A Review of the Gulf of Mexico yellowedge grouper (*Hyporthodus flavolimbatus*) Age-length Data, 1977-2021

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I. Introduction

This report describes the age-length data submitted by the National Marine Fisheries Service (NMFS) Panama City Lab and external data providers to the US Gulf of Mexico (GOM) Southeast Data Assessment and Review (SEDAR) 85 operational assessment (SEDAR O85) for yellowedge grouper, *Hyporthodus flavolimbatus*, for the years 1977 to 2021. Of the n = 40,148 available records, n = 20,193 had an estimated age; otoliths deemed unreadable were not included in this total. The dataset is comprised of historical data submitted from the previous assessment (SEDAR 22, 2010) for the years 1977 to 2009 (n = 14,977 total records, n = 8,702 records with ages) and new data for the years 2010 to 2021 (n = 25,171 total records, n = 11,491 records with ages). Metadata submitted for SEDARO85 (1977-2021) follow the SEDAR Best Practices Template (SBPT) that went into effect in December 2022 (See Appendix 1).

The objectives of this report are to summarize otolith collection by fishery, mode, and gear, and describe 1) how final length and weight values were derived using conversion equations, 2) how historical data submitted to SEDAR 22 were imported to the current dataset including documentation of unexpected issues, and 3) age determination protocols and estimates of precision.

II. Methods

A. Otolith collection

Data providers for SEDAR O85 included both federal (NMFS Panama City Age, Growth and Reproduction database (AGR), NMFS Panama City Biological Sample Database (BSD)), and state agencies (Florida Fish and Wildlife Research Institute (FWRI), and FWRI Fisheries Independent Monitoring (FWRI-FIM); Gulf States Marine Fisheries Commission, Fisheries Information Network (GulfFIN)) (Table 1). Otoliths were collected from 1977 to 2021 (excluding 1981, 1990, and 1995-1997) from fishery-dependent (FD), fishery-independent (FI), or unknown fishing sectors (UNK). Commercial (COM) samples were provided by several sampling programs including the Cooperative Research Project

(CO-OP), Florida Fish and Wildlife Conservation Commission (FWRI), NMFS Galveston Observer Program (GOP), special sample collection by Herbert Prytherch (PRYTHERCH), NMFS Shark Bottom Longline Observer Program (SBLOP), and the Trip Interview Program (TIP). Commercial fishing gear listed in the data field titled "Gear_Group_Code" included handline (HL), longline (LL), or was listed as unknown (UNK).

Recreational (REC) sampling programs included Gulf States Marine Fisheries Commission, Fisheries Information Network (GulfFIN), FIN-BIOSTAT, Headboat Observer (FWRI-OBS), Beaufort Headboat Survey (HB), Louisiana Department of Wildlife and Fisheries (LADWF), Marine Recreational Fishing Statistics Survey (MRFSS), NMFS, Panama City (PCLAB), Recreational Fisheries Information Network (RECFIN), Southeast Region Headboat Survey (SRHS), and TIP. Recreational fishing modes included charter boat (CB), charter party (CP), headboat (HB), and private vessels (PR). Recreational fishing gear was comprised entirely of HL. However, no age readings were recorded for the sampling program NMFS Panama City, FL (PCLAB) (n = 5) or SRH (n = 5) because no recreational samples were aged by data provider NMFS Panama City - AGR and NMFS Panama City – BSD for the sampling years 2010-2021.

Fishery-independent samples were collected by personnel participating in scientific surveys (SS) under the following sampling programs: Expanded Annual Stock Assessment (EASA), FWRI-FIM, LADWF, NMFS Pascagoula Mississippi (MSLAB), SBLOP, and the U.S. Geological Survey (USGS). Gear types included HL, LL, trap (TR), and trawl (TRW).

B. Updates to historical data (1977-2009) submitted to SEDAR 22.

The field "Sampling_Unit_ID" was blank in the original submission of data for SEDAR 22 for n = 4,060 records in years ranging from 1977-2006, all from the data provider NMFS Panama City – AGR. The sampling programs with this blank information were primarily from FWRI (n = 3,671), followed by TIP (n = 388), and LADWF = (n = 1). Since the field "Samping_Unit_ID" is used to denote species specific collection interviews which is necessary for length and age compositions. For records where "Sample_Unit_ID" was blank, the digits to the left of the underscore in the field "DP_Unique_Identifier" (a field from the SBPT) was used to populate the "Sample_Unit_ID" field. The field "DP_Unique_Identifier" represents the NMFS Panama City Lab barcode field in the AGR database, which incorporates the Panama City collection number as described above.

Based on information in Prytherch (1983), records were updated for years 1982-1983 to reflect Sampling Program = PRYTHERCH, Fishery = COM, Fishing_Mode= CM, Gear_Code = LL.

B. Deriving values for GOM yellowedge grouper length and weight

Each observed length was converted to a final total length (TL, mm) while observed weights were converted to final gutted weights (GWt, g) following the morphometric conversions outlined in SEDAR 22 (SEDAR, 2011). Final TLs were converted from observed lengths (if available) using the following hierarchy: 1) observed maximum TL; 2) observed natural TL; 3) observed fork length (FL; mm), or 4) observed standard length (SL, mm). Observed maximum or natural TL values were directly transposed to final TL (i.e., not converted) if available, while FL or SL were converted to Final TL using the equations listed in SEDAR 22 (see Table 6 in SEDAR 22, 2011). Final GW was converted from observed weight using the following hierarchy: 1) observed GWt; 2) observed WWt; or 3) final TL. Observed GWt values were directly transposed to final GWt if available. Final GWt was converted from WWt or final TL using equations in SEDAR 22. No distinction was made in SEDAR 22 between maximum TL and natural TL in the TL conversion equations listed in Table 6 in SEDAR 22 (2011). Therefore, the same conversion equation was used to convert maximum TL or natural TL to final TL. Only n = 4 records did not have any length or weight value from which to estimate final TL or GWt.

C. Otolith subsampling strategy

Due to the large number of otoliths collected by TIP from 2001, 2003, and 2007 to 2009, fish collected in Florida (FL) harvested by COM/LL were selected for subsampling following the methods outlined in Cook and Hendon (2010). For 2010 to 2012 samples, the subsampling strategy was not well documented and remains unclear because subsampling was likely calculated outside of the database and cannot be reproduced. For 2013 to 2021 samples, the subsampling strategy used prior to 2010 was altered due to time constraints and delays stemming from COVID-19, staff turnover (i.e., retirements or new job opportunities), and backlogs from other SEDAR species. This new subsampling strategy was implemented halfway through 2013. A maximum of 200 otoliths per year were randomly selected for processing/ageing from each significant strata (east COM/HL, east COM/LL, west COM/HL, and west COM/LL) (Table 2). An additional 25 samples were added to each significant strata to account for possible unreadable otoliths. If < 225 otoliths were available in a significant strata, all otoliths were selected for processing. No COM samples from AGR were included from 2014-2021. All FI samples housed in AGR were selected for processing.

D. Otolith processing and ageing

Beginning in 2014, all otoliths were weighed (if whole), scanned using Fourier transform-near infrared spectroscopy (FT-NIRS), and imaged using Zeiss imaging software prior to sectioning. Otoliths were sectioned using either a Hillquist high-speed saw or an Isomet low-speed wafering saw following the protocols outlined in the NMFS Panama City Lab Procedure Manual for Age, Growth, and Reproduction (NOAA, 2008). Typically, all yellowedge grouper otoliths are sectioned using the Hillquist saw. However, both saws were utilized to process samples from 2013 to 2021 to maximize production due to time constraints.

Results from bomb radiocarbon (^{14}C), the method used to validate ageing for yellowedge grouper, supports an estimated maximum longevity of at least 85 years (Cook et al. 2009). The assignment of annuli count and readability codes followed the protocols described in Cook (2007). Following the methods outlined in SEDAR 22, edge codes were not assigned with annuli counts due to the predominance of older age samples and difficulty in identifying faint and compacted annuli near the otolith margin (Cook and Hendon, 2010; SEDAR, 2011). Therefore, the “Final Age” field for all records was set equal to the annuli count, while the field “Calendar Age” was left blank because no ages were advanced. Each otolith was aged independently of fish length and date of capture. Fractional ages were calculated given a birthdate of August 1, which was determined based on the midpoint of the peak spawning season (July through September) indicated by gonadosomatic index values reported in Cook (2007). However, fractional ages should be used with caution given the uncertainty in peak spawning month reported in Cook (2007).

Yellowedge grouper ages provided by NMFS Panama City from 1977 to 2011 were aged by Melissa Cook (MC) or Michael Hendon (MH) (Cook and Hendon, 2010) (Table 3). Due to personnel changes, yellowedge grouper otoliths from a portion of 2012; and all of 2013 to 2021 were aged by either Ashley Pacicco (AP) or Laura Thornton (LT), both of whom served as primary readers. Very few otoliths (n~100) from 2013 to 2021 were aged by both LT and AP. Ages from the TIP sampling program from 2011-2021 were housed in the BSD, while ages from historical collections, observer and FI sources from 1977-2021 were recorded in AGR. Approximately 20% of all otoliths from 2013-2021 aged by AP or LT also were aged by a third reader, Jennifer Potts, with experience ageing other grouper species (including deepwater groupers).

Von Bertlanffy growth model parameters were not updated for SEDAR O85 given the outlined Terms of Reference[1], but were estimated for SEDAR 22 (SEDAR, 22).

E. NMFS Panama City ageing error and estimates of precision

All age readers prior to the start of production ageing of samples from 2013 to 2021 were required to achieve <10% average percentage error (APE) on the yellowedge grouper reference set comprised of 200 otolith sections. Jennifer Potts (JP) served as the expert reader and aged 20% of all otoliths (referred to as overlap reads) aged by either AP or LT in approximately equal proportion (i.e.,

[1] https://sedarweb.org/documents/sedar-85-gulf-of-mexico-yellowedge-grouper-terms-of-reference/ (Accessed 5/25/2023)

50% of overlap for each primary reader). Indices of precision (i.e., APE and percent agreement) were calculated from JP's overlap reads for each year for samples aged by either AP or LT to ensure consistency between both primary readers. Overlap reads occurred relatively soon after primary ageing for each year was completed to identify and correct any potential drift in primary ageing in real time. Ages estimated by JP were used only for estimating ageing error for use in SS3 and not used as final ages in the data submitted for SEDAR OA 85.

Ageing error estimation followed the methods described in Punt et al. (2008) and specifically, the methods described by Thorson et al. (2008) for the R package "nwfscAgeingError". Stepwise model selection was conducted in R (R Core Team, 2021) by estimating precision and bias parameters in an incomplete factorial design. Scenarios tested during model fitting included two bias assumptions for the primary ager: 1) no bias or 2) linear bias, and four precision assumptions: 1) no error, 2) constant CV, 3) curvilinear SD, or 4) curvilinear CV. Precision assumptions were applied to both primary and expert agers. All combinations of bias and precision were included in stepwise model selection except for the scenario where both the primary and expert readers' ages were assumed to have linear bias. Ageing error models were estimated to assess which functional form best described the error relationship between the primary reader age and the expert reader age (i.e., the "true age"). As an alternative option, ageing error also was estimated by comparing primary reader ages to the reference set ages (i.e., "true ages). In this case, error parameters for each primary reader were mirrored such that a single set of parameters and SD-at-age values would be produced for input into SS3 if desired. The expert reader age estimates for the reference set were not included in this set of models. Model option combinations were similar to those described for primary vs expert scenarios described above, but reference set ages were always assumed to be without bias. Again, due to time constraints given the large number of samples processed, two primary agers were utilized, but both were considered a single entity in ageing error estimation as nearly all otoliths were aged by only one of the two primary agers. Final model selection was based on Akaike's Information Criterion (AIC) (Akaike, 1981) corrected for small sample size. Primary vs expert ages were examined for precision and bias with the FSA package (Ogle et al., 2022) by estimating the precision indices (i.e., percent agreement; average coefficient of variation, ACV; or average percent error, APE) and comparative plots of reader-specific ages with 1:1 line and 95% confidence intervals.

III. Results and Discussion

A. Otolith Collection

Otoliths were primarily sampled from the COM fishery (94.69%), followed by FI (4.92%), and REC (0.39%) (Table 4). Among all three fisheries (COM, REC, FI), the most observed gear type used to capture yellowedge grouper was LL (72.93%), followed by HL (26.33%), TRW (0.42%), and UNK (0.29%) (Table 5). The majority of otoliths were collected from yellowedge grouper landed in Florida (51.30%), followed by Louisiana (34.43%), Texas (13.52%), Alabama, (0.54%), and Mississippi (0.07%) (Table 6). A total of 17 samples (0.08%) were reported with no state landed (NL), which were FI samples collected via SS (sampling program= FWRI-FIM).

B. Otolith processing and age determination

Yellowedge grouper ages provided by NMFS Panama City ranged from 0-85 years, with a majority of ages ranging from 8-17 years (58.70%; Figure 1). Age-12 was the most frequently observed age (6.91%), followed closely by age-11 (6.64%). Median ages and quantile ranges have shifted to older ages since 2013 (age 14 to 24 years) compared to ages sampled from 1999 to 2012 (age 9 to 18 years) (Figure 2). Overall, yellowedge grouper proved to be a challenging species to age, with a majority of readability codes scored as difficult. Yellowedge grouper grow rapidly during their first few years of life (0-4 years), then less rapidly for several decades until approximately age-30 when they likely approach their asymptotic length, then may live for another half century or more given the validated longevity estimate of 85 years Cook et al. (2009) (Figure 3).

Yellowedge grouper lengths were very similar among states and fisheries while CB and PR REC modes captured slightly larger individuals (Figure 4). The overwhelming majority of aged samples with a known gear were collected by LL (n=14,721) or HL (n=5,315) gear with very similar length distributions, while TR (n=8) and TRW (n=84) gears captured only a small number of much smaller individuals (Figure 5). Gutted weights were very similar among states and fisheries while private (PR, CB, and CP) REC modes took heavier individuals (Figure 6). Gutted weights of individuals collected with HL and LL were heavier than fish collected with other known gear types (Figure 7). Individuals collected with TRW gear weighed much less than fish collected with other gear types.

A relatively strong linear correlation was observed between whole otolith weight and age (n=13,596; r^2=0.78) suggesting that whole otolith weight may be a useful tool in estimating age in GOM yellowedge grouper or in identifying potential outliers or transcription errors enter into the database (Figure 8) (Cook, 2007). No results from FT-NIRS or otolith imaging are available for yellowedge grouper at this time.

C. NMFS Panama City ageing error and estimates of precision

A total of 1,136 otoliths were aged by the expert ager and at least one of the primary agers. Percent agreement between expert and primary reader age was 36.44%, while ACV was 5.40 and APE was 3.82. The estimated APE value was extremely low relative to the acceptable error threshold of 10% for this species, which is notoriously difficult to age due to the depths of capture and its longevity.

Of the n = 200 otolith sections available in the reference set, 185 were assigned an estimated age based on sample quality by primary readers (i.e., 15 were deemed unreadable by one or more primary readers). Percent agreement was lower than expected at 7.03%, in part because age estimates from two readers were compared to the reference set rather than a single reader. For reader 1, percent agreement was 22.1%, with 64.2% of ages within ±2 years and 86.3% within ±5 years of the reference set age. For reader 2, percent agreement was 15.6% with 49.0% of ages within ±2 years and 77.6% within ±5 years. Pair-wise t-tests of reference set ages vs each primary reader age indicated no significant difference (each age-specific p-value >0.05). The ACV and APE for both readers estimated from the FSA package was 16.92 and 9.77, respectively.

Despite the relatively high agreement and precision among the expert and primary agers, ageing error model parameters provided unreasonable results when estimated for expert vs primary overlap reads (Figure 9). The best-fit model based on AICc values was one in which primary ages were assigned linear bias with curvilinear CV while expert ages were without bias and had curvilinear SD. However, error models assigned dramatically more error to the expert's overlap ages, which resulted in excessively low SD-at-age estimates for the primary readers. This results in overfitting to the age composition data because there is very little error (SD) around estimates of age. Thus, the ageing error model parameters estimated for primary vs reference set reads were used to inform ageing error in the assessment model. Estimates of SD-at-age for primary vs reference set reads were much more reasonable (Table 7) and provided comparable estimates to those used in SEDAR 22. Reference set ages were assumed to be without bias and reader agreement plots (Figure 10) indicated that neither of the primary readers estimated YEG ages with. The best-fit model for describing ageing error, based on AICc values, had curvilinear CV for both the reference set and primary readers (Figure 11). Curvilinearity in SD-at-age was low upon visual inspection. The model with linear SD-at-age for the reference set and curvilinear CV for the primary readers was the best fit based on BIC criterion, and was only ~7 points higher than the previously described model based on AIC or AICc. The SD-at-age value for the best fit model based on AICc criteria had a SD value of 0.37 at age-0, increasing to 5.14 at age-40 (i.e. plus group age).

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Tables

Table 1. Summary of the number (n) of final ages submitted by each data provider: Florida Fish and Wildlife Research Institute, Fisheries Independent Monitoring (FWRI), Gulf States Marine Fisheries Commission, Fisheries Information Network (GulfFIN), National Marine Fisheries Service, Panama City Laboratory: Age, Growth and Reproduction database (NMFS Panama City – AGR), and National Marine Fisheries Service, Panama City Laboratory: Biological Sampling Database (NMFS Panama City – BSD). Unreadable otoliths (i.e., read but no age estimated) are not included in the totals.

Year	FWRI	GulfFIN	NMFS Panama City-AGR	NMFS Panama City-BSD	Total
1977			4		4
1978			116		116
1979			193		193
1980			132		132
1982			706		706
1983			195		195
1984			33		33
1985			8		8
1986			25		25
1987			3		3
1988			9		9
1989			5		5
1991			249		249
1992			69		69
1993			9		9
1994			2		2
1998			5		5
1999			97		97
2000			138		138
2001			439		439
2002			238		238
2003			814		814
2004			581		581
2005			681		681
2006			478		478
2007			867		867
2008	2		1274		1276
2009			1330		1330
2010	1	1	1431		1433
2011			280	1214	1494
2012			160	1837	1997
2013			105	1263	1368
2014			24	845	874
2015	4	3	17	698	722
2016		2		691	693
2017	5	1	12	653	671
2018	5		16	668	689
2019			7	699	706
2020				417	417
2021		3	11	418	432
Total	17	10	10763	9403	20193

Table 2. Number of subsampled otoliths from the commercial (COM) collection in BSD only (no observer samples) from 2013-2021. The numbers listed in each column represent the total number of otoliths collected in each year per significant strata (i.e., east COM HL, east COM LL; west COM HL, west COM LL). The numbers in parentheses indicate the number selected for random subsample. If < 225 otoliths were available, all otoliths were selected. EAST= Florida, Alabama (no otoliths from Mississippi were received), WEST=Louisiana, Texas.

	EAST		**WEST**	
Year	**CM/HL**	**CM/LL**	**CM/HL**	**CM/LL**
2013	73 (73)	1107 (225)	586 (225)	1032 (225)
2014	74 (74)	1173 (225)	707 (225)	571 (225)
2015	73 (73)	1147 (225)	463 (225)	555 (225)
2016	38 (38)	830 (225)	504 (225)	639 (225)
2017	34 (34)	802 (225)	416 (225)	856 (225)
2018	31 (31)	966 (225)	326 (225)	859 (225)
2019	71 (71)	1039 (225)	272 (225)	1073 (225)
2020	23 (23)	133 (133)	48 (48)	532 (225)
2021	32 (32)	132 (132)	48 (48)	351 (225)
Total subsample (n)	449	1840	1671	2025

Table 3. An estimate of the number of final ages provided by the primary reader (Age Reader 1) for NMFS Panama City (i.e., data provider = NMFS Panama City - AGR, NMFS Panama City – BSD). Age Reader 1 is the reader designated first in the database hierarchy for samples with multiple age estimates. Readers include Ashley Pacicco (AP), Laura Thornton (LT), Melissa Cook (MC), Michael Hendon (MH), or unknown reader (UNK). Unreadable otoliths (i.e., read but no age estimated) are not included in the totals.

Year	AP	LT	MC	MH	UNK	Total (n)
1977				4		4
1978				116		116
1979				193		193
1980				132		132
1982			181	525		706
1983			36	159		195
1984				33		33
1985				8		8
1986					25	25
1987					3	3
1988					9	9
1989					5	5
1991			248		1	249
1992			69			69
1993			9			9
1994			2			2
1998			5			5
1999			97			97
2000			136		2	138
2001			430		9	439
2002			238			238
2003			814			814
2004			569	2	10	581
2005			677		4	681
2006			478			478
2007			867			867
2008			1274			1274
2009			1330			1330
2010			559	872		1431
2011			680	814		1494
2012	160		907	930		1997
2013	708	660				1368
2014	386	483				869
2015	305	410				715
2016	301	390				691
2017	369	296				665
2018	291	393				684
2019	307	399				706
2020	191	226				417
2021	188	241				429
Total (n)	3206	3498	9606	3788	68	20166

Table 4. Number of age samples per year by fishery (commercial, COM; fishery independent, FI; recreational, REC; or unknown (UNK).

Year	**COM**	**FI**	**REC**	**UNK**	**Total (n)**
1977	4				4
1978	116				116
1979	187	6			193
1980	132				132
1982	693	13			706
1983	170	25			195
1984	4	29			33
1985		8			8
1986			25		25
1987			3		3
1988			9		9
1989			5		5
1991	224		25		249
1992	69				69
1993	9				9
1994	2				2
1998	5				5
1999	55	42			97
2000	103	35			138
2001	402	37			439
2002	191	47			238
2003	751	62	1		814
2004	534	47			581
2005	658	23			681
2006	429	48	1		478
2007	830	37			867
2008	1252	24			1276
2009	1291	39			1330
2010	1405	27	1		1433
2011	1214	279	1		1494
2012	1959	38			1997
2013	1341	27			1368
2014	845	24			869
2015	698	21	2	1	722
2016	691		2		693
2017	653	17	1		671
2018	668	21			689
2019	699	7			706
2020	417				417
2021	418	11	3		432
Total (n)	19119	994	79	1	20193

Table 5. The number of age samples by fishery (commercial, COM; recreational, REC; or fishery independent, FI), mode (CM=commercial, CB=charter boat, CP=charter party, HB=headboat, PR=private, TRN= tournament, SS=scientific survey, or unknown, UNK), and gear (HL=handline, LL=bottom longline, TR=trap, or TRW=trawl) by year.

	COM			REC				FI				UNK	
				CB	CP	HB	PR	SS					
Year	**HL**	**LL**	**UNK**	**HL**	**HL**	**HL**	**HL**	**HL**	**LL**	**TR**	**TRW**	**HL**	**Total (n)**
1977	4												4
1978	116												116
1979	185	2							6				193
1980	67	20	45										132
1981													0
1982		682	11						13				706
1983		170							25				195
1984		2	2						29				33
1985									8				8
1986						25							25
1987						3							3
1988						9							9
1989						5							5
1991	212	12			23	2							249
1992	31	38											69
1993	6	3											9
1994	2												2
1998		5											5
1999		55						1	41				97
2000	13	90							29		6		138
2001	52	350							28	1	8		439
2002	39	152							40	1	6		238
2003	47	704			1				55		7		814
2004	41	493							37		10		581
2005	78	580							10	2	11		681
2006	53	376					1		34		14		478
2007	116	714							31		6		867
2008	244	1008							9	3	12		1276
2009	281	1010							36		3		1330
2010	405	994	6				1		26		1		1433
2011	315	899					1	4	274		1		1494
2012	681	1278						3	35				1997
2013	482	859							27				1368
2014	311	534							24				869
2015	270	428		2				3	17	1		1	722
2016	253	438		2									693
2017	236	417		1				5	12				671
2018	247	421						5	16				689
2019	283	416							7				706
2020	69	348											417
2021	75	343		3					11				432
Total (n)	5214	13841	64	8	24	44	3	21	880	8	85	1	20193

Table 6. Number of aged samples per year by state landed (Alabama, AL; Florida, FL; Louisiana, LA; Mississippi, MS; Texas, TX; Not Landed, NL; Unknown (UNK).

Year	FL	LA	TX	AL	MS	NL	UNK	Total (n)
1977	4							4
1978	116							116
1979	191		2					193
1980	127						5	132
1982	694			12				706
1983	170	25						195
1984	4		29					33
1985	8							8
1986			21				4	25
1987			3					3
1988			9					9
1989			5					5
1991		247	2					249
1992	11	58						69
1993		9						9
1994		2						2
1998	5							5
1999	56	20		21				97
2000	103	8	25	2				138
2001	382	37	15	5				439
2002	177	51	3	1	6			238
2003	781	16	8	2	7			814
2004	493	34	53	1				581
2005	556	92	33					681
2006	298	114	62	4				478
2007	543	99	223	1	1			867
2008	605	302	366	1		2		1276
2009	617	420	288	5				1330
2010	606	715	109	2		1		1433
2011	599	769	121	5				1494
2012	682	777	534	4				1997
2013	555	511	302					1368
2014	343	372	135	19				869
2015	298	375	43	2		4		722
2016	246	297	140	10				693
2017	248	338	75	5		5		671
2018	253	387	40	4		5		689
2019	273	379	50	4				706
2020	152	254	11					417
2021	164	244	24					432
Total (n)	10360	6952	2731	110	14	17	9	20193

Table 7. Primary reader estimates of SD-at-age for ages 0-85 year estimated for SEDAR 85. Min age = 0, max age = 85, minus age = 0, plus age = 40 years.

True age	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Expected age	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5
SD-at-age	0.37	0.37	0.71	1.00	1.26	1.50	1.71	1.90	2.07	2.22	2.37	2.50	2.62	2.73	2.83	2.93
True age	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	30	**31**
Expected age	16.5	17.5	18.5	19.5	20.5	21.5	22.5	23.5	24.5	25.5	26.5	27.5	28.5	29.5	30.5	31.5
SD-at-age	3.03	3.12	3.21	3.30	3.38	3.46	3.55	3.63	3.71	3.79	3.88	3.96	4.04	4.13	4.21	4.30
True age	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**
Expected age	32.5	33.5	34.5	35.5	36.5	37.5	38.5	39.5	40.5	41.5	42.5	43.5	44.5	45.5	46.5	47.5
SD-at-age	4.39	4.48	4.57	4.66	4.75	4.85	4.94	5.04	5.14	5.24	5.34	5.44	5.54	5.64	5.75	5.85
True age	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**
Expected age	48.5	49.5	50.5	51.5	52.5	53.5	54.5	55.5	56.5	57.5	58.5	59.5	60.5	61.5	62.5	63.5
SD-at-age	5.96	6.06	6.17	6.28	6.38	6.49	6.60	6.71	6.83	6.94	7.05	7.16	7.27	7.39	7.50	7.62
True age	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**
Expected age	64.5	65.5	66.5	67.5	68.5	69.5	70.5	71.5	72.5	73.5	74.5	75.5	76.5	77.5	78.5	79.5
SD-at-age	7.73	7.84	7.96	8.08	8.19	8.31	8.42	8.54	8.66	8.77	8.89	9.01	9.12	9.24	9.36	9.48
True age	**80**	**81**	**82**	**83**	**84**	**85**										
Expected age	80.5	81.5	82.5	83.5	84.5	85.5										
SD-at-age	9.60	9.71	9.83	9.95	10.07	10.19										

Figures

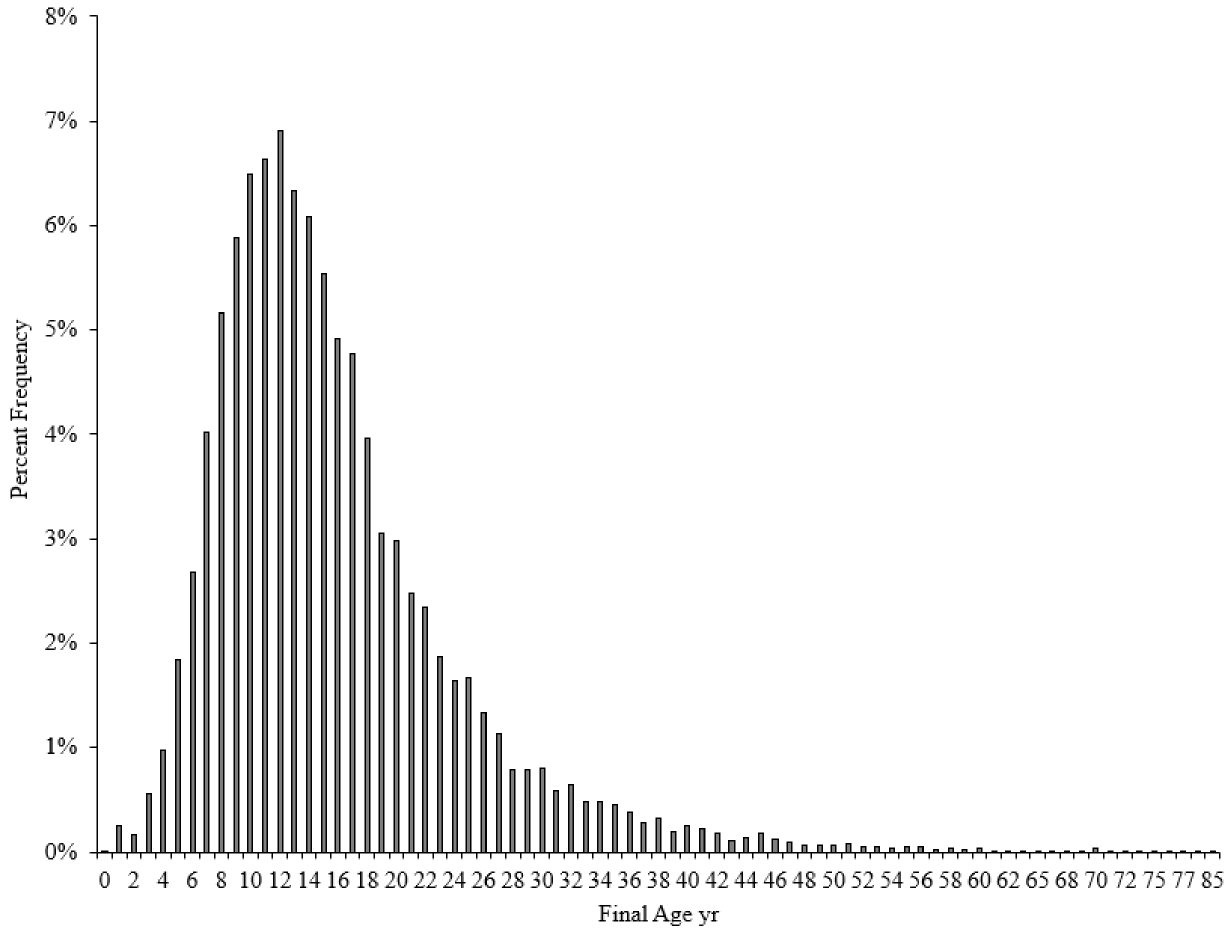

Figure 1. Percent frequency of final ages (year) submitted by all data providers for GOM yellowedge grouper SEDAR O85 (n=20,193).

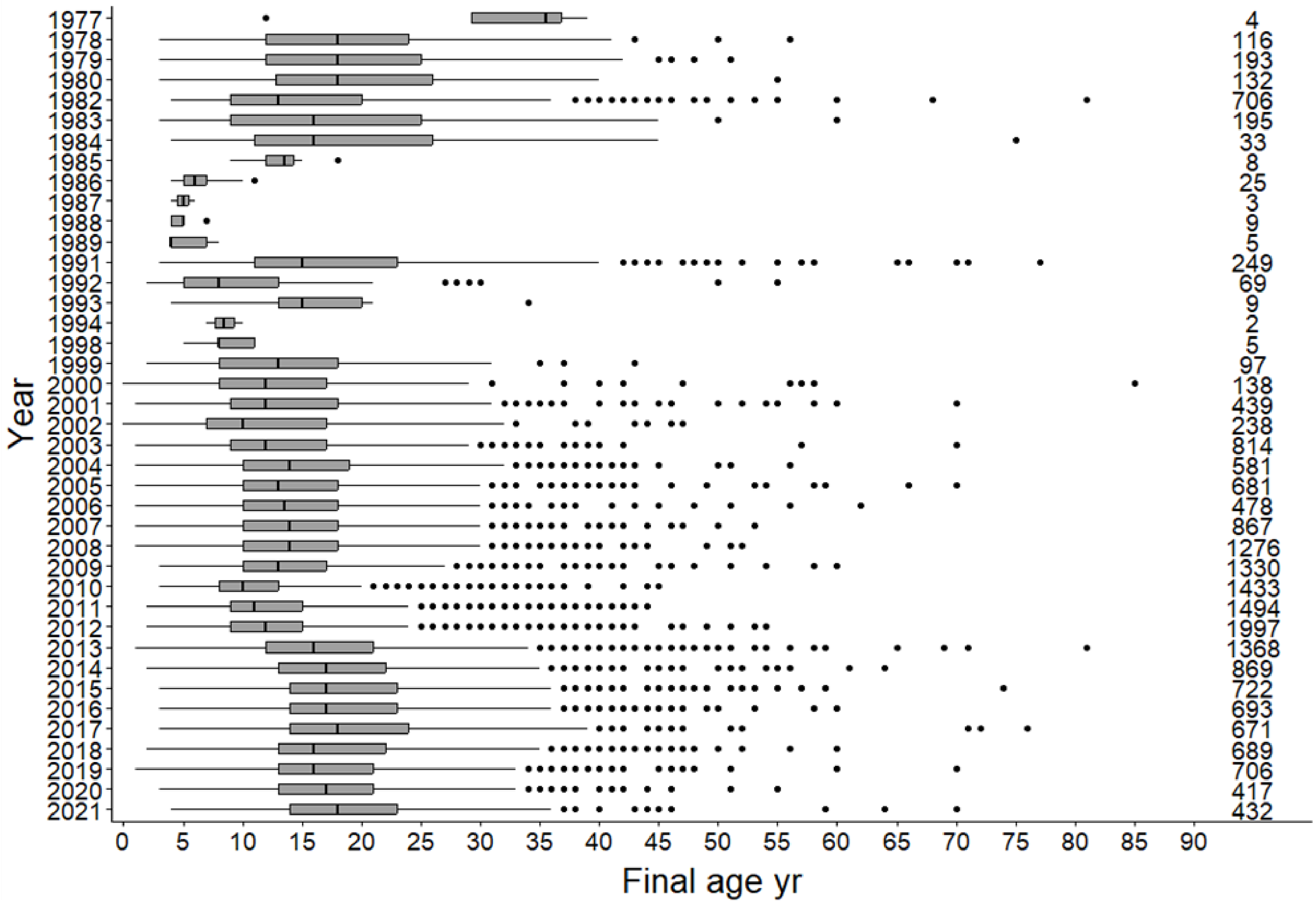

Figure 2. Boxplots of final age (annuli count, yr) by year for GOM yellowedge grouper SEDAR O85. Black lines indicate median values, box ends indicate the 25th and 75th percentiles, and whiskers indicate ±1.5*IQR Points indicate values falling outside the 1.5*IQR. Sample sizes are shown to the right of each box.

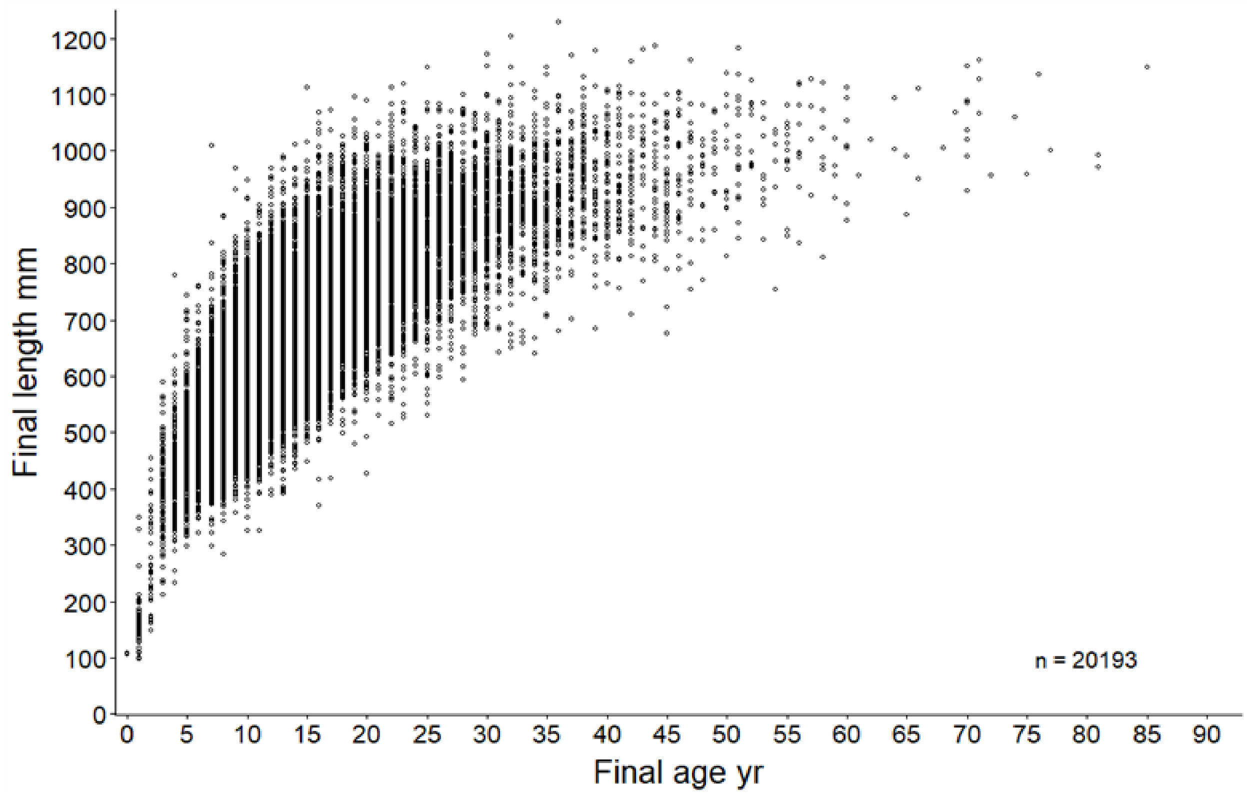

Figure 3. Final age (annuli count, yr) versus final length (TL, mm) for age-length data submitted by all data providers for GOM yellowedge grouper SEDAR O85.

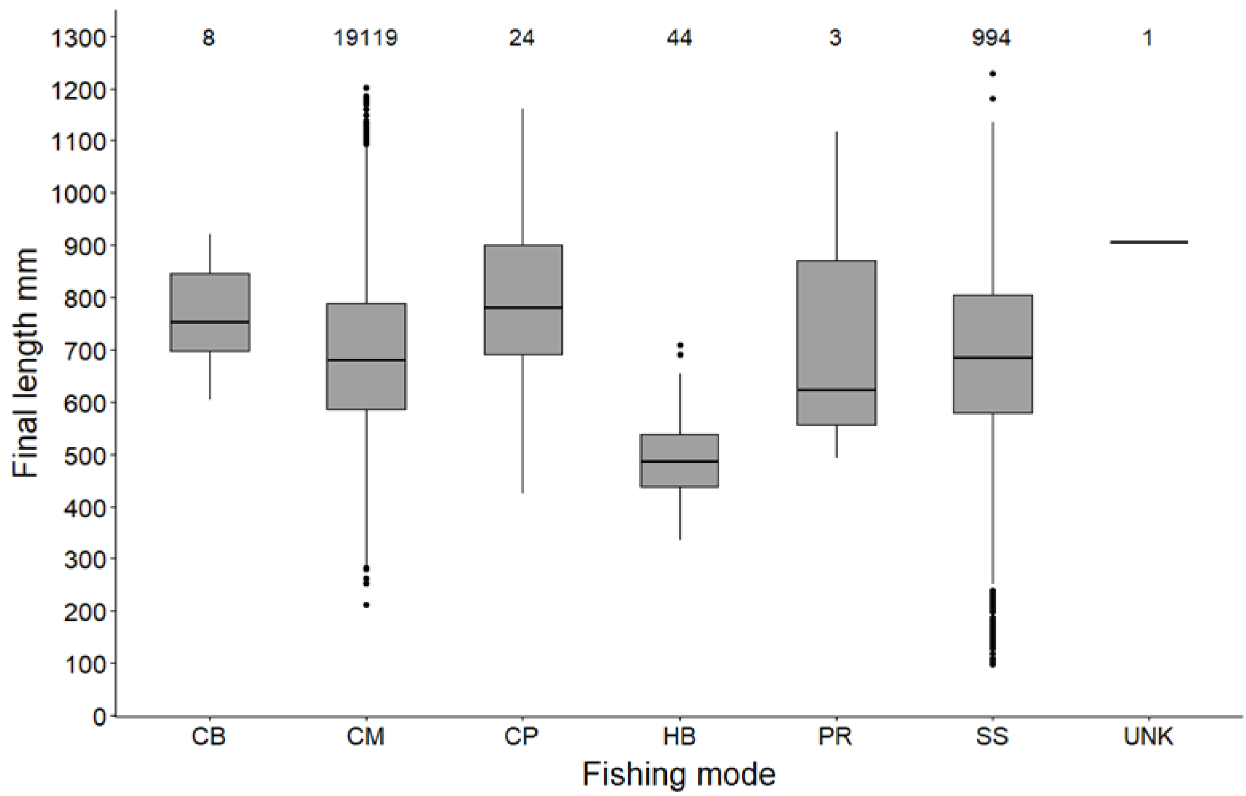

Figure 4. Boxplots of final length (TL mm) by fishing mode (charterboat, CB; commercial, CM; charter party, CP; headboat, HB; private recreational, PR; scientific survey, SS; or unknown, UNK) for GOM yellowedge grouper SEDAR O85. Black lines indicate median values, box ends indicate the 25th and 75th percentiles, and whiskers indicate ±1.5*IQR Points indicate values falling outside the 1.5*IQR. Sample sizes are shown atop each box.

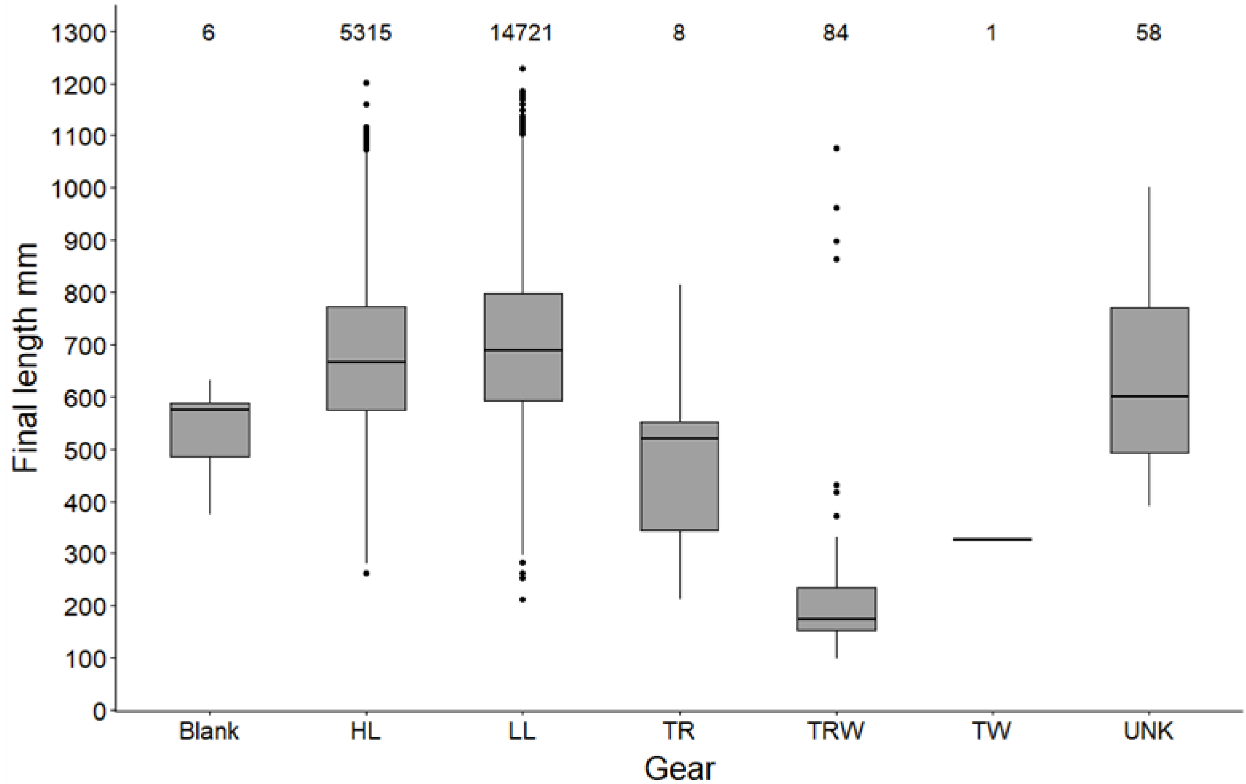

Figure 5. Boxplots of final length (TL mm) by gear group code (unknown, blank or UNK; handline, HL; bottom longline, LL; trap, TR; trawl, TRW or TW) for GOM yellowedge grouper SEDAR O85. Black lines indicate median values, box ends indicate the 25th and 75th percentiles, and whiskers indicate ±1.5*IQR Points indicate values falling outside the 1.5*IQR. Sample sizes are shown atop each box.

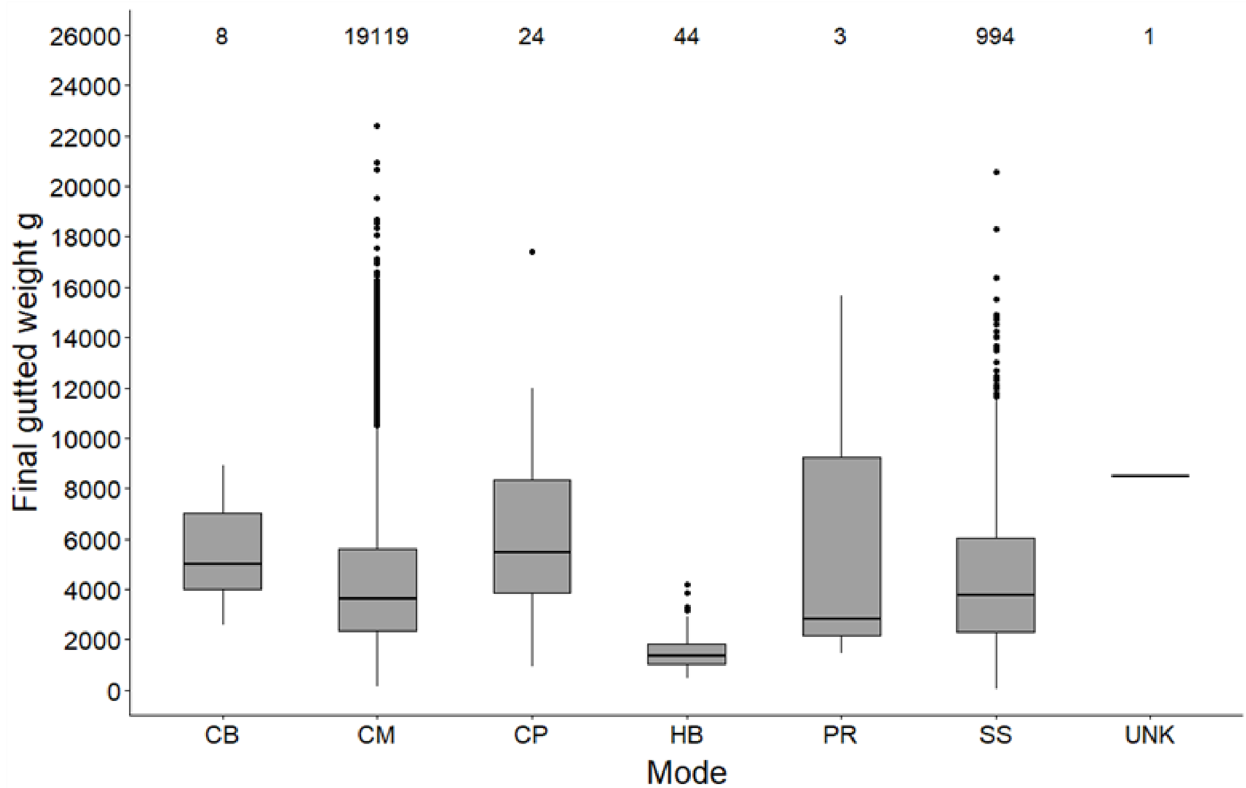

Figure 6. Boxplots of final gutted weight (g) by fishing mode (charter boat, CB; commercial, charter party, CP; COM; headboat, HB; private, PR; scientific survey, SS; or unknown, UNK) for GOM yellowedge grouper SEDAR O85. Black lines indicate median values, box ends indicate the 25th and 75th percentiles, and whiskers indicate ±1.5*IQR Points indicate values falling outside the 1.5*IQR. Sample sizes are shown atop each box.

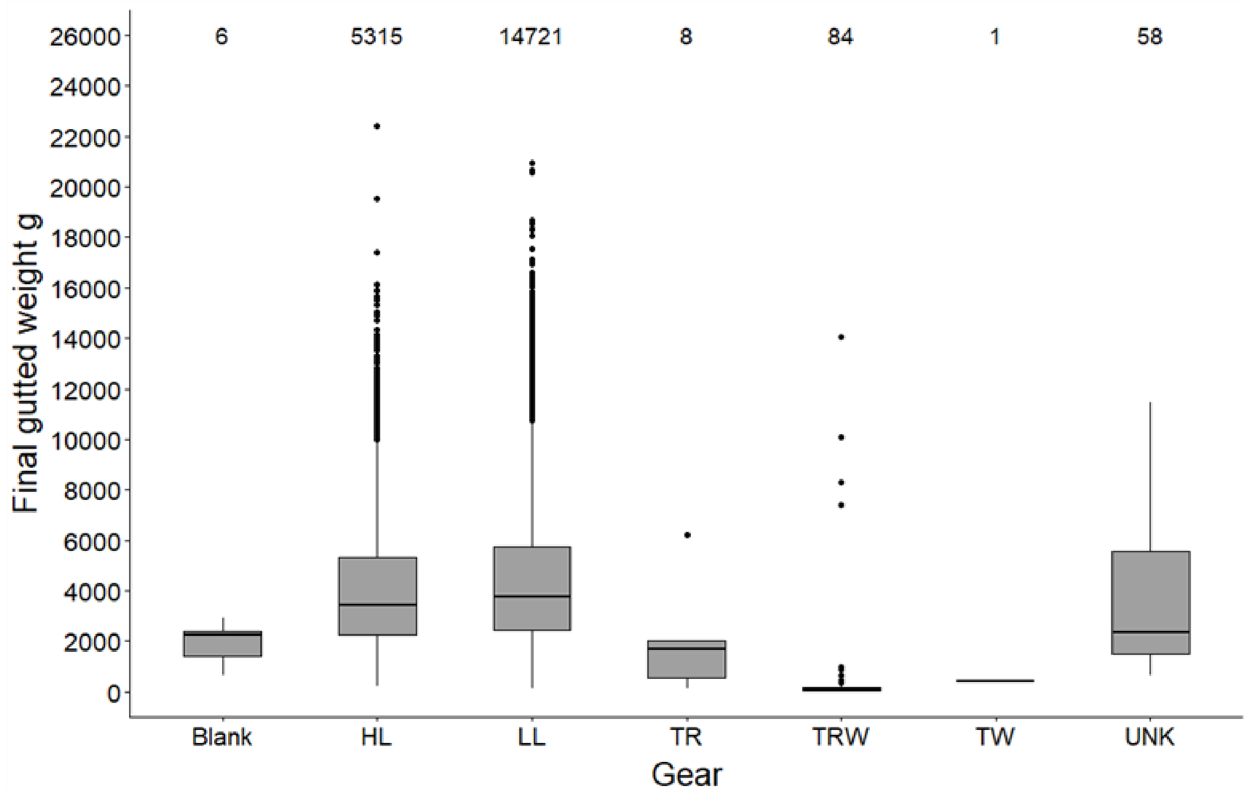

Figure 7. Boxplots of final gutted weight (g) by fishing gear (unknown, blank or UNK; handline, HL; bottom longline, LL; trap, TR; or trawl, TRW or TW) for GOM yellowedge grouper SEDAR O85. Black lines indicate median values, box ends indicate the 25th and 75th percentiles, and whiskers indicate ±1.5*IQR Points indicate values falling outside the 1.5*IQR. Sample sizes are shown atop each box.

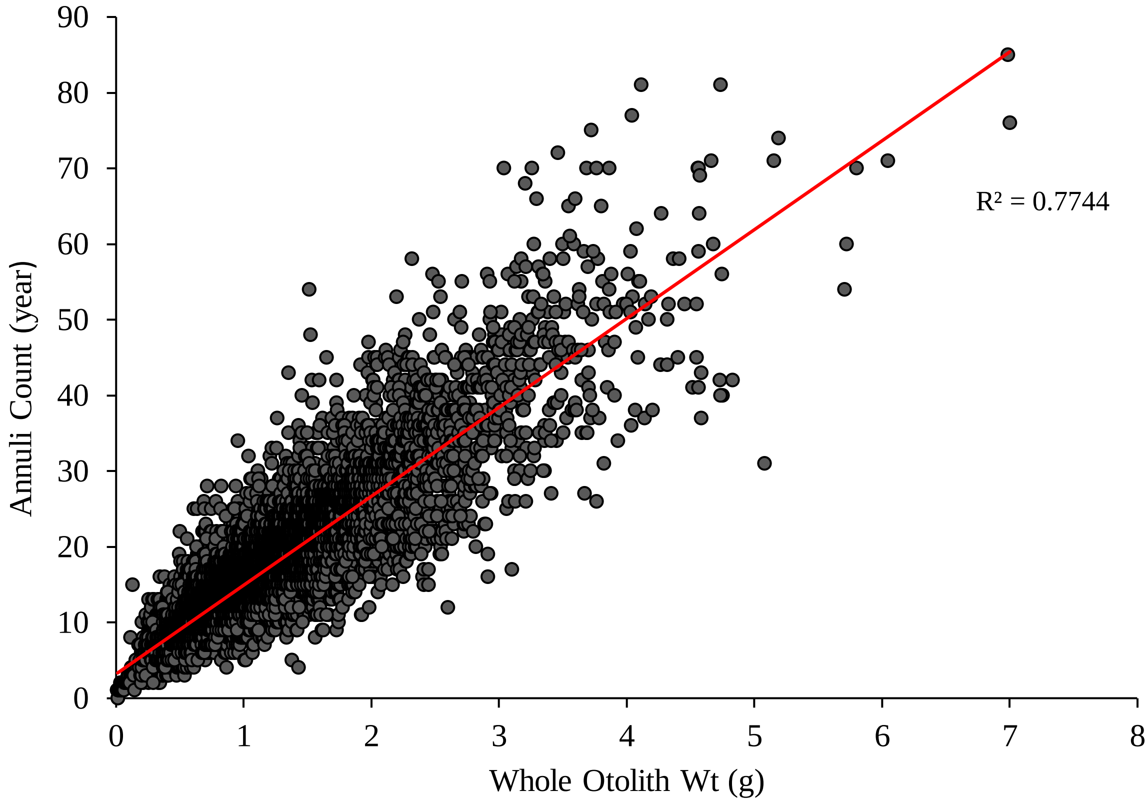

Figure 8. Whole otolith weight (g) vs age for GOM yellowedge grouper data submitted by NMFS Panama City for GOM yellowedge grouper SEDAR O85 (n=13,596).

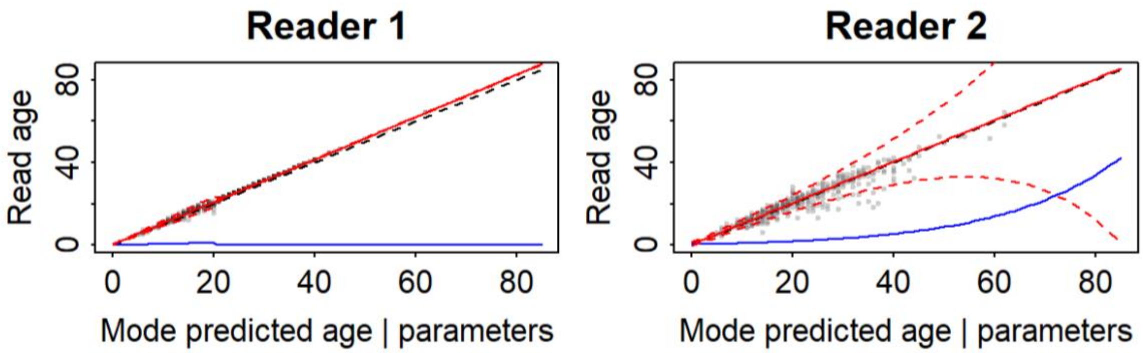

Figure 9. Plots of estimated age vs mode predicted age for primary (reader 1) vs expert (reader 2) age given the variance parameters estimated in the ageing error model for GOM yellowedge grouper SEDAR O85. Gray points indicate observed ages, the black dashed line indicates the 1:1 line of agreement, the red solid line indicates the expected age, red dashed lines indicate the 95% CI for expected ages, and the blue line indicates the SD-at-age. The reference set was assumed to be unbiased and without error. The two primary readers, acting as a single ager providing data were assigned mirrored parameter estimates during the model estimation, hence identical plots for readers 1 and 2.

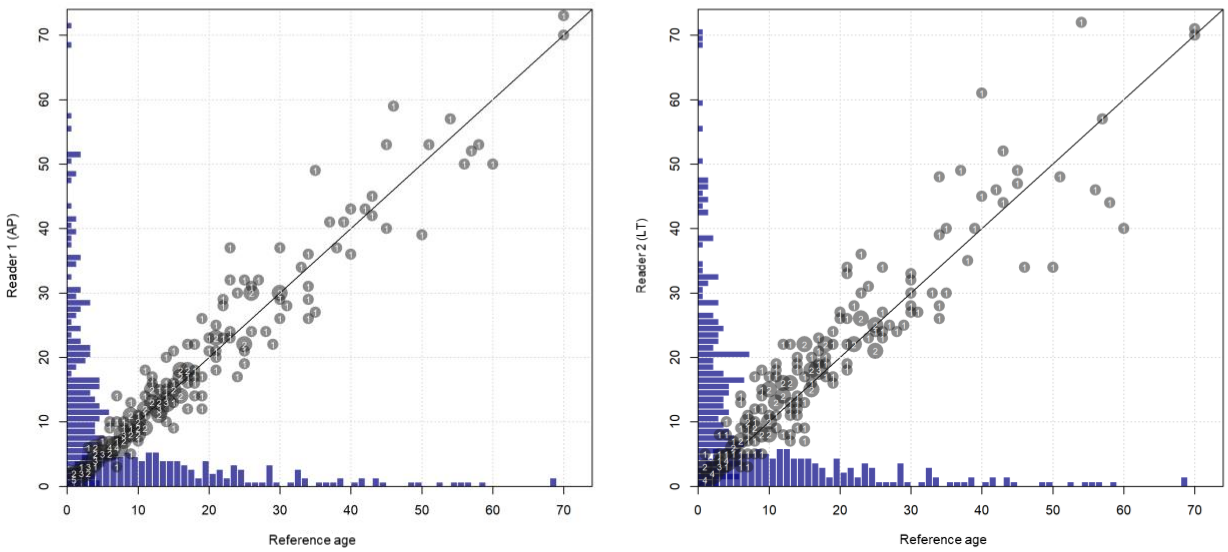

Figure 10. Primary reader (reader 1 or 2) vs reference set ages for GOM yellowedge grouper SEDAR O85.

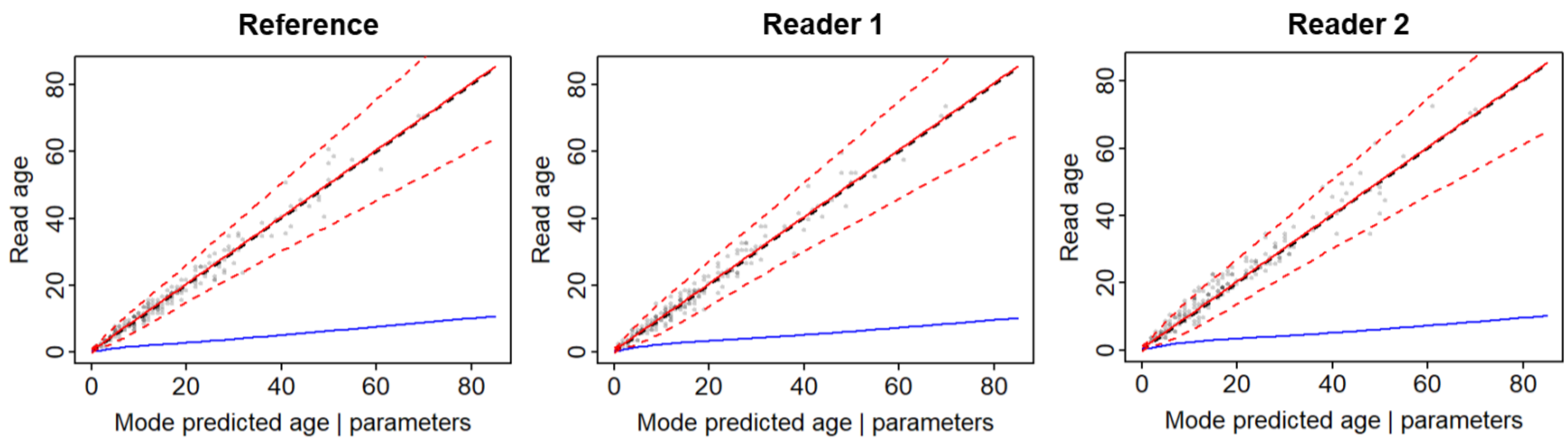

Figure 11. Plots of estimated age vs mode predicted age for readers 1 and 2 vs reference ages given the variance parameters estimated in the ageing error model for GOM yellowedge grouper SEDAR O85. Gray points indicate observed ages, the black dashed line indicates the 1:1 line of agreement, the red solid line indicates the expected age, red dashed lines indicate the 95% CI for expected ages, and the blue line indicates the SD-at-age. The reference set was assumed to be unbiased but with error. The two primary readers, acting as a single ager providing data were assigned mirrored parameter estimates during the model estimation, hence identical plots for readers 1 and 2.

Appendix 1

SEDAR Data Best Practices Template (Updated version December 2022)

Based on SEDAR. 2015. SEDAR Procedural Workshop 7: Data Best Practices. SEDAR, North Charleston SC. 151 pp. available online at: http://sedarweb.org/pw-07

Fields and definitions: Yellowedge Grouper SEDAR85Operational
Key Updated May 2023

Field Names	**Description**	**Type**	**Units**	**Acceptable Values**
SEDAR	Year SEDAR is scheduled to begin and assigned SEDAR number (yearSEDARnumber).	Text		2023SEDAROA85
SEDAR_Date_Submit[3]	Month, and Year data submitted to data assessors, this can be added by LHG data compiler (ex: June 2015).	Text		January 2023
Species	Current scientific name.	Text		*Hyporthodus flavolimbatus*
Stock[1]	Stock identification based on stock definition through Stock ID process (ex: Gulf of Mexico, South Atlantic, or Caribbean). See most recent SEDAR Documentation for Terms of Reference.	Text		Gulf of Mexico
Data_Provider[1]	Name (Acronym) of agency or university providing the life history dataset to SEDAR. The list is not exclusive/exhaustive. Add acronym as appropriate and define in metadata. This does not include sampling program within data provider (See sampling program descriptor below).	Text		FWRI - Florida Fish and Wildlife Conservation Commission, Florida Wildlife Research Institute GulfFIN- Gulf States Marine Fisheries Commission, Fisheries Information Network NMFS Panama City – AGR, National Marine Fisheries Service, Panama City Laboratory: Age, Growth and Reproduction database ; NMFS Panama City – BSD, National Marine Fisheries Service, Panama City Laboratory: Biological Sampling Database
Sampling_Program[1]	Sampling Program that collected morphometric data and/or life history sample. Can use acronym as long as more detail is provided in the metadata tab. Formerly called "Source".	Text		CO-OP - Cooperative Research Project EASA - Expanded Annual Stock Assessment Survey FIN-BIOSTAT – Fishery Information Network FWRI - Florida Fish and Wildlife Conservation Commission, Florida Wildlife Research Institute

Field Names	Description	Type	Units	Acceptable Values
				FWRI-FIM - Florida Wildlife Research Institute, Fisheries Independent Monitoring FWRI-OBS - Florida Wildlife Research Institute, Observer GOP - Galveston Observer Program HB – Beaufort Head Boat Survey LADWF – Louisiana Department of Wildlife and Fisheries MRFSS – Marine Recreational Fishing Statistics Survey MSLAB - NMFS Pascagoula, MS PCLAB - NMFS Panama City, FL PRYTHERCH - special sample collections by Herbert Prytherch RECFIN - Recreational Fisheries Information Network SBLOP - NOAA Fisheries, Shark Bottom Longline Observer Program SRH- Southeast Region Headboat Survey TIP - Trip Interview Program USGS - U.S. Geological Survey
Sample_Method_Type[2]	Record how sample was collected by sampler. This will need to be described by individual data sources.	Text		As Available Landed Sorted Landed Unsorted Random Intercept Targeted Biological (Blank values are acceptable, if Random or Bias_Type are recorded)
Random[2]	Record if sample was randomly collected based on collection method. This is being pulled from TIPS as IS_Random, or contributor's data submission.	Text		Y - Yes N - No (Blank values are acceptable, if Sample_Method_Type or Bias_Type are recorded)
Bias_Type[2]	Record if the sample was collected using a bias method. This will need to be described by individual data sources.	Text		No Bias Known R-Random
Fishery[1]	Broad designation as recreational, commercial or fishery independent based on Fishing_Mode.	Text		COM - Commercial FI – Fishery-Independent REC-Recreational UN - Unknown
Fishing_Mode[1]	Type of fishing activity listed for fishery-dependent and fishery-independent samples identified to the trip level. For Special permitted trips, be sure to include a description or working paper to SEDAR	Text		CB - Charter Boat CM – Commercial CP- Charter Party HB - Headboat PR - Private Vessel SS - Scientific Survey TRN - Tournament UNK - Unknown

Field Names	Description	Type	Units	Acceptable Values
	or Life History group describing how the data were collected and why they should or should not be used to characterize the landings (randomly collected, included in other program such as TIP or SRHS).			
Sampling_Unit_ID[1]	Interview or collection number - identifies a unique trip/collection from within a sampling program.	Text		
Specimen_ID[1]	Unique identifier, assigned by the sampling program for an individual fish within sampling unit ID.	Text		
DP_Unique_Identifier	Unique number or identifier assigned by the Data Provider (e.g., auxiliary number or barcode).	Text (no spaces)		
Month[1]	Month sample collected.	Integer		
Day[1]	Day sample collected.	Integer		
Year[1]	Year sample collected.	Integer		
State_Landed[1]	Postal state abbreviations from USPS. If a sample was collected through a Scientific survey (Fishery-independent program, and the fish is not landed), then it'll be labeled as NL (Not landed as part of fishery-dependent landings).	Text		AL – Alabama FL – Florida LA- Louisiana MS – Mississippi NL - Not Landed (mode-SS, data provider=FWRI) TX – Texas UNK- Unknown
County_Landed	Fishery-dependent data (COM, REC) - county landed. Fishery-independent data, this may reflect a specific sampling site. If available, otherwise leave blank.	Text		BALDWIN BAY BRAZORIA CAMERON CHARLOTTE COLLIER ESCAMBIA FRANKLIN GALVESTON GRAND ISLE HILLSBOROUGH JACKSON JEFFERSON LAFOURCHE LEE MADISON MANATEE MATAGORDA MOBILE

Field Names	Description	Type	Units	Acceptable Values
				MONROE NUECES OKALOOSA PASCAGOULA PINELLAS PLAQUEMINES SARASOTA TERREBONNE VERMILION WALTON
Headboat_Area	Headboat Area assigned by the SRHS.	Integer		21 22 23 26
NMFS_Statistical_Grid	Standard statistical grid including sub-areas (decimals).	Numeric		Values 0 to 21.8888
Latitude	Latitude of where fish was caught.	Numeric	Decimal Degrees	Latitudes and Longitudes are currently in a variety of formats of decimal degrees, degrees and decimal minutes, and degrees minutes seconds.
Longitude	Longitude of where fish was caught.	Numeric	Decimal Degrees	Latitudes and Longitudes are currently in a variety of formats of decimal degrees, degrees and decimal minutes, and degrees minutes seconds. Some records will include the negative sign and some will not.
Gear_Code	Specific Gear Code number used by sampling program – provide a complete list, specific to sampling program.	Text		0 300 610 611 612 613 614 616 675 676 989 HL HNL LL TR TRPV TRW TRWS UNK

Field Names	Description	Type	Units	Acceptable Values
Gear_Name	Text description of the Gear Code – provide a complete description.	Text		12.8-m Trawl (SEAMAP Cruises - SA and GOM) BUOY GEAR, VERTICAL Hand-Line Hook and Line - actively fished Hook and Line - actively fished, repetitive time drop (3 anglers) LINES HAND, OTHER LINES LONG SET WITH HOOKS LINES LONG, REEF FISH Long-Line NOT CODED 000 REEL, ELECTRIC OR HYDRAULIC REEL, MANUAL ROD & REEL ROD AND REEL ROD AND REEL, ELECTRIC (HAND) Trap Trap, Chevron Trawl UNSPECIFIED GEAR Use this gear to denote fish of unknown gear.
Gear_Group_Code[1]	Collapsed grouping of the Gear Code using acronyms. If additional values, please provide value and description in order to cross reference to NMFS codes if necessary.	Text		HL - Hook and-Line (Handline, vertical hook and line gear with limited number of hooks, but not longline) LL - Long-Line TR – Trap TRW/TW – Trawl UA- Unassigned UNK - Unassigned, unknown, or combined gear VLL- Vertical longline
Min_Depth	Minimum depth of fishing. If only one depth provided, put in this column.	Numeric	meters	
Max_Depth	Maximum depth of fishing.	Numeric	meters	
Jurisdictional_Waters	Refers to water body jurisdiction where fish was caught.	Text		Federal
Distance_from_Shore	Record the distance from shore where the fish was caught. Leave blank if unknown.	Numeric	Nautical Miles	
Original_Length_Unit	Length unit used in measurement (cm, mm, inches) recorded by the source.	Text		mm

Field Names	Description	Type	Units	Acceptable Values
Observed_Maximum_TL_mm	Measured maximum total length (i.e. tail pinched).	Integer	mm	
Observed_Natural_TL_mm	Measured natural total length (tail not pinched).	Integer	mm	
Observed_FL_mm	Measured fork length.	Integer	mm	
Observed_SL_mm	Measured standard length.	Integer	mm	
Predicted_Maximum_TL_mm[3]	Use morphometric conversions to calculate- Will be calculated by Life History data compiler.	Integer	mm	
Predicted_Natural_TL_mm[3]	Use morphometric conversions to calculate- Will be calculated by Life History data compiler.	Integer	mm	
Predicted_FL_mm[3]	Use morphometric conversions to calculate- Will be calculated by Life History data compiler.	Integer	mm	
Predicted_SL_mm[3]	Use morphometric conversions to calculate- Will be calculated by Life History data compiler.	Integer	mm	
Final Length_mm[3]	This is the designated length for specific SEDAR. It will vary by species and assessment. A combination of observed and predicted lengths. Will be calculated by Life History data compiler.	Integer	mm	
Final_Length_Type[3]	Is it FL or Natural TL or Maximum TL? Will be recorded by Life History data compiler.	Text		TL
Whole_Weight	Measured whole weight.	Numeric	g	
Gutted_Weight	Measured gutted weight.	Numeric	g	
Fresh_Gonad_Weight[6]	Measured gonad weight from fresh gonads only.	Numeric	g	
Condition_Type	Description of weight recorded (head on; head off, etc.).	Text		Whole
Predicted_Whole_Weight[3]	Use morphometric conversions to calculate- Will be calculated by Life History data compiler (start with WW = GW, then WW= FL then WW = maxTL etc.).	Numeric	g	
Final_Whole_Weight[3]	Compilation of measured and predicted.	Numeric	g	
Duplicate_Length	Refers to whether the length is recorded in another data set (Eg., TIP, SRH, SERFS, etc.).	Text		N – No Y - Yes

Field Names	Description	Type	Units	Acceptable Values
Annuli_Count	Reader(s) consensus of annuli count.	Integer		
Edge_Type	Reader(s) consensus of edge type, edge type may vary by ageing facility. If other edge types are used, please provide and define.	Text		Code Description (Gulf States, Atlantic States) 2 - translucent zone <1/3 complete 3 - translucent zone 1/3 to 2/3 complete 4 - translucent zone >2/3 to fully complete Codes Description (Panama City Lab) (n=3, typically not assigned for YEG) 6_PC - translucent zone 1/3 to fully complete
Calendar_Age	Age assigned to an individual fish to place that fish in a calendar year. Can be considered Cohort age. Allows us to account for time of capture and when it would lay down an annulus. Since it is subjective, it needs to be analyzed by individual reader or data provider if consensus age is submitted. To be filled out by data contributors unless it's a species that uses annuli count, then leave blank.	Integer		Field intentionally left blank
Final_Age	Age to be used in age compositions. Species-specific, could be annuli count or calendar age. Can be filled out by contributors.	Integer		
Fractional_Age[3]	Fractional age assigned to an individual fish based on peak spawning date/month. This will be species-specific. To be filled out by data compilers.	Numeric		Two decimal places
Sub_Sampled	Whether or not an individual fish was subsampled from a larger set of samples. If subsampled, please provide methodology in metadata (e.g. simple random, stratified random, etc.).	Text		N – No Y – Yes

Field Names	Description	Type	Units	Acceptable Values
Gonad_Observed[1,4]	Observed in the field (macro assessment, gonad weight).	Text		N – No Y – Yes
Histo_Sample[1,5,6]	Tissue - histologically processed.	Text		N – No Y – Yes
Macro_Sex[4]	Sex identified by field sampler based on macroscopic appearance of gonad.	Text		D- Did not attempt F- Female M- Male N- No Gonad Tissue Present (TIP Code) T- Transitional U- Unknown
Secondary_Sex	Secondary sex characteristics expressed in fish size, shape or color.	Text		
Secondary_Sex_Attribute	A description of the secondary sex attribute (e.g. “copperbelly” in gag, “adipose fin” in tilefish).	Text		
Macro_Repro_Phase[4]	Maturity based on macroscopic evaluation of reproductive tissue.	Text		DN - Did Not attempt
Histo_Sex[5]	Sex assigned after histological reading of gonad tissue.	Text		F - Female M - Male T - Transitional
Histo_Historic_Data[5]	Any histological data not recorded following Brown-Peterson et al. (2011).	Text		
Histo_Repro_Phase[5]	Standardized terminology that includes both males and females. Reference documents (Brown-Peterson et al. (2011), Tables 2 and 3; see also Lowerre-Barbieri et al. (2009) Table 1).	Text		
Histo_Repro_Subphase[5]	Further detailed information of Histo_Repro_Phase. For description of male GE subphases, see Brown-Peterson et al. (2011). Other subphases from Table 1 in Lowerre-Barbieri et al. (2009).	Text		
Histo_Most_Advanced_Gamete_Stage[5,6]	Males and females. Stage must occur in $\geq$ 5% of the tissue section to be considered “most advanced”. Scan of the entire slide: 4x on female	Text		

Field Names	Description	Type	Units	Acceptable Values
	tissue and 10x on male tissue.			
Histo_POF[5,6]	Relative age of post-spawning indicator. POF = postovulatory follicle.	Text		
BF_Est[6]	Batch fecundity estimate.	Number		
BF_Pres[6]	How were gonads for fecundity preserved?	Text		
Catch_time	Time of day fish was caught (include time zone in metadata)	Numeric		
Histo_Melanomacrophages	One or more melanomacrophage centers observed in the gonad.	Text		
Macro_Gonad_Parasites	Macroscopic evidence of parasitic infection anywhere in gonad.	Text		U - Unknown/did not assess
Histo_Gonad_Parasites	Histological evidence of parasitic infection anywhere in gonad.	Text		
Histo_Indicator_1	Other structures found within the histological section that support Histo_Repro_Phase classifications, especially in the case of immature vs regenerating specimens. Order of three Histological Indicator fields does not indicate priority.	Text		
Histo_Indicator_2	Other structures found within the histological section that support Histo_Repro_Phase classifications, especially in the case of immature vs regenerating specimens. Order of three Histological Indicator fields does not indicate priority.	Text		
Histo_Indicator_3	Other structures found within the histological section that support Histo_Repro_Phase classifications, especially in the case of immature vs regenerating specimens.	Text		

Field Names	Description	Type	Units	Acceptable Values
	Order of three Histological Indicator fields does not indicate priority.			