2 LIFE HISTORY

2.1 OVERVIEW

The life history working group (LHWG) met to review and discuss all life history data available for gray triggerfish at the SEDAR100 data workshop. New information on age, length, growth, natural mortality, and meristic conversions from data collected since the previous assessment in 2015 (terminal year 2013) was updated and examined to provide recommendations to the stock assessment panel. Data quality was examined with exploratory analyses to evaluate temporal and spatial representativeness. Specifically, the LHWG examined the data to look for issues within the available data types (e.g., length, age, compositions, etc.) as well as periods of low sample size resulting in poor data quality specific to each fleet in either region (East or West) or combined Gulfwide. The LHWG also assessed the impact of a new spine-ageing methodology, implemented for SEDAR100, on length-at-age and subsequent data products. A summary of the data presented, discussed, and recommendations made by the LHWG is presented in this document. Metadata submitted for SEDAR100 (1999-2024) follow the SEDAR Best Practices Template developed in December 2022.

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2.1.1 Work Group members and participants in Life History webinars

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2.1.2 Topics Reviewed by the Life History Group

1. Morphometrics
2. Length-at-age data
3. Calendar age assignment
4. Growth
5. Reader Precision/Ageing Error
6. Natural Mortality
7. Length Compositions
8. Age Compositions
9. Reproduction

10. Research Recommendations

2.2 MORPHOMETRICS

All morphometric conversion equations were updated for SEDAR100 (Table 2.13.1) due to the quantity of length and weight data collected since they were last estimated for SEDAR43 (2003-2013). Despite the large increase in data quantity, the estimated regression model parameters were very similar for length-length and length-weight conversions compared to previous estimates. Although all length-length conversion equations were updated, fork length (FL, mm), either observed or predicted, was used for final length. If an observed FL was not recorded, an alternative available length measurement was converted to FL based on the approach used in SEDAR43: 1) observed natural total length, 2) observed maximum total length; or 3) observed standard length. If an observed whole weight (WWt, g) was not recorded, it was converted from final FL (observed or converted) following the morphometric equations updated during SEDAR100 (Table 2.13.1; Figure 2.14.1). A conversion equation from gutted weight to whole weight was not provided in SEDAR43 and was not developed for SEDAR100. Only n = 9 records did not have any final length or weight estimate (see SEDAR100-DW-14).

2.2.1 Recommendations for SEDAR 100

The LHWG recommends using the updated meristic equations developed during SEDAR100 given the length of time since they were last updated and the large increase in sample sizes used to develop the parameter estimates.

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2.3 LENGTH-AT-AGE DATA

Life history data submitted for SEDAR100 were provided by both federal (NMFS Panama City) and state agencies (Florida Fish and Wildlife Research Institute (FWRI), the Gulf Fisheries Information Network (GulfFIN), and Dauphin Island Sea Lab/University of South Alabama (USA/DISL), Table 2.13.2). Of the n = 20,544 available samples, n = 19,407 had an age estimate; spines deemed unreadable were not included in this total. NMFS Panama City contributed the majority of age estimates (61.54%) followed by GulfFIN (26.24%). The dataset includes historical data submitted from previous assessments (SEDAR 9, 2006; SEDAR 43, 2015), which included years 1999-2013 in addition to new data to be considered for 2014 to 2024. No samples were collected in 2001. Of the samples with a valid age estimate, n=5,812 samples had unique sampling interviews, belonging to fishery-dependent (FD) (79.64%), fishery-independent (FI) (20.32%), or unknown (0.04%) sources (see SEDAR100-DW-14). All available samples had a value for the state landed category, with n = 4,480 samples having a specific catch location (i.e., latitude and longitude). The state with the highest number of samples was FL (57.82%), followed by Alabama (15.38%). Not landed (NL) was recorded for 5.78% of the FI samples collected via scientific survey (sampling program= FWRI-FIM; data provider=FWRI). However, these fish were assumed to come from FL as FWRI only samples from state or federal waters off of FL. The eastern Gulf (state landed = FL, AL, MS, and NL [assumed FL]) had a disproportionately higher number of samples (79.4%) compared to the western Gulf (state landed = LA, TX; 20.6%; Figure 2.14.2). Most spine samples were collected from the recreational (REC) fishery (47.95%) followed by the commercial (COM) fishery (31.69%) and those collected by fishery-independent (FI) surveys (20.32%). Very few samples were collected from unknown sources (0.04%). The majority of samples were collected from fish caught with handline (HL) gear (81.69%) followed by trap (TR; 6.45%) or longline (LL; 4.61%) gear (see SEDAR 100-DW-14). Samples collected at the beginning of the time series (1999-2000, 2002) were caught via neuston nets (NEU) deployed during scientific surveys (data provider = DISL/USA, state landed= MS). No samples were collected in 2001. Production ageing began in 2003 at the NMFS Panama City laboratory resulting in dramatic increases in the number of dorsal spines aged per year (Figure 2.14.3). FWRI-FIM and GulfFIN began ageing gray triggerfish spines in 2006 and 2007, respectively.

Dorsal spines were processed following the standard protocol from SEDAR43 and Allman et al. (2018). Edge types varied depending on the data provider, with some noting wide or narrow opaque zones. Otherwise, data providers recorded the edge type as opaque, translucent, or left the category blank. In SEDAR62, all dorsal spine ages were deemed unreliable and excluded from the assessment due to dorsal spine sections significantly underestimating otolith-based ages, specifically for fish aged 5 years and older (Patterson et. al 2019). For SEDAR100, all historical samples (i.e., collected from 1999-2017) originally aged 5 years and older were re-aged. New age data collected from 2018 to 2024 were read using the new dorsal spine ageing method described in Potts et al. (2023). Results from eye lens bomb radiocarbon (^{14}C) analysis validated that the new spine-ageing method (i.e., including compacted bands along the margin in annuli counts for fish age-5+) used in SEDAR100 was comparable to otolith-based age estimates, which are considered more accurate and without bias (Chamberlin et al. 2024).

Gray triggerfish spine age estimates ranged from 0 to 16 years, with the majority of age estimates between 3 and 6 years old (67.47%). A total of 100 samples were older than age-12 and only 1 fish was estimated at age-16. Samples collected via neuston net were collected from floating sargassum mats and all estimated as either age-0 or age-1 fish (n = 66). Fish collected from the COM sector had a mean age (± SD) of 5.65 (± 2.26) years, while fish sampled from the REC fishery had a mean age of 4.92 (± 1.90) years. Sampled fish caught with HL gear were on average 5.00 (± 2.01) years, while sampled fish caught with LL gear had a mean age of 7.04 (± 2.34) years. Overall, length-at-age was highly variable in all year classes from 2003-2024 (Figure 2.14.3). This variability is due in part to natural variability in length-at-age of gray triggerfish but also due to the difficulty in ageing this species because of deposition issues

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pertaining to compaction of annuli along the margin and the infrequent occurrence of false or paired annuli called "doublets" that do not correspond to a year's worth of otolith deposition.

2.3.1 Recommendations for SEDAR 100

The LHWG recommends that the spine-based age estimates are accepted for use in SEDAR100 as the new age estimates follow the protocol described in Potts et al. (2023) and validated by Chamberlin et al. (2024). This new approach also was accepted for use in SEDAR82 for spine-based age estimates of South Atlantic gray triggerfish.

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2.4 CALENDAR AGE ASSIGNMENT

In SEDAR43, gray triggerfish with a capture month from January to June with no visible translucent zones (i.e., age-0) were advanced to calendar age 1. Fish caught from July to December with a final (fork) length ≥160 mm were also advanced to calendar age 1, and fish <160 mm were not advanced (Allman et al. 2019; see SEDAR100-DW-14). The LHWG explored updating the ageing algorithm used for assigning calendar age to reduce mis assignment of young fish to incorrect year classes. Length-frequency histograms by month and calendar-age assignment indicated a large portion of young fish from age-0 to 2 were likely mis assigned using the previous algorithm. Frequency-histograms suggested that fish originally assigned a calendar age of 1 and collected from January through April should have been advanced to calendar age 2. Fish originally assigned a calendar age of 1 and collected from September through December should have been assigned to the previous age class (calendar age 0; Figure 2.14.4). The LHWG identified and investigated two potential sources of error that potentially required adjustment of calendar age assignments:

1. A settlement mark may have been incorrectly identified as a true annulus
2. Incorrect adjustments based on the previous algorithm

To further explore potential settlement mark misidentification, Panama City Lab personnel re-aged dorsal spines for fish with annuli counts of 0 or 1 that were caught from September through December and were < 250 mm FL (n = 134 total; data provider = NMFS Panama City). Trawl-collected, age-0 gray triggerfish showed settlement marks on dorsal spine sections when fish were between 40 and 160-mm FL (Ingram, 2001; SEDAR 9, 2006). The settlement mark can be extremely similar to the first true translucent zone of a dorsal spine annulus in young fish (age-1 and age-2). Fioramonti (2012, Masters Thesis), estimated that the first annulus was 1.5 mm +/- 0.04 mm, and this estimate was used as a guide during visual reinspection by Panama City Lab personnel, which resulted in n = 56 ages being changed from an age-1 to age-0. In response to the first source of error: Panama City Lab personnel also re-aged samples that appeared as potential outliers in the data for fish with an annuli count of 2 that were caught from April through May with a FL >400 mm (data provider NMFS Panama City), which resulted in n = 29 ages being changed to between 3 and 7 years old. In response to the second source of error, the LHWG discussed whether or not to adjust the ageing algorithm used for SEDAR43. Alternative approaches were discussed, such as using edge type assignments to advance or subtract year classes, which is common practice for many other fishery species. However, because a single annual peak in translucent edge formation was not apparent in the data (Figure 2.14.5), coupled with the fact that edge type was not determined or unreliably determined for many samples aged with the previous ageing protocol, the LHWG deemed edge-type assignments an unreliable solution to adjusting the calendar-age algorithm. Otherwise, annuli count equaled calendar age. Edge type was not used to assign calendar age given the inherent difficulty in assigning edge type, which requires estimating the proportion of total annulus formation. Fractional age was calculated using the established birthdate of July 1, which corresponds to the average peak spawning date of gray triggerfish in the Gulf (Allman et al. 2018; Kelly-Stormer et al. 2017). Each spine was aged independently of fish length and date of capture.

The LHWG also explored the use of ELEFAN with age slicing as an alternative approach to the calendar-age advancement algorithm used in SEDAR43. ELEFAN was used to fit a seasonally-oscillating von Bertalanffy growth function (VBGF) to monthly length-frequency data of fishery independent samples with annuli less than 3. This was done to ensure that the samples were not impacted by regulatory selectivity (i.e., minimum length limits) and focus on the age classes where modal progressions were most obvious. A VBGF model was fit to the data using the function ELEFAN_GA with the R package *TropFishR* using the following settings: 2-cm length bins, moving average = 5, Maxage = 4, Maxiter = 1000, t_anchor (time at length 0) originally estimated then fixed at optimal (0.17, March) for reproducibility. The resulting parameter estimates (Figure 2.14.6) were L_∞=57.06 mm FL, K=0.33yr^{-1}, t_{anchor}= 0.17 years, C = 0.67 (amplitude of growth oscillation where 0 is no seasonal growth and 1 is complete growth cessation during the unfavorable season), and t_s=0.56 (starting point of the growth oscillation as a fraction of the year when the period of slowest growth begins). The group determined that age slicing using ELEFAN was useful for correcting the calendar age of fish with annuli counts of 0 and 1, but not recommended beyond that as modes became less distinct with age. Age slicing (Figure 2.14.7) was applied to the entire dataset of samples with annuli counts of 0 and 1 (both fishery dependent and independent samples) using the growth parameters estimated in the previous step. The slicing was done using the point midway between the lower length bin of calendar age + 1 month and calendar age + 1 year (Figure 2.14.7). Of the 352 samples with annuli count = 0, n = 331 were assigned a calendar age of 0 and n = 21 were assigned a calendar age of 1. Of the 375 samples with annuli count = 1, n=167 were assigned a calendar age of 0, n = 163 a calendar age of 1, n = 25 a calendar age of 2, and n = 20 a calendar age of 3 (Figure 2.14.8).

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2.4.1 Recommendations for SEDAR 100

The LHWG recommends that calendar age for samples with annuli counts of 0 or 1 be assigned according to the age slicing algorithm developed using ELEFAN during the data workshop. For all other samples (annuli counts of 2 and up), the annulus count should equal the estimated calendar age.

2.5 GROWTH

Growth (length-at-age) was modeled with von Bertalanffy growth functions (VBGF) estimated in AD Model Builder (Fournier et al., 2012). The length-at-age data used to model growth included all data used in SEDAR43, but with ages for fish 5+ years updated using the new ageing protocol, as well as data from the new data period. Growth models were fit under four different scenarios: 1) sex-specific models; 2) sexes combined; 3) sexes combined but with size-correction for minimum length limits (MLLs) using the updated Diaz method (Diaz et al. 2004); or 4) region-specific models (i.e., East vs West of the MS river outflow) with sexes combined and without size-correction. Although gray triggerfish are known to exhibit sexually dimorphic growth (Kelly-Stormer et al. 2017; Jefferson et al. 2019; Chamberlain et al. 2025), the life-history data submitted for SEDAR100 did not provide sufficient contrast to fit sex-specific growth models (Figure 2.14.9). Likewise, the data did not support modeling growth separately for fish from the eastern or western Gulf (Figure 2.14.10). However, applying the size-correction method to the growth model with sexes combined greatly improved model fit based on visual inspection of residual plots. The parameter estimates for the best-fit VBGF corrected for size-selectivity were L_∞= 468.37 mm FL, K=0.292 yr^{-1}, and t_0=-0.900 years (Figure 2.14.11). Correcting the data for MLLs indicated that selectivity was particularly strong in the COM HL fleet.

2.5.1 Recommendations for SEDAR 100

The LHWG recommended the use of a single set of VBGF parameter estimates (for sexes combined and without regional delineation) to describe gray triggerfish growth in the assessment. The parameter estimates for the best-fit VBGF corrected for size-selectivity were L_∞=468.37 mm FL, K=0.292 yr^{-1}, and t_0=-0.900 years.

2.6 READER PRECISION/AGEING ERROR

The primary age data providers (# of readers; % of total samples aged) for SEDAR100 were NMFS Panama City (two expert readers; 61.54%) and FWRI (one expert reader; 23.12%). Prior to production ageing, each ageing laboratory reviewed and aged the reference set (n=115 spine thin sections with consensus ages) developed for gray triggerfish to ensure comparable reading methodologies and allow for ageing error estimation. The consensus ages for the reference set were established by expert gray triggerfish readers from the South Atlantic (Jennifer Potts and Walt Rogers) using the protocol described in Potts et al. (2023). Given that gray triggerfish are considered a difficult species to age, an individual with an average percent error (APE) of ≤10% for the reference set was considered acceptable to begin production ageing. Bias plots and estimates of precision were calculated using the *FSA* (Fisheries Stock Analysis) package in R (Ogle et al. 2025). Bland-Altman plots with statistical comparisons (paired t-tests, ∝=0.05) of each reader's reference set age estimates indicated there was no significant bias observed for any age class from any of the three readers that provided age data for SEDAR100 (Figure 2.14.12).

Ageing error estimates were provided only for the new data period (2018-2024) and were estimated by fitting a single error model to all three sets of age estimates for the gray triggerfish reference set. Candidate models were fit to mode-predicted ages under several different scenarios to estimate bias and precision using the Northwest Fisheries Science Center's *agingerror* package in R (Punt et al. 2008). Bias models included options for no bias or linear bias. Precision model scenarios included parameters that estimated a 1) constant coefficient of variation (CV), 2) curvilinear SD, 3) curvilinear CV, 4) SD that varied as a linear function of age, or 5) CV that varied as a linear function of age. Consensus age estimates for the reference set were assumed to have imprecision but no bias. Precision parameter estimates were mirrored (i.e., each of the three reader-specific data sets were treated as replicates and modeled together) to produce a single SD-at-age matrix, for input into the stock assessment. A single, generalized SD-at-age matrix is estimated for use in the assessment model because each ageing lab provides estimates for multiple fisheries (i.e., recreational, commercial, or fishery independent) which are confounded among data sets input into the assessment model's data structures. Akaike's information criterion (AIC), its form corrected for small sample size (AICc), and Bayesian information criterion (BIC) along with diagnostic plots of expected values, expected confidence intervals (CI's), and SD were used to select the best fit model to describe ageing error and provided to stock assessment analysts. Ageing error models were not estimated separately for each subregion because there is no evidence to suggest a difference in readability among regions. Although bias was slightly apparent it was not significant in Bland-Altman plots from the FSA package. However, the model that best-fit ageing error data was one that estimated linear bias and curvilinear SD in precision-at-age (Table 2.13.3; Figure 2.14.13).

2.6.1 Recommendations for SEDAR 100

The LHWG recommends including the ageing-error matrix with linear bias and curvilinear SD for describing ageing error in the stock assessment model.

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2.7 NATURAL MORTALITY

In SEDAR43, target *M* was estimated using the Hoenig (1983) method, assuming a maximum age (t_{max}) of 15 years, and scaled at age using the Lorenzen (1996) method. The LHWG group discussed two alternative estimators to estimated *M* in SEDAR100: Then et al. (2015), and Hamel and Cope (2022). The Then et al. (2015) estimator is essentially the Hoenig (1983) approach revisited using an updated and larger dataset where $M = 4.899t_{max}^{-0.916}$. Hamel and Cope (2022) re-evaluated the approach used by Then et al. (2015) and recommended an alternative relationship be used where $M = \frac{5.4}{t_{max}}$. This estimator evaluates Then et al.'s (2015) updated dataset of *M* and maximum age using a more appropriate transformation than was used by Then et al. (2015) (see Hamel and Cope 2022 for more detail on the approach). The LHWG agreed that the Hamel and Cope (2022) estimator was an improvement over the Then et al. (2015) estimator and should be used in SEDAR100.

2.7.1 Recommendations for SEDAR 100

The LHWG recommends continuing to use a maximum age (t_{max}) estimate of 15 years and a minimum/fully selected age of 3 when estimating *M*. The LHWG recommends the Hamel and Cope (2022) equation be used to estimate target *M* (*M*=0.36) and then scale target *M* to age-specific values using the Lorenzen (1996) function (Table 2.13.4 and Figure 2.14.14).

2.8 LENGTH COMPOSITIONS

2.8.1 Commercial

Weighting methodology and final nominal and weighted length compositions for the commercial handline and longline fleets were presented in SEDAR100-DW-07, with preliminary compositions presented in the main paper, and updated final compositions presented in the appendix. The discussion of commercial length compositions at the workshop focused on available sample sizes for a potential 2 area model (East/West) vs. an all-Gulf model, and the potential for splitting longline out as its own fleet vs. proceeding with a single commercial fleet. A minimum sample size of n=30 fish was used to determine suitability of the length compositions. It was also recommended that the samples come from a minimum of n=10 trips to maintain spatial representativeness of samples. However, such a threshold can greatly reduce the amount of data available for use in the assessment, so a 10-trip threshold was used to identify low sample sizes but samples were not excluded if the number fell below that threshold.

When considering a 2-area model, sample sizes for nominal length compositions were sufficient in all years from 1990-2024 for HL samples from the East region, but sample sizes from the HL fleet in the West region were insufficient in some years. For the LL fleet, LL samples from the

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East were sufficient to estimate nominal length compositions in roughly half of the years but were insufficient in all years for samples from the West region (for which only a few years had any data). For weighted length compositions, sample sizes for the HL fleet were insufficient for both the East and West regions in several years, while all years had insufficient data to estimate weighted length compositions for the LL fleet in either region. Data suitability for the COM 2-area model is shown in Table 2.13.5.

When considering an all-Gulf model, the HL fleet had sufficient sample sizes for a nominal length composition in all years from 1990-2024, while the LL fleet had sufficient sample sizes to estimate nominal length compositions in approximately half of the years. For weighted length compositions, the HL fleet had sufficient sample sizes in most years, while the LL fleet had insufficient sample sizes in all years. Data suitability for the commercial all-Gulf model is shown in Table 2.13.6.

2.8.2 Recreational

Final nominal and weighted length compositions are presented in Figures A1-A4 of SEDAR100-DW-04. Most of the discussion in the LHWG section focused on evaluating whether the length compositions were suitable for inclusion in the assessment. For the Gulf-wide or East stocks, all years had sufficient sample sizes (nfish ≥30 and ntrip ≥10) to estimate nominal length compositions (Table 2.13.7). For the West stock, there were insufficient sample sizes for most years after 2013. In the mid-1980s to early 2000s, there were sufficient samples to either estimate weighted compositions Gulf-wide, or separately for East and West stocks, however sample sizes were insufficient for the later part of the time series (Table 2.13.7).

2.8.3. Recommendations for SEDAR 100

The LHWG recommended: 1) proceeding with an all-Gulf model due to the limited data available for estimating compositions separately for the East and West in some years; and 2) using weighted length compositions when sufficient data are available and nominal length compositions for years when weighting is not possible. Use of nominal vs. weighted compositions should be compared to evaluate if weighting is having a large impact on compositions.

2.9 AGE COMPOSITIONS

2.9.1 Commercial

The weighting methodology and final nominal and weighted age compositions are presented in the appendix of SEDAR100-DW-07. For age compositions, the minimum sample size required for suitability was n=10 fish from n=10 trips. However, as with the length compositions, the number of trips was not used as a hard cutoff due to the potential reduction in data availability. Sample sizes for both a 2-area model (East/West) and an all-Gulf model were considered.

When considering the 2-area model, the HL fleet in the East region had sufficient sample sizes for estimating nominal age compositions in all years from 2003-2024, while data for the HL fleet in the West were sufficient in 2009, and 2011-2024. For the LL East fleet, sample sizes were sufficient for nominal compositions from 2004-2024, with the exception of 2020. For the West LL fleet, sample sizes were insufficient in all years to estimate nominal age compositions. For weighted age compositions, there were sufficient sample sizes for the HL East fleet from 2011-2024, while for the HL fleet in the West had only a few years with sufficient sample sizes. For both the LL fleets in East and West, there were insufficient sample sizes in all years to develop weighted age compositions. Data suitability for the COM 2-area model is shown in Table 2.13.5.

When considering the all-Gulf model, the HL fleet had sufficient sample sizes for nominal age compositions in all years from 2003-2024, and the LL fleet had sufficient sample sizes for nominal age compositions in all years from 2003-2024, except for 2020. For weighted age compositions, the HL fleet had sufficient sample sizes in most years, while the LL fleet had insufficient sample sizes in all years. Data suitability for the COM all-Gulf model is shown in Table 2.13.6.

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2.9.2 Recreational

Final nominal and weighted age compositions are presented in Figures A5-A11 in SEDAR100-DW-04. Weighted age bubble plots are also provided in the Recreational Fishery Statistics section of this report. Most of the discussion in the LHWG focused on evaluating whether the age compositions were suitable for inclusion in the assessment. Only 6 years have sufficient sample sizes (nfish ≥10 and ntrip ≥10) to estimate nominal age compositions in the West region while the Gulf-wide and East stocks have sufficient sample sizes for all years (Table 2.13.7). Weighted length compositions are used to produce weighted age compositions. Weighted age compositions were only available to be produced for 5 years in the West, 8 years in the East, and 12 years Gulf-wide because of insufficient sample sizes for weighted length compositions and/or insufficient number of age samples (Table 2.13.7). Sample sizes in the West were low for conditional age-at-length (CAAL) and mean length-at-age in the West, but are sufficient in the East and Gulf-wide (Table 2.13.7).

2.9.3 Recommendations for SEDAR 100

The LHWG recommends comparing nominal and weighted age compositions to evaluate whether the weighting procedure is dramatically influencing age compositions. If weighting is not having a large impact, they recommend using nominal age compositions. If weighting is having a large impact, consider only using weighted age compositions for the years they are available. The group also recommends using conditional age-at-length (CAAL) where data are sufficient, but recognizes it may not be informative for many fleets because of insufficient contrast across age classes. They also recommend using mean length-at-age (MLAA) to aid in model diagnostics.

2.10 REPRODUCTION

There have been no significant updates to the available maturity or fecundity information when compared to analysis conducted in SEDAR43 (SEDAR, 2015). While 406 reproduction samples were provided by University of Southern Mississippi/Alabama Department of Conservation Natural Resources, the vast majority were outside the months used in reproductive analyses (June-August) conducted during SEDAR43. In addition, no age estimates or batch fecundity estimates were provided.

2.10.1 Recommendations for SEDAR 100

Following recommendations made during SEDAR 74 for Gulf red snapper, the LHWG suggested that the assessment analyst utilize spawning stock biomass as the measure of reproductive potential within the stock assessment model instead of batch fecundity estimates which were used in SEDAR43. The assessment model treats batch fecundity as known and does not take into account uncertainty. The batch fecundity estimates recommended during SEDAR 43 were based on 73 individuals between 26 and 39 cm FL (~2 – 6 years).

2.11 RESEARCH RECOMMENDATIONS

The LHWG drafted the following recommendations:

- Continue refining ageing algorithms for assigning calendar and fractional ages. This includes further research into the use of edge type, which requires that age readers record narrow versus opaque margin codes to get a better understanding of seasonality of annulus formation.
- Consider evaluating maturity-at-age given the ageing issues identified for ages 0-2
- Continue to examine data for region- and sex-specific differences in growth as data accrue over time.
- Continue to recommend that all age-data providers read the gray triggerfish reference set following the Potts et al. (2023) protocol prior to conducting any production ageing.
- Consider exploring epigenetic ageing as a complementary approach to gain insight into sex-specific growth and to potentially improve confidence in age-class assignments.

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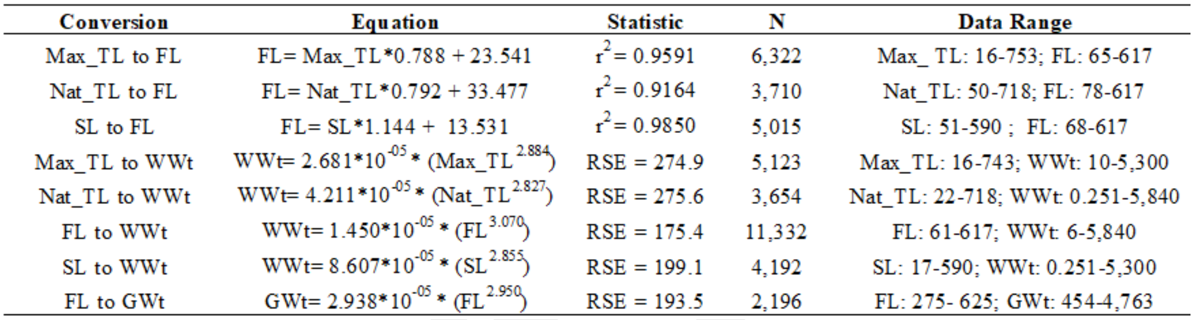
2.13 TABLES

Table 2.13.1. Meristic regressions for gray triggerfish (1999-2024) from the Gulf of America. Data is combined from all data sources, both fishery dependent and independent, and includes data without ages if length and/or weight information was provided. Length Type: Max_TL- Maximum total length, FL- Fork length, Nat_TL – Natural total length, SL- Standard length. Weight Type: GWt- Gutted weight when "Condition Type" = "Gutted-head on", WWt- Whole weight. Units: length (mm) and weight (g). Linear and nonlinear regressions were calculated using R (lm and nls functions, respectively).



Conversion	Equation	Statistic	N	Data Range
Max_TL to FL	$\text{FL}= \text{Max\_TL}*0.788 + 23.541$	$r^2 = 0.9591$	6,322	Max_ TL: 16-753; FL: 65-617
Nat_TL to FL	$\text{FL}= \text{Nat\_TL}*0.792 + 33.477$	$r^2 = 0.9164$	3,710	Nat_TL: 50-718; FL: 78-617
SL to FL	$\text{FL}= \text{SL}*1.144 + 13.531$	$r^2 = 0.9850$	5,015	SL: 51-590 ; FL: 68-617
Max_TL to WWt	$\text{WWt}= 2.681*10^{-05} * (\text{Max\_TL}^{2.884})$	RSE = 274.9	5,123	Max_TL: 16-743; WWt: 10-5,300
Nat_TL to WWt	$\text{WWt}= 4.211*10^{-05} * (\text{Nat\_TL}^{2.827})$	RSE = 275.6	3,654	Nat_TL: 22-718; WWt: 0.251-5,840
FL to WWt	$\text{WWt}= 1.450*10^{-05} * (\text{FL}^{3.070})$	RSE = 175.4	11,332	FL: 61-617; WWt: 6-5,840
SL to WWt	$\text{WWt}= 8.607*10^{-05} * (\text{SL}^{2.855})$	RSE = 199.1	4,192	SL: 17-590; WWt: 0.251-5,300
FL to GWt	$\text{GWt}= 2.938*10^{-05} * (\text{FL}^{2.950})$	RSE = 193.5	2,196	FL: 275- 625; GWt: 454-4,763

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Table 2.13.2. Number of gray triggerfish (final) age samples (n =19,407) collected from the Gulf of America from 1999 to 2024 by data provider. Black line indicates the terminal year for SEDAR 43 (i.e., 2013). No age samples were collected during 2001.

YEAR	FWRI	GulfFIN	AGR	BSD	USA/DISL	
1999	0	0	0	0	2	
2000	0	0	0	0	3	
2002	0	0	0	0	60	
2003	0	0	149	0	0	
2004	0	0	167	0	0	
2005	0	0	269	0	0	
2006	11	0	259	0	0	
2007	28	296	206	0	0	
2008	0	191	424	0	0	
2009	0	173	574	0	0	
2010	81	27	331	0	55	
2011	48	191	227	187	66	
2012	91	126	407	298	17	
2013	42	131	495	495	29	
2014	76	7	232	405	26	
2015	125	6	148	775	57	
2016	164	1354	433	664	599	
2017	126	192	57	594	337	
2018	116	691	254	757	0	
2019	30	287	126	803	0	
2020	4	261	109	290	0	
2021	16	347	82	83	0	
2022	116	344	74	491	0	
2023	15	306	280	440	0	
2024	32	162	0	358	0	
Total (n)	1121	5092	5303	6640	1251	19407
%	5.78	26.24	27.33	34.21	6.45	100.00

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Table 2.13.3. Estimates of expected age and standard deviation-at-age fit to consensus age estimates from the gray triggerfish reference set using the NWFSC *ageingerror* package in R.

True_Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Expected_age	0.53	1.58	2.64	3.70	4.75	5.81	6.87	7.92	8.98	10.04	11.09	12.15	13.21	14.26
SD	0.394	0.394	0.463	0.529	0.592	0.651	0.707	0.761	0.811	0.859	0.904	0.947	0.988	1.026

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Table 2.13.4. Recommended values for age-specific natural mortality (M) for gray triggerfish in the Gulf of America. Target M was calculated using the Cope and Hamel (2022) estimator (M=0.36) then scaled to age-specific values using the Lorenzen (1996) function.

Age	Age-specific M
0	1.374
1	0.775
2	0.589
3	0.500
4	0.450
5	0.419
6	0.398
7	0.384
8	0.375
9	0.368
10	0.363
11	0.359
12	0.356
13	0.354
14	0.353
15	0.352

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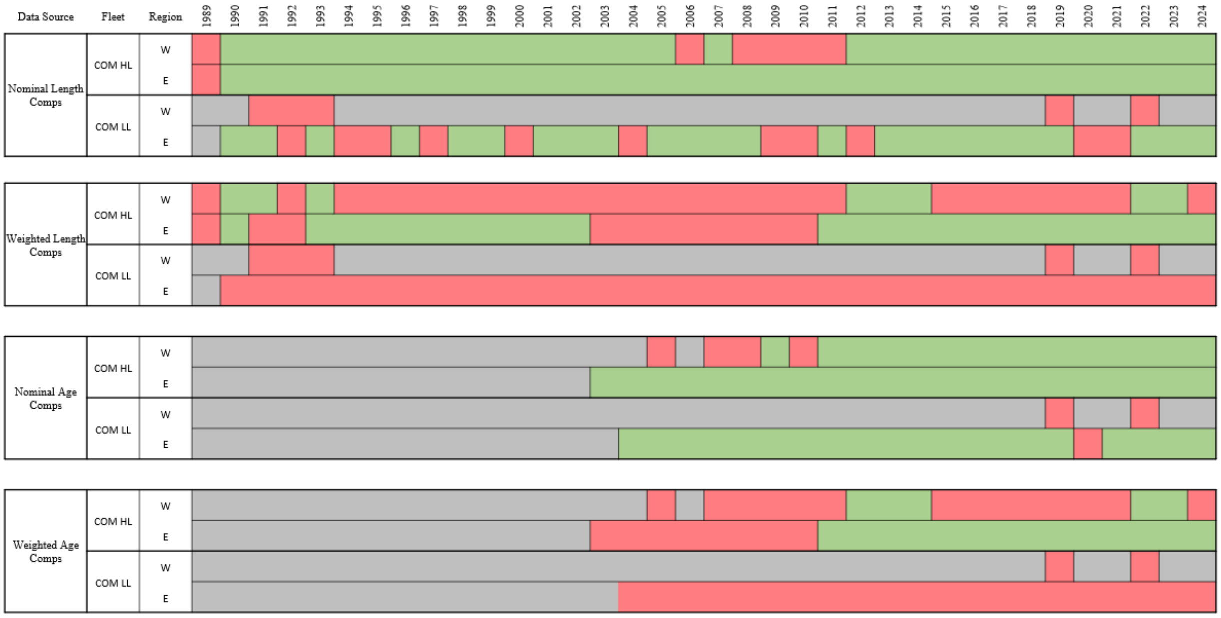
Table 2.13.5. Final recommendations regarding the suitability of the available length and age data for the Commercial Handline (COM HL) and Commercial Longline (COM LL) fisheries under a 2-area model scenario (East/West). Years in green are considered suitable, red are considered unsuitable, and gray have no available data. Suitability is shown for nominal length compositions, weighted length compositions, nominal age compositions, and weighted age compositions.



Data Source	Fleet	Region	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Nominal Length Comps	COM HL	W	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟩	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
		E	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	COM LL	W	⬜	⬜	🟥	🟥	🟥	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟥	⬜	⬜	🟥	⬜	⬜
		E	⬜	🟩	🟩	🟥	🟩	🟥	🟥	🟩	🟥	🟩	🟩	🟥	🟩	🟩	🟩	🟥	🟩	🟩	🟩	🟩	🟥	🟥	🟩	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟩	🟩	🟩
Weighted Length Comps	COM HL	W	🟥	🟩	🟩	🟥	🟩	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟥
		E	🟥	🟩	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	COM LL	W	⬜	⬜	🟥	🟥	🟥	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟥	⬜	⬜	🟥	⬜	⬜
		E	⬜	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
Nominal Age Comps	COM HL	W	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟥	⬜	🟥	🟥	🟩	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
		E	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	COM LL	W	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟥	⬜	⬜	🟥	⬜	⬜
		E	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟩	🟩	🟩	🟩
Weighted Age Comps	COM HL	W	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟥	⬜	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟥
		E	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	COM LL	W	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟥	⬜	⬜	🟥	⬜	⬜
		E	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥

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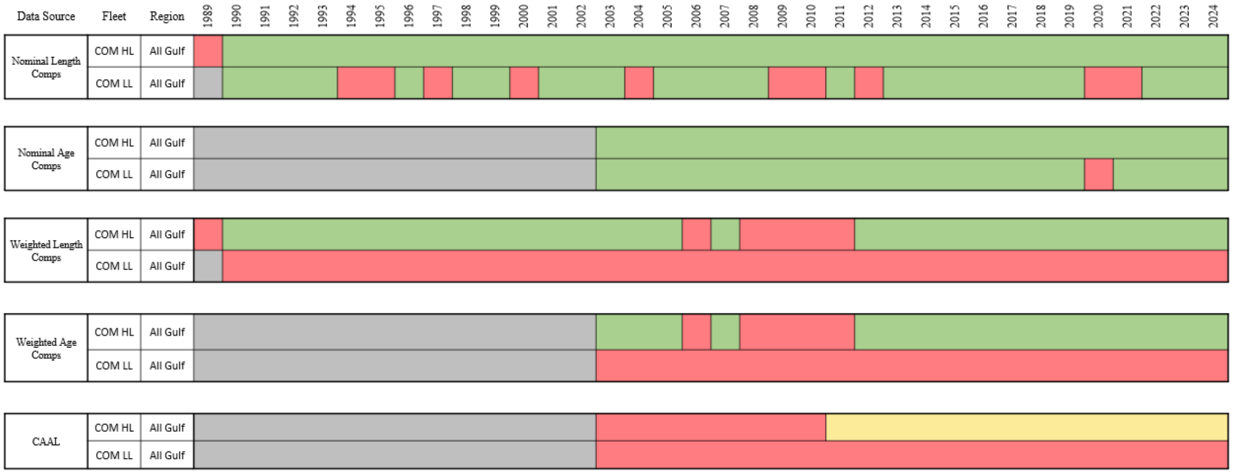
Table 2.13.6. Final recommendations regarding the suitability of the available length and age data for the Commercial Handline and Commercial Longline fisheries for an All Gulf model. Years in green are considered suitable, red are considered unsuitable, yellow is considered suitable on if informative in the model, and gray have no available data. Suitability is shown for nominal length compositions, weighted length compositions, nominal age compositions, and weighted age compositions, and conditional age-at-length (CAAL).



Data Source	Fleet	Region	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Nominal Length Comps	COM HL	All Gulf	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	COM LL	All Gulf	⬜	🟩	🟩	🟩	🟩	🟥	🟥	🟩	🟥	🟩	🟩	🟥	🟩	🟩	🟩	🟥	🟩	🟩	🟩	🟩	🟥	🟥	🟩	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟩	🟩	🟩
Nominal Age Comps	COM HL	All Gulf	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	COM LL	All Gulf	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟩	🟩	🟩	🟩
Weighted Length Comps	COM HL	All Gulf	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟩	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	COM LL	All Gulf	⬜	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
Weighted Age Comps	COM HL	All Gulf	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟩	🟩	🟩	🟥	🟩	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
	COM LL	All Gulf	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
CAAL	COM HL	All Gulf	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨
	COM LL	All Gulf	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥

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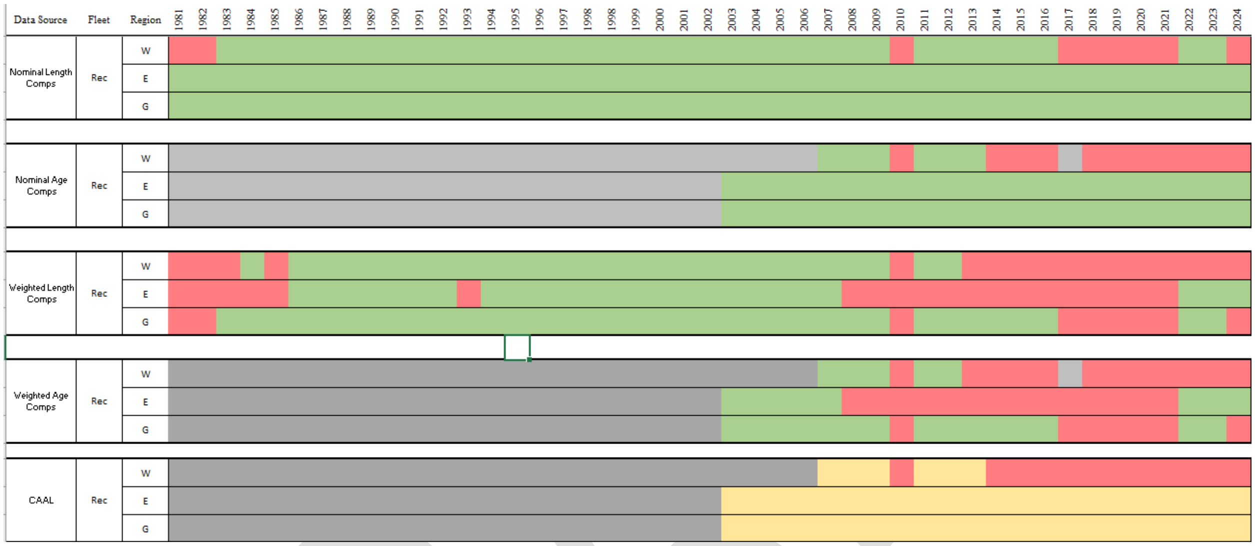
Table 2.13.7. Final recommendations regarding the quality of nominal length and age compositions, weighted length and age compositions, and conditional age-at-length (CAAL) for the recreational fishery for the West (W), East (E), and Gulf-wide (G) stocks. Years in green are deemed sufficient for use in the assessment, yellow are deemed questionable/potentially unreliable for use in assessment, and red are deemed insufficient/unacceptable for use in assessment. Years in gray have no data available.



Data Source	Fleet	Region	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Nominal Length Comps	Rec	W	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟥
		E	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
		G	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Nominal Age Comps	Rec	W	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟩	🟩	🟩	🟥	🟩	🟩	🟩	🟥	🟥	🟥	⬜	🟥	🟥	🟥	🟥	🟥	🟥	🟥
		E	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
		G	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Weighted Length Comps	Rec	W	🟥	🟥	🟥	🟩	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
		E	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟩
		G	🟥	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟥
Weighted Age Comps	Rec	W	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟩	🟩	🟩	🟥	🟩	🟩	🟥	🟥	🟥	🟥	⬜	🟥	🟥	🟥	🟥	🟥	🟥	🟥
		E	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟩
		G	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟩	🟩	🟥
CAAL	Rec	W	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟨	🟨	🟨	🟥	🟨	🟨	🟨	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥
		E	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨
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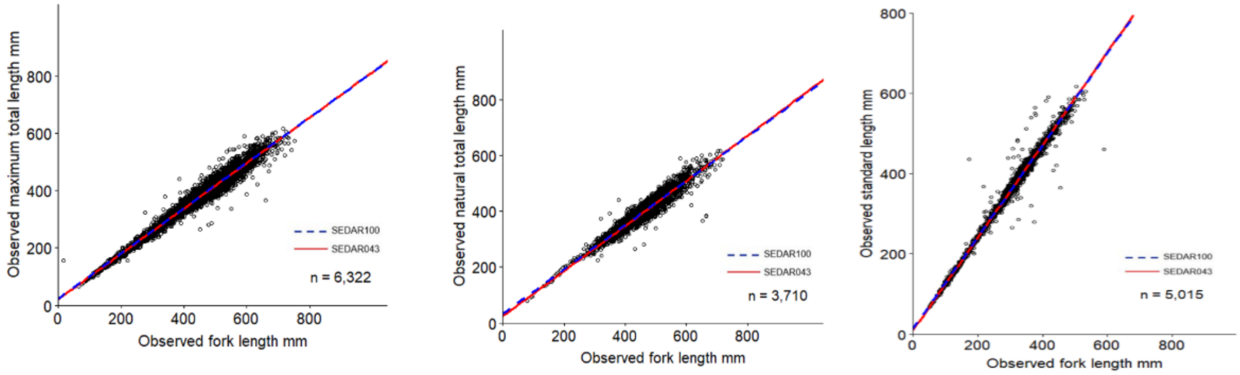
2.14 Figures

LENGTH VS LENGTH



LENGTH VS WEIGHT

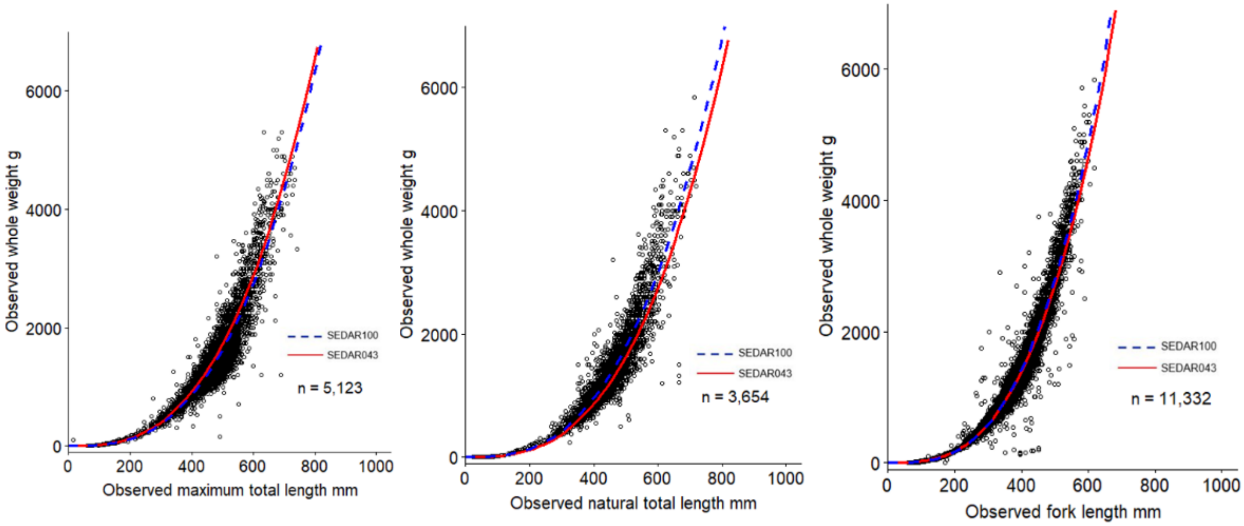


Figure 2.14.1. Scatterplots of observed fork length (FL; mm) versus observed maximum total length (MTL; mm), natural total length (NTL; mm), and standard length (SL; mm), and observed MTL, NTL, and FL versus observed whole weight (g) for SEDAR 43 compared to SEDAR 100 for gray triggerfish data collected from the Gulf of America from 1999-2024.

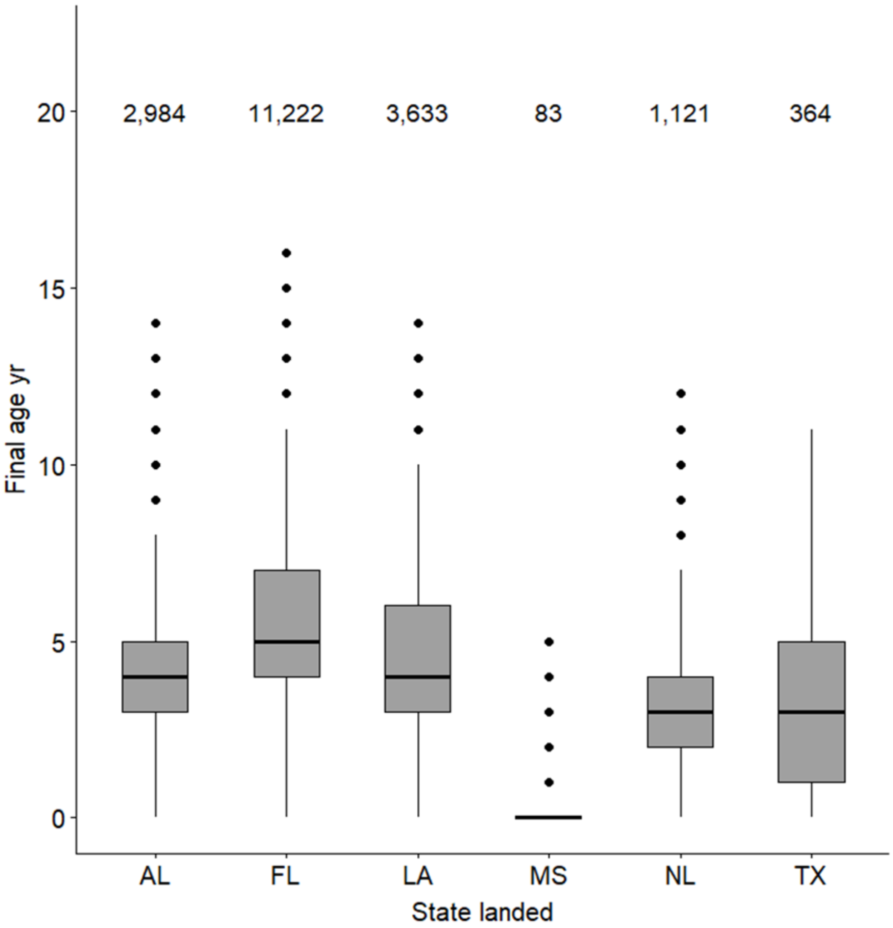


Figure 2.14.2. Boxplot of final age (yr) by state landed (Alabama, AL; Florida, FL; Louisiana, LA; Mississippi, MS; Not Landed, NL; Texas, TX) for gray triggerfish age samples collected from the Gulf of America from 1999 to 2024. No age samples were collected during 2001. Sample numbers are shown along the top of the figure. Boxes indicate the 25th and 75th percentiles, horizontal lines indicate median values, vertical lines indicate the min and max values of the IQR*1.5, and points indicate values outside that range.

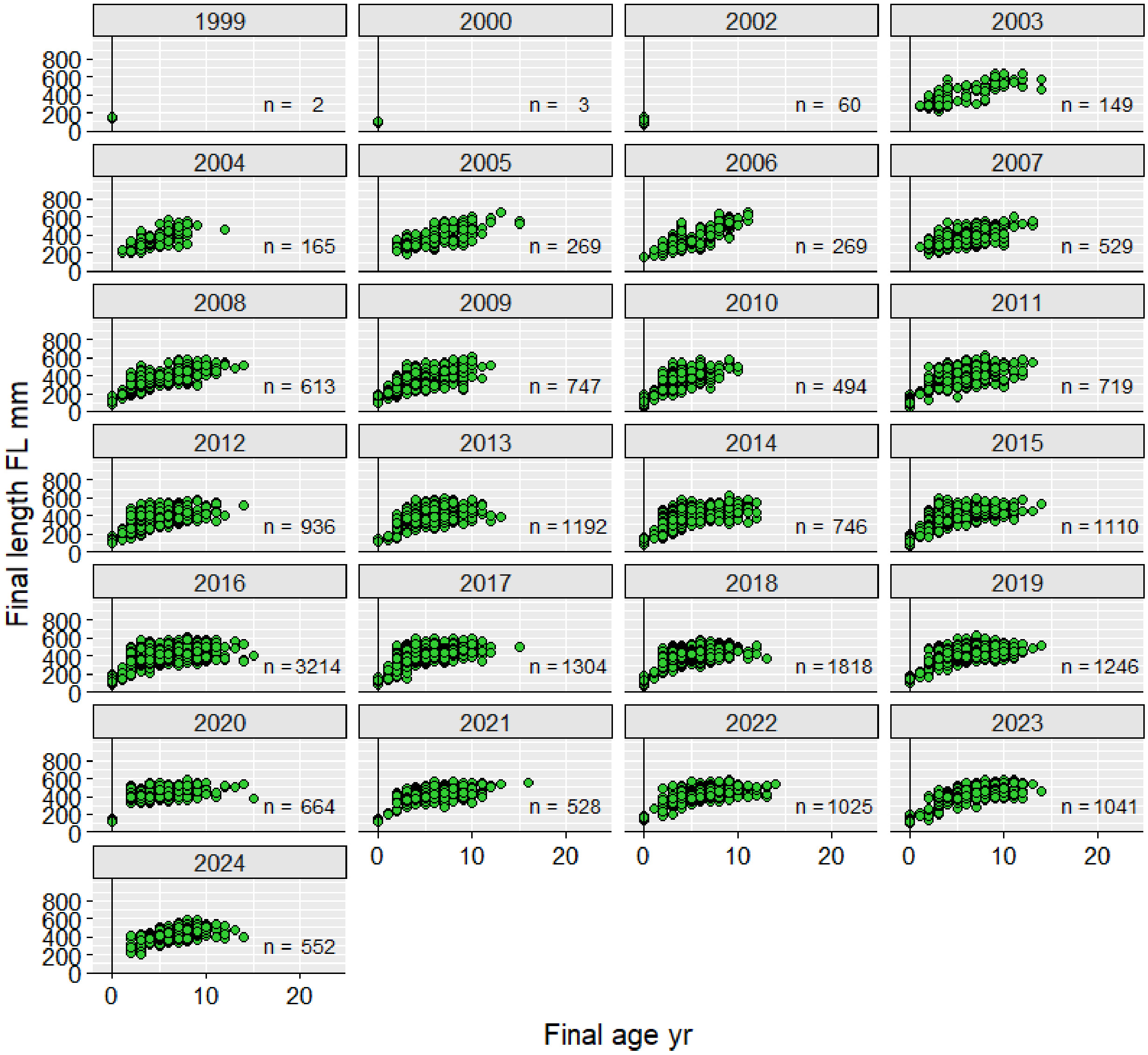


Figure 2.14.3. Scatterplots of final age (yr) at length (FL mm) for gray triggerfish samples collected from the Gulf of America from 1999 to 2024. No age samples were collected from 2001. The number of observations are shown at the bottom right of each panel.

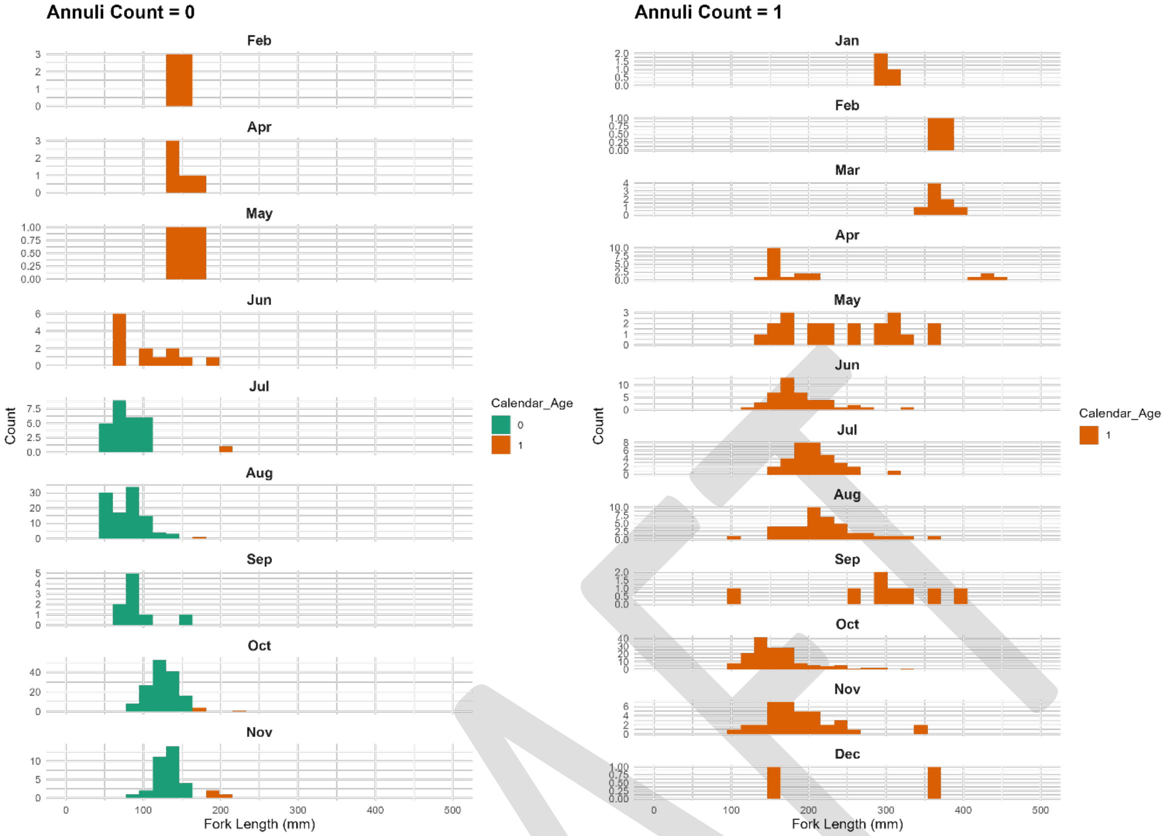


Figure 2.14.4. Monthly histograms of fish size for individuals with an annulus count of zero (left) and one (right). The calendar ages reflect the ages obtained using the SEDAR 43 age adjustment algorithm (fish caught between January and June with no visible translucent zones and fish caught from July to December with FL ≥ 160 mm were advanced by 1 year).

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Figure 2.14.5. Edge type assignment by month and annuli count for the samples where month and edge type were recorded (1,987 out of 20,544 samples). The timing of growth band formation remains unclear.

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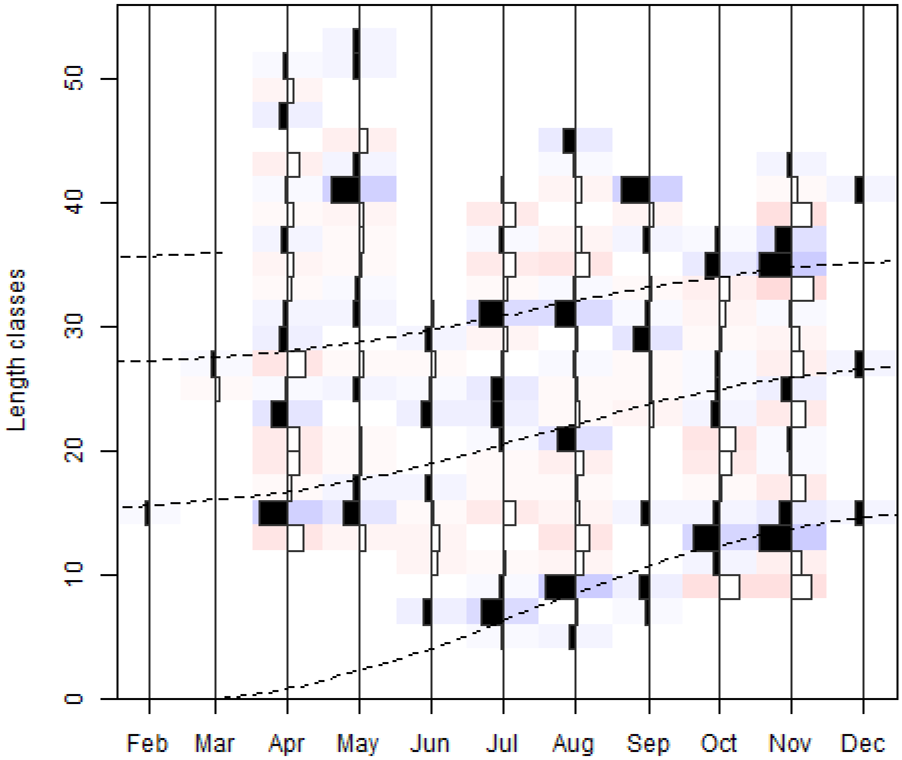

Figure 2.14.6. Monthly length frequency data (histograms) used in fitting the seasonally-oscillating von Bertalanffy growth model (dashed line).

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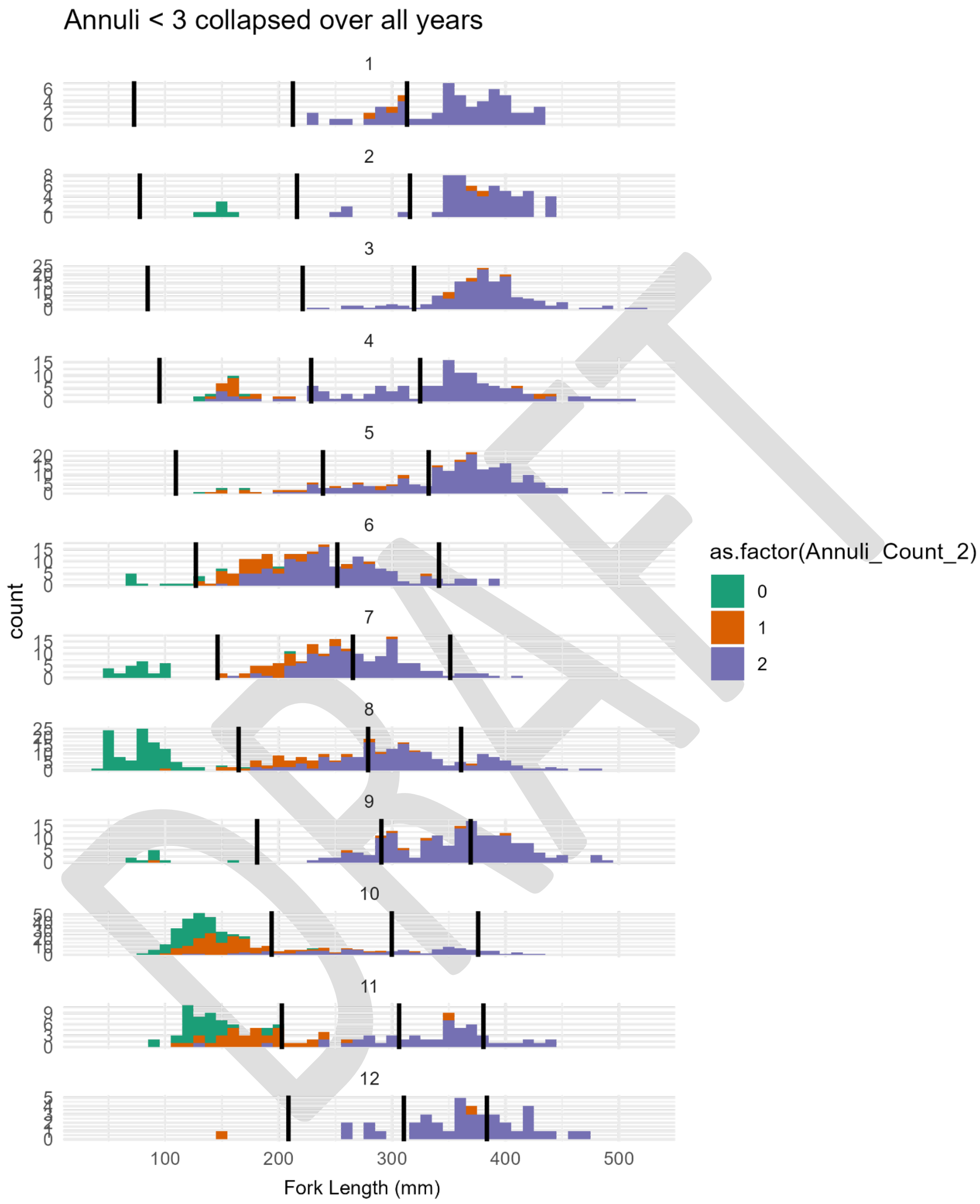

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Figure 2.14.7. Location of the age slicing (black vertical lines) against the monthly length frequency data of sample with annuli counts less than 3. Fish with annuli counts of 0 or 1 falling to the left of the first vertical line are assigned a calendar age of 0, fish between the first and second vertical lines a calendar age of 1, etc. Fish with annuli counts of 2 and beyond remained unaltered.

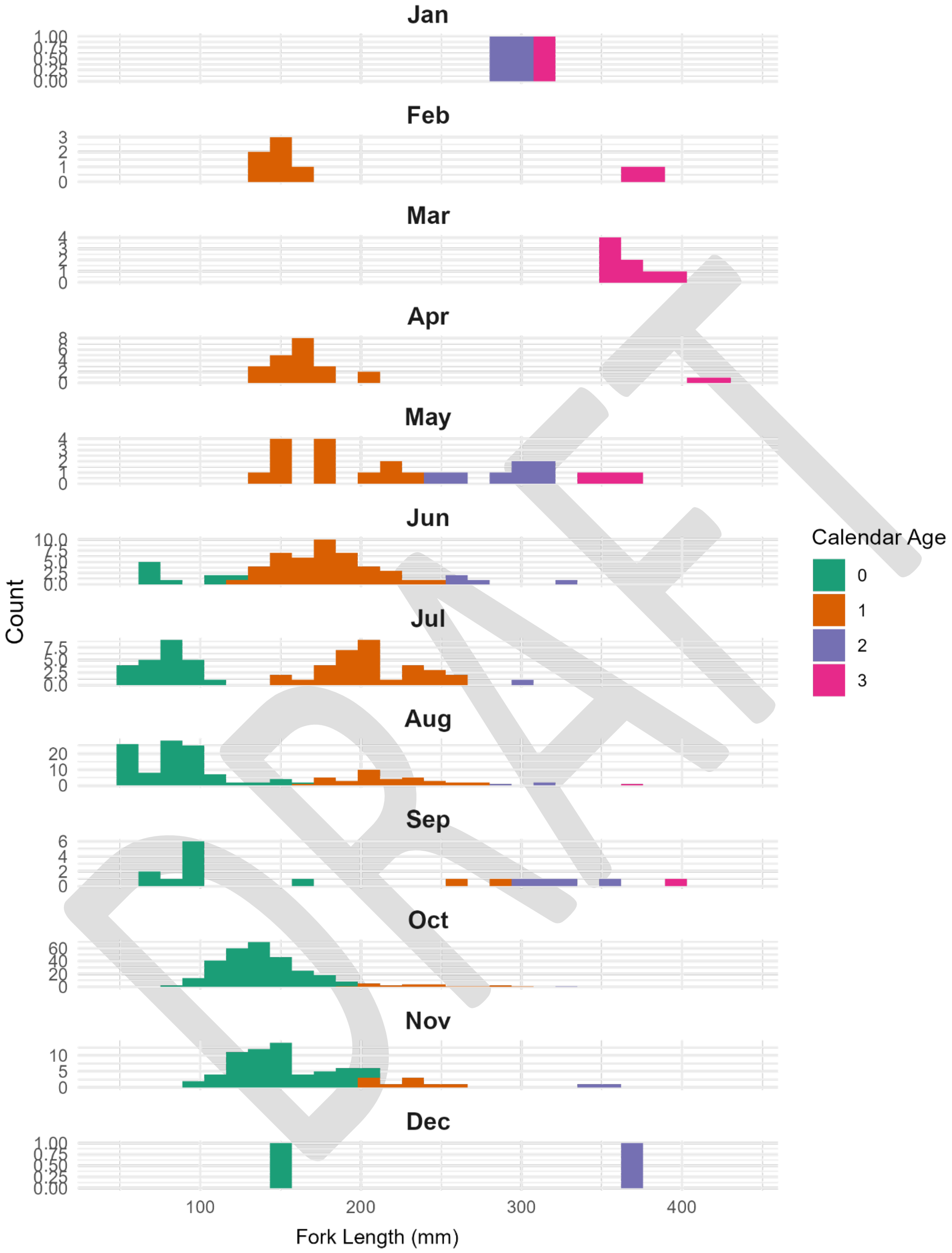

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Figure 2.14.8. New calendar age assignments for samples with annuli counts of 0 and 1 using ELEFAN and age slicing.

Population model – sex-specific

Male vs Female - Unweighted VBGF – constant σ

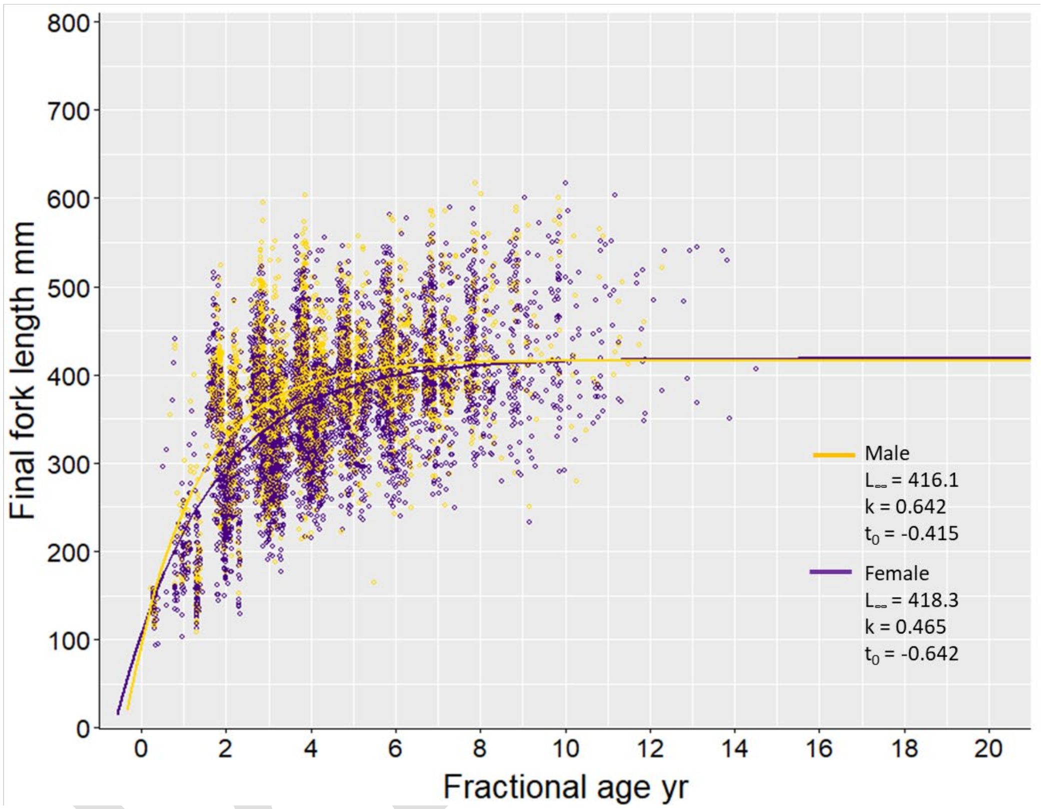

Figure 2.14.9. Von Bertalanffy growth models of gray triggerfish age-at-length (yr, mm) specified by sex. Males are indicated with yellow circles, while females are indicated with purple circles.

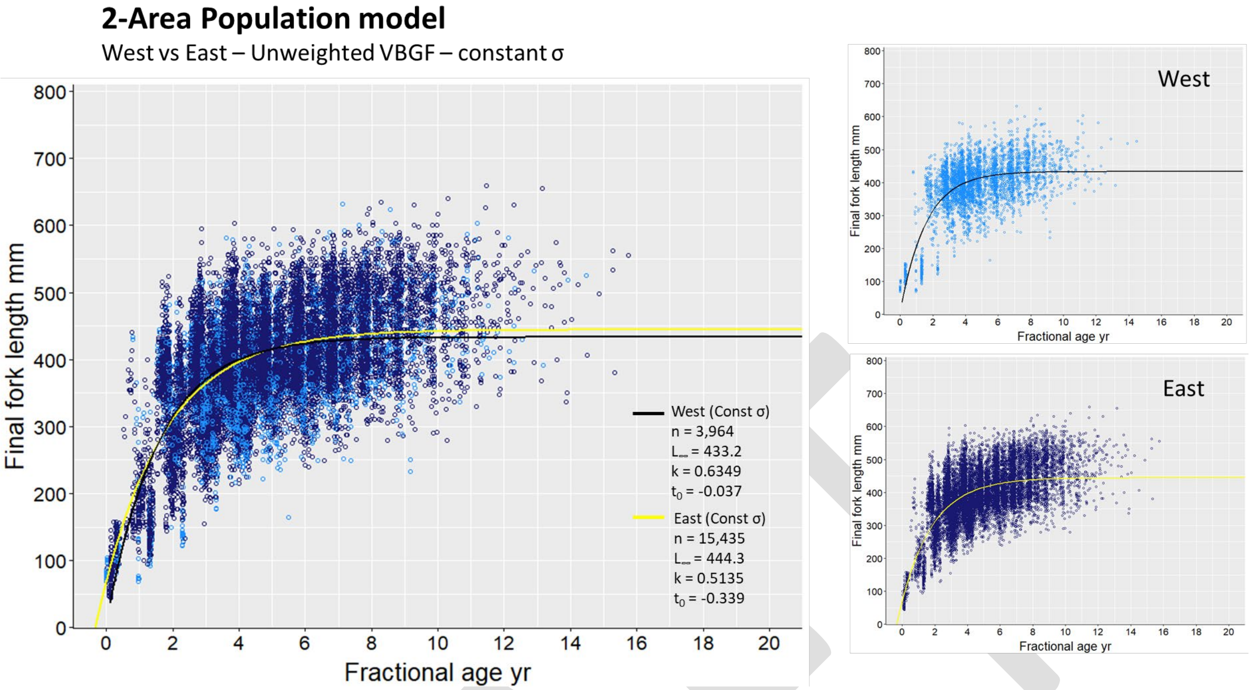

Figure 2.14.10. Von Bertalanffy growth models of gray triggerfish age-at-length (yr, mm) for fish collected from the East vs West Gulf of America (demarcated by the MS river outflow).

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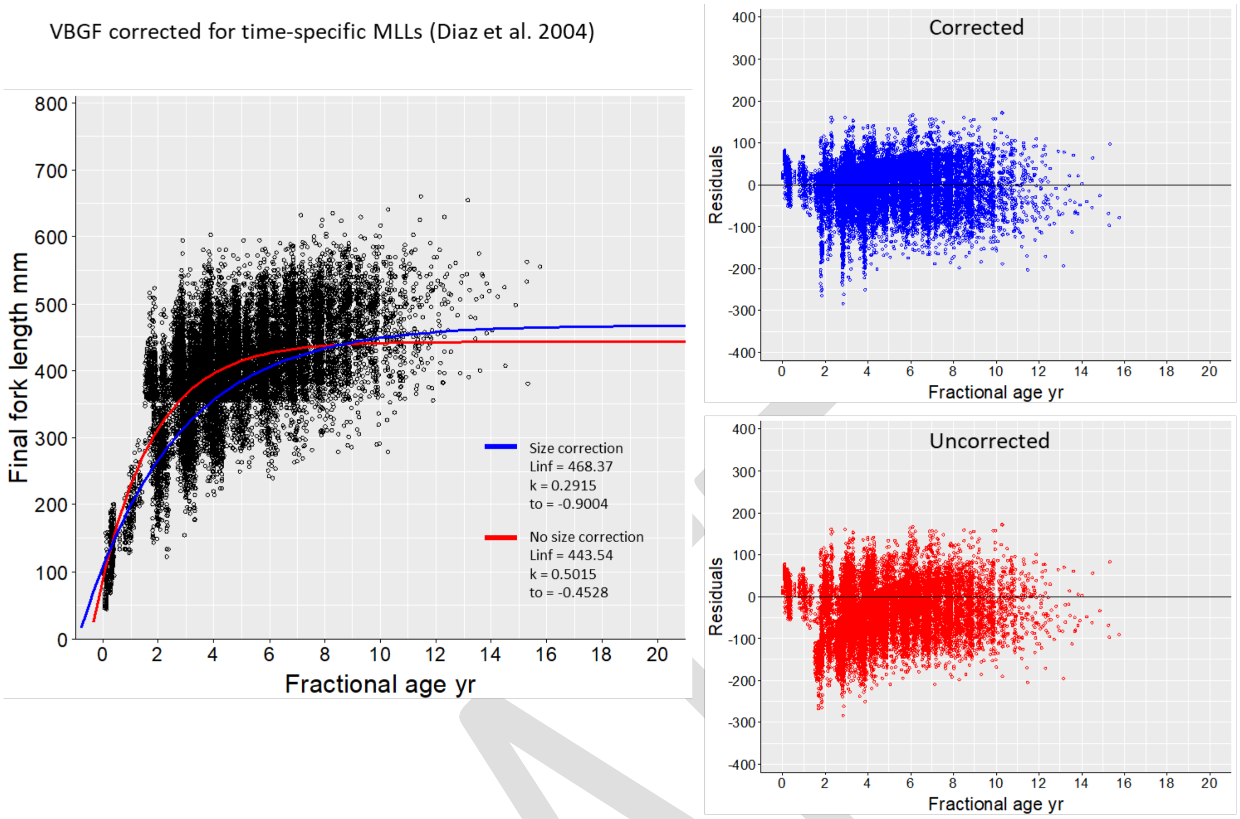

Figure 2.14.11. Von Bertalanffy growth models for gray triggerfish age-at-length (black circles; yr, mm) with lengths uncorrected (red circles, residuals) vs corrected (blue circles, residuals) for truncation due to minimum length limits (i.e., the Diaz method).

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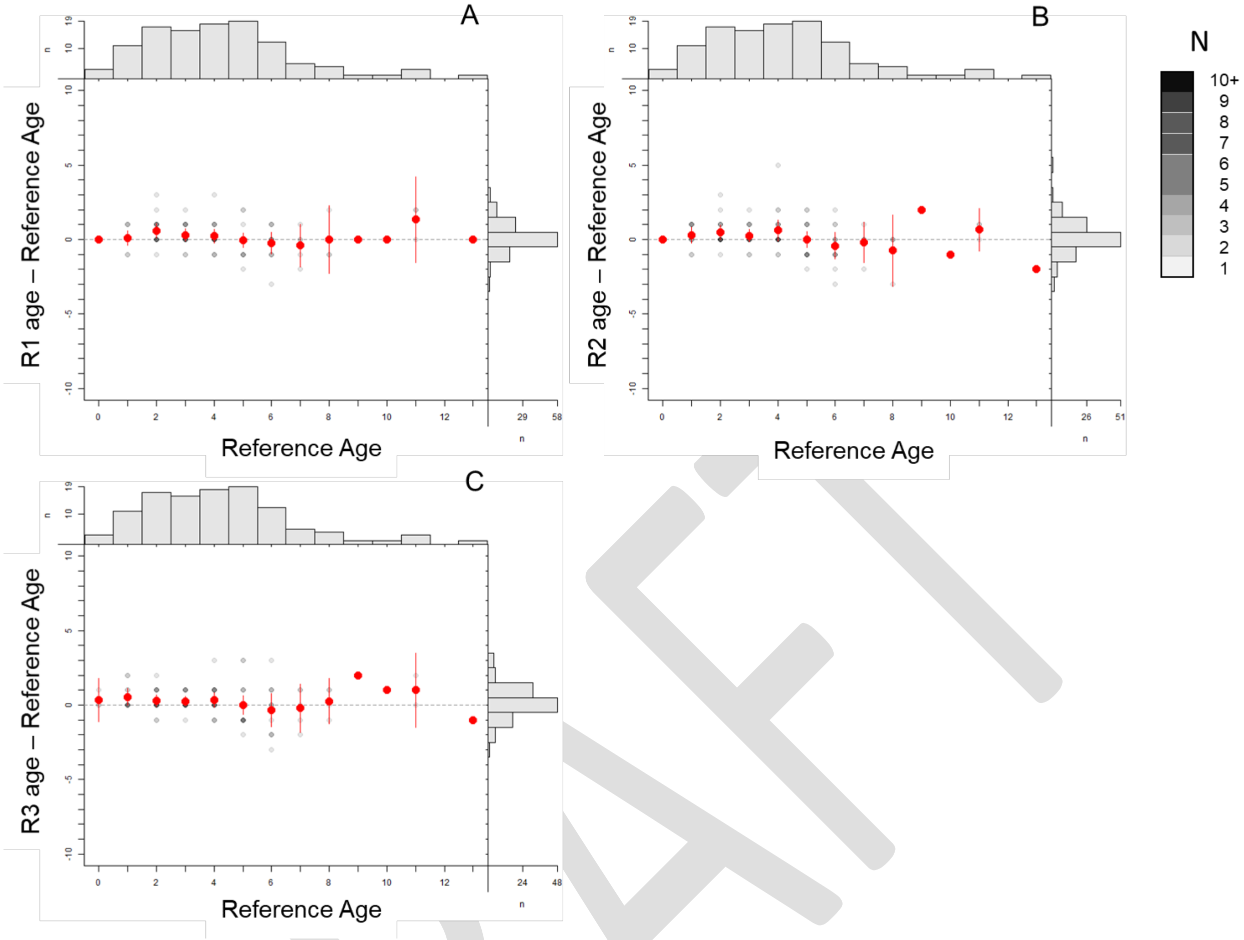

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Figure 2.14.12. Bland-Altman plots of reader-specific age estimates vs reference ages for readers from the NMFS Panama City Laboratory (panels A and B) and Florida Fish and Wildlife Research Institute (panel C). Gray-scale circles indicate the number of observations at each point; filled red circles indicate each reader’s mean age estimate for each reference age, open red circles indicate means that are significantly different from zero; vertical red lines indicate the standard error of the mean; and gray bars indicate sample sizes for the reference set (top of each plot) and reader-specific age differences (right of each plot).

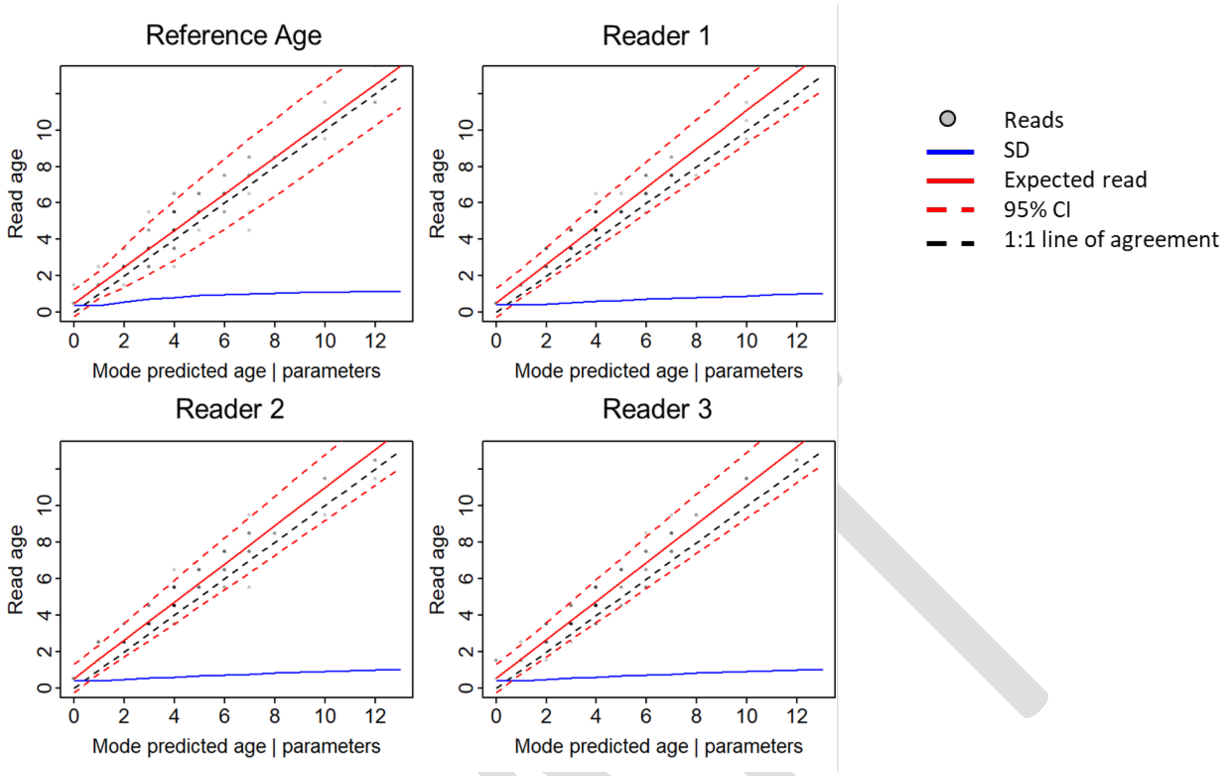

Figure 2.14.13. Output plot indicating ageing error- and bias-at-age estimates from the best-fit model applied to reader-specific age reads of the gray triggerfish reference set. Reader-specific parameters were fixed (i.e., mirrored) to estimate a single set of bias and error parameters for input into the stock assessment.

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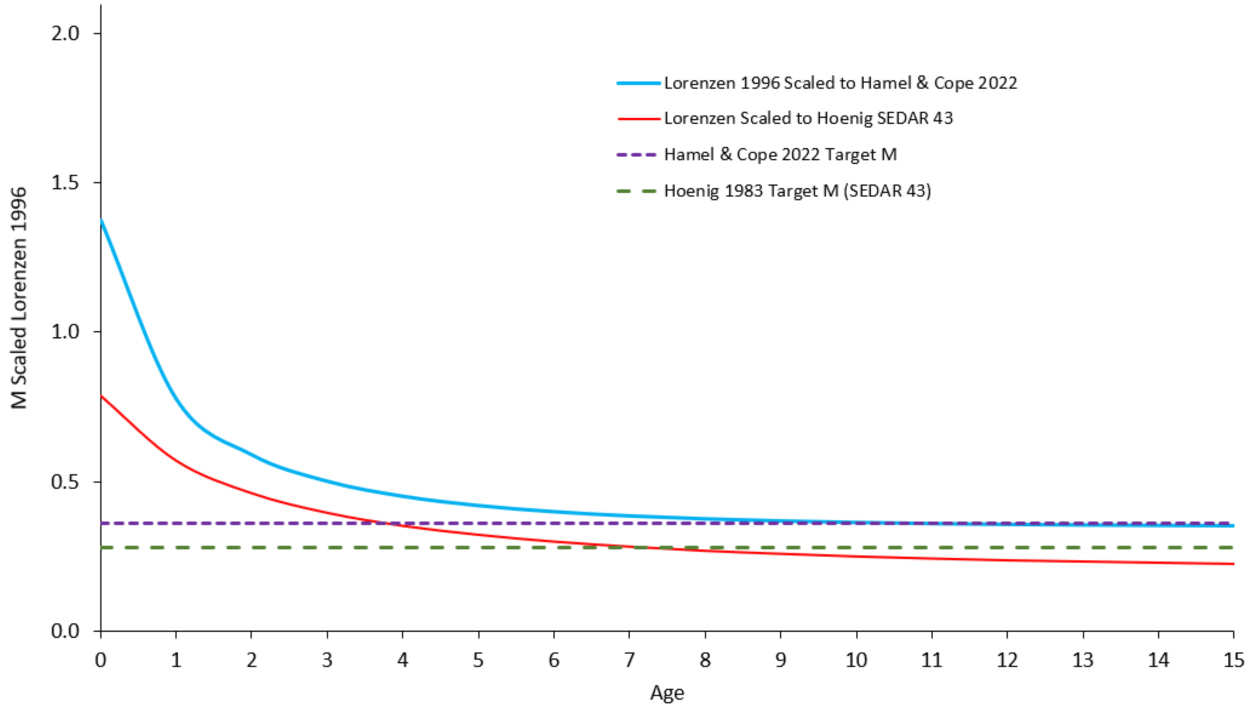

Figure 2.14.14. The recommended age-specific natural mortality (M) vector scaled to the Lorenzen equation (1996) for SEDAR 100 (blue line). The target M based on Hamel & Cope 2022 was 0.36 (dashed purple line). Age-specific M values and Target M used in SEDAR 43 are shown for comparison by the red solid line and the dashed green line, respectively.

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