South Atlantic U.S. red snapper (*Lutjanus campechanus*) age and length composition from the recreational fisheries

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SEDAR41-AW03

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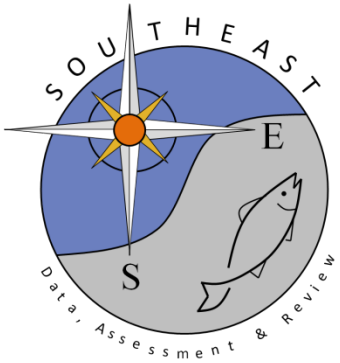

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South Atlantic U.S. red snapper (*Lutjanus campechanus*) age and length composition from the recreational fisheries

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30 November 2015

1 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.

2 Data Description

2.1 Lengths

Headboat Survey Biological Sampling
Lengths were collected from 1972 to 2014 by headboat dockside samplers (Table 1). From 1972 to 1975, only North Carolina and South Carolina were sampled whereas Georgia and northeast Florida were sampled beginning in 1976. The Southeast Region Headboat Survey conducted dockside sampling for the entire range of Atlantic waters along the southeast portion of the US from the NC-VA border through the Florida Keys beginning in 1978.

MRFSS/MRIP Biological Sampling
The MRFSS/MRIP angler intercept survey includes the sampling of fish lengths from the harvested (landed, whole condition) catch (Table 2). Up to 15 of each species landed per angler interviewed are measured to the nearest millimeter (mm) along a center line (defined as tip of snout to center of tail along a straight line, not curved over body). Weights are typically collected for the same fish measured. When time is constrained a weight may be collected without a length measurement.

State of Florida Mini-Season Surveys

Red snapper lengths were collected during random intercept surveys of private recreational boats in Florida during the recreational harvest season openings in 2012, 2013, and 2014. Site selection methods and intercept survey procedures are detailed in SEDAR41-DW42.

SCDNR State Finfish Survey (SFS)

The SFS collects finfish intercept data in South Carolina through a non-random intercept survey at public boat landings along the SC coast. The survey focuses on known productive sample sites, targets primarily private boat mode, and is conducted year-round (January- December) using a questionnaire and interview procedure similar to the intercept portion of the MRIP. From 1988 through March 2009 mid-line lengths were measured and from April 2009 to 2011 total lengths were measured. Mid-line (fork) measurements from 1988-2009 were converted to total length measurements Red snapper lengths were collected through the SCDNR State Finfish Survey (SFS) from 1988 to 2012. In 2013 SCDNR took over MRIP sampling responsibilities in SC. The SFS survey was therefore terminated except for January and February sampling. No red snapper were sampled during those months in 2013 and 2014.

2.2 Ages

Aging structures and other biological samples are not collected during MRFSS/MRIP assignments because of concerns over the introduction of bias to survey data collection. Biological samples (scales, otoliths, spines, stomachs and gonads) are collected by the SRHS and processed for aging, diet studies, and maturity studies. Aging structures provided from the charter boat and private boat modes were collected ad hoc by MRFSS/MRIP state subcontractors and SRHS port agents.

Annual numbers of red snapper sampled for age and the number of annual trips that were sampled from the recreational fishery are reported in Table 3.

3 Weighting methods

3.1 Lengths

A minimum of 30 fish per region was established to calculate a weighted length composition. The recreational landings estimates for SEDAR 41 were developed at the year and region (2 regions, NC/SC and GA/FL) level in order to consolidate the MRFSS/MRIP and SRHS landings estimates. Therefore, the finest scale to weight the length data was year and region data was by year and region for each of the fleet groupings (SRHS and MRIP). For each year, the region-specific length composition was multiplied by the proportion of landings from that region. The weighted region-specific length compositions were then combined and scaled to sum to one.

3.1.1. Summary of length data treatment

- State/spatial strata cutoff: include region of 30 or more fish sampled
- Filtered all samples to include only “Hook and line” gear

- Region assigned (NC/SC & GA/FL)
- Fleet assigned: 1. Headboat and 2. (SC Finfish Survey, MRIP, FWC)
- Range of lengths: 12 to 108 cm (3cm bins)
- Added very small number in place of zeros or na's (0.0000001)

3.2 Ages

A minimum of 10 fish per region was established to calculate a weighted age composition. 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 for 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 (2009) in that the length composition is weighted by the landings.

3.2.1. Summary of age data treatment

- State/spatial strata cutoff: include region of 10 or more fish sampled
- Filtered all samples to include only "Hook and line" gear
- Region assigned (NC/SC & GA/FL)
- Fleet assigned: 1. Headboat and 2. (SC Finfish Survey, MRIP, FWC)
- Range of lengths: 27 to 99 cm (3cm bins)
- Added very small number in place of zeros or na's (0.0000001)

4 Results

4.1 Lengths

The recreational (both SRHS and MRIP) length compositions were very similar and showed slightly smaller fish (30-45 cm FL) prior to the 1992 inch size regulation. Between 1992 and 2009 red snapper were generally between 50 and 65 cm FL for both recreational fleets. Following the closure in 2010, a divergence between the headboat and MRIP fisheries occurred. Red snapper measured during the mini-seasons from headboats ranged between 30-50 cm FL, while red snapper measured from MRIP (private and charterboat modes) ranged from 60 and 85 cm FL. It's important to note that weighting had limited influence on the length composition (Figure 1 & 2).

4.2 Ages

The weighted age compositions are very similar to the nominal age compositions (Figure 2). Prior to 2010, ages encountered in both the SRHS and MRIP fleets ranged from 2-5. During the mini-seasons following the 2010 closure ages ranged from 2-7.

5 Discussion

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

Literature Cited

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. Annual number of fish measured and annual number of trips containing measured red snapper in the SRHS. A minimum of 30 length measurements was required.

Year	n.fish	n.trips
1972	48	30
1973	32	26
1974	95	52
1975	155	74
1976	497	117
1977	718	197
1978	740	208
1979	230	80
1980	234	73
1981	652	183
1982	457	154
1983	1006	253
1984	1321	314
1985	1191	298
1986	435	190
1987	306	158
1988	204	116
1989	365	157
1990	367	137
1991	152	64
1992	45	49
1993	203	96
1994	120	57
1995	147	74
1996	55	29
1997	57	33
1998	149	78
1999	140	73
2000	107	59
2001	239	103
2002	341	142
2003	329	145
2004	290	102
2005	189	92
2006	159	91
2007	153	55
2008	435	81
2009	738	166
2012	132	16
2013	177	31
2014	291	42

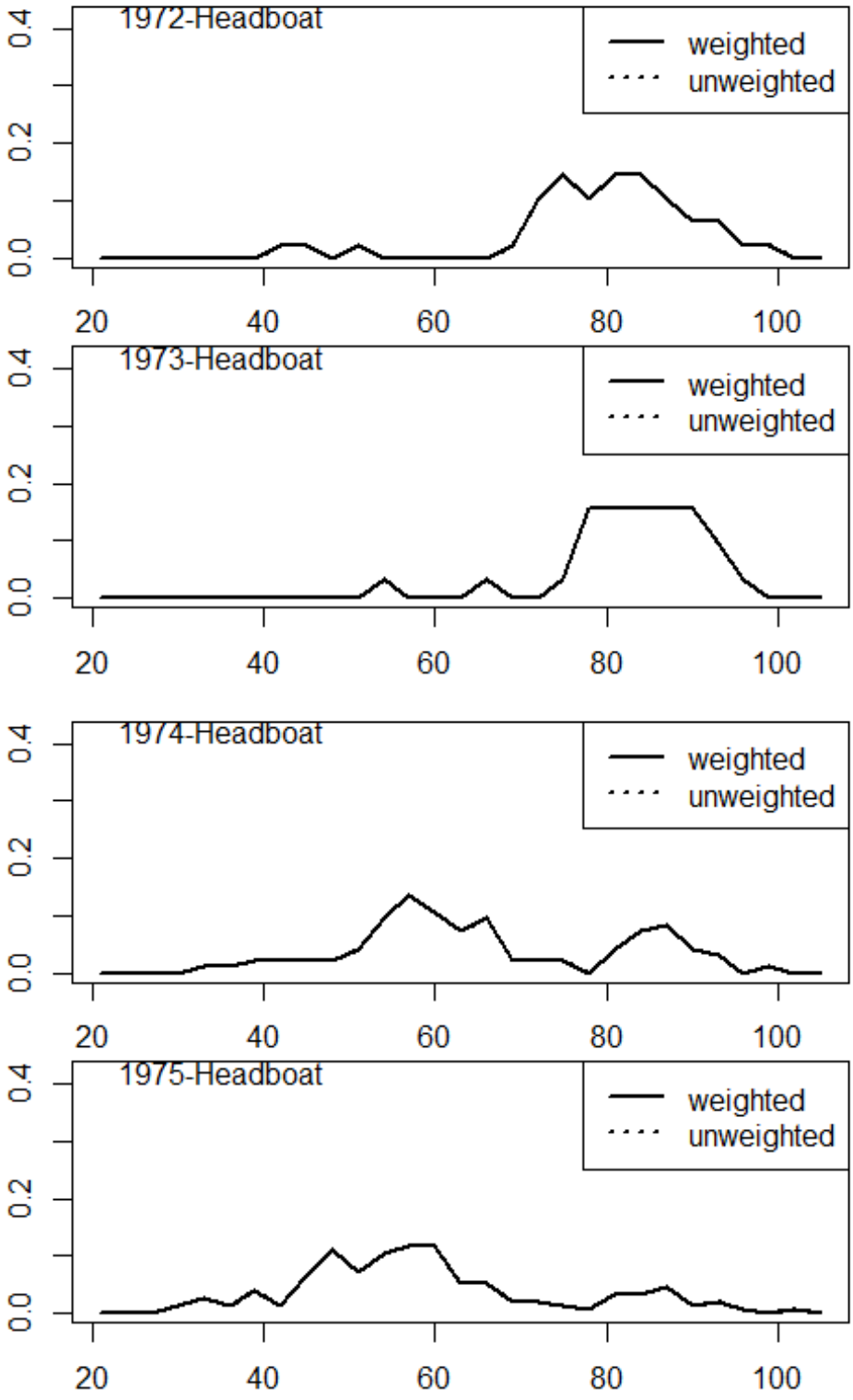
Table 2. Annual number of fish measured and annual number of trips containing measured red snapper in the MRIP CH and PR modes. A minimum of 30 length measurements was required.

Year	n.fish	n.trips
1984	67	12
1985	39	15
1986	225	82
1987	69	16
1988	82	27
1989	48	15
1999	161	39
2000	108	39
2001	105	47
2002	248	56
2003	173	54
2004	149	55
2005	72	30
2006	62	24
2007	59	24
2008	182	58
2009	210	50
2012	494	180
2013	647	256
2014	1917	693

Table 3. Annual numbers of red snapper sampled for age and the number of annual trips containing aged red snapper in the SRHS (Headboat) and MRIP (CH and PR).

Headboat															
Year		n.fish	n.trips	1	2	3	4	5	6	7	8	9	10	11	12	13
	1977	72	22	0.1275	0.5802	0.1607	0.1115	0.0064	0.0050	0.0081	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006
	1978	275	80	0.0257	0.3790	0.5195	0.0239	0.0353	0.0048	0.0086	0.0000	0.0000	0.0000	0.0000	0.0000	0.0032
	1979	46	31	0.0000	0.7157	0.0928	0.0470	0.0718	0.0319	0.0408	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1980	87	30	0.1229	0.6791	0.1484	0.0352	0.0000	0.0144	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1981	405	141	0.0244	0.6975	0.1650	0.0368	0.0170	0.0281	0.0054	0.0112	0.0045	0.0000	0.0000	0.0000	0.0102
	1982	131	55	0.0628	0.3788	0.4536	0.0577	0.0322	0.0037	0.0000	0.0062	0.0050	0.0000	0.0000	0.0000	0.0000
	1983	741	167	0.3843	0.4571	0.1002	0.0279	0.0111	0.0082	0.0042	0.0038	0.0011	0.0000	0.0000	0.0000	0.0022
	1984	581	166	0.1604	0.6561	0.1260	0.0173	0.0144	0.0027	0.0037	0.0010	0.0014	0.0008	0.0033	0.0019	0.0108
	1985	504	160	0.0395	0.7197	0.2094	0.0205	0.0017	0.0029	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000	0.0055
	1986	184	97	0.0668	0.4753	0.3741	0.0664	0.0068	0.0026	0.0026	0.0000	0.0000	0.0000	0.0000	0.0000	0.0053
	1987	86	60	0.1412	0.2087	0.5490	0.0820	0.0191	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1989	49	9	0.0000	0.2722	0.7028	0.0167	0.0083	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1990	33	23	0.0817	0.1239	0.2076	0.3129	0.2061	0.0306	0.0373	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1991	21	13	0.0000	0.0000	0.4762	0.3963	0.1037	0.0238	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	1998	21	2	0.0000	0.0000	0.0667	0.2667	0.4000	0.2000	0.0333	0.0000	0.0333	0.0000	0.0000	0.0000	0.0000
	2004	27	8	0.0000	0.0000	0.9115	0.0847	0.0038	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2005	60	22	0.0000	0.0071	0.4561	0.4240	0.1017	0.0000	0.0000	0.0000	0.0000	0.0110	0.0000	0.0000	0.0000
	2006	150	49	0.0000	0.0042	0.2221	0.6694	0.0427	0.0096	0.0255	0.0000	0.0085	0.0000	0.0000	0.0000	0.0180
	2007	71	34	0.0000	0.2582	0.1525	0.5145	0.0488	0.0102	0.0000	0.0091	0.0068	0.0000	0.0000	0.0000	0.0000
	2008	133	47	0.0000	0.0358	0.8958	0.0184	0.0125	0.0234	0.0105	0.0000	0.0035	0.0000	0.0000	0.0000	0.0000
	2009	1239	241	0.0000	0.0067	0.5564	0.3842	0.0048	0.0064	0.0118	0.0052	0.0017	0.0024	0.0062	0.0035	0.0108
	2012	604	40	0.0245	0.3412	0.2788	0.0678	0.1711	0.0831	0.0335	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2013	242	35	0.0116	0.0490	0.3028	0.2021	0.0592	0.2156	0.1031	0.0440	0.0076	0.0034	0.0017	0.0000	0.0000
	2014	364	49	0.0741	0.4870	0.1140	0.1056	0.0658	0.0145	0.0744	0.0441	0.0161	0.0029	0.0000	0.0000	0.0016
MRIP																
Year		n.fish	n.trips	1	2	3	4	5	6	7	8	9	10	11	12	13
	2001	43	15	0.000	0.184	0.706	0.085	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2002	262	83	0.000	0.131	0.561	0.195	0.054	0.034	0.011	0.006	0.000	0.003	0.000	0.000	0.005
	2003	354	91	0.000	0.103	0.338	0.352	0.104	0.032	0.016	0.018	0.000	0.020	0.000	0.000	0.017
	2004	312	83	0.000	0.145	0.407	0.257	0.109	0.043	0.008	0.003	0.003	0.001	0.001	0.000	0.023
	2005	338	78	0.000	0.000	0.364	0.352	0.165	0.084	0.008	0.010	0.000	0.006	0.000	0.003	0.008
	2006	169	26	0.000	0.000	0.017	0.444	0.236	0.111	0.055	0.035	0.028	0.002	0.002	0.000	0.070
	2007	29	7	0.000	0.000	0.000	0.534	0.290	0.111	0.060	0.005	0.000	0.000	0.000	0.000	0.000
	2009	463	58	0.000	0.010	0.331	0.619	0.006	0.011	0.007	0.001	0.000	0.005	0.010	0.000	0.000
	2012	1664	121	0.002	0.126	0.126	0.058	0.336	0.212	0.097	0.008	0.004	0.009	0.004	0.004	0.014
	2013	1467	139	0.011	0.079	0.151	0.137	0.038	0.221	0.170	0.123	0.003	0.008	0.011	0.013	0.035
	2014	3325	315	0.002	0.134	0.056	0.131	0.100	0.031	0.165	0.183	0.136	0.003	0.004	0.015	0.040

Figure 1. Annual weighted and unweighted length composition of the SRHS.



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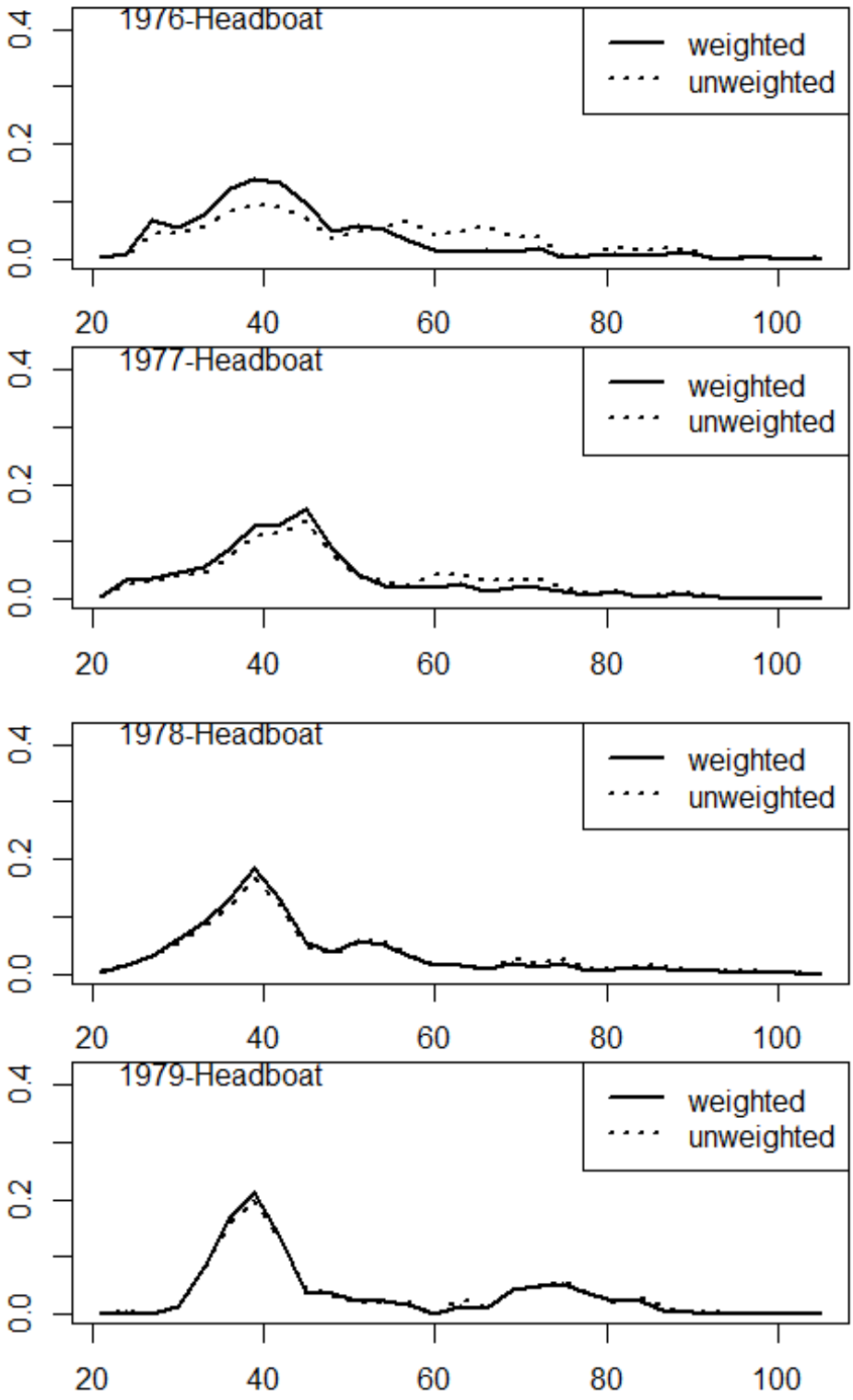

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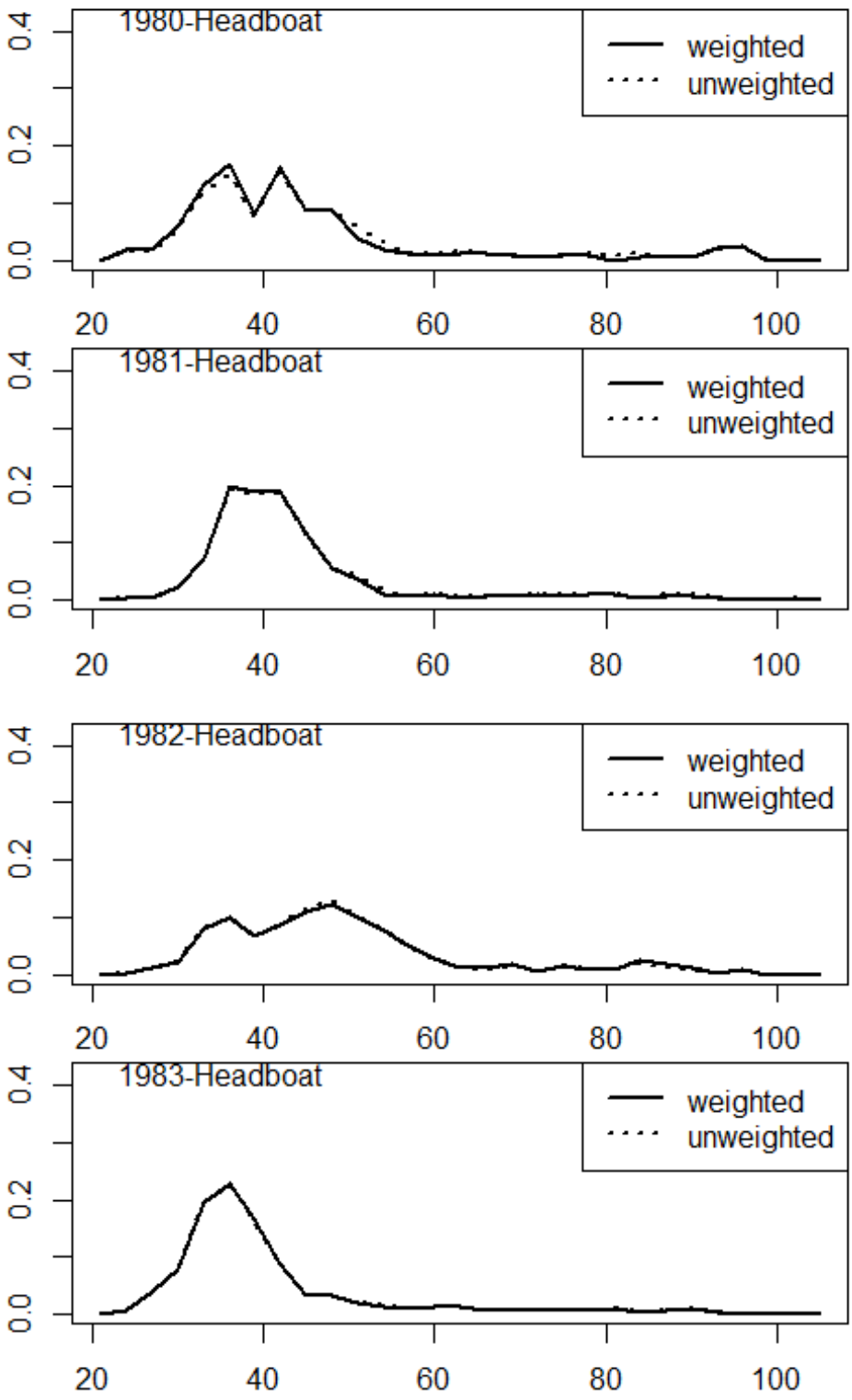

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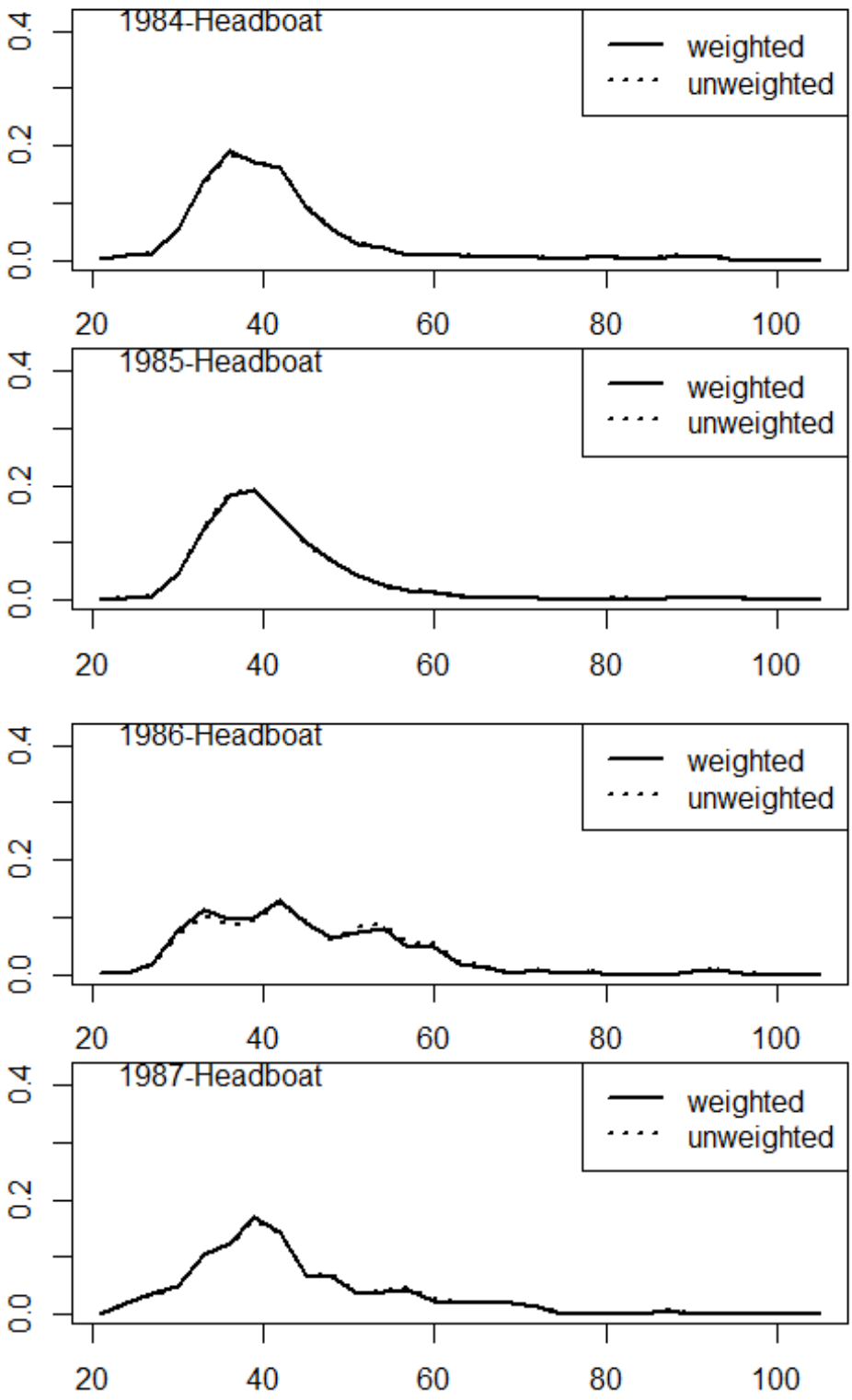

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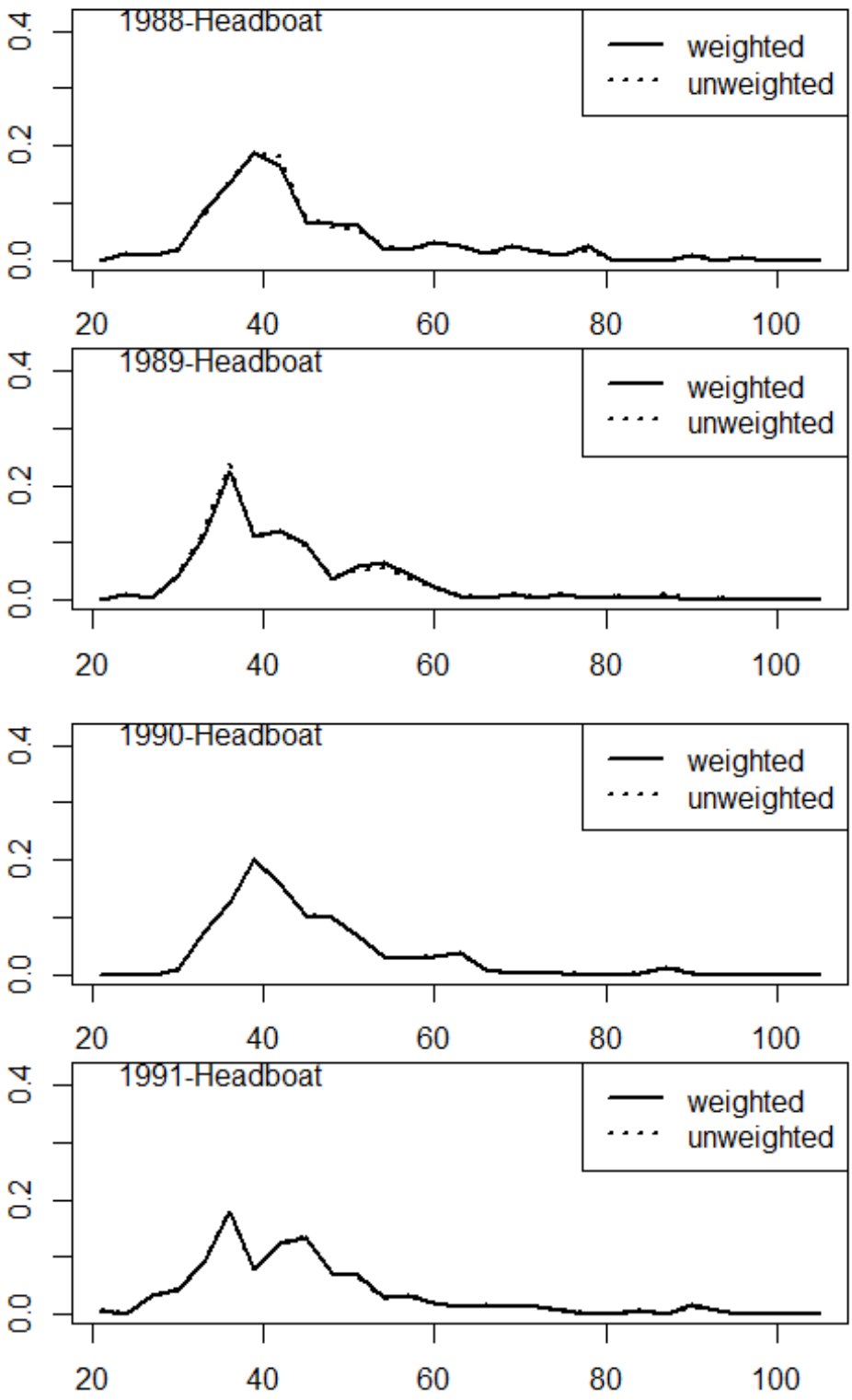

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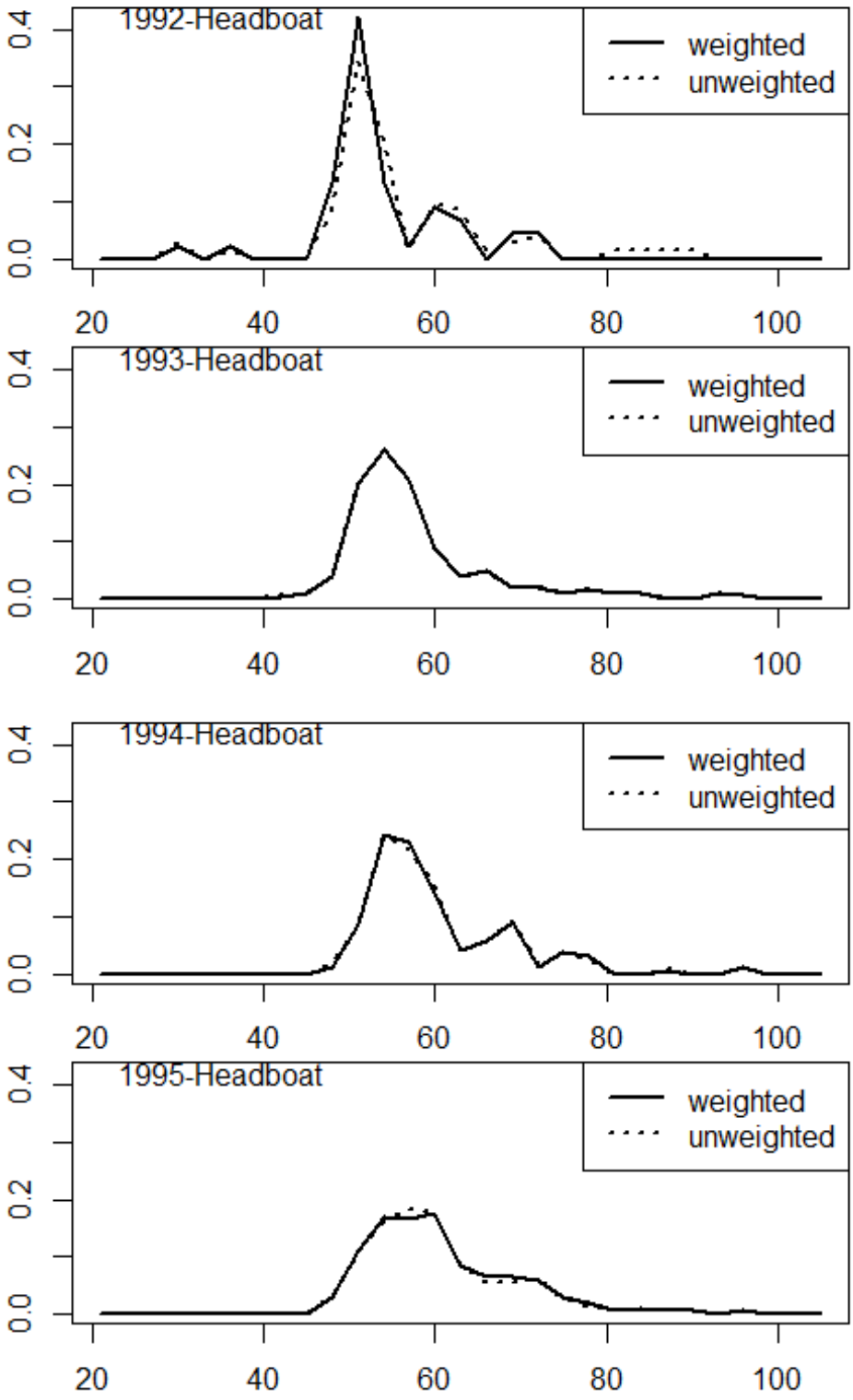

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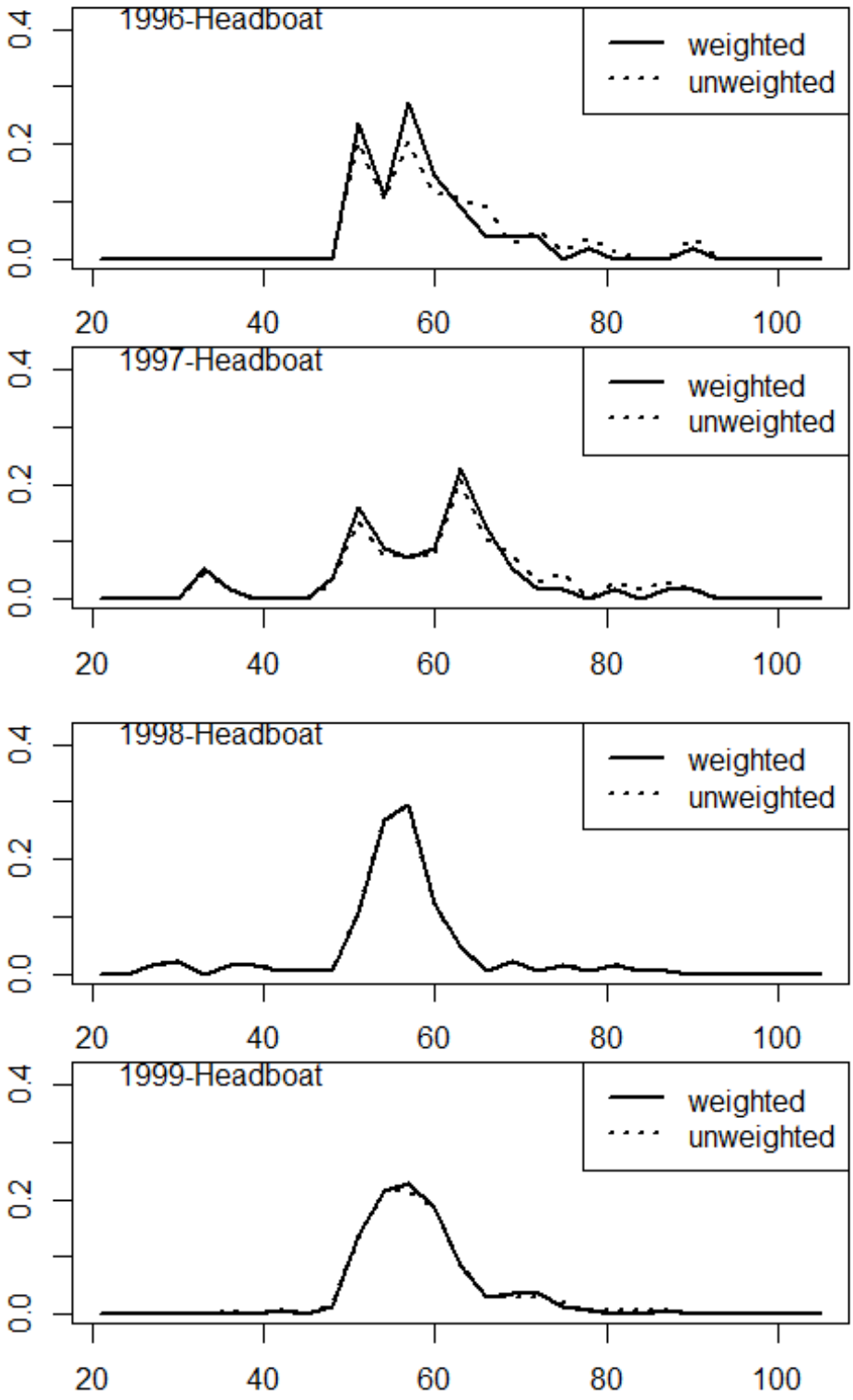

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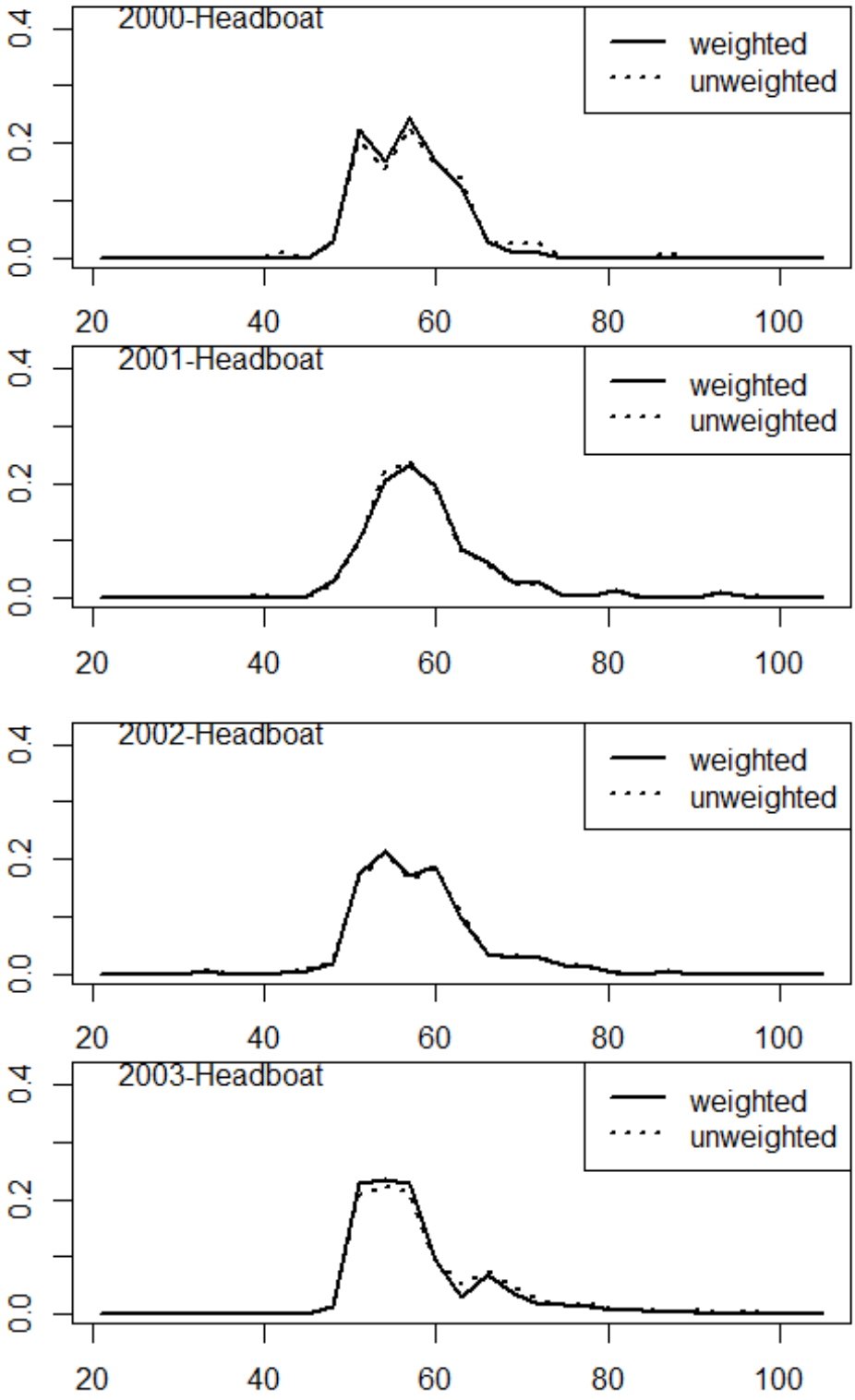
2000-Headboat
weighted
unweighted
2001-Headboat
weighted
unweighted
2002-Headboat
weighted
unweighted
2003-Headboat
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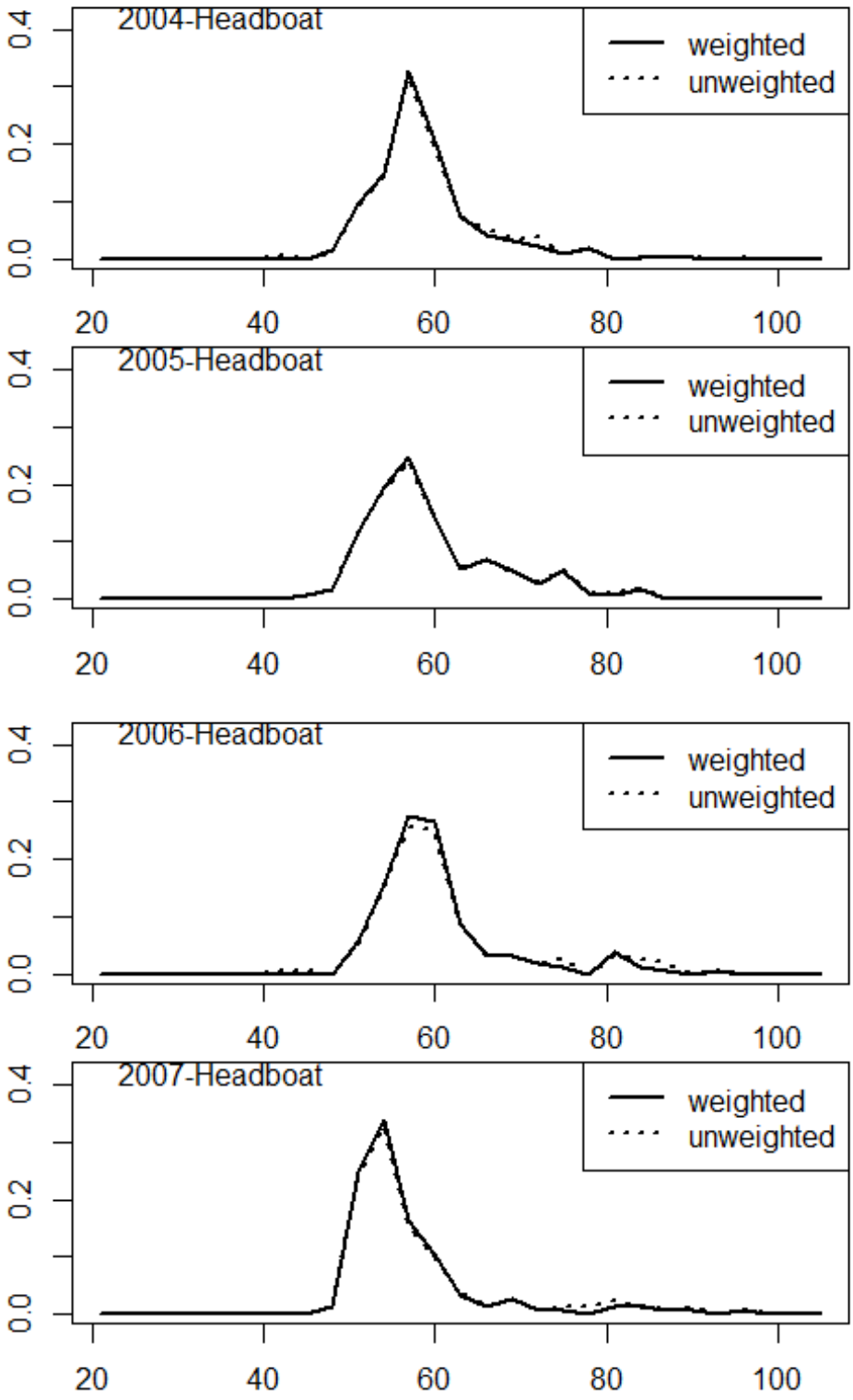
0.0
0.2
0.4
20
40
60
80
100

Figure 1. (cont.)



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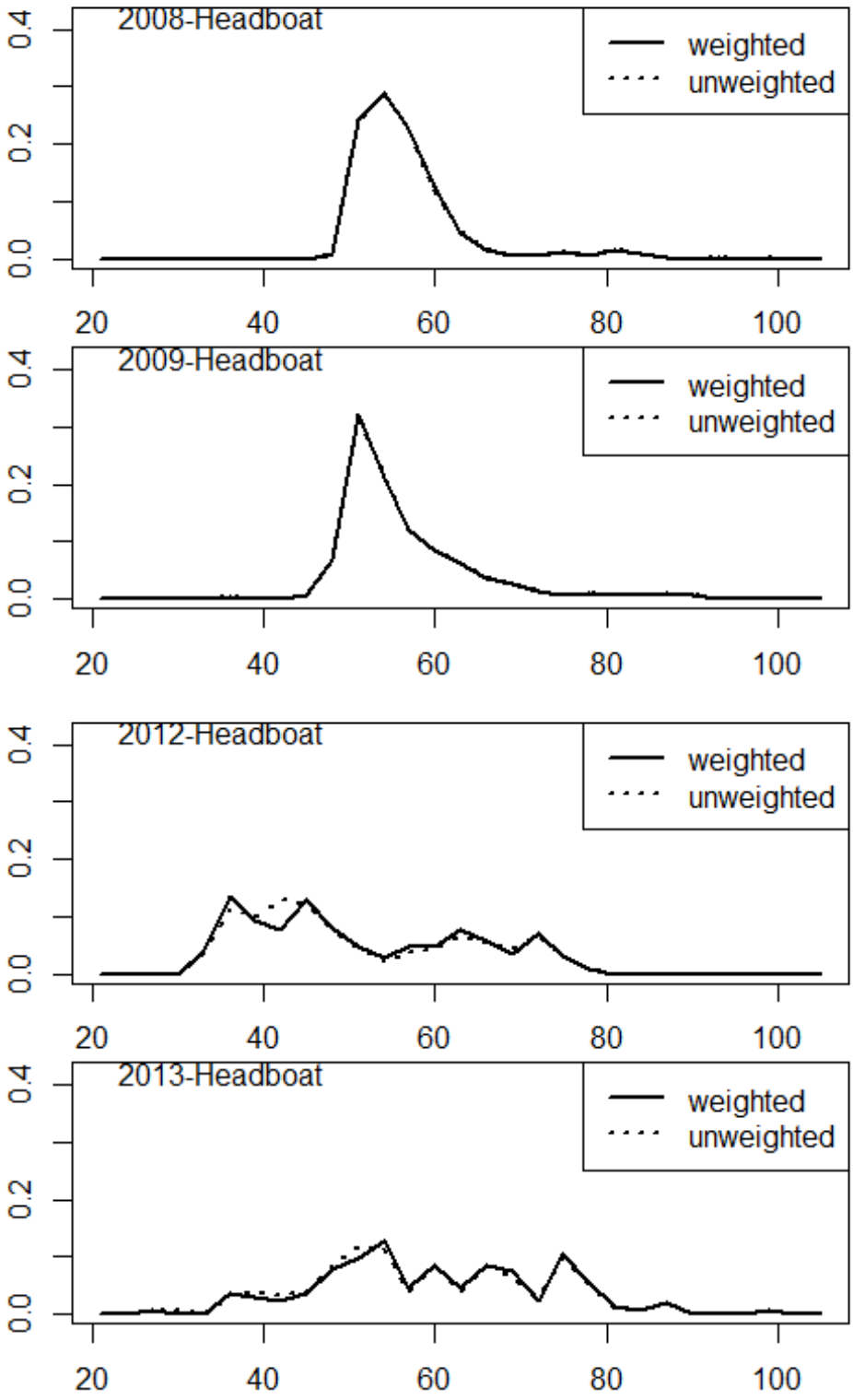

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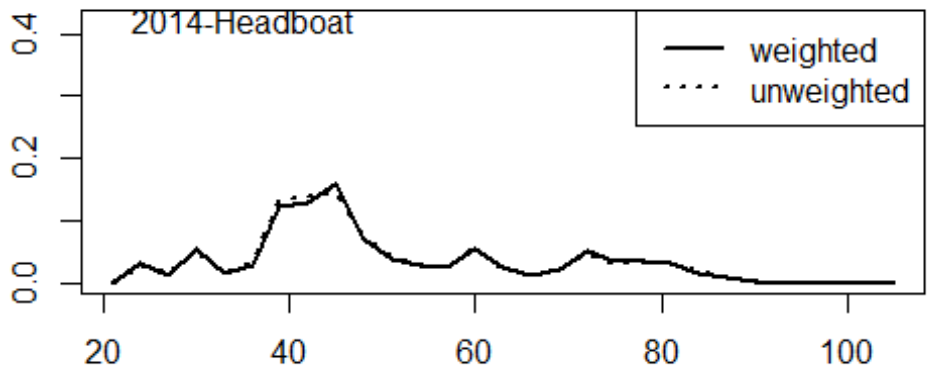
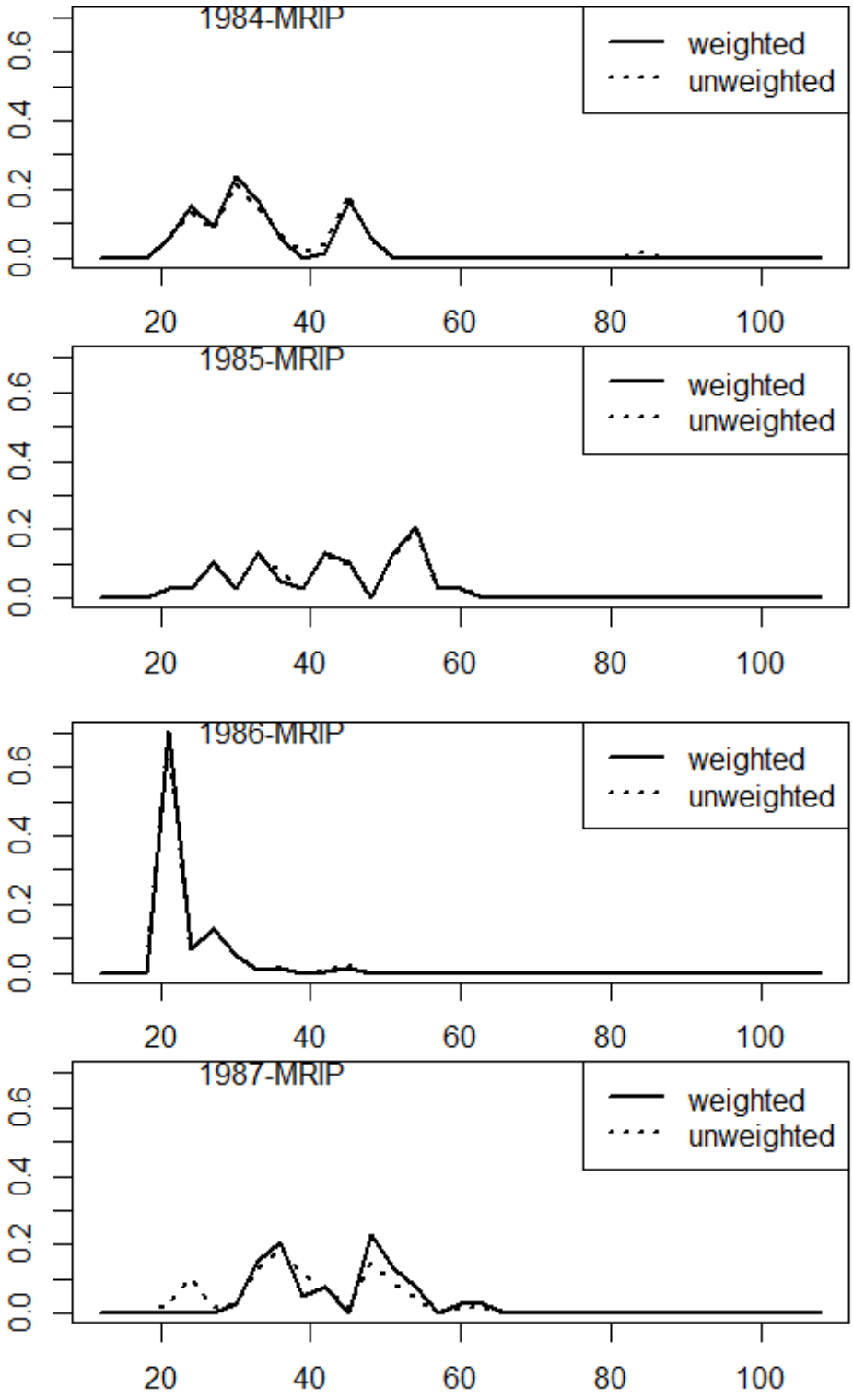


Figure 2. Annual weighted and unweighted length composition of the MRIP (CH and PR modes).



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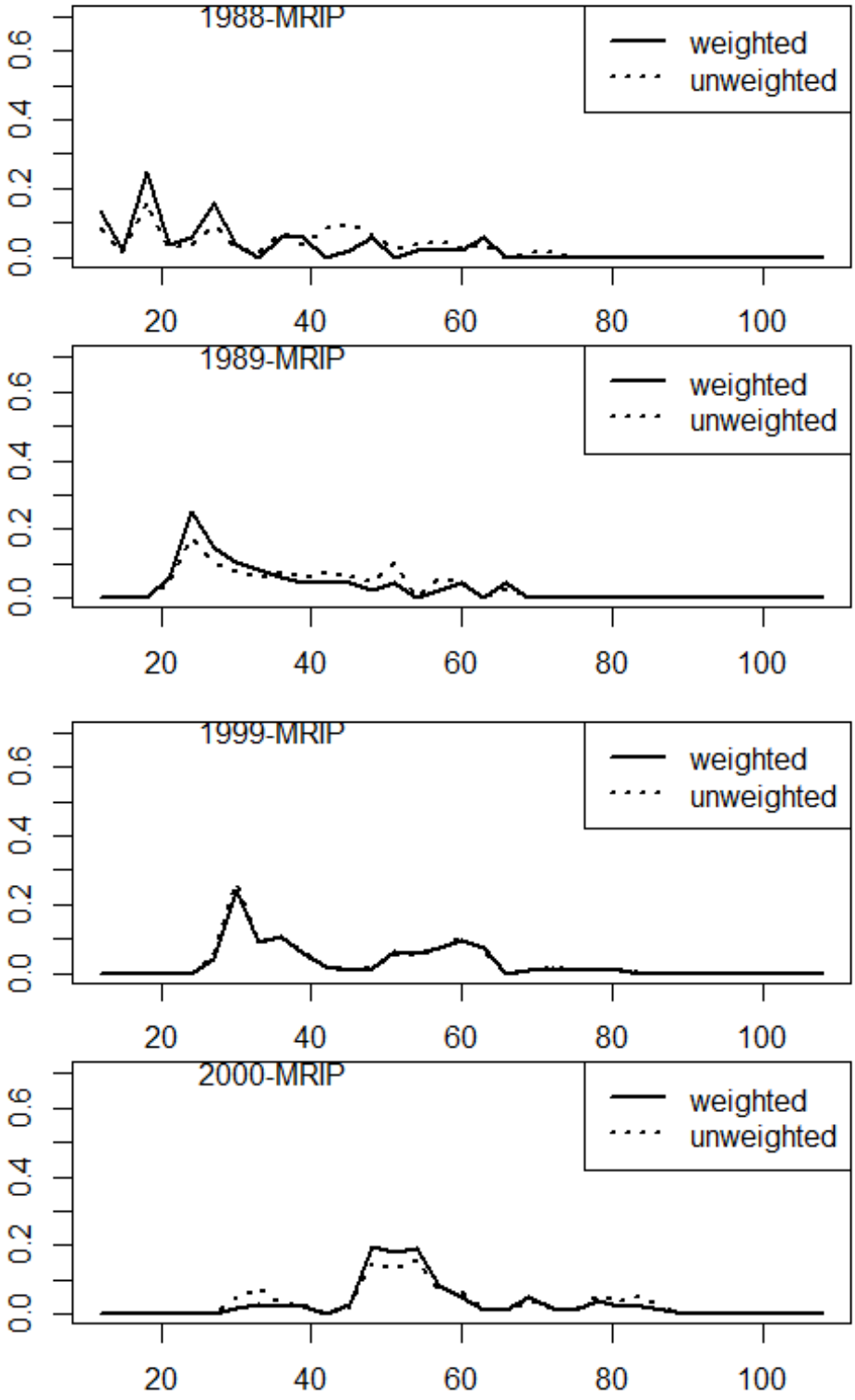

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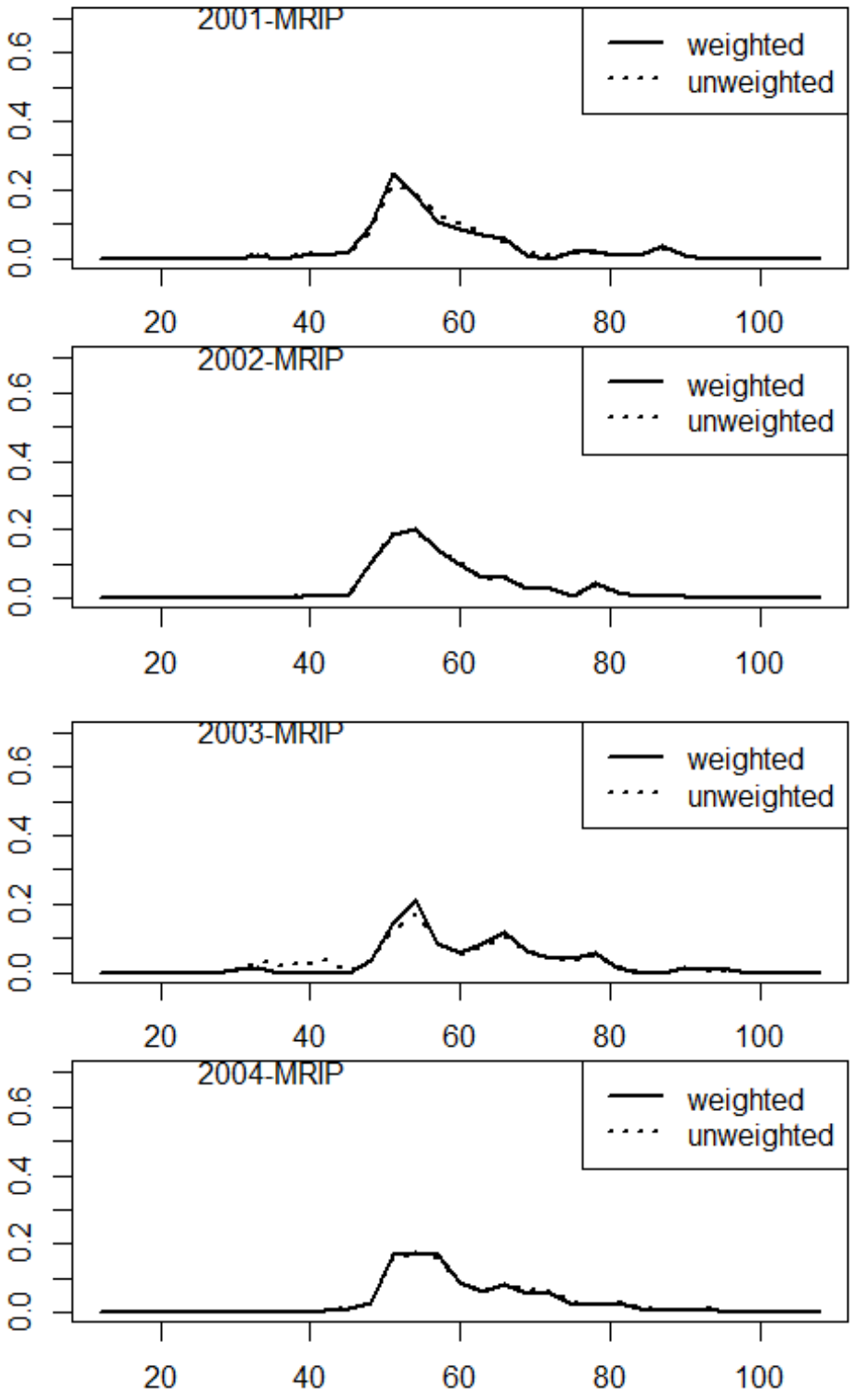

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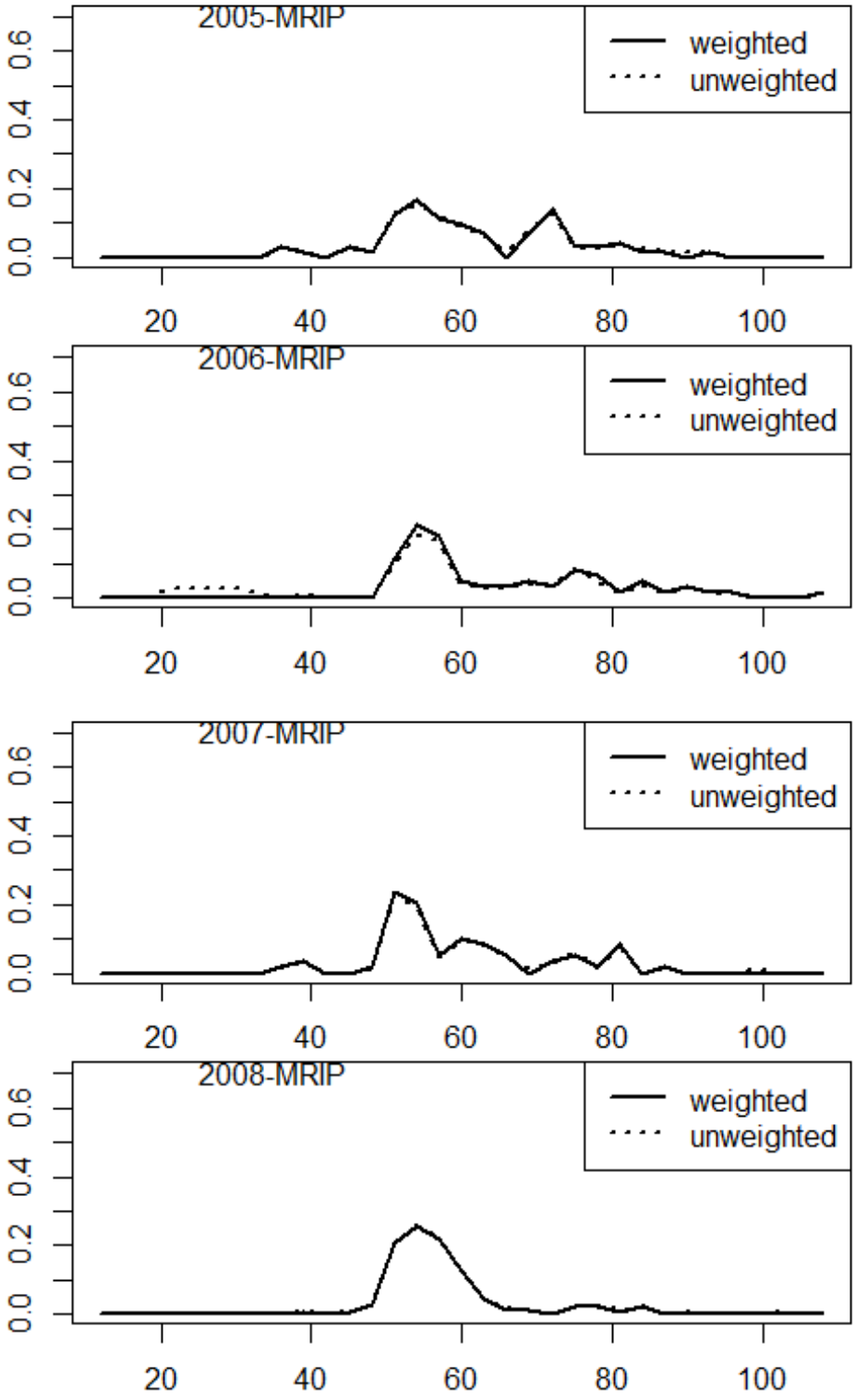

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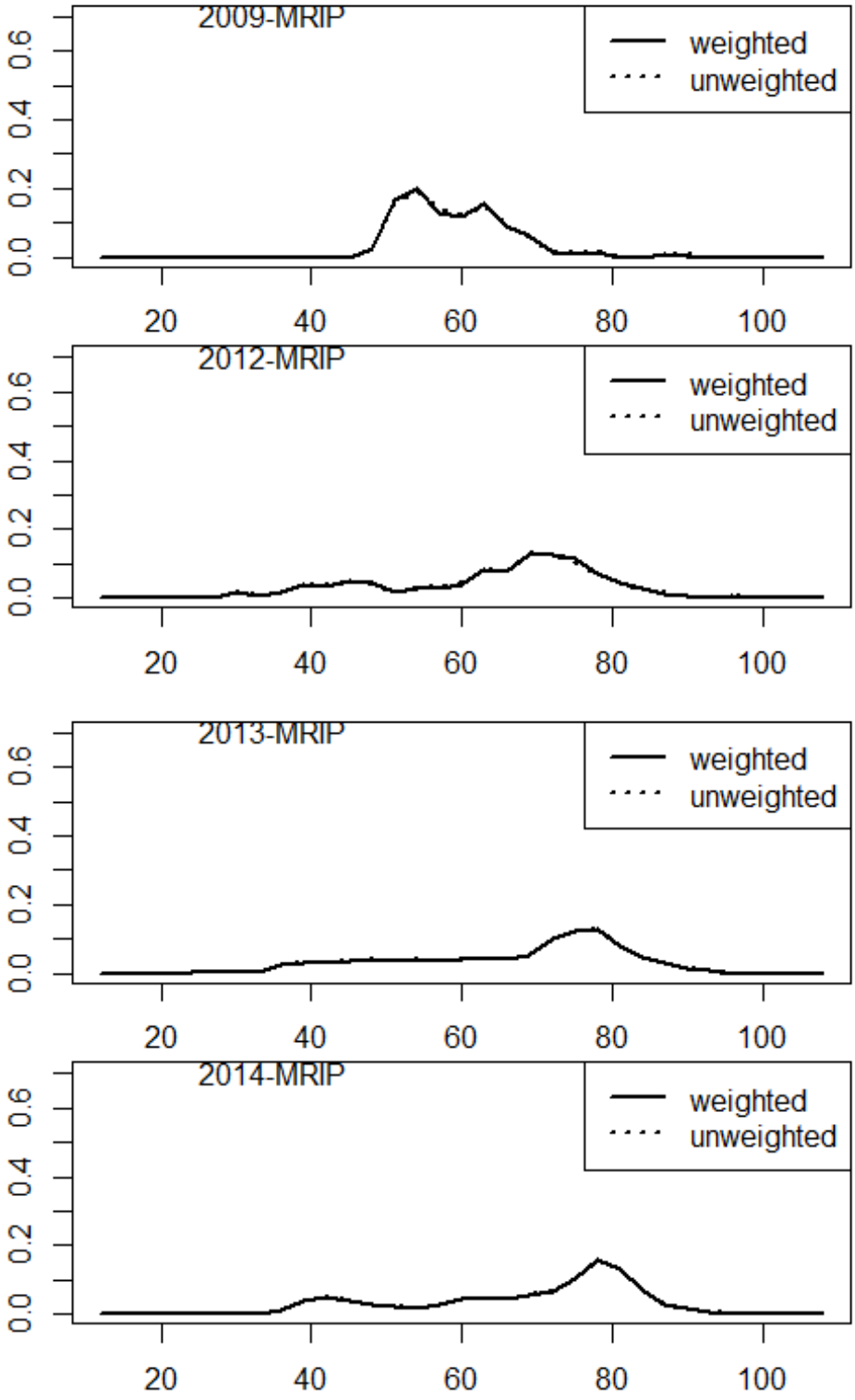
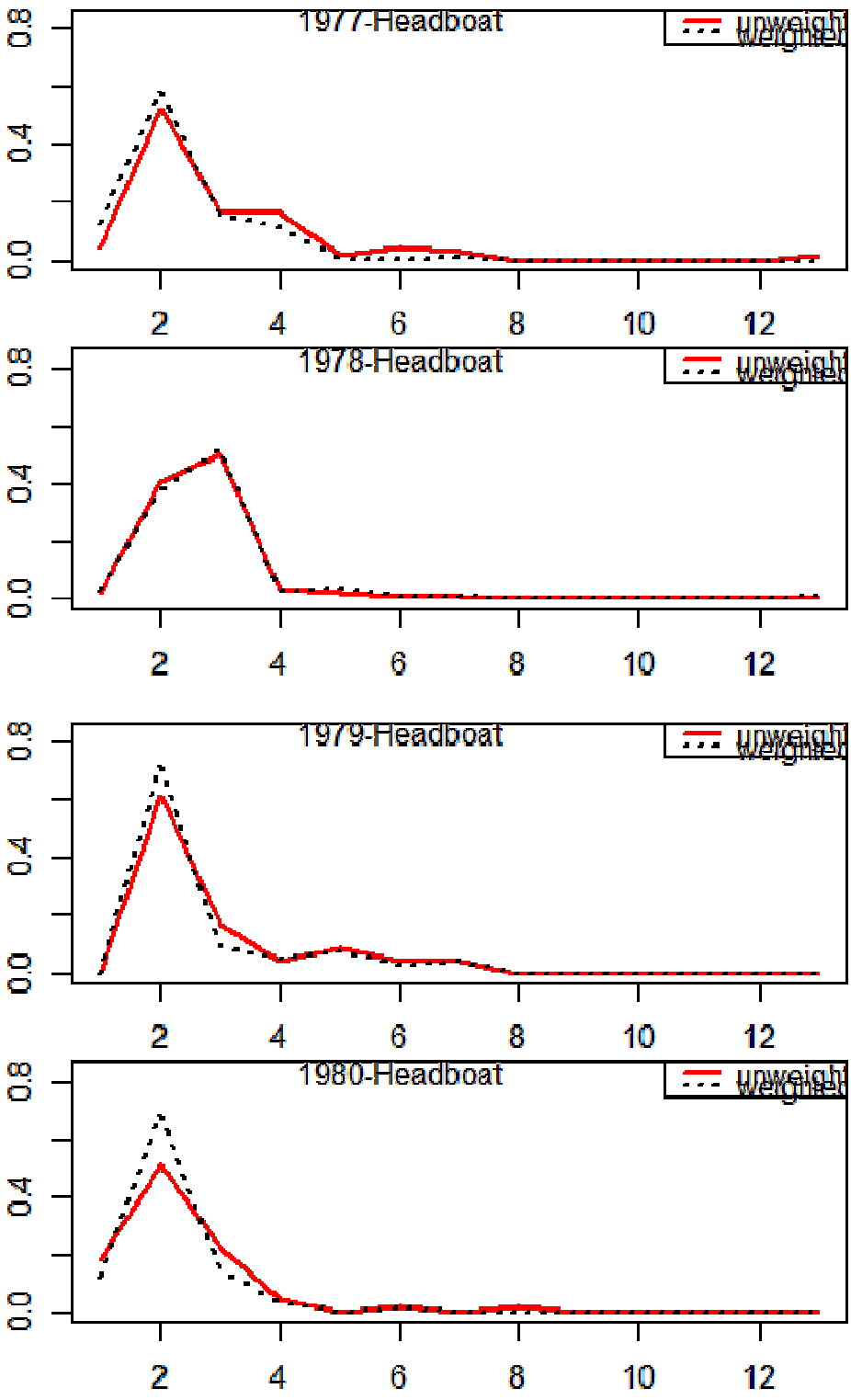


Figure 3.Annual weighted and unweighted age compositions of the SRHS.



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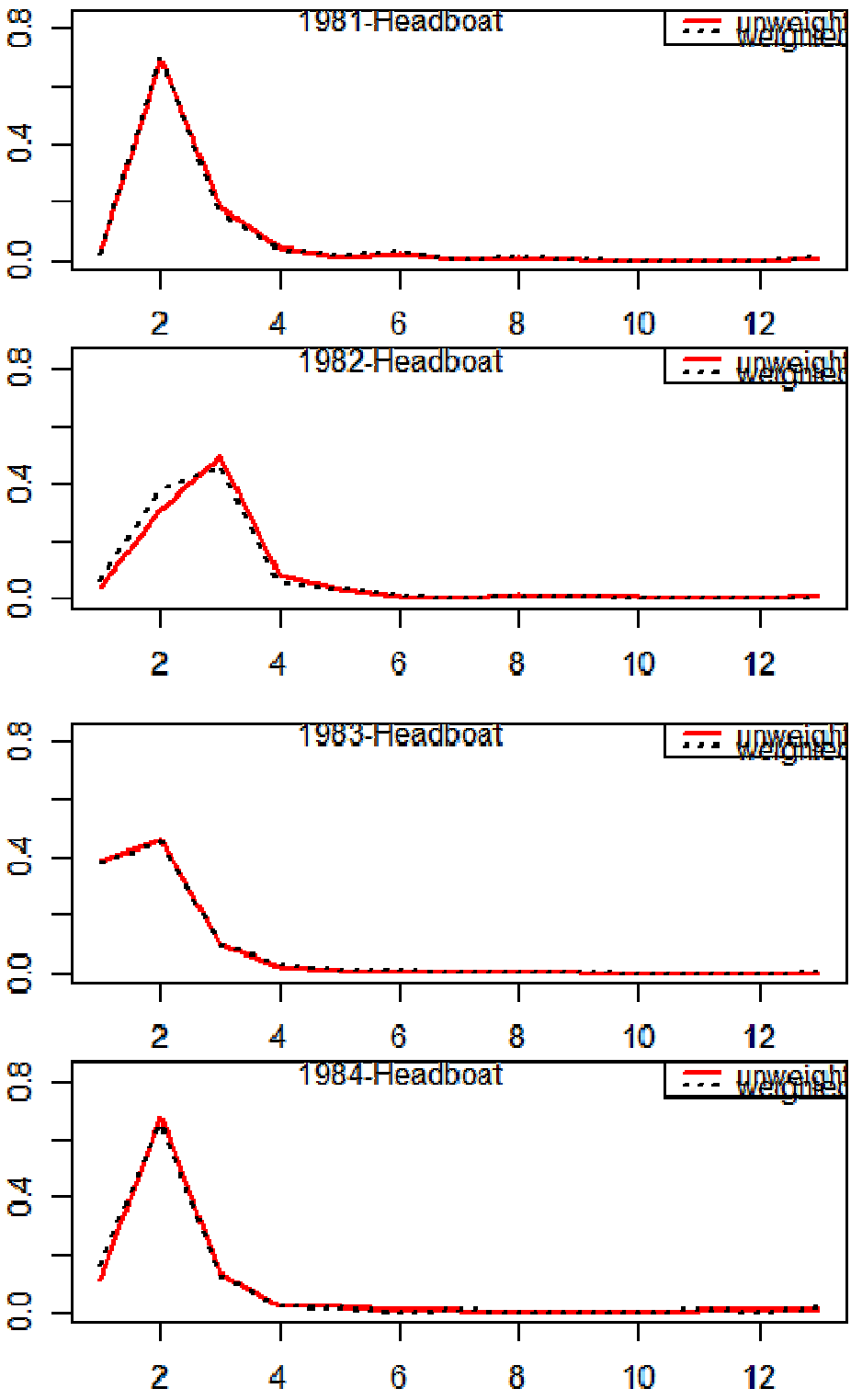

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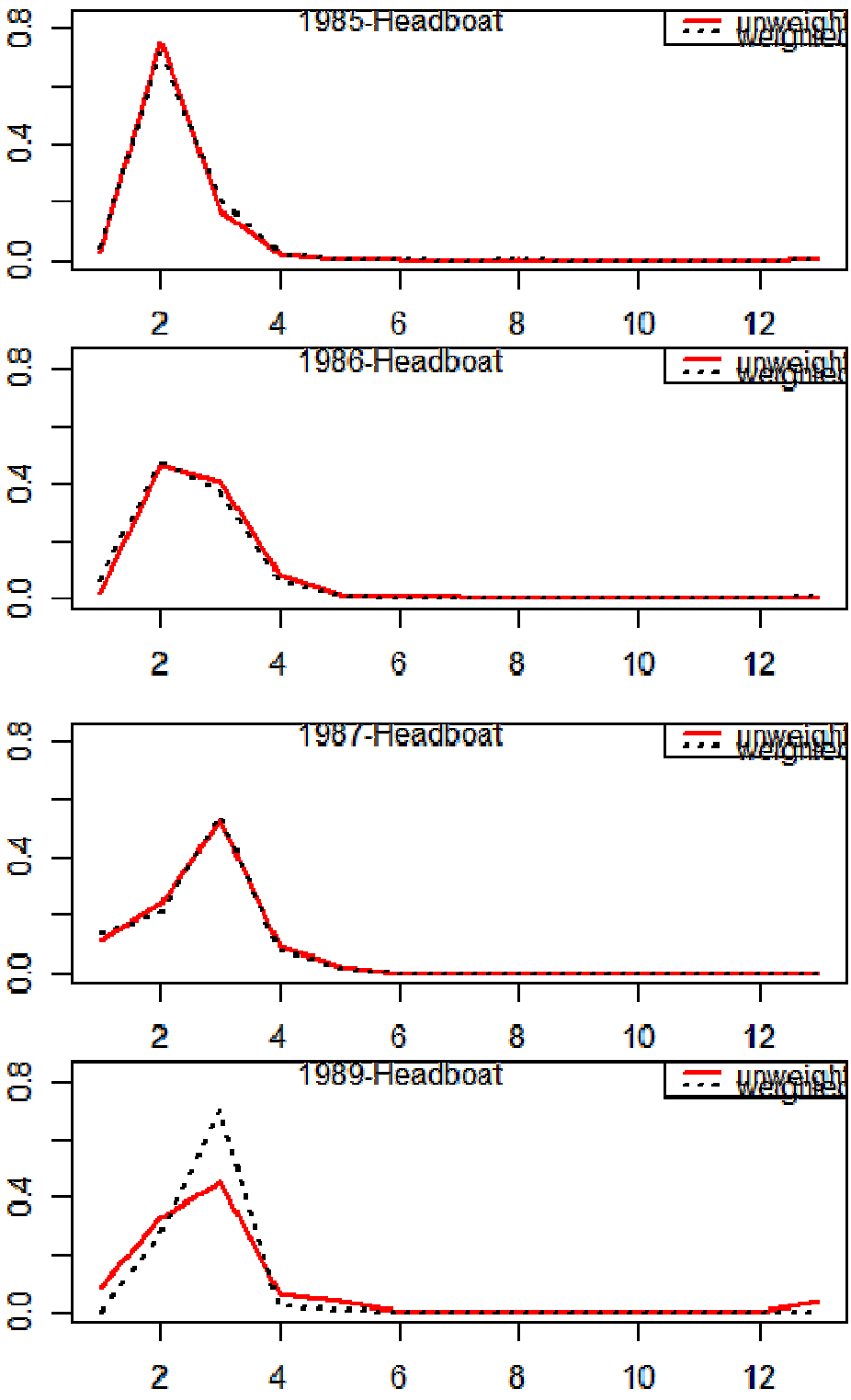

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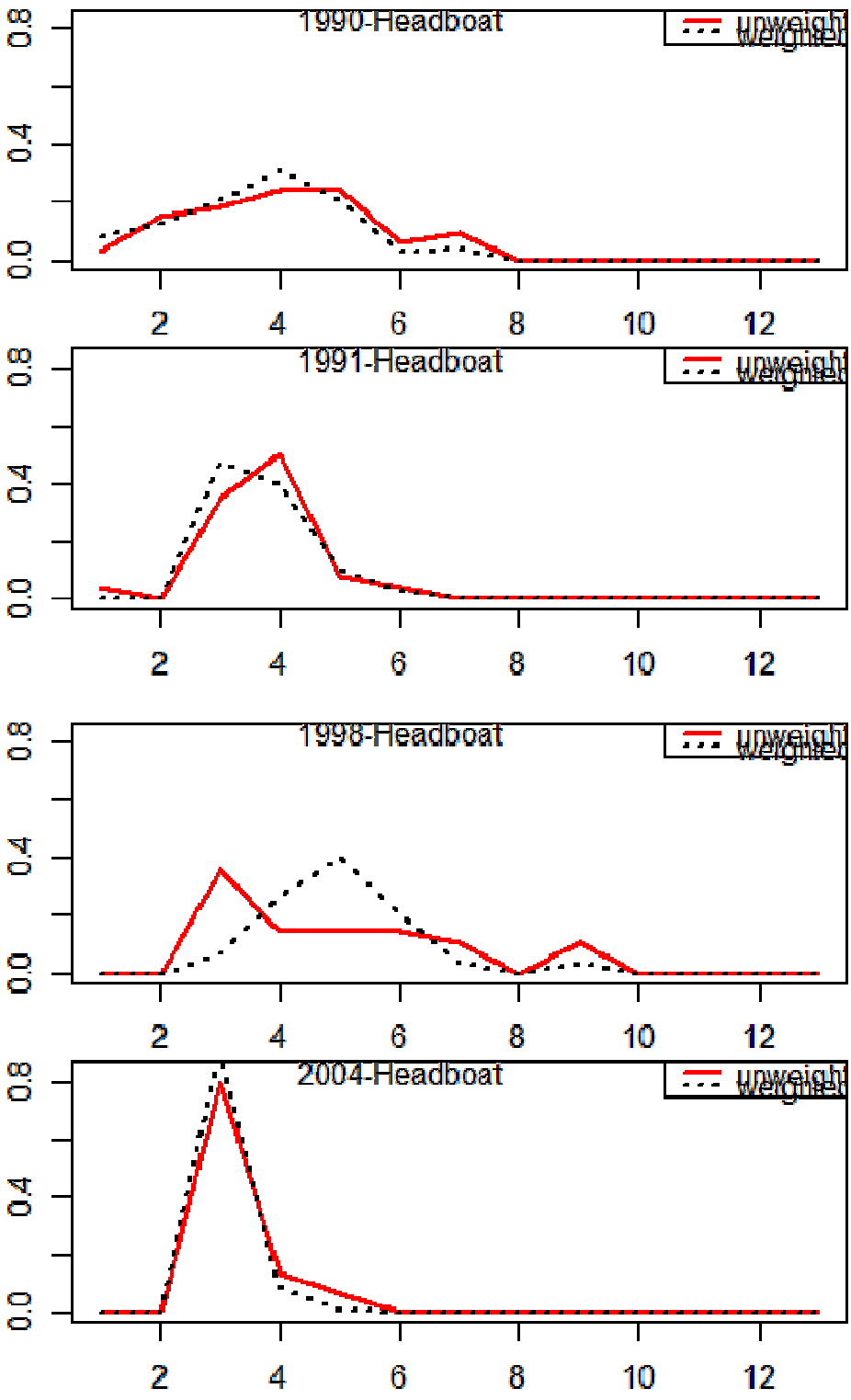

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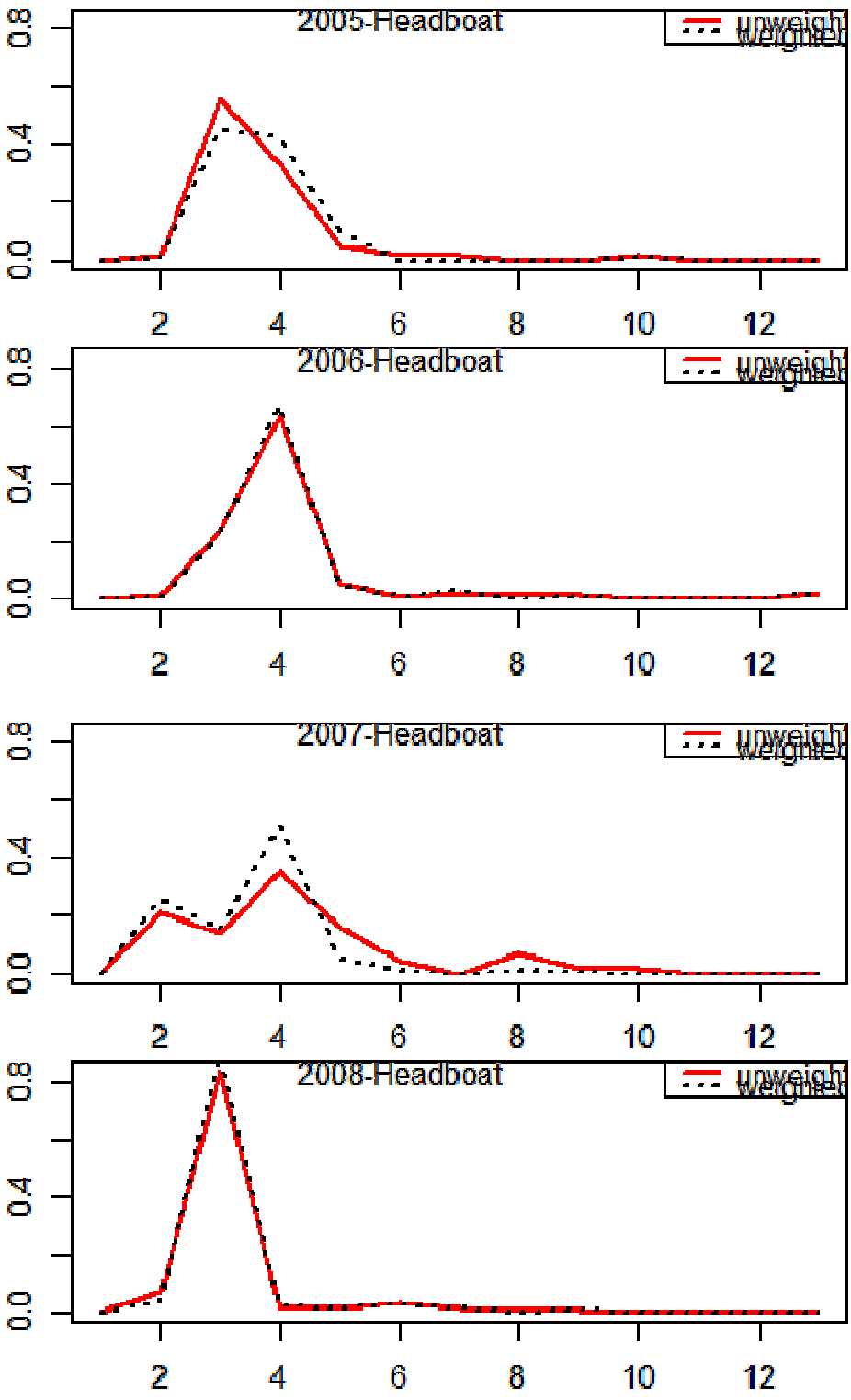


Figure 3. (cont.)

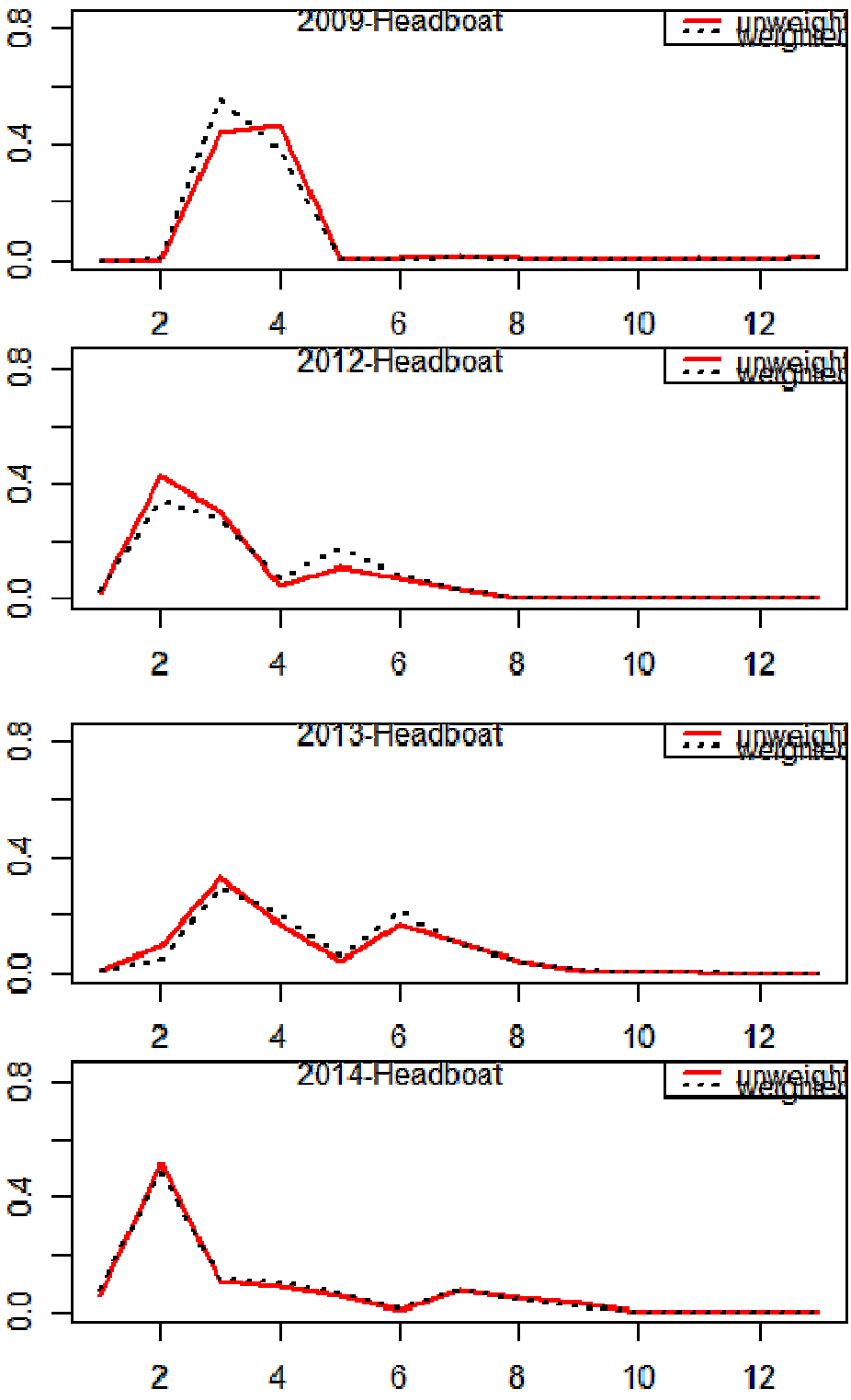


Figure 4. Annual weighted and unweighted age compositions of the MRIP (CH and PR modes).

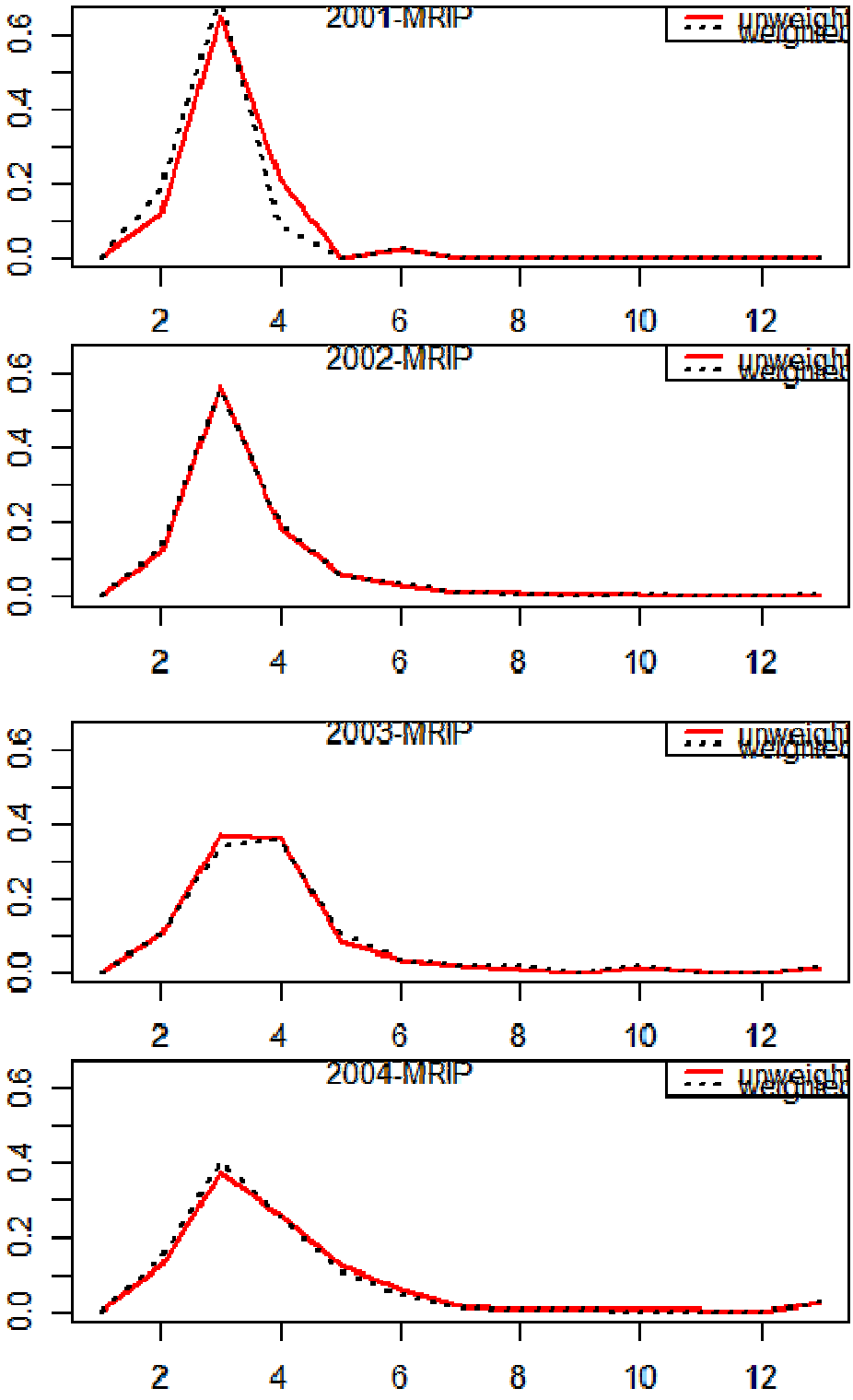


Figure 4. (cont.)

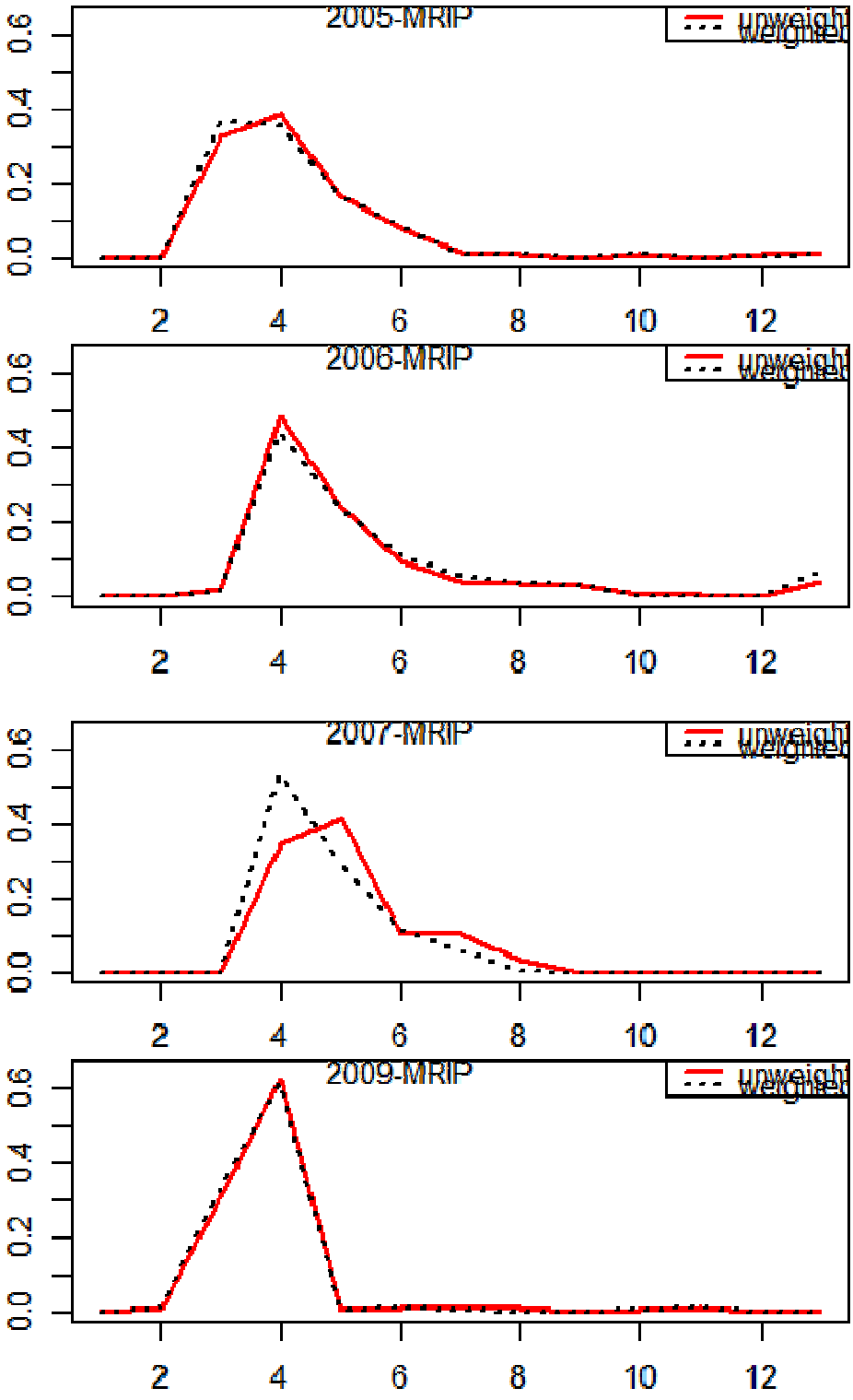
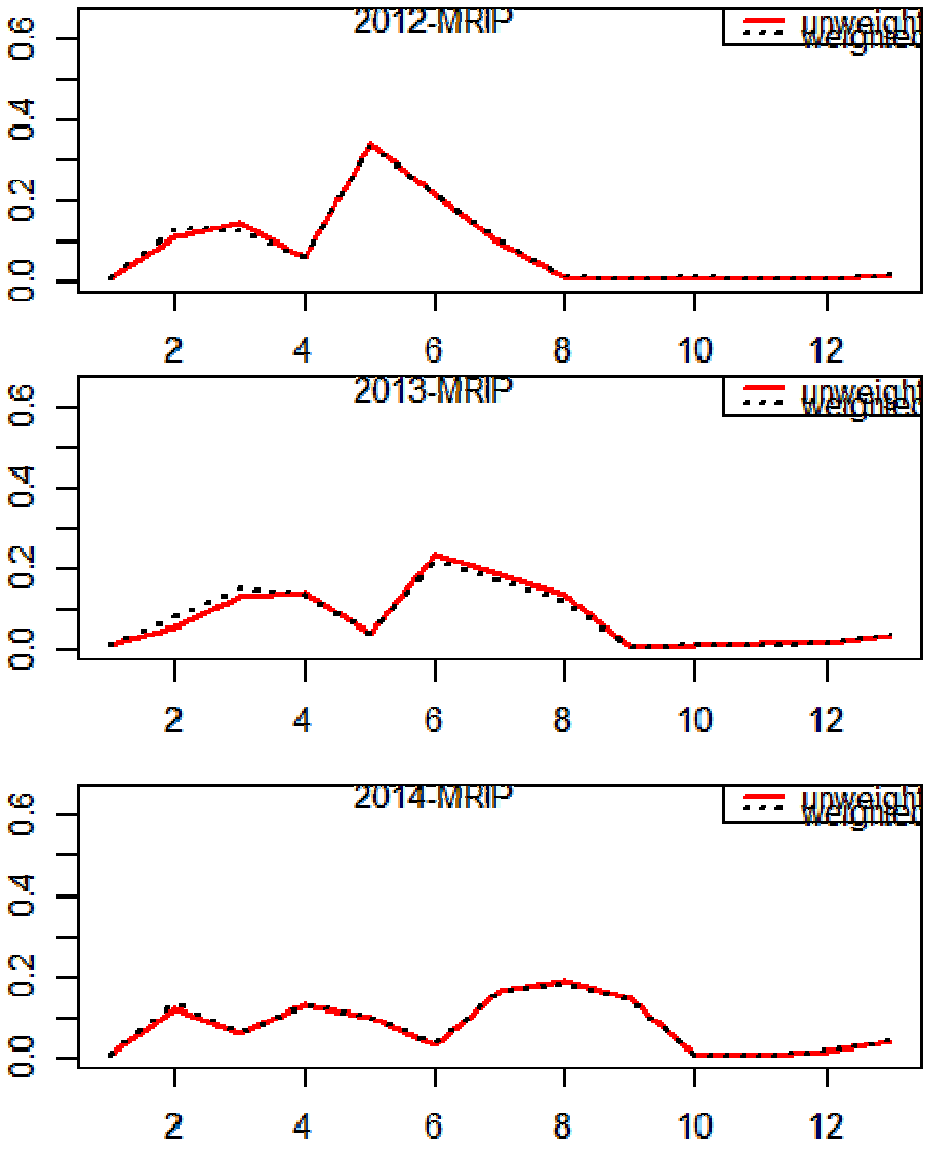


Figure 4. (cont.)



Appendixes

Appendix 1: Weighted length composition of red snapper in the SRHS in 3cm bins.

Year	Fish (n)	Trips (n)	21	24	27	30	33	36	39	42	45	48	51	54
1972	48	30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0208	0.0208	0.0000	0.0208	0.0000
1973	32	26	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0313
1974	95	52	0.0000	0.0000	0.0000	0.0000	0.0105	0.0105	0.0211	0.0211	0.0211	0.0211	0.0421	0.0947
1975	155	74	0.0000	0.0000	0.0000	0.0129	0.0258	0.0129	0.0387	0.0129	0.0645	0.1097	0.0710	0.1032
1976	497	117	0.0030	0.0090	0.0663	0.0535	0.0767	0.1235	0.1386	0.1305	0.0978	0.0487	0.0569	0.0506
1977	718	197	0.0033	0.0312	0.0361	0.0443	0.0542	0.0887	0.1285	0.1308	0.1571	0.0865	0.0434	0.0243
1978	740	208	0.0035	0.0158	0.0310	0.0589	0.0899	0.1311	0.1832	0.1302	0.0530	0.0383	0.0566	0.0507
1979	230	80	0.0000	0.0043	0.0000	0.0130	0.0826	0.1696	0.2130	0.1348	0.0348	0.0348	0.0217	0.0217
1980	234	73	0.0000	0.0171	0.0171	0.0598	0.1325	0.1667	0.0812	0.1624	0.0855	0.0855	0.0385	0.0171
1981	652	183	0.0000	0.0046	0.0046	0.0230	0.0721	0.1994	0.1902	0.1887	0.1166	0.0537	0.0353	0.0107
1982	457	154	0.0000	0.0021	0.0104	0.0230	0.0794	0.0986	0.0660	0.0856	0.1107	0.1232	0.0986	0.0777
1983	1006	253	0.0000	0.0080	0.0399	0.0787	0.1954	0.2293	0.1645	0.0867	0.0319	0.0325	0.0188	0.0146
1984	1321	314	0.0008	0.0071	0.0131	0.0546	0.1388	0.1911	0.1710	0.1622	0.0924	0.0527	0.0291	0.0206
1985	1191	298	0.0000	0.0041	0.0066	0.0448	0.1252	0.1826	0.1910	0.1465	0.1001	0.0692	0.0422	0.0261
1986	435	190	0.0025	0.0025	0.0175	0.0752	0.1128	0.0952	0.0991	0.1289	0.0902	0.0629	0.0747	0.0797
1987	306	158	0.0000	0.0209	0.0349	0.0497	0.1044	0.1239	0.1701	0.1415	0.0693	0.0660	0.0358	0.0394
1988	204	116	0.0000	0.0121	0.0099	0.0198	0.0859	0.1362	0.1880	0.1639	0.0686	0.0639	0.0600	0.0191
1989	365	157	0.0000	0.0100	0.0025	0.0426	0.1103	0.2256	0.1103	0.1209	0.0964	0.0370	0.0570	0.0651
1990	367	137	0.0000	0.0000	0.0000	0.0082	0.0738	0.1256	0.2018	0.1582	0.1037	0.1006	0.0679	0.0325
1991	152	64	0.0080	0.0000	0.0325	0.0429	0.0896	0.1788	0.0773	0.1240	0.1324	0.0731	0.0689	0.0283
1992	45	49	0.0000	0.0000	0.0000	0.0222	0.0000	0.0222	0.0000	0.0000	0.0000	0.1333	0.4222	0.1333
1993	203	96	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0048	0.0095	0.0388	0.2027	0.2606
1994	120	57	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0122	0.0878	0.2439
1995	147	74	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0301	0.1094	0.1688
1996	55	29	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2364	0.1091
1997	57	33	0.0000	0.0000	0.0000	0.0000	0.0526	0.0175	0.0000	0.0000	0.0000	0.0351	0.1579	0.0877
1998	149	78	0.0000	0.0000	0.0134	0.0201	0.0000	0.0134	0.0134	0.0067	0.0067	0.0067	0.1075	0.2686
1999	140	73	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0071	0.0000	0.0143	0.1357	0.2143
2000	107	59	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0280	0.2243	0.1682
2001	239	103	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0042	0.0000	0.0042	0.0293	0.1004	0.2050
2002	341	142	0.0000	0.0000	0.0000	0.0000	0.0059	0.0000	0.0000	0.0029	0.0059	0.0176	0.1730	0.2141
2003	329	145	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0093	0.1579	0.1931
2004	290	102	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0034	0.0000	0.0138	0.0966	0.1483
2005	189	92	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0053	0.0159	0.1164	0.1958
2006	159	91	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0566	0.1572
2007	153	55	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0131	0.2484	0.3399
2008	435	81	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0069	0.2414	0.2897
2009	738	166	0.0000	0.0000	0.0000	0.0014	0.0000	0.0027	0.0000	0.0014	0.0068	0.0691	0.3211	0.2100
2012	132	16	0.0000	0.0000	0.0000	0.0000	0.0395	0.1338	0.0920	0.0761	0.1279	0.0790	0.0489	0.0283
2013	177	31	0.0000	0.0000	0.0067	0.0013	0.0000	0.0347	0.0306	0.0239	0.0360	0.0787	0.0972	0.1284
2014	291	42	0.0000	0.0323	0.0122	0.0526	0.0162	0.0284	0.1216	0.1297	0.1577	0.0689	0.0365	0.0283

Appendix 1: (continued).

Year	57	60	63	66	69	72	75	78	81	84	87	90	93	96
1972	0.0000	0.0000	0.0000	0.0000	0.0208	0.1042	0.1458	0.1042	0.1458	0.1458	0.1042	0.0625	0.0625	0.0208
1973	0.0000	0.0000	0.0000	0.0313	0.0000	0.0000	0.0313	0.1563	0.1563	0.1563	0.1563	0.1563	0.0938	0.0313
1974	0.1368	0.1053	0.0737	0.0947	0.0211	0.0211	0.0211	0.0000	0.0421	0.0737	0.0842	0.0421	0.0316	0.0000
1975	0.1161	0.1161	0.0516	0.0516	0.0194	0.0194	0.0129	0.0065	0.0323	0.0323	0.0452	0.0129	0.0194	0.0065
1976	0.0302	0.0146	0.0108	0.0151	0.0132	0.0188	0.0035	0.0039	0.0071	0.0062	0.0092	0.0087	0.0000	0.0030
1977	0.0199	0.0188	0.0268	0.0140	0.0204	0.0207	0.0137	0.0060	0.0122	0.0024	0.0073	0.0068	0.0024	0.0000
1978	0.0311	0.0133	0.0148	0.0069	0.0189	0.0105	0.0193	0.0065	0.0069	0.0090	0.0085	0.0045	0.0040	0.0025
1979	0.0174	0.0000	0.0130	0.0087	0.0435	0.0478	0.0522	0.0348	0.0217	0.0217	0.0043	0.0043	0.0000	0.0000
1980	0.0128	0.0085	0.0128	0.0128	0.0085	0.0043	0.0085	0.0085	0.0000	0.0043	0.0043	0.0043	0.0214	0.0256
1981	0.0061	0.0107	0.0046	0.0061	0.0077	0.0107	0.0077	0.0107	0.0107	0.0031	0.0077	0.0077	0.0031	0.0015
1982	0.0497	0.0289	0.0130	0.0109	0.0184	0.0042	0.0146	0.0084	0.0096	0.0251	0.0176	0.0121	0.0034	0.0088
1983	0.0088	0.0118	0.0118	0.0079	0.0078	0.0068	0.0059	0.0078	0.0088	0.0039	0.0057	0.0096	0.0020	0.0000
1984	0.0082	0.0074	0.0087	0.0043	0.0047	0.0045	0.0008	0.0037	0.0047	0.0013	0.0066	0.0058	0.0058	0.0000
1985	0.0170	0.0141	0.0069	0.0016	0.0026	0.0019	0.0008	0.0010	0.0035	0.0010	0.0035	0.0024	0.0018	0.0018
1986	0.0476	0.0490	0.0184	0.0120	0.0025	0.0075	0.0025	0.0050	0.0000	0.0000	0.0000	0.0050	0.0078	0.0014
1987	0.0436	0.0239	0.0196	0.0183	0.0190	0.0126	0.0000	0.0000	0.0000	0.0000	0.0070	0.0000	0.0000	0.0000
1988	0.0198	0.0297	0.0236	0.0121	0.0259	0.0137	0.0099	0.0243	0.0000	0.0000	0.0000	0.0076	0.0000	0.0061
1989	0.0454	0.0241	0.0075	0.0025	0.0094	0.0025	0.0110	0.0025	0.0050	0.0025	0.0075	0.0000	0.0025	0.0000
1990	0.0271	0.0299	0.0380	0.0081	0.0027	0.0027	0.0027	0.0000	0.0000	0.0027	0.0109	0.0027	0.0000	0.0000
1991	0.0325	0.0203	0.0122	0.0161	0.0142	0.0122	0.0080	0.0000	0.0000	0.0061	0.0000	0.0161	0.0061	0.0000
1992	0.0222	0.0889	0.0667	0.0000	0.0444	0.0444	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1993	0.2075	0.0877	0.0394	0.0489	0.0203	0.0191	0.0095	0.0149	0.0101	0.0107	0.0000	0.0000	0.0101	0.0054
1994	0.2299	0.1429	0.0395	0.0561	0.0895	0.0122	0.0378	0.0316	0.0000	0.0000	0.0061	0.0000	0.0000	0.0105
1995	0.1653	0.1743	0.0848	0.0641	0.0641	0.0598	0.0297	0.0195	0.0051	0.0098	0.0051	0.0051	0.0000	0.0051
1996	0.2727	0.1455	0.0909	0.0364	0.0364	0.0364	0.0000	0.0182	0.0000	0.0000	0.0000	0.0182	0.0000	0.0000
1997	0.0702	0.0877	0.2281	0.1228	0.0526	0.0175	0.0175	0.0000	0.0175	0.0000	0.0175	0.0175	0.0000	0.0000
1998	0.2953	0.1209	0.0470	0.0067	0.0201	0.0067	0.0134	0.0067	0.0134	0.0067	0.0067	0.0000	0.0000	0.0000
1999	0.2286	0.1857	0.0857	0.0286	0.0357	0.0357	0.0143	0.0071	0.0000	0.0000	0.0071	0.0000	0.0000	0.0000
2000	0.2430	0.1682	0.1215	0.0280	0.0093	0.0093	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2001	0.2301	0.1967	0.0837	0.0628	0.0251	0.0251	0.0042	0.0042	0.0126	0.0000	0.0000	0.0000	0.0084	0.0042
2002	0.1701	0.1877	0.0968	0.0352	0.0264	0.0293	0.0147	0.0117	0.0029	0.0000	0.0059	0.0000	0.0000	0.0000
2003	0.1783	0.0956	0.1024	0.0974	0.0765	0.0320	0.0116	0.0195	0.0046	0.0046	0.0023	0.0125	0.0000	0.0023
2004	0.3276	0.2069	0.0724	0.0414	0.0310	0.0207	0.0069	0.0172	0.0000	0.0034	0.0034	0.0034	0.0000	0.0034
2005	0.2487	0.1429	0.0529	0.0688	0.0476	0.0265	0.0476	0.0106	0.0053	0.0159	0.0000	0.0000	0.0000	0.0000
2006	0.2767	0.2642	0.0881	0.0314	0.0314	0.0189	0.0126	0.0000	0.0377	0.0126	0.0063	0.0000	0.0063	0.0000
2007	0.1634	0.1046	0.0327	0.0131	0.0261	0.0065	0.0065	0.0000	0.0131	0.0131	0.0065	0.0065	0.0000	0.0065
2008	0.2253	0.1241	0.0437	0.0161	0.0046	0.0046	0.0115	0.0046	0.0138	0.0069	0.0023	0.0000	0.0023	0.0000
2009	0.1220	0.0840	0.0610	0.0366	0.0271	0.0136	0.0054	0.0095	0.0068	0.0068	0.0081	0.0054	0.0014	0.0000
2012	0.0472	0.0489	0.0772	0.0584	0.0336	0.0696	0.0301	0.0094	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	0.0468	0.0841	0.0468	0.0841	0.0736	0.0226	0.1029	0.0548	0.0134	0.0067	0.0201	0.0000	0.0000	0.0000
2014	0.0243	0.0547	0.0242	0.0121	0.0222	0.0506	0.0344	0.0344	0.0324	0.0162	0.0081	0.0020	0.0000	0.0000

Appendix 1: (continued).

Year	99	102	105
1972	0.0208	0.0000	0.0000
1973	0.0000	0.0000	0.0000
1974	0.0105	0.0000	0.0000
1975	0.0000	0.0065	0.0000
1976	0.0004	0.0000	0.0004
1977	0.0000	0.0000	0.0000
1978	0.0005	0.0005	0.0000
1979	0.0000	0.0000	0.0000
1980	0.0000	0.0000	0.0000
1981	0.0000	0.0031	0.0000
1982	0.0000	0.0000	0.0000
1983	0.0010	0.0000	0.0000
1984	0.0000	0.0000	0.0000
1985	0.0000	0.0010	0.0008
1986	0.0000	0.0000	0.0000
1987	0.0000	0.0000	0.0000
1988	0.0000	0.0000	0.0000
1989	0.0000	0.0000	0.0000
1990	0.0000	0.0000	0.0000
1991	0.0000	0.0000	0.0000
1992	0.0000	0.0000	0.0000
1993	0.0000	0.0000	0.0000
1994	0.0000	0.0000	0.0000
1995	0.0000	0.0000	0.0000
1996	0.0000	0.0000	0.0000
1997	0.0000	0.0000	0.0000
1998	0.0000	0.0000	0.0000
1999	0.0000	0.0000	0.0000
2000	0.0000	0.0000	0.0000
2001	0.0000	0.0000	0.0000
2002	0.0000	0.0000	0.0000
2003	0.0000	0.0000	0.0000
2004	0.0000	0.0000	0.0000
2005	0.0000	0.0000	0.0000
2006	0.0000	0.0000	0.0000
2007	0.0000	0.0000	0.0000
2008	0.0023	0.0000	0.0000
2009	0.0000	0.0000	0.0000
2012	0.0000	0.0000	0.0000
2013	0.0067	0.0000	0.0000
2014	0.0000	0.0000	0.0000

Appendix 2: Weighted length composition of red snapper in the MRIP private and charter modes in 3cm bins.

Year	Fish (n)	Trips (n)	12	15	18	21	24	27	30	33	36	39
1984	67	12	0.0000	0.0000	0.0000	0.0597	0.1493	0.0896	0.2388	0.1642	0.0597	0.0000
1985	39	15	0.0000	0.0000	0.0000	0.0256	0.0256	0.1026	0.0256	0.1282	0.0513	0.0256
1986	225	82	0.0000	0.0000	0.0000	0.7067	0.0711	0.1289	0.0533	0.0089	0.0133	0.0000
1987	69	16	0.0000	0.0000	0.0000	0.0321	0.1124	0.0161	0.0293	0.1279	0.1866	0.1229
1988	82	27	0.1093	0.0156	0.2030	0.0312	0.0468	0.1249	0.0312	0.0063	0.0657	0.0468
1989	48	15	0.0000	0.0000	0.0000	0.0625	0.2500	0.1458	0.1042	0.0833	0.0625	0.0417
1999	161	39	0.0000	0.0000	0.0000	0.0000	0.0000	0.0405	0.2453	0.0913	0.1076	0.0568
2000	108	39	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0168	0.0269	0.0195	0.0195
2001	105	47	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0095	0.0000	0.0095
2002	248	56	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0050
2003	173	54	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0044	0.0584	0.0372	0.0496
2004	149	55	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	72	30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0278	0.0139
2006	62	24	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2007	59	24	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0169	0.0339
2008	182	58	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0055
2009	210	50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	494	180	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018	0.0165	0.0037	0.0165	0.0367
2013	647	256	0.0000	0.0000	0.0000	0.0000	0.0015	0.0015	0.0046	0.0046	0.0263	0.0309
2014	1917	693	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016	0.0026	0.0104	0.0386

Appendix 2: (continued).

Year	42	45	48	51	54	57	60	63	66	69	72	75
1984	0.0149	0.1642	0.0597	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1985	0.1282	0.1026	0.0000	0.1282	0.2051	0.0256	0.0256	0.0000	0.0000	0.0000	0.0000	0.0000
1986	0.0044	0.0133	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1987	0.0720	0.0161	0.1357	0.0825	0.0399	0.0000	0.0133	0.0133	0.0000	0.0000	0.0000	0.0000
1988	0.0439	0.0595	0.0594	0.0125	0.0282	0.0344	0.0219	0.0468	0.0000	0.0063	0.0063	0.0000
1989	0.0417	0.0417	0.0208	0.0417	0.0000	0.0208	0.0417	0.0000	0.0417	0.0000	0.0000	0.0000
1999	0.0214	0.0082	0.0152	0.0621	0.0590	0.0731	0.0984	0.0723	0.0000	0.0082	0.0163	0.0082
2000	0.0000	0.0254	0.1942	0.1781	0.1882	0.0797	0.0516	0.0127	0.0127	0.0509	0.0161	0.0127
2001	0.0095	0.0190	0.0952	0.2476	0.1810	0.1048	0.0857	0.0667	0.0571	0.0095	0.0000	0.0190
2002	0.0050	0.0089	0.1034	0.1840	0.1997	0.1407	0.0995	0.0601	0.0595	0.0272	0.0272	0.0078
2003	0.0744	0.0124	0.0344	0.0922	0.1318	0.1023	0.0475	0.0651	0.0871	0.0643	0.0387	0.0264
2004	0.0067	0.0134	0.0268	0.1678	0.1745	0.1678	0.0872	0.0604	0.0805	0.0537	0.0537	0.0201
2005	0.0000	0.0278	0.0139	0.1250	0.1667	0.1111	0.0972	0.0694	0.0000	0.0694	0.1389	0.0278
2006	0.0000	0.0000	0.0000	0.1129	0.2097	0.1774	0.0484	0.0323	0.0323	0.0484	0.0323	0.0806
2007	0.0000	0.0000	0.0169	0.2373	0.2034	0.0508	0.1017	0.0847	0.0508	0.0000	0.0339	0.0508
2008	0.0000	0.0055	0.0275	0.2088	0.2582	0.2198	0.1264	0.0440	0.0110	0.0110	0.0000	0.0220
2009	0.0000	0.0000	0.0238	0.1667	0.2000	0.1286	0.1190	0.1571	0.0905	0.0619	0.0143	0.0095
2012	0.0330	0.0478	0.0416	0.0171	0.0275	0.0294	0.0404	0.0801	0.0753	0.1273	0.1236	0.1158
2013	0.0325	0.0355	0.0417	0.0355	0.0402	0.0340	0.0417	0.0402	0.0417	0.0541	0.1020	0.1252
2014	0.0490	0.0386	0.0292	0.0214	0.0177	0.0245	0.0417	0.0443	0.0449	0.0569	0.0668	0.1054

Appendix 2: (continued).

Year	78	81	84	87	90	93	96	99	102	105	108
1984	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1985	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1986	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1987	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1988	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1989	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0082	0.0082	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2000	0.0389	0.0228	0.0202	0.0127	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2001	0.0190	0.0095	0.0095	0.0381	0.0095	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2002	0.0446	0.0156	0.0039	0.0039	0.0039	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2003	0.0475	0.0088	0.0000	0.0000	0.0088	0.0044	0.0044	0.0000	0.0000	0.0000	0.0000
2004	0.0201	0.0268	0.0134	0.0067	0.0067	0.0134	0.0000	0.0000	0.0000	0.0000	0.0000
2005	0.0278	0.0417	0.0139	0.0139	0.0000	0.0139	0.0000	0.0000	0.0000	0.0000	0.0000
2006	0.0645	0.0161	0.0484	0.0161	0.0323	0.0161	0.0161	0.0000	0.0000	0.0000	0.0161
2007	0.0169	0.0847	0.0000	0.0169	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2008	0.0220	0.0055	0.0220	0.0000	0.0055	0.0000	0.0000	0.0000	0.0055	0.0000	0.0000
2009	0.0143	0.0000	0.0000	0.0095	0.0048	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	0.0710	0.0453	0.0245	0.0128	0.0043	0.0000	0.0061	0.0018	0.0000	0.0000	0.0000
2013	0.1298	0.0819	0.0448	0.0309	0.0124	0.0062	0.0000	0.0000	0.0000	0.0000	0.0000
2014	0.1560	0.1320	0.0709	0.0271	0.0136	0.0057	0.0010	0.0000	0.0000	0.0000	0.0000

Appendix 3: Weighted age composition of sampled red snapper in the SRHS.

Year	Fish (N)	Trips (N)	1	2	3	4	5	6	7	8	9	10	11	12	13
1977	72	22	0.1275	0.5802	0.1607	0.1115	0.0064	0.0050	0.0081	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006
1978	275	80	0.0257	0.3790	0.5195	0.0239	0.0353	0.0048	0.0086	0.0000	0.0000	0.0000	0.0000	0.0000	0.0032
1979	46	31	0.0000	0.7157	0.0928	0.0470	0.0718	0.0319	0.0408	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1980	87	30	0.1229	0.6791	0.1484	0.0352	0.0000	0.0144	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1981	405	141	0.0244	0.6975	0.1650	0.0368	0.0170	0.0281	0.0054	0.0112	0.0045	0.0000	0.0000	0.0000	0.0102
1982	131	55	0.0628	0.3788	0.4536	0.0577	0.0322	0.0037	0.0000	0.0062	0.0050	0.0000	0.0000	0.0000	0.0000
1983	741	167	0.3843	0.4571	0.1002	0.0279	0.0111	0.0082	0.0042	0.0038	0.0011	0.0000	0.0000	0.0000	0.0022
1984	581	166	0.1604	0.6561	0.1260	0.0173	0.0144	0.0027	0.0037	0.0010	0.0014	0.0008	0.0033	0.0019	0.0108
1985	504	160	0.0395	0.7197	0.2094	0.0205	0.0017	0.0029	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000	0.0055
1986	184	97	0.0668	0.4753	0.3741	0.0664	0.0068	0.0026	0.0026	0.0000	0.0000	0.0000	0.0000	0.0000	0.0053
1987	86	60	0.1412	0.2087	0.5490	0.0820	0.0191	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1989	49	9	0.0000	0.2722	0.7028	0.0167	0.0083	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1990	33	23	0.0817	0.1239	0.2076	0.3129	0.2061	0.0306	0.0373	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1991	21	13	0.0000	0.0000	0.4762	0.3963	0.1037	0.0238	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1998	21	2	0.0000	0.0000	0.0667	0.2667	0.4000	0.2000	0.0333	0.0000	0.0333	0.0000	0.0000	0.0000	0.0000
2004	27	8	0.0000	0.0000	0.9115	0.0847	0.0038	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2005	60	22	0.0000	0.0071	0.4561	0.4240	0.1017	0.0000	0.0000	0.0000	0.0000	0.0110	0.0000	0.0000	0.0000
2006	150	49	0.0000	0.0042	0.2221	0.6694	0.0427	0.0096	0.0255	0.0000	0.0085	0.0000	0.0000	0.0000	0.0180
2007	71	34	0.0000	0.2582	0.1525	0.5145	0.0488	0.0102	0.0000	0.0091	0.0068	0.0000	0.0000	0.0000	0.0000
2008	133	47	0.0000	0.0358	0.8958	0.0184	0.0125	0.0234	0.0105	0.0000	0.0035	0.0000	0.0000	0.0000	0.0000
2009	1239	241	0.0000	0.0067	0.5564	0.3842	0.0048	0.0064	0.0118	0.0052	0.0017	0.0024	0.0062	0.0035	0.0108
2012	604	40	0.0245	0.3412	0.2788	0.0678	0.1711	0.0831	0.0335	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	242	35	0.0116	0.0490	0.3028	0.2021	0.0592	0.2156	0.1031	0.0440	0.0076	0.0034	0.0017	0.0000	0.0000
2014	364	49	0.0741	0.4870	0.1140	0.1056	0.0658	0.0145	0.0744	0.0441	0.0161	0.0029	0.0000	0.0000	0.0016

Appendix 4: Weighted age composition of sampled red snapper in the MRIP private and charter modes.

Year	Fish (n)	Trips (n)	1	2	3	4	5	6	7	8	9	10	11	12	13
2001	43	15	0.000	0.184	0.706	0.085	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2002	262	83	0.000	0.131	0.561	0.195	0.054	0.034	0.011	0.006	0.000	0.003	0.000	0.000	0.005
2003	354	91	0.000	0.103	0.338	0.352	0.104	0.032	0.016	0.018	0.000	0.020	0.000	0.000	0.017
2004	312	83	0.000	0.145	0.405	0.257	0.109	0.043	0.008	0.003	0.003	0.001	0.001	0.000	0.023
2005	338	78	0.000	0.000	0.365	0.352	0.165	0.084	0.008	0.010	0.000	0.006	0.000	0.003	0.008
2006	169	26	0.000	0.000	0.017	0.443	0.236	0.111	0.055	0.035	0.028	0.002	0.002	0.000	0.070
2007	29	7	0.000	0.000	0.000	0.535	0.290	0.111	0.060	0.005	0.000	0.000	0.000	0.000	0.000
2009	463	58	0.000	0.010	0.331	0.619	0.006	0.011	0.007	0.001	0.000	0.005	0.010	0.000	0.000
2012	1664	121	0.002	0.126	0.126	0.058	0.336	0.212	0.097	0.008	0.004	0.009	0.004	0.004	0.014
2013	1467	139	0.011	0.079	0.151	0.137	0.038	0.220	0.170	0.123	0.003	0.008	0.011	0.013	0.035
2014	3325	315	0.002	0.134	0.056	0.131	0.100	0.031	0.165	0.183	0.137	0.003	0.004	0.015	0.040

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