Updated shrimp bycatch estimates for SEDAR 52

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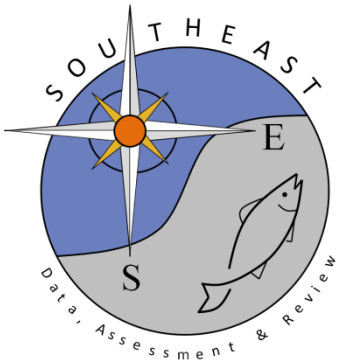

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Bycatch from the Shrimp Fishery

Shrimp bycatch estimates for Gulf of Mexico red snapper were generated using the approach developed by Nichols (2004a, 2004b) in the SEDAR 7 Gulf of Mexico red snapper assessment, and applied by Linton (2012) in the SEDAR 31 Gulf of Mexico red snapper assessment. The primary data on CPUE in the shrimp fishery came from a series of shrimp observer programs beginning in 1972 that extend to the current shrimp observer program. Additional CPUE data were obtained from the SEAMAP groundfish survey. Point estimates and associated standard errors of shrimp effort were generated by the NMFS Galveston Lab using their SN-pooled model (Nance 2004). Most CPUE data were reported in fish per net-hour. As shrimp effort data were reported in vessel-days, data from the Vessel Operating Units File were needed to estimate the average number of nets per vessel for the shrimp fishery to convert total shrimp effort to net-hours. A detailed description of data and methods used to produce shrimp bycatch estimates can be found in Linton (2012). The December 2012 Gulf of Mexico Red Snapper Model number 02 from Nichols (2004a) was used to estimate shrimp bycatch. Data were stratified into 3 depth zones (0–10 fm, 10–30 fm, >30 fm), consistent with the SEDAR 31 Gulf of Mexico red snapper assessment. The shrimp bycatch estimation model was fit using WinBUGS version 3.2.2. Markov Chain Monte Carlo (MCMC) methods were used to estimate the marginal posterior distributions of key parameters and derived quantities. Convergence of the MCMC chains was determined by visual inspection of trace plots, marginal posterior density plots, and Gelman-Rubin statistic (Brooks and Gelman 1998) plots.

The MCMC chains demonstrated good convergence properties. Region-specific annual estimates of shrimp bycatch from the three depth zone run are presented in Tables 1 and 2. Marginal posterior densities of the annual shrimp bycatch estimates all showed varying degrees of right-skew. In the eastern Gulf, CVs of the annual estimates ranged from 0.10-2.03 with a mean CV of 1.22. In the western Gulf, CVs of the annual estimates ranged from 0.08-2.29 with a mean CV of 0.91. Trimester-based estimates of shrimp bycatch were also produced, and are available for use in the assessment.

Shrimp effort is used as an index of shrimp fishing mortality in the assessment, in addition to its use in the estimation of shrimp bycatch. Shrimp effort for depths greater than 10 fm was chosen to provide an index of shrimp fishing mortality in the assessment, because effort from these depths is thought to best represent the fishing pressure experienced by red snapper in the shrimp fishery. This decision is in keeping with decisions made for SEDAR 7 and the 2009 Gulf of Mexico red snapper update assessment. Shrimp effort for depths greater than 10 fm is presented in Table 3.

References

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Table 1 Summary statistics of marginal posterior densities of annual estimates of shrimp bycatch in the eastern Gulf of Mexico.

Year	Mean	SD	MC Error	2.50%	Median	97.50%
1973	1.907	2.456	0.02954	0.2929	1.217	7.965
1974	1.136	1.619	0.02379	0.155	0.6925	4.795
1975	1.33	0.5379	0.00791	0.6938	1.216	2.636
1976	1.867	2.842	0.02898	0.2599	1.083	8.316
1977	1.795	1.279	0.01502	0.7954	1.508	4.564
1978	0.3759	0.5194	0.00675	0.07259	0.2424	1.492
1979	1.669	2.226	0.04952	0.2691	1.088	6.441
1980	0.6521	0.7744	0.00814	0.1715	0.4467	2.427
1981	2.131	3.335	0.03947	0.3838	1.31	9.014
1982	2.232	2.477	0.03886	0.5395	1.618	7.518
1983	1.874	3.437	0.04128	0.2658	1.144	7.592
1984	1.367	2.378	0.03056	0.1918	0.8192	5.896
1985	1.133	1.766	0.02059	0.1611	0.6972	4.768
1986	0.335	0.4654	0.00631	0.05104	0.2175	1.319
1987	0.5208	0.8057	0.00987	0.07314	0.325	2.133
1988	0.5857	0.7767	0.00981	0.08883	0.3808	2.268
1989	1.174	2.361	0.0248	0.1323	0.6553	5.304
1990	3.678	5.89	0.06875	0.4708	2.182	15.82
1991	3.025	4.918	0.06089	0.397	1.838	12.63
1992	1.638	1.323	0.01339	0.5075	1.29	4.837
1993	1.415	2.425	0.02285	0.1894	0.751	6.769
1994	2.12	4.349	0.03775	0.3898	1.091	10.31
1995	2.719	5.005	0.04996	0.2865	1.462	12.8
1996	2.074	4.633	0.03912	0.229	1.061	10.25
1997	3.129	6.154	0.06062	0.3571	1.689	14.51
1998	1.764	0.7075	0.00944	0.9768	1.618	3.379
1999	2.973	7.213	0.06597	0.4342	1.864	11.89
2000	3.122	4.692	0.04153	1.03	2.127	11.11
2001	2.426	0.6333	0.00676	1.673	2.316	3.821
2002	2.199	0.2211	0.00157	1.821	2.181	2.682
2003	1.336	0.375	0.00302	1.018	1.273	2.009
2004	1.536	0.6666	0.00574	1.125	1.413	2.742
2005	1.003	1.61	0.01636	0.2529	0.6255	3.944
2006	2.17	1.45	0.01537	0.8246	1.838	5.407
2007	1.405	0.8603	0.00989	0.6347	1.217	3.233
2008	0.1839	0.1247	0.0014	0.1074	0.1605	0.4028
2009	0.3783	0.1575	0.00165	0.2053	0.3514	0.6986
2010	0.2234	0.1766	0.0015	0.1372	0.1902	0.5222
2011	0.3728	0.1805	0.001987	0.3264	0.6054	1.842
2012	0.4419	0.2462	0.0027	0.2465	0.3865	0.9642

2013	0.5318	0.2355	0.001736	0.2418	0.509	0.9595
2014	0.2005	0.3068	0.00344	0.3618	0.1275	0.7978
2015	0.1138	0.1739	0.02073	0.1758	0.7264	0.4557

Table 2. Summary statistics of marginal posterior densities of annual estimates of shrimp bycatch in the western Gulf of Mexico.

Year	Mean	SD	MC Error	2.50%	Median	97.50%
1972	202.1	406.4	5.295	21.94	106.2	930.4
1973	17.95	13.38	0.157	5.888	14.46	52.05
1974	19.65	9.459	0.1464	9.79	17.55	42.59
1975	14.52	22.9	0.2854	1.832	8.357	64.28
1976	30.98	6.446	0.07309	21.44	30	46.19
1977	12.12	4.73	0.04812	7.756	11.32	21.01
1978	7.437	4.226	0.04943	3.682	6.575	16.02
1979	37.11	60.17	1.306	4.442	21.97	163.2
1980	27.51	9.04	0.09435	16.38	25.55	50.3
1981	83.57	145.7	1.449	26.65	53.21	319.5
1982	44.26	86.22	0.9365	6.278	23.92	209.2
1983	30.31	52.61	0.6621	4.209	17.56	133.4
1984	21.87	35.32	0.4877	2.654	12.51	97.71
1985	17.81	28.94	0.3183	2.46	10.44	79.25
1986	9.339	15.72	0.1928	1.243	5.441	40.57
1987	19.73	30.43	0.3319	2.621	11.76	85.34
1988	16.2	25.55	0.2838	2.102	9.602	71.54
1989	18	35.44	0.393	2.34	10.5	75.24
1990	72.11	124.6	1.553	9.053	40.97	321.8
1991	70.91	131.7	1.391	8.912	40.89	309.4
1992	33.65	14.61	0.1299	22.04	31.66	55.82
1993	35.45	4.895	0.03991	27.65	34.9	46.44
1994	35.52	12.56	0.09915	26.62	34.4	50.82
1995	49.19	10.72	0.1037	33.5	47.47	74.43
1996	52.45	66.06	0.6371	17.35	36.26	194.3
1997	30.32	17.02	0.2154	13.51	26.29	70.97
1998	61.39	26.93	0.2505	32.78	56.07	119.4
1999	26.89	13.46	0.1759	15.96	23.87	55.75
2000	13.22	6.231	0.06935	8.761	11.96	25.23
2001	26.7	14.23	0.1497	17.94	23.97	52.58
2002	22.42	2.68	0.0234	17.91	22.14	28.43
2003	31.41	6.175	0.04813	22.03	30.51	45.92
2004	30.63	13.54	0.1387	20.56	27.84	57.82
2005	20.39	33.12	0.3293	5.248	12.25	85.91
2006	13.03	7.041	0.09992	6.414	11.43	29.02
2007	7.023	1.497	0.01847	5.415	6.812	9.938
2008	2.722	0.2087	0.00161	2.363	2.71	3.14
2009	3.774	0.7193	0.00573	2.501	3.726	5.314
2010	2.974	1.017	0.00986	2.161	2.779	4.975
2011	6.408	0.689	0.0052	5.13	6.389	7.835
2012	8.521	0.8446	0.00619	6.932	8.494	10.26
2013	6	0.5577	0.00444	4.971	5.979	7.145
2014	3.715	0.6918	0.00752	3.969	20.17	173.3
2015	3.174	0.5527	0.00599	3.716	17.26	151.3

Table 3 Gulf of Mexico shrimp effort (days fished) for depths greater than 10 fm.

Year	East	West	Gulfwide
1972	24,338	72,350	96,688
1973	26,828	57,689	84,518
1974	25,950	56,919	82,869
1975	25,878	53,859	79,737
1976	24,005	62,661	86,667
1977	28,638	53,672	82,310
1978	21,984	62,809	84,793
1979	22,626	65,484	88,110
1980	13,852	39,688	53,539
1981	21,746	61,312	83,058
1982	21,669	62,621	84,290
1983	23,736	50,568	74,303
1984	27,874	64,404	92,278
1985	26,876	62,592	89,468
1986	27,859	86,109	113,968
1987	22,574	88,206	110,780
1988	21,283	85,452	106,734
1989	25,875	76,977	102,852
1990	22,634	74,000	96,634
1991	23,260	89,911	113,171
1992	28,202	92,730	120,932
1993	23,293	91,600	114,893
1994	24,093	73,573	97,667
1995	28,500	63,856	92,356
1996	32,269	67,133	99,402
1997	33,958	81,666	115,624
1998	42,667	74,103	116,771
1999	26,291	69,751	96,042
2000	22,593	76,096	98,689
2001	25,378	81,591	106,969
2002	30,375	96,078	126,453
2003	25,164	77,521	102,684
2004	24,957	71,209	96,166
2005	21,018	51,477	72,495
2006	13,626	38,425	52,051
2007	10,233	31,001	41,234
2008	6,690	22,238	28,928
2009	10,304	26,469	36,773
2010	6,463	25,891	32,354
2011	8,049	31,822	39,870
2012	7,935	25,549	33,484
2013	9,221	28,162	37,383

2014	6,880	30,863	37,383
2015	5,705	33,468	37,743
2016	5,975	35,346	41,221