South Atlantic U.S. vermilion snapper (*Rhomboplites aurorubens*) age and length composition from the recreational fisheries

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South Atlantic U.S. vermilion snapper (*Rhomboplites aurorubens*) age and length composition from the recreational fisheries

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1 Introduction

The SEDAR 55 data workshop developed raw length and age compositions for each of the recreational 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). This document describes 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 2016 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 1). 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.

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 vermilion snapper sampled for age and the number of annual trips that were sampled from the recreational fishery are reported in Table 2.

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 55 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
- Region assigned (NC/SC and GA/FL)
- Fleet assigned: 1. Headboat (SRHS) and 2. CH/PR (MRIP)
- Range of lengths: 10 to 101 cm (1 cm bins)

3.2 Ages

A minimum of 10 fish per region was established to calculate a weighted age composition. For vermilion snapper age could not be determined, therefore the increment count was used and will hereafter be referred to as age. 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
- Region assigned (NC/SC and GA/FL)
- Fleet assigned: 1. Headboat (SRHS) and 2. CH/PR (MRIP)
- Range of ages: 1 to 16 (1 increment bins)
- Range of lengths: 19 to 63 cm (1 cm bins)

Fluctuations in the PR mode landings significantly affected the weight of the PR mode samples, causing extreme variability in the MRIP CH/PR length composition. Therefore, the length composition of aged CH/PR mode samples was compared to the MRIP CH/PR nominal mode length composition (Figure 1). In most years the composition of the aged fish was very similar to that of the overall nominal length composition. This indicates a lack of bias in the age sampling. Therefore, due to the variability of the weighted length composition in the MRIP CH/PR mode, the aged fish were instead weighted by the nominal length composition.

4 Results

4.1 Lengths

The SRHS length compositions (Figure 2) showed a wide range of fish (10 to 101 cm TL). Prior to the mid-1980s fish sampled in the headboat fishery generally ranged from 18 cm to 60 cm TL. The maximum length capture decreased to approximately 40 cm TL in the late 1980s. The minimum length captured increased to approximately 20 cm TL in the mid-1980s.

It's important to note that weighting had limited influence on the length composition (Figure 1), of the SRHS, in years that met the 30 fish minimum.

The MRIP CH/PR mode length compositions showed a smaller range of fish (14 to 78 cm TL). In the early 1980s to mid-1990s fish sampled in the charter/private boat fishery (Figure 3) generally ranged from 18 cm to 60 cm TL, with a small number of samples outside of that range. Beginning in the late1990s the minimum length captured increased to approximately 20 cm to 25 cm TL.

4.2 Ages

The weighted age compositions are very similar to the nominal age compositions. Slightly older fish were encountered in the SRHS (1-16 years, Figure 4) than in the MRIP CH/PR modes (1-11 years, Figure 5). However, the majority of fish encountered in the SRHS were under 12 years and in the MRIP CH/PR modes under 9 years.

5 Discussion

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

In SEDAR 17 (as well as the 2012 update) nominal compositions were input into the model for the MRIP CH/PR mode. The weighted length composition is not recommended for use due to fluctuations in the PR mode landings significantly impacting the weight of the PR mode samples, causing variability in the length composition. Due to a lack of bias in the age sampling, the nominal length composition was used when weighting the age composition. The resulting weighted age composition is very similar to the nominal age composition. However, the weighted composition is recommended for use in order 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.

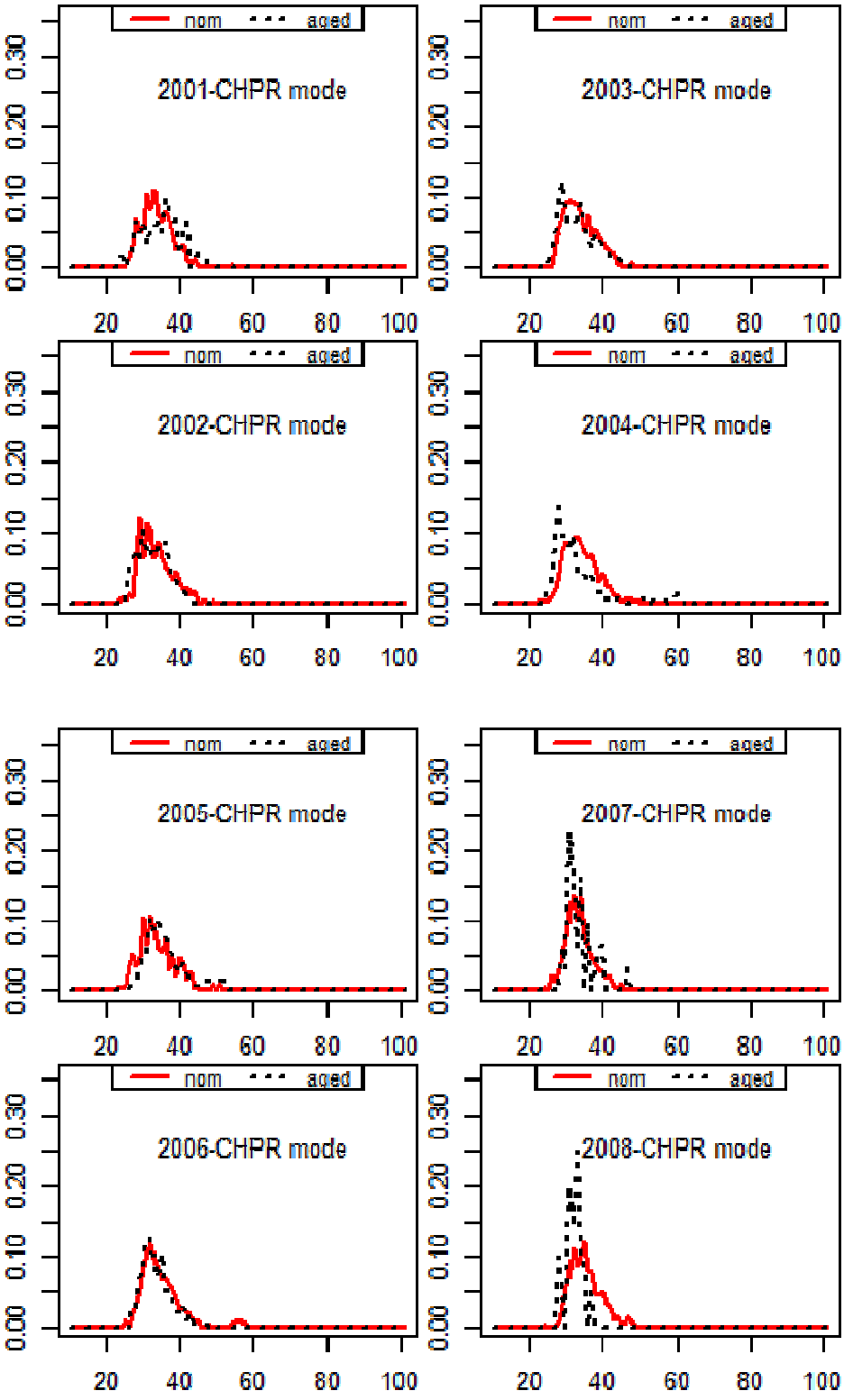
Table 1. Annual number of fish measured and annual number of trips containing measured vermilion snapper in the recreational fishery. A minimum of 30 length measurements was required.

	SRHS		MRIP	
Year	Fish (n)	Trips (n)	Fish (n)	Trips (n)
1972	1,127	188		
1973	542	141		
1974	1,306	223		
1975	1,333	255		
1976	1,289	254		
1977	1,034	190		
1978	1,795	324		
1979	1,384	220		
1980	1,346	218		
1981	1,337	267	3	1
1982	2,781	378	22	4
1983	4,489	646	22	5
1984	4,548	682	14	3
1985	5,923	735	17	6
1986	6,190	720	20	8
1987	6,332	790	39	17
1988	4,774	539	149	32
1989	4,775	498	85	26
1990	4,842	380	66	20
1991	4,016	315	57	18
1992	2,834	303	140	38
1993	3,325	313	78	31
1994	5,589	317	85	33
1995	4,778	299	91	27
1996	3,709	266	37	12
1997	3,996	300	85	37
1998	4,162	365	77	20
1999	4,321	331	200	46
2000	4,475	285	219	32
2001	3,382	254	406	57
2002	3,923	326	394	56
2003	3,835	338	578	60
2004	3,507	351	888	88
2005	2,201	254	230	50
2006	3,213	317	540	52
2007	3,679	293	386	62
2008	2,627	235	514	82
2009	2,737	245	337	54
2010	1,623	171	503	71
2011	1,370	172	208	30
2012	1,697	153	182	36
2013	2,074	241	339	58
2014	2,812	292	354	64
2015	2,160	251	406	72
2016	3,117	328	361	99

Table 2. Annual numbers of vermilion snapper sampled for age and the number of annual trips containing aged vermilion snapper in the recreational fishery. A minimum of 10 aged fish was required.

Year	SRHS		MRIP	
	Fish (n)	Trips (n)	Fish (n)	Trips (n)
1972	-	-		
1973	-	-		
1974	-	-		
1975	1	1		
1976	-	-		
1977	-	-		
1978	-	-		
1979	-	-		
1980	11	9		
1981	107	31	-	-
1982	32	9	-	-
1983	2	2	-	-
1984	-	-	-	-
1985	-	-	-	-
1986	88	17	-	-
1987	8	4	-	-
1988	2	2	-	-
1989	-	-	-	-
1990	-	-	-	-
1991	157	52	-	-
1992	40	21	-	-
1993	39	19	-	-
1994	250	68	-	-
1995	174	50	-	-
1996	62	19	-	-
1997	13	5	-	-
1998	2	1	-	-
1999	-	-	-	-
2000	22	5	-	-
2001	21	3	60	8
2002	10	3	188	47
2003	102	33	369	59
2004	308	86	268	58
2005	487	109	299	42
2006	702	171	220	28
2007	806	200	31	5
2008	372	123	20	2
2009	678	165	10	3
2010	791	140	90	6
2011	275	97	43	9
2012	613	102		
2013	948	182	41	16
2014	895	158	3	1
2015	770	128	106	19
2016	1,789	296	7	3

Figure 1: Vermilion snapper nominal length composition of fish measured and of fish aged from the charter and private boat modes.



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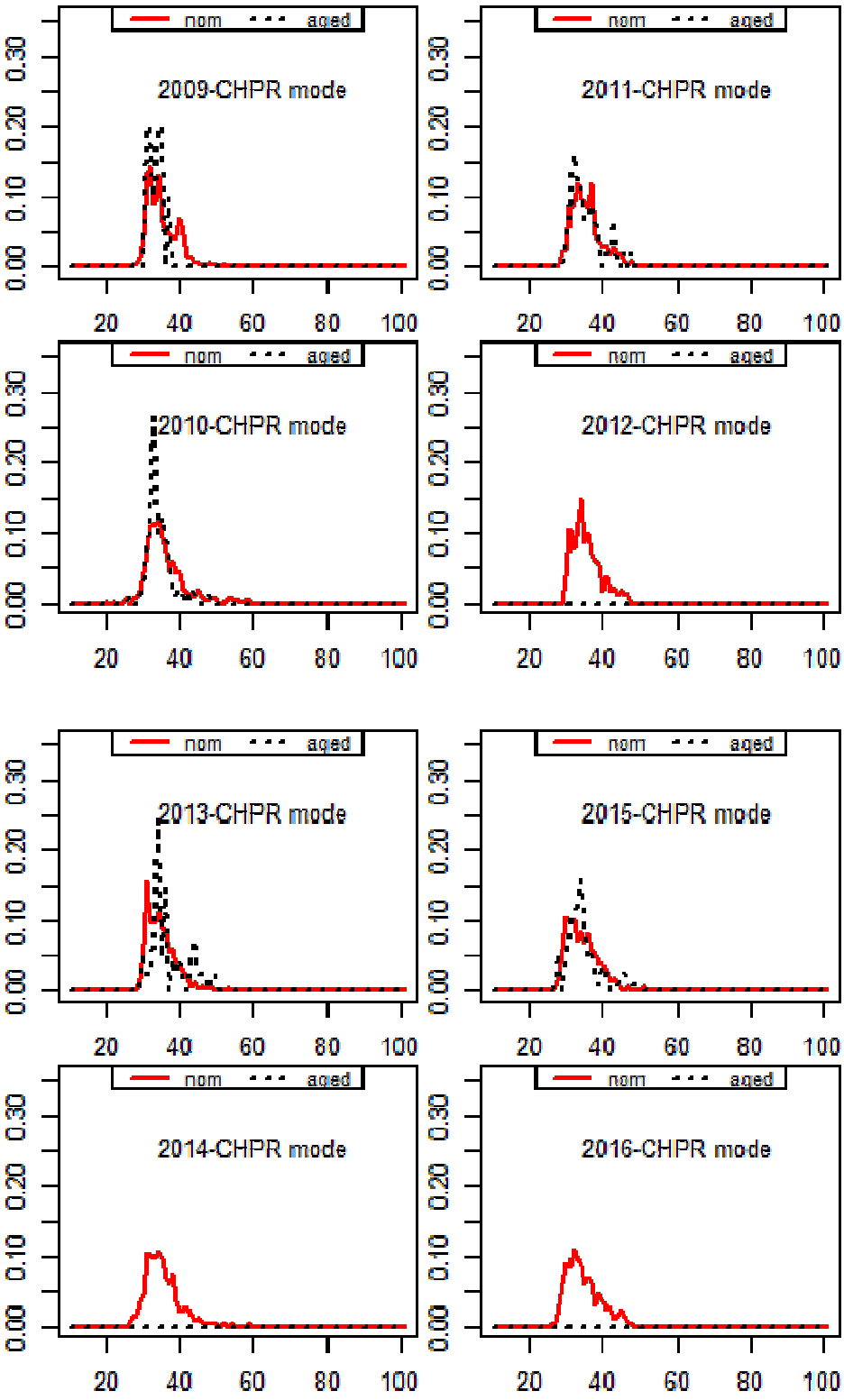
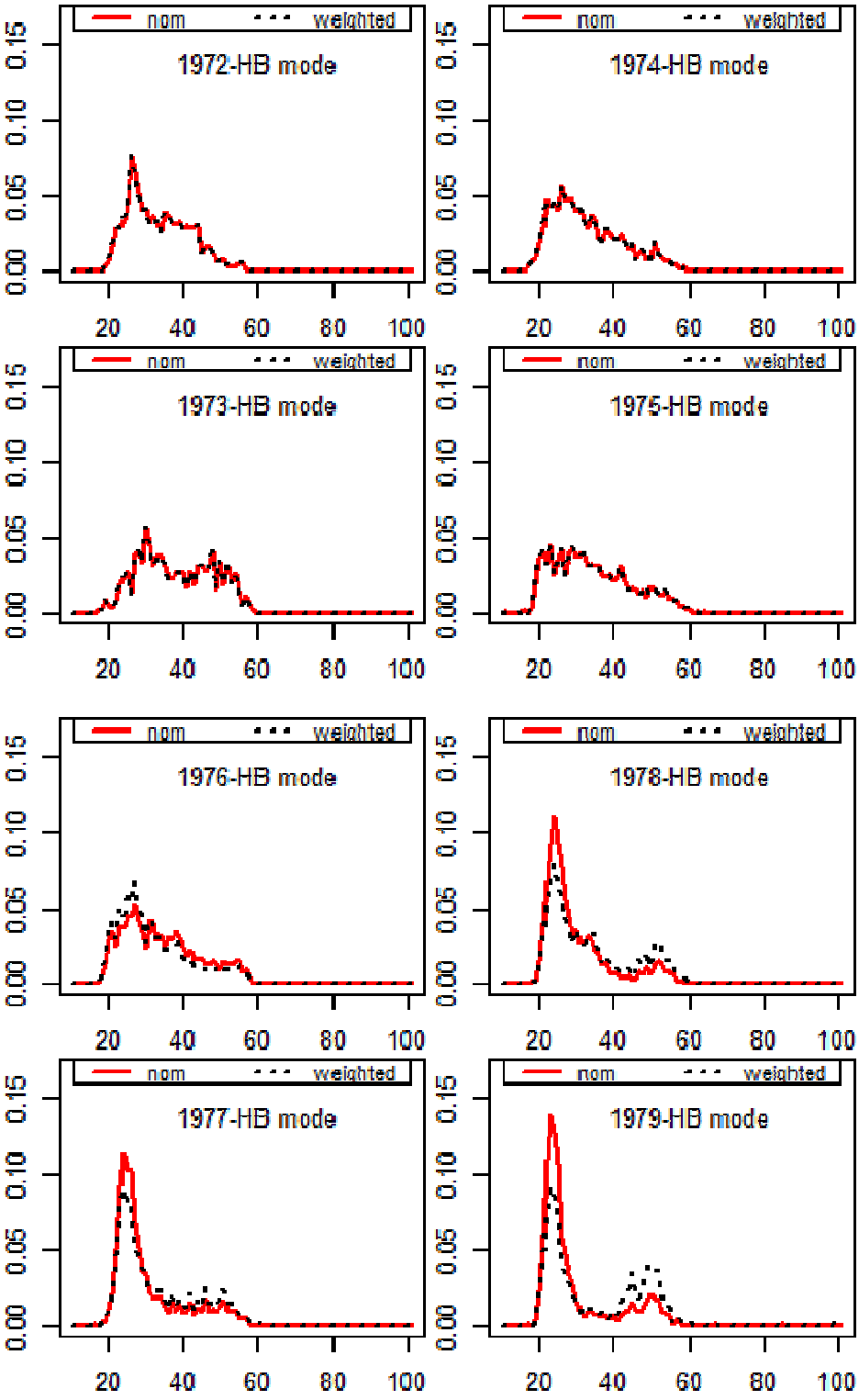


Figure 2: Vermilion snapper nominal and weighted length composition from the headboat fishery.



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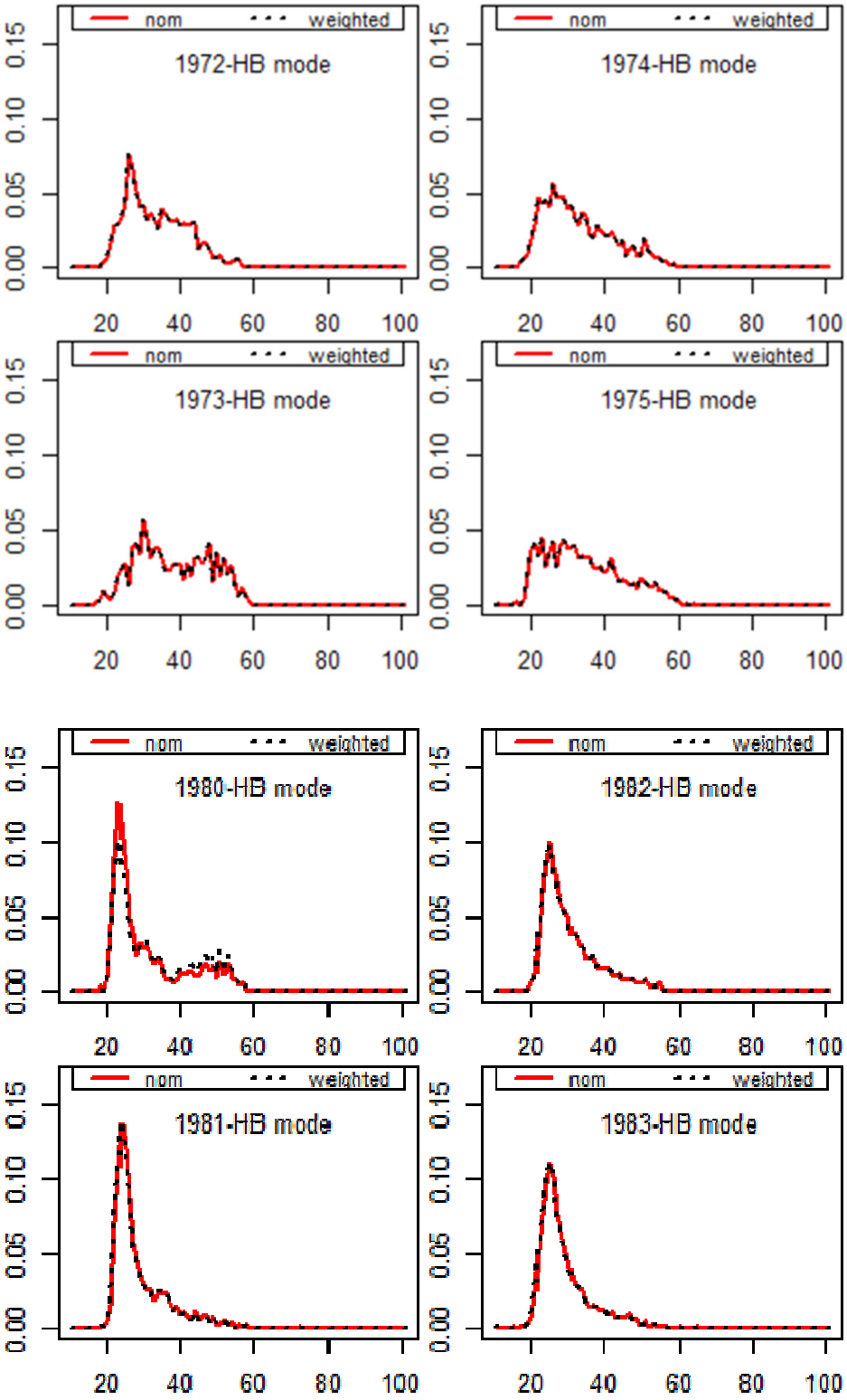

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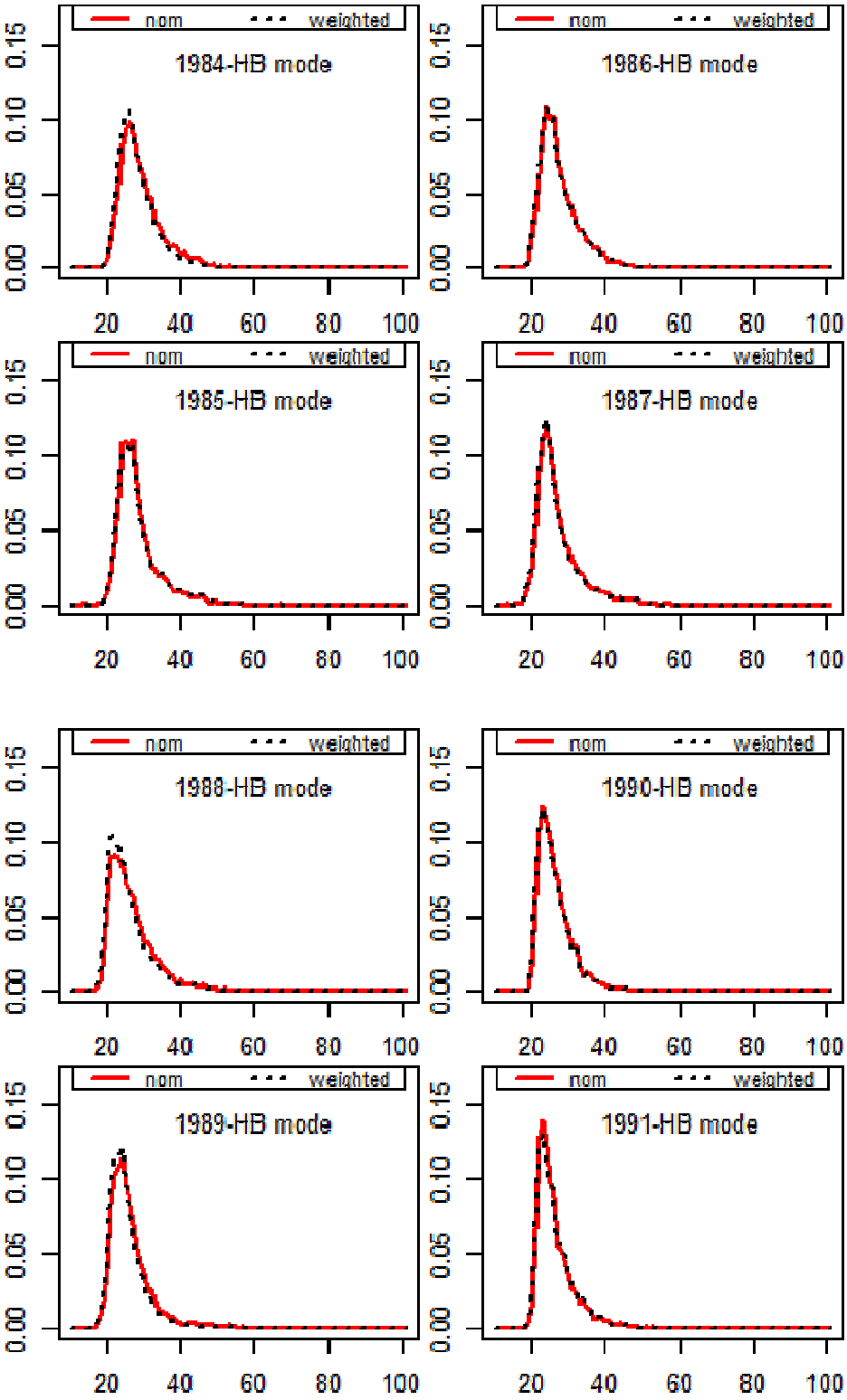

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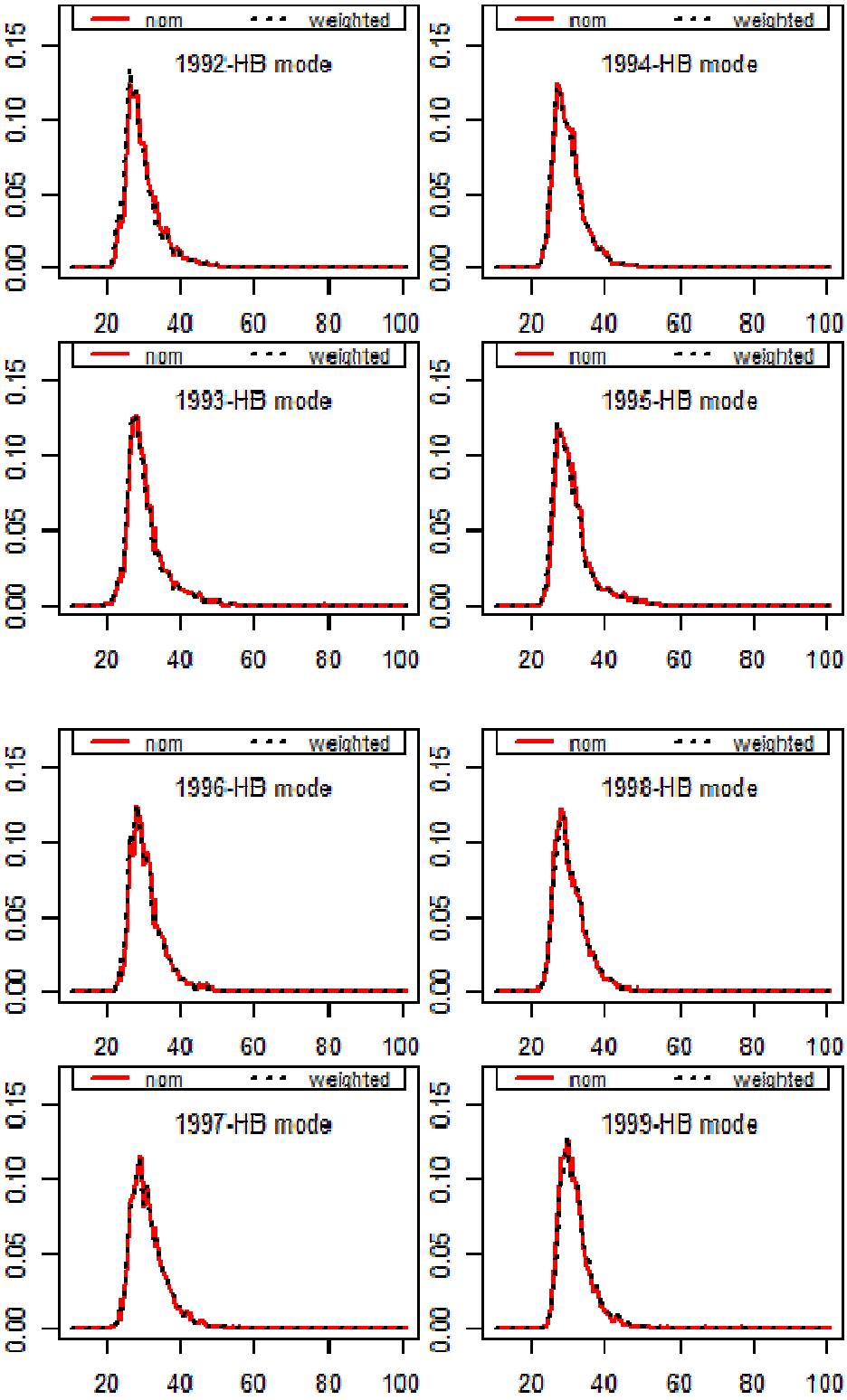

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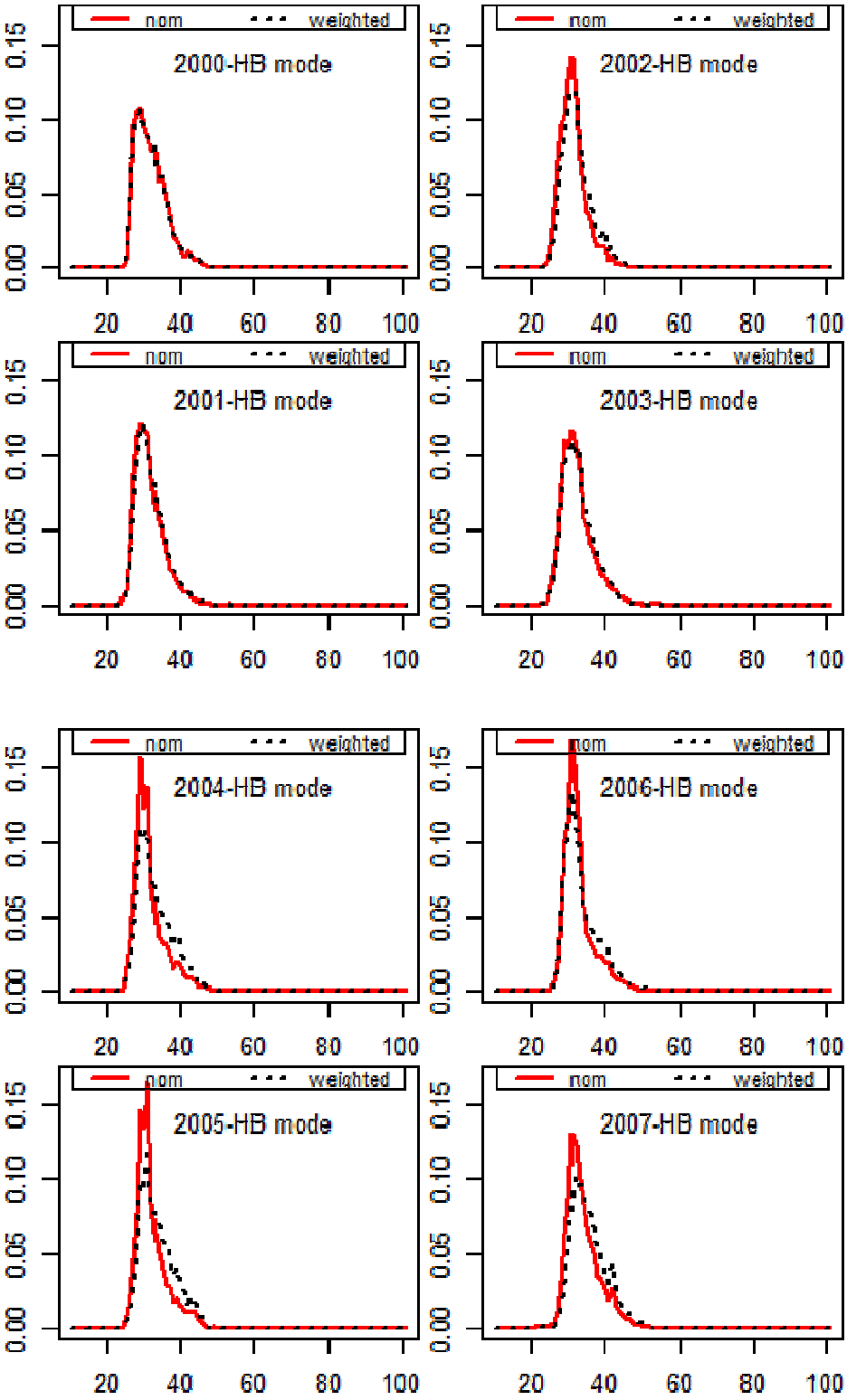

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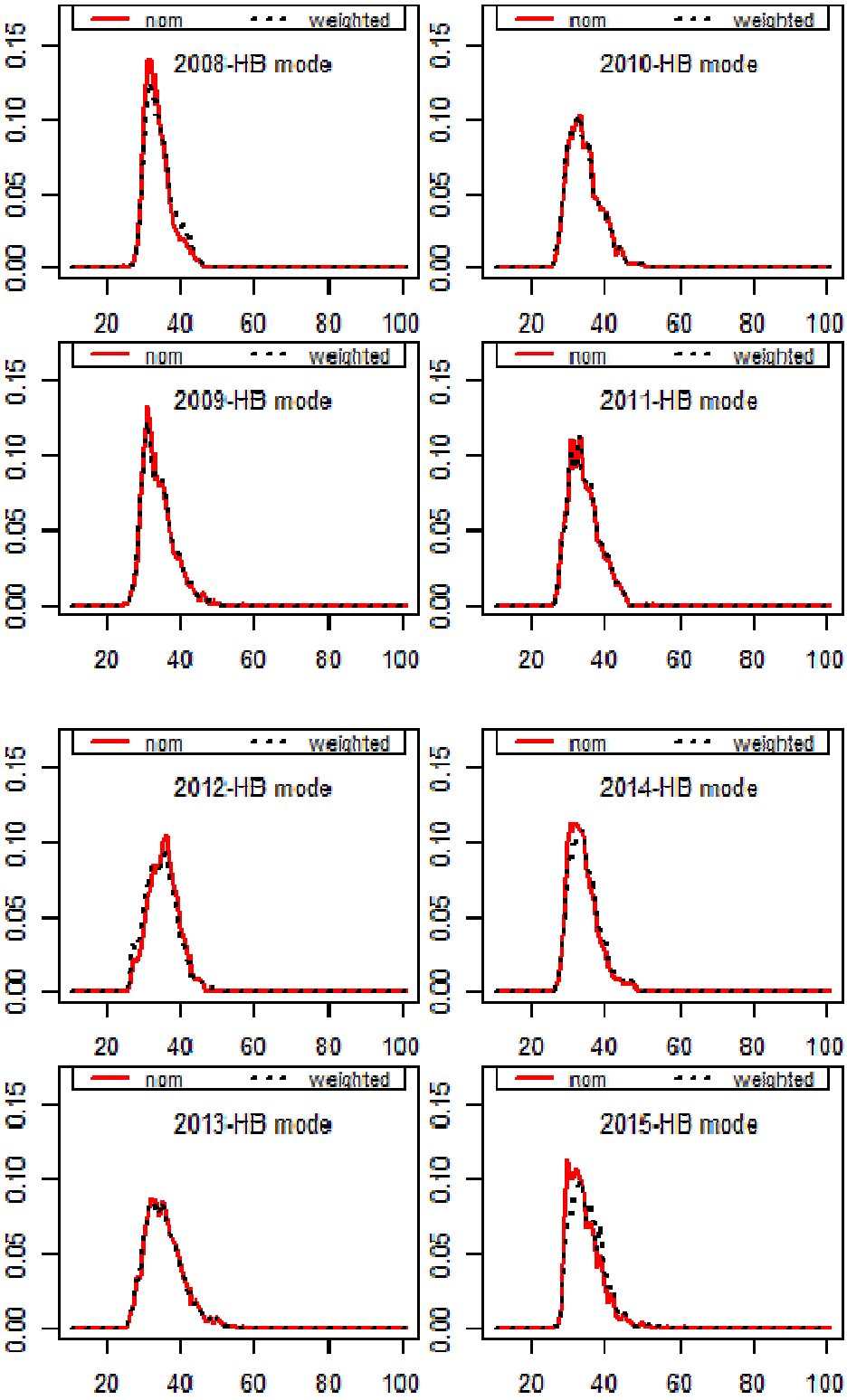

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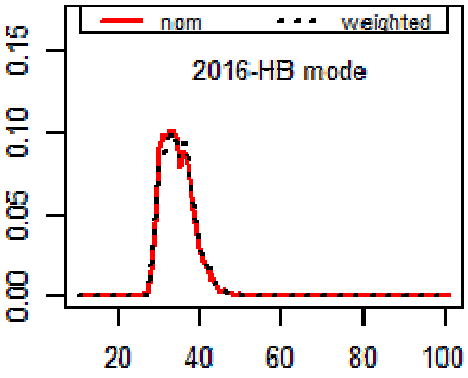
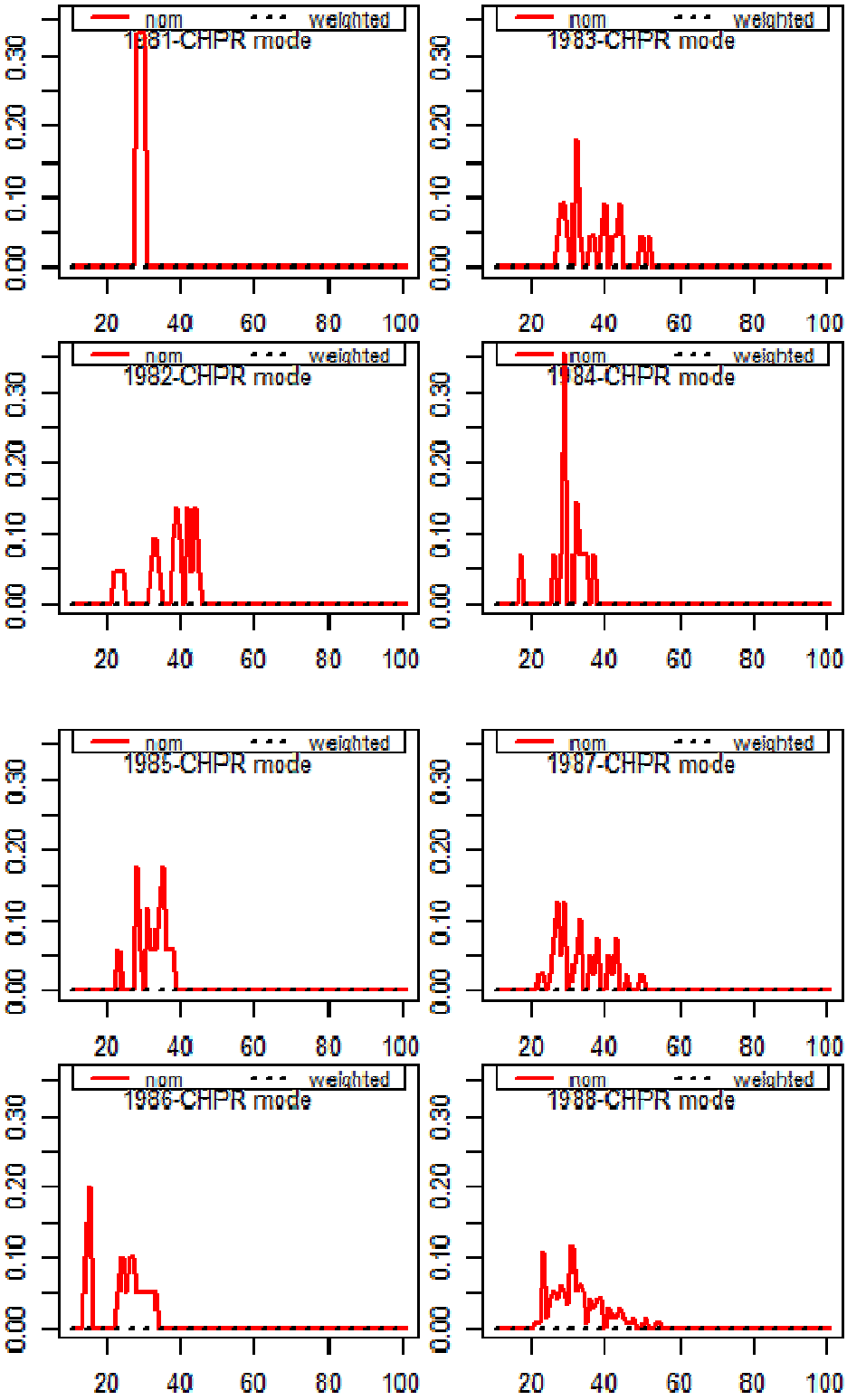


Figure 3: Vermilion snapper nominal and weighted length composition from the charter and private modes.



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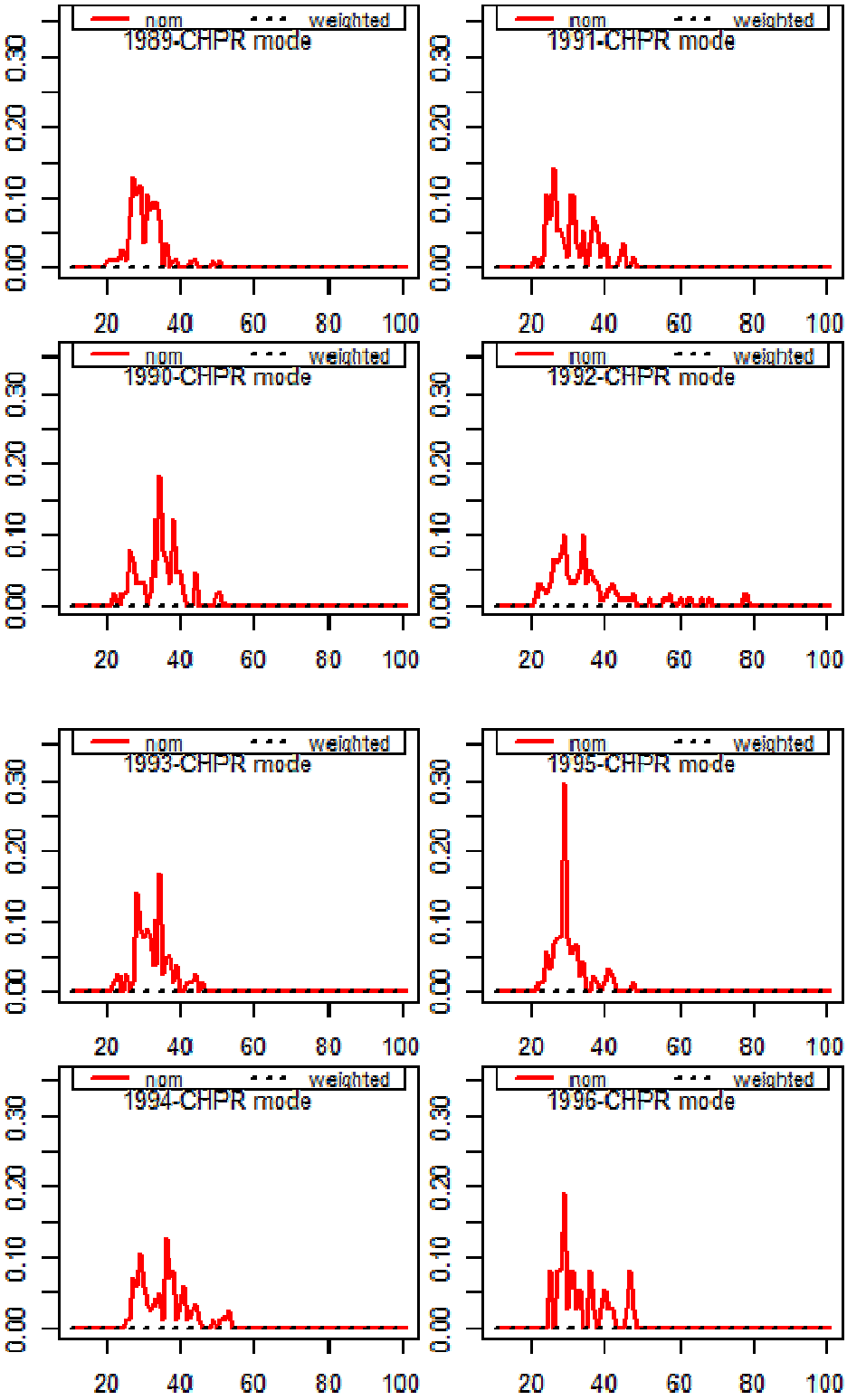

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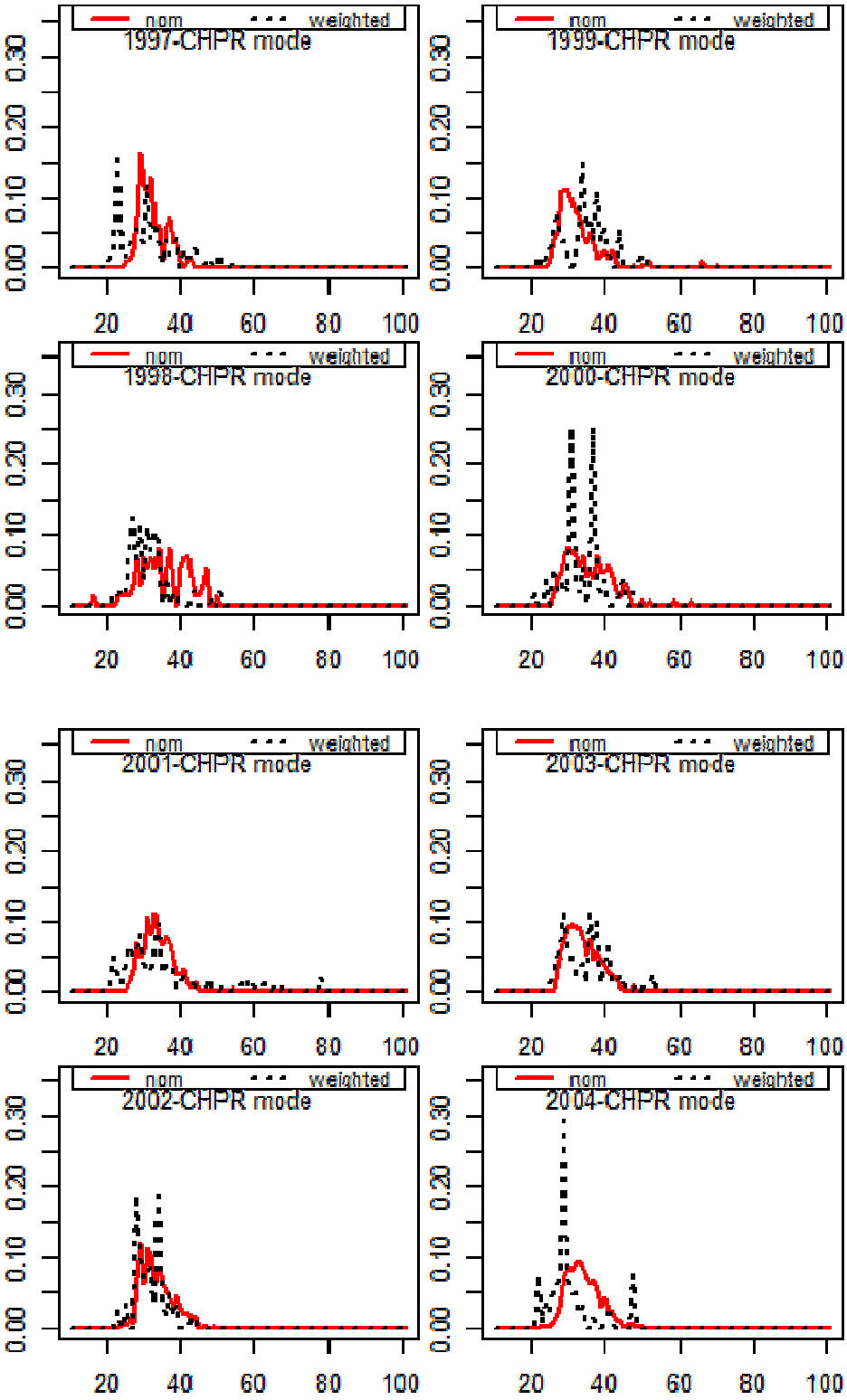

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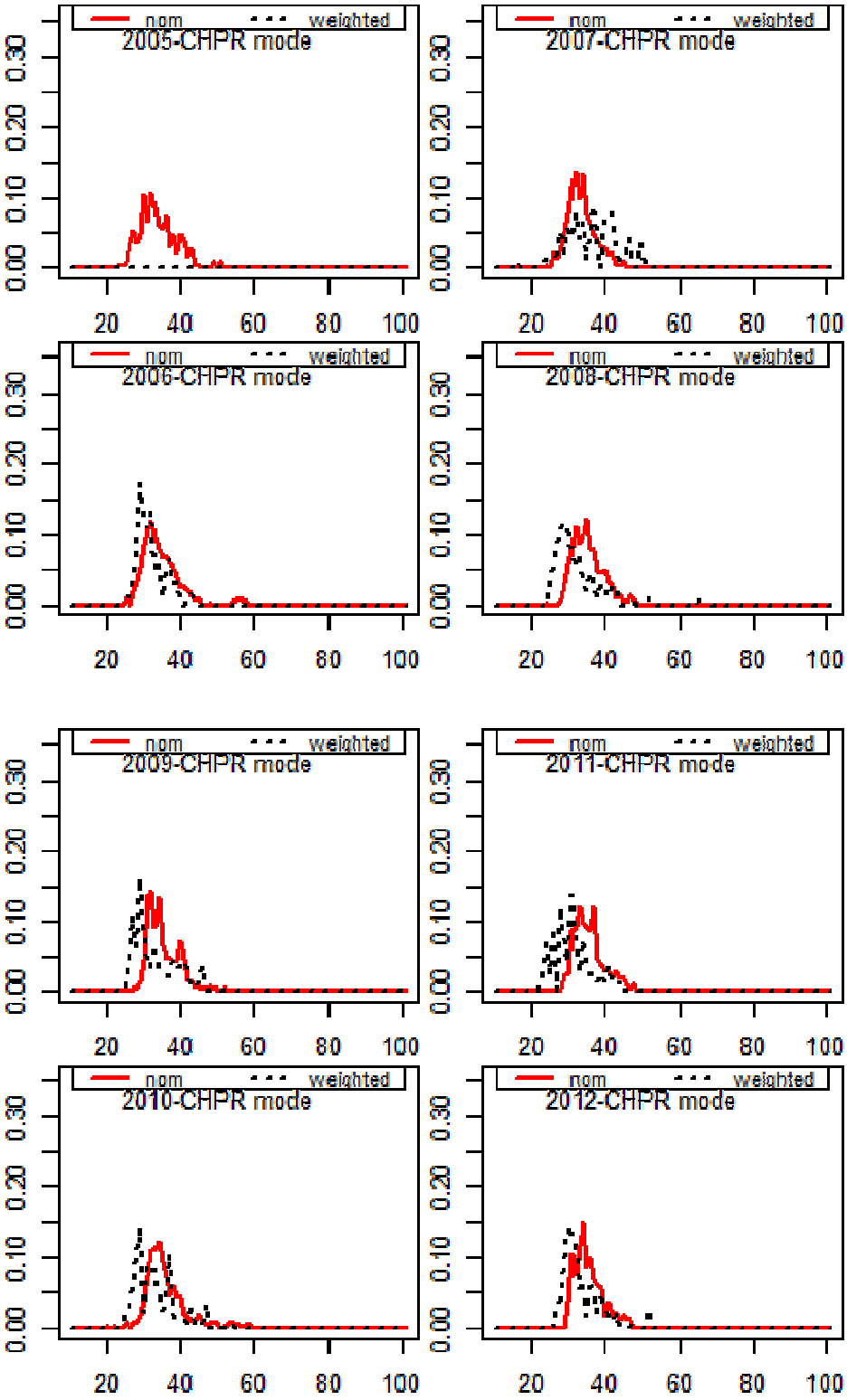

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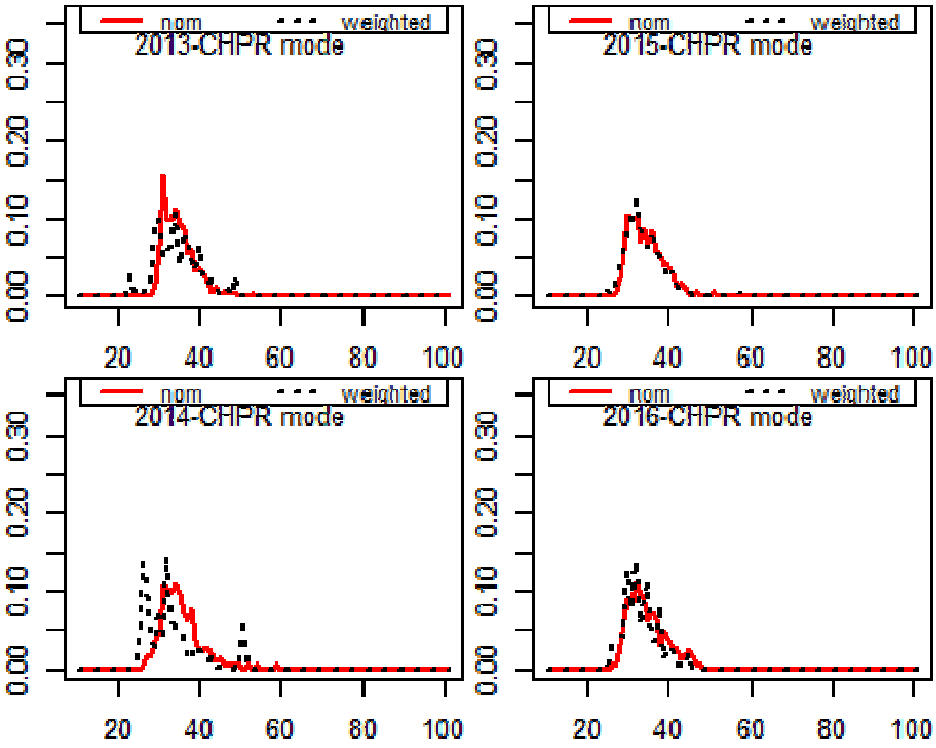
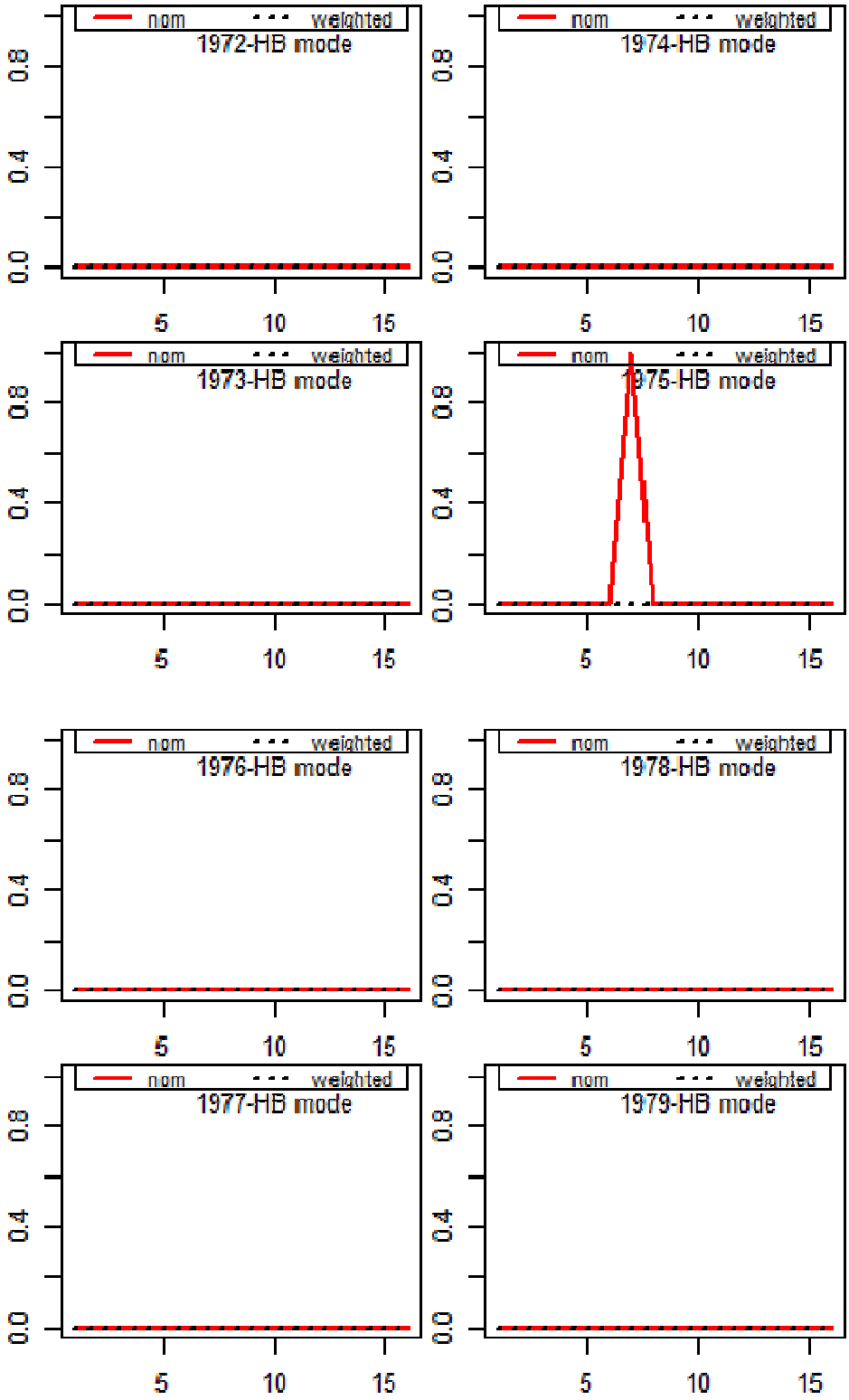


Figure 4: Vermilion snapper nominal and weighted age composition from the headboat fishery.



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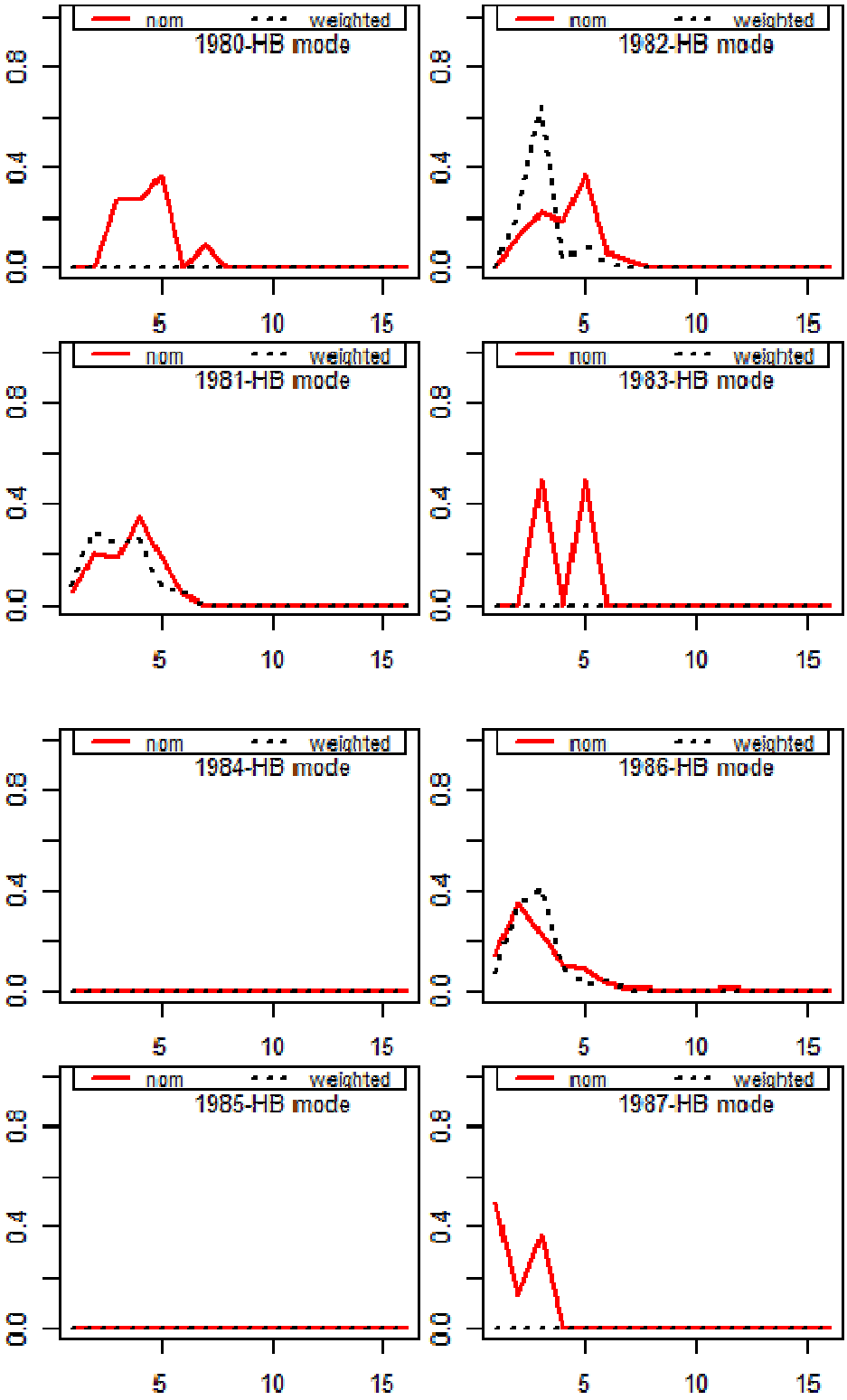

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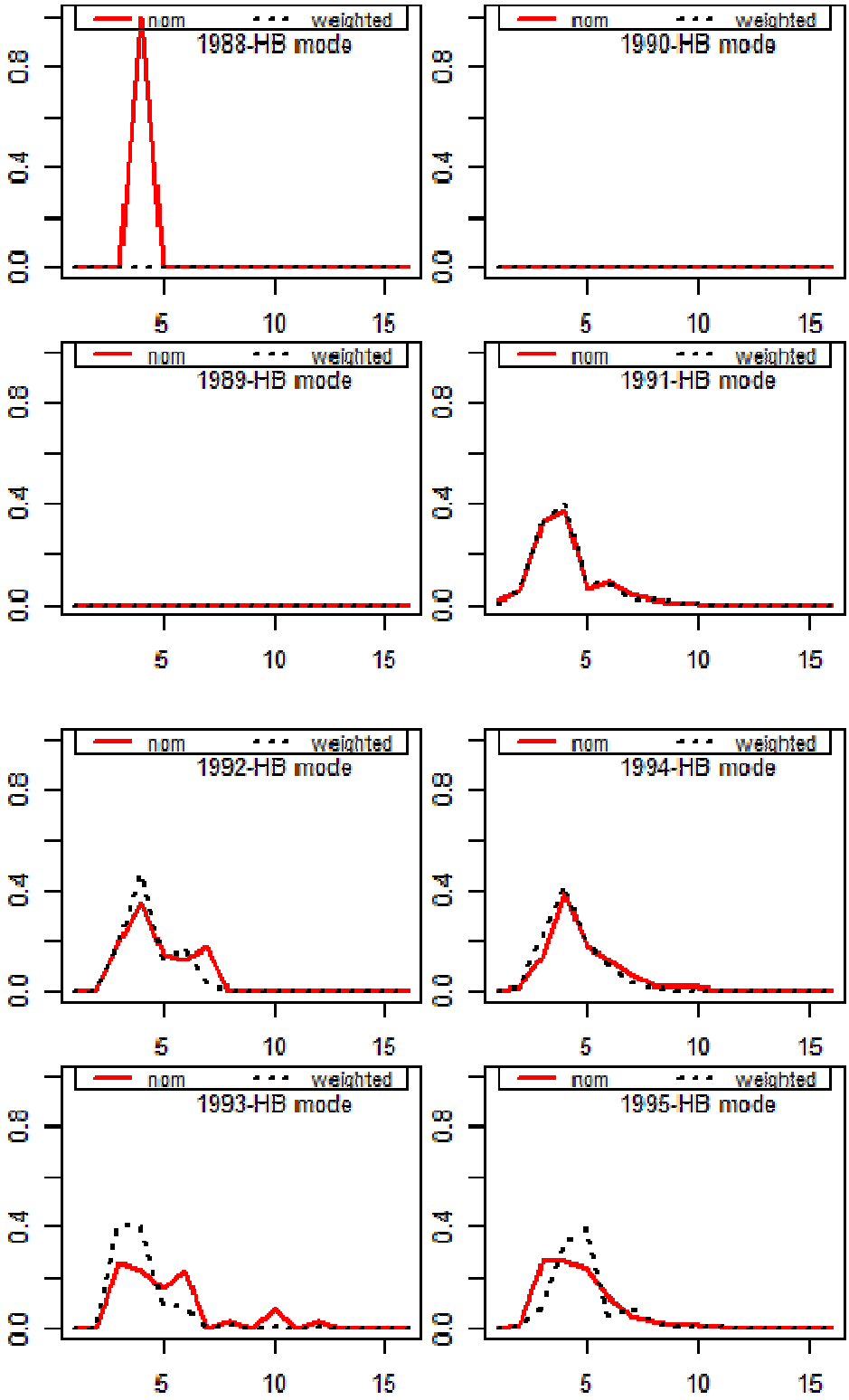

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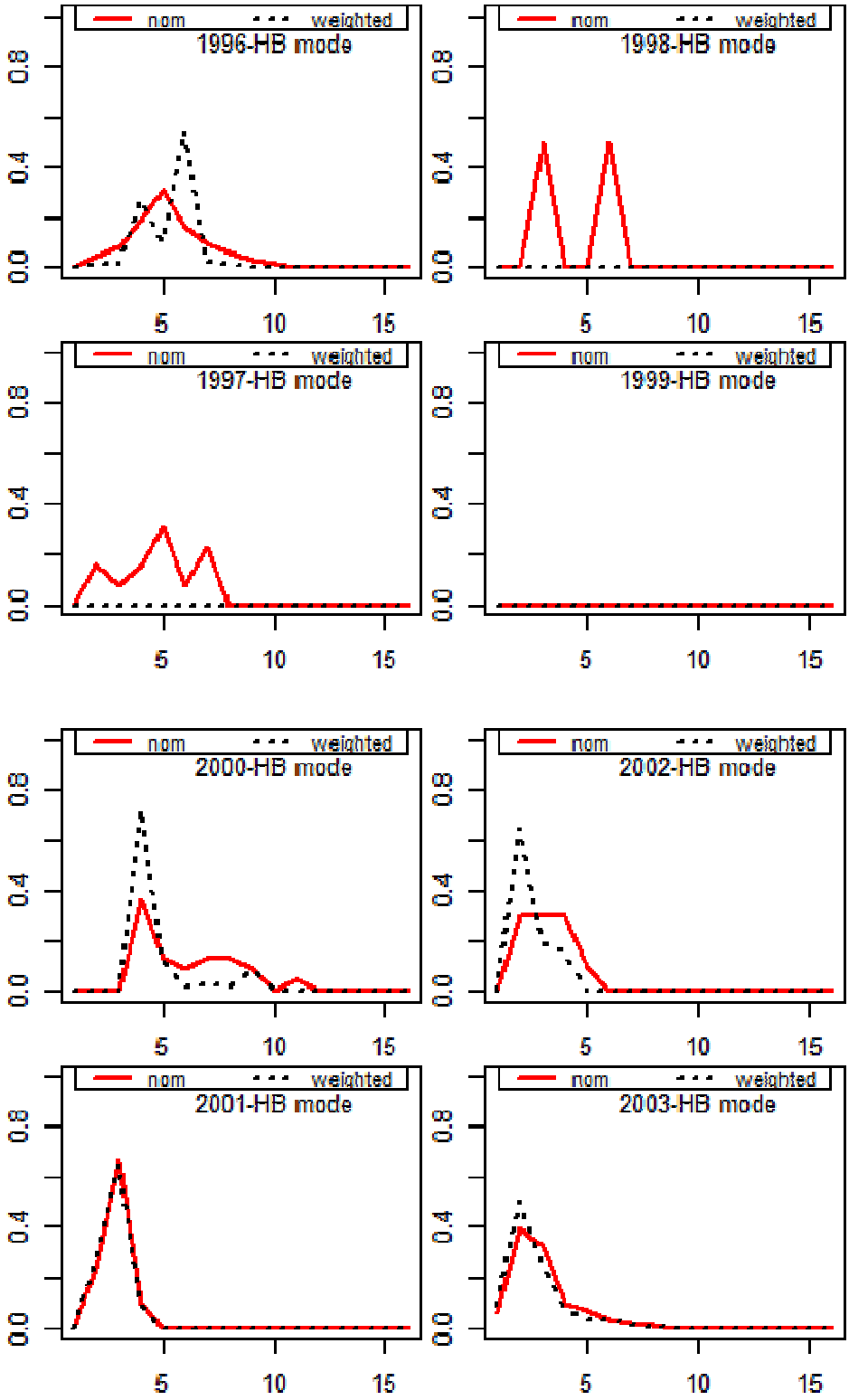

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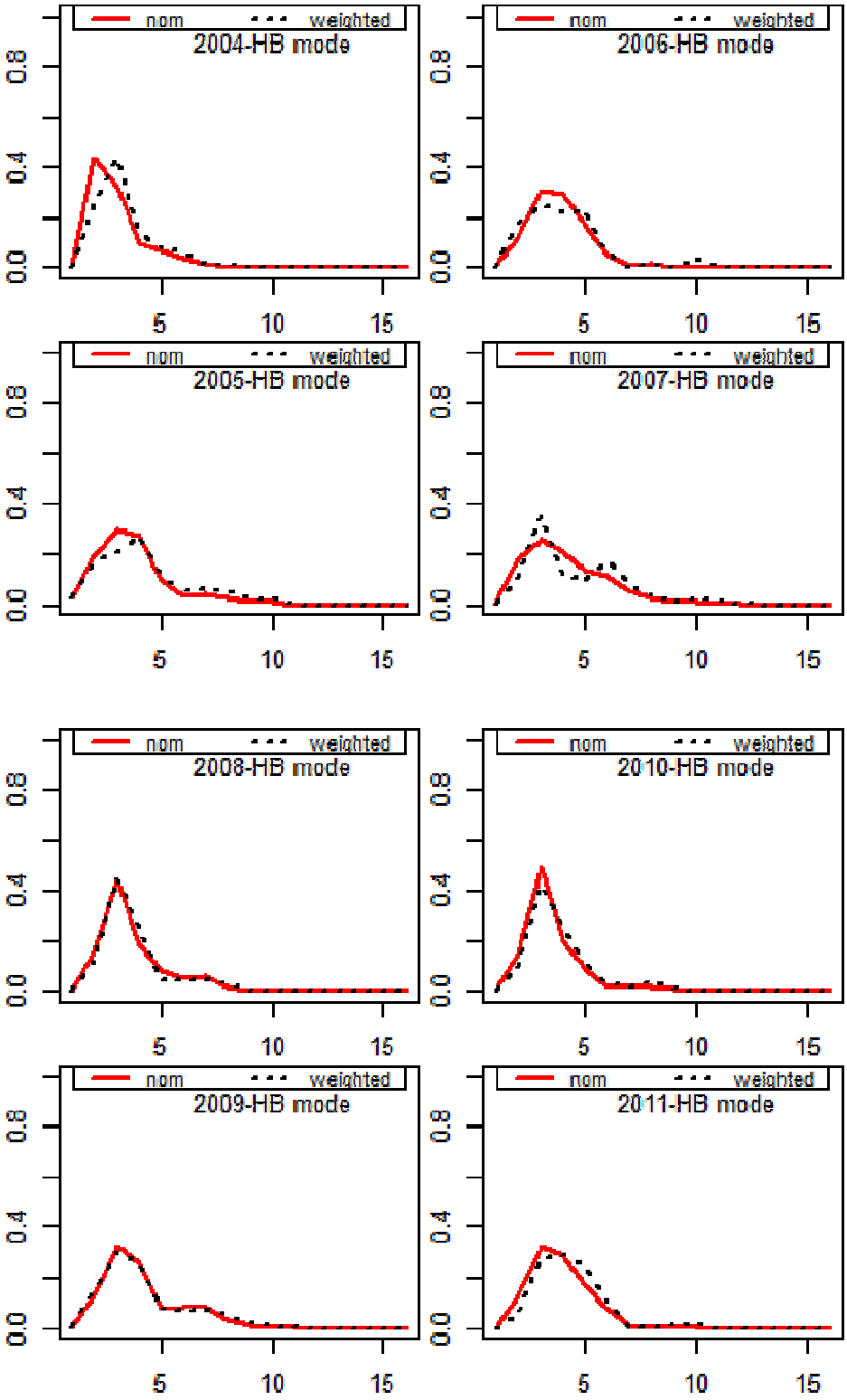

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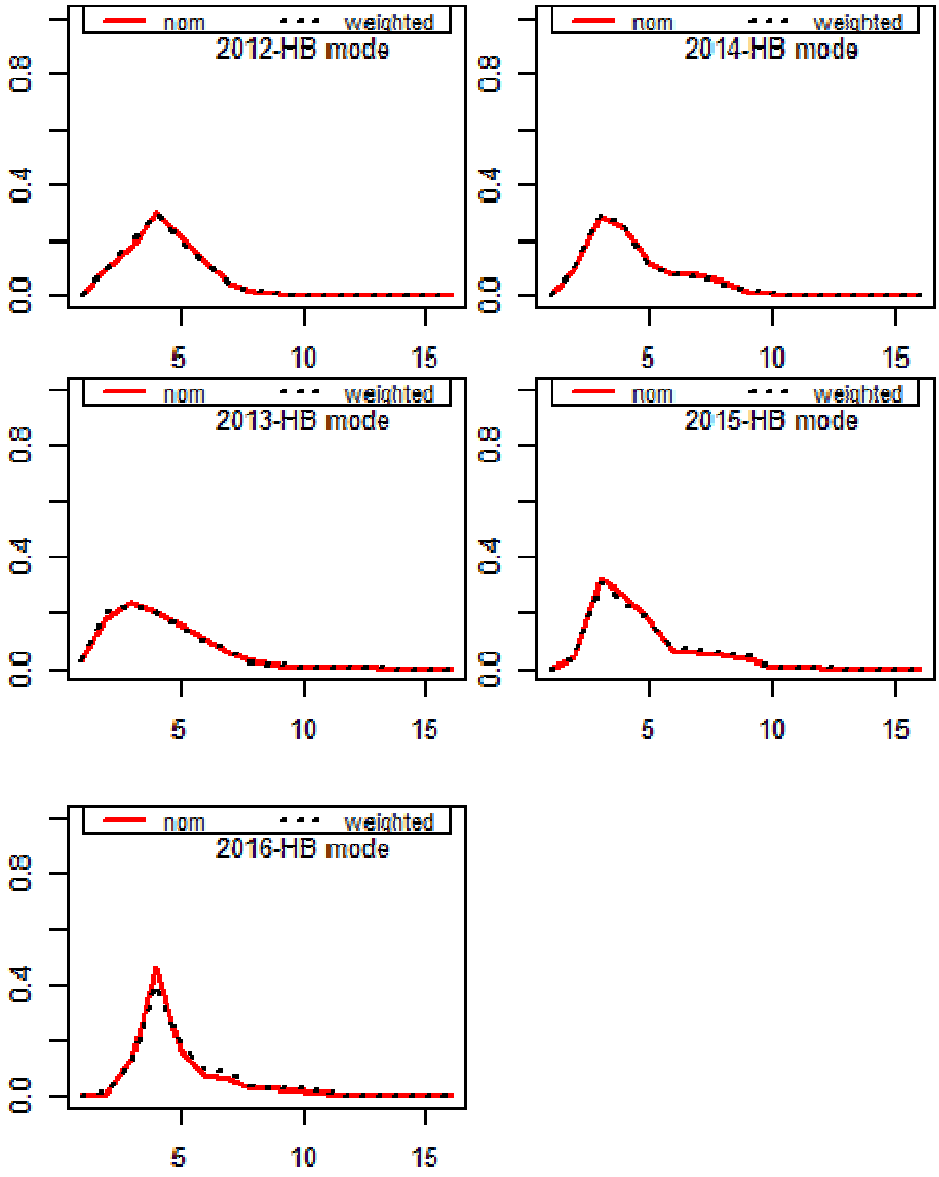

Figure 5: Vermilion snapper nominal and weighted age compositions from the charter and private boat modes. The weighted age composition is weighted by the nominal length composition.

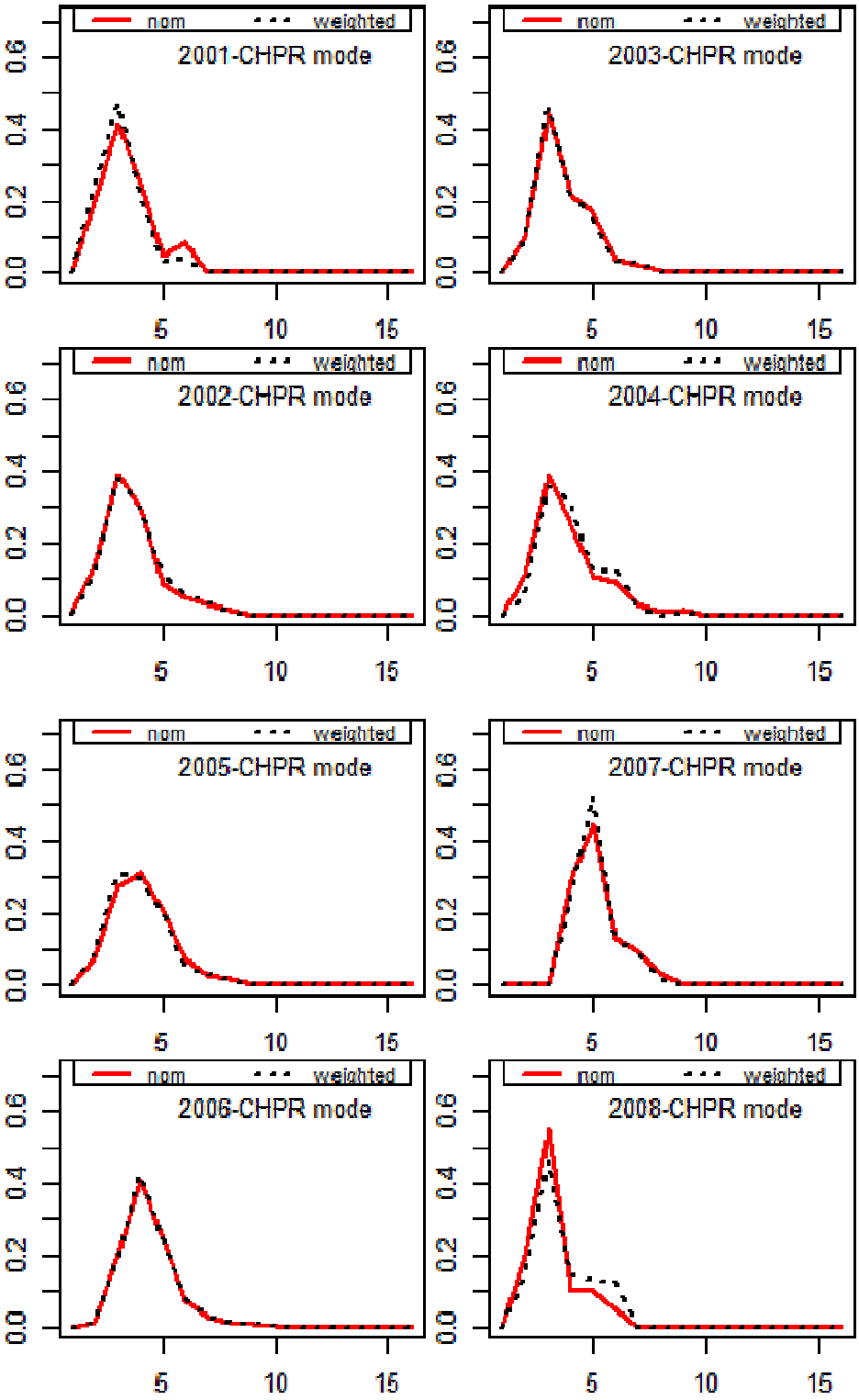

Figure 5: Continued.