Atlantic States Marine Fisheries Commission

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MEMORANDUM

January 29, 2019

To: **Summer Flounder, Scup, and Black Sea Bass Management Board**

From: **Summer Flounder, Scup, and Black Sea Bass Technical Committee**

RE: **2019 Scup Recreational Measures for Northern Region States**

List of Participants

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The following memo contains the Summer Flounder, Scup, and Black Sea Bass Technical Committee Review of analysis on proposed 2019 Scup recreational measures.

The Board and Council met in December of 2018 to establish the 2019 recreational management program for Scup. At this meeting, the Board moved to extend the ad hoc regional management through 2019. Based on preliminary, back-calibrated data through Wave 5 (September-October 2018), coastwide harvest was 5.61 million pounds, with harvest for the full year projected to be 5.66 million pounds. If the projected harvest holds, 2018 harvest would be 1.71 million pounds below the 2018 Recreational Harvest Limit (RHL) of 7.37 million pounds. In 2019, the RHL will remain at 7.37 million pounds and under status quo measures if harvest is consistent with 2018 results, harvest could increase by approximately 30% to achieve but not exceed the 2019 RHL. Given this information, the Board tasked the Technical Committee (TC) with evaluating the impact on projected 2019 coastwide harvest if the northern region states of Massachusetts through New York were to liberalize their measures, including by increasing the possession limit.

The TC met via conference call on January 29th to review analyses on scup recreational measures for only the states of Massachusetts through New York. For reference the 2018 recreational measures are included below in Table 1.

Table 1. 2018 State by state scup recreational measures. Cells are shaded to improve readability.

State	Minimum Size (inches)	Possession Limit	Open Season
Massachusetts (Private Mode)	9	30 fish; 150 fish/vessel with 5+ anglers on board	May 1-December 31
Massachusetts (For-Hire Only)	9	45 fish	May 1-June 30
		30 fish	July 1-December 31
Rhode Island (Private & Shore)	9	30 fish	May 1-December 31
RI Shore Program (7 designated shore sites)	8		
RI (Party/Charter)	9	30 fish	May 1-August 31; November 1-December 31
		45 fish	September 1-October 31
Connecticut	9	30 fish	May 1-December 31
CT Shore Program (46 designed shore sites)	8		
CT DEEP Registered Party/Charter	9	30 fish	May 1-August 31; November 1-December 31
		45 fish	September 1-October 31
New York	9	30 fish	May 1-December 31
NY (Anglers aboard Licensed Party/Charter Boats)	9	30 fish	May 1-August 31; November 1-December 31
		45 fish	September 1- October 31
New Jersey	9	50 fish	January 1- December 31
Delaware	8	50 fish	January 1-December 31
Maryland	8	50 fish	January 1-December 31
Virginia	8	30 fish	January 1-December 31
North Carolina, North of Cape Hatteras (N of 35° 15'N)	8	50 fish	January 1-December 31

The TC considered analyses focused on increasing the bag limit from 45 to 50 fish, lengthening the season, and extending the timeframe for when the largest bag limit would be implemented (i.e. the bonus season). The current scup RHL is based upon an assessment utilizing harvest estimates derived from the Coastal Household Telephone Survey (CHTS) (as opposed to the newer FES estimates) and these analyses were conducted utilizing CHTS-based MRIP data. Two types of analyses were used to evaluate proposed changes to the current regulations; 1) an additive approach and 2) a generalized additive modeling (GAM) approach. The additive approach assumes that every intercept hitting the current bag limit would catch more fish if regulations allowed, and adds fish to those intercepts to achieve the new proposed bag limit. MRIP weighted frequency distributions of catch per angler were manipulated to evaluate increases in the bag limit and non-compliant changes in the proposed measures. The potential increase in harvest under alternative regulations for each of the past three years was estimated. The GAM approach can synthetically account for effects across various management measures and allows for both linear and non-linear effects to be modeled for variables. The variables included in the model were year, region, state, wave, fishing mode, RHL, bag limit, season length (per wave), and minimum fish size. The predicted harvest for each regulatory option is compared to the predicted harvest from status quo measures to determine the expected change in harvest. Data for the GAM approach evaluated regulations for the last 11 years (2008-2018). More information can be found on both approaches in the documents following this memo.

Both analytical approaches evaluated the same scenarios for changes in regulations, with one additional scenario for the additive approach. The analysis from the additive approach included the following scenarios and results:

1) Increase the for-hire sector bag limit to 50 fish for the current bonus season (Wave 3 for MA and Wave 5 for RI-NY): **Results in a 0.27% increase in harvest (approximate 44,984 fish)**

2) Increase the bag limit to 50 fish for all fishing modes for the current bonus season: **Results in a 1.33% increase in harvest (approximate 220,428 fish)**

3) Increase the bag limit to 50 fish for all fishing modes and for the entire current fishing season (May 1-December 31): **Results in a 3.05% increase in harvest (approximate 504,103 fish)**

4) A Year Round Season (365 days) at 30 fish with a 45 fish possession limit during the current bonus season for the for-hire sector (Wave 3 for MA and Wave 5 for RI-NY): **Results in a 1.96% increase in harvest (approximate 324,740 fish)**

5) Maintain current May 1-December 31 season, but have a 50 fish bag limit in two bonus season waves for the for-hire sector (one in Wave 3 and one in Wave 5): **Results in a 0.54% increase in harvest (approximate 88,901 fish)**

6) Maintain current May 1-December 31 season, but have a 50 fish bag limit in a bonus season that extends across two waves for the for-hire sector (Waves 3-4 for MA; Waves 5-6 for RI-NY): **Results in a 0.39% increase in harvest (approximate 64,462 fish)**

7) Increase the for-hire bonus season to 50 fish and open Waves 1 and 2 for all modes under current bag limit of 30 fish: **Results in 2.23% increase in harvest (approximate 369,723 fish)**

The analysis from the GAM approach included the following scenarios and results:

1) Increase the for-hire sector bag limit to 50 fish for the current bonus season (Wave 3 for MA and Wave 5 for RI-NY): **Results in a virtually no change from status quo, increase of 0.4% (approximate 58,886 fish)**

2) Increase the bag limit to 50 fish for all fishing modes for the current bonus season: **Results in a 44% increase in harvest (approximate 5,937,494 fish)**

3) Increase the bag limit to 50 fish for all fishing modes and for the entire current fishing season (May 1-December 31) : **Results in an approximate 200% increase in harvest (approximate 26,561,197 fish)**

4) Open Wave 2 with a 30 fish possession limit with a 45 fish possession limit during the current bonus season for the for-hire sector (Wave 3 for MA and Wave 5 for RI-NY): **Results in a 3% increase in harvest (approximate 391,459 fish)**

5) Maintain current May 1-December 31 season, but have a 50 fish bag limit in two bonus season waves for the for-hire sector (one in Wave 3 and one in Wave 5): **Results in a 2% increase in harvest (approximate 225,458 fish)**

6) Maintain current May 1-December 31 season, but have a 50 fish bag limit in a bonus season that extends across two waves for the for-hire sector (Waves 3-4 for MA; Waves 5-6 for RI-NY): **Results in a 2% increase in harvest (approximate 202,888 fish)**

The TC compared both approaches and results, with specific focus on how results differed significantly for options 2 and 3. In considering the additive approach, the group agreed that it relies primarily on the empirical Marine Recreational Information Program (MRIP) data, which demonstrates that across fishing modes few for-hire trips and private anglers are achieving the bag limit. For the GAM approach, the model accounts for non-linear effects, with the results demonstrating that increasing the bag limit does not significantly impact harvest in scenarios where only the for-hire sector's measures are adjusted (bonus season duration). The GAM approach also allows for the inclusion of uncertainty in the estimates. Between the two modeling approaches, this finding was consistent: changing only the for-hire bag limit (from 45 to 50 fish) under different bonus season lengths would likely not result in a significant change to harvest in

2019. In comparing the results between the two approaches, there was a significant deviation for options 2 and 3, in which other fishing modes (private anglers by boat and shore based fishing) using the GAM approach showed a more significant increase in harvest (44% and 200% for options 2 and 3 respectively). The TC agreed that these differences are likely driven by uncertainty in the proposed change in regulations under the options; it is not clear how increasing the bag limit from 30 to 50 fish for the private mode will affect angler behavior and ultimately harvest. Additionally, it was noted that the change for the private and shore modes was much more significant (a 20 fish difference in the bag limit), while the change to the party and charter mode was more modest (a 5 fish difference).

Overall, the group appreciated the ability to evaluate the proposed scenarios using two separate analyses. In considering the results of the two approaches, the TC recommend that the Board only consider proposed options that extend the overall season, and adjust the bag limit (from 45 to 50 fish) and bonus season length (adding an additional two months/wave) for the for-hire sector (options 1,4-7) in setting 2019 recreational scup measures. In addition to the previously mentioned concerns about the uncertainty in the change in regulations for the private boat and shore modes, the TC continues to advise the Board that recreational measures should not be adjusted significantly year to year. The group deemed the proposed changes to the for-hire measures as not significant based on the analysis. The TC notes that significant changes to regulations year to year present challenges in evaluating and predicating the resulting impacts to harvest.

As previously noted, the RHL is based upon an assessment that uses CHTS-based estimates and the TC must use estimates in the same "currency" to evaluate the past year's performance and any proposed management changes. FES-based estimates are considered to be an improvement over the CHTS estimates, and using incorrect data to continue to manage a fishery is concerning to the TC. The harvest estimates generated by CHTS and FES differ in overall magnitude, and the difference varies by state, wave and mode. The TC advises caution when undertaking management decisions based upon CHTS data. However, the stock is robust, the RHL very large, and despite relatively relaxed measures harvest has not been close to the RHL in recent years.

Regarding a preferred methodology, while the group found many benefits in the GAM approach the TC recommended that for setting 2019 measures the additive approach should be used if new recreational measures are proposed by the northern region states following the Board Meeting. The TC hopes to move toward using the GAM approach in future years for evaluating and setting recreational measures for all three species in the FMP (scup, summer flounder, and black sea bass), and even suggests a workshop be considered later this year to educate the full group on this modeling approach.

Other Business

The TC briefly discussed 2019 black sea bass recreational measures. The TC reiterated their support for maintaining status quo measures for 2019. Beyond the previously noted concerns with using back-calibrated data to adjust recreational measures, as described in the TC memo dated January 28th, 2019, the TC also expressed concern that the recent government shutdown may delay the release of MRIP recreational harvest data for Wave 6. If harvest data are released later than usual (February 15th) this could create additional challenges if the states are instructed to adjust their regulations for 2019. Lastly, several TC members reemphasized the need to increase regulatory stability by considering the confidence intervals around the RHL and MRIP harvest estimates when setting recreational measures.

2019 Scup Recreational Regulation Analysis - Additive Model

John Maniscalco

In early January, additional scup options were proposed for the northern region states (MA-NY) that required analysis. Building off of the work that Tiffany Vidal (MA) submitted earlier, the 6 options were analyzed using an additive approach for changes to possession limits. It is basically assumed that any angler trip that resulted in a limit catch (30 fish or 45 fish during the For-hire bonus season) under current regulations would catch the newly proposed limit (50 fish). Pre-calibration MRIP intercept data and harvest estimates from 2015-2017 were used to analyze the impact of 7 options:

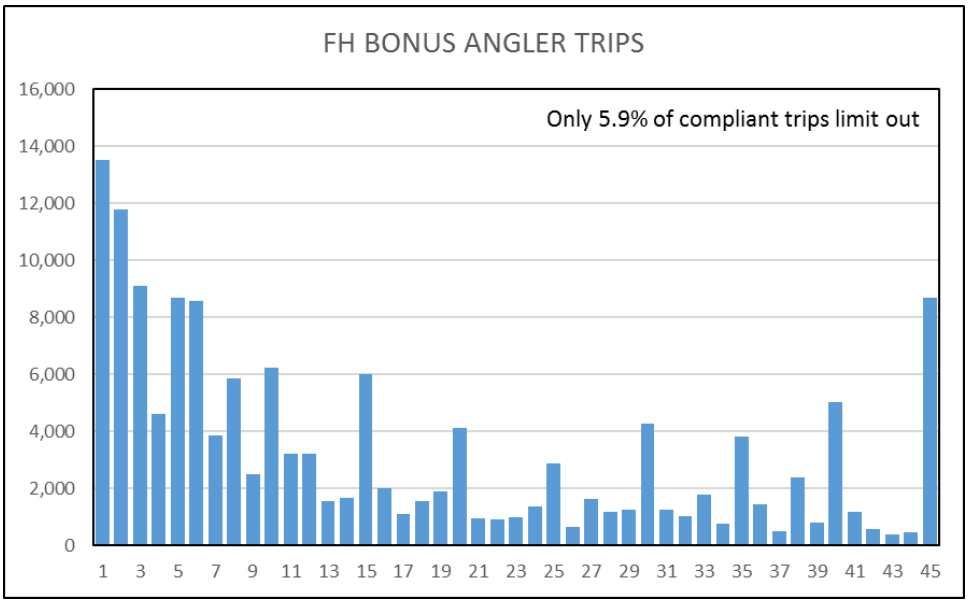
1. For-hire bonus 50 fish
2. Bonus 50 fish for all modes.
3. 50 fish for all modes for the entire season (May-December)
4. Open Waves 1 and 2 for all modes under current possession limit (30 fish)
5. For-hire bonus 50 fish in Waves 3 and 5
6. For-hire bonus 50 fish for 2 sequential Waves (3&4 or 5&6)
7. For-hire bonus 50 fish and open Waves 1 and 2 for all modes under current possession limit (30 fish)

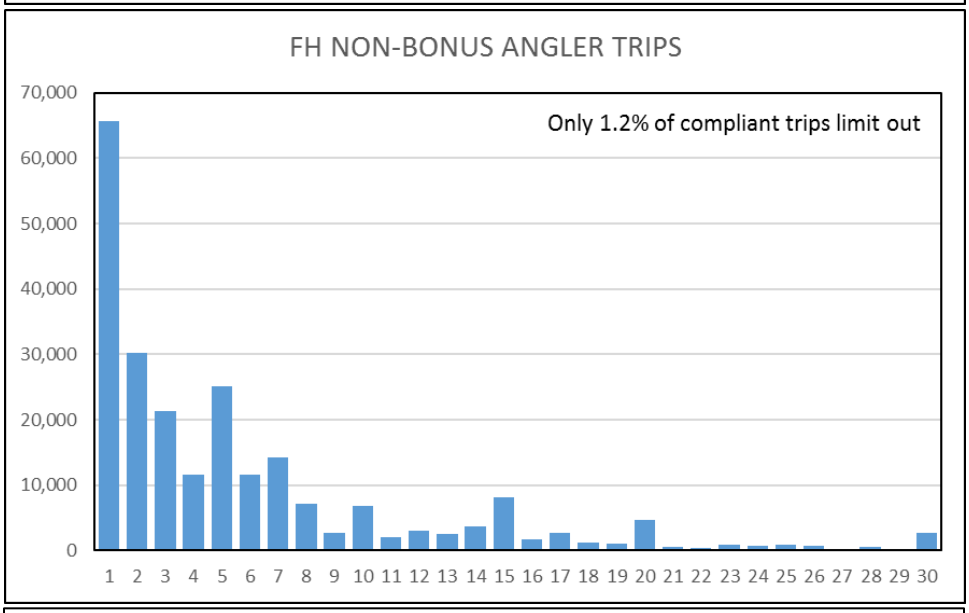
The R code and datasets provided by Tiffany Vidal were used to generate weighted frequency distributions of catch per angler by state, wave and mode; and treats the issue of grouped catch by dealing out fish like a deck of cards across anglers associated with a single leader. The frequency distributions of catch per angler were then manipulated in Excel to increase limit and non-compliant catches to the new proposed limits.

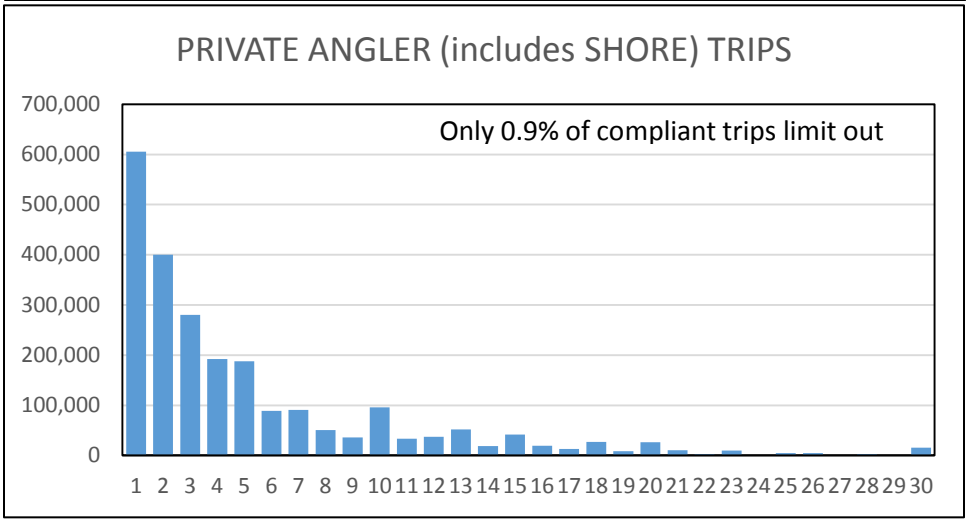
There were very few years with scup harvest or catch from the northern states during Wave 2 and there is no MRIP sampling during Wave 1 north of North Carolina. It was assumed that harvest in Waves 1 and 2 would be most similar to harvest in Wave 6. Harvest in Wave 6 accounted for 0.98% of scup harvested from 2015-2017. It is expected that using the harvest in Wave 6 over-estimates the harvest that would occur in Waves 1 and 2.

1. For-hire bonus 50 fish **+0.27% harvest (approximate increase of 44,984 fish)**
2. Bonus 50 fish for all modes **+1.33% harvest (approximate increase of 220,428 fish)**
3. 50 fish for all modes for the entire season (May-December) **+3.05% harvest (approximate increase of 504,103 fish)**
4. Open Waves 1 and 2 for all modes under current possession limit (30 fish) **+1.96% harvest (approximate increase of 324,740 fish)**
5. For-hire bonus 50 fish in Waves 3 and 5 **+0.54% harvest (approximate increase of 88,901 fish)**
6. For-hire bonus 50 fish for 2 sequential Waves (3&4 MA or 5&6 RI,CT and NY) **+0.39% harvest (approximate increase of 64,462 fish)**
7. For-hire bonus 50 fish and open Waves 1 and 2 for all modes under current possession limit (30 fish) **+2.23% harvest (approximate increase of 369,723 fish)**

Very few angler trips intercepted by samplers are at the current possession limit, resulting in only minor increases in harvest as a result of these proposed changes. The additive model, which assumes that all trips at the current limit would catch the new proposed limit, may also over-estimate increased harvest under these proposed measures. The additive model does not take into account any changes in angler behavior and effort.


FH BONUS ANGLER TRIPS
Only 5.9% of compliant trips limit out
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45


FH NON-BONUS ANGLER TRIPS
Only 1.2% of compliant trips limit out
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30


PRIVATE ANGLER (includes SHORE) TRIPS
Only 0.9% of compliant trips limit out
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

Options for Recreational Scup in 2019 for the Northern Region

RI DMF

January 25, 2019

Introduction

For 2019 the Northern Region (NR) states of Massachusetts, Rhode Island, Connecticut, and New York will be able to liberalize their recreational scup fishery by approximately 31%. Given the ability to liberalize, some options were analyzed that would better align the NR states with the fisheries in the southern portion of the range, as well as with the federal program. A new technique is introduced to analyze the effects of different management measures on the scup fishery in the NR. The technique is to use a Generalized Additive Model (GAM) to synthetically account for effects across various management measures rather than only doing so by analyzing different measures seperately and combining them. This technique is described in further detail below.

The goal of the options are to move the NR in to better alignment with the management occurring to the south by way of season length and bag limit. Given the good stock status of scup and the fact that the fishery has been underperforming in recent years, this seemed like an opportune time to test some new management options. While high bag limits are not ideal in recreational fisheries, given that the bag limits are already quite high in this fishery, this aspect of the options below is not believed to create any new risk factors for this fishery.

Data and Methods

Formula

GAMs were used to look at various options for the NR. The use of a GAM to model the effects of management measures on recreational landings allows for the inclusion of non-linear effects, which is certainly the case for the effect of minimum size, wave, and bag limit on harvest. Additionally, other potential controlling effects were added in to the modeling framework to account for other fishery elements that have an impact on harvest such as the recreational harvest limits, year effects, and the state the harvest is occurring in.

$$log(H) = \beta_0 + \beta_4(State) + \beta_1(Year) + \beta_2(Region) + \beta_5(Fishing.Mode) + \beta_3(RHL) + f_1(MinLen) + f_2(Wave) + f_3(Season) + f_4(Bag)$$

Where H is harvest in lbs, the β terms represent regression coefficients for the linear and categorical variables, and the f terms indicate smoothed functions to address nonlinear relationships between those predictors and the response variable. Year, region, state, and fishing mode are all treated as factors. These models were fit using the R package {mcgv}.

The MRIP data time series used for the GAMs spanned from 2007 - 2018 to have a longer time series and avoid spurious trends and relationships. These data were the aggregated MRIP data associated with harvest by year, state, wave, and mode. The fishing modes were combined into private and for-hire. Because harvest is highly skewed and should be constrained from going in to negative space, a logarithmic transformation was applied prior to model fitting. To evaluate the percentage increase in harvest associated with bag and seasonal changes, we predicted the harvest associated with the observed MRIP data, and then made predictions with the bag or season changes. The difference between these predictions was taken as the percent harvest increase for a new option versus status quo regulations.

There are a couple of important considerations. This analysis ignores the special shore sites, or at least does not model them explicitly. Additionally, in some cases the regulations change in the middle of waves. In these cases, the predominate bag for that wave was used. This was mainly an issue in 2010 and 2011. A final note is that there are still some issues with the regulation information used. This information should be vetted by the technical committee to make sure the dataset with regard to the state regulations is as accurate as possible as this is used in the analysis.

Options

There are six options that were considered:

1. increase the for-hire bag to 50 fish for the bonus season;
2. increase the bag to 50 fish for the bonus season only but for all modes;
3. increase the bag to 50 fish for all modes and for the entire season;
4. increase the season by opening Wave 2 under current bag limits;
5. increase the bag to 50 fish for waves 3 and 5 for the For Hire modes for all four states; and
6. add an additional wave to the bonus season and increase the bag to 50 fish.

Using the GAM model described above, these six options were tested and compared to each other by way of impacts to the Northern region fishery.

Results

Option 1 - increase the for-hire bag to 50 fish for the bonus season

This option looks at increasing the bag limit for just the for-hire mode to 50 fish during the bonus season. These are the state specific tables for this analysis.

Table 1 - Option 1 Massachusetts

State and Mode	Wave	Landings
MA P+C	Wave3	78762.611
MA P+C	Wave4	64192.171
MA P+C	Wave5	32291.115
MA P+C	Wave6	5361.282
MA Pr+S	Wave3	896149.250
MA Pr+S	Wave4	2132322.430
MA Pr+S	Wave5	1072639.669
MA Pr+S	Wave6	178089.985
Sum		4459808.513

Table 2 - Option 1 Rhode Island

State and Mode	Wave	Landings
RI P+C	Wave3	5667.903
RI P+C	Wave4	13486.365
RI P+C	Wave5	19806.442
RI P+C	Wave6	1126.371
RI Pr+S	Wave3	188275.234
RI Pr+S	Wave4	447987.325
RI Pr+S	Wave5	225354.744
RI Pr+S	Wave6	37415.568
Sum		939119.954

Table 3 - Option 1 Connecticut

State and Mode	Wave	Landings
CT P+C	Wave3	9828.242
CT P+C	Wave4	23385.591
CT P+C	Wave5	34344.714
CT P+C	Wave6	1953.147
CT Pr+S	Wave3	326472.523
CT Pr+S	Wave4	776817.794
CT Pr+S	Wave5	390769.036
CT Pr+S	Wave6	64879.245
Sum		1628450.292

Table 4 - Option 1 New york

State and Mode	Wave	Landings
NY P+C	Wave3	38991.065
NY P+C	Wave4	92776.423
NY P+C	Wave5	136253.971
NY P+C	Wave6	7748.618
NY Pr+S	Wave3	1295197.210
NY Pr+S	Wave4	3081828.237
NY Pr+S	Wave5	1550277.375
NY Pr+S	Wave6	257392.004
Sum		6460464.902

There is virtually no change from the status quo fishery for this option.

```
perc.diff.opt1  #Proportional change from status quo
```

```
## [1] 1.004385
```

```
SQ.Sum  #Status Quo total harvest in numbers of fish
```

```
## [1] 13428958
```

```
Opt1.Sum  #Total harvest in numbers of fish for this option
```

```
## [1] 13487844
```

Option 2 - increase the all modes to 50 fish for the bonus season

This option looks at increasing the bag limit for all modes to 50 fish during the bonus season. These are the state specific tables for this analysis.

Table 5 - Option 2 Massachusetts

State and Mode	Wave	Landings
MA P+C	Wave3	78762.611
MA P+C	Wave4	64192.171
MA P+C	Wave5	32291.115
MA P+C	Wave6	5361.282
MA Pr+S	Wave3	2616320.306
MA Pr+S	Wave4	2132322.430
MA Pr+S	Wave5	1072639.669
MA Pr+S	Wave6	178089.985
Sum		6179979.569

Table 6 - Option 2 Rhode Island

State and Mode	Wave	Landings
RI P+C	Wave3	5667.903
RI P+C	Wave4	13486.365
RI P+C	Wave5	19806.442
RI P+C	Wave6	1126.371
RI Pr+S	Wave3	188275.234
RI Pr+S	Wave4	447987.325
RI Pr+S	Wave5	657926.338
RI Pr+S	Wave6	37415.568
Sum		1371691.547

Table 7 - Option 2 Connecticut

State and Mode	Wave	Landings
CT P+C	Wave3	9828.242
CT P+C	Wave4	23385.591
CT P+C	Wave5	34344.714
CT P+C	Wave6	1953.147
CT Pr+S	Wave3	326472.523
CT Pr+S	Wave4	776817.794
CT Pr+S	Wave5	1140855.684
CT Pr+S	Wave6	64879.245
Sum		2378536.939

Table 8 - Option 2 New york

State and Mode	Wave	Landings
NY P+C	Wave3	38991.065
NY P+C	Wave4	92776.423
NY P+C	Wave5	136253.971
NY P+C	Wave6	7748.618
NY Pr+S	Wave3	1295197.210
NY Pr+S	Wave4	3081828.237
NY Pr+S	Wave5	4526056.546
NY Pr+S	Wave6	257392.004
Sum		9436244.073

There is a 44% increase in harvest from the status quo fishery for this option.

```
perc.diff.opt2  #Proportional change from status quo
```

```
## [1] 1.442141
```

```
Opt2.Sum  #Total harvest in numbers of fish for this option
```

```
## [1] 19366452
```

Option 3 - increase all modes to 50 fish for entire season

This option looks at increasing the bag limit for all modes to 50 fish during the entire season, and adds in wave 2 to the existing season. These are the state specific tables for this analysis.

Table 9 - Option 3 Massachusetts

State and Mode	Wave	Landings
MA P+C	Wave2	10925.27
MA P+C	Wave3	78762.61
MA P+C	Wave4	187409.95
MA P+C	Wave5	94274.36
MA P+C	Wave6	15652.34
MA Pr+S	Wave2	362913.43
MA Pr+S	Wave3	2616320.31
MA Pr+S	Wave4	6225345.25
MA Pr+S	Wave5	3131586.56
MA Pr+S	Wave6	519936.21
Sum		13243126.29

Table 10 - Option 3 Rhode Island

State and Mode	Wave	Landings
RI P+C	Wave2	2295.330
RI P+C	Wave3	16547.522
RI P+C	Wave4	39373.633
RI P+C	Wave5	19806.442
RI P+C	Wave6	3288.457
RI Pr+S	Wave2	76245.795
RI Pr+S	Wave3	549672.188
RI Pr+S	Wave4	1307905.281
RI Pr+S	Wave5	657926.338
RI Pr+S	Wave6	109235.277
Sum		2782296.261

Table 11 - Option 3 Connecticut

State and Mode	Wave	Landings
CT P+C	Wave2	3980.142
CT P+C	Wave3	28693.689
CT P+C	Wave4	68274.562
CT P+C	Wave5	34344.714
CT P+C	Wave6	5702.241
CT Pr+S	Wave2	132211.531
CT Pr+S	Wave3	953141.110
CT Pr+S	Wave4	2267930.447
CT Pr+S	Wave5	1140855.684
CT Pr+S	Wave6	189415.865
Sum		4824549.985

Table 12 - Option 3 New york

State and Mode	Wave	Landings
NY P+C	Wave2	15790.21
NY P+C	Wave3	113834.96
NY P+C	Wave4	270862.07
NY P+C	Wave5	136253.97
NY P+C	Wave6	22622.20
NY Pr+S	Wave2	524515.83
NY Pr+S	Wave3	3781346.43
NY Pr+S	Wave4	8997440.77
NY Pr+S	Wave5	4526056.55
NY Pr+S	Wave6	751459.57
Sum		19140182.54

There is almost a 200% increase in harvest for this option.

```
perc.diff.opt3  #Proportional change from status quo
```

```
## [1] 2.977905
```

```
Opt3.Sum  #Total harvest in numbers of fish for this option
```

```
## [1] 39990155
```

Option 4 - increase the season by opening Wave 2 under current bag limits

This option looks at increasing the season by adding in an open wave 2, but keeping the rest of the regulations the same as current. These are the state specific tables for this analysis.

Table 13 - Option 4 Massachusetts

State and Mode	Wave	Landings
MA P+C	Wave2	8535.143
MA P+C	Wave3	61531.664
MA P+C	Wave4	64192.171
MA P+C	Wave5	32291.115
MA P+C	Wave6	5361.282
MA Pr+S	Wave2	124306.111
MA Pr+S	Wave3	896149.250
MA Pr+S	Wave4	2132322.430
MA Pr+S	Wave5	1072639.669
MA Pr+S	Wave6	178089.985
Sum		4575418.819

Table 14 - Option 4 Rhode Island

State and Mode	Wave	Landings
RI P+C	Wave2	786.2027
RI P+C	Wave3	5667.9027
RI P+C	Wave4	13486.3653
RI P+C	Wave5	15473.3739
RI P+C	Wave6	1126.3712
RI Pr+S	Wave2	26115.9200
RI Pr+S	Wave3	188275.2345
RI Pr+S	Wave4	447987.3253
RI Pr+S	Wave5	225354.7444
RI Pr+S	Wave6	37415.5684
Sum		961689.0085

Table 15 - Option 4 Connecticut

State and Mode	Wave	Landings
CT P+C	Wave2	1363.289
CT P+C	Wave3	9828.242
CT P+C	Wave4	23385.591
CT P+C	Wave5	26831.099
CT P+C	Wave6	1953.147
CT Pr+S	Wave2	45285.458
CT Pr+S	Wave3	326472.523
CT Pr+S	Wave4	776817.794
CT Pr+S	Wave5	390769.036
CT Pr+S	Wave6	64879.245
Sum		1667585.424

Table 16 - Option 4 New york

State and Mode	Wave	Landings
NY P+C	Wave2	5408.505
NY P+C	Wave3	38991.065
NY P+C	Wave4	92776.423
NY P+C	Wave5	106445.602
NY P+C	Wave6	7748.618
NY Pr+S	Wave2	179658.609
NY Pr+S	Wave3	1295197.210
NY Pr+S	Wave4	3081828.237
NY Pr+S	Wave5	1550277.375
NY Pr+S	Wave6	257392.004
Sum		6615723.648

There is a 3% increase in harvest for this option.

```
perc.diff.opt4  #Proportional change from status quo
```

```
## [1] 1.02915
```

```
Opt4.Sum  #Total harvest in numbers of fish for this option
```

```
## [1] 13820417
```

Option 5 - increase the bag to 50 fish for waves 3 and 5 for the For Hire modes for all four states

This option looks at increasing the bag limit to 50 during the bonus season and adding a second wave in to the bonus season. The open waves will be waves 3 to align with MA and wave 5 to align with RI - NY. These are the state specific tables for this analysis.

Table 17 - Option 5 Massachusetts

State and Mode	Wave	Landings
MA P+C	Wave3	78762.611
MA P+C	Wave4	64192.171
MA P+C	Wave5	94274.364
MA P+C	Wave6	5361.282
MA Pr+S	Wave3	896149.250
MA Pr+S	Wave4	2132322.430
MA Pr+S	Wave5	1072639.669
MA Pr+S	Wave6	178089.985
Sum		4521791.762

Table 18 - Option 5 Rhode Island

State and Mode	Wave	Landings
RI P+C	Wave3	16547.522
RI P+C	Wave4	13486.365
RI P+C	Wave5	19806.442
RI P+C	Wave6	1126.371
RI Pr+S	Wave3	188275.234
RI Pr+S	Wave4	447987.325
RI Pr+S	Wave5	225354.744
RI Pr+S	Wave6	37415.568
Sum		949999.573

Table 19 - Option 5 Connecticut

State and Mode	Wave	Landings
CT P+C	Wave3	28693.689
CT P+C	Wave4	23385.591
CT P+C	Wave5	34344.714
CT P+C	Wave6	1953.147
CT Pr+S	Wave3	326472.523
CT Pr+S	Wave4	776817.794
CT Pr+S	Wave5	390769.036
CT Pr+S	Wave6	64879.245
Sum		1647315.740

Table 20 - Option 5 New york

State and Mode	Wave	Landings
NY P+C	Wave3	113834.960
NY P+C	Wave4	92776.423
NY P+C	Wave5	136253.971
NY P+C	Wave6	7748.618
NY Pr+S	Wave3	1295197.210
NY Pr+S	Wave4	3081828.237
NY Pr+S	Wave5	1550277.375
NY Pr+S	Wave6	257392.004
Sum		6535308.797

There is a 2% increase in harvest for this option.

```
perc.diff.opt5  #Proportional change from status quo
```

```
## [1] 1.016789
```

```
Opt5.Sum  #Total harvest in numbers of fish for this option
```

```
## [1] 13654416
```

Option 6 - add an additional wave to the bonus season and increase the bag to 50 fish

This option looks at increasing the bag limit to 50 during the bonus season and adding a second wave in to the bonus season that is contiguous with the existing bonus season wave. The open waves will be waves 3 and 4 for MA and waves 5 and 6 for RI - NY. These are the state specific tables for this analysis.

Table 21 - Option 6 Massachusetts

State and Mode	Wave	Landings
MA P+C	Wave3	78762.611
MA P+C	Wave4	187409.945
MA P+C	Wave5	32291.115
MA P+C	Wave6	5361.282
MA Pr+S	Wave3	896149.250
MA Pr+S	Wave4	2132322.430
MA Pr+S	Wave5	1072639.669
MA Pr+S	Wave6	178089.985
Sum		4583026.286

Table 22 - Option 6 Rhode Island

State and Mode	Wave	Landings
RI P+C	Wave3	5667.903
RI P+C	Wave4	13486.365
RI P+C	Wave5	19806.442
RI P+C	Wave6	3288.457
RI Pr+S	Wave3	188275.234
RI Pr+S	Wave4	447987.325
RI Pr+S	Wave5	225354.744
RI Pr+S	Wave6	37415.568
Sum		941282.039

Table 23 - Option 6 Connecticut

State and Mode	Wave	Landings
CT P+C	Wave3	9828.242
CT P+C	Wave4	23385.591
CT P+C	Wave5	34344.714
CT P+C	Wave6	5702.241
CT Pr+S	Wave3	326472.523
CT Pr+S	Wave4	776817.794
CT Pr+S	Wave5	390769.036
CT Pr+S	Wave6	64879.245
Sum		1632199.385

Table 24 - Option 6 New york

State and Mode	Wave	Landings
NY P+C	Wave3	38991.06
NY P+C	Wave4	92776.42
NY P+C	Wave5	136253.97
NY P+C	Wave6	22622.20
NY Pr+S	Wave3	1295197.21
NY Pr+S	Wave4	3081828.24
NY Pr+S	Wave5	1550277.38
NY Pr+S	Wave6	257392.00
Sum		6475338.48

There is a 2% increase in harvest for this option.

```
perc.diff.opt6  #Proportional change from status quo
```

```
## [1] 1.015108
```

```
Opt6.Sum  #Total harvest in numbers of fish for this option
```

```
## [1] 13631846
```

Conclusion

From this analysis we see that all of the options with the exception of options 2 and 3 would be well under the allowed liberalization for 2019. In general the model performs fairly well, and the model effects produce results that make logical sense (Figure 1). The model is able to reproduce the harvest for 2017 fairly closely, and predicts well for the states of CT and NY. The model tends to overpredict the state of MA harvest and underpredicts the state of RI, but when looking at the overall harvest for the NR, the model seems to work well.

Figure

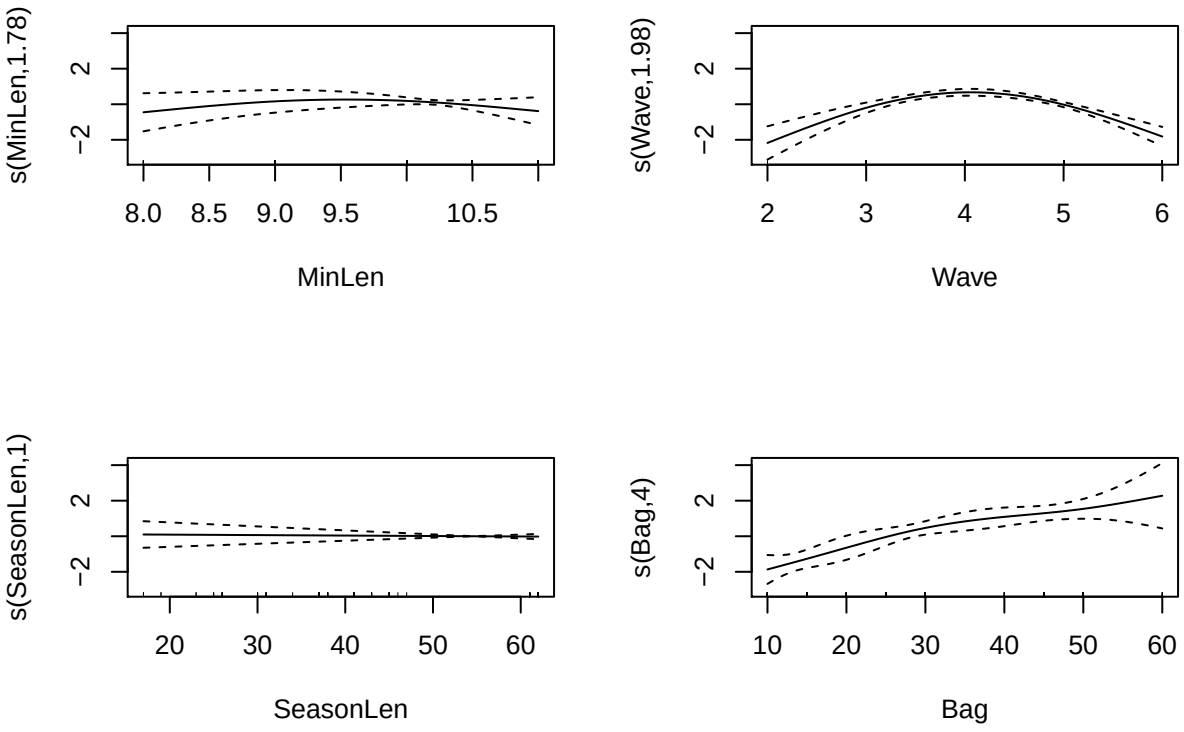


Figure 1 - Model output for the GAM smoothed parameters.

Model Summary Table

Table 25 - GAM model summary

A. parametric coefficients	Estimate	Std. Error	t-value	p-value
(Intercept)	8.4450	0.6605	12.7858	< 0.0001
factor(State)B.MA	-0.3683	0.2735	-1.3467	0.1789
factor(State)C.CT	-1.3781	0.2863	-4.8128	< 0.0001
factor(State)D.RI	-1.9285	0.2772	-6.9562	< 0.0001
factor(State)E.NJ	-1.1061	0.1925	-5.7462	< 0.0001
factor(State)F.VA	-0.2885	0.3729	-0.7737	0.4396
factor(State)G.MD	-1.6486	0.4521	-3.6468	0.0003
factor(State)H.DE	-2.1443	0.3728	-5.7511	< 0.0001
factor(State)I.NC	-1.2755	0.3124	-4.0825	0.0001
factor(Year)2008	2.9651	0.7485	3.9615	0.0001
factor(Year)2009	2.8340	0.7189	3.9421	0.0001
factor(Year)2010	2.7309	0.7576	3.6045	0.0004
factor(Year)2011	1.4299	0.6893	2.0745	0.0387
factor(Year)2012	-0.6195	0.4343	-1.4265	0.1545
factor(Year)2013	-0.9247	0.2864	-3.2289	0.0014
factor(Year)2014	-0.8691	0.3072	-2.8294	0.0049
factor(Year)2015	-1.0947	0.3069	-3.5666	0.0004
factor(Year)2016	-0.7661	0.3289	-2.3293	0.0204
factor(Year)2017	-0.5398	0.3555	-1.5185	0.1297
factor(Year)2018	-0.9769	0.3810	-2.5641	0.0107
factor(Region)2	-1.1061	0.1925	-5.7462	< 0.0001
factor(Region)3	-5.3570	0.3012	-17.7867	< 0.0001
factor(Fishing.Mode)2	3.5031	0.1896	18.4803	< 0.0001
RHL	0.3056	0.0848	3.6039	0.0004
B. smooth terms	edf	Ref.df	F-value	p-value
s(MinLen)	1.7828	1.9528	2.0327	0.1470
s(Wave)	1.9784	1.9995	25.0035	< 0.0001
s(SeasonLen)	1.0000	1.0000	0.0688	0.7933
s(Bag)	4.0000	4.0000	13.7266	< 0.0001