

**Center for Independent Experts (CIE) independent peer
review of
Stock assessment of Caribbean data-limited species
SEDAR 46**

Prepared by:

Panayiota Apostolaki

Assignment undertaken for:

Center for Independent Experts, CIE, US

Table of Content

| | |
|---|----|
| Executive Summary | 3 |
| Background | 4 |
| Description of the Reviewer’s Role in the Review Activities..... | 5 |
| Summary of Findings | 6 |
| TOR 1. Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions | 6 |
| TOR 2. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data..... | 9 |
| TOR 3. Consider how uncertainties in the assessment, and their potential consequences, are addressed | 13 |
| TOR 4. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted | 15 |
| TOR 5. Consider whether the stock assessment constitutes the best scientific information available using the following criteria as appropriate: relevance, inclusiveness, objectivity, transparency, timeliness, verification, validation, and peer review of fishery management information..... | 17 |
| TOR 6. Provide guidance on key improvements in data or modeling approaches that should be considered when scheduling the next assessment..... | 18 |
| Conclusions/Recommendations | 19 |
| Appendix 1. Bibliography..... | 23 |
| Appendix 2. Statement of Work for Dr Panagiota Apostolaki..... | 26 |
| Appendix 3. Panel Membership | 33 |
| Appendix 4. Research recommendations made by the teams that contributed to the SEDAR 46 assessment:..... | 33 |

Executive Summary

The Caribbean Data-limited species panel review meeting took place in Miami, between February 23rd and February 25th, 2016. The focus of the review was the Management Strategy Evaluation (MSE) work done under SEDAR 46 that aimed to explore multiple data-limited models for stock assessment and management advice.

A conventional stock assessment was not carried out under SEDAR 46 due to paucity of relevant data. Instead, the assessment carried out used an analytical framework to enable objective comparison of the models considered and test diagnostics that could be used to compare performance of different management procedures and inform management discussions. Three appointed reviewers from the Center of Independent Experts (CIE) discussed the data and methods with the scientific team and other attendees to assess the quality of assessment and relevant findings. Criteria considered to reach a decision included the adequacy and reliability of data, appropriateness of assessment methods including ability to capture uncertainty, and whether the outcomes could be used to inform managers about stock trends and conditions.

The MSE approach used an age-structured model as the operating model and tested a suite of management procedures (MPs) that were deemed more appropriate for data poor species. All six stocks considered under SEDAR 46 (yellowtail snapper and hogfish from Puerto Rico, spiny lobster and queen triggerfish from St. Thomas, and spiny lobster and stoplight parrotfish from St. Croix) fall into that category. The criteria used to assess performance reflected the need to prevent overexploitation and avoid drastic changes in allowable catches from one year to another.

The results indicated that most of the MPs cannot be employed at present since they require more data than what is currently available or further work is needed to understand the dynamic behaviour they exhibit. Nevertheless, a small number of MPs have performed well and could potentially be used to support management decisions. The latter group of MPs also performed better than the MP that is currently in place for almost all scenarios tested.

Although a conventional stock assessment was not done, the MSE work and relating analysis were appropriate for the data available and produced results that can inform decisions about future OFL. They provided very useful knowledge and made progress with developing scientific advice to support management decisions. Further, the results of the analysis have provided an insight into knowledge gaps to which models are more sensitive so, can also inform discussions about prioritisation of future scientific work.

Background

The 2016 Caribbean Data-limited Species Assessment focused on six U.S. Caribbean species for which limited information about life history and exploitation exists. The six species are yellowtail snapper and hogfish from Puerto Rico, spiny lobster and queen triggerfish from St. Thomas, and spiny lobster and stoplight parrotfish from St. Croix.

Stock assessments have been carried out in the past for only four of the species covered here (yellowtail snapper from Puerto Rico, spiny lobster and queen triggerfish from St. Thomas, and spiny lobster from St. Croix). Although the assessments used less data-intensive analytical techniques such as CPUE trends and production models in an attempt to overcome the paucity of relevant data, their outcomes were largely considered to be unsatisfactory in terms of determining stock status. As a result, optimum fishing limits in the US Caribbean are determined using catch information (e.g. catch scalars, reliable catch series). Measures that aim to protect important habitats (corals) in the US Caribbean area are also in place under the Coral Fishery Management plan.

Given limited information to support stock assessment, the SEDAR 46 applied data-limited techniques to provide an insight into the assessment tools and management procedures that could be adopted for the six species considered to help prevent overfishing and achieve long term optimum yield. A relatively new package called Data Limited Methods Toolkit (DLMtool, Carruthers et al. 2015) was used to test different data-limited stock assessment models and management procedures (MPs) in a management strategy evaluation context. Although the package is new, the assessment approaches and the majority of MPs included are well known and have been used extensively in the past.

The analysis chose one fishing technique for each of the six species, dive fishery for hogfish, and handline for yellowtail snapper, trap fishery for the two St. Thomas species (queen triggerfish and spiny lobster), and dive fishery for stoplight parrotfish and spiny lobster in St. Croix. The choice was made based on the fishery that caught the greatest proportion of fish for each of the six species.

The catch and CPUE information for each of the species varied in terms of the time they covered and representation of the stock (i.e. stock-specific data); the two lobster stocks had the longest time series of catches (1975 onwards) while for hogfish and yellowtail snapper in Puerto Rico had the longest CPUE time series (1990 onwards). Life history was characterised by considerable uncertainty and values of biological parameters from other areas were also employed to inform the selection of parameter values.

As this was not a traditional stock assessment, the outcomes of the work focused mainly on the performance of different management procedures rather than on estimating stock status and common management metrics such as MSY. The assessment employed sensitivity analysis to test the effects of uncertainty on MPs performance and identify those parameters and issues that had the biggest impact on findings.

The data and assumptions used in the assessment were discussed at the Data/Assessment workshop held in November 2015; webinars were used in the two months after the workshop to finalise the assessment. The workshop to review the assessment took place in February 2016.

Three CIE reviewers were commissioned to conduct an impartial and independent peer review of the 2016 Caribbean Data-limited Species Assessment (SEDAR 46) in accordance with the SoW and stock assessment ToRs listed in Appendix 2. Each CIE reviewer is also required to produce an independent peer review report. This document provides my review of the work covered in the Caribbean data-limited assessment and supporting material that underpinned that work. Further details on the reviewer's role and the review request of the Center for Independent Experts are presented below and in Appendix 2.

Description of the Reviewer's Role in the Review Activities

I was contracted to:

- 1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
- 2) Actively participate during the panel review meeting as a member of the review panel and focus my peer review tasks on the ToRs as specified herein, and conduct an independent peer review in accordance with the ToRs (Appendix 2, Annex 2).
- 3) No later than 21 March 2016, submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Dr. Manoj Shivlani, CIE Lead Coordinator and Dr. David Sampson, CIE Regional Coordinator. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in Annex 2 (Appendix 2).

This document provides the outcome of this review.

Summary of Findings

TOR 1. Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions, and consider the following:

- a. Are data decisions made by the DW and AW sound and robust?
- b. Are data uncertainties acknowledged, reported, and within normal or expected levels?
- c. Are data applied properly within the assessment model?
- d. Are input data series reliable and sufficient to support the assessment approach and findings?

Note: This and following ToRs use the word “assessment” to refer to some of the information that the review should cover. This review adopts the interpretation of the word “assessment” that was also used for the Review Panel report: assessment means a determination of whether the MP is sustainable over the long term or not, whereas stock assessment implies stock status (which is not an option in the analyses considered).

According to the assessment team, the chief aims of the SEDAR 46 stock evaluations and the focus of the assessment report was (RW-03: Cummings et al., 2016):

- 1) provide managers with an alternative approach to setting ACLs for data-limited stocks (i.e., the DLMtool and the mean length estimator),*
- 2) to identify important concerns that should be taken into account when evaluating performance of multiple management procedures (MP)s; and*
- 3) to outline possible options for selecting between MPs for management decisions.*

This report has taken those aims into account when reviewing the assessment and responding to the questions in each ToR (Appendix 2, Annex 2).

The data considered as part of this assessment included fishery statistics and CPUE series, life history information, and length frequency data.

For life history information, very limited area- and stock-specific information was available or appropriate to use. For yellowtail snapper in Puerto Rico, area and stock-specific parameter values were available for the weight-length relationship and maturity while for queen triggerfish in St. Thomas such values were available for the weight-length relationship only. Other life history parameters (e.g. growth, maximum age, mortality) for those two species and all life history parameters for the other four species were calculated using information from studies covering either other Caribbean areas (e.g. Puerto Rico studies used for St. Croix) or areas further away such as South Atlantic, Gulf of Mexico, and Brazil.

The decision to use parameter values from different areas to fill the gaps was sound given the lack of studies for the specific stocks. However, that will affect the accuracy of the model in representing the life history of the species assessed. Although that is less important for this study since it evaluates the appropriateness of assessment models and MPs for species that resemble the dynamics and exploitation of the six species under consideration, effort to calculate stock-specific parameters is recommended. This will help reduce concerns about appropriate model parametrisation once conventional stock assessments can be run for the six stocks.

The assessment acknowledged the uncertainty in the biological and other parameters and included it in the model inputs. When such information was not provided in the relevant studies used to choose point estimates for each model parameter the Life History Working Group (LHWG) assigned an arbitrary CV or described uncertainty based on the range of values for a single parameter calculated using different methodologies. Sensitivity runs were also used to test the sensitivity of the outcomes to the choice of parameter values. The approach followed is reasonable but some details still need refinement. For example, uniform distributions were used to describe all input parameters treated as uncertain; that was a simplification and it is recommended that further work is done to develop distributions that are more representative and reflect current knowledge about each of the parameters.

The selection of values for the steepness of the stock recruitment function, used to calculate TACs, is a good example of the high uncertainty that characterises the input parameters. The range of values for that parameter found in the literature spans almost the entire range of plausible values (e.g. spiny lobster) and come from areas around the world. So, in addition to other life history parameters mentioned earlier, the values for steepness are not reliable and therefore, it is recommended that alternative (possibly indirect) ways to calculate TAC are used if such information is required by managers.

The models used in the assessment simulated a single fishery only; the DW and AW chose to include the fishery with the greatest proportion of trips reporting landings of each species in the models. This is a realistic choice and the large difference between the trip proportion of the chosen fishery and the second best fishery would generally provide some reassurance about representativeness. Some concern remains though given the nature of fishing practices chosen, such as diving (or traps); they could be localized and might not sample the whole stock so, their signal could be biased. Information about the spatial distribution of the trips of the chosen fishery relative to the area that is covered by the stock will help address this concern. However, the choice to use a single fishery to describe exploitation for each species is adequate for the purpose of the MSE exercise undertaken in this assessment.

Catch series were available for all six species but varied in terms of their length and reliability. The catch series for hogfish and yellowtail in Puerto Rico covered the period from 1983 to 2014, and the discard series was available starting in 2000 both for commercial and recreational fisheries. The catch series for both lobster stocks covered almost 40 years while the catch series for the remaining two stocks were much shorter with only a few years of species-specific data since both triggerfish and stoplight parrotfish were reported as part of a species complex until 2011. Discard information was available for Puerto Rico fisheries but not for the other two islands.

The catch data for commercial landings from Puerto Rico were adjusted using expansion factors to account for incomplete reporting. The choice of area specific factors to estimate total catches is reasonable, and the general approach responds to recommendations and issues noted at previous assessment meetings. What is still of concern is the fact that data collected after those earlier meetings also need to be adjusted suggesting that misreporting continues. The assessment report did not cover the specific steps followed to calculate the expansion factors but recommended further examination of the process. This is an element of the assessment that needs to be covered in more detail in the future since it has the potential to add considerable bias to estimates of conventional stock assessments. Therefore, it is recommended that the process and uncertainty associated with the

calculation of area-specific multipliers to adjust catches is fully covered in the assessment report.

The data from the other two islands were used without any adjustment since landings from those areas were assumed to be fully recorded. However, the report prepared by Bennett (2015) suggests that reporting in USVI is probably incomplete, too. Therefore, the decision to treat those catch data as fully reported is not robust. Further, discussions during the assessment meeting indicated that some level of over-reporting might have happened by fishermen who wanted to build/maintain a fishing track record.

Therefore, further consideration of the catch data and possible ways to verify past records would be recommended. This is important given that current annual catch limits are set based on past catch information but it will also help improve the accuracy of catch data used in stock assessment when a stock assessment can be run for these species.

More generally, the majority of the catch data come from self-reported logbook records and the accuracy of those records is unclear since a mechanism to cross reference/check the records does not appear to be in place. Information presented in the assessment report and supplementary material has highlighted the need for a mechanism to validate the data in the logbooks to address any misreporting problems in the future. This issue is also relevant to the discussion about CPUEs that follows since misreporting of catches will affect the accuracy of any corresponding CPUE series.

CPUE indices were produced for all six species using fishery-dependent catch and effort information from the logbooks/sales receipts. Criteria used to filter the data included whether the type of gear was recorded and whether the trip record covered several gears or trips (for Puerto Rico only). Outliers were also excluded as well as trips that did not record the number of hours fished (Puerto Rico only).

The criteria used to clean the data are sound and grouping similar gears together is a reasonable simplification given the limited amount of data available for each species-gear combination. Although standardized CPUE series were produced they were not used because of concerns about the standardization methods. Generally, the choice of a delta-lognormal function to standardize the CPUE series is valid, but in this case, the analysis used did not seem to capture variability in the CPUE data correctly. I agree with the DW/AW that further work is needed to refine the standardization process but it will need to extend to both effort information as well as choosing catch records that do not reflect misreporting.

The analysis also used fishery independent data that were available for two of the six stocks (yellowtail snapper and queen triggerfish) to produce CPUE indices but those were not used in the assessment since they were characterized by low numbers of positive stations. However, power analysis was done to calculate the number of survey stations needed to detect a change in CPUE in the near future (5 or 10 years) and could guide future monitoring work.

The CPUE development and choices are less important for this assessment in terms of their reliability to support a stock assessment, because a stock assessment was not the focus of the SEDAR 46 and the OM was not conditioned on past data, but it should be a priority for future work (see also discussion about the effectiveness of different MPs under ToR 2 which highlights the need for robust catch and CPUE

indices). This includes further work to improve the robustness of fishery-independent indices which, although they were not considered reliable at this stage, could be a quicker (more easily controlled) way to build a robust relative index of abundance.

The assessment also used length frequency data for two purposes; to build selectivity curves for the gear considered for each species, and calculate the total mortality for each species using the mean length-based mortality estimator model (Gedamke and Hoenig, 2006). The use of length frequency data for those purposes is appropriate and augments the range of information that can inform the assessment. However, the choice of parameters to describe the selectivity curve for the gears assessed does not reflect best practice. The assessment assumes that length at full selectivity is equal to the length at which the cumulative proportion of fish caught is equal to 95%. This produces selectivity curves that are shifted to the right so, only a small fraction of the population is assumed to be fully selected. The standard simple approach for identifying the length at which the selectivity reaches its maximum is based on the mode of the length frequency distribution. For all species considered the latter approach would result in lengths at full selectivity that are much lower than those adopted for the model parametrization.

The approach adopted provides an unrealistic representation of the vulnerability of different length classes to the assessed gear. The choice is not considered appropriate and the team produced new model runs using selectivity curves that were calculated based on the mode of the catch-at-length frequency distribution. It is recommended that the catch-at-length frequency distribution rather than the corresponding cumulative distribution is used to provide an estimate of the length at full selectivity.

Overall, despite serious data limitations, the data used and the process by which the input data were developed represent a sound and appropriate way forward. Some changes were needed and the assessment team responded efficiently to recommendations from the reviewers to improve data inputs and processes used. Significant data gaps remain, but the data used provided an acceptable basis for the MSE approach.

TOR 2. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data, and considering the following:

- a. Are the data-limited methods scientifically sound and robust?
- b. Are the methods appropriate given the available data?
- c. Are the data-limited models configured properly and used in a manner consistent with standard practices?
- d. Are the quantitative estimates produced reliable? Does the method produce management metrics (e.g. MSY, ABC, ACL) or other indicators (e.g. trends in F or Z, probability of overfishing) that may be used to inform managers about stock trends and conditions?

As mentioned already, SEDAR 46 did not undertake a conventional stock assessment due to data limitations. The Assessment workshop explored different data-limited assessment models and management procedures to ascertain their effectiveness with regard to US Caribbean fisheries. They did so through application of a Data Limited Methods toolkit (DLMtool) to evaluate the potential of different Management Procedures (MP).

The assessment considered data-limited approaches such as index-based models that rely on catches and relative abundance series, catch-based methods and depletion-based methods, and data moderate approaches such as delay-difference stock assessment.

The DLM toolkit is a software package written in R with built-in functions to simulate different assessment procedures and uses management strategy evaluation (MSE) to test the performance of those assessment models and management procedures in a simulation environment (Carruthers 2015). The DLMtool uses a standard MSE approach which is comprised of three components: an operating model that reflects the “true” situation for the system of interest (i.e. “true” state for stock and fishery), a series of assessments models and management rules (MPs), and criteria for evaluating the performance of MPs.

The operating model (OM) is a spatially disaggregated, age-structured model that uses the Beverton-Holt stock recruitment function to describe recruitment and a movement matrix to simulate stock mixing. The OM uses a single value for natural mortality (age-independent), simulates a single fishery, and allows for uncertainty in biological/other parameters to be captured in the calculations. It also includes a number of other assumptions/functions that relate to the spatially disaggregated dynamics it simulates such as regional availability of the stock to fishing and distribution of effort across the sub areas simulated. This review does not comment on the way those features were formulated given they were not used for the current assessment.

For SEDAR 46, the OM was a single area model and was parametrised using parameter values that represented the best available knowledge about each of the six stocks. Probability distributions and sensitivity analysis were used to capture uncertainty in the model parameters including potential bias in catch data. The OM was run for 75 years with random selections made for each of the uncertain parameters, and that period was assumed to characterize the historical exploitation pattern for US Caribbean fisheries. After that, the OM was used to run projections covering a period of 40 years.

In addition to the modelling approaches described above that came with the DLMtool package, SEDAR 46 also considered the Gedamke-Hoenig (2006) mean length estimator approach, which had been previously applied in the US Caribbean fisheries, and tested its performance using the DLMtool.

The DW/AW Panel chose three criteria/diagnostics to compare the performance of the MPs based on the stock and fleet dynamics that described each of the six species covered by the SEDAR 46. Those were:

- i. Probability of not overfishing – the probability had to be at or above 50%
- ii. Probability of the stock biomass remaining above half of B_{msy} – this had to be at or above 50%
- iii. Average annual variability in yield remaining with 15% - the probability of this happening should be at or more than 50%.

The assessment also calculated a fourth metric which was the long-term mean yield over the last ten years of the projection.

The use of simulation evaluation to understand the relative merits of different management procedures for the Caribbean stocks is appropriate and a valid choice

given data limitations and difficulties with conventional stock assessments. The MSE components have been used in a number of other fisheries and are tested, and their application in this assessment is in line with standard practices. However, a few aspects of the DLMtool and analysis carried out need further development or adjustment. Specifically:

- Although the general approach, MSE, is well understood the details of the functions used in the DLMtool are still not clear. For example, it was not possible to find the mathematical description of the ML2D function or an explanation why the use of uniform distribution was appropriate for all parameters treated as uncertain in the calculations. Generally, a comprehensive mathematical description of the model needs to be part of the stock assessment report.
- The operating model offers a range of features to improve realism in the simulation of the system and allows for uncertainty to be included in the analysis. However, it does not allow for age-specific mortality or for multiple fisheries and that is very restrictive and a weakness of the tool. Further, it does not allow for simulation of the processes that characterise species that change gender so, simulation of the dynamics of hogfish (which are protogynous hermaphrodites) is restricted by that.
- The model does not check if the combinations of the uncertain parameters drawn from the corresponding distributions are valid, and that means that the model could sample from a parameter space that includes combinations of parameter values that are not realistic/permissible (e.g. unrealistic combinations of L_{inf} , K) or correlation was not taken into account. That does not invalidate the approach, but makes it more time consuming and could affect its robustness. Some preliminary work to address this concern was done using the Gedamke-Hoenig mean length estimator in the DLMtool and the results were made available to the reviewers after the meeting. The results confirmed that accounting for correlation in input parameters reduced the parameter space sampled and identified sensitivity trends that were not apparent previously. Therefore, further work on the configuration of the model to better define the acceptable parameter space and account for correlation between input parameters is recommended.
- The OM is not conditioned on information from the relevant system; the model is parametrised using best estimates for the relevant model parameters and uncertainty that characterises them but it is not fitted to past data and that means that inference cannot be made about the ability of the OM to replicate past, observed behaviour of the system. It is acknowledged that, given the uncertainty in past observations it is expected that fitting the OM to past data for these six species might not be very informative or useful in terms of estimating the parameters of the model. However, the unconditional model is a weakness so, it is recommended that future assessments try to condition the OM, even if that involves estimation of a small number of parameters, so some knowledge can be gained about the ability of the OM to replicate past behaviour. This will improve the robustness of the OM and that of the overall assessment.
- The concerns about gear selectivity values included in the model which were covered in ToR 1 is also relevant for this ToR as it will influence the reliability of the results.

- The Management Procedures currently used to set catch limits for the six species should be included in the analysis. This will provide a transparent and robust way to compare alternative MPs to the existing one. The assessment team has undertaken further simulations to calculate the performance metrics for the existing MPs and the results were made available to the reviewers during and after the review meeting.

The assessment used the non-equilibrium Gedamke-Hoenig mean length estimator to calculate total mortality and overfishing levels. The method used data from the Trip Interview Program (TIP) to identify the value of the critical length L_c (length at full selectivity) that is an input for the estimator and ran the analysis with different values of L_c to assess the sensitivity of the model results to the choice of critical length. The recent fishing mortality rates were then derived as the difference between the estimated total mortality rates and the assumed natural mortality rates.

Yield-per-recruit (YPR) and spawning potential ratio (SPR) analyses were used to calculate $F_{0.1}$ and $F_{30\%}$, as proxies for F_{MSY} for the six stocks. Overfishing limits (OFLs) were calculated by using the corresponding F_{MSY} proxies and current abundance estimates. The latter was estimated as the ratio of recent catch to recent fishing mortality rate calculated with the mean length estimator. Both proxies indicated that reduction in catches relative to recent ones was needed for all species. The only exception was Puerto Rico yellowtail snapper and St. Thomas spiny lobster where SPR analyses were used to calculate the F_{MSY} proxy.

The application of the mean length estimator is appropriate and helped make the most of the length frequency information available for the stocks. Given the data-limited nature of the assessment, this is a good choice but has weaknesses. An important one is that it assumes that recruitment is constant over the years, and that can lead to higher estimates of optimum/maximum exploitation levels. Therefore, such values should be used with caution.

The DW/AW Panel used the outcomes of the SME to identify the top six MPs for each species. For a given species, the list of the top six MPs varied considerably depending on whether the input data were assumed to be precise and unbiased or not. Generally, MPs that relied on abundance or depletion estimates or those considered to be data-moderate performed better when the precise and unbiased input data assumption was used while index based and length based MPs performed better when the model accounted for bias and imprecision in input data.

The assessment team further reduced the list of identified MPs to exclude those for which the necessary data are not currently available for the six species covered in the assessment. The remaining MPs were applied to real data available for each of the species to calculate estimates of Total Allowable Catches.

The results indicated that some of the remaining MPs lead to highly imprecise and possible unrealistic TACs so, those were also excluded from the final list of MPs. In particular, the model results using the DD and DD4010 MPs, were very uncertain and supported TAC values that appear to be unrealistic. That was also true for other MPs such as MCD. Therefore, the behaviour of those MPs needs further exploration, and I will also recommend that the code is checked to ensure that the relevant methods have been programmed correctly.

The application of the MPs to real data indicated that index-based MPs and length-based MPs are more appropriate for the type of stocks/systems considered in SEDAR 46. Catch-based MPs were also included in the list for two of the species, but it was not possible to identify an MP that could be used for stoplight parrotfish at present due to high data limitations for that species and associated uncertainty in the assessment.

The MPs' performance, although not a conventional management metric, provides useful insight into management approaches that could be considered in the short to medium term or until the quality of data and knowledge about the six species improves. The three criteria chosen to assess performance address key management objectives and can inform discussions about management of fisheries that is in line with the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and does not result in drastic changes in catch quotas.

Although the criteria are generally sound, their evaluation over a 40-year period raises some issues about the realism of the underlying assumptions. For example, the criterion about stock biomass will be met even if the size of the stock is below half of B_{msy} for several years in a row (but less than 20 years in total); it is difficult to see how that would not trigger additional work to bring the stock back to its B_{msy} level (or equivalent proxy) within 10 years, if possible, as the MSFCMA guidelines indicate. This will be an issue with a smaller time period as well but it becomes more apparent as the time period used for the projections increases. So, further consideration of the constraints within which an MP needs to operate (and refinement of the performance criteria as needed) is recommended to ensure that its performance would be satisfactory in real life.

From a biological point of view, the length of the projection period was chosen arbitrarily, so it did not take into account key characteristics such as rate at which the stock grows or duration of life which influence how quickly a population can recover; it is recommended that the choice of the projection period is linked to the life history of the species, e.g. generation time.

The application of the MPs to real data has provided some information about levels of TACs and that can also inform management decisions, so it is an appropriate metric (but see comments about reliability of current results below).

Generally, the process followed is sound and the calculated metrics and indicators are fit for purpose. However, the input data for the application of the MPs to the six species (real data) remain very uncertain, so the outcomes, especially absolute values, need to be treated with caution. Nevertheless, the analysis suggested that all the alternative MPs that made the final list performed better than the MP currently used to manage the exploitation of the six species.

TOR 3. Consider how uncertainties in the assessment, and their potential consequences, are addressed.

- Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods.
- Ensure that the implications of uncertainty in technical conclusions are clearly stated.

There is considerable uncertainty across all data and parameters used in the assessment and that reflects the nature of the stocks and systems considered (i.e.

data poor). The assessment recognizes that and have taken steps to capture uncertainty in the analysis and outcomes.

In the OM, the values of biological parameters were allowed to vary by $\pm 15\%$ to reflect the limited knowledge on which the point estimates were based, while an alternative parametrisation of the OM was also done which assigned 5% error to three key biological parameters (M, Linf, and K), and maintained the 15% error for the rest of the biological parameters, to test whether the MPs performance will be affected.

The OM also accounted for uncertainty in gear selectivity; the assessment used different versions of the OM for those species for which selectivity was considered to be dome shaped (those were STT queen triggerfish, STT spiny lobster, and STX spiny lobster), but there was uncertainty about the shape of the right hand side of the selectivity curve. So, two versions of the OM were created for each of the three species; one OM representing moderately dome-shaped selectivity (“moderate dome selex”), and one that assumed high dome selectivity (“High dome selex”).

The assessment also tested the performance of each MPs under two assumptions; that the data produced by the observation model were precise and unbiased, or imprecise and biased data inputs. The assessment used the results from the precise/unbiased runs as the base case but results were also presented for the imprecise and biased scenario.

The assessment team responded to questions from the RW Panel and ran additional simulations to test how sensitive the model results were to changes in the catch data. The MSE analysis was rerun with a 30% increase in the input catches and revised TAC's were presented.

To capture the uncertainty in the model projections, the OM was used to conduct 500 simulations with 250 replicates with the values of uncertain parameters characterising the species and fishery being randomly drawn from a uniform distribution for each simulation. Model stability and convergence was assessed using convergence plots for the performance metrics.

For the application of the best performing MPs to real data, the calculations included a sensitivity analysis to capture the effects of uncertainty in input parameters on the TACs calculated. Specifically, 200 random samples were drawn from the distributions describing uncertainty in the model parameters to produce a distribution of the plausible TACs and reflect the uncertainty in the TAC values.

The model assigns uncertainty to a wide range of parameters to reflect the limited knowledge about the components of the system, and the way that uncertainty is incorporated into the calculation is sound. The decision to sample from uniform distributions needs to be considered/tested further and justified, but it is not a significant weakness of the model. Nevertheless, it is recommended that future assessments provide a clear justification for the distribution chosen to represent plausible values in a parameter and the model is extended, if needed, to allow for use of distributions other than a uniform one.

The implementation phase of the model does not account for implementation error which could be an important source of uncertainty, especially if the enforcement mechanism is not very strong. Therefore, it is recommended that the model is extended to account for situations in which the implementation of catch limits (or other restrictions applied) is not perfect.

Sensitivity analysis showed that model predictions about TACs were more sensitive to the values of K and L_{inf} from the von Bertalanffy growth equation, the catch, and natural mortality rate. The analysis with the mean-length estimator showed that outcomes are more sensitive to the choice of the L_{inf} than of other parameters (such as L_c). These results highlight the need for more work to develop better estimates of the values of those parameters and improve the accuracy in catch data series.

The calculation of MPs performance under precise and unbiased conditions as well as biased and imprecise was useful, and helped identify MPs that could perform well under both scenarios. Although the former was set as the base case, given the level of uncertainty and possible misreporting (that could be only underreporting or only over reporting during certain time periods) it is recommended that the assessment continues to consider both scenarios in the future.

The configuration of the model to describe biased and imprecise input data covers both issues at once, as well as assumes that the values of several input parameters are biased. That means that one cannot ascertain which of the two (imprecision or bias) has the biggest impact on the assessment outcomes. Therefore, it is suggested that future sensitivity analysis considers each of the two factors separately. Further, it is recommended that the model is run with bias assigned to those parameters for which some information exists to suggest that they might be biased. This will provide a more informed version of this sensitivity analysis in terms of its representation of the system of interest.

Overall, the analysis reflects well the uncertainties in the data and its implications in the model results and their use. The metrics used to present the uncertainty in the results are also appropriate.

TOR 4. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.

- Clearly denote research and monitoring that could improve the reliability of future assessments.
- Provide recommendations on possible ways to improve the SEDAR process.

a) Research and monitoring recommendations:

Several sets of research recommendations were included in the assessment report and other papers provided before or during the review meeting. For ease of reference, I have included them in a single list that can be found in Appendix 4. The list is very long, but that is not surprising given the number of gaps in knowledge for all species considered. All research recommended by the assessment/data teams is reasonable, and aims to fill those gaps and produce data and values for input parameters that would support a conventional stock assessment.

In this section I have focused on research that, based on the findings of the assessment and other information, is expected to make the biggest difference for the analysis/approach considered in this report and therefore, I will recommend as a priority.

The results of the assessment showed that the models are sensitive to the catch data used and MPs that rely on CPUE slope (islope family of MPs) have the greatest potential to guide management discussions for the six species even with the limited

information that is currently available. Those MPs require good information on catch and CPUE. Therefore, further work to reassess the catch and effort data for past years and try to identify any additional information on past exploitation is recommended. This can improve the quality of the CPUE, but also help identify potential bias in the data that can inform parametrization of the model.

More generally, work to collect the data required to use the MPs that performed better, i.e. strengthen collection of future catch and effort data, both from fishery and non-fishery dependent sources, as well as collection of length frequency data is also recommended. The focus on fishery independent data is particularly important when fishery data are not cross checked to confirm their validity or there are concerns about misreporting. Both those issues are of relevance here.

Revisiting the work done to choose the values of the biological parameters of the model is also recommended to consider whether data from different studies on the same parameter can/should be combined instead of choosing to use one of them or take the average of the calculated values.

Calculation of area/stock specific parameter values, especially for those parameters to which the models are more sensitive (e.g. L_{inf} , natural mortality), should also receive priority. However, it is recognized that unless data are already available and can be analyzed, this work might take some time to provide stock/area specific estimates.

As mentioned in earlier sections of this report, additional work to refine the performance criteria is needed to ensure that they reflect the conditions and any regulatory or other constraints that an MP will need to meet in reality.

b) Recommendations on possible ways to improve the SEDAR process

A comprehensive description of the model used in the calculations needs to be part of the assessment report, so the report is a stand-alone document and it is clear what equations and packages were used for the specific assessment.

Similarly, a comprehensive section on current management, covering existing process for setting quota for the species considered, differences in management among areas and species, and specific changes in the management of the studied species over the years would help reviewers put the assessment and the ToRs into context.

Given the nature of data-limited assessments, there is often a much greater number of assumptions and corrections/adjustments needed to produce the data used in the stock assessment. For this reason, I would recommend that the review process includes an extra day dedicated to raw data which will cover all the assumptions and decisions made to fill knowledge gaps and produce the data for the stock assessment. This will provide the opportunity to look at this part of the assessment in more depth and identify changes or possible issues straight away. Alternatively, giving reviewers the opportunity to attend all or part of the data workshop might be another way to identify issues with assumptions used to develop the data for the stock assessment early on and allow more time for the analysts to address them.

There is overlap in the ToRs with ToR 1c covering similar issues as those covered in ToR 2c. Also, ToR 4 asks for research recommendations that could improve future assessment and ToR 6 asks for guidance on improvements in data and models that

should be considered. So, I would suggest merging those to avoid duplication and make the reviewers' report more concise. ToR 5 also needs refinement since some of the terms are difficult to interpret (e.g. validation and peer review of the assessment) and it leads to some overlap with ToR 1-3.

TOR 5. Consider whether the stock assessment constitutes the best scientific information available using the following criteria as appropriate: relevance, inclusiveness, objectivity, transparency, timeliness, verification, validation, and peer review of fishery management information.

The work undertaken as part of SEDAR 46 represents a very good approach to making progress with the assessment of the six stocks and offering scientific advice to support fisheries management. It has used the most appropriate modelling approach to address data limitations, and a well-thought process for defining the values of the parameters needed for the analysis.

The assessment has made use of relevant and up-to-date knowledge on assessment and management evaluation of data-poor species; they have employed MSE, which is a tool that has been used to provide scientific advice for fisheries management in many other fisheries and is well documented and tested. They have collated information from a wide range of studies to inform the selection of biological parameters to use as input to the models. The latter reflects the team's attempt to include all relevant information to respond to the knowledge gaps that characterize the six species included in the assessment. Similarly, the use of MSE allows for progress to be made even though a conventional stock assessment was not possible, and offers an objective and transparent way to consider different assessment models and harvest rules and inform relevant management discussions. The assessment has also provided valuable insight into biological and other parameters to which models are more sensitive.

Based on the information presented, fishery data seemed to have been discussed in detail with experts and fishermen as part of the DW suggesting a good level of scrutiny. Some issues were identified such as the characterization of gear selectivity and possible bias, and those require further consideration. However, the assessment team conducted further analysis to address some of them and the results added to the robustness of the overall approach.

It is difficult to judge whether this assessment could have been done earlier but that does not mean that the current work is not timely. On the other hand, the assessment describes current challenges and issues well highlighting those that probably need to be addressed in the future, so it provides a good basis for identifying and focusing future efforts both in terms of field and modelling work.

The assessment tried to verify information/methods used, but given the data-poor nature of the stocks the opportunities to do so were limited. For example, the assessment incorporated fishery independent data into the original discussion as an alternative way to verify trends and abundance indices, but those were not deemed robust enough to include in the calculations. Evaluation of multiple assessment tools and MPs is another way to increase the robustness of any conclusions or recommendations and the assessment did so. The use of different methods to develop TAC distributions also offered another level of assurance and the addition of the mean length estimator which was used in previous assessments maintained continuity.

Although good effort has been made in terms of both verification and validation, some additional work is recommended to ensure that the behavior of the model is fully understood. This is important given the software used is fairly new (even though its mathematical formulae are well established) and not extensively tested, and there were concerns about some of the MPs like DD and DD4010 which failed to converge in a number of parametrizations. Future work to improve the data and extend the MSE model, so the operating model can be conditioned using past data will also help with validation.

TOR 6. Provide guidance on key improvements in data or modeling approaches that should be considered when scheduling the next assessment.

This ToR overlaps with ToR4 as a lot of the recommendations and points made under the latter would improve data or modelling approaches. Those recommendations are not repeated here.

The uncertainty characterizing catch and effort data remain considerable so, additional work to identify periods in the catch/effort series which might be characterized by bias and capture that into the simulations is recommended as the model results are sensitive to such assumptions. Further, standardization of CPUE series was not possible in this assessment as the analysis undertaken was not considered robust enough. Consideration of alternative ways to develop CPUE series such as using only data from a subset of vessels/fishing business which are reliable or can be checked and investigation of additional factors that can explain the trends in the CPUE data is recommended as it could improve the quality of the standardized CPUE series.

I agree with recommendations in the assessment report about extending the operating model (and relevant assessment models) to allow for age/length specific natural mortality and also simulate more than one fisheries/abundance indices. Generally, work to extend the model and address some of the issues identified (incorporation of error in the implementation phase of the EMS, conditioning of the operating model, etc.) is also recommended if this tool is adopted for future assessments as it will add more realism to the assessment.

The effort for two of the species included in the assessment is expressed in number of traps; however, those traps could be in the water for several hours or days, so they could represent different effort levels. It is recommended that data analysis look to provide a more accurate picture of the fishing effort for that gear. Alternatively, it is recommended that the assessment team explore using only a subset of catch data for which the effort can be better described or is similar across all the fishing events.

Fishery independent data from SEAMAP-C were considered, but were not used to develop indices of relative abundance because of low sample size. However, it is not clear whether those data and any data collected in the future could inform other parts of this assessment such as work to improve estimates of L_{inf} or gear selectivity. It is recommended that such additional uses are considered and covered in the next assessment or future analysis discussions.

There was considerable discussion about the sampling approach that the DLMtool was using which did not account for restrictions that come once parameter values are seen in combination (e.g. L_{inf} and K). A more refined sampling function is

recommended to account for correlation between parameters and exclude combinations that are not realistic/biologically plausible.

Minor issues/typos:

- Table 3 in the assessment report and Table 1 in the introduction include the wrong fishery for St. Croix stoplight parrotfish.
- Table 3.2.3A and 3.2.4A include a different definition for L50 but the same data input range. The definition suggests that the error for this parameter went from 15% to 5%. That's not correct.
- Table 3.2.5 includes a distribution for the parameter that adjusts fishing in relation to vulnerable biomass. That parameter is not used in the calculations since the model uses a single area.

Conclusions/Recommendations

The Caribbean Data-limited species panel review meeting took place in Miami, between February 23rd and February 25th, 2016. The meeting reviewed the assessment undertaken for six Caribbean species which were yellowtail snapper and hogfish from Puerto Rico, spiny lobster and queen triggerfish from St. Thomas, and spiny lobster and stoplight parrotfish from St. Croix. Due to data limitations, a conventional stock assessment could not be done and therefore, Management Strategy Evaluation (MSE) was used to explore the performance of several data-limited models for stock assessment and management advice. The findings suggested that a small number of Management procedures (MPs) could perform well if used to manage the fisheries under consideration despite paucity of data and associated uncertainty. Those were the MPs that relied on catch and CPUE indices or length frequency data to adjust future catches. Analysis performed during the review meeting also showed that those MPs would outperform the one currently used. Key conclusions of this review are:

- Overall, the assessment was sound and represented an approach that is fit for purpose and a very good choice for dealing with the challenges that data-poor species, such as those covered in SEDAR 46, pose.
- The findings of the assessment are based on robust analysis and best knowledge about the six species, and can inform discussions about management of the exploitation of those species.
- The data used and the process by which the input data for the model were developed represent a sound and appropriate way forward.
- Significant data gaps remain but the data used provided an acceptable basis for the MSE approach adopted.
- The MSE approach has been used in a number of other fisheries and has been tested and its application in this assessment is in line with standard practices.
- A few aspects of the MSE tool used (DLMtool) and analysis carried out, both to determine the values of the input parameters and to run the simulations, need further development or consideration. Suggestions for addressing those issues were covered in the previous sections and are also listed here (list of Recommendations below).

- The MPs' performance although not a conventional management metric, provides useful insight into management approaches that could be considered in the short to medium term or until the quality of data and knowledge about the six species improves.
- The application of the MPs to real data has provided some information about levels of TACs and that can inform management decisions, so it is an appropriate metric. However, the input data for the application of the MPs to the six species (real data) remain very uncertain, so the outcomes, especially absolute values, need to be treated with caution.
- Preliminary results from the mean length estimator method suggested that reduction in catches relative to recent ones was needed for all species. The only exception was Puerto Rico yellowtail snapper and St. Thomas spiny lobster when the SPR analyses were used to calculate the F_{MSY} proxy.
- Although some issues were identified, the way in which the analysis captures the uncertainty in the data is sound and the assessment report clearly articulates the implications of those uncertainties in the model results and their use.
- A long list of research recommendations was made by the assessment and Data Panel, and reflect the number of gaps in knowledge for all species considered. All research recommendations included in the assessment report are valid and will help fill those gaps.

Recommendations made under each of the ToR (Summary of Findings) in this review are also listed below:

Recommendation 1: Work to calculate stock and area-specific parameters for key biological processes (growth, maturity, steepness of the stock recruitment function, etc.) is recommended. This will help improve the current assessment but will also reduce concerns about appropriate model parametrisation once conventional stock assessments can be run for the six stocks.

Recommendation 2: Revisiting the work done to choose the values of the biological parameters of the model to consider whether data from different studies on the same parameter can/should be combined instead of choosing to use one of them or take the average of the calculated values would strengthen the assessment.

Recommendation 3: It is not clear whether data from the SEAMAP-C could inform parts of this assessment, other than the development of CPUE indices, such as work to improve estimates of L_{inf} or gear selectivity. It is recommended that such additional uses are considered and covered in the next assessment or future analysis discussions.

Recommendation 4: Uniform distributions were used to describe all input parameters in the model that were treated as uncertain; that was a simplification and it is recommended that further work is done to develop distributions that are more representative and reflect current knowledge about each of the parameters and extend the model, if needed, to use distributions other than a uniform one.

Recommendation 5: The process and uncertainty associated with the calculation of area-specific multipliers to adjust catches needs to be fully covered in the assessment report, so it can be reviewed and any potential sources of uncertainty can be identified.

Recommendation 6: Further consideration of the catch data and possible/alternative ways to verify past records is recommended. This is important given that current annual catch limits are set based on past catch information, but it will also help improve the accuracy of catch data used in stock assessment when a stock assessment can be run for these species.

Recommendation 7: Generally, work to collect the data required to use the MPs that performed better, i.e. strengthen collection of future catch and effort data, both from fishery and non-fishery independent sources as well as collection of length frequency data is highly recommended.

Recommendation 8: Further work is needed to refine the standardization process for CPUE series, and that will need to extend to both effort information as well as choosing catch records that are not affected by misreporting.

Recommendation 9: Fishing effort for traps is currently expressed in number of traps per trip and that scale cannot distinguish between traps that were in the water for just a few hours and those that were in the water for several days. It is recommended that data analysis look to provide a more accurate picture of the fishing effort associated with traps.

Recommendation 10: It is recommended that the mode of the catch-at-length frequency distribution is used to provide an estimate of the length at full selectivity for the simulated gears.

Recommendation 11: Further work on the configuration of the model to better define the acceptable parameter space from which the model samples and account for correlation between input parameters is recommended.

Recommendation 12: It is recommended that future assessments try to condition the OM even if that involves estimation of a small number of parameters, so some knowledge can be gained about the ability of the OM to replicate past behaviour. This will improve the robustness of the OM and that of the overall assessment.

Recommendation 13: Extending the operating model (and relevant assessment models) to allow for age/length specific natural mortality, and also simulate more than one fisheries/abundance indices and allow for incorporation of implementation error is highly advisable.

Recommendation 14: It is recommended that future assessments also test the performance of Management Procedures currently used to set catch limits for the six species. This will provide a transparent and robust way to compare alternative MPs to the existing one.

Recommendation 15: Further refinement of the performance criteria used to judge the performance of the MPs is advisable to ensure that they reflect the conditions and any regulatory or other constraints that an MP will need to meet in reality.

Recommendation 16: It is recommended that the choice of the projection period be linked to the life history of the species (e.g. generation time).

Recommendation 17: The configuration of the model to describe biased and imprecise input data covers both issues at once. It would be more useful if future sensitivity analysis considers each of the two factors separately and a run is done

assigning bias only to those parameters for which some information exists to suggest that they might be biased.

Recommendation 18: Additional work is recommended to ensure that the behavior of the model is fully understood. This is important given the software used is fairly new and not extensively tested, and there were concerns about some of the MPs like DD and DD4010 which failed to converge in a number of parametrizations. The behaviour of those MPs needs further exploration, and that could also cover the code to ensure that the relevant methods have been programmed correctly.

Recommendation 19: A comprehensive description of the model used in the calculations needs to be part of the assessment report, so the report is a stand-alone document. Similarly, the report would benefit from a comprehensive section on current management, covering existing process for setting quota for the species considered, differences in management among areas and species, and specific changes in the management of the studied species over the years.

Recommendation 20: I would recommend that the review process for data-poor species includes an extra day dedicated to raw data which will cover all the assumptions and decisions made to fill knowledge gaps and produce the data for the stock assessment. This will provide the opportunity to look at this part of the assessment in more depth and identify changes or possible issues straight away.

Appendix 1: Bibliography

| Document # | Title | Authors | Date Submitted |
|--|---|--|----------------|
| Documents Prepared for the Data and Assessment Workshop | | | |
| SEDAR46-WP-01 | A comparison of data-rich versus data-limited methods in estimating overfishing limits | Skyler R. Sagarese, John F. Walter, J. Jeffery Isely, Meaghan D. Bryan, Nancie Cummings | 19 Oct 2015 |
| SEDAR46-WP-02 | Enhancing tools for data-limited management strategy evaluation within the South Atlantic, Gulf of Mexico, and U.S. Caribbean: An introduction | Skyler Sagarese, William Harford, Mandy Karnauskas, John F. Walter, Elizabeth A. Babcock, Nancie J. Cummings ² , Meaghan Bryan, Shannon Calay | 19 Oct 2015 |
| SEDAR46-WP-03 | Probabilistic assessment of fishery status using data-limited methods | William Harford, Meaghan Bryan, Elizabeth A. Babcock | 16 Oct 2015 |
| SEDAR46-WP-04 | Overfishing limits (OFLs) for Greater Amberjack from the Stock Synthesis (SS) population model and from several data limited methods with a preliminary review of varying assumptions on natural mortality and current abundance on OFL results | Nancie Cummings and Skyler R. Sagarese | 26 Oct 2015 |
| SEDAR46-WP-05 | Summary of the Trip Interview Program data from the US Caribbean | Meaghan D. Bryan | 29 Oct 2015 |
| SEDAR46-WP-06 | A summary of commercial fishing reporting compliance for Puerto Rico and the U.S. Virgin Islands for calendar years 2013 and 2014 | Josh Bennett | 3 Nov 2015 |
| SEDAR46-WP-07 | Recreational Survey Data for Puerto Rico from the Marine Recreational Fisheries Statistics Survey (MRFSS) and the Marine Recreational Information Program (MRIP) | Vivian M. Matter | 4 Feb 2016 |
| Documents Prepared for the Review Workshop | | | |
| SEDAR46-RW-01 | Estimating total mortality rates and calculating overfishing limits from length observations | Quang C. Huynh | 14 Jan 2016 |

| | | | |
|---------------------------------------|---|---|-----------------|
| | for six U.S. Caribbean stocks | | |
| SEDAR46-RW-02 | Management strategy evaluations for mean length-based management procedures using DLMtool | Quang C. Huynh | 22 Feb 2016 |
| SEDAR46-RW-03 | An alternative approach to setting annual catch limits for data-limited fisheries: Use of the DLMtool and mean length estimator for six US Caribbean stocks | Nancie Cummings, Skyler Sagarese and Quang C. Huynh | 22 Feb 2016 |
| Final Stock Assessment Reports | | | |
| SEDAR46-SAR1 | Caribbean Species | Data-limited | SEDAR 46 Panels |
| | | | |
| Reference Documents | | | |
| SEDAR46-RD01 | Fisheries Technical Workshop #1: "Length-Based Stock Assessment of Puerto Rico Reef Fishes & Computer-based Tools Laboratory" | Jerald S. Ault, Steven G. Smith, Nathan R. Vaughan, Marc O. Nadon, Natalia Zurcher | |
| SEDAR46-RD02 | Fisheries Technical Workshop #1 and #2 "Length-Based Stock Assessment of Puerto Rico Reef Fishes & Computer-based Tools Laboratory" and Fisheries Technical Workshop #3 "Building Fisheries Information Systems for Sustaining Coral Reef Fisheries of Puerto Rico" | Jerald S. Ault, Steven G. Smith, Nathan R. Vaughan, Natalia Zurcher | |
| SEDAR46-RD03 | Report of the U.S. Caribbean Fishery-Independent Survey Workshop | Shannon L. Cass-Calay, William S. Arnold, Meaghan Bryan, Jennifer Schull | |
| SEDAR46-RD04 | Evaluating methods for setting catch limits in data-limited fisheries | Thomas R. Carruthers, André E. Punt, Carl J. Walters, Alec MacCall, Murdoch K. McAllister, Edward J. Dick, Jason Cope | |
| SEDAR46-RD05 | Evaluating methods for setting catch limits in data-limited fisheries: Supplemental Appendix A | Thomas R. Carruthers, André E. Punt, Carl J. Walters, Alec MacCall, Murdoch K. McAllister, Edward J. Dick, Jason Cope | |
| SEDAR46-RD06 | DLMtool: Data-Limited Methods Toolkit (v2.1.1) | Tom Carruthers and Adrian Hordyk | |
| SEDAR46-RD07 | Length-based assessment of sustainability benchmarks for coral reef fishes in Puerto Rico | Jerald S. Ault, Steven G. Smith, Jiangang Luo, Mark E. Monaco, and Richard S. Appeldoorn | |
| SEDAR46-RD08 | Data Limited Techniques for Tier 4 Stocks: An alternative approach to setting harvest control rules using closed loop simulations for management strategy evaluation | Jason McNamee, Gavin Fay, and Steven Cadrin | |
| SEDAR46- | Application of Data-Poor | John Wiedenmann | |

| | | |
|--------------|--|---|
| RD09 | Harvest Control Rules to Atlantic Mackerel | |
| SEDAR46-RD10 | September 2015 Mid-Atlantic SSC Meeting Report – Black Sea Bass Review | Mid-Atlantic SSC |
| SEDAR46-RD11 | Stock assessment of protogynous fish: evaluating measures of spawning biomass used to estimate biological reference points | Elizabeth N. Brooks, Kyle W. Shertzer, Todd Gedamke, and Douglas S. Vaughan |

Appendix 2. Statement of Work for Dr Panagiota Apostolaki

External Independent Peer Review by the Center for Independent Experts SEDAR 46 US Caribbean Data Limited Species Assessment Review Workshop

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: SEDAR 46 will be a compilation of data, an assessment of the stocks, and CIE assessment review conducted for Caribbean Data-limited Species. The review workshop provides an independent peer review of SEDAR stock assessments. The term review is applied broadly, as the review panel may request additional analyses, error corrections and sensitivity runs of the assessment models provided by the assessment panel. The review panel is ultimately responsible for ensuring that the best possible assessment is provided through the SEDAR process. The stocks assessed through SEDAR 46 are within the jurisdiction of the Caribbean Fisheries Management Council and the territorial waters of Puerto Rico and the U.S. Virgin Islands. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall have working knowledge expertise in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the primary task of providing peer-review advice in compliance with the workshop Terms of Reference. Experience with data-limited assessment methods would be preferred. Each CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in **Miami, Florida during February 23-25, 2016**.

Statement of Tasks: Each CIE reviewers shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.
Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE

reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewers participate during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: <http://deemedexports.noaa.gov/>
http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration-system.html

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send (by electronic mail or make available at an FTP site) to the CIE reviewers the necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE Lead Coordinator on where to send documents. CIE reviewers are responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein. The CIE reviewers shall read all documents in preparation for the peer review.

Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs cannot be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements. CIE reviewers shall conduct an impartial and independent peer review of the assessment in accordance with the SoW and ToRs herein.

A description of the SEDAR Review process can be found in the SEDAR Policies and Procedures document:

http://sedarweb.org/docs/page/A6-SEDARPoliciesandProcedures_June2014_0.pdf

The CIE reviewers may contribute to a Summary Report of the Review Workshop produced by the Workshop Panel.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required

format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Other Tasks – Contribution to Summary Report: Each CIE reviewer may assist the Chair of the panel review meeting with contributions to the Summary Report, based on the terms of reference of the review. Each CIE reviewer is not required to reach a consensus, and should provide a brief summary of the reviewer’s views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1. Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2. Participate during panel review meeting in **Miami, FL during February 23-25, 2016**.
3. In **Miami, FL during February 23-25, 2016** as specified herein, and conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4. No later than March 10, 2016, each CIE reviewer shall submit an independent peer review report addressed to the “Center for Independent Experts,” and sent to Dr. Manoj Shivlani, CIE Lead Coordinator, via email to mshivlani@ntvifederal.net, and CIE Regional Coordinator, via email to Dr. David Sampson david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

| | |
|-----------------------------|---|
| <i>January 12, 2016</i> | CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact |
| <i>February 9, 2016</i> | NMFS Project Contact sends the CIE Reviewers the pre-review documents |
| February 23-25, 2016 | Each reviewer participates and conducts an independent peer review during the panel review meeting |
| <i>March 10, 2016</i> | CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator |
| <i>March 24, 2016</i> | CIE submits CIE independent peer review reports to the COTR |
| <i>March 31, 2016</i> | The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director |

Modifications to the Statement of Work: This ‘Time and Materials’ task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council’s SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The

Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on changes. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COTR (Allen Shimada, allen.shimada@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:

- 1) The CIE report shall be completed with the format and content in accordance with **Annex 1**,
- 2) The CIE report shall address each ToR as specified in **Annex 2**,
- 3) The CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

Allen Shimada
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
Allen Shimada@noaa.gov Phone: 301-427-8174
Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
10600 SW 131st Court, Miami, FL 33186
mshivlani@ntvifederal.com Phone: 305-968-7136

Key Personnel:

NMFS Project Contact:
Julie A Neer
SEDAR Coordinator
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405
(843) 571-4366
julie.neer@safmc.net

Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

- a) Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a brief summary of findings, of the science, conclusions, and recommendations.
- b) Reviewers should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.
- c) Reviewers should elaborate on any points raised in the Summary Report that they feel might require further clarification.
- d) Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.
- e) The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

Appendix 1: Bibliography of materials provided for review

Appendix 2: A copy of the CIE Statement of Work

Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review
SEDAR 46 US Caribbean Data Limited Species Assessment Review Workshop

1. Evaluate the data used in the assessment, including discussion of the strengths and weaknesses of data sources and decisions, and consider the following:
 - a. Are data decisions made by the DW and AW sound and robust?
 - b. Are data uncertainties acknowledged, reported, and within normal or expected levels?
 - c. Are data applied properly within the assessment model?
 - d. Are input data series reliable and sufficient to support the assessment approach and findings?

2. Evaluate and discuss the strengths and weaknesses of the methods used to assess the stock, taking into account the available data, and considering the following:
 - a. Are the data-limited methods scientifically sound and robust?
 - b. Are the methods appropriate given the available data?
 - c. Are the data-limited models configured properly and used in a manner consistent with standard practices?
 - d. Are the quantitative estimates produced reliable? Does the method produce management metrics (e.g. MSY, ABC, ACL) or other indicators (e.g. trends in F or Z, probability of overfishing) that may be used to inform managers about stock trends and conditions?

3. Consider how uncertainties in the assessment, and their potential consequences, are addressed.
 - Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods.
 - Ensure that the implications of uncertainty in technical conclusions are clearly stated.

4. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.
 - Clearly denote research and monitoring that could improve the reliability of future assessments.
 - Provide recommendations on possible ways to improve the SEDAR process.

5. Consider whether the stock assessment constitutes the best scientific information available using the following criteria as appropriate: relevance, inclusiveness, objectivity, transparency, timeliness, verification, validation, and peer review of fishery management information.

6. Provide guidance on key improvements in data or modeling approaches that should be considered when scheduling the next assessment.

7. CIE Reviewers May contribute to a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference.

Note – CIE reviewers typically address scientific subjects, hence ToRs usually do not involve CIE reviewers with regulatory and management issues unless this expertise is specifically requested in the SoW.

Annex 3: Tentative Agenda
SEDAR 46 US Caribbean Data Limited Species Assessment Review Workshop
Miami, Florida

Tuesday

9:00 a.m. Introductions and Opening Remarks Coordinator

- *Agenda Review, TOR, Task Assignments*

9:30 a.m. – 11:30 a.m. Assessment Presentations Analytic Team

- *Assessment Data & Methods*

- *Identify additional analyses, sensitivities, corrections*

11:30 a.m. – 1:00 p.m. Lunch Break

1:00 p.m. – 6:00 p.m. Assessment Presentations (continued) Analytic Team

- *Assessment Data & Methods*

- *Identify additional analyses, sensitivities, corrections*

6:00 p.m. – 6:30 p.m. Public comment Chair

Tuesday Goals: Initial presentations completed, sensitivity and base model discussion begun

Wednesday

8:00 a.m. – 11:30 a.m. Panel Discussion Chair

- *Assessment Data & Methods*

- *Identify additional analyses, sensitivities, corrections*

11:30 a.m. – 1:00 p.m. Lunch Break

1:00 p.m. – 6:00 p.m. Panel Discussion/Panel Work Session Chair

- *Continue deliberations*

- *Review additional analyses*

- *Recommendations and comments*

6:00 p.m. – 6:30 p.m. Public comment Chair

Wednesday Goals: sensitivities and modifications identified, preferred models selected, projection approaches approved, Report drafts begun

Thursday

8:00 a.m. – 11:30 a.m. Panel Discussion Chair

- *Final sensitivities reviewed.*

- *Projections reviewed. Chair*

11:30 a.m. – 1:00 p.m. Lunch Break

1:00 p.m. – 5:30 p.m. Panel Discussion or Work Session Chair

- *Review Reports*

5:30 p.m. – 6:00 p.m. Public comment Chair

6:00 p.m. ADJOURN

Thursday Goals: Complete assessment work and discussions, final results available. Draft Reports reviewed.

Appendix 3: Panel Membership
In alphabetical order

Panayiota Apostolaki (CIE reviewer)
Jerald Ault
Cathy Dichmont (CIE reviewer)
John Hoenig
Paul Medley (CIE reviewer)
Vance Vicente (Chair)

**Appendix 4: Research recommendations made by the teams that contributed to
the SEDAR 46 assessment:**

A) *Recommendations from the assessment report*

i) Recommendations associated with the selection of species:

Investigate additional data sets and re-evaluate species selection criteria for future stock evaluations, including:

- The information available for queen conch (*Strombus gigas*) in the National Ocean Service's Biogeography visual surveys (Menza et al. 2006) and in data collected by universities in the region.
- Mesophotic reef surveys in western Puerto Rico (García-Sais et al. 2012), visual surveys and passive acoustic monitoring in western Puerto Rico and Mona Island (Scharer-Umpierre et al., 2014), and SEAMAP-C (Pagan 2002, Ingram 2014).

To the extent possible, these (and any other datasets) should be integrated and comprehensively summarized to facilitate comparisons and explorations in future analyses.

The LHWG research recommendations were:

- Representative sampling across size/age spectra for under-sampled US Caribbean stocks.
- Updated studies of life history and demographic characteristics are needed that focus on sampling under-represented size classes, particularly large (old) fishes to provide more accurate estimates of asymptotic length, and small (young) fishes to more accurately estimate the rate at which fishes approach asymptotic length. This recommendation stems from a concern that maximum lengths were too often considerably longer than L_{∞} estimates. This observation could stem from inadequate sampling of the largest length classes, region-specific differences in asymptotic growth (where parameters were borrowed from other regions), or where exploitation has dramatically modified stock structure.
- Additional sampling is also necessary for improving stock-specific maturity schedules, and these data should be fit via logistic regressions methods to obtain the most robust estimates of length at maturity.
- Research efforts into compilation of various datasets of life history demographic parameters for all exploited species in the tropical western Atlantic, through a Regional Expert Demographic Workshop are recommended.

ii) Commercial research recommendations

- Evaluate the efficacy of existing commercial landings expansion factors used in Puerto Rico; provide recommendations for improved methods to calculate expansion factors; examine the impact on landings estimates due to methodological changes implemented in 2003 for calculating expansion factors
- Verify, using port samplers or other appropriate methods, self-reported landings in the US Virgin Islands and Puerto Rico
- Obtain species-specific estimates of discards from the commercial sector in Puerto Rico and in the US Virgin Islands
- Quantify the sizes and discard conditions of fish discarded by commercial fisheries in Puerto Rico and in the US Virgin Islands

iii) Recreational research recommendations

- Increase representative sampling of the recreational sector in Puerto Rico and expand to collect recreational data in the US Virgin Islands
- Include spiny lobster and conch in the MRIP in order to estimate recreational catch for these important Caribbean species
- Explore changes in the Puerto Rico recreational catch estimates as a result of the change in intercept protocols and estimation methodologies from MRFSS to MRIP in 2014

iv) Research recommendations associated with fishery independent abundance indices

- Conduct additional examinations to identify auxiliary variables that could be informative in standardization
- Begin the spiny lobster nominal and standardized index further back in time
- Invest in regional scale fisheries-independent surveys to estimate relative (or absolute) abundance
- Investigate methods for subsetting to trips targeting the target species
- Account for change in regulations that may affect CPUE
- Obtain supplementary information and evaluate the use of aggregation of data over gears. The recommendation for SEDAR 46 was to group gear types that were assumed to have similar selectivity's. Additional efforts could help determine when it is or is not appropriate to use gear groups.

v) Research recommendations associated with fishing effort data

- Investigate issue associated with fishers not reporting effort information in St. Croix
- Review any caveats/concerns such as species having more than one dominant fishery or noted changes in fishing behavior
- Extend the data-limited approaches to allow two fisheries, or a single fishery with two distinct types of selectivity/catchability

vi) Research recommendations about the length frequency data

- The TIP sampling operational framework in Puerto Rico and in the USVI should be reviewed to ensure sampling is representative of the primary fisheries.
- Conduct review of supplemental information on size from data series not readily available for these evaluations.
- Evaluate the use of aggregation of length samples over gears. The recommendation by the SEDAR 46 DW Panel was to group gear types that were assumed to have similar selectivities.
- Address difficulty in assigning the fishing areas to develop a continuous series for the USVI. Develop a consistent time series of area assignments for St. Thomas and St. John. Consider if alternative approaches to aggregating the fishing area information in the TIP data may be feasible.

Regarding data availability, continued explorations are warranted on the following topics to address uncertainty within key data inputs for data-limited stock assessment models:

1. A statistical review of existing fishery independent surveys to identify an optimum sampling design for development of fishery independent abundance indices. Fishery independent surveys can contribute critical information regarding trends in stock abundance, which can be applied in relatively simple management procedures.
2. Develop indices of abundance for spiny lobster using all available data since 1970s with focus on a fishery independent survey.
3. Investigate more justifiable estimates of stock depletion (Dep) and depletion over time (Dt), such as through Productivity-Susceptibility Analysis (e.g., Cope et al. 2015) or using methods such as mean length estimators.
4. Investigate more justifiable estimates of current stock abundance.
5. Enhanced catch at length by gear sampling is needed to better inform selectivity at age.
6. Investigate fleet dynamics to more accurately capture fishery characteristics.
7. Identify target catch or index levels which could be used in conjunction with catch and index time series.
8. Identify target length levels which could be used in conjunction with catch and a length frequency series.
9. Develop a weighting scheme for length composition and multiple gear fisheries reflective of the stock.
10. Consider organizing species into species complexes for assessment based on similar life history, market characteristics, and vulnerability. This could help streamline the stock assessment process in a data-limited context.

vii) Recommendations for enhancing the practical use of the DLMtool from the analytical team:

1. Revisions of the DLMtool software to enhance the model functionality to allow multiple indices of abundance.
2. Revision of the DLMtool software to allow age varying M.
3. Allow for implementation error of the harvest control rule (e.g., TAC overages) within the implementation model in the MSE.

viii) *Recommendations for enhancing the practical use of the DLMtool from the developer (Carruthers (2015a) that the SEDAR 46 analytical team considers of practical relevance to US Caribbean fisheries application of the toolkit:*

1. Idealized observation models for catch composition data
“Currently, DLMtool simulates catch-composition data from the true simulated catch composition data via a multinomial distribution and some effective sample size. This observation model may be unrealistically well-behaved and favor those approaches that use these data. Harvest control rules must be integrated into data-limited MPs”.
2. Harvest control rules
“In the version of DLMtool applied in SEDAR 46 (version 2.1.2), harvest control rules (e.g., the 40-10 rule) must be written into a data-limited MP. There is currently no ability to do a factorial comparison of say 4 harvest controls rules against 3 MPs (the user must describe all 12 combinations).

The reason for this is that it would require further subclasses. For example, the 40-10 rule may be appropriate for the output of DBSRA but it would not be appropriate for some of the simple management procedures such as DynF that already incorporate throttling of TAC recommendations according to stock depletion.”

3. Implementation error

“In this edition of DLMtool there is no implementation error. The only imperfection between a management recommendation and the simulated TAC comes in the form of the MaxF argument that limits the maximum fishing mortality rate on any given age-class in the operating model. The default is 0.8 which is high for all but the shortest living fish species.”

B) Recommendations from Cummings et al 2016 (SD46_RW3)

While the recommended DLMtool and mean length estimator methods could be employed in the interim, the following guidance further outlines areas where application of the DLM tool and the mean length estimator could be improved on in the long term:

1. Data sufficiency and integrity (life history, catch, abundance time series, fishery dynamics, depletion, abundance):

- Convene a workshop of regional experts in the wider Caribbean to review important life history demographic data for key commercially and recreationally important species
- Convene an expert team to review and develop reasonable estimates of important data-limited model parameters (e.g., depletion estimates) and explore the use of Productivity-Susceptibility Analysis for informing depletion.

2. Assessment method modeling of processes

Convene a workshop of experts trained in application of data-limited models to review available methods for determining harvest levels (e.g., NMFS 2011) and address the following topics at a minimum:

- Data requirements of the method?
- Model assumptions
- Robustness of models to departures (biases)
- Model uncertainty framework to evaluate models
- Identification of scenarios where models fail or are inappropriate or not applicable
- Identify process to evaluate model results that incorporates objectivity, transparency (i.e., simulation/ management strategy evaluation)
- Consideration of the frequency of assessment
- Consideration of implementation of management considerations on the choice of method used to set ACLs