ENGAGEMENT OF U.S. STAKEHOLDERS IN MANAGEMENT STRATEGY EVALUATION OF ATLANTIC BLUEFIN TUNA FISHERIES

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SUMMARY

A series of workshops with U.S. stakeholders in Atlantic bluefin tuna fisheries was initiated to explain Management Strategy Evaluation (MSE) and the ICCAT implementation of MSE for Atlantic bluefin tuna to get stakeholder perspectives on management objectives, aspects of operating models, alternative management procedures, and performance indicators. The first workshop was held in April 2019 in New Bedford Massachusetts to explain MSE, describe the MSE approach being developed by ICCAT, and present preliminary demonstrations of MSE for Atlantic Bluefin Tuna. The workshop was announced as primarily informational and educational, with no binding decisions or formal consensus-based recommendations. U.S. stakeholders from commercial fishing groups, recreational fishermen, fishery managers, and scientists from university, research institutes, federal agencies, state agencies, and conservation groups attended the initial workshop and provided valuable feedback. Discussions at the workshop helped to inform U.S. scientists participating in ICCAT SCRS. Workshop participants offered recommendations for alternative operating models, performance metrics and candidate management procedures. Previously developed operating models and estimation models are being revised to address stakeholder perspectives and to evaluate alternative management procedures for meeting stakeholders' objectives.

RÉSUMÉ

Une série d'ateliers avec les parties prenantes américaines dans les pêcheries de thon rouge de l'Atlantique ont été organisés pour expliquer l'évaluation de la stratégie de gestion (MSE) et la mise en œuvre par l'ICCAT de la MSE pour le thon rouge de l'Atlantique afin de connaître le point de vue des parties prenantes sur les objectifs de gestion, les aspects des modèles opérationnels, les procédures de gestion alternatives, et les indicateurs de performance. Le premier atelier s'est tenu en avril 2019 à New Bedford (Massachusetts) pour expliquer la MSE, décrire l'approche de la MSE développée par l'ICCAT et présenter des démonstrations préliminaires de la MSE pour le thon rouge de l'Atlantique. L'atelier a été annoncé comme étant principalement informatif et éducatif, sans décisions contraignantes ni recommandations officielles fondées sur un consensus. Des intervenants américains de groupes de pêcheurs commerciaux, de pêcheurs récréatifs, de gestionnaires des pêcheries et de scientifiques d'universités, d'instituts de recherche, d'agences fédérales, d'organismes d'État et de groupes de conservation ont assisté à l'atelier initial et fourni des commentaires précieux. Les discussions de l'atelier ont permis d'informer les scientifiques américains participant au SCRS de l'ICCAT. Les participants à l'atelier ont formulé des recommandations sur d'autres modèles opérationnels, mesures des performances et de possibles procédures de gestion. Les modèles opérationnels et les modèles d'estimation élaborés antérieurement sont en cours de révision afin de tenir compte du point de vue des intervenants et d'évaluer d'autres procédures de gestion permettant d'atteindre les objectifs des intervenants.

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RESUMEN

Se inició una serie de talleres con partes interesadas en las pesquerías de atún rojo del Atlántico estadounidenses para explicar la evaluación de estrategias de ordenación (MSE) y la implementación de la MSE por parte de ICCAT para el atún rojo del Atlántico con el fin de obtener la perspectiva de las partes interesadas sobre los objetivos de ordenación, aspectos de los modelos operativos, procedimientos de ordenación alternativos e indicadores del desempeño. El primer taller se celebró en abril de 2019 en New Bedford, Massachusetts, para explicar la MSE, describir el enfoque de MSE que está desarrollando ICCAT y presentar demostraciones preliminares de la MSE para el atún rojo del Atlántico. El taller fue anunciado como principalmente informativo y educativo, sin decisiones vinculantes ni recomendaciones formales basadas en el consenso. Las partes interesadas estadounidenses procedentes de grupos de pesca comerciales, pescadores recreativos, gestores pesqueros y científicos de la universidad, institutos de investigación, agencias federales, agencias estatales y grupos conservacionistas asistieron al taller inicial y aportaron sugerencias y comentarios muy útiles. Las discusiones mantenidas en el taller ayudaron a aportar información a los científicos de Estados Unidos que participan en el SCRS de ICCAT. Los participantes en el taller ofrecieron recomendaciones para modelos operativos alternativos, mediciones del desempeño y procedimientos de ordenación candidatos. Los modelos de estimación y los modelos operativos desarrollados previamente están siendo revisados para incluir las perspectivas de las partes interesadas y evaluar procedimientos de ordenación alternativos para cumplir los objetivos de las partes interesadas.

KEYWORDS

Atlantic bluefin tuna, management strategy evaluation, simulation, management procedure, stakeholder engagement

1. Introduction

ICCAT is developing a Management Strategy Evaluation (MSE) for Atlantic bluefin tuna fisheries (Carruthers *et al.* 2015; Carruthers and Kell 2016; Carruthers and Butterworth 2018a, 2018b; ICCAT 2019), and the NOAA Bluefin Tuna Research Program supported a parallel and complementary effort to develop Atlantic bluefin tuna MSE (Kerr *et al.* 2012, 2014, 2016, 2017; Morse *et al.*, 2017a, 2017b, 2019). The scope of MSE varies widely among applications, from relatively narrow analyses by a small group of scientists that use a single operating model (OM) and management procedure (MP) to answer a specific question (e.g., Geromont and Butterworth 2014) to multi-disciplinary and multi-organizational analyses of several operating models, alternative management procedures, and extensive stakeholder involvement (e.g. Cochrane *et al.* 1998, Smith *et al.* 1999). Bunnefeld *et al.* (2011) recommend that stakeholder engagement in MSE is helpful for understanding tradeoffs, accepting results, and achieving sustainability (e.g., Goethel *et al.* 2018). Furthermore, Smith *et al.* (1999) conclude that stakeholder involvement is essential, primarily during the implementation phase of MSE.

Although ICCAT has explicit fishery management objectives (i.e., maximum sustainable yield, MSY; Allen 2010), stakeholders often value different objectives (Hilborn 2007). For example, commercial fishermen typically value maximum economic yield (Dichmonth *et al.* 2010), recreational fishermen typically value fishing opportunities (Powers and Lackey 1976), and conservation groups value ecosystem structure and function (Sainsbury *et al.* 2000). MSE with stakeholder involvement can evaluate performance of alternative management procedures for achieving multiple objectives and can identify tradeoffs among objectives (Mapstone *et al.* 2008). Goethel *et al.* (2018) considered ICCAT's MSE for Atlantic bluefin tuna and recommended 1) more open dialogue with stakeholders (informal, stock-specific workgroups), 2) improved and varied educational opportunities (e.g., interactive tools), 3) engagement of stakeholders who are trusted leaders of their constituencies, 4) standardized terminology and format for presentation of results, 5) guidance from communication and graphic design experts, and 6) commitment of sufficient time and funding to the process.

We are engaging U.S. stakeholders in MSE of Atlantic bluefin tuna fisheries to 1) increase understanding of the ICCAT MSE process by U.S. stakeholders in Atlantic bluefin tuna fisheries so that they can effectively contribute to the MSE; 2) consider stakeholder perspectives on management objectives, aspects of operating models, performance indicators, and alternative management procedures; and 3) evaluate the performance of alternative management procedures under several operating model scenarios.

2. Methods

The Atlantic tuna bluefin tuna MSE funded by the NOAA Bluefin Tuna Research Program (Morse *et al.* 2019) was expanded to engage stakeholders. A partnership was formed between the principal MSE analysts, NOAA assessment scientists and fishery managers, fishery organizations (Blue Water Fishermen's Association, International Game Fish Association), conservation groups (e.g., The Ocean Foundation) and other tuna scientists to organize a series of interactive workshops.

The first workshop was held (29-30 April 2019), scheduled to be after the Intersessional Meeting of the ICCAT Bluefin Tuna MSE Technical Group (7-9 February 2019) and Intersessional Meeting of ICCAT Panel 2 (4-7 March 2019) and before the start of the U.S. Atlantic bluefin tuna fishing season. The workshop was hosted by the University of Massachusetts School for Marine Science and Technology (SMAST) in New Bedford Massachusetts, which is in the Gulf of Maine region where approximately 70% of the U.S. Atlantic bluefin tuna catch is taken. Outreach included individual contacts with fishermen and conservation groups in person, by phone and email as well as through fishing organizations, and notices at fishery meetings (e.g., the U.S. ICCAT Advisory Committee) and through fishery networks.

In collaboration with NOAA partners, an agenda was developed (**Appendix 1**) and the meeting was announced in the U.S. Federal Register:

> *DEPARTMENT OF COMMERCE*
> *National Oceanic and Atmospheric Administration*
> *Workshop on Atlantic Bluefin Tuna Management Strategy Evaluation*
> *AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.*
> *ACTION: Notice of workshop.*
> *SUMMARY: The University of Massachusetts Dartmouth, School for Marine Science and Technology and the Gulf of Maine Research Institute are hosting a workshop on "Stakeholder Engagement in Management Strategy Evaluation of Atlantic Bluefin Tuna Fisheries". This educational workshop is supported with NMFS funding through the Bluefin Tuna Research Program and is open to the public.*
> *DATES: A workshop that is open to the public will be held on April 29, 2019, from 10:00 a.m. to 5:00 p.m. EDT and April 30, 2019, from 9:00 a.m. to12:00 p.m. EST.*
> *ADDRESS: The workshop will take place at University of Massachusetts Dartmouth, School for Marine Science and Technology, 836 South Rodney French Boulevard, New Bedford MA, Rooms 101-103.*
> *FOR FURTHER INFORMATION CONTACT: Steve Cadrin scadrin@umassd.edu or (508) 910-6358.*
> *SUPPLEMENTARY INFORMATION: The International Commission for the Conservation of Atlantic Tunas (ICCAT) is engaged in developing a management strategy evaluation (MSE) process for Atlantic bluefin tuna. MSE is a simulation that allows stakeholders (e.g., industry, managers, scientists, and non-governmental organizations) to assess how well different alternative management strategies, such as harvest control rules, could meet the objectives of the fishery. This workshop is intended to explain the concept of MSE as a tool for fisheries management, describe the MSE approach being developed by ICCAT, and present preliminary demonstrations as an illustration of MSE for Atlantic Bluefin Tuna. The aim is to solicit feedback from U.S. fishery stakeholders on scientists' representation of the Atlantic bluefin resource and fisheries in models, fishery management objectives, management performance indicators, and candidate management procedures. The workshop will primarily be informational and educational, and there will be no binding decisions or formal consensus-based recommendations. This workshop is intended to complement, not replace, existing opportunities for U.S. stakeholder input. Discussions at the workshop will help to inform U.S. scientists who are participating in work of ICCAT's Standing Committee on Research and Statistics. Limited funding is available to support travel to this workshop for Atlantic bluefin tuna stakeholders.*

A series of short presentations were prepared to introduce MSE and the ICCAT ABT MSE to a non-technical audience. The presentations were designed to promote conceptual understanding and discussion. A second series of presentations was designed to describe operating models, management procedures and performance metrics and to solicit stakeholder feedback. An open discussion was moderated after each topical presentation. A dinner reception was planned to promote small-group discussions, and the second day was focused on developing conclusions and recommendations. An online post-workshop survey was distributed to all participants to evaluate progress and to help plan future workshops in the series.

Conclusions and recommendations were developed by the authors based on workshop discussions and general agreements, but they do not represent the position of any participant or their organization. A draft report was distributed to all participants for review and input.

3. Results

A diverse group of 52 people from fishing industries, conservation groups and scientists participated in the workshop (**Appendix 2**). Most participants attended the workshop and a few others joined by conference call or participated by correspondence. Conclusions and recommendations were developed by the authors based on workshop discussions and general agreements, but they do not represent the position of any participant or their organization.

For the purposes of stakeholder understanding and clear communication, workshop participants supported the use of a glossary (e.g., Tuna RFMOs 2018) and strict adherence to correct terminology and precise definitions.

Recommendations for operating models included:
- Multiple plausible operating models should be considered to represent major uncertainties (e.g., **Table 1**) with a range of plausible scenarios.
- Only the most plausible scenarios should be considered.
- If possible, operating models should be weighted by plausibility.

Recommendations for performance metrics included (with reference to the proposed metrics from ICCAT 2019 Panel 2, **Appendix 3**):
- Risk tolerance, reference point definitions, and other aspects of performance metrics should be the same for eastern and western stocks.
- Risk tolerance for metric 28 (probability of $B<B_{lim}$ over 30 years) should consider the definition of B_{lim} (e.g., a low risk tolerance should be associated with a B_{lim} that reflects stock collapse, but a higher risk tolerance can be considered for a B_{lim} that indicates a moderate stock).
- Defining B_{lim} as 40% of B_{MSY} (like Atlantic albacore and swordfish) may be a reasonable definition for Atlantic bluefin tuna.

Recommendations for candidate management procedures included:
- Candidate management procedures should be similar and equitable for eastern and western fisheries.
- Candidate harvest control rules (HCRs) should consider thresholds based on B_{lim} (e.g., reduced fishing or fishery closure when $B<B_{lim}$).
- Frequency of MP implementation should be an explicit feature of candidate MPs.
- Candidate HCRs should consider a range of constraints on interannual change in TAC to achieve the change-in-yield goals, and change-in-yield constraints should consider the frequency of implementation.
- Performance of candidate MPs should be compared to performance of the current ICCAT management of Atlantic bluefin tuna.

Responses to the post-workshop survey were generally positive (**Appendix 4**). Most participants had a better understanding of MSE after the workshop, felt that their stakeholder group was represented, but not all groups were represented. For future workshop planning, all respondents replied that a two-day workshop was appropriate, the venue was adequate, and most respondents felt that the meeting material were useful and they were likely to attend future workshops.

4. Discussion

Although discussions were initially focused on elements of MSE (OMs, objectives, performance metrics, MPs), many questions, comments, conclusions and recommendations were more integrative and related to several aspects of MSE. For example, many performance metrics can be directly accounted for in HCRs (e.g., stock size thresholds, constraints to change-in-yield) to help achieve specific goals.

4.1 Operating Models

Alternative operating models were discussed as scenarios to represent major uncertainties about the populations and fisheries, each with different model assumptions, to test management procedures under a range of plausible scenarios. There was some concern about how alternative operating models would be considered. The group preferred a small set of the most plausible scenarios to address major uncertainties (**Table 1**) but recognized that combinations of scenarios add up quickly. One option to reduce the number of combinations would be to identify the most plausible scenario, and consider each dimension of uncertainty with a single alternative to the most plausible scenario.

Movement patterns and rates were identified as a major source of uncertainty, and the group suggested a small set of movement scenarios that capture reality. Although all information from tagging, genetics and otolith chemistry agree that there is extensive mixing of eastern and western populations, these information sources provide different perspectives on movement rates and stock composition. The ICCAT ABT-MSE is considering 'robustness OMs' that reduce or increase movement estimates by 50%. Uncertainty in movement rates can also be accounted for by assuming different movement rates among OM realizations and by simulating time-varying movement. The group felt that a greater understanding of movement ecology (e.g., the patterns, mechanisms, causes and consequences of movement) is needed to estimate movement more accurately. A related source of uncertainty for the western population is the possibility of spawning outside the Gulf of Mexico, which could be associated with an early maturity scenario in which young fish spawn in the Caribbean or Slope Seas (Richardson *et al.* 2016).

The U.S. Bluefin Tuna Research Program funded MSE was presented as being complementary to the ICCAT ABT-MSE process. Operating Models from both initiatives are conditioned on the available information for Atlantic bluefin tuna fisheries and can evaluate a range of candidate MPs. The major differences are that 1) the US-BTRP-MSE OM is conditioned on telemetry-based movement estimates and ICCAT (2017) perceptions of recruitment and fishing mortality (similar to the initial 'B-level' OMs in the ICCAT ABT-MSE), and the 'A-level' OMs in the ICCAT ABT-MSE are conditioned directly on data; and 2) the US-BTRP MSE supports age-based or index-based estimation models and reference points, and the ICCAT ABT-MSE supports index-based or age-aggregate estimation models and reference points. The consideration of historic productivity was considered. Although there is evidence of greater historical productivity, the available data are less certain.

The group agreed that the current MSE process should focus on the major uncertainties identified in recent stock assessments (**Table 1**). However, future iterations of MSE can address other dimensions of uncertainty. For example, as ecosystem effects on Atlantic bluefin tuna and fisheries can be quantified, and OMs can be linked to climate models or multispecies models to account for predicted changes in distribution or productivity. Future regime shifts could also be considered in future iterations of the MSE.

4.2 Management Objectives and Performance Metrics

Performance metrics (Appendix C, from ICCAT 2019 Panel 2) were discussed in relation to more aspirational fishery management objectives, like sustainable fisheries, maximum sustainable yield MSY, avoiding overfishing. For example, the aspirational objectives of sustainable fisheries and avoiding overfishing can be measured by the goal of >60% probability of being in Kobe green condition (i.e., not overfished, no overfishing). Each precise goal involves an explicit probability of the outcome and an implicit risk tolerance (e.g., 40% risk of not achieving Kobe green status). Performance metrics in the ICCAT ABT MSE are based simulated 30-year projections under candidate MPs to evaluate near-term outcomes (e.g., within the next 3 years), medium-term outcomes (e.g., within the next 10 years), or long-term outcomes (e.g., within the next 30 years).

Although there are 28 proposed performance metrics, the workshop noted that many are related and can be grouped into four categories (stock depletion, exploitation rate, yield, and change-in-yield). Considering that each metric applies to both the eastern and western area (or the eastern and western population), performance may be measured by eight of the most informative metrics (4 categories x 2 stocks).

Many of the proposed performance metrics are related to management reference point such as F_{MSY}, B_{MSY}, B_0, and B_{lim}. One advantage of the general MSE approach is that reference points like these that are difficult to estimate in practice are known quantities in the OM of the MSE. Many MP outcomes can also be compared to the reference outcome from no fishing, similar to the way B_0 reflect long-term equilibrium biomass with no fishing. The concept of dynamic B_0 was explained as an attempt to account for changes in stock productivity (e.g., MacCall *et al.* 1985), and the application of B_{lim} as a stock size to avoid (e.g., the hinge point of a hockey-stick stock recruit relationship, the lowest observed stock size; ICES 1997). Workshop participants noted that B_{lim} was defined as 40% of B_{MSY} Atlantic albacore and swordfish by ICCAT and that may be a reasonable definition for Atlantic bluefin tuna. The group recognized that risk tolerance should consider the definition of B_{lim}, because a low risk tolerance should be associated with a B_{lim} that reflects stock collapse, but a higher risk tolerance can be considered for a B_{lim} that indicates a moderate stock. Some guidance states that there should be very low tolerance for B<Blim, but B_{lim} has been defined as greater than B_{MSY} for some fisheries. The definition of B_{lim} may also be associated with its role in the HCR (e.g., reduced fishing when $B<B_{lim}$).

The stability objective and change-in-catch performance metrics were discussed extensively. The group recognized that change-in-yield and performance of candidate MPs will depend on the frequency of MP implementation (e.g., updating the data (and possibly a stock assessment), and determining target catch every two years?; … every three years?), and there is a tradeoff between frequency of MP implementation and change-in-yield performance.

Workshop participants recognized that the management of eastern fisheries affects western fisheries (and vice versa) because of both spawning populations mix in the eastern and western Atlantic. Therefore, risk tolerance, reference point definitions, and other aspects of performance metrics should be the coordinated for eastern and western stocks.

4.3 Candidate Management Procedures

Similar to the discussion and recommendation to standardize eastern and western performance metrics, workshop participants recognized that candidate management procedures should also be similar and equitable for eastern and western fisheries. The workshop also recognized that candidate HCRs can include elements that help to achieve the management goals expressed by performance metrics. For example, candidate HCRs should consider thresholds based on B_{lim} (e.g., reduced fishing or fishery closure when $B<B_{lim}$) to help achieve metric 28.

Alternative HCRs were considered that ranged from constant-F or constant-catch to those that are more responsive to perceptions of stock size (or a stock index), in which catch is either reduced below a threshold stock size or the fishery is closed below a threshold stock size. There were different opinions on HCRs that require fishery closures among participants. Some felt that closures would force the pelagic longline fishery out of business, but other thought temporary closures were preferred to longer-term severe restrictions.

Candidate harvest control rules should also consider constraints on interannual change in Total Allowable Catch (TAC) to achieve the change-in-yield goals. For example, the Atlantic albacore HCR has a 20% constraint on increasing TAC as well as a constraint on decreasing TAC when biomass estimates are greater than a threshold. Frequency of MP implementation should be an explicit feature of candidate MPs, and change-in-yield constraints should consider the frequency of implementation. The U.S. ICCAT Advisory Committee suggested that constraints of 0% (no constraint), 20%, 30%, and 40% should be considered to find the optimal constraint. Some workshop participants suggested more restrictive constraints (e.g., as low as 5%), but others were concerned that such tight constraints would not be responsive to changing stock conditions and would ultimately forego long-term yield. Similar to Atlantic Albacore, constraints can also be a function of perceived stock size. Considering the different magnitudes of eastern and western Atlantic yield, different change-in-yield constraints could be considered for each.

Preliminary evaluations of a constant-$F_{0.1}$ (Morse *et al.*, 2019) that emulates the current management procedure implemented by ICCAT was considered as an example for demonstration. The group felt that it may be helpful to compare performance of alternative MPs to the current MP. The group also valued the ability to evaluate performance of model-based MPs that include age-based estimation models and reference points. The group recognized that index-based MPs are much easier to understand and implement, but some participants were concerned that no single index can accurately reflect trends in both populations. The next step suggested for the US BTRP-MSE is to evaluate a multi-index empirical MP (e.g., based on larval surveys and small US Rod & Reel CPUE).

4.4 Future Directions

A plan was developed to present recommendations to the Intersessional Meeting of the ICCAT Bluefin Tuna MSE Technical Group and adapt to ICCAT decisions and timeline for implementation of the ABT-MSE. If the process continues as planned, a second workshop with stakeholders will be held in late fall 2019 (ideally after the U.S. ICCAT Advisory Committee and before the ICCAT Commission meeting) in Massachusetts. The workshop will be focused on presenting evaluations of candidate MPs. If the ICCAT ABT-MSE process is delayed, the workshop timing will be more flexible, and preliminary performance evaluations will be considered.

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Table 1. Major sources of uncertainty and alternative for operating models (each source of uncertainty is independent, resulting in several combinations of alternatives).

	Alternative 1	*Alternative 2*	*Alternative 3*	*Populations*
Movement	model estimates	telemetry-based estimates	low movement?	east & west
Recruitment	Beverton-Holt	hockey stick		east & west
Maturity	young*	old		west
Natural Mortality	low	high		east & west

* Can be associated with spawning outside the Gulf of Mexico.

Appendix 1

Workshop Agenda

Workshop on Atlantic Bluefin Tuna Management Strategy Evaluation
April 29-30 2019, UMass School for Marine Science & Technology
836 South Rodney French Boulevard, New Bedford MA

The workshop is organized by the UMass School for Marine Science & Technology (SMAST) and the Gulf of Maine Research Institute (GMRI) and is funded by the National Marine Fisheries Service (NMFS).

- Management Strategy Evaluation (MSE) will be introduced as a tool for fisheries management, including the MSE approach being developed by the International Commission for the Conservation of Atlantic Tunas (ICCAT) and preliminary demonstrations as an illustration of MSE for Atlantic Bluefin Tuna.
- The aim of the workshop is to solicit feedback from U.S. stakeholders on representation of the Atlantic bluefin resource and fisheries in models, fishery management objectives, management performance indicators, and candidate management procedures.
- Stakeholder feedback will be considered in future research and reported to ICCAT, but the workshop will primarily be informational and educational, and there will be no binding decisions from the workshop.

Agenda

Monday Morning (10am-1pm)

- Welcome and Introductions – Walt Golet (University of Maine, GMRI)
- Introduction to Management Strategy Evaluation – Steve Cadrin (SMAST)
- The ICCAT Process for Management Strategy Evaluation of Bluefin Tuna – John Walter (NMFS)
- The Process for U.S. Stakeholder Input to ICCAT – Terra Lederhouse (NMFS)

Lunch – served at SMAST

Monday Afternoon (2-5pm)

- Modeling Atlantic Bluefin Tuna Populations and Fisheries – Lisa Kerr (GMRI)
- Candidate Management Procedures – Lisa Kerr (GMRI)
- Indicators of Management Performance – Ashley Weston (GMRI)

Monday Evening – Dinner at the United Fishermen's Club (639 Orchard St, New Bedford, 6pm)

Tuesday Morning (9-noon) – moderated by Walt Golet (GMRI) and Steve Cadrin (SMAST)

- Summary of Monday's Discussions
- Workshop Conclusions
- Research Recommendations

Appendix 2

Workshop Participants

Name		Affiliation
Andrew	Applegate	New England Council staff for EBFM
Rick	Bellavance	Priority Charters, NEFMC, RI Party and Charter Boat Association
Eugene	Bergson	Blue Harvest Fisheries
Jim	Bisagni	SMAST
Charles	Blaney	Large Pelagics Research Center
Kevin	Blinkoff	On The Water Media
Steve	Cadrin	SMAST
Peter	Chaibongsai	The Billfish Foundation
Jonathan	Cummings	SMAST
Glenn	Delaney	BWFA
Jonathan	Deroba	NOAA NEFSC
Benjamin	Galuardi	NOAA/SMAST
Steven	Getto	ABTA
Willy	Goldsmith	VIMS graduate
Walt	Golet	Professor UMaine
Alex	Hansell	SMAST
Amanda	Hart	SMAST
Janne	Haugen	SMAST
Rachel	Hopkins	Pew Charitable Trusts
Lisa	Kerr	Gulf of Maine Research Institute
Jeff	Kneebone	New England Aquarium
Tim	Lam	University of Massachusetts Boston
Terra	Lederhouse	NOAA Fisheries, Office of International Affairs & Seafood Inspection
Molly	Lutcavage	University of Massachusetts Boston
Tyler	MaCallister	ABTA Member Commercial Tuna Fisherman
Sarah	McLaughlin	NMFS - HMS Mgmt Division
Patrick	Mead	Compass Seafood
Shana	Miller	The Ocean Foundation
Alanna	Mnich	SMAST
Peter	Moore	Commercial Fisherman
Shawn	Moore	Commercial Fisherman
Mitch	Nepolitano	Dantilu Custom Charters
Bobby	Nguyen	Gulf of Mexico (liaison)
Ashleigh	Novak	SMAST
Cate	O'Keefe	MA Division of Marine Fisheries
Rachel	O'Malley	NMFS Office of International Affairs
Ellen	Peel	The Billfish Foundation
Michael	Pierdinock	ICCAT AC
Lucas	Pina	Bluefin sales and marketing
George	Purmont	HMS-AP. ICCAT
Brian	Rothschild	SMAST
Martin	Scanlon	BWFA/President
David	Schalit	American Bluefin Tuna Association
Matthew	Seeley	Mid-Atlantic Fishery Management Council Staff
Greg	Skomal	MA Division of Marine Fisheries
Scott	Taylor	DAY BOAT SEAFOOD
Sam	Truesdell	GMRI
John	Walter	SEFSC
Rick	Weber	South Jersey Marina / HMS AP / IAC
Steve	Weiner	Bluefin fisherman
Ashley	Weston	GMRI
Brooke	Wright	SMAST

Appendix 3

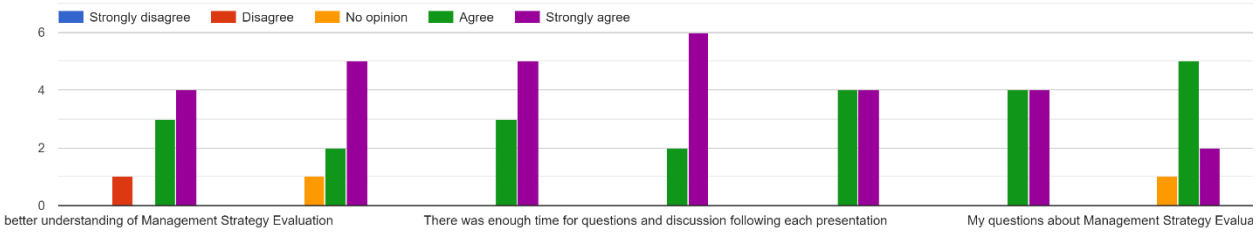
Preliminary performance metrics for Atlantic Bluefin tuna MSE (from ICCAT 2019 Panel 2)

number	statistic	Description	What it applies to
1	AvC30	Average catch over years 1-30 (per area – west or east)	Area (East and West)
2	C3	Average catch over years 1-3	Area (East and West)
3	C6	Average catch over year 1-6	Area (East and West)
4	C10	Average catch over years 1-10	Area (East and West)
5	C20	Average catch over year 10-20	Area (East and West)
6	C30	Average catch over year 20-30	Area (East and West)
7	D10	Depletion relative to dynamic B_0 at 10 years (per stock – western or eastern origin)	Biological Stock (East and West)
8	D20	Depletion at 20 years	Biological Stock (East and West)
9	D30	Depletion at 30 years	Biological Stock (East and West)
10	LD	Lowest depletion over 30 years	Biological Stock (East and West)
11	DNC	Depletion at year 30 relative to no catch (i.e. "dynamic"), this differs from D30 because dynamic B_0 may not be reached at year 30	Biological Stock (East and West)
12	LDNC	Lowest depletion relative to no catch	Biological Stock (East and West)
13	POF	Probability of Over-Fishing ($F>F_{MSY}$) over 30 years	Biological Stock (East and West)
14	POS	Probability of Over-Fished status ($B<B_{MSY}$) over 30 years	Biological Stock (East and West)
15	POF10	Probability of Over-Fishing ($F>F_{MSY}$) over years 1-10	Biological Stock (East and West)
16	POS10	Probability of Over-Fished status ($B<B_{MSY}$) over years 1-10	Biological Stock (East and West)
17	POF20	Probability of Over-Fishing ($F>F_{MSY}$) over years 11-20	Biological Stock (East and West)
18	POS20	Probability of Over-Fished status ($B<B_{MSY}$) over years 11-20	Biological Stock (East and West)
19	POF30	Probability of Over-Fishing ($F>F_{MSY}$) over years 21-30	Biological Stock (East and West)
20	POS30	Probability of Over-Fished status ($B<B_{MSY}$) years 21-30	Biological Stock (East and West)
21	PGK	Probability of Green Kobe region ($F<F_{MSY}$ AND $B>B_{MSY}$) over 30 years	Biological Stock (East and West)
22	AAVC	Average variation in catch between TAC changes over 30 year time period	Area (East and West)
23	NegC	Maximum negative change in catch (per area) over 30 year time period	Area (East and West)
24	PosC	Maximum positive change in catch (per area) over 30 year time period	Area (East and West)
25	Br30	Depletion (B relative to dynamic B_{MSY}) after projection year 30	Stock (East and West)
26	BR10	Depletion (B relative to dynamic B_{MSY}) after projection year 10	Biological Stock (East and West)
27	BR20	Depletion (B relative to dynamic B_{MSY}) after projection year 20	Biological Stock (East and West)
28	PBlim	Probability of $B<B_{lim}$ over 30 years	Biological Stock (East and West)

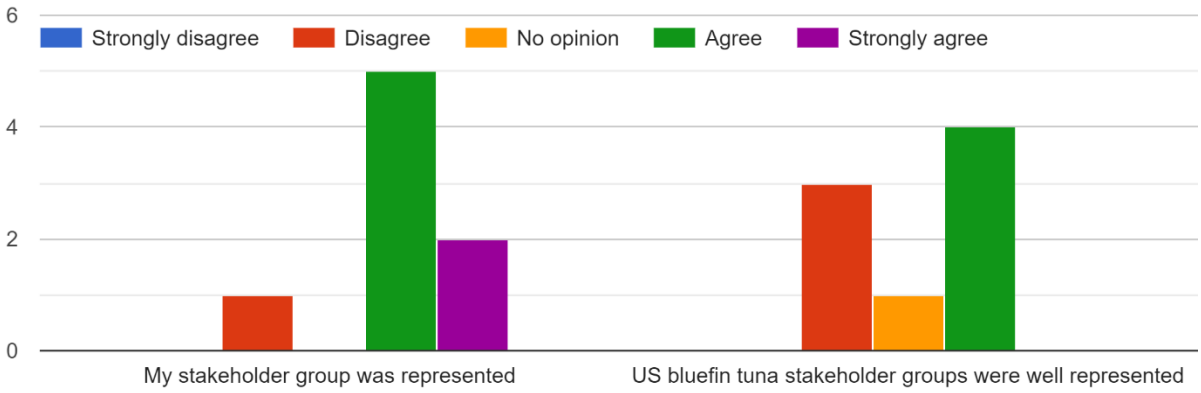
Appendix 4

Responses to post-workshop survey

Please select your level of agreement with the following statements regarding workshop content



Please select your level of agreement with the following statements regarding workshop representation



Please select your level of agreement with the following statements regarding workshop logistics