Gulf of Mexico Spanish Mackerel (*Scomberomorus maculatus*) Commercial Landings Length and Age Compositions

Molly H. Stevens

SEDAR81-WP-07

21 December 2022

Please cite this document as:

Stevens, Molly H. 2022. Gulf of Mexico Spanish Mackerel (*Scomberomorus maculatus*) Commercial Landings Length and Age Compositions. SEDAR81-WP-07. SEDAR, North Charleston, SC. 17 pp.

Gulf of Mexico Spanish Mackerel (*Scomberomorus maculatus*) Commercial Landings Length and Age Compositions

Molly H. Stevens
NOAA Southeast Fisheries Science Center, 75 Virginia Beach Drive, Miami FL 33149

December 2022

Introduction

This document outlines the data and methodologies used to estimate length and age compositions of commercial landings for the SEDAR 81 Gulf of Mexico Spanish Mackerel Assessment. These compositions were estimated using data sources approved in SEDAR 28. While SEDAR 28 included nominal length compositions, the Center of Independent Experts (CIE) Review recommended considering post-stratification prior to combining data for compositions (Cordue 2013). Therefore, gear-specific commercial length compositions weighted annually with spatially stratified landings data were explored. Resulting analyses, data limitations, and research recommendations are discussed below.

Because fishery-dependent sampling is typically opportunistic, sampled lengths may not be representative of the true size composition of landings (and, by extension, sampled otoliths may not be representative of the true age composition of the landings). To account for these potential biases, length samples from commercial fleets were weighted by their respective landings at the finest spatial and temporal scale available without losing data. Commercial age data were considered conditional on the length data, therefore conditional age-at-length (CAAL) and mean length-at-age (MLAA) were estimated because these data contain more detailed information on the relationship between size and age while avoiding double use of fish (Thorson *et al.* 2017, Methot *et al.* 2020).

Data Description

SEDAR 81 assesses all Gulf of Mexico Spanish Mackerel in federal waters extending northward from the Texas/Mexico border and eastward to the Florida Keys US1 boundary. Commercial data sources utilized to generate length compositions include length samples from the Trip Interview Program (TIP, 1983-2021) and landings data from the Accumulated Landings Systems from 1983 until state trip ticket programs came into effect (Orhun *et al.* 2022). Age estimates from GulfFIN and FWRI-Fishery Independent Monitoring were compiled by the SEFSC Panama City Laboratory alongside their age data.

Commercial fleets were defined by vertical line (VL) and gillnet (GN) gears. These data were compiled using length bins of 2 centimeters (cm) to match SEDAR 28. Total length (TL) was converted to fork length (FL) using the following conversion equation:

$$FL = -1.18218 + 0.8816 * TL$$

Since 1983, the commercial fisheries have had a minimum size limit of 12” (30cm) FL in Gulf federal waters. Fish landings measuring less than 10cm FL were deleted as these were assumed to be unit errors (e.g. fish recorded as 10cm were likely 10”). Fish lengths greater than 1.4m FL were deleted and assumed to be errors, while fish measuring more than 75cm FL were aggregated into a ‘plus-length’ group.

Commercial Length Compositions of Landings

Because fishery-dependent sampling is typically opportunistic, lengths may not be representative of the true landings composition throughout the entire Gulf of Mexico. Possible sampling bias in the collection of length samples are typically removed by weighting the length compositions with the associated landings on the finest spatial and temporal scale available without losing data.

Commercial fleets (VL, GN) were aggregated into three subregions in the Gulf of Mexico based on the NMFS areas fished shown in Figure 1: Eastern (E: areas 1-6), Central (C: areas 7-12), and Western (W: areas 13-21). These gears were sufficiently distinct to remain separate fleets (Figure 2) and gear-specific annual compositions are shown in Figure 3. Length distributions were shown by fishing areas grouped by stock (W, C, E) for VL (Figure 4) and GN (Figure 5). Sample sizes of commercial lengths (Table 1) and trips (Table 2) were provided for each strata (year, subregion) for each fleet. Strata with less than 30 length samples were dropped from further analyses. Due to the sporadic nature of the commercial data for this species, the 10 trip limit was relaxed to salvage hundreds of samples and increase representation of landings.

Within each fleet, subregional-specific nominal length compositions were estimated using length bins of 2 cm, where for each year i, length bin j, and subregion r

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

$n_{i,j,r}$ is the number of samples in year i, subregion r, and lower inclusive length bin j; $n_{i,r}$ is the number of samples in year i and subregion r; and $LC_{i,j,r}$ is the proportion of the total number of sampled fish in each year i and subregion r within each lower inclusive length bin j. A minimum sample size threshold was applied annually within each strata, $LC_{i,r}$, where these were dropped and excluded from further analyses if $n_{i,r} < 30$. Next, the remaining subregional-specific length compositions were weighted based on the distribution of the landings estimates among subregions.

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

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

resulting in the final weighted estimates of landings length compositions, $LC_{i,j}$. The proportion of landings, $p_{i,r}$, for each year i and subregion r are aggregated into time periods and shown in Table 3. This procedure would downweight, for example, any instances where 60% of the length samples come from a stratum that only accounts for 20% of the landings for that fleet. The effects of this weighting procedure are shown for vertical line (Figure 6) and gillnet (Figure 7).

Commercial Conditional Age-at-Length

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. Sample sizes of commercial ages (Table 4) and commercial trips sampled for age (Table 5) were provided. Spanish Mackerel maximum age was estimated to be 11 years.

Within each commercial fleet (VL, GN) conditional age-at-length was estimated where for each year i, length bin j, and age class k

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

$a_{i,j,k}$ 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 (Figure 8 and Figure 9).

Fleet-specific mean length-at-age and associated sample sizes were also provided to aide 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.

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

Data Limitations and Research Recommendations

Spanish Mackerel commercial data examined for these compositions demonstrated unrepresentative sampling for this fishery. There were some strata that had length samples, but no associated landings (West VL 1992, 1993, 1995). This should be highly unlikely, but length and landings data providers verified that there were no errors they could detect in the data from these strata. Furthermore, nearly all of the length samples for some years came from strata with very low landings (West VL 2015:2017). The length composition weighting procedure did have the desired effect to improve the representativeness of the data. For example, the West region generally has the largest length distribution. The majority of the VL landings came from the Eastern and Central strata, and the weighted compositions for 2015-present more accurately represent the smaller size compositions expected for these landings (Table 1, Table 3, Figure 13). It is recommended to further investigate seasonal migration patterns alongside the commercial fishing year (April-March) to ensure there are no errors in the data. It is also recommended to merge the age data with lengths to ensure representative sampling, or at least better inform the appropriateness of utilizing CAAL.

References

Cordue, P.L. 2013. SEDAR 28: Gulf of Mexico Cobia and Spanish Mackerel Stock Assessment Review. CIE Independent System for Peer Review. 39 pp.

Methot, R.D., C.R. Wetzel, I.G. Taylor, K. Doering. 2020. Stock Synthesis User Manual Version 3.30.16. NOAA Fisheries, Seattle WA. 220 pp.

Orhun, M.R., Atkinson, S.F., Pawluk, M.E. 2022. Commercial Landings of Gulf of Mexico Spanish Mackerel (*Scomberomorus maculatus*) 1887-2021. SEDAR81-WP04. SEDAR, North Charleston, SC. 19pp.

Thorson, J.T., K.F. Johnson, R.D. Methot, I.G. Taylor. 2017. Model-based estimates of effective sample size in stock assessment models using the Dirichlet-multinomial distribution. Fisheries Research 192: 84–93.

Tables

Table 1. *Annual number of Spanish Mackerel commercial vertical line (VL) and gillnet (GN) length samples by spatial strata (W, C, E). The length compositions resulting from these samples were dropped from further analyses if n<30.*

Year	VL_W	VL_C	VL_E	GN_W	GN_C	GN_E
1983	131	0	0	0	0	0
1984	118	0	0	0	80	128
1985	72	169	0	0	288	955
1986	16	0	0	0	452	1,136
1987	0	0	6	0	2,130	3,144
1988	0	0	0	0	846	1,711
1989	47	0	5	0	122	1,307
1990	11	0	0	0	595	1,333
1991	245	2	73	0	179	1,690
1992	235	29	29	0	335	2,417
1993	98	61	8	12	676	899
1994	106	3	7	8	473	1,691
1995	38	0	0	67	384	478
1996	12	0	341	40	0	1,949
1997	1	4	412	12	258	80
1998	0	20	78	0	268	523
1999	1	1	354	0	459	514
2000	0	29	25	0	389	408
2001	0	3	81	0	309	611
2002	5	11	16	0	1,282	671
2003	33	3	56	0	2,223	644
2004	4	3	9	0	2,502	50
2005	43	0	35	0	2,267	70
2006	38	1	14	0	2,350	56
2007	9	0	14	20	3,161	0
2008	24	0	13	0	3,365	30
2009	35	7	0	0	2,687	0
2010	38	0	8	0	2,896	0
2011	195	0	84	0	3,532	41
2012	36	0	64	0	7,187	0
2013	23	5	7	0	4,299	61
2014	93	52	79	0	4,433	38
2015	608	9	96	0	4,283	58
2016	491	4	14	0	7,803	0
2017	264	61	169	0	4,655	0
2018	133	4	1	0	5,396	0
2019	128	26	2	0	4,433	0
2020	3	49	8	0	2,461	0
2021	48	59	41	0	2,018	0

Table 2. *Annual number of Spanish Mackerel commercial vertical line (VL) and gillnet (GN) trips sampled for lengths by spatial strata (W, C, E).*

Year	VL_W	VL_C	VL_E	GN_W	GN_C	GN_E
1983	34	0	0	0	0	0
1984	43	0	0	0	1	1
1985	28	11	0	0	5	8
1986	2	0	0	0	8	17
1987	0	0	1	0	24	45
1988	0	0	0	0	12	30
1989	6	0	1	0	3	20
1990	2	0	0	0	8	25
1991	28	1	3	0	8	29
1992	37	1	2	0	7	35
1993	28	4	3	3	15	8
1994	26	2	2	4	13	18
1995	13	0	0	7	6	9
1996	3	0	13	3	0	26
1997	1	2	12	2	5	2
1998	0	5	7	0	7	7
1999	1	1	9	0	12	7
2000	0	1	3	0	8	6
2001	0	3	3	0	7	10
2002	1	1	3	0	24	11
2003	8	2	3	0	36	10
2004	2	2	2	0	39	2
2005	11	0	3	0	31	4
2006	10	1	1	0	34	2
2007	3	0	1	1	42	0
2008	11	0	1	0	51	1
2009	14	2	0	0	45	0
2010	15	0	1	0	32	0
2011	44	0	4	0	54	2
2012	13	0	4	0	120	0
2013	11	1	1	0	93	2
2014	36	2	7	0	74	1
2015	139	6	8	0	71	1
2016	138	1	1	0	112	0
2017	118	1	3	0	79	0
2018	79	4	1	0	87	0
2019	56	14	2	0	60	0
2020	3	5	1	0	37	0
2021	21	23	2	0	31	0

***Table 3**. Distribution of commercial vertical line (VL) and gillnet (GN) landings by subregion and time interval, where these were estimated as averages of landings proportions in numbers $p_{i,r}$ from year i and subregion r within fleets.*

Years	VL_W	VL_C	VL_E	GN_W	GN_C	GN_E
1983 - 1990	0.09	0.47	0.44	0.00	0.16	0.83
1991 - 2012	0.06	0.14	0.81	0.00	0.48	0.52
2013 - 2021	0.05	0.09	0.86	0.00	0.82	0.18

Table 4. *Annual number of commercial vertical line (VL) and gillnet (GN) age samples by stock.*

Year	VL_W	VL_C	VL_E	GN_W	GN_C	GN_E
1988	0	3	0	0	0	32
1989	0	117	0	0	0	0
1990	0	159	1	0	0	221
1991	147	0	4	0	0	125
1992	28	0	0	29	0	385
1993	57	0	6	2	0	77
1994	12	0	11	0	0	403
1995	6	8	4	0	18	195
1996	0	0	8	0	0	243
1997	0	3	2	0	0	0
1998	0	4	6	0	0	0
1999	0	0	2	0	0	0
2000	0	0	0	0	8	13
2001	2	0	10	0	0	37
2002	0	0	13	0	0	0
2003	0	29	7	0	0	0
2004	0	0	5	0	0	12
2005	28	0	0	0	0	0
2006	11	0	0	0	0	0
2007	4	15	0	0	0	0
2008	10	0	12	0	0	0
2009	35	0	0	0	0	0
2010	37	0	1	0	0	0
2011	189	4	2	0	0	37
2012	35	18	9	0	10	0
2013	20	0	0	0	0	15
2014	88	0	11	0	14	31
2015	339	3	15	0	0	38
2016	260	0	1	0	0	0
2017	171	0	0	0	0	0
2018	98	0	0	0	0	0
2019	73	1	0	0	0	0
2020	1	0	3	0	0	0
2021	44	42	0	0	0	0

***Table 5**. Annual number of commercial vertical line (VL) and gillnet (GN) trips sampled for ages by stock.*

Year	VL_W	VL_C	VL_E	GN_W	GN_C	GN_E
1988	0	0	0	0	0	0
1989	0	1	0	0	0	0
1990	0	1	1	0	0	1
1991	21	0	1	0	0	7
1992	7	0	0	5	0	48
1993	19	0	3	1	0	5
1994	2	0	2	0	0	4
1995	1	1	2	0	1	4
1996	0	0	1	0	0	3
1997	0	1	1	0	0	0
1998	0	1	1	0	0	0
1999	0	0	1	0	0	0
2000	0	0	0	0	1	1
2001	1	0	1	0	0	1
2002	0	0	3	0	0	0
2003	0	0	2	0	0	0
2004	0	0	2	0	0	3
2005	8	0	0	0	0	0
2006	4	0	0	0	0	0
2007	3	0	0	0	0	0
2008	6	0	1	0	0	0
2009	14	0	0	0	0	0
2010	15	0	1	0	0	0
2011	44	1	1	0	0	2
2012	13	0	1	0	3	0
2013	9	0	0	0	0	2
2014	36	0	3	0	4	1
2015	94	3	7	0	0	1
2016	80	0	1	0	0	0
2017	78	0	0	0	0	0
2018	57	0	0	0	0	0
2019	43	1	0	0	0	0
2020	1	0	1	0	0	0
2021	19	18	0	0	0	0

Figures

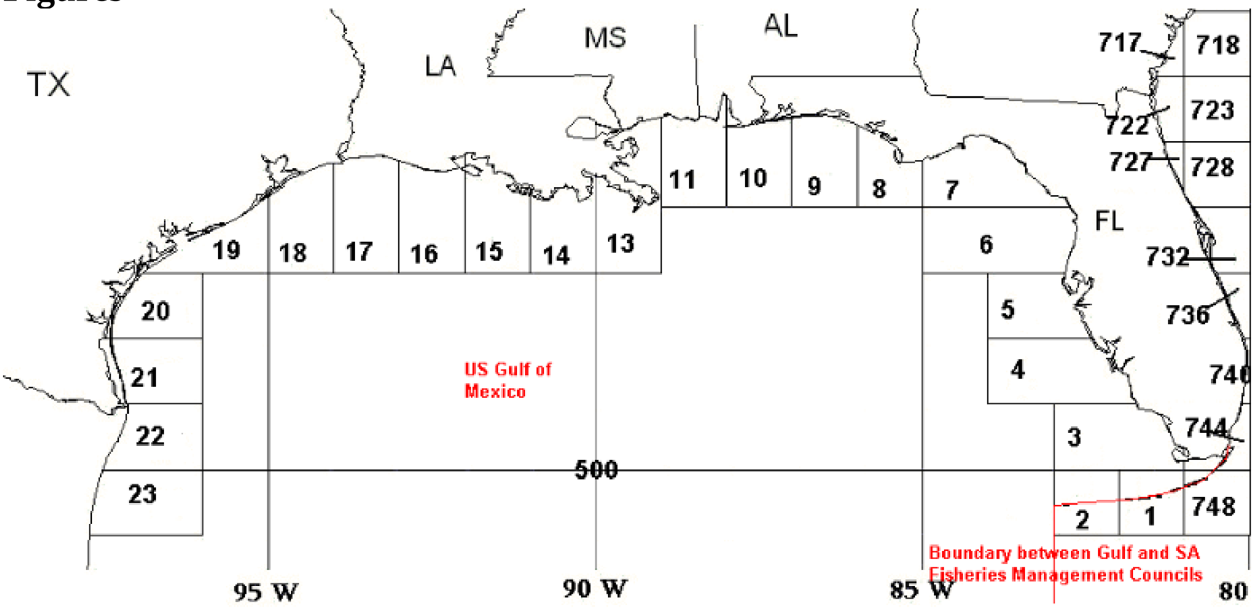

Figure 1: NMFS commercial fishing areas in the Gulf of Mexico used to define stock boundaries.

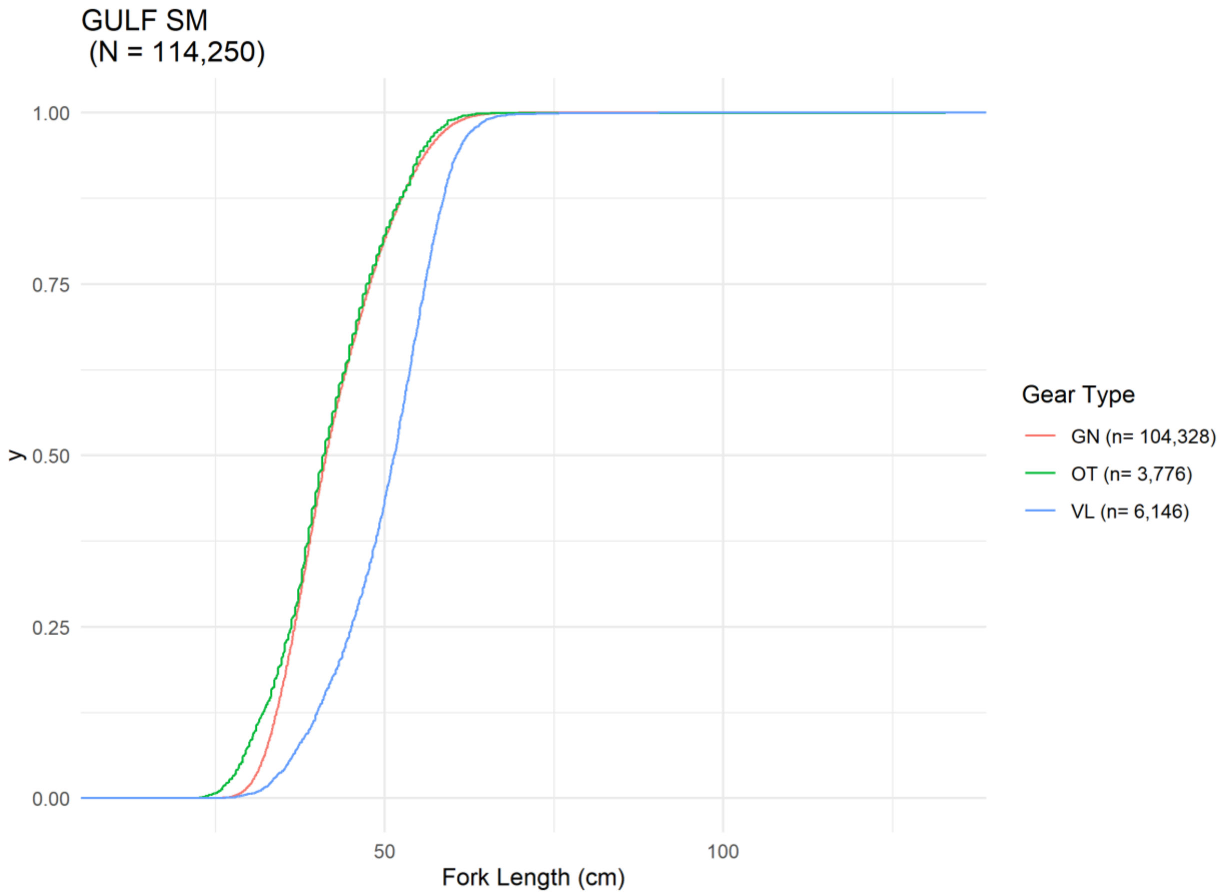

Figure 2: Anually and spatially aggregated commercial gear cumulative length distributions: gillnet (GN), vertical line (VL), and other (OT) gears.

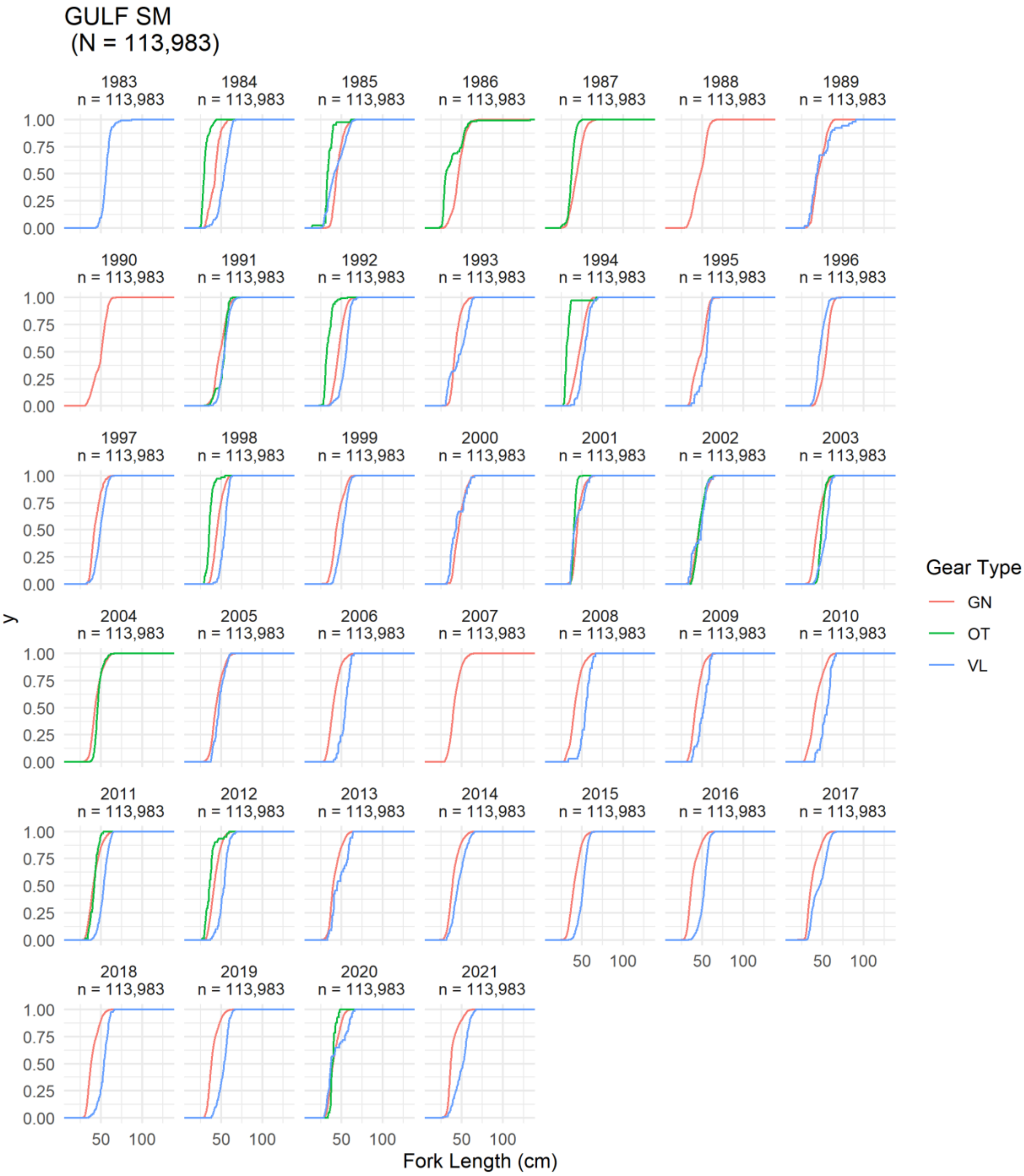

Figure 3: Spatially aggregated Spanish Mackerel commercial gear cumulative length distributions: gillnet (GN) and vertical line (VL) gears. Strata with less than 30 samples were dropped.

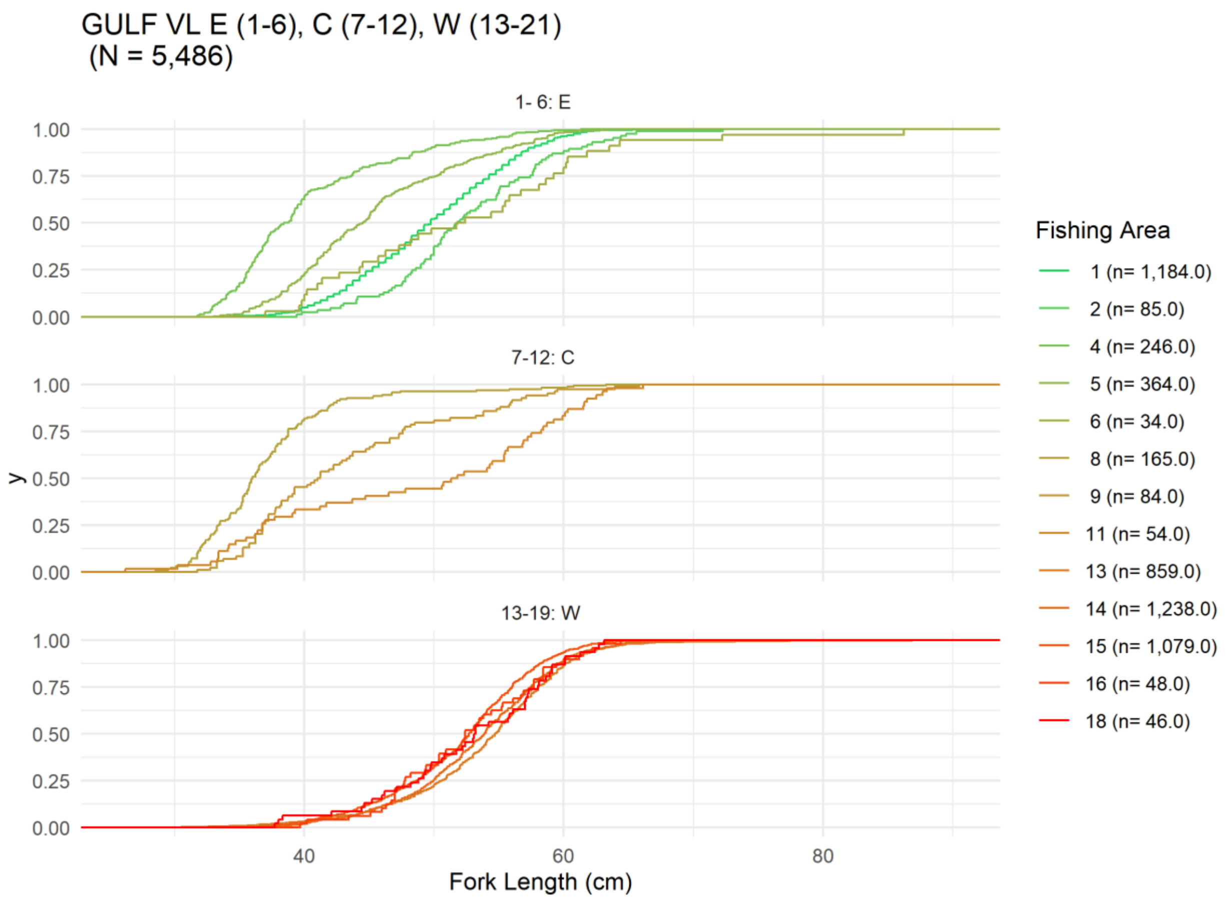

Figure 4: Annually aggregated Spanish Mackerel commercial VL cumulative length distributions for each stock: Eastern (E: 1-6), Central (C: 7-12), and Western (W: 13-21).

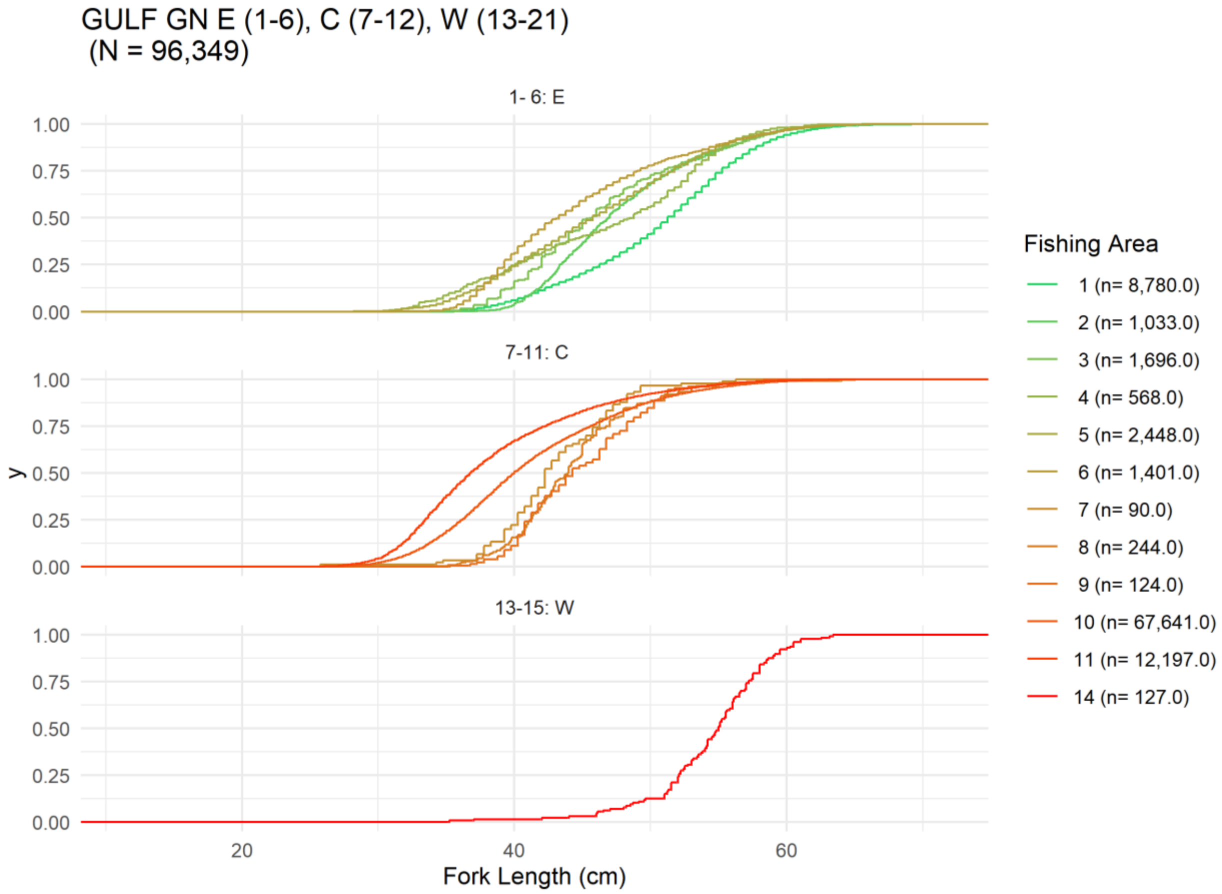

Figure 5: Annually aggregated Spanish Mackerel commercial GN cumulative length distributions for each stock: Eastern (E: 1-6), Central (C: 7-12), and Western (W: 13-21).

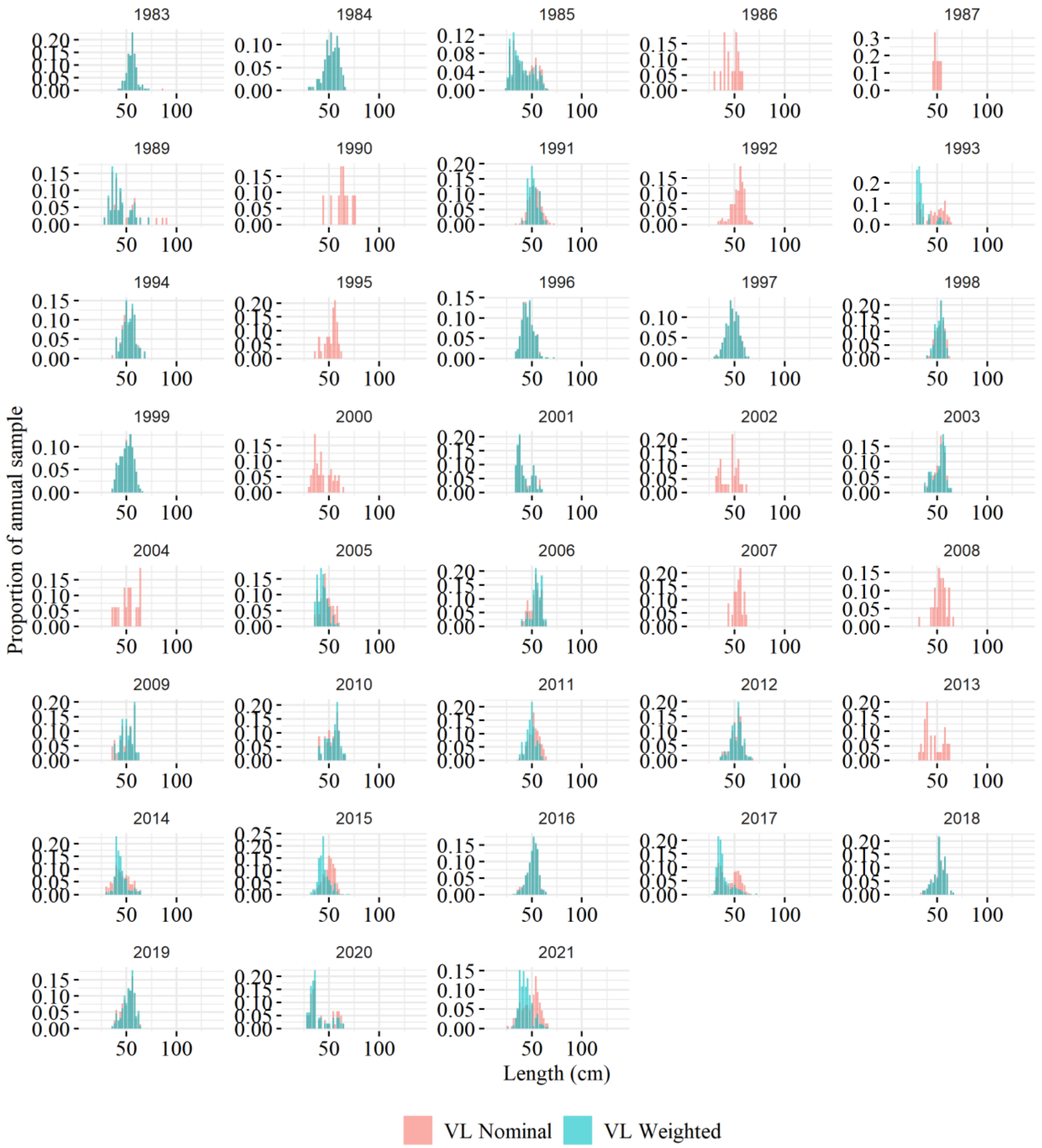

Figure 6: Nominal and weighted Spanish Mackerel length compositions from the commercial vertical line fleet.

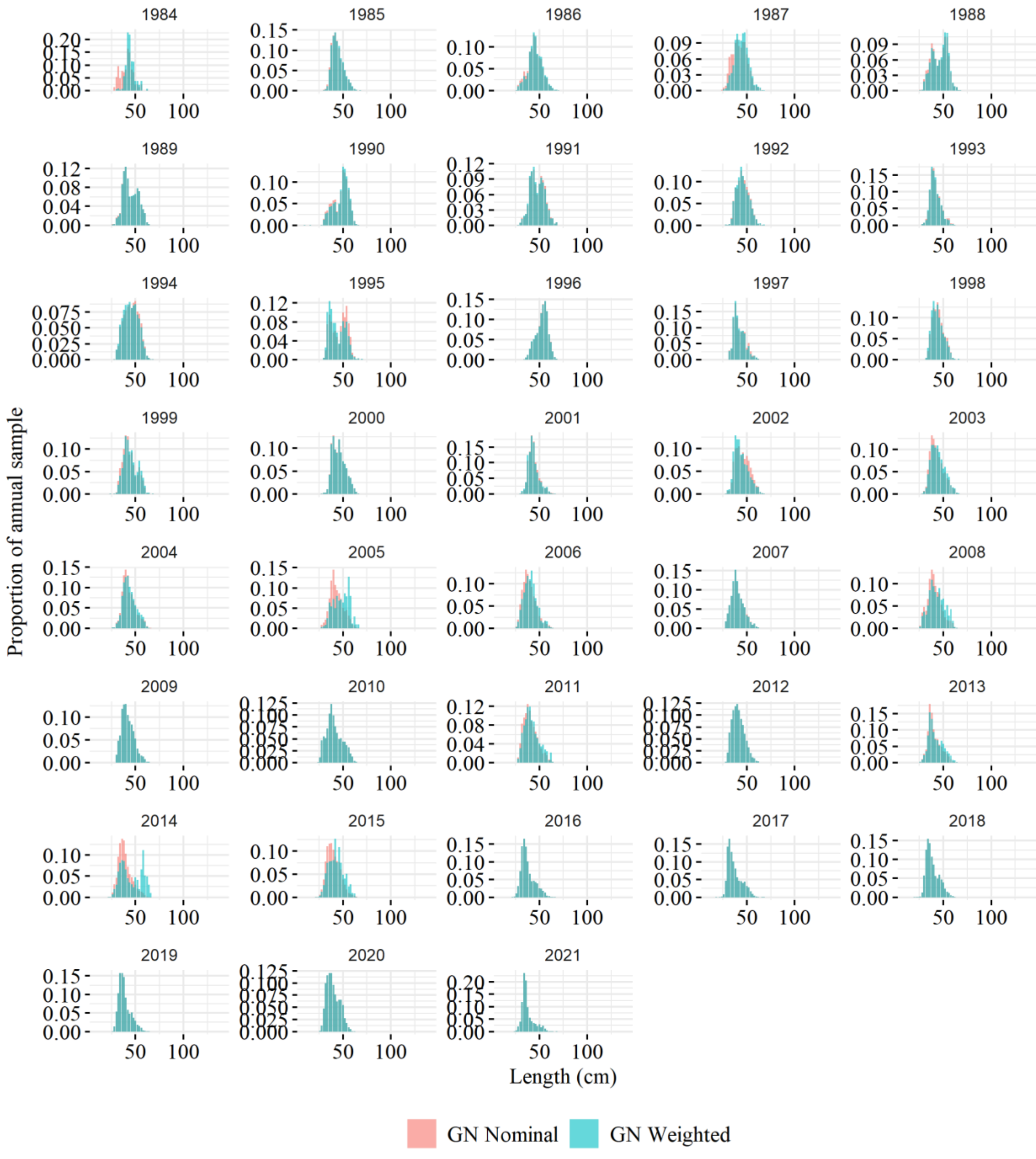

Figure 7: Nominal and weighted Spanish Mackerel length compositions from the commercial gillnet fleet.

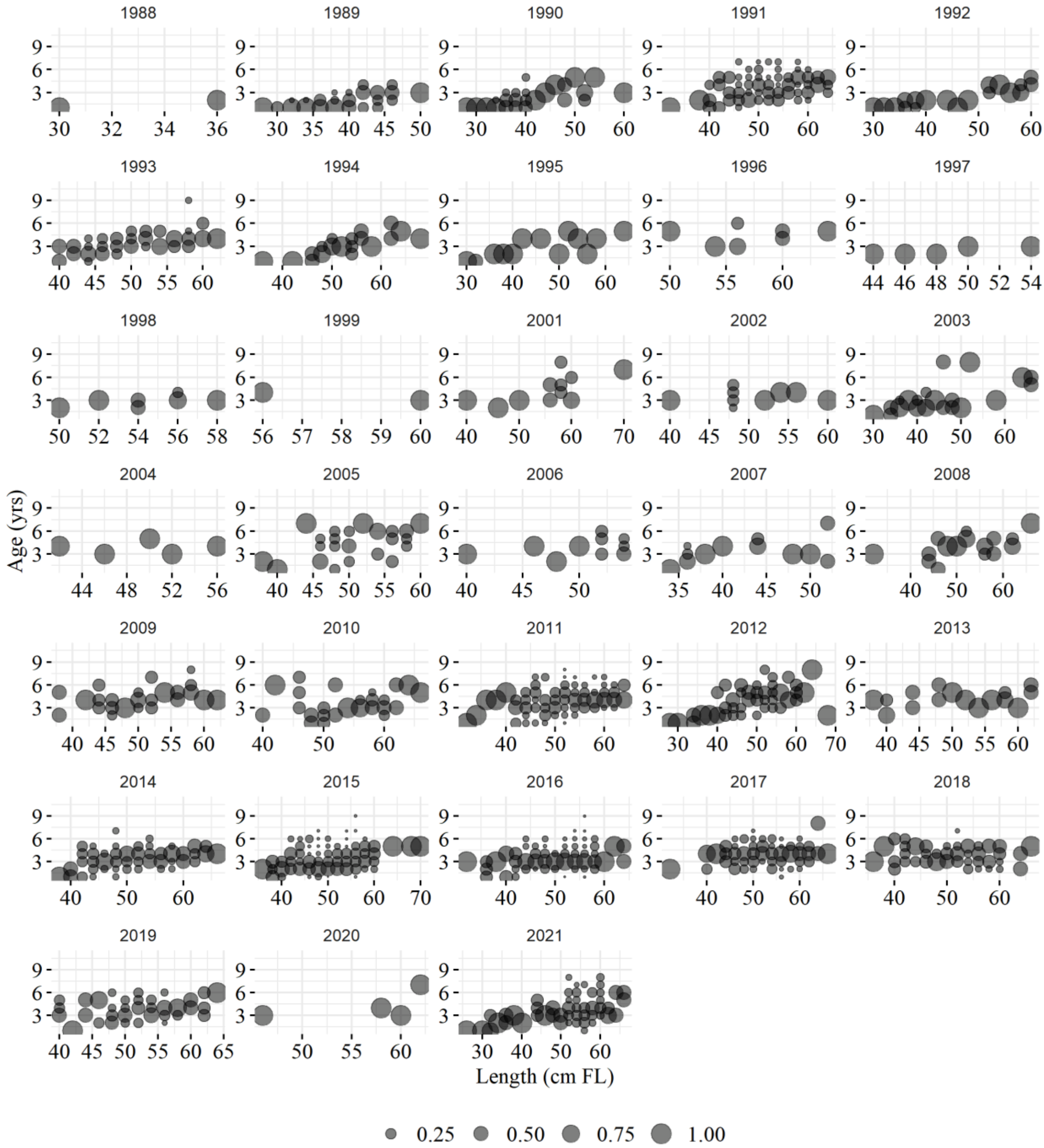

Figure 8: Annual Spanish Mackerel conditional age-at-length estimates from the commercial gillnet fleet.

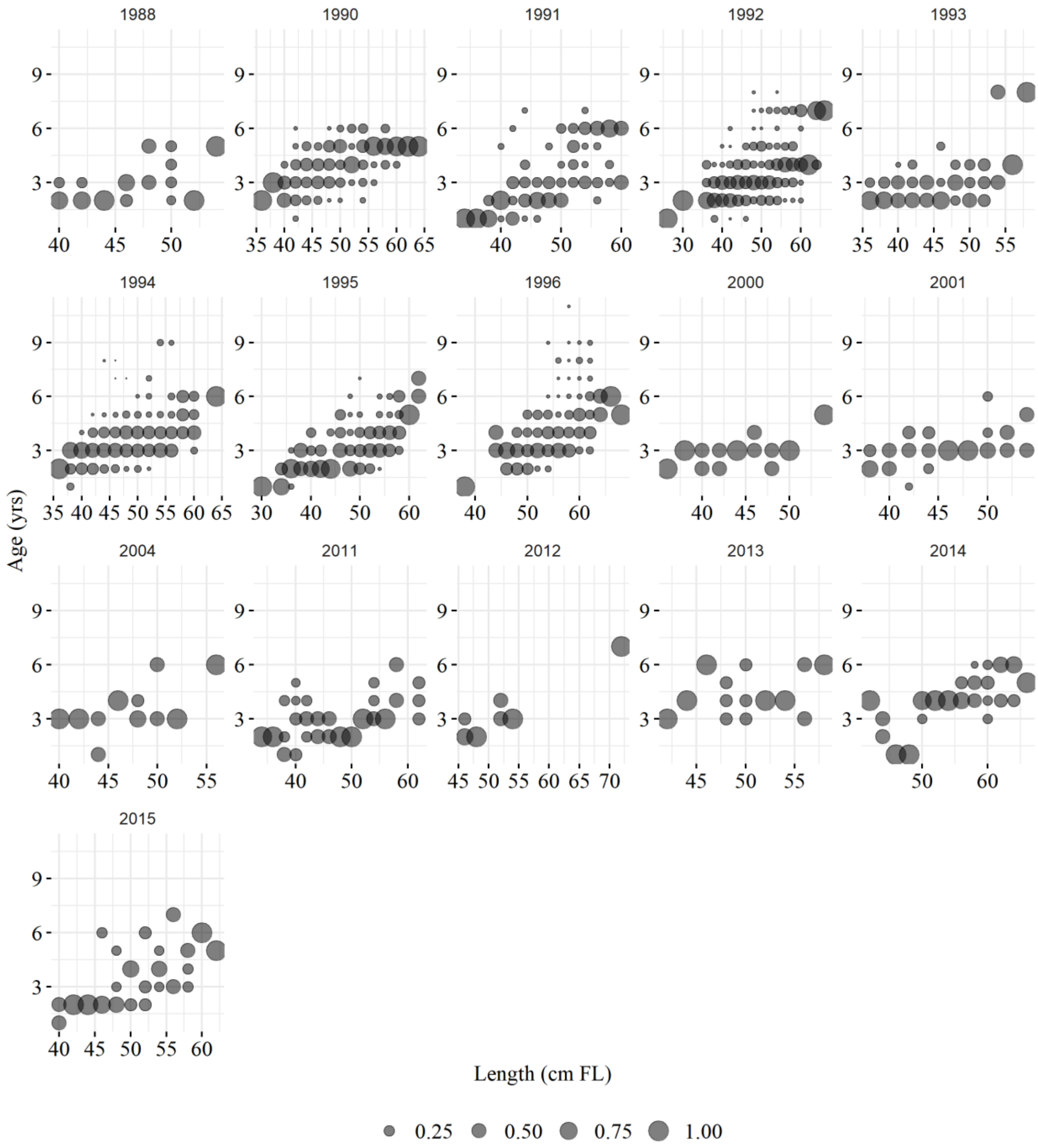

Figure 9: Annual Spanish Mackerel conditional age-at-length estimates from the commercial gillnet fleet.