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Commercial age and length composition weighting for U.S. red grouper (*Epinephelus morio*)

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Introduction

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 because the selection process is rarely 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. These methods have been used in previous SEDAR assessments and completed between the data and assessment workshops.

Data Description

Commercial – general

Biological sample data were obtained from the NMFS/SEFSC Trip Interview Program (TIP). Data were filtered to eliminate those records: 1) that included a size or effort bias, 2) where lengths were collected using a non-random method, 3) were not from commercial trips, 4) were selected by quota sampling, or 5) the data was not collected shore-side. These data were further limited to those that could be assigned a year, gear, and state. Length samples were assigned a state based on landing location or sample location if there was no landing location assigned.

Commercial-Lengths

The number of fish sampled had a high of 2711 for longline and handline gear in 2007 and 1243 for pot and trap gear in 1986 (Table 1). The number of fish sampled by state relative to estimated landings was less than 1% in most years and states.

All red grouper lengths were converted to TL in mm using the formula provided by the SEDAR 19 Life History Group and binned into one centimeter intervals (e.g. 25cm interval = 24.5cm to 25.4cm). The length data and landings data were grouped into two categories; 1) handlines and longlines and 2) pots and traps.

Commercial Ages

Very few age samples were collected from 'other' gear between 1997 and 2015. Age samples of red grouper from handline and longline occurred between 1994 and 2015. The lowest numbers of trips sampled was in 2000. The highest number of trips sampled was in 2007. The number of commercial trips sampled for red grouper ages can be found by year, gear, and state can be found in Table 2.

Since SEDAR 19, approximately 2,752 red grouper age data were brought forward by MARMAP that were collected from South Carolina staff from various sampling programs. These samples were mostly collected between 2005 and 2008.

Weighting methods

The finest scale to weight the SEFSC-TIP length data was by year and state for each of the gear groupings (handline and longline). For each year, the state-specific length composition was multiplied by the proportion of landings from that state. The weighted state-specific length compositions were then combined and scaled to sum to one.

The fishery-dependent age composition estimates were weighted to correct biases in age composition due to non-representative sampling. This weighting method was adapted from a technique to reduce bias associated with non-representative age sampling to produce unbiased growth curves (Chih, 2009) and has been previously used in SEDAR assessments. Lengths are recorded for each fish sampled for age. 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:

$$RW_{ij} = \frac{LC_{ij}}{OL_{ij}/TO_j}$$

where LC_{ij} is the weighted length composition value associated with the year *j* and length interval *i* of each aged fish, 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). The numerator in this method differs slightly from the method used by Chih in that the length composition is weighted by the landings.

Results

Commercial Lengths

The commercial handline and longline length compositions were similar in size spatially for most years (Figure 1). The weighting of the length composition for the handline and longline fishery had almost no influence. The commercial "other" lengths were excluded as data input because of poor sample size over most years and minimal landings.

The commercial longline length compositions were very similar when compared across regions (Figure 1). Therefore, the weighting of the length composition for the longline fishery had almost no influence.

Ages

Commercial

One way to investigate sampling bias related to the collection of age samples is to compare the length composition of the aged fish to the length composition. The weighted age compositions are very similar to the nominal age compositions for longline and the combined (handline and longline) age compositions (Figure 2).

Discussion

There is minimal influence when weighting the commercial length or age composition for red grouper. However, the weighted compositions are recommended for use as a matter of protocol and to remove whatever minimal bias may be present.

The commercial weighted length composition for input into the model is given in Table 3.

Several factors where considered in determining the maximum age for the model including the growth, maturity, and fecundity. Based on these analyses a plus group is recommended at 16 years of age.

Tables

Table 1. Number of fish sampled for lengths for red grouper by year and gear for the combined commercial handline and longline gears and other gears (pot and trap).

	Handline & Longline				Pot & Trap			
	N.trips		N.fish		N.trips		N.fish	
Year	Car	GFl	Car	GFl	Car	GFl	Car	GFl
1984	18	1	90	1	0	0	0	0
1985	18	13	95	36	0	0	0	0
1986	19	14	87	930	0	13	0	1243
1987	27	19	122	1388	0	6	0	756
1988	42	25	179	1797	0	1	0	33
1989	49	11	288	482	0	8	0	357
1990	61	12	551	48	0	6	0	70
1991	50	26	305	319	3	2	3	27
1992	19	23	128	66	0	2	0	21
1993	42	29	317	111	0	0	0	0
1994	57	19	395	179	0	1	0	15
1995	78	16	943	121	0	0	0	0
1996	77	2	360	3	0	0	0	0
1997	59	5	393	7	0	0	0	0
1998	86	19	646	42	0	0	0	0
1999	155	21	1570	66	0	0	0	0
2000	187	27	1528	67	0	0	0	0
2001	135	14	786	64	0	0	0	0
2002	103	13	568	28	0	0	0	0
2003	115	19	692	113	0	0	0	0
2004	178	3	1205	33	0	0	0	0
2005	237	3	1268	31	0	0	0	0
2006	281	1	2036	6	0	0	0	0
2007	394	5	2711	26	4	0	26	0
2008	369	0	2380	0	0	0	0	0
2009	259	1	1380	9	0	0	0	0
2010	176	0	783	0	0	0	0	0
2011	163	1	682	3	0	0	0	0
2012	130	4	597	29	0	0	0	0
2013	76	13	284	118	0	0	0	0
2014	67	7	226	73	1	0	7	0
2015	40	2	92	3	0	0	0	0

Table 2. Number of trips sampled and number of fish sampled (number of fish in parentheses) for age and for red grouper by year and gear by state for the commercial gears. * SCDNR aged red grouper from commercial landings. The number of trips sampled is an estimate. Also, SCDNR was unable to assign state of landing to all samples ("U"). "Other" gear group includes Traps, Spears, Trolling lines, Gill nets, and Unknown or unassigned.

	HL_LL				Other		
Year	FL	NC	SC	U	FL	NC	SC
1994			2 (3)				
1996*			6 (20)				
1997*	7 (18)	1 (1)	12 (45)	13 (62)	2 (3)		
1998*	19 (41)	58 (1576)	1 (7)	7 (54)	1 (1)		
1999*	13 (28)	3 (60)					
2000	10 (22)				1 (3)		
2001	19 (52)				1 (2)		
2002	17 (25)						
2003	7 (18)	3 (9)					
2004	6 (23)	49 (208)					
2005	3 (9)	108 (459)	14 (31)				
2006	3 (8)	130 (662)	76 (166)		2 (4)	1 (5)	
2007	12 (71)	259 (993)	99 (223)			8 (39)	1 (2)
2008	6 (8)	255 (1837)	107 (270)		1 (1)	4 (14)	
2009	15 (37)	151 (739)	88 (222)		1 (1)	1 (5)	4 (10)
2010	4 (4)	133 (598)	61 (177)		3 (5)	5 (15)	6 (9)
2011	4 (6)	137 (584)	43 (118)		5 (26)	3 (7)	9 (20)
2012	1 (1)	132 (578)	30 (74)		4 (10)	6 (22)	1 (1)
2013	7 (23)	75 (290)	15 (22)		3 (10)	4 (7)	3 (4)
2014	24 (62)	65 (210)	9 (17)		21 (41)	13 (43)	
2015	4 (7)	34 (70)	9 (14)		13 (28)	6 (17)	

Table 3. Weighted age composition for commercial handline and longline red grouper with ages 17-25 pooled to the 16-plus bin.

Year	n.fish	n.trips	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1996	20	6	0.000	0.000	0.043	0.203	0.178	0.549	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1997	126	33	0.000	0.000	0.081	0.252	0.166	0.418	0.042	0.041	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1998	1678	85	0.000	0.000	0.021	0.429	0.271	0.125	0.096	0.025	0.012	0.005	0.001	0.016	0.000	0.000	0.000	0.001
1999	88	16	0.000	0.000	0.020	0.162	0.608	0.150	0.026	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2000	22	10	0.000	0.062	0.031	0.062	0.538	0.213	0.095	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2001	52	19	0.000	0.000	0.078	0.165	0.167	0.344	0.174	0.028	0.021	0.008	0.000	0.016	0.000	0.000	0.000	0.000
2002	25	17	0.000	0.000	0.160	0.469	0.000	0.111	0.185	0.037	0.000	0.037	0.000	0.000	0.000	0.000	0.000	0.000
2003	18	7	0.000	0.000	0.000	0.330	0.529	0.000	0.107	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2004	231	55	0.000	0.000	0.107	0.232	0.188	0.150	0.033	0.046	0.051	0.019	0.012	0.001	0.161	0.000	0.000	0.000
2005	490	122	0.000	0.000	0.054	0.291	0.246	0.193	0.071	0.010	0.025	0.049	0.042	0.012	0.001	0.006	0.000	0.000
2006	828	206	0.000	0.000	0.018	0.343	0.185	0.281	0.031	0.068	0.006	0.008	0.011	0.028	0.009	0.008	0.000	0.005
2007	1287	370	0.000	0.000	0.003	0.144	0.446	0.159	0.108	0.049	0.029	0.004	0.013	0.016	0.014	0.009	0.001	0.005
2008	2107	362	0.000	0.000	0.000	0.016	0.283	0.450	0.080	0.045	0.035	0.017	0.006	0.012	0.027	0.017	0.008	0.004
2009	998	254	0.000	0.000	0.000	0.010	0.022	0.626	0.252	0.038	0.012	0.009	0.006	0.005	0.008	0.007	0.003	0.002
2010	775	194	0.000	0.000	0.005	0.018	0.029	0.080	0.549	0.251	0.026	0.007	0.004	0.005	0.011	0.009	0.003	0.005
2011	702	180	0.000	0.000	0.063	0.111	0.051	0.026	0.123	0.479	0.098	0.024	0.004	0.008	0.003	0.002	0.002	0.004
2012	652	162	0.000	0.000	0.024	0.187	0.148	0.042	0.022	0.149	0.240	0.119	0.027	0.017	0.004	0.002	0.007	0.012
2013	335	97	0.000	0.000	0.015	0.106	0.300	0.173	0.044	0.026	0.080	0.127	0.076	0.034	0.002	0.007	0.006	0.004
2014	289	98	0.000	0.000	0.007	0.070	0.187	0.221	0.074	0.024	0.041	0.101	0.155	0.041	0.026	0.023	0.005	0.025
2015	84	43	0.000	0.000	0.000	0.000	0.053	0.164	0.188	0.056	0.008	0.119	0.164	0.181	0.033	0.013	0.000	0.022

Figures

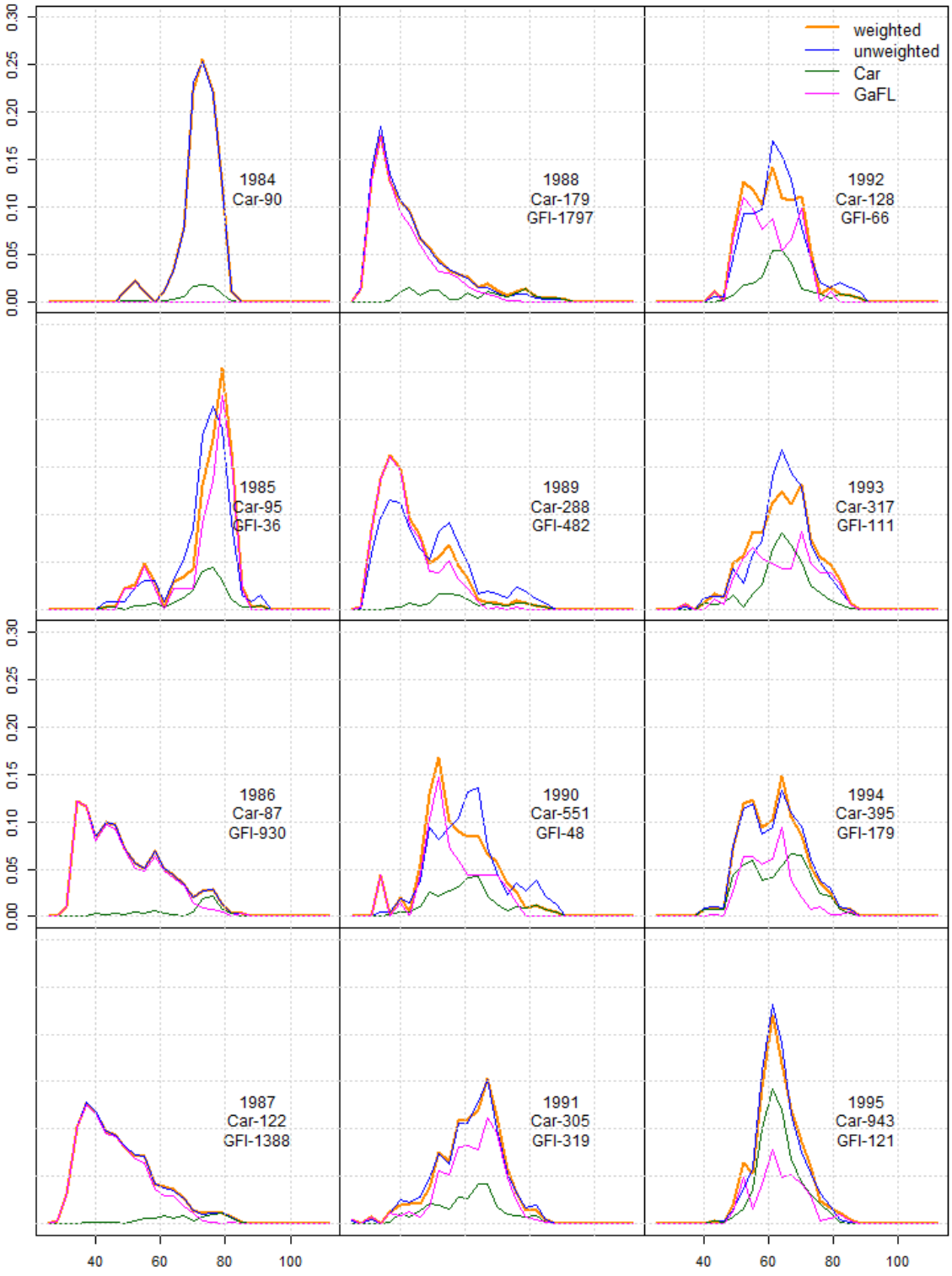


Figure 1. Weighted and un-weighted red grouper length composition for handline and longline gear by region by year.

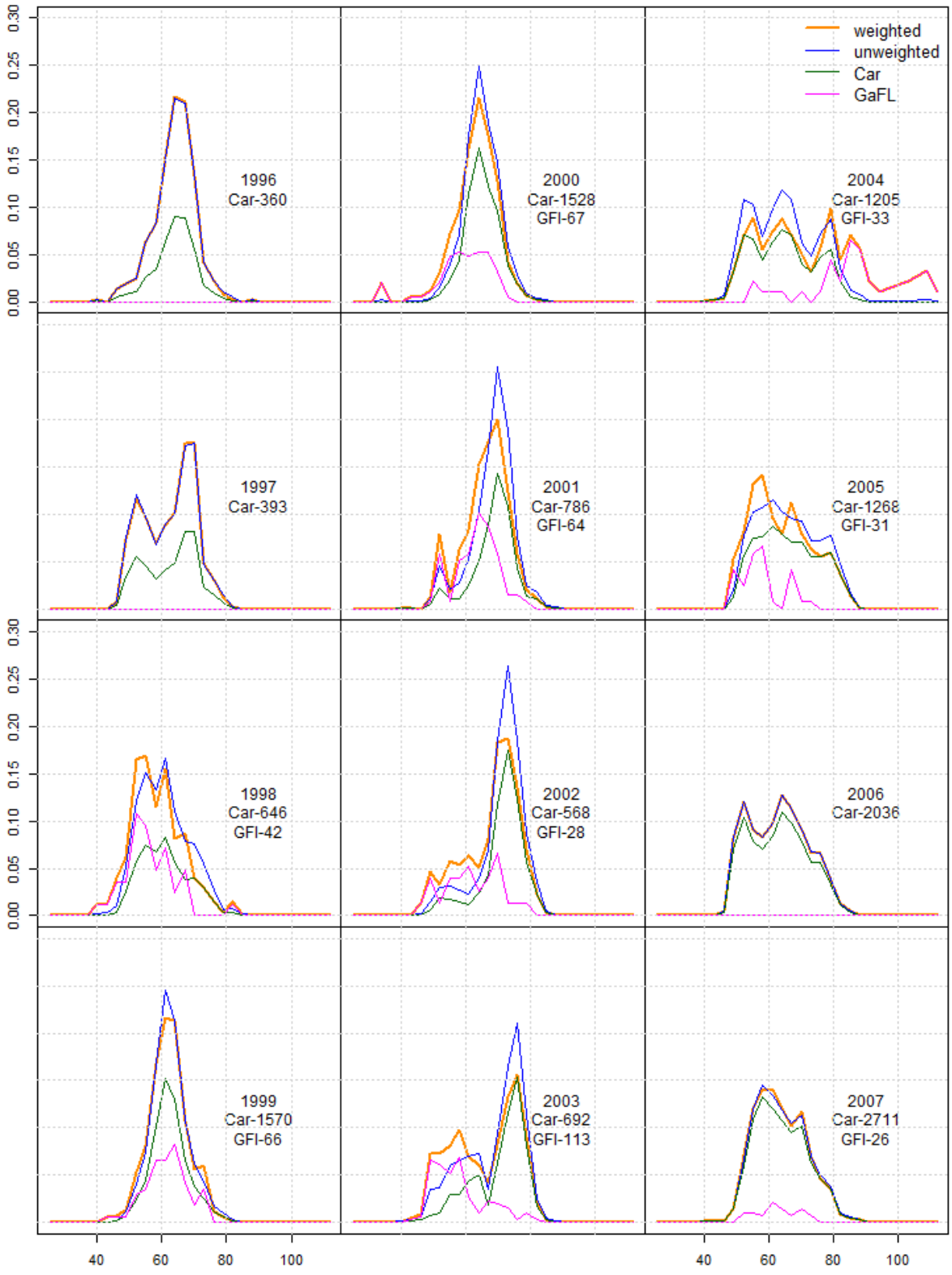
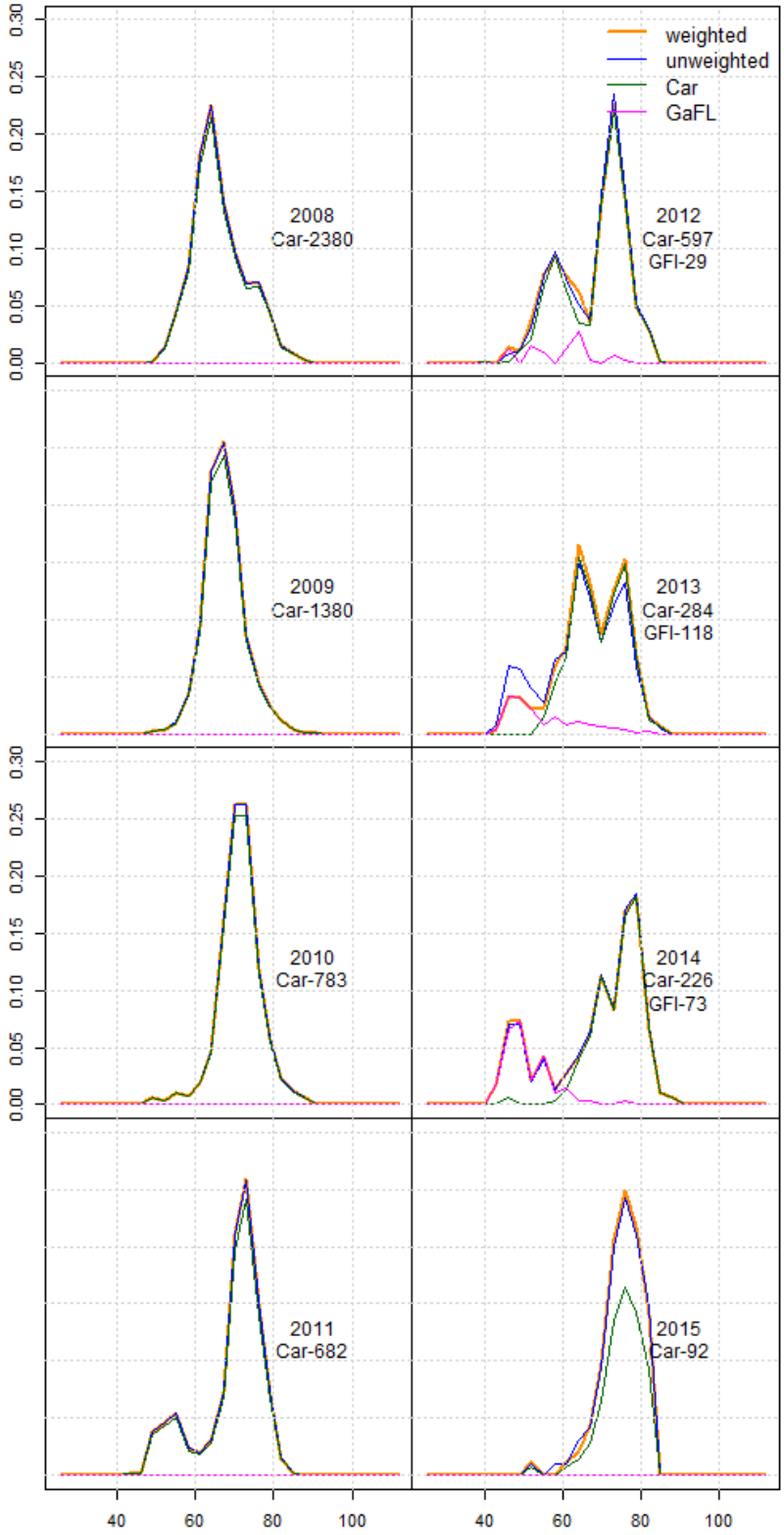


Figure 1 (continued).



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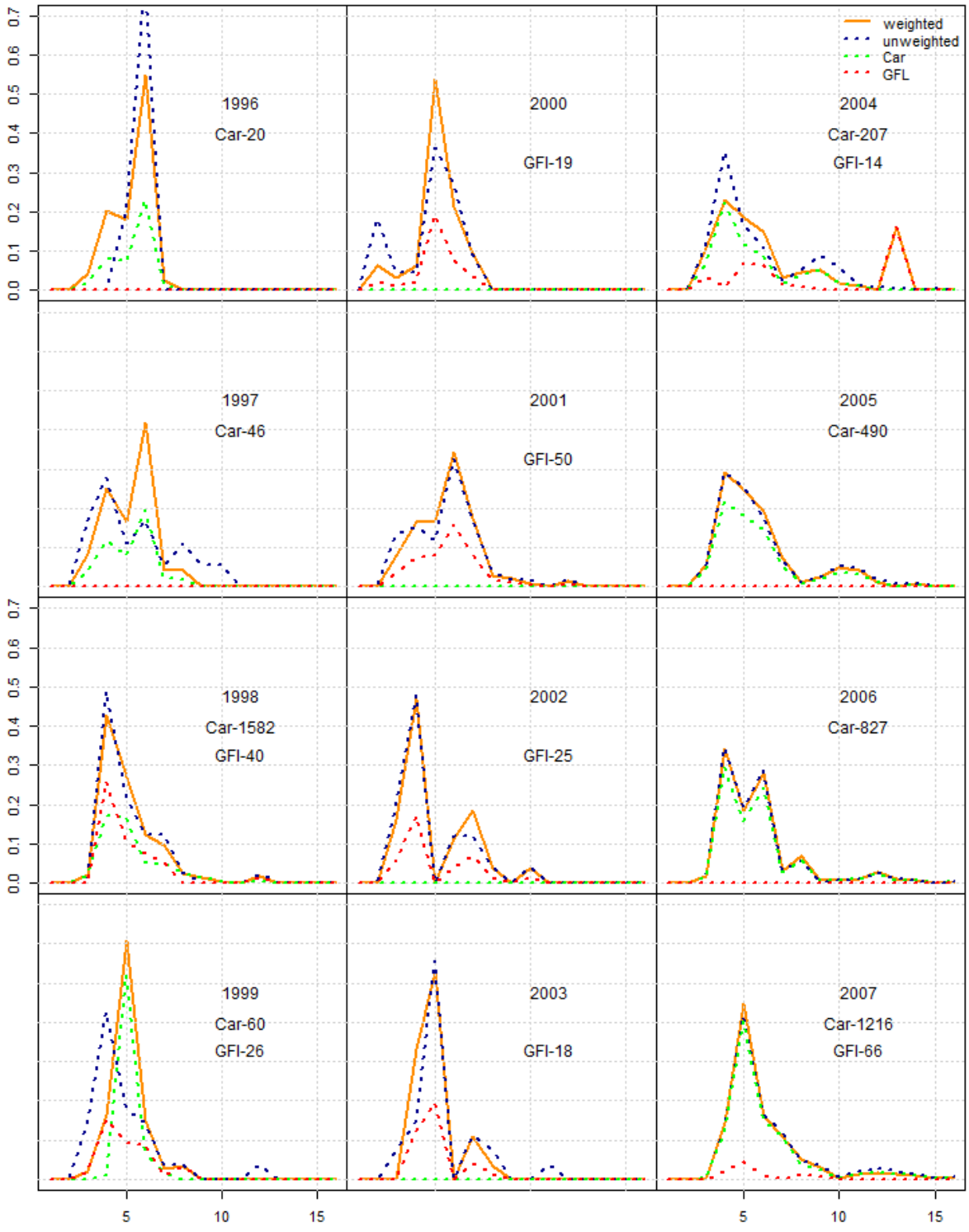

Figure 2. Weighted and un-weighted red grouper age composition for handline and longline gear by region by year.

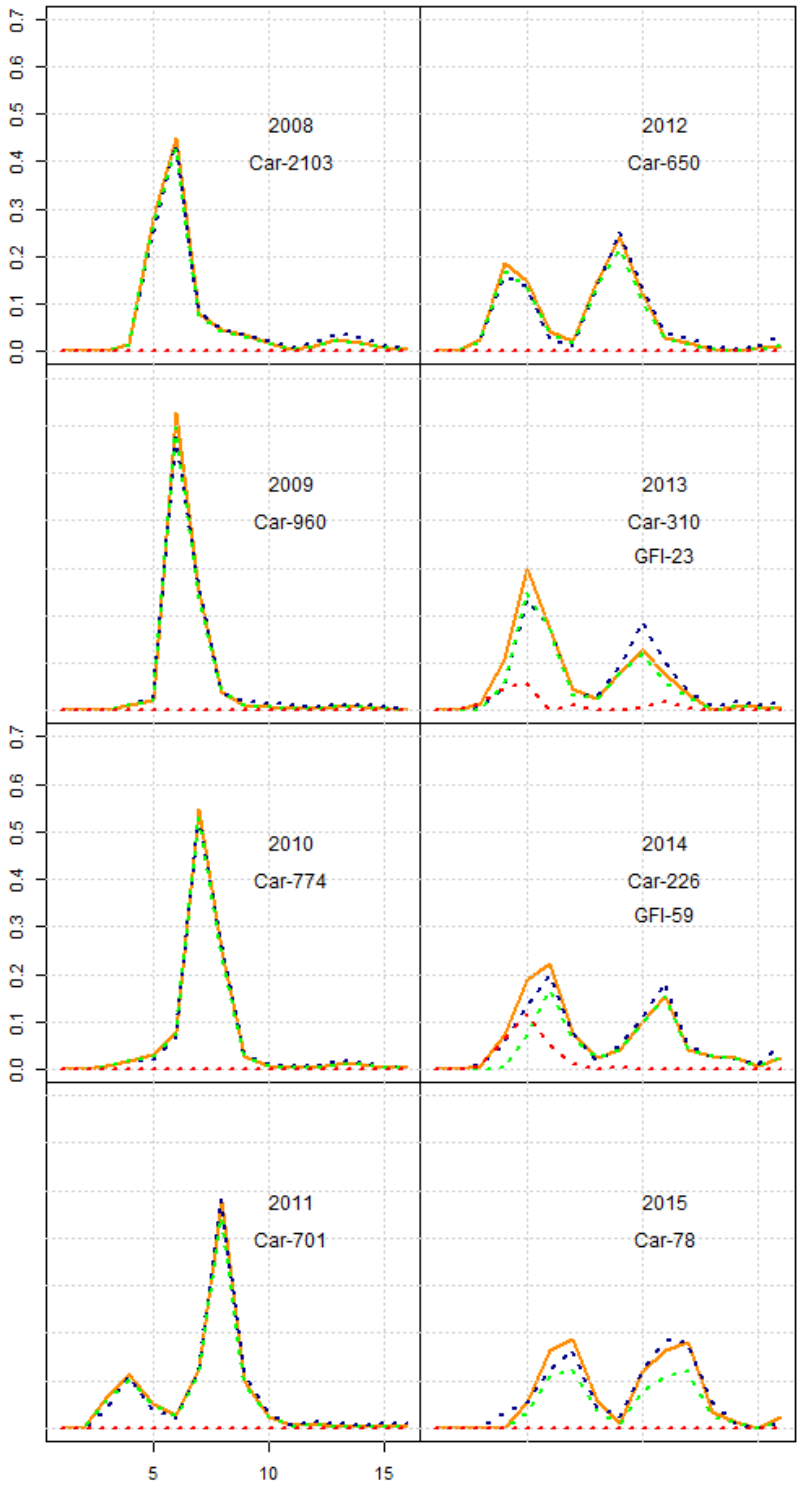

Figure 2. (continued).