Center for Independent Experts (CIE) independent report of the SEDAR 35 Caribbean red hind assessment desk review

Dr. Massimiliano Cardinale

October 2014

Executive Summary

• This document is the individual CIE Reviewer report of the SEDAR 35 Caribbean red hind assessment conducted during August-September 2014 and provided at the request of the Center for Independent Experts (CIE) (see Attachment A).

• This report solely represents the view of the independent reviewer (Dr. Massimiliano Cardinale).

• The reviewer does not completely agree with all of the findings reported in the SEDAR 35 Caribbean red hind assessment report. Taking into account all available information, the reviewer considers that there is a high probability that Caribbean red hind is subject to overfishing. Findings that are reported in the SEDAR 35 Caribbean red hind assessment report are not necessarily fully repeated in this individual report. This report focuses on clarification of elements contained in the SEDAR 35 Caribbean red hind assessment report (including the Data Workshop Report and the backgrounds documents) and some additional views of the individual reviewer about how available data could have been better explored to derive more robust and alternative estimates of the exploitation rate and stock status of Caribbean red hind.

• The Assessment team addressed all the assigned terms of reference (TORs).

• The reviewer considers that the Assessment team has done a satisfactory job in carrying out the assessment, analysing all available data, modelling uncertainty and providing a full sensitivity analysis of both the data and the models. However, the reviewer considers that data for Caribbean red hind are underutilised and that more could have been done in terms of data analysis in order to derive estimates of exploitation rates and stock status for Caribbean red hind.

• Further recommendations aimed at improving the available data used in the Caribbean red hind assessment were made. These are mainly based on additional re-analysis and modelling of the original data set.

Introduction

SEDAR 35 Caribbean red hind assessment report and associated background documents containing detailed information on the data used in the assessment were provided to the independent reviewer (Dr. Massimiliano Cardinale) well in advance of the deadline scheduled for the 12th of September 2014. The report was reviewed at the request of the Center for Independent Experts (CIE) (see Attachment A).

Description of review activities

This review was undertaken by Dr. Massimiliano Cardinale as desk work during August-September 2014 at the request of the Center for Independent Experts (CIE) (see Attachment A).

Relevant documents (see bibliography, Attachment B) and background information were made available four weeks prior to the deadline through email and via a link to an ftp or SEDAR 35 website (http://www.sefsc.noaa.gov/sedar/Sedar_Documents.jsp?WorkshopNum=35&FolderType=Data). The assessment report was made available four weeks prior the deadline via a link to an ftp or SEDAR 35 website (http://www.sefsc.noaa.gov/sedar/Sedar_Documents.jsp?WorkshopNum=35&FolderType=Assessment). The documentation was reviewed prior to the deadline and the deadline was met. The background information and assessment report of Caribbean red hind was presented through several documents (see Attachment B). Background information relevant to this review is presented in a series of appendices, including: CIE Statement of Work (Attachment A); a bibliography (Attachment B), report format (Annex 1) and Terms of Reference (Annex 2). Comments included here are provided following the terms of reference (TORs) (Annex 2) and are those of the independent reviewer only. The list of main documents provided to the reviewer as background material is included in Attachment B.

Summary of findings

Main recommendations

1. Redefine the effective effort used to estimate CPUE trends in SEDAR35-AW-01 and SEDAR35-DW-04.

2. Redefine the models used to fit the self-reported fisher logbook (SEDAR35-AW-01) and the SEAMAP-C data (SEDAR35-DW-04).

3. Some of the data were underutilised, especially several of the length frequency distributions and some of the CPUE time series presented in SEDAR-RD-05, and should be explored in future assessments.

4. Conduct a statistical age estimation analysis of the total number of Caribbean red hind caught by length class to estimate the number of fish landed per age class for selected combination of areas, gears and years with a sufficient amount of length measurements (i.e. a general rule of thumb would be to use years with more than 150 or 200 individuals measured).

5. Explore different methodologies to derive yearly estimates of total mortality and F_{MSY} from the number of fish landed per length class in order to verify and confront the results obtained by the mean length analysis. A virtual population analysis (VPA) (e.g. VIT software) assuming a steady state (i.e. pseudo-cohort analysis) and combining the different gears could have been used for selected combination of years, areas and gears.

6. Conduct an YPR analysis that takes into account the effect of selectivity at size/age to estimate proxies of F_{MSY}.

7. Use time series of properly standardised CPUE data reported in SEDAR35-RD-05 as quantitative supplementary information of the mean length analysis.

8. The reviewer considers that the probabilities of current F being larger than the F_{MSY} proxy estimated for Puerto Rico, Saint Thomas and Saint John and Saint Croix (i.e. up to 40, 57 and 66%, respectively) are large enough to conclude that the stock of Caribbean red hind is undergoing overfishing in these areas.

9. Given that contrasting information was available for the trend in CPUE of Caribbean red hind, and that the assessment does not provide an estimate of the absolute biomass of the stock, the reviewer is unable to determine with certainty whether the stock of Caribbean red hind is currently overfished. However, the reviewer is of the opinion that more emphasis should be given to the SEAMAP-C time series and that, according to this data source, the stock of Caribbean red hind might be actually overfished.

10. A virtual population analysis (VPA), assuming a steady state (i.e. pseudo-cohort analysis) and combining different gears, should be used for selected combination of years, areas and gears in future assessments of Caribbean red hind.

11. More care should be devoted to the presentation of the results. The presentation of the available data and part of the assessment section is not clear and somewhat incomplete. There are several mistakes, especially in tables and figures, which complicate the evaluation of the assessment report (see details in answer under ToR 1).

ToRs

ToR1: Evaluate the data used in the assessment, addressing the following:

a) Are data decisions made by the Assessment Workshop 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?

General comments

I consider the data used within the chosen assessment model (i.e. mean length analysis) as appropriate and uncertainty properly acknowledged and integrated. However, I found the presentation of the available data rather confusing and somewhat incomplete. Also, it is sometimes difficult to understand the link between the different times series presented. In particular, the TIP (Trip Interview Sampling) was used to estimate trends in average length of Caribbean red hind between 1983 and 2012 (in some cases up to 2011, depending on the gear and area), but it is not clear which is the relationship between the TIP and the SEAMAP-C program, which also sampled commercial red hind catches in the same area and during the same period.

Some of the models used to estimate trends in CPUE of the self-reported fisher logbooks data and the SEAMAP-C fisheries independent data could have been specified differently. Further, modelling results of the CPUE data contained in SEDAR35-DW-01 and SEDAR35-DW-04 should have been presented more thoroughly and in further detail.

Some of the available data were underutilised, especially the length frequency distribution and several of the CPUE time series presented in SEDAR RD-05.

Specific comments

Commercial landings data

Landings of Caribbean red hind from Puerto Rico have been adjusted for incomplete reporting using so called expansion factors to estimate the total actual landings. It is however unclear, both from the assessment report and from the background documents, how the expansion factors have been estimated, what is the source of the factors, how large are the factors and if they vary between years and for the different areas and gears. As a minimum, the yearly expansion factor used to estimate the total landings should have been presented in a table of the report.

Fisheries-dependent and fisheries-independent data

SEDAR35 Section II (Data Workshop Report; page 75) states that preliminary analysis of SEAMAP-C fishery independent data indicates a "sparseness of complete catch and effort data for red hind in the USVI area sparseness in the continuity of the time series of the trap data, and a higher variability in the weight data. Therefore, hand-line catch-per-unit-effort (CPUE) data in numbers of rind hind collected off the southwest coast of Puerto Rico was used to develop abundance indices of the red hind population." I can agree with the choice to not use data from USVI for the reasons stated in the document (i.e. SEDAR35-DW-04), but

the Assessment team should add one or two figures or tables to substantiate this choice or at least should refer to a document where USVI data are reported. I initially assumed that the underlying data presented in SEDAR35-DW-04 were those reported in SEDAR-RD-05 but after a more careful analysis of both documents, I cannot see a direct correspondence between the data contained in SEDAR-RD-05 and SEDAR35-DW-04. It is indeed unclear what is the relationship between these two different data sets that otherwise seem to be apparently collected in the same area, during approximately the same time and by the same project (SEAMAP-C). Indeed the presentation of the available data is somewhat confusing. I had difficulties to understand the difference between the SEAMAP-C fisheries-dependent data presented in SEDAR-RD-05 and the standardized catch rates presented in SEDAR-AW-01. Moreover, there are complete data series reported in SEDAR RD-05 (e.g. figure 17, page 46), which are not mentioned in the assessment report and were apparently not used.

The standardized catch rates presented in SEDAR AW-01 are defined as self-reported, while time series of CPUE presented in SEDAR-RD-05 are derived from a direct sampling of the commercial catches during SEAMAP-C. This will reinforce the idea that time series reported in SEDAR-RD-05 are a valuable source of information and should be used. Again, the presentation of the available data is somewhat confusing and the choice of some of the data used for the assessment of Caribbean red hind is debatable. The Assessment team gives more relevance to the self-reported catch and effort data time series, while I would be in favour of the SEAMAP-C data due to the uncertainty (e.g. misreporting, discards, imprecision when data are collected by self-sampling) generally associated with self-reported catch data from the fisheries. Interestingly, the Assessment team also defines the self-reported catch and effort data "…of unknown accuracy" but then rely on them for the trend in stock abundance and for inferring on the status of Caribbean red hind. Also, I cannot categorically exclude that I have partially mixed up the time series but the way the data are presented certainly does not help the reader to understand the difference between them.

The effort of the self-reported fisher logbooks is described in total number of hours fished (SEDAR35-AW-01). While number of hours fished might be in theory a good proxy of the effective effort for spearfishing (i.e. although targeting is an issue with spearfishing CPUE data, see also answer under ToR 3), I doubt it reflects the effective effort for the hooks and line fishing and more so for the trap fisheries. From the report, it seems that the number of gears (i.e. traps and hooks) used is available, and thus a more correct way to define the effective effort would be to use the number of hours fished times the number of traps for the fish pots and trap fisheries and the number of hours fished times the number of hooks for the hook and line fisheries.

I do not understand the reason why interaction effects were added as random factor in the model presented in SEDAR35-AW-01. An explanatory line would be beneficial here. It would also be relevant to add the first model for which the reduction in deviance per degrees of freedom is less than 1% in Table 4. More residuals plots should have been presented, as for example the distribution and the autocorrelation of the residuals. Also, the kind of distribution used for the delta models in SEDAR35-DW-04 should be reported, the y-axis in figure 2 of SEDAR35-DW-04 should indicate the unit of measure of the CPUE, and the unit of measure of CPUE should also have been indicated in table 7, 8 and 9 of SEDAR35-AW-01.

In general, the presentation of the results reported in SEDAR35-DW-04 needs to be improved. The distribution of the modelled CPUE and the proportion of positive trips are missing. As for SEDAR35-AW-01, more residuals plots should have been presented as for example the distribution and the autocorrelation of the residuals. As the Assessment team used a backward stepwise approach based on AIC, at least the first model for which the AIC does not decrease should be shown in the table.

Recreational data for Caribbean red hind are also presented but they are too sparse for allowing any kind of analysis. In this context, the reviewer agrees with the evaluation made by the Assessment team.

Data and assessment presentation

I found the presentation of the different data sources and part of the assessment section somewhat incomplete. Here I report a series of issues with the data presentation, which complicated the evaluation of the assessment of Caribbean red hind. A misperception in the data presentation arises when comparing figures of the mean length and model fit presented in Section III (Assessment Workshop Report) with tables reported in Section II (Data workshop report). For example (but this applies also to other combination of gears and areas), I expected that the number of lengths (which I interpret as number of individuals) in Table 5.3.2 of the Section II (Data workshop report) should match the numbers associated with the bubbles in Figure 35 of Section III (Assessment Workshop Report). This is obviously not the case, which makes the evaluation of the effect of the sample size on the analysis problematic.

In figure 5.4.2 of Section II (Data workshop report), it appears that Caribbean red hind specific effort data are available from 2011 while the text states that species-specific landings reporting obligation started in 2012 (Figure 5.4.1).

In Section III (Assessment Workshop Report), table 8 is somewhat confusing as it reports a range of values of k between 0.48 and 0.72, while Table 2.8.2 in Section II and sensitivity analysis figures in the Assessment Workshop report indicate a range of values used for the sensitivity analysis roughly between 0.05 and 0.30.

The text for the diving fleet analysis in Section III (Assessment Workshop Report), reports a total mortality for L_c equal to 370 mm ranging between 0.68 and 1, while the values in Figure 22 are between 0.30 and 0.50.

The lines of the 95% CI in the legend of figure 4, 5 and 6 in SEDAR35-AW-01 are wrong as they should be dashed lines and not thick lines.
The caption in Table 1 in SEDAR35-DW-04 is not correct as it reports data for red snapper collected by long lines in the Gulf of Mexico (or at least it indicates so).

Modelling issues

Depth in SEDAR35-AW-04 model should have been treated as a continuous variable and not as a factor. It is not clear if this was actually the case in the fitted model. Moreover, CPUEs reflect several aggregated cohorts, with the same cohorts contained in successive years. Thus, a smoother would be more suitable here to model the year effect for both models (SEDAR35-AW-01 and SEDAR35-DW-04), although I recognise that missing years in the time series of the SEAMAP-C data (SEDAR35-DW-04) might represent an issue. Finally, the interaction factor between the main effects should have been tested also in the SEDAR35-DW-04 model as done for the SEDAR35-AW-01 model.

The analysis presented in figures 9 and 10 of Section III (Assessment Workshop Report), should be improved and made easier to present if a modelling approach, including other factors than simply a year effect, was used to estimate the changes in depth over time in the SEAMAP-C program.

Recommendations:

- Redefine the effective effort used to estimate CPUE trends in SEDAR35-AW-01 and SEDAR35-DW-04.
- Redefine the models used to fit the self-reported fisher logbook (SEDAR35-AW-01) and the SEAMAP-C data (SEDAR35-DW-04).
- Some of the data were underutilised, especially several of the length frequency distributions and some of the CPUE time series presented in SEDAR-RD-05, and should be explored in future assessments.

ToR2: 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?

The methodology (i.e. Gedamke and Hoenig 2006 method also defined as "mean length analysis") used to estimate Z has been applied correctly and I consider it as a robust and appropriate alternative for deriving estimates of exploitation rate given the available data. However, biological sampling showed in general that length frequency distributions of Caribbean red hind were characterized by the presence of several modes. Clearly, the length frequency distributions contain information on the age structure of the population, which are in part underutilized when using the Gedamke and Hoenig 2006 method. Moreover, given the numerous changes in the management of the species during the analysed period (e.g., introduction of closed areas to protect the spawning aggregation in 1996 off the west coast of Puerto Rico) and in the fisheries, differences in catchability between sexes, the influence of the market on the size of Caribbean red hind targeted by the fisheries and many others, the observed changes in average size of the catches might not be simply an effect of changes in total mortality but could be an artefact of changes in fishing practices and fishing selectivity linked to modifications in management regulations. In this case, other approaches should have been used in conjunction with the Gedamke and Hoenig (2006) method to derive alternative estimates of exploitation rate for Caribbean red hind and allow for comparison.

For several combinations of areas, gear and years, the data are sufficient to estimate the yearly total number of fish caught by length class for the different areas and gears. A method defined as statistical age estimation (beside the more simple knife-edge slicing method, which can be also used here) has recently been developed (see Kell and Kell, 2011; Scott et al., 2011) to generate age structured data from length frequency distribution (LFD) data and VBF growth curve parameters to be used in stock assessment (e.g., ICES 2014). The method is very flexible and offers a sophisticated framework for converting numbers at length to numbers at age as well as estimating the mean length at age of the different cohorts by assuming different distributions of the length data (i.e. Gaussian, gamma and lognormal).

Age data derived by the slicing methods (i.e. knife-edge slicing and statistical slicing) can be used to derive estimates of total mortality using VIT software (Lleonart & Salat, 2000), which can also be used when a single year of LFD and growth parameters are available. The method is extensively used in similar data situation as for several Mediterranean stocks (e.g. STECF 2012) and stocks in the North East Atlantic (e.g. ICES 2014). VIT conducts a virtual population analysis (VPA) assuming a steady state (also known as pseudo-cohort analysis). This is a rather strong assumption for species, like small pelagics, with highly fluctuating abundance due to both variable recruitment and relatively low number of age classes, but it is a much more supported assumption for demersal fish such as Caribbean red hind for which

the population is made up by several age classes. As it requires knowledge of the catches over one year only (Lleonart & Salat, 2000) it might be used for years, areas and species for which the data allows for such an analysis. In addition to the above mentioned data, VIT requires a set of biological information such as growth parameters, length-weight relationship, natural mortalities and percentage mature by size or age, and proportions caught by each fishing gear (when available but not strictly necessary). Such information is available for Caribbean red hind and is reported in SEDAR35 documents.

The use of a pseudo-cohort analysis would allow obtaining an alternative and possibly more robust estimate of Z (and F assuming that M is known) from the same data and also to compare Z estimated with VIT against those derived using Gedamke and Hoenig (2006) method. Another feature of the VIT is that it allows for the combination of different gears within the same model, which would also allow estimating partial F for the different gears, an important piece of information from a management perspective. Therefore, I consider that VIT estimates of F would be crucial to better evaluate the results obtained from the Gedamke and Hoenig (2006) method.

I also consider that the mean length analysis does not explicitly account for selectivity, which has a large impact on estimates of F and F_{MSY}. The use of VIT would also allow for conducting a yield per recruit (YPR) analysis and derive estimates of F_{MSY} (using $F_{30\%}$ and $F_{40\%}$ as a proxy), taking into account selectivity at size/age. A YPR analysis based on selected yearly catch at age data from collected length frequency distributions would be a valuable piece of information to verify estimates of F and F_{MSY} obtained from the mean length analysis. It can be argued that for several years, sample size of Caribbean red hind is too low to conduct such kind of analysis. However, this also applies to the estimation of the average length used in the Gedamke and Hoenig (2006) method and constitutes a further argument for combining different approaches to estimate Z. It would also allow for a more thorough utilisation of the available data, especially for those years for which a large number of individual length data are available.

In general, I consider that the reader is left with the doubt that much more could have been done with the same kind of data and that the Assessment team should have at least explored the possibility of using different methodologies to derive alternative estimates of exploitation rates and F_{MSY} than those obtained using the Gedamke and Hoenig (2006) method. The same concerns were expressed by the reviewer in a previous evaluation (February 2013) of two other commercial species caught in the same area (i.e. Caribbean queen triggerfish and Caribbean blue tang) but apparently they were not considered by the Assessment team for the Caribbean red hind stock.

Recommendations:

- Conduct a statistical age estimation analysis (e.g. knife-edge slicing and/or statistical slicing sensu Scott et al., 2011) of the total number of Caribbean red hind caught by length class to estimate the number of fish landed per age class for selected combination of areas, gear and years with sufficient amounts of length measurements (a general rule of thumb would be to use years with more than 150 or 200 individuals measured).

- Explore different methodologies to derive estimates of total mortality from the estimated number of fish landed per age class in order to verify and confront the results obtained by the mean length analysis. A virtual population analysis (VPA) (e.g.

VIT software) assuming a steady state and combining the different gears should have been used for selected combination of years, areas and gears.

- Conduct an YPR analysis to estimate proxies of F_{MSY} that takes into account the effect of selectivity at age.

- Use time series of appropriately standardised CPUE data reported in SEDAR35-RD-05 as quantitative supplementary information for the mean length analysis.

ToR3: Evaluate the assessment findings with respect to the following:

a) Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support status inferences?
b) Is the stock overfished? What information helps you reach this conclusion?
c) Is the stock undergoing overfishing? What information helps you reach this conclusion?

I consider that estimates of exploitation rates of Caribbean red hind are consistent with the input data and assessment model (i.e. Gedamke and Hoenig 2006 method) used by the Assessment team but that the Assessment team should have explored also different methodologies to derive estimates of total mortality and proxies of F_{MSY} (see details in the answer given for ToR2). I also consider that, due to the effect of the numerous changes that occurred in the fisheries and in the management of the species during the analysed period (see answer in Tor1 for details), observed changes in average length of the catches might be in part an artefact of changes in fishing practices linked to modifications in management regulations more than a direct effect of fishing mortality. In this case, a different methodology to estimate trends in F would be necessary. Moreover, the use of CPUE estimated from self-reported fisheries-dependent data in the case of a changing fishery is contradictory and, in this specific situation, the reviewer considers that more emphasis should have been given to the SEAMAP-C data.

The reviewer also considers that a probability up to 40% of Caribbean red hind in Puerto Rico being currently overfished cannot be considered low (i.e. as stated in the Section III Assessment Workshop Report). Also, the reviewer considers that estimated probabilities for Saint Thomas and Saint John and Saint Croix (i.e. up to 57 and 66%, respectively) are large enough to conclude that the stock of Caribbean red hind is undergoing overfishing in these areas.

The shift from traps and pots and vertical lines to spearfishing is alarming, as this kind of fishery has generally a much higher efficiency than the traps and pots and/or the hook and vertical lines fisheries for species as Caribbean red hind. Most importantly, spearfishing has an inherently technological creep linked to targeting, which implies that CPUE might suffer from the hyper-aggregation phenomenon. Contrasting information was available for the trend in CPUE of Caribbean red hind. SEDAR35-DW-04 reported a large decline in CPUE, based on the SEAMAP-C data, while self-reported fisher logbook data presented in SEDAR-AW-01 shows a rather stable trend with a tendency to increase in the last years of the time series. On the other hand, several time series reported in SEDAR35-RD-05 (i.e. figures 5, 6, 7, 8, 16, 17 and 21) show a large decline in CPUE. The Assessment team gave more relevance to the self-reported catch and effort data time series (i.e. SEDAR-AW-01), while I would be in favour of the SEAMAP-C data due to the uncertainty (e.g. misreporting, discards, etc.) generally

associated with self-reported catch data from fisheries. As hypothesized by Marshak in SEDAR35-RD-05, an increase in the mean length of the population could also be the results of failure in recruitment. The mean length analysis alone is unable to distinguish this scenario from a more optimistic situation where the mean size increases as fishing mortality declines. Therefore, given the considerations presented above, a different methodology should have bene applied to the data to verify and confront the results obtained by the mean length analysis.

Recommendations

- The reviewer considers that estimated probabilities of current F being larger than proxy of F_{MSY} for Puerto Rico, Saint Thomas and Saint John and Saint Croix (i.e. up to 40, 57 and 66%, respectively) are large enough to conclude that the stock of Caribbean red hind is undergoing overfishing in these areas.
- Given that contrasting information was available for the trend in CPUE of Caribbean red hind, and that the assessment does not provide an estimate of the absolute biomass of the stock, the reviewer is unable to determine with certainty whether the stock of Caribbean red hind is currently overfished. However, the reviewer is of the opinion that more emphasis should have been given to the SEAMAP-C time series and that, according to this data, the stock of red hind might be actually overfished.

ToR 4: Evaluate the stock projections, addressing the following:
a) Are the methods consistent with accepted practices and available data?
b) Are the methods appropriate for the assessment model and outputs?
c) Are the results informative and robust, and useful to support inferences of probable future conditions?
d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?

Tor4 deals with the stock projections, which were not carried out by the assessment team due to data restrictions.

Recommendations

None

ToR 5: Consider how uncertainties in the assessment, and their potential consequences, are addressed.
a) 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
b) Ensure that the implications of uncertainty in technical conclusions are clearly stated

As the Assessment team correctly pointed out, the keys parameters for the method currently used to assess Caribbean red hind are the von Bertalanffy growth curve parameters and the L_c, which are used to estimate M and F (and proxies of F_{MSY}). The reviewer agrees with the evaluation made by the Assessment team and the treatment of the uncertainty in the key

parameters of the mean length analysis. Also, the probabilistic way of analysing the occurrence of overfishing is adequate and generally nicely presented.

A minor issue was found in Section III (Assessment Workshop Report). It is unclear from the current text how the L_c values used in the sensitivity analysis and in the evaluation of the uncertainty were selected by visual inspection. I consider that it would have been more appropriate to conduct a sensitivity analysis on the effect of the L_c values based on the CI of the average length mode estimated for each gear and reported in Figure 14, 15 and 16.

Recommendations

None

ToR 6: Consider the research recommendations provided by the Assessment workshop 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.

• Provide recommendations on possible ways to improve the SEDAR process.

The Assessment team provides an exhaustive list for future data to be collected, which would notably improve the capability of assessing the status of the Caribbean red hind stock. However, I consider that the description of the additional research and future monitoring is not exhaustively presented and it could have been much more detailed and comprehensive.

The reviewer agrees with the Assessment team that priority should be to given to derive data which allows movement towards more traditional assessment approaches. However, the reviewer also considers that this could in part already be pursued by the Assessment team using other methods than the mean length analysis (see ToR 2 and ToR 3).

Recommendations

- A virtual population analysis (VPA), assuming a steady state and combining different gears, should be used for selected combination of years, areas and gears in a future assessment of Caribbean red hind.

ToR 7: Provide guidance on key improvements in data or modelling approaches which should be considered when scheduling the next assessment.

See comments under ToR 2 and 3.

Recommendations

- See recommendations under ToR 2 and 3.

Others

More care should have been devoted to the presentation of the results. The presentation of the available data and part of the assessment section is rather confusing and often incomplete. There are several mistakes, especially in tables and figures, which complicate the evaluation of the assessment report (see details in answer under ToR 1).

Conclusions

The Assessment team should be commended for their effort, timing and correctness in the use of the assessment methodologies. However, I consider that some of the available data are underutilised and that the report suffers sometime from the inaccuracy in the way the data, the methods and the results are presented. Also, the lack of alternative estimates of Z beside these coming from the Gedamke and Hoenig (2006) method makes it difficult to fully evaluate the results. A series of recommendations on how the data utilisation could be improved and how alternative estimates of the exploitation rates could have been produced have been given under the specific ToRs. Nevertheless, the reviewer considers that, given the available information, the Caribbean red hind stock in Puerto Rico, Saint Thomas and Saint John and Saint Croix should be considered as subject to overfishing. Instead, given that contrasting information was available for the trend in CPUE of Caribbean red hind, and that the assessment does not provide an estimate of the absolute biomass of the stock, the reviewer is unable to determine with certainty whether the stock of Caribbean red hind is currently overfished. However, the reviewer is of the opinion that more emphasis should have been given to the SEAMAP-C time series and that, according to these data, the stock of Caribbean red hind might be overfished. Finally, the reviewer considers that a virtual population analysis (VPA), assuming a steady state (i.e. pseudo-cohort analysis) and combining different gears, should be used for selected combination of years, areas and gears in a future assessment of the Caribbean red hind stock in Puerto Rico, Saint Thomas and Saint John and Saint Croix.

Basic data and model framework were presented through documents and circulated well in advance of the review. The presence of a *Glossary* and an *Acronyms* list at the end of the document greatly facilitated the reading of the report and was greatly appreciated by the reviewer.

Reference list

ICES. 2014. Report of the Benchmark Workshop on Baltic Flatfish Stocks (WKBALFLAT), 27–31 January 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:39. 320 pp.

Kell L.T., and Kell A., 2011. A comparison of age slicing and statistical age estimation for Mediterranean swordfish (*Xiphias gladious*). Collect. Vol. Sci. Pap. ICCAT, 66(4): 1522-1534, 2011.

Lleonart, J. and Salat, J., 2000. VIT (version 1. 1): Software for fishery analysis. User's manual. On line: http//www.faocopemed.org/es/activ/infodif/vit.htm.

Scientific, Technical and Economic Committee for Fisheries (STECF) – Assessment of Mediterranean Sea stocks – part 1 (STECF 12-19). (eds. Cardinale M. (Chairman) Osio C. & Charef A.). 2012. Publications Office of the European Union, Luxembourg, EUR 25602 EN, JRC 76735, 502 pp.

Scott F, Osio G, Cardinale M 2011. Comparison of age slicing methods - Working Document in support to the STECF Expert Working Group 11-12 Assessment of Mediterranean Sea stocks - part II. EUR 25054 EN. Luxembourg.

Appendix A: List of main documents provided as background material

SEDAR 35
Caribbean Red Hind
Workshop Document List

Document #	Title	Authors	Date Submitted
Documents Prepared for the Data Workshop			
SEDAR35-DW-01	Monitoring of Commercially Exploited Fisheries Resources in Puerto Rico	Aida Rosario Jimenez	20 Sept 2013
SEDAR35-DW-02	Reef Fish Monitoring	Aida Rosario Jiménez, Verónica Seda Matos, and Noemí Peña-Alvarado	20 Sept 2013
SEDAR35-DW-03	Red hind data from Puerto Rico	Michelle Scharer, Michael Nemeth and Daniel Matos	3 March 2014
SEDAR35-DW-04	Abundance Indices of Red Hind Collected in Caribbean SEAMAP Surveys from Southwest Puerto Rico	G. Walter Ingram, Jr.	13 May 2014
Documents Prepared for the Assessment Process			
SEDAR35-AW-01	Standardized Catch Rates for Red Hind from the Commercial Diving, Trap, and Vertical Line Fisheries in Puerto Rico	Adyan Rios	8 August 2014
Final Stock Assessment Reports			
SEDAR35-SAR1	Caribbean Red Hind		
Reference Documents			
SEDAR35-RD01	A Cooperative Multiagency Reef Fish Monitoring Protocol for the U.S. Virgin Islands Coral Reef Ecosystem, v. 1.00	David R. Bryan, Andrea J. Atkinson, Jerald S. Ault, Marilyn E. Brandt, James A. Bohnsack, Michael W. Feeley, Matt E. Patterson, Ben I. Ruttenberg, Steven G. Smith, Brian D. Witcher	
SEDAR35-RD02	Fishery independent survey of commercially exploited fish and shellfish populations from mesophotic reefs within the Puerto Rican EEZ	Jorge R. García-Sais, Jorge Sabater-Clavell, Rene Esteves, Milton Carlo	
SEDAR35-RD03	Portrait of the commercial fishery of	Daniel Matos-Caraballo	

	red hind, *Epinephelus guttatus*, in Puerto Rico during 1992-1999	
SEDAR35-RD04	Portrait of the commercial fishery of red hind, *Epinephelus guttatus*, in Puerto Rico during 1988-2001	Daniel Matos-Caraballo, Milagros Cartagena-Haddock, and Noemi Pena-Alvarado
SEDAR35-RD05	Evaluation of seasonal closures of red hind, *Epinephelus guttatus* (Pisces: Serranidae), spawning aggregations to fishing off the west coast of Puerto Rico, using fishery-dependent and independent time series data	Anthony Robert Marshak
SEDAR35-RD06	Description of larval development of the red hind *Epinephelus guttatus*, and the spatio-temporal distributions of ichthyoplankton during a red hind spawning aggregations off La Parguera, Puerto Rico	Edgardo Ojeda Serrano
SEDAR35-RD07	Brief Summary of SEAMAP Data Collected in the Caribbean Sea from 1975 to 2002	G. Walter Ingram, Jr.
SEDAR35-RD08	Population characteristics of a recovering US Virgin Islands red hind spawning aggregation following protection	Richard S. Nemeth
SEDAR35-RD09	Spatial and temporal patterns of movement and migration at spawning aggregations of red hind, *Epinephelus guttatus*, in the U.S. Virgin Islands	Richard S. Nemeth, Jeremiah Blondeau, Steve Herzlieb, and Elizabeth Kadison

Appendix B: Statement of Work for Dr. Massimiliano Cardinale

External Independent Peer Review by the Center for Independent Experts

SEDAR 35 Caribbean red hind assessment review

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

Project Description: SEDAR 35 will be a compilation of data, benchmark assessments of the stocks, and an assessment review conducted for Caribbean red hind. The review is responsible for ensuring that the best possible assessment is provided through the SEDAR process and will provide guidance to the SEFSC to aid in their review and determination of best available science, and when determining if the assessment is useful for management. The stocks assessed through SEDAR 35 are within the jurisdiction of the Caribbean Fishery Management Council and the territorial waters of Puerto Rico and the U.S. Virgin Islands. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall have working knowledge and recent experience in the application of The CIE reviewers shall have expertise in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the tasks of the scientific peer-review described herein. Experience with data-limited assessment methods is desirable. Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review as a desk review, therefore no travel is required.

Statement of Tasks: Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COTR, who forwards this information to the NMFS Project

Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, and other pertinent information. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

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

Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs cannot be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

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

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Conduct an independent peer review in accordance with the ToRs (**Annex 2**).
3) No later than September 12, 2014, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Dr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and Dr. David Sampson, CIE Regional Coordinator, via email to david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

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

4 August 2014	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
18 August 2014	NMFS Project Contact sends the CIE Reviewers the report and background documents
25 August through 12 September 2014	Each reviewer conducts an independent peer review as a desk review
12 September 2014	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
26 September 2014	CIE submits the CIE independent peer review reports to the COTR
30 September 2014	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on changes. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

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

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on changes. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

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

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Key Personnel:

NMFS Project Contact:

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

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

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs. The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed. The CIE independent report shall be an independent peer review of each ToRs.

3. The reviewer report shall include the following appendices:

   Appendix 1: List of main documents provided as background material for review
   Appendix 2: A copy of the CIE Statement of Work

Annex 2: Terms of Reference for the Peer Review

SEDAR 35 Caribbean red hind assessment review

1. Evaluate the data used in the assessment, addressing the following:
   a) Are data decisions made by the Assessment Workshop 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 for the available data?
3. Evaluate the assessment findings with respect to the following:
   a) Are abundance, exploitation, and biomass estimates reliable, consistent with input data and population biological characteristics, and useful to support status inferences?
   b) Is the stock overfished? What information helps you reach this conclusion?
   c) Is the stock undergoing overfishing? What information helps you reach this conclusion?
   d) Is there an informative stock recruitment relationship? Is the stock recruitment curve reliable and useful for evaluation of productivity and future stock conditions?
   e) Are the quantitative estimates of the status determination criteria for this stock reliable? If not, are there other indicators that may be used to inform managers about stock trends and conditions?
4. Evaluate the stock projections, addressing the following:
   a) Are the methods consistent with accepted practices and available data?
   b) Are the methods appropriate for the assessment model and outputs?
   c) Are the results informative and robust, and useful to support inferences of probable future conditions?
   d) Are key uncertainties acknowledged, discussed, and reflected in the projection results?
5. Consider how uncertainties in the assessment, and their potential consequences, are addressed.
   - Comment on the degree to which methods used to evaluate uncertainty reflect and capture the significant sources of uncertainty in the population, data sources, and assessment methods

- Ensure that the implications of uncertainty in technical conclusions are clearly stated.

6. Consider the research recommendations provided by the Assessment workshop 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.
   - Provide recommendations on possible ways to improve the SEDAR process.
7. Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.