Special Report No. 84
of the

Atlantic States Marine Fisheries Commission

Healthy, self-sustaining populations for all Atlantic coast fish species or successful restoration well in progress by the year 2015

Multispecies VPA (MSVPA-X) Internal Peer Review

Terms of Reference and Panel Report

October 2005

Special Report No. 84
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Atlantic States Marine Fisheries Commission

Terms of Reference and Internal Peer Review Panel Report for the Multispecies VPA (MSVPA-X) Internal Peer Review

Conducted on
July 14-16, 2004
Norfolk, Virginia

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Preface

Summary of the Commission Peer Review Process

The Stock Assessment Peer Review Process, adopted in October 1998 by the Atlantic States Marine Fisheries Commission, was developed to standardize the process of stock assessment reviews and validate the Commission's stock assessments. The purpose of the peer review process is to: (1) ensure that stock assessments for all species managed by the Commission periodically undergo a formal peer review; (2) improve the quality of Commission stock assessments; (3) improve the credibility of the scientific basis for management; and (4) improve public understanding of fisheries stock assessments. The Commission stock assessment review process includes evaluation of input data, model development, model assumptions, scientific advice, and review of broad scientific issues, where appropriate.

The Stock Assessment Peer Review Process report outlines four options for conducting a peer review of Commission managed species. These options are, in order of priority:

1. The Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC) conducted by the National Marine Fisheries Service (NMFS), Northeast Fisheries Science Center (NEFSC) or the Southeast Data and Assessment Review (SEDAR) conducted by the National Marine Fisheries Service (NMFS), Southeast Fisheries Science Center (SEFSC).

2. A Commission stock assessment review panel composed of 3-4 stock assessment biologists (state, federal, university) will be formed for each review. The Commission review panel will include scientists from outside the range of the species to improve objectivity.

3. A formal review using the structure of existing organizations (i.e. American Fisheries Society, International Council for Exploration of the Sea, or the National Academy of Sciences).

4. An internal review of the stock assessment conducted through the Commission's existing structure (i.e. Technical Committee, Stock Assessment Committee).

Twice annually, the Commission's Interstate Fisheries Management Program (ISFMP) Policy Board prioritizes all Commission managed species based on species Management Board advice and other prioritization criteria. The species with highest priority are assigned to a review process to be conducted in a timely manner.

In the 2003, the Multispecies Virtual Population Analysis (MSVPA-X) stock assessment model recommended to go to an internal peer review. A review panel was convened of stock assessment biologists and representatives from the fishing community and non-government organizations. Panel members had expertise in Atlantic menhaden, striped bass, bluefish and weakfish life history, trophic interactions of the species and multispecies stock assessment methods. The ASMFC internal peer review for the MSVPA-X model was conducted July 14-16, 2004 in Norfolk, VA.

Purpose of the Terms of Reference and Advisory Report

The Terms of Reference and Advisory Report provides summary information concerning the data used in the MSVPA-X, assumptions for filling data "gaps" when reliable data was not available, model formulation and functionality, research recommendations and recommendations on how to incorporate multispecies information into single species assessments. The Multispecies VPA (MSVPA-X) User's Manual "An Expanded Multispecies Virtual Population Analysis Approach (MSVPAX) to Evaluate Predator-Prey Interactions in Exploited Fish Ecosystems" can be obtained via the Commission's website at www.asmfc.org under the Research and Statistics - Multispecies page or by contacting the Commission at (202) 289-6400.

Acknowledgements

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Thanks are also extended to the ASMFC Striped Bass, Atlantic Menhaden, Weakfish, and Bluefish Technical Committees that reviewed the input data that has been utilized in the model and the model formulation.

Special appreciation is given to the staff dedicated to the performance of the Internal Review and finalization of peer review reports – Geoffrey White, Nancy Wallace and Patrick Kilduff.

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2. Evaluate assumptions for data gap filling when reliable data were not available (diet, biomass of prey species, feeding selectivity). *3*

3. Review model formulation (overall setup, data handling, VPA calculations, assessment options, uncertainty analysis, recruitment model options, and forward projection options). *5*

4. Develop research recommendations for data collection, model formulation, and model results presentation. *7*

5. Develop recommendations on how to utilize the model and results in the Commission's stock assessment for individual species. *11*

Terms of Reference for the Multispecies VPA (MSVPA-X) Internal Peer Review

In preparation for a full peer review in 2005, the Expanded Multispecies Virtual Population Analysis model (MSVPA-X) was evaluated by an Atlantic States Marine Fisheries Commission Internal Peer Review Panel. The Panel reviewed the input data, gap filling methods for unavailable data, and model formulation and functionality. The Panel also made short- and long-term research recommendations and suggestions for incorporating multispecies information into single species assessment. As the model was developed, it was presented to each of the species technical committees (Atlantic menhaden, *Brevoorita tyrannus*; striped bass, *Morone saxatilis*; bluefish, *Pomatomus saltatrix*; and weakfish, *Cynoscion regalis*) to familiarize each group with the formulation and application of the MSPVA-X, summarize the model inputs, and request feedback on the data used to model predator and prey populations. This Panel Report will be used to help guide the ASMFC Multispecies Assessment Subcommittee in their preparations (e.g., model formulation and input data improvements) for the SARC Peer Review in Fall 2005.

The MSVPA-X generally draws from the most recent available stock assessment information developed by technical committees for Atlantic menhaden, striped bass, bluefish and weakfish. The input data and assessment methods for individual species were structured to match those currently used in these assessments to the extent possible. Supplementary diet and physiological information was drawn from published and unpublished sources. Estimates of the total seasonal biomass of alternative prey species not explicitly modeled were drawn from literature sources.

The MSVPA-X approach builds upon the framework of the standard (International Council for the Exploration of the Seas – ICES) MSVPA, but modifies the consumption model by estimating dietary linkages, suitability indices, and spatial overlap outside of MSVPA-X model (see Term of Reference 2). The Panel noted that this approach allows for model formulation and conceptualization for the MSVPA-X species along the Atlantic coast in the absence of a "year of the stomach", by merging data from diet studies that do not overlap geographically and temporally. In the absence of complete diet data sets, this approach permits tracking of dietary regime changes in the MSVPA-X species.

1. Evaluate adequacy and appropriateness of model input data, including fishery-dependent data, fishery-independent data, diet data, etc.

The Panel recognized that data currently used in the single species assessments (landings, effort, growth, maturity, recruitment, fishery independent indices, etc.) have already been reviewed by individual species technical committees and by peer review panels. As such, the most recent single species assessment data should be used as input data for the MSVPA-X. The Panel recommended that the most recent striped bass and weakfish data (scheduled to be updated fall 2004) should be used to create the base MSVPA-X run. The Panel also noted that the MSVPA-X will only be as good as the underlying single species models, and recommended improvements to the single species assessments as deemed appropriate by the single species technical committees. The Panel noted that weakfish and striped bass length and weight at age data has

been variable over time according to stock assessments and suggested that an average value be used in the base MSVPA-X run until verification of single species length-weight data.

The Panel focused discussion of data inputs on the diet data and consumption model parameters, as they are not included in single species assessments. The Panel recognized that diet data was available for estuarine and offshore areas and referenced several additional sources, but was lacking from intermediate (coastal) areas throughout the range. Diet studies from winter months are lacking. Diet data already used in the model should be supplemented with the most recent two years and other data, as available. The Panel felt that the compilation of diet data was currently thorough, but would be much improved with inclusion of the above data. The Panel made a long-term recommendation to conduct a diet and abundance study of the US Atlantic coast, as it would provide valuable diet information for this modeling approach.

The Panel discussed the appropriateness of the prey groupings in the model, presented in the example MSVPA-X as Atlantic menhaden, anchovy, macrozooplankton, sciaenids, and benthic invertebrates. The role of alternative prey in the model is an important function for prey switching at low or other levels of menhaden abundance; therefore, including important alternative prey species is critical to evaluate the model formulation. Based on information from the documented diet studies, the Panel suggested a revision of the prey groupings to the following:

Full MSVPA-X Age-structured Prey

- Atlantic menhaden

Other Prey

- Sciaenids (spot, croaker)
- Small Forage Fish (anchovy, silversides, and sand lance)
- Medium Forage Fish (butterfish, squid, mullets)
- Clupeids (Atlantic herring, thread herring, and others)
- *Alosa* spp. (shads and river herrings, and others)
- Benthic invertebrates (worms)
- Benthic crustaceans (lobsters, blue crabs, jonah crabs, calico crabs)
- Macrozooplankton (shrimps, mysids, amphipods)

Prey items were deemed important if they were consumed by several predators or if their availability made them a large component of the prey field during critical timeframes. Prey items were categorized by similar life histories and role in the ecosystem. Pulses of availability for certain prey items can be accounted for using type preference and spatial overlap parameters (see Term Of Reference #2 for methods). The Panel suggested clupeids and *Alosa* spp. should be explored as separate groupings but recognized they may need to be combined due to *Alosa* spp. data availability. The Panel noted that as the number of prey species increases, the prey suitability rankings become more difficult to determine. Long-term research recommendations made by the Panel include estimating the carrying capacity of the system to compare with model

estimation for carrying capacity and to improve biomass estimates for prey species on a coastwide basis.

The Panel recognized that although adults of the four species winter off of North Carolina, no diet data are available for that area and season. A second data gap was identified for near shore areas. It was noted that the model would use the type, size, and spatial overlap parameters to predict diets in seasons where complete diet data are not available. The Panel recommended sampling the winter North Carolina fisheries and near shore coastal regions to verify diets predicted by the model. The Panel also recommended conducting stomach selectivity research for predator species and to encourage fishery independent surveys to take regular gut contents to improve the prey-ranking matrix. Another recommendation was to evaluate whether striped bass disease (mycobacteria) is correlated with natural mortality and food availability or if the disease is disrupting striped bass consumption.

For several of the prey groupings, absolute abundance or trends in biomass may be difficult to estimate for input into the MSVPA-X. Mechanisms to expand localized biomass estimates using primary productivity information were discussed for anchovy and other alternative prey (see below). The Panel discussed the addition of other age-structured species, but felt that there were no other appropriate prey species that should be included at this time.

The Panel noted and emphasized that the MSVPA-X approach was designed to model a specific portion of interactions within the ecosystem that includes the full geographic extent of the four highlighted species (menhaden, striped bass, bluefish and weakfish). It was not designed to be spatially explicit, such as on a regional basis.

2. Evaluate assumptions for data gap filling when reliable data were not available (diet, biomass of prey species, feeding selectivity).

This implementation of the MSVPA-X model relies on the development of feeding selectivity parameters that are separated into two components of prey suitability (type and size selection) and spatial overlap among species on a seasonal basis. This formulation is very flexible, and allows for inclusion of species for which complete diet data are unavailable. However, it relies on expert input and can be viewed as subjective in the absence of reliable data. Prey suitability relies on a rank index that assumes prey choice between types, but not overall consumption, is independent of abundance. Spatial overlap parameter weights consumption by the proximity (both temporally and spatially) between predator and prey species. The Panel agreed the methods were appropriate, but suggested weighting data based on study size to de-emphasize the subjectivity of expert input in hopes that different people ranking the parameters would arrive at essentially the same values. The Panel developed a more empirical method to rank diet information, specifically the three parameters of type selection, size selection, and spatial overlap by species and age class:

Prey Type Selection Ranking

Step 1: Obtain all raw diet data and information on the scales and sampling methods of the individual studies.

Step 2: Weight individual studies by length of time series, geographical coverage, and the number of samples. Also, diet studies in which the abundance of a single prey item dominates should be examined closely. Assigning a weighting factor for spatial, temporal, and sample size differences will attempt to account for local abundance issues associated with the particular diet study.

Step 3: Generate an average seasonal diet matrix over temporal and spatial range of model to separate effect of differences in abundance.

Step 4: Develop a relative abundance/biomass matrix by season for all prey species. This would aid both when considering the influence of abundance of prey affecting selectivity and testing the difference between generalist feeding and choice of prey type.

Step 5: Calculate an electivity matrix based on diet and abundance information to develop prey type ranking.

Prey Size Selection

Step 1: Compile data for relative length frequency of prey items in diet by species.

Step 2: These studies should also be weighted on the length of study (number of years), area covered, and number of samples to obtain average picture of prey length consumed.

The Panel noted that the MSVPA-X method for this aspect of feeding selectivity is a more quantitative approach than is available for ranking prey type selection and for developing spatial overlap indices. The Panel noted that a change in size-at-age for predator and prey can affect the ratio of predator-prey consumption-at-age, but that the MSVPA-X is size selective and not age selective.

Spatial Overlap Indices

Although the parameters are set on a coastal basis (i.e. the model was not developed to address local/regional scale questions), the Panel suggested using data from five areas to average into the coastal index:

1. All estuaries combined
2. Coastal & offshore: Maine to Georges Bank
3. Coastal & offshore: Georges Bank to Montauk Point, New York
4. Coastal & offshore: Montauk Point, New York to Cape Hatteras, North Carolina
5. Coastal & offshore: Cape Hatteras, North Carolina to Florida

If additional data are available or there is a need to develop better resolution, then the near shore and offshore ocean should be split.

The Panel recommended adding a section describing the calculation of size selectivity patterns and a flowchart that details model parameter estimation to the model documentation. A long-term recommendation of the Panel was to explore the utility of implementing the Williamson spatial overlap index in the model.

For MSVPA-X Predators and Full Prey distribution:

The Panel did not identify a preferred empirical method to determine spatial overlap indices for these species, but identified the use of fisheries independent surveys, tagging, and commercial & recreational landings to examine spatial and temporal distribution. The Panel recommended evaluating other methods to set the spatial overlap index.

The Panel noted that when other MSVPA approaches have been applied to other regions, the entire system has been covered by a single survey that sampled the full range of the species included. In this formulation, no survey covers the full geographic range for all species included in the model (Maine to Florida).

Biomass and distribution of MSVPA-X "Other Prey" species:

The Panel questioned if coast wide biomass or seasonal distribution estimates exist for some of the "Other Prey" species that were recommended for inclusion in the model (e.g. shrimp, benthic invertebrates, and anchovy); therefore, formulating spatial overlap indices for these species would be difficult. While biomass estimates are available for the Chesapeake Bay and in some cases small areas of the coast, the Panel was concerned with expanding local estimates to the whole Atlantic coast and recommended that a thorough literature search be conducted to determine the extent of information. Also, the Panel suggested examining data from existing surveys to see if it could be used to develop coastal abundance estimates for other prey types.

The Panel agreed that using a measure of primary productivity by area could be investigated as a method to scale up the local biomass estimates. The premise for this expansion would be that area primary productive should be related and proportional to the productivity of alternative prey, particularly given their low trophic status of prey species. The Panel recommended obtaining coast wide primary productivity information from the ASMFC Spatial Multispecies Model developers to estimate biomass of alternative prey species.

3. Review model formulation (overall setup, data handling, VPA calculations, assessment options, uncertainty analysis, recruitment model options, and forward projection options).

The Panel has operated the model and was satisfied with the overall setup of the application and data handling. The software is user friendly, and is arranged in an understandable fashion. The model allows data to be hand entered or uploading of Excel spreadsheets, and the Panel made suggestions to improve Excel spreadsheet functionality. However setup of a model run required several spreadsheets to be loaded and alternate methods to upload data could be investigated to reorganize data into fewer worksheets. The Panel was pleased with the option to perform four types of single species VPA and include biomass predators. However, the Panel requested that a future iteration of the model include ICA and production models to improve overall flexibility in assessment options.

Model outputs are clearly organized and available in either graph or datasheet format, which can be exported to Excel for alternate graphical presentation. The Panel approved of the options provided, and requested additional presentation of consumption rate on a weight specific basis

(i.e., g/g/d) and changing R from respiration to total losses in the appropriate section of the model documentation.

The Panel noted that this approach allows for model formulation and conceptualization for the MSVPA-X species along the Atlantic coast in the absence of a "year of the stomach", by merging data from diet studies that do not overlap geographically and temporally. In the absence of complete diet data sets, this approach permits tracking of dietary regime changes in the MSVPA-X species.

The Panel noted that this implementation of MSVPA-X differs from the traditional ICES MSVPA in the handling of diet composition, and suitability indexes. The ICES MSVPA requires diet information for all species (and age classes) included in the model within a single year at a minimum. Actual diet compositions by species and age are inputs to the ICES MSVPA model, and suitability indices, abundances, predation, and fishing mortalities are evaluated simultaneously in the model. That is, the linkages between predators and prey items, suitability indices, are calculated and refined within ICES MSVPA model based on associated abundance estimates.

In contrast, the MSVPA-X model does not directly employ diet information from any given year or set of years included in the model. Rather, diet information is used to develop the type preference, size preference, and spatial overlap parameters. These parameters are then applied to the calculation of suitability indices outside of MSVPA-X model. That is, the suitability indices are given to the model and are not evaluated and refined in the MSVPA-X model by predator and prey abundances. The Panel made a long-term recommendation to run both the ICES MSVPA and the MSVPA-X for a system that has the required data in order to compare the two formulations of the MSVPA approach. An additional long-term recommendation made by the Panel was to explore the possibility to add other predators to the model (birds, mammals, other fish).

The Panel agreed with the overall approach to determine prey suitability, but provided a more clearly defined process for developing the rank indexes to reduce subjectivity. The Panel accepted the conceptualization of the parameters and approved of the models flexibility when data are not available. Panel also noted that sensitivity analyses are critical to evaluation of the inputs and as a general diagnostic for this model. The Panel also noted that the gear used to sample a fishery imparts bias on diet studies.

The Panel discussed the forward projection portion of the model and approved of the general formulation, user options, and recruitment options. The Panel suggested several options to improve software flexibility including; input of fixed catches, proportional partitioning of biomass predators, and setting a recruitment vector. The Panel was also pleased with the implementation of a weak Type III feeding response, but made the long-term recommendation of investigating Type II and weak Type III feeding responses for MSVPA-X species in field studies. This feeding response yields more realistic dynamics in forward projection, is more consistent with the literature, and is an improvement over standard MSVPA-X formulation. The Panel made two recommendations regarding model results presentation. The first was to develop an application allowing suitability coefficients to be reviewed annually and to develop

an application similar to the "amoeba" program developed for the ICES MSVPA as a future model improvement.

Due to the complexity of the MSVPA-X formulation, it was noted that methods used to characterize the uncertainty of standard single-species model estimates, such as bootstrapping and Monte Carlo simulations, were not feasible in the MSVPA-X. Alternatively, the Panel recommended several sensitivity analyses to conduct in order to determine the effect of changes to model parameters. The final run will be based on the outcome of the sensitivity analysis.

4. Develop research recommendations for data collection, model formulation, and model results presentation.

High Priority Recommendations (to be addressed prior to SARC review):

Data improvements for evaluation and inclusion in base run:

- Obtain additional/updated diet data from the following sources:
  - J. Buckel (bluefish and striped bass)
  - NEFSC food habits database
  - ChesFIMS diet data
  - ChesMMAP diet data
  - SEAMAP Cooperative Winter Tagging Cruise (striped bass)
  - J. Smith (thread herring data landings, size and age information from reduction fishery)
  - M. Cieri (Atlantic herring)
  - A. Overton (striped bass)
  - G. Shepherd (length frequency data)
  - Festa 1979
  - Chao et al. 1977
  - T. Lankford and T. Targett 1997
  - Maryland TIES survey
  - Naughton and Saloman 1984 (raw data)
  - NMFS Sandy Hook Laboratory
- Include latest single species stock assessment information as currently reviewed or when updated
- Incorporate a bluefish age-structured assessment & catch-at-age matrix, if an age-based assessment in completed by the Bluefish Technical Committee
- Determine if the New Jersey Ocean Trawl Survey can be used to develop a coastal abundance estimate of bay anchovy abundance
- Add other prey information with new guilds as suggested in Term of Reference 2
- Generate new prey selectivity (type and size) ranks following quantitative algorithms
- Revise spatial overlap indices based on suggested analysis as suggested in Term of Reference 2

Model formulation and documentation:

- Add option to permit partitioning of biomass (vary size-structure of biomass predators) predators in forward projections
- Add option to input a recruitment vector in the forward projection model
- Add option to input catch as opposed to F into forward projection model to simulate quota management approaches
- It might be necessary to input recruitment vector by species for forward projection model instead of predicting it in forecast and this could be programmed into the model if it is found to be very important
- Add a section describing the calculation of size selectivity patterns to the model documentation
- Document how parameters are estimated within model with a flow chart to present the order of the estimation process
- Change output to include daily consumption rate to g/g/d instead of seasonal consumption rate
- Change R from respiration to total losses in the appropriate section of the model documentation
- Implement additional error trapping for model runs
- Reset minimum size of forms to be slightly smaller to allow better visualization and add the minimum screen resolutions needed for proper viewing of the MSVPA-X application to the model documentation
- Document structure of Excel spreadsheets, allow the cut/paste function of blocks of Excel spreadsheets to the MSVPA-X spreadsheets, and determine how to remove strange characters when data are pasted from Excel
- Adjust the program to permit user to exit MSVPA-X program to set up an Excel spreadsheet

Model Results Presentation

- Develop an application that allows suitability coefficients to be reviewed annually
    - Option under output no big deal (by predator age-class, prey species age-class, year, season

Long Term Research Recommendations:

Data Collection

- All research recommendations for single species assessments apply to the MSVPA-X research recommendations
- If not achieved before SARC review, add a bluefish age-structure/catch-at-age matrix
- Adult index for menhaden (e.g., an aerial line transect survey) and other species
- Obtain population weight-at-age estimates

- Conduct a coastwide diet and abundance study (i.e. an Atlantic coast "year of the stomach")
- Collect diet data for adults of all four MSVPA-X species for the winter season off of Cape Hatteras, North Carolina
- Collect more diet data for all four MSVPA-X species along the entire Atlantic coast, especially for near shore sites, during all seasons. Data sources include SEAMAP, the New Jersey ocean trawl, and cooperate/collaborate with existing with NMFS programs
- Conduct stomach selectivity research for predator species to improve prey ranking matrix
- Encourage existing fishery independent surveys to take regular gut contents
- Evaluate if striped bass disease (mycobacteria) is correlated with natural mortality (M1) and food availability or if disease is disrupting striped bass feeding and causing starvation. The panel noted that if disease affects striped bass feeding in recent years, then using historical striped bass diet data might bias striped bass consumption in the model output
- Estimate carrying capacity for the system to evaluate what model estimates/suggests for carrying capacity
- Improve estimates of biomass for prey species on coastwide basis
- Conduct a parallel comparison with ICES MSVPA model on a system that has the necessary data collected (Georges Bank or the North Sea) to identify the differences in results. In ICES MSVPA the effect of changing the year of stomach/diet data was significant and should be compared to selectivity of type/size/overlap parameters
- Explore the ability to add other predators to model (birds, mammals, other fish, other systems)
- Explore the utility of implementing the Williamson spatial overlap index in the model
- Investigate Type II and Type III feeding responses of the MSPVPA-X species in field studies

Model formulation and documentation:

- Add uncertainty to model forward projections and incorporate elements of Monte Carlo simulations on recruitment curves. The Panel noted that a stochastic MSVPA model is being developed and may provide insight on methods to incorporate uncertainty into the MSVPA-X
- Alter biomass predator bin sizes for more flexible way to vary for projection model, if necessary after conducting sensitivity analyses or until an age structured stock assessment is developed for bluefish
- Add ICA and production model options to retrospective
- Develop a similar application to the "amoeba" program developed by J. Collie. The amoeba program is written in S-Plus and allows the user to vary changes in model parameters (Moved to long-term recommendations)

Consensus Base Run Configuration to Prepare for SARC Review:

Retrospective

- Use newly identified diet data and objective approach (described above) to set revised ranks for type and size selectivity using revised type and size selectivity matrix
- Revise spatial overlap indices based on suggested analysis in Term of Reference #2
- Set natural mortality (M1) for menhaden close to 0.5
- Use fixed long-term average size-at-age for weakfish and striped bass and bluefish (Note: This may affect retrospective and forward projection portions of the model)
- Use the time varying size-at-age for menhaden
- The base run should then be corroborated with the empirical data

Forward Projection

- Status quo
- Determine the affect/sensitivity of the model to the removal of all fishing pressure from system (or just on prey species)
- Insert recovery benchmarks
- Start projection at 1996 (mid-cast or some date sufficiently before terminal year to minimize concerns with retrospective bias) run
- Explore options for adaptive management framework with stock-recruitment options

Consensus Sensitivity Analyses to Conduct to Prepare for SARC Review:

Retrospective and Forward Projection

- Vary predation mortality, M1, for predators and prey. The Panel expects that consumption rate will be sensitive.
- Set prey type selectivity equal across all predators for all prey items – use as default vs. results from empirical ranking based on length frequency data (TOR #2)
- Vary evacuation rate for predator and full prey species
- Vary prey suitability parameters (type selectivity, size selectivity, and spatial overlap) by 5%, 10%, 25%, 50% -OR- define reasonable limits on parameters by upper and lower ranges (fewer alternate runs) The Panel agreed that biologically reasonable minimum and maximum limits should be utilized when possible and should set the minimum and maximum parameter values to 0.5 and 2 times the estimate for parameters with no known data
- Conduct a run with the spatial overlap for all species combinations equal to one and investigate if rank changes for spatial overlap allow view of changes in diet composition
- Model sensitivity to addition and deletion of prey species should be investigated. The Panel noted that total other prey biomass in model should remain constant when changing the number and available biomass of prey items and this should be compared to removal of that

biomass from the model. The Panel also noted that the ICES MSVPA model is insensitive to the addition or deletion of prey species and that MSVPA-X will likely be more sensitive to differences in other prey based on how the model is configured

- The Panel noted that abundance in the model could be driven by seasonal spatial overlap, but that it is hard to develop a good biomass vector. The Panel was interested in the sensitivity of the model to biomass values, as these values need to be realistic to drive prey-switching model
- Conduct a sensitivity analysis on the affect of tuning/weighting of survey indices on recruitment indices
- A retrospective analysis by species was recommended as a way to examine bias in predation mortality (M2) of menhaden
- A model run utilizing data through 1990 to conduct a forward projection that would be compared to the base run. The Panel noted it would be necessary to force the recruitment pattern to historical recruitment and to test rest of model predictions
- Examine the sensitivity of a small bias in one species is multiplicative when applied in the full model across species
- Determine the effect of predation mortality (M2) on menhaden on the back calculation of recruitment and use in forward projection model

5. Develop recommendations on how to utilize the model and results in the Commission's stock assessment for individual species.

The Panel discussed several scenarios in which the model will be useful to evaluate potential management options. This section assumes that a stable model has been developed with acceptable sensitivity analyses and has successfully passed a SARC review. Although the model will be able to estimate multispecies benchmarks, and explore trophic relationships between species, the MSVPA-X is not designed to address all ecosystem level questions or local depletion issues.

The Panel was comfortable with using the model for the following purposes:

- Improve single species models for single species population adjustments (i.e. age and year specific inclusion of M)
- Insight on multiple species benchmarks based on species trade-offs
- Investigate predation mortality versus catch for important prey species by age class
- Determine the tradeoffs among harvesting strategies when fisheries exist for both predator and prey
- Develop short-term projections for explicitly modeled species
- Provide guidance for rebuilding predator stocks
- Evaluate change in predator management and it's effects on prey and competing predators

- Explore potential feedbacks between lack of prey, abundance of alternative prey, fishing mortality on the predator populations
- Longer projections can be performed as exploratory tool to investigate linkages among species but should not be used as a management tool
- Examine the role of predator consumption in reduced prey recruitment to the fishery

However, the Panel noted this model should not address the following issues:

- Setting reference points or harvest limits for single species from MSVPA-X
- Estimations of absolute abundance for explicitly modeled species
- Examining local abundance or depletion
- Long-term projections are subject to the limitations of recruitment variability for the prey population and predator populations

Overall, the Panel found the model acceptable as formulated, and thought that the model was ready, with minor adjustments, to conduct a multispecies assessment to go to before a peer review panel in the fall of 2005. The Panel did make recommendations on data to incorporate in the model before its implementation, methods to minimize the subjectivity involved in model parameter estimation, ways to improve model formulation, documentation and presentation. The Panels also recommended a base run configuration, suggested sensitivity analysis to determine the final model configuration, and made recommendations on how the model results could be utilized in management.