Reviewer Report to the Center for Independent Experts on the SEDAR 21 Highly Migratory Species (HMS) Sandbar, Dusky, and Blacknose sharks Review Workshop held April 18-22, 2011 in Annapolis, Maryland

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Executive Summary

This document contains my independent reviewer report of review activities and findings for the 21st Southeast Data, Assessment and Review (SEDAR 21) Review Workshop, held April 18-22, 2011, at the Loews Hotel in Annapolis, Maryland. Assessments for sandbar shark, dusky shark and the Atlantic and Gulf of Mexico blacknose shark stocks, including the findings of the data and assessment workshops, as well as the status of the stocks, were reviewed at the meeting.

Information about life history, commercial and recreational fisheries, and abundance indices for these stocks was compiled for these assessments providing a comprehensive overview of what is known about each stock. Two assessment models, a state-space age-structured production model (ASPM) and an age-structured, catch production model (ASCFM), were used in these assessments. Both models were implemented in AD-Model Builder. ASPM was used for the assessment of the two blacknose shark stocks and for sandbar shark. ASCFM was used for the dusky shark assessment. The implementations of the models were technically sound, but some issues with the underlying assumptions and uncertainties in some data inputs led the review panel to question whether the resulting abundance and fishing mortality time series were adequate to form the basis for management advice. Key sources of uncertainty in the assessment include the landings and removals from the stocks, productivity (including reproduction and natural mortality) and the status of the population at the start of the time period used in the model. Many sensitivity analyses were carried out by the assessment team before and during the review workshop to characterize the uncertainty resulting from model assumptions. This work also helped to formulate the recommendations for future model improvements that are provided.

Three of the four assessments were considered suitable for providing advice on status. For Gulf of Mexico blacknose shark, the model had difficulty fitting both the catch time series, which were relatively stable at a level that caused abundance declines in the early time period, and some of the indices that showed recent increases in abundance. Additionally, it was not clear that the stock would have been at a virgin abundance in 1950 (a model assumption) because a significant portion of the catches were in the shrimp fishery. Given these issues, this assessment was not accepted as a basis for providing advice on status. The other three assessments showed considerable uncertainty in the estimates of current stock size and exploitation, but the sensitivity analyses showed relatively consistent results with respect to whether the stocks were overfished and whether overfishing was occurring. The results indicate that dusky shark, Atlantic blacknose shark and sandbar shark all appear to be in an overfished state. They also indicate that overfishing is occurring for Atlantic blacknose shark and dusky shark, but not for sandbar shark.

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1.0. Background

This document contains my independent reviewer report of review activities and findings for the 21st Southeast Data, Assessment and Review (SEDAR 21) Review Workshop, held April 18-22, 2011, at the Loews Hotel in Annapolis, Maryland. Assessments for sandbar shark, dusky shark and the Atlantic and Gulf of Mexico (GOM) blacknose shark stocks, including the findings of the data and assessment workshops, as well as the status of the stocks, were reviewed at the meeting. Prior to the meeting, the review committee (Appendix 1), was provided with a Statement of Work (Appendix 2), including the Terms of Reference (TOR) for the assessment as well as for the review panel (RP). Assessment documents and background material (Appendix 3) were provided via a website and/or FTP site during the three weeks prior to the meeting. During the meeting there was a general consensus among the RP on most of the main discussion points and findings of the panel as outlined in the Review Workshop (RW) Report. This document contains a summary of those findings as well as my own opinions about these assessments.

2.0. Individual Reviewer Activities

Prior to the meeting I reviewed the assessment and background documents provided for the workshop. I participated in the Review Workshop in Annapolis, Maryland, April 18-22, 2011. The assessment team (AT) presented the assessment results in an informal manner with a lot of discussion during each presentation, an approach that worked very well in this case. During the meeting, I actively participated as member of the meeting review panel, questioned several aspects of the assessments, and made recommendations on how the uncertainty could better be characterized. These issues are expanded upon in the next section.

After the review workshop, I prepared this individual, independent report and assisted in writing the Review Workshop Report. As outlined in Appendix 3, this independent report is intended to summarize review activities completed during the panel review meeting, including providing a detailed summary of findings, conclusions, and recommendations for each TOR. The following section in this document contains my findings for these assessments.

3.0. Summary of Findings, Conclusions and Recommendations in Accordance with the TOR's

TOR 1: Evaluate the adequacy, appropriateness, and application of data used in the assessment.

During this RW, less emphasis was placed on review of the estimation of the landings and CPUE data inputs than was placed on the life history model inputs, model formations and projection methods. Altogether, the Data Workshop (DW) Report, the revisions to the data inputs described in the Assessment Workshop (AW) Report, and the supporting documentation, provided a comprehensive overview of the information available for the assessment of these four stocks.

For this assessment, the AT treated sandbar and dusky sharks in the GOM and the western North Atlantic Ocean as single stocks, but considered blacknose sharks in GOM and in the Atlantic as two separate stocks. For sandbar and dusky sharks this decision was based on genetic studies indicating no significant differentiation between the Gulf of Mexico and the Atlantic, and tag-recapture data showing a lot of movement between these regions. For blacknose sharks, tagging studies showed very little movement between the Gulf of Mexico and the western North Atlantic, and the available life history data indicated that the reproductive cycle differed between these regions. The AT correctly highlighted that there is relatively little information for determining if finer scale population structure exists. It was not clear that the existing genetics and tagging studies would detect structuring if populations were segregated during reproduction, but were mixed during most of the year. (This is difficult to determine without *a priori* information about where reproduction occurs.) Given the available information, the decisions about stock structure appear reasonable. However, caution is warranted because if a finer scale population structuring does exist, populations may have different levels of productivity and less productive populations could potentially be overfished if harvested in mixed population fisheries at levels consistent with the average productivity.

Landings and removals for sandbar, dusky and blacknose sharks, including commercial landings, recreational landings, discards and discard mortality and bycatch, are difficult to estimate. Issues were well described in the DW reports, including: under-reporting, species identification, spatial coverage, landings being aggregated for more than one species and whether data were included in more than one database creating the potential for double counting.

When estimating the numbers of released sharks that would have died post-release, the AT used a discard mortality rate of 6% based on a single study on blue sharks that had values for both at-vessel (13%) and post-release (19%) mortality. If it is assumed that the survival probability of released animals decreases with increases in stress, and that the proportion of the animals landed dead is an indicator of the level of stress, it might be more appropriate to scale the discard mortality rate by the proportion of animals landed dead. For example, after converting the values from the blue shark study to instantaneous mortality rates, their ratio is 1.51. Applying this ratio to the at-vessel mortality rate for blacknose shark (61%) after converting to an instantaneous mortality rate, would yield an instantaneous post-release mortality rate of 1.42. Based on this method, 75% of blacknose sharks would be expected to die post-release, a value that is higher than the one obtained for blacknose shark of 67% obtained by adding 6% to the at-vessel rate as was done in the assessment.

Landings and removals, their associated uncertainties and the way they were incorporated into the model varied among stocks. For sandbar shark, the commercial and unreported catch series were split into the Gulf of Mexico and Atlantic components to allow for different selectivities. A combined recreational and Mexican catch series, and a menhaden fishery discards time series were also used for this species. In the case of Atlantic blacknose shark, catches included: commercial landings from bottom longlines, nets and lines, recreational catches, shrimp bycatch and bottom longline discards. For Gulf of Mexico blacknose shark, catches included: commercial landings from bottom longlines, nets and lines, recreational catches, shrimp bycatch and bottom longline discards. To address the uncertainties in the catches, the AW conducted sensitivity analyses using higher and lower values. This is a reasonable approach to determine how the abundance estimates and status change at higher and lower catch levels, but if there are changes over time that could lead to over-estimation in some years, and under-estimation in others, marked differences in the abundance trajectories and overall status could occur that would not be identified using these sensitivity analyses. However, whether these temporal changes have occurred is not known. For dusky shark, the AT considered the catches to be too uncertain to be useful, leading to the use of a catch-free model. The model inputs for dusky shark to characterize the fishery were relative effort series developed for the directed bottom longline, pelagic longline fishery and the recreational fishery.

Both of the assessment models used for these stocks require that a year is identified when the populations could be assumed to have been at virgin levels, and a method is needed to estimate landings between this year and the time at which catches are available. (This period is referred to as the historical period.) The AT addressed this issue by assuming fishing effort increased (linearly or exponentially) during the historical period, and used sensitivity analyses to explore the effects of this assumption. The RP agreed that this was a reasonable approach given that landings and removals are not known, but in my opinion this is a key source of uncertainty in the assessments. This was particularly problematic for GOM blacknose shark where the shrimp bycatch comprises most of the catches for this stock. Given this fishery existed before the start of the historical period as defined in the model (1950), in my opinion it is difficult to justify the assumption that this stock was at virgin size at the start of the historical period.

The DW considered a total of fifty-eight indices of abundance, based on both fishery dependent and fishery independent data, for use in these assessments. Eleven indices were chosen for sandbar shark, five were chosen for dusky shark (plus two for sensitivity analysis), seven were used for Atlantic blacknose shark (plus one for sensitivity) and eight were used for GOM blacknose shark, all of which were standardized using GLM's. Many of the time series are quite short and exhibited higher annual variability than might be expected given the life history of these species, and many did not cover the full range of the stocks. The RP agreed with the AT observation that some indices showed different trends that they were likely responding to factors other than abundance.

The AT examined the influence of the indices on the assessment results using a several weighting and ranking schemes, by fitting to subsets for the indices and by deriving a single index using a hierarchical model. The AT carried forward some of these results as sensitivity analyses.

The AT thoroughly reviewed the information on life history available of these species, including natural mortality, growth rates, maturity schedules, fecundity and reproductive cycles. Fecundity appears reasonably well known and was used to calculate spawning stock fecundity. The number of age-1 recruits in the next year was calculated using a density-dependent survival parameter. An upper bound of one was used for this parameter. It is not clear that this bound was appropriate in all cases. For example, in the sandbar shark model, a fecundity-length relationship was used in the model, which gives the mean fecundity-at-length. If fecundity is density dependent, then the number of offspring produced could potentially exceed the average returned by this relationship, in which case a higher bound would be more appropriate. Alternatively, the maximum fecundity (or fecundity-at-length) could be used as the input. Natural mortality is highly uncertain, and the AT thoroughly explored uncertainty in natural mortality using sensitivity analyses to assumptions made about mortality-at-age. The AT used the maximum lifetime reproductive rate and steepness to characterize overall productivity. While this approach is common in fishery assessments, my personal preference is to see an annual reproductive rate as well as natural mortality presented separately, and sensitivities on these parameters carried out individually because the rates at which changes in the annual reproductive rates and changes in natural mortality effect population growth may be different. (At least when the population is not at an equilibrium age structure, a high productivity scenario conducted by decreasing natural mortality may result in a different population growth rate than a high productivity scenario conducted by changing the annual reproductive rate.) These options were explored at the RW.

ToR 2: Evaluate the adequacy, appropriateness, and application of methods used to assess the stock.

Two assessment models, a state-space age-structured production model (ASPM) and an age-structured, catch production model (ASCFM), were used in these assessments. Both models were implemented in AD-Model Builder (ADMB). In general, I believe that, given the uncertainty in the landings and removals, the very limited age data, and because relative to many fish species, productivity can be better derived from life history parameters, the choice of these models was appropriate for these assessments. This said, these models do have shortcomings that should be addressed prior to the next assessment.

ASPM was used for the assessments of the two blacknose shark stocks and for sandbar shark. This model begins with the assumption that the population is at an unfished equilibrium at some point in time (the year is assumed based on expert knowledge), and the population is projected forward by adding recruits to the population at age-1, and by removing animals from the population via either age-specific natural mortality or as catches (including discard mortality) distributed over the age classes using selectivity functions. The model is fit to the catches and abundance indices using maximum likelihood. In this implementation, a decision was made to model reproduction by calculating spawning stock fecundity (either number of spawners multiplied by the fecundity, or the sum of the number of spawners-at-length multiplied by the fecundity-at-length). Density-dependence was included in the model as pup survival to age-1, modeled with a Beverton-Holt spawner-recruit function. The slope at the origin for this function could either be a fixed or an estimated model parameter, and if an estimated parameter, either with or without an informative prior. In the sandbar shark assessment, this parameter was estimated with an informative prior. Exploratory analyses at the RW showed that if estimated without the prior, the model would estimate a value that was not biologically possible given the fecundity. In my opinion, while using a prior to help to address this issue is relatively standard practice in assessment models, for these species, where we know the data is producing implausibly high values, I would prefer the use of a fixed value for this parameter, together with sensitivity analyses to model productivity, rather than using a single model run in which the data would be expected to bias the estimate upwards. These additional analyses were completed at the RW.

A second issue with this implementation of ASPM was the derivation of the selectivities for the commercial fisheries and the abundance indices, an analysis carried out externally to the model. This approach leads to circular reasoning: in order to estimate selectivity, true abundance-at-age must be assumed, which requires some assumption about F. The estimated selectivity is then put into the model and used to estimate F, leading to estimates influenced by the originally assumed F.

In these assessments, because relatively little length information was available, data were at times aggregated over years prior to being converted to ages. Age-frequencies were derived using an age-length key based on proportions-at-age in each length category. Because the age data are very sparse, this approach led to some anomalies in age-length keys (e.g. for dusky shark, sharks in the 180-190 cm category were assigned to age classes 5, 7, 8 and 10 with 25% of the sharks in each age class).

Selectivities were then estimated using either an algorithm or by fitting by eye. When the algorithm was used, a trend line was fit to the log proportions-at-age, the slope of which would be influenced by natural mortality, fishing mortality, selectivity and potentially the aggregation of length data from more than one year, and deviations around this line were used to estimate selectivity. The approach also required an assumption that the fully selected age class is the one that was at highest abundance in the sample, an assumption that may not be valid if total mortality is high. Although I was willing to accept that the selectivity inputs for these models are based on expert knowledge, to avoid the issues above, I strongly recommend estimating selectivity within the model, an approach that was not attempted in these assessments. My preferred method (which is not uncommon) is to use a growth model to estimate abundance-at-length within the model, and to fit to the proportions-at-length when fitting the model. Given that relatively few length data were available, it is not known for which fisheries and indices this approach might have worked. The AT did openly acknowledge the limitations of their approach for estimating selectivities, and I do agree with the RP's decision to accept that, given the limited data and the models being used (the models were not set up to fit to length data), the selectivity curves were sufficient for these assessments.

A third issue with the choice of this model is the assumption that a year can be specified when the population is at an unfished equilibrium and that fishing mortality can be modeled from that year until the time when catch data become available. Any statement of status relative to a biomass reference level would depend on the relative abundance estimated by the model at the time when catch data become available. As mentioned under TOR 1, this assumption could not reasonably be justified for GOM blacknose shark. Ideally, both abundance and the virgin biomass should be estimated individually in the model, although I was willing to accept that given the data limitations, this was likely not possible in these assessments. However, because it was not attempted, we do not know.

This state space implementation of ASPM could be considered overly complex given the available data and shark biology. For example, in the sandbar shark assessment, the catch was weighted five times more heavily than the abundance indices, and as a result, the catches were fit nearly perfectly, a result that is very similar to assuming they are known without error. The model used annual effort deviates as a proxy for fishing effort, and 116 effort deviates were fit in order to estimate annual fishing mortality for each of the three fleets. If the catch was simply assumed known without error, these parameters could be dropped from the model and fishing mortality calculated directly. This would not have been the case for GOM blacknose shark, where catches, particularly in the shrimp fishery, are quite uncertain.

ASCFM was used for the dusky shark assessment. This model has the advantage that it does not rely on catch data, a major source of uncertainty in the dusky shark assessment, when estimating abundance. A key disadvantage is that only estimates of relative biomass are provided in the model output, and therefore cannot be used directly to evaluate the effects of many management actions such as establishing a TAC. In this implementation, the catch from a few years was used to scale the relative abundance estimates model output to absolute levels, an approach that considerably improves the utility of the model. However, to make best use of the tools available in ADMB for characterizing uncertainty, this approach might be better implemented directly in the model. The selectivities for the dusky shark assessment were also derived externally to the assessment model, so the comments above with respect to this issue apply here as well. This application of ASCFM also required the choice of a year at which the population could be assumed to be at virgin biomass, an assumption that may be difficult to avoid in the absence of reliable catch data.

Notwithstanding the issues above, the AT did a very thorough job exploring model options and the effects of assumptions, including: continuity runs, retrospective analyses, fitting to various combinations of indices, using different weighting schemes and using different mortality vectors. The population dynamics, as modeled, were appropriate for these species of sharks, and although the scale of abundance and fishing mortality differed among the model scenarios, the general conclusions about whether overfishing is occurring and whether the population is in an overfished state were relatively robust with respect to these "alternate states of nature". For these reasons, I was willing to accept with some reservations that these models were sufficient for this assessment, but strongly recommend further work to address the issues discussed above prior to the next assessment.

ToR 3: Recommend appropriate estimates of stock abundance, biomass, and exploitation.

Overall, I considered the assessments for Atlantic blacknose shark, sandbar shark and dusky shark to be sufficient for recommending appropriate estimates of stock abundance, biomass and exploitation, and that the major sources of uncertainty in these three assessments were associated with the assumptions made when setting up the model. For this reason, and as correctly identified by the AT, no single sets of estimates are appropriate for describing these stocks. For the GOM blacknose shark stock, there were two issues that were not reconciled at the RW that are important enough that I do not believe the results sufficiently to recommend estimates of stock abundance, biomass or exploitation based on the analyses. The first of these, as discussed above, is the uncertainty in the status of the population at the start of the historical period (when the population is assumed to be at a virgin size). The second issue pertains to difficulties fitting to both the catches and the survey indices simultaneously. The catch series shows relatively stable catches, mostly bycatch, until about 2005 followed by gradual decline. Given the low productivity of the stock, when these catches are reasonably fit, the model estimates a general downward trend in abundance from 1950 to about 2008. In contrast, the BLLOP, NMFS SE LL, SEAMAP summer and SEAMAP fall indices appear to indicate stable or increasing abundance trends and the marked residual patterns indicate how poorly the model results fits these indices. At the RW, the AT did a model run with a very low weight on the catch data in order to see what the predicted catch series would look like if the indices were fit well. Both the magnitude and trend of the predicted catches were sufficiently different from the observed catches, that it was not possible to reconcile the catch and abundance index time series at the RW.

In order to evaluate the effects of model assumptions on the assessment results, the RP requested additional sensitivity runs for each of the sandbar, dusky and Atlantic blacknose shark stocks.

These runs were intended to aid in evaluating the uncertainty resulting from assumptions about productivity (higher and lower assumed productivity), and about the catches that are used in the model to scale the abundance. I do not consider these runs to bracket the full set of possible outcomes for these assessments (For example if the catch time series was changed in one part of the series but not another, the results could be very different.), but I do concur with the RP that these scenarios, developed in consultation with the AT, bracket the uncertainty in biomass scale and productivity. The scenarios carried forward at the RW are described in Table 1.

The results of the base model (not to be considered the most representative model) and six sensitivity analyses for the Atlantic blacknose shark stock are shown in Figure 1 and Table 2. All results show increases in fishing mortality and decreases in spawning stock fecundity beginning in the 1980's (Figure 1). Abundance estimates in 2009 range from about 107,000 to about 439,000 animals (Table 2). Estimates of the depletion of the stock from an unfished state (SSF_{2009}/SSF_0) range from 0.17 to 0.26. Fishing mortality estimates in 2009 range from 0.29 to 0.48 (Table 2).

The results of the base model (not to be considered the most representative model) and seven sensitivity analyses for sandbar shark are shown in Figure 2 and Table 3. All results show increases in fishing mortality and decreases in spawning stock fecundity beginning in the early 1990's (Figure 2) followed by marked decreases in fishing mortality by 2008. Abundance estimates in 2009 range from just less than 1 million to about 4.6 million animals (Table 3). Estimates of the depletion of the stock from an unfished state (SSF_{2009}/SSF_0) range from 0.18 to 0.34. Fishing mortality estimates in 2009 range from 0.01 to 0.02 (Table 3).

The results of the base model (not to be considered the most representative model) and four sensitivity analyses for dusky shark are shown in Figure 3 and Table 4. All results show declining trends in spawning stock fecundity. Increases in fishing mortality occurred during the 1980's and 1990's followed by decreases in fishing mortality in the 2000's (Figure 3). Estimates of the depletion of the stock from an unfished state (SSB_{2009}/SSB_0) range from 0.13 to 0.24 (Table 4). Fishing mortality estimates in 2009 range from 0.026 to 0.084 (Table 4).

Table 1. Sensitivity analyses selected for the Review Workshop (from the draft Review Workshop report).

Run	Code	Description
Blacknose NWAT		
Base	RW-Base	Base case as provided by the Assessment Team with down-weighted UNC index
Inverse CV	RW-S1	Inverse CV abundance index weighting
1 year cycle	RW-S2	One year reproduction cycle
High catch	RW-S3	Catch increased one standard deviation
Low catch	RW-S4	Catch decreased one standard deviation
High productivity	RW-S5	Fecundity fixed at 6 pups for all ages, pup survival increased to 0.90
Low productivity	RW-S6	Pups per female reduced to 1, pup survival reduced to 0.75, *M* for ages 1-max increased to 0.25
Sandbar		
Base	Base	Base case as provided by the Assessment Team
Inverse CV	S1	Inverse CV abundance index weighting by the Assessment Team
2 year cycle	S5	Two year reproduction cycle by the Assessment Team
3 year cycle	S6	Three year reproduction cycle by the Assessment Team
High catch	RW-S1	Midpoint of base and high catch scenario of S13 by the Assessment Team
Low catch	RW-S2	Midpoint of base and low catch scenario of S12 by the Assessment Team
High productivity	RW-S3	Fecundity fixed at 9.5 pups for all ages, pup survival increased to 0.90, *M* for ages 1-max set to 0.105
Low productivity	RW-S4	Pup survival reduced to 0.80, *M* for ages 1-max increased by 10%
Dusky		
Base	Base	Base case as provided by the Assessment Team
High *M*	S3	Base *M* multiplied by 1.342
U-shaped *M*	S4	Elevated *M* for older age classes
High productivity	S17	Pups per female 10, two year reproductive cycle, pup survival 0.97
Low productivity	S18	Pups per female 4, pup survival 0.51

Table 2. Results of scenarios selected to explore the range of model outputs for the Atlantic blacknose shark stock (from the draft Review Workshop report).

	RW-Base		**RW-S1 (Inv-CV)**		**RW-S2 (1-yr cycle)**		**RW-S3 (high catch)**		**RW-S4 (low catch)**		**RW-S5 (high productivity)**		**RW-S6 (low productivity)**	
	Estimate	CV	Estimate	CV	Estimate	CV	Estimate	CV	Estimate	CV	Estimate	CV	Estimate	CV
SSF_{2009}/SSF_{MSY}	**0.60**	0.16	**0.43**	0.16	**0.61**	0.18	**0.58**	0.16	**0.64**	0.16	**0.61**	0.18	**0.55**	0.15
F_{2009}/F_{MSY}	**5.02**	0.32	**4.77**	0.36	**3.37**	0.32	**5.51**	0.33	**4.67**	0.32	**3.26**	0.32	**22.53**	0.32
SSF_{MSY}/SSF_0	0.79		0.58		0.75		0.64		0.69		0.74		0.74	
MSY	24495		22978		20810		66625		17910		20429		36996	
SPR_{MSY}	0.67	0.03	0.67	0.04	0.48	0.04	0.67	0.03	0.67	0.03	0.46	0.04	0.94	0.034
F_{MSY}	0.08		0.07		0.14		0.08		0.08		0.15		0.01	
SSF_{MSY}	96809		90814		123900		288360		77577		116650		104620	
N_{MSY}	153709		144550		122172		576722		155385		118788		247916	
F_{2009}	0.38	0.32	0.34	0.36	0.46	0.32	0.41	0.33	0.35	0.32	0.48	0.32	0.29	0.32
SSF_{2009}	58049	0.19	38816	0.17	76066	0.20	168300	0.19	49395	0.19	71346	0.20	57920	0.19
N_{2009}	155000		107418		120381		439136		131490		116155		222969	
SSF_{2009}/SSF_0	0.24	0.08	0.17	0.11	0.21	0.19	0.24	0.08	0.26	0.07	0.20	0.17	0.26	0.14
B_{2009}/B_0	0.22	0.17	0.16	0.14	0.20	0.18	0.21	0.15	0.24	0.15	0.20	0.19	0.22	0.16
R_0	85148	0.06	79571	0.08	66366	0.06	252780	0.07	68012	0.06	64308	0.06	145330	0.06
Pup-survival	0.81		0.81		0.81		0.81		0.81		0.90		0.75	
Alpha	2.26		2.26		4.52		2.26		2.26		5.02		1.14	
steepness	0.36		0.36		0.53		0.36		0.36		0.56		0.22	

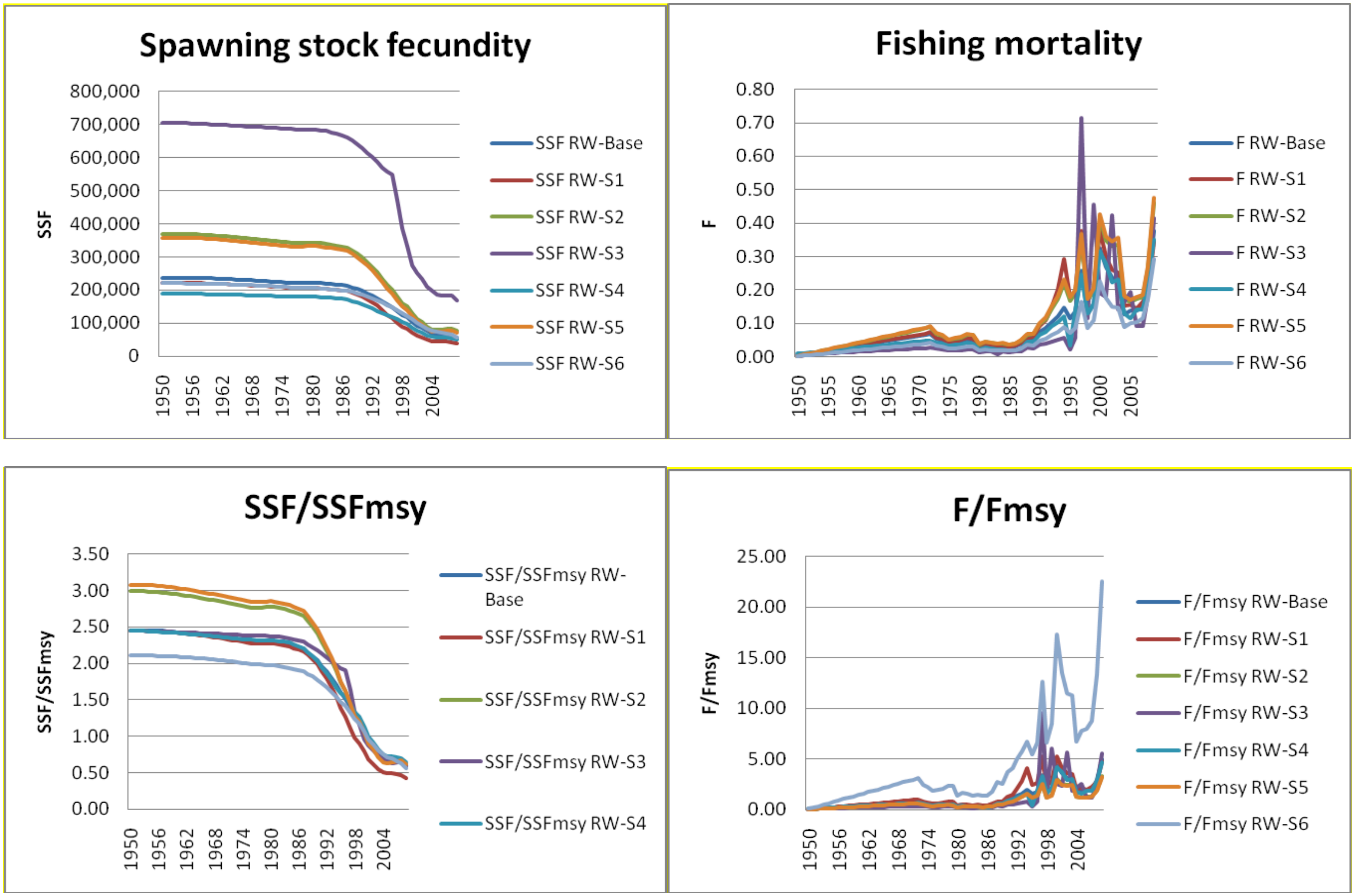

Figure 1. Time trajectories of key stock status indicators for Atlantic NWAT shark (from the draft Review Workshop report). Four trajectories are shown: SSF (spawning stock fecundity; top left panel), total apical F (top right panel), relative biomass (bottom left panel), and relative fishing mortality (bottom right panel).

Table 3. Results of scenarios selected to explore the range of model outputs for sandbar shark (from the draft Review Workshop report).

	BASE		S5 (2 yr rep cycle)		S6 (3 yr rep cycle)		S1 (Inv CV)		RW-1 (high catch)		RW-2 (low catch)		RW-3 (high prod)		RW-4 (low prod)	
Parameter	**Estimate**	**CV**	**Estimate**	**CV**	**Estimate**	**CV**	**Estimate**	**CV**	**Estimate**	**CV**	**Estimate**	**CV**	**Estimate**	**CV**	**Estimate**	**CV**
AICc	718.01		717.81		718.71		652.84		715.02		716.89		716.91		716.16	
Objective function	117.95		117.85		118.30		85.37		116.46		117.39		117.40		117.02	
SSF_{2009}/SSF_{MSY}	**0.66**	0.83	**0.64**	0.71	**0.66**	1.09	**0.56**	0.70	**0.71**	0.78	**0.67**	0.85	**0.51**	0.55	**0.72**	3.49
F_{2009}/F_{MSY}	**0.62**	0.57	**0.46**	0.55	**0.93**	0.61	**0.62**	0.44	**0.29**	0.57	**0.64**	0.57	**0.36**	0.48	**2.62**	0.61
N_{2009}/N_{MSY}	0.74		0.74		0.78		0.65		0.77		0.76		0.87		0.70	
MSY	160643		152940		173414		152907		461238		118699		98928		194389	
SPR_{MSY}	0.78	0.06	0.69	0.09	0.86	0.04	0.74	0.09	0.78	0.06	0.77	0.07	0.53	0.14	0.95	0.01
F_{MSY}	0.021		0.030		0.030		0.025		0.022		0.019		0.059		0.004	
SSF_{MSY}	477590		503420		503420		430320		1377800		349330		425530		530410	
N_{MSY}	1928165		1768504		2012907		1804687		5530573		1427463		1037329		2500141	
F_{2009}	0.01	0.57	0.01	0.55	0.01	0.61	0.02	0.44	0.01	0.57	0.01	0.57	0.02	0.48	0.01	0.61
SSF_{2009}	312890	0.60	319760	0.59	313510	0.63	240950	0.40	984770	0.58	234320	0.60	215900	0.55	381620	0.61
N_{2009}	1539102		1408804		1688767		1277408		4605900		1165723		975580		1899533	
SSF_{2009}/SSF_0	0.28	0.41	0.25	0.42	0.32	0.41	0.24	0.27	0.32	0.38	0.28	0.41	0.18	0.44	0.34	0.38
B_{2009}/B_0	0.34	0.33	0.33	0.33	0.35	0.34	0.30	0.18	0.37	0.31	0.34	0.33	0.27	0.33	0.36	0.33
R0	563490	0.20	516810	0.18	612140	0.23	516900	0.14	1587000	0.21	423250	0.20	281740	0.12	774030	0.24
Pup-survival	0.84	0.29	0.84	0.29	0.84	0.29	0.94	0.30	0.84	0.29	0.85	0.29	0.90	0.29	0.76	0.29
alpha	1.64		2.05		1.37		1.84		1.65		1.66		3.80		1.10	
steepness	0.29		0.34		0.25		0.31		0.29		0.29		0.49		0.22	
SSF_0	1097900	0.20	1258700	0.18	993980	0.23	1007200	0.14	3092300	0.21	824700	0.20	1192200	0.12	1121000	0.24
SSF_{MSY}/SSF_0	0.43		0.40		0.48		0.43		0.45		0.42		0.36		0.47	

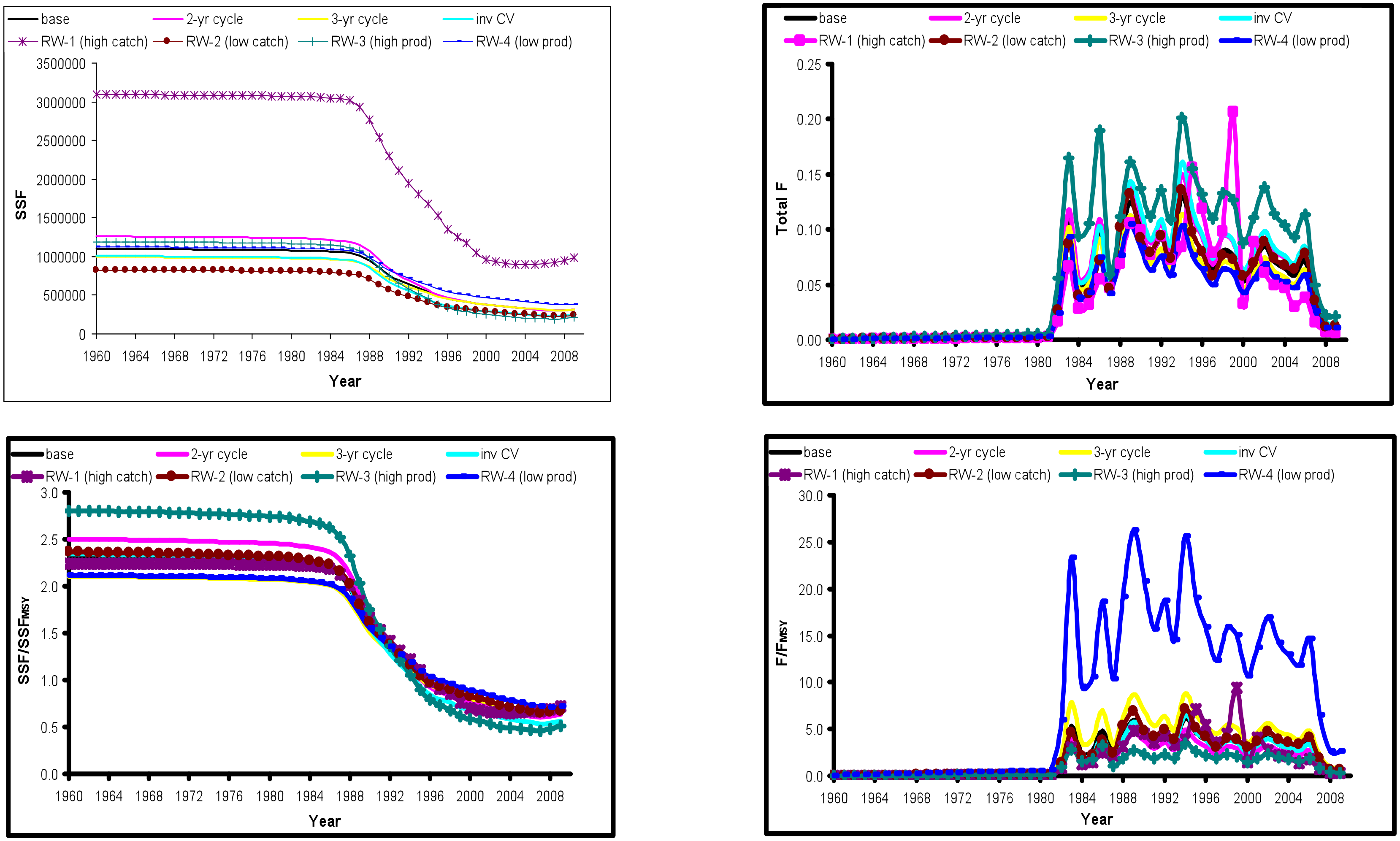

Figure 2. Time trajectories of key stock status indicators for sandbar shark (from the draft Review Workshop report). Four trajectories are shown: SSF (spawning stock fecundity; top left panel), total apical F (top right panel), relative biomass (bottom left panel), and relative fishing mortality (bottom right panel).

Table 4. Results of scenarios selected to explore the range of model outputs for dusky shark (from the draft Review Workshop report).

Run	**Base**	**S3**	**S4**	**S17**	**S18**
Description	--	High M	U shaped M	High productivity	Low productivity
F_{2009}	0.054	0.034	0.026	0.080	0.030
F_{MSY}	0.035	0.017	0.019	0.054	0.007
SSB_{2009}/SSB_0	0.15	0.18	0.18	0.13	0.24
SSB_{MSY}/SSB_0	0.35	0.43	0.43	0.28	0.47
SSB_{2009}/SSB_{MSST}	**0.46**	**0.45**	**0.44**	**0.49**	**0.53**
SSB_{2009}/SSB_{MSY}	**0.44**	**0.42**	**0.41**	**0.45**	**0.5**
F_{2009}/F_{MSY}	**1.55**	**2.01**	**1.39**	**1.49**	**4.35**
Pup survival	0.89	0.95	0.96	0.97	0.51
Steepness	0.51	0.32	0.32	0.71	0.25

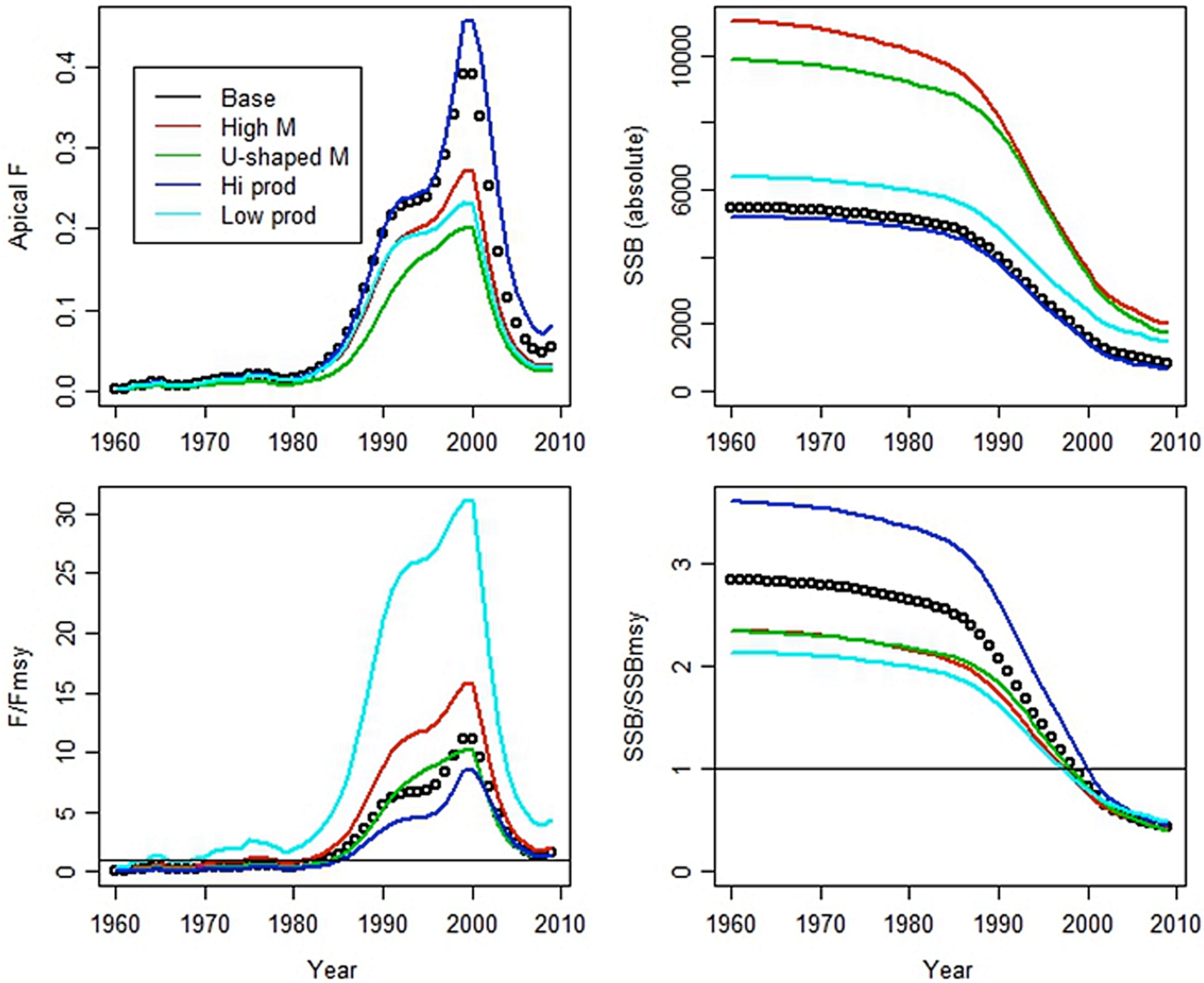

Figure 3. Time trajectories of key stock status indicators for dusky shark (from the draft Review Workshop report). Four trajectories are shown: total apical F (top left panel), SSB (spawning stock biomass; top right panel), relative fishing mortality (bottom left panel) and relative biomass (bottom right panel).

ToR 4: Evaluate the methods used to estimate population benchmarks and stock status (e.g., MSY, FMSY, BMSY, MSST, MFMT, or their proxies); recommend appropriate management benchmarks, provide estimated values for management benchmarks, and declare stock status, consistent with the stock status determination criteria, benchmark, and biological reference points in the Consolidated HMS FMP, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards.

The AT used F_{msy} and SSF_{msy} (for sandbar and Atlantic blacknose sharks) as the main population benchmarks in the assessments. Because selectivity, natural mortality, fecundity and pup survival were model inputs in many scenarios, the values of F_{msy} were nearly determined by these inputs. (Differences in the predicted catches for each fleet could affect the overall selectivity and therefore F_{msy}.). The minimum spawning stock size threshold (MSST) was defined as [(1-M) or 0.5 whichever is greater]*SSFMSY, and the maximum fishing mortality threshold (MFMT) was defined as F_{MSY}.

For the Atlantic blacknose shark stock, estimates of F_{msy} ranged from 0.01 to 0.15, and the ratio of F_{2009} to F_{msy} ranged from 3.26 to 22.53 (Table 2). The highest value for this ratio is from the lowest productivity scenario. Estimates of SSF_{msy} ranged from just over 77,000 to just over 288,000 animals, and the ratio of SSF_{2009} to SSF_{msy} ranged from 0.43 to 0.64 (Table 2). All scenarios estimate the current F to be above F_{msy} and the current SSF to be below MSST.

For sandbar shark, estimates of F_{msy} ranged from <0.01 to 0.059, and the ratio of F_{2009} to F_{msy} ranged from 0.29 to 2.62 (Table 3). The highest value for this ratio was the lowest productivity scenario. Estimates of SSF_{msy} ranged from just over 349,000 to just under 1.4 million animals, and the ratio of SSF_{2009} to SSF_{msy} ranged from 0.43 to 0.64 (Table 3). All scenarios except the low productivity scenario estimate the current F to be below F_{msy} and all scenarios estimate the current SSF to be below MSST.

For dusky shark, estimates of F_{msy} ranged from <0.01 to 0.054, and the ratio of F_{2009} to F_{msy} ranged from 1.39 to 4.35 (Table 4). The ratio of SSB_{2009} to SSB_{msy} ranged from 0.41 to 0.50. All scenarios estimate the current F to be above F_{msy} and the current SSB to be below MSST.

ToR 5: Evaluate the adequacy, appropriateness, and application of the methods used to project future population status, rebuilding timeframe, and generation time; recommend appropriate estimates of future stock condition (e.g., exploitation, abundance, biomass).

Two methods were used to project future population status. The AT used Pro-2Box for the projections for sandbar sharks and Atlantic blacknose sharks. Process error was included in the spawner-recruitment relationship with lognormal recruitment deviations with SD=0.4. Starting abundance-at-age was assumed known without error, and no other sources of variation were included in the projections. Projections were bootstrapped 500 times. The AT used a different approach for the projections for dusky shark. Here same dynamics were used as in the assessment model, and the initial biomass, fishing mortality and pup survival at low biomass were sampled from a multivariate normal distribution. This approach allows parameter covariance to be maintained, thereby reducing the probability of selecting sets of parameter values that are unlikely to have generated the data. This second approach has three advantages over the first: the population dynamics used in the projections are the same as those used in the assessment model, uncertainty in the 2009 biomass is incorporated into the projections, and parameter covariance is preserved. In my opinion, the decisions of the RP to not accept the projection methods used for sandbar or blacknose sharks, but to accept the method used for dusky sharks for individual scenarios and to request that the method be applied to the other scenarios, were appropriate decisions. I also agree with the RP recommendation that projections for sandbar and black sharks be undertaken with a method similar to the one used for dusky shark. These results were not all available at the time of writing this report.

When considering the projection methods, the RP concluded that the set of projections should minimally include: possible states of nature (different scenarios or sensitivity analyses) particularly if they are a significant source of uncertainty; uncertainty in the overall abundance estimate in the terminal year; uncertainty in the key productivity parameters; and parameter covariance.

There are additional sources of variation that could be included in the projection model, including implementation uncertainty (variation in F), autocorrelation in all model parameters, depensation and catastrophic events, all of which are difficult to estimate. However, because many of the timelines established for rebuilding are based on percentiles (30^{th} and 70^{th}) of the population projections rather than on the median, if all sources of variability or not included, the timelines for rebuilding will be underestimated.

There has been considerable discussion in the population viability analysis (PVA) literature on the appropriate use of long-term projections. The projections used in these assessments for rebuilding are analogous to the population projections used in PVA. PVAs are used extensively in conservation biology to predict both the risk of extinction for populations and species and to evaluate management strategies to recover at-risk populations. Several authors have cautioned against the use of PVAs because the predictions, typically time to extinction or to recovery, are almost always quite uncertain (e.g. Taylor 1995; McCarthy et al. 1996; Ludwig 1999). However, other authors believe that PVAs can be used to assess relative risk (e.g. Akçakaya & Raphael 1998; Beissinger & Westphal 1998; McCarthy et al. 2003) even if the timelines are highly questionable. Several reviews of PVAs are available in the literature. Beissinger and Westphal (1998) review the use of demographic models in species-at-risk management including analytical; deterministic, single population; stochastic, single population; meta-population and spatially-explicit models. They stress that predictions from these models are unreliable due to issues such as difficulties in estimating variances for demographic rates, lack of information on dispersal, uncertainty in the timing and nature of density dependence, and uncertainty about environmental trends and fluctuations. They suggest that PVAs are most useful for evaluating relative rather than absolute rates of extinction or rebuilding, and that short-term projections should be emphasized (although long-term can be used as extensions of short-term projections for strategy evaluation). Reed et al. (2002) also argue that these relative evaluations are the most appropriate use of PVAs. Similarly, this is most likely the best use of the projections in these assessments and the associated timelines should be considered, at best, uncertain.

ToR 6: Evaluate the adequacy, appropriateness, and application of methods used to characterize the uncertainty in estimated parameters. Provide measures of uncertainty for estimated parameters. Ensure that the implications of uncertainty in technical conclusions are clearly stated.

The AT thoroughly characterized uncertainty in the assessment results in two ways: by providing standard errors and confidence intervals for model parameters and output, and by evaluating the effects of model assumptions on model output via sensitivity analyses.

The AT used two of the three methods available within ADMB to characterize the uncertainty in the estimated parameters. As part of its standard output, ADMB provides standard errors (based on normal approximations and the delta method) for estimated parameters and derived values. Confidence intervals can be reasonably estimated if parameters are normally distributed. In addition, ADMB can provide profile likelihoods for specified parameters from which confidence interval can be obtained. The AT appropriately used both of these methods. Additionally, ADMB can produce posterior probability distributions for parameters of interest via Markov Chain Monte Carlo (MCMC) methods. The AT explored this method, but had difficulty getting the posterior distributions to converge. While I have a preference for MCMC for characterizing uncertainty because the resulting confidence intervals to be within the parameter bounds and because parameter covariance is better preserved, I believe methods used by the AT for single model runs were sufficient for this assessment.

As is often the case in stock assessments, more uncertainty results from decisions about data inputs and model structure and is associated with the parameter estimates from a single run. As discussed under TORs 2 and 3, the AT's thorough investigation of many model assumptions greatly aided the review. The resulting uncertainty in status is provided here under TORs 3 and 4.

ToR 7: Ensure that stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations. If there are differences between the AW and RW due to reviewer's requests for changes and/or additional model runs, etc., describe those reasons and results.

This TOR is ongoing at the time of writing of this independent reviewer report (this report is due before the Summary Report). As described above, the RP did request additional model runs to fully explore how assumptions made about natural mortality, reproduction and catches influenced and the reported results in the draft RW report are consistent with these requests.

TOR 8. Evaluate the SEDAR Process as applied to the reviewed assessments and identify any Terms of Reference that were inadequately addressed by the Data or Assessment Workshops.

Even though the one of the assessments was not accepted by the RP, and there were uncertainties identified for the other three, I believe the SEDAR process has, overall, led to a comprehensive compilation of information and status of blacknose, dusky and sandbar sharks. The data workshop and assessment workshop reports were very good summaries and sufficient detail was provided in the background material. During the RW, there was quite a bit of discussion on the advantages of including reviewers earlier in the process. This is likely case specific, depending on the issues encountered during the assessments. In my opinion, the AT recommendation that not more than two stocks be assessed at one time with the same number of participants is a good one. From the perspective of a reviewer, the time required for the review depending on both the number of stocks and the complexity of the analyses. Of the four assessments presented at this RW, three used the same model, which facilitated the review, and less time was placed reviewing the derivations of the catch and abundance indices than in some reviews. This said, and based on my review of the inputs prior to the meeting, I doubt that the outcome of these assessments would have been different had greater emphasis been placed on these inputs, although research recommendations may have been improved.

TOR 9. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted. Clearly denote research and monitoring needs that could improve the reliability of future assessments. Recommend an appropriate interval for the next assessment, and whether a benchmark or update assessment is warranted.

Overall, I agree with the research recommendations as discussed in the RW report. With respect to life history research, I agree that research on post-release survival by fishing sector and gear type, as well as research on fecundity, reproductive frequency and natural mortality are priorities. A better understanding of stock structure is also important given the potential to overfish lower productivity stocks, if they exist.

With respect to the abundance indices, I agree that evaluation of the individual indices via power analyses to determine whether they are informative about abundance trends, as well as further consideration about how to make the best use of the knowledge of the DW participants for developing index rankings are priorities.

With respect to the landings and removals, I agree that research that improves the understanding of historical landings, both in the modern and historical period and to support the assumptions about when stocks are at virgin biomass is a high priority.

As noted in this report and throughout the RW report, these assessments would be considerably improved by the routine collection of sex, age and length data for the indices as well as the landings and removals. Overall, I consider this a top priority. Construction of better age-length keys, estimation of selectivity within the model, and fitting of the model to length or age data thereby incorporating changes in age structure into the fitting process would all be expected to improve the assessment procedure, but all require better age and length data in order to be implemented.

Tagging studies, either integrated into the assessment model, or used to estimate fishing mortality or population size outside the model, may also be beneficial to the assessments although careful consideration needs to be given to the design of the study based on how the resulting data will be used in the assessment.

With respect to the assessment models, in my opinion further model development is needed prior to the next assessment. Minimally, the fishery and survey selectivities should be estimated within the assessment model, the model should be fit to either length or age data, a two sex model would make the better use of length and age data, and models that do not require an assumption that the population is at virgin levels at some point in time should be explored.

I also agree with the RP recommendation that simulation tests (management strategy evaluation) be used to test the performance of alternative assessment methods (including the catch-free model, ASPM, ASPIC, SS3, or stock-specific models), recruitment parameterizations, harvest control rules, assessment frequency and data collection.

Recommendation of appropriate time intervals for the next assessments is problematic for these stocks. The appropriate interval of the next assessment for GOM blacknose shark depends on progress made towards reconciling the issues raised during this assessment process. For the other stocks population growth is expected to be relatively slow, although abundance could drop rapidly if F increases unexpectedly. However, the recommended modifications to the model could potentially result in a different assessment of status. For these reasons, the next assessments should take place as soon as is practical, once the appropriate modifications to the models are made. Benchmark assessments are recommended.

Given the above, as long as management actions are effectively controlling fishing mortality, then changes in population size are expected to be relatively slow. In the longer-term, I recommend development of a set of indicators (age-structure, total mortality estimates from catch curves, changes in abundance indices values) that could be used to determine whether status has changed sufficiently to warrant a full assessment. As an example, a framework of indicators is used to determine whether full assessments will be requested from the ICES Working Group on North Atlantic Salmon each year based on the values of abundance indices. The development of the framework is described in ICES (2007), and its application in the annual Work Group Reports (e.g. ICES 2007b).

TOR 10. Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Provide a list of tasks that were not completed, who is responsible for completing each task, and when each task will be completed. Complete and submit the Final Summary Report within 3 weeks of workshop conclusion.

This TOR is ongoing at the time of writing of this independent reviewer report. Writing tasks for the Peer Review Summary were assigned to the RP members at the meeting, and a schedule was developed to ensure the Summary Report would be completed on time: the Reviewers were to provide draft sections of the report to the Chair by April 28th; the Chair was to compile the sections and produce a complete draft of the RW report and return it to the Reviewers by May 3rd; the Reviewers were to provide edits, additions, clarification and other comments back to the Chair by May 6th; the Chair was to incorporate these changes into the report and to return it to the Reviewers for final review by May 10th; and the reviewers were to approve the final report by May 12th. At the time of writing of this independent report, the Summary Report appeared to be on schedule.

4.0. Acknowledgments

Overall, I believe that this assessment review meeting provided a thorough review of the status of dusky, sandbar and blacknose sharks in the Gulf of Mexico and western North Atlantic Ocean as a result of the hard work of many people. Thanks go to Larry Massey for chairing the meeting and for providing the RT the latitude to fully explore some aspects of the assessment. Enric Cortez, Kate Andrews and Paul Conn presented the assessments and carried out further analyses during the review meeting. Their efforts greatly helped this review. I also wish to thank the other panel members, Neil Klaer and Shelton Harley for stimulating discussions both during and around the meeting; and Manoj Shivlani for his work coordinating the review on behalf of CIE and his assistance with travel arrangements. Julie Neer provided coordination around the meeting and guidance about the overall SEDAR process that aided in the review.

5.0. References

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6.0. Appendices

Appendix 1: Panel Membership
Appendix 2: CIE Statement of Work
Appendix 3: Bibliography of Materials Provided for Review

Appendix 1: Review Panel Membership.

Review Panel Membership

Workshop Panel

Larry Massey, Chair...NMFS SEFSC
Jamie Gibson...CIE Reviewer
Neil Klaer...CIE Reviewer
Shelton Harley ....CIE Reviewer

Analytic Representation

Enric Cortés .... NMFS SEFSC Panama City
Kate Andrews..NMFS SEFSC Beaufort
Paul Conn...NMFS AFSC

Rapporteur

Ivy Baremore .... NMFS SEFSC Panama City

HMS Representation

Karyl Brewster-Geisz...NMFS

Observers

.... SERO
.... SERO

Staff

Julie Neer .... SEDAR
Tyree Davis..NMFS Miami

Appendix 2: CIE Statement of Work.

Attachment A: Statement of Work for Dr. Jamie Gibson

External Independent Peer Review by the Center for Independent Experts

SEDAR 21 Highly Migratory Species (HMS) Sandbar, Dusky, and Blacknose sharks Review Workshop

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

Project Description: SEDAR 21 will be a compilation of data, a benchmark assessment of the stock, and an assessment review for conducted for HMS Sandbar, Dusky, and Blacknose sharks. The review workshop provides an independent peer review of SEDAR stock assessments. The term review is applied broadly, as the review panel may request additional analyses, error corrections and sensitivity runs of the assessment models provided by the assessment workshop panel. The review panel is ultimately responsible for ensuring that the best possible assessment is provided through the SEDAR process. The stocks assessed through SEDAR 21 are within the jurisdiction of the Highly Migratory Species Division of NOAA Fisheries and the states of Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**. The tentative agenda of the panel review meeting is attached in **Annex 3**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall have expertise, working knowledge, and recent experience in stock assessment, statistics, fisheries science, and marine biology sufficient to complete the primary task of reviewing the technical details of the methods used for the assessment. Each CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review described herein.

Location of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in Annapolis, MD during 18-22 April 2011.

Appendix 2: CIE Statement of Work.

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

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering Committee, the CIE shall provide the CIE reviewer information (full name, title, affiliation, country, address, email) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

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

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

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

Appendix 2: CIE Statement of Work.

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

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

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

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Participate during the panel review meeting in Savannah, Georgia during 18-22 April 2011.
3) In Annapolis, Maryland during 18-22 April 2011 as specified herein, conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4) No later than 6 May 2011, each 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 CIE Regional Coordinator, via email to David Sampson david.sampson@oregonstate.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

Appendix 2: CIE Statement of Work.

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

21 March 2011	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
4 April 2011	NMFS Project Contact sends the CIE Reviewers the pre-review documents
18-22 April 2011	Each reviewer participates and conducts an independent peer review during the panel review meeting
6 May 2011	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
20 May 2011	CIE submits CIE independent peer review reports to the COTR
27 May 2011	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 approved by the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the COTR 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 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).

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 completed with 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 acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Appendix 2: CIE Statement of Work.

Support Personnel:

William Michaels, Program Manager, COTR
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Appendix 2: CIE Statement of Work.

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

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

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

   a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a brief summary of findings, of the science, conclusions, and recommendations.

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

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

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

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

3. The reviewer report shall include the following appendices:

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

Appendix 2: CIE Statement of Work.

Annex 2: Tentative Terms of Reference for the Peer Review

SEDAR 21 Highly Migratory Species (HMS) Sandbar, Dusky, and Blacknose sharks Review Workshop

1. Evaluate the adequacy, appropriateness, and application of data used in the assessment.
2. Evaluate the adequacy, appropriateness, and application of methods used to assess the stock.
3. Recommend appropriate estimates of stock abundance, biomass, and exploitation.
4. Evaluate the methods used to estimate population benchmarks and stock status(*e.g., MSY, Fmsy, Bmsy, MSST, MFMT, or their proxies*); recommend appropriate management benchmarks, provide estimated values for management benchmarks, and declare stock status, consistent with the stock status determination criteria, benchmark, and biological reference points in the Consolidated HMS FMP, proposed FMPs and Amendments, other ongoing or proposed management programs, and National Standards.
5. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status, rebuilding timeframe, and generation time; recommend appropriate estimates of future stock condition (e.g., exploitation, abundance, biomass).
6. Evaluate the adequacy, appropriateness, and application of methods used to characterize the uncertainty in estimated parameters. Provide measures of uncertainty for estimated parameters. Ensure that the implications of uncertainty in technical conclusions are clearly stated.
7. Ensure that stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations. If there are differences between the AW and RW due to reviewer's requests for changes and/or additional model runs, etc., describe those reasons and results.
8. Evaluate the SEDAR Process as applied to the reviewed assessments and identify any Terms of Reference that were inadequately addressed by the Data or Assessment Workshops.
9. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted. Clearly denote research and monitoring needs that could improve the reliability of future assessments. Recommend an appropriate interval for the next assessment, and whether a benchmark or update assessment is warranted.
10. Prepare a Peer Review Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Provide a list of tasks that were not completed, who is responsible for completing each task, and when each task will be completed. Complete and submit the Final Summary Report within 3 weeks of workshop conclusion.

Appendix 2: CIE Statement of Work.

The review panel may request additional sensitivity analyses, evaluation of alternative assumptions, and correction of errors identified in the assessments provided by the assessment workshop panel; the review panel may not request a new assessment. Additional details regarding the latitude given the review panel to deviate from assessments provided by the assessment workshop panel are provided in the *SEDAR Guidelines* and the *SEDAR Review Panel Overview and Instructions*.

** The panel shall ensure that corrected estimates are provided by addenda to the assessment report in the event corrections are made in the assessment, alternative model configurations are recommended, or additional analyses are prepared as a result of review panel findings regarding the TORs above.**

Appendix 2: CIE Statement of Work.

Annex 3: Tentative Agenda

SEDAR 21 Highly Migratory Species (HMS) Sandbar, Dusky, and Blacknose sharks Review Workshop

Annapolis, Maryland April 18-22, 2011

Monday

1:00 p.m.	**Convene**	
1:00 – 1:30	**Introductions and Opening Remarks** *- Agenda Review, TOR, Task Assignments*	**Coordinator**
1:30 – 3:30	**Assessment Presentation**	**TBD**
3:30 – 4:00	**Break**	
4:00 – 5:00	**Continue Presentation/Discussion**	**Chair**
5:00 p.m. - 6:00 p.m.	**Panel Work Session**	**Chair**

Tuesday

8:30 a.m. – 11:30 a.m.	**Assessment Presentation**	**Chair**
11:30 a.m. – 1:00 p.m.	**Lunch Break**	
1:00 p.m. – 3:30 p.m.	**Panel Discussion** **-** *Assessment Data & Methods* *- Identify additional analyses, sensitivities, corrections*	**TBD**
3:30 p.m. – 3:45 p.m.	**Break**	
3:45 p.m. – 5:00 p.m.	**Panel Discussion** *- Continue deliberations* *- Review additional analyses*	**Chair**
5:00 p.m. - 6:00 p.m.	**Panel Work Session**	**Chair**

***Tuesday Goals*:** Initial presentations completed, sensitivities and modifications identified.

Wednesday

8:30 a.m. – 11:30 a.m.	**Panel Discussion** *- Review additional analyses, sensitivities* *- Consensus recommendations and comments*	**Chair**
11:30 a.m. – 1:00 p.m.	**Lunch Break**	
1:00 p.m. – 3:30 p.m.	**Panel Discussion**	**TBD**
3:30 p.m. – 3:45 p.m.	**Break**	
3:45 p.m. – 5:00 p.m.	**Panel Discussion**	**Chair**
5:00 p.m. - 6:00 p.m.	**Panel Work Session**	**Chair**

Wednesday Goals: Final sensitivities identified, Preferred models selected, Projection approaches approved, Summary report drafts begun

Thursday

8:30 a.m. – 11:30 a.m.	**Panel Discussion** *- Final sensitivities reviewed.* *- Projections reviewed.*	**Chair**
11:30 a.m. – 1:00 p.m.	**Lunch Break**	
1:00 p.m. – 3:30 p.m.	**Panel Discussion or Work Session**	**Chair**
3:30 p.m. - 3:45 p.m.	**Break**	
3:45 p.m. - 6:00 p.m.	**Panel Work Session** *- Review Consensus Reports*	**Chair**

Appendix 2: CIE Statement of Work.

Thursday Goals: Complete assessment work and discussions. Final results available. Draft Summary Report reviewed.

Friday

8:30 a.m. – 12:00 p.m.	**Panel Work Session**	**Chair**
12:00 p.m.	**ADJOURN**	

Appendix 3: Bibliography of Materials Provided for Review.

SEDAR 21
HMS Sandbar, Dusky, and Blacknose Sharks
Workshop Document List

Document #	Title	Authors	Working Group
Documents Prepared for the Data Workshop			
SEDAR21-DW-01	Standardized catch rates of sandbar and blacknose shark from a fishery independent survey in northwest Florida, 1996-2009.	John Carlson and Dana Bethea	Indices
SEDAR21-DW-02	Standardized catch rates of sandbar, dusky and blacknose sharks from the Commercial Shark Fishery Longline Observer Program, 1994-2009	John Carlson, Loraine Hale, Alexia Morgan and George Burgess	Indices
SEDAR21-DW-03	Standardized Catch Rates of Blacknose Shark from the Southeast Shark Drift Gillnet Fishery: 1993-2009	John Carlson and Michelle Passerotti	Indices
SEDAR21-DW-04	Standardized Catch Rates of Blacknose Shark from the Southeast Sink Gillnet Fishery: 2005-2009	John Carlson and Michelle Passerotti	Indices
SEDAR21-DW-05	The effect of turtle excluder devices (TEDS) on the bycatch of small coastal sharks in the Gulf of Mexico Peneid shrimp fishery	S.W. Raborn, K.I. Andrews, B.J. Gallaway, J.G. Cole, and W.J. Gazey	Catch Statistics
SEDAR21-DW-06	Reproduction of the sandbar shark *Carcharhinus plumbeus* in the U.S. Atlantic Ocean and Gulf of Mexico	Baremore, I.E. and L.F. Hale	Life History
SEDAR21-DW-07	Description of data sources used to quantify shark catches in commercial and recreational fisheries in the U.S. Atlantic Ocean and Gulf of Mexico	Baremore, I.E., Balchowski, H., Matter, V, Cortes, E.	Catch Statistics
SEDAR21-DW-08	Standardized catch rates for dusky and sandbar sharks from the US pelagic longline logbook and observer programs using generalized linear mixed models.	Enric Cortés	Indices
SEDAR21-DW-09	Updated catches	Enric Cortés	Catch Statistics
SEDAR21-DW-10	Large and Small Coastal Sharks Collected Under the Exempted Fishing Program Managed by the Highly Migratory Species	Jackie Wilson	Catch Statistics

Appendix 3: Bibliography of Materials Provided for Review.

	Management Division		
SEDAR21-DW-11	Abundance series from the MRFSS data set	Beth Babcock	Indices
SEDAR21-DW-12	Catches of Sandbar Shark from the Southeast US Gillnet Fishery: 1999-2009	Michelle S. Passerotti and John K. Carlson	Catch Statistics
SEDAR21-DW-13	Errata Sheet for 'CATCH AND BYCATCH IN THE SHARK GILLNET FISHERY: 2005-2006', NOAA Technical Memorandum NMFS-SEFSC-552	Michelle S. Passerotti and John K. Carlson	Catch Statistics
SEDAR21-DW-14	Data Update to Illegal Shark Fishing off the coast of Texas by Mexican Lanchas	Karyl Brewster-Geisz, Steve Durkee, and Patrick Barelli	Catch Statistics
SEDAR21-DW-15	An update of blacknose shark bycatch estimates taken by the Gulf of Mexico penaeid shrimp fishery from 1972 to 2009	W.J. Gazey and K. Andrews	Catch Statistics
SEDAR21-DW-16	A Negative Binomial Loglinear Model with Application for the Estimation of Bycatch of Blacknose Shark in the Gulf of Mexico Penaeid Shrimp Fishery	W.J. Gazey, K. Andrews, and B.J. Gallaway	Catch Statistics
SEDAR21-DW-17	Life history parameters for the sandbar shark in the Northwest Atlantic and Eastern Gulf of Mexico	Romine and Musick	Life History
SEDAR21-DW-18	Standardized catch rates of sandbar sharks and dusky sharks in the VIMS Longline Survey: 1975-2009	Romine, Parsons, Grubbs, Musick, and Sutton	Indices
SEDAR21-DW-19	Updating the blacknose bycatch estimates in the Gulf of Mexico using the Nichols method	Katie Andrews	Catch Statistics
SEDAR21-DW-20	Tag and recapture data for blacknose, *Carcharhinus acronotus*, sandbar, *C. plumbeus*, and dusky shark, *C. obscurus*, as kept in the NOAA Fisheries Southeast Fisheries Science Center Elasmobranch Tagging Management System, 1999-2009	D. Bethea and Carlson, J.K.	Life History
SEDAR21-DW-21	Age and growth of the sandbar shark, *Carcharhinus plumbeus*, in the Gulf of Mexico and southern Atlantic Ocean.	L. Hale and I. Baremore	Life History
SEDAR21-DW-22	Catch and bycatch in the bottom longline observer program from 2005	Hale, L.F., S.J.B. Gulak, and J.K.	Catch Statistics

Appendix 3: Bibliography of Materials Provided for Review.

	to 2009	Carlson	
SEDAR21-DW-23	Identification and evaluation of shark bycatch in Georgia's commercial shrimp trawl fishery with implications for management	C. N. Belcher and C. A. Jennings	Catch Statistics
SEDAR21-DW-24	Increases in maximum observed age of blacknose sharks, *Carcharhinus acronotus*, based on three long term recaptures from the Western North Atlantic	Bryan S. Frazier, William Driggers, and Christian Jones	Life History
SEDAR21-DW-25	Catch rates and size distribution of blacknose shark *Carcharhinus acronotus* in the northern Gulf of Mexico, 2006-2009	J. M. Drymon, S.P. Powers, J. Dindo and G.W. Ingram	Indices
SEDAR21-DW-26	Reproductive cycle of sandbar sharks in the northwestern Atlantic Ocean and Gulf of Mexico	Andrew Piercy	Life History
SEDAR21-DW-27	Standardized catch rates for juvenile sandbar sharks caught during NMFS COASTSPAN longline surveys in Delaware Bay	Camilla T. McCandless	Indices
SEDAR21-DW-28	Standardized catch rates for sandbar and dusky sharks caught during the NEFSC coastal shark bottom longline survey	Camilla T. McCandless and Lisa J. Natanson	Indices
SEDAR21-DW-29	Standardized catch rates for sandbar and blacknose sharks caught during the Georgia COASTSPAN and GADNR red drum longline surveys	Camilla T. McCandless and Carolyn N. Belcher	Indices
SEDAR21-DW-30	Standardized catch rates for sandbar and blacknose sharks caught during the South Carolina COASTSPAN and SCDNR red drum surveys	Camilla T. McCandless and Bryan Frazier	Indices
SEDAR21-DW-31	Standardized catch rates of sandbar and dusky sharks from historical exploratory longline surveys conducted by the NMFS Sandy Hook, NJ and Narragansett, RI Labs	Camilla T. McCandless and John J. Hoey	Indices
SEDAR21-DW-32	Standardized catch rates of dusky and sandbar sharks observed in the gillnet fishery by the Northeast Fisheries Observer Program	NOT RECEIVED	Indices
SEDAR21-DW-33	Standardized catch rates for blacknose, dusky and sandbar sharks caught during a UNC longline survey conducted between 1972 and 2009 in	Frank J. Schwartz, Camilla T. McCandless, and John J. Hoey	Indices

	Onslow Bay, NC		
SEDAR21-DW-34	Sandbar and blacknose shark occurrence in standardized longline, drumline, and gill net surveys in southwest Florida coastal waters of the Gulf of Mexico	Robert Hueter, John Morris, and John Tyminski	Indices
SEDAR21-DW-35	Atlantic Commercial Landings of blacknose, dusky, sandbar, unclassified, small coastal, and requiem sharks provided by the Atlantic Coastal Cooperative Statistics Program (ACCSP)	Christopher Hayes	Catch Statistics
SEDAR21-DW-36	Life history and population structure of blacknose sharks, *Carcharhinus acronotus*, in the western North Atlantic Ocean	William B. Driggers III, John K. Carlson, Bryan Frazier, G. Walter Ingram Jr., Joseph M. Quattro, James A. Sulikowski and Glenn F. Ulrich	Life History
SEDAR21-DW-37	Movements and environmental preferences of dusky sharks, *Carcharhinus obscurus*, in the northern Gulf of Mexico	Eric Hoffmayer, James Franks, William Driggers, and Mark Grace	Life History
SEDAR21-DW-38	Preliminary Mark/Recapture Data for the Sandbar Shark (*Carcharhinus plumbeus*), Dusky Shark (*C. obscurus*), and Blacknose Shark (*C. acronotus*) in the Western North Atlantic	Nancy E. Kohler and Patricia A. Turner	Life History
SEDAR21-DW-39	Catch rates, distribution and size composition of blacknose, sandbar and dusky sharks collected during NOAA Fisheries Bottom Longline Surveys from the U.S. Gulf of Mexico and U.S. Atlantic Ocean	Walter Ingram	Indices
SEDAR21-DW-40	Standardized catch rates of the blacknose shark (*Carcharhinus acronotus*) from the United States south Atlantic gillnet fishery, 1998-2009	Kristin Erickson and Kevin McCarthy	Indices
SEDAR21-DW-41	Index of Abundance of Sandbar Shark (*Carcharinus plumbeus*) in the Southeast Region, 1992-2007, From United States Commercial Fisheries	Heather Balchowsky and Kevin McCarthy	Indices

Appendix 3: Bibliography of Materials Provided for Review.

	Longline Vessels		
SEDAR21-DW-42	Examination of commercial bottom longline data for the construction of indices of abundance of dusky shark in the Gulf of Mexico and US South Atlantic	Kevin McCarthy	Indices
SEDAR21-DW-43	Indices of abundance for blacknose shark from the SEAMAP trawl survey	Walter Ingram	Indices
SEDAR21-DW-44	Standardized catch rates of sandbar sharks (*Carcharhinus plumbeus*) and dusky sharks (*Carcharhinus obscurus)* from the large pelagic rod and reel survey 1986-2009	John F. Walter and Craig Brown	Indices
SEDAR21-DW-45	A note on the number of pups for two blacknose sharks (*Carcharhinus acronotus*) from the Gulf of Mexico	David Stiller	Life History
SEDAR21-DW-46	Mote LL index	Walter Ingram	Indices
Documents Prepared for the Assessment Process			
SEDAR21-AP-01	Hierarchical analysis of blacknose, sandbar, and dusky shark CPUE indices	Paul Conn	
SEDAR21-AP-02	Computer code for the SEDAR 21 age-structured catch-free model for dusky sharks	Sustainable Fisheries Branch – NMFS Beaufort Lab	
SEDAR21-AP-03	SEDAR 21 Sandbar Shark pre-review assessment process report	SEDAR 21 Assessment Process Panel	
SEDAR21-AP-04	SEDAR 21 Dusky Shark pre-review assessment process report	SEDAR 21 Assessment Process Panel	
SEDAR21-AP-05	SEDAR 21 Atlantic Blacknose Shark pre-review assessment process report	SEDAR 21 Assessment Process Panel	
SEDAR21-AP-06	SEDAR 21 Gulf of Mexico Blacknose Shark pre-review assessment process report	SEDAR 21 Assessment Process Panel	
Documents Prepared for the Review Workshop			
SEDAR21-RW-01	Computer code for the SEDAR 21 age-structured production model for sandbar sharks	Sustainable Fisheries Branch – NMFS Panama City Lab	
SEDAR 21-RW-02	Computer code for the SEDAR 21 age-structured production model for blacknose sharks	Sustainable Fisheries Branch – NMFS Beaufort Lab	
Final Stock Assessment Reports			

Appendix 3: Bibliography of Materials Provided for Review.

SEDAR21-SAR1	Sandbar Shark	
SEDAR21-SAR2	Dusky Shark	
SEDAR21-SAR3	Gulf of Mexico Blacknose Shark	
SEDAR21-SAR4	Atlantic Blacknose Shark	
Reference Documents		
SEDAR21-RD01	SEDAR 11 (LCS) Final Stock Assessment Report	SEDAR 11 Panels
SEDAR21-RD02	SEDAR 13 (SCS) Final Stock Assessment Report	SEDAR 13 Panels
SEDAR21-RD03	Stock assessment of dusky shark in the U.S. Atlantic and Gulf of Mexico	E. Cortés, E. Brooks, P. Apostolaki, and C.A. Brown
SEDAR21-RD04	Report to Directed Shark Fisheries, Inc. on the 2006 SEDAR 11 Assessment for Sandbar Shark	Frank Hester and Mark Maunder
SEDAR21-RD05	Use of a Fishery-Independent Trawl Survey to Evaluate Distribution Patterns of Subadult Sharks in Georgia	Carolyn Belcher and Cecil Jennings
SEDAR21-RD06	Demographic analyses of the dusky shark, *Carcharhinus obscurus*, in the Northwest Atlantic incorporating hooking mortality estimates and revised reproductive parameters	Jason G. Romine & John A. Musick & George H. Burgess
SEDAR21-RD07	Observations on the reproductive cycles of some viviparous North American sharks	José I. Castro
SEDAR21-RD08	Sustainability of elasmobranchs caught as bycatch in a tropical prawn (shrimp) trawl fishery	Ilona C. Stobutzki, Margaret J. Miller, Don S. Heales, David T. Brewer
SEDAR21-RD09	Age and growth estimates for the dusky shark, *Carcharhinus obscurus,* in the western North Atlantic Ocean	Lisa J. Natanson, John G. Casey and Nancy E. Kohler
SEDAR21-RD10	Reproductive cycle of the blacknose shark *Carcharhinus acronotus* in the Gulf of Mexico	J. A. Sulikowski, W. B. Driggers III, T. S. Ford, R. K. Boonstra and J. K. Carlson
SEDAR21-RD11	A preliminary estimate of age and growth of the dusky shark Carcharhinus obscurus from the south-west Indian Ocean, with comparison to the western north Atlantic population	L.J. Natanson and N.E. Kohler
SEDAR21-RD12	Bycatch and discard mortality in commercially caught blue sharks *Prionace glauca* assessed using archival satellite pop-up tags	Steven E. Campana, Warren Joyce, Michael J. Manning
SEDAR21-RD13	Short-term survival and movements	C. W. D. Gurshin and S. T.

Appendix 3: Bibliography of Materials Provided for Review.

	of Atlantic sharpnose sharks captured by hook-and-line in the north-east Gulf of Mexico	Szedlmayer
SEDAR21-RD14	Plasma catecholamine levels as indicators of the post-release survivorship of juvenile pelagic sharks caught on experimental drift longlines in the Southern California Bight	Barbara V. Hight, David Holts, Jeffrey B. Graham, Brian P. Kennedy, Valerie Taylor, Chugey A. Sepulveda, Diego Bernal, Darlene RamonB, Randall Rasmussen and N. Chin Lai
SEDAR21-RD15	The physiological response to capture and handling stress in the Atlantic sharpnose shark, *Rhizoprionodon terraenovae*	Eric R. Hoffmayer & Glenn R. Parsons
SEDAR21-RD16	The estimated short-term discard mortality of a trawled elasmobranch, the spiny dogfish (*Squalus acanthias*)	John W. Mandelman & Marianne A. Farrington
SEDAR21-RD17	At-vessel fishing mortality for six species of sharks caught in the northwest Atlantic and Gulf of Mexico	Alexia Morgan and George H. Burgess
SEDAR21-RD18	Evaluating the physiological and physical consequences of capture on post-release survivorship in large pelagic fishes	G.B. Skomal
SEDAR21-RD19	The Physiological Response of Port Jackson Sharks and Australian Swellsharks to Sedation, Gill-Net Capture, and Repeated Sampling in Captivity	L. H. Frick, R. D. Reina, and T. I. Walker
SEDAR21-RD20	Serological Changes Associated with Gill-Net Capture and Restraint in Three Species of Sharks	C. Manire, R. Hueter, E. Hull and R. Spieler
SEDAR21-RD21	Differential sensitivity to capture stress assessed by blood acid–base status in five carcharhinid sharks	John W. Mandelman & Gregory B. Skomal
SEDAR21-RD22	Review of information on cryptic mortality and the survival of sharks and rays released by recreational fishers	Kevin McLoughlin and Georgina Eliason
SEDAR21-RD23	Pathological and physiological effects of stress during capture and transport in the juvenile dusky shark, *Carcharhinus obscurus*	G. Cliff and G.D. Thurman
SEDAR21-RD24	Pop-off satellite archival tags to chronicle the survival and movements of blue sharks following release from	Michael Musyl and Richard Brill

Appendix 3: Bibliography of Materials Provided for Review.

	longline gear	
SEDAR21-RD25	Evaluation of bycatch in the North Carolina Spanish and king mackerel sinknet fishery with emphasis on sharks during October and November 1998 and 2000 including historical data from 1996-1997	Chris Jensen and Glen Hopkins