5. Measures of Population Abundance

5.1. Overview

The combined Index and Bycatch Working Group (IBWG) reviewed relative abundance indices and accompanying analyses from six fishery-independent datasets and two fishery-dependent datasets that represented relative abundance trends in the Gulf for gray triggerfish. For this assessment, the IBWG was tasked with making recommendations for two different spatial configurations for the stock assessment model, with one being for a full Gulf-wide stock assessment model and the second being a two-area stock assessment model that would be split into West and East regions.

Full descriptions of the datasets, analytical methods and model diagnostics reviewed by the IBWG can be found in Section 5.2. The IBWG reviewed and evaluated indices independently for the entire Gulf and for each of the two regions (West and East) following the criteria listed in Section 5.3. Relative spatial coverage of "Suitable" and "Suitable and Recommended" indices are included in Figures 5.9.1 and 5.9.2, respectively. Rationalizations for the recommendation or exclusion of an index (Table 5.8.1) are given in the 'Comments on Adequacy for Assessment' in Sections 5.4 (fishery-independent) and 5.5 (fishery-dependent).

For the Gulf-wide model, three fishery-independent and one fishery-dependent indices of abundance are recommended for use in the assessment by the IBWG. Relative abundance and the coefficient of variation on the mean (CV, standard error/mean) for recommended indices Gulf-wide are shown in Table 5.8.2, and overall trends in Figure 5.9.3.

Recommended	Not Recommended
SEAMAP Summer and Fall Groundfish Old (1987 – 2008)	SEAMAP Fall Groundfish Old (1987 – 2007)
SEAMAP Summer and Fall Groundfish New (2009 – 2024)	SEAMAP Fall Groundfish New (2008 – 2024)
SEAMAP / G-FISHER Reef Fish Video (1993 – 2023)	SEAMAP Fall Plankton (1986 – 2023)
Headboat Survey (1986 – 2007)	Commercial Handline (1993 – 2024)

For the West, three fishery-independent and one fishery-dependent indices of abundance are recommended for use in the assessment by the IBWG. Relative abundance and the coefficient of variation on the mean (CV, standard error/mean) for recommended indices in the West are shown in Table 5.8.3, and overall trends in Figure 5.9.4.

Recommended	Not Recommended
SEAMAP Summer and Fall Groundfish Old (1987 – 2008)	SEAMAP Fall Groundfish Old (1987 – 2007)
SEAMAP Summer and Fall Groundfish New (2009 – 2024)	SEAMAP Fall Groundfish New (2008 – 2024)
SEAMAP / G-FISHER Reef Fish Video (1993 – 2023)	SEAMAP Fall Plankton (1986 – 2023)

Headboat Survey (1986 – 2007)	Commercial Handline (1993 – 2024)

For the East, two fishery-independent and one fishery-dependent indices of abundance are recommended for use in the assessment by the IBWG. Relative abundance and the coefficient of variation on the mean (CV, standard error/mean) for recommended indices in the East are shown in Table 5.8.4, and overall trends in Figure 5.9.5.

Recommended	Not Recommended
SEAMAP Summer and Fall Groundfish New (2009 – 2024)	SEAMAP Fall Groundfish New (2008 – 2024)
SEAMAP / G-FISHER Reef Fish Video (1993 – 2023)	SEAMAP Fall Plankton (1986 – 2023)
Headboat Survey (1986 – 2007)	Commercial Handline (1993 – 2024)

5.1.1. Terms of Reference

The IBWG was tasked with completing objectives associated from the Data Workshop Terms of Reference (note that the numbering tracks the original Terms of Reference):

4. Provide fishery-independent measures of population abundance developed through the terminal year where possible.

- Evaluate the G-FISHER composite video index for use in the assessment.
- Consider any changes to the fishery-independent indices comprising the GFISHER index as provided for the previous assessment and evaluate the representativeness through time of the composition data.
- Evaluate the compositions available. Recommend modifications needed to inform differences in catchability and selectivity of the surveys.
- Provide appropriate measures of uncertainty for all fishery-independent abundance indices and effort time series considered.

The IBWG was also tasked with examining the follow objective (specific items bolded) from the Assessment Process Terms of Reference:

2. Consider continuity model stratification and data structure and suggest any recommended revisions.

- Re-evaluate whether commercial and recreational fleets should be separated by East and West by reviewing all available data (landings, discards, indices, compositions).
- Provide estimates of uncertainty around each set of landings and discard estimates.
- Review ageing validation and ageing structures studies and consider their appropriateness for inclusion in the assessment model.
    - Update life history data/analyses (e.g., maximum age, growth, mortality, ageing error matrix, reproduction) given revised age data following recent

ageing studies as needed.

- **Explore the use of a combined video index from the FWRI, Pascagoula, and Panama City video surveys (e.g., G-FISHER). Recommend modifications needed to inform differences in catchability and selectivity of the surveys.**
- Evaluate the start year and initial Fs used in the assessment model.
- Explore shrimp trawl bycatch magnitude and age-structure, if data are available using new effort and bycatch methodologies (e.g., SEAMAP Summer and Fall Groundfish trawls and shrimp observer data).
- Explore fleet-specific length compositions and **remote sensing data for sargassum coverage as a potential index of recruitment.**
- Consider recent discard mortality studies and analytical results and incorporate updated discard mortality rate(s) as appropriate.

5.1.2. Group Membership

Members of the IBWG included: Adam Pollack (co-lead), Cheston Peterson (co-lead), Kate Overly, Kevin Thompson, Matthew Nuttall, Ted Switzer, Heather Christiansen, Kyle Dettloff, Sarina Atkinson, David Hanisko, Matthew Campbell, Frank Hernandez, and Glenn Zapfe.

5.2. Review of Working Papers

The IBWG reviewed the following working papers:

SEDAR100-DW-09	-	Standardized Catch per Unit Effort for US Gulf of America Gray Triggerfish (*Balistes capriscus*) from the Southeast Region Headboat Survey
SEDAR100-DW-15	-	Standardized catch rates of Gray Triggerfish from the United States Gulf of America commercial handline fishery, 1993-2024
SEDAR100-DW-16	-	Gray Triggerfish Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of America
SEDAR100-DW-18	-	Indices of abundance for Gulf Gray Triggerfish (*Balistes capriscus*) using data from multiple video surveys
SEDAR100-DW-19	-	Gray Triggerfish (*Balistes capriscus*) indices of relative abundance from SEAMAP Fall Plankton Surveys, 1986 to 2023

5.3. Consensus Recommendations and Survey Evaluations

All indices presented to the IBWG were evaluated based on the following criteria:

- Type of Survey (Fishery Dependent or Independent)

- Data Sources
- Temporal Range
- Spatial Range
- Survey Design (e.g., fixed sampling sites, stratified random etc.)
- Sampling Methodology (e.g., gear, vessels, effort etc.)
- Ages and/or sizes represented
- Appropriate Analytical Methods

After an index was evaluated, it was deemed either Suitable or Not Suitable, following the guidance in the Terms of Reference from SEDAR 74. Once all the indices were evaluated on their own merits and determined to be Suitable or Not Suitable, they entered the second stage of review to determine a recommendation for use in the assessment. Indices were then assigned one of the following categories.

- Suitable and Recommended: Based on the criteria listed above, the index met the minimum requirements for being considered for use in the assessment and was deemed to be a representative example of the population trends for a given area.

- Suitable and Not Recommended: Based on the criteria listed above, the index met the minimum requirements for being considered for use in the assessment but was deemed not to be a representative example of the population trends for a given area.

- Not Suitable (Not Recommended): Based on the criteria listed above, the index did not meet the minimum requirements for being considered for use in the assessment.

5.4. Fishery Independent Indices

5.4.1. SEAMAP Groundfish Survey

The NOAA Fisheries Southeast Fisheries Science Center (SEFSC) Population and Ecosystem Monitoring Division Trawl and Plankton Branch and state partners have conducted standardized fall groundfish surveys under the Southeast Area Monitoring and Assessment Program (SEAMAP) in the Gulf of America (GOA) since 1987. SEAMAP is a collaborative effort between federal, state and university programs, designed to collect, manage and distribute fishery independent data throughout the southeast region. The primary objective of this trawl survey is to collect data on the abundance and distribution of demersal organisms. This survey, which is conducted semi-annually (summer and fall), provides an important source of fisheries independent information on many commercially and recreationally important species throughout the GOA occupying low-relief, sand and mud habitats across the shelf.

Major changes in the SEAMAP sample design occurred between the 2008 summer and fall surveys. The time of day stratification was dropped, tow time was standardized to 30 minutes, and sampling effort was allocated proportionally by each combination of shrimp statistical zone (SSZ) and depth zone spatial area. While the change in sample design occurred in 2008, it is important to note that the state partners did not adopt the new sample design until 2010.

Additionally, minor changes to depth zones were made during subsequent years with the current design utilizing two depth zones, which have been consistent since 2013.

In 2008, SEAMAP received supplemental funding that provided the opportunity to conduct experimental bottom trawl surveys on the West Florida Shelf. Based on the success of the experimental trawl surveys by the state of Florida, the surveys were fully expanded in 2010 to include the area from Mobile Bay, AL to Key West, FL. The survey gear consists of a 12.8-m (42 ft) semi-balloon shrimp trawl with a 12.8-m headrope and does not contain a turtle excluder device (TED) or any bycatch reduction devices (BRD).

5.4.1.1. Methods of Estimation

Working Paper Number: SEDAR100-DW-16

Data Type: Fishery Independent

Time Series: 1987 – 2008**,** 2009 – 2024

Sampling Intensity: Table 1 (summer), Tables 2 (fall) in working paper.

Size/Age Data: Predominantly juveniles, see Figures 3 – 5 in working paper for length and age distributions

Data Filtering Techniques: Standard filtering protocols to remove problematic stations.

Standardization: Delta-lognormal following methods outlined by Lo *et al.* (1992)

Submodel Variables

Gulf-wide – SEAMAP Summer and Fall Groundfish (old design, 1987 – 2008)

Binomial submodel: Year, SSZ, Season, Depth
Lognormal submodel: Year, SSZ, Season, Time of Day, Depth

Gulf-wide – SEAMAP Summer and Fall Groundfish (new design, 2009 – 2024)

Binomial submodel: Year, SSZ, Season, Depth
Lognormal submodel: Year, SSZ, Time of Day, Depth

West Gulf – SEAMAP Summer and Fall Groundfish (old design, 1987 – 2008)

Binomial submodel: Year, SSZ, Season, Depth
Lognormal submodel: Year, SSZ, Season, Time of Day, Depth

West Gulf – SEAMAP Summer and Fall Groundfish (new design, 2009 – 2024)

Binomial submodel: Year, SSZ, Season, Depth
Lognormal submodel: Year, SSZ, Time of Day, Depth

East Gulf – SEAMAP Summer and Fall Groundfish (new design, 2009 – 2024)

Binomial submodel: Year, SSZ, Season, Weight of Sponge, Depth
Lognormal submodel: Year, SSZ, Season

Abundance Indices: Addendum Table 1 (Gulf-wide – old design), Addendum Table 2 (Gulf-wide – new design), Addendum Table 3 (West Gulf – old design), Addendum Table 4 (West Gulf– new design), Addendum Table 5 (East Gulf– new design) in SEDAR100-DW-16

5.4.1.2. Comments on Adequacy for Assessment

Initially, only indices from the SEAMAP Fall Groundfish Survey Old Design (1987 – 2008) and SEAMAP Fall Groundfish Survey New Design (2009 – 2024) were presented for use in the assessment following what had been done for previous SEDARs. Both indices represent a long-term fishery-independent survey that has good spatial and temporal coverage. Indices were presented for the Gulf-wide model and for the West for the SEAMAP Fall Groundfish Survey Old Design and for all three regions (East, West, and Gulf-wide) for the SEAMAP Fall Groundfish Survey New Design. However, during the course of the Data Workshop, we examined combining the summer and fall survey data into a single index. Length data were compared and no apparent differences in the distribution were noted, aside from a shift in lengths that would be expected from the fish being older when captured in the fall survey.

Due to the recommendation for combining Summer and Fall survey data, indices from the fall survey were deemed “Suitable and Not Recommended”.

The survey coverage across all regions showed broad spatio-temporal sampling, with the entire area being covered in most years. Therefore, the IBWG deemed the summer and fall combined indices for all of the regions “Suitable and Recommended”.

5.4.2. SEAMAP / G-FISHER Reef Fish Video Survey – East (EGOA), West (WGOA) and Gulf-wide (GOA)

Historically, three different stationary video surveys were conducted to assess trends in reef fish relative abundance in the Gulf of America (GOA). The NMFS SEAMAP reef fish video survey (SRFV), carried out by NMFS Mississippi Laboratory, has the longest running time series (1993-1997, 2002, and 2004+), followed by the NMFS Panama City lab survey (PC; 2005+), with the most recent survey being the Florida Fish and Wildlife Research Institute video survey (FWRI, starting year 2010). Survey efforts were integrated under a unified design as the Gulf Fishery Independent Survey of Habitat and Ecosystem Resources (G-FISHER) beginning in 2020. Given the surveys use standardized deployment, camera field of view, and fish abundance methods to assess fish abundances on reef or structured habitat, combining indices across datasets allows for the largest possible sample sizes in model fitting and encompassing a greater proportion of the distribution of the stock. Gray Triggerfish, found throughout the GOA, is considered a single stock based on its prolonged, indeterminate larval stage. As requested for this assessment, indices of abundance were provided for the East GOA (EGOA, > -89° longitude), West GOA (WGOA; < -89° longitude), and Gulf-wide GOA (GOA) regions.

5.4.2.1. Methods of Estimation

Working Paper Number: SEDAR100-DW-18

Data Type: Fishery Independent

Time Series: 1993-2023 (All indices; EGOA, WGOA, GOA)

Sampling Intensity: See Table 1 for total number of stations sampled per region per year in SEDAR100-DW-18

Size/Age Data: Data represents juveniles through adult. 10 - 88 cm (EGOA), 16 - 68 cm (WGOA), 10 – 88 cm (GOA). See Figure 19 in SEDAR100-DW-18

Data Filtering Techniques: For all surveys, video reads were excluded if they were unreadable due to low visibility or deployment errors. Data from the SRFV survey collected in 1992 were excluded from the EGOA, WGOA and GOA index calculations because of differences in counting methods in this first year, and no survey data are available for years 1998-2001 and 2003. Additionally, PC survey data from 2005 was excluded because of an incomplete survey. Due to COVID restrictions on field sampling, no data were collected in the WGOA in 2020. As a result, 2020 data were excluded from analysis in the WGOA index. Final sample sizes by region, survey and year can be found in Table 1 and spatial coverage is shown in Figures 1 and 2 in SEDAR100-DW-18. Data were separated into EGOA (zones 2-11) and WGOA (zones 13-21) and GOA (zones 2-21) regions following the Stock ID identified in SEDAR 9, and analyses were completed for each of these regions independently. The same data reduction procedures were applied to the video length data set such that annual size composition vectors were generated solely from stations used to generate standardized indices for each stock.

Standardization: Relative abundance indices were generated using a stepwise approach. First a habitat variable was created that included each of the separate survey individual variables that could be applied to all the data. This was done so final index models can account for changing sampling effort and habitat allocation through time rather than limiting the model to be predicted only by year and survey. We first determined the percentage of sites that occurred on High, Medium, or Low (H, M, L) proportion positive habitats for each survey and region independently. For this we used a categorical regression tree approach (CART). These subsequent variables were then used in a negative-binomial GLM along with year and survey to predict annual abundances for each region independently.

Submodel Variables:

<u>EGOA CART variables by survey:</u>
SFRV east: *presence/absence of sponge, presence/absence of soft coral, combined maximum relief, latitude, and longitude*
PC: *longitude, general habitat category, and relief*
FWRI: *latitude, longitude, presence/absence of sponge, geoform, depth*
GF east: *latitude, longitude, presence/absence of rock, presence/absence of sponge*

<u>WGOA CART variables by survey:</u>
SFRV west: *depth, latitude, presence/absence of rock, presence/absence of silt/sand/clay*
GF west: *depth*

<u>GOA CART variables by survey:</u>
SFRV east: *presence/absence of sponge, presence/absence of soft coral, combined maximum relief, latitude, and longitude*
SFRV west: *depth, latitude, presence/absence of rock, presence/absence of silt/sand/clay*
PC: *longitude, general habitat category, and relief*
FWRI: *latitude, longitude, presence/absence of sponge, geoform, depth*
GF east: *latitude, longitude, presence/absence of rock, presence/absence of sponge*
GF west: *depth*

Annual Abundance Indices: See Table 8 and Figure 16 for EGOA, Table 9 and Figure 17 for WGOA, and Table 10 and Figure 18 for GOA in SEDAR100-DW-18.

5.4.2.2. Comments on Adequacy for Assessment

All three indices were deemed suitable and recommended by the IBWG at the SEDAR100 Data Workshop in Tampa, FL.

Prior to the G-FISHER survey, previous SEDARs utilized different methods for calculating the abundance indices between multiple reef fish video surveys. SEDAR 62 combined three separate surveys (SRFV, PC, FWRI) to derive estimated annual abundances for the combined EGOA index. This was achieved by fitting a GLM to data using CART-derived habitat groups as a shared variable. This approach predated the formal standardization of the survey universe and design established by G-FISHER. Separately, the WGOA index was derived exclusively from the SRFV dataset, as PC and FWRI did not sample that region at the time. (SRFV also produced standalone EGOA and GOA-wide indices). For all three regions, the SRFV analysis utilized a negative binomial model.

Following SEDAR 62, the G-FISHER survey came online (2020), sampling GOA-wide with a standardized sampling universe, design and methodologies. Additionally, we developed GOA-wide model-weighting methods that allowed us to account for the variation in spatial footprint in the surveys when combining data (current and historical), allowing for a more representative index of regional relative abundance trends. Ultimately, for this assessment we used this updated habitat-based approach to combine relative abundance data for generating annual trends for gray triggerfish (Balistes capriscus) in the EGOA, WGOA, and GOA-wide. This combined approach resulted in low CVs (2021-2024 8-7%). Due to the wide range of the stock being covered in terms of spatial coverage and habitats sampled, the large sample sizes of video sets, and the size range of this species being indexed the combined G-FISHER approach was supported for the EGOA, WGOA, and GOA-wide indices. While we provided all three, the analytical team can use their discretion to determine which index/indices are ultimately included.

Review of the length compositions and survey designs of the independent video surveys did not uncover any obvious differences that would warrant the implementation of time varying selectivity and catchability be applied, and the combined length frequencies across years were similar among surveys (Fig. 19). However, the analytical team can use their discretion to explore time-varying parametrizations if they are determined to be warranted during model development.

5.4.3. SEAMAP Fall Plankton Survey

The Southeast Area Monitoring and Assessment Program (SEAMAP) has supported the collection and analysis of ichthyoplankton samples from fishery-independent resource surveys in the Gulf since 1982 with the goal of producing a long-term database on the early life stages of fishes.

5.4.3.1. Methods of Estimation

Working Paper Number: SEDAR100-DW-19

Data Type: Fishery Independent

Time Series: 1986 to 2023

Sampling Intensity: See Table 4 in SEDAR100-DW-19

Size/Age Data: Intended to index adult spawning stock

Data Filtering Techniques: Preliminary indices of abundance were based on the occurrence and catch per unit effort (CPUE) from SEAMAP Fall Plankton Surveys. Year to year variability in spatial coverage from Fall Plankton Survey data was addressed by limiting observations to samples taken at systematic grid stations that were sampled during at least (~66%) of all years for which there was consistent spatial coverage. Based on this protocol, the core data of the Gulf index includes all samples taken during at least 19 of the 28 years of available data with the years 1992, 1998, 2004, 2005, 2008, 2015, 2017, 2021 and 2023 excluded. Years in which gray triggerfish were not observed were removed prior to the generation of indices.

Standardization: Generalized linear modeling (GLM) methods were used to estimate the proportion of positive occurrence (PPOS) and relative catch per unit effort (CPUE) of larval and juvenile gray triggerfish in neuston nets. PPOS was modeled utilizing a binomial distribution with a logit link. CPUE was estimated by a log linked negative binomial model based on counts of larvae with effort (minutes fished) as an offset. The factors Year, Time of Day (TOD), Region and Depth were examined as possible influences on PPOS and CPUE.

Annual Abundance Indices: See Table 4 for the preliminary PPOS index and Table 5 for the preliminary negative binomial CPUE index in SEDAR100-DW-19.

5.4.3.2. Comments on Adequacy for Assessment

Gray triggerfish indices of CPUE derived from SEAMAP Fall Plankton Surveys have been used as an estimate of adult spawning biomass in previous assessments. Detailed analysis of length composition carried out for SEDAR 62 and SEDAR 100 indicate that gray triggerfish in SEAMAP neuston nets are dominated by older larvae (>5 mm Body Length [BL]) and juvenile stages (>10 mm BL) which account respectively for 12.1% and 78.7% of fish collected in samples. Therefore, CPUE and PPOS indices derived from SEAMAP neuston net samples are primarily composed of juvenile stages (> 10 mm BL) which are much further removed from the larval stages (< 10 mm BL) typically used to reflect trends in adult spawning stock. Larval gray triggerfish at or below 5 mm BL from neuston tows could potentially index spawning stock biomass, but larvae in this size range are rare and only occur in 2% of samples over the time series. Given that gray triggerfish CPUE and PPOS is primarily driven by juvenile fish further removed from the larval stages (< 10 mm BL) typically used to reflect trends in adult spawning stock, the authors of the working paper recommended that the SEAMAP Fall Plankton Survey CPUE and PPOS indices not be included in the assessment as a spawning stock index. This recommendation was discussed and adopted by the IBWG.

Indexing the relative abundance of gray triggerfish from neuston net collections is complicated by their consistent association with floating Sargassum. Examination of gray triggerfish in SEAMAP neuston tows (2006 to 2022) with paired observations of Sargassum catch indicate that older larvae and juveniles co-occur with Sargassum 78% of the time and primarily when Sargassum exceeds 1 liter / 10 min tow. In contrast, larvae at 5 mm BL or less only co-occur with Sargassum 22% of the time and when little (< 1 liter/ 10 min tow) or no Sargassum is observed in the sample. Although, catches of gray triggerfish greater than 5 mm BL are associated with Sargassum catch, a clear relationship with increasing catch of gray triggerfish and increasing catches of Sargassum was not apparent in our data. However, we did see a pattern of extreme (outliers) gray triggerfish CPUE in samples associated with large catches of Sargassum. Our ability to elucidate the relationship between gray triggerfish and Sargassum CPUE may be limited by the methods used to quantify Sargassum in neuston net tows. Currently, the protocols only record liters of Sargassum taken in the net, but information on the type of Sargassum aggregation, relative density at the surface, at depth and patchiness along or near the neuston tow may be needed to determine a relationship, and account for the seen pattern of extreme observations we see in our data. The use of satellite imagery products is being evaluated to provide a more detailed measurement of Sargassum abundance. This data will be used in future analyses to examine the intricate link between Sargassum abundance and variability of gray triggerfish recruitment in the northern Gulf of America.

At this time, the SEAMAP larval CPUE and PPOS from neuston nets primarily represent an incomplete picture of late-stage larvae and juvenile recruitment to Sargassum habitat. These fish may rely on Sargassum for refuge and transport to suitable benthic habitat for settlement, but major questions regarding these mechanisms are yet unanswered. The IBWG briefly discussed the potential merits of the SEAMAP Fall Plankton Survey CPUE and PPOS indices as an index of recruitment, but ultimately decided that the SEAMAP trawl surveys better represented a more direct recruitment path to the fishery.

5.4.4. Sargassum

As discussed above, indexing the relative abundance of gray triggerfish from neuston net collections is complicated by their consistent association with floating Sargassum. A clear relationship with increasing catch of gray triggerfish and increasing catches of Sargassum was not apparent in our data. The use of satellite imagery products is being evaluated to provide a more detailed measurement of Sargassum abundance. This data will be used in future analyses to examine the intricate link between Sargassum abundance and variability of gray triggerfish recruitment in the northern Gulf of America.

5.5. Fishery Dependent Indices

5.5.1. SRHS Headboat Index

The Southeast Region Headboat Survey (SRHS) collects catch, effort, and biological information from recreational headboats operating throughout the southeast region. First implemented in the Carolinas in 1972, the spatial extent of this survey has since grown, covering the entire South Atlantic by 1978 and the Gulf by 1986. Designed to be a census, SRHS catch records capture the majority of headboat fishing activity across the southeast, with compliance being near 100 percent since permits became tied to reporting requirements in 2008. These catch records are from industry-reported logbooks, which were submitted via paper forms until 2013 when the survey switched to electronic reporting.

5.5.1.1. Methods of Estimation

Working Paper Number: SEDAR100-DW-09

Data Type: Fishery Dependent

Time Series: 1986-2007

Sampling Intensity: The SRHS Working Paper (SEDAR100-DW-01) summarizes the number of headboats actively fishing (Tables 5-7) and their total fishing effort (Tables 14-17, Figure 7)

Size/Age Data: The SRHS Working Paper (SEDAR 100-DW-01) summarizes the lengths and weights of those landed fish sampled by SRHS port samplers (Tables 20-23, Figures 8-9)

Data Filtering Techniques: Standard filtering protocols to remove vessels with infrequent participation in the fishery, trips that reported six or fewer anglers, and trips with suspected data errors. Trips conducted during the closed season for Gulf Gray Triggerfish were also excluded.

SRHS logbook records after 2007 were excluded following perceived effects of management regulations on Gray Triggerfish catch rates (e.g., circle hook mandate, size and bag limits, spatial and seasonal fishery closures). Trip selection was conducted using the guild approach, which retained trips that were positive for those reef fish species believed well-sampled by the SRHS program.

Standardization: delta-lognormal

Submodel Variables

East:
Binomial: Year + Area + Year*Area
Positive Observations: Year + Area + Season + Year*Area

West:
Binomial: Year + Trip Duration + Day/Night + Year*Trip Duration
Positive Observations: Year + Season + Red Snapper Season

Gulf:
Binomial: Year + Area + Year*Area
Positive Observations: Year + Area + Season + Year*Area

Annual Abundance Indices: Table 2 (East), Table 4 (West), and Table 6 (Gulf)

5.5.1.2. Comments on Adequacy for Assessment

The IBWG found the provided SRHS Headboat Indices "Suitable and Recommended" for all regions. These indices provide one of the longest time series (1986+) and have widespread spatial coverage compared to other regional indices. It covers a time period over which fishery-independent indices are generally not available, and was truncated to account for the potential effects of management, including regulations aimed at Gray Triggerfish but also other reef fish that may interact with Gray Triggerfish.

5.5.2. Commercial Vertical Line

This index uses landings data from the Coastal Fisheries Logbook Program (CFLP) to characterize population trends of Gray Triggerfish as represented by the commercial vertical line (handline and electric reel) fishery. This index was used in both SEDAR 43 and 62 and the methods presented here are generally similar to those analyses. However, notable improvements were made to the subsetting routine for the Stephens MacCall procedure, the subsequent spatial zones used in the index, and the final model form which are more reflective of current best practices for indices produced with this dataset.

5.5.2.1. Methods of Estimation

Working Paper Number: SEDAR100-DW-15

Data Type: Fishery Dependent

Time Series: 1993-2024

Sampling Intensity: Between 614-1,982 trips (N) per year

Size/Age Data: Reflective of the commercial landings from handline

Data Filtering Techniques: Initial filtering was for East and West where, due to proportion positive catch of Gray Triggerfish, the East was defined by SEAMAP zones 5-12 and West included zones 13-20 (Table 1 in SEDAR 100-DW-15). Data were then further filtered for trips with incomplete information and for extreme outliers (99^{th} percentile). Stephens MacCall was then used to subset to trips that are considered reflective of Gray Triggerfish habitat using other species associations. Species found positively and negatively associated with Gray Triggerfish in this assessment were generally in line with the previous indices provided in SEDAR 43 and 62.

Standardization: Delta models were used with a binomial component and a positive CPUE component with a gamma distribution for East, West and Gulf-wide.

> **Submodel Variables** Backwards selection with AIC evaluation was used and all three models had all possible variables in the final model for both the binomial and positive catch components. Variables included were:
>
> YEAR – Year was necessarily included, as standardized catch rates by year are the desired outcome. Years modeled were 1993-2024
> SEASON – Season included four levels: (Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec)
>
> AREA – The SEAMAP zone as a factor with the East including zones 5-12, and the West with zones 13-20 (8 levels each)
>
> DAYS AT SEA – Days at sea (sea days) were pooled into four levels as quartiles of the data for the respective dataset (East, West, or Gulf-wide)
>
> CREW SIZE – Crew size was included as a factor with levels from 1-6 (min to max value)
>
> HOOK HOURS – Trip total hook hours as a four-level factor pooled into quartiles of the data for the respective dataset (East, West, or Gulf-wide)

Annual Abundance Indices: SEDAR100-DW-15 Tables 2-4.

5.5.2.2. Comments on Adequacy for Assessment

This index was deemed suitable based on the time series, segment of the population represented in both length composition and spatial extent, and modeling methodology. However, it was not recommended for use in the assessment. The changing management through time of this species in regards to trip limits, size limits, and reduced season duration make this fishery dependent time series difficult to decouple from these impacts on fishery behavior. Furthermore, it was deemed duplicative in terms of length composition and habitats sampled as the independent, G-FISHER survey which was recommended for use in this assessment.

5.6. Research Recommendations

- Evaluate potential red tide impacts
- Explore incorporating artificial reef / platform data from G-FISHER (short time series)
- Understanding the connection between sargassum habitat and abundance / life history of gray triggerfish
  - Daily aging of sub-age 0 gray triggerfish
  - Is sargassum obligate?

5.7. Literature Cited

Lo, N.C.H., L.D. Jacobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Canadian Journal of Fisheries and Aquatic Science 49: 2515-2526.

5.8. Tables

Table 5.8.1. Breakdown of the fishery independent (top) and fishery dependent (bottom) surveys considered for use in the assessment along with their final determination. (S/R – Suitable and Recommended, S/NR – Suitable and Not Recommended, * - recommended with the understanding that the survey is spatially limited in the eastern gulf)

Fishery Independent Surveys	Gulf-wide	West	East
SEAMAP Fall Groundfish (1987 - 2007)	S/NR	S/NR	
SEAMAP Fall Groundfish (2008 - 2024)	S/NR	S/NR	S/NR
SEAMAP/G-FISHER Reef Fish Video (1993 - 2023)	S/R	S/R	S/R
SEAMAP Fall Plankton (1986 - 2023)	S/NR	S/NR	S/NR
SEAMAP Summer + Fall Groundfish (2009 - 2024)	S/R	S/R	S/R
SEAMAP Summer + Fall Groundfish (1987 - 2008)	S/R*	S/R	

Fishery Dependent Surveys	Gulf-wide	West	East
Commercial Handline (1993 - 2024)	S/NR	S/NR	S/NR
Headboat (1986 - 2007)	S/R	S/R	S/R

Table 5.8.2. Relative abundance (Index) scaled to a mean of one for each time series and the coefficient of variation on the mean (CV, standard error/mean) of Gulf of America indices recommended for consideration in the assessment.

Year	SEAMAP Summer + Fall Groundfish - Old		SEAMAP Summer + Fall Groundfish - New		SEAMAP / G-FISHER		Headboat	
	Scaled Index	CV	Scaled Index	CV	Scaled Index	CV	Scaled Index	CV
1986							0.87078	0.28836
1987	0.56835	0.19422					0.725005	0.29970
1988	0.4953	0.18968					0.87672	0.28776
1989	0.94459	0.16063					1.30915	0.27191
1990	0.45549	0.19061					2.047945	0.23935
1991	2.12051	0.12036					1.470091	0.24176
1992	0.27423	0.20794					1.480927	0.24418
1993	1.38049	0.14471			0.414269	0.19035	1.244823	0.24951
1994	1.45428	0.12897			0.933006	0.48495	1.27111	0.26385
1995	0.91974	0.15517			0.467131	0.30182	1.047011	0.29284
1996	0.65535	0.1858			0.375482	0.15845	1.122074	0.29087
1997	0.56956	0.17321			1.5776	0.20402	1.06009	0.28747
1998	0.10533	0.32013					0.941592	0.27705
1999	1.23651	0.13952					0.999605	0.26817
2000	1.96108	0.12436					0.542469	0.29785
2001	2.97053	0.13786					0.448137	0.30606
2002	0.94186	0.15086			0.900191	0.69144	0.623839	0.30017
2003	0.49846	0.18469					0.731692	0.29248
2004	0.50154	0.16484			0.652346	0.35212	0.797104	0.27902
2005	0.83504	0.15025			0.627868	0.21874	1.021499	0.26247
2006	1.38013	0.15047			1.200054	0.17882	0.642355	0.28554
2007	0.77025	0.16508			1.044374	0.19354	0.725984	0.28789
2008	0.96138	0.12369			1.085496	0.15869		
2009			0.61897	0.11589	1.48863	0.13915		
2010			0.70009	0.14607	0.741284	0.16141		
2011			0.90649	0.13997	0.840483	0.15283		
2012			1.21177	0.12073	0.688465	0.15174		
2013			0.64263	0.17613	0.568017	0.13420		
2014			0.93016	0.12766	0.666497	0.10558		
2015			1.26452	0.10983	0.858797	0.09649		
2016			0.47892	0.17682	1.266416	0.06667		
2017			0.75718	0.13612	1.072754	0.07404		
2018			0.98507	0.12388	1.041269	0.08434		
2019			1.14612	0.13527	0.905208	0.07928		
2020			0.78121	0.20421	1.556289	0.15459		
2021			1.3194	0.12839	1.653959	0.10195		
2022			1.86293	0.12511	1.74845	0.09047		
2023			1.72429	0.11596	1.625666	0.08137		
2024			0.67024	0.16309				

Table 5.8.3. Relative abundance (Index) scaled to a mean of one for each time series and the coefficient of variation on the mean (CV, standard error/mean) of west Gulf of America indices recommended for consideration in the assessment.

Year	SEAMAP Summer + Fall Groundfish - Old		SEAMAP Summer + Fall Groundfish - New		SEAMAP / G-FISHER		Headboat	
	Scaled Index	CV	Scaled Index	CV	Scaled Index	CV	Scaled Index	CV
1986							0.683745	0.23507
1987	0.56304	0.19792					0.812996	0.21658
1988	0.45253	0.20054					1.087124	0.19699
1989	0.95888	0.16346					1.050667	0.21867
1990	0.47975	0.19439					1.589953	0.17919
1991	2.119	0.12341					2.52238	0.15202
1992	0.26502	0.21294					1.807058	0.16429
1993	1.36879	0.15369			0.149586	0.625	1.681793	0.17305
1994	1.41369	0.13303			1.459932	0.812	1.582176	0.17579
1995	0.96362	0.15656			0.194915	0.638	1.164559	0.18289
1996	0.55524	0.19615			0.33414	0.24	1.338432	0.19055
1997	0.59367	0.17437			3.192575	0.271	0.816146	0.21127
1998	0.11264	0.33014					0.640204	0.21981
1999	1.28985	0.14009					0.452752	0.26216
2000	1.93435	0.12721					0.215218	0.26512
2001	3.1296	0.14041					0.316262	0.23869
2002	0.96754	0.15502			1.764596	0.96	0.470578	0.21605
2003	0.46774	0.20036					0.673872	0.19449
2004	0.49796	0.1731			1.247655	0.495	0.749522	0.18561
2005	0.80951	0.15419			1.06584	0.335	0.785661	0.17293
2006	1.35775	0.15563			0.911536	0.563	0.660336	0.17953
2007	0.78665	0.16702			0.988967	0.405	0.898565	0.17474
2008	0.91316	0.1275			1.283476	0.331		
2009			0.30954	0.18981	0.568642	0.353		
2010			0.54099	0.22447	1.261437	0.396		
2011			0.87263	0.18966	1.774749	0.326		
2012			1.58582	0.16013	1.786139	0.271		
2013			0.4783	0.27617	0.99117	0.279		
2014			0.68605	0.20383	0.826124	0.291		
2015			1.31314	0.16091	0.327755	0.586		
2016			0.2088	0.3106	0.732415	0.307		
2017			0.67187	0.20299	1.170404	0.229		
2018			0.92783	0.18334	0.726635	0.218		
2019			0.86136	0.22143	0.241806	0.328		
2020			0.80129	0.27829				
2021			1.45306	0.16381	0.728675	0.22		
2022			2.76839	0.17071	0.544817	0.228		
2023			2.22968	0.15389	0.726014	0.22		
2024			0.29125	0.31778				

Table 5.8.4. Relative abundance (Index) scaled to a mean of one for each time series and the coefficient of variation on the mean (CV, standard error/mean) of east Gulf of America indices recommended for consideration in the assessment.

Year	SEAMAP Summer + Fall Groundfish - Old		SEAMAP Summer + Fall Groundfish - New		SEAMAP / G-FISHER		Headboat	
	Scaled Index	CV	Scaled Index	CV	Scaled Index	CV	Scaled Index	CV
1986							0.92459	0.38094
1987							0.655596	0.43189
1988							0.757932	0.41019
1989							1.330944	0.36396
1990							2.332684	0.30268
1991							1.362103	0.31348
1992							1.418992	0.31090
1993					0.768665	0.198	1.076832	0.33190
1994					0.923364	0.234	1.132578	0.35826
1995					0.961285	0.322	0.962184	0.41655
1996					0.651515	0.2	0.969531	0.41463
1997					0.831543	0.176	1.030454	0.40226
1998							1.025469	0.35667
1999							1.215352	0.32928
2000							0.650139	0.38151
2001							0.446371	0.40803
2002					0.538689	0.198	0.659246	0.38689
2003							0.734911	0.38879
2004					0.432993	0.225	0.818797	0.36721
2005					0.551896	0.181	1.156903	0.33669
2006					1.555499	0.164	0.630368	0.38627
2007					1.386453	0.212	0.708025	0.38449
2008					1.105631	0.166		
2009			1.26805	0.13895	2.132814	0.139		
2010			1.00236	0.18506	0.681176	0.143		
2011			0.97905	0.2075	0.66574	0.12		
2012			0.85167	0.18818	0.471503	0.131		
2013			0.89383	0.21944	0.461266	0.135		
2014			1.2116	0.15712	0.661946	0.106		
2015			1.2081	0.14859	1.136682	0.096		
2016			0.90836	0.20037	1.433038	0.07		
2017			0.78901	0.17841	1.089281	0.081		
2018			0.94298	0.16406	1.196008	0.108		
2019			1.39336	0.16137	1.052933	0.083		
2020			0.6052	0.30197	1.296986	0.111		
2021			0.95653	0.21544	1.255586	0.081		
2022			1.02324	0.18347	1.410275	0.071		
2023			1.02242	0.17948	1.347235	0.068		
2024			0.94424	0.17638				

5.9. Figures

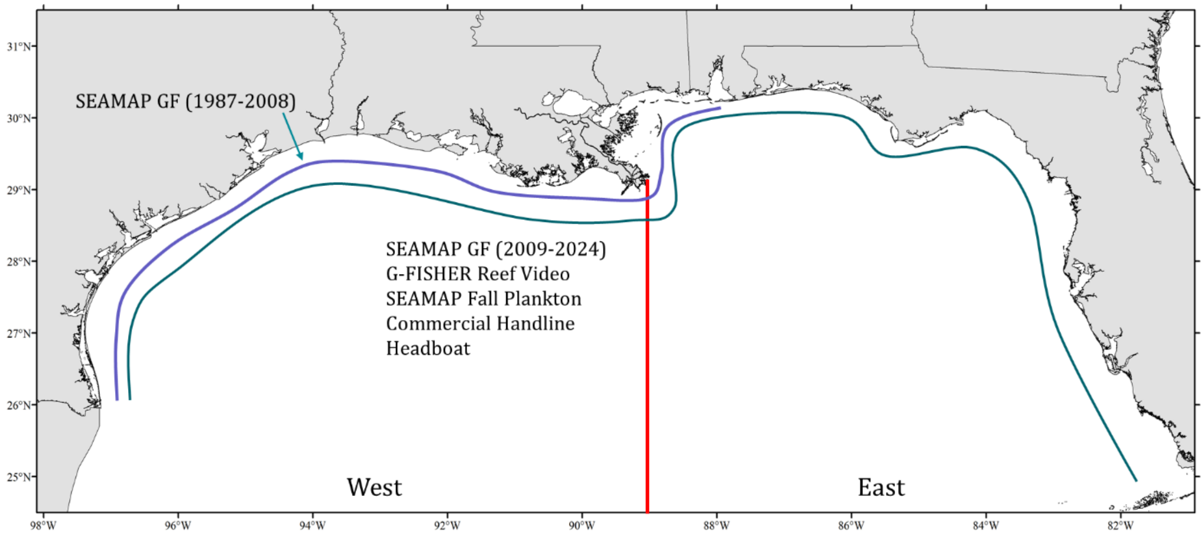

Figure 5.9.1. Relative spatial extent of indices found to be suitable for further review. Red line represents the boundary between the regions as defined in SEDAR43.

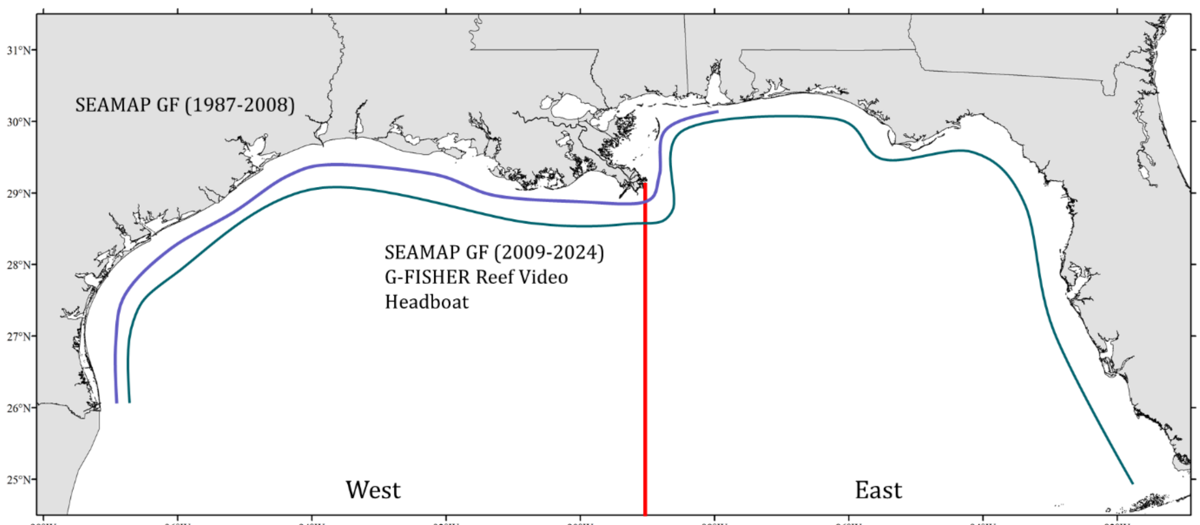

Figure 5.9.2. Relative spatial extent of indices found to be “Suitable and Recommended” for use in the assessment. Red line represents the boundary between the regions as defined in SEDAR43.

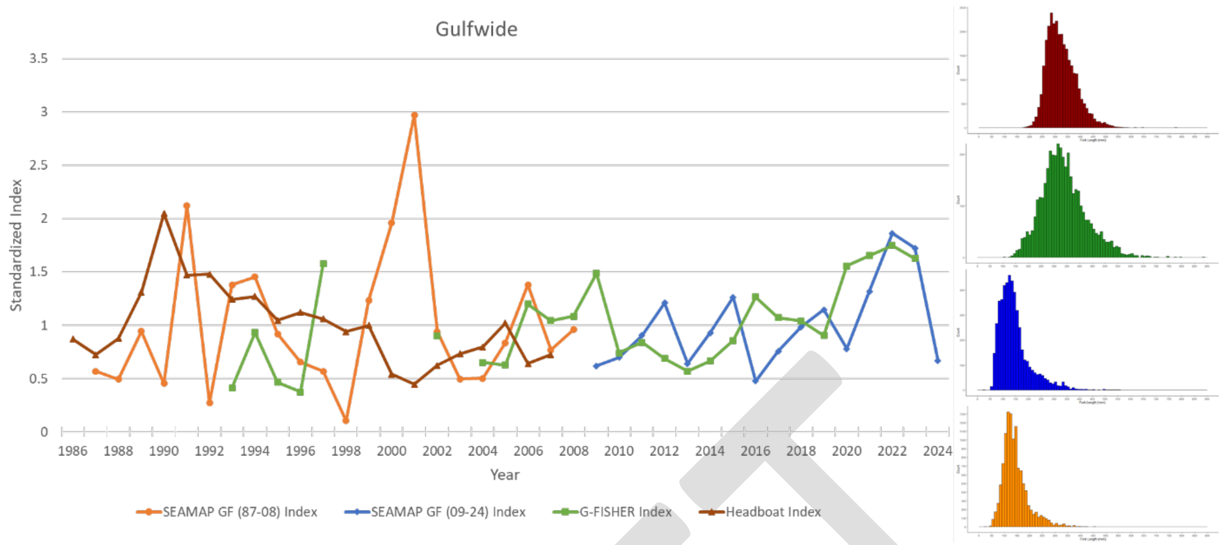

Figure 5.9.3. Recommended relative abundance indices for the Gulf of America, scaled to a mean of one for each time series. Length distribution of gray triggerfish for each time series is displayed in the corresponding color. Note the x-axis on the length distribution is from 0 to 900 mm, with 50 mm breaks.

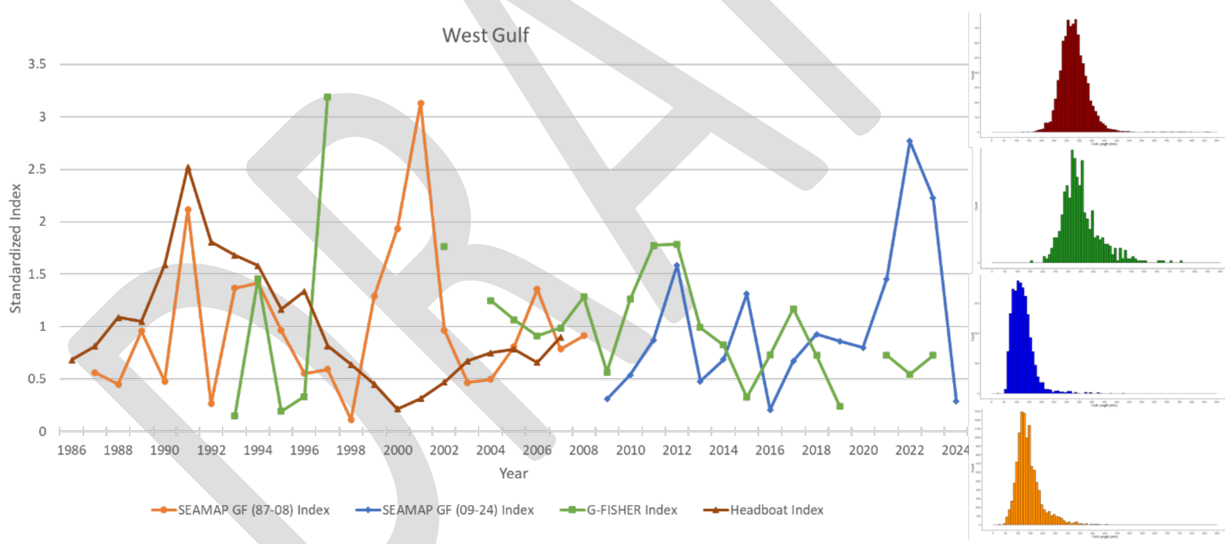

Figure 5.9.4. Recommended relative abundance indices for the western Gulf of America, scaled to a mean of one for each time series. Length distribution of gray triggerfish for each time series is displayed in the corresponding color. Note the x-axis on the length distribution is from 0 to 900 mm, with 50 mm breaks.

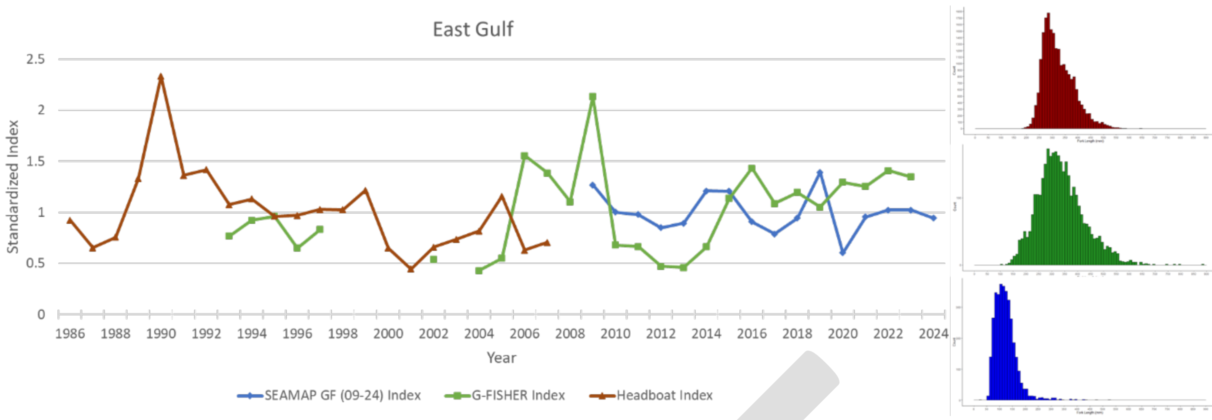

Figure 5.9.5. Recommended relative abundance indices for the eastern Gulf of America, scaled to a mean of one for each time series. Length distribution of gray triggerfish for each time series is displayed in the corresponding color. Note the x-axis on the length distribution is from 0 to 900 mm, with 50 mm breaks.