	0	0	0	0
WATL	0	1	1	1	1	1	0
GSL	0	1	1	0	1	1	0
SATL	0	1	1	1	1	1	0
NATL	0	1	1	1	1	1	0
EATL	0	1	1	1	1	1	0
MED	0	1	1	1	1	1	0

Quarter 4

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	1	1	1	0	0	0	0
WATL	1	1	1	1	1	1	0
GSL	1	1	1	1	1	1	0
SATL	0	1	1	1	1	1	0
NATL	0	1	1	1	1	1	0
EATL	0	1	1	1	1	1	0
MED	0	1	1	1	1	1	0

East stock (all age classes) **Possible: 67%**

Quarter 1

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	0	1	0	0	0	0	0
WATL	0	1	1	1	1	1	0
GSL	0	1	1	1	1	1	0
SATL	0	1	0	1	1	1	1
NATL	0	1	0	1	1	1	1
EATL	0	1	0	1	1	1	0
MED	0	0	0	1	0	1	1

Quarter 2

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	0	1	1	1	0	0	1
WATL	0	1	1	1	1	1	1
GSL	0	0	1	0	0	0	0
SATL	0	1	1	1	1	1	1
NATL	0	1	1	1	1	1	1
EATL	0	1	1	1	1	1	1
MED	0	0	0	1	0	0	1

Quarter 3

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	0	1	1	0	0	0	0
WATL	0	1	1	1	1	1	1
GSL	0	1	1	0	1	1	0
SATL	0	1	1	1	1	1	1
NATL	0	1	1	1	1	1	1
EATL	0	1	1	1	1	1	1
MED	0	1	1	1	1	1	1

Quarter 4

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	0	1	1	0	0	0	0
WATL	0	1	1	1	1	1	1
GSL	0	1	1	1	1	1	0
SATL	0	1	1	1	1	1	1
NATL	0	1	1	1	1	1	1
EATL	0	1	1	1	1	1	1
MED	0	1	1	1	1	1	1

Appendix 1

Agenda

1. Opening, adoption of agenda and meeting arrangements
2. Review of July meeting results regarding Operating models (OMs)
3. Compile candidate reference and robustness sets OMs
4. Develop plausibility weighting scenarios
5. Develop graphical presentation of CMP results
6. Other matters
   Workplan and schedule 2020
7. Recommendations
8. Adoption of the report and closure

Appendix 2

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Appendix 3

List of Papers and Presentations

Number	Title	Authors
SCRS/P/2019/062	Progress on Operating Model Conditioning since St Andrews	Butterworth D. and Carruthers T.

Appendix 4

SCRS Document and Presentations Abstracts as provided by the authors

SCRS/P/2019/062 – The authors presented progress on Operating Model Conditioning since St Andrews at the second BFT MSE TG meeting. It was checked the changes made to OM conditioning code were correct, and those changes were included in the Trial Specification Document. Investigation on how iterative re-weighting of likelihood data components affects model fit was conducted, but it was found that the weighting does not get scale in SSB. Alternative approach was investigated by changing the weighting of the larval indices in the Gulf of Mexico and in the Mediterranean.

Appendix 5

Report of sub-group on Trial Specification Document

A sub-group reviewed the Trial Specification Document's (TSD) **Tables 2.1, 2.2, and 3.1,** and cross-referenced the information in these tables with the data file used for the operating model (M3.dat file). Tables were also reviewed and updated for accuracy regarding the correct quarter (Q), strata (operating model 7-areas), fleet assignment, relationships with abundance for fishery independent indices, and size ranges for selectivities. Major changes were made to the relationships all fishery-independent indices except the French Aerial survey. The Canadian acoustic survey should relate to abundance in numbers of combined east and west stocks in quarter 3 for the GSL stratum only. Originally it was assumed to relate to the SSB of the western stock for all strata combined. This change was made because the data in recent years shows the GSL has a mix of eastern and western stock (Anon. 2017), and the unit of this index is the number of fish. The relationships for the Western MED Larval survey, GOM Larval Survey, and Aerial survey (GBYP) should be SSB in the stratum and the quarter where the survey has taken place. Some minor changes were also made to the US rod and reel size range of selectivites that were established in July 2019 MSE meeting.

The sub-group recognized that there are still challenges in using CATDIS for quarterly allocated catches by stratum by fleet in the OMs. These challenges arise from the estimation of catches that had missing data and hence failed to report Catch/Effort by quarter (e.g. purse seine catch in the Med after 2009). Further revisions may be considered later for a better understanding of the catch distribution.

TSD-Table 2.1 The standardized CPUE indices used to fit the operating models (many of which are used in stock assessments previously conducted by ICCAT). Many of these indices are available after 2016 but the operating model uses data to 2016 only due to the unavailability of CATDIS updated catch data for more recent years at the original time of model conditioning. The right-most column indicates the fishing fleets used to assign selectivity to each CPUE index; the fishing fleets are described in **Table 3.1**.

	Flag	Gear	Details	Fleet (selectivity) assigned
1	Spain	Baitboat	1964-2006, Q3, E Atl	3: BBold
2	Spain / France	Baitboat	2007-2014, Q3, E Atl	4: BBnew
3	Morocco / Spain	Trap	1981-2011, Q2, S Atl	12: TPold
4	Morocco / Portugal	Trap	2012-2016, Q2, S Atl	13: TPnew
5	Japan	Longline	1975-2009, Q2, S Atl	2: LLJPN
6	Japan	Longline	1990-2009, Q4, N Atl	2: LLJPN
7	Japan	Longline	2010-2016, Q4, N Atl	18: LLJPNnew
8	US (66cm - 114cm)	Rod and reel	1993-2016, Q3, W Atl	15: RRUSAFS (50 – 125cm)
9	US (115cm - 144cm)	Rod and reel	1993-2016, Q3, W Atl	15: RRUSAFS (100 – 150cm)
10	US (177cm+)	Rod and reel	1993-2016, Q3, W Atl	16: RRUSAFB (175cm+)
11	US (<145cm)	Rod and reel	1980-1992 (gap in 1984), Q3, W Atl	15: RRUSAFS (50 – 150cm)
12	US (195cm+)	Rod and reel	1983-1992, Q3, W Atl	16: RRUSAFB (200cm+)
13	US	Longline	1987-1991, Q2, GOM	1: LLOTH
14	US	Longline	1992-2016, Q2, GOM	1: LLOTH
15	Japan	Longline	1974-1980, Q2, GOM	2: LLJPN
16	Japan	Longline	1976-2009, Q4, W Atl	2: LLJPN
17	Japan	Longline	2010-2016, Q4, W Atl	18: LLJPNnew
18	Canada GSL	Rod and reel	1984-2016, Q3, GSL	14: RRCAN
19	Canada SWNS	Rod and reel	1988-2016, Q3, W Atl	14: RRCAN

TSD-Table 2.2 Fishery-independent indices used in the fitting of operating models.

	Type	Details	Infers:
1	French aerial survey past	2000-2003, Q3, Med	Vulnerable biomass in Q3 in Med, according to the RRUSAFS selectivity due to similar assumed size of fish
2	French aerial survey recent	2009-2016 (gap in 2013), Q3, Med	Vulnerable biomass in Q3 in Med, according to the RRUSAFS selectivity due to similar assumed size of fish
3	Western Med Larval survey	2001-2015 (gaps in 2006-2011), Q2, Med	SSB eastern stock in Q2 in Med
4	Canadian acoustic survey	1994-2016, Q3, GSL, index in number of fish greater than 159cm	Number of combined eastern and western fish in Q3 for the GSL stratum according to the estimated vulnerable biomass available to the CANRR fleet for 150cm plus
5	USA Larval Survey	1977-2016 (gaps in 1979-1980, and 1985), Q2, GOM	SSB western stock in Q2 in GOM stratum
6	Aerial survey – GBYP*	2010-2015 (gaps in 2012, 2014, and 2016), Q2, Med	SSB eastern stock in Q2 in Med

* Only the Balearic component is used for SSB (because there are problems with consistency regarding patchy or low biomass inference in other regions surveyed in the Med).

TSD-Table 3.1 Fishing fleets included in the operating model, based on the selectivities of fleets active historically in the Atlantic. Catch and length composition by fleet are prepared by year, quarter, and strata from the revised CATDIS (Kimoto *et al*. (in press)) and screened Task 2 Size. The columns of "Strata" and "Quarter" list the strata and quarters that have catches in the revised CATDIS (Kimoto *et al*. (in press)).

No.	Name	Gear	Flag	Strata	Quarter	Start – End	Selectivity type/Bounds on fleet selectivity*
1	LLOTH	LL	All except Japan	All (no GSL)	All	1964-2016	DN; 12.5 – 412.5
2	LLJPNold	LL	Japan	All (no GSL)	All	1964-2009	DN; 12.5 – 387.5
3	BBold	BB	EU.Spain, EU.France	Bay of Biscay (EATL)	2,3,4	1960-2006	DN; 12.5 – 262.5
4	BBnew	BB	EU.Spain, EU.France	Bay of Biscay (EATL)	2,3,4	2007-2016	DN; 12.5 – 312.5
5	PSMEDold	PS	All except EU.Croatia	MED	1,3,4	1960-2008	DN; 12.5 – 387.5
6	PSMEDold-Q2	PS	All except EU.Croatia	MED	2	1960-2008	DN; 12.5 – 337.5
7	PSMEDnew	PS	All except EU.Croatia	MED	All	2009-2016	DN; 12.5 – 387.5
8	PSNOR	PS	Norway	NATL, EATL	3,4	1964-2016	DN; 112.5 – 362.5
9	PSHRV	PS	EU.Croatia	MED	All	1991-2016	DN; 12.5 – 337.5
10	PSWold	PS	USA, Canada	WATL	2,3,4	1964-1984	DN; 12.5 – 362.5
11	PSWnew	PS	USA, Canada	WATL	All	1985-2015	DN; 62.5 – 337.5
12	TPold	TP	EU.Spain, Morocco, EU. Portugal	St. Gibraltar (SATL, MED)	All	1964-2011	DN; 37.5 – 362.5
13	TPnew	TP	EU.Spain, Morocco, EU. Portugal	St. Gibraltar (SATL)	2,3,4	2012-2016	DN; 37.5 – 387.5
14	RRCAN	RR	Canada	WATL, GSL	All	1964-2016	Logistic; 12.5 – 387.5
15	RRUSAFS	RR	USA	WATL	2,3,4	1964-2016	DN; 12.5 – 187.5
16	RRUSAFB	RR	USA	WATL	2,3,4	1964-2016	DN; 62.5 – 387.5
17	OTH	other	other	All	All	1964-2016	DN; 12.5 – 387.5
18	LLJPNnew	LL	Japan	WATL, SATL, NATL, EATL	All	2010-2016	DN; 62.5 – 337.5

* Selectivity type DN means double normal. Boundary shows the middle point in a length bin (width of length bin is 25cm).

Table 1. Summary table of input catch data used in the OMs will be included in the TSD. (be added to TSD).

Fishery	1: LLOTH																							
Country	All except Japan																							
Strata	1:GOM				2:WATL				4:SATL				5:NATL				6:EATL				7:MED			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1950																								
1951																								
1952					2	2	2	2																
1953					0	0	0	0																
1954																								
1955					1	1	1	1																
1956																								
1957					4	4	4	4																
1958					10	10	10	10																
1959					21	21	21	21																
1960					0	0	0	0																
1961											19													
1962					7	7	31	88																
1963					24	24	196	123													200	200	200	200
1964					25	25	214	39			63										75	75	75	75
1965					55	55	147	61			30				2				2		100	100	100	100
1966					127	141	179	157			31				5				5		125	125	125	125
1967					594	602	625	611			41										75	75	75	75
1968					359	348	346	340	1	2	77	116									150	150	150	150
1969					118	121	118	121	17	80	101	1									100	100	100	100
1970					50	50	51	50	23	20	207	3									17	17	17	17
1971					2	7	6		0	8	88	1									32	32	32	32
1972		6			1	22	1	11		1	20	0									31	31	31	31
1973			1		2	31	0	25	0	0	46										69	69	69	69
1974	0	0	0	0	6	49	4	21		1	43	5									48	67	50	48
1975	0	27			2	34	3	8	6	1	15	1									26	58	30	26
1976		6			7	153	88	28	18	20	25	12									10	116	132	17
1977		37			13	5	26	51	83	42	23	45						15	4		3	71	41	5
1978		17	8		19	23	31	10	87	29	14	27									4	58	51	6
1979	8	8	8	8	9	34	42	6	82	0	6	31									4	58	54	7
1980	3	10	3	3	1	21	6		34	56	24	7									6	61	57	9
1981	21	37	21	21		22	5	2	23	18	18	1									10	129	135	16
1982	8	22	8	8	20	17	0	0	86	8	14	34									23	258	306	39
1983	61	12			1	11	45		13	2	1	2									12	146	127	18
1984	68	21				10	49		6	1	6	31									9	221	100	14
1985	71	11			0	11	116	3	15	19	12	45									40	267	43	40
1986	352	13			33	50	251	2	38	184	33	13									9	500	101	14
1987	57	68	20	6	46	50	23	7	17	10	34	65									16	565	108	5
1988	59	23	1	0	124	87	53	25	2	0	10	5									5	989	174	9
1989	56	41	1	2	81	54	31	92	12	3	13	97									7	922	278	30
1990	171	2	2	3	75	8	31	13	26	10	4	6									24	829	130	23
1991	185	42		1	28	37	37	13	26	119	53	18									61	2,450	396	65
1992	150	24		2	66	67	43	35	23	113	108	24									82	2,371	509	60
1993	26	25	1	1	31	54	38	42		131	147	40									88	1,185	338	66
1994	16	29	2	4	39	46	19	40	0	134	69	33									84	5,352	602	419
1995	22	59	3		24	63	45	26		382	130	39									651	5,260	1,047	698
1996	16	81		1	29	100	34	15	32	735	61	43									726	6,273	1,231	861
1997	41	24	2	1	14	51	30	43	271	744	62	62							0	14	484	3,251	2,464	929
1998	16	16		6	12	40	25	80	87	418	0	1			31	37	5	5	5	7	148	2,030	1,264	314
1999	65	48		16	443	42	38	59	103	182	0	1		2	57	83	101	101	134	117	130	1,891	650	286
2000	83	56	9	0	280	21	47	91	177	174	100	100			124	167					123	2,869	193	103
2001	18	41	1	2	54	34	27	32	210	289	96	97	37		71	79					86	3,515	293	98
2002	23	73	1	4	35	106	72	50	261	57	2	0			0	1			7	32	99	2,383	280	82
2003	57	62	4	2	37	51	43	105	1	9	25	7			3	9					194	2,202	546	225
2004	41	58	1	3	18	93	56	84	4	3	7	2			2	39					132	1,641	432	185
2005	29	34	4	1	70	62	40	50	9	63	22	1				24				0	128	2,366	337	202
2006	17	18	2	5	60	106	69	61	61	61	222	24				12			6	24	94	1,856	488	140
2007	19	16	1	2	55	47	34	68	15	0	2	3				48	24				206	1,735	619	242
2008	14	39	0	0	28	67	29	95	9	0	1	1			4	115	1		9	0	174	1,258	627	238
2009	19	48	1	1	71	71	118	80	2	1		1			9		0	1	6	28	43	952	271	60
2010	22	17		1	92	66	83	70								38					72	566	474	130
2011	14	6	1	2	39	134	101	70								36					52	817	62	31
2012	88	60		7	106	51	52	50		8						38			0		15	450	92	29
2013	29	32	4	3	85	57	45	44	0							38					15	350	150	90
2014	52	30	1	5	70	91	47	40								37	6	6	6	6	86	175	267	60
2015	50	9	1	2	11	26	45	83	0						8	45	7	7	7	7	66	218	312	188
2016	45	19	0	2	13	67	40	60	3	3	0	2			76	134	1	1	31	2	143	641	309	430

Fishery	2: LLJPNold																							
Country	Japan																							
Strata	1:GOM				2:WATL				4:SATL				5:NATL				6:EATL				7:MED			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1950																								
1951																								
1952																								
1953																								
1954																								
1955																								
1956																								
1957						3	0	26		2	5	26												
1958					15	13		3		0	1	1												
1959					140	16	2	43			10	46												
1960					27	123	20	169	10	155	170	147												
1961					180	29	4	159	10	8	77	108												
1962					134	276	116	693	186	145	846	1,307												
1963				1	905	4,642	112	531	24	176	715	703												
1964	22	12	1		3,913	7,754	47	294	179	97	170	135												
1965					1,313	7,666	88	80	92	221	45	42		1	2			0						
1966		3			79	2,345	35	9	1	11	15	23		0		0								
1967					6	635	19	34	6	7	23	64			0	0				0				
1968		40			3	175	49	6	1	7	4	0		0	1									
1969		0			2	110	1	2		1	1	0												
1970		1			15	8	24	18	5	15	1	0												
1971					67	280	964	64	7	104	0	44			0			1						
1972	0	32			16	38	211	24	90	138	0	7							5			43	68	1
1973		52			1	55	443	546	6	26		3	4	1				4				243	3	
1974		98			547	86	123	51	145	427	82	321			1			2	1,217			1,861	334	
1975	32	1,202	1		19	104	28	127	828	1,701	10	19		1	0			9	332		1	284	975	
1976	92	1,131	0		848	14	11	805	292	1,305	68	245		7				29	27			576	392	
1977	316	731			2,190	6	1	415	125	1,279	70	83						34	3			274	246	
1978	484	807			1,496	4	6	347	200	314	1			1		0		61				6	55	
1979	713	798			1,147	98	10	855	52	551	0	0		1	0			26				26	73	
1980	1,154	20			1,371	32	29	1,330	121	723						35	1					115	4	
1981	448	260			2,270	74	55	665	110	386	0	5	12	1			1			0		28	72	
1982					124	3	3	162	52	2,339	138	0		16	0	3		20	5			165	796	
1983					327		0	384	50	2,494	33							33			3	375	299	
1984					331	10	0	355	71	1,374	29					23	0	17				637	399	
1985					1,045	46	0		24	356	1	18				16		5		0		914	92	
1986					135	3	2	444	78	553	6	5	34			63						333	8	
1987					435	4	0	522	258	613	11	14	3			2						280		
1988					600		0	509	237	895	7	9	6			15					1	241	16	
1989					178		1	290	206	273	0	8	84			94	15	158	2			101	26	
1990					331			219	190	615	5	0	90			550	1	13				172		
1991					197			491	101	1,010	23	5	184			1,645	0	1		11		83	2	
1992					273		0	239	271	1,365	90		569		28	984	0	26		17		122	1	
1993					327		2	252	121	706	41	4	520	0	2	1,071	19					552	241	
1994					391			36	130	605			475		2	786	1			77		536		
1995					45			342	80	1,098	17	215	67		398	2,045	51			1		813		
1996					140			296	90	469	8	13			850	1,900			2	10		765		
1997					76			254	189	397		4			690	1,182			62	382		99	40	46
1998					231		5	455	237	506					874	1,399		0	71	107		361		
1999					79			286	103	237	1	17	1		365	1,728			94	144		381		
2000					230		4	258	320	113		0	11		502	1,923	2		9	16		136		
2001					5		3	498	98	276	3	1	703	43	483	732			76	10		152		
2002					193	86	0	296	292	415		11	42		596	1,153			1	26		390		
2003							0	57	195	305					261	1,394			31	509		316		
2004					343			127	76	141					107	999			140	550		638		
2005					220	24		21	197	236			59		219	1,357	6	3	21	502		378		
2006					369	0		7	865	288					11	428	1		67	237		556		
2007					259			18	248	119			54		121	624	66		73	307		466		
2008					166			325	158	158			169		342	1,455	9		35	25		80		
2009					100		7	55	1	21			23		294	1,529				36		18		
2010																								
2011																								
2012																								
2013																								
2014																								
2015																								
2016																								

Fishery	3: BBold			4: BBnew			5: PSMEDold			6: PSMEDoldQ2	7: PSMEDnew			
Country	EU.Spain, EU.France						All except EU.Croatia							
Strata	6:EATL						7:MED							
Quarter	2	3	4	2	3	4	1	3	4	2	1	2	3	4
1950	131	2,384	460				164	531	164	531				
1951	170	3,103	598				133	463	133	463				
1952	206	3,755	724				250	583	250	583				
1953	182	3,314	639				266	632	266	632				
1954	242	4,408	850				312	830	312	830				
1955	289	5,257	1,014				225	566	225	566				
1956	150	2,732	527				155	453	155	453				
1957	177	3,219	621				155	393	155	393				
1958	187	3,399	655				151	365	151	365				
1959	167	3,045	587				97	281	97	281				
1960	60	1,101	212				56	281	56	281				
1961	70	1,280	247				118	290	118	290				
1962	75	1,364	263				105	193	105	193				
1963	61	1,107	213				383	419	383	419				
1964	55	1,010	195				315	338	315	338				
1965	79	1,432	276				109	126	109	126				
1966	147	2,673	515				255	624	560	457				
1967	78	1,420	274				409	956	867	705				
1968	58	1,053	203				300	1,205	1,064	787				
1969	78	1,411	272				586	1,129	1,044	878				
1970	104	1,897	366				363	759	699	575				
1971	99	1,807	349				494	1,286	1,209	918				
1972	93	1,685	325				785	1,180	1,122	996				
1973	106	1,932	372				442	1,251	893	1,739				
1974	73	1,321	255				924	2,219	1,525	3,451				
1975	172	1,417	324				1,139	2,186	1,704	3,036				
1976	19	905	88				1,617	3,615	3,084	5,655				
1977	98	1,522	171				1,324	1,980	3,727	2,533				
1978	33	1,818	671				824	1,373	2,125	2,977				
1979	60	1,196	192				944	1,118	2,233	1,808				
1980	53	1,062	171				1,208	1,938	1,530	3,865				
1981	39	775	125				578	1,984	1,246	4,721				
1982	29	843	42				1,540	3,148	2,960	4,483				
1983	15	623	2,120				1,502	2,646	2,444	3,893				
1984	53	2,167	711				1,326	2,450	2,272	4,576				
1985	40	1,647	541				1,607	3,338	3,036	4,479				
1986	39	1,588	521				1,560	4,161	1,978	3,416				
1987	37	1,513	496				1,065	4,316	1,614	3,038				
1988		1,624	936				1,340	5,703	1,970	3,553				
1989	124	1,766	529				894	4,309	1,370	4,309				
1990	62	1,606	192				1,023	4,736	1,521	4,518				
1991	8	1,365	216				1,120	4,951	1,639	4,677				
1992		847	541				1,342	7,584	2,369	6,209				
1993	22	3,664	18				1,633	7,249	2,521	7,604				
1994	48	436	875				1,929	12,156	4,021	8,432				
1995	43	1,553	1,357				1,162	9,699	2,334	9,383				
1996	918	3,615	500				2,615	9,860	3,581	8,605				
1997	495	4,314	1,385				3,271	3,900	3,494	12,526				
1998	298	2,197	300				6,606	7,792	7,466	9,040				
1999	67	1,395	2				7,015	8,556	7,129	10,177				
2000	155	1,018	138				8,064	7,386	7,298	9,575				
2001	220	1,621	221				6,961	8,022	7,177	9,994				
2002	228	1,679	229				6,601	8,124	6,554	11,790				
2003	62	457	62				7,393	8,970	7,355	12,436				
2004	161	1,191	163				7,408	8,368	7,491	13,776				
2005	493	1,013	642				6,811	7,422	6,811	14,578				
2006	488	164	288				7,715	8,210	7,710	13,705				
2007				340	1,764		721	898	708	45,852				
2008				1,034	709	357	806	252	252	11,409				
2009				56	881	57					366	9,740	366	366
2010				19	507	87					194	4,034	194	194
2011				36	454	53					38	3,825	38	38
2012				0	173	46					26	5,749	21	21
2013					74	0						6,670	933	
2014					2							6,870	947	
2015				4	37	1					354	6,618	1,575	1,010
2016				25	593	134					918	7,902	1,142	920

Table 1. Continued.

Fishery	8: PSNOR			9: PSHRV				10: PSWold			11: PSWnew			
Country	Norway			EU.Croatia				USA, Canada						
Strata	5:NATL		6:EATL	7:MED				2:WATL						
Quarter	3	4	3	1	2	3	4	2	3	4	1	2	3	4
1950	2,200								1	0				
1951	6,728								94	6				
1952	14,752													
1953	10,217													
1954	12,145								52	3				
1955	13,394													
1956	5,313													
1957	6,437													
1958	3,860								130	8				
1959	3,241								735	46				
1960	4,215								261	16				
1961	8,553								850	53				
1962	8,730								3,548	220				
1963	167							652	4,655	462				
1964	1,461							1,348	3,802					
1965	2,506							4	3,327					
1966	1,000								1,006					
1967	2,015								2,082					
1968	753								687					
1969	842							10	1,108					
1970	470							194	4,094					
1971	653							222	3,547					
1972	430							16	1,995					
1973	421								1,656					
1974	869								960					
1975	988							493	1,827					
1976	529								1,582					
1977	764							1,204	298					
1978	221							1,071	159					
1979	60							989	392					
1980	206	29	47					193	565					
1981	59		102					250	516	144				
1982	50							63	132	42				
1983	1							102	213	69				
1984	243	0						107	223	72				
1985												100	209	67
1986	31											96	200	64
1987												98	204	66
1988													383	
1989													385	
1990													384	
1991					1,212	206							237	
1992				29	7	799	242						300	
1993				60	44	858	96						295	
1994					990	399	21						301	
1995					857	345	18						249	
1996					955	385	20						245	
1997					764	308	16						250	
1998					498	329	62						249	
1999	5				516	340	64						103	145
2000					513	338	64						275	
2001					499	329	62						196	
2002				4	659	207	105						208	
2003					880	109	148						265	
2004					376	451							32	
2005					448	429	140						178	
2006					831	191							4	
2007					817								28	
2008				13	808									
2009					609						3	4	3	2
2010					370									
2011					366									
2012					367						0	0	0	0
2013					380						19	18	5	1
2014					378						14	22	4	2
2015					438						6	11	8	15
2016	42				436									

Fishery	12: TPold								13: TPnew		
Country	EU.Spain, Morocco, EU. Portugal										
Strata	4:SATL				7:MED				4:SATL		
Quarter	1	2	3	4	1	2	3	4	2	3	4
1950	12	11,193	1,573	623			176	20			
1951	11	7,256	1,086	553			411	46			
1952	16	7,387	1,232	836			642	71			
1953	21	10,693	1,738	1,101			70	8			
1954	9	8,019	1,153	488			629	70			
1955	10	10,595	1,466	522			61	7			
1956	18	12,028	1,813	925			155	17			
1957	7	12,912	1,660	370			384	43			
1958	5	13,209	1,652	283			323	36			
1959	7	6,597	939	384			433	48			
1960	10	9,106	1,294	541			662	74			
1961	12	6,204	1,000	618			601	67			
1962	6	7,841	1,031	287			389	43			
1963	3	3,884	512	153			843	94			
1964	4	4,541	622	223			588	65			
1965	1	4,602	548	38			1,266	141			
1966	1	2,788	354	77			146	16			
1967	2	3,990	502	88			187	21			
1968	0	1,825	222	24			15	2			
1969	3	2,022	303	147			195	22			
1970	0	1,614	194	12			252	28			
1971	0	639	75	0			81	9			
1972	1	363	71	34			112	12			
1973		453	53				132	15			
1974		70	8				16	2			
1975		401	47				3	0			
1976		438	52				3	0			
1977		503	58				2	0			
1978		567	67				1	0			
1979		537	63				21	2			
1980		731	86								
1981		1,061	125				3	0			
1982		2,067	242				59	7			
1983		1,750	206				33	4			
1984		2,059	243				559	62			
1985		1,458	172				272	30			
1986		875	182				185	21			
1987		931	109				335	37			
1988		2,348	276				292	32			
1989		1,336	156				531	59			
1990		2,407	97				1,429	159			
1991		1,414	108				842	94			
1992		1,121	244				195	22			
1993		1,505	126				71	8			
1994		1,517	113				633	70			
1995	0	1,038	113	1			115	13			
1996	1	1,831	85	4			14	2			
1997		3,698	269	15			58	6			
1998		3,164	390	32			36	4			
1999		3,841	118	0	1		27	3			
2000		2,947	50		0	0	35	4			
2001		3,525	60			1	276	31			
2002		3,142	83	11		0					
2003	0	2,053	62	0		0					
2004	0	1,957	21	0	1						
2005		2,391	8	9	0						
2006	0	2,866	28	0							
2007	0	3,764	24	0							
2008	0	3,138	28	0			3	0			
2009		3,137	27								
2010		2,259	33								
2011		1,980	93	64							
2012									2,124	111	77
2013									2,434	99	30
2014									2,146	23	207
2015									1,875	695	335
2016									2,363	258	95

Fishery	14: RRCAN						15:RRUSAFS			16:RRUSAFB		
Country	Canada						USA					
Strata	2:WATL				3:GSL		2:WATL					
Quarter	1	2	3	4	3	4	2	3	4	2	3	4
1950			349	9	62	12	9	27	2	46	136	8
1951			209	5	71	14	0	1	0	49	147	9
1952			293	7	57	11				29	85	5
1953			168	4	24	5	1	4	0	27	80	5
1954			124	3	40	8	3	9	1	12	35	2
1955			121	3	7	1	1	3	0	6	18	1
1956			36	1	2	0	0	1	0	6	17	1
1957			42	1	3	1	4	11	1	8	24	1
1958			37	1			1	2	0	21	62	4
1959			77	2	12	2	2	5	0	25	75	5
1960			0		4	1	2	6	0	40	118	7
1961			1		34	7	5	16	1	29	88	5
1962			1		33	7	30	91	6	69	207	13
1963			1		74	15	96	287	18	172	513	31
1964			1		81	16	45	134	8	83	248	15
1965			1		77	16	87	259	16	160	479	29
1966			1		91	18	324	969	59	555	1,660	101
1967			1		46	9	26	77	5	61	183	11
1968			2		148	30	39	118	7	85	254	15
1969			2		140	28	27	81	5	189	564	34
1970			2		124	25	14	41	2	124	372	23
1971			1		72	15	29	88	5	267	799	49
1972			2		155	31	27	80	5	292	873	53
1973			3		197	39	7	22	1	151	453	28
1974			5		336	67	566	1,692	103	96	286	17
1975			12		187	7	29	87	5	166	497	30
1976			2		251	89	7	20	1	137	409	25
1977			2		253	47	14	43	3	160	480	29
1978			2		169	37	12	37	2	192	576	35
1979			1		136	77	23	68	4	189	566	35
1980					248	11	19	57	3	157	471	29
1981			1		243	35	17	51	3	137	410	25
1982			209	41	127	59	21	64	4	109	327	20
1983			280	47	65	34	28	84	5	187	558	34
1984			193	31	22	14	28	83	5	162	485	30
1985			90	14	11	7	32	96	6	187	559	34
1986			29	5	4	3	23	68	4	131	393	24
1987			24	4	3	2	37	112	7	165	495	30
1988			201	32	26	16	30	90	5	149	446	27
1989			430	69	49	32	39	116	7	194	582	35
1990	4	2	352	65	8	1	178	230	68	231	297	88
1991		0	289	123	15	51	13	438	32	18	622	45
1992		0	300	67	44	22	89	27		407	125	
1993			256	38	22	89	6	196	7	19	605	20
1994			241	2	64	1	10	82	1	70	587	9
1995			285	40	105	71	35	223	2	99	624	6
1996			244	125	100	16	36	311	8	63	545	14
1997			265	68	52	53	6	166	4	29	822	21
1998			293	99	97	22	22	138	7	100	641	32
1999			287	69	112	43	3	98	2	24	748	17
2000			177	119	180	56	7	34	8	121	571	129
2001			266	73	114	47	7	235	1	32	1,075	5
2002			351	1	207		75	430	14	153	881	29
2003			266		193		38	260	16	93	632	39
2004			187	52	236	3	44	257	28	57	336	37
2005			188	114	245	8	40	119	12	68	201	20
2006			251	108	277	48	23	123	12	37	193	19
2007			88	122	174	45	14	373	11	9	241	7
2008		8	154	93	123	144	112	240		107	230	
2009			143	33	156	114	14	118	11	78	643	61
2010			91	9	125	176	29	78	4	158	423	21
2011			84	65	150	56	87	76	11	245	215	31
2012			77	76	174	86	29	100	20	93	318	63
2013		1	50	96	180	75	3	111	1	9	283	3
2014		1	36	55	167	124	4	88	8	18	393	35
2015			55	57	181	159	32	131	10	110	456	33
2016			39	59	158	123	9	175	32	30	572	104

Fishery	17: OTH												
Country	other												
Strata	1:GOM		2:WATL				3:GSL	4:SATL				5:NATL	
Quarter	2	3	1	2	3	4	3	1	2	3	4	3	4
1950			89	89	89	89		113	113	113	113	94	
1951			129	129	129	129		448	448	448	448	222	
1952			50	50	50	50		251	251	251	251	316	
1953			192	192	192	192		551	551	551	551	52	
1954			133	133	133	133		78	78	78	78	95	
1955			94	94	94	94		480	480	480	480	94	
1956			45	45	45	45		14	14	14	14	12	
1957			101	101	101	101		251	251	251	251	96	
1958			217	217	217	217		635	635	635	635	6	
1959			95	95	95	95		871	871	871	871	34	
1960			59	59	59	59		572	572	572	572	42	
1961			40	40	40	40		749	749	749	749	13	
1962			56	56	56	56		407	407	407	407	15	
1963			76	76	76	76		398	398	398	398		
1964			120	120	120	120		516	515	516	515		
1965			62	62	62	62		245	242	322	295		
1966			55	55	55	55		465	462	552	521		
1967			78	78	78	78		535	531	631	597		
1968			32	32	32	32		138	135	244	207		
1969			58	58	58	58		197	193	312	272		
1970	15		33	71	33	33		162	153	415	326	4	
1971	13		15	49	15	15		82	70	394	284	3	
1972	8		7	28	7	7		87	209	836	330		
1973		0	36	49	36	36		85	75	465	794		
1974			64	83	65	64		51	65	856	355		
1975				1	143			91	576	2,592	646	2	
1976					97	75		222	281	647	37	8	
1977					195	177		638	731	743	114	2	
1978					70	151		232	919	862	77	2	
1979					6	25		181	340	1,215	261		
1980					3	44		140	147	41	287		
1981					3	38		142	257	75	242	0	
1982					5	63		483	165	47	5		
1983					1	6		186	183	152	194	1	
1984					3	0		113	103	84	59		
1985			2	2	19	4		89	53	15	69		
1986								87	49	192	40		
1987			1	1	11	7		76	73	121	71		
1988			1	1	10	6		52	109	111	61		
1989			1	1	1	1		131	139	60	93		
1990			4	4	5	5		23	33	170	71		
1991			4	4	4	4		59	26	18	15	1	
1992			4	4	4	5		125	126	118	134		
1993			1	1	18	12		8	14	123	63		
1994			11	11	67	33		169	177	146	991		
1995			2	2	47	30		118	118	118	256		
1996			1	1	46	46		129	111	214	224		
1997			1	1	52	8		787	646	183	394		
1998				0	67	3		593	450	47	17		1
1999				0	44	1		568	199	59	51		
2000				2	13	2		540	172	401	432		
2001					14	3		223	76	174	131		
2002					28	1		759	222	303	175		
2003				0	84	0		594	502	86	245		
2004					26	7		997	218	112	1		
2005				1	5	2		776	218	22			
2006					3	0		355	104	13	34		
2007				1	3			93	142	100	7		
2008					23			62	3	189	45		
2009					20	3		6	3	198	63	1	
2010				7	32			10	9	93	20	0	
2011					26		16	36	27	33	15	3	
2012			0	2	15	0		38	4	33	14	3	
2013			0	2	10	0		145	17	11	17	1	
2014					18	1		67	2	19	20	8	
2015					6			124	11	47	9		
2016					10			227	39	40	63	2	

Fishery	17: OTH (cont.)							
Country	other							
Strata	6:EATL				7:MED			
Quarter	1	2	3	4	1	2	3	4
1950		1,048			252	2,638	1,917	252
1951		1,502			329	2,807	2,078	329
1952		2,418			367	1,859	1,389	367
1953		1,115			450	2,874	2,352	450
1954		1,563			375	2,259	1,882	375
1955		2,222			522	2,623	1,991	522
1956		1,034			344	1,752	1,752	344
1957		1,934			505	2,445	2,422	505
1958		617			383	2,390	2,390	383
1959		1,794			422	2,025	1,893	422
1960		494			425	2,198	1,814	425
1961		441			525	2,130	1,762	525
1962		355			381	1,997	1,593	381
1963		3			529	1,450	1,194	529
1964		44			414	1,816	1,440	414
1965		23			327	1,860	1,259	327
1966		2			175	1,414	1,111	175
1967		15			547	2,379	1,997	547
1968		8			228	2,138	1,901	228
1969		1			223	2,108	1,961	223
1970		15			90	1,061	816	90
1971	25	28	25	25	56	1,781	356	56
1972	25	32	25	25	43	1,201	268	43
1973	3	8	3	3	56	754	293	56
1974	1	2	1	1	45	1,701	780	45
1975		2			56	1,246	448	67
1976	1	2	1	1	85	1,214	491	85
1977		3			88	1,089	286	160
1978		1			68	810	428	127
1979		2			94	721	309	107
1980		2			168	556	343	195
1981		3	1		240	723	398	241
1982		0			142	973	644	189
1983		0			93	1,004	620	421
1984	9	9	9	9	603	1,825	1,380	613
1985	28	65	28	28	489	1,125	993	492
1986	19	19	19	19	199	935	729	421
1987					179	1,050	649	562
1988	61	62	61	61	237	1,579	686	352
1989	13	18	87	35	199	1,198	1,191	286
1990	36	36	36	36	356	1,185	662	519
1991	29	29	29	29	204	841	514	489
1992	131	131	131	131	215	852	720	707
1993	234	271	234	234	234	884	654	555
1994	68	68	68	68	468	1,282	1,192	1,129
1995	136	136	137	136	717	1,897	1,249	1,263
1996	63	63	63	63	381	1,238	1,112	775
1997	34	34	34	34	404	909	1,098	764
1998	83	84	103	83	247	950	841	383
1999	80	80	80	133	139	1,136	1,080	230
2000	115	113	121	125	696	879	1,206	457
2001	132	131	135	133	334	1,070	758	257
2002	151	151	165	152	196	1,078	491	611
2003	130	130	133	130	205	795	367	463
2004	129	129	130	129	233	765	373	320
2005	187	187	188	188	74	573	185	78
2006	288	288	289	290	73	365	184	79
2007	125	125	126	125	48	142	56	50
2008	0	1	184	1	32	189	25	52
2009			302	3	27	158	121	36
2010			85	61	96	512	74	49
2011	0		46	18	47	283	171	21
2012	0	0	58	15	31	156	136	8
2013	1	1	147	16	31	161	273	28
2014	2	2	212	13	104	142	282	31
2015	56	56	65	60	116	116	238	111
2016	8	3	224	24	13	14	215	78

Fishery	18: LLJPNnew							
Country	Japan							
Strata	2:WATL			4:SATL	5:NATL			6:EATL
Quarter	1	3	4	2	1	3	4	4
2010	201	11	140	9	1	25	1,070	50
2011	369	60	149			5	1,084	
2012		56	233				1,093	
2013	28	158	131			5	1,124	
2014		59	243			38	1,075	22
2015	1	71	274			12	1,344	30
2016		47	298			24	1,457	98

Appendix 6

Report of sub-group on seasonal variability in the Gulf of Mexico and in the Mediterranean

A sub-group met to discuss the current state of knowledge of stock migrations and the estimation of movement in the OMs used for the MSE. The sub-group highlighted that the current OM reports do not reflect seasonal variation in Mediterranean biomass; this is considered biologically unrealistic.

The sub-group noted that movement restrictions identified previously have been implemented in the OM conditioning, including the exclusion of GOM-origin fish migration into the MED and MED-origin fish migration into the GOM, no residency of fish in the GOM during quarter (Q) 3, and no fish present in the GSL during Q1. The sub-group first identified two additional movement constraints that should be included in the OMs:

1) the biomass of GOM-origin ageclass[†] 3 fish should be greatest in the GOM during the spawning season (Q2), and
2) the biomass of MED-origin ageclasses 2 and 3 should be greatest in the MED during the spawning season (also Q2). Ageclass 1 was not included because most of the juveniles stay in the MED and hence should not be used to estimate the seasonality in the MED.

The sub-group was asked to provide values of the relative proportions of residency of biomass by quarter within each spawning ground. After revising the available information for each of these two strata, it was evident that the estimation of those proportions had to use different approaches for each of these two strata. The recommendations that follow were agreed upon by the sub-group as being critical to capture the known biology of the stocks accurately.

Quarterly distribution of BFT in Gulf of Mexico

To obtain a quarterly relative distribution of fish in the Gulf of Mexico, the catch rate was estimated from the model applied in the Joint CPUE standardization exercise (Walter *et al*. 2017) which uses data from Mexico and United States pelagic longline fleets. The standardization model used in Walter *et al*. 2017 is a negative binomial generalized linear model with year, flag, hook type, day/night of set, area and quarter, with an offset for effort in number of hooks. The model in Walter *et al*. 2017 also used sea surface temperature which, in this analysis, was removed as it had an undesirable impact on the standardization by increasing the predicted catch of BFT in the summer quarter, when the fish are actually less abundant. The model accounts for much of the differential targeting and differences in fishing practices between the fleets. It also benefits substantively from using data from both fleets as they cover the entire Gulf of Mexico, for which there appears to be slightly different spatial habitat utilization by quarter with fish in the Southern part in quarter 1 and Northern part in the quarter 2, as indicated by electronic tag track inference (Teo *et al*., 2015). As the data are from onboard observers, they account for both catch and discarded fish. The quarterly distribution is obtained from the least square means of the quarter effect, calculated across mean levels of the other factors. The percent distribution across the four quarters can be summarized as 31, 61, 7 and 1% for Jan-Mar (Q1), Apr-June (Q2), July-Sept (Q3) and Oct-Dec (Q4) respectively (**Figure 1**).

This index of distribution is assumed to apply to western spawning bluefin tuna. As the Mexico and U.S. longline fleets fish throughout the year, these estimates should represent an unbiased view of the relative temporal distribution of Gulf of Mexico spawning fish.

[†] Ageclass 1 refers to ages 0 to 4, ageclass 2 refers to ages 5 to 8, and ageclass 3 refers to ages 9+

Table 1. Log scale estimate and standard errors for the quarterly distribution of BFT in the Gulf of Mexico.

Quarter	Log scale estimate	SE	LCL	UCL	Arithmetic mean	% distribution
1	-3.2022	0.0684	-3.3362	-3.0681	0.0407	31%
2	-2.5059	0.0584	-2.6203	-2.3915	0.0816	61%
3	-4.6247	0.0989	-4.8186	-4.4309	0.0098	7%
4	-7.1735	0.2648	-7.6925	-6.6545	0.0008	1%

Quarterly distribution of BFT in The Mediterranean

After reviewing the CATDIS estimates by quarter and gear, it was noted that catches of BFT in the Mediterranean have many "substitutions", as few CPCs have reported catch/effort (C/E) by month/quarter. Therefore, it was decided to use only those catches of Mediterranean BFT from fleets that had submitted C/E by month/quarter in the 1990's to avoid the impact of management regulations.

The selected fisheries/fleets were Spanish traps, PS and LL which for almost all years in the 1990s reported catch per quarter. An average proportion of the total annual catch by quarter was estimated from this information (**Table 2**). These percentages can be used as a proxy for BFT relative availability for the western Mediterranean. This index was applied to the entire Mediterranean in the absence of any additional information on relative seasonal abundance. Overall these averages indicated higher percentages of catches in Q2 and Q3, with relative lower catches for Q4 and Q1 (**Table 2**).

Table 2. The percentage of Atlantic bluefin tuna catch by quarter in Task 2 Catch and Effort data by Gear, CPC and Period.

% of Nominal Catch per quarter						
Gear	Country	Periods	**Q1**	**Q2**	**Q3**	**Q4**
Trap	Spain	1990´s	0	92	8	0
Purse Seine	Spain	1990´s	0	52	39	9
Longline	Spain	1990´s	7	55	33	4

Two of the gears were disregarded because they had not operated all year around (Traps and Purse Seine) or because they were mostly targeting ageclass 1 (Purse Seine). Consequently, the selected vector of proportions by quarter corresponds to the Spanish longline fleet .

However, the use of nominal catches as a proxy of seasonal variability in the region raised concerns because the associated underlying assumption is that fishing effort is constant throughout the year. Consequently, the sub-group decided on two actions. First, to find out if there is any standardized index of CPUE by quarter; this question will be addressed to the Spanish research scientists working on this fishery (IEO). Secondly, to extract the effort by quarter for Spanish LL from the ICCAT Task 2 Catch and Effort data. The latter was achieved during the meeting, and the catches by quarter and year were divided by the corresponding efforts. The CPUE per quarter was estimated by averaging the CPUE´s over the period considered (the 1990s). The final relative CPUE per quarter was:

% of CPUE	**Q1**	**Q2**	**Q3**	**Q4**
Spain longline 1990´s	11%	63%	22%	4%

Additionally, the E-tag data also showed seasonality in the Mediterranean for ageclasses 2 and 3, but higher residency for ageclass 1 (**Figure 1**).

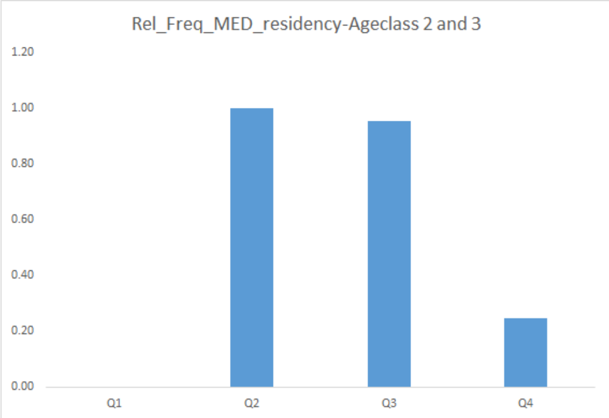

Figure 1. Mean proportions of days spent in the Mediterranean by quarter from electronically tagged fish at liberty >364 days and which entered this spawning ground (all fish were tagged in the western Atlantic, sample size = 5 fish).

To summarise, nominal CPUE data were used to derive a preliminary prior for seasonal trend in ageclasses 2 and 3 fish in the Mediterranean. The impact of this preliminary prior will be tested in the model while more rigorous CPUE standardization options are investigated.

Movements (Spatial biomass distribution and regional transition restrictions)

The OMs can predict spatial biomass distributions that would be difficult to reconcile with the current knowledge of the biology and distribution of the stocks (for example placing a large fraction of fish in the South Atlantic stratum due to the complete lack of model constraints for this stratum). A possible solution is to constrain the range of fish movements in the model to those that have been identified from either conventional tag returns or from electronic tracks. The OM conditioning already includes a 'movement exclusion matrix' that is currently used to prevent movements of eastern-origin fish to the GOM and western-origin fish to the Mediterranean. In order to constrain the model further in its estimation of plausible quarterly movements, the electronic tagging and conventional tagging data will be analysed to identify transitions that have never been observed; these will then be used to extend the movement exclusion matrix (**Table 3**). The impact of this new constraint will be investigated before it might be incorporated in the finalised conditioning process.

Table 3. Movements between spatial strata by stock and quarter used to restrict the movement of fish based on conventional tag returns or electronic tag tracks in the OMs. These are possible movements present in a particular stratum (row) that move to a stratum (column) in the following quarter for all ageclasses. The left panel applies to the Western Stock (i.e. excludes the MED), and the right panel to the Eastern Stock (i.e. excludes the GOM). Insertions are 1 if at least one such movement has been observed, and 0 if none have been observed.

West stock (all age classes) **Possible: 64%**

Quarter 1

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	1	1	0	0	0	0	0
WATL	1	1	1	1	1	1	0
GSL	1	1	1	1	1	1	0
SATL	0	1	0	1	1	1	0
NATL	0	1	0	1	1	1	0
EATL	0	1	0	1	1	1	0
MED	0	0	0	1	0	1	0

Quarter 2

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	1	1	1	1	0	0	0
WATL	1	1	1	1	1	1	0
GSL	0	0	1	0	0	0	0
SATL	1	1	1	1	1	1	0
NATL	1	1	1	1	1	1	0
EATL	1	1	1	1	1	1	0
MED	0	0	0	1	0	0	0

Quarter 3

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	1	1	1	0	0	0	0
WATL	0	1	1	1	1	1	0
GSL	0	1	1	0	1	1	0
SATL	0	1	1	1	1	1	0
NATL	0	1	1	1	1	1	0
EATL	0	1	1	1	1	1	0
MED	0	1	1	1	1	1	0

Quarter 4

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	1	1	1	0	0	0	0
WATL	1	1	1	1	1	1	0
GSL	1	1	1	1	1	1	0
SATL	0	1	1	1	1	1	0
NATL	0	1	1	1	1	1	0
EATL	0	1	1	1	1	1	0
MED	0	1	1	1	1	1	0

East stock (all age classes) **Possible: 67%**

Quarter 1

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	0	1	0	0	0	0	0
WATL	0	1	1	1	1	1	0
GSL	0	1	1	1	1	1	0
SATL	0	1	0	1	1	1	1
NATL	0	1	0	1	1	1	1
EATL	0	1	0	1	1	1	0
MED	0	0	0	1	0	1	1

Quarter 2

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	0	1	1	1	0	0	1
WATL	0	1	1	1	1	1	1
GSL	0	0	1	0	0	0	0
SATL	0	1	1	1	1	1	1
NATL	0	1	1	1	1	1	1
EATL	0	1	1	1	1	1	1
MED	0	0	0	1	0	0	1

Quarter 3

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	0	1	1	0	0	0	0
WATL	0	1	1	1	1	1	1
GSL	0	1	1	0	1	1	0
SATL	0	1	1	1	1	1	1
NATL	0	1	1	1	1	1	1
EATL	0	1	1	1	1	1	1
MED	0	1	1	1	1	1	1

Quarter 4

	GOM	WATL	GSL	SATL	NATL	EATL	MED
GOM	0	1	1	0	0	0	0
WATL	0	1	1	1	1	1	1
GSL	0	1	1	1	1	1	0
SATL	0	1	1	1	1	1	1
NATL	0	1	1	1	1	1	1
EATL	0	1	1	1	1	1	1
MED	0	1	1	1	1	1	1

Appendix 7

An initial attempt at an updated roadmap

D. S. Butterworth and G. Melvin

NB: Any schedule such as suggested below will depend on the nature of the stock assessment process intended to reach finalisation in September 2020 – this will be debated at the forthcoming bluefin session.

Note that this document should be read noting the contents of **Appendix 8**, which summarises decisions relating to the adjustments agreed at this MSE Technical Group meeting which are to be incorporated in advancing the MSE process.

1. Mini technical review meeting (5 days; +- February 2020)

The paragraph following in *italics* is in the form of draft text for possible inclusion in the main text of a meeting report.

*The meeting considered that to advance the process of finalising the Operating Models (OMs) for the bluefin MSE process, it would be important for a very small group of technical experts in constructing and conditioning OMs to meet early in 2020 for a week with the contractee. The meeting would be to review in detail the contractee's work to that time to take account of all issues raised at September 2019 meeting of the MSE Technical Group (see the items listed in **Appendix 8**) so as to:*

- *i) investigate possible modifications,*
- *ii) finalise those changes following further computer runs,*
- *iii) critically review the OMs to confirm their conditioning as being satisfactory,*
- *iv) develop a full proposal for a complete set OMs for consideration for adoption at a subsequent meeting as detailed in 2) below, and*
- *v) provide suggestions for approaches (e.g. a Delphi method) to plausibility-weight these OMs for review at that subsequent meeting.*

The Contractee together with 5-6 persons (to be selected in an appropriate manner) would be needed for this mini technical review meeting, for which funding from the GBYP is to be sought.

It must be stressed that this meeting would not have any authority to make final decisions. Rather its purpose is to prepare the material required by the subsequent meeting (2. below) to make such decisions. This meeting will also need to make proposals for which the indices might be used as input to CMPs.

Electronic exchanges with MSE Technical Group members (possibly including webinars) will be needed both before and after this meeting to inform and to assist progress in reaching consensus on the final OM selection.

Deliverables: Candidate Reference set of OMs (and associated standard HTML reports for each OM and comparing amongst OMs) will need to be provided at an appropriate time prior to meeting 2.

2. BFT MSE Technical Group meeting (likely within BFT WG meeting) (3 days; +- April 2020)

Note that this meeting would form part of the BFT WG "Data prep" meeting needed at that time to prepare for the assessment to be completed in September 2020.

The primary purpose (of the MSE component) is to thoroughly review the output from meeting 1. above for a complete set of OMs, to amend this if necessary, and then to have the BFT WG adopt these as the **FINAL** set to be used in testing the CMPs advanced from which one is eventually intended to be adopted by the Commission in October 2021.

This meeting will also need to agree upon a process to plausibility-weight these OMs.

Deliverables: Final Reference grid of OMs and major robustness trials. Final set of candidate indices recommended for use as input to CMPs. A process to plausibility-weight OMs.

3. CMP developers' mini-meeting (4 days; +- July 2020)

Following 2), the contractee would update the "package" for CMP testing, which CMP developers would then use intersessionally to further develop their CMPs. At this meeting their results are tabled and discussed to assist these developers in subsequently refining their CMPs further.

Note that this might be either a "mini" meeting constituted similarly to that in 1) above, or a meeting of the MSE Technical Group, but the core target attendees are the CMP developers.

Deliverables: CMPs from each development team, summarized performance results across the Reference grid and major robustness test OMs. These are to be presented in an agreed common format, making use of the existing shinyapp, and in terms of a tuning process agreed by the meeting.

4. BFT MSE Technical Group meeting (3 days before bluefin session, September 2020)

Revised CMPs are reviewed and reduced to provide a set of probably 2-3 to take further through to, in turn, the bluefin session, the SCRS, and then the Commission. Each remaining CMP might be taken forward for a range of utilization vs conservation trade-offs.

Deliverables: 2-3 CMPs, each tuned to 2 or 3 agreed different conservation levels, with tables and plots of performance statistics.

5. October 2020 to October 2021

An appropriate series of meetings between scientists and stakeholders/managers/decision makers to refine and reduce the number of CMPs further. This process would aim to present one or at most a very few options to the 2021 Commission meeting, for that meeting to then make a selection (if necessary) and adopt the MP to be used to recommend future TACs.

Note that advice has already been received from Panel 2 regarding CMP objectives. It is envisaged that the next such interaction would take place only after October 2020, when results for CMPs are available to show to decision makers, so they can become aware of the limitations imposed by the feasible region for trade-off space before advising further.

Appendix 8

Further operating model specifications for commencing an updated roadmap

T. Carruthers and D. S. Butterworth

a) "Priors" to nudge seasonal patterns in the GOM and Med to correspond to inferences from data
For both natal spawning areas, the Gulf of Mexico and the Mediterranean, a seasonal vector of relative abundance will be added to the model as a prior. This is intended to address a current 'reality' test in which the model estimates seasonally constant biomass in those areas (See **Appendix 6**).

b) Default weighting in vs Revised default weighting out

Likelihood component	**Symbol**	**Value of ω**	
Scheme #		*Default weighting coming to Sept 2019 meeting*	*Default weighting coming out of meeting*
Total catches (weight)	ω_c	1/100	1/1000
Fishery independent index of biomass (e.g. a larval survey for spawning stock biomass)	$\omega_{FIindex}$	1	1
Fishery dependent index of exploitable biomass (CPUE index)	ω_{CPUE}	1	1
Length composition	ω_{CAL}	1/1000	1/10000
Stock of origin	ω_{SOO}	1	1/10: genetics 1/60: microchemistry
Electronic tag (known stock of origin)	ω_{ET}	1	1/10

Compared to the earlier suggestion, all data-based components except the abundance (biomass) indices have been reduced by a multiplicative factor of 1/10 – this is to ensure reasonable fits to those abundance indices and hence restoration of "scale".

The SOO (micro-chemistry) contribution has been (somewhat arbitrarily) down-weighted by a further factor of 1/6 for this revised default; 1/3 for balance with the greater number of micro-chemistry data compared to genetic data, and a further ½ given some potential uncertainties related to the micro-chemistry estimates.

c) Revised specifications for incorporating abundance indices in the model fit
The specification of fishery dependent CPUE indices and fishery independent survey indices has been reviewed and updated (Trial Specifications document Tables 2.1 and 2.2, respectively) (See **Appendix 5**).

d) Specification of a "low Superman" trial
A principal source of uncertainty not currently considered in the reference set of operating models is the recent trend in eastern stock biomass. Some indices are consistent with a steep increase over the most recent 15 years ('Superman'); others are consistent with a much less pronounced increase ('low Superman'). Following investigation of fits, a low Superman reference operating model has been proposed that may be achieved by heavily down-weighting two principal indices: the Canadian rod and reel CPUE index in the Gulf of St Lawrence and the western Mediterranean larval survey.

e) Updated set for interim grid
The current grid

	Western stock	Eastern stock
Recruitment		
1	B-H with h=0.6 ("high R0") switches to h = 0.9 ("low R0") starting from 1975	50-87 B-H h=0.98 switches to 88+ B-H *h*=0.98
2	B-H with h=0.6 fixed, high R0	B-H with h=0.7 fixed, high R0
3	Historically as in Level 1. In projections, "low R0" switches back to "high R0" after 10 years	Historically as in Level 1. In projections, 88+ B-H with *h*=0.98 switches back to 50-87 B-H with *h*=0.98 after 10 years.
Spawning fraction both stocks		Natural Mortality rate both stocks
A	Younger (E+W same)	High
B	Older (E+W older but different for the 2 stocks)	Low
Mixing		
I	Best estimates	
II	Four times increase in weight of likelihood component for electronic tags (increased Eastern stock in West, decreased Western stock in East)	

Addition from this meeting:

Recent east stock trend

i	Steep increase ('Superman') [i.e. as at present in all the interim grid OMs]
ii	Less steep increase ('low Superman') [as specified in d) above]

f) Updated set of MAJOR robustness trials
Taking account also of CMP evaluations carried out for the July 2019 BFT MSE Technical Group meeting they following seem to remain major robustness OMs:

1. Stock scale (east magnitude reduced by e.g. down-weighting fishery independent indices)
2. Brazilian catches
3. Senescence
4. Decreased weight of fishery dependent CPUE indices
5. Use of the Western growth curve for Eastern stock

g) Further conditioning evaluations

1. Evaluate model component weightings **ω** in the light of applicable statistical principles and sensitivity of results to different weighting scenarios
2. Profiling of key parameters (e.g. R0)
3. Split the MED larval and GSL indices (can the Superman/not Superman dichotomy be achieved by simply invoking a change in catchability in these indices under a hypothesis that varying availability of fish to these surveys could have occurred?)