South Atlantic U.S. red grouper (*Epinephelus morio*) age and length composition from the recreational fisheries

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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 2015 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.

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 grouper 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 53 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: 16 to 118 cm (3 cm bins)

3.2 Ages

A minimum of 10 fish per region was established to calculate a weighted age composition. For red grouper 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 26 (1 increment bins)
- Range of lengths: 22 to 89 cm (3 cm bins)

4 Results

4.1 Lengths

The SRHS length compositions (Figure 1) showed a wide range of fish (16 to 118 cm TL). Prior to the mid-1970s fish sampled in the headboat fishery generally ranged from 20 cm to 100 cm TL. Beginning in 1978 the maximum length captured decreased to approximately 80 cm TL. The minimum length captured increased to approximately 30 cm TL in the early 1980s and again to approximately 50 cm TL in the early 1990s.

In the early 1980s to early 1990s fish sampled in the charter/private boat fishery (Figure 2) generally ranged from 20 cm to 80 cm TL. Beginning in the early1990s the minimum length captured increased to approximately 35 cm to 40 cm TL before increasing again in the mid-1990s to approximately 40 cm to 50 cm TL. Slightly larger fish (over 90 cm TL) were caught beginning in the early 2010s.

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

4.2 Ages

The weighted age compositions are very similar to the nominal age compositions. Ages encountered in both the SRHS (Figure 3) and MRIP (Figure 4) fleets generally fell under 15, but ranged from 1-26.

5 Discussion

There is minimal influence when weighting the recreational length or age compositions 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.

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 grouper in the recreational fishery. A minimum of 30 length measurements was required.

Year	SRHS Fish (n)	SRHS Trips (n)	MRIP Fish (n)	MRIP Trips (n)
1972	0	0		
1973	0	0		
1974	0	0		
1975	0	0		
1976	39	18		
1977	96	56		
1978	113	53		
1979	142	80		
1980	163	94		
1981	218	137	0	0
1982	280	162	0	0
1983	368	211	0	0
1984	589	277	0	0
1985	574	239	0	0
1986	384	197	0	0
1987	270	159	43	26
1988	212	140	0	0
1989	242	154	0	0
1990	132	87	0	0
1991	64	53	0	0
1992	83	59	0	0
1993	91	62	0	0
1994	141	102	0	0
1995	189	113	42	29
1996	207	138	35	29
1997	259	170	41	30
1998	456	267	55	42
1999	310	192	50	36
2000	204	132	36	25
2001	160	119	60	42
2002	167	132	106	64
2003	121	94	88	53
2004	80	65	82	36
2005	148	104	0	0
2006	137	93	54	14
2007	127	85	134	20
2008	34	28	169	48
2009	0	0	42	13
2010	73	60	0	0
2011	93	64	0	0
2012	163	75	0	0
2013	129	73	30	26
2014	121	58	41	31
2015	93	52	36	20

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

Year	SRHS		MRIP	
	Fish (n)	Trips (n)	Fish (n)	Trips (n)
1972	0	0		
1973	0	0		
1974	0	0		
1975	0	0		
1976	0	0		
1977	0	0		
1978	10	5		
1979	36	27		
1980	150	73		
1981	161	108	0	0
1982	69	48	0	0
1983	35	33	0	0
1984	42	40	0	0
1985	24	20	0	0
1986	14	12	0	0
1987	0	0	0	0
1988	20	12	0	0
1989	0	0	0	0
1990	0	0	0	0
1991	14	11	0	0
1992	0	0	0	0
1993	0	0	0	0
1994	0	0	0	0
1995	0	0	0	0
1996	0	0	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	0	0	0	0
2001	0	0	14	10
2002	0	0	38	26
2003	0	0	27	23
2004	33	29	18	16
2005	79	63	0	0
2006	59	52	0	0
2007	47	42	0	0
2008	18	11	0	0
2009	0	0	0	0
2010	21	19	0	0
2011	54	33	0	0
2012	126	53	0	0
2013	99	53	0	0
2014	112	52	13	9
2015	40	40	0	0

Figure 1: Red grouper nominal and weighted length composition from the headboat fishery.
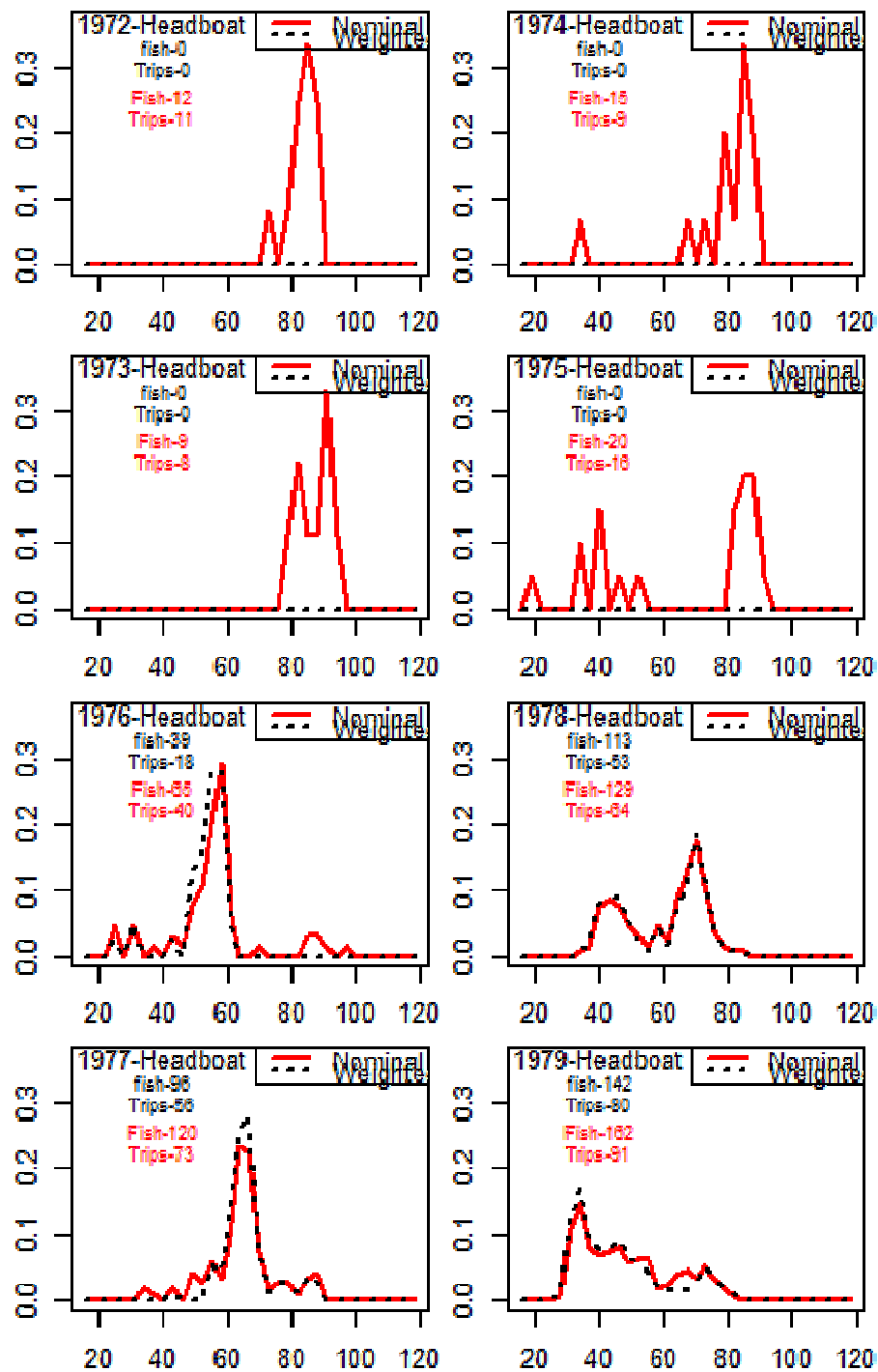
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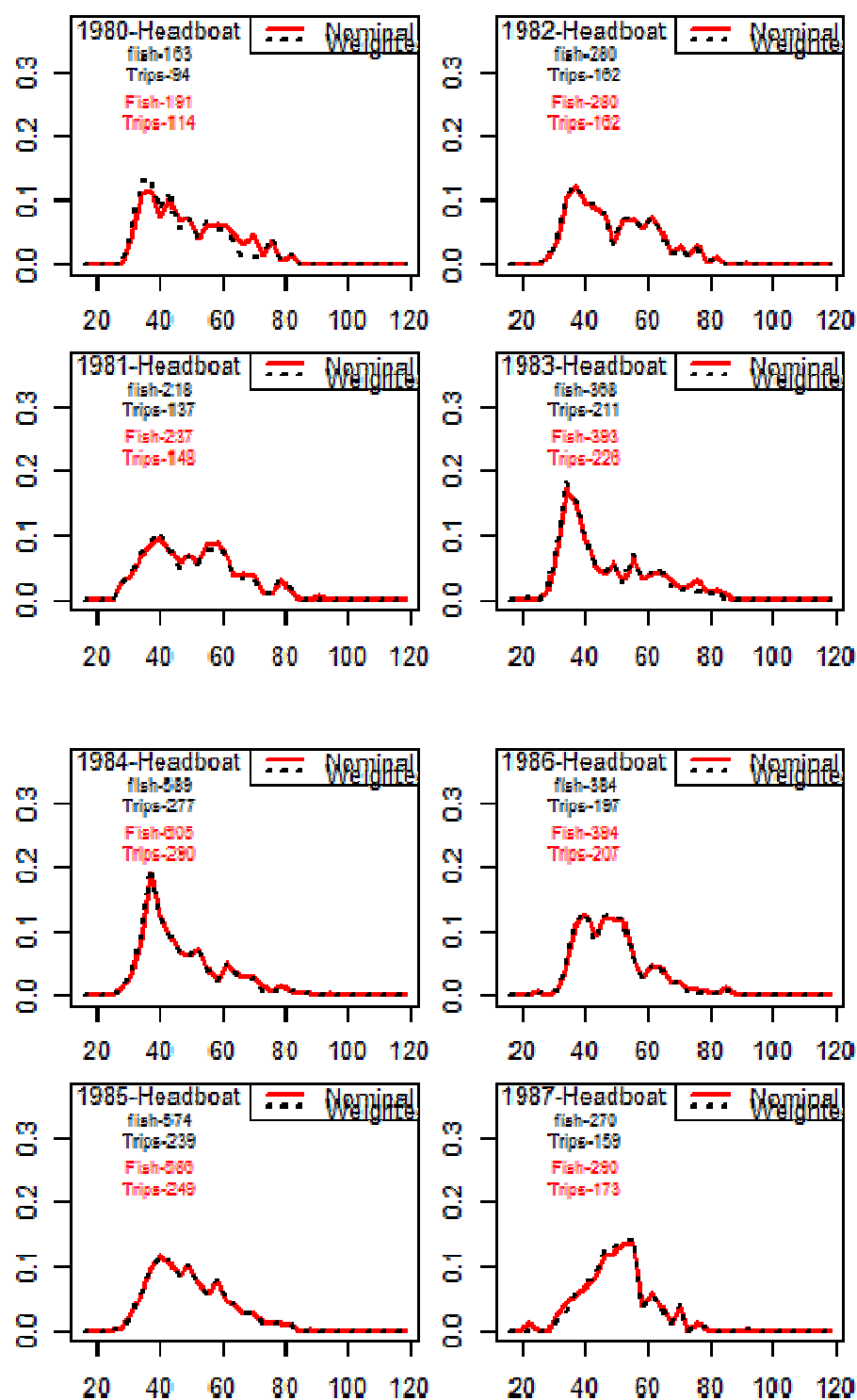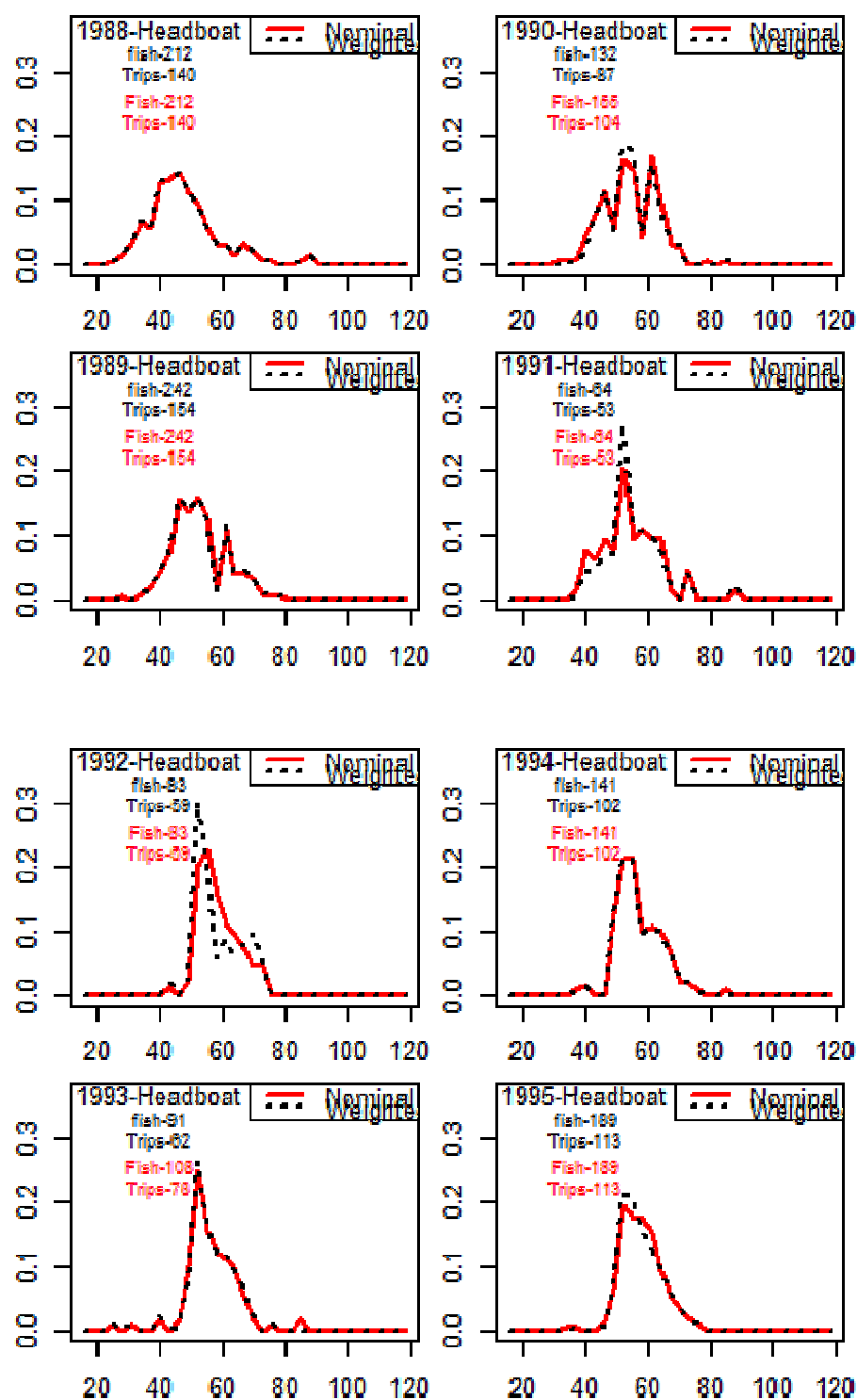
Figure 1: Continued.
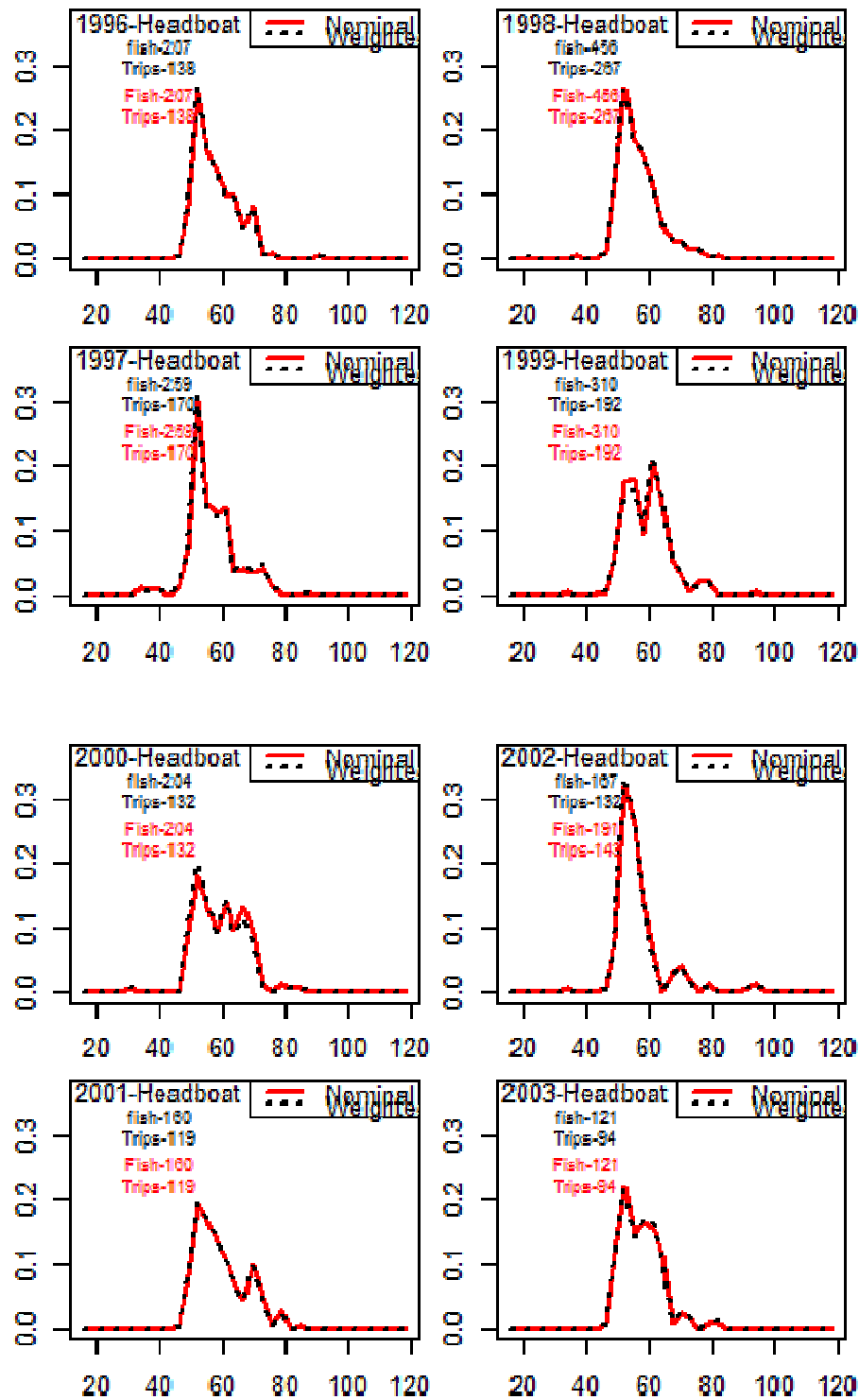
Figure 1: Continued.
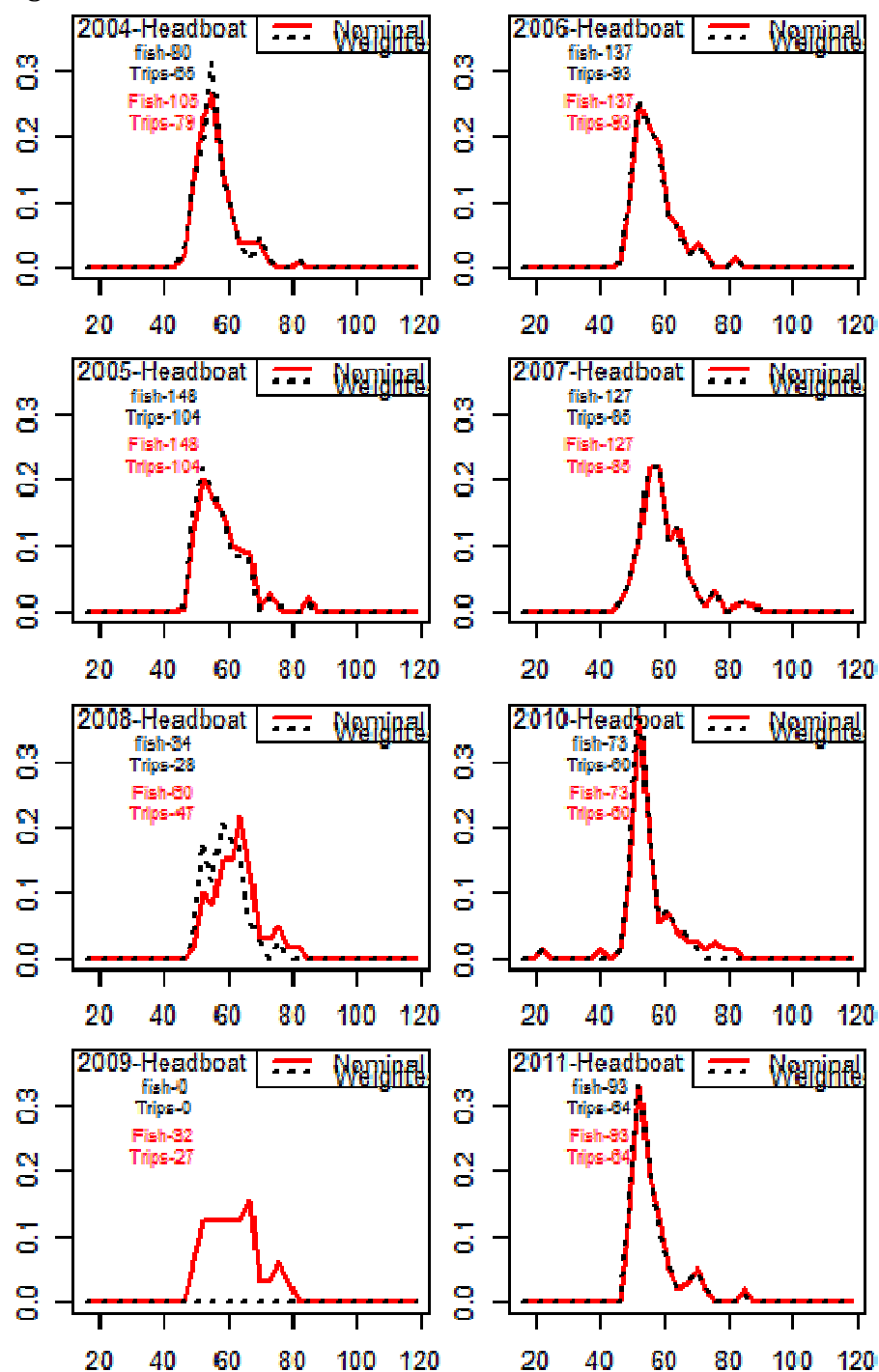
Figure 1: Continued.
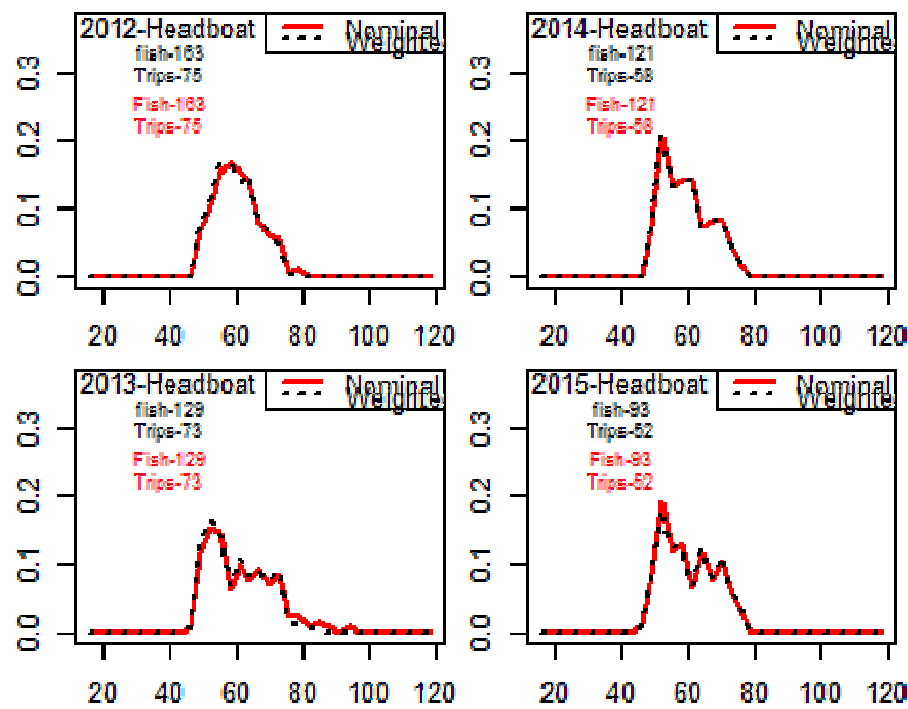
Figure 1: Continued.

Figure 2: Red grouper nominal and weighted length composition from the charter and private modes.
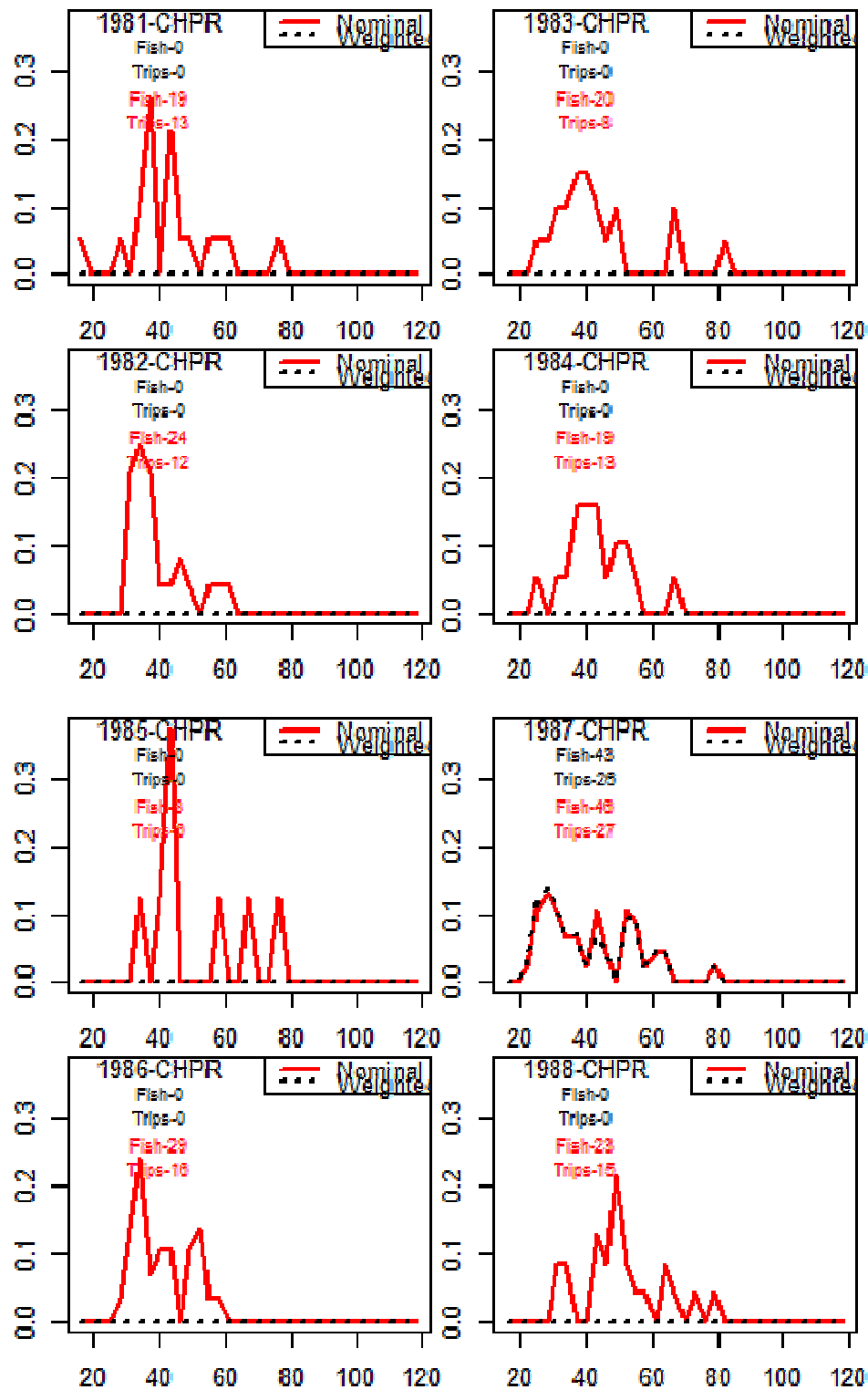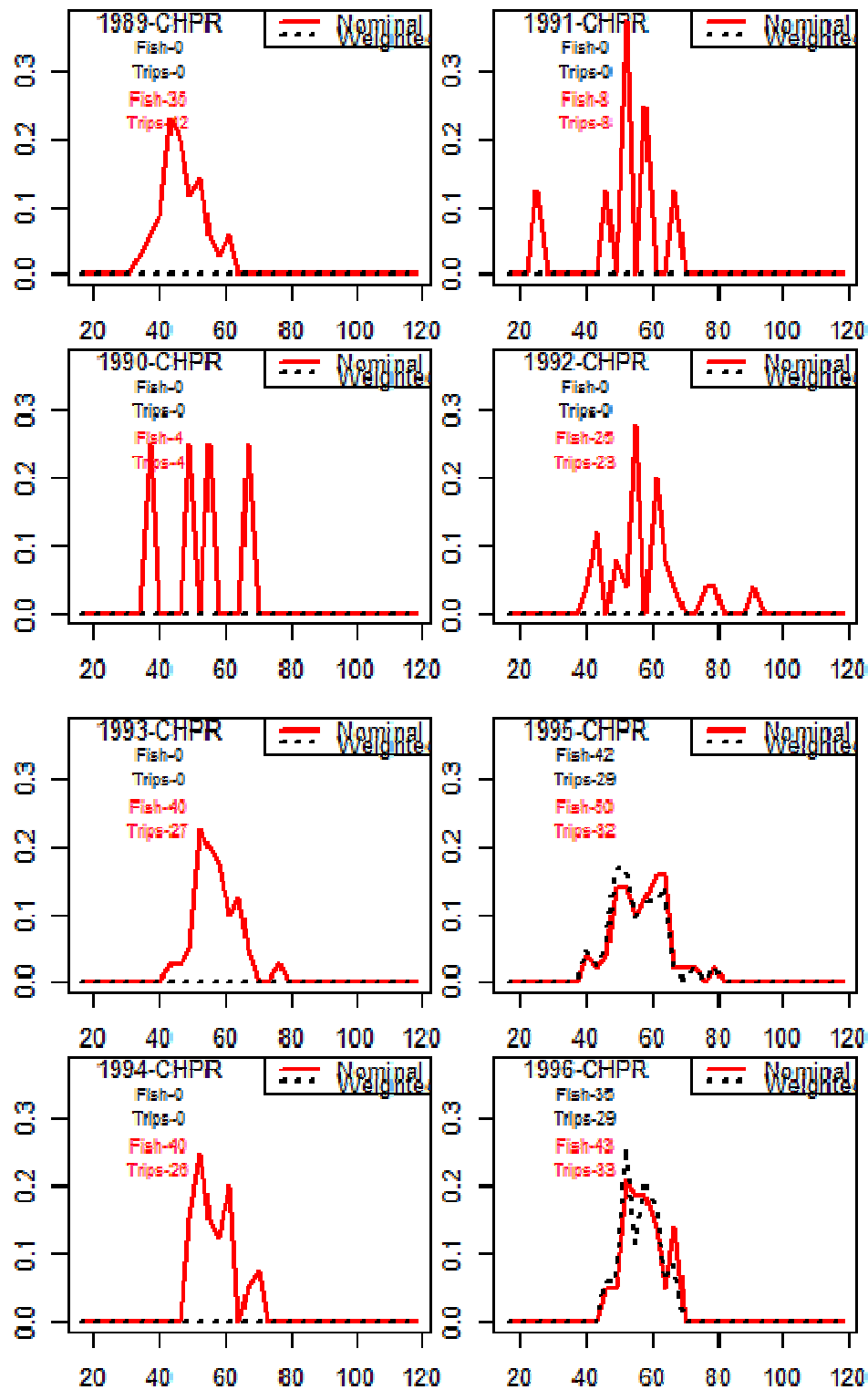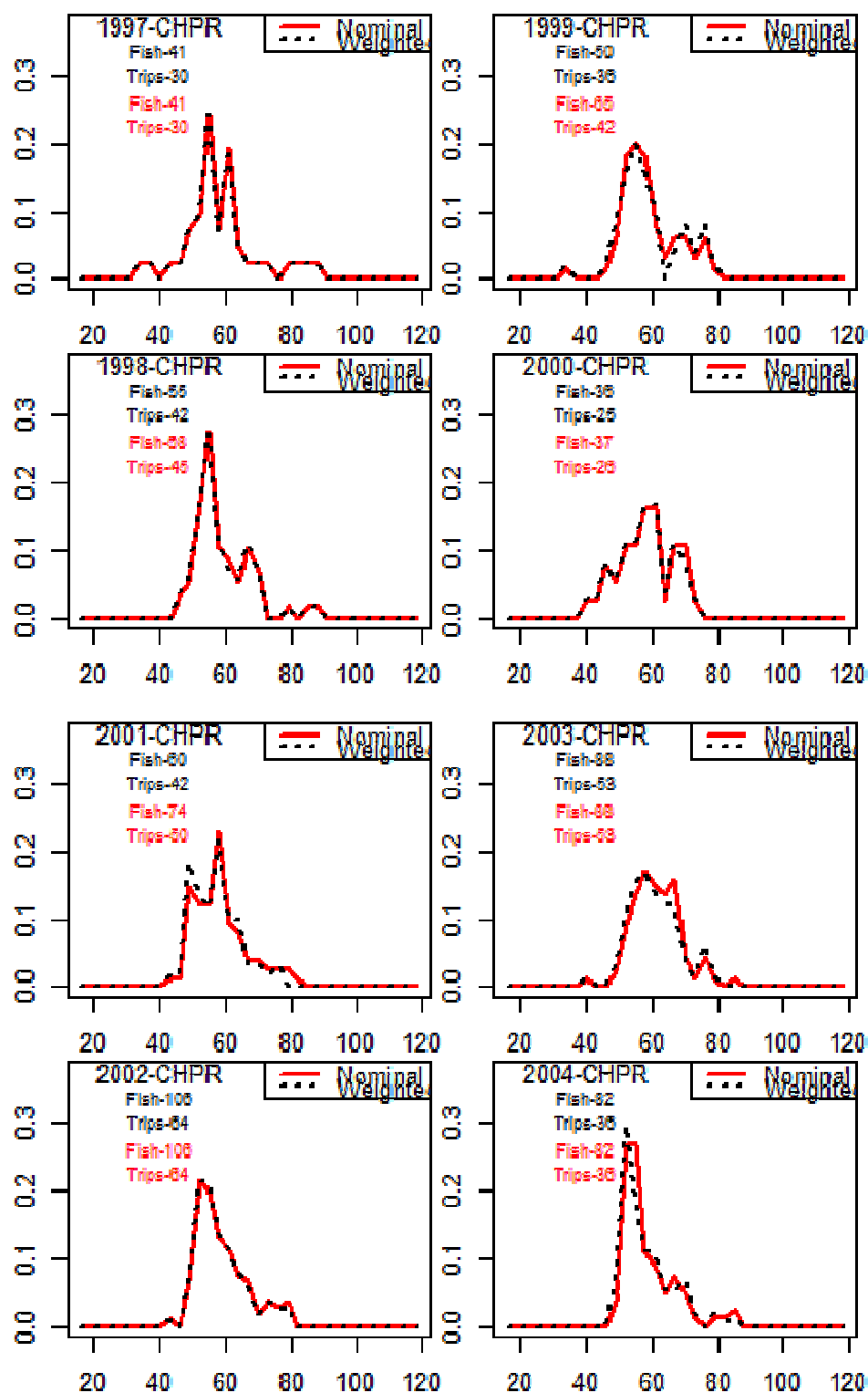
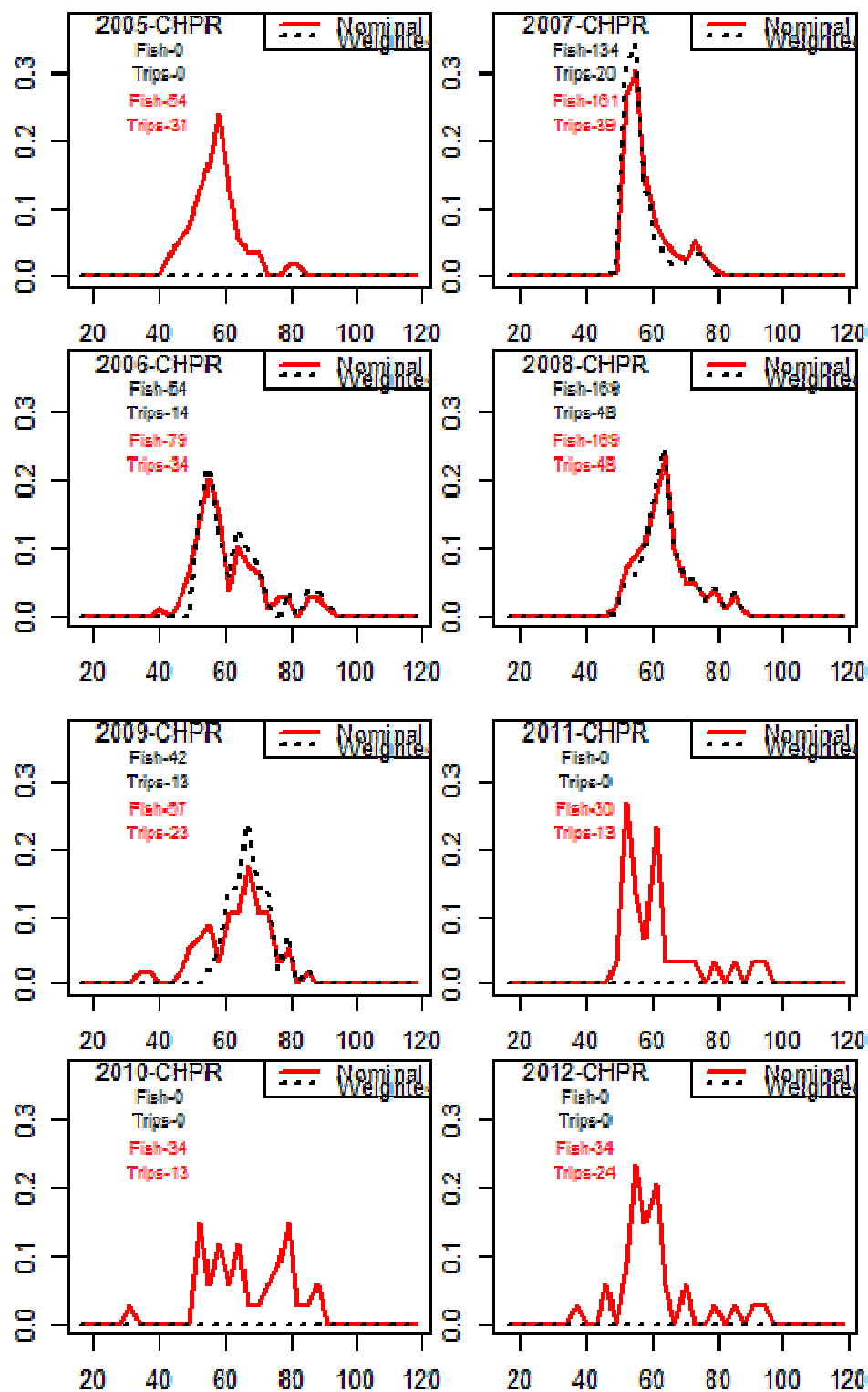Figure 2: Continued.

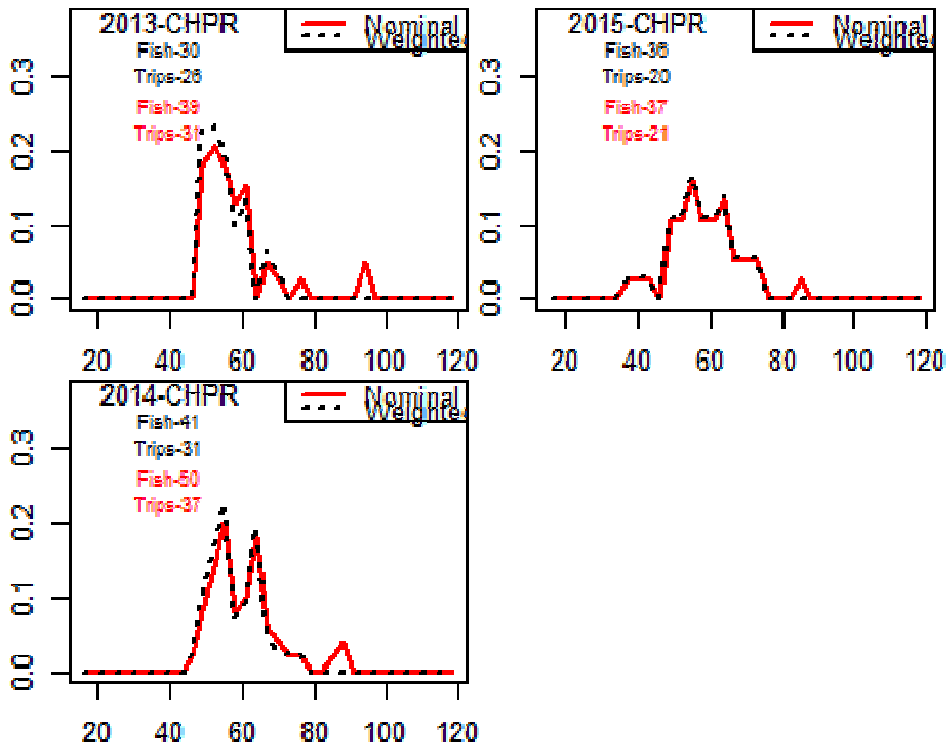Figure 2: Continued.

Figure 2: Continued.

Figure 2: Continued.

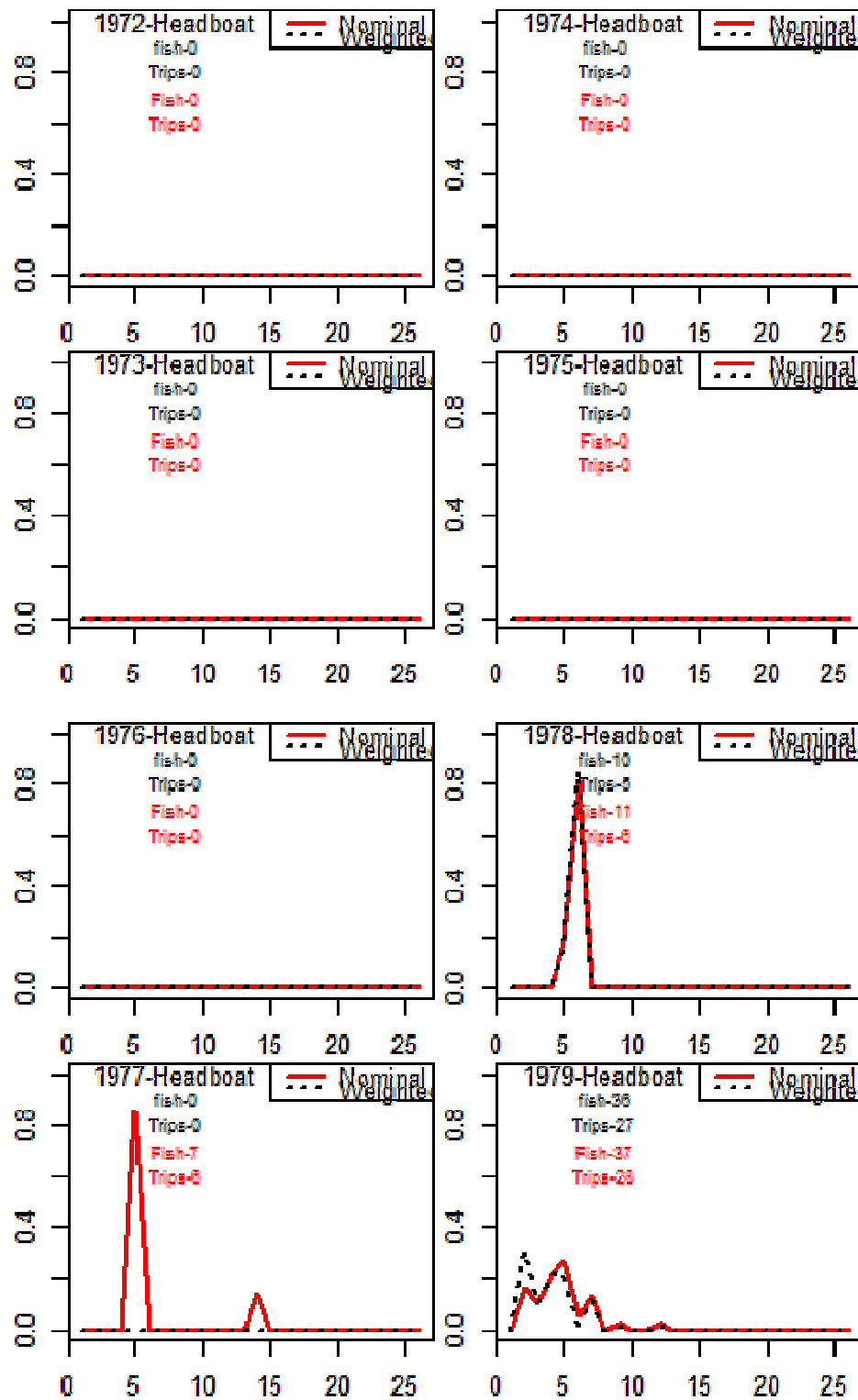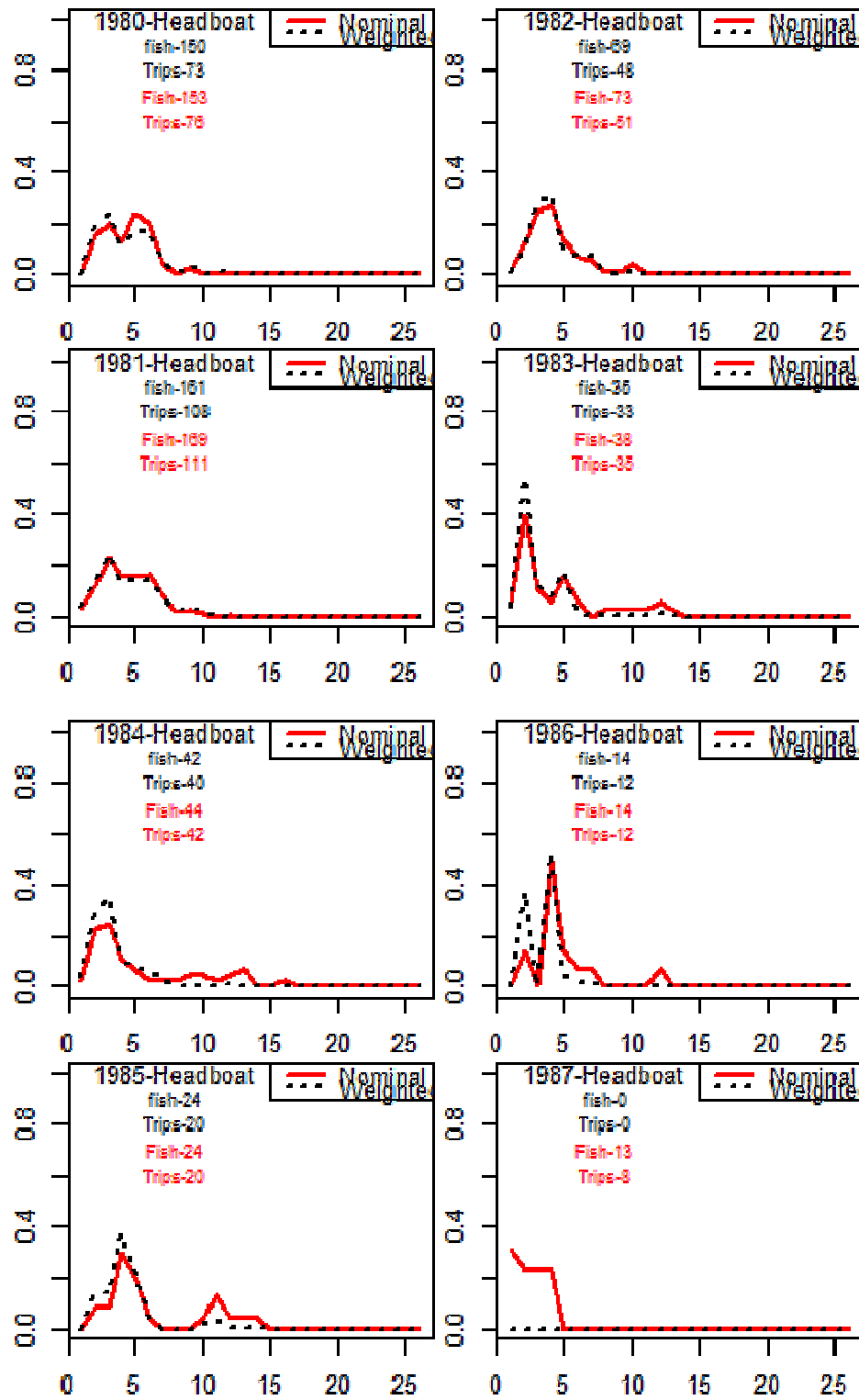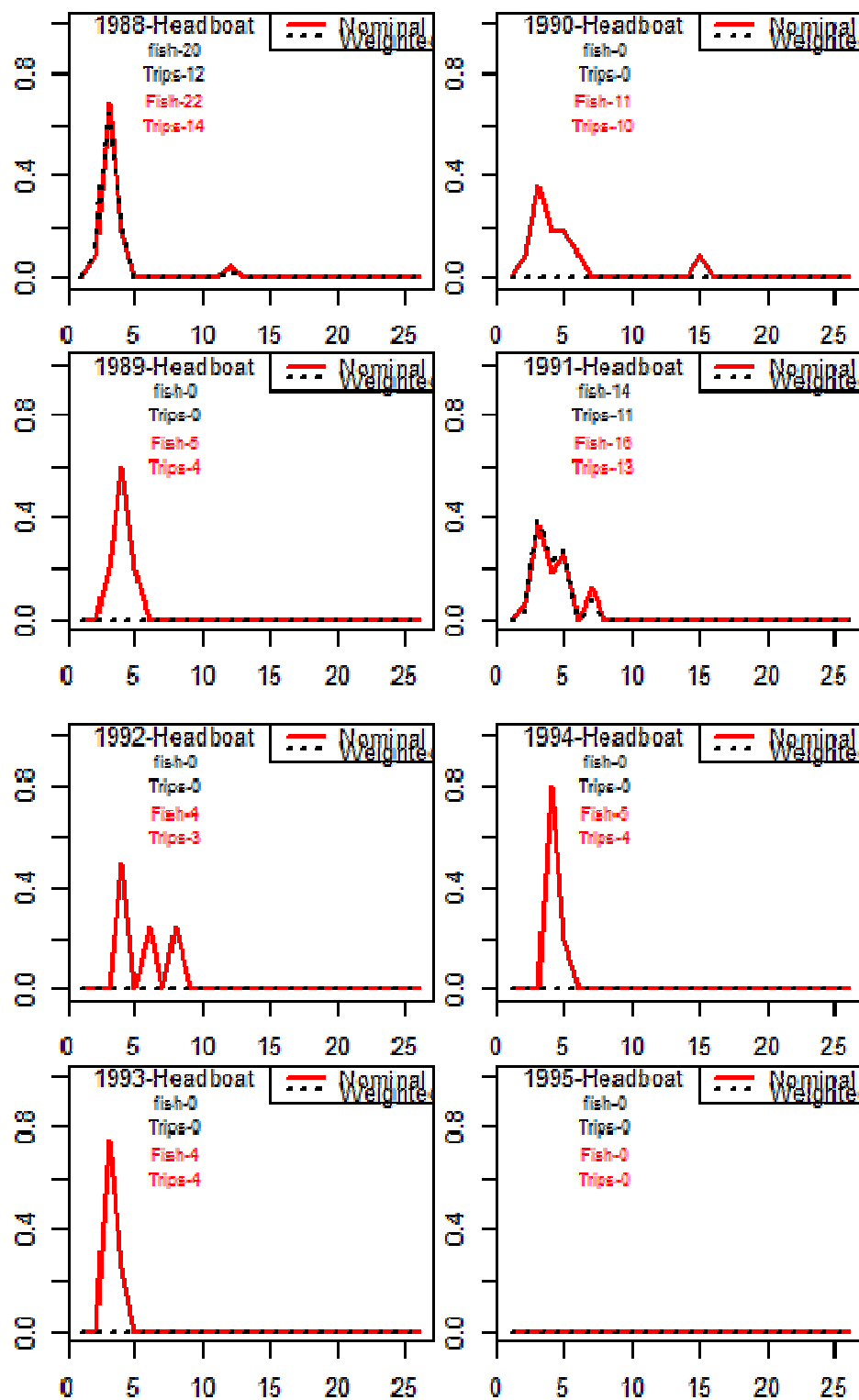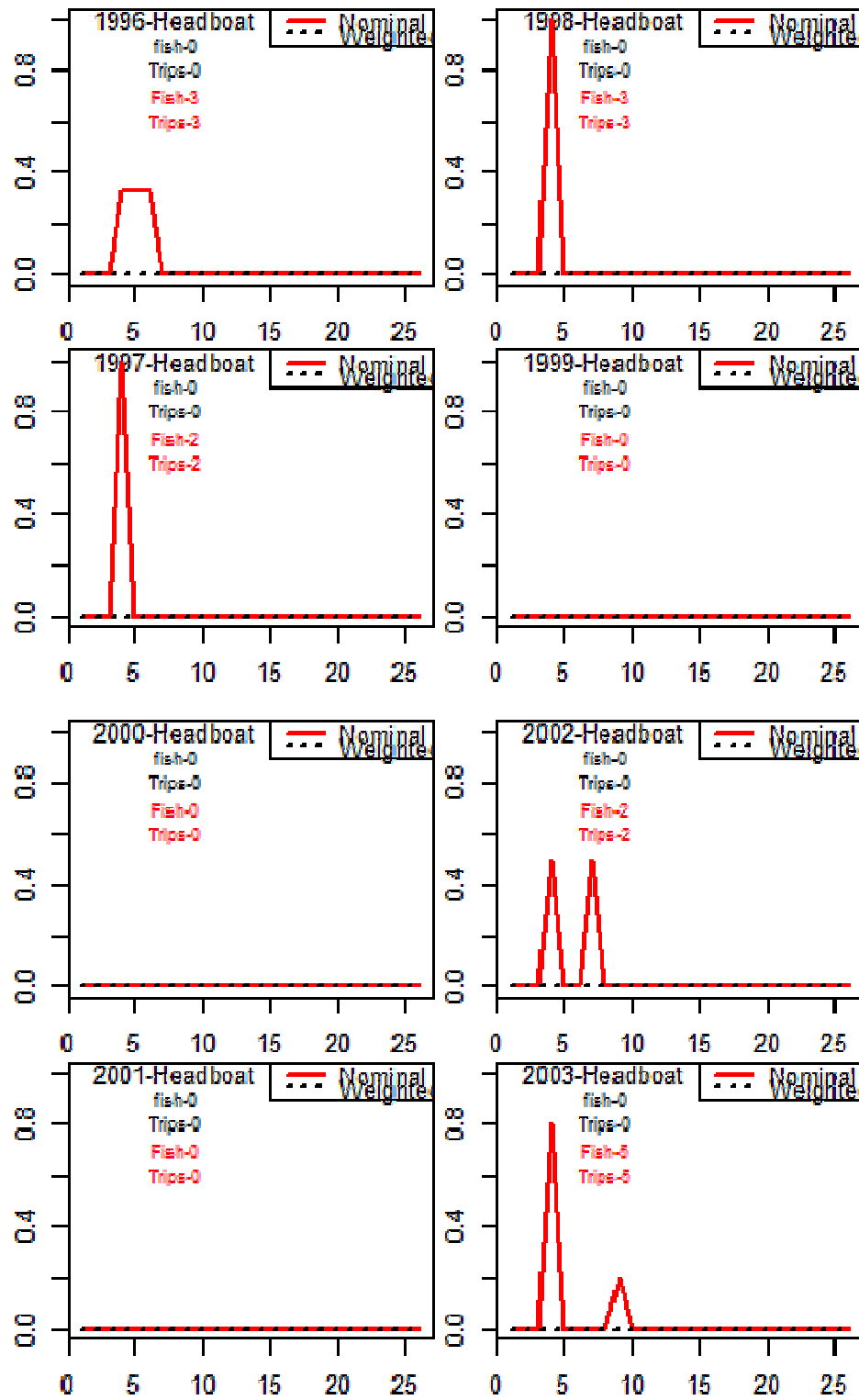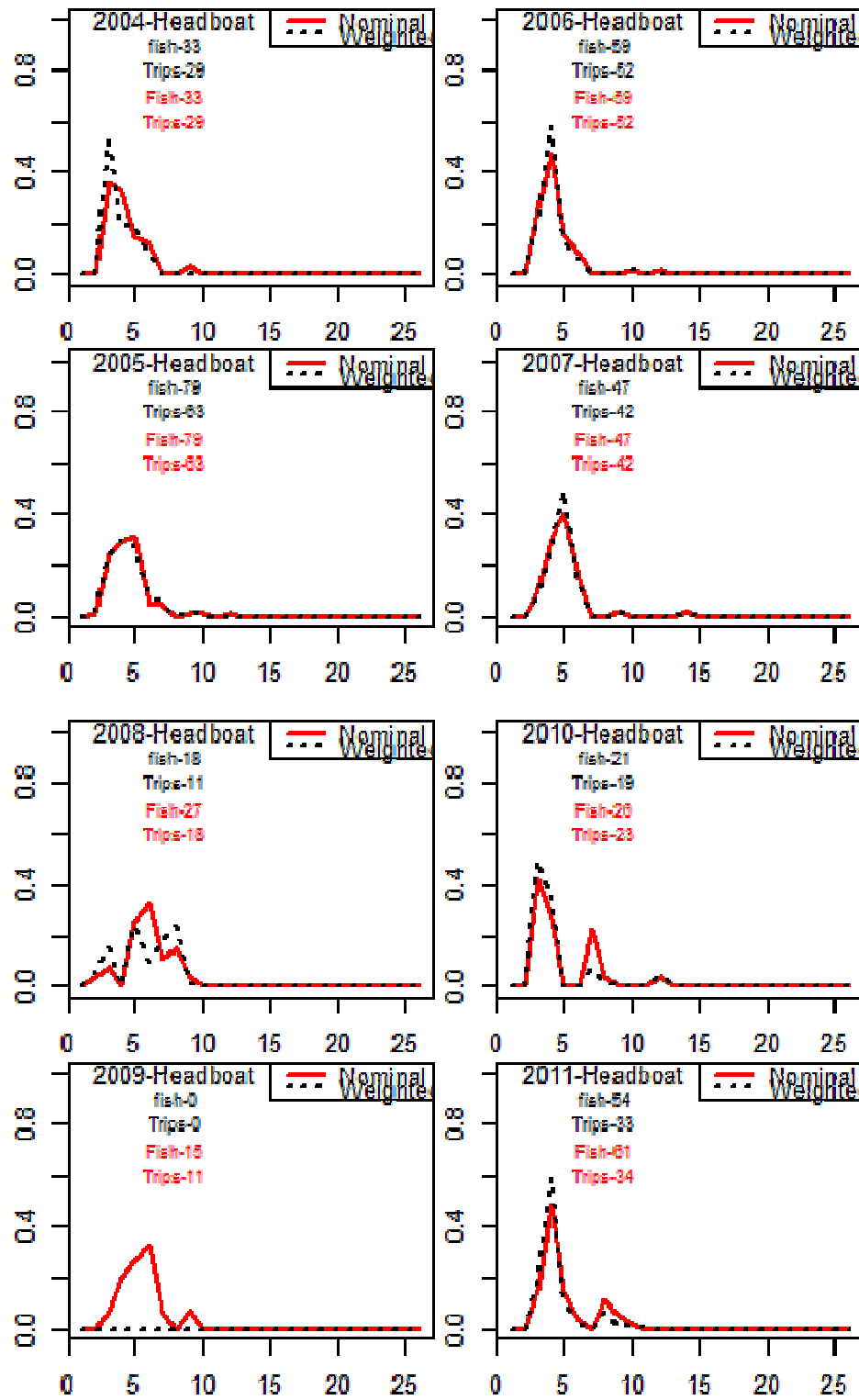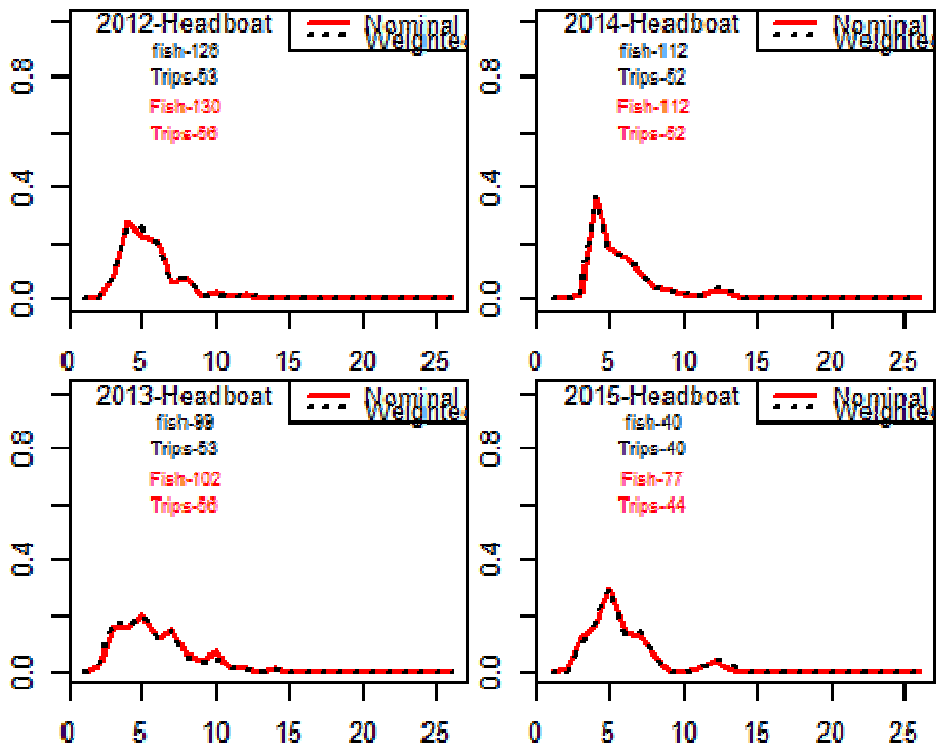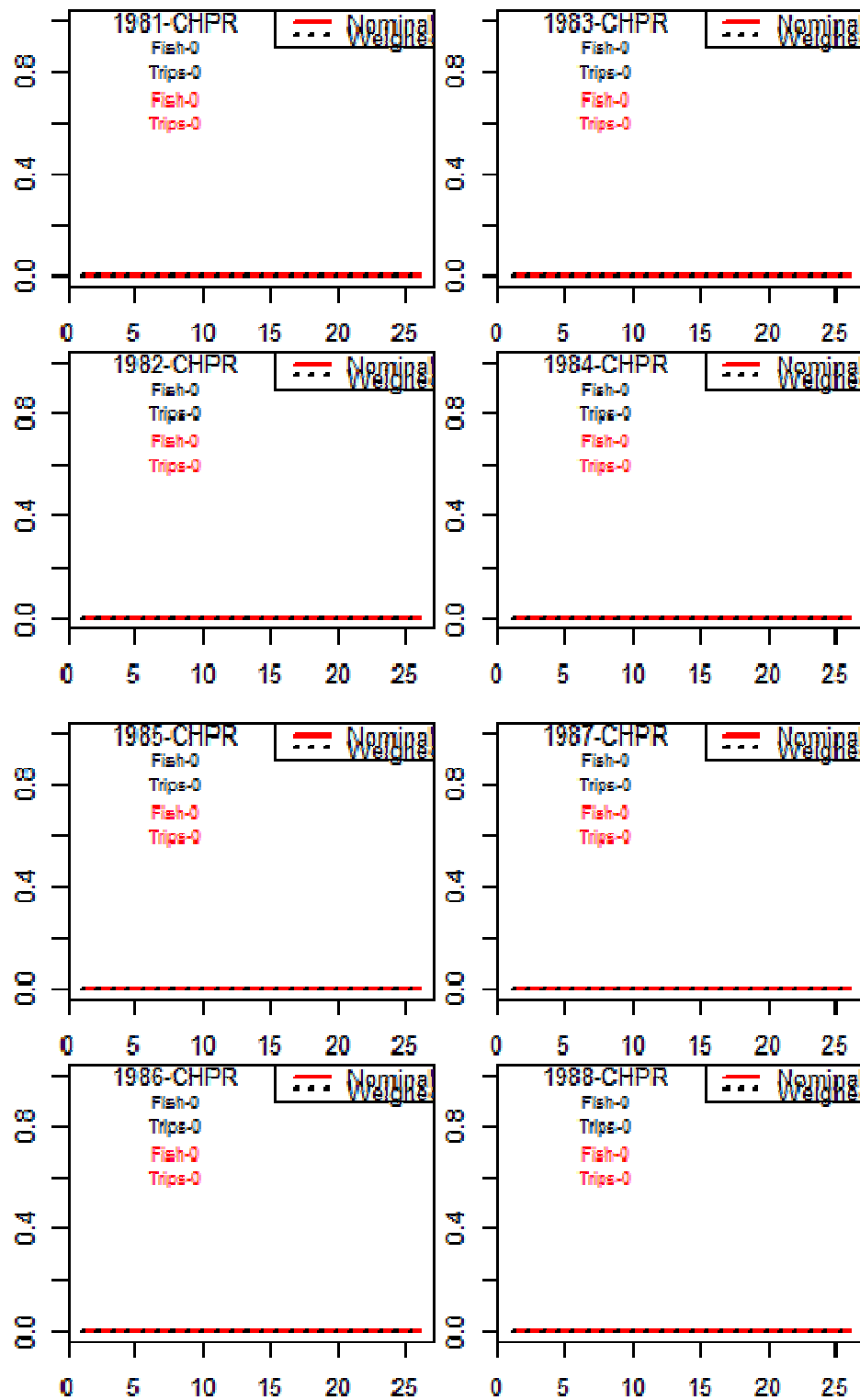Figure 3: Red grouper nominal and weighted age composition from the headboat fishery.

Figure 3: Continued.

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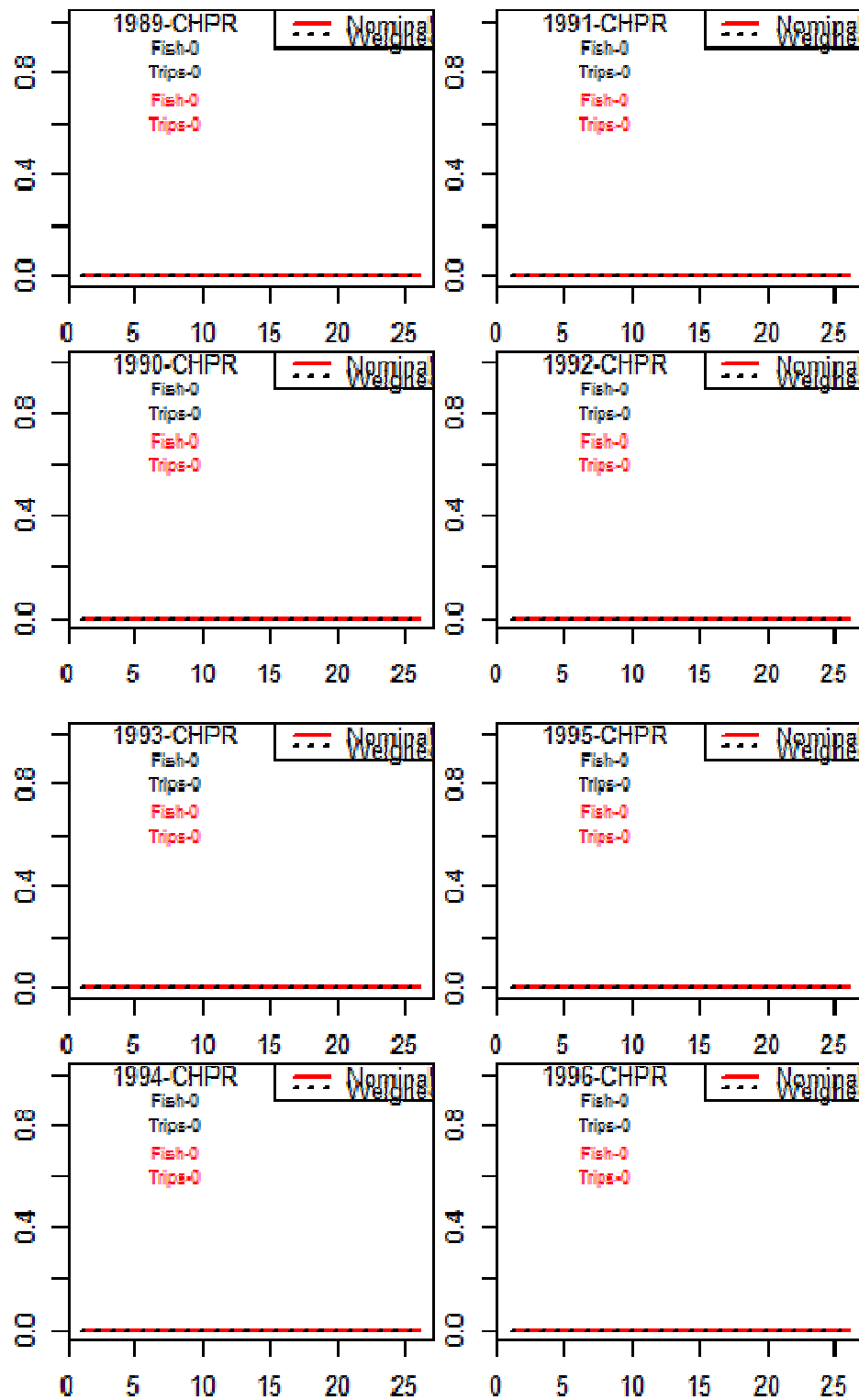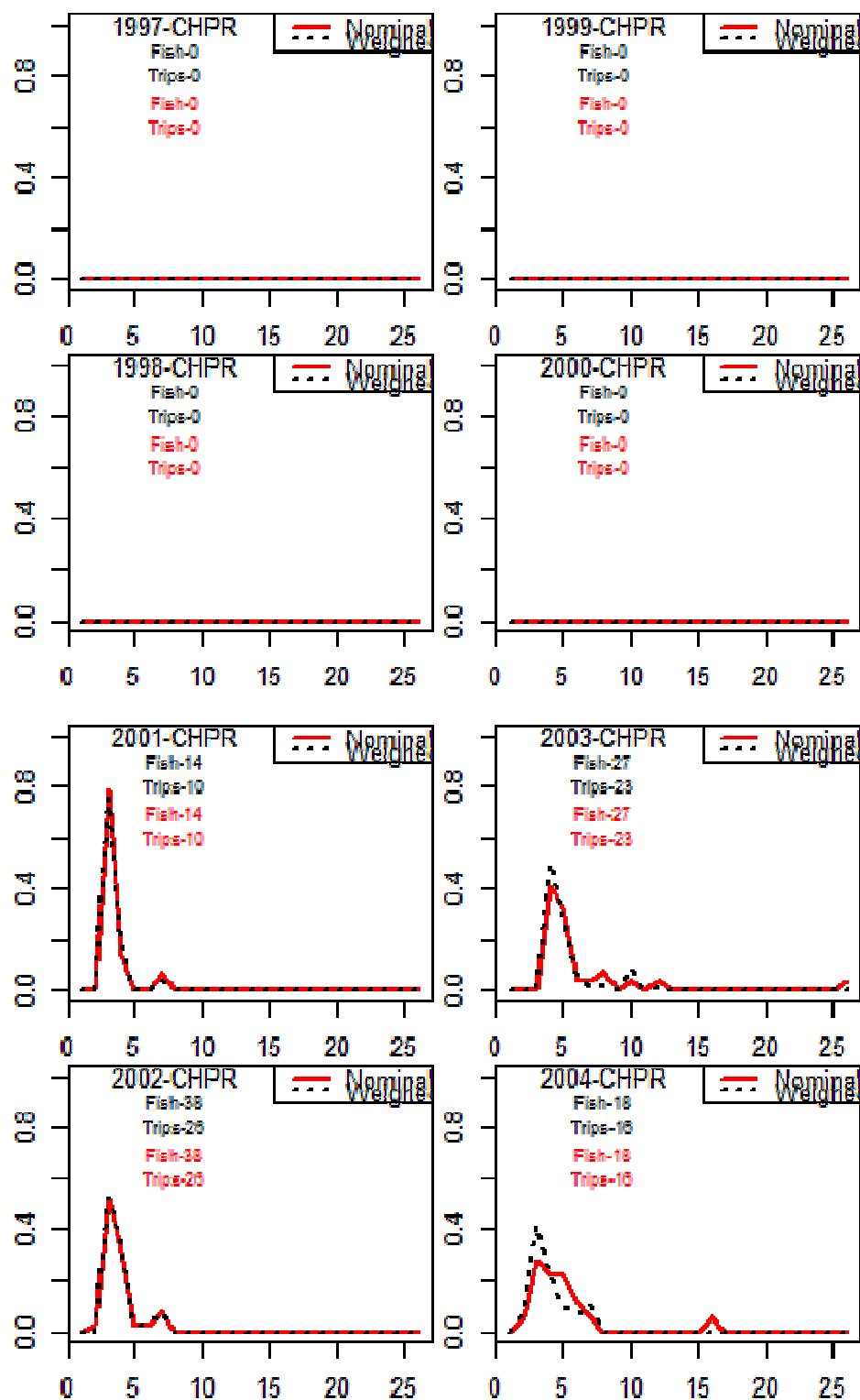Figure 4: Red grouper nominal and weighted age compositions from the charter and private boat modes.

Figure 4: Continued.
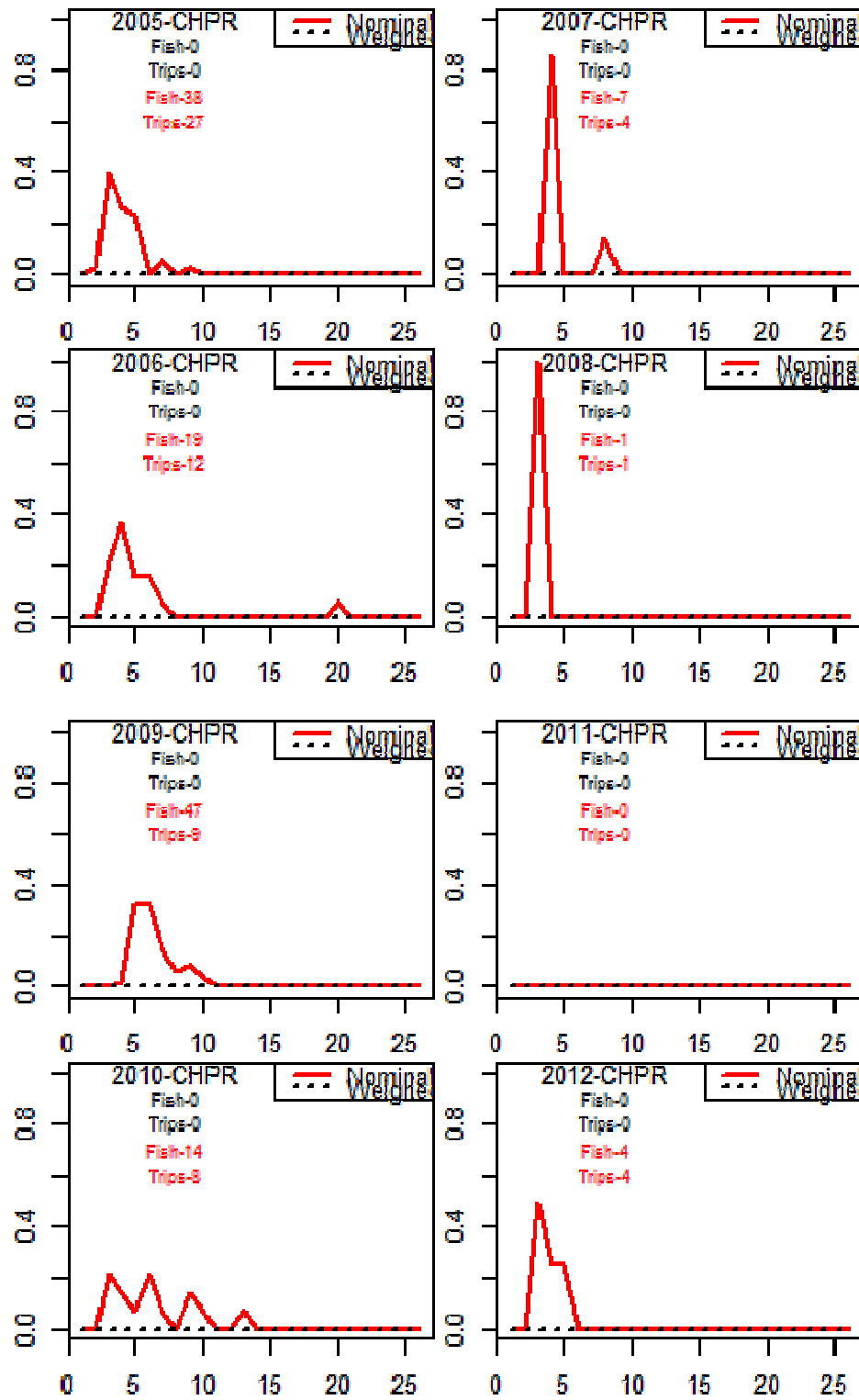
Figure 4: Continued.

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