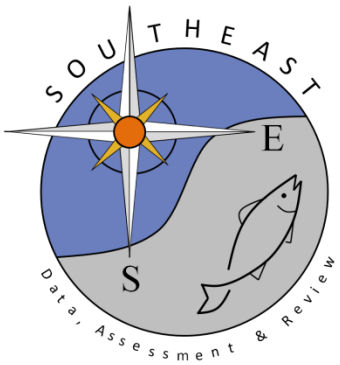
Length frequency distributions for gray snapper length and age samples collected from the Gulf of Mexico

Ching-Ping Chih

SEDAR51-DW-04

9 April 2017



Please cite this document as:

Chih, C-P. 2017. Length frequency distributions for gray snapper length and age samples collected from the Gulf of Mexico. SEDAR51-DW-04. SEDAR, North Charleston, SC. 30 pp.

Length frequency distributions for gray snapper length and age samples collected from the Gulf of Mexico

Ching-Ping Chih

Abstract

This report documents the differences in the length frequency distributions (LFDs) for gray snapper length and age samples from the Gulf of Mexico (GOM) collected from different regions and shore areas, by different fishing modes, and by different sampling programs. Results from these analyses provide insight regarding how length and age samples should be sub-stratified and weighted for different strata and regions. The differences in LFDs between age and length samples in many strata and regions also suggest that ALK methods should be used for estimating the age frequency distributions for gray snapper.

Materials and Methods

Most length and age samples from commercial fisheries were obtained from the Trip Interview Program (TIP) database housed at the Southeast Fisheries Science Center (SEFSC). A small number of commercial samples were also obtained from the Gulf State Marine Fisheries Commission FIN database (GFIN). Length and age samples from recreational fisheries were obtained from the Marine Recreational Fisheries Statistics Survey (i.e., the Marine Recreational Information Program, MRIP), the Head Boat Survey (HB), the Texas Parks and Wildlife Department database (TPWD), the Gulf State Marine Fisheries Commission FIN database (GFIN), and the TIP database. Otolith samples were processed and read by the Panama City Laboratory, SEFSC.

Length and age samples collected from commercial fisheries were stratified into four strata: commercial hand line (CMHL), commercial long line (CMLL), commercial trap (CMTR) and commercial gill net (CMGN). Length and age samples collected from recreational fisheries were also stratified into four strata: charter boat (CP), head boat (HB), private boat (PR) and shore (SH). The boundary of GOM stock for gray snapper, based on the recommendation of the gray snapper stock ID workshop, includes all fish

samples collected in Monroe County. Because of the distinct differences in LFDs among different regions (see below), samples from all strata were further sub-stratified into two regions: the Monroe County region (MC) and north of the Monroe County region (nMC) (Tables 1-4). For TIP and GFIN samples, Monroe County samples included all samples collected from all subareas from grids 1, 2, and 748, and three sub areas from grid 744 (744.1,744.6, and 744.7). For HB samples, Monroe County samples included samples collected from HB areas 12, 17 and 18. For MRIP samples, Monroe County samples included samples collected from Florida Region 3. When fishing area information was not available, landing areas (state/county) were used to define the GOM boundary and Monroe County region. To understand the overall size distributions of the entire gray snapper stock, a few comparisons of regional LFDs for samples collected from the South Atlantic (SA) with those collected from the GOM were made.

For samples from the MRIP and TPWD databases, samples collected from state or federal waters can be identified. State waters are from shore to 3 nautical miles in the SA and from shore to 9 nautical miles in the GOM. The shore area categories include inshore (shore=1), fishing area <= 3 miles (shore=2), fishing area > 3 miles (shore=3), fishing area <= 10 miles (shore=4), and fishing area > 10 miles (shore=5). Shore categories 1, 2 and 4 belong to state waters, while shore categories 3 and 4 belong to federal waters.

All lengths are fork lengths in centimeters. Conversion equations for different length types were provided by the Panama City Laboratory.

Results and Discussion

1. Regional differences in LFDs

There are clear regional differences in estimated LFDs for gray snapper samples collected from both commercial and recreational fisheries from both the GOM and the SA. (Figs. 1-4). For commercial TIP samples, LFDs estimated from samples collected from grids 1, 2 and 748 (near Monroe County) had much larger proportions of small fish than the rest of the GOM (Fig. 1 (a)). Larger fish were collected mostly from the Florida West or west GOM areas. Similarly, a greater portion of large gray snapper TIP samples were also found along the northern regions of Florida's east coast (Fig. 1 (b)). Regional differences in LFDs were consistent among TIP samples collected from different years (Fig. 2).

For recreational HB samples, LFDs estimated from samples collected from the Florida South Region (HB areas 12, 17, and 18) had greater proportions of smaller fish than all other GOM and the SA regions (Fig. 3). Regional differences in LFDs were also consistent among HB samples collected for different years (Fig. 4). Results from both TIP and HB samples showed that larger gray snappers tend to move from South Florida toward the north of either GOM or SA.

2. Effect of fishing distance to shore on estimated LFDs

The availability of distance to shore information in the MRIP and TPWD databases allows the analyses of the effect of 'fishing distance to shore' on the changes in size distributions. For gray snappers collected from the same region in GOM, LFDs estimated from samples from federal waters consistently have a greater proportion of larger fish as compared to those estimated with samples collected from state waters and inshore (Fig. 5 (a)). Similar patterns in differences in LFDs among different water areas were also found in the SA (Fig 5. (b)). Also, for gray snappers collected from the same water categories (state or federal waters), LFDs estimated from samples from the GOM west region consistently have greater proportions of larger fish as compared to those estimated with samples collected from the Florida West and Florida South regions (Fig. 6). Regional differences in LFDs were not significant among samples collected from near shore. These analyses showed that both regions and 'fishing distance to shore' are important factors that affect the size distribution. Fishing distance to shore may influence the size of fish caught because (a) smaller fish tend to gather near shore or in shallow water areas, and (b) size limit regulations for fish collected in state (total length > 10 inches) and federal waters (total length > 12 inches) are different. How much of the LFD differences in different shore areas were attributable to fishing depth is not clear since depth information is not available in the MRIP/TPWD databases.

Difference in LFDs among the three fishing modes (CP, PR, SH) in the MRIP and TPWD data (Fig. 7(a)) were most likely due to differences in the percentage of fish samples caught at different shore areas among the different modes. For the private boat fishery, about 84% of MRIP/TPWD samples were collected in shore or state waters. For the charter boat fishery, about 37% of MRIP/TPWD samples were collected in shore or state waters. The size distributions for gray snapper collected from the same shore categories were similar for the different fishing modes (Fig. 7(b), Fig. 8).

3. Stratification based on regions

The above analyses suggested that length samples should be further sub-stratified and weighted by corresponding landings by regions and by fishing distance to

shore. However, further sub-stratification may not be feasible when (a) sample sizes for individual strata are too small, (b) information for distance to shore (e.g., commercial and HB samples) is not available, and (c) accurate landing information for individual strata is missing. Based on these considerations, LFDs were sub-stratified into Monroe County and north Monroe County for four strata (CMHL, CP, PR, HB) in this analysis. Consistent yearly differences in LFDs between the two regions are seen in all four strata (Figs. 9-12). In all strata, proportions of smaller fish in the LFDs estimated from samples collected from the MC region were much greater than those estimated from samples collected from the nMC region. The differences in LFDs between these two regions were less significant for private boat samples (Fig. 12), probably because most private boat samples were collected from shallow waters.

4. Age vs. length samples

In order to estimate age frequency distributions (AFD), the age samples also need to be weighted by regional landings to adjust for the differences in AFDs/LFDs between the MC and nMC regions. However, the age sample sizes from many years/strata were too small for the estimation of AFDs/LFDs. Also, there were significant differences in the LFDs estimated from age and length samples collected from charter boat and private boat fisheries, which represents a large portion of gray snapper landings (Figs14 and 15). In these two strata, there were greater proportions of larger fish in age samples than in length samples. Smaller differences in LFDs between the age and length data were found in the commercial and recreation head boat fisheries (Figs13 and 16). These results suggest that direct estimates of AFDs from age samples may be inappropriate and that the ALK method should be used to estimate AFDs for gray snappers.

Since age samples are subsamples of length samples, the differences in LFDs for length samples from different GOM regions also mean that length-at-age or growth curves estimated from age samples collected from different GOM regions may be different (Chih, 2009). Estimation of a growth curve for the entire GOM stock may therefore require (a) corrections for differences in LFDs between age and length samples from some strata/regions (e.g. charter boat/private boat) and (b) corrections for the non-proportional sampling of age samples by corresponding landings (e.g. weight the age samples for individual strata by corresponding landings).

Recommendations

1. The consistent differences in regional LFDs for length samples over many years suggest that length samples should be sub-stratified into different regions and that estimated LFDs should be weighted by the corresponding regional landings. Results from these analyses support the sub-stratification of the GOM stock into Monroe County and north Monroe County regions.

2. The ALK method is recommended for estimating AFDs for gray snappers because (a) the LFDs estimated from age and length samples were different for many strata/years (e.g., charter boat and private boat), and (b) the age sample sizes in many strata/regions/years were too small to be representative.

References

Ching-Ping Chih, 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 length samples collected from the Gulf of Mexico between 1984 and 2015 (CMHL- commercial hand line, CMLL- commercial long line, CMTR- commercial trap, CMGN- commercial gill net, MC- Monroe County region, nMC- north of Monroe County region).

	CMHL		CMLL		CMTR		CMGN	
Year	MC	nMC	MC	nMC	MC	nMC	MC	nMC
1984		42						
1985	81	67						
1986		6	265	5	10			
1987	842	1					298	
1988	406	1					285	
1989	2016	6	10	22			816	75
1990	1197	191	16	196	129	11	188	
1991	1695	442	3	309		51	10	5
1992	1205	577	23	308		20		13
1993	890	369		70	27	36		8
1994	2188	863	3	71	18	3		15
1995	1407	467	17	33	6	22	3	4
1996	931	1345	3	28	25	20	2	
1997	1243	897		30	32	51		
1998	927	989	4	260	49	51	1	
1999	864	1998	11	228	39	25		
2000	345	1289	3	128	33	20		
2001	1308	1050	5	152	12	35		
2002	576	914	5	345	4	10		
2003	676	475	12	232	1	42		
2004	447	452		414	19			
2005	379	354	2	232		3		
2006	386	253	2	259		16		
2007	326	296	1	227				
2008	600	421	5	346				
2009	605	1100		114	1			2
2010	388	445	9	210	1			
2011	269	628	4	272				
2012	704	1120	2	219				
2013	665	855	4	355				
2014	675	787	7	419				
2015	289	602	6	299				

Table 2. Sample sizes for recreational length samples collected from the Gulf of Mexico between 1984 and 2015 (CP- charter boat, HB- head boat, P- private boat, SH- shore, MC- Monroe County region, nMC- north of Monroe County region).

	CP		HB		PR		SH	
Year	MC	nMC	MC	nMC	MC	nMC	MC	nMC
1978			12					
1979			68					
1980			53					
1981		3	79	17	28	37	61	16
1982		9	193	30	44	19	96	38
1983	1	22	344	54	3	25	14	48
1984	5	10	483	56	20	8	37	4
1985		1	516	22	4	9	20	12
1986	15	57	709	513	28	29	16	22
1987	17	58	488	450	125	117	14	8
1988	6	14	373	439	24	81	30	59
1989	18	4	309	531	44	123	30	56
1990	2	19	255	326	22	64	11	14
1991	25	74	196	220	39	122	31	32
1992	21	151	163	354	58	319	22	83
1993	22	144	171	284	101	272	89	72
1994	27	351	166	334	112	311	103	40
1995	9	70	127	325	140	341	83	26
1996	4	72	103	253	73	222	55	22
1997	50	203	349	613	36	198	17	46
1998	106	370	365	868	61	392	25	63
1999	81	378	555	786	97	593	27	49
2000	94	414	334	447	22	622	1	49
2001	67	379	526	779	40	472	43	43
2002	118	709	446	809	35	513		30
2003	138	805	261	889	80	742		58
2004	73	763	295	161	21	821		39
2005	26	793	273	540	16	1143		52
2006	56	741	242	282	35	1062		34
2007	102	857	273	356	110	997	5	52
2008	138	995	305	363	86	1563		107
2009	293	942	454	1172	71	2380		94
2010	306	479	495	1497	89	604		30
2011	154	763	445	1098	31	543	1	6
2012	212	858	1449	1343	50	799	15	59
2013	263	880	791	638	122	1377	6	34
2014	620	1075	1327	197	269	1694	5	31
2015	388	543	1069	507	149	1080	6	11

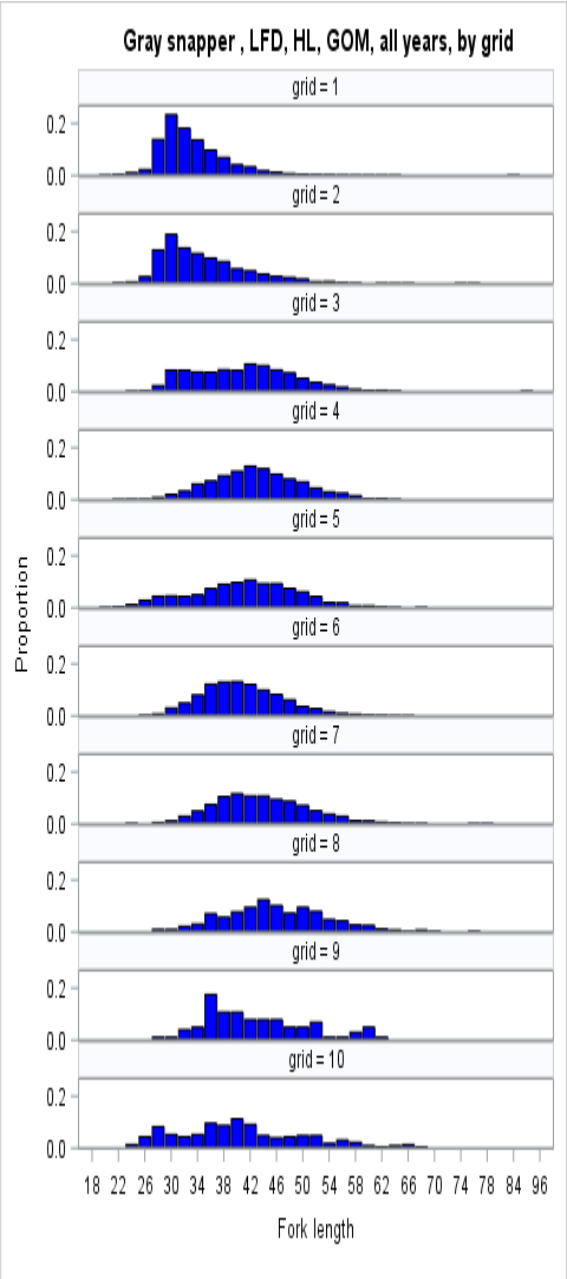
Table 3. Sample sizes for commercial age samples collected from the Gulf of Mexico between 1984 and 2015 (CMHL- commercial hand line, CMLL- commercial long line, CMTR- commercial trap, CMGN- commercial gill net, MC- Monroe County region, nMC- north of Monroe County region).

	CMHL		CMLL		CMTR	
Year	MC	nMC	MC	nMC	MC	nMC
1982				195		
1983				83		
1991	9	32				
1992	5	15		1		
1993	10	38		1		9
1994	12	79		3		2
1995	36	18				
1996	33	33	2	2		4
1997	52	49		2		
1998	106	6	1	5		5
1999	81	4		5		3
2000	42	20		5		6
2001	85	57		36	2	
2002	46	59	1	38	2	2
2003	115	114	2	38	2	6
2004	45	110		169		
2005	70	151	2	106		
2006	126	160	2	247		7
2007	82	246		194		
2008	204	344	4	314		
2009	200	1008		131		
2010	169	393	8	193	1	
2011	169	551	2	238		
2012	485	1058	2	206		
2013	616	802	2	354		
2014	585	640	7	399		
2015	341	585	5	261	1	

Table 4. Sample sizes for recreational age samples collected from the Gulf of Mexico between 1984 and 2015 (CP- charter boat, HB- head boat, PR- private boat, SH- shore, MC- Monroe County region, nMC- north of Monroe County region).

	CP		HB		PR		SH	
Year	MC	nMC	MC	nMC	MC	nMC	MC	nMC
1980			33					
1981			25					
1982			34	69				
1983			5					
1990				3				
1991		10	33	25	5			
1992	2	44		149	22			
1993	4	83		101	7	1		
1994		203	5	144	8			
1995		90	39	57	3	1		
1996		104	24	55				
1997		108	43	146	2	21		
1998		81		12	10	12		
1999	1	61		7	2			
2000		9	4	11	7	4		
2001	15	35	3	13	29	1		
2002	65	124	4	49	16	12		
2003	6	137	7	41	54	94		
2004	16	58	38	59	38	14		
2005		117	130	310	30	181		
2006		105	115	104	26	70		
2007	15	256	115	102	68	277		
2008	69	360	144	134	65	476		8
2009	237	275	262	438	62	542		
2010	134	172	246	538	64	174		
2011	40	332	266	244		173		
2012	22	468	727	84		233		
2013	40	488	445	167	1	129		
2014	236	177	674	36	29	96	4	
2015	207	191	755	205	9	105		

Fig 1 (a). Length frequency distributions for commercial TIP hand line length samples collected from different grids in the Gulf of Mexico between 1984 and 2015.



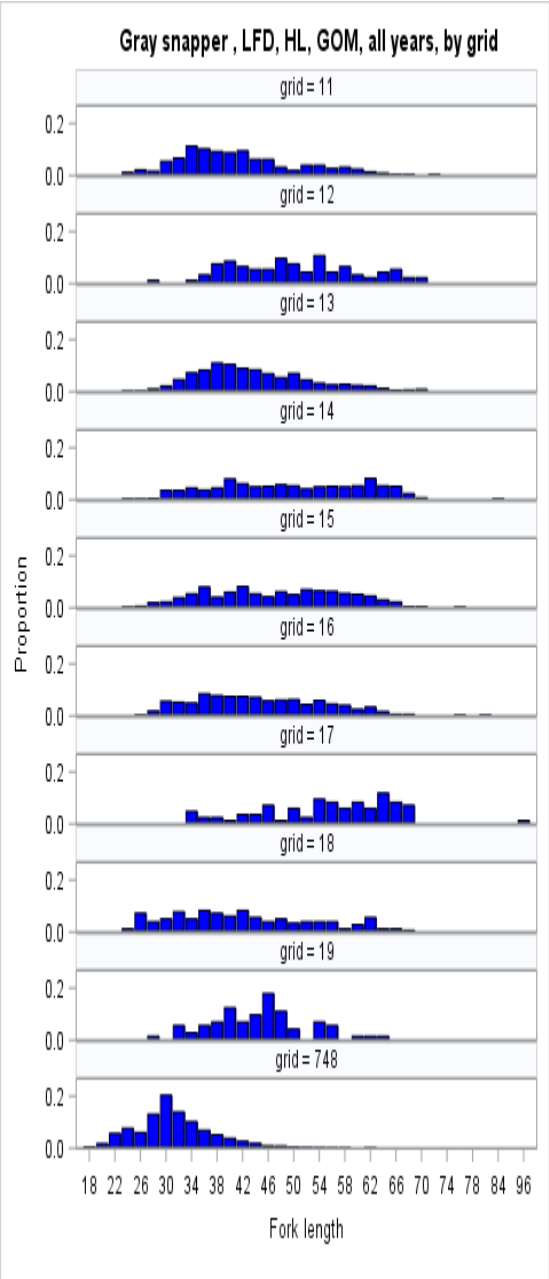


Fig 1 (b). Length frequency distributions for TIP commercial hand line length samples collected from different grids in the South Atlantic between 1984 and 2015.

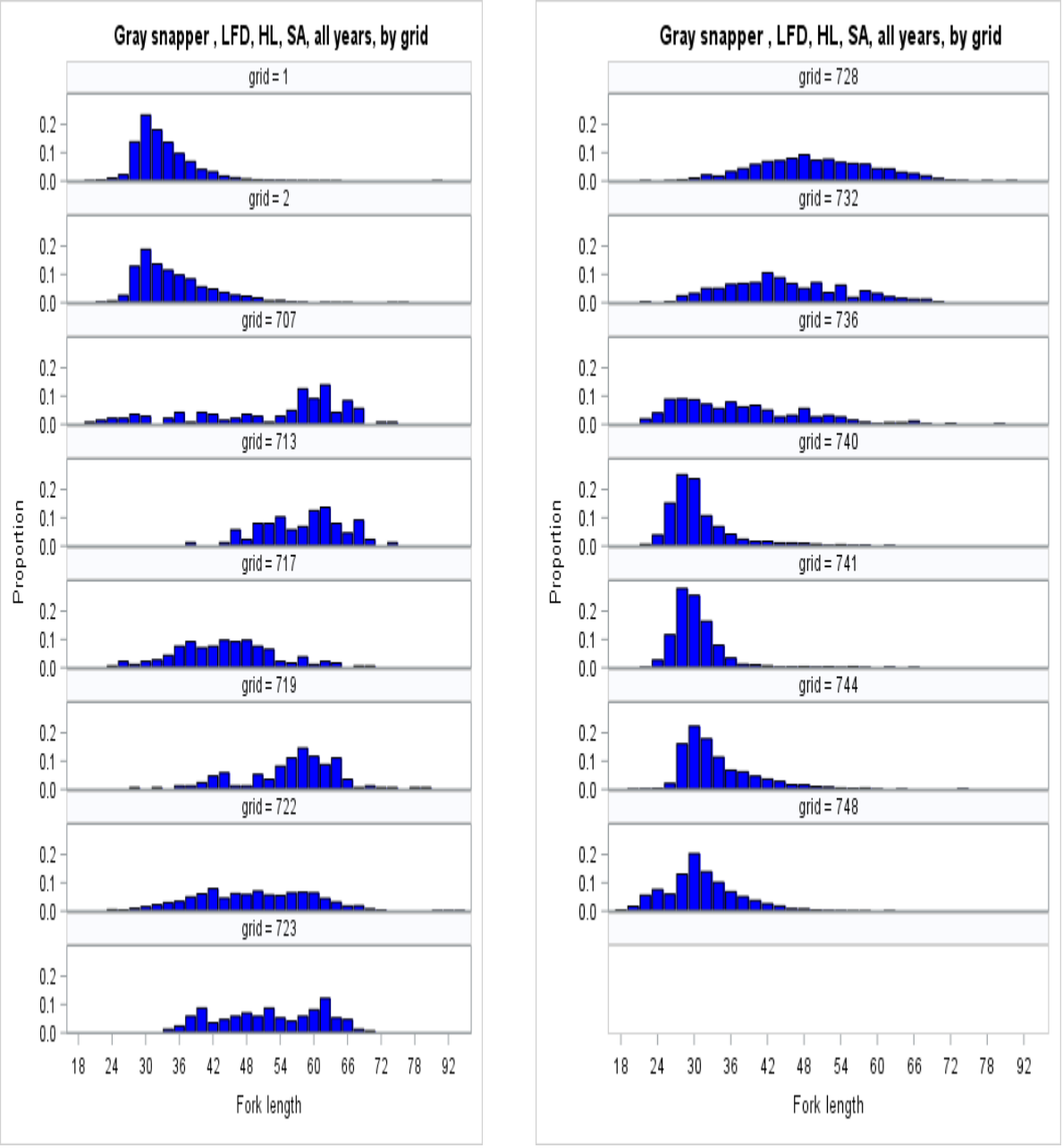
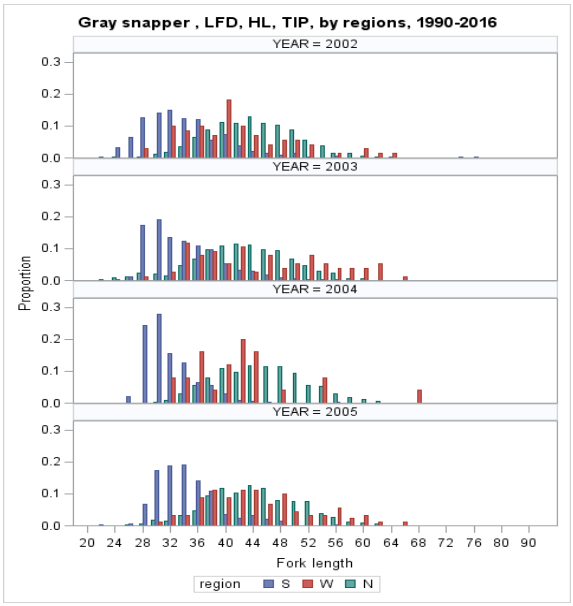
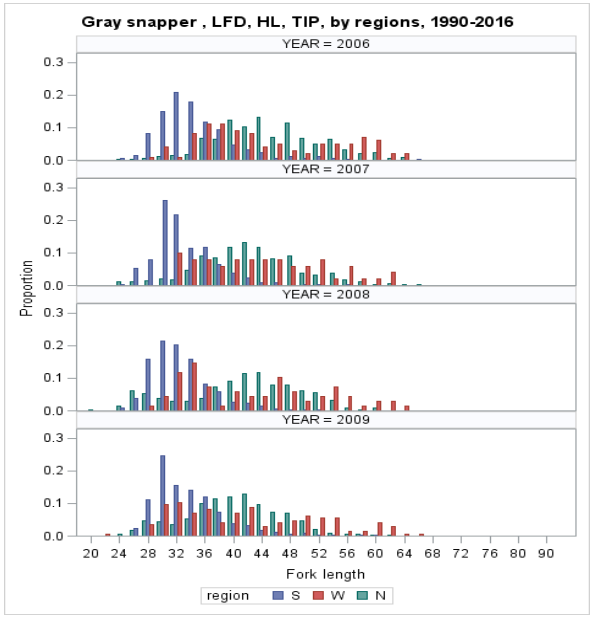
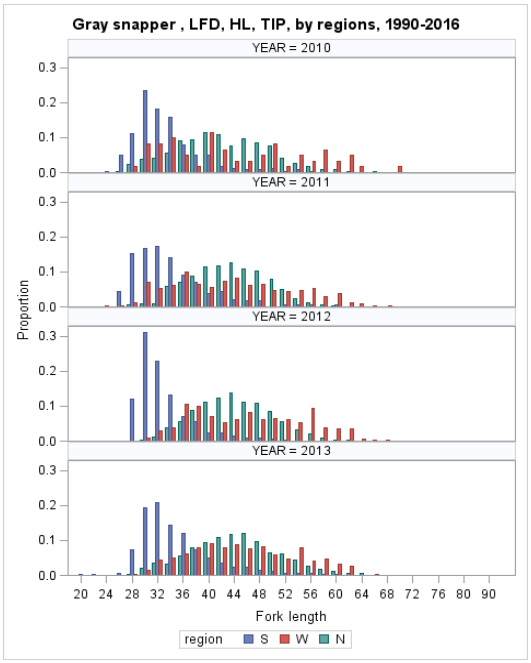


Fig 2. Comparisons of length frequency distributions for TIP commercial hand line length samples collected from the south (S: grid 1,2,748), north (N: grid 3-8) and west (W: grid 9-21) regions of the Gulf of Mexico between 2002 and 2016.







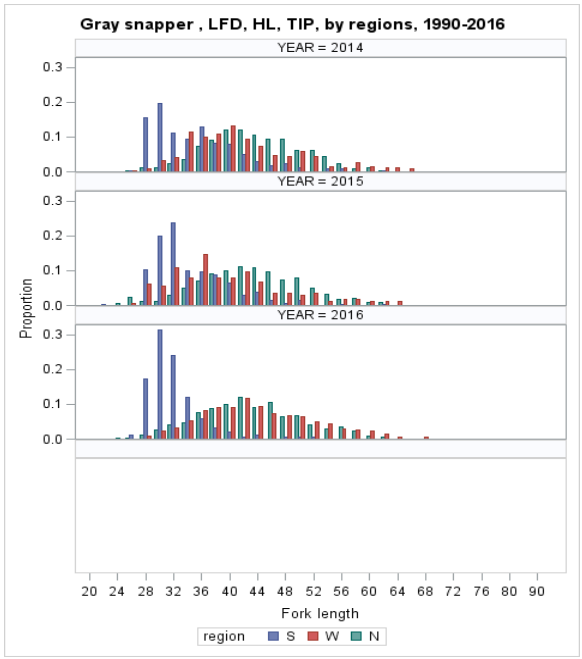


Fig 3. Comparisons of combined length frequency distributions for recreational head boat length samples collected from the Florida south (FS: HB areas 12, 17, and 18), Florida west (FW: HB areas 21, 22, and 23), west (W: HB areas > 23) and Florida east (E: HB areas < 12) regions of the Gulf of Mexico and the South Atlantic between 1986 and 2015.

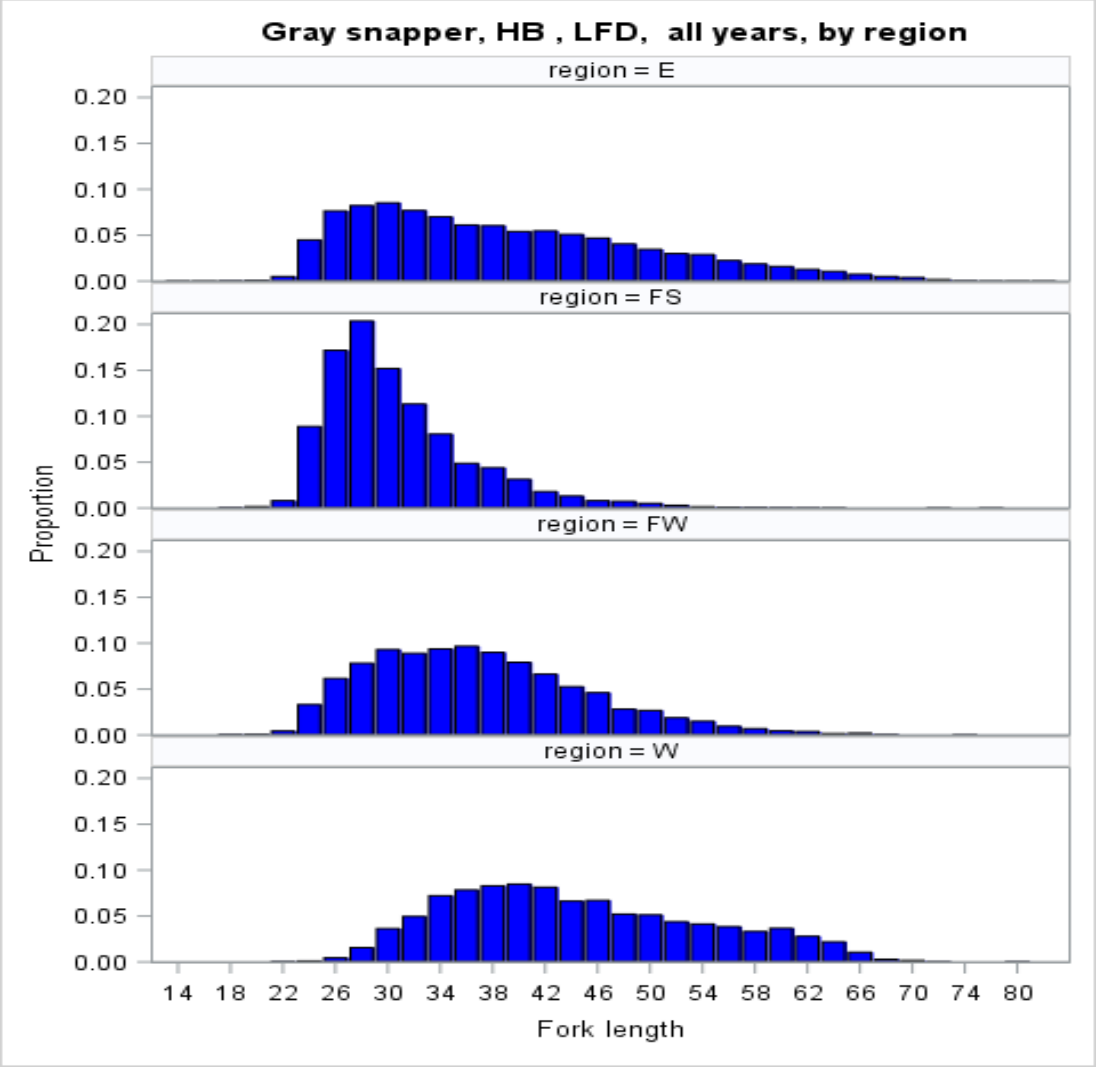
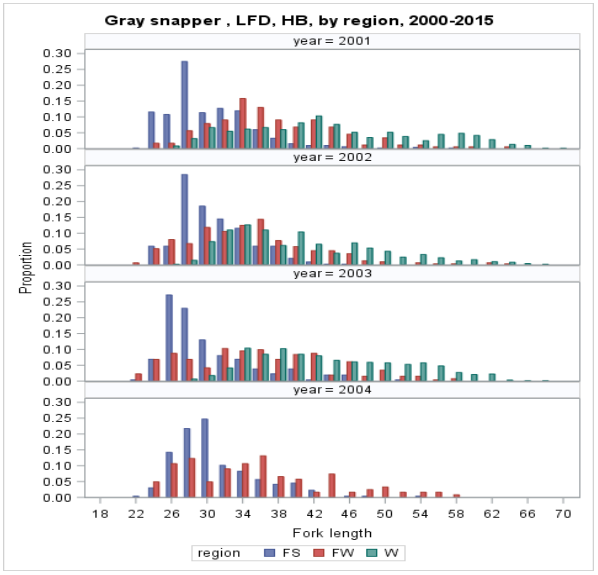
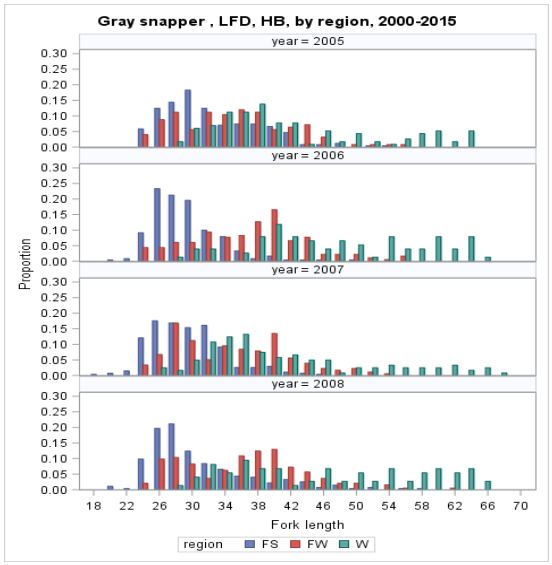
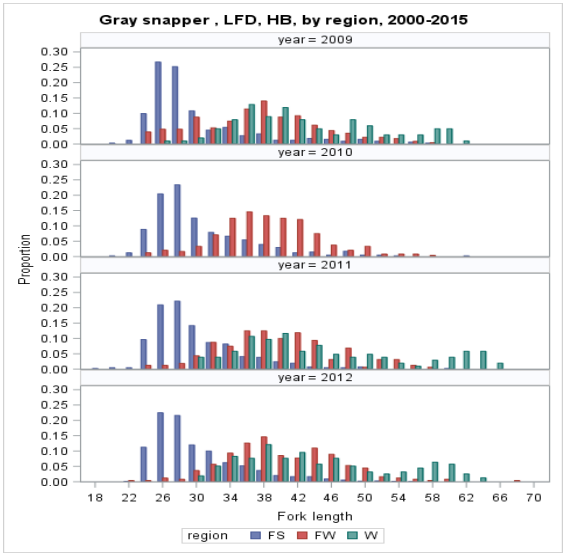


Fig 4. Comparisons of length frequency distributions for recreational head boat length samples collected from the Florida south (FS: HB areas 12, 17, and 18), the Florida west (FW: HB areas 21, 22, and 23), and the west (W: HB areas > 23) regions of the Gulf of Mexico between 2001 and 2015.







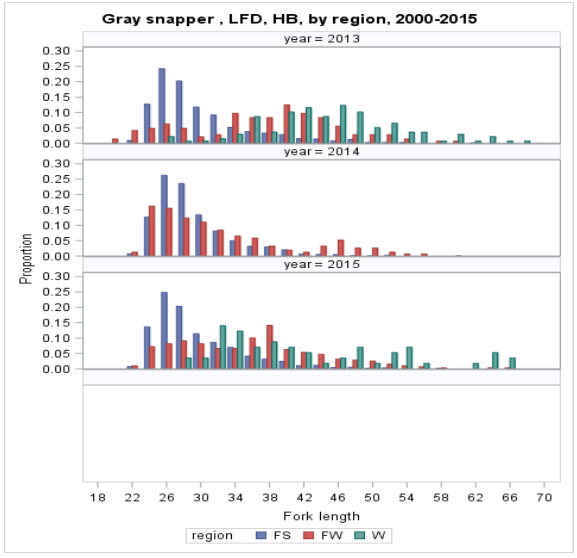
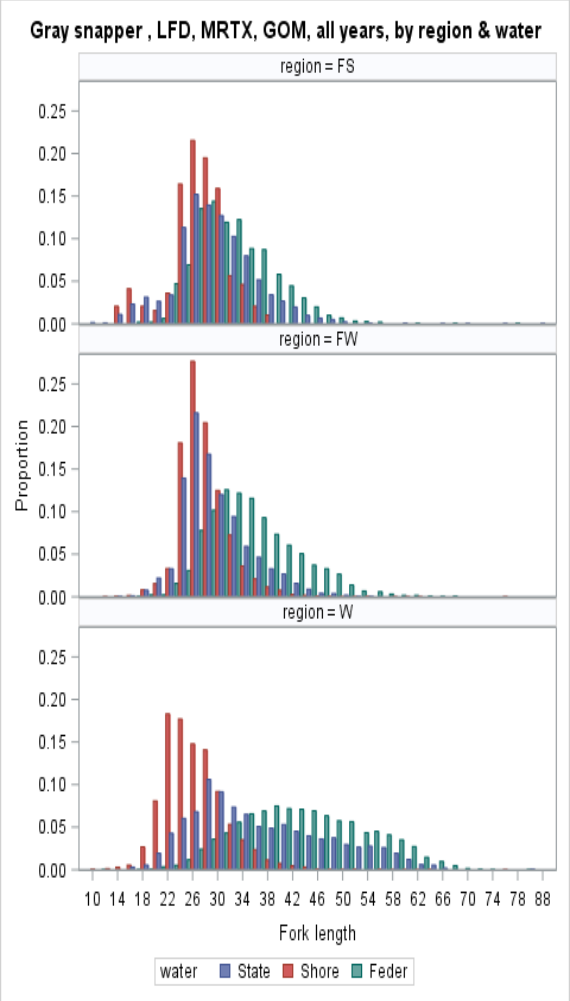


Fig 5. Comparisons of combined length frequency distributions for recreational length samples collected by the MRIP and TPWD programs (MRTX) from state and federal waters. The regions included in this analysis were the Florida south (FS: Monroe County), Florida west (FW: Suwanee County to Collier County), and west (W: west of Dixie County) regions of the Gulf of Mexico, and the Florida east (FE: Miami Dade County to Indian River County) and Florida northeast (FEN: north of Indian River County) regions of the South Atlantic between 1981 and 2015.



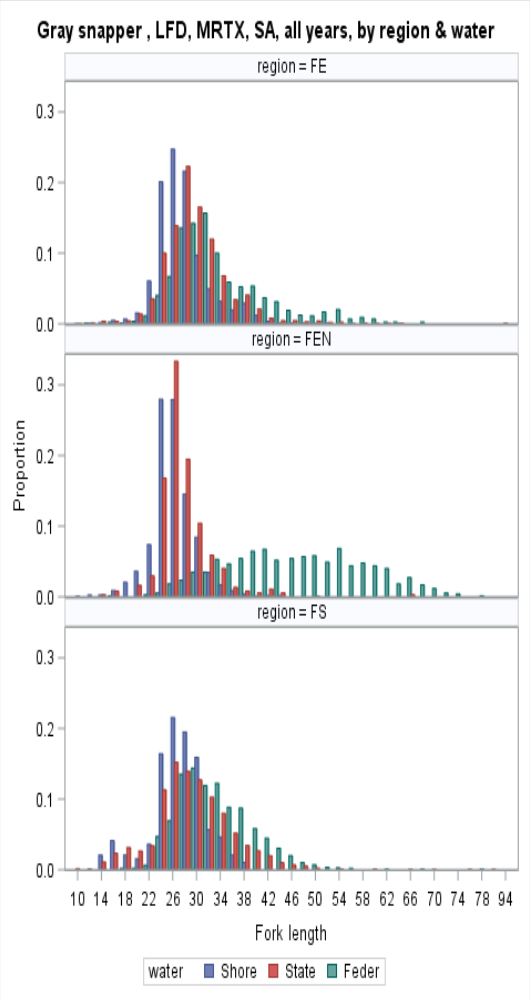


Fig 6. Comparisons of combined length frequency distributions for recreational length samples collected by the MRIP and TPWD programs (MRTX) from ~~the~~ state and federal waters. The regions included in this analysis were the Florida south (FS: Monroe County), Florida west (FW: Suwanee County to Collier County), and west (W: west of Dixie County) regions of the Gulf of Mexico between 1981 and 2015.

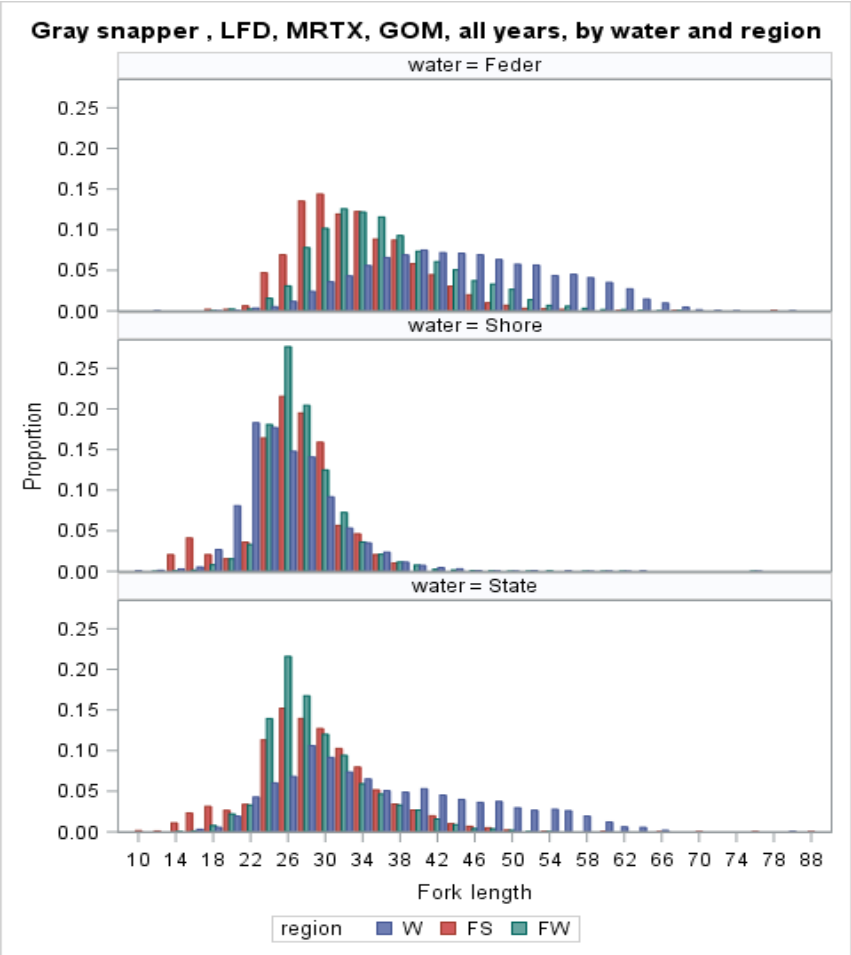
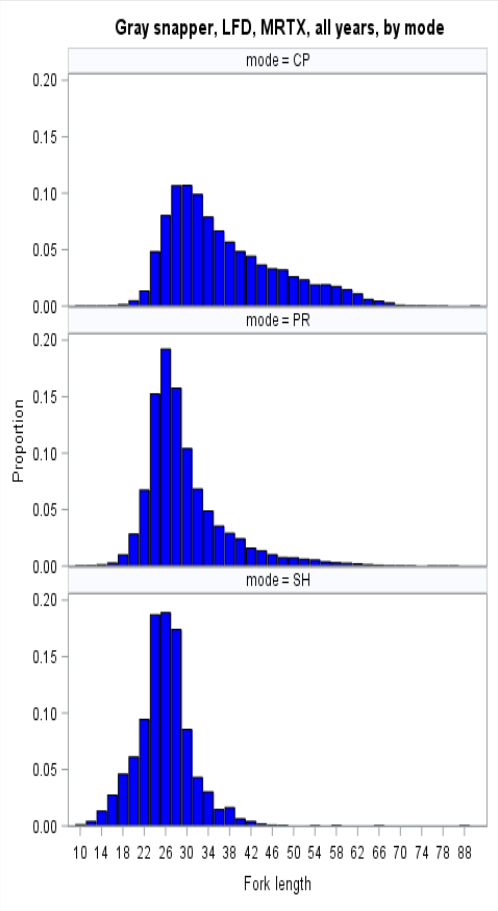


Fig 7. Comparisons of combined length frequency distributions for recreational length samples collected by the MRIP and TPWD programs (MRTX) from (a) different fishing modes, and (b) from different fishing modes and shore areas in the Gulf of Mexico between 1981 and 2015 (see the text for definition of shore areas).

(a)



(b)

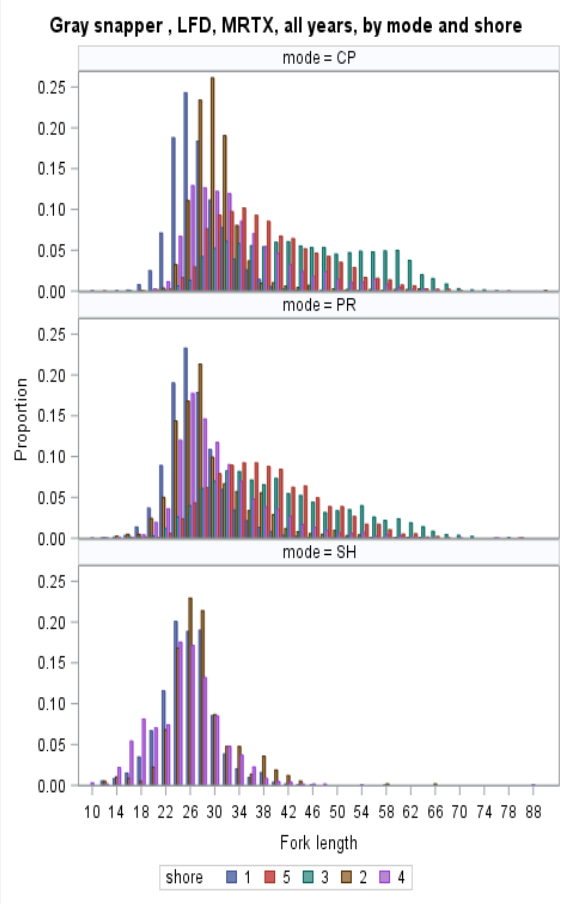


Fig 8. Comparisons of combined length frequency distributions for recreational length samples collected by the MRIP and TPWD programs (MRTX) from different shore areas and different fishing modes in the Gulf of Mexico between 1981 and 2015 (see the text for definition of shore areas).

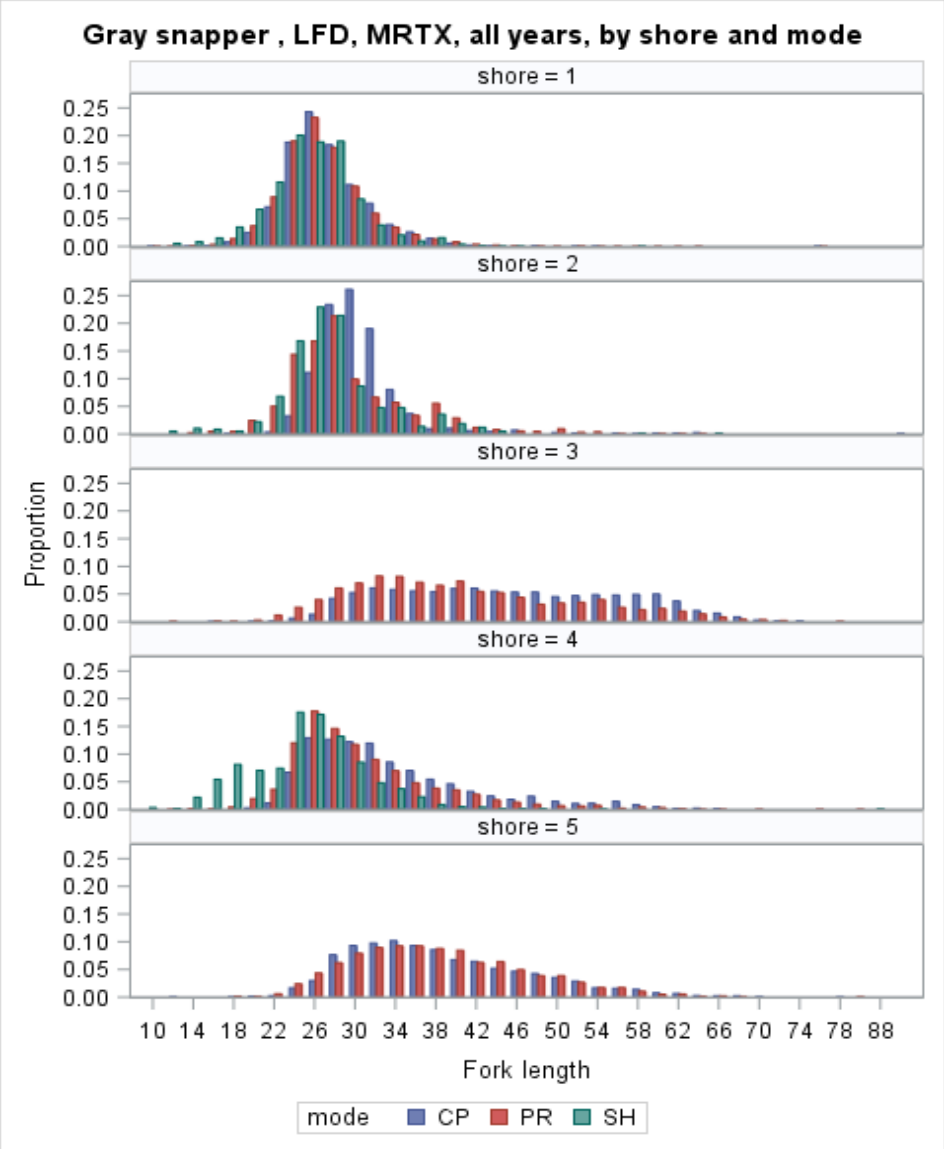
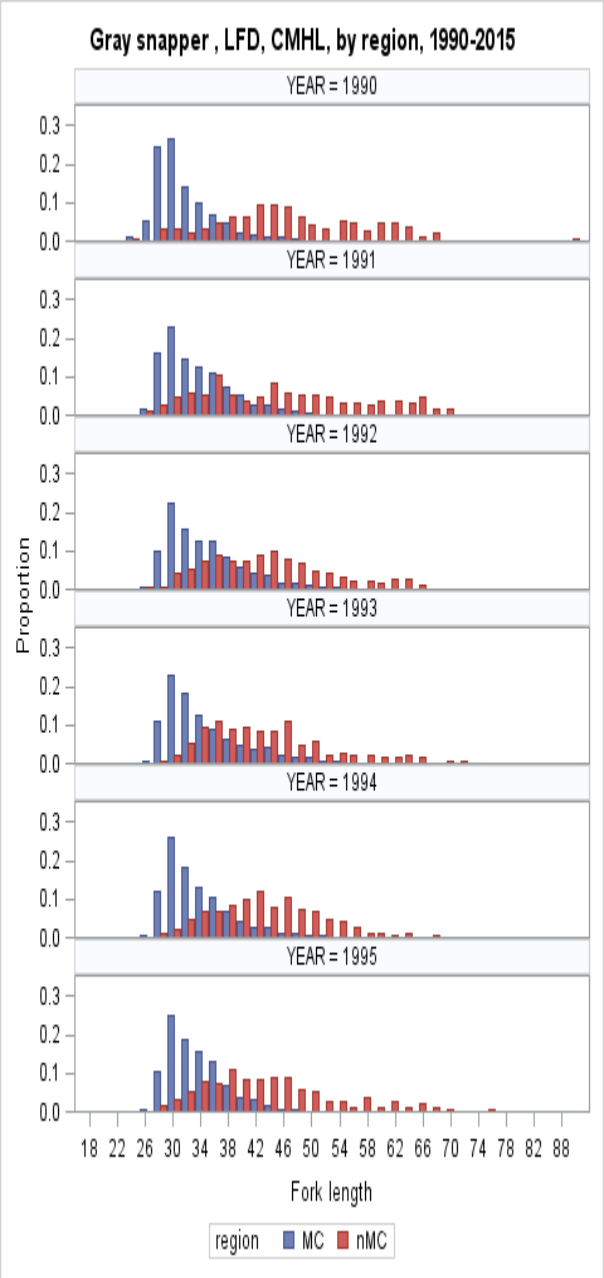


Fig 9. Comparisons of length frequency distributions for commercial hand line length samples collected from the Monroe County region (MC: grids 1, 2, and 748), and north of the Monroe County region (nMC) in the Gulf of Mexico between 1990 and 2015.



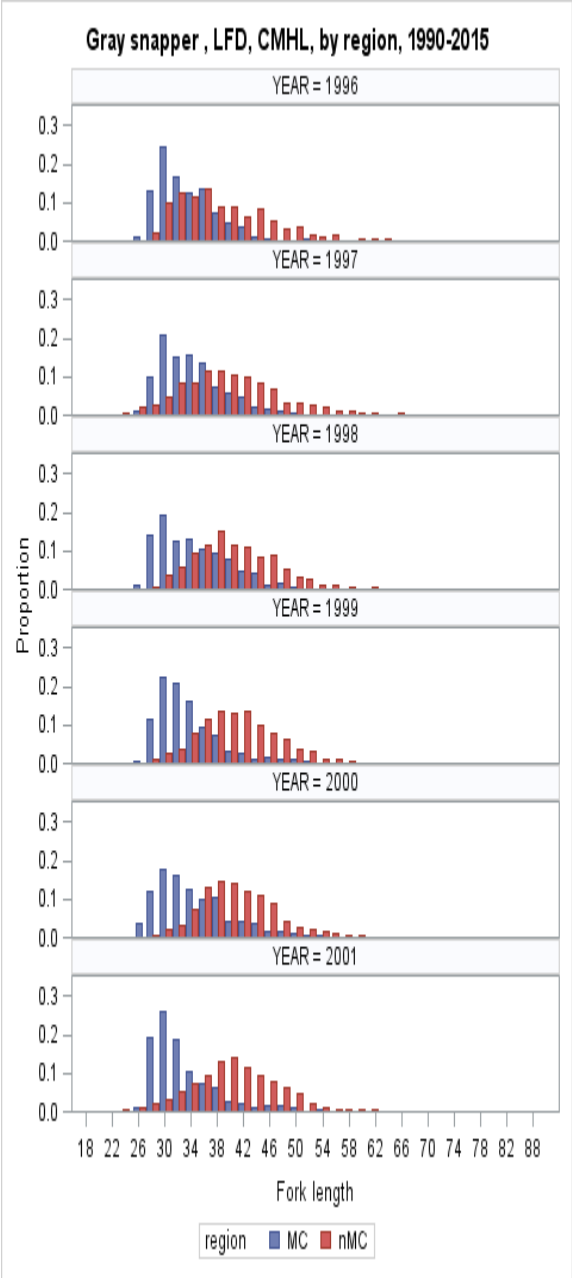
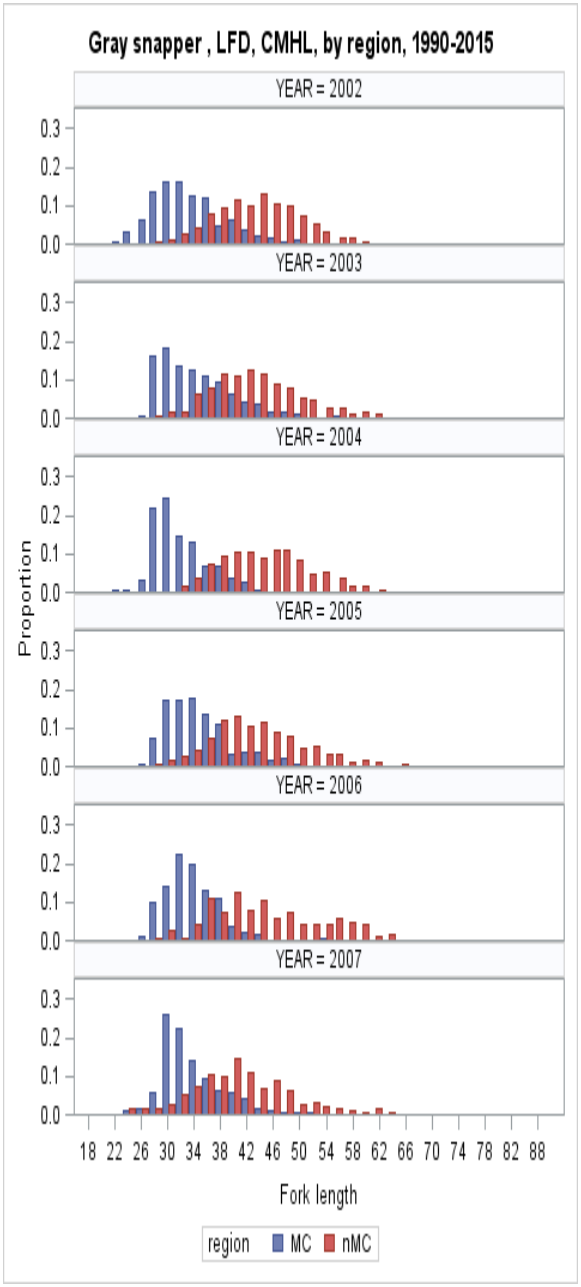


Fig 9. Continued.



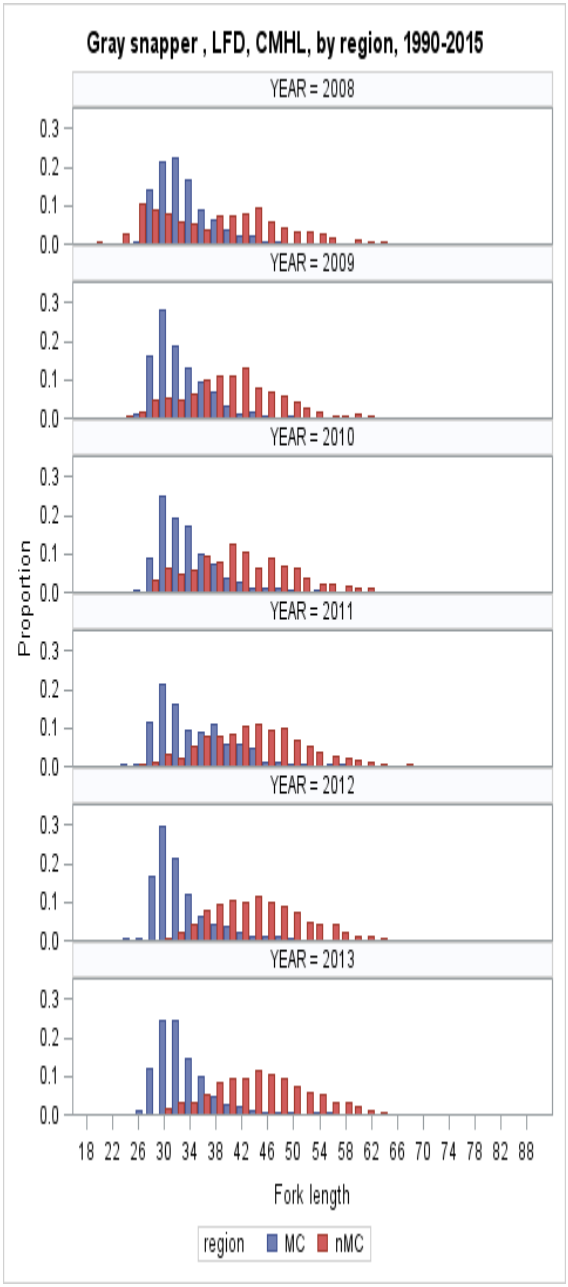


Fig 10. Comparisons of length frequency distributions for recreational head boat length samples collected from the Monroe County region (MC), and north of the Monroe County region (nMC) in the Gulf of Mexico between 1986 and 2015.

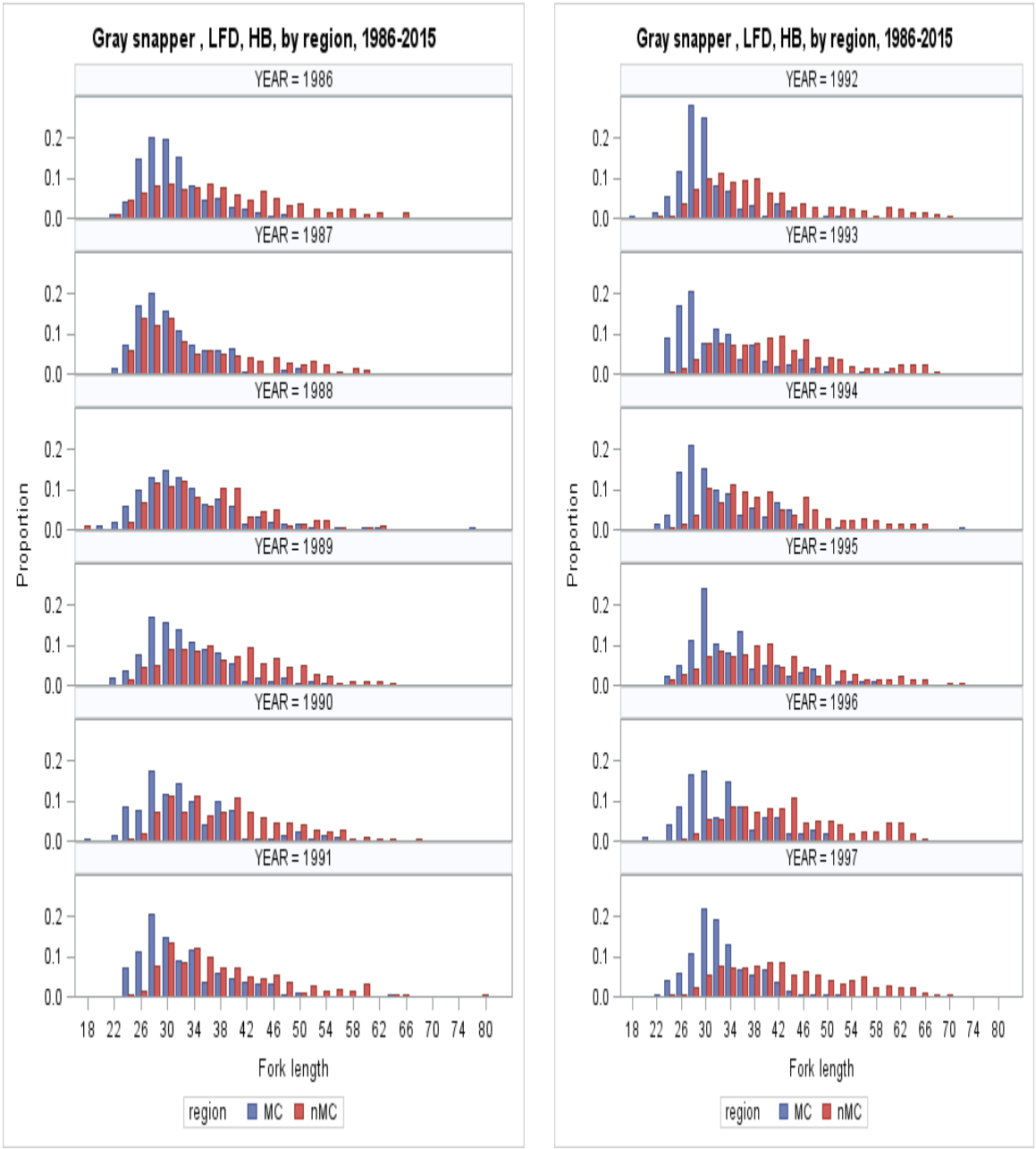
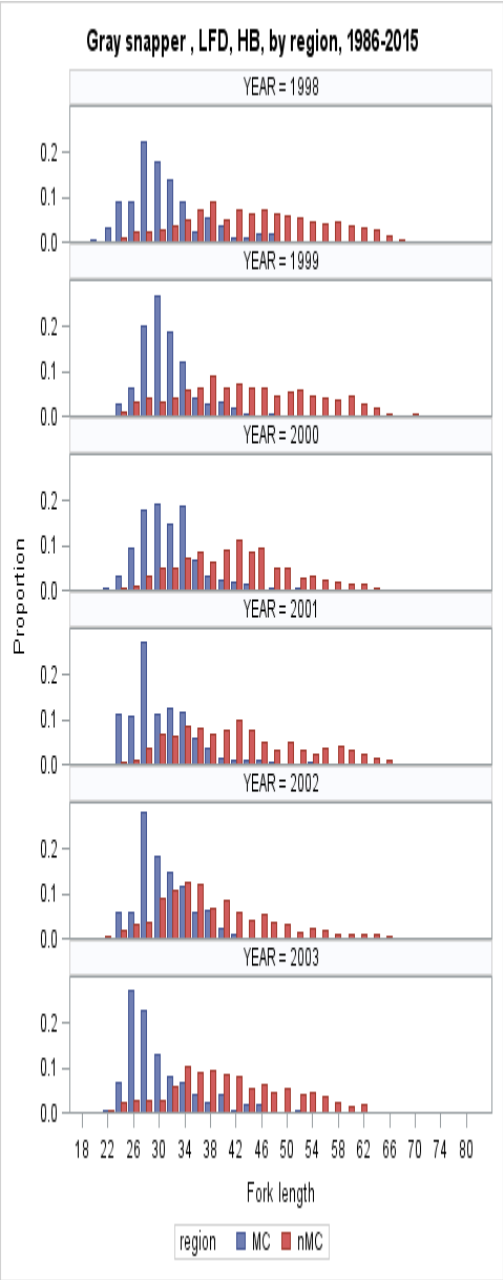


Fig 10. Continued.



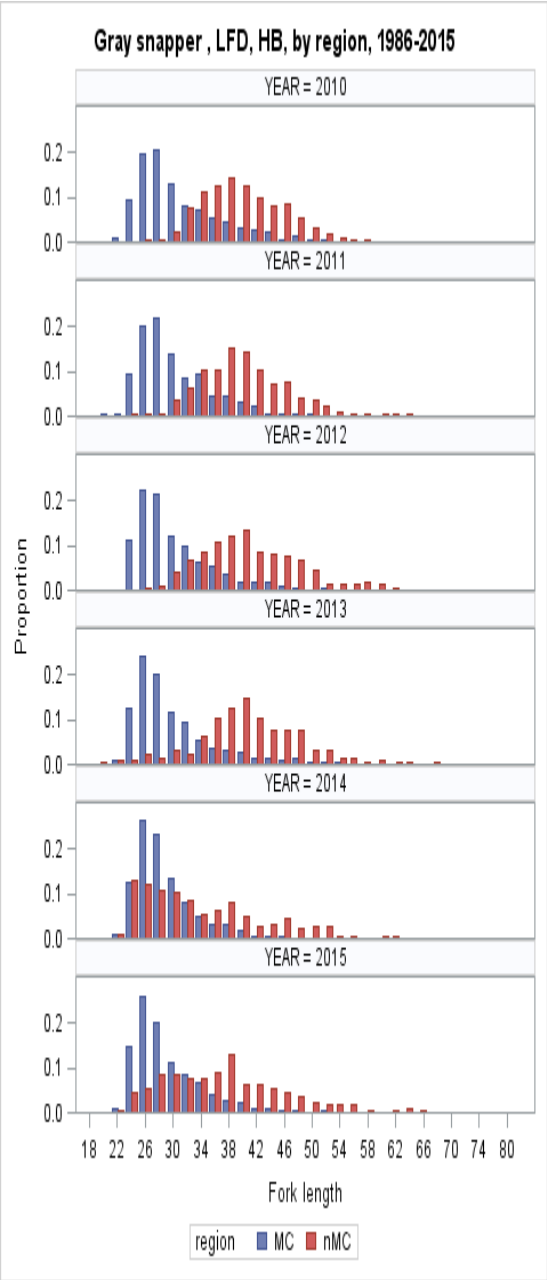


Fig 11. Comparisons of length frequency distributions for recreational charter boat length samples collected from the Monroe County region (MC), and north of the Monroe County region (nMC) in the Gulf of Mexico between 1998 and 2015.

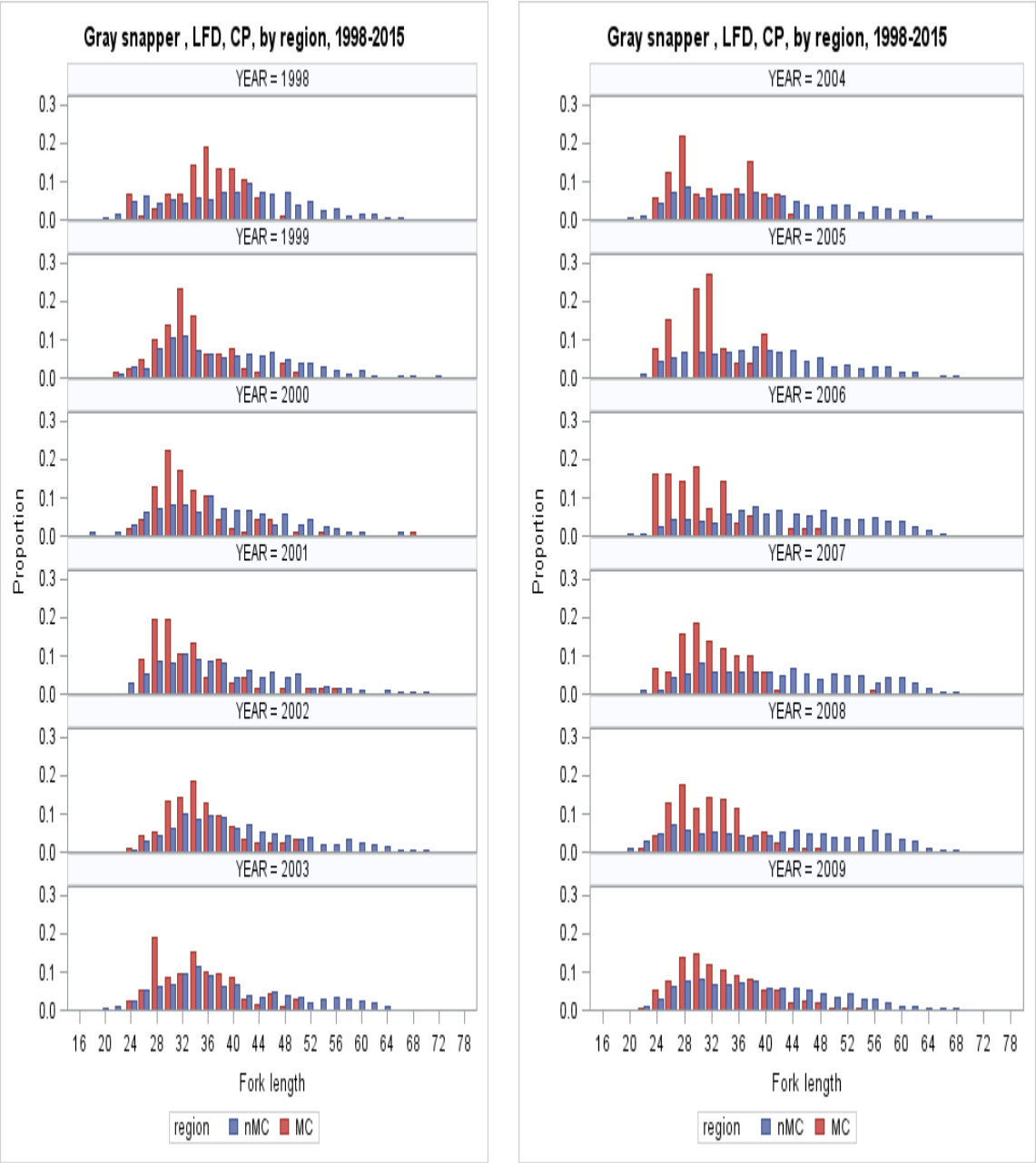


Fig 11. Continued.

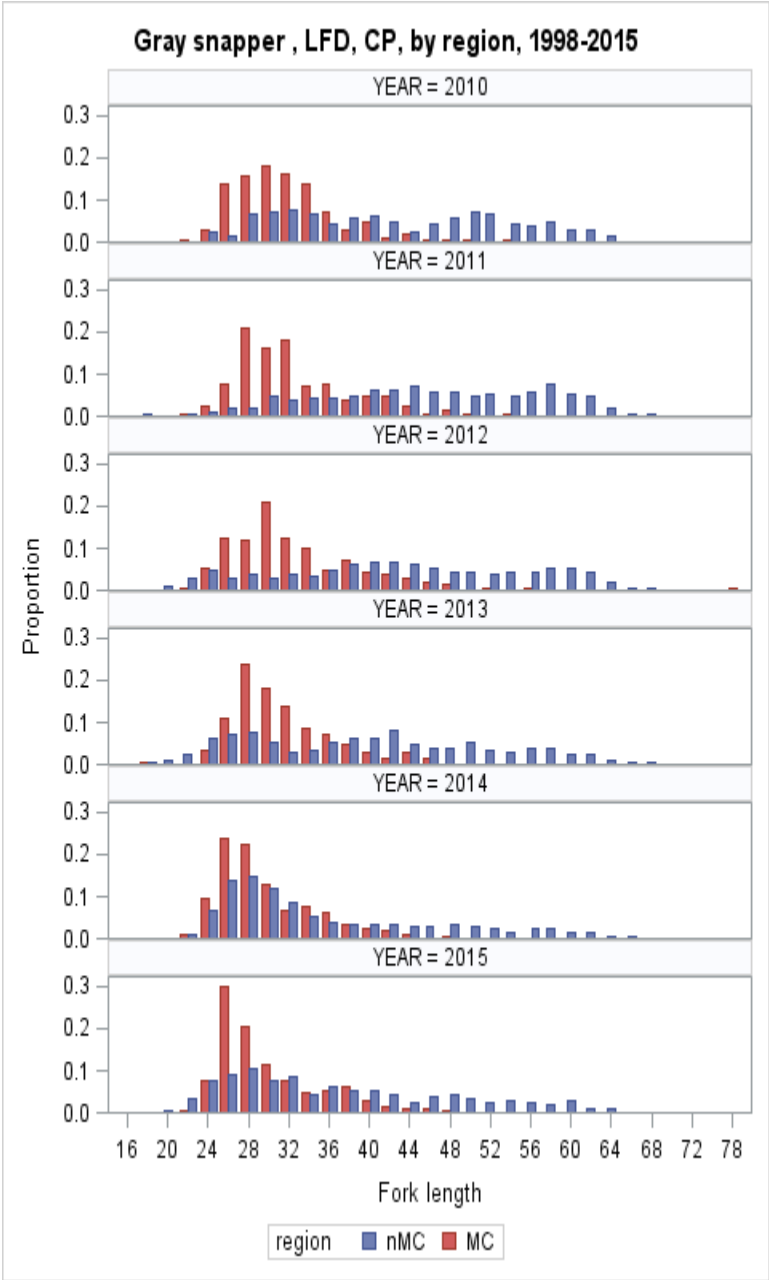


Fig 12. Comparisons of length frequency distributions for recreational private boat length samples collected from the Monroe County region (MC), and north of Monroe County region (nMC) in the Gulf of Mexico between 1998 and 2015.

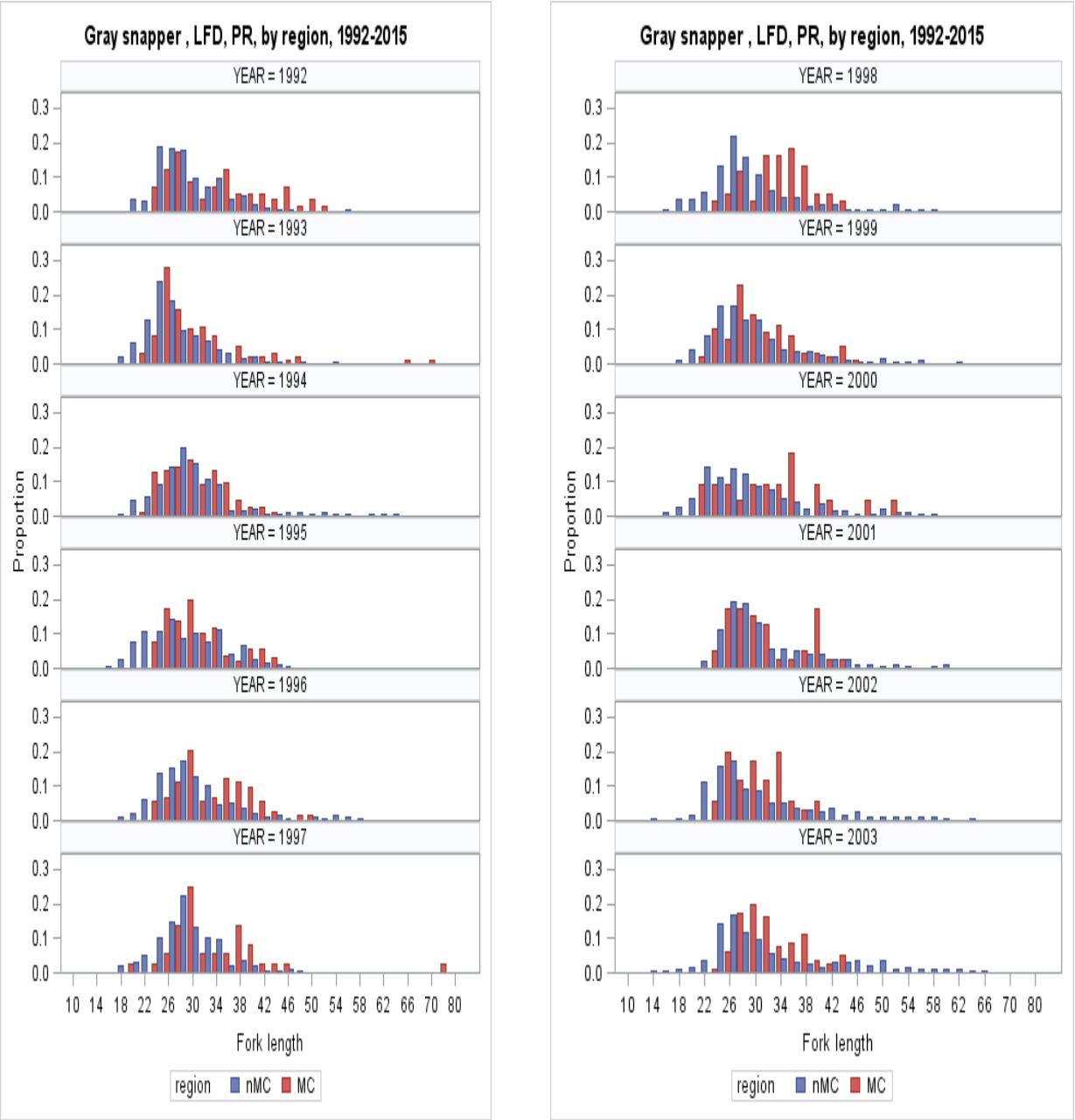
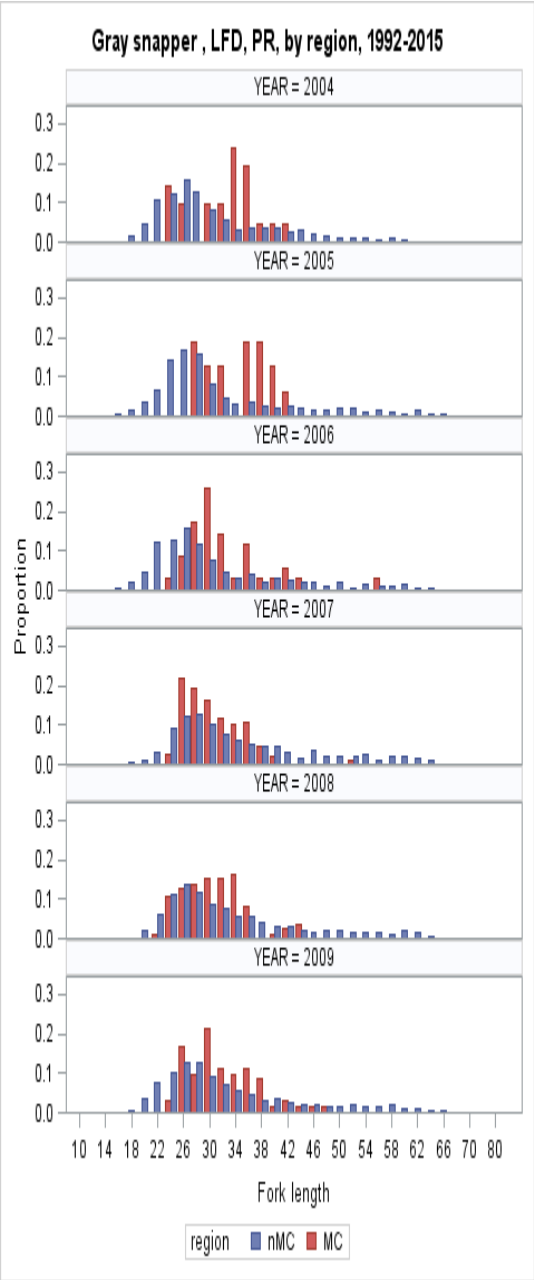


Fig 12. Continued.



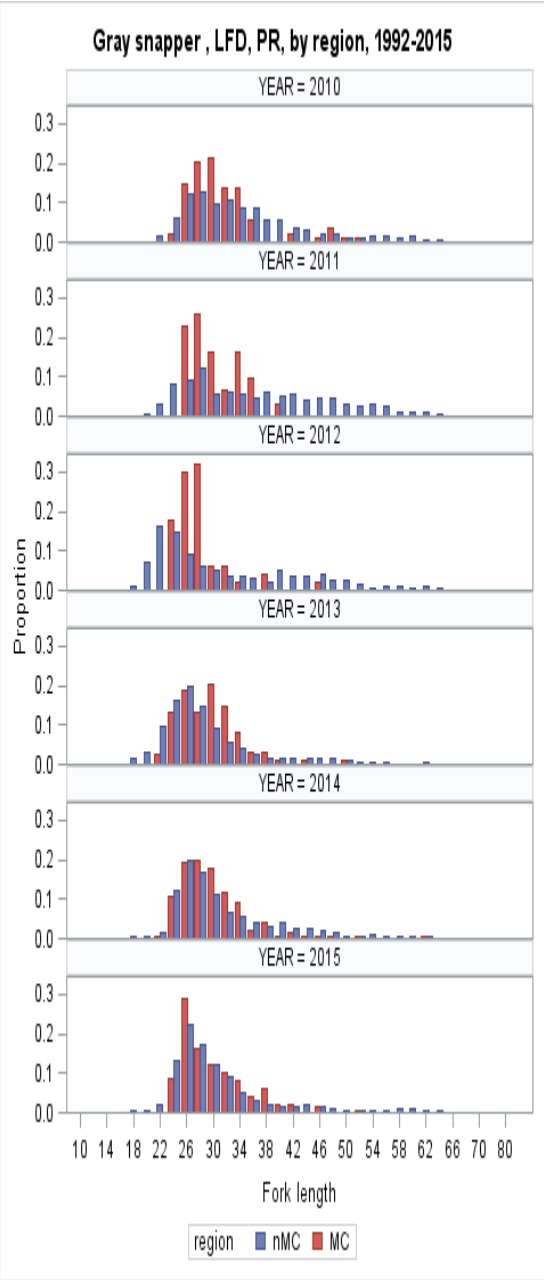
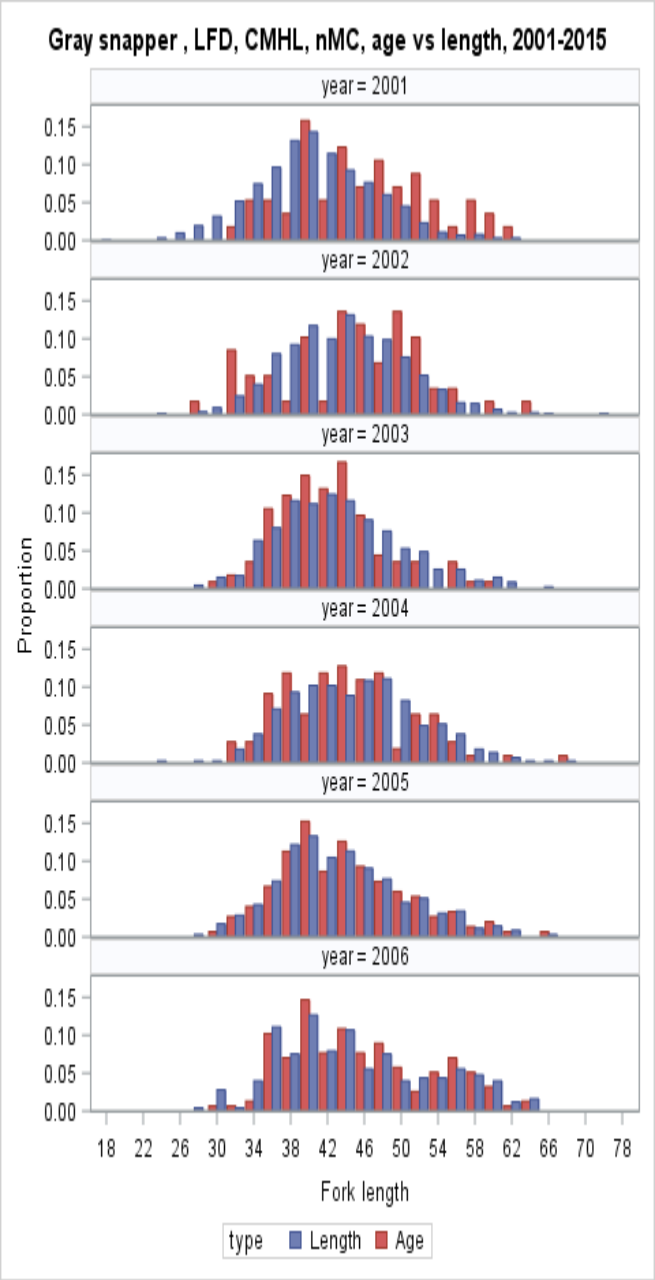


Fig 13. Comparisons between age and length samples of length frequency distributions for commercial hand line fisheries from 2001 to 2015.



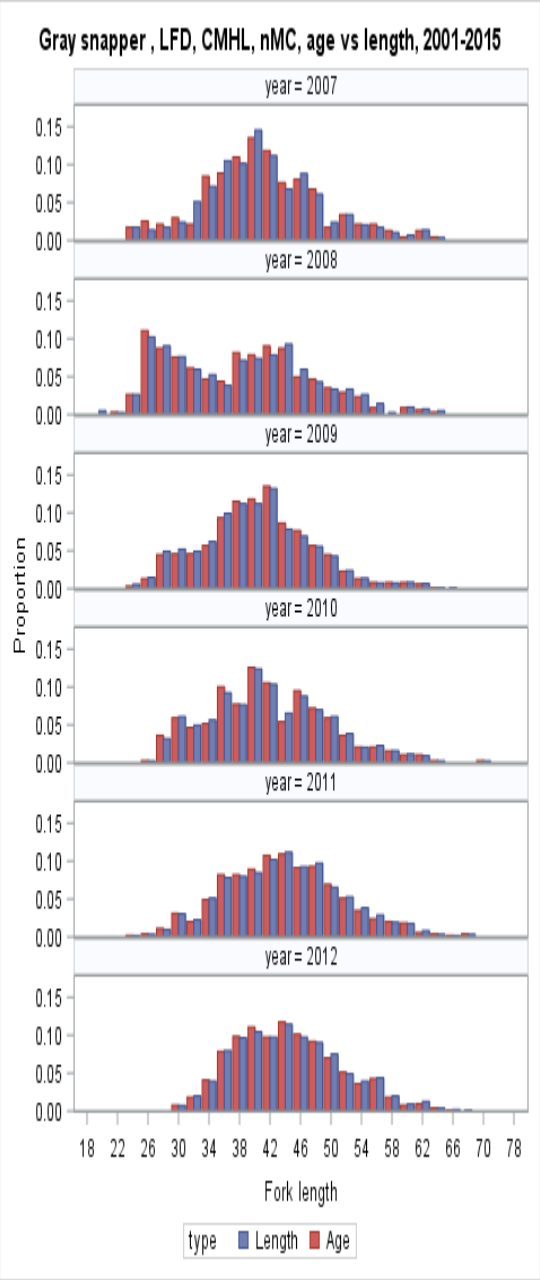
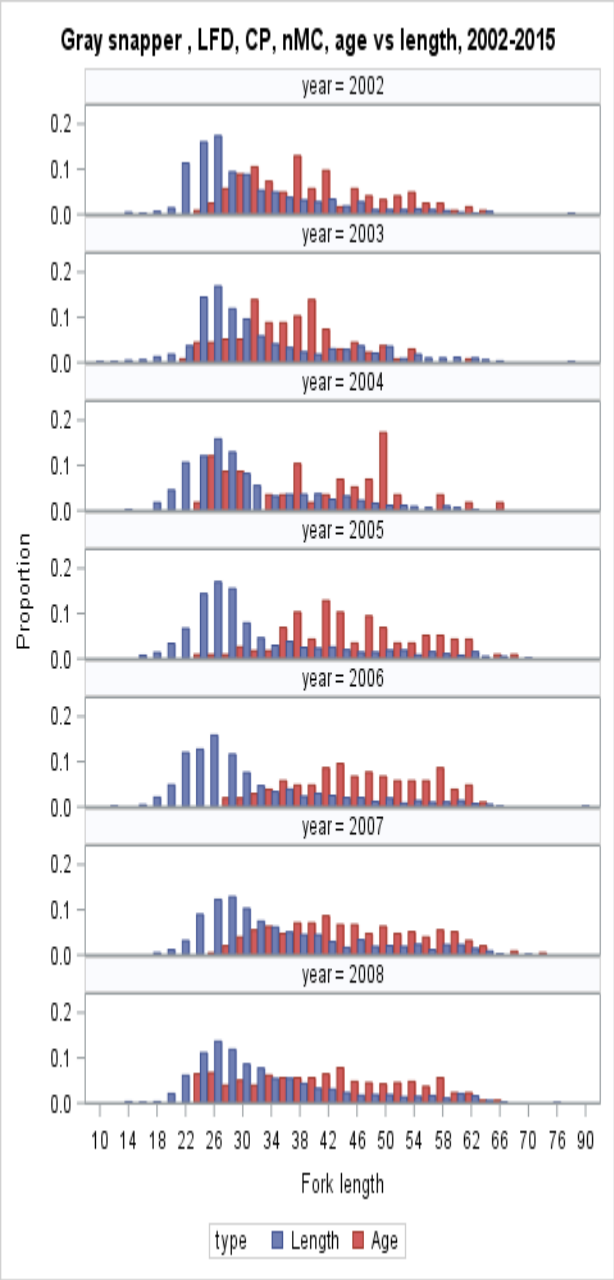


Fig 14. Comparisons between age and length samples of length frequency distributions for recreational charter boat fisheries from 2002 to 2015.



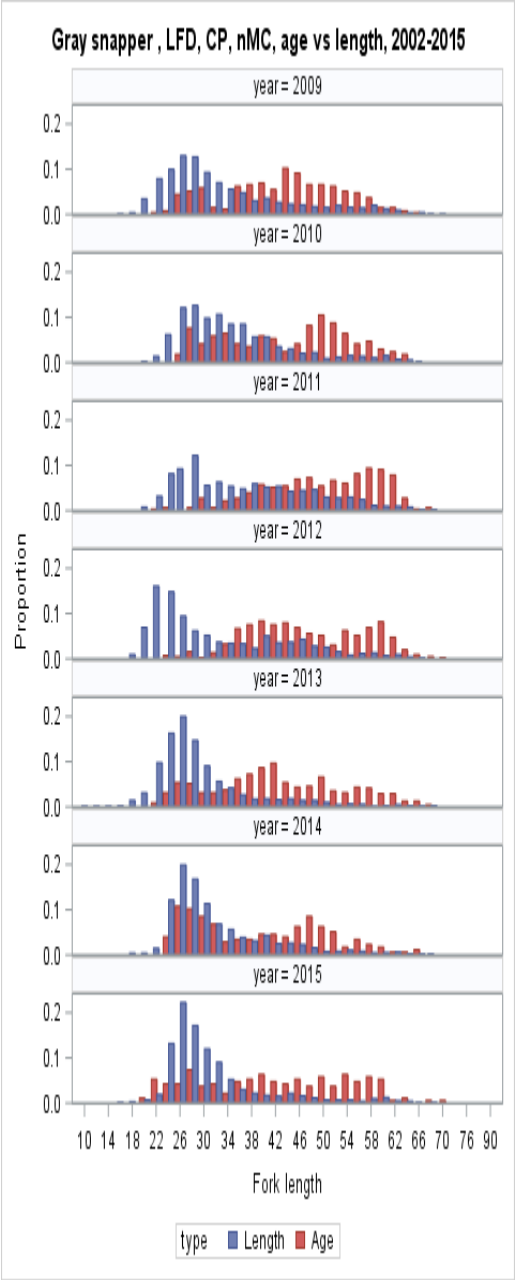


Fig 15. Comparisons between age and length samples of length frequency distributions for recreational private boat fisheries from 2005 to 2015.

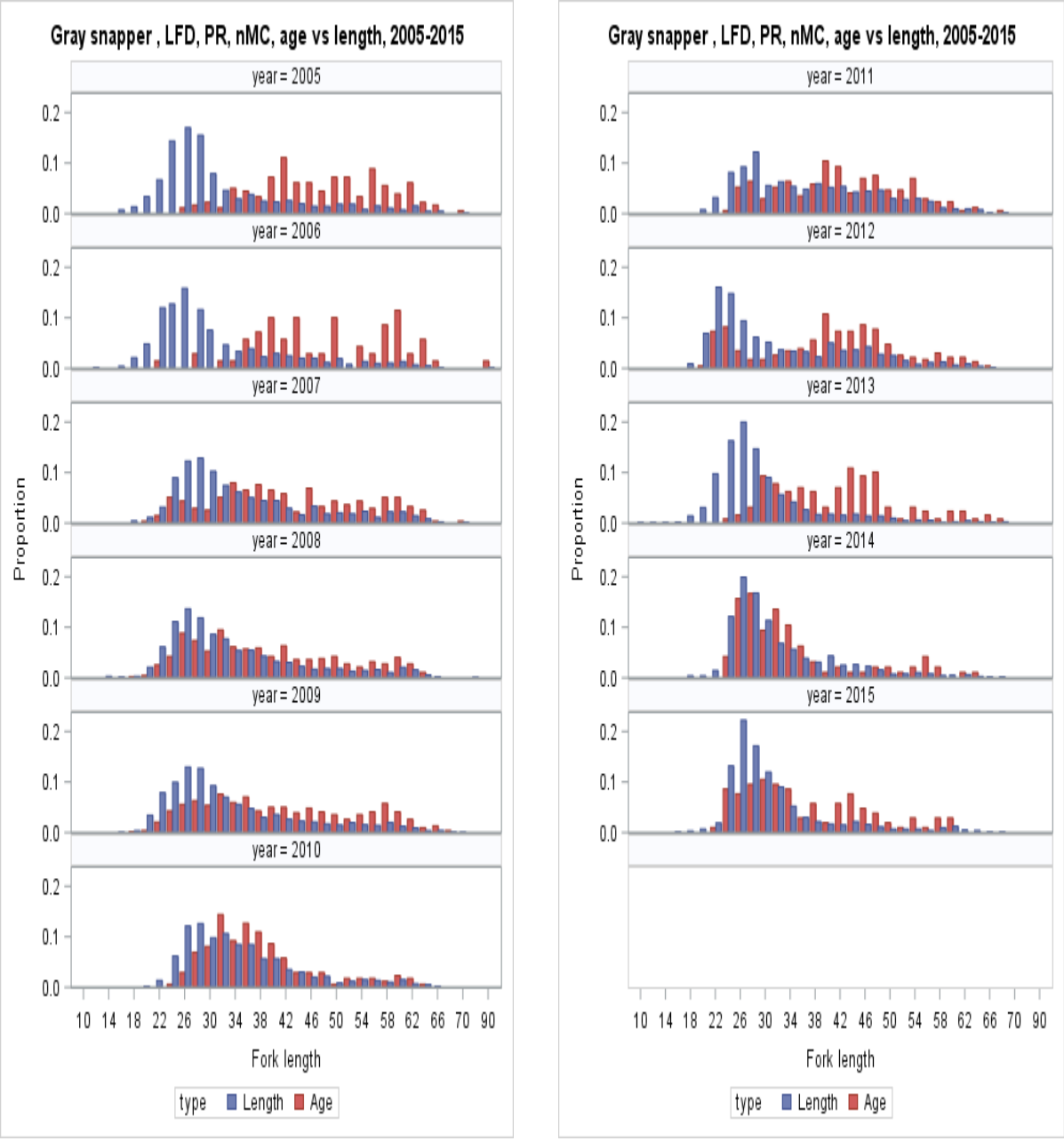


Fig 16. Comparisons between age and length samples of length frequency distributions for recreational head boat fisheries from 2001 to 2015.