Gulf of Mexico Cobia (*Rachycentron canadum*) Commercial and Recreational Length Compositions

Molly H. Stevens and Alexandra E. Smith

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Molly H. Stevens[1] and Alexandra E. Smith[2]
[1]*NOAA Southeast Fisheries Science Center, 75 Virginia Beach Drive, Miami FL 33149*
[2]*University of Miami CIMAS, 4600 Rickenbacker Causeway, Miami FL 33149*

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Introduction

This document outlines the data and methodologies used to estimate commercial length compositions and recreational length compositions for the SEDAR 28 Update of Gulf of Mexico Cobia. These compositions were estimated using the same data sources approved in SEDAR 28. Best practices were applied to these data where available (SEDAR 2015), some of which have changed since Gulf of Mexico Cobia were last assessed nearly a decade ago. Because fishery-dependent sampling is typically opportunistic, sampled lengths may not be representative of the true size composition of landings. To account for this potential bias, length samples from commercial fisheries were weighted by associated landings at the finest spatial and temporal scale available without losing data. Recreational surveys in the Gulf of Mexico have been overhauled since 2011, and new variables were utilized to improve recreational length composition estimation. Undersized fish are not uncommon in these databases, but a minimum size limit of 33" Fork Length (FL) has been in place since 1985 and was considered when filtering the raw data. All approved data sources were updated through 2018 for this assessment.

Data Description

The SEDAR 28 Update assesses all Gulf of Mexico Cobia in federal waters extending northward from the Texas/Mexico border and eastward to the Florida/Georgia line. 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 in SEDAR 28 and updated here include the Trip Interview Program (TIP, 1983-2018), Accumulated Landings Systems (ALS, 1962-2018), and Reef Fish Observer Program (RFOP, 2006-2018). Recreational sources utilized were the Marine Recreational Information Program (MRIP, 2008-2018), formerly Marine Recreational Fisheries Statistics Survey (MRFSS, 1981-2007), Texas Parks and Wildlife Department's Marine Sport-Harvest Monitoring Program (TPWD, 1981-2018), and Southeast Regional Headboat Survey (SRHS, 1979-2018). Following SEDAR 28, commercial and recreational compositions were estimated with all gears/modes aggregated using length bins of 3 centimeters (cm). Years wherein less than thirty fish were measured were excluded from this analysis.

Commercial Methodology

Length Samples of Landings
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 (n=22). Total length (TL) was converted to FL using the conversion equation applied in SEDAR 28.

$$FL_{cm} = -1.002 + 0.901 * TL_{cm}$$

Samples recorded in maximum total length (n=1) and standard length (n=98) were deleted since no Gulf of Mexico SEDAR 28 conversion parameters were available, and these samples represented less than two percent of the total. There was a slight bimodal distribution on the lower range of samples which could indicate a length unit error (e.g. inches vs. centimeters), resulting in the deletion of 30 samples measuring 45 cm FL or less. One large fish was deleted that was over 20 cm larger than the next largest fish. The minimum annual sample size threshold (n=30) resulted in the deletion of data from 1983 (n=12).

Length Composition of Landings
Because fishery-dependent sampling is typically opportunistic, sampled lengths may not be representative of the true landings composition. Possible sampling bias in the collection of commercial length samples in the TIP data was removed by weighting the length compositions with the associated landings on the finest spatial and temporal scale available without losing data. Due to sparse landings in some states, data were aggregated into three major regions: Western Gulf of Mexico (GMW: Texas, Louisiana), Eastern Gulf of Mexico (GME: Mississippi, Alabama, western Florida), and Eastern Florida (FLE) (Table 1). First, region-specific nominal length compositions were estimating using length bins of 3 cm for each year i, length bin j, and region r

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

where $LC_{i,j,r}$ is the proportion of the total number of sampled fish in each year i and region r ($n_{i,r}$) within each lower inclusive length bin j. Next, these region-specific length compositions were weighted using the ALS landings estimates by region. Proportions of annual landings from each region, $p_{i,r}$, were calculated and used to scale the regional length compositions, $LC_{i,j,r}$, which were then summed across regions r

$$LC_{i,j} = \sum_r (LC_{i,j,r} * p_{i,r})$$

resulting in the final weighted estimates of commercial landings length compositions, $LC_{i,j}$. This procedure would downweight, for example, any instances where 60% of the length samples come from a region that only accounts for 20% of the landings. Impacts of the weighting procedure are shown in Figure 1.

Length Composition of Catch
The RFOP was designed by NMFS-SEFSC to characterize the commercial reef fishery operating in the Gulf of Mexico and is assumed to be a representative survey of the true length compositions from this fleet (Scott-Denton *et al.*, 2011). Commercial catch is defined here as fish that are both kept and discarded. The length composition of catch is more representative of gear selectivity because it is not a function of regulations such as quotas and minimum size limits. Since LC is a standard definition for length compositions of landings, DC was used to define the length composition of both landed and discarded fish. The length composition including discards was estimated for each year i within 3 cm length bins j

$$DC_{i,j} = \frac{c_{i,j}}{c_i}$$

where $DC_{i,j}$ is the proportion of the total number of sampled fish in each year i (c_i) within each lower inclusive length bin j.

Recreational Methodology

Length Samples of Landings
The recreational sampling program, MRIP, has been redesigned over the last decade to remove sources of potential bias from the sampling process. Included in this new design are imputed lengths and an assigned weighting factor, which accounts for bias associated with nonrepresentative sampling of landings. More detailed information on the MRIP survey can be found in Papacostas & Foster (2018), and more detailed information on MRIP Gulf of Mexico Cobia data can be found in Matter & Nuttall (2020). Data collected from TPWD and SRHS were converted from total length to fork length using the equation reported above from SEDAR 28. SRHS samples that did not include information on length were deleted (n=59).

The recreational data also displayed an unusually shaped lower distribution, possibly indicating errors in length units, particularly considering the longstanding minimum size limit of 33" FL (83.8 cm FL). Therefore, all fish 45 cm FL or less were deleted (MRIP n=45, SRHS n=1, TPWD n=19). Similar to the commercial length data, one fish from SRHS was deleted that was over 60 cm larger than the next largest fish. Two years of data did not meet the sample size threshold $n \geq 30$, 1979 (SRHS n=22) and 1980 (SRHS n=15), and were excluded from this analysis.

Length Composition of Landings
These recreational data sources were collected under separate survey designs. Therefore, recreational length compositions were initally generated separately for each of the three data sources: MRIP, SRHS, and TPWD (Table 2). The MRIP-recommended imputed lengths and weighting factors were utilized to generate the MRIP length composition, but the sample size reported in Table 2 used for merging these datasets together included measured fish only. Source-specific nominal length compositions, $RC_{i,j,s}$, were estimated using length bins of 3 cm for each year i, length bin j, and source s

$$RC_{i,j,s} = \frac{m_{i,j,s}}{m_{i,s}}$$

where the sum of all fish (or sum of MRIP weighting factors) within year i and lower inclusive length bin j ($m_{i,j,s}$) were divided by the sum of all fish (or sum of all MRIP weighting factors) within each data source annually ($m_{i,s}$). Next, these source-specific length compositions were aggregated using the proportion of samples from their relative source. Proportions of samples from each data source, $p_{i,s}$, were calculated and used to compile the recreational length compositions, $RC_{i,j,s}$, which were then summed across sources s

$$RC_{i,j} = \sum_s (RC_{i,j,s} * p_{i,s})$$

resulting in the final estimate of recreational landings length compositions, $RC_{i,j}$. Annual recreational length compositions are shown in Figure 2.

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Tables

Table 1: Annual number of Cobia commercial TIP length samples by state, with dotted lines indicating regional aggregations: western Gulf, eastern Gulf, and eastern Florida.

Year	TX	LA	MS	AL	GA	FLW	FLE
1984		109				16	134
1985		154	33				19
1986		57	3	2	1		124
1987		4	1			3	81
1988							61
1989		24	1			1	13
1990		53	5			12	3
1991		87				12	37
1992		84				12	83
1993	7	39				55	73
1994		88				71	46
1995		39				100	53
1996		28				164	19
1997		35				205	30
1998		6				164	57
1999			4			146	90
2000		4	1			99	63
2001		9	1			90	42
2002		2				128	68
2003		2		1		137	78
2004		6		4		102	33
2005		6		1		44	24
2006		6				6	38
2007		3				8	49
2008		5		2		14	9
2009		2		2		9	31
2010		1				16	50
2011		2		2		12	53
2012	20	7		2		16	115
2013	16	12				37	102

Year	TX	LA	MS	AL	GA	FLW	FLE
2014	2	32				44	71
2015	4	80		3		39	57
2016		119		1		25	35
2017	1	74		4		26	40
2018	14	74		2		15	22
Total	64	1,253	49	26	1	1,828	1,903

Table 2: Annual number of Cobia recreational length samples by source, where MRIP sample size does not include imputed lengths.

Year	SRHS	MRIP	TPWD	Total
1981	30	20	0	50
1982	28	68	0	96
1983	29	34	24	87
1984	45	56	18	119
1985	23	42	26	91
1986	90	100	19	209
1987	67	72	30	169
1988	54	52	18	124
1989	64	33	19	116
1990	56	41	15	112
1991	50	79	21	150
1992	121	103	32	256
1993	158	69	23	250
1994	143	105	44	292
1995	173	54	47	274
1996	161	75	122	358
1997	154	108	85	347
1998	241	122	84	447
1999	220	193	48	461
2000	93	113	52	258
2001	128	151	47	326
2002	89	154	33	276
2003	105	212	76	393
2004	49	177	63	289

Year	SRHS	MRIP	TPWD	Total
2005	35	117	51	203
2006	67	135	71	273
2007	81	153	63	297
2008	59	74	91	224
2009	69	69	86	224
2010	82	110	49	241
2011	58	118	59	235
2012	147	102	63	312
2013	214	76	43	333
2014	160	147	62	369
2015	121	107	82	310
2016	127	90	70	287
2017	84	73	55	212
2018	66	62	68	196
Total	3,778	3,666	1,859	9,303

Figures

Figure 1: Annual Cobia TIP length compositions, both unweighted (nominal) and weighted. Weights were defined spatially from the ALS landings data.
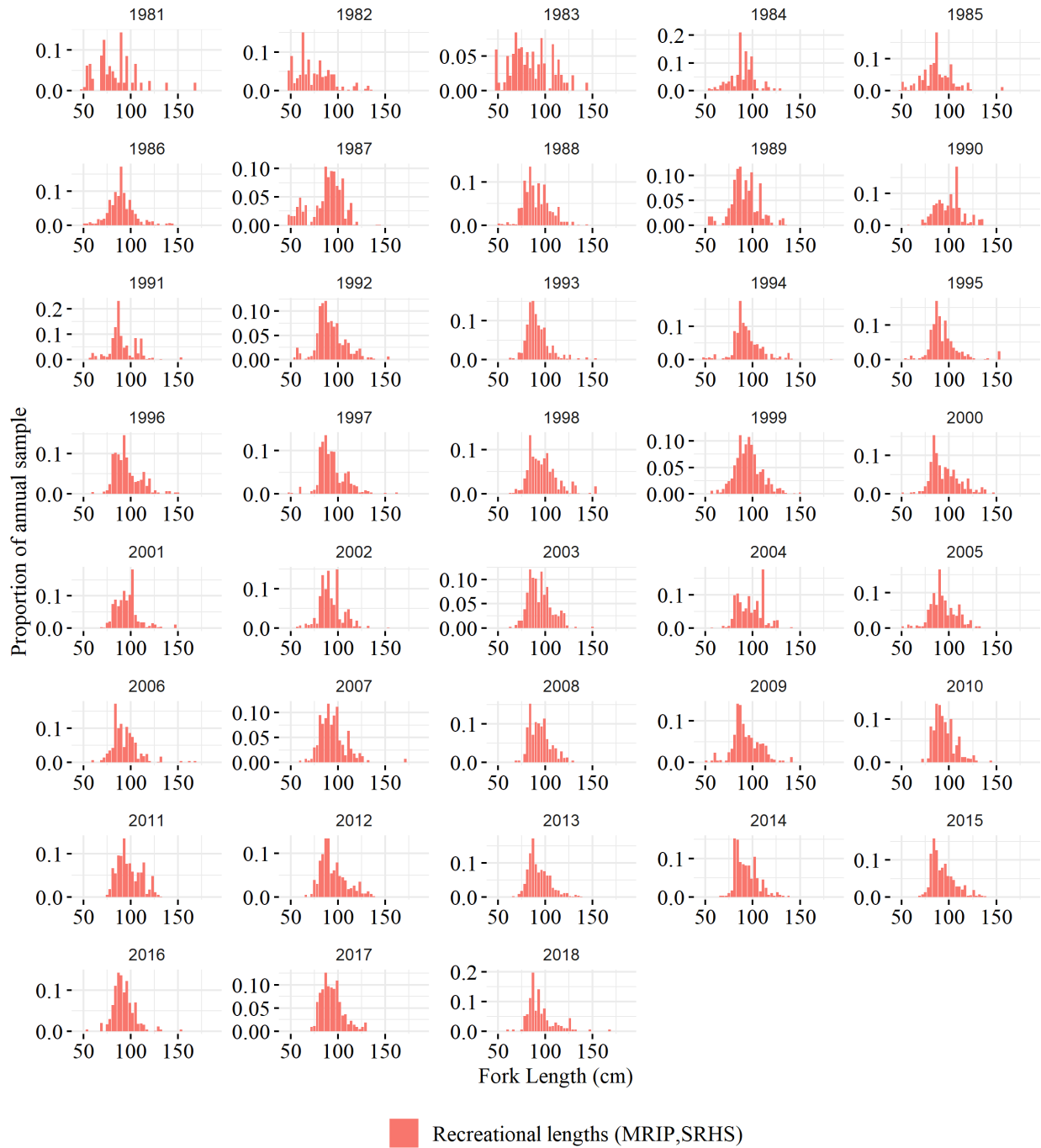
Figure 2: Annual Cobia recreational length compositions for all recreational modes combined.