2012 Recreational Gulf Gray Triggerfish Annual Catch Target Closure Analysis

NOAA Fisheries Service
Southeast Regional Office
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Introduction

A recent stock assessment determined that gray triggerfish are overfished and undergoing overfishing. NOAA Fisheries Service is in the process of implementing a temporary rule to reduce the recreational gray triggerfish annual catch limit (ACL) to 241,200 pounds whole weight (lbs ww), and the annual catch target (ACT) to 217,100 lbs ww. The temporary rule includes a provision to close the recreational sector during the 2012 fishing year once the ACT is met. This report uses historical landings and a seasonal forecasting model to predict when the ACT will be reached in 2012.

Methods

Data Sources

Recreational gray triggerfish landings were obtained from three data sources:

1. Marine Recreational Fisheries Statistics Survey (MRFSS), including the For-hire charter survey;
2. Southeast Fisheries Science Center Headboat survey (HBS); and,
3. Texas Parks and Wildlife Department (TPWD) charter and private/rental creel survey.

MRFSS gray triggerfish landings are estimated using a combination of dockside intercepts (landings data) and phone surveys (effort data). Landings are estimated in both numbers and whole weight (lbs) by 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).

Headboat landings are collected through logbooks completed by headboat operators. Landings (lbs ww) 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 TPWD creel survey estimates landings in numbers for private/rental boats and charter vessels fishing off Texas. Landings are reported in numbers by high (May 15-November 20) and low-use time periods (November 21-May 14), area fished (state vs. federal waters), and mode of fishing (private vs. charter). To convert TPWD landings in numbers to landings in pounds, gray triggerfish average lengths by mode, wave, and area fished were converted to weights using length-weight conversion formula from SEDAR 7 (2005).

Two methods were used to project when the ACT would be met. Method 1 used a seasonal auto-regressive integrated moving average (SARIMA) model to predict when the ACT would be met. SARIMA uses historical and current landings data and future exploitable abundance to forecast landings. Method 2 used cumulative recreational landings during 2011 to determine when the ACT would be exceeded. This method assumed catch rates in 2012 would be similar to catch rates in 2011.

Method 1: SARIMA Model

Because gray triggerfish landings have a long-term time-series trend and a seasonal trend, forecasting future catches is particularly well-suited to a SARIMA model (Box and Jenkins 1976). A SARIMA model analyzes and forecasts equally-spaced univariate time series data, predicting a value in a response time series as a linear combination of its own past values, past errors, and past, current, and projected future values of other time series. Because the time series of gray triggerfish recreational catch per day shows strong seasonality, a SARIMA (p,d,q)*(P,D,Q) model was used. The auto-regressive component, designated as p, represents the lingering effects of previous observations. The integrated component, designated as d, represents trends, including seasonality. The moving average component, designated as q, represents lingering effects of previous random shocks (or error). In the SARIMA model, monthly landings, in pounds whole weight of recreational gray triggerfish were projected as a linear combination of past values. Monthly landings were computed using the SEFSC ACL Recreational Dataset (Apr 2012), which includes headboat, MRFSS, and TPWD landings. MRFSS and TPWD landings are estimated on a bimonthly wave basis and were assumed to be distributed uniformly across days within months, while headboat landings are estimated monthly.

The Deepwater Horizon/BP oil spill resulted in large fishery closures in the Gulf of Mexico from April-December 2010. To avoid distortion of model predictions due to the unique fishery dynamics caused by spill-related fishery closures, headboat data for April-December 2010 and MRFSS and TPWD data for Waves 2-6 of 2010 were replaced with the average of 2009 and 2011 for the same months. Landings during Jan-Feb 2010 (e.g., Wave 1) were unusually low due to cold and windy weather conditions. To avoid distortions caused by this unusually cold winter when projecting landings for the mild winter of 2012, catch-per-day data for Jan-Feb 2010 were also replaced with the average of 2009 and 2011 for the same months.

Because the SARIMA model also allows for a predictive covariate, abundance at age was obtained from the most recent gray triggerfish stock assessment (S. Saul, SEFSC, pers. comm.) and converted to exploitable abundance using the selectivity at age for the recreational sector (Figure 1; Gray Triggerfish SEDAR Update 2012). Input data are summarized in Appendix 1.

The SARIMA model was implemented using Proc ARIMA in SAS v9.2 for Windows (SAS Institute, Inc., Cary, NC). SARIMA model selection was guided by examination of autocorrelations, inverse autocorrelations, partial autocorrelations, and cross-correlations. Stationarity tests were used to guide differencing selection. Residual diagnostics and Akaike Information Criterion (AIC) values were used to select the final model (AIC=2923; see Appendix), which was specified as a SARIMA(0,0,1)*(0,1,1)s model where s=12 months, with model fit using

conditional least squares. The final model incorporated exploitable abundance as a predictor and captured non-seasonal and seasonal trends in monthly catch per day using an MA(0) model (Moving Average Operator: 1 + 0.9035 B**(1)) combined with an SMA(1) model at a 12 month lag (Moving Average Operator: 1 - 0.37723 B**(12)). Gray triggerfish SEDAR Update (2012) projected values of exploitable abundance were used to seed the forecast of the final model (Figures 1).

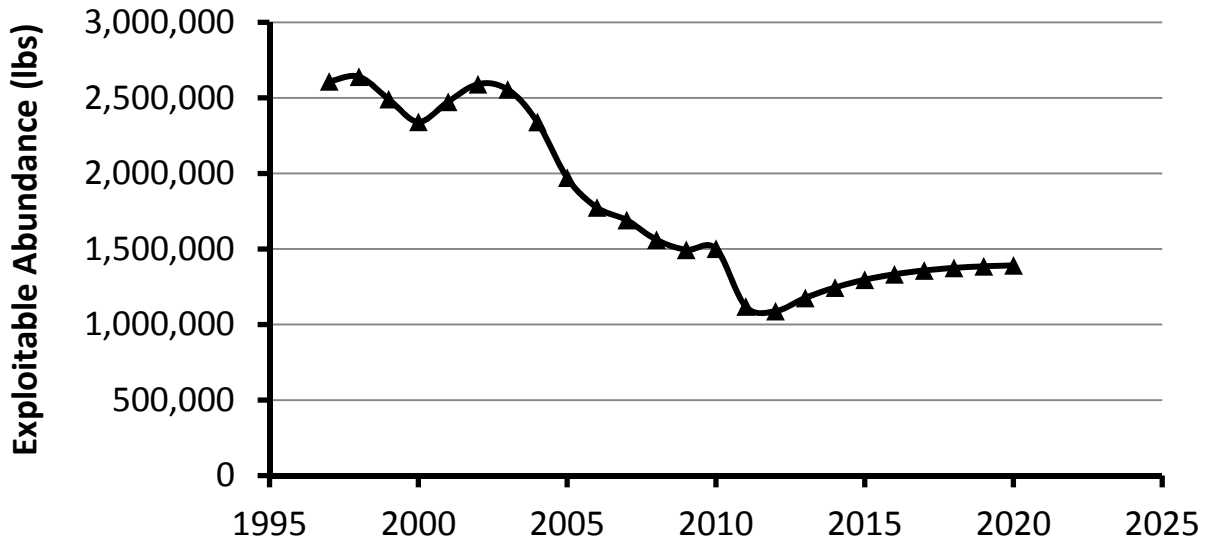

Figure 1. Projected change in abundance of recreationally exploitable Gulf gray triggerfish (Gray Triggerfish SEDAR Update; S. Saul, SEFSC, pers. comm.).

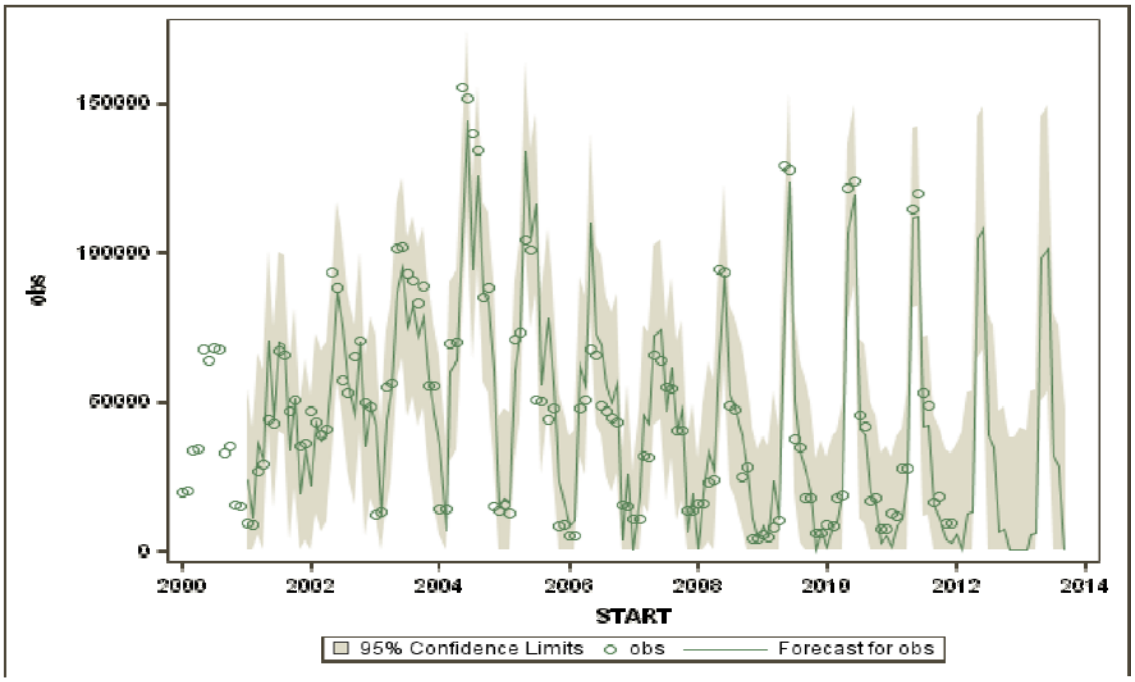

Figure 2. SARIMA model fit to recreational catch-per-month (in lbs ww). Bands indicate 95% confidence limits.

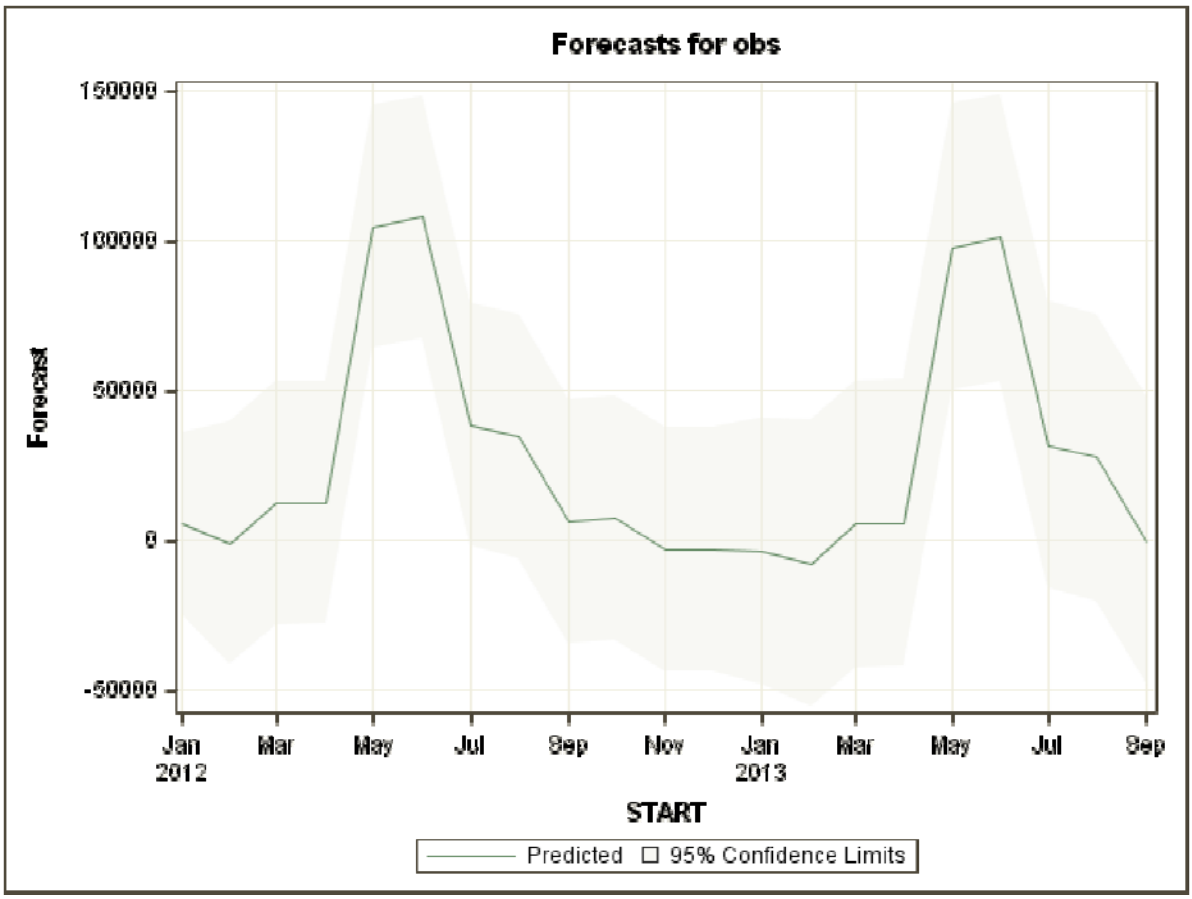

Figure 3. SARIMA model forecast for recreational landings. Bands indicate 95% confidence limits.

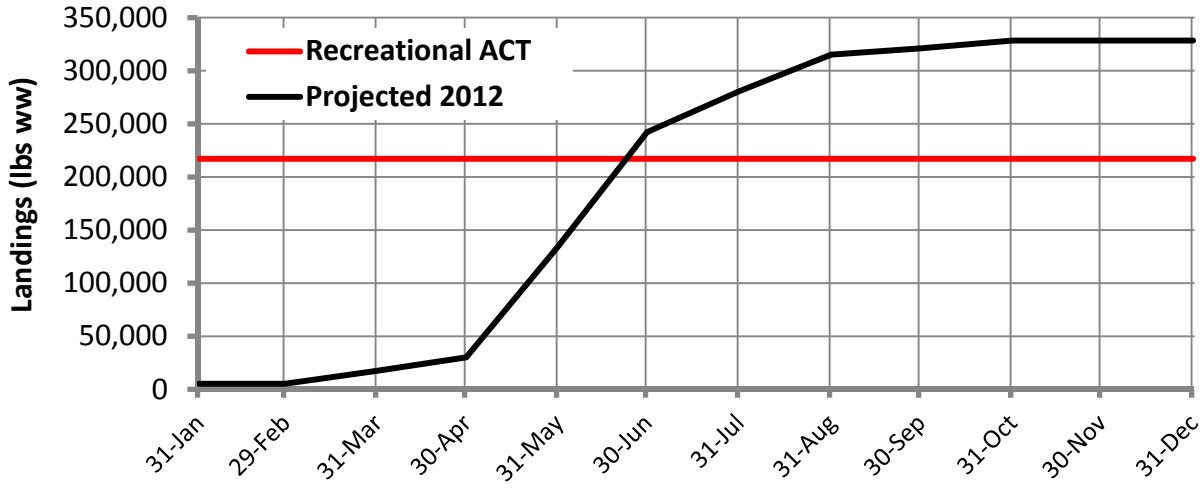

Figure 4. SARIMA model cumulative recreational landings forecast relative to ACT.

Method 2: Cumulative 2011 Landings

Landings were obtained from the SEFSC ACL Recreational Dataset (Apr 2012), which includes headboat, MRFSS, and TPWD landings. MRFSS and TPWD landings are estimated on a bimonthly wave basis and were assumed to be distributed uniformly across days within months, while headboat landings are estimated monthly. Landings were cumulatively summed from January through December. The closure date was determined based on when cumulative landings reached the ACT.

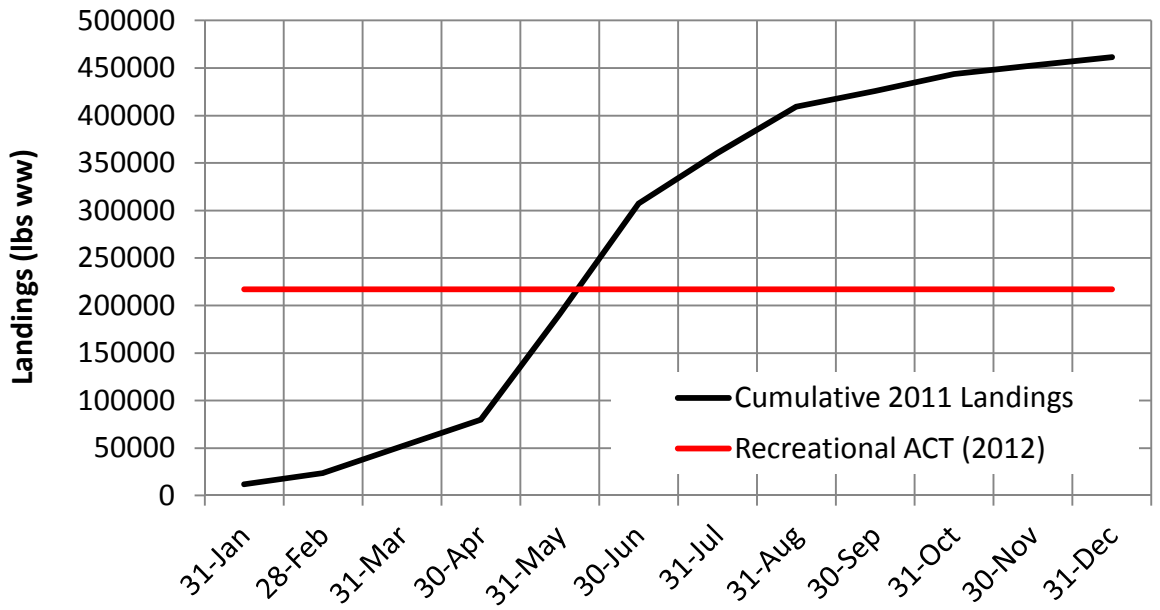

Figure 5. Cumulative 2011 gray triggerfish recreational landings relative to ACT.

Results

The SARIMA model (Method 1) projected the gray triggerfish recreational ACT would be met on June 23, 2012. Diagnostic plots suggested a (0,0,1)(0,1,1) SARIMA model for monthly recreational gray triggerfish landings was an appropriate model structure (Figure 2 and Figure A1). The model indicates a strong seasonal trend, with the highest landings during May-July (Figures 3- 4). Cumulative 2011 gray triggerfish recreational landings (Method 2) predicted a June 7, 2012, closure (Figure 5). Similar to the SARIMA model, there was a strong seasonal trend in landings, with the highest landings during summer. Total 2012 annual landings predicted by the SARIMA model were substantially less than cumulative landings reported in 2011 resulting in a longer projected season length.

Discussion

The 2012 recreational gray triggerfish season is estimated to range from 158 to 174 days. Both methods used historical landings data to predict when the ACT will be met. The SARIMA model used trends in the fishery over the long-term and the immediate past to influence model dynamics, while also accounting for changes in underlying stock size. In contrast, 2011 cumulative landings were assumed to represent 2012 catch rates, but did not account for changes in underlying stock size or past trends in harvest. If 2012 effort and landings are lower than projected, owing to high fuel prices, after-effects of the BP/DeepWater Horizon oil spill, and economic factors, then a longer season than those presented in this report might be required to catch the entire recreational quota.

References

Box GEP, Jenkins G. 1976. Time Series Analysis: Forecasting and Control, Holden-Day.

Hanson PJ, Vaughan DS, Narayan S. 2006. Forecasting annual harvests of Atlantic and Gulf menhaden. North American Journal of Fisheries Management 26: 753-764.

SEDAR Gray Triggerfish Update. 2012. Stock assessment of gray triggerfish in the Gulf of Mexico: Report of the update assessment workshop, Miami, Florida. 224 p.

Appendix

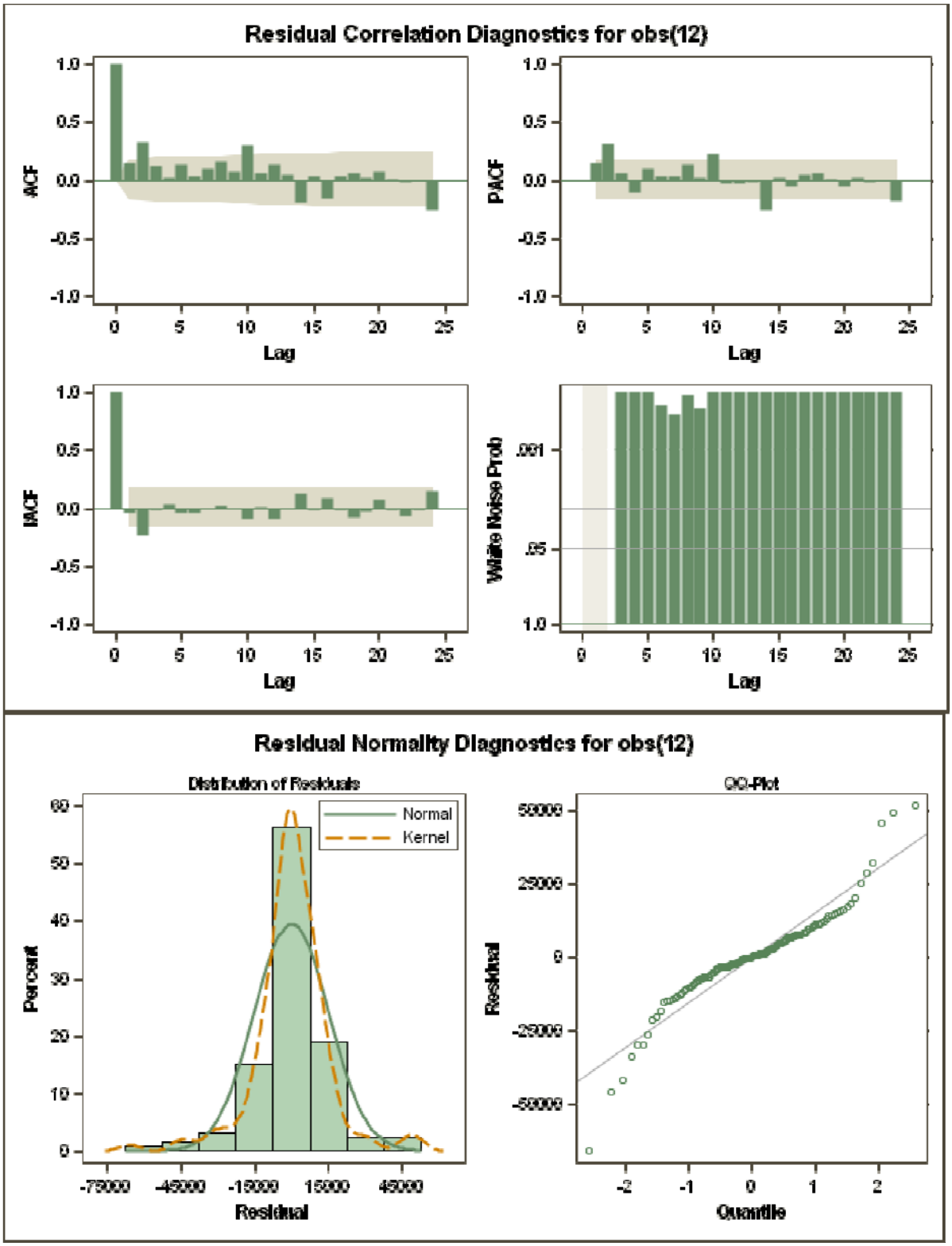

Figure A1. Model diagnostics for Gulf gray triggerfish monthly recreational catch in lbs ww fit to a SARIMA(0,0,1)(0,1,1) model.