

Methods for Decision Tools

Modeling the Combined Effects of Gulf Framework Action Proposed Management Measures for Commercially and Recreationally Caught Greater Amberjack

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Introduction

The first formal assessment of greater amberjack (*Seriola dumerili*) stocks in the Gulf of Mexico indicated that the stock was overfished and undergoing overfishing as of 1998 (Turner et al. 2000). Management measures to reduce the recreational bag limit from three to one fish were implemented in January 1997 and a commercial seasonal closure from March through May was implemented in January 1998; however, these closures were not incorporated into the Turner et al. (2000) assessment. The projected effects of these management measures were expected to eliminate overfishing; therefore, no new management measures were implemented under the rebuilding plan approved by Secretarial Amendment 2 in 2003 (NMFS 2003).

In 2006, a new stock assessment was completed and determined the greater amberjack stock was overfished, undergoing overfishing, and not recovering at the rate previously projected (SEDAR 9 2006c). In response to these assessment results, the Gulf of Mexico Fishery Management Council (Gulf Council) and the National Marine Fisheries Service (NMFS) developed Amendment 30A to the Reef Fish FMP to end overfishing and rebuild the stock (GMFMC 2008). Upon implementation in August 2008, Amendment 30A required a reduction of fishing mortality and implemented a total allowable catch of 1.871 million pounds whole weight (mp ww) (GMFMC 2008). Amendment 30A also established annual catch limits (ACLs) for the recreational and commercial sectors at 1.368 mp and 0.503 mp ww, respectively. In addition to establishing quotas, Amendment 30A also increased the recreational size limit to 30-inches FL, eliminated the bag limit for captain and crew of for-hire vessels, and implemented sector accountability measures (AMs). Under the AMs, if a sector's ACL is met or projected to be met during the fishing year, harvest and retention of greater amberjack by that sector is prohibited for the remainder of the year. Additionally, if a sector exceeds its ACL, the overage is deducted from the sector's ACL in the subsequent fishing year.

In 2009, the recreational fishing season for Gulf of Mexico greater amberjack was closed on October 24, 2009, because the recreational ACL was projected to be exceeded in-season. The total 2009 recreational landings exceeded the ACL by 0.125 mp despite the in-season closure. The 2010 recreational ACL was set at 1.243 mp. Recreational harvest in 2010 was slowed by fishery closures associated with the Deepwater Horizon oil spill, and the 2010 recreational fishing season remained open through the end of the fishing year. The 2010 recreational ACL was exceeded by 0.053 mp. The 2011 recreational ACL was set at 1.315 mp to adjust for the 2010 overage. The Gulf Council also approved a regulatory amendment that prohibited recreational greater amberjack harvest and retention from June 1-July 31. This closure was intended to slow the rate of harvest and reduce the likelihood of an early end of year closure, and was first implemented during the 2011 fishing year. Approximately 78.5% of the recreational

ACL was landed in 2011 and 97% of the recreational ACL was landed in 2012. The recreational ACL was exceeded by 18% in 2013.

In 2008, a rebuilding plan and accountability measures for greater amberjack were established in the Gulf of Mexico. Only 87.31% of the commercial ACL was landed in 2008; however, the commercial ACL was exceeded by 20% in 2009 and 43% in 2010. In 2010, longline endorsements were required and hook and area restrictions were implemented. The commercial ACL was exceeded by 49% in 2011. In 2012, a 2000-lb commercial trip limit was implemented. The ACL was exceeded by 30% in 2012. In 2013, the commercial greater amberjack sector was closed on July 1, 2013 because the commercial ACL was projected to be exceeded in-season. The total 2013 commercial landings exceeded the ACL by 0.0477 mp (12%) despite this in-season closure. The 2014 commercial ACL was set at 0.481 mp and was projected to be met on August 25, 2014. The season was closed for the remainder of the year and will reopen on January 1, 2015.

In June 2014, the Gulf Council's Scientific and Statistical Committee (SSC) reviewed the SEDAR 33 (2014) stock assessment for greater amberjack and recommended an acceptable biological catch (ABC) of 1.72 mp ww; a 3.4% reduction from the ABC established by Amendment 35. In response to the SSC's recommendation, the Gulf Council began drafting a framework action that will adjust the greater amberjack rebuilding plan and implement management measures to constrain recreational and commercial harvest to the reduced ACL levels. In January 2015, the SSC approved the SEDAR 33 (2014) projections for management use by the Gulf Council. This amendment considers recreational annual catch targets (ACTs) ranging from 0 lb to 1.256 mp, and commercial ACLs ranging from 0 lb to 0.464 mp. This report presents the development of a recreational decision tool (RDT) and a commercial decision tool (CDT) to simulate the impacts of various combinations of proposed management measures to support the 2015 greater amberjack framework action.

Current Management Regulations

The following regulations currently apply to the Gulf of Mexico greater amberjack fishery:

- 1) One greater amberjack recreational bag limit (implemented January 1997).
- 2) 30-inch FL recreational minimum size limit (implemented August 2008).
- 3) 36-inch FL commercial minimum size limit (implemented February 1990).
- 4) June 1 through July 31 recreational closed season (implemented June 2011).
- 5) March 1 through May 31 commercial closed season (implemented January 1998).
- 6) 2,000 pound ww commercial trip limit (implemented December 2012).

Methods

The RDT and CDT were implemented in Microsoft Excel using drop-down menus to obtain user inputs regarding desired management measures (Figures 1A and 1B). Excel was chosen because it is widely available for constituent use. Impacts of management measures were simulated using programs written in SAS (SAS Institute, Cary, NC). The following management options were evaluated in this report:

Recreational Sector

- 1) Seasonal closures
- 2) Size limits

Commercial Sector

- 1) Seasonal closures
- 2) Trip limits

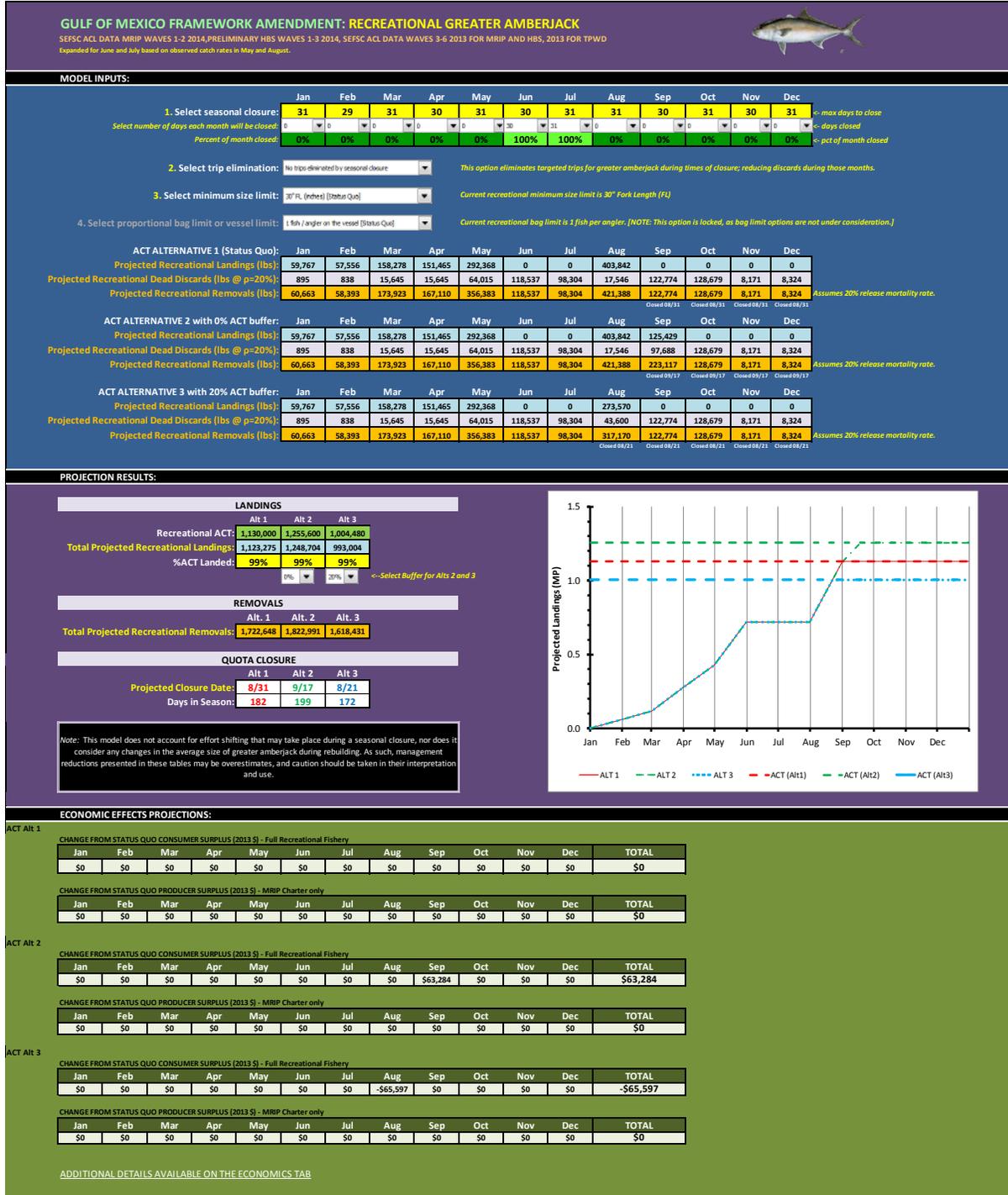


Figure 1A. Screenshot of greater amberjack recreational decision tool, showing dropdown menus for user-specified management measures.

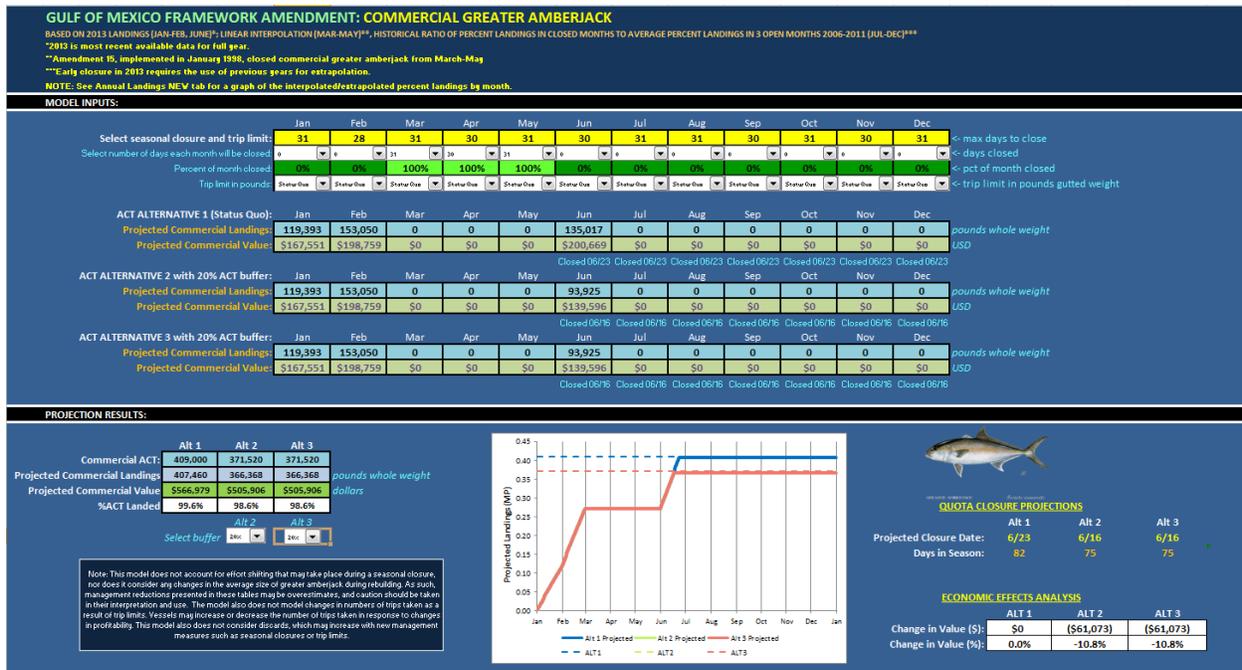


Figure 1B. Screenshot of greater amberjack commercial decision tool, showing dropdown menus for user-specified management measures.

Data Sources

Recreational landings data for Gulf of Mexico greater amberjack were obtained from the Southeast Fisheries Science Center's (SEFSC) ACL Dataset (accessed August 2014), which provided aggregated landings data from the Marine Recreational Information Program (MRIP), the SEFSC's Headboat Survey (HBS), and the Texas Parks and Wildlife Department (TPWD) Creel Survey. The ACL dataset provides improved quality assurance and quality control (QA/QC) on the raw data generated by the MRIP and SEFSC headboat survey. The ACL dataset uses MRIP weight estimates when available. In some cases, MRIP provides an estimate of numbers landed but no weight estimate, due to missing weights in the intercept data. In these cases, the SEFSC uses weight substitutions based on a minimum of 30 samples to provide a weight estimate in the ACL data. MRIP intercepts collect data on port agent observed landings ('A' catch) and angler reported landings ('B1' catch) and discards ('B2' catch) in numbers by species, two-month 'wave' (e.g., Wave 1 = Jan/Feb, ..., Wave 6 = Nov/Dec), area fished (inland, state, and federal waters), mode of fishing (charter, private/rental, shore), and state (west Florida, Alabama, Mississippi, and Louisiana). HBS landings are generated after the end of each calendar year, at which time they are included in the ACL dataset. HBS landings in weight are calculated using a combination of logbook reports and dockside sampling, and adjustments to landings are made based on underreporting and misreporting determined through dockside validation by port agents. HBS records contain trip-level information on number of anglers, trip duration, date, area fished, landings (number of fish) and releases (number fish) by species. TPWD generates estimates of landings for private/rental boats and charter vessels fishing off Texas. TPWD landings are reported in numbers by 'high-use' (May 15-November 20) and 'low-use' time periods (November 21-May 14), area fished (state and federal waters), and mode (charter, private/rental). TPWD high and low use landings estimates can be re-estimated to correspond to MRFSS two-month waves. Landings, biological data (size of catch), and catch-effort information from each of these surveys were used to evaluate reductions in landings and discards (when available) associated with various greater amberjack closed seasons, vessel limits, fractional bag limits, and size limits. Following approaches used in the most recent stock assessment, MRFSS data from Monroe County were post-stratified and removed west Florida landing and discard estimates.

Typically, projected impacts of management measures are modeled as compared to a two- or three-year baseline; however, as evidenced by an overage in 2013, fishing pressure on the greater amberjack stock in the Gulf appears to be increasing within the recreational sector. Changes in the MRIP intercept survey sampling design in 2013 may also explain some of the observed increases. Thus, for projection purposes, data from the most recent fishing years (2013-2014) is believed to be the best approximation of future harvest patterns. The SEFSC ACL Dataset contained MRIP landings and discards through Wave 2, 2014. Preliminary headboat landings from Jan-June 2014 were obtained from the SEFSC Southeast Headboat Survey Coordinator. To establish a recreational landings baseline, MRIP-Private (including Shore), MRIP-Charter, TPWD-Private, TPWD-Charter, and HBS landings were broken into monthly landings assuming a uniform distribution of landings within waves. The baseline was formed from 2014 landings when available, with gap filling from 2013 for months where 2014 data was unavailable (Table 1). This baseline landings time series was converted to monthly catch rates assuming a uniform distribution of landings across days in the month. Baseline monthly discards in numbers were

computed in a similar fashion, with headboat discards computed based on SEDAR 33 (2014) estimates of headboat discard ratios. Baseline discards were converted to pounds using the mean discard weights by sector from the final year (2012) in the SEDAR-33 (2014) assessment. The output from the base run of the assessment was obtained from the SEFSC (N. Cummings, pers. comm.). Discard numbers-at-age were computed by fleet (MRIP and HBS) by subtracting numbers-at-age times selectivity times retention from numbers-at-age times selectivity. Similarly, discard biomass-at-age was computed by fleet by subtracting biomass-at-age times selectivity times retention from biomass-at-age times selectivity. Mean discard weights were computed as the sum of discarded biomass across ages divided by the sum of discarded numbers across ages. Mean discard weight for MRIP was 6.16 lb (2.79 kg); mean discard weight from HBS was 6.80 lb (3.08 kg). These discard weights correspond to a 22 and 23 inch fish, respectively. TPWD discards were not estimated by the SEDAR-33 (2014) assessment and were similarly not included in the RDT. Dead discards were assumed to be 20% of the total discards under the base model release mortality rate used in SEDAR-33 (2014).

Commercial landings data for Gulf of Mexico greater amberjack were obtained from the SEFSC's commercial ACL dataset (accessed August 2014), and the SEFSC's commercial logbook program (accessed August 2014). The SEFSC commercial ACL dataset provides additional QA/QC for data collected through 2013 via state trip ticket programs¹. Landings data are provided in pounds whole weight, and logbook records summarize landings on a trip level, with information for each species encountered including landings (in lbs), primary gear used, and primary area and depth of capture. Monthly commercial logbook landings for open months in 2013 (the most recent data for full year) were converted to a percentage of the total annual landings. Commercial harvest of greater amberjack has been prohibited in March, April, and May since January 1998. To predict what landings trends might be if these months were re-opened, linear interpolation was used to estimate percent annual landings between February and June. Re-opening March-May is projected to increase annual landings by 108%, assuming no quota closure. Quota closures for commercial greater amberjack were implemented in July through December of 2013; these months were back-filled using the average historical ratio of landings in each closed month to the three-month average landings in Jan, Feb, and June². The goal was to capture historical seasonality patterns between the months that were closed in 2013 and the months that were open, while allowing the actual landings in 2013 to drive the magnitude of the estimates. To compute the average historical ratio of closed months to the average landings in January, February, and June, for each relevant month, all years from 2006 to 2012 in which the month was open were used³. The average historical ratio for each closed month was then multiplied by the average three-month percentage of annual landings in 2013 (January, February, and June) to estimate the percentage of annual landings that might have occurred in each of the 2013 closed months had they been open. The commercial logbook provides incomplete landings information due to noncompliance and failure to include state-licensed commercial fishermen. Monthly percentages of annual landings derived from logbook

¹ The SEFSC's commercial ACL data for 2014 will not be available until July 2015.

² The most recent fully open year (excluding the seasonal closure) was 2008, so in order to incorporate more recent information into the estimates, a historical ratio approach was chosen in lieu of using the average percent of annual landings from a fully open year.

³ Years used to compute monthly average ratio were as follows: July and August (2006-2010); September and October (2006-2011); and November and December (2006-2008).

records were scaled to reported landings in the SEFSC's ACL dataset (457,821 lb as of July 2014). The baseline commercial landings by month are presented in Table 1B. Because the baseline forecasts landings during months that were closed in 2013 (i.e. Mar-May; Jul-Dec), the projected baseline of 1.62 mp landed in the absence of any closures is substantially higher than the 0.458 mp landed in 2013.

Table 1. Projected baseline monthly A) recreational landings, B) recreational discards, and C) commercial landings in pounds whole weight (lb ww) of Gulf greater amberjack under status quo management measures with no seasonal or quota closures.

A: REC LANDINGS	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
HBS	7,550	8,407	9,800	2,671	4,321	4,181	16,840	16,840	8,273	17,612	3,805	2,239
TPWD CHARTER	0	0	0	0	0	0	1,837	1,837	0	0	0	0
TPWD PRIVATE	0	0	0	0	521	504	2,057	2,057	0	0	0	0
MRFSS CHARTER	0	0	50,531	48,901	85,624	82,862	215,370	215,370	61,178	63,218	8,286	8,562
MRFSS PRIVATE	52,217	47,164	103,223	99,893	201,903	195,390	167,738	167,738	151,893	156,956	7,047	7,282
	59,767	55,571	163,553	151,465	292,368	282,937	403,842	403,842	221,345	237,786	19,139	18,084

B: REC DISCARDS	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
HBS	2,483	2,243	1,969	1,906	1,303	1,261	3,134	3,185	5,741	5,933	1,098	2,233
TPWD CHARTER	0	0	0	0	0	0	0	0	0	0	0	0
TPWD PRIVATE	0	0	0	0	0	0	0	0	0	0	0	0
MRFSS CHARTER	1,993	1,801	68,988	66,762	13,237	12,810	66,083	66,083	43,652	45,107	0	0
MRFSS PRIVATE	0	0	9,878	9,559	305,533	295,678	18,461	18,461	343,131	354,568	20,617	21,304
	4,476	4,043	80,835	78,227	320,073	309,748	87,678	87,730	392,524	405,608	21,715	23,537

Source: SEFSC ACL Data MRIP Waves 1-2 2014, Preliminary HBS Waves 1-3 2014, SEFSC ACL Data Waves 3-6 2013 for MRIP and HBS, 2013 for TPWD. All data accessed August 2014.

C: COMM LANDINGS	Jan	Feb	Mar [†]	Apr [†]	May [†]	Jun	Jul ^{††}	Aug ^{††}	Sep ^{††}	Oct ^{††}	Nov ^{††}	Dec ^{††}
COMMERCIAL	119,393	153,050	158,815	164,580	170,345	176,109	125,400	129,377	131,984	84,303	104,015	101,640

Source: 2013 commercial logbook data (accessed 8/2014) scaled to 2013 ACL data (accessed 8/2014).

[†]Based upon linear interpolation between February and June landings.

^{††}Expanded using average historical ratio of landings in each month to three-month average landings in Jan, Feb, and June. Years used to compute monthly average ratio were as follows: July and August (2006-2010); September and October (2006-2011); and November and December (2006-2008).

Seasonal Closure Analyses

Landings of greater amberjack are highly seasonal in the Gulf of Mexico; thus, reductions associated with seasonal closures differ greatly depending upon the time period selected for closure (Figure 2). To model the effects of a seasonal closure, users of the RDT and CDT models can specify the number of days closed for each month. These choices were converted to a percentage of days closed for a given month. The projected landings during that month under the other user-specified management measures were then reduced by the percentage of the month that was closed. Landings were assumed uniformly distributed within months; no effort shifting or effort compression was modeled. In the RDT, landings that were eliminated by a seasonal closure were converted to dead discards at a release mortality rate of 20%.

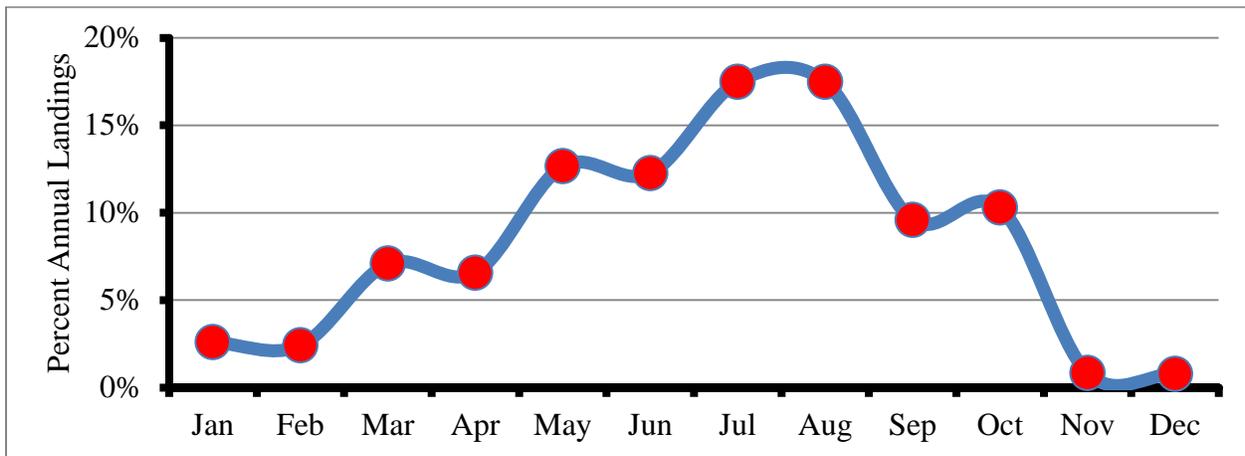


Figure 2A. Distribution by month of simulated ‘baseline’ Gulf recreational greater amberjack landings from MRIP, HBS, and TPWD. Landings assumed uniformly distributed within waves. MRIP landings from Monroe County were removed following SEDAR-33 (2014).

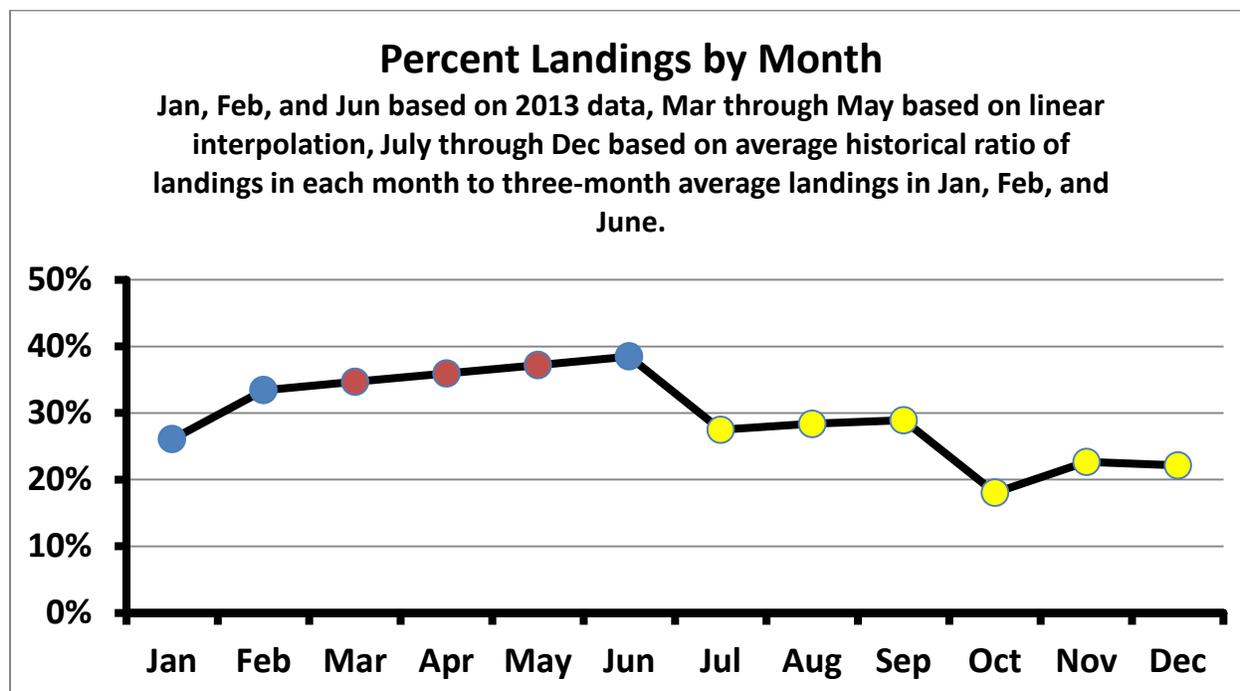


Figure 2B. Distribution by month of simulated ‘baseline’ Gulf commercial greater amberjack landings from logbook data (accessed 8/2014). Landings from Mar-May (red) predicted via linear interpolation between February-June. Landings from Jul-Dec (yellow) predicted from the average historical ratio of monthly landings to three-month average landings (January, February, March) during most recent years without quota closures.

Recreational Target Trip Elimination

A total greater amberjack harvest prohibition during a given month may reduce angler incentive to deliberately target greater amberjack, which may, in turn, reduce encounter rates with the stock during that month. The MRIP intercept records where anglers reported targeting greater amberjack were identified as ‘target’ trips. If this option was selected by the RDT user, in the event of a management or quota closure, target trips were assumed to no longer occur. Landings and discards were then re-estimated using a catch estimate program, developed by NMFS Office of Science and Technology, applied to modified intercept records with target trips removed. Landings and discards from 2012-2013 were averaged to determine the percentage of status quo landings and discards that would remain in 2015 under a trip elimination scenario. Because June-July have been closed since 2011, the trip elimination function was disabled for these months.

MRIP Private mode reductions in target trips were used as a proxy for encounters that would be eliminated for TPWD Private mode. MRIP Charter mode reductions in target trips were used as a proxy for encounters that would be eliminated for HBS and TPWD Charter. This simulation had an impact upon total removals, by reducing the formerly landed catch that was converted to dead discards at a release mortality rate of 20% and also by reducing the discarded catch relative to baseline levels. Trip elimination is predicted to have the most substantial impacts during the first four months of the year, and the impacts are more pronounced for the private mode.

Table 2A. Projected reductions in monthly recreational landings and discards of greater amberjack under ‘trip elimination’ relative to simulation baseline for for-hire (charter, headboat) and private modes. Note the trip elimination function was disabled for June-July as the recreational sector was closed.

A: LANDINGS	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
FOR-HIRE	72%	72%	63%	63%	61%			57%	54%	54%	77%	77%
PRIVATE	62%	62%	76%	76%	58%			61%	71%	71%	79%	79%

B: DISCARDS	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
FOR-HIRE	63%	63%	56%	56%	52%			52%	53%	53%	52%	52%
PRIVATE	98%	98%	74%	74%	53%			57%	51%	51%	63%	63%

Recreational Minimum Size Limit Analyses

Length measurements collected during biological sampling associated with HBS, MRIP, and TPWD were converted to inches FL using standard conversion factors and equations summarized in Table 3 (SEDAR-33 2014). MRIP weight measurements were recorded in kilograms whole weight (ww) and headboat weight measurements were recorded in grams ww. No weight information was available for TPWD intercepts. All fish weights for TPWD intercepts and some fish weights for MRIP intercepts were not recorded for greater amberjack so whole weight was estimated from length using the equations summarized in Table 3. All weight measurements were recorded for each intercept in the headboat database. Data were used from HBS catch-effort files and SEFSC-prepared MRIP catch-effort files for 2012-2013.

Table 3. Meristic conversions for Gulf of Mexico greater amberjack. Source: SEDAR-33 (2014).

Conversion	Source	Model
TL (mm) vs. FL (mm)	FIN	TL = 1.085(FL) + 36.113
Whole weight (lbs) vs. FL (in)	TIP	WW = 1.808E-03(FL) ^{2.633}

Reductions in harvest (both numbers and weight of fish) were calculated for each mode of fishing (charter, headboat, and private/rental) for minimum size limits (MSL) at 1 inch intervals between 30-36 inches as follows:

Percent reduction = $((C - G) - B)/C$, where:

C = catch in either number of fish or pounds WW

G = number or weight of fish that are greater than or equal to the MSL

B = number or weight of fish smaller than the 30-inch FL MSL (non-compliance or measurement error)

MSL from 30 to 36 inches FL in one-inch increments were evaluated. Percent reductions associated with MSL were estimated by mode of fishing normalized to a 0% reduction at the recreational status quo of 30 inches (Table 4). Data were pooled to avoid sample sizes lower than 30 fish. The MRFSS and TPWD output were pooled by mode and outputs for all sources

were pooled across nearest months until a sample size of 30 fish (in numbers) for status quo was achieved. The same pattern used to achieve the target sample size in numbers was then applied to compute reductions in pounds. Projected MSL impacts varied by month and mode and are less than projected in the Amendment 35 RDT (SERO-LAPP-2011-09) due to a substantial increase in the size of landed greater amberjack in recent years (Figure 4).

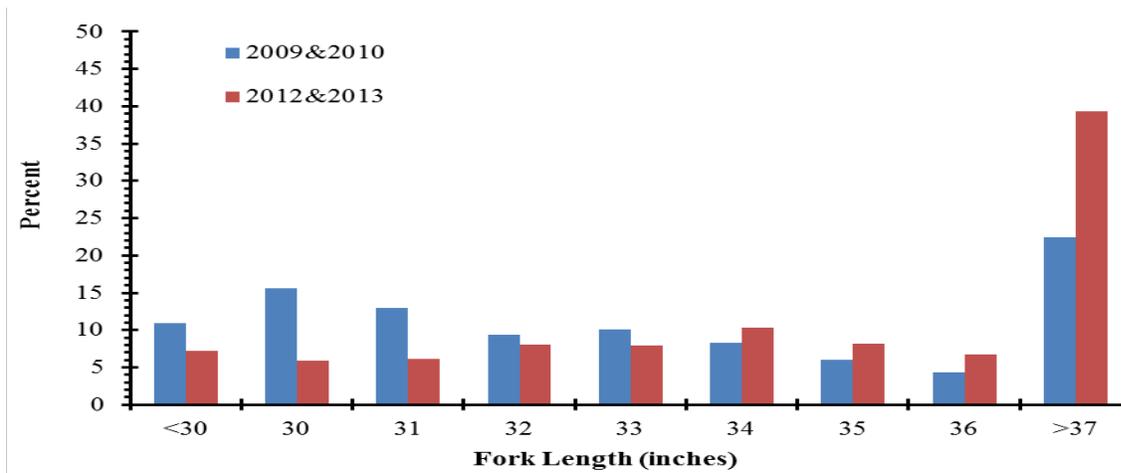


Figure 4. Fork lengths of landed greater amberjack reported by MRIP, HBS, and TPWD (combined) for Amendment 35 analysis (2009-2010) and current framework action analysis (2012-2013).

Table 4. Projected reduction of headboat, MRIP and TPWD Charter, and MRIP and TPWD Private mode greater amberjack landings by month for various minimum size limits. Warmer colors denote higher reductions. Note data have been pooled to achieve a minimum sample size of 30 fish per estimate.

MSL (inches FL)	MONTHLY PERCENT REDUCTION IN HB LANDINGS (POUNDS; 2012-2013)											
	1	2	3	4	5	6	7	8	9	10	11	12
30	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
31	5%	7%	6%	2%	0%	0%	3%	3%	1%	2%	3%	1%
32	8%	10%	12%	7%	2%	2%	5%	5%	2%	3%	10%	3%
33	11%	15%	19%	12%	3%	3%	8%	8%	3%	5%	18%	11%
34	16%	15%	19%	16%	11%	10%	10%	10%	5%	9%	24%	19%
35	23%	22%	26%	21%	13%	12%	12%	12%	7%	11%	28%	26%
36	30%	31%	32%	25%	18%	17%	15%	15%	9%	15%	32%	32%

MSL (inches FL)	MONTHLY PERCENT REDUCTION IN CHARTER LANDINGS (POUNDS; 2012-2013)											
	1	2	3	4	5	6	7	8	9	10	11	12
30	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
31	1%	0%	3%	7%	2%	2%	5%	5%	1%	3%	2%	0%
32	3%	1%	7%	12%	8%	8%	7%	8%	5%	6%	6%	4%
33	3%	4%	11%	18%	17%	18%	12%	12%	10%	14%	13%	4%
34	4%	4%	15%	25%	24%	24%	17%	18%	15%	23%	21%	8%
35	4%	10%	26%	39%	35%	35%	23%	24%	27%	36%	32%	8%
36	9%	16%	32%	46%	45%	44%	28%	29%	33%	44%	41%	16%

MSL (inches FL)	MONTHLY PERCENT REDUCTION IN PRIVATE LANDINGS (POUNDS; 2012-2013)											
	1	2	3	4	5	6	7	8	9	10	11	12
30	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
31	3%	6%	5%	7%	11%	8%	6%	5%	5%	4%	5%	4%
32	4%	9%	8%	8%	14%	8%	6%	5%	5%	4%	5%	4%
33	4%	10%	10%	11%	20%	14%	10%	8%	9%	5%	6%	5%
34	7%	15%	15%	18%	33%	18%	12%	9%	10%	7%	8%	8%
35	14%	22%	22%	24%	36%	20%	13%	11%	13%	12%	14%	14%
36	21%	31%	30%	28%	41%	25%	18%	18%	20%	18%	21%	22%

Commercial Trip Limits

Commercial trip limits are a tool for extending the season length by reducing the rate of commercial harvest. In 2013, the majority of greater amberjack trips taken landed less than 500 pounds gw of the species (Figure 5). As seen in Figure 6, however, the bulk of the commercial greater amberjack harvest was landed on trips with higher yields. Trip limits from 500-2,000 lb gw per trip were examined using commercial logbook data. To model trip limits, if total catch per logbook-reported trip was greater than the trip limit being analyzed, the value was re-set to the new trip limit, otherwise no changes to catch were made. Commercial fishermen were assumed to stop targeting amberjack once their trip limit was met. If the CDT user selected a trip limit for a given month, the percent reduction predicted by the trip limit model was applied to baseline monthly landings (Table 5)⁴.

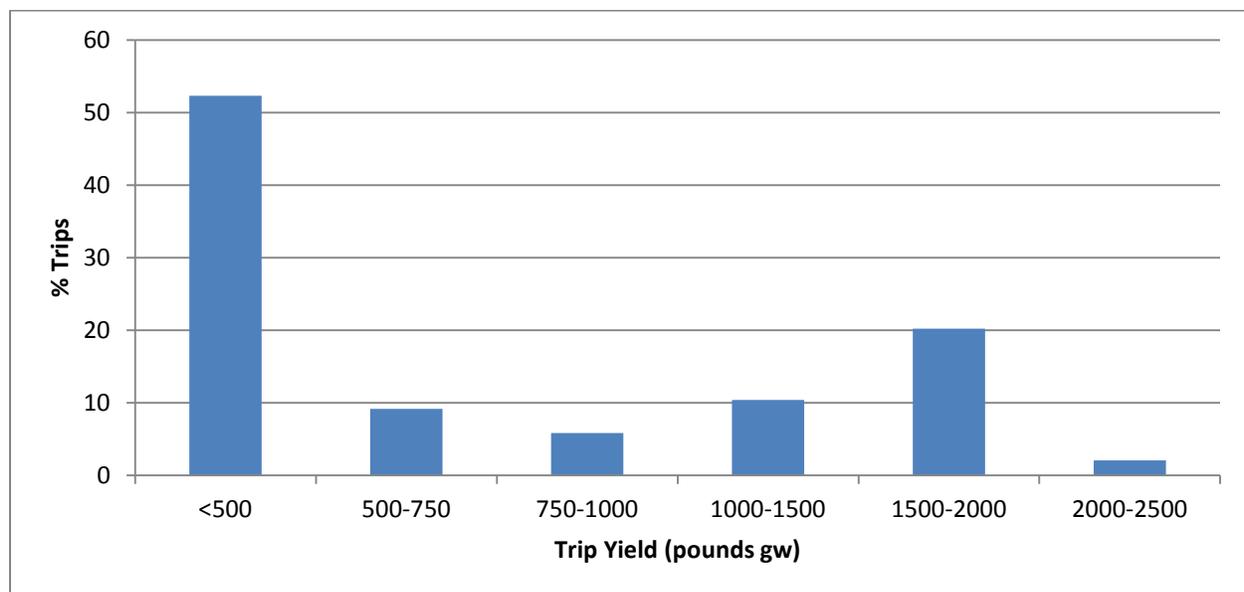


Figure 5. Distribution of commercial greater amberjack trip yields as reported to the SEFSC logbooks in 2013.

⁴ The historical monthly landings ratios described earlier that were used to estimate landings in months that were under quota closures in 2013 were re-calculated for each trip limit option as well.

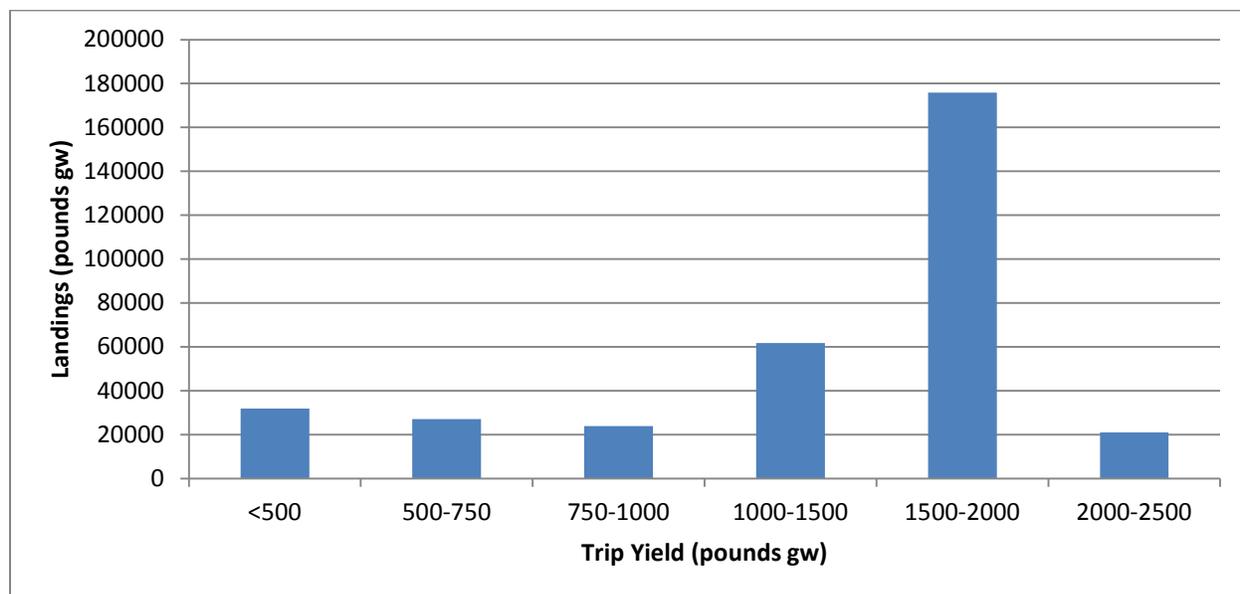


Figure 6. Total commercial greater amberjack landings by trip yield category as reported to SEFSC logbooks in 2013.

Table 5. Projected monthly commercial greater amberjack landings for various trip limits.

MONTH	Status Quo - 1,923 LB (2000 LB WW)	1,500 LB	1,000 LB	750 LB	500 LB
Jan	119,393	108,852	87,058	72,149	53,443
Feb	153,050	133,939	104,026	85,057	61,949
Mar	158,815	140,027	108,969	89,288	65,462
Apr	164,580	146,116	113,912	93,518	68,974
May	170,345	152,204	118,855	97,749	72,487
Jun	176,109	158,292	123,798	101,980	75,999
Jul	125,400	109,857	83,413	66,844	48,347
Aug	129,377	112,654	84,982	67,857	49,001
Sep	131,984	115,658	88,102	71,358	52,297
Oct	84,303	74,117	58,670	48,194	35,242
Nov	104,015	93,369	74,580	62,255	46,713
Dec	101,640	92,449	74,205	61,390	46,103

Note: Purple shading denotes gaps filled with linear interpolation; orange shading denotes extrapolation from average historical ratio of landings in each closed month to the three-month average landings in January, February, and June.

Combined Effects of User-Defined Management Measures

The projected impacts of the various management measures produced output in pounds of landings (i.e. trip limit) or percent reductions (i.e. vessel limit, proportional bag limit, size limit). These results were incorporated into Microsoft Excel RDT and CDT models. For both models, if month (m) was 100% closed, landings were set to zero pounds for all sectors. For the RDT, if a month was partially or fully open, the projected landings (L) were computed as follows:

$$L_{sector,m} = BL_{sector,m} * O_m * \zeta_{sector,m}$$

where BL: baseline landings, O: percent of month open to fishing, and ζ : percent landed catch remaining following size limit implementation.

If month (m) was partially closed and the user-defined trip elimination (τ) to be false, projected discards (D) were computed as baseline discards (BD) plus baseline landings (BL). Similarly, if month (m) was partially closed and the user-defined trip elimination (τ) to be true, discards (D) were computed as:

$$D_{sector,m} = BD_{sector,m} * \tau_{sector,m}^D + \underbrace{\left[\left((BL_{sector,m}) - L_{sector,m} \right) * \tau_{sector,m}^L * (1 - O_m) \right]}_{\text{new management discards}}$$

where τ : the percent reduction in landings (L) and discards (D) due to trip elimination. Projected discards were multiplied by a 20% release mortality rate to convert to dead discards. Projected dead discards were added to projected landings to determine total removals.

For the CDT, projected monthly landings were computed as:

$$L_m = T_m * O_m$$

where T_m : projected landings under user-defined trip limit (see Table 5).

For both decision tools, the projected monthly landings were summed across the year for a variety of user-defined management scenarios and compared to the Framework Action ACL alternatives. In instances where the management measures were insufficient to constrain harvest below the ACL, the projected quota closure date was computed along with the aggregate landings at the time of closure.

Economic Effects

Dynamic economic effects projections are built in to both the RDT and CDT. Both sets of estimates are displayed in 2013 real dollars. Baseline economic values for the recreational and commercial greater amberjack fisheries are estimated using the RDT and CDT with all options set to current management alternatives. Separate baselines were estimated for the non-trip elimination and trip elimination scenarios.

For the recreational sector, economic effects are estimated as changes in consumer surplus (CS) and producer surplus (PS). The RDT converts estimated pounds (ww) landed to number of fish

using mean weights of greater amberjack from each wave of data. The number of fish are then multiplied by the willingness to pay (WTP) per greater amberjack to estimate the consumer surplus derived from catching and keeping the fish as discussed in Section 3.3.2.3 of GMFMC 2015. Under the trip elimination scenario, in addition to changes in CS, there are changes in PS. Changes to PS are estimated by multiplying the change in the number of greater amberjack target trips by the net operating revenue (NOR) per trip, as discussed in Section 3.3.2.3 of GMFMC 2015.

For the commercial sector, economic effects are estimated as changes to commercially generated greater amberjack revenues. Revenues are estimated by multiplying the projected landings in each month by the 2013 average monthly ex-vessel price of greater amberjack calculated from the SEFSC's commercial ACL dataset (accessed August 2014)⁵. Since the commercial sector is expected to achieve the quota under most management alternatives, changes in revenues from adjusting the trip limit mainly reflect changes in the monthly distribution of landings and the average monthly prices received for those landings⁶. The only other factor influencing estimated revenues is the difference in estimated daily catch rates across months. The CDT simulates a quota closure in the day preceding the day in which an estimated overage would occur, so depending on daily catch rates, there is the potential for the annual landings estimates to be closer to or further from the actual commercial ACT.

Results

Recreational

Table 6 presents recreational season lengths under a variety of management alternatives. With a quota closure in effect, under status quo management, the landings would be constrained to the ACT of 1.13 mp with a quota closure on 31 Aug. Status quo removals would range from 1.592-1.723 mp, depending on the ACT selected and assumptions regarding trip elimination. If the June-July seasonal closure is eliminated, the RDT predicts a quota closure would likely be necessary between June 30 and July 19, limiting the season to 181-200 days, depending on the ACT alternative selected (Figure 7A). Removals would range from 1.475-1.793 mp, depending on the ACT selected and assumptions regarding trip elimination. Increasing the recreational size limit to 34 inches is projected to extend the season around 20 days (Figure 7B). Removals would range from 1.475-1.775 mp, depending on the ACT selected and assumptions regarding trip elimination. A June-July closed season would reduce the total days open to 172-199, but would provide opportunities for fishing into September (Figure 7C). Removals would range from 1.475-1.775 mp, depending on the ACT selected and assumptions regarding trip elimination. A June-July closed season coupled with a 34 inch size limit would increase the total fishable days to 196-233, and provide fishing opportunities into October (Figure 7D). Removals would range from 1.540-1.811 mp, depending on the ACT selected and assumptions regarding trip elimination.

⁵ For months that were closed in 2013, there were limited price observations. As such, average monthly prices for those months were computed by taking an average of the average monthly prices (converted to 2013 dollars) from 2009-2013.

⁶ The CDT implicitly assumes that changes in greater amberjack supply will have no effect on monthly prices.

Under ACT Alternative 2 with a 13% buffer (i.e., ACT = 1.092 mp), a June-July closure coupled with a 36 inch size limit would allow fishing until 25 Oct; for 237 fishing days. Removals would range from 1.680-1.695 mp, depending on assumptions regarding trip elimination. Similarly, under ACT Alternative 2 with a 13% buffer, recreational regulations consistent with the commercial regulations (March-May spawning closure, 36 inch size limit) would maximize reproductive potential of the stock and allow fishing through 3 Oct (185 fishing days). Removals would range from 1.558-1.695 mp, depending on assumptions regarding trip elimination. Application of the larger 20% buffer would result in shorter seasons with reduced removals.

Table 6. Projected recreational season length (days) for Gulf greater amberjack under a variety of proposed management measures.

Closed Seasons	Size Limit	ACT Alt 1	ACT Alt 2		ACT Alt 3	
			13% buffer	20% buffer	13% buffer	20% buffer
June 1 - July 31	30	182	179	172	179	172
none	30	190	187	181	187	181
March 1 to May 31	30	145	142	135	142	135
January 1 – May 31 and November 1 – December 31	30	97	92	85	92	85
June 1 - July 31	32	196	191	180	191	180
none	32	199	195	188	195	188
March 1 to May 31	32	152	149	142	149	142
January 1 – May 31 and November 1 – December 31	32	108	102	91	102	91
June 1 - July 31	34	215	209	196	209	196
none	34	211	208	200	208	200
March 1 to May 31	34	168	162	150	162	150
January 1 – May 31 and November 1 – December 31	34	123	118	104	118	104
June 1 - July 31	36	258	237	222	237	222
none	36	227	224	215	224	215
March 1 to May 31	36	192	185	170	185	170
January 1 – May 31 and November 1 – December 31	36	147	140	125	140	125

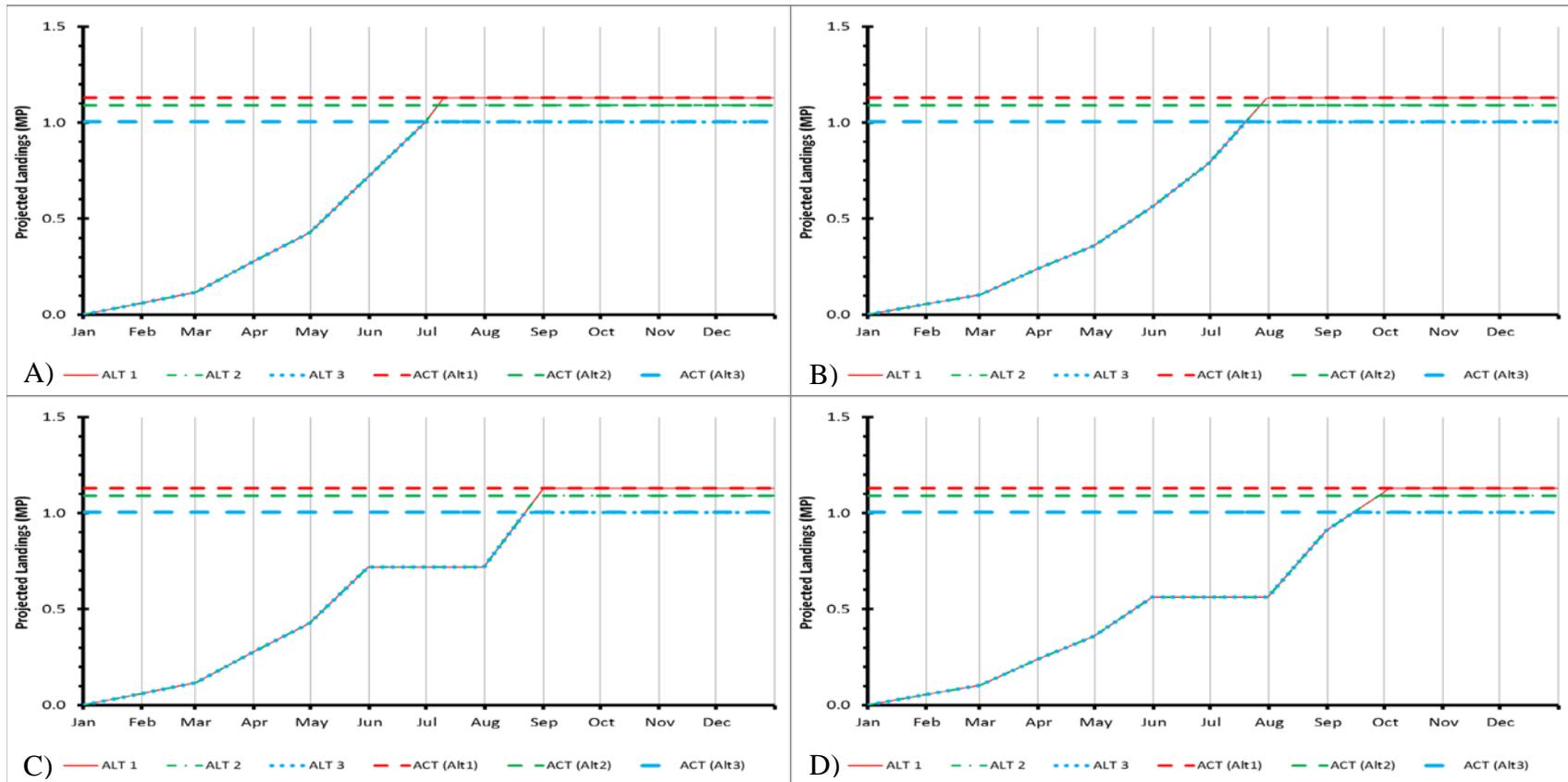


Figure 7. Projected recreational harvest in million pounds whole weight (MP) under A) no seasonal closure or additional management measures, B) a 34 inch size limit, C) a June-July seasonal closure, and D) a 34 inch size limit with a June-July closure for annual catch target (ACT) alternatives 1 (red; 1.130 MP), 2 (green; 1.092 MP with a 13% buffer), and 3 (blue; 1.004 MP with a 20% buffer).

As seen in Table 7, CS decreases in relation to the recreational greater amberjack ACT. On its own, the size limit does not have a large effect on CS, mainly because the value used for CS is invariant to the size of the fish harvested and anglers are expected to reach the allowable harvest under all of the alternatives. The dual January 1 through May 31 and November 1 through December 31 closed season results in the largest increase in CS over the status quo for all ACT and size limit alternatives. If charter trips targeting greater amberjack are assumed to not occur during season closures, then for-hire business NORs may be impacted as well. The changes in NOR associated with the various management options are presented in Table 8. As the recreational ACT is reduced, the tool predicts less trips will occur, which leads to lower NORs. Keeping all else constant, increasing the recreational size limit for greater amberjack will result in higher NORs since lower harvest rates result in a longer season and more charter trips. The option to have no specified closed season results in the highest NORs due to the high rate at which target trips occur during the period May through August. Again, this assumes that for-hire customers would not be able to substitute other target species for greater amberjack and would only book trips if greater amberjack were open. In reality, the management actions may not have a measurable impact on for-hire businesses.

Table 7. Projected change in CS (2013 \$) for Gulf greater amberjack under a variety of proposed management measures.

Closed Seasons	Size Limit	ACT Alt 1	ACT Alt 2		ACT Alt 3	
			13% buffer	20% buffer	13% buffer	20% buffer
June 1 - July 31	30	\$ -	\$(19,679.13)	\$ (65,597.09)	\$ (19,679.13)	\$ (65,597.09)
none	30	\$ (3,433.62)	\$(23,504.89)	\$ (63,647.42)	\$ (23,504.89)	\$ (63,647.42)
March 1 to May 31	30	\$ 19,088.62	\$ (590.51)	\$ (46,508.47)	\$ (590.51)	\$ (46,508.47)
January 1 – May 31 and November 1 – December 31	30	\$ 20,831.96	\$ 2,219.10	\$ (43,698.86)	\$ 2,219.10	\$ (43,698.86)
June 1 - July 31	32	\$ 2,224.35	\$(15,478.26)	\$ (59,579.08)	\$ (15,478.26)	\$ (59,579.08)
none	32	\$ 4,261.91	\$(20,757.44)	\$ (64,541.31)	\$ (20,757.44)	\$ (64,541.31)
March 1 to May 31	32	\$ 16,361.84	\$ (1,992.32)	\$ (44,818.68)	\$ (1,992.32)	\$ (44,818.68)
January 1 – May 31 and November 1 – December 31	32	\$ 20,646.80	\$ (596.34)	\$ (42,119.62)	\$ (596.34)	\$ (42,119.62)
June 1 - July 31	34	\$ 5,289.48	\$(15,033.34)	\$ (58,008.93)	\$ (15,033.34)	\$ (58,008.93)
none	34	\$ 4,767.48	\$(12,349.26)	\$ (57,993.91)	\$ (12,349.26)	\$ (57,993.91)
March 1 to May 31	34	\$ 17,887.38	\$ (1,947.51)	\$ (46,257.45)	\$ (1,947.51)	\$ (46,257.45)
January 1 – May 31 and November 1 – December 31	34	\$ 17,973.22	\$ 1,281.50	\$ (44,999.91)	\$ 1,281.50	\$ (44,999.91)
June 1 - July 31	36	\$ 9,498.14	\$(11,468.90)	\$ (55,745.11)	\$ (11,468.90)	\$ (55,745.11)
none	36	\$ 5,284.01	\$ (9,624.30)	\$ (54,349.22)	\$ (9,624.30)	\$ (54,349.22)
March 1 to May 31	36	\$ 18,209.91	\$ (2,452.32)	\$ (45,623.22)	\$ (2,452.32)	\$ (45,623.22)
January 1 – May 31 and November 1 – December 31	36	\$ 21,243.50	\$ 581.27	\$ (43,694.94)	\$ 581.27	\$ (43,694.94)

Table 8. Projected change in NOR (2013 \$) for Gulf greater amberjack under a variety of proposed management measures, assuming charter trips targeting greater amberjack are eliminated during closed seasons*.

Closed Seasons	Size Limit	ACT Alt 1	ACT Alt 2		ACT Alt 3	
			13% buffer	20% buffer	13% buffer	20% buffer
June 1 - July 31	30	\$ -	\$(47,552.17)	\$ (158,507.23)	\$(47,552.17)	\$(158,507.23)
none	30	\$191,190.91	\$143,638.75	\$ 48,534.41	\$ 143,638.75	\$ 48,534.41
March 1 to May 31	30	\$(10,970.76)	\$(58,522.92)	\$ (169,477.98)	\$(58,522.92)	\$(169,477.98)
January 1 – May 31 and November 1 – December 31	30	\$ 7,928.47	\$ 4,193.56	\$ (106,761.50)	\$ 4,193.56	\$(106,761.50)
June 1 - July 31	32	\$ 10,457.77	\$ 6,722.85	\$ (31,701.45)	\$ 6,722.85	\$ (31,701.45)
none	32	\$333,847.42	\$270,444.53	\$ 159,489.47	\$ 270,444.53	\$ 159,489.47
March 1 to May 31	32	\$ 84,133.58	\$ 36,581.41	\$ (74,373.65)	\$ 36,581.41	\$ (74,373.65)
January 1 – May 31 and November 1 – December 31	32	\$ 16,145.30	\$ 11,663.39	\$ (11,657.17)	\$ 11,663.39	\$ (11,657.17)
June 1 - July 31	34	\$ 24,650.46	\$ 20,168.56	\$ 10,457.77	\$ 20,168.56	\$ 10,457.77
none	34	\$524,056.09	\$476,503.92	\$ 349,698.14	\$ 476,503.92	\$ 349,698.14
March 1 to May 31	34	\$ 96,085.32	\$ 91,603.42	\$ 52,432.14	\$ 91,603.42	\$ 52,432.14
January 1 – May 31 and November 1 – December 31	34	\$ 27,350.05	\$ 23,615.13	\$ 13,157.36	\$ 23,615.13	\$ 13,157.36
June 1 - July 31	36	\$ 93,782.73	\$ 41,084.11	\$ 29,879.35	\$ 41,084.11	\$ 29,879.35
none	36	\$777,667.65	\$730,115.49	\$ 587,458.98	\$ 730,115.49	\$ 587,458.98
March 1 to May 31	36	\$114,012.93	\$108,784.04	\$ 97,579.29	\$ 108,784.04	\$ 97,579.29
January 1 – May 31 and November 1 – December 31	36	\$ 45,277.66	\$ 40,048.77	\$ 28,844.02	\$ 40,048.77	\$ 28,844.02

*Target data for headboats are not available; thus, changes in headboat NOR have not been estimated.

Commercial

Table 7 presents projected commercial season lengths under a variety of management alternatives. The CDT predicts that under the no action alternative, a quota closure would occur on June 23, 2015 with a total season length of 82 days. The combination of options that would result in the longest commercial greater amberjack season is ACT Alternative 1 and a 500 lb trip limit. Under this combination, nearly 100% of the selected ACT (409,000 lb) is expected to be harvested and the season is expected to be open for 233 days, with a closure on November 21, 2015.

Table 7. Projected season length (days) for commercial Gulf greater amberjack under various ACT and trip limit alternatives*.

Trip Limit (lbs gw)	ACT Alt 1	ACT Alt 2		ACT Alt 3	
		15% buffer	20% buffer	15% buffer	20% buffer
1,923** (status quo)	82	79	75	79	75
1,500	91	87	83	87	83
1,000	123	118	110	118	110
750	157	151	140	151	140
500	233	223	207	223	207

*All estimates reflect current seasonal closure from March 1 through May 31.

**2000-lb ww

Almost all of the ACT and trip limit combinations result in a loss in estimated ex-vessel revenue. The estimated losses increase as the ACT decreases. For all ACT alternatives, the 1,500-lb ww trip limit produces the most favorable revenue estimates. Conversely, the largest predicted revenue loss occurs with the 500-lb ww trip limit.

Table 8. Projected change in ex-vessel revenue (2013 \$) under various ACT and trip limit alternatives*.

Trip Limit (lbs gw)	ACT Alt 1	ACT Alt 2		ACT Alt 3	
		15% buffer	20% buffer	15% buffer	20% buffer
1923** (status quo)	\$ -	\$ (26,174.25)	\$ (61,073.25)	\$ (26,174.25)	\$ (61,073.25)
1500	\$ 3,599.38	\$ (20,703.19)	\$ (52,071.39)	\$ (20,703.19)	\$ (52,071.39)
1000	\$ (15,365.12)	\$ (30,831.43)	\$ (57,007.06)	\$ (30,831.43)	\$ (57,007.06)
750	\$ (32,731.67)	\$ (48,799.33)	\$ (74,922.19)	\$ (48,799.33)	\$ (74,922.19)
500	\$ (39,684.14)	\$ (59,739.48)	\$ (89,210.90)	\$ (59,739.48)	\$ (89,210.90)

*All estimates reflect current seasonal closure from March 1 through May 31.

**2000-lb ww

Discussion

As with most projection models, the reliability of the RDT and CDT results are dependent upon the accuracy of their underlying data and input assumptions. We have attempted to create a realistic baseline as a foundation for comparisons, under the assumption that 2013 (or 2014, when available) is the most representative year for future trends. Uncertainty exists in this baseline, as economic conditions, weather events, changes in catch-per-unit effort (CPUE), fisher response to management regulations, and a variety of other factors may cause departures from this assumption. The bounds of this uncertainty are not captured by the model as currently configured; as such, it should be used with caution when evaluating future management. In addition to the aforementioned sources of uncertainty, the modeled reductions associated with management measures assume that past performance in the fishery is a good predictor of future dynamics. We have attempted to constrain the range of data considered to recent years to reduce the unreliability of this assumption; however, due to the long-standing commercial spawning closure and quota closures in previous years, we have been forced to fill gaps in recent data when establishing a baseline. Greater uncertainty exists in our predictions during these extrapolated time periods relative to months where greater amberjack was open in 2013.

2013 was selected as the baseline year for landings in the CDT since it is the most recent fishing year with a complete and vetted data set. Preliminary Gulf greater amberjack landings estimates for 2014 produced by SERO are about 4.6% higher than 2013 landings. Total landings predictions in the CDT are driven by the ACT, with the assumption that the fishing season will close promptly upon reaching the ACT. Aggregate landings predictions are therefore not likely to be affected by the choice of baseline years. Commercial landings were; however, more spread out in 2014 than 2013. There was a 55 day longer season in 2014. If 2015 monthly catch rates remain consistent with 2014, then the season length predictions from the CDT may be underestimates. With regards to revenue estimates, it is not possible to compare the choice of baselines (2013 versus 2014) because average monthly price and effort data are not currently available for 2014.

The relative impacts of various proposed management options explored in the RDT are anticipated to be robust to uncertainty in future catch rates; however, the exact season lengths projected are subject to high uncertainty. The RDT used the most recent available complete and vetted recreational landings data from the SEFSC Recreational ACL dataset (i.e., a hybrid of 2013 and 2014 data). Preliminary 2014 data suggest that 2014 catch rates were around 20% lower than 2013. It is unclear if future catch rates will be closer to 2013 or 2014 levels; however, fuel prices dropped substantially starting in late 2014, which may result in higher landings in future seasons than observed in 2014, due to a reduced opportunity cost for recreational anglers. As such, the 2013 data used in the RDT may be a good predictor of future catch rates. Another factor contributing to the uncertainty in projected season lengths is the changes in the MRIP survey between 2012 and 2013. The current ACL and ACT for greater amberjack are based on the SEDAR-33 (2014) stock assessment, which used MRIP re-estimates for 2004-2012 and MRIP data for 2013. In a more recent stock assessment, the Gulf of Mexico red snapper SEDAR-31 Update (2015), the MRIP re-estimates for 2004-2012 were re-calibrated to better reflect the changes in MRIP survey methodology that began in 2013. These re-calibrations resulted in higher estimates of 2004-2012 catches, which in turn resulted in a higher

ABC recommendation from the assessment that was approved on Feb 20, 2015 by the Gulf Council's SSC. If a similar re-calibration were performed on the Gulf of Mexico greater amberjack MRIP re-estimates from 2004-2012, it is likely these estimates (and the associated stock assessment ABC recommendation) would be higher. As such, the ACTs and associated season lengths from the RDT may represent underestimates relative to the true maximum sustainable yield of the Gulf of Mexico greater amberjack stock.

Neither model accounts for effort shifting that may take place during a seasonal closure. Effort shifting may lead to increased removal rates before and after a closure that partially offset the reductions expected from the closure. The models also do not consider non-compliance with various proposed regulations, which would similarly offset the projected reductions. Neither model considers any changes in the average size of greater amberjack during rebuilding. An increased average size would lead to fishermen capturing their quota more rapidly relative to previous years under similar effort levels. All of these factors would result in more pessimistic projections. As such, management reductions presented in this report may be overestimates, and caution should be taken in their interpretation and use. By contrast, continued adverse economic conditions and rising fuel prices may reduce effort, which would counter these other trends.

In general, the models suggest additional management regulations are necessary to rebuild greater amberjack within the allowable time frame and constrain harvest below the ACL. For the recreational sector, the June-July seasonal closure would not accomplish this objective independent of other management measures. In 2013, with a June-July seasonal closure, the recreational fishery exceeded their ACL of 1,299 mp by 18%. Increasing the recreational size limit to 34 inches fork length (FL) would extend the season and may be biologically advantageous. Murie and Parkyn (2008) determined the size of 50% maturity to be about 35 inches fork length and spawning potential ratio (SPR) would be greatly enhanced by increasing the size limit (SERO 2011). Although greater amberjack release mortality rate is poorly quantified, it is estimated to be around 20% (SEDAR 9 Update 2010); thus, a high percentage of fish released due to an increased size limit may survive to spawn and promote recovery of the stock.

Assumptions regarding changes in the level of dead discards due to new management measures were highly sensitive to both the ACT Alternative selected and the assumptions about trip elimination during a seasonal or quota closure. A higher ACT results in a longer season, which reduces removals unless trip elimination happens after a quota closure, in which case an early quota closure results in less total removals. Attempts to validate the utility of the trip elimination function based on historical data were inconclusive. Validation of the trip elimination function would be simplified by closures of entire waves or MRIP data availability on a monthly rather than bimonthly basis; however, the uncertainty in the level of self-reported discards and self-identified 'targeted trips' from year-to-year would still be a major confounding factor for the evaluation of the utility of this function. Due to uncertainty about which option was most appropriate, both options for trip elimination were retained in the RDT to allow the user to investigate the uncertainty around estimates of total removals. It should be noted that an especially high level of uncertainty surrounds how self-reported discards were partitioned between May and June for Wave 3 and between July and August for Wave 4. These estimates were assumed to be uniformly distributed within Waves; however, if trip elimination is taking

place, the expectation would be that a higher proportion of discards would have originated from open months. Similarly, if trip elimination is not taking place, a higher proportion of discards would have originated from closed months, as fish that would have been landed would have been discarded instead.

For the commercial sector, retaining or extending the current March-May spawning closure and coupling it with a trip limit appears to be necessary to constrain harvest and extend the length of the commercial fishing season. Based on CDT predictions, a 500 lb trip limit enacted during all open months would extend the greater amberjack season the longest. This projection is limited by the assumption that fishermen will not make additional trips to partially offset their losses due to a severely restrictive trip limit nor will they cancel trips based on changes in profitability. Not accounting for this dynamic behavior could result in the CDT overestimating or underestimating the reductions associated with trip limits and the potential economic effects. Higher trip limits would extend the length of the commercial fishing season, but may or may not be sufficient to prevent quota closures.

References

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