# MEMORANDUM

**July 30, 2013**

**TO:** **South Atlantic State/Federal Fisheries Management Board**

**FROM:** **Kirby Rootes-Murdy, FMP Coordinator**

**RE:** **Traffic Light Method Analysis Report for the Atlantic Croaker Fishery**

This memorandum serves as a report on the use of the traffic light approach the South Atlantic State/Federal Management Board requested the Atlantic Croaker Technical Committee (TC) develop during the 2012 August Board meeting. As noted by the TC in the Annual Assessment Update of the Atlantic Croaker Triggers (2013), this methodology is useful in providing a more comprehensive view of trends in the Croaker fishery. The TC requests to use this methodology in conjunction with the current triggers mandated in Amendment 1 to the Interstate Fishery Management Plan for Atlantic Croaker.

## A Comparison of Fuzzy Traffic Light Models for assessment use in the Atlantic Croaker Fishery.

Under the current 70% trigger scheme outlined in Amendment 1 of the Interstate Fishery Management Plan for Atlantic Croaker, the high degree of variability in year to year index values results in rapid changes that make it difficult to respond to the trigger indices beyond a general review by the TC or PRT because of the effort involved. In relatively short lived species like Atlantic croaker (and other sciaenidae such as spot) it is not always necessary to respond to rapid annual changes in management index triggers but rather to persistent periodic declines that occur over several years. Declines that might occur over several years require close monitoring in order to anticipate when management action may be required. With this in mind, a management response scheme which uses techniques that illustrate multi-year changes and trends would be more useful than simply examining year to year changes against the previous year or 2 years. Knowing the level at which to respond or initiate some type of management action should be based on long term knowledge of general stock levels as well as how that stock has changed over time. The traffic light model offers the ability to illustrate changing trends based on relevant stock parameters based on historical abundance, life history parameters, and response to fishing pressure by using assessment based reference points.

This section of the analysis directly compares the current hard trigger indices from Amendment 1 section 3.2 (Commercial and Recreational Harvest) as well as 4 fishery independent indices using a 70% threshold of the previous 2-year index average with a Traffic Light analysis (TLA) of these same indices. The Traffic Light analysis will be broken into two separate models:

1. Strict Traffic Light Analysis (STLA)
2. Fuzzy Traffic Light Analysis (FTLA)

The fishery independent indexes used for the comparison were the following:

1. NEFSC Fall Groundfish trawl survey (NMFS)
2. VIMS Juvenile fish and blue crab survey
3. NCDMF Program 195 Survey
4. SEAMAP trawl survey of the south Atlantic coast

All changes using the 70% threshold of the previous 2-year index average for the hard triggers and the fishery independent surveys are highlighted in Table 1. Both traffic light models used the 1996-2008 time period to set reference boundaries for color transition zones. This time period was chosen because it encompassed known population changes that were documented in the 2010 stock assessment (ASMFC, 2010) where reference estimates of population characteristics (SSB, $F_{msy}$, M) were available. Additionally, setting population mean over a longer time period allows inclusion of documented increases and declines in the population.

cc: Spot Plan Review Team

M13-63

**Table 1**. Percent change from previous 2-year average for current trigger indices for Atlantic Croaker: Pink highlighted cells indicate years where trigger was tripped for that particular index. Only Harvest indices are hard triggers. The four independent indices are included for comparison.

| Year | Percent Change by Index from the Previous 2-Yr Average | | | | | |
|---|---|---|---|---|---|---|
| | MRIP Harvest | Comm Harvest | VIMS Spring | NCDMF 120.00 | SEAMAP Fall | NMFS Fall |
| 1972 | | | | | | |
| 1973 | | | | | | |
| 1974 | | | | | | 331.91 |
| 1975 | | | | | | 381.37 |
| 1976 | | | | | | 287.93 |
| 1977 | | | | | | 78.08 |
| 1978 | | | | | | 52.41 |
| 1979 | | | | | | 9.77 |
| 1980 | | | | | | 22.27 |
| 1981 | | | | | | 818.30 |
| 1982 | | | | | | 48.58 |
| 1983 | | | | | | 85.41 |
| 1984 | 218.20 | 110.15 | | | | 789.97 |
| 1985 | 79.55 | 125.02 | | | | 82.59 |
| 1986 | 196.90 | 114.81 | | | | 69.65 |
| 1987 | 81.60 | 92.01 | | | | 128.38 |
| 1988 | 113.37 | 91.25 | | 71.74 | | 9.05 |
| 1989 | 62.74 | 76.51 | | 138.51 | | 226.94 |
| 1990 | 48.91 | 65.52 | 84.87 | 352.57 | | 104.16 |
| 1991 | 124.49 | 52.16 | 276.50 | 110.54 | | 2.49 |
| 1992 | 123.21 | 87.55 | 16.10 | 21.20 | 26.82 | 58.48 |
| 1993 | 116.60 | 223.92 | 46.28 | 263.68 | 129.52 | 34.32 |
| 1994 | 172.50 | 163.91 | 10.46 | 65.38 | 127.26 | 5457.99 |
| 1995 | 101.65 | 141.07 | 53.27 | 52.26 | 30.46 | 30.70 |
| 1996 | 92.27 | 168.62 | 2.09 | 40.61 | 52.16 | 52.78 |
| 1997 | 191.52 | 155.16 | 6272.00 | 347.32 | 44.98 | 49.73 |
| 1998 | 133.43 | 105.75 | 38.69 | 309.63 | 125.14 | 120.02 |
| 1999 | 93.43 | 102.20 | 12.73 | 137.05 | 502.84 | 580.21 |
| 2000 | 127.25 | 102.57 | 13.27 | 23.45 | 37.82 | 97.57 |
| 2001 | 130.30 | 107.09 | 50.30 | 24.57 | 24.57 | 9.62 |
| 2002 | 88.15 | 94.06 | 562.75 | 54.94 | 269.93 | 74.99 |
| 2003 | 91.07 | 104.39 | 19.67 | 180.40 | 237.29 | 302.18 |
| 2004 | 105.06 | 93.27 | 101.88 | 358.93 | 131.68 | 220.24 |
| 2005 | 109.24 | 90.74 | 103.44 | 73.05 | 161.50 | 84.13 |
| 2006 | 97.43 | 83.26 | 267.51 | 38.51 | 61.60 | 102.66 |
| 2007 | 73.97 | 87.82 | 104.42 | 63.00 | 51.25 | 356.64 |
| 2008 | 74.33 | 92.81 | 354.65 | 249.17 | 112.94 | 16.02 |
| 2009 | 90.36 | 81.14 | 59.30 | 38.61 | 81.94 | 114.89 |
| 2010 | 75.36 | 92.73 | 151.93 | 624.37 | 196.87 | 62.78 |
| 2011 | 51.52 | 73.15 | 22.54 | 14.21 | 42.62 | 110.34 |
| 2012 | 75.93 | 81.29 | 317.14 | 180.35 | 276.35 | 159.98 |

**Pink highlighted cells indicate when 70% trigger level (of previous 2Yr average) was met.

## Commercial Harvest

The commercial harvest index was only examined as far back as 1984 since the recreational index only went back to 1982 and the first year where a comparison could be made to the previous 2-year average would have been 1984. However, commercial landings are available back to 1951.

The 70% trigger was tripped in 1990-1991 (Table 1). In comparison, the STLA model would have triggered a red flag from 1983 through 1995 based on the 1996-2008 reference time frame for the yellow/green and yellow/red boundaries (Fig. 1). The FTLA model showed steady decline with the increasing proportion of red from 1982-1992 indicating that the same decline as the STLA model. The years where the index shows some improvement (1997-2003), there is still a relatively high proportion of yellow. The increasing proportion of green in 1997-2003 supports the positive trend in commercial harvest. However, the FTLA does show the beginning of the recent decline beginning in 2004 where the proportion of green decreases until getting back into the yellow/red zone in 2006. All of the trends shown in stock changes, while reflected in both STLA and FTLA, appear to be more detailed and better reflected in the fuzzy model. The FTLA was more sensitive to changes than the 70% trigger because it takes the longer time frame into consideration for the long term mean. It must also be noted that the commercial landings were primarily driven by harvest in only a few states (VA, NC, MD) compared to the recreational harvest.

## Recreational Harvest

The 70% trigger was tripped in 1989-1990 and 2011. In comparison, the STLA model indicated red in 1982-1985, 1987-1996, and 2010-2012 (Fig. 2). Green years in the STLA model coincided with peak years in the recreational harvest index. The FTLA model showed declining red with the first indication of green proportions showing up in 1997. In recent years, the STLA model stayed green in 2000-2006 while the fuzzy model began to show the declining trend via the decreasing proportion of green as harvest decreased in 2006, even though it remained above the long term mean. The FTLA model has red showing up 3 years earlier than the STLA model indicating the beginning of the recent declining trend. The boundaries and trends in the FTLA model held with both the entire time series mean as well as the 1996-2012 mean and boundary values.

**Figure 1.** Strict and Fuzzy traffic light models for commercial Atlantic croaker harvest using 1996-2008 long term mean for reference points.

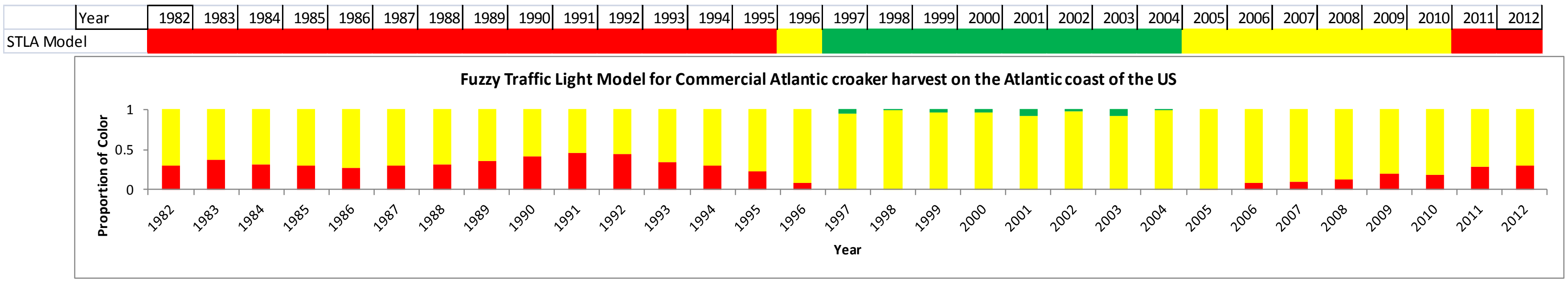
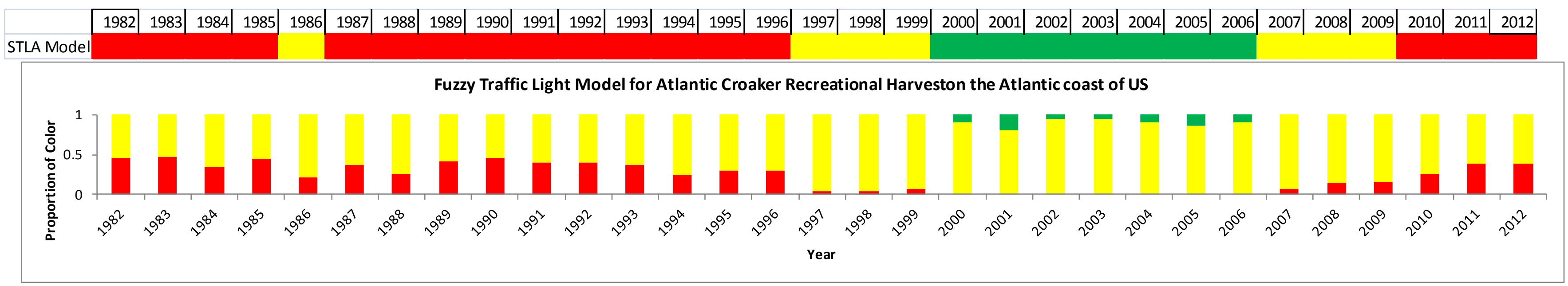



**Figure 2**. Strict and Fuzzy traffic light models for recreational Atlantic croaker harvest using 1996-2008 long term mean for reference points.



**VIMS Spring Surveys**

The VIMS survey was conducted in Chesapeake Bay and the rivers in Virginia (Fig. 3). This was a juvenile survey and shows a high degree of year to year variability which likely reflects variable recruitment and year-class strength. Both the STLA and FTLA models reflect extended periods of low abundance (1988, 1994-1996, 1999-2005, and 2011) and some periods of highly elevated catches (1997, 2008, 2010, and 2012). Under the 70% threshold scheme, the index triggered in the same years, except in 2010 where only the 70% threshold triggered (Table 1), but the FTLA did not. The FTLA and the STLA models showed the changes in index values earlier as well as covering the overlapping time periods of the 70% threshold scheme. This was true even in years where the STLA model was green while the greater proportion of the FTLA model was yellow rather than green (1998). The FTLA model generally showed greater sensitivity to changes than either the 70% threshold model or the STLA. There was a greater degree of transition between red and green in the STLA compared to the FTLA which likely reflects that these indexes were being influenced by changes in annual recruitment and year-class strength increasing year to year variability compared to some of the other trigger indexes that sampled adult Atlantic croaker.

**NCDMF- Program 195**

The 70% threshold scheme was tripped in 11 out of 26 years (Table 1) indicating a high degree of variability in catch effort. The STLA model showed red for 14 of the 26 years with the red years in the STLA model and the 70% threshold scheme overlapping in all but 3 years (1987-1989) (Fig. 4). The STLA model showed greater sensitivity with critical levels generally reached earlier than with the 70% threshold scheme.

The FTLA model was, again, more sensitive with the degree of change from year to year being reflected in the changing proportions of colors. This was particularly true in years where the STLA model showed green and the FTLA model would have some proportion of green but a much greater proportion of yellow. There were only a few years where the proportion on green was greater than that of yellow (1998-1999, 2010, 2012).

**Figure 3.** VIMS juvenile fish and blue crab survey.

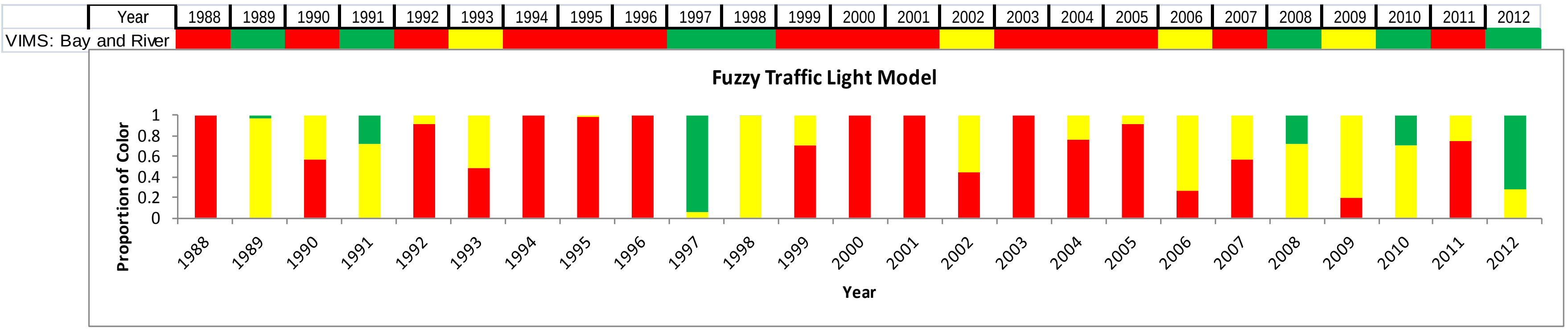
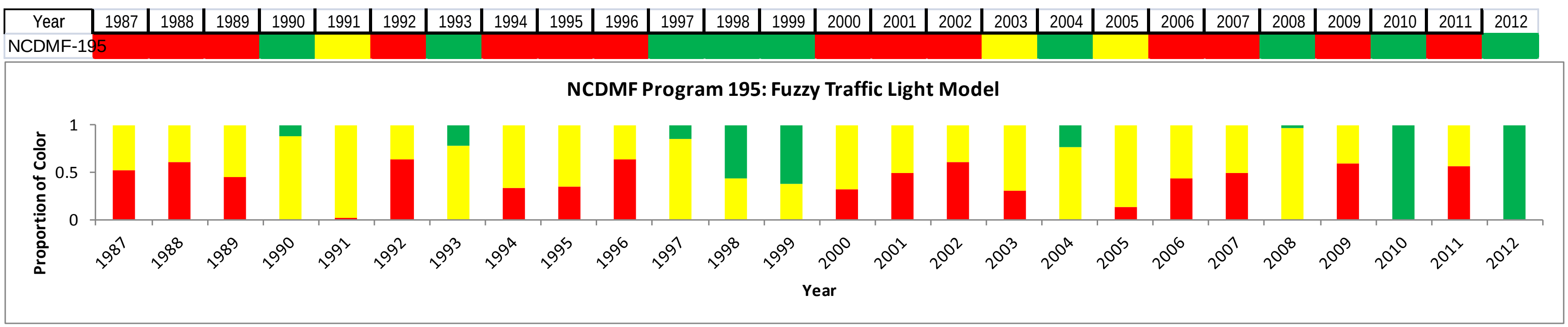



**Figure 4.** NCDMF Program 195 survey



## SEAMAP Fall Trawl Survey

For the SEAMAP survey, the 70% threshold was tripped in 9 out of 20 years: 1992, 1995-1997, 2000-2001, 2006-2007, and 2011 (Table 1). The STLA model agreed with 7 of the 9 years where the 70% threshold had tripped by coming out red (1992, 1995-1997, 2000-2001, 2011) (Fig. 5). The FTLA model generally showed the trends better with a general decline beginning from 1994-2001, with the exception of one year (1999) in that time period. Even in the years ranked green by the STLA model, the FTLA model generally showed higher proportions of yellow indicating the early declining trends, except in 2005 which was the second highest CPUE in the index. The most recent year (2012) was the highest year in the entire index for CPUE.

## NEFSC (NMFS) Fall Ground-Fish Survey

The NMFS fall ground-fish survey was the longest time series (1972-2012) and had two different trends in the overall abundance index. From 1972 to 1993 the range of annual CPUE values was relatively narrow, while the most recent years (1994-2012) have shown an approximate 80% increase in mean annual CPUE and a much higher degree of year to year variability (Fig. 6). During the early time period (1972-1993) the CPUE was well below the lower threshold for both the the long term mean for the data series as well as the 1996-2008 time period, which represented the yellow/red boundary. During the second time period (1994-2012) the mean CPUE increased approximately 80% with 7 years above the series long term mean and 7 years below.

Under the 70% threshold scheme, the entire index has tripped 15 out of 41 years, with 9 of those events occurring in the 1972-1993 time period. In recent years, the threshold was tripped 6 times from 1994-2012 and 4 times in the 1996-2008 reference time period. The overall increase in the index in the last 20 years has resulted in fewer instances where the 70% threshold could be tripped unless there was a single year where a drastic reduction in CPUE occurred.

The STLA model (Fig. 7) had all years prior to 1998 in the red (with the exception of 1994 and 1996), and the FTLA model had relatively high proportions of red for all of these years. This was due to the increase in the long term mean from the increased catch levels which occurred in the reference time period, although, this same pattern occurs using the entire time series as the reference time period as well. The FTLA model was more sensitive to changes with downward or upward shifts occurring earlier than they did in the STLA model.

**Figure 5.** Strict and Fuzzy Traffic Light models for SEAMAP trawl survey for Atlantic croaker.

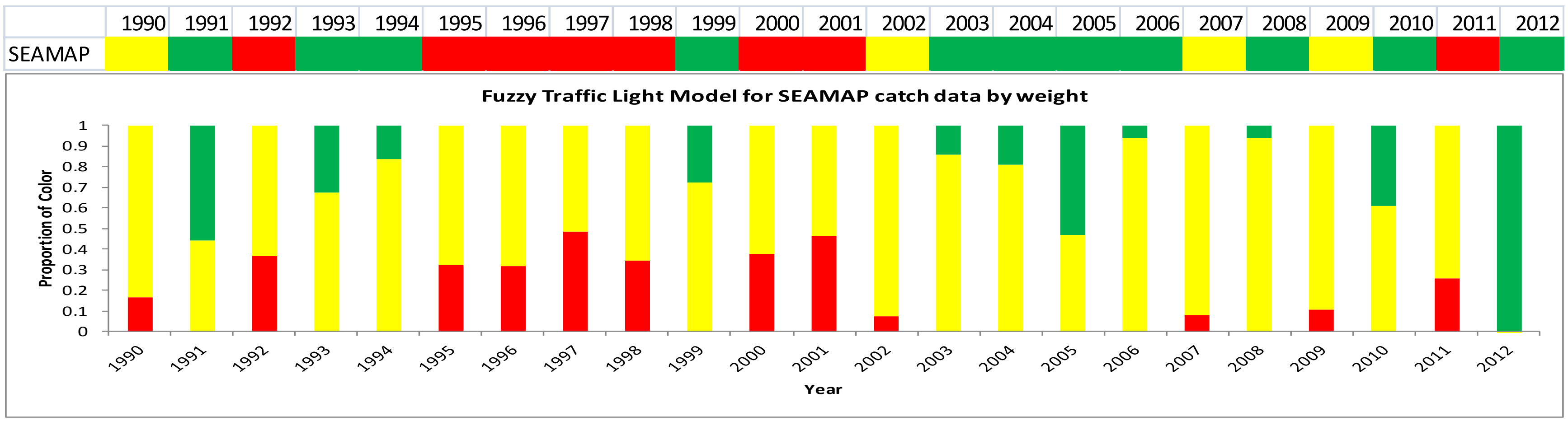



**Figure 6**. Mean annual stratified CPUE for NEFSC Fall Ground-fish survey with strict traffic light designations using 1996-2008 for boundary reference points (dotted lines).

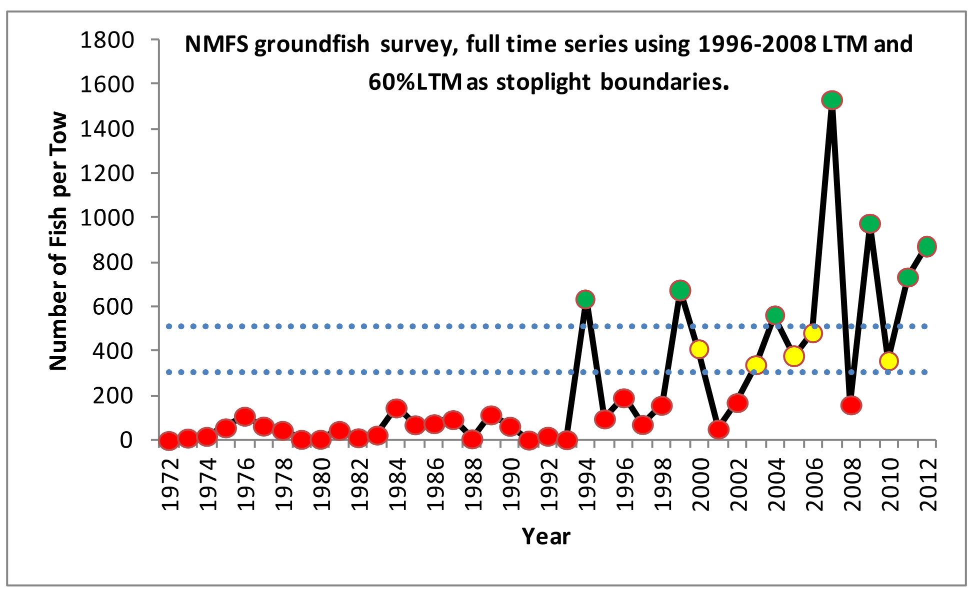
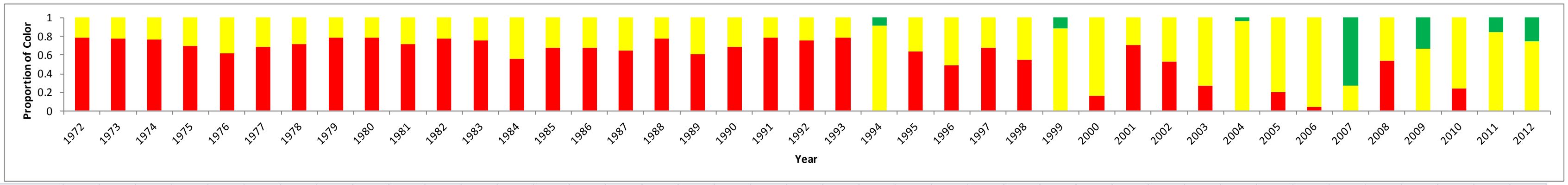


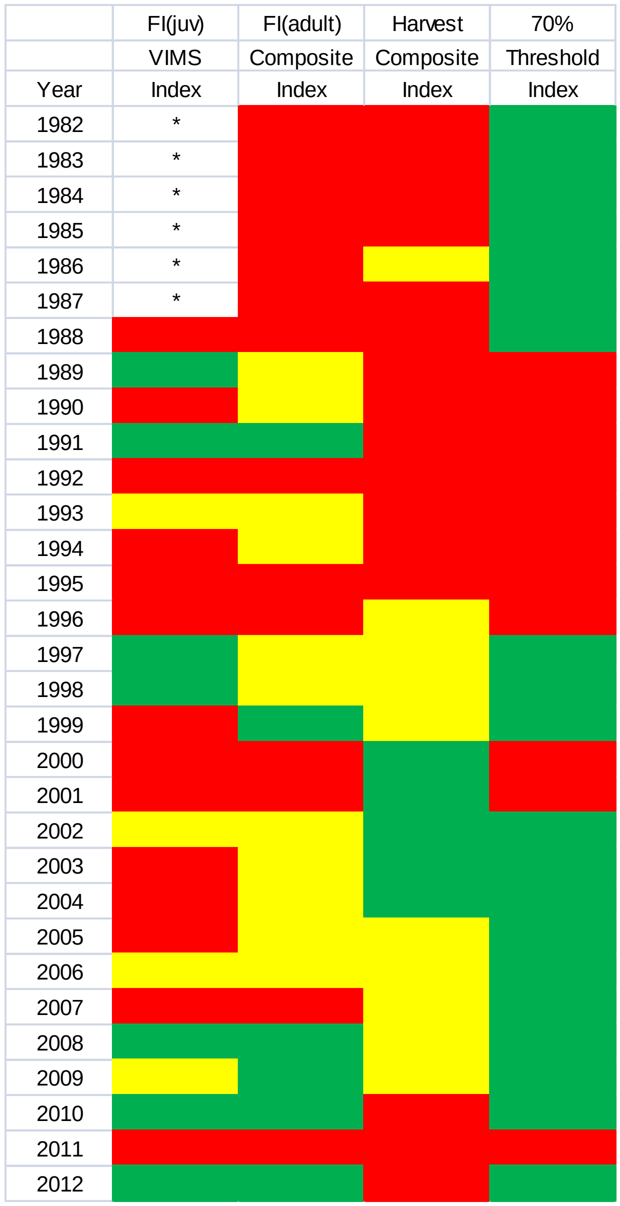
**Figure 7.** Strict and Fuzzy Traffic Light models for NEFSC Fall Ground-Fish trawl survey using 1996-2008 as the color reference boundaries for setting reference points.




| Strict Model | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NMFS: 1972-2012 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

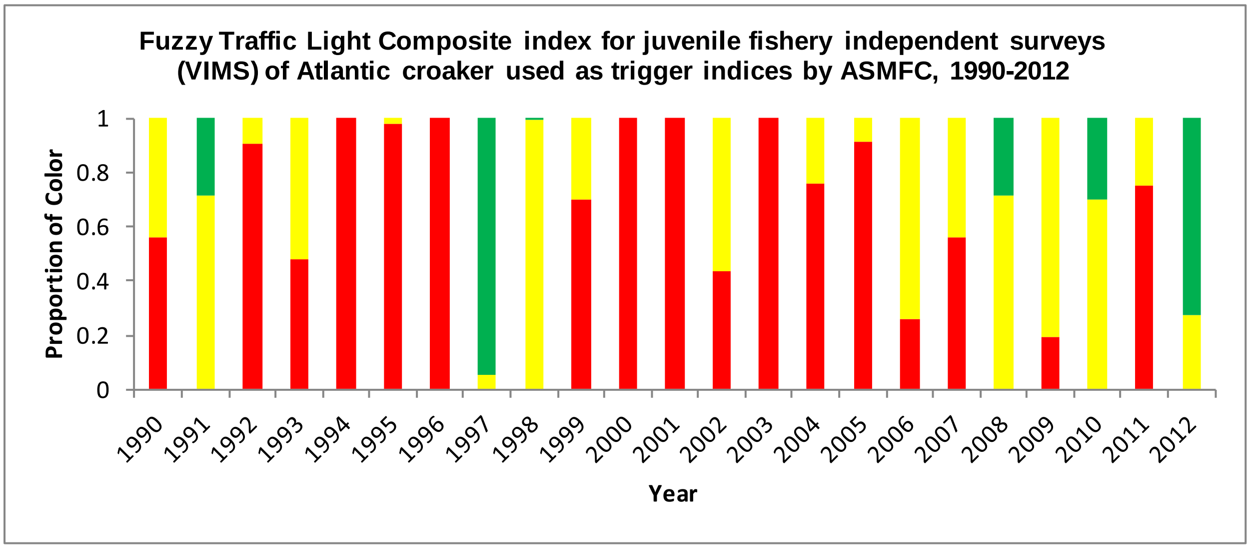
Given the changes in catch levels that occurred after 1994, the use of the entire time series means to set boundary reference points would not be prudent because of the level of low catches which occurred in the first 20 years of the data series, relative to catch levels in the second 20 years of the time series. Additionally, increased year to year variability in catch levels since 1994 makes the use of the 70% threshold problematic since catch levels can shift by this amount annually and could be the result of stochastic and system perturbations as opposed to fishing pressure. The NEFSC survey data set is a good example of why it is important to pick representative time periods for setting reference points and color boundaries for the traffic light method that relate to the current time period as well as documented population trends from the most recent stock assessment.

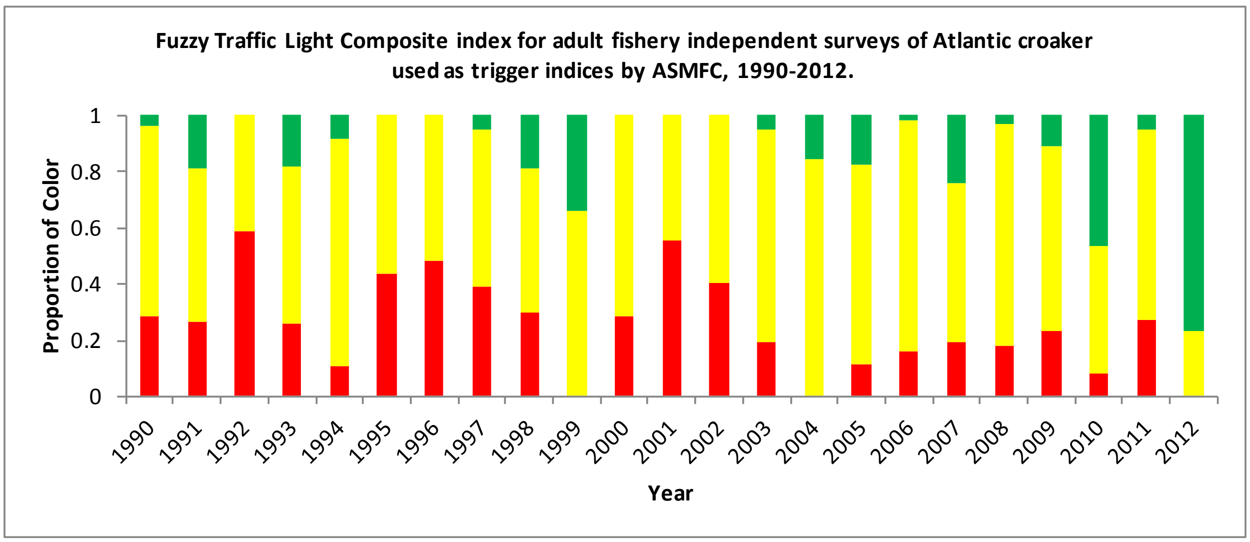
**Figure 8.** Composite Strict Traffic Light Models for fishery independent abundance trigger surveys (divided between juvenile surveys (VIMS, NCDMF) and adult surveys (NEFSC, SEAMAP,)), fishery dependent "hard" harvest triggers, and the 70% threshold index. Red in the 70% threshold index indicates year where it would have tripped either the fishery dependent harvest triggers or more than two fishery independent indices.

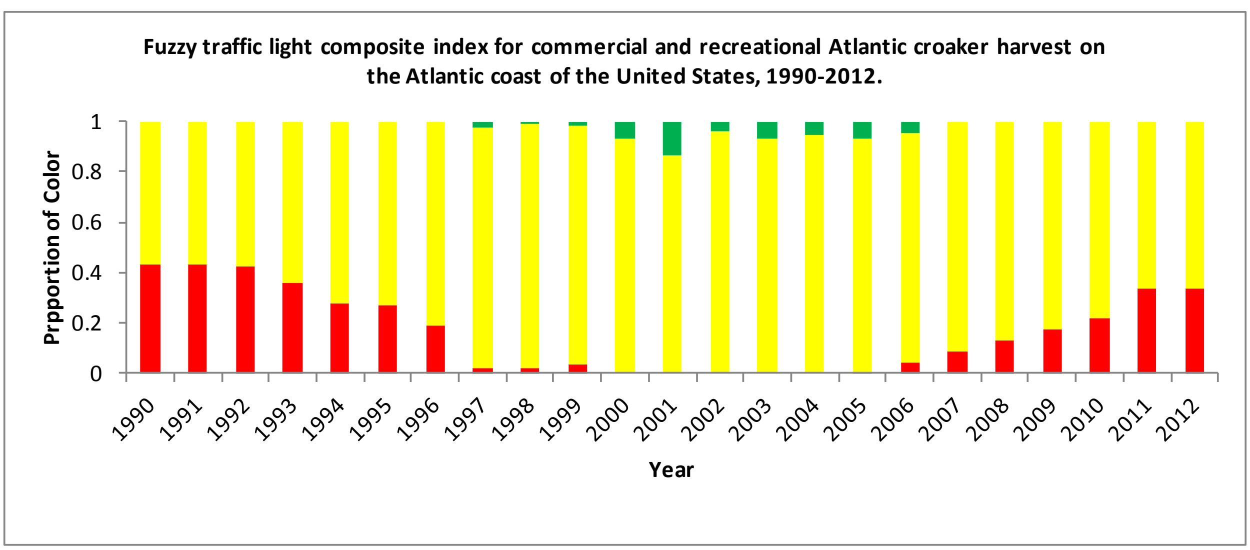



There were only three years (1992, 1995, and 2011) where the 70% trigger and the composite indices were tripped. The STLA composite models tripped red in 6 years (1982-1985, 1987-1988). The STLA model showed greater sensitivity to changes than the 70% trigger index.

**Figure 9.** Fuzzy Traffic Light composite models for fishery independent abundance indexes for adult (NEFSC, , SEAMAP) and juvenile (VIMS and NCDMF) Atlantic croaker and Fishery Dependent harvest indexes (commercial and recreational harvest) using a 1996-2008 reference time period.



## Summary

One important thing to note on the composite models is that since each indicator is additive within a given characteristic (abundance, harvest, etc) all three colors can occur within a given year for any particular composite characteristic. The abundance characteristic was separated into adult and juvenile models because of the differences in distribution and life history stage as well as year to year variability. All of the composite FTLA models were run using the 1990-2012 time period which was when all of the indicator component indices were available.

The juvenile FTLA showed much greater variability with rapid shifts between red and green and not as high a proportion of yellow (indicating rapid transition) in most years. This should be somewhat expected given the high degree of variability in juvenile recruitment indices in most fishery independent surveys. The green years would be those years with strong recruitment and (likely) subsequent strong year classes. Strong recruitment years included 1991, 1997, 2008, 2010, and 2012. 1997 appears to be a particularly strong year-class. The FTLA juvenile index's higher proportion of red during the 1993-1996 and 1999-2005 time periods would indicate periods of poor recruitment but should not be used to draw conclusions on trends in the adult population.

The adult FTLA composite model had higher proportions of green occurring at approximately 5-6 year intervals (1993, 1996, 2001, 2005) through the mid 2000's. After 2005, the years with higher proportions of green occurred in shorter intervals of approximately every 2 years (2005, 2007, 2010, 2012). Declining trends showed this cyclical pattern for similar time periods (1990-1992, 1994-1998, 2000-2003) but after 2006 the relative proportion of red remains at a similar level, except in 2012 where there is no red due to the high proportion of green in the index that year. The long term trend in the FTLA beginning in 2003 is an overall increasing trend in the all of the threshold indices.

The composite FTLA model for harvest (commercial and recreational harvest combined) showed peak harvests occurring from 1997-2006. While harvest was in the red from 1990-1996, the increase in general harvest levels that occurred from 1997-2006 still had relatively high proportions of yellow compared to green which indicated that while harvest was up, it was still largely in the transition (yellow) zone. While this is apparent in the FTLA it was not apparent in the STLA or the 70% threshold index. In the most recent years (2006-2012), harvest has declined, indicated by the increasing proportion of red in the FTLA harvest index. The years with highest proportions of green in the harvest composite FTLA (2000-2003) coincided with decreasing abundance in the FTLA composite model during those years, which suggests that there is either a lag between peak abundance years and general harvest levels or that the two are not directly comparable. The harvest FTLA levels might be affected by additional fishery related factors that would not influence the fishery independent FTLA composite model. It must also be noted that while recreational harvest occurred all along the Atlantic coast, the majority of the commercial harvest occurred in only two states (VA, NC), which may also be a contributing factor.

# Atlantic States Marine Fisheries Commission

1050 N. Highland Street • Suite 200A-N • Arlington, VA 22201
703.842.0740 • 703.842.0741 (fax) • www.asmfc.org


## MEMORANDUM

**July 30, 2013**

**TO:** **South Atlantic State/Federal Fisheries Management Board**

**FROM:** **Kirby Rootes-Murdy, FMP Coordinator**

**RE:** **Spot Management Triggers Update for 2012 Fishing year**

The Spot Plan Review Team (PRT) met three times over May, June, and July 2013 via conference call to review the Spot Management Triggers, as included in the Omnibus Amendment, for the 2012 fishing year. Although the Commercial and Recreational Landings both fell below the 10$^{th}$ percentile, the management trigger was **not tripped**, as none of the fishery-independent indices fell below the 10$^{th}$ percentile. However, the commercial landings for Spot has dipped below the 10$^{th}$ percentile five of the past eight years, and the recreational landings have dipped below the 10$^{th}$ percentile twice in the past 3 years. These values continue an overall decreasing trend in commercial and recreational landings over the past decade.

The Spot Plan Review Team remains concerned about the trend seen in the commercial and recreational landings data. Similar to the Atlantic Croaker management triggers, the PRT feels the current Spot triggers do not fully reflect the trends in the fishery and would like to have the traffic light approach -recently used in analyzing the Atlantic Croaker fishery- incorporated into the trigger exercises. To aid in better highlighting trends not captured by the triggers, the PRT would like to show the board other metrics such as changes in average length, comparative citations between Virginia and North Carolina. While the group is unsure of what else to include in the trigger exercises outside of what has been listed, there is enough concern that **guidance from the board is needed**, especially with regards to reactive changes in landings in trigger data that may cause a classification a trigger being 'tripped' in hindsight & vice-versa. The PRT finds this of high importance as there are no current management measures set up for the Board to take based on the results of the trigger exercises.

M13-065