ASMFC
Red Drum Benchmark Assessment
Review Workshop: Traffic Light Analysis

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8/14/24

Introduction

- The traffic light analysis (TLA) was first developed for data-limited fisheries (Caddy 1998, Caddy 1999, Caddy et al. 2005, Caddy and Mahon 1995)

- Can provide an information basis for management decisions not constrained by a model-based framework

- Uses traffic light colors to represent the state of a fishery based on appropriate indicators (i.e., an index or time-series of relevant data)

- TLA was explored in the 2022 Red Drum Simulation Assessment
  - Suitable for status determination
  - Outperform the age-structured models in characterizing recruitment condition
  - Could serve as a supplemental method for other assessment approaches
  - Could potentially be used for interim assessments
  - RW recommendation to revise threshold optimization

TLA Approach

- TLA uses reference points to assess status
  - Target- desirable outcomes where a stock status objective has been achieved
  - Limit or **threshold** - unacceptable outcomes such as an indicator value moving from yellow to red
- Reference points are appropriate metrics which:
  - Indicate when stock status moves from fully acceptable to unacceptable
  - Have a buffer zone between the two to provide warning of proximity to unacceptable conditions
- Two common approaches:
  - Strict traffic light -hard boundaries based on reference points to assign a color and uses a binary logic model
  - "Fuzzy" traffic light- fuzzy logic model where the transitional color (yellow) is based on the proportion of adjacent color the indicator is trending towards (e.g., yellow/red or yellow/green)

Fuzzy TLA
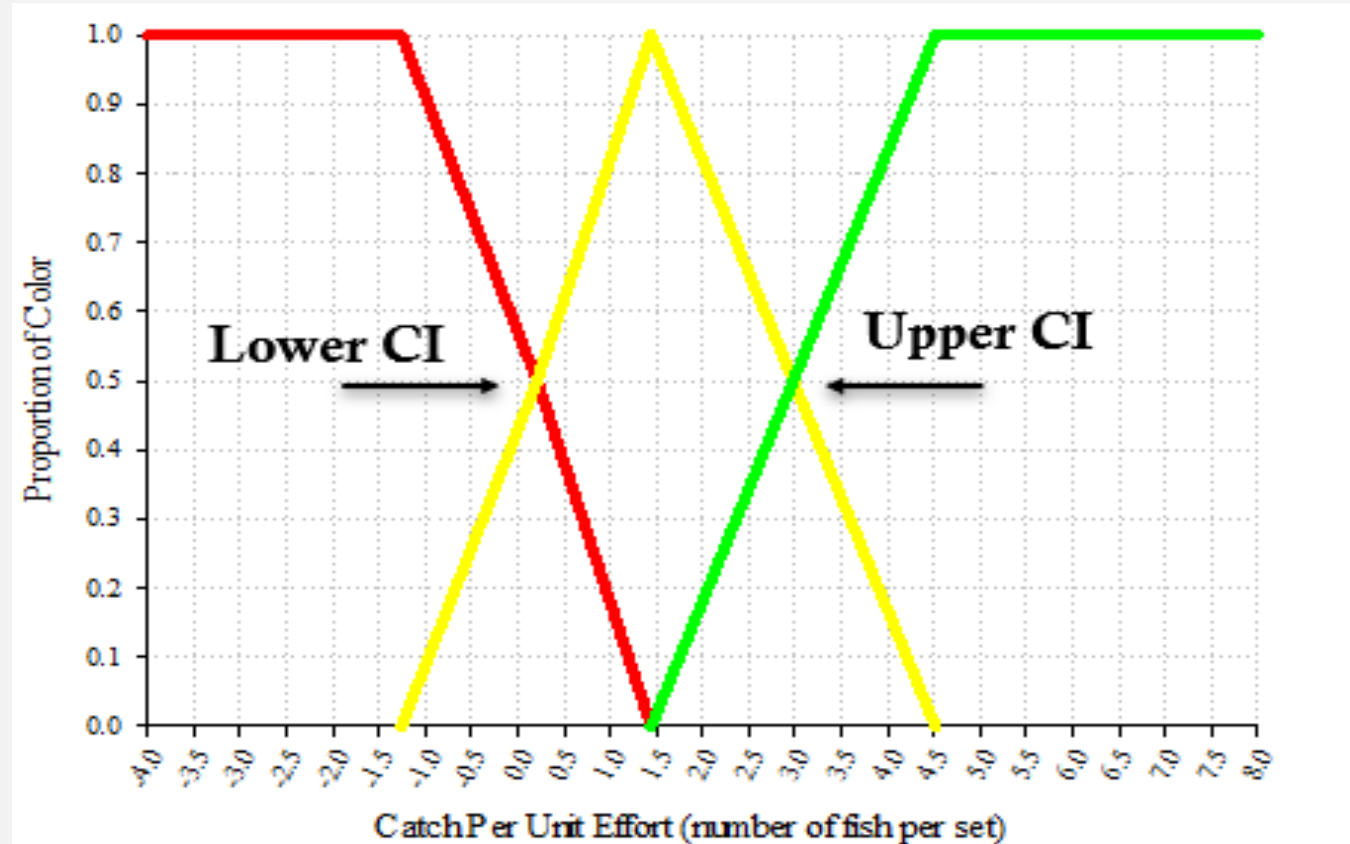
Intersection of red and yellow lines occurs at the lower 95% confidence interval and the intersection of yellow and green lines occurs at the upper 95% confidence interval. Figure adapted from ASMFC (2020).

Fuzzy TLA

- Fuzzy method incorporated by setting the expected value of an indicator to a relative proportion of 1 for yellow and 0 for red and green
  - Expected values calculated as the geometric mean of indicator values during the reference period
- Intersection of the color lines at 0.5 relative proportion corresponds to the 95% confidence intervals derived from the threshold values
  - Confidence intervals based on the expected value and standard deviation from the indicator values during the reference period
- Relative proportion of 1 for red and green and 0 for yellow were set to 2 times the confidence intervals
- Corresponding linear regression equations calculated to determine the slope and intercept coefficients used to determine a proportion of red, yellow, and green for each value of an index
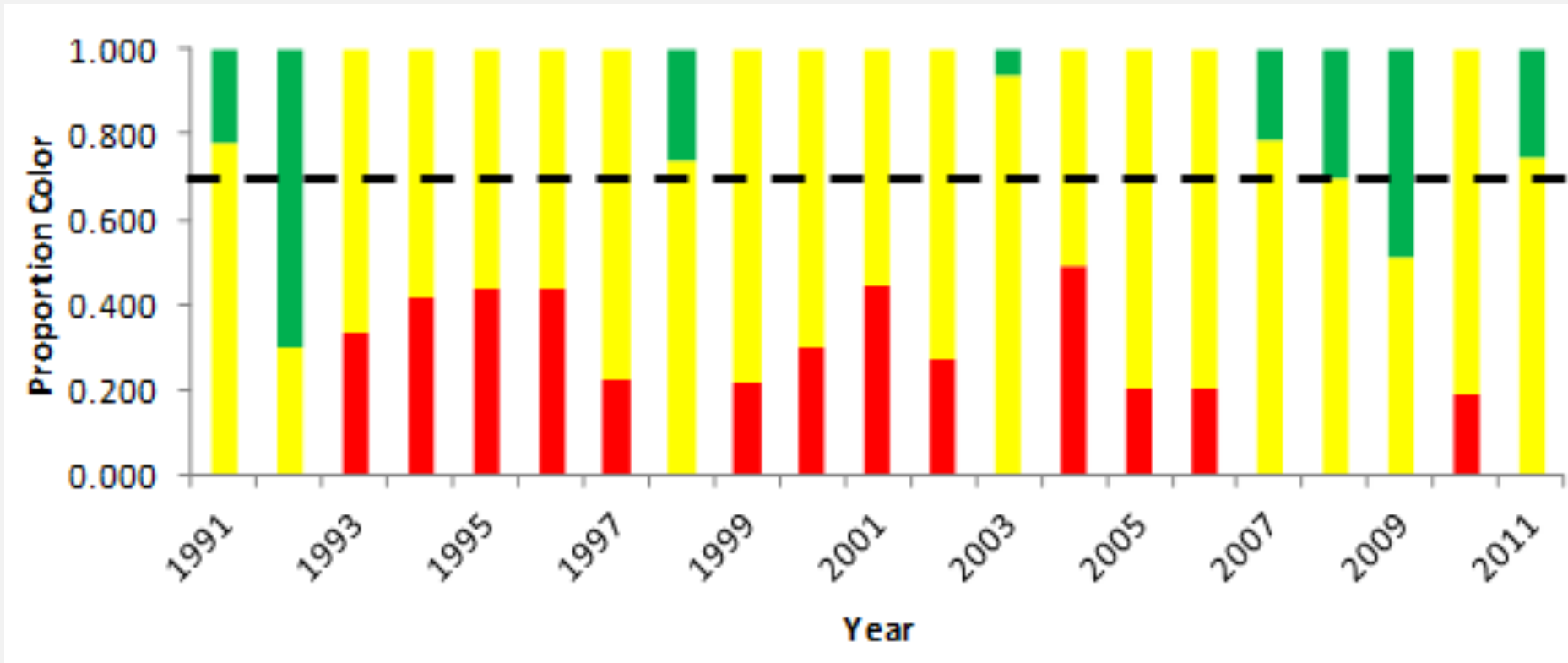
Indicator Status

Figure adapted from ASMFC (2020).

Indicators

- Compare recent years with previous years to detect trends
  - Based on population and/or fishery dynamics
- Derived from available fishery-independent or fishery-dependent sources
  - Representative of various phases in the life cycle (e.g., juvenile, sub-adult, adult).
- Should span multiple generations to be representative of population trends
- Multiple indicators of the same characteristic combined into composite "characteristics"
  - Designed to collectively represent a characteristic of interest for management (e.g., abundance, recruitment, fishery performance)
  - Indicators are additive and the resulting combined index was rescaled from 0 to 1 (ASMFC 2020; Halliday et al. 2001)
- Selected indicators based on results from the 2022 Simulation Assessment

Reference Periods

- Relative proportions of each color for each year based on the trends from a selected reference period

- Important to select representative time-series for the reference period
  - Stocks were not overfished based on the previous stock assessment results
  - Long-term averages can be affected by regime shifts in stock productivity and/or fishing pressure
  - Northern: **1996–2013**; Southern **1991-2013**

- Evaluated model sensitivity to reference periods
  - Changed endpoints and length by 3 year increments

Thresholds

Thresholds optimized using a grid search procedure

- Value and number of consecutive years to trigger management action

- Performed for each year in the historic time series for each stock

- Grid matrix consisted of:
  - Potential threshold values ranging from 0.05 to 0.95 by 0.05 increments
  - Number of consecutive years to trigger management action from 1 to 10 years

Action Triggers

- Color proportions were compared to a selected threshold
  - Triggers based on a conditional rule such using developed thresholds
  - Trigger would result in a prescribed management action
- Appropriate number of consecutive years above the threshold for the initiation of management action
  - Short-time frame may be too sensitive to annual variability (stochasticity) in indicator values and can be mistaken for changes in fishing pressure
  - Long-time frame requirement may result in slow responsiveness to significant changes in fishing pressure

Stock Characteristics

Characteristic	Input Data Type	Stock Status
Recruitment	Recruitment (age-1) index of abundance	Recruitment Condition
Adult Abundance	Longline Survey of adult abundance	Spawning Stock Biomass
Fishery Performance	Harvest of slot-sized fish divided by slot-sized index of abundance	Fishing Mortality

Data sources

Characteristic	Northern	Southern
Recruitment	NC Bag Seine	FL 21.3 Haul Seine GA Gill Net SC Trammel (Age-1)
Adult Abundance	NC Longline	GA Longline SC Longline (contemporary)
Fishery Performance	NC Gill Net	FL 183 Haul Seine SC Trammel (Age 2-3)

Northern Configuration

Characteristic	Years to Trigger Management Action	Threshold
Recruitment	1	0.05
Adult Abundance	10	0.78 (0.39)
Fishery Performance	7	0.76

- Adult abundance set at 50% threshold (0.39) to account for high number of adult age classes
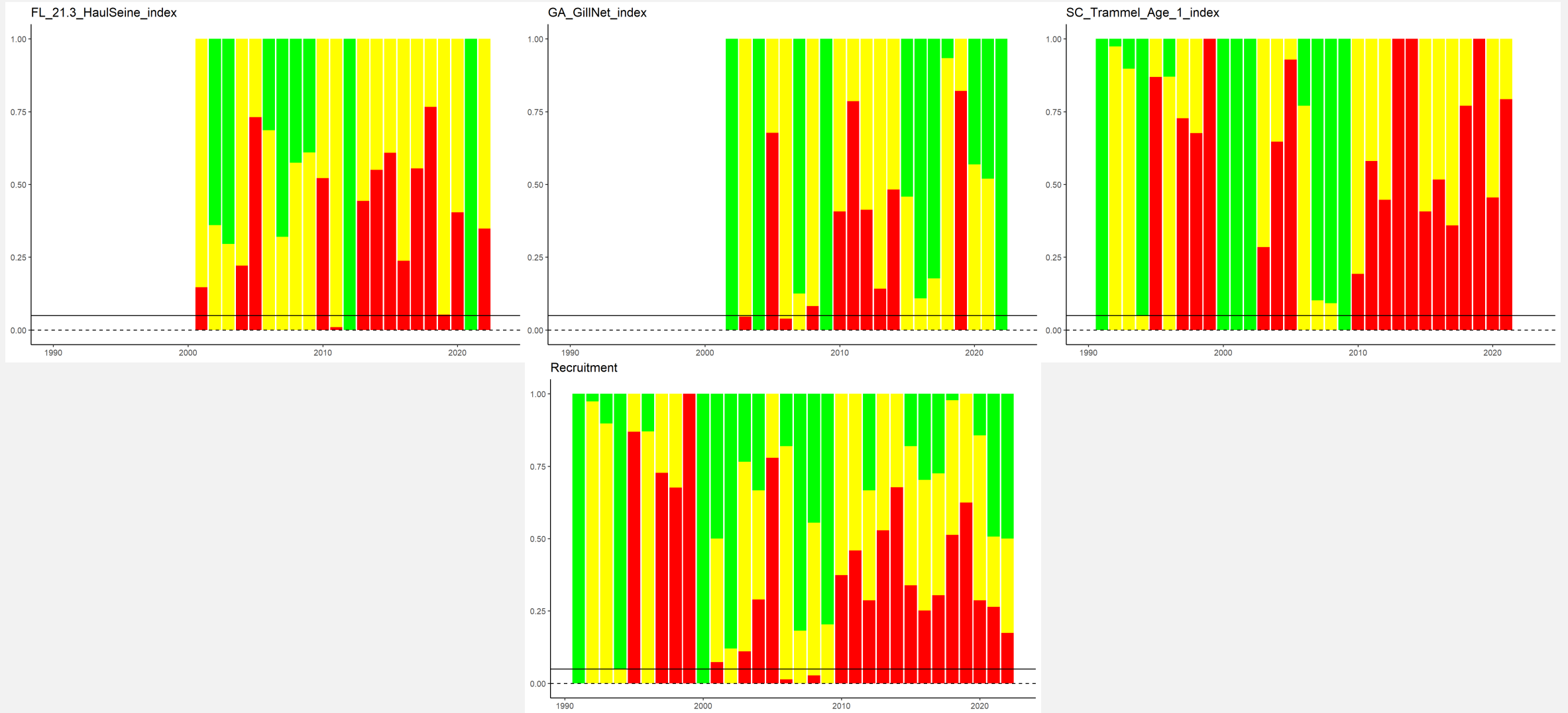- Reference period was **1996–2013**

Northern

Year	Recruitment	Adult Abundance	Fishery Performance
2018	No Action	No Action	Moderate Action
2019	Moderate Action	No Action	Moderate Action
2020	Moderate Action	No Action	Moderate Action
2021	**Moderate Action**	**No Action**	**Moderate Action**

Northern Annual Status

Northern Reference Period Sensitivity

Recruitment	Adult Abundance	Fishery Performance	Frequency
Moderate Action	**No Action**	**Moderate Action**	6
Moderate Action	No Action	Elevated Action	2

Southern Configuration

Characteristic	Years to Trigger Management Action	Threshold
Recruitment	1	0.05
Adult Abundance	9	0.78 (0.39)
Fishery Performance	6	0.52

- Adult abundance set at 50% threshold (0.39) to account for high number of adult age classes
- Reference period was **1991–2013**

Southern Status Results

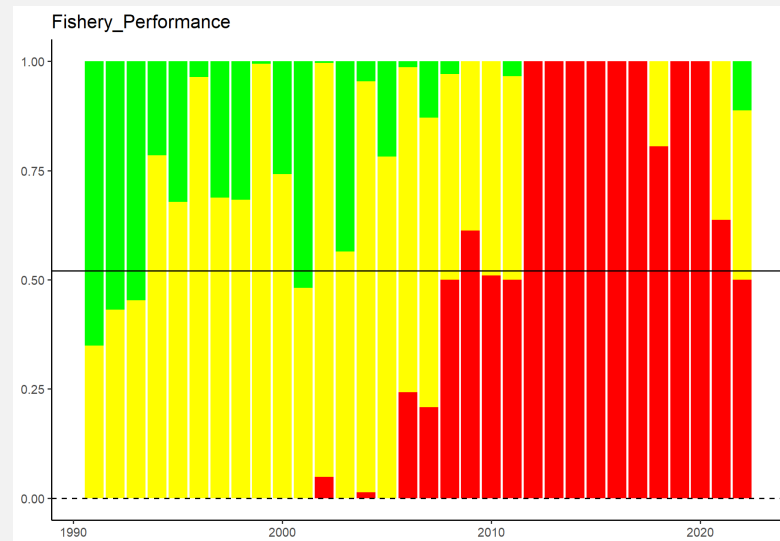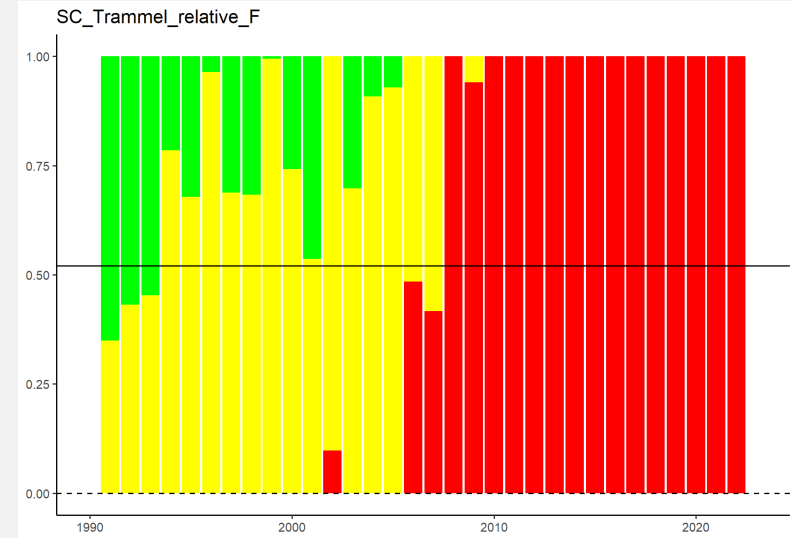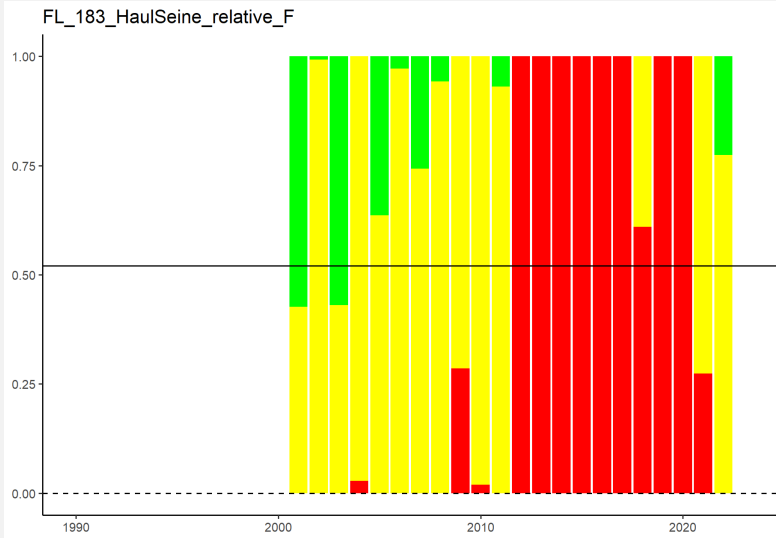| Year	Recruitment	Adult Abundance	Fishery Performance
2018	Elevated Action	Moderate Action	Elevated Action
2019	Elevated Action	Moderate Action	Elevated Action
2020	Elevated Action	Moderate Action	Elevated Action
2021	**Elevated Action**	**Moderate Action**	**Elevated Action**

Southern Annual Status
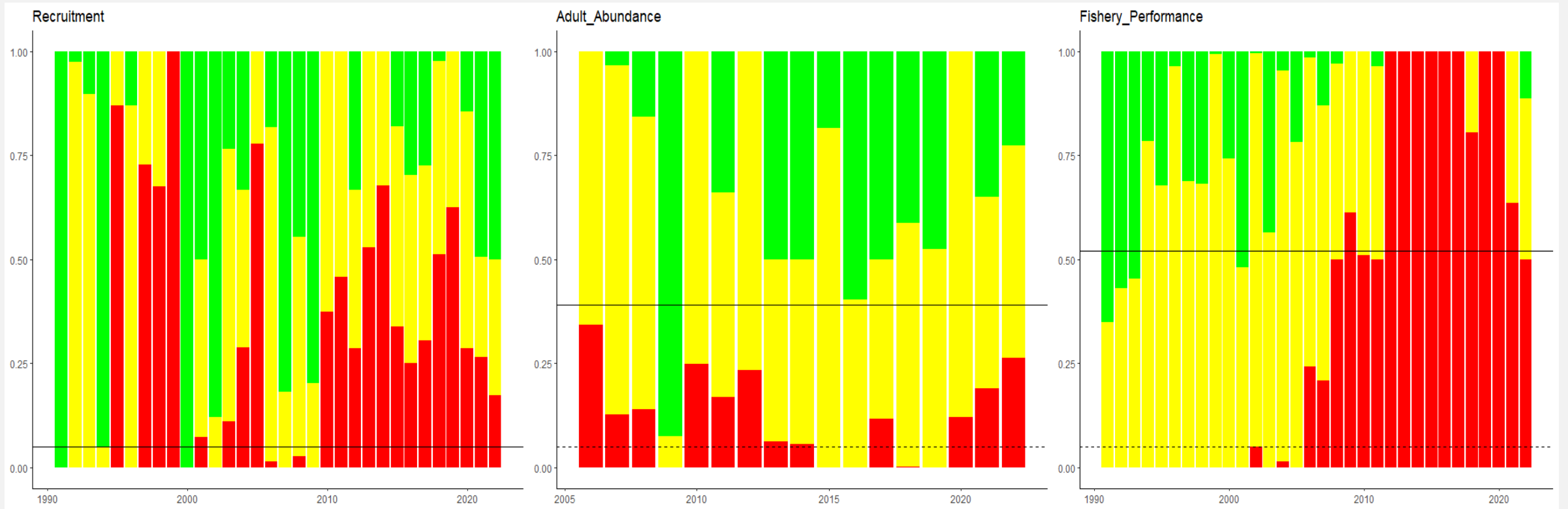
Southern Recruitment

Southern Adult Abundance
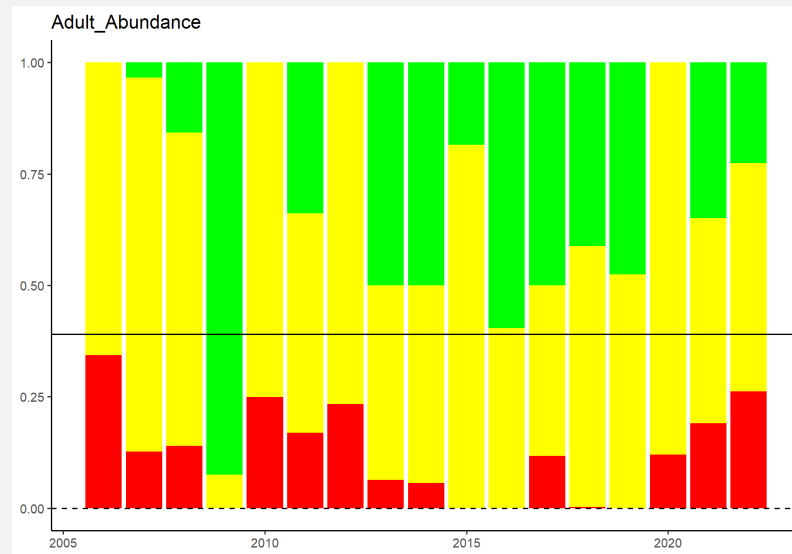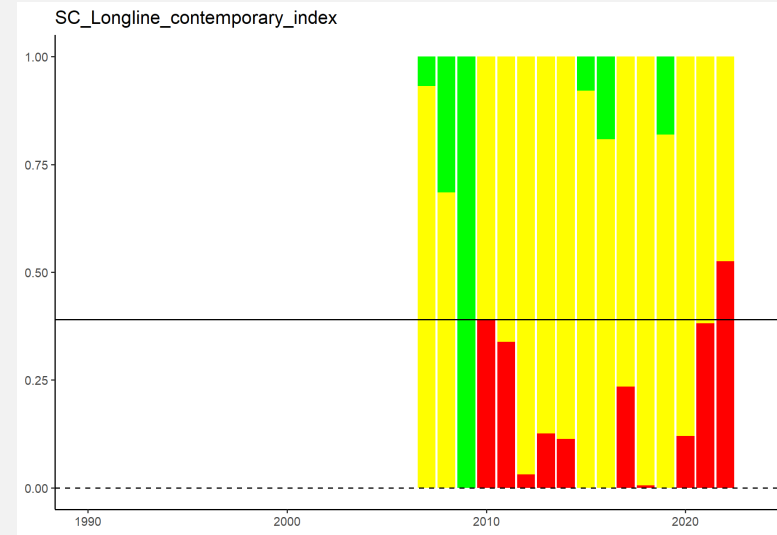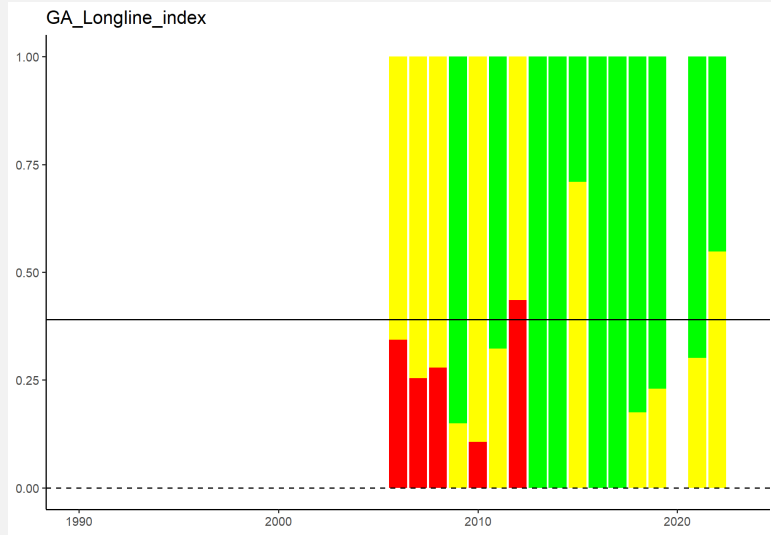
Southern Fishery Performance

Southern Reference Period Sensitivity

Recruitment	Adult_Abundance	Fishery_Performance	Frequency
Elevated Action	**Moderate Action**	**Elevated Action**	**4**
Elevated Action	No Action	Elevated Action	7

Conclusions

- Stocks status varies in the terminal year
  - Northern- 2 Moderate action, 1 No action
  - Southern- 2 Elevated action, 1 Moderate action

- Status of both stocks may be on a declining trend when looking at successive years

- TLA seems insensitive to changes in reference period
  - Same or +/- one category difference
  - Longer threshold windows may be affected by individual years

- Current framework relatively easy to implement for interim updates

Questions?