An evaluation of Gulf of Mexico red snapper landings by sector and days fished with and without sector separation

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Introduction and Background

In November 2010, the Gulf of Mexico Fishery Management Council (Gulf Council) hosted a Sector Separation Workshop in Tampa, Florida, to discuss and obtain perspectives on sector separation (GMFMC 2010). Sector separation refers to the dividing of the recreational quota into one or more separate for-hire and private angler sector quotas. During the past year, the Gulf Council has included actions considering sector separation in several fishery management plan amendments, and most recently voted to begin development of a standalone amendment to address sector separation.

During the sector separation workshop, several questions emerged from participants (see GMFMC 2010) that led to the development of this document. These questions included:

- What would sector separation look like if implemented?
- How might catch be apportioned among for-hire and private-recreational anglers?
- How would individuals be affected by sector separation, including specific indicators such as relative landings by sector and season length under different allocation scenarios?

During the wrap-up session on the last day of the Sector Separation Workshop many participants expressed a strong interest in comparing management with and without sector separation. The following excerpts are from the Sector Separation Workshop report:

> *"Participants expressed a strong interest in seeing a comparison between the number of fishing days under status quo and sector separation scenarios, based on different allocation options and stock status projections. Many felt that these projections, though hypothetical, would help them have a more informed stance on sector separation." (pg. 14)*
>
> *"Following the wrap-up session, Gulf Council members and Reef Fish Advisory Panel members addressed the audience directly. They agreed with the need to further define sector separation and explore hypothetical scenarios, …" (pg. 14)*

To address the questions above and comments offered during the Sector Separation Workshop, the Southeast Regional Office developed a projection model for comparing red snapper fishing season lengths with and without sector separation. The model is intended to provide constituents with an opportunity to evaluate the relative benefits and tradeoffs of sector separation under a variety of input assumptions, including different levels of baseline allocation, different rates of change in average weight of fish and fishing population growth by sector, different levels of state for-hire vessel participation, and different levels of effort compensation for a restricted season.

Methods

The sector separation model (SSM) was developed using Microsoft Excel and Visual Basic software. Excel was chosen because it is widely available for constituent use. Model users must enable Excel macros and install *Solver* to allow the model to estimate red snapper season lengths. Instructions for configuring Excel prior to model use are summarized in Appendix 1. Instructions for using the SSM are summarized in Appendix 2.

Baseline Allocation

The SSM allows the user to specify a series of years from which allocation is determined from historical landings data for the for-hire and private/rental sectors. The user may also over-ride this computed allocation with a specified percentage for each sector between 0-100% . Computed allocations were determined using recreational red snapper landings data obtained from the Southeast Fisheries Science Center's (SEFSC) annual catch limit (ACL) dataset (Table 1). Landings from 1986-2009 were considered in this analysis. This dataset includes a compilation of Gulf of Mexico red snapper landings in pounds whole weight by data source. Marine Recreational Fisheries Statistics Survey (MRFSS) private and charter landings are estimated using a combination of dockside intercepts (landings data) and phone surveys (effort data). Landings are estimated in numbers by two-month wave (e.g., Wave 1 = Jan/Feb, …, Wave 6 = Nov/Dec), area fished (state and federal waters), mode (charter, private/rental), and state (west Florida, Alabama, Mississippi, and Louisiana) and then converted to whole weight in pounds using average weights of fish intercepted. Landings from Gulf headboats are estimated by the SEFSC from logbooks submitted to the Southeast Headboat Survey (HBS). HBS landings are reported by vessel, day/month, and statistical reporting area (i.e., area 18 = Dry Tortugas off west coast of Florida, …, area 27 = Southeast Texas). The Texas Parks and Wildlife Department (TPWD) creel survey generates estimates of landings for private/rental boats and charter vessels fishing off Texas. 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). To convert TPWD landings in numbers to landings in pounds, red snapper average lengths by mode, wave, and area fished (state vs. federal waters) were converted to weights using a standard length-weight conversion formula from SEDAR 7 (2005).

Table 1. For-hire and private red snapper landings (lbs ww) by year, 1986-2009.

Year	For-Hire Landings	Private Landings	Total Rec Landings
1986	2,026,404	750,833	2,777,237
1987	1,310,453	506,716	1,817,169
1988	1,531,503	1,039,396	2,570,900
1989	1,705,982	951,952	2,657,934
1990	1,034,684	580,615	1,615,299
1991	1,653,544	707,437	2,360,981
1992	1,957,438	1,944,339	3,901,778
1993	3,484,671	2,204,903	5,689,574
1994	3,197,152	2,107,172	5,304,324
1995	2,905,781	1,914,270	4,820,051
1996	3,090,150	1,261,261	4,351,411
1997	3,766,984	2,246,423	6,013,407
1998	2,925,970	1,334,921	4,260,891
1999	1,933,211	2,068,686	4,001,898
2000	2,241,487	1,693,861	3,935,348
2001	2,060,450	2,410,909	4,471,358
2002	2,955,898	2,430,719	5,386,617
2003	2,608,649	2,240,647	4,849,296
2004	2,761,322	2,237,668	4,998,990
2005	2,202,702	1,884,239	4,086,941
2006	2,246,432	1,779,002	4,025,435
2007	2,151,781	2,291,425	4,443,206
2008	1,579,575	2,133,830	3,713,406
2009	2,007,284	2,618,237	4,625,521

Source: SEFSC ACL Dataset (2010).

Increasing Average Weight

Average weights for red snapper were provided by the SEFSC (B. Linton, pers. comm.). Average weights are based on data from red snapper stock projections (SEFSC 2009). In 2009, the average weight projected was 5.25 pounds ww, compared to a reported average weight of 5.06 pounds ww. In 2010, the average projected weight was 5.56 pounds ww, compared to an average reported weight of 5.29 pounds ww. As the red snapper stock rebuilds, the average weight of red snapper is projected to rapidly increase (Figure 1) from 5.56 pounds ww in 2010 to nearly 7.0 pounds in 2015. The sector separation model allows users to select the rate of red snapper weight increase relative to projected increases (i.e., equal to projected or ±10 percent of projected). The average weight assumed impacts the total number of red snapper fishing days, but has little influence on the relative percent change in days fished when comparing sector separation versus no sector separation.

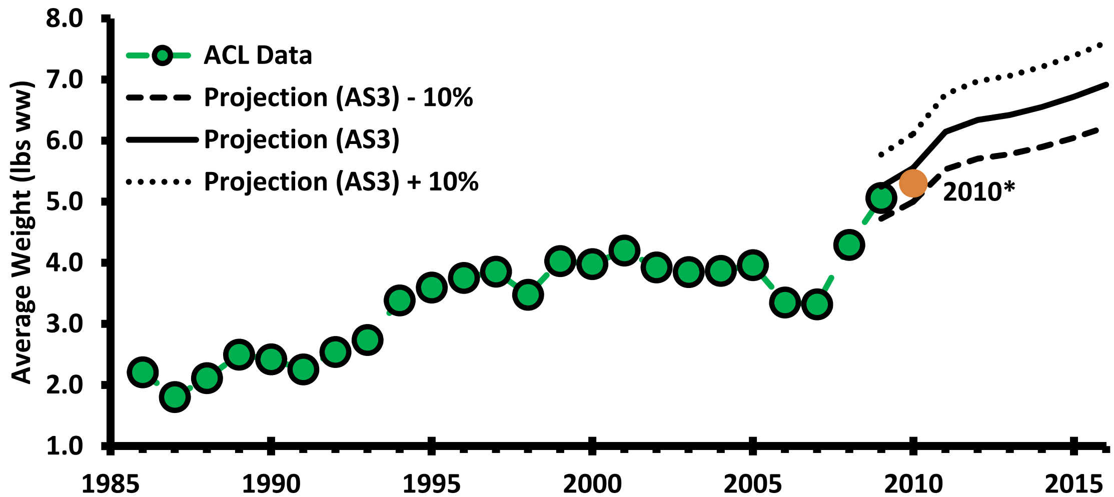


Figure 1. Estimated and projected red snapper average weights, 1986-2015.

Changes in Gulf Fishing Population

Data for assessing trends in Gulf fishing population and participation were obtained from the U.S. Census (2010), Woods and Poole (2006), Gulf States Marine Fisheries Commission (2000-2009), NOAA Fisheries Service for-hire permit data, and state vessel registration data (Ball 2011, Campbell 2011, FDHSMV 2011, LDWF 2011, Shipman 2011). Linear regressions were fit to each of these datasets to determine an annual rate of increase or decrease. These trends in effort were then used to evaluate the sensitivity of the sector separation model to different trends in fishing effort.

The U.S. Census provides estimates of Gulf coastline county population growth by decade. Between 1960 and 2008, the coastal county population along the Gulf of Mexico increased by 250 percent (Figure 2), representing a 0.3 percent annual increase. Woods and Poole Economics Group (2006) projected coastal population growth along the Gulf of Mexico coast through 2045. Between 2010 and 2045 they projected the coastal population would increase from ~25 million people to nearly 40 million people (Figure 3), a projected annual increase of 1.1 percent. The Gulf States Marine Fisheries Commission has produced annual reports of state license data since 2000. Annual reports from 2000-2009 were used to compute the total number of recreational angler licenses sold. Between 2000 and 2009, the total number of state fishing licenses sold in all Gulf states increased from 2.31 million to 2.78 million (Figure 4), representing an annual increase of 0.3 percent. Federal permit data for charter and headboats has been collected by NOAA Fisheries Service since 2003, when a moratorium on for-hire permits was implemented. In 2003, NOAA Fisheries Service issued 1,693 for-hire permits. As of early 2011, 1,392 for-hire permits were still valid or renewable (Figure 5). This reduction represents a 2.4 percent decrease in for-hire permits per year. Approximately 35 for-hire permits are terminated each year because the operator fails to renew the permit. Recreational vessel registration data was obtained from all Gulf states (Ball 2011, Campbell 2011, FDHSMV 2011, LDWF 2011, Shipman 2011). Florida private vessel registrations increased from ~125,000 in 1964 to a peak of nearly 1 million in 2007, before declining (Figure 6). From 2005-2010, Gulf-wide private vessel registrations declined from 2.14 to 2.06 million, representing an annual rate of decrease of 0.6 percent (Figure 7). As not all states differentiate between private and charter/for-hire vessels during their registration process, it was impossible to separate trends by sector from the vessel registration data.

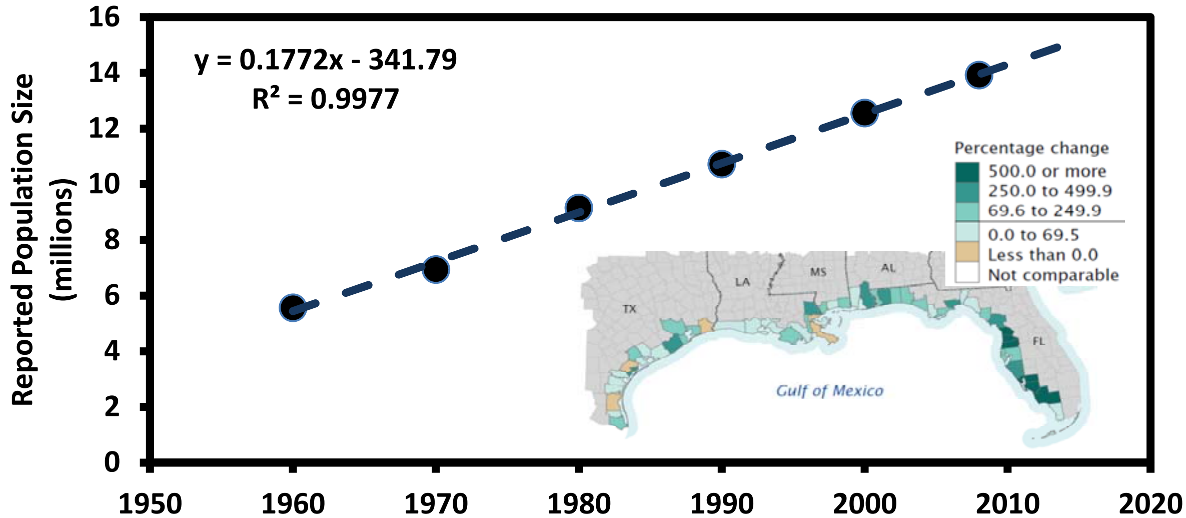


Figure 2. Projected Growth of Coastline County Population in U.S. Gulf of Mexico from U.S. Census Bureau (2010).

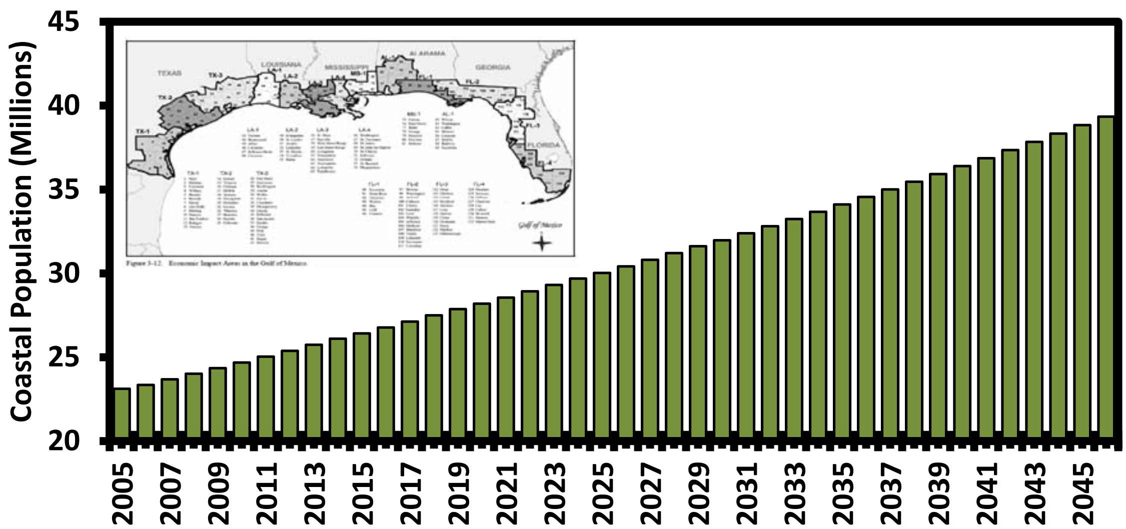


Figure 3. Projected Growth of Coastal Population in U.S. Gulf of Mexico from Woods & Poole Economics, Inc. (2006).

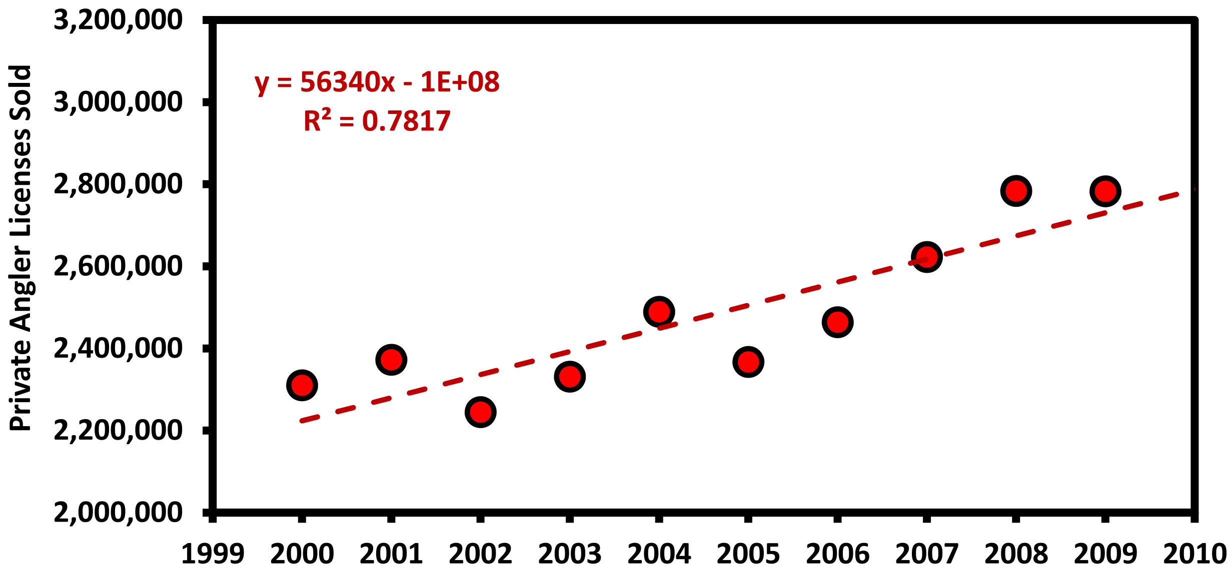


Figure 4. Private angler licenses sold in Gulf states, 2000-2009.

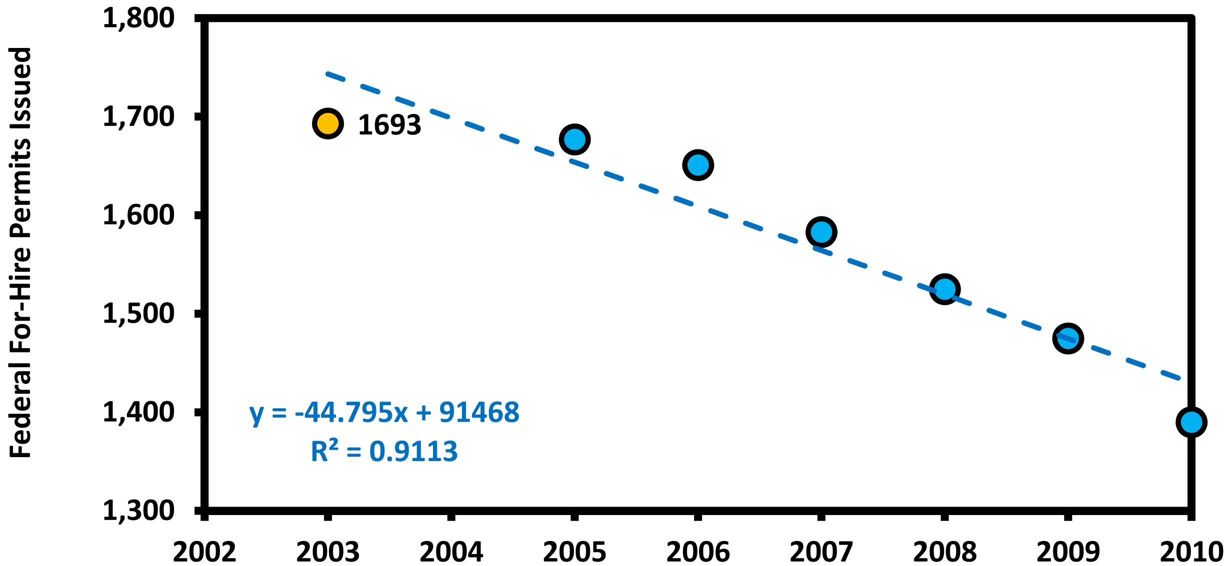


Figure 5. Federal for-hire reef fish permits issued, 2003-2010. Note: 1,693 permits were originally issued in 2003.

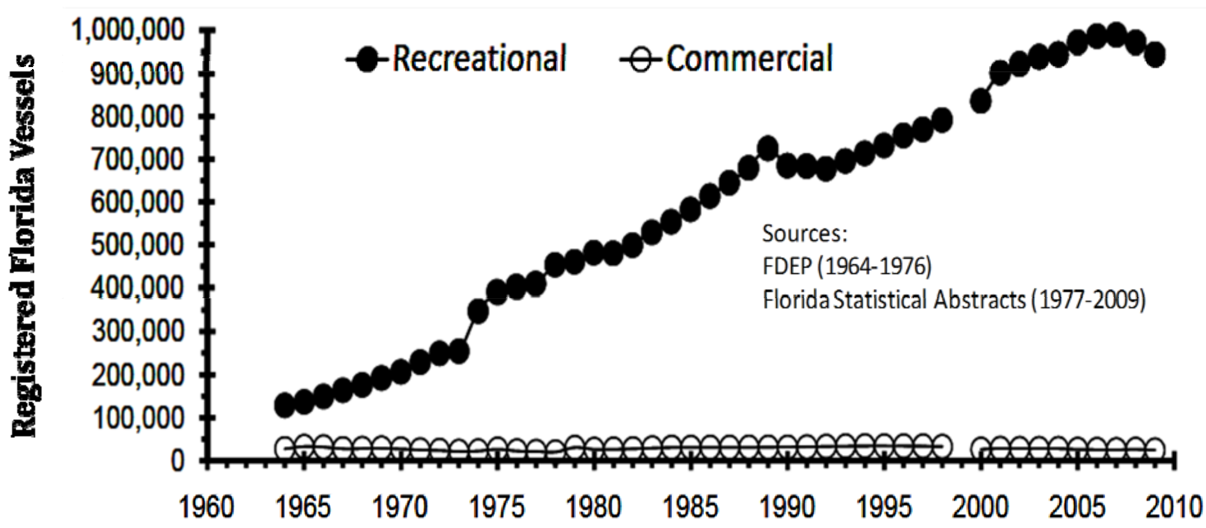


Figure 6. Registered commercial and recreational Florida vessels, 1964-2009. Sources: Florida Department of Environmental Protection (1964-1976) and Florida Statistical Abstracts (1977-2009). Graphic provided by Dr. Jerald S. Ault, University of Miami RSMAS.

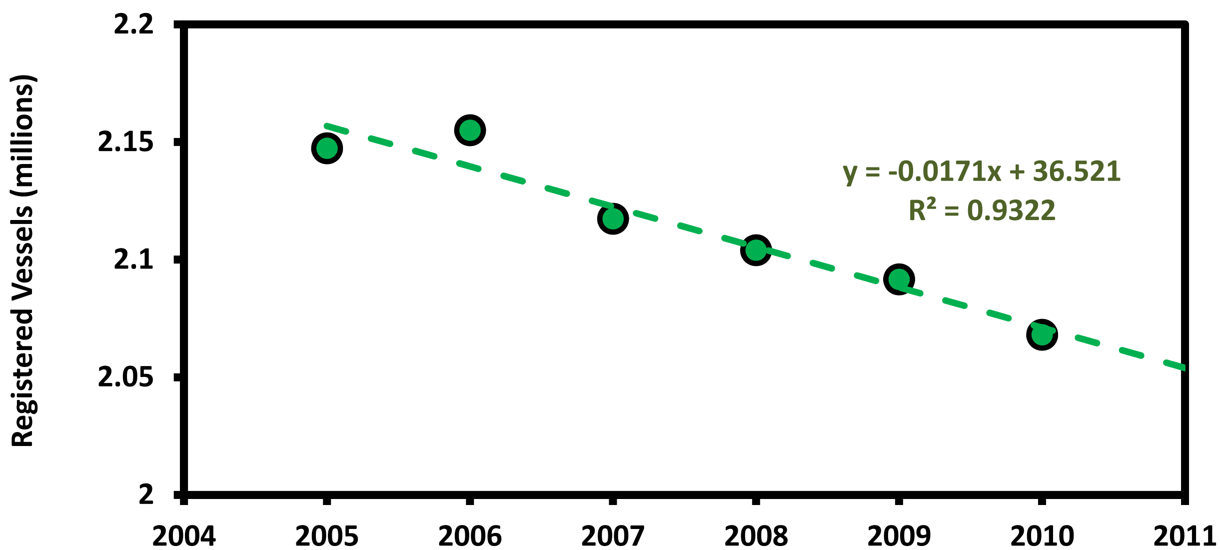


Figure 7. Registered recreational vessels in the Gulf of Mexico, 2005-2010. Sources: AL-DCNR, FL-DHSMV, LA-DWF, MS-DWFP, TPWD.

Changes in Annual Quota

Projected red snapper yields were obtained from the 2009 update stock assessment (SEFSC 2009). The 2009 stock assessment projected overfishing to end in 2009. The Council's Scientific and Statistical Committee has approved increases in the allowable biological catch (ABC) for red snapper for 2011 and 2012. ABC is set equal to 75% of the overfishing limit (OFL). Table 2 summarizes OFLs, ABCs, ACLs, and quotas for red snapper from 2011-2015. The Council has set the overall 2011 and 2012 ACLS equivalent to ABC. For 2013-2015, it is assumed that the ACL will continue to be set equal to the ABC and 75% of the OFL. Future ACLs may be higher or lower and will be dependent on future red snapper stock assessments, SSC recommendations of ABC, and Council recommendations for ACL.

Table 2. Recreational and commercial quotas (million lbs ww) based on projected yields from the 2009 update stock assessment. The Council's Scientific and Statistical Committee has recommended acceptable biological catches (ABC) be set equal to 75% of the overfishing limit for 2011 and 2012. The Council has proposed setting the annual catch limits for 2011 and 2012 equal to the ABC. ABCs and ACLs for 2013-2015 are based on projections and are subject to change based on future stock assessment updates.

Year	Recreational Quota	Commercial Quota	Annual Catch Limit	Acceptable Biological Catch	Overfishing Limit
2011	3.52	3.66	7.19	7.19	9.58
2012	3.67	3.82	7.49	7.49	9.98
2013	3.90	4.06	7.97	7.97	10.62
2014	4.11	4.28	8.39	8.39	11.19
2015	4.31	4.49	8.80	8.80	11.73

Changes in Spawning Stock Biomass

Gulf red snapper is in a rebuilding plan, and projections indicate spawning stock biomass (SSB) will increase rapidly from 2009 levels (Figure 8). Increases in SSB and red snapper abundance may result in increased catch rates of red snapper, which in turn might result in the quota being caught faster. The SSM fixes catch per angler trip in a given year ($CPAT_{year}$) at the average of 2008-2009. Increasing CPAT relative to increases in the ratio of SSB_{year}/SSB_{2009} was explored, but it was decided not to include this given catch rates are already largely constrained by a two fish bag limit.

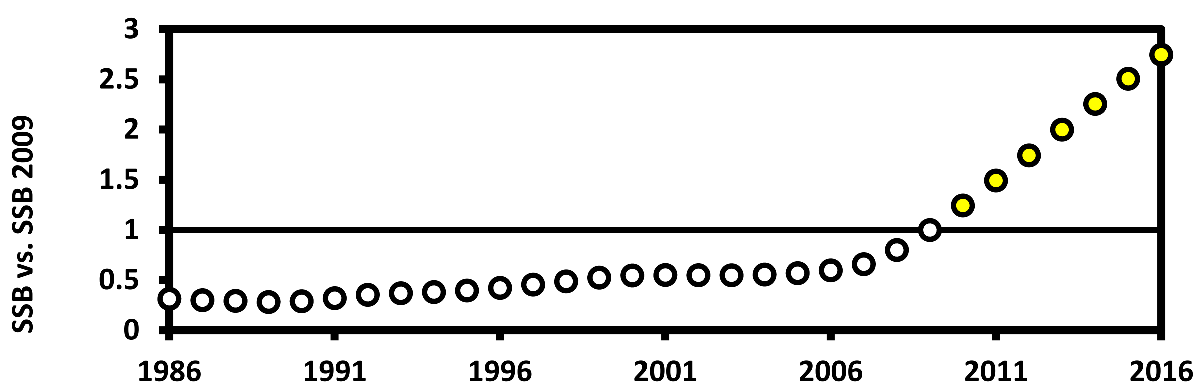


Figure 8. Red snapper assessment model backward (white) and forward-projected (yellow) spawning stock biomass (SSB) levels relative to 2009 level.

State-Permitted For-Hire Vessels

Some proportion of charter landings of red snapper reported to MRFSS and TPWD would be attributable to for-hire vessels without Federal permits, while nearly all headboats landing red snapper are federally licensed. Vessels without federal permits would not likely be incorporated into the For-Hire sector under any sector separation management action given the Gulf Council has no authority to regulate these vessels. As such, it would be unrealistic to incorporate them into the For-Hire projections for the model. Federal permits were issued to 1,693 For-Hire vessels (i.e., charter boats and headboats) in the Gulf of Mexico in 2003. Between 2003-2009, charter boat landings of red snapper in state waters have comprised, on average, 13% ± 7% (Mean ± SD) of the overall recreational For-Hire landings. In 2009, Amendment 30B was implemented, which required Federally-permitted For-Hire vessels to adhere to the more restrictive of state or federal regulations when fishing in state waters. In 2009, Charter landings of red snapper in state waters comprised only 7% of the overall recreational For-Hire landings. This represents a likely maximal value for the percent of For-Hire landings of red snapper originating from non-Federally-permitted vessels. The SSM allows the user to choose a percent of landings between 0-10% to re-allocate from the For-Hire allocation to the Private/State For-Hire allocation, to accommodate landings from state For-Hire vessels. For example, if the user-specified baseline years led to a computed allocation of 50% For-hire and 50% private, and state For-Hire vessels represented 5% of the For-Hire landings, then 5% of 50% (2.5%) of the For-Hire allocation would be re-allocated to the Private sector, yielding an effective allocation of 47.5% to the For-hire sector and 52.5% to the Private/State For-Hire sector.

Angler-Trips

Annual estimates of angler-trips for red snapper were computed using MRFSS, HBS, and TPWD data. An angler-trip was counted for each angler on a boat if any angler on the boat reported catching a red snapper. This approach is taken because if one person caught a red snapper, theoretically, anyone on the vessel could have, because the vessel fished in waters where red snapper occur.

Red snapper angler-trips were computed using MRFSS data using a modification of a catch-effort program described in Holiman (1996). The catch-effort program uses ‘Type 2’ (i.e., unavailable or Type B catch), ‘Type 3’ (i.e., available or Type A catch) and ‘Type 4’ (group catch) records. The program uses MRFSS effort files for expansion of intercepted catch-effort to final Gulf-wide estimates.

The HBS generates estimates of angler days, but estimates of total angler trips are not produced. To generate estimates of angler trips directly comparable to MRFSS, the following methods were used to produce estimates of headboat angler trips. The SEFSC obtains office records from operators to determine the total number of angler-trips conducted by a headboat. Based on dockside interviews and sampling, the SEFSC determines if a vessel has reported or partially reported for each month. If no records are obtained from a vessel during a month, then a proxy vessel is used to estimate landings and effort. If all records are not reported, then the SEFSC develops expansion factors ('K-factors') to account for trips taken with no corresponding logbook records.

$$K_{A_X \to A_X} = \frac{AnglerDays_{A_{est}}}{AnglerDays_{A_{raw}}}$$

$$K_{A_X \to B_X} = \frac{AnglerDays_{B_{est}}}{AnglerDays_{A_{raw}}}$$

where K is the expansion factor. If vessel A under-reported during month X:

$$A_{X_{est}} = A_{X_{raw}} * K_{A_X \to A_X}$$

If vessel B did not report during month X, and vessel A is the proxy vessel:

$$B_{X_{est}} = A_{X_{raw}} * K_{A_X \to B_X}$$

For the computation of catch effort for red snapper, if a vessel reported that an angler on a trip caught a red snapper, the total angler-trips for red snapper from that headboat record is equal to the total number of anglers reported on the vessel during the trip times the relevant expansion factor. If a vessel did not report during a month, but its proxy vessel had trips reporting landings of red snapper, the total angler-trips for red snapper from the non-reporting headboat is equal to the total number of anglers reported on the proxy vessel during its trips that month times the relevant A→B expansion factor.

To compute angler-trips from TPWD data, Dr. Mark Fisher (Science Director, TPWD) queried the number of trips by area (i.e., state and federal waters) landing red snapper, and summed the number of anglers by year, area, mode, and season to get observed snapper angler-trips. Next, he summed the number of anglers by area to get observed angler-trips, match-merged the two data sets, and calculated the proportion of snapper angler-trips by dividing by total angler-trips. He then multiplied this proportion by the TPWD expanded angler-trip estimates to get snapper angler-trips.

In general, angler-trips for red snapper have increased through time, although for-hire trips have declined somewhat in recent years (Figure 9).

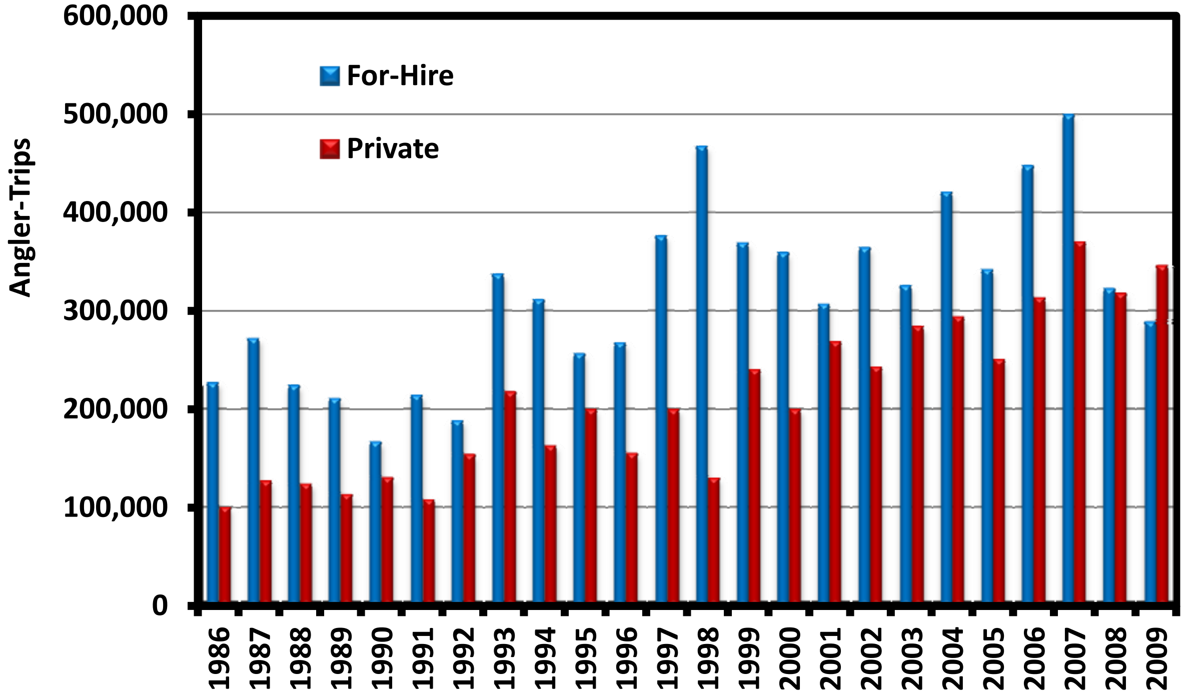


Figure 9. Angler-trips for red snapper by sector, 1986-2009.

As fishing pressure on red snapper has intensified, management measures have become increasingly restrictive, in attempts to keep the recreational sector from exceeding their quota. A primary mechanism utilized by managers has been shortening the red snapper fishing season. However, the Gulf states have not always adopted seasons compatible with the federal season. To account for this discrepancy, 'effective season length' for red snapper was computed as the weighted average of the federal and Gulf states season lengths, with the weighting terms being percent landings in federal waters and in state waters, by state (Table 3).

Estimates of angler-trips per day were generated by dividing the number of angler-trips by effective days open (Figure 10). As the length of the red snapper season has decreased, the number of angler trips per day has increased (see 'Effort Compensation' section for additional information).

Table 3. Red snapper state and federal fishing season lengths and effective Gulf-wide fishing season length, by year.

YEAR	AL	FLW	LA	MS	TX	FED	GULF
1986	365	365	365	365	365	365	**365**
1987	365	365	365	365	365	365	**365**
1988	365	365	365	365	365	365	**365**
1989	365	365	365	365	365	365	**365**
1990	365	365	365	365	365	365	**365**
1991	365	365	365	365	365	365	**365**
1992	365	365	365	365	365	365	**365**
1993	365	365	365	365	365	365	**365**
1994	365	365	365	365	365	365	**365**
1995	365	365	365	365	365	365	**365**
1996	365	365	365	365	365	365	**365**
1997	365	365	365	330	365	330	**334**
1998	304	304	272	272	365	272	**275**
1999	304	304	240	240	365	240	**251**
2000	194	200	194	194	365	194	**197**
2001	194	200	194	194	365	194	**196**
2002	194	200	194	194	365	194	**196**
2003	194	200	194	194	365	194	**195**
2004	194	200	194	194	365	194	**197**
2005	194	200	194	194	365	194	**199**
2006	194	200	194	194	365	194	**198**
2007	194	200	194	194	365	194	**198**
2008	65	65	65	65	365	65	**74**
2009	75	75	75	75	365	75	**80**

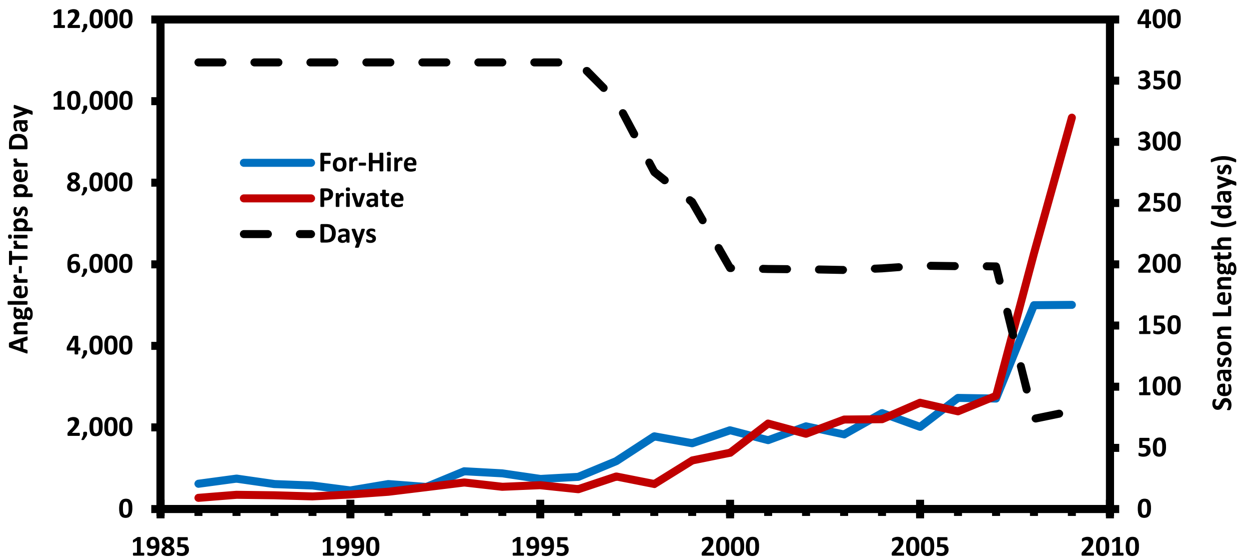


Figure 10. Red snapper angler-trips per day and effective season length, 1986-2009.

Effort Compensation

An important dynamic in the recreational red snapper fishery that can affect season length is the ability of the recreational sectors to compensate for reductions in season length by compressing their effort into a limited season. This dynamic has been observed in other fisheries, such as the red snapper commercial fishery prior to implementation of the Individual Fishing Quota program, and is commonly referred to as ‘effort compensation’, ‘effort stuffing’, or a ‘derby fishery.’ The term ‘effort compensation’ includes the dynamics of more anglers on the water during the open season (rather than spreading their effort across the year), and the ability of individual anglers to run multiple trips in a day.

As stepwise linear regression approaches failed to identify useful predictive relationships for seasons shorter than those already observed in the red snapper fishery (Appendix 3), the *Curve Estimation* procedure in SPSS 17.0 (PASW Statistics Inc.) was used to fit logarithmic regressions to effective season length and angler trips per day for both the for-hire and private sectors (Figure 11). Regression fits were significant (For-Hire: $F_{1,33}$=333.5, p<0.001; Private: $F_{1,33}$=278.5, p<0.001), with log-transformed effective season length explaining 94% of the variability in for-hire angler trips per day and 93% of the variability in private angler trips per day. Regression coefficients are provided in Tables 4 and 5.

Predicting the ability of the fishery to compensate for a season potentially shorter than 65 days is challenging, given the lack of data beyond this point. It is possible that effort was saturated in 2008; however, it is also possible that each sector might fish even harder during a season shorter than 65 days. Two 'derby fishery' scenarios are presented in the output: (1) Assuming effort compensation increases if the season gets shorter, and (2) Assuming effort compensation remains at 2008 peak levels if the season is shorter than 65 days. The regression relationships in Figure 11 were used to simulate angler effort compensation in the SSM under two scenarios: (1) Assuming effort compensation increases as the season gets shorter, and (2) Assuming effort compensation peaked at the highest observed annual average value (For-Hire: 4,377 angler trips per day; Private: 4,318 angler trips per day).

Table 4. Logarithmic regression coefficients for for-hire sector angler trips per day vs. effective season length.

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
ln(E_Days)	-2098.150	114.899	-.969	-18.261	.000
(Constant)	13073.875	637.909		20.495	.000

Table 5. Logarithmic regression coefficients for private sector ATPD vs. effective season length.

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
ln(E_Days)	-2303.798	138.037	-.963	-16.690	.000
(Constant)	13842.264	766.369		18.062	.000

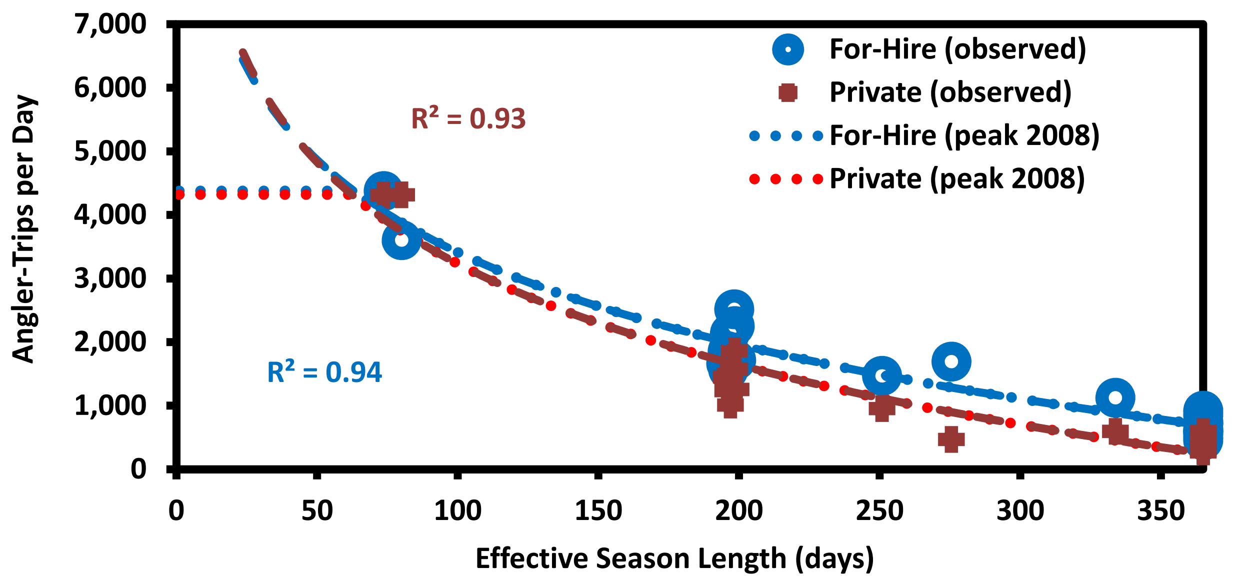


Figure 11. Logarithmic relationship between red snapper angler-trips per day relative to effective season length used to predict effort compensation dynamic. Dotted lines represent simulated effort compensation with saturation at highest observed point.

Relative Change in Season Lengths

The SSM computes the total number of days the recreational red snapper season is projected to be open from 2011-2015. Because this is a theoretical model, and the goal of this analysis is to assess the benefits and tradeoffs of sector separation, results are summarized as the relative percent change in days open with and without sector separation. Future red snapper season lengths are contingent on numerous factors, such as red snapper fishing effort, average weights, catch rates, and quotas. Because these factors may change over time, outputs of absolute season length are not provided.

To calculate the catch in pounds per day, the following equations were used:

$$\frac{Catch_{lbs}^{For-Hire}}{day} = AvgWeight * \frac{Catch_{N}^{For-Hire}}{trip} * \frac{Trips_{N}^{For-Hire}}{day} * \Delta Effort^{For-Hire}$$

$$\frac{Catch_{lbs}^{Private}}{day} = AvgWeight * \frac{Catch_{N}^{Private}}{trip} * \frac{Trips_{N}^{Private}}{day} * \Delta Effort^{Private}$$

$$\frac{Catch_{lbs}^{Rec}}{day} = AvgWeight * \left(\frac{Catch_{N}^{For-Hire}}{trip} * \frac{Trips_{N}^{For-Hire}}{day} * \Delta Effort^{For-Hire} + \frac{Catch_{N}^{Private}}{trip} * \frac{Trips_{N}^{Private}}{day} * \Delta Effort^{Private}\right)$$

where *Rec* represents both sectors combined (i.e., no sector separation), and catch in numbers is denoted by *N*. Average weight was obtained from the 2009 stock assessment, as described previously. $Catch_N$ per Trip was computed based on dividing the total number of red snapper caught in 2008 and 2009, by the total estimated number of directed angler trips. The years 2008-2009 were chosen to calculate angler catch-per-trip as the bag and size limits during this time period were constant. Trips-per-day were computed under the saturated and unsaturated effort compensation scenarios illustrated in Figure 11. Percent change in effort (*ΔEffort*) is a user-specified change from 2009 levels as described under '*Changes in Gulf Fishing Population*' above.

To calculate the effective season lengths (in days) allowable by sector and under no sector separation, the following equations were used:

$$Effective\ Season\ Length_{days}^{For-Hire} = \frac{Allocation_{\%}^{For-Hire} * Annual\ Catch\ Limit_{lbs}^{Rec}}{\left(\frac{Catch_{lbs}^{For-Hire}}{day}\right)}$$

$$Effective\ Season\ Length_{days}^{Private} = \frac{Allocation_{\%}^{Private} * Annual\ Catch\ Limit_{lbs}^{Rec}}{\left(\frac{Catch_{lbs}^{Private}}{day}\right)}$$

$$Effective\ Season\ Length_{days}^{Rec} = \frac{Annual\ Catch\ Limit_{lbs}^{Rec}}{\left(\frac{Catch_{lbs}^{For-Hire}}{day} + \frac{Catch_{lbs}^{Private}}{day}\right)}$$

The sector separation utilizes *Solver* to calculate the effective season length in days. *Solver* is an optimization model that has three parts: a target parameter, parameters that are allowed to change, and constraints. The model estimated the maximum allowable season, by sector and for combined sectors, by minimizing the difference between the estimated catch and the allocated catch. Season length was constrained to between 2 and 365 days. Relative differences in season length were computed by sector by dividing the effective season length for each sector under sector separation by the effective season length without sector separation.

Results

The relative benefits of sector separation are, in part, dependent upon the years selected for the computation of allocation. The percentage of the red snapper harvest accounted for by the For-Hire sector has declined from 73% to 44% over the period 1986-2009, a rate of decline of approximately 1% per year (Figure 12). In general, a longer baseline period for the computation of allocation is more favorable to the For-Hire sector while a shorter, more recent baseline period is more favorable to the Private sector, as each of these periods fix allocation at or higher to the current sector harvest percentage.

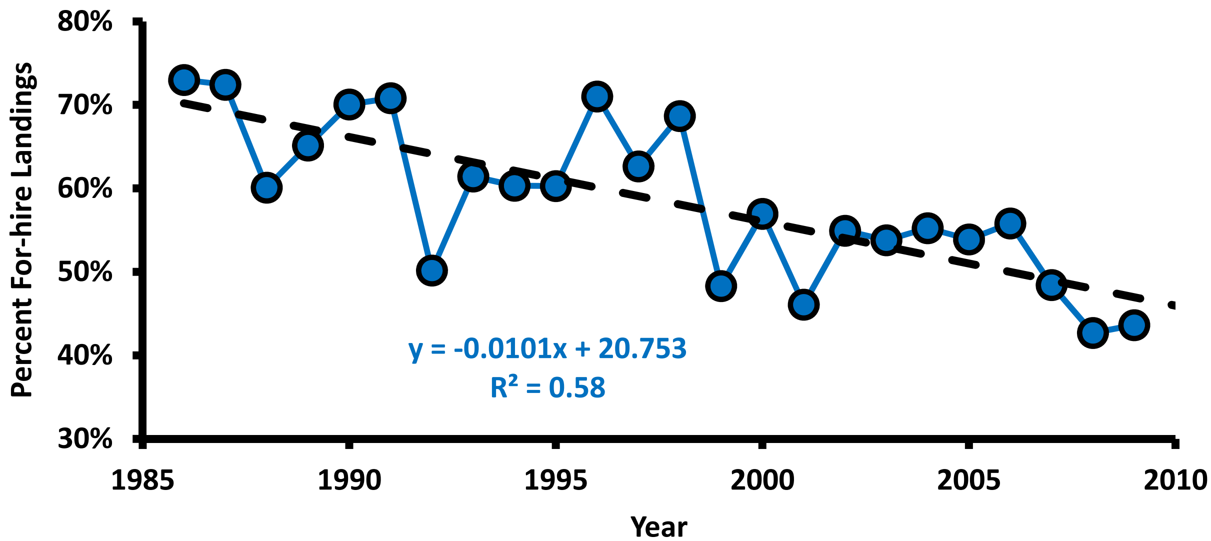


Figure 12. Trend in the proportion of red snapper landings accounted for by For-Hire vessels, 1986-2009.

A variety of model runs are presented in Scenarios 1-12, below. Output results are summarized in Table 6. Scenarios were chosen to provide contrasts within a range of input parameters, to test sensitivity of the model to user inputs. The model allows users to evaluate numerous other possible scenarios, which are not considered in this report.

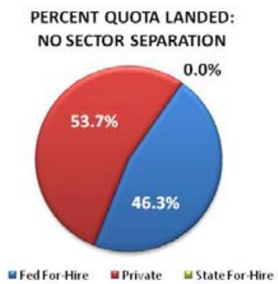
Table 6. Summary of output from SSM projection Scenarios 1-12.

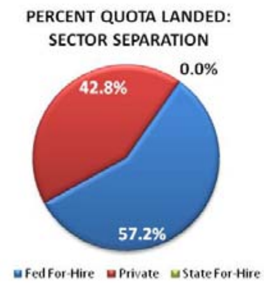
							EFFORT COMPENSATION			
							SATURATED		INCREASES	
SCENARIO	Years	ΔAvg. Weight	%State For-Hire	Sector	ΔEffort	Effective Allocation	Δ%TAC	ΔDays	Δ%TAC	ΔDays
Scenario 1	1986-2009	As Projected	0%	For-Hire	0%	57%	11%	26%	11%	48%
				Private	0%	43%	-11%	-20%	-11%	-33%
Scenario 2	2000-2009	As Projected	0%	For-Hire	0%	51%	5%	10%	5%	21%
				Private	0%	49%	-5%	-9%	-5%	-17%
Scenario 3	2005-2009	As Projected	0%	For-Hire	0%	49%	3%	5%	3%	10%
				Private	0%	51%	-3%	-5%	-3%	-9%
Scenario 4	2005-2009	-10% of Projected	0%	For-Hire	0%	49%	3%	6%	3%	10%
				Private	0%	51%	-3%	-4%	-3%	-9%
Scenario 5	2005-2009	+10% of Projected	0%	For-Hire	0%	49%	3%	5%	3%	11%
				Private	0%	51%	-3%	-4%	-3%	-9%
Scenario 6	2000-2009	-10% of Projected	4%	For-Hire	0%	49%	5%	7%	5%	12%
				Private	0%	51%	-5%	-5%	-5%	-10%
Scenario 7	2000-2009	-10% of Projected	9%	For-Hire	0%	46%	5%	1%	5%	2%
				Private	0%	54%	-5%	0%	-5%	-2%
Scenario 8	1986-2009	-10% of Projected	4%	For-Hire	0%	49%	11%	25%	11%	39%
				Private	0%	51%	-11%	-16%	-11%	-28%
Scenario 9	1986-2009	-10% of Projected	4%	For-Hire	0.8%	49%	11%	29%	11%	40%
				Private	0.8%	51%	-11%	-16%	-11%	-28%
Scenario 10	2000-2009	-10% of Projected	4%	For-Hire	-3.0%	49%	8%	27%	8%	34%
				Private	0.4%	51%	-5%	-12%	-9%	-21%
Scenario 11	2005-2009	-10% of Projected	4%	For-Hire	-3.0%	47%	6%	16%	6%	20%
				Private	0.4%	53%	-6%	-8%	-6%	-13%
Scenario 12	User-defined	As Projected	0%	For-Hire	0%	40%	-6%	-14%	-6%	-20%
				Private	0%	60%	6%	12%	6%	22%

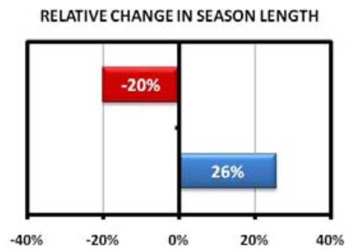
SCENARIO 1 - Model Inputs:

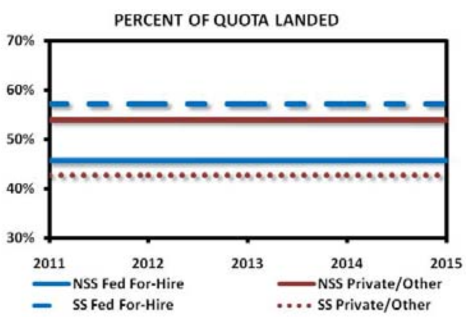
- Computed allocation from 1986-2009 average landings.
- 0% of the 57% For-Hire allocation (~0%) will be attributed to Private for the purposes of projection.
- Average weight will increase as projected by SEDAR Update Assessment.
- For-hire participation will remain at 2009 levels (0% increase).
- Private/Other participation will remain at 2009 levels (0% increase).

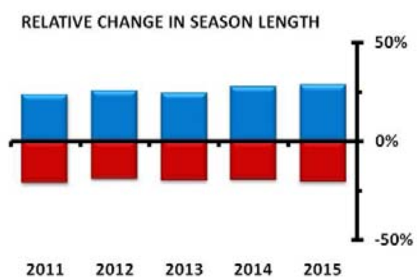
If Effort Compensation Saturated:



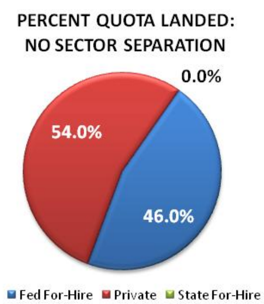


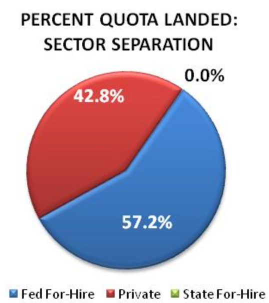


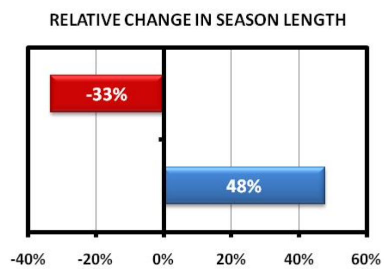


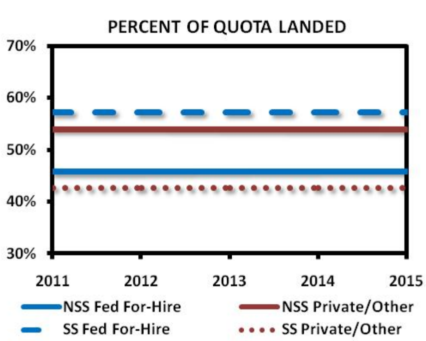


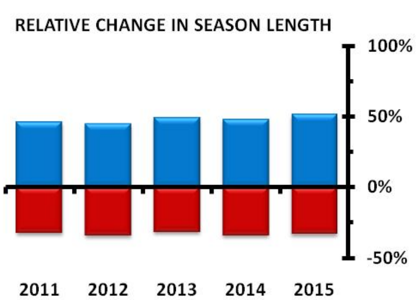
If Effort Compensation Increases:







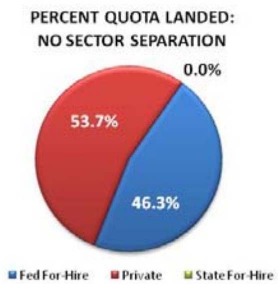


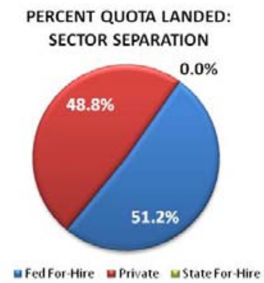


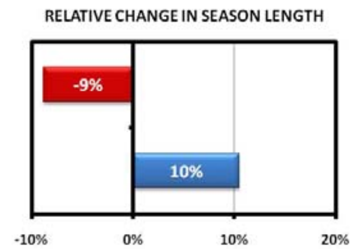
SCENARIO 2 - Model Inputs:

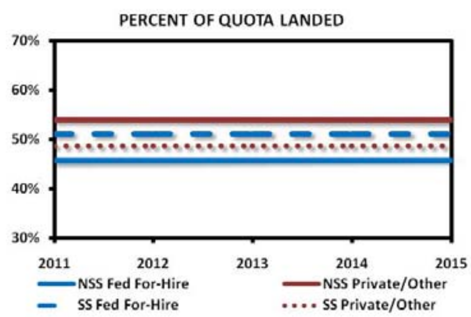
- Computed allocation from 2000-2009 average landings.
- 0% of the 51% For-Hire allocation (~0%) will be attributed to Private for the purposes of projection.
- Average weight will increase as projected by SEDAR Update Assessment.
- For-hire participation will remain at 2009 levels (0% increase).
- Private/Other participation will remain at 2009 levels (0% increase).

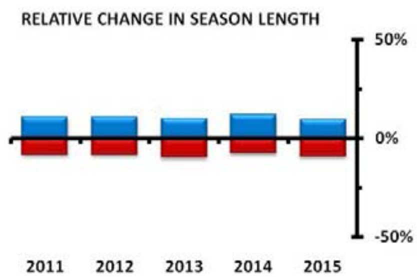
If Effort Compensation Saturated:











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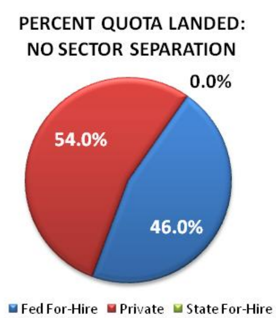
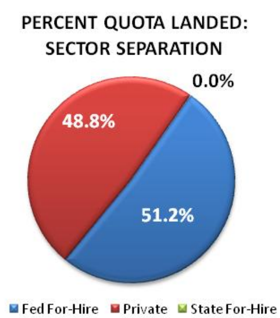
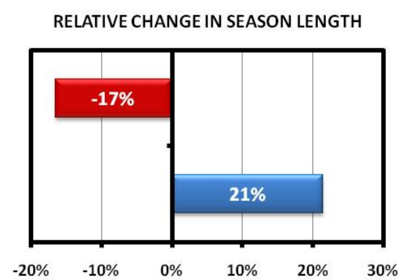
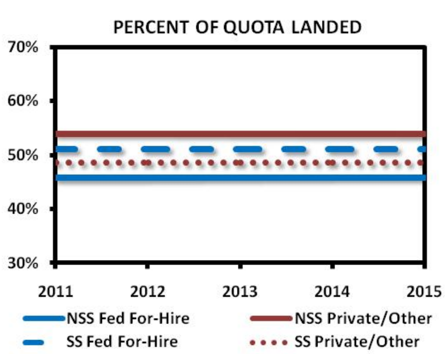
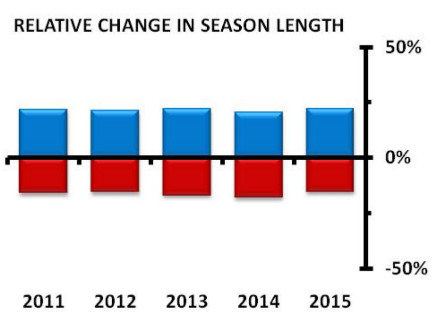






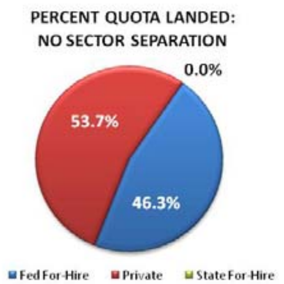


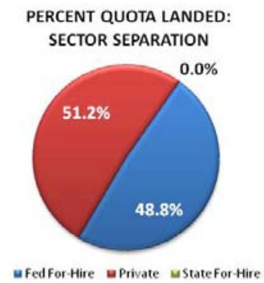


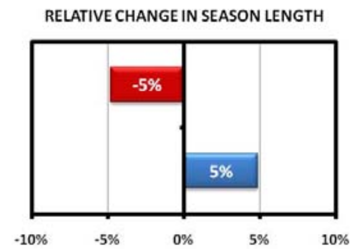
SCENARIO 3 - Model Inputs:

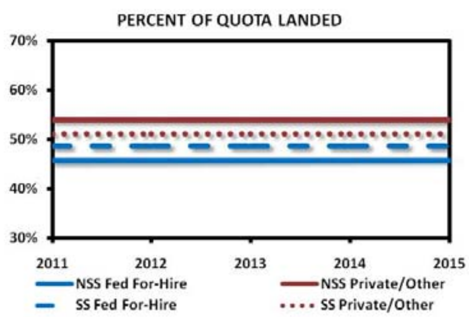
- Computed allocation from 2005-2009 average landings.
- 0% of the 49% For-Hire allocation (~0%) will be attributed to Private for the purposes of projection.
- Average weight will increase as projected by SEDAR Update Assessment.
- For-hire participation will remain at 2009 levels (0% increase).
- Private/Other participation will remain at 2009 levels (0% increase).

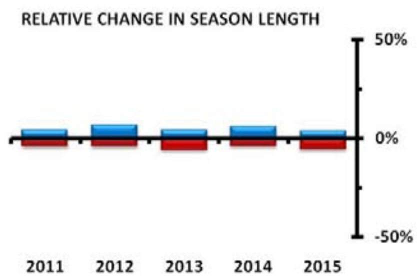
If Effort Compensation Saturated:











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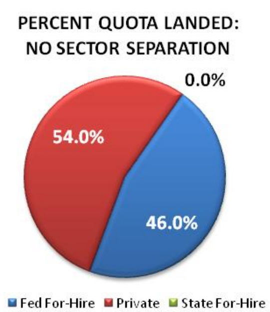
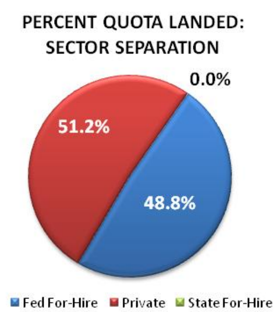
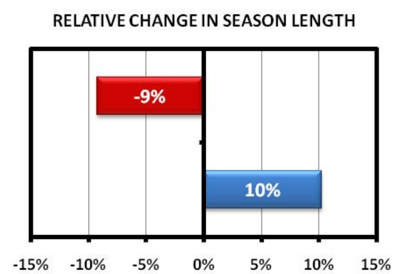
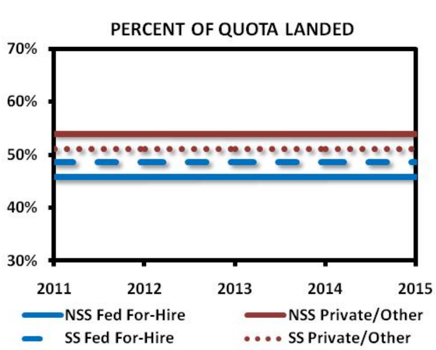
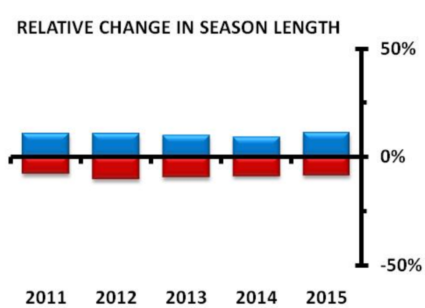






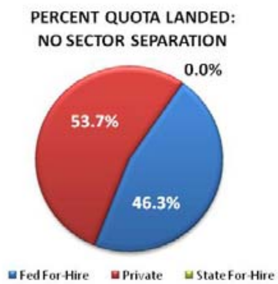


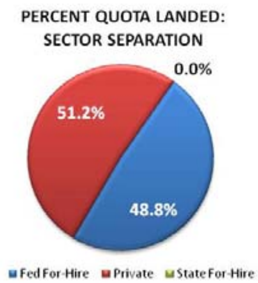


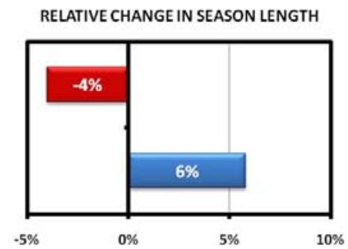
SCENARIO 4 - Model Inputs:

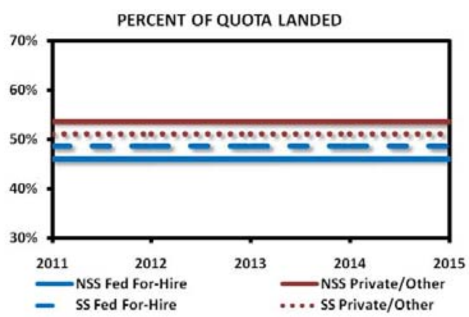
- Computed allocation from 2005-2009 average landings.
- 0% of the 49% For-Hire allocation (~0%) will be attributed to Private for the purposes of projection.
- Average weight will increase at 10% less than projected.
- For-hire participation will remain at 2009 levels (0% increase).
- Private/Other participation will remain at 2009 levels (0% increase).

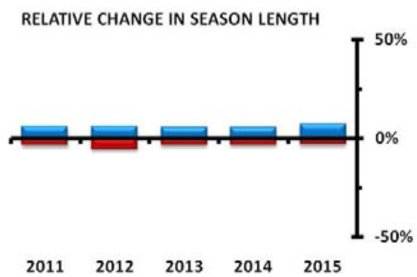
If Effort Compensation Saturated:











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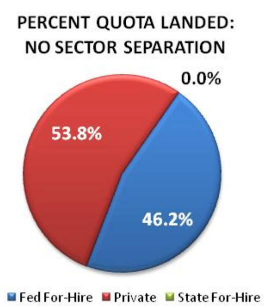
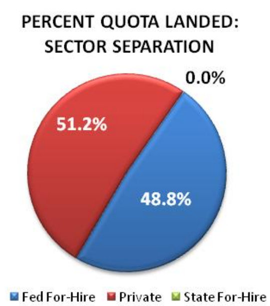
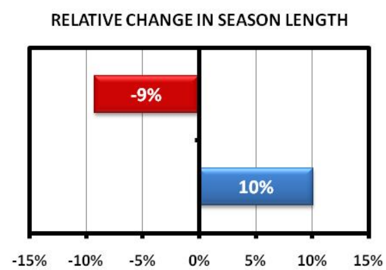
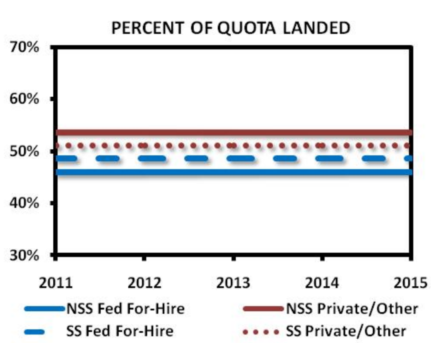
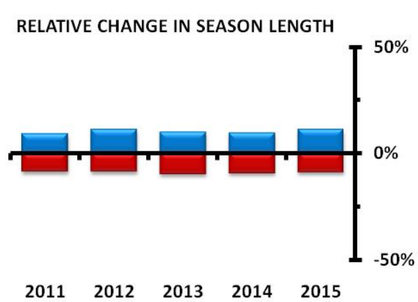






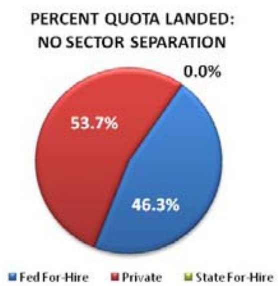


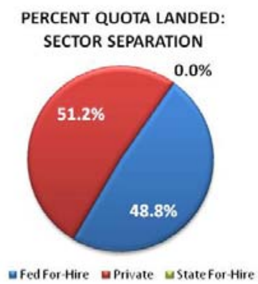


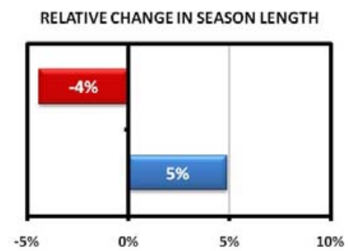
SCENARIO 5 - Model Inputs:

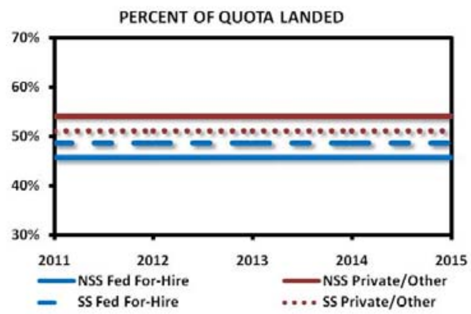
- Computed allocation from 2005-2009 average landings.
- 0% of the 49% For-Hire allocation (~0%) will be attributed to Private for the purposes of projection.
- Average weight will increase at 10% more than projected.
- For-hire participation will remain at 2009 levels (0% increase).
- Private/Other participation will remain at 2009 levels (0% increase).

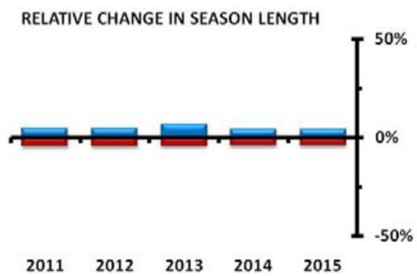
If Effort Compensation Increases:











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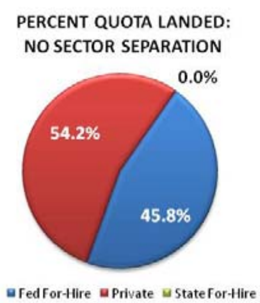
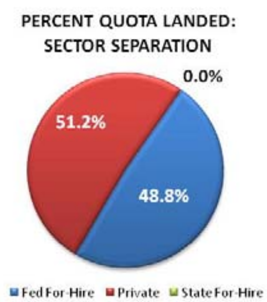
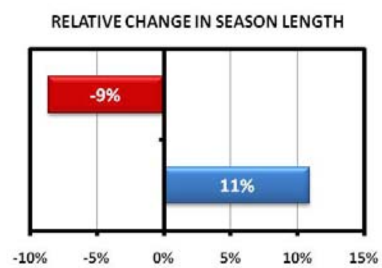
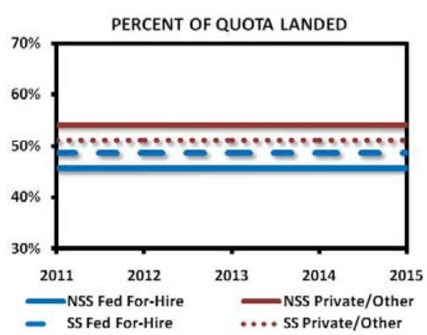
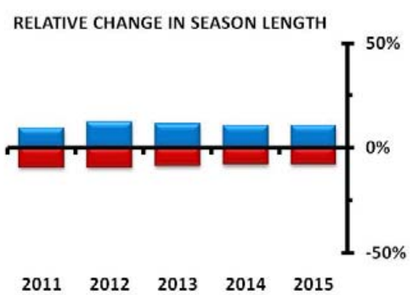






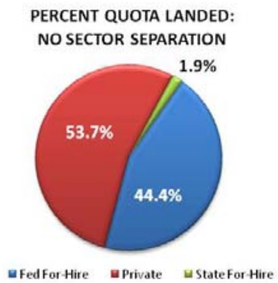


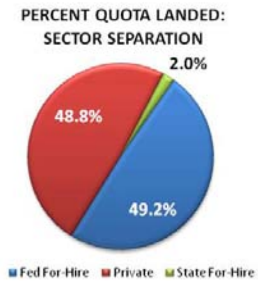


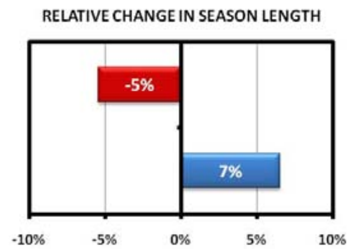
SCENARIO 6 - Model Inputs:

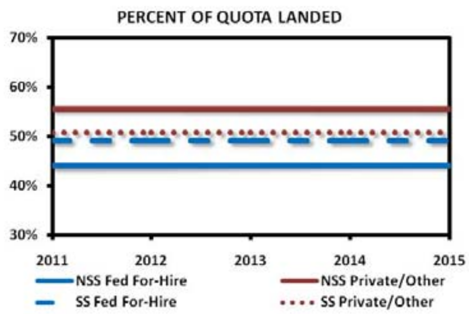
- Computed allocation from 2000-2009 average landings.
- 4% of the 51% For-Hire allocation (~2%) will be attributed to Private for the purposes of projection.
- Average weight will increase at 10% less than projected.
- For-hire participation will remain at 2009 levels (0% increase).
- Private/Other participation will remain at 2009 levels (0% increase).

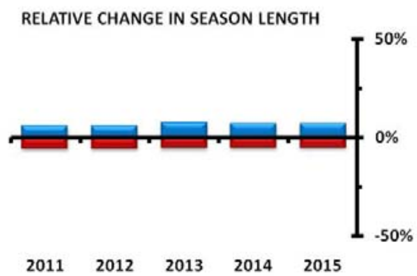
If Effort Compensation Saturated:



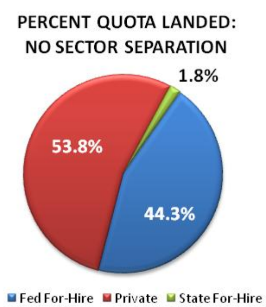


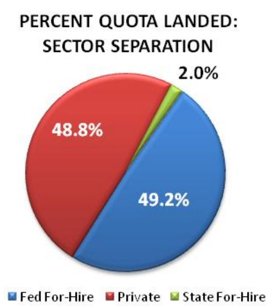


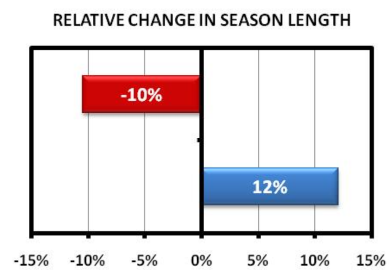


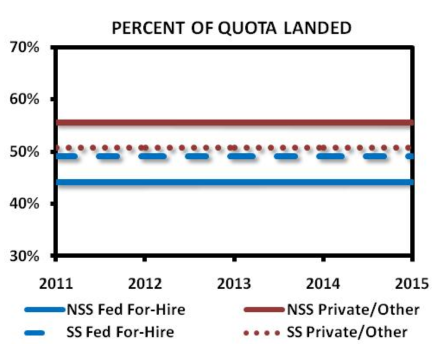


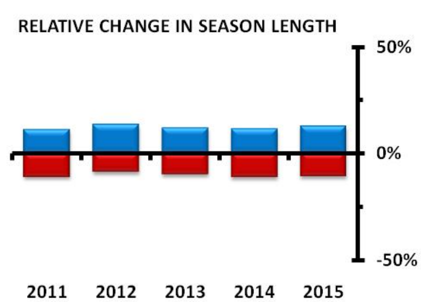
If Effort Compensation Increases:







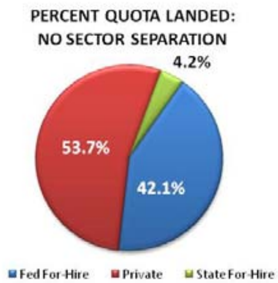


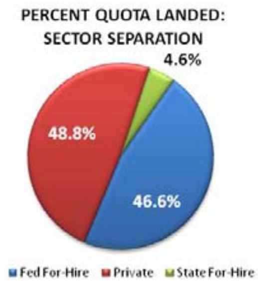


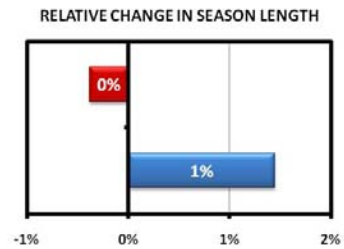
SCENARIO 7 - Model Inputs:

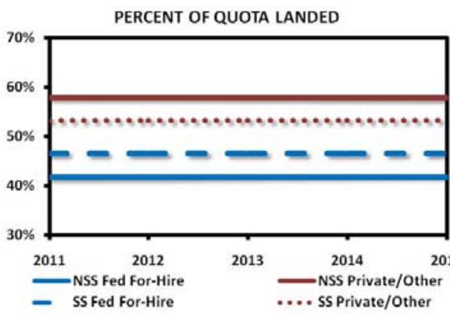
- Computed allocation from 2000-2009 average landings.
- 9% of the 51% For-Hire allocation (~5%) will be attributed to Private for the purposes of projection.
- Average weight will increase at 10% less than projected.
- For-hire participation will remain at 2009 levels (0% increase).
- Private/Other participation will remain at 2009 levels (0% increase).

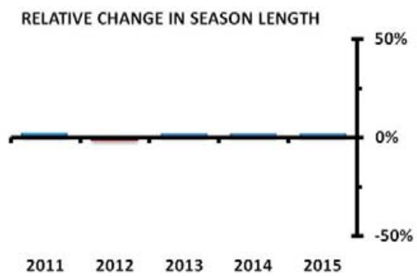
If Effort Compensation Saturated:



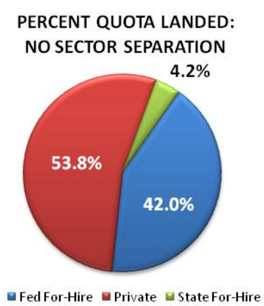


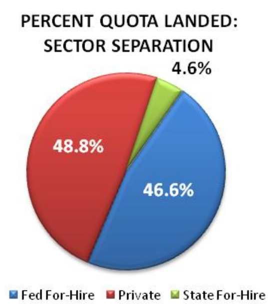


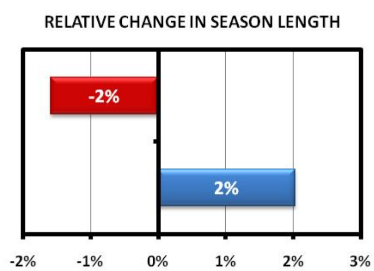


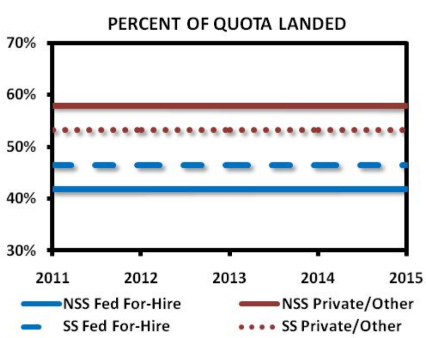


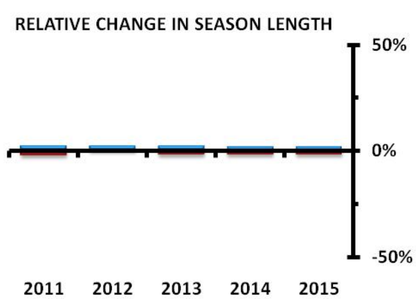
If Effort Compensation Increases:







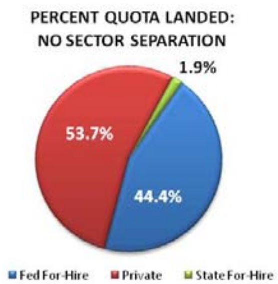


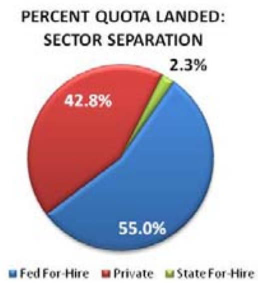


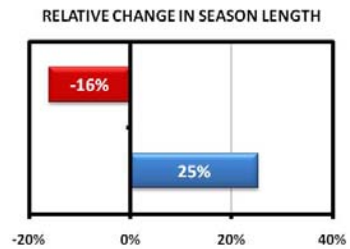
SCENARIO 8 - Model Inputs:

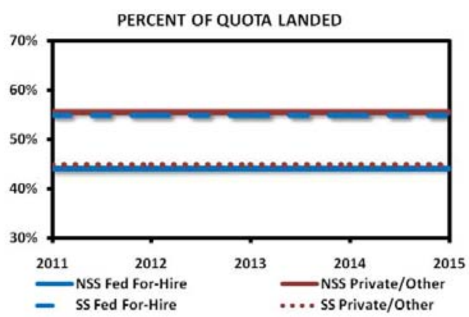
- Computed allocation from 1986-2009 average landings.
- 4% of the 57% For-Hire allocation (~2%) will be attributed to Private for the purposes of projection.
- Average weight will increase at 10% less than projected.
- For-hire participation will remain at 2009 levels (0% increase).
- Private/Other participation will remain at 2009 levels (0% increase).

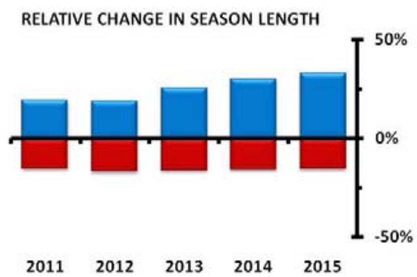
If Effort Compensation Saturated:



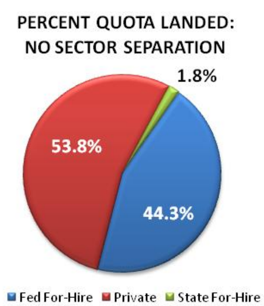


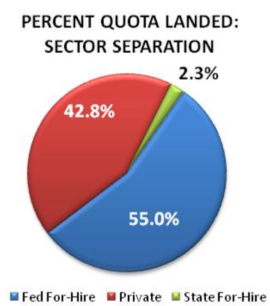


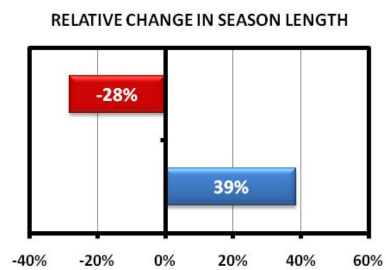


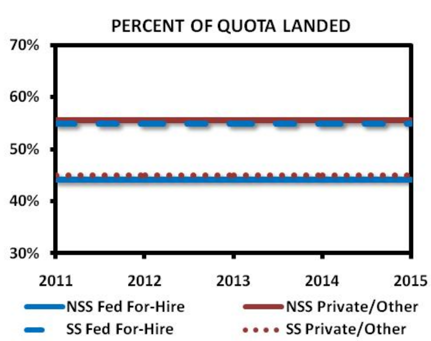


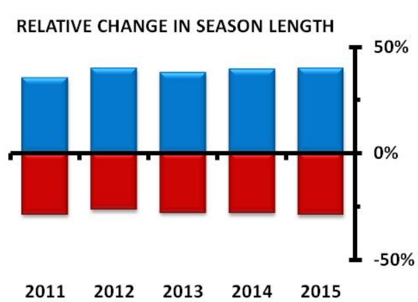
If Effort Compensation Increases:







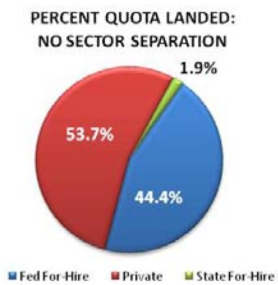


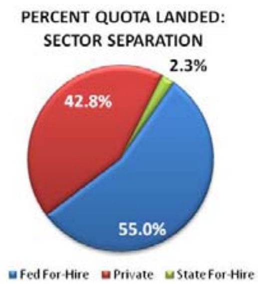


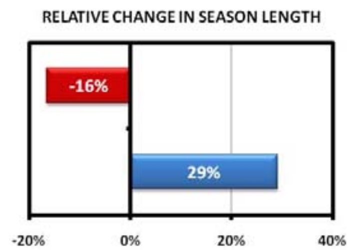
SCENARIO 9 - Model Inputs:

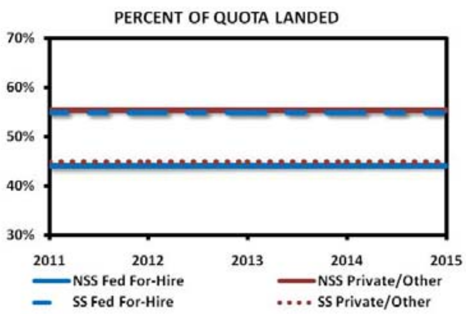
- Computed allocation from 1986-2009 average landings.
- 4% of the 57% For-Hire allocation (~2%) will be attributed to Private for the purposes of projection.
- Average weight will increase at 10% less than projected.
- For-hire participation will increase proportional to registered vessel projections (0.8% annual decrease).
- Private/Other participation will increase proportional to registered vessel projections (0.8% annual decrease).

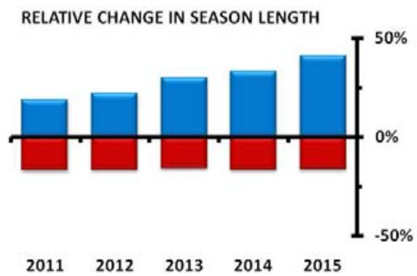
If Effort Compensation Saturated:



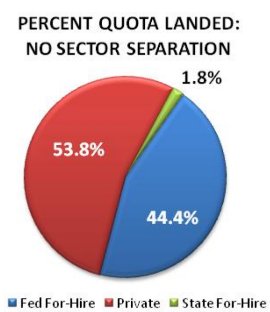


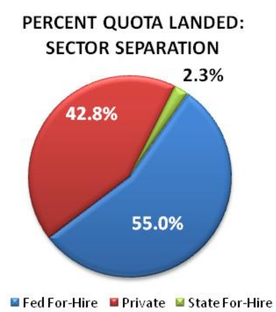


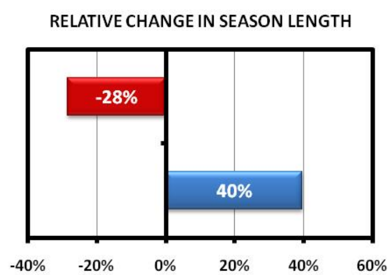


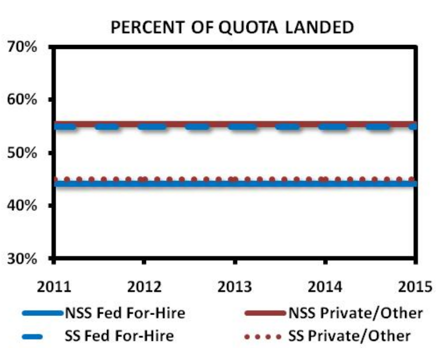


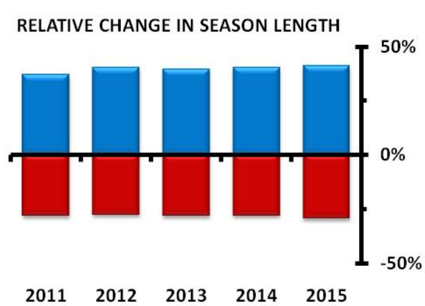
If Effort Compensation Increases:







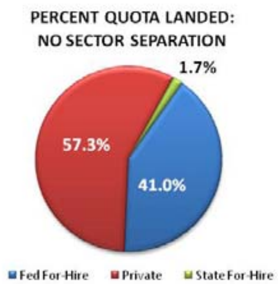


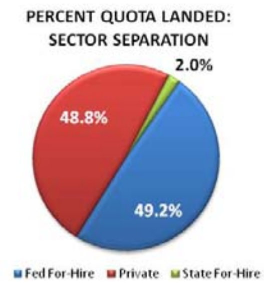


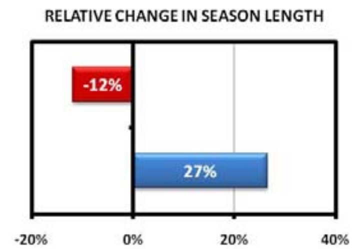
SCENARIO 10 - Model Inputs:

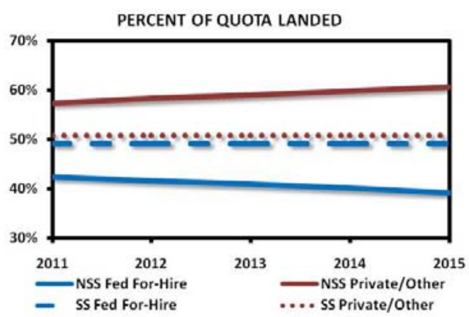
- Computed allocation from 2000-2009 average landings.
- 4% of the 51% For-Hire allocation (~2%) will be attributed to Private for the purposes of projection.
- Average weight will increase at 10% less than projected.
- For-hire participation will increase as projected from issued Federal permits (3% annual decrease).
- Private/Other participation will increase as projected from state license sales (0.4% annual increase).

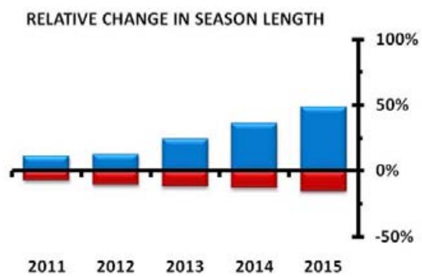
If Effort Compensation Saturated:



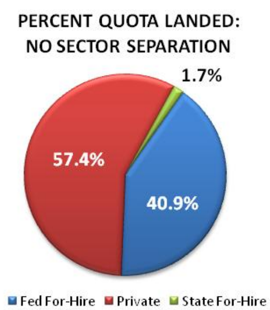


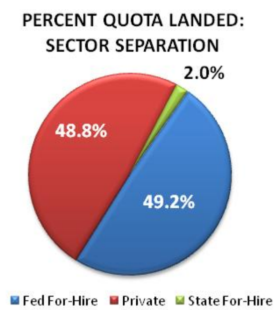


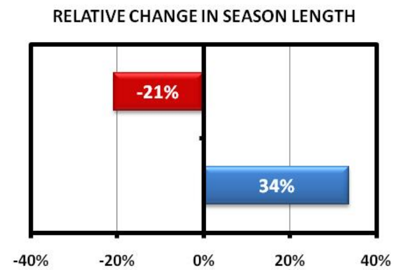


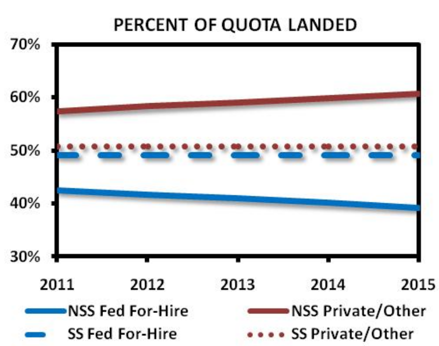


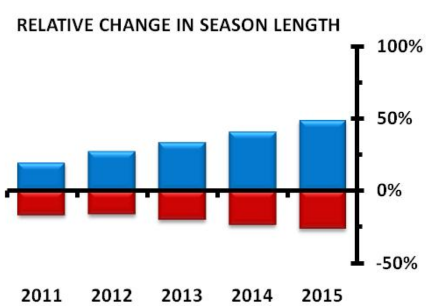
If Effort Compensation Increases:







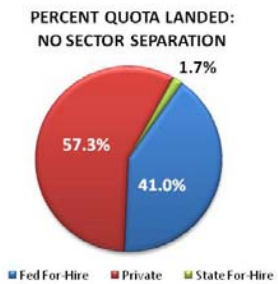


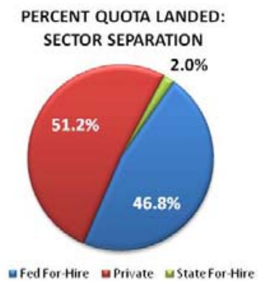


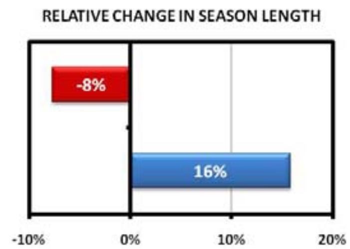
SCENARIO 11 - Model Inputs:

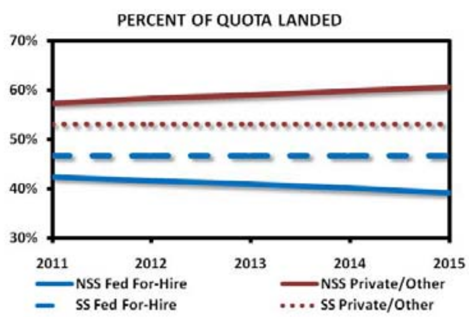
- Computed allocation from 2005-2009 average landings.
- 4% of the 49% For-Hire allocation (~2%) will be attributed to Private for the purposes of projection.
- Average weight will increase at 10% less than projected.
- For-hire participation will increase as projected from issued Federal permits (3% annual decrease).
- Private/Other participation will increase as projected from state license sales (0.4% annual increase).

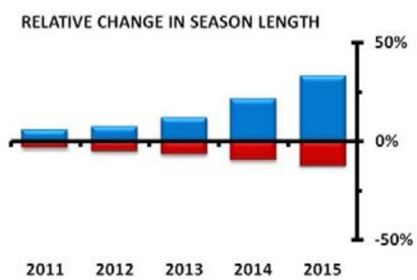
If Effort Compensation Saturated:



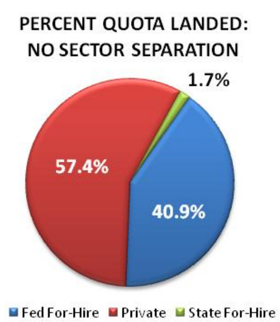


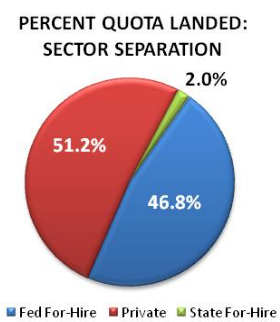


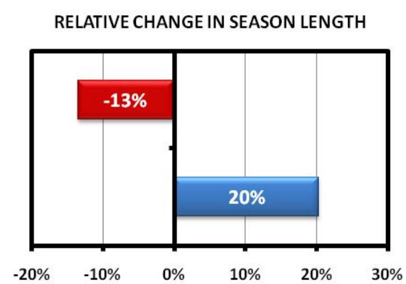


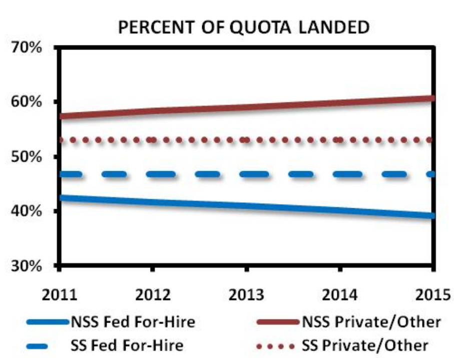


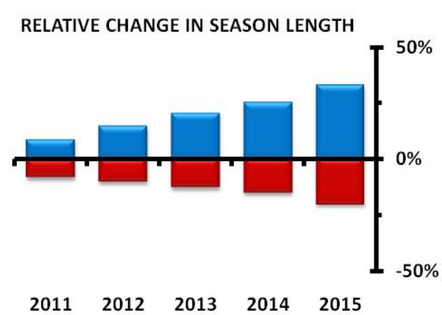
If Effort Compensation Increases:







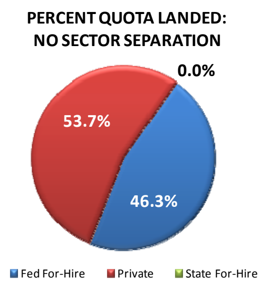


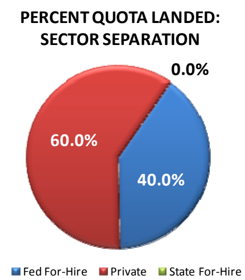


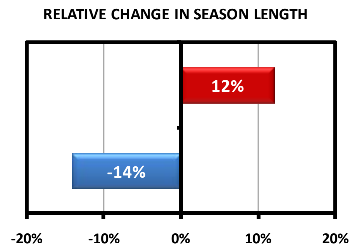
SCENARIO 12 - Model Inputs:

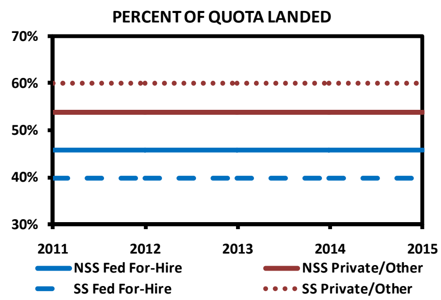
- User-defined allocation: 60% private: 40% For-Hire
- 0% of the 35% For-Hire allocation (~0%) will be attributed to Private for the purposes of projection.
- Average weight will increase as projected by SEDAR Update Assessment.
- For-hire participation will remain at 2009 levels (0% increase).
- Private/Other participation will remain at 2009 levels (0% increase).

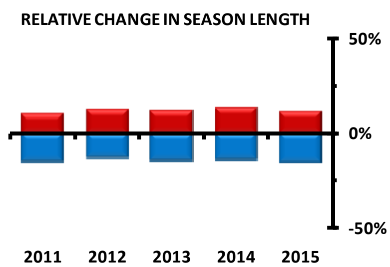
If Effort Compensation Saturated:











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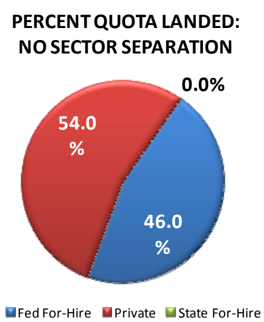

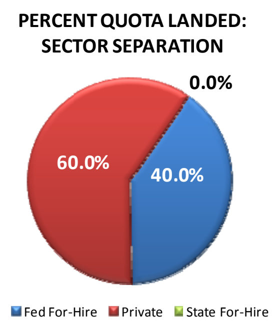

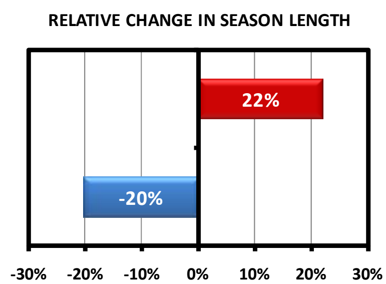

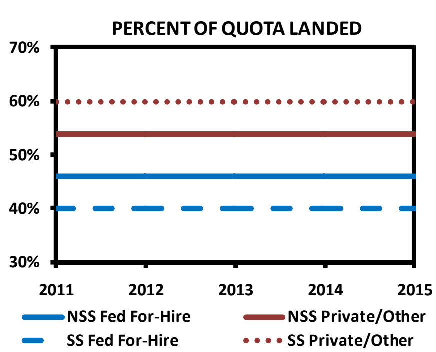

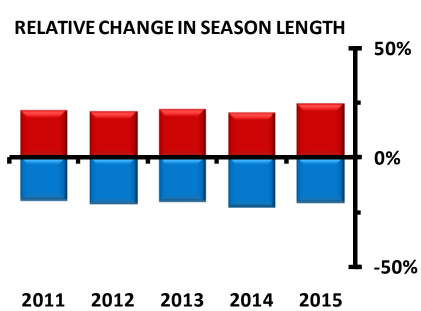

Discussion

The Sector Separation Model (SSM) described in this paper is a theoretical projection model. It is intended to provide constituents and managers a relative sense of the benefits and drawbacks of sector separation. As with most projection models, the reliability of the SSM's results is dependent upon the accuracy of its underlying data and input assumptions. Rather than constrain the model to a fixed set of input parameters, we have attempted to capture the range of realistic input parameters with regards to allocation, changes in average weight, changes in participation levels, the percent of state For-Hire vessels, and effort compensation by both sectors in response to increasingly restrictive season lengths.

For all of the scenarios investigated using historical landings to define sector allocations (i.e., Scenarios 1-11), sector separation results in a greater percentage of the quota being caught by the Federal For-Hire sector and a longer relative season length for the Federal For-Hire sector, as compared to no sector separation. The Private/Other sector correspondingly loses a percentage of the quota and relative days under all projected scenarios using historical landings to define sector allocations (i.e., Scenarios 1-11). Only Scenario 12, which had a user-defined 60% Private/40% For-hire allocation, resulted in the Private/Other sector receiving a greater percentage of the quota and a longer relative season length as compared to no sector separation.

Changes to model parameters impacted the magnitude of benefits of sector separation, but not the trends. A comparison of Scenarios 1-3 suggests a longer baseline landings period for setting allocation favors the For-Hire sector by allocating them a greater percentage of the quota. A comparison of Scenarios 3-5 suggests that if average weight increases more slowly than projected, both sectors will benefit from slightly longer seasons, but the relative percentage of quota captured by each sector is essentially the same. Examination of average weight data did not suggest a difference in average weights by sector. If average weights were higher for the one sector, that sector would catch their quota faster, and the benefits of sector separation would be more pronounced for the other sector.

Quantifying the percentage of red snapper For-Hire landings originating from non-Federally-permitted vessels was challenging, given that the MRFSS and TPWD Charter estimates do not distinguish between Federally-permitted and non-Federally-permitted vessels. However, given that only 7% of red snapper For-Hire landings originated from state waters in 2009 following the implementation of Amendment 30B, this seems to be a realistic maximum value for the projected percentage. A comparison of Scenarios 2, 6 and 7 suggests an increased effective allocation to the Private/Other sector to account for state For-Hire vessels reduces the relative benefits of sector separation for the For-Hire sector by reallocating their TAC to the Private/Other sector.

Comparison of Scenarios 8-9 revealed little change in season length when participation in both sectors is projected to decrease at similar rates, while comparison of Scenarios 10-11 suggests increased relative benefits of sector separation for the For-Hire sector if participation in the

Private/Other sector grows substantially faster than the For-Hire sector. Federal permits data suggests For-Hire participation will decline by 18% by 2015. Other indices based on population projections may not be appropriate for the For-Hire sector, as growth in this sector is driven more by economic conditions. By contrast, most effort indices suggest the Private/Other sector will grow at pace with or faster than the For-Hire sector. The only index suggesting a decline in Private/Other participation is Gulf recreational vessel registrations 2005-2009; however, registered vessels grew significantly prior to this time (see Figure 6).

Although not explicitly modeled because the 2-fish bag limit restricts growth in catch rate, it is relatively simple to predict the impact of catch rates increasing with increasing stock abundance. If catch per trip increases as the stock rebuilds season lengths would be shorter than predicted assuming equivalent levels of effort. Similarly, , if the For-Hire sector's catch per trip rate increases at a faster rate than the Private/Other sector, then the benefits of sector separation would become less pronounced for the For-Hire sector, and vice versa.

In conclusion, model results indicate the allocation between sectors is the most important factor in determining whether a sector will or will not benefit from sector separation. The more a sector is allocated relative to the proportion of landings accounted for without sector separation, the greater the change in season lengths. Relative season lengths were relatively insensitive to changes in average fish weight, although absolute season lengths would be longer or shorter if the average weight of red snapper is less than or greater than projected. Similarly, model results indicated the benefits of sector separation would become more pronounced if participation rates for each sector changed at varying rates.

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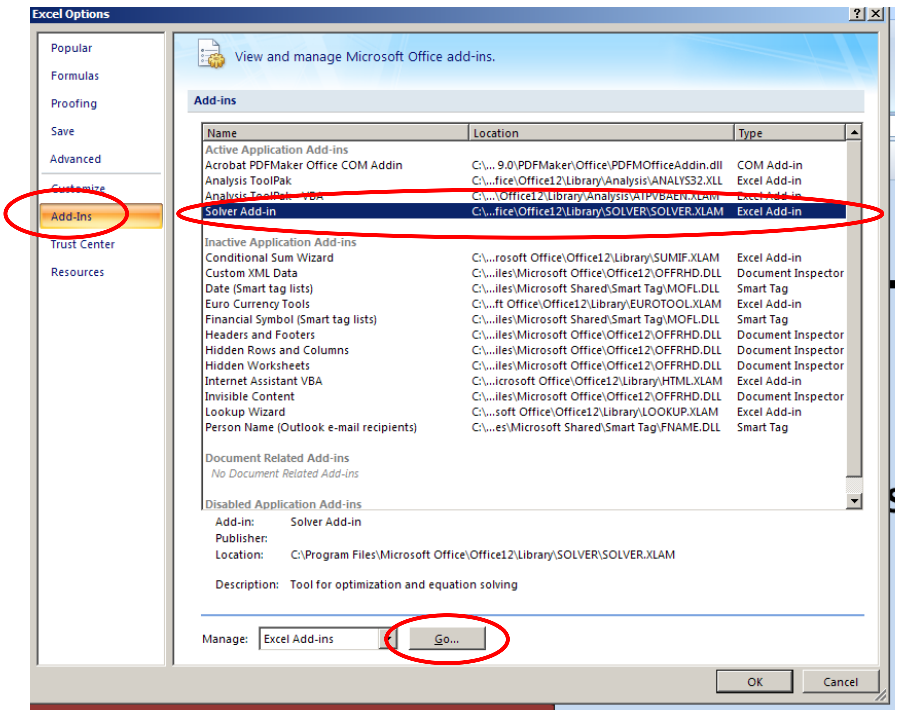
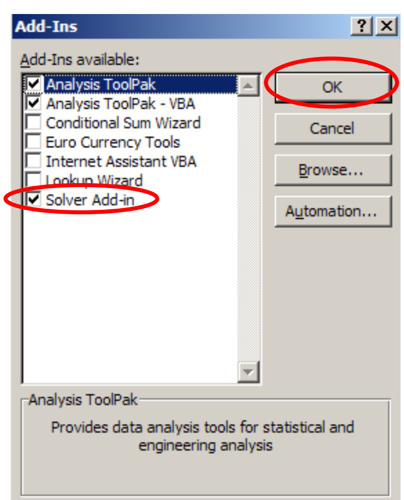
APPENDIX 1: INSTALLING SOLVER AND ENABLING MACROS

Installing Solver

To install *Solver*, click on the Office Button in the upper left corner of your screen. The Office Button looks like this  . Next, select Excel Options at the bottom of the drop down menu and then select Add-Ins . After selecting Add-Ins , select and highlight 'Solver Add-in', then select 'Go' at the bottom of the page.

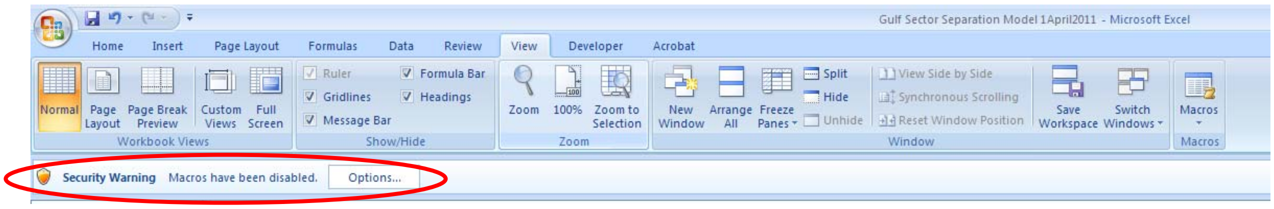


To enable *Solver*, check the solver Add-in box and then press OK.

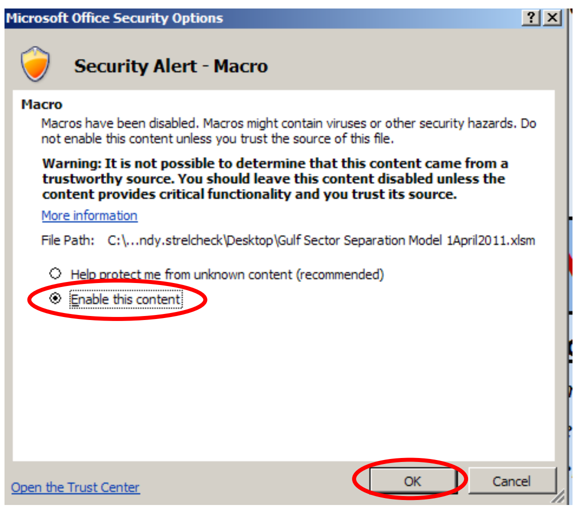


Enabling Macros

When opening the Sector Separation Model, you will receive a Security Warning under the toolbar banner at the top of the screen. The Security Warning indicates macros have been disabled. To enable macros, select Options on the Security Warning banner.



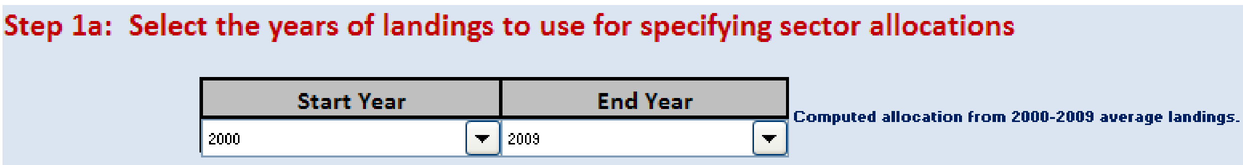
After selecting Options, select Enable this content, then select OK to use the model.



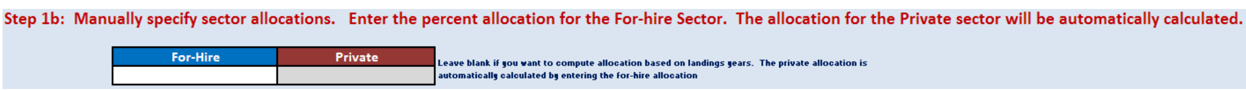
APPENDIX 2: USING THE SECTOR SEPARATION MODEL

Steps 1a and 1b: Allocation

In Step 1a, the user can select a start year and an end year, from which the allocation will be computed:

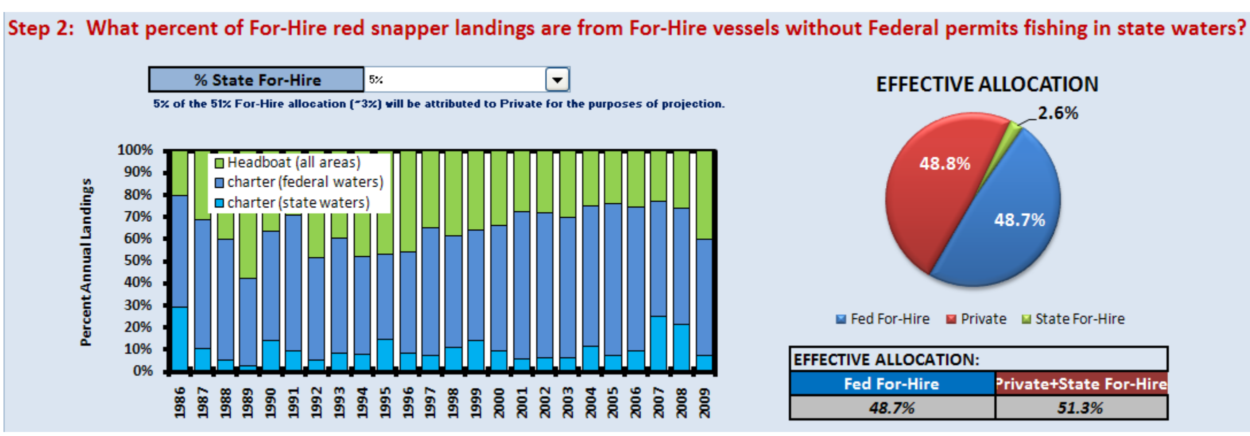


Or, in Step 1b the user can manually input their desired allocation as a percentage. If you put a number (i.e., 50%) in the For-hire box, the Private box will automatically compute the remaining percentage.



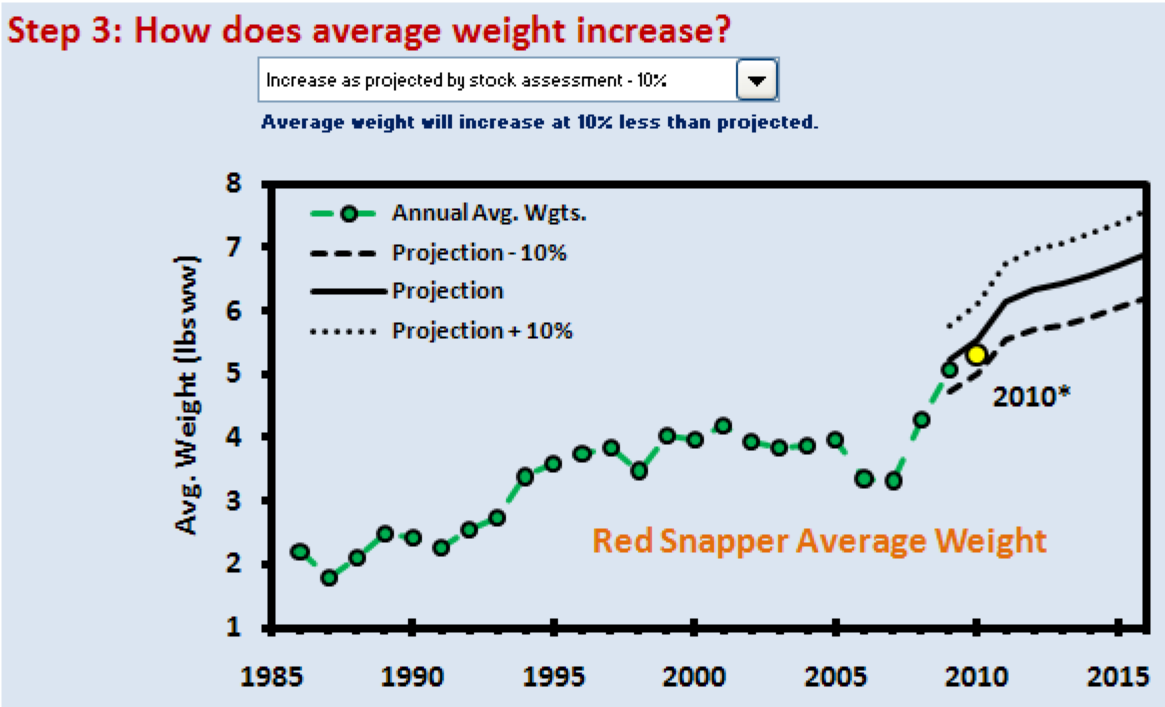
Step 2: State For-Hire Vessel Landings

The user can select a percentage between 0-10% from the drop down menu for the effective reallocation of some of the For-Hire TAC to the Private/Other sector to account for non-Federally-permitted For-Hire vessels landing red snapper in state waters:



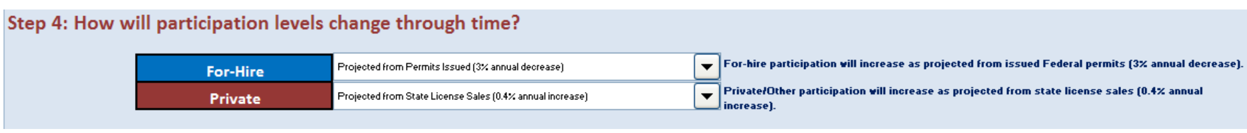
Step 3: Changes in Average Weight

The user can select between three scenarios for the change in average weight from the drop-down menu. Average weights are based on stock assessment projections (± 10%):



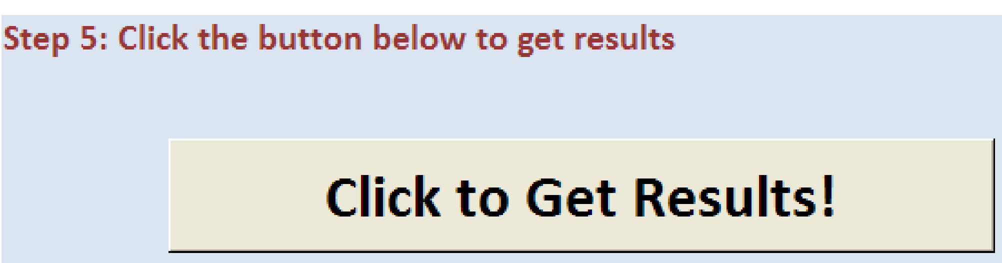
Step 4: Changes in Participation

The user can select between 7 scenarios for the changes in participation from the two sectors from the drop-down menu:

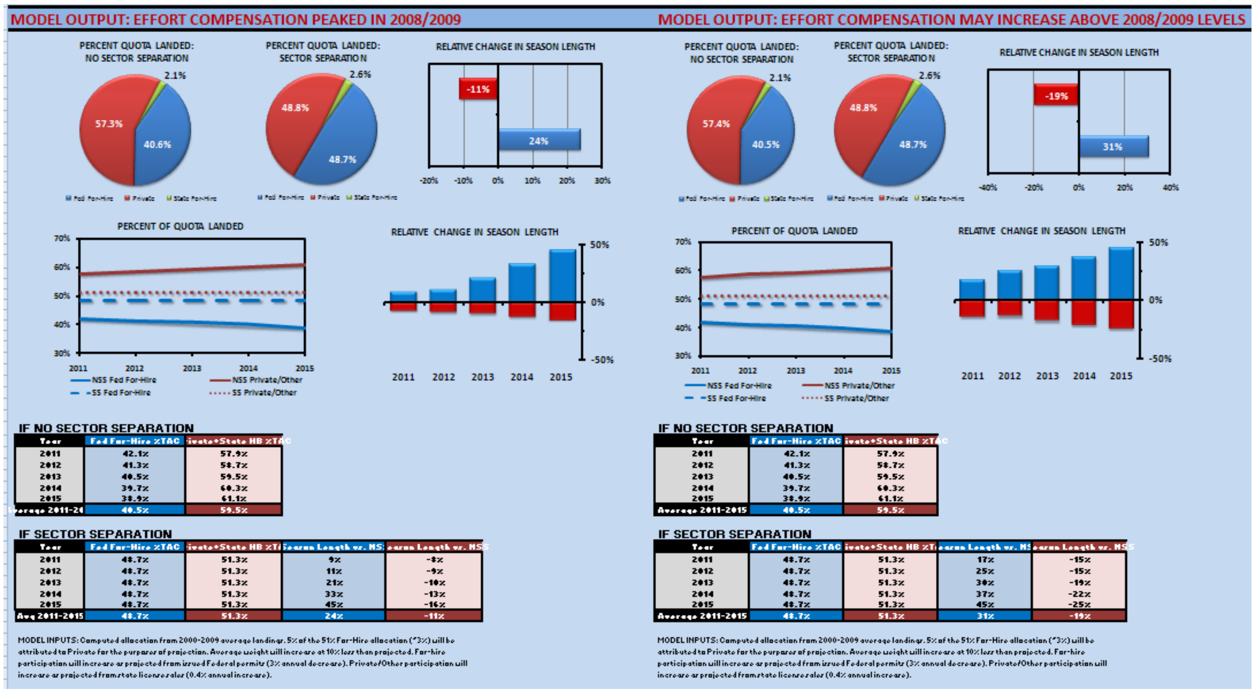


Step 5: Get Results

Please note if you do not click the button, the results will not be correct for the input parameters you have selected. Once you click the button, the model will run, computing the relative difference in days red snapper can be open under sector separation and no sector separation scenarios. The output is automatically generated for the two effort compensation scenarios: (1) Effort Compensation Peaked in 2008/2009, and (2) Effort Compensation Increases:



You can assess the relative benefits and drawbacks of sector separation under your listed input parameters by using the automatically generated tables and graphics near the bottom of the page. Selected input parameters are listed below the tables and graphics.



Appendix 3: Stepwise Regression Methods to Evaluate Effort Compensation

Stepwise linear regression analysis was used to determine the most important predictor variables for the number of angler-trips for red snapper taken per effective open day of the red snapper fishing season. Understanding this dynamic and expressing it as angler-trips-per-day is critical, as adjustments to the red snapper fishing season length is the most important post-season accountability measure for the recreational red snapper fishery. Input variables considered in a stepwise regression model included effective season length, average weight, bag limit, size limit, SSB/SSB_{2009}, quota, average annual fuel price, MRFSS participation estimates, and Gulf aggregated cyclone energy (ACE).

Table A3.1. Stepwise linear regression inputs for predicting angler-trips-per-day with restricted fishing seasons for red snapper.

Avg Wgt	Bag Limit	Size Limit	SSB/SSB_{2009}	Rec. Quota	Ln (Fuel)	Ln (E_Days)	Ln (ACE)	$MRFSS_{part}/MRFSS_{part2009}$	Ln (FH_TPD)	Ln (PV_TPD)
2.21		13	0.31		0.54	5.90	1.03	0.81	6.43	5.61
1.80		13	0.30		0.52	5.90	0.25	0.71	6.61	5.85
2.11		13	0.29		0.50	5.90	1.45	0.80	6.42	5.82
2.50		13	0.28		0.54	5.90	1.75	0.59	6.36	5.73
2.42	7	13	0.29	1.96	0.62	5.90	0.37	0.60	6.12	5.88
2.26	7	13	0.32	1.96	0.57	5.90	-4.61	0.67	6.37	5.69
2.54	7	13	0.35	2.94	0.54	5.90	2.42	0.68	6.24	6.04
2.74	7	13	0.37	2.94	0.51	5.90	-0.71	0.66	6.83	6.39
3.38	7	14	0.38	2.94	0.49	5.90	1.20	0.68	6.75	6.10
3.60	5	15	0.40	4.47	0.49	5.90	2.36	0.72	6.55	6.30
3.75	5	15	0.42	4.47	0.53	5.90	0.48	0.67	6.60	6.05
3.86	5	15	0.46	4.47	0.52	5.81	0.96	0.73	7.03	6.39
3.48	4	15	0.49	4.47	0.38	5.62	2.77	0.70	7.44	6.15
4.03	4	15	0.53	4.47	0.45	5.52	2.44	0.70	7.29	6.86
3.98	4	16	0.55	4.47	0.65	5.28	1.47	0.96	7.51	6.92
4.20	4	16	0.55	4.47	0.60	5.28	1.53	1.10	7.35	7.22
3.93	4	16	0.55	4.47	0.52	5.28	2.42	0.95	7.53	7.12
3.85	4	16	0.55	4.47	0.64	5.28	2.11	1.16	7.42	7.28
3.87	4	16	0.56	4.47	0.76	5.28	2.95	1.23	7.67	7.31
3.96	4	16	0.57	4.47	0.91	5.29	4.03	1.17	7.45	7.14
3.35	4	16	0.60	4.47	1.00	5.29	1.10	1.28	7.72	7.36
3.32	2	16	0.66	3.19	1.05	5.29	0.81	1.25	7.83	7.53
4.29	2	16	0.80	2.45	1.18	4.30	3.16	1.12	8.38	8.37
5.06	2	16	1.00	2.45	0.86	4.38	0.96	1.00	8.19	8.37

NOTE: *Fuel*: Fuel prices in dollars (Source: US Department of Energy), *E_Days*: Effective days open, *ACE*: Accumulated cyclone energy (Source: NOAA/NWS/National Hurricane Center), $MRFSS_{part}/MRFSS_{part2009}$: Ratio of MRFSS estimated participants in Gulf of Mexico to 2009 level (Source: NMFS Office of Science and Technology), *FH_TPD*: For-hire red snapper angler-trips per day, *PV_TPD*: Private red snapper angler-trips per day.

Diagnostic tests associated with stepwise linear regression revealed significant correlations among variables (Table A3.2). For-hire angler trips per day was best predicted by bag limit and effective season length (Table A3.3). Private angler trips per day was best predicted by effective season length, MRFSS participation ratio, and SSB ratio (Table A3.4). Examination of the regression relationships also suggested a lack of predictive value beyond the observed range of data and extreme deviations in predicted values between models. Given that the bag limit is likely to remain fixed at 2 fish per angler in the near future, and the SSM already incorporates options for changing participation levels, an increased focus on the relationship between angler trips per day and effective fishing days was explored.

Table A3.2. Correlations among predictor variables from stepwise linear regression input.

		ln_FH_TPD	Avgwgt	BagLimit	SizeLimit	SSBrel09	Quota	ln_Fuel	ln_E_Days	ln_StormACE	MRFSSpart09
Pearson Correlation	ln_FH_TPD	1.000	.754	-.912	.837	.910	.215	.664	-.902	.435	.775
	Avgwgt	.754	1.000	-.790	.829	.804	.430	.286	-.736	.543	.482
	BagLimit	-.912	-.790	1.000	-.891	-.893	-.297	-.627	.843	-.471	-.727
	SizeLimit	.837	.829	-.891	1.000	.745	.591	.505	-.710	.561	.807
	SSBrel09	.910	.804	-.893	.745	1.000	.022	.670	-.947	.348	.662
	Quota	.215	.430	-.297	.591	.022	1.000	-.218	.058	.531	.288
	ln_Fuel	.664	.286	-.627	.505	.670	-.218	1.000	-.726	.179	.774
	ln_E_Days	-.902	-.736	.843	-.710	-.947	.058	-.726	1.000	-.369	-.694
	ln_StormACE	.435	.543	-.471	.561	.348	.531	.179	-.369	1.000	.380
	MRFSSpart09	.775	.482	-.727	.807	.662	.288	.774	-.694	.380	1.000
Sig. (1-tailed)	ln_FH_TPD	.	.000	.000	.000	.000	.182	.001	.000	.028	.000
	Avgwgt	.000	.	.000	.000	.000	.029	.111	.000	.007	.016
	BagLimit	.000	.000	.	.000	.000	.102	.002	.000	.018	.000
	SizeLimit	.000	.000	.000	.	.000	.003	.012	.000	.005	.000
	SSBrel09	.000	.000	.000	.000	.	.463	.001	.000	.066	.001
	Quota	.182	.029	.102	.003	.463	.	.178	.404	.008	.109
	ln_Fuel	.001	.111	.002	.012	.001	.178	.	.000	.225	.000
	ln_E_Days	.000	.000	.000	.000	.000	.404	.000	.	.055	.000
	ln_StormACE	.028	.007	.018	.005	.066	.008	.225	.055	.	.049
	MRFSSpart09	.000	.016	.000	.000	.001	.109	.000	.000	.049	.

Table A3.3. Stepwise regression model coefficients for for-hire sector angler-trips per day.

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	8.804	.179		49.183	.000	8.428	9.180					
	BagLimit	-.346	.037	-.912	-9.421	.000	-.423	-.269	-.912	-.912	-.912	1.000	1.000
2	(Constant)	11.477	.870		13.194	.000	9.642	13.313					
	BagLimit	-.199	.056	-.524	-3.552	.002	-.317	-.081	-.912	-.653	-.282	.290	3.450
	ln_E_Days	-.614	.197	-.460	-3.118	.006	-1.029	-.198	-.902	-.603	-.248	.290	3.450

Table A3.4. Stepwise regression model coefficients for private sector angler-trips per day.

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	15.315	.645		23.746	.000	13.960	16.670					
	ln_E_Days	-1.555	.118	-.952	-13.213	.000	-1.802	-1.308	-.952	-.952	-.952	1.000	1.000
2	(Constant)	12.796	.867		14.766	.000	10.967	14.624					
	ln_E_Days	-1.240	.127	-.759	-9.753	.000	-1.509	-.972	-.952	-.921	-.547	.519	1.928
	MRFSSpart09	.888	.249	.278	3.566	.002	.363	1.414	.805	.654	.200	.519	1.928
3	(Constant)	8.983	1.857		4.838	.000	5.047	12.919					
	ln_E_Days	-.696	.266	-.426	-2.613	.019	-1.261	-.131	-.952	-.547	-.131	.095	10.506
	MRFSSpart09	.878	.224	.274	3.925	.001	.404	1.352	.805	.700	.198	.518	1.929
	SSBrel09	1.634	.723	.354	2.262	.038	.102	3.166	.940	.492	.114	.103	9.699