Length and age frequency distributions for vermilion snappers collected in the Gulf of Mexico from 1981 to 2014

Ching-Ping Chih

SEDAR45-WP-08

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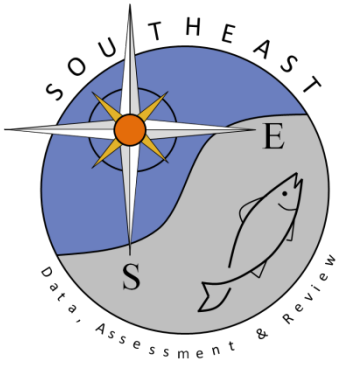

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Introduction

This report documents changes in the length frequency distributions (LFDs) and age frequency distributions (AFDs) of vermilion snappers collected from the Gulf of Mexico from 1981 to 2014. Stratification of length and age samples follows what was used in the SEDAR 2011 update for vermilion snappers. More detailed analyses of length frequency distributions (LFD), age frequency distributions (AFDs), age at length (AAL) and length at age (LAA) for different regions are presented here to investigate the underlying reasons for regional variations in LFDs and AFDs and to provide a basis for more efficient stratification of length and age samples in the future. The method for estimating AFDs differ from what was used in the SEDAR 2011 update in that reweighted AFDs were used instead of direct AFDs. Some sampling issues are also noted in this report.

Materials and Methods

Length samples from commercial hand line fisheries were obtained from the TIP database housed at the Southeast Fisheries Science Center (SEFSC). Commercial hand line samples were grouped into two strata: East and West (Table 1). Fishing areas were used to define the east (1<=grid <=12) and west (grid > 12) regions. When fishing area information was not available, landing areas were used to define the east (Florida, Alabama, and Mississippi) and west (Louisiana and Texas) regions. Length samples for recreational fisheries (Table 2) were obtained from the Marine Recreational Fisheries Statistics Survey (i.e., the Marine Recreational Information Program, MRIP), the Head Boat Survey, the Texas Parks and Wildlife Department database, the Gulf FIN database, and the TIP

database. All recreational samples were combined into one stratum. Otolith samples were subsamples of length samples. Age samples were processed and read by the Panama City Laboratory, SEFSC. All lengths are fork lengths in centimeters. Conversion equations for different length types were provided by the Panama City Laboratory.

Age samples were stratified as length samples (Tables 2 and 4). Recreational age samples only came from three fishing modes (charter boats (CP), head boats (HB), and private boats (PR)). For the estimation of AFDs, age samples were reweighted by length samples because some age samples were non-randomly selected. The reweighting method was published previously (Chih, 2009). The length interval used for the reweighting procedure was 5 cm. For each stratum, age samples from each region were reweighted by the LFDs for that region.

Results and Discussion

Length frequency distributions (LFDs)

Length frequency distributions estimated from east and west hand line samples were significantly different in all years investigated (Fig 1 (a)-(e)). In particular, most fish samples below 25 centimeters were from the east region. A detailed analysis of LFDs among different grids (Fig 2) showed that most small fish congregate in grid 7, while the proportion of larger fish increased gradually toward either the east or west of grid 7. The proportions of larger size vermilion snappers are highest in grids 20 and 21. These apparent differences in LFDs among grids indicate that either proportional sampling or stratification by grid may be necessary in the future. Since proportional sampling for both length and age samples is difficult to implement in practice, stratification by grid may be a better solution. For stratification by grid to work, adequate sample sizes by grid and accurate and detailed landing information by grid are needed.

Length samples from recreational fisheries were combined as one strata to be consistent with previous SEDAR assessments, and also because of small age sample sizes from recreational fisheries in many years (Table 4). There are also a distinct differences in LFDs estimated from east and west recreational samples before 2010, but such differences are not observed for LFDs estimated after 2010 (Fig 3 (a)-(e)). Since differences in east and west LFDs remained after 2010 for commercial hand line samples, the observed changes in east-west variations in LFDs before and after 2010 for recreational samples is most likely due to changes in sampling practices.

Reweighted age frequency distributions (rAFDs)

In agreement with the LFDs, rAFDs estimated from east and west hand line age and length samples were also very different (Fig 4). The majority fish of two years or younger were found in the east region. Differences in rAFDs among grids were not analyzed due to small otolith sample sizes in some grids.

Age at length (AAL)

The differences in LFDs and AFDs between east and west regions can be due to either changes in age-related selectivity/movement or in size-related selectivity/movement. To identify the factors that drive the differences in LFDs/AFDs between the east and west regions, the AALs for various length intervals were estimated from hand line and recreational otolith samples collected during 2005-2014 (Figs 6, 7). For most length intervals examined, the AALs (i.e., ALKs) were distinctly different between the east and west regions, with a larger proportion of older fish in the west. These results indicate that the differences between regional LFDs/AFDs may at least be partially due to changes in age-related selectivity or movement between the two regions.

Length at age (LAA)

Although changes in LAAs are commonly interpreted as changes in growth, changes in size selectivity and sampling practices can also significantly influence the estimated LAAs (Chih, 2009). Fig 8 shows that estimated LAAs from vermilion snapper otolith samples collected from the east and west regions were consistently different for age 1 to age 9. These differences in regional LAAs could be due to changes in size-related selectivity or in size-related movements between the east and west regions, since there are significant differences in LFDs between the two regions. These differences in regional LAAs could also be due to different sampling practices in the two regions since some otolith samples may have been non-randomly sampled. Thus, any differences in estimated growth curves between the east and west regions will need cautious interpretation because of the possible differences in size selectivity and sampling practices between the two regions.

References

Ching-Ping Chih, 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.

Chih, C.P. 2009. The effects of otolith sampling methods on the precision of growth curves. North American Journal of Fisheries Management 29: 1519-1528.

Table 1. Sample sizes for commercial hand line length samples collected from the Gulf of Mexico between 1984 and 2014.

Year	East	West	Total
1984	765	1651	2416
1985	432	905	1337
1986	114	915	1029
1987	59	272	331
1988	140	184	324
1989	197	705	902
1990	2179	4139	6318
1991	1816	5500	7316
1992	2154	5129	7283
1993	4875	2920	7795
1994	6778	3281	10059
1995	5064	1817	6881
1996	4369	1648	6017
1997	4095	1888	5983
1998	9725	1411	11136
1999	12591	902	13493
2000	8609	345	8954
2001	5446	542	5988
2002	4103	654	4757
2003	4141	1082	5223
2004	2342	797	3139
2005	3499	1219	4718
2006	3401	1230	4631
2007	5899	2051	7950
2008	9104	1931	11035
2009	12046	1684	13730
2010	5529	2213	7742
2011	10555	1769	12324
2012	13326	5537	18863
2013	10540	4963	15503
2014	8592	4264	12856

Table 2. Sample sizes for commercial hand line otolith samples collected from the Gulf of Mexico between 1994 and 2014.

Year	East	West	Total
1994	1	15	16
1995	18	41	59
1998	138		138
2000	227	26	253
2001	1292	56	1348
2002	1332	97	1429
2003	2135	552	2687
2004	667	487	1154
2005	731	807	1538
2006	775	868	1643
2007	731	1187	1918
2008	885	1203	2088
2009	1102	975	2077
2010	781	1064	1845
2011	2935	869	3804
2012	661	574	1235
2013	522	496	1018
2014	529	518	1047

Table 3. Sample sizes for recreational length samples collected from the Gulf of Mexico between 1984 and 2014.

Year	East	West	Total
1981	78	16	94
1982	361	19	380
1983	290	7	297
1984	188	6	194
1985	40	43	83
1986	1595	1562	3157
1987	1931	945	2876
1988	2315	850	3165
1989	2616	1555	4171
1990	2893	1601	4494
1991	4595	2583	7178
1992	4445	1367	5812
1993	2838	1069	3907
1994	2557	1947	4504
1995	1900	1463	3363
1996	1657	915	2572
1997	1858	503	2361
1998	2124	661	2785
1999	3238	251	3489
2000	3446	424	3870
2001	3471	540	4011
2002	3644	743	4387
2003	3983	552	4535
2004	3717	328	4045
2005	3361	283	3644
2006	4729	349	5078
2007	4116	753	4869
2008	3787	621	4408
2009	4864	518	5382
2010	5718	283	6001
2011	9068	897	9965
2012	5989	1751	7740
2013	7449	4112	11561
2014	7428	4621	12049

Table 4. Sample sizes for recreational otolith samples collected from the Gulf of Mexico between 1984 and 2014.

Year	East	West	Total
1994	33	0	33
1995	9	0	9
1996	217	44	261
1997	42	0	42
1998	14	0	14
1999	246	0	246
2000	187	23	210
2001	115	25	140
2002	258	0	258
2003	90	1	91
2004	88	39	127
2005	144	25	169
2006	170	1	171
2007	126	330	456
2008	551	468	1019
2009	993	307	1300
2010	987	212	1199
2011	850	455	1305
2012	1046	838	1884
2013	1021	710	1731
2014	1077	329	1406

Fig 1. Comparisons of length frequency distributions for commercial hand line length samples collected from the east and west regions of the Gulf of Mexico between 1990 and 2014.

(a) 1990-1994

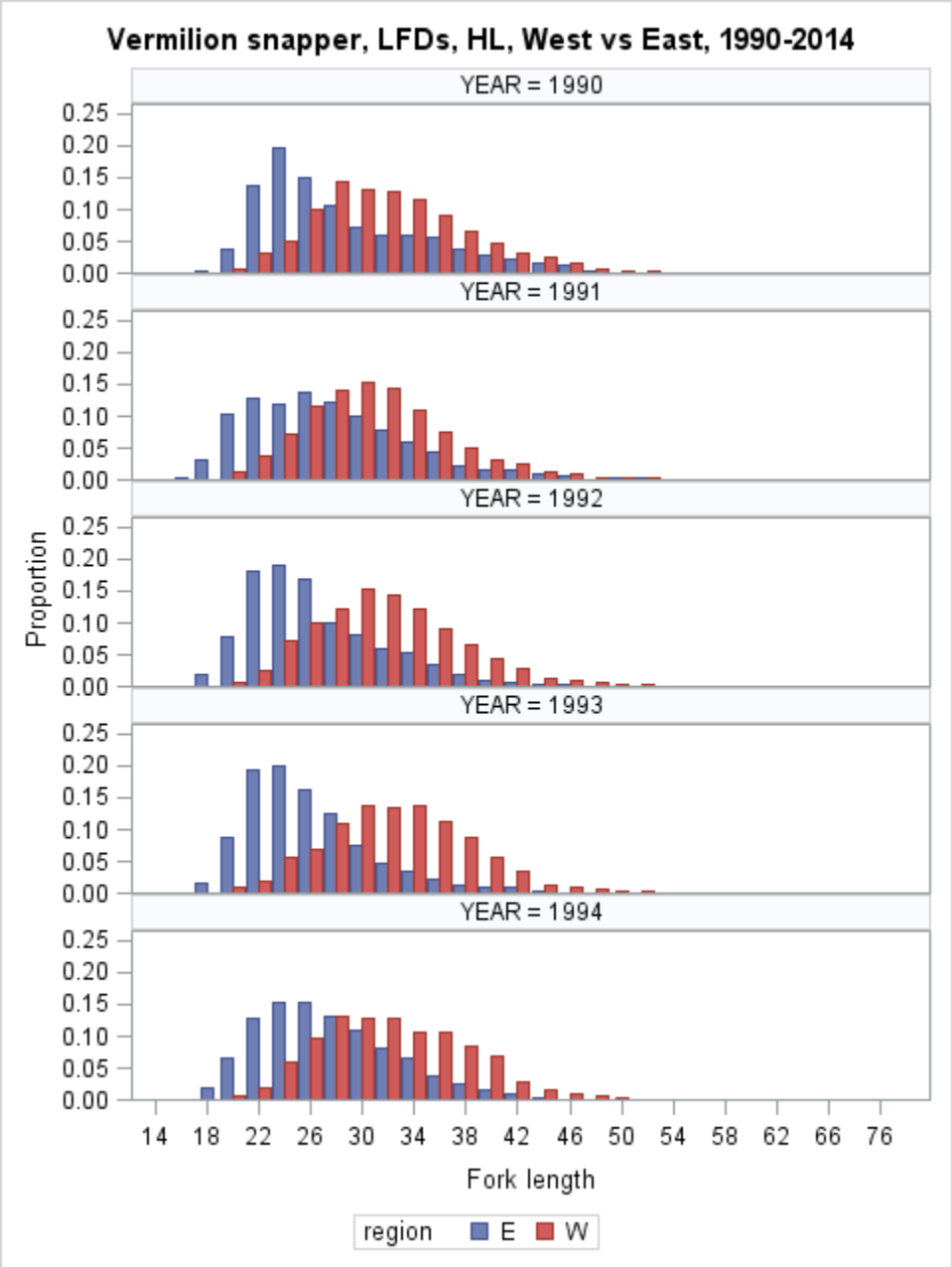


Fig 1 (continued)

(b) 1995-1999

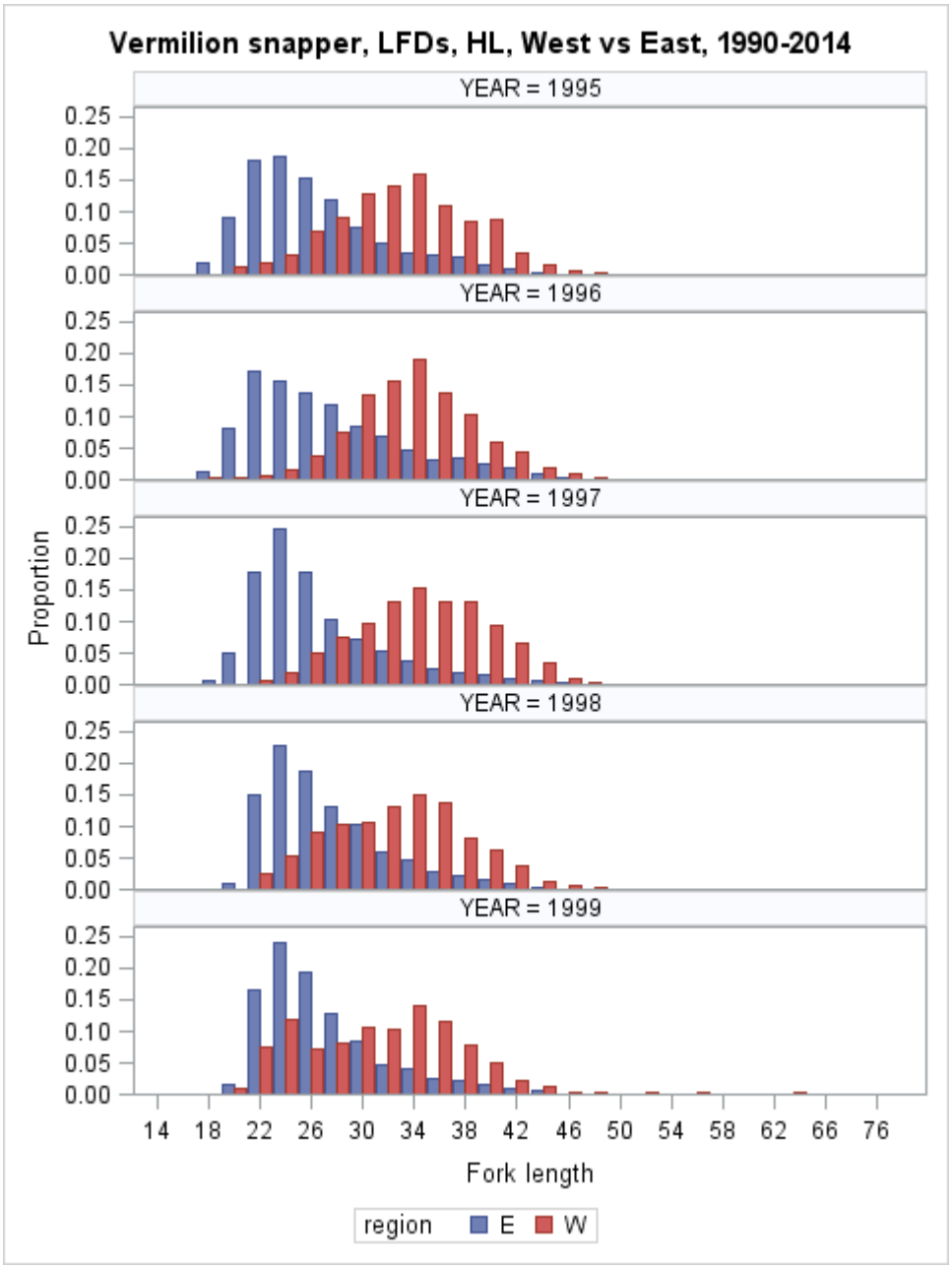


Fig 1 (continued)

(c) 2000-2004

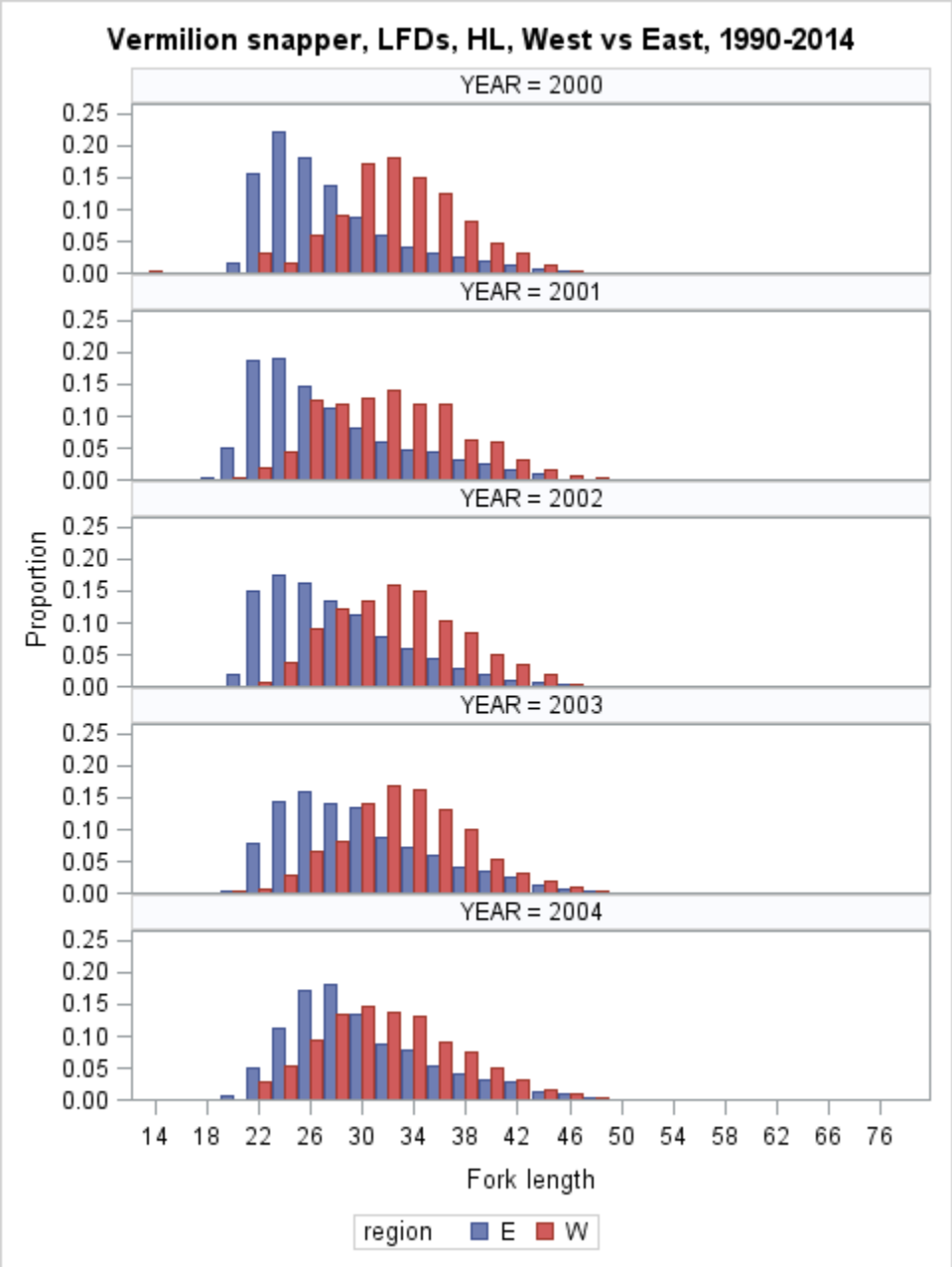


Fig 1 (continued)

(d) 2005-2009

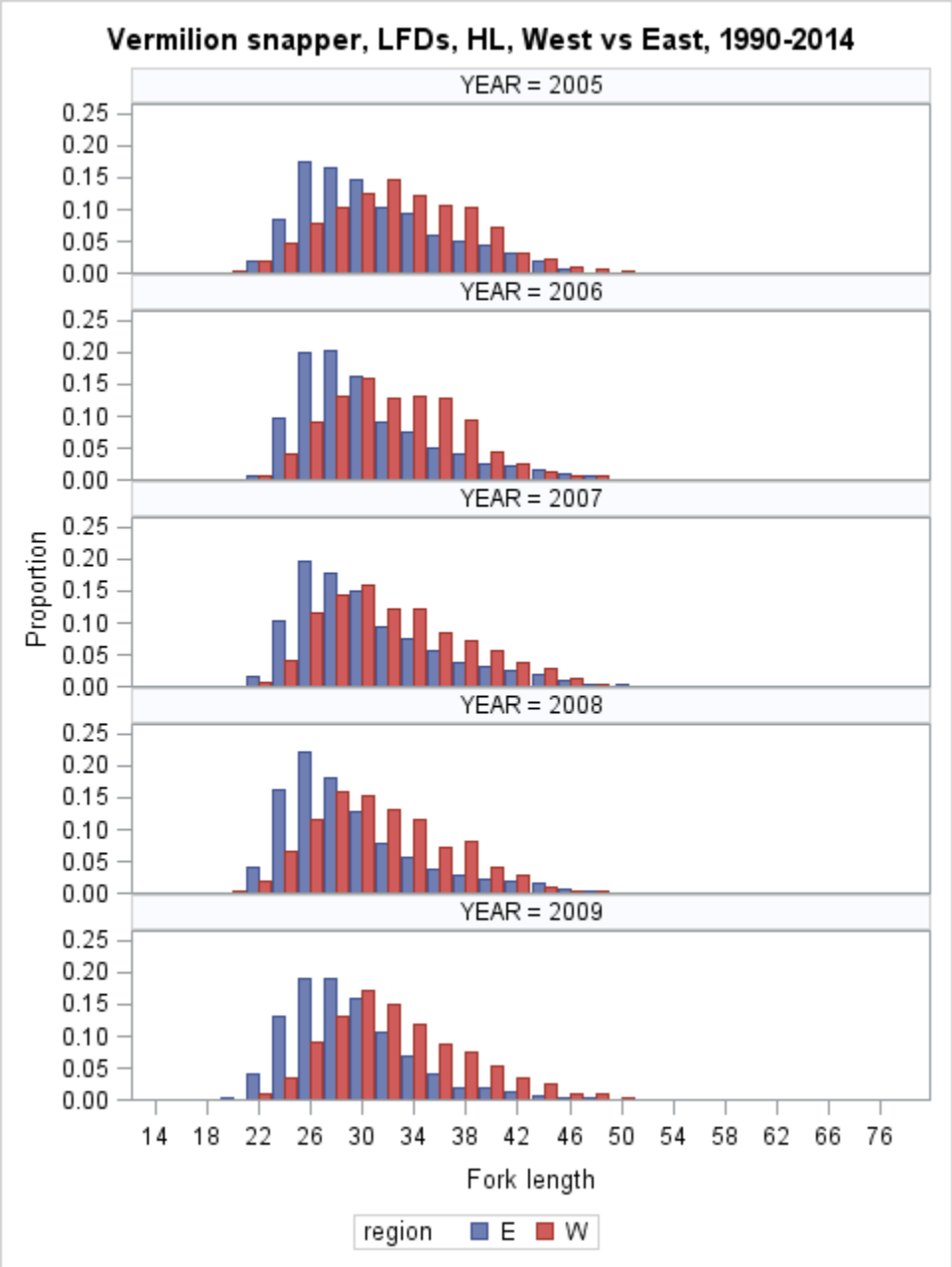


Fig 1 (continued)

(e) 2010-2014

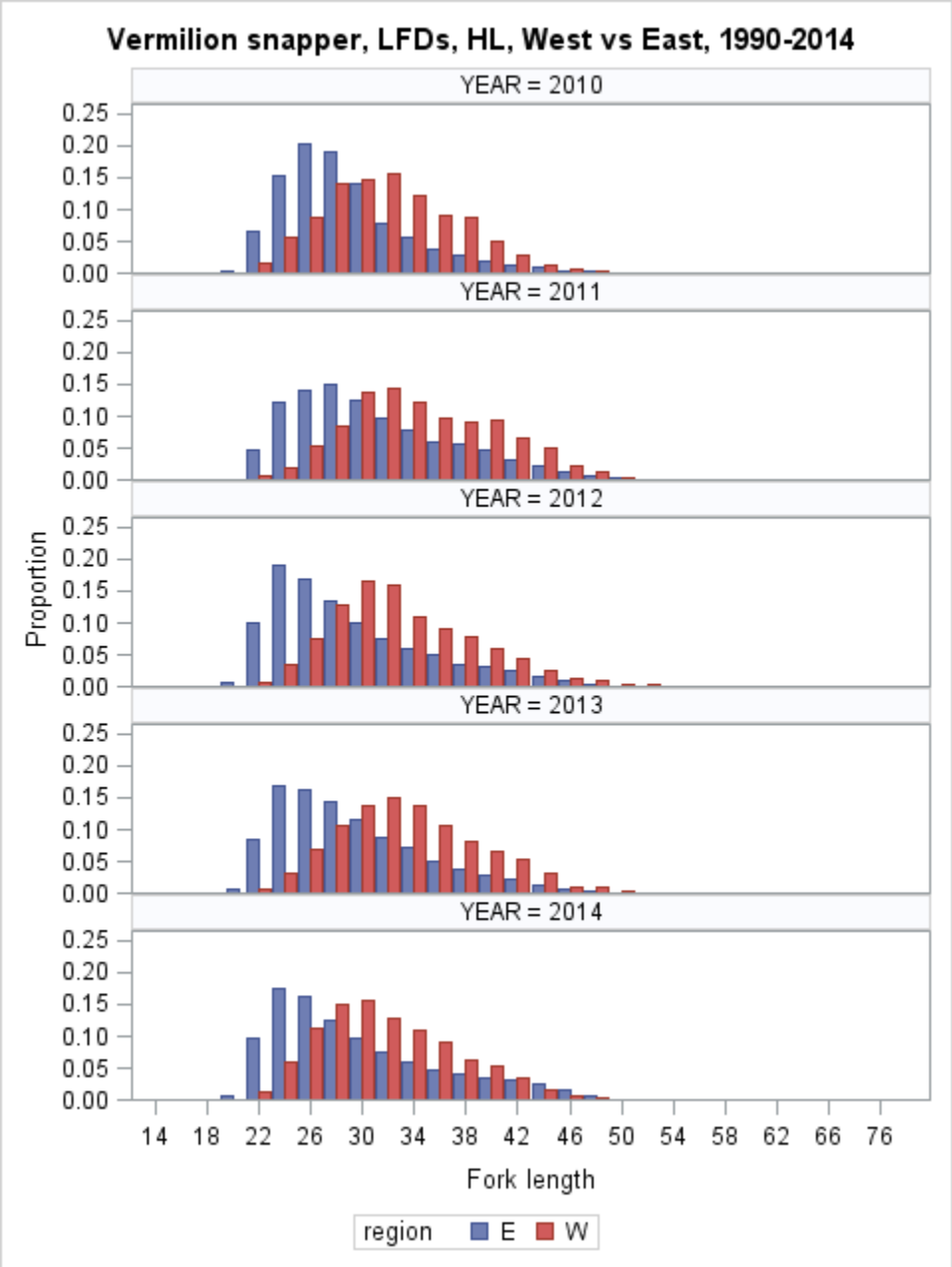


Fig 2. Length frequency distributions for commercial hand line length samples collected from different grids in the Gulf of Mexico between 2005 and 2014.

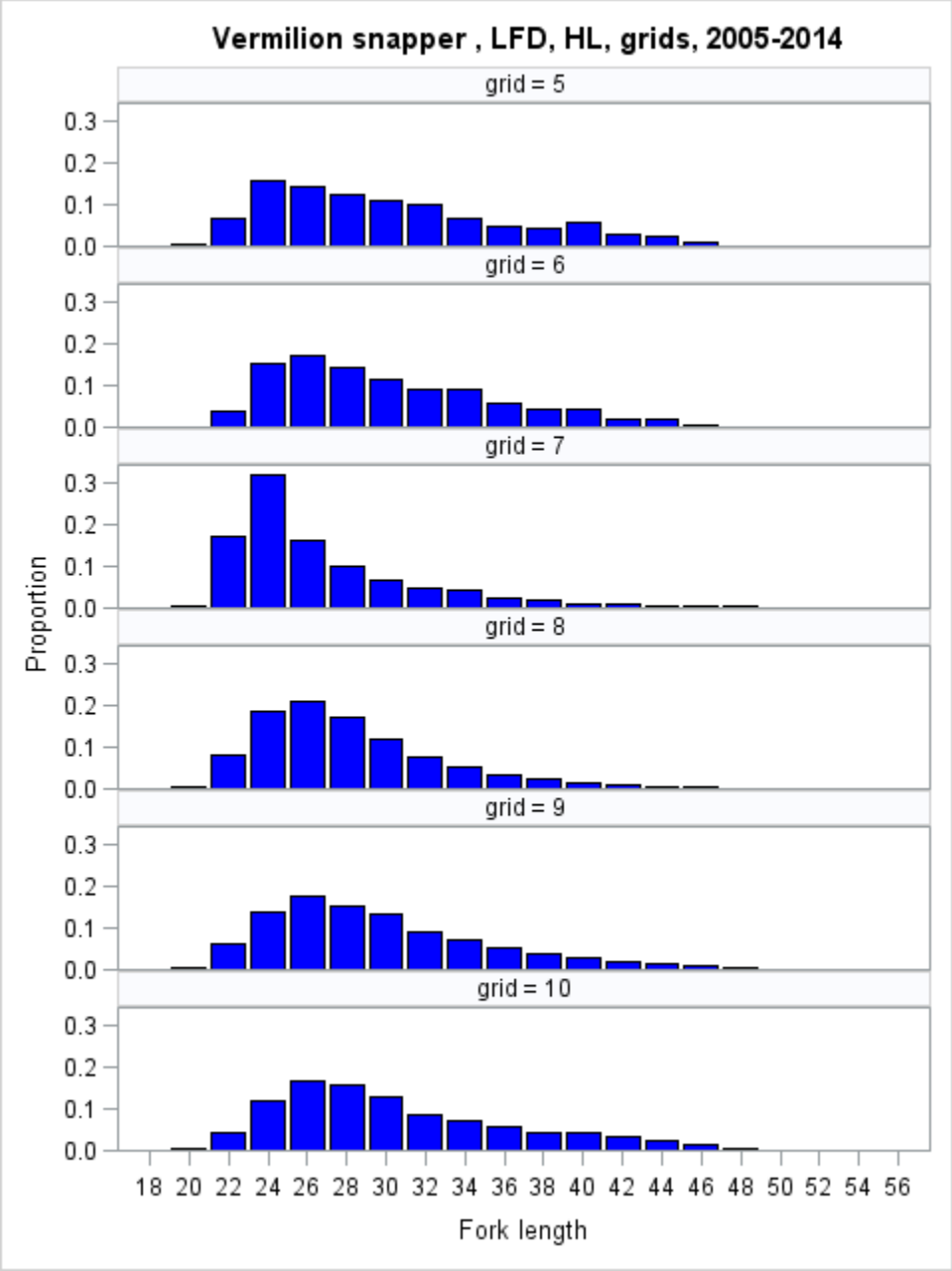


Fig 2 (continued)

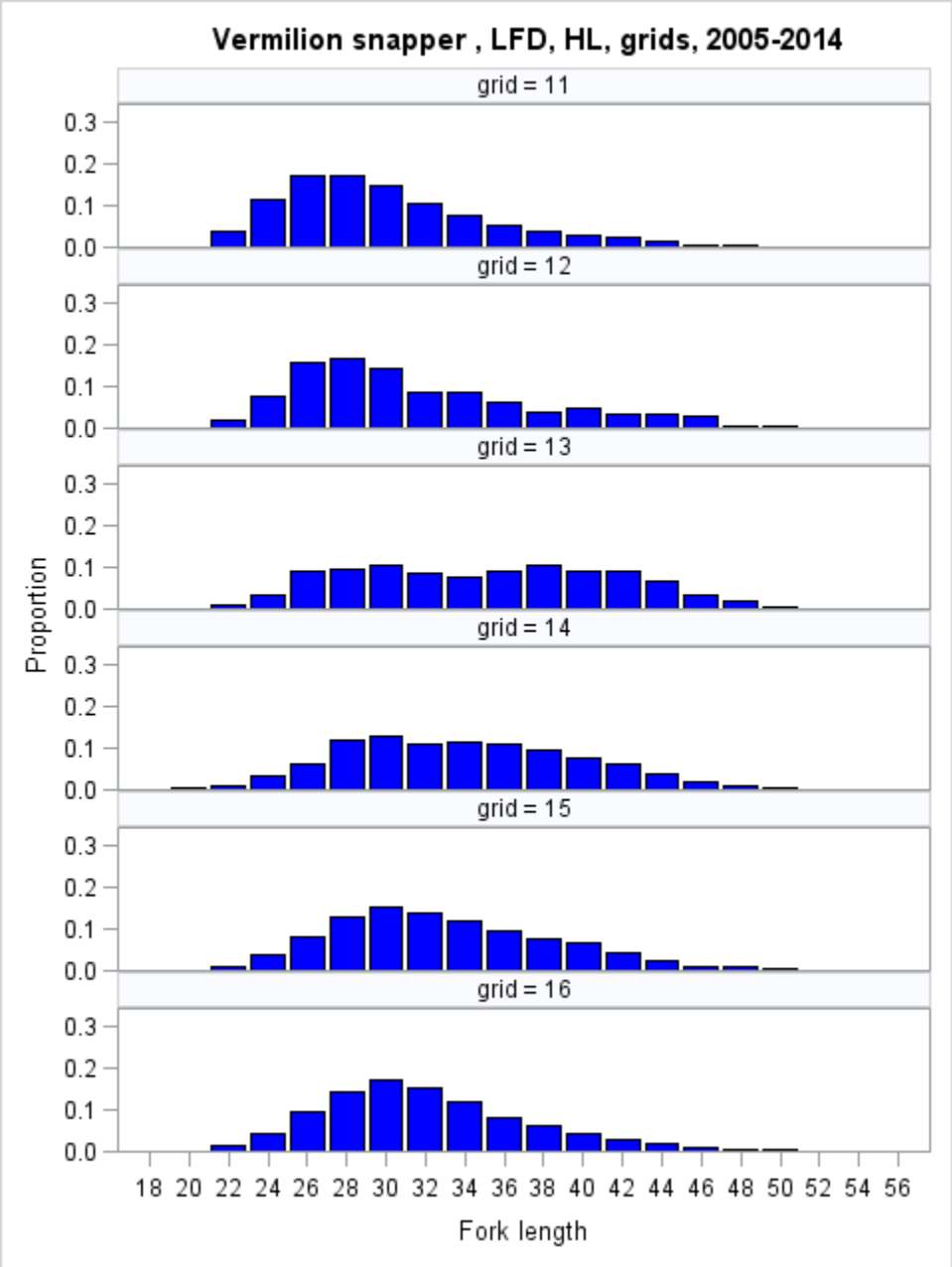


Fig 2 (continued)

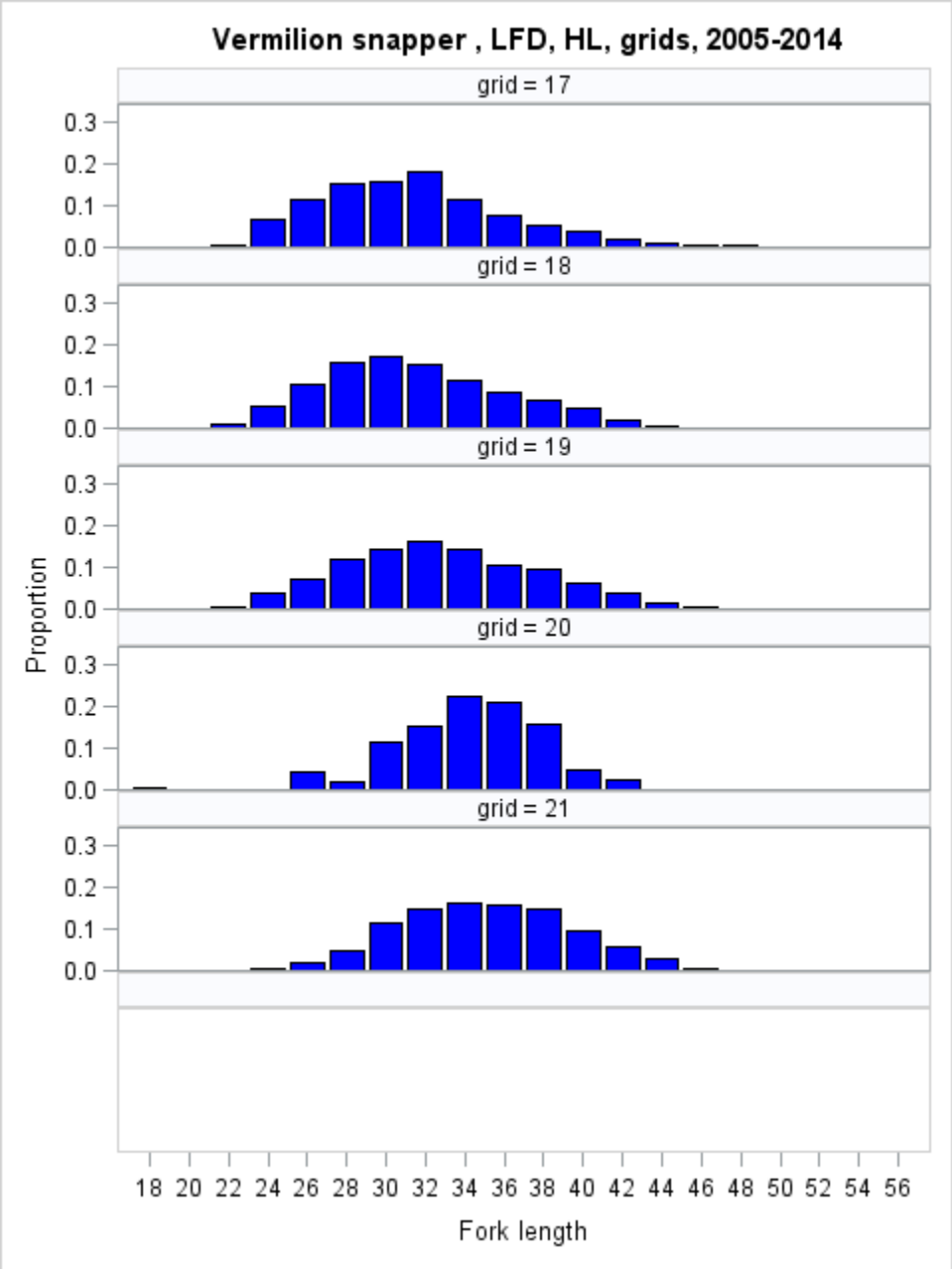


Fig 3. Comparisons of length frequency distributions for recreational length samples collected from the east and west regions of the Gulf of Mexico between 1986 and 2014.

(a) 1986-1991

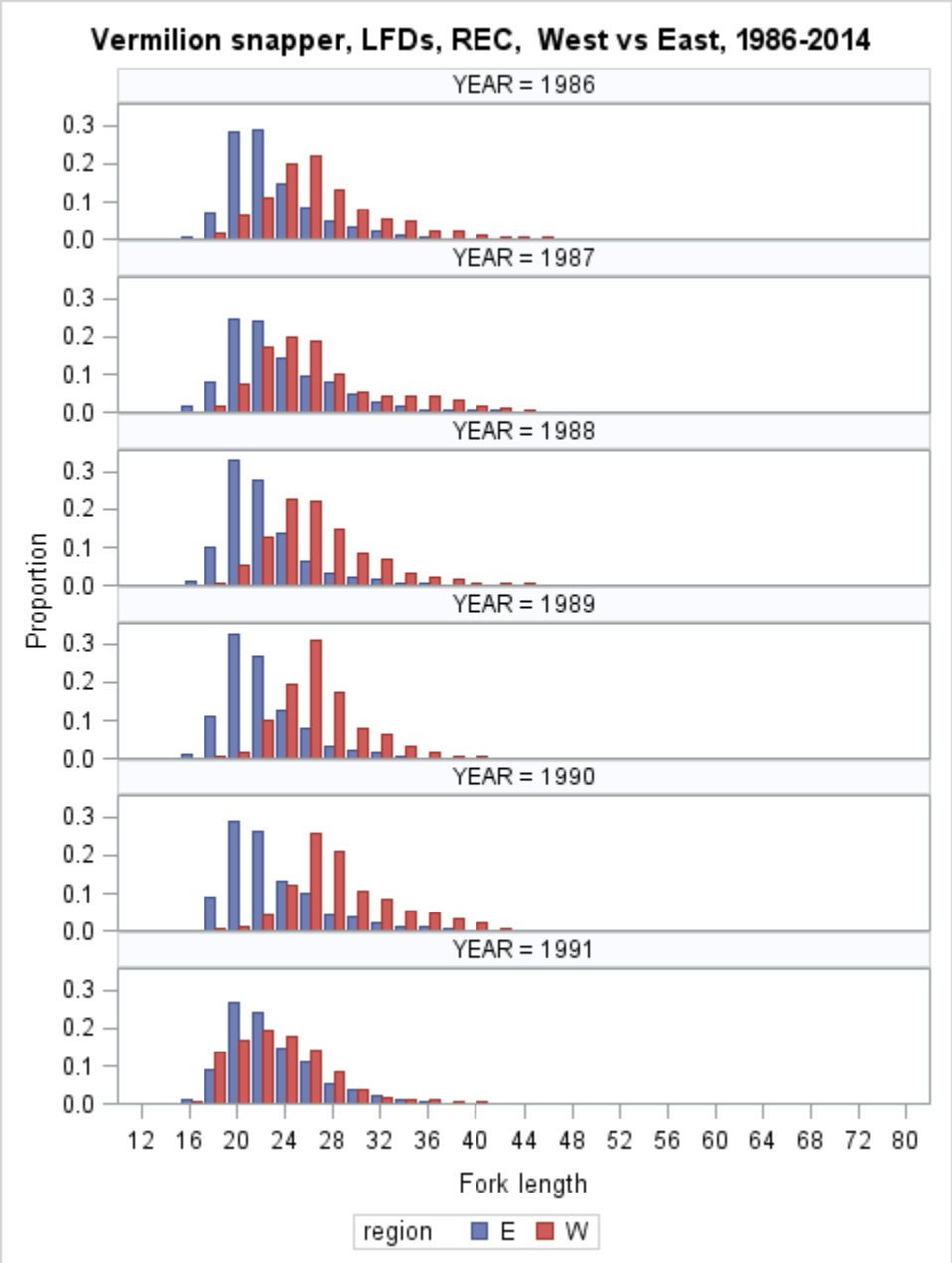


Fig 3 (continued)

(b) 1992-1997

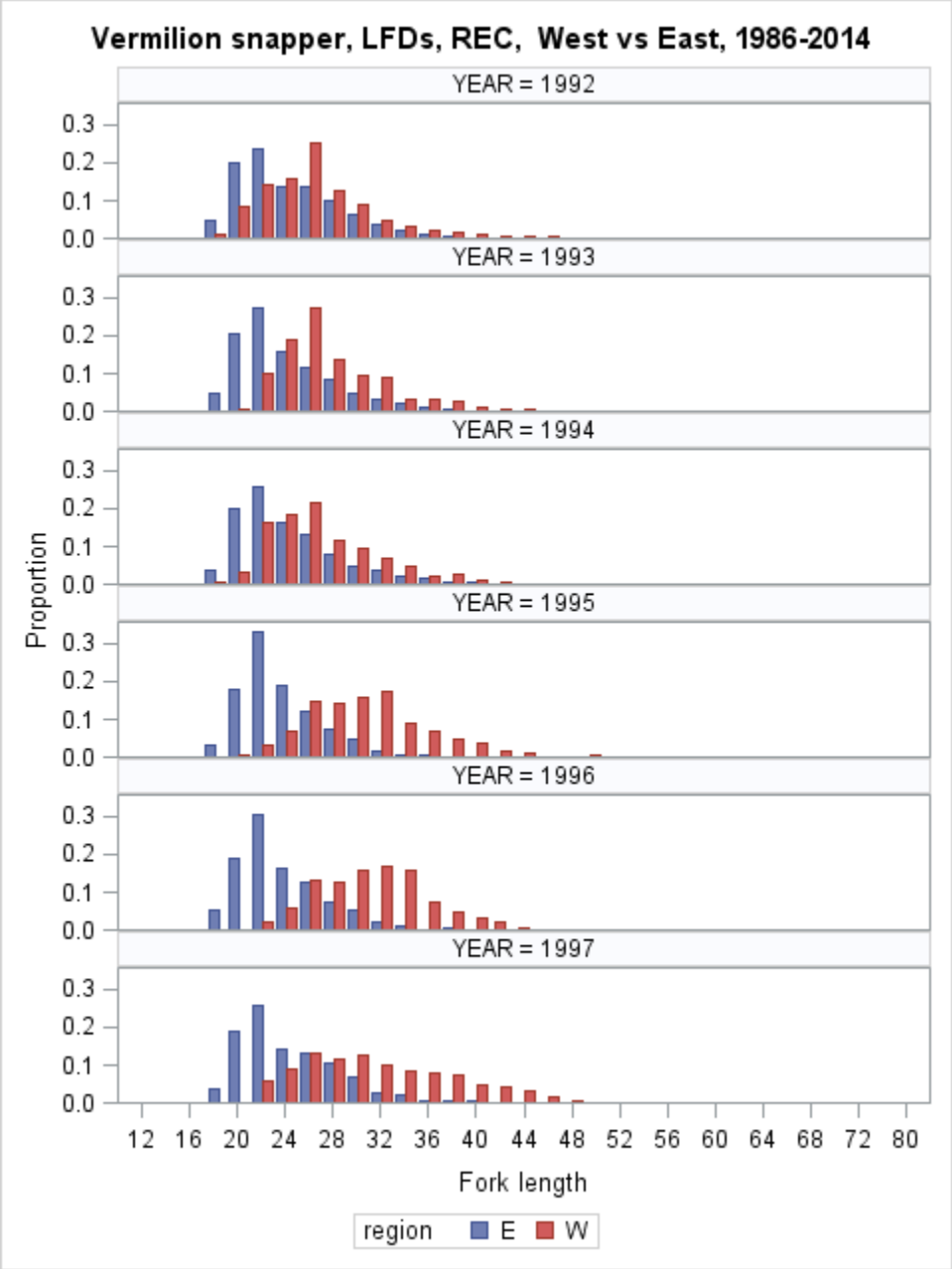


Fig 3 (continued)

(c) 1998-2003

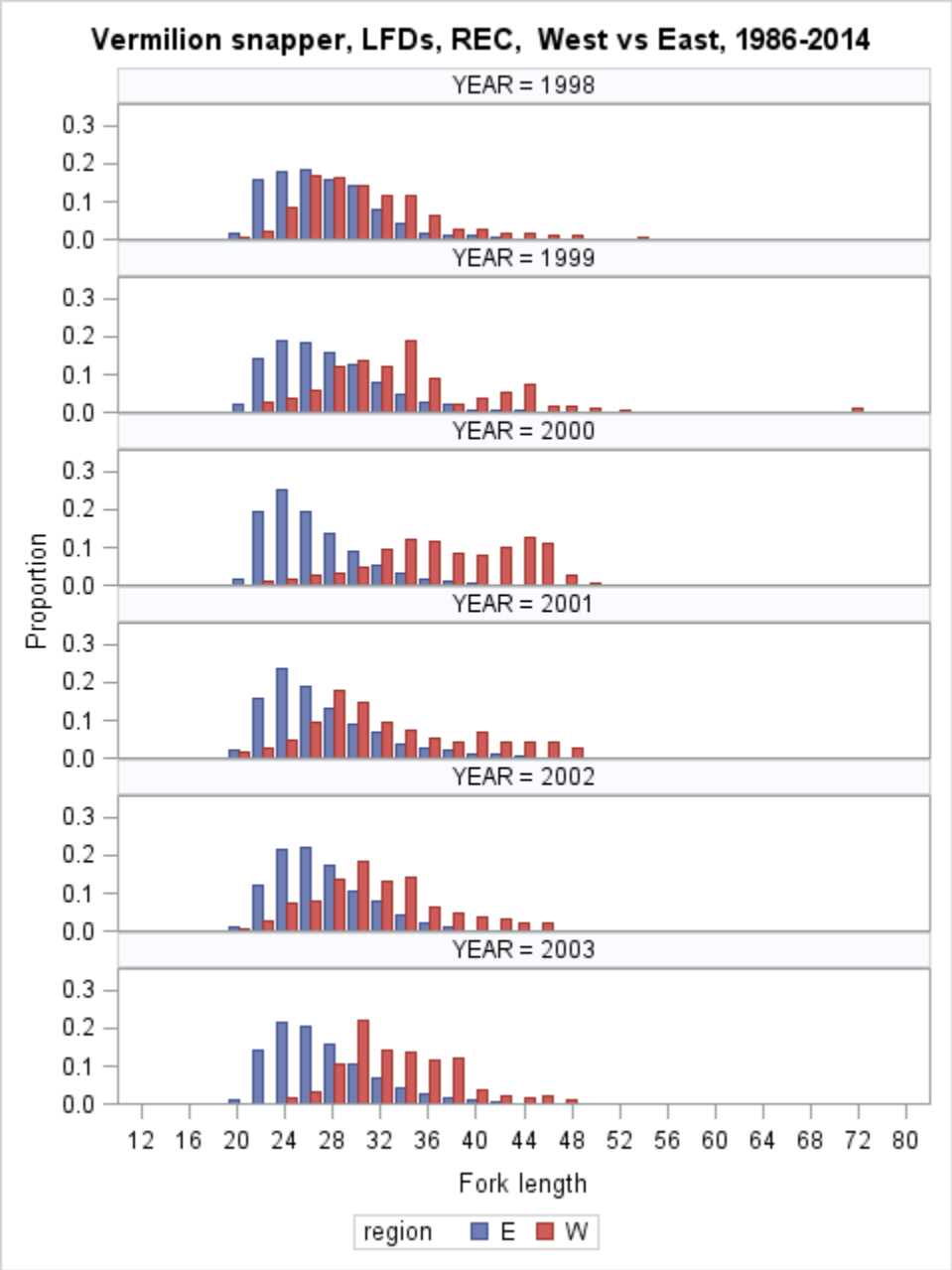


Fig 3 (continued)

(d) 2004-2009

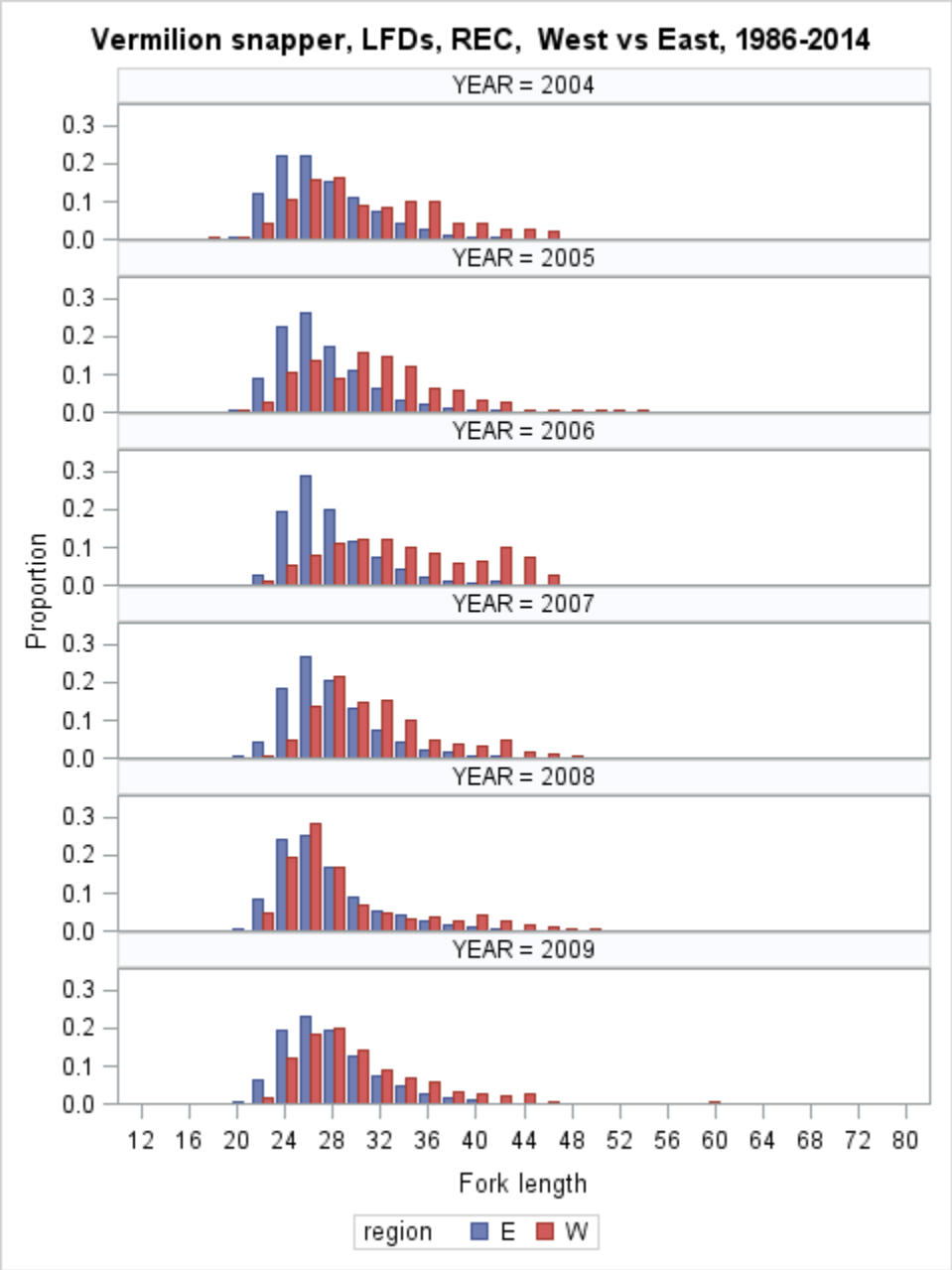


Fig 3 (continued)

(e) 2010-2014

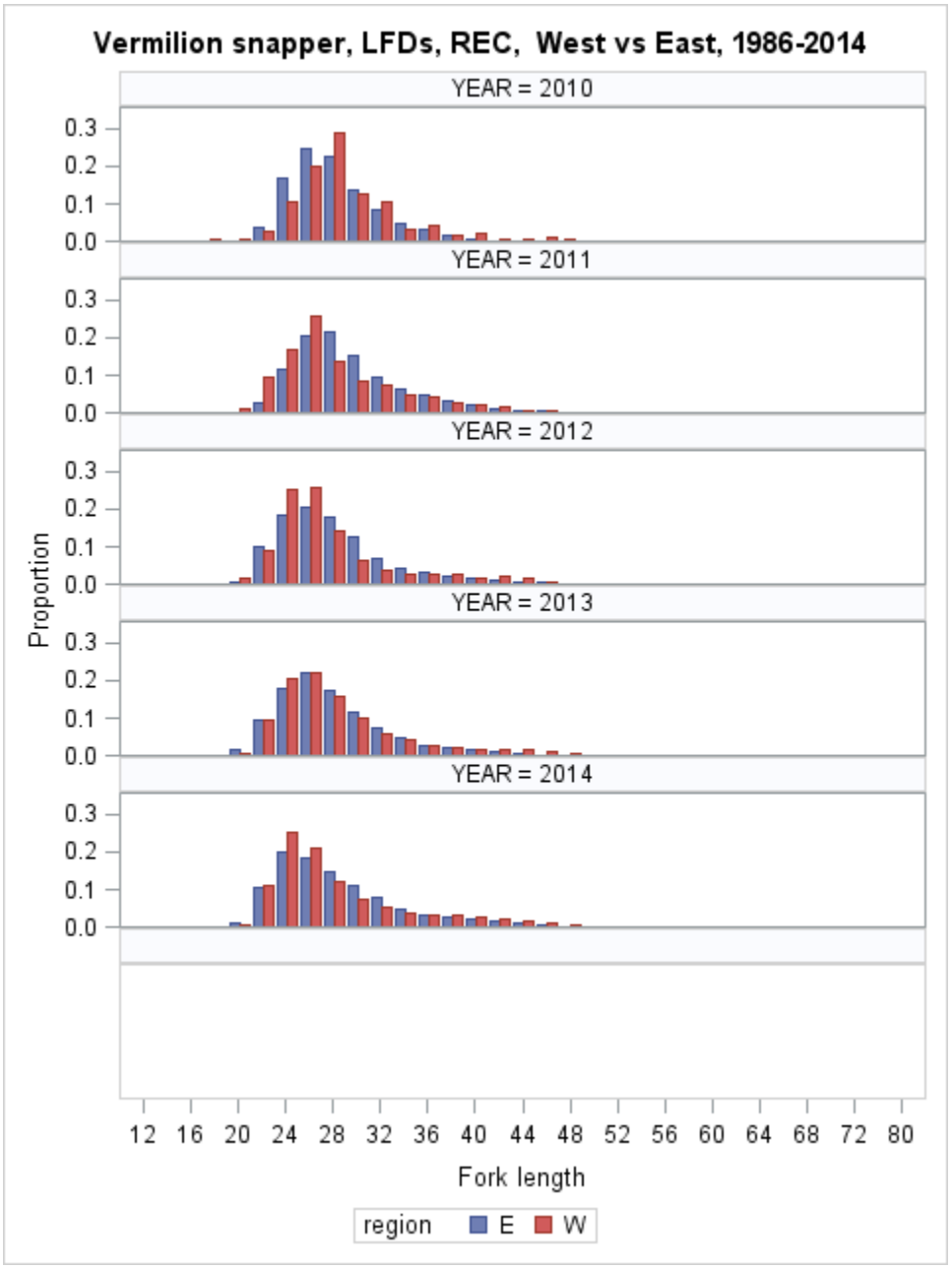


Fig 4. Reweighted age frequency distributions for commercial hand line samples collected from the Gulf of Mexico between 2000 and 2014.

(a) 2000-2004

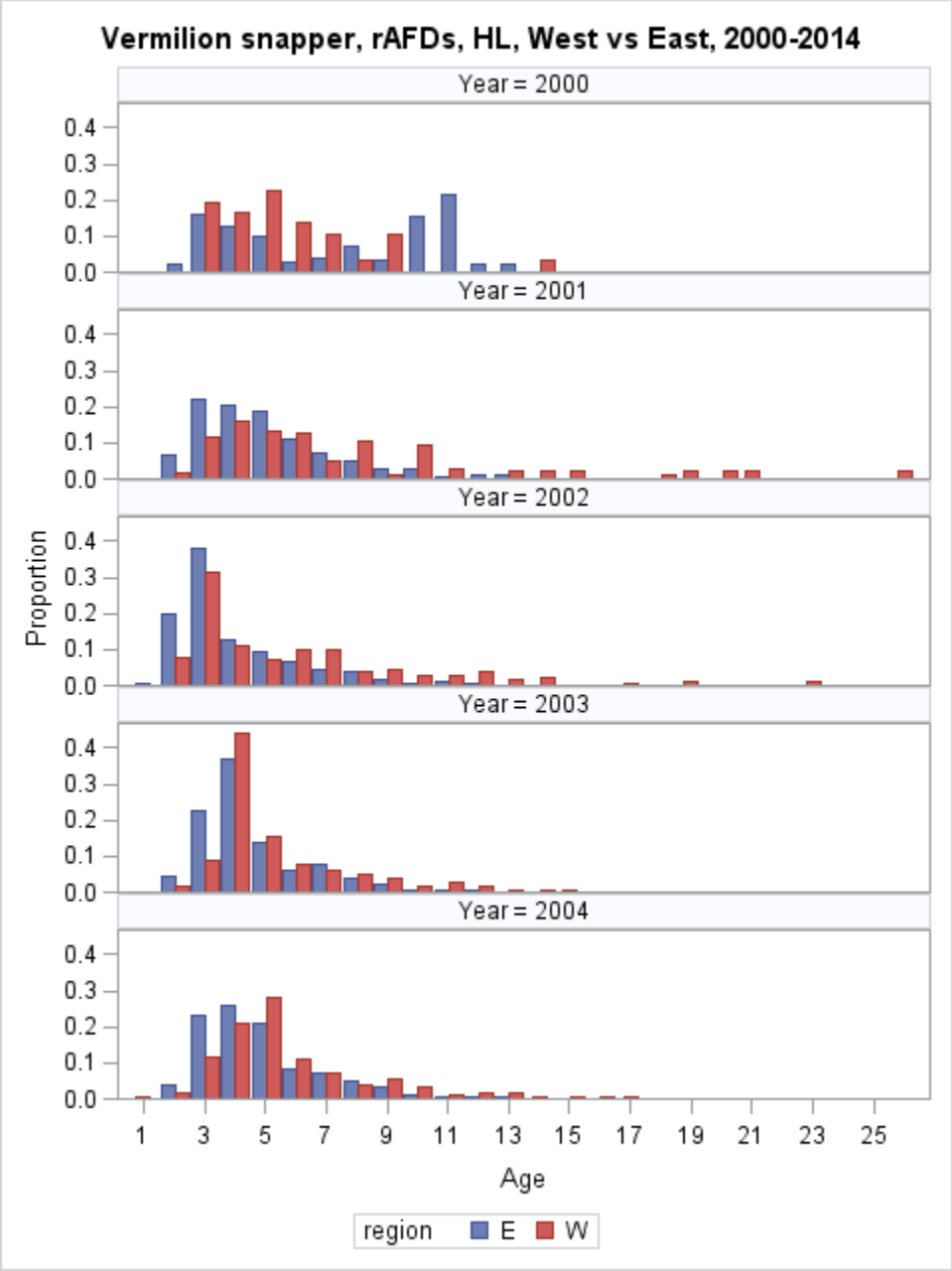


Fig 4 (continued)

(b) 2005-2009

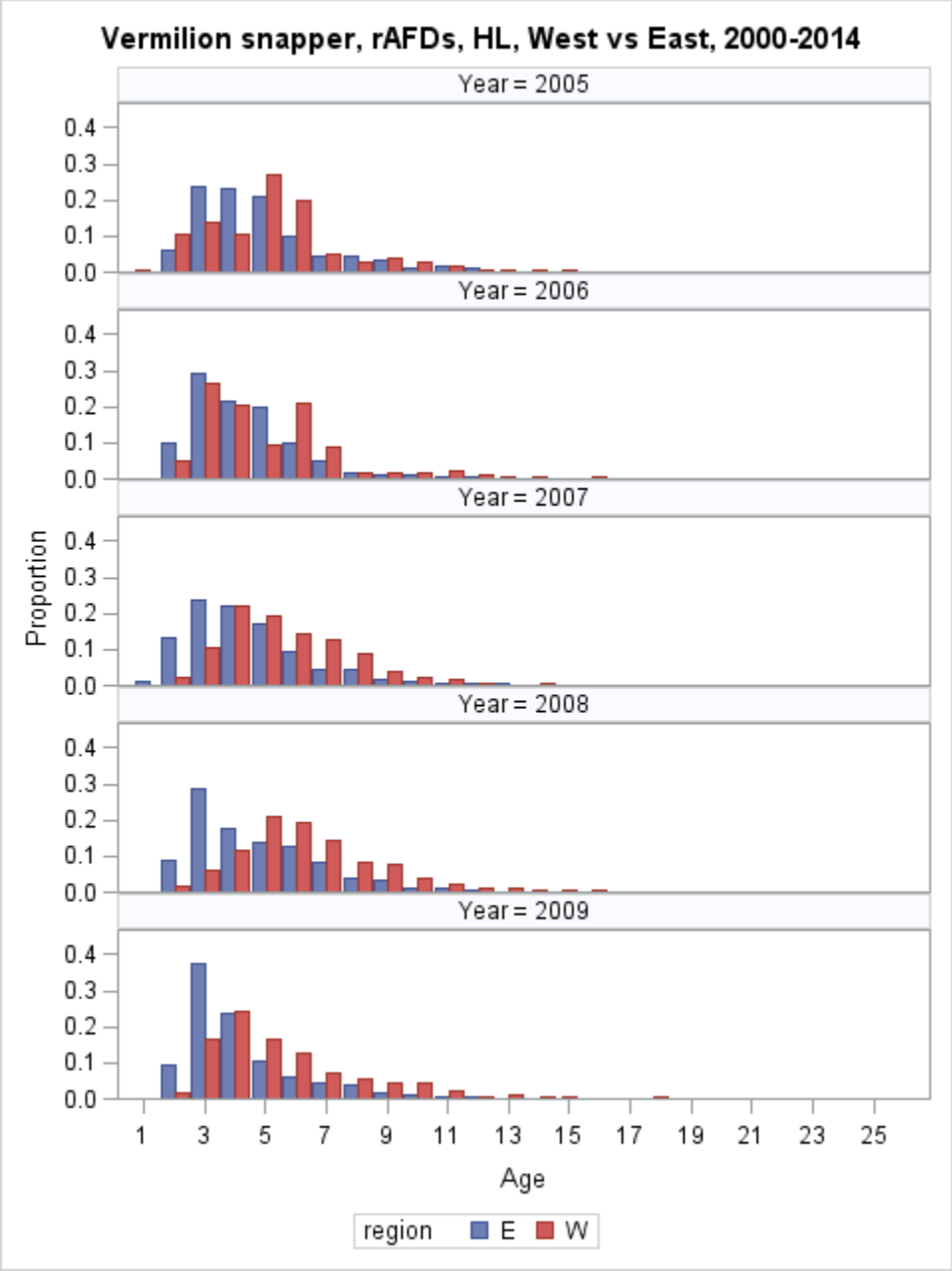


Fig 4 (continued)

(c) 2010-2014

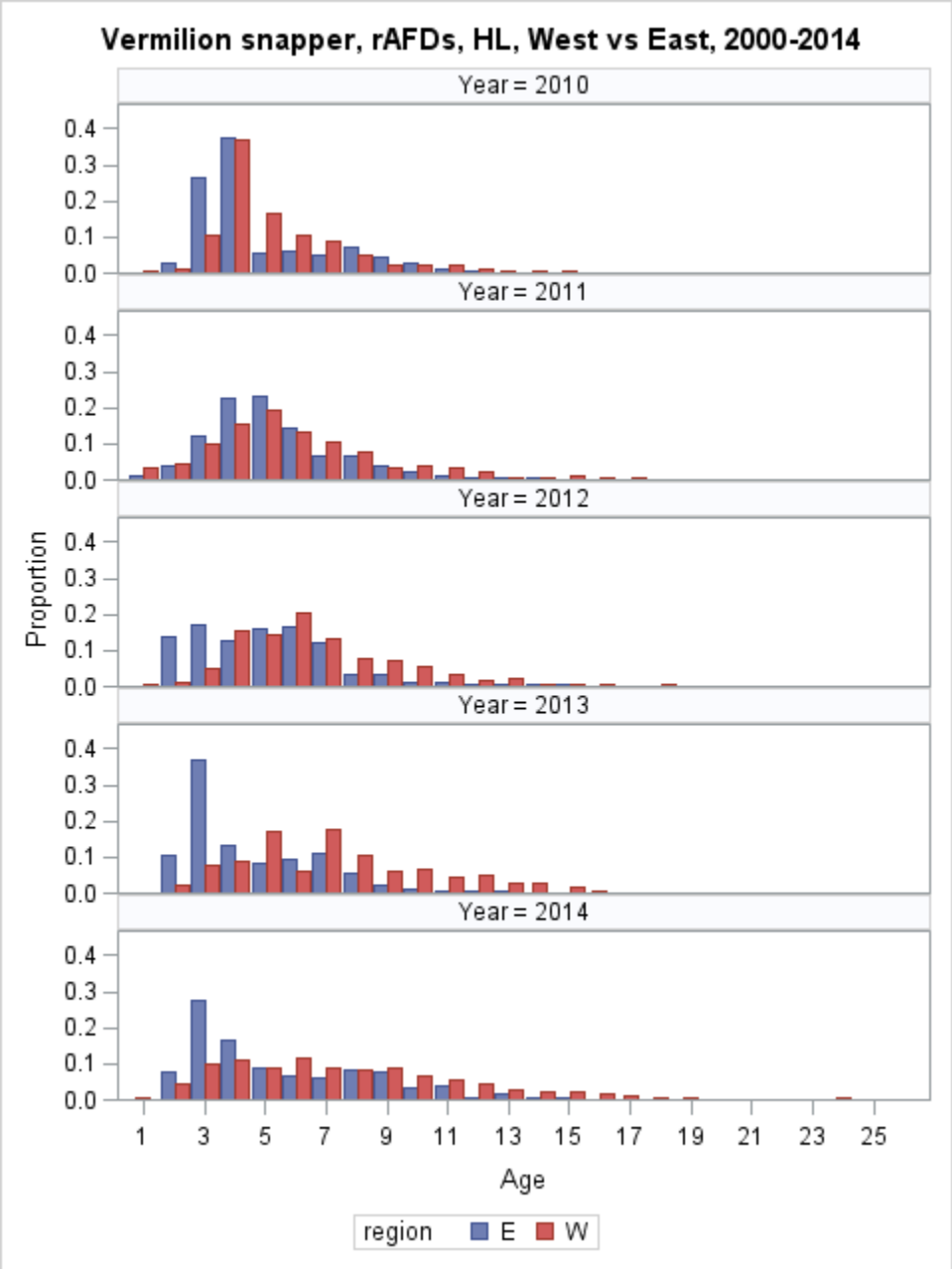


Fig 5. Reweighted age frequency distributions for recreational samples collected from the Gulf of Mexico between 2000 and 2014.

(a) 2000-2004

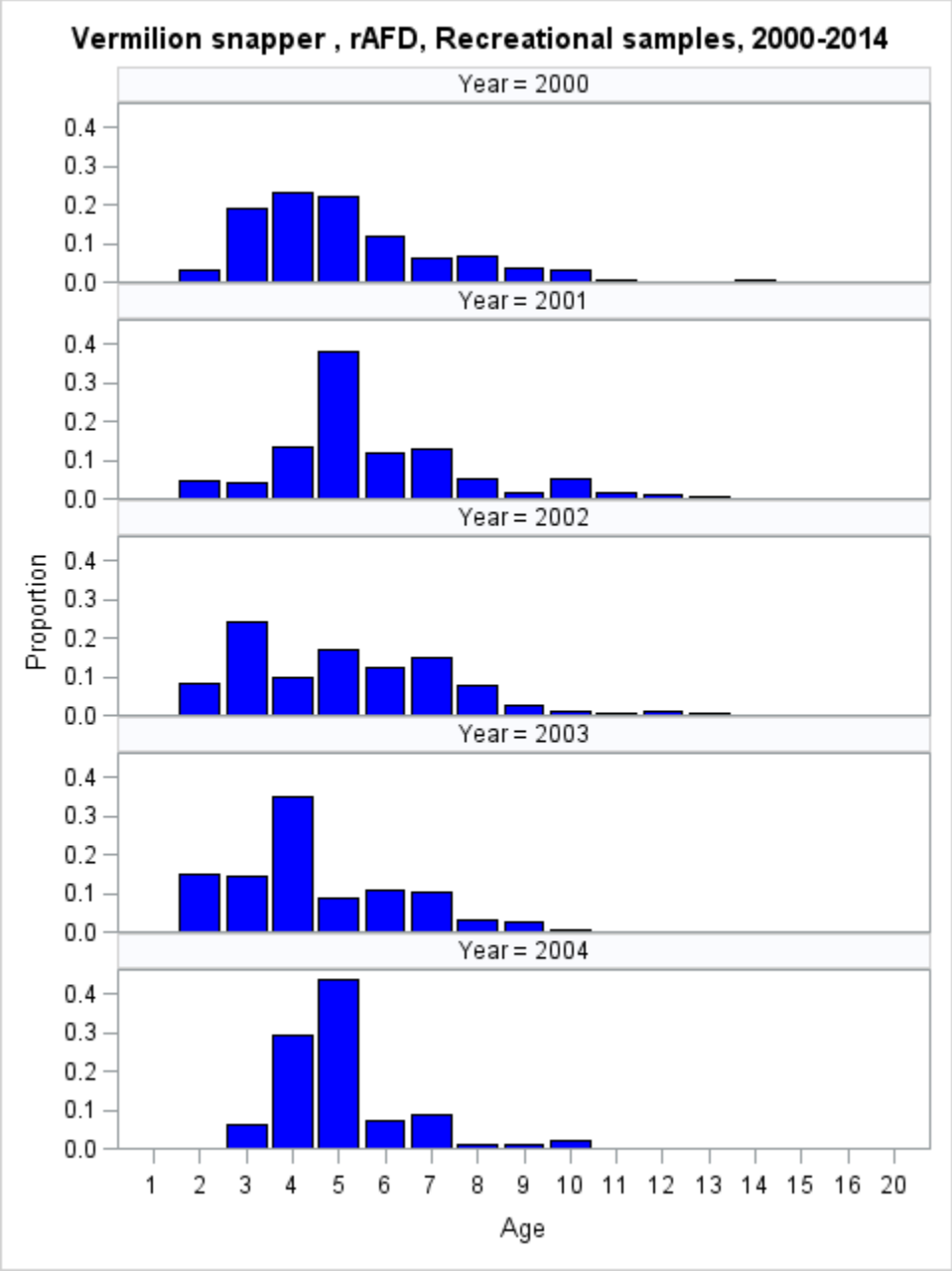


Fig 5 (continued)

(b) 2005-2009

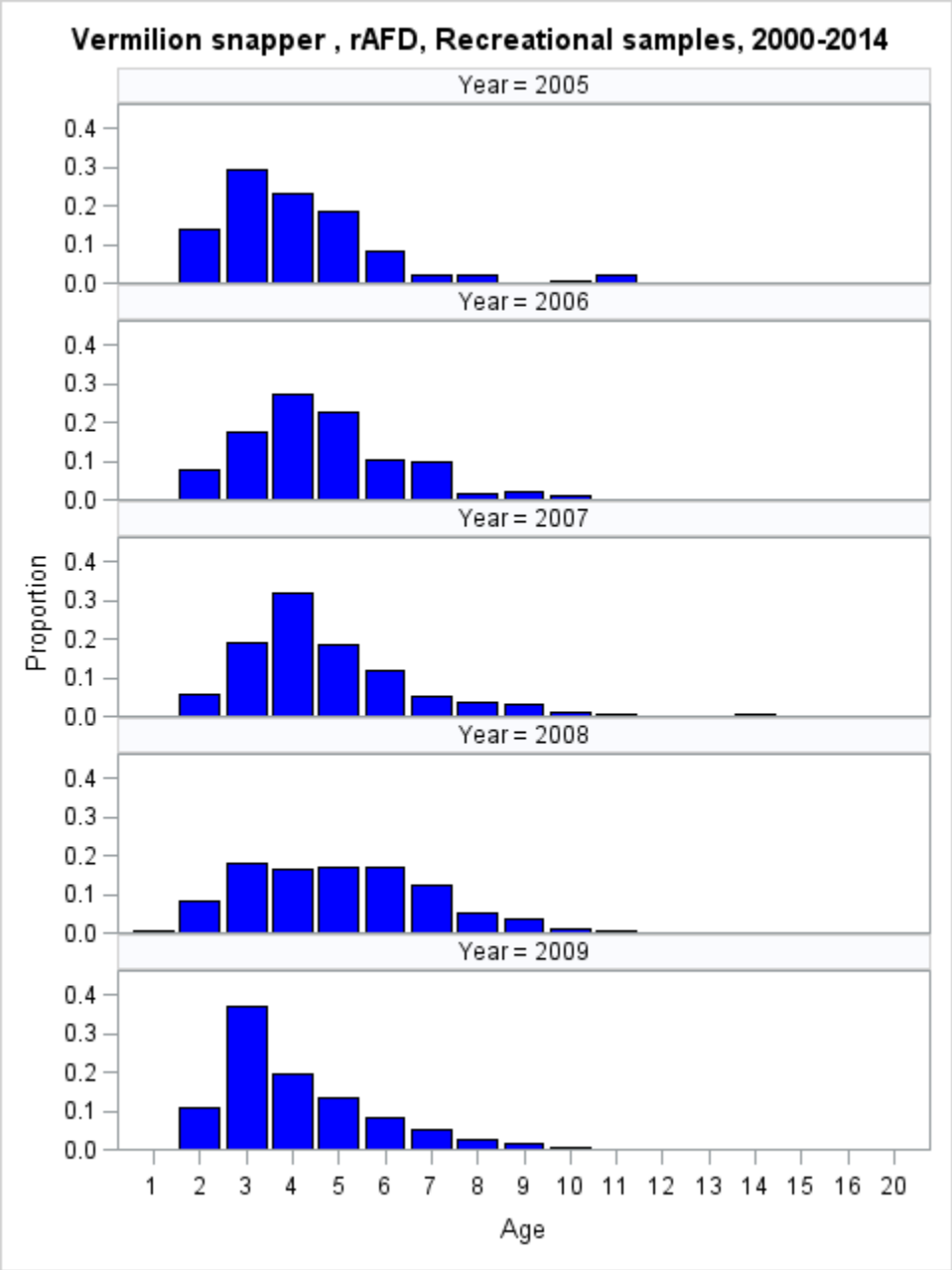


Fig 5 (continued)

(c) 2010-2014

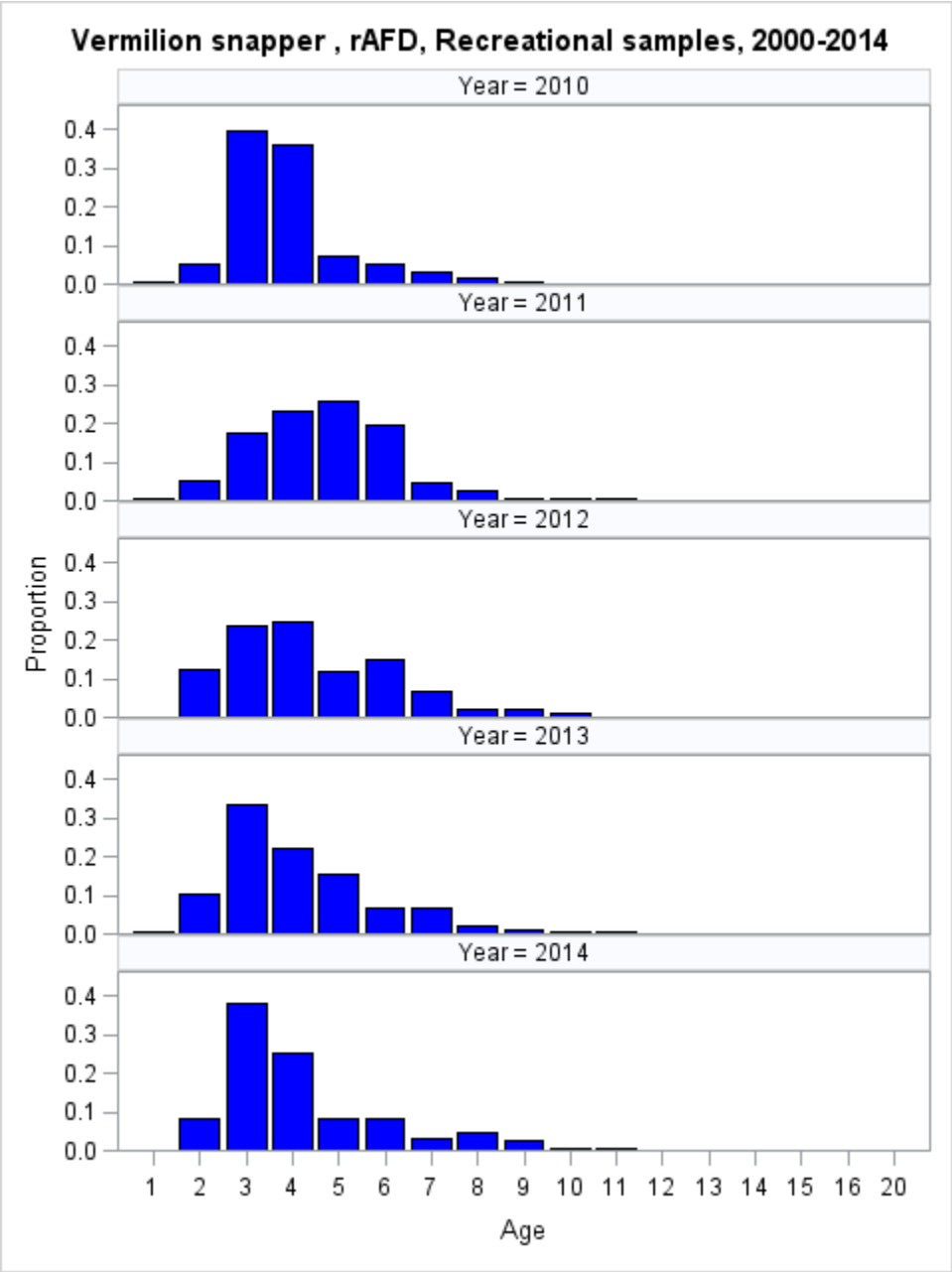
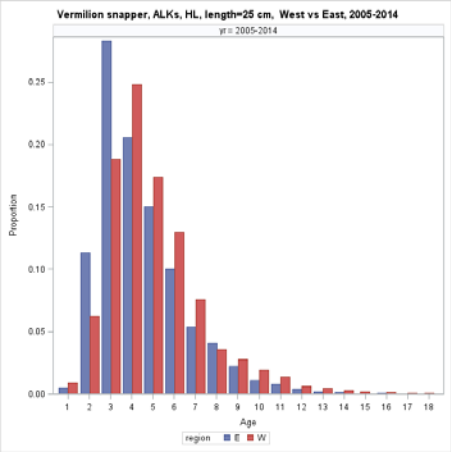
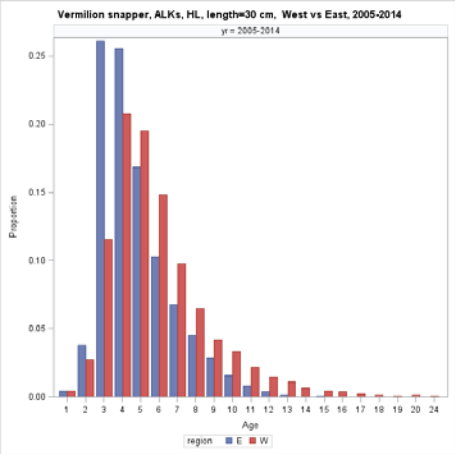


Fig 6. Comparison of age-at-length (AAL) at various lengths (length= 25, 30, 35, 40 cm, length interval=5 cm) for commercial hand line otolith samples collected from the east and west regions of the Gulf of Mexico between 2005 and 2014.

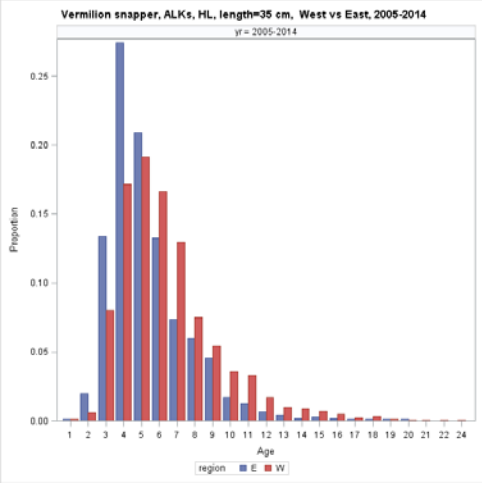
(a) length=25



(b) length=30



(c) length=35



(d) length=40

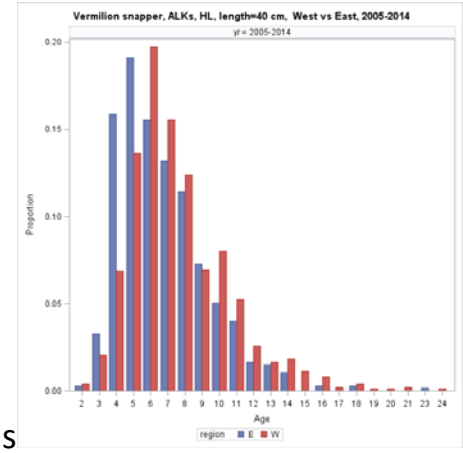


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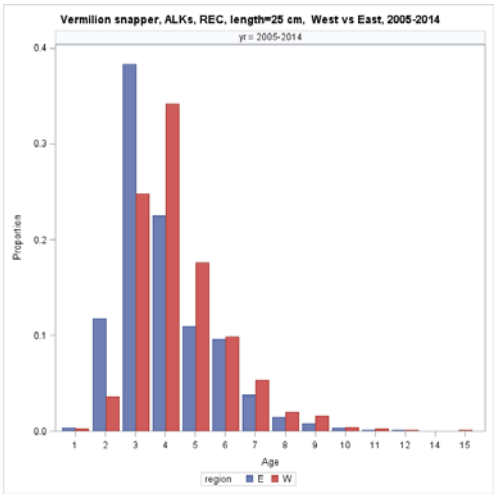
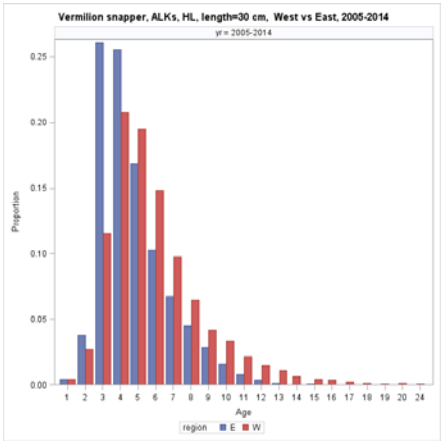
Fig 7. Comparison of age-at-length (AAL) at various lengths (length= 25, 30, 35, 40 cm, length interval=5 cm) for recreational otolith samples collected from the east and west regions of the Gulf of Mexico between 2005 and 2014.

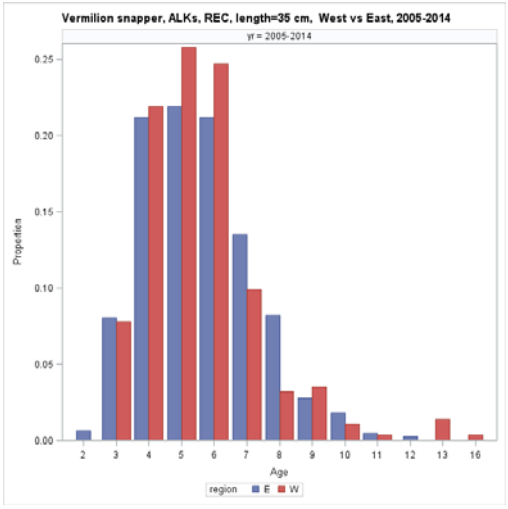
(a) length=25



(b) length=30



(c) length=35



(d) length=40

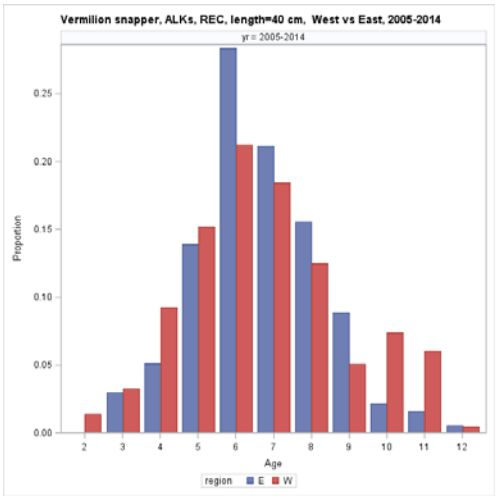


Fig 8. Comparison of length-at-age (LAA) at different ages (age 1-9) for commercial hand line otolith samples collected from the east and west regions of the Gulf of Mexico between 2005 and 2014.