Commercial age and length composition weightings for Atlantic red snapper (*Lutjanus campechanus*)
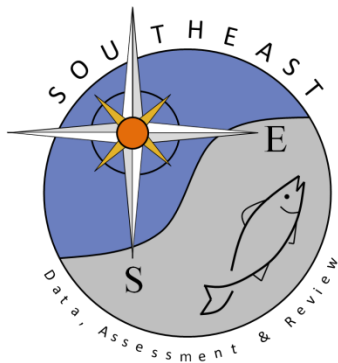
Sustainable Fisheries Branch, National Marine Fisheries Service (contact: Rob Cheshire)

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Commercial age and length composition weightings for Atlantic Red Snapper (*Lutjanus campechanus*)

Sustainable Fisheries Branch, National Marine Fisheries Service, Southeast Fisheries Science Center, 101 Pivers Island Rd., Beaufort, NC 28516

Introduction

The SEDAR 41 data workshop developed raw length and age compositions for each of the fisheries where sufficient data were available. The fishery- dependent data collection for lengths and ages may be biased due to sampling protocols, state-specific sampling effort, or other non-random methods. The selection of fish from which to collect ageing structures may be biased, typically towards larger fish, because the selection process is rarely formally randomized. One technique to overcome bias in the length sampling is to weight samples by the associated landings at a spatial and temporal scale at which the bias is expected. Usually this is unknown and samples are weighted at the finest scale available without losing data (e.g. length samples with no associated landings). In this document we describe how the length data were weighted and how these weightings are extended to the age data. Similar methods have been used in previous SEDAR assessments and completed between the data and assessment workshops.

Summary of DW decisions (see SEDAR41-DW report)
- Develop length and age compositions for handline gear only.
- Weight length compositions by regional landings (Carolinas and Georgia-Florida).
- Weight age compositions by length compositions.
- Exclude years with very limited spatial coverage or small sample size.

Weighted Length Composition (Figure 1)
Summary of decisions and methods
- Use a year and region-specific cutoff of 30 fish.
- Remove 2011 (1 fish) and 2010 Carolina's (1trip with few fish).
- Develop weighted composition in 3cm bins with pooling the tails of the length distribution at 21 and 99cm for the lower and upper values respectively.
- Multiply each region's annual composition by its annual proportion of commercial handline landings.
- Combine regional compositions and renormalize so that each year sums to 1.

Weighted Age Composition (Figure 1)
Summary of decisions and methods

- Use a year and region-specific cutoff of 10 fish.
- Weight by region-specific length composition to account for non-random sampling of fish for age structures.

  A reweighting value (RW) associated with the year (j) and length interval (i) of the age sample was assigned to each age sample by fishery as in the formula:

  $$RW_{ij} = \frac{NL_{ij}/TN_j}{OL_{ij}/TO_j}$$

  where NL_{ij} is the number of observations associated with the year j and length interval i from the length samples, TN_j is the total number length observations in year j, OL_{ij} is the number of aged samples in length interval i and year j, and TO_j is the total number of aged samples in year j. This weighting corrects for a potential sampling bias of age samples relative to length samples (Chih, 2009). This reweighting factor is assigned to each age observation and then summed across year and age to give a weighted age composition for each region.

- Multiply each region's annual age composition by its annual proportion of commercial handline landings.
- Combine regional age compositions and renormalize so that each year sums to 1.
- Pool ages over 13 years with age-13 fish.

Results
Sample sizes changed slightly from the nominal compositions due to cutoffs and are given in Table 1 for length compositions and in Table 2 for age compositions. Commercial handline length compositions vary over time and across regions for some years (Table 3 and Figure 2). The effect of weighting commercial handline age compositions was more pronounced for years with smaller sample sizes and when the ages are predominantly from the Carolinas (Table 4 and Figure 3).

References
Chih, Ching-Ping. 2009. Evaluation of the sampling efficiency of three otolith sampling methods for commercial king mackerel fisheries. Transactions of the American Fisheries Society. 138:990-999.

Table 1. Sample size of weighted length compositions with number of fish sampled (n.fish) and number of trips sampled (n.trips).

Year	n.fish	n.trips
1983	35	12
1984	2089	125
1985	2162	139
1986	933	94
1987	748	89
1988	539	84
1989	828	88
1990	608	63
1991	527	106
1992	366	82
1993	728	116
1994	773	102
1995	1100	127
1996	872	157
1997	460	105
1998	467	121
1999	1026	167
2000	945	149
2001	1894	196
2002	1009	144
2003	1385	155
2004	880	138
2005	615	133
2006	436	133
2007	588	185
2008	673	172
2009	2548	261
2010	67	3
2012	139	40
2013	458	92
2014	367	61

Table 2. Sample size of weighted age compositions with number of fish sampled (n.fish) and number of trips sampled (n.trips).

Year	n.fish	n.trips
1988	32	7
1990	29	11
1992	38	11
1993	12	8
1994	20	14
1995	16	2
1996	204	48
1997	174	45
1998	50	14
1999	164	15
2000	288	28
2001	115	23
2002	30	5
2003	59	10
2004	78	25
2005	135	53
2006	229	84
2007	267	132
2008	389	158
2009	2432	263
2010	30	1
2012	148	39
2013	722	109
2014	465	64

Table 3. Weighted coastwide length composition for commercial handline red snapper in 3cm bins pooled at 21 and 99 cm.

Year	24	27	30	33	36	39	42	45	48
1983	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0167	0.0168	0.0000
1984	0.0000	0.0000	0.0007	0.0089	0.0295	0.0467	0.2647	0.1739	0.1362
1985	0.0000	0.0007	0.0016	0.0040	0.0314	0.0930	0.1819	0.2000	0.1165
1986	0.0000	0.0000	0.0027	0.0155	0.0385	0.0407	0.0548	0.1074	0.1695
1987	0.0000	0.0000	0.0107	0.0608	0.1254	0.0808	0.1244	0.1098	0.0732
1988	0.0000	0.0030	0.0056	0.0256	0.0795	0.1104	0.1103	0.0802	0.0951
1989	0.0006	0.0000	0.0035	0.0041	0.0349	0.0788	0.1245	0.1003	0.0892
1990	0.0000	0.0000	0.0000	0.0130	0.0849	0.1793	0.0957	0.0711	0.0645
1991	0.0000	0.0000	0.0221	0.0938	0.0743	0.0669	0.0744	0.0686	0.0493
1992	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0027	0.0095	0.0383
1993	0.0000	0.0000	0.0000	0.0010	0.0000	0.0029	0.0097	0.0141	0.0365
1994	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0258
1995	0.0000	0.0000	0.0007	0.0007	0.0036	0.0017	0.0052	0.0099	0.0234
1996	0.0000	0.0000	0.0000	0.0000	0.0012	0.0021	0.0010	0.0000	0.0065
1997	0.0000	0.0000	0.0000	0.0016	0.0049	0.0045	0.0041	0.0019	0.0050
1998	0.0000	0.0000	0.0000	0.0000	0.0020	0.0031	0.0028	0.0127	0.1144
1999	0.0000	0.0000	0.0004	0.0009	0.0071	0.0198	0.0154	0.0070	0.0527
2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0015	0.0618
2001	0.0000	0.0005	0.0287	0.0362	0.0184	0.0168	0.0076	0.0078	0.0616
2002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014	0.0387
2003	0.0000	0.0000	0.0090	0.0142	0.0082	0.0141	0.0177	0.0227	0.0213
2004	0.0000	0.0000	0.0106	0.0153	0.0203	0.0185	0.0095	0.0049	0.0181
2005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0058	0.0000	0.0254
2006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0032	0.0027	0.0034	0.0175
2007	0.0000	0.0000	0.0000	0.0012	0.0032	0.0042	0.0039	0.0041	0.0625
2008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0024	0.0007	0.0012	0.0775
2009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0022	0.0046	0.0295
2010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	0.0000	0.0185	0.0000	0.0000	0.0000	0.0333	0.0265	0.0477	0.0000
2013	0.0030	0.0000	0.0000	0.0071	0.0112	0.0087	0.0253	0.0225	0.0705
2014	0.0000	0.0049	0.0165	0.0033	0.0460	0.0338	0.0255	0.0205	0.0358

Table 3 continued.

Year	51	54	57	60	63	66	69	72	75
1983	0.0546	0.0263	0.0264	0.0308	0.0672	0.0207	0.1449	0.0174	0.0000
1984	0.1137	0.0638	0.0626	0.0330	0.0078	0.0043	0.0039	0.0160	0.0014
1985	0.0916	0.0636	0.0770	0.0356	0.0208	0.0094	0.0050	0.0078	0.0036
1986	0.0956	0.0907	0.0552	0.0771	0.0557	0.0390	0.0310	0.0216	0.0117
1987	0.0348	0.0382	0.0475	0.0678	0.0598	0.0481	0.0228	0.0206	0.0102
1988	0.0749	0.0746	0.0720	0.0505	0.0488	0.0185	0.0189	0.0166	0.0250
1989	0.1208	0.0639	0.0868	0.0592	0.0306	0.0312	0.0114	0.0176	0.0182
1990	0.0910	0.0477	0.0511	0.0677	0.0470	0.0398	0.0320	0.0172	0.0307
1991	0.0828	0.0429	0.0522	0.0222	0.0590	0.0309	0.0286	0.0365	0.0180
1992	0.1162	0.0747	0.0731	0.0786	0.0849	0.0955	0.0886	0.0507	0.0524
1993	0.1414	0.1560	0.1170	0.0746	0.0620	0.0327	0.0382	0.0532	0.0365
1994	0.1347	0.1762	0.1858	0.1250	0.1190	0.0691	0.0383	0.0184	0.0146
1995	0.0960	0.1412	0.1180	0.1204	0.0982	0.0649	0.1107	0.0597	0.0376
1996	0.0586	0.1258	0.1271	0.1245	0.1381	0.0688	0.0711	0.0908	0.0706
1997	0.0478	0.0561	0.0701	0.1235	0.1286	0.1016	0.0992	0.0983	0.0839
1998	0.1163	0.1254	0.1203	0.0725	0.0455	0.0341	0.0680	0.0722	0.0643
1999	0.1385	0.1347	0.1037	0.1351	0.1098	0.0659	0.0385	0.0204	0.0169
2000	0.2155	0.1577	0.1139	0.0901	0.0558	0.0385	0.0513	0.0340	0.0303
2001	0.1737	0.1874	0.1452	0.1086	0.0543	0.0379	0.0310	0.0177	0.0154
2002	0.1648	0.1818	0.1487	0.1196	0.1087	0.0623	0.0647	0.0499	0.0106
2003	0.0643	0.1015	0.1332	0.1233	0.1291	0.0771	0.0861	0.0594	0.0545
2004	0.0514	0.0801	0.1094	0.1064	0.1142	0.0862	0.1129	0.1086	0.0683
2005	0.1131	0.0638	0.0841	0.1073	0.0689	0.0787	0.0826	0.0933	0.1197
2006	0.0489	0.1163	0.1021	0.0804	0.0984	0.0522	0.0757	0.0909	0.0765
2007	0.1923	0.1196	0.0366	0.0370	0.0442	0.0487	0.0626	0.0656	0.0906
2008	0.2815	0.2337	0.1385	0.0746	0.0281	0.0124	0.0079	0.0196	0.0295
2009	0.1144	0.1639	0.1450	0.1476	0.1116	0.0530	0.0559	0.0342	0.0205
2010	0.1209	0.5610	0.1495	0.0992	0.0411	0.0187	0.0000	0.0000	0.0000
2012	0.0072	0.0518	0.0280	0.0564	0.1015	0.0987	0.1078	0.1476	0.1473
2013	0.0902	0.0889	0.0621	0.0493	0.0883	0.0716	0.0645	0.0900	0.0737
2014	0.0431	0.0622	0.0567	0.0809	0.0899	0.0728	0.0919	0.0946	0.0830

Table 3 continued.

Year	78	81	84	87	90	93	96	99
1983	0.0000	0.0979	0.2721	0.0865	0.0251	0.0292	0.0673	0.0000
1984	0.0006	0.0019	0.0172	0.0058	0.0056	0.0011	0.0006	0.0002
1985	0.0062	0.0034	0.0098	0.0129	0.0101	0.0097	0.0043	0.0000
1986	0.0058	0.0079	0.0102	0.0107	0.0338	0.0088	0.0063	0.0099
1987	0.0033	0.0062	0.0017	0.0075	0.0167	0.0124	0.0065	0.0107
1988	0.0039	0.0157	0.0166	0.0167	0.0164	0.0131	0.0084	0.0000
1989	0.0207	0.0089	0.0264	0.0345	0.0193	0.0084	0.0050	0.0012
1990	0.0123	0.0047	0.0231	0.0027	0.0104	0.0088	0.0054	0.0000
1991	0.0255	0.0296	0.0313	0.0422	0.0293	0.0125	0.0039	0.0030
1992	0.0486	0.0418	0.0417	0.0379	0.0240	0.0332	0.0044	0.0031
1993	0.0416	0.0394	0.0353	0.0326	0.0402	0.0216	0.0084	0.0051
1994	0.0150	0.0093	0.0113	0.0153	0.0171	0.0206	0.0045	0.0000
1995	0.0163	0.0142	0.0204	0.0217	0.0149	0.0156	0.0026	0.0023
1996	0.0472	0.0199	0.0138	0.0155	0.0093	0.0072	0.0000	0.0011
1997	0.0497	0.0535	0.0236	0.0125	0.0061	0.0115	0.0072	0.0048
1998	0.0441	0.0211	0.0288	0.0138	0.0127	0.0200	0.0059	0.0000
1999	0.0281	0.0408	0.0107	0.0145	0.0258	0.0096	0.0012	0.0025
2000	0.0182	0.0402	0.0315	0.0308	0.0141	0.0126	0.0000	0.0022
2001	0.0134	0.0101	0.0099	0.0073	0.0034	0.0053	0.0009	0.0009
2002	0.0132	0.0081	0.0128	0.0045	0.0000	0.0051	0.0027	0.0025
2003	0.0268	0.0070	0.0076	0.0118	0.0047	0.0016	0.0049	0.0000
2004	0.0365	0.0091	0.0075	0.0070	0.0015	0.0004	0.0032	0.0000
2005	0.0727	0.0369	0.0239	0.0098	0.0066	0.0061	0.0004	0.0007
2006	0.0662	0.0778	0.0386	0.0238	0.0185	0.0070	0.0000	0.0000
2007	0.0627	0.0556	0.0638	0.0211	0.0189	0.0016	0.0000	0.0000
2008	0.0384	0.0141	0.0266	0.0092	0.0032	0.0008	0.0000	0.0000
2009	0.0319	0.0321	0.0255	0.0208	0.0052	0.0016	0.0005	0.0000
2010	0.0000	0.0000	0.0000	0.0095	0.0000	0.0000	0.0000	0.0000
2012	0.0879	0.0062	0.0090	0.0247	0.0000	0.0000	0.0000	0.0000
2013	0.0787	0.0397	0.0402	0.0103	0.0043	0.0000	0.0000	0.0000
2014	0.0548	0.0332	0.0308	0.0130	0.0066	0.0000	0.0000	0.0000

Table 4. Coastwide weighted age composition for commercial handline red snapper pooled at age 13.

Year	1	2	3	4	5	6	7
1988	0.0000	0.1111	0.3298	0.5176	0.0415	0.0000	0.0000
1990	0.0000	0.0000	0.1298	0.4010	0.4691	0.0000	0.0000
1992	0.0000	0.0000	0.0000	0.5567	0.2080	0.0570	0.0780
1993	0.0000	0.0000	0.0000	0.0000	0.6860	0.3045	0.0000
1994	0.0000	0.0000	0.0000	0.0000	0.3998	0.3175	0.2127
1995	0.0000	0.3844	0.2330	0.2910	0.0000	0.0000	0.0000
1996	0.0000	0.0037	0.1931	0.1034	0.2015	0.2155	0.1546
1997	0.0000	0.0431	0.0762	0.4328	0.1112	0.1697	0.0593
1998	0.0000	0.0593	0.4308	0.0714	0.2170	0.0943	0.0275
1999	0.0000	0.0493	0.2204	0.5495	0.0213	0.0280	0.0469
2000	0.0000	0.0140	0.4217	0.2879	0.0941	0.0167	0.0297
2001	0.0000	0.1155	0.4626	0.3102	0.0178	0.0184	0.0062
2002	0.0000	0.0000	0.5104	0.3473	0.0460	0.0880	0.0083
2003	0.0000	0.0789	0.1617	0.3619	0.2733	0.0700	0.0000
2004	0.0000	0.0543	0.2660	0.4558	0.1497	0.0501	0.0138
2005	0.0000	0.0038	0.3094	0.2445	0.2389	0.1121	0.0478
2006	0.0000	0.0052	0.0990	0.4711	0.0708	0.0766	0.1669
2007	0.0000	0.4304	0.0172	0.0459	0.1263	0.1020	0.1222
2008	0.0000	0.0341	0.8734	0.0373	0.0027	0.0238	0.0044
2009	0.0000	0.0097	0.3498	0.4944	0.0083	0.0080	0.0308
2010	0.0000	0.2602	0.6169	0.1077	0.0000	0.0000	0.0000
2012	0.0198	0.0921	0.0915	0.0734	0.5369	0.1090	0.0493
2013	0.0063	0.0630	0.2660	0.2852	0.0608	0.1504	0.0831
2014	0.0533	0.1145	0.1095	0.2492	0.1259	0.0238	0.1768

Table 54 continued.

Year	8	9	10	11	12	13plus
1988	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1990	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1992	0.0234	0.0000	0.0769	0.0000	0.0000	0.0000
1993	0.0000	0.0000	0.0000	0.0000	0.0000	0.0095
1994	0.0610	0.0000	0.0000	0.0000	0.0000	0.0090
1995	0.0634	0.0281	0.0000	0.0000	0.0000	0.0000
1996	0.0452	0.0097	0.0184	0.0079	0.0135	0.0334
1997	0.0362	0.0356	0.0129	0.0000	0.0000	0.0231
1998	0.0211	0.0236	0.0143	0.0061	0.0092	0.0254
1999	0.0375	0.0085	0.0031	0.0017	0.0029	0.0310
2000	0.0800	0.0065	0.0071	0.0054	0.0000	0.0368
2001	0.0143	0.0030	0.0203	0.0069	0.0060	0.0190
2002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2003	0.0000	0.0182	0.0100	0.0000	0.0063	0.0196
2004	0.0103	0.0000	0.0000	0.0000	0.0000	0.0000
2005	0.0182	0.0118	0.0000	0.0000	0.0000	0.0134
2006	0.0114	0.0060	0.0173	0.0158	0.0000	0.0599
2007	0.0793	0.0350	0.0191	0.0000	0.0008	0.0218
2008	0.0066	0.0112	0.0026	0.0010	0.0003	0.0028
2009	0.0211	0.0220	0.0197	0.0138	0.0072	0.0152
2010	0.0152	0.0000	0.0000	0.0000	0.0000	0.0000
2012	0.0000	0.0000	0.0051	0.0086	0.0000	0.0142
2013	0.0478	0.0073	0.0000	0.0017	0.0017	0.0265
2014	0.0637	0.0494	0.0056	0.0019	0.0112	0.0153

Figure 1. Flow chart for weighting length and age compositions.
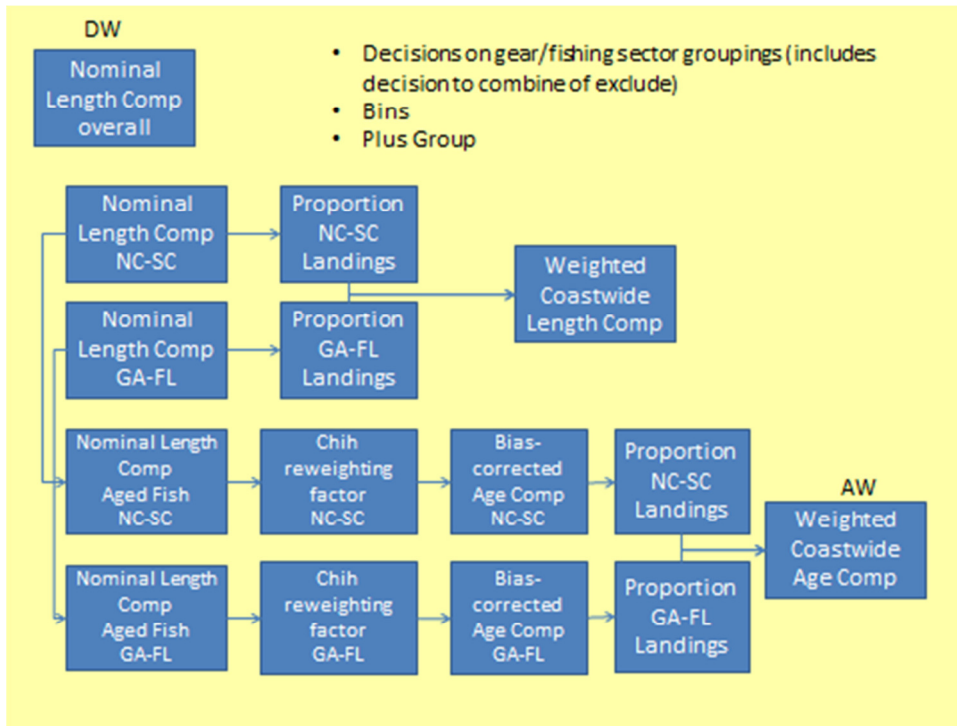
Figure 2. Nominal and weighted coastwide length compositions of red snapper in 1 and 3 cm bins respectively.
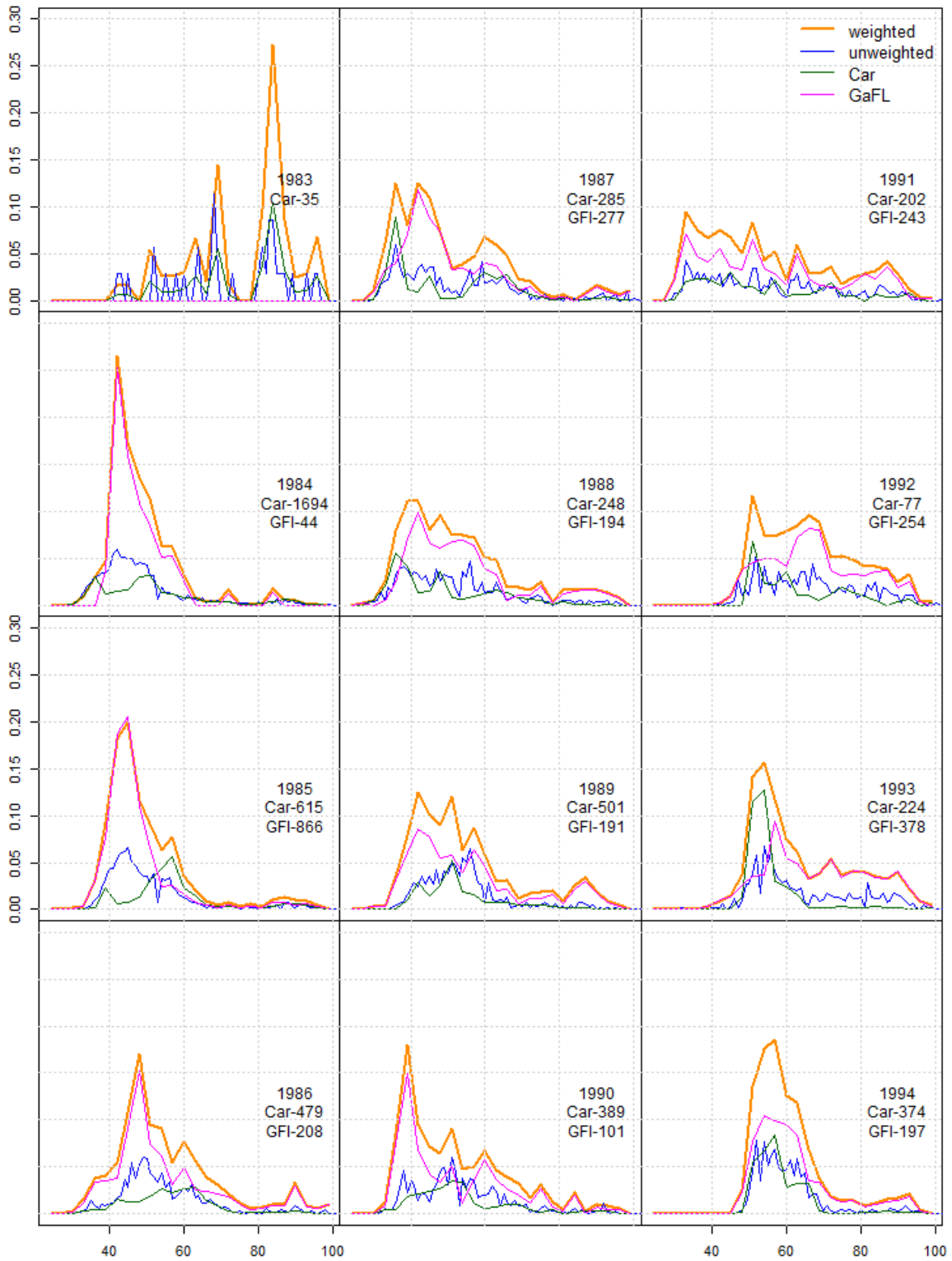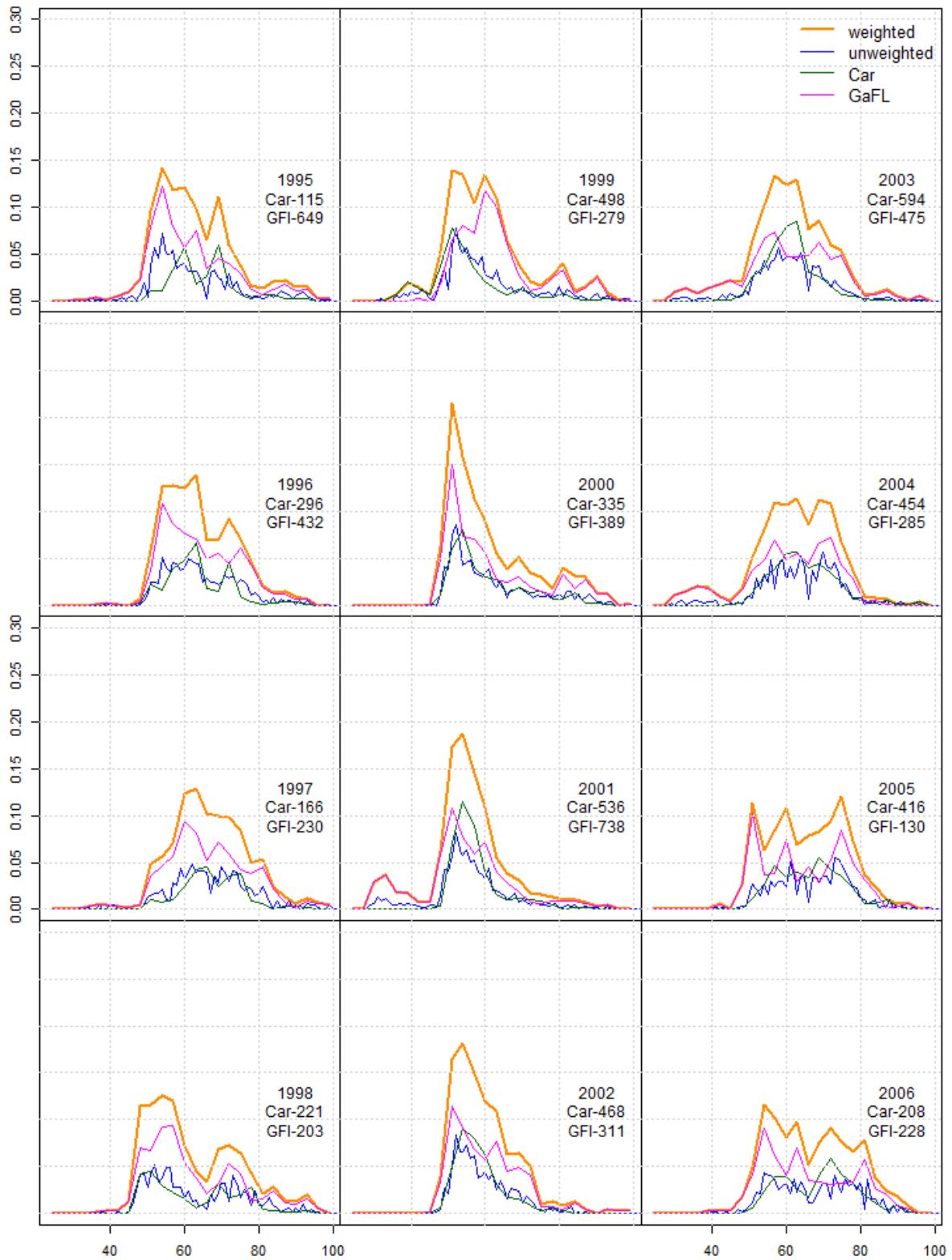
Figure 2 Continued.
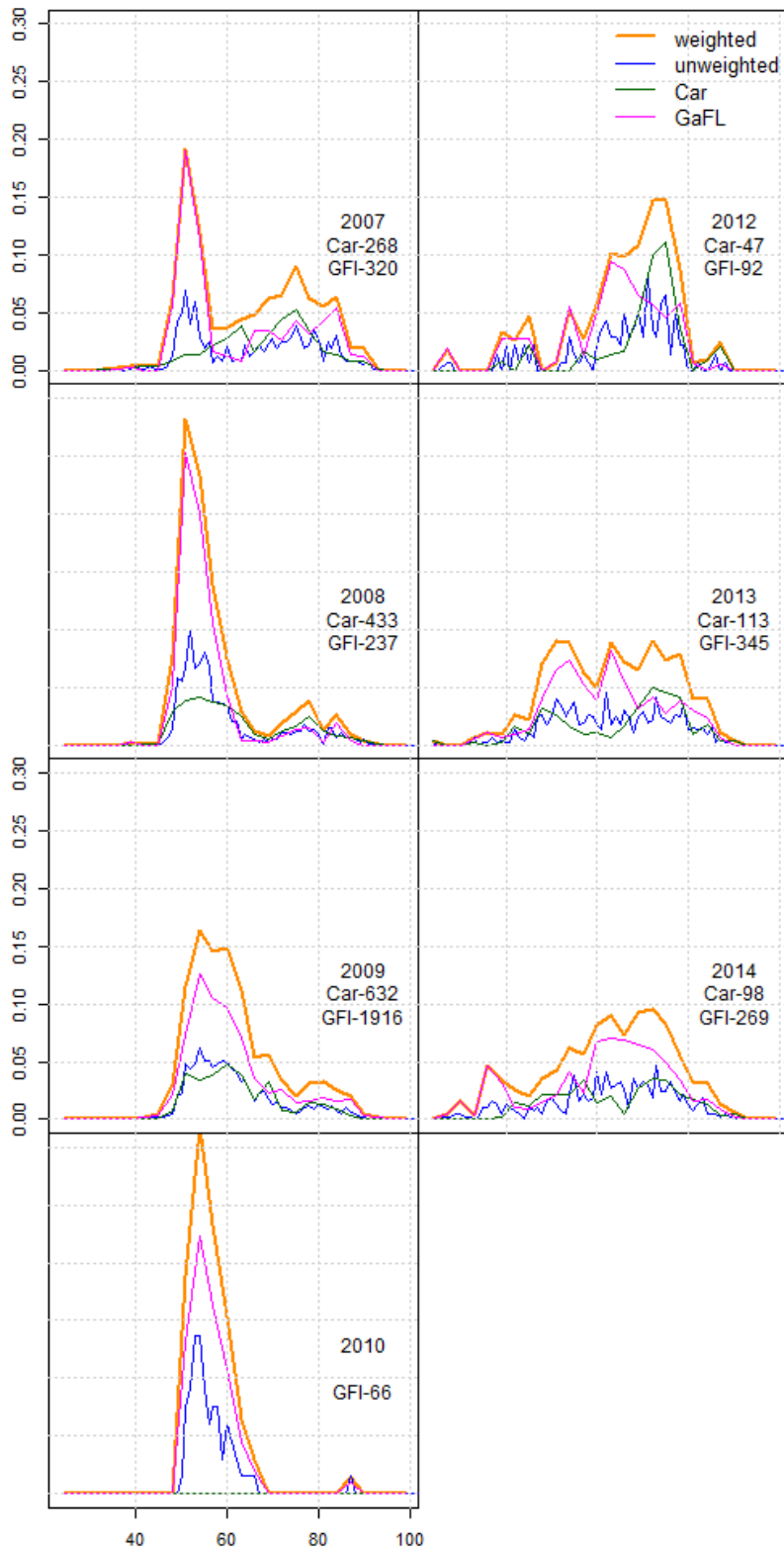
Figure 2 Continued.

Figure 3. Nominal and weighted coastwide age compositions of red snapper. Region-specific sample sizes are provided for each year.
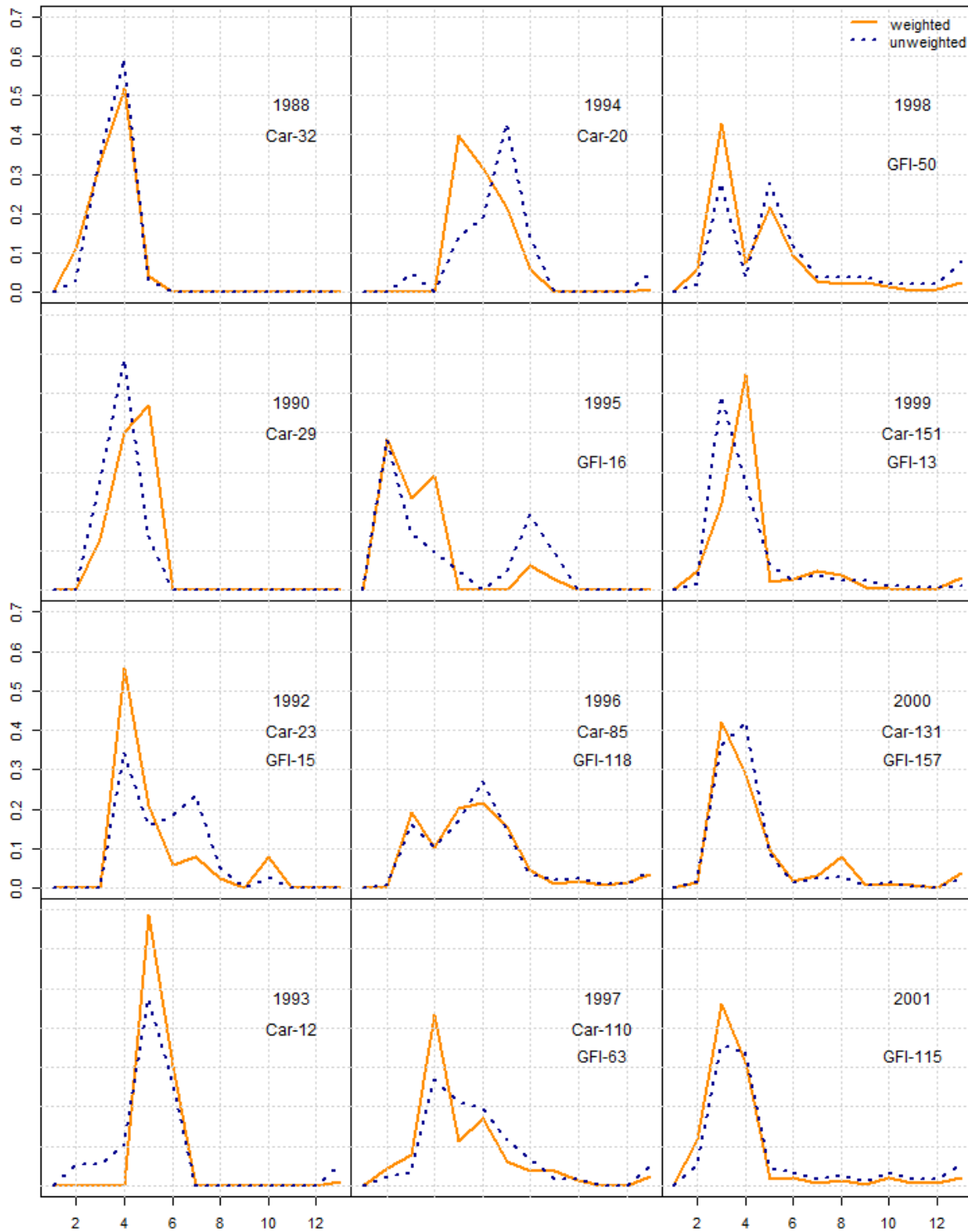
Figure 3 continued.