2016 Gulf of Mexico Red Snapper Recreational Season Length Estimates
NOAA Fisheries, Southeast Regional Office

Executive Summary

The Gulf of Mexico red snapper recreational fishing season opens each year on June 1 and closes when the recreational annual catch targets (ACTs) are projected to be reached. Amendment 40 to the Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico (RF-40) established separate ACTs for the federal for-hire and private angler components. Prior to June 1 each year, NOAA Fisheries projects the closing dates for each component's season based on previous years of data, and notifies the public of the closing dates for the upcoming seasons. Upon implementation of Amendment 28 to the Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico (RF-28), the ACTs for 2016 will be 2,434,000 pounds whole weight (lb ww) to the federal for-hire component and 3,320,000 lb ww to the private angler component.

Using data from the Marine Recreational Information Program, Louisiana and Texas creel surveys, and the Southeast Region Headboat Survey, 2015 landings were summarized and compared to the 2015 ACTs. The total federal for-hire landings for 2015 were 2,005,265 lb ww. These landings were 365,735 lb ww (15 percent) under the component ACT and 958,735 lb ww (32 percent) under the ACL. The total private angler and state charter landings for 2015 were 3,850,807 lb ww. These landings were 616,807 lb ww (19 percent) over the ACT but 192,193 lb ww (5 percent) under the annual catch limit (ACL). The observed federal season catch rates for 2015 were within the range projected in SERO-LAPP-2015-04; median values were 6 percent underestimated for private angler mode and 4 percent underestimated for federal for-hire. The private angler mode overage was attributable primarily to underestimation of state catches, due in part to state seasons that were extended or announced following the announcement of the 2015 federal seasons.

A tiered projection approach was taken for forecasting red snapper recreational average weight and catch rates in the Gulf of Mexico (Gulf) for 2016. Because state seasons are assumed to be inconsistent with federal seasons in 2016, state season average weights and daily catch rates for 2016 were based on observed values from 2015. Ten projection scenarios were developed for determining federal season length for the private angler and federal for-hire modes; five were based on recent years' data and five were based on regression methods using year, year of rebuilding, spawning stock biomass, fuel prices, per capita gross domestic product, and state and federal season lengths as predictive covariates.

Median projected federal season lengths from the ten projection scenarios for 2016 were 48 days for for-hire (range: 38-56 days) and 8 days for private angler mode (range: 6-9 days). Based on the most recent two years, the mean season length would be 46 days for federal for-hire mode and 9 days for private angler mode. Across the ten projection scenarios, a median of 21 percent of bootstrapped private angler model runs and a median of 17 percent of bootstrapped federal for-hire model runs exceeded the ACL under these season lengths. The

state water seasons established by each state in 2016 are projected to land approximately half of the private angler component ACT and reduce the median private angler federal season length from 15 days to 8 days. Assuming inconsistent state seasons, the implementation of RF-40 reduced the private angler mode federal season length by 8 days (a 50 percent reduction) but increased the federal for-hire season by 32 days (a threefold increase). Bootstrapping was used to capture model uncertainty; assuming sector separation and inconsistent state seasons in 2016, the mean risk of exceeding the ACL at a 20 percent ACT buffer was estimated at 15 percent for federal for-hire and 17 percent for private angler mode.

Introduction

Red snapper are managed in Gulf federal waters from the west coast of Florida to Texas by the Gulf of Mexico Fishery Management Council (Council). On April 20, 2015, a final rule (80 FR 14328) established a red snapper recreational ACT by applying a buffer to the recreational quota, which is based on the Council's ACL/ACT control rule developed in the Generic ACL Amendment (76 FR 82044). The ACL/ACT control rule is used to determine the appropriate target catch levels, accounting for management uncertainty, to maintain catches at or less than the ACL (quota).

For the recreational sector, the control rule specified a 20 percent buffer to constrain landings to less than the quota. In 3 of the last 5 years (2011-2015), landings exceeded the recreational quota (equals the ACL). However, in the past two years (2014-2015), the recreational quota was not exceeded. The final rule (80 FR 14328) also revised the procedure for determining the recreational season length (closure date). The red snapper recreational closure dates are now based on when the recreational component ACTs are projected to be reached instead of when the recreational component quotas are projected to be met. Using the ACT to set the season length serves as an in-season accountability measure (AM); projections indicated the 20 percent buffer reduced the probability of exceeding the recreational quota during a fishing year from 50 percent to 15 percent (SERO-LAPP-2014-04). This final rule also revised the recreational AMs to include a quota overage adjustment (payback). If red snapper are overfished and the recreational quota is exceeded, then in the year following the overage, the recreational quota will be reduced by the amount of the recreational quota overage in the prior fishing year, unless the best scientific information available determines that a greater, lesser, or no overage adjustment is necessary. If the recreational quota is adjusted, the recreational ACT will also be reduced to maintain the 20 percent buffer between the component ACTs and the adjusted component quotas.

On April 10, 2015, the Secretary of Commerce approved RF-40 (FB15-006). This rulemaking provided a basis for increased flexibility in future management of the recreational sector, and reduced the chance for recreational quota overruns, which could jeopardize the rebuilding of the red snapper stock. The rule established sub-quotas for federally permitted for-hire vessels and private anglers who fish for red snapper for a three-year period beginning in 2015. The federal for-hire component is comprised of all for-hire operators with a valid or renewable federal reef fish charter vessel/headboat permit. The private angling component is comprised

of private anglers and other for-hire operators who do not have a federal reef fish charter vessel/headboat permit. The rule implemented sub-quotas using RF-40's allocation of 42.3 percent to the federal for-hire component and 57.7 percent to the private angler component.

The red snapper federal for-hire and private angler recreational fishing seasons open each year on June 1 and close when their respective recreational ACTs are projected to be reached. On May 1, 2015, NOAA Fisheries implemented a final rule increasing the quotas for 2015-2017 and beyond (80 FR 24832) to the highest levels ever for Gulf red snapper. Prior to the June 1, 2016 federal opening for red snapper recreational harvest, RF-28 is expected to be implemented. RF-28 will reallocate the red snapper harvest between the commercial and recreational sectors from 51:49 percent to 48.5:51.5 percent, respectively. The reallocation is based on changes in recreational data incorporated into the 2014 red snapper update assessment. These changes are attributable to the calibration of the Marine Recreational Information Program (MRIP) catch data. In 2016, the recreational ACL (quota) for red snapper will be 7,192,000 lb ww. The sub-quotas (component ACLs) are 3,042,000 lb ww (42.3 percent) to the for-hire sector and 4,150,000 lb ww (57.7 percent) to the private angler component (including state-licensed charter vessels). The ACTs for 2016 will be 2,434,000 lb ww to the federal for-hire component and 3,320,000 lb ww to the private angler component.

Prior to June 1 each year, NOAA Fisheries projects the federal for-hire and private angler season closing dates and notifies the public of the closing dates for the upcoming season. If subsequent data indicate that the ACTs have not been reached, NOAA Fisheries may re-open the seasons. The purpose of this report is to provide preliminary 2015 landings, project the 2016 recreational red snapper federal for-hire mode and private angler fishing season lengths, and to characterize the uncertainty of those projections.

State Regulations

This analysis assumes bag limits and size limits for Gulf states other than Texas will be consistent with the federal 2-fish bag limit and 16-inch total length minimum size limit (MSL), but seasons for all Gulf states will be inconsistent with the federal season (**Table 1**). The Florida Fish and Wildlife Commission approved a 78-day state waters fishing season beginning with two-day weekends starting May 7, then opening continuously Memorial Day weekend (May 28) thru July 10, with Labor Day weekend and three-day weekends in Sept-Oct open as well. Mississippi and Alabama have yet to specify their season length. Analyses herein presume Mississippi and Alabama will have similar seasons as they did in 2015. Louisiana opened on Jan 8 and will manage towards a target of 726,189 lb ww for their private anglers (18.4% of the private angler component ACL; J. Shepard, LA-DWF, pers. comm.). In 2016, as in previous years, Texas will be open year-round in state waters with a 4-fish bag limit and a 15-inch total length MSL. The private angler mode federal season lengths projected account for landings from state waters by private anglers and non-federally permitted charter vessels during state seasons to avoid a quota overage.

Data Sources

Recreational red snapper landings were obtained from four data sources (**Table 2**):

1. MRIP, including the For-hire charter survey.
2. Southeast Region Headboat survey (SRHS).
3. Louisiana Department of Wildlife and Fisheries (LDWF) creel survey ("LA Creel").
4. Texas Parks and Wildlife Department (TPWD) charter and private/rental creel survey.

MRIP for-hire and private angler red snapper landings are estimated using a combination of dockside intercepts (landings data) and phone surveys (effort data). Landings are estimated in both numbers and lb ww 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 angler mode/rental, shore), and state (west Florida, Alabama, Mississippi, and Louisiana). Uncertainty in MRIP mean estimates in average weights, numbers of fish landed, and pounds of fish landed is expressed as percent standard error (PSE). MRIP has replaced the Marine Recreational Fisheries Statistics Survey program as the primary methodology for collecting and estimating recreational catches in the Gulf. In 2013, MRIP implemented changes to the Access Point Angler Intercept Survey (APAIS). These changes to APAIS required a recalibration of historical landings to account for biases in sampling time period; these re-calibrated landings were incorporated into the SEDAR-31 Update (2014) stock assessment and were used to generate the inputs for the 2016 season length projections in this report. MRIP data for 2014-2015 were obtained from the SEFSC Recreational ACL Data.

Headboat landings are collected through logbooks completed by headboat operators and submitted to the SRHS. 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). Landings from vessels participating in the 2014 and 2015 Headboat Collaborative Exempted Fishing Permit (HBC; http://gulfheadboat.com/) were included in the SRHS data. These vessels were identified and various approaches were explored to determine their historic catch rates in the context of federal season projections. No estimates of uncertainty are generated by the SRHS; the magnitude of expansions between reported and expanded landings from the SRHS was used as a proxy for uncertainty. In recent years, these expansion factors were very small (<5%), as nearly all vessels were compliant with reporting requirements. Headboat expanded landings were obtained through 2015 from the SEFSC Recreational ACL Dataset (accessed Mar 2016). Headboat unexpanded landings were obtained from the SRHS program's "CRNF" file (accessed Mar 2016).

LDWF's quota monitoring survey ("LA Creel") provides estimates of the number of red snapper landed in Louisiana during the 2014 and 2015 recreational seasons. Dockside interviews were conducted by state personnel at sites that are stratified by fishing activity (Offshore Charter, Offshore Private Angler, Inshore Charter, Inshore Private Angler). Stratifying dockside sampling for sites where anglers commonly land offshore species increased the probability of encountering anglers landing red snapper. To estimate fishing effort of private anglers, LDWF

contact a stratified random portion of saltwater licensed anglers. Saltwater licensed anglers holding a Louisiana Recreational Offshore Landing Permit were surveyed at a higher rate than those not holding the permit. By doing so, the probability of contacting a saltwater angler fishing offshore species such as red snapper was increased. Other strata include SE LA, SW LA North LA and out-of-state anglers. Anglers were surveyed by phone and/or e-mail on a weekly basis and asked if they fished, how many trips were taken the previous week, the basin they fished (offshore is considered a basin), if they landed at a public site, what time they returned to the dock, and whether they fished on a paid charter. The randomly selected saltwater anglers were notified by e-mail each Monday of their selection to be surveyed. Those selected anglers had the option to answer the effort survey questions by reply e-mail. E-mail non-respondents were contacted by phone. Charter captains holding a Louisiana Guide License were also contacted weekly by LDWF to collect information on the total number of for-hire trips they took the previous week. Those captains holding a Louisiana Recreational Offshore Landing Permit were surveyed at a higher rate than those not holding the permit. Charter captains had the option to respond via e-mail prior to LDWF personnel contacting them via phone. Estimated landings were produced for each sector based on observed catch rates and estimated fishing effort (as adjusted for private anglers not possessing a Louisiana saltwater fishing license or charter captains not having a Louisiana guide license). Uncertainty in LDWF survey weekly estimates of fish landed is expressed as PSE. An estimated landing by weight was calculated by multiplying landings in numbers of fish for that season and sector by their average weight. There was no MRIP sampling in Louisiana in 2014; the LA Creel survey was considered to represent the best available data for both charter and private angler modes in 2014. MRIP 2015 Louisiana charter estimates were not available at the time of projections; therefore, 2015 LA Creel survey charter estimates were used. MRIP 2015 Louisiana private angler mode estimates were available at the time projections were made and were used rather than 2015 LA Creel survey estimates for private angler mode. The LA Creel survey is currently under review and undergoing certification from NOAA Fisheries; preliminary findings suggest no significant difference in red snapper landings between LA Creel and MRIP private angler mode survey estimates in 2015 (J. Shepard, LDWF, pers. comm.).

The TPWD creel survey generates estimates of landings in numbers for charter vessels and private angler mode/rental boats fishing off Texas. Landings are reported in numbers by high- (May 15-November 20) and low-use (November 21-May 14) time periods, area fished (state versus federal waters), and mode of fishing (charter versus private angler mode). To convert TPWD landings in numbers to landings in pounds, red snapper average lengths by mode, wave, and area fished are converted to weights using a length-weight conversion formula. High- and low-use estimates of uncertainty in TPWD numbers of fish landed are expressed as PSE and were obtained from TPWD staff for this analysis. TPWD staff also provided preliminary 2015 landings for this analysis, which were parsed to MRIP wave using observed ratios from 2014.

Methods

2015 Landings

In 2015, the red snapper recreational ACL was 7,007,000 lb ww, and the ACT was 5,608,000 lb ww. The federal for-hire component season was open for 44 days, from June 1-July 14, and the private angler component federal season was open for 10 days, from June 1-June 10 (SERO-LAPP-2015-04). Additionally, the state of Florida had a 70-day state water season (May 23-July 12, Labor Day weekend Sept 5-7, two-day weekends Sept-Oct). The state of Alabama had a 31-day state water season (July 1-31). The state of Mississippi had a 108-day state water season (July 16-Oct 31). The state of Louisiana had 215-day state water season (Mar 20-Sept 8, Nov 20-Dec 31). Alabama, Florida, Mississippi, and Louisiana all had a 2-fish bag limit and a 16-inch MSL. The state of Texas had a year round (365 day) state waters season with a 4-fish bag limit and 15-inch MSL.

Landings from 2015 were obtained from the various data sources described in **Table 2**. Federal in-season catch rates were determined using MRIP, LA Creel, SRHS, and TPWD estimates. These were compared to federal season catch rates projected in SERO-LAPP-2015-04. Landings from inconsistent state seasons were partitioned into state and federal season landings. Landings were assumed to originate from state seasons if they were from waves during which the federal season was closed. For states other than Louisiana, if the federal season was open during a wave but a state season was open during days outside the federal season in that wave, federal season landings were considered to be federal waters landings plus the landings in state waters times the ratio of the federal season length in the wave to the state season length in the wave. For example, if the federal season were open for 30 days in a 60-day wave, and the state season was open for the entire wave, 100% of the landings originating from federal waters and 50% of the landings originating from state waters would be attributed to the federal season and the remaining 50% of state waters landings would be attributed to the state season. If the state season ended before the federal season in a wave, then all landings were assumed to come from the federal season. For Louisiana, LA Creel weekly data were used to parse landings between in-season and out-of-season. Following the allocation decisions made in RF-40, for-hire landings from outside the federal season that were attributed towards the state seasons were counted towards the private angler component's quota, as they were assumed to originate from charter vessels without federal permits. All headboat landings were assumed to originate from the federal season.

2016 Projections: Model Runs

A tiered projection approach was taken for forecasting recreational red snapper average weight and catch rates in the Gulf for 2016. Landings anticipated during assumed 2016 state seasons (**Table 1**) were projected based on observed 2015 landings. Since 2007, the federal recreational fishing season has decreased from 194 days to 9 days (2014 season length), in part due to increasing daily catch rates as the federal season is shortened (**Figure 2**). Once landings were distributed to state versus federal seasons, they were converted to daily catch rates assuming a uniform distribution of landings across open days within the wave. Average weights were computed for in-season and out-of-season landings by state/region and mode. Separate models were developed for each state because of differences in state regulations in recent years. Aggregate models were developed for the Eastern (Florida, Alabama, Mississippi) and

Western (Louisiana, Texas) states in the Gulf because the stock assessment treated the Eastern and Western Gulf as separate regions and the Western Gulf states have different data collection programs. Different projections were done for headboat, charter, and private angler modes to account for differences in the effort dynamics of these modes, the implementation of RF-40, and the availability and completeness of data.

Generalized linear regression models were implemented using R v3.2.3 (R Core Team 2014). The best-fitting models for each of the model scenarios in **Table 3** were identified based on significance of parameter terms and lowest Akaike Information Criterion (AIC; Akaike 1973). Parametric bootstrapping techniques were applied, where the mean and variance per year were used to define a distribution of possible values at each observed point. This extension allowed different variance estimates at each point, directly incorporating variance estimates from the surveys (e.g., MRIP, LDWF, and TPWD) into the projection framework. Because catch rates and average weights for many region-mode combinations appeared stabilized over the 2013-2015 time period, additional sensitivity runs were performed using recent years or averaging across recent years as a proxy for future catch rates and average weights.

To generate a mean estimate with variance for 2016 average weights for the charter, private angler, and headboat modes, 1,000 bootstrapped time series were generated around the mean in-season average weights, by state/region and mode of fishing. These bootstrapped time series incorporated uncertainty using weighted mean PSE for red snapper average weights. State- and mode-specific average weight PSE estimates were obtained from the MRIP website (www.countmyfish.noaa.gov), LDWF, and TPWD staff. PSE estimates were weighted by landings in pounds when aggregated to the region-mode level. Headboat PSEs were assumed equivalent to charter PSEs by state/region. Generalized linear model regressions with a Gaussian distribution were fit to each of the 1,000 bootstrapped time series of average weights from 2004-2015 and forecast to 2016. Residual diagnostics were used to verify goodness-of-fit.

To generate a mean estimate with variance for 2016 Gulf red snapper catch rates in numbers of fish landed per open day for the charter, private angler, and headboat modes, 1,000 bootstrapped time series were generated around the mean in-season daily catch rates in numbers by state/region and mode of fishing. These bootstrapped time series incorporated uncertainty using PSE from the SEFSC MRIP-based Recreational ACL Database (accessed March 2016). PSE estimates were weighted by landings in numbers when aggregated to the region-mode level. Uncertainty estimates are not generated for headboat survey catches. Headboat catches are expanded for unreported catch based on dockside validation. Headboat annual expansion factors, by state/region, were used as proxies for PSE. Different projection scenarios were developed to address uncertainty in headboat catch rates caused by the fact that many headboats in 2014-2015 participated in the HBC, which allowed them to fish for red snapper outside the federal season in 2014 and outside the federal for-hire component season in 2015 (**Table 3**). In most model scenarios, it was assumed that vessels in the HBC would have caught their allocation of red snapper during the federal season if they had been restricted to fishing during the federal for-hire season. In one model scenario, 2014 was dropped because the federal season was only 9 days and effort compression may have reached an asymptote. In

another model scenario, the ratio between HBC and non-HBC vessels was used to scale up 2014 catch rates from non-HBC vessels to represent what HBC vessels would have caught if forced to fish during the 9 day season. For each scenario, generalized linear model regressions with a log-linked negative binomial distribution were fit to each of the 1,000 bootstrapped time series of catch rates from 2007-2015 and forecast to 2016.

Predictive covariates considered for regressions on average weight and catch rates were federal and state season lengths in days, model-estimated and model-projected spawning stock biomass (SSB; from SEDAR-31 Update 2014), annual mean fuel prices in nominal United States dollars (Fuel; http://www.eia.gov/petroleum/data.cfm#prices), annual per capita Gross Domestic Product in 2016 United States dollars (GDP; http://data.worldbank.org/country/united-states), Jan-Mar Google Search hits on the phrase "red snapper season" (Google Hits; https://www.google.com/trends/, Carter et al. 2015), and year of rebuilding (the current rebuilding plan began in 2007). Trends in these covariates are shown in **Figure 1**. SSB was included to potentially account for changes in stock size (and corresponding availability) as the population rebuilds. Mean fuel prices were included because they are believed to have an influence on the willingness of recreational fishermen to fish further offshore where higher catch rates of red snapper are possible. Per capita GDP was included because it is an indicator of the economic status of the United States overall, which may predict the ability of recreational anglers to afford to take trips for red snapper. Preliminary values (Jan-Mar) of mean fuel prices (http://www.eia.gov/petroleum/gasdiesel/) and per capita GDP (http://knoema.com/atlas/United-States-of-America/GDP-per-capita) were used to seed model predictions for 2016. Google hits were explored because red snapper catch rates have been shown to be well-predicted by Google search counts (Carter et al. 2015); however, there were limited data in the time series for this covariate. Year of rebuilding was a metric used to describe the path to recovery for the red snapper population.

For all regressions, AIC and significance of parameter estimates were used to guide final model selection and included covariates. Mean and variance estimates for 2016 predictions of average weight and catch per day (in pounds per day), by mode, were computed by running summary statistics on the product of the 1,000 bootstrapped forecasts for 2016 average weight and the 1,000 bootstrapped forecasts for 2016 catch rate in numbers for each state/region and mode.

Because all Gulf states have adopted or suggested they may approve fishing seasons for red snapper in state waters that would be inconsistent with the federal season, separate out-of-season catch rates were computed for each state and mode using 2015 data as proxies. For Louisiana, LDWF weekly charter catch data from 2015 were used to parse in-season and out-of-season catches. For other Gulf states and modes, catch rates in 2015 waves outside the federal season were used directly as proxies for 2016 out-of-season catch rates. All 2015 state season landings were converted to catch rates with associated average weights and PSEs. In 1,000 bootstrapped runs, state season catch rates were expanded to 2016 state season landings based on anticipated state seasons in 2016 shown in **Table 1**. Bootstrapping was used to incorporate uncertainty in state catch rates and average weights.

2016 Projections: Season Length

Forecasts of catch rates and average weights from the best-fitting models were incorporated, along with their variance, into an Excel-based season length projection model to determine the federal season length under each model scenario. This season length projection model accounted for out-of-season catch rates and state incompatibility with federal season length as described previously. Prior to the 2016 season, Congress passed a budgetary resolution, which temporarily extends red snapper management jurisdiction for Alabama, Mississippi, and Louisiana from 3 nautical miles from shore out to 9 nautical miles from shore. Model sensitivity to assumptions regarding increases in state season catch rates for Alabama, Mississippi, and Louisiana associated with this regulation was evaluated using scalars of +10%, +25%, +50%, +100%, +200%, and +300%. Additional projections were performed to evaluate how long the federal season would have been if all states were compatible (i.e., only open when the federal season was open) and if RF-40 had not been implemented.

Uncertainty in season length projections was based on the risk of a given season length exceeding the ACL. The percentage of bootstrapped runs exceeding the ACL was tallied for each component ACL for each of the ten projection scenarios. Additionally, the risk of exceeding the ACL was evaluated at different ACT buffers (i.e., 5 percent, 10 percent, 15 percent, and 20 percent) by tabulating the percentage of 1000 bootstrapped runs for each component across all projection scenarios that exceeded the ACL when the season length for the component was set so the mean landings of the 1000 bootstrapped runs would equal the component ACT at a given buffer level.

Results

Total 2015 Gulf recreational red snapper landings are presented in **Table 4**. The total federal for-hire landings were 2,005,265 lb ww. Federal for-hire landings were 365,735 lb ww (15%) under the ACT and 958,735 lb ww (32%) under the ACL. The total private angler mode and state charter landings were 3,850,807 lb ww. Private angling and state charter landings were 616,807 lb ww (19%) greater than the ACT, but 192,193 lb ww (5%) under the ACL. The median projected 2015 federal for-hire catch rate across Scenarios A-D in SERO-LAPP-2015-04 was 47,216 lb ww/day (range: 45,849 to 53,601 lb ww/day). The observed 2015 federal for-hire catch rate was 45,367 lb ww/day; a 4% underestimate, well within the PSE for federal for-hire catch rates and within the range of projected catch rates for 2015. The median projected 2015 private angler catch rate across Scenarios A-D in SERO-LAPP-2015-04 was 225,312 lb ww/day (range: 194,612 to 304,741 lb ww/day). The observed 2015 private angler catch rate was 211,458 lb ww/day; a 6% underestimate, well within the PSE for private angler mode catch rate and within the range of projected catch rates for 2015.

2016 Projections: Model Runs

Regression model fits and predicted average weights and catch rates are shown in **Figures 3-13**. Significant predictors for AIC-selected final model configurations are provided in **Table 5**. In general, SSB and year of rebuilding were useful predictors for average weight trends. Year or year of rebuilding along with fuel prices, SSB, GDP, and season length were often useful predictors of trends in catch rates. Dropping 2014 often simplified model fit and reduced the number of significant predictors; predicted values for 2016 in the model runs excluding 2014 were often similar to 2015 observations.

Forecasts for Florida charter are shown in **Figure 3A**. Average weight was predicted to increase, and catch rate was predicted to stabilize relative to 2015 observations. Forecasts for Florida charter with 2014 dropped are shown in **Figure 3B**. Average weight was predicted to stabilize, and catch rate was predicted to decrease. Forecasts for Florida private angler mode are shown in **Figure 3C**. Average weight was predicted to increase, and catch rate was predicted to split the difference between the very different observed values in 2014 and 2015. Forecasts for Florida private angler mode with 2014 dropped are shown in **Figure 3D**. Average weight was predicted to increase, and catch rate was predicted to slightly decrease.

Forecasts for Alabama charter are shown in **Figure 4A**. Average weight was predicted to stabilize and catch rate was predicted to increase slightly from 2015 observations. Forecasts for Alabama charter with 2014 dropped are shown in **Figure 4B**. Average weight was predicted to stabilize and catch rate was predicted to increase slightly. Forecasts for Alabama private angler mode are shown in **Figure 4C**. Average weight was predicted to stabilize and catch rate was predicted to increase slightly. Forecasts for Alabama private angler mode with 2014 dropped are shown in **Figure 4D**. Average weight was predicted to stabilize and catch rate was predicted to decrease.

Forecasts for Mississippi charter are shown in **Figure 5A**. Average weight was predicted to increase and catch rate was predicted to stabilize relative to 2015 observations. Forecasts for Mississippi charter with 2014 dropped are shown in **Figure 5B**. Average weight was predicted to increase and catch rate was predicted to stabilize. Forecasts for Mississippi private angler mode are shown in **Figure 5C**. Average weight was predicted to decrease and catch rate was predicted to stabilize. Forecasts for Mississippi private angler mode with 2014 dropped are shown in **Figure 5D**. Average weight and catch rate were predicted to increase.

Forecasts for Louisiana charter are shown in **Figure 6A**. Average weight and catch rate were predicted to decrease relative to 2015 observations. Forecasts for Louisiana charter with 2014 dropped are shown in **Figure 6B**. Average weight was predicted to stabilize and catch rate was predicted to decrease. Forecasts for Louisiana private angler mode are shown in **Figure 6C**. Average weights and catch rates were predicted to stabilize. Forecasts for Louisiana private angler mode with 2014 dropped are shown in **Figure 6D**. Average weight was predicted to stabilize and catch rate was predicted to increase.

Forecasts for Texas charter are shown in **Figure 7A**. Average weight was predicted to stabilize and catch rate was predicted to split the difference between recent observations. Forecasts for

Texas charter with 2014 dropped are shown in **Figure 7B**. Average weight and catch rates were both predicted to increase slightly relative to 2015 observations. Forecasts for Texas private angler mode are shown in **Figure 7C**. Average weight and catch rates were predicted to increase. Forecasts for Texas private angler mode with 2014 dropped are shown in **Figure 7D**. Average weights and catch rates were predicted to increase.

Forecasts for Eastern Gulf charter are shown in **Figure 8A**. Average weights and catch rates were predicted to stabilize at levels slightly above 2015 observations. Forecasts for Eastern Gulf charter with 2014 dropped are shown in **Figure 8B**. Average weight and catch rate were predicted to stabilize near 2015 observations. Forecasts for Eastern Gulf private angler mode are shown in **Figure 8C**. Average weight was predicted to decrease and catch rates were predicted to increase relative to 2015 observations. Forecasts for Eastern Gulf private angler mode with 2014 dropped are shown in **Figure 8D**. Average weight was predicted to decrease and catch rate was predicted to increase relative to 2015 observations.

Forecasts for Western Gulf charter are shown in **Figure 9A**. Average weight was predicted to decrease and catch rate was predicted to split the difference between the very different observations in 2014 and 2015. Forecasts for Western Gulf charter with 2014 dropped are shown in **Figure 9B**. Average weight was predicted to stabilize and catch rate was predicted to decline to levels slightly below 2015 observations. Forecasts for Western Gulf private angler mode are shown in **Figure 9C**. Average weight was predicted to increase and catch rates was predicted to be near 2015 observed values. Forecasts for Western Gulf private angler mode with 2014 dropped are shown in **Figure 9D**. Average weights and catch rates were predicted to increase relative to 2015 observations.

Forecasts for Eastern Gulf headboat are shown in **Figure 10A**. Average weight was predicted to stabilize and catch rate was predicted to split the difference between very different values observed in 2014 and 2015. Forecasts for Eastern Gulf headboat with 2014 dropped are shown in **Figure 10B**. Average weight was predicted to stabilize and catch rate were predicted to decrease slightly relative to 2015 observations. Forecasts for Western Gulf headboat are shown in **Figure 10C**. Average weight was predicted to stabilize and catch rate was predicted to split the difference between very different values observed in 2014 and 2015. Forecasts for Western Gulf headboat with 2014 dropped are shown in **Figure 10D**. Average weight was predicted to stabilize and catch rate was predicted to increase slightly relative to 2015 observations.

Figure 11 shows the percentage of headboat landings 2004-2015 originating from vessels that participated in the HBC in 2014-2015. HBC vessels have accounted for 43-47% of total headboat landings during 2010-2015, with the exception of the short federal season (9 days) in 2014, when they accounted for 73% of the total headboat landings. **Figure 12** shows the reductions in overall headboat daily catch rates in 2014 in the Eastern and Western Gulf when HBC catches are scaled to the 43% observed ratio from 2013.

Forecasts for Eastern Gulf headboat with 2014 catch rates scaled between the non-HBC and HBC vessels are shown in **Figure 13A**. Average weight was predicted to stabilize and catch rate was predicted to split the difference between catch rates observed in 2014 and 2015. Forecasts for Western Gulf headboat with 2014 catch rates scaled between the non-HBC and HBC vessels are shown in **Figure 13B**. Average weight was predicted to stabilize and catch rate was predicted to split the difference between catch rates observed in 2014 and 2015.

2016 Projections: Season Length

Table 6 and **Figure 14** show projected catch rates and federal season lengths for Gulf recreational red snapper, by mode, assuming the extension of Alabama, Mississippi, and Louisiana red snapper management jurisdiction from 3 to 9 nautical miles increases state waters catch rates by 10%. Median private angler mode season length was 8 days (range: 6-9 days), for-hire season length was 48 days (range: 38-56 days). Median private angler mode catch rate was 209,520 lb ww/day; median for-hire catch rate was 50,672 lb ww/day. A median of 13% of private angler mode projection runs and 11% of for-hire projection runs exceeded the ACL (**Table 6**). Based on the most recent two years, the mean season length would be 9 days for private angler mode and 46 days for federal for-hire mode. Across the ten projection scenarios, a median of 21 percent of bootstrapped private angler model runs and a median of 17 percent of bootstrapped federal for-hire model runs exceeded the ACL under these season lengths. Large increases in state water catch rates would result in a shorter private angler mode season (**Table 7**). If all Gulf states had adopted state seasons compatible with the federal season, the median private angler mode federal season length would nearly double to 15 days (range: 11-17 days; **Table 8**). If RF-40 had not been implemented but Gulf states still adopted the inconsistent seasons shown in **Table 1**, the median red snapper recreational season length would be 16 days (range: 12-17 days; **Table 9**).

Figure 15 shows projected landings by state and mode for the "2015 as proxy" (**Figure 15A**) and "Regression" (**Figure 15B**) projection model runs. Federal for-hire landings originate primarily from Alabama and Florida. Federal private angler mode landings originate primarily from Alabama. State private angler mode landings originate primarily from Florida and Louisiana. Each of these model runs assumes the state waters boundary change in the Northern Gulf increases Alabama, Mississippi, and Louisiana landings by 10%. When this assumed change in catch rate is increased to 100% (i.e., double the catch rate), the proportion of private angler mode landings originating from state seasons exceeds the proportion of private angler mode landings originating from the federal season for the "Regression" projection model run. Assuming a 200% increase in state waters catch rates (i.e., triple the catch rate), the proportion of private angler mode landings originating from the state seasons exceeds those originating from the federal season for both the "2015 as proxy" and "Regression" model runs (**Figure 15C-D**).

Figure 16 shows the risk of exceeding the ACL, by mode, at different ACT buffer levels, assuming state water catch rates for Alabama, Mississippi, and Louisiana increase by 10% under their extended jurisdiction to 9 nautical miles. Under the status quo ACT buffer level of 20%, private angler mode has a risk of exceeding the ACL of 17% ± 6%; for-hire has a mean risk of exceeding the ACL of 15% ± 9% (mean ± standard deviation). At an ACT buffer level of 15%, the mean risk of exceeding the ACL is 25% ± 6% for the private angler mode and 24% ± 9% for the for-hire mode.

Discussion

In previous years, the Gulf red snapper recreational quota has been exceeded for a variety of reasons, including challenges with predicting angler behavior and catch rates, inconsistent state regulations, and rapidly increasing fish sizes. Projection assumptions have been refined to better account for changes in average weights and daily catch rates. These refinements have led to increasingly more accurate predictions as described in SERO-LAPP-2013-10, SERO-LAPP-2014-04, SERO-LAPP-2015-04, and the retrospective analysis in this report. Additionally, the implementation of a 20 percent buffer between the ACL and ACT has accounted for management uncertainty inherent in a protracted fishing season where the majority of landings are estimated by surveys and landings data is delivered to managers after the season ends.

Accounting for catches from state seasons is critical to accurate projections of the federal season. The percentage of private angler mode catch originating from state waters has increased substantially for most states in recent years as states have expanded their inconsistent season lengths (**Figure 17**). There is considerable uncertainty in 2016 out-of-season state waters catch rates for the season length projection scenarios presented. Uncertainty in 2015 out-of-season state water catch rates and extension of state seasons following the announcement of the 2015 federal season (**Figure 18**) were the primary reason for the 19 percent private angler mode ACT overage in 2015. Additionally, in 2015, a high percentage of private angler (44 percent) and charter mode (66 percent) landings were self-reported as originating from federal waters during waves when the federal season was closed. Limited data exist to inform the uncertainty in out-of-season state water catch rates in 2016, so the most recent data from 2015 were used as a proxy. If daily out-of-season catches in state waters are higher in 2016 than in previous years, the season lengths presented in **Table 6** may be overestimated. This could happen if more anglers participate in state seasons or if red snapper population rebuilding results in higher catch rates in state waters.

If 2016 state catch rates are two or more times higher relative to 2015 in waters off of Alabama, Mississippi, and Louisiana due to a Congressional budgetary action that has temporarily extended their state water jurisdiction from 3 to 9 nautical miles, the private angler mode federal season may need to be shortened. Federal private angler mode season estimates were somewhat robust to assumptions regarding state water catch rates for a few reasons: (1) the private angler mode season is set in days and cannot exceed the component ACT, often leaving

some leftover quota to be absorbed under the component ACT; (2) Alabama catch rates in Wave 4 of 2015 were relatively low; (3) Mississippi state catch rates are historically low; and (4) although Louisiana state catch rates are relatively high, Louisiana total catch is being managed towards a state-defined 'quota' – although they may catch their 'quota' more quickly, Louisiana is not assumed to catch more total fish under assumptions of increased state catch rates. If the Gulf states implement longer seasons than anticipated following the federal season announcement, as several did in 2015 (**Figure 18**), the federal season length estimates presented in **Table 6** may be overestimates for the private angler component.

As with any projection model, the approaches discussed herein are dependent upon assumptions that historical data are accurately estimated and that historical trends are representative of future dynamics. Previous evaluations of Gulf recreational red snapper catch rates have indicated that catch rates increase as the stock rebuilds and season is shortened (SERO-LAPP-2012-01; **Figure 2**). These dynamics are implicitly incorporated into the generalized linear regression approaches described by this document. Regression modeling approaches for the 2014 season (SERO-LAPP-2014-04) generated a catch rate estimate that was within 3.5 percent of the observed 2014 federal catch rate. Catch rate estimates for the 2015 season (SERO-LAPP-2015-04) were within 4 percent of the observed 2015 federal for-hire catch rate and within 6 percent of the observed 2015 federal private angler mode catch rate.

Some covariates were consistently useful predictors in regression models of red snapper average weights and catch weights. SSB was frequently a useful predictor of average weights; this is not surprising, as it is an indirect index of the exploitable biomass in the population. Regression models on catch rate tended to incorporate SSB as a predictor for Eastern Gulf states and the trend in the Eastern Gulf SSB is declining (see **Table 5** and **Figure 1**). Fuel prices have declined in recent years and were a useful predictor of catch rates in Eastern Gulf states. Visual inspection of **Figures 3-13** suggests some stabilization in catch rates between the 2013-2015 seasons. This may be due to trends in red snapper recruitment to the recreational sector, reductions in the Eastern Gulf population (see SSB trend in **Figure 1**), or possible saturation in effort compression in the 2014 season, which was only 9 days long. Additionally, state seasons in 2013-2015 were longer than the federal season, which may have decelerated effort compression in the federal season.

In general, season lengths based on regression models were longer for for-hire and shorter for private angler mode than those based on 2013-2015 data. Under RF-40 regulations and assuming states implement the seasons presented in **Table 1**, median projected season lengths for 2016 were 48 days for for-hire (range 38-56) and 8 days for private angler mode (range 6-9). Based on the most recent two years, the mean season length would be 9 days for private angler mode and 46 days for federal for-hire mode. The inconsistent seasons assumed for Gulf states in 2016 (see **Table 1**) reduce the median private angler mode federal season length from 15 days to 8 days (a 47 percent reduction). The implementation of RF-40 reduced the private angler mode federal season length by 8 days (a 50 percent reduction) but increased the federal for-hire season by 32 days (a threefold increase).

NOAA's revised National Standard 1 Guidelines indicate that if catch exceeds the ACL for a given stock more than once in four years, the system of ACLs and AMs should be revisited (74 FR 3180). The 20 percent ACT buffer was established by the Council in 2014 through a framework action to provide a 15 percent risk of exceeding the ACL (Gulf Council 2014). For the projections presented in this report, the mean risk of exceeding the ACL at a 20 percent ACT buffer was estimated at 15 percent for federal for-hire and 17 percent for private angler mode (see **Figure 17**). For a private angler component season of 9 days, the median percentage of model runs across all projection scenarios that exceeded the ACL was 21 percent. For a federal for-hire component season of 46 days, the median percentage of model runs across all projection scenarios that exceeded the ACL was 17 percent.

References

Akaike, H. 1973. Information theory and an extension of the maximum likelihood principle. *In* Petrov, B.N.; Csáki, F., 2nd International Symposium on Information Theory, Tsahkadsor, Armenia, USSR, September 2-8, 1971, Budapest: Akadémiai Kiadó, p. 267-281.

Carter, D.W., Crosson, S., Liese, C. 2015. Nowcasting intraseasonal recreational fishing harvest with internet search volume. PlosOne: http://dx.doi.org/10.1371/journal.pone.0137752.

Gulf of Mexico Fishery Management Council (Gulf Council). 2014. Recreational accountability measures for red snapper: Final Draft Framework Action for the Reef Fish Resources of the Gulf of Mexico. Gulf of Mexico Fishery Management Council, Tampa, Florida. 106 pp.

R Core Team. 2014. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria, available from www.R-project.org, Version 3.0.2.

SEDAR-31 Update. 2014. Gulf of Mexico Red Snapper: Stock Assessment Report. SEDAR, North Charleston, SC. Available online: http://sedarweb.org/docs/suar/SEDARUpdateRedSnapper2014_FINAL_9.15.2015.pdf

SERO-LAPP-2012-01. 2012. 2012 Gulf of Mexico Red Snapper Recreational Season Length Estimates. NOAA Fisheries Service, Southeast Regional Office, St. Petersburg, FL.

SERO-LAPP-2013-02 Addendum. 2013. Updated 2013 Gulf of Mexico Red Snapper Recreational Season Length Estimates. NOAA Fisheries Service, Southeast Regional Office, St. Petersburg, FL, May 21, 2013; updated June 4, 2013.

SERO-LAPP-2013-10. 2013. 2014 Gulf of Mexico Red Snapper Recreational Season Length Estimates. NOAA Fisheries Service, Southeast Regional Office, St. Petersburg, FL, December 10, 2013.

SERO-LAPP-2014-04. 2014. 2014 Gulf of Mexico Red Snapper Recreational Season Length Estimates (Revised and Updated). NOAA Fisheries Service, Southeast Regional Office, St. Petersburg, FL, April 21, 2014.

Table 1. Potential Gulf state water recreational red snapper regulations for 2016. Cells highlighted in gray indicate regulations inconsistent with 2016 federal regulations.

State	Size Limit	Bag Limit	Season	Days Open
Florida	16" TL	2-fish	Open Saturdays and Sundays in May starting May 7. On May 28, the season would open continuously through July 10. Finally, the season would reopen for Fridays, Saturdays and Sundays in September and October, and on Labor Day.	78
Alabama*	16" TL	2-fish	Open federal season, July 1-31	Federal season plus 31 days
Mississippi*	16" TL	2-fish	Open federal season, July 16-Oct 31	Federal season plus 108 days
Louisiana	16" TL	2-fish	Opens Jan 8	358 days (or closure when target of 726,189 lb ww caught)
Texas	15" TL	4-fish	Jan 1-Dec 31	366

**Not finalized*

Table 2. Data inputs used in projections.

Source	Time Period	Details
Marine Recreational Information Program (MRIP)	2004-2015	Landings and PSE by wave, 2004-2013 landings recalibrated for changes in angler intercept survey; 2014-2015 from SEFSC Recreational ACL Database (Mar 2016)
Texas Parks and Wildlife Department (TPWD)	2004-2015	Landings 2004-2014 by wave from SEFSC Recreational ACL Database (Mar 2016); 2015 landings and PSEs 2004-2015 obtained from TPWD staff; 2015 landings parsed to MRIP wave based on 2014 percentages
Louisiana Department of Wildlife and Fisheries (LDWF)	2014-2015	Weekly landings and error estimates from LDWF staff
Southeast Region Headboat Survey (SRHS)	2004-2015	Monthly landings from SEFSC Recreational ACL Database (Mar 2016); expansion factors from CRNF file from SRHS staff
Southeast Fisheries Science Center Recreational Annual Catch Limit Dataset (SEFSC ACL data)	2004-2015	Average weights by year and mode of fishing

Table 3. Projection scenarios for the 2016 recreational Gulf of Mexico red snapper season.

Scenario	Description
2015	Uses 2015 catch rates and average weights as proxy
2014	Uses 2014 catch rates and average weights as proxy
2013	Uses 2013 catch rates and average weights as proxy
2014-2015	Uses mean 2014-2015 catch rates and average weights as proxy
2013-2015	Uses mean 2013-2015 catch rates and average weights as proxy
Regression	Predicts 2016 values by state and mode from regression fits with AIC-selected covariates for average weights (from 2004-2015 inputs, excluding 2010) and catch rates (from 2007-2015 inputs, excluding 2010)
Regression (drop 2014)	Predicts 2016 values by state and mode from regression fits with AIC-selected covariates for average weights (from 2004-2015 inputs, excluding 2010 and 2014) and catch rates (from 2007-2015 inputs, excluding 2010 and 2014)
Regression (East West with scaled HBC)	Predicts 2016 values for the Eastern and Western Gulf of Mexico from regression fits with AIC-selected covariates for average weights (from 2004-2015 inputs, excluding 2010) and catch rates (from 2007-2015 inputs, excluding 2010), with total headboat federal season catch rate for 2014 scaled from non-headboat collaborative (HBC) vessels based on the observed ratio from 2013 between HBC and non-HBC vessels. This scaling attempted to address concern that the HBC vessels in 2014 had a much longer season to land red snapper as compared to the 9 day season for the non-HBC vessels.
Regression (East West)	Predicts 2016 values for the Eastern and Western Gulf of Mexico from regression fits with AIC-selected covariates for average weights (from 2004-2015 inputs, excluding 2010) and catch rates (from 2007-2015 inputs, excluding 2010), with catch rates allocated to Eastern (FL, AL, MS) and Western (LA, TX) states based on 2015 ratios.
Regression (East West drop 2014)	Predicts 2016 values for the Eastern and Western Gulf of Mexico from regression fits with AIC-selected covariates for average weights (from 2004-2015 inputs, excluding 2010 and 2014) and catch rates (from 2007-2015 inputs, excluding 2010 and 2014), with catch rates allocated to Eastern (FL, AL, MS) and Western (LA, TX) states based on 2015 ratios.

Table 4. 2015 Gulf of Mexico recreational red snapper landings, by mode and state.

Mode	Source	FLW	AL	MS	LA	TX	TOTAL	TOTAL	ACL	ACT	% ACL	% ACT
Private angler mode + State charter	MRIP/ LA Creel/ TPWD	757,748	1,751,666	33,942	1,088,064	219,386	3,850,807	3,850,807	4,043,000	3,234,000	95%	119%
Federal For-Hire	MRIP/ LA Creel/ TPWD	626,526	664,612	5,955	106,854	21,091	1,425,038	2,005,265	2,964,000	2,371,000	68%	85%
	SRHS	124,938	95,417	18,267		341,605	580,227					

Source: MRIP and Southeast Region Headboat Survey (SRHS) data Waves 1-6 from SEFSC Recreational ACL Database (Mar 2016), LA charter estimates from LA-DWF Creel Survey, Texas Private angler mode and charter estimates from TPWD Creel Survey.

Table 5. Significant covariates in AIC-selected final regression model configurations, by state/region and mode.

		Florida				Alabama				Mississippi				Louisiana				Texas				Eastern Gulf							Western Gulf					
	Mode	charter		Private angler		charter		Private angler		charter		Private angler		charter		Private angler		charter		Private angler		charter		Private angler		Headboat			charter		Private angler		Headboat		
	Include 2014?	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	Y*	N	Y	N	Y	N	Y	Y*	N
Average Weight	Year																			X	X										X	X			
	YrRebuild	X		X	X					X	X	X		X	X	X	X	X	X			X							X	X			X	X	X
	Fed. Days																																		
	State Days																																		
	SSB		X			X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X			X	X	X
	Fuel Price																																		
	GDP																																		
	Google																																		
Catch Rate	Year			X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X		X		X					X	X	X			
	YrRebuild	X				X																X		X		X		X					X	X	X
	Fed. Days	X										X										X		X			X	X							X
	State Days			X					X							X																			
	SSB	X			X	X		X	X							X	X					X						X				X			
	Fuel Price	X	X			X		X	X													X		X				X	X	X					X
	GDP	X				X		X	X													X		X											
	Google																																		

*Scale HBC vessels to non-HBC vessel catch rates in 2014 based on observed 2013 ratio.

Table 6. Projected 2016 Gulf of Mexico recreational red snapper catch rates (lb ww / federal day) and season lengths, by mode, for various projection scenarios.

	Catch Rate (lb ww/day)		Season Length (days)		% Runs Exceeding ACL	
Scenario	**Private angler**	**Federal For-Hire**	**Private angler**	**Federal For-Hire**	**Private angler**	**Federal For-Hire**
2015	211,458	45,367	8	53	15%	28%
2014	201,760	62,828	9	38	20%	8%
2013	196,030	51,994	9	44	12%	1%
2014-2015	207,583	55,391	8	43	14%	13%
2013-2015	204,077	54,497	8	44	10%	11%
Regression	286,121	49,349	6	49	26%	11%
Regression (drop 2014)	207,270	44,099	8	55	15%	10%
Regression (East West w/ scaled HBC)	243,218	52,802	7	46	10%	28%
Regression (East West)	243,218	48,322	7	49	10%	28%
Regression (East West drop 2014)	228,092	42,916	8	56	11%	9%
Mean	**222,882**	**50,757**	**8**	**48**	14%	15%
SD	**27,854**	**6,052**	**1**	**6**	5%	10%
Median	**209,520**	**50,672**	**8**	**48**	13%	11%
Mode	**243,218**	**n/a**	**8**	**44**	n/a	n/a
Min	**196,030**	**42,916**	**6**	**38**	10%	1%
Max	**286,121**	**62,828**	**9**	**56**	26%	28%

Note: Assumes 3→9 nmi boundary change will increase AL, MS, and LA state season catch rates by 10%.

Table 7. Sensitivity of 2016 Gulf of Mexico recreational red snapper median projected season lengths, by mode, to assumptions regarding assumed increase in state waters catch rate for AL, MS, and LA due to legislative change of state boundaries from 3 nautical miles to 9 nautical miles offshore.

Assumed increase in state waters catch rate	Season Length (days)	
	Private angler	**Federal For-Hire**
10%	8	48
25%	8	48
50%	8	48
100%	8	48
200%	7	48
300%	6	48

Table 8. Projected 2016 Gulf of Mexico recreational red snapper season lengths, by mode, for various projection scenarios, assuming all Gulf states adopted state seasons compatible with the federal season.

	Season Length (days)	
Scenario	**Private angler**	**Federal For-Hire**
2015	15	53
2014	16	38
2013	17	46
2014-2015	16	44
2013-2015	16	44
Regression	11	49
Regression (drop 2014)	15	55
Regression (East West with scaled HBC)	13	46
Regression (East West)	13	50
Regression (East West drop 2014)	14	56
Mean	**15**	**48**
SD	**2**	**6**
Median	**15**	**48**
Mode	**16**	**46**
Min	**11**	**38**
Max	**17**	**56**

Table 9. Projected 2016 Gulf of Mexico recreational red snapper season lengths, if there were no sector separation, for various projection scenarios, assuming inconsistent seasons by Gulf states as summarized in Table 1.

Scenario	Federal Days
2015	16
2014	16
2013	17
2014-2015	16
2013-2015	16
Regression	12
Regression (drop 2014)	16
Regression (EW scaleHBC)	14
Regression (East West)	14
Regression (East West drop 2014)	15
Mean	15
SD	1
Median	16
Mode	16
Min	12
Max	17

Note: Assumes 3→9 nmi boundary change will increase AL, MS, and LA state season catch rates by 10%.

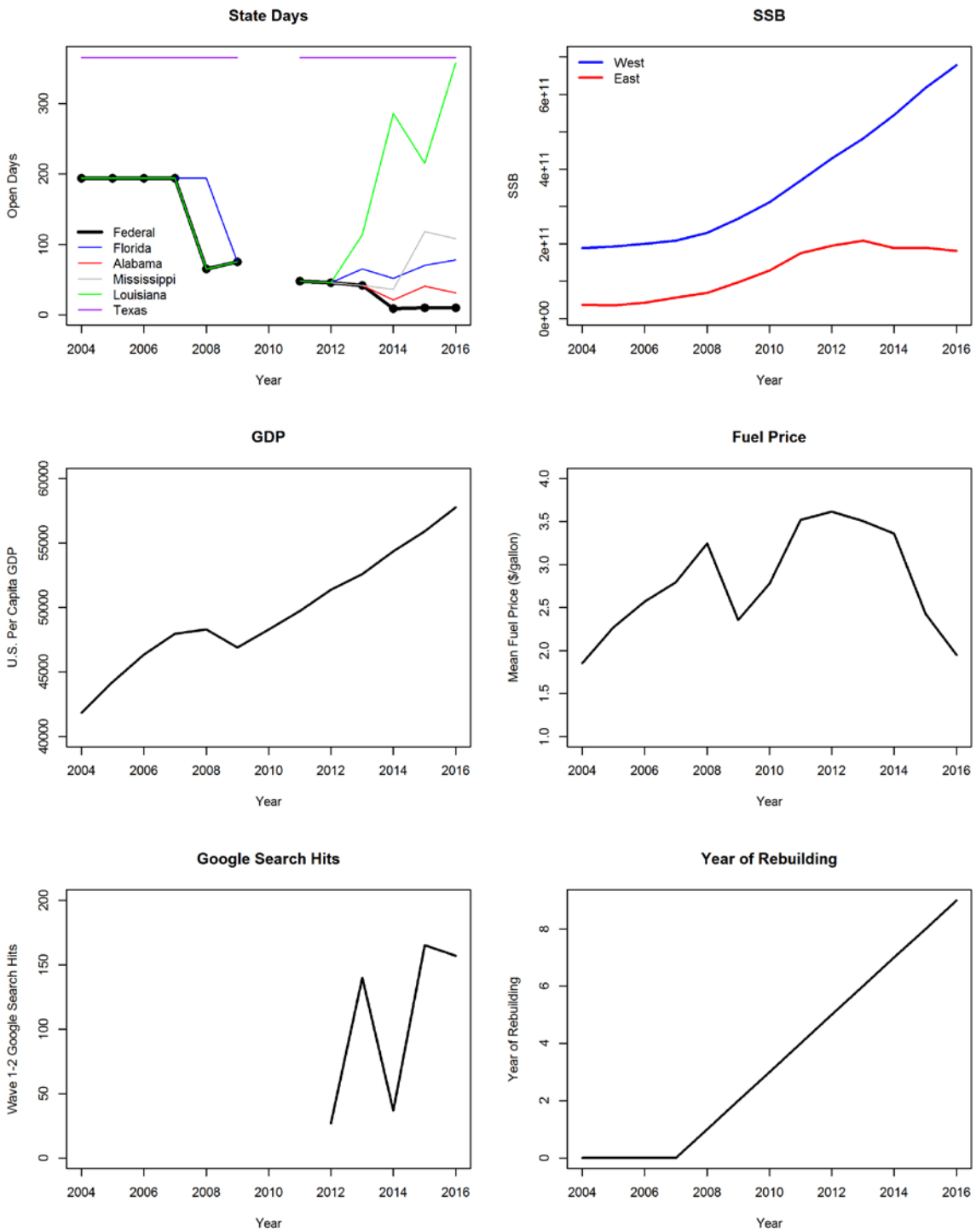

Figure 1. *Projection covariates.* State season lengths compared to federal season ("State Days"; 2010 excluded), spawning stock biomass (SSB) estimates, in billions of eggs, from SEDAR-31 Update (2014) stock assessment model for Eastern (red) and Western (blue) Gulf of Mexico red snapper stock, U.S. Gross Domestic Product (GDP), mean unleaded fuel price, Google search hits for "red snapper season" from Jan-Mar 2004-2016, and year of rebuilding.

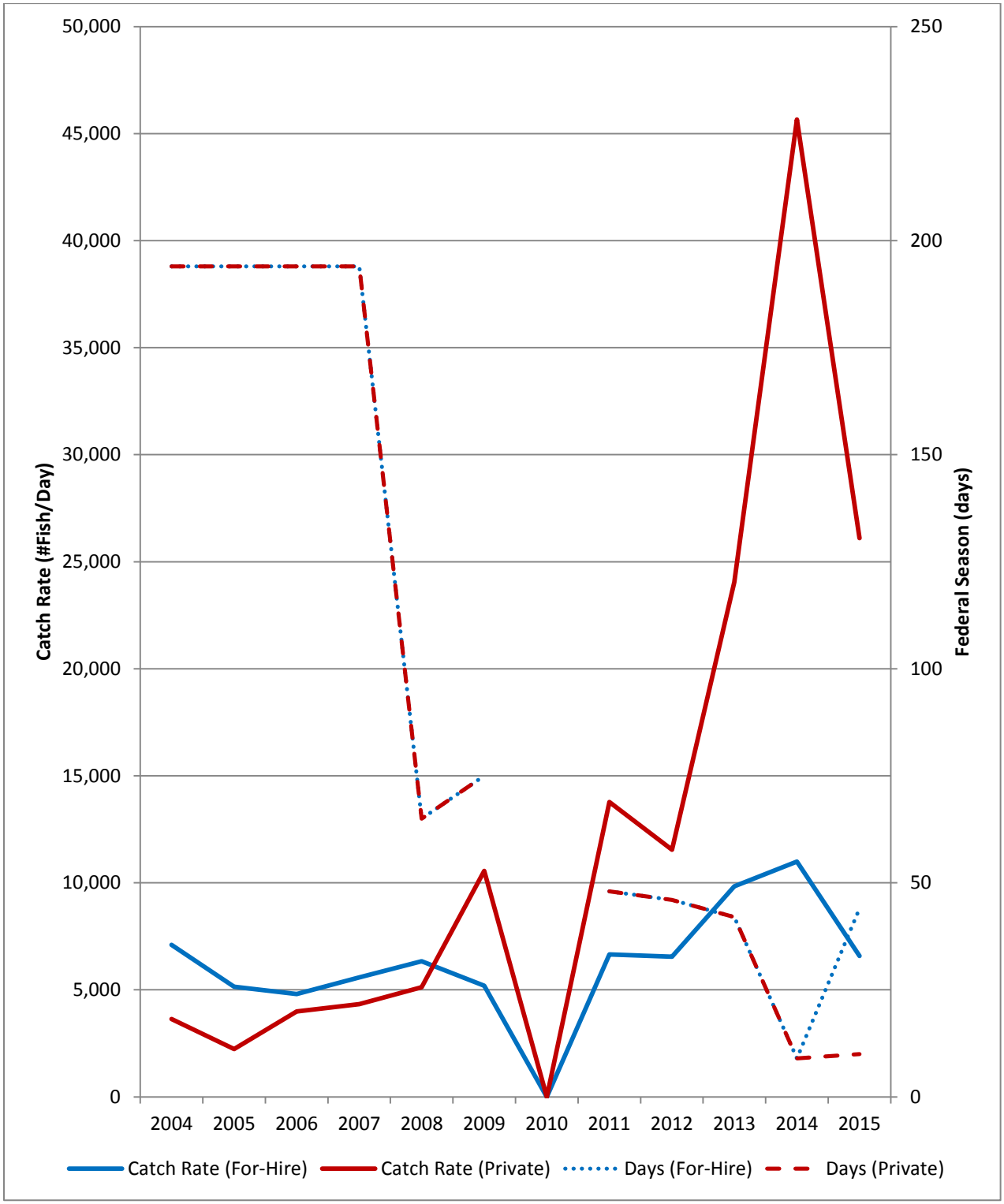

Figure 2. *Effort compression.* Reductions in federal season length (dashed lines) and corresponding increases in daily catch rates (solid lines).

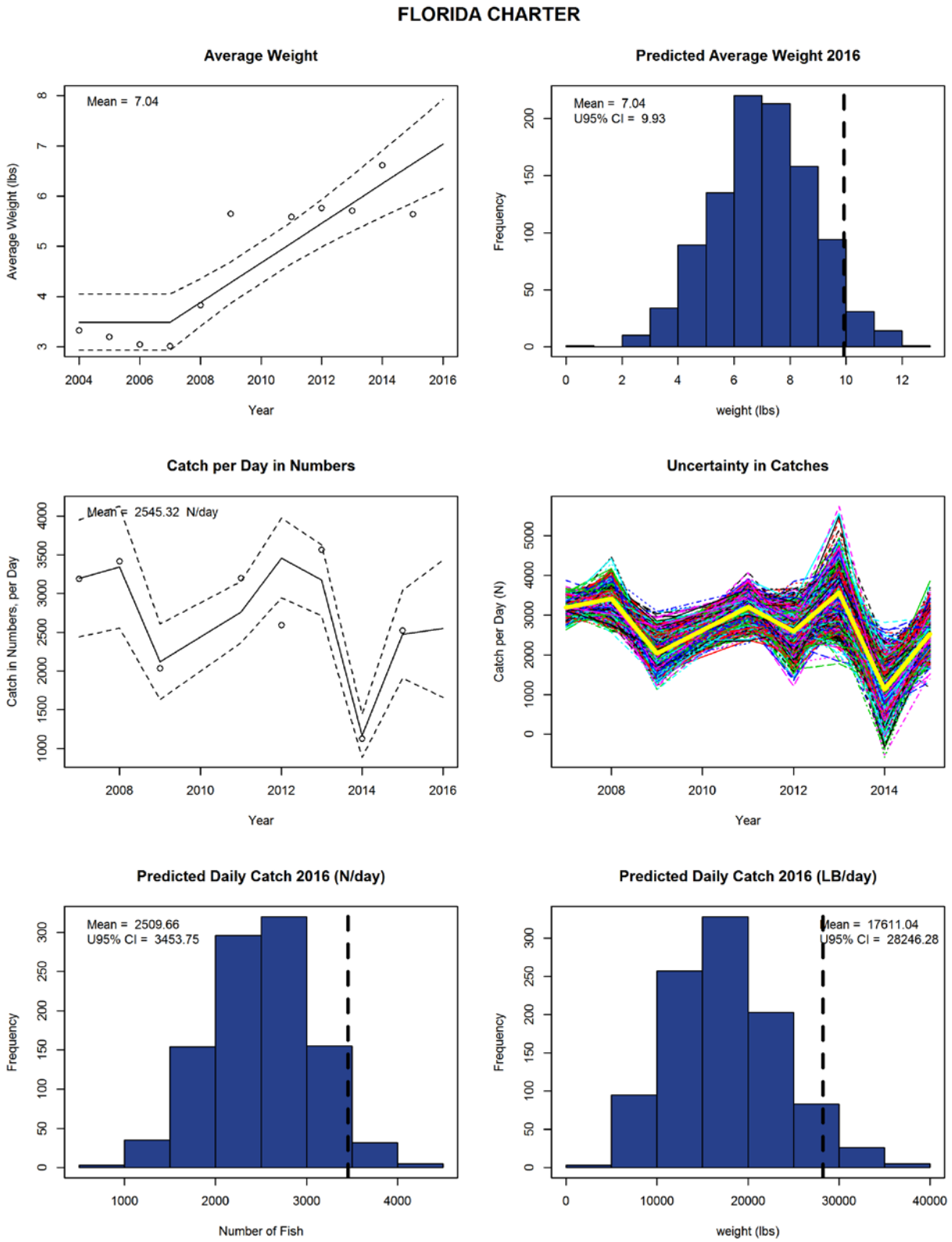

Figure 3A. Forecast for Florida charter average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

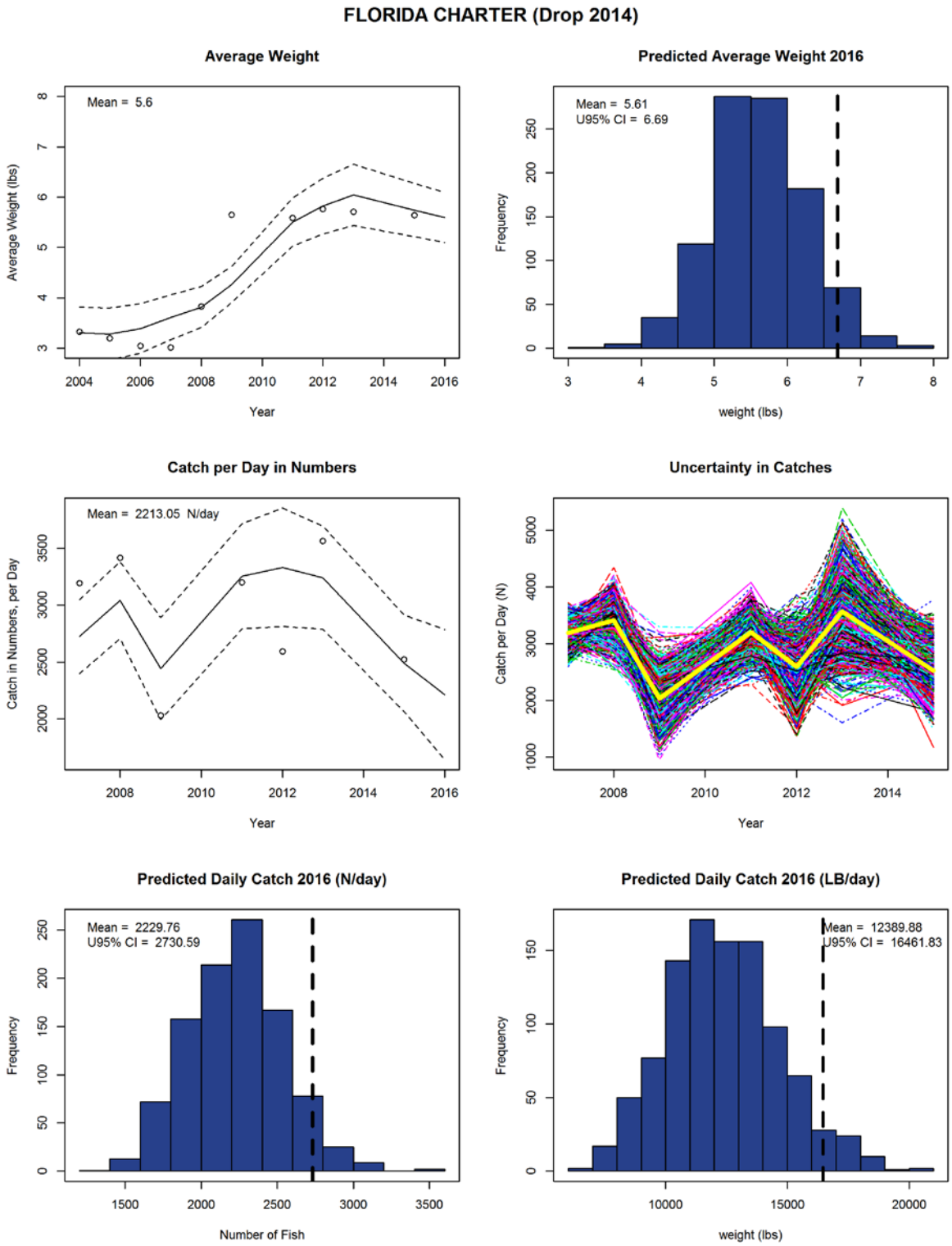

Figure 3B. Forecast for Florida charter average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

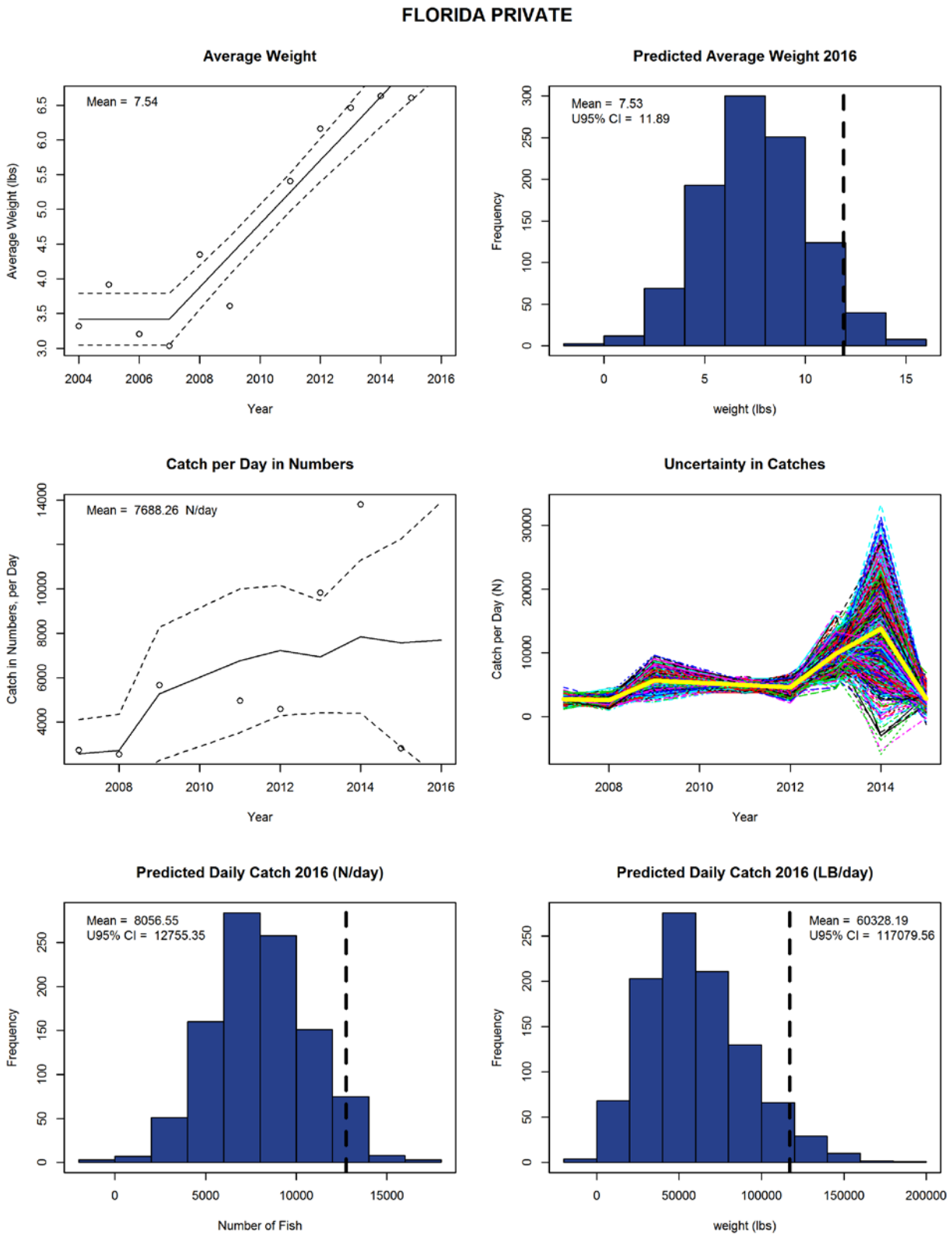

Figure 3C. Forecast for Florida private angler mode average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

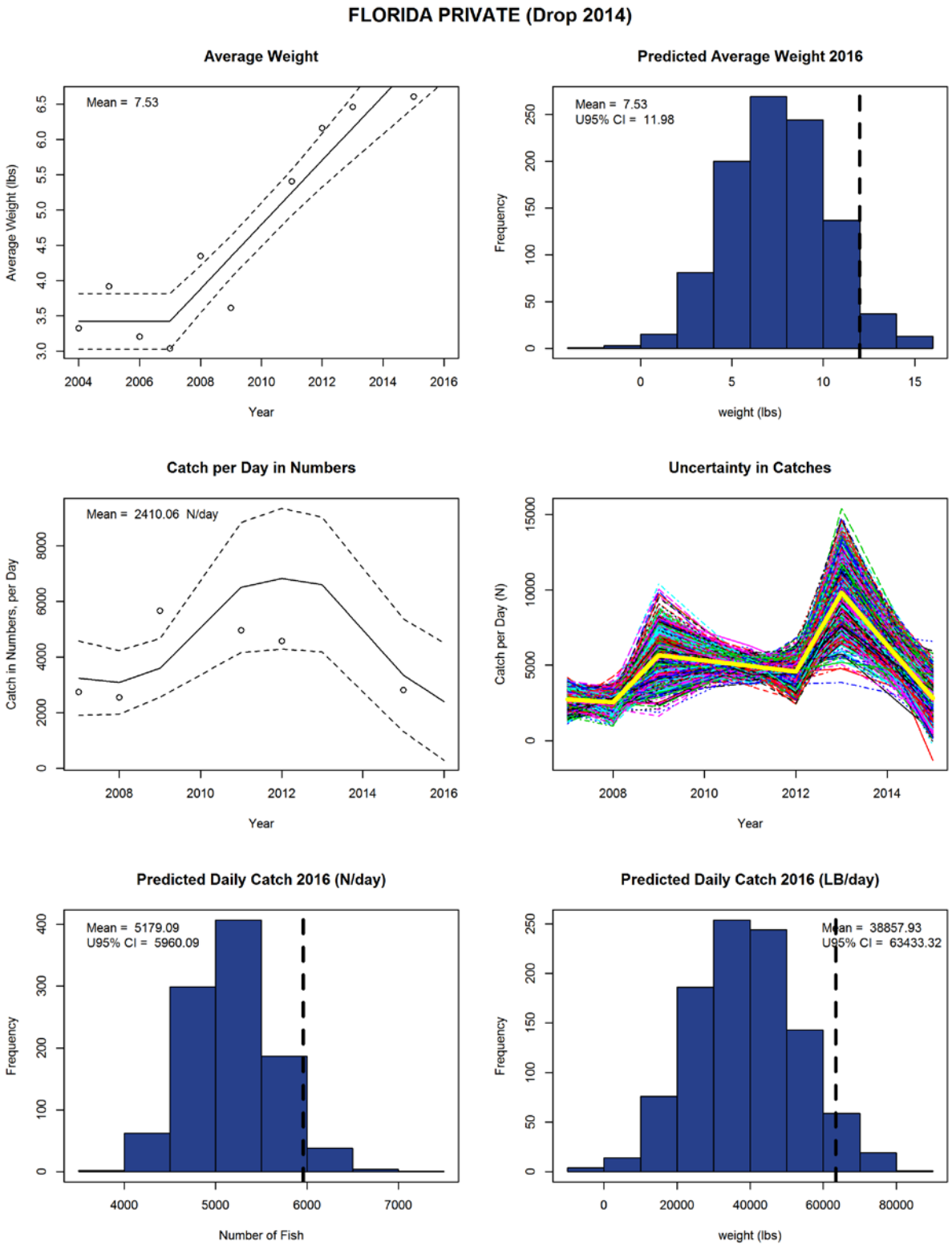

Figure 3D. Forecast for Florida private angler mode average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

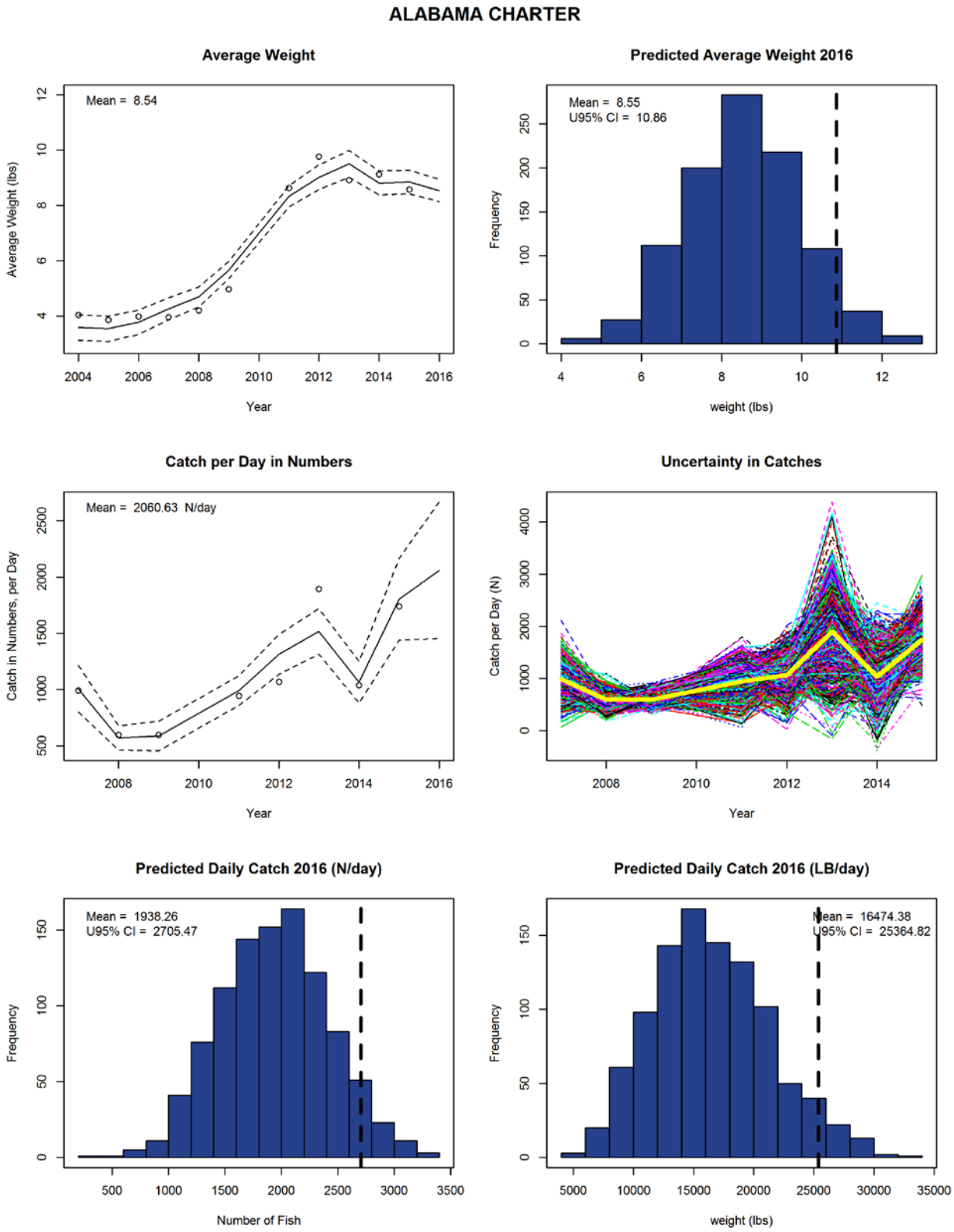

Figure 4A. Forecast for Alabama charter average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

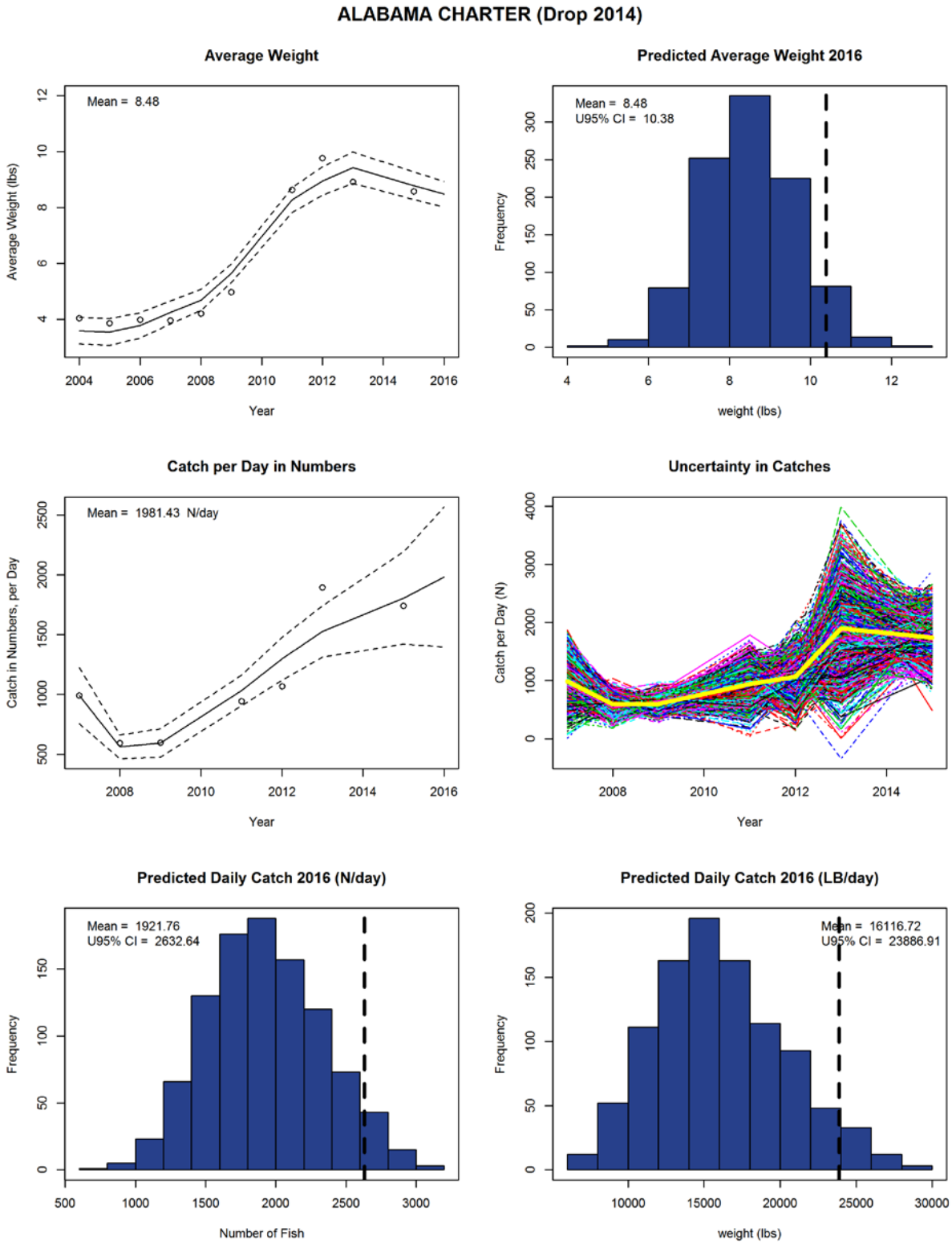

Figure 4B. Forecast for Alabama charter average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

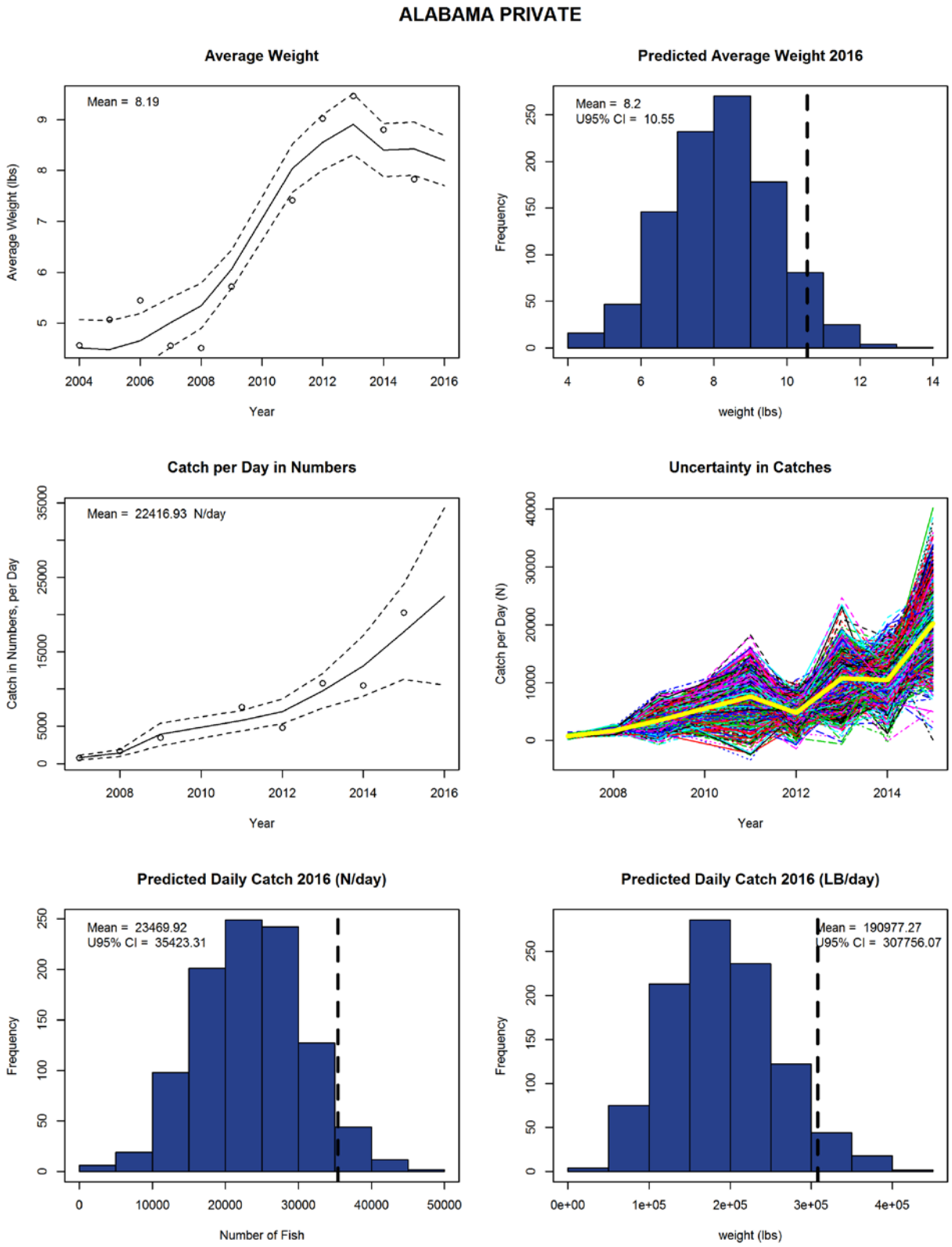

Figure 4C. Forecast for Alabama private angler mode average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

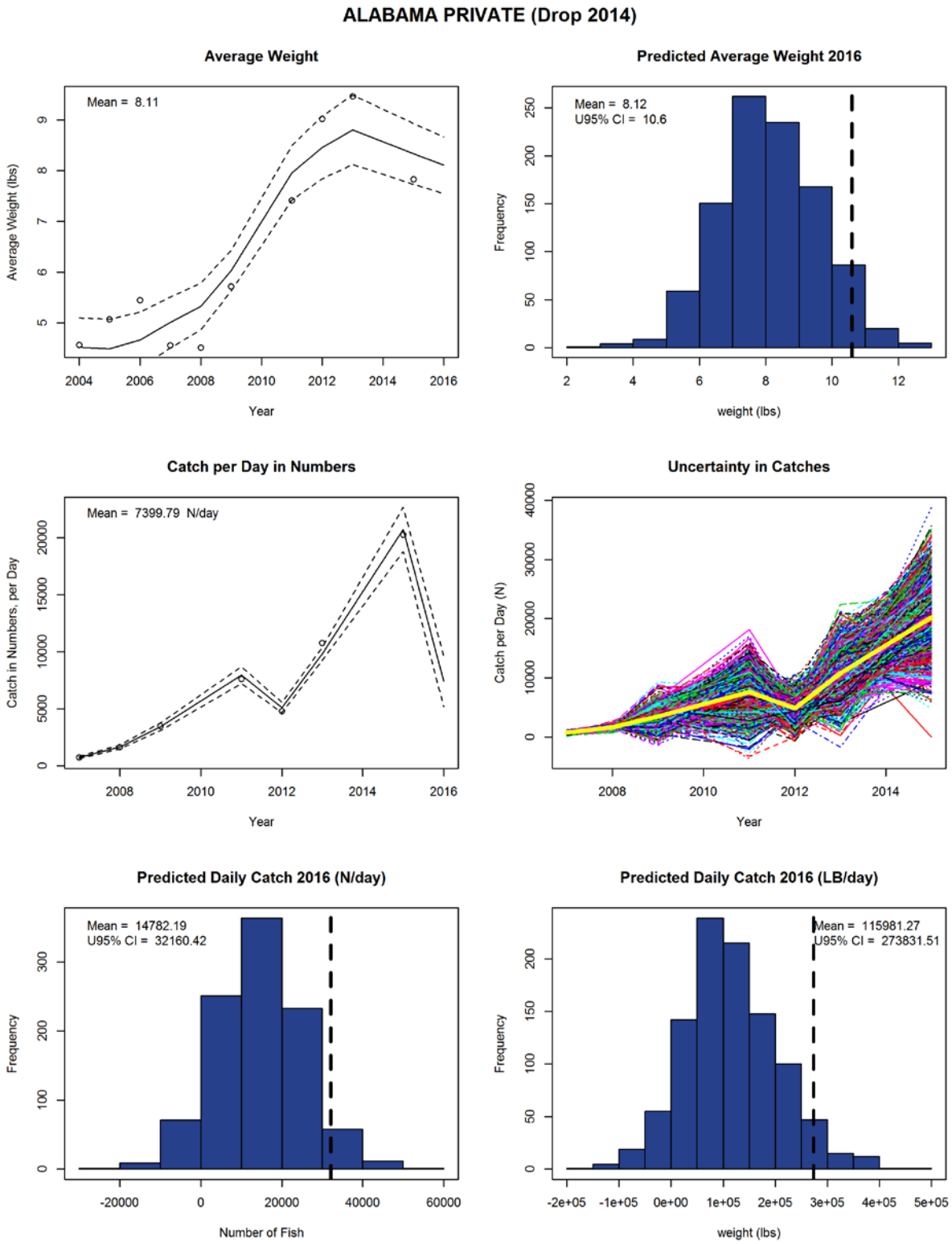

Figure 4D. Forecast for Alabama private angler mode average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

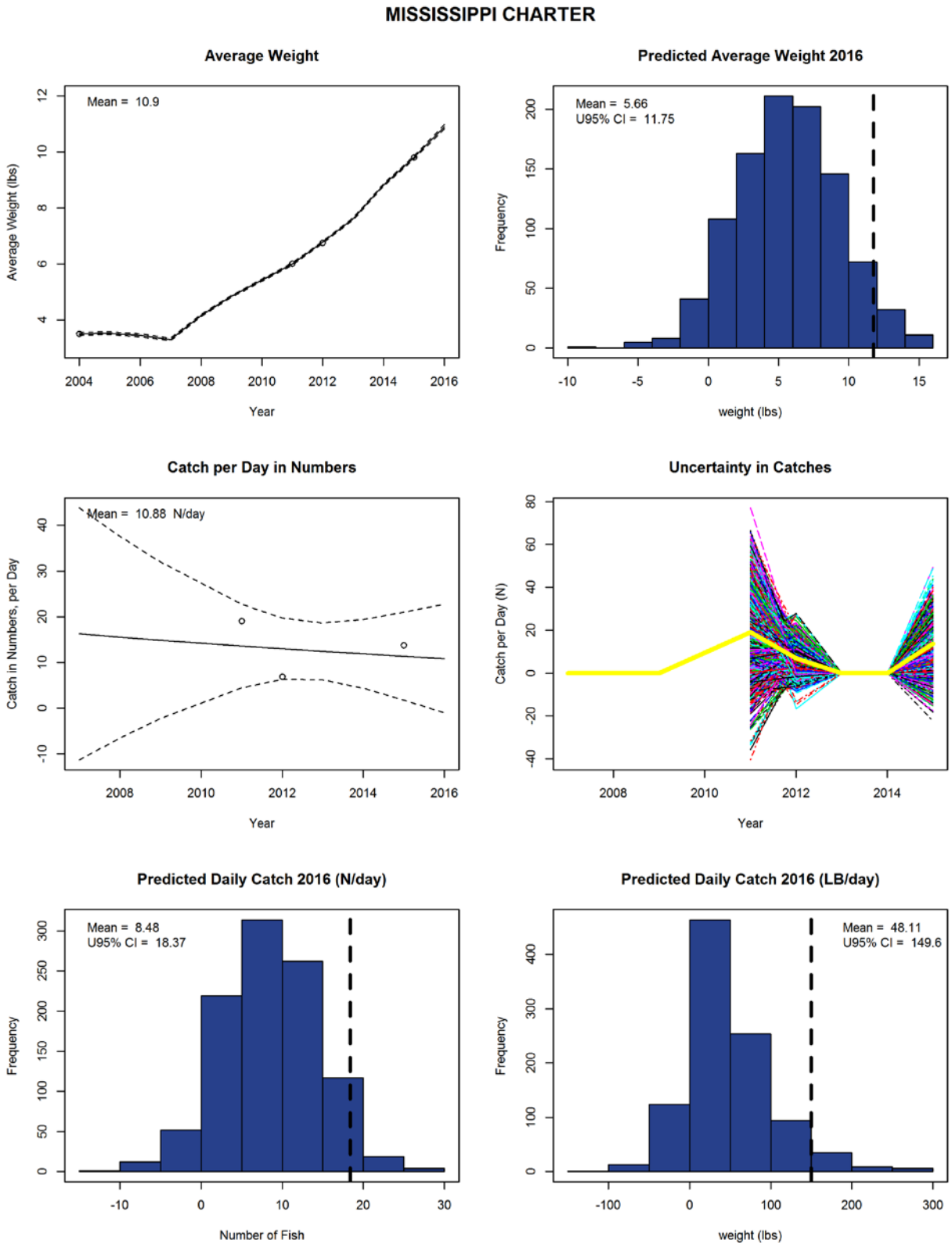

Figure 5A. Forecast for Mississippi charter average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

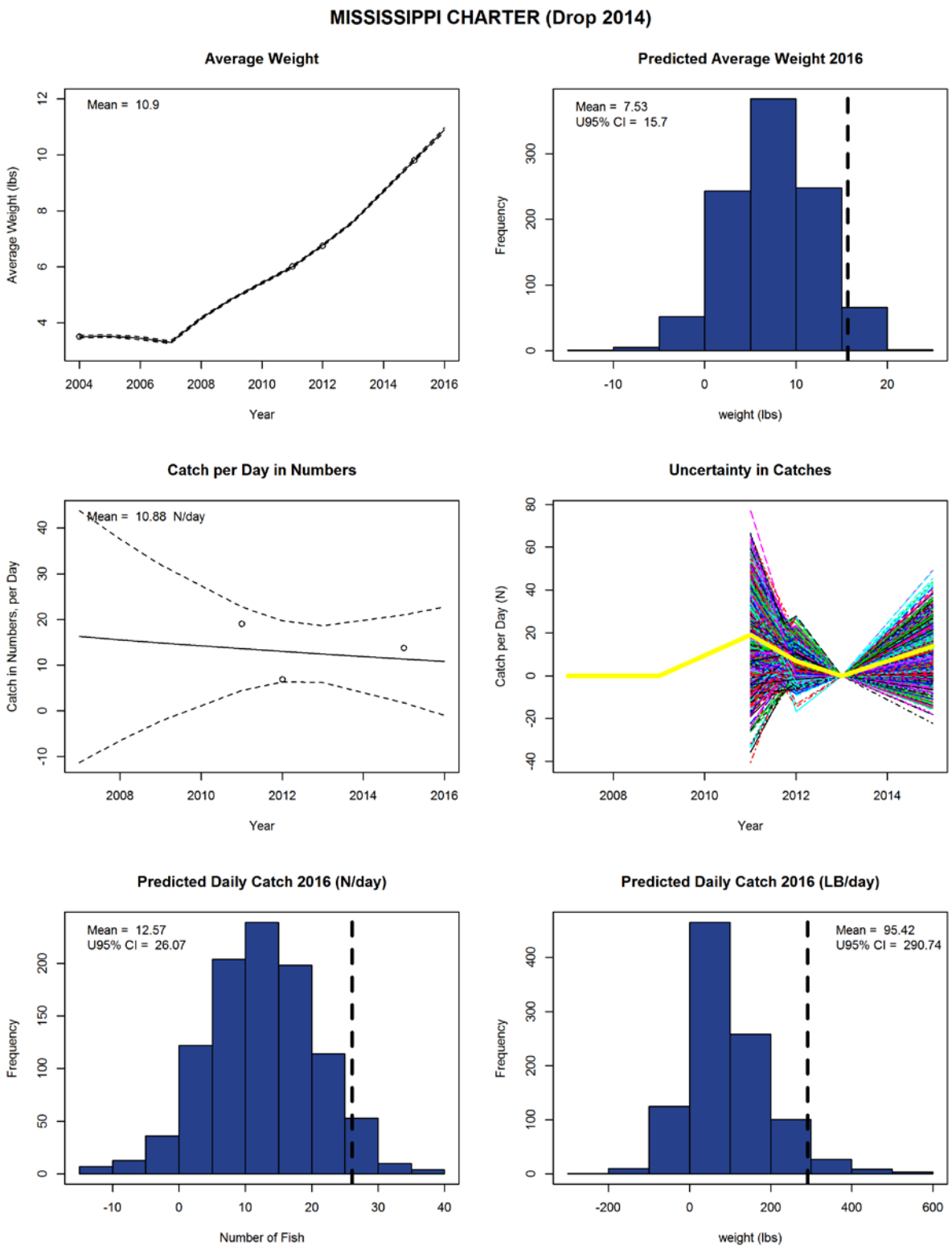

Figure 5B. Forecast for Mississippi charter average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

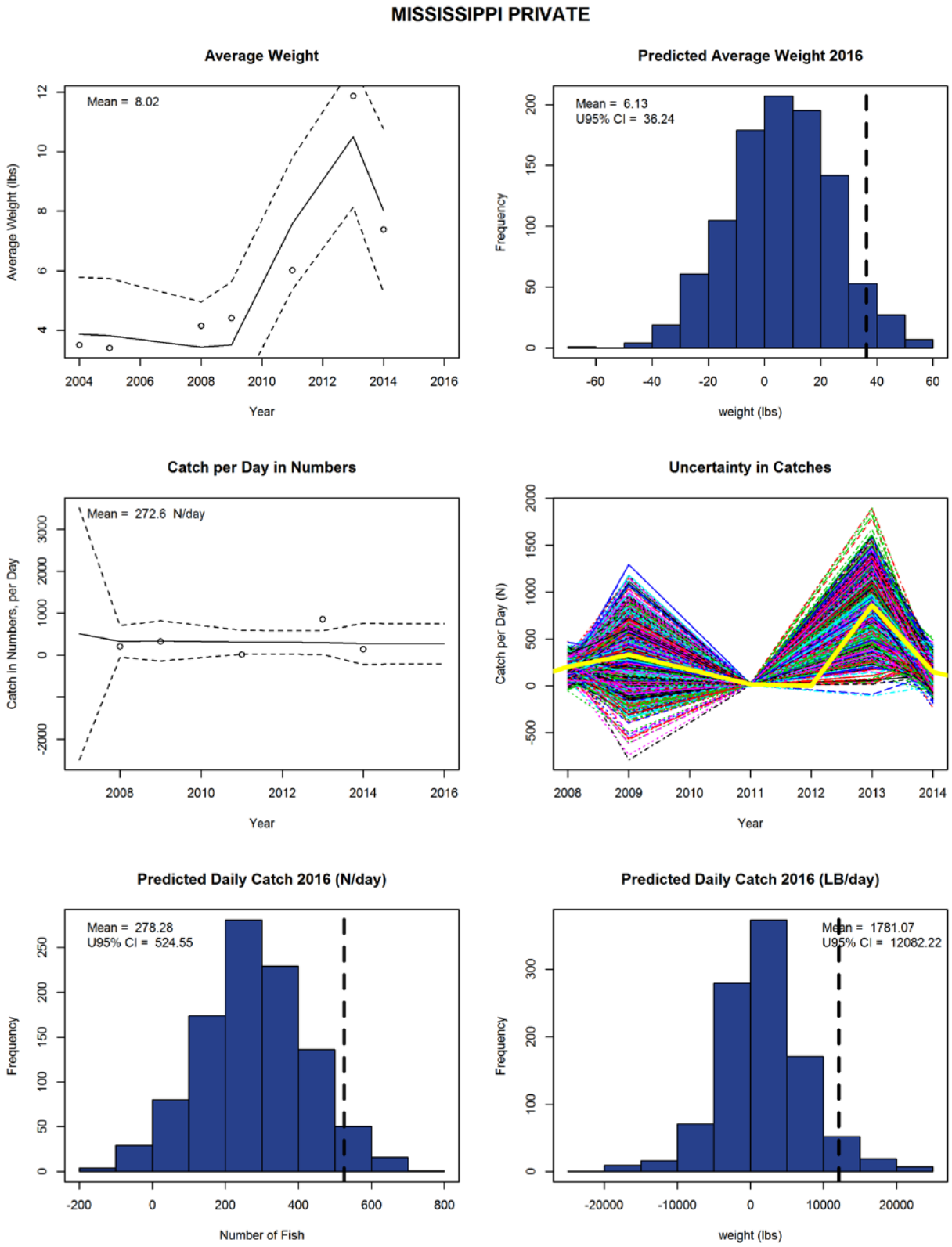

Figure 5C. Forecast for Mississippi private angler mode average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

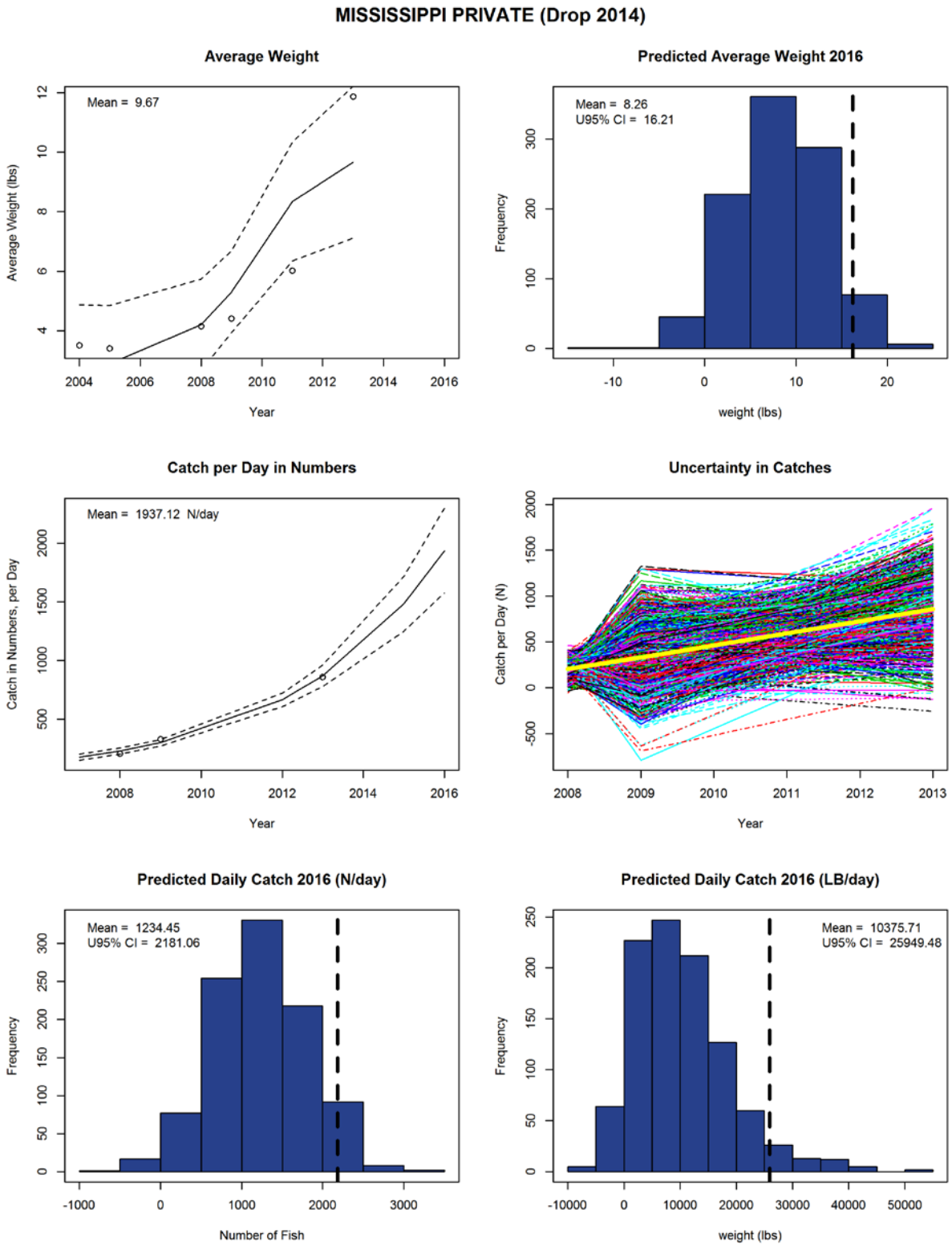

Figure 5D. Forecast for Mississippi private angler mode average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

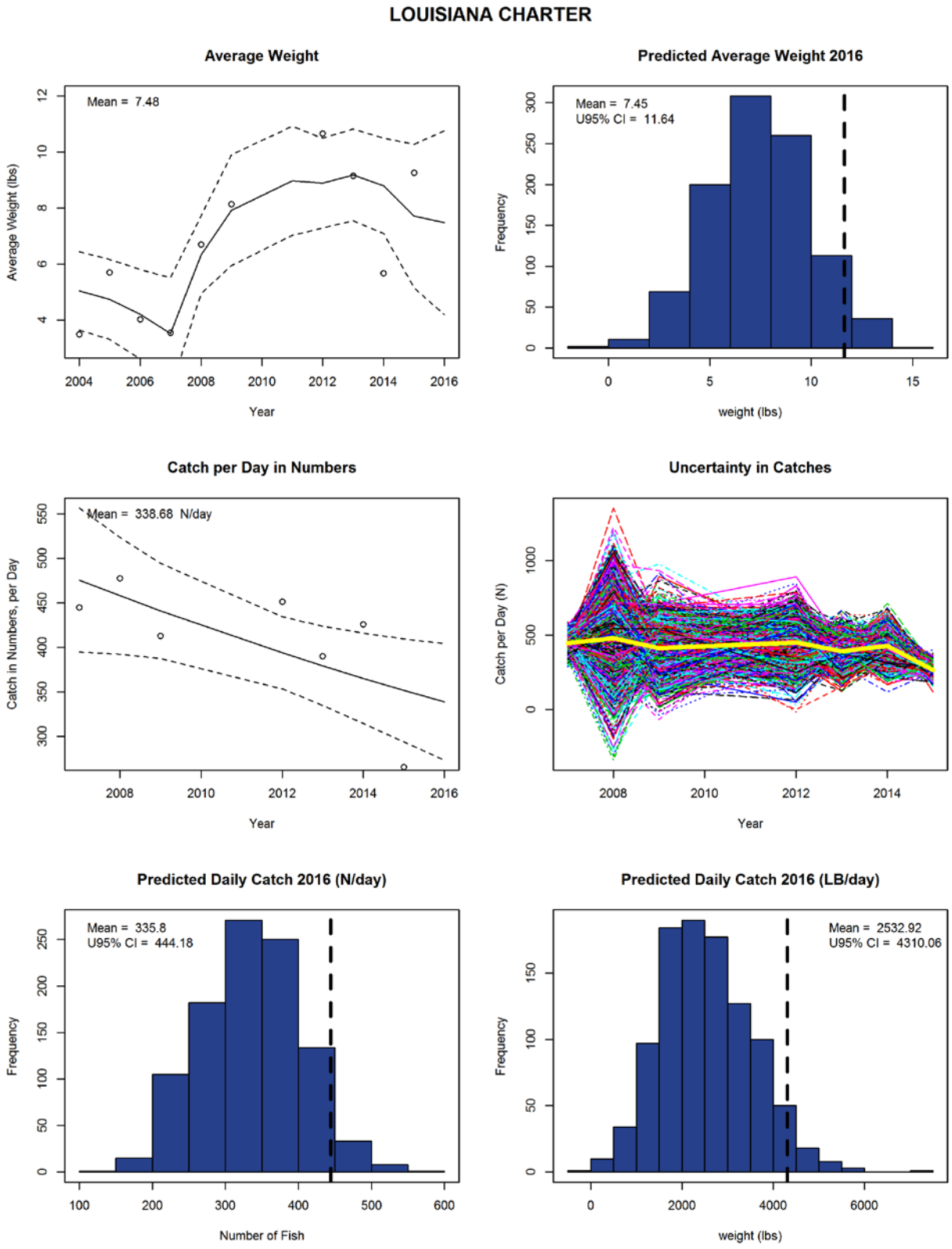

Figure 6A. Forecast for Louisiana charter average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

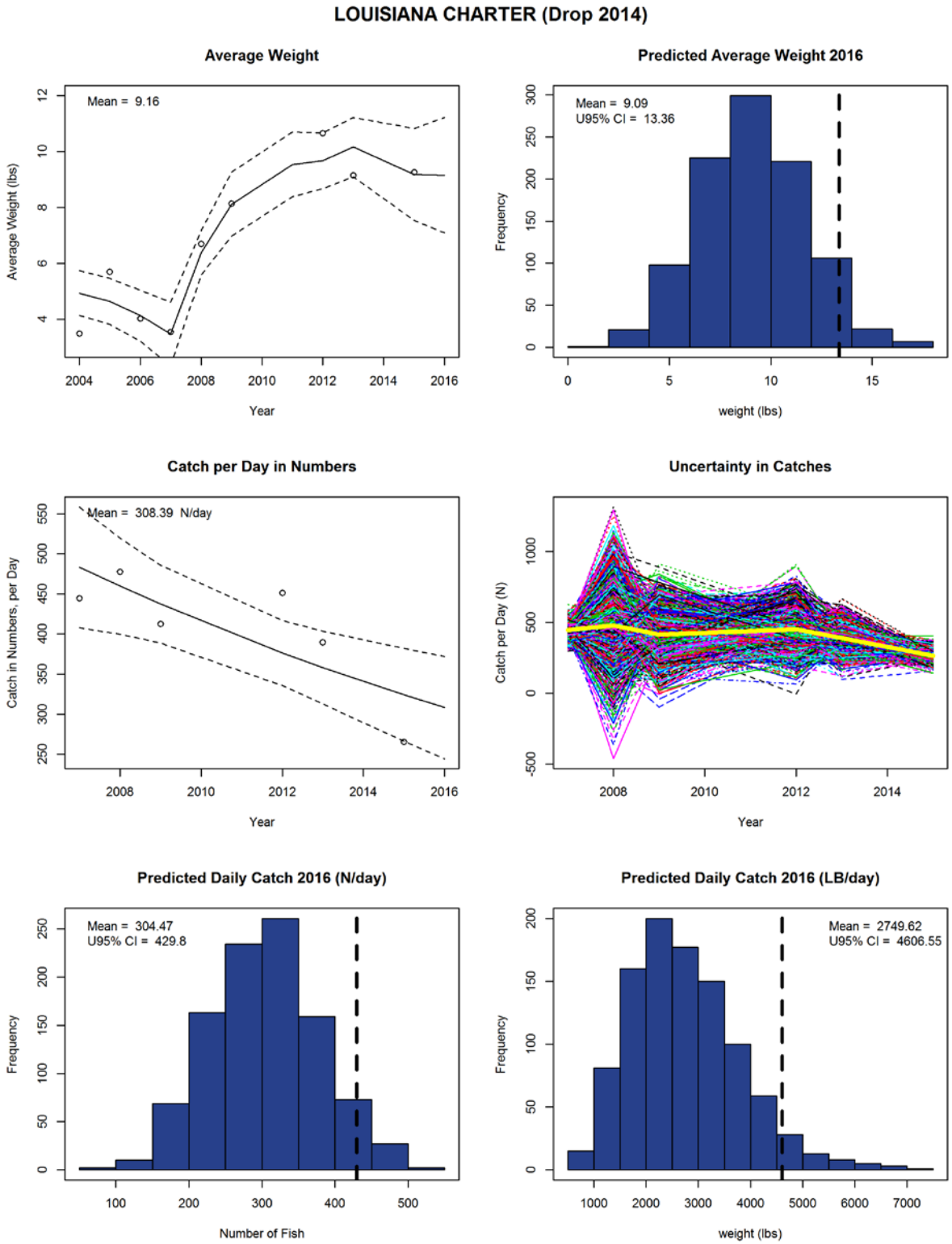

Figure 6B. Forecast for Louisiana charter average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

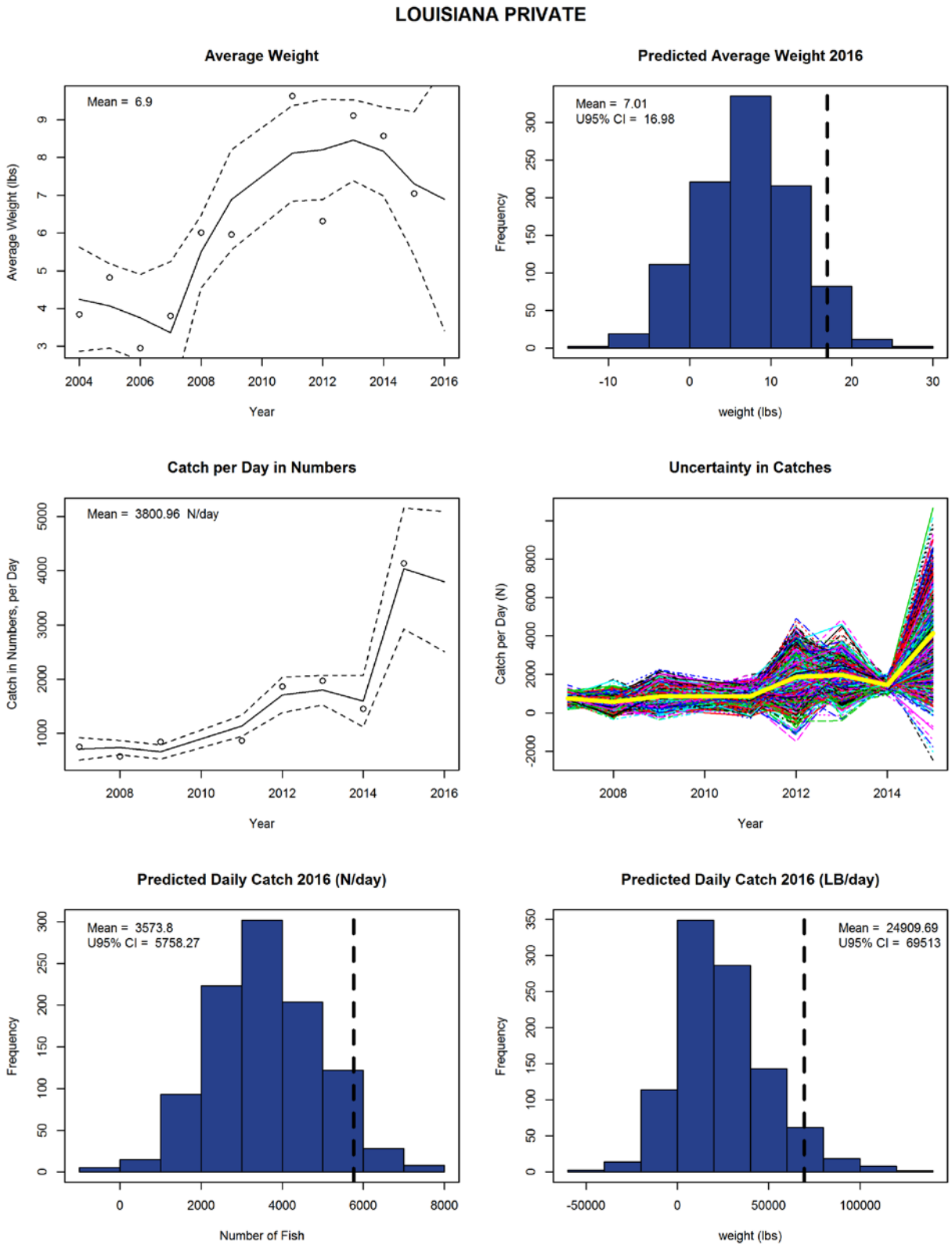

Figure 6C. Forecast for Louisiana private angler mode average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

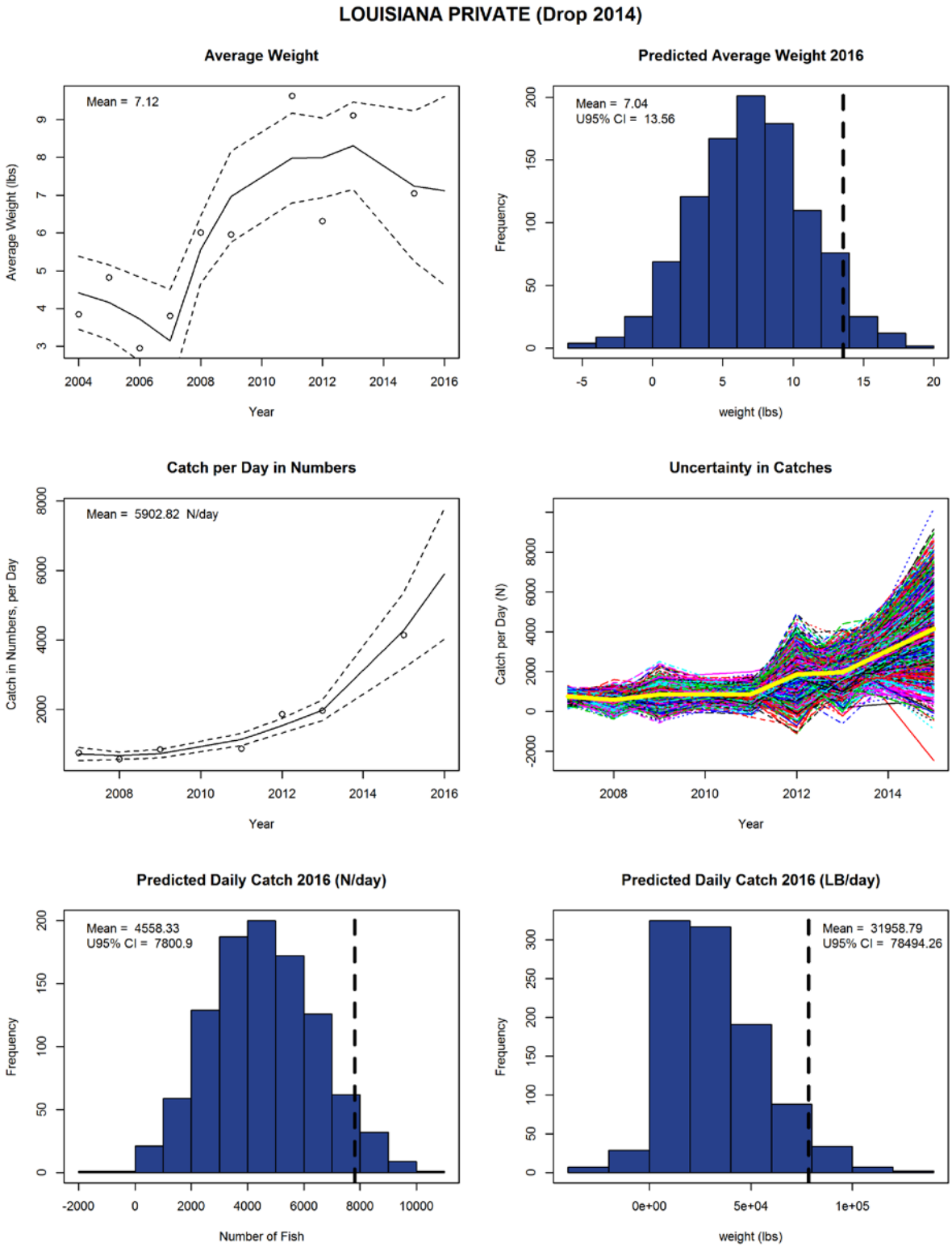

Figure 6D. Forecast for Louisiana private angler mode average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

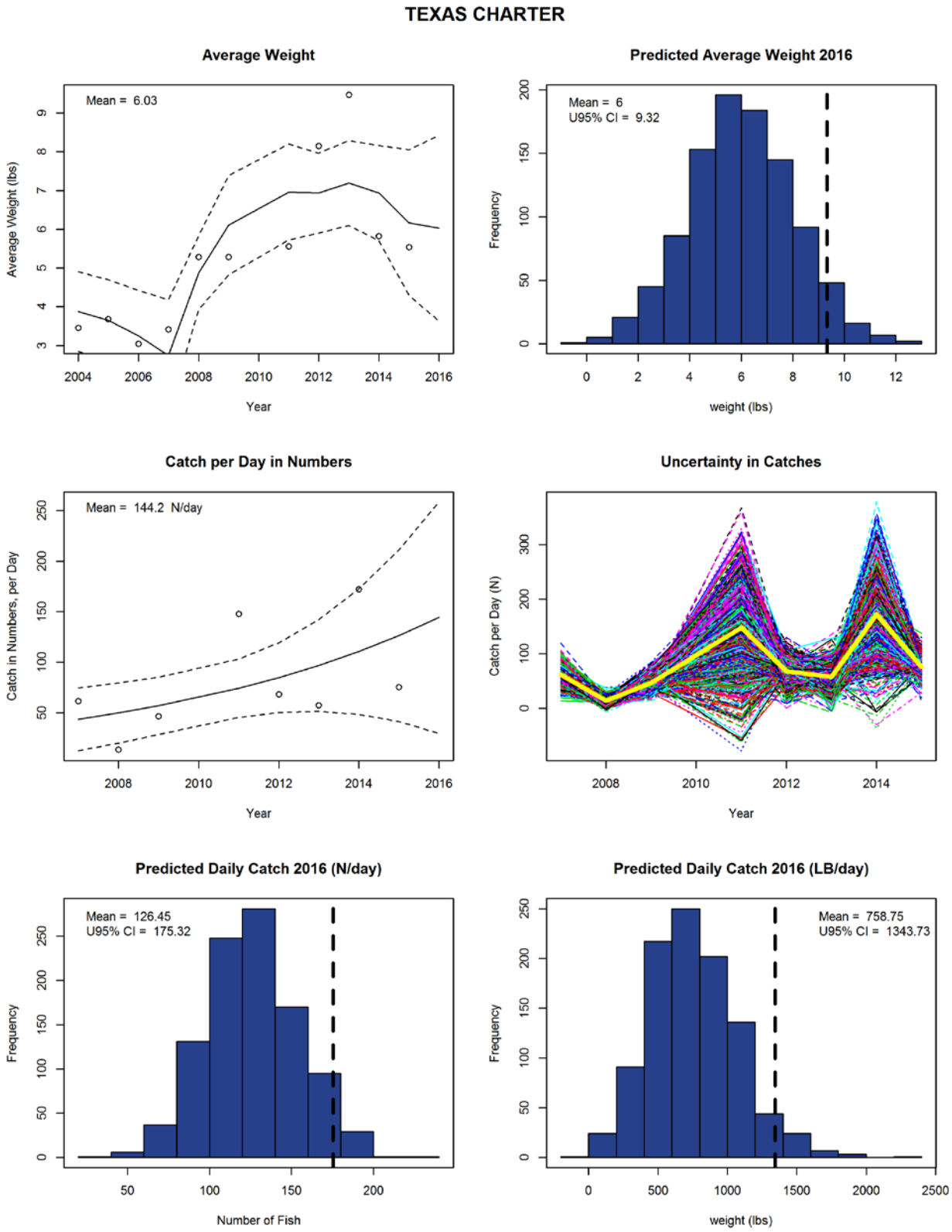

Figure 7A. Forecast for Texas charter average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

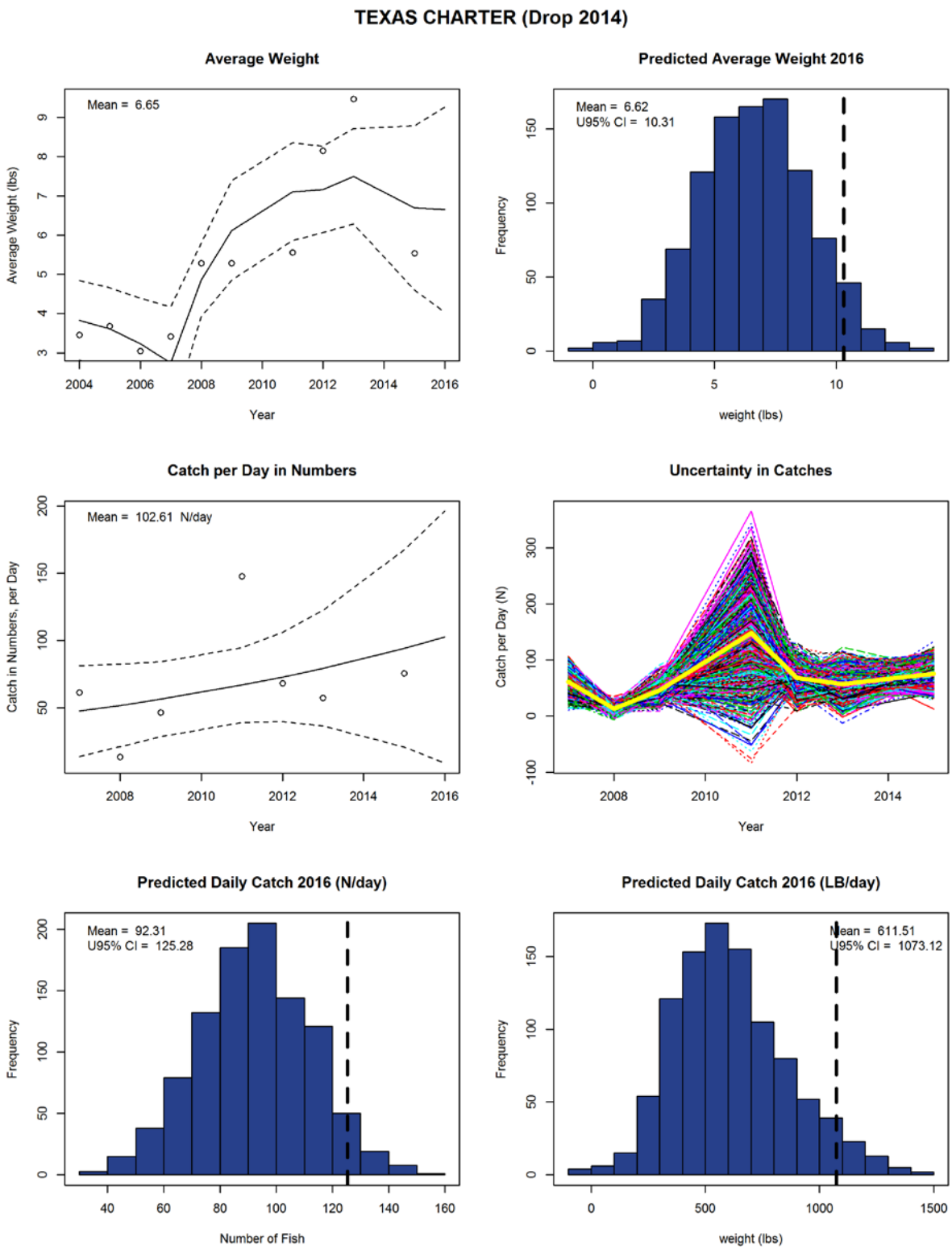

Figure 7B. Forecast for Texas charter average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

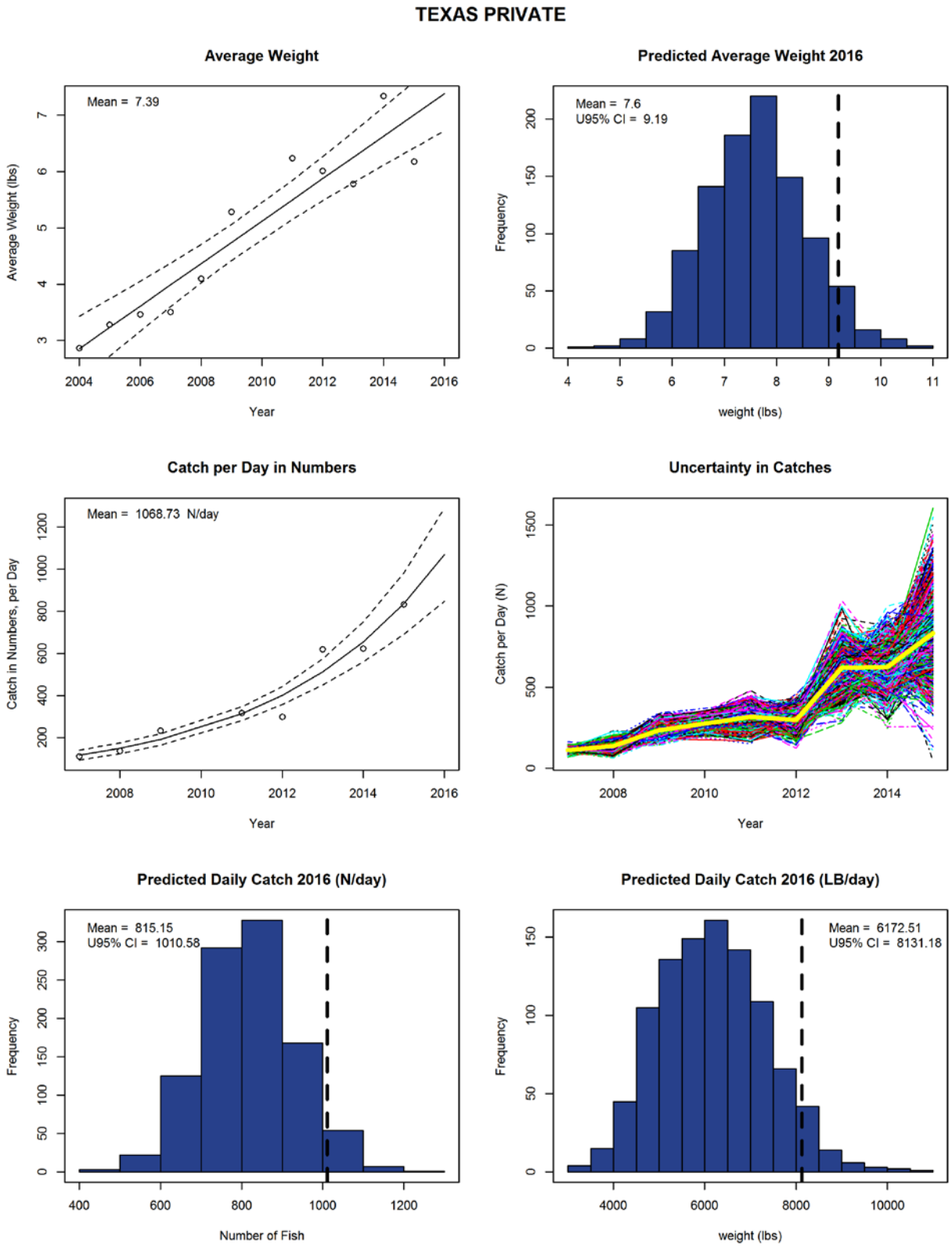

Figure 7C. Forecast for Texas private angler mode average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

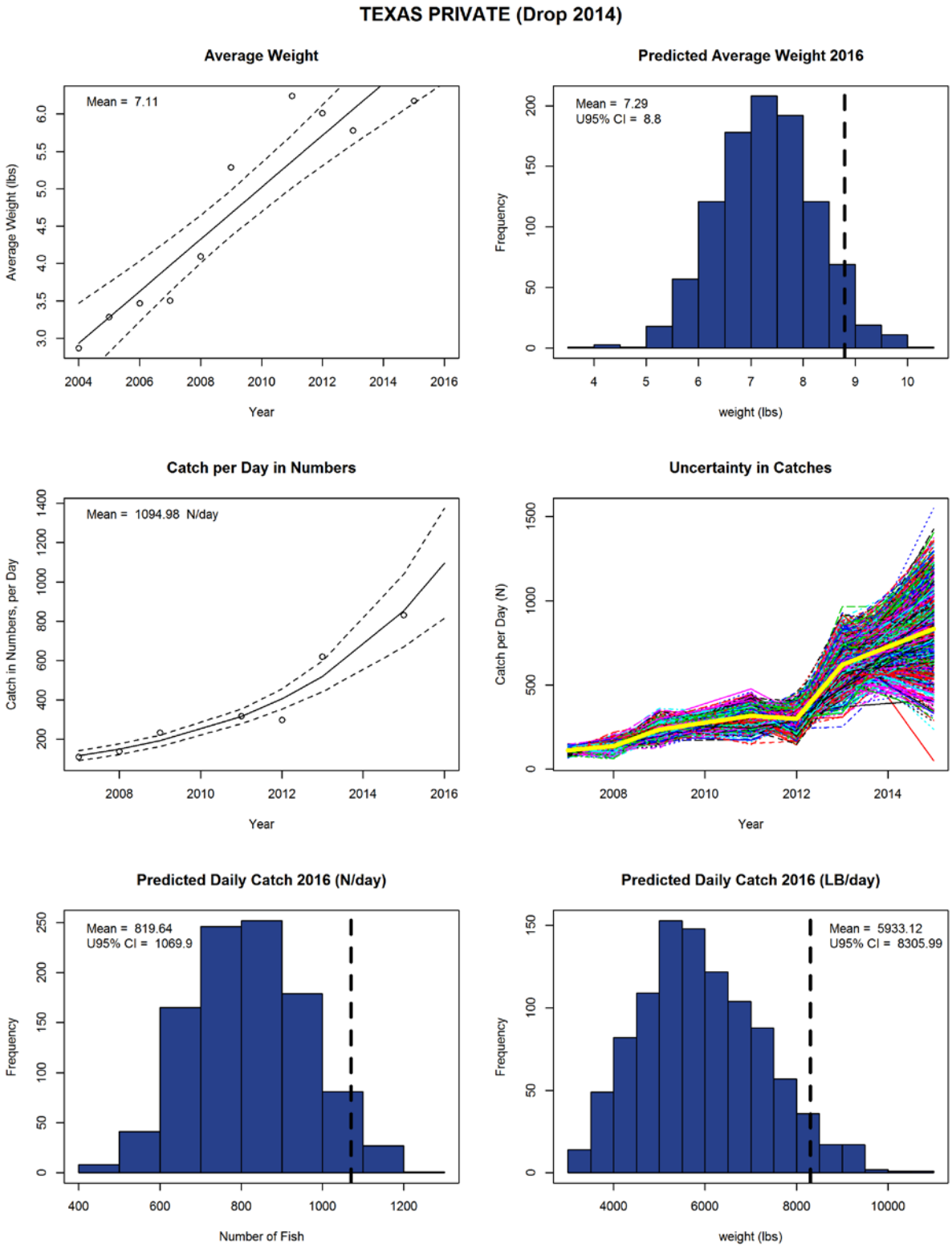

Figure 7D. Forecast for Texas private angler mode average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

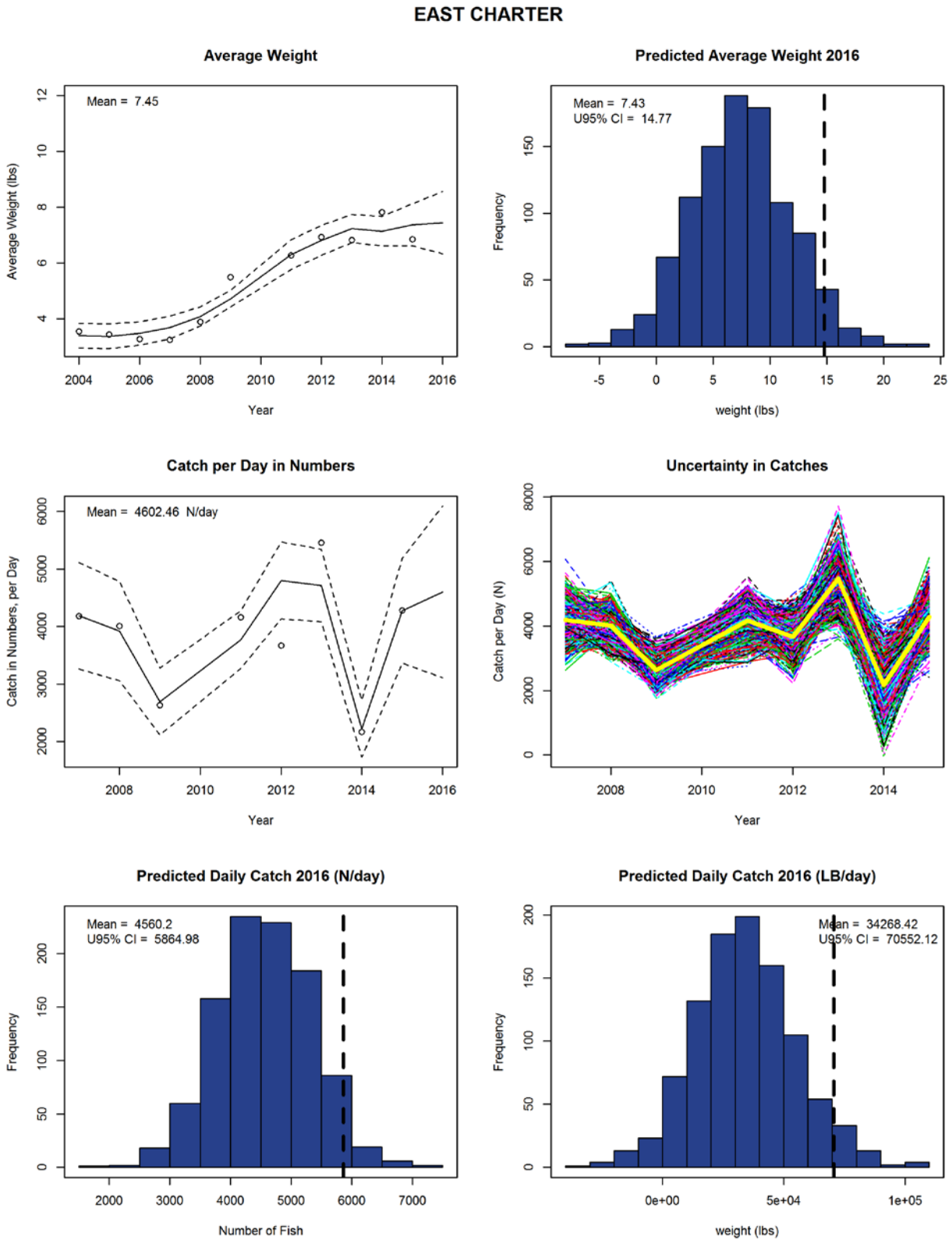

Figure 8A. Forecast for Eastern Gulf of Mexico charter average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

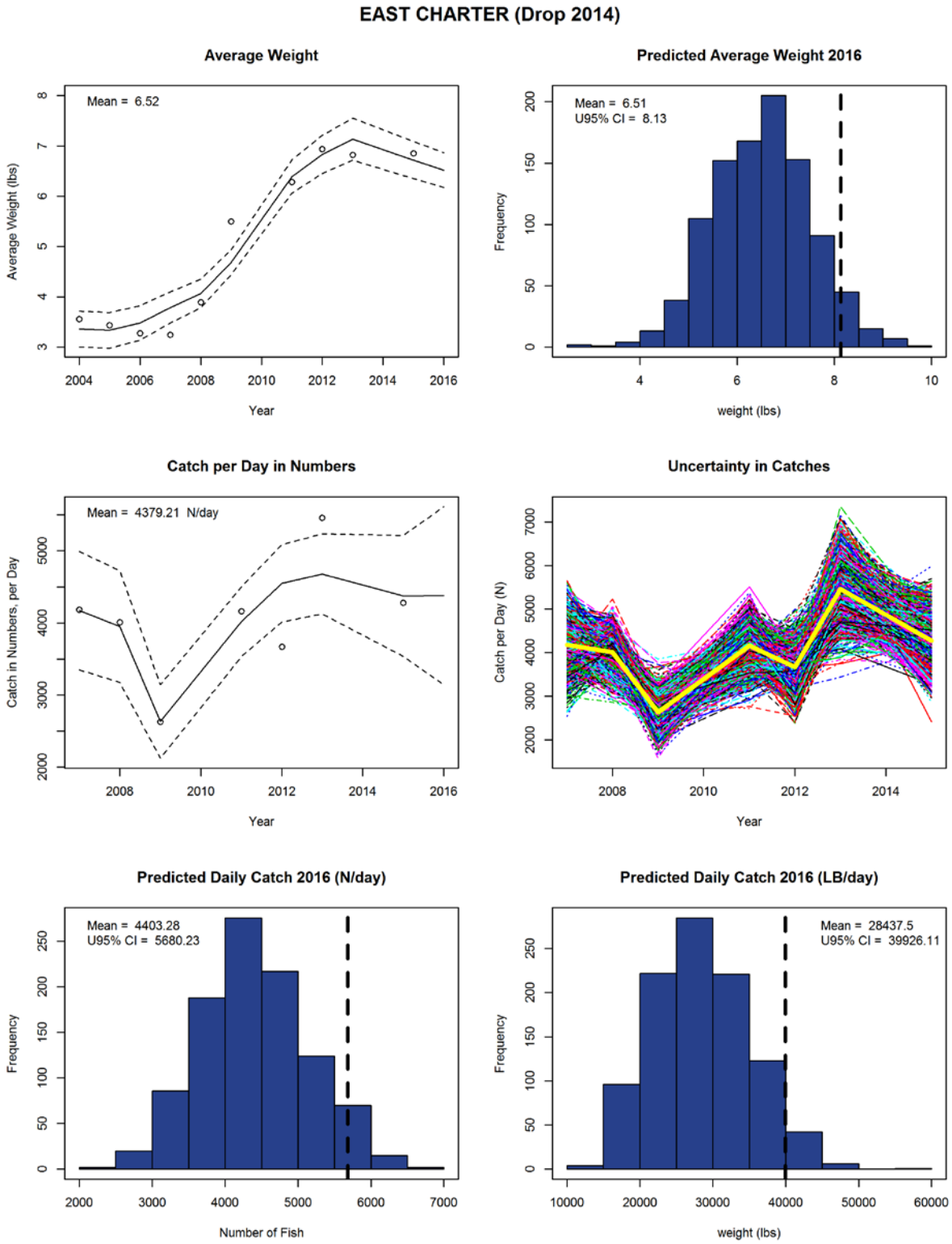

Figure 8B. Forecast for Eastern Gulf of Mexico charter average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

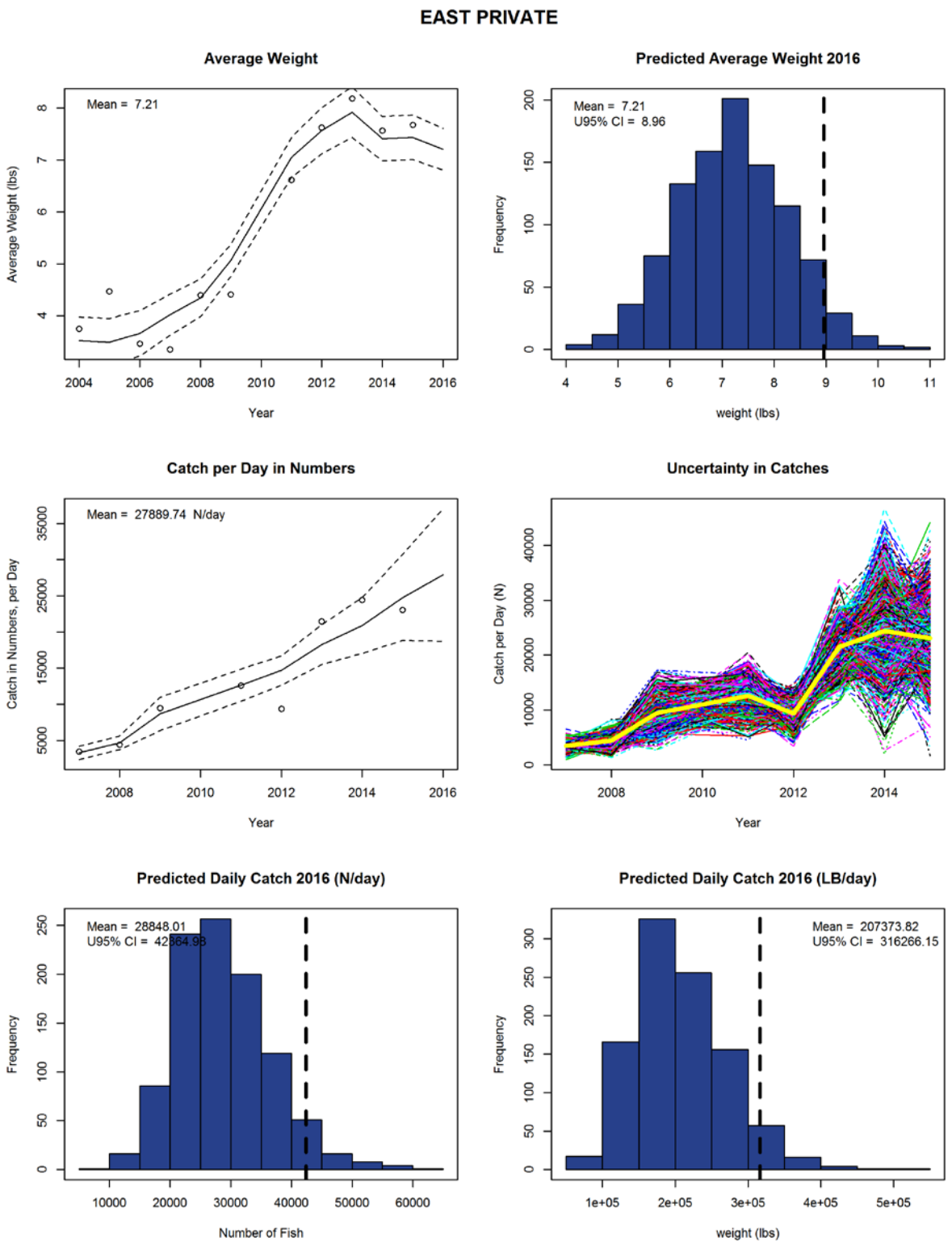

Figure 8C. Forecast for Eastern Gulf of Mexico private angler mode average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

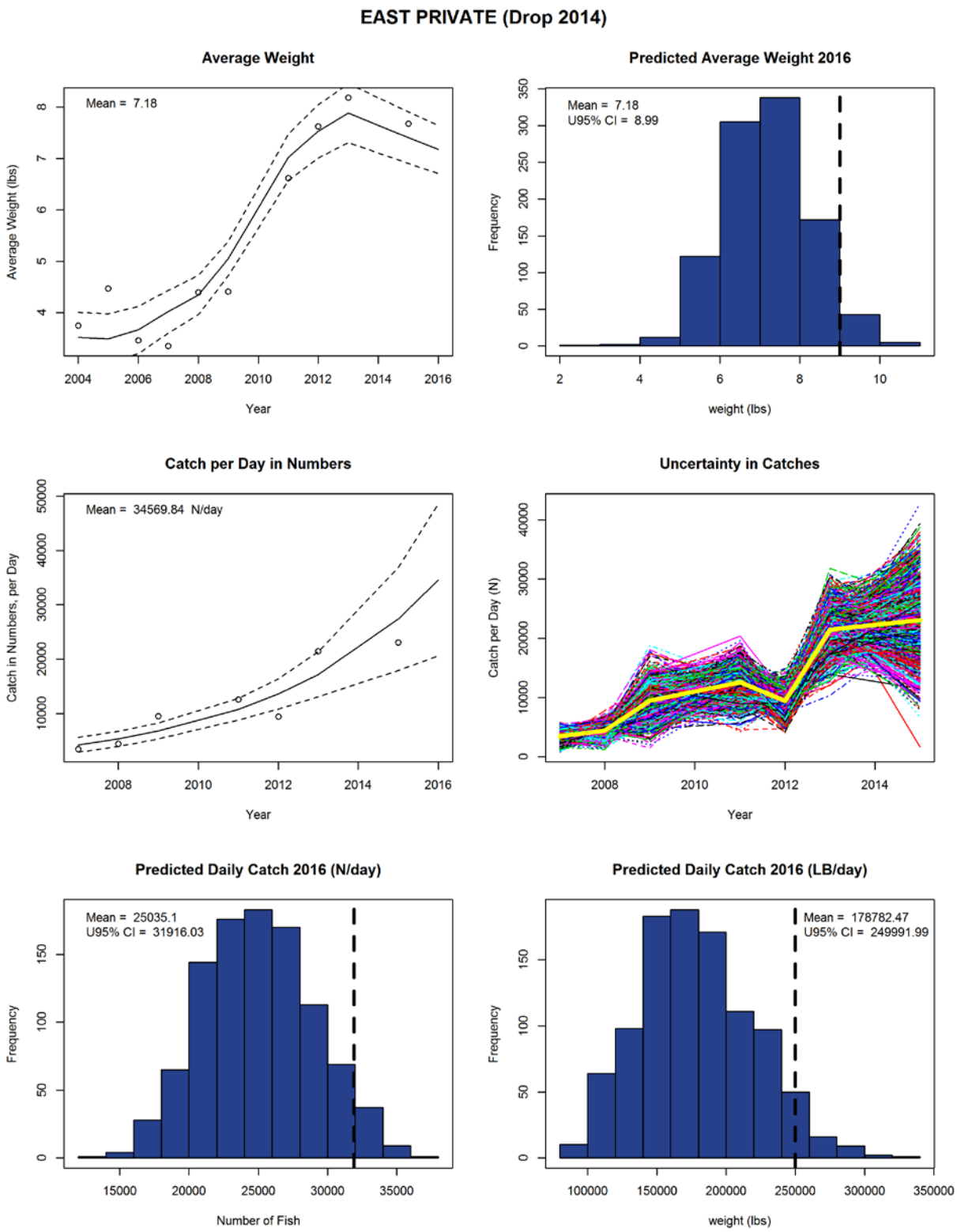

Figure 8D. Forecast for Eastern Gulf of Mexico private angler mode average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

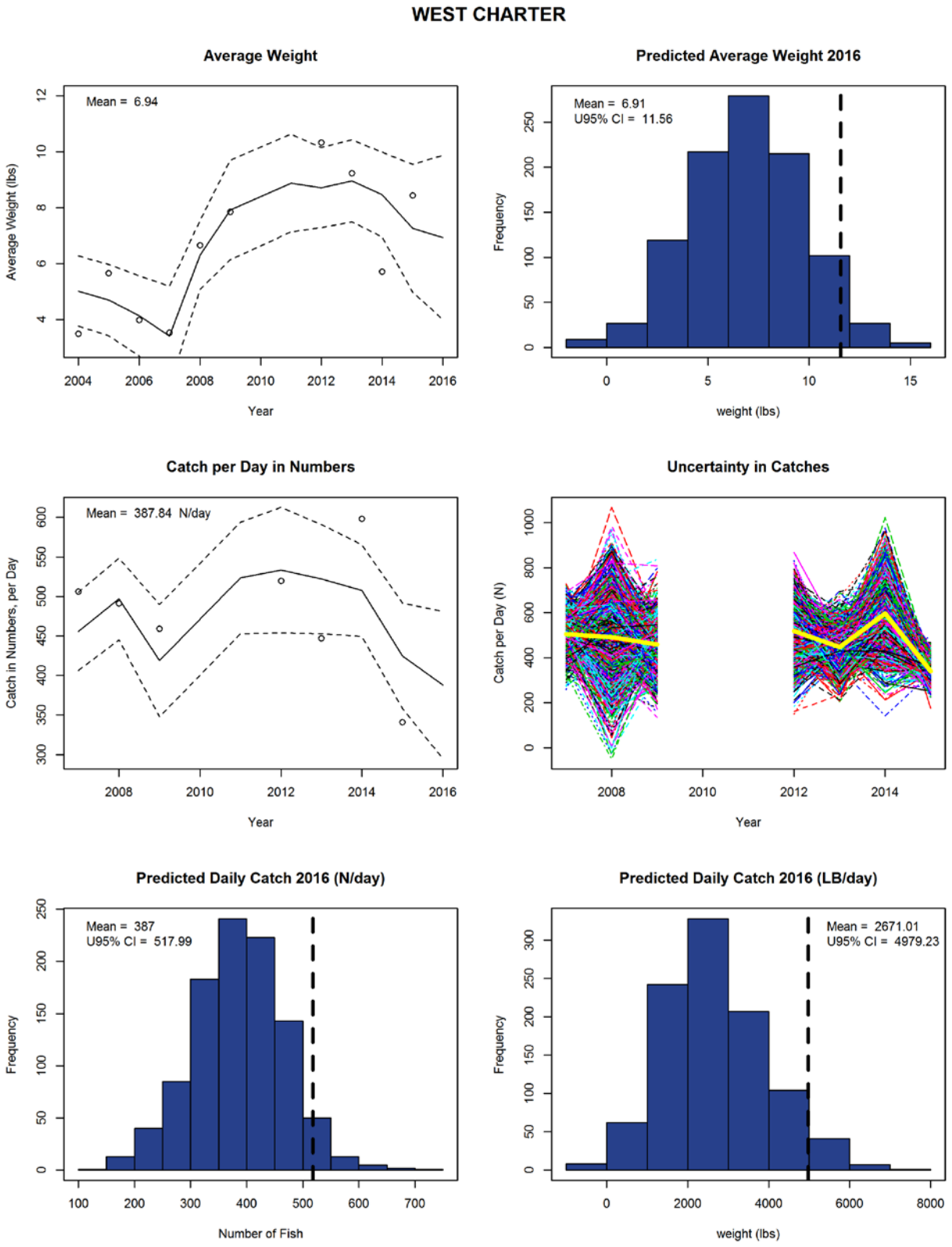

Figure 9A. Forecast for Western Gulf of Mexico charter average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

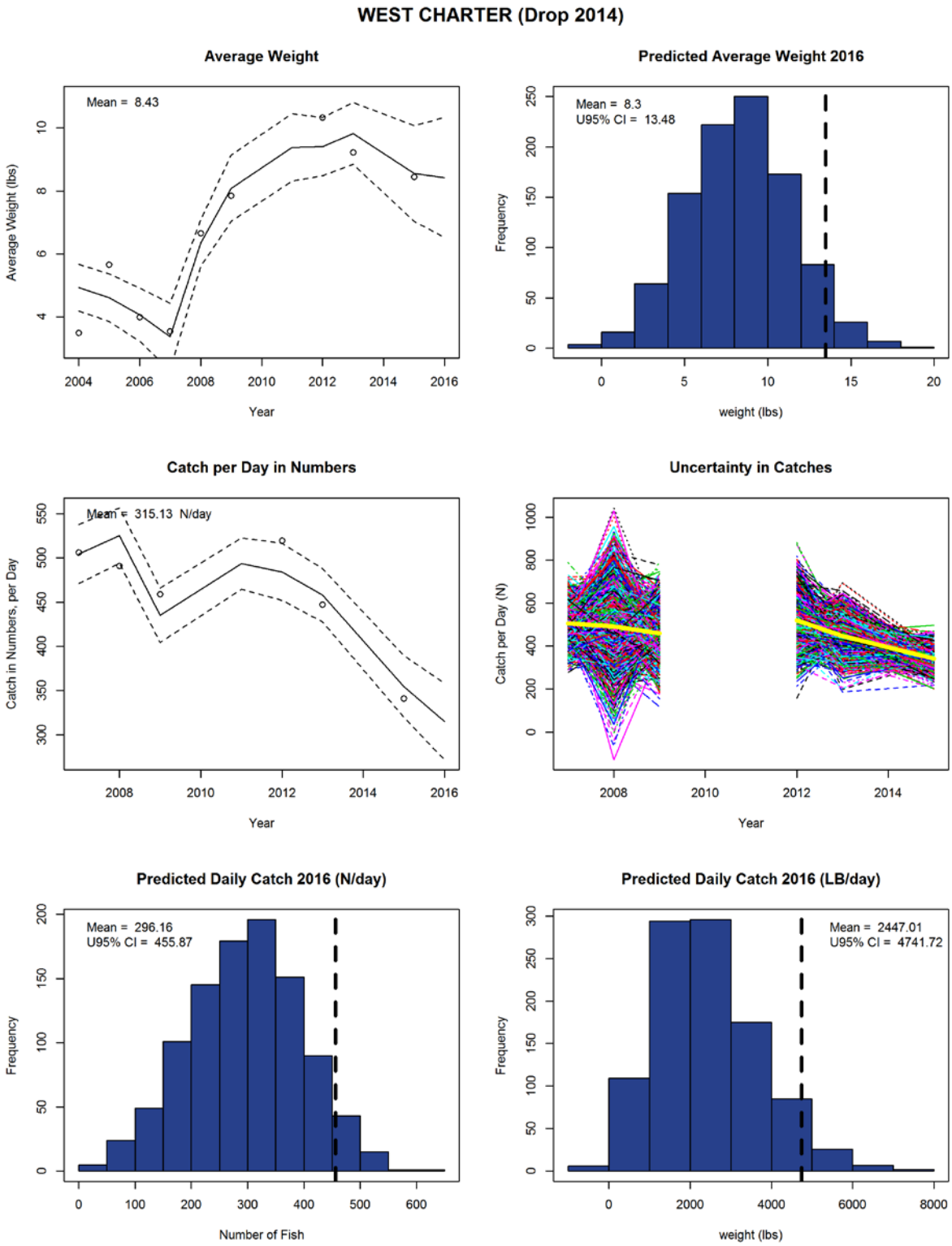

Figure 9B. Forecast for Western Gulf of Mexico charter average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

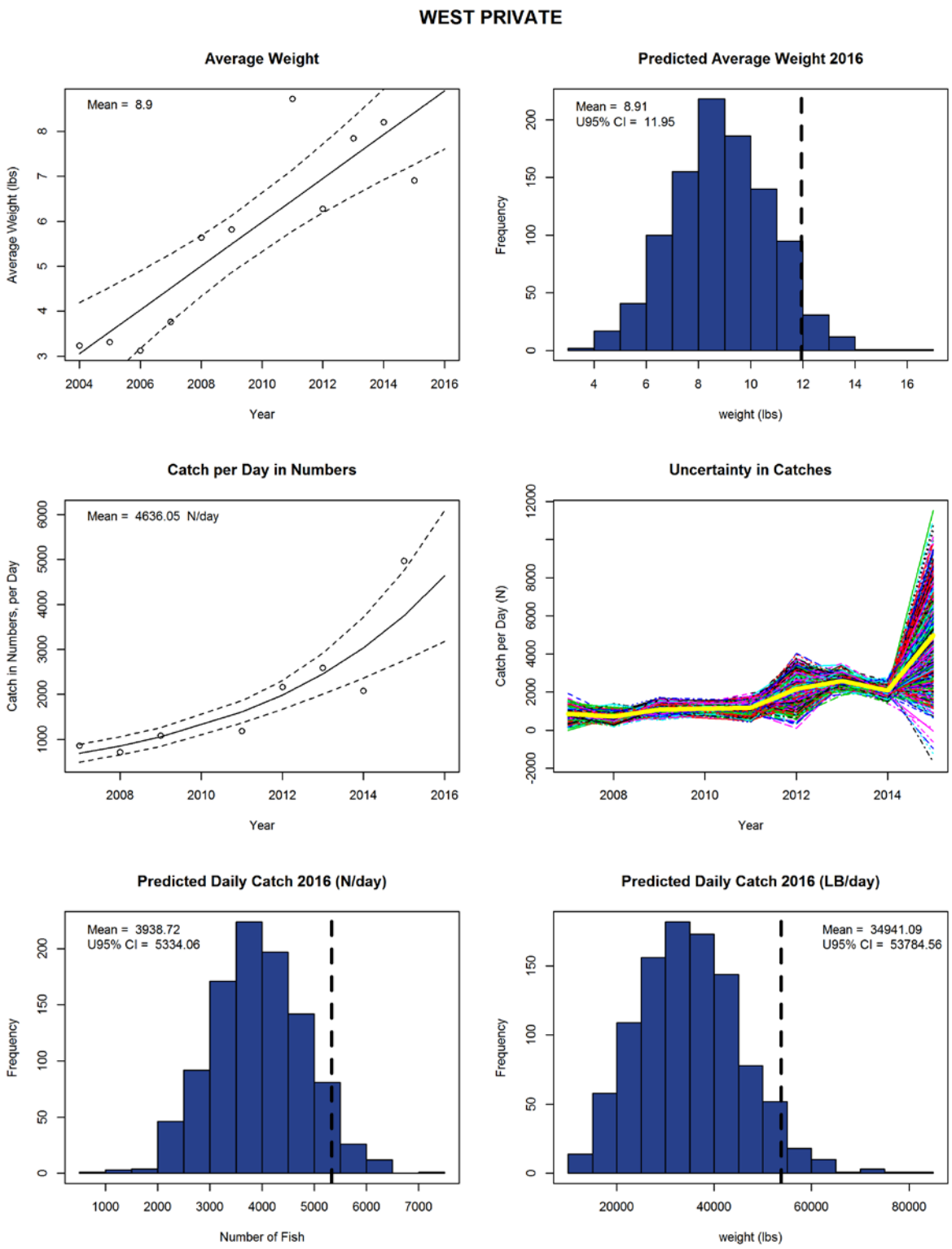

Figure 9C. Forecast for Western Gulf of Mexico private angler mode average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

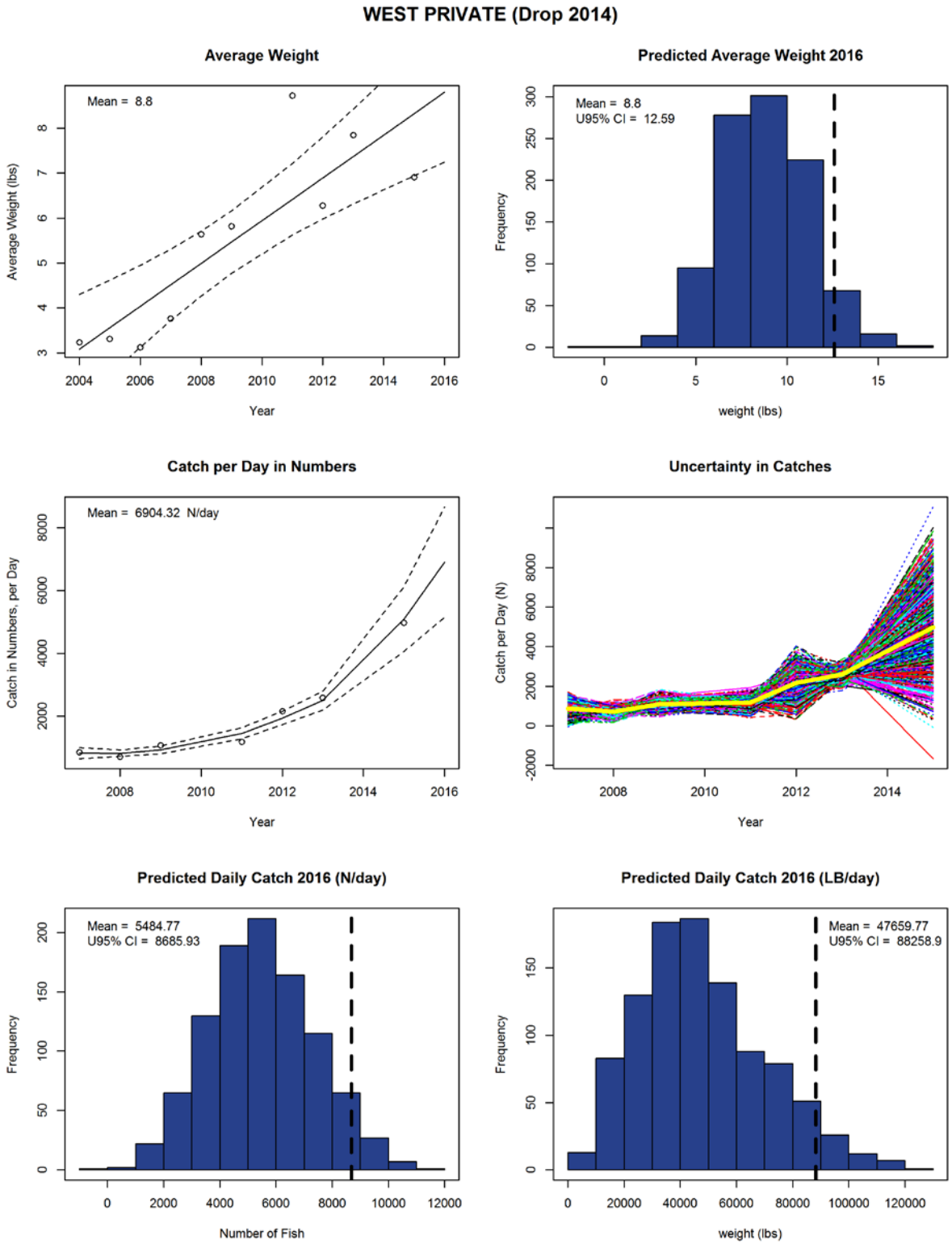

Figure 9D. Forecast for Western Gulf of Mexico private angler mode average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

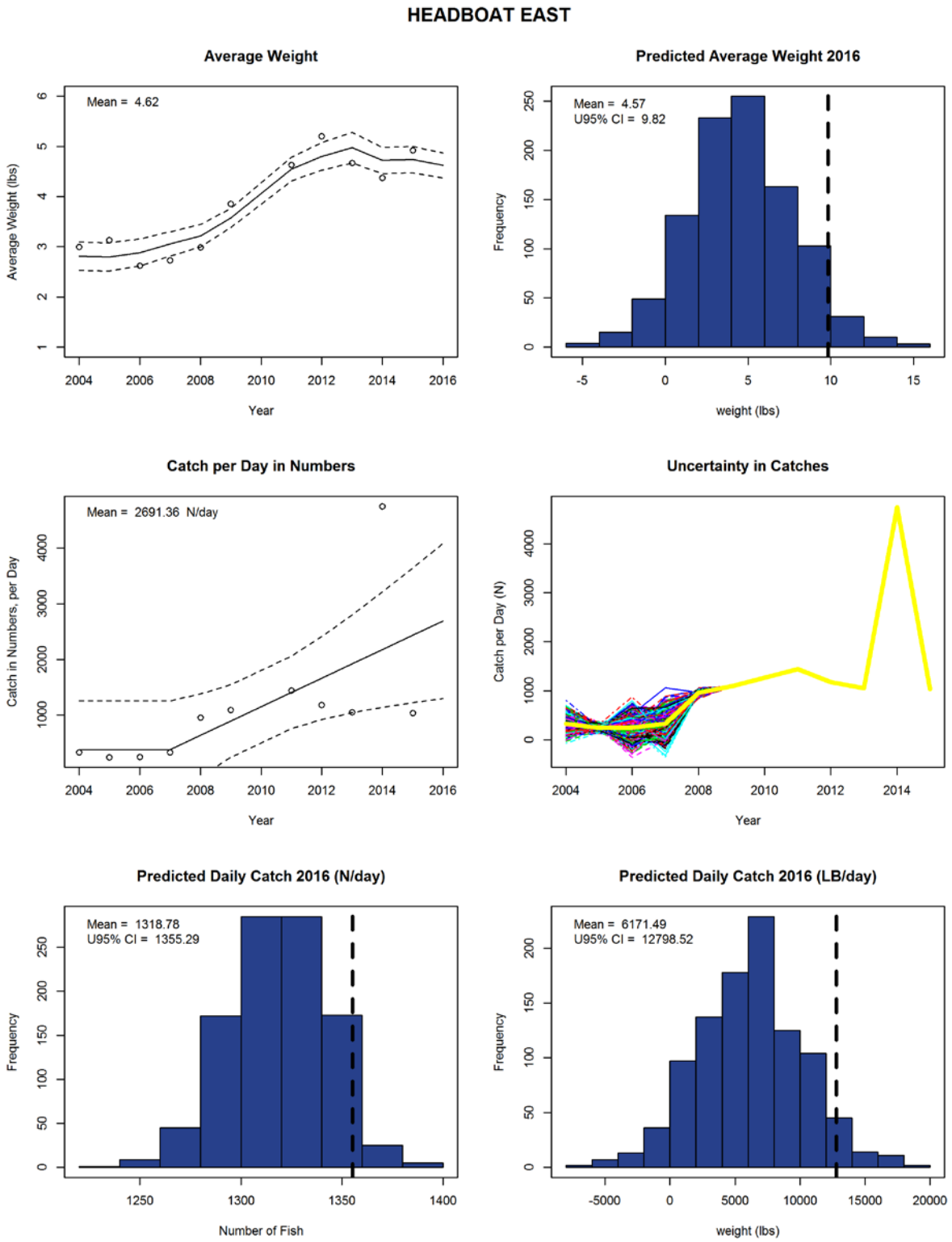

Figure 10A. Forecast for Eastern Gulf of Mexico headboat average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

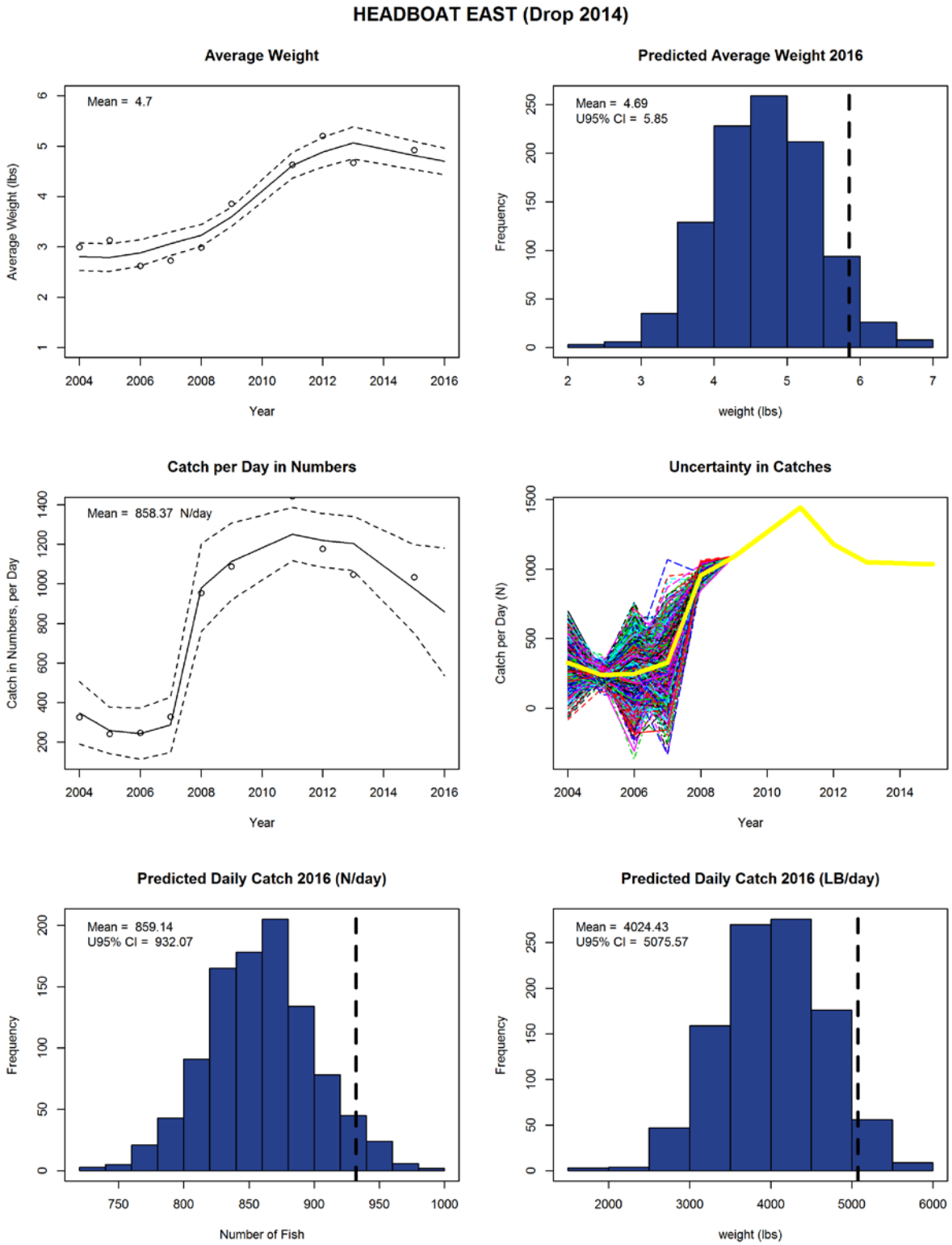

Figure 10B. Forecast for Eastern Gulf of Mexico headboat average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

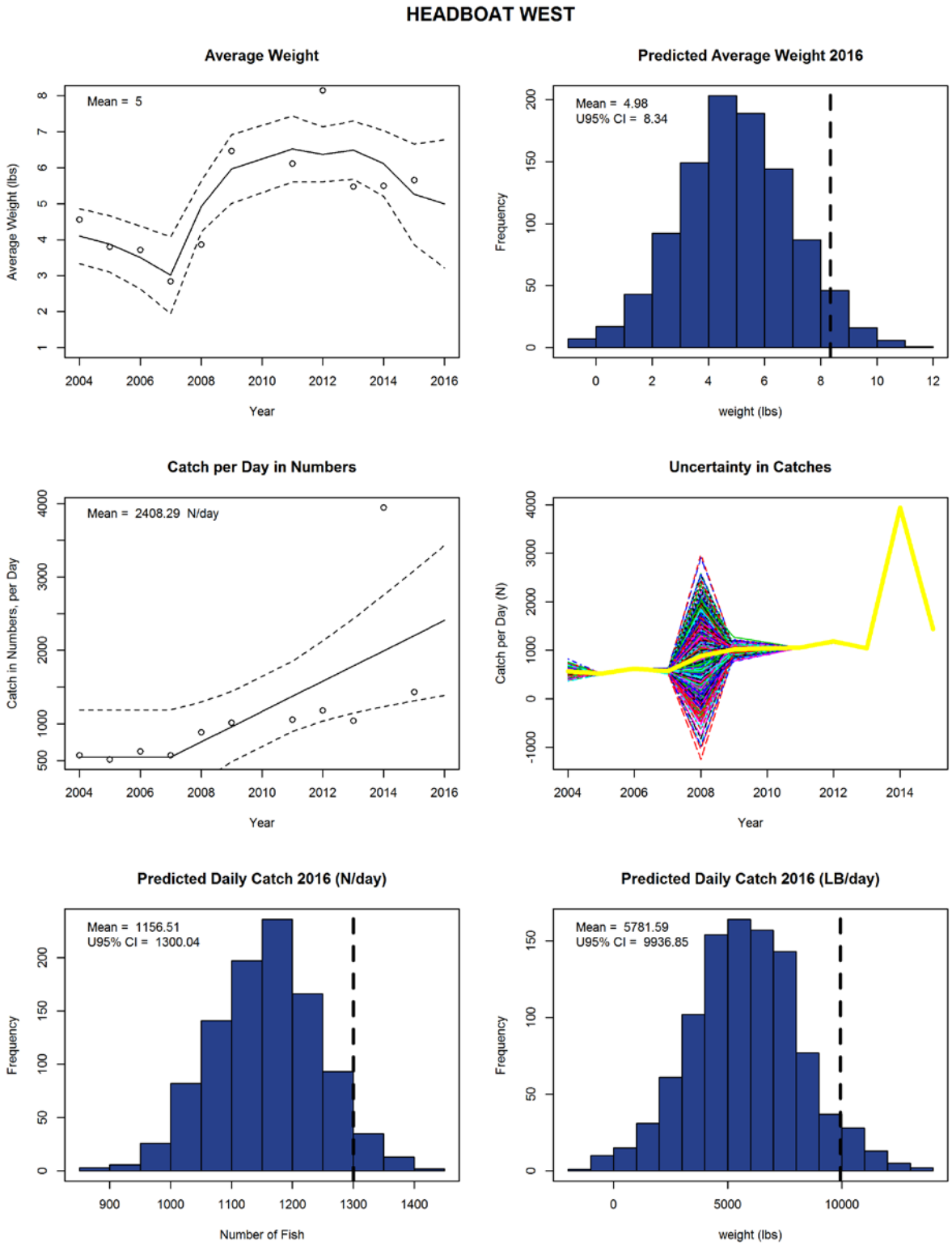

Figure 10C. Forecast for Western Gulf of Mexico headboat average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates.

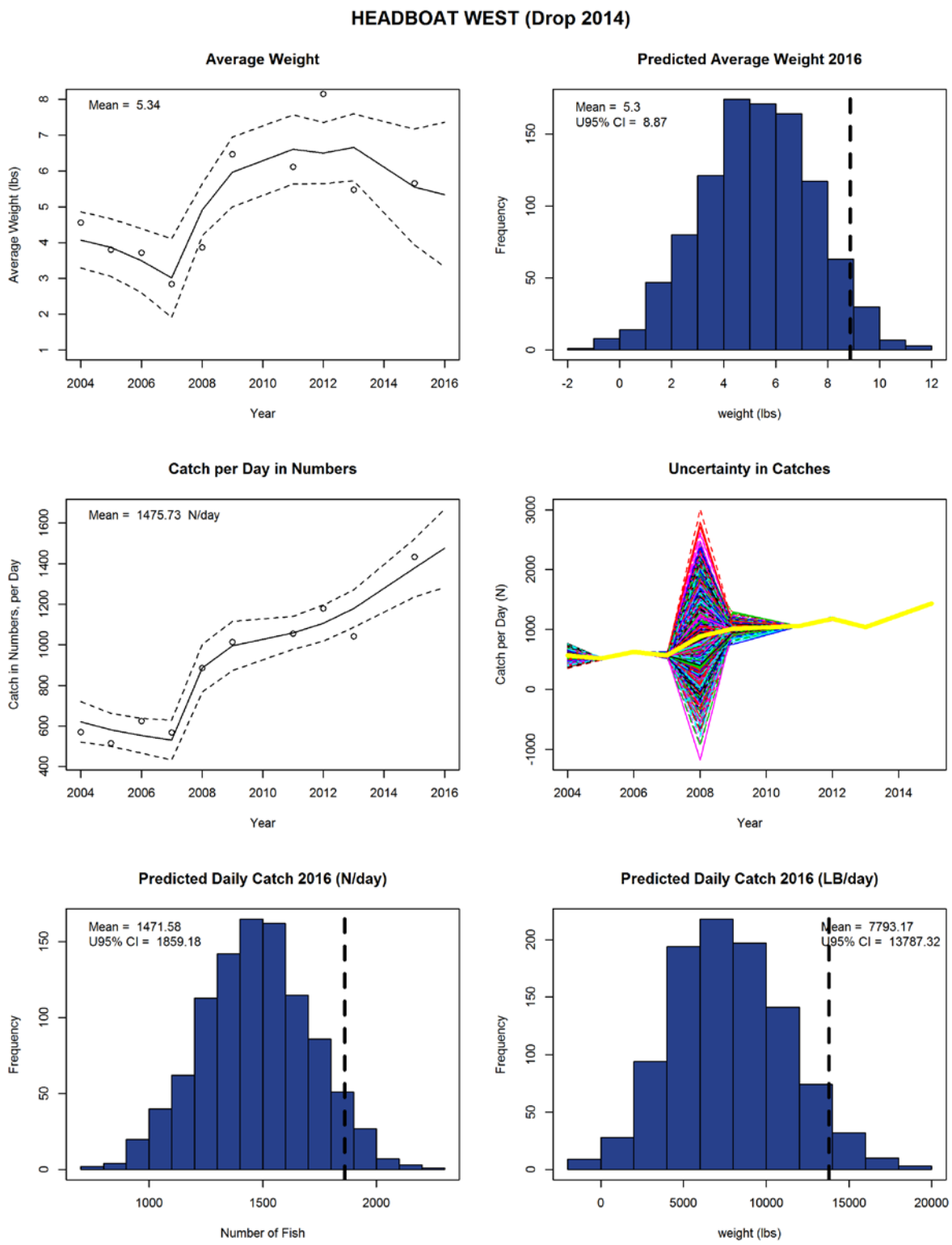

Figure 10D. Forecast for Western Gulf of Mexico headboat average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 catch estimate dropped due to short federal season (9 days).

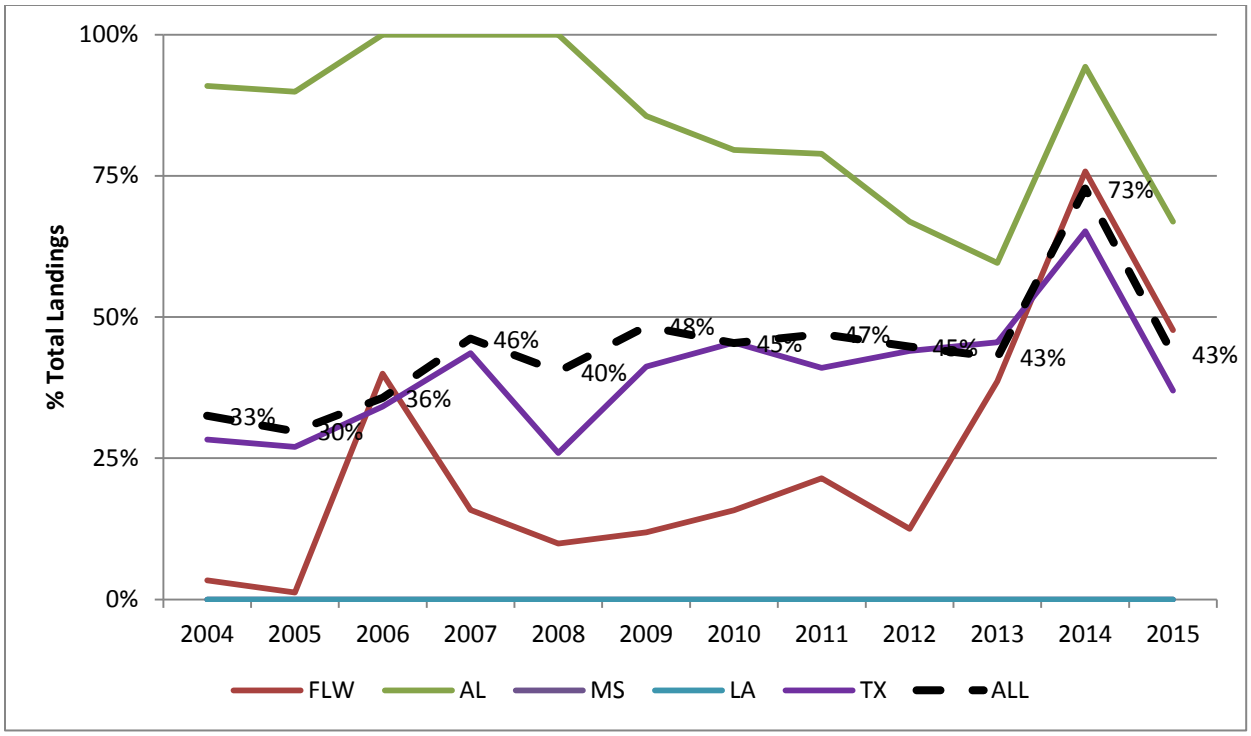

Figure 11. Percent of total headboat landings (lb ww) from Headboat Collaborative Program participants 2014-2015. HBC vessels had more time to land red snapper during the short 2014 season.

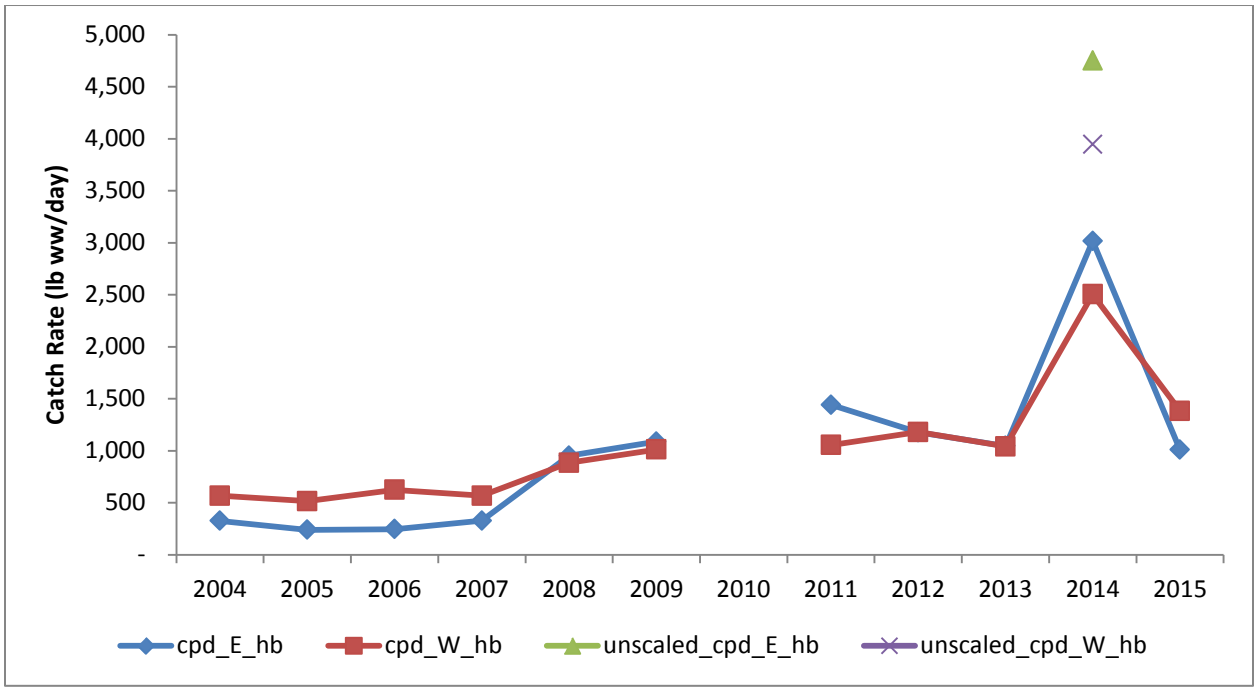

Figure 12. Headboat catch rates in the Eastern and Western Gullf of Mexico with 2014 catch rate for HBC vessels scaled to 2014 non-HBC vessel catch rate based on 2013 observed ratio. Note 2014 was a short federal season (9 days), so non-HBC vessels had little opportunity to book trips as compared to HBC vessels. The unscaled headboat catch rates for 2014 are provided for comparison.

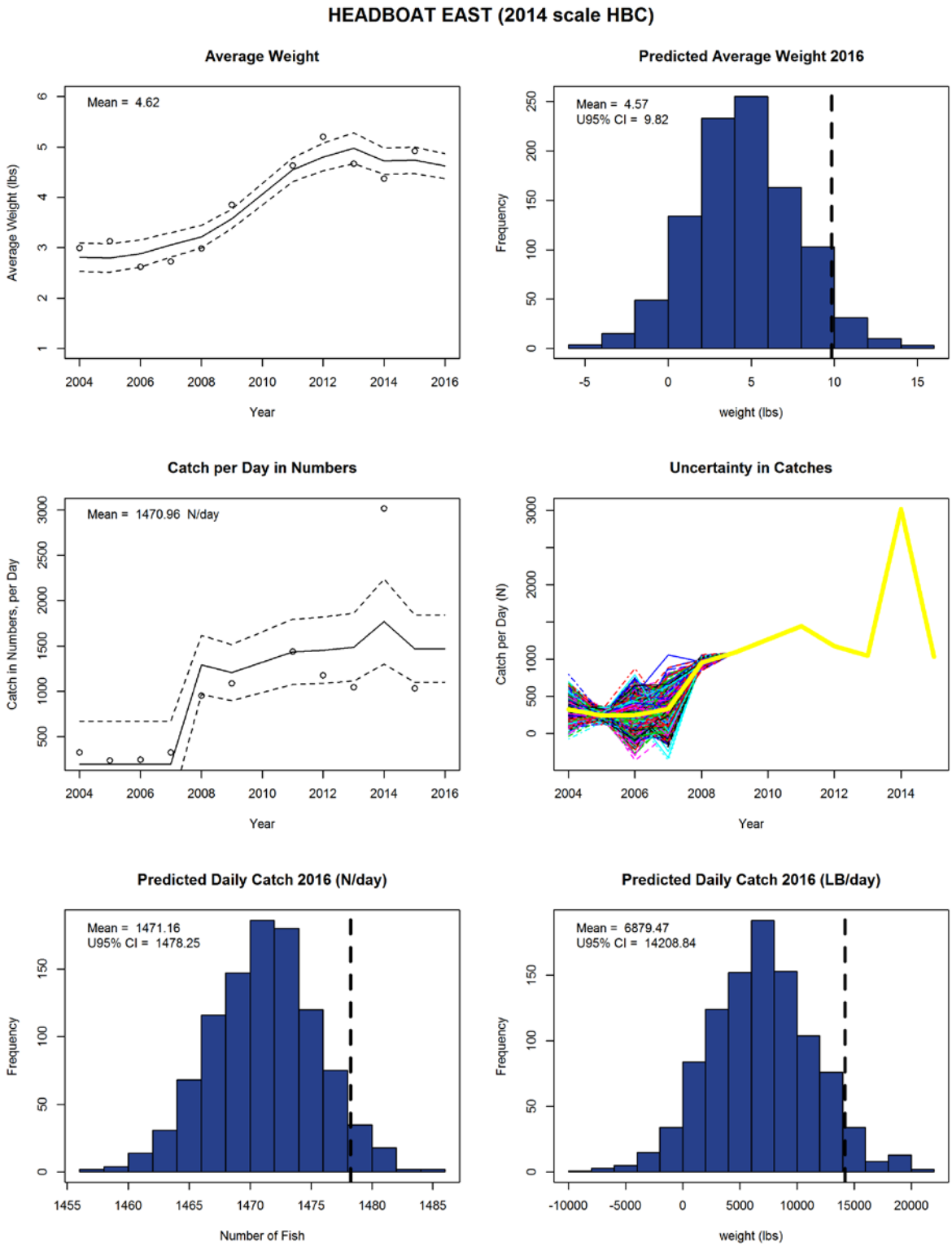

Figure 13A. Forecast for Eastern Gulf of Mexico headboat average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 headboat collaborative catches scaled to non-HBC catches based on 2013 ratio.

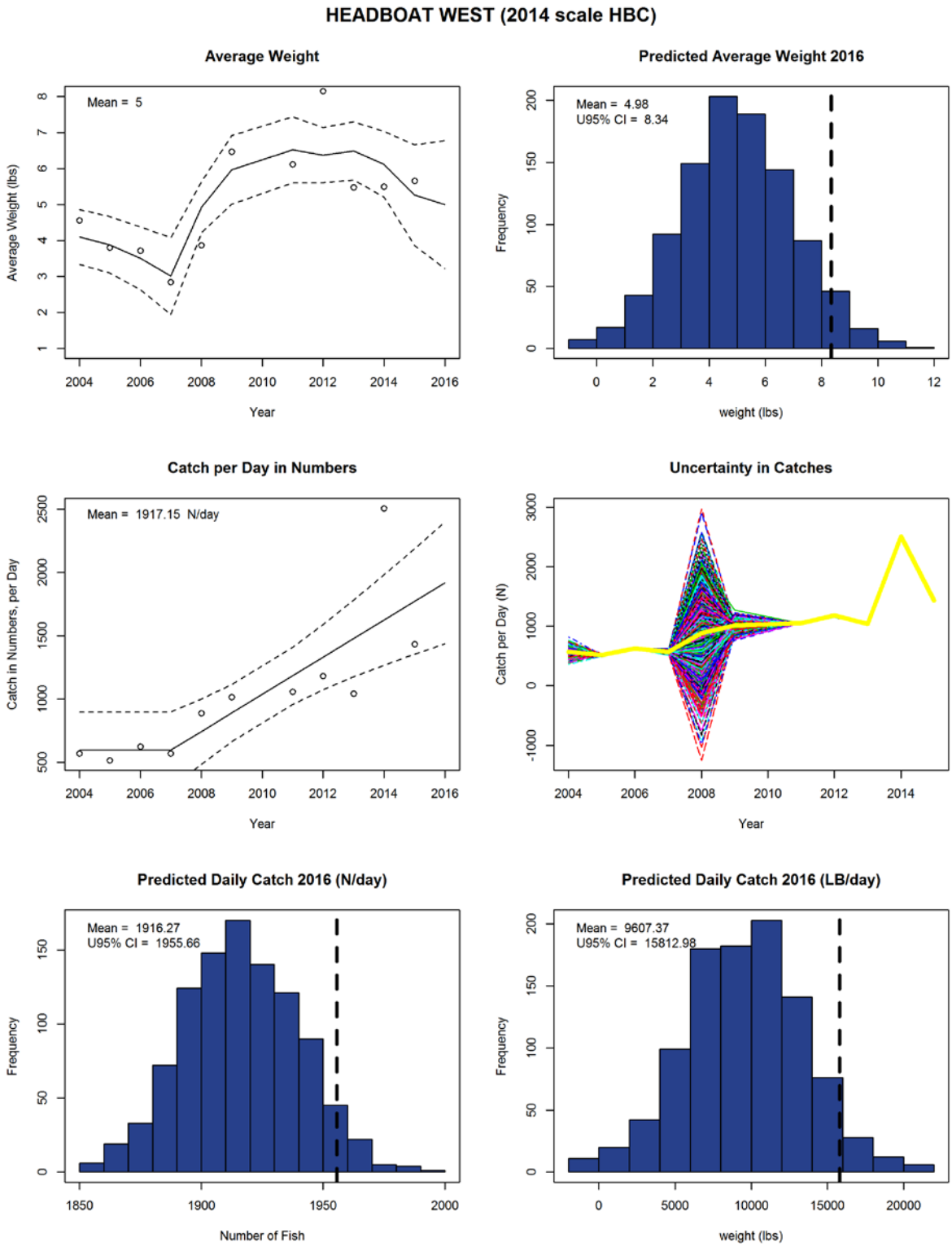

Figure 13B. Forecast for Western Gulf of Mexico headboat average weight and catch per day, showing basic model fits and bootstrapped run histograms accounting for uncertainty in weight and catch estimates. 2014 headboat collaborative catches scaled to non-HBC catches based on 2013 ratio.

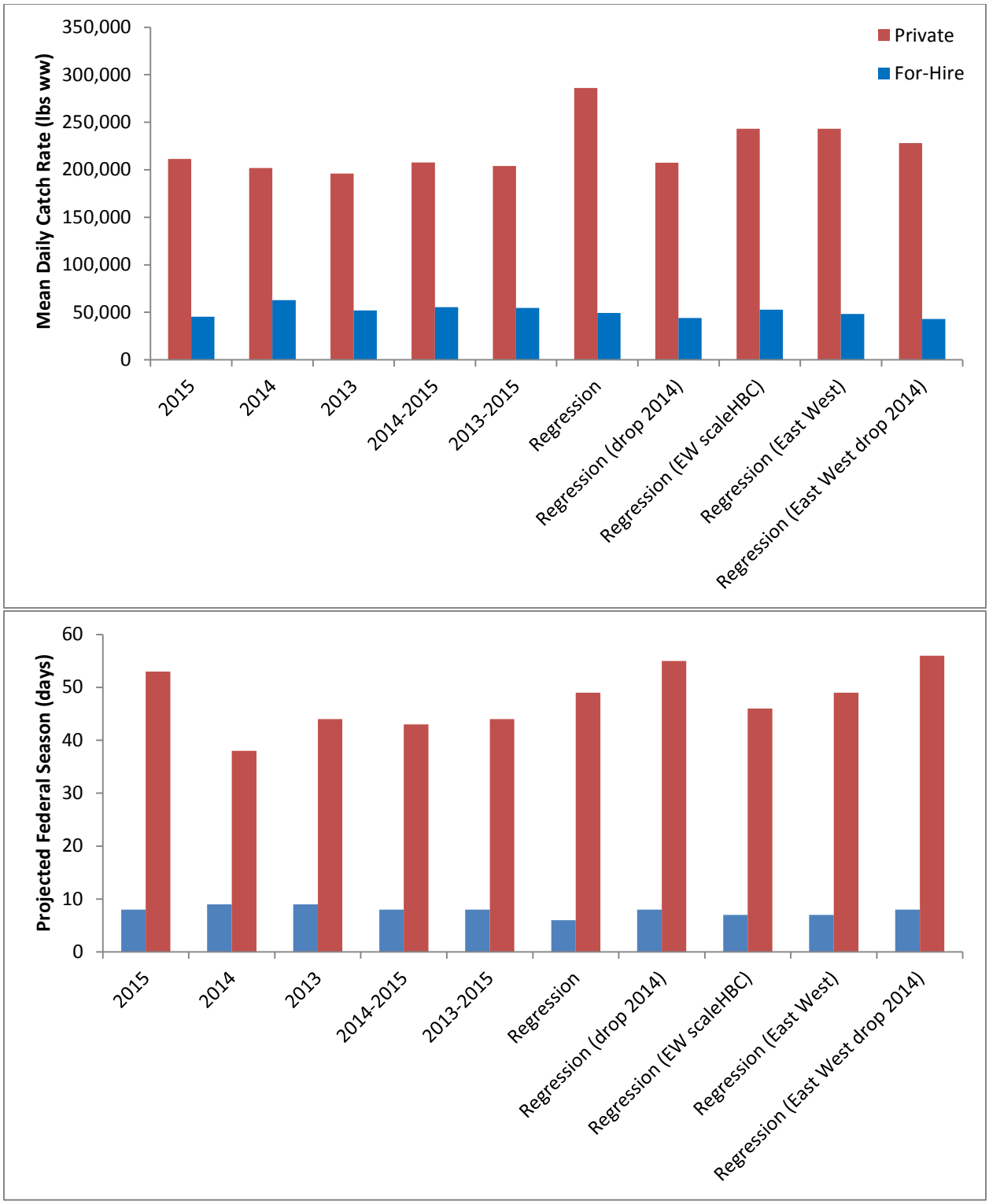

Figure 14. *Projected catch rates and season lengths*. 2016 forecast catch rates (top) and federal season lengths (bottom) under different projection scenarios. Assumes 3→9 nmi boundary change will increase AL, MS, and LA state season catch rates by 10%.

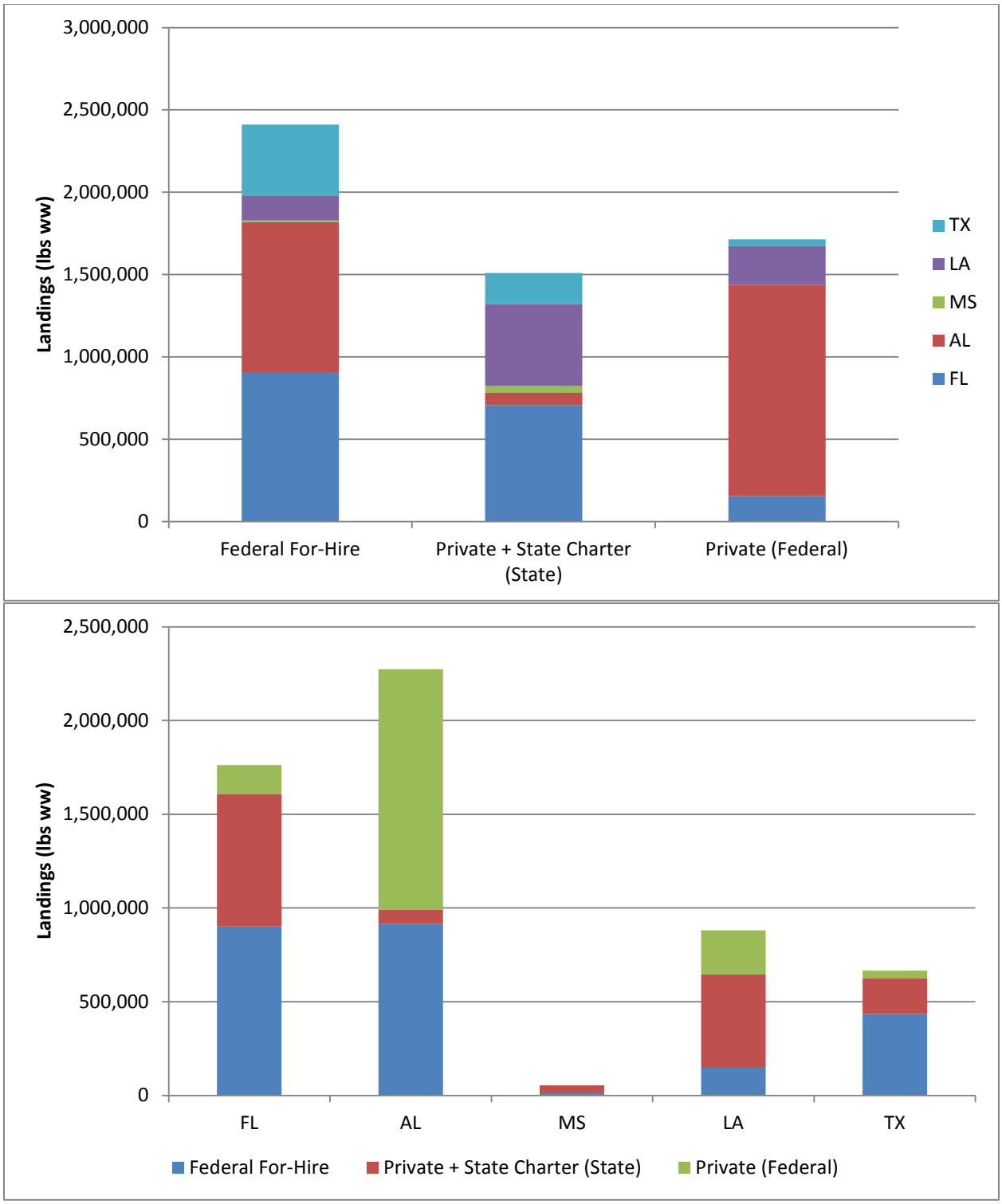

Figure 15A. *Projected landings by state and mode*. 2016 forecast landings under the "2015 as proxy" projection model, showing landings by mode broken out by state (top) and landings by state broken out by mode (bottom). Assumes 3→9 nmi boundary change will increase AL, MS, and LA state season catch rates by 10%.

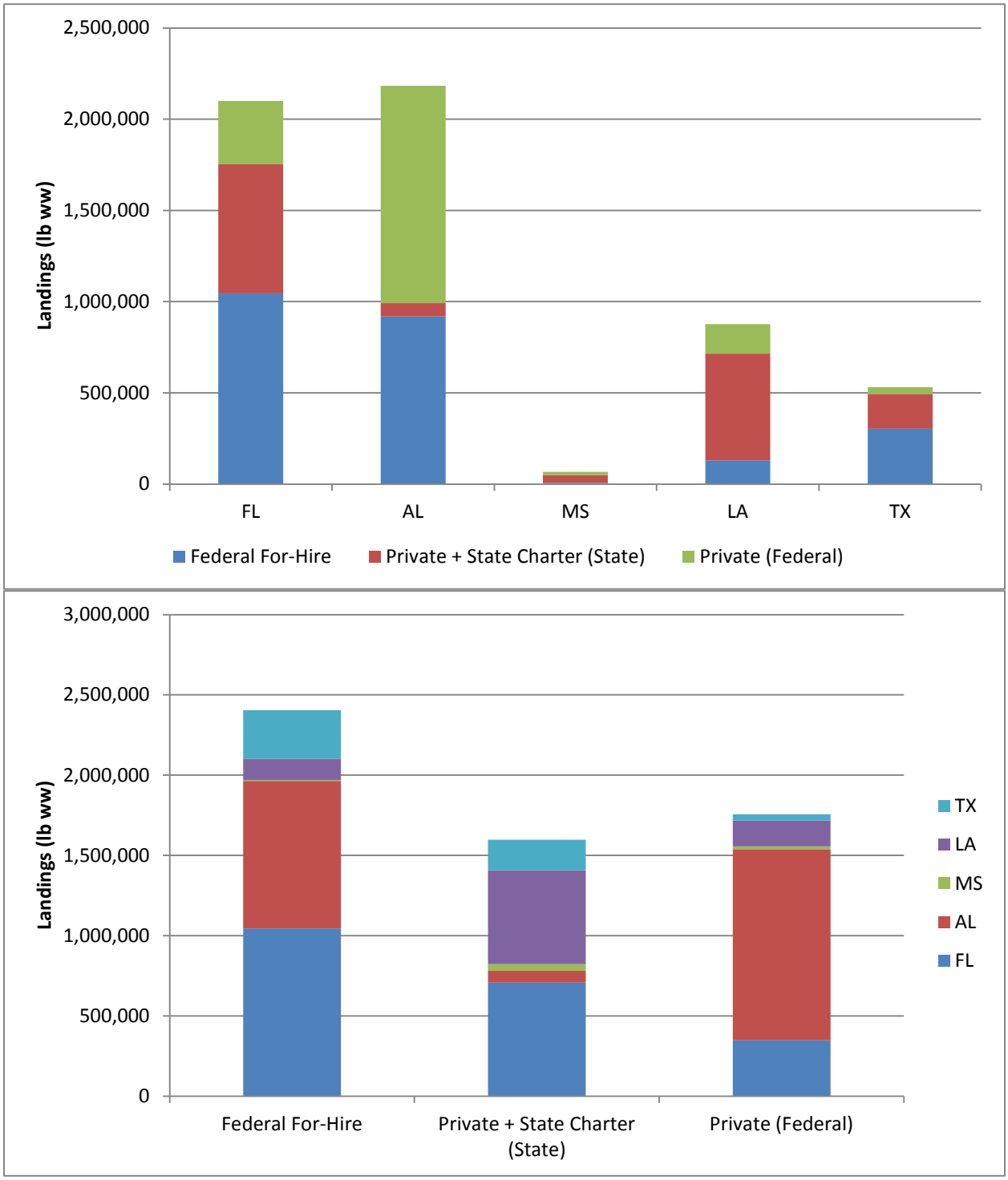

Figure 15B. *Projected landings by state and mode*. 2016 forecast landings under the "Regression" projection model, showing landings by mode broken out by state (top) and landings by state broken out by mode (bottom). Assumes 3→9 nmi boundary change will increase AL, MS, and LA state season catch rates by 10%.

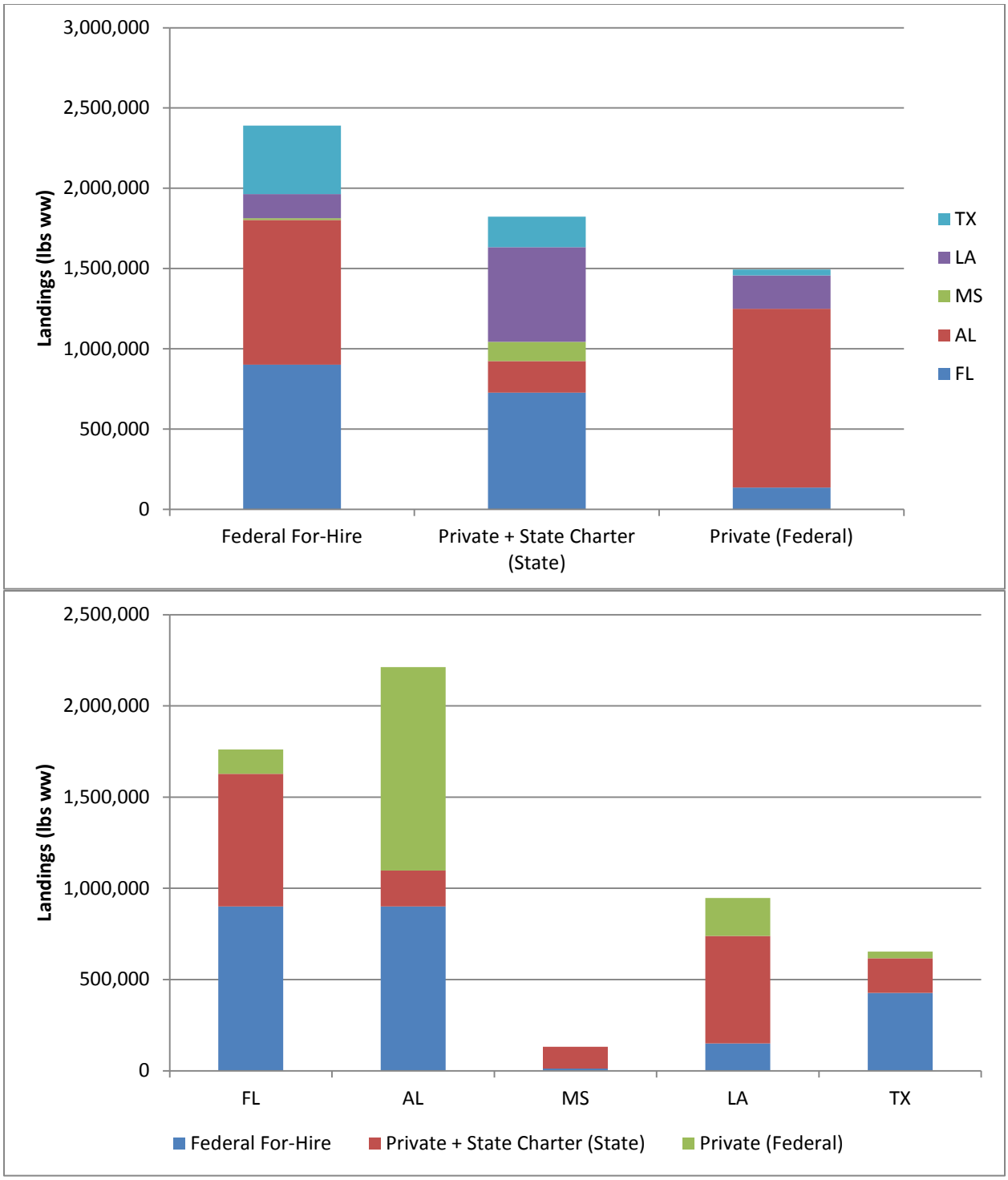

Figure 15C. *Projected landings by state and mode*. 2016 forecast landings under the "2015 as proxy" projection model, showing landings by mode broken out by state (top) and landings by state broken out by mode (bottom). Assumes 3→9 nmi boundary change will increase AL, MS, and LA state season catch rates by 200%.

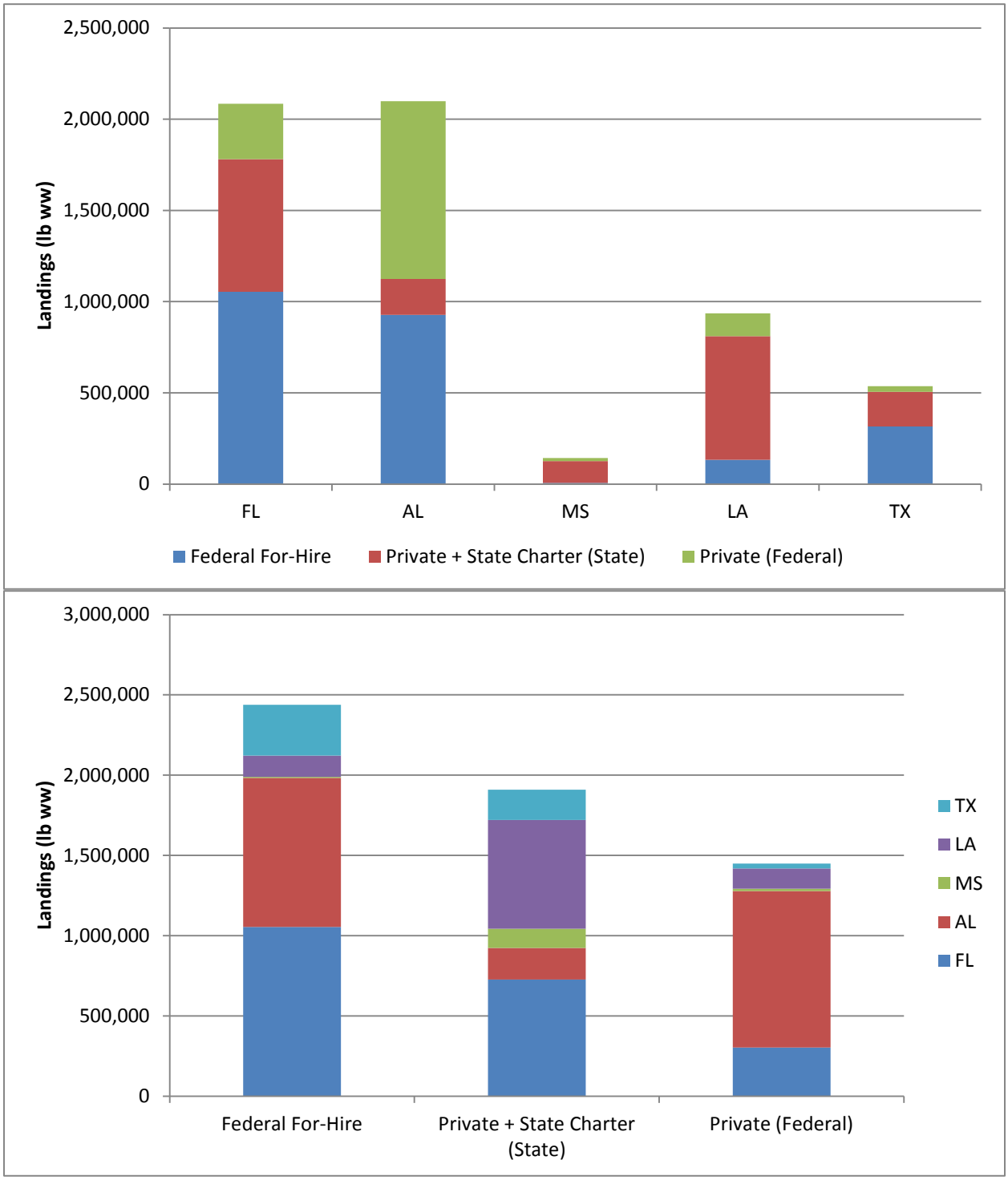

Figure 15D. *Projected landings by state and mode*. 2016 forecast landings under the "Regression" projection model, showing landings by mode broken out by state (top) and landings by state broken out by mode (bottom). Assumes 3→9 nmi boundary change will increase AL, MS, and LA state season catch rates by 200%.

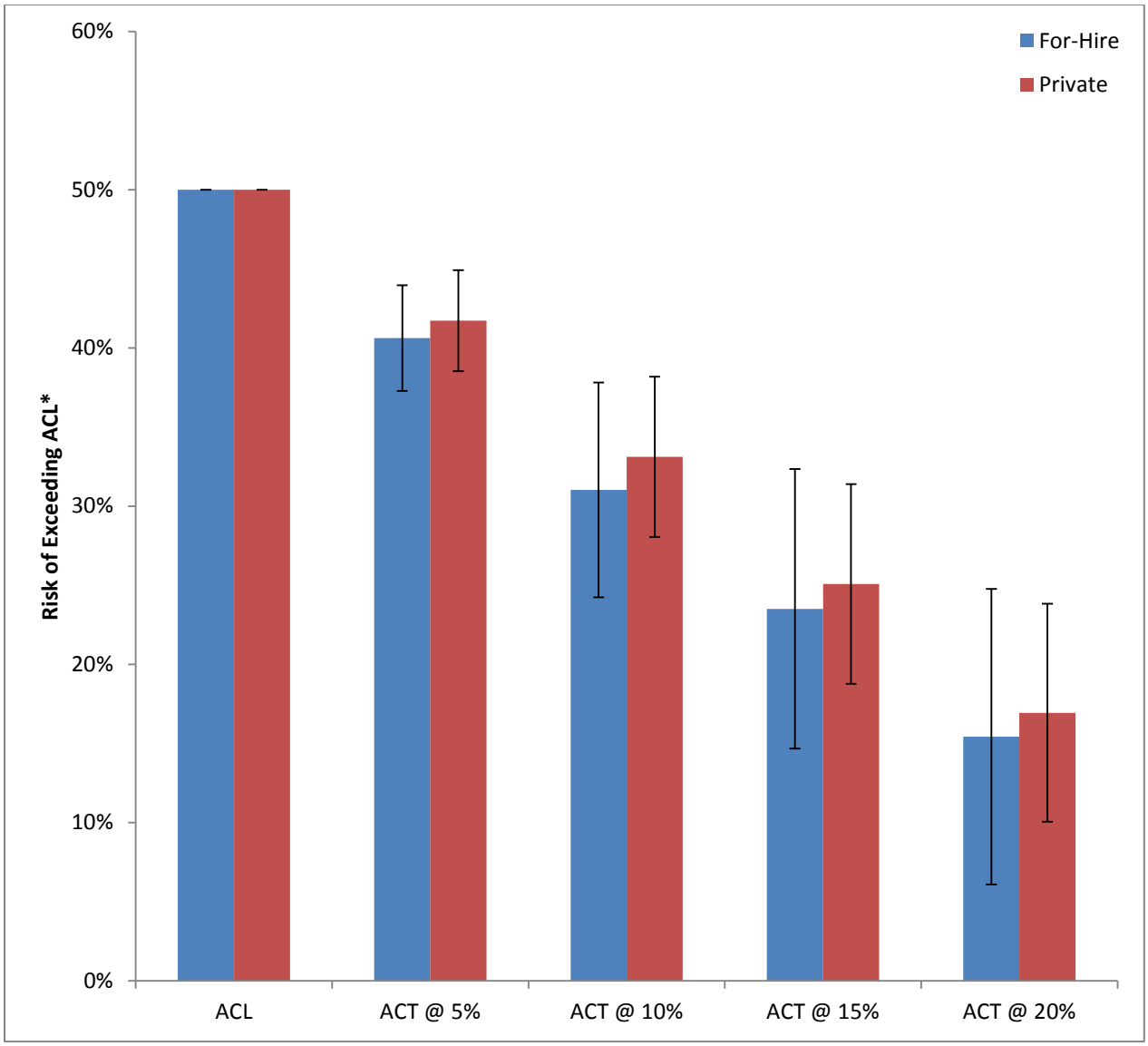

Figure 16. *Risk of exceeding ACL at different ACT buffers, by mode*. Mean percentage of 1000 bootstrapped runs of projected landings that exceeded ACL across 1000 bootstrapped runs across all projection scenarios. Models configured with federal season lengths set to have mean landings equal to ACT at different buffer levels. Error bars denote standard deviation. Assumes 3→9 nmi boundary change will increase AL, MS, and LA state season catch rates by 10%.

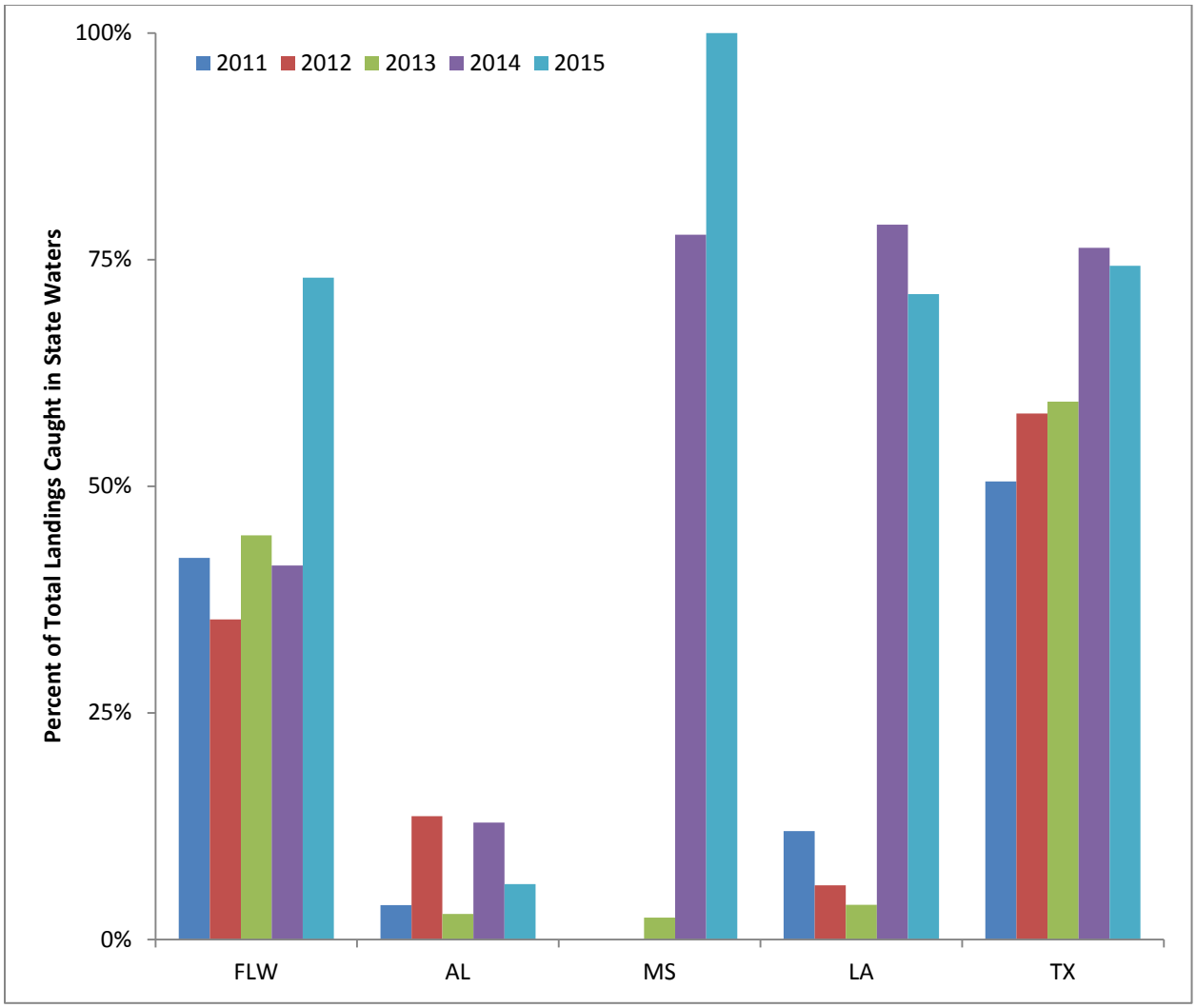

Figure 17. *Percent of private angler mode landings from state waters*. Percentage of private angler mode landings (lb ww) originating from state waters, by state and year.

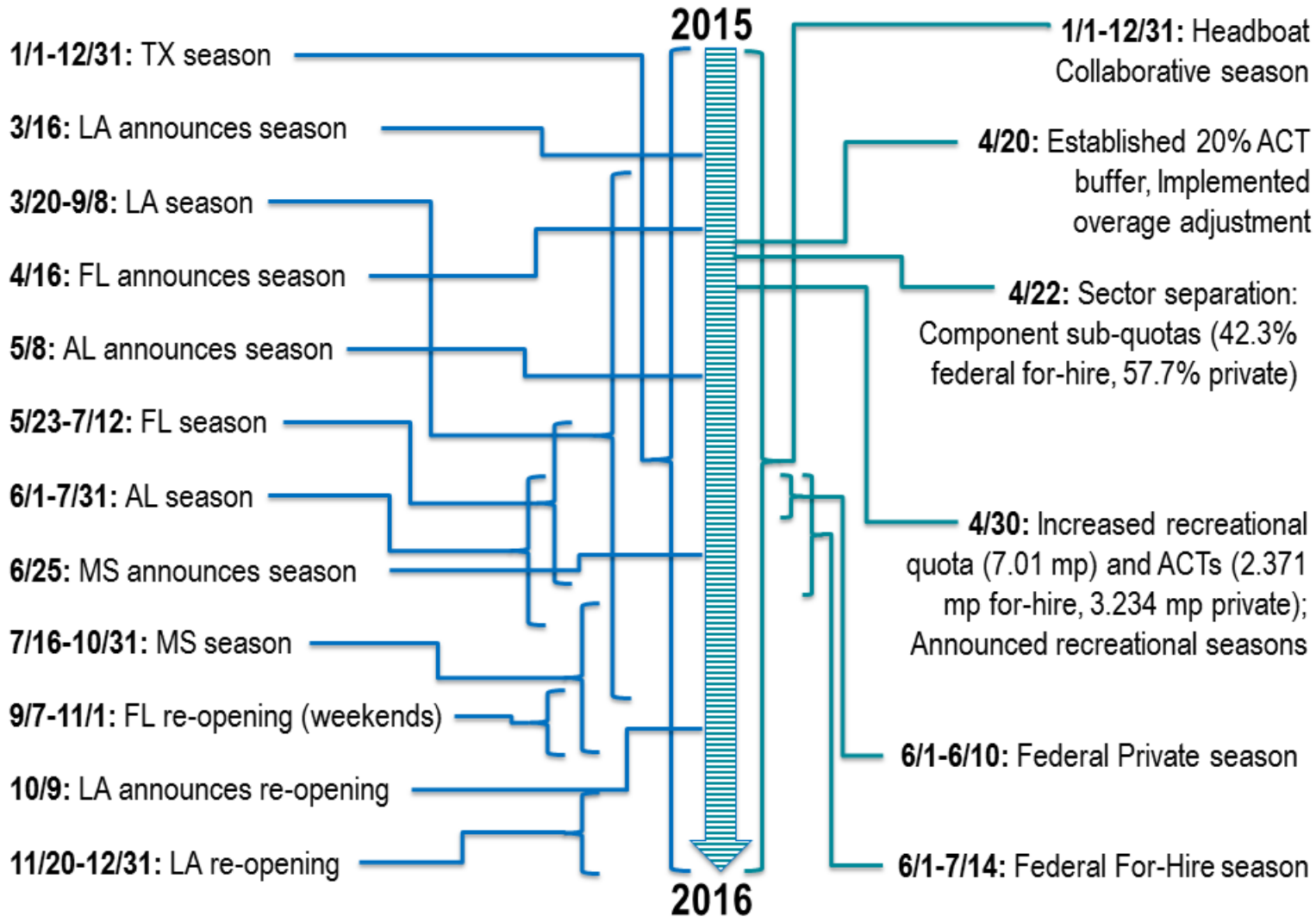

Figure 18. *Timeline of Gulf of Mexico red snapper season length announcements*. Timeline showing Gulf State red snapper season announcements (left) relative to federal red snapper season announcements (right) in 2015.