Addendum to SEDAR41-DW16: Report on Life History of South Atlantic Gray Triggerfish, *Balistes capriscus*, from Fishery-Independent Sources: UPDATE on analyses of maturity, spawning fraction, and sex ratio

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SEDAR41-RW01

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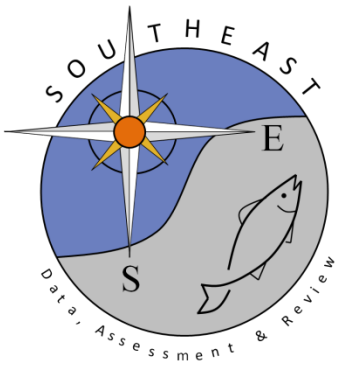

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Life History of South Atlantic Gray Triggerfish, *Balistes capriscus*
UPDATE: on analyses of maturity, spawning fraction, and sex ratio

SEDAR 41-RW1
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This report represents an update to SEDAR41-DW16 (Gray Triggerfish life history) that was done for two reasons: 1) an error in programming code was discovered in January 2016, and 2) the results of sex ratio analysis reported in the September 2015 Data Workshop report did not include macroscopic sex data collected in 2014. In January 2016, the assessment team noted that there were 300+ records with no data for maturity (i.e., reproductive phase) that were inadvertently included in analyses done by MARMAP/SEAMAP-SA Reef Fish Survey staff in 2014 in preparation for the first Data Workshop. Dr. Nikolai Klibansky of the assessment team determined that the maturity variable was coerced to a factor class variable because some values were numbers, while others were letters. This resulted in the records with no data (i.e., blanks) being treated as being equal to empty quotes (“ ”) by R statistical software. As a result, these records were not eliminated in the 2014 analyses, but were coded as mature by default. Corrections were made to the R code and the maturity and spawning fraction analyses were re-run using the same data, with the results presented in this update (Tables 1-5). Note that no histological data were collected in 2014, hence the most recent year in the data analyses was 2013. It should also be noted that the results were very similar to those reported in the September 2015 Data Workshop report.

This report also includes an update of the sex ratio analyses, results that were reported in previously in a working paper (SEDAR41-DW16-B) but not the September 2015 Data Workshop report. Table 2.10 and Figures 2.10 and 2.11 from Data Workshop report were updated with the 2014 macroscopic data (Table 6, Figs. 4 and 6 below). One table and four additional graphs summarizing the results were added (Table 7, Figs. 1-3 and 5 below). As was true for the maturity and spawning fraction analyses, the sex ratio results were very similar to those reported in the Data Workshop report.

Table 1. (Update of Table 2.6 in 2015 Data Workshop report)

Female Gray Triggerfish Fork Length (FL in cm) at maturity (N = 4,855). Obs. Mature= proportion mature in observations. Pred. Mature is predicted proportion mature at size estimated with a Logistic model (=1-1/(1+exp(a+b*FL))). FL_{50} = 177 mm.

Fork Length	# Immature	# Mature	# Total	Obs. Mature	Pred. Mature
8	2	0	2	0.000	0.005
9	0	0	0	NA	0.008
10	4	0	4	0.000	0.014
11	2	0	2	0.000	0.024
12	1	0	1	0.000	0.040
13	3	0	3	0.000	0.068
14	8	1	9	0.111	0.113
15	10	1	11	0.091	0.182
16	17	3	20	0.150	0.279
17	18	15	33	0.455	0.403
18	13	24	37	0.649	0.540
19	13	30	43	0.698	0.672
20	12	46	58	0.793	0.781
21	6	46	52	0.885	0.861
22	10	79	89	0.888	0.915
23	5	72	77	0.935	0.950
24	7	119	126	0.944	0.970
25	0	129	129	1.000	0.983
26	1	182	183	0.995	0.990
27	1	138	139	0.993	0.994
28	1	249	250	0.996	0.997
29	1	217	218	0.995	0.998
30	1	367	368	0.997	0.999
31	0	293	293	1.000	0.999
32	0	378	378	1.000	1.000
33	0	316	316	1.000	1.000
34	0	358	358	1.000	1.000
35	0	311	311	1.000	1.000
36	0	365	365	1.000	1.000
37	0	231	231	1.000	1.000
38	0	242	242	1.000	1.000
39	0	155	155	1.000	1.000
40	0	147	147	1.000	1.000
41	0	83	83	1.000	1.000
42	0	51	51	1.000	1.000

43	0	26	26	1.000	1.000
44	0	18	18	1.000	1.000
45	0	9	9	1.000	1.000
46	0	9	9	1.000	1.000
47	0	4	4	1.000	1.000
48	0	1	1	1.000	1.000
49	0	2	2	1.000	1.000
50	0	1	1	1.000	1.000
51	0	0	0	NA	1.000
52	0	0	0	NA	1.000
53	0	0	0	NA	1.000
54	0	0	0	NA	1.000
55	0	0	0	NA	1.000
56	0	1	1	1.000	1.000

Parameters	a	SE	b	SE
Estimates	-9.828	0.740	0.056	0.004

Table 2. (Update of Table 2.7 in 2015 Data Workshop report)

Female Gray Triggerfish age-at-maturity (N = 3,817). Predicted proportion mature at age estimated with the Logistic model (= 1 - 1/(1 + exp(a+b*age))), except at Age 0. *Age 0 female predicted proportion mature set to 0. Age_{50} = 0.196 yr.

Calendar Age (yr)	# Immature	# Mature	# Total	Observed Proportion Mature	Predicted Proportion Mature
0	2	0	2	0.000	0*
1	60	230	290	0.793	0.793
2	35	734	769	0.954	0.953
3	9	1078	1087	0.992	0.991
4	3	834	837	0.996	0.998
5	0	470	470	1	1
6	0	171	171	1	1
7	0	108	108	1	1
8	0	50	50	1	1
9	0	22	22	1	1
10	0	5	5	1	1
11	0	5	5	1	1
12	0	1	1	1	1

Parameters	a	SE	b	SE
Estimates	-0.330	0.245	1.669	0.137

Table 3. (Update of Table 2.8 in 2015 Data Workshop report)

Male Gray Triggerfish Fork Length (FL in cm) at maturity (N = 4,206). Obs. Mature= proportion mature in observations. Pred. Mature is predicted proportion mature at length estimated with the Logistic model (=1-1/(1+exp(a+b*FL)). FL_{50} = 180 mm.

Fork Length	# Immature	# Mature	# Total	Obs. Mature	Pred. Mature
13	1	0	1	0.000	0.087
14	5	0	5	0.000	0.132
15	6	0	6	0.000	0.197
16	8	2	10	0.200	0.282
17	16	6	22	0.273	0.387
18	14	20	34	0.588	0.503
19	18	27	45	0.600	0.619
20	14	43	57	0.754	0.723
21	6	41	47	0.872	0.807
22	7	71	78	0.910	0.870
23	2	50	52	0.962	0.915
24	6	85	91	0.934	0.945
25	6	73	79	0.924	0.965
26	3	77	80	0.963	0.978
27	2	93	95	0.979	0.986
28	2	123	125	0.984	0.991
29	2	121	123	0.984	0.995
30	0	171	171	1.000	0.997
31	0	156	156	1.000	0.998
32	0	203	203	1.000	0.999
33	0	209	209	1.000	0.999
34	0	308	308	1.000	0.999
35	0	189	189	1.000	1.000
36	0	317	317	1.000	1.000
37	0	217	217	1.000	1.000
38	0	248	248	1.000	1.000
39	0	166	166	1.000	1.000
40	0	232	232	1.000	1.000
41	0	170	170	1.000	1.000
42	0	206	206	1.000	1.000
43	0	108	108	1.000	1.000
44	0	112	112	1.000	1.000
45	0	83	83	1.000	1.000
46	0	58	58	1.000	1.000
47	0	28	28	1.000	1.000

48	0	32	32	1.000	1.000
49	0	13	13	1.000	1.000
50	0	13	13	1.000	1.000
51	0	7	7	1.000	1.000
52	0	4	4	1.000	1.000
53	0	3	3	1.000	1.000
54	0	2	2	1.000	1.000
55	0	0	0	NA	1.000
56	0	0	0	NA	1.000
57	0	0	0	NA	1.000
58	0	1	1	1.000	1.000

Parameters	a	SE	b	SE
Estimates	-8.508	0.733	0.047	0.003

Table 4. (Update of Table 2.9 in 2015 Data Workshop report)

Male Gray Triggerfish age at maturity (N=3,221). Predicted proportion mature at age estimated with the Logistic model (= 1 - 1/(1 + exp(a+b*age))), except at Age 0. Age_{50} = 0.167 yr.

Cal Age	**# Immature**	**# Mature**	**# Total**	**Obs. Proportion Mature**	**Predicted Proportion Mature**
1	46	189	235	0.804	0.796
2	36	612	648	0.944	0.952
3	5	890	895	0.994	0.990
4	1	731	732	0.999	0.998
5	1	445	446	0.998	1.000
6	0	146	146	1.000	1.000
7	0	80	80	1.000	1.000
8	0	28	28	1.000	1.000
9	0	10	10	1.000	1.000
10	0	1	1	1.000	1.000

Parameters	a	SE	b	SE
Estimates	-0.270	0.272	1.635	0.149

Table 5. (Update of Table 2.11 in 2015 Data Workshop report)

Spawning fraction in female Gray Triggerfish captured in chevron traps by the SERFS during 1991-2013. *The duration of oocyte maturation (OM) and postovulatory complexes (POC) is estimated to be ~30 hr (6 hr for OM with no hydration + 24 hr for POC), based on Fitzhugh et al. (1993) and Fitzhugh et al. (2012; SEDAR31-DW07). Spawning season duration = 1st and last occurrence of spawners during 5 May – 28 August. # batches = (Prop. Spawners/30 hr*24 hr day^{-1}) * spawning season duration in days.

Calendar Age (yr)	# adult females	Prop. Spawners (OM, POC; ~24 h)	Avg. Spawning Interval (d)	Est. Spawning Season Duration (d)	# Batches/ind.fish by Age
1	163	0.010	104	8	0.1
2	584	0.026	38	87	2.3
3	861	0.034	30	104	3.5
4	637	0.058	17	79	4.6
5	345	0.062	16	102	6.4
6	124	0.110	9	75	8.2
7	75	0.064	16	115	7.4
8	32	0.025	40	0	0
9	13	0.000			
10	3	0.000			
11	3	0.266	4	0	0
12	1	0.000			
6+	**251**	**0.080**	**13**	**95**	**7.6**

Table 6. (Update of Table 2.10 in 2015 Data Workshop report)

Sex ratio in the Gray Triggerfish population. Age < 7 is sex ratio of all individuals less than 7 yr old in SERFS data. Overall dataset includes fishery-independent (84 %) and fishery-dependent (16 %) data from SERFS and NMFS Beaufort, respectively. SERFS: South East Reef Fish Survey.

	Ratio: Female:Male	# Male	# Female	Proportion Female	Chi-squared	P-value
SERFS	1.19	4,883	5,789	0.542	76.91	<0.0001
Age < 7	1.21	3,551	4,290	0.547	69.65	<0.0001
Overall	1.20	5,174	6,220	0.546	96.03	<0.0001

Table 7.

Age specific sex ratios calculated to estimate total egg production in the Gray Triggerfish population. Dataset includes fishery-independent (92 %) and fishery-dependent (8 %) data from SERFS and NMFS Beaufort, respectively. SERFS: South East Reef Fish Survey.

Cal Age	Males	Females	Total	PropMale	PropFemale
0	0	3	3	0.00	1.00
1	317	398	715	0.44	0.56
2	815	1042	1857	0.44	0.56
3	1115	1382	2497	0.45	0.55
4	883	1059	1942	0.45	0.55
5	527	584	1111	0.47	0.53
6	175	236	411	0.43	0.57
7	94	136	230	0.41	0.59
8	30	67	97	0.31	0.69
9	10	23	33	0.30	0.70
10	3	6	9	0.33	0.67
11	0	5	5	0.00	1.00
12	0	4	4	0.00	1.00

Figure 1. Overall sex ratio by year for adult Gray Triggerfish. Data from SERFS: South East Reef Fish Survey and NMFS Beaufort.

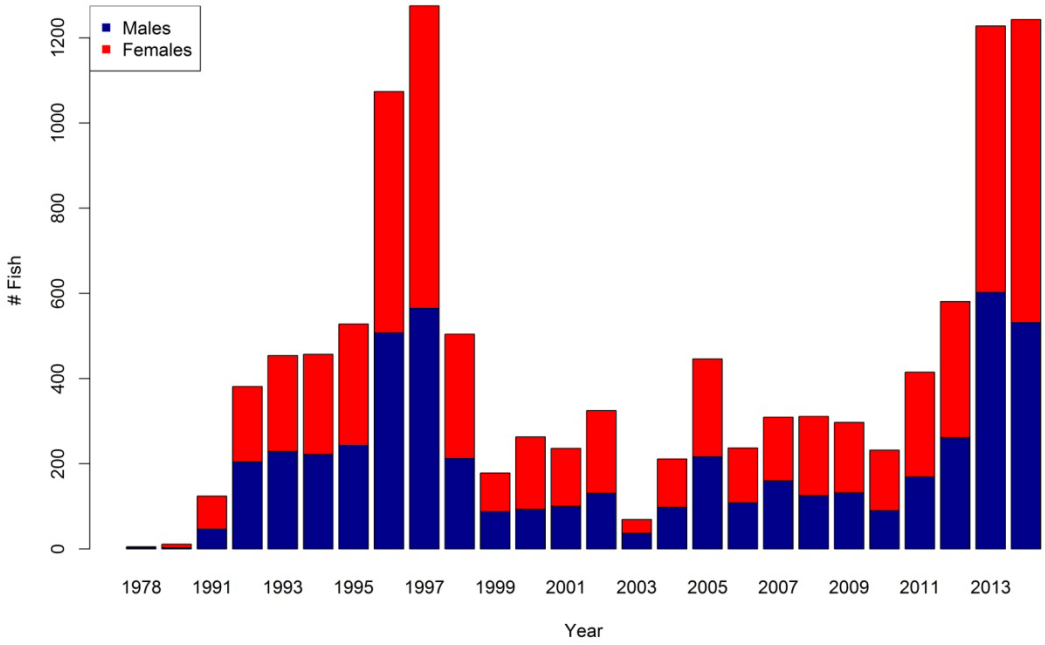

Figure 2. Overall proportion of females and males by year for adult Gray Triggerfish. Data from SERFS: South East Reef Fish Survey and NMFS Beaufort.

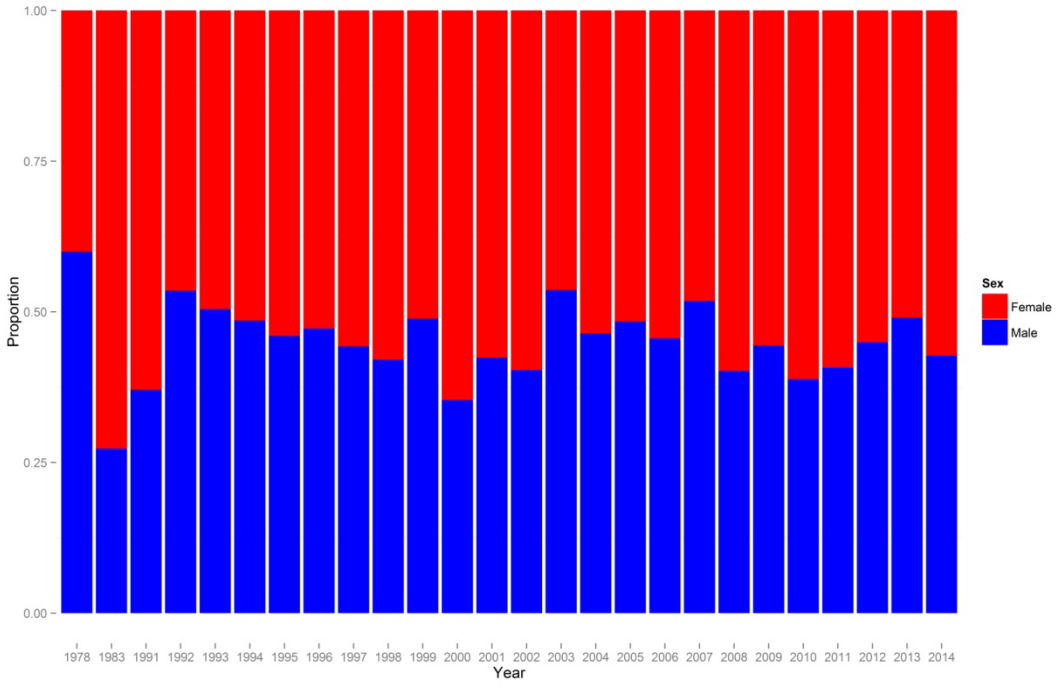

Figure 3. Overall sex ratio by calendar age (in years) for adult Gray Triggerfish. Data from SERFS: South East Reef Fish Survey and NMFS Beaufort.

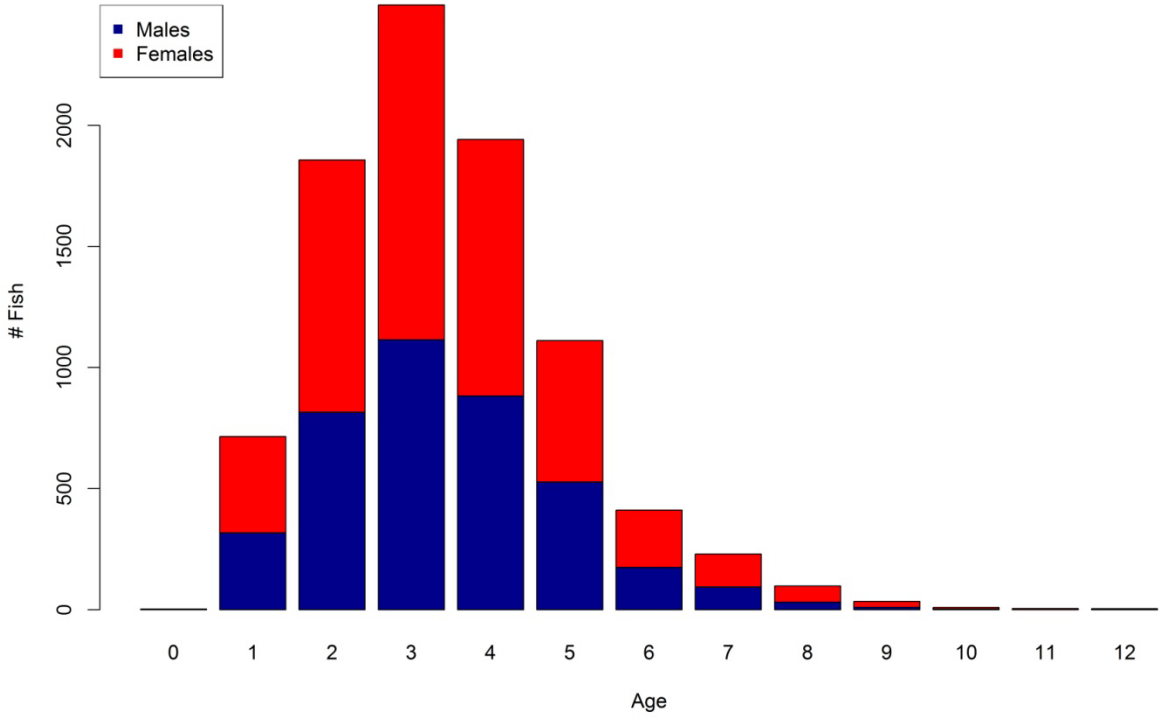

Figure 4. (Update of Figure 2.10 in 2015 Data Workshop report)

Overall proportion of females and males by calendar age (in years) for adult Gray Triggerfish. Data from SERFS: South East Reef Fish Survey and NMFS Beaufort.

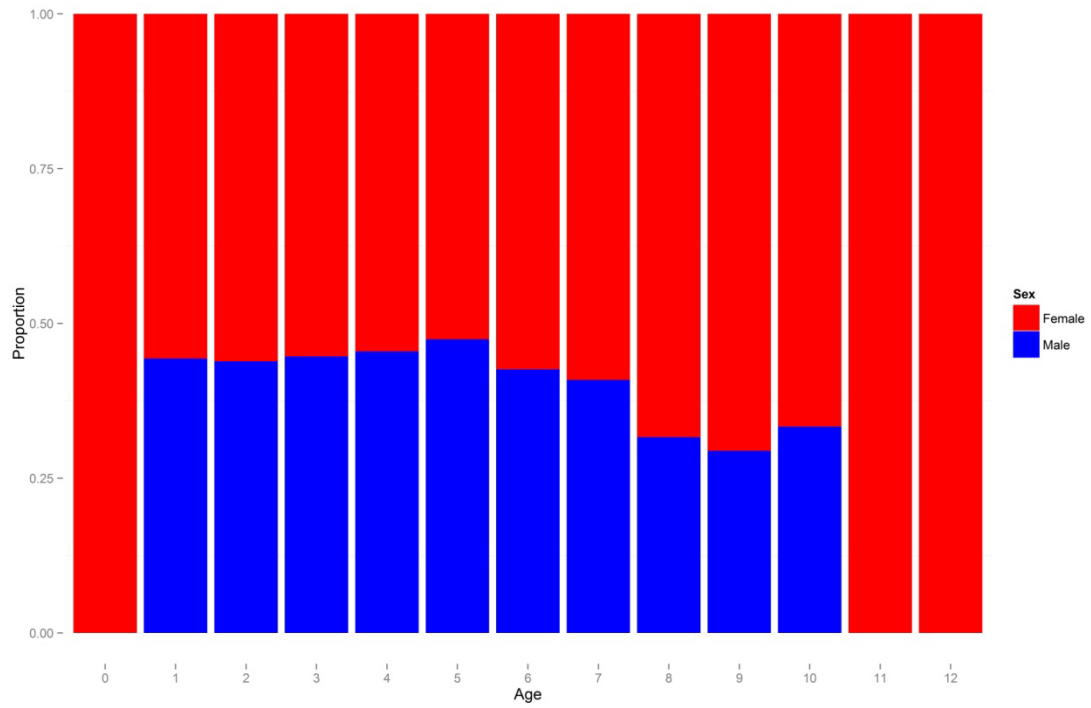

Figure 5. Overall sex ratio by fork length (cm) for adult Gray Triggerfish. Data from SERFS: South East Reef Fish Survey and NMFS Beaufort.

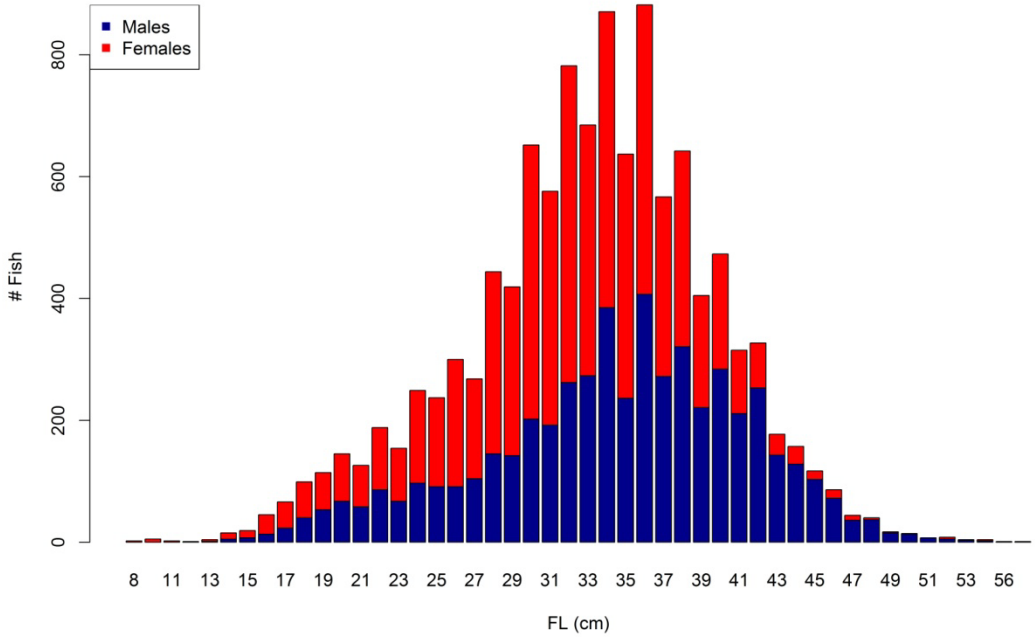

Figure 6. (Update of Figure 2.11 in 2015 Data Workshop report)

Overall proportion of females and males by fork length (cm) for adult Gray Triggerfish. Data from SERFS: South East Reef Fish Survey and NMFS Beaufort.