Center for Independent Experts (CIE) Independent Peer Review of the SEDAR 57 U.S. Caribbean Spiny Lobster Benchmark Assessment Review

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Executive Summary

- This report contains the author's findings and recommendations of the SEDAR 57 Review Workshop that took place in Miami 9th – 11th July 2019. The review covered the U.S. Caribbean spiny lobster (*Panulirus argus*) stock assessment for the three stocks: St. Thomas (STT), St. Croix (STX) and Puerto Rico (PR).
- The decisions made by the data workshop (DW) and assessment workshop (AW) and stock assessment methods used were sound and robust. Uncertainties were evaluated and reported, and methods were correctly applied. The main recommended change by the review panel was to use alternative growth parameters from Cuba.
- With the review panel's recommended changes, the stock assessment overall was sufficiently reliable to provide scientific advice to management and represents the best scientific information available for these stocks. The sensitivity analyses should be used to provide an estimate of the uncertainty in the assessment.
- None of the three stocks were overfished and overfishing was not occurring in either the review panel's recommended base case or in any of the sensitivities.
- The primary recommendation to be completed before the next stock assessment is to develop one or more abundance indices from the available catch and effort data in each fishery.

Background

The National Marine Fisheries Service (NMFS) science products may require independent scientific peer reviews to ensure their credibility. Scientific peer review, such as that conducted here, employed three qualified experts to review scientific information for three spiny lobster (*Panulirus argus*) stocks of the U.S. Caribbean to ensure their quality and credibility. The experts were employed as part of the CIE program and charged with conducting their peer review impartially, objectively, and without conflicts of interest. The reviewers were independent of the development of the science, and without influence from any position that the agency or constituent groups may have. Further information on the CIE program may be obtained from www.ciereviews.org.

The SEDAR 57 Data Workshop (DW) was held on June 20-22, 2018 in San Juan, Puerto Rico and the SEDAR 57 assessment workshop (AW) was conducted via a series of webinars held between March 2018 and November 2018. The review meeting which considered all the data and stock assessment decisions took place in Miami 9th – 11th July 2019. The review was due to take place earlier in 2019, but was delayed due to government funding limits.

Review Activities

The three reviewers took no part in either the data workshop (DW) or the assessment workshops (AW). Materials from the DW and AW were received and read ahead of the review meeting, and included reports from the DW, the final stock assessment report and supporting papers (see Appendix 1). The final data and assessment reports were presented at the meeting. I subsequently attended the review panel (RP) meeting in Miami 9th – 11th July 2019.

During the review meeting, the assessment scientists presented the work that had been completed by the DW and AW. As well as reviewing and commenting on the work that had been completed, the RP requested a range of sensitivity runs. The sensitivities explored the effect of the key assumptions for growth, natural mortality, initial stock status and the effect of differences among selectivity parameters.

The sensitivity runs were used to justify an alternative base case using different growth parameters recommended by the RP that was put back to the AW. This was tested and an addendum of the diagnostics and results was provided after the review workshop in which the RP recommended base case was found acceptable. As the outputs from the review, this report, the RP consensus report and stock assessment addendum were produced.

Evaluate the data used in the assessment

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

The data decisions made by the Data Workshop (DW) and Assessment Workshop (AW) were sound and robust, with the exception of the choice of growth model parameters. The data are limited, and the stock assessment model was appropriately simple, so the decisions that had to be made were few. The most important were the choices for fixed parameters and the type of selectivity in the model.

Total catches by gear were estimated by raising catch/effort observations to the total landings for each fleet. In one year (PR – 2005) the estimated catch seemed poor (unrealistically high) and was replaced by the interpolated value. Length sampling was used from the majority of years where sampling was undertaken. Fishery independent data were not used because they did not support any inference relevant to stock assessment. Otherwise small amounts of data were excluded in all assessments because of recording errors. All these decisions seemed reasonable.

The catch-effort data were not used to develop an abundance index. No detailed information was presented on this, so it is not possible to comment much on this specific decision, but there has been a problem with interpreting fishing effort consistently over time. Without good measures of fishing effort and a good process of standardization, the CPUE index is not likely to be reliable. Therefore, excluding these data at this stage is not unreasonable, but developing a CPUE-based abundance index should form the focus for developing these stock assessments further.

The fishery independent data could be most useful in providing abundance indices. However, to be useful, consistent data need to be collected over a long time period and across the extent of the population being monitored. Due to their nature, spiny lobsters may be difficult to find in visual surveys, and there is a separation of size by depth. Therefore, designing any effective fishery independent monitoring program would be difficult. Excluding these data was justified and appropriate and no useful information was lost.

Dome-shaped selectivity was justifiable. Spiny lobster migrate from juvenile areas to deeper water. It makes sense that fisheries, in maximizing their catch rates, will target particular areas that result in reduced fishing mortality of the smallest and largest lobster. However, there was no specific data to support the dome-shaped selectivity in this case, so further evaluation in future stock assessments is still advised.

The assessment had reviewed possible changes in selectivity over time. It made sense, given limited data, to apply the effect of retention (change in minimum size) as a fixed effect which did not require parameter estimation. For STX and STT, a single selectivity was estimated and for PR there was sufficient data to separate traps and diving with two distinct time blocks. Further possible selectivity differences that were discussed were not supported by the limited data.

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

All important uncertainties have been acknowledged and reported. Uncertainties were within expected levels and were acceptable. However, there are some issues that could be dealt with better in future stock assessments:

- The raised catch data are treated as observations rather than estimates. Although uncertainties over the estimate of total catches is well-described, the error has not been quantified and could be introduced in future assessments.
- The precision of measurement of carapace length, to the nearest ¼ inch, is very imprecise. Measurement to a millimeter is usually expected and easy to obtain. As noted by the DW/AW, the lack of precision in the data will prevent the model explaining detailed variations in recruitment or growth.
- The St. Thomas / St. John stock may be shared with the UK Virgin Islands. Not including this part of the stock increases somewhat the uncertainty in the stock assessment. It does not appear that UKVI collect routine data, but presumably they could estimate their total annual catch. There may be some benefit to including these data in future assessments, but their effect would not likely be significant.
- Unrecorded catches (mainly recreational catch) were considered but cannot be incorporated into the assessment because they have not been quantified. Techniques, such as raising commercial catch estimates by fixed percentages for example, would not help because the model would compensate by introducing biomass to cover these extra catches. Sensitivity analyses on natural mortality suggested that biomass changes based on realistic differences in mortality would not be large, but nevertheless contributes to the uncertainty.
- The interpretation of size depends upon the growth model, and results are often sensitive to the L_∞ estimates. Basically, the higher the proportion of animals in landings samples that are close to L_∞, the lower the mortality estimate will be. Interpretation of the largest animals in the sample depends upon how much process error is allowed between the mean and observed asymptotic sizes. Reasonable estimates for a CV might be 5-30% (Gurney et al. 2007) but may decrease with age. This was modelled in this case in SS3 with a declining CV at age from 0.100 to 0.043. The approach is perfectly reasonable and consistent with best practice. However, most information on length-at-age relates to finfish not crustaceans. It is worth noting that these values are an assumption and will affect mortality estimates, and more flexibility may be required as other information becomes available.

Are data applied properly within the assessment model?

Data were used properly within the stock assessment model. There were two minor issues identified in the current assessment which could be improved in future.

Effective sample size is calculated as square root of sample size (√N). This probably had the opposite effect of what might have been intended as it weighted the years more equally by reducing the relative differences among sample sizes. How these data are weighted will become more important when there are more data sources and when these are in conflict. Therefore, while this issue has little impact at this stage, it may become more important in future assessments. A simple alternative would be use the number of trips as the effective sample size, or the effective sample size could be estimated more rigorously (Pennington et al. 2002).

There may also be some benefit to changing the year in which data are aggregated to start in the summer (e.g., 1st August) rather than 1st January. The way that the data were combined in this assessment may be smoothing depletion effects over a two-year period.

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

The data series were reliable and sufficient to support the stock assessment and its findings. The stock assessment was data moderate as it was limited to a total catch and length composition time series. The model would be using the length data primarily to inform on the fishing mortality, and the fishing mortality with the total catch to estimate an appropriate biomass. Assuming data were consistent, the model should allow good estimates for average biomass and mortalities over the period it has been applied. Data were only available to 2016, so the assessment did not provide information on status after 2017.

Evaluate the methods used to assess the stock, taking into account the available data.

Are methods scientifically sound and robust?

The methods used were scientifically sound and robust. The stock assessment method was fitting a maximum likelihood age structure model with priors on some parameters using Stock Synthesis ver. 3 (SS3). SS3 is part of the NMFS toolbox, is widely used and has undergone extensive testing. SS3 provides a flexible platform for this type of analysis and is scientifically sound.

Given appropriate growth parameter and natural mortality values, a length frequency and the total catch time series can provide estimates of mortality and biomass. Although many of the parameters have had to be fixed because there was insufficient information in the data, the fixed values were justified. There have been many studies and estimates of spiny lobster growth and mortality, which can be used to propose realistic estimates to be used in this type of assessment.

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

The stock assessment included basic diagnostics consisting of checking parameter correlation, likelihood profiles of key parameters, jitter analysis and retrospective analysis. These diagnostics suggested that the model had been configured properly.

The stock assessment attempted to estimate very few parameters. For STT and STX fisheries, the mean unexploited recruitment (R_0), fishing mortality and three selectivity parameters for each island were estimated. For the PR fishery, the assessment also estimated an initial fishing mortality, and separate selectivity parameters for the two gears and a change in selectivity from 1983-98 to 1999-2016, which included a change in retention (discarding small lobsters), so a total of 16 parameters. The growth, length-weight, steepness and natural mortality parameters were fixed.

Recruitment deviations could not be well estimated. Recruitment was very stable in early years and shows greater variation in more recent years. For PR, recruitment has shown significant change, but this may also be due to the assumed stock-recruitment relationship steepness.

Various small changes were explored such as adjusting the year when selectivity changed and removing possible observations which may have been too influential. The results from these changes suggested that the assessment was robust.

There is a difference in growth between sexes, as well as a difference in the sex ratio in the biological sampling, which was used to help estimate size-dependent selectivity as long as the size-based selectivity was not sex-specific. A likelihood profile on female L_∞ suggested that the growth differences between females and males can be fitted, and that the Cuban growth parameter estimates were very close to the best-fit estimate. This helped the RP choose the Cuban growth parameters as the recommended configuration.

Are the methods appropriate given the available data?

The assessment is essentially data moderate (Tier 3). The only data available for the stock assessment were total catches and length frequencies by gear. The assessment approach was chosen on the basis that selectivity was a major determining factor in the fishing mortality and therefore it was necessary that the method could estimate the dome-shaped selectivity. Simpler approaches based on mean length for example, assume logistic selectivity.

The assessment was required to fix some key parameters, notably growth parameters and natural mortality. The results will be sensitive to these parameters in particular. The parameter choices made were reasonable and consistent with what is known about *P. argus*.

Evaluate the assessment findings

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

The results were informative and can be used for management advice. Broadly, the length data is informative on fishing mortality, and the total catches with fishing mortality can estimate the biomass. Assuming data were consistent, this should provide a reasonable, if imprecise, estimate of stock size and fishing mortality rates.

The status determination was robust to commonly encountered problems in this type of assessment. Often fisheries status is dependent on initial stock status when fishery data series starts. If the initial state needs to be estimated, reference point estimates may be poor. In these cases, the initial status appeared to be robustly estimated, with the total catch time series being relatively complete. In addition, using the spawner-per-recruit reference point did not rely on initial stock size, and so was also more robust.

The perception of the stock status could change if an abundance index was to be included. The available data could not result in conflicting information, but also having an abundance index could. Including an abundance index may require changes to the configuration which could affect the perception on stock status. Therefore, uncertainty may be underestimated in the current assessment.

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

It is not likely that these stocks were overfished in 2016. This was supported by the raw data as well as the stock assessment results with the RP recommended configuration and with the sensitivity analyses, in all cases. Furthermore, in considering 2017 and 2018, which are not covered by the available data, reports from stakeholders at the meeting and other information suggested that fishing effort had fallen since 2016 (due to, among other things, recent hurricanes damaging gear), so it is also less likely that the stock status has declined since 2016. Note however that hurricanes may also affect juvenile survival, so the net effect on the fishery is unknown.

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

It is not likely that any of the three stocks was undergoing overfishing in 2016, and with the reported reduction in effort since 2016, it was unlikely that overfishing occurred in 2018. This can be inferred from the stock assessment results and was consistent with the raw data. The RP recommended configuration and all sensitivity analyses for each stock indicated fishing mortality is below F_{MSY} for all stocks.

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.

Based on the available information for this assessment, the implications of uncertainty in technical conclusions are clearly stated in the stock assessment report, primarily by presenting estimates based across all sensitivity analyses. However, on balance, it is likely that the uncertainty was underestimated for this stock assessment. It should be possible to evaluate uncertainty better in future stock assessments as more data become available.

The most important sources of uncertainty were assessed using sensitivity analyses. These primarily focused on alternative values for important fixed parameters (growth, natural mortality, and initial level of depletion). Assessing parameters in this way tends to overestimate uncertainty because the parameter values at the edge of their range are given equal weight with the most likely value. It may be possible to estimate some of these parameters in future.

Measures of uncertainty in the parameter estimates are based on their assumed normality. This should adequately account for observation error. Although other methods could be used (e.g., MCMC, bootstrap), it is not clear the additional work involved would improve these error estimates significantly.

Process error has not been estimated. Although there was some attempt at estimating recruitment deviates, this was not possible due to the limited data. It is less likely that these fisheries are as recruitment dependent as fisheries targeting shallow water banks (e.g., The Bahamas, Cuba), as they exhibit less dome-shaped selectivity, taking a broader range of sizes and ages. Nevertheless, recruitment may be an important factor in the between-year variability and will be under-estimated in this assessment.

One of the advantages of integrated stock assessments is including a wide range of data from different sources. If signals in these data are consistent, it increases confidence in the result. Conversely, the extent to which the signals conflict increases the uncertainty associated with the result. With data limited/moderate assessments, the lack of different data sources means it prevents the assessment from having conflicting signals. This was true in this case, and it should be borne in mind that as more data become available, the stock assessment could change significantly.

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.

The research recommendations have been consolidated in a RP consensus report appendix, which also includes priority. All those recommendations are valid, but those that would improve the fisheries data collection programs would benefit the stock assessment most, particularly in the longer term.

Although the DW addresses catch and effort data issues, it did not explicitly recommend development of CPUE abundance indices. While there are clearly issues with historical CPUE, recent improvements in the data collection should allow the development of an index, even if it is only available in more recent years (2011-19). Trap-based fisheries effort in particular is often difficult to measure. Because an abundance index provides an independent source of information on how the spiny lobster population is changing over time, it should be very informative.

If fishery independent data are to be collected, the collection program is most likely to be successful if it makes use of the areas closed to fishing so that there is more contrast in the data collected. Fishery independent data usually consist of smaller samples than fishery dependent data but can be collected in a way that maximizes the information obtained. In contrast, general surveys, particularly if not specifically directed at spiny lobster, are unlikely to be useful in this type of stock assessment. Puerulus collectors to monitor recruitment could be useful but would require a commitment over a very long time period.

In any case, all fishery independent data collection will be expensive and risky. For example, if selectivity is primarily dependent on area fished, simply fishing inside and outside an MPA will provide information of limited use for the stock assessment. For this reason, if fishery independent data is to be collected, it will be preferable to conduct pilot studies initially to identify the best approach (e.g., standardized gear trials, tagging) as well as determine the sampling effort required to obtain meaningful results.

If a valid abundance index becomes available, it may conflict with the interpretation of the length frequency data. I suspect that this would lead to lower estimates of L_∞, particularly of males, and subsequent reductions in estimated fishing mortality, but may also require adjustments of the growth CV in the model. It should be borne in mind that low data stock assessments are vulnerable to significant changes in stock status perceptions in either direction because additional data can strongly influence results.

There may be some small benefit to shifting the way data are combined by moving the year from the calendar year to some point in the summer when effort and landing levels are usually low. It is likely that recruitment to the fishery occurs during late summer / autumn, so the data will be less likely to mix cohorts between years. This may be particularly useful for a CPUE index which might be able to track recruitment and possibly detect within-year depletion.

A seasonal pattern, which is observable in the Turks and Caicos (Medley and Ninnes 1997), and more weakly observed in the Bahamas (Medley 2017), may provide necessary contrast in catch rates. After the summer recruitment, the stock size may decline through the autumn and winter due to migration and depletion. This within-season change in abundance index may help provide contrast and help fit selectivity and catchability.

Strictly speaking, the lobster population in the British Virgin Islands will be the same as the St. Thomas population and therefore should be assessed as a single stock. Perhaps the British Virgin Islands fisheries department could be approached to provide at least annual catch data for the next assessment.

The effect of hurricanes may be significant, but hurricanes are unpredictable. In terms of management their potential impact should be included in the uncertainties in projections.

The length-weight estimates were reasonable, but they perhaps could be improved. It may have been better to apply a GLM to all data combined to see how significant the differences were between the sexes and locations rather than splitting sexes into different models. There may have been an opportunity to reduce the number of parameters that needed to be estimated.

SS3 models growth in a standard way based on a von Bertalanffy growth curve and the population model is based on age rather size structure. Due to the need to translate age to size and back again with size-based selectivity, the model smooths the age-size relationship. A model based on size structure using a transition matrix for growth avoids this particular problem and should work better, as long as there are no characteristics dependent on age. It would also be possible to include any tagging data in the model to estimate transition matrix parameters (Yuying and Yao 2018).

A Bayesian model would be able to capture uncertainty better than a maximum likelihood model. This would require the model to be fitted using MCMC. The SS3 implementation of MCMC often does not appear to work well and when it does not work well, there are few options to fix the problems. In my experience, most MCMC convergence issues arise from problems with model structure, and solutions require re-parameterizing the model. This is not really possible in SS3, limiting the opportunities for using MCMC and Bayesian modelling.

It may be possible to improve the model by changing the modelling platform from SS3. Although there may be some advantages with moving away from SS3 to allow implementation of a Bayesian model with transition matrix approach for growth, this would also require significant additional work in developing and testing such a model. I believe that this would be worthwhile, but only if the model could be used for a wide range of fisheries with similar structure (e.g., crustacean fisheries in the US).

Key improvements in data or modeling approaches which should be considered when scheduling the next assessment.

For these fisheries, the focus should be on developing an abundance index. An abundance index would have, by far, the largest impact on the next assessment. This should addressed before scheduling a new stock assessment.

Recommendations on possible ways to improve the SEDAR process.

The SEDAR process is a well developed system to provide the best scientific information for fisheries in the SE USA. SEDAR is already very elaborate, so adding more to the process for these smaller fisheries is probably unnecessary.

One option that might be considered which could work well, particularly in the moderate data case, is to document all data processing and preparation leading into the actual assessment itself and beyond using RMarkdown scripts (https://rmarkdown.rstudio.com/). This would make the entire assessment from raw data to stock assessment reproducible. This would also potentially make it possible to conduct the review remotely since the entire process would be documented as a “literate program” and a reviewer could run it independently, inspecting each step themselves. This could provide greater rigor in the review and also reduce meeting costs.

Prepare a Peer Review Summary summarizing the Panel’s overall conclusions and recommendations.

A consensus panel report was also prepared and has been submitted separately. There was no disagreement among the RP. However, this report may contain some additional material and views not shared by other reviewers.

References

Gurney, W.S.C., Tyldesley, G., Wood, S.N., Bacon, P.J., Heath, M.R., Youngson, A., Ibbotson, A. 2007. Modelling length-at-age variability under irreversible growth. Can. J. Fish. Aquat. Sci.64: 638–653.

Medley, P.A.H. and C.H. Ninnes. 1997. A recruitment index and population model for spiny lobster (Panulirus argus) using catch and effort data. Canadian Journal of Fisheries and Aquatic Sciences 54: 1414-1421.

Medley, PA.H. 2017. The Bahamas Spiny Lobster Stock Assessment 2016/17. Final Report to WWF 3rd November 2017.

Pennington, M., Burmeister, L-M., Hjellvik, V. 2002. Assessing the precision of frequency distributions estimated from trawl-survey samples. Fish. Bull. 100:74–80.

Yuying Zhang, Nan Yao. 2018. Estimating Growth of Caribbean Spiny Lobster Using Mark–Recapture Data. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 10:481–492 DOI: 10.1002/mcf2.10046.

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	
Reference Documents			
SEDAR57-RD01	Line Point-Intercept (LPI) Survey	National Coral Reef Monitoring Program (NCRMP), Coral Reef	

	Protocol for the U.S. Caribbean and Flower Garden Banks National Marine Sanctuary	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 assessment of the Caribbean Spiny Lobster (*Panulirus argus*)	Western Central Atlantic Fishery Commission
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

Appendix 2: 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.

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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.

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