**Mid-Atlantic Fishery Management Council**
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# MEMORANDUM

**Date:** July 30, 2015

**To:** Council

**From:** Kiley Dancy, Staff

**Subject:** Black Sea Bass Management Measures for 2016-2018

The following materials are provided for Council consideration of the above subject, starting with the most recent documents. Note that some materials are found behind other briefing book tabs.

1) Advisory Panel comments from July 29 webinar, with additional advisor comments received through July 29 (*found behind the summer flounder specifications tab; Tab 9*)
2) July 2015 Monitoring Committee Meeting Summary (*found behind the summer flounder specifications tab; Tab 9*)
3) July 2015 SSC meeting report dated July 27, 2015 (*found behind the bluefish tab; Tab 8*)
4) ABC recommendation memo to SSC from Jason McNamee, Dr. Gavin Fay, and Dr. Steve Cadrin, dated July 18, 2015
5) July 2015 report on Data Limited Techniques for Tier 4 Stocks
6) Staff Memo dated July 9, 2015
7) Black Sea Bass Data Update for 2015
8) 2015 Summer Flounder, Scup, and Black Sea Bass Fishery Performance Report (*found behind the summer flounder specifications tab; Tab 9*)
9) 2015 Black Sea Bass Fishery Information Document

**MEMORANDUM**

DATE: July 18, 2015

TO: Mid Atlantic Council Scientific and Statistical Committee

FROM: Jason McNamee
RIDEM – Division of Fish and Wildlife
Dr Gavin Fay
University of Massachusetts Dartmouth
Dr Steven Cadrin
University of Massachusetts Dartmouth

RE: Recommendation for an ABC for black sea bass based on the Data Limited analysis

A thorough analysis of a number of data limited methods for black sea bass was provided to the Mid Atlantic Council's Scientific and Statistical Committee (SSC) (see document titled "Data Limited Techniques for Tier 4 Stocks: An alternative approach to setting harvest control rules using closed loop simulations for management strategy evaluation", hereafter "document"). The goal of the analysis was to provide the SSC with an alternative approach when setting specifications for their tier 4 stocks. In addition to the alternative methodology, the group that performed the analysis (hereafter "group") is aware that the SSC will need to set specific harvest recommendations for black sea bass for the coming years. It is with this in mind that we offer a specific recommendation on black sea bass for your consideration.

## Recommendation

Based on the MSE analysis performed, the group believes that the method referred to as **"GB_slope"** provides the best alternative for setting harvest specifications for black sea bass until a full analytical assessment can be accomplished. This method offers a good balance between the trade-offs of yield and stock status, as well as offering confidence with the data sources used by the procedure.

## Reasoning

During the MSE portion of the analysis outline in the document, GB_slope was one of the methods that performed well by providing relatively high yield levels, but at the same time still offered a low probability of overfishing or dropping to a low biomass level. This was the first consideration when developing this recommendation.

When referring to the trade-off plots in figure 1 of the document, other procedures performed better than did GB_slope, for instance some of the F based procedures. The reason for the selection of GB_slope over these better performing procedures was based on a subsequent review of the data needs of each procedure (Table 1, below). The better performing F based procedures rely on estimates of things like current biomass levels, and levels of Fmsy/M. The estimates used for the analysis were derived from the information produced by the last analytical assessment, which did not pass peer review. The MSE and subsequent sensitivity analyses did indicate that these procedures still performed well across a range of input values and uncertainty levels, but the group thought that the SSC might be uncomfortable using information derived from an assessment that did not pass peer review, and therefore did not select one of these procedures.

GB_slope uses information such as catch and an existing and routinely used fishery independent index, including associated uncertainties for these values. The group believed there would be confidence in these datasets, seeing as how one of them (Catch) is currently used by the SSC for the current ABC control rule for black sea bass. This review of the underlying data was the second important consideration when selecting the recommended method of GB_slope.

A final consideration for the recommendation was in the sensitivity analyses. GB_slope and its associated data requirements did not indicate a high level of sensitivity to the values or uncertainty values selected (see figure 7 from the document). Given that we have an imperfect understanding of catch or abundance, it is important to note that even if our point estimates for these two quantities are mischaracterized to some degree, the performance of the method will not be impacted greatly, and should still offer protection against overfishing or dropping to low biomass levels.

The critique of Little et al (2011) warrants some discussion. They suggested that techniques such as that employed by GB_slope perform best if the recent average catch rate is about the same as that expected at BMSY (for yield), or when F is below FMSY (for overfishing). The group believes this is a safe assumption for the current state of the black sea bass stock given information from recent analytical assessments on the stock as well as high indices of abundance found in many state surveys and anecdotal reports of high fishing catches in particular in the northern stretches of the stocks range.

**ABC calculation**

Given the recommended procedure of GB_slope, the following is a calculation of an associated ABC. Using current catch and abundance data (NMFS spring trawl survey) for black sea bass, an OFL was derived for black sea bass using GB_slope. The OFL value from this procedure is 3,797 metric tons. The SSC has not applied additional buffers for uncertainty to their tier 4 stock ABC calculations for the case of black sea bass in the past, but believing that the SSC still may desire to buffer away from the OFL value when setting their ABC, a control rule procedure was implemented that was believe to be an analogue to some of the other procedures employed by the SSC for tier 3 and above stocks.

Uncertainty was characterized for both data sources in the GB_slope procedure. These uncertainties were used in the stochastic implementation of the GB_slope method, and a distribution of OFL values was generated. From the distribution, a CV was calculated.

Using the calculated CV, and working this in to the pstar approach used by the SSC for other stocks, a buffer from the OFL was calculated to be an ABC = 3,668 metric tons. The data used and results are shown in Table 2 below.

**References**

Little, R, Wayte, S, Tuck, G, Smith, A, Klaer, N, Haddon, M, Punt, A, Thomson, R, Day, J, Fuller, M. 2011. Development and evaluation of a cpue-based harvest control rule for the southern and eastern scalefish and shark fishery of Australia. ICES Journal of Marine. Vol. 68 Issue 8, p1699-1705. 7p.

Table 1 – Required data for the different data limited approaches tested.

| Management Procedure | Catch | Index of abundance | Depletion | FMSY/M | BMSY/B0 | M | Age @ Maturity | Current biomass | VBK | L @ First Capture | Linf | t0 | MaxAge | a | b | h | Ref Cat | FMSY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CC1** | | | | | | | | | | | | | | | | | | |
| **DCAC** | | | | | | | | | | | | | | | | | | |
| **DCAC_40** | | | | | | | | | | | | | | | | | | |
| **DynF** | | | | | | | | | | | | | | | | | | |
| **Fadapt** | | | | | | | | | | | | | | | | | | |
| **Fdem** | | | | | | | | | | | | | | | | | | |
| **FMSYref** | | | | | | | | | | | | | | | | | | |
| **FMSYref50** | | | | | | | | | | | | | | | | | | |
| **FMSYref75** | | | | | | | | | | | | | | | | | | |
| **Fratio** | | | | | | | | | | | | | | | | | | |
| **GB_slope** | | | | | | | | | | | | | | | | | | |
| **Gcontrol** | | | | | | | | | | | | | | | | | | |
| **Islope1** | | | | | | | | | | | | | | | | | | |
| **Rcontrol** | | | | | | | | | | | | | | | | | | |
| **SBT1** | | | | | | | | | | | | | | | | | | |
| **SPMSY** | | | | | | | | | | | | | | | | | | |
| **matsizlim*** | | | | | | | | | | | | | | | | | | |
| **area1MPA*** | | | | | | | | | | | | | | | | | | |
| **DD** | | | | | | | | | | | | | | | | | | |
| **GB_CC** | | | | | | | | | | | | | | | | | | |

*** are not quota-based methods**

Table 2 – ABC calculations.

| Parameter | Value |
|---|---|
| OFL | 3,797 mt |
| B/BMSY | 1 |
| CV | 9% |
| sigma | 0.090 |
| P* | 0.35 |
| ABC | 3,668 mt |

# Data Limited Techniques for Tier 4 Stocks: An alternative approach to setting harvest control rules using closed loop simulations for management strategy evaluation

**Jason McNamee: RI Division of Fish and Wildlife**

**Gavin Fay: University of Massachusetts Dartmouth**

**Steven Cadrin: University of Massachusetts Dartmouth**

## Introduction

The Mid-Atlantic Scientific and Statistical Committee (SSC) uses a classification system for managing the information on the marine resources that they are responsible for. This classification system categorizes the information, usually in the form of an analytical stock assessment, in to one of four tiers. The tier used to categorize information useful for setting an overfishing limit (OFL) when an analytical assessment is not available is referred to as tier 4. Under tier 4, the SSC uses a pre-defined method of setting a constant catch value. The constant catch that is defined is taken from the catch that was achieved during a period of time where the SSC believes the stock was rebuilding and is therefore believed to be a safe harvest level (Carmichael and Fenske 2011).

Performance evaluations of constant catch control rules for data-limited stocks suggests that they may be sustainable, but not necessarily a good proxy for maximum sustainable yield (ICES 2012; Geromont and Butterworth 2014; Carruthers et al. 2014). With a constant catch approach there are issues that arise as a population rebounds, where potential yield will be foregone if that constant catch value is set too low, and conversely if a population declines, the constant catch approach could lead to overharvest unless the constant catch value is adjusted down. The following analysis seeks to provide an alternative approach for use on tier 4 stocks that is performance tested, dynamic, straightforward, rapid to implement, and which offers a comparative analysis of harvest control rule approaches that can be used in situations where data are lacking or are not accepted by the SSC for specification setting.

Analytical stock assessments are the usual basis for estimating an OFL. In many cases fisheries lack the data necessary to support a conventional stock assessment, requiring the use of methods that can be used in data- or analysis-limited situations. Even if a fishery has ample data and research, there are situations where an analytical assessment is not possible due to external constraints, such as not enough human resources to perform the analysis or a lack of economic incentives to devote an analyst's time to developing a comprehensive assessment. Finally, sometimes an analytical assessment exists, but is not useful for specification setting due to not passing peer review or not being accepted due to diagnostic issues. This latter situation is the case for black sea bass, the focus of this work.

Management strategy evaluation (MSE) is a technique that can be used to evaluate and compare the performance of assessment and management methods (Bunnefeld et al. 2011). Simulating the behavior of harvest control rules through MSE and then using this information to evaluate the performance of a set of methods allows for an objective way to consider trade-offs among management objectives (Wetzel and Punt 2011; Wilberg et al. 2011, Geromont and Butterworth 2014; Carruthers et al. 2014). The following analysis uses an MSE approach as developed by Carruthers et al. (2014) to evaluate the relative performance of a suite of data limited analytical techniques for black sea bass. This approach may offer the SSC an alternative to the current approach for tier 4 stocks. The application to black sea bass may also provide a framework for specification setting until an approved analytical assessment can be accomplished.

## Methods

The procedures as defined by Carruthers et al. (2014) were used for this analysis. This procedure is implemented through the use of an application developed for the R statistical software package (R Core Team 2014) through the R package "DLMtool" (Carruthers 2015). This package provides flexible specification of an operating model of population dynamics of a fished stock, effort dynamics of a targeted fishery, an observation model that can reflect biases and imprecision associated with monitoring data, and a set of stock assessment methods and harvest control rules that determine management advice fed back into the operating model. Although the dynamics of the black sea bass fishery were not exactly represented, the models underlying DLMtool provide a flexible and comprehensive framework for comparing assessment and control rule performance across a range of uncertainties. We therefore use this package to emulate and evaluate plausible behavior given dynamics and uncertainties that are characteristic of black sea bass.

A black sea bass specific operating model, which is a set of biological and fishery specific parameters for the black sea bass fishery, was developed. The operating model was created using information generated from the last peer reviewed stock assessment for black sea bass (NEFSC 2012), and assuming reasonable estimates for the degree of uncertainty around parameters when no specific information on uncertainty were available (uncertainty estimates are needed for the stochastic implementation of the MSE procedure). The information that is available to the assessment and control rule procedures is determined by an observation model. The parameters for the observation model were specified to allow for simulated data to be both imprecise and possibly biased, appropriately reflecting the nature of monitoring data.

The operating model includes numerous uncertainties that are tested through the MSE procedure. Some of the most important uncertainties tested for the black sea bass case were natural mortality (M), steepness of the spawner-recruit relationship (h), depletion of the stock (D), vulnerability of the oldest age class (Vmaxage), spatial targeting of the stock (Spat_targ), and a hyperstability parameter for the fishery independent information (beta). These uncertainties were all tested with a range of point estimate values as well as adequate ranges for their associated uncertainties (Table 1). Other input parameters that are used by the various procedures are better supported by research, including Von Bertalanffy equation parameters, length weight parameters, maximum age, and age at first capture, so were treated with appropriate levels of uncertainty. All of the uncertainties included in the operating model become the framework that the MSE samples within, and allows for testing of the most important uncertainties for each specific procedure.

The operating model was run through a closed loop MSE procedure, and a set of appropriate analytical assessment methods and harvest control rules (procedures) were identified and compared. Two separate effort scenarios were tested, one referred to as "flat effort", which allows for trends through time to be both negative and positive, and "increasing effort", which only allows for a positive trend in effort through time. These procedures were then filtered based on a set of performance criteria that were meant to mimic management objectives. The criteria used were yield, probability of overfishing, and the probability of depleting the stock to low abundance (10% of BMSY). Each MSE was run twice to compare the stability of the simulation.

In addition to the built-in procedures in the DLMtool package, two additional procedures were developed that are based on observations of the historical exploitation of the stock, one that uses a reference slope of the exploitation rate index and one that uses a target exploitation rate index. These additional procedures were also run through the MSE and compared to the other procedures. The code for these additional procedures can be viewed in Appendix 1. Methodology for all other procedures can be viewed by typing the procedure name in to the R statistical environment with the DLMtool package loaded.

Once a set of appropriate procedures were determined based on the closed loop MSE, an additional analysis was run on actual data for black sea bass. These data were derived from recent fishery statistics on catch, information from appropriate fishery independent surveys, and information from the last stock assessment for black sea bass (NEFSC 2012). Fishery independent information used was the spring index of the National Marine Fisheries Service (NMFS) trawl survey. This index was selected as the most defensible for this exercise as the survey takes place during a period of time in which the black sea bass population is undergoing its seasonal migration so is most likely susceptible to trawl gear, is in general representing only fish older than 1 year, and spans the entire extent of the known northern stock range (NEFSC 2012).

From the real dataset, overfishing levels (OFLs) for black sea bass are produced based on the chosen management procedures and preferred options are offered for consideration. A procedure similar to that currently used by the SSC is also offered for comparative review with the chosen approaches.

## **Results**

### *MSE*

Using the operating model as described above, an MSE was run to determine the best procedures to use for the black sea bass case. For the full list of approaches, see the DLMtool package information (Carruthers 2015). From a suite of 47 different data limited procedures available in the DLMtool package, the approaches were narrowed down based on the outcome of the MSE. The approaches were narrowed based on a set of criteria that are meant to mimic management objectives such as minimizing the probability of overfishing, optimizing yield, and minimizing the potential of dropping to low biomass levels. Specifically the metrics chosen were a probability of overfishing of less than 30%, a probability of dropping to low biomass of less than 20%, and having a relative yield of greater than 50%. Per Carruthers et al. (2014), the yield metric is calculated based on the last five years of each projection (e.g., the yield from a method in projected years 26–30 divided by the yield of the Fref strategy in projected years 26–30) since it is of more interest to identify methods that can achieve sustainable long-term yields. This gets averaged over multiple simulations to provide the expected relative yield of a management method. The way the other management metrics (probability of overfishing and probability of dropping to a low biomass) percentages are calculated is by taking all of the individual realizations from the MSE simulations, and calculating how often the simulations violate the selected management objective criteria. As an example, the MSE procedure "CC1" was simulated 500 times. In these 500 simulations, a median value of 26.87% of those 500 simulations resulted in overfishing. In this example, this procedure would be acceptable per the chosen criteria for probability as defined above. One additional note on the final preferred approaches, two methods ("DCAC4010" and "DBSRA4010") were excluded due to the approaches producing an error during the MSE simulations.

The performance of the best procedures is shown in tables 2 and 3 as well as figures 1 and 2. There was a high degree of correspondence between the preferred procedures in the two different effort scenarios that were modeled as well as between simulations within the same effort scenario, indicating stability in the preferred approaches. All of the selected approaches had low probability of resulting in overfishing during the 30 years of the projections, and had low frequency of low biomass levels. The amount of yield achieved depended on the approach selected and is explored further below.

*OFL determination based on application to black sea bass data*

Once the best procedures were determined, these were applied to the black sea bass dataset (Figure 3; data file provided to the SSC for review). The best procedures from the MSE analysis were compared to the procedures available with the existing real dataset (the MSE compared the performance of the full set of procedures with varying data requirements). Procedures that were both among the preferred approaches and the possible approaches were used for the OFL calculations (Table 4). The method for calculation of the OFL is specific to each procedure and can be found in the DLMtool package documentation (Carruthers 2015). All of the calculated OFLs are represented graphically in figure 6 and median OFL values by procedure are presented in table 5. The remaining procedures were evaluated based on the reliability of the data available, the underlying assumptions of the procedure being reviewed, and the trade-offs in yield versus stock status. The results presented in the figure show the distribution for the OFL calculation, but it is important to note that the MSE was run using guidance from a fixed percentile ("pstar") from these distributions. The pstar value used for the MSE was 0.5.

## Discussion

One of the goals of this exercise was to analyze a set of harvest control rules and compare that to the current harvest control rule employed by the SSC for tier 4 stocks. The procedure in the DLMtool package that is closest to the procedure currently used by the SSC is named "CC1" and is a procedure that uses a constant catch from a set number of years. This procedure is not exactly as that used by the SSC, but is a reasonable proxy for comparison. This analysis indicates that the static constant catch approaches are not the best procedures as they can lead to foregone yield and higher probabilities of overfishing (Figures 1 and 2). ICES (2012) evaluations of data-limited harvest control rules found similar performance of constant catch scenarios, in which fisheries were sustainable, but low stocks remained low, and high stocks remained high. This general result also corroborates the analysis as noted in Geromont and Butterworth (2014), where they determined that the use of a constant catch procedure with no feedback control was not a preferred option. Carruthers et al. (2014) also arrived at the same conclusion about static catch based approaches, finding them to have poorer performance with realized yield and greater probabilities of overfishing than other more dynamic approaches.

The usefulness of depletion based approaches (e.g. DCAC, DBSRA) was downgraded for the black sea bass case, because they are sensitive to the initial estimate of depletion, creating a need to be very cautious with the estimate, which can lead to the potential of foregone yield. In addition, the assumption of the stock being in an unfished state in the initial years is also violated for the black sea bass case, another assumption violation of these approaches (Dick and MacCall 2010). The catch stream chosen for this analysis starts in 1982 as this is the period of time where recreational catch information has been systematically collected. Recreational harvest makes up a large proportion of black sea bass removals, and therefore is an important source of removals to account for. The stock was already exploited during this time period. In addition to the issues with the underlying assumptions, sensitivity analysis indicates that the performance of the different harvest control rule procedures is fairly robust to most of the operating model inputs, the main exception being the choice in stock depletion level, which can have significant impacts on the outcomes of the MSE (Figure 7). The depletion based approaches may be viable for other tier 4 stocks, in particular if the stock is believe to be newly exploited. Carruthers et al (2014) also found that the depletion methods they tested performed well when the depletion assumption was reasonably close to actual depletion.

As noted above, the procedures were all robust to the operating model inputs. Plots of the effect of varying input values for a set of important uncertainties is shown in figure 7. The exception to this robustness was found in the depletion values, which did have a significant impact on relative yield, probability of biomass dropping below 50% of BMSY, and overfishing. Beyond the depletion input value, the rest of the parameters did not show dramatic changes in outcomes for the ranges of values used in this analysis. One note that is important, the steepness (h) values used for the analysis were chosen to be low. This was due to the finding that the steepness parameter was causing errors in the MSE process for some of the simulations. These steepness values could be examined further, but for the input values used for this analysis, it did not impact the outcome of the MSE to a large degree.

One procedure that offered a good balance given the trade-offs between yield, overfishing probability, and probability of dropping to a low stock size, as well as the characteristics of the species and the reliability of the data available is the approach referred to as "GB_slope" in Carruthers (2015). This approach uses the slope of recent estimates of abundance to determine catch advice, with the aim of obtaining stable catch rates, and is similar to an approach from Geromont and Butterworth (2014). This previous work also regarded this approach as one that performed well given the tradeoffs that were considered. It is important to note that Little et al. (2011) showed that this type of method only performs well if the recent average catch rate is about the same as that expected at BMSY (for yield), or when F is below FMSY (for overfishing). This may be the case for black sea bass given information from recent analytical assessments on the stock as well as high indices of abundance found in many state surveys and anecdotal reports of high catch in particular in the northern stretches of the stocks range. While the "GB_slope" procedure offers a good balance of yield and risk, additional procedures analyzed also indicated good long term yield while maintaining a low probability of overfishing or dropping to a low stock size, and could also be useful for specification setting.

One extension of this analysis that could be considered for the black sea bass case would be to use more fishery independent information in the analysis. This analysis chose a single fishery independent index (namely the NMFS trawl survey spring index) as the most defensible source of information at present, but other sources of fishery independent information exists as well, in particular from state run fishery independent surveys. Approaches could be developed that combine indices through approaches such as using a hierarchical modeling approach as developed by Paul Conn (Conn 2010), or by weighting the surveys through an areal extent approach. These analyses could provide a more robust estimate of population abundance information that may not be as subject to large swings in abundance estimates from year to year.

An important final note for this analysis is that this is offered as an approach to consider for the SSCs tier 4 stocks. In the specific case of black sea bass, this approach is only offered as a potential interim solution for specification setting, as a full analytical assessment process is underway for this stock. This full analytical assessment is being performed by the analysts from this work along with other partners in black sea bass fishery science. Therefore these data limited approaches should not be considered to the exclusion of a full analytical assessment. These alternatives are provided for consideration as approaches to accommodate the period of time before a full analytical assessment is peer reviewed and approved for management use for black sea bass. It is further hoped that this approach can be applied beyond the black sea bass case to help with the SSCs work on existing and future tier 4 stocks.

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## Tables

Table 1 – Parameter values and uncertainties used for the operating model: natural mortality (M), steepness of the spawner-recruit relationship (h), depletion of the stock (D), vulnerability of the oldest age class (Vmaxage), spatial targeting of the stock (Spat_targ), and a hyperstability parameter for the fishery independent information (beta), Von Bertalanffy Parameters (K, t0, Linf), maximum age (maxage), length weight parameters (a, b), observation error in catch (Cobs) and fishery independent index (Iobs). Full information on all inputs can be found in Appendix 1.

| Parameter | Value or Range of Values | Associated CV or Bias Estimate | Source |
|---|---|---|---|
| M | 0.2 – 0.5 | 0.0 – 0.2 | NEFSC 2012 |
| h | 0.3 – 0.4 | 0.3 | NEFSC 2012 |
| D | 0.3 – 0.7 | 0.2 – 0.3 | Reasonable Estimate |
| Vmaxage | 0.4 – 1 | NA | Reasonable Estimate |
| Spat_targ | -0.5 – 3 | NA | Reasonable Estimate |
| beta | 0.333 – 3 | NA | Reasonable Estimate |
| K | 0.17 – 0.22 | 0.0 – 0.03 | NEFSC 2012 |
| t0 | 0.14 – 0.19 | NA | NEFSC 2012 |
| maxage | 20 | 0.3 | Dery and Mayo (http://www.nefsc.noaa.gov/fbp/age-man/bsb/bsb.htm) |
| Linf | 62 - 70 | 0.0 – 0.03 | NEFSC 2012 |
| a | 0.0000108 | NA | NEFSC 2012 |
| b | 3.0595 | NA | NEFSC 2012 |
| ageM | 4 – 6 | 1 | NEFSC 2012 |
| Cobs | NA | 0.2 – 0.4 | Reasonable Estimate |
| Iobs | NA | 0.2 – 0.4 | Reasonable Estimate |

Table 2 – Best performing procedures and their performance for the “flat effort” scenario. Values presented are median percentage values. POF = Probability of overfishing; P10 = Probability of dropping below 10% BMSY; P50 = Probability of dropping below 50% BMSY; P100 = Probability of dropping below BMSY

| Method | Yield | POF | P10 | P50 | P100 |
|---|---|---|---|---|---|
| CC1 | 61.4 | 27.31 | 12.28 | 18.92 | 27.85 |
| DCAC | 83.35 | 12.65 | 3.37 | 8.47 | 17.28 |
| DCAC_40 | 79.46 | 12.63 | 3.41 | 8.55 | 17.27 |
| DynF | 72.44 | 0.19 | 0.91 | 5.73 | 14.39 |
| Fadapt | 79.44 | 0.01 | 0.89 | 5.61 | 14.25 |
| Fdem | 120.12 | 3.07 | 1.27 | 8.14 | 19.25 |
| FMSYref | 150.32 | 8.1 | 2.4 | 12.89 | 25.77 |
| FMSYref50 | 127.73 | 0 | 1.33 | 7.7 | 18.57 |
| FMSYref75 | 146.09 | 0.22 | 1.75 | 10.37 | 22.08 |
| Fratio | 59.05 | 0 | 0.87 | 5.19 | 13.77 |
| GB_slope | 62.07 | 27.97 | 13.54 | 20.4 | 29.09 |
| Gcontrol | 54.88 | 22.98 | 12.08 | 18.19 | 26.73 |
| Islope1 | 60.46 | 11.05 | 3.32 | 8.23 | 16.71 |
| Rcontrol | 39.84 | 27.17 | 13.16 | 20.91 | 30.04 |
| SBT1 | 59.61 | 27.83 | 13.59 | 20.36 | 28.9 |
| SPMSY | 45.82 | 9.21 | 3.55 | 8.41 | 16.75 |
| matsizlim | 70.7 | 16.88 | 2.04 | 7.34 | 16.04 |
| area1MPA | 56.13 | 5.41 | 0.85 | 6.05 | 14.6 |

Table 3 – Best performing procedures and their performance for the "increasing effort" scenario. Values presented are median percentage values. POF = Probability of overfishing; P10 = Probability of dropping below 10% BMSY; P50 = Probability of dropping below 50% BMSY; P100 = Probability of dropping below BMSY

| Method | Yield | POF | P10 | P50 | P100 |
|---|---|---|---|---|---|
| CC4 | 52.88 | 11.91 | 6.02 | 11.93 | 19.64 |
| DCAC | 63.77 | 12.3 | 4.5 | 10.4 | 18.44 |
| DCAC_40 | 62.1 | 11.67 | 4.47 | 10.38 | 18.44 |
| DD | 54.51 | 27.32 | 10.63 | 19.91 | 29.87 |
| DynF | 65.73 | 0.18 | 2.52 | 7.73 | 15.91 |
| Fadapt | 73.43 | 0.01 | 2.54 | 7.72 | 15.74 |
| Fdem | 111.17 | 1.73 | 2.92 | 10.02 | 18.99 |
| FMSYref | 143.88 | 7.64 | 3.78 | 14.07 | 24.97 |
| FMSYref50 | 120.94 | 0 | 2.95 | 9.85 | 18.66 |
| FMSYref75 | 139.18 | 0.23 | 3.32 | 12.06 | 21.61 |
| Fratio | 53.14 | 0 | 2.45 | 7.51 | 15.15 |
| Gcontrol | 77.64 | 26.55 | 16.87 | 24.16 | 32.01 |
| Islope1 | 55.39 | 15.17 | 5.85 | 12.07 | 20.45 |
| Islope4 | 48.64 | 6.8 | 3.7 | 9.13 | 16.71 |
| SPMSY | 38.06 | 10.5 | 5.81 | 11.63 | 19.28 |
| matsizlim | 71.7 | 26.73 | 5.03 | 11.87 | 20.74 |
| area1MPA | 56.42 | 9.67 | 2.57 | 9.17 | 17.86 |

Table 4 – Methods that overlapped between the preferred approaches as determined by the MSE analysis and the methods possible given the real dataset used for black sea bass.

| Overlapping Methods Used for OFL Calculations |
|---|
| CC1 |
| DCAC |
| DCAC_40 |
| DD |
| DynF |
| Fadapt |
| Fdem |
| Fratio |
| GB_CC |
| GB_slope |
| Gcontrol |
| Islope1 |
| SBT1 |
| SPMSY |
| SPslope |
| Rcontrol |
| CC4 |

Table 5 – Median OFL calculation for the various methods in metric tons.

| Methods | Median OFL Calculation (MT) |
|---|---|
| CC1 | 2,496 |
| DCAC | 2,526 |
| DCAC_40 | 2,481 |
| DD | 3,898 |
| DynF | 1,108 |
| Fadapt | 6,237 |
| Fdem | 6,988 |
| Fratio | 3,002 |
| Islope1 | 2,710 |
| GB_CC | 3,731 |
| GB_slope | 3,797 |
| Gcontrol | 1,519 |
| SBT1 | 3,091 |
| SPMSY | 4,111 |
| SPslope | 2,354 |
| Rcontrol | 4,248 |
| CC4 | 1,744 |

# Figures

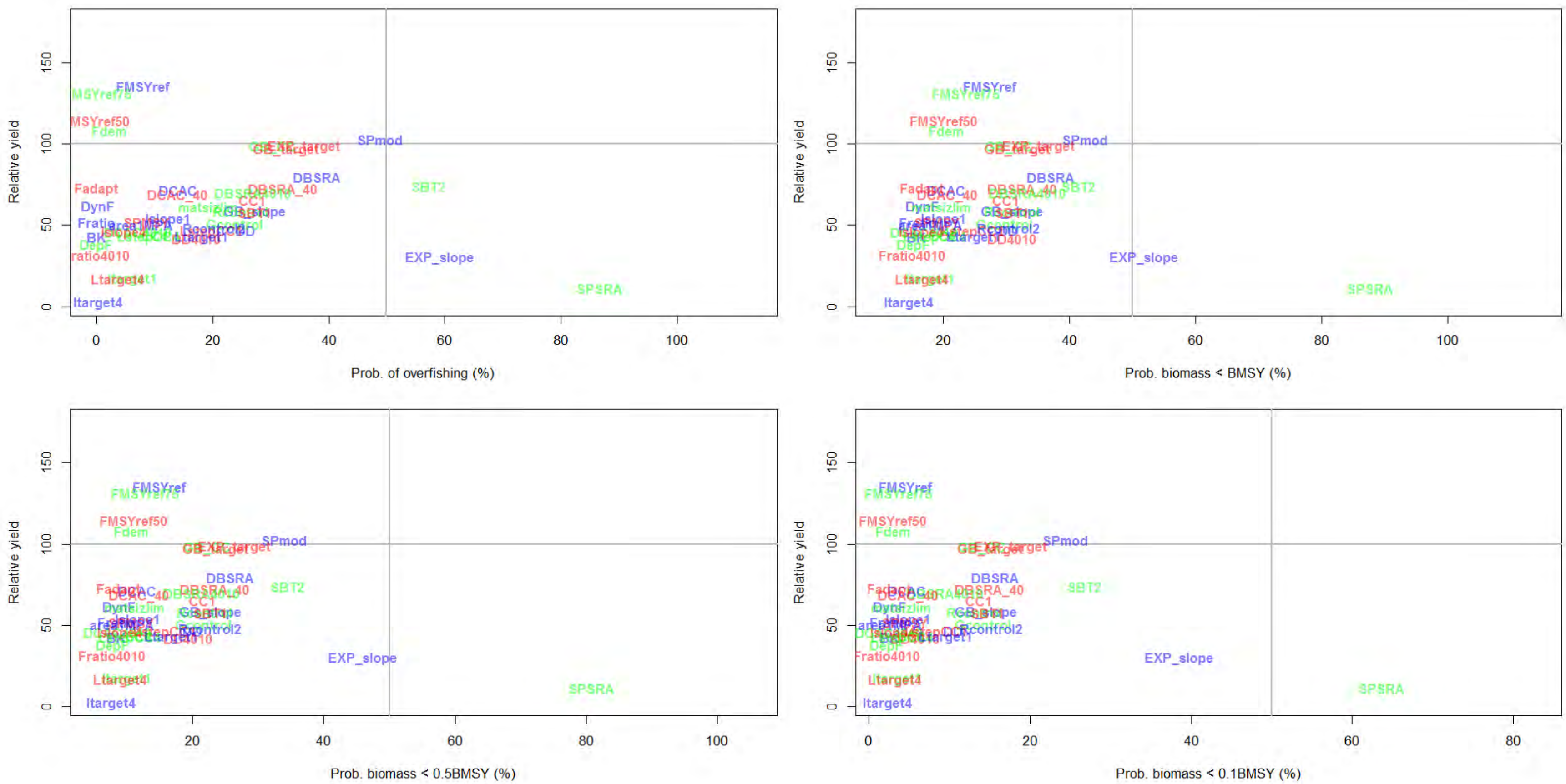


Figure 1 – Trade-off plots of the MSE for each of the procedures used for the “flat effort” simulations.

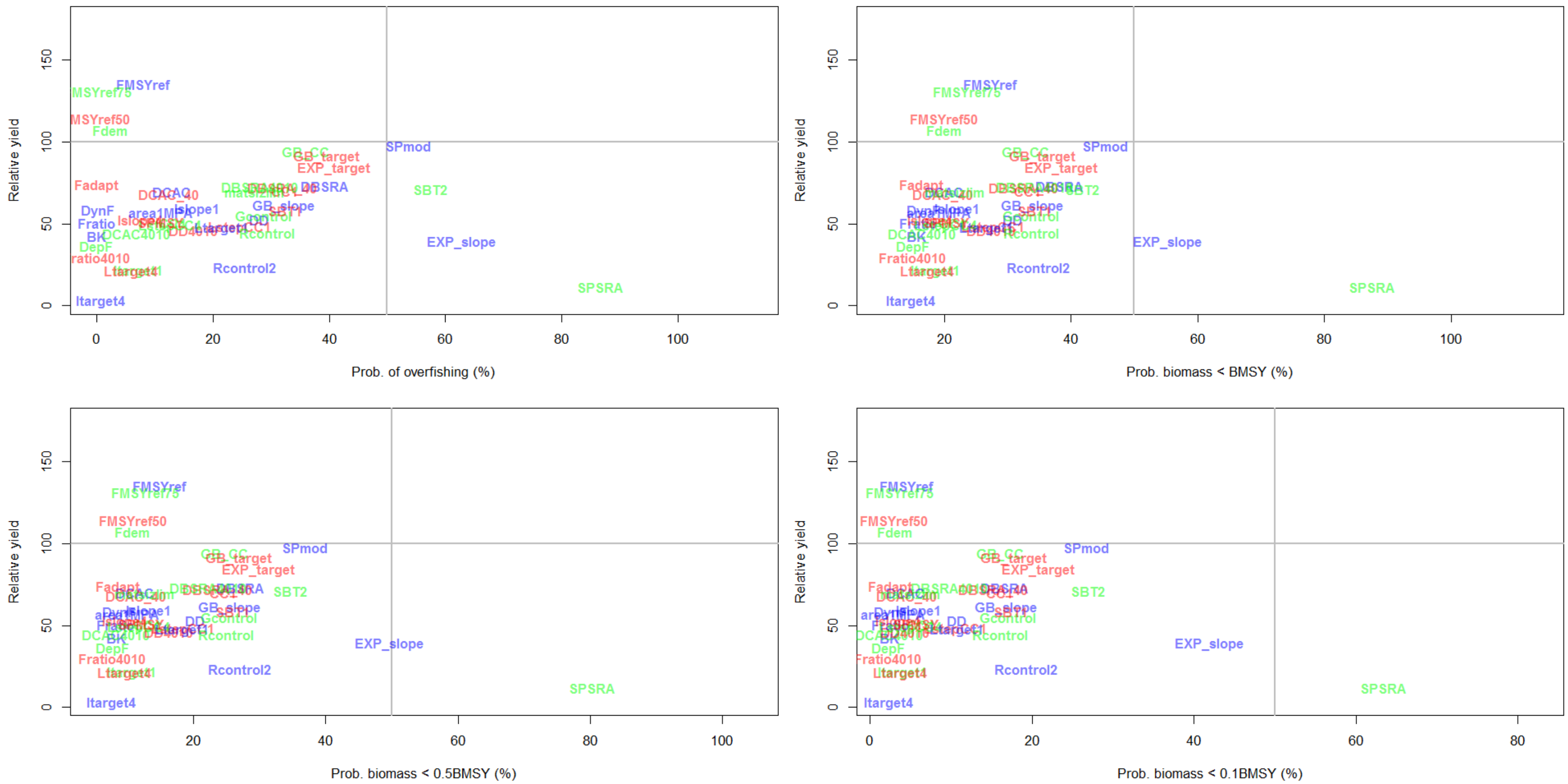


Figure 2 – Trade-off plots of the MSE for each of the procedures used for the “increasing effort” simulations.

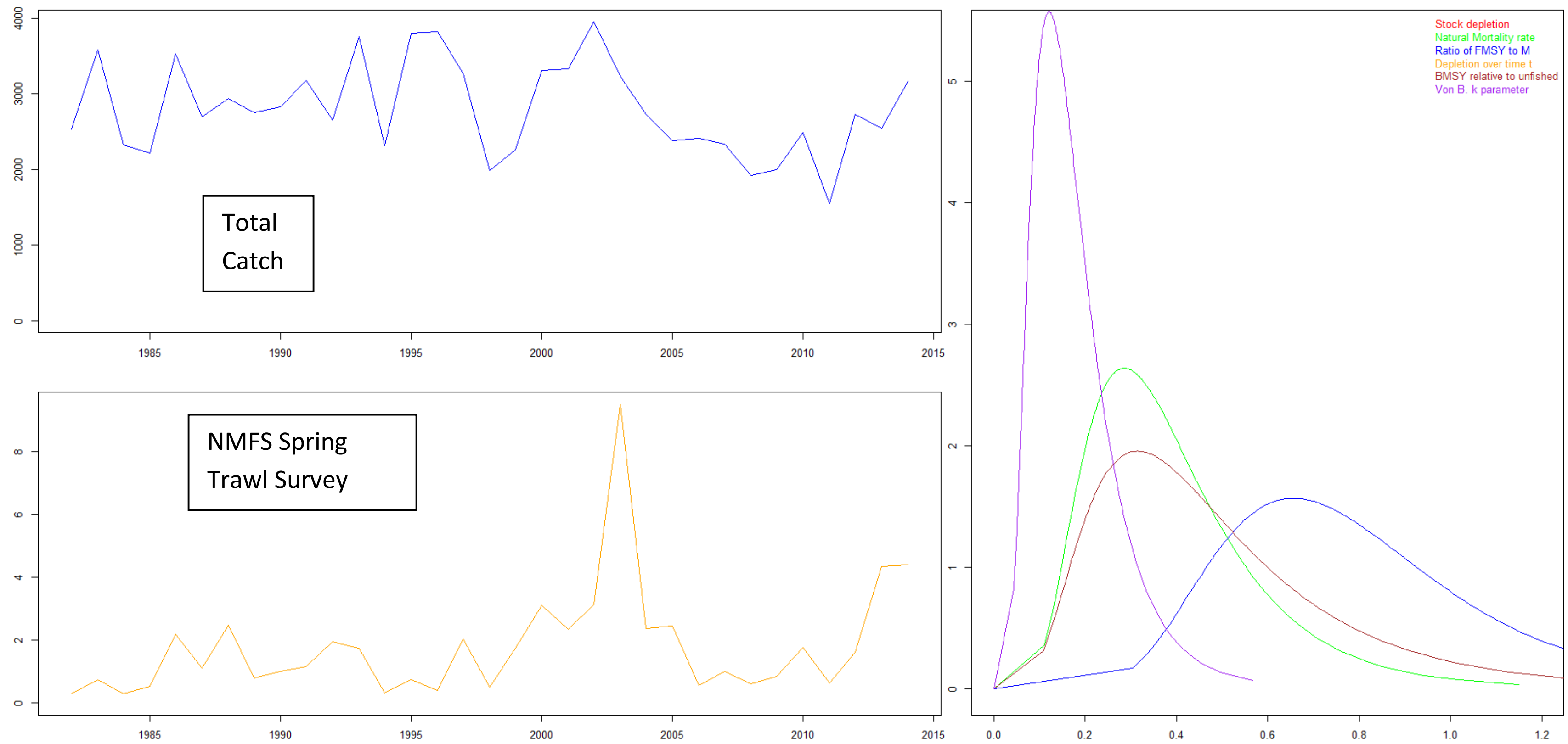


Figure 3 – Graphical summary of black sea bass input data and assumed values (ranges) for management procedure input parameters.

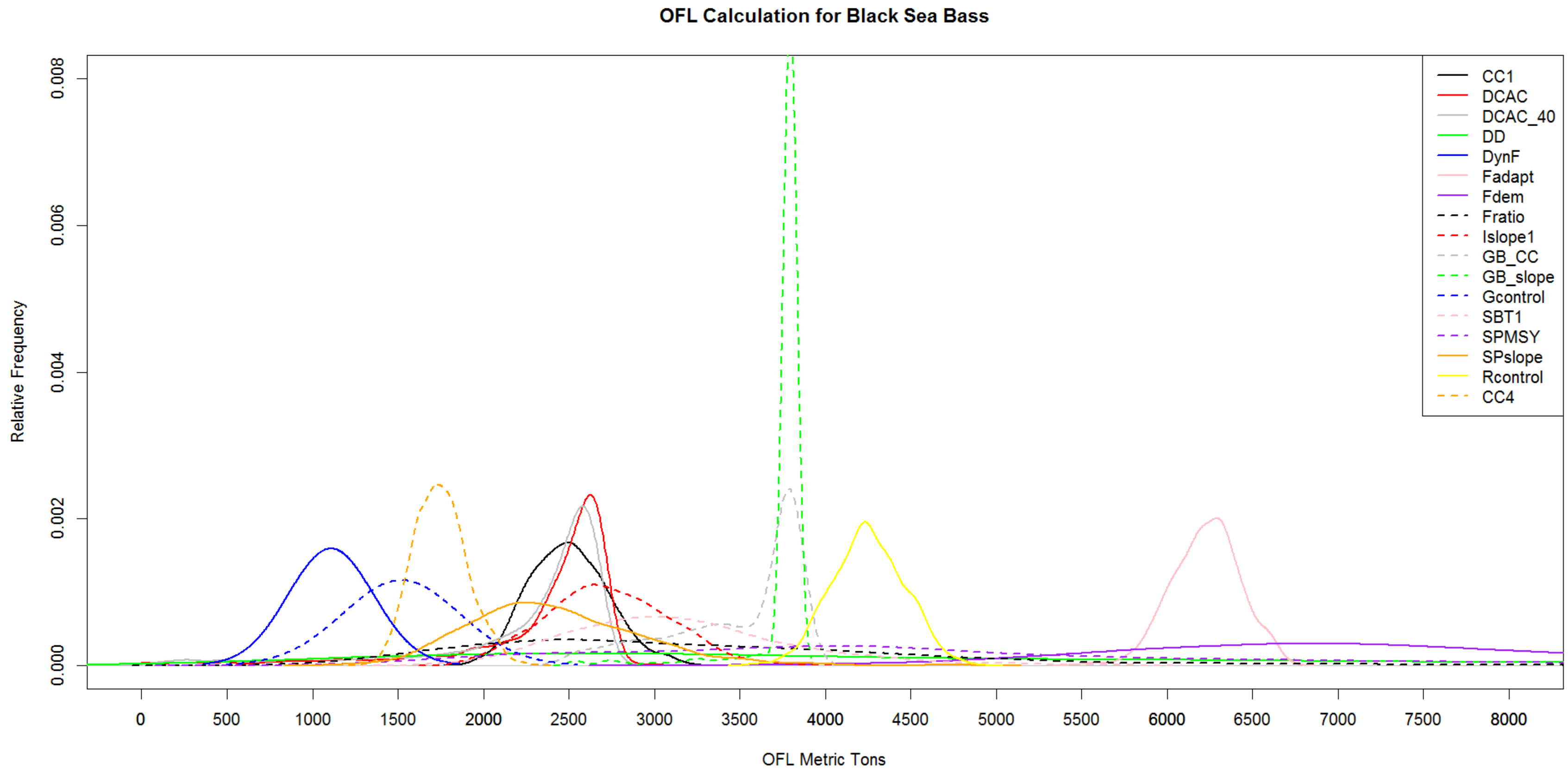


Figure 6 – Calculated OFLs for all approaches.

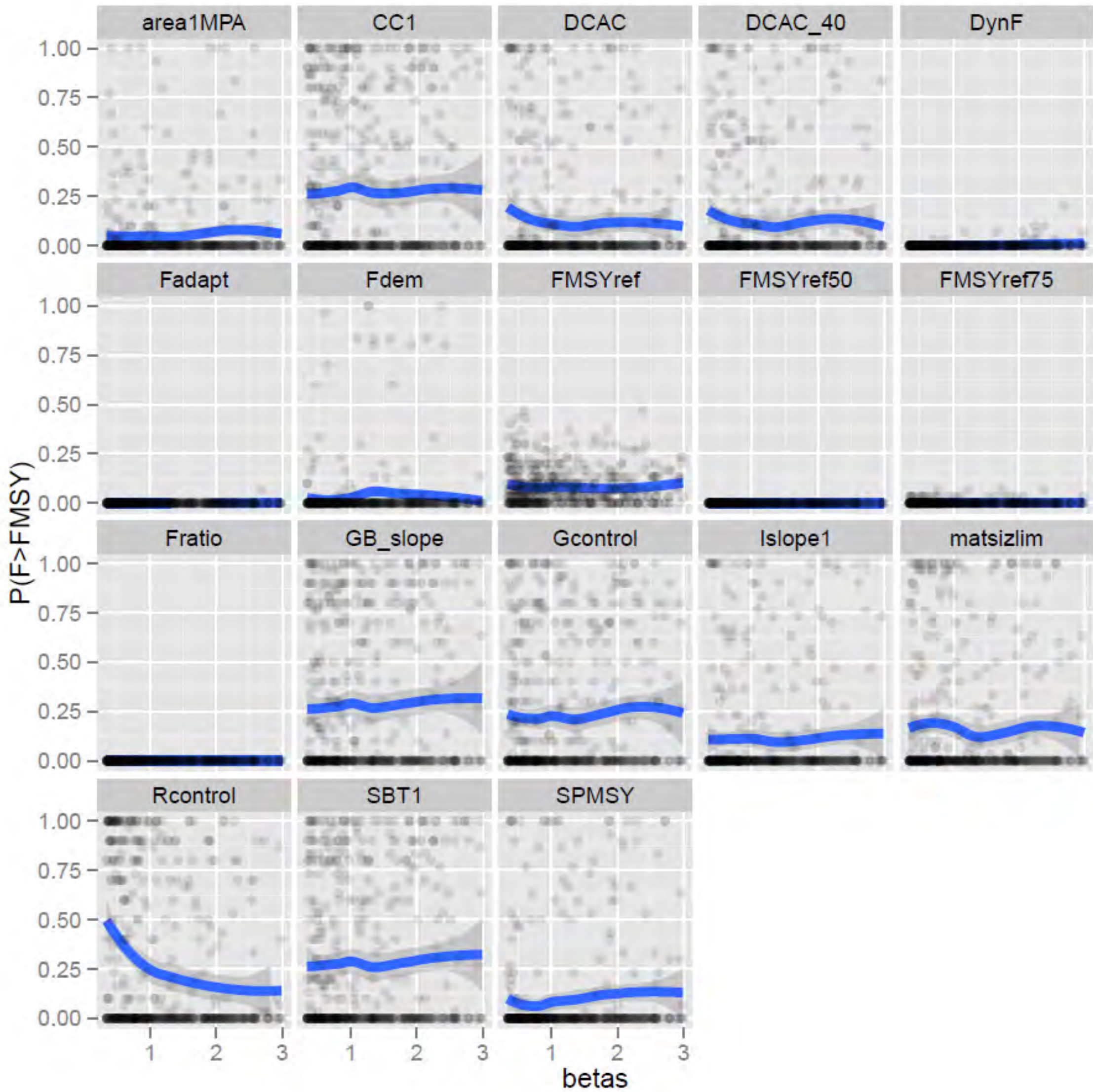


Figure 7a – Sensitivity of the procedures to the beta parameter

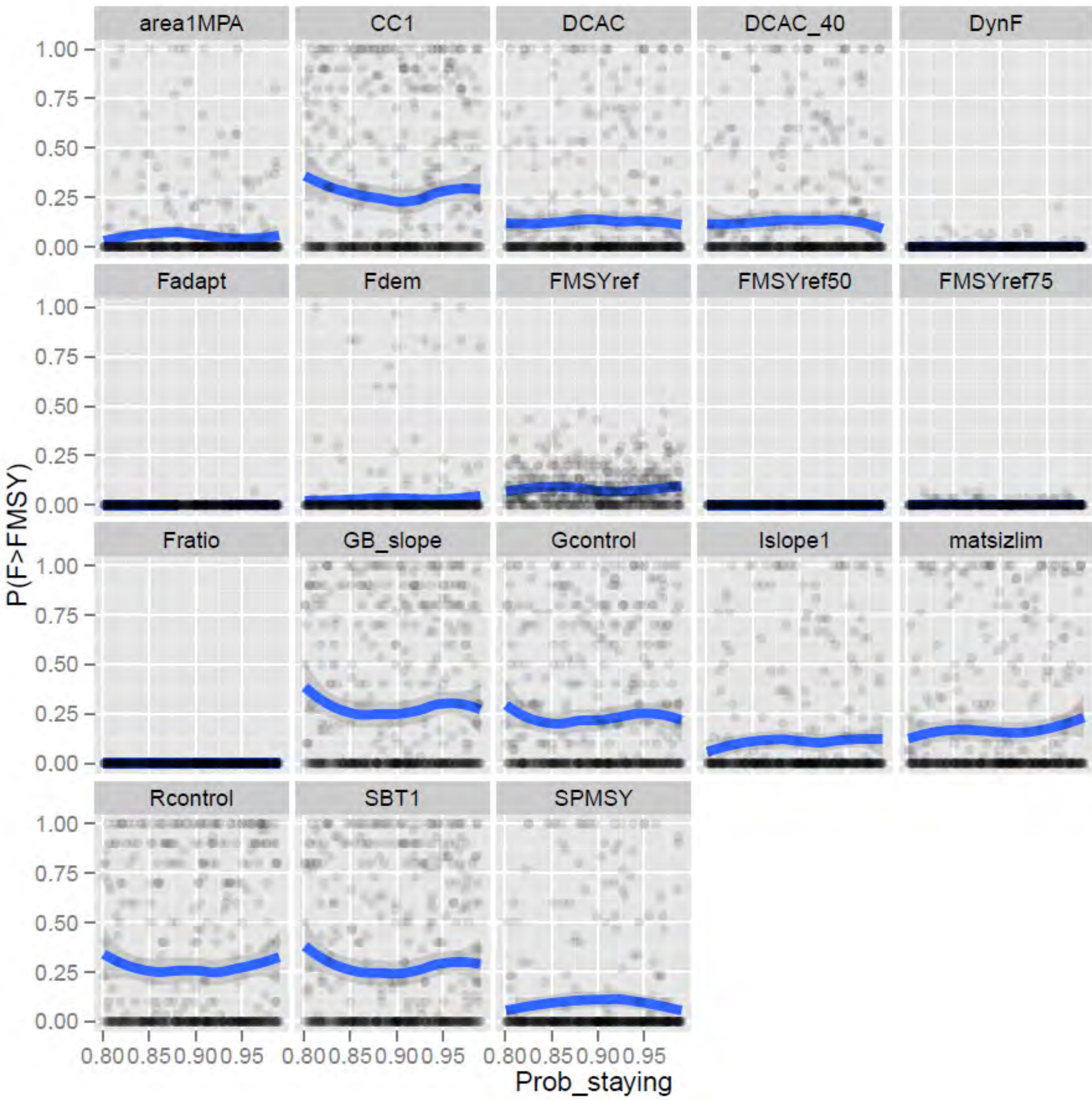


Figure 7b – Sensitivity of the procedures to the Prob_staying parameter

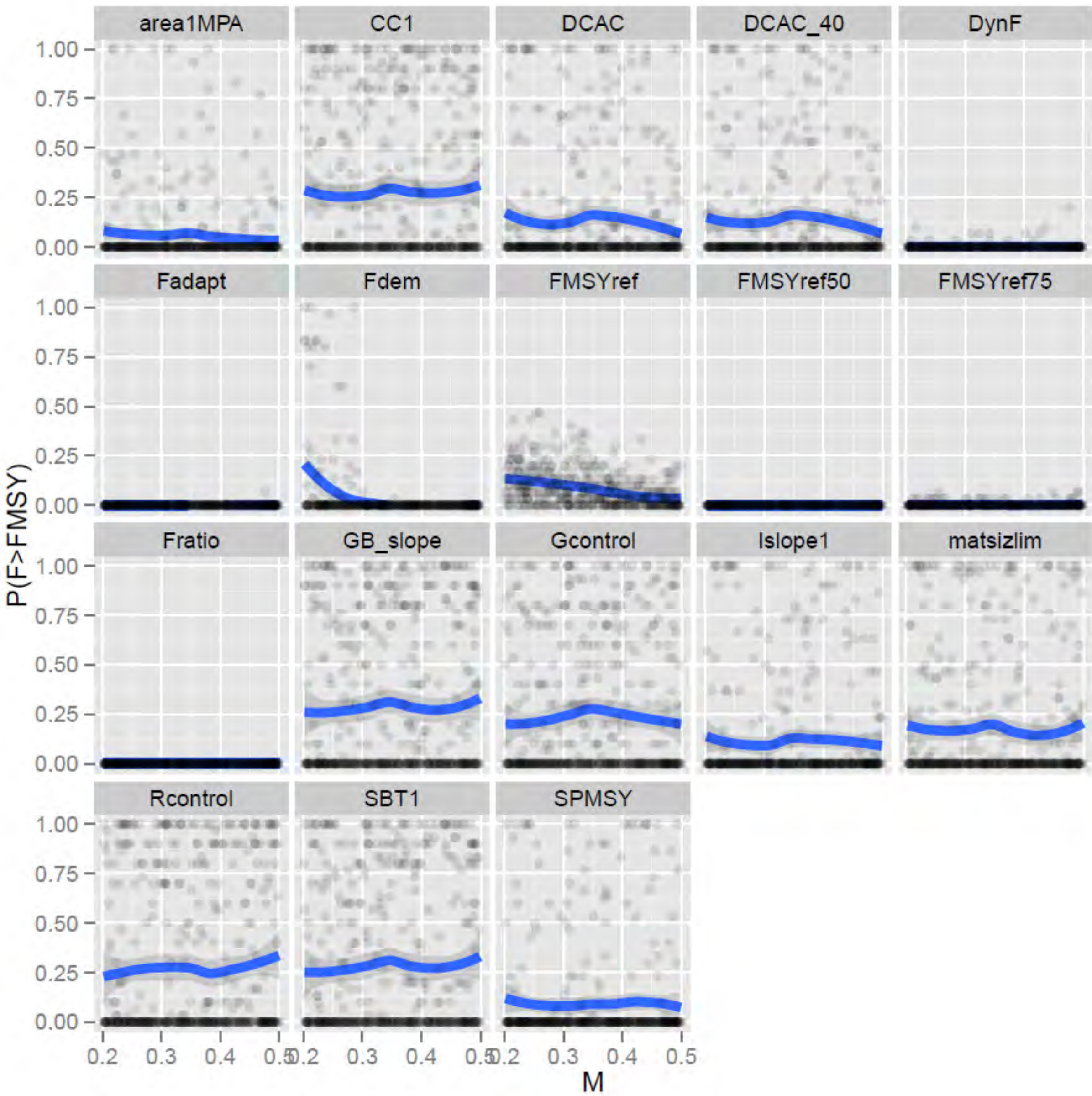


Figure 7c – Sensitivity of the procedures to the M parameter

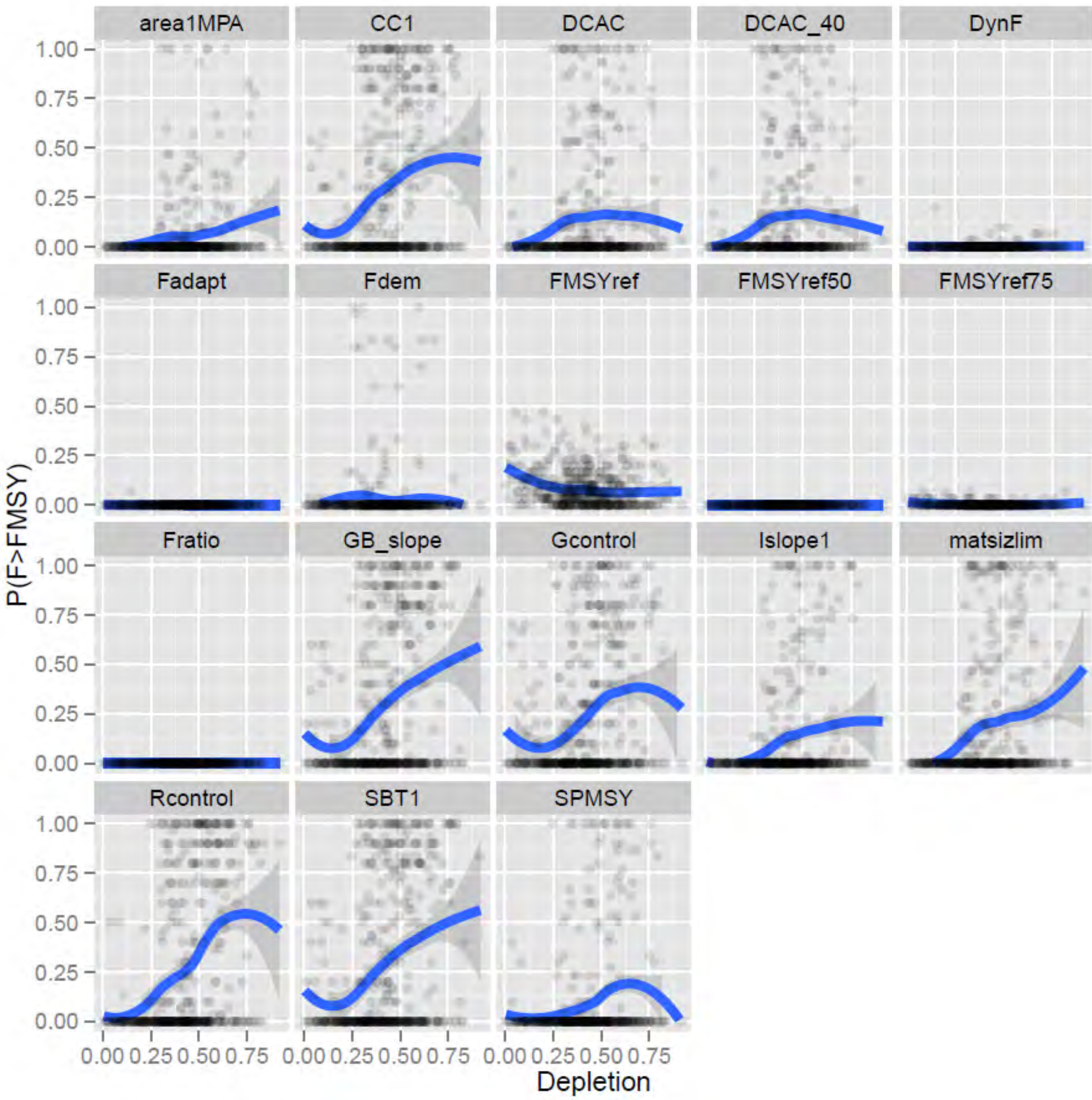


Figure 7d – Sensitivity of the procedures to the Depletion parameter

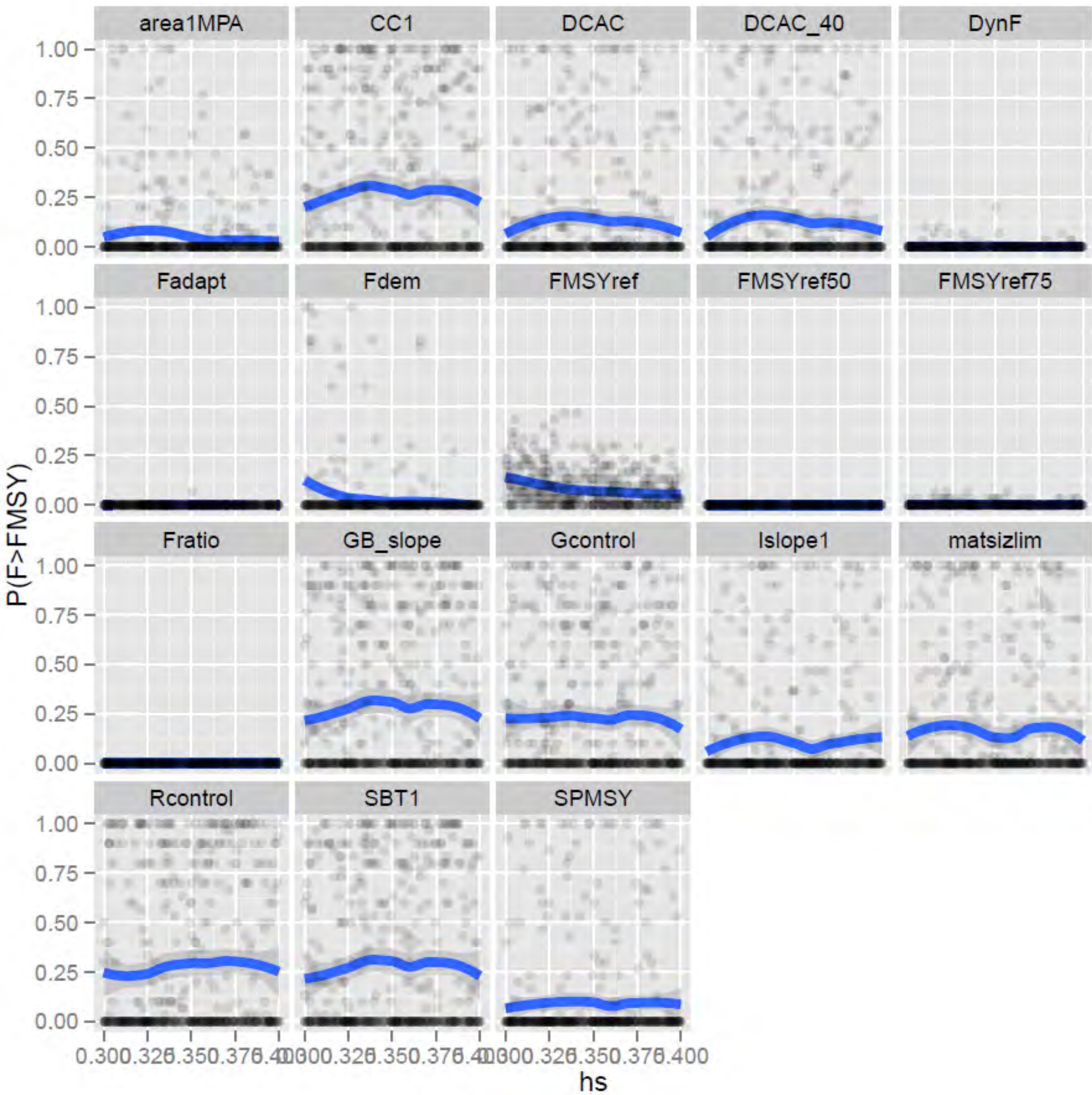


Figure 7e – Sensitivity of the procedures to the h parameter

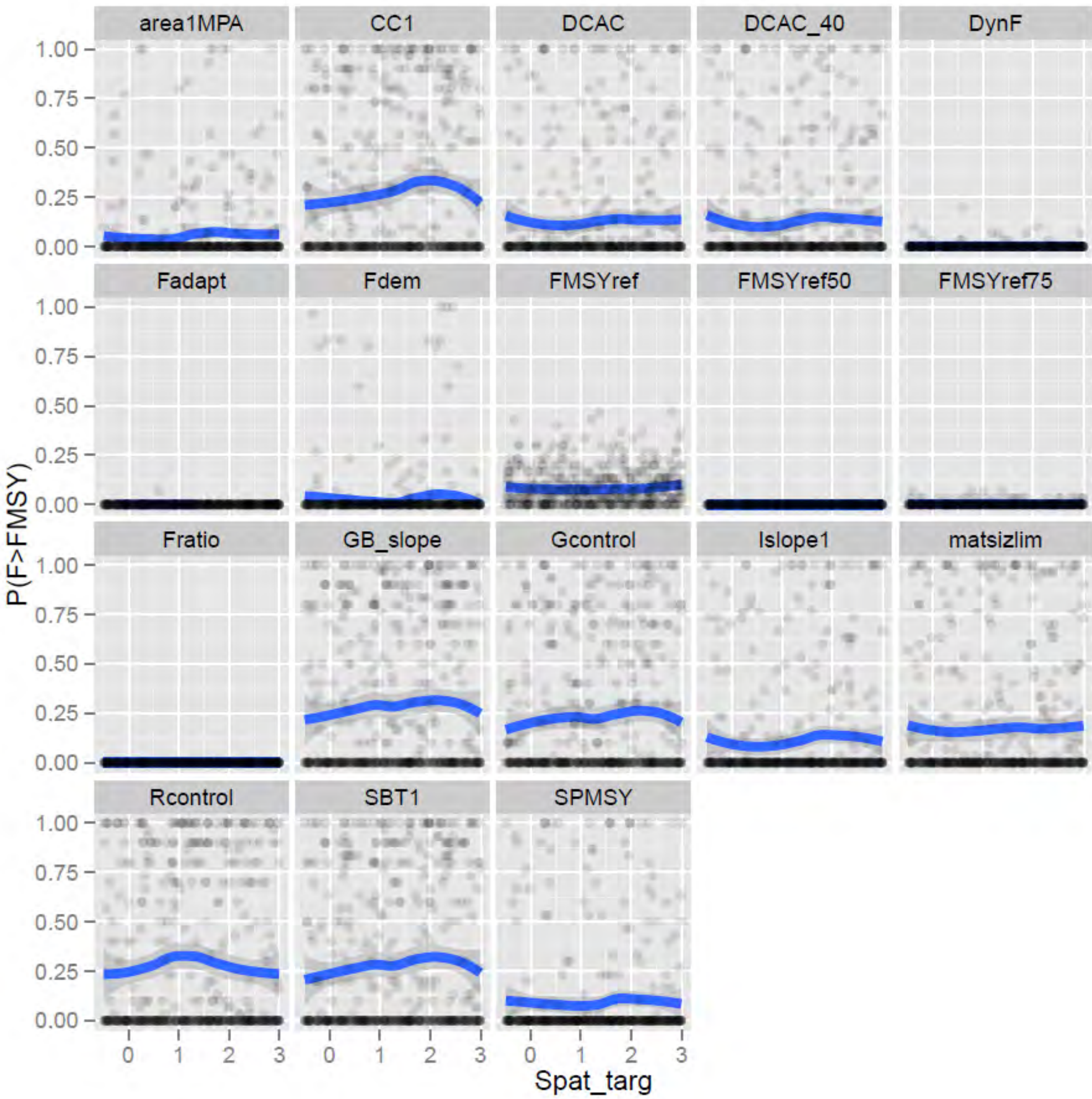


Figure 7f – Sensitivity of the procedures to the Spat_targ parameter

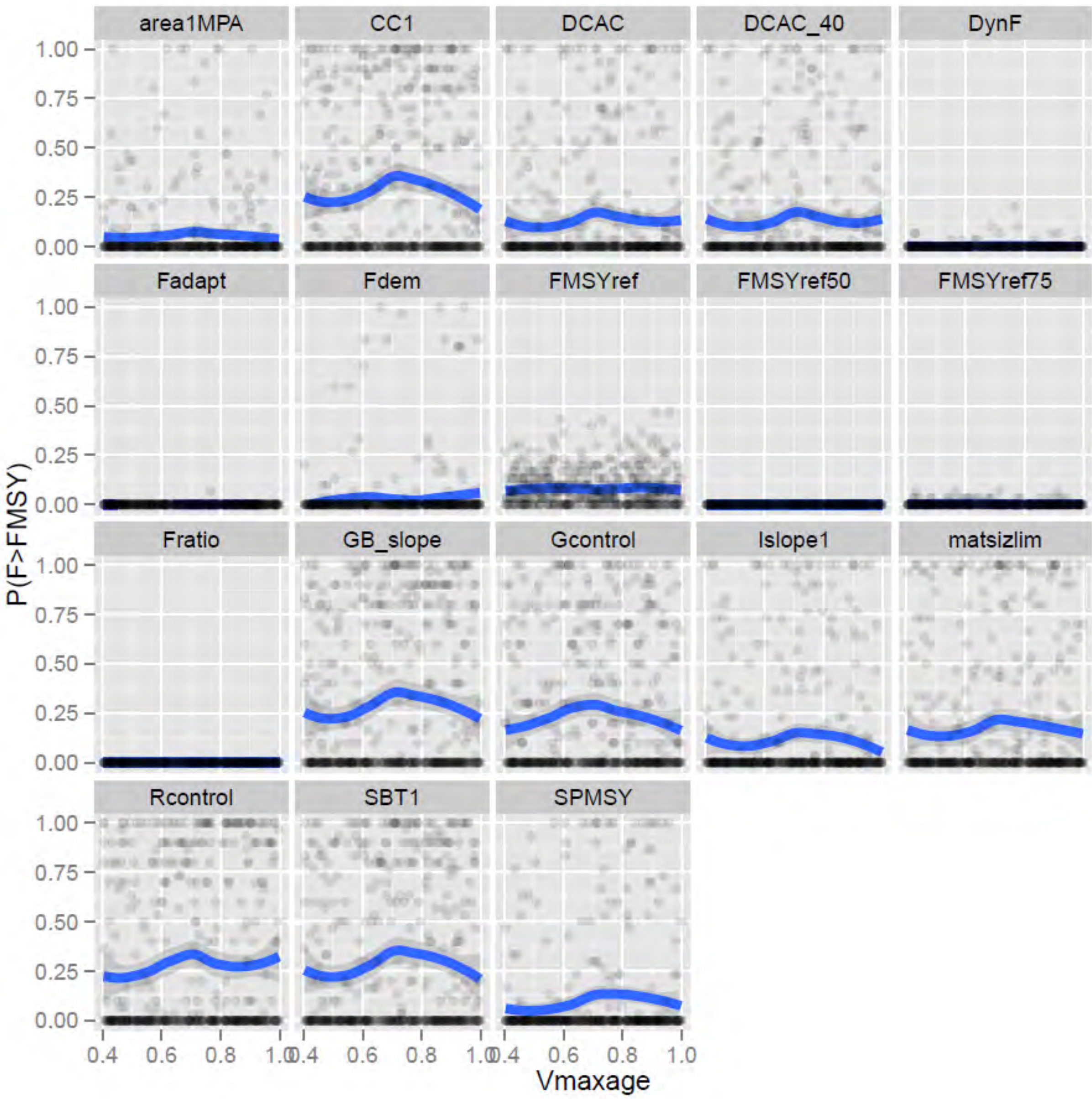


Figure 7g – Sensitivity of the procedures to the Vmaxage parameter

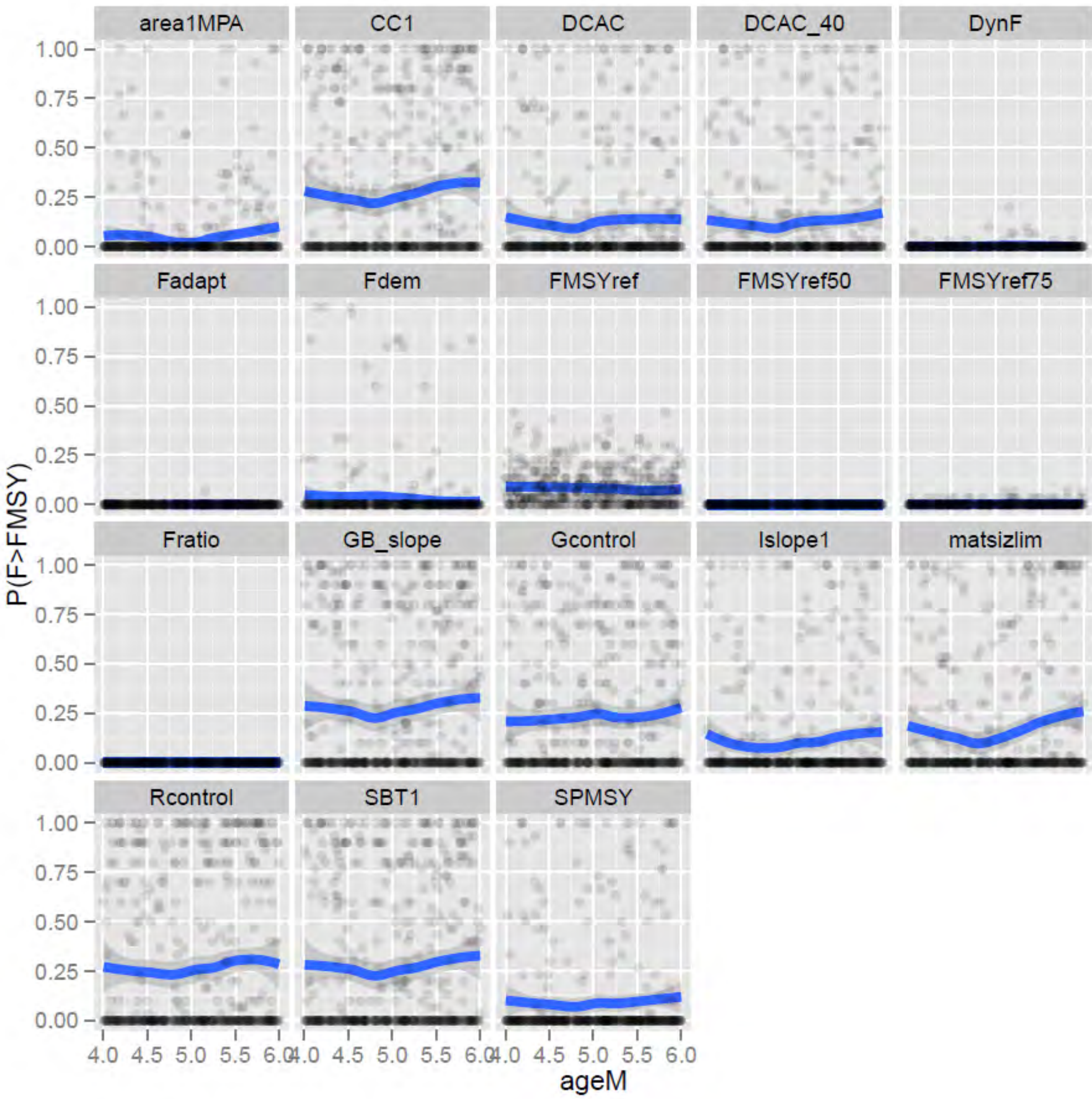


Figure 7h – Sensitivity of the procedures to the ageM parameter

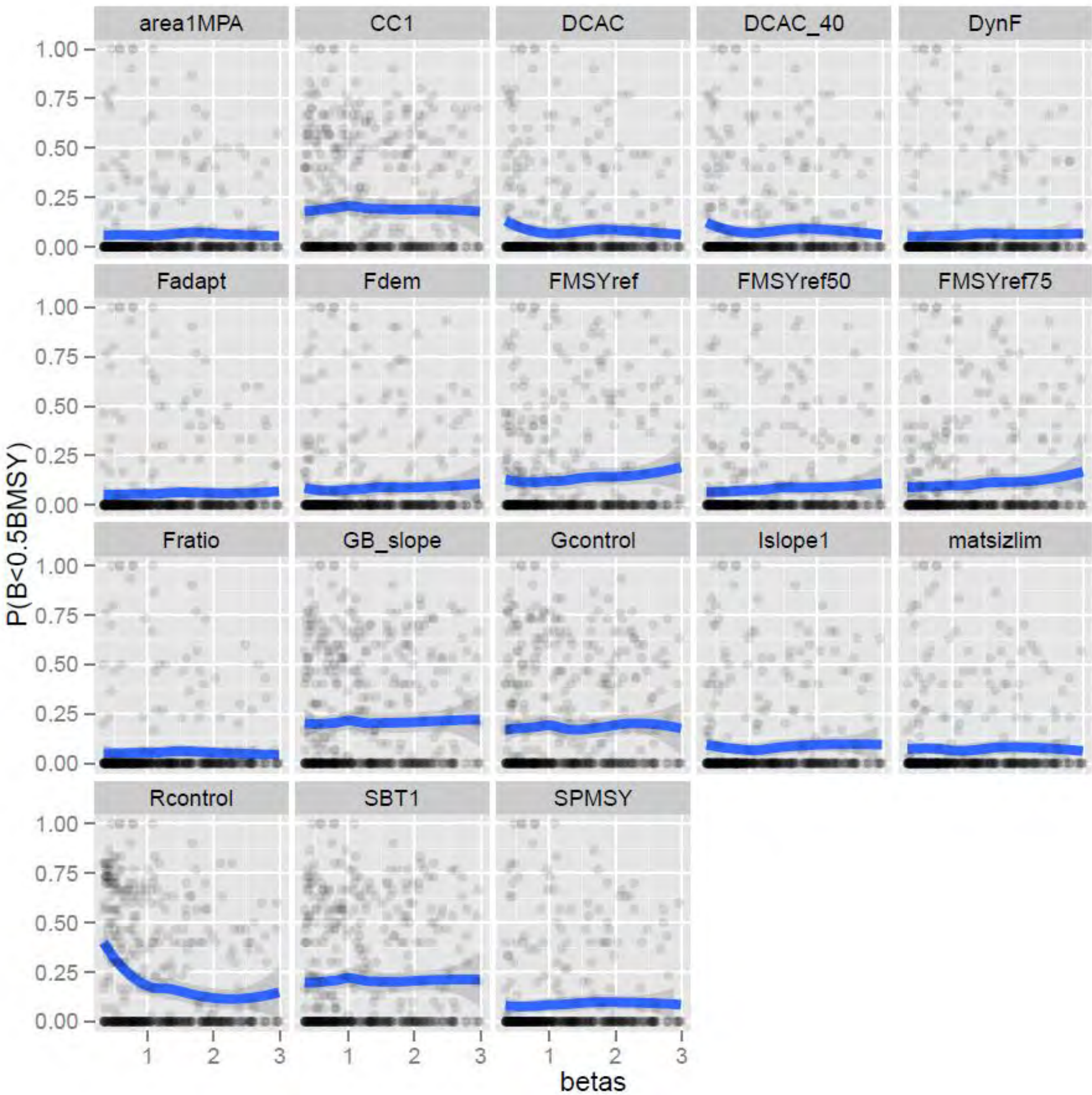


Figure 7i – Sensitivity of the procedures to the beta parameter

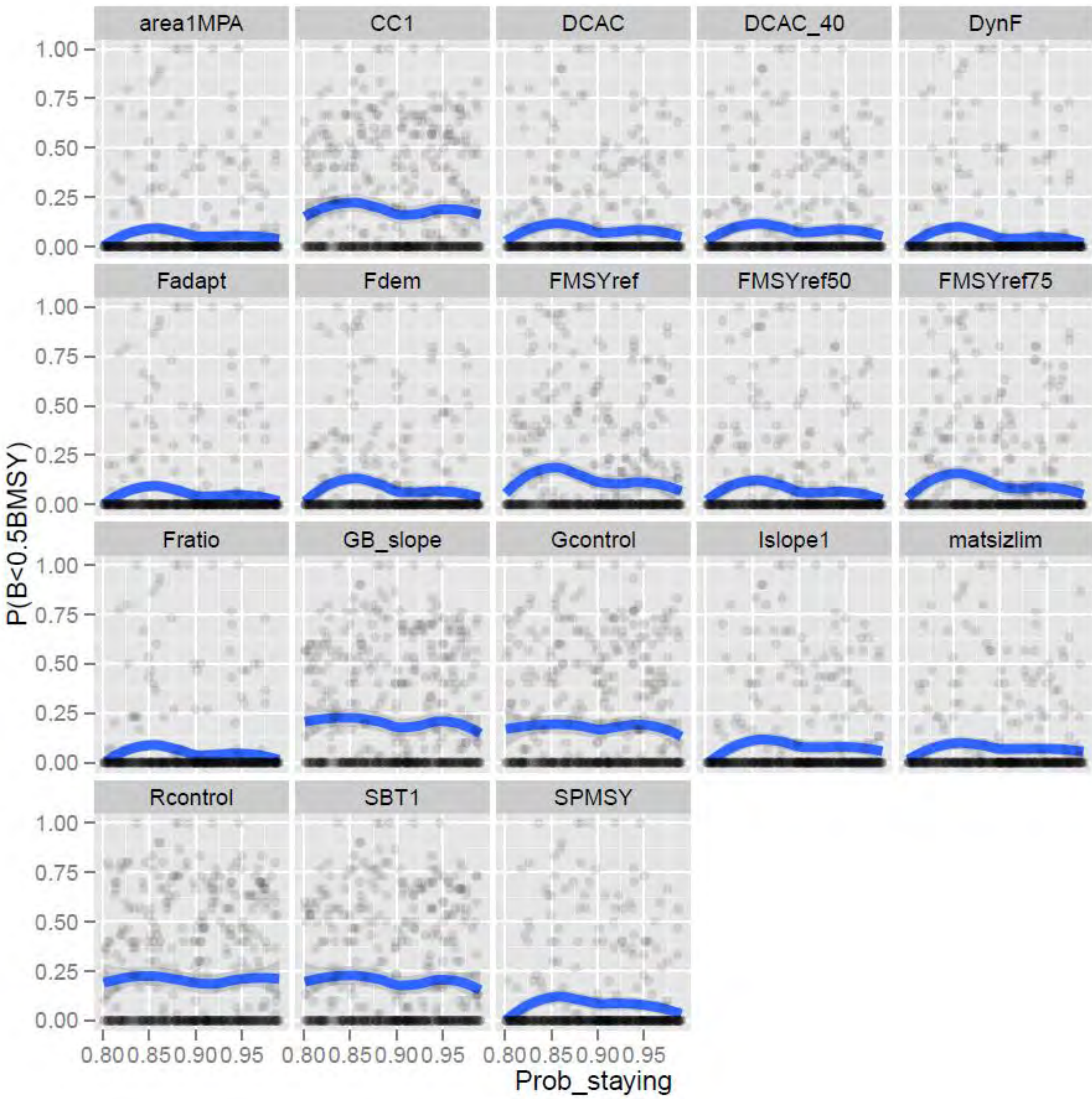


Figure 7j – Sensitivity of the procedures to the Prob_staying parameter

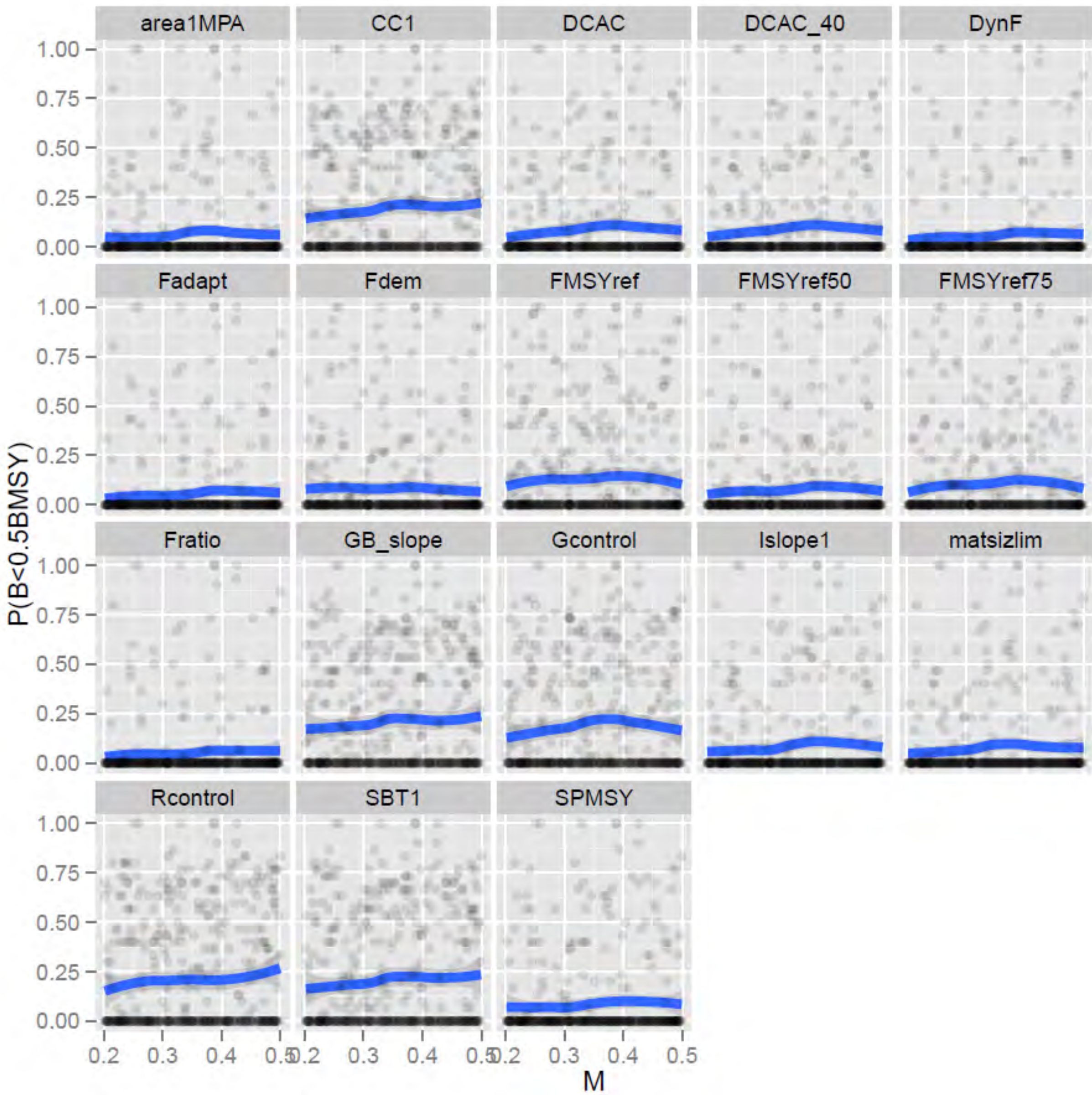


Figure 7k – Sensitivity of the procedures to the M parameter

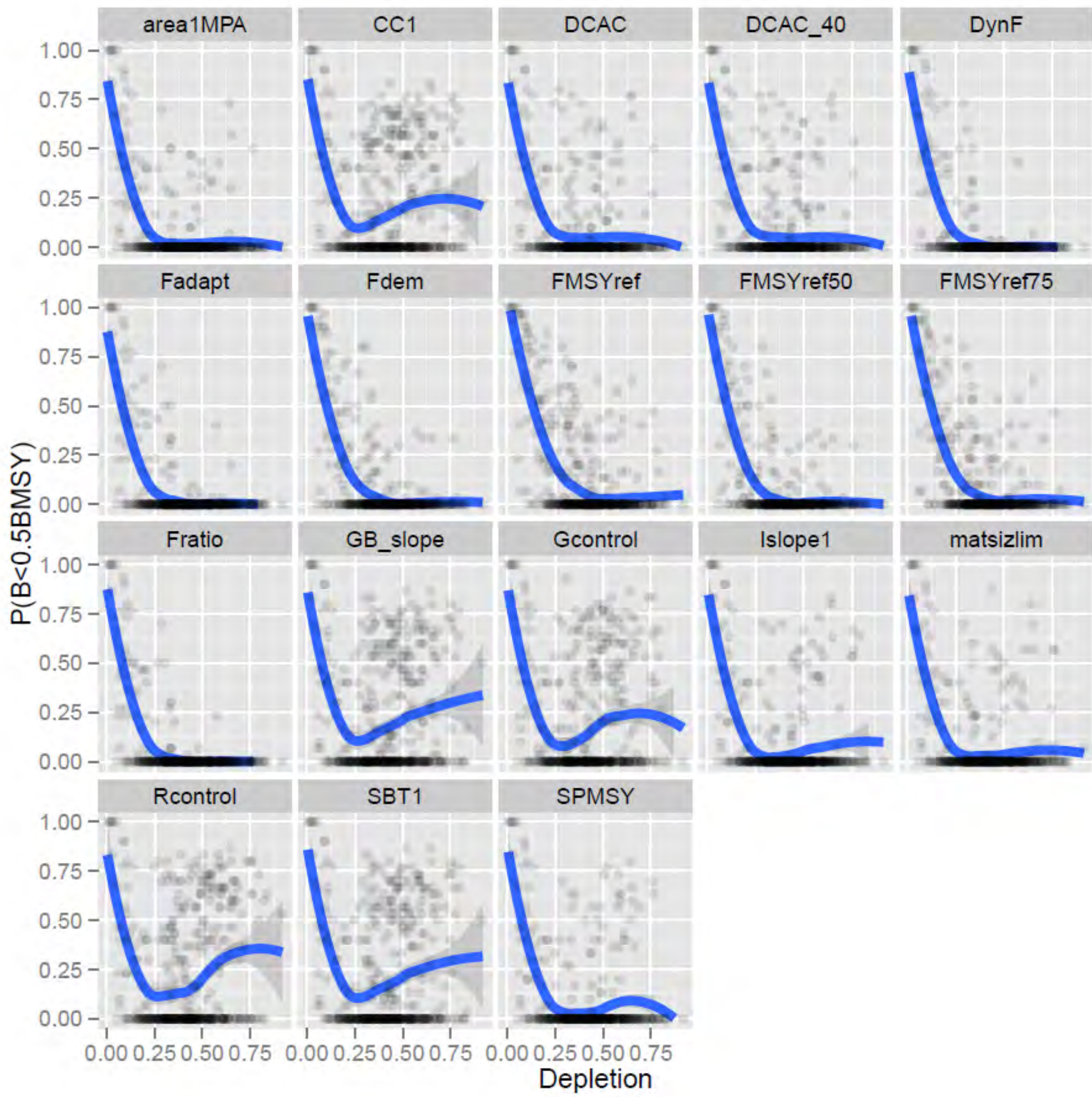


Figure 7l – Sensitivity of the procedures to the Depletion parameter

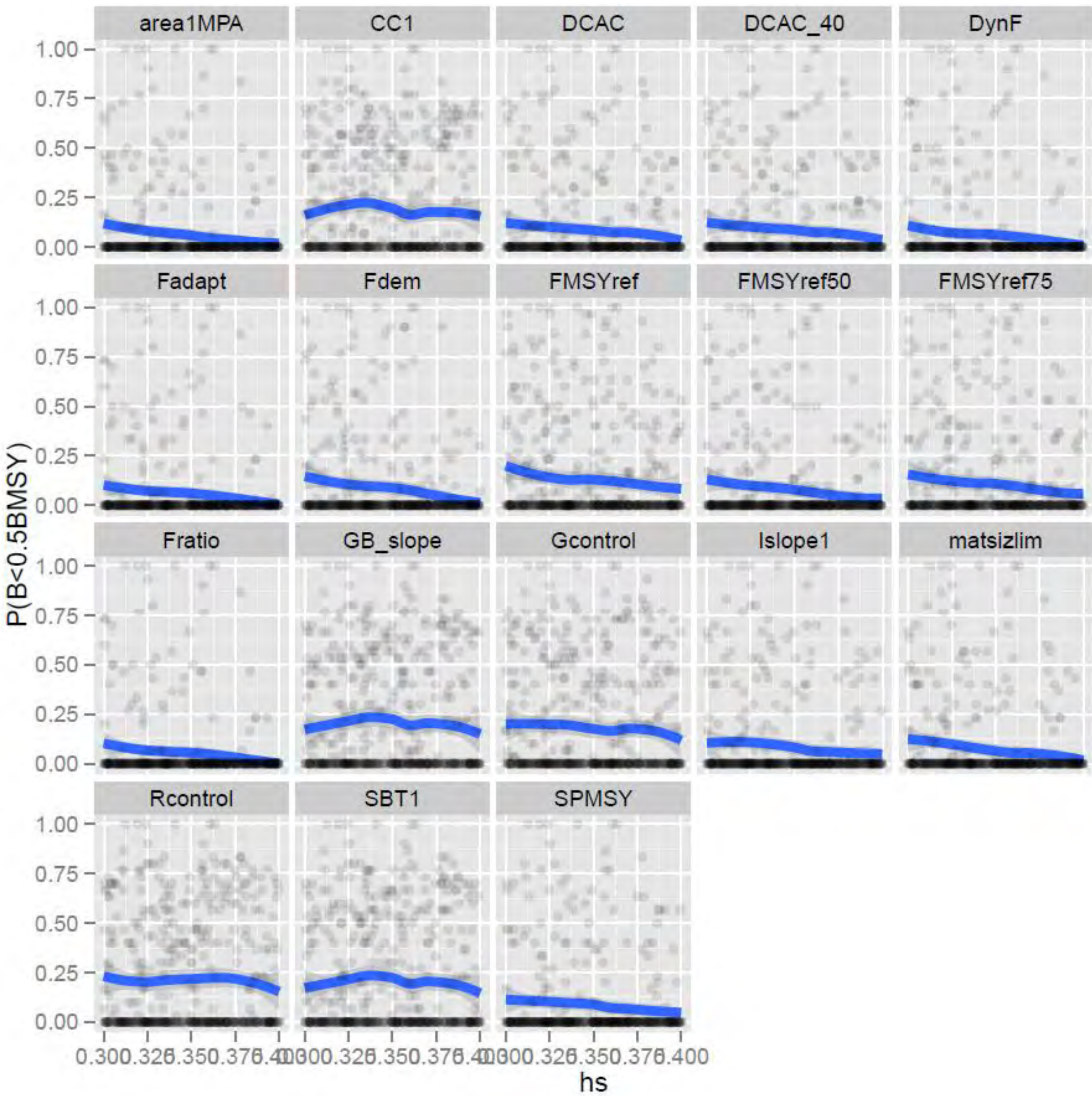


Figure 7m – Sensitivity of the procedures to the h parameter

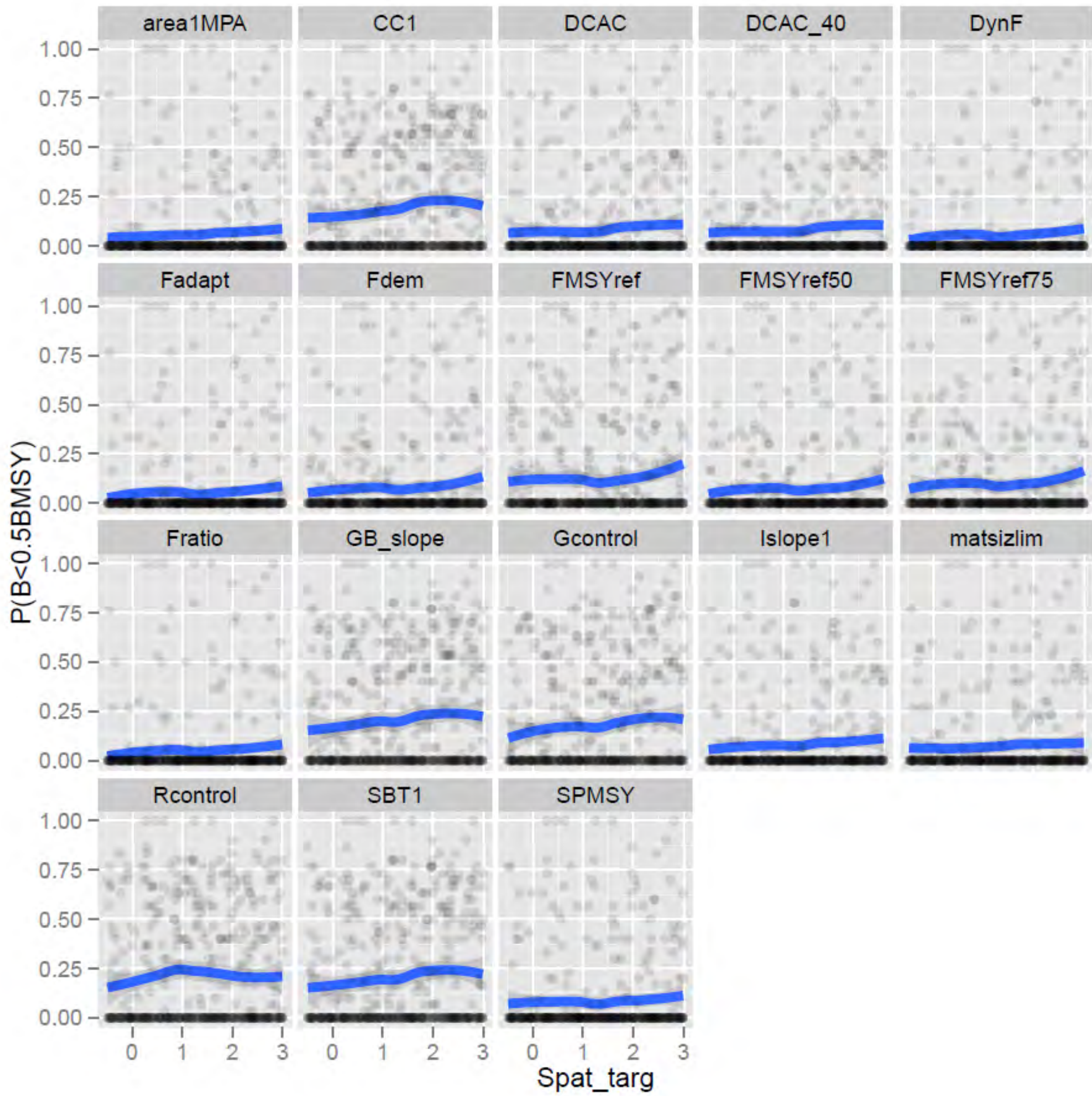


Figure 7n– Sensitivity of the procedures to the Spat_targ parameter

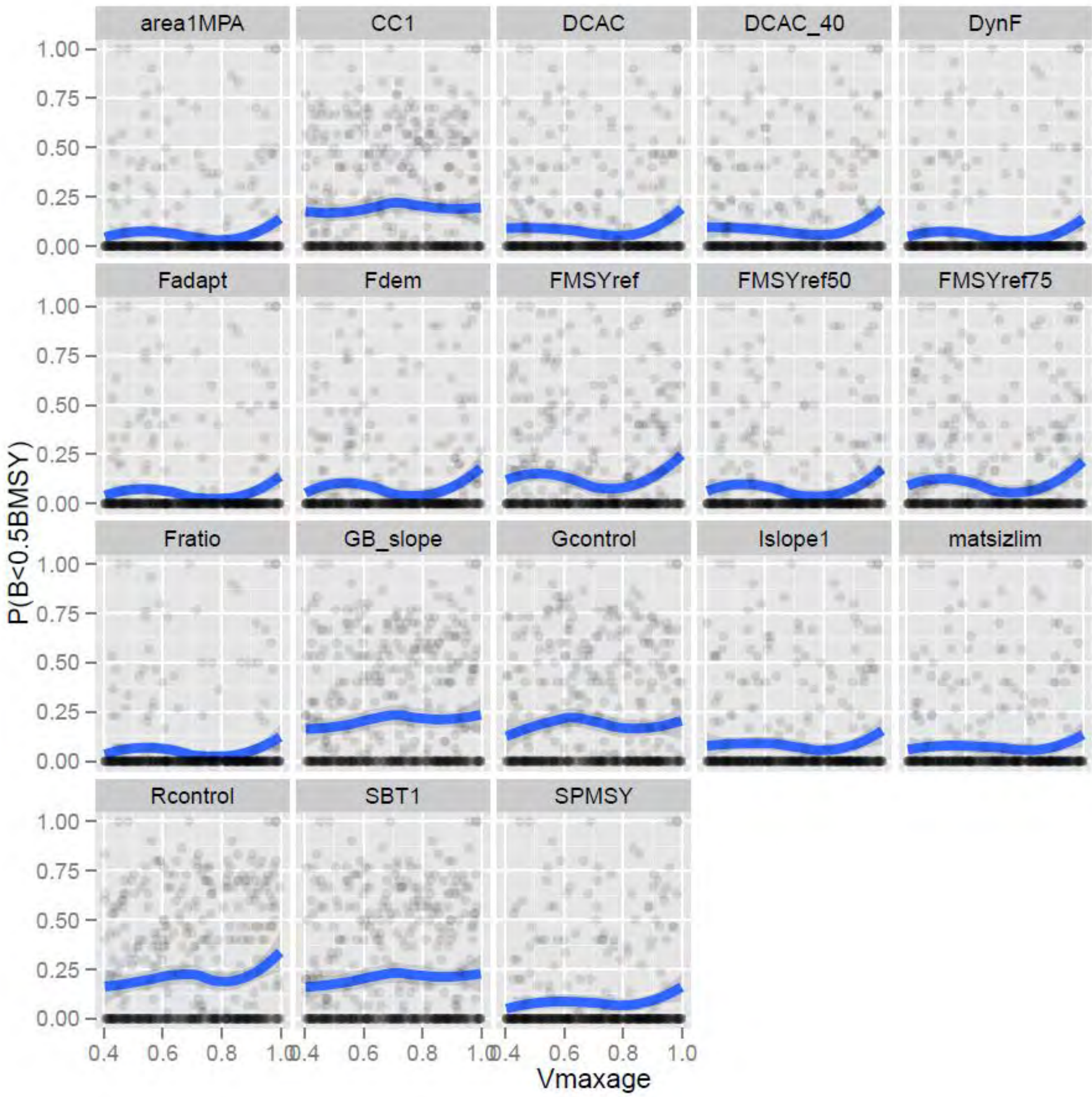


Figure 7o – Sensitivity of the procedures to the Vmaxage parameter

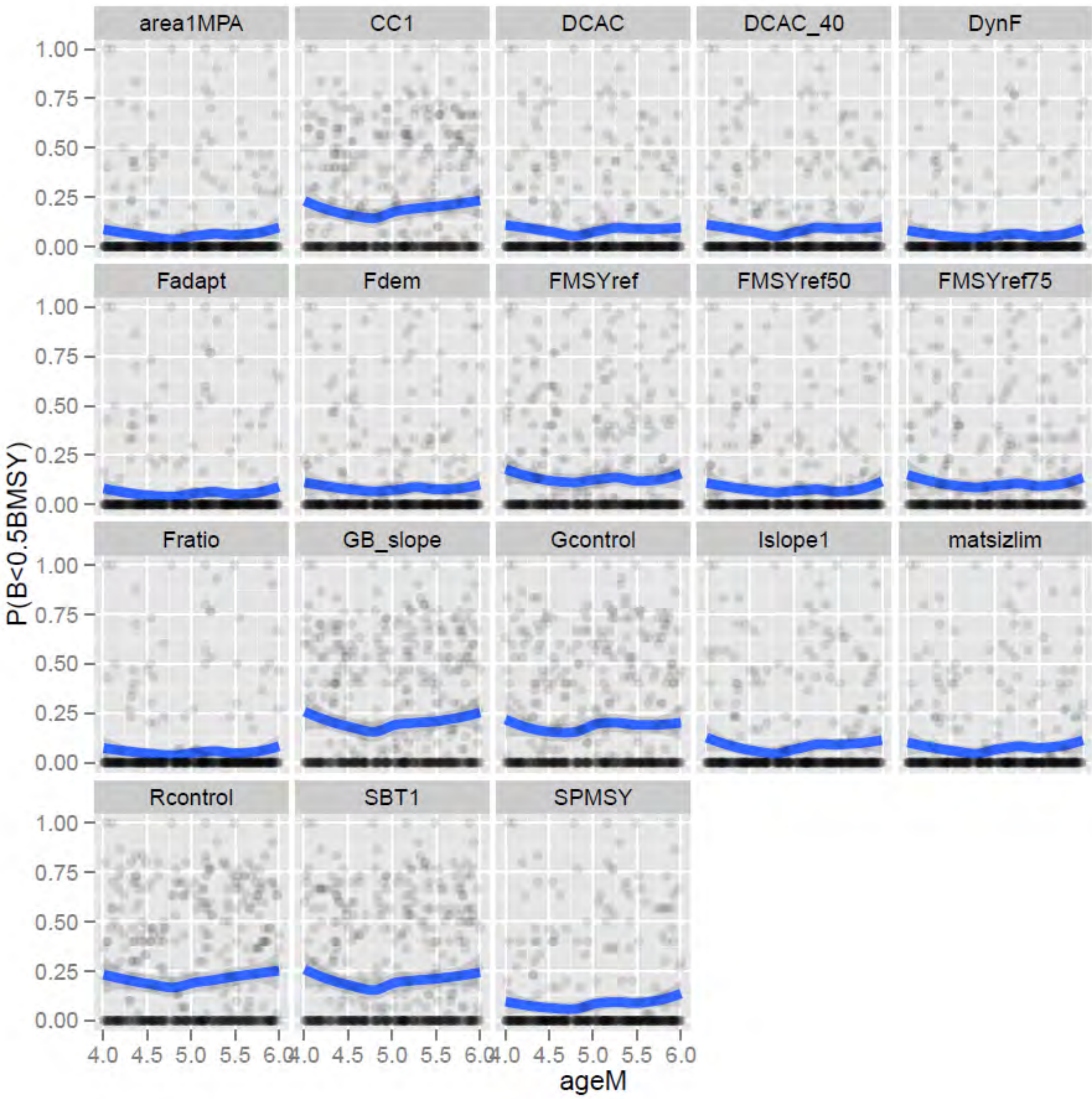


Figure 7p – Sensitivity of the procedures to the ageM parameter

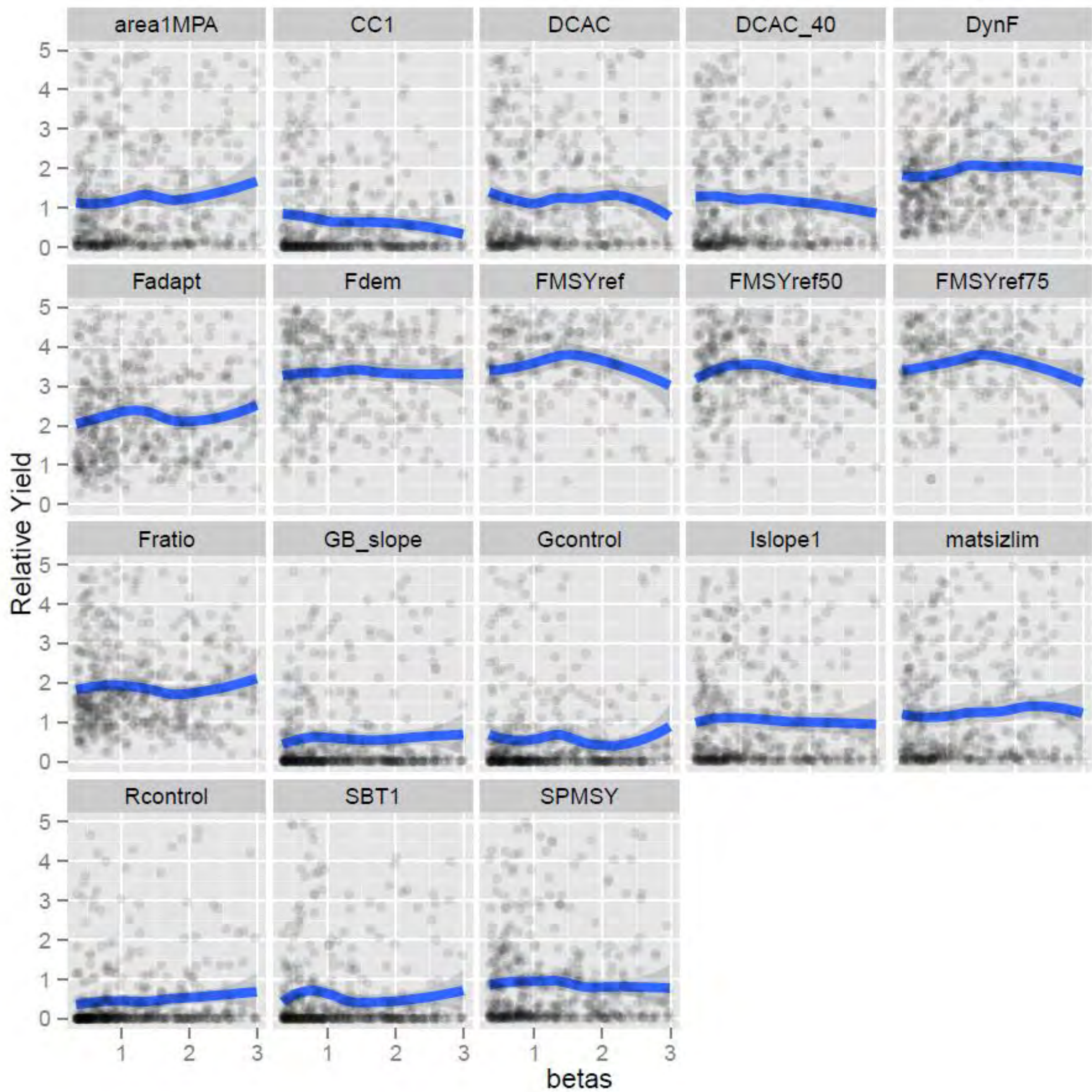


Figure 7q – Sensitivity of the procedures to the beta parameter

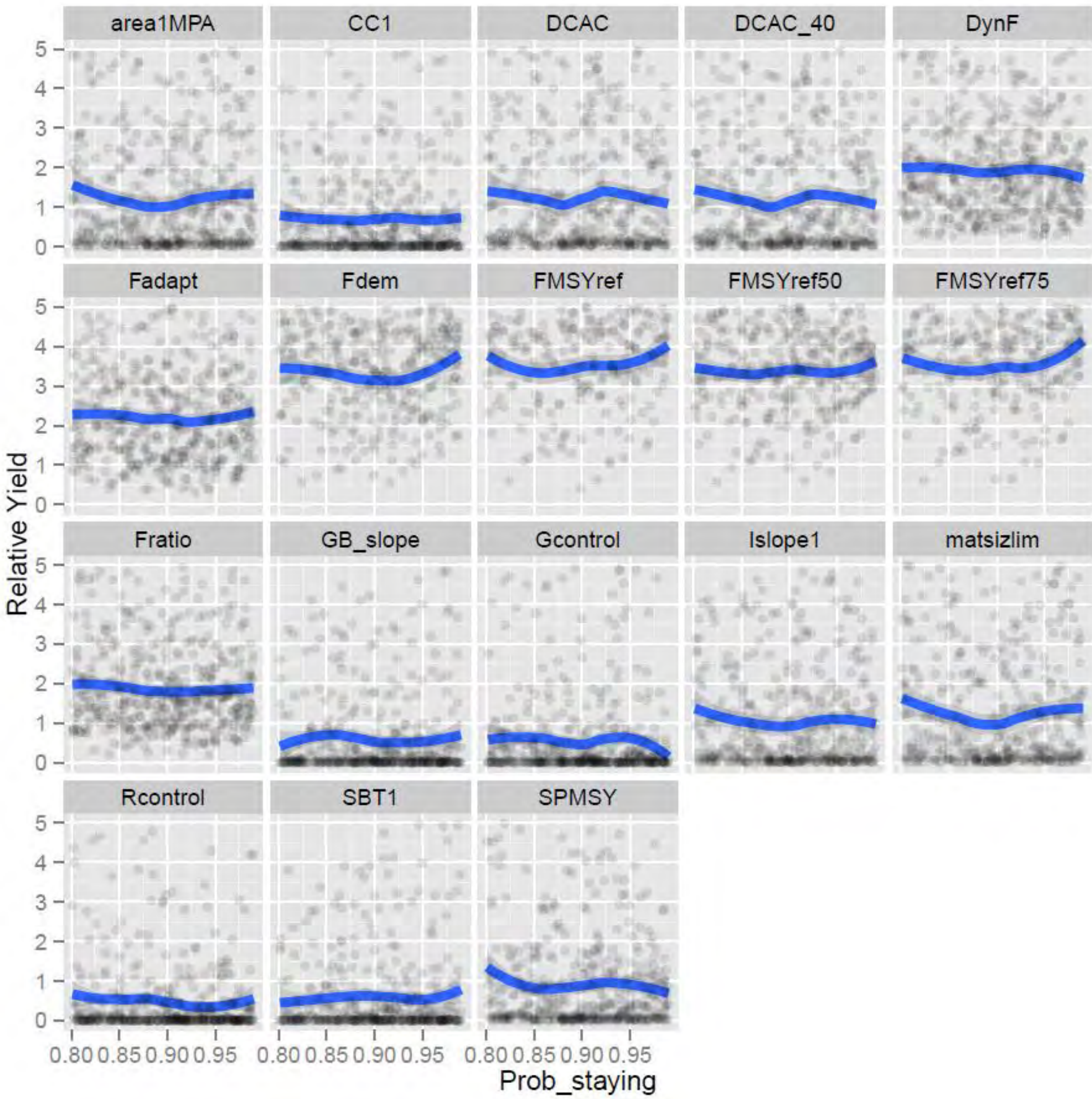


Figure 7r – Sensitivity of the procedures to the Prob_staying parameter

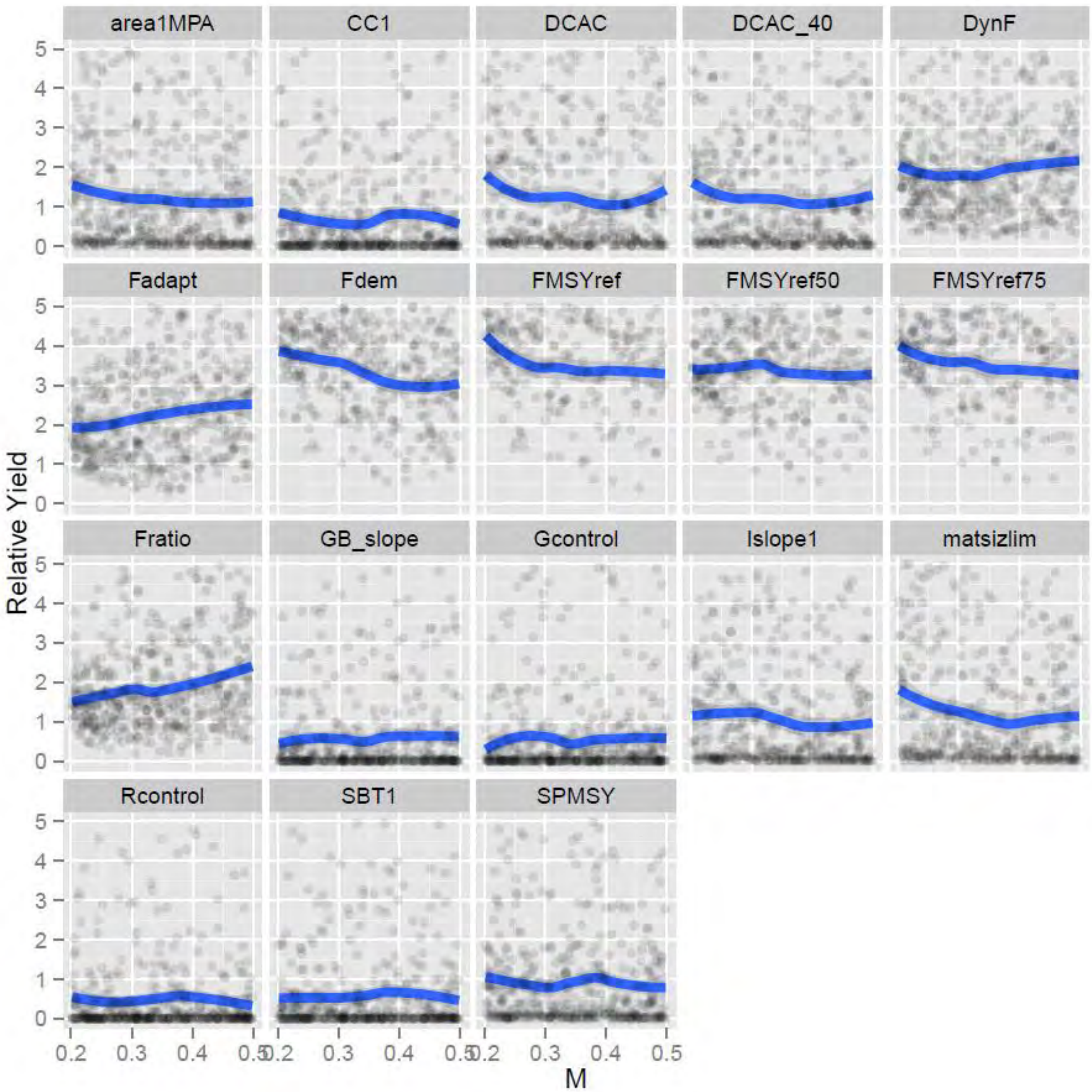


Figure 7s – Sensitivity of the procedures to the M parameter

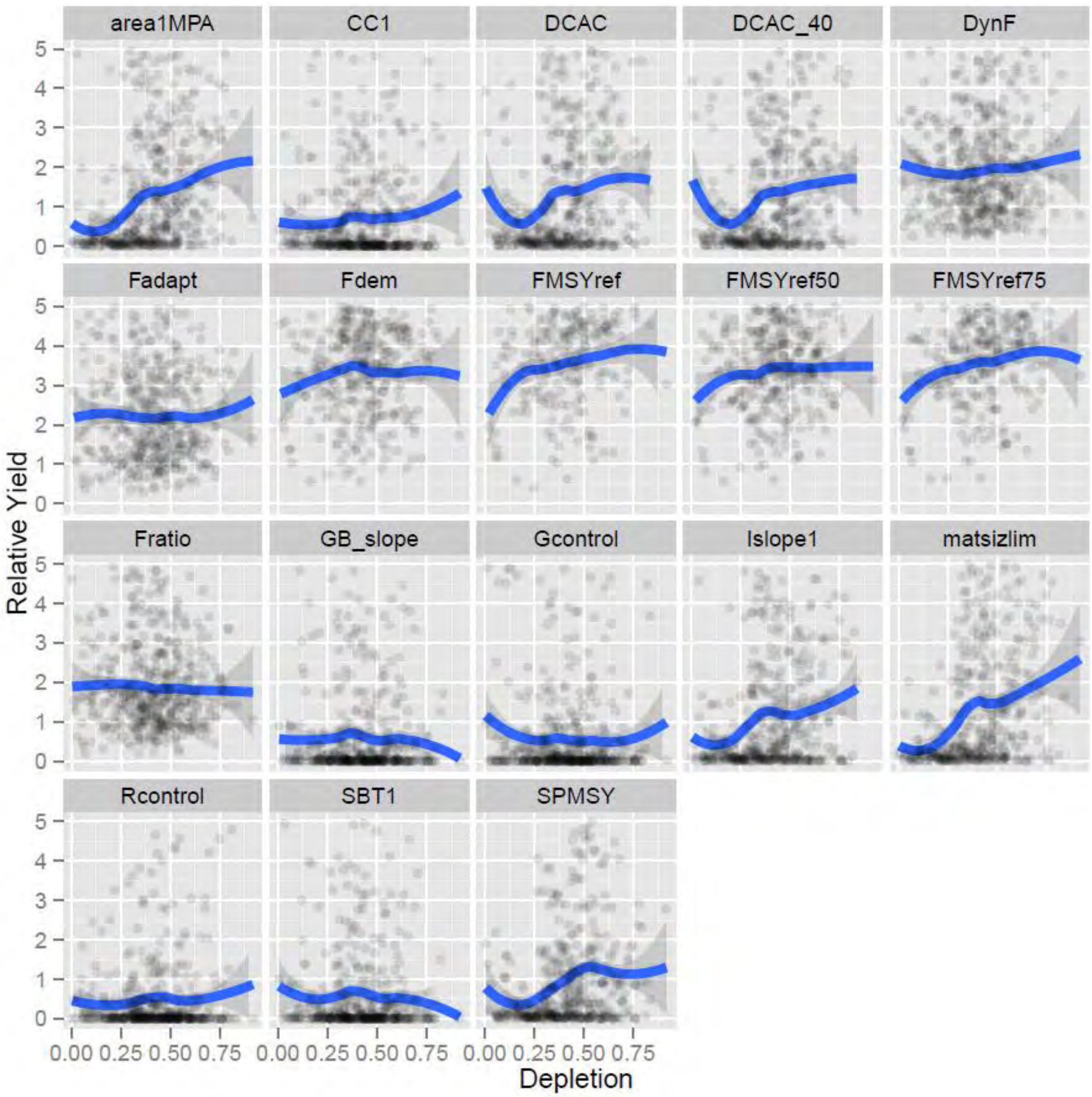


Figure 7t – Sensitivity of the procedures to the Depletion parameter

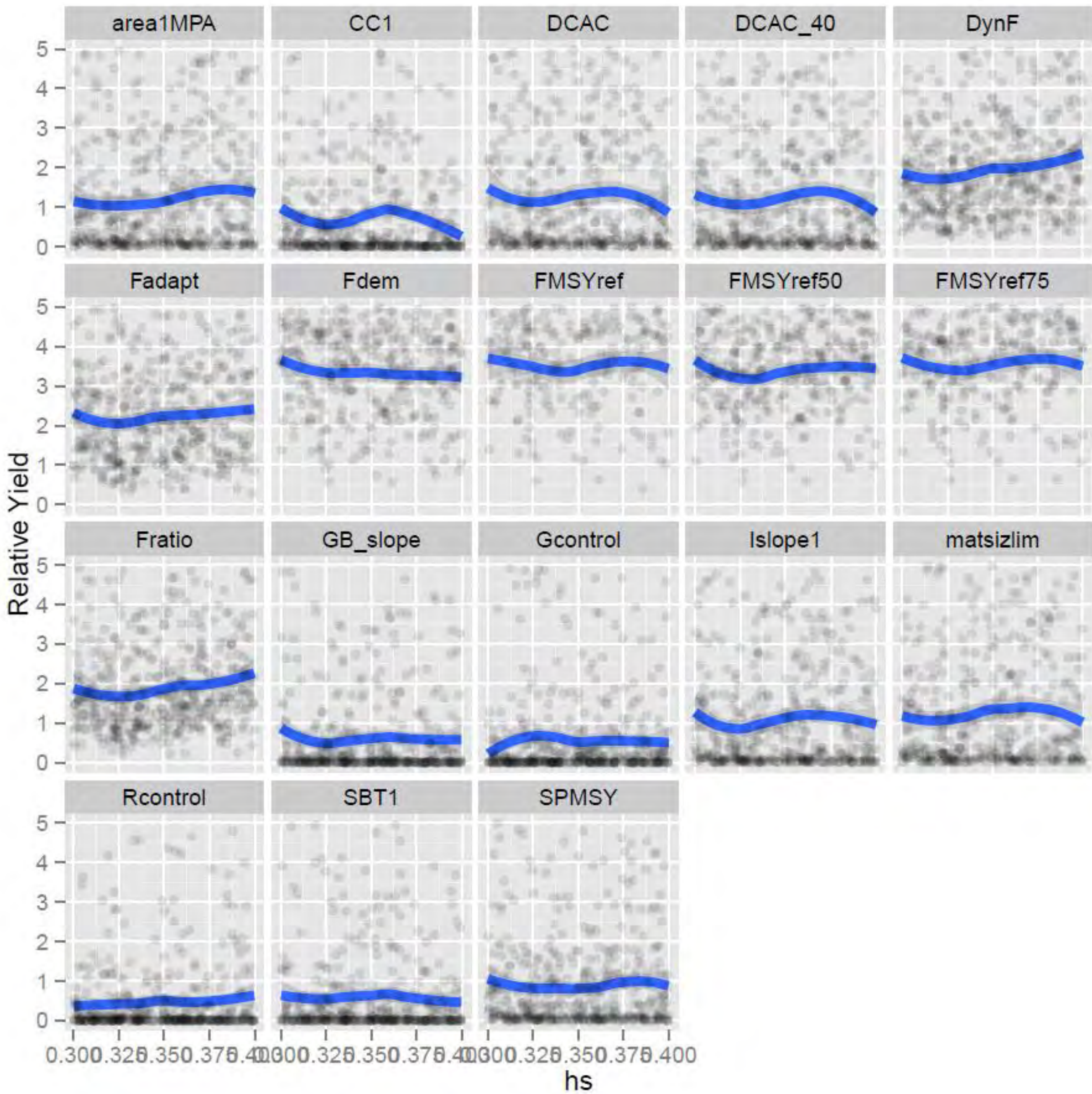


Figure 7u – Sensitivity of the procedures to the h parameter

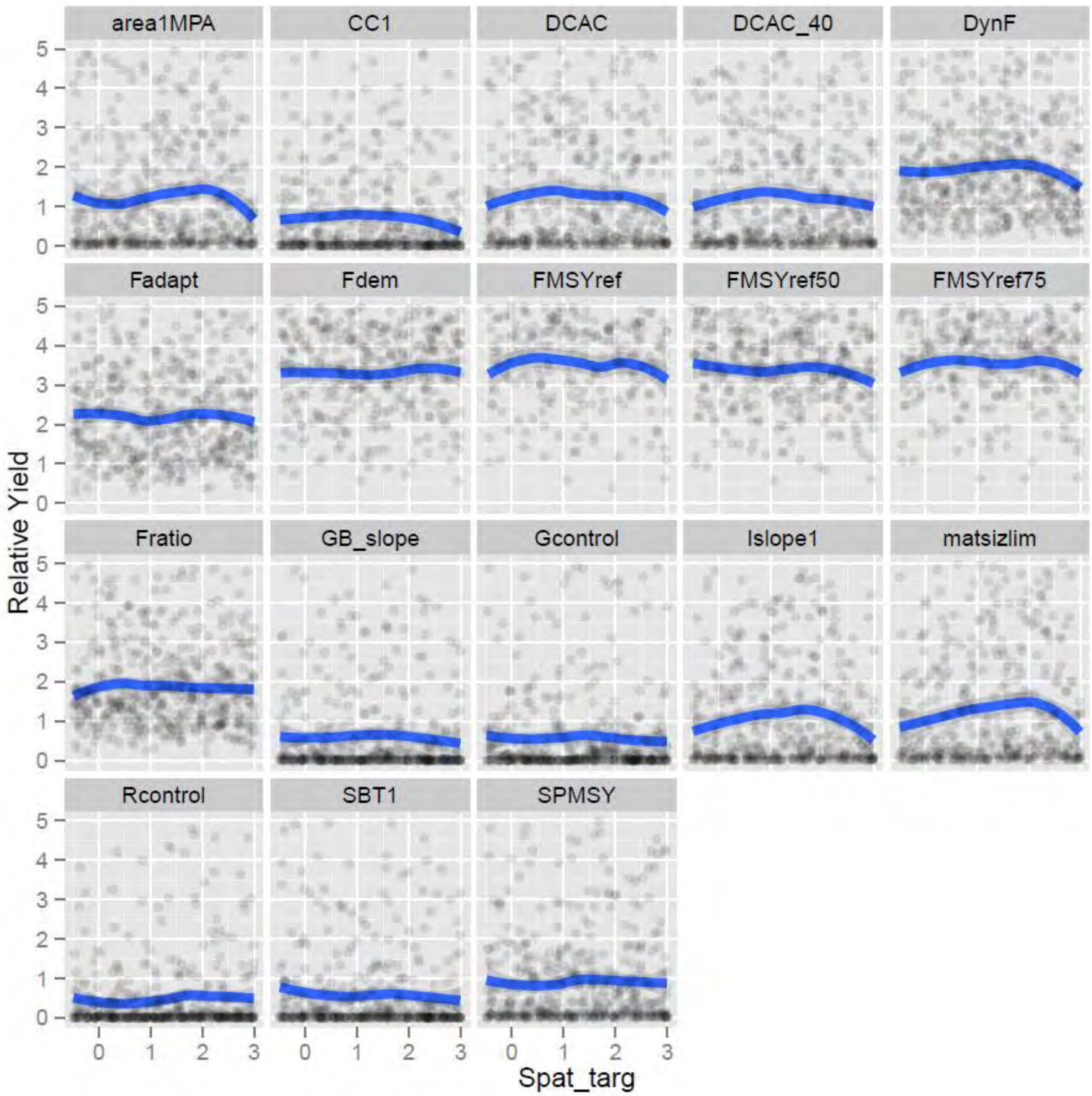


Figure 7v – Sensitivity of the procedures to the Spat_targ parameter

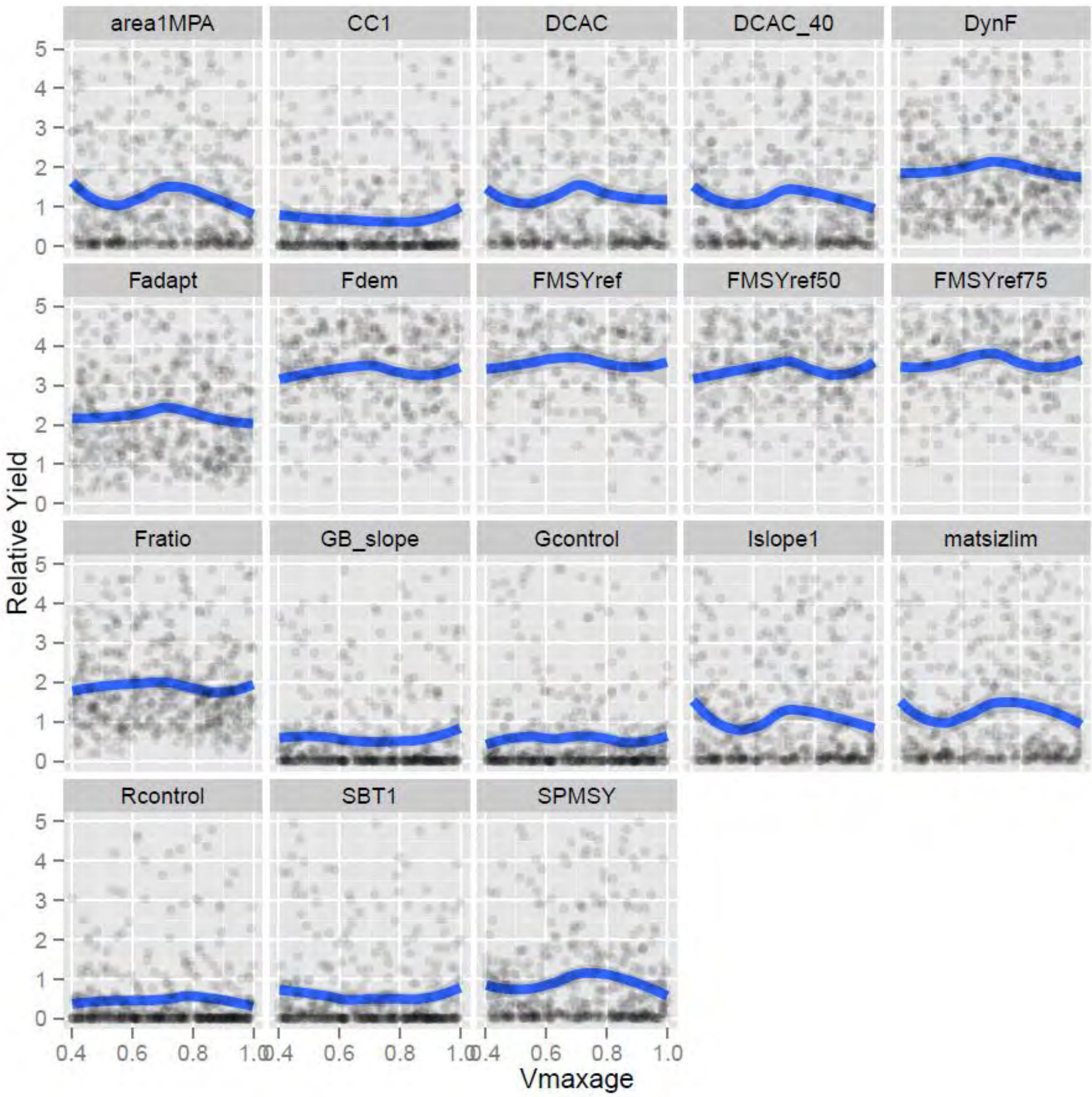


Figure 7w – Sensitivity of the procedures to the Vmaxage parameter

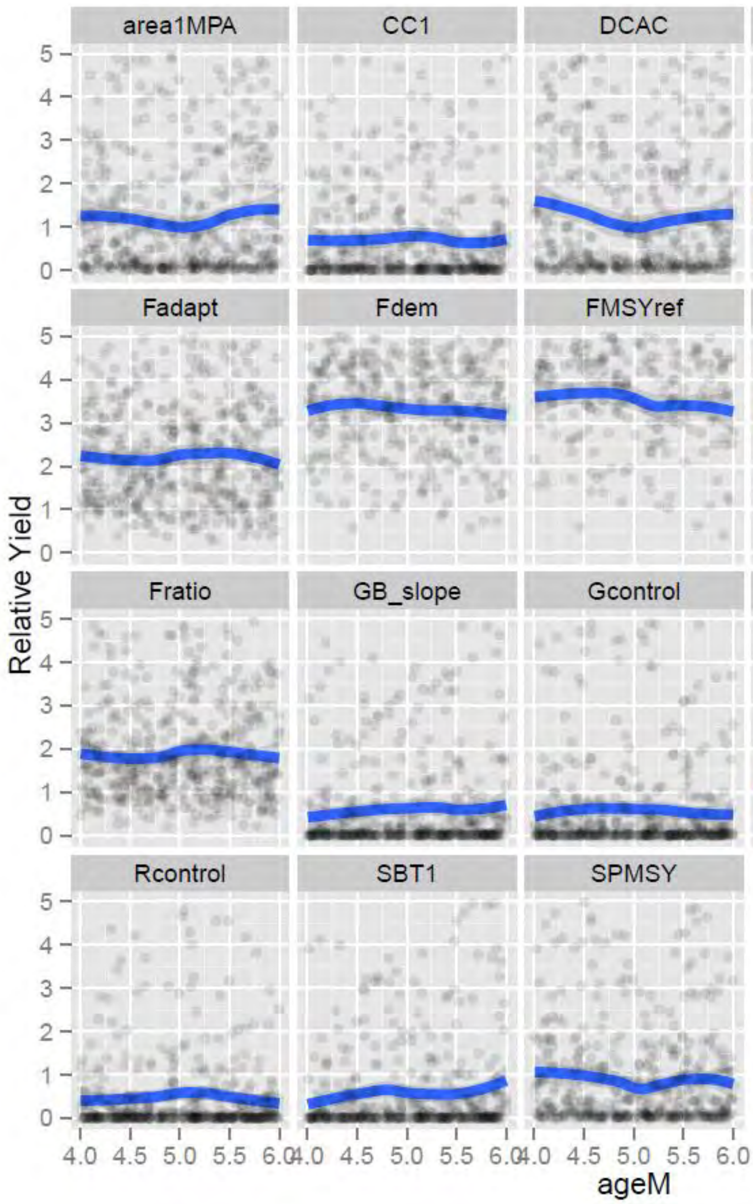


Figure 7x – Sensitivity of the procedures to the ageM parameter

## Appendix 1 – Model code

```
####################################################################################
#   Black sea bass data-limited / moderate assessments and MSE                  #
#   07/10/2015                                                   #
#   Code adapted from Carruthers (2015)                                 #
#   Jason McNamee, Gavin Fay, Steven Cadrin                                #
####################################################################################
####################################################################################
#    needed commands for startup                                        #
####################################################################################
library(DLMtool)
for(i in 1:length(DLMdat))assign(DLMdat[[i]]@Name,DLMdat[[i]])
sfInit(parallel=T,cpus=8)
sfExportAll()
set.seed(1)

####################################################################################
#   Create Black sea bass stock object for MSE                              #
#   Use Porgy and then modify parameters to fit our case                      #
####################################################################################


##Call in Porgy to use as stock object template
ourstock<-Porgy

###Modify to fit black sea bass case, info of source next to each parameter###
ourstock@Name<-"Black Sea Bass"
```

```
ourstock@maxage<-20  #max age at 20 from Dery and Mayo (http://www.nefsc.noaa.gov/fbp/age-man/bsb/bsb.htm)

ourstock@R0<-10000000  # unfished recruitment; arbitrary, set it at value higher than highest catch value seen in MT

ourstock@M<-c(0.2,0.5)  #M between 0.2 and 0.5, based on 2012 assessment (SARC 53)

ourstock@Msd<-c(0.0, 0.2)  #interannual variation in M, expressed as CV, used reasonable estimate

ourstock@Mgrad<-c(-0.2, 0.2)  #temporal change in M, expressed as a percent

ourstock@h<-c(0.3, 0.4)   #c(0.5, 0.99)  #steepness, started with estimates based on SARC 53, but had to adjust down due to errors with DBSRA

ourstock@SRrel<-1  #spawner recruit relationship, set to BH=1, Ricker is 2

ourstock@Linf<-c(62,70)  #Von B Linf param, bounded by info in 2012 assessment

ourstock@K<-c(0.17,0.22)  #Von B K parameter, bounded by info in 2012 assessment

ourstock@t0<-c(0.14,0.19)  #Von B t0 param, bounded by info in 2012 assessment

ourstock@Ksd<-c(0.0,0.03)  #interannual variability in K parameter, bounded by reasonable estimate

ourstock@Kgrad<-c(-0.2, 0.2)  #temporal trend in K parameter, expressed as percent

ourstock@Linfsd<-c(0.0,0.03)  #interannual variability in Linf param, bounded by reasonable estimate

ourstock@Linfgrad<-c(-0.25,0.25)  #mean temporal trend in Linf param, bounded by reasonable estimate

ourstock@recgrad<-c(-10,10)  #mean temporal trend in lognormal rec devs, resonable est

ourstock@AC<-c(0.1, 0.9)   #Autocorrelation in recruitment deviations rec(t)=AC*rec(t-1)+(1-AC)*sigma(t)

ourstock@a<- 0.0000108 #Length-weight parameter alpha (note should not be in logspace, info from Gary S see expl spreadsheet)

ourstock@b<- 3.0595   #Length-weight parameter beta

ourstock@ageM<-c(4,6) #age at maturity, age 5 from sarc 53, so made it between 4 and 6

ourstock@ageMsd<-1   #interannual-variability in age-at-maturity

# changed depletion to include smaller range

ourstock@D<-c(0.3,0.7)  #depletion, Bcurr/Bunfished, reasonable estimate

ourstock@Size_area_1<-c(0.2, 0.5)  #next 3 things are area specific info, reasonable estimate because we don't know this info, not sure if this will be useful here

#changed Frac_area_1 to larger range to cover more options

ourstock@Frac_area_1<-c(0.2, 0.5)    #The fraction of the unfished biomass in stock 1
```

```
# changed to high vals to limit movement and induce spatial differences

ourstock@Prob_staying<-c(0.8, 0.99)   #The probability of inviduals in area 1 remaining in area 1 over the course of one year

ourstock@Source<-"Much is from SARC 53, some were reasonable stimates"

ourstock@Perr <- c(0.5,0.8)  #The extent of inter-annual log-normal recruitment variability (sigma R)



######################################################################################

#   Choose Fleet for MSE                                            #

#   Start with flat effort                                          #

######################################################################################


ourfleet<-Generic_FlatE  #assumes flat effort in recent times


ourfleet@nyears<-50 #33  #number of years for the historical simulation

ourfleet@AFS<-c(3,4)  #youngest age fully vulnerable to fishing

ourfleet@age05<-c(0.2, 0.5)  #youngest age 5% vulnerable to fishing

# changed to allow possibility of flat-top selex

ourfleet@Vmaxage<-c(0.4,1.0)  #vulnerability of the oldest age class

ourfleet@Fsd<-c(0.1, 0.2)  #inter annual variability in F

ourfleet@Fgrad<-c(-0.5,0.5)  #historical gradient in F expressed as a percentage per year

# added more extreme spatial targetting

ourfleet@Spat_targ <- c(-0.5,3)


######################################################################################

#   Fleet 2 for MSE                                                 #

#   Increasing effort                                               #

######################################################################################
```

```
ourfleet2<-Generic_IncE  #assumes incr effort in recent times


ourfleet2@nyears<-50 #33  #number of years for the historical simulation

ourfleet2@AFS<-c(3,4)  #youngest age fully vulnerable to fishing

ourfleet2@age05<-c(0.2, 0.5)  #youngest age 5% vulnerable to fishing

# changed to allow possibility of flat-top selex

ourfleet2@Vmaxage<-c(0.4,1.0)  #vulnerability of the oldest age class

ourfleet2@Fsd<-c(0.1, 0.2)  #inter annual variability in F

ourfleet2@Fgrad<-c(0,1)  #historical gradient in F expressed as a percentage per year

# added more extreme spatial targetting

ourfleet2@Spat_targ <- c(-0.5,3)


####################################################################################

#   Create Black sea bass Operating model for MSE                              #

#   Use Black sea bass object and then modify OM parameters                    #

####################################################################################


ourobs <- Imprecise_Biased

# changed beta to include linear relationship

ourobs@beta<-c(0.333, 3)  #this is helpful, this is a hyperstability parameter, values greater than 1 have hyperdepletion, meaning the indices decrease faster than the population, might be the case with bsb. Need to investigate the math, but just picked numbers for now

ourobs@Cobs<-c(0.2,0.4)   #log normal catch observation error, expressed as a cv

ourobs@Cbiascv<-0.3   #cv controlling sampling bias in catch observations

ourobs@CAAobs<-c(40,60)  #range of effective sample sizes around 50, from SARC 53

ourobs@CALobs<-c(0.1,0.2)  #observation error of catch at length obs

ourobs@Iobs<-c(0.2,0.4)   #observation error in FI indices expressed as a CV

##ourobs@Perr<-c(0.5,0.8)  # inter-annual log-normal recruitment variability (sigma R)
```

**ourobs@Mcv<-0.3     #Persistent bias in the prescription of natural mortality rate sampled from a log-normal distribution with coefficient of variation, estimated for now, go back and run actual sampling on them**

**ourobs@Kcv<-0.05  #Persistent bias in the prescription of growth parameter k sampled from a log-normal distribution with coefficient of variation, estimated at this point**

**ourobs@t0cv<-0.05   #Persistent bias in the prescription of t0 sampled from a log-normal distribution with coefficient of variation**

**ourobs@Linfcv<-0.05  #Persistent bias in the prescription of maximum length sampled from a log-normal distribution with coefficient of variation**

**ourobs@LFCcv<-0.3   #Persistent bias in the prescription of lenght at first capture sampled from a log-normal distribution with cv**

**ourobs@LFScv<-0.3  #Persistent bias in the prescription of length-at-fully selection sampled from a log-normal distribution with coefficient of variation**

**ourobs@B0cv<-0.3   #Persistent bias in the prescription of maximum lengthunfished biomass sampled from a log-normal distribution with coefficient of variation**

**ourobs@FMSYcv<-0.2   #Persistent bias in the prescription of FMSY sampled from a log-normal distribution with coefficient of variation**

**ourobs@FMSY_Mcv<-0.2  #Persistent bias in the prescription of FMSY/M sampled from a log-normal distribution with coefficient of variation**

**ourobs@BMSY_B0cv<-0.2   #Persistent bias in the prescription of BMsY relative to unfished sampled from a log-normal distribution with coefficient of variation**

**ourobs@ageMcv<-0.3  #Persistent bias in the prescription of age-at-maturity sampled from a log-normal distribution with coefficient of variation**

**ourobs@rcv<-0.2   #Persistent bias in the prescription of intrinsic rate of increase sampled from a log-normal distribution with coefficient of variation**

**##ourobs@Fgaincv<-0.05  #Persistent bias in the prescription of trend in fishing mortality rate sampled from a log-normal distribution with coefficient of variation**

**ourobs@A50cv<-0.3    #Persistent bias in the prescription of age at 50 percent vulnerability sampled from a log-normal distribution with coefficient of variation**

**ourobs@Dbiascv<-0.2   #Persistent bias in the prescription of stock depletion sampled from a log-normal distribution with coefficient of variation**

**ourobs@Dcv<-c(0.2,0.3)   #Imprecision in the prescription of stock depletion among years, expressed as a coefficient of variation**

**ourobs@Btbias<-c(0.1,0.2)   #Persistent bias in the prescription of current stock biomass sampled from a uniform-log distribution with range**

**ourobs@Btcv<-c(0.2, 0.3)  #Imprecision in the prescription of current stock biomass among years expressed as a coefficient of variation**

```
ourobs@Fcurbiascv<-c(0.1,0.2)   #Persistent bias in the prescription of current fishing mortality rate sampled from a log-normal distribution with coefficient of variation

ourobs@Fcurcv<-c(0.1,0.2)   #Imprecision in the prescription of current fishing mortality rate among years expressed as a coefficient of variation

ourobs@hcv<-0.3   #Persistent bias in steepness

ourobs@Icv<-0.4   #Observation error in realtive abundance index expressed as a coefficient of variation

ourobs@maxagecv<-0.3  #Bias in the prescription of maximum age

ourobs@Reccv<-c(0.3, 0.5)   #Bias in the knowledge of recent recruitment strength

ourobs@Irefcv<-0.2   #Bias in the knowledge of the relative abundance index at BMSY

ourobs@Brefcv<-0.2   #Bias in the knowledge of BMSY

ourobs@Crefcv<-0.3   #Bias in the knowledge of MSY


# create OM


ourOM<-new('OM',ourstock,ourfleet,ourobs)  #create the OM, start with imprecise and biased assumption

ourOM2<-new('OM',ourstock,ourfleet2,ourobs)  #create the second OM for incr effort


########################################################################################

#   Create Black sea bass MSE                                   #

#                                                   #

########################################################################################

# add our HCRs for exploitation index

setwd("C:/Users/jason.mcnamee/Desktop/Z Drive stuff/ASMFC/Fluke Scup BCB info/Black Sea Bass/2015/BSB_MSE")

source('HCRs.r')


for (iseed in 1:2)

{

set.seed(iseed)
```

```
ourMSE<-runMSE(ourOM,proyears=30,interval=3,nsim=500,reps=100)

save(ourMSE,file=paste('Results/bsb_',iseed,'.RData',sep=""))

}

for (iseed in 1:2)
{
  set.seed(iseed)

  ourMSE2<-runMSE(ourOM2,proyears=30,interval=3,nsim=500,reps=100)

  save(ourMSE2,file=paste('Results/bsb2_',iseed,'.RData',sep=""))

}

Results<-summary(ourMSE)  #summarizes trade off info, can use this info to cull the herd
Results

Targetted<-subset(Results, Results$Yield>50 & Results$POF<30 & Results$P10<20 & Results$Method!="DCAC4010" & Results$Method!="DBSRA4010")  #drop result that don't meet certain criteria, here drop yields less than 50 and prob of overfishing greater than 30 and prob of dropping to low biomass level less than 20%. Additional note DCAC and DBSRA 4010 dropped due to error when running MSE
Targetted
```

```
ourMSE1.2<-runMSE(ourOM,Targetted$Method,proyears=30,interval=3,nsim=500,reps=100)  #now we can up the simulations to get more stable answers

summary(ourMSE1.2)

Results2<-summary(ourMSE2)

Results2

Targetted2<-subset(Results2, Results2$Yield>50 & Results2$POF<30 & Results2$P10<20 & Results2$Method!="DCAC4010"& Results2$Method!="DBSRA4010")  #drop result that don't meet certain criteria, here drop yields less than 50 and prob of overfishing greater than 30 and prob of dropping to low biomass level less than 20%

Targetted2

ourMSE2.2<-runMSE(ourOM2,Targetted2$Method,proyears=30,interval=3,nsim=500,reps=100)

summary(ourMSE2.2)

sfStop()

windows()

Tplot(ourMSE)

Pplot(ourMSE1.2)

Kplot(ourMSE1.2)

Tplot(ourMSE2)

Pplot(ourMSE2.2)
```

```
Kplot(ourMSE2.2)



###################################################################################
#   Run preferred procedures on                          #
#   Black sea bass data                                  #
#                                                        #
###################################################################################


bsb=new('DLM',"C:\\Users\\jason.mcnamee\\Desktop\\Z Drive stuff\\ASMFC\\Fluke Scup BCB info\\Black Sea Bass\\2015\\BSB_MSE\\bsb_NMFSspr.csv")  #create a DLM object to run analysis

slotNames(bsb)


bsb@Rec=as.matrix(c(65,  82,  90,      60,     80,     59,     100,    105,    70,     40,     45,
        110,    85,     62,     38,     90,     160,    90,     115,    60,     50,     50,     70,
        65,     100,    80,     40,     45,     75.2,   160,    75.2,   75.2,   75.2))


bsb@AM=4


summary(bsb)


Can(bsb)


Needed(bsb)


Targetted$Method  #reference what i can do with my dataset versus what I did with my MSE run
```

```
bsbOFL1<-getQuota(bsb, Meths=c("CC1","DCAC", "DCAC_40" ), reps=1000)  #calculate an OFl for specific methods, could use overlapping methods with MSE as a way to do this

bsbOFL2<-getQuota(bsb, Meths=c("DD", "DynF", "Fadapt" ), reps=1000)

bsbOFL3<-getQuota(bsb, Meths=c("Fdem","Fratio","Islope1" ), reps=1000)

bsbOFL4<-getQuota(bsb, Meths=c("GB_CC","GB_slope","Gcontrol"), reps=1000)

bsbOFL5<-getQuota(bsb, Meths=c("SBT1","SPMSY","SPslope"), reps=1000)

bsbOFL6<-getQuota(bsb, Meths=c("Rcontrol","CC4"), reps=1000)



##########################################################################################################

#  visualize the OFL distributions, easier to see if you split them up,                          #

#  otherwise everything gets plotted together and is difficult to see                            #

##########################################################################################################

##Seperate plots

par(mfrow=c(1,1), mar=c(5, 4, 3, 2))

plot(density(bsbOFL1@quota[1,,1], na.rm=T), ylim=c(0,0.0025), xlim=c(0,7500), col="black", main="OFL Calculation for Black Sea Bass", ylab="Relative Frequency", xlab="OFL Metric Tons", lwd=2)

axis(1, at = seq(0, 7500, by = 500))

lines(density(bsbOFL1@quota[2,,1], na.rm=T), col="red", lwd=2)

lines(density(bsbOFL1@quota[3,,1], na.rm=T), col="grey", lwd=2)

legend("topright",c("CC1","DCAC", "DCAC_40" ), lty=c(1,1,1), col=c("black", "red", "grey") )


plot(density(bsbOFL2@quota[1,,1], na.rm=T), ylim=c(0,0.002), xlim=c(0,7500), col="black", main="OFL Calculation for Black Sea Bass", ylab="Relative Frequency", xlab="OFL Metric Tons", lwd=2)
```

```
axis(1, at = seq(0, 7500, by = 500))

lines(density(bsbOFL2@quota[2,,1], na.rm=T), col="red", lwd=2)

lines(density(bsbOFL2@quota[3,,1], na.rm=T), col="grey", lwd=2)

legend("topright",c("DD", "DynF", "Fadapt"), lty=c(1,1,1), col=c("black", "red", "grey") )


plot(density(bsbOFL3@quota[1,,1], na.rm=T), ylim=c(0,0.0021), xlim=c(0,7500), col="black", main="OFL Calculation for Black Sea Bass", ylab="Relative Frequency", xlab="OFL Metric Tons", lwd=2)

axis(1, at = seq(0, 7500, by = 500))

lines(density(bsbOFL3@quota[2,,1], na.rm=T), col="red", lwd=2)

lines(density(bsbOFL3@quota[3,,1], na.rm=T), col="grey", lwd=2)

legend("topright",c("Fdem","Fratio","Islope1"), lty=c(1,1,1), col=c("black", "red", "grey") )


plot(density(bsbOFL4@quota[1,,1], na.rm=T), ylim=c(0,0.008), xlim=c(0,7500), col="black", main="OFL Calculation for Black Sea Bass", ylab="Relative Frequency", xlab="OFL Metric Tons", lwd=2)

axis(1, at = seq(0, 7500, by = 500))

lines(density(bsbOFL4@quota[2,,1], na.rm=T), col="red", lwd=2)

lines(density(bsbOFL4@quota[3,,1], na.rm=T), col="grey", lwd=2)

legend("topright",c("GB_CC","GB_slope","Gcontrol"), lty=c(1,1,1), col=c("black", "red", "grey") )


plot(density(bsbOFL5@quota[1,,1], na.rm=T), ylim=c(0,0.001), xlim=c(0,7500), col="black", main="OFL Calculation for Black Sea Bass", ylab="Relative Frequency", xlab="OFL Metric Tons", lwd=2)

axis(1, at = seq(0, 7500, by = 500))

lines(density(bsbOFL5@quota[2,,1], na.rm=T), col="red", lwd=2)

lines(density(bsbOFL5@quota[3,,1], na.rm=T), col="grey", lwd=2)

legend("topright",c("SBT1","SPMSY","SPslope"), lty=c(1,1,1), col=c("black", "red", "grey") )


plot(density(bsbOFL6@quota[1,,1], na.rm=T), ylim=c(0,0.0025), xlim=c(0,7500), col="black", main="OFL Calculation for Black Sea Bass", ylab="Relative Frequency", xlab="OFL Metric Tons", lwd=2)

axis(1, at = seq(0, 7500, by = 500))

lines(density(bsbOFL6@quota[2,,1], na.rm=T), col="red", lwd=2)
```

```
legend("topright",c("Rcontrol","CC4"), lty=c(1,1,1), col=c("black", "red") )
```

```
##Combo plot

windows()

plot(density(bsbOFL1@quota[1,,1], na.rm=T), ylim=c(0,0.008), xlim=c(0,8000), col="black", main="OFL Calculation for Black Sea Bass", ylab="Relative Frequency", xlab="OFL Metric Tons", lwd=2)

axis(1, at = seq(0, 8000, by = 500))

lines(density(bsbOFL1@quota[2,,1], na.rm=T), col="red", lwd=2)

lines(density(bsbOFL1@quota[3,,1], na.rm=T), col="grey", lwd=2)

lines(density(bsbOFL2@quota[1,,1], na.rm=T), col="green", lwd=2)

lines(density(bsbOFL2@quota[2,,1], na.rm=T), col="blue", lwd=2)

lines(density(bsbOFL2@quota[3,,1], na.rm=T), col="pink", lwd=2)

lines(density(bsbOFL3@quota[1,,1], na.rm=T), col="purple", lwd=2)

lines(density(bsbOFL3@quota[2,,1], na.rm=T), col="black", lwd=2, lty=2)

lines(density(bsbOFL3@quota[3,,1], na.rm=T), col="red", lwd=2, lty=2)

lines(density(bsbOFL4@quota[1,,1], na.rm=T), col="grey", lwd=2, lty=2)

lines(density(bsbOFL4@quota[2,,1], na.rm=T), col="green", lwd=2, lty=2)

lines(density(bsbOFL4@quota[3,,1], na.rm=T), col="blue", lwd=2, lty=2)

lines(density(bsbOFL5@quota[1,,1], na.rm=T), col="pink", lwd=2, lty=2)

lines(density(bsbOFL5@quota[2,,1], na.rm=T), col="purple", lwd=2, lty=2)

lines(density(bsbOFL5@quota[3,,1], na.rm=T), col="orange", lwd=2)

lines(density(bsbOFL6@quota[1,,1], na.rm=T), col="yellow", lwd=2)

lines(density(bsbOFL6@quota[2,,1], na.rm=T), col="orange", lwd=2, lty=2)

legend("topright",c("CC1","DCAC", "DCAC_40", "DD", "DynF", "Fadapt", "Fdem","Fratio","Islope1", "GB_CC","GB_slope","Gcontrol", "SBT1","SPMSY","SPslope", "Rcontrol","CC4" ), lty=c(1,1,1,1,1,1,1,2,2,2,2,2,2,2,1,1,2), col=c("black", "red", "grey", "green", "blue", "pink", "purple","black", "red", "grey", "green", "blue", "pink", "purple", "orange", "yellow", "orange" ) , lwd=c(2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2))
```

```
##get median values for table
```

```
median(bsbOFL1@quota[1,,1], na.rm=T)

median(bsbOFL1@quota[2,,1], na.rm=T)

median(bsbOFL1@quota[3,,1], na.rm=T)

median(bsbOFL2@quota[1,,1], na.rm=T)

median(bsbOFL2@quota[2,,1], na.rm=T)

median(bsbOFL2@quota[3,,1], na.rm=T)

median(bsbOFL3@quota[1,,1], na.rm=T)

median(bsbOFL3@quota[2,,1], na.rm=T)

median(bsbOFL3@quota[3,,1], na.rm=T)

median(bsbOFL4@quota[1,,1], na.rm=T)

median(bsbOFL4@quota[2,,1], na.rm=T)

median(bsbOFL4@quota[3,,1], na.rm=T)

median(bsbOFL5@quota[1,,1], na.rm=T)

median(bsbOFL5@quota[2,,1], na.rm=T)

median(bsbOFL5@quota[3,,1], na.rm=T)

median(bsbOFL6@quota[1,,1], na.rm=T)

median(bsbOFL6@quota[2,,1], na.rm=T)
```

**HCR.r code**

```
###############################################################################################
#  Control rules for exploitation index for black sea bass                    #
#  7/9/2015                                                      #
###############################################################################################


###############################################################################################
#    Create exploitation slope procedure                                      #
###############################################################################################
EXP_slope=function (x, DLM, reps = 100, yrsmth = 5, lambda = 1,xx=0.2)
```

```
{
  dependencies = "DLM@Year, DLM@Cat, DLM@CV_Cat, DLM@Ind"
  #expl_biom<-DLM@Cat[x, length(DLM@Cat[x, ])]   #*0.65   #looked at exploitable biomass data provided by Gary and found on average about 65% of the catch is exploitable, so used this calculation (Catch*0.65) to simplify approach


  #calculate slope over last yrsmth years
  ind <- (length(DLM@Year) - (yrsmth - 1)):length(DLM@Year)
  I_hist <- DLM@Ind[x, ind]
  expl_cat <- DLM@Cat[x,ind]
  yind <- 1:yrsmth
  expl_ind<-expl_cat/I_hist


  #sample from etimation error for slope
  slppar <- summary(lm(expl_ind ~ yind))$coefficients[2, 1:2]
  Islp <- rnorm(reps, slppar[1], slppar[2])


  #some stuff copied from one of the GB rules, currently dealing with first case
  if (is.na(DLM@MPrec[x])) {
    TACstar <- (1 - xx) * trlnorm(reps, mean(expl_cat), DLM@CV_Cat/(yrsmth^0.5))
  }
  else {
    TACstar <- rep(DLM@MPrec[x], reps)
  }


  #calculate OFL, max interannual 20% change from recent catch
  OFL <- TACstar * (1 + lambda * Islp)
  OFL[OFL > (1.2 * expl_cat)] <- 1.2 * expl_ind
  OFL[OFL < (0.8 * expl_cat)] <- 0.8 * expl_ind
```

```
  OFLfilter(OFL)
}
class(EXP_slope)<-"DLM quota"
environment(EXP_slope) <- asNamespace('DLMtool')
sfExport("EXP_slope")

#####################################################################################
#    Create exploitation target procedure                                           #
#####################################################################################
EXP_target <- function(x,DLM,reps=100, yrsmth = 5, lambda = 1,xx=0.2)
{
  dependencies = "DLM@Year, DLM@Cat, DLM@Cref, DLM@Iref, DLM@Ind, DLM@CV_Cref,
  DLM@CV_Cat, DLM@CV_Iref"
  ind <- (length(DLM@Year) - (yrsmth - 1)):length(DLM@Year)
  I_hist <- DLM@Ind[x, ind]
  Catrec <- DLM@Cat[x,ind]
  yind <- 1:yrsmth
  expl_ind <- Catrec/I_hist
  #Curr_expl <- mean(expl_ind,na.rm=TRUE)

  #sample for possible values of exploitation index based on distribution from last yrsmth years
  Curr_expl <- trlnorm(reps,mean(expl_ind,na.rm=T),
                    sd(expl_ind,na.rm=TRUE)/mean(expl_ind,na.rm=T)/(yrsmth^0.5))

  #Find the targets
  TACtarg <- trlnorm(reps, DLM@Cref[x], DLM@CV_Cref)
  Itarg <- trlnorm(reps, DLM@Iref[x], DLM@CV_Iref)
  #target value for exploitation index
```

```
  Etarg <- TACtarg/Itarg


  #values for previous Catch (used to limit changes in TAC)
  TACrec <- trlnorm(reps,mean(Catrec,na.rm=T),DLM@CV_Cat/(yrsmth^0.5))


  #get OFL, max 20% interannual change
  OFL <- TACtarg * (1 + lambda * (Curr_expl/Etarg))
  OFL[OFL > (1.2 * TACrec)] <- 1.2 * TACrec
  OFL[OFL < (0.8 * TACrec)] <- 0.8 * TACrec
  OFLfilter(OFL)
}
class(EXP_target)<-"DLM quota"
environment(EXP_target) <- asNamespace('DLMtool')
sfExport("EXP_target")
```

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Christopher M. Moore, Ph.D., Executive Director

# MEMORANDUM

**DATE**: July 10, 2014

**TO**: Chris Moore, Executive Director

**FROM**: Kiley Dancy, Staff

**SUBJECT**: Black Sea Bass Management Measures for 2016-2017

## Executive Summary

The most recent stock assessment update was completed in July 2012, with data through 2011. The results of this update indicated that the black sea bass stock was not overfished and overfishing was not occurring in 2011. The 2011 stock was estimated to be at 102% of the spawning stock biomass at maximum sustainable yield ($SSB_{MSY}$).

The SSC did not accept the Overfishing Limit (OFL) derived from this assessment, and has used an alternative "constant catch" methodology to set ABCs for black sea bass for several years. Since establishing a new basis for a constant catch ABC recommendation in January 2013, the SSC has revisited the resulting specifications twice, each time concluding that there was no compelling evidence at the time to warrant a change in the ABC, nor was there new information upon which to base a revised ABC recommendation.

Based on the constant catch level as revised in 2013, the current (2015) ABC is 5.50 mil lb (2,494 mt), which results in a commercial Annual Catch Limit (ACL) of 2.60 million lb (1,180 mt), and a recreational ACL of 2.90 million lb (1,314 mt). Based on the recommendation of the Monitoring Committee, both the commercial Annual Catch Target (ACT) and the recreational ACT were set equal to their respective sector ACLs for 2015. After adjusting for projected discards, the current commercial quota is 2.21 mil lb (1,004 mt), and the recreational harvest limit is 2.33 mil lb (1,056 mt; Table 1).

A benchmark stock assessment is currently scheduled for December 2016. Progress is currently being made toward reducing uncertainties in the assessment, and exploring alternative assessment approaches. The Council has hired a contractor to facilitate the development of a quantitative stock assessment for black sea bass. The contracted group, along with members of the Atlantic States Marine Fisheries Commission's Summer Flounder Technical Committee, are currently preparing an analysis of alternative methods for setting ABCs for black sea bass and other level 4 stocks. This analysis will be presented to the SSC at the July meeting, and will include options for black sea bass ABCs in 2016 and 2017. <u>Pending the results of this analysis, staff have no recommendations for catch and landings limits at this time. Staff recommend setting 2-year specifications for black sea bass given the timing of the scheduled assessment.</u>

Staff also recommend that a thorough analysis of the current commercial management measures be conducted, including a review of the current minimum fish size (11 inch total length) and commercial gear requirements (4.5 inch mesh with 500/100 lb trigger; current pot/trap vent requirements). Pending this additional analysis, staff are not proposing specific changes to the commercial measures at this time.

**Table 1:** Current (2015) constant catch specifications for black sea bass.

| Management Measure | 2016 | | Basis |
|---|---|---|---|
| | mil lb. | mt | |
| **ABC** | 5.50 | 2,494 | SSC-recommended constant catch ABC |
| ABC Landings Portion | 4.56 | 2,070 | Prior year proportion of landed catch[1] |
| ABC Discards Portion | 0.93 | 424 | Prior year proportion of discarded catch[1] |
| **Commercial ACL** | 2.60 | 1,180 | 49% of ABC landings portion (per FMP) + 39% of ABC discards portion |
| Commercial ACT | 2.60 | 1,180 | Commercial ACL, less deduction for management uncertainty |
| Projected Commercial Discards | 0.37 | 166 | 39% of ABC discards portion, based on 2010-2011 average % discards by sector |
| **Commercial Quota** | 2.23 | 1,014 | Commercial ACT, less discards |
| **Recreational ACL** | 2.90 | 1,314 | 51% of ABC landings portion (per FMP) + 61% of ABC discards portion |
| Recreational ACT | 2.90 | 1,314 | Recreational ACL, less deduction for management uncertainty |
| Projected Recreational Discards | 0.57 | 258 | 61% of ABC discards portion, based on 2010-2011 average % discards by sector |
| **Recreational Harvest Limit** | 2.33 | 1,056 | Recreational ACT, less discards |

## Introduction

The Magnuson-Stevens Act (MSA) requires each Council's Scientific and Statistical Committee (SSC) to provide ongoing scientific advice for fishery management decisions, including recommendations for ABC, preventing overfishing, and maximum sustainable yield. The Council's catch limit recommendations for the upcoming fishing year(s) cannot exceed the ABC recommendation of the SSC. In addition, the Monitoring Committee established by the Fishery Management Plan (FMP) is responsible for developing recommendations for management measures designed to achieve the recommended catch limits.

[1] When the ABC was last revised in 2013, 2011 data was the most recent full year available to derive these proportions. For 2011, 83% of catch was landed and 17% was discarded. Based on the 2015 data update, these proportions were the same in 2014.

Multi-year specifications may be set for black sea bass for up to three years at a time. The SSC must recommended ABCs that addresses scientific uncertainty, while the Monitoring Committee must recommend an annual catch target (ACT) that addresses management uncertainty. Based on the SSC and Monitoring Committee recommendations, the Council will make a recommendation to the National Marine Fisheries Service (NMFS) Greater Atlantic Regional Administrator. Because the FMP is cooperatively managed with the Atlantic States Marine Fisheries Commission, the Commission's Summer Flounder, Scup, and Black Sea Bass Board will meet jointly with the Council to recommend black sea bass catch limits and management measures. In this memorandum, information is presented to assist the SSC and Monitoring Committee in developing recommendations for the Council and Board to consider for the 2016-2017 fishing years for black sea bass.

Additional relevant information about fishery performance and past management measures is presented in the June 2015 Black Sea Bass Fishery Information Document prepared by Council staff, and the June 2015 Fishery Performance Report for black sea bass developed by the Council and Commission Advisory Panels.

## Recent Catch and Landings

According to the Black Sea Bass Data Update for 2015,[2] commercial landings in 2014 were 1,089 mt (2.40 million lb), and recreational landings were 1,635 mt (3.60 million lb).[3] The 2015 commercial landings as of the week ending June 27, 2015, indicate that 56% of the coastwide commercial quota has been landed (Table 2).

**Table 2**: 2015 black sea bass commercial quota and landings by state as of week ending June 27, 2015.

| State | Cumulative Landings (lb) | Quota (lb) | Percent of Quota (%) |
|---|---|---|---|
| ME | 0 | -- | -- |
| NH | 0 | -- | -- |
| MA | 2,033 | -- | -- |
| RI | 125,306 | -- | -- |
| CT | 17,240 | -- | -- |
| NY | 84,863 | -- | -- |
| NJ | 247,080 | -- | -- |
| DE | 23,372 | -- | -- |
| MD | 175,752 | -- | -- |
| VA | 252,092 | -- | -- |
| NC | 306,257 | -- | -- |
| Other | 3,349 | -- | -- |
| **Totals** | **1,237,344** | **2,213,441** | **56** |

Source: NMFS Weekly Quota Report for week ending June 27, 2015.

[2] Northeast Fisheries Science Center. 2015. Black Sea Bass 2014 Catch and Survey Information for Northern Stock: Report to the Mid-Atlantic Science and Statistical Committee.

[3] Recreational landings for Maine through Cape Hatteras, NC.

## Regulatory Review

As described above, the last assessment update for black sea bass was completed in 2012 (with data through 2011). The basis for this update was the model used in the most recent accepted benchmark assessment on black sea bass, which was peer-reviewed and accepted in December 2008 by the DPSWG Peer Review Panel.[4] This assessment was based on a statistical catch at a length, or "SCALE" model. Documentation associated with this assessment and previous stock assessments, such as reports on stock status, including annual assessment and reference point update reports, Stock Assessment Workshop (SAW) reports, and Stock Assessment Review Committee (SARC) panelist reports, are available online at the NEFSC website: http://www.nefsc.noaa.gov/saw/.

The overfishing limit (OFL) provided by the 2012 assessment update was 7.00 million lb (3,175 mt), based on an $F_{MSY}$ proxy of $F_{40\%} = 0.44$. However, the SSC did not endorse this estimate because of concerns about the unresolved uncertainty in the OFL related to potential stock structure within the designated management unit, life history, and natural mortality. The SSC designated the assessment as level 4,[5] and considered the following to be the most significant sources of uncertainty:

- Difficulty in determining appropriate reference points due to atypical life history strategy (protogynous hermaphrodite);
- Assessment assumes a completely mixed stock, while tagging analyses suggesting otherwise;
- Uncertainty exists with respect to M because of the unusual life history strategy the current assumption of a constant M in the model for both sexes may not adequately capture the dynamics in M); and
- Concern about the application of trawl calibration coefficients (ALBATROSS IV vs BIGELOW) and their influence on the selectivity pattern and results of the assessment.

Because the SSC did not accept the OFL derived from the assessment, for the past several years the SSC has used alternative methods to recommend ABCs, as per the Council's risk policy for a level 4 assessment species. Each year from 2010-2013, the SSC recommended an ABC of 4.50 million lb (2,041 mt), based on a constant catch approach.

In January 2013, the SSC met to reconsider that recommendation, after reviewing new information relative to fishery performance (including recent catch data) and abundance and recruitment (i.e., state survey data). The SSC concluded that there was little data available that would justify a change in the ABC recommendation, the constant catch approach, or the designation of the assessment as level 4. However, the SSC believed it was appropriate to evaluate whether the constant catch level used since 2010 (4.50 mil lb) was still appropriate. The SSC evaluated the performance of the ABC and concluded that its continued application in 2013 and 2014 was overly conservative, and recommended a 2013-2014 ABC based on a constant catch level of 5.50 million lb (2,494 mt). This results in a commercial ACL (=ACT) of 2.60 million lb (1,180 mt) and a recreational ACL (=ACT) of 2.90 million lb (1,314 mt).

---

[4] Northeast Data Poor Stocks Working Group. 2009. The Northeast Data Poor Stocks Working Group Report, December 8-12, 2008 Meeting. Part A. Skate species complex, deep sea red crab, Atlantic wolffish, scup, and black sea bass. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 09-02; 496 p. Available at http://www.nefsc.noaa.gov/publications/crd/crd0902/.

[5] Based on SSC and Council discussions in March/April 2015, the "level 4" assessment designation is now known as "OFL cannot be specified given current state of knowledge."

In September 2013, the SSC determined that available scientific evidence was not compelling enough to warrant a change to the ABC, and recommended extending the ABC of 5.50 million lb (2,494 mt) into 2014 and 2015. In July 2014, the SSC reviewed a black sea bass data update and saw no compelling evidence to change its previous ABC recommendation for 2015.

**Biological Reference Points**

The biological reference points for black sea bass were updated during the 2012 stock assessment update,[6] as the result of several changes made to the information incorporated into the SCALE model. The fishing mortality threshold for black sea bass is $F_{MSY} = F_{40\%}$ (as $F_{MSY}$ proxy) = 0.44, and $SSB_{MSY}$ is 24.00 million lb (10,880 mt). The minimum stock size threshold, one-half $SSB_{MSY}$ is estimated to be 12.00 million lb (5,440 mt).

**Stock Status**

The last full stock assessment update was completed in July 2012. This update indicated that the black sea bass stock was not overfished and overfishing was not occurring in 2011, relative to the biological reference points. Fishing mortality ($F_{MULT}$) in 2011 was estimated at F=0.21, below the fishing mortality threshold of F=0.44. Total stock biomass in 2011 was estimated at 28.0 million lb (12,700 mt), above $B_{MSY}$. Spawning stock biomass (SSB) in 2011 was estimated at 24.57 million lb (11,145 mt), and was at 102% of $SSB_{MSY}$.

Recruitment estimated by the model was relatively constant through the time series with the exception of the 1999 and 2001 year classes. These cohorts appeared to be the driving force behind the increase in biomass and SSB. The estimated average recruitment (age one) in 2011 (2010 cohort) was 21.0 million fish. As it includes data only through 2011, this assessment update does not reflect the large recruitment to the stock of the 2011 year class, of which evidence has emerged through review of catch and survey data over the past several years.

**ABC Recommendations for 2016-2017**

Staff recommend setting 2-year specifications for black sea bass. There are no catch limits currently in place for 2016. The next benchmark stock assessment is currently scheduled for December 2016. Because specifications for summer flounder, scup, and black sea bass are required to be implemented by January 1 each year and given the December 2016 scheduled assessment, the Council and Board should also consider implementing an ABC for 2017. In 2016, the SSC could then review and potentially recommend revisions to the 2017 ABC based on the results of the 2016 assessment.

Progress toward addressing uncertainties in the stock assessment, as well as exploration of alternative assessment approaches, is ongoing. In April 2013, a black sea bass data workshop was sponsored by the Partnership for Mid-Atlantic Fisheries Science (PMFAS) and conducted by the Atlantic States Marine Fisheries Commission (ASMFC). The working group concluded that consideration of additional indices and datasets were not likely to result in any near-term changes in the perception of uncertainty in the

[6]Shepherd, G.R. 2012. Black Sea Bass Assessment Summary for 2012. Northeast Fisheries Science Center.

assessment. Additionally, an assessment update would not likely be used for management purposes given the existing perception of uncertainty in the assessment. The working group recommended delaying a black sea bass benchmark stock assessment to 2016 or later, to allow for progress to be made on interim analyses and advances in modeling approaches.

The Council has recently hired a contractor to facilitate the development of a quantitative stock assessment for black sea bass. The contracted group, along with members of the ASMFC Technical Committee, is currently preparing a proposal for alternative methods of setting constant catch ABCs for black sea bass (and other level 4 stocks) in the near term, prior to completion of a new benchmark assessment. This analysis will be presented to the SSC at their July meeting, and will include options for black sea bass ABCs in 2016 and 2017.

The group's analysis seeks to provide an alternative approach to setting catch limits for level 4 stocks that is potentially more dynamic in nature, easy to implement, and which offers a comparative analysis of harvest control rule approaches that can be used in situations where data is lacking or is not accepted by the SSC for specification setting. This approach uses a Management Strategy Evaluation (MSE) approach as developed by Carruthers et al. (2014)[7] to evaluate the relative performance of a suite of data limited analytical techniques. It is hoped that this approach will be valuable to the SSC by way of offering an alternative to their current approach for level 4 stocks, as well as providing a framework for specification setting for black sea bass until an acceptable analytical assessment becomes available. <u>Pending the results of this analysis, staff have no recommendation for specific ABCs at this time.</u>

## <u>Other Management Measures</u>

### *Recreational and Commercial Annual Catch Limits*

As defined by the Omnibus ACLs and AMs Amendment (Amendment 15 to the Summer Flounder, Scup, and Black Sea Bass FMP), the ABC includes both landings and discards, and is equal to the sum of the commercial and recreational ACLs for black sea bass (Figure 1).

Based on the allocation percentages in the FMP, 49% of the landings are allocated to the commercial fishery, and 51% to the recreational fishery. Discards are apportioned based on the contribution from each fishing sector using the most recent available two-year percentage contribution of discards by sector. When the ABC was revised in 2013, the most recent available ratios were from 2010-2011, when 61% of dead discards were attributable to the recreational fishery and 39% to the commercial fishery (Table 1). Based on the 2015 data update for black sea bass, the 2013-2014 ratios are very similar, with 62% of dead discards attributable to the recreational fishery, and 38% to the commercial fishery.

[7] Carruthers, T, Punt, A, Walters, C, MacCall, A, McAllister, M, Dick, E, Cope, J. 2014. Evaluating methods for setting catch limits in data-limited fisheries. Fisheries Research. 153: 48 – 68.

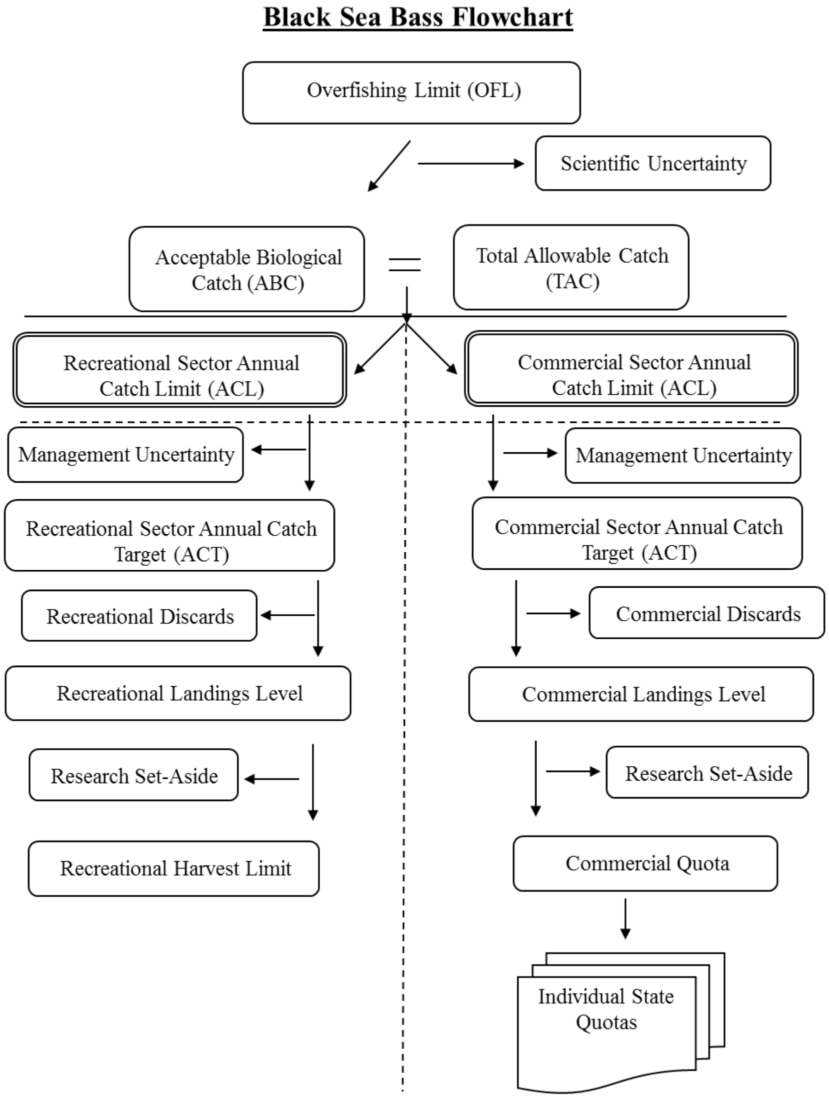



**Figure 1:** Flowchart for black sea bass catch and landings limits.

### *Annual Catch Targets*

The Monitoring Committee is responsible for recommending Annual Catch Targets (ACTs), which are intended to account for management uncertainty, for the Council and Board's consideration. The Monitoring Committee is responsible for considering all relevant sources of management uncertainty in the black sea bass fishery and providing the technical basis, including any formulaic control rules, for any reduction in catch when recommending an ACT. The ACTs, technical basis for ACT recommendations, and sources of management uncertainty should be described and provided to the Council. The relationships between the recreational and commercial ACTs and other catch components are given in Figure 1.

Management uncertainty is comprised of two parts: uncertainty in the ability of managers to control catch and uncertainty in quantifying the true catch (i.e., estimation errors). Management uncertainty can occur because of a lack of sufficient information about the catch (e.g., due to late reporting, underreporting, and/or misreporting of landings or discards) or because of a lack of management precision (i.e., the ability to constrain catch to desired levels).

The sector-specific landings performance in recent years indicates that the commercial landings have generally been near the commercial quotas for most of the past five years. The commercial quota monitoring system is timely and typically successful in managing the landings. In contrast, the recreational fishery has generally exceeded its harvest limits in recent years, with periodic substantial overages (Table 3). The Monitoring Committee has noted that extremely high availability of black sea bass, largely due to a substantial 2011 year class, is resulting in recreational overages despite very restrictive management measures. In recent years, the Monitoring Committee has indicated that it would address recreational management uncertainty during the process for setting recreational measures in each year. Specifically, the Monitoring Committee has recommended that to address management uncertainty in the recreational fishery, the data used while setting recreational measures should be considered carefully by the Monitoring Committee, ASMFC Technical Committee, and Council and Board. Last fall, the Monitoring Committee recommended holding a recreational data workshop to review recreational data use and to develop tools to inform future recreational analyses. This workshop is tentatively planned for September 2015. This workshop should evaluate specific sources of, and methods to address, management uncertainty in the recreational fishery. Staff recommend no reduction in catch from the recreational or commercial ACL, so that each sector's ACT would be set equal to the ACL.

**Table 3:** Black sea bass commercial and recreational fishery performance relative to quotas and harvest limits, 2010-2014.

| Year | Commercial Landings (mil lb)[a] | Commercial Quota (mil lb) | Percent Overage(+)/ Underage(-) | Recreational Landings (mil lb)[b] | Recreational Harvest Limit (mil lb) | Percent Overage(+)/ Underage(-) |
|---|---|---|---|---|---|---|
| **2010** | 1.75 | 1.76 | -1% | 3.03 | 1.83 | +66% |
| **2011** | 1.69 | 1.71 | -1% | 1.13 | 1.78 | -37% |
| **2012** | 1.72 | 1.71 | +1% | 3.18 | 1.32 | +141% |
| **2013** | 2.26 | 2.17 | +4% | 2.32 | 2.26 | +3% |
| **2014** | 2.40 | 2.21 | +9% | 3.60 | 2.33 | +55% |
| **5-yr Avg.** | - | - | +2% | - | - | +45% |

[a] Source: NMFS dealer data as of February 9, 2015, and 2015 Black Sea Bass Data Update. [b] Source: NMFS MRIP database as of June 30, 2015; recreational landings north of Cape Hatteras, NC.

### *Commercial Quotas and Recreational Harvest Limits*

Projected discards are removed to derive landings limits, which include annual commercial quotas and recreational harvest limits. The sum of the commercial quota and recreational harvest limit is equivalent to the total allowable landings in a given year. Under the current constant catch ABC and resulting ACLs and ACTs, the resulting commercial quota is 2.23 mil lb (1,014 mt), and the recreational harvest limit is 2.33 mil lb (1,026 mt; Table 1).

The ASMFC allocates the commercial quota to each state based on the allocation percentages given in Table 4.

**Table 4**: The Commission state-by-state commercial allocation percentages.

| State | Allocation (percent) |
|---|---|
| ME | 0.5 |
| NH | 0.5 |
| MA | 13.0 |
| RI | 11.0 |
| CT | 1.0 |
| NY | 7.0 |
| NJ | 20.0 |
| DE | 5.0 |
| MD | 11.0 |
| VA | 20.0 |
| NC | 11.0 |
| Totals | 100 |

As described above, pending additional analysis to be presented to the SSC, staff has no recommendations for commercial quotas and recreational harvest limits at this time.

Specific management measures that will be used to achieve the harvest limit for the recreational fishery in 2016 will not be determined until after the first four waves of 2015 recreational landings are reviewed. These data will become available in October 2015. The Monitoring Committee will meet in November to review these data and make recommendations regarding any necessary changes in the recreational management measures (i.e., possession limit, minimum size, and season). Given the performance of the recreational fishery relative to the recreational harvest limit in recent years, management measures (i.e., minimum size, possession limits, and seasons) should be implemented that are designed to achieve the recreational harvest limit while preventing the recreational ACL from being exceeded.

### *Commercial Gear Regulations and Minimum Fish Size*

Management measures in the commercial fishery other than quotas and harvest limits (i.e., minimum fish size, gear requirements, etc.) have remained constant since 2006.

Amendment 9 established minimum fish sizes for black sea bass in federal and state waters. The Council and Commission increased the size limit to 11-inch total length (TL) in 2002.

Amendment 9 also established gear regulations that became effective in December of 1996. Current regulations state that large trawl nets are required to possess a minimum of 75 meshes of 4.5 inch diamond mesh in the codend, or the entire net must have a minimum mesh size of 4.5 inch throughout. The threshold level used to trigger the minimum mesh requirement size is 500 lb from January through March and 100 lb from April through December.

The Council and Commission adopted modifications to the circle vent size in black sea bass pots/traps, effective in 2007, based on the findings of a Council and Commission sponsored workshop. The minimum circle vent size requirements for black sea bass pots/traps were increased from 2.375 inch to

2.5 inch. The requirements of 1.375 inch x 5.75 inch for rectangular vents and 2 inch for square vents remained unchanged. In addition, 2 vents are required in the parlor portion of the pot/trap.

Given that these measures have not been re-examined in detail in several years, staff recommend that a thorough review be conducted to examine the current minimum fish size, minimum mesh size, seasonal thresholds that trigger the minimum mesh size requirement, and pot/trap vent requirements, for consideration by the Council and Board in December. Pending this additional analysis, staff is not proposing specific changes at this time.

# Black Sea Bass 2014 Catch and Survey Information for Northern Stock

Report to the Mid-Atlantic Science and Statistical Committee

NOAA Fisheries Service

Northeast Fisheries Science Center

166 Water Street

Woods Hole, MA

June, 2015

## *Commercial Fishery*

Landings in 2014 were 1089 mt, predominately from otter trawls and fish pots, an increase from 1027 mt in 2013. The majority of landings were reported from the Mid-Atlantic statistical areas between New York and Delaware.

Table 1. Commercial black sea bass landings (kg) by region, market category and year.

By Statistical Area

**2013** kg

| Area | uncl | large | jumbo | medium | small | total | Pct. |
|---|---|---|---|---|---|---|---|
| 512-539 | 14,355 | 76,359 | 87,402 | 45,056 | 12,400 | 235,572 | 23% |
| 611-623 | 22,733 | 220,399 | 223,245 | 167,130 | 16,603 | 650,110 | 63% |
| 625-636 | 91 | 41,136 | 26,321 | 54,594 | 19,148 | 141,290 | 14% |
| total | 37179 | 337894 | 336968 | 266780 | 48151 | | |
| % | 4% | 33% | 33% | 26% | 5% | 1,026,972 | |

**2014** kg

| Area | uncl | large | jumbo | medium | small | total | Pct. |
|---|---|---|---|---|---|---|---|
| 514-562 | 12,565 | 46,994 | 69,190 | 34,466 | 15,578 | 178,793 | 16% |
| 611-623 | 25,201 | 232,168 | 269,377 | 216,703 | 19,081 | 762,530 | 70% |
| 625-636 | 11,763 | 40,929 | 23,782 | 48,210 | 22,954 | 147,638 | 14% |
| total | 49,529 | 320,091 | 362,349 | 299,379 | 57,613 | | |
| % | 5% | 29% | 33% | 27% | 5% | 1,088,961 | |

Table 2. Commercial black sea bass landings (kg) by gear type, market category and year.

By Gear

**2013**, kg

| | uncl | large | jumbo | medium | small | Grand Total | |
|---|---|---|---|---|---|---|---|
| TRAWL,OTTER,BOTTOM,FISH | 5,566 | 222,814 | 260,773 | 90,128 | 14,799 | 594,079 | 58% |
| POTS + TRAPS,FISH | 9,939 | 60,909 | 49,832 | 91,365 | 28,065 | 240,110 | 23% |
| HANDLINE | 4,170 | 34,232 | 20,680 | 28,385 | 2,159 | 89,625 | 9% |
| OTHER | 4,433 | 23,791 | 23,823 | 47,386 | 3,727 | 103,159 | 10% |

**2014**, kg

| | uncl | large | jumbo | medium | small | Grand Total | |
|---|---|---|---|---|---|---|---|
| TRAWL,OTTER,BOTTOM,FISH | 5,534 | 177,604 | 245,300 | 98,305 | 17,249 | 543,992 | 50% |
| POTS + TRAPS,FISH | 15,938 | 62,824 | 50,591 | 80,447 | 35,960 | 245,759 | 23% |
| HANDLINE | 10,215 | 38,272 | 22,226 | 24,935 | 2,435 | 98,084 | 9% |
| OTHER | 17,842 | 41,391 | 44,232 | 95,693 | 1,969 | 201,126 | 18% |

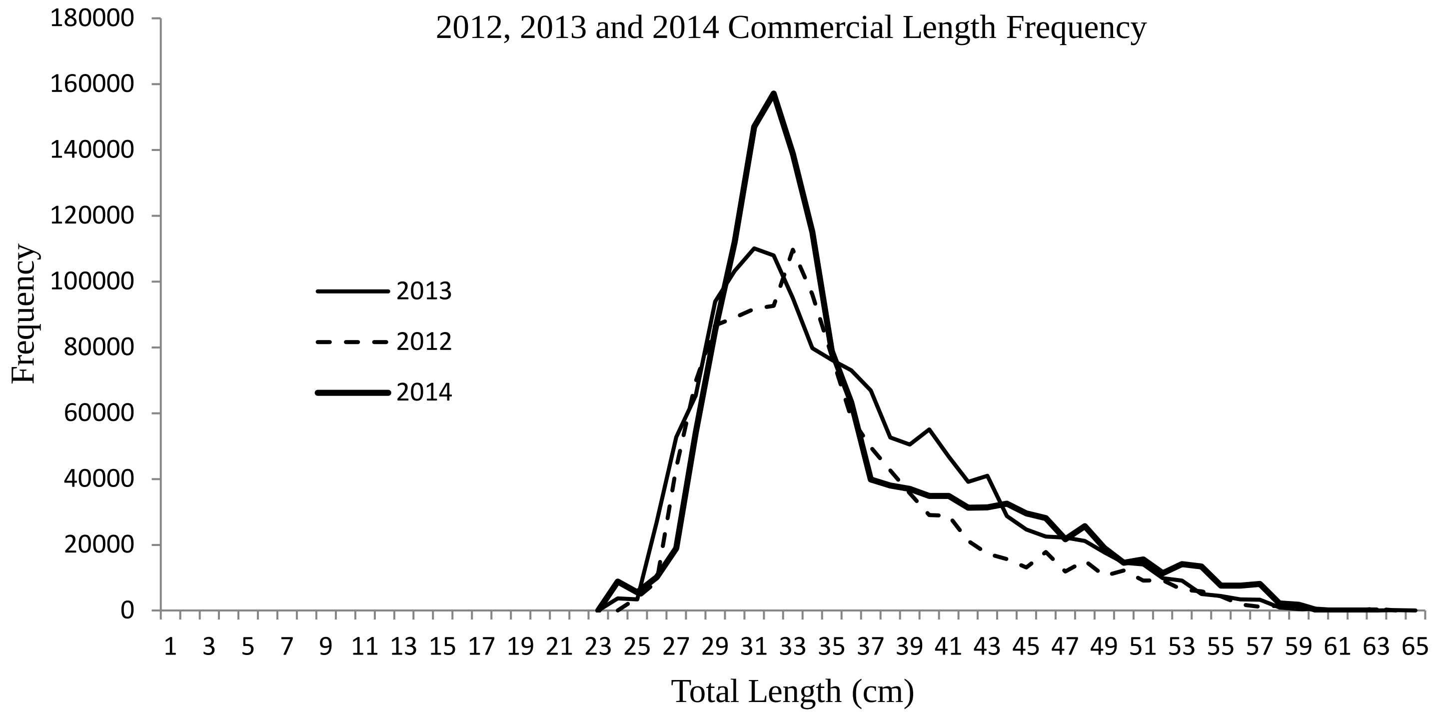



Figure 1. Length frequency of 2012, 2013 and 2014 black sea bass commercial landings.

Commercial discards from otter trawls were estimated from Northeast Fisheries Observer trips discard to kept all ratios.  All other gears were estimated from discarded sea bass recorded in Vessel Trip Reports by gear and are likely underestimates. Mortality rates as used in previous assessment.

Table 3. Commercial black sea bass discards (mt) by gear and year.

| 2014 | mt | mortality rate | losses (mt) |
|---|---|---|---|
| Bottom otter trawl | 220.0 | 1.00 | 220.0 |
| handline | 4.5 | 0.15 | 0.7 |
| fish pot | 28.7 | 0.15 | 4.3 |
| lobster pot-offshore | 9.0 | 0.15 | 1.4 |
| other | 4.5 | 1.00 | 4.5 |
| | | | |
| total discard mt | 266.7 | | |
| total discard loss mt | | | 230.8 |

| 2013 | mt | mortality rate | losses (mt) |
|---|---|---|---|
| Bottom otter trawl | 148.4 | 1.00 | 148.4 |
| handline | 11.1 | 0.15 | 1.7 |
| fish pot | 31.1 | 0.15 | 4.7 |
| lobster pot-offshore | 1.7 | 0.15 | 0.3 |
| other | 2.9 | 1.00 | 2.9 |
| | | | |
| total discard mt | 195.2 | | |
| total discard loss mt | | | 157.9 |

## *Recreational Fishery*

Recreational landings in 2014 for Maine through Cape Hatteras, NC were 2.078 million fish equal to 1635.3 mt. Associated discards (B2 only) were 8.596 million fish. Assuming a discard mortality rate of 15%, discard losses equal 1.289 million fish and 315 mt. Landings in 2013 equaled 1.274 million with discards of 8.492 million. 2013 discard losses equaled 1.274 million fish or 307.5 mt. Black sea bass catch from vessel trip reports for January-February party/charter vessels was negligible.

Table 4. Recreational black sea bass catch (number) by year. A mortality rate of 15% applied to live discards (B2).

Number

| | AB1 | B2 | B2 mortality |
|---|---|---|---|
| 2013 | 1,274,388 | 8,492,053 | 1,273,808 |
| 2014 | 2,077,759 | 8,595,977 | 1,289,397 |

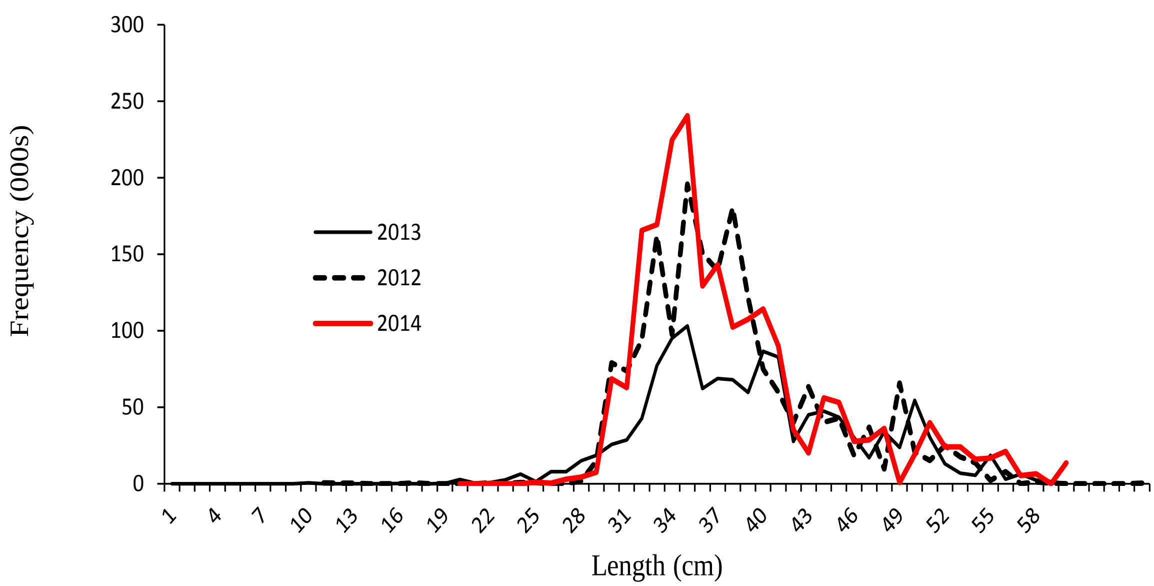



Figure 2. Length frequency (TL cm) of 2012, 2013 and 2014 black sea bass recreational harvest (AB1), ME- NC (Cape Hatteras).

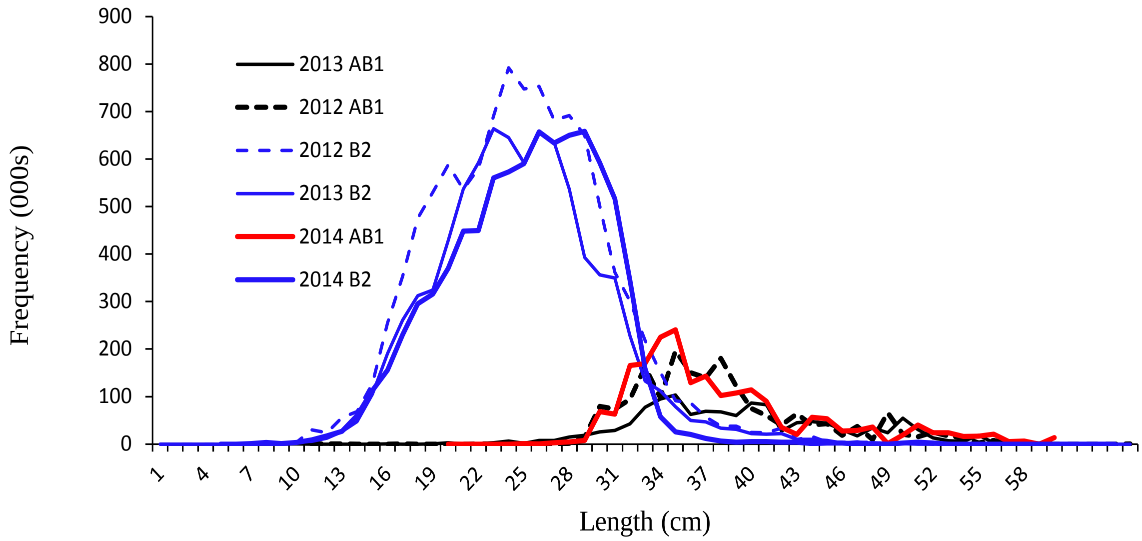



Figure 3. Length frequency (TL cm) of 2012, 2013 and 2014 black sea bass recreational landings (AB1) and discards (B2), ME- NC (Cape Hatteras).

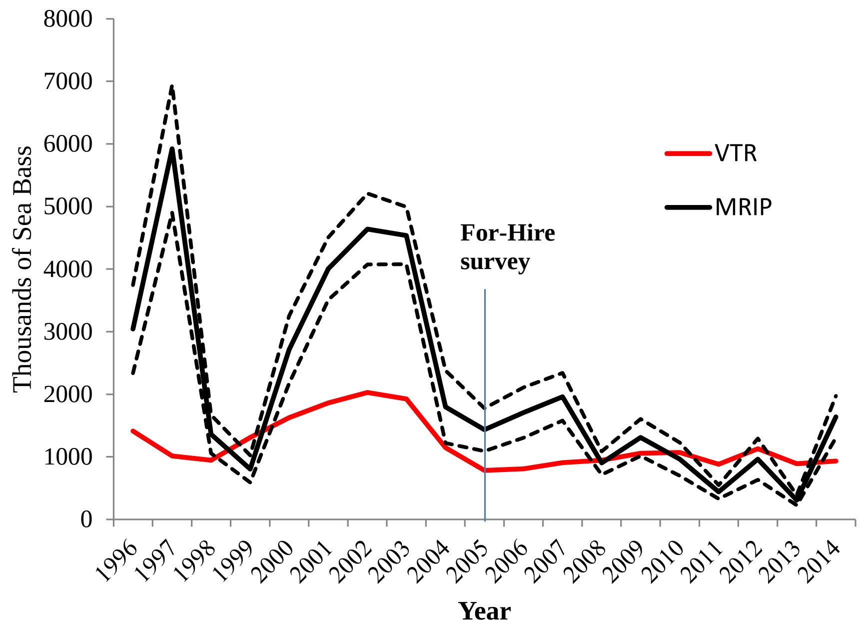



Figure 4. Comparison of black sea bass EEZ For-hire MRIP total catch (A,B1,B2), Waves 2-6 with For-Hire Vessel Trip Reports (VTR) from March-December, North and Mid-Atlantic combined. MRIP results with approximate ± 95% CI. Line denotes when MRIP For-hire survey was initiated.

Table 6. Black sea bass catch (MT, landings plus discard mortalities), 1981-2014 for northern stock.

| Year | Landings Com | Discard losses Com | Landings Rec (AB1) | Discard losses Rec (B2*15%) | Total |
|---|---|---|---|---|---|
| 1981 | 1129 | 67 | 625 | 35 | 1,857 |
| 1982 | 1177 | 70 | 1243 | 40 | 2,530 |
| 1983 | 1513 | 90 | 1860 | 114 | 3,577 |
| 1984 | 1519 | 105 | 666 | 36 | 2,326 |
| 1985 | 1075 | 89 | 1002 | 45 | 2,210 |
| 1986 | 1508 | 101 | 1824 | 95 | 3,528 |
| 1987 | 1635 | 98 | 929 | 36 | 2,698 |
| 1988 | 1424 | 102 | 1324 | 90 | 2,940 |
| 1989 | 1105 | 82 | 1502 | 39 | 2,727 |
| 1990 | 1402 | 53 | 1283 | 92 | 2,830 |
| 1991 | 1190 | 19 | 1876 | 92 | 3,176 |
| 1992 | 1264 | 91 | 1219 | 82 | 2,657 |
| 1993 | 1353 | 179 | 2167 | 64 | 3,762 |
| 1994 | 848 | 34 | 1355 | 80 | 2,318 |
| 1995 | 889 | 36 | 2753 | 124 | 3,802 |
| 1996 | 1448 | 483 | 1804 | 91 | 3,826 |
| 1997 | 1198 | 31 | 1920 | 112 | 3,261 |
| 1998 | 1171 | 136 | 588 | 86 | 1,981 |
| 1999 | 1305 | 36 | 802 | 112 | 2,255 |
| 2000 | 1205 | 42 | 1800 | 263 | 3,310 |
| 2001 | 1299 | 187 | 1556 | 295 | 3,336 |
| 2002 | 1587 | 24 | 1968 | 372 | 3,952 |
| 2003 | 1359 | 58 | 1512 | 301 | 3,230 |
| 2004 | 1405 | 370 | 817 | 140 | 2,733 |
| 2005 | 1298 | 29 | 902 | 153 | 2,383 |
| 2006 | 1285 | 16 | 945 | 166 | 2,413 |
| 2007 | 1037 | 57 | 1052 | 192 | 2,338 |
| 2008 | 875 | 37 | 771 | 242 | 1,925 |
| 2009 | 523 | 165 | 1088 | 226 | 2,002 |
| 2010 | 751 | 110 | 1373 | 251 | 2,485 |
| 2011 | 765 | 135 | 512 | 133 | 1,546 |
| 2012 | 782 | 111 | 1444 | 387 | 2,724 |
| 2013 | 1027 | 158 | 1113 | 308 | 2,605 |
| 2014 | 1089 | 231 | 1635 | 315 | 3,271 |

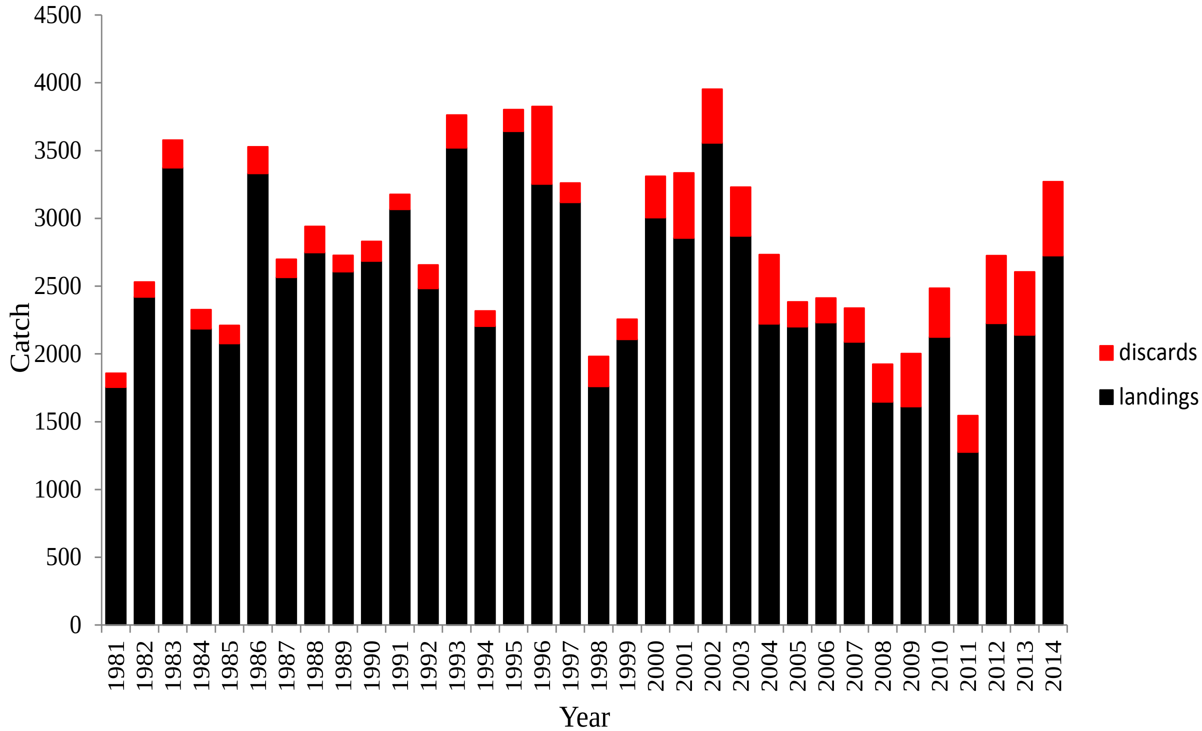



Figure 4. Black sea bass catch, Maine to North Carolina 1981-2014.

*Surveys*

Due to logistic issues, the 2014 spring Northeast Fisheries Science Center survey was not conducted for strata south of the Delmarva Peninsula (Figure 5). A comparison was made between the black sea bass indices for the equivalent subset from 2009 – 2013 and the 2014 indices. Although with the subset showed the same trend over time (Figure 6), the 2014 index of number per tow could be biased high by an average of 14% (a range from 2009-2013 of 7-22%) (Figure 7). The size distribution showed little to no difference between the full set and the subset.

The NEFSC spring offshore index of sea bass abundance in 2014 (4.40 mean number of fish per tow) remained comparable to the 2013 index of 4.337 fish per tow (Bigelow indices calibrated to Albatross units). The 2011 year class remained a dominant cohort in the population through 2013 and 2014. Recruitment in spring 2014 (age 1 fish) was below average (0.045 fish per tow) and the lowest value since 2006 (0.036).

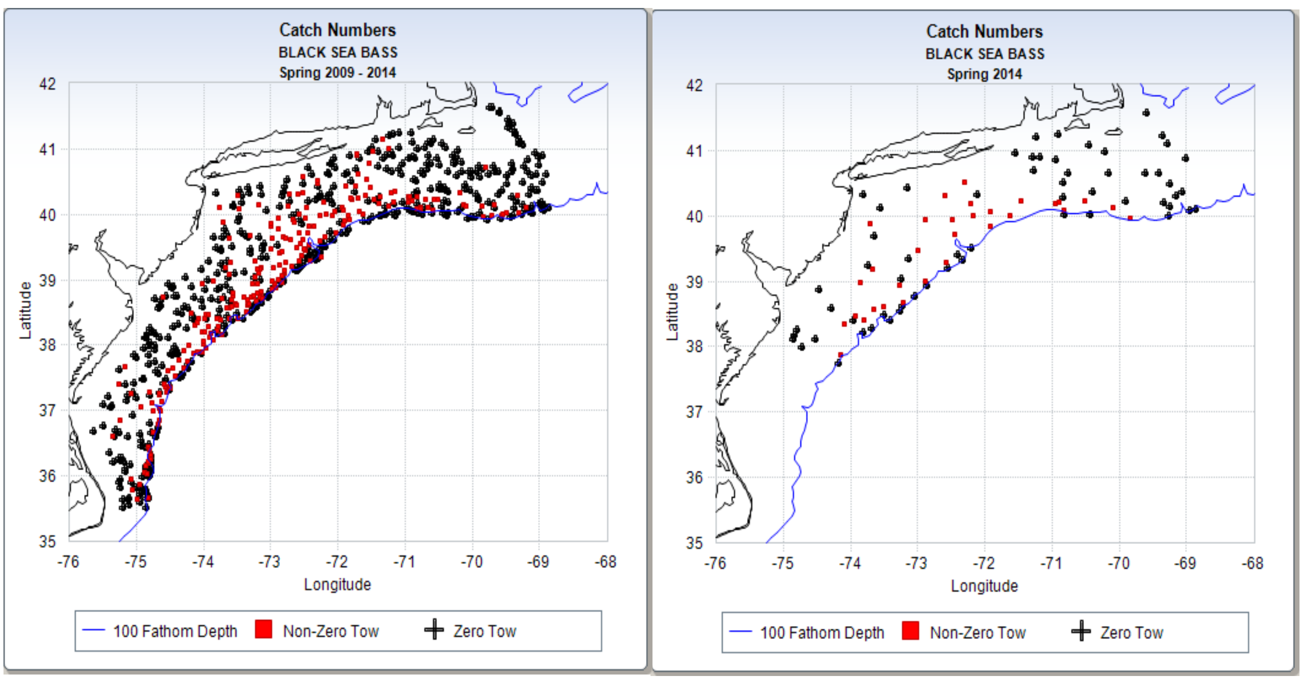



Figure 5. Locations of black sea bass positive tows from NEFSC spring survey, 2009-2014 (left) and 2014 (right).

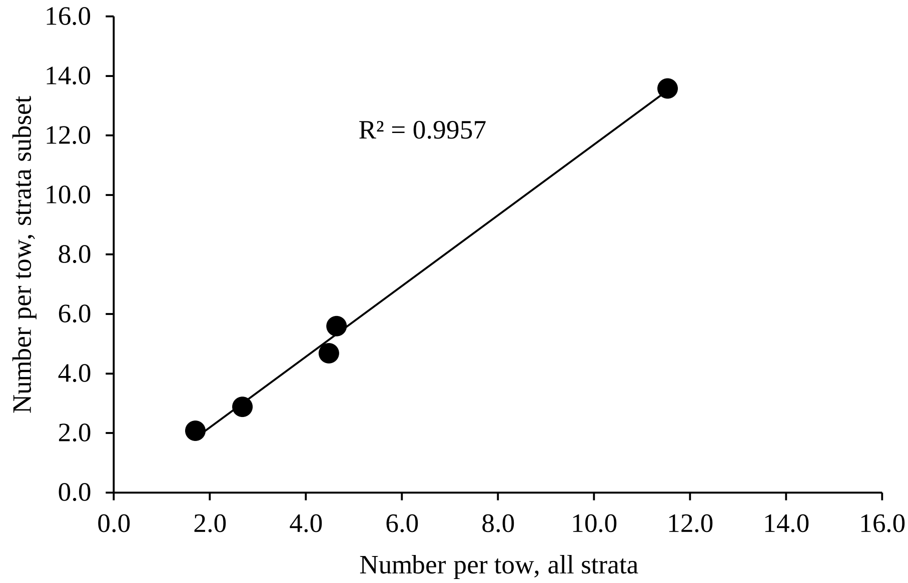



Figure 6. The relationship between the 2009-2013 NEFSC spring black sea bass indices for complete strata set and strata subset sampled in 2014.

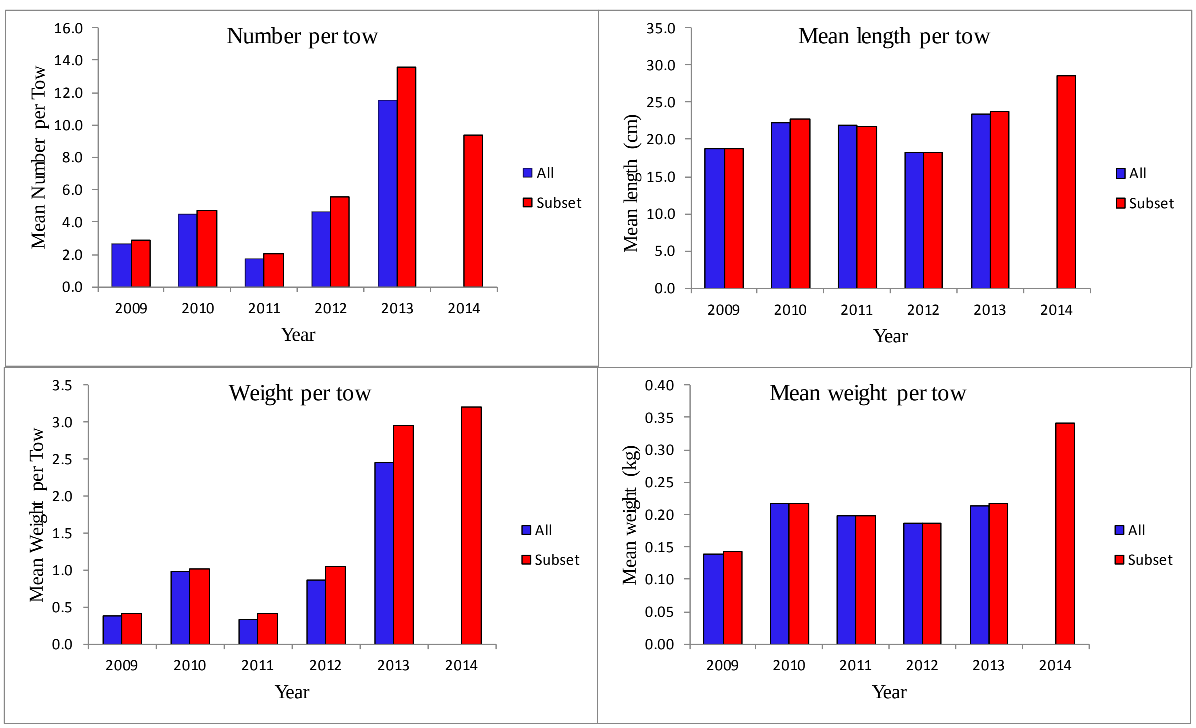



Figure 7. Black sea bass mean number per tow, mean weight per tow, mean length and mean weight from NEFSC spring survey complete strata set and subset sampled in 2014

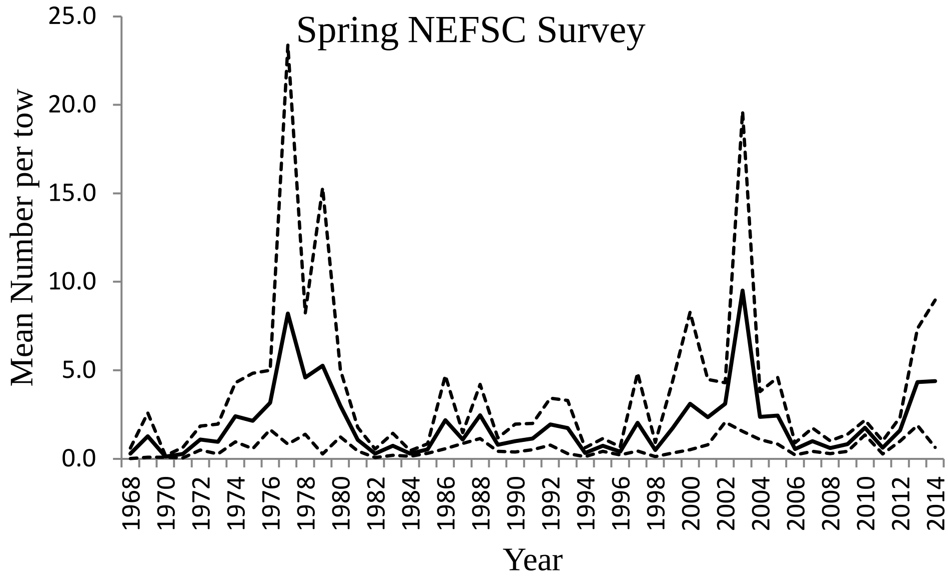



Figure 8. NEFSC spring offshore stratified mean number per tow (± 95% CI) of black sea bass, 1968-2014. Bigelow data calibrated to Albatross units for 2009-2014.

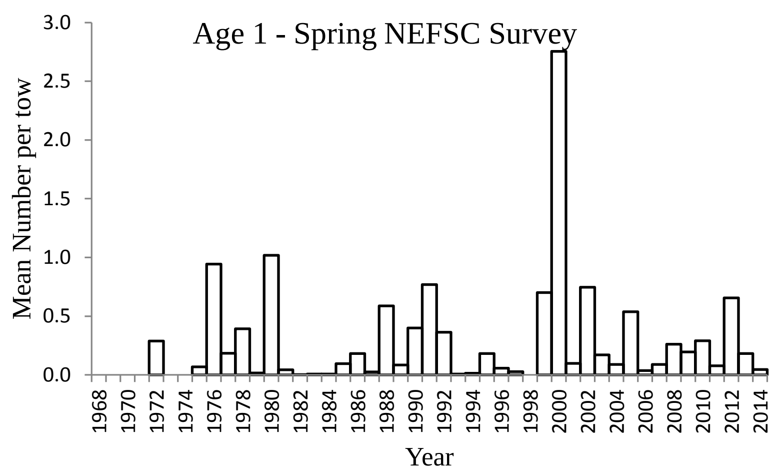



Figure 9. Indices of black sea bass recruitment (mean #/tow, age 1) from NEFSC spring offshore survey, 1968-2014. Indices from 2009-2014 calibrated to Albatross equivalent units.

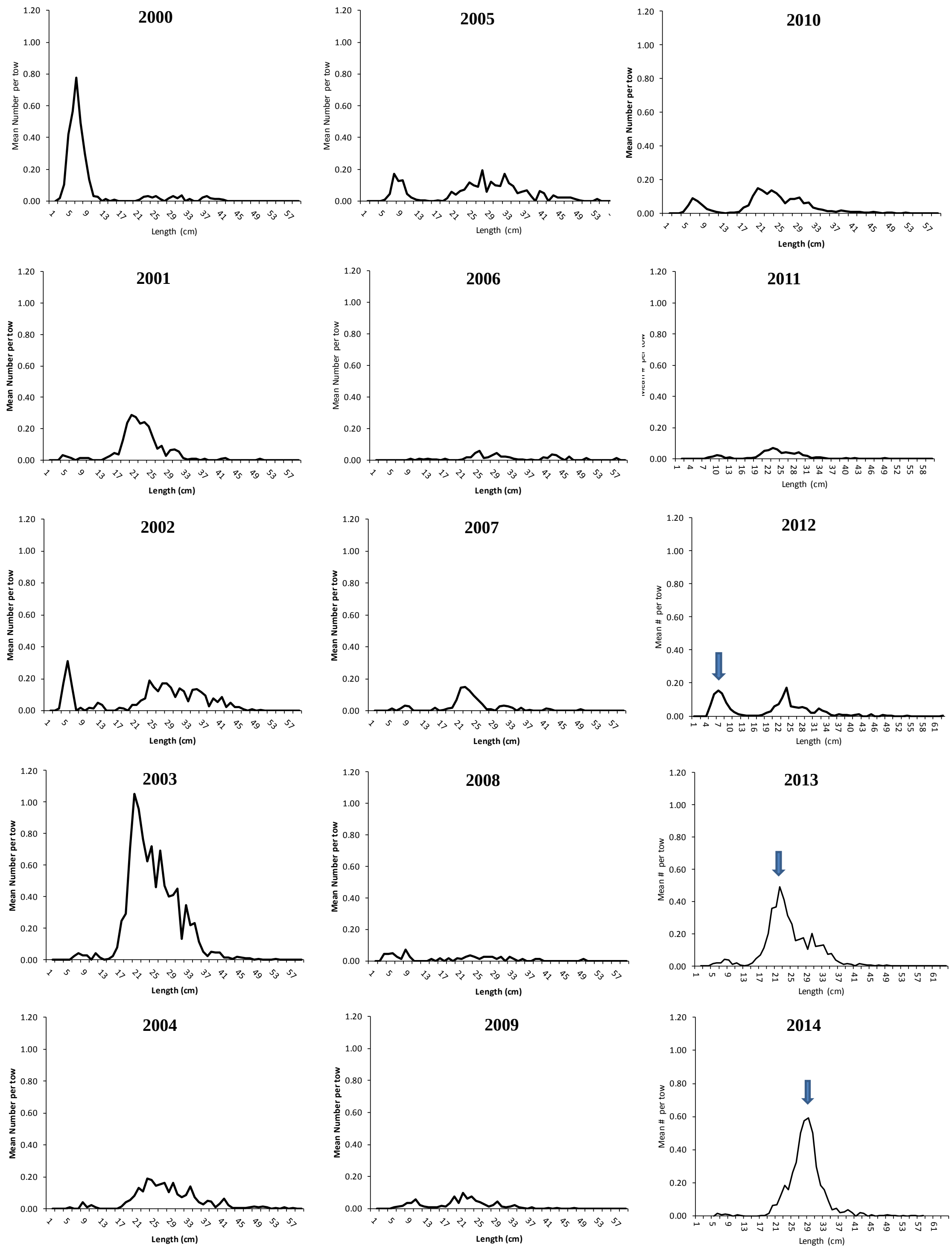


Figure 10. Length frequency distributions of black sea bass from NEFSC spring offshore survey, 2000-2014

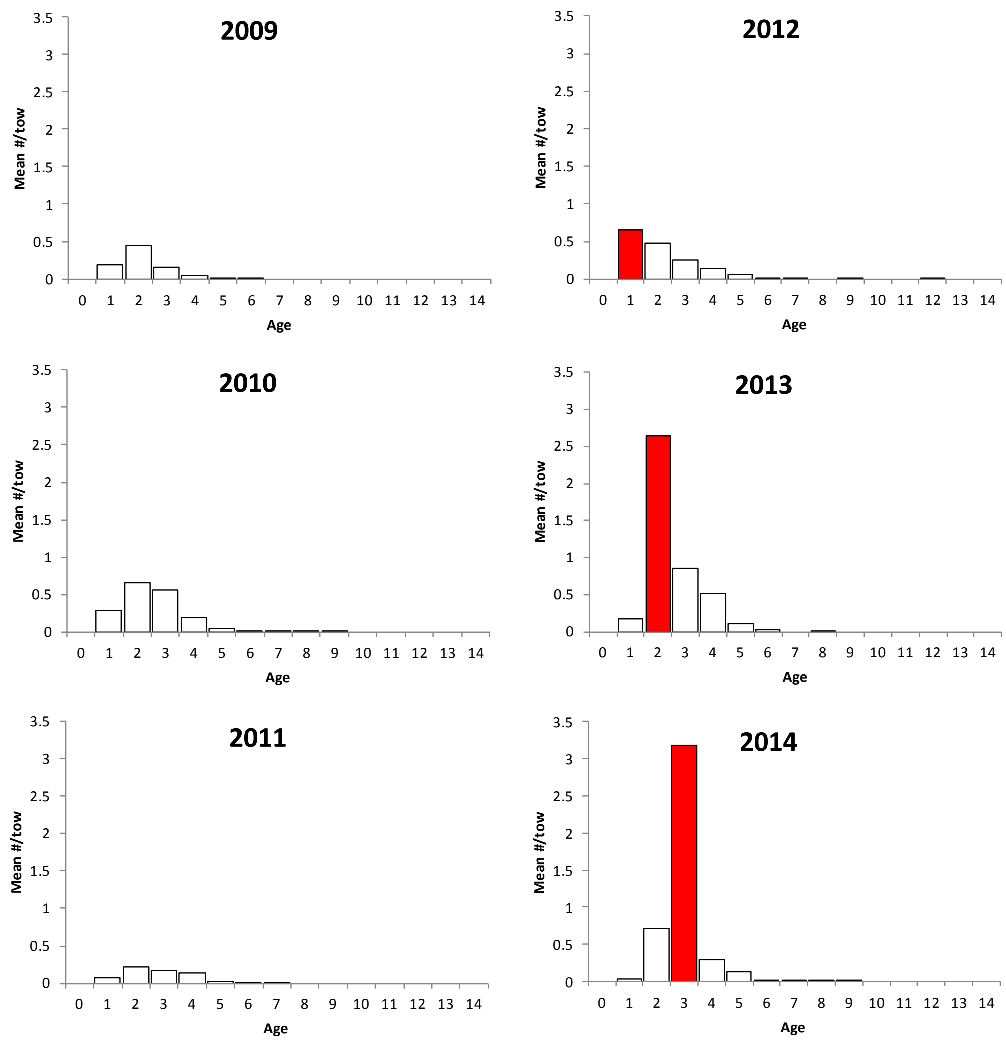



Figure 11. Mean number per tow at age of black sea bass from NEFSC spring offshore survey, 2009-2013. 2011 year class highlighted in red. Data is uncalibrated Bigelow mean number per tow.

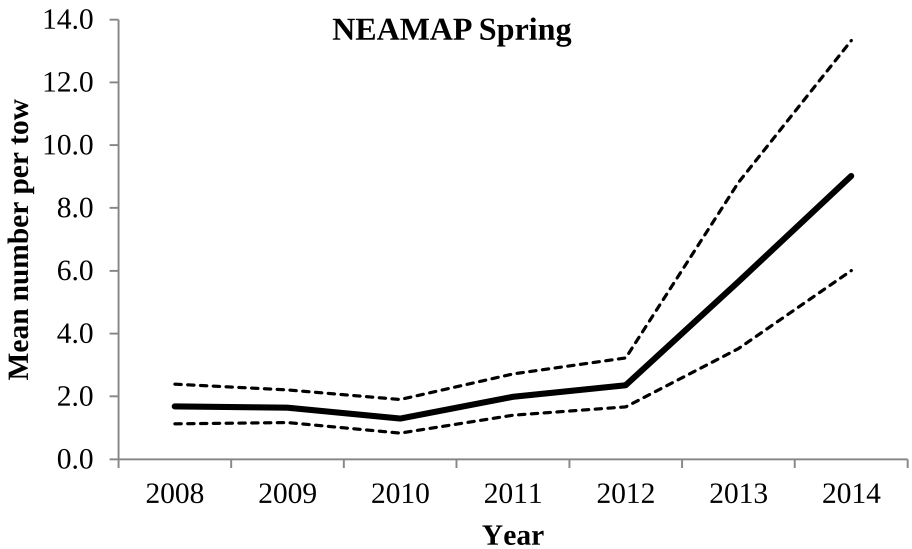
Table 7. Mean number per tow of black sea bass from Northeast Monitoring and Assessment Program (NEAMAP) survey spring and fall series.

Spring Survey

| Year | n | Numerical Index | | | Biomass Index | | |
|---|---|---|---|---|---|---|---|
| | | LCI | Index | UCI | LCI | Index | UCI |
| 2007 | | | | | | | |
| 2008 | 44 | 1.13 | 1.68 | 2.39 | 0.77 | 1.18 | 1.69 |
| 2009 | 47 | 1.17 | 1.64 | 2.21 | 0.55 | 0.84 | 1.20 |
| 2010 | 43 | 0.83 | 1.30 | 1.90 | 0.49 | 0.78 | 1.13 |
| 2011 | 43 | 1.40 | 1.99 | 2.72 | 0.64 | 1.01 | 1.46 |
| 2012 | 43 | 1.67 | 2.36 | 3.23 | 0.60 | 0.88 | 1.21 |
| 2013 | 43 | 3.52 | 5.66 | 8.81 | 1.81 | 2.83 | 4.23 |
| 2014 | 43 | 6.01 | 9.02 | 13.33 | 3.32 | 5.02 | 7.40 |

Fall Survey

| Year | n | Numerical Index | | | Biomass Index | | |
|---|---|---|---|---|---|---|---|
| | | LCI | Index | UCI | LCI | Index | UCI |
| 2007 | 150 | 0.60 | 0.85 | 1.13 | 0.18 | 0.28 | 0.39 |
| 2008 | 150 | 0.31 | 0.45 | 0.61 | 0.07 | 0.15 | 0.23 |
| 2009 | 160 | 0.43 | 0.66 | 0.93 | 0.15 | 0.25 | 0.37 |
| 2010 | 150 | 0.24 | 0.36 | 0.49 | 0.10 | 0.16 | 0.22 |
| 2011 | 150 | 0.52 | 0.69 | 0.87 | 0.18 | 0.25 | 0.33 |
| 2012 | 150 | 0.75 | 1.05 | 1.40 | 0.23 | 0.37 | 0.52 |
| 2013 | 150 | 0.67 | 0.89 | 1.14 | 0.31 | 0.44 | 0.59 |
| 2014 | 150 | 0.50 | 0.70 | 0.94 | 0.22 | 0.34 | 0.46 |



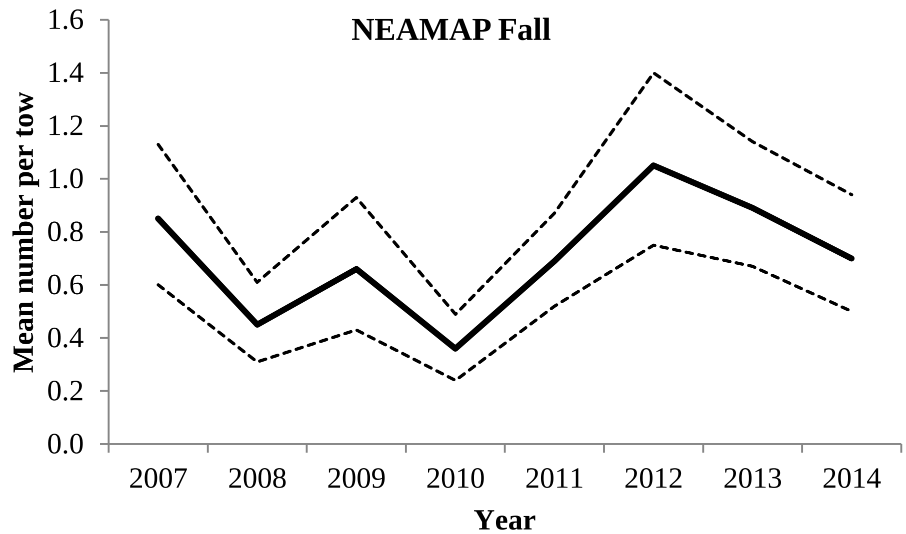




Figure 12. NEAMAP black sea bass abundance indices (Mean number per tow ± 95% CI) for spring and fall surveys.

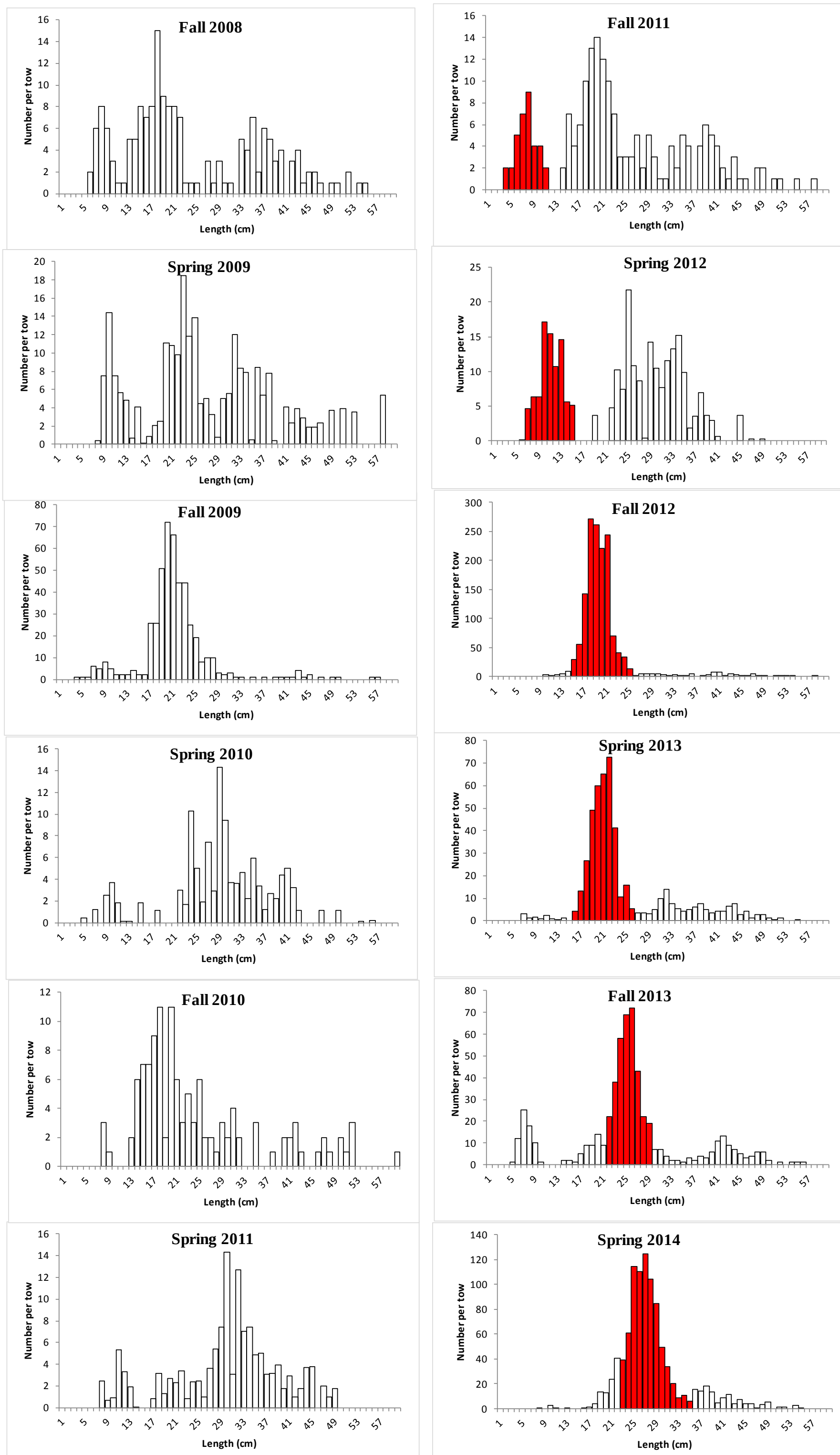



Figure 13. Black sea bass length frequencies from NEAMAP spring and fall surveys. The 2014 cohort highlighted in red (approximate sizes).

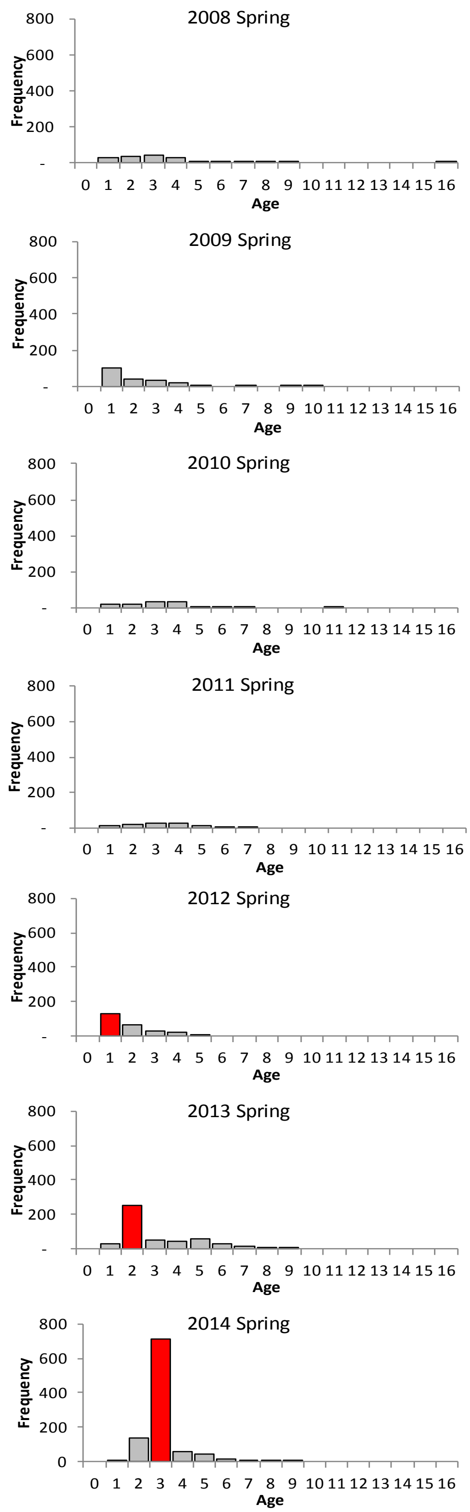



Figure 14. Black sea bass age frequencies from NEAMAP spring surveys. Scale standardized to 2014 values and the 2014 cohort is highlighted in red.

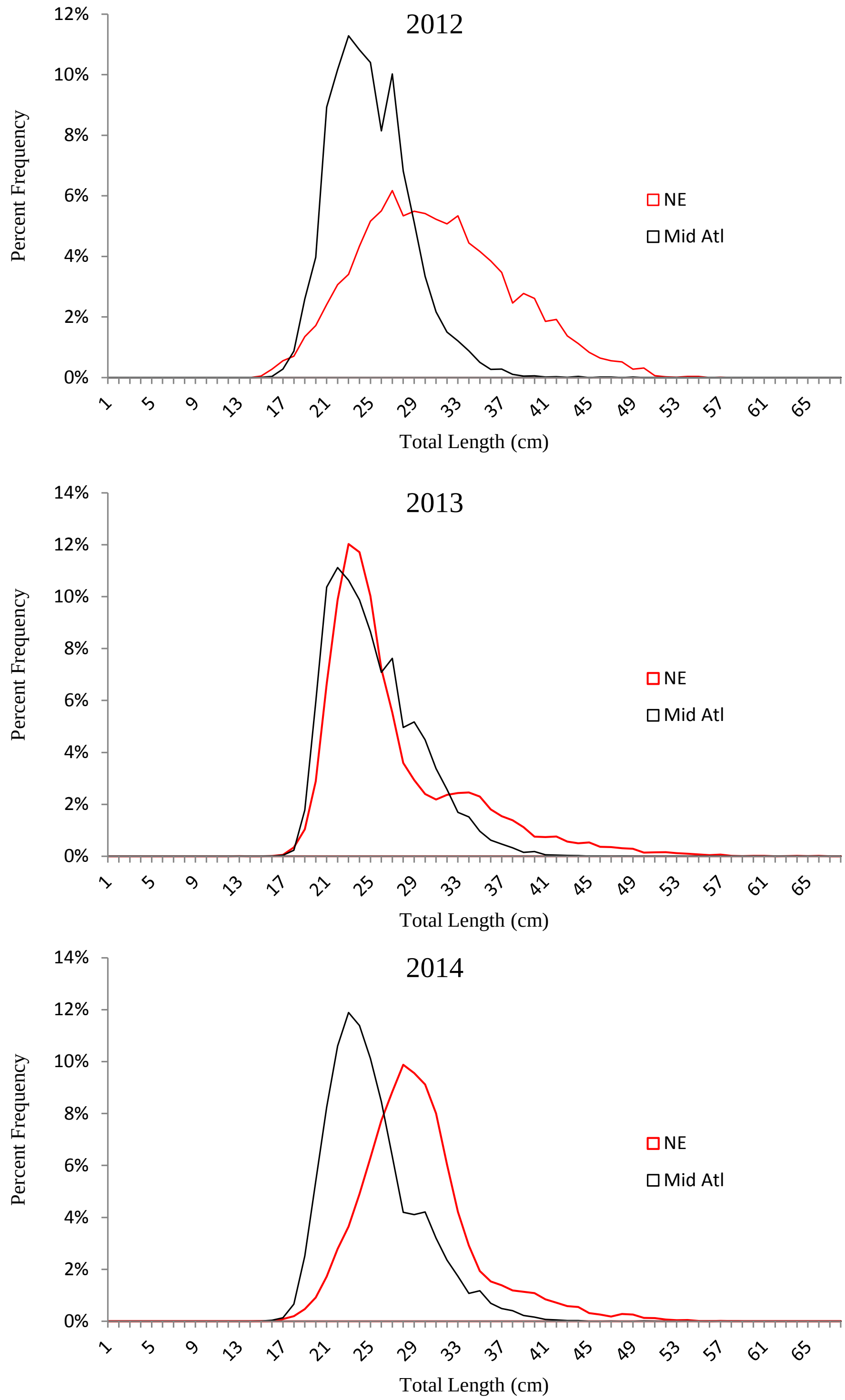
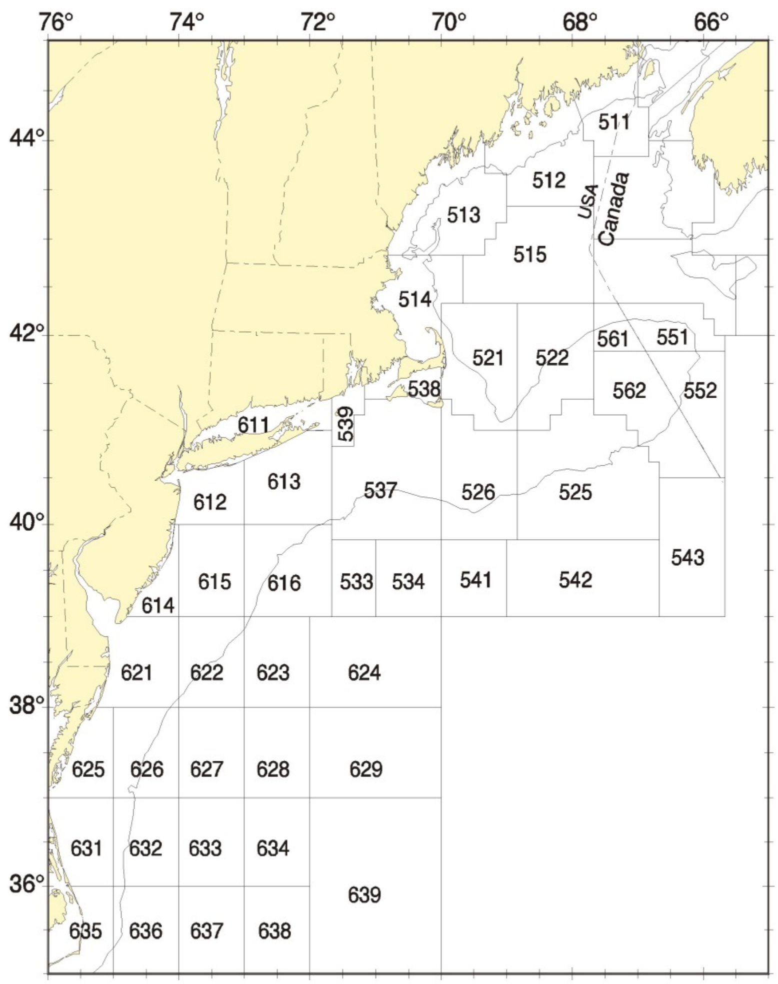



Figure 15. Length frequencies collected during University of Rhode Island RSA pot survey. Lengths represent season totals for New England (MA, RI and NY (2014) combined) and Mid-Atlantic (NJ and VA) by year.

## *Acknowledgments*

NEAMAP information courtesy of Chris Bonzack and Jim Gartland, VIMS, URI Pot Survey information courtesy of Laura Skrobe, URI and NEFSC age information compiled by Josh Dayton, NEFSC.




Commercial statistical areas

# Black Sea Bass Fishery Information Document

**June 2015**

This document provides a brief overview of the biology, stock condition, management system, and fishery performance for black sea bass with an emphasis on 2014, the most recent complete fishing year.

## 1. Biology

Black sea bass (*Centropristis striata*) are distributed from the Gulf of Maine through the Gulf of Mexico. Adults and juveniles are mostly found on the continental shelf, but young of the year (i.e. fish less than one year old) can be found in estuaries. Adults prefer to be near structures such as rocky reefs, coral patches, cobble and rock fields, mussel beds, and shipwrecks. Adults in the Mid-Atlantic show strong site fidelity during the summer but migrate to offshore wintering areas south of New Jersey when water temperatures decrease in the fall. Adults in the South Atlantic and Gulf of Mexico do not migrate during the winter.[1]

Black sea bass are protogynous hermaphrodites, meaning that they are born female but later transition to males, usually around 2-5 years of age. Male black sea bass are either of the dominant or subordinate type. Dominant males are larger than subordinate males and develop a bright blue nuccal hump during the spawning season. About half of black sea bass are sexually mature by 2 or 3 years of age and about 20 cm in length. Most black sea bass greater than 19 cm are either in a transitional stage between female and male or have fully transitioned to the male stage. Studies have shown that fishing pressure can decrease the age of transition from female to male. Black sea bass reach a maximum size of about 60 cm and a maximum age of about 12 years.[1,2]

Black sea bass in the Mid-Atlantic spawn in nearshore continental shelf areas at depths of 20-50 meters. Spawning usually takes place between April and October. During the summer, adult black sea bass share complex coastal habitats with tautog, hakes, conger eel, sea robins and other migratory fish species. Essential Fish Habitat (EFH) for black sea bass consists of pelagic waters, structured habitat, rough bottom, shellfish, sand, and shell, from the Gulf of Maine through Cape Hatteras, North Carolina. Juvenile and adult black sea bass mostly feed on crustaceans, small fish, and squid. The NEFSC food habits database lists spiny dogfish, Atlantic angel shark, skates, spotted hake, summer flounder, windowpane, and goosefish as predators of black sea bass. [1]

## 2. Status of the Stock

The protogynous life history (i.e. transitioning from female to male) and structure-orienting behavior of black sea bass make them difficult species to assess with analytical stock assessment models. Most stock assessments of mid-Atlantic species rely heavily on data collected during the Northeast Fisheries Science Center's biannual bottom trawl survey. This survey largely avoids areas with structures that could damage the trawl gear, such as rocky outcroppings and reefs. Black sea bass prefer to be near such structures and so they are, for the most part, not susceptible to capture by the trawl survey.[2]

The northern stock of black sea bass (i.e. black sea bass north of Cape Hatteras, North Carolina) was designated as overfished in 2000, and was under a stock rebuilding strategy from 2000 until 2009. In 2009, the stock was declared rebuilt after a 2008 stock assessment indicated that it was not overfished and overfishing was not occurring in 2007. The peer review panel which reviewed this assessment approved it for use in management but cautioned that there was “considerable uncertainty with respect to stock status”. The panel recommended that the Council “allow for the sizeable uncertainty in stock status when establishing catch limits”.[2]

When the assessment model was updated in 2012, it was determined that the stock was not overfished and that overfishing was not occurring in 2011 (Figures 1 and 2).[3]

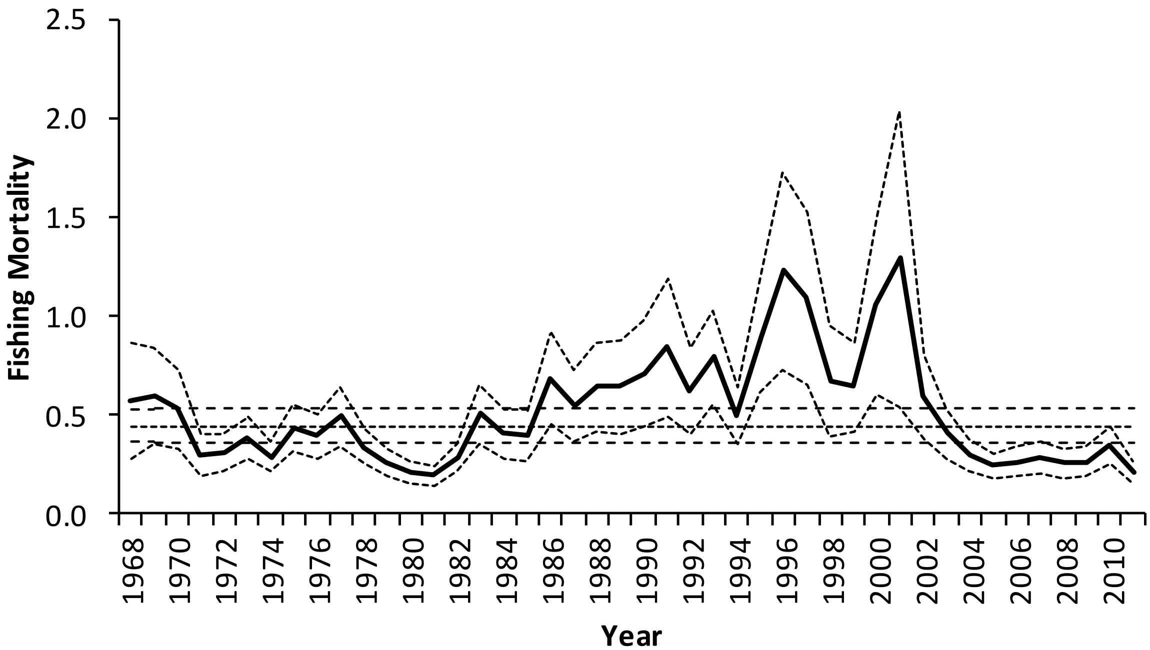



**Figure 1:** Estimated fishing mortality rate (F; +/- 2 standard deviations) of black sea bass from 1968-2011. Horizontal lines represent $F_{MSY}$ and an 80% confidence interval.[3]

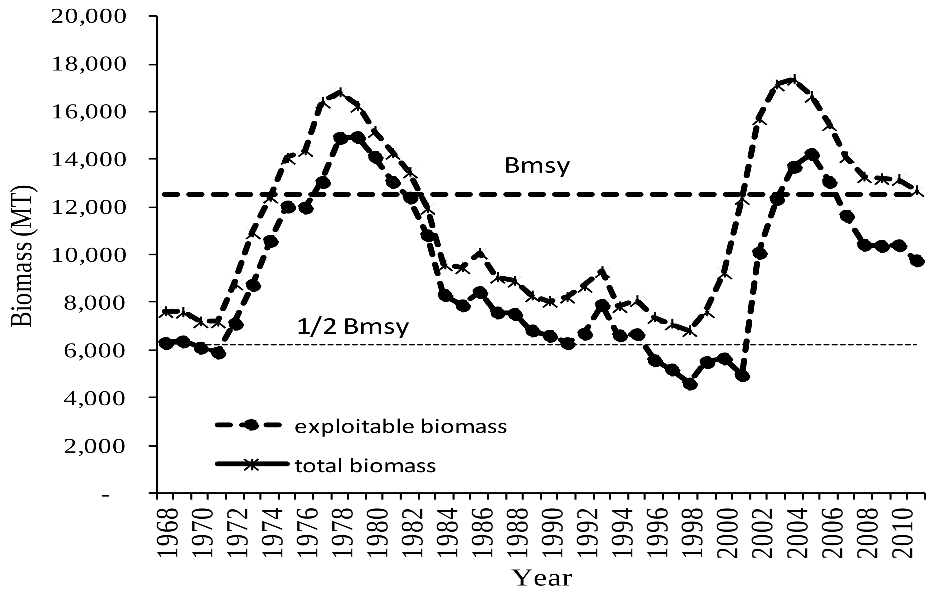



**Figure 2**: Estimated black sea bass total and exploitable biomass, 1968-2011. $B_{MSY}$ is the biomass target, and ½ $B_{MSY}$ is the minimum biomass threshold, below which the stock is considered overfished.[3]

## 3. Management System and Overall Fishery Performance

The Mid-Atlantic Fishery Management Council (MAFMC or Council) and the Atlantic States Marine Fisheries Commission (ASMFC or Commission) work cooperatively to develop fishery regulations for black sea bass off the east coast of the United States. The Council and Commission work in conjunction with the National Marine Fisheries Service (NMFS), which serves as the federal implementation and enforcement entity. This cooperative management endeavor was developed because a significant portion of the catch is taken from both state waters (0-3 miles offshore) and federal waters (3-200 miles offshore, also known as the Exclusive Economic Zone or EEZ). The management unit for black sea bass includes U.S. waters from Cape Hatteras, North Carolina to the U.S.-Canadian border.

The Council has managed back sea bass since 1997 when it amended the Summer Flounder and Scup Fishery Management Plan (FMP) to include black sea bass. The original FMP and subsequent amendments and frameworks are available at: [www.mafmc.org/fisheries/fmp/sf-s-bsb](www.mafmc.org/fisheries/fmp/sf-s-bsb).

Commercial and recreational black sea bass fisheries are managed using catch and landings limits, commercial quotas, recreational harvest limits, minimum fish sizes, gear regulations, permit requirements, and other provisions as prescribed by the FMP. The Council allocates 49% of the total allowable landings of black sea bass to the commercial fishery as a commercial quota and 51% of allowable landings to the recreational fishery as a recreational harvest limit.

The Council's Scientific and Statistical Committee (SSC) recommends annual Acceptable Biological Catch (ABC) levels for black sea bass, which are then approved by the Council and Commission and submitted to NMFS. The ABC is divided into commercial and recreational Annual Catch Limits (ACLs), based on the landings allocation prescribed in the FMP and the recent distribution of discards between the commercial and recreational fisheries. The Council first implemented recreational and commercial ACLs, with a system of overage accountability, in 2012. Both ABCs and ACLs include both projected landings and discards. Projected discards are subtracted to determine the commercial quota and recreational harvest limit, which are landings-based limits. Black sea bass catch and landings limits for the past ten years are shown in Table 1.

Total black sea bass landings (commercial and recreational) peaked in 1986, when approximately 15.8 million pounds of black sea bass were landed (Figure 3). About 6.16 million pounds of black sea bass were landed by commercial and recreational fishermen from Maine to North Carolina in 2014.[4,5]

**Table 1:** Summary of catch limits, landings limits, and landings for commercial and recreational black sea bass fisheries and landings from 2005 through 2015.

| Management measures | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ABC (millions of lb)[a] | -- | -- | -- | -- | -- | 4.50 | 4.50 | 4.50 | 5.50 | 5.50 | 5.50 |
| Commercial ACL (millions of lb)[b] | -- | -- | -- | -- | -- | -- | -- | 1.98 | 2.60 | 2.60 | 2.60 |
| Commercial quota (millions of lb)[c] | 3.95 | 3.83 | 2.38 | 2.03 | 1.09 | 1.76 | 1.71 | 1.71 | 2.17 | 2.17 | 2.21 |
| Commercial landings (millions of lb) | 2.87 | 2.84 | 2.29 | 1.93 | 1.17 | 1.75 | 1.69 | 1.72 | 2.26 | 2.38 | -- |
| % of commercial quota landed | 73% | 74% | 96% | 95% | 107% | 99% | 99% | 101% | 104% | 110% | -- |
| Recreational ACL (millions of lb)[b] | -- | -- | -- | -- | -- | -- | -- | 1.86 | 2.90 | 2.90 | 2.90 |
| Recreational harvest limit (millions of lb)[c] | 4.13 | 3.99 | 2.47 | 2.11 | 1.14 | 1.83 | 1.78 | 1.32 | 2.26 | 2.26 | 2.33 |
| Recreational landings (millions of lb)[d] | 2.18 | 1.91 | 2.34 | 2.09 | 2.67 | 3.36 | 1.27 | 3.31 | 2.39 | 3.78 | -- |
| % of recreational limit harvested | 53% | 48% | 95% | 99% | 234% | 184% | 71% | 251% | 106% | 167% | -- |

[a] The ABC is the Acceptable Biological Catch, recommended by the SSC and approved by the Council. The ABC is divided into commercial and recreational annual catch limits (ACLs), based on the allocation percentages prescribed in the FMP.

[b] The ACLs (Annual Catch Limits) are annual sector-specific catch limits for the commercial and recreational fisheries. The ACLs include both landings and discards.

[c] For 2005-2014, commercial quotas and recreational harvest limits are adjusted for both Research Set Aside (RSA) and projected discards. Quotas and harvest limits for 2015 do not reflect an adjustment for RSA, as the program was suspended for 2015.

[d] Includes landings for all of North Carolina.

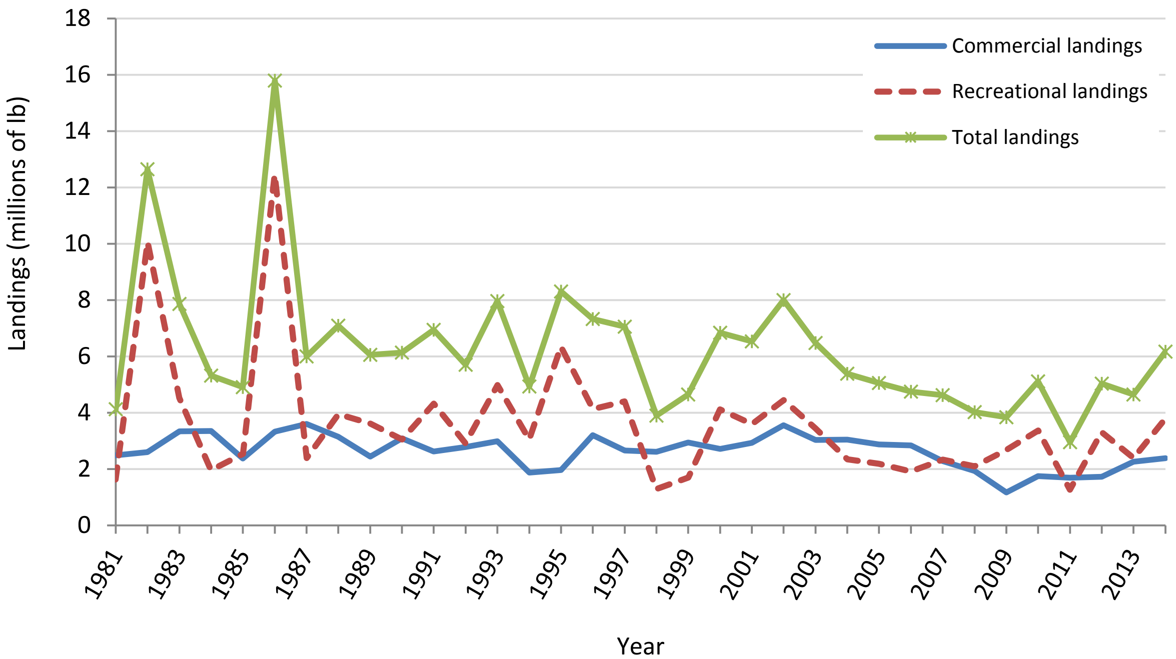



**Figure 3:** Commercial and recreational black sea bass landings in millions of pounds from Maine to North Carolina, 1981-2014.[4,5]

## 4. Commercial Black Sea Bass Measures and Fishery Performance

Commercial landings of black sea bass peaked in 1987 at 3.61 million pounds, and reached a low of 1.17 million pounds in 2009 (Figure 3). In 2014, commercial fishermen landed approximately 2.38 million pounds of black sea bass (corresponding to 110% of the commercial quota).[4]

A moratorium permit is required to fish commercially for black sea bass in federal waters. In 2014, 743 vessels held federal commercial black sea bass permits.[6]

The minimum commercial size limit for black sea bass of 11 inches total length has been in place since 2002. The ASMFC divides the black sea bass commercial quota among the states based on the allocation percentages given in Table 2, and states set measures to achieve their state-specific commercial quotas.

**Table 2:** Allocation of commercial black sea bass quota among states.

| State | Allocation (percent) |
|---|---|
| Maine | 0.5 |
| New Hampshire | 0.5 |
| Massachusetts | 13.0 |
| Rhode Island | 11.0 |
| Connecticut | 1.0 |
| New York | 7.0 |
| New Jersey | 20.0 |
| Delaware | 5.0 |
| Maryland | 11.0 |
| Virginia | 20.0 |
| North Carolina | 11.0 |
| Total | 100 |

In 2014, about 64% of the commercial black sea bass caught by federal permit holders from Maine to North Carolina was caught with bottom otter trawl gear. About 21% were caught with fish pots and traps, 8% in offshore lobster traps, and about 5% with hand lines. Other gear types accounted less than 1% each of total commercial landings.[7]

Any vessel which uses otter trawl gear and catches more than 500 pounds of black sea bass from January through March, or more than 100 pounds from April through December, must use nets with a minimum mesh size of 4.5 inch diamond mesh applied throughout the codend for at least 75 continuous meshes forward of the end of the net. Pots and traps used to target black sea bass commercially must have two escape vents with degradable hinges in the section known as the parlor. The escape vents must measure 1.375 inches by 5.75 inches if rectangular, 2 inches by 2 inches if square, or have a diameter of 2.5 inches if circular.

Vessel trip report (VTR) data suggest that statistical area 621 was responsible for the largest percentage of commercial black sea bass catch in 2014. Most of the trips during which black sea bass were caught took place in statistical area 616 (Table 3, Figure 4).[7]

**Table 3:** Statistical areas that accounted for at least 5% of the total commercial black sea bass catch in 2014, with associated number of trips.[7]

| Statistical Area | Percent of 2014 Commercial Black Sea Bass Catch | Number of Trips |
|---|---|---|
| 621 | 31% | 182,233 |
| 616 | 13% | 587,417 |
| 622 | 10% | 91,198 |
| 538 | 6% | 49,229 |
| 632 | 6% | 35,682 |

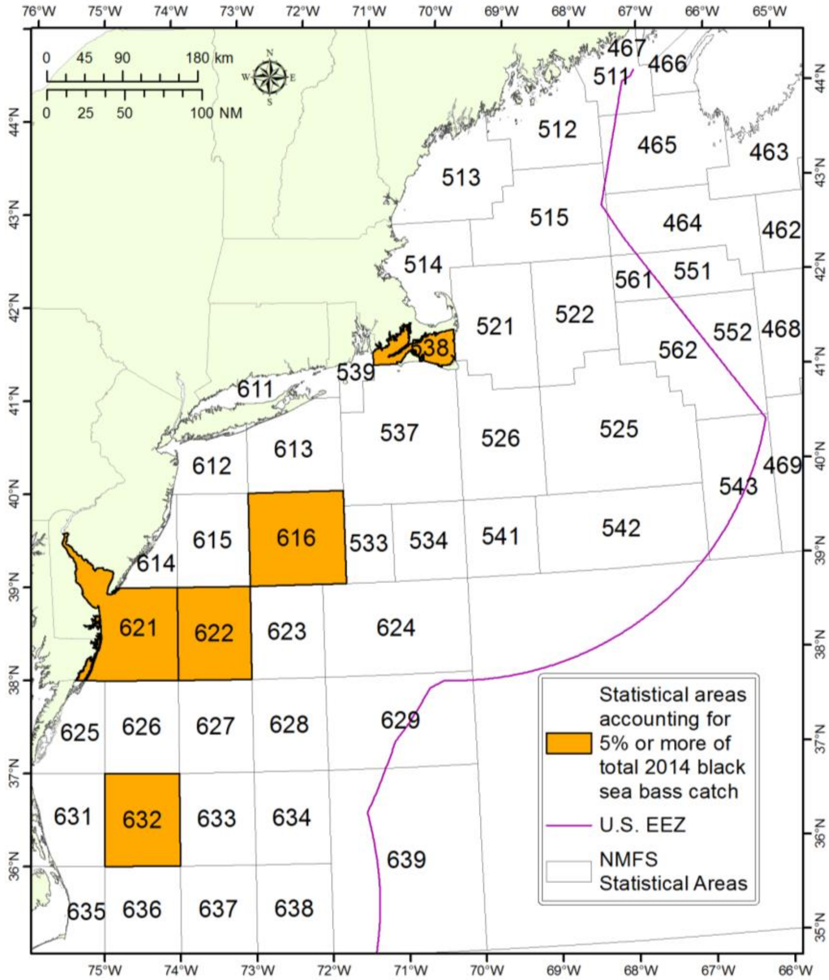



**Figure 4:** NMFS Statistical Areas, highlighting those that each accounted for more than 5% of the commercial black sea bass catch in 2014.[7]

Over the past two decades, total black sea bass ex-vessel value from Maine to North Carolina has ranged from a low of $3.69 million in 1994 (adjusted to real 2014 dollars to account for inflation) to a high of $9.64 million in 2006. Black sea bass reached its lowest average annual price per pound in 1996, at $1.14 ($1.83 in 2014 dollars). It reached its highest average annual price per pound in 2012, at $3.33 ($3.39 in 2014 dollars; Figure 5).[4]

In 2014, 2.38 million pounds of black sea bass were landed in the commercial fishery, generating $7.70 million in revenues at an average price of $3.24 per pound (Figure 5).[4]

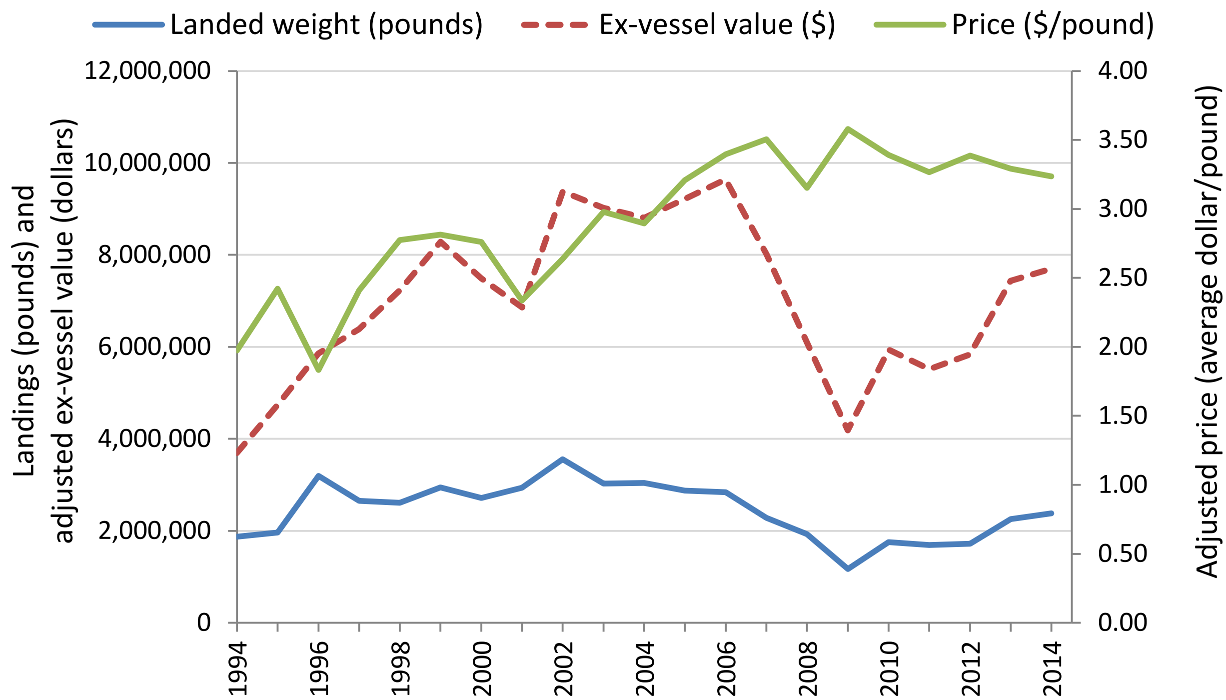



**Figure 5:** Landings, ex-vessel value, and price for black sea bass, from Maine through North Carolina, 1994-2014. Ex-vessel value and price are adjusted to real 2014 dollars.[4]

At least 100,000 pounds of black sea bass were landed in each of seven ports in six east coast states in 2014. These seven ports accounted for 52% of all commercial black sea bass landings in 2014 (table 4).[4] Detailed community profiles developed by the Northeast Fisheries Science Center's Social Science Branch can be found at www.mafmc.org/communities/.

**Table 3:** Ports reporting at least 100,000 lb of black sea bass landings in 2014, and corresponding percentage of total 2014 commercial scup landings. C = Confidential.[4]

| Port name | Pounds of black sea bass landed | % of total commercial black sea bass landed | Number of vessels landing black sea bass |
|---|---|---|---|
| Ocean City, MD | 230,099 | 10% | 15 |
| Cape May, NJ | 227,536 | 10% | 39 |
| Point Pleasant, NJ | 215,705 | 9% | 46 |
| Point Judith, RI | 195,168 | 8% | 139 |
| Chincoteague, VA | 131,678 | 6% | 19 |
| Montauk, NY | 127,041 | 5% | 94 |
| Indian River, DE | 102,722 | 4% | 3 |

Over 205 federally-permitted dealers from Maine through North Carolina bought black sea bass in 2014. More dealers bought black sea bass in New York than in any other state (Table 5). All dealers purchased approximately $7.7 million worth of black sea bass in 2014.[4]

**Table 4:** Dealers, by state, who reported buying black sea bass in 2014. C = confidential.[4]

| State | MA | RI | CT | NY | NJ | DE | MD | VA | NC |
|---|---|---|---|---|---|---|---|---|---|
| **Number of dealers** | 34 | 30 | 17 | 48 | 31 | C | 4 | 14 | 27 |

## 5. Recreational Black Sea Bass Measures and Fishery Performance

Black sea bass support a sizable recreational fishery in the Mid-Atlantic region. Most recreational black sea bass landings occur in state waters when the fish migrate inshore during the warm summer months.

The Council develops coast-wide regulations for the recreational black sea bass fishery in federal waters, including a minimum size, a possession limit, and open seasons (Table 6). The ASMFC and member states develop recreational black sea bass regulations in state waters (Table 7).

**Table 6:** Federal recreational measures for black sea bass, north of Cape Hatteras, NC, 2005 through 2015.

| Measure | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum size (inches, total length) | 12 | 12 | 12 | 12 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 | 12.5 |
| Possession limit | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 20 | 15 | 15 |
| Open season | 1/1-12/31 | 1/1-12/31 | 1/1-12/31 | 1/1-12/31 | 1/1-10/5 | 5/22-10/11 and 11/1-12/31 | 5/22-10/11 and 11/1-12/31 | 5/19-10/14 and 11/1-12/31 | 5/19-10/14 and 11/1-12/31 | 5/19-9/18 and 10/18-12/31 | 5/15-9/21 and 10/22-12/31 |

**Table 7:** Black sea bass recreational fishing measures in 2015, by state.

| State | Minimum Size (inches) | Possession Limit | Open Season |
|---|---|---|---|
| Maine | 13 | 10 fish | May 19 - September 18 |
| New Hampshire | 13 | 10 fish | January 1 - December 31 |
| Massachusetts | 14 | 8 fish | May 23 - August 27 |
| Rhode Island | 14 | 1 fish | July 2 - August 31 |
| | | 7 fish | September 1 - December 31 |
| Connecticut | 14 | 3 fish | June 1 - August 31 |
| | | 5 fish | September 1- December 31 |
| Connecticut authorized party/charter monitoring program vessels | 14 | 8 fish | June 21-December 31 |
| New York | 14 | 8 fish | July 15 - October 31 |
| | | 10 fish | November 1 - December 31 |
| New Jersey | 12.5 | 2 fish | July 1 - July 31 |
| | | 15 fish | May 27 - June 30; October 22- December 31 |
| Delaware | 12.5 | 15 fish | May 15 - September 21 and October 22 - December 31 |
| Maryland | 12.5 | 15 fish | May 15 - September 21 and October 22 - December 31 |
| Potomac River Fisheries Commission | 12.5 | 15 fish | May 15 - September 21 and October 22 - December 31 |
| Virginia | 12.5 | 15 fish | May 15 - September 21 and October 22 - December 31 |
| North Carolina (north of Cape Hatteras) | 12.5 | 15 fish | May 15 - September 21 and October 22 - December 31 |

Recreational data for years 2004 and later are available from the Marine Recreational Information Program (MRIP). For years prior to 2004, recreational data were generated by the Marine Recreational Fishery Statistics Survey (MRFSS). Recreational black sea bass catch and landings peaked in 1986 when an estimated 29.17 million fish were caught and 21.90 million fish were landed by recreational fishermen from Maine to North Carolina. Recreational catch reached a low of 5.30 million fish in 1981, and recreational landings were at their lowest in 2011, when 0.88 million fish were landed. In 2014, an estimated 3.78 million pounds of black sea bass were landed, corresponding to 167% of the 2014 recreational harvest limit (Table 8).[5]

For-hire vessels carrying passengers in federal waters must obtain a federal party/charter permit. In 2014, 763 party and charter boats held federal recreational black sea bass permits. Many of these vessels also hold recreational permits for summer flounder and scup.[6]

**Table 8:** Estimated recreational black sea bass catch and landings from 1981 through 2014 from Maine through North Carolina (includes all of North Carolina).[5]

| Year | Catch (thousands of fish) | Landings (thousands of fish) | Landings (thousands of pounds) |
|---|---|---|---|
| 1981 | 5,301 | 2,734 | 1,628 |
| 1982 | 11,615 | 10,249 | 10,054 |
| 1983 | 8,707 | 5,631 | 4,530 |
| 1984 | 4,330 | 2,491 | 1,961 |
| 1985 | 7,131 | 4,216 | 2,540 |
| 1986 | 29,167 | 21,904 | 12,461 |
| 1987 | 5,912 | 3,467 | 2,392 |
| 1988 | 9,363 | 4,060 | 3,945 |
| 1989 | 7,000 | 4,649 | 3,621 |
| 1990 | 9,622 | 4,269 | 3,047 |
| 1991 | 11,224 | 5,458 | 4,316 |
| 1992 | 8,296 | 3,869 | 2,914 |
| 1993 | 9,451 | 6,197 | 4,985 |
| 1994 | 7,688 | 3,571 | 3,054 |
| 1995 | 14,481 | 6,887 | 6,339 |
| 1996 | 8,437 | 3,764 | 4,125 |
| 1997 | 11,088 | 4,868 | 4,399 |
| 1998 | 5,699 | 1,259 | 1,290 |
| 1999 | 7,758 | 1,412 | 1,697 |
| 2000 | 17,667 | 3,755 | 4,122 |
| 2001 | 14,626 | 3,006 | 3,596 |
| 2002 | 15,080 | 3,421 | 4,442 |
| 2003 | 12,649 | 3,392 | 3,449 |
| 2004 | 8,884 | 1,925 | 2,340 |
| 2005 | 8,358 | 1,489 | 2,181 |
| 2006 | 8,729 | 1,392 | 1,911 |
| 2007 | 9,601 | 1,630 | 2,338 |
| 2008 | 11,102 | 1,342 | 2,092 |
| 2009 | 9,875 | 1,909 | 2,672 |
| 2010 | 11,133 | 2,335 | 3,361 |
| 2011 | 5,794 | 881 | 1,267 |
| 2012 | 14,553 | 1,946 | 3,305 |
| 2013 | 10,700 | 1,239 | 2,390 |
| 2014 | 12,109 | 2,200 | 3,783 |

In 2014, about 61% of black sea bass landed by recreational fishermen were caught in state waters, and about 39% in federal waters (Table 9). Landings by state indicate that the majority of black sea bass were landed in Massachusetts, Connecticut, New York, and New Jersey. These four states accounted for about 82% of all recreational landings from Maine to North Carolina in 2014 (Table 10).[5]

**Table 9:** Estimated percentage of black sea bass recreational landings (in numbers of fish) in state vs. federal waters, from Maine through North Carolina, 2005 through 2014.[5]

| Year | State waters | Federal waters |
|---|---|---|
| 2005 | 29.9% | 70.1% |
| 2006 | 34.9% | 65.1% |
| 2007 | 34.8% | 65.2% |
| 2008 | 60.3% | 39.7% |
| 2009 | 67.5% | 32.5% |
| 2010 | 72.1% | 27.9% |
| 2011 | 63.8% | 36.2% |
| 2012 | 72.6% | 27.4% |
| 2013 | 66.6% | 33.4% |
| 2014 | 60.9% | 39.1% |
| **2005-2014 average** | **56.3%** | **43.7%** |
| **2012-2014 average** | **66.7%** | **33.3%** |

**Table 10:** State-by-state contribution (as a percentage) to total recreational landings of black sea bass (in numbers of fish), Maine through North Carolina, in 2013 and 2014.[5]

| State | 2013 | 2014 |
|---|---|---|
| Maine | 0.0% | 0.0% |
| New Hampshire | 1.0% | 0.0% |
| Massachusetts | 20.4% | 19.4% |
| Rhode Island | 5.7% | 9.7% |
| Connecticut | 8.6% | 20.7% |
| New York | 27.5% | 18.8% |
| New Jersey | 26.9% | 22.9% |
| Delaware | 2.1% | 1.2% |
| Maryland | 2.1% | 3.1% |
| Virginia | 1.7% | 0.7% |
| North Carolina | 4.0% | 3.5% |

About 63% of recreational black sea bass landings in 2014 were caught by anglers fishing on private or rental boats, about 36% from anglers aboard party or charter boats, and about 1% from shore (Table 11).[5]

**Table 11:** The number of black sea bass landed (in thousands of fish) by recreational fishing mode, Maine through North Carolina, 1981-2014.[5]

| Year | Shore (thousands of fish) | Party/charter (thousands of fish) | Private/rental (thousands of fish) | Total (thousands of fish) |
|---|---|---|---|---|
| 1981 | 452 | 1,440 | 841 | 2,734 |
| 1982 | 81 | 8,104 | 2,063 | 10,249 |
| 1983 | 222 | 4,006 | 1,404 | 5,631 |
| 1984 | 98 | 1,128 | 1,265 | 2,491 |
| 1985 | 163 | 2,393 | 1,660 | 4,216 |
| 1986 | 1,022 | 16,695 | 4,187 | 21,904 |
| 1987 | 72 | 1,157 | 2,238 | 3,467 |
| 1988 | 141 | 1,691 | 2,228 | 4,060 |
| 1989 | 238 | 1,992 | 2,420 | 4,649 |
| 1990 | 289 | 2,269 | 1,710 | 4,269 |
| 1991 | 251 | 2,586 | 2,621 | 5,458 |
| 1992 | 45 | 2,043 | 1,780 | 3,869 |
| 1993 | 55 | 4,580 | 1,562 | 6,197 |
| 1994 | 243 | 2,006 | 1,322 | 3,571 |
| 1995 | 276 | 5,197 | 1,414 | 6,887 |
| 1996 | 71 | 2,632 | 1,062 | 3,764 |
| 1997 | 8 | 3,950 | 909 | 4,868 |
| 1998 | 7 | 778 | 474 | 1,259 |
| 1999 | 19 | 621 | 771 | 1,412 |
| 2000 | 177 | 1,798 | 1,780 | 3,755 |
| 2001 | 14 | 1,827 | 1,165 | 3,006 |
| 2002 | 17 | 2,066 | 1,338 | 3,421 |
| 2003 | 11 | 2,073 | 1,308 | 3,392 |
| 2004 | 9 | 698 | 1,217 | 1,925 |
| 2005 | 13 | 606 | 869 | 1,489 |
| 2006 | 49 | 731 | 613 | 1,392 |
| 2007 | 10 | 910 | 710 | 1,630 |
| 2008 | 9 | 480 | 853 | 1,342 |
| 2009 | 24 | 442 | 1,443 | 1,909 |
| 2010 | 6 | 520 | 1,809 | 2,335 |
| 2011 | 8 | 311 | 562 | 881 |
| 2012 | 6 | 702 | 1,238 | 1,946 |
| 2013 | 12 | 191 | 1,036 | 1,239 |
| 2014 | 20 | 794 | 1,386 | 2,200 |

## References

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[6] Unpublished NMFS permit data.

[7] Unpublished NMFS Vessel Trip Report (VTR) data.