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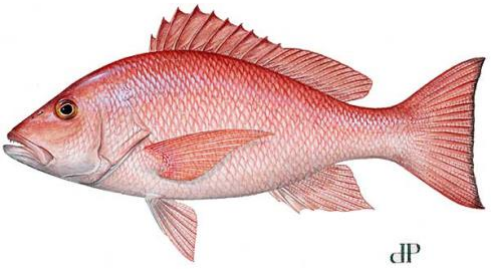

Gulf of Mexico Red Snapper (*Lutjanus campechanus*) Commercial and Recreational Landings Length and Age Compositions

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Introduction

This document outlines the data and methodologies used to estimate nominal length and age compositions of commercial and recreational landings for the SEDAR 74 Gulf of Mexico Red Snapper Assessment. These compositions were estimated using data sources approved in SEDAR 52 and additional data sources will be considered at the Data Workshop. Following the SEDAR 74 Stock Identification workshop, the eastern stock was split near the previous boundary used to weight the length compositions (e.g. Big Bend region of Florida). Under this new structure, there are sparser data in the Eastern and Central stocks (previously combined as Eastern). Therefore, this working paper outlines data availability and provides nominal compositions. At the Data Workshop, methodologies for tracking cohorts in the assessment model will be recommended.

Data Description

SEDAR 74 assesses all Gulf of Mexico Red Snapper in federal waters extending northward from the Texas/Mexico border and eastward to the Florida Keys US1 boundary. Length data from the commercial and recreational fisheries of the Gulf of Mexico are collected by multiple state and federal agencies. Commercial data sources utilized to generate length compositions include the Trip Interview Program (TIP, 1983-2019). Recreational sources utilized were the Marine Recreational Information Program (MRIP, 1981-2019), Texas Parks and Wildlife Department's Marine Sport-Harvest Monitoring Program (TPWD, 1981-2019), and the Southeast Region Headboat Survey (SRHS, 1986-2019). The Gulf States Marine Fisheries Commission's Fisheries Information Network (GulfFIN) provided both commercial and recreational length and age data from multiple state sources (2001-2019).

Age estimates from GulfFIN, Dauphin Island Sea Lab, FWRI-Fishery Independent Monitoring, FWRI-Movement Ecology and Reproductive Resilience, Gulf Coast Research Lab, and Texas A&M University-Corpus Christi were compiled by the SEFSC Panama City Laboratory alongside their age data.

Commercial fleets were defined by vertical line (VL) and longline (LL) gears, and recreational fleets were defined by headboat (HB), charterboat (CB), and private (PR) modes. These data were aggregated using length bins of 2 centimeters (cm) to match SEDAR 52, but may be adapted at the Data Workshop. Natural total length (TL_{nat}), maximum total length (TL_{max}), and standard length (SL) were converted to fork length (FL) using the following conversion equations:

$$FL = 0.138 + 0.926 * TL_{max}$$
$$FL = -0.085 + 0.930 * TL_{nat}$$
$$FL = 1.756 + 1.137 * SL$$

Fish landings measuring less than 10cm FL ($n = 26$) were deleted as these were assumed to be unit errors (e.g. fish recorded as 10cm were likely 10"). Fish lengths greater than 1.2m FL ($n = 3$) were also deleted and assumed to be errors, where all deleted records were >2.5m FL.

Commercial and Recreational Length Compositions of Landings

Length Samples

Length samples of commercial landings were obtained from the TIP database maintained by the NMFS Southeast Fisheries Science Center (SEFSC) and were filtered to remove biases that include samples from pooled trips. Length samples of recreational landings were obtained through federal and state sampling programs via SEFSC and GulfFIN, respectively.

Length Compositions

Because fishery-dependent sampling is typically opportunistic, lengths may not be representative of the true landings composition throughout the entire Gulf of Mexico. Possible sampling bias in the collection of length samples are typically removed by weighting the length compositions with the associated landings on the finest spatial and temporal scale available without losing data.

Commercial fleets (VL, LL) were aggregated into three stocks in the Gulf of Mexico based on the NMFS areas fished shown in Figure 1: Eastern (E: areas 1-6), Central (C: areas 7-12), and Western (W: areas 13-21). These gears were sufficiently distinct to remain separate fleets (Figure 2) and gear-specific annual compositions are shown in Figure 3. Length distributions were shown by fishing areas grouped by stock (W, C, E) for VL (Figure 4) and LL (Figure 5). In this case, the spatial resolution of the stocks are on the same scale used to weight the length compositions in SEDAR 52. Therefore, nominal compositions were provided for each fleet alongside sample sizes of commercial lengths (Table 1) and trips (Table 2) for each stock (W, C, E) to inform discussions on final compositions at the Data Workshop.

Recreational fleets (HB, CB, PR) were aggregated into three stocks in the Gulf of Mexico based on county landed, where potential breaks were constrained by MRIP sampling design: Eastern (E: FL Collier-FL Levy), Central (C: FL Dixie-MS), and Western (W: LA-TX). SRHS data also facilitated this break in their survey design in the Gulf of Mexico shown in Figure 6: Eastern (E: 21), Central (C: 23, 28, 29) and Western (W: 24:27). While charter and private modes were aggregated in SEDAR52, they appeared sufficiently distinct to remain separate fleets at this time (Figure 7). Spatially aggregated annual recreational length compositions are shown by mode in Figure 8. Length distributions were shown by fishing areas grouped by stock (W, C, E) for headboat (Figure 9), charterboat (Figure 10), and private (Figure 11). Nominal compositions were provided for each recreational fleet alongside sample sizes of recreational lengths (Table 3) and trips (Table 4).

Within each commercial and recreational fleet (defined by gear/mode), nominal length compositions were estimated using length bins of 2 cm, where for each year i, length bin j, and stock s

$$LC_{i,j,s} = \frac{n_{i,j,s}}{n_{i,s}}$$

$n_{i,j,s}$ is the number of samples in year i, stock s, and lower inclusive length bin j; $n_{i,s}$ is the number of samples in year i and stock s; and $LC_{i,j,s}$ is the proportion of the total number of sampled fish in each year i and stock s within each lower inclusive length bin j. A minimum sample size threshold was applied annually within each strata, $LC_{i,s}$, where these were dropped and excluded from further analyses if $n_{i,s} < 30$.

Commercial and Recreational Age Compositions of Landings

Age Samples

Age data compiled by the SEFSC Panama City Laboratory were filtered to remove duplicated and biased data. Nominal age compositions were estimated for each fleet alongside sample sizes of commercial ages (Table 7), commercial trips sampled for age (Table 8), recreational ages (Table 9), and recreational trips sampled for age (Table 10) to inform discussions on final compositions at the Data Workshop. Red Snapper maximum age was estimated to be 57 years.

Age Compositions

Age compositions were estimated for each recreational mode (CB, PR, HB) and commercial gear (VL, LL) within each stock (E, C, W), resulting in 15 sets of age compositions. The process outlined below was applied to each fleet individually, and any strata with less than 10 age samples was recommended to be dropped. Nominal age compositions of landings were estimated for all modes/gears using the following equation within each year i, age bin k, and stock s.

$$AC_{i,k,s} = \frac{a_{i,k,s}}{a_{i,s}}$$

$a_{i,k,s}$ is the number of age samples in year i, stock s, and lower inclusive age bin k; $a_{i,s}$ is the number of age samples in year i and stock s; and $AC_{i,k,s}$ is the proportion of the total number of sampled fish in each year i and stock s within each lower inclusive age bin k. A minimum sample size threshold was applied annually within each strata, $AC_{i,s}$, where these were dropped and excluded from further analyses if $a_{i,s} < 10$.

Data Limitations

Length and age data are very sparse in the Eastern stock for all recreational fleets. The Central commercial longline fleet has limited length samples, and the Central and Western longline fleets have limited age samples.

Tables

Table 1*. Annual number of length samples for commercial vertical line (VL) and longline (LL) gears by stock. The length compositions resulting from these samples were dropped from further analyses if n<30.*

Year	W_VL	W_LL	C_VL	C_LL	E_VL	E_LL
1984	2,821	826	1,379	118	818	746
1985	2,948	1,072	281	16	894	750
1986	1,855	413	912	6	375	1,005
1987	827	47	655	0	188	394
1988	1,159	180	241	12	114	178
1989	1,476	404	550	0	78	29
1990	7,558	376	1,989	58	327	240
1991	6,917	211	2,487	51	38	79
1992	5,093	114	1,214	36	35	122
1993	7,719	61	2,372	0	67	144
1994	3,497	3	3,952	18	82	78
1995	5,792	74	2,502	0	59	133
1996	2,831	11	2,538	0	109	79
1997	6,802	63	3,270	11	198	57
1998	7,881	253	4,016	115	304	131
1999	4,705	218	4,563	0	913	290
2000	3,552	540	4,908	0	175	283
2001	4,110	180	4,788	47	199	184
2002	5,598	542	4,824	40	265	242
2003	4,993	259	4,977	33	381	279
2004	2,582	398	4,680	3	225	350
2005	3,614	178	4,428	66	237	451
2006	4,154	382	3,397	0	274	222
2007	2,052	363	5,189	93	330	118
2008	3,426	382	4,686	184	190	337
2009	4,058	265	4,671	31	400	103
2010	4,900	85	4,241	1	503	1,016
2011	4,412	14	6,556	23	798	569
2012	9,322	157	10,133	37	1,104	196
2013	11,243	148	12,620	14	1,423	688
2014	16,721	73	9,909	4	1,362	1,199
2015	19,319	340	17,141	28	1,050	873
2016	17,227	134	18,727	27	1,057	745
2017	17,846	183	15,028	45	1,306	508
2018	13,206	388	16,155	142	910	532
2019	14,130	924	18,694	104	1,201	791

***Table 2**. Annual number of commercial vertical line (VL) and longline (LL) trips sampled for lengths by stock.*

Year	W_VL	W_LL	C_VL	C_LL	E_VL	E_LL
1984	49	22	18	4	23	32
1985	66	40	14	2	48	38
1986	42	18	17	1	31	102
1987	40	7	16	0	32	41
1988	55	9	11	2	11	20
1989	54	18	24	0	2	6
1990	211	8	46	7	22	43
1991	201	9	68	5	6	25
1992	164	5	27	2	11	27
1993	215	4	52	0	14	35
1994	173	1	116	2	16	23
1995	125	3	80	0	10	32
1996	49	2	51	0	12	21
1997	158	1	64	1	18	11
1998	221	6	80	1	20	25
1999	179	5	122	0	42	56
2000	138	17	175	0	17	46
2001	156	8	183	3	19	40
2002	226	24	170	2	24	48
2003	194	13	179	3	22	45
2004	114	17	183	1	16	49
2005	160	8	145	3	24	69
2006	169	14	106	0	29	43
2007	76	14	174	5	21	17
2008	110	18	169	8	25	33
2009	101	16	144	3	39	9
2010	127	5	152	1	67	101
2011	141	1	300	2	99	71
2012	277	10	420	2	150	36
2013	305	10	497	1	155	74
2014	311	8	378	1	160	74
2015	283	16	447	3	127	104
2016	294	15	509	3	125	114
2017	275	19	457	9	140	81
2018	250	22	445	15	107	80
2019	212	42	523	7	130	97

Table 3*. Annual number of Red Snapper recreational charterboat (CB), private (PR), and headboat (HB) length samples by stock (W, C, E). The length compositions resulting from these samples were dropped from further analyses if n<30.*

Year	W_HB	W_CB	W_PR	C_HB	C_CB	C_PR	E_HB	E_CB	E_PR
1981	9	22	35	32	78	81	3	0	30
1982	133	5	153	24	79	80	0	0	2
1983	415	440	462	111	158	8	42	7	7
1984	26	219	437	8	16	15	10	24	6
1985	62	134	631	12	34	6	2	1	5
1986	6,252	358	389	141	160	11	23	9	5
1987	5,978	265	452	191	467	174	1	1	1
1988	4,591	29	490	194	345	16	1	3	16
1989	6,314	29	317	280	148	5	6	8	8
1990	4,263	48	349	330	163	55	3	0	2
1991	3,420	294	449	496	734	180	1	1	1
1992	7,872	369	664	682	1,741	495	1	4	1
1993	7,055	153	802	385	668	231	0	0	0
1994	6,642	166	1,101	806	444	167	510	0	0
1995	8,325	192	1,867	441	245	112	0	0	1
1996	5,260	193	1,425	496	217	103	0	2	3
1997	3,996	162	1,348	1,139	1,182	179	0	5	0
1998	6,556	297	1,159	2,156	2,854	140	0	26	0
1999	3,284	126	756	839	7,335	742	45	11	9
2000	3,194	187	966	1,130	7,731	426	5	3	0
2001	2,531	130	832	648	6,436	496	5	15	0
2002	2,547	683	1,349	1,250	10,745	957	0	14	3
2003	2,144	759	1,620	1,095	13,444	795	3	46	6
2004	975	964	1,495	571	9,699	628	1	10	10
2005	1,150	846	2,088	301	10,645	348	54	16	7
2006	993	1,110	2,424	484	7,391	432	96	22	7
2007	768	1,450	1,431	1,264	4,853	396	17	16	8
2008	401	824	1,126	1,374	2,235	263	49	22	17
2009	866	879	1,345	1,130	1,476	281	357	67	5
2010	796	135	1,005	896	2,403	263	313	139	16
2011	978	672	945	898	2,124	333	378	73	20
2012	456	775	1,032	680	2,742	471	192	30	5
2013	2,335	1,017	1,355	1,273	2,233	512	209	46	10
2014	4,773	491	1,770	2,638	1,141	1,137	86	116	19
2015	4,013	882	1,845	2,412	2,287	1,211	187	194	1
2016	3,793	760	1,382	746	2,031	1,541	99	69	16
2017	2,887	1,077	1,833	969	1,455	1,390	317	192	412
2018	3,936	1,128	2,218	870	1,797	1,282	328	304	73
2019	3,788	746	2,507	1,504	2,157	1,890	294	346	66

***Table 4**. Annual number of Red Snapper recreational charterboat (CB), private (PR), and headboat (HB) trips sampled for lengths by stock (W, C, E).*

Year	W_HB	W_CB	W_PR	C_HB	C_CB	C_PR	E_HB	E_CB	E_PR
1981	1	3	4	12	13	12	3	0	5
1982	16	3	33	13	19	21	0	0	2
1983	54	70	100	42	21	3	29	1	1
1984	4	30	100	5	6	4	10	3	2
1985	17	8	105	10	6	4	2	1	1
1986	413	39	87	64	29	6	10	5	3
1987	393	31	99	99	78	58	1	1	1
1988	299	6	112	93	61	7	1	1	6
1989	289	7	81	122	38	3	4	1	4
1990	247	11	95	114	32	17	2	0	2
1991	212	34	104	143	100	38	1	1	1
1992	323	52	158	181	193	82	1	3	1
1993	328	26	181	126	108	52	0	0	0
1994	324	31	245	132	87	36	29	0	0
1995	357	25	407	111	43	32	0	0	1
1996	241	29	330	115	48	30	0	1	2
1997	231	34	309	164	197	46	0	3	0
1998	343	37	266	248	309	39	0	9	0
1999	221	23	184	126	585	151	6	5	4
2000	150	29	222	136	638	103	1	3	0
2001	187	26	191	88	474	116	2	5	0
2002	221	76	247	126	1,258	139	0	12	2
2003	190	88	269	134	4,455	165	2	8	5
2004	93	95	271	106	3,430	183	1	8	2
2005	101	96	355	46	4,806	124	53	3	4
2006	79	114	409	98	2,695	119	86	7	5
2007	65	143	266	113	544	106	4	4	2
2008	37	85	211	231	417	75	49	12	12
2009	63	92	247	278	393	77	324	66	5
2010	40	19	141	245	1,424	71	298	121	14
2011	53	56	190	209	873	126	366	73	15
2012	35	77	178	142	1,361	161	166	16	3
2013	120	88	245	271	1,689	176	194	23	9
2014	142	61	238	313	757	450	6	36	15
2015	193	113	322	201	361	294	11	45	1
2016	149	89	229	76	318	415	54	22	8
2017	130	132	341	188	262	334	133	71	97
2018	201	176	405	158	307	298	110	59	25
2019	204	104	455	172	373	456	112	83	21

Table 5*. Annual number of age samples for commercial vertical line (VL) and longline (LL) gears by stock.*

Year	W_VL	W_LL	C_VL	C_LL	E_VL	E_LL
1991	25	0	178	0	0	12
1992	210	0	116	0	18	15
1993	312	29	136	0	13	30
1994	500	0	121	4	28	4
1995	97	0	85	0	7	19
1996	0	0	9	0	0	6
1997	0	0	1	3	31	7
1998	1,172	347	181	0	11	25
1999	1,797	76	902	0	70	102
2000	695	342	1,381	0	29	82
2001	1,026	179	1,233	14	65	75
2002	2,420	340	1,155	11	14	167
2003	1,393	256	1,473	27	9	168
2004	1,891	640	969	18	113	234
2005	2,313	252	1,097	34	68	311
2006	2,599	556	1,146	0	153	202
2007	1,446	352	1,077	93	54	124
2008	1,577	342	933	182	24	315
2009	2,124	270	929	20	595	678
2010	2,038	82	1,148	1	451	1,004
2011	1,660	14	2,776	120	599	453
2012	2,911	148	3,521	60	649	219
2013	1,499	115	1,922	133	640	585
2014	1,129	74	1,708	39	759	1,110
2015	1,646	104	2,285	63	556	800
2016	1,694	112	2,634	27	804	828
2017	1,240	132	3,123	21	1,114	528
2018	1,496	306	4,112	116	731	536
2019	1,120	681	4,329	76	948	775

Table 6*. Annual number of commercial vertical line (VL) and longline (LL) gear trips sampled for ages by stock.*

Year	W_VL	W_LL	C_VL	C_LL	E_VL	E_LL
1991	1	0	12	0	0	2
1992	16	0	4	0	6	4
1993	31	2	16	0	7	10
1994	54	0	23	1	6	3
1995	9	0	16	0	2	7
1996	0	0	3	0	0	4
1997	0	0	1	1	2	2
1998	45	6	7	0	3	6
1999	76	2	29	0	3	12
2000	37	14	56	0	4	7
2001	43	9	57	1	3	17
2002	105	15	55	2	5	37
2003	56	13	385	2	3	38
2004	71	24	51	2	11	40
2005	85	10	52	2	8	51
2006	80	17	53	0	43	40
2007	55	15	180	5	29	27
2008	108	25	110	36	23	81
2009	54	17	148	9	88	48
2010	68	5	367	1	179	614
2011	55	1	1,826	34	253	254
2012	115	9	1,690	17	266	111
2013	238	10	1,514	19	406	123
2014	221	10	1,286	17	389	110
2015	254	15	1,813	11	281	154
2016	250	16	2,124	12	689	712
2017	227	19	2,476	17	1,019	471
2018	241	20	3,422	69	714	511
2019	222	33	3,900	32	895	661

***Table 7**. Annual number of recreational headboat (HB), charterboat (CB), and private (PR) age samples by stock.*

Year	W_HB	W_CB	W_PR	C_HB	C_CB	C_PR	E_HB	E_CB	E_PR
1986	348	0	0	1	0	0	1	0	0
1987	146	0	0	0	0	0	0	0	0
1988	350	0	0	1	0	0	0	0	0
1989	82	0	0	0	0	0	1	0	0
1990	36	0	0	0	0	0	0	0	0
1991	102	526	0	20	237	0	0	2	0
1992	26	485	0	70	347	2	5	0	0
1993	910	189	24	254	370	0	0	62	0
1994	385	0	0	170	423	0	53	0	0
1995	10	0	0	11	360	0	0	0	0
1996	0	0	0	95	100	0	0	0	0
1997	0	0	0	95	56	0	1	0	0
1998	957	135	212	669	945	237	1	1	0
1999	263	97	75	351	658	581	14	0	0
2000	250	2	3	139	504	0	1	2	0
2001	74	0	0	217	377	1	1	11	0
2002	205	245	322	219	2,506	309	0	15	0
2003	139	229	600	70	6,022	353	2	35	3
2004	168	400	627	63	3,815	197	1	3	0
2005	205	422	815	48	5,089	194	52	5	0
2006	205	238	1,081	109	3,383	251	78	5	2
2007	67	475	530	185	402	64	7	14	1
2008	133	467	340	146	366	30	46	7	10
2009	428	427	323	367	520	73	318	52	2
2010	393	49	434	236	1,269	58	240	122	13
2011	660	413	130	185	1,138	80	260	73	13
2012	361	401	380	227	1,670	157	127	14	0
2013	1,471	615	313	665	1,987	113	155	21	7
2014	1,230	241	515	2,890	835	314	103	81	12
2015	998	455	381	2,337	1,807	650	203	141	0
2016	723	341	568	321	1,307	858	39	24	10
2017	1,070	529	433	385	899	581	158	66	267
2018	1,062	601	509	709	1,232	815	236	207	40
2019	1,059	382	540	770	1,331	649	189	207	14

***Table 8**. Annual number of recreational headboat (HB), charterboat (CB), and private (PR) trips sampled for ages by stock.*

Year	W_HB	W_CB	W_PR	C_HB	C_CB	C_PR	E_HB	E_CB	E_PR
1986	58	0	0	1	0	0	1	0	0
1987	47	0	0	0	0	0	0	0	0
1988	69	0	0	0	0	0	0	0	0
1989	27	0	0	0	0	0	1	0	0
1990	11	0	0	0	0	0	0	0	0
1991	5	29	0	10	43	0	0	1	0
1992	6	27	0	23	62	1	1	0	0
1993	107	9	1	90	69	0	0	2	0
1994	57	0	0	68	73	0	13	0	0
1995	2	0	0	8	52	0	0	0	0
1996	0	0	0	31	29	0	0	0	0
1997	0	0	0	46	11	0	1	0	0
1998	87	6	10	144	42	19	1	1	0
1999	33	1	10	74	41	12	3	0	0
2000	54	1	0	29	60	0	1	0	0
2001	19	0	0	34	52	1	1	3	0
2002	42	23	33	41	134	39	0	5	0
2003	23	32	55	24	3,973	63	2	15	3
2004	31	35	68	37	2,970	84	1	3	0
2005	28	44	106	12	4,290	55	52	5	0
2006	27	25	84	44	2,497	76	78	5	2
2007	13	51	49	46	137	22	7	14	1
2008	11	41	43	146	165	10	46	6	10
2009	50	52	50	219	242	23	318	52	2
2010	31	4	26	141	1,123	20	240	122	13
2011	44	30	20	113	674	64	260	73	13
2012	30	32	29	113	1,202	73	127	14	0
2013	119	46	34	243	1,617	58	151	20	7
2014	135	26	56	1,567	678	263	67	29	12
2015	153	41	51	280	286	134	24	22	0
2016	87	34	58	52	168	232	13	9	6
2017	80	56	53	62	129	144	24	16	63
2018	130	79	67	102	197	172	40	39	14
2019	139	44	61	125	232	150	30	45	9

Figures

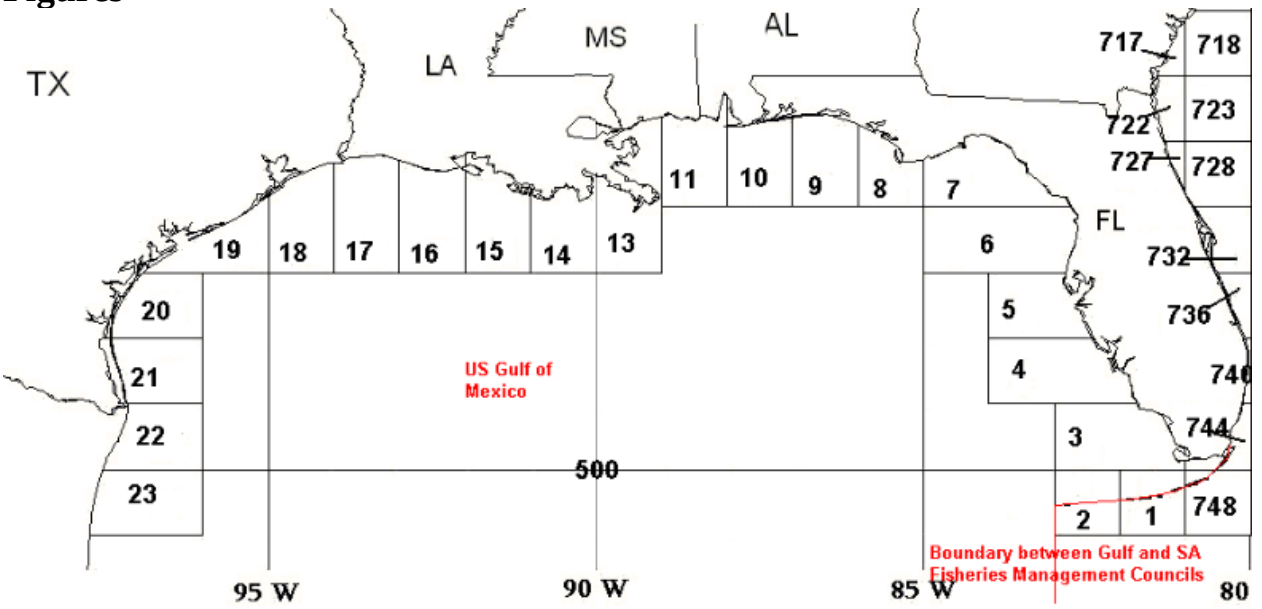

Figure 1: NMFS commercial fishing areas in the Gulf of Mexico used to define stock boundaries.

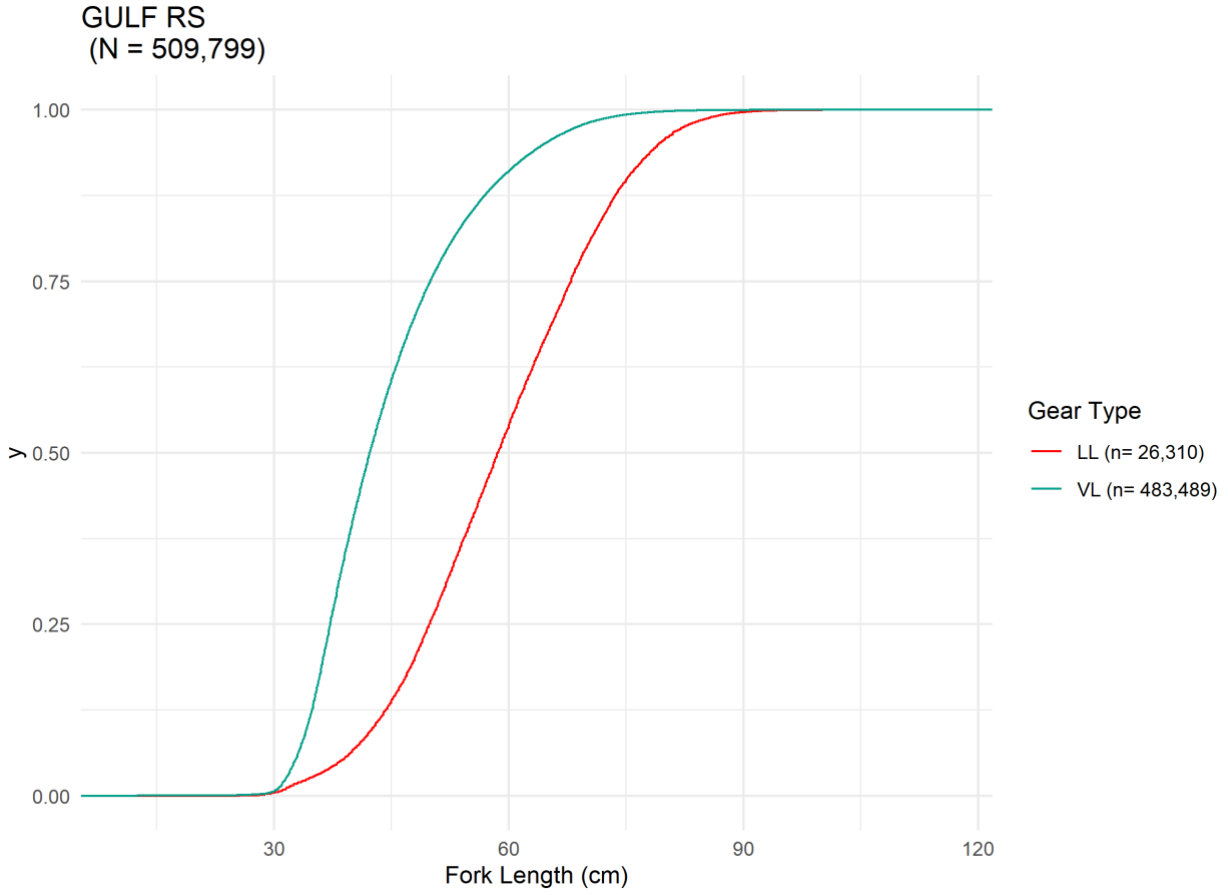

Figure 2: Anually and spatially aggregated commercial gear cumulative length distributions: longline (LL) and vertical line (VL) gears.

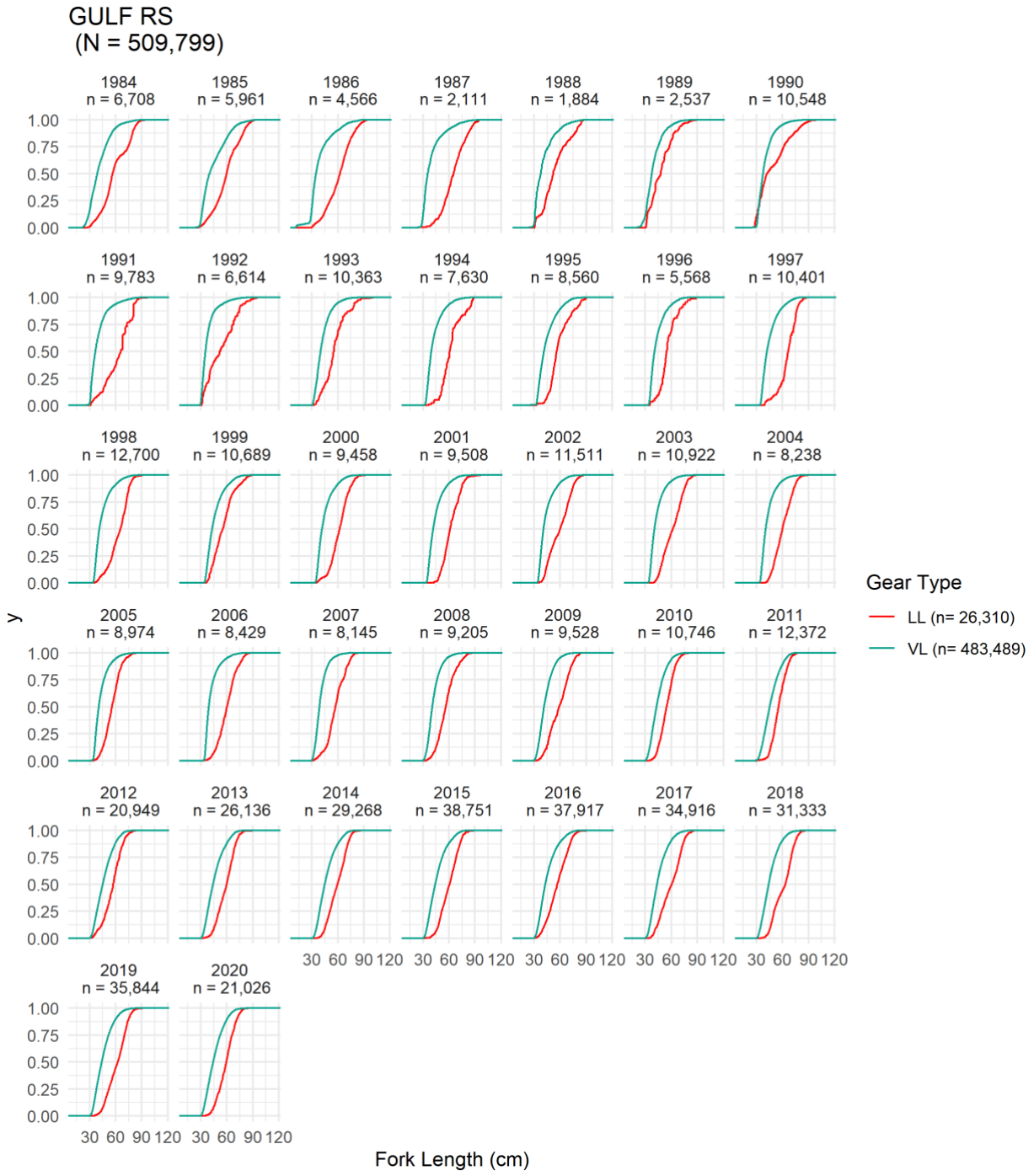

Figure 3: Spatially aggregated Red Snapper commercial gear cumulative length distributions: longline (LL) and vertical line (VL) gears. Strata with less than 30 samples were dropped.

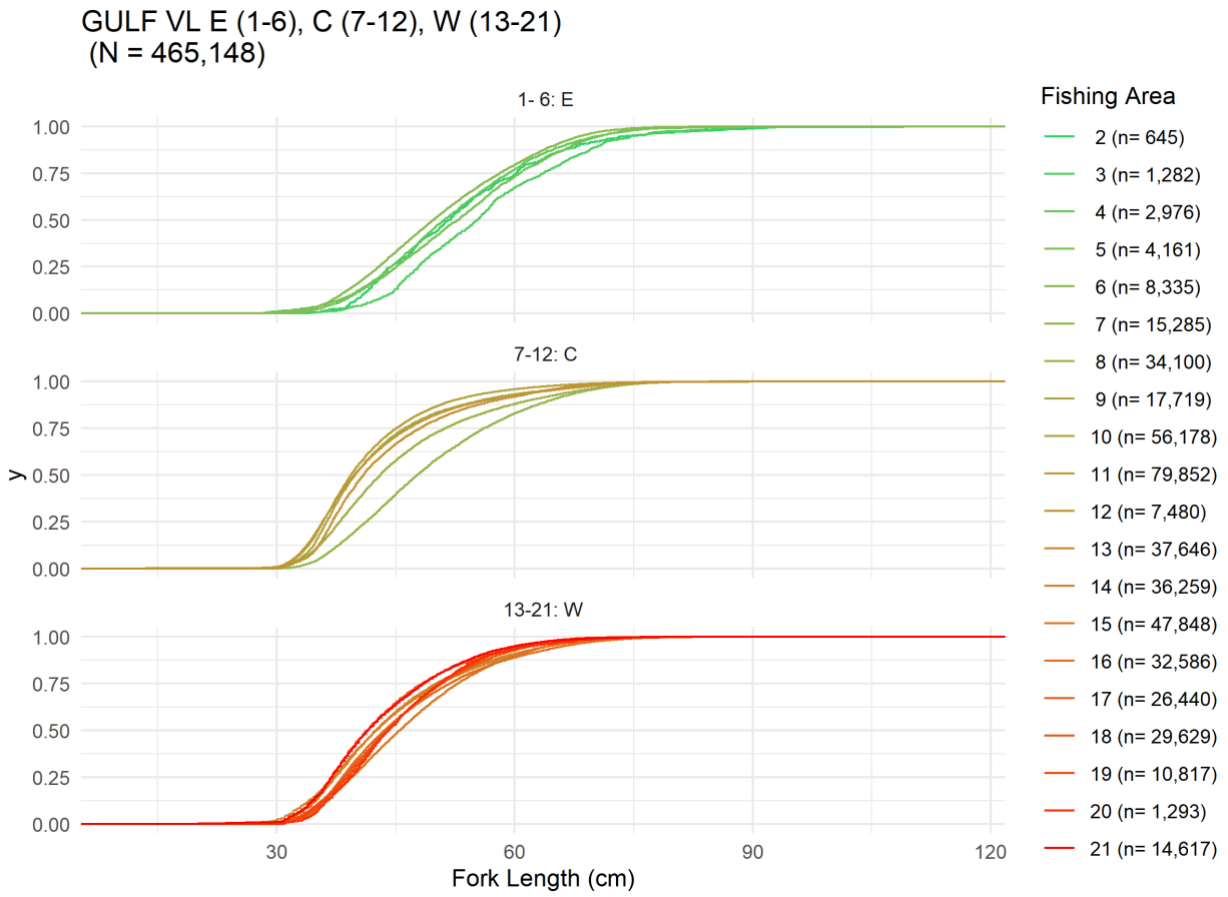

Figure 4: Annually aggregated Red Snapper commercial VL cumulative length distributions for each stock: Eastern (E: 1-6), Central (C: 7-12), and Western (W: 13-21).

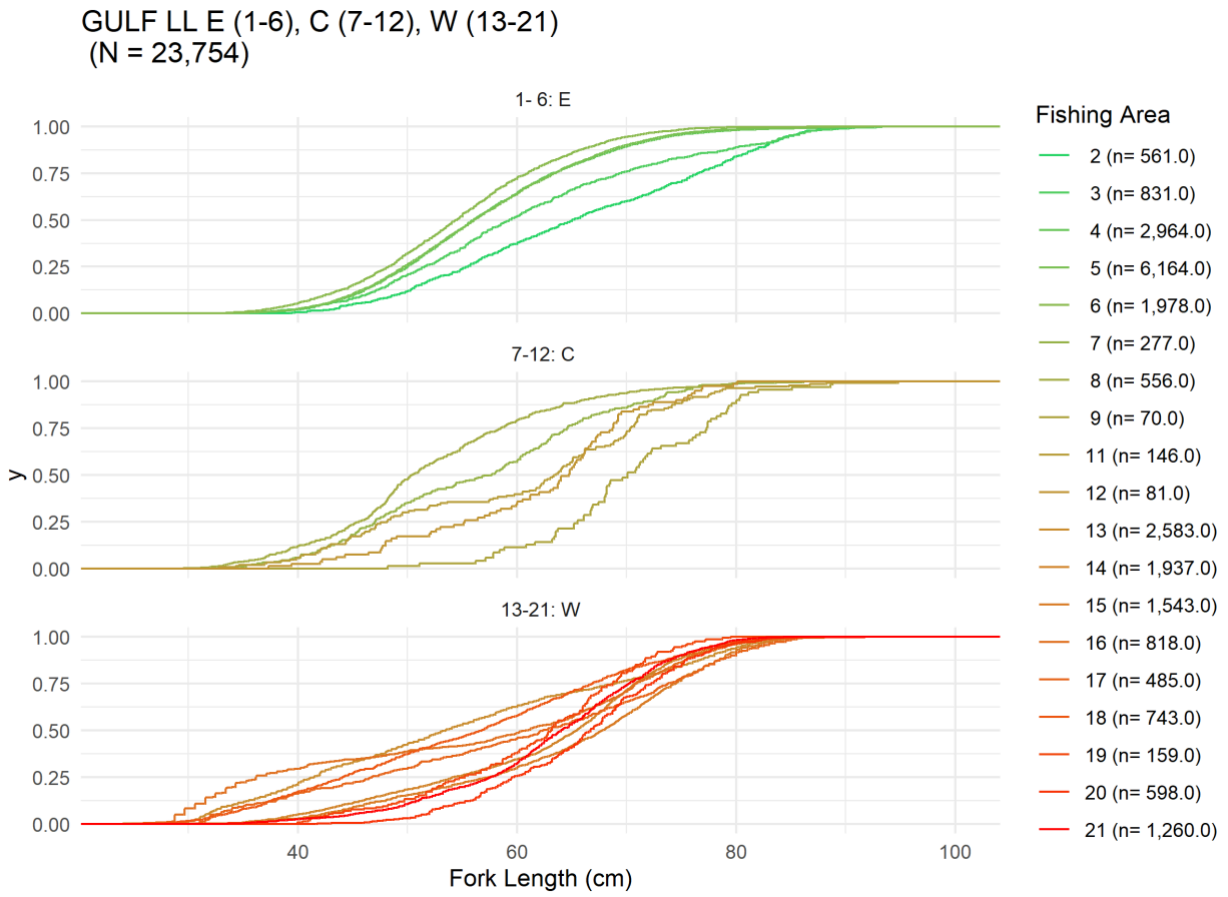

Figure 5: Annually aggregated Red Snapper commercial LL cumulative length distributions for each stock: Eastern (E: 1-6), Central (C: 7-12), and Western (W: 13-21).

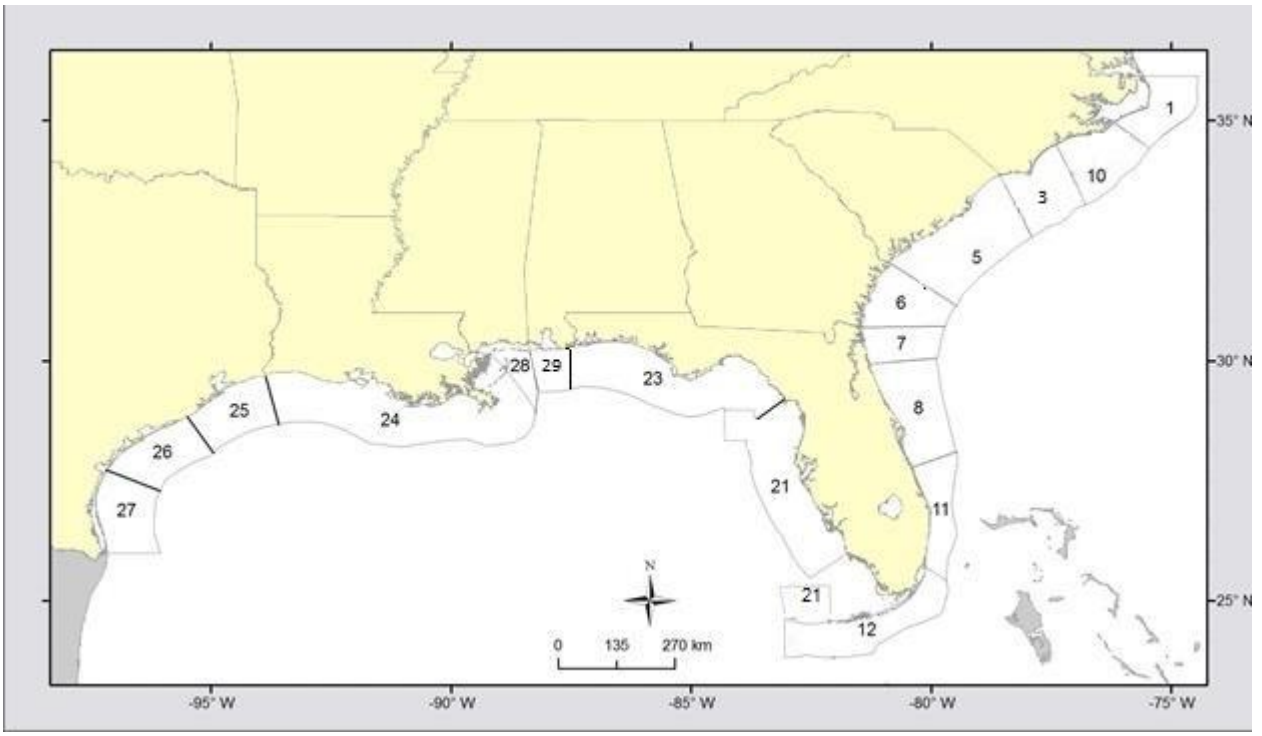

Figure 6: SRHS headboat areas in the Gulf of Mexico used to define stock boundaries. Pre-2013, Alabama could not be distinguished from the Florida panhandle (e.g. area 23 encompassed area 29 in the SRHS survey design).

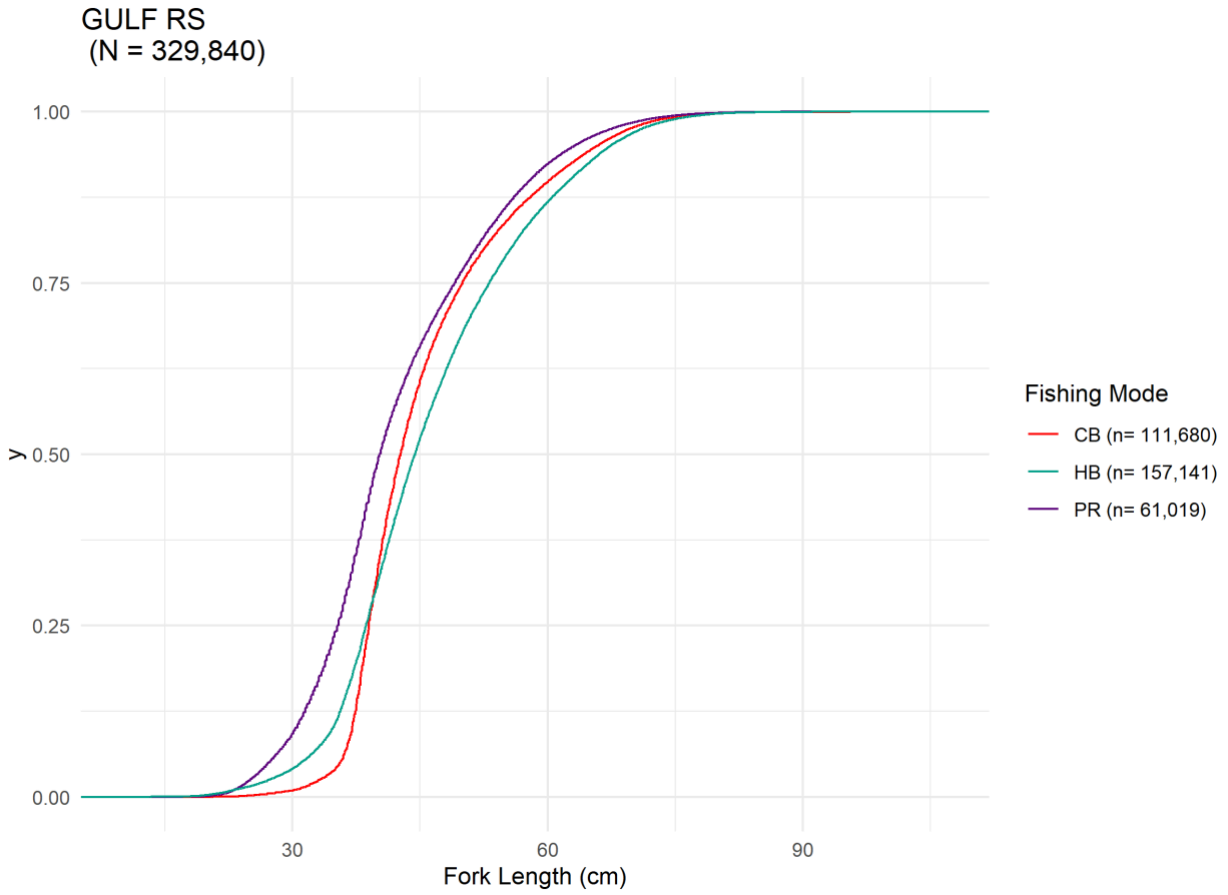

Figure 7: Annually and spatially aggregated Red Snapper cumulative length distributions by recreational modes: charterboat (CB), headboat (HB), and private (PR).

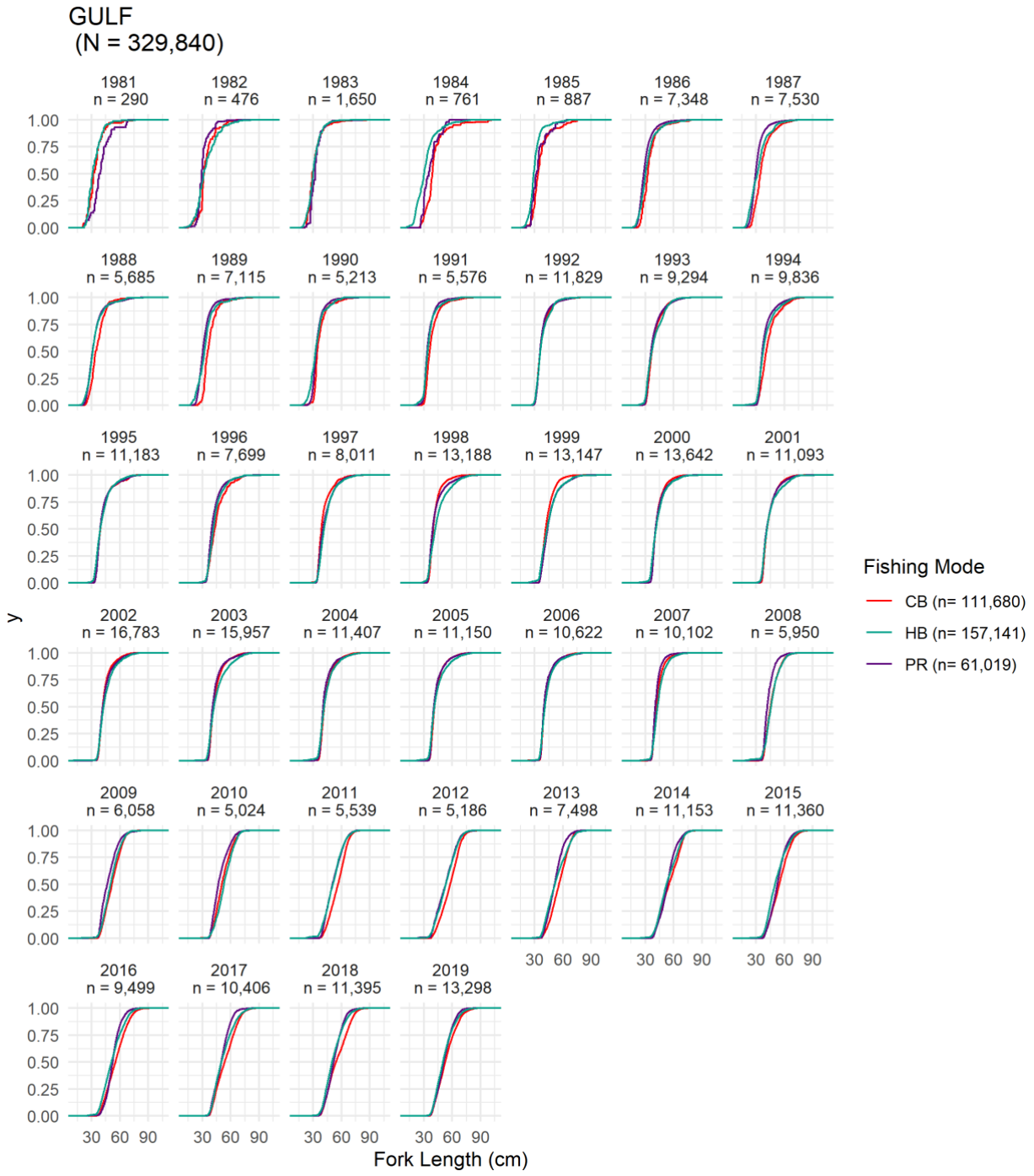

Figure 8: Spatially aggregated Red Snapper cumulative length distributions by recreational modes: charterboat (CB), headboat (HB), and private (PR). Strata with less than 30 samples were dropped.

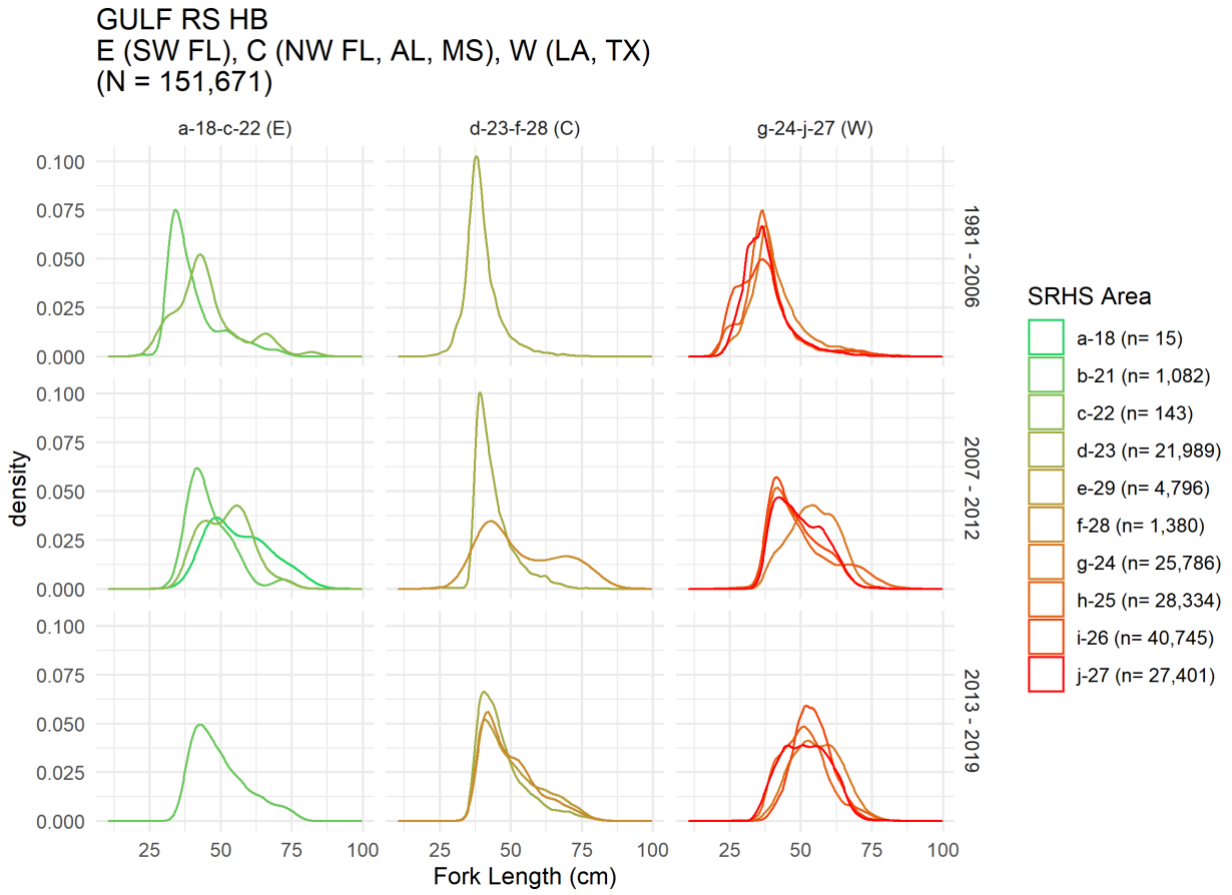

Figure 9: Annually aggregated Red Snapper headboat length distributions by headboat areas for each stock: W, C, E.

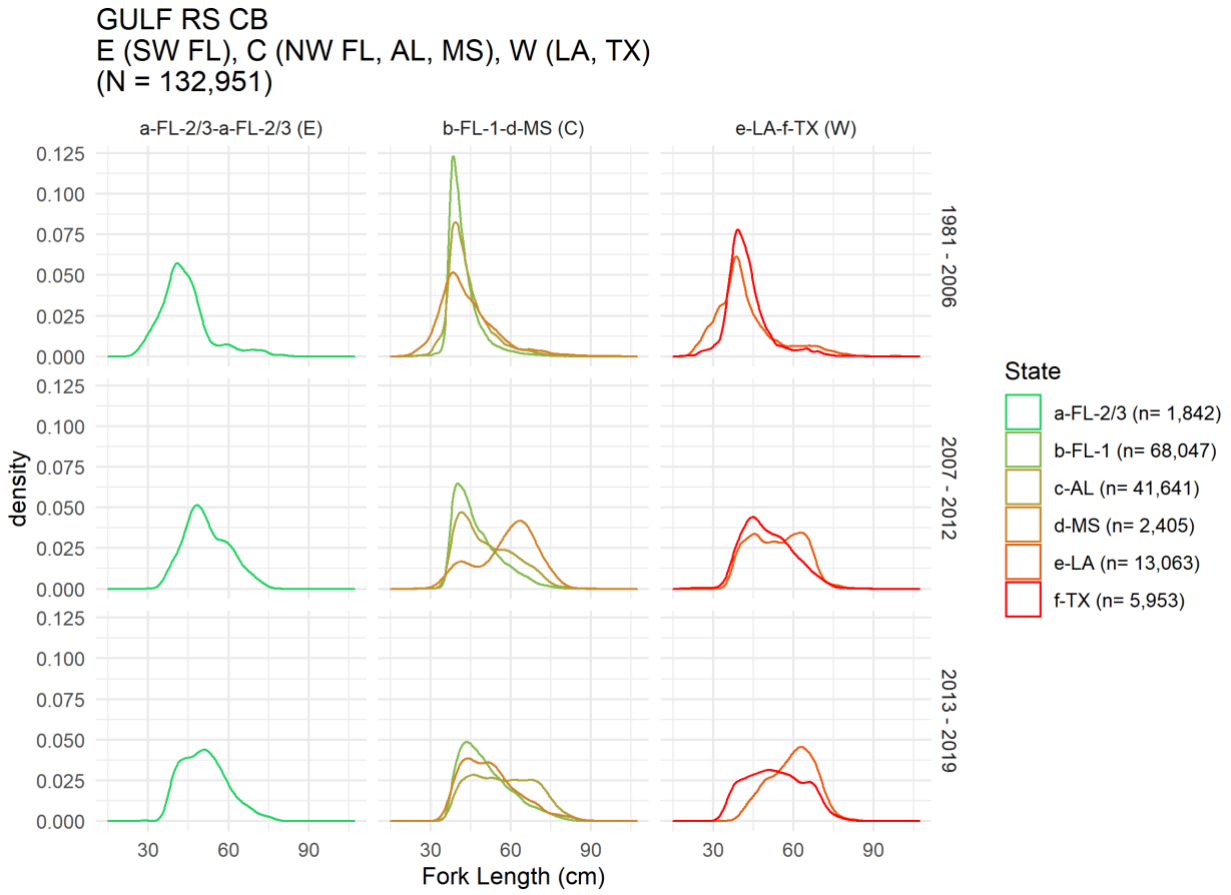

Figure 10: Annually aggregated Red Snapper charterboat length distributions by MRIP areas for each stock: W, C, E.

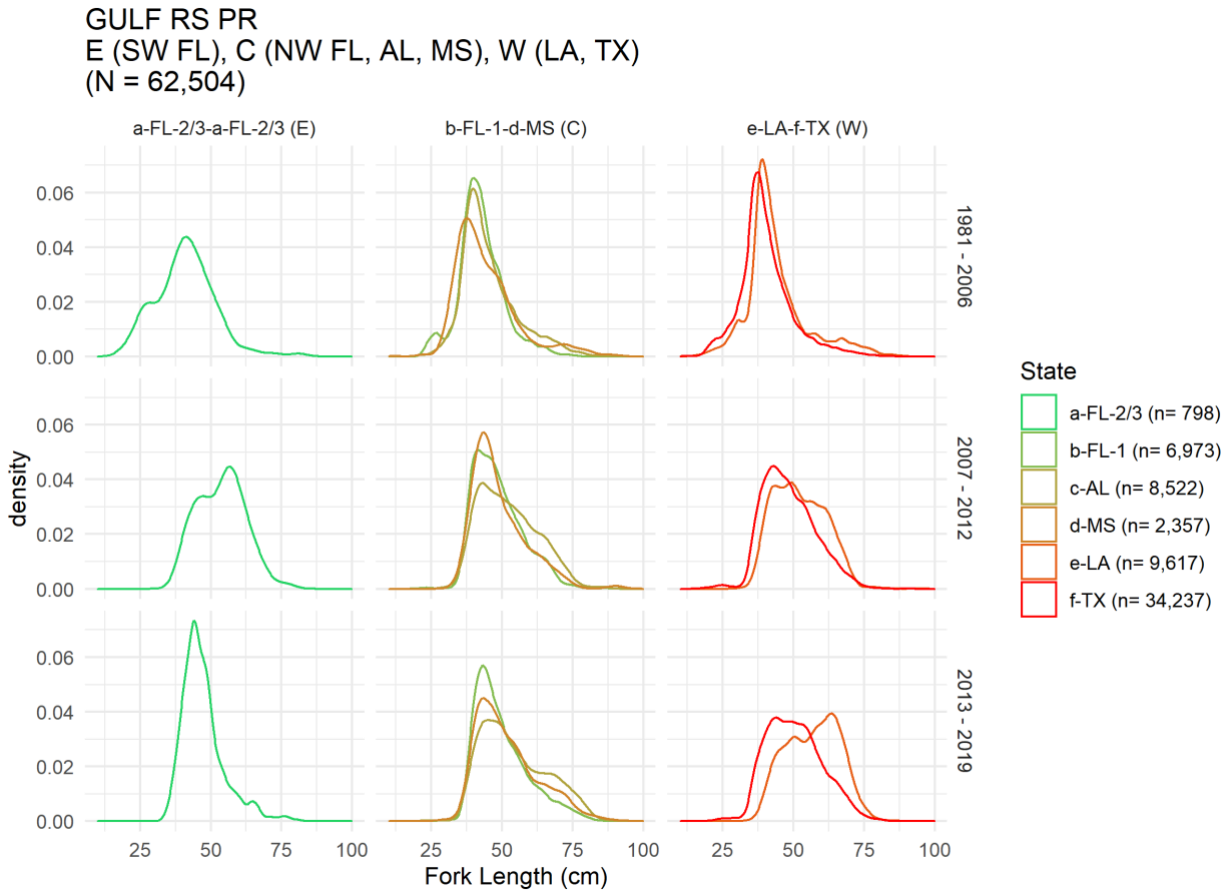

Figure 11: Annually aggregated Red Snapper private mode length distributions by MRIP areas for each stock: W, C, E.