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Micki Pawluk

SEDAR105-WP-04

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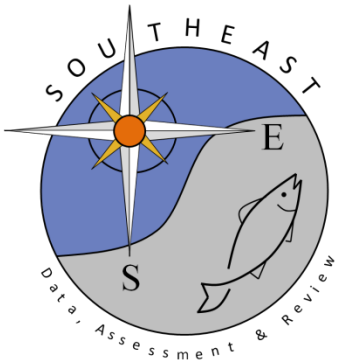

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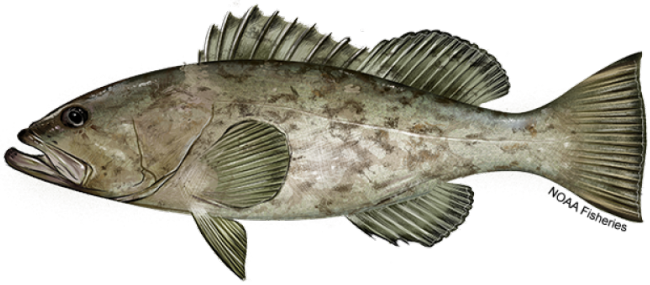

Gulf of America Gag Grouper (*Mycteroperca microlepis*) Length and Age Compositions for the Commercial Handline and Longline Fisheries

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Introduction

This document outlines the data and methodologies used to estimate length and age compositions of the commercial handline and longline landings for the SEDAR 105 Gulf of America (formerly Gulf of Mexico, hereafter referred to as "Gulf") Gag Grouper Assessment. These compositions were estimated using data sources approved in SEDAR 10, and used in SEDAR 33 and SEDAR 72. Annual nominal and weighted length and age compositions are presented here, as well as conditional age at length and mean length at age.

Data Description

SEDAR 105 assesses all Gulf Gag Grouper in federal waters from the Florida Keys west to the Texas-Mexico border. For this assessment, compositions were estimated for two fleets: commercial handline and longline. At the request of the analytical team, the Gulf was split into three subregions (South Florida (SFL) – areas 744, 748, 1 – 6; North Florida – Alabama (NFL-AL) – areas 7 – 10; and Mississippi – Texas (MS-TX) – areas 11 – 21) for weighting the compositions by landings and are shown in Figure 1. For the landings other gears are combined into the handline+ fleet. However, for length and age compositions only handline samples are used and samples from other gears are excluded. This is to avoid bias in the compositions due to the majority of the landings data coming from handline gears compared to "other" gears. The commercial data source utilized to generate the length and age compositions for the commercial fleets consists of length samples from the Trip Interview Program (Beggerly *et al.* 2022) and age samples collected by federal and state sampling programs.

Commercial Length Compositions of Landings

Length Samples

Length samples of commercial landings were obtained from the TIP database maintained by the NMFS Southeast Fisheries Science Center (SEFSC) and were filtered to remove biases that include samples from pooled trips and any size or effort bias. Samples from the handline and longline fisheries were available starting in 1984.

These data were compiled using length bins of 2 centimeters (cm) with the floor of the bin being labeled. Maximum total length (MTL), Natural total length in cm (NTL) and standard length in cm (SL) were converted to fork length in cm (FL) using the following conversion equations:

$$FL = 0.115 + 0.97 * MTL$$

$$FL = 1.317 + 0.96 * NTL$$

$$FL = 2.618 + 1.11 * SL$$

A minimum length bin of 20 cm was used, and a maximum length bin of 158 cm was used, with fish falling outside of this range being pooled in the smallest or largest bin. Any fish lengths greater than 250 cm FL were deleted and assumed to be errors.

Nominal length Compositions

Nominal length compositions for the commercial handline fleet (HL) and commercial longline fleet (LL) were estimated for Gag Grouper landings from the GMFMC/SAFMC boundary to the TX/Mexico border. Annual nominal length compositions were estimated using length bins of 2 cm, where for each year i, and length bin j,

$$LC_{i,j} = \frac{n_{i,j}}{n_i}$$

where $n_{i,j}$ is the number of samples in year i and length bin j; n_i is the number of samples in year i (i.e., summed across length bins); and $LC_{i,j}$ is the proportion of the total number of sampled fish in each year i within each length bin j.

Nominal length compositions are shown by gear in Figure 2. Annual sample sizes of commercial lengths and trips are shown in Tables 1 and 2 for commercial handline and longline, respectively, by weighting strata (Year & Subregion) as well as annual totals. For the nominal compositions, the total column is used to identify years with sufficient samples. Years with fewer than 30 length samples or fewer than 10 trips are recommended to be dropped from further analyses. All available years are presented in Tables 1 and 2, regardless of the recommendation to drop.

Weighted length compositions

In order to account for potential spatial bias in sampling effort, and account for the spatial distribution of fishing effort, nominal length compositions were re-weighted using fleet-specific landings proportions by subregion (SFL – areas 744, 748, 1 – 6; NFL-AL – areas 7 – 10; and MS-TX – areas 11 – 21) and year. Length sample sizes and number of trips are provided by weighting strata in Tables 1 and 2 for handline and longline, respectively. Weighting strata (year, fleet, and subregion) with fewer than 30 length samples or fewer than 10 trips are recommended to be dropped from further analyses and have been highlighted in **red**.

For the commercial handline fleet, weighting strata-specific nominal length compositions were estimated using length bins of 2 cm, where for each year i, length bin j, and subregion r,

$$LC_{i,j,\mathrm{r}} = \frac{n_{i,j,\mathrm{r}}}{n_{i,\mathrm{r}}}$$

$n_{i,j,r}$ is the number of samples in year i, subregion r, and length bin j; $n_{i,\mathrm{r}}$ is the number of samples in year i and subregion r (i.e., summed across length bins); and $LC_{i,j,r}$ is the proportion of the total number of sampled fish in each year i and subregion r within each length bin j. Nominal length compositions by subregion are shown in Figures 3 and 4 for handline and longline respectively. Next, the weighting strata-specific length compositions were weighted based on the proportion of landings in each subregion r and year i.

Proportions of annual landings from each subregion r in year i, $p_{i,r}$, were used to weight the strata-specific length compositions, $LC_{i,j,r}$, which were then summed across subregions r

$$LC_{i,j} = \sum_{s} \left(LC_{i,j,r} * p_{i,r} \right)$$

resulting in the final weighted estimates of landings length compositions, $LC_{i,j}$. This procedure would down-weight, for example, any instances where 60% of the length samples come from a subregion that only accounts for 20% of the landings for that fleet. Annual proportions of landings by subregion were used in the weighting process, however, to protect confidentiality of the landings data, proportions are presented by time block in this report. The proportions of landings by management period (1984 – 2006; 2007 – 2023) and subregion, $p_{i,\mathrm{r}}$ are presented for commercial handline and longline in Table 3. A split of the time series at 2007 was used due to the implementation of the Red Snapper IFQ often leading to changes in fishing behavior when comparing before and after implementation. The effects of this weighting procedure are shown in Figures 5 and 6 for handline and longline, respectively. The effects of weighting are minimal in many years. The weighted length compositions for the commercial handline and longline fleets are recommended for use in the model for years with sufficient sample sizes.

Commercial Age Compositions of Landings

Age Samples

The commercial age samples were a subset of the length samples. Age data compiled by the SEFSC Panama City Laboratory were filtered to remove duplicated and biased data. For the commercial age compositions, a plus group of 20 was used, meaning all ages 20+ have been grouped into the same age bin.

Nominal Age Compositions

Nominal age compositions were estimated for the commercial handline fleet (HL) and longline fleet (LL) in each year. Any strata with fewer than 10 age samples or fewer than 10 trips were recommended to be dropped. Nominal age compositions of landings were estimated using the following equation within each year i, and age bin k,

$$AC_{i,k} = \frac{a_{i,k}}{a_i}$$

where $a_{i,k}$ is the number of age samples in year i and age bin k; a_i is the number of age samples in year i; and $AC_{i,k}$ is the proportion of the total number of sampled fish in each year i within each age bin k. A minimum sample size threshold was recommended annually within each year stratum, AC_{ik}, where these were recommended to be dropped and excluded from further analyses if $a_{is} < 10$ or if the number of trips the fish were sampled from is less than 10.

The annual nominal age compositions are shown by gear in Figure 7. Bubble plots showing the annual age compositions are shown in Figures 8 and 9 for handline and longline, respectively. Annual sample sizes of commercial ages and trips by gear group are shown in Table 4.

Weighted Age Compositions

In order to account for potential sampling biases in the age data, the nominal age compositions are typically re-weighted by the weighted length compositions. In order for the data to be

deemed sufficient for weighted age compositions, each stratum must contain a minimum of 10 ages from 10 trips, and there must be a corresponding weighted length composition (i.e. there must be a minimum of 30 lengths from 10 trips in each subregion). Summaries of data availability (including the availability of weighted age compositions) are shown in Table 5.

In order to weight the nominal age compositions, first a re-weighting factor, $RW_{i,j}$, was calculated within each year i and length bin j to correct the composition of the age data (number of age samples in each length bin divided by the annual total) to more closely represent the final length composition of the landings. The re-weighting factor was calculated as follows,

$$RW_{i,j} = \frac{LC_{i,j}}{a_{i,j}/a_i}$$

where $LC_{i,j}$ is the weighted length composition in year i and length bin j, $a_{i,j}$ is the number of age samples in year i and length bin j, and a_i is the total number of age samples in year i. Under this methodology, if there were age samples $a_{i,j}$ not represented in $LC_{i,j}$, they were down-weighted to zero and effectively dropped from further analysis. The final commercial weighted age compositions were estimated as

$$AC_{i,k} = \sum_j \left(RW_{i,j} * \frac{a_{i,j,k}}{a_i} \right)$$

where all length bins j within an age class k were summed, then re-scaled to sum to 1 across each year. The re-weighting factor will up-weight ages from less represented length bins and will generate a more representative estimate of landings' age compositions. Effects of the age composition weighting procedure are shown in Figures 10 and 11 for the commercial handline and longline fleets, respectively. The figures show minimal differences between composition types in most years. Additionally, bubble plots showing the final weighted age distributions are shown in Figures 12 and 13, for the commercial handline and longline fleets, respectively.

Commercial Conditional Age-at-Length

Conditional age-at-length (CAAL) is the proportion of fish, at age, in a given length bin. When data are sufficient (i.e. wide spread of ages and lengths represented), CAAL is considered to be more informative than length and age compositions because it can be used to directly estimate the length-at-age process and the variability in length-at-age (Taylor and Methot 2013; Piner et al. 2016; Lee et al. 2019). Another benefit of CAAL is that it avoids double use of fish for both age and length compositions, especially when age compositions are weighted by the length compositions.

For each commercial fleet (handline, longline) conditional age-at-length was estimated where for each year i, length bin j, and age class k

$$CAAL_{i,s,j,k} = \frac{a_{i,j,k}}{a_{i,j}}$$

$a_{i,j,k}$ is the number of age samples in year i, lower inclusive length bin j, and age class k; $a_{i,j}$ is the number of age samples in year i, and lower inclusive length bin j; and $CAAL_{i,j,k}$ is the

proportion of fish samples in year i, and length bin j within age class k**Error! Reference source not found.**. Conditional age-at-length by year is shown in Figures 14 and 15 for commercial handline and longline, respectively.

Data availability summarized across nominal lengths, nominal ages, weighted lengths, weighted ages, and conditional age at length are provided in Table 5. Mean length at age, discussed below, is excluded from this table, as it is not a model input subject to sample size limitations, but rather a diagnostic tool for the analyst.

Commercial Mean Length-at-Age

Fleet-specific mean length-at-age and associated sample sizes were also provided to the lead analyst to aid in model diagnostics. Mean length-at-age, $MLAA_{i,k}$, was estimated as the sum of all lengths $L_{i,k}$ divided by the associated sample sizes $a_{i,k}$ within each year i and age class k.

$$MLAA_{i,k} = \frac{\sum L_{i,k}}{a_{i,k}}$$

The mean length-at-age by year is shown in Figures 16 and 17 for commercial handline and longline fleets, respectively.

Changes from SEDAR 72

Updates to the TIPS database extraction have led to differences in sample sizes between SEDAR 72 and SEDAR 105. Firstly, buoy gear had previously been classified as a handline gear, however, it has since been classified as a longline gear due to the methodology with which it was being used. This change resulted in 14,344 samples changing from handline to longline. Updates to the gear determination hierarchy resulted in 1,711 fish that were previously assigned to "other" which are now assigned to handline. Additionally, updates to the classification of random/non-random sampling resulted in the dropping of 1,103 samples. Finally, updates to standard area assignments surrounding Monroe county, FL, and to areas near the TX-Mexico border, resulted in 106 fish that were previously considered to be caught in the Gulf to now be considered non-Gulf, and therefore they have been dropped. While these updates resulted in significant differences in the number of samples per strata in some cases, the final weighted length comps were very similar when comparing SEDAR 72 and SEDAR 105, as shown in Figures 18 and 19 for handline and longline, respectively.

References

Beggerly, S., M. Stevens, H. Baertlein. 2022. Trip Interview Program Metadata. SEDAR74-DW14. 12pp.

Lee, H., K.R. Piner, I.G. Taylor, and T. Kitakado. 2019. On the use of conditional age at length data as a likelihood component in integrated population dynamics models. Fisheries Research. 216:204-211.

Piner, K.R., H.H. Lee, and M.N. Maunder. 2016. Evaluation of using conditional age-at-length observations and an equilibrium approximation of the population age structure in fitting the von Bertalanffy growth function. Fisheries Research. 180:128-137.

Taylor, I.G., R.D. Methot, Jr. 2013. Hiding or dead? A computationally efficient model of selective fisheries mortality. Fisheries Research. 142:75-85

Tables

Table 1. *Annual number of Gulf Gag Grouper commercial* ***handline (HL)*** *length samples and associated trips by subregion, and totals across subregion. Years not meeting the recommended* ***30*** *fish or* ***10*** *trip minimum filter are highlighted in* ***red****. When evaluating data for nominal compositions, the sample sizes from the Total columns are used. When evaluating data for weighted compositions, the sample sizes from the subregion columns are used. Any year with either too few fish or too few trips is recommended to be dropped.*

	MS-TX		NFL-AL		SFL		Total	
Year	# of fish	# of trips	# of fish	# of trips	# of fish	# of trips	# of fish	# of trips
1984	**20**	**7**	64	**5**	737	22	821	34
1985	56	24	140	10	578	25	774	59
1986	78	12	**0**	**0**	276	14	354	26
1987	**14**	**9**	**0**	**0**	545	25	559	34
1988	**0**	**0**	**0**	**0**	175	**9**	175	**9**
1989	**0**	**0**	**0**	**0**	42	**2**	42	**2**
1990	45	23	222	13	710	32	977	68
1991	192	79	280	12	207	29	679	120
1992	110	63	166	13	839	52	1115	128
1993	141	56	485	40	1066	63	1692	159
1994	63	30	759	52	1778	72	2600	154
1995	47	23	1654	130	702	69	2403	222
1996	74	25	1828	120	1163	80	3065	225
1997	122	53	2528	109	719	69	3369	231
1998	269	48	3515	104	4235	142	8019	294
1999	104	35	1979	78	3843	158	5926	271
2000	53	19	1657	96	2299	125	4009	240
2001	38	19	2087	100	3385	115	5510	234
2002	**26**	13	2159	124	1928	102	4113	239
2003	**24**	12	1266	83	911	94	2201	189
2004	42	15	2209	84	602	72	2853	171
2005	48	27	974	79	428	51	1450	157
2006	**24**	18	296	32	381	59	701	109
2007	**24**	17	105	12	261	47	390	76
2008	69	29	513	29	428	60	1010	118
2009	48	26	195	23	629	131	872	180
2010	52	29	183	21	586	108	821	158
2011	49	34	764	112	610	107	1423	253
2012	123	72	739	138	1070	193	1932	403
2013	184	94	984	150	1156	221	2324	465
2014	64	44	536	131	1065	195	1665	370
2015	95	50	538	123	489	98	1122	271
2016	122	69	1185	179	1027	124	2334	372
2017	68	38	639	124	1106	132	1813	294

2018	82	43	717	151	816	124	1615	318
2019	108	50	963	201	533	129	1604	380
2020	**25**	18	562	161	402	99	989	278
2021	32	12	478	89	278	54	788	155
2022	50	36	518	119	639	181	1207	336
2023	38	29	343	114	306	130	687	273
2024	**24**	15	211	65	261	82	496	162

Table 2. *Annual number of Gulf Gag Grouper commercial* ***longline (LL)*** *length samples and associated trips by subregion, and totals across subregion. Years not meeting the recommended* ***30*** *fish or* ***10*** *trip minimum filter are highlighted in* ***red****. When evaluating data for nominal compositions, the sample sizes from the Total columns are used. When evaluating data for weighted compositions, the sample sizes from the subregion columns are used. Any year with either too few fish or too few trips is recommended to be dropped.*

	MS-TX		NFL-AL		SFL		Total	
Year	# of fish	# of trips	# of fish	# of trips	# of fish	# of trips	# of fish	# of trips
1984	**0**	**0**	**0**	**0**	458	22	458	22
1985	**29**	**8**	**0**	**0**	548	24	577	32
1986	**2**	**1**	**8**	**1**	1125	72	1135	74
1987	**0**	**0**	**0**	**0**	685	23	685	23
1988	**0**	**0**	32	**2**	244	14	276	16
1989	**0**	**0**	**10**	**1**	119	**5**	129	**6**
1990	**12**	**3**	42	**5**	1591	62	1645	70
1991	56	**5**	93	**7**	767	65	916	77
1992	**11**	**5**	**8**	**3**	924	74	943	82
1993	**4**	**3**	35	**7**	751	89	790	99
1994	**0**	**0**	120	**6**	651	86	771	92
1995	**1**	**1**	141	10	865	91	1007	102
1996	**1**	**1**	**3**	**1**	1051	97	1055	99
1997	**0**	**0**	59	**5**	1162	127	1221	132
1998	**0**	**0**	59	**4**	5011	271	5070	275
1999	**1**	**1**	**2**	**1**	4656	309	4659	311
2000	**0**	**0**	42	**6**	4170	240	4212	246
2001	**0**	**0**	201	14	3960	216	4161	230
2002	**8**	**1**	40	**6**	4076	251	4124	258
2003	**3**	**1**	285	14	3622	302	3910	317
2004	**11**	**2**	58	**8**	2462	259	2531	269
2005	**2**	**1**	98	**7**	2391	270	2491	278
2006	33	**6**	**21**	**2**	1713	241	1767	249
2007	**10**	**6**	31	**3**	964	186	1005	195
2008	**16**	**6**	**26**	**3**	1254	196	1296	205
2009	**7**	**3**	**26**	**2**	744	123	777	128
2010	**5**	**5**	**0**	**0**	1178	151	1183	156
2011	**0**	**0**	104	11	431	89	535	100
2012	**9**	**4**	47	**7**	438	101	494	112
2013	31	12	121	18	599	122	751	152
2014	**1**	**1**	83	10	931	127	1015	138
2015	**2**	**2**	79	10	973	112	1054	124
2016	**1**	**1**	110	**7**	1249	139	1360	147
2017	**18**	**9**	50	11	897	135	965	155
2018	**15**	11	130	16	654	97	799	124
2019	**11**	**9**	106	12	553	80	670	101

2020	**6**	**4**	**26**	**7**	75	31	107	42
2021	**9**	**8**	42	**4**	177	40	228	52
2022	**1**	**1**	137	10	707	134	845	145
2023	**3**	**3**	56	10	287	85	346	98
2024	**1**	**1**	32	**4**	135	49	168	54

Table 3. *Proportion of landings by subregion for two time blocks (Pre and Post Red Snapper IFQ) for the commercial handline and longline fleets.*

Management Period	Handline			Longline		
	MS-TX	NFL-AL	SFL	MS-TX	NFL-AL	SFL
1984 - 2006	0.0499	0.3757	0.5744	0.0132	0.1158	0.8711
2007 - 2024	0.0294	0.4438	0.5268	0.0080	0.1224	0.8697

Table 4. *Annual number of Gulf Gag Grouper commercial age samples and associated trips* ***by fleet****. Years not meeting the recommended* ***10*** *fish or* ***10*** *trip minimum filter are highlighted in* ***red****. Any year with either too few fish or too few trips is recommended to be dropped.*

	Handline		Longline	
Year	# of fish	# of trips	# of fish	# of trips
1991	210	27	**7**	**1**
1992	66	17	22	12
1993	417	85	12	**7**
1994	435	44	**3**	**2**
1995	284	46	31	**7**
1996	197	21	57	14
1997	34	**9**	**6**	**5**
1998	106	13	101	21
1999	145	21	243	49
2000	387	57	177	28
2001	745	94	867	138
2002	809	106	1085	155
2003	520	108	1117	220
2004	894	114	1484	220
2005	740	101	857	93
2006	641	94	534	181
2007	408	80	936	195
2008	680	64	506	94
2009	840	167	765	126
2010	799	151	1091	147
2011	1428	259	523	100
2012	1610	360	459	101
2013	2217	462	803	208
2014	1515	355	999	158
2015	973	258	984	124
2016	1734	312	1195	149
2017	1558	253	903	146
2018	1394	276	700	118
2019	1345	345	624	98
2020	769	257	87	38
2021	653	141	190	47
2022	1220	619	768	140
2023	670	316	622	390
2024	480	192	141	45

Table 5. *Data availability summary by data product and fleet. Strata highlighted in green are appropriate for use in the stock assessment model. Strata highlighted in red are inappropriate for use in the stock assessment model. Strata highlighted in yellow should be used with caution. Strata highlighted in gray have no data available.*

	Nominal Length Comps		Weighted Length Comps		Nominal Age Comps		Weighted Age Comps		CAAL	
Year	HL	LL	HL	LL	HL	LL	HL	LL	HL	LL
1984										
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1986										
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1991										
1992										
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Figures

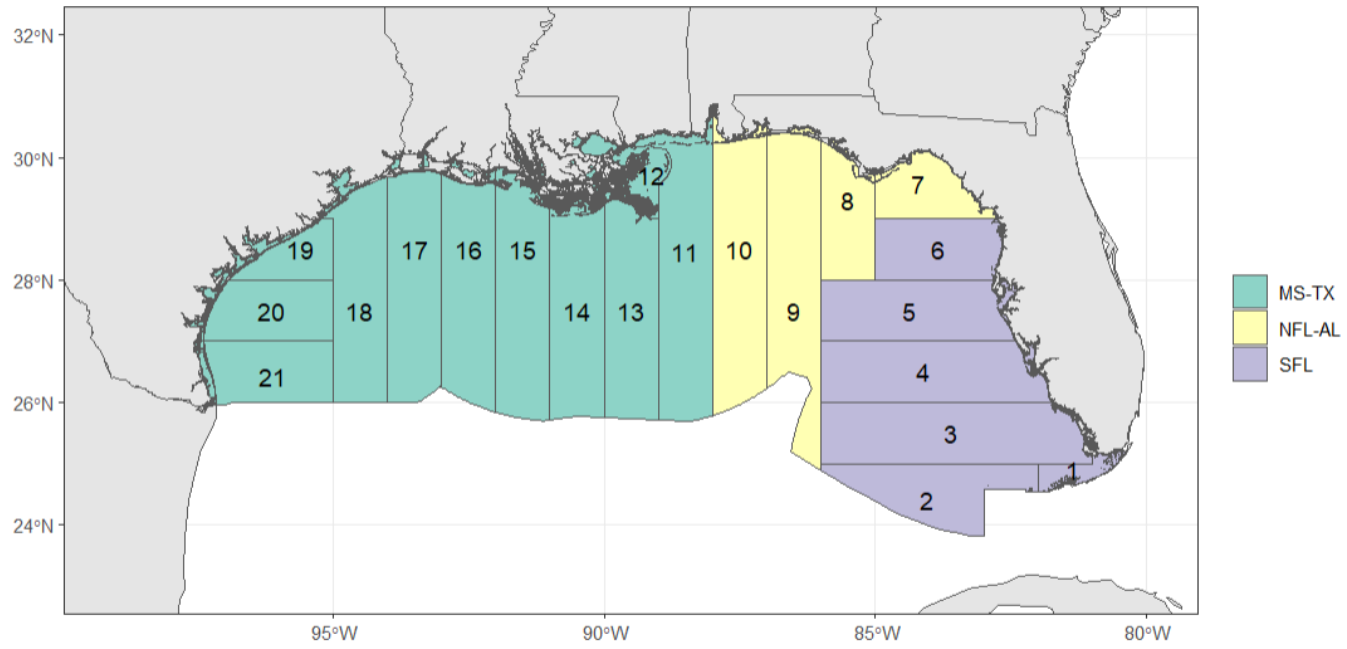

Figure 1. Gulf Gag Grouper subregions used for weighting the length compositions.

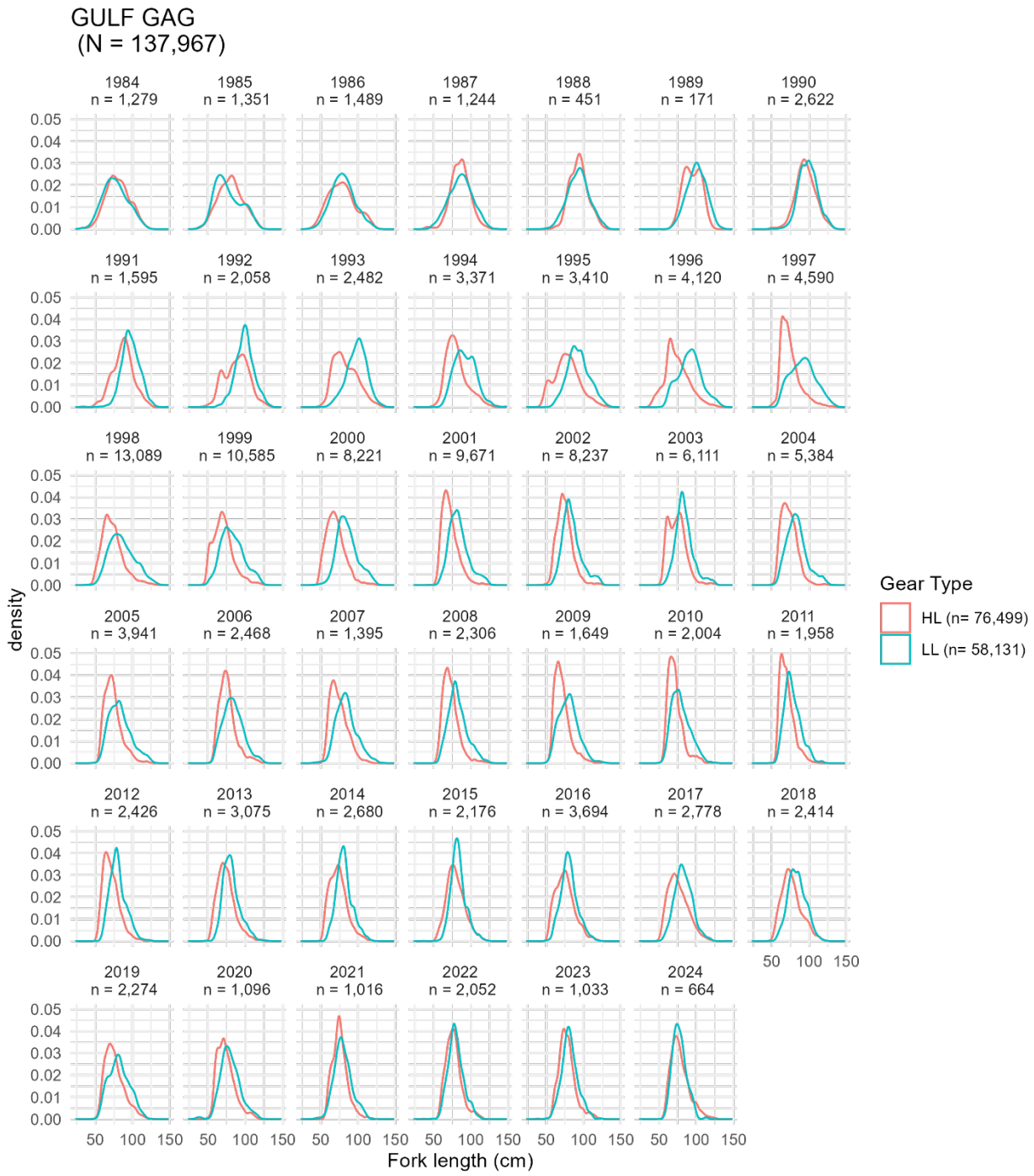

Figure 2. Annual nominal length distributions for the Gulf Gag Grouper commercial handline and longline fisheries.

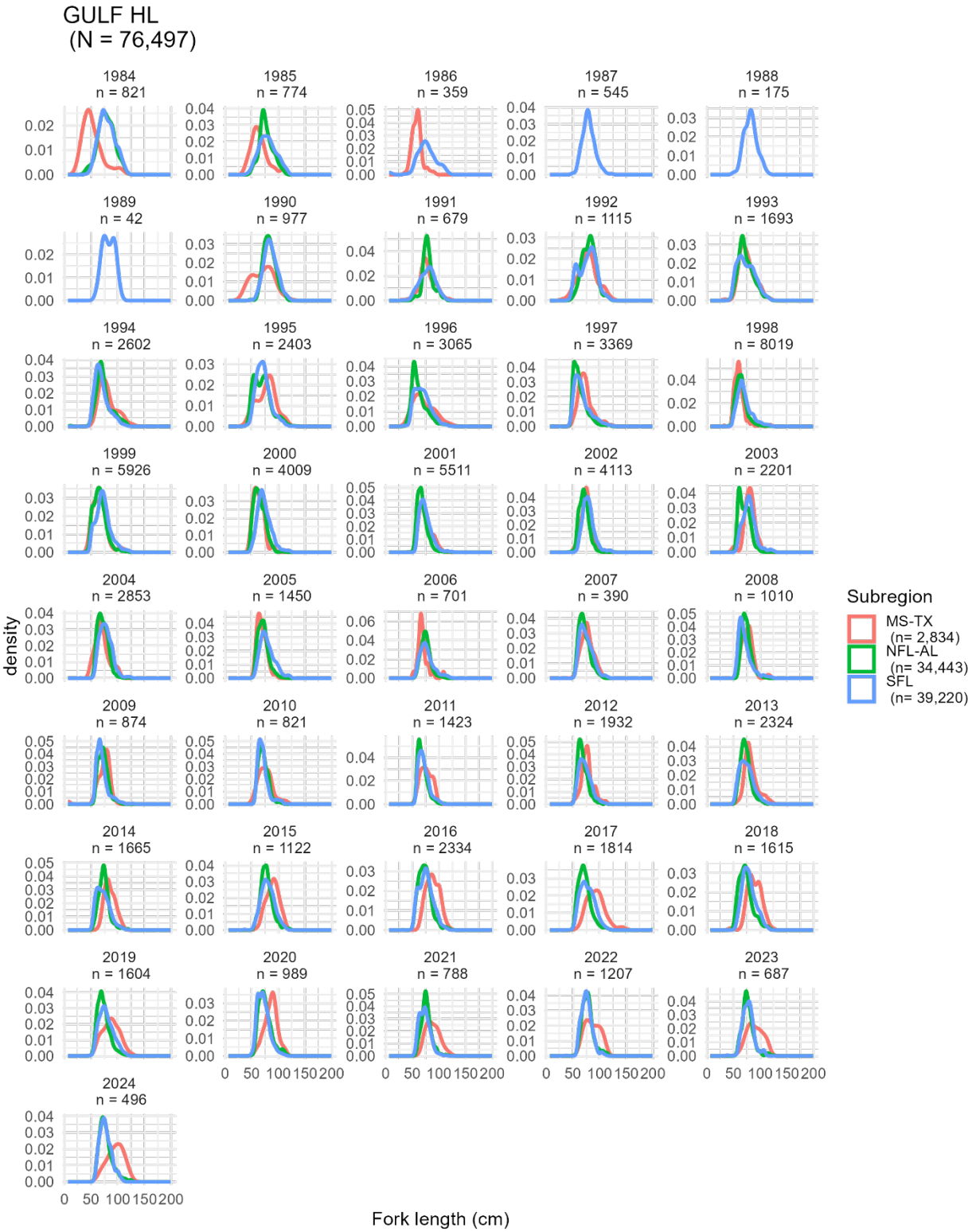

Figure 3. Annual nominal length distributions for the Gulf Gag Grouper commercial ***handline fishery*** *by weighting subregion.*

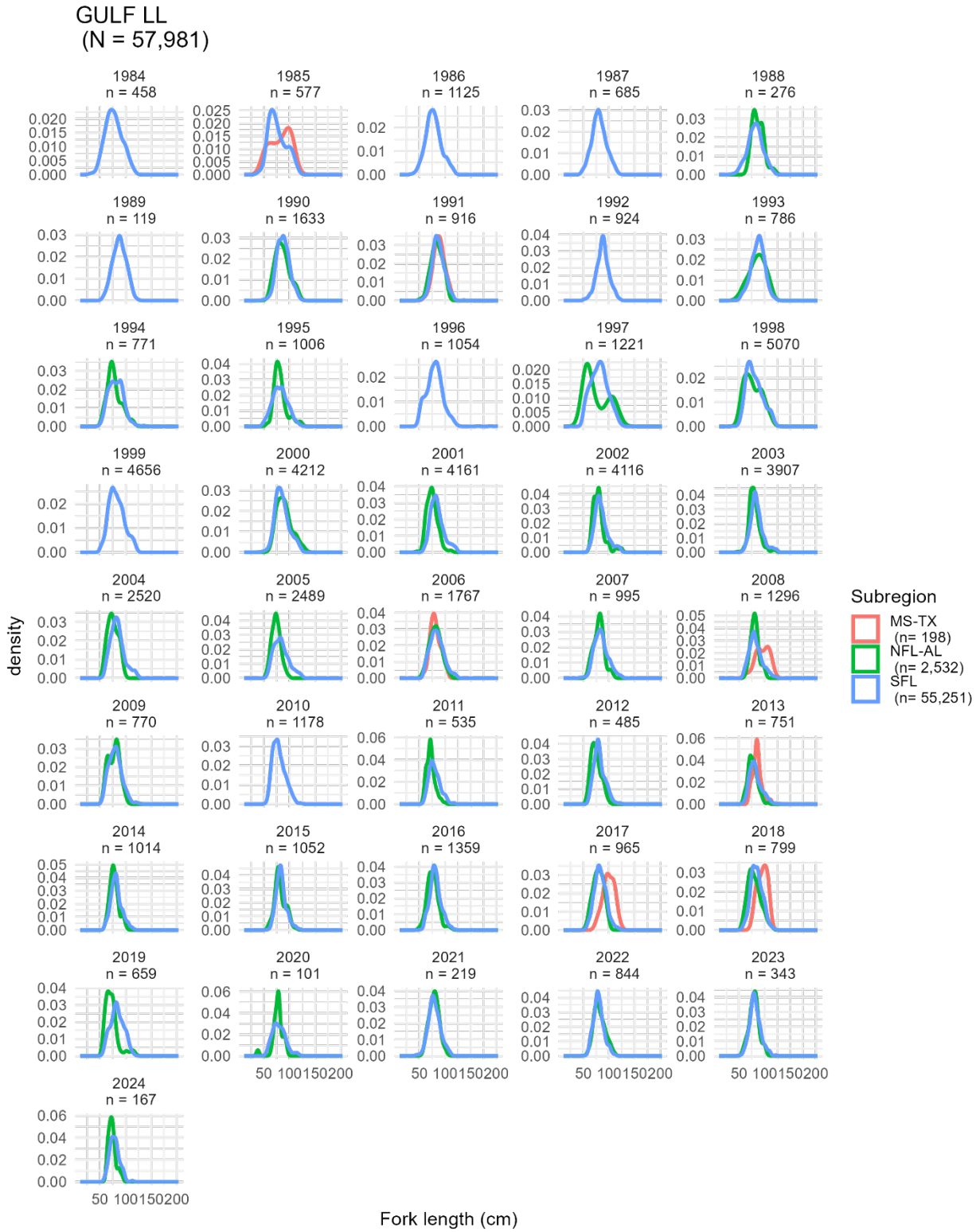

*Figure 4. Annual nominal length distributions for the Gulf Gag Grouper commercial **longline fishery** by weighting subregion.*

Figure 5. Annual comparison of the nominal and weighted length compositions for the Gulf Gag Grouper commercial ***handline fishery.***

*Figure 6. Annual comparison of the nominal and weighted length compositions for the Gulf Gag Grouper commercial **longline fishery**.*

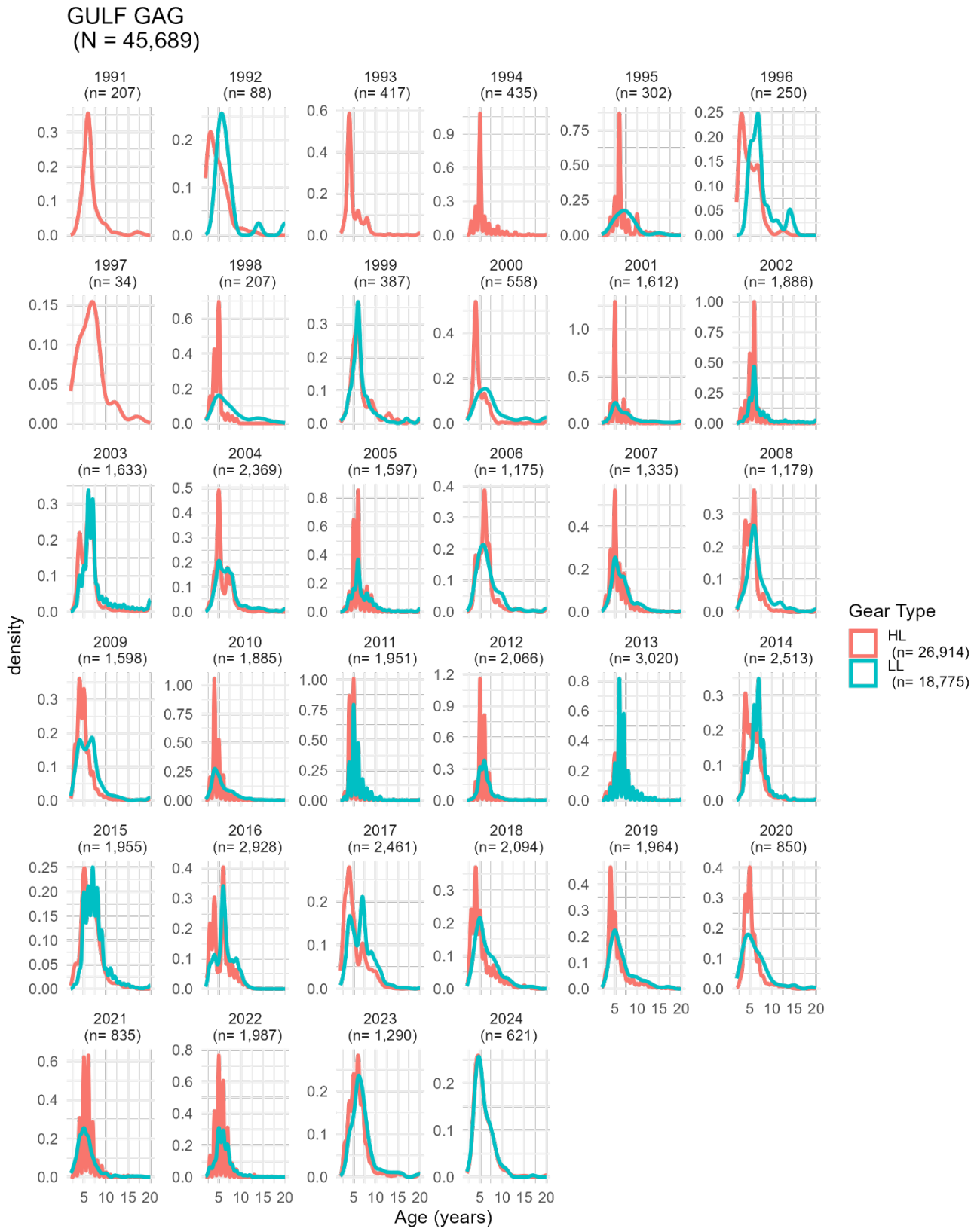

Figure 7. Annual nominal age compositions for the Gulf Gag Grouper commercial handline and longline fisheries.

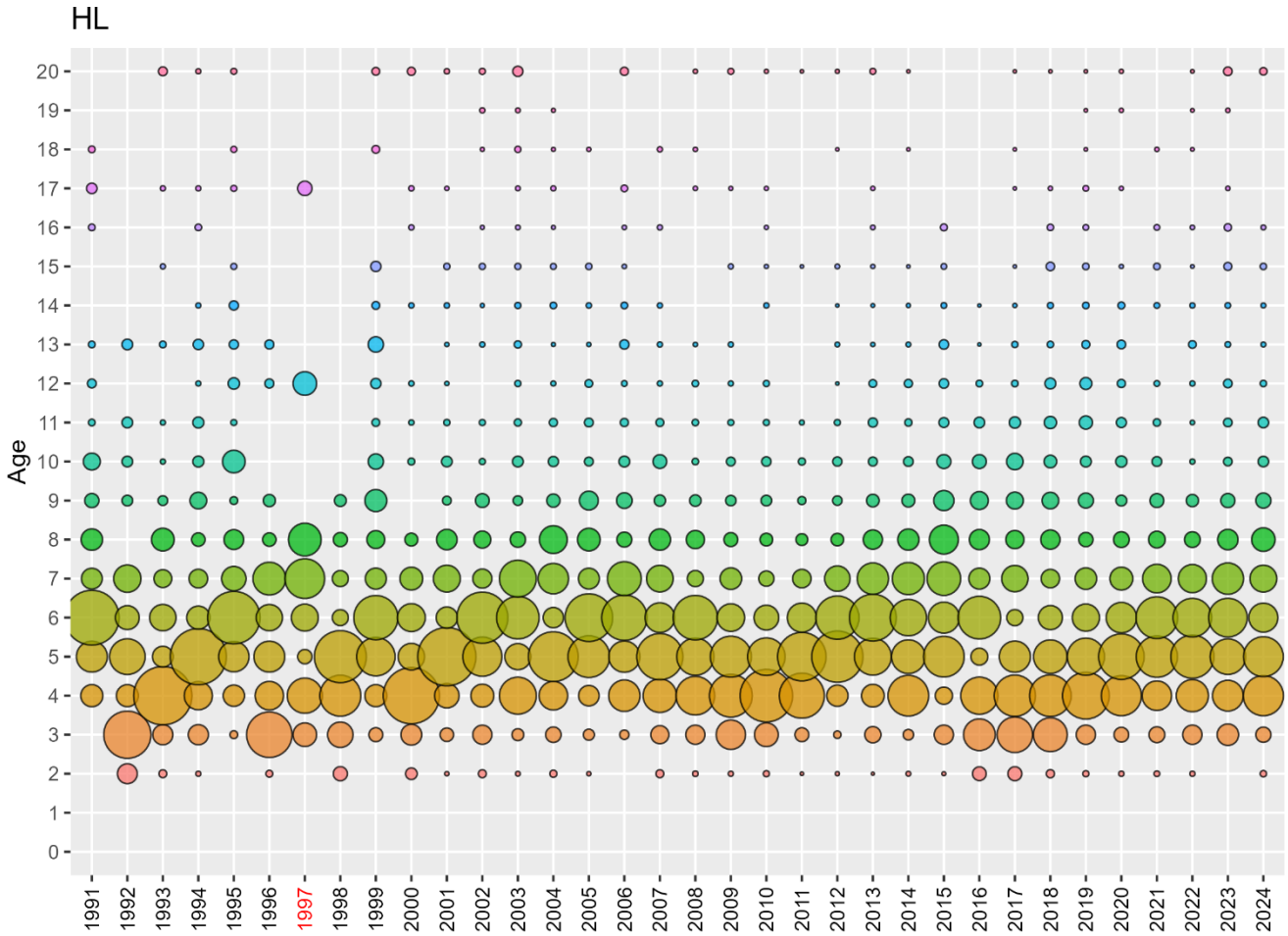

*Figure 8. Annual nominal age compositions for the Gulf Gag Grouper commercial **handline fishery**. The size of the dots represents the relative proportion at age. Years recommended to be dropped have been highlighted in **red**.*

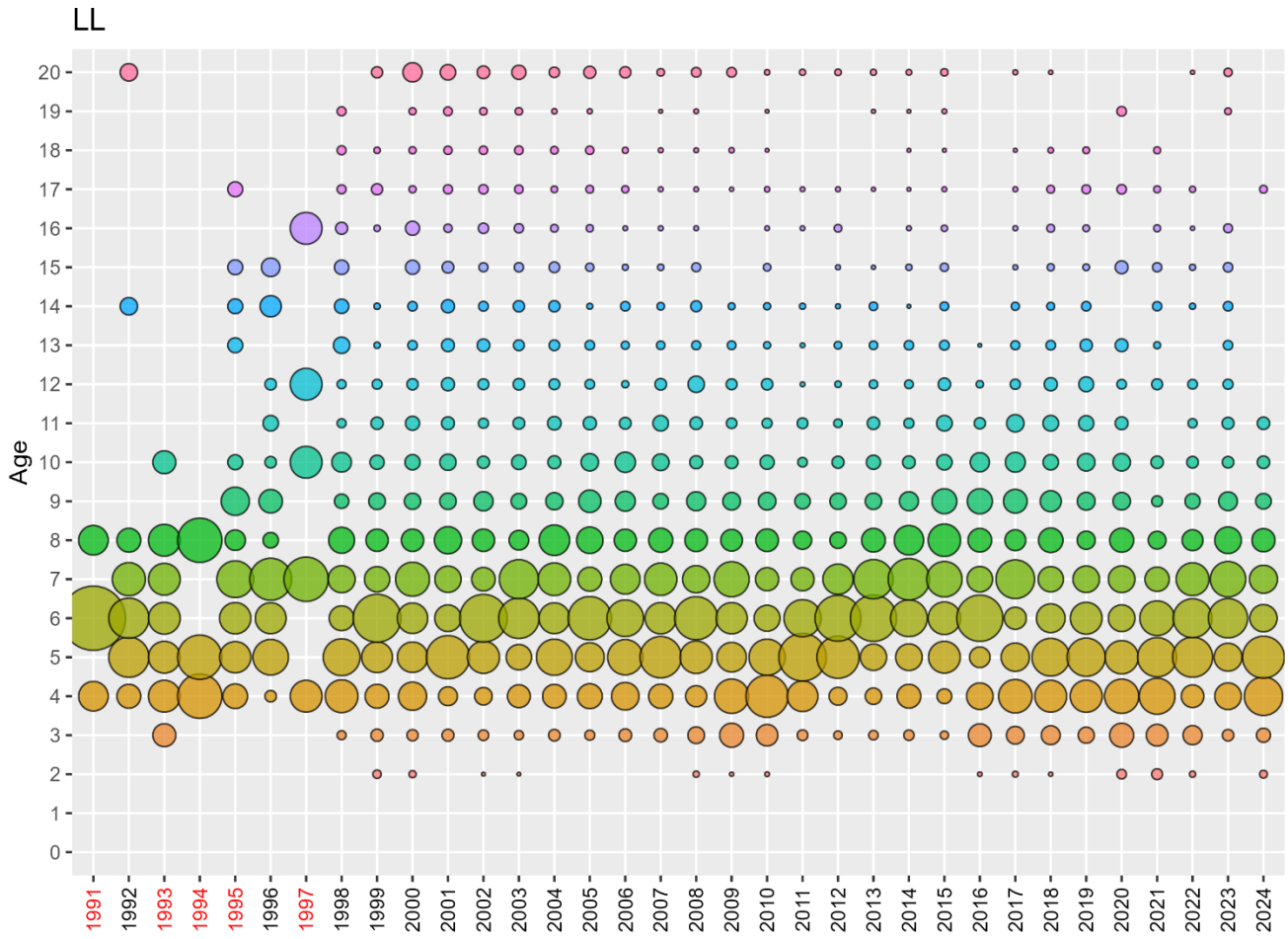

*Figure 9. Annual nominal age compositions for the Gulf Gag Grouper commercial **longline fishery**. The size of the dots represents the relative proportion at age. Years recommended to be dropped have been highlighted in **red**.*

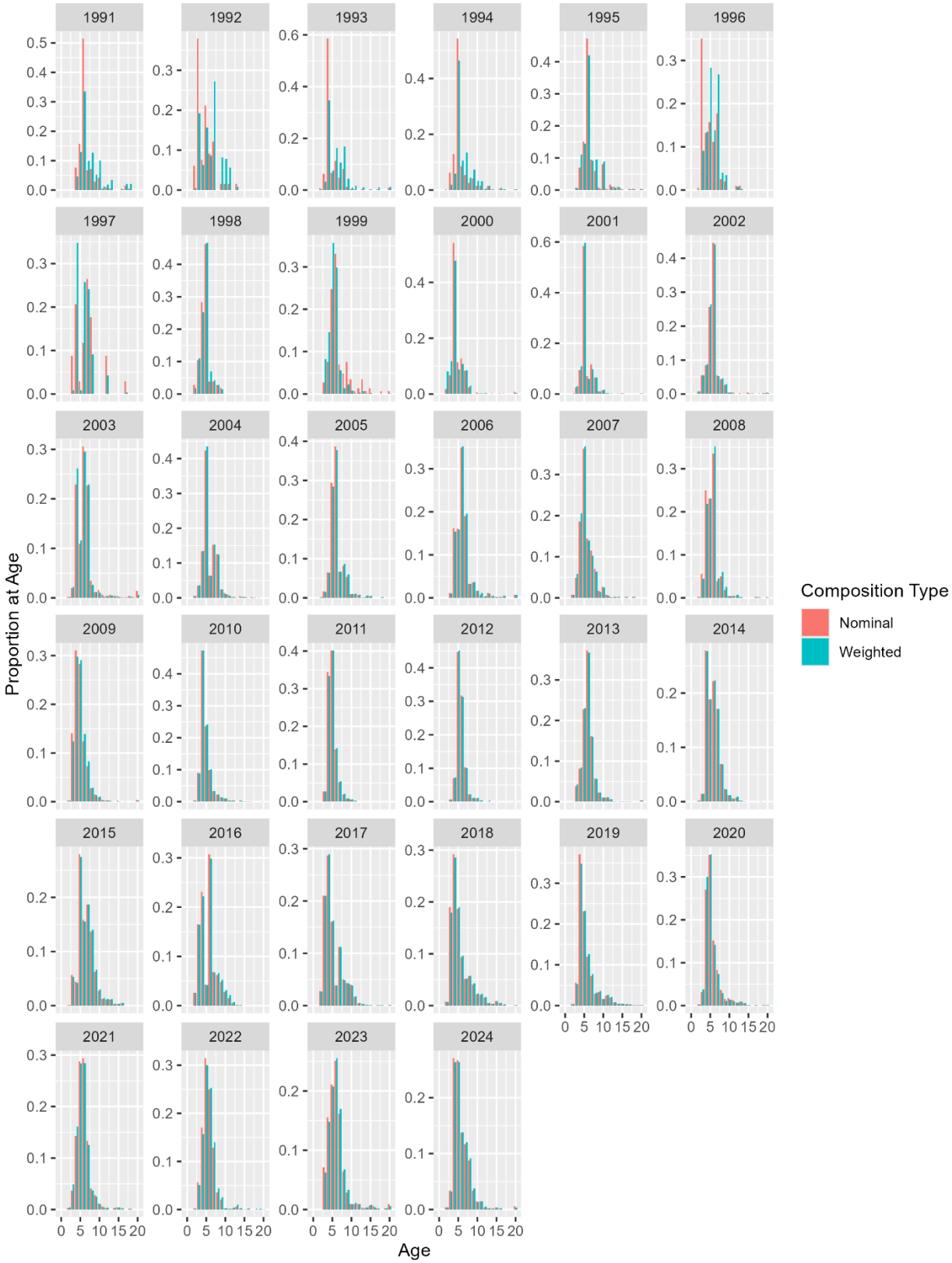

*Figure 10. Annual comparison of the nominal and weighted age compositions for the Gulf Gag Grouper commercial **handline fishery**.*

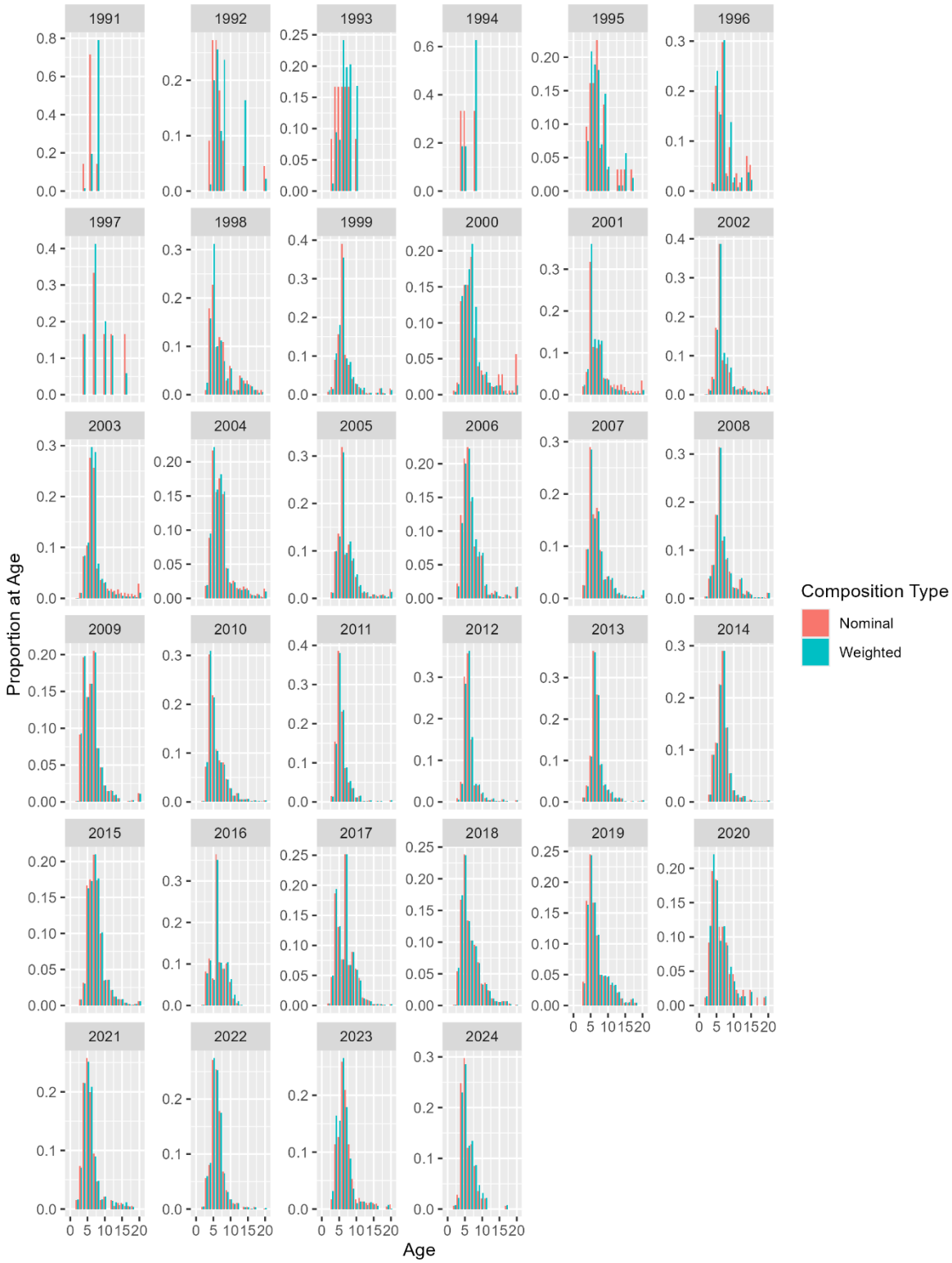

*Figure 11. Annual comparison of the nominal and weighted age compositions for the Gulf Gag Grouper commercial **longline fishery**.*

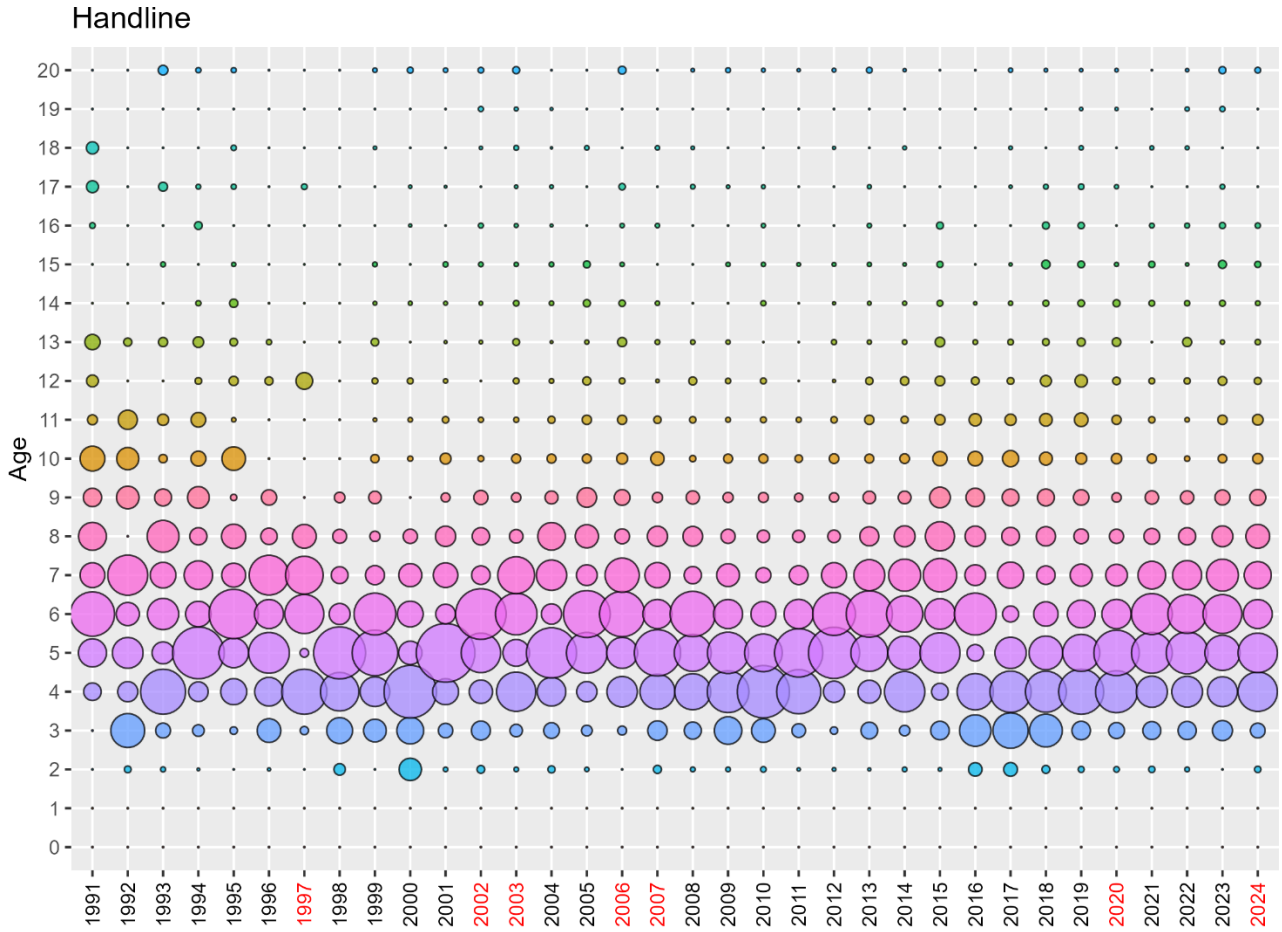

*Figure 12. Annual weighted age compositions for the Gulf Gag Grouper commercial **handline fishery**. The size of the dots represents the relative proportion at age. Years recommended to be dropped have been highlighted in **red**.*

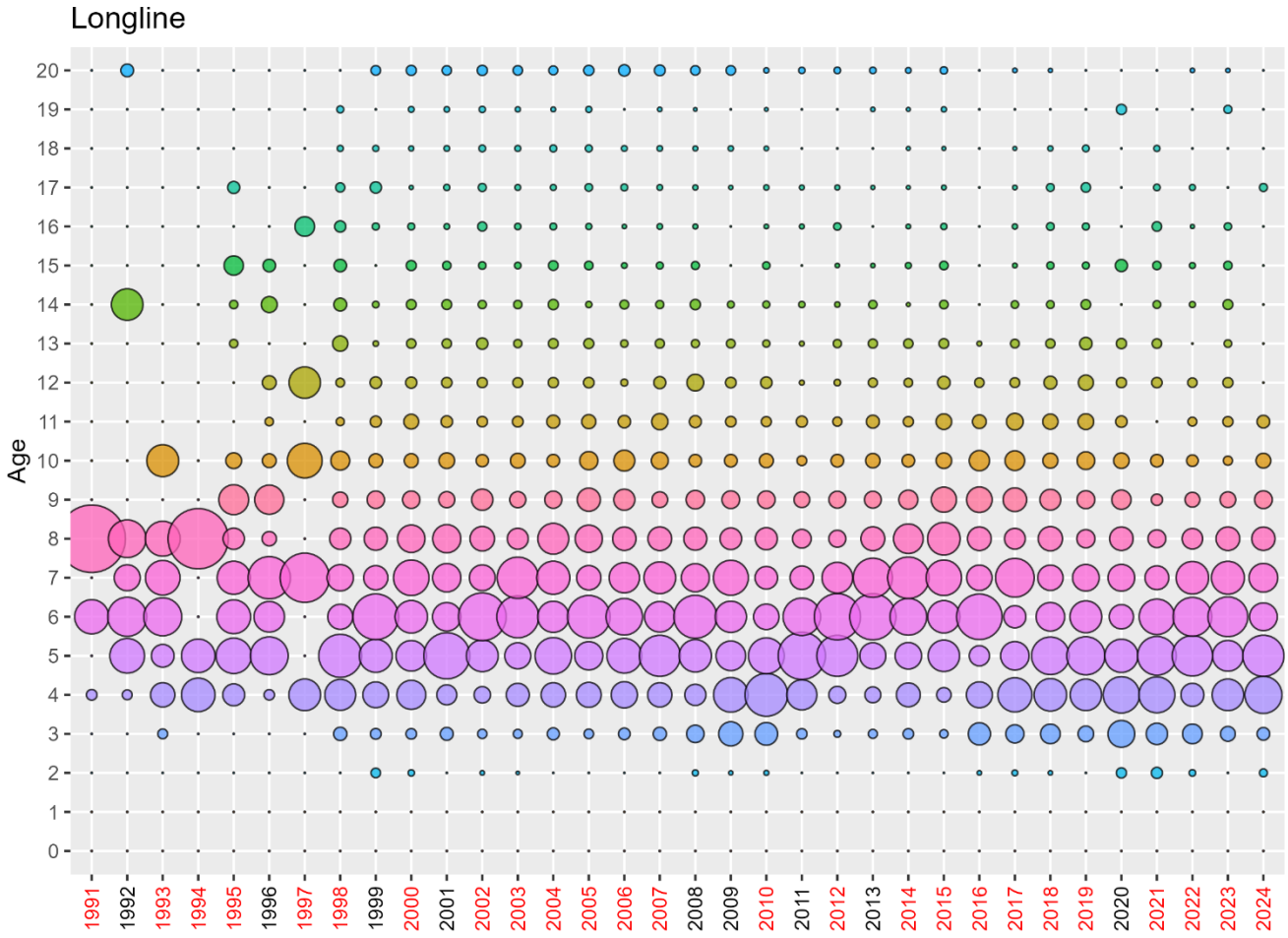

*Figure 13. Annual weighted age compositions for the Gulf Gag Grouper commercial **longline fishery**. The size of the dots represents the relative proportion at age. Years recommended to be dropped have been highlighted in **red**.*

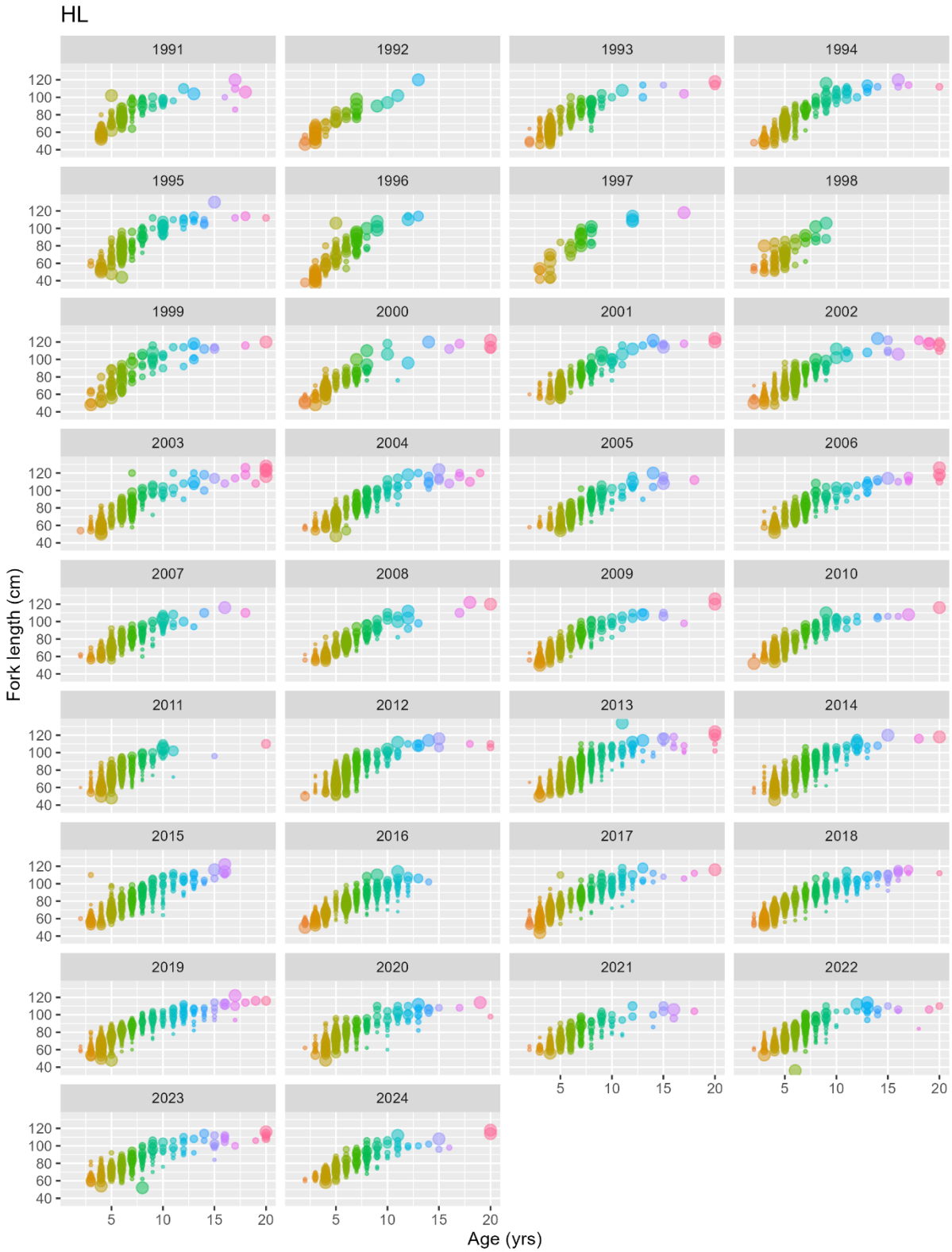

*Figure 14. Conditional Age-at-Length for the Gulf Gag Grouper commercial **handline fishery**. The size of the dots represents the relative proportion at age for a given length bin.*

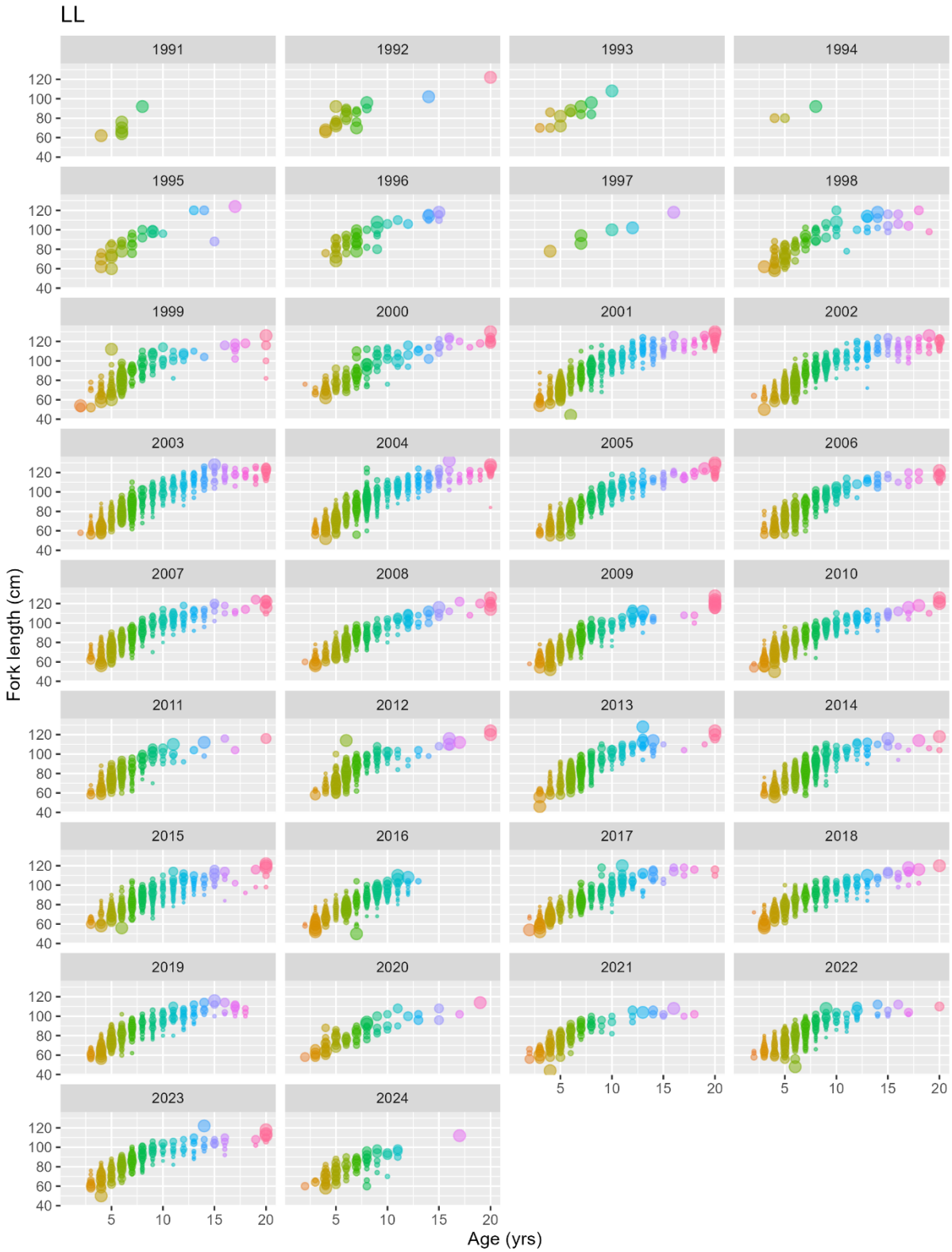

*Figure 15. Conditional Age-at-Length for the Gulf Gag Grouper commercial **longline fishery**. The size of the dots represents the relative proportion at age for a given length bin.*

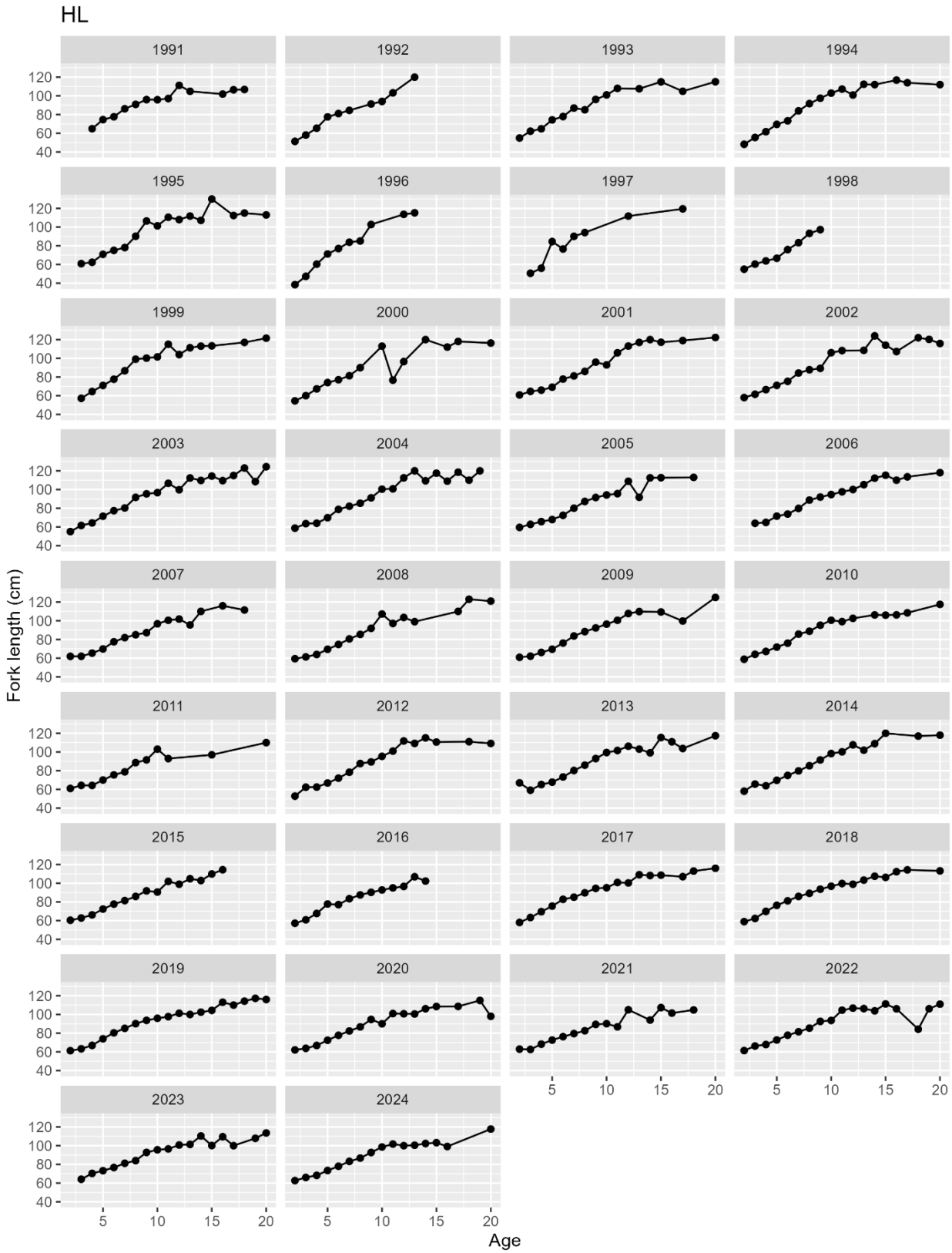

Figure 16. Annual mean fork length at age for the Gulf Gag Grouper commercial ***handline fishery****.*

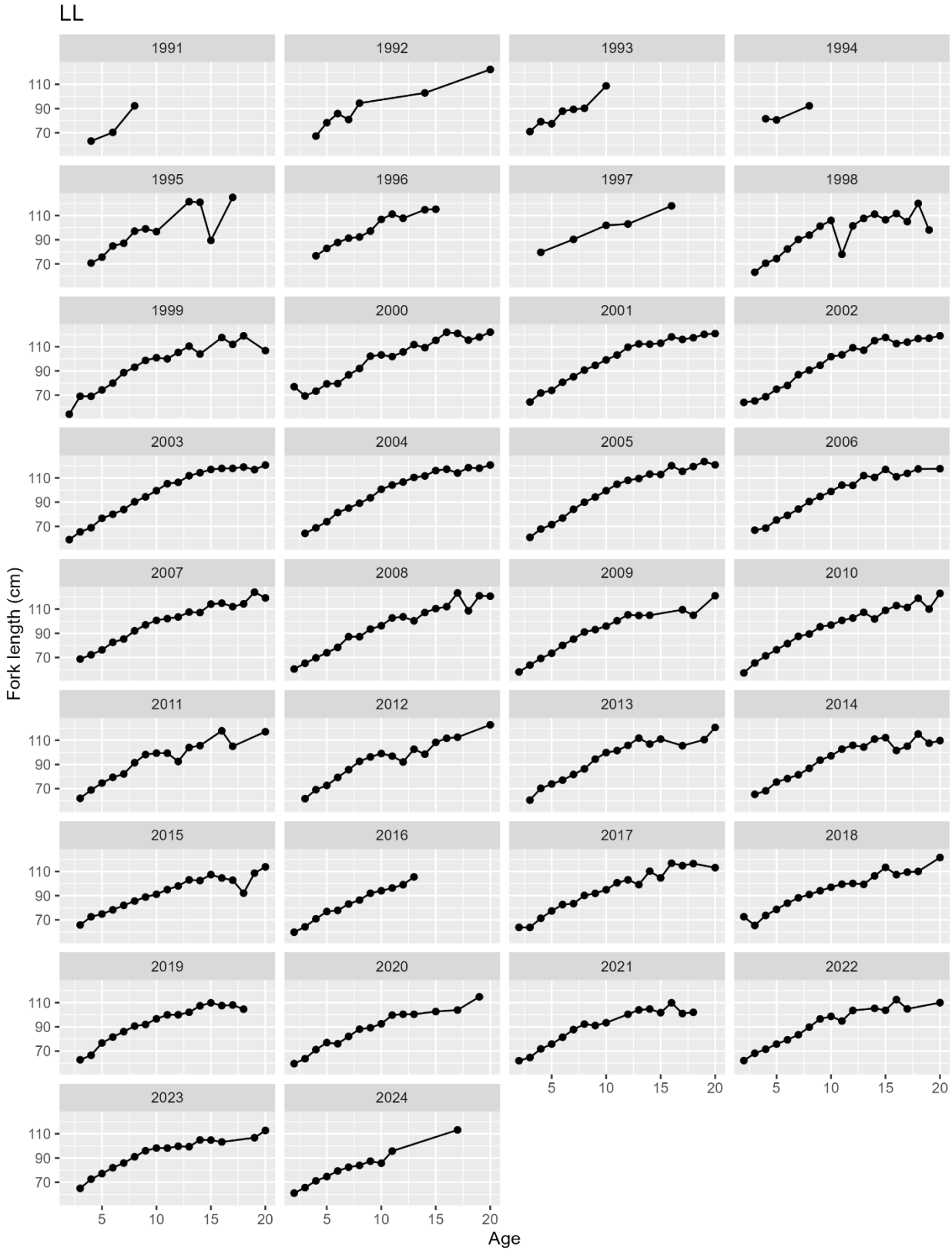

Figure 17. Annual mean fork length at age for the Gulf Gag Grouper commercial ***longline fishery****.*

*Figure 18. Comparison of the weighted length compositions for the Gulf Gag Grouper commercial **handline fishery** for SEDAR 72 and SEDAR 105.*

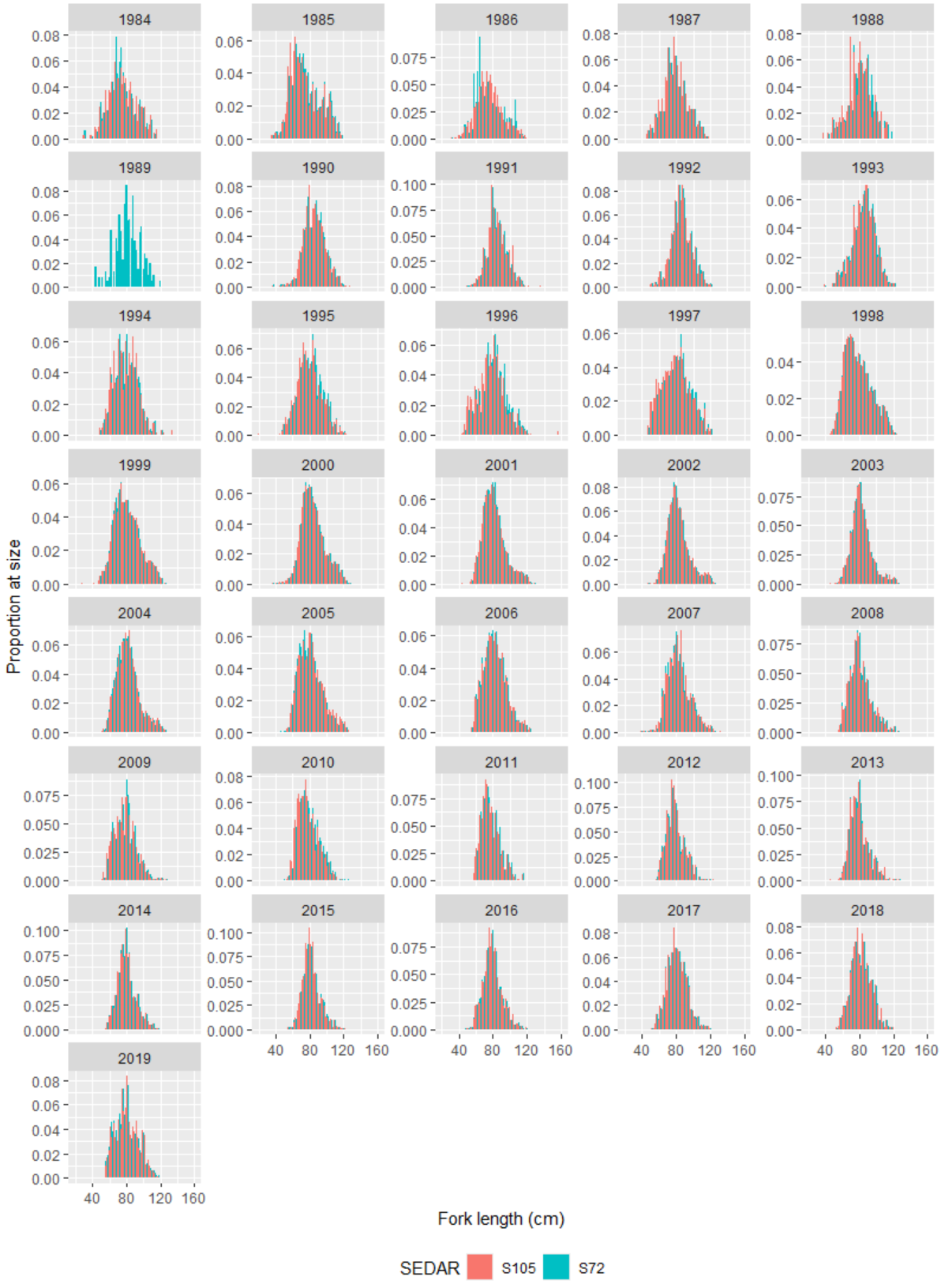

*Figure 19. Comparison of the weighted length compositions for the Gulf Gag Grouper commercial **longline fishery** for SEDAR 72 and SEDAR 105.*