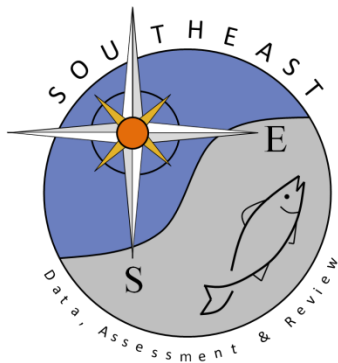


## South Atlantic U.S. gray triggerfish (*Balistes capriscus*) age and length composition from the recreational fisheries

Fisheries Ecosystem Branch, National Marine Fisheries Service (contact: Kelly Fitzpatrick)

SEDAR41-AW04

Submitted: 08 December 2015



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## South Atlantic U.S. gray triggerfish (*Balistes capriscus*) age and length composition from the recreational fisheries

Sustainable Fisheries Branch, National Marine Fisheries Service, Southeast Fisheries Science Center, 101 Pivers Island Rd., Beaufort, NC 28516

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.

##### *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. Gray triggerfish 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.

## 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 gray triggerfish 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
- Region assigned (GA north & FL)
- Fleet assigned: 1. Headboat (SRHS, MRIP) and 2. CH/PR (SC Finfish Survey, MRIP)
- Range of lengths: 11 to 83 cm (1cm bins)

### 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 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 (GA north & FL)
- Fleet assigned: 1. Headboat (SRHS, MRIP) and 2. CH/PR (SC Finfish Survey, MRIP)
- Range of lengths: 24 to 57 cm (1cm bins)

## 4 Results

### 4.1 Lengths

The recreational (both SRHS and MRIP) length compositions showed a wide range of fish (11 to 83 cm FL). Prior to the late 1970s fish sampled in the recreational fishery generally ranged from 30 cm to 60 cm FL. Beginning in 1978 slightly smaller fish (20 cm FL) were captured. This coincides with an increase in desirability of gray triggerfish in those years. It's important to note that weighting had limited influence on the length composition (Figure 1).

### 4.2 Ages

The weighted age compositions are very similar to the nominal age compositions. Ages encountered in both the SRHS and MRIP fleets ranged from 1-10 (Figure 2).

## 5 Discussion

There is minimal influence when weighting the recreational and commercial length or age compositions for gray triggerfish. 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 gray triggerfish in the recreational fishery. A minimum of 30 length measurements was required.

Year	Fish (n)	Trips (n)
1972	112	60
1973	96	50
1974	298	106
1975	377	141
1976	422	179
1977	457	179
1978	597	225
1979	350	141
1980	427	180
1981	484	238
1982	565	247
1983	988	423
1984	865	426
1985	989	446
1986	756	363
1987	588	307
1988	462	254
1989	795	314
1990	856	286
1991	664	236
1992	831	296
1993	940	324
1994	1294	306
1995	996	301
1996	1287	252
1997	1708	357
1998	1025	381
1999	902	330
2000	478	216
2001	646	272
2002	886	348
2003	1203	398
2004	1654	444
2005	1149	334
2006	931	357
2007	1297	446
2008	881	298
2009	1271	434
2010	1916	475
2011	1517	403
2012	1563	412
2013	3039	506
2014	2194	559



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

Year	Fish (n)	Trips (n)
1990	18	10
1991	37	21
2003	43	24
2004	60	24
2005	157	53
2006	111	39
2007	79	48
2008	18	10
2009	29	28
2010	97	55
2011	60	35
2012	123	35
2013	494	134
2014	586	196

Figure 1. GTF nominal and weighted length compositions.

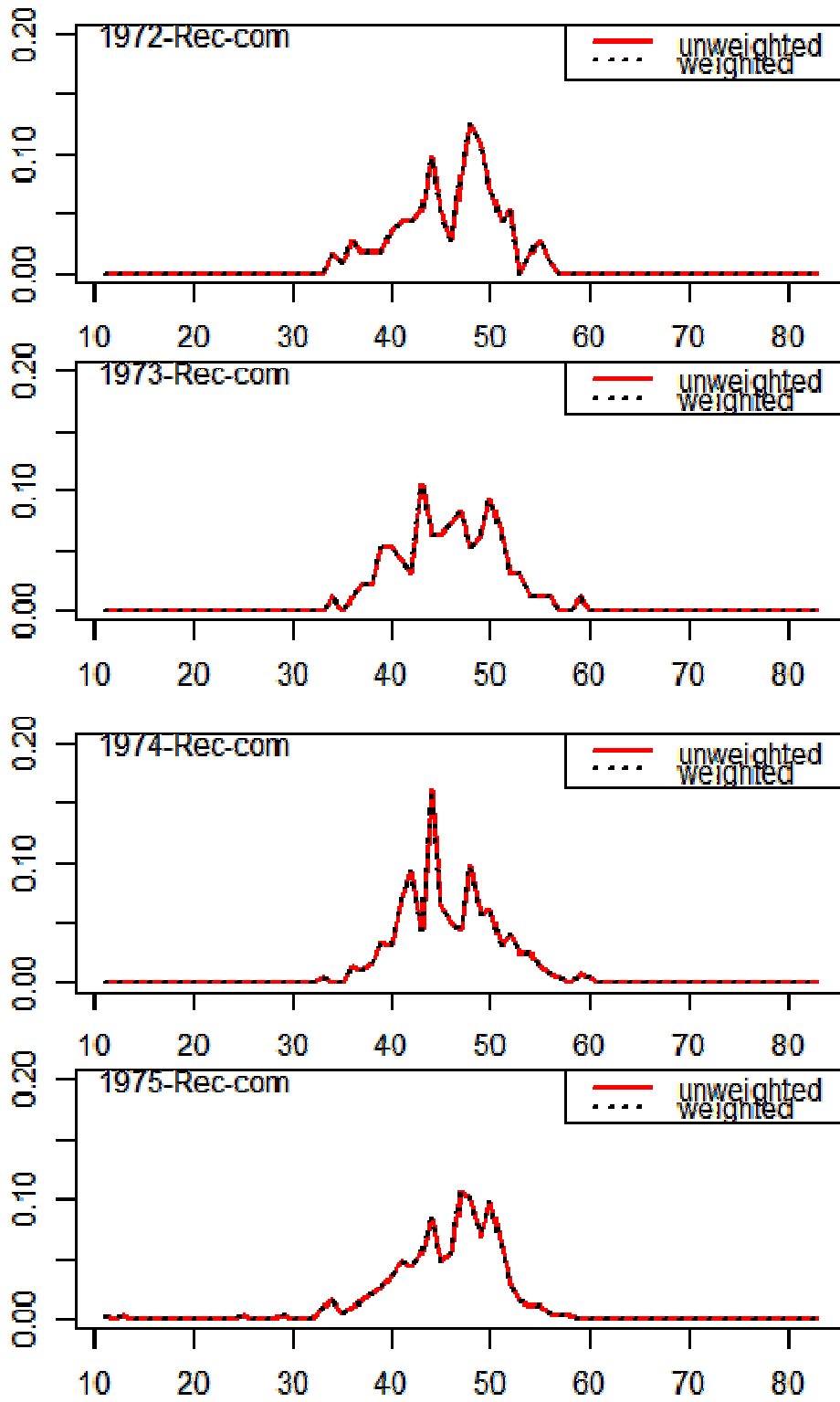


Figure 1. (cont.)

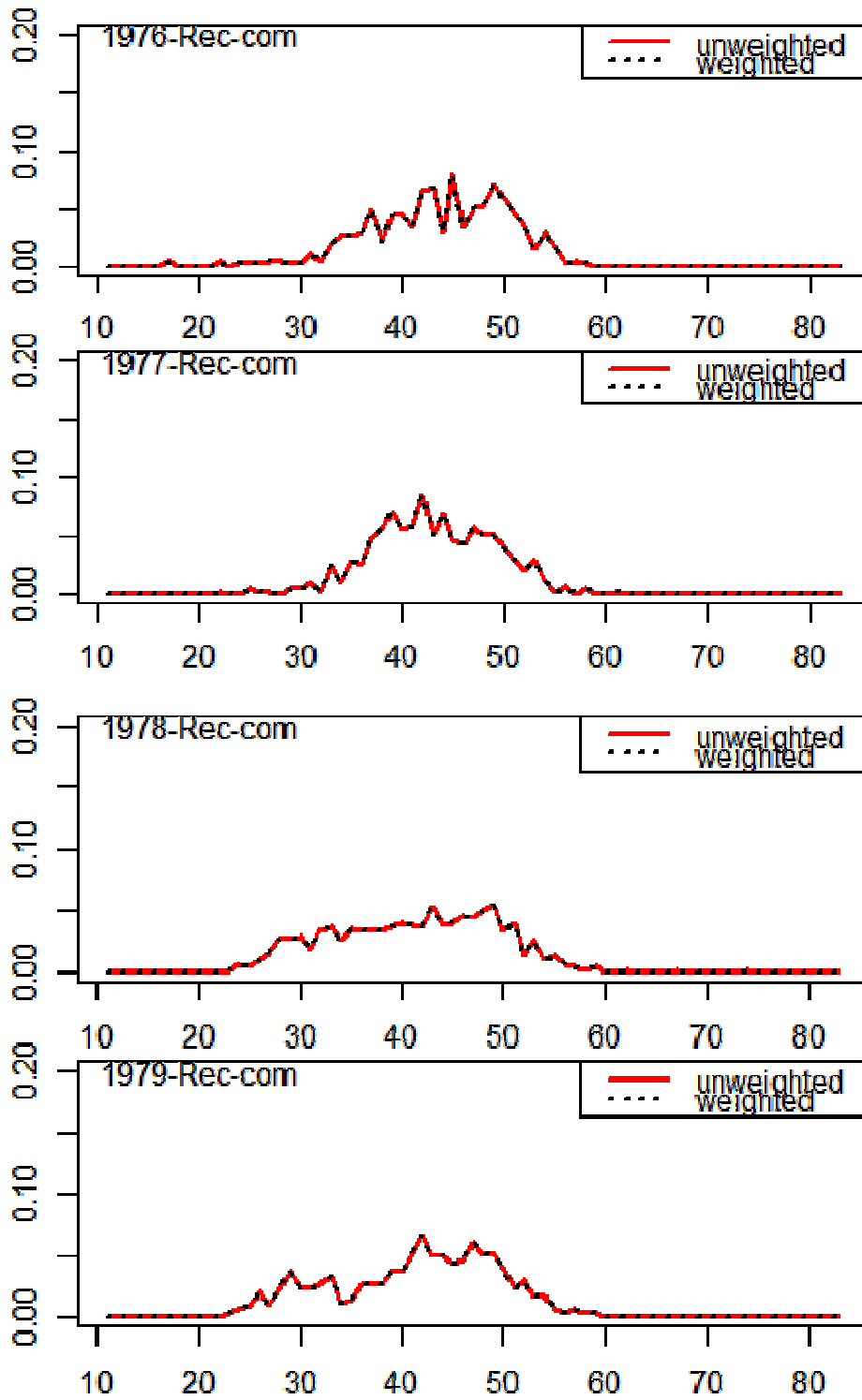


Figure 1. (cont.)

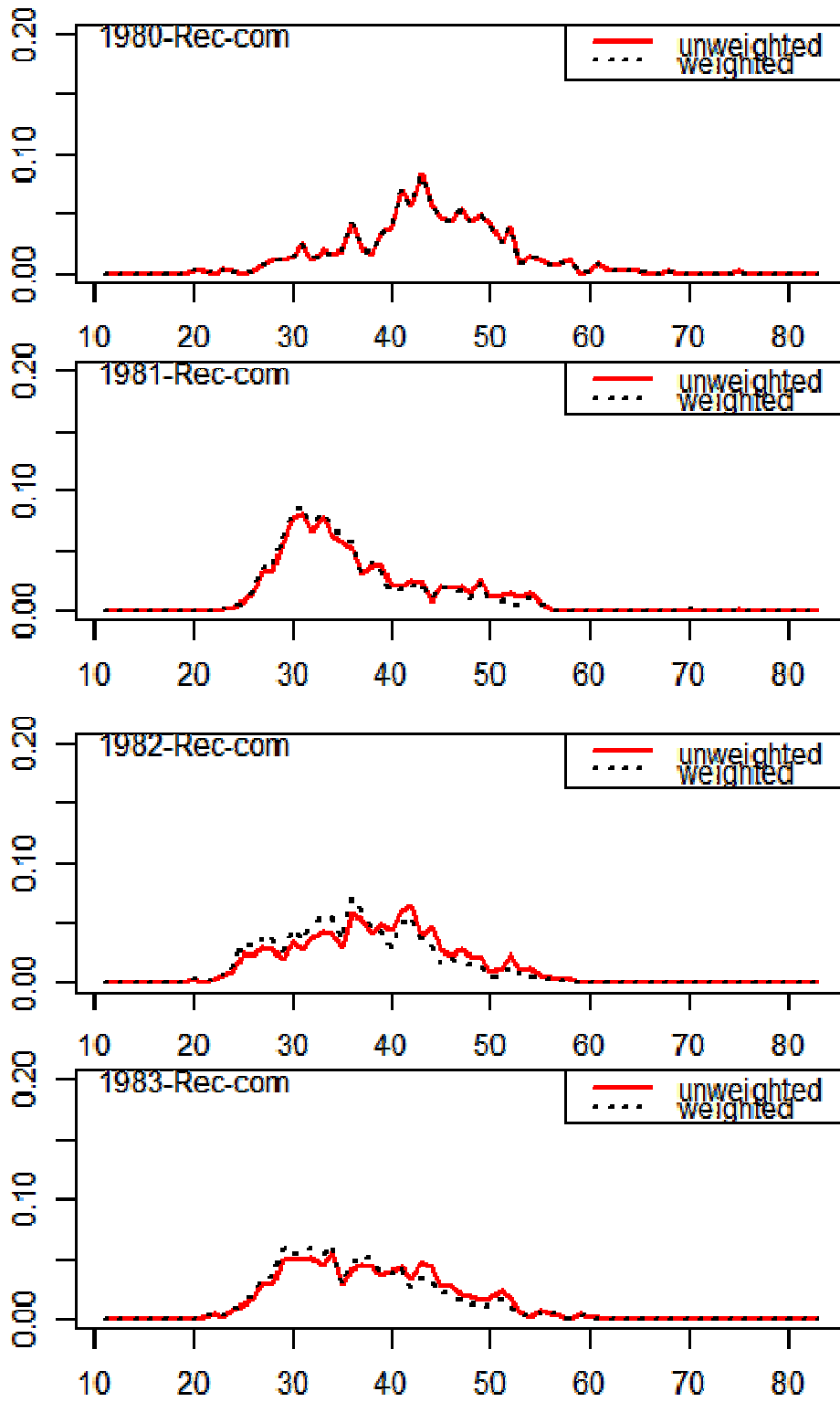


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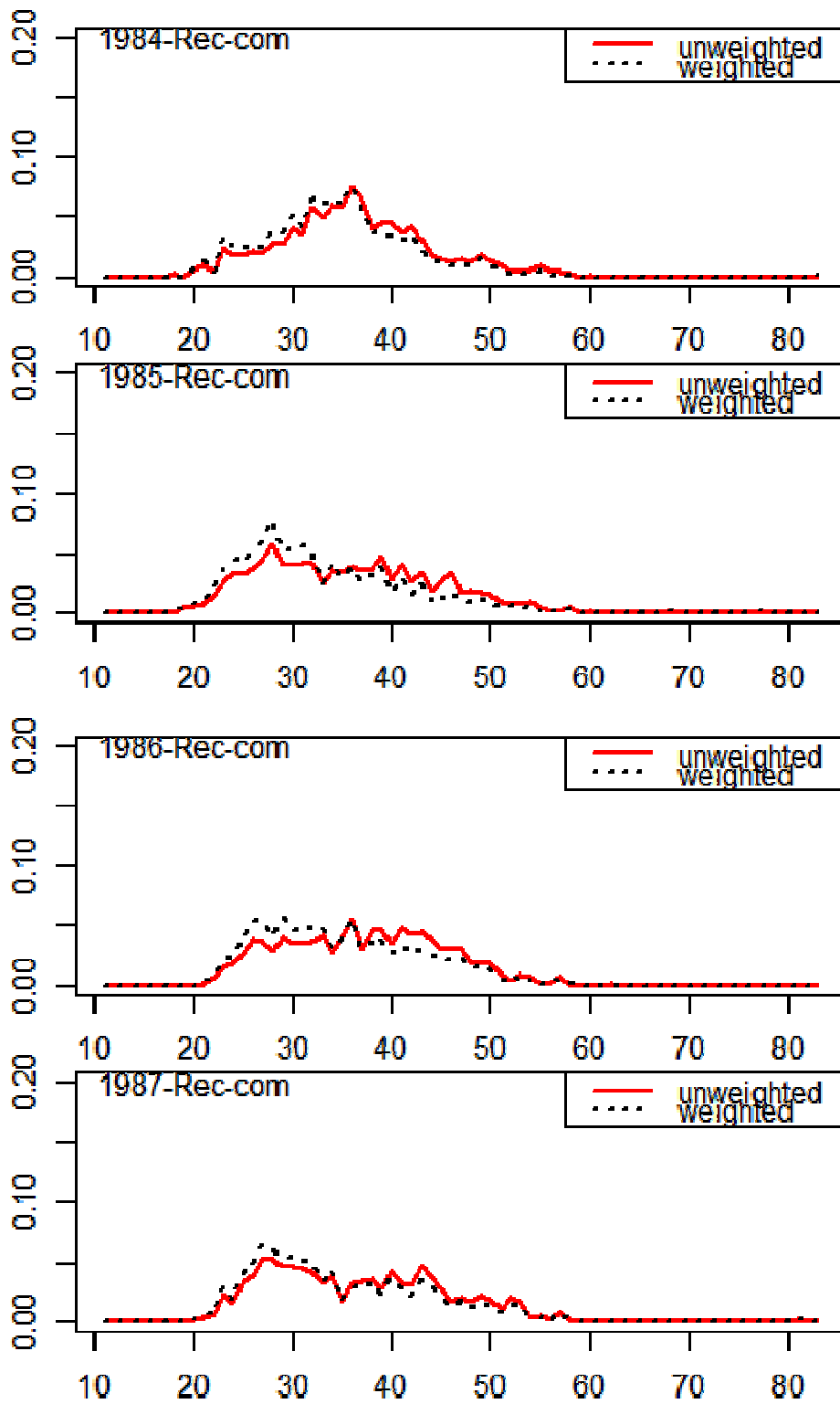


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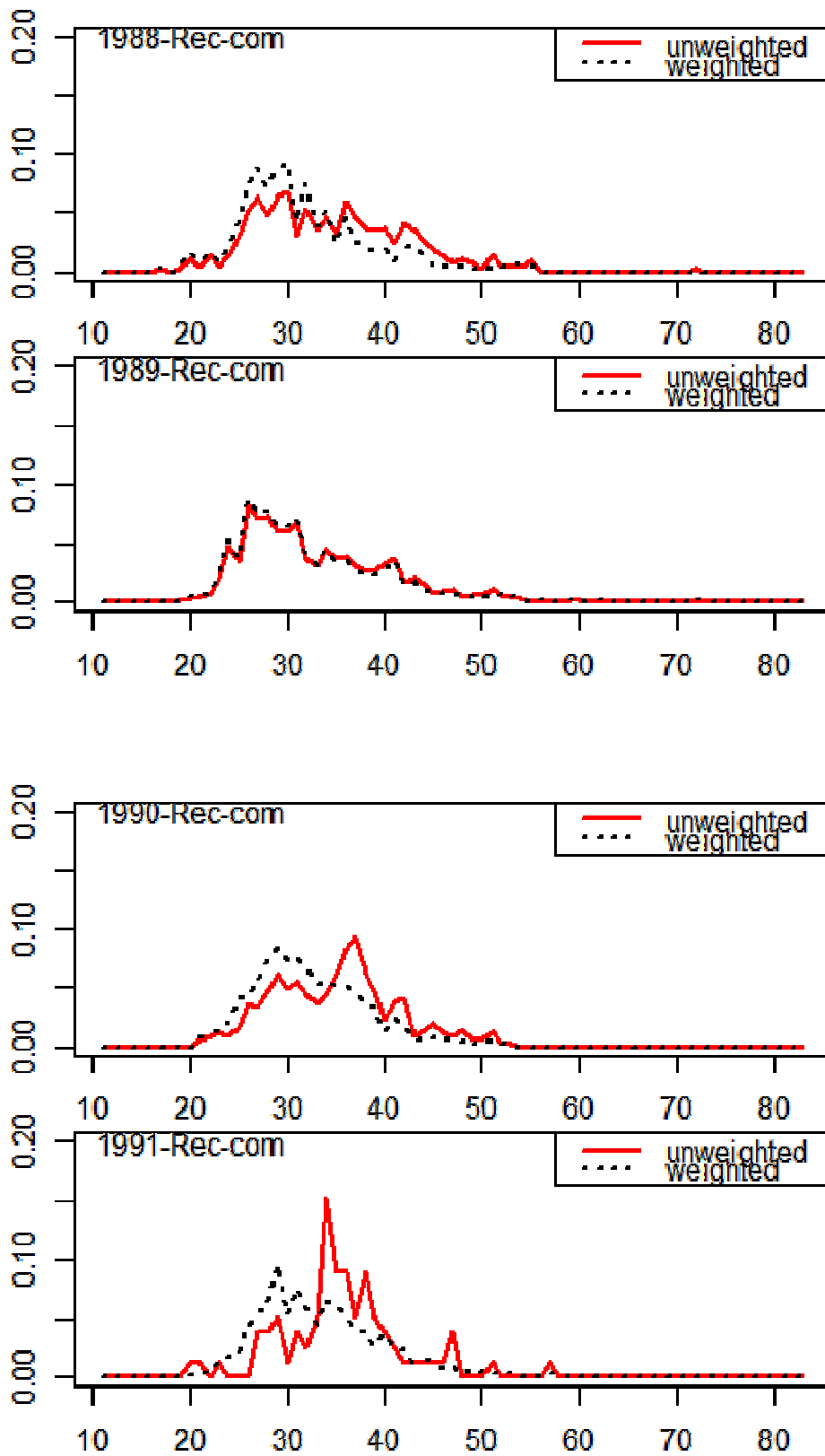


Figure 1. (cont.)

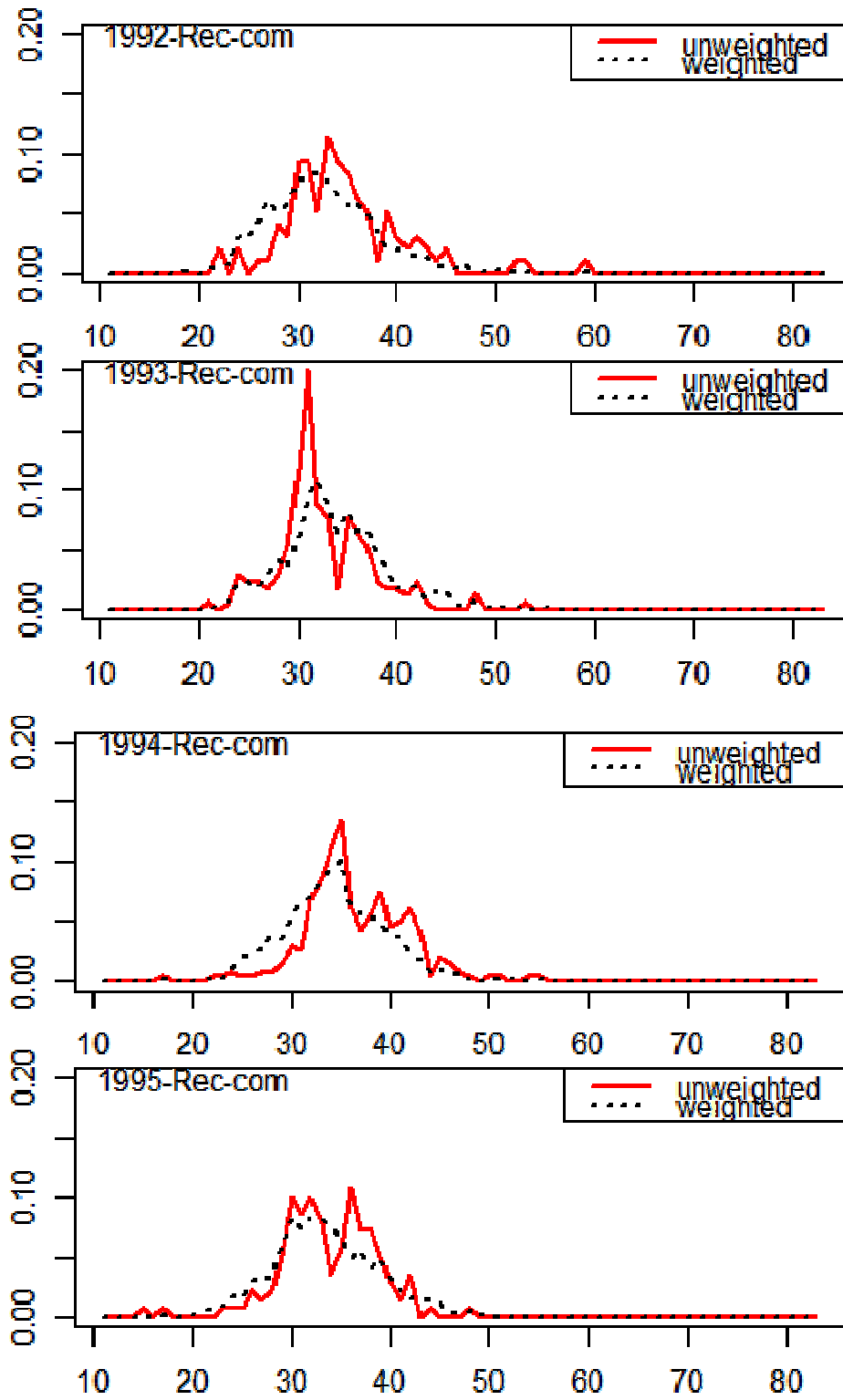


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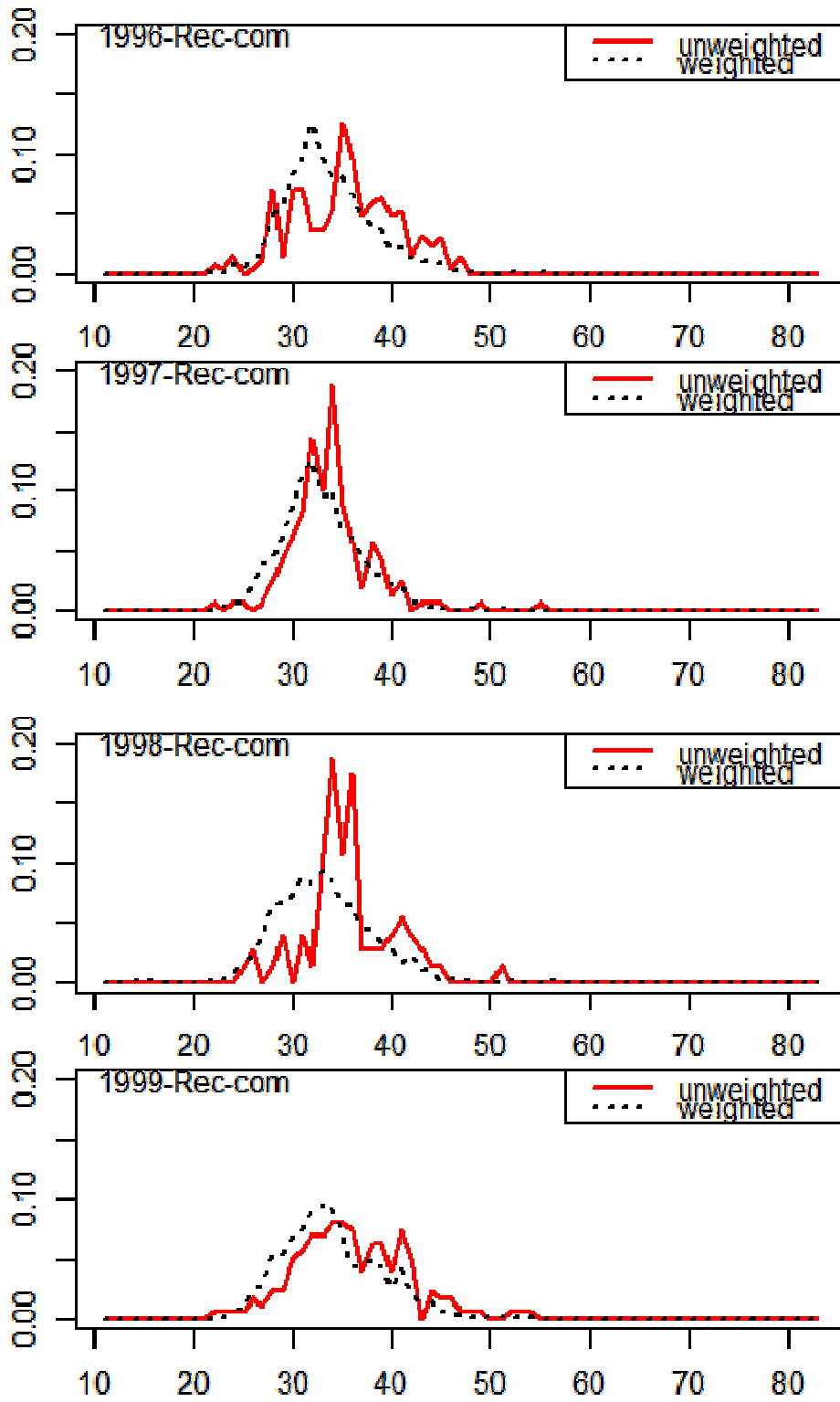




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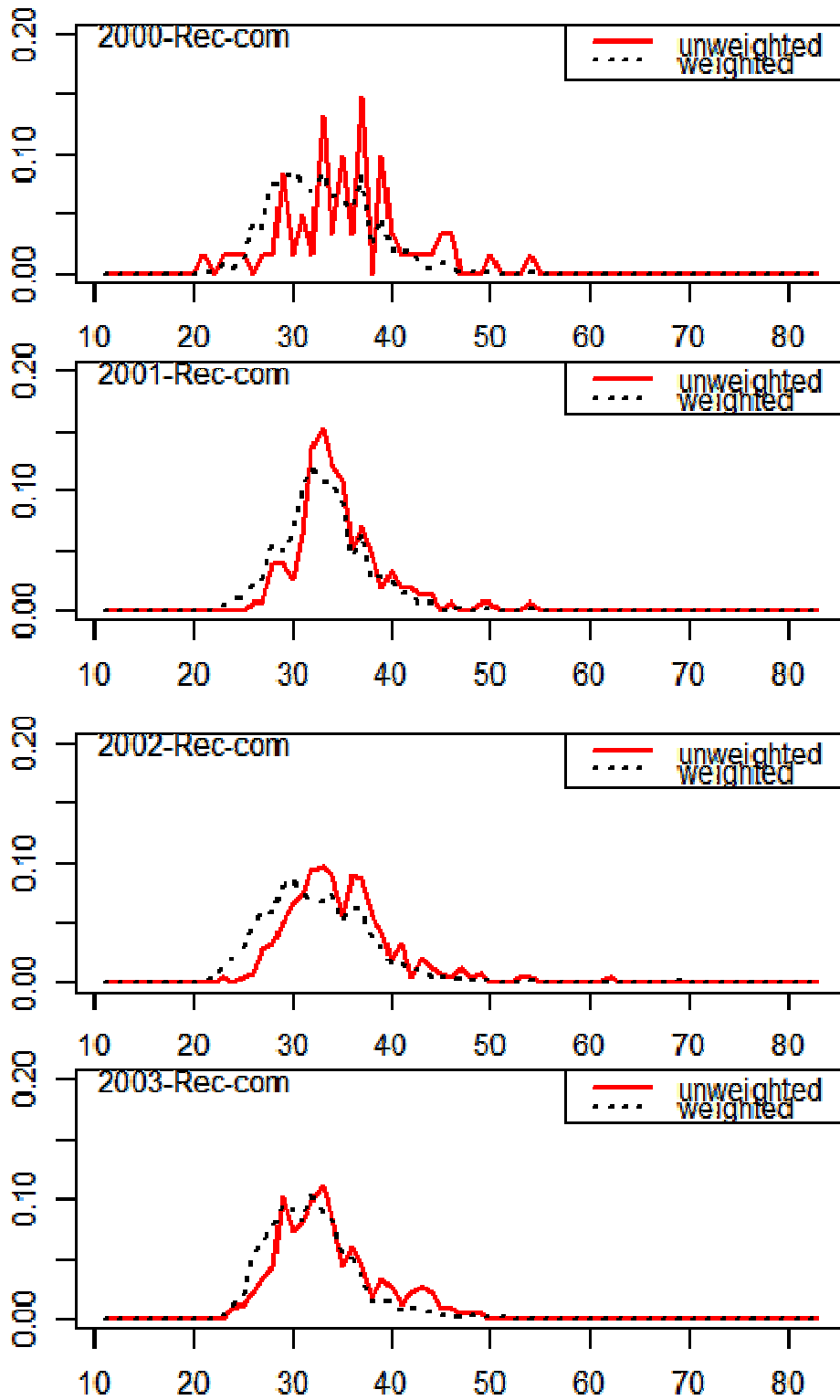


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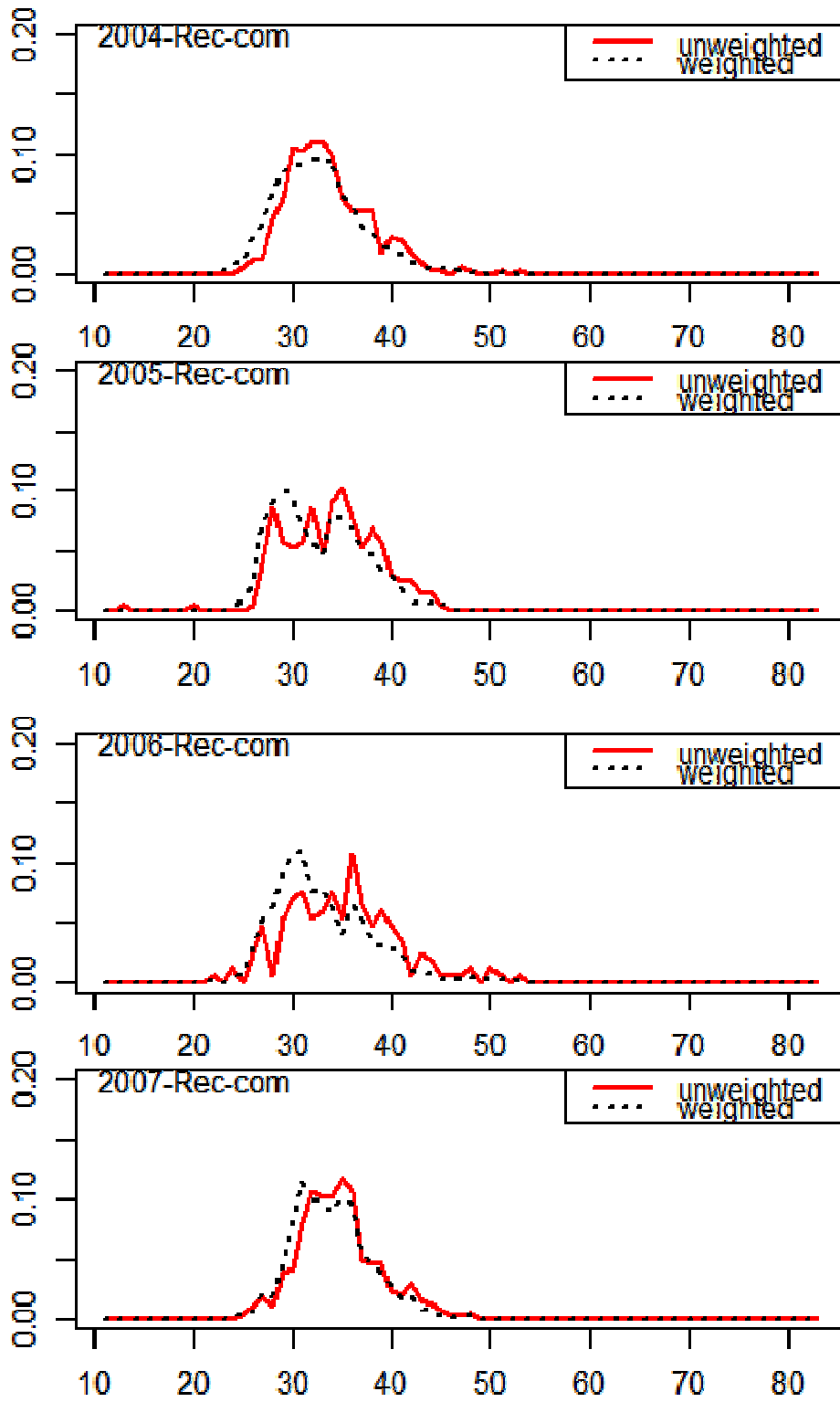


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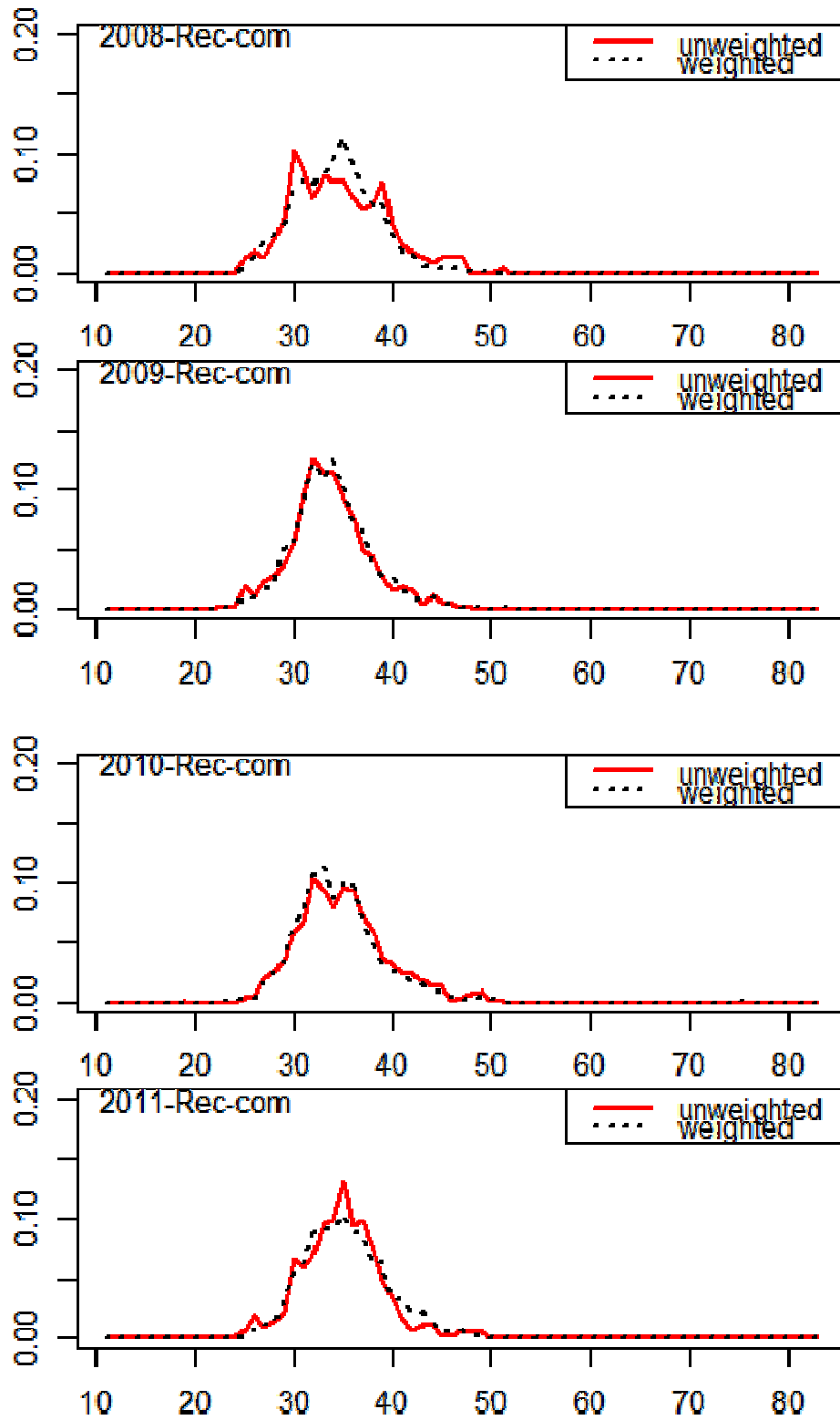


Figure 1. (cont.)

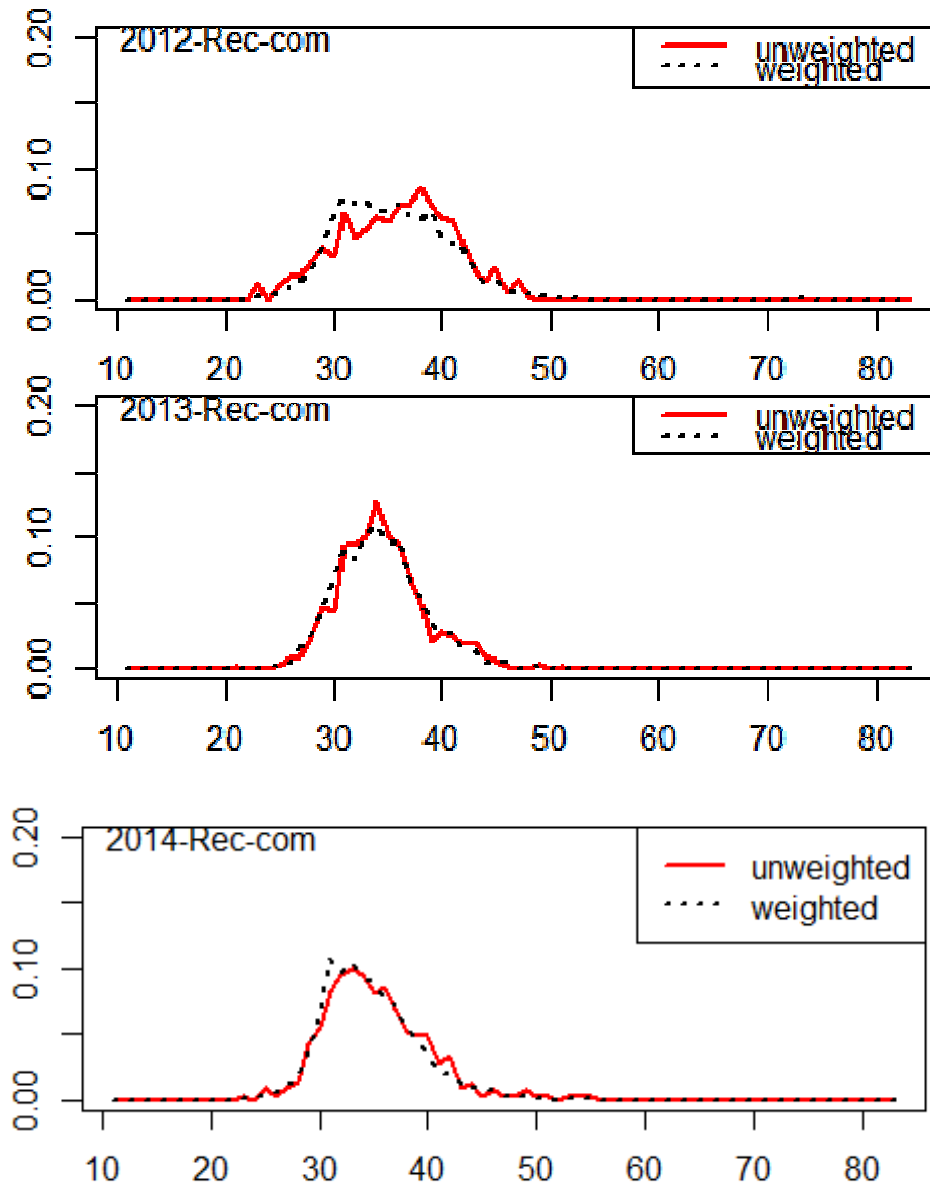
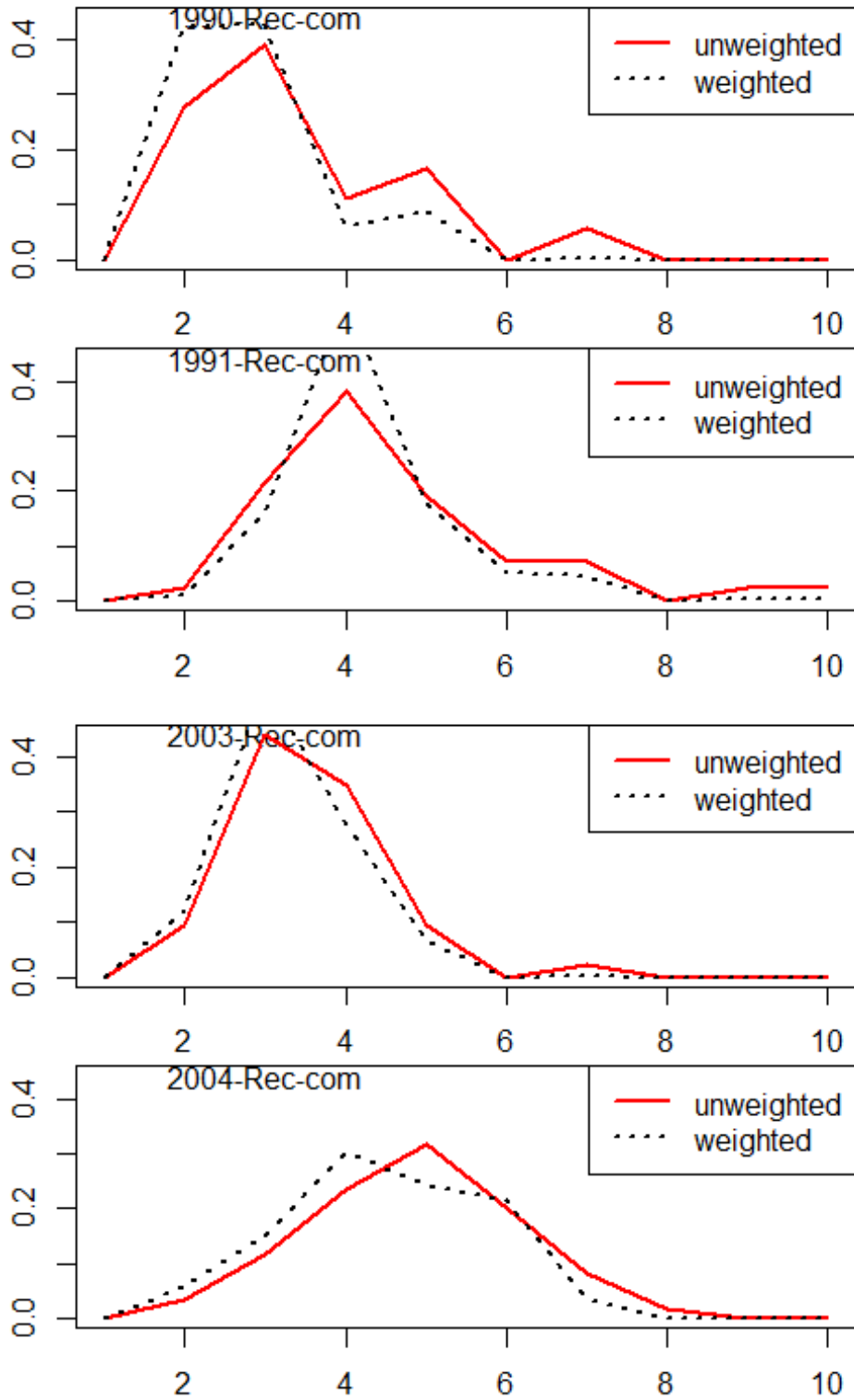
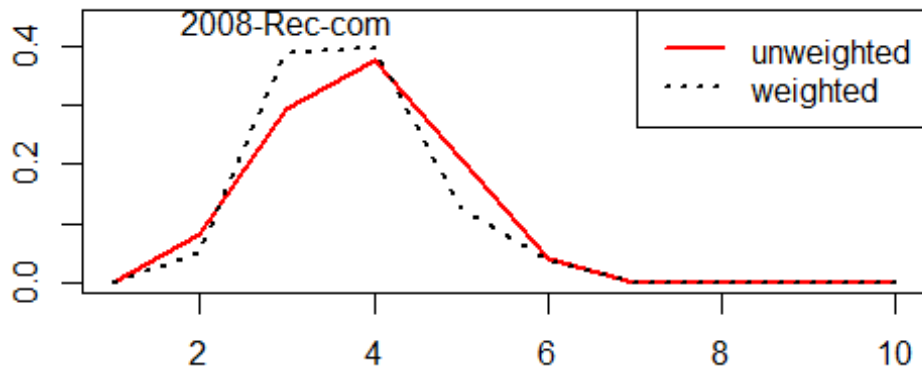
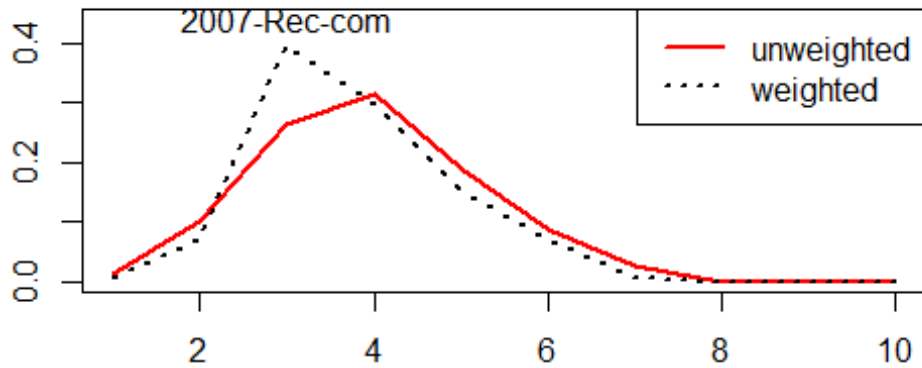
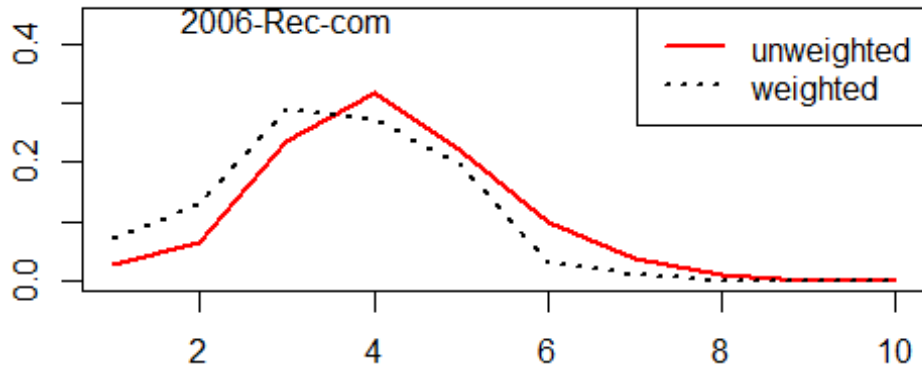
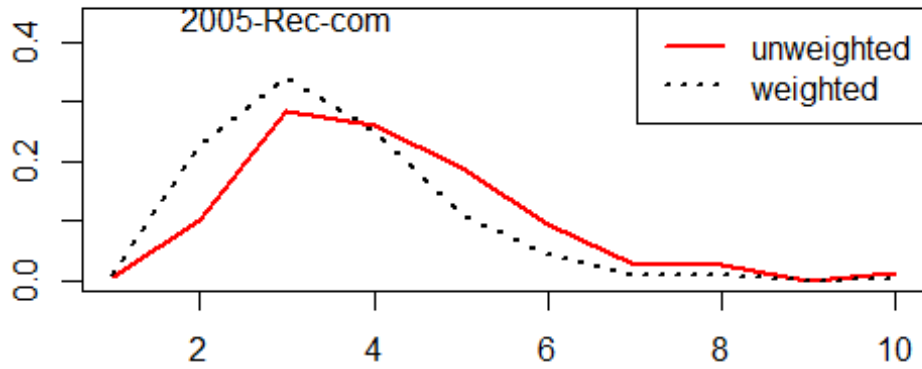
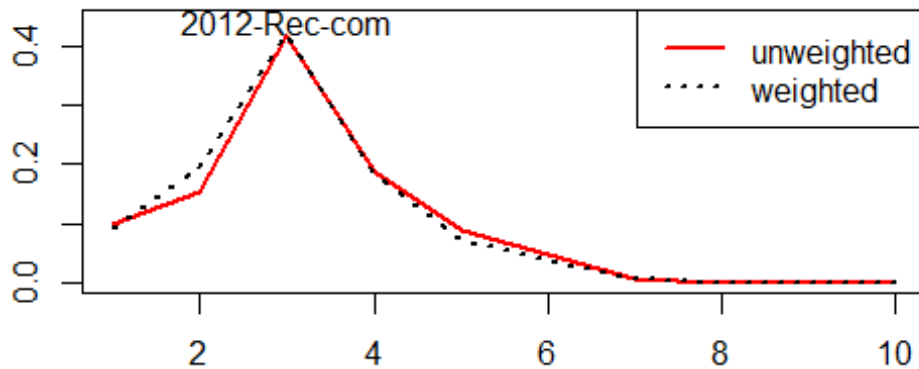
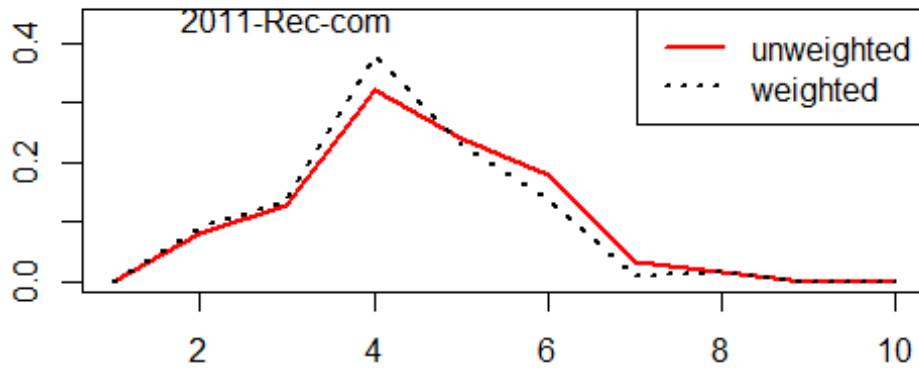
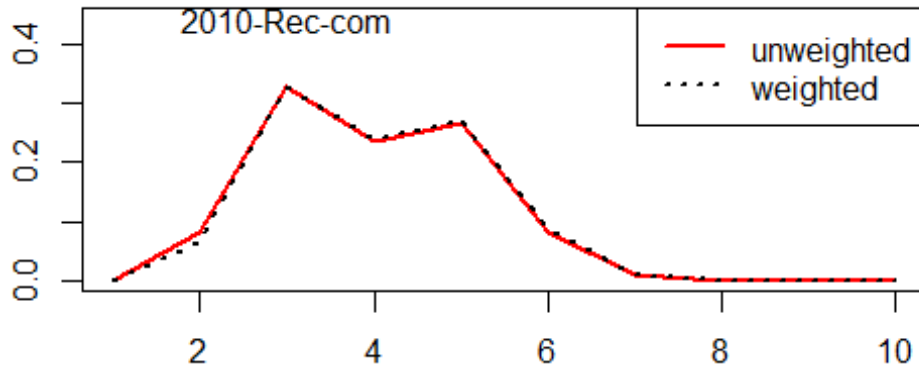
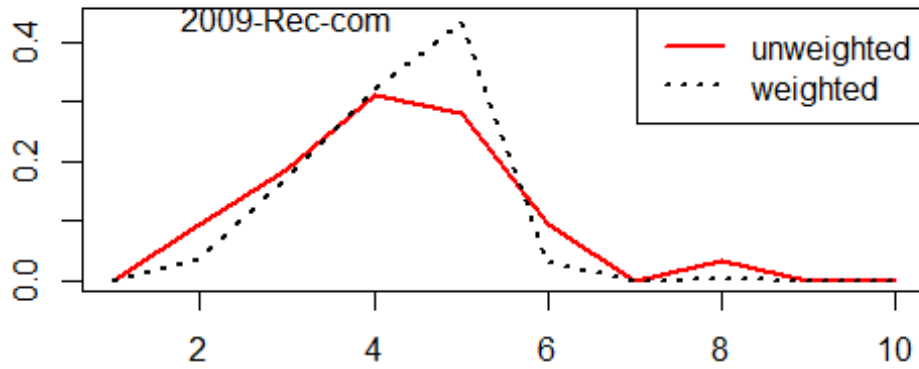
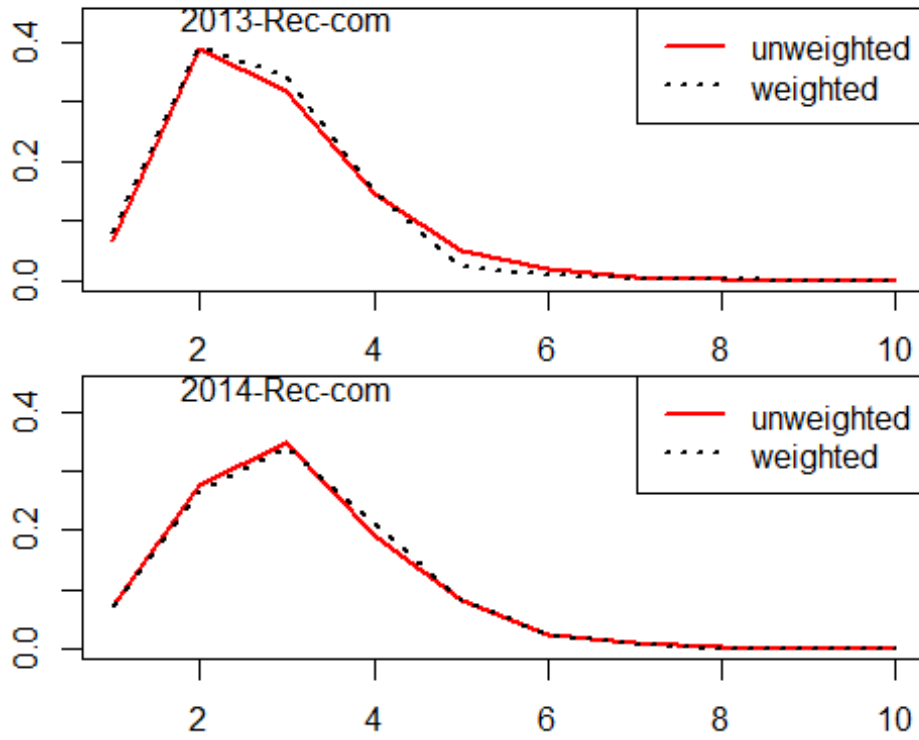


Figure 2. GTF nominal and weighted age compositions.











Appendix 1: Weighted length composition of red snapper in the recreational fishery, 1972-2014.

Year	Fish (n)	Trips (n)	11	12	13	14	15	16	17
1972	112	60	0	0	0	0	0	0	0
1973	96	50	0	0	0	0	0	0	0
1974	298	106	0	0	0	0	0	0	0
1975	377	141	0.002653	0	0.002653	0	0	0	0
1976	422	179	0	0	0	0	0	0	0.004739
1977	457	179	0	0	0	0	0	0	0
1978	597	225	0	0	0	0	0	0	0
1979	350	141	0	0	0	0	0	0	0
1980	427	180	0	0	0	0	0	0	0
1981	484	238	0	0	0	0	0	0	0
1982	565	247	0	0	0	0	0	0	0
1983	988	423	0	0	0	0	0	0	0
1984	865	426	0	0	0	0	0	0	0
1985	989	446	0	0	0	0	0	0	0
1986	756	363	0	0	0	0	0	0	0
1987	588	307	0	0	0	0	0	0	0
1988	462	254	0	0	0	0	0	0	0.00323
1989	795	314	0	0	0	0	0	0	0
1990	856	286	0	0	0	0	0	0	0
1991	664	236	0	0	0	0	0	0	0
1992	831	296	0	0	0	0	0	0	0
1993	940	324	0	0	0	0	0	0	0
1994	1294	306	0	0	0	0	0	0	0.001289
1995	996	301	0	0	0	0	0.001572	0	0.001572
1996	1287	252	0	0	0	0	0	0	0
1997	1708	357	0	0	0	0	0	0	0
1998	1025	381	0	0	0.000972	0.000972	0	0.001944	0
1999	902	330	0	0	0	0	0	0	0
2000	478	216	0	0	0	0	0	0	0
2001	646	272	0	0	0	0	0	0	0
2002	886	348	0	0	0	0	0.001095	0	0
2003	1203	398	0	0	0	0	0	0	0
2004	1654	444	0	0	0	0	0	0	0
2005	1149	334	0	0	0.000535	0	0	0	0
2006	931	357	0	0	0	0	0	0	0
2007	1297	446	0	0	0	0	0	0	0
2008	881	298	0	0	0	0	0	0	0
2009	1271	434	0	0	0	0	0	0	0
2010	1916	475	0	0	0	0	0	0	0
2011	1517	403	0	0	0	0	0	0	0
2012	1563	412	0	0	0	0	0	0	0
2013	3039	506	0	0	0	0	0	0	0
2014	2194	559	0	0	0	0	0	0	0

## Appendix 1: (continued).

Year	18	19	20	21	22	23	24	25	26
1972	0	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0.002653	0
1976	0	0	0	0	0.004739	0	0.00237	0.00237	0.00237
1977	0	0	0	0	0.002188	0	0	0.004376	0.002188
1978	0	0	0	0	0	0.001675	0.005025	0.00335	0.01005
1979	0	0	0	0	0	0.002857	0.005714	0.008571	0.02
1980	0	0	0.002342	0.002342	0	0.004684	0.002342	0	0.002342
1981	0	0	0	0	0	0.002258	0.002258	0.009032	0.015806
1982	0	0	0.002377	0	0.002377	0.007132	0.011887	0.033284	0.030907
1983	0	0	0	0.001217	0.006084	0.002433	0.008517	0.014601	0.020684
1984	0.00312	0	0.006712	0.012478	0.004679	0.032755	0.024956	0.023396	0.026989
1985	0	0.005593	0.008389	0.011185	0.020972	0.036352	0.044741	0.04283	0.051732
1986	0	0	0	0.001876	0.009382	0.019582	0.026271	0.039406	0.053358
1987	0	0	0.002096	0.004192	0.008384	0.029342	0.018863	0.041042	0.048205
1988	0	0.00323	0.016152	0.006461	0.016712	0.006461	0.019383	0.042555	0.072189
1989	0	0.001369	0.004108	0.005478	0.008216	0.021911	0.052038	0.036974	0.088588
1990	0	0.001409	0	0.00773	0.00986	0.014773	0.021129	0.041502	0.04432
1991	0	0	0.001735	0.004649	0.00347	0.015058	0.017349	0.021442	0.043995
1992	0	0.001881	0	0.002695	0.008339	0.007271	0.030103	0.03173	0.041697
1993	0	0	0	0.002245	0.001314	0.007502	0.020807	0.022505	0.018726
1994	0	0	0	0	0.002556	0.001922	0.010901	0.021231	0.023788
1995	0	0	0.001572	0.005582	0.006449	0.008725	0.01745	0.015337	0.030131
1996	0	0	0	0	0.003978	0.000732	0.00837	0.004185	0.012763
1997	0	0	0	0	0.000544	0.002844	0.003833	0.011477	0.019688
1998	0	0	0	0.000969	0.000972	0.001944	0.006805	0.016512	0.024267
1999	0	0	0	0	0.000996	0.002264	0.006792	0.009055	0.023006
2000	0	0	0	0.004109	0	0.009202	0.004109	0.01331	0.041255
2001	0	0	0	0	0.000812	0.004287	0.006496	0.013673	0.022151
2002	0	0	0	0.002313	0.002313	0.014911	0.020632	0.027447	0.047769
2003	0	0	0	0	0	0.002385	0.010563	0.01874	0.051716
2004	0	0	0	0	0.001098	0.002937	0.009166	0.010339	0.029548
2005	0	0	0.000535	0	0	0.000535	0.00107	0.011238	0.02194
2006	0	0	0	0	0.001688	0	0.004174	0.006568	0.026791
2007	0	0	0	0	0	0	0.002426	0.002904	0.007243
2008	0	0	0	0	0	0	0	0.005604	0.014512
2009	0	0	0	0	0.000899	0.000899	0.002452	0.010545	0.009562
2010	0	0.000368	0	0	0	0.000692	0.000692	0.003826	0.003826
2011	0	0	0.000606	0	0	0	0.000735	0.002076	0.008303
2012	0	0	0	0	0.001496	0.002507	0.002992	0.005257	0.010008
2013	0	0	0	0.000406	0	0	0.001283	0.001803	0.004496
2014	0	0	0	0	0	0.000415	0.000415	0.003582	0.006071

## Appendix 1: (continued).

Year	27	28	29	30	31	32	33	34	35
1972	0	0	0	0	0	0	0	0.017857	0.008929
1973	0	0	0	0	0	0	0	0.010417	0
1974	0	0	0	0	0	0	0.003356	0	0
1975	0	0	0.002653	0	0	0	0.01061	0.015915	0.005305
1976	0.004739	0.004739	0.00237	0.00237	0.009479	0.004739	0.018957	0.026066	0.026066
1977	0.002188	0	0.004376	0.004376	0.008753	0.002188	0.02407	0.008753	0.028446
1978	0.015075	0.026801	0.026801	0.028476	0.018425	0.033501	0.036851	0.025126	0.035176
1979	0.008571	0.022857	0.037143	0.022857	0.022857	0.025714	0.034286	0.011429	0.014286
1980	0.007026	0.01171	0.01171	0.014052	0.023419	0.01171	0.018735	0.016393	0.018735
1981	0.036128	0.036128	0.060965	0.08226	0.088061	0.072255	0.08226	0.068712	0.061938
1982	0.036471	0.035661	0.026152	0.045171	0.034094	0.049926	0.053923	0.053113	0.036471
1983	0.033453	0.035285	0.058398	0.054128	0.057787	0.058393	0.053536	0.062035	0.029789
1984	0.024343	0.037434	0.036348	0.051332	0.04136	0.064337	0.060551	0.063723	0.05999
1985	0.060563	0.076828	0.052617	0.051661	0.055413	0.052546	0.025397	0.04129	0.029893
1986	0.052542	0.040223	0.056294	0.045609	0.045609	0.048302	0.046513	0.030928	0.039095
1987	0.064097	0.060595	0.053962	0.053962	0.052742	0.04977	0.034569	0.043828	0.019208
1988	0.088341	0.07107	0.0889	0.092131	0.042555	0.075419	0.038332	0.051813	0.024417
1989	0.075417	0.078579	0.065308	0.064039	0.070562	0.03802	0.031273	0.044967	0.034211
1990	0.052805	0.075308	0.08438	0.073866	0.075308	0.066823	0.054011	0.055351	0.05161
1991	0.053849	0.062036	0.096245	0.053293	0.074803	0.059122	0.044892	0.063975	0.061266
1992	0.06107	0.050136	0.057966	0.078712	0.081152	0.083438	0.07698	0.06625	0.056998
1993	0.02924	0.042107	0.033782	0.058968	0.090122	0.108301	0.089903	0.064006	0.081415
1994	0.026302	0.037921	0.033295	0.051084	0.06769	0.068705	0.085227	0.093551	0.101727
1995	0.03257	0.034088	0.059289	0.082538	0.07403	0.083894	0.081943	0.074627	0.067527
1996	0.015899	0.047916	0.056383	0.082738	0.096026	0.125199	0.096441	0.078871	0.078968
1997	0.038564	0.043097	0.062196	0.085728	0.11057	0.126414	0.094938	0.100116	0.065718
1998	0.036927	0.06604	0.066011	0.072768	0.089287	0.082453	0.09405	0.084336	0.06786
1999	0.029798	0.053977	0.053432	0.070002	0.073807	0.090376	0.095247	0.091987	0.072798
2000	0.038131	0.074701	0.077995	0.085872	0.077077	0.06886	0.08414	0.065566	0.060881
2001	0.025626	0.055992	0.049496	0.063981	0.096747	0.119184	0.107494	0.105153	0.09369
2002	0.059148	0.05859	0.081287	0.084571	0.074823	0.0665	0.067285	0.074823	0.051279
2003	0.064171	0.076173	0.095026	0.090597	0.082305	0.103619	0.090103	0.082531	0.05622
2004	0.041416	0.06693	0.086345	0.087768	0.093506	0.09779	0.090388	0.097223	0.063526
2005	0.072369	0.089548	0.101651	0.09368	0.071094	0.056701	0.045998	0.080758	0.075242
2006	0.05232	0.060576	0.089297	0.108665	0.108516	0.07577	0.077922	0.063932	0.04128
2007	0.019337	0.01802	0.041405	0.078914	0.114546	0.101377	0.095332	0.089815	0.102012
2008	0.025074	0.030529	0.041589	0.07161	0.07786	0.074195	0.082393	0.095327	0.113357
2009	0.017325	0.019453	0.051562	0.05483	0.087681	0.122745	0.109011	0.124387	0.101823
2010	0.015717	0.026127	0.035395	0.065421	0.075131	0.106152	0.112744	0.087407	0.098992
2011	0.01025	0.012672	0.029843	0.057396	0.061072	0.088233	0.091562	0.090175	0.103929
2012	0.014517	0.024303	0.041632	0.066177	0.078934	0.074045	0.07453	0.067472	0.069106
2013	0.01416	0.028179	0.043294	0.069387	0.090815	0.082753	0.100963	0.108691	0.094987
2014	0.010183	0.017436	0.035136	0.064554	0.10712	0.097123	0.103556	0.095333	0.087815

## Appendix 1: (continued).

Year	36	37	38	39	40	41	42	43
1972	0.026786	0.017857	0.017857	0.017857	0.035714	0.044643	0.044643	0.053571
1973	0.010417	0.020833	0.020833	0.052083	0.052083	0.041667	0.03125	0.104167
1974	0.013423	0.010067	0.016779	0.033557	0.030201	0.07047	0.09396	0.043624
1975	0.01061	0.015915	0.02122	0.026525	0.037135	0.047745	0.04244	0.055703
1976	0.028436	0.049763	0.021327	0.045024	0.045024	0.033175	0.066351	0.06872
1977	0.02407	0.04814	0.056893	0.070022	0.054705	0.059081	0.085339	0.050328
1978	0.033501	0.033501	0.033501	0.036851	0.040201	0.038526	0.036851	0.053601
1979	0.025714	0.025714	0.025714	0.037143	0.037143	0.051429	0.065714	0.048571
1980	0.042155	0.021077	0.016393	0.032787	0.039813	0.070258	0.056206	0.081967
1981	0.05645	0.032584	0.039358	0.033904	0.016153	0.017438	0.020669	0.022267
1982	0.070617	0.05954	0.043708	0.043054	0.028084	0.049481	0.054236	0.03506
1983	0.047443	0.052314	0.048655	0.037691	0.038903	0.041943	0.026714	0.035819
1984	0.075308	0.05801	0.036121	0.036927	0.032581	0.030355	0.034421	0.023169
1985	0.037839	0.026	0.032176	0.038955	0.016726	0.029168	0.015328	0.024159
1986	0.054437	0.030442	0.036246	0.038122	0.026533	0.03364	0.027194	0.03013
1987	0.029316	0.029661	0.032632	0.023028	0.036638	0.027565	0.021967	0.035577
1988	0.045045	0.025102	0.022865	0.016963	0.020194	0.008824	0.021313	0.022306
1989	0.035257	0.02704	0.023255	0.022832	0.027563	0.034734	0.015263	0.017678
1990	0.052264	0.045976	0.036837	0.032679	0.013815	0.024363	0.018041	0.005567
1991	0.050789	0.040867	0.036491	0.025877	0.036422	0.024493	0.023313	0.010546
1992	0.057811	0.051099	0.034625	0.0211	0.019982	0.017846	0.012966	0.012711
1993	0.064058	0.067289	0.046266	0.033727	0.016206	0.017904	0.018835	0.007446
1994	0.060382	0.0566	0.052713	0.048339	0.039549	0.035008	0.02419	0.018444
1995	0.048613	0.055225	0.040104	0.048613	0.032679	0.022057	0.015446	0.016313
1996	0.069354	0.048745	0.03996	0.037446	0.020084	0.023219	0.012763	0.010042
1997	0.060474	0.046519	0.032587	0.02702	0.02091	0.01821	0.008711	0.003266
1998	0.063946	0.04651	0.042647	0.033905	0.027133	0.016472	0.024223	0.010661
1999	0.043273	0.047623	0.048796	0.043546	0.026253	0.041187	0.020007	0.013583
2000	0.052663	0.080676	0.021935	0.04774	0.02095	0.015857	0.02095	0.007232
2001	0.0454	0.064494	0.024324	0.029065	0.025136	0.013899	0.014126	0.003475
2002	0.062039	0.058941	0.036864	0.028892	0.016728	0.01582	0.00888	0.012412
2003	0.050276	0.036457	0.0145	0.017528	0.013326	0.007534	0.010941	0.006814
2004	0.056896	0.039987	0.033727	0.023539	0.019831	0.016137	0.009537	0.005873
2005	0.06716	0.05238	0.045794	0.034115	0.029299	0.01821	0.006587	0.006587
2006	0.06473	0.055064	0.033487	0.030723	0.029128	0.024155	0.010037	0.007551
2007	0.096239	0.057531	0.044515	0.039117	0.027279	0.016364	0.018858	0.007721
2008	0.09109	0.069681	0.056895	0.058336	0.03125	0.017383	0.015731	0.00625
2009	0.074528	0.064397	0.036689	0.028272	0.027864	0.015281	0.011276	0.005473
2010	0.100223	0.067639	0.048571	0.033267	0.027412	0.023729	0.016724	0.014191
2011	0.088317	0.085894	0.061502	0.063231	0.032006	0.032829	0.022274	0.020934
2012	0.072604	0.06387	0.060574	0.067548	0.04749	0.043065	0.039609	0.022301
2013	0.097895	0.069561	0.054396	0.034201	0.028106	0.0255	0.015799	0.012878
2014	0.077721	0.071209	0.055158	0.045655	0.03496	0.019121	0.019836	0.012433

## Appendix 1: (continued).

Year	44	45	46	47	48	49	50	51	52
1972	0.098214	0.053571	0.026786	0.080357	0.125	0.107143	0.071429	0.044643	0.053571
1973	0.0625	0.0625	0.072917	0.083333	0.052083	0.0625	0.09375	0.0625	0.03125
1974	0.161074	0.063758	0.050336	0.043624	0.097315	0.057047	0.060403	0.030201	0.040268
1975	0.084881	0.047745	0.055703	0.106101	0.100796	0.068966	0.098143	0.061008	0.029178
1976	0.028436	0.080569	0.033175	0.052133	0.052133	0.07109	0.059242	0.045024	0.035545
1977	0.070022	0.045952	0.043764	0.056893	0.050328	0.050328	0.039387	0.028446	0.019694
1978	0.038526	0.040201	0.045226	0.043551	0.050251	0.055276	0.033501	0.040201	0.0134
1979	0.048571	0.042857	0.045714	0.06	0.051429	0.051429	0.04	0.022857	0.028571
1980	0.056206	0.046838	0.044496	0.053864	0.044496	0.04918	0.042155	0.025761	0.039813
1981	0.009032	0.020009	0.01518	0.016153	0.009379	0.022927	0.008719	0.007121	0.008093
1982	0.029704	0.01685	0.021501	0.015283	0.015231	0.012853	0.004049	0.008804	0.013663
1983	0.031558	0.021245	0.019418	0.015175	0.012737	0.011534	0.010914	0.017604	0.010919
1984	0.012531	0.011585	0.009078	0.009412	0.009078	0.016264	0.008938	0.005486	0.001893
1985	0.010319	0.012461	0.016956	0.011345	0.009876	0.012301	0.007593	0.003982	0.005964
1986	0.025803	0.020903	0.020903	0.021963	0.016489	0.013553	0.013796	0.005717	0.00245
1987	0.0286	0.021277	0.013079	0.018147	0.013079	0.016741	0.013424	0.007322	0.01552
1988	0.012055	0.005034	0.006027	0.001678	0.005468	0.001678	0.000559	0.006027	0.00379
1989	0.012201	0.0061	0.007046	0.008416	0.004631	0.005154	0.004731	0.008416	0.005577
1990	0.005567	0.006908	0.006941	0.004158	0.003437	0.002096	0.002783	0.004879	0.002817
1991	0.015263	0.013528	0.007631	0.009435	0.002359	0.007008	0.004093	0.003538	0.002359
1992	0.009203	0.004322	0.004067	0.00783	0.000813	0.000813	0.002695	0.001627	0.001627
1993	0.015878	0.014017	0.003176	0.005804	0.005968	0.001862	0.002792	0.001862	0.001314
1994	0.007648	0.009549	0.005725	0.007014	0.001268	0	0.000634	0.001922	0.000634
1995	0.012844	0.011814	0.004336	0.001734	0.004877	0.002439	0	0.001572	0
1996	0.010359	0.008053	0.002196	0.002928	0.001464	0	0.001257	0	0.000732
1997	0.003811	0.001089	0.000544	0.001855	0.003611	0.000544	0.000544	0.001311	0.001089
1998	0.008731	0.000972	0.001944	0.001941	0.000972	0	0	0.000972	0.000972
1999	0.014306	0.006792	0.006792	0.002987	0.002264	0.000996	0.001991	0.001268	0.002264
2000	0.004109	0.009202	0.007232	0	0.001562	0.001562	0.001562	0	0
2001	0.00695	0	0.004287	0.000812	0	0.000812	0.000812	0	0
2002	0.004564	0.005659	0.001095	0.003408	0.001157	0.003284	0	0	0
2003	0.005792	0.003407	0.002461	0.001741	0.002536	0.000871	0.000795	0.000871	0
2004	0.003308	0.00439	0.002195	0.00439	0.000371	0.001098	0	0.000371	0
2005	0.006052	0.004391	0.002731	0.000535	0	0.001661	0.000535	0	0
2006	0.007458	0.001688	0.002486	0.003377	0.003377	0.001688	0.003377	0.001688	0.000798
2007	0.006986	0.002648	0.002169	0.000956	0.004595	0	0	0	0.000478
2008	0.005604	0.003951	0.003951	0.00589	0.000646	0.000646	0	0.000646	0
2009	0.008663	0.005557	0.002452	0.00196	0.00196	0.000899	0	0.001553	0
2010	0.009628	0.008433	0.004329	0.00212	0.004607	0.003826	0.001751	0.000692	0
2011	0.011766	0.004974	0.006056	0.006445	0.001946	0.003158	0	0.000606	0.000606
2012	0.012051	0.016297	0.005035	0.007279	0.004024	0.002002	0.000506	0.000506	0.001011
2013	0.005309	0.006172	0.005067	0.000406	0.000991	0.001511	0	0.000584	0
2014	0.009503	0.006989	0.007077	0.002841	0.002841	0.002338	0.001421	0.000918	0

## Appendix 1: (continued).

Year	53	54	55	56	57	58	59	60
1972	0	0.017857	0.026786	0.008929	0	0	0	0
1973	0.03125	0.010417	0.010417	0.010417	0	0	0.010417	0
1974	0.02349	0.02349	0.013423	0.006711	0.003356	0	0.006711	0.003356
1975	0.015915	0.01061	0.01061	0.005305	0.002653	0.002653	0	0
1976	0.014218	0.028436	0.016588	0.00237	0.004739	0.00237	0	0
1977	0.028446	0.010941	0.002188	0.006565	0	0.004376	0	0
1978	0.025126	0.01005	0.0134	0.005025	0.00335	0.001675	0.00335	0
1979	0.017143	0.017143	0.005714	0.002857	0.005714	0.002857	0.002857	0
1980	0.009368	0.014052	0.01171	0.007026	0.009368	0.01171	0	0.002342
1981	0.004863	0.010664	0.005489	0.000973	0	0	0	0
1982	0.006427	0.005669	0.00243	0.003187	0.00081	0.00081	0	0
1983	0.004247	0.001217	0.006681	0.004252	0.002429	0	0.002424	0.001217
1984	0.001893	0.002366	0.003786	0.00142	0.001893	0.000946	0	0.000473
1985	0.003097	0.005894	0.00177	0.000885	0.001841	0.003168	0	0.001398
1986	0.009139	0.004083	0.000817	0.002693	0.006203	0.001876	0	0
1987	0.013955	0.002441	0.003661	0.00122	0.007853	0.00122	0	0
1988	0.00379	0.006461	0.004909	0	0	0	0	0
1989	0.004208	0.003685	0	0.000946	0	0	0.000946	0.000946
1990	0.000687	0	0	0	0	0	0	0
1991	0.002359	0	0.001179	0	0.002914	0.001179	0	0
1992	0.001627	0	0	0	0	0	0.000813	0
1993	0.001862	0	0.000931	0.001862	0	0	0	0
1994	0	0.001268	0.000634	0	0	0	0.001289	0
1995	0.000867	0	0	0.001572	0	0	0	0
1996	0.000732	0	0.000732	0	0.001464	0	0	0
1997	0.000544	0.000544	0.000544	0	0	0	0	0
1998	0	0.000969	0	0.001941	0	0	0	0
1999	0.001268	0.001268	0	0	0	0	0	0
2000	0	0.001562	0	0	0	0	0	0
2001	0	0.000812	0	0	0	0	0	0
2002	0.001095	0.001095	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0
2004	0.000371	0	0	0	0	0	0	0
2005	0.000535	0	0	0.000535	0	0	0	0
2006	0.001688	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0
2011	0.000606	0	0	0	0	0	0	0
2012	0.000506	0	0	0	0	0	0	0
2013	0	0.000406	0	0	0	0	0	0
2014	0.000415	0.000415	0.000415	0	0	0	0	0







## Appendix 1: (continued).

Year	79	80	81	82	83
1972	0	0	0	0	0
1973	0	0	0	0	0
1974	0	0	0	0	0
1975	0	0	0	0	0
1976	0	0	0	0	0
1977	0	0	0	0	0
1978	0	0	0	0	0
1979	0	0	0	0	0
1980	0	0	0	0	0
1981	0	0	0	0	0
1982	0	0	0	0	0
1983	0	0	0	0	0
1984	0	0	0	0	0.00156
1985	0	0	0	0	0
1986	0	0	0	0	0
1987	0	0	0.00122	0	0
1988	0	0	0	0	0
1989	0	0	0	0	0
1990	0	0	0	0	0
1991	0	0	0	0	0
1992	0	0	0	0	0
1993	0	0	0	0	0
1994	0	0	0	0	0
1995	0	0	0	0	0
1996	0	0	0	0	0
1997	0	0	0	0	0
1998	0	0	0	0	0
1999	0	0	0	0	0
2000	0	0	0	0	0
2001	0	0	0	0	0.000812
2002	0	0	0	0	0
2003	0	0	0	0	0
2004	0	0	0	0	0
2005	0	0	0	0	0
2006	0	0	0	0	0
2007	0	0	0	0	0
2008	0	0	0	0	0
2009	0	0	0	0	0
2010	0	0	0	0	0
2011	0	0	0	0	0
2012	0	0	0	0	0
2013	0	0	0	0	0
2014	0	0	0	0	0

Appendix 2: Weighted age composition of gray triggerfish in the recreational fishery.

Year	Fish (n)	Trips (n)	1	2	3	4	5	6	7	8	9	10
1990	18	10	0	0.4232	0.4276	0.0602	0.0864	0	0.0026	0	0	0
1991	37	21	0	0.0087	0.1587	0.5519	0.1760	0.0505	0.0455	0	0.0043	0.0043
2003	43	24	0	0.1204	0.5322	0.2770	0.0678	0	0.0027	0	0	0
2004	60	24	0	0.0571	0.1503	0.3024	0.2430	0.2129	0.0328	0.0014	0	0
2005	157	53	0.0102	0.2260	0.3439	0.2515	0.1097	0.0431	0.0075	0.0074	0	0.0007
2006	111	39	0.0725	0.1306	0.2886	0.2718	0.1952	0.0296	0.0105	0.0012	0	0
2007	79	48	0.0062	0.0694	0.3961	0.2982	0.1533	0.0698	0.0069	0	0	0
2008	18	10	0	0.0517	0.3896	0.3961	0.1245	0.0381	0	0	0	0
2009	29	28	0	0.0372	0.1716	0.3237	0.4348	0.0307	0	0.0020	0	0
2010	97	55	0	0.0653	0.3278	0.2370	0.2703	0.0879	0.0117	0	0	0
2011	60	35	0	0.0908	0.1349	0.3799	0.2309	0.1389	0.0082	0.0165	0	0
2012	123	35	0.0907	0.1925	0.4180	0.1839	0.0711	0.0376	0.0063	0	0	0
2013	494	134	0.0814	0.3949	0.3419	0.1492	0.0221	0.0079	0.0019	0.0007	0	0
2014	586	196	0.0719	0.2640	0.3388	0.2121	0.0802	0.0255	0.0064	0.0010	0	0