Gulf of Mexico Scamp (*Mycteroperca phenax*) and Yellowmouth Grouper (*Mycteroperca interstitialis*) Commercial and Recreational Length and Age Compositions

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1 Introduction

This document outlines the data and methodologies used to estimate commercial and recreational length and age compositions for the SEDAR 68 Gulf of Mexico Scamp and Yellowmouth Grouper Assessment. 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 associated landings at the finest spatial and temporal scale available within gear groups without losing data. Commercial age samples were weighted by their respective fleet's final length composition to remove any potential sampling bias (Chih 2009, SEDAR 2015). Length samples from recreational fleets did not have sufficient sampling across modes or spatial strata to support the weighting procedures.

2 Data Description

SEDAR 68 assesses all Gulf of Mexico Scamp and Yellowmouth Grouper in federal waters extending northward from the Texas/Mexico border and eastward to the Florida Keys US1 boundary. Length data from the commercial and recreational fisheries of the Gulf of Mexico are collected by multiple state and federal agencies. Commercial data sources utilized to generate length compositions include the Trip Interview Program (TIP, 1983-2017) and Accumulated Landings Systems (ALS, 1962-2017). Recreational sources utilized were the Marine Recreational Information Program (MRIP, 2008-2017), formerly the Marine Recreational Fisheries Statistics Survey (MRFSS, 1981-2007), Texas Parks and Wildlife Department's Marine Sport-Harvest Monitoring Program (TPWD, 1981-2017), and the Southeast Region Headboat Survey (SRHS, 1979-2017). The Gulf States Marine Fisheries Commission's Fisheries Information Network (GulfFIN) provided both commercial and recreational length and age data from multiple state sources (2004-2017). The majority of the age data were processed by and received from the SEFSC's Panama City Laboratory (1977-2017). Commercial fleets were defined by handline (HL) and longline (LL) gears, and recreational fleets were defined by headboat (HB) and charter/private (CP) modes. These data were aggregated using length bins of

3 centimeters (cm) following exploratory data analyses where smaller bin sizes led to too many bins with zero observations.

Natural total length (TL_{nat}), maximum total length (TL_{max}), and standard length (SL) were converted to fork length (FL) using the following conversion equations estimated in the Data Workshop:

$$FL = 1.774 + 0.89 * TL_{nat}$$
$$FL = 2.301 + 0.87 * TL_{max}$$
$$FL = 1.953 + 1.12 * SL$$

Since 1999, the recreational and commercial fisheries have had a minimum size limit of 16" (41cm) TL in Gulf federal waters. In 1990, Florida had implemented a state size limit of 20" (51cm) TL, but it was validated both anecdotally and analytically to have unidentifiable impacts on the length composition of landings, which were believed to have been primarily caught in federal waters. Length compositions for the recreational fleets are shown by potential management period in Figure 1. Commercial fleets, which typically operate further offshore, also display an adherence to federal regulations only. Fish measuring less than 15cm FL ($n = 1$) were deleted as these were assumed to be unit errors (e.g. fish recorded as 15cm were likely 15"). Considering the current and retired recreational world records from the region range from 89-107cm TL, fish lengths greater than 130cm FL ($n = 6$) were also deleted and assumed to be errors.

3 Commercial Length Compositions

3.1 Samples of Commercial Landings

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. These were supplemented with commercial lengths submitted by state agencies through GulfFIN.

3.2 Compositions of Commercial Landings

Because fishery-dependent sampling is typically opportunistic, sampled lengths may not be representative of the true landings composition. Possible sampling bias in the collection of commercial length samples was removed by weighting the length compositions with the associated landings on the finest spatial and temporal scale available without losing data. HL and LL data were aggregated into three major subregions in the Gulf of Mexico based on the NMFS areas fished shown in Figure 2: SouthEastern (SE: areas 1-5), NorthEastern (NE: areas 6-12), and Western (W: areas 13-21). Within each commercial fleet, subregional-specific nominal length compositions were estimating using length bins of 3 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 $n_{i,r} < 30$ (Table 1). Next, the remaining subregional-specific length compositions were weighted based on the distribution of the ALS landings estimates among subregions (Table 2). Proportions of annual landings from each subregion, $p_{i,r}$, were calculated and used to scale the subregional length compositions, $LC_{i,j,r}$, which were then summed across subregions r

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

resulting in the final weighted estimates of commercial landings length compositions, $LC_{i,j}$. This procedure would downweight, for example, any instances where 60% of the length samples come from a subregion that only accounts for 20% of the landings. Nominal compositions were supplied for 1984-1985 since Scamp and Yellowmouth Grouper landings were included in aggregate Grouper landings during these years and were insufficient for the weighting procedure.

4 Recreational Length Compositions

4.1 Samples of Recreational Landings

The recreational sampling program, MRIP, has been redesigned over the last decade to remove sources of potential bias from the sampling process. Included in this new design are imputed lengths and an assigned weighting factor, which accounts for bias associated with nonrepresentative sampling of landings. More detailed information on the MRIP survey can be found in Papacostas & Foster (2018) and more detailed information on MRIP Gulf of Mexico Scamp and Yellowmouth Grouper data can be found in Matter & Nuttall (2020).

4.2 Composition of Recreational Landings

The recreational fleets in SEDAR 68 were headboat and charter/private. The private fishing mode had insufficient samples to generate length compositions alone and was aggregated with charter mode because of their similar length distributions and collection through the same survey (MRIP). CP data were aggregated into three major subregions in the Gulf of Mexico based on county landed defined east to west: SouthEastern (SE: FL Collier-FL Levy), NorthEastern (NE: FL Dixie-MS), and Western (W: LA-TX). These regions approximately match the regions defined in the commercial fleets. HB data were aggregated into two major subregions in the Gulf of Mexico based on state landed: Eastern (E: FL-MS) and Western (W: LA-TX). Spatial weighting was investigated for all recreational fleets, but there were insufficient samples in most strata to allow for this procedure (Table 3). Within each recreational fleet, nominal length compositions, $LC_{i,j}$, were estimated for each year i and length bin j

$$LC_{i,j} = \frac{m_{i,j}}{m_i}$$

where the sum of all fish within year i and lower inclusive length bin j ($m_{i,j}$) were divided by the sum of all fish within each fleet annually (m_i). A minimum sample size threshold was applied where length compositions LC_i were dropped and excluded from further analyses if $m_i < 30$. This resulted in the deletion of CP: 1981, 1983:1992, 1994:1996 and HB: 1981:1985, 2001.

5 Commercial and Recreational Age Compositions

5.1 Age Samples

Otolith processing for scamp was compromised for data collected 2003-2012. A proxy age was estimated using otolith weights for as much of these data as possible to generate as a placeholder for this Research Track Assessment, where methodology is detailed in SEDAR (2020). These technical difficulties have resulted in less accurate ages in these years and a large gap in the recreational data and commercial HL data (Table 4).

5.2 Age Compositions

Age compositions were estimated for each commercial (HL, LL) and recreational (CP, HB) fleet. The process outlined below was applied to each fleet individually, and any year with less than 10 age samples was dropped. Nominal age compositions of landings were estimated using the following equation for each year i and age bin k.

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

The recreational age compositions were completed at this phase (Figures 3-6). The recreational age samples encompassed a wider range of lengths compared to the length-only samples, making the reweighting procedure outlined below inferior. To account for potential sampling biases in the commercial data, a reweighting factor was estimated within year i and length bin j. The reweighting factor, $RW_{i,j}$, corrects 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 landings,

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

where $LC_{i,j}$ is the final length composition, $a_{i,j}$ is the number of age samples in year i and length bin j, and a_i is the number of age samples in year i. 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 rescaled to sum to 1 across each year. The reweighting factor will upweight ages from less represented length bins and will generate a more representative estimate of commercial landings' age compositions. For example, weighting the HL age composition from the year 2000 resulted in a younger age distribution (Figures 7 and 8) because the length composition of the samples with otoliths collected was from a larger size distribution than the representative estimate (Figures 9 and 10). Similarly, the weighting procedure resulted in an older age distribution in 1992 because the samples with otoliths taken (HL Otoliths) were from a smaller size distribution than the representative estimate (HL Weighted). If the length compositions of the length and age data are equal, there will be no effect on the final age compositions (e.g. $RW_{i,j} = 1$). The effects of the weighting procedure for

LL fleets (Figures 11 and 12) can be explained by observing the differences in the years' respective length compositions (Figures 13 and 14).

6 References

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7 Tables

Table 1: Annual number of commercial handline (HL) and longline (LL) length samples by subregion. The length compositions resulting from these samples were weighted with landings where there were more than 30 samples in each strata or dropped from further analyses if n<30.

Year	SE_HL	NE_HL	W_HL	SE_LL	NE_LL	W_LL
1984	232	86	135	315	9	9
1985	203	96	259	423	70	127
1986	171	32	164	695	31	17
1987	214	1	68	410	0	10
1988	212	29	27	186	98	18
1989	34	11	71	45	1	9
1990	128	218	351	384	188	14
1991	322	204	891	440	177	79
1992	327	128	785	656	73	58
1993	328	837	468	599	82	71
1994	312	772	461	354	107	0
1995	539	1,277	296	623	169	10
1996	539	1,321	139	273	222	7
1997	240	1,474	275	767	396	0
1998	1,003	833	62	2,841	456	0
1999	1,100	1,048	96	3,025	259	26
2000	352	434	20	1,639	457	36
2001	527	575	56	1,609	323	0
2002	581	545	71	1,938	333	16
2003	286	536	148	2,551	487	73
2004	129	614	34	2,203	278	8
2005	237	242	113	1,873	147	13
2006	274	328	123	1,043	180	33
2007	73	375	293	1,052	183	43
2008	75	404	285	1,184	536	91
2009	188	737	153	1,057	146	36
2010	353	316	179	924	307	26
2011	315	606	258	843	315	4

Year	SE_HL	NE_HL	W_HL	SE_LL	NE_LL	W_LL
2012	542	1,159	1,115	704	144	148
2013	375	1,220	904	556	235	251
2014	330	792	728	609	113	0
2015	242	961	774	732	88	15
2016	311	1,242	1,613	957	187	6
2017	331	662	1,001	667	334	67

Table 2: Annual distribution of commercial handline (HL) and longline (LL) ALS landings by subregion, where each value is the proportion of landings $p_{i,r}$ from year i and subregion r within fleets. The majority of HL samples were caught in the NE, while the majority of LL samples were caught in the SE. These proportions were used to re-scale length compositions where there were more than 30 samples in each strata.

Year	SE_HL	NE_HL	W_HL	SE_LL	NE_LL	W_LL
1986	0.1840	0.575	0.2414	0.417	0.2776	0.30586
1987	0.2036	0.575	0.2214	0.499	0.3606	0.14083
1988	0.1855	0.435	0.3797	0.414	0.4074	0.17817
1989	0.1007	0.489	0.4103	0.409	0.2698	0.32159
1990	0.2515	0.703	0.0456	0.389	0.3882	0.22239
1991	0.4459	0.497	0.0574	0.720	0.1967	0.08343
1992	0.5213	0.383	0.0959	0.809	0.1271	0.06441
1993	0.4367	0.504	0.0592	0.781	0.2133	0.00529
1994	0.3501	0.601	0.0493	0.766	0.2342	0.00000
1995	0.0218	0.959	0.0195	0.253	0.7468	0.00000
1996	0.2485	0.723	0.0283	0.623	0.3772	0.00000
1997	0.2850	0.674	0.0406	0.553	0.4468	0.00000
1998	0.3702	0.586	0.0439	0.741	0.2550	0.00387
1999	0.2796	0.695	0.0251	0.637	0.3384	0.02481
2000	0.1281	0.432	0.4404	0.620	0.2815	0.09805
2001	0.1895	0.564	0.2467	0.683	0.3029	0.01463
2002	0.1973	0.496	0.3062	0.668	0.2981	0.03378
2003	0.1758	0.539	0.2854	0.653	0.2885	0.05814
2004	0.1661	0.500	0.3335	0.735	0.2419	0.02294
2005	0.1597	0.546	0.2947	0.699	0.2905	0.01028

Year	SE_HL	NE_HL	W_HL	SE_LL	NE_LL	W_LL
2006	0.2068	0.543	0.2505	0.744	0.2357	0.02062
2007	0.1237	0.538	0.3381	0.756	0.2142	0.02959
2008	0.0878	0.598	0.3139	0.557	0.3826	0.06025
2009	0.1012	0.663	0.2359	0.663	0.2636	0.07360
2010	0.2350	0.507	0.2583	0.791	0.2052	0.00341
2011	0.2407	0.515	0.2446	0.831	0.1623	0.00649
2012	0.2383	0.636	0.1258	0.844	0.1508	0.00565
2013	0.2323	0.639	0.1284	0.805	0.1921	0.00277
2014	0.2078	0.546	0.2463	0.905	0.0889	0.00616
2015	0.2494	0.528	0.2228	0.799	0.1691	0.03225
2016	0.2242	0.556	0.2199	0.796	0.1776	0.02677
2017	0.2471	0.471	0.2823	0.770	0.1657	0.06416
2018	0.2717	0.519	0.2093	0.802	0.1841	0.01368
2019	0.2730	0.490	0.2371	0.710	0.2525	0.03792

Table 3: Annual number of Scamp recreational charter/private (CP) and headboat (HB) length samples within defined subregions in the Gulf. Insufficient samples within subregions led to the generation of nominal compositions for all recreational fleets.

Year	SE_CP	NE_CP	W_CP	E_HB	W_HB
1981	1	4		16	
1982	4	28		6	
1983		1	1	13	
1984		1		10	
1985			7	7	
1986	4	7	4	98	78
1987	5	10	5	98	48
1988	5	7	1	72	15
1989	2	2		185	19
1990		3	1	99	24
1991	1	3	4	43	6
1992		24	3	36	27
1993	4	29	1	38	10

Year	SE_CP	NE_CP	W_CP	E_HB	W_HB
1994		4	2	44	33
1995		2	3	40	28
1996		6	1	40	13
1997	3	33	5	19	12
1998		137	1	25	12
1999	10	214	4	26	12
2000	6	86	11	33	2
2001	1	216	2	21	6
2002	1	241	6	40	4
2003	21	268	3	154	11
2004	38	386	7	41	5
2005	8	260	15	22	6
2006	5	168	27	41	10
2007	5	133	7	58	5
2008	6	118	11	38	3
2009	4	70	4	58	5
2010	16	59	4	108	4
2011		245	8	79	1
2012	4	113	15	99	44
2013	8	65	3	50	48
2014	11	104		27	51
2015	10	110	1	39	69
2016	2	90	3	27	66
2017	5	34	1	33	48

Table 4: Annual number of age samples for commercial handline (HL) and longline (LL) fleets, and recreational charter/private (CP) and headboat (HB) fleets used to estimate final age compositions (a_i<10 fish were excluded). Data are shown as number of fish (number of trips), where trip identifying factors were likely unreliable 1977-1981. These sample sizes include proxy ages for 2003-2012, which were primarily LL samples.

Year	HL	LL	CP	HB
1977	20 (1)	-- (--)	-- (--)	-- (--)
1978	15 (1)	-- (--)	-- (--)	-- (--)

Year	HL	LL	CP	HB
1979	149 (1)	-- (--)	-- (--)	11 (1)
1980	96 (1)	-- (--)	-- (--)	17 (1)
1981	102 (1)	-- (--)	12 (1)	-- (--)
1986	-- (--)	-- (--)	-- (--)	35 (29)
1988	-- (--)	-- (--)	-- (--)	12 (10)
1989	-- (--)	-- (--)	-- (--)	19 (12)
1991	199 (29)	24 (2)	-- (--)	18 (15)
1992	58 (20)	48 (19)	11 (10)	51 (36)
1993	265 (70)	39 (9)	10 (6)	30 (23)
1994	117 (36)	-- (--)	59 (22)	49 (36)
1995	110 (33)	-- (--)	51 (16)	32 (26)
1996	64 (19)	-- (--)	118 (35)	38 (26)
1997	10 (4)	15 (2)	27 (10)	21 (13)
1998	31 (8)	34 (7)	47 (14)	-- (--)
1999	26 (8)	70 (26)	47 (9)	-- (--)
2000	52 (10)	120 (27)	-- (--)	-- (--)
2001	418 (76)	681 (106)	-- (--)	-- (--)
2002	333 (69)	1243 (137)	54 (12)	24 (4)
2003	-- (--)	520 (159)	10 (7)	14 (5)
2004	-- (--)	326 (134)	-- (--)	-- (--)
2005	-- (--)	352 (130)	25 (11)	-- (--)
2006	-- (--)	200 (102)	-- (--)	-- (--)
2007	-- (--)	208 (83)	-- (--)	-- (--)
2008	-- (--)	312 (121)	-- (--)	-- (--)
2009	49 (27)	210 (73)	-- (--)	-- (--)
2010	57 (34)	153 (42)	-- (--)	-- (--)
2011	167 (90)	178 (75)	22 (17)	-- (--)
2012	782 (238)	180 (57)	-- (--)	-- (--)
2013	497 (231)	640 (228)	111 (14)	64 (35)
2014	515 (205)	538 (114)	135 (22)	46 (28)
2015	533 (228)	498 (118)	165 (89)	70 (50)
2016	620 (196)	521 (125)	201 (67)	65 (33)
2017	645 (185)	545 (134)	76 (34)	52 (30)

8 Figures

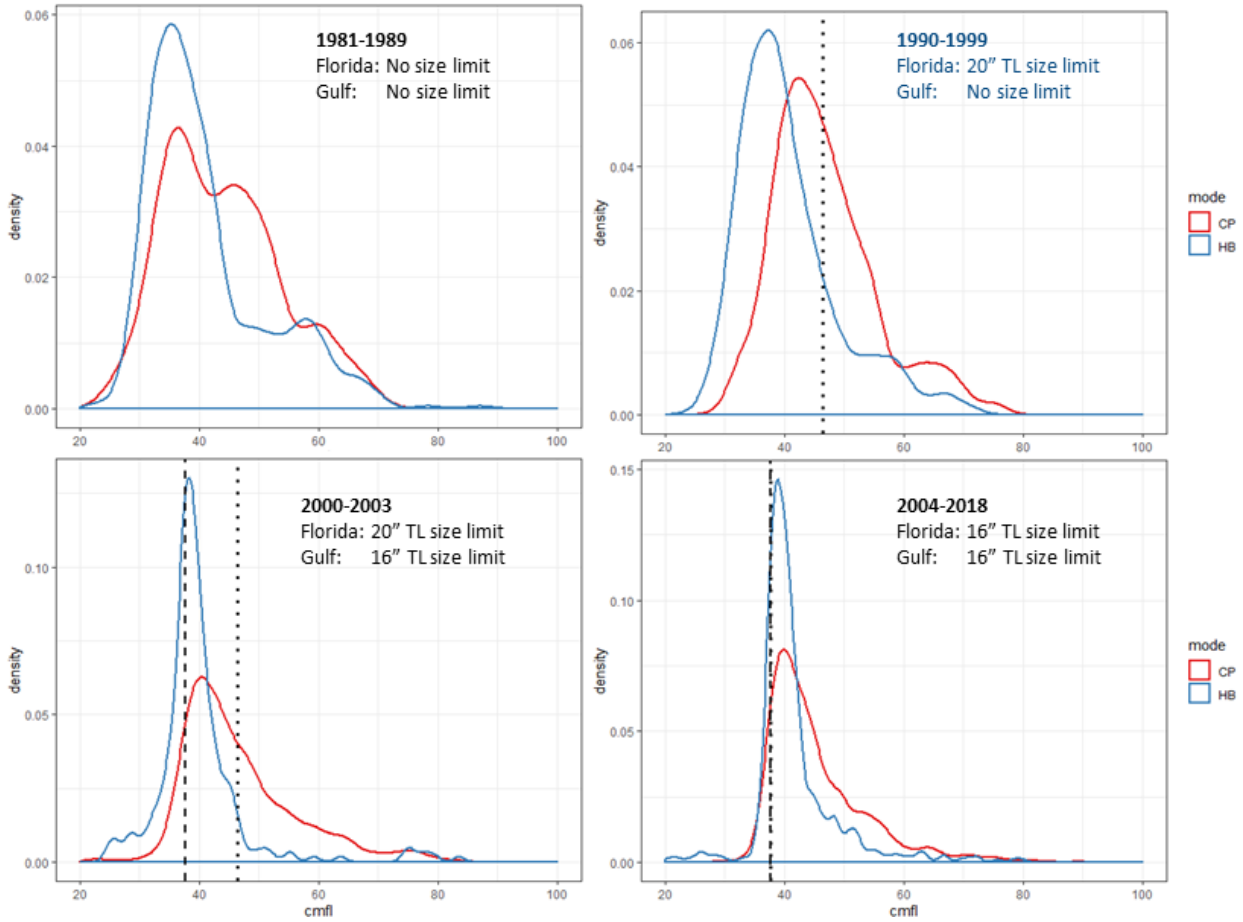

Figure 1: Recreational length compositions from Florida in management time periods where there were no size limits (1981-1989), 20" TL in state waters (1990-1999), 20" TL in state waters & 16" TL in federal waters (2000-2003), and 16" TL in both state and federal waters (2004-2018). State regulations had no apparent impact on size compositions of scamp data.

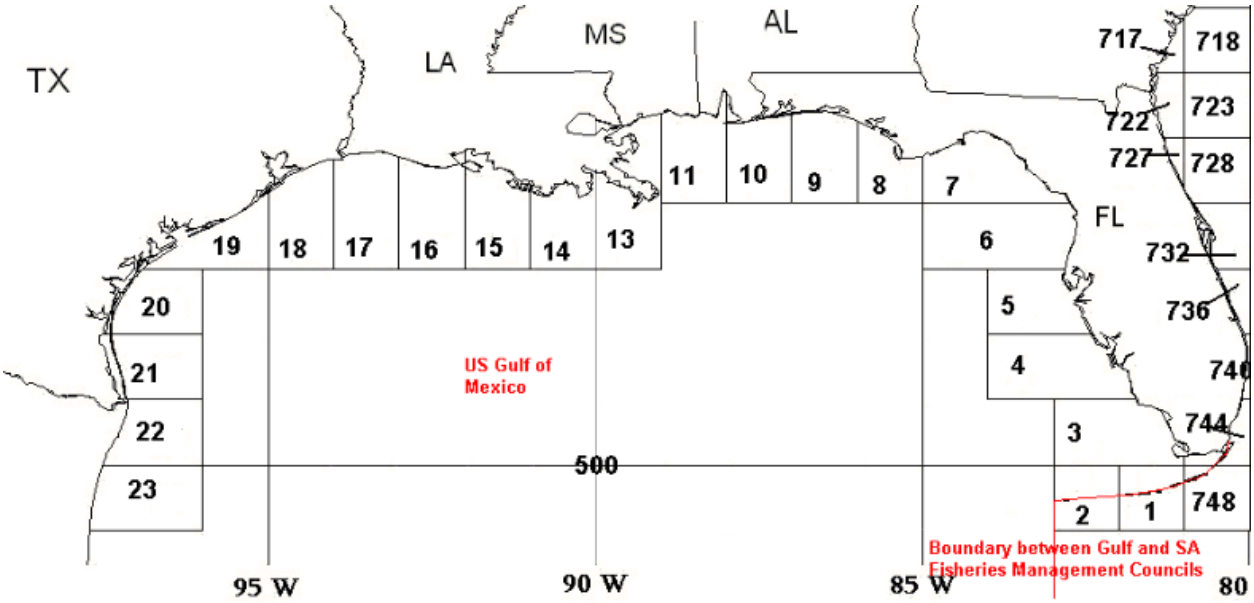

Figure 2: NMFS commercial fishing areas in the Gulf of Mexico used to define spatial strata in the weighting procedure.

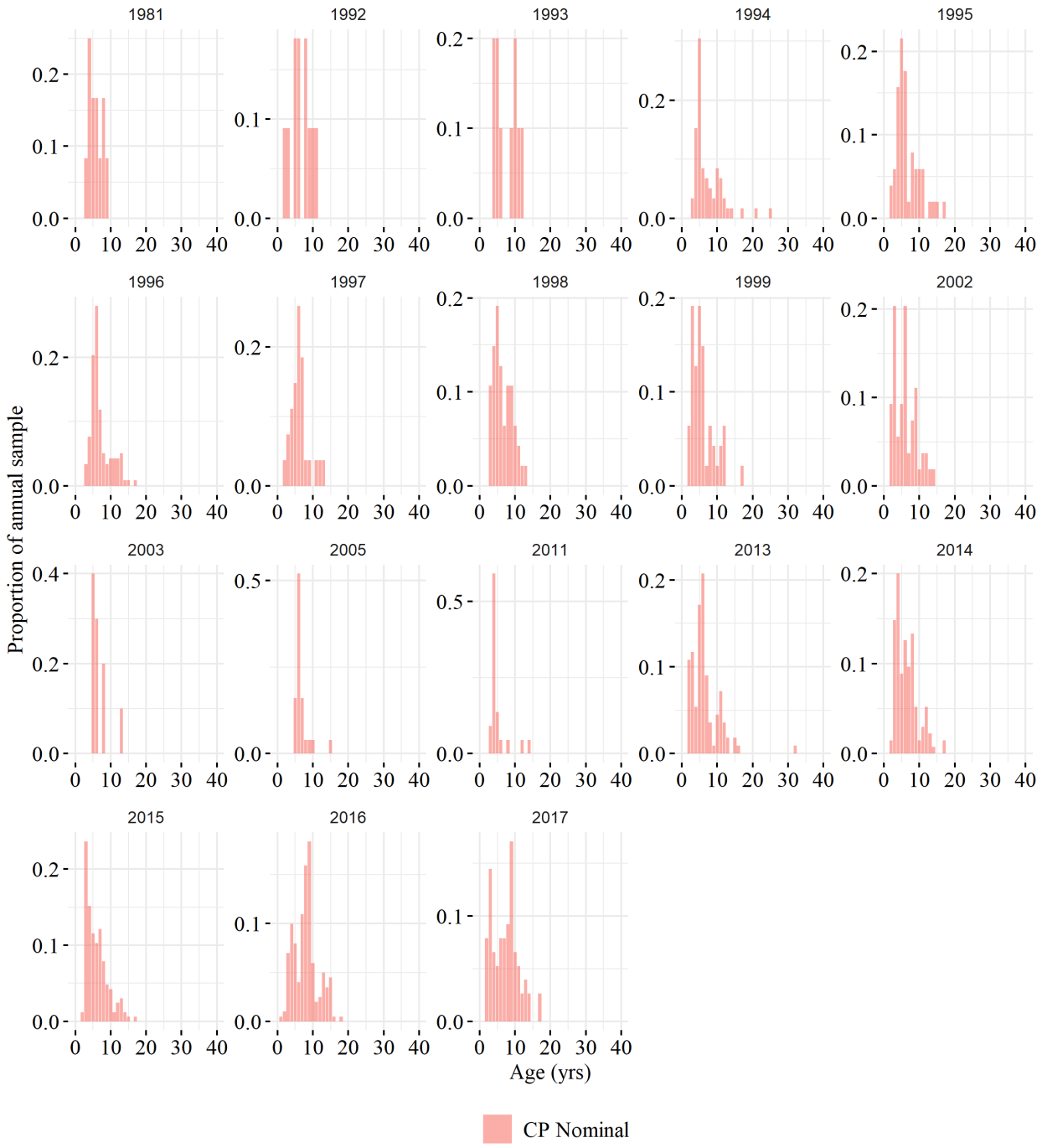

Figure 3: Annual Scamp recreational charter/private age frequency distributions.

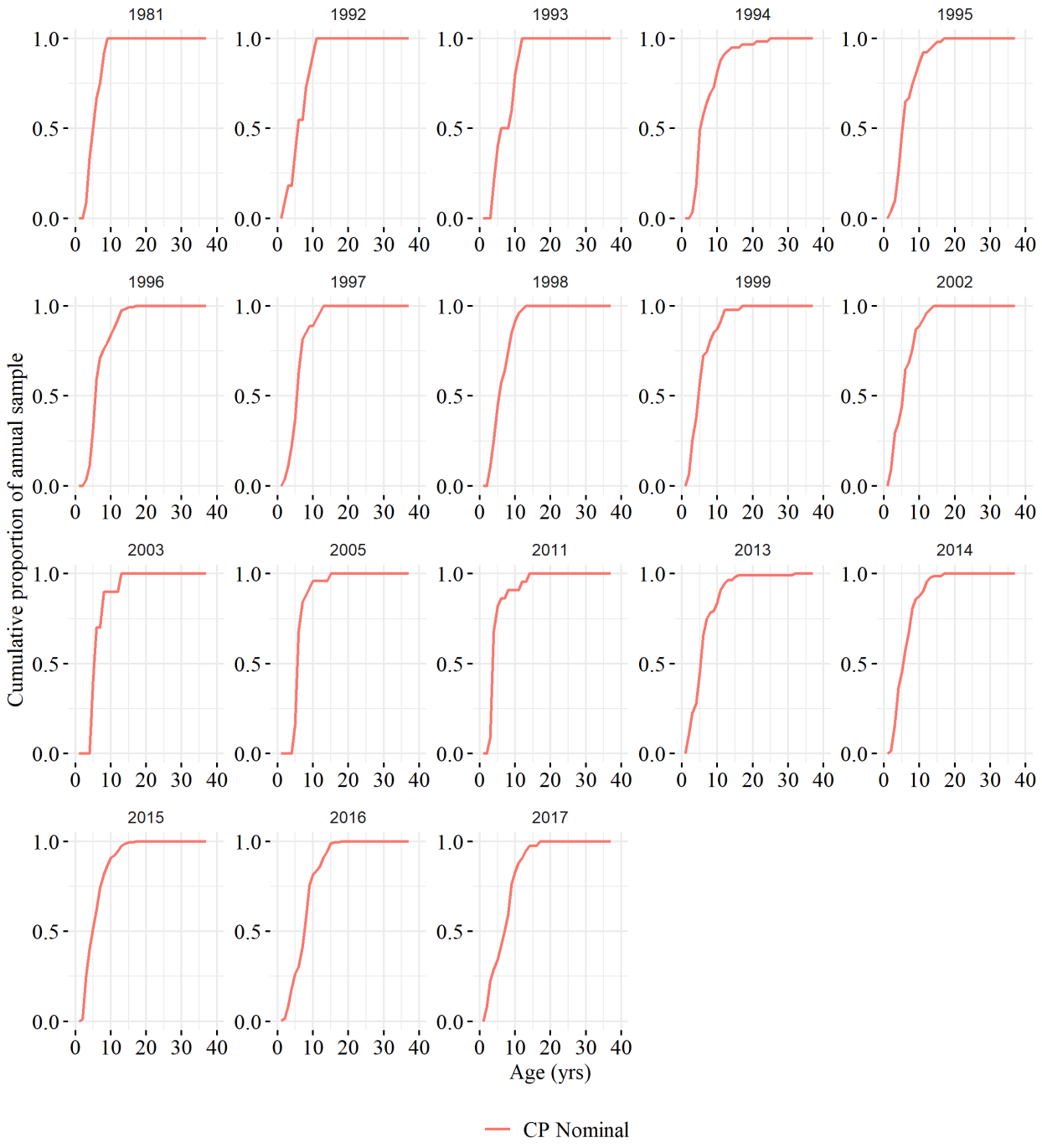

Figure 4: Annual Scamp recreational charter/private cumulative age distributions.

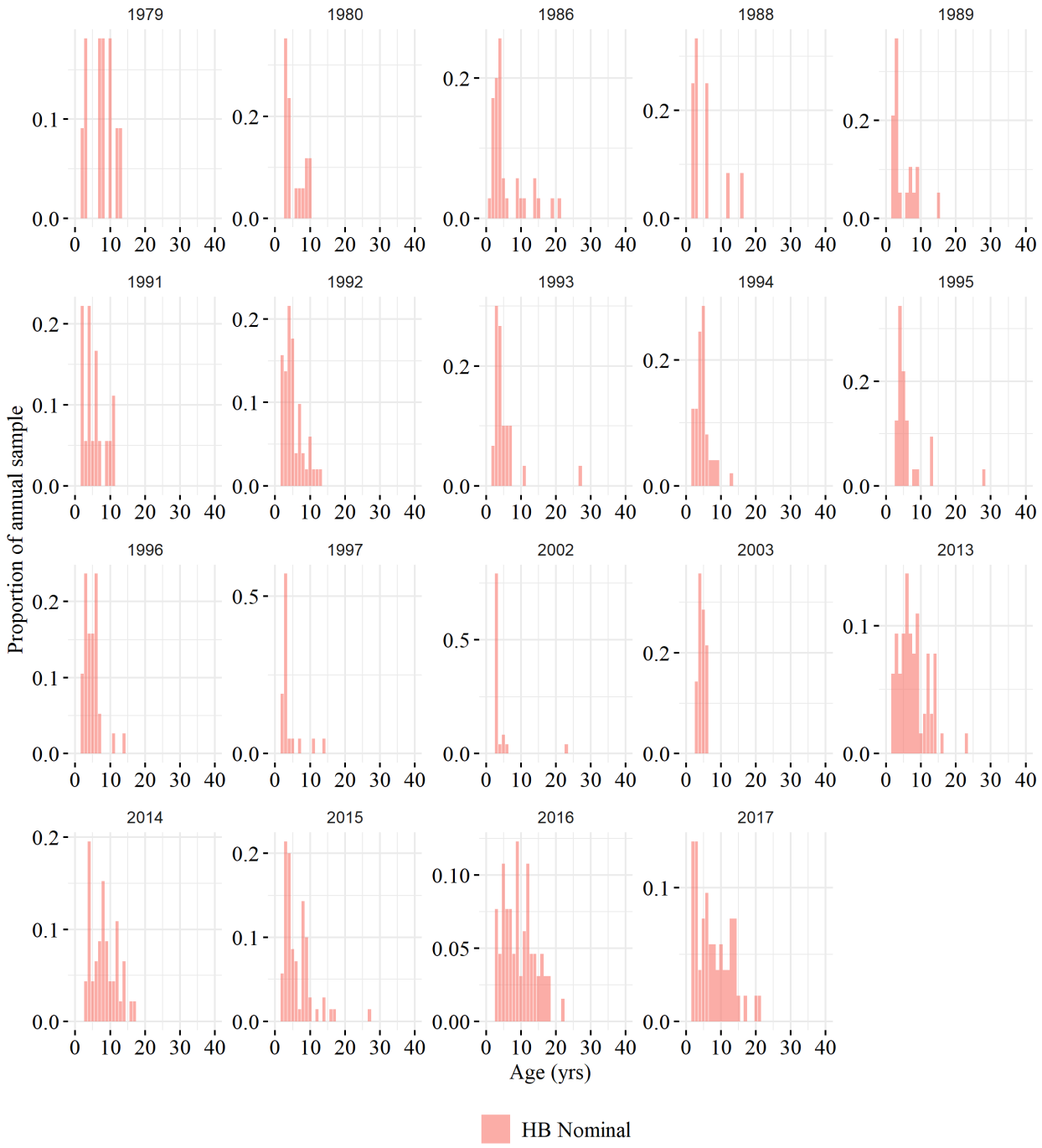

Figure 5: Annual Scamp recreational headboat age frequency distributions.

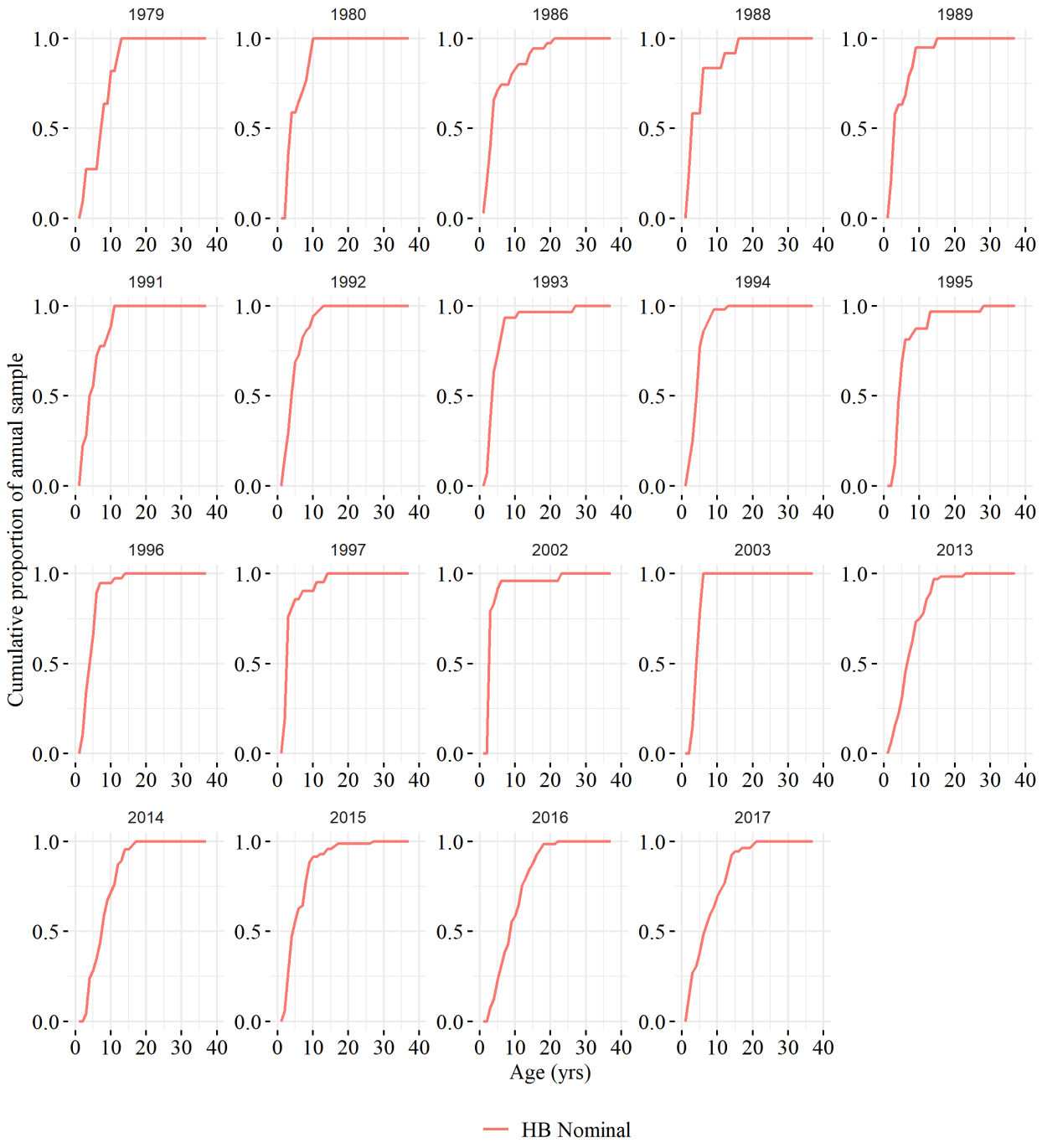

Figure 6: Annual Scamp recreational headboat cumulative age distributions.

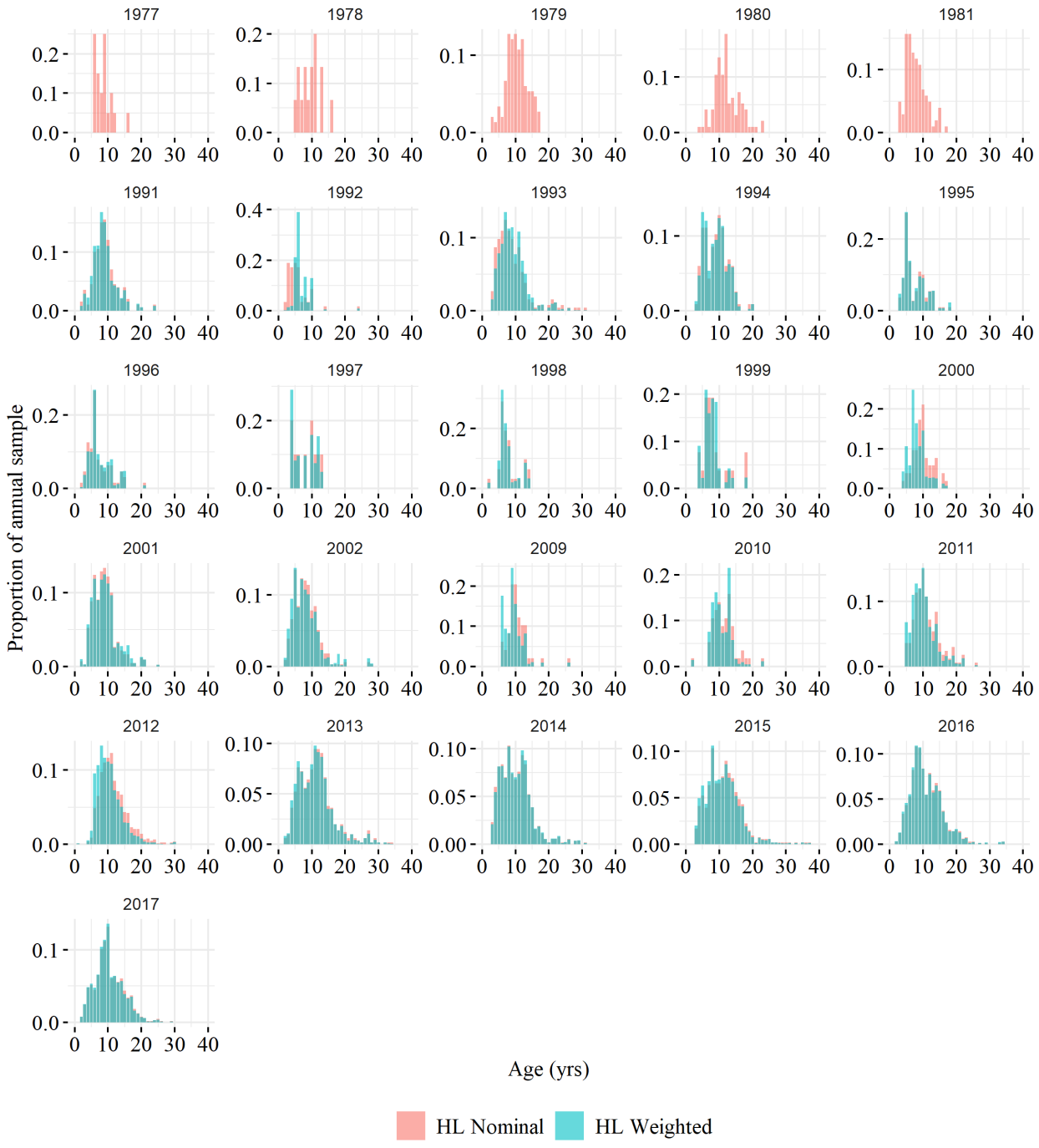

Figure 7: Annual Scamp commercial HL age frequency distributions, both unweighted (nominal) and weighted with the final length compositions.

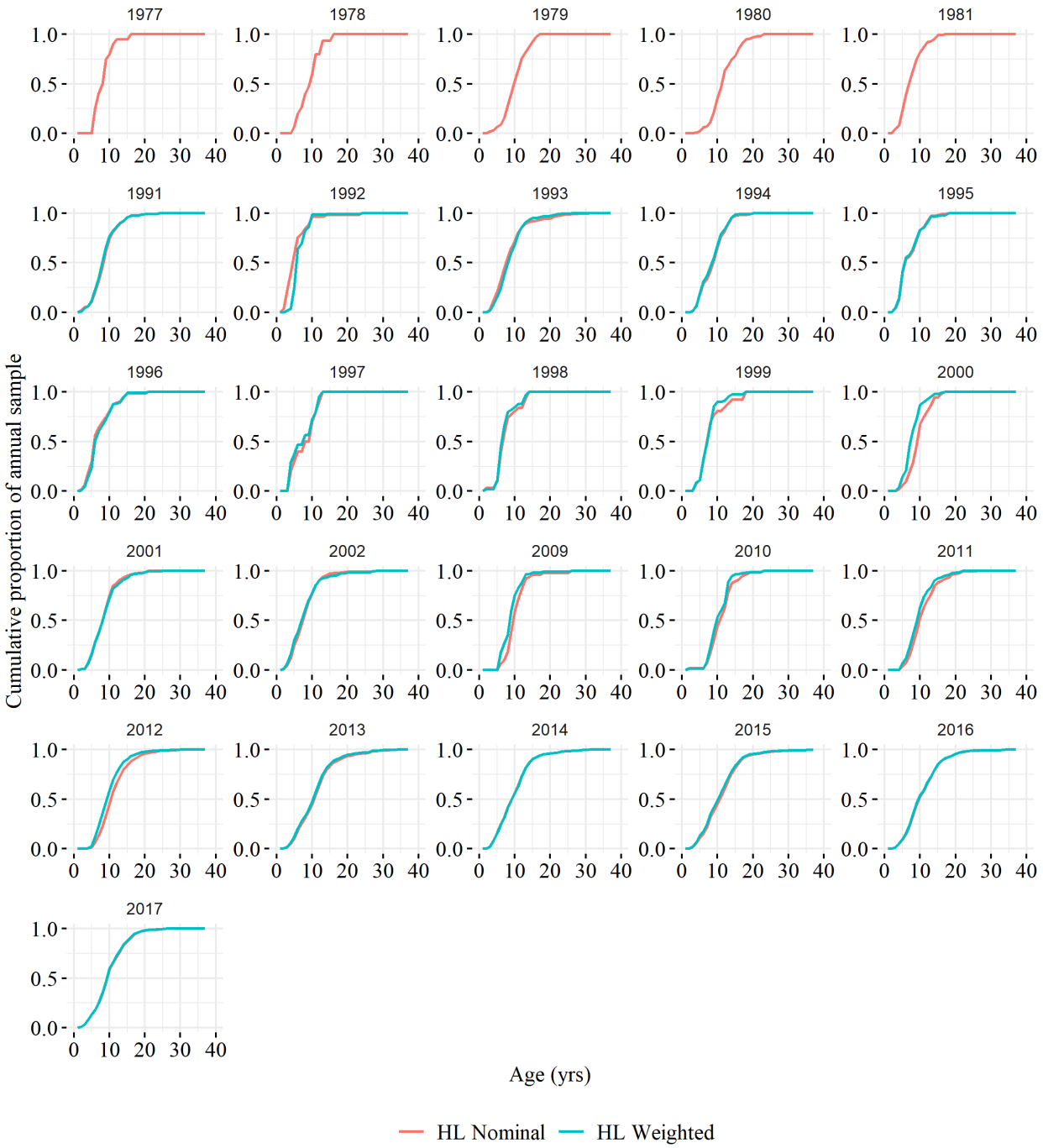

Figure 8: Annual Scamp commercial HL cumulative age distributions, both unweighted (nominal) and weighted with the final length compositions.

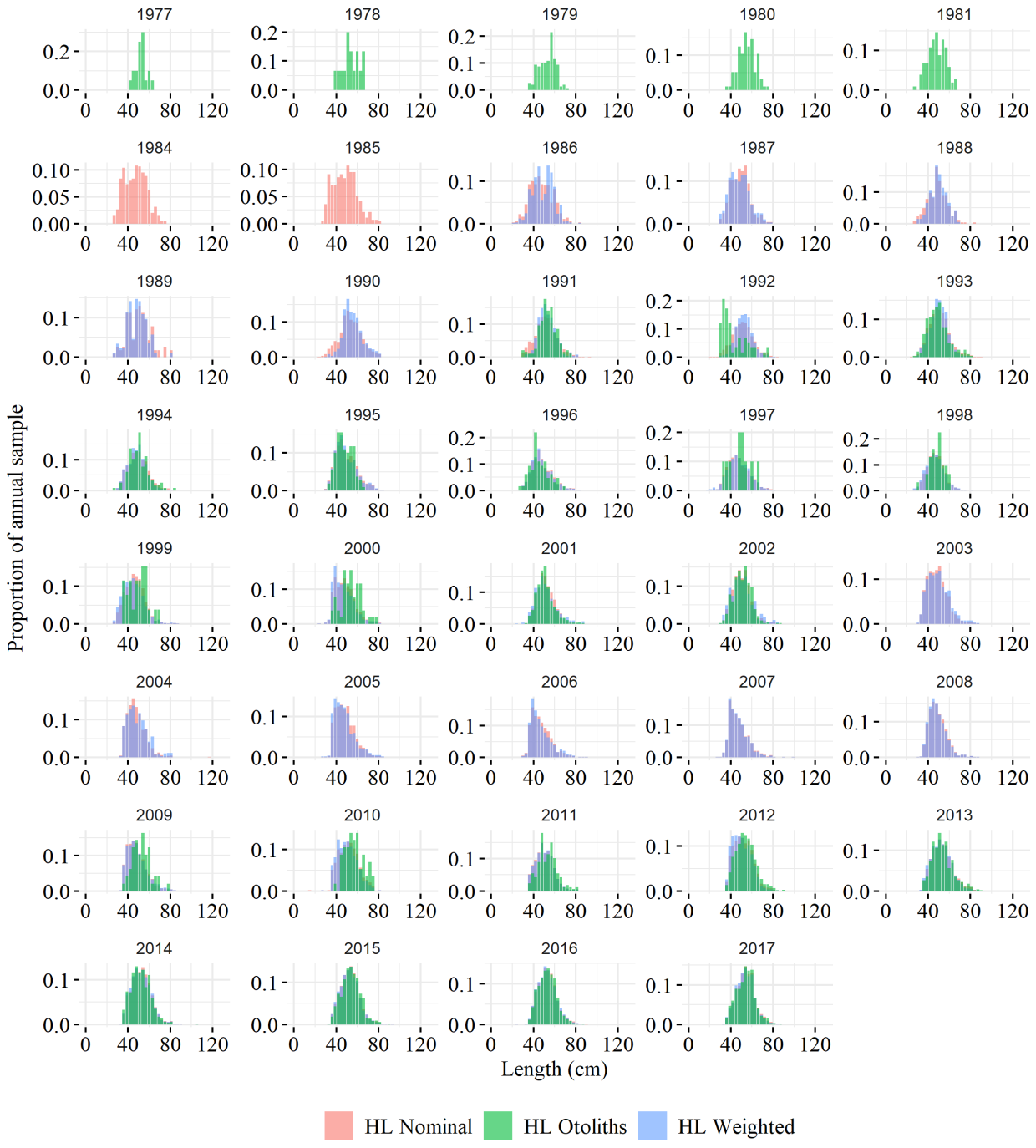

Figure 9: Annual Scamp commercial HL length frequency distributions: unweighted (nominal), weighted with the final landings, and age data (otoliths).

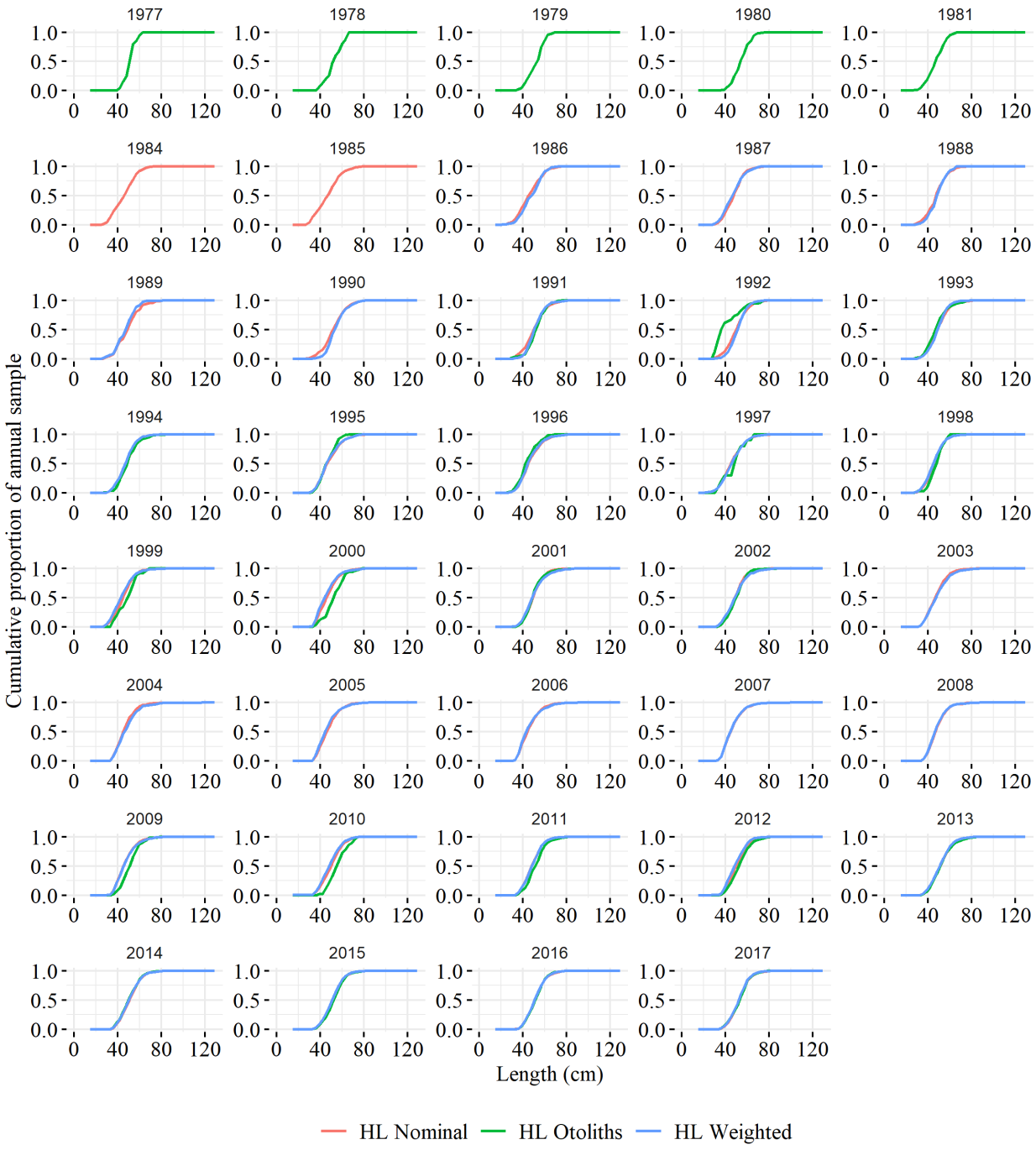

Figure 10: Annual Scamp commercial HL cumulative length distributions: unweighted (nominal), weighted with the final landings, and age data (otoliths).

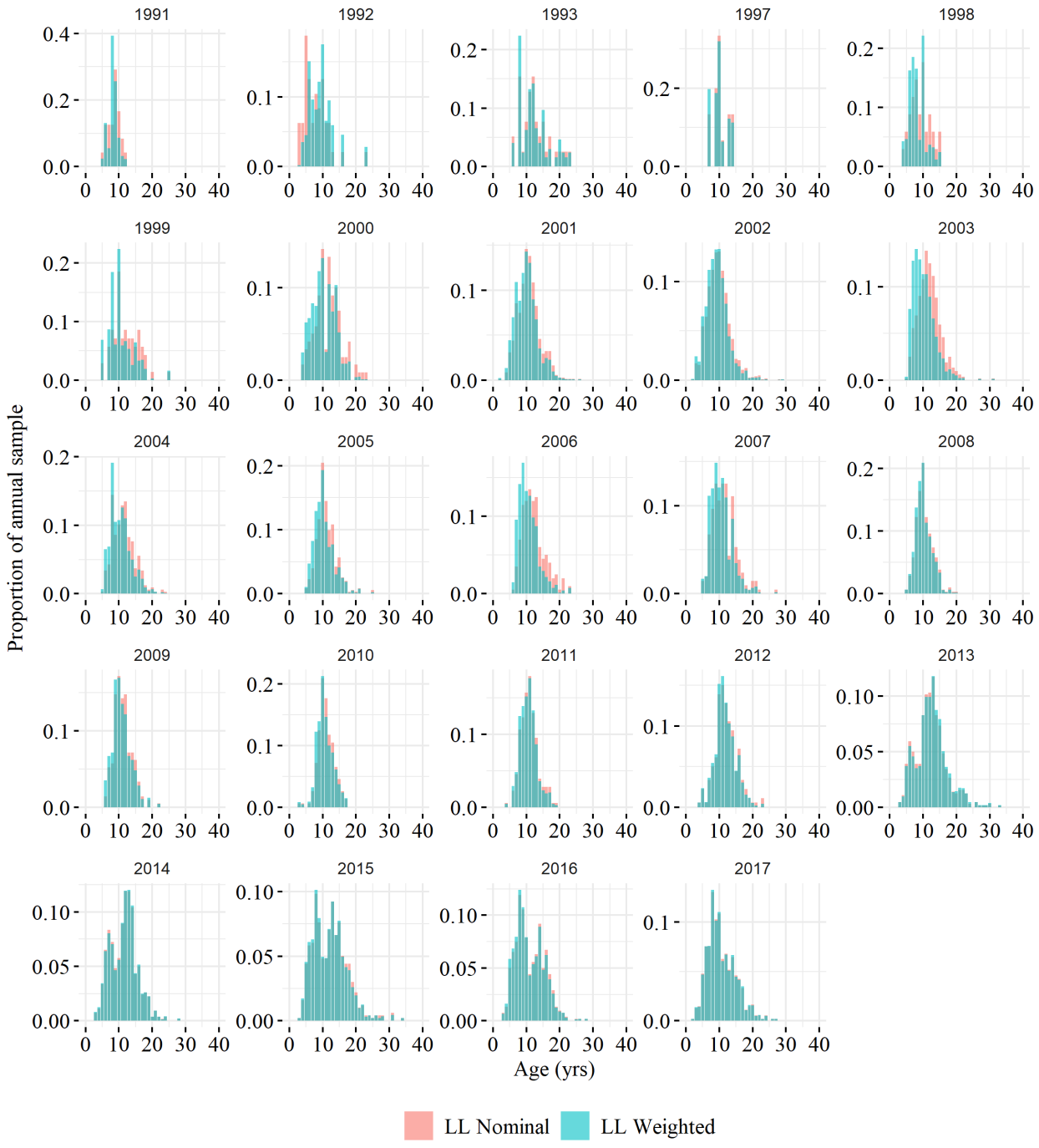

Figure 11: Annual Scamp commercial LL age frequency distributions, both unweighted (nominal) and weighted with the final length compositions.

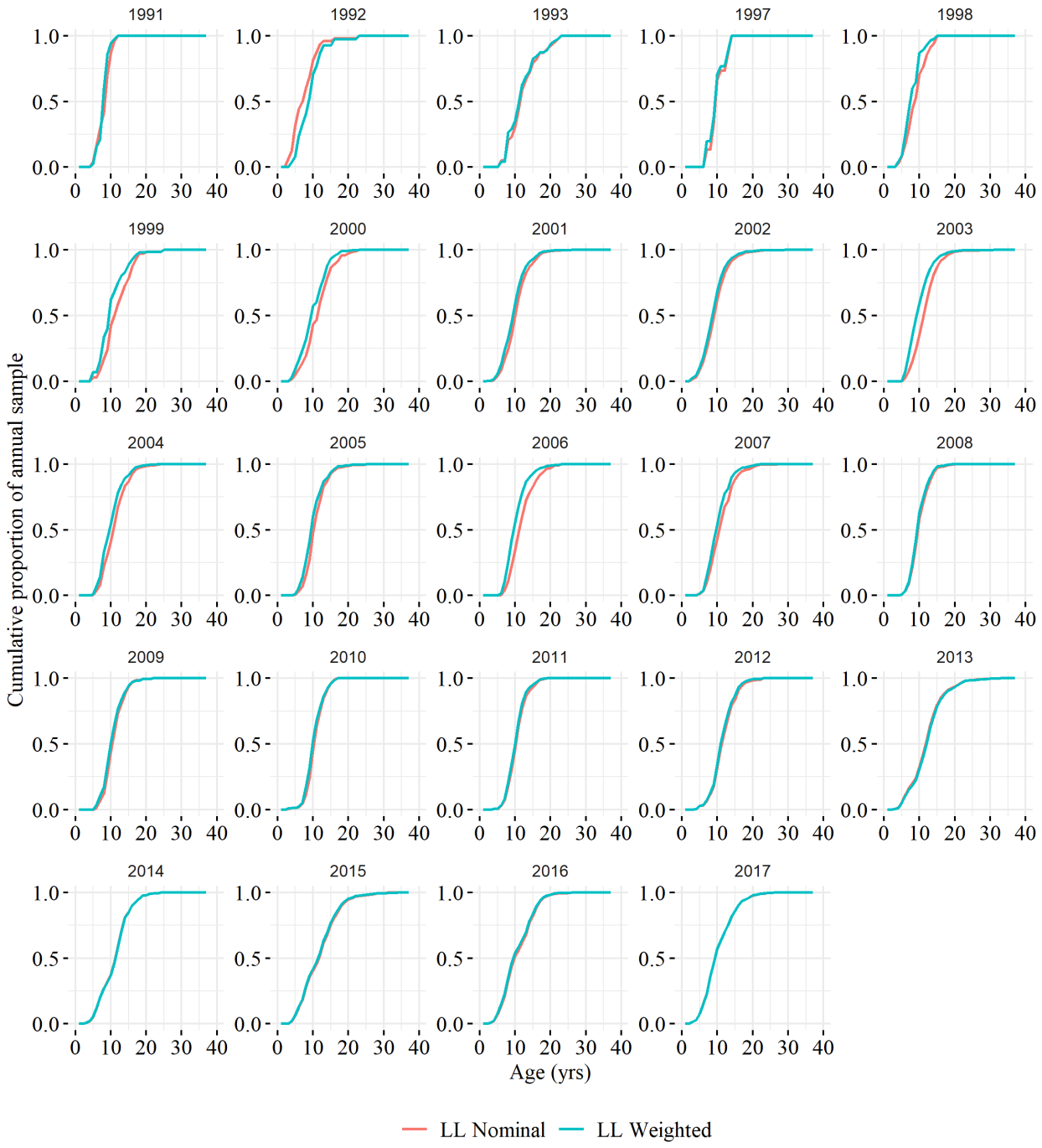

Figure 12: Annual Scamp commercial LL cumulative age distributions, both unweighted (nominal) and weighted with the final length compositions.

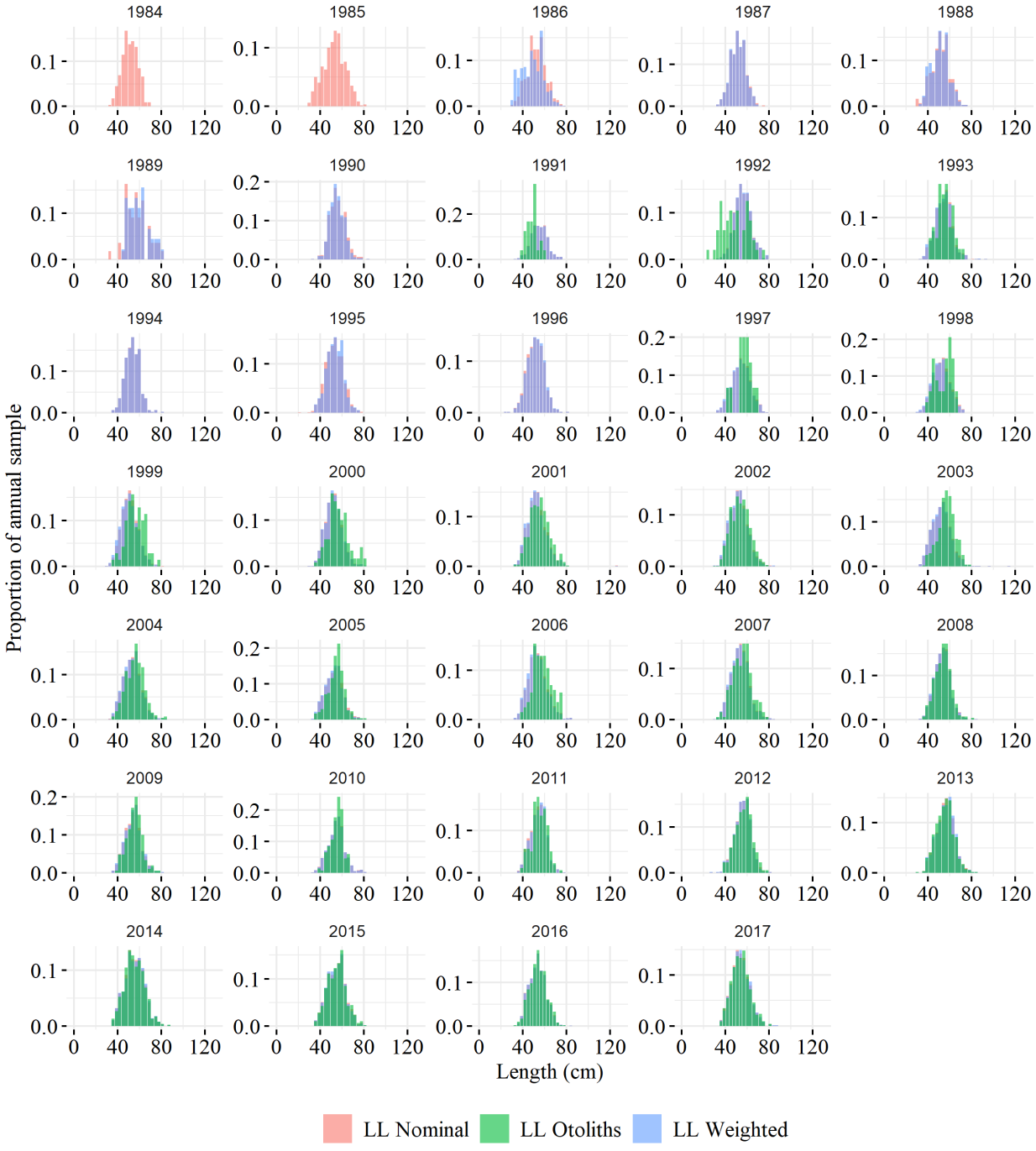

Figure 13: Annual Scamp commercial LL length frequency distributions: unweighted (nominal), weighted with the final landings, and age data (otoliths).

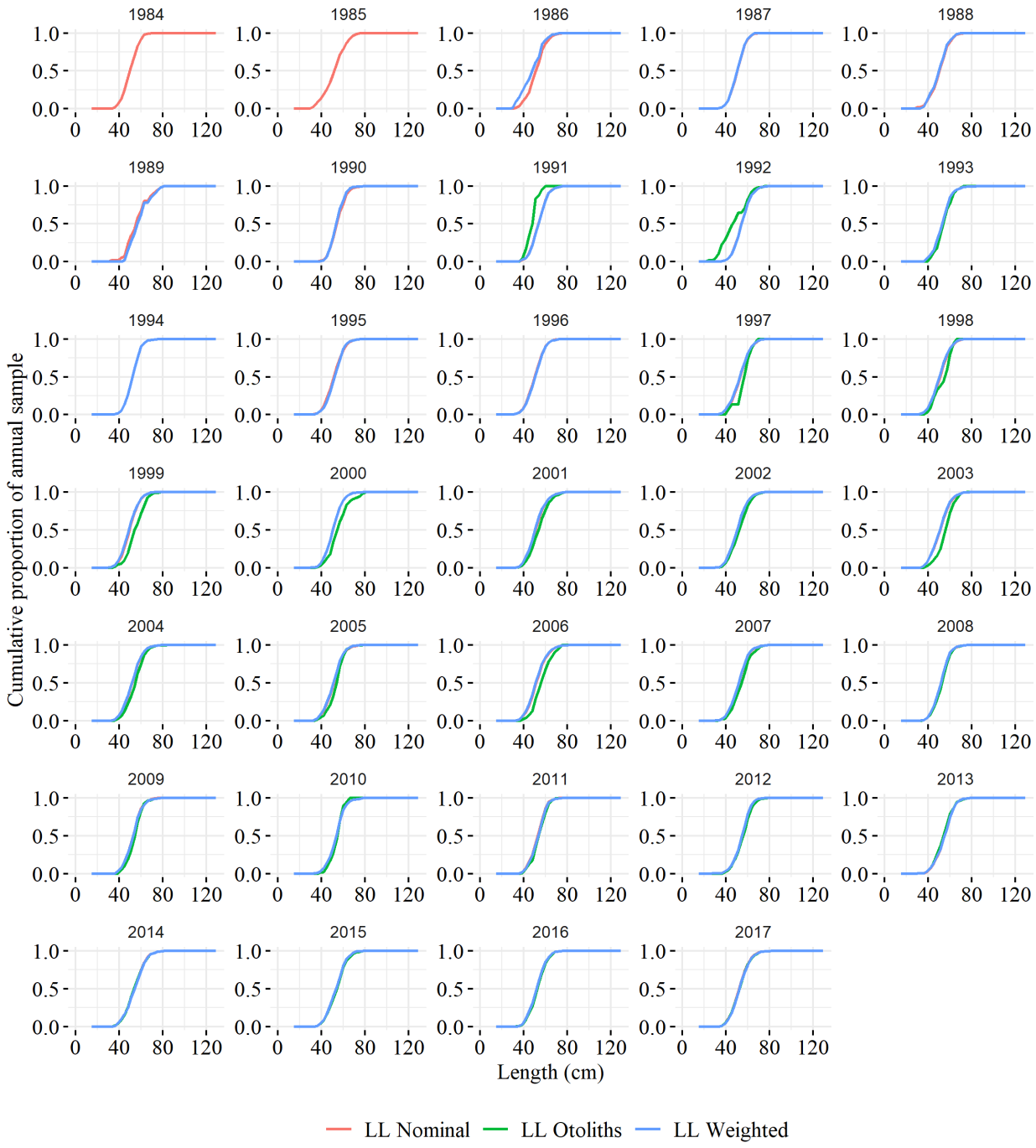

Figure 14: Annual Scamp commercial LL cumulative length distributions: unweighted (nominal), weighted with the final landings, and age data (otoliths).