CENTER FOR INDEPENDENT EXPERTS (CIE) INDEPENDENT PEER REVIEW OF THE SEDAR 57 US CARIBBEAN SPINY LOBSTER BENCHMARK ASSESSMENT

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2 EXECUTIVE SUMMARY

The review workshop for the U.S. Caribbean spiny lobster took place in Miami, Florida from 9 to 11 July 2019 with CIE review panel (RP) members Drs Dichmont, Frusher and Medley, the SSC panel members Gregory (chair) and Seara, the spiny lobster assessment team, other scientists involved in the stock assessment, data collection and management personnel, management representatives and industry members from each island region. Several additional data analyses and assessment runs were requested during the review workshop. Given the volume of additional work requested, the final day was used to develop and finalise the recommended base case which was confirmed post workshop when the results were finalised. Several very insightful presentations were provided during the review, with very open and free flowing discussion. These greatly contributed to the reviewers' knowledge base.

During the review, several further output diagnostics were requested as well as further information on model runs. Sensitivity tests were also requested and provided. The interaction between the review team and the review attendees was extremely informative and helpful. The assessment teams were supportive of the review panel's (RP) conclusions (including changing the base case). Industry and management input throughout the review was highly informative and important. The value of this interaction was greatly appreciated.

All the Terms of References (ToRs) are supported except for changing the original base to the panel recommended base case:

- The growth curves used in the original base case did not conform to a) general knowledge of dimorphism in spiny lobsters' growth rates and b) the asymptotic length at which growth is zero (Linf). Linf for females particularly is larger than expected, given the length composition data available, despite estimated dome shaped selectivity. Nearby Cuban growth rate data were included initially as a sensitivity test, but this model fit the data much better and adoption of this growth curve is therefore part of the recommended base case.

- Due to the new growth curve, several consequential assumptions from the original base case in the PR assessment could be relaxed. Most notably, the recommended base case also changes assumptions about selectivity time blocks and priors, thereby reducing the number of parameters estimated and did not require selectivity priors.

- The total landings figure for PR in 2005 was interpolated between 2004 and 2006 due to its unusually large value in its expanded form. On investigation of catch and raw (unstandardised) effort data over this period, these showed little differences between 2004 and 2006. However, when the expansion factors were investigated for this period, the 2005 value did stand out and particularly in one region of PR. The RP therefore recommended that the interpolation should be undertaken on the expansion factors, particularly in the region that seems to be an outlier. The changed approach recommended by the RP was incorporated into the recommended base case and is supported.

The St Thomas (STT), St Croix (STX) and Puerto Rico (PR) status remain as not overfished and not overfishing for the recommended base case.

The use of Stock Synthesis (SS) is appropriate given the availability of other packages, the assumptions made and the available data, and will be useful for the inclusion of future

recommended research data, if collected. SS is not traditionally used for hard to age species like lobster, but the reasoning for its use is supported. It is appropriately implemented.

In all management units (STT, STX and PR), dome shaped selectivity is still supported by the data in the recommended base case, however, given the importance of this result, research recommendations include options for further data collection in Marine Protected Areas (MPA) to assist in collecting information on selectivity. Additionally, regular MPA length composition sampling would move this assessment from data limited/moderate to data moderate over time. This work is recommended as a priority.

Further work is required on the PR expansion factors. It is inappropriate that a single expansion factor is used for all species. Furthermore, the error in the factors themselves are not carried over to the landings calculations and therefore also not into the assessment. Further recommendations are made in this regard, and are a priority.

An abundance index should be developed – a fisheries independent survey is likely to be expensive and logistically difficult and is therefore a low priority. On the other hand, further work on effort in the fishery is likely to produce dividends in terms of knowledge of catch rates. The focus should initially be on the recent (post-2011) series where the commercial data collection has been clearer and more consistent.

3 BACKGROUND

The Caribbean spiny lobster (*Panulirus argus*) occurs in the Caribbean Sea, the Gulf of Mexico and the Western Central and South Atlantic Ocean. A fishery using mainly divers, and pot and trap gear occurs within the regions of St Croix (STX), St Thomas (STT), and Puerto Rico (PR). An integrated length and age-based stock assessment model, using the software known as Stock Synthesis (SS), was applied to each of STX, STT and PR that uses sex and gear-specific carapace length and fishery landings data. The model estimated fishery selectivity for STT and then used these estimates as informative priors for STX and PR. No reliable independent indices of abundance are available and the assessment can therefore not freely estimate annual recruitment (deviations); therefore, the SS model is set up as a data moderate assessment.

Several assumptions are made, notably that recreational removal is negligible and therefore can be assumed to be zero; that the fishery started at the beginning of the data series for STT and STX, but was well underway in PR (which means that initial fishing mortality in year 1 of the data cannot be assumed to be zero in PR and needed to be estimated) and that landings are known with little uncertainty.

By the end of the review workshop (RW) several tests were undertaken, notably:

- Sensitivity of the base case models to assumptions such as natural mortality, growth, first year fishing mortality and selectivity options;
- Retrospective analyses of the effect of removing recent data;
- Jitter tests for local minima;
- Correlation analyses of the different parameters; and
- Likelihood profiles to test components of the likelihood against different parameter values.

Stock status estimates were provided using placeholder proxies of SPR (ratio of biomass per recruit compared to virgin conditions) of 30%. Overfishing advice is also provided, plus Overfishing Level (OFL) projections.

4 DESCRIPTION OF THE INDIVIDUAL REVIEWER'S ROLE IN THE REVIEW ACTIVITIES

The review workshop for the U.S. Caribbean spiny lobster took place in Miami, Florida from 9 to 11 July 2019 with CIE review panel members Drs Dichmont, Frusher and Medley, and SSC panel members Gregory (chair) and Seara. In attendance were the spiny lobster assessment team, other scientists involved in the stock assessment, data collection and management, management representatives and industry members from each island region (or management unit) (see list in Heading 11, Appendix 3 for the list of names). The review and background documents were placed on the SEDAR web site for both the Data and Assessment workshops (see Heading 9, Appendix 1).

Several very insightful presentations were provided during the review, with very open and free flowing discussion. These greatly contributed to the reviewers' knowledge base.

Several additional data analyses and assessment runs were requested during the review workshop. Preliminary results were provided during the RW. Given the volume of additional work requested, the final day was used to develop and provisionally develop the recommended base case which was confirmed post workshop (2 August 2019) when the results were finalised as an Addendum to the Assessment Report. This required an approved extension to the panel and independent review timelines.

A panel report was required and contributed to during and after the RW. This report is the individual CIE reviewer's report. Both reported against each of the Terms of References (ToRs), being:

1. Evaluate the data used in the assessment, addressing 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 the methods used to assess the stock, taking into account the available data.
    a. Are methods scientifically sound and robust?
    b. Are assessment models configured properly and used consistent with standard practices?
    c. Are the methods appropriate given the available data?
3. Evaluate the assessment findings with respect to the following:
    a. Can the results be used to inform management in the U.S. Caribbean (i.e. develop annual catch recommendations)?
    b. Is it likely the stock is overfished? What information helps you reach this conclusion?
    c. Is it likely the stock is undergoing overfishing? What information helps you reach this conclusion?
4. 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.

5. 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, and information provided by future assessments.
6. Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.
7. Provide recommendations on possible ways to improve the SEDAR process.
8. Prepare a Peer Review Summary summarizing the Panel's overall conclusions and recommendations.

5 SUMMARY OF FINDINGS FOR EACH TOR IN WHICH THE WEAKNESSES AND STRENGTHS ARE DESCRIBED

5.1 TOR 1: EVALUATE THE DATA USED IN THE ASSESSMENT, ADDRESSING THE FOLLOWING: ARE DATA DECISIONS MADE BY THE DW AND AW SOUND AND ROBUST? ARE DATA UNCERTAINTIES ACKNOWLEDGED, REPORTED, AND WITHIN NORMAL OR EXPECTED LEVELS? ARE DATA APPLIED PROPERLY WITHIN THE ASSESSMENT MODEL?

This ToR is supported apart from the 2005 Puerto Rican expansion factor and the use of the PR growth function for the base case. An alternate to the original base case, here termed the recommended base case, was developed during the review workshop and should be used as the base case for management. The recommendations on the growth function and PR expansion factors were incorporated into the RP's recommended base case (also the Assessment Addendum RW-preferred model) and is supported.

5.1.1 Are data decisions made by the DW and AW sound and robust?

The data decisions were ***supported*** *apart from the PR expansion factors to calculate the total landings in 2005 and the original base case growth parameters.*

5.1.1.1 Life history information

The basis for the life history parameters was appropriate, ***except for growth****.*

Natural mortality is a key input to the stock assessment models. Several sources are available that show that spiny lobster natural mortality ranges from 0.3 to 0.4 year^{-1} (FAO, 2001). Assessments in the Caribbean have reportedly used values of 0.34 and 0.36 year^{-1}. This assessment used the lower of these 2 values, being 0.34 year^{-1}. Although this choice is appropriately in the range of plausible values, no sensitivity tests were undertaken on this value (discussed further in Terms of Reference 4).

Release mortality is assumed to be negligible by the DW mainly due to the selective nature of diving and limited handling of fish in the traps. There does appear to be some potential unrecorded mortality from moulting fish being kept in pots, but these are not likely to be the dominant source of uncertainty in the data and assessment.

Length-weight and maturity information seems to be appropriately calculated and has a sound basis.

Growth rate assumptions have turned out during the review to contribute greatly to the uncertainty in the assessment. Several Caribbean and surrounds growth curves are available for spiny lobster, most notably from Mexico (Velazquez-Abunader et al., 2015), Cuba (de León et al., 2005) and PR (Mateo, 2004) (summarised in Table 1). In all these cases, von Bertalanffy growth curves were obtained from length data. Although von Bertalanffy growth curves are not the typical growth models applied to crustaceans given they moult, the use of this function is supported given the available data and the type of assessment used in this case. A STT mark-recapture data set was also used to develop a new curve but these data were mainly of smaller animals and could not be used for this purpose. They were used to corroborate the model growth trajectories from PR, but this

could only be applied to the lower part of the function and not to the Linf, which is where most of the uncertainty lies. The PR growth curve used is notably different from the other studies in the region in that there is little difference in the Linf between males and females. This is particularly remarkable when considering the published growth curves for spiny lobster as referenced for example in the Assessment Report Addendum.

Table 1: von Bertalanffy growth parameters modified from Table 2.7 from SEDAR 57 Data Workshop Report

Study	Region/Country	Sex	Linf (mm) CL	K ($year^{-1}$)
Mateo (2004) –1999 data	PR	M	197	0.24
		F	191	0.25
Mateo (2004) – 2000 data	PR	M	195	0.24
		F	185	0.23
De León et al. (2005)	Cuba	M	184	0.24
		F	155	022
Velazquez-Abunader et al. (2015)	Mexico. Yucatan	M	203	0.28
		F	189	0.34

Furthermore, when the PR Linf values were compared to the length composition data, these do not agree, i.e., many more large animals should be observed given the growth function (despite there being dome shaped selectivity) or there is a very large standing stock of unfished large animals in the population for which there was no anecdotal evidence.

Although choosing a local value for the growth curve is generally recommended, this curve needs to be re-analysed. This is particularly important when one notes that the Mateo study developed two growth curves, one for each year, which produced different growth curves. Based on the length composition data obtained for these fisheries and the unusual nature of the Linf values, the use of the PR growth curve used in this assessment is **not supported**.

The impact of the growth curve on the assessment is further discussed in following ToR in more detail.

> **Recommendation High 1. In the short term, it is recommended that more modern techniques are applied to re-analyse the original data to obtain PR specific growth functions in a combined form (not annual) and use this result to decide on further research, if required.**

5.1.1.2 Fishery dependent data

The major data sources for the spiny lobster are both from fishery dependent sources, being landings (from logbooks) and length composition (from the Trip Interview Program – TIP) data by gear type for each management unit. Both these data sources are essential, without which the present assessment could not be run. These data show large differences in the emphasis on gears between STT, STX and PR. These differences have been well considered in the data collection and analysis process, and carried into the assessment.

The collection of length composition data in some years has been patchy even on the main gear types, particularly in STX and STT. This should always be avoided as a consistent dataset is crucial to the future assessment of these stocks.

The length composition data is collected in 0.25 inch increments, which is unusual for lobster fisheries that are able to collect in 1 or 2 mm bins.

Recommendation Medium 1. Unless the volume of length composition data will be compromised, it is recommended to move to smaller bin sizes for the length composition data.

Recommendation High 2. Emphasis on collecting regular landings and length composition data for all management units is recommended. It is also essential that this collection is by gear type as has recently been the case.

As stated in the DW, PR reported landings have been incompletely reported, which has required the development of an annual correction or expansion factor. Since 2003, the expansion factors have been coast-specific whereas before they were for the whole PR region. The expansion factors are collected separate from the TIP collection system where there is an attempt to sample all fishers in a specific period across all gear types, vessel types, fishers and species. The data are combined to a single value per coast across all gears, fishers, vessels and species. Much information such as sample size and statistical properties are lost in this calculation. Using a single factor for all species does not, given the available information provided, make sense and is **not supported**. It is much more likely that under-reporting of logbooks would be fishery specific as sentiment, logistics and management changes drive reporting rates. Spatial separation by coast **is supported**, as is presently the case.

Recommendation High 3. It is recommended that the expansion rates are calculated at the species or species group level, in this case spiny lobster.

Recommendation High 4. The design of the collection and calculation of expansion factors need to be investigated and reported.

During the PR workshop, the 2005 landings outlier was further investigated. The expanded landings for 2005 using the original logbook landings and expansion factors meant that the 2005 data point was much higher than any other part of the catch series. As a fix to this issue, the 2005 value was calculated using the average of the 2004 and 2006 expanded landings for PR. When the total trip data were investigated, there was no indication that the 2005 data point was an outlier in the logbooks. On the other hand, the expansion factor for one coastal region (east) was very different to surrounding values pointing to an issue with this specific factor. Three methods were investigated to calculate the expanded landings for 2005 – the original average (original base case value), only interpolating for the 2005 east expansion factor (Method 1) or interpolating the 2005 expansion factors for all four regions (Method 2). Method 2 suggested only minor changes to the original base case value whereas, Method 1 had a larger impact on the expanded landings. Given that the outlier was only in one region, the latter method (Method 1) was supported for use in the recommended base case by the RP and **is supported**.

However, this highlights that further work is required on the expansion factors and discussed further in Section 5.1.2 below.

No correction factors were required for STX and STT.

Effort and catch-per-unit effort (CPUE) were not used in the assessment or presented during the RP meeting until requested. Much discussion on the logbook forms was undertaken with informative input from industry, managers and scientists. The forms have changed over time and how effort has been captured means that producing a consistent effort series over time is problematic. This conclusion is supported.

However, it was noted that the logbook form has remained reasonably stable over the past few years (2011 or later), which is a period of large change in the stock status from the assessment,

especially in PR and STT. There would therefore be utility in emphasising work in this period on developing a CPUE series, which could be used in one of two ways – either as an index within the assessment (which would become more useful as time progresses) or as an independent series that could be used to corroborate stock assessment findings. The choice of these two options would depend on how well the series can be standardised or not.

The effort and CPUE, even in its raw form, are likely to be useful as evidenced when the PR 2005 expansion factor was investigated.

> **Recommendation High 5. Undertaking further work on developing a (standardised) CPUE series for at least 2011 onwards with emphasis on PR is recommended.**

Recreational fishing data are not available for spiny lobster in this region. Anecdotally, information was provided to the RP that recreational fishing was not a large source of mortality and was not considered in the assessment. Studies in PR (Valle-Esquivel and Trumble, 2018) and STX (Goedeke et al., 2016) found collecting these data challenging, especially since few interviews were obtained and the fishery is distributed. There were also signs that the fishery has an unknown Illegal, Unreported and Unregulated (IUU) landing portion and as such goes beyond only recording an unreported recreational catch. More intensive sampling using daytime sampling and monitoring of social media is recommended in Valle-Esquivel and Trumble (2018).

However, of main concern is how this unrecorded catch could be included in the assessment. With the unknown total landings and the pattern of this landing over time, it is difficult to suggest an alternative approach to inclusion of this catch in the assessment beyond treating the final outputs with more caution. Furthermore, given issues with the uncertainty associated with PR total landings' expansion factors, the uncertainty in the commercial landings in PR is likely to be greater for the commercial data.

> **Recommendation Medium 2. Further work on estimating the relative size of the IUU catch as suggested by DW is supported.**

5.1.1.3 Fishery independent data

Various fishery independent data (FID) sources were investigated by the data workshop (DW) to test their utility in assessing spiny lobsters. None of these were aimed at spiny lobster and therefore deemed not useful for lobsters. That these were not useful for the present assessment is **supported**.

Furthermore, the cost of developing an independent survey is likely to be prohibitive given the value of the stock and logistics. However, further recommendations are made regarding research in the various MPAs that could be a mid-way step to move the data information base further over time. These are suggested in ToR 5 (Section 5.5).

5.1.1.4 Socio-economic and ecological events

The inclusion of socio-economic, management and ecological events was very useful to place the data in context, and its continued use is recommended. Anecdotal information provided during the workshop, showed that projections will be difficult given the impact of the recent hurricane. Given the recent substantial changes in the region this work on collecting socio-economic and ecological information should be emphasised.

> **Recommendation High 6. Given recent changes in the region due to hurricanes and its impact on the fisheries and tourism industries, emphasis on socio-economic work is needed in the short term.**

5.1.2 Are data uncertainties acknowledged, reported, and within normal or expected levels?

All data uncertainties were acknowledged and reported. However, some uncertainties require further work, notably:

- the use of expansion factors for PR that have a) not been well documented in terms of methods used, b) may not be statistically robust given a single value is applied to all fisheries and species in PR, c) not had uncertainty values calculated, and d) these uncertainties have not been included in the assessment. These uncertainties may be significant and annually variable, but are presently unknown.

- the assessment model relies heavily on a small data set, being landings (assumed known with high precision) and size frequency data (assumed representative of the fishery). This would be variously classified as a data limited or moderate assessment. It should be further highlighted that the lack of abundance indices may lead to the assessment underestimating uncertainty.

> **Recommendation Low 1. It would be useful to have a comprehensive time series of changes to management, logbook systems and how these have been included (or not) in data analyses and assessments.**
>
> **Recommendation Medium 3. Report the process of calculating the expansion factors applied to each region for transparency.**
>
> **Recommendation Medium 4. Carry the uncertainty in the calculation of the expansion factors into the assessment and report these within the DW and AW reports.**

5.1.3 Are data applied properly within the assessment model?

The data have been applied properly within the assessment model. There were data changes suggested for the recommended base case, being the 2005 PR expansion factor.

For the assessment, the input effective sample size was calculated using the square root of the observed sample size. This is an essential step so that pseudo-replication is avoided, which would result in overestimating sample sizes for some years. However, the approach using the square root of catch is useful when there is a view that large values are outliers. The effect means that it downweights large sample sizes relative to small. This approach is useful in some cases, but is not appropriate here. Several approaches for calculating effective sample sizes can be used, such as that reported in Pennington et al., (2002).

> **Recommendation Medium 5. Investigate the use of alternative methods of calculating effective sample size such as that in Pennington et al., (2002). The effective sample size for the length composition data may be better defined using a method related to the internal correlation structure of the sampling.**

5.1.4 Are input data series reliable and sufficient to support the assessment approach and findings?

The input data series used were reliable in the context of a data moderate assessment to support the assessment approach and findings of the recommended base case.

While in some cases sample sizes are small, the data appear consistent and provide sufficient information to monitor trends in stock size and mortality over the period. Since no indices of abundance were available, there were strong restrictions on the type of assessment model that could be applied.

5.2 ToR 2: Evaluate the methods used to assess the stock, taking into account the available data. Are methods scientifically sound and robust? Are assessment models configured properly and used consistent with standard practices?

This ToR is supported given the available data. An alternate to the original base case, here termed the recommended base case, was developed during the review workshop and should be used as the base case for management.

5.2.1 Are methods scientifically sound and robust?

The methods used are scientifically sound and robust.

Several approaches over the past decades have been attempted for spiny lobster from examining landing and CPUE, various production models, Yield per Recruit and different data-limited models. This assessment uses a statistical catch-at-age integrated stock assessment model with the Stock Synthesis software – a respected and internationally used age-length based assessment package. The assessment package has been extensively simulation tested, is documented and used in several other fisheries (see review of USA assessment packages in Dichmont et al., 2016).

The assessment assumptions on recruitment resulted in almost constant recruitment levels over time – a result that would need additional information such as index of relative abundance to change. This assumption is likely to be unrealistic and would result in a model showing less uncertainty than is the case in reality, however, it is consistent with a data limited/moderate assessment.

5.2.2 Are assessment models configured properly and used consistent with standard practices?

The assessment models were configured properly and used consistent with standard practice, but there is a new recommended base case to be used for management.

The panel recommended changes to the base case based on sensitivity tests undertaken during the RW. The most important of these were changing the growth function from that estimated using PR data to that from Cuba. Although the alternative Mateo parameters could also have been used, these are not argued for use in the recommended base case since they do not address the need for smaller Linf sizes in general, given the length composition data. This rejection of the alternative Mateo parameters was further substantiated by increased Negative Log Likelihood (NLL) values compared to the original base case (Config. 15 during the RW). On the other hand, the Cuban growth parameters greatly enhance the model results with lower NLL values compared to the original base case (Config 14 in Table 1 of the Addendum).

Several consequential changes were also recommended based on runs undertaken during the RW, notably to the assumption on how selectivity and retention is calculated for PR.

In the original base model, the selectivity parameters for the STT region were used as informative priors for the STX and PR selectivity parameters. In the original base case, there was information in the data to justify changing the selectivity parameters, particularly P3, which is the parameter that determines the degree of dome shaped selectivity. This remained true for the recommended base

case although the parameter values themselves have changed (Table 2 and 3 in Addendum compared to Table 7 and 8 in the Assessment Report).

For PR, more changes were investigated (N.B. not all tests from the RW are mentioned below) before moving to the recommended base case from the original base case (16 parameters and 8 selectivity priors):

- As per the other regions, the Cuban growth parameters better explained the data through lower NLL (Config. 14 in Table 1 of Addendum) (16 parameters and 8 selectivity priors).
- The new 2005 total landings were also included thereafter with marginally better fits (but not the main reason for their use as described in ToR 1 – section 5.1.1.2) (Config. 16 - 16 parameters and 8 selectivity priors).
- Config. 16 showed that the length composition data were informative. Furthermore, it was unclear whether the selectivity time block was needed. A test was undertaken which removed the time block and only kept the priors on the selectivity parameter P3 (Config. 18 – 10 parameters and 2 selectivity priors). Again, the fit to the data was improved.
- After exploring several combinations of priors, a final test to check whether any priors were needed was undertaken (Config. 21 – 10 parameters and 0 selectivity priors). The NLL value is essentially the same as Config. 18. This run therefore became the recommended base case as it produced the best combination of fit to the data (through lower NLL values), low parameter values with no prior taken from STT.

Of concern for this recommended base case is the very high degree of correlation between the parameters R0 and Initial F. This correlation was higher than that for the original base case. This shows that there is little information at the start of the series that can clearly distinguish between these two parameters. Of some comfort is the fact that the Initial F value of the original base case was extremely high (1.36 $year^{-1}$), hinting at a larger industry than seems anecdotally the case. The recommended base case Initial F value (0.60 $year^{-1}$), although high, may be more reasonable. This is clearly an area that needs further work. Restructuring past landings data and developing an index of abundance are important aspects of moving this forward. Because of these results, this assessment would remain data moderate and the results should be viewed as underestimating uncertainty.

Recommendation High 7. Reconstruct past landings data for PR

While there may be configurations that would, in the longer term, explain the observations better, the data were unable to support estimating these differences. For example, the size composition data provided evidence suggesting that dive fishing may select differently for each sex.

5.2.3 Are the methods appropriate given the available data?

The methods are appropriate given the available data.

Key to the choice of method is that there is no index of abundance which excludes more data moderate (e.g., biomass dynamic models) and data rich (e.g., size-based models and full age-length integrated models) approaches. An additional feature is that there were strong indications (both as outputs from the models and anecdotally from industry) that selectivity is dome shaped. This excluded many methods but especially catch only and some mean length approaches. The fishery had also experienced potential changes in retention and selectivity over time, which prevented the use of, for example, catch only methods.

Stock Synthesis is a well-respected software package and is appropriately used here in its data limited format.

5.3 TOR 3: EVALUATE THE ASSESSMENT FINDINGS WITH RESPECT TO THE FOLLOWING: CAN THE RESULTS BE USED TO INFORM MANAGEMENT IN THE U.S. CARIBBEAN (I.E. DEVELOP ANNUAL CATCH RECOMMENDATIONS)? IS IT LIKELY THE STOCK IS OVERFISHED? WHAT INFORMATION HELPS YOU REACH THIS CONCLUSION? IS IT LIKELY THE STOCK IS UNDERGOING OVERFISHING? WHAT INFORMATION HELPS YOU REACH THIS CONCLUSION?

This ToR is supported given the available data. The recommended base case can be used to inform management. The three management units are not overfished and are not subject to overfishing.

5.3.1 Can the results be used to inform management in the U.S. Caribbean (i.e. develop annual catch recommendations)?

Yes, for all three management units (STT, STX and PR) in terms of defining whether the fisheries are overfished or overfishing is occurring. The recommended base case is the preferred RP base case.

The recommended base case uses a different growth curve to the original base case and changes the PR 2005 value as described in detail in ToR 2. Several other inputs and assumptions were changed as a consequence of the changed growth curve. These mainly related to how selectivity is estimated within the models of STX and PR. This recommended base case model set up is more appropriate.

A further consequence of this change is that the sensitivity tests showed that fishing mortality at Maximum Sustainable Yield (F_{MSY}) is often poorly estimated (including for the recommended base case) for all of the management units. The RP proposed that the $SPR_{30\%}$ proxy is used as the alternative and is **supported**.

Given the data moderate nature of these assessments, the Probability Density Function (PDF) is likely to be underestimating the uncertainty and therefore it is not recommended that it be used in isolation from other information on uncertainty.

5.3.2 Is it likely the stock is overfished? What information helps you reach this conclusion?

Based on the recommended and original base case, the stock is not likely to be overfished for any of the three management units.

This conclusion is based on extensive tests of the assessment showing robustness to the final conclusions.

The sensitivity tests showed that the stock remains not overfished including under the recommended base case. The retrospective analyses showed that the original base case was reasonably insensitive to removal of recent data and likelihood profiles showed where the uncertainty in parameters was well defined (or not). Jitter tests demonstrated that local minima were avoided. These properties remained for the recommended base case with minor but acceptable differences.

However, of concern, was the strong correlation between the initial fishing mortality and initial recruitment in PR. This highlights the uncertainty in the assessment and the data moderate nature of the assessment.

5.3.3 Is it likely the stock is undergoing overfishing? What information helps you reach this conclusion?

The recommended and original base case shows that the resources in the different management units are not subject to overfishing. The recommended base case is the preferred base case for management use.

These conclusions are based on the assessment results using the RP proposed $SPR_{30\%}$ proxy. None of the sensitivity test suggested that overfishing is occurring.

5.4 ToR 4: 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.

The uncertainty was fully evaluated in the context of a data limited assessment. Some further sensitivity tests were requested and were influential. The final SEDAR 57 Addendum clearly states the implications and sources of uncertainty for the recommended base case.

Several tests were undertaken by the end of the AW and RW, notably:

- Jitter tests for local minima;
- Correlation analyses of the different parameters;
- Likelihood profiles to test components of the likelihood against different parameter values;
- Residual plots;
- Retrospective analyses of the effect of removing recent data; and
- Sensitivity of the base case models to assumptions such as growth, first year fishing mortality and selectivity options;

These tests are extensive and supported for future assessments.

Jitter test results suggested that the global minima had been obtained for both the base case and the recommended base case. Some runs did reach local minima, and as such, jittering is essential for any future assessments.

Correlation analyses for both the base case and recommended base case were the strongest for virgin recruitment (R0) and initial fishing mortality in PR. This correlation rose for the recommended base case, which is not ideal. High parameter correlations are often a feature of data limited and moderate assessments, especially without an index of abundance. Again, moving towards using an assessment with CPUE included as an additional data set is recommended.

Likelihood profiles were similar for the AW base case and recommended base case models, other than the R0 likelihood values and in one case, P3. Also, the PR bivariate plots of initial F and R0 are different, reflecting the stronger correlation between the two parameters for the recommended base case. These changes also reflect the final result that the recommended base case has much lower negative log likelihood base case values than the AW base case.

Residual plots of the length composition data were reflected mainly in two classes of plots – annual bubble plots of the residuals for male and females for each gear type; and aggregate residual plots for males and females by gear. These were initially plotted on the same axes, but changed to keeping the males and females separate for clarity as the combined plots were difficult to interpret. Additional plots were requested and provided during the RW that showed these in terms of age, rather than only length. This allows investigating whether large animals were (incorrectly) amassing in the unfished part of the population – a consequence of dome-shaped selectivity and other parameters being mis-specified. This test is especially important with dome shaped selectivity. It is recommended that annual residual plots for both age and length are provided in future assessments. Although there were large residuals for some sizes in some years (as expected given the data limited/moderate nature of the assessment), there were no patterns indicating underlying structural issues for the recommended base case. In the case of the original base case, there were indications that the larger AW base case Linf values meant that smaller landed animals were

sometimes missed especially for STX and STT females, but there was no clear annual pattern. These residuals are better for the recommended base case.

Recommendation Low 2. Provide both age and length based annual residual plots in future assessments.

Retrospective analyses for both the base case and recommended base case dropping the last 1-5 years of the dataset were unremarkable and stable, unless moving closer to a transition point as seen in the 5-year removal in PR original base case, which could be corrected. This latter phenomenon was not observed in the recommended base case due to the loss of the selectivity time block

Few sensitivity tests were undertaken beyond testing for whether dome shaped selectivity was most consistent with the data and whether the data is able to estimate R0, initial F and selectivity parameters (as described in Figure 4 of AW report). In all cases, the base case results reflected the need for the assumption that selectivity was dome shaped.

Additional sensitivity tests were requested during the RW – a) using the Cuban growth parameters; b) using the alternative Mateo growth parameters; c) removing the first few years of the data for STT and STX; d) not including the divers' length composition data in the NLL from STX and STT; and e) running with the upper and lower bounds for M of 0.3 and 0.4 yr^{-1}. These were all undertaken on the AW base case.

The effects of changing to the Cuban growth parameters were profound, as already discussed in ToR 2 (see Section 5.2.2) and not discussed further here. The Mateo growth parameters also changed the results, often differently between the regions. However, the NLL was increased, i.e., the fit to the data was weaker compared to the original base case.

When the first few years of the data were removed for STT and STX on the original base case, for STT there was almost no change to the original base case, whereas for STX it slightly reduced the relative spawning biomass for the test versus the original base case. Only small initial changes to the relative spawning biomass were observed, which settled to overlap with the original base case. The absolute F values also overlap with the original base case.

The effect of removing one gear's length composition data was tested. When the divers' length composition data was excluded from the NLL, this slightly lowered the relative spawning biomass and increased the absolute F for STT and STX. There was no perceptible reason why these data would be excluded for some islands as part of the base case or for a sensitivity test.

Sensitivity tests were undertaken using the upper and lower bounds of natural mortality of 0.3 and 0.4 $year^{-1}$ (FAO, 2001). These had the expected results of spanning the base case results. Given the published uncertainty in the natural mortality values, sensitivity tests to this parameter should be undertaken against the base case as a norm.

Recommendation High 8. Undertake more extensive sensitivity tests, particularly on less certain input parameters, such as growth and natural mortality

5.5 ToR 5: 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, and information provided by future assessments.

Comments on the DW and AW recommendations are provided below. These are prioritised.

5.5.1 Reviewer priorities

The reviewer's key priorities are:

In order to move the stock assessment to a more rigorous and certain assessment, the following steps over time should be taken as a high priority:

1. An abundance index should be developed – a fisheries independent survey is likely to be expensive and logistically difficult and is therefore a lower priority. On the other hand, further work on effort in the fishery is likely to produce dividends in terms of CPUE. The focus should initially be on the recent decade series where the commercial landings recording form (post 2011) has been consistent and clearer and the trip ticket form (post 2014) has been in use. Although currently this is a short series, the value of this will increase over time. In the short term, however, these data could still be valuable, since outputs from the assessment models for all management units demonstrate large recent changes, especially in PR and STT. The direction of these could therefore be confirmed (or not) by the CPUE indices at least anecdotally until they are of use to the assessment:
2. The assessment would further benefit from another key source of information, particularly from the MPAs and other closures in the region. These regions could be used to start a sequence of scientific studies to address the key uncertainties in the assessment;
    a. Initially, the selectivity of the gear could be estimated. Dome shaped selectivity is a key finding and is not precautionary if this is incorrectly estimated. Presently, the strength of this dome shape is uncertain. This work would additionally provide access to an essentially unfished population (for areas where the MPAs have been in place for a while).
    b. An on-going program of collecting unfished population length composition data would benefit the model in terms of selectivity, fishing mortality and growth. It would essentially provide the unfished version of the commercial length composition data in the model.
3. Growth parameters specific to the region are needed as these were a key uncertainty within the assessment:
    a. This could initially be undertaken by re-examining the original data from Mateo (2004) using more modern techniques and combining the data sets rather than estimating different curves for each year. This work could direct the next steps in terms of a) need and b) statistical design.
    b. If needed, further data may need to be collected either through a mark-recapture study within the MPA region (to obtain animals over the whole size range) or using the length composition data as described above.
4. The total catch estimation needs continual improvement as also stated in the DW.
    a. Further work is required on the expansion factors within PR – in terms of the 2005 value and how it is interpolated, creating a species-specific factor, statistical design and carrying the uncertainties in the factor through to the assessment.

b. Studies on obtaining the extent of additional mortalities remain important, especially on the IUU catch (including recreational, discards and illegal fishing).

5. Given the large recent changes in the fishery and tourism industry in the region, socio-economic work on their impacts (in terms of the assessment effort interpretations and projections settings, and impact on the fishing businesses) is essential.

5.5.2 Reviewer response to combined DW and AW Recommendations

Reviewers comments (**blue and bold**) against DW and RW Recommendations (normal black text).

High priority

1. Investigate potentially unaccounted for discards in the self-reported commercial logbook data to be able to quantify the number of lobsters discarded dead, as well as the number of lobster discarded alive. **As also supported in reviewer list above, but should be seen in the context of obtaining unaccounted for catch/mortality in general.**
2. DW: General data improvements are recommended, including continued reporting of specific gear categories (e.g., different types of diving). AW: Improve data on commercial landings and catch and effort. Concerns of misreporting should be investigated and corrected where practicable. Commercial catch and effort may provide CPUE indices in the future. **Agree.**
3. Investigate the sensitivity of stock assessment results to landings data associated with high uncertainty. **Agree, especially for PR.**
4. Investigate improvements or alternatives to past correction factors in Puerto Rico (2005 in particular). **Agree, but should also be undertaken with point above.**
5. Continue SEFSC funded commercial landings validation studies in Puerto Rico and begin similar surveys in the US Virgin Islands. **Agree.**
6. General data improvements are recommended, including encouraging complete reporting of discards. **Agree.**
7. From DW: Permanent programs that quantify the recreational effort and landings in the US Caribbean are needed. The results of recent pilot studies (Valle-Esquivel and Trumble 2016 and Goedeke et al. 2016) should be used to develop future surveys. AW: Collect data on recreational landings. The magnitude of recreational removals of spiny lobster on each island platform is unknown. **Agree. Increased work on all forms of unreported catch is important as listed above. Recreational catch is an essential aspect of this.**
9. Continue comprehensive bio-socio-economic database of events, compile references and time series of quantitative data as available. **Emphasis should be placed on post hurricane recovery effects and changes in fisher behaviour due to markets and the environment. Information should be both qualitative and quantitative.**
10. A Caribbean-specific staff for data statistics and assessments was recommended to aid in establishing and maintaining high **technical** expertise. **Local knowledge and support staff are always essential in more remote areas.**
11. Where possible, the research recommended above should consider ecosystem linkages toward developing capacity in the region for ecosystem-based fisheries management. **Agree. Ecosystem based management is important, especially given the major recent changes in the region and the complex nature of the fisheries.**
12. Independently estimate availability/selectivity. There are three main parameters currently estimated in the SEDAR 57 stock assessment for Caribbean spiny lobster in Puerto Rico. They are R0, selectivity, and initial F. Selectivity, as it is used in the model, is both a combination of contact selectivity, e.g., selection created by contact with the gear itself such as trap opening diameter, and availability, which might be a function of depth and habitat. In the base model, selectivity is assumed to be dome-shaped based on information from STT. This is an important assumption since it affects the estimates of both initial F and R0. Knowing more about gear

selectivity or having a survey that can provide the underlying size distribution of all lobster in the population, across all habitat and depths, and not just those targeted by the commercial fishery, could greatly improve the stock assessment in Puerto Rico and help determine the appropriateness of the assumed selectivity pattern. **Agree. This priority is in the reviewer's key list above.**

13. More basic biological studies to improve understanding of key life history processes such as growth, length/age at maturity, fecundity, and their spatial variability. **Agree. High for growth, this priority is in the reviewer's key list above. The other life history processes are presently a low priority.**

Medium priority

1. Identify significant ecosystem-based management (EBM) quantitative socioeconomic indicators (ex. gravity of the market, network market analyses, population growth, tourism, poaching). **Agree. Immediate priority is post hurricane effects as above.**

Low priority

1. Research on stock structure is needed, particularly as it relates to connectivity caused by larval dispersal. **Agree – already have existing information, globally been difficult to incorporate into stock assessments. Useful to support other forms of information.**
2. Encountering the right habitat is important for survival of juvenile lobster recruits. Research should be conducted to explore effects of sargassum, water quality, coastal development, and mangrove root communities on the availability and quality of habitat for juvenile spiny lobsters. **Agree. Low, unless there are indications that there have been changes to these habitats especially during extreme events as has recently occurred.**
3. Explore plausibility of cause and effect mechanisms that may lead to temporal growth variation. **Agree. Presently, research on growth is a high priority, but cause and effect are not a priority.**
4. Research aimed at quantifying post-release mortality (including post-release predation) of spiny lobster to better understand and propose mechanisms that could potentially mitigate mortality among lobsters that are discarded. **Agree. Low priority, given the information provided by industry.**
5. Further explore TIP data for possible data entry and/or measurement errors, particularly regarding the number of individuals associated with a given length entry and associated with potentially miscoded species. **The focus should rather be on Data Quality Control.**
6. Development of fishery-independent surveys that are specifically designed for spiny lobster, which would require considerable planning regarding data priorities (e.g., relative abundance versus length), the life stage to target (e.g., adult, juveniles, or larvae), type of gear, sampling design, temporal and spatial resolution, and the availability of funds. In addition to discussing field sampling, planning of how best to record and store data would be beneficial to future analyses and stock assessments. **Agree. Low priority due to logistics and costs, suggest alternative approaches in the MPAs.**
7. Research aimed at identifying correlations between larval and juvenile abundance from the SEAMAP-C surveys and lobster landings could assist in determining the relationship between juvenile abundance and adult abundance (e.g., Butler et al. 2010) **Agree. Very few of these studies have greatly enhanced management. Given other priorities, suggest low priority.**

5.6 ToR 6: Provide guidance on key improvements in data or modelling approaches which should be considered when scheduling the next assessment.

The important aspect of this assessment is that it is data moderate with the main reason being the absence of an index of abundance. However, a key feature of the existing assessment is that there is a large contrast in the relative spawning index of the past decade. This means that difficulties with producing a long-term CPUE index because of major logbook changes over time could be overcome by focusing initially on the recent logbook series where logbook formats have been more consistent. These data could be very useful in providing some direction and contrast to the stock assessment model. Depending on the length of the time series and degree to which these data could be standardised, the CPUE series could be used either anecdotally external to the model to help select between sensitivity tests or within the model itself. The latter is, of course, preferred. Ideally, a long-term index of abundance would allow recruitment deviations to be estimated. Presently, these are almost static (and unrealistic). In the long-term as the series becomes more extensive, the view could be broadened to include environmental drivers if required.

A large source of uncertainty in the PR assessment, was the degree to which the population had been fished prior to the landings data collection. Extending the data further back, even if not to the standard of an assessment, should be considered. This could be undertaken by interviewing fishers from the 1970s and 80s.

Much comment has been made about the research recommendations in ToR 5. If the uncertainty in growth particularly, but also selectivity, were to be addressed, a key uncertainty in the assessment would be addressed. The recommended research in the MPAs - notably undertaking a) selectivity studies to test for dome shaped selectivity and to provide further data to estimate selectivity within the model, and b) regular collection of unfished population size frequency information (preferably with gear that does not have such strong dome shaped selectivity) - would provide the additional information on the unfished population. It would also help with adding sex-based selectivity for specific gears.

These additional data described above should provide more information on parameters in the model and enable more accurate estimates of the assessment's uncertainties. The present use of Stock Synthesis would mean that this assessment model's inherent flexibility could be harnessed to address these additional information sources without moving to another platform.

Although the AW undertook extensive model diagnostics, more sensitivity tests could have been undertaken. This would, in the future, address uncertainties in the assessment beyond parameter uncertainty. Although not much discussed during the RW, the use of a fixed input steepness value of 0.95 in the assessment is extremely high and less precautionary compared to other lobster assessments.

Recommendation High 9. A test of lower steepness values commensurate with other lobster assessments is recommended.

Although as yet unclear, it is likely that the large impact of the hurricane would be felt for several years and emphasis on collecting the required socio-economic information would inform whether the assessment model will need additional settings to cater for this impact.

5.7 ToR 7: Provide recommendations on possible ways to improve the SEDAR process.

The RW was undertaken in a constructive spirit. It is was particularly important and informative that local fishers and managers that know the region well attended the meetings.

The 3-day meeting was too short for the work needed, especially since essentially three separate assessments were reviewed. It would only have been enough if there was no additional work required – usually unlikely. This meant that the assessors were undertaking additional work under enormous time pressure. There were also consequential decisions to be made from the initial sensitivity tests which were rushed on the last day of the review.

Final work had to be completed over the 3-week period post RW for which the RP had to gain additional time thereafter to work through the final result. This is not ideal from the perspective of work scheduling and the risk of finding major changes post RW. One more RW day would likely have been enough.

Individual CIE RP reports are only made available temporally far along the management process - there appears to be considerable delay. The panel report does cover much of what is required in summary, but any detail would not be considered by managers. Make CIE reports available as quickly as possible to the SEDAR process.

5.8 ToR 8: **Prepare a Peer Review Summary summarizing the Panel's overall conclusions and recommendations.**

A summary report highlighting the RP overall conclusions and recommendations was provided.

6 CONCLUSIONS AND RECOMMENDATIONS IN ACCORDANCE WITH THE TORS.

6.1 CONCLUSIONS

All the Terms of References (ToRs) were met except for changing the original base to the panel recommended base case after extensive tests during the review. The recommended base case should be the model run used to provide management advice. The St Thomas (STT), St Croix (STX) and Puerto Rico (PR) status remain as not overfished and no overfishing for the recommended base case.

6.2 RECOMMENDATIONS

6.2.1 High recommendations

6.2.2 Medium recommendations

6.2.3 Low recommendations

7 REVIEW PROCESS

Provided in ToR 7.

8 REFERENCES

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SEDAR 57. 2019. SEDAR 57 U.S. Caribbean Spiny Lobster: Section VI: Post-Review Workshop Addendum Report.

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Valle-Esquivel, M., and R. J. Trumble. 2016. Pilot Study of the Recreational Queen Conch (Strombus gigas) and Spiny Lobster (Panulirus argus) Fishery in Puerto Rico for the Gulf States Marine Fisheries Commission. MRAG Americas, Inc. 136 pp.

Velazquez-Abunader, I., V. M. Gomez-Munoz, S. Salas, and J. M. Ruiz-Velazco. 2015. Intercohort growth for three tropical resources: tilapia, octopus, and lobster. Rev. Biol. Trop. 63:617–627.

9 APPENDIX 1: BIBLIOGRAPHY OF MATERIALS PROVIDED FOR REVIEW

Document #	Title	Authors	Date Submitted
Documents Prepared for the Data Workshop			
SEDAR57-DW-01	Inventory of Fishery-Independent Programs and Survey Data Available for Stock Assessment of Caribbean Spiny Lobster in the US Caribbean	Skyler Sagarese, William Harford, Aida Rosario, Matt Johnson and Jay Grove	1 June 2018 Updated: 26 July 2018
SEDAR57-DW-02	Summary of Life History Information of Spiny Lobster for SEDAR 57	William Harford and Adyan Rios	6 June 2018 Updated: 18 Sept 2018
SEDAR57-DW-03	Building a Timeline of Major Socioeconomic Events Affecting Lobster Fisheries in Puerto Rico	Adyan Rios and Juan Agar	6 June 2018
SEDAR57-DW-04	Building a Timeline of Major Socioeconomic Events Affecting Lobster Fisheries in St. Croix USVI	Adyan Rios and Juan Agar	6 June 2018
SEDAR57-DW-05	Building a Timeline of Major Socioeconomic Events Affecting Lobster Fisheries in St. Thomas and St. John USVI	Adyan Rios and Juan Agar	6 June 2018
SEDAR57-DW-06	Summary of the Trip Interview Program data for Spiny Lobster from the US Caribbean	Adyan Rios, Skyler Sagarese, and William Harford	15 June 2018
Documents Prepared for the Assessment Process			
SEDAR57-AP-01	Efficacy of TIP length composition for use in length-based mortality estimation	William Harford and Adyan Rios	24 September 2018

			Updated: 16 April 2019
SEDAR57-AP-02	Reliability testing of non-equilibrium mean length mortality estimation routines	Victoria P. Simmons, Quang C. Huynh, Elizabeth A. Babcock, and William J. Harford	3 November 2018
Final Stock Assessment Reports			
SEDAR57-SAR1	U.S. Caribbean Spiny Lobster	SEDAR 57 Panels	
SEDAR75_Addendum_for_SAR	SEDAR 57 U.S. Caribbean Spiny Lobster: Section VI: Post-Review Workshop Addendum Report	SEDAR 57 Assessors 2 August 2019	
Reference Documents			
SEDAR57-RD01	Line Point-Intercept (LPI) Survey Protocol for the U.S. Caribbean and Flower Garden Banks National Marine Sanctuary	National Coral Reef Monitoring Program (NCRMP), Coral Reef Conservation Program (CRCP), National Oceanic and Atmospheric Administration	
SEDAR57-RD02	Report of the US Caribbean Fishery-Independent Survey Workshop	Shannon L. Cass-Calay, William S. Arnold, Meaghan D. Bryan, Jennifer Schull	
SEDAR57-RD03	Working Towards a Framework for Stock Evaluations in Data-Limited Fisheries	Skyler R. Sagarese, Adyan B. Rios, Shannon L. Cass-Calay, Nancie J. Cummings, Meaghan D. Bryan, Molly H. Stevens, William J. Harford, Kevin J. McCarthy, and Vivian M. Matter	
SEDAR57-RD04	The United States Virgin Islands 2015 Comprehensive Economic Development Strategy		
SEDAR57-RD05	Report on the FAO/Danida/CFRAMP/WECAFC Regional Workshops on the	Western Central Atlantic Fishery Commission	

	assessment of the Caribbean Spiny Lobster (*Panulirus argus*)	
SEDAR57-RD06	Population dynamics, ecology and behavior of spiny lobsters, *Panulirus argus*, of St. John, USVI: II Growth and Mortality	David A. Olsen and Ian G. Koblic
SEDAR57-RD07	A review of the literature and life history study of Caribbean spiny lobster, *Panulirus argus*	Steven Saul
SEDAR57-RD08	Maturity of spiny lobsters in the US Caribbean	David Die
SEDAR57-RD09	A Collaborative Assessment of the Virgin Islands Spiny Lobster Fishery	David Olsen, Josh Nowlis, and Daryl Bryan
SEDAR57-RD10	A study of the Virgin Islands Spiny Lobster Fishery: Growth, Population Size and Mortality	David Olsen, Josh Nowlis, and Daryl Bryan
SEDAR57-RD11	Pilot Study of the Recreational Queen Conch (*Strombus gigas*) and Spiny Lobster (*Panulirus argus*) Fishery in Puerto Rico	Monica Valle-Esquivel and Robert J. Trumble
SEDAR57-RD12	Patterns of Spiny Lobster (*Panulirus argus*) Postlarval Recruitment in the Caribbean: A CRTR Project	Mark J. Butler, Angela M. Mojica, Eloy Sosa-Cordero, Marines Millet, Paul Sanchez-Navarro, Miguel A. Maldonado, Juan Posada, Bladimir Rodriguez, Carlos M. Rivas, Adrian Oviedo, Marcio Arrone, Martha Prada, Nick Bach, Nilda Jimenez, Maria Del Carmen Garcia-Rivas, Kirah Forman, Donald C. Behringer, Jr., Thomas Matthews, Claire Paris, And Robert Cowen
SEDAR57-RD13	Dependence of recruitment on parent stock of the spiny lobster, Panulirus argus, in Florida	Nelson M. Ehrhardt* And Mark D. Fitchett
SEDAR57-RD14	Larval Connectivity and the International Management of Fisheries	Andrew S. Kough, Claire B. Paris, Mark J. Butler IV
SEDAR57-RD15	Implications of the ecosystem approach to fisheries management in large ecosystems: The Caribbean spiny lobster, *Panulirus argus*, fisheries as a case	Nelson Ehrhardt, Rafael Puga and Mark Butler IV

SEDAR57-RD16	A pilot, cooperative fishery-independent trap survey of Saint Croix, United States Virgin Islands	Meaghan D. Bryan, Todd Gedamke, and John F. Walter
SEDAR57-RD17	USVI Caribbean Spiny Lobster Assessment	Shenell Gordon & Jason Vasques
SEDAR57-RD18	Activity and harvest patterns in the U.S. Virgin Islands recreational fisheries	Ivan Mateo, Ruth Gomez, K.Roger Uwate, Barbara Kojis, Dean C. Plaskett
SEDAR57-RD19	Recreational Fisheries Habitat Assessment for St. Thomas/St. John	Barry VoIson, Shenell Gordon, Ginger Chapman, Gene Brin, George Green, Arthur Adams, and Joseph Barbel
SEDAR57-RD20	Environmental Impact Statement/Fishery Management Plan and Regulatory Impact Review for the Spiny Lobster Fishery of Puerto Rico and the U.S. Virgin Islands	CFMC/NMFS
SEDAR57-RD21	Portrait of the Spiny Lobster (Panulirus argus) Fishery in Puerto Rico during 1998 - 2013	Daniel Matos Caraballo, Martha Ricaute Chica, Jesus León, and Luis A. Rivera
SEDAR57-RD22	Census of licensed fishers of the U.S. Virgin Islands (2016)	Barbara Kojis, Norman Quinn, and Juan J. Agar
SEDAR57-RD23	Assessing socioeconomic impacts of climate change on Puerto Rico's coral reef fisheries through a participatory approach	Tarsila Seara, Karin Jakubowski, Richard Pollnac, and Thomas Webler

10 APPENDIX 2: A COPY OF THE CIE STATEMENT OF WORK

Performance Work Statement (PWS)

National Oceanic and Atmospheric Administration (NOAA)

National Marine Fisheries Service (NMFS)

Center for Independent Experts (CIE) Program

External Independent Peer Review

SEDAR 57 U.S. Caribbean Spiny Lobster Benchmark Assessment Review

Background

The National Marine Fisheries Service (NMFS) is mandated by the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, and Marine Mammal Protection Act to conserve, protect, and manage our nation's marine living resources based upon the best scientific information available (BSIA). NMFS science products, including scientific advice, are often controversial and may require timely scientific peer reviews that are strictly independent of all outside influences. A formal external process for independent expert reviews of the agency's scientific products and programs ensures their credibility. Therefore, external scientific peer reviews have been and continue to be essential to strengthening scientific quality assurance for fishery conservation and management actions.

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards. (http://www.cio.noaa.gov/services_programs/pdfs/OMB_Peer_Review_Bulletin_m05-03.pdf).

Further information on the CIE program may be obtained from www.ciereviews.org.

Scope

The **SouthEast Data, Assessment, and Review (SEDAR)** is the cooperative process by which stock assessment projects are conducted in NMFS' Southeast Region. SEDAR was initiated to improve planning and coordination of stock assessment activities and to improve the quality and reliability of assessments.

SEDAR 57 will be a compilation of data, an assessment of the stock, and CIE assessment review conducted for U.S. Caribbean spiny lobster. 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 stock assessed through SEDAR 57 is within the jurisdiction of the Caribbean Fisheries Management Council and the territories of Puerto Rico and the U.S. Virgin Islands.

The specified format and contents of the individual peer review reports are found in **Annex 1**. The Terms of Reference (TORs) of the peer review are listed in **Annex 2**. Lastly, the tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements

NMFS requires three (3) reviewers to conduct an impartial and independent peer review in accordance with the PWS, OMB guidelines, and the TORs below. The reviewers shall have a working knowledge 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 fisheries stock assessment. Expertise in data-limited methods would be preferred.

Tasks for Reviewers

1) Review the following background materials and reports prior to the review meeting:

Working papers, reference documents, and the Data Workshop and Assessment Process Reports will be available on the SEDAR website: http://sedarweb.org/sedar-57

2) Attend and participate in the panel review meeting. The meeting will consist of presentations by NOAA and other scientists, stock assessment authors and others to facilitate the review, to answer any questions from the reviewers, and to provide any additional information required by the reviewers.

3) After the review meeting, reviewers shall conduct an independent peer review report in accordance with the requirements specified in this PWS, OMB guidelines, and TORs, in adherence with the required formatting and content guidelines; reviewers are not required to reach a consensus.

4) Each reviewer should assist the Chair of the meeting with contributions to the summary report.

5) Deliver their reports to the Government according to the specified milestones dates.

Foreign National Security Clearance

When 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 reviewers who are non-US citizens. For this reason, the 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/ and http://deemedexports.noaa.gov/compliance_access_control_procedures/noaa-foreign-national-registration- system.html. The contractor is required to use all appropriate methods to safeguard Personally Identifiable Information (PII).

Place of Performance

The place of performance shall be at the contractor's facilities, and in Miami, FL.

Period of Performance

The period of performance shall be from the time of award through September 2019. The CIE reviewers' duties shall not exceed 14 days to complete all required tasks.

Schedule of Milestones and Deliverables: The contractor shall complete the tasks and deliverables in accordance with the following schedule.

Within two weeks of award	Contractor selects and confirms reviewers
Approximately 2 weeks later	Contractor provides the pre-review documents to the reviewers
July 9-11, 2019	Panel review meeting
Approximately 3 weeks later	Contractor receives draft reports
Within 2 weeks of receiving draft reports	Contractor submits final reports to the Government

Applicable Performance Standards

The acceptance of the contract deliverables shall be based on three performance standards:

(1) The reports shall be completed in accordance with the required formatting and content; (2) The reports shall address each TOR as specified; and (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

Travel

All travel expenses shall be reimbursable in accordance with Federal Travel Regulations (http://www.gsa.gov/portal/content/104790). International travel is authorized for this contract. Travel is not to exceed $7,000.

Restricted or Limited Use of Data

The contractors may be required to sign and adhere to a non-disclosure agreement.

Project Contacts:

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SEDAR Coordinator

Science and Statistics Program

South Atlantic Fishery Management Council

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Annex 1: Peer Review Report Requirements

1. The report must 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 report must contain a background section, description of the individual reviewers' roles 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 must describe in their own words the review activities completed during the panel review meeting, including 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, but especially where there were divergent views.

   c. Reviewers should elaborate on any points raised in the summary report that they believe 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 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 report shall represent the peer review of each TOR, and shall not simply repeat the contents of the summary report.

3. The report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review

   Appendix 2: A copy of this Performance Work Statement

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

Annex 2: Terms of Reference for the Peer Review

SEDAR 57 U.S. Caribbean Spiny Lobster Benchmark Assessment Review

1. Evaluate the data used in the assessment, addressing 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 the methods used to assess the stock, taking into account the available data.
    a. Are methods scientifically sound and robust?
    b. Are assessment models configured properly and used consistent with standard practices?
    c. Are the methods appropriate given the available data?
3. Evaluate the assessment findings with respect to the following:
    a. Can the results be used to inform management in the U.S. Caribbean (i.e. develop annual catch recommendations)?
    b. Is it likely the stock is overfished? What information helps you reach this conclusion?
    c. Is it likely the stock is undergoing overfishing? What information helps you reach this conclusion?
4. 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.
5. 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, and information provided by future assessments.
6. Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.
7. Provide recommendations on possible ways to improve the SEDAR process.
8. Prepare a Peer Review Summary summarizing the Panel's overall conclusions and recommendations.

Annex 3: Agenda - SEDAR 57 U.S. Caribbean Spiny Lobster Benchmark Assessment Review

July 9-11, 2019, Miami, FL

Tuesday

9:00 a.m.	**Introductions and Opening Remarks** *- Agenda Review, TOR, Task Assignments*	**Coordinator**
9:30 a.m. – 11:30 a.m.	**Assessment Presentations** *- Assessment Data & Methods* *- Identify additional analyses, sensitivities, corrections*	**Analytic Team**
11:30 a.m. – 1:00 p.m.	**Lunch Break**	
1:00 p.m. – 6:00 p.m.	**Assessment Presentations (continued)** *- Assessment Data & Methods* *- Identify additional analyses, sensitivities, corrections*	**Analytic Team**
6:00 p.m. – 6:30 p.m.	**Public comment**	**Chair**

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

Wednesday

8:30 a.m. – 11:30 a.m.	**Panel Discussion** *- Assessment Data & Methods* *- Identify additional analyses, sensitivities, corrections*	**Chair**
11:30 a.m. – 1:00 p.m.	**Lunch Break**	
1:00 p.m. – 6:00 p.m.	**Panel Discussion/Panel Work Session** *- Continue deliberations* *- Review additional analyses* *- Recommendations and comments*	**Chair**

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

Thursday

8:30 a.m. – 11:30 a.m.	**Panel Discussion** *- Final sensitivities reviewed.* *- Projections reviewed.*	**Chair** **Chair**
11:30 a.m. – 1:00 p.m.	**Lunch Break**	
1:00 p.m. – 5:30 p.m.	**Panel Discussion or Work Session** *- Review Reports*	**Chair**
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

11 APPENDIX 3: PANEL MEMBERSHIP OR OTHER PERTINENT INFORMATION FROM THE PANEL REVIEW MEETING.

Panelists

Adyan Rios (Co-Lead analyst) ..... NMFS Miami
Bill Harford (Co-Lead analyst) ..... Univ. of Miami
Cathy Dichmont..... CIE
Stewart Frusher..... CIE
Doug Gregory (Chair) ..... SSC
Paul Medley ..... CIE
Tarsila Seara ..... SSC

Appointed Observers

Julian Magras ..... STT/STJ Fisherman
Gerson N. Martinez.....STX Fisherman
Carlos J. Velazquez ..... P.R. Fisherman

Attendees

Nicole Carmouze ..... NMFS Miami (Intern)
Kevin McCarthy ..... NMFS Miami
Matthew Nuttell..... NMFS Miami
Skylar Sagerase..... NMFS Miami
Nathan Vaughn ..... NMFS Miami

Staff

Julie Neer.....SEDAR
Graciela Garcia-Moliner .....CFMC
Kathleen Howington .....SEDAR