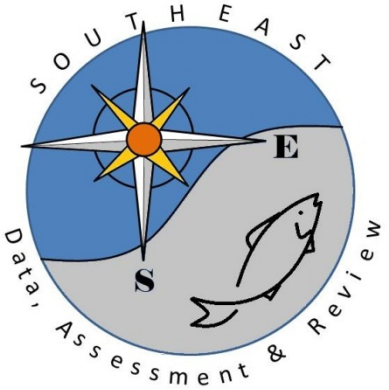


Southeast Data, Assessment, and Review

Update assessment to SEDAR 29

HMS Gulf of Mexico Blacktip Shark

Addendum and Post-Review Updates

September 2018

SEDAR
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405

This addendum incorporates answers to questions raised in the two internal NOAA peer reviews (see **Appendix 1**) that were conducted during August-mid-September 2018 and documents changes that were introduced to the HMS Gulf of Mexico Blacktip Shark stock assessment after the Stock Assessment Report (SAR) was made available at the end of July 2018..

1 Addressing Internal NOAA Peer Reviews

1.1 Review by F. Carvalho

The reviewer had no major issues with the assessment, found that all ToRs had been adequately addressed, and offered no specific recommendations for additional work.

1.2 Review by K.Sosebee

The reviewer had no major issues with the assessment, found that all ToRs had been adequately addressed, and offered no specific recommendations for additional work.

Comment: The assessment documented all modelling framework choices very thoroughly. I was initially confused about the discussion of input CVs, but after a second read, I believe what was done was a single CV for each data series as opposed to each data point within each series having a different CV.

Response: Yes, the reviewer was correct. We used a single CV for each data series as opposed to each data point within each series having a different CV.

2 Revisions

2.1 New MRIP recreational estimates

New estimates from the Marine Recreational Information Program (MRIP) for Gulf of Mexico blacktip shark became available in August 2018. These new estimates, which were calibrated for the effect of improved survey designs: the FES (Fishing Effort Survey) and APAIS (Access Point Angler Intercept Survey), were substantially higher than those previously generated and used in the update assessment (**Tables 1 and 2**, **Figure 1**). As can be seen in Figure 1, some of the peaks in the original estimates were accentuated, particularly in the high catch scenario and as a result of the B2 estimates.

Given this new set of recreational catch estimates, the analytical team proceeded to re-run the entire assessment (the six model runs). However, we wish to emphasize that these new recreational estimates should be fully vetted in a benchmark assessment in the future since some of the peaks are potentially suspicious and decisions about how to treat them (e.g., whether to smooth them or not) should be done by a Data Panel and not in isolation by the analytical team. **Figure 2** shows the catches used in the new baseline scenario and **Tables 3** and **4** show the catches used in the high and low catch scenarios, respectively.

Although not used directly in the stock assessment, catch in weight for the baseline scenario was also updated. **Table 5** shows catch by sector in weight assuming a 1.39 conversion ratio between dressed and whole weight, corresponding to the catch in numbers used in the updated baseline run. Note that this table includes the following differences with respect to that shown in the update assessment (Table 2.6.1.b): the new calibrated MRIP estimates were used for recreational catches; the Mexican catches were erroneously presented in whole weight in Table 2.6.1.b and are now expressed in dressed weight; the mean weight used to transform numbers into weight for the menhaden fishery was adjusted. Note that for the recreational A+B1 estimates, there was a very high peak in 2013 that was smoothed by taking the geometric mean of the two preceding and ensuing years.

2.2 Results

2.2.1. Benchmarks/Reference Points

Results of the base and the five additional scenarios reflective of plausible states of nature with the recreational catches from the original MRIP estimates are summarized in **Table 6.Panel A**. Estimates of SSF_{2016} ranged from 3.79×10^6 to 3.81×10^7 (**Table 6.Panel A**). Estimates of SSF_{MSY} and SSF_{MSST} ranged from 1.75×10^6 to 1.38×10^7 and from 1.48×10^6 to 1.17×10^7, respectively (**Table 6.Panel A**). Estimates of spawning stock fecundity benchmarks ranged from 2.15 to 2.76 for SSF_{2016}/SSF_{MSY}, 2.56 to 3.25 for SSF_{2016}/SSF_{MSST}, and 0.63 to 0.99 for SSF_{2016}/SSF_0 (**Table 6.Panel A**). Estimates of F_{2016} ranged from 0.0007 to 0.0119 (**Table 6.Panel A**). Estimates of

F_{MSY} ranged from 0.016 to 0.108 and estimates of the fishing mortality benchmark ranged from 0.014 to 0.120 for F_{2016}/F_{MSY} (**Table 6.Panel A**). Assuming an informative, lognormal distribution for R_0 resulted in the least optimistic stock status of all scenarios explored, with pup survival hitting the upper bound, indicating that the parameters we considered may not have been biologically reasonable (**Table 6.Panel A**). Considering catches lower than those in the base run resulted in the most optimistic stock status of all scenarios explored (**Table 6.Panel A**). Considering catches higher than those in the base run changed stock status very little (**Table 6.Panel A**). Assuming lower stock productivity resulted in a more pessimistic status, with virgin recruitment (R_0) hitting the upper bound, indicating that the parameters we considered may not have been biologically reasonable (**Table 6.Panel A**). The high productivity scenario also resulted in a more pessimistic status than the base run, with SSF_{2016} and SSF_{MSST} values being 4.2-fold and 3.9-fold smaller than in the base run and F_{MSY} and F_{2016} values being about two- and nine-fold larger than in the base run, respectively (**Table 6.Panel A**).

The high and low catch runs estimated a status close to that of the base run, with the deviations coming from the high and low productivity, and lognormal distribution for R_0 scenarios (**Table 6.Panel A; Figure 3.Panel A**). The estimates of current (2016) apical fishing mortality relative to *MSY* (F_{2016}/F_{MSY}) in the base, high and low catch runs were very uncertain (CV >1; **Table 6.Panel A**). All six scenarios (base and five alternative states of nature) resulted in the same conclusion that the stock was not overfished (i.e. $SSF_{2016} > SSF_{MSST}$) and overfishing was not occurring (i.e. $F_{2016} < F_{MSY}$) (**Table 6.Panel A; Figure 3.Panel A**), providing evidence that stock status determination based on estimated SSF_{MSST} and point estimated F_{MSY} is robust to changes in catch, productivity and prior distribution of R_0. However, the estimates of current (2016) apical fishing mortality relative to *MSY* (F_{2016}/F_{MSY}) might be reliable only in the high productivity scenario (CV <1, neither virgin recruitment (R_0) nor pup survival hit the upper bounds) (**Table 6.Panel A**). In addition, all runs estimated that the stock had never been overfished and overfishing only had occurred for the high productivity and lognormal distribution for R_0 scenarios some years during 1985-1992 (**Figure 4.Panel A**).

Results of the base and the five additional scenarios reflective of plausible states of nature <u>with the recreational catches from the new calibrated MRIP estimates</u> are summarized in **Table 6.Panel B**. Estimates of SSF_{2016} ranged from 3.95×10^6 to 4.33×10^7 (**Table 6.Panel B**). Estimates of SSF_{MSY} and SSF_{MSST} ranged from 1.90×10^6 to 1.56×10^7 and from 1.61×10^6 to 1.33×10^7, respectively (**Table 6.Panel B**). Estimates of spawning stock fecundity benchmarks ranged from 2.08 to 2.77 for SSF_{2016}/SSF_{MSY}, 2.45 to 3.27 for SSF_{2016}/SSF_{MSST}, and 0.68 to 0.99 for SSF_{2016}/SSF_0 (**Table 6.Panel B**). Estimates of F_{2016} ranged from 0.0006 to 0.0202 (**Table 6.Panel B**). Estimates of F_{MSY} ranged from 0.026 to 0.166 and estimates of the fishing mortality benchmark ranged from 0.012 to 0.167 for F_{2016}/F_{MSY} (**Table 6.Panel B**). Assuming an informative, lognormal distribution for R_0 resulted in the least optimistic stock status of all scenarios explored, with pup survival hitting the upper bound, indicating that the parameters we considered may not have been biologically reasonable (**Table 6.Panel B**). Considering catches

lower than those in the base run resulted in the most optimistic stock status of all scenarios explored , with virgin recruitment (R_0) hitting the upper bound, indicating that the parameters we considered may not have been biologically reasonable (**Table 6.Panel B**). Considering catches higher than those in the base run changed stock status very little (**Table 6.Panel B**). Assuming lower stock productivity resulted in a more pessimistic status, with virgin recruitment (R_0) hitting the upper bound, indicating that the parameters we considered may not have been biologically reasonable (**Table 6.Panel B**). The high productivity scenario also resulted in a more pessimistic status than the base run, with SSF_{2016} and SSF_{MSST} values being about 4-fold smaller than in the base run and F_{MSY} and F_{2016} values being about two- and ten-fold larger than in the base run, respectively (**Table 6.Panel B**).

The high and low catch runs estimated a status close to that of the base run, with the deviations coming from the high and low productivity, and lognormal distribution for R_0 scenarios (**Table 6.Panel B; Figure 3.Panel B**). The estimates of current (2016) apical fishing mortality relative to *MSY* (F_{2016}/F_{MSY}) in all runs became more reliable (CV <1; **Table 6.Panel B**). All six scenarios (base and five alternative states of nature) resulted in the same conclusion that the stock was not overfished (i.e. $SSF_{2016} > SSF_{MSST}$) and overfishing was not occurring (i.e. $F_{2016} < F_{MSY}$) (**Table 6.Panel B; Figure 3.Panel B**), providing evidence that stock status determination based on estimated SSF_{MSST} and point estimated F_{MSY} is robust to changes in catch, productivity and prior distribution of R_0. However, the estimates of current (2016) apical fishing mortality relative to *MSY* (F_{2016}/F_{MSY}) might be more reliable in the base, high catch and the high productivity scenarios (CV <1, neither virgin recruitment (R_0) nor pup survival hit the upper bounds) (**Table 6.Panel B**). In addition, all runs estimated that the stock had never been overfished and overfishing had never occurred (**Figure 4.Panel B**).

Percent of change (- decrease, + increase) in estimates and CVs from the base and the five additional scenarios reflective of plausible states of nature, with the recreational catches from the new calibrated MRIP estimates compared to those in the original MRIP estimates, are summarized in **Table 7**. Percent of change in estimates of SSF_{2016} ranged from -1% to 54% (**Table 7**). Percent of change in CVs of SSF_{2016} ranged from -99% to 29% (**Table 7**). Percent of change in estimates of SSF_{MSY} and SSF_{MSST} ranged from 1% to 52-53% (**Table 7**). Percent of change in CVs of SSF_{MSY} and SSF_{MSST} ranged from -92% to 26% (**Table 7**). Percent of change in estimates of spawning stock fecundity benchmarks ranged from -4% to 6% for SSF_{2016}/SSF_{MSY} and SSF_{2016}/SSF_{MSST}, and -4% to 7% for SSF_{2016}/SSF_0 (**Table 7**). Percent of change in CVs of spawning stock fecundity benchmarks ranged from -50% to 6% for SSF_{2016}/SSF_{MSY} and SSF_{2016}/SSF_{MSST}, and -90% to 7% for SSF_{2016}/SSF_0 (**Table 7**). Percent of change in estimates of F_{2016} ranged from -11% to 130% (**Table 7**). Percent of change in CVs of F_{2016} ranged from -92% to 34% (**Table 7**). Percent of change in estimates of F_{MSY} ranged from 0% to 63% and estimates of the fishing mortality benchmark ranged from -11% to 41% for F_{2016}/F_{MSY} (**Table 7**). Percent of change in CVs of F_{MSY} did not exist (i.e. there is no CVs for point estimated F_{MSY}) and percent of change in the fishing mortality benchmark ranged from -92% to 34% for F_{2016}/F_{MSY} (**Table 7**).

Appendix 2 shows predicted abundance, spawning stock fecundity (numbers x proportion mature x fecundity in numbers), total and fleet-specific instantaneous apical fishing mortality rates) from the base and five additional scenarios reflective of plausible states of nature (High Catch, Low Catch, High Productivity, Low Productivity and Prior R_0) runs with the recreational catches from both the original and the new calibrated MRIP estimates.

2.2.2. Projections

A summary of projection model results is presented for the base model configuration and model sensitivities with the recreational catches from the original and the new MRIP estimates (**Table 8**). Projection results provide examples from 10,000 Monte Carlo projections of a given fixed level of total annual removals due to fishing (1,000s of sharks) which resulted in both the $Pr(SSF_t > SSF_{MSY}) \geq 70\%$ and $Pr(F_t > F_{MSY}) \leq 30\%$ during the years 2017 – 2046). Projections were completed for the baseline SSASPM configuration (Base) and selected SSASPM model sensitivity analyses (Low Catch, High Catch, Low Productivity, High Productivity, and Lognormal Prior R_0). With the present allocation of effort among fishing sectors, projection results indicated that the stock appears to be capable of supporting total annual removals due to fishing depending on the scenario (i.e. with both the $Pr(SSF_t > SSF_{MSY}) \geq 70\%$ and $Pr(F_t > F_{MSY}) \leq 30\%$ during the years 2017 – 2046) from 2.00×10^5 to 1.20×10^6 sharks with the recreational catches from the original MRIP estimates (**Table 8.Panel A**) and from 2.00×10^5 to 2.10×10^6 sharks with the recreational catches from the new calibrated MRIP estimates, respectively (**Table 8.Panel B**). Percent of change (- decrease, + increase) in projected total sustainable annual removals due to fishing ranged from 0% (lognormal distribution for R_0 scenario) to 110% (high catch scenario) with recreational catches from the new calibrated MRIP estimates compared to the original MRIP estimates (**Table 9**). See **Appendix 3** for the full addendum projection report.

2.3 Discussion

Estimated stock status from all model runs (utilizing both the original and new calibrated MRIP estimates) indicate that the GOM blacktip stock is neither experiencing overfishing nor overfished (**Table 6; Figures 3 and 4**), which is consistent with the most recent GOM blacktip shark stock assessments (2012 SEDAR 29 standard GOM blacktip shark assessment and 2006 SEDAR 11 benchmark GOM blacktip shark assessment). Stock assessment results also show an evolving perception of blacktip shark status over time as data quality and quantity and models used have improved: 1) early assessments indicated that the ATL+GOM stock was most likely overfished and experiencing overfishing (1998 assessment, terminal year 1997); 2) later

assessments (2002 assessment, terminal year 2001) indicated the ATL+GOM stock was most likely neither experiencing overfishing nor overfished; and 3) the most recent GOM blacktip benchmark and standard assessments (SEDAR 11, terminal year 2004; SEDAR 29, terminal year 2010) also indicated that the GOM stock was neither overfished nor experiencing overfishing.

SSASPM model results should be interpreted cautiously for model runs that resulted with parameters estimated at or near boundary conditions. The estimated parameter R_0 hit the upper bound for the low catch scenario only with recreational catches from the new calibrated MRIP estimates; estimated R_0 hit the upper bound for the low productivity scenario with recreational catches from both the original and the new calibrated MRIP estimates; estimated pup-survival hit the upper bound for the lognormal distribution for R_0 scenario with recreational catches from both the original and the new calibrated MRIP estimates (**Tables 6 and** 7). Therefore, percent of change (- decrease, + increase) in estimates and CVs, especially R_0 and pup-survival, with recreational catches from the new calibrated MRIP estimates compared to the original MRIP estimates might be problematic for these three scenarios which hit a bound. Based on the fact that some parameters hit a bound in the low catch, low productivity, and lognormal distribution for R_0 scenarios, the estimated stock status results with recreational catches from the new calibrated MRIP estimates should be considered more reliable in the base, high catch, and high productivity scenarios (CV <1, neither virgin recruitment (R_0) nor pup survival hit the upper bounds).

Similarly, projection results should also be interpreted cautiously for those SSASPM model runs with parameters estimated at or near boundary conditions. SSASPM parameter estimates utilizing the original MRIP recreational catch estimates appeared to be at or near a boundary condition for projection scenarios 4 and 6 (i.e. low productivity and lognormal distribution for R_0 scenarios), which may have affected both the absolute scale of the projections and uncertainty in the initial parameters used in this projection scenario (**Table 8. Panel A**). Similarly, SSASPM parameter estimates utilizing the updated MRIP recreational catch estimates appeared to be at or near a boundary condition for projection scenarios 2, 4, and 6 (i.e. low catch, low productivity and lognormal distribution for R_0 scenarios), which may have affected both the absolute scale of the projections and uncertainty in the initial parameters used in this projection scenario (**Table 8. Panel B**).

With the present allocation of effort among fishing sectors and with the new calibrated MRIP recreational catch estimates, projection results indicated that the stock appears to be capable of supporting total annual removals due to fishing depending on the scenario (i.e. with both the $\Pr(SSF_t > SSF_{MSY}) \geq 70\%$ and $\Pr(F_t > F_{MSY}) \leq 30\%$ during the years 2017 – 2046) of 1.60×10^6 , 2.10×10^6 and 3.0×10^5 sharks for the base, high catch and high productivity scenarios, respectively (**Table 8.Panel B**). It is worth noting that two patterns emerged in the stock assessment results obtained from these three scenarios with the new calibrated MRIP recreational catch estimates. The first pattern (base and high catch scenarios) is a lack of response in population numbers to the historical catch time series. The second pattern (high productivity

scenario) is a trend in relative population size over time (SSF_t/SSF_{MSY}) (decreasing followed by increasing) and relative fishing mortality (F_t/F_{MSY}) (increasing followed by decreasing) in response to the observed trend in catch (increasing followed by decreasing) (**Figure 4.Panel B**). The first pattern results from a relatively large estimated population size and implies relatively little population level response to historical fishing mortality rates over time. The second pattern results from a relatively smaller estimated population size and implies more of a population level response to historical fishing mortality rates over time, consistent with the expectation of elasmobranch vulnerability to fishing pressure based on the life history of the GOM blacktip stock. Finally, the assessment and projection results based on the new set of recreational catch estimates provided by MRIP should be interpreted cautiously until the new recreational estimates can be fully vetted in a benchmark assessment.

Tables

Table 1. Catches of GOM blacktip shark by fleet in numbers used in the updated base run. Catches are separated into four fisheries: commercial + unreported, recreational catches, Mexican catches, and menhaden fishery discards. Recreational catches have been updated to incorporate the new calibrated MRIP estimates.

Year	Com+Unrep	Recreational	Mexican	Menhaden discards
1981	7261	88130	64247	17495
1982	7261	76232	36156	17933
1983	7844	25141	37550	17714
1984	10712	30172	53258	17714
1985	9950	96759	43762	15964
1986	71435	135913	40073	15746
1987	69772	71003	42142	16402
1988	140261	169964	46239	15964
1989	144784	136167	54320	16839
1990	76851	178364	63659	16402
1991	81034	150719	48262	12684
1992	93187	120473	52856	11153
1993	66661	137283	61613	11372
1994	62028	101887	56715	12028
1995	84805	91499	47730	11372
1996	64741	121362	52332	11153
1997	46814	106122	35968	11372
1998	63798	198209	36589	10935
1999	52823	60706	26662	12028
2000	49888	128113	25838	10279
2001	39943	83536	18707	9622
2002	31968	93179	20545	9404
2003	69315	77601	17300	9185
2004	43732	91382	21086	9404
2005	33375	73628	20947	9404
2006	55073	92613	11491	8966
2007	46276	44546	11264	8966
2008	14439	33988	11595	8966
2009	14909	51372	13989	8966
2010	21541	66544	19482	8966
2011	16477	56041	11533	8966
2012	16161	143823	13556	8092
2013	20023	86977	16941	7654
2014	13722	37114	15355	6779
2015	22687	50815	12760	6779
2016	14159	39749	3872	6779

Table 2. Same as Table 1, but with the commercial + unreported and recreational series broken down into individual components. PRM= live discard post-release mortalities.

							Menhaden
Year	Com+Unrep			Recreational		Mexican	discards
	Landings	Dead discards	PRM	AB1	B2 PRM		
1981	7261			64520	23610	64247	17495
1982	7261			69750	6482	36156	17933
1983	7844			21070	4071	37550	17714
1984	10712			22467	7705	53258	17714
1985	9950			89550	7209	43762	15964
1986	71435			122301	13612	40073	15746
1987	69772			65271	5732	42142	16402
1988	140261			157315	12649	46239	15964
1989	144784			131379	4788	54320	16839
1990	76851			162743	15621	63659	16402
1991	81034			138660	12059	48262	12684
1992	93187			103230	17243	52856	11153
1993	63147	3179	335	124747	12536	61613	11372
1994	56603	5125	300	88206	13681	56715	12028
1995	75133	9274	398	77126	14373	47730	11372
1996	53187	11273	282	104013	17349	52332	11153
1997	41885	4707	222	86076	20046	35968	11372
1998	58595	4893	311	157552	40657	36589	10935
1999	47729	4842	253	50120	10586	26662	12028
2000	45326	4322	240	97513	30600	25838	10279
2001	35710	4044	189	60936	22600	18707	9622
2002	27123	4701	144	58493	34686	20545	9404
2003	64321	4653	341	41385	36216	17300	9185
2004	40151	3368	213	60330	31052	21086	9404
2005	29000	4375	0	51502	22126	20947	9404
2006	43679	11282	112	43863	48750	11491	8966
2007	45768	366	142	24010	20536	11264	8966
2008	14051	350	37	16570	17418	11595	8966
2009	14538	190	182	27527	23845	13989	8966
2010	21000	220	320	38611	27933	19482	8966
2011	15964	114	399	31846	24195	11533	8966
2012	15425	368	369	61606	82217	13556	8092
2013	19801	222	0	33588	53390	16941	7654
2014	13336	307	78	22286	14828	15355	6779
2015	22417	205	66	23195	27620	12760	6779
2016	13979	143	37	25997	13752	3872	6779

Table 3. Catches of GOM blacktip shark by fleet in numbers used in the high catch scenario. Catches are separated into four fisheries: commercial + unreported, recreational catches, Mexican catches, and menhaden fishery discards. Recreational catches have been updated to incorporate the new calibrated MRIP estimates.

Year	Com+Unrep	Recreational	Mexican	Menhaden discards
1981	7261	252924	111432	17495
1982	7261	154132	62200	17933
1983	7844	55720	64507	17714
1984	10712	83234	91269	17714
1985	9950	195749	75595	15964
1986	71435	248421	69263	15746
1987	69772	127849	73024	16402
1988	140261	274750	80133	15964
1989	144784	227668	93949	16839
1990	76851	285122	110252	16402
1991	81034	300940	83454	12684
1992	93187	209824	91477	11153
1993	67114	259789	106533	11372
1994	67888	184445	98163	12028
1995	89221	168404	82508	11372
1996	69462	198768	90408	11153
1997	49406	183545	61572	11372
1998	66670	358665	63194	10935
1999	54411	106675	46029	12028
2000	50801	217049	44487	10279
2001	40200	152547	31935	9622
2002	32976	216265	35200	9404
2003	71492	172452	29664	9185
2004	45019	194362	36092	9404
2005	34868	141379	36226	9404
2006	56276	253599	19810	8966
2007	48317	93156	19423	8966
2008	15023	77299	20060	8966
2009	15820	115912	24198	8966
2010	22829	150892	33794	8966
2011	17856	141186	19997	8966
2012	17253	352776	23490	8092
2013	20975	212918	29287	7654
2014	14719	81226	26507	6779
2015	24034	127624	22004	6779
2016	14837	91403	6583	6779

Table 4. Catches of GOM blacktip shark by fleet in numbers used in the low catch scenario. Catches are separated into four fisheries: commercial + unreported, recreational catches, Mexican catches, and menhaden fishery discards. Recreational catches have been updated to incorporate the new calibrated MRIP estimates.

Year	Com+Unrep	Recreational	Mexican	Menhaden discards
1981	7261	0	28307	17495
1982	7261	10015	16033	17933
1983	7844	2106	16671	17714
1984	10712	807	23689	17714
1985	9950	11971	19344	15964
1986	71435	46505	17705	15746
1987	69772	24729	18581	16402
1988	140261	82941	20386	15964
1989	144784	52792	23987	16839
1990	76851	94168	28080	16402
1991	81034	20175	21315	12684
1992	93187	57061	23328	11153
1993	66531	34046	27213	11372
1994	57405	41753	25030	12028
1995	81189	40322	21085	11372
1996	60955	68098	23130	11153
1997	44693	58781	16012	11372
1998	61450	93740	16175	10935
1999	51560	30007	11791	12028
2000	49238	77086	11586	10279
2001	39870	44495	8545	9622
2002	31156	36906	9328	9404
2003	67580	38681	7869	9185
2004	42713	35849	9675	9404
2005	32022	36748	9272	9404
2006	54034	23848	5104	8966
2007	44526	22385	5009	8966
2008	13932	15011	5133	8966
2009	14252	21664	6197	8966
2010	20661	25792	8595	8966
2011	15614	12264	5111	8966
2012	15504	60794	6006	8092
2013	19154	35139	7536	7654
2014	12918	14230	6835	6779
2015	21540	17315	5702	6779
2016	13571	10060	1794	6779

Table 5. Catches of GOM blacktip shark by fleet in weight (lb dw) assuming a conversion ratio of 1.39 between dressed and whole weight. Catches are separated into four fisheries: commercial + unreported, recreational catches, Mexican catches, and menhaden fishery discards. Recreational catches have been updated to incorporate the new calibrated MRIP estimates.

Year	Com+Unrep	Recreational	Mexican	Menhaden discards
1981	174269	577343	838229	200011
1982	174269	519533	525277	205011
1983	188256	352780	555392	202511
1984	257097	435887	810992	202511
1985	238805	1276231	603298	182510
1986	1714436	574916	548273	180010
1987	1674533	349404	557013	187510
1988	3366256	623016	610091	182510
1989	3474810	739821	736604	192510
1990	1844435	960493	847337	187510
1991	1944808	1095531	656132	145008
1992	2236499	956911	710466	127507
1993	1599853	1096094	838568	130007
1994	1204213	586697	761453	137507
1995	1509661	515662	651669	130007
1996	1281542	1393932	720480	127507
1997	1169345	1090890	554778	130007
1998	1670280	1169287	505558	125007
1999	1587207	464255	370438	137507
2000	1520085	960233	341703	117506
2001	1234201	507080	254022	110006
2002	972288	716483	272245	107506
2003	1441011	501378	222621	105006
2004	1028650	491692	262302	107506
2005	951283	425736	279487	107506
2006	1258323	369814	159037	102506
2007	1085464	221937	153882	102506
2008	402317	155765	153726	102506
2009	448250	175860	184814	102506
2010	635808	312771	251054	102506
2011	379131	186553	144821	102506
2012	424391	672148	172941	92505
2013	553225	530998	219340	87505
2014	443489	295892	203562	77504
2015	637966	613823	167881	77504
2016	422633	220390	51160	77504

Table 6. Summary of stock status results from the base and five additional scenarios reflective of plausible states of nature (High Catch, Low Catch, High Productivity, Low Productivity and Prior R_0) runs for GOM blacktip shark. *SSF* is spawning stock fecundity (sum of number at age times pup production at age). *SSF* at the minimum spawning stock size threshold (*MSST*) is calculated as $(1-\overline{M}_a)*SSF_{MSY}$. Age-independent natural mortality ($\overline{M}_a$) is defined as mean age-specific natural mortality for ages 1-18. *MSY* is expressed in numbers. *N* is total abundance. R_0 is the number of age-1 pups at virgin conditions. All estimates of CV are based on the numerical Hessian evaluated at the posterior mode.

Panel A. Recreational catches from the original MRIP estimates

	Base		High catch		Low catch		High productivity		Low productivity		Prior R_0	
	Est	CV	Est	CV	Est	CV	Est	CV	Est	CV	Est	CV
SSF_{2016}/SSF_{msy}	2.68	0.33	2.70	0.45	2.76	0.23	2.61	0.31	2.15	0.83	2.17	0.21
SSF_{2016}/SSF_{msst}	3.16	0.33	3.18	0.45	3.25	0.23	2.90	0.31	2.64	0.83	2.56	0.21
$\overline{M}_a$	0.153	NA	0.153	NA	0.153	NA	0.102	NA	0.187	NA	0.153	NA
F_{2016}/F_{msy}	0.024	2.60	0.027	3.89	0.014	1.65	0.110	0.61	0.059	0.16	0.120	0.32
MSY	8.46E+05	2.46	9.99E+05	3.63	1.16E+06	1.60	2.06E+05	0.48	3.32E+05	0.83	1.94E+05	0.23
F_{msy}	0.0560	NA	0.0720	NA	0.0500	NA	0.1080	NA	0.0160	NA	0.063	NA
SSF_{msy}	9.53E+06	2.50	1.02E+07	3.69	1.38E+07	1.59	2.33E+06	0.62	7.17E+06	0.83	1.75E+06	0.32
SSF_{msst}	8.07E+06	2.50	8.61E+06	3.69	1.17E+07	1.59	2.09E+06	0.62	5.83E+06	0.83	1.48E+06	0.32
F_{2016}	0.0013	2.60	0.0019	3.89	0.0007	1.65	0.0119	0.61	0.0009	0.16	0.0075	0.32
SSF_{2016}	2.55E+07	2.68	2.74E+07	4.05	3.81E+07	1.66	6.06E+06	0.81	1.54E+07	0.06	3.79E+06	0.33
N_{2016}	3.90E+07	2.62	4.20E+07	3.94	5.76E+07	1.64	4.93E+06	0.66	5.14E+07	0.06	6.55E+06	0.29
SSF_{2016}/SSF_0	0.96	0.16	0.95	0.28	0.99	0.06	0.63	0.30	0.97	0.06	0.72	0.11
R_0	6.07E+06	2.53	6.61E+06	3.76	8.84E+06	1.60	6.26E+05	0.51	1.00E+07	0.00	1.20E+06	0.23
Pup-survival	0.80	0.30	0.81	0.35	0.79	0.29	0.86	0.30	0.88	0.28	0.99	0.01

Note: estimated R_0 hit the upper bound for the low productivity scenario and estimated pup-survival hit the upper bound for the lognormal distribution for R_0 scenario.

Panel B. Recreational catches from the new calibrated MRIP estimates

	Base		High catch		Low catch		High productivity		Low productivity		Prior R_0	
	Est	CV	Est	CV	Est	CV	Est	CV	Est	CV	Est	CV
SSF_{2016}/SSF_{msy}	2.73	0.26	2.68	0.22	2.77	0.21	2.76	0.33	2.09	0.75	2.08	0.19
SSF_{2016}/SSF_{msst}	3.22	0.26	3.16	0.22	3.27	0.21	3.08	0.33	2.57	0.75	2.45	0.19
$\overline{M}_a$	0.153	NA	0.153	NA	0.153	NA	0.102	NA	0.187	NA	0.153	NA
F_{2016}/F_{msy}	0.023	0.67	0.036	0.31	0.012	0.15	0.122	0.82	0.083	0.20	0.167	0.34
MSY	1.48E+06	0.65	1.78E+06	0.28	1.30E+06	0.22	3.11E+05	0.68	4.10E+05	0.74	2.43E+05	0.22
F_{msy}	0.0870	NA	0.1130	NA	0.0500	NA	0.1660	NA	0.0260	NA	0.098	NA
SSF_{msy}	1.44E+07	0.67	1.55E+07	0.30	1.56E+07	0.21	3.22E+06	0.78	7.28E+06	0.75	1.90E+06	0.28
SSF_{msst}	1.22E+07	0.67	1.31E+07	0.30	1.33E+07	0.21	2.89E+06	0.78	5.92E+06	0.75	1.61E+06	0.28
F_{2016}	0.0020	0.67	0.0041	0.31	0.0006	0.15	0.0202	0.82	0.0022	0.20	0.0163	0.34
SSF_{2016}	3.94E+07	0.66	4.15E+07	0.22	4.33E+07	0.02	8.89E+06	1.04	1.52E+07	0.06	3.95E+06	0.32
N_{2016}	5.97E+07	0.65	6.33E+07	0.22	6.54E+07	0.02	6.89E+06	0.89	5.08E+07	0.05	6.87E+06	0.28
SSF_{2016}/SSF_0	0.97	0.04	0.96	0.03	0.99	0.02	0.68	0.34	0.96	0.06	0.69	0.12
R_0	9.25E+06	0.63	9.95E+06	0.20	1.00E+07	0.00	8.57E+05	0.70	1.00E+07	0.00	1.31E+06	0.21
Pup-survival	0.79	0.29	0.80	0.28	0.78	0.29	0.84	0.30	0.90	0.27	0.99	0.00

Note: estimated R_0 hit the upper bound for the low catch and low productivity scenarios and estimated pup-survival hit the upper bound for the lognormal distribution for R_0 scenario.

Table 7. Percent of change (- decrease, + increase) in estimates and CVs from the base and five additional scenarios reflective of plausible states of nature (High Catch, Low Catch, High Productivity, Low Productivity and Prior R_0) with recreational catches from the new calibrated MRIP estimates compared to the original MRIP estimates for GOM blacktip shark. *SSF* is spawning stock fecundity (sum of number at age times pup production at age). *SSF* at the minimum spawning stock size threshold (*MSST*) is calculated as (1-$\overline{M}_a$)*SSF_{MSY}. Age-independent natural mortality ($\overline{M}_a$) is defined as mean age-specific natural mortality for ages 1-18. *MSY* is expressed in numbers. *N* is total abundance. R_0 is the number of age-1 pups at virgin conditions. All estimates of CV are based on the numerical Hessian evaluated at the posterior mode.

	Base		High catch		Low catch		High productivity		Low productivity		Prior R_0	
	Est	CV	Est	CV	Est	CV	Est	CV	Est	CV	Est	CV
SSF_{2016}/SSF_{msy}	2%	-22%	-1%	-50%	0%	-8%	6%	6%	-3%	-10%	-4%	-12%
SSF_{2016}/SSF_{msst}	2%	-22%	-1%	-50%	1%	-8%	6%	6%	-3%	-10%	-4%	-12%
$\overline{M}_a$	0%	NA	0%	NA	0%	NA	0%	NA	0%	NA	0%	NA
F_{2016}/F_{msy}	-4%	-74%	33%	-92%	-11%	-91%	11%	34%	41%	27%	39%	4%
MSY	75%	-74%	78%	-92%	12%	-86%	51%	41%	23%	-10%	25%	-5%
F_{msy}	55%	NA	57%	NA	0%	NA	54%	NA	63%	NA	56%	NA
SSF_{msy}	51%	-73%	52%	-92%	13%	-87%	38%	26%	1%	-9%	9%	-11%
SSF_{msst}	51%	-73%	53%	-92%	13%	-87%	38%	26%	1%	-9%	9%	-11%
F_{2016}	53%	-74%	114%	-92%	-11%	-91%	71%	34%	130%	27%	117%	4%
SSF_{2016}	54%	-76%	51%	-95%	14%	-99%	47%	29%	-1%	-2%	4%	-2%
N_{2016}	53%	-75%	51%	-94%	14%	-99%	40%	34%	-1%	-17%	5%	-2%
SSF_{2016}/SSF_0	2%	-75%	1%	-90%	0%	-71%	7%	13%	-1%	-2%	-4%	7%
R_0	52%	-75%	51%	-95%	13%	-100%	37%	38%	0%	-100%	9%	-6%
Pup-survival	-1%	-4%	-1%	-19%	-1%	-1%	-3%	1%	2%	-2%	0%	-65%

Note: estimated R_0 hit the upper bound for the low catch scenario with recreational catches from only the new calibrated MRIP estimates; estimated R_0 hit the upper bound for the low productivity scenario with recreational catches from both the original and the new calibrated MRIP estimates; estimated pup-survival hit the upper bound for the lognormal distribution for R_0 scenario with recreational catches from both the original and the new calibrated MRIP estimates. Therefore, percent of change (- decrease, + increase) in estimates and CVs, especially R_0 and pup-survival, with recreational catches from the new calibrated MRIP estimates compared to the original MRIP estimates might be problematic for these three scenarios which hit a bound.

Table 8. A summary of projection model results is presented for the base model configuration and model sensitivities. Projection results provide examples from 10,000 Monte Carlo projections of a given fixed level of total annual removals due to fishing (1,000s of sharks) which resulted in both the Pr($SSF_t > SSF_{MSY}$) ≥ 70% and Pr($F_t > F_{MSY}$) ≤ 30% during the years 2017 – 2046).

Panel A. Recreational catches from the original MRIP estimates

Projection scenario	Model configuration	Example of fixed removals (1000s)
1	Base	800
2	Low catch	1200
3	High catch	1000
4 [1]	Low productivity	400
5	High productivity	200
6 [2]	Lognormal Prior R_0	200

[1] The SSASPM parameter estimates for equilibrium recruitment, R_0, appeared to be at an upper boundary condition ($1.0x10^7$) for Projection Scenario 4 (i.e. low productivity) which likely affected both the absolute scale of the projections and uncertainty in the initial parameters used in these projection scenarios.
[2] The SSASPM parameter estimate for pup survival at low biomass, e^{-M_0}, appeared to be near an upper boundary condition (0.99) for Projection Scenario 6 (i.e. lognormal Prior R_0), which may also have affected both the absolute scale of the projections and uncertainty in the initial parameters used in this projection scenario.

Panel B. Recreational catches from the new calibrated MRIP estimates

Projection scenario	Model configuration	Example of fixed removals (1000s)
1	Base	1600
2 [1]	Low catch	1600
3	High catch	2100
4 [1]	Low productivity	500
5	High productivity	300
6 [2]	Lognormal Prior R_0	200

[1] The SSASPM parameter estimates for equilibrium recruitment, R_0, appeared to be at an upper boundary condition ($1.0x10^7$) in projection scenarios 2 and 4 (i.e. low catch and low productivity), which likely affected both the absolute scale of the projections and uncertainty in the initial parameters used in these projection scenarios.
[2] The SSASPM parameter estimate for pup survival at low biomass, e^{-M_0}, appeared to be near an upper boundary condition (0.99) for Projection Scenario 6 (i.e. lognormal Prior R_0), which may also have affected both the absolute scale of the projections and uncertainty in the initial parameters used in this projection scenario.

Table 9. Percent of change (- decrease, + increase) in projection model results is presented for the base model configuration and model sensitivities with recreational catches from the new calibrated MRIP estimates compared to the original MRIP estimates. Projection results provide examples from 10,000 Monte Carlo projections of a given fixed level of total annual removals due to fishing (1,000s of sharks) which resulted in both the Pr($SSF_t > SSF_{MSY}$) ≥ 70% and Pr($F_t > F_{MSY}$) ≤ 30% during the years 2017 – 2046).

Projection scenario	Model configuration	Example of fixed removals (1000s)
1	Base	100%
2	Low catch	33%
3	High catch	110%
4	Low productivity	25%
5	High productivity	50%
6	Lognormal Prior R_0	0%

Figures

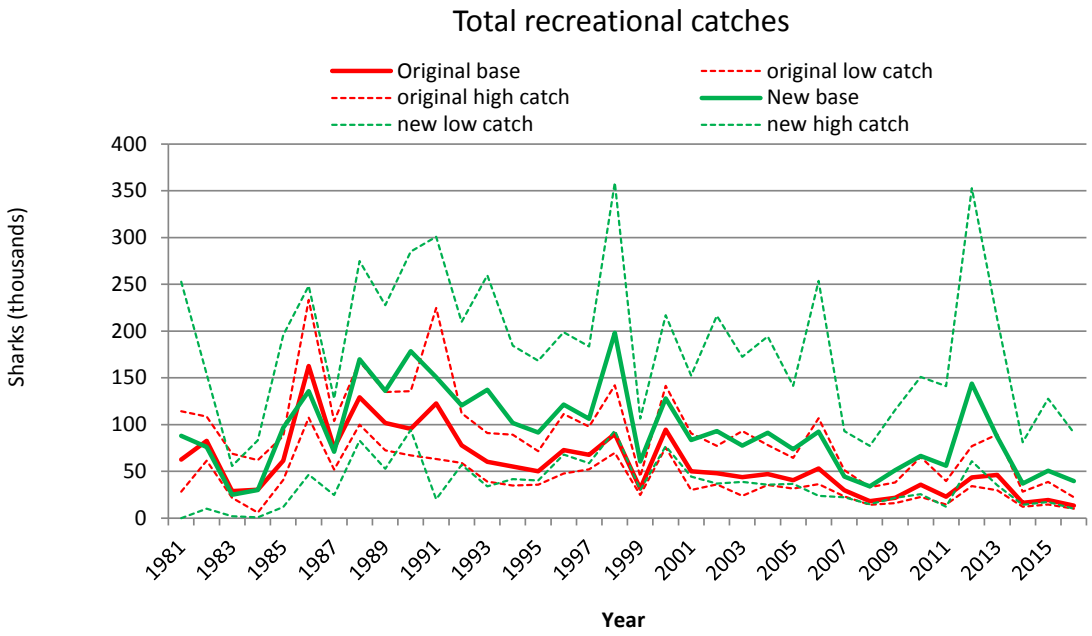


Figure 1. Total recreational catches (AB1 + B2 live discard post-release mortalities) of GOM blacktip shark. The figure shows the catches used in the original base and low and high catch runs compared to the updated estimates (new base) and the new low and high catch scenarios.

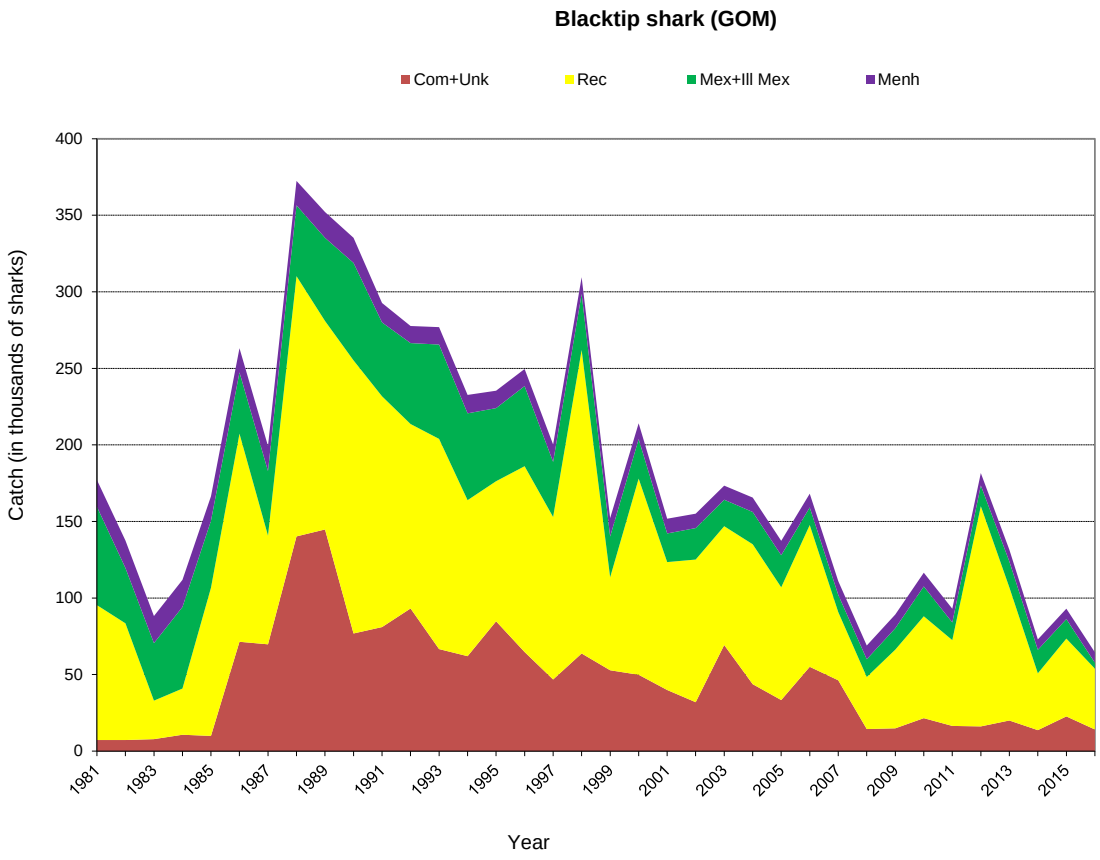


Figure 2. Catches of GOM blacktip shark by fleet in numbers used in the base scenario displaying the updated recreational estimates.

Panel A. Recreational catches from the original MRIP estimates

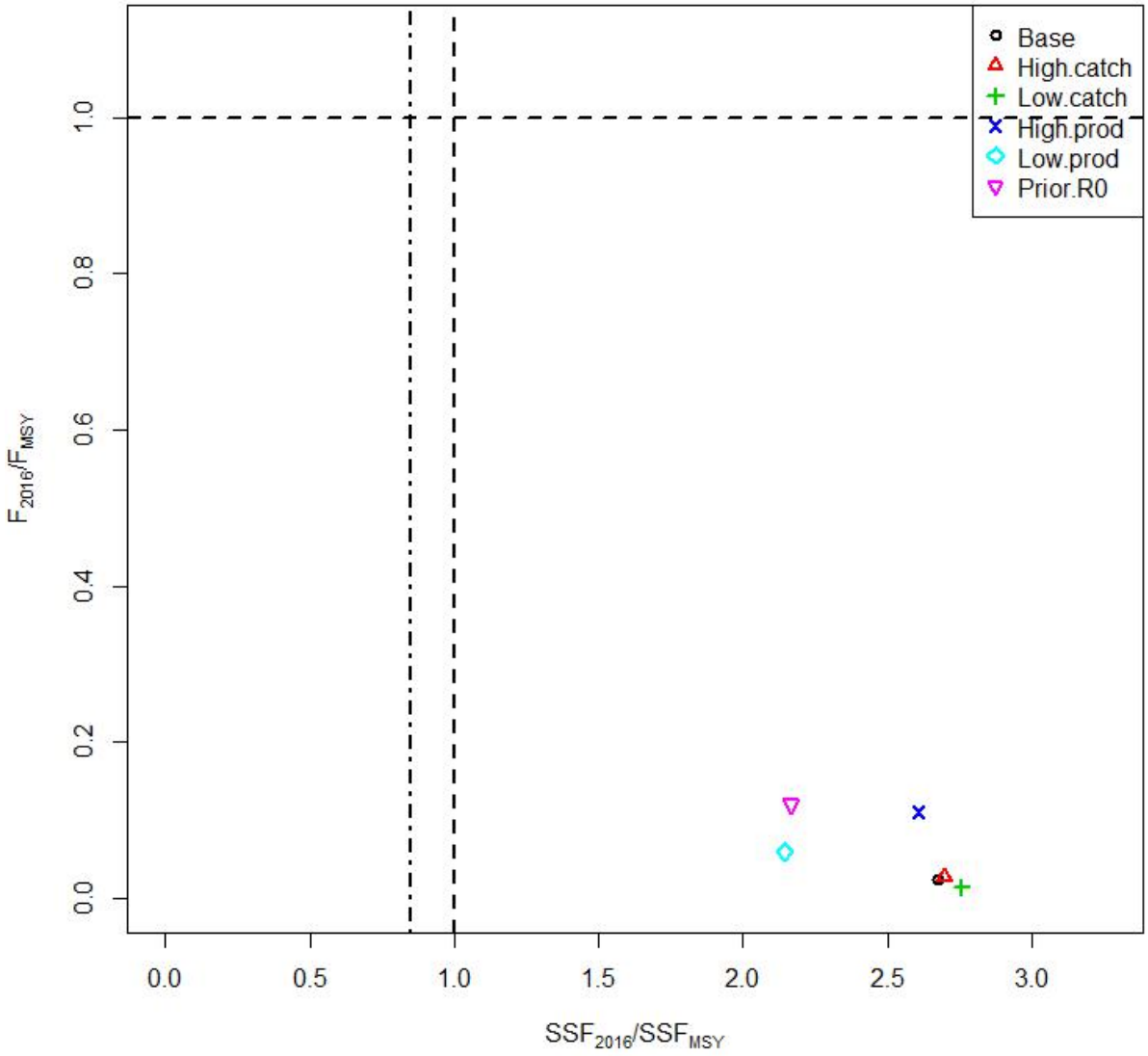


Figure 3. A phase plot summarizing stock status of blacktip sharks in the terminal year (2016) from SSASPM for GOM blacktip shark for the base and five additional scenarios reflective of plausible states of nature (Base, High Catch, Low Catch, High Productivity, Low Productivity, and Prior R_0). For clarity we only show the overfished reference point (relative to SSF_{MSST}) for the base run of this assessment update (horizontal dot-dashed line). None of the runs estimated an overfished status ($SSF_{2016} < SSF_{MSST}$, no points to the left of the dot-dashed vertical bar) or that overfishing was occurring ($F_{2016} > F_{MSY}$, no points above the horizontal black line).

Panel B. Recreational catches from the new calibrated MRIP estimates

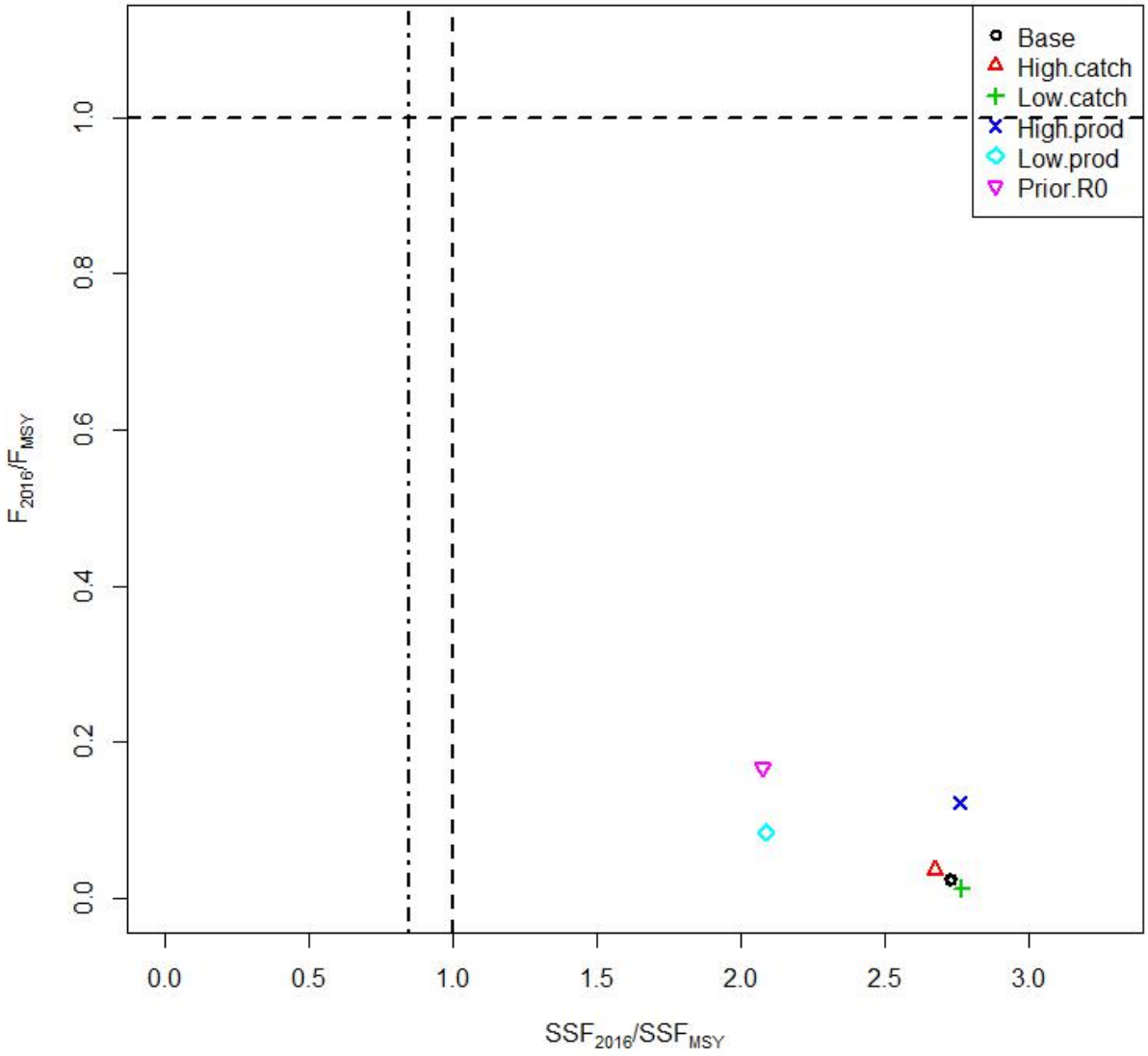


Figure 3. A phase plot summarizing stock status of blacktip sharks in the terminal year (2016) from SSASPM for GOM blacktip shark for the base and five additional scenarios reflective of plausible states of nature (continued).

Panel A. Recreational catches from the original MRIP estimates

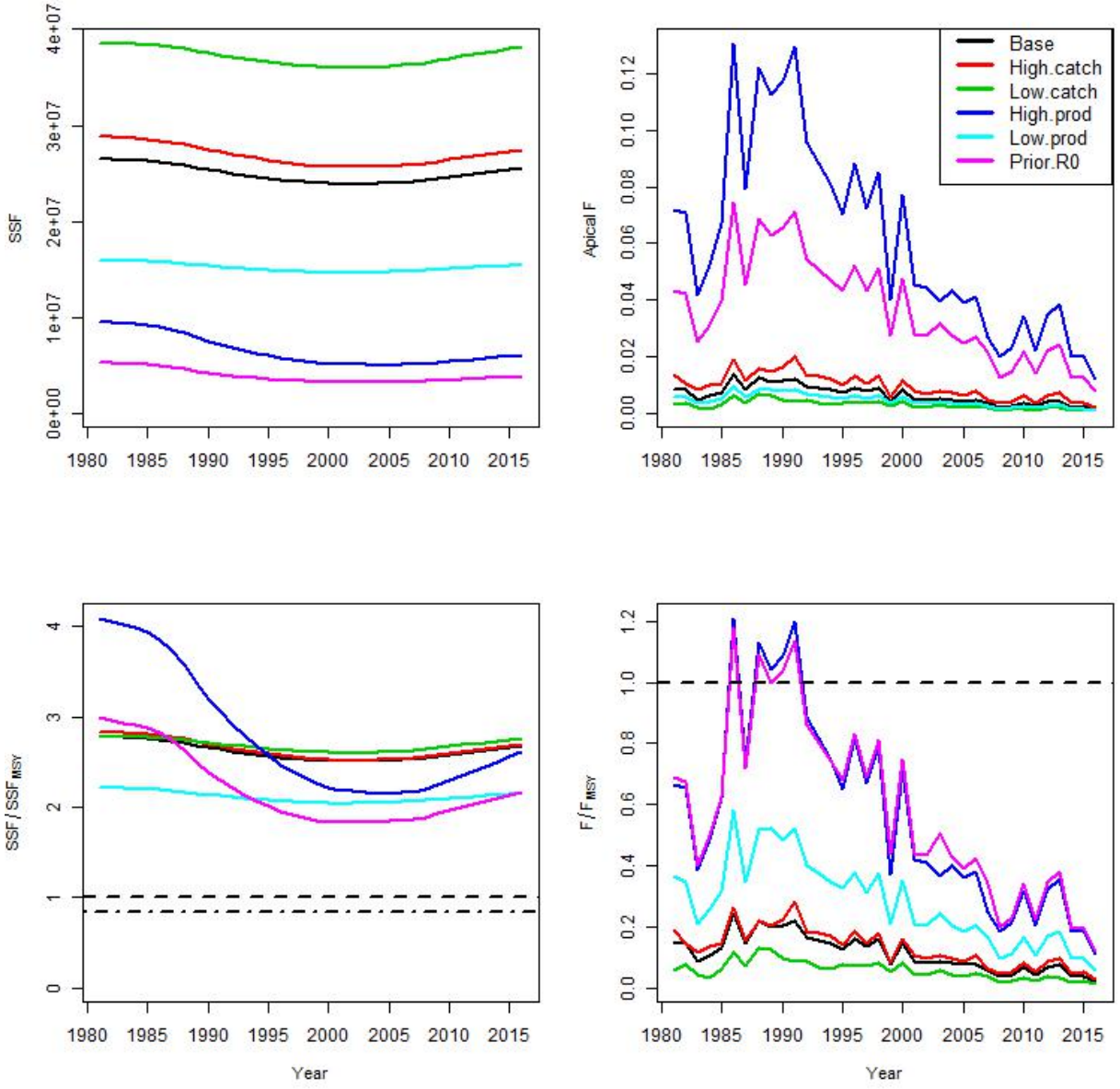


Figure 4. Estimated time series of spawning stock fecundity, apical fishing mortality rates, spawning stock fecundity in relation to *MSY* levels, and fishing mortality rates in relation to *MSY* levels from SSASPM for GOM blacktip shark for the base and five additional scenarios reflective of plausible states of nature (Base, High Catch, Low Catch, High Productivity, Low Productivity and Prior R_0). For clarity we only show the overfished reference point (relative to SSF_{MSST}) for the base run of this assessment update (horizontal dot-dashed line), with points below the line indicating the stock was estimated to be overfished ($SSF_{2016} < SSF_{MSST}$).

Panel B. Recreational catches from the new calibrated MRIP estimates

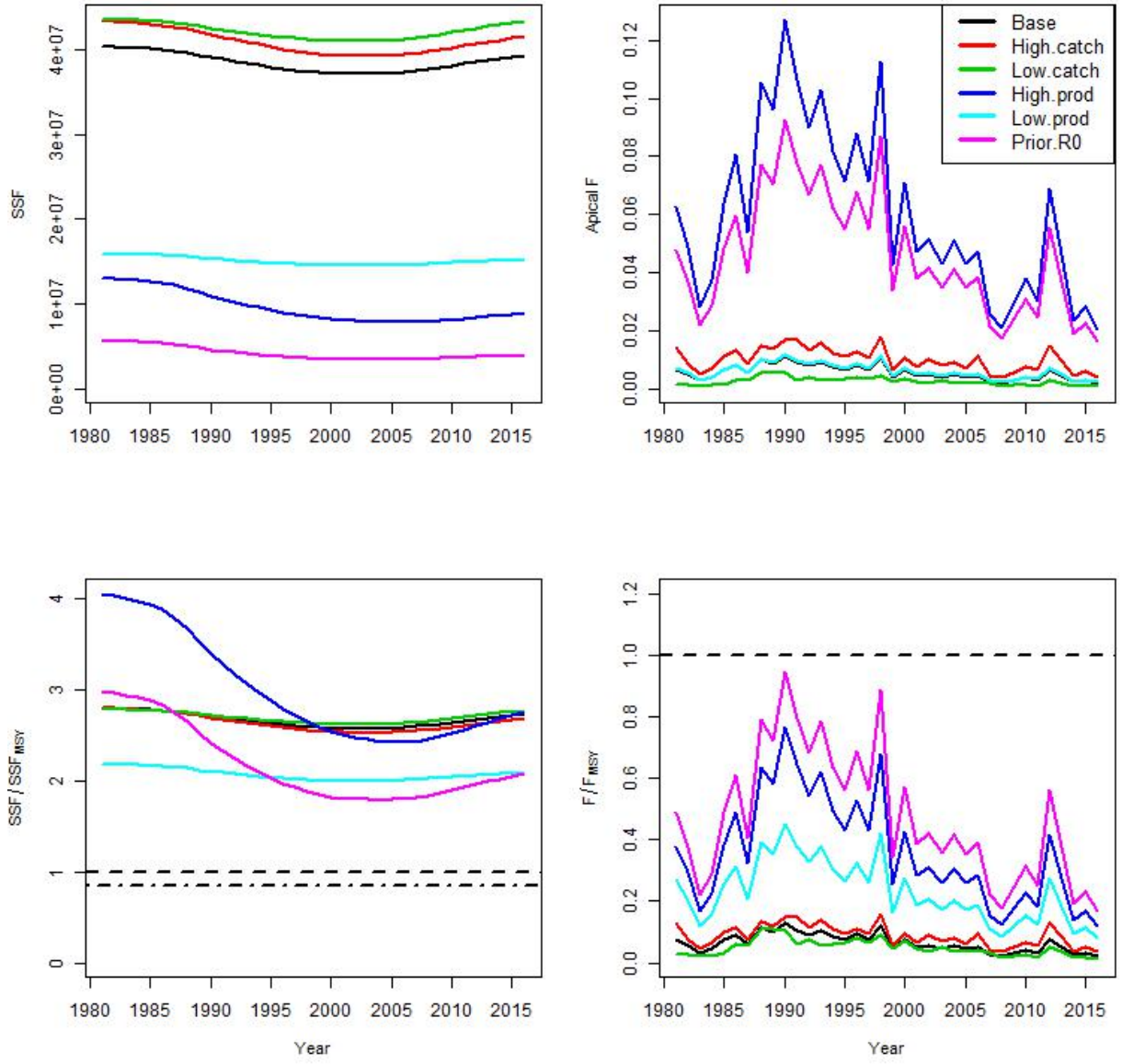


Figure 4. Estimated time series of spawning stock fecundity, apical fishing mortality rates, spawning stock fecundity in relation to *MSY* levels, and fishing mortality rates in relation to *MSY* levels from SSASPM for GOM blacktip shark for the base and five additional scenarios reflective of plausible states of nature (continued).

Appendix 1.

Review by F. Carvalho (NOAA Fisheries PIFSC)

Report on the update assessment to SEDAR 29 HMS Gulf of Mexico blacktip shark.

Summary of findings relevant to review of terms of reference of the Gulf of Mexico blacktip shark stock assessment update.

ToR 1. Evaluate whether the assessment updated all data inputs (to 2016) used in the SEDAR 29 base run and states of nature identified in SEDAR 29.

In this report of the update assessment to SEDAR 29 HMS Gulf of Mexico blacktip shark (hereafter termed the 'Update Report'), all catch and CPUE data were updated up to 2016 (six new years of data).

ToR 2. Evaluate whether the assessment documented any changes or corrections made to the input datasets, if applicable, and provided updated input data tables.

The Update Report provides full description of the data available (CPUE, catch, and life history), as well as the additional and modified information used. These information are presented in detail in the text and in a series of updated Figures and Tables.
Differences between the 2012 (SEDAR 29) and this assessment update include: there are now seven indices of relative abundance in the base run (vs. six indices in 2012); all indices were re-analyzed and include six more years of data; recruitment annual deviation process error was assumed to be an independent and lognormally distributed random variable with mean=0, a CV of 0.01, and bounded between -0.05 and 0.05 (vs. no process error in 2012); there are new biological parameters, including a new von Bertalanffy growth curve with a slower growth coefficient K=0.162 (vs. 0.187), and there are new estimates of natural mortality at age (ranging from 0.206 to 0.132 vs. 0.226 to 0.134).

ToR 3. Evaluate whether the assessment documented any changes or corrections made to the modeling approach and justified those changes, if appropriate.

The Update Report used the same assessment method as in the preceding SEDAR 29: State Space Age-Structured Production Model (SSASPM). Full description of the model is provided. The model was applied to seven scenarios reflective of plausible states of nature identified and approved in the SEDAR 29 assessment.
One of the SEDAR 29 CIE reviewers' recommendations was that indices were weighted by an assigned rank prior to fitting the model in an effort to avoid bias, and also to avoid the model from being arbitrarily driven by more precise indices (with lower CVs). In the Update Report this recommendation was only applied in the scenario consisting of the NEFS LL SE index explored. The results of this scenario were considered not reliable and therefore not consider on further evaluations.

ToR 4. Evaluate whether the State Space Age-Structured Production Model (SSASPM) used was configured properly and used consistent with the approach and structure used in SEDAR 29.

The State Space Age-Structured Production Model (SSASPM) has been employed in numerous assessments and is well-tested and scientifically sound. The SSASPM that were implemented in the Update Report was configured properly and is consistent with the approach used in SEDAR 29.

ToR 5. Evaluate whether the assessment provided updated parameter estimates and measures of uncertainty, updated estimates of stock status and management benchmarks (e.g.,Fcurrent/FMSY, SSFcurrent/SSFMSY, SSFcurrent/SSFMSST), and updated projections of future stock status, as conducted in SEDAR 29.

The Update Report provide details of findings with respect to parameter estimation, estimates of management benchmarks, and projections. The results from the updated base model run and five considered additional scenarios (Low Catch, High Catch, Low Productivity, High Productivity, and Lognormal Prior on *R0*) are presented in the text and in a series of updated Figures and Tables.
A summary of projection model results is also presented for the base model run and additional scenarios. To quantify uncertainty marginal posterior distributions for key assessment parameters were estimated. The Coefficient of Variation (CV) was used to report uncertainty, and its use was appropriate and informative.

ToR 6. Considering that this assessment was an update and that, consequently, the data input streams, the stock assessment model, and the methods used to project stock status were constrained to be essentially the same as those used in the previous SEDAR 29 standard stock assessment:

a. Are the spawning stock fecundity and exploitation rate estimates reliable and consistent with input data and biological characteristics of this stock and useful to support inferences on the status of the stock?

The estimates of abundance and exploitation rate estimates produced by the State Space Age-Structured Production Model are consistent with the data input to that model and with the biological characteristics of the stock. However, the reliability of the estimates, and their usefulness for status determination must be considered in the context of the explicit uncertainty reported in the Update Report.

b. Are the conclusions on overfished and overfishing status justified?

As noted above, the fitted State Space Age-Structured Production Model for 1981-2016 produces parameter estimates that relate to the status of the Gulf of Mexico blacktip shark and its level of exploitation in 2016. The Update Report present detailed information of the

predictions of current levels of abundance and exploitation, and estimates of projected spawning stock fecundity and exploitation rate estimates following 2016.
The Update Report contained detailed text, Tables and Figures describing benchmarks and MSY reference points for the base model run and the five additional scenarios reflective of plausible states of nature. All runs clearly indicated that the stock was not overfished and overfishing currently was not occurring. The evaluation of stock status was robust and fully justified to all of the various scenarios used to the test the model and the data.

c. Are the results obtained from stock projections useful and robust to support inferences of probable future conditions?

Projections were completed for the base model run and five additional scenarios. The first full projection year was 2017, and projections were run until the year 2046 (30 years). Projection methods followed those employed in numerous assessments and is well-tested and scientifically sound. The projection approach utilized Monte Carlo bootstrapping at alternative fixed landings levels to compute the probability that spawning stock fecundity (SSF) will exceed the level of SSF that will produce MSY (SSF_{MSY}), Pr(SSFt > SSF_{MSY}), and the probability that fishing mortality (Ft) will exceed the level of F that will produce MSY (F_{MSY}), Pr(Ft > F_{MSY}), for a given projection year (2017 – 2046) and a given fixed level of total annual removals due to fishing (1,000s). The projection results were useful and robust, and indicated that the stock appears to be capable of supporting total annual removals due to fishing from $2.00x10^5$ to $1.20x10^6$ sharks depending on the scenario.

ToR 7. Did the stock assessment update report include all the information required to evaluate the work undertaken?

Yes. The stock assessment report included all the information required to evaluate the work undertaken.

Felipe Carvalho, Ph.D.

Research Mathematical Statistician

Fisheries Research and Monitoring Division
Pacific Islands Fisheries Science Center
NOAA Fisheries

NOAA Daniel K. Inouye Regional Center

1845 Wasp Boulevard, Building 176

Honolulu, Hawaii 96818
(808) 725 5605

Review by K. Sosebee (NOAA Fisheries NEFSC)

SEDAR 29 (GOM Blacktip Shark) Update Assessment Review

1. Evaluate whether the assessment updated all data inputs (to 2016) used in the SEDAR 29 base run and states of nature identified in SEDAR 29.

   This assessment updated all data inputs used in the SEDAR 29 base run and alternate states of nature identified in SEDAR 29.

2. Evaluate whether the assessment documented any changes or corrections made to the input datasets, if applicable, and provided updated data input tables.

   All changes to the data inputs were identified. Renaming and adding two gillnet surveys to the new GULFSPAN Gillnet, splitting BLLOP into two series, adding TX and LA to the bottom longline series and excluding the MS handline index from the dame series were all fully documented and justified.

   The new growth curves using additional data were fit properly and justified to update the values of M used for input into the model.

   The commercial catches were updated as in SEDAR 29 and any changes to methodology (using the geometric mean for MRIP data for Mississippi Wave 4 to account for an anomalously high value was appropriate.

3. Evaluate whether the assessment documented any changes or corrections made to the modelling approach and justified those changes, if appropriate.

   The assessment documented all modelling framework choices very thoroughly. I was initially confused about the discussion of input CVs, but after a second read, I believe what was done was a single CV for each data series as opposed to each data point within each series having a different CV.

4. Evaluate whether the State Space Age-Structured Production Model (SSASPM) used was configured properly and used consistent with the approach and structure used in SEDAR 29.

   The model was configured properly as used in SEDAR 29.

5. Evaluate whether the assessment provided updated parameter estimates and measures of uncertainty, updated estimates of stock status and management benchmarks (*e.g.* $F_{current}/F_{MSY}$, $SSF_{current}/SSF_{MSY}$, $SSF_{current}/SSF_{MSST}$), and updated projections of future stock status, as conducted in SEDAR 29.

   All parameter estimates and measures of uncertainty were provided as well as updates of stock status and management benchmarks. Projections were run with some modifications that were well documented.

6. Considering that this assessment was an update and that, consequently, the data input streams, the stock assessment model, and the methods used to project stock status were constrained to be essentially the same as those used in the previous SEDAR 29 standard stock assessment:
    a. Are the spawning stock fecundity and exploitation rate estimates reliable and consistent with input data and biological characteristics of this stock and useful to support inferences on the status of the stock?

        The estimates appear to be reliable and are appropriate for use in management.

    b. Are the conclusions on overfished and overfishing justified?

        Yes, the conclusion about stock status are justified.

    c. Are the results obtained from stock projections useful and robust to support inferences of probable future conditions?

        The projection results appear to be robust to support inferences.

7. Did the stock assessment update report include all the information required to evaluate the work undertake?

    The report was very thorough and well-written. All the input data were documented and the model formulation was explained. The states of nature were thoroughly explored.

Appendix 2.

Table A. Predicted abundance (*N*) and spawning stock fecundity (*SSF*) from SSASPM from the base and five additional scenarios reflective of plausible states of nature (High Catch, Low Catch, High Productivity, Low Productivity and Prior R_0) runs for GOM blacktip shark.

Panel A1. Recreational catches from the original MRIP estimates:
Base scenario

Year	N	SSF
1981	3.94E+07	2.65E+07
1982	3.94E+07	2.65E+07
1983	3.89E+07	2.64E+07
1984	3.86E+07	2.64E+07
1985	3.83E+07	2.63E+07
1986	3.86E+07	2.62E+07
1987	3.81E+07	2.60E+07
1988	3.78E+07	2.58E+07
1989	3.74E+07	2.56E+07
1990	3.70E+07	2.54E+07
1991	3.68E+07	2.52E+07
1992	3.65E+07	2.50E+07
1993	3.64E+07	2.48E+07
1994	3.62E+07	2.46E+07
1995	3.61E+07	2.45E+07
1996	3.60E+07	2.43E+07
1997	3.59E+07	2.42E+07
1998	3.64E+07	2.41E+07
1999	3.68E+07	2.40E+07
2000	3.71E+07	2.39E+07
2001	3.74E+07	2.39E+07
2002	3.76E+07	2.39E+07
2003	3.78E+07	2.39E+07
2004	3.80E+07	2.39E+07
2005	3.81E+07	2.40E+07
2006	3.83E+07	2.41E+07
2007	3.84E+07	2.42E+07
2008	3.86E+07	2.43E+07
2009	3.87E+07	2.45E+07
2010	3.89E+07	2.46E+07
2011	3.90E+07	2.48E+07
2012	3.91E+07	2.49E+07
2013	3.93E+07	2.51E+07
2014	3.93E+07	2.53E+07
2015	3.94E+07	2.54E+07
2016	3.90E+07	2.55E+07

Table A (continued). Predicted abundance (*N*) and spawning stock fecundity (*SSF*) from SSASPM.

Panel A2. Recreational catches from the original MRIP estimates:
High Catch scenario

Year	N	SSF
1981	4.28E+07	2.88E+07
1982	4.26E+07	2.88E+07
1983	4.21E+07	2.87E+07
1984	4.18E+07	2.86E+07
1985	4.15E+07	2.85E+07
1986	4.17E+07	2.84E+07
1987	4.12E+07	2.82E+07
1988	4.08E+07	2.80E+07
1989	4.04E+07	2.77E+07
1990	4.00E+07	2.74E+07
1991	3.97E+07	2.72E+07
1992	3.94E+07	2.70E+07
1993	3.92E+07	2.68E+07
1994	3.90E+07	2.66E+07
1995	3.89E+07	2.64E+07
1996	3.87E+07	2.62E+07
1997	3.86E+07	2.60E+07
1998	3.92E+07	2.59E+07
1999	3.96E+07	2.58E+07
2000	4.00E+07	2.57E+07
2001	4.02E+07	2.56E+07
2002	4.05E+07	2.56E+07
2003	4.07E+07	2.56E+07
2004	4.09E+07	2.57E+07
2005	4.11E+07	2.57E+07
2006	4.13E+07	2.58E+07
2007	4.14E+07	2.59E+07
2008	4.15E+07	2.61E+07
2009	4.17E+07	2.62E+07
2010	4.19E+07	2.64E+07
2011	4.20E+07	2.66E+07
2012	4.22E+07	2.68E+07
2013	4.23E+07	2.70E+07
2014	4.24E+07	2.71E+07
2015	4.25E+07	2.73E+07
2016	4.20E+07	2.74E+07

Table A (continued). Predicted abundance (*N*) and spawning stock fecundity (*SSF*) from SSASPM.

Panel A3. Recreational catches from the original MRIP estimates:
Low Catch scenario

Year	N	SSF
1981	5.72E+07	3.86E+07
1982	5.73E+07	3.85E+07
1983	5.68E+07	3.85E+07
1984	5.63E+07	3.84E+07
1985	5.61E+07	3.84E+07
1986	5.65E+07	3.83E+07
1987	5.61E+07	3.82E+07
1988	5.56E+07	3.80E+07
1989	5.52E+07	3.77E+07
1990	5.48E+07	3.75E+07
1991	5.45E+07	3.73E+07
1992	5.42E+07	3.71E+07
1993	5.40E+07	3.70E+07
1994	5.38E+07	3.68E+07
1995	5.37E+07	3.66E+07
1996	5.35E+07	3.65E+07
1997	5.34E+07	3.63E+07
1998	5.41E+07	3.62E+07
1999	5.47E+07	3.61E+07
2000	5.52E+07	3.61E+07
2001	5.56E+07	3.60E+07
2002	5.59E+07	3.60E+07
2003	5.63E+07	3.60E+07
2004	5.65E+07	3.61E+07
2005	5.67E+07	3.61E+07
2006	5.69E+07	3.63E+07
2007	5.71E+07	3.64E+07
2008	5.73E+07	3.66E+07
2009	5.75E+07	3.68E+07
2010	5.77E+07	3.70E+07
2011	5.78E+07	3.72E+07
2012	5.80E+07	3.74E+07
2013	5.81E+07	3.76E+07
2014	5.83E+07	3.78E+07
2015	5.84E+07	3.80E+07
2016	5.76E+07	3.81E+07

Table A (continued). Predicted abundance (*N*) and spawning stock fecundity (*SSF*) from SSASPM.

Panel A4. Recreational catches from the original MRIP estimates:
High Productivity scenario

Year	N	SSF
1981	6.20E+06	9.53E+06
1982	6.06E+06	9.44E+06
1983	5.91E+06	9.35E+06
1984	5.82E+06	9.26E+06
1985	5.73E+06	9.16E+06
1986	5.66E+06	8.97E+06
1987	5.41E+06	8.69E+06
1988	5.26E+06	8.33E+06
1989	5.00E+06	7.85E+06
1990	4.77E+06	7.44E+06
1991	4.63E+06	7.12E+06
1992	4.48E+06	6.79E+06
1993	4.37E+06	6.49E+06
1994	4.30E+06	6.24E+06
1995	4.25E+06	5.99E+06
1996	4.22E+06	5.75E+06
1997	4.20E+06	5.57E+06
1998	4.23E+06	5.41E+06
1999	4.22E+06	5.27E+06
2000	4.27E+06	5.17E+06
2001	4.27E+06	5.09E+06
2002	4.33E+06	5.06E+06
2003	4.38E+06	5.03E+06
2004	4.40E+06	5.00E+06
2005	4.43E+06	5.01E+06
2006	4.48E+06	5.03E+06
2007	4.50E+06	5.05E+06
2008	4.55E+06	5.12E+06
2009	4.63E+06	5.24E+06
2010	4.71E+06	5.35E+06
2011	4.75E+06	5.46E+06
2012	4.81E+06	5.59E+06
2013	4.86E+06	5.71E+06
2014	4.89E+06	5.83E+06
2015	4.94E+06	5.95E+06
2016	4.93E+06	6.06E+06

Table A (continued). Predicted abundance (*N*) and spawning stock fecundity (*SSF*) from SSASPM.

Panel A5. Recreational catches from the original MRIP estimates:
Low Productivity scenario

Year	N	SSF
1981	5.23E+07	1.59E+07
1982	5.24E+07	1.59E+07
1983	5.17E+07	1.59E+07
1984	5.13E+07	1.58E+07
1985	5.13E+07	1.58E+07
1986	5.18E+07	1.58E+07
1987	5.18E+07	1.57E+07
1988	5.10E+07	1.56E+07
1989	5.04E+07	1.55E+07
1990	4.98E+07	1.53E+07
1991	4.93E+07	1.52E+07
1992	4.89E+07	1.52E+07
1993	4.86E+07	1.51E+07
1994	4.84E+07	1.50E+07
1995	4.84E+07	1.49E+07
1996	4.88E+07	1.48E+07
1997	4.92E+07	1.48E+07
1998	4.95E+07	1.47E+07
1999	4.97E+07	1.47E+07
2000	4.99E+07	1.46E+07
2001	5.01E+07	1.46E+07
2002	5.02E+07	1.46E+07
2003	5.04E+07	1.47E+07
2004	5.05E+07	1.47E+07
2005	5.06E+07	1.47E+07
2006	5.07E+07	1.48E+07
2007	5.08E+07	1.48E+07
2008	5.10E+07	1.49E+07
2009	5.11E+07	1.50E+07
2010	5.13E+07	1.50E+07
2011	5.15E+07	1.51E+07
2012	5.17E+07	1.52E+07
2013	5.18E+07	1.52E+07
2014	5.20E+07	1.53E+07
2015	5.22E+07	1.54E+07
2016	5.14E+07	1.54E+07

Table A (continued). Predicted abundance (*N*) and spawning stock fecundity (*SSF*) from SSASPM.

Panel A6. Recreational catches from the original MRIP estimates:
Lognormal Prior R_0 scenario

Year	N	SSF
1981	7.76E+06	5.22E+06
1982	7.62E+06	5.18E+06
1983	7.45E+06	5.13E+06
1984	7.36E+06	5.09E+06
1985	7.25E+06	5.03E+06
1986	7.24E+06	4.94E+06
1987	6.98E+06	4.79E+06
1988	6.83E+06	4.61E+06
1989	6.57E+06	4.36E+06
1990	6.35E+06	4.16E+06
1991	6.20E+06	4.01E+06
1992	6.06E+06	3.86E+06
1993	5.95E+06	3.73E+06
1994	5.88E+06	3.62E+06
1995	5.82E+06	3.52E+06
1996	5.78E+06	3.42E+06
1997	5.77E+06	3.35E+06
1998	5.83E+06	3.30E+06
1999	5.84E+06	3.25E+06
2000	5.91E+06	3.22E+06
2001	5.91E+06	3.20E+06
2002	5.97E+06	3.21E+06
2003	6.02E+06	3.21E+06
2004	6.04E+06	3.20E+06
2005	6.08E+06	3.22E+06
2006	6.12E+06	3.25E+06
2007	6.14E+06	3.26E+06
2008	6.19E+06	3.31E+06
2009	6.28E+06	3.37E+06
2010	6.35E+06	3.44E+06
2011	6.40E+06	3.50E+06
2012	6.46E+06	3.56E+06
2013	6.51E+06	3.62E+06
2014	6.55E+06	3.68E+06
2015	6.59E+06	3.74E+06
2016	6.55E+06	3.79E+06

Table A (continued). Predicted abundance (*N*) and spawning stock fecundity (*SSF*) from SSASPM.

Panel B1. Recreational catches from the new calibrated MRIP estimates:
Base scenario

Year	N	SSF
1981	5.99E+07	4.04E+07
1982	5.98E+07	4.03E+07
1983	5.92E+07	4.03E+07
1984	5.88E+07	4.02E+07
1985	5.85E+07	4.01E+07
1986	5.88E+07	4.00E+07
1987	5.83E+07	3.99E+07
1988	5.79E+07	3.96E+07
1989	5.73E+07	3.94E+07
1990	5.69E+07	3.91E+07
1991	5.65E+07	3.89E+07
1992	5.62E+07	3.86E+07
1993	5.60E+07	3.84E+07
1994	5.57E+07	3.82E+07
1995	5.56E+07	3.80E+07
1996	5.54E+07	3.78E+07
1997	5.53E+07	3.76E+07
1998	5.61E+07	3.74E+07
1999	5.66E+07	3.73E+07
2000	5.71E+07	3.72E+07
2001	5.75E+07	3.71E+07
2002	5.79E+07	3.71E+07
2003	5.82E+07	3.71E+07
2004	5.85E+07	3.72E+07
2005	5.87E+07	3.72E+07
2006	5.89E+07	3.74E+07
2007	5.91E+07	3.75E+07
2008	5.93E+07	3.77E+07
2009	5.96E+07	3.79E+07
2010	5.98E+07	3.81E+07
2011	5.99E+07	3.84E+07
2012	6.01E+07	3.86E+07
2013	6.02E+07	3.88E+07
2014	6.03E+07	3.90E+07
2015	6.05E+07	3.92E+07
2016	5.97E+07	3.94E+07

Table A (continued). Predicted abundance (*N*) and spawning stock fecundity (*SSF*) from SSASPM.

Panel B2. Recreational catches from the new calibrated MRIP estimates: High Catch scenario

Year	N	SSF
1981	6.44E+07	4.34E+07
1982	6.42E+07	4.33E+07
1983	6.35E+07	4.33E+07
1984	6.30E+07	4.32E+07
1985	6.26E+07	4.31E+07
1986	6.29E+07	4.29E+07
1987	6.22E+07	4.27E+07
1988	6.18E+07	4.24E+07
1989	6.12E+07	4.21E+07
1990	6.07E+07	4.18E+07
1991	6.02E+07	4.15E+07
1992	5.98E+07	4.12E+07
1993	5.95E+07	4.09E+07
1994	5.92E+07	4.06E+07
1995	5.90E+07	4.04E+07
1996	5.88E+07	4.01E+07
1997	5.87E+07	3.98E+07
1998	5.95E+07	3.97E+07
1999	6.00E+07	3.95E+07
2000	6.06E+07	3.94E+07
2001	6.10E+07	3.93E+07
2002	6.14E+07	3.92E+07
2003	6.17E+07	3.92E+07
2004	6.20E+07	3.92E+07
2005	6.22E+07	3.93E+07
2006	6.25E+07	3.94E+07
2007	6.26E+07	3.96E+07
2008	6.29E+07	3.98E+07
2009	6.32E+07	4.00E+07
2010	6.34E+07	4.02E+07
2011	6.36E+07	4.05E+07
2012	6.38E+07	4.07E+07
2013	6.37E+07	4.09E+07
2014	6.39E+07	4.11E+07
2015	6.41E+07	4.13E+07
2016	6.33E+07	4.15E+07

Table A (continued). Predicted abundance (*N*) and spawning stock fecundity (*SSF*) from SSASPM.

Panel B3. Recreational catches from the new calibrated MRIP estimates:
Low Catch scenario

Year	N	SSF
1981	6.41E+07	4.36E+07
1982	6.44E+07	4.36E+07
1983	6.39E+07	4.35E+07
1984	6.35E+07	4.35E+07
1985	6.34E+07	4.34E+07
1986	6.41E+07	4.34E+07
1987	6.37E+07	4.32E+07
1988	6.32E+07	4.30E+07
1989	6.27E+07	4.28E+07
1990	6.22E+07	4.25E+07
1991	6.19E+07	4.23E+07
1992	6.16E+07	4.22E+07
1993	6.13E+07	4.20E+07
1994	6.11E+07	4.18E+07
1995	6.10E+07	4.17E+07
1996	6.08E+07	4.15E+07
1997	6.07E+07	4.13E+07
1998	6.16E+07	4.12E+07
1999	6.22E+07	4.11E+07
2000	6.27E+07	4.11E+07
2001	6.32E+07	4.10E+07
2002	6.35E+07	4.10E+07
2003	6.39E+07	4.10E+07
2004	6.41E+07	4.11E+07
2005	6.44E+07	4.11E+07
2006	6.46E+07	4.13E+07
2007	6.48E+07	4.14E+07
2008	6.50E+07	4.16E+07
2009	6.52E+07	4.18E+07
2010	6.54E+07	4.21E+07
2011	6.56E+07	4.23E+07
2012	6.58E+07	4.25E+07
2013	6.59E+07	4.28E+07
2014	6.61E+07	4.30E+07
2015	6.62E+07	4.32E+07
2016	6.54E+07	4.33E+07

Table A (continued). Predicted abundance (*N*) and spawning stock fecundity (*SSF*) from SSASPM.

Panel B4. Recreational catches from the new calibrated MRIP estimates:
High Productivity scenario

Year	N	SSF
1981	8.49E+06	1.31E+07
1982	8.33E+06	1.30E+07
1983	8.17E+06	1.29E+07
1984	8.08E+06	1.28E+07
1985	7.98E+06	1.27E+07
1986	7.87E+06	1.25E+07
1987	7.64E+06	1.22E+07
1988	7.49E+06	1.18E+07
1989	7.19E+06	1.13E+07
1990	6.93E+06	1.09E+07
1991	6.71E+06	1.06E+07
1992	6.54E+06	1.02E+07
1993	6.41E+06	9.86E+06
1994	6.29E+06	9.56E+06
1995	6.22E+06	9.26E+06
1996	6.16E+06	8.97E+06
1997	6.12E+06	8.74E+06
1998	6.16E+06	8.52E+06
1999	6.10E+06	8.32E+06
2000	6.18E+06	8.17E+06
2001	6.20E+06	8.05E+06
2002	6.26E+06	7.97E+06
2003	6.32E+06	7.90E+06
2004	6.35E+06	7.83E+06
2005	6.38E+06	7.82E+06
2006	6.44E+06	7.82E+06
2007	6.46E+06	7.83E+06
2008	6.53E+06	7.89E+06
2009	6.64E+06	8.01E+06
2010	6.72E+06	8.13E+06
2011	6.76E+06	8.25E+06
2012	6.83E+06	8.38E+06
2013	6.81E+06	8.50E+06
2014	6.84E+06	8.63E+06
2015	6.92E+06	8.77E+06
2016	6.89E+06	8.89E+06

Table A (continued). Predicted abundance (*N*) and spawning stock fecundity (*SSF*) from SSASPM.

Panel B5. Recreational catches from the new calibrated MRIP estimates:
Low Productivity scenario

Year	N	SSF
1981	5.23E+07	1.59E+07
1982	5.23E+07	1.59E+07
1983	5.17E+07	1.59E+07
1984	5.12E+07	1.58E+07
1985	5.12E+07	1.58E+07
1986	5.17E+07	1.57E+07
1987	5.17E+07	1.57E+07
1988	5.10E+07	1.56E+07
1989	5.03E+07	1.54E+07
1990	4.97E+07	1.53E+07
1991	4.92E+07	1.52E+07
1992	4.87E+07	1.51E+07
1993	4.83E+07	1.50E+07
1994	4.82E+07	1.49E+07
1995	4.81E+07	1.48E+07
1996	4.85E+07	1.47E+07
1997	4.89E+07	1.47E+07
1998	4.92E+07	1.46E+07
1999	4.93E+07	1.46E+07
2000	4.95E+07	1.45E+07
2001	4.97E+07	1.45E+07
2002	4.98E+07	1.45E+07
2003	4.99E+07	1.45E+07
2004	5.00E+07	1.45E+07
2005	5.01E+07	1.46E+07
2006	5.02E+07	1.46E+07
2007	5.03E+07	1.47E+07
2008	5.05E+07	1.47E+07
2009	5.07E+07	1.48E+07
2010	5.09E+07	1.49E+07
2011	5.10E+07	1.49E+07
2012	5.12E+07	1.50E+07
2013	5.13E+07	1.51E+07
2014	5.14E+07	1.51E+07
2015	5.16E+07	1.52E+07
2016	5.08E+07	1.52E+07

Table A (continued). Predicted abundance (*N*) and spawning stock fecundity (*SSF*) from SSASPM.

Panel B6. Recreational catches from the new calibrated MRIP estimates: Lognormal Prior R_0 scenario

Year	N	SSF
1981	8.44E+06	5.68E+06
1982	8.27E+06	5.64E+06
1983	8.11E+06	5.59E+06
1984	8.01E+06	5.54E+06
1985	7.91E+06	5.48E+06
1986	7.86E+06	5.39E+06
1987	7.63E+06	5.24E+06
1988	7.48E+06	5.05E+06
1989	7.18E+06	4.80E+06
1990	6.93E+06	4.59E+06
1991	6.72E+06	4.42E+06
1992	6.56E+06	4.26E+06
1993	6.44E+06	4.11E+06
1994	6.32E+06	3.98E+06
1995	6.24E+06	3.86E+06
1996	6.20E+06	3.74E+06
1997	6.19E+06	3.66E+06
1998	6.25E+06	3.58E+06
1999	6.19E+06	3.51E+06
2000	6.27E+06	3.47E+06
2001	6.28E+06	3.44E+06
2002	6.34E+06	3.43E+06
2003	6.39E+06	3.42E+06
2004	6.41E+06	3.40E+06
2005	6.43E+06	3.41E+06
2006	6.48E+06	3.43E+06
2007	6.49E+06	3.44E+06
2008	6.55E+06	3.49E+06
2009	6.65E+06	3.55E+06
2010	6.72E+06	3.61E+06
2011	6.76E+06	3.67E+06
2012	6.83E+06	3.73E+06
2013	6.81E+06	3.78E+06
2014	6.85E+06	3.84E+06
2015	6.92E+06	3.90E+06
2016	6.87E+06	3.95E+06

Table B. Estimated total and fleet-specific apical instantaneous fishing mortality rates by year from SSASPM from the base and five additional scenarios reflective of plausible states of nature (High Catch, Low Catch, High Productivity, Low Productivity and Prior R_0) runs for GOM blacktip shark.

Panel A1. Recreational catches from the original MRIP estimates:
Base scenario

Year	TotalF	Fleet-specific F			
		ComUnrep	Recreational	Mexican	Menhaden Disc
1981	0.0084	0.0004	0.0041	0.0039	0.0005
1982	0.0080	0.0004	0.0054	0.0022	0.0005
1983	0.0047	0.0004	0.0020	0.0023	0.0005
1984	0.0059	0.0005	0.0021	0.0033	0.0005
1985	0.0074	0.0005	0.0042	0.0028	0.0005
1986	0.0137	0.0036	0.0109	0.0025	0.0004
1987	0.0082	0.0036	0.0051	0.0027	0.0005
1988	0.0123	0.0073	0.0089	0.0030	0.0005
1989	0.0111	0.0076	0.0071	0.0035	0.0005
1990	0.0113	0.0041	0.0067	0.0042	0.0005
1991	0.0122	0.0043	0.0087	0.0032	0.0004
1992	0.0093	0.0050	0.0055	0.0035	0.0003
1993	0.0087	0.0036	0.0043	0.0041	0.0003
1994	0.0080	0.0034	0.0040	0.0038	0.0004
1995	0.0071	0.0046	0.0036	0.0032	0.0003
1996	0.0090	0.0036	0.0052	0.0035	0.0003
1997	0.0075	0.0026	0.0048	0.0024	0.0003
1998	0.0088	0.0035	0.0062	0.0024	0.0003
1999	0.0042	0.0029	0.0022	0.0017	0.0004
2000	0.0081	0.0028	0.0063	0.0016	0.0003
2001	0.0047	0.0022	0.0033	0.0012	0.0003
2002	0.0047	0.0018	0.0032	0.0013	0.0003
2003	0.0048	0.0037	0.0029	0.0011	0.0003
2004	0.0046	0.0024	0.0031	0.0013	0.0003
2005	0.0042	0.0018	0.0026	0.0013	0.0003
2006	0.0044	0.0029	0.0034	0.0007	0.0003
2007	0.0033	0.0024	0.0019	0.0007	0.0003
2008	0.0021	0.0008	0.0012	0.0007	0.0003
2009	0.0025	0.0008	0.0014	0.0008	0.0003
2010	0.0037	0.0011	0.0023	0.0012	0.0003
2011	0.0024	0.0009	0.0015	0.0007	0.0003
2012	0.0038	0.0008	0.0028	0.0008	0.0002
2013	0.0042	0.0010	0.0030	0.0010	0.0002
2014	0.0022	0.0007	0.0011	0.0009	0.0002
2015	0.0022	0.0012	0.0013	0.0008	0.0002
2016	0.0013	0.0007	0.0009	0.0002	0.0002

Table B (continued). Estimated total and fleet-specific apical instantaneous fishing mortality rates by year from SSASPM.

Panel A2. Recreational catches from the original MRIP estimates:
High Catch scenario

Year	TotalF	Fleet-specific F			
		ComUnrep	Recreational	Mexican	Menhaden Disc
1981	0.0135	0.0003	0.0069	0.0062	0.0004
1982	0.0105	0.0003	0.0066	0.0035	0.0005
1983	0.0084	0.0004	0.0043	0.0037	0.0005
1984	0.0096	0.0005	0.0039	0.0053	0.0005
1985	0.0104	0.0005	0.0056	0.0045	0.0004
1986	0.0188	0.0033	0.0145	0.0040	0.0004
1987	0.0113	0.0033	0.0066	0.0043	0.0004
1988	0.0158	0.0067	0.0107	0.0048	0.0004
1989	0.0148	0.0070	0.0088	0.0057	0.0005
1990	0.0160	0.0038	0.0089	0.0067	0.0004
1991	0.0202	0.0040	0.0148	0.0051	0.0003
1992	0.0133	0.0047	0.0074	0.0056	0.0003
1993	0.0128	0.0034	0.0060	0.0065	0.0003
1994	0.0122	0.0034	0.0059	0.0060	0.0003
1995	0.0101	0.0045	0.0048	0.0051	0.0003
1996	0.0132	0.0036	0.0074	0.0056	0.0003
1997	0.0105	0.0025	0.0065	0.0038	0.0003
1998	0.0130	0.0034	0.0090	0.0038	0.0003
1999	0.0058	0.0028	0.0028	0.0027	0.0003
2000	0.0114	0.0026	0.0087	0.0026	0.0003
2001	0.0076	0.0021	0.0055	0.0018	0.0003
2002	0.0069	0.0017	0.0047	0.0020	0.0003
2003	0.0075	0.0036	0.0056	0.0017	0.0002
2004	0.0070	0.0023	0.0047	0.0020	0.0003
2005	0.0061	0.0017	0.0039	0.0020	0.0002
2006	0.0077	0.0028	0.0064	0.0011	0.0002
2007	0.0044	0.0024	0.0031	0.0011	0.0002
2008	0.0033	0.0007	0.0020	0.0011	0.0002
2009	0.0039	0.0008	0.0023	0.0013	0.0002
2010	0.0060	0.0011	0.0039	0.0019	0.0002
2011	0.0037	0.0009	0.0024	0.0011	0.0002
2012	0.0061	0.0008	0.0046	0.0013	0.0002
2013	0.0071	0.0010	0.0053	0.0016	0.0002
2014	0.0033	0.0007	0.0017	0.0015	0.0002
2015	0.0037	0.0011	0.0023	0.0012	0.0002
2016	0.0019	0.0007	0.0014	0.0004	0.0002

Table B (continued). Estimated total and fleet-specific apical instantaneous fishing mortality rates by year from SSASPM.

Panel A3. Recreational catches from the original MRIP estimates:
Low Catch scenario

Year	TotalF	Fleet-specific F			
		ComUnrep	Recreational	Mexican	Menhaden Disc
1981	0.0028	0.0003	0.0013	0.0012	0.0003
1982	0.0037	0.0003	0.0027	0.0007	0.0003
1983	0.0020	0.0003	0.0010	0.0007	0.0003
1984	0.0016	0.0004	0.0003	0.0010	0.0003
1985	0.0030	0.0003	0.0019	0.0008	0.0003
1986	0.0059	0.0025	0.0049	0.0008	0.0003
1987	0.0035	0.0024	0.0024	0.0008	0.0003
1988	0.0064	0.0049	0.0047	0.0009	0.0003
1989	0.0064	0.0051	0.0034	0.0011	0.0003
1990	0.0048	0.0027	0.0032	0.0012	0.0003
1991	0.0042	0.0029	0.0030	0.0009	0.0003
1992	0.0044	0.0033	0.0028	0.0010	0.0002
1993	0.0034	0.0024	0.0019	0.0012	0.0002
1994	0.0030	0.0021	0.0017	0.0011	0.0002
1995	0.0038	0.0030	0.0017	0.0009	0.0002
1996	0.0036	0.0022	0.0023	0.0010	0.0002
1997	0.0035	0.0016	0.0025	0.0007	0.0002
1998	0.0041	0.0023	0.0032	0.0007	0.0002
1999	0.0025	0.0019	0.0011	0.0005	0.0002
2000	0.0041	0.0018	0.0034	0.0005	0.0002
2001	0.0020	0.0015	0.0013	0.0004	0.0002
2002	0.0022	0.0011	0.0016	0.0004	0.0002
2003	0.0029	0.0024	0.0011	0.0003	0.0002
2004	0.0021	0.0015	0.0016	0.0004	0.0002
2005	0.0020	0.0011	0.0014	0.0004	0.0002
2006	0.0024	0.0019	0.0016	0.0002	0.0002
2007	0.0020	0.0016	0.0010	0.0002	0.0002
2008	0.0010	0.0005	0.0006	0.0002	0.0002
2009	0.0011	0.0005	0.0007	0.0003	0.0002
2010	0.0015	0.0007	0.0010	0.0003	0.0002
2011	0.0010	0.0005	0.0006	0.0002	0.0002
2012	0.0019	0.0005	0.0015	0.0002	0.0002
2013	0.0017	0.0007	0.0013	0.0003	0.0001
2014	0.0009	0.0004	0.0005	0.0003	0.0001
2015	0.0011	0.0007	0.0006	0.0002	0.0001
2016	0.0007	0.0005	0.0005	0.0001	0.0001

Table B (continued). Estimated total and fleet-specific apical instantaneous fishing mortality rates by year from SSASPM.

Panel A4. Recreational catches from the original MRIP estimates:
High Productivity scenario

Year	TotalF	Fleet-specific F			
		ComUnrep	Recreational	Mexican	Menhaden Disc
1981	0.0718	0.0018	0.0357	0.0335	0.0030
1982	0.0710	0.0018	0.0486	0.0196	0.0032
1983	0.0417	0.0020	0.0178	0.0210	0.0032
1984	0.0523	0.0028	0.0190	0.0303	0.0032
1985	0.0670	0.0027	0.0389	0.0255	0.0030
1986	0.1308	0.0196	0.1043	0.0239	0.0030
1987	0.0793	0.0201	0.0504	0.0260	0.0033
1988	0.1222	0.0426	0.0898	0.0295	0.0033
1989	0.1125	0.0470	0.0733	0.0359	0.0037
1990	0.1174	0.0263	0.0709	0.0432	0.0037
1991	0.1297	0.0290	0.0938	0.0334	0.0030
1992	0.0958	0.0347	0.0573	0.0361	0.0027
1993	0.0881	0.0258	0.0439	0.0417	0.0028
1994	0.0807	0.0247	0.0399	0.0381	0.0030
1995	0.0703	0.0345	0.0359	0.0318	0.0029
1996	0.0880	0.0269	0.0512	0.0343	0.0029
1997	0.0721	0.0197	0.0464	0.0231	0.0029
1998	0.0849	0.0268	0.0596	0.0229	0.0028
1999	0.0399	0.0225	0.0208	0.0163	0.0031
2000	0.0772	0.0212	0.0594	0.0155	0.0026
2001	0.0451	0.0169	0.0317	0.0111	0.0024
2002	0.0442	0.0134	0.0300	0.0120	0.0023
2003	0.0395	0.0282	0.0273	0.0100	0.0023
2004	0.0434	0.0180	0.0292	0.0122	0.0023
2005	0.0392	0.0136	0.0251	0.0120	0.0023
2006	0.0413	0.0221	0.0327	0.0066	0.0021
2007	0.0268	0.0184	0.0184	0.0064	0.0021
2008	0.0197	0.0057	0.0112	0.0065	0.0021
2009	0.0229	0.0057	0.0131	0.0078	0.0021
2010	0.0341	0.0081	0.0215	0.0108	0.0020
2011	0.0220	0.0061	0.0138	0.0064	0.0020
2012	0.0350	0.0059	0.0259	0.0075	0.0018
2013	0.0385	0.0071	0.0276	0.0094	0.0017
2014	0.0197	0.0048	0.0099	0.0084	0.0015
2015	0.0200	0.0079	0.0116	0.0070	0.0015
2016	0.0119	0.0049	0.0083	0.0022	0.0015

Table B (continued). Estimated total and fleet-specific apical instantaneous fishing mortality rates by year from SSASPM.

Panel A5. Recreational catches from the original MRIP estimates:
Low Productivity scenario

Year	TotalF	Fleet-specific F			
		ComUnrep	Recreational	Mexican	Menhaden Disc
1981	0.0058	0.0003	0.0028	0.0027	0.0004
1982	0.0056	0.0003	0.0037	0.0015	0.0004
1983	0.0033	0.0003	0.0013	0.0016	0.0004
1984	0.0041	0.0005	0.0014	0.0023	0.0004
1985	0.0051	0.0004	0.0029	0.0019	0.0003
1986	0.0093	0.0031	0.0073	0.0017	0.0003
1987	0.0055	0.0031	0.0034	0.0018	0.0004
1988	0.0083	0.0062	0.0060	0.0020	0.0003
1989	0.0084	0.0064	0.0048	0.0024	0.0004
1990	0.0078	0.0034	0.0046	0.0028	0.0004
1991	0.0084	0.0036	0.0059	0.0022	0.0003
1992	0.0064	0.0042	0.0038	0.0024	0.0003
1993	0.0060	0.0030	0.0030	0.0028	0.0003
1994	0.0056	0.0028	0.0027	0.0026	0.0003
1995	0.0052	0.0039	0.0025	0.0022	0.0003
1996	0.0060	0.0030	0.0035	0.0023	0.0003
1997	0.0050	0.0022	0.0032	0.0016	0.0003
1998	0.0060	0.0030	0.0042	0.0016	0.0002
1999	0.0033	0.0025	0.0015	0.0012	0.0003
2000	0.0056	0.0023	0.0043	0.0011	0.0002
2001	0.0033	0.0018	0.0023	0.0008	0.0002
2002	0.0033	0.0015	0.0022	0.0009	0.0002
2003	0.0039	0.0031	0.0020	0.0007	0.0002
2004	0.0033	0.0020	0.0022	0.0009	0.0002
2005	0.0029	0.0015	0.0019	0.0009	0.0002
2006	0.0033	0.0025	0.0024	0.0005	0.0002
2007	0.0026	0.0021	0.0014	0.0005	0.0002
2008	0.0015	0.0006	0.0008	0.0005	0.0002
2009	0.0018	0.0007	0.0010	0.0006	0.0002
2010	0.0026	0.0010	0.0016	0.0008	0.0002
2011	0.0017	0.0007	0.0010	0.0005	0.0002
2012	0.0027	0.0007	0.0020	0.0006	0.0002
2013	0.0029	0.0009	0.0021	0.0007	0.0002
2014	0.0015	0.0006	0.0007	0.0006	0.0001
2015	0.0015	0.0010	0.0009	0.0005	0.0001
2016	0.0009	0.0006	0.0006	0.0002	0.0001

Table B (continued). Estimated total and fleet-specific apical instantaneous fishing mortality rates by year from SSASPM.

Panel A6. Recreational catches from the original MRIP estimates:
Lognormal Prior R_0 scenario

Year	TotalF	Fleet-specific F			
		ComUnrep	Recreational	Mexican	Menhaden Disc
1981	0.0435	0.0019	0.0211	0.0201	0.0025
1982	0.0424	0.0019	0.0284	0.0116	0.0026
1983	0.0251	0.0021	0.0103	0.0124	0.0026
1984	0.0312	0.0028	0.0110	0.0178	0.0026
1985	0.0395	0.0027	0.0224	0.0148	0.0024
1986	0.0744	0.0197	0.0587	0.0136	0.0024
1987	0.0453	0.0202	0.0282	0.0147	0.0026
1988	0.0686	0.0424	0.0497	0.0166	0.0026
1989	0.0629	0.0461	0.0403	0.0200	0.0029
1990	0.0654	0.0254	0.0388	0.0240	0.0029
1991	0.0715	0.0276	0.0510	0.0185	0.0023
1992	0.0542	0.0326	0.0321	0.0203	0.0020
1993	0.0506	0.0240	0.0249	0.0238	0.0021
1994	0.0470	0.0228	0.0229	0.0220	0.0023
1995	0.0430	0.0315	0.0209	0.0186	0.0022
1996	0.0524	0.0244	0.0302	0.0203	0.0021
1997	0.0434	0.0178	0.0276	0.0138	0.0022
1998	0.0512	0.0242	0.0356	0.0137	0.0021
1999	0.0276	0.0202	0.0125	0.0098	0.0023
2000	0.0472	0.0191	0.0361	0.0094	0.0019
2001	0.0278	0.0152	0.0193	0.0068	0.0018
2002	0.0274	0.0120	0.0184	0.0074	0.0017
2003	0.0317	0.0253	0.0168	0.0062	0.0017
2004	0.0271	0.0161	0.0179	0.0075	0.0017
2005	0.0245	0.0122	0.0154	0.0074	0.0017
2006	0.0267	0.0199	0.0201	0.0041	0.0016
2007	0.0214	0.0166	0.0113	0.0040	0.0016
2008	0.0125	0.0052	0.0069	0.0041	0.0016
2009	0.0145	0.0052	0.0081	0.0049	0.0016
2010	0.0214	0.0074	0.0133	0.0067	0.0015
2011	0.0139	0.0056	0.0085	0.0040	0.0015
2012	0.0219	0.0054	0.0159	0.0047	0.0014
2013	0.0239	0.0066	0.0169	0.0058	0.0013
2014	0.0123	0.0045	0.0061	0.0052	0.0011
2015	0.0125	0.0073	0.0071	0.0043	0.0011
2016	0.0075	0.0046	0.0051	0.0014	0.0011

Table B (continued). Estimated total and fleet-specific apical instantaneous fishing mortality rates by year from SSASPM.

Panel B1. Recreational catches from the new calibrated MRIP estimates: Base scenario

Year	TotalF	Fleet-specific F			
		ComUnrep	Recreational	Mexican	Menhaden Disc
1981	0.0066	0.0002	0.0038	0.0026	0.0003
1982	0.0050	0.0002	0.0033	0.0014	0.0003
1983	0.0029	0.0003	0.0011	0.0015	0.0003
1984	0.0039	0.0004	0.0014	0.0022	0.0003
1985	0.0064	0.0003	0.0043	0.0018	0.0003
1986	0.0078	0.0024	0.0060	0.0016	0.0003
1987	0.0052	0.0023	0.0032	0.0017	0.0003
1988	0.0099	0.0047	0.0077	0.0019	0.0003
1989	0.0088	0.0049	0.0062	0.0023	0.0003
1990	0.0112	0.0026	0.0082	0.0027	0.0003
1991	0.0093	0.0028	0.0070	0.0021	0.0002
1992	0.0080	0.0032	0.0056	0.0023	0.0002
1993	0.0092	0.0023	0.0064	0.0027	0.0002
1994	0.0074	0.0022	0.0047	0.0025	0.0002
1995	0.0065	0.0030	0.0043	0.0021	0.0002
1996	0.0081	0.0023	0.0057	0.0023	0.0002
1997	0.0067	0.0017	0.0050	0.0016	0.0002
1998	0.0106	0.0023	0.0089	0.0015	0.0002
1999	0.0040	0.0019	0.0027	0.0011	0.0002
2000	0.0067	0.0018	0.0055	0.0010	0.0002
2001	0.0045	0.0014	0.0036	0.0008	0.0002
2002	0.0049	0.0011	0.0040	0.0008	0.0002
2003	0.0041	0.0024	0.0033	0.0007	0.0002
2004	0.0049	0.0015	0.0039	0.0008	0.0002
2005	0.0041	0.0012	0.0031	0.0008	0.0002
2006	0.0045	0.0019	0.0039	0.0005	0.0002
2007	0.0025	0.0016	0.0019	0.0004	0.0002
2008	0.0021	0.0005	0.0014	0.0005	0.0002
2009	0.0029	0.0005	0.0022	0.0005	0.0002
2010	0.0037	0.0007	0.0028	0.0008	0.0002
2011	0.0030	0.0006	0.0024	0.0005	0.0002
2012	0.0067	0.0005	0.0060	0.0005	0.0001
2013	0.0044	0.0007	0.0037	0.0007	0.0001
2014	0.0023	0.0005	0.0016	0.0006	0.0001
2015	0.0027	0.0007	0.0021	0.0005	0.0001
2016	0.0020	0.0005	0.0017	0.0002	0.0001

Table B (continued). Estimated total and fleet-specific apical instantaneous fishing mortality rates by year from SSASPM.

Panel B2. Recreational catches from the new calibrated MRIP estimates: High Catch scenario

Year	TotalF	Fleet-specific F			
		ComUnrep	Recreational	Mexican	Menhaden Disc
1981	0.0145	0.0002	0.0101	0.0041	0.0003
1982	0.0088	0.0002	0.0062	0.0023	0.0003
1983	0.0050	0.0002	0.0023	0.0025	0.0003
1984	0.0072	0.0003	0.0035	0.0035	0.0003
1985	0.0114	0.0003	0.0082	0.0029	0.0003
1986	0.0131	0.0022	0.0102	0.0027	0.0003
1987	0.0085	0.0022	0.0054	0.0028	0.0003
1988	0.0150	0.0044	0.0116	0.0032	0.0003
1989	0.0137	0.0046	0.0098	0.0037	0.0003
1990	0.0170	0.0025	0.0124	0.0044	0.0003
1991	0.0166	0.0026	0.0131	0.0034	0.0002
1992	0.0130	0.0030	0.0092	0.0037	0.0002
1993	0.0158	0.0022	0.0113	0.0043	0.0002
1994	0.0122	0.0023	0.0081	0.0040	0.0002
1995	0.0109	0.0030	0.0074	0.0034	0.0002
1996	0.0125	0.0023	0.0087	0.0037	0.0002
1997	0.0107	0.0017	0.0081	0.0025	0.0002
1998	0.0177	0.0023	0.0151	0.0025	0.0002
1999	0.0064	0.0018	0.0044	0.0018	0.0002
2000	0.0106	0.0017	0.0088	0.0017	0.0002
2001	0.0075	0.0014	0.0062	0.0012	0.0002
2002	0.0101	0.0011	0.0086	0.0013	0.0002
2003	0.0081	0.0024	0.0069	0.0011	0.0002
2004	0.0092	0.0015	0.0078	0.0013	0.0002
2005	0.0071	0.0011	0.0057	0.0013	0.0002
2006	0.0109	0.0018	0.0101	0.0007	0.0002
2007	0.0046	0.0016	0.0037	0.0007	0.0002
2008	0.0040	0.0005	0.0031	0.0007	0.0002
2009	0.0056	0.0005	0.0046	0.0009	0.0002
2010	0.0073	0.0007	0.0060	0.0012	0.0002
2011	0.0065	0.0006	0.0056	0.0007	0.0002
2012	0.0148	0.0005	0.0139	0.0009	0.0001
2013	0.0096	0.0007	0.0084	0.0011	0.0001
2014	0.0043	0.0005	0.0032	0.0010	0.0001
2015	0.0059	0.0008	0.0050	0.0008	0.0001
2016	0.0041	0.0005	0.0037	0.0003	0.0001

Table B (continued). Estimated total and fleet-specific apical instantaneous fishing mortality rates by year from SSASPM.

Panel B3. Recreational catches from the new calibrated MRIP estimates: Low Catch scenario

Year	TotalF	Fleet-specific F			
		ComUnrep	Recreational	Mexican	Menhaden Disc
1981	0.0014	0.0002	0.0000	0.0011	0.0003
1982	0.0013	0.0002	0.0004	0.0006	0.0003
1983	0.0010	0.0002	0.0001	0.0006	0.0003
1984	0.0012	0.0003	0.0000	0.0009	0.0003
1985	0.0015	0.0003	0.0005	0.0007	0.0003
1986	0.0030	0.0022	0.0018	0.0007	0.0003
1987	0.0028	0.0022	0.0010	0.0007	0.0003
1988	0.0055	0.0044	0.0034	0.0008	0.0003
1989	0.0054	0.0045	0.0022	0.0009	0.0003
1990	0.0053	0.0024	0.0039	0.0011	0.0003
1991	0.0031	0.0025	0.0009	0.0008	0.0002
1992	0.0039	0.0029	0.0024	0.0009	0.0002
1993	0.0029	0.0021	0.0014	0.0011	0.0002
1994	0.0030	0.0018	0.0018	0.0010	0.0002
1995	0.0033	0.0026	0.0017	0.0008	0.0002
1996	0.0040	0.0020	0.0029	0.0009	0.0002
1997	0.0033	0.0014	0.0025	0.0006	0.0002
1998	0.0046	0.0020	0.0038	0.0006	0.0002
1999	0.0022	0.0017	0.0012	0.0004	0.0002
2000	0.0036	0.0016	0.0030	0.0004	0.0002
2001	0.0022	0.0013	0.0017	0.0003	0.0002
2002	0.0019	0.0010	0.0014	0.0003	0.0002
2003	0.0026	0.0021	0.0015	0.0003	0.0002
2004	0.0019	0.0014	0.0014	0.0004	0.0002
2005	0.0019	0.0010	0.0014	0.0003	0.0002
2006	0.0020	0.0017	0.0009	0.0002	0.0002
2007	0.0017	0.0014	0.0009	0.0002	0.0002
2008	0.0009	0.0004	0.0006	0.0002	0.0001
2009	0.0012	0.0004	0.0008	0.0002	0.0001
2010	0.0014	0.0006	0.0010	0.0003	0.0001
2011	0.0008	0.0005	0.0005	0.0002	0.0001
2012	0.0027	0.0005	0.0023	0.0002	0.0001
2013	0.0017	0.0006	0.0013	0.0003	0.0001
2014	0.0009	0.0004	0.0005	0.0002	0.0001
2015	0.0010	0.0006	0.0007	0.0002	0.0001
2016	0.0006	0.0004	0.0004	0.0001	0.0001

Table B (continued). Estimated total and fleet-specific apical instantaneous fishing mortality rates by year from SSASPM.

Panel B4. Recreational catches from the new calibrated MRIP estimates: High Productivity scenario

Year	TotalF	Fleet-specific F			
		ComUnrep	Recreational	Mexican	Menhaden Disc
1981	0.0629	0.0013	0.0366	0.0244	0.0022
1982	0.0487	0.0013	0.0325	0.0142	0.0023
1983	0.0283	0.0015	0.0111	0.0151	0.0023
1984	0.0372	0.0020	0.0134	0.0217	0.0023
1985	0.0638	0.0019	0.0438	0.0182	0.0021
1986	0.0810	0.0140	0.0622	0.0169	0.0022
1987	0.0537	0.0142	0.0335	0.0182	0.0023
1988	0.1053	0.0295	0.0827	0.0206	0.0023
1989	0.0961	0.0320	0.0689	0.0250	0.0025
1990	0.1273	0.0177	0.0949	0.0304	0.0026
1991	0.1066	0.0194	0.0815	0.0234	0.0021
1992	0.0900	0.0230	0.0630	0.0255	0.0018
1993	0.1028	0.0171	0.0716	0.0298	0.0019
1994	0.0820	0.0163	0.0530	0.0273	0.0021
1995	0.0716	0.0227	0.0471	0.0228	0.0020
1996	0.0879	0.0177	0.0616	0.0247	0.0020
1997	0.0712	0.0130	0.0528	0.0167	0.0020
1998	0.1127	0.0178	0.0944	0.0167	0.0019
1999	0.0427	0.0149	0.0290	0.0119	0.0021
2000	0.0710	0.0141	0.0583	0.0112	0.0018
2001	0.0475	0.0113	0.0380	0.0080	0.0017
2002	0.0516	0.0090	0.0416	0.0087	0.0016
2003	0.0432	0.0191	0.0346	0.0073	0.0016
2004	0.0507	0.0121	0.0405	0.0088	0.0016
2005	0.0429	0.0092	0.0328	0.0087	0.0016
2006	0.0472	0.0149	0.0411	0.0048	0.0015
2007	0.0258	0.0125	0.0198	0.0046	0.0015
2008	0.0209	0.0039	0.0149	0.0047	0.0015
2009	0.0292	0.0039	0.0223	0.0056	0.0014
2010	0.0378	0.0055	0.0288	0.0078	0.0014
2011	0.0302	0.0042	0.0244	0.0046	0.0014
2012	0.0686	0.0041	0.0622	0.0055	0.0013
2013	0.0460	0.0050	0.0382	0.0069	0.0012
2014	0.0234	0.0034	0.0163	0.0062	0.0011
2015	0.0281	0.0055	0.0221	0.0051	0.0010
2016	0.0202	0.0034	0.0177	0.0016	0.0010

Table B (continued). Estimated total and fleet-specific apical instantaneous fishing mortality rates by year from SSASPM.

Panel B5. Recreational catches from the new calibrated MRIP estimates:
Low Productivity scenario

Year	TotalF	Fleet-specific F			
		ComUnrep	Recreational	Mexican	Menhaden Disc
1981	0.0070	0.0003	0.0040	0.0027	0.0004
1982	0.0053	0.0003	0.0034	0.0015	0.0004
1983	0.0031	0.0003	0.0012	0.0016	0.0004
1984	0.0041	0.0005	0.0014	0.0023	0.0004
1985	0.0067	0.0004	0.0045	0.0019	0.0003
1986	0.0081	0.0031	0.0061	0.0017	0.0003
1987	0.0053	0.0031	0.0032	0.0018	0.0004
1988	0.0102	0.0062	0.0079	0.0020	0.0003
1989	0.0092	0.0064	0.0065	0.0024	0.0004
1990	0.0118	0.0034	0.0086	0.0029	0.0004
1991	0.0098	0.0036	0.0074	0.0022	0.0003
1992	0.0085	0.0042	0.0059	0.0024	0.0003
1993	0.0098	0.0030	0.0068	0.0028	0.0003
1994	0.0079	0.0029	0.0050	0.0026	0.0003
1995	0.0069	0.0039	0.0045	0.0022	0.0003
1996	0.0084	0.0030	0.0058	0.0024	0.0003
1997	0.0068	0.0022	0.0050	0.0016	0.0003
1998	0.0110	0.0030	0.0092	0.0016	0.0002
1999	0.0042	0.0025	0.0028	0.0012	0.0003
2000	0.0072	0.0023	0.0059	0.0011	0.0002
2001	0.0049	0.0019	0.0039	0.0008	0.0002
2002	0.0054	0.0015	0.0043	0.0009	0.0002
2003	0.0045	0.0032	0.0036	0.0007	0.0002
2004	0.0053	0.0020	0.0042	0.0009	0.0002
2005	0.0045	0.0015	0.0034	0.0009	0.0002
2006	0.0049	0.0025	0.0043	0.0005	0.0002
2007	0.0028	0.0021	0.0021	0.0005	0.0002
2008	0.0022	0.0007	0.0016	0.0005	0.0002
2009	0.0031	0.0007	0.0024	0.0006	0.0002
2010	0.0040	0.0010	0.0030	0.0008	0.0002
2011	0.0032	0.0007	0.0026	0.0005	0.0002
2012	0.0072	0.0007	0.0065	0.0006	0.0002
2013	0.0048	0.0009	0.0039	0.0007	0.0002
2014	0.0025	0.0006	0.0017	0.0006	0.0001
2015	0.0029	0.0010	0.0023	0.0005	0.0001
2016	0.0022	0.0006	0.0019	0.0002	0.0001

Table B (continued). Estimated total and fleet-specific apical instantaneous fishing mortality rates by year from SSASPM.

Panel B6. Recreational catches from the new calibrated MRIP estimates: Lognormal Prior R_0 scenario

Year	TotalF	Fleet-specific F			
		ComUnrep	Recreational	Mexican	Menhaden Disc
1981	0.0480	0.0017	0.0275	0.0185	0.0023
1982	0.0371	0.0017	0.0242	0.0107	0.0024
1983	0.0218	0.0019	0.0082	0.0114	0.0024
1984	0.0285	0.0026	0.0100	0.0163	0.0024
1985	0.0480	0.0025	0.0324	0.0137	0.0022
1986	0.0598	0.0181	0.0453	0.0125	0.0022
1987	0.0400	0.0184	0.0244	0.0134	0.0024
1988	0.0773	0.0385	0.0600	0.0152	0.0024
1989	0.0707	0.0418	0.0499	0.0184	0.0026
1990	0.0927	0.0231	0.0682	0.0223	0.0026
1991	0.0779	0.0252	0.0589	0.0173	0.0021
1992	0.0669	0.0299	0.0463	0.0189	0.0019
1993	0.0770	0.0221	0.0531	0.0223	0.0020
1994	0.0621	0.0211	0.0397	0.0206	0.0021
1995	0.0549	0.0293	0.0357	0.0174	0.0020
1996	0.0676	0.0228	0.0469	0.0190	0.0020
1997	0.0549	0.0167	0.0402	0.0128	0.0020
1998	0.0870	0.0228	0.0725	0.0129	0.0020
1999	0.0337	0.0192	0.0224	0.0093	0.0021
2000	0.0560	0.0181	0.0456	0.0089	0.0018
2001	0.0378	0.0144	0.0299	0.0064	0.0017
2002	0.0413	0.0114	0.0330	0.0069	0.0016
2003	0.0349	0.0241	0.0276	0.0058	0.0016
2004	0.0410	0.0154	0.0324	0.0071	0.0016
2005	0.0348	0.0117	0.0263	0.0070	0.0016
2006	0.0383	0.0190	0.0330	0.0039	0.0015
2007	0.0217	0.0159	0.0159	0.0038	0.0015
2008	0.0173	0.0049	0.0120	0.0038	0.0015
2009	0.0239	0.0050	0.0180	0.0046	0.0015
2010	0.0308	0.0071	0.0232	0.0063	0.0015
2011	0.0246	0.0053	0.0196	0.0038	0.0015
2012	0.0553	0.0052	0.0498	0.0044	0.0013
2013	0.0369	0.0064	0.0303	0.0055	0.0012
2014	0.0188	0.0043	0.0129	0.0050	0.0011
2015	0.0226	0.0071	0.0175	0.0041	0.0011
2016	0.0163	0.0044	0.0141	0.0013	0.0011

Appendix 3. Projection results using recreational catches from the new calibrated MRIP estimates.

Table 3.1. Stock projection information.

Panel A. Projection information

Projection information	Value
First projection year	2017
End projection year	2046 (30 years) (One generation is cf., 11 years)
Interim projection years at current fishing mortality rate	2017, 2018, 2019 (3 years)
Projection criteria in the following years	Fixed removals (2020-2046)

Table 3.1. Continued. Stock projection information.

Panel B. Projections iteratively solved for the annual fishing mortality at the indicated fixed level of total removals due to fishing

Alternative	Fixed removals (1000s)[1]	Fixed removals (1000s)[2]
1	0	1000
2	100	1100
3	200	1200
4	300	1300
5	400	1400
6	500	1500
7	600	1600
8	700	1700
9	800	1800
10	900	1900
11	1000	2000
12	1100	2100
13	1200	2200
14	1300	2300
15	1400	2400
16	1500	2500
17	1600	2600
18	1700	2700
19	1800	2800
20	1900	2900
21	2000	3000

[1] Projection scenarios for Ranked CPUE Weighting, Low Catch, Low Productivity, High Productivity, and Lognormal Prior on R0—with updated MRIP recreational catch estimates.
[2] Projection Scenario for High Catch—with updated MRIP recreational catch estimates.

Table 3.2. A summary of projection model results is presented for the baseline SSASPM configuration (Ranked CPUE Weighting) and selected SSASPM model sensitivity analyses (Low Catch, High Catch, Low Productivity, High Productivity, and Lognormal Prior on R0) with updated MRIP recreational catch estimates. Projection results provide examples from 10,000 Monte Carlo projections of a given fixed level of total annual removals due to fishing (1,000s of sharks) which resulted in both the $Pr(SSF_t > SSF_{MSY}) \geq 70\%$ and $Pr(F_t > F_{MSY}) \leq 30\%$ during the years 2017 – 2046).

Projection scenario	Model configuration (Updated Recreational Catch)	Example of fixed removals (1000s)
1	Baseline, Ranked CPUE Weighting— with updated MRIP recreational catch estimates	1600
2	Sensitivity, Low Catch— with updated MRIP recreational catch estimates	1600[1]
3	Sensitivity, High Catch— with updated MRIP recreational catch estimates	2100
4	Sensitivity, Low Productivity— with updated MRIP recreational catch estimates	500[1]
5	Sensitivity, High Productivity— with updated MRIP recreational catch estimates	300
6	Sensitivity, Lognormal Prior R0— with updated MRIP recreational catch estimates	200[2]

[1] The SSASPM parameter estimates for equilibrium recruitment, R_0, appeared to be at an upper boundary condition (1.0×10^7) in two Projection Scenarios (2 and 4), which likely affected both the absolute scale of the projections and uncertainty in the initial parameters used in these projection scenarios (**Figure 3.3 Panels B and D; Figure 3.4 Panels B and D**).

[2] The SSASPM parameter estimate for pup survival at low biomass, e^{-M_0}, appeared to be near an upper boundary condition (0.99) for Projection Scenario 6, which may also have affected both the absolute scale of the projections and uncertainty in the initial parameters used in this projection scenario (**Figure 3.3 Panel F; Figure 3.4 Panel F**).

Table 3.3. Probabilities from 10,000 Monte Carlo bootstrap projections that spawning stock fecundity (SSFt) will exceed the level of SSF that will produce MSY (SSF_{MSY}), Pr(SSFt > SSF_{MSY}), for a given year (2037 – 2046) and a given fixed removals level (1,000s); Green Pr ≥ 70%, Yellow 70% > Pr ≥ 50%, Red Pr < 50%.

Panel A. Projection Scenario-1 (Baseline, Ranked CPUE Weighting— with updated MRIP recreational catch estimates).

Fixed Harvest	1,000s	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
1	0	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97	0.98	0.98
2	100	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97
3	200	0.95	0.95	0.95	0.96	0.96	0.96	0.96	0.96	0.97	0.97
4	300	0.95	0.95	0.95	0.96	0.96	0.96	0.96	0.96	0.96	0.96
5	400	0.94	0.94	0.95	0.95	0.95	0.95	0.95	0.95	0.96	0.96
6	500	0.94	0.94	0.94	0.94	0.95	0.95	0.95	0.95	0.95	0.95
7	600	0.93	0.93	0.93	0.93	0.94	0.94	0.94	0.94	0.94	0.94
8	700	0.92	0.93	0.93	0.93	0.93	0.93	0.93	0.94	0.94	0.94
9	800	0.91	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.93
10	900	0.91	0.91	0.91	0.91	0.92	0.92	0.92	0.92	0.92	0.92
11	1000	0.90	0.90	0.90	0.90	0.90	0.90	0.91	0.91	0.91	0.91
12	1100	0.89	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
13	1200	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
14	1300	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.87
15	1400	0.86	0.86	0.86	0.86	0.85	0.85	0.85	0.85	0.85	0.85
16	1500	0.85	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.84	0.84
17	1600	0.85	0.85	0.84	0.84	0.84	0.83	0.83	0.83	0.82	0.82
18	1700	0.84	0.83	0.83	0.82	0.82	0.82	0.81	0.81	0.80	0.80
19	1800	0.82	0.82	0.81	0.81	0.80	0.79	0.79	0.78	0.77	0.77
20	1900	0.80	0.80	0.79	0.78	0.78	0.77	0.76	0.75	0.75	0.74
21	2000	0.79	0.78	0.77	0.77	0.76	0.75	0.74	0.73	0.72	0.71

Panel B. Projection Scenario-2 (Sensitivity, Low Catch— with updated MRIP recreational catch estimates).

Fixed Harvest	1,000s	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
1	0	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99
2	100	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	1.00	1.00
3	200	>=0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	300	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	400	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	1.00	1.00	1.00	1.00	1.00
6	500	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99	>=0.99
7	600	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	700	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	800	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	900	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1000	>=0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	1200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	1300	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15	1400	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99
16	1500	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99
17	1600	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.98
18	1700	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.98	0.98	0.97
19	1800	1.00	1.00	1.00	0.99	0.99	0.99	0.98	0.97	0.96	0.94
20	1900	1.00	1.00	0.99	0.99	0.98	0.98	0.96	0.95	0.92	0.90
21	2000	1.00	0.99	0.99	0.98	0.97	0.96	0.94	0.90	0.86	0.81

Table 3.3. Continued.

Panel C. Projection Scenario-3 (Sensitivity, High Catch— with updated MRIP recreational catch estimates).

Fixed Harvest	1,000s	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
1	1000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	1100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	1200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99
4	1300	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99
5	1400	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99
6	1500	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
7	1600	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
8	1700	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98
9	1800	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98
10	1900	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.97
11	2000	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.97	0.97
12	2100	0.99	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.96	0.96
13	2200	0.98	0.98	0.97	0.97	0.97	0.96	0.96	0.95	0.95	0.94
14	2300	0.98	0.97	0.97	0.96	0.96	0.95	0.94	0.94	0.93	0.92
15	2400	0.97	0.97	0.96	0.96	0.95	0.94	0.93	0.92	0.91	0.89
16	2500	0.97	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.88	0.86
17	2600	0.96	0.95	0.94	0.93	0.92	0.90	0.88	0.86	0.84	0.81
18	2700	0.95	0.94	0.93	0.91	0.90	0.88	0.85	0.83	0.80	0.76
19	2800	0.94	0.92	0.91	0.89	0.87	0.84	0.81	0.77	0.72	0.68
20	2900	0.92	0.91	0.89	0.86	0.83	0.80	0.75	0.71	0.66	0.60
21	3000	0.91	0.89	0.86	0.83	0.79	0.75	0.70	0.64	0.57	0.50

Panel D. Projection Scenario-4 (Sensitivity, Low Productivity— with updated MRIP recreational catch estimates).

Fixed Harvest	1,000s	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
1	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	300	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99
5	400	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99
6	500	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99
7	600	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98
8	700	1.00	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.97	0.97
9	800	0.99	0.99	0.99	0.99	0.98	0.98	0.97	0.96	0.95	0.94
10	900	0.99	0.99	0.98	0.98	0.97	0.96	0.95	0.93	0.92	0.90
11	1000	0.99	0.98	0.97	0.96	0.95	0.93	0.91	0.89	0.86	0.83
12	1100	0.98	0.97	0.96	0.94	0.92	0.89	0.86	0.82	0.77	0.72
13	1200	0.97	0.95	0.93	0.90	0.87	0.82	0.77	0.70	0.63	0.55
14	1300	0.95	0.92	0.89	0.84	0.78	0.71	0.63	0.54	0.44	0.34
15	1400	0.91	0.87	0.81	0.74	0.64	0.54	0.43	0.32	0.22	0.13
16	1500	0.85	0.79	0.70	0.59	0.46	0.33	0.21	0.12	0.06	0.02
17	1600	0.77	0.66	0.53	0.39	0.25	0.14	0.06	0.02	0.01	0.00
18	1700	0.65	0.50	0.35	0.21	0.10	0.04	0.01	0.00	0.00	0.00
19	1800	0.49	0.32	0.17	0.07	0.02	0.00	0.00	0.00	0.00	0.00
20	1900	0.30	0.15	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00
21	2000	0.16	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 3.3. Continued.

Panel E. Projection Scenario-5 (Sensitivity, High Productivity— with updated MRIP recreational catch estimates).

Fixed Harvest	1,000s	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
1	0	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99
2	100	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97
3	200	0.92	0.92	0.92	0.93	0.93	0.93	0.93	0.93	0.94	0.94
4	300	0.85	0.85	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.84
5	400	0.74	0.72	0.71	0.70	0.68	0.66	0.64	0.62	0.60	0.58
6	500	0.55	0.51	0.47	0.42	0.38	0.33	0.27	0.22	0.17	0.12
7	600	0.31	0.25	0.19	0.13	0.08	0.04	0.01	0.00	0.00	0.00
8	700	0.10	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	1100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	1300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	1400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Panel F. Projection Scenario-6 (Sensitivity, Lognormal Prior R0— with updated MRIP recreational catch estimates).

Fixed Harvest	1,000s	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
1	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	200	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
4	300	0.91	0.90	0.89	0.89	0.88	0.87	0.86	0.85	0.84	0.83
5	400	0.61	0.55	0.48	0.41	0.34	0.26	0.20	0.13	0.08	0.05
6	500	0.12	0.07	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00
7	600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	1100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	1300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	1400	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	1600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	1700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	1800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 3.4. Probabilities from 10,000 Monte Carlo bootstrap projections that fishing mortality (F_t) will exceed the level of F that will produce MSY (F_{MSY}), Pr($Ft > F_{MSY}$), for a given year (2037 – 2046) and a given fixed removals level (1,000s); Green Pr ≤ 30%, Yellow 30% > Pr ≤ 50%, Red Pr > 50%.

Panel A. Projection Scenario-1 (Baseline, Ranked CPUE Weighting— with updated MRIP recreational catch estimates).

Fixed Harvest	1,000s	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
1	0	<=0.01	<=0.01	0.00	<=0.01	0.00	<=0.01	0.00	<=0.01	<=0.01	<=0.01
2	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	200	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4	300	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5	400	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
6	500	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
7	600	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
8	700	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
9	800	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
10	900	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
11	1000	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
12	1100	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08
13	1200	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
14	1300	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
15	1400	0.14	0.14	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.15
16	1500	0.16	0.17	0.17	0.17	0.17	0.18	0.18	0.18	0.19	0.19
17	1600	0.20	0.21	0.21	0.21	0.22	0.22	0.23	0.23	0.24	0.24
18	1700	0.25	0.26	0.26	0.27	0.28	0.29	0.30	0.31	0.32	0.33
19	1800	0.32	0.33	0.34	0.35	0.37	0.38	0.40	0.41	0.43	0.45
20	1900	0.41	0.43	0.45	0.47	0.49	0.51	0.54	0.56	0.59	0.62
21	2000	0.52	0.55	0.58	0.61	0.64	0.68	0.72	0.76	0.79	0.83

Panel B. Projection Scenario-2 (Sensitivity, Low Catch— with updated MRIP recreational catch estimates).

Fixed Harvest	1,000s	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
1	0	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01
2	100	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01
3	200	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	0.00	0.00	0.00	0.00
4	300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	400	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	0.00	0.00	0.00	0.00
6	500	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01
7	600	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	700	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	800	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	1100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
14	1300	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02
15	1400	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04
16	1500	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.07	0.09	0.10
17	1600	0.03	0.04	0.06	0.08	0.10	0.13	0.17	0.21	0.25	0.30
18	1700	0.11	0.16	0.23	0.31	0.39	0.49	0.58	0.67	0.76	0.84
19	1800	0.56	0.74	0.88	0.98	1.00	1.00	1.00	1.00	1.00	1.00
20	1900	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
21	2000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 3.4. Continued.

Panel C. Projection Scenario-3 (Sensitivity, High Catch— with updated MRIP recreational catch estimates).

Fixed Harvest	1,000s	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
1	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	1100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	1200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
4	1300	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
5	1400	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
6	1500	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
7	1600	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
8	1700	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
9	1800	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.06
10	1900	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.08	0.08	0.09
11	2000	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15
12	2100	0.11	0.12	0.14	0.15	0.17	0.19	0.22	0.24	0.27	0.29
13	2200	0.21	0.23	0.26	0.29	0.33	0.36	0.40	0.44	0.48	0.53
14	2300	0.36	0.41	0.46	0.52	0.57	0.63	0.68	0.74	0.79	0.84
15	2400	0.60	0.67	0.73	0.79	0.85	0.90	0.94	0.96	0.98	0.99
16	2500	0.85	0.91	0.95	0.97	0.99	1.00	1.00	1.00	1.00	1.00
17	2600	0.98	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
18	2700	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
19	2800	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	2900	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
21	3000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Panel D. Projection Scenario-4 (Sensitivity, Low Productivity— with updated MRIP recreational catch estimates).

Fixed Harvest	1,000s	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
1	0	<=0.01	<=0.01	<=0.01	0.00	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01
2	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	300	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
5	400	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03
6	500	0.03	0.03	0.04	0.04	0.05	0.06	0.06	0.07	0.08	0.09
7	600	0.21	0.25	0.28	0.32	0.36	0.41	0.45	0.49	0.54	0.58
8	700	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	800	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	900	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	1200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	1300	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15	1400	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
16	1500	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
17	1600	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
18	1700	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
19	1800	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	1900	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
21	2000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 3.4. Continued.

Panel E. Projection Scenario-5 (Sensitivity, High Productivity— with updated MRIP recreational catch estimates).

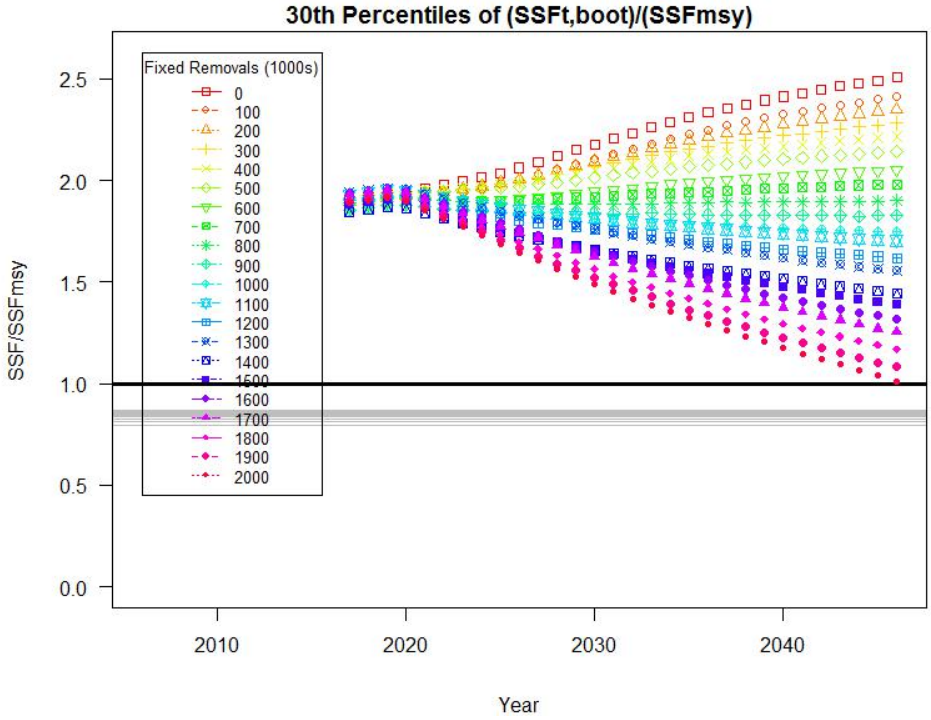
Fixed Harvest	1,000s	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
1	0	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01
2	100	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
3	200	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
4	300	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.16
5	400	0.77	0.81	0.86	0.90	0.94	0.97	0.99	1.00	1.00	1.00
6	500	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	600	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	700	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	800	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	900	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	1200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	1300	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15	1400	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
16	1500	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
17	1600	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
18	1700	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
19	1800	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	1900	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
21	2000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Panel F. Projection Scenario-6 (Sensitivity, Lognormal Prior R0— with updated MRIP recreational catch estimates).

Fixed Harvest	1,000s	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
1	0	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01	<=0.01
2	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	200	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	300	0.48	0.52	0.57	0.62	0.67	0.72	0.77	0.82	0.86	0.90
5	400	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	500	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	600	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	700	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	800	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	900	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	1200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	1300	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15	1400	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
16	1500	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
17	1600	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
18	1700	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
19	1800	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	1900	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
21	2000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Figure 3.1. The 30th percentiles of $SSF_{t,boot}$/ SSF_{MSY} (2017 – 2046) represent the 70% probability of maintaining $SSF_{t,}$ above SSF_{MSY} from 10,000 Monte Carlo bootstrap projections for a given level of fixed removals (in 1000s) and a given year.

Panel A. Projection Scenario-1 (Baseline, Ranked CPUE Weighting— with updated MRIP recreational catch estimates).



Panel B. Projection Scenario-2 (Sensitivity, Low Catch— with updated MRIP recreational catch estimates).

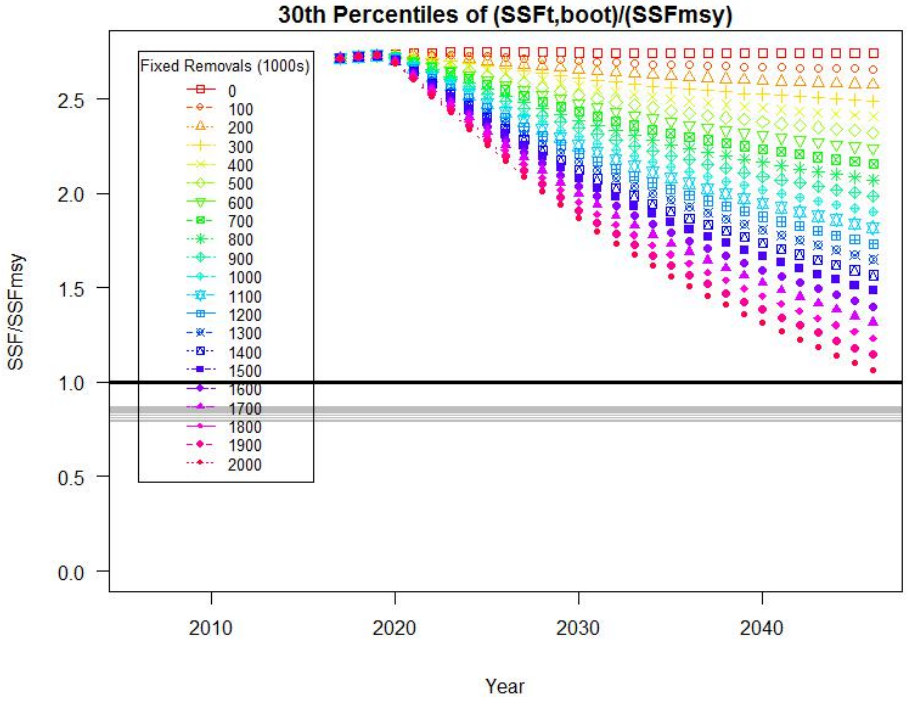
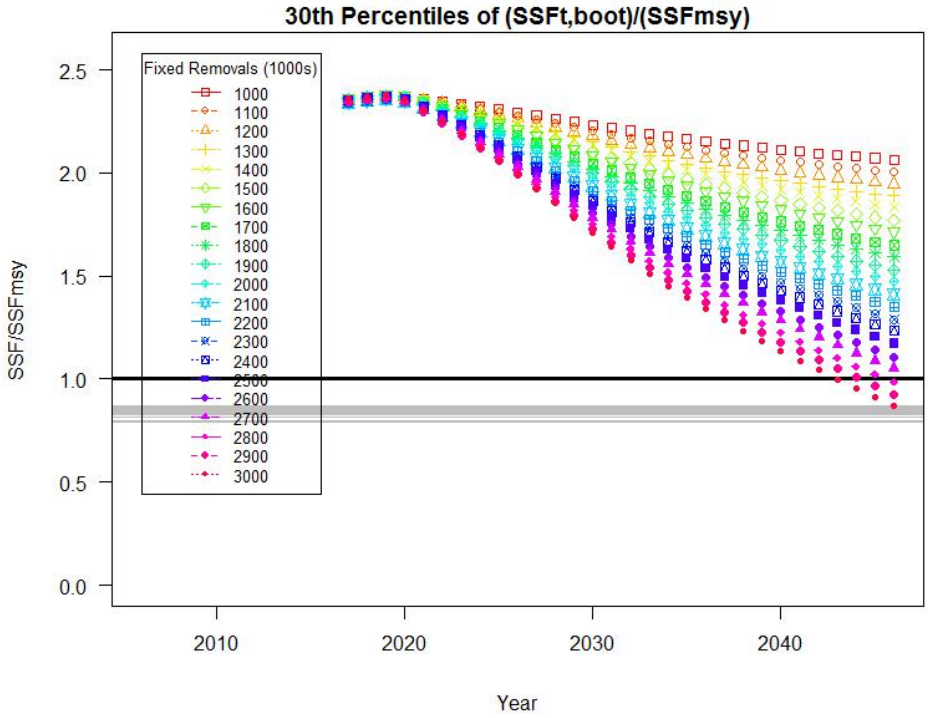


Figure 3.1. Continued.

Panel C. Projection Scenario-3 (Sensitivity, High Catch— with updated MRIP recreational catch estimates).



Panel D. Projection Scenario-4 (Sensitivity, Low Productivity— with updated MRIP recreational catch estimates).

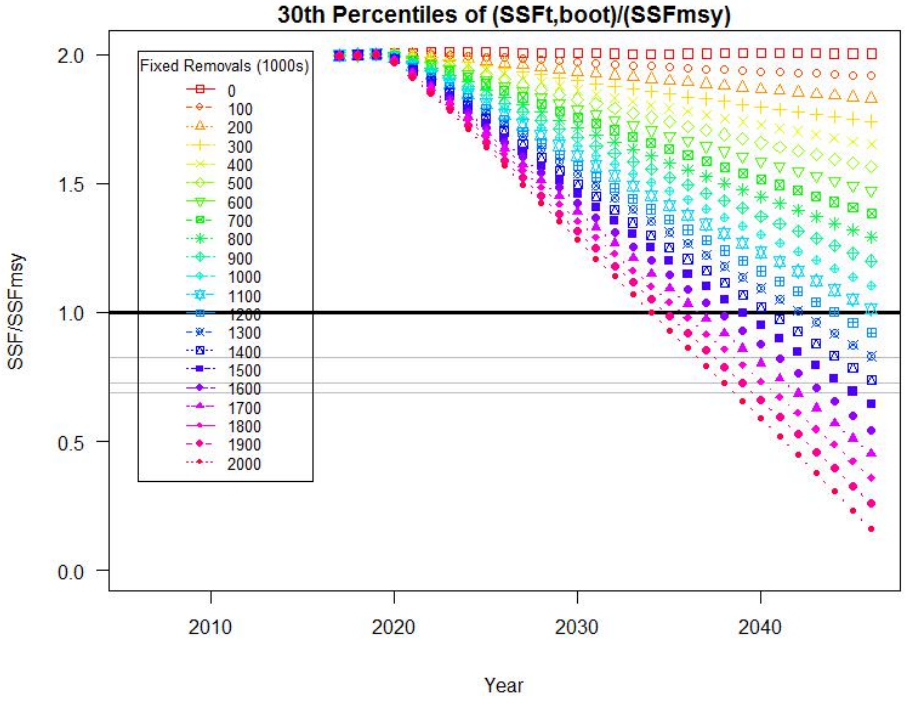
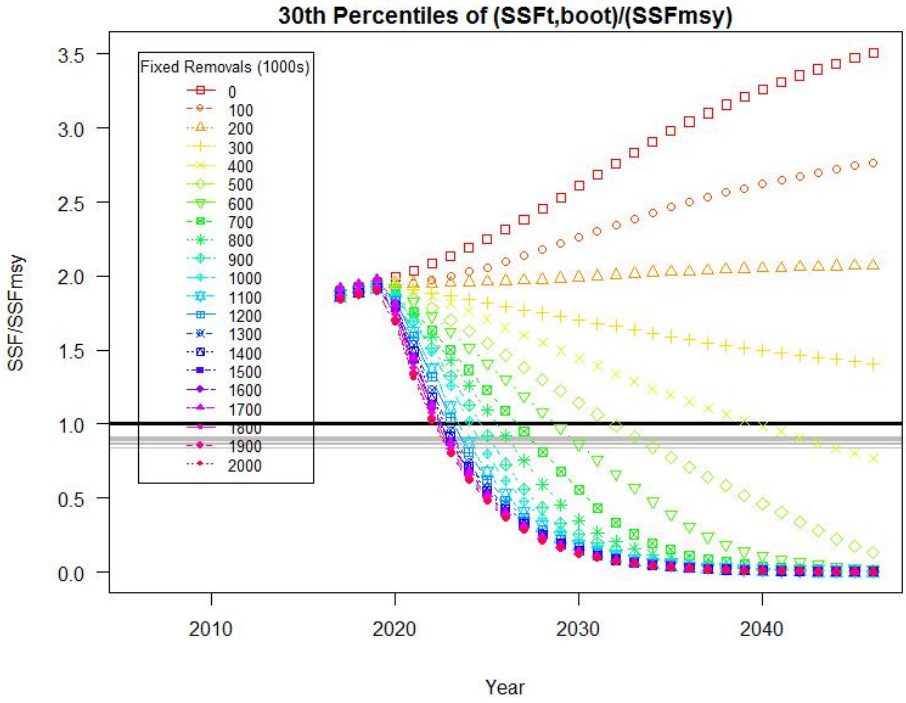


Figure 3.1. Continued.

Panel E. Projection Scenario-5 (Sensitivity, High Productivity— with updated MRIP recreational catch estimates).



Panel F. Projection Scenario-6 (Sensitivity, Lognormal Prior R0— with updated MRIP recreational catch estimates).

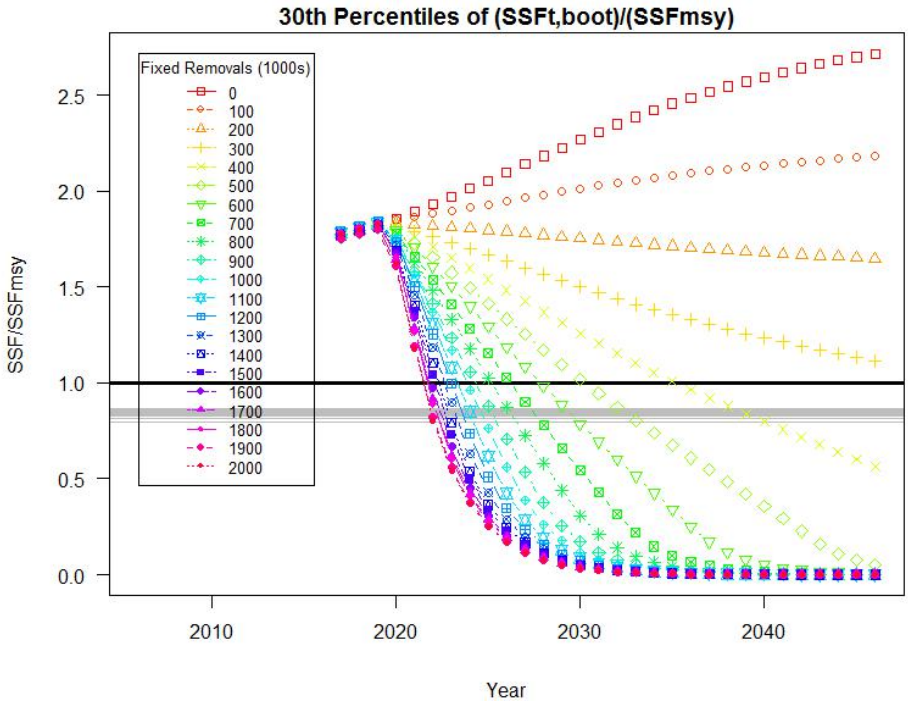
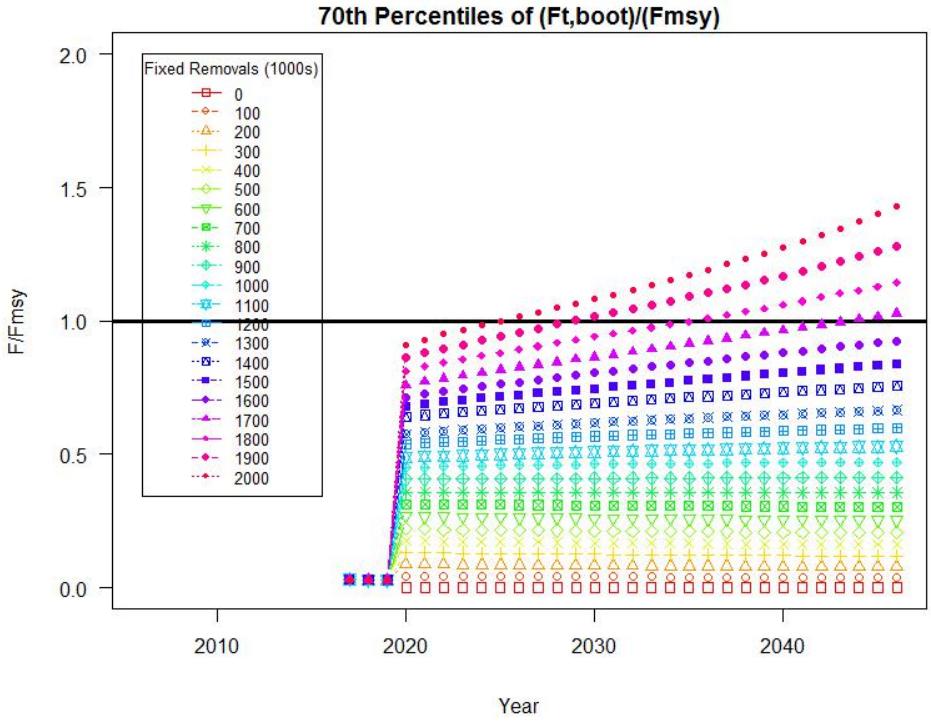


Figure 3.2. The 70th percentiles of $F_{t,boot}/ F_{MSY}$ (2017 – 2046) represent the 30% probability of $F_{t,boot}$ exceeding F_{MSY} for a given level of fixed removals (in 1000s) and a given year.

Panel A. Projection Scenario-1 (Baseline, Ranked CPUE Weighting— with updated MRIP recreational catch estimates).



Panel B. Projection Scenario-2 (Sensitivity, Low Catch— with updated MRIP recreational catch estimates).

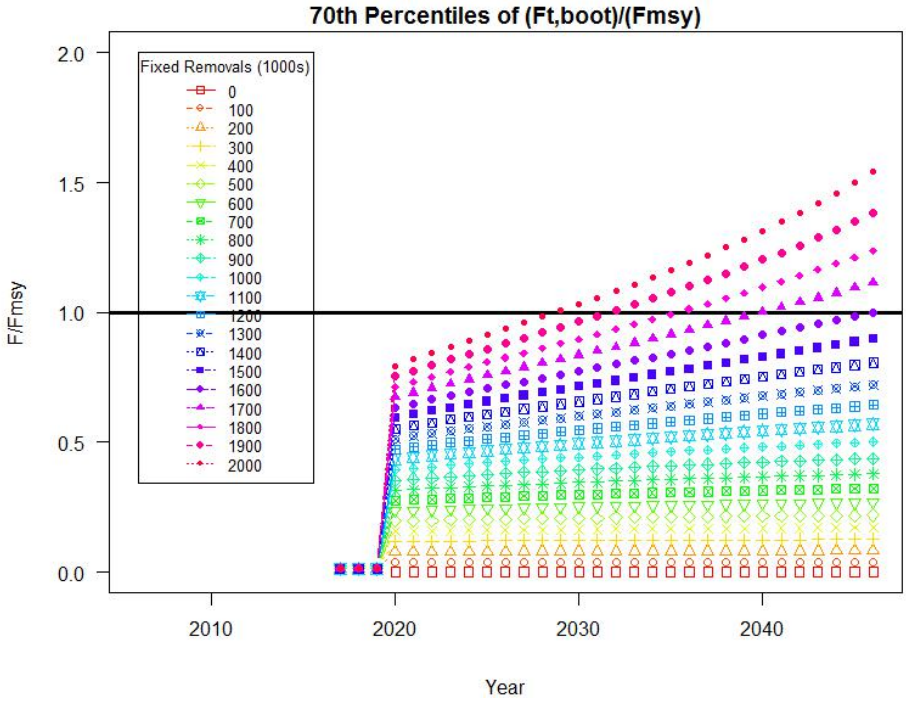
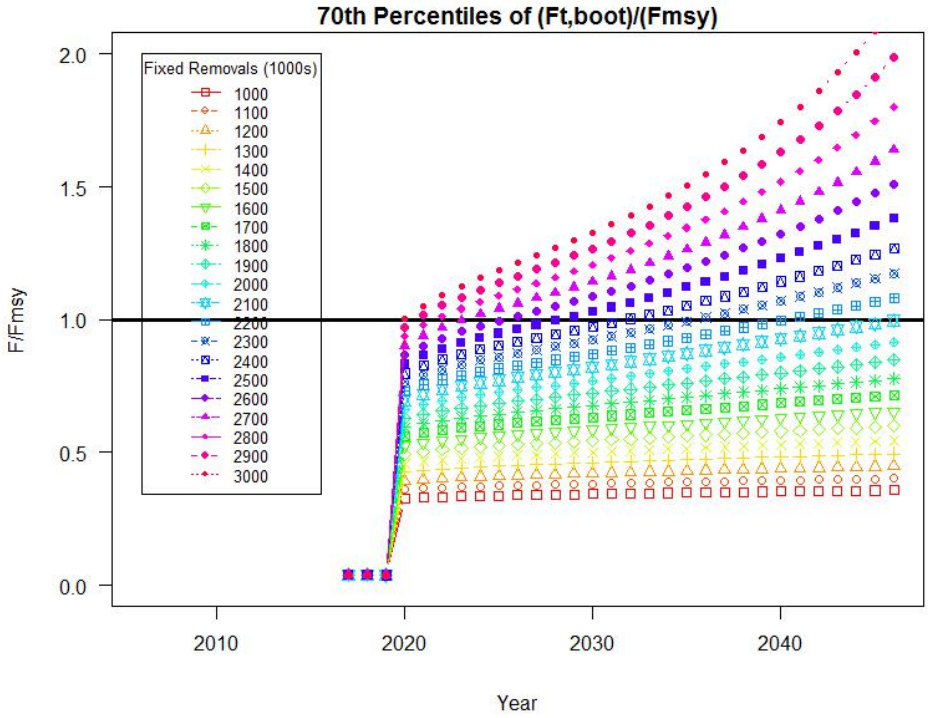


Figure 3.2. Continued.

Panel C. Projection Scenario-3 (Sensitivity, High Catch— with updated MRIP recreational catch estimates).



Panel D. Projection Scenario-4 (Sensitivity, Low Productivity— with updated MRIP recreational catch estimates).

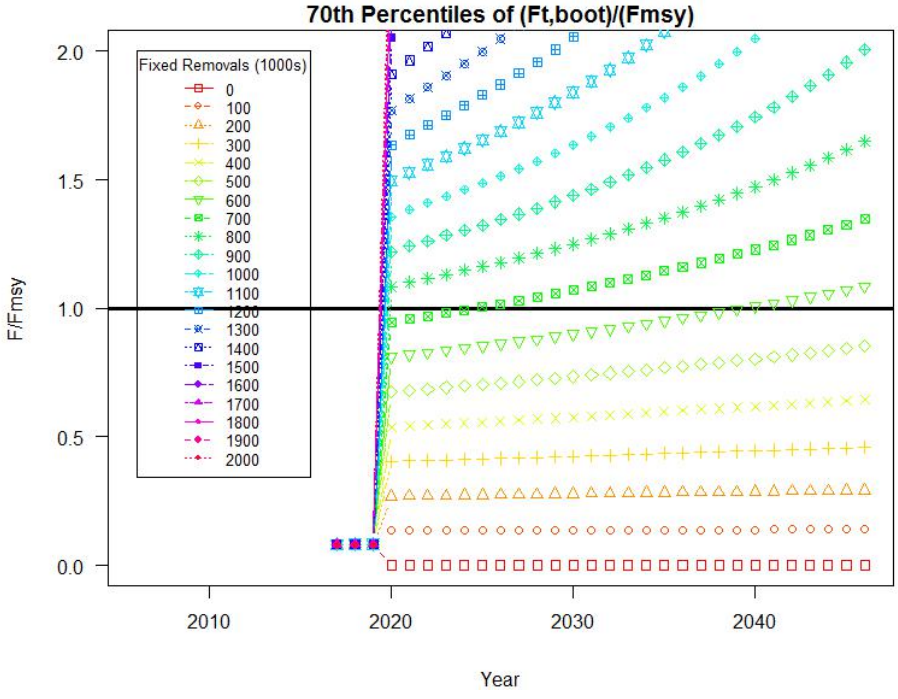
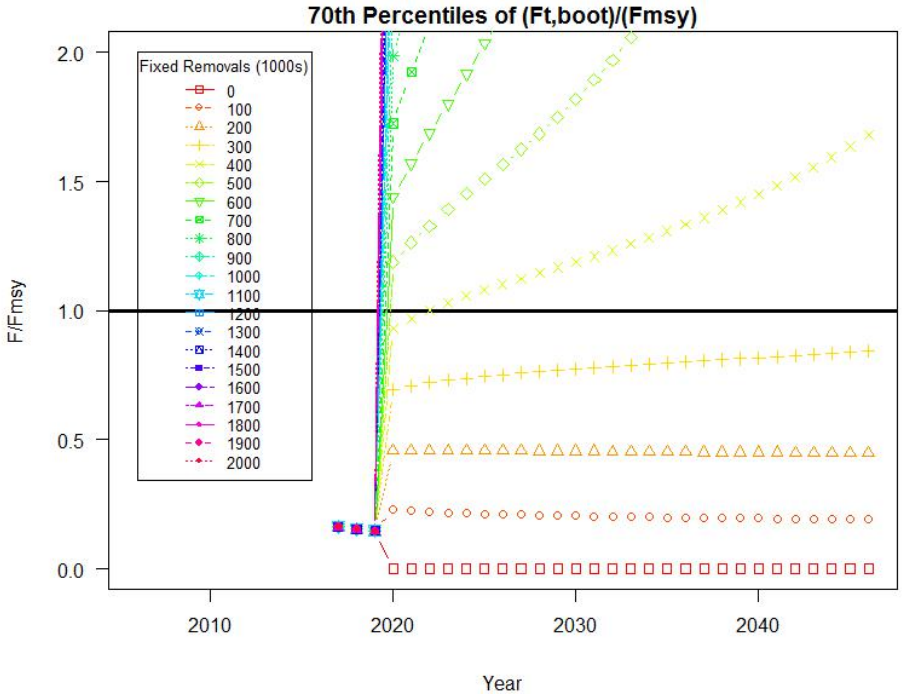


Figure 3.2. Continued.

Panel E. Projection Scenario-5 (Sensitivity, High Productivity— with updated MRIP recreational catch estimates).



Panel F. Projection Scenario-6 (Sensitivity, Lognormal Prior R0— with updated MRIP recreational catch estimates).

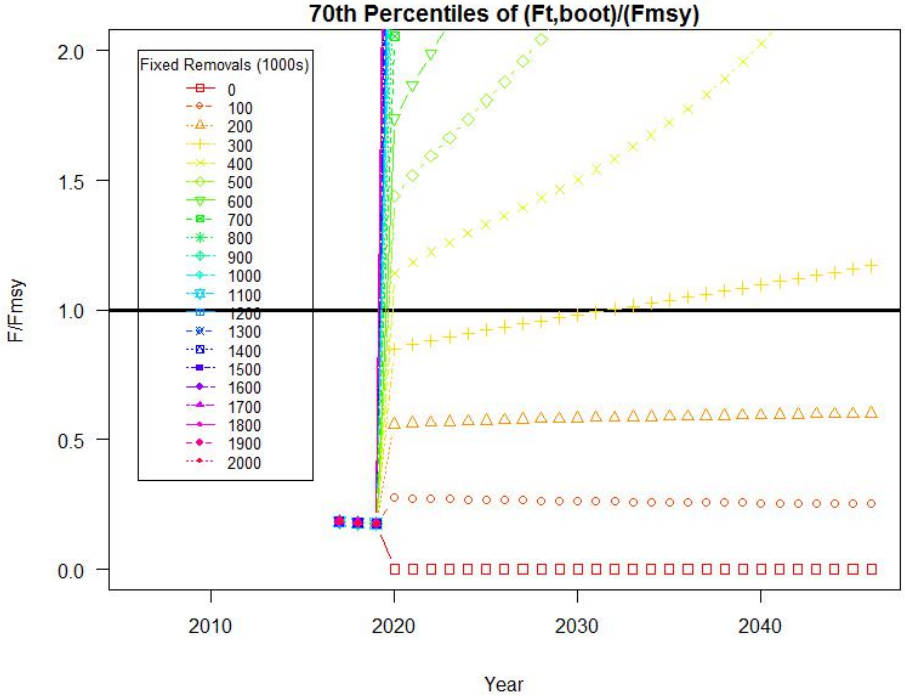


Figure 3.3. Frequency distributions from 10,000 Monte Carlo simulations (random draws obtained for projections) from a bivariate normal distribution for initial numbers (N_{2016}^{boot}) and fishing mortality (F_{2016}^{boot}) and a second bivariate normal distribution for pup survival at low biomass ($e^{-M_0}{}_{2016}^{boot}$) and equilibrium recruitment ($R_0{}_{2016}^{boot}$); median of the bootstrapped parameter value distribution (solid line); and the original SSASPM parameter value estimate (dashed line).

Panel A. Projection Scenario-1 (Baseline, Ranked CPUE Weighting— with updated MRIP recreational catch estimates).

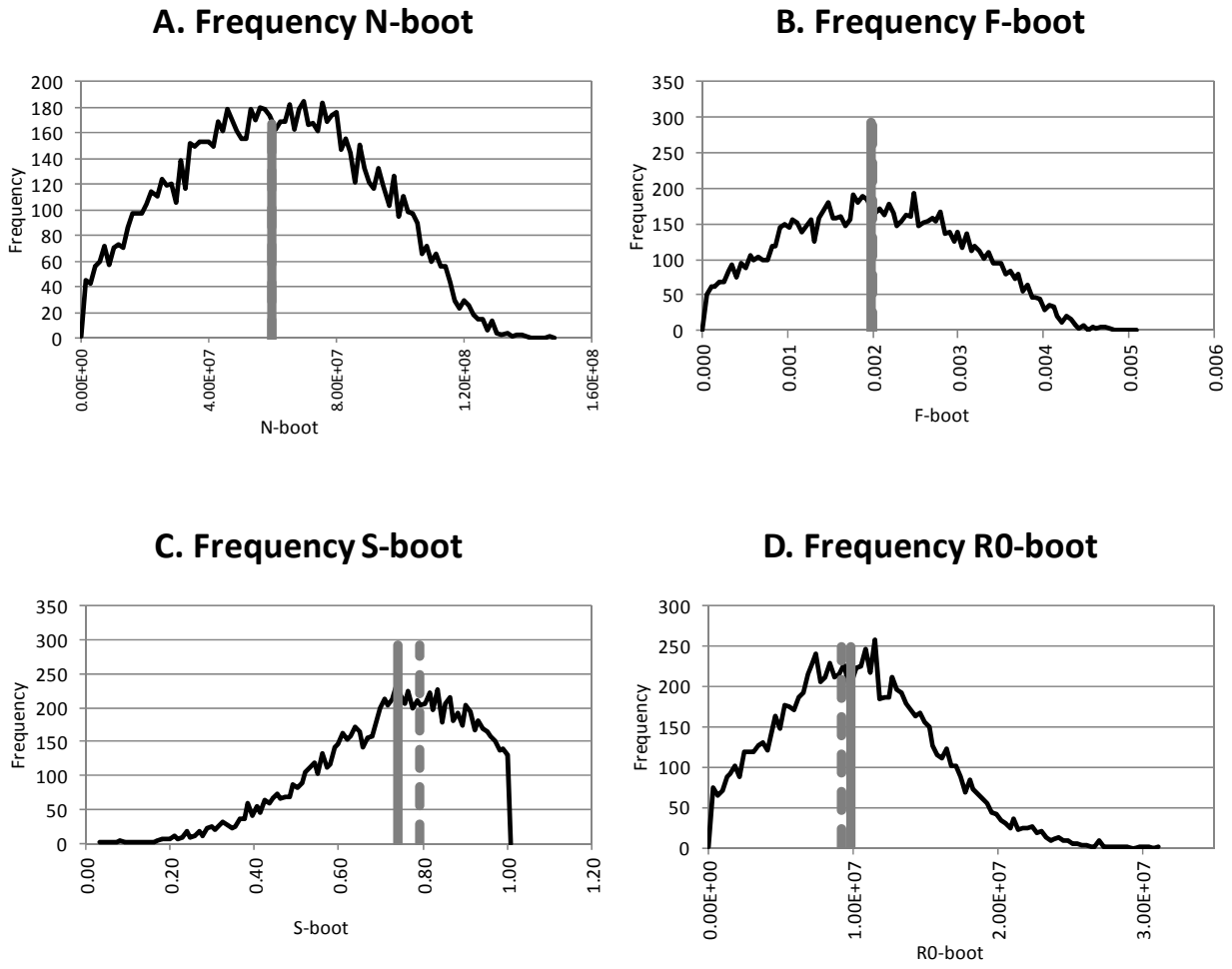


Figure 3.3. Continued.

Panel B. Projection Scenario-2 (Sensitivity, Low Catch— with updated MRIP recreational catch estimates).

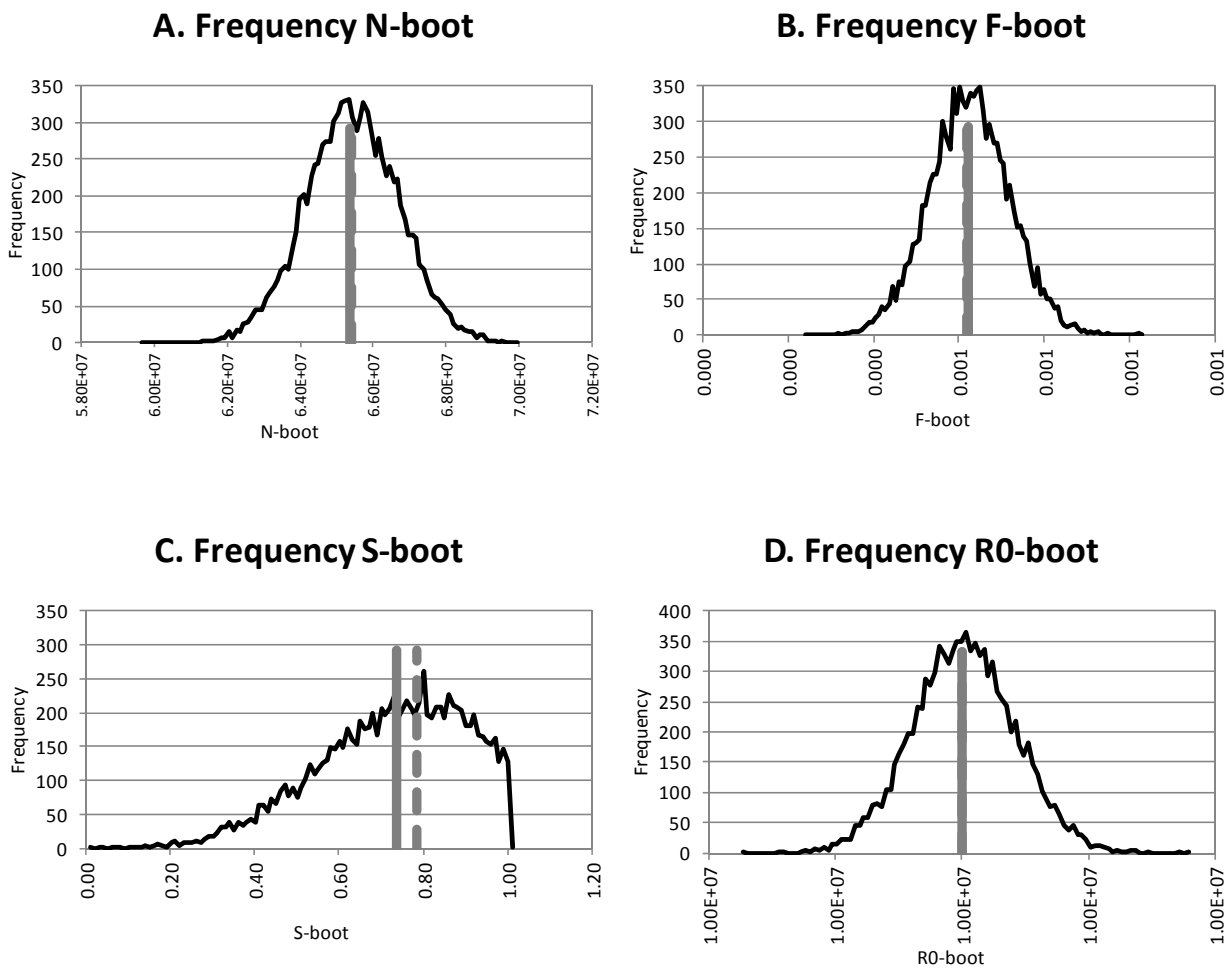


Figure 3.3. Continued.

Panel C. Projection Scenario-3 (Sensitivity, High Catch— with updated MRIP recreational catch estimates).

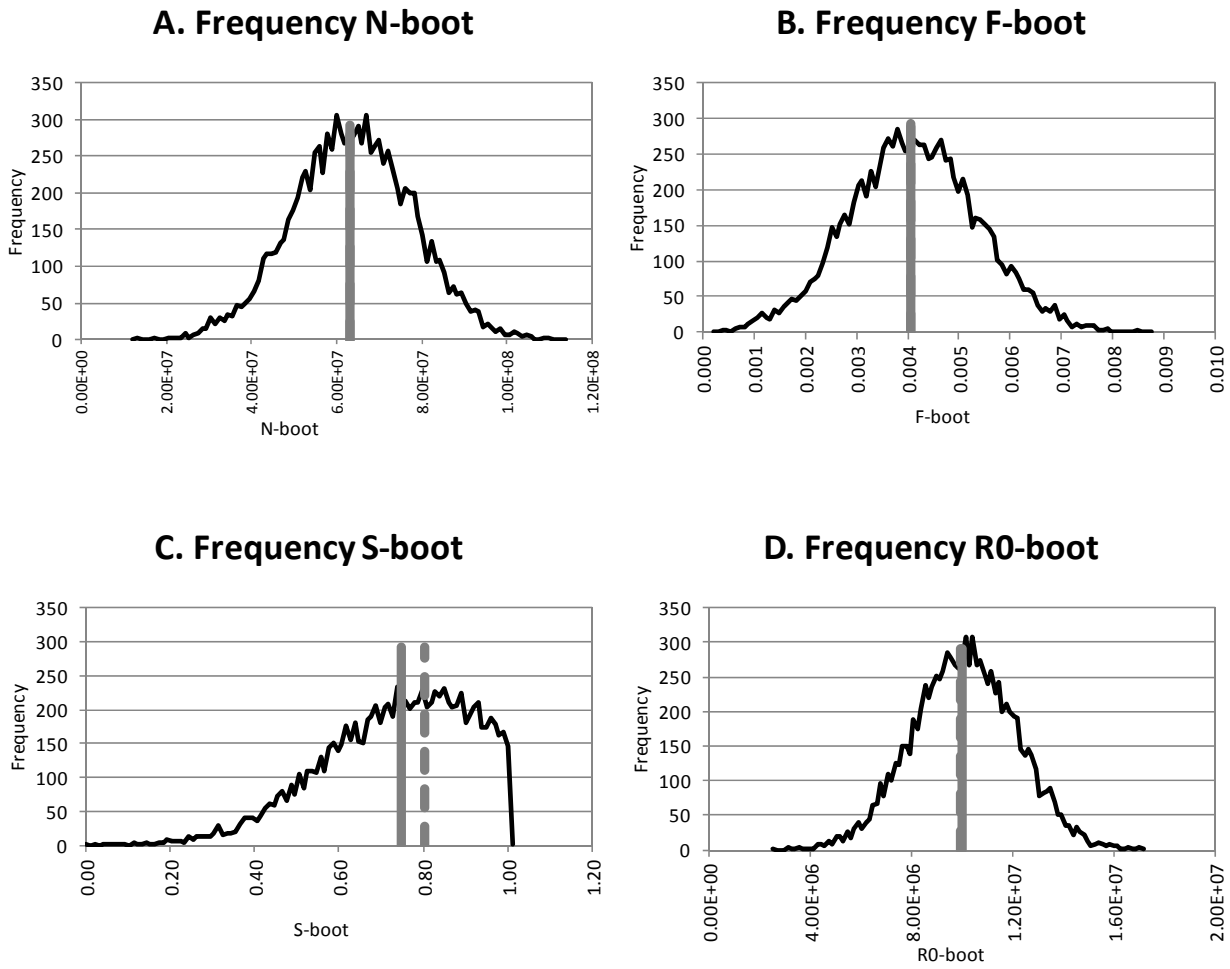


Figure 3.3. Continued.

Panel D. Projection Scenario-4 (Sensitivity, Low Productivity— with updated MRIP recreational catch estimates).

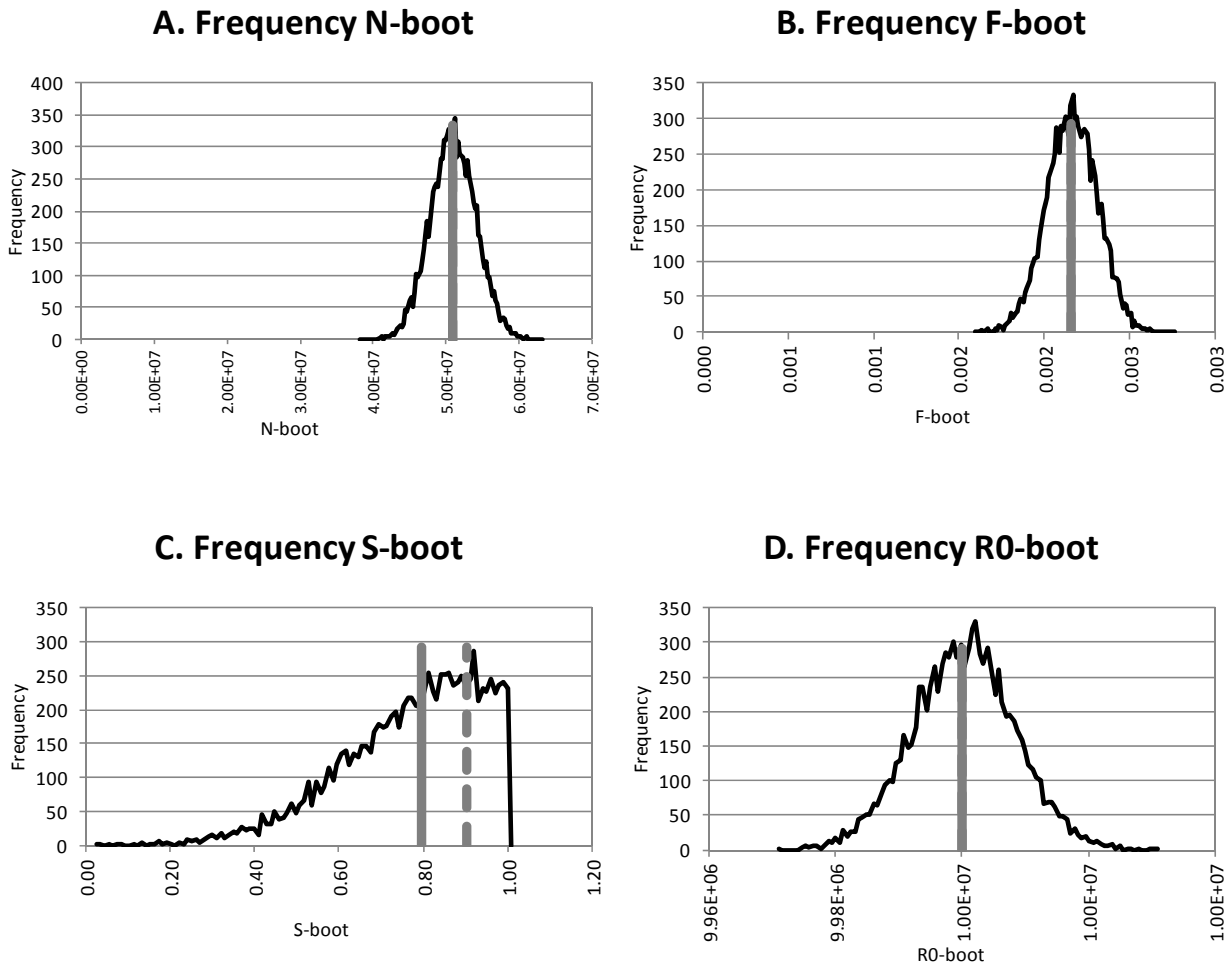


Figure 3.3. Continued.

Panel E. Projection Scenario-5 (Sensitivity, High Productivity— with updated MRIP recreational catch estimates).

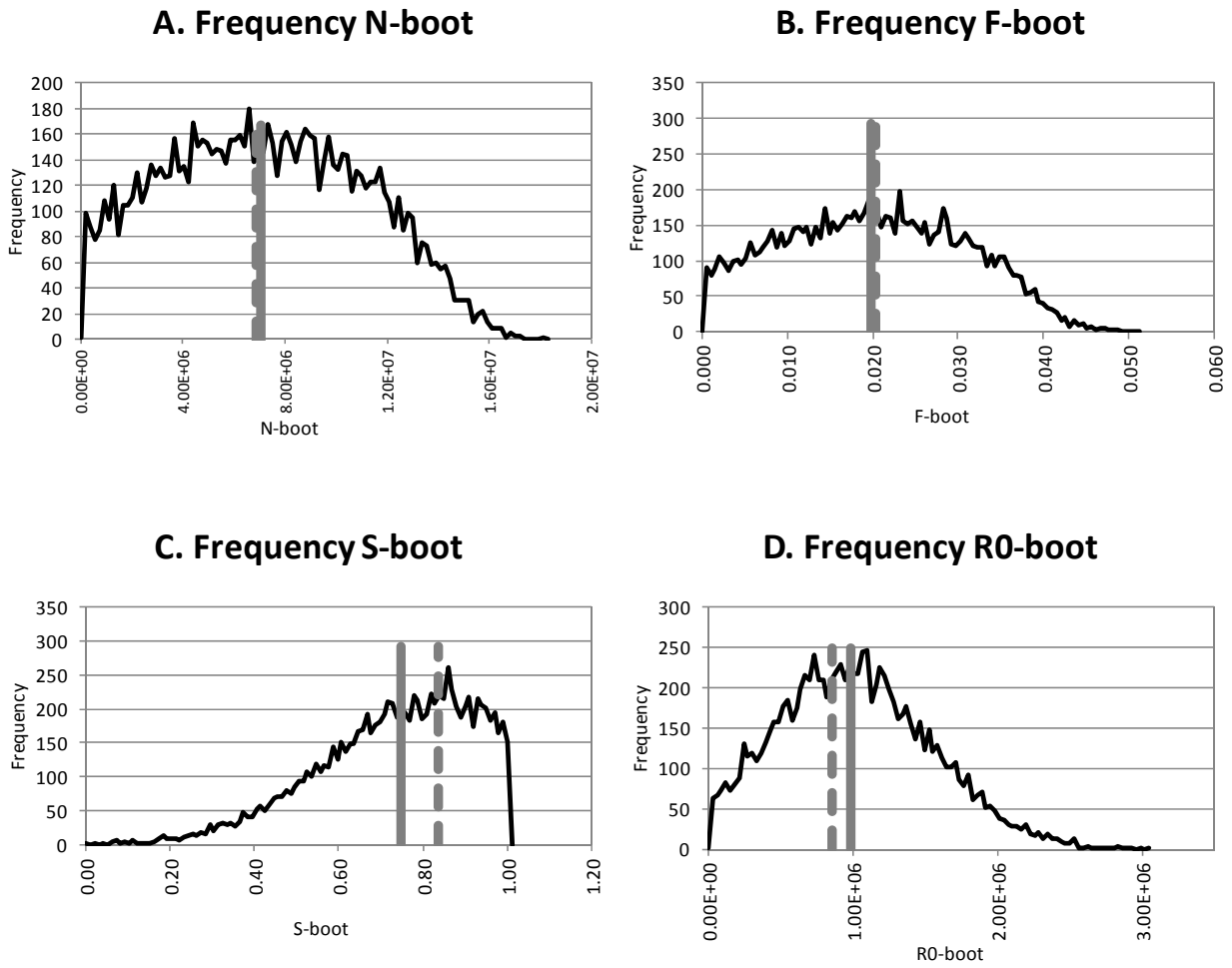


Figure 3.3. Continued.

Panel F. Projection Scenario-6 (Sensitivity, Lognormal Prior R0— with updated MRIP recreational catch estimates).

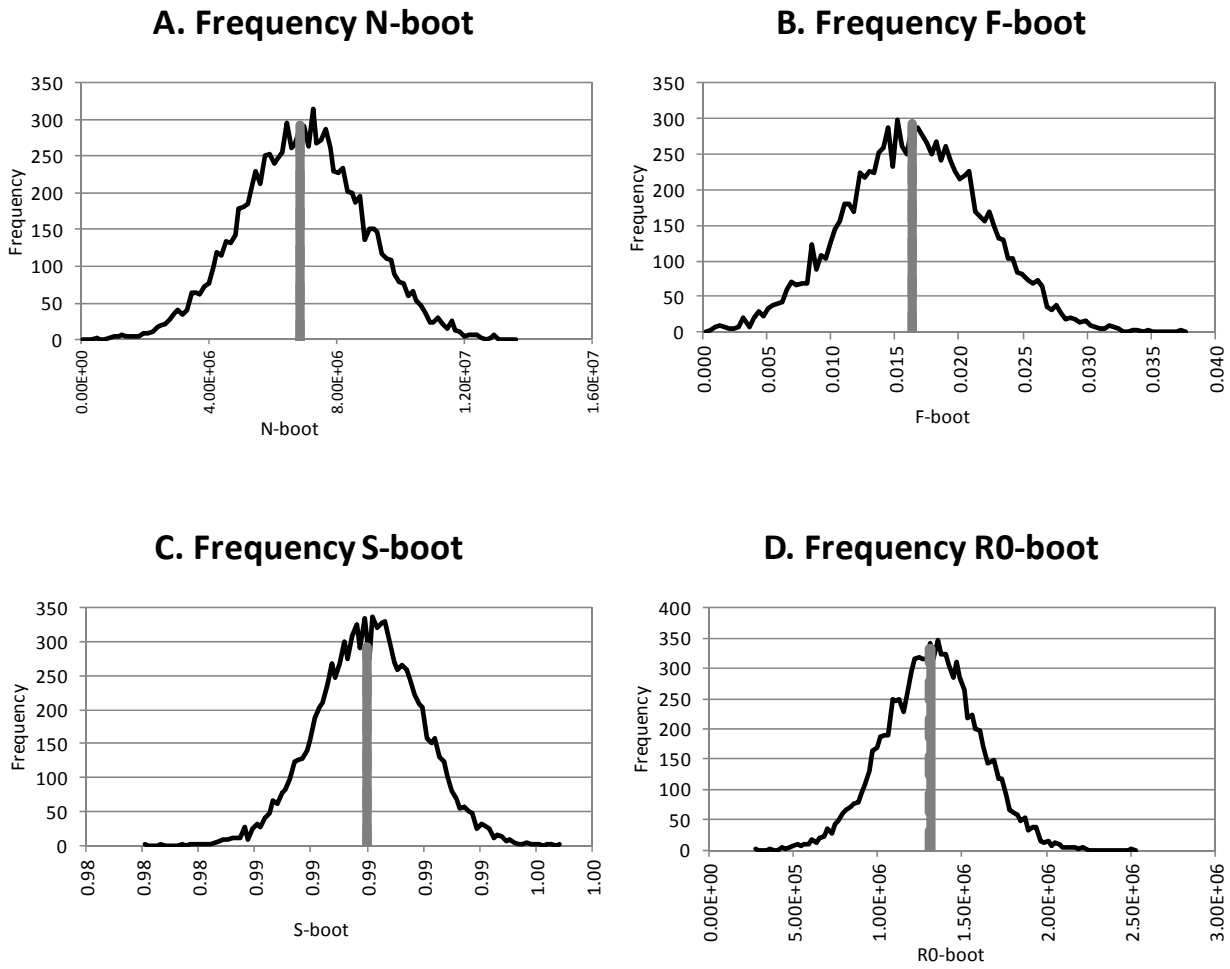
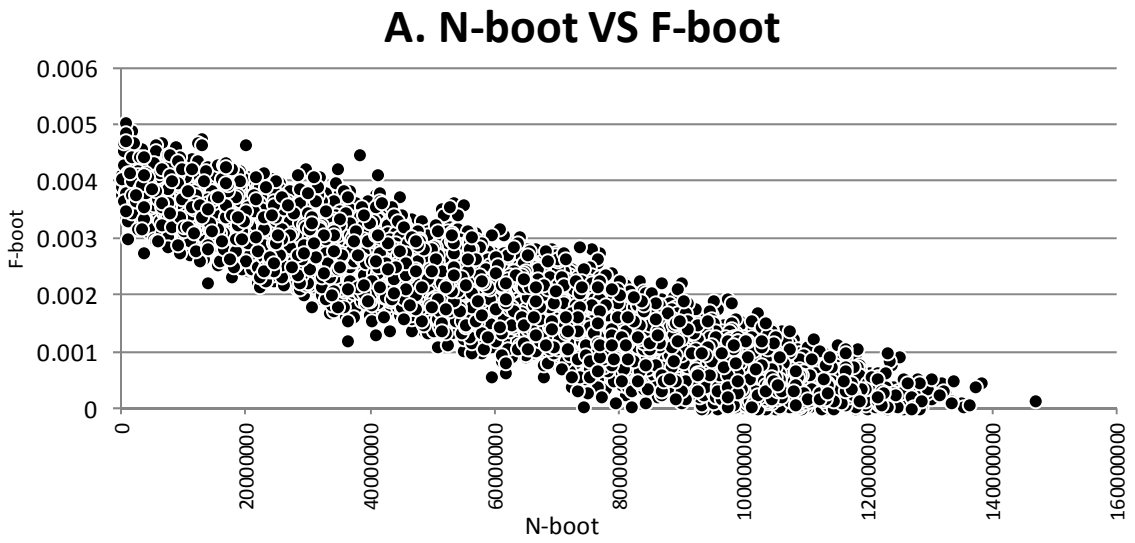


Figure 3.4. Correlations from 10,000 Monte Carlo simulations (random draws obtained for projections) from a bivariate normal distribution for initial numbers (N_{2016}^{boot}) and fishing mortality (F_{2016}^{boot}) and a second bivariate normal distribution for pup survival at low biomass ($e^{-M_0}{}_{2016}^{boot}$) and equilibrium recruitment ($R_0{}_{2016}^{boot}$).

Panel A. Projection Scenario-1 (Baseline, Ranked CPUE Weighting— with updated MRIP recreational catch estimates).



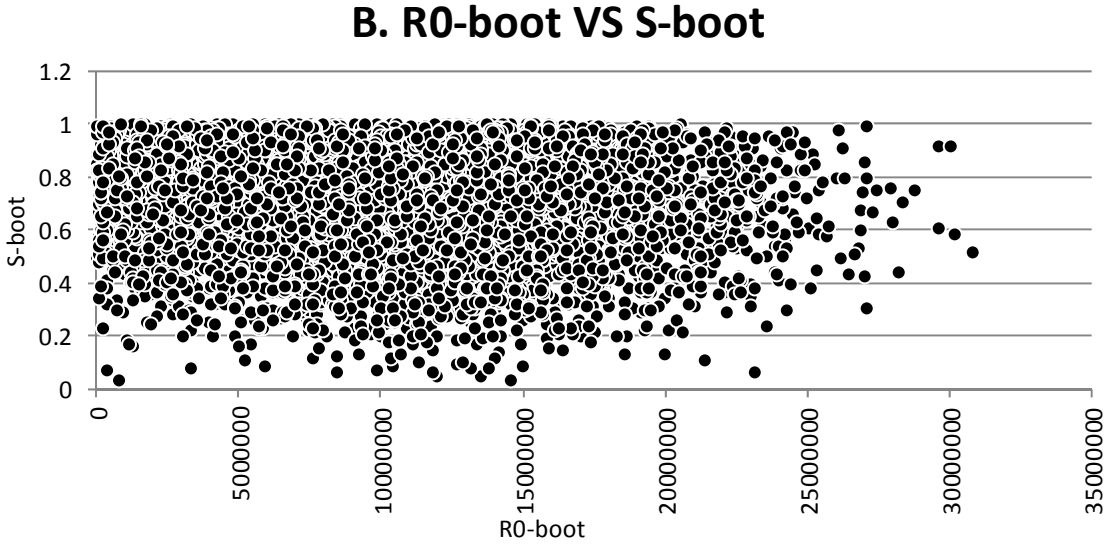
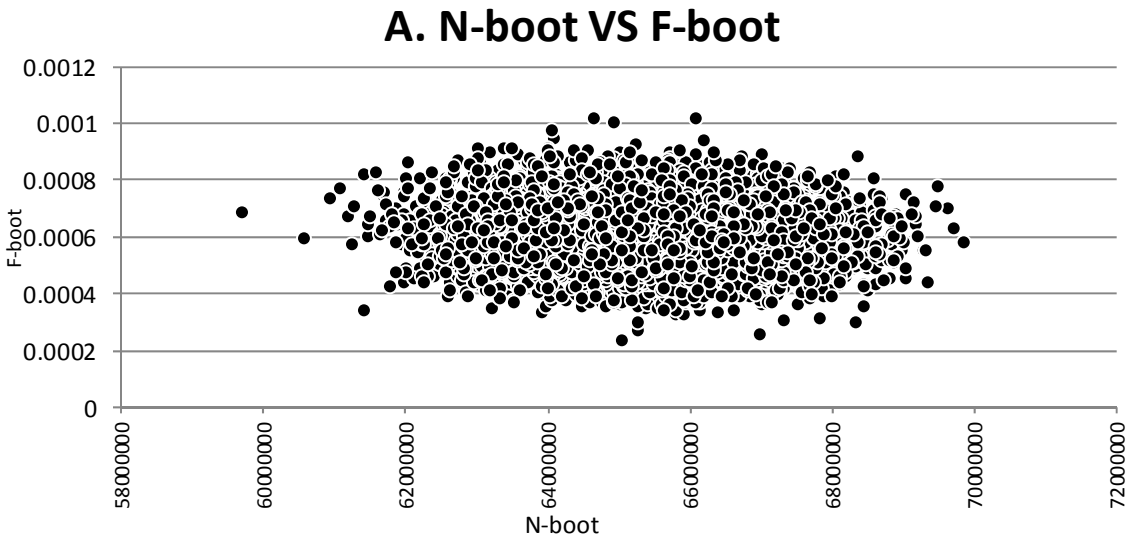


Figure 3.4. Continued.

Panel B. Projection Scenario-2 (Sensitivity, Low Catch— with updated MRIP recreational catch estimates).



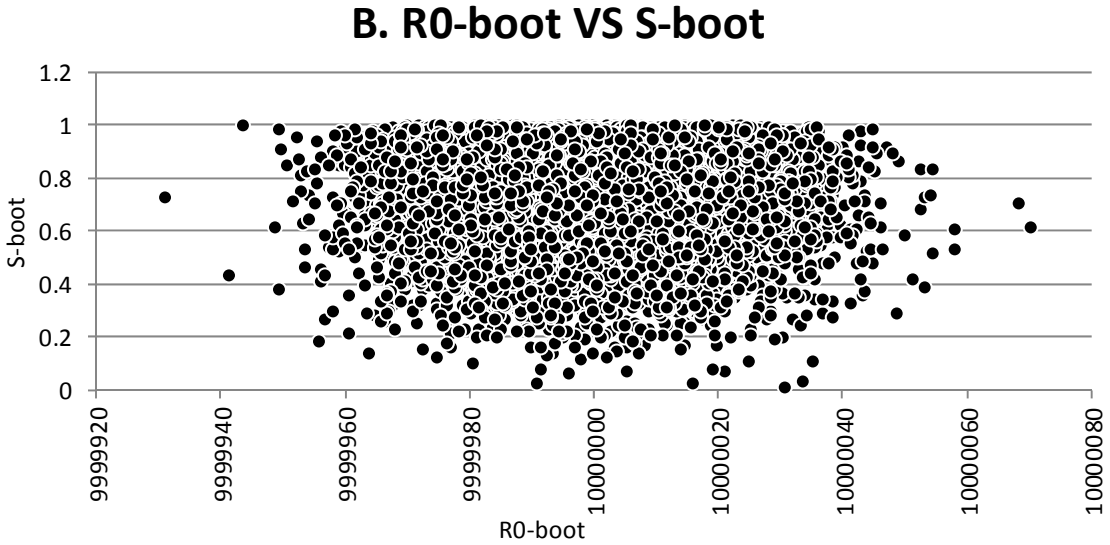
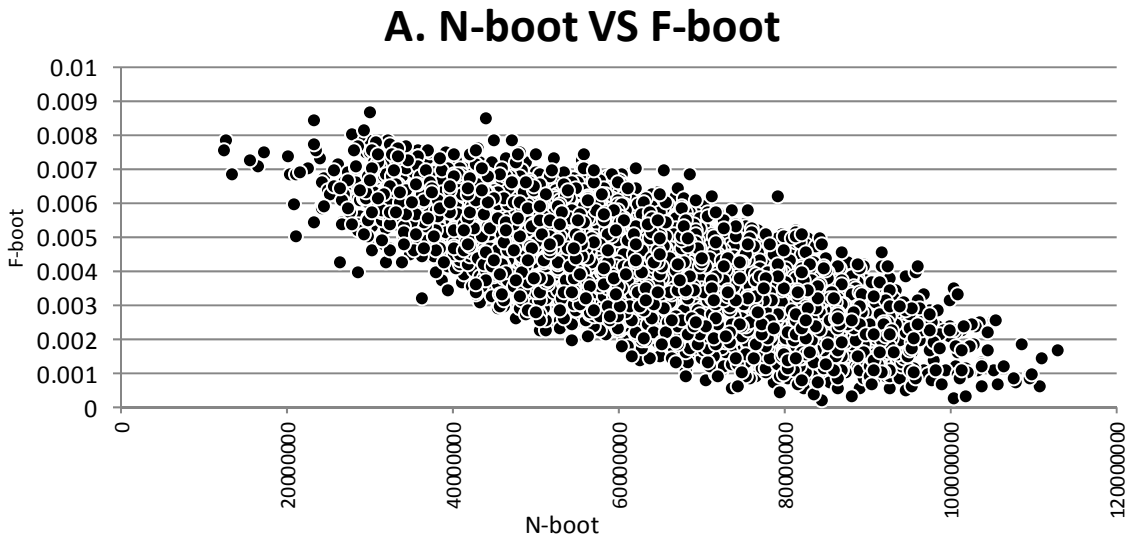


Figure 3.4. Continued.

Panel C. Projection Scenario-3 (Sensitivity, High Catch— with updated MRIP recreational catch estimates).



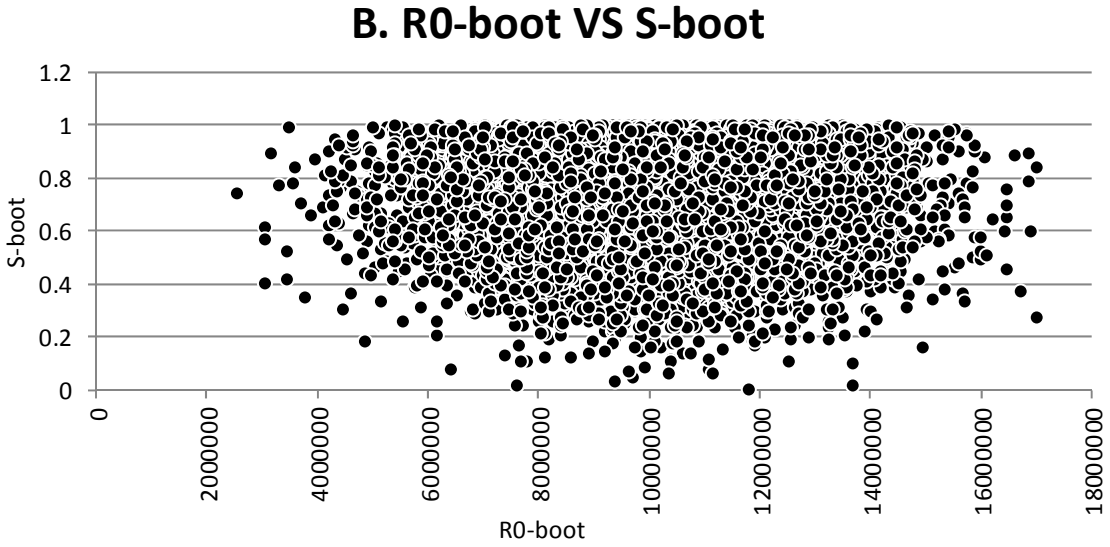
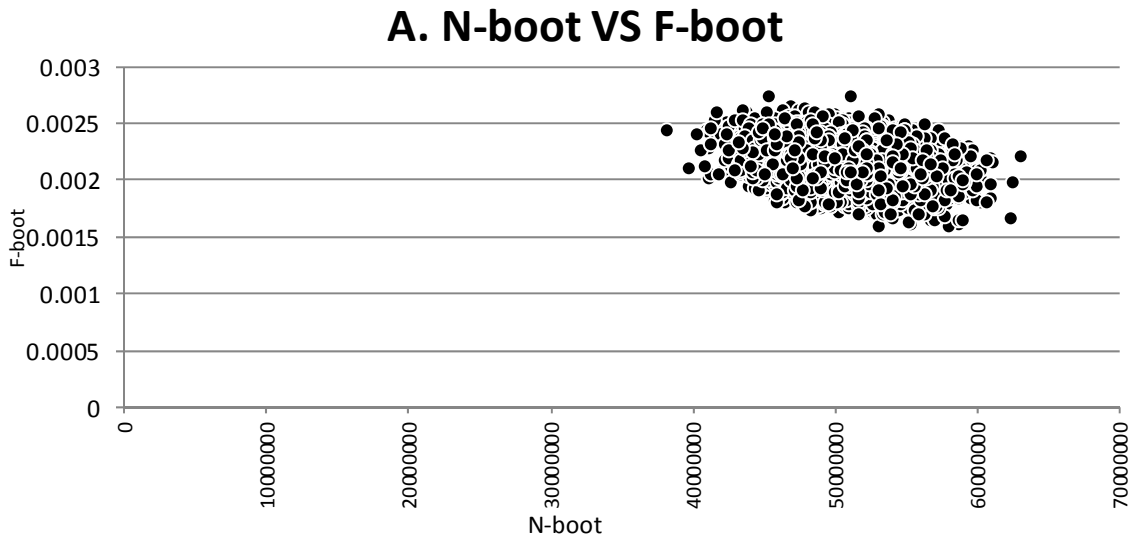


Figure 3.4. Continued.

Panel D. Projection Scenario-4 (Sensitivity, Low Productivity— with updated MRIP recreational catch estimates).



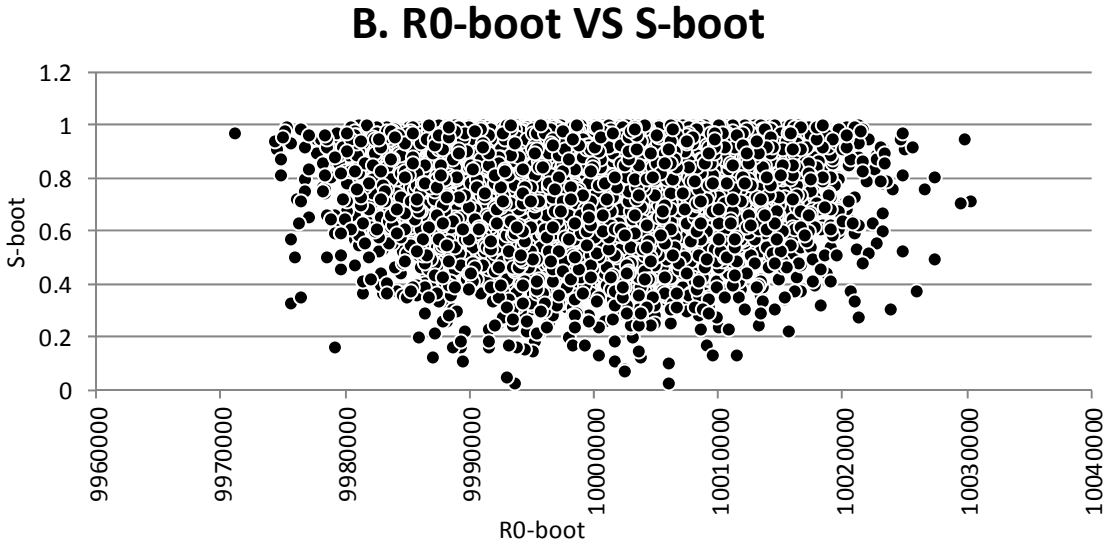


Figure 3.4. Continued.

Panel E. Projection Scenario-5 (Sensitivity, High Productivity— with updated MRIP recreational catch estimates).

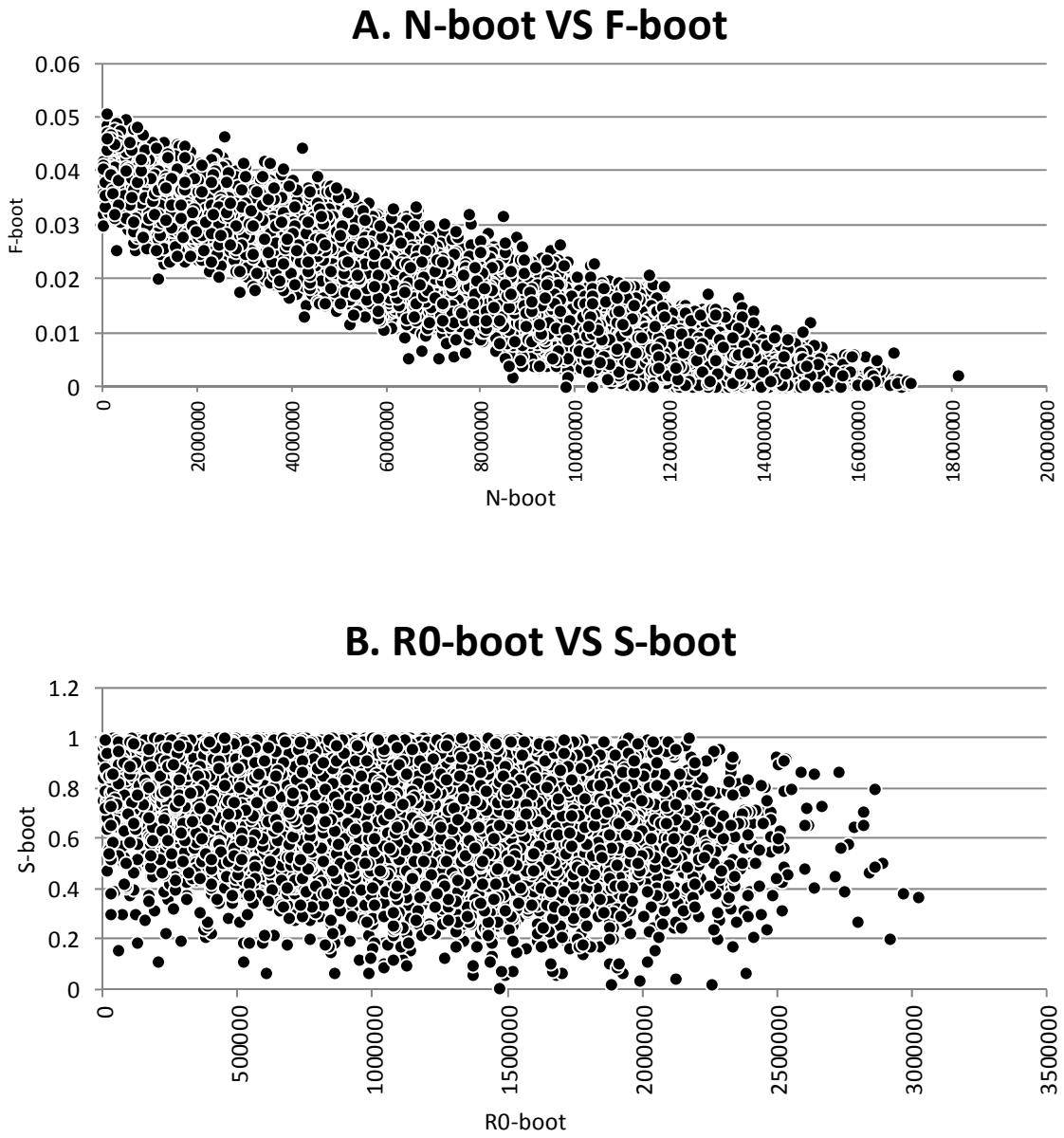


Figure 3.4. Continued.

Panel F. Projection Scenario-6 (Sensitivity, Lognormal Prior R0— with updated MRIP recreational catch estimates).