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NMFS: Sustainable Fisheries Branch

SEDAR86-WP01

Received: 6/16/2023

Please cite this document as:

NMFS: Sustainable Fisheries Branch. Commercial age and length composition weighting for U.S. red grouper (Epinephelus morio). SEDAR86-WP03. SEDAR, North Charleston, SC. 13 pp.

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

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June 2023

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 by state relative to estimated landings was less than 1% in most years and states (Table 1)

All red grouper lengths were converted to FL 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. Age samples of red grouper from handline and longline occurred between 1994 and 2021. The number of commercial trips sampled for red grouper ages can be found by year, gear, and state can be found in Table 2.

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.

Several factors where considered in determining the maximum age for the model including the growth, maturity, and fecundity.

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	51	1	229	14	0	1	0	45
1985	34	26	208	660	0	0	0	0
1986	25	5	114	161	0	3	0	8
1987	46	8	185	233	0	2	0	11
1988	57	11	385	25	0	1	0	33
1989	60	10	425	20	1	8	27	30
1990	61	15	740	527	0	6	0	28
1991	64	27	556	73	4	3	55	396
1992	24	46	169	98	0	4	0	4
1993	53	66	470	653	1	6	5	17
1994	58	26	430	352	0	2	0	7
1995	77	46	987	111	0	2	0	11
1996	91	28	410	58	0	6	0	19
1997	71	36	452	91	0	4	0	6
1998	117	59	983	135	0	5	0	8
1999	175	58	1715	155	0	10	0	21
2000	200	61	1614	143	0	5	0	7
2001	138	47	801	170	0	9	0	12
2002	105	42	588	131	1	3	1	5
2003	128	29	799	71	9	7	15	8
2004	185	28	1261	102	5	3	33	10
2005	245	12	1322	59	2	3	7	4
2006	292	17	2077	37	4	3	9	4
2007	414	33	2822	113	1	5	4	9
2008	389	9	2472	11	2	5	4	11
2009	292	14	1576	35	11	4	41	6
2010	201	6	870	8	12	5	27	7
2011	196	3	801	5	13	6	35	28
2012	163	6	680	9	9	5	57	17
2013	94	27	333	118	7	4	17	8
2014	81	32	272	173	13	11	46	31
2015	54	16	142	134	8	11	23	33
2016	52	17	96	194	6	1	25	2
2017	30	17	45	78	9	14	30	27
2018	49	4	94	16	9	12	22	20
2019	51	9	123	11	9	11	18	20
2020	25	18	46	28	4	9	5	15
2021	20	10	28	16	3	12	4	32

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 handline and longline gears.

	Georgia-Florida		Carolinas	
year	n.fish	n.trips	n.fish	n.trips
1997	18	7		
1998	40	19		
1999	28	13		
2000	61	11		
2001	51	18		
2002	23	16		
2003	15	5		
2004	22	6	170	38
2005	9	2	456	120
2006	8	3	834	207
2007	73	13	2328	389
2008	16	7	2130	376
2009	37	15	961	226
2010	4	4	775	194
2011	5	3	699	182
2012	1	1	577	151
2013	26	7	352	93
2014	37	21	232	77
2015	8	5	86	44
2016	33	11	72	45
2017	32	13	37	24
2018	13	3	86	44
2019	11	9	102	49
2020	21	14	44	23
2021	7	5	24	19

Figures

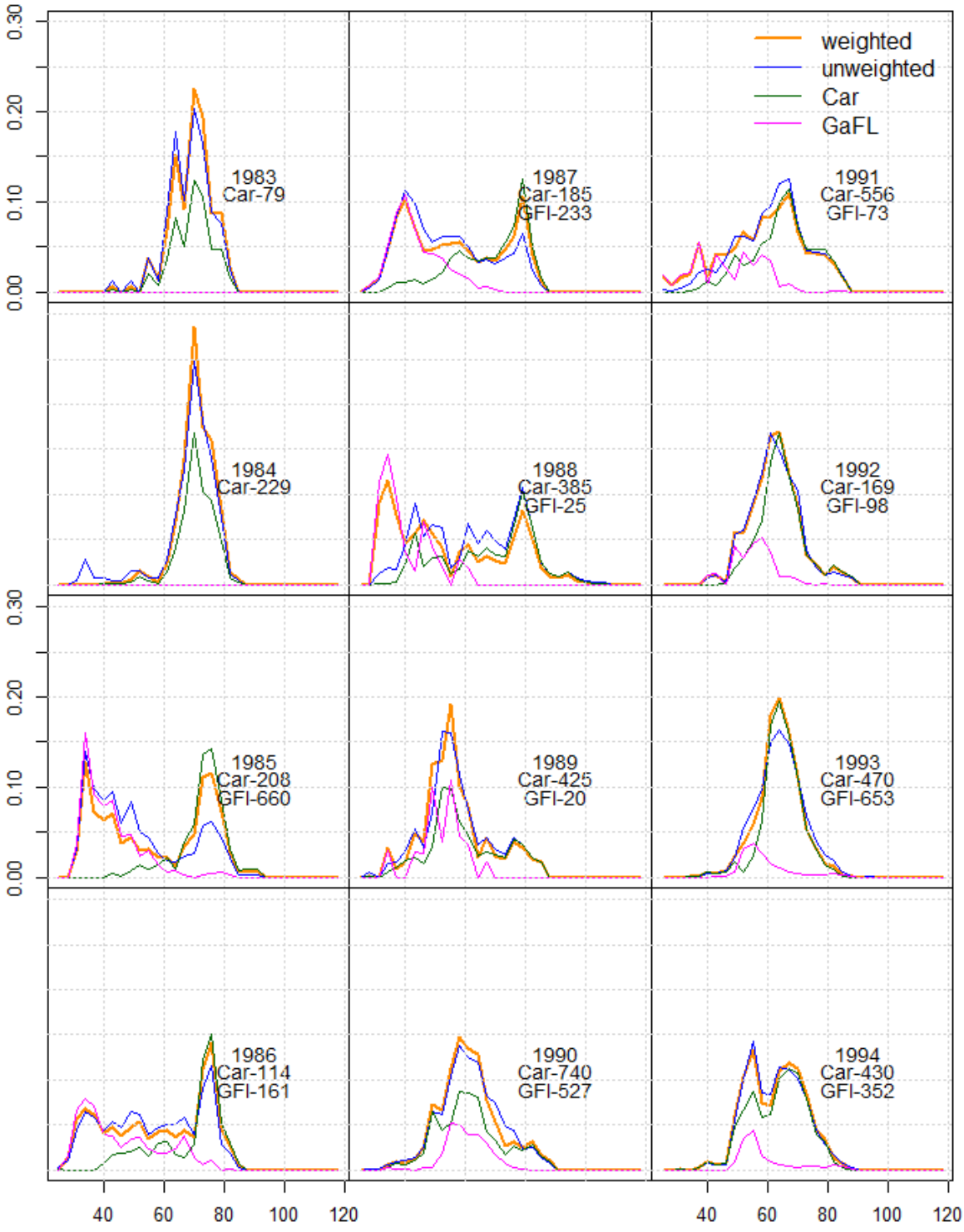

Figure 1. Weighted and un-weighted red grouper length composition for handline and longline gear by region by year.

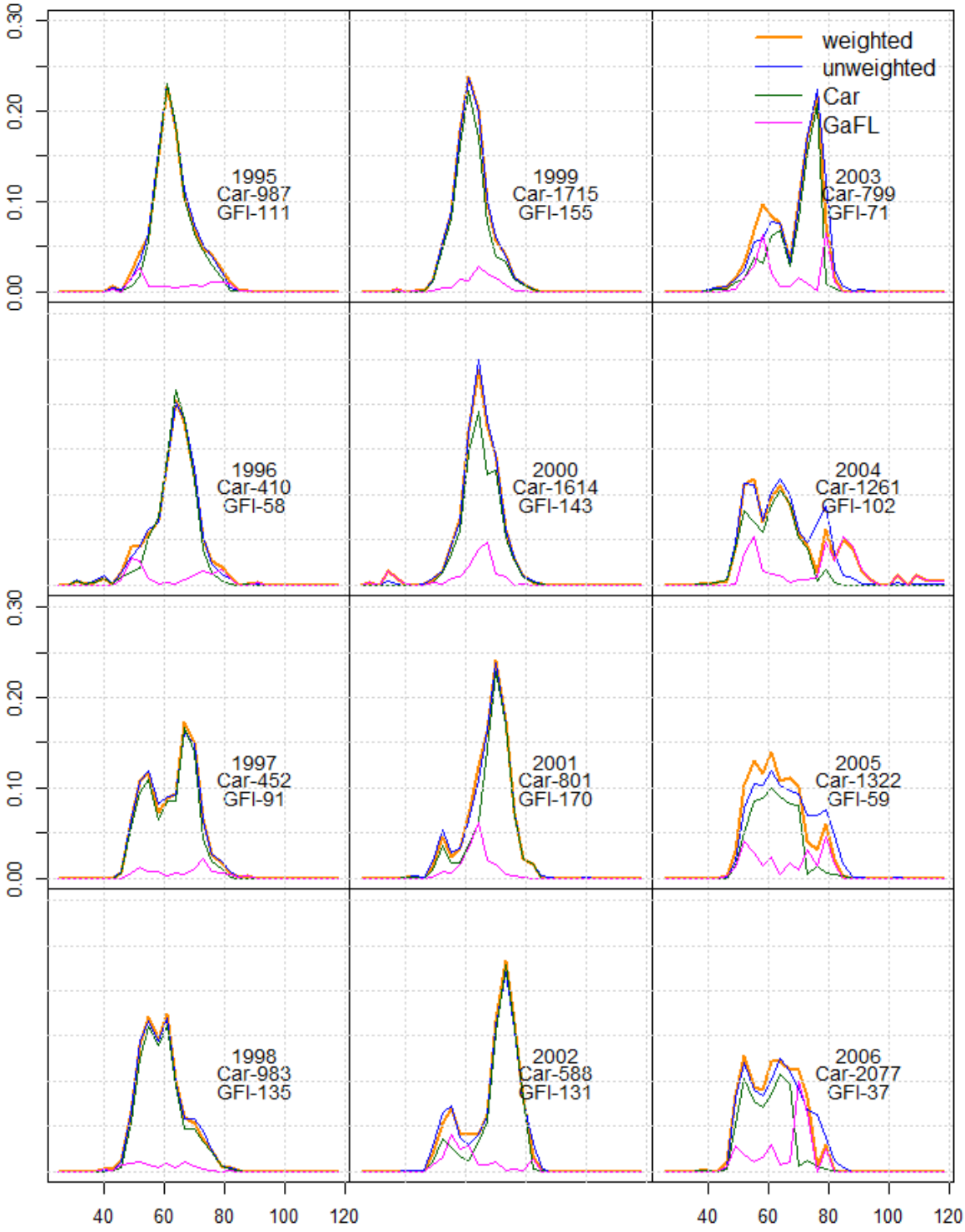

Figure 1 (continued).

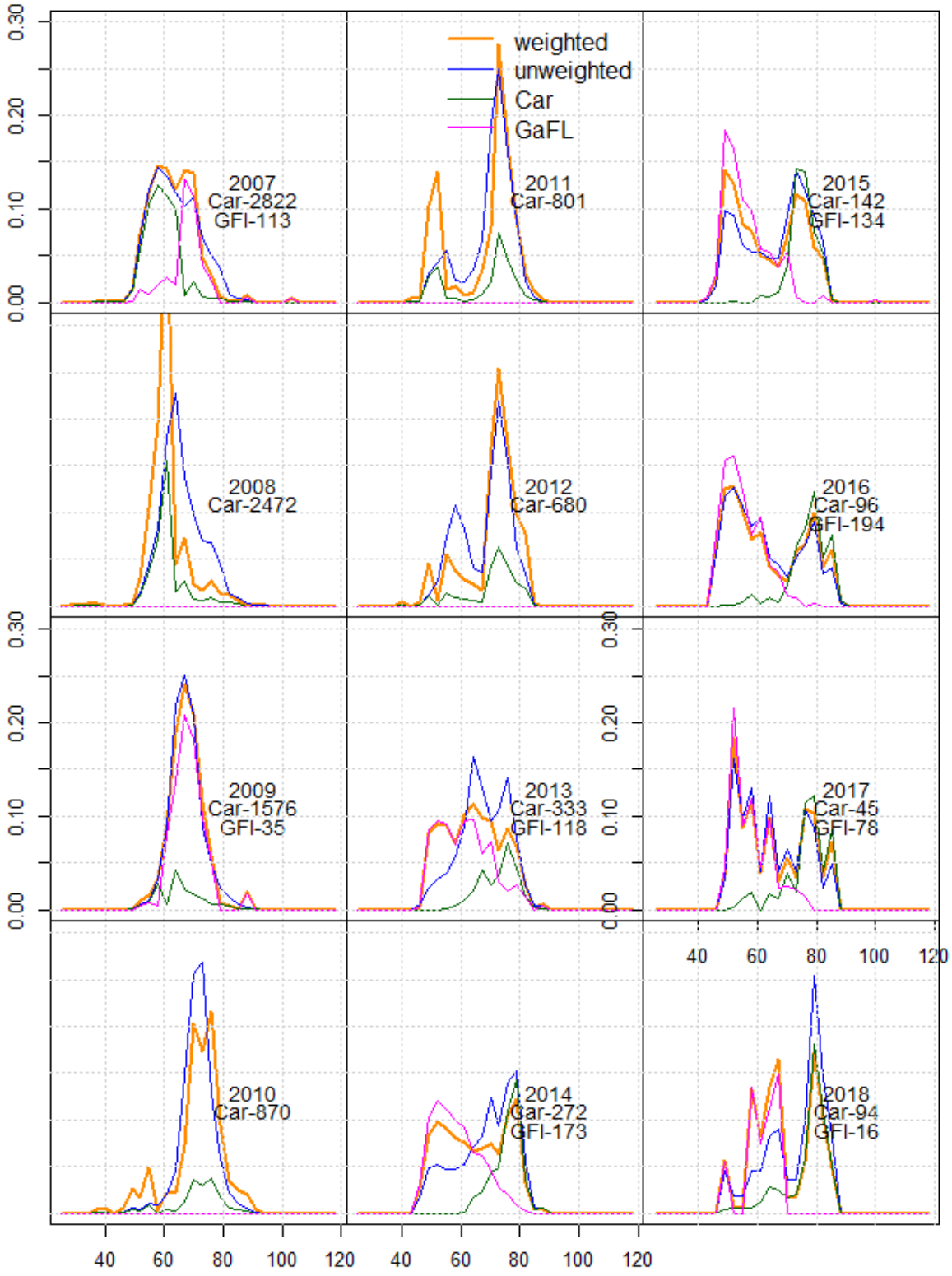

Figure 1 (continued).

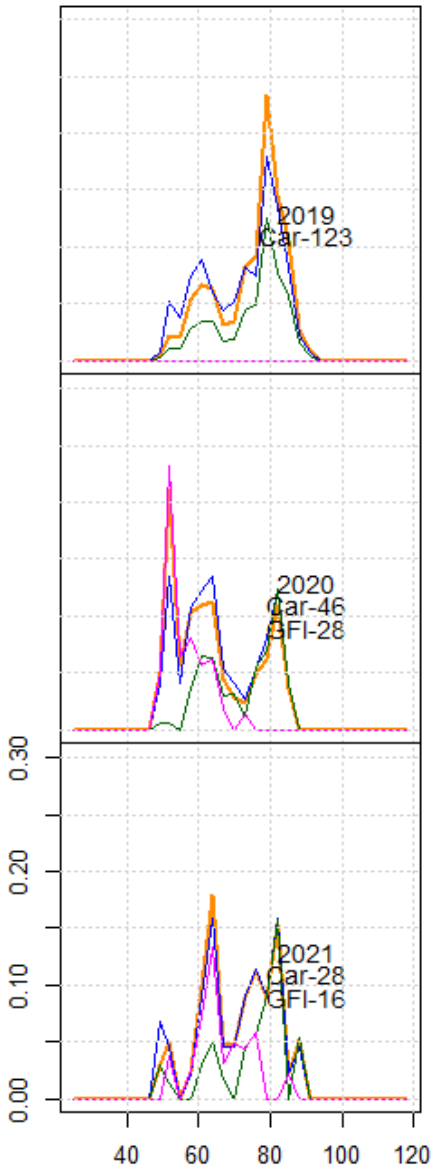

Figure 1 (continued).

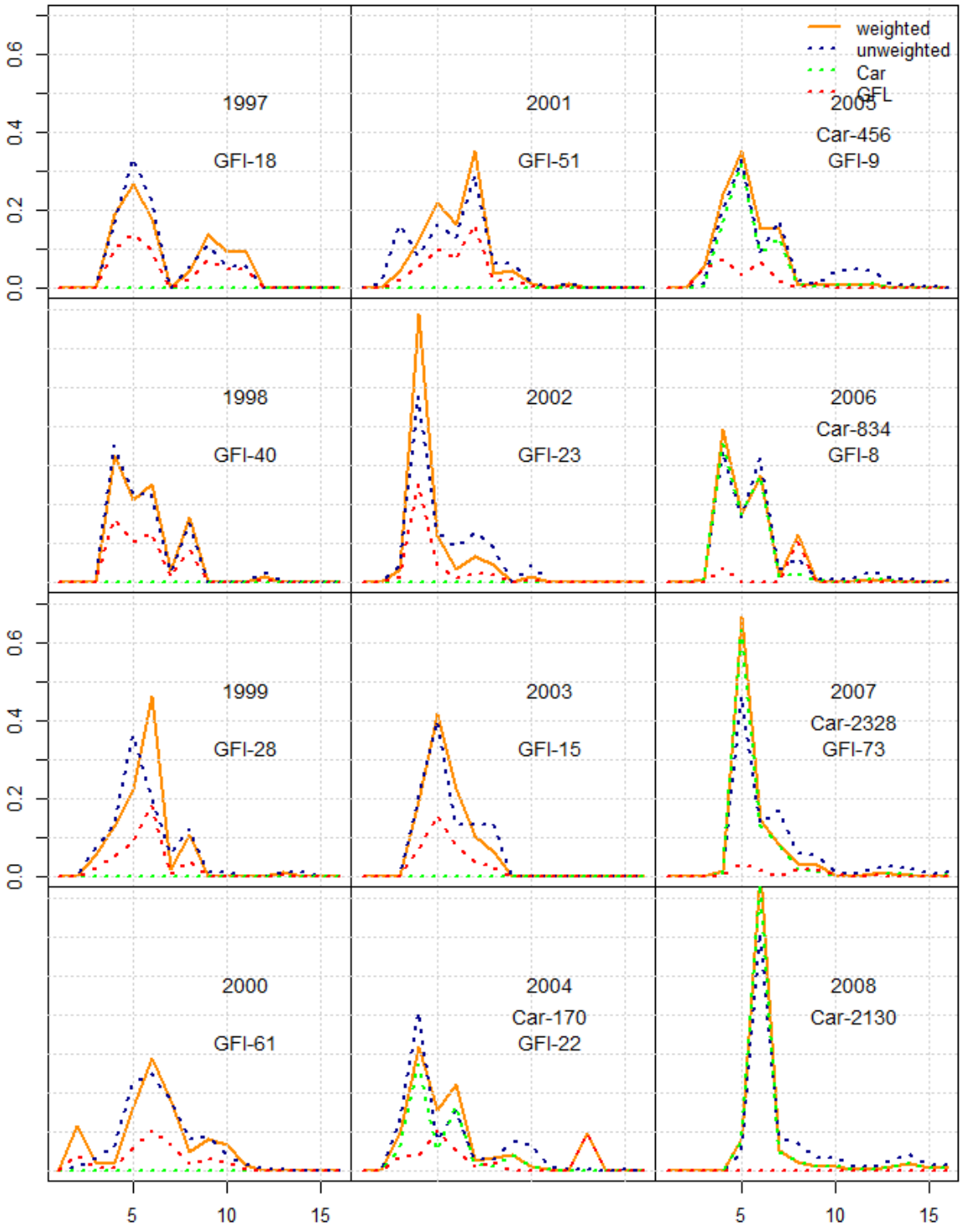

Figure 2. Weighted and un-weighted red grouper age composition for handline and longline gear by region by year.

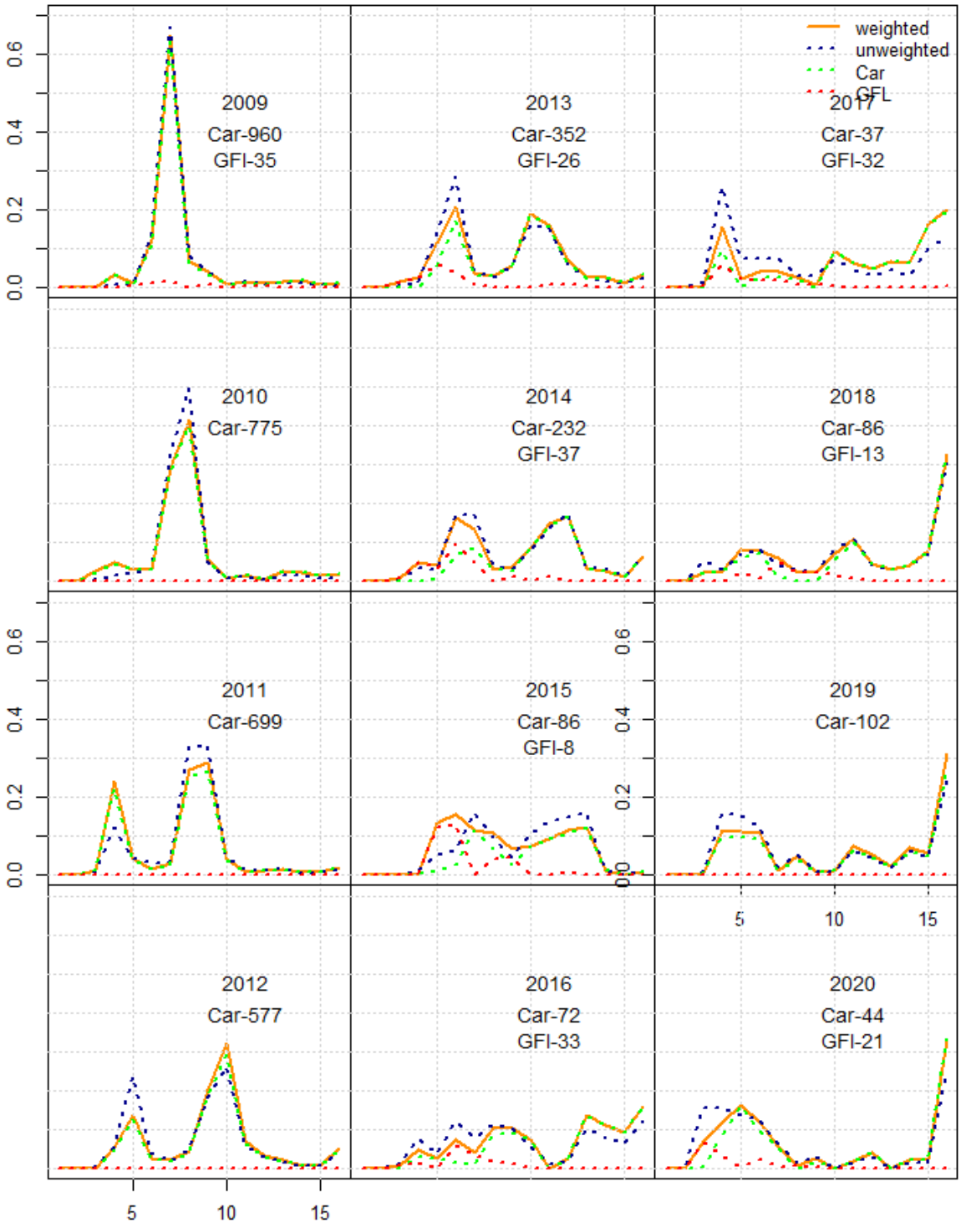

Figure 2. (continued).

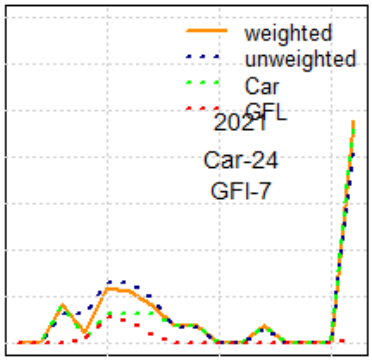

Figure 2 (continued).