Center for Independent Experts
Consultant Report on:

SEDAR Procedural Workshop
Caribbean Data Evaluation I
January 26 - January 29, 2009

Paul A. Medley
Sunny View
Jack Hole
Alne, YO61 1RT
UK
paul.medley@virgin.net

Contents

1 Executive Summary

- For managing data-poor fisheries, SEDAR should develop measurable performance indicators meeting the Annual Catch Limits (ACL) requirements under the Magnuson Stevens Act based on length composition and/or catch and effort. Ideally both standardised catch-per-unit-effort (CPUE) and mean length should be used for the species of interest. Estimated catches can be reserved as a measure of performance of the accountability measures. (Section 5.1)
- Analytical methods should primarily link the measured performance indicator to reference points (benchmarks) that are consistent with ACL requirements. Indicators and reference points cannot be based directly on data provided voluntarily by fishermen, but should be collected independently. Measured variables, such as mean length, should be treated as random variables, and therefore reference points can take into account risk. (Section 5.3)
- The focus should be on the collection of accurate fishery dependent data. However, there needs to be a more detailed review of the data collection programs. This should include commercial and recreational catch, biostatistical sampling and fishery independent surveys for Puerto Rico and US Virgin Islands, with the purpose of identifying what relevant information could be obtained and modifying sampling procedures accordingly. (Section 5.2)
- A sampling programme should be designed for each performance indicator chosen for the fisheries management plan. For simple data on which direct decisions are made, independent data are required. For example, raising catches should be based on a sampling design and raising factors should depend upon the sampling frame. Good estimates of catches, in particular, are necessary for almost all reliable stock assessment methods. (Sections 4.3 and 5.3)
- It will be necessary to rely on fishermen to obtain much of the data necessary for management. For this to be reliable, the fishing community will need to be engaged and fishermen will need to understand not only how the data are to be provided, but how the data will be used. It is likely that reliable data will only be provided by a proportion of, often better educated, fishermen and that this proportion will decline with the complexity of the information required. (Sections 4.2, 4.3, 4.4 and 5.2)
- Various additional data collection options have been suggested in this report, including using GPS data loggers within the trip interview programme and fishing experiments to provide short term data to support the long term monitoring. (Sections 4.1 and 4.2)
- Uncertainty needs to be handled explicitly ideally through a Bayesian approach. In data poor situations, risk is the dominant factor that might be more easily hidden using simple techniques. Bayesian assessment, particularly using simple population models, are very flexible and allow use of information from sources usually excluded from methods fitting models limited to likelihood only. (Section 5.3)

- If a Bayesian approach is adopted, standard acceptable methods will be required to generate priors for the main parameters. These could include, but not be limited to: relating the intrinsic rate of increase (r) to natural mortality (M) and vice versa, life-history models for the intrinsic rate of increase (r), and area based estimates for unexploited stock size (B_∞) based on unexploited density for different habitats. (Section 4.3 and 5.3)
- It would be valuable for SEDAR to establish a process for defining acceptable "Best Practice" for non-standard approaches. Establishing best practice when a method is equivocal should specifically challenge independent reviewers to provide demonstrably better approaches rather than simply reject them in favour of standards which cannot be reached for practical reasons. (Section 5.3)
- Any analytical methods will need to produce good diagnostics to show that the assumptions, which the assessment is sensitive to, have been met. Sensitive assumptions can be identified using management strategy evaluations covering the likely range of possible operational parameters and models. (Section 4.3 and 5.3)

2 Background

This review is primarily focused on recommendations on how the requirements of the Magnuson Stevens Act National Standards might be met under the constraints which apply in the US Caribbean. Following a series of SEDAR stock assessment reviews which resulted in no final determination of stock status, it was decided to undertake a review of the data and possible methods which might be used to provide scientific advice to management. The review would also be used to decide upon the stocks or stock complexes on which to focus efforts to develop Annual Catch Limits (ACLs), meeting the higher requirements of the Magnuson Stevens Act National Standards.

The Magnuson Stevens Fishery Conservation and Management Act guidelines imply that fisheries must set controls on the basis of total catch. The problem faced by the US Caribbean is that data are more limited than many other fisheries in the US, and data collection problems are significant. The size of the fisheries is small and landed over a wide region making monitoring catches difficult and directly enforcing catch limits is likely to be prohibitively expensive. While the Act allows for alternative approaches, these will need to be justified and all advice must be based on the best available science.

The workshop discussed the available data and methods regarding use in assessing U.S. Caribbean fish stocks, previous recommendations made by SEDAR Panels, definition of stock complexes and, given the results of the review, guidance on which stocks or stock complexes might be most likely to develop good ACLs.

The workshop did not carry out a detailed review of specific methods, the weaknesses of which the scientists are well aware. Specific approaches were only sketched out, as were the available data. This review, based on the current system, makes some recommendations for developing methods and data collection, and provides guidance on prioritizing activities.

3 Description of Review Proceedings

3.1 ToR 5: Brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations. The CIE reviewer shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

The workshop took place from Monday, 26 January 2009 to Thursday, 29 January 2009 in Hotel El Convento, Old San Juan. During this period there were a number of formal presentations, and discussions on future development of stock assessment in the US Caribbean with particular reference to developing ACLs.

The style of the review was entirely appropriate for the objectives outlined in its terms of reference. This SEDAR workshop did not follow a standard review process as might be done, for example, when reviewing a stock assessment. There was no review panel at this workshop.

Overviews of data and possible methods for the analysis were presented. Each presentation led to a short discussion of the data and/or methods. The formal presentations were:

- A summary of ABC Overview and Assessment Framework, including the National SSC meeting in Hawaii, 2008
- Description of the fisheries in Puerto Rico and US Virgin Islands (St. Croix and St. Thomas/St.John).
- Fisheries Dependent Data Overview
    - Catch Data and Expansion Factors
    - TIP sampling
    - MRFSS for recreational fishing catch estimation
    - Recreational reef fish tournament data
- Fishery-Independent Data Overview
    - SEAMAP surveys
    - Reef.org data
- Analytical approaches
    - Mean length approach
    - Catch-per-unit-effort approach
    - Other stock assessment approaches
- Stock Complexes

Fishers were well represented at the meeting and took part in the discussions. However, there was a mismatch between the terms of reference of the meeting and some fishermen's expectations. Some of the fishermen were expecting more of a consultation on management policy.

I made a short presentation on ParFish (Participatory fisheries stock assessment), which formed one of the "other stock assessment approaches". The method, with which only a few participants were familiar, provided an alternative but complementary approach to the methods presented.

The workshop met most of its terms of reference, at least partially, but there was insufficient time to complete all tasks in depth. This report completes some of the activities, notably a review of recommendations from other SEDAR workshops, in greater depth than achieved during the meeting. This is limited to my personal views rather than those of the workshop participants.

4 Summary of Findings

4.1 ToR 1: Evaluation, findings and recommendations of data collection operations and survey design.

It was clear from the reviews of the available data, that most scientific advice was likely to be derived from fishery dependent data. The two main sources of data from the commercial fishery were:

- Trip Interview Program (TIP) for length compositions from sampled trips.
- Catch reports submitted by fishermen

For recreational fishery data, there are the MRFSS data from 2000 from Puerto Rico, but none for USVI.

Although some information was presented on fishery independent surveys, there was inadequate information to provide a useful review. The surveys do not have the primary purpose of estimating the abundance of any of the stocks discussed, and have not so far proved useful due to their low catchability and small data set. Comments are made here on the sampling design of the fishery dependent data collection, where the data are more substantial and have been shown to be useful for stock assessments.

Given that catches are based on a subset of fishermen's reports, catches are "raised" by assuming that they are a subsample from a complete set. There are problems with the raising factors, which are not known precisely, and potential bias as the "sampling" is not random.

A potential solution is to use the Trip Interview Program to provide an alternative estimate of total catches:

Total catch at a Port = CPUE * Proportion Active * Number of vessels at the port

where the CPUE can be obtained from TIP or fishermen's trip reports (trip tickets), there is an independent record of the number of vessels landing at each site and the number of vessels that could land at a site are registered. However, this only works if vessels have a fixed landing site.

An alternative approach, which should always work, would be based on sampling landing site – time interval units through the year. For example, a team of two data collectors could be allocated to sample from 10 landing sites through the year. They could sample any site on any afternoon or evening (or other time interval through the day). The raising factor then becomes clear (Number of sites * Number of time intervals) and as long as all landings are monitored through the time interval, the estimate of total catch will be unbiased.

Various sampling approaches might be used including multistage designs (Thompson 1992; Cotter and Pilling 2007), where usually stratification is used to increase efficiency. However, in these cases where the sampling effort and population being sampled from is small, stratification may not be of much help. Unequal probability designs provide the greatest efficiency in these circumstances as well as a clear way to raise estimates to totals (Thompson, 1992).

Unequal probability designs have two problems. Firstly they are generally complex and require a computer to both select the sample and carry out the estimation automatically. Secondly, it is possible that, rarely, poor estimates result from the random selection of a set of low probability items. However, this can be guarded against at the cost of greater complexity in the method through excluding such combinations from the sample when they arise.

Fishery independent data are expensive to collect. Therefore data sets are small and often have a wide scope in their purpose, so that the information they contain on any one stock or stock complex has been deemed as inadequate or unreliable. There are a large number of fishery independent surveys. Although these were not reviewed in detail, previous SEDAR workshops have not been able to make use of these data.

The possible exceptions to the emphasis on fishery dependent data collection were:

- The conch stock assessment has been unable to use CPUE due to the features of the diving fishery making CPUE insensitive to changes in abundance. It appears that it will be necessary to conduct a survey of conch abundance. This can be carried out by using divers swimming fixed length transects at random locations over conch habitat stratified by depth.
- A recruitment index would be invaluable in modelling spiny lobster populations in the US Caribbean. Puerulus settlement data are being collected under SEAMAP, but data have been reported to be insufficient for the generation of a reliable index. Other options include using indices reported by other nearby countries (FAO, 2001) or generate an index from the CPUE data (Medley and Ninnes 1997).

Other data which might be considered to be collected routinely are hard parts for aging select species. Routine small samples of aged fish can be used to test growth assumptions and build or update growth models. Aging techniques may need to be developed for each species, but this may be required to estimate growth parameters anyway.

Fishing experiments can be used to estimate catchability and, importantly, selectivity. Even with non-uniform selectivity, intensive fishing can result in a good snapshot of the local population for the purposes of estimating mean length of the population (rather than catch) and relative species abundance.

As well as fishermen recording effort and catch by species, some fishermen might also record some length measurements as long as the data requirements are not too onerous. For example, some fishermen might be persuaded to record the smallest, most frequent size and largest fish on each trip. These data can be used to monitor size and to compare with TIP samples when taken from the same vessels.

Placing observers aboard small boats is probably not an option due to cost and size of the vessel, but GPS recording equipment may be an option. Data loggers can be automated, making data recording, downloading and processing straightforward. However, giving them a reliable source

of power and making them tamper proof (if not voluntary) may require some development. Often artisanal fisheries behave like trap fisheries, with fixed locations where fish aggregate naturally. Therefore time since a site was last visited is an important parameter in CPUE if it can be obtained. Most, if not all, GPS units output ASCII character records through a serial interface which could be read and stored by a small handheld computer, so that construction of a logger should be inexpensive. Real time transmission would be less reliable and more expensive, but if it is not being used as an enforcement tool, storage for later download becomes a better option.

4.2 ToR 2: Evaluation, findings, and recommendations of data quality.

The data quality has been generally poor in the US Caribbean. All data collection programmes appear to have had problems in terms of quality and/or quantity of data.

Where there is a reliance on fishermen reporting without any method to enforce compliance, the good will of the fishing community is absolutely necessary. There appears to be a high level of interest in the fishing community to cooperate in collecting data, but there is also clearly some discontent over how data might be used.

The landings estimates are raised using the estimated proportion of the landings that have been reported. However, there is no proper sampling frame. The landings observations were based on self-reporting, so co-operation has varied over time leading to big changes in the expansion factor. Reporting rates are now considered very high and estimates of landings are likely to be reasonably good as long as reporting is accurate. Even if catch estimates continue to improve into the future, the historical time series remains highly uncertain.

There is a useful initiative to persuade fishermen to help design data forms (Berkson, pers comm.). This should enhance reporting rates and reduce errors in reports from fishermen. Improving the form with fishermen's help will not only improve data acquisition, but provide a platform to exchange knowledge on the fishery and how data are being used.

It appears that sampling among sites by TIP has not been based on a standard sampling approach. TIP sampling requires some degree of co-operation from fishermen, processors and buyers. In the interpretation of the data, there is an assumption that where sampling has occurred, it is representative of the entire fishery.

Main data sources are total catch by species by trip reported by fishers and fishing effort by trip (and by gear type), both mean length from independent port sampling. TIP data for catch and effort are also available, but too sparse to be useful by themselves.

SEAMAP-C survey should provide, in theory, a relative index of abundance of conch on the Puerto Rican shelf, and a recruitment index of spiny lobster. However, data are limited and have so far not successfully provided adequate information for an assessment. The SEAMAP reef fish monitoring data appears of limited use as these data are sparse for individual species assessment.

There is also a semi-quantitative visual census data for shallow water finfish provided by www.reef.org, which is available for 1994 onwards and covers the wider Caribbean. The data are abundance indices only, and have no size information. The quality of the data may vary, but there are relatively large amounts which could provide comparative indices. The data are available free of charge.

A number of problems were identified at this workshop as well as in previous SEDAR workshops (see section 4.4). In particular, the gear type definition and codes, and the catch species identification and reporting need clarification and possible revision.

4.3 ToR 3: Evaluation, findings, and recommendations of analytic methodologies.

Alternative stock assessment methods generally make up for the lack of data by increasing the number of assumptions. By either showing that the assessment is robust if these assumptions are broken (the method still gives the right answer even if for the wrong reasons) or having diagnostics available to ensure the assumptions are met indicate how useful the method is.

4.3.1 Mean Length based Method

A Beverton-Holt estimator of fishing mortality (Gedamke and Hoenig 2006) in which the equilibrium assumption has been relaxed was proposed. The method is similar to using length converted catch curves (e.g. Ehrhardt and Legault, 1996), but requires estimating only one parameter instead of two. The method clearly works if the assumptions are met. The five assumptions presented were:

1. von Bertalanffy growth with K and L_∞ known and constant over time.
2. No individual variability in growth.
3. Constant and continuous recruitment over time.
4. Mortality constant with age.
5. Mortality constant over time which implies that the population is in equilibrium (mean length reflects mortality).

The method has been shown to be robust to some reasonable levels of departure from the strict assumptions. However, management strategy evaluations would be valuable in each case to look at a set of realistic departures from assumptions so that the implications to management can be assessed.

In addition to the assumptions above, the underlying model assumes a particular knife-edge selectivity most likely to apply in less selective gears, such as trawls. Domed-shaped selectivity, where older, larger fish might be less likely to be caught as in gill nets, for example, may still work as a relative measure of fishing mortality, but may not provide a good absolute measure. Highly selective gears would show an insensitive response of mean length to changes in fishing pressure.

Of greater concern might be changing selectivity over time. A change in depth, gear, fishing location or discarding practice may produce a change in mean size. However, changes in these variables might be monitored in the same way as changes in catchability. Not accounting for selectivity, real or perceived, is likely to undermine the value of the method in terms of convincing fishermen as to the need for management intervention.

The uncertainty associated with length or age sampling might be underestimated. Fitting catch-at-age models to length and age compositions using multinomial likelihood even where the sample size is set to be number of hauls or trips rather than number of fish measured, often underestimates the variance compared to other methods based on observed expected values from

the model fit. One likely reason is that the length frequencies are unlikely to be based on independent samples which the likelihood assumes. Within trip length samples will be strongly correlated, so that the effective sample size will be much smaller than the number of fish measured.

Length samples in many years seemed very small. Given that the number of measurements may over-estimate the effective sample size due to correlation between measurements, individual year estimates may be poor. This leads to a reliance on a long time series using the mean length measure suggested and may make it difficult to base decisions only on the most recent estimates. The method may be either slow to react to changes in the fishery, or to be effective, overly precautionary action might be required.

Diagnostics are required for the method to test assumptions, but with these sorts of simple methods, useful diagnostic tests are difficult to define. Two general approaches were presented:

- Realistic levels of fishing mortality. For example, domed-shaped selectivity will produce unrealistically high estimates, but would not necessarily invalidate the approach.
- Examine changes in mean length and residual patterns over time, to look for patterns and changes in variance. Discrete changes in fishing mortality might be accounted for using the method of Gedamke and Hoenig (2006).

4.3.2 CPUE Analysis

Overall, the catch and effort series for the species presented (Single Species Abundance Trends: Silk and Queen Snapper in Puerto Rico through 2007) seemed to provide a useful index, albeit "trip" is a very crude measure of effort. However, it cannot be guaranteed that the index is tracking abundance. Silk snapper showed a spike at the beginning of the time series unlikely to be due to change in stock size. The queen snapper index appeared to be increasing, and unless catches decreased over the same period, this is unlikely to be accounted for in a stock assessment model.

Although I prefer a likelihood that integrates zero as another observation (such as in the Poisson), the log-normal model appeared to fit the residuals reasonably well for the series examined. The concern with these models is usually the presence-absence of the species concerned, since including inappropriate trips can bias the results.

Various alternative models might be used to further explore the relationship between the target catch, total effort and the other species landed. For example, a simple linear model might be:

$$C_j = qN\left(E - \sum_{i \neq j}^{n} h_i C_i\right)$$

This might be fitted used a generalized linear model (GLM) (with additional covariates added as appropriate) to estimate qNh_i for each species in a mixed catch, where h_i is the "handling time" (i.e. the effort removed from the total available effort, for dealing with the alternative catch or the effect of the alternative catch as it replaces the target species through competition for traps or hooks or similar). The h_i parameters in the model should be fitted as random effects to constrain parameters, so that $\Sigma h_i C_i$ does not exceed the total effort E.

The diagnostics form an important part of the analysis and it is important to demonstrate, as far as possible, that the CPUE index is valid. Diagnostics were presented for the preliminary CPUE indices, but they were not complete.

While more diagnostics are available compared to mean length in terms of residual Q-Q plots, for example, the fundamental test, whether and how the index tracks abundance is more difficult to prove. GLM structures usually reflect the available covariates rather than some theoretical choice of explanatory variables.

An important, simple diagnostic is to plot catch against effort. Any reasonable effort measure should show a linear increase. Effort is fundamentally a measure of the work done to capture the fish. With interferences due to management measures (e.g. trip quotas) or mis-recording, the variance associated with this linear relationship will be unusually high. While CPUE accounts for the linear correlation, the unexplained variance is used as an index of abundance, and this may become apparent as a poor choice on inspection of a plot of catch vs. effort. Also, a non-linear relationship might become apparent and may be corrected using an appropriate transform, if it can be justified.

Diagnostics for the analysis of catch and effort should include:

- Catch vs. effort plots by trip and year (and other breakdowns considered appropriate): to identify outliers and non-linearities in the relationship
- Plot residuals for any standardisation GLM including Q-Q plot, residuals vs. time and residuals vs. expected
- For the delta lognormal, plot both the proportion positive trips and the mean CPUE for positive trips as separate indices to check that both have the same trend.
- Nominal and standardised CPUE on the same plot
- Plot with standard error or confidence interval on each point or parameter estimate.

Use of CPUE data should ideally be accompanied by a rational argument as to why the index should track abundance, which accounts for the gear and the gear operation and fishermen's behaviour. Ideally, covariates included in the standardisation should also be justified as to why they influence catchability rather than abundance.

4.3.3 Stock Complexes

Species complexes need to be defined by the fisheries management plan. From the management point of view, clearly the most important consideration is the species which tend to be landed together.

The cluster analysis presented was based on identifying groups of trips with common species landings. This was a useful way of summarising the information on landings relevant to this issue. The results were also checked with fishermen present at the meeting, which was important, particularly considering potential errors in reporting data.

Based on the analysis and discussions with fishermen present at the meeting, the re-evaluated species complexes remained broadly the same. Although other multivariate analyses might be used, it is unlikely further light would be shed on this matter. The multivariate analysis together with consultation with stakeholders represents best practice in the approach to this matter.

4.3.4 Alternative Analytical Approaches

ParFish was presented, which is a method encouraging fishermen to be involved in stock assessment and management of data-poor small-scale fisheries in developing countries. The method is based on Bayesian decision analysis, and makes use of, among other things, subjective information obtained from interviews. The interviews are designed to collect differences in opinion among fishermen which are modelled as uncertainty. A test of the method is currently being undertaken in Puerto Rico, and will be reported at a later date.

A second alternative approach which was discussed was a productivity-susceptibility assessment (PSA), which is a risk analysis approach for identifying species which may be at risk from overfishing. It is semi-quantitative and relies on subjective expert judgement. However, categories for scoring are very broad helping to make the method more robust.

In my opinion, PSA is a useful way of dealing with a large number of species which may be caught as by-catch for example. It can be used to rapidly assess large numbers of species and allow the assessment to focus on the most vulnerable. However, I do not think that it is useful to assess target species. Such species would in all but exceptional cases attract a high susceptibility score, as fishermen will presumably make every effort to make the species as susceptible as possible, making target species most likely to be designated as "at risk". Relying on subjective information of this form for the assessment of target species is not likely to be acceptable to a wide range of people.

Finally, a method called Depletion Corrected Average Catch (DCAC) was presented, which made use of a time series of catch data. The aim is to adjust the observed average catch for the likely productivity of the stock. The method is based on 'back-of-an-envelope' potential yield calculations where key parameters indicating the state of the resource (as a proportion of the unexploited state) and the productivity (as natural mortality or intrinsic rate of increase) are supplied.

The results from DCAC are exactly the same as might be obtained from a Bayesian analysis of a dynamic model with prior probabilities on the productivity and initial state of the stock. However, a Bayesian analysis would encourage the uncertainty in this assessment to be made more explicit and therefore, in my opinion, is preferable to this type of approach.

4.4 ToR 4: Recommendations for further improvements.

The following is a summary of the recommendations compiled for the current data evaluation workshop. I have combined and prioritized the recommendations as much as possible and provided some interpretation. Therefore, these recommendations would probably benefit from further review and streamlining, so that their cost, effectiveness and impact on the stock assessments can be evaluated more easily. Previous recommendations have tended to form a "wish-list" rather than a research plan.

This section goes further towards meeting one of the ToRs of the workshop, which was only partially met during the meeting itself:

> *Review the research and monitoring recommendations from the previous assessments in the U.S. Caribbean. Note any which have been completed, make any necessary additions or clarifications, and prioritize data and research needed to successfully complete benchmark stock assessments.*

The SEDAR 8, 12 and 14 reports provided a wide range of research recommendations related to biology, fishery data, fishery-independent data and assessment methods. Some recommendations are specific to a species and/or an island. However, there are enough common problems identified that a general review of the data collection and data management is warranted.

The forty pages of research recommendations provided to the workshop were not reviewed in detail during the meeting. Because there was not time to go through these during the review meeting, it is unclear which have been addressed if any, and which remain to be done. Furthermore, there is repetition among recommendations, where the same task would benefit several species. Most of the recommendations refer to monitoring programs, rather than scientific research.

Only a few recommendations were made at the SEDAR 8 and 14 workshops on analytical methodology. The issues raised were covered in greater detail in the current SEDAR data evaluation workshop and dealt with elsewhere in this report.

4.4.1 General

The SEDAR 8 Review Panel strongly endorsed the need to develop partnerships with local fishermen primarily to collect data, but also conduct other research. This is the most cost-effective way to collect much of the data necessary for the assessments. The reports suggest that there is a high level of interest in the fishing community to cooperate in collecting data.

The SEDAR 14 Review Panel recommended that future data workshop (DW) and assessment workshop (AW) reports provide a single section collating all recommendations, with priorities and expected contribution of the results clearly identified. Recommendations are scattered throughout the various SEDAR reports, but without any prioritization according to short-term and longer-term needs or any indication of the extent to which the results could improve the assessment and management of the stocks.

It was also recommended that research and monitoring programs be developed that enable quantitatively evaluating management actions such as seasonal and area closures, especially as such actions can significantly alter fishery operations and limit traditional data collection approaches.

Data sources should be prioritized. In my opinion, the overall results presented suggest that the focus of development should lie with fishery dependent data sources. Generally, fishery independent data sets are small and, despite a better theoretical basis, seem to possess significant problems. While there is an argument that all sources of information should be included if possible, the analytical resources available to the NMFS end up being spread very thin where a number of disparate data sets need considerable work to maintain and interpret them. The only data which appear to have provided a good source of information for stock assessment are the fishery dependent data. This would suggest these data sets are given priority, and if necessary, resources are diverted from the collection and maintenance of fishery independent data to improvements in these sources.

4.4.2 Life History and Spatial Mapping

Maturity, growth and fecundity data could form part of a specific short term project. Good growth parameter estimates by sex are needed for length-based models, and growth and maturity

data are needed for development of biological reference points. Length weight relationships, even if not estimable from existing data, should be easily estimated using only a short time period from catch data.

Where there are questions over shared stocks, stock identity might be obtained from larval dispersal patterns using genetic markers and otolith microchemistry, information on physical oceanographic processes and associated models as well as genetic studies.

The relatively good knowledge of habitat distributions and of habitat usage by various species/life stages provides a valuable opportunity to explore the power of habitat-based spatial models in this region. This might usefully be combined with the information on the areas fished and greatly enhanced with local knowledge from fishers. Whilst such information may not necessarily feed directly into stock assessment models, it is important for interpreting CPUE data, evaluating the impact of effort redistribution during closures, and noting the possibility for over-fishing of localized populations with limited dispersal and mixing.

Habitat distributions and usage could provide the basis for developing priors for key stock assessment model parameters. Surveys of “no take” areas or small scale fishing experiments might be used to help establish reference points by providing an estimate of unexploited density. This could be raised to a wider area based on proportional density estimates by habitat type areas. Similarly, habitat area could be used to help identify stratification for survey designs.

The approach of using densities from various areas of the Caribbean under different levels of exploitation as reference points has been specifically proposed for conch (SEDAR 12). This will need to account for the influence of habitat type and stock structure (juveniles and adults) on the comparisons. Similarly Marine Protected Areas in the waters of Puerto Rico and USVI hold potential for estimating unexploited conch densities in the area.

For many species, spawning aggregations form an important source of information. It is important to map past and present spawning aggregation sites and migration corridors. These maps, as well as being important in their own right, can form the basis for planning various monitoring activities.

Specifically, it would be valuable to investigate very old conch in deep refuges. Such refuges may be off St. Thomas/St. John, in patches in Puerto Rico and potentially in protected areas on all three platforms, and may contribute significantly to maintaining the spawning stock.

4.4.3 Commercial Catch and Biological Sampling

Improvement in the accuracy and coverage of fishery data is a high priority. Fishery dependent data appear to be the most promising in providing adequate information for a stock assessment and scientific advice. More samples should be collected for TIP and reporting rates of trip records should be improved from fishermen.

Data quality was identified as a common problem. Missing fields (e.g. sampling fraction), inconsistent measurements (e.g. whole/gutted, cleaned/uncleaned etc.), and data entry errors were found in many data. Standardized sampling protocols and systems for quality assurance and quality control for data collection are needed throughout the Caribbean. Problems with data can likely be resolved through extensive meetings with port samplers and others familiar with US Caribbean fisheries.

A review of the field methods and protocols of the fishery data collection systems in the U.S. Caribbean needs to be conducted to evaluate what relevant attributes need to be collected to characterized trip specific catch.

Identification of fishing effort units (e.g. soak time for traps; hook-hours) that are most likely to provide a linear relationship between CPUE and population abundance, and the capturing of historical TIP data on landing weight per trip for trips with soak time or other effort data. For all primary harvest gears, optimum CPUE should be in terms of number of individuals, biomass, and the amount of effort in hook-hours (i.e., time hooks are in the water) or trap soak-time in hours.

Other covariates (e.g. depth) should be collected to help explain variability in CPUE data other than changes in abundance and changes in selectivity. Accurate documentation of changes over time in fishing effort, fishing gears and their deployment, and species targeting and fish-location technology (e.g. GPS) is needed to help interpret CPUE data and identify periods when catchability may have changed. In addition, information should be collected to determine whether fish were captured in a spawning aggregation or otherwise.

There is a need to ensure data are recorded accurately by species and gear over all areas.

There is a need to ensure that relevant links between data records are maintained. Link any biological sampled data for a fishing trip to the landings records reported by fishermen for that trip, for example.

Specific recommendations are not made on sampling, beyond improving the current schemes as outline above. This is primarily achieved through increasing the amount of sampling, to the extent that some panels have recommended eliminating the need for expansion factors by obtaining information on all landings.

Priority has been given to improving compliance with reporting requirements, which is most likely to be achieved through greater involvement of fishers in data collection schemes. This should also apply to recreational fishermen.

- Commercial fishermen should submit monthly catch reports including for months when they do not fish, and to complete all the fields in the reports, since critical information is often missing or incomplete.
- Feedback should be provided to fishermen on the data they report (e.g. stock assessment results and annual reports for distribution to the fishing community). It was reported that the fishing community in the U.S. Virgin Islands would be reluctant to provide more additional information, unless they see their data of approximately the last 30 years being used.
- How representative the reported fishery data are should be evaluated, for example by interviewing fishermen who have submitted log sheets in recent years but did not before.
- An internet data acquisition system could be explored, where anglers and maybe divers report their catch and effort as well as additional information directly onto forms on the internet.

A time series of additional information should be maintained which is not specific to trips, such as discrete or external events including management efforts, economic impacts, weather events, or other factors that may have influenced fishing effort, catch rates or targeting. Evaluate impacts of management measures, particularly closed areas.

The exception to developing a CPUE index appears to be conch, for which CPUE does not appear to be a good measure of relative abundance, because diver effort under daily quotas cannot be measured in any way that would result in CPUE being responsive to abundance changes. This suggests that fishery-independent abundance indices should be used as the main source of information on conch abundance.

Discards are not seen to be a particular problem in these fisheries. Nevertheless, methods to monitor discarding would exclude the problem in future. Quantity and state of discarded fish could be recorded, but probably only by fishermen at sea, which would require co-operation.

4.5 Recreational Catch

Surveys need to be conducted to estimate the magnitude of the USVI recreational landings for all species including conch and lobster.

Conch and lobster need to be included in the MRFSS for Puerto Rico, together with additional survey attributes specifically to draw out information on mutton snapper.

The sampling effort of the MRFSS intercepts should be increased to a level that would result in adequate sample sizes for biological characterization of the catches.

The uncertainty around the current and future recreational landings estimates should be further investigated, as complete coverage of these landings is unlikely.

4.6 Fishery Independent Data

Fishery independent surveys are expensive, which results in small data sets which have proved unreliable or too sparse. Some fishery independent data are collected in the Caribbean, but so far these data have not been of great use. The mutton snapper data workshop listed 14 different sources of fishery independent data from different areas around Puerto Rico and the U.S. Virgin Islands, but only five provided data on mutton snapper.

Various methodological changes have occurred during the SEAMAP surveys, but some major logistical problems are ongoing. Although sampling is annual, it does not occur during the same time each year (confounding seasonal variability) and the time series is short. The objective of the SEAMAP survey is to cover a wide a number of species making it less effective for any one species due to the low catchability.

Fishery independent surveys currently rarely include stations in deep water, the preferred habitat of adult mutton snapper and adult yellowfin grouper.

To address these problems, all panels supported an increase the fishery independent sampling effort in the U.S. Caribbean and that this effort be diversified across the region to include equal coverage of appropriate habitats/depths.

The design of surveys needs to be linked clearly to their objectives. Surveys designed to collect data on parameters such as relative size composition of mature fish, may benefit from taking place on known spawning sites at spawning time rather than be randomly placed.

Desk studies should be used to establish the requirements for design, intensity and sampling to deliver the required accuracy of estimates from any such surveys. It was also suggested to investigate other methods for fishery-independent stock monitoring, for example beach-seine surveys to provide recruitment indices for mutton snapper and other species, and tag-release programs to estimate mortality rates as well as fish movements.

Visual surveys could be used in the Virgin Islands and in Puerto Rico to collect additional abundance information on the reef fish resource, but such data would provide abundance indices only for shallow water species.

If gear surveys, visual surveys and/or mark-recapture experiments are undertaken, it should be considered to combine them with a fishing experiment rather than attempt a full survey. This would almost certainly be the most efficient approach if fish are site-attached.

For spiny lobster, a standardized annual recruitment index is required to support any assessment. The SEAMAP Caribbean sampling group is aware that the puerulus sampling program is insufficient and has been considering alternatives.

If the locations of (spawning) aggregations of appropriate species, including queen conch, are mapped, regularly visiting these could provide a good index of abundance of the spawning stock without the excessive costs of a random survey. Historical indicators of spawner abundance might also be available (e.g., directed visual census, catch statistics for spawning peaks, etc). This approach could be important for species such as yellowfin grouper and mutton snapper.

Using fishery independent surveys is the most promising for queen conch stock assessments in the near future. More detailed spatial expansions of survey densities should be planned in preparation of the 2010 Conch Update. For this, significant improvements in available data and analyses are required, including but not limited to the following:

- Numbers by size class and size composition by depth strata.
- Detailed bathymetry data for Puerto Rico and US Virgin Islands
- Inclusion of more detailed habitat maps for the Puerto Rico western platform

Data from past conch density surveys should be re-analyzed so that values can be expanded on the basis of both habitat and depth, including confidence limits. Habitats should be matched to those available for existing/planned habitat maps.

Scientific tagging studies of adult yellowtail snapper, mutton snapper, yellowfin grouper, and queen conch can potentially obtain data on abundance, movements, stock structure, habitat utilization, growth and mortality. Studies to further evaluate the maturation (size and spatial variation) and growth of these species in the Caribbean are needed.

Tagging studies on conch should be initiated to quantify rates of exploitation. This would allow existing SPR models for conch to be used in assessments. The only estimate to date of conch fishing mortality came from a conch tagging study in the 1980s.

The feasibility of small-scale intensive tagging experiments could be examined in addition to more extensive experiments. For example, the spatial scale of migrations by individuals participating in spawning aggregations through tag and release studies could be examined.

5 Conclusions and Recommendations

5.1 General Approach

It is beyond the scope of this report to comment specifically on the Magnuson Stevens Act National Standards, except to note that interpretation of these has significant implications for management and that it appears two interpretations are possible.

The costs of management should be considered in implementing the system. Under Section 301 of the Magnuson Stevens Act, the general intention includes references to efficiency and cost.

> "(2) Conservation and management measures shall be based upon the best scientific information available."
>
> "(7) Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication."

While not explicitly stated, management measures should include the monitoring programs, therefore making the monitoring programme as efficient and effective as possible should be of concern.

Catches are not an appropriate control in the US Caribbean. Fishery management plans shall "establish a mechanism for specifying annual catch limits in the plan … at a level such that overfishing does not occur in the fishery, including measures to ensure accountability." – MSA Section 303(a)(15). However, catches are not measured directly, but are usually estimated from sampling. Clearly a landings control requires that all landings are measured and checked by an independent authority. With a large number of dispersed landing sites and a large number of small landings, covering artisanal fisheries in this way is expensive relative to the value of the fishery. In addition, controls on landings in multispecies fisheries are rarely effective or, if effective, rarely efficient.

Alternatively, catch might be used as a performance indicator only. It can therefore be derived through alternative measures, meeting the strict requirements of the Act, but avoiding the onerous task of direct measurement and control. Given that Annual Catch Limits and Accountability Measures have been defined separately, any management control might be applied as long as the catch indicator can be shown to decline below the appropriate reference levels which have been defined either for rebuilding or sustaining the stock.

I recommend that both mean length and standardised CPUE should be considered for developing an appropriate decision rule (Fig. 1). In a data poor situation, reference points can be developed for the measured variables taking into account not only uncertainty in the stock status and dynamics, but also the measurement error of the variable itself. Once a measurement variable is decided upon, it will be necessary to design an effective monitoring programme to obtain accurate reliable estimates.

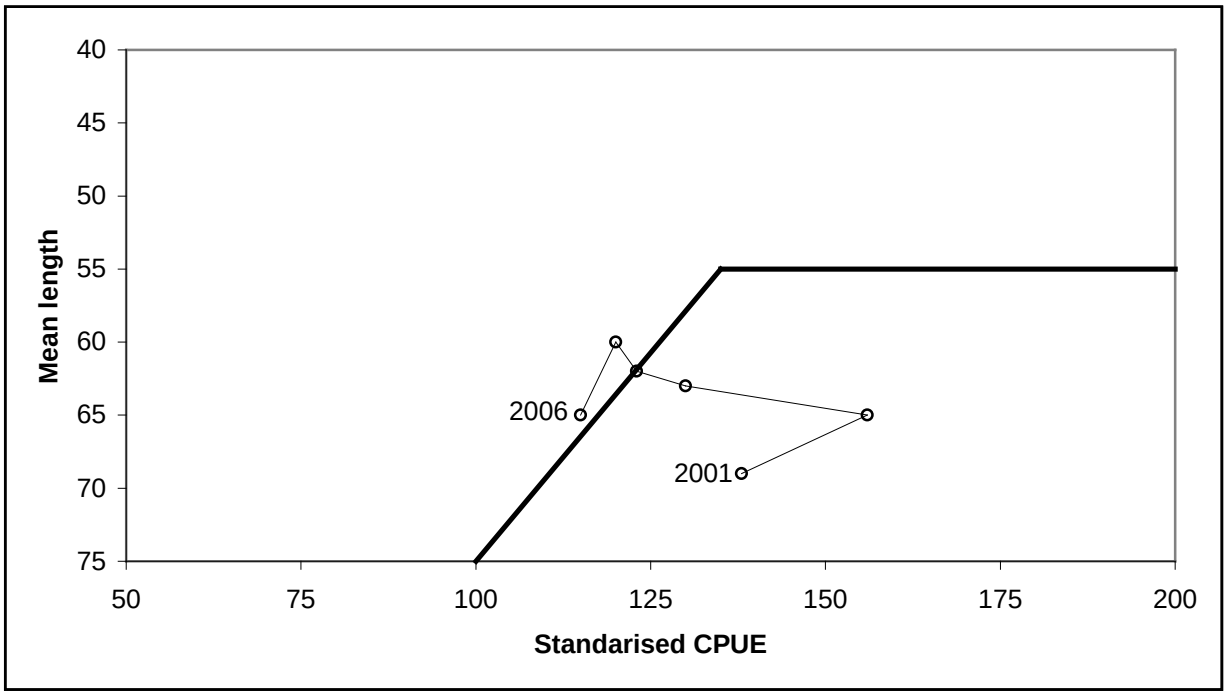

Figure 1 A simple example of a simulated decision rule based on mean length (as a proxy for F) and standardised CPUE (as a proxy for biomass). In this scheme, the absolute levels of biomass and fishing mortality are uncertain, but the measured variables can provide an indication of their relative size year by year. This has the additional advantage of providing variables (mean size and catch rates) which are of direct interest to fishermen, and for which they can immediately see the point of controlling in order to optimise the yield from the fishery. Management strategy evaluations can be used to test how robust this scheme would be.

5.2 Data Collection

There needs to be a complete review of the data collection programs, including commercial and recreational catch, biostatistical sampling and fishery independent surveys for Puerto Rico and US Virgin Islands, with the purpose of identifying what relevant information could be obtained and modifying sampling procedures accordingly, including the identification of key economic and ecological indicator species (SEDAR 14 Review Panel).

The focus on future data collection initiatives and improvements should be, in the first instance, on fishery dependent data collection programmes, particularly TIP. TIP provides an independent source of information which does not rely on voluntary reporting. It can therefore be used to provide estimates of values of interest (CPUE, length composition and total catch) as well as bias correction and a check on fishermen reporting levels.

A robust data collection method should be implemented to support the desired decision rule. This should probably be based on TIP sampling. An unequal probability sampling design should be considered as the most efficient way for the TIP system to obtain accurate unbiased estimates of total catch by species.

Where possible, raising factors should be based on sample theory rather than *ad hoc* schemes dependent on vessel groupings. While grouping CPUE by vessel size and gear may appear

reasonable, sampling structure means that aliasing is more likely and the method rapidly becomes overly complex and difficult to prove that it is unbiased.

It will be necessary to rely on fishermen to obtain much of the data necessary for management. For this to be reliable, the fishing community will need to be engaged and fishermen will need to understand not only how the data are to be provided, but how the data will be used. It is likely that reliable data will only be provided by a proportion of, often better educated, fishermen and that this proportion will decline with the complexity of the information required.

It is particularly important that fishermen realize the importance of the data they report. In a review of fisheries decision making in Europe, Van Densen and McCay (2007) found few fishermen realized that the ratios between precautionary and biologically hard limit reference points indirectly reflect the estimation uncertainty for stock size and fishing pressure.

As an exception to the emphasis on fishery dependent data collection above, there is justification to conduct a fishery independent survey of conch for the 2010 update stock assessment.

Other potential sources of information considered by a review should include:

- Exploring what processors (fish houses) might collect routinely for commercial purposes and which could be confidentially supplied to scientists.
- Additional variables that might be reported by fishermen from each trip, such as target species or species complex for the trip, and the smallest, largest and most common size fish in catch for select species.
- Use of GPS data loggers on a sample of fishing trips or vessels coordinated with TIP sampling to obtain a detailed record of some trips. These data might be used either to improve recording and interpretation of effort measures or as an index in their own right.
- Use of fishing experiments to obtain “snap-shots” of the fish population in particular areas and estimate gear selectivities and catchability. Whether this is possible depends upon identifying appropriate locations where fish population immigration/emigration might be considered negligible during the experiment.
- Visual census data from www.reef.org could be used to develop multispecies monitoring for the ecosystem. However, the non-standard nature of this data source suggests that considerable work would be required to make the data usable and build confidence in their value.

5.3 Analytical Methods

I recommended that a Bayesian approach be developed for all analytical methods. A Bayesian approach forms a flexible basis for dealing with uncertainty (Peterman 2004), and allows information other than the available data to be included. Prior probabilities need to be defined based on “best practice”, informed by other treatments (e.g. Millar, 2002; Sullivan 1991) or innovations (as used in ParFish).

A typical application of the Bayesian approach is where information is missing. Hammond and Trenkel (2005) carried out a stock assessment using a biomass dynamics model where catches are considered censored. In the cases presented at this meeting, the raising factor could be

considered a prior or likelihood probability on the "censored" parameter rather than a fixed value.

If a Bayesian approach is adopted, standard acceptable methods will be required to generate priors for the main parameters (Millar 2002). These could include, but not be limited to: relating the intrinsic rate of increase (r) to natural mortality (M) and vice versa, life-history models for the intrinsic rate of increase (r), and area based estimates for unexploited stock size (B_∞) based on unexploited density for different habitats.

A weakness of the "mean length" estimator described is the lack of good diagnostics to test whether the assumptions are being met. Diagnostics may require some further data collection, ageing small numbers of fish, for example, to test for growth changes or other data such as mean fishing depth to adjust for changes in selectivity. Although standardised CPUE has more options for diagnostics, fundamental issues revolving around whether CPUE is tracking abundance should also be addressed by short term research or further data collection if possible.

Given that it is a mean which is of interest, it may be possible to set up the analysis of mean length in a hierarchical modelling framework, such as a generalized linear model, to account for different causes for changes in mean length simultaneously. A value of this approach might be to obtain additional residual plots as diagnostics for testing for cause of change.

Management strategy evaluations should be used to check for assumptions which could cause problems with the mean length estimator failing to detect overfishing. For example, an increase in L_∞ due to a fall in density (Lorenzen and Enberg 2002), could make the mean length remain constant or even increase as the exploitation rate increased, which is not precautionary. The converse of decreasing asymptotic size (e.g. Rijnsdorp *et al*. 2004), while reducing the accuracy of the method in estimating F, would remain precautionary, and therefore might be more easily ignored.

Alternative methods should be considered analysing several species simultaneously within a complex to improve the power of the overfishing tests. While mixed fisheries landing several species simultaneously is general considered a complication, they might provide a stronger analysis when considered as a single group. For example, for CPUE indices, a standardisation model should be considered that tracks the CPUE for all species combined, then looks at the species composition as another term conditional upon this total CPUE (see McCullagh and Nelder 1989).

Within each species complex, a species productivity-susceptibility risk analysis (Smith *et al.* 2007) would ideally form the basis for a single species assessment within a species complex rather than simply the most abundant species in the catch.

In cases where there is no clear scientific approach to assessment or analysis, such as where subjective opinion is to be used, best practice needs to be established. SEDAR workshops might be used to define best practice for specific methods which guide assessment scientists in coping with issues which have no clear solution beyond those which cannot be implemented for practical reasons. Establishing best practice when a method is equivocal should specifically challenge independent reviewers to provide demonstrably better approaches rather than simply reject them in favour of standards which for practical reasons cannot be reached.

6 References

Cotter A.J.R. and Pilling G.M. (2007) Landings, logbooks, and observer surveys: improving the protocols for sampling commercial fisheries. Fish and Fisheries, 8(2): 123-152

Ehrhardt, N.M., and C.M. Legault. (1996) Crustacean Stock Assessment Techniques Incorporating Uncertainty. Report of the FAO/CFRAMP Stock Assessment Workshop. Port of Spain, Trinidad and Tobago. 8-12 January 1996.

FAO/WECAFC (2001) Report on the FAO/DANIDA/CFRAMP/WECAFC Regional Workshops on the Assessment of the Caribbean Spiny Lobster *(Panulirus argus).* Belize City, Belize, 21 April-2 May 1997 and Merida, Yucatan, Mexico, 1-12 June 1998. *FAO Fisheries Report.* No. 619. Rome, FAO. 2001. 381p.

Gedamke, T. and Hoenig, J.M. (2006) Estimating Mortality from Mean Length Data in Nonequilibrium Situations, with Application to the Assessment of Goosefish. Transactions of the American Fisheries Society 135:476–487, 2006

Hammond, T. R., and Trenkel, V. M. (2005) Censored-catch data in fisheries stock assessment. ICES Journal of Marine Science, 62: 1118-1130.

Lorenzen, K. and Enberg, K. (2002) Density-dependent growth as a key mechanism in the regulation of fish populations: evidence from among-population comparisons. *Proc. R. Soc. Lond. B* 269: 49-54.

McCullagh, P. and Nelder, J.A. (1989) Generalized linear models. Second Edition. Monographs on Statistics and Applied Probability. Chapman and Hall/CRC, Baca Raton, FL.

Medley, P.A.H. and Ninnes, C.H. (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*.

Mees, C.C. (1997) Multispecies responses to fishing at Indian Ocean and Tongan offshore reefs. Proceedings 8th International Coral Reef Symposium 2:2039-2044.

Millar R.B. (2002) Reference priors for Bayesian fisheries models. Canadian Journal of Fisheries and Aquatic Sciences, 59(9): 1492-1502(11)

Peterman, R. M. 2004. Possible solutions to some challenges facing fisheries scientists and managers. ICES Journal of Marine Science, 61: 1331-1343.

Rijnsdorp, A.D., van Keeken, O.A., and Bolle, L.J. (2004) Changes in the productivity of the southeastern North Sea as reflected in the growth of plaice and sole. ICES CM 2004/K:13

Smith, A. D. M., Fulton, E. J., Hobday, A. J., Smith, D. C., and Shoulder, P. (2007) Scientific tools to support the practical implementation of ecosystem-based fisheries management. ICES Journal of Marine Science, 64: 633–639.

Sullivan K. (1991) The estimation of parameters of the multispecies production model. ICES Mar. Sci. Symp. 193: 185-193.

Thompson, S.K. (1992) Sampling. Wiley, New York.

Van Densen, W. L. T., and McCay, B. J. (2007) Improving communication from managers to fishers in Europe and the US. – ICES Journal of Marine Science, 64: 811–817.

7 Appendix 1: Bibliography of materials provided for review

Document Number	Title	Author
SP3-01	Preliminary Evaluation of Available US Caribbean Fisheries - Length-Frequency Data and Spatial Changes in the Fisheries.	Todd Gedamke, Staci Hudy, Kevin McCarthy
SP3-02	United States Virgin Islands Fisheries Description and Available Data: Preliminary Evaluation.	Kevin McCarthy and Todd Gedamke
SP3-03	A multi-pronged approach to evaluating managed species groups in Puerto Rico from reported landings.	Nick Farmer and Andy Strelcheck
SP3-04	Management History for Reef Fish Resources	Jason Rueter
SP3-05	Map of closures	Jason Rueter
SP3-06	Evaluation of the variability in reporting rates of commercial fishers in Puerto Rico during 2006 and 2007	Nancie Cummings and Daniel Matos
SP3-07	Consolidated Caribbean SEDAR Research Recommendations	Edited by Julie A. Neer
SP3-08	Quick Reference to the Fishing Regulations History in the US Caribbean	Graciela García-Moliner
SP3-R1	Length-based assessment of sustainability benchmarks for coral reef fishes in Puerto Rico	JERALD S. AULT, STEVEN G. SMITH, JIANGANG LUO, MARK E. MONACO AND RICHARD S. APPELDOORN
SP3-R2	Evaluation of average length as an estimator of exploitation status for the Florida coral-reef fish community	Jerald S. Ault, Steven G. Smith, and James A. Bohnsack
SP3-R3	SEDAR 8 SAR1 Caribbean Yellowtail Snapper	SEDAR
SP3-R4	SEDAR 8 SAR2 Caribbean Lobster	SEDAR
SP3-R5	SEDAR 14 SAR1 Caribbean Yellowfin Grouper	SEDAR
SP3-R6	SEDAR 14 SAR2 Caribbean Mutton Snapper	SEDAR
SP3-R7	SEDAR 14 SAR3 Caribbean Queen Conch	SEDAR
SP3-R8	SEDAR 4 Data Workshop Report	SEDAR

8 Appendix 2: A copy of the CIE Statement of Work

Attachment A: Statement of Work for Dr. Paul Medley

External Independent Peer Review by the Center for Independent Experts

Caribbean Data Evaluation Workshop

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract to provide external expertise through the Center for Independent Experts (CIE) to conduct impartial and independent peer reviews of NMFS scientific projects. This Statement of Work (SoW) described herein was established by the NMFS Contracting Officer's Technical Representative (COTR) and CIE based on the peer review requirements submitted by NMFS Project Contact. The CIE reviewer is selected by the CIE Coordination Team and Steering Committee to conduct the peer review of NMFS science with project specific Terms of Reference (ToRs). The CIE reviewer shall produce a CIE independent peer review report with specific format and content requirements (**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.

Project Description: This is a topical workshop convened through SEDAR to evaluate data sources for US Caribbean fisheries and identify stocks for further assessment consideration. The workshop will convene Federal and Territorial agency scientists, University researchers, and constituents to evaluate and critique fisheries datasets and discuss metadata issues that affect data interpretation and use in quantitative fisheries analyses. This workshop addresses specific recommendations of several prior SEDAR reviews of assessments of Caribbean stocks which were rejected due to a lack of adequate data. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**, and the tentative agenda of the panel review meeting is attached in **Annex 3**. Additional information (i.e., Workshop Statement of Work) is attached in **Annex 4.**

Requirements for CIE Reviewers: One CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. The CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein. The CIE reviewer shall have the expertise, background, and experience to complete an independent peer review in accordance with the SoW and ToRs herein. The CIE reviewer shall have expertise with Caribbean fisheries, tropical fisheries biology and assessment, data-poor stock assessment methods, and fisheries data collection.

Location of Peer Review: The CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in San Juan, Puerto Rico during January 26 – 29, 2009.

Statement of Tasks: The 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 (name, affiliation, and contact

details) 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 reviewer. The NMFS Project Contact is responsible for providing the CIE reviewer with the background documents and information concerning meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: Foreign National Security Clearance for non-US citizen CIE reviewer will not be required since the meeting will be held at a non-governmental facility.

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 the CIE reviewer all 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 on where to send documents. The CIE reviewer shall read all provided documents in preparation for the peer review, and is responsible only for the pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein.

Panel Review Meeting: The CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs. **Modifications to the SoW and ToRs can not 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 reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and the peer review tasks shall be focused on the ToRs as specified in the contract SoW. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements. The CIE reviewer is expected to participant in all workshop discussions regarding data and sampling issues, potential assessment methodology, and research recommendations. Their insight and expertise is requested to provide a potentially different view point from those who have been working directly with the data and species to be discussed.

Contract Deliverables - Independent CIE Peer Review Reports: The 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. The CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Contribution to Summary Report: The CIE reviewer will assist the Chair with contributions to a Summary Report, and is not required to provide a consensus will any aspect of the peer review.

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

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review;
2) Participate during the panel review meeting in San Juan, Puerto Rico, from January 26-29, 2009, as called for in the SoW, and conduct an independent peer review in accordance with the ToRs (Annex 2);
3) No later than REPORT February 12, 2009, the CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. 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*. The CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in Annex 2;
4) The CIE reviewer shall address changes as required by the CIE review in accordance with the schedule of milestones and deliverables.

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

December 23, 2008	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
January 14, 2009	NMFS Project Contact sends the CIE Reviewer the pre-review documents
January 26-29, 2009	The reviewer participates and conducts an independent peer review during the panel review meeting
February 12, 2009	CIE reviewer submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
February 16, 2009	CIE submits CIE independent peer review reports to the COTR
March 5, 2009	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: Requests to modify this SoW must be made through the Contracting Officer's Technical Representative (COTR) who submits the modification for approval to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the CIE within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and Terms of Reference (ToR) of the SoW as long as the role and ability of the CIE reviewer to complete the SoW deliverable in accordance with the ToRs and deliverable schedule are not adversely impacted. The SoW and ToRs cannot 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. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (the CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards: (1) each CIE report shall have the format and content in accordance with Annex 1, (2) each CIE report shall address each ToR as specified in Annex 2, (3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

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

Key Personnel:

William Michaels, Contracting Officer's Technical Representative (COTR)
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-713-2363 ext 136

Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
10600 SW 131st Court, Miami, FL 33186
shivlanim@bellsouth.net Phone: 305-383-4229

NMFS Project Contact:

Julie Neer,
SEDAR, 4055 Faber Place Drive Suite 201, North Charleston, SC 29405
julie.neer@safmc.net Phone: 843-571-4366

Bonnie Ponwith, SEFSC Science Director
NMFS, SEFSC, 75 Virginia Beach Drive, Miami, FL 33149
Bonnie.ponwith@noaa.gov Phone: 305-361-4264

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.

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, and Conclusions and Recommendations in accordance with the ToRs.

   a. The CIE Reviewer should describe in their own words the review activities completed during the panel review meeting, including providing a detailed summary of findings, conclusions, and recommendations.

   b. The CIE reviewer should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.

   c. The CIE reviewer should elaborate on any points raised in the Summary Report that they feel might require further clarification.

   d. The CIE reviewer shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

   e. The CIE independent report shall be a stand-alone document for others to understand the proceedings and findings of the meeting, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The CIE reviewer report shall include as separate appendices as follows:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work
   Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the Peer Review

Caribbean Data Evaluation Workshop

1. Evaluation, findings and recommendations of data collection operations and survey design
2. Evaluation, findings, and recommendations of data quality
3. Evaluation, findings, and recommendations of analytic methodologies
4. Recommendations for further improvements
5. Brief description on panel review proceedings highlighting pertinent discussions, issues, effectiveness, and recommendations

Annex 3: Tentative Agenda

Caribbean Data Evaluation Workshop

Hotel El Convento
100 Cristo Street, Old San Juan, PR 00901

Monday, 26 January 2009

1300 Introduction (John Carmichael and Julie Neer)
1330 Fisheries overview and history (Industry Representatives - Puerto Rico and USVI)
1400 Fisheries Description – Puerto Rico (SEFSC)
1445 Fisheries Description – USVI (SEFSC)
1530 Break
1600 Overview of territorial fisheries dependent data (Daniel Matos and Toby Tobias)
1630 Overview Fishery Independent data (SEFSC? Ron Hill?)
1700 Presentation on possible methods (SEFSC)

Tuesday, 27 January 2009

0830 CPUE Standardization presentation (SEFSC)
0900 Presentation on cluster analysis method for species complex identification (SEFSC)
0930 Data set evaluation (Todd Gedamke)
1200 Lunch
1330 Continue presentations and discussion

Wednesday, 28 January 2009

0830 Continued group discussion
1200 lunch
1330 Continued group discussion

Thursday, 29 January 2009

0830 Group Recommendations discussion
1200 lunch
1330 Finalize recommendations
1500 Adjourn

Annex 4: SEDAR Procedural Workshop: Caribbean Data Evaluation I Statement of Work

Overview:

The Council-Federal cooperative SEDAR process provides stock assessments for fisheries resources of the Southeast Region. Assessment priorities are typically established by management need or perceptions of management or population problems, and often do not consider data availability. As a result, despite several attempts by SEDAR, no acceptable quantitative assessments have been developed for Caribbean stocks because data to support traditional stock assessment methods simply do not exist. Independent peer review panels suggest that a comprehensive review of available data, along with consideration of alternative assessment methods, are required before scarce resources are applied to develop another uninformative assessment. It is clear that alternative methods need to be developed that will allow assessing Caribbean fisheries resources in a manner that will withstand independent peer review. Identifying and evaluating available data sources across all managed species is a strong first step that is consistent with peer review and assessment report recommendations.

SEDAR will convene a workshop including representatives from Federal agencies, territorial governments, non-governmental organizations, Council technical and constituent advisors, and university researchers to catalog and evaluate basic data, address alternative assessment methods that will accommodate the available data, and recommend assessment priorities that are consistent with available data and methods.

Objectives of the workshop:

- Review the available data and develop recommendations regarding their accuracy and reliability
- Review non-traditional assessment methods
- Recommend species or stocks for which informative assessments may be feasible
- Determine which species, if any, can be managed as species complexes

Academic and science agency participants will produce fisheries descriptions by region (Puerto Rico and USVI) it serve as background material, distributed prior to the workshop. Additional pre-workshop effort will include identifying university and territorial agency data sources that may not have been considered in previous assessment efforts and tabulating relevant descriptive characteristics of all datasets.

Constituent representatives will contribute their first-hand knowledge of fishing methods, data issues, and historical perspectives of the species and fisheries being discussed.

Management agency staff will review and document regulatory histories for species and fisheries, with particular attention paid to reef associated species.

Analysts will present alternative stock assessment methods which may be appropriate for data poor species, and given the information discussed during the workshop recommend which species and methods would be best for use in future SEDAR assessments.

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

The meeting was not convened with a review panel. The objective of the meeting was to evaluate possible paths to developing assessments meeting the requirements of the Magnuson Stevens Act for 2010, therefore no specific methods or assessment were put up for review. The large participants were listed on the SEDAR web site.