Atlantic Greater Amberjack Abundance Indices From Commercial Handline and Recreational Charter, Private, and Headboat Fisheries through fishing year 1997

By

N. J. Cummings, S. C. Turner, D. B. McClellan, and C. M. Legault

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, Florida 33149 USA

July 1999

Sustainable Fisheries Division Contribution No. SFD-98/99-62

Introduction

Parrack (1993a,b), Cummings and McClellan (1996, 1997) and Cummings (1998) presented catch per unit of effort (CPUE) statistics for the Atlantic greater amberjack, *Seriola dumerili*, stock. This report updates the CPUE analyses of earlier studies through the 1997 fishing year, incorporates new analysis procedures, and presents a new index of stock abundance developed from tagging data observations. Virtual Population Analysis (VPA) techniques have been used to evaluate the condition of this stock. Information external to the input fishery catch at age data are required for tuning (calibrating) the VPA estimates of stocksize and mortality trends. Standardized CPUE observations or abundance trends (independent and fishery dependent) have been shown effective in the standardization or calibration of VPA's. Therefore, providing updated CPUE trends and implementing improvements in analysis methods is important in the analysis of the Atlantic greater amberjack stock status.

Materials and Methods

As in the previous 1996 evaluation of stock status, three separate sources of CPUE data existed for estimating temporal trends in abundance of the Atlantic greater amberjack stock. These included observations of recreational catch per angler and catch per angler hour from the Marine Recreational Fisheries Sampling Survey (MRFSS) data base of intercepted angler fishing trips from the shore, charter, and private vessel modes in the Atlantic ocean. In addition, for headboats operating from North Carolina through the Florida Keys, the National Marine Fisheries Service (NMFS), Beaufort Laboratory conducts a survey. This database is an archive of captain reports of landed catch in number per trip, and the number of anglers per trip collected since 1972 in the Carolinas, since 1976 in North Carolina through Daytona, Florida, and since 1977 in the Florida Keys. The third source of CPUE data was the NMFS Atlantic Snapper - Grouper and the Gulf of Mexico Reeffish Logbook database. This combined set of commercial data referred to as the "Logbook" data in this report, is an archival landings reports made by all commercial fishermen that have federal permits to fish in the Atlantic Snapper - Grouper and also in the Gulf of Mexico fishery. The logbook survey was begun in January 1992 in the Atlantic in response to the mandate of Amendment 4 of the South Atlantic Snapper-Grouper Fishery Management Plan to collect information pertaining to the Atlantic reeffish fisheries. The logbook survey was begun in April 1990 in the Gulf of Mexico as part of the Gulf of Mexico Fishery Management Plan Data collection requirements (McClellan and Bohnsack 1991, Anon. 1987). During the early years only a sample of the permit holders (drawn randomly at a 25% rate) were required to report. Reporting became mandatory in 1993 in the Atlantic (Harris et al. 1994) and in 1991 for Florida vessels fishing in the Gulf of Mexico. It was necessary to select landings reports from the Gulf survey as well as the Atlantic since some permit holders who fish the Atlantic stock, especially in the Florida Keys region, may report to both systems. Reports were identified as duplicates and removed prior to analyses. A new abundance index for the Atlantic greater amberjack was developed from tagging observations from releases made by scientific and recreational anglers from the early 1960's through 1998.

MRFSS CPUE Analysis Procedures

The MRFSS based CPUE indices included intercepts from recreational fishing trips having a positive catch of greater amberjack (whether targeting or not) and also intercepts with zero catches of greater amberjack that indicated they were targeting any of the four highly sought amberjack species (greater, banded rudder, almaco and lesser). As with previous MRFSS indices, observations from Monroe county Florida were considered in the analysis. Information recorded for each observation included the year, month, state and county of intercept, and whether targeting greater amberjack. In addition, a variable referred to as bag limit stanza corresponding to un-regulated or 3 fish per person was defined and each observation coded for this variable. Fishing year was calculated, as May 1-April 30, for each observation from the month and year of intercept. These five independent variables (fishing year, month, state-county, target id, and bag limit stanza) were used to adjust the fishing year CPUE indices for the estimated effects of these variables on catch rates. General linear modeling statistical methods (Robson 1966) as previously used in Parrack (1993a,b) and Cummings and McClellan (1996,1997), were used in calculating the abundance indices for the MRFSS observations of positive catch.

The Lo method (Lo et al. 1992) was explored to develop an abundance index for Atlantic greater amberjack from the combined set of charter and private CPUE observations of zero catch in addition to the positive catches. The Lo method assumes a delta-lognormal error structure in the raw data and generates an estimate of CPUE from the product of two models. One model estimates frequency (the proportion of intercepts in which greater amberjack was caught) assuming a binomial error distribution and the second model estimates the mean density of greater amberjack within positive trips assuming a lognormal error distribution.

Previous analyses of the MRFSS CPUE observations indicated the amount of observed variability in the raw catch per hour fished data was high, especially in the private boat f fishery, therefore this year's analyses were made separately for the charter and the private boat data as well as the combined set of charter and private data. Few intercepts were from the shore-based fishery therefore these were not considered in the CPUE abundance analyses.

Commercial Logbook CPUE Analysis Procedures

The NMFS Atlantic Snapper - Grouper and the Gulf of Mexico Logbooks were also used to develop an index of abundance for greater amberjack in the Atlantic. This combined set of commercial data referred to as 'logbook' below contains landings reports from commercial fishermen that have federal permits to fish in the Atlantic Snapper - Grouper and the Gulf of Mexico reef fish fisheries. The logbook survey was initiated in the early 1990's. During the early years only a sample of the permit holders (drawn randomly) were required to report, however, reporting became mandatory in about 1994 in the Atlantic. It was necessary to select landings reports from the Gulf survey as well as the Atlantic since some permit holders who fish the Atlantic stock, especially in the

Florida Keys region, could report to either or both systems. Duplicate reports in the two databases were identified and removed prior to analysis.

Logbook records existed from 1991 to 1998 by trip; no within trip information was available (if a trip involved fishing in multiple locations and/or on multiple days, the catch (i.e., landings) and effort data could not be identified for those separate events). Recorded data included landed weight by species (converted to whole weight as necessary), information on the primary fishing gear used and location of the effort and/or catch by 1^{o} latitude and longitude square. A preliminary definition of fishing year from April through March of the following year was used for initial examination of the data. A variety of effort measures were available depending on the fishing gear and at a minimum included days at sea and hours fished.

The number of trips, proportion of trips with greater amberjack and the proportion of greater amberjack in the total landings were summarized by fishing gear and fishing year to determine which gear(s) would be used for developing indices of abundance.

Multiple measures of fishing effort were evaluated to select one for use in developing indices of abundance; these reviews included both examination of frequency distributions of individual effort components (hours fished, sea days, hooks per line, lines, etc) as well as total annual effort measures. The data indicated that apparently extreme values occurred for some effort measures such as hooks per line. In an attempt to reduce the influence of extreme observations on catch rates, a policy of eliminating the upper and lower 1% of the observations for each effort measure was established.

Regression tree analysis (Venables and Ripley 1997) was used for preliminary data exploration primarily for the purpose of defining seasons and regions for use as explanatory variables. Separate analyses were conducted using as the dependent variable (1) proportion of positive caches and (2) catch per hook on trips on which caught greater amberjack (successful trips). Independent variables examined included fishing year, month or season (3 month seasons with January-March, etc.), latitude and longitude (based on the southeast corner of each one degree square) or region (defined from the results of earlier regression tree analyses).

General linear model (GLM) analyses were used to select the effort measure for trips on which greater amberjack were caught. The dependent variable was the log of the landed weight, and a lognormal error distribution was assumed. Multiple analyses were made each including a different measure of effort as an explanatory variable along with fishing year, season and region. The coefficient of determination (R^2) and the probability of the F statistic for the effort effect were used to select the measure of effort for use in calculating catch rates.

Indices of abundance were derived using the Lo method (Lo et al 1992) which assumes a delta lognormal error structure, employs separate GLM analyses of the proportions of positive trips and the catch rates on trips which caught amberjack, and combines the results of the separate analyses to derive the index. A binomial error assumption was used for the proportion positive analyses and a lognormal error assumption was used for the analyses of positive trips. Fishing year, season and region were included in the analyses along with the season * region interaction if significant. In addition random effects year (fishing year) interactions with season and region were included where data were sufficient and if a significant effect was indicated. If possible three-way random effects year interactions (fishing year*season*region) were included; if the data would not support a three-way interaction one or more two-way random effects year interactions were included.

NMFS Headboat CPUE Analysis Procedures

Data were available from the NMFS headboat survey from 1974-1998. The data consists of captains' reports of the number and estimated weight of landed catch by species, the number of anglers on board the boat, the type of trip. Trip type included information on the length of the trip: half day, ¾ day, full day, multi-day and the time of the trip: day or night for full as well as early or late in the day or night for partial day trips. The data usually included information on the geographical location of the catch by 10' square.

To eliminate effort clearly unrelated to greater amberjack, data were restricted to 10' squares in which greater amberjack (*Seriola dumerili*) or other members of the genus were ever recorded. To ensure that catches came from the stock under consideration, it was assumed that greater amberjack from the other side of the Gulf Stream were from a different population and fishing effort in the Bahamas and similar areas were excluded.

To examine possible positive or negative associations of greater amberjack catch rates with other fishes; catches of other taxa were tabulated along with those of greater amberjack. Both relatively desegregated and highly aggregated taxonomic groupings were investigated. The desegregated classification included single species groups (such as black sea bass), genera (such as *Myctoperca*), families and groupings of similar species (such as large pelagics, or inshore Lujanids or offshore Lujanids); a total of 25 taxa were defined. Three classifications of aggregated taxa were defined; they were inshore species, offshore bottom oriented species and offshore pelagic species. Taxa were classified by their proportion of the total number of fish reported from a trip. Four levels of classification were used for preliminary analyses and two levels for subsequent analyses. The four levels were 0 (absent), and 1-3 indicating increasing proportions. The divisions between levels were taxa specific, because some taxa were frequently observed at all proportions while others were observed frequently up to some intermediate percentage of the catch. In final analyses the classifications for the aggregated taxa were summarized into 0 (absent or low) or 1 (moderate to high).

Preliminary analyses indicated that there was a negative relationship between greater amberjack catch and the number of anglers on the boat, and therefore the basic unit of effort was defined as the trip and catch rates were defined as catch per trip.

Regression tree analysis was used to explore the data set for possible aggregation into seasons and regions and to investigate the possible influences of the various taxonomic groupings.

Indices of abundance were derived using the Lo method (Lo et al. 1992), which assumes a delta lognormal error structure, employs separate GLM analyses of the proportions of positive trips and of the catch rates on trips which caught amberjack, and combines the results of the separate analyses to derive the index. A binomial error assumption was used for the proportion positive analyses and a lognormal error assumption was used for the analyses of positive trips. Fishing year, season and region were included in the analyses and in most cases information on catches of other species on the trip was also included. For the season, region and taxonomic factors two-way and three-way interactions were investigated to the extent permitted by the distribution of the data and the analysis. In addition random effects year (fishing year) interactions with the other factors were included if possible where data were sufficient and if a significant effect was indicated. The highest order random effect interactions, which could be estimated, were included.

Tagging Data Analyses

Tag and recapture observations from 1960 through 1998 were available. McClellan and Cummings (1997) provided a description of the data for the years 1960-1994. The more recent data (1994-1998) were extracted from the NMFS, Cooperative Tagging Center tagging database (D. Rosenthal, pers. comm.) and the observations combined. For each observation the date of tagging and date of recapture was recorded thus allowing the corresponding fishing year period, May – April to be calculated. These data were used to generate a fishery independent estimates of the relative loss of the Atlantic greater amberjack stock. Several estimates were developed and the “best” estimate of relative loss used to create an index of relative abundance for the Atlantic greater amberjack stock.

Porch’s (1998) method of estimating annual mortality rates from tagging data is based upon the probability of a tagged fish being recaptured assuming M and reporting rates are constant over time:

$$p(recapture) = \frac{F_w e^{-\sum_{i=a}^{w-1} Z_i \Delta_i - Z_w (t_w - d_w)}}{\sum_{i=a}^{I} \frac{F_i}{Z_i}(1 - e^{-Z_i \Delta_i}) e^{-\sum_{j=a}^{i-1} Z_j \Delta_j}}$$

Where

t_α = time (date) animal was tagged
t_w = time (date) animal was recaptured
α = discrete time interval during which the animal was tagged
w = discrete time interval during which the animal was recaptured
d_I = time (date) at start of i’th interval, except $d_\alpha = t_\alpha$
Δ_I = time spent in each interval (d_{i+1}-d_i)
I = last interval for which data are available

F = fishing mortality rate
Z = all sources of tag loss, includes natural and fishing mortality, tag shedding, non-reported recaptures, emigration, etc.

This method in practice cannot distinguish between sources of tag loss. The method estimates the total tag losses (Z*) for each time period. These Z* values contain the effects of tag shedding, emigration from the study area, non reported recaptures, etc in addition to natural and fishing mortality rates. If all factors other than annual fishing mortality rates can be assumed constant during the study period, then the relative change in the annual Z* estimates from this method can be used as an index of the relative changes of annual F in the fishery. The loss rate reported here is formed by dividing each annual Z* estimate by the average of all estimates such that the index is centered about 1.0. This standardization allows for easy comparison of values estimated under different assumptions or from different subsets of the database.

The program TAP2 (C. Porch; NMFS, SEFSC, pers. comm.) allows for two methods of estimating these time period specific Z* rates. Each Z* can be estimated independently or through a Bayesian random walk. In the case of the random walk, the amount of change allowed in Z* between successive time intervals is determined by a user supplied value (σ) which causes changes larger than e^{σ} to be unlikely. The discrete time intervals used in the program were fishing years from May of one year to April of the next calendar year, with the exception of the first and last time periods. The first time period ranged from January 1960 to April 1961 and the last time period ranged from May 1997 to December 1998. Not enough data was available in these periods to use only single fishing years.

Four estimation procedures were considered for the time series; estimating annual loss rates for all years independently and fixing the random walk sigma at the values of 0.1, 0.3 and 0.5. The random walk sigmas constrain the model such that interannual variation in Z*'s are permitted to vary to lower degrees with lower sigmas. These estimates used only fish, which had at least one day at large between time of tagging and time of recapture. A number of sensitivity analyses were also performed, for example, estimating Z* values for periods of two years, changing the minimum number of days at large, or allowing changes in tag-recapture rates. The resulting series of Z* estimates were rescaled by the average for that time series and case to produce the relative loss values.

The number of greater amberjack caught each year in the private angler sector of the recreational fishery (Cummings and McClellan 1999) was used to transform the loss estimates into relative abundance estimates because the majority of tags were from this sector. The catches were either kept and released dead fish (A+B1) or all catch, including fish released alive, (A+B1+B2). These annual catches were used in the catch equation by assuming a constant level for the natural mortality rate (M) and a constant level for non-fishing related tag loss such that the Z* could be separated into its components of M, F and non-fishing related tag loss. The only remaining unknown in the catch equation is then the population abundance in numbers [$N=CZ/(F(1-e^{-Z}))$]. Each time series of values was re-scaled to average 1.0 by dividing annual values by the average of the time series.

These relative abundance values could be used as a tuning index for age structured assessment models, such as virtual population analysis.

Greater Amberjack CPUE Analysis Results

MRFSS CPUE Analyses

Summary statistics on the number of MRFSS intercepts and the nominal CPUE values of catch per angler hour (CPH) fished available for the charter and private boat fisheries for Atlantic greater amberjack are given in Tables 1a – 1e. Fishing year 1998/99 (May 1 1998 - April 30 1999) was incomplete as data were only available through December 1998 thus only fishing years 1981/82 – 1997/98 were used in developing abundance trends. The majority of the intercepts were from fishing years 1986 through 1995/96. Most anglers catching one or more of the amberjack species were intercepted on the East Coast of Florida (n=767) followed by North Carolina (n=565), and then off Monroe county, Florida (n=319) (Table 1b). Recreational fishing trips from Georgia and South Carolina contributed 4% and 12% respectively to the total database of charter and private boat intercepts. Intercepts from the charterboat recreational mode made up 69 % of the data and 31 % of the intercepts were from the private boat fishery. The nominal CPUE values suggest that the private boat fishery CPUE (CPH) was higher (across all years) than for the charterboat fishery for Atlantic greater amberjack (Table 1c). The exception to this was in Georgia. The monthly distribution of MRFSS intercept observations (Table 1d) indicates that amberjack were encountered during most months of most fishing years and also indicates temporal differences in the nominal CPUE values. Effort measures other than anglers or hours fished were not recorded thus catch per angler angler hour was calculated and used. The plotted CPH data showed skewed distributions suggesting a transformation was appropriate (Figure 1). A log transformation of the raw CPH fished observations resulted in a more symmetrical distribution of the charter and private boat fishery intercepts (Figure 1).

Relative abundance trends, referred to as standardized abundance trends, in this paper, were calculated using the GLM approach for the charter and private fisheries separately, the combined dataset of charter and private boat intercepts, and for the charter and private intercepts from Florida only. Summary results pertaining to each fit are included in Table 2. For each fit, the y-variate, was CPH fished and auxiliary information included in each fit as (X) variables to adjust CPH trends were the fishing year, month of intercept, state-county id, whether targeting greater amberjack or not, and bag limit stanza. In the case of the charter and private boat combined analysis, fishery type was also included as an independent variable in the mode.

As in previous year's analyses of the MRFSS CPUE observations for Atlantic greater amberjack, the analyses indicated the amount of un-explained variability in the data from these models was high. The proportional amount of the variance explained by the fits was not high, ranging from 21 to 44 %. The best fit in terms of R^2 was obtained using the charterboat fishery observations, all states combined. For the majority of the fits, the inclusion of bag limit stanza (3 or none) or a term for whether the angler was targeting greater amberjack or was not targeting this species not was not significant in the model.

The calculated standardized abundance trends from the GLM fits for the charter and private boat fisheries off Florida were not in total agreement (Figure 2). The estimated fishing year abundance pattern from the charterboat fishery showed variability from 1981 through 1992 and stable abundance thereafter (Figure 2). The private boat fishery abundance pattern suggested increased abundance from 1990-1993 and followed by a decline through 1996 (Figure 2). The variability in these estimates was high.

Estimates of the number of fishing trips from these fisheries are available through the MRFSS survey; these were summarized by fishing year to obtain some feeling for the amount of total recreational effort expended by each fishery group (Figure 3). Estimated charterboat effort (number of fishing trips) was stable from about 1990 through 1997 while the estimated private boat effort (number of fishing trips) showed large increases between 1985 and 1988, a decline of about 30% in 1989, varied without trend through 1995, and declined again in 1996.

The GLM estimated abundance trends from the "all states combined fit" charter and private boat fisheries are shown by fishing year with the estimated total effort for each fishery (Figure 4). The all states combined abundance estimation results were used in subsequent analyses of the stock evaluation as the trends did not differ when only the Florida samples were used; using the observations from all states better represented the range of the Atlantic greater amberjack stock, increased the sample size and the R^2 values were higher.

The Lo method was used to develop abundance trends of the Atlantic greater amberjack stock using the combined data from the charter and private boat fisheries, all states combined. For this analysis observations of positive catches of Atlantic greater amberjack and also observations of zero catches of greater amberjack that occurred when an angler was intercepted and reported catching one of the other commonly sought after amberjacks (e.g., Alamo, banded rudder, lesser) but did not catch greater amberjack. were used. These anglers could have reported targeting greater amberjack (or any of the other jacks listed here). The model included the same independent variables as used in the previous GLM runs (fishing year, month, state-county, fishery, bag_limit stanza, and whether targeting greater amberjack or not). The Lo method produced similar results, as did the GLM procedure for the charter and private boat data combined, however the variance estimates of the fishing year parameter were much higher. All of the independent variables were important in explaining CPUE except for bag limit as the case found using the GLM. In this application since very few observations of zero greater amberjack catches existed in this dataset, the analysis set was very similar to that of the input data used in the GLM. The proportion of positive catches was very high and similar results would be expected since this portion of the data dominated in the calculation of the expected CPUE. For this reason and also because the variability was lower for the fishing year estimates estimate via GLM, the GLM abundance estimates results were used in further analyses related to the status of the Atlantic greater amberjack stock. Future evaluation of this approach using the total intercept database may be warranted.

Commercial Logbook CPUE Analyses

The number of trips, proportion with greater amberjack and the pounds per trip by fishing gear and fishing year (Tables 3-5), were reviewed to select which observations would be used for developing indices of abundance. Data from gears from which little data were available [cast net, gill net, trap, vertical longline (buoy) or other] were not included in those tables and were not considered for analysis. It was decided to develop an index from handline data because there were substantial numbers of trips recorded and greater amberjack generally represented a substantial fraction of the total landings (roughly 15-25% across all trips). Longlines were rejected because greater amberjack generally represented less than 1% of the total landings. Powerheads are a special kind of spear fishing gear. Development of a combined spear and powerhead index was initially considered, because greater amberjack were reported on a substantial fraction of the powerhead and spear trips (generally over 35% and 20%, respectively) and represented substantial fractions of the total yield (roughly 20-40%). It was thought necessary to distinguish the two gears in developing an index of abundance, because of probable differences in efficiency. It was noted that the two gears would not be distinguished in the earliest years of the data set and the consistency in the number of trips per year suggested that they were reliably distinguished only from 1995-1998. It was decided that an index would not be developed from these gears, because of the small number of years available. It was decided not to develop an index from the troll data, because of the relatively small proportion of amberjack in the total yield reported taken by trolling.

Regression tree analysis of handline catch rates and proportions of positive trips were used to define seasons and regions. Examination of proportion positive and catch rates by month (Appendices 1 and 2) indicated that lower positive catch rates and lower proportions positive occurred in the more northern latitudes. It was noted that latitude 29 had high positive catch rates in most months and high proportions positive. May and March (months 5 and 15) had high positive catch rates and high proportions positive, while April had lower statistics. Differences were noted in the relative importance of latitudes between the proportion positive and the positive catch rate analyses. In aggregating latitudes into regions, greater weight was placed on the proportion positive results (i.e., estimates of the probability of catching amberjack on a trip), because often proportion positive has a stronger influence on abundance index patterns than the positive catch rates. Therefore four regions (24-26N, 27-28N, 29-33N and 34-35N) were defined. The analytical results with respect to month were more consistent between the proportion positive and positive catch rate analyses. Because May and March were the months of the highest positive catch rates and proportion positives, they were combined with April into one season and three other 3 month seasons were defined.

Units of effort considered for calculating catch rates from the handline fishery included days at sea, hours fished during the entire trip, number of lines fished per day, number of hooks fished per day, total number of line-days (lines per day * days at sea), total number of line-hours, total number of hook-days and total number of hook-hours. GLM analyses of greater amberjack landings per trip with the various effort measures (Table 6) had low

R^2 (10-12%). Hooks per day had the lowest probability for the F statistic and highest R^2 and was selected as the unit of effort.

All Vessels

Fishing year, season and region were investigated as effects in analyses with data from all handline vessels. The season*region interactions were statistically significant in both the proportion positives and the yield per hook analyses and the random effects three way interaction was estimable and included (Tables 7 and 8). The estimated index of abundance (Table 9 and Figure 6) had a high fishing year 1991 value with a coefficient of variation of 0.51 which was roughly twice that of subsequent years. After 1991 the index shows an increase to 1995 and a decline thereafter. The confidence intervals (two standard errors above and below the index) suggest that differences in the annual index values were not highly significant.

Analysis of Restricted Data Sets

There was concern that some handline vessels might not target amberjack or species with which amberjack might be associated. If the fraction of vessels not targeting amberjack or associated species changed over time then an index of abundance from the entire fishery might be influenced by changes not related to abundance. Therefore additional indices were derived using data from selected vessels which might have been targeting amberjack or associated species.

Restricted data sets were developed by limiting the observations to those vessels with either high proportions of trips with greater amberjack or high greater amberjack catch rates on successful trips. Additionally, to be included, vessels had to have reported at least 10 handline trips in each of at least 5 years in a region.

90^{th}-99^{th} Percentile Vessels

Results of the analyses of data from vessels in the top 10% of vessels in proportion positive or catch rate on successful trips are presented in Tables 10 and 11. Data from the 27-28N region were excluded to permit a more balanced distribution of data across fishing years, seasons and regions. The three-way random effects interaction (i.e., fishing year*season*region) appeared to be influential and was included in both models. The standardized index (Table 12 and Figure 7) indicated high catch rates of Atlantic greater amberjack in the 1994 and 1995 fishing years with catch rates in 1992-1993 and 1996-1997 at similar levels and the lowest catch rate in 1998.

75^{th}-99^{th} Percentile Vessels

Results of analyses of data from vessels in the top 25% of vessels in proportion positive or catch rate on successful trips are presented in Tables 13 and 14. Data from 1991 and from the 27-28N region were excluded to permit a more balanced distribution of observations across fishing years, seasons and regions. The season*region interaction was significant in both models, and the three-way random effects interaction appeared to be influential in both. The standardized index (Table 15 and Figure 8) indicated high catch rates in 1992, 1994 and 1995 with catch rates in 1993 and 1996-1997 at similar levels and the lowest catch rate in 1998.

Comparison between the three indices (Figure 9) showed that the indices had similar patterns. The analyses using all handline vessels and using the vessels in the 90th-99th percentile included 1991; the divergence of those indices in 1991 may reflect sparse data distribution in that year. Because of the possibility that effects not related to greater amberjack abundance may have influenced the all vessel index trend, the restricted data set trends were preferred. Because the two restricted sets had generally similar patterns, the 75th-99th percentile index was selected for use in subsequent assessments, because this index was based on more data and the data were more evenly distributed because of the elimination of 1991 year data and the observations from 27-28N region.

NMFS Headboat CPUE Analyses Results

Regression tree analysis of headboat catch (number of fish) per angler was used to gain insight into effects due to trip types, associated taxa as well as seasonal and geographic patterns in the data. Initial analyses included trip type and desegregated taxa (Appendix 3) and trip type with aggregated taxonomic information (Appendix 4). The analyses with trip type consistently indicated substantially higher catch rates for full day trips than for partial day trips. Because the partial day catch rates were so low, it was concluded that they might not provide much information on greater amberjack abundance patterns and they were excluded from subsequent analyses. Additional analysis was conducted using only full day trips with the aggregated taxonomic information (Appendix 5). Common components of all three of these analyses were that latitude 30 or 30 and 31 had higher catch rates than the other latitudes and that substantially higher average catch rates occurred in 1981-1982 or 1980-1982. When data splits were based on month, May was almost always classified with the higher catch rates and April was often in that grouping. It was also noted that in these analyses the first low catch rate node (node 2) accounted for 80-90% of the observations, and there was less discrimination provided by the explanatory variables for those low catch rates than for the higher catch rates classified below node 3. Thus the numerous low catch rate observations had less information content than the higher catch rate observations.

Examination of positive catch rates by latitude and month (Figures 10 and 11) provided additional detail for defining regions and seasons. The high catch rates in the area of 30N were apparent. Examination of the associated raw data revealed that those catch rates were associated with multiple vessels in multiple months and that lower catch rates were observed in the same region at about the same time. Based on the regression tree results and Figure 10, four regions were defined: 24-25.4N, 25.5-28.6N, 28.7-30.6N, and 30.7-35N. It was decided to use four seasons of three months each. As noted from the regression tree results and in Figure 11, April and May often had higher catch rates and June had higher rates than March. Therefore April, May and June were combined and the remaining months assigned to appropriate seasons. The fishing year thus started in April and continued through March of the following year.

Initial analyses of proportions positive and positive catch rate revealed difficulties associated with the taxonomic variables. Those variables were often correlated and typically there were few observations for some levels of those effects which resulted in a very sparse distribution of the data and associated difficulties in analytical fitting. Collapsing the three aggregated taxonomic groups to two levels from four did not eliminate the problems; therefore one of those variables (inshore species) was selected for inclusion in the final model.

The data available for the earliest years of the head boat survey were limited in number and geographic coverage. Because of very limited samples in those early years all data from 1974 and 1975 were excluded, the data for the 25.5-28.6N region were restricted to 1978 and later, and the data for the 24-25.4N region were restricted to 1979 and later. Final analyses included factors for fishing year, season, region and the relative importance of inshore species in the catch. A four-way random effect interaction term was included. Results of the analyses of proportions positive and of catch rates on trips with greater amberjack are shown in Tables 16 and 17. The final index showed an increase from 1977 to a peak in 1982, a general decline through much of the 1980's, with fluctuating levels in the late 1980's through mid 1990's and lower levels since then (Table 18 and Figure 12).

One additional set of analyses was performed to investigate the influence of the inshore taxa factor on the estimated standardized catch rates by redoing the all final analytical steps without that factor. Figure 13 shows that the relative index was quite similar with or without the inshore factor.

Tagging Data Loss Rate Results

The number of greater amberjack tagged, the number recaptured, and the relative loss values with coefficients of variation for each year are presented in Table 19 and relative loss is shown in Figure 14 The general pattern is the same in all four scenarios, high values in the 60's, decreasing to the lowest values in the 80's, followed by an increasing trend in the 90's. The coefficients of variation (CV) for the random walk models reflect the constraint imposed by the random walk process while the CV for the independent estimation of each year depends upon the sample size for that year (Table 19 and Figure 15). Three types of sensitivity analyses were performed. Instead of estimating Z* for every year, one Z* was estimated for every two years in order to examine if the low number of observations in some years were causing artifacts in the Z* estimates. The relative loss pattern did not change (Figure 16). Secondly, the minimum number of days at large was changed from one to either zero or seven in order to examine whether sufficient mixing of tagged and untagged fish was occurring. Again, the relative loss pattern did not change (Figure 17). The final sensitivity analysis allowed the proportion of tags reported to vary through a random walk process instead of being held constant in order to examine whether changes in reporting rates could explain the changes in Z*. Under two levels of sigma for the reporting rate random walk, the relative loss pattern did not change (Figure 18) even though the fraction reported was estimated to decrease over time (Figure 19).

Since all sensitivity analyses showed the same relative loss pattern, the EstAll time series was used to form relative abundance time series using the two catch series (Figure 20) and four assumptions of how Z* could be split into its components (Table 20 and

Figure 21). The eight relative abundance time series are similar in trend and have a similar pattern of uncertainty about the point estimates, as demonstrated by Case 1 (Figure 22). The trend in abundance is increasing, but highly variable especially at the two peaks, from 1981 through 1989. From 1989 to 1990, the relative abundance values drop suddenly both in value and in variability. The trend from 1990 through 1997 is decreasing, with lower levels of uncertainty than the 1981 through 1989 estimates. This change in level of variability is caused by a large change in sample size (see Table 19).

Given the high level of uncertainty in the 1981 through 1989 values, the relative abundance trends for the eight cases were computed for only years 1990 through 1997 (Table 21 and Figure 23). Note these computations only rescaled the estimates from 1990-1997, they did not require additional Z* estimation. These values grouped by the catch used in the calculations, with the four assumptions of how Z* is split adding only a small additional amount of variability among the cases. The relative abundance trends are more dependent upon the choice of catch than the choice of M and non-fishing related tag loss, when the latter two are assumed constant over the time series. If either M or the non-fishing related tag loss varied within the time series, these variables would become much more important in determining the trend in relative abundance. Plotting the uncertainty about the point estimates for Case 1 shows that some of the values are significantly different from others at the 80% confidence level (Figure 24).

A summary of the indices considered for use in further evaluations of the Atlantic greater amberjack stock condition is given in Table 22. These results provide four measures of the abundance of this stock. Three of the indices overlap in some degree as they all derived from recreational fishery, MRFSS charter, MRFSS private, and the tagging index. Future CPUE examinations should further examine the disparity between the MRFSS charter and the private index. Further examinations of the logbook data might consider the effect of zero trips in the analysis as done for the headboat fishery. Analyses of the tagging data might consider the impact of time at liberty on the loss rate calculation. Sutherland and Scott (see McClellan and Cummings 1996) reported greater amberjack generally had limited movements with about one third of the tagged fish recaptured within 60 days of release. McClellan and Cummings (1996) reported that 41 % were recovered within 90 days, 69% within one year and 84.8% within two years.

Acknowledgments

Patty Phares provided all data pertaining to the recreational and headboat fishery. John Poffenberger provided commercial logbook data and Nelson Johnson answered many questions related to using these data. Clay Porch provided the analysis program, TAP, used in the tagging analysis. Larry Massey provided editorial assistance. Thanks are extended to these individuals for their timeliness.

Literature Cited

Cummings, N. J. 1998. Fishery statistics for the Atlantic greater amberjack, *Seriola dumerili*, since 1995. U.S. Dept. of Comm., NOAA, NMFS, SEFSC, Sustainable Fisheries Division SFD/98/99-41 27p.

Cummings, N. J. and D. B. McClellan. 1999. Characteristics of the Atlantic greater amberjack fishery through fishing year 1997. U.S. Dept. of Comm., NOAA, NMFS, SEFSC, Sustainable Fisheries Division SFD/98/99-61p.

Cummings, N. J. and D. B. McClellan. 1997. Status of the Greater Amberjack, *Seriola dumerili*, in the southeastern United States through 1995. Proc. Gulf and Carib. Fish. Inst. 49: 246-272.

Harris, K. C., G. N. Johnson, C. W. Krouse, and A. J. Chester. 1994. The 1993 South Atlantic snapper-grouper logbook program. U.S. Dept. of Comm., NOAA, NMFS, SEFSC Miami Lab. Contr. MIA- 50p.

Lo, N.C., L.D. Jackson, and J.L. Squire. 1992. Indices of relative abundance From fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49: 2515-2526.

McClellan, D.B. and J. A. Bohnsack. 1991. Review of the Gulf of Mexico reef fish logbook reporting system. U.S. Dept. of Comm., NOAA, NMFS, SEFSC Miami Lab. Contr. MIA- 36p.

McClellan, D.B and N.J. Cummings. 1997. Preliminary analysis of tag and recapture data of the greater amberjack, *Seriola dumerili*, in the southeastern United States. Gulf and Caribbean Fisheries Institute Proceedings 49: 25-45.

Parrack, N. C. [1993] The exploitation status of the Atlantic amberjack fisheries through 1991. U.S. Dept. of Comm., NOAA, NMFS, SEFSC Miami Lab. Contr. MIA-92/93-77. 32 p.

Parrack, N. C. 1993b. Updated fisheries information for greater amberjack through 1992. U.S. Dept. of Comm., NOAA, NMFS, SEFSC, Miami Lab. Contr. No. MIA-92/93-77 32 p.

Porch, C. E. 1998. Estimating Atlantic bluefin tuna mortality from the release and recapture dates of recovered tags (preliminary results). ICCAT SCRS/98/65. 9 pp.

Robson, D. S. 1966. Estimation of the relative fishing power of individual ships. ICNAF Res. Bull. No. 3:5-15.

Venables, W. N. and B. D. Ripley. 1997. Modern applied statistics with S-Plus. Springer. New York. 548 p.

Table 1a. Summary of Atlantic Greater Amberjack MRFSS CPUE data on Catch per Hour)and Catch per Angler hour (CPA).

Fishing Year	Number of Observations	Mean CPH	Mean CPA
1981/82	18	0.41	2
1982/83	29	0.19	1.15
1983/84	46	0.2	0.98
1984/85	62	0.19	1.16
1985/86	68	0.28	1.22
1986/87	145	0.27	1.25
1987/88	137	0.22	1.05
1988/89	167	0.19	0.76
1989/90	140	0.28	1.09
1990/91	132	0.25	1.18
1991/92	182	0.27	1.08
1992/93	159	0.26	1.21
1993/94	139	0.32	1.44
1994/95	123	0.24	1.06
1995/96	130	0.24	1.05
1996/97	109	0.23	1.06
1997/98	105	0.25	1.21
1998/99	71	0.22	1.06

Table 1b. Summary of Atlantic Greater Amberjack MRFSS CPUE Data (Catch Per Hour) by fishing year and state of intercept.

	Florida (west)		Florida (east)		Georgia		South Carolina		North Carolina		All States	
Fishing Year	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH
1980/81			3	0.42							3	0.42
1981/82	10	0.51	8	0.29							18	0.41
1982/83	9	0.19	15	0.21	2	0.06	2	0.16	1	0.2	29	0.19
1983/84	14	0.26	27	0.19			3	0.07	2	0.13	46	0.2
1984/85	12	0.15	32	0.23	7	0.17	9	0.15	2	0.04	62	0.19
1985/86	8	0.55	34	0.27	8	0.09	14	0.23	4	0.34	68	0.28
1986/87	29	0.35	45	0.28	11	0.23	50	0.24	10	0.13	145	0.27
1987/88	10	0.28	33	0.41	10	0.15	39	0.15	45	0.16	137	0.22
1988/89	20	0.12	64	0.3	6	0.1	46	0.14	31	0.1	167	0.19
1989/90	11	0.23	58	0.41	1	0.4	26	0.21	44	0.17	140	0.28
1990/91	13	0.21	68	0.33	2	0.08	7	0.26	42	0.15	132	0.25
1991/92	34	0.33	91	0.3	1	0.12	5	0.17	51	0.21	182	0.27
1992/93	34	0.44	72	0.28	11	0.27	6	0.06	36	0.1	159	0.26
1993/94	24	0.26	52	0.34			10	0.2	53	0.34	139	0.32
1994/95	13	0.17	41	0.35	5	0.1	2	0.28	62	0.19	123	0.24
1995/96	12	0.17	41	0.35	2	0.06	1	0.06	74	0.19	130	0.24
1996/97	6	0.1	31	0.39	4	0.04	9	0.16	59	0.19	109	0.23
1997/98	45	0.23	23	0.24	4	0.04	8	0.37	25	0.31	105	0.25
1998/1999	15	0.1	29	0.23	2	0.07	1	0.08	24	0.29	71	0.22
Total	319	0.27	767	0.31	76	0.15	238	0.19	565	0.2	1965	0.25

Table 1c. Summary of Atlantic Greater amberjack MRFSS CPUE Data by fishing mode and state of intercept.

	Florida (west)		Florida (east)		Georgia		South Carolina		North Carolina		All States	
Fishing Mode	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH
Charter	268	0.24	501	0.3	47	0.17	192	0.17	351	0.16	1359	0.23
Private	51	0.45	266	0.32	29	0.12	46	0.28	214	0.26	606	0.3
ALL	319	0.27	767	0.31	76	0.15	238	0.19	565	0.2	1965	0.25

Table 1d. Summary of Atlantic Greater Amberjack MRFSS CPUE Data by fishing year and month of intercept.

	MONTH													
	January		February		March		April		May		June		July	
Fishing Year	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH
1980/81							3	0.42						
1981/82							4	0.78	4	0.24	6	0.47		
1982/83			1	0.15	2	0.11	4	0.27	6	0.12	2	0.11	4	0.17
1983/84			9	0.32	5	0.15	5	0.24	4	0.16	7	0.27	4	0.05
1984/85			2	0.06	9	0.26	1	0.4	21	0.25	3	0.12	4	0.11
1985/86	6	0.25	8	0.29			23	0.35	9	0.19	6	0.11	4	0.25
1986/87	1	0.17	2	0.49	8	0.25	16	0.42	7	0.17	19	0.18	16	0.25
1987/88			3	0.28	5	0.25	10	0.17	8	0.14	24	0.35	20	0.31
1988/89	3	0.18			9	0.14	40	0.27	17	0.17	17	0.32	19	0.1
1989/90					7	0.32	28	0.47	26	0.27	5	0.3	13	0.28
1990/91	1	0.25	2	0.15	13	0.38	27	0.26	34	0.29	9	0.21	11	0.19
1991/92	13	0.36	10	0.36	44	0.26	22	0.28	32	0.36	16	0.27	12	0.19
1992/93			15	0.37	9	0.45	9	0.44	28	0.36	20	0.19	23	0.16
1993/94	3	0.11	11	0.27	11	0.28	23	0.35	16	0.24	15	0.28	13	0.48
1994/95	4	0.17	1	1.08	5	0.24	6	0.07	23	0.53	17	0.17	33	0.16
1995/96	2	0.17	8	0.2	27	0.23	19	0.41	16	0.38	28	0.2	14	0.12
1996/97	4	0.18	5	0.56	13	0.27	5	0.22	15	0.14	11	0.18	18	0.31
1997/98	16	0.34	8	0.14	8	0.32	4	0.2	2	0.04	10	0.18	13	0.43
1998/99									13	0.24	8	0.31	11	0.34
Total	53	0.28	85	0.31	175	0.27	249	0.33	281	0.29	223	0.24	232	0.23

	August		September		October		November		December		All Months	
Fishing Year	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH
1980/81											3	0.42
1981/82	1	0.02	1	0.33			2	0.07			18	0.41
1982/83	3	0.43	4	0.18	2	0.18			1	0.05	29	0.19
1983/84	6	0.07	3	0.22	3	0.15					46	0.2
1984/85	9	0.18	5	0.15	6	0.09	2	0.07			62	0.19
1985/86	7	0.35	2	0.5	2	0.2	1	0			68	0.28
1986/87	16	0.25	33	0.19	7	0.18	10	0.38	10	0.48	145	0.27
1987/88	27	0.21	24	0.15	9	0.1	6	0.15	1	0.25	137	0.22
1988/89	9	0.1	20	0.09	12	0.18	20	0.2	1	0.2	167	0.19
1989/90	11	0.19	15	0.21	26	0.18	8	0.29	1	0.11	140	0.28
1990/91	15	0.21	3	0.07	7	0.19	6	0.13	4	0.36	132	0.25
1991/92	13	0.16	12	0.2	4	0.07	4	0.2			182	0.27
1992/93	17	0.25	11	0.17	13	0.19	7	0.18	7	0.16	159	0.26
1993/94	23	0.43	4	0.34	6	0.18	12	0.21	2	0.17	139	0.32
1994/95	8	0.12	8	0.21	9	0.27	6	0.1	3	0.04	123	0.24
1995/96	5	0.15	1	0.1	6	0.11	3	0.04	1	0.13	130	0.24
1996/97	16	0.3	5	0.14	11	0.16	5	0.05	1	0.04	109	0.23
1997/98	12	0.32	6	0.15	11	0.18	6	0.21	9	0.13	105	0.25
1998/99	5	0.13	6	0.15	11	0.18	12	0.14	5	0.16	71	0.22
Total	203	0.24	163	0.17	145	0.17	110	0.19	46	0.23	1965	0.25

Table1e. Summary of Atlantic Greater Amberjack MRFSS Data for observed Catch per Hour (CPH) by state and code county.

	Florida (west)		Florida (east)		Georgia		South Carolina		North Carolina		All States	
Fishing Area	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH	Number of Trips	Mean CPH
5022	319	0.27									319	0.27
6023			110	0.29							110	0.29
6024			95	0.29							95	0.29
6025			397	0.33							397	0.33
6026			37	0.26							37	0.26
6027			9	0.43							9	0.43
6028			4	0.23							4	0.23
6029			24	0.18							24	0.18
6030			23	0.39							23	0.39
6032			12	0.72							12	0.72
6034			50	0.21							50	0.21
6035			6	0.24							6	0.24
7029					1	0.04					1	0.04
7039					10	0.2					10	0.2
7051					29	0.15					29	0.15
7127					34	0.14					34	0.14
7191					2	0.09					2	0.09
8013							118	0.21			118	0.21
8015							1	0.25			1	0.25
8019							33	0.21			33	0.21
8043							77	0.15			77	0.15
8051							9	0.16			9	0.16
9019									62	0.1	62	0.1
9031									98	0.11	98	0.11
9055									281	0.24	281	0.24
9095									48	0.32	48	0.32
9129									60	0.13	60	0.13
9133									7	0.19	7	0.19
9141									9	0.18	9	0.18
ALL	319	0.27	767	0.31	76	0.15	238	0.19	565	0.2	1965	0.25

Table 2. Summary Results of the Atlantic Greater amberjack MRFSS CPUE Analyses

RUN ID	TYPE MODEL FIT	# Observations	Proportion of Total Sum of Squares Explained	Comments On Model Fit
1 Florida Charter	GLM ON Positive Catches	735	21.56	Bag Limit Term Not Significant
2 Florida Private	GLM ON Positive Catches	304	20.66	Bag Limit Term Not Ssignificant
3 Charter All States	GLM ON Positive Catches	1195	44.16	Bag Limit Term Not Significant
4 Private All States	GLM ON Positive Catches	525	27.71	Bag Limit Term Not ignificant, Month not Significant
5 Charter and Private	GLM ON Positive Catches	1725	34.23	

Table 3. Number of trips by gear and fishing year. H = handline, L=longline, P=powerhead, S=spear, and TR=troll.

FISHYEAR	GEAR					
	H	L	P	S	TR	Total
1990	91	6	0	4	0	101
1991	1467	77	0	83	156	1783
1992	6820	348	0	532	777	8477
1993	14216	773	5	1066	1705	17765
1994	15436	719	89	869	1972	19085
1995	14613	886	245	708	2148	18600
1996	16338	653	275	763	1995	20024
1997	16140	584	286	833	4119	21962
1998	13419	441	233	709	8050	22852
Total	98540	4487	1133	5567	20922	130649

Table 4. Proportion of trips with greater amberjack by gear and fishing year. H = handline, L=longline, P=powerhead, S=spear, and TR=troll

FISHYEAR	GEAR				
	H	L	P	S	TR
1990	0.0769	0.1667	0	0	0
1991	0.1506	0.0779	0	0.506	0.0769
1992	0.1412	0.1868	0	0.2632	0.0914
1993	0.1583	0.1565	0.4	0.2523	0.1091
1994	0.1631	0.1043	0.4831	0.2831	0.0791
1995	0.1708	0.0982	0.5959	0.1977	0.0982
1996	0.1694	0.0873	0.5127	0.194	0.0957
1997	0.1494	0.1318	0.3531	0.1669	0.0583
1998	0.1104	0.0545	0.4979	0.1975	0.0245

Table 5. Proportion of greater amberjack in the total yield by gear and fishing year. H = handline, L=longline, P=powerhead, S=spear, and TR=troll

FISHYEAR	GEAR				
	H	L	P	S	TR
1990	0.0234	0.0044	0	0	0
1991	0.2681	0.0011	0	0.3027	0.0193
1992	0.1778	0.0097	0	0.3129	0.0429
1993	0.1597	0.0119	0.1469	0.3269	0.0498
1994	0.1598	0.009	0.323	0.4002	0.039
1995	0.1516	0.0088	0.4001	0.214	0.0418
1996	0.14	0.0039	0.3952	0.2337	0.0346
1997	0.1298	0.0063	0.3388	0.2367	0.0382
1998	0.086	0.0019	0.1961	0.2884	0.0143

Table 6. GLM analyses of greater amberjack landings per trip including fishing year, season, region and various measures of effort.

Class Level Information

Class	Levels	Values
FISHYEAR	8	1991 1992 1993 1994 1995 1996 1997 1998
REGION	4	24-26N 27-28N 29-33N 34-35N
SEASON	4	AprMayJun JanFebMar JulAugSep OctNovDec

Dependent Variable: LYIELD

____ days at sea ____

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	23	2867.24724505	124.66292370	61.32	0.0001
Error	11799	23985.88178275	2.03287412		
Corrected Total	11822	26853.12902780			

R-Square	C.V.	Root MSE	LYIELD Mean
0.106775	28.19378	1.42578895	5.05710517

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FISHYEAR	7	129.38310373	18.48330053	9.09	0.0001
SEASON	3	76.17393025	25.39131008	12.49	0.0001
REGION	3	1206.77279904	402.25759968	197.88	0.0001
SEADAYS	1	12.55311285	12.55311285	6.18	0.0130
REGION*SEASON	9	559.67895500	62.18655056	30.59	0.0001

Table 6. continued

hours fished per trip

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	23	2856.96346700	124.21580291	61.08	0.0001
Error	11799	23996.16556080	2.03374570		
Corrected Total	11822	26853.12902780			

R-Square	C.V.	Root MSE	LYIELD Mean
0.106392	28.19982	1.42609456	5.05710517

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FISHYEAR	7	130.95314713	18.70759245	9.20	0.0001
SEASON	3	75.83075670	25.27691890	12.43	0.0001
REGION	3	1213.27857881	404.42619294	198.86	0.0001
HOURS	1	2.26933480	2.26933480	1.12	0.2908
REGION*SEASON	9	562.31155308	62.47906145	30.72	0.0001

lines fished per day

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	23	2866.91694706	124.64856292	61.32	0.0001
Error	11799	23986.21208074	2.03290212		
Corrected Total	11822	26853.12902780			

R-Square	C.V.	Root MSE	LYIELD Mean
0.106763	28.19397	1.42579876	5.05710517

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FISHYEAR	7	133.56931020	19.08133003	9.39	0.0001
SEASON	3	77.08774217	25.69591406	12.64	0.0001
REGION	3	1195.25913902	398.41971301	195.99	0.0001
LINES	1	12.22281486	12.22281486	6.01	0.0142
REGION*SEASON	9	566.88608784	62.98734309	30.98	0.0001

hooks

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	23	3153.12758289	137.09250360	68.25	0.0001
Error	11799	23700.00144491	2.00864492		
Corrected Total	11822	26853.12902780			

R-Square	C.V.	Root MSE	LYIELD Mean
0.117421	28.02526	1.41726671	5.05710517

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FISHYEAR	7	145.79341018	20.82763003	10.37	0.0001
SEASON	3	71.42778432	23.80926144	11.85	0.0001
REGION	3	1067.00430432	355.66810144	177.07	0.0001
HOOKS	1	298.43345069	298.43345069	148.57	0.0001
REGION*SEASON	9	559.42805481	62.15867276	30.95	0.0001

line hours

Table 6. (Cont.)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	23	2863.03519140	124.47979093	61.22	0.0001
Error	11799	23990.09383640	2.03323111		
Corrected Total	11822	26853.12902780			

R-Square	C.V.	Root MSE	LYIELD Mean
0.106618	28.19625	1.42591413	5.05710517

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FISHYEAR	7	131.74095511	18.82013644	9.26	0.0001
SEASON	3	75.96541654	25.32180551	12.45	0.0001
REGION	3	1258.56529031	419.52176344	206.33	0.0001
LINEHRS	1	8.34105920	8.34105920	4.10	0.0428
REGION*SEASON	9	564.76375924	62.75152880	30.86	0.0001

hook hours

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	23	2871.22217371	124.83574668	61.42	0.0001
Error	11799	23981.90685409	2.03253724		
Corrected Total	11822	26853.12902780			

R-Square	C.V.	Root MSE	LYIELD Mean
0.106923	28.19144	1.42567080	5.05710517

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FISHYEAR	7	131.57462723	18.79637532	9.25	0.0001
SEASON	3	75.18703810	25.06234603	12.33	0.0001
REGION	3	1206.75418156	402.25139385	197.91	0.0001
HOOKHRS	1	16.52804151	16.52804151	8.13	0.0044
REGION*SEASON	9	562.38608511	62.48734279	30.74	0.0001

line days

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	23	2859.15955705	124.31128509	61.13	0.0001
Error	11799	23993.96947075	2.03355958		
Corrected Total	11822	26853.12902780			

R-Square	C.V.	Root MSE	LYIELD Mean
0.106474	28.19853	1.42602931	5.05710517

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FISHYEAR	7	132.13634565	18.87662081	9.28	0.0001
SEASON	3	75.62713686	25.20904562	12.40	0.0001
REGION	3	1252.50869287	417.50289762	205.31	0.0001
LINEDAYS	1	4.46542485	4.46542485	2.20	0.1384
REGION*SEASON	9	564.88972109	62.76552457	30.86	0.0001

Table 6. continued.

____ hook days ____

(Table 6. (Cont.)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	23	2880.25851885	125.22863125	61.64	0.0001
Error	11799	23972.87050895	2.03177138		
Corrected Total	11822	26853.12902780			

R-Square	C.V.	Root MSE	LYIELD Mean
0.107260	28.18613	1.42540218	5.05710517

Source	DF	Type III SS	Mean Square	F Value	Pr > F
FISHYEAR	7	130.98176524	18.71168075	9.21	0.0001
SEASON	3	75.90441963	25.30147321	12.45	0.0001
REGION	3	1201.46154159	400.48718053	197.11	0.0001
HOOKDAYS	1	25.56438665	25.56438665	12.58	0.0004
REGION*SEASON	9	560.83839763	62.31537751	30.67	0.0001

Table 7. Analysis of proportions of all handline trips which caught greater amberjack in the Atlantic Ocean in the United States EEZ.

Class	Levels	Values
FISHYR2	8	1991 1992 1993 1994 1995 1996 1997 1998
SEASON2	4	DecJanFeb JunJulAug MarAprMay SepOctNov
REGION	4	24-26N 27-28N 29-33N 34-35N

Model Fitting Information for proportion positive

Description	Value
Observations	122.0000
Res Log Likelihood	-53.0508
Akaike's Information Criterion	-56.0508
Schwarz's Bayesian Criterion	-59.9435
-2 Res Log Likelihood	106.1017

Information Criteria

Better	Parms	q	p	AIC	HQIC	BIC	CAIC
Larger	3	3	0	-56.1	-57.6	-59.9	-61.4
Larger	26	3	23	-79.1	-92.7	-112.8	-125.8
Smaller	3	3	0	112.1	115.3	119.9	122.9
Smaller	26	3	23	158.1	185.4	225.6	251.6

Tests of Fixed Effects

Source	NDF	DDF	Type III ChiSq	Type III F	Pr > ChiSq	Pr > F
FISHYR2	7	21	17.85	2.55	0.0127	0.0456
SEASON2	3	21	12.22	4.07	0.0067	0.0199
REGION	3	21	306.58	102.19	0.0001	0.0001
SEASON2*REGION	9	57	171.46	19.05	0.0001	0.0001

.

Covariance Parameter Estimates (REML)

Cov Parm	Estimate
FISHYR2*SEASON2	0.01043981
FISHYR2*REGION	0.05463983
Residual	2.98853706

Solution for Fixed Effects

Effect	FISHYR2	SEASON2	REGION	Estimate	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper
INTERCEPT				-2.86513510	0.19966732	21	-14.35	0.0001	0.05	-3.2804	-2.4499

Table 7. (Cont.)

FISHYR2	1991			0.56403445	0.26525109	21	2.13	0.0455	0.05	0.0124	1.1157
FISHYR2	1992			0.32957568	0.20967553	21	1.57	0.1309	0.05	-0.1065	0.7656
FISHYR2	1993			0.54515533	0.20017459	21	2.72	0.0127	0.05	0.1289	0.9614
FISHYR2	1994			0.53972636	0.19943970	21	2.71	0.0132	0.05	0.1250	0.9545
FISHYR2	1995			0.68474341	0.19942989	21	3.43	0.0025	0.05	0.2700	1.0995
FISHYR2	1996			0.71064434	0.19921340	21	3.57	0.0018	0.05	0.2964	1.1249
FISHYR2	1997			0.52088696	0.19886114	21	2.62	0.0160	0.05	0.1073	0.9344
FISHYR2	1998			0.00000000	.	.	.	.	.	.	.
SEASON2		DecJanFeb		-0.22143936	0.19302191	21	-1.15	0.2642	0.05	-0.6229	0.1800
SEASON2		JunJulAug		0.47716142	0.15463618	21	3.09	0.0056	0.05	0.1556	0.7987
SEASON2		MarAprMay		0.08318874	0.17630589	21	0.47	0.6419	0.05	-0.2835	0.4498
SEASON2		SepOctNov		0.00000000	.	.	.	.	.	.	.
REGION			24-26N	-0.42702914	0.18418072	21	-2.32	0.0306	0.05	-0.8101	-0.0440
REGION			27-28N	0.95113815	0.24252795	21	3.92	0.0008	0.05	0.4468	1.4555
REGION			29-33N	1.99511248	0.17897000	21	11.15	0.0001	0.05	1.6229	2.3673
REGION			34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		DecJanFeb	24-26N	0.56281743	0.20408933	57	2.76	0.0078	0.05	0.1541	0.9715
SEASON2*REGION		DecJanFeb	27-28N	0.05965008	0.29261423	57	0.20	0.8392	0.05	-0.5263	0.6456
SEASON2*REGION		DecJanFeb	29-33N	0.14603110	0.20324331	57	0.72	0.4754	0.05	-0.2610	0.5530
SEASON2*REGION		DecJanFeb	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		JunJulAug	24-26N	-0.45051447	0.17425632	57	-2.59	0.0123	0.05	-0.7995	-0.1016
SEASON2*REGION		JunJulAug	27-28N	-0.36412550	0.25813015	57	-1.41	0.1638	0.05	-0.8810	0.1528

Table 7. continued.

SEASON2*REGION	JunJulAug	29-33N	-0.46351812	0.16529139	57	-2.80	0.0069	0.05	-0.7945	-0.1325
SEASON2*REGION	JunJulAug	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION	MarAprMay	24-26N	0.83105120	0.18641964	57	4.46	0.0001	0.05	0.4578	1.2044
SEASON2*REGION	MarAprMay	27-28N	0.04561799	0.26783357	57	0.17	0.8654	0.05	-0.4907	0.5819
SEASON2*REGION	MarAprMay	29-33N	-0.25210842	0.18684167	57	-1.35	0.1826	0.05	-0.6263	0.1220
SEASON2*REGION	MarAprMay	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION	SepOctNov	24-26N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION	SepOctNov	27-28N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION	SepOctNov	29-33N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION	SepOctNov	34-35N	0.00000000	.	.	.	.	.	.	.

Least Squares Means

Effect	FISHYR2	LSMEAN	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper	COV1	COV2	COV3
FISHYR2	1991	-1.57938625	0.22493361	21	-7.02	0.0001	0.05	-2.0472	-1.1116	0.05	0.00	0.00
FISHYR2	1992	-1.81384501	0.15490599	21	-11.71	0.0001	0.05	-2.1360	-1.4917	0.00	0.02	0.00
FISHYR2	1993	-1.59826536	0.14142199	21	-11.30	0.0001	0.05	-1.8924	-1.3042	0.00	0.00	0.02
FISHYR2	1994	-1.60369434	0.14040080	21	-11.42	0.0001	0.05	-1.8957	-1.3117	0.00	0.00	0.00
FISHYR2	1995	-1.45867729	0.14041218	21	-10.39	0.0001	0.05	-1.7507	-1.1667	0.00	0.00	0.00
FISHYR2	1996	-1.43277636	0.14019537	21	-10.22	0.0001	0.05	-1.7243	-1.1412	0.00	0.00	0.00
FISHYR2	1997	-1.62253374	0.13957250	21	-11.63	0.0001	0.05	-1.9128	-1.3323	0.00	0.00	0.00
FISHYR2	1998	-2.14342070	0.14236832	21	-15.06	0.0001	0.05	-2.4395	-1.8473	0.00	0.00	0.00

Table 8. Analysis of positive catch rates of greater amberjack from all handline trips in the United States EEZ in the Atlantic.

Class	Levels	Values
FISHYR2	8	1991 1992 1993 1994 1995 1996 1997 1998
SEASON2	4	DecJanFeb JunJulAug MarAprMay SepOctNov
REGION	4	24-26N 27-28N 29-33N 34-35N

Model Fitting Information for LCPHOOK

Description	Value
Observations	13241.00
Res Log Likelihood	-25454.6
Akaike's Information Criterion	-25456.6
Schwarz's Bayesian Criterion	-25464.1
-2 Res Log Likelihood	50909.17

Information Criteria

Better	Parms	q	p	AIC	HQIC	BIC	CAIC
Larger	2	2	0	-25457	-25459	-25464	-25465
Larger	25	2	23	-25480	-25511	-25573	-25586
Smaller	2	2	0	50913.2	50918.2	50928.1	50930.1
Smaller	25	2	23	50959.2	51021.7	51146.4	51171.4

Tests of Fixed Effects

Source	NDF	DDF	Type III F	Pr > F
FISHYR2	7	98	1.70	0.1183
SEASON2	3	98	4.87	0.0034
REGION	3	98	229.95	0.0001
SEASON2*REGION	9	98	6.46	0.0001

Table 8. continued.

Covariance Parameter Estimates (REML)

Cov Parm	Estimate
FISHYR*SEASON*REGION	0.06836473
Residual	2.70392982

Solution for Fixed Effects

Effect	FISHYR2	SEASON2	REGION	Estimate	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper
INTERCEPT				2.08063743	0.16768212	98	12.41	0.0001	0.05	1.7479	2.4134
FISHYR2	1991			0.38002686	0.19554093	98	1.94	0.0548	0.05	-0.0080	0.7681
FISHYR2	1992			0.01035985	0.13238102	98	0.08	0.9378	0.05	-0.2523	0.2731
FISHYR2	1993			-0.08193061	0.11935143	98	-0.69	0.4940	0.05	-0.3188	0.1549
FISHYR2	1994			0.07975599	0.11808182	98	0.68	0.5010	0.05	-0.1546	0.3141
FISHYR2	1995			0.23178827	0.11764791	98	1.97	0.0516	0.05	-0.0017	0.4653
FISHYR2	1996			0.07485880	0.11791557	98	0.63	0.5270	0.05	-0.1591	0.3089
FISHYR2	1997			0.02078504	0.11797023	98	0.18	0.8605	0.05	-0.2133	0.2549
FISHYR2	1998			0.00000000	.	.	.	.	.	.	.
SEASON2		DecJanFeb		0.12244925	0.22329299	98	0.55	0.5847	0.05	-0.3207	0.5656
SEASON2		JunJulAug		-0.04830498	0.19451186	98	-0.25	0.8044	0.05	-0.4343	0.3377
SEASON2		MarAprMay		-0.16233190	0.20873767	98	-0.78	0.4386	0.05	-0.5766	0.2519
SEASON2		SepOctNov		0.00000000	.	.	.	.	.	.	.
REGION			24-26N	1.86023658	0.19257579	98	9.66	0.0001	0.05	1.4781	2.2424
REGION			27-28N	2.22513015	0.23462561	98	9.48	0.0001	0.05	1.7595	2.6907
REGION			29-33N	1.06742680	0.18294703	98	5.83	0.0001	0.05	0.7044	1.4305
REGION			34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		DecJanFeb	24-26N	0.04425942	0.27643427	98	0.16	0.8731	0.05	-0.5043	0.5928
SEASON2*REGION		DecJanFeb	27-28N	-0.61064583	0.33065271	98	-1.85	0.0678	0.05	-1.2668	0.0455
SEASON2*REGION		DecJanFeb	29-33N	-0.15560263	0.26983767	98	-0.58	0.5655	0.05	-0.6911	0.3799
SEASON2*REGION		DecJanFeb	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		JunJulAug	24-26N	0.16264767	0.25968612	98	0.63	0.5326	0.05	-0.3527	0.6780
SEASON2*REGION		JunJulAug	27-28N	-0.38352089	0.30681820	98	-1.25	0.2143	0.05	-0.9924	0.2253
SEASON2*REGION		JunJulAug	29-33N	-0.12648973	0.24799538	98	-0.51	0.6112	0.05	-0.6186	0.3656
SEASON2*REGION		JunJulAug	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		MarAprMay	24-26N	1.23843232	0.26286674	98	4.71	0.0001	0.05	0.7168	1.7601
SEASON2*REGION		MarAprMay	27-28N	0.22341456	0.31112261	98	0.72	0.4744	0.05	-0.3940	0.8408
SEASON2*REGION		MarAprMay	29-33N	-0.03735220	0.25835643	98	-0.14	0.8853	0.05	-0.5501	0.4753
SEASON2*REGION		MarAprMay	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		SepOctNov	24-26N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		SepOctNov	27-28N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		SepOctNov	29-33N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		SepOctNov	34-35N	0.00000000	.	.	.	.	.	.	.

Least Squares Means

Table 8. (Cont.)

Effect	FISHYR2	LSMEAN	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper	COV1	COV2	COV3
FISHYR2	1991	3.74901219	0.17673619	98	21.21	0.0001	0.05	3.3983	4.0997	0.03	0.00	0.00
FISHYR2	1992	3.37934518	0.10193083	98	33.15	0.0001	0.05	3.1771	3.5816	0.00	0.01	0.00
FISHYR2	1993	3.28705472	0.08353141	98	39.35	0.0001	0.05	3.1213	3.4528	0.00	0.00	0.01
FISHYR2	1994	3.44874132	0.08174061	98	42.19	0.0001	0.05	3.2865	3.6110	0.00	0.00	0.00
FISHYR2	1995	3.60077359	0.08101959	98	44.44	0.0001	0.05	3.4400	3.7616	0.00	0.00	0.00
FISHYR2	1996	3.44384412	0.08188709	98	42.06	0.0001	0.05	3.2813	3.6063	0.00	0.00	0.00
FISHYR2	1997	3.38977036	0.08186413	98	41.41	0.0001	0.05	3.2273	3.5522	0.00	0.00	0.00
FISHYR2	1998	3.36898532	0.08666967	98	38.87	0.0001	0.05	3.1970	3.5410	0.00	0.00	0.00

Table 9. Index of abundance of Atlantic greater amberjack from all handline vessels. CPUE is the standardized catch rates on trips with greater amberjack, PPOS is the proportion positive, INDEX is the standardized index and SE_I and CV_I are the standard error and coefficient of variation about the index.

FISHYR2	CPUE	PPOS	BC_CPU	GC	BC_POS	INDEX	SE_I	CV_I
1991	43.1477	0.17088	152.326	3.58591	0.17088	26.0298	13.4532	0.51684
1992	29.5044	0.14017	110.895	3.77818	0.14017	15.5446	3.8948	0.25055
1993	26.8575	0.16822	101.287	3.78446	0.16822	17.0389	3.9976	0.23462
1994	31.5660	0.16747	119.079	3.78501	0.16747	19.9417	4.6549	0.23343
1995	36.7470	0.18867	138.640	3.78522	0.18867	26.1571	6.0467	0.23117
1996	31.4122	0.19267	118.496	3.78496	0.19267	22.8302	5.2769	0.23114
1997	29.7587	0.16486	112.259	3.78497	0.16486	18.5065	4.3189	0.23337
1998	29.1583	0.10495	109.906	3.78348	0.10495	11.5344	2.7962	0.24242

Table 10. Analysis of proportions of trips which caught greater amberjack from handline vessels in the 90th-99th percentile for positive catch rate or proportion of trips with greater amberjack in the Atlantic Ocean in the United States EEZ.

Class	Levels	Values
FISHYR2	8	1991 1992 1993 1994 1995 1996 1997 1998
SEASON2	4	DecJanFeb JunJulAug MarAprMay SepOctNov
REGION	3	24-26N 29-33N 34-35N

Model Fitting Information for proportion positive

Description	Value
Observations	88.0000
Res Log Likelihood	-88.1390
Akaike's Information Criterion	-90.1390
Schwarz's Bayesian Criterion	-92.3731
-2 Res Log Likelihood	176.2779

Information Criteria

Better	Parms	q	p	AIC	HQIC	BIC	CAIC
Larger	2	2	0	-90.1	-91.0	-92.4	-93.4
Larger	21	2	19	-109.1	-118.4	-132.6	-143.1
Smaller	2	2	0	180.3	182.1	184.7	186.7
Smaller	21	2	19	218.3	236.9	265.2	286.2

Tests of Fixed Effects

Source	NDF	DDF	Type III ChiSq	Type III F	Pr > ChiSq	Pr > F
FISHYR2	7	69	18.66	2.67	0.0093	0.0168
SEASON2	3	69	7.89	2.63	0.0483	0.0569
REGION	2	69	259.82	129.91	0.0001	0.0001
SEASON2*REGION	6	69	21.65	3.61	0.0014	0.0036

Table 10. continued.

Covariance Parameter Estimates (REML)

Cov Parm	Estimate
FISHYR*SEASON*REGION	0.02716895
Residual	3.02890551

Solution for Fixed Effects

Effect	FISHYR2	SEASON2	REGION	Estimate	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper
INTERCEPT				-2.68879147	0.35750756	69	-7.52	0.0001	0.05	-3.4020	-1.9756
FISHYR2	1991			-1.19406655	0.45073617	69	-2.65	0.0100	0.05	-2.0933	-0.2949

Table 10 (Cont.)

FISHYR2	1992			0.23333536	0.25551856	69	0.91	0.3643	0.05	-0.2764	0.7431
FISHYR2	1993			0.35453350	0.22593506	69	1.57	0.1212	0.05	-0.0962	0.8053
FISHYR2	1994			0.29794656	0.21307125	69	1.40	0.1665	0.05	-0.1271	0.7230
FISHYR2	1995			0.34350400	0.21874988	69	1.57	0.1209	0.05	-0.0929	0.7799
FISHYR2	1996			0.50978014	0.21252487	69	2.40	0.0192	0.05	0.0858	0.9338
FISHYR2	1997			0.18608108	0.21153549	69	0.88	0.3821	0.05	-0.2359	0.6081
FISHYR2	1998			0.00000000	.	.	.	.	.	.	.
SEASON2		DecJanFeb		-0.01046292	0.49706658	69	-0.02	0.9833	0.05	-1.0021	0.9812
SEASON2		JunJulAug		0.73481476	0.39910808	69	1.84	0.0699	0.05	-0.0614	1.5310
SEASON2		MarAprMay		0.29368077	0.45734478	69	0.64	0.5229	0.05	-0.6187	1.2061
SEASON2		SepOctNov		0.00000000	.	.	.	.	.	.	.
REGION			24-26N	1.62405383	0.35802196	69	4.54	0.0001	0.05	0.9098	2.3383
REGION			29-33N	3.63088962	0.43772466	69	8.29	0.0001	0.05	2.7577	4.5041
REGION			34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		DecJanFeb	24-26N	0.86410285	0.53667362	69	1.61	0.1119	0.05	-0.2065	1.9347
SEASON2*REGION		DecJanFeb	29-33N	0.31462152	0.65314549	69	0.48	0.6315	0.05	-0.9884	1.6176
SEASON2*REGION		DecJanFeb	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		JunJulAug	24-26N	-0.72502077	0.45365002	69	-1.60	0.1146	0.05	-1.6300	0.1800
SEASON2*REGION		JunJulAug	29-33N	-0.73118867	0.56943291	69	-1.28	0.2034	0.05	-1.8672	0.4048
SEASON2*REGION		JunJulAug	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		MarAprMay	24-26N	0.92120931	0.49791794	69	1.85	0.0686	0.05	-0.0721	1.9145
SEASON2*REGION		MarAprMay	29-33N	-0.01722804	0.62119193	69	-0.03	0.9780	0.05	-1.2565	1.2220
SEASON2*REGION		MarAprMay	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		SepOctNov	24-26N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		SepOctNov	29-33N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		SepOctNov	34-35N	0.00000000	.	.	.	.	.	.	.

Least Squares Means

Effect	FISHYR2	LSMEAN	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper
FISHYR2	1991	-1.82449403	0.42672697	69	-4.28	0.0001	0.05	-2.6758	-0.9732
FISHYR2	1992	-0.39709212	0.20532531	69	-1.93	0.0572	0.05	-0.8067	0.0125
FISHYR2	1993	-0.27589398	0.16753649	69	-1.65	0.1042	0.05	-0.6101	0.0583
FISHYR2	1994	-0.33248092	0.15227606	69	-2.18	0.0324	0.05	-0.6363	-0.0287
FISHYR2	1995	-0.28692348	0.15924372	69	-1.80	0.0759	0.05	-0.6046	0.0308
FISHYR2	1996	-0.12064734	0.15061298	69	-0.80	0.4259	0.05	-0.4211	0.1798
FISHYR2	1997	-0.44434640	0.15002127	69	-2.96	0.0042	0.05	-0.7436	-0.1451
FISHYR2	1998	-0.63042748	0.16518984	69	-3.82	0.0003	0.05	-0.9600	-0.3009

Table 11. Analysis of positive catch rates of greater amberjack from handline vessels in the 90th-99th percentile for positive catch rate or proportion of trips with greater amberjack in the United States EEZ in the Atlantic.

Class	Levels	Values
FISHYR2	8	1991 1992 1993 1994 1995 1996 1997 1998
SEASON2	4	DecJanFeb JunJulAug MarAprMay SepOctNov
REGION	3	24-26N 29-33N 34-35N

Model Fitting Information for LCPHOOK

Description	Value
Observations	2516.000
Res Log Likelihood	-4833.58
Akaike's Information Criterion	-4835.58
Schwarz's Bayesian Criterion	-4841.41
-2 Res Log Likelihood	9667.169

Information Criteria

Better	Parms	q	p	AIC	HQIC	BIC	CAIC
Larger	2	2	0	-4835.6	-4837.7	-4841.4	-4842.4
Larger	21	2	19	-4854.6	-4876.8	-4915.7	-4926.2
Smaller	2	2	0	9671.2	9675.4	9682.8	9684.8
Smaller	21	2	19	9709.2	9753.6	9831.4	9852.4

Tests of Fixed Effects

Source	NDF	DDF	Type III F	Pr > F
FISHYR2	7	66	0.93	0.4877
SEASON2	3	66	2.25	0.0902
REGION	2	66	86.78	0.0001
SEASON2*REGION	6	66	1.51	0.1892

Covariance Parameter Estimates (REML)

Cov Parm	Estimate
FISHYR*SEASON*REGION	0.17655247
Residual	2.64402346

.

Solution for Fixed Effects

Effect	FISHYR2	SEASON2	REGION	Estimate	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper

Table 11. continued

INTERCEPT				2.39591751	0.37487176	66	6.39	0.0001	0.05	1.6475	3.1444
FISHYR2	1991			0.61768191	0.43669487	66	1.41	0.1619	0.05	-0.2542	1.4896
FISHYR2	1992			-0.00592735	0.25141439	66	-0.02	0.9813	0.05	-0.5079	0.4960
FISHYR2	1993			-0.08532597	0.23753645	66	-0.36	0.7206	0.05	-0.5596	0.3889
FISHYR2	1994			-0.19772427	0.23821992	66	-0.83	0.4095	0.05	-0.6733	0.2779
FISHYR2	1995			0.23684258	0.24053442	66	0.98	0.3284	0.05	-0.2434	0.7171
FISHYR2	1996			-0.05181778	0.23655368	66	-0.22	0.8273	0.05	-0.5241	0.4205
FISHYR2	1997			-0.08614604	0.23862268	66	-0.36	0.7192	0.05	-0.5626	0.3903
FISHYR2	1998			0.00000000	.	.	.	.	.	.	.
SEASON2		DecJanFeb		0.10803930	0.51908095	66	0.21	0.8358	0.05	-0.9283	1.1444
SEASON2		JunJulAug		0.18949622	0.41912004	66	0.45	0.6527	0.05	-0.6473	1.0263
SEASON2		MarAprMay		0.20493591	0.47210371	66	0.43	0.6656	0.05	-0.7376	1.1475
SEASON2		SepOctNov		0.00000000	.	.	.	.	.	.	.
REGION			24-26N	2.08931846	0.38800321	66	5.38	0.0001	0.05	1.3146	2.8640
REGION			29-33N	1.43492352	0.39191222	66	3.66	0.0005	0.05	0.6524	2.2174
REGION			34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		DecJanFeb	24-26N	0.30298976	0.58333961	66	0.52	0.6052	0.05	-0.8617	1.4677
SEASON2*REGION		DecJanFeb	29-33N	0.08611037	0.59184638	66	0.15	0.8848	0.05	-1.0955	1.2678
SEASON2*REGION		DecJanFeb	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		JunJulAug	24-26N	0.10248058	0.50351230	66	0.20	0.8393	0.05	-0.9028	1.1078
SEASON2*REGION		JunJulAug	29-33N	-0.66443579	0.50959332	66	-1.30	0.1968	0.05	-1.6819	0.3530
SEASON2*REGION		JunJulAug	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		MarAprMay	24-26N	0.77202870	0.53963626	66	1.43	0.1572	0.05	-0.3054	1.8494
SEASON2*REGION		MarAprMay	29-33N	-0.07894883	0.55192403	66	-0.14	0.8867	0.05	-1.1809	1.0230
SEASON2*REGION		MarAprMay	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		SepOctNov	24-26N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		SepOctNov	29-33N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		SepOctNov	34-35N	0.00000000	.	.	.	.	.	.	.

Least Squares Means

Effect	FISHYR2	LSMEAN	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper
FISHYR2	1991	4.35731667	0.40502632	66	10.76	0.0001	0.05	3.5487	5.1660
FISHYR2	1992	3.73370741	0.18689290	66	19.98	0.0001	0.05	3.3606	4.1069
FISHYR2	1993	3.65430879	0.16553883	66	22.08	0.0001	0.05	3.3238	3.9848
FISHYR2	1994	3.54191049	0.16427999	66	21.56	0.0001	0.05	3.2139	3.8699
FISHYR2	1995	3.97647734	0.16672717	66	23.85	0.0001	0.05	3.6436	4.3094
FISHYR2	1996	3.68781698	0.16450706	66	22.42	0.0001	0.05	3.3594	4.0163
FISHYR2	1997	3.65348872	0.17075389	66	21.40	0.0001	0.05	3.3126	3.9944
FISHYR2	1998	3.73963476	0.17944356	66	20.84	0.0001	0.05	3.3814	4.0979

Table 12. Index of abundance of Atlantic greater amberjack from handline vessels in the 90^{th}-99^{th} percentile for positive catch rate or proportion of trips with greater amberjack. CPUE is the standardized catch rates on trips with greater amberjack, PPOS is the proportion positive, INDEX is the standardized index and SE_I and CV_I are the standard error and coefficient of variation about the index.

FISHYR2	CPUE	PPOS	BC_CPU	GC	BC_POS	INDEX	SE_I	CV_I
1991	84.7190	0.13890	255.758	3.27696	0.13890	35.5236	23.1021	0.65033
1992	42.5709	0.40201	150.565	3.59910	0.40201	60.5287	18.0386	0.29802
1993	39.1739	0.43146	139.578	3.61219	0.43146	60.2223	16.6506	0.27648
1994	35.0020	0.41764	124.764	3.61291	0.41764	52.1061	14.2605	0.27368
1995	54.0752	0.42876	192.597	3.61150	0.42876	82.5774	22.7552	0.27556
1996	40.5019	0.46987	144.358	3.61278	0.46987	67.8301	18.3756	0.27091
1997	39.1761	0.39071	139.346	3.60913	0.39071	54.4431	15.1309	0.27792
1998	42.7656	0.34741	151.659	3.60384	0.34741	52.6885	15.1951	0.28840

Table 13. Analysis of proportions of trips which caught greater amberjack from handline vessels in the upper quartile for positive catch rate or proportion of trips with greater amberjack in the Atlantic Ocean in the United States EEZ.

Class Level Information

FISHYR2	7	1992 1993 1994 1995 1996 1997 1998
SEASON2	4	DecJanFeb JunJulAug MarAprMay SepOctNov
REGION	3	24-26N 29-33N 34-35N

Model Fitting Information for proportion positive

Description	Value
Observations	84.0000
Res Log Likelihood	-29.5827
Akaike's Information Criterion	-31.5827
Schwarz's Bayesian Criterion	-33.7723
-2 Res Log Likelihood	59.1654

Information Criteria

Better	Parms	q	p	AIC	HQIC	BIC	CAIC
Larger	2	2	0	-31.6	-32.4	-33.8	-34.8
Larger	20	2	18	-49.6	-58.2	-71.5	-81.5
Smaller	2	2	0	63.2	64.9	67.5	69.5
Smaller	20	2	18	99.2	116.5	143.0	163.0

Tests of Fixed Effects

Source	NDF	DDF	Type III ChiSq	Type III F	Pr > ChiSq	Pr > F
FISHYR2	6	66	37.05	6.17	0.0001	0.0001
SEASON2	3	66	9.17	3.06	0.0271	0.0343
REGION	2	66	696.37	348.18	0.0001	0.0001
SEASON2*REGION	6	66	49.68	8.28	0.0001	0.0001

Covariance Parameter Estimates (REML)

Cov Parm	Estimate
FISHYR*SEASON*REGION	0.02215622
Residual	1.36240272

Solution for Fixed Effects

Effect	FISHYR2	SEASON2	REGION	Estimate	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper

.

Table 13. continued

INTERCEPT				-2.23927569	0.15841048	66	-14.14	0.0001	0.05	-2.5556	-1.9230
FISHYR2	1992			0.05398519	0.12537838	66	0.43	0.6682	0.05	-0.1963	0.3043
FISHYR2	1993			0.24864594	0.11158500	66	2.23	0.0293	0.05	0.0259	0.4714
FISHYR2	1994			0.40121342	0.10445202	66	3.84	0.0003	0.05	0.1927	0.6098
FISHYR2	1995			0.42872011	0.10442902	66	4.11	0.0001	0.05	0.2202	0.6372
FISHYR2	1996			0.51778203	0.10303116	66	5.03	0.0001	0.05	0.3121	0.7235
FISHYR2	1997			0.27079088	0.10266791	66	2.64	0.0104	0.05	0.0658	0.4758
FISHYR2	1998			0.00000000	.	.	.	.	.	.	.
SEASON2		DecJanFeb		-0.29267627	0.23647781	66	-1.24	0.2202	0.05	-0.7648	0.1795
SEASON2		JunJulAug		0.22084715	0.18300184	66	1.21	0.2318	0.05	-0.1445	0.5862
SEASON2		MarAprMay		-0.10358777	0.21142178	66	-0.49	0.6258	0.05	-0.5257	0.3185
SEASON2		SepOctNov		0.00000000	.	.	.	.	.	.	.
REGION			24-26N	0.39613220	0.17070082	66	2.32	0.0234	0.05	0.0553	0.7369
REGION			29-33N	2.04353654	0.16875845	66	12.11	0.0001	0.05	1.7066	2.3805
REGION			34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		DecJanFeb	24-26N	0.79643521	0.26754459	66	2.98	0.0041	0.05	0.2623	1.3306
SEASON2*REGION		DecJanFeb	29-33N	0.30588732	0.27034879	66	1.13	0.2620	0.05	-0.2339	0.8457
SEASON2*REGION		DecJanFeb	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		JunJulAug	24-26N	-0.08166709	0.22618406	66	-0.36	0.7192	0.05	-0.5333	0.3699
SEASON2*REGION		JunJulAug	29-33N	-0.18506509	0.22357525	66	-0.83	0.4108	0.05	-0.6314	0.2613
SEASON2*REGION		JunJulAug	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		MarAprMay	24-26N	1.01443590	0.24354949	66	4.17	0.0001	0.05	0.5282	1.5007
SEASON2*REGION		MarAprMay	29-33N	0.11079588	0.24843406	66	0.45	0.6571	0.05	-0.3852	0.6068
SEASON2*REGION		MarAprMay	34-35N	0.00000000	.	.	.	.	.	.	.

Table 13. continued.

SEASON2*REGION	SepOctNov	24-26N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION	SepOctNov	29-33N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION	SepOctNov	34-35N	0.00000000	.	.	.	.	.	.	.

Least Squares Means

Effect	FISHYR2	LSMEAN	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper
FISHYR2	1992	-1.25251996	0.10211779	66	-12.27	0.0001	0.05	-1.4564	-1.0486
FISHYR2	1993	-1.05785922	0.08383715	66	-12.62	0.0001	0.05	-1.2252	-0.8905
FISHYR2	1994	-0.90529174	0.07370699	66	-12.28	0.0001	0.05	-1.0525	-0.7581
FISHYR2	1995	-0.87778505	0.07394219	66	-11.87	0.0001	0.05	-1.0254	-0.7302
FISHYR2	1996	-0.78872313	0.07199429	66	-10.96	0.0001	0.05	-0.9325	-0.6450
FISHYR2	1997	-1.03571427	0.07135239	66	-14.52	0.0001	0.05	-1.1782	-0.8933
FISHYR2	1998	-1.30650516	0.07751767	66	-16.85	0.0001	0.05	-1.4613	-1.1517

Table 14. Analysis of positive catch rates of greater amberjack from handline vessels in the upper quartile for positive catch rate or proportion of trips with greater amberjack in the United States EEZ in the Atlantic.

Class	Levels	Values
FISHYR2	7	1992 1993 1994 1995 1996 1997 1998
SEASON2	4	DecJanFeb JunJulAug MarAprMay SepOctNov
REGION	3	24-26N 29-33N 34-35N

Model Fitting Information for LCPHOOK

Description	Value
Observations	4737.000
Res Log Likelihood	-9359.40
Akaike's Information Criterion	-9361.40
Schwarz's Bayesian Criterion	-9367.86
-2 Res Log Likelihood	18718.80

Information Criteria

Better	Parms	q	p	AIC	HQIC	BIC	CAIC
Larger	2	2	0	-9361.4	-9363.7	-9367.9	-9368.9
Larger	20	2	18	-9379.4	-9402.1	-9444.0	-9454.0
Smaller	2	2	0	18722.8	18727.3	18735.7	18737.7
Smaller	20	2	18	18758.8	18804.2	18888.0	18908.0

Tests of Fixed Effects

Source	NDF	DDF	Type III F	Pr > F
FISHYR2	6	18	3.72	0.0139
SEASON2	3	18	4.30	0.0188
REGION	2	4701	352.06	0.0001
SEASON2*REGION	6	4701	6.93	0.0001

Covariance Parameter Estimates (REML)

Cov Parm	Estimate
FISHYR2*SEASON2	0.01317355
Residual	3.01818937

Solution for Fixed Effects

Effect	FISHYR2	SEASON2	REGION	Estimate	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper

Table 14. continued.

INTERCEPT				1.80303914	0.20391082	18	8.84	0.0001	0.05	1.3746	2.2314
FISHYR2	1992			0.32577896	0.14894908	18	2.19	0.0422	0.05	0.0128	0.6387
FISHYR2	1993			0.14214768	0.13339517	18	1.07	0.3007	0.05	-0.1381	0.4224
FISHYR2	1994			0.40890511	0.12456882	18	3.28	0.0041	0.05	0.1472	0.6706
FISHYR2	1995			0.38984144	0.12464482	18	3.13	0.0058	0.05	0.1280	0.6517
FISHYR2	1996			0.06139608	0.12207424	18	0.50	0.6211	0.05	-0.1951	0.3179
FISHYR2	1997			0.07917134	0.12335113	18	0.64	0.5291	0.05	-0.1800	0.3383
FISHYR2	1998			0.00000000	.	.	.	.	.	.	.
SEASON2		DecJanFeb		0.20136832	0.31749487	18	0.63	0.5339	0.05	-0.4657	0.8684
SEASON2		JunJulAug		0.00111888	0.23454941	18	0.00	0.9962	0.05	-0.4917	0.4939
SEASON2		MarAprMay		0.21202516	0.27868998	18	0.76	0.4566	0.05	-0.3735	0.7975
SEASON2		SepOctNov		0.00000000	.	.	.	.	.	.	.
REGION			24-26N	2.35748472	0.20539400	4701	11.48	0.0001	0.05	1.9548	2.7602
REGION			29-33N	1.55207810	0.19356811	4701	8.02	0.0001	0.05	1.1726	1.9316
REGION			34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		DecJanFeb	24-26N	-0.09177194	0.33418435	4701	-0.27	0.7836	0.05	-0.7469	0.5634
SEASON2*REGION		DecJanFeb	29-33N	-0.09769020	0.32854244	4701	-0.30	0.7662	0.05	-0.7418	0.5464
SEASON2*REGION		DecJanFeb	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		JunJulAug	24-26N	0.00735847	0.26452119	4701	0.03	0.9778	0.05	-0.5112	0.5259
SEASON2*REGION		JunJulAug	29-33N	-0.28696103	0.24774606	4701	-1.16	0.2468	0.05	-0.7727	0.1987
SEASON2*REGION		JunJulAug	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		MarAprMay	24-26N	0.52851306	0.29509914	4701	1.79	0.0734	0.05	-0.0500	1.1070
SEASON2*REGION		MarAprMay	29-33N	-0.25668368	0.29113312	4701	-0.88	0.3780	0.05	-0.8274	0.3141
SEASON2*REGION		MarAprMay	34-35N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		SepOctNov	24-26N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		SepOctNov	29-33N	0.00000000	.	.	.	.	.	.	.
SEASON2*REGION		SepOctNov	34-35N	0.00000000	.	.	.	.	.	.	.

Least Squares Means

Effect	FISHYR2	LSMEAN	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper
FISHYR2	1992	3.51919751	0.12186229	18	28.88	0.0001	0.05	3.2632	3.7752
FISHYR2	1993	3.33556624	0.10108673	18	33.00	0.0001	0.05	3.1232	3.5479
FISHYR2	1994	3.60232367	0.08934641	18	40.32	0.0001	0.05	3.4146	3.7900
FISHYR2	1995	3.58326000	0.08894656	18	40.29	0.0001	0.05	3.3964	3.7701
FISHYR2	1996	3.25481463	0.08667997	18	37.55	0.0001	0.05	3.0727	3.4369
FISHYR2	1997	3.27258989	0.08735639	18	37.46	0.0001	0.05	3.0891	3.4561
FISHYR2	1998	3.19341855	0.09603308	18	33.25	0.0001	0.05	2.9917	3.3952

Table 15. Index of abundance of Atlantic greater amberjack from handline vessels in the upper quartile for positive catch rate or proportion of trips with greater amberjack. CPUE is the standardized catch rates on trips with greater amberjack, PPOS is the proportion positive, INDEX is the standardized index and SE_I and CV_I are the standard error and coefficient of variation about the index.

FISHYR2	CPUE	PPOS	BC_CPU	GC	BC_POS	INDEX	SE_I	CV_I
1992	34.0089	0.22226	132.734	3.93201	0.22226	29.5021	15.5259	0.52626
1993	28.2382	0.25772	114.798	4.08616	0.25772	29.5856	11.3573	0.38388
1994	36.8301	0.28796	150.042	4.09019	0.28796	43.2067	16.4397	0.38049
1995	36.1333	0.29364	147.213	4.09032	0.29364	43.2273	16.4434	0.38040
1996	26.0123	0.31244	106.018	4.09103	0.31244	33.1247	12.5778	0.37971
1997	26.4804	0.26198	107.914	4.09082	0.26198	28.2711	10.7509	0.38028
1998	24.4842	0.21307	99.630	4.08796	0.21307	21.2284	8.1291	0.38293

Table 16. Analysis of the proportion of full day headboat trips catching greater amberjack in the Atlantic.

Class	Levels	Values
FISHYEAR	22	1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
SEASON	4	AprMayJun JanFebMar JulAugSep OctNovDec
REGION	4	24-25.4N 25.5-28.6N 28.7-30.6N 30.7-35N
INSHORPL	2	0 1

Covariance Parameter Estimates (REML)

Cov Parm	Estimate
FISH*SEAS*REGI*INSHO	0.59830579
Residual	1.45801288

Model Fitting Information for proportion positive

Description	Value
Observations	636.0000
Res Log Likelihood	-986.820
Akaike's Information Criterion	-988.820
Schwarz's Bayesian Criterion	-993.224
-2 Res Log Likelihood	1973.641

Information Criteria

Better	Parms	q	p	AIC	HQIC	BIC	CAIC
Larger	2	2	0	-988.8	-990.5	-993.2	-994.2
Larger	34	2	32	-1020.8	-1050.0	-1095.7	-1112.7
Smaller	2	2	0	1977.6	1981.1	1986.4	1988.4
Smaller	34	2	32	2041.6	2099.9	2191.4	2225.4

.

Tests of Fixed Effects

Source	NDF	DDF	Type III ChiSq	Type III F	Pr > ChiSq	Pr > F
FISHYEAR	21	604	145.31	6.92	0.0001	0.0001
SEASON	3	604	22.32	7.44	0.0001	0.0001
REGION	3	604	275.57	91.86	0.0001	0.0001
INSHORPL	1	604	52.94	52.94	0.0001	0.0001
SEASON*INSHORPL	3	604	2.23	0.74	0.5265	0.5269

Solution for Fixed Effects

Table 16. continued

Effect	FISHYEAR	SEASON	REGION	INSHORPL	Estimate	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper
INTERCEPT					-1.12349358	0.25284719	604	-4.44	0.0001	0.05	-1.6201	-0.6269
FISHYEAR	1976				0.66521915	0.32313991	604	2.06	0.0400	0.05	0.0306	1.2998
FISHYEAR	1977				0.59327828	0.32317403	604	1.84	0.0669	0.05	-0.0414	1.2280
FISHYEAR	1978				1.37584146	0.29692796	604	4.63	0.0001	0.05	0.7927	1.9590
FISHYEAR	1979				1.44550375	0.28907735	604	5.00	0.0001	0.05	0.8778	2.0132
FISHYEAR	1980				1.06458597	0.28961701	604	3.68	0.0003	0.05	0.4958	1.6334
FISHYEAR	1981				1.20457285	0.28875466	604	4.17	0.0001	0.05	0.6375	1.7717
FISHYEAR	1982				1.32576477	0.29189779	604	4.54	0.0001	0.05	0.7525	1.8990
FISHYEAR	1983				1.42876079	0.29191615	604	4.89	0.0001	0.05	0.8555	2.0021
FISHYEAR	1984				0.98440360	0.29065417	604	3.39	0.0008	0.05	0.4136	1.5552
FISHYEAR	1985				0.99361698	0.28892729	604	3.44	0.0006	0.05	0.4262	1.5610
FISHYEAR	1986				1.11037145	0.28662038	604	3.87	0.0001	0.05	0.5475	1.6733
FISHYEAR	1987				1.20482677	0.28893582	604	4.17	0.0001	0.05	0.6374	1.7723
FISHYEAR	1988				0.78992575	0.29525010	604	2.68	0.0077	0.05	0.2101	1.3698
FISHYEAR	1989				0.82251665	0.29113025	604	2.83	0.0049	0.05	0.2508	1.3943
FISHYEAR	1990				0.16427913	0.29793305	604	0.55	0.5816	0.05	-0.4208	0.7494
FISHYEAR	1991				0.52598373	0.29379480	604	1.79	0.0739	0.05	-0.0510	1.1030
FISHYEAR	1992				0.41189326	0.29083629	604	1.42	0.1572	0.05	-0.1593	0.9831
FISHYEAR	1993				0.31344176	0.29866424	604	1.05	0.2944	0.05	-0.2731	0.9000
FISHYEAR	1994				0.28904997	0.29695369	604	0.97	0.3308	0.05	-0.2941	0.8722
FISHYEAR	1995				-0.24352314	0.31209069	604	-0.78	0.4355	0.05	-0.8564	0.3694
FISHYEAR	1996				0.11839574	0.30356622	604	0.39	0.6967	0.05	-0.4778	0.7146
FISHYEAR	1997				0.00000000	.	.	.	.	.	.	.
SEASON		AprMayJun			-0.03097359	0.13808804	604	-0.22	0.8226	0.05	-0.3022	0.2402
SEASON		JanFebMar			-0.57498712	0.14644331	604	-3.93	0.0001	0.05	-0.8626	-0.2874
SEASON		JulAugSep			-0.09376446	0.14048917	604	-0.67	0.5048	0.05	-0.3697	0.1821
SEASON		OctNovDec			0.00000000	.	.	.	.	.	.	.
REGION			24-25.4N		-1.36325737	0.13164354	604	-10.36	0.0001	0.05	-1.6218	-1.1047
REGION			25.5-28.6N		-1.38434368	0.11760003	604	-11.77	0.0001	0.05	-1.6153	-1.1534
REGION			28.7-30.6N		0.14391753	0.09574681	604	1.50	0.1333	0.05	-0.0441	0.3320
REGION			30.7-35N		0.00000000	.	.	.	.	.	.	.
INSHORPL				0	-0.79748339	0.17361097	604	-4.59	0.0001	0.05	-1.1384	-0.4565
INSHORPL				1	0.00000000	.	.	.	.	.	.	.
SEASON*INSHORPL		AprMayJun		0	0.29851697	0.22817436	604	1.31	0.1913	0.05	-0.1496	0.7466
SEASON*INSHORPL		AprMayJun		1	0.00000000	.	.	.	.	.	.	.
SEASON*INSHORPL		JanFebMar		0	0.29883029	0.24958985	604	1.20	0.2317	0.05	-0.1913	0.7890
SEASON*INSHORPL		JanFebMar		1	0.00000000	.	.	.	.	.	.	.
SEASON*INSHORPL		JulAugSep		0	0.13666297	0.23015538	604	0.59	0.5529	0.05	-0.3153	0.5887
SEASON*INSHORPL		JulAugSep		1	0.00000000	.	.	.	.	.	.	.
SEASON*INSHORPL		OctNovDec		0	0.00000000	.	.	.	.	.	.	.
SEASON*INSHORPL		OctNovDec		1	0.00000000	.	.	.	.	.	.	.

Table 16. continued.

Least Squares Means

Effect	FISHYEAR	LSMEAN	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper
FISHYEAR	1976	-1.59111702	0.22938800	604	-6.94	0.0001	0.05	-2.0416	-1.1406
FISHYEAR	1977	-1.66305789	0.22932360	604	-7.25	0.0001	0.05	-2.1134	-1.2127
FISHYEAR	1978	-0.88049472	0.18752473	604	-4.70	0.0001	0.05	-1.2488	-0.5122
FISHYEAR	1979	-0.81083242	0.17259415	604	-4.70	0.0001	0.05	-1.1498	-0.4719
FISHYEAR	1980	-1.19175021	0.17372769	604	-6.86	0.0001	0.05	-1.5329	-0.8506
FISHYEAR	1981	-1.05176332	0.17130183	604	-6.14	0.0001	0.05	-1.3882	-0.7153
FISHYEAR	1982	-0.93057141	0.17717425	604	-5.25	0.0001	0.05	-1.2785	-0.5826
FISHYEAR	1983	-0.82757539	0.17832982	604	-4.64	0.0001	0.05	-1.1778	-0.4774
FISHYEAR	1984	-1.27193257	0.17681728	604	-7.19	0.0001	0.05	-1.6192	-0.9247
FISHYEAR	1985	-1.26271919	0.17349824	604	-7.28	0.0001	0.05	-1.6035	-0.9220
FISHYEAR	1986	-1.14596473	0.16864509	604	-6.80	0.0001	0.05	-1.4772	-0.8148
FISHYEAR	1987	-1.05150940	0.17397958	604	-6.04	0.0001	0.05	-1.3932	-0.7098
FISHYEAR	1988	-1.46641043	0.18420369	604	-7.96	0.0001	0.05	-1.8282	-1.1047
FISHYEAR	1989	-1.43381952	0.17664831	604	-8.12	0.0001	0.05	-1.7807	-1.0869
FISHYEAR	1990	-2.09205705	0.18845973	604	-11.10	0.0001	0.05	-2.4622	-1.7219
FISHYEAR	1991	-1.73035245	0.18128319	604	-9.55	0.0001	0.05	-2.0864	-1.3743
FISHYEAR	1992	-1.84444291	0.17666911	604	-10.44	0.0001	0.05	-2.1914	-1.4975
FISHYEAR	1993	-1.94289441	0.18991864	604	-10.23	0.0001	0.05	-2.3159	-1.5699
FISHYEAR	1994	-1.96728621	0.18721092	604	-10.51	0.0001	0.05	-2.3349	-1.5996
FISHYEAR	1995	-2.49985931	0.21204049	604	-11.79	0.0001	0.05	-2.9163	-2.0834
FISHYEAR	1996	-2.13794043	0.19857801	604	-10.77	0.0001	0.05	-2.5279	-1.7480
FISHYEAR	1997	-2.25633618	0.23425202	604	-9.63	0.0001	0.05	-2.7164	-1.7963

Table 17. Analysis greater amberjack catch per successful trip on full day headboats in the Atlantic.

Class	Levels	Values
FISHYEAR	22	1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
SEASON	4	AprMayJun JanFebMar JulAugSep OctNovDec
REGION	4	24-25.4N 25.5-28.6N 28.7-30.6N 30.7-35N
INSHORPL	2	0 1

Covariance Parameter Estimates (REML)

Cov Parm	Estimate
FISH*SEAS*REGI*INSHO	0.14311818
Residual	0.82551867

Model Fitting Information for LCATCH

Description	Value
Observations	14165.00
Res Log Likelihood	-19108.5
Akaike's Information Criterion	-19110.5
Schwarz's Bayesian Criterion	-19118.0
-2 Res Log Likelihood	38216.93

Information Criteria

Better	Parms	q	p	AIC	HQIC	BIC	CAIC
Larger	2	2	0	-19110	-19113	-19118	-19119
Larger	37	2	35	-19145	-19192	-19285	-19304
Smaller	2	2	0	38220.9	38226.0	38236.0	38238.0
Smaller	37	2	35	38290.9	38384.0	38570.5	38607.5

Tests of Fixed Effects

Source	NDF	DDF	Type III F	Pr > F
FISHYEAR	21	505	1.60	0.0451
SEASON	3	505	3.97	0.0081
REGION	3	505	19.17	0.0001
INSHORPL	1	505	1.58	0.2094
SEASON*INSHORPL	3	505	1.99	0.1140
REGION*INSHORPL	3	505	5.18	0.0016

Solution for Fixed Effects

Effect	FISHYEAR	SEASON	REGION	INSHORPL	Estimate	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper
INTERCEPT					0.89379072	0.14252531	505	6.27	0.0001	0.05	0.6138	1.1738

FISHYEAR	1976				0.23907278	0.17497613	505	1.37	0.1724	0.05	-0.1047	0.5828
FISHYEAR	1977				0.02186154	0.17569103	505	0.12	0.9010	0.05	-0.3233	0.3670
FISHYEAR	1978				-0.00499205	0.16161827	505	-0.03	0.9754	0.05	-0.3225	0.3125
FISHYEAR	1979				0.02348899	0.15971175	505	0.15	0.8831	0.05	-0.2903	0.3373
FISHYEAR	1980				0.29548736	0.16161167	505	1.83	0.0681	0.05	-0.0220	0.6130
FISHYEAR	1981				0.47978009	0.16021523	505	2.99	0.0029	0.05	0.1650	0.7946
FISHYEAR	1982				0.21980532	0.16114595	505	1.36	0.1732	0.05	-0.0968	0.5364
FISHYEAR	1983				0.03203377	0.15950647	505	0.20	0.8409	0.05	-0.2813	0.3454
FISHYEAR	1984				-0.02513226	0.16065355	505	-0.16	0.8758	0.05	-0.3408	0.2905
FISHYEAR	1985				0.10528290	0.15965483	505	0.66	0.5099	0.05	-0.2084	0.4190
FISHYEAR	1986				0.04772195	0.15830275	505	0.30	0.7632	0.05	-0.2633	0.3587
FISHYEAR	1987				0.22612974	0.15906654	505	1.42	0.1558	0.05	-0.0864	0.5386
FISHYEAR	1988				0.14496015	0.16294358	505	0.89	0.3741	0.05	-0.1752	0.4651
FISHYEAR	1989				0.20941977	0.16195307	505	1.29	0.1966	0.05	-0.1088	0.5276
FISHYEAR	1990				0.03317395	0.16919319	505	0.20	0.8446	0.05	-0.2992	0.3656
FISHYEAR	1991				0.08114795	0.16408936	505	0.49	0.6211	0.05	-0.2412	0.4035
FISHYEAR	1992				0.04262583	0.16219498	505	0.26	0.7928	0.05	-0.2760	0.3613
FISHYEAR	1993				0.11099462	0.16736332	505	0.66	0.5075	0.05	-0.2178	0.4398
FISHYEAR	1994				0.18593043	0.16732754	505	1.11	0.2670	0.05	-0.1428	0.5147
FISHYEAR	1995				0.05517173	0.17952458	505	0.31	0.7587	0.05	-0.2975	0.4079
FISHYEAR	1996				0.15501258	0.17267229	505	0.90	0.3698	0.05	-0.1842	0.4943
FISHYEAR	1997				0.00000000	.	.	.	.	.	.	.
SEASON		AprMayJun			0.01260266	0.07314836	505	0.17	0.8633	0.05	-0.1311	0.1563
SEASON		JanFebMar			-0.09185946	0.07997070	505	-1.15	0.2512	0.05	-0.2490	0.0653
SEASON		JulAugSep			-0.04560979	0.07482914	505	-0.61	0.5425	0.05	-0.1926	0.1014
SEASON		OctNovDec			0.00000000	.	.	.	.	.	.	.
REGION			24-25.4N		-0.37824293	0.09226893	505	-4.10	0.0001	0.05	-0.5595	-0.1970
REGION			25.5-28.6N		-0.54633774	0.07789239	505	-7.01	0.0001	0.05	-0.6994	-0.3933
REGION			28.7-30.6N		-0.00776815	0.06412718	505	-0.12	0.9036	0.05	-0.1338	0.1182
REGION			30.7-35N		0.00000000	.	.	.	.	.	.	.
INSHORPL				0	-0.34837088	0.11487573	505	-3.03	0.0025	0.05	-0.5741	-0.1227
INSHORPL				1	0.00000000	.	.	.	.	.	.	.
SEASON*INSHORPL		AprMayJun		0	0.28644954	0.12379935	505	2.31	0.0211	0.05	0.0432	0.5297
SEASON*INSHORPL		AprMayJun		1	0.00000000	.	.	.	.	.	.	.
SEASON*INSHORPL		JanFebMar		0	0.12770443	0.14146543	505	0.90	0.3671	0.05	-0.1502	0.4056
SEASON*INSHORPL		JanFebMar		1	0.00000000	.	.	.	.	.	.	.
SEASON*INSHORPL		JulAugSep		0	0.09039852	0.12623129	505	0.72	0.4742	0.05	-0.1576	0.3384
SEASON*INSHORPL		JulAugSep		1	0.00000000	.	.	.	.	.	.	.
SEASON*INSHORPL		OctNovDec		0	0.00000000	.	.	.	.	.	.	.
SEASON*INSHORPL		OctNovDec		1	0.00000000	.	.	.	.	.	.	.
REGION*INSHORPL			24-25.4N	0	0.43541221	0.17185755	505	2.53	0.0116	0.05	0.0978	0.7731
REGION*INSHORPL			24-25.4N	1	0.00000000	.	.	.	.	.	.	.
REGION*INSHORPL			25.5-28.6N	0	0.39422457	0.14512734	505	2.72	0.0068	0.05	0.1091	0.6794
REGION*INSHORPL			25.5-28.6N	1	0.00000000	.	.	.	.	.	.	.
REGION*INSHORPL			28.7-30.6N	0	0.34368319	0.10168813	505	3.38	0.0008	0.05	0.1439	0.5435
REGION*INSHORPL			28.7-30.6N	1	0.00000000	.	.	.	.	.	.	.
REGION*INSHORPL			30.7-35N	0	0.00000000	.	.	.	.	.	.	.
REGION*INSHORPL			30.7-35N	1	0.00000000	.	.	.	.	.	.	.

Table 17. continued.

Least Squares Means

Effect	FISHYEAR	LSMEAN	Std Error	DF	t	Pr > |t|	Alpha	Lower	Upper
FISHYEAR	1976	0.90410826	0.11998098	505	7.54	0.0001	0.05	0.6684	1.1398
FISHYEAR	1977	0.68689702	0.12102923	505	5.68	0.0001	0.05	0.4491	0.9247
FISHYEAR	1978	0.66004343	0.09651112	505	6.84	0.0001	0.05	0.4704	0.8497
FISHYEAR	1979	0.68852447	0.09154141	505	7.52	0.0001	0.05	0.5087	0.8684
FISHYEAR	1980	0.96052284	0.09647414	505	9.96	0.0001	0.05	0.7710	1.1501
FISHYEAR	1981	1.14481557	0.09165864	505	12.49	0.0001	0.05	0.9647	1.3249
FISHYEAR	1982	0.88484081	0.09470865	505	9.34	0.0001	0.05	0.6988	1.0709
FISHYEAR	1983	0.69706925	0.09210008	505	7.57	0.0001	0.05	0.5161	0.8780
FISHYEAR	1984	0.63990322	0.09529045	505	6.72	0.0001	0.05	0.4527	0.8271
FISHYEAR	1985	0.77031838	0.09343635	505	8.24	0.0001	0.05	0.5867	0.9539
FISHYEAR	1986	0.71275743	0.09073477	505	7.86	0.0001	0.05	0.5345	0.8910
FISHYEAR	1987	0.89116523	0.09296191	505	9.59	0.0001	0.05	0.7085	1.0738
FISHYEAR	1988	0.80999563	0.09866936	505	8.21	0.0001	0.05	0.6161	1.0038
FISHYEAR	1989	0.87445526	0.09659322	505	9.05	0.0001	0.05	0.6847	1.0642
FISHYEAR	1990	0.69820943	0.10887852	505	6.41	0.0001	0.05	0.4843	0.9121
FISHYEAR	1991	0.74618343	0.10023442	505	7.44	0.0001	0.05	0.5493	0.9431
FISHYEAR	1992	0.70766131	0.09789412	505	7.23	0.0001	0.05	0.5153	0.9000
FISHYEAR	1993	0.77603010	0.10656611	505	7.28	0.0001	0.05	0.5667	0.9854
FISHYEAR	1994	0.85096591	0.10680126	505	7.97	0.0001	0.05	0.6411	1.0608
FISHYEAR	1995	0.72020722	0.12614758	505	5.71	0.0001	0.05	0.4724	0.9680
FISHYEAR	1996	0.82004806	0.11574956	505	7.08	0.0001	0.05	0.5926	1.0475
FISHYEAR	1997	0.66503548	0.13330300	505	4.99	0.0001	0.05	0.4031	0.9269

Table 18. Index of abundance of Atlantic greater amberjack from headboats. CPUE is the standardized catch rates on trips with greater amberjack, PPOS is the proportion positive, INDEX is the standardized index and SE_I and CV_I are the standard error and coefficient of variation about the index.

FISHYEAR	CPUE	PPOS	BC_CPU	GC	BC_POS	INDEX	SE_I	CV_I
1976	2.48757	0.16923	3.70080	1.49846	0.16923	0.62627	0.15457	0.24681
1977	2.00290	0.15935	2.97850	1.49813	0.15935	0.47463	0.11961	0.25200
1978	1.95198	0.29308	2.92074	1.50335	0.29308	0.85600	0.14399	0.16821
1979	2.00432	0.30771	3.00192	1.50407	0.30771	0.92373	0.14282	0.15461
1980	2.65086	0.23295	3.96662	1.50338	0.23295	0.92401	0.15606	0.16889
1981	3.16758	0.25889	4.74408	1.50406	0.25889	1.22818	0.19686	0.16029
1982	2.44183	0.28281	3.65503	1.50362	0.28281	1.03367	0.16783	0.16237
1983	2.02340	0.30416	3.03018	1.50399	0.30416	0.92165	0.14616	0.15858
1984	1.91277	0.21893	2.86279	1.50354	0.21893	0.62674	0.10870	0.17344
1985	2.18760	0.22051	3.27532	1.50381	0.22051	0.72223	0.12241	0.16950
1986	2.05981	0.24123	3.08547	1.50418	0.24123	0.74430	0.12044	0.16182
1987	2.45873	0.25894	3.68156	1.50387	0.25894	0.95329	0.15551	0.16313
1988	2.26749	0.18749	3.39146	1.50304	0.18749	0.63586	0.11777	0.18521
1989	2.42726	0.19250	3.63193	1.50336	0.19250	0.69916	0.12428	0.17775
1990	2.03868	0.10987	3.04279	1.50146	0.10987	0.33432	0.07047	0.21078
1991	2.12165	0.15054	3.17232	1.50281	0.15054	0.47757	0.09138	0.19135
1992	2.05530	0.13653	3.07458	1.50316	0.13653	0.41976	0.07958	0.18958
1993	2.20624	0.12533	3.29452	1.50183	0.12533	0.41290	0.08523	0.20641
1994	2.37257	0.12268	3.54274	1.50180	0.12268	0.43463	0.08894	0.20463
1995	2.08874	0.07587	3.10472	1.49838	0.07587	0.23555	0.05887	0.24992
1996	2.31561	0.10546	3.45078	1.50030	0.10546	0.36393	0.08108	0.22279
1997	1.97239	0.09480	2.92625	1.49697	0.09480	0.27742	0.07390	0.26637

Table 19. *Estimates of relative loss for the four cases with coefficients of variation and the number tagged (Tag) and recaptured (Rec). Year corresponds to May of the fishing year, May-April. EstAll=each year estimated independently, Sig01=random walk sigma of 0.1, Sig03=random walk sigma of 0.3, Sig05=random walk sigma of 0.5.*

			Relative Loss				Coefficient of Variation			
Year	Tag	Rec	EstAll	Sig01	Sig03	Sig05	EstAll	Sig01	Sig03	Sig05
1960	9	4	2.040	1.875	2.576	2.467	53	15	19	22
1961	14	14	2.988	1.871	2.716	2.856	28	7	19	28
1962	37	33	3.376	1.825	2.708	3.014	19	7	17	24
1963	32	22	2.344	1.675	2.073	2.172	25	7	16	22
1964	36	28	1.203	1.506	1.457	1.348	21	7	16	21
1965	35	35	1.154	1.387	1.276	1.210	19	7	15	20
1966	30	34	1.197	1.300	1.221	1.203	19	7	15	20
1967	21	26	1.194	1.219	1.152	1.153	23	7	16	21
1968	28	19	0.838	1.135	1.023	0.962	25	7	16	22
1969	26	32	1.209	1.085	1.072	1.117	21	7	16	21
1970	31	27	1.038	1.014	0.961	0.986	23	7	16	21
1971	25	22	0.687	0.937	0.791	0.745	25	7	16	22
1972	34	23	0.639	0.887	0.728	0.683	24	7	16	22
1973	21	25	0.659	0.862	0.734	0.700	23	7	16	21
1974	20	27	0.832	0.854	0.807	0.820	23	7	16	21
1975	26	34	1.017	0.839	0.845	0.912	22	7	16	21
1976	32	24	0.688	0.796	0.714	0.706	26	7	16	22
1977	21	17	0.511	0.755	0.611	0.571	30	7	16	22
1978	22	20	0.526	0.731	0.577	0.549	29	7	17	23
1979	17	21	0.519	0.712	0.551	0.525	29	7	17	23
1980	5	9	0.390	0.696	0.507	0.461	39	7	17	24
1981	3	12	0.496	0.699	0.523	0.492	37	7	18	25
1982	0	5	0.410	0.702	0.521	0.481	51	7	18	27
1983	2	6	0.528	0.711	0.541	0.510	50	7	19	28
1984	2	2	0.390	0.720	0.550	0.509	77	7	19	29
1985	6	4	0.516	0.733	0.580	0.556	56	7	19	29
1986	9	10	0.751	0.748	0.617	0.622	39	7	19	29
1987	9	8	0.589	0.758	0.607	0.582	42	7	19	28
1988	11	3	0.382	0.769	0.590	0.526	61	7	18	27
1989	28	13	0.546	0.796	0.637	0.585	30	7	18	27
1990	43	26	0.655	0.842	0.738	0.699	21	7	17	23
1991	86	63	1.049	0.913	0.976	1.013	14	6	15	19
1992	62	85	1.158	0.948	1.062	1.111	13	6	13	16
1993	51	42	0.750	0.918	0.860	0.813	17	6	13	16
1994	37	50	0.861	0.926	0.900	0.880	16	7	14	17
1995	16	37	1.068	0.946	1.010	1.042	19	7	15	19
1996	2	18	1.191	0.953	1.074	1.149	28	7	18	23
1997	1	10	1.612	0.955	1.119	1.271	48	7	20	30

Table 20. *Estimates of greater amberjack relative abundance from the Z* time series EstAll (see Table 1), two catch time series, and four assumptions of how Z* could be split into its components. Year corresponds to May of the fishing year, May-April.*

	Case1	Case2	Case3	Case4	Case5	Case6	Case7	Case8
Catch	A+B1	A+B1	A+B1	A+B1	A+B1+B2	A+B1+B2	A+B1+B2	A+B1+B2
M	0.2	0.2	0.3	0.3	0.2	0.2	0.3	0.3
Tag Loss	0.05	0.1	0.05	0.1	0.05	0.1	0.05	0.1
Year								
81	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
82	1.291	1.407	1.549	1.134	1.219	1.344	1.510	1.157
83	0.485	0.461	0.398	0.161	0.779	0.749	0.658	0.280
84	3.630	4.147	5.092	6.519	3.022	3.492	4.375	5.864
85	1.196	1.146	1.000	0.414	1.581	1.532	1.365	0.591
86	1.017	0.894	0.693	0.242	1.186	1.055	0.834	0.305
87	1.389	1.279	1.053	0.399	1.501	1.398	1.174	0.465
88	1.863	2.177	2.836	6.523	1.773	2.095	2.785	6.706
89	2.665	2.506	2.127	0.842	2.161	2.055	1.779	0.737
90	0.524	0.471	0.376	0.136	0.494	0.449	0.366	0.139
91	0.494	0.420	0.311	0.104	0.559	0.481	0.364	0.127
92	0.630	0.531	0.391	0.129	0.781	0.666	0.500	0.173
93	0.381	0.335	0.260	0.091	0.487	0.433	0.343	0.125
94	0.576	0.498	0.378	0.129	0.428	0.375	0.290	0.104
95	0.519	0.441	0.326	0.108	0.473	0.406	0.307	0.107
96	0.277	0.233	0.171	0.056	0.353	0.301	0.225	0.078
97	0.064	0.053	0.038	0.012	0.203	0.170	0.125	0.042

Table 21. *Estimates of greater amberjack relative abundance from the Z* time series EstAll (see Table 1), two catch time series, and four assumptions of how Z* could be split into its components for years 1990-1997 only. Year corresponds to May of the fishing year, May-April.*

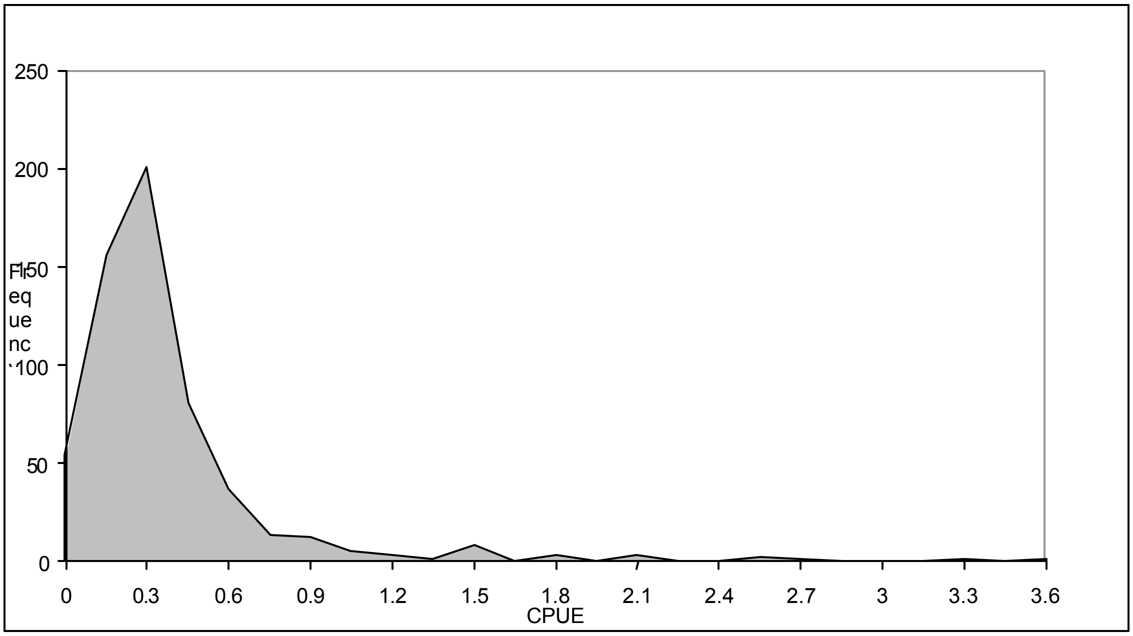
	Case1	Case2	Case3	Case4	Case5	Case6	Case7	Case8
Catch	A+B1	A+B1	A+B1	A+B1	A+B1+B2	A+B1+B2	A+B1+B2	A+B1+B2
M	0.2	0.2	0.3	0.3	0.2	0.2	0.3	0.3
Tag Loss	0.05	0.1	0.05	0.1	0.05	0.1	0.05	0.1
Year								
90	1.209	1.263	1.335	1.423	1.045	1.095	1.161	1.242
91	1.141	1.126	1.106	1.083	1.184	1.172	1.155	1.135
92	1.454	1.425	1.389	1.348	1.653	1.625	1.588	1.546
93	0.881	0.900	0.924	0.950	1.032	1.057	1.088	1.123
94	1.330	1.336	1.343	1.346	0.907	0.914	0.921	0.926
95	1.199	1.182	1.160	1.133	1.001	0.989	0.974	0.955
96	0.640	0.626	0.608	0.589	0.748	0.733	0.715	0.695
97	0.147	0.142	0.135	0.129	0.429	0.415	0.398	0.380

Table 22. Indices considered for use in assessments.

	fishery	handline		mrfss private		mrfss charter		headboat		tagging: M=0.3 Loss= 0.1	
	units	**biomass**		number		number		number		number	
	time of year	mid		mid		mid		mid		mid	
	age range	1-20+		1-20+		1-20+		1-20+		1-20+	
fishing year		index	cv	index	cv	index	cv	index	cv	index	cv + 0.1
1977								0.4746	0.2520		
1978								0.8560	0.1682		
1979								0.9237	0.1546		
1980								0.9240	0.1689		
1981				0.3158	0.2324	0.1786	0.4076	1.2282	0.1603		
1982				0.1098	0.2940	0.1236	0.2563	1.0337	0.1624		
1983				0.1436	0.1652	0.1851	0.3452	0.9217	0.1586		
1984				0.1558	0.1475	0.1830	0.2650	0.6267	0.1734		
1985				0.1627	0.1680	0.2107	0.2309	0.7222	0.1695		
1986				0.1887	0.1269	0.2614	0.2109	0.7443	0.1618		
1987				0.2059	0.1178	0.2104	0.2205	0.9533	0.1631		
1988				0.1504	0.1163	0.1658	0.2291	0.6359	0.1852		
1989				0.1762	0.1183	0.2367	0.2110	0.6992	0.1778		
1990				0.1698	0.1178	0.1539	0.2215	0.3343	0.2108	1.2416	0.31
1991				0.1745	0.0880	0.2761	0.1675	0.4776	0.1914	1.1345	0.24
1992		29.5021	0.5263	0.1596	0.1183	0.4762	0.2310	0.4198	0.1896	1.5459	0.23
1993		29.5856	0.3839	0.1845	0.1169	0.5115	0.2466	0.4129	0.2064	1.1225	0.27
1994		43.2067	0.3805	0.1526	0.1273	0.3030	0.2592	0.4346	0.2046	0.9262	0.26
1995		43.2273	0.3804	0.1623	0.1217	0.3669	0.2435	0.2356	0.2499	0.9546	0.29
1996		33.1247	0.3797	0.1531	0.1277	0.2412	0.2455	0.3639	0.2228	0.6948	0.38
1997		28.2711	0.3803	0.1321	0.1250	0.4308	0.2699	0.2774	0.2664	0.3798	0.58
1998		21.2284	0.3829								

Figure 1. Observed CPUE observations (CPH) for the Atlantic Ocean greater amberjack for the private boat fishery (a) catch per angler hour, (b) log (catch per angler hour), for the charterboat fishery © catch per angler hoiur and (d) log (catch per angler hour) based on the MRFSS data 1981-1998.

a)



b)

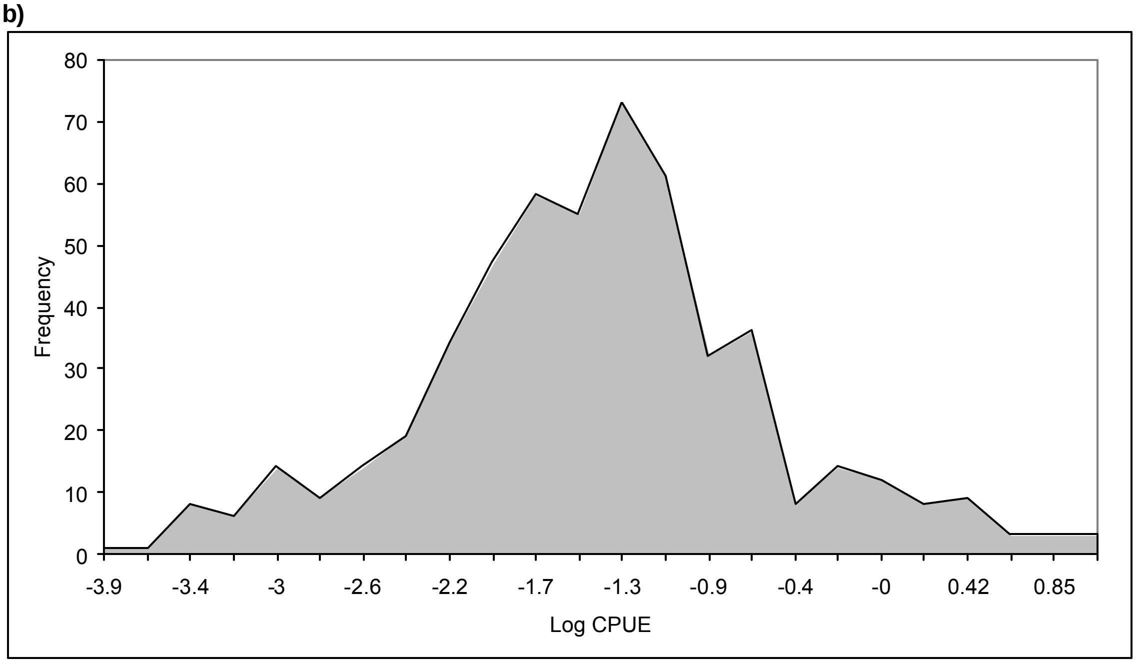
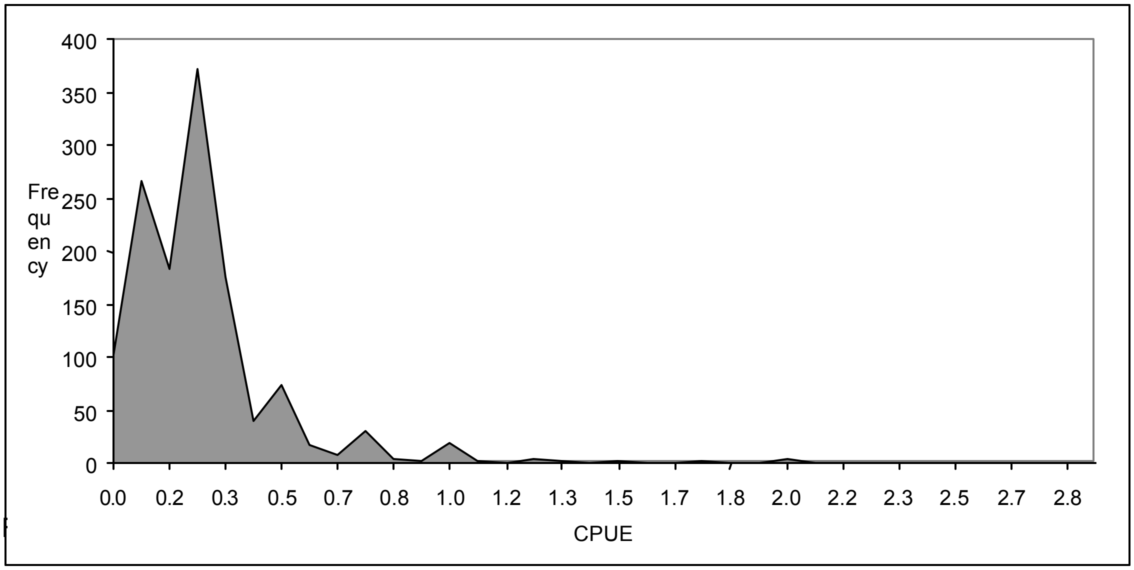


Figure 1. (Cont.)

c)



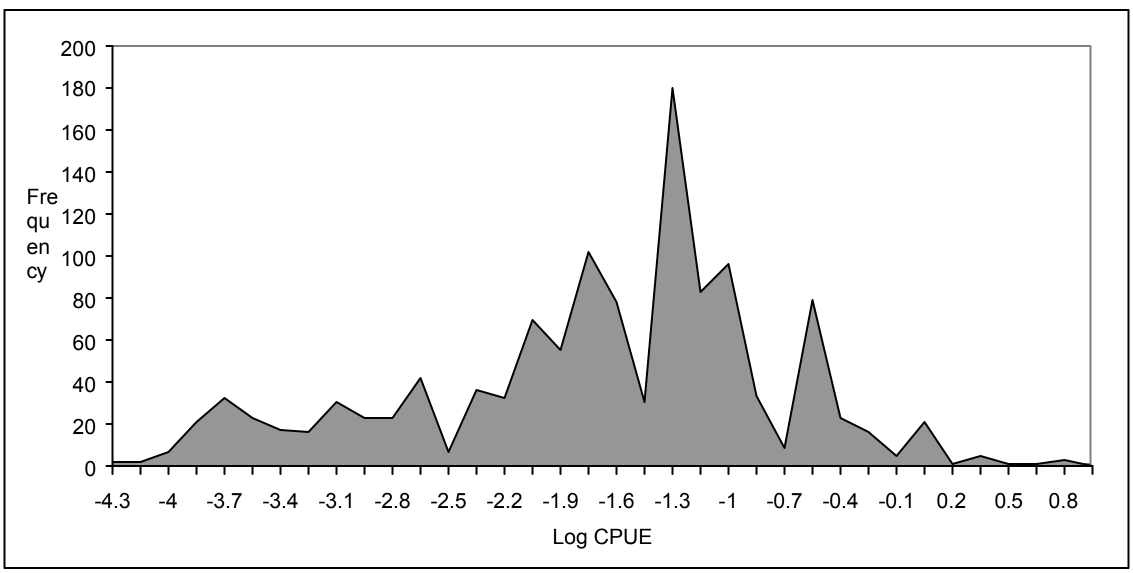


Figure 3. Estimated number of fishing trips by mode and fishing years in the Atlantic Ocean based on Summary of trips the MRFSS survey. The 1997 fishig year values are preliminary.

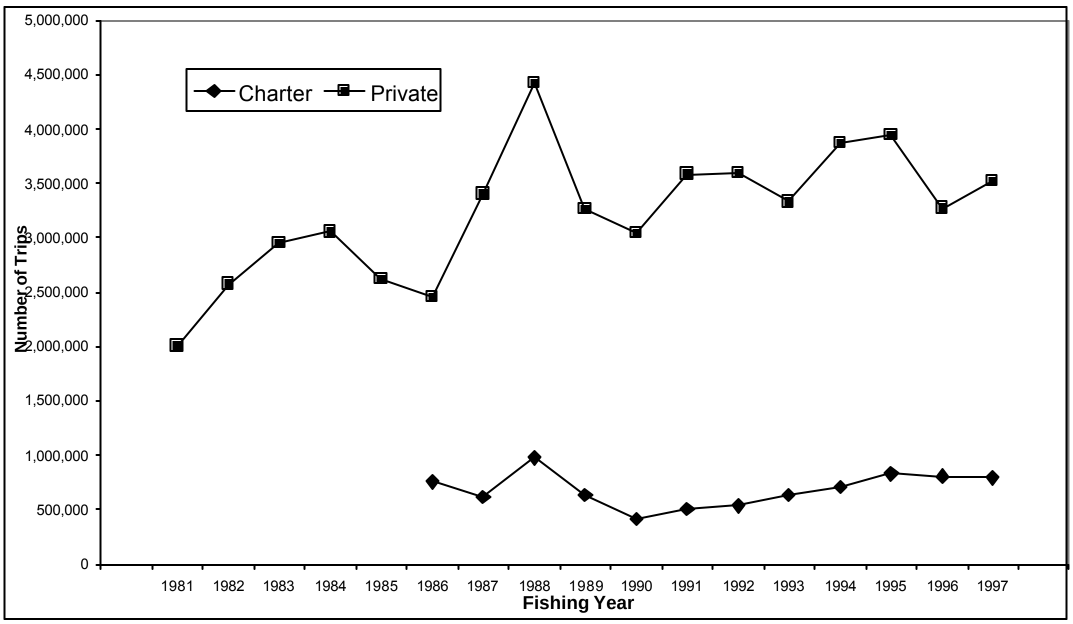
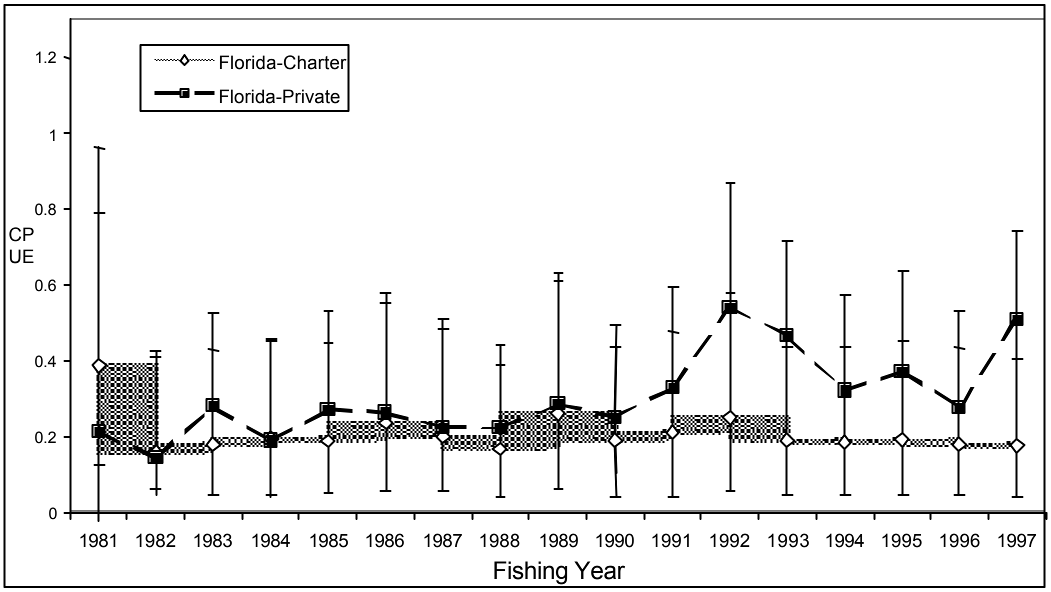


Figure 2. Standardized CPUE abundance trends (Catch per angler hour) and 95% Confidence for the Atlantic Ocean greater amberjack by fishing year from the (a) Florida charter and private and b) all states combined charter and privatemodes, based on the MRFSS

a)



b)

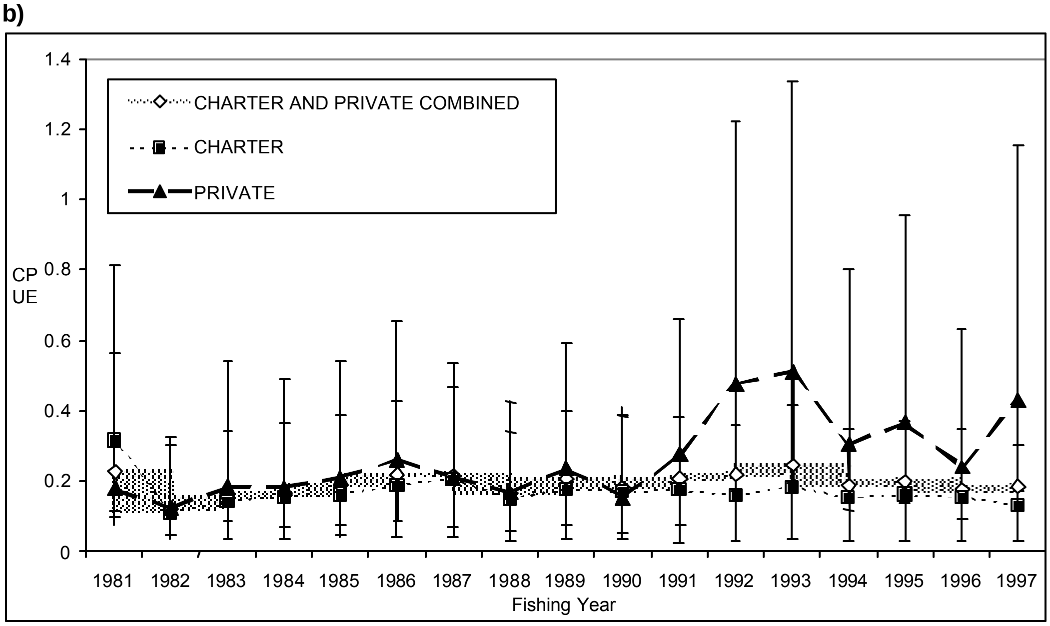
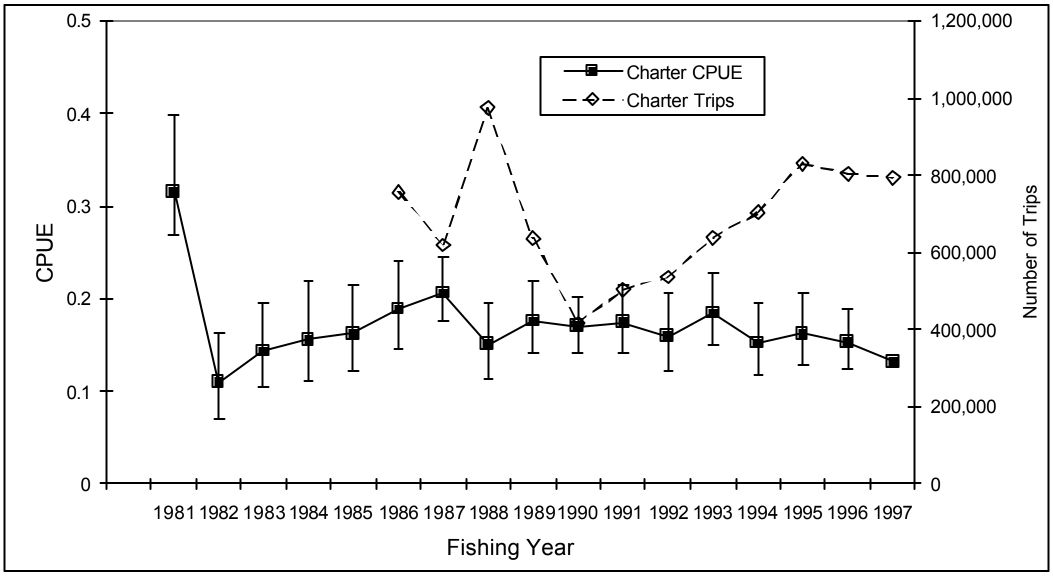
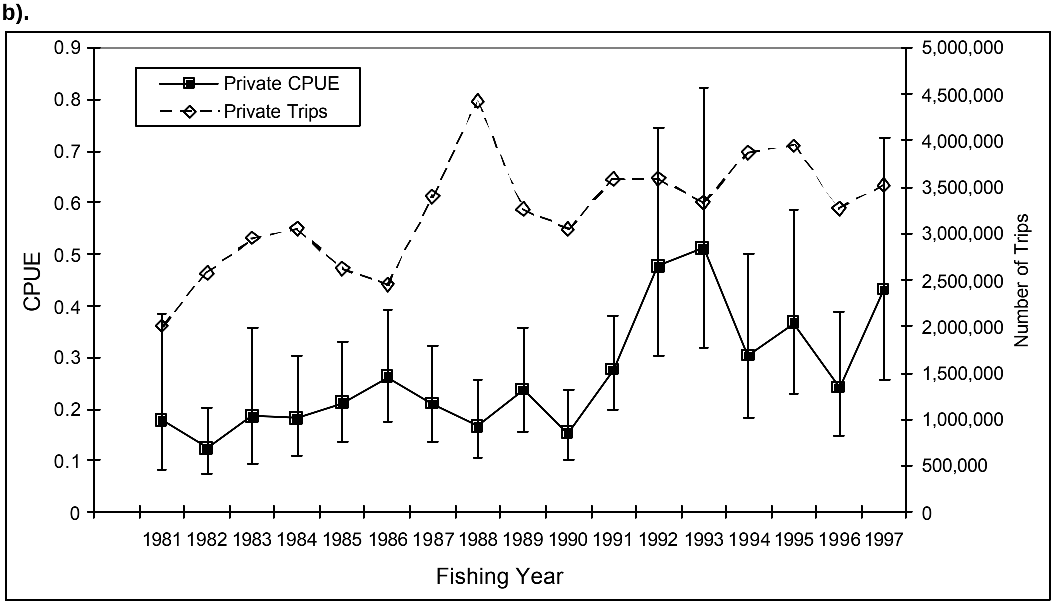


Figure 4. Standardized catch per angler hour for the Atlantic Ocean greater amberjack by fishing year from the (a) charter and (b) private modes based on the MRFSS data. The estimated number of recreational fishing trips for the Atlantic Ocean by mode for all species is plotted on the second Y axis.

a.)



b).



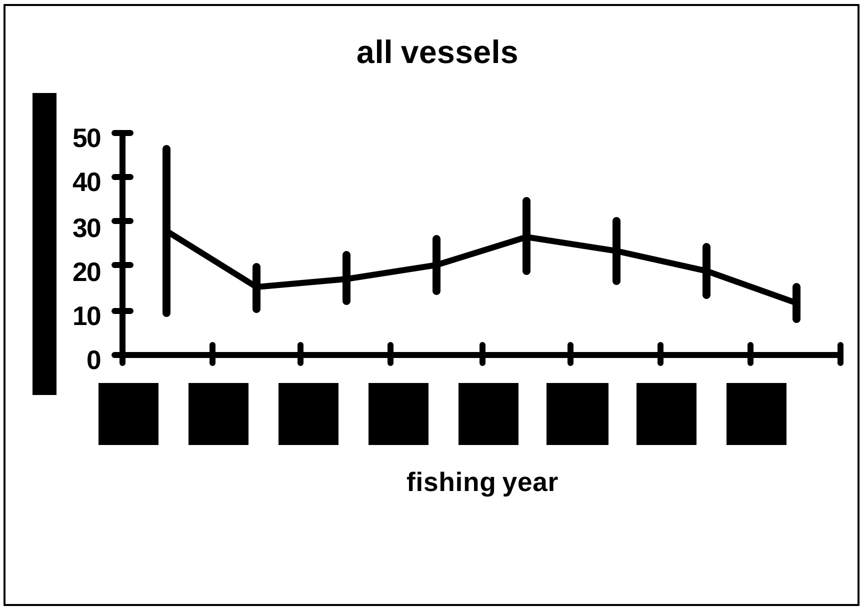


Figure 6. Standardized yield per hook from all handline vessels with 80% confidence intervals.

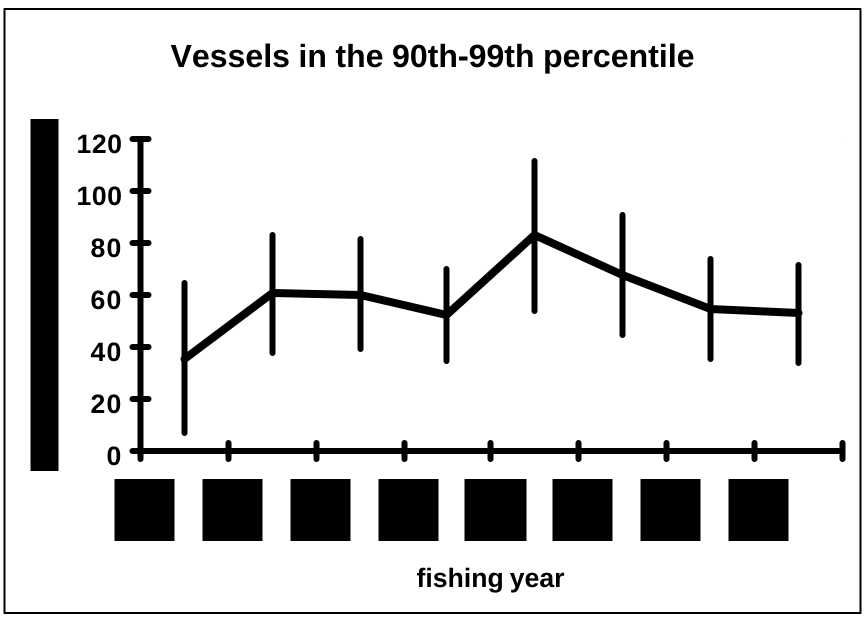


Figure 7. Standardized yield per hook from handline vessels in the 90^{th}-99^{th} percentile for proportion positive or catch rate on successful trips with 80% confidence intervals.

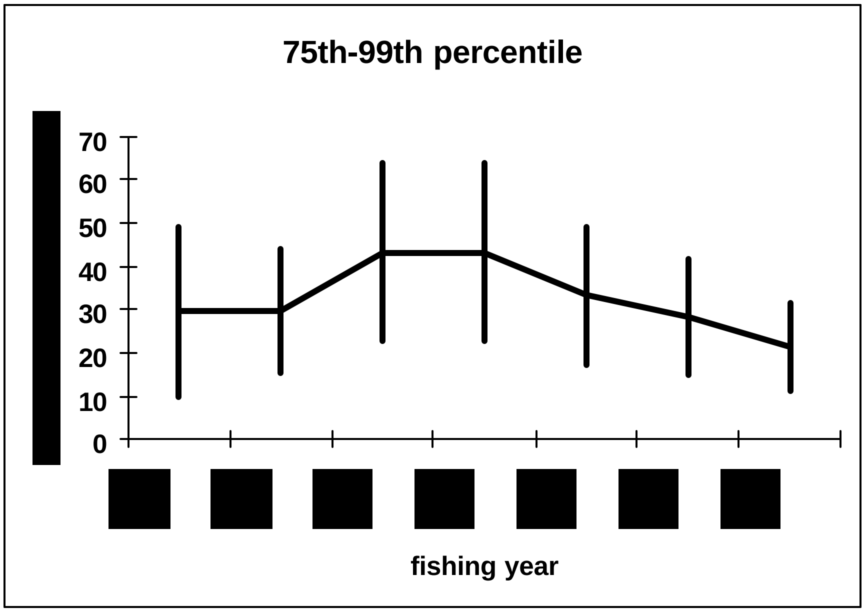


Figure 8. Standardized yield per hook from handline vessels in the 75^{th}-99^{th} percentile for proportion positive or catch rate on successful trips. Confidence intervals

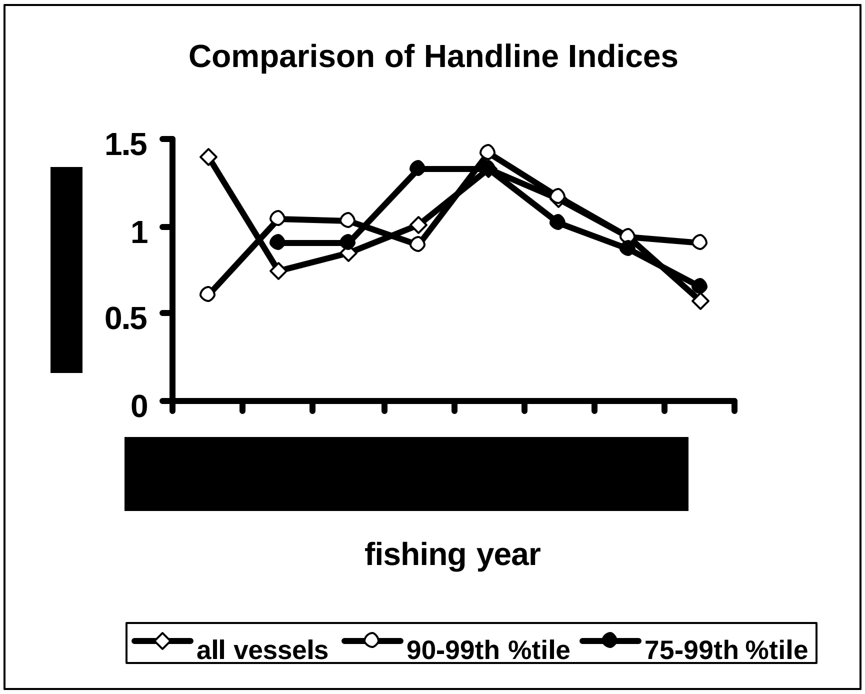


Figure 9. Comp arison of handline indices of abundance standardized to their means.

Figure 10. Greater amberjack catch per trip in the Atlantic by latitude.
Figure 11. Greater amberjack catch per trip in the Atlantic by month. Months 13 to 15 are January to March of the following calendar year.

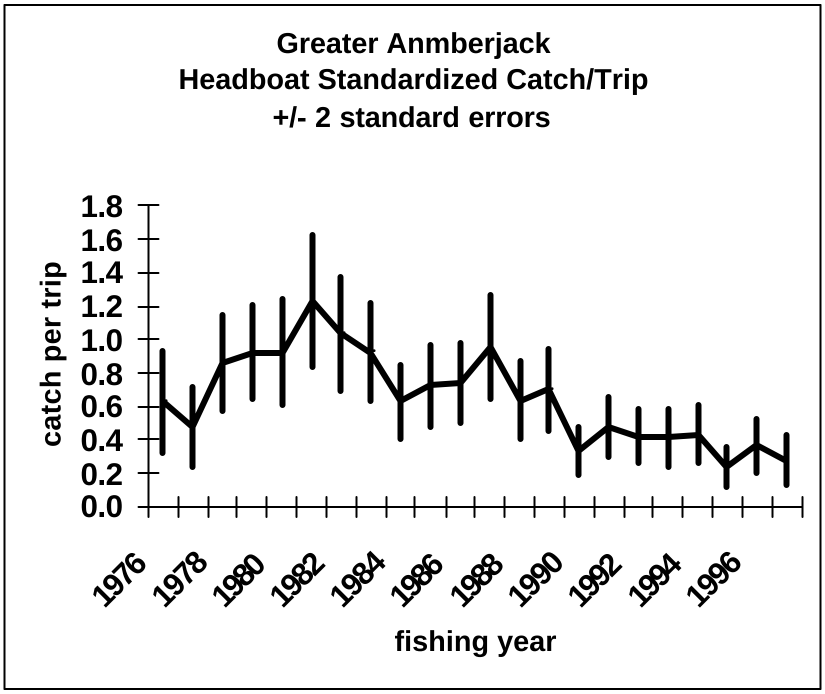


Figure 12. Standardized catch of Atlantic greater amberjack per trip from the headboat fishery with confidence intervals of 2 standard errors.

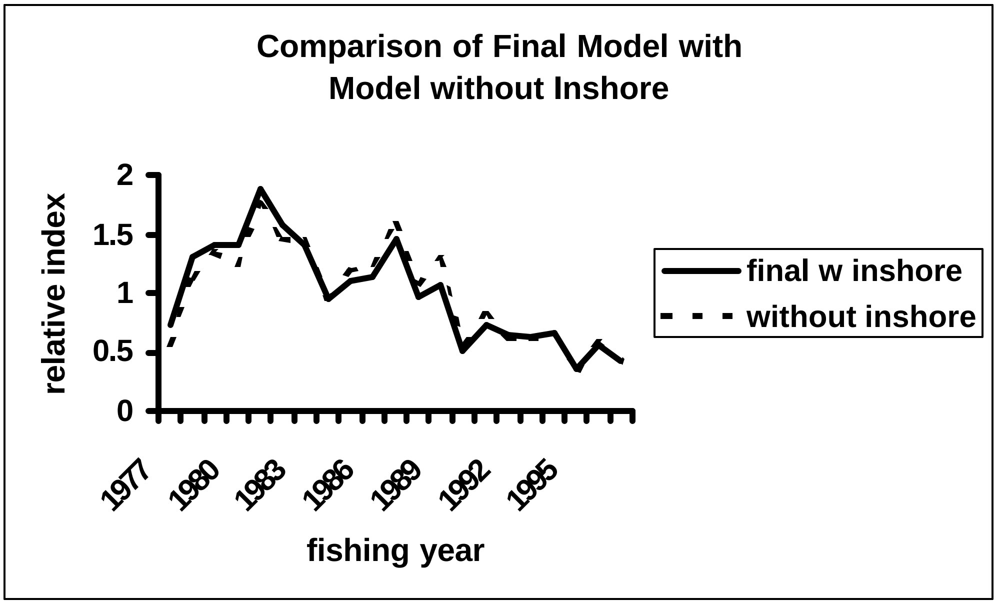


Figure 13. Comparison of standardized indices from the headboat fishery with and without the inshore species factor.

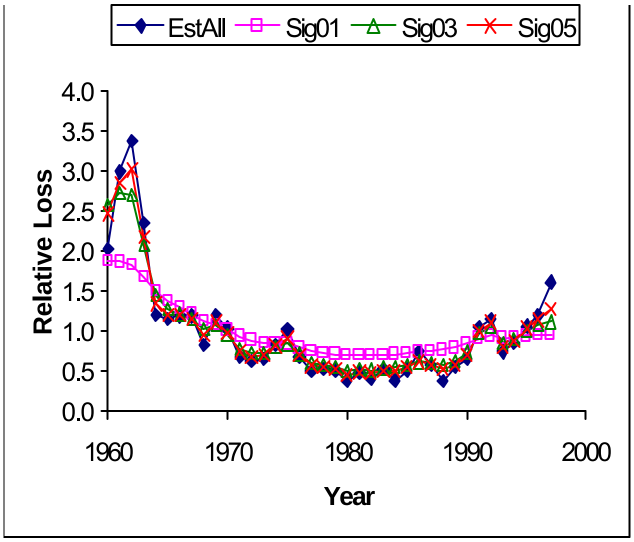


Figure 14. Relative loss estimated from four procedures.

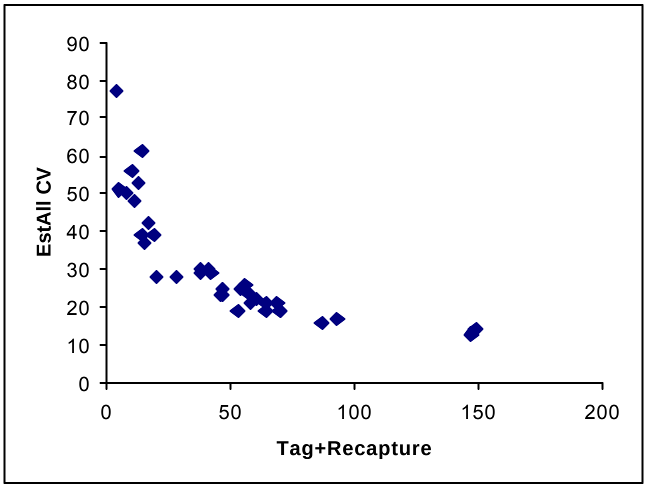


Figure 15. Relationship between sample size and uncertainty in relative loss estimation for the EstAll scenario.

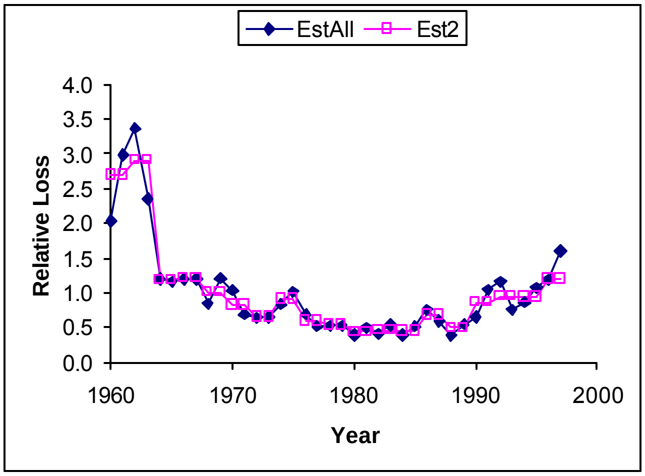


Figure 16. Sensitivity analysis estimating one Z* for every two years.

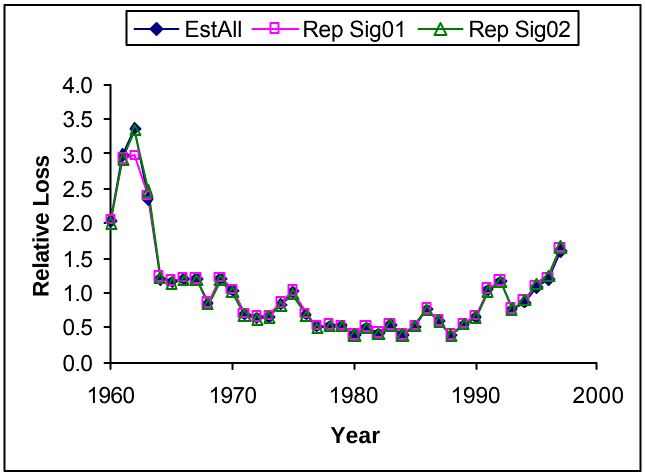


Figure 17. Sensitivity analysis changing the minimum number of days at large.

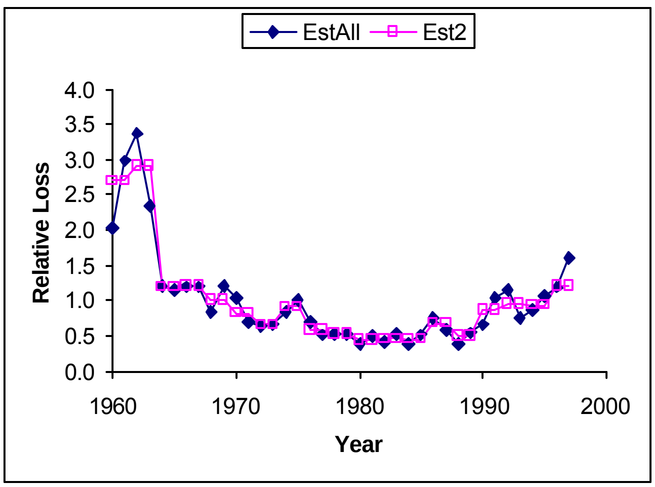


Figure 18. Sensitivity analyses estimating reporting rates with a random walk

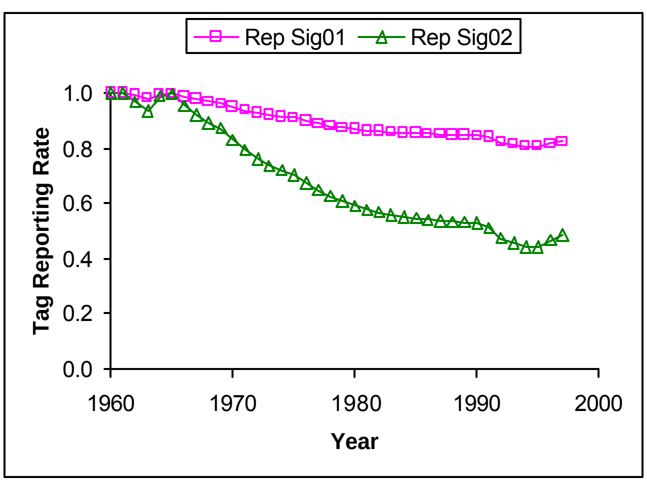


Figure 19. Sensitivity analyses estimating reporting rates with a random walk.

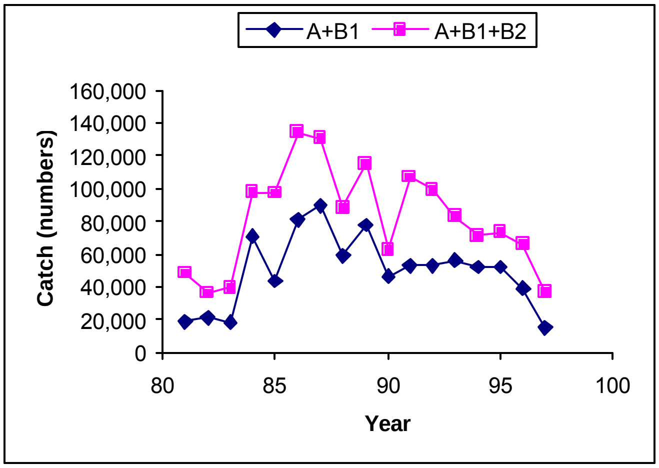


Figure 20. Two estimate types of the greater amberjack catch in the recreational fishery in the southeast Atlantic Ocean.

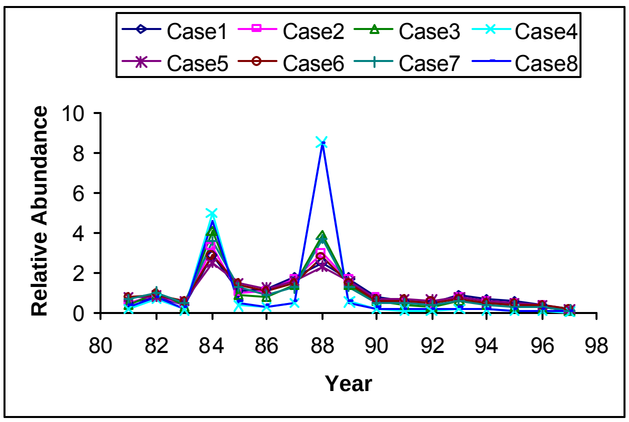


Figure 21. Relative abundance estimates (see Table 20).

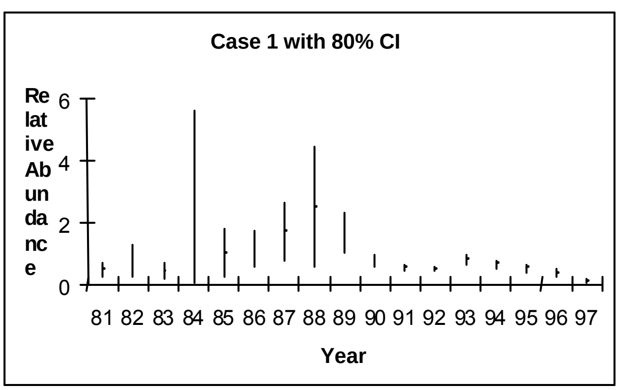


Figure 22. Case I relative abundance estimates with 80% confidence intervals.

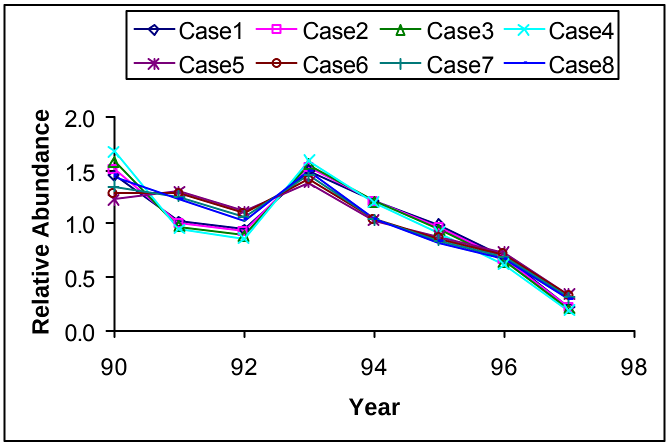


Figure 23. Relative abundance estimates (see Table 21).

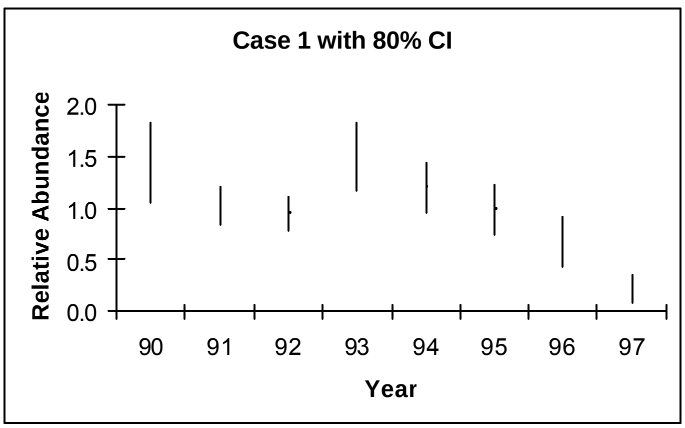


Figure 24. Case I relative abundance with 80% confidence intervals.

Appendix 1. Regression tree examination of proportion of trips with greater amberjack with explanatory variables for fishing year, month, latitude and longitude (fishyrc, monthc, and latc). Months 11-16 indicate January-April in the calendar year after the associated months 5-12. For each node of the tree is given: node number (first node is 1), the levels of observations of the variable being split (latidude is split at node 2 and 3 with 24-28N and 30-35N falling in node 2 and latitude 29N falling in node 3), the number of observations associated with that node (93121 observations for node 1), the deviance associated with the information in that node, and the average proportion positive associated with that node.

```
Tree formula:  PROPGA ~ FISHYRC + MONTHC + LATC,

  1) root 93121 4326.00 0.06343
    2) LATC:  24,  25,  26,  27,  28,  30,  31,  32,  33,  34,  35 90471 3751.00 0.05635
      4) MONTHC:   6,   7,   8,   9,  10,  11,  12,  13,  14,  16 71428 2009.00 0.04162
        8) LATC:  24,  25,  26,  32,  33,  34,  35 65649 1664.00 0.03661
         16) MONTHC:   6,   7,   8,   9,  10,  11,  12,  13,  16 56986 1256.00 0.03309
           32) FISHYRC:1991,1992,1993,1994,1998 28383  448.80 0.02463
             64) MONTHC:   7,   8,   9,  10,  11,  12,  16 20641  261.10 0.02130 *
             65) MONTHC:   6,  13 7742  187.00 0.03349 *
           33) FISHYRC:1995,1996,1997 28603  803.40 0.04149
             66) LATC:  24,  25,  26,  34,  35 25114  704.70 0.03763
              132) LATC:  34,  35 4101   29.34 0.01755 *
              133) LATC:  24,  25,  26 21013  673.40 0.04155
                266) MONTHC:   6,   7,   8,  10,  11,  12,  16 16073  441.60 0.03595
                  532) FISHYRC:1995,1997 10358  247.90 0.03128 *
                  533) FISHYRC:1996 5715  193.10 0.04440 *
                267) MONTHC:   9,  13 4940  229.70 0.05979 *
             67) LATC:  32,  33 3489   95.64 0.06922 *
         17) MONTHC:  14 8663  402.60 0.05981 *
        9) LATC:  27,  28,  30,  31 5779  324.40 0.09845 *
      5) MONTHC:   5,  15 19043 1668.00 0.11160
       10) LATC:  30,  31,  32,  33,  34,  35 3822   33.23 0.02908 *
       11) LATC:  24,  25,  26,  27,  28 15221 1602.00 0.13230
         22) LATC:  24,  27 12628 1236.00 0.12120
           44) MONTHC:  15 6631  577.70 0.10560
             88) FISHYRC:1992,1998 1620  100.30 0.07075 *
             89) FISHYRC:1991,1993,1994,1995,1996,1997 5011  474.80 0.11690
              178) FISHYRC:1994,1995,1996,1997 3831  333.60 0.10740 *
              179) FISHYRC:1991,1993 1180  139.80 0.14780 *
           45) MONTHC:   5 5997  654.80 0.13840
             90) FISHYRC:1991,1993,1994,1995,1996,1997,1998 5810  611.00 0.13320
              180) FISHYRC:1991,1995,1997,1998 3202  311.00 0.12310 *
              181) FISHYRC:1993,1994,1996 2608  299.20 0.14570 *
             91) FISHYRC:1992 187   38.70 0.30000 *
         23) LATC:  25,  26,  28 2593  357.10 0.18640 *
    3) LATC:  29 2650  415.90 0.30520 *
```

Appendix 2. Regression tree examination of handline yield per hook on trips with greater amberjack with explanatory variables for fishing year, month, latitude and longitude (fishyrc, monthc, latc, and longc). Months 11-16 indicate January-April in the calendar year after the associated months 5-12. For each node of the tree is given: node number (first node is 1), the levels of observations of the variable being split, the number of observations associated with that node, the deviance associated with the information in that node, and the average proportion positive associated with that node.

Tree formula: CPHOOK ~ FISHYRC + MONTHC + LATC + LONGC,

```
  1) root 13241 1528000000 182.40
    2) LATC:  30,  31,  32,  33,  34,  35 5566   64440000  38.58 *
    3) LATC:  24,  25,  26,  27,  28,  29 7675 1265000000 286.70
      6) MONTHC:   6,   7,   8,   9,  10,  11,  12,  13,  14,  16 4976  658300000 228.90
       12) LATC:  24,  25,  26,  27,  28 3781  427200000 203.30
         24) MONTHC:   6,   7,   8,   9,  10,  11,  12,  13,  16 2993  267000000 180.90
           48) LATC:  25 306   10610000  86.80 *
           49) LATC:  24,  26,  27,  28 2687  253400000 191.60
             98) MONTHC:   7,  11,  12,  16 1132   68560000 149.50 *
             99) MONTHC:   6,   8,   9,  10,  13 1555  181400000 222.20
              198) FISHYRC:1992,1993,1996,1998 710   62710000 180.30 *
              199) FISHYRC:1991,1994,1995,1997 845  116400000 257.40 *
         25) MONTHC:  14 788  153000000 288.20
           50) FISHYRC:1995,1996,1997,1998 460   45430000 233.70 *
           51) FISHYRC:1991,1992,1993,1994 328  104200000 364.80 *
       13) LATC:  29 1195  220800000 309.90
         26) MONTHC:   6,   7,   8,   9,  11,  12 675  105800000 264.00 *
         27) MONTHC:  10,  13,  14,  16 520  111700000 369.40 *
      7) MONTHC:   5,  15 2699  559000000 393.40
       14) FISHYRC:1993,1994,1995,1996,1997,1998 2378  426500000 365.10
         28) FISHYRC:1996,1997,1998 1173  185900000 319.50
           56) FISHYRC:1998 249   19100000 261.10 *
           57) FISHYRC:1996,1997 924  165800000 335.20
            114) LONGC:  79,  81 212   28020000 299.60 *
            115) LONGC:  80 712  137400000 345.80 *
         29) FISHYRC:1993,1994,1995 1205  235700000 409.50
           58) LATC:  25,  26,  28,  29 394   63380000 303.20 *
           59) LATC:  24,  27 811  165700000 461.10
            118) LONGC:  81 156   25550000 326.20 *
            119) LONGC:  80 655  136700000 493.30 *
       15) FISHYRC:1991,1992 321  116500000 603.40 *
```

Appendix 3. Regression tree examination of headboat catch rates of greater amberjack. Explanatory variables included calendar year, month, triptype, latitude and longitude (yearc, monthc, triptypc, nlatmc, and nlongmc) as well as numerous variables related to the proportion of various disaggregated taxonomic groups. For each node of the tree is given: node number (first node is 1), the levels of observations of the variable being split, the number of observations associated with that node, the deviance associated with the information in that node, and the average catch rate for that node.

```
Tree formula:  CPUE ~ YEARC + MONTHC + TRIPTYPC + NLATMC + NLONGMC + CARCHPC + HOLOCPC +
EPINEPPC + MYCTERPC + OTHSERPC + BIGEYEPC +
    BLUELIPC + SANDTIPC + WAHCOBPC + OTSERIPC + INPORGPC + LABRIDPC + OTHMACPC + BALISTPC
+ CENTROPC + CARANXPC + HMSPC + LUJANUPC +
    OCYURUPC + RHOMBOPC + GRUNTSPC + PAGARUPC + KATSUWPC + KINGMAPC,

Variables actually used in tree construction:
[1] "NLATMC"   "TRIPTYPC" "MONTHC"   "YEARC"    "CENTROPC" "GRUNTSPC"

  1) root 153996 7874.00 0.017180
    2) NLATMC: -24, -25, -26, -27, -28, -29, -32, -33, -34, -35 139103 1627.00 0.009383
      4) TRIPTYPC: 1/2 day am, 1/2 day pm, 1/2 nite pm, 3/4 day 120719 1075.00 0.007068
        8) MONTHC: 1, 2, 3, 6, 7, 8, 9,10,12 91250  337.90 0.004600 *
        9) MONTHC: 4, 5,11 29469  734.50 0.014710 *
      5) TRIPTYPC:full day 18384  547.30 0.024580 *
    3) NLATMC: -30, -31 14893 6159.00 0.090030
      6) YEARC:1977,1978,1979,1980,1983,1984,1985,1986,1987,1988,1989,1990,
1991,1992,1993,1994,1995,1996,1997 13099  825.40 0.051770
       12)
YEARC:1978,1979,1983,1984,1985,1986,1987,1988,1989,1990,1991,1992,1993,1994,1995,1996,199
7 11540  223.40 0.034850 *
       13) YEARC:1977,1980 1559  574.20 0.177000 *
      7) YEARC:1981,1982 1794 5175.00 0.369400
       14) MONTHC: 3, 4, 6, 7, 8, 9,10,11,12 1417 1238.00 0.208900
         28) MONTHC: 3, 7, 8, 9,10,11 869  138.70 0.078460 *
         29) MONTHC: 4, 6,12 548 1061.00 0.415800
           58) TRIPTYPC: day am, day pm 365  188.10 0.184100 *
           59) TRIPTYPC:full day 183  814.50 0.878000
            118) CENTROPC:2,3 109   28.62 0.210500 *
            119) CENTROPC:0,1 74  665.80 1.861000 *
       15) MONTHC: 1, 2, 5 377 3763.00 0.972600
         30) CENTROPC:0,2,3 254  665.90 0.428700 *
         31) CENTROPC:1 123 2867.00 2.096000
           62) GRUNTSPC:1,2,3 63  162.10 0.468700 *
           63) GRUNTSPC:0 60 2363.00 3.804000 *
```

Appendix 4. Regression tree examination of headboat catch rates of greater amberjack. Explanatory variables included calendar year, month, triptype, latitude and longitude (yearc, monthc, triptypc, nlatmc, and nlongmc) as well as aggregated taxonomic groups indicators (inshorpl, offbotpl and offpelpl). For each node of the tree is given: node number (first node is 1), the levels of observations of the variable being split, the number of observations associated with that node, the deviance associated with the information in that node, and the average catch rate for that node.

```
Tree formula: CPUE ~ YEARC + MONTHC + TRIPTYPC + NLATMC + NLONGMC + INSHORPL + OFFBOTPL +
OFFPELPL,
       data = Analy6rev, na.action = na.fail, mincut = 25, minsize = 50, mindev = 0.1

Variables actually used in tree construction:
[1] "NLATMC"   "TRIPTYPC" "MONTHC"   "INSHORPL" "OFFBOTPL" "YEARC"

  1) root 153996 7874.00 0.017180
    2) NLATMC: -24, -25, -26, -27, -28, -29, -32, -33, -34, -35 139103 1627.00 0.009383
      4) TRIPTYPC: 1/2 day am, 1/2 day pm, 1/2 nite pm, 3/4 day 120719 1075.00 0.007068
        8) MONTHC: 1, 2, 3, 6, 7, 8, 9,10,12 91250  337.90 0.004600 *
        9) MONTHC: 4, 5,11 29469  734.50 0.014710 *
      5) TRIPTYPC:full day 18384  547.30 0.024580 *
    3) NLATMC: -30, -31 14893 6159.00 0.090030
      6) INSHORPL:2,3 12816  639.20 0.045620 *
      7) INSHORPL:0,1 2077 5339.00 0.364100
       14) OFFBOTPL:0,2,3 1793 1203.00 0.177800
         28) OFFBOTPL:3 1303   31.98 0.042800 *
         29) OFFBOTPL:0,2 490 1084.00 0.536800
           58)
YEARC:1977,1978,1979,1983,1984,1985,1986,1987,1988,1989,1990,1991,1992,1993,1994,1995,199
6,1997 294   59.26 0.113500 *
           59) YEARC:1980,1981,1982 196  893.00 1.172000
            118) MONTHC: 3, 4, 6, 7, 8, 9,10,11,12 140  214.60 0.755200 *
            119) MONTHC: 1, 2, 5 56  593.40 2.212000 *
       15) OFFBOTPL:1 284 3681.00 1.540000
         30)
YEARC:1978,1979,1981,1983,1984,1985,1986,1987,1988,1989,1990,1992,1993,1994,1995,1996,199
7 204  262.30 0.345600 *
         31) YEARC:1980,1982 80 2386.00 4.586000
           62) TRIPTYPC: day am, day pm 36  264.50 1.862000 *
           63) TRIPTYPC:full day 44 1635.00 6.814000 *
```

Appendix 5. Regression tree examination of headboat catch rates of greater amberjack with data restricted to full day trips. Explanatory variables included calendar year, month, triptype, and latitude (yearc, monthc, and nlatmc) as well as aggregated taxonomic groups indicators (inshorpl, offbotpl and offpelpl). Year refers to fishing year with April as the first month of the fishing year. Months 13 to 15 refer to January to March. For each node of the tree is given: node number (first node is 1), the levels of observations of the variable being split, the number of observations associated with that node, the deviance associated with the information in that node, and the average catch rate for that node.

```
tree(formula = CPUE ~ YEARC + MONTHC + TRIPTYPC + NLATMC + INSHORPL + OFFBOTPL +
OFFPELPL,
       data = Anal6cfd, na.action = na.omit, mincut = 25, minsize = 50, mindev = 0.05)

Variables actually used in tree construction:
[1] "YEARC"    "NLATMC"   "OFFBOTPL" "INSHORPL" "MONTHC"

  1) root 25450 5623.00 0.05966
    2)
YEARC:1975,1976,1977,1978,1979,1983,1984,1985,1986,1987,1988,1989,1990,1991,1992,1993,199
4,1995,1996,1997 21924  476.70 0.03383
      4) NLATMC: -24, -25, -26, -27, -28, -29, -32, -33, -34, -35 16214  235.90 0.02185 *
      5) NLATMC: -30, -31 5710  231.90 0.06785 *
    3) YEARC:1980,1981,1982 3526 5041.00 0.22030
      6) NLATMC: -24, -25, -26, -27, -28, -29, -31, -32, -33, -34 2275  312.30 0.04411
       12) OFFBOTPL:0,2,3 1975   55.03 0.02715 *
       13) OFFBOTPL:1 300  253.00 0.15580 *
      7) NLATMC: -30 1251 4530.00 0.54070
       14) INSHORPL:2,3 843  339.20 0.17480
         28) MONTHC: 7, 8, 9,10,11,12,14,15,16 657   83.97 0.11380 *
         29) MONTHC: 5, 6,13 186  244.10 0.39050 *
       15) INSHORPL:0,1 408 3845.00 1.29600
         30) OFFBOTPL:0,2,3 344  642.10 0.56430
           60) OFFBOTPL:3 235   19.22 0.13460 *
           61) OFFBOTPL:0,2 109  485.90 1.49100
            122) MONTHC: 6, 7, 8, 9,10,11,12,15,16 74  109.20 0.95010 *
            123) MONTHC: 5,13,14 35  309.30 2.63400 *
         31) OFFBOTPL:1 64 2027.00 5.23200
           62) YEARC:1980,1981 39   91.87 2.45900 *
           63) YEARC:1982 25 1167.00 9.55700 *
```