# Queen conch (*Strombus gigas*) standardized catch rates from the Puerto Rico and US Virgin Island commercial fisheries

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## INTRODUCTION

Landings and fishing effort of commercial vessels operating in Puerto Rico are monitored by the Fisheries Research Laboratory of the Puerto Rico Department of Natural and Environmental Resources (DNER). The program collects landings and effort data from coastal municipalities and major fishing centers in Puerto Rico. In the US Virgin Islands, commercial fishers report catch and effort data on a monthly basis to the US Virgin Islands Division of Fish and Wildlife (DFW). A separate data set is maintained for St. Croix, but data from St. Thomas and St. John are contained in a single database. Both DNER and DFW have cooperative agreements with NOAA National Marine Fisheries Service.

The available catch per unit effort (CPUE) series, from 1983 – 2005 (Puerto Rico) and 1986-2005 (USVI), were used to develop several abundance indices for queen conch. An initial series of abundance indices were developed using the models of Valle-Esquivel (2002a) from a previous queen conch assessment. New models were also developed for Puerto Rico, southwest Puerto Rico, St. Croix, and for St. Thomas/St. John.

## Methods

### Replication of 2002 indices

The following indices were constructed using the models applied during the previous queen conch assessment (Valle-Esquivel, 2002a). They are intended to demonstrate the effect of updating the data without changing the standardization procedure.

Puerto Rico lognormal (positive trips) model

In Puerto Rico fishers may report multiple trips on a single sales record (report to DNER). Only single trip records were included in the dataset. Two approaches were used to define single record trips and an index was constructed for each approach. One approach defined single trip records if the sales record indicated that trips=1 or if trips was reported as 0 or if number of trips was missing (Valle-Esquivel, 2002b). Those data will be referred to as trips=1, 0, or missing. A second approach included only those data that included trips=1 on the sales record. Those data will be referred to as trips=1. Following the methods a Valle-Esquivel (2002a), trips that reported landings beyond 99.5% of the combined multispecies cumulative distribution of landings (total weight=1,037 lbs/trip where trips=1, 0, or missing; total weight=765 lbs/trip where trips=1) or less than 1% of the conch landings distribution (2.5 lbs conch/trip where trips=1, 0, missing; 2.25 lbs conch/trip where trips=1) were excluded from the analyses.
Trips were additionally limited to those that reported SCUBA, skin diving, or spear fishing as the fishing gear used. A factor, COAST, was included that divided the island into four regions: north (fishing centers

10-170), east (180-251), south (260-362), and west (370-423; see Valle-Esquivel, 2002b for a map of these locations). This definition of COAST differs from Valle-Esquivel (2002a) in that there are only four regions defined rather than seven. This was done to ensure larger sample size for the analyses. CPUE was defined as pounds of conch landed per trip.

A lognormal model was fit to catch rates on positive trips. The model fit to the data was:

**LOG(lbs/trip) = YEAR + MONTH + COAST + GEAR + YEAR*MONTH + YEAR*COAST**

Puerto Rico delta lognormal model

The dataset used to construct two indices including factors similar to those described for the lognormal (positive trips) indices above. Trips in the delta lognormal analyses included all trips with the reported gears SCUBA, skin diving, and spear fishing with the pounds landed limitations listed above. The assumption was that such trips had the potential to catch conch. The development of the delta lognormal indices included a binomial model of the proportion positive trips in addition to the lognormal model on positive trips. The two definitions of single trips (trips=1, 0, or missing vs. trips=1), coast, month, and year were again included in the final model (Valle-Esquivel, 2002a).

A lognormal model was fit to catch rates on positive trips. The model fit to the data was:

**LOG(lbs/trip) = YEAR + MONTH + COAST + GEAR + YEAR*MONTH + YEAR*COAST**

A binomial model was fit to catch rates on proportion positive trips. The model fit to the data was:

**Proportion positive = YEAR + MONTH + COAST + YEAR*MONTH + YEAR*COAST**

Southwest Puerto Rico lognormal (positive trips) model

The dataset used to construct these indices was limited to trips landing conch in southwestern Puerto Rico (fishing centers 370-384). Only positive trips were included in these analyses and the two definitions of single record trips (trips=1, 0, or missing and trips=1) limited the dataset for the analyses. The factor COUNTY (Lajas, Cabo Rojo, and Mayaguez; see Valle-Esquivel, 2002a for a map of these locations)was included rather COAST (Valle-Esquivel, 2002a). Other factors were similar to the previous analyses.

A lognormal model constructed by Valle-Esquivel (2002a) was fit to catch rates on positive trips. The model fit to the data was:

**LOG(lbs/trip) = YEAR + MONTH + COUNTY + YEAR*MONTH + YEAR*COUNTY**

St. Croix lognormal (positive trips) model

This index was constructed from a dataset that included all trips reporting conch landings, regardless of gear used. The dataset included conch landings and effort for the years 1989-2005. Area was defined as southwest, southeast, east, northeast, northwest, and west St. Croix.

A lognormal model constructed by Valle-Esquivel (2002a) was fit to catch rates on positive trips. The model fit to the data was:

**LOG(lbs/trip) = YEAR + MONTH + AREA + YEAR*MONTH + YEAR*AREA**

**Additional Indices**

Additional indices were developed for Puerto Rico, southwest Puerto Rico, St. Croix, and St. Thomas/St. John. Lognormal indices on positive trips were developed for each of the above regions. Delta lognormal indices were also developed for Puerto Rico and southwest Puerto Rico. For the Puerto Rico indices, the two approaches to defining single record trips (i.e. trips=1, 0, missing vs. trips=1 reported on the sales record) were used to develop separate indices. Data were further limited by including only trips that reported using SCUBA, skin diving, or spear fishing and that reported landings within the ranges defined above.

***Index Development***

Puerto Rico

For the Puerto Rico lognormal and delta lognormal indices, seven factors were considered as possible influences on the CPUE and the proportion of positive trips:

| Factor | Levels | Value |
|---|---|---|
| YEAR | 23 | 1983-2005 |
| MONTH | 12 | January-December |
| WAVE | 6 | Two month periods; January-February, etc. |
| SEASON | 4 | Three month periods; January-March, etc. |
| GEAR | 3 | SCUBA, skin diving, spear fishing |
| COAST | 4 | North, east, south, west as defined above |
| TARGET* | 2 | 1=only conch landed, 0=other species landed, may also have landed conch |

*TARGET was excluded from the binomial portion of delta lognormal analyses because all TARGET=1 trips are positive

An initial lognormal model on positive trips was developed for Puerto Rico. CPUE was defined as pounds of conch landed/trip. This approach involved an iterative generalized linear model (GLM) analysis to identify those factors that had a significant effect on CPUE. For the analysis, a type-3 model assuming lognormal error distribution was examined. The linking function selected was "normal", and the response variable was ln(CPUE).

The process began by developing a base model that included year. Each potential factor was added to the null model sequentially and the reduction in deviance per degree of freedom was examined. The factor that caused the greatest reduction in deviance per degree of freedom was added to the base model, provided the factor was significant (Chi-square test, $p>0.05$) and the reduction per degree of freedom was ≥1%. The model with the newly included factor became the base model and the process was repeated until no additional factors met the criteria for inclusion in the model. All two-way interactions of significant main effects were examined and those that met the inclusion criteria were added to the model. No higher order interactions were examined. Parameterization of each model was accomplished using a GLM procedure (GENMOD; Version 8.02 of the SAS System for Windows © 2000. SAS Institute Inc., Cary, NC, USA). The final lognormal model was fit using the procedure Proc Mixed in SAS and included a correction of log transform bias modified from an algorithm developed by Lo et al. (1992). A relative index and relative nominal CPUE series were calculated by dividing each value in the series by the mean value of the series.

The delta lognormal model approach (Lo et al. 1992) was also used to develop standardized indices of abundance for the conch data. This method combines separate GLM analyses of the proportion of successful trips (trips that landed conch) and the catch rates on successful trips to construct a single standardized CPUE index. Parameterization of each model was accomplished using a GLM procedure (GENMOD; Version 8.02 of the SAS System for Windows © 2000. SAS Institute Inc., Cary, NC, USA).

For each GLM procedure of proportion positive trips, a type-3 model was fit, a binomial error distribution was assumed, and the logit link was selected. The response variable was proportion successful trips. During the analysis of catch rates on successful trips, a type-3 model assuming lognormal error distribution was examined. The linking function selected was "normal", and the response variable was ln(CPUE). The response variable was calculated as: ln(CPUE) = ln(pounds of conch landed/trip). All 2-way interactions among significant main effects were examined. A stepwise approach was again used to quantify the relative importance of the factors. Higher order interaction terms were not examined.

The final delta-lognormal model was fit using a SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute). All factors were modeled as fixed effects except two-way interaction terms containing YEAR which were modeled as random effects. To facilitate visual comparison, a relative index and relative nominal CPUE series were again calculated by dividing each value in the series by the mean value of the series.

Southwest Puerto Rico

Indices developed from southwest Puerto Rico data followed the methods and data limitations listed above for the indices constructed for the whole island. For the southwest Puerto Rico lognormal and delta lognormal indices, five factors were considered as possible influences on the CPUE and the proportion of positive trips:

| Factor | Levels | Value |
|---|---|---|
| YEAR | 23 | 1983-2005 |
| SEASON | 4 | Three month periods; January-March, etc. |
| GEAR | 3 | SCUBA, skin diving, spear fishing |
| COUNTY | 3 | Fishing centers of Lajas, Cabo Rojo, and Mayaguez |
| TARGET* | 2 | 1=only conch landed, 0=other species landed, may also have landed conch |

*TARGET was excluded from the binomial portion of delta lognormal analyses because all TARGET=1 trips are positive

St. Croix

Methods used to construct an additional index of abundance from St. Croix conch landings and effort information followed the methods previously described for developing lognormal models. All trips that reported conch landings were included in the analysis, regardless of the gear employed. Data for the years 1986, 1988, and 1999 were excluded from the analysis because data from those years were insufficient for the analysis. For the St. Croix lognormal index, three factors were considered as possible influences on the CPUE per trip:

| Factor | Levels | Value |
|---|---|---|
| YEAR | 17 | 1987, 1990-2005 |
| SEASON | 4 | Three month periods; January-March, etc. |
| AREA | 6 | Northeast, east, southeast, southwest, west, and unknown |

St. Thomas/St. John

Methods for constructing the lognormal index for St. Thomas and St. John were similar to those used to develop the St. Croix index. All positive conch trips were included in the dataset. Data for the year 1986 were insufficient for the analysis and the years 1988-1994 were excluded because the fishery was closed. For the St. Thomas/St. John lognormal indices, three factors were considered as possible influences on the CPUE and the proportion of positive trips:

| Factor | Levels | Value |
|---|---|---|
| YEAR | 12 | 1987, 1995-2005 |
| SEASON | 4 | Three month periods; January-March, etc. |
| AREA | 3 | North of the islands, south of the islands, unknown |

## Results and Discussion

**Replication of 2002 Puerto Rico indices**

Puerto Rico Lognormal

The updated index (where trips included were reported as 1, 0, or missing) is very similar to the 2002 index, except for the 1984 CPUEs (Figures 1 and 3). Relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are provided in Table 1. The updated index developed from data where trips=1 was also similar to the 2002 index over much of the time series, however there were some differences in CPUE in several years (Figures 2 and 3 ). QQ plots of residuals for successful catch rates, frequency distributions of ln(CPUE) for positive catches, and plots of residuals for lognormal models on successful catch rates by each main effect are shown in Appendix 1 Figures A1-A12. These data appear to have met the assumptions for the analysis.

Over much of the time series for both of these indices, there is no apparent trend in CPUE. Differences between the updated indices and the 2002 index may be due to updated data and edits of those data. Sample sizes are generally low during the first three years of the time series and any data edits may have a substantial effect on the analyses. Also, redefining COAST to ensure adequate sample size probably explains some of the observed differences.

Puerto Rico Delta-lognormal

The updated delta-lognormal indices (trips=1, 0, or were missing and trips=1) are similar to the 2002 index (Figures 4-6), although there are differences in some years. Relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are provided in Table 2. Proportion positive trips, QQ plots of residuals for successful catch rates, and plots of chi-square residuals for the delta lognormal model on proportion successful trips by each main effect are provided in Appendix 1. Frequency distributions of ln(CPUE) for positive catches and plots of residuals for lognormal models on successful catch rates by each main effect are shown in Appendix 1 Figures A13-A32. These data appear to have met the assumptions for the analysis.

As with the lognormal indices, differences may be due to data updates and editing completed since 2002 and the redefined factor COAST. CPUEs varied considerably over time during the first six to seven years of each time series, however there was no clear trend in CPUE over the remainder of the series.

Southwest Puerto Rico Lognormal

The updated delta-lognormal indices (trips=1, 0, or were missing) was more similar to the 2002 index than the updated index developed from data where only trips=1 were included (Figures 7-9). Relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are provided in Table 3. QQ plots of residuals for successful catch rates, frequency distributions of ln(CPUE) for positive catches, and plots of residuals for lognormal models on successful catch rates by each main effect are shown in Appendix 1 Figures A33-A42. These data appear to have met the assumptions for the analysis.

The index that included data from trips reported as 1, 0, or missing was likely most similar to that used in developing the 2002 index. Minor differences in the 2002 index and the updated index (trips=1, 0, or missing) may, again, be due to data editing since 2002.

**Additional Puerto Rico Indices**

Puerto Rico lognormal indices

The final models for the lognormal on CPUE of positive trips were identical for both trips=1, 0, or missing data and for trips=1 data:

**LN(CPUE) = YEAR + TARGET + COAST + GEAR + YEAR*COAST**

The linear regression statistics of the final models are summarized in Table 4a and Table 4b. Relative nominal CPUE, relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are shown in Figures 10-11. Relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are provided in Table 5. Relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are provided in Table 3. QQ plots of residuals for successful catch rates, frequency distributions of ln(CPUE) for positive catches, and plots of residuals for lognormal models on successful catch rates by each main effect are shown in Appendix 1 Figures A43-A54. These data appear to have met the assumptions for the analysis. These two indices are very similar, with large variability early in the time series and no apparent trend in CPUE since 1990.

Puerto Rico delta-lognormal indices

The final models for the binomial on proportion positive trips and the lognormal on CPUE of successful trips for trips=1, 0, or missing were:

**PPT = YEAR + COAST + MONTH + YEAR*MONTH + YEAR*COAST**

**LN(CPUE) = YEAR + TARGET + COAST + GEAR + YEAR*COAST**

For trips=1 the final models were:

**PPT = YEAR + MONTH + COAST + YEAR*COAST**

**LN(CPUE) = YEAR + TARGET + COAST + GEAR + YEAR*COAST**

The linear regression statistics of the final models are summarized in Tables 6 and 7. Relative abundance indices, CVs, and 95% confidence intervals are provided in Table 8. The delta-lognormal Puerto Rico standardized abundance indices with 95% confidence intervals and standardized nominal CPUE, are shown in Figures 12-13. Proportion positive trips, QQ plots of residuals for successful catch rates, plots of chi-square residuals for the delta lognormal model on proportion successful trips by each main effect, frequency distributions of ln(CPUE) for positive catches, and plots of residuals for lognormal models on successful catch rates by each main effect are shown in Appendix 1 A55-A74. These data appear to have met the assumptions for the analysis. These two indices differed in a few of the initial years of the time series and diverged slightly in the final years of the series. CPUEs for trips=1 were slightly higher over the last six years of the series.

Southwest Puerto Rico lognormal indices

The final model for the lognormal on CPUE of positive trips for trips=1, 0, or missing data was:

**LN(CPUE) = YEAR + TARGET + COUNTY + YEAR*COUNTY**

The final model for the lognormal on CPUE of positive trips for trips=1 data was:

**LN(CPUE) = YEAR + TARGET + COUNTY+ GEAR + YEAR*COUNTY**

The linear regression statistics of the final models are summarized in Tables 9a and 9b. Relative nominal CPUE, relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are shown in Figures 14-15. Relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are provided in Table 10. Relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are provided in Table 3. QQ plots of residuals for successful catch rates, frequency distributions of ln(CPUE) for positive catches, and plots of residuals for lognormal models on successful catch rates by each main effect are shown in Appendix 1 Figures A75-A85. These data appear to have met the assumptions for the analysis. These two indices differ little, with some differences early in the time series and no apparent trend in CPUE since 1990.

Southwest Puerto Rico delta-lognormal indices

The final models for the binomial on proportion positive trips and the lognormal on CPUE of successful trips for trips=1, 0, or missing were:

**PPT = YEAR + SEASON + COUNTY + YEAR*SEASON + YEAR*COUNTY**

**LN(CPUE) = YEAR + TARGET + COUNTY+ YEAR*COUNTY**

For trips=1 the final models were:

**PPT = YEAR + SEASON + COUNTY + YEAR*SEASON**

**LN(CPUE) = YEAR + TARGET + COUNTY+ GEAR + YEAR*COUNTY**

The linear regression statistics of the final models are summarized in Tables 11 and 12. Relative abundance indices, CVs, and 95% confidence intervals are provided in Table 13. The delta-lognormal Puerto Rico standardized abundance indices with 95% confidence intervals and standardized nominal CPUE, are shown in Figure 16-17. Proportion positive trips, QQ plots of residuals for successful catch rates, plots of chi-square residuals for the delta lognormal model on proportion successful trips by each main effect, frequency distributions of ln(CPUE) for positive catches and plots of residuals for lognormal models on successful catch rates by each main effect are shown in Appendix 1 Figures A86-A104. These data appear to have met the assumptions for the analysis.

These two indices differed greatly only in 1988, however they were both much lower in the first two years of the series than were the CPUEs of the lognormal indices for southwest Puerto Rico. In addition, the delta-lognormal indices had higher CPUEs in 1992 and 1993 than did the lognormal indices. Over the last 11 years, however, all the indices were in close agreement and showed little apparent trend in CPUE.

**Replication of 2002 St. Croix lognormal**

The updated index differs from the 2002 index, but most of those differences are minor and overall trends in each index are similar (Figures 19-20 ). Relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are provided in Table 15. Relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are provided in Table 3. QQ plots of residuals for successful catch rates, frequency distributions of ln(CPUE) for positive catches, and plots of residuals for lognormal models on successful catch rates by each main effect are shown in Appendix 1 Figures A105-A109. These data appear to have met the assumptions for the analysis.

Yearly differences in CPUE between indices, as with the Puerto Rico indices, may be due to data updates since 2002. For example, data was insufficient from 1998 to include data from that year in constructing the 2002 index, however additional data now included in the St. Croix dataset allowed for

1998 to be added to the time series. The updated index has a clear decreasing trend during 1989-1992, but no obvious trend after 1992. In the 2002 index, that initial decreasing trend is less clear and a slight increasing trend is apparent from 1998-2001. In the updated index, that trend is not apparent.

**Additional USVI indices**

St. Croix lognormal index

The final model for the lognormal on CPUE of positive conch trips developed from St. Croix data was:

**LN(CPUE) = YEAR + AREA + YEAR*AREA**

The linear regression statistics of the final model are summarized in Table 14. Relative nominal CPUE, relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are shown in Figures 20-21. Relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are provided in Table 15. Relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are provided in Table 3. QQ plots of residuals for successful catch rates, frequency distributions of ln(CPUE) for positive catches, and plots of residuals for lognormal models on successful catch rates by each main effect are shown in Appendix 1 Figures A110-113. These data appear to have met the assumptions for the analysis.

The index has a steady decline in CPUE over the first four years of the continuous series, however the CPUE calculated for these data from 1987 is lower than the 1990 and 1991 CPUEs. After 1993 there was, perhaps, a very slight increase in CPUE through 2005.

St. Thomas/St. John lognormal index

The final model for the lognormal on CPUE of positive conch trips developed from St. Thomas/St. John data was:

**LN(CPUE) = YEAR + SEASON + YEAR* SEASON**

The linear regression statistics of the final model are summarized in Table 16. Relative nominal CPUE, relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are shown in Figure 22. Relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are provided in Table 17. Relative abundance indices, coefficients of variation, and upper and lower 95% confidence intervals are provided in Table 3. QQ plots of residuals for successful catch rates, frequency distributions of ln(CPUE) for positive catches, and plots of residuals for lognormal models on successful catch rates by each main effect are shown in Appendix 1 Figures A114-117. These data appear to have met the assumptions for the analysis.

The index had a much higher CPUE in 1987 than was observed in the continuous portion of the index (1995-2005). During that period, the index showed no trend, although CPUE in 2005 was somewhat lower than other years. No index was developed for the 2002 assessment due to insufficient data. The dataset used to generate this index included 756 positive conch trips over the entire time series.

**LITERATURE CITED**

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**Table 1**. Standardized CPUE, coefficients of variation and 95% confidence intervals for Puerto Rico lognormal (positive trips) commercial conch fishery index where trips=1, 0, or missing and the lognormal index where trips=1. Both based upon the Valle-Esquivel 2002 model.

| Trips=1, 0, or missing | | | | | Trips=1 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI | Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI |
| 1983 | 1.282722 | 0.161695 | 0.930232 | 1.76878 | 1983 | 1.099804 | 0.167158 | 0.789083 | 1.532879 |
| 1984 | 2.508396 | 0.153447 | 1.848794 | 3.403327 | 1984 | 2.434079 | 0.180734 | 1.700633 | 3.483845 |
| 1985 | 1.088235 | 0.170069 | 0.776344 | 1.525426 | 1985 | 1.050679 | 0.16931 | 0.750666 | 1.470595 |
| 1986 | 1.542049 | 0.15579 | 1.131334 | 2.101868 | 1986 | 1.697731 | 0.203917 | 1.133834 | 2.542072 |
| 1987 | 1.346603 | 0.157584 | 0.98447 | 1.841945 | 1987 | 1.03739 | 0.305655 | 0.570636 | 1.885928 |
| 1988 | 1.560645 | 0.1652 | 1.124031 | 2.166856 | 1988 | 1.640188 | 0.163937 | 1.184248 | 2.271665 |
| 1989 | 1.140635 | 0.161176 | 0.828033 | 1.571251 | 1989 | 1.223981 | 0.159457 | 0.891539 | 1.680386 |
| 1990 | 0.695147 | 0.157777 | 0.508013 | 0.951215 | 1990 | 0.63508 | 0.160638 | 0.461518 | 0.873915 |
| 1991 | 0.749652 | 0.157621 | 0.548012 | 1.025483 | 1991 | 0.716621 | 0.158009 | 0.523468 | 0.981045 |
| 1992 | 0.747949 | 0.162803 | 0.541236 | 1.03361 | 1992 | 0.75098 | 0.165327 | 0.540747 | 1.042948 |
| 1993 | 0.776497 | 0.157039 | 0.568286 | 1.060993 | 1993 | 0.807141 | 0.15606 | 0.591851 | 1.100745 |
| 1994 | 0.68958 | 0.155265 | 0.506438 | 0.938952 | 1994 | 0.706432 | 0.153856 | 0.520252 | 0.959241 |
| 1995 | 0.744887 | 0.155634 | 0.546659 | 1.014995 | 1995 | 0.768953 | 0.153894 | 0.566253 | 1.044212 |
| 1996 | 0.742986 | 0.162214 | 0.538267 | 1.025566 | 1996 | 0.775257 | 0.160511 | 0.563525 | 1.066543 |
| 1997 | 0.74287 | 0.155184 | 0.54566 | 1.011353 | 1997 | 0.77052 | 0.153497 | 0.567849 | 1.045525 |
| 1998 | 0.974463 | 0.155207 | 0.715741 | 1.326707 | 1998 | 0.964206 | 0.157481 | 0.70505 | 1.318619 |
| 1999 | 0.891705 | 0.155666 | 0.654365 | 1.215128 | 1999 | 0.908196 | 0.154115 | 0.668501 | 1.233834 |
| 2000 | 0.725493 | 0.15924 | 0.52867 | 0.995594 | 2000 | 0.762746 | 0.157963 | 0.557211 | 1.044095 |
| 2001 | 0.766742 | 0.155771 | 0.562546 | 1.045058 | 2001 | 0.802683 | 0.15397 | 0.591003 | 1.090179 |
| 2002 | 0.774117 | 0.155457 | 0.568308 | 1.054459 | 2002 | 0.80902 | 0.153664 | 0.596028 | 1.098125 |
| 2003 | 0.967044 | 0.159243 | 0.704684 | 1.327083 | 2003 | 1.020742 | 0.157355 | 0.746576 | 1.395588 |
| 2004 | 0.816224 | 0.163761 | 0.589534 | 1.130082 | 2004 | 0.854192 | 0.161989 | 0.619105 | 1.178547 |
| 2005 | 0.725359 | 0.156473 | 0.531451 | 0.990018 | 2005 | 0.76338 | 0.154633 | 0.561334 | 1.03815 |

**Table 2**. Standardized CPUE, coefficients of variation and 95% confidence intervals for Puerto Rico delta-lognormal commercial conch fishery index where trips=1, 0, or missing and the delta-lognormal index where trips=1. Both based upon the Valle-Esquivel 2002 model.

| Trips=1, 0, or missing | | | | | Trips=1 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI | Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI |
| 1983 | 0.472855 | 0.383906 | 0.22525 | 0.992638 | 1983 | 0.364786 | 0.416774 | 0.163843 | 0.812175 |
| 1984 | 1.801727 | 0.332789 | 0.942299 | 3.445002 | 1984 | 1.585428 | 0.417208 | 0.711542 | 3.532583 |
| 1985 | 1.440829 | 0.3164 | 0.776818 | 2.672424 | 1985 | 1.551966 | 0.323901 | 0.825149 | 2.918986 |
| 1986 | 2.563627 | 0.262299 | 1.530397 | 4.294431 | 1986 | 1.917167 | 0.456917 | 0.802498 | 4.580113 |
| 1987 | 1.809497 | 0.287755 | 1.02937 | 3.180858 | 1987 | 0.570267 | 0.727135 | 0.154955 | 2.098707 |
| 1988 | 2.151744 | 0.288612 | 1.222089 | 3.788596 | 1988 | 2.543118 | 0.2914 | 1.436807 | 4.501263 |
| 1989 | 1.120185 | 0.320149 | 0.599745 | 2.092246 | 1989 | 1.337631 | 0.324764 | 0.710053 | 2.51989 |
| 1990 | 0.721901 | 0.314215 | 0.390799 | 1.333529 | 1990 | 0.648881 | 0.338351 | 0.335895 | 1.253508 |
| 1991 | 0.929416 | 0.296753 | 0.519844 | 1.661678 | 1991 | 0.966622 | 0.307566 | 0.529811 | 1.763567 |
| 1992 | 1.028009 | 0.294148 | 0.57781 | 1.828982 | 1992 | 1.148681 | 0.304257 | 0.633508 | 2.082796 |
| 1993 | 1.03573 | 0.289302 | 0.587482 | 1.825991 | 1993 | 1.245904 | 0.290505 | 0.705097 | 2.201508 |
| 1994 | 0.747211 | 0.305859 | 0.41086 | 1.358914 | 1994 | 0.877519 | 0.308207 | 0.480398 | 1.60292 |
| 1995 | 0.833951 | 0.303571 | 0.460522 | 1.510185 | 1995 | 0.972865 | 0.306277 | 0.53452 | 1.770685 |
| 1996 | 0.779788 | 0.316577 | 0.420281 | 1.446816 | 1996 | 0.889434 | 0.322741 | 0.473914 | 1.669277 |
| 1997 | 0.733774 | 0.313473 | 0.397776 | 1.353587 | 1997 | 0.833421 | 0.319288 | 0.446928 | 1.554145 |
| 1998 | 0.708691 | 0.336545 | 0.36808 | 1.364493 | 1998 | 0.737794 | 0.351042 | 0.373111 | 1.458923 |
| 1999 | 0.642454 | 0.340678 | 0.331145 | 1.246425 | 1999 | 0.749846 | 0.344202 | 0.383999 | 1.464244 |
| 2000 | 0.516868 | 0.342576 | 0.265483 | 1.006288 | 2000 | 0.604965 | 0.348247 | 0.307511 | 1.190147 |
| 2001 | 0.486229 | 0.345585 | 0.248367 | 0.95189 | 2001 | 0.566074 | 0.350698 | 0.286451 | 1.118655 |
| 2002 | 0.533528 | 0.34091 | 0.274883 | 1.03554 | 2002 | 0.620155 | 0.345813 | 0.316645 | 1.214585 |
| 2003 | 0.624091 | 0.350515 | 0.315915 | 1.232891 | 2003 | 0.729741 | 0.355495 | 0.366041 | 1.454815 |
| 2004 | 0.595181 | 0.347971 | 0.302691 | 1.170304 | 2004 | 0.688838 | 0.353315 | 0.346906 | 1.367801 |
| 2005 | 0.722715 | 0.316686 | 0.389442 | 1.341194 | 2005 | 0.848897 | 0.320738 | 0.454001 | 1.587278 |

**Table 3**. Standardized CPUE, coefficients of variation and 95% confidence intervals for southwest Puerto Rico lognormal (positive trips) commercial conch fishery index where trips=1, 0, or missing and the lognormal index where trips=1. Both based upon the Valle-Esquivel 2002 model.

| Trips=1, 0, or missing | | | | | Trips=1 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI | Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI |
| 1983 | 1.493672 | 0.281423 | 0.859918 | 2.594498 | 1983 | 0.148417 | 0.820828 | 0.035327 | 0.623529 |
| 1984 | 3.070987 | 0.26103 | 1.837708 | 5.131918 | 1984 | 1.117671 | 0.838149 | 0.259851 | 4.807339 |
| 1985 | 1.444196 | 0.301989 | 0.799877 | 2.607526 | 1985 | 1.035409 | 0.535551 | 0.37926 | 2.82675 |
| 1986 | 1.910584 | 0.225756 | 1.223232 | 2.984169 | 1986 | 3.457101 | 0.529509 | 1.279071 | 9.34393 |
| 1987 | 1.301137 | 0.221555 | 0.839816 | 2.015869 | 1987 | 1.312088 | 0.722221 | 0.359096 | 4.794193 |
| 1988 | 1.5664 | 0.236788 | 0.981815 | 2.499053 | 1988 | 3.732525 | 0.330373 | 1.960845 | 7.10497 |
| 1989 | 0.593139 | 0.220396 | 0.383696 | 0.916906 | 1989 | 0.661113 | 0.372761 | 0.321345 | 1.360127 |
| 1990 | 0.561266 | 0.225545 | 0.35949 | 0.876294 | 1990 | 0.518179 | 0.381178 | 0.24806 | 1.082437 |
| 1991 | 0.524998 | 0.221647 | 0.338798 | 0.813532 | 1991 | 0.567481 | 0.36505 | 0.279729 | 1.151241 |
| 1992 | 0.702287 | 0.221927 | 0.452963 | 1.088844 | 1992 | 1.495859 | 0.309913 | 0.816303 | 2.741131 |
| 1993 | 0.873223 | 0.211985 | 0.574139 | 1.328107 | 1993 | 1.587273 | 0.287259 | 0.903797 | 2.787611 |
| 1994 | 0.737437 | 0.209947 | 0.486777 | 1.117171 | 1994 | 0.758617 | 0.307652 | 0.415736 | 1.384292 |
| 1995 | 0.730817 | 0.213712 | 0.478905 | 1.115239 | 1995 | 0.644198 | 0.368977 | 0.315283 | 1.316249 |
| 1996 | 0.599489 | 0.210391 | 0.395378 | 0.908969 | 1996 | 0.577961 | 0.364613 | 0.285121 | 1.171571 |
| 1997 | 0.662222 | 0.213197 | 0.434387 | 1.009555 | 1997 | 0.516619 | 0.3973 | 0.240239 | 1.110954 |
| 1998 | 0.772075 | 0.214123 | 0.50554 | 1.179136 | 1998 | 0.298528 | 0.506501 | 0.114791 | 0.776359 |
| 1999 | 0.965166 | 0.214043 | 0.632069 | 1.473802 | 1999 | 0.607881 | 0.450638 | 0.257244 | 1.436456 |
| 2000 | 0.764296 | 0.211794 | 0.502706 | 1.162008 | 2000 | 0.558955 | 0.423137 | 0.248239 | 1.258587 |
| 2001 | 0.731213 | 0.21163 | 0.481098 | 1.111357 | 2001 | 0.552436 | 0.413629 | 0.249515 | 1.223113 |
| 2002 | 0.743309 | 0.211374 | 0.489299 | 1.129183 | 2002 | 0.533645 | 0.426123 | 0.235752 | 1.207955 |
| 2003 | 0.768018 | 0.210585 | 0.506338 | 1.164936 | 2003 | 0.760493 | 0.372452 | 0.369858 | 1.563708 |
| 2004 | 0.708761 | 0.211261 | 0.46666 | 1.076462 | 2004 | 0.630879 | 0.393653 | 0.295299 | 1.347816 |
| 2005 | 0.775311 | 0.211632 | 0.510111 | 1.178384 | 2005 | 0.926669 | 0.368234 | 0.454143 | 1.890848 |

**Table 4**. Linear regression statistics for the final GLM models on catch rates on positive trips for Puerto Rico commercial conch fishery index where trips=1, 0, or missing (a) and where trips=1 (b).

a.

| source | df | % reduction dev/df | chi square | p>chi square |
|---|---|---|---|---|
| Year | 22 | | 1013.28 | <0.0001 |
| Target | 1 | 7.01 | 3102.35 | <0.0001 |
| Coast | 3 | 6.60 | 106.61 | <0.0001 |
| Gear | 2 | 1.04 | 38.81 | <0.0001 |
| Year*coast | 66 | 2.85 | 1298.59 | <0.0001 |

b.

| source | df | % reduction dev/df | chi square | p>chi square |
|---|---|---|---|---|
| Year | 22 | | 193.43 | <0.0001 |
| Target | 1 | 8.64 | 3277.01 | <0.0001 |
| Coast | 3 | 7.77 | 75.47 | <0.0001 |
| Gear | 2 | 1.15 | 37.05 | <0.0001 |
| Year*coast | 65 | 2.22 | 890.14 | <0.0001 |

**Table 5**. Standardized CPUE, coefficients of variation and 95% confidence intervals for Puerto Rico lognormal (positive trips) commercial conch fishery index where trips=1, 0, or missing and the lognormal index where trips=1.

| Trips=1, 0, or missing | | | | | Trips=1 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI | Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI |
| 1983 | 1.212704 | 0.149167 | 0.901368 | 1.631577 | 1983 | 0.985188 | 0.156955 | 0.721139 | 1.345921 |
| 1984 | 2.534744 | 0.141872 | 1.911257 | 3.361623 | 1984 | 2.834725 | 0.170564 | 2.020327 | 3.977409 |
| 1985 | 0.984127 | 0.158441 | 0.718262 | 1.348401 | 1985 | 0.931166 | 0.159485 | 0.678218 | 1.278453 |
| 1986 | 1.589742 | 0.144034 | 1.19361 | 2.117343 | 1986 | 1.637202 | 0.190178 | 1.123003 | 2.386841 |
| 1987 | 1.320054 | 0.145915 | 0.987457 | 1.764678 | 1987 | 1.098653 | 0.290027 | 0.622322 | 1.939573 |
| 1988 | 1.422814 | 0.153011 | 1.049572 | 1.928785 | 1988 | 1.43932 | 0.15399 | 1.059707 | 1.95492 |
| 1989 | 1.049614 | 0.149532 | 0.779588 | 1.413168 | 1989 | 1.089552 | 0.150022 | 0.808471 | 1.468356 |
| 1990 | 0.733982 | 0.146035 | 0.54892 | 0.981435 | 1990 | 0.650816 | 0.151025 | 0.481969 | 0.878816 |
| 1991 | 0.768586 | 0.146001 | 0.574838 | 1.027635 | 1991 | 0.728229 | 0.148578 | 0.541899 | 0.978628 |
| 1992 | 0.789181 | 0.150974 | 0.584494 | 1.065547 | 1992 | 0.795708 | 0.15591 | 0.58364 | 1.084833 |
| 1993 | 0.797377 | 0.145444 | 0.597026 | 1.064963 | 1993 | 0.814184 | 0.146701 | 0.608104 | 1.090102 |
| 1994 | 0.706862 | 0.143698 | 0.531077 | 0.940831 | 1994 | 0.710811 | 0.144518 | 0.533183 | 0.947616 |
| 1995 | 0.762867 | 0.144055 | 0.572751 | 1.016088 | 1995 | 0.776596 | 0.14461 | 0.582421 | 1.035506 |
| 1996 | 0.75838 | 0.150375 | 0.562345 | 1.022755 | 1996 | 0.784931 | 0.151218 | 0.581068 | 1.060318 |
| 1997 | 0.760426 | 0.143485 | 0.57156 | 1.011701 | 1997 | 0.775 | 0.144083 | 0.581829 | 1.032305 |
| 1998 | 0.9728 | 0.143109 | 0.731729 | 1.293293 | 1998 | 0.93897 | 0.147626 | 0.700028 | 1.25947 |
| 1999 | 0.971964 | 0.143349 | 0.730755 | 1.292792 | 1999 | 0.97937 | 0.144121 | 0.735205 | 1.304625 |
| 2000 | 0.773146 | 0.146984 | 0.577131 | 1.035736 | 2000 | 0.802364 | 0.148117 | 0.597608 | 1.077275 |
| 2001 | 0.784109 | 0.143608 | 0.589219 | 1.043462 | 2001 | 0.810937 | 0.144142 | 0.608738 | 1.080299 |
| 2002 | 0.798568 | 0.143164 | 0.600608 | 1.061775 | 2002 | 0.821623 | 0.143714 | 0.617279 | 1.093612 |
| 2003 | 0.980454 | 0.146794 | 0.732155 | 1.312961 | 2003 | 1.020672 | 0.14734 | 0.761368 | 1.368288 |
| 2004 | 0.802393 | 0.151035 | 0.594209 | 1.083516 | 2004 | 0.824453 | 0.151959 | 0.609437 | 1.115329 |
| 2005 | 0.725105 | 0.144163 | 0.544284 | 0.965997 | 2005 | 0.749529 | 0.144671 | 0.562054 | 0.999535 |

**Table 6.** Linear regression statistics for the final GLM models on proportion positive trips (a) and catch rates on positive trips (b) for Puerto Rico commercial conch fishery index where trips=1, 0, or missing.

a.

| source | df | % reduction dev/df | chi square | p>chi square |
|---|---|---|---|---|
| Year | 22 | | 731.81 | <0.0001 |
| Coast | 3 | 4.21 | 2333.20 | <0.0001 |
| Month | 11 | 3.95 | 1394.45 | <0.0001 |
| Year*month | 242 | 6.57 | 9049.34 | <0.0001 |
| Year*coast | 66 | 1.81 | 2355.58 | <0.0001 |

b.

| source | df | % reduction dev/df | chi square | p>chi square |
|---|---|---|---|---|
| Year | 22 | | 1013.28 | <0.0001 |
| Target | 1 | 7.01 | 3102.35 | <0.0001 |
| Coast | 3 | 6.60 | 106.61 | <0.0001 |
| Gear | 2 | 1.04 | 38.81 | <0.0001 |
| Year*coast | 66 | 2.85 | 1298.59 | <0.0001 |

**Table 7.** Linear regression statistics for the final GLM models on proportion positive trips (a) and catch rates on positive trips (b) for Puerto Rico commercial conch fishery index where trips=1.

a.

| source | df | % reduction dev/df | chi square | p>chi square |
|---|---|---|---|---|
| Year | 22 | | 377.33 | <0.0001 |
| Month | 11 | 4.84 | 1089.68 | <0.0001 |
| Coast | 3 | 4.79 | 552.37 | <0.0001 |
| Year* coast | 66 | 1.51 | 1833.78 | <0.0001 |

b.

| source | df | % reduction dev/df | chi square | p>chi square |
|---|---|---|---|---|
| Year | 22 | | 193.43 | <0.0001 |
| Target | 1 | 8.64 | 3277.01 | <0.0001 |
| Coast | 3 | 7.77 | 75.47 | <0.0001 |
| Gear | 2 | 1.15 | 37.05 | <0.0001 |
| Year*coast | 65 | 2.22 | 890.14 | <0.0001 |

**Table 8**. Standardized CPUE, coefficients of variation and 95% confidence intervals for Puerto Rico delta lognormal commercial conch fishery index where trips=1, 0, or missing and the delta lognormal index where trips=1.

| Trips=1, 0, or missing | | | | | Trips=1 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI | Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI |
| 1983 | 0.447889 | 0.378449 | 0.215472 | 0.931002 | 1983 | 0.239321 | 0.337349 | 0.124115 | 0.461467 |
| 1984 | 1.824073 | 0.327509 | 0.963355 | 3.453809 | 1984 | 1.522793 | 0.431169 | 0.666773 | 3.477794 |
| 1985 | 1.305432 | 0.310199 | 0.712005 | 2.393458 | 1985 | 1.183355 | 0.340747 | 0.609868 | 2.296117 |
| 1986 | 2.647886 | 0.255409 | 1.601583 | 4.37773 | 1986 | 1.820928 | 0.440123 | 0.784872 | 4.22461 |
| 1987 | 1.777172 | 0.281404 | 1.023168 | 3.086825 | 1987 | 0.552695 | 1.023056 | 0.101721 | 3.003036 |
| 1988 | 1.965195 | 0.28205 | 1.130038 | 3.417578 | 1988 | 2.373774 | 0.209313 | 1.568836 | 3.59171 |
| 1989 | 1.032705 | 0.314385 | 0.558874 | 1.908267 | 1989 | 1.05626 | 0.239494 | 0.658632 | 1.693942 |
| 1990 | 0.763664 | 0.30825 | 0.418035 | 1.395059 | 1990 | 0.663796 | 0.252593 | 0.403663 | 1.091566 |
| 1991 | 0.954689 | 0.290553 | 0.54024 | 1.687086 | 1991 | 0.908222 | 0.229759 | 0.577014 | 1.429543 |
| 1992 | 1.086739 | 0.287542 | 0.618462 | 1.90958 | 1992 | 1.054247 | 0.244392 | 0.651234 | 1.706662 |
| 1993 | 1.065586 | 0.282994 | 0.611648 | 1.856417 | 1993 | 1.141153 | 0.219404 | 0.739618 | 1.760679 |
| 1994 | 0.767378 | 0.299933 | 0.426659 | 1.380187 | 1994 | 0.777478 | 0.225717 | 0.49781 | 1.214262 |
| 1995 | 0.855689 | 0.297597 | 0.477849 | 1.532289 | 1995 | 0.896294 | 0.218202 | 0.582267 | 1.379682 |
| 1996 | 0.79746 | 0.310404 | 0.434781 | 1.462671 | 1996 | 0.863286 | 0.226537 | 0.551879 | 1.35041 |
| 1997 | 0.752533 | 0.30761 | 0.412435 | 1.373081 | 1997 | 0.79638 | 0.221928 | 0.513651 | 1.23473 |
| 1998 | 0.708822 | 0.330875 | 0.372027 | 1.350519 | 1998 | 0.812451 | 0.238211 | 0.507853 | 1.299739 |
| 1999 | 0.701607 | 0.334925 | 0.365493 | 1.346819 | 1999 | 0.862937 | 0.233343 | 0.544478 | 1.367661 |
| 2000 | 0.551863 | 0.336676 | 0.286558 | 1.062798 | 2000 | 0.819318 | 0.224717 | 0.525611 | 1.277146 |
| 2001 | 0.498184 | 0.339917 | 0.257143 | 0.965172 | 2001 | 0.750141 | 0.221688 | 0.484052 | 1.162501 |
| 2002 | 0.551424 | 0.335139 | 0.287143 | 1.058941 | 2002 | 0.76715 | 0.222152 | 0.494585 | 1.189925 |
| 2003 | 0.633954 | 0.344703 | 0.324352 | 1.23908 | 2003 | 1.053428 | 0.22152 | 0.679977 | 1.631982 |
| 2004 | 0.58622 | 0.341781 | 0.301546 | 1.139639 | 2004 | 1.022651 | 0.217366 | 0.665427 | 1.571646 |
| 2005 | 0.723834 | 0.310505 | 0.394566 | 1.327878 | 2005 | 1.061944 | 0.206665 | 0.705453 | 1.598582 |

**Table 9**. Linear regression statistics for the final GLM models on catch rates on positive trips for southwest Puerto Rico commercial conch fishery index where trips=1, 0, or missing (a) and where trips=1 (b).

a.

| source | df | % reduction dev/df | chi square | p>chi square |
|---|---|---|---|---|
| Year | 22 | | 422.39 | <0.0001 |
| Target | 1 | 3.86 | 405.13 | <0.0001 |
| County | 3 | 4.29 | 252.82 | <0.0001 |
| Year*county | 65 | 1.65 | 374.63 | <0.0001 |

b.

| source | df | % reduction dev/df | chi square | p>chi square |
|---|---|---|---|---|
| Year | 22 | | 411.61 | <0.0001 |
| Target | 1 | 5.07 | 1087.78 | <0.0001 |
| County | 2 | 4.02 | 13.27 | 0.0013 |
| Gear | 2 | 1.12 | 140.50 | <0.0001 |
| Year*county | 39 | 1.57 | 309.97 | <0.0001 |

**Table 10**. Standardized CPUE, coefficients of variation and 95% confidence intervals for southwest Puerto Rico lognormal (positive trip) commercial conch fishery index where trips=1, 0, or missing and the lognormal index where trips=1.

| Trips=1, 0, or missing | | | | | Trips=1 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI | Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI |
| 1983 | 1.385494 | 0.272632 | 0.811019 | 2.366893 | 1983 | 1.239216 | 0.316398 | 0.668121 | 2.29847 |
| 1984 | 2.883343 | 0.254585 | 1.746743 | 4.759525 | 1984 | 4.143085 | 0.34211 | 2.129874 | 8.059235 |
| 1985 | 1.341667 | 0.294138 | 0.754121 | 2.386978 | 1985 | 1.024057 | 0.310511 | 0.558213 | 1.878663 |
| 1986 | 2.048733 | 0.217009 | 1.334006 | 3.146392 | 1986 | 2.205534 | 0.30898 | 1.205677 | 4.034562 |
| 1987 | 1.281536 | 0.213953 | 0.8394 | 1.956557 | 1987 | 0.718493 | 0.41265 | 0.325083 | 1.588004 |
| 1988 | 1.648921 | 0.229789 | 1.047538 | 2.595554 | 1988 | 2.57767 | 0.275935 | 1.499466 | 4.431164 |
| 1989 | 0.583586 | 0.212208 | 0.383539 | 0.887975 | 1989 | 0.67097 | 0.211799 | 0.441318 | 1.020128 |
| 1990 | 0.58085 | 0.218255 | 0.377303 | 0.894205 | 1990 | 0.473091 | 0.233902 | 0.29818 | 0.750603 |
| 1991 | 0.533879 | 0.214203 | 0.349519 | 0.815483 | 1991 | 0.444225 | 0.254127 | 0.269349 | 0.732641 |
| 1992 | 0.724648 | 0.214219 | 0.474396 | 1.10691 | 1992 | 0.817199 | 0.261615 | 0.488475 | 1.36714 |
| 1993 | 0.892167 | 0.204193 | 0.595517 | 1.33659 | 1993 | 0.866256 | 0.244737 | 0.534754 | 1.40326 |
| 1994 | 0.773839 | 0.202313 | 0.518421 | 1.155096 | 1994 | 0.511062 | 0.2191 | 0.33143 | 0.788053 |
| 1995 | 0.696536 | 0.205899 | 0.463399 | 1.046963 | 1995 | 0.571294 | 0.22343 | 0.367409 | 0.888321 |
| 1996 | 0.627168 | 0.20282 | 0.419748 | 0.937085 | 1996 | 0.522196 | 0.220015 | 0.338053 | 0.806644 |
| 1997 | 0.692875 | 0.2052 | 0.461589 | 1.040051 | 1997 | 0.544536 | 0.222703 | 0.350692 | 0.845528 |
| 1998 | 0.818966 | 0.204701 | 0.546117 | 1.228133 | 1998 | 0.608645 | 0.226152 | 0.389381 | 0.951378 |
| 1999 | 1.035642 | 0.204792 | 0.690483 | 1.553339 | 1999 | 0.879431 | 0.223368 | 0.565644 | 1.367288 |
| 2000 | 0.804153 | 0.202769 | 0.538253 | 1.201409 | 2000 | 0.69944 | 0.215946 | 0.456368 | 1.071978 |
| 2001 | 0.696244 | 0.202389 | 0.466369 | 1.039425 | 2001 | 0.643116 | 0.216873 | 0.418866 | 0.987421 |
| 2002 | 0.718684 | 0.202098 | 0.481672 | 1.072321 | 2002 | 0.674885 | 0.217455 | 0.439064 | 1.037363 |
| 2003 | 0.759812 | 0.201434 | 0.509893 | 1.132226 | 2003 | 0.711587 | 0.218614 | 0.461907 | 1.09623 |
| 2004 | 0.688098 | 0.202147 | 0.461129 | 1.026783 | 2004 | 0.625713 | 0.235913 | 0.392855 | 0.996593 |
| 2005 | 0.783158 | 0.203031 | 0.523934 | 1.170636 | 2005 | 0.828301 | 0.230882 | 0.525103 | 1.306567 |

**Table 11.** Linear regression statistics for the final GLM models on proportion positive trips (a) and catch rates on positive trips (b) for southwest Puerto Rico commercial conch fishery index where trips=1, 0, or missing.

a.

| source | df | % reduction dev/df | chi square | p>chi square |
|---|---|---|---|---|
| Year | 22 | | 1187.83 | <0.0001 |
| Season | 3 | 7.54 | 401.03 | <0.0001 |
| County | 2 | 1.99 | 406.70 | <0.0001 |
| Year*season | 66 | 9.36 | 4339.14 | <0.0001 |
| Year* county | 43 | 1.35 | 595.83 | <0.0001 |

b.

| source | df | % reduction dev/df | chi square | p>chi square |
|---|---|---|---|---|
| Year | 22 | | 422.39 | <0.0001 |
| Target | 1 | 3.86 | 405.13 | <0.0001 |
| County | 3 | 4.29 | 252.82 | <0.0001 |
| Year*county | 65 | 1.65 | 374.63 | <0.0001 |

**Table 12.** Linear regression statistics for the final GLM models on proportion positive trips (a) and catch rates on positive trips (b) for southwest Puerto Rico commercial conch fishery index where trips=1.

a.

| source | df | % reduction dev/df | chi square | p>chi square |
|---|---|---|---|---|
| Year | 22 | | 1356.30 | <0.0001 |
| Season | 3 | 10.13 | 169.09 | <0.0001 |
| County | 2 | 2.44 | 791.43 | <0.0001 |
| Year*season | 62 | 9.59 | 3602.19 | <0.0001 |

b.

| source | df | % reduction dev/df | chi square | p>chi square |
|---|---|---|---|---|
| Year | 22 | | 411.61 | <0.0001 |
| Target | 1 | 5.07 | 1087.78 | <0.0001 |
| County | 2 | 4.02 | 13.27 | 0.0013 |
| Gear | 2 | 1.12 | 140.50 | <0.0001 |
| Year*county | 39 | 1.57 | 309.97 | <0.0001 |

**Table 13**. Standardized CPUE, coefficients of variation and 95% confidence intervals for southwest Puerto Rico delta-lognormal commercial conch fishery index where trips=1, 0, or missing and the delta-lognormal index where trips=1.

| Trips=1, 0, or missing | | | | | Trips=1 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI | Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI |
| 1983 | 0.212139 | 0.745186 | 0.056153 | 0.801436 | 1983 | 0.148417 | 0.820828 | 0.035327 | 0.623529 |
| 1984 | 1.027988 | 0.599848 | 0.339195 | 3.115493 | 1984 | 1.117671 | 0.838149 | 0.259851 | 4.807339 |
| 1985 | 1.330679 | 0.538979 | 0.484656 | 3.653537 | 1985 | 1.035409 | 0.535551 | 0.37926 | 2.82675 |
| 1986 | 3.190641 | 0.310297 | 1.739912 | 5.850979 | 1986 | 3.457101 | 0.529509 | 1.279071 | 9.34393 |
| 1987 | 1.756551 | 0.34313 | 0.901313 | 3.423308 | 1987 | 1.312088 | 0.722221 | 0.359096 | 4.794193 |
| 1988 | 1.950217 | 0.39206 | 0.915466 | 4.154548 | 1988 | 3.732525 | 0.330373 | 1.960845 | 7.10497 |
| 1989 | 0.685911 | 0.377829 | 0.33035 | 1.424165 | 1989 | 0.661113 | 0.372761 | 0.321345 | 1.360127 |
| 1990 | 0.763696 | 0.356702 | 0.382227 | 1.525874 | 1990 | 0.518179 | 0.381178 | 0.24806 | 1.082437 |
| 1991 | 0.690214 | 0.355017 | 0.346517 | 1.37481 | 1991 | 0.567481 | 0.36505 | 0.279729 | 1.151241 |
| 1992 | 1.298867 | 0.266932 | 0.768579 | 2.195031 | 1992 | 1.495859 | 0.309913 | 0.816303 | 2.741131 |
| 1993 | 1.61294 | 0.250609 | 0.984574 | 2.642335 | 1993 | 1.587273 | 0.287259 | 0.903797 | 2.787611 |
| 1994 | 1.247194 | 0.277841 | 0.722898 | 2.151747 | 1994 | 0.758617 | 0.307652 | 0.415736 | 1.384292 |
| 1995 | 0.737189 | 0.390322 | 0.347133 | 1.565534 | 1995 | 0.644198 | 0.368977 | 0.315283 | 1.316249 |
| 1996 | 0.672587 | 0.380058 | 0.32263 | 1.402145 | 1996 | 0.577961 | 0.364613 | 0.285121 | 1.171571 |
| 1997 | 0.672912 | 0.406482 | 0.307823 | 1.47101 | 1997 | 0.516619 | 0.3973 | 0.240239 | 1.110954 |
| 1998 | 0.468793 | 0.500542 | 0.182086 | 1.206937 | 1998 | 0.298528 | 0.506501 | 0.114791 | 0.776359 |
| 1999 | 0.698943 | 0.475645 | 0.283256 | 1.724664 | 1999 | 0.607881 | 0.450638 | 0.257244 | 1.436456 |
| 2000 | 0.740849 | 0.419613 | 0.331079 | 1.657781 | 2000 | 0.558955 | 0.423137 | 0.248239 | 1.258587 |
| 2001 | 0.607935 | 0.429313 | 0.267063 | 1.383883 | 2001 | 0.552436 | 0.413629 | 0.249515 | 1.223113 |
| 2002 | 0.612452 | 0.433575 | 0.267037 | 1.404668 | 2002 | 0.533645 | 0.426123 | 0.235752 | 1.207955 |
| 2003 | 0.76566 | 0.396999 | 0.356241 | 1.645614 | 2003 | 0.760493 | 0.372452 | 0.369858 | 1.563708 |
| 2004 | 0.582909 | 0.432944 | 0.254438 | 1.335426 | 2004 | 0.630879 | 0.393653 | 0.295299 | 1.347816 |
| 2005 | 0.672736 | 0.427904 | 0.296265 | 1.527594 | 2005 | 0.926669 | 0.368234 | 0.454143 | 1.890848 |

**Table 14.** Linear regression statistics for the final GLM models on catch rates on positive trips for the St. Croix commercial conch fishery index.

| source | df | % reduction dev/df | chi square | p>chi square |
|---|---|---|---|---|
| Year | 16 | | 116.24 | <0.0001 |
| Area | 6 | 2.56 | 124.39 | <0.0001 |
| Year*area | 85 | 3.33 | 720.72 | <0.0001 |

**Table 15**. Standardized CPUE, coefficients of variation and 95% confidence intervals for St. Croix lognormal commercial conch fishery indices: Valle-Esquivel (2002) model and 2007 model.

| Valle-Esquivel (2002) model | | | | | 2007 model | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI | Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI |
| 1987 | | | | | 1987 | 1.048149 | 0.092857 | 0.870847 | 1.26155 |
| 1988 | | | | | 1988 | | | | |
| 1989 | 1.898464 | 0.169204 | 1.356655 | 2.656657 | 1989 | | | | |
| 1990 | 1.323547 | 0.104035 | 1.07552 | 1.62877 | 1990 | 1.351498 | 0.094254 | 1.119769 | 1.631182 |
| 1991 | 1.186801 | 0.09427 | 0.98328 | 1.432446 | 1991 | 1.266331 | 0.088657 | 1.060941 | 1.511483 |
| 1992 | 0.896275 | 0.11149 | 0.717631 | 1.11939 | 1992 | 0.939493 | 0.108302 | 0.757004 | 1.165975 |
| 1993 | 0.829043 | 0.101493 | 0.677092 | 1.015095 | 1993 | 0.938642 | 0.096256 | 0.774615 | 1.137403 |
| 1994 | 0.808983 | 0.091266 | 0.674265 | 0.970617 | 1994 | 0.836016 | 0.08448 | 0.706263 | 0.989607 |
| 1995 | 0.850487 | 0.087207 | 0.714602 | 1.012213 | 1995 | 0.872414 | 0.080787 | 0.742449 | 1.025131 |
| 1996 | 0.897622 | 0.089972 | 0.750071 | 1.074198 | 1996 | 0.951415 | 0.08305 | 0.806042 | 1.123008 |
| 1997 | 0.858614 | 0.092535 | 0.71383 | 1.032765 | 1997 | 0.96174 | 0.086507 | 0.809205 | 1.143027 |
| 1998 | 0.81742 | 0.093922 | 0.677711 | 0.985929 | 1998 | 0.891322 | 0.088144 | 0.747518 | 1.06279 |
| 1999 | 0.894163 | 0.090851 | 0.745875 | 1.071931 | 1999 | 0.974385 | 0.084589 | 0.822978 | 1.153648 |
| 2000 | 0.887948 | 0.088211 | 0.74459 | 1.058907 | 2000 | 0.916369 | 0.083484 | 0.775681 | 1.082574 |
| 2001 | 1.102336 | 0.08885 | 0.92319 | 1.316245 | 2001 | 1.118235 | 0.08398 | 0.945622 | 1.322357 |
| 2002 | 0.924561 | 0.087845 | 0.775856 | 1.101769 | 2002 | 0.98061 | 0.082632 | 0.831467 | 1.156505 |
| 2003 | 0.860567 | 0.089555 | 0.719703 | 1.029001 | 2003 | 0.919877 | 0.084801 | 0.776613 | 1.089571 |
| 2004 | 0.929532 | 0.089489 | 0.777481 | 1.11132 | 2004 | 0.968062 | 0.083698 | 0.819089 | 1.14413 |
| 2005 | 1.033637 | 0.088973 | 0.865445 | 1.234515 | 2005 | 1.065439 | 0.08424 | 0.900509 | 1.260578 |

**Table 16.** Linear regression statistics for the final GLM models on catch rates on positive trips for the St. Thomas and St. John commercial conch fishery index.

| source | df | % reduction dev/df | chi square | p>chi square |
|---|---|---|---|---|
| Year | 11 | | 116.11 | <0.0001 |
| Season | 3 | 1.25 | 11.38 | 0.0098 |
| Year*Season | 23 | 7.24 | 80.62 | <0.0001 |

**Table 17**. Standardized CPUE, coefficients of variation and 95% confidence intervals for St. Thomas/St. John lognormal commercial conch fishery index.

| Trips=1, 0, or missing | | | | |
|---|---|---|---|---|
| Year | Standardized Index | CV | Lower 95% CI | Upper 95% CI |
| 1987 | 2.392383 | 0.149968 | 1.775391 | 3.223794 |
| 1988 | | | | |
| 1989 | | | | |
| 1990 | | | | |
| 1991 | | | | |
| 1992 | | | | |
| 1993 | | | | |
| 1994 | | | | |
| 1995 | 0.969322 | 0.17084 | 0.690469 | 1.360793 |
| 1996 | 0.989909 | 0.148489 | 0.736753 | 1.330051 |
| 1997 | 0.896049 | 0.152357 | 0.661842 | 1.213135 |
| 1998 | 0.896181 | 0.1698 | 0.63967 | 1.255555 |
| 1999 | 0.884017 | 0.154583 | 0.650105 | 1.202093 |
| 2000 | 0.897828 | 0.162443 | 0.650152 | 1.239857 |
| 2001 | 0.78297 | 0.152125 | 0.578583 | 1.059557 |
| 2002 | 0.912055 | 0.150476 | 0.676161 | 1.230247 |
| 2003 | 0.970568 | 0.148414 | 0.722465 | 1.303872 |
| 2004 | 0.878436 | 0.164623 | 0.633395 | 1.218274 |
| 2005 | 0.530282 | 0.174166 | 0.375281 | 0.749303 |

**Figure 1.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the lognormal model developed by Valle-Esquivel (2002) from Puerto Rico queen conch commercial fishery data. Analyses restricted to trips reporting conch landings where trips=1, 0, or missing.

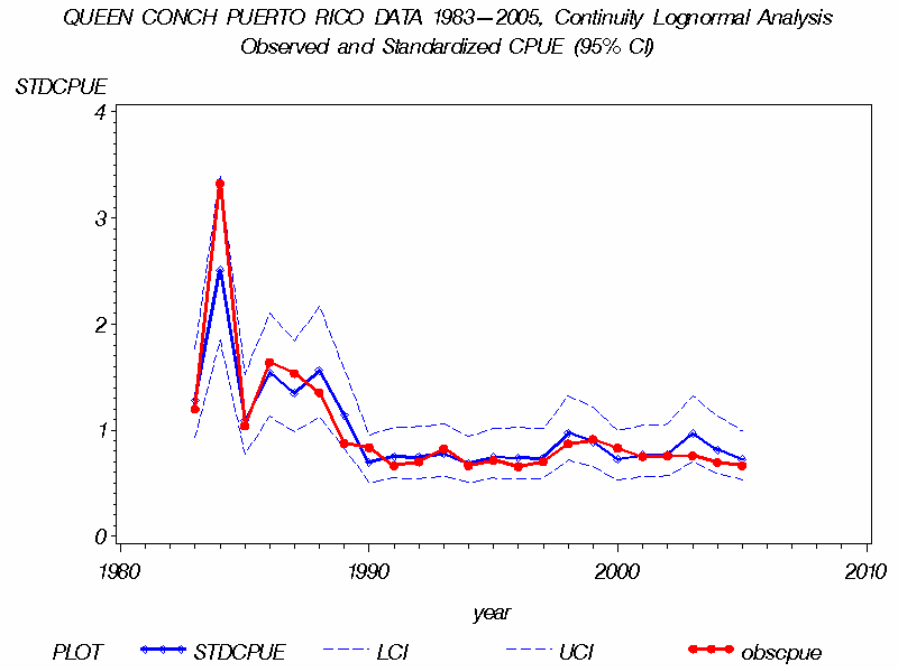



**Figure 2.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the lognormal model developed by Valle-Esquivel (2002) from Puerto Rico queen conch commercial fishery data. Analyses restricted to trips reporting conch landings where trips=1.

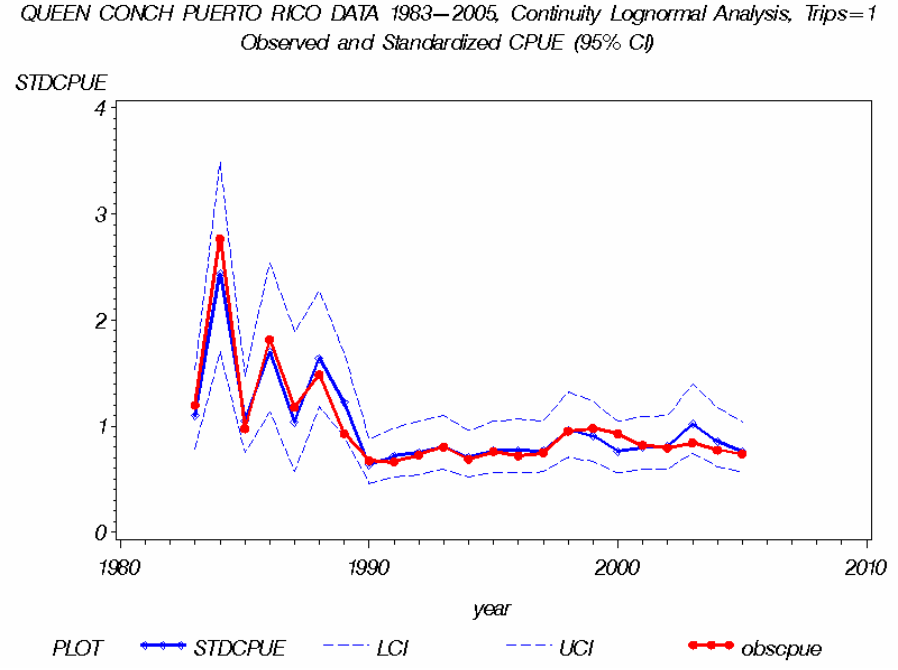


**Figure 3.** Standardized CPUE of the lognormal model developed by Valle-Esquivel (2002) from the Puerto Rico queen conch commercial fishery data; 2002 index, 2007 index where trips=1, and 2007 index where trips=1, 0, or missing.

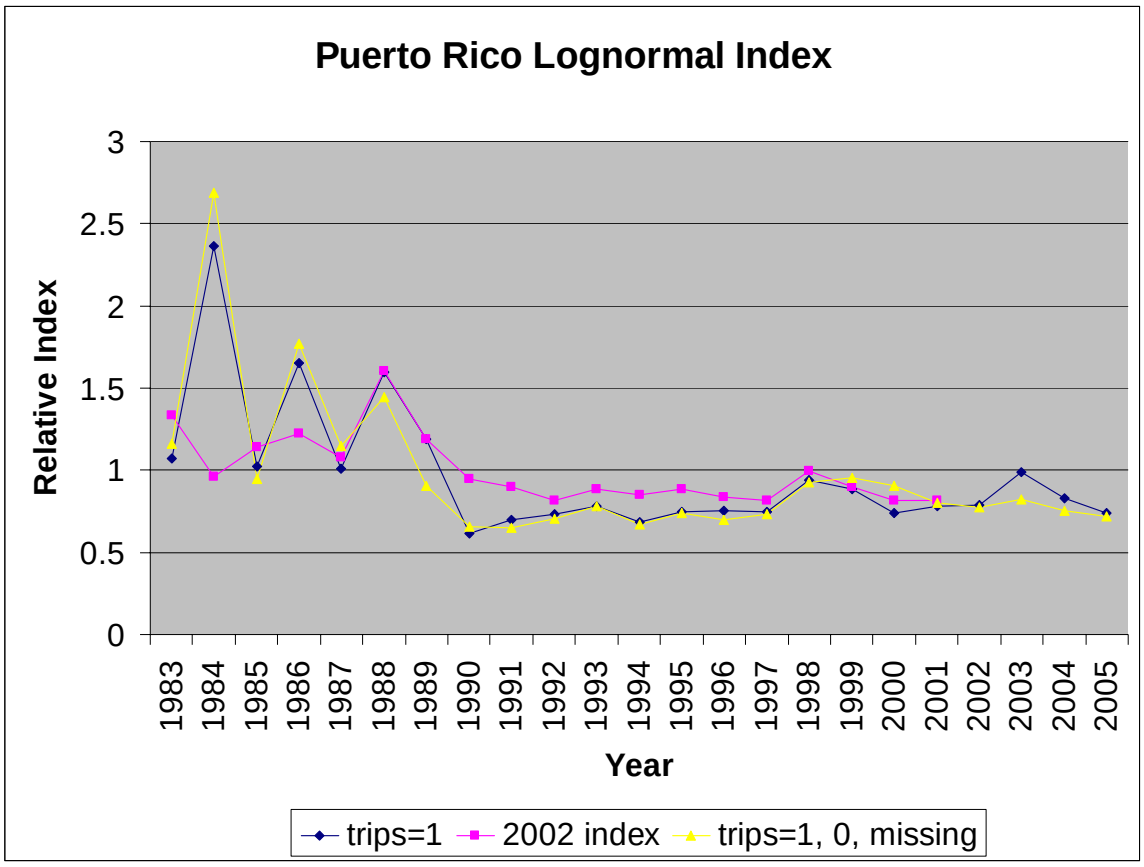


**Figure 4.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the delta-lognormal model developed by Valle-Esquivel (2002) from Puerto Rico queen conch commercial fishery data. Analyses restricted to trips reporting conch landings where trips=1, 0, or missing.

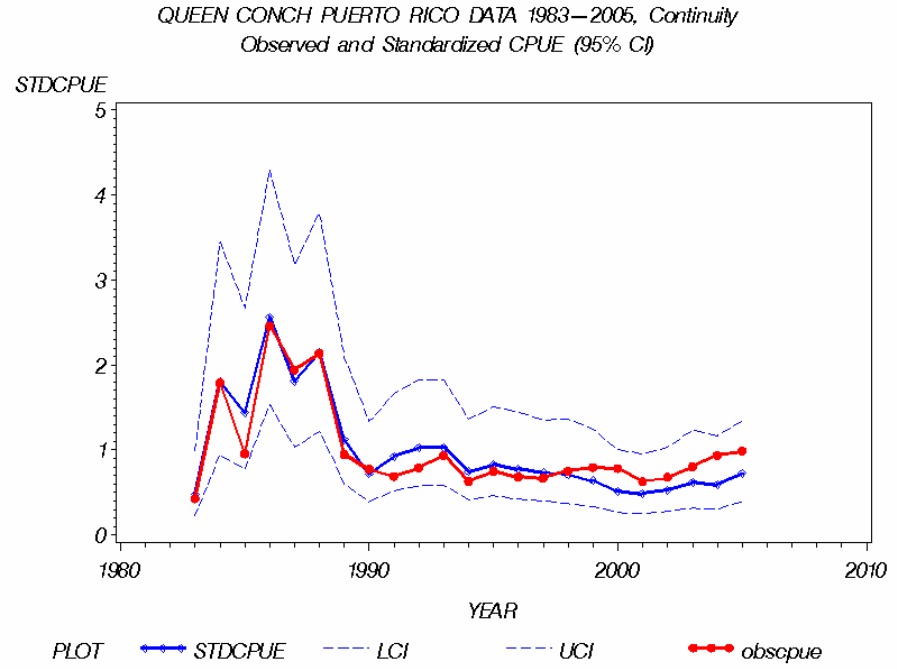



**Figure 5.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the delta-lognormal model developed by Valle-Esquivel (2002) from Puerto Rico queen conch commercial fishery data. Analyses restricted to trips reporting conch landings where trips=1.

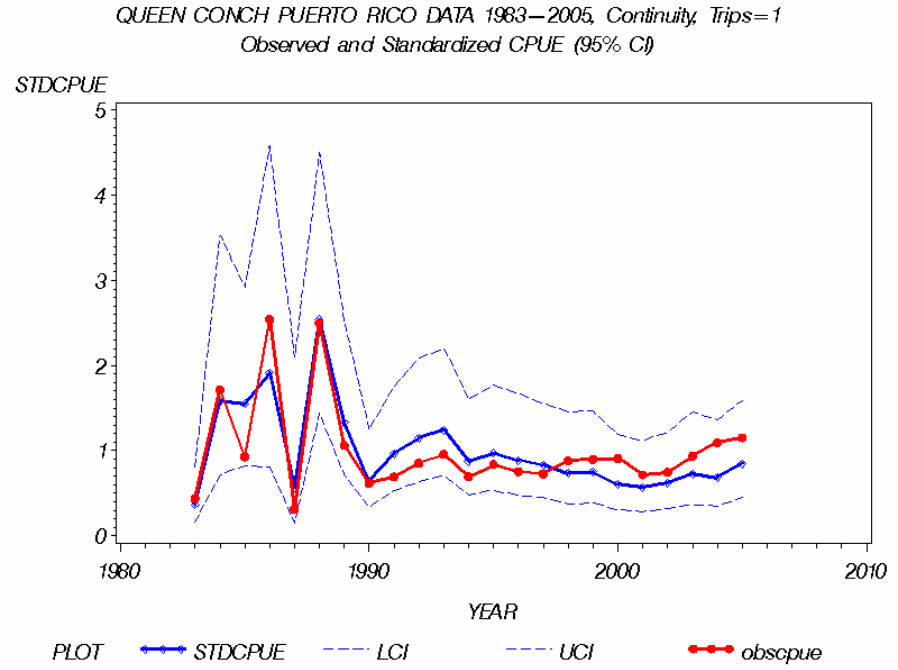


**Figure 6.** Standardized CPUE of the delta-lognormal model developed by Valle-Esquivel (2002) from the Puerto Rico queen conch commercial fishery data; 2002 index, 2007 index where trips=1, and 2007 index where trips=1, 0, or missing.

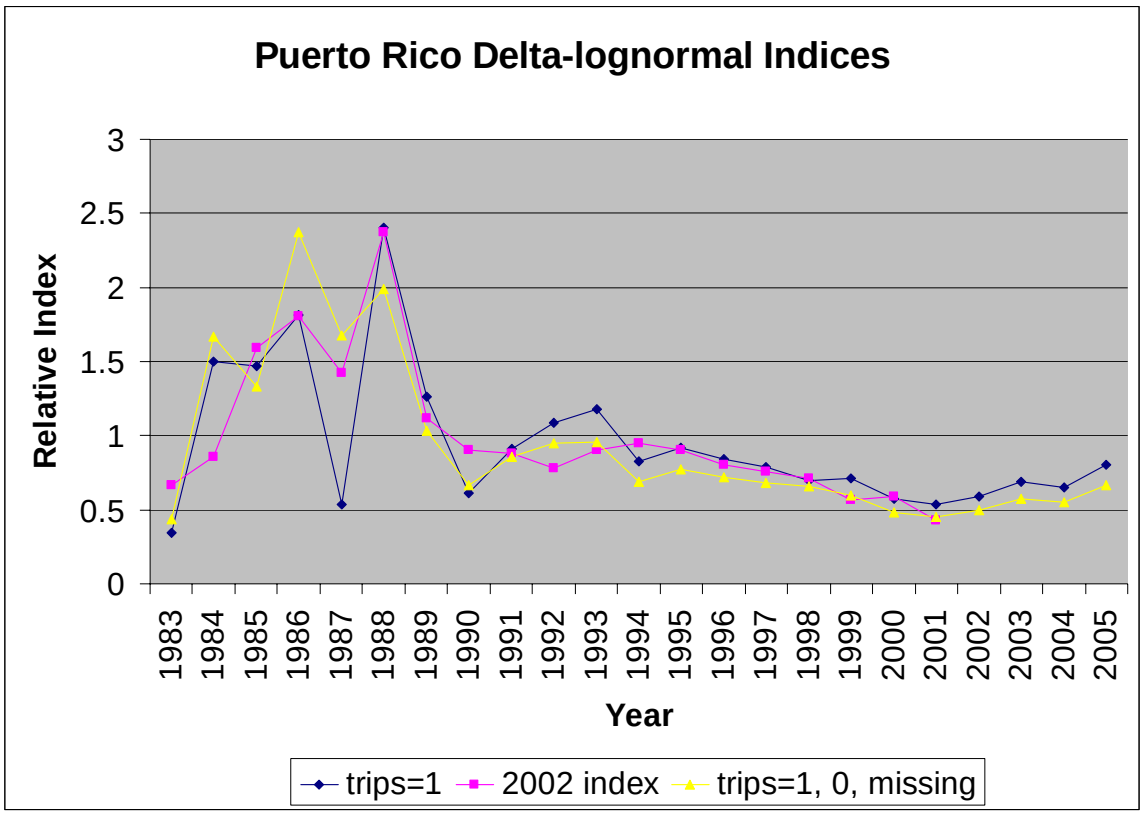


**Figure 7.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the lognormal model developed by Valle-Esquivel (2002) from southwestern Puerto Rico queen conch commercial fishery data. Analyses restricted to trips reporting conch landings where trips=1, 0, or missing.

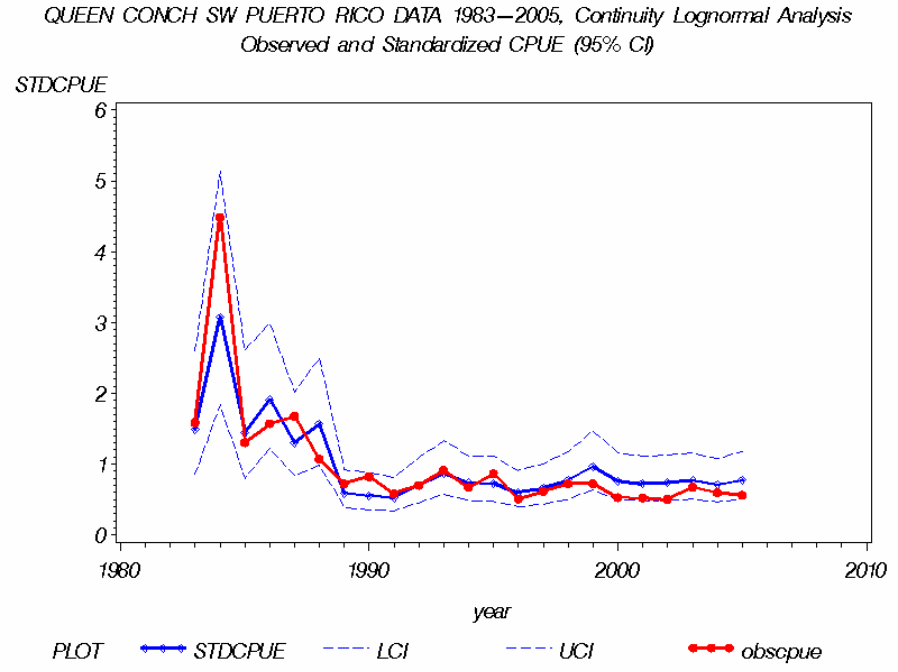



**Figure 8.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the lognormal model developed by Valle-Esquivel (2002) from southwestern Puerto Rico queen conch commercial fishery data. Analyses restricted to trips reporting conch landings where trips=1.

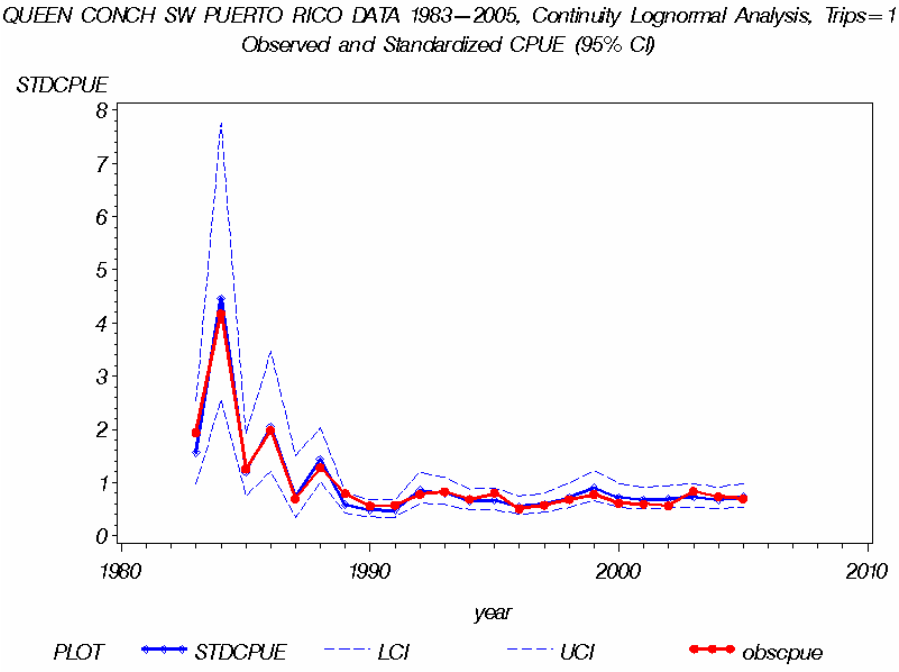


**Figure 9.** Standardized CPUE of the lognormal model developed by Valle-Esquivel (2002) from the southwest Puerto Rico queen conch commercial fishery data; 2002 index, 2007 index where trips=1, and 2007 index where trips=1, 0, or missing.

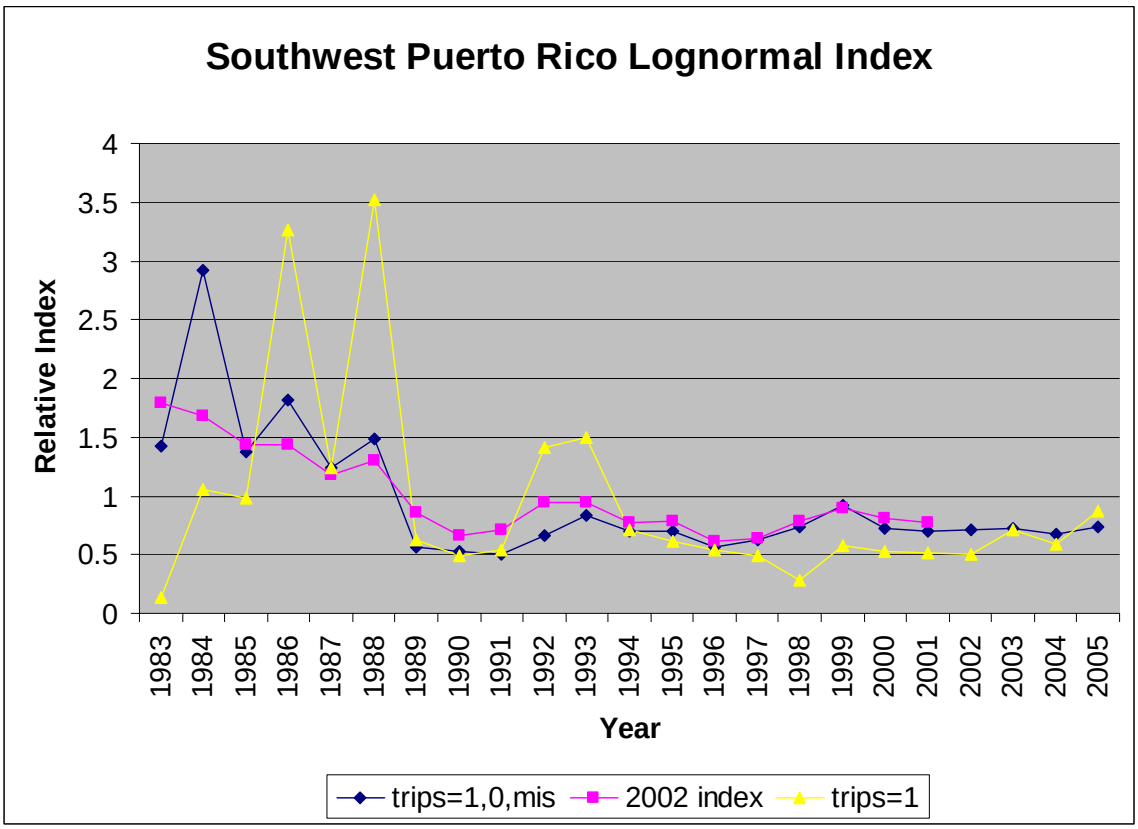


**Figure 10.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the lognormal model developed from Puerto Rico queen conch commercial fishery data. Analyses restricted to trips reporting conch landings where trips=1, 0, or missing.

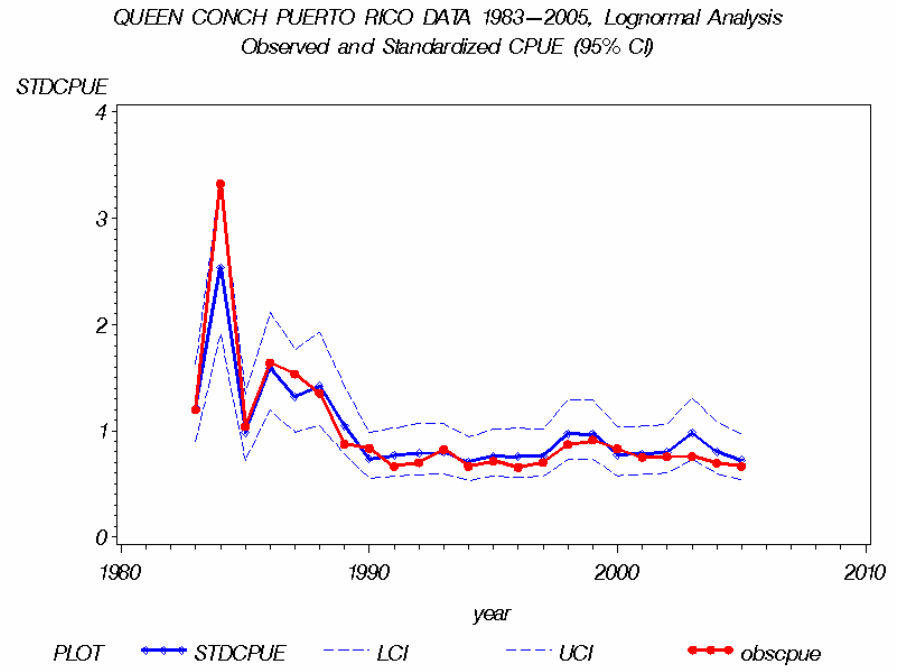



**Figure 11.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the lognormal model developed from Puerto Rico queen conch commercial fishery data. Analyses restricted to trips reporting conch landings where trips=1.

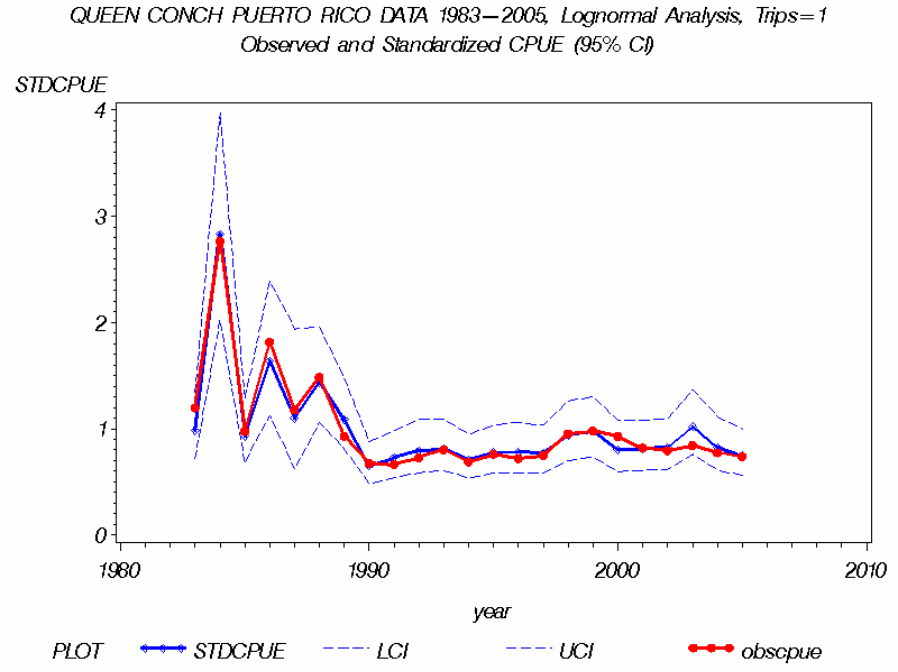


**Figure 12.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the delta-lognormal model of Puerto Rico queen conch commercial fishery data. Analyses restricted to trips reporting conch landings where trips=1, 0 or missing.

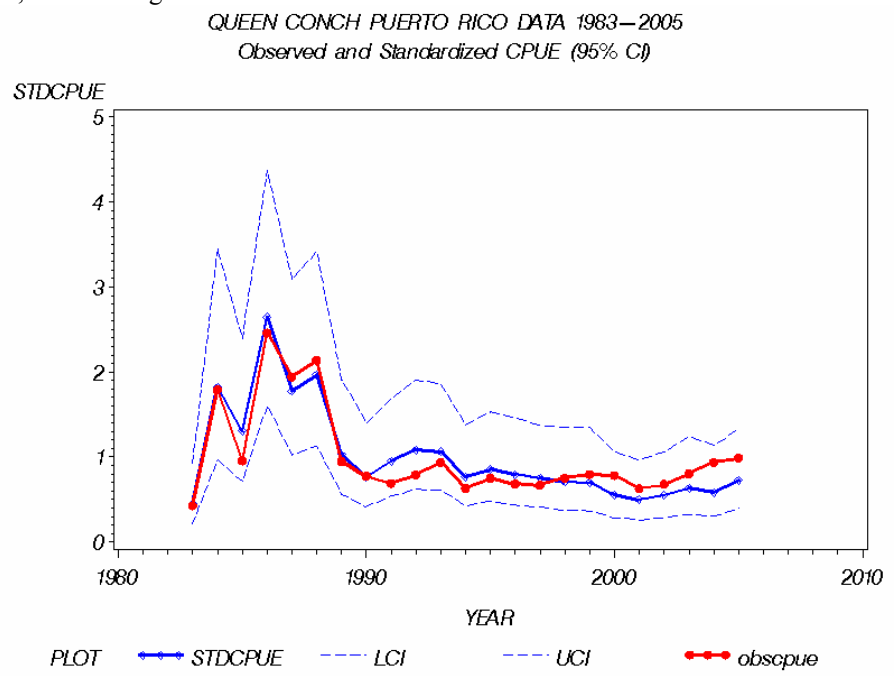



**Figure 13.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the delta-lognormal model of Puerto Rico queen conch commercial fishery data. Analyses restricted to trips reporting conch landings where trips=1.

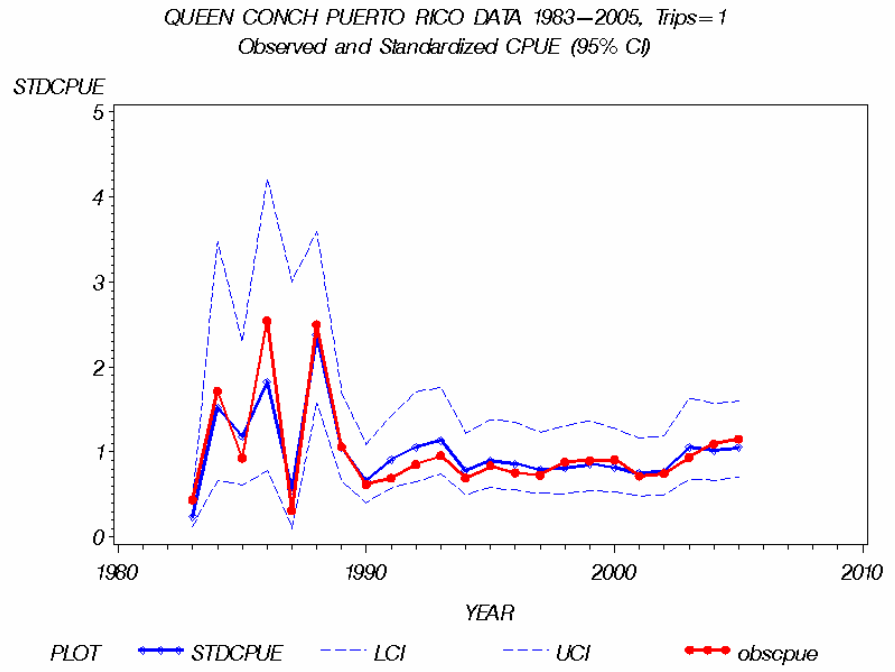


**Figure 14.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the lognormal model of southwestern Puerto Rico queen conch commercial fishery data. Analyses restricted to trips reporting conch landings where trips=1, 0 or missing.

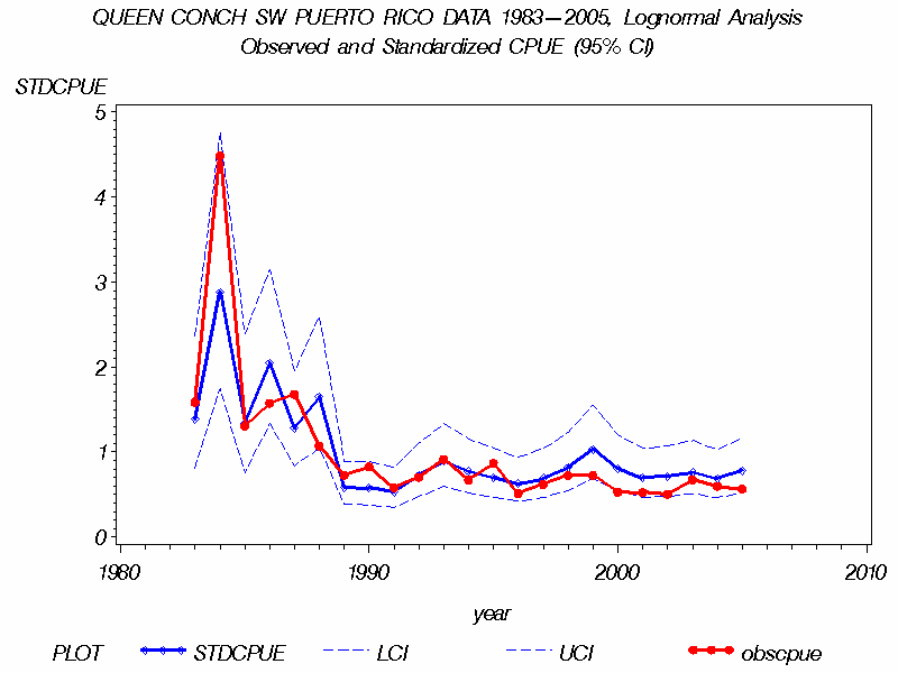



**Figure 15.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the lognormal model of southwestern Puerto Rico queen conch commercial fishery data. Analyses restricted to trips reporting conch landings where trips=1.

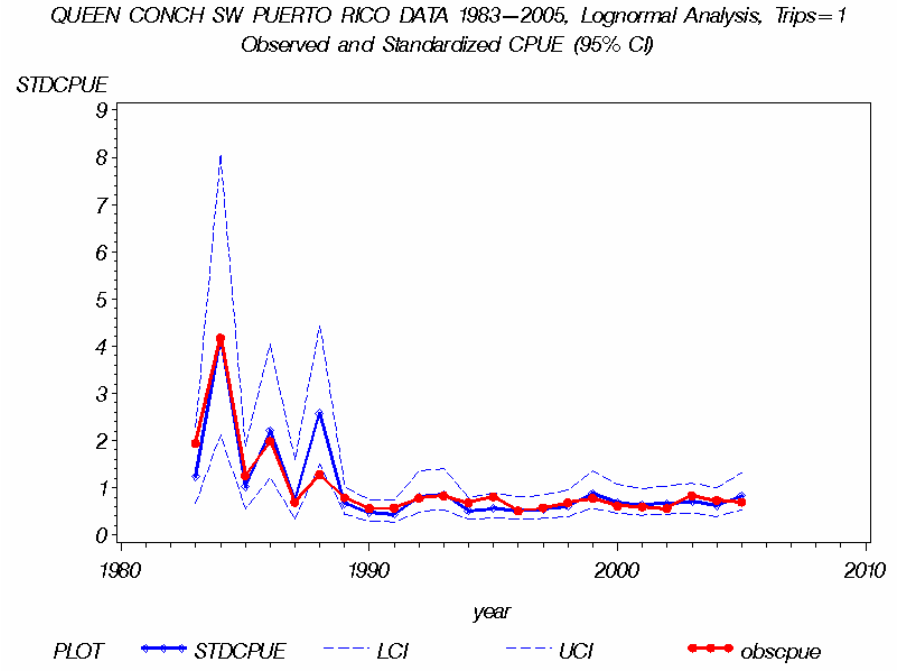


**Figure 16.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the delta-lognormal model of southwestern Puerto Rico queen conch commercial fishery data. Analyses restricted to trips reporting conch landings where trips=1, 0 or missing.

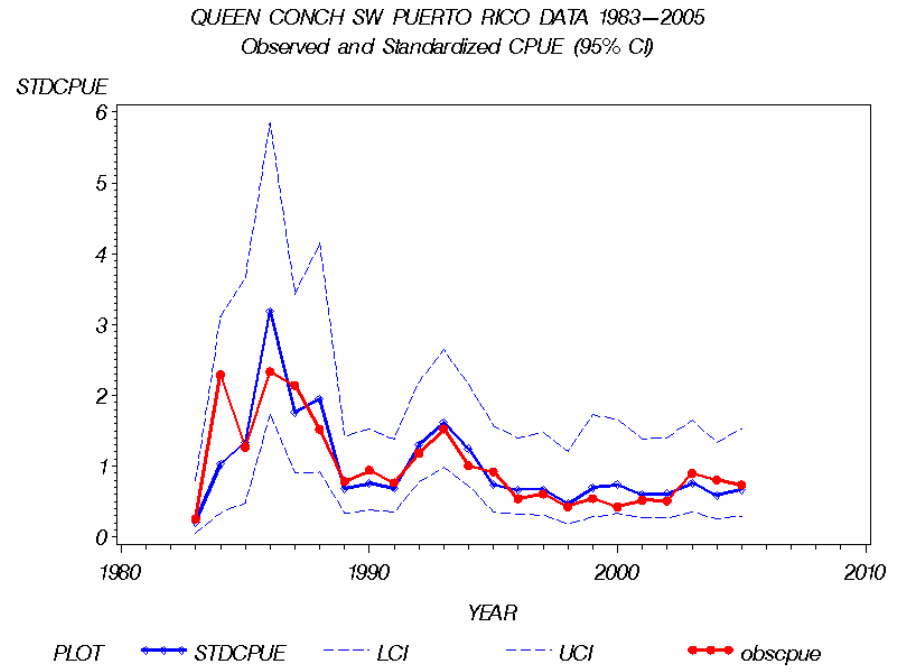



**Figure 17.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the delta-lognormal model of southwestern Puerto Rico queen conch commercial fishery data. Analyses restricted to trips reporting conch landings where trips=1.

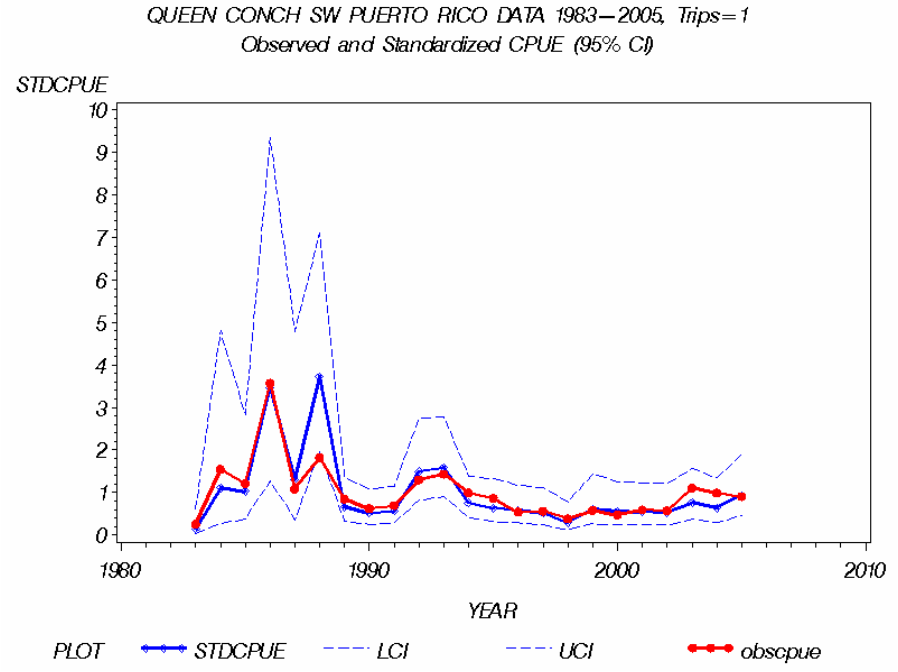


**Figure 19.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the lognormal model developed by Valle-Esquivel (2002) from St. Croix queen conch commercial fishery data.

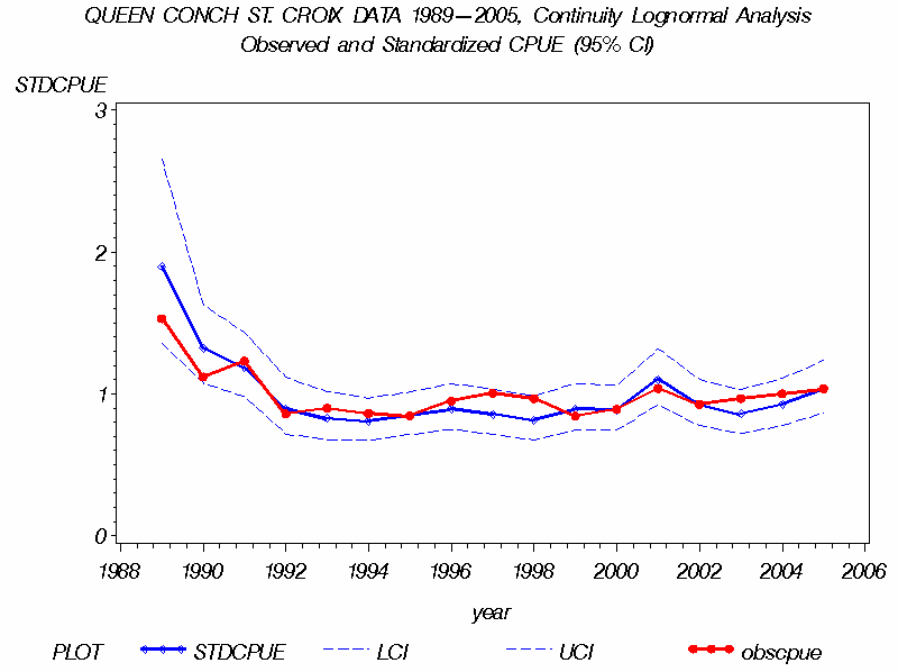



**Figure 20.** Standardized CPUE of the lognormal model developed by Valle-Esquivel (2002) from the St. Croix queen conch commercial fishery data; 2002 index, 2007 index, and 2007 index where trips=1, 0, or missing.

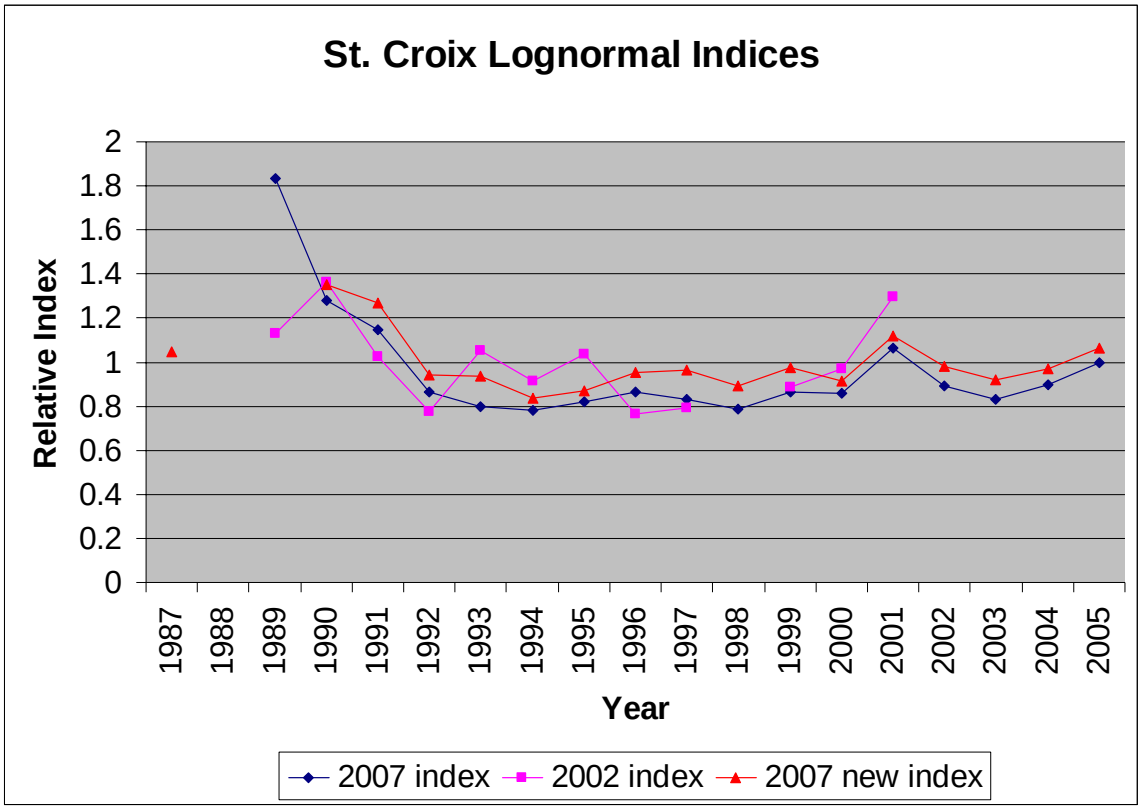


**Figure 21.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the lognormal model developed from St. Croix queen conch commercial fishery data.

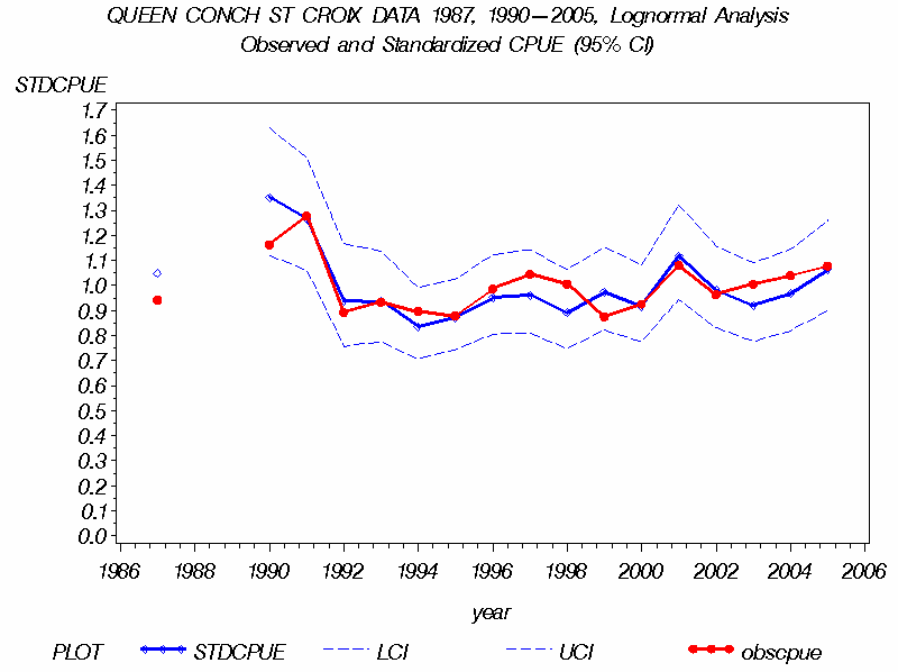
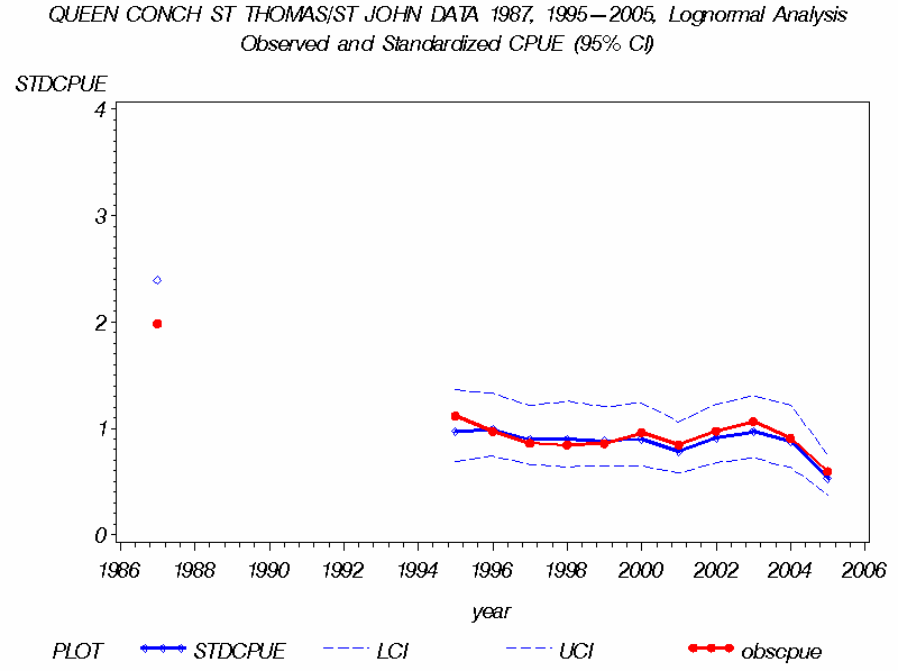



**Figure 22.** Nominal CPUE (solid circles), standardized CPUE (open diamonds) and upper and lower 95% confidence limits of the standardized CPUE estimates (dashed lines) for the lognormal model developed from St. Thomas/St. John queen conch commercial fishery data.



# Appendix A

**Figure A1.** Error distribution ln(CPUE) of the final lognormal 2002 model of Puerto Rico conch landings data, included data from trips=1, 0, or missing. The solid line in each graph is the expected normal distribution.

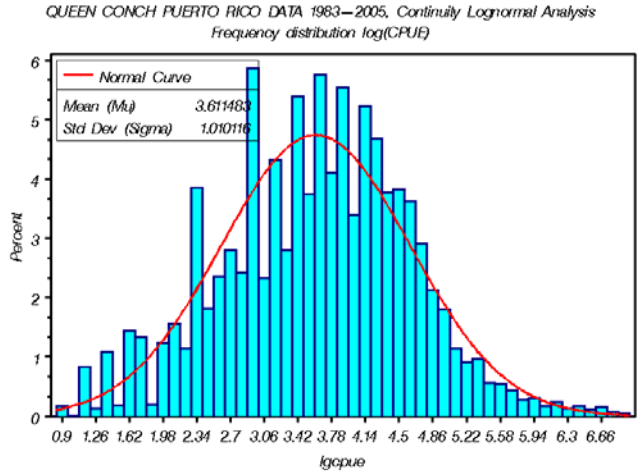



**Figure A2.** QQ plots of residuals of the final lognormal 2002 model of successful catch rates for vessels landing queen conch in Puerto Rico where trips=1, 0, or missing.

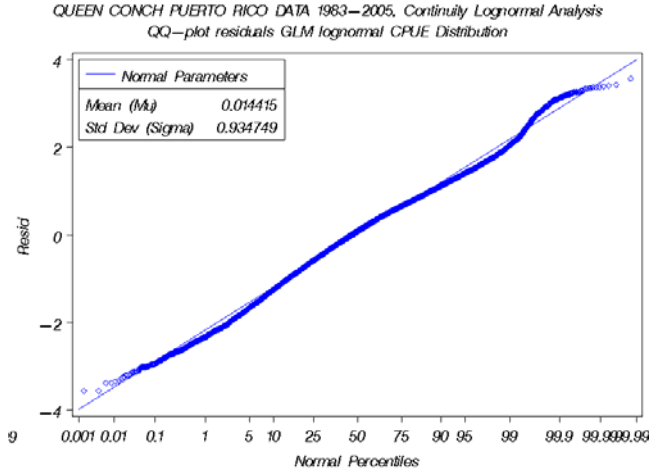



**Figure A3.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

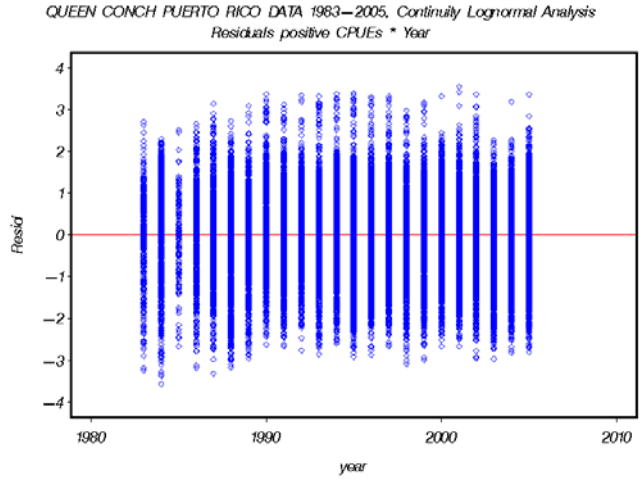


**Figure A4.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

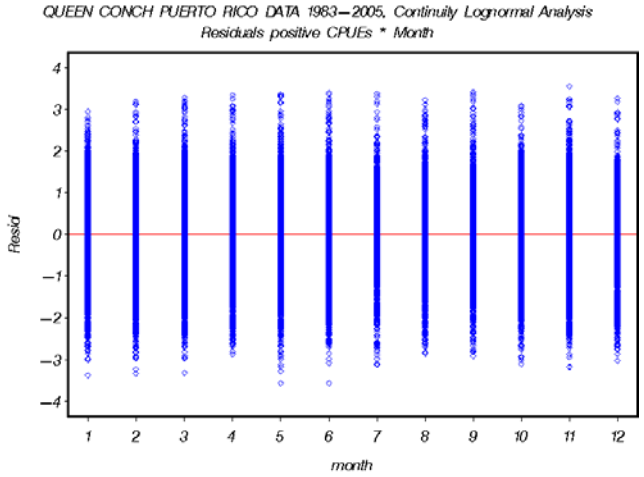



**Figure A5.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

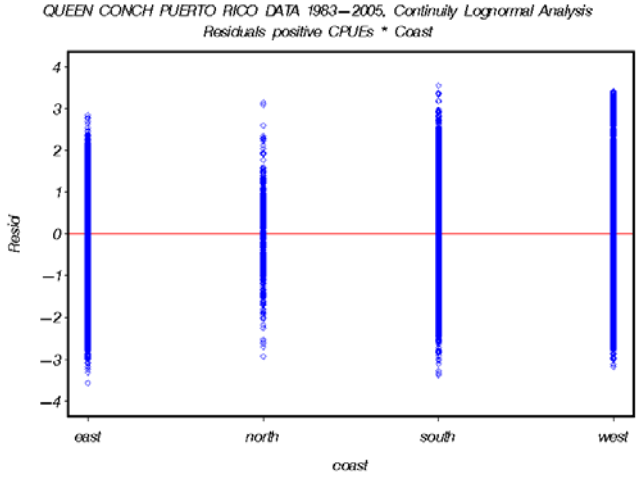



**Figure A6.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

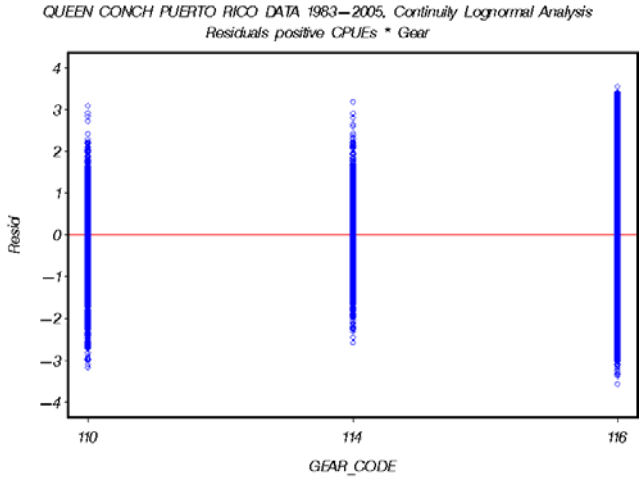


**Figure A7.** Error distribution ln(CPUE) of the final lognormal 2002 model of Puerto Rico conch landings data, included data from trips=1. The solid line in each graph is the expected normal distribution.

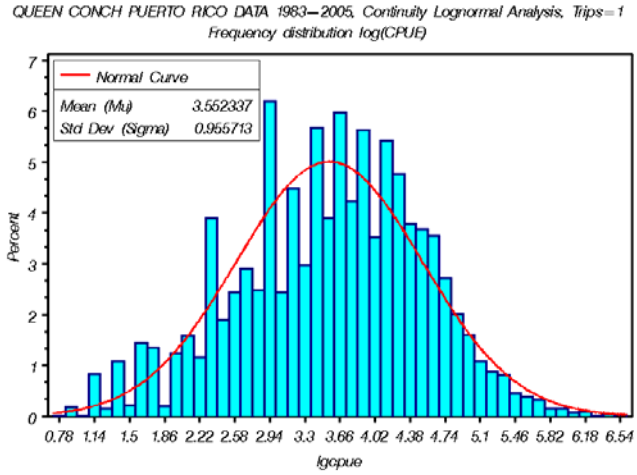



**Figure A8.** QQ plots of residuals of the final lognormal 2002 model of successful catch rates for vessels landing queen conch in Puerto Rico where trips=1.

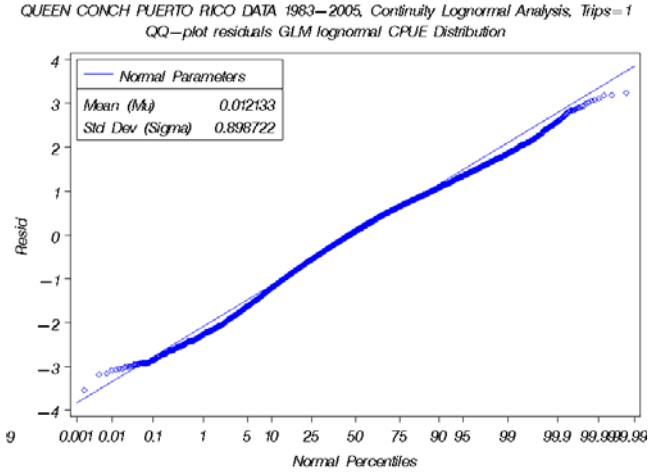



**Figure A9.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

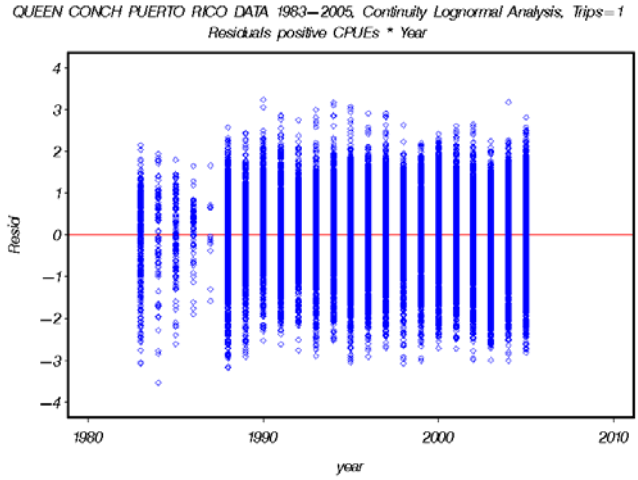


**Figure A10.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

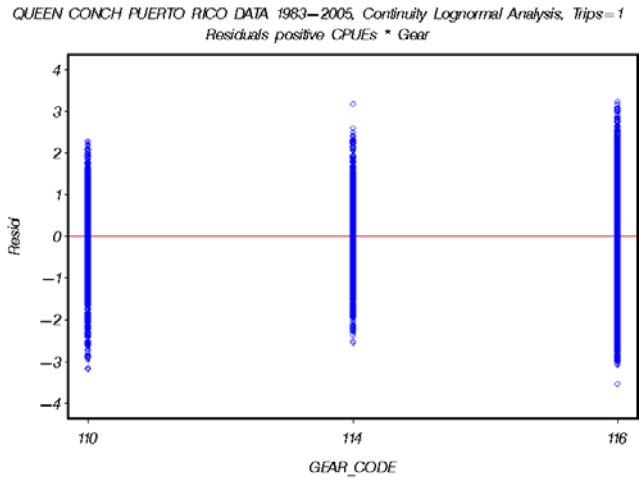



**Figure A11.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

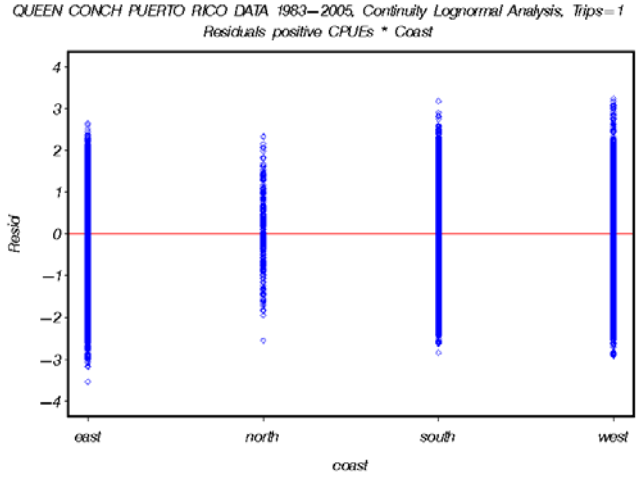



**Figure A12.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

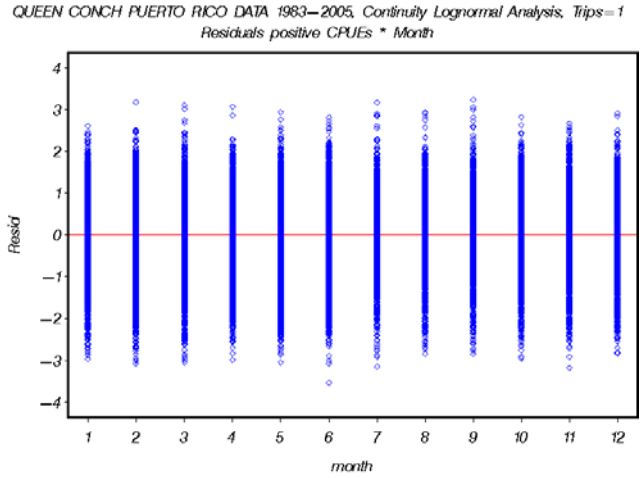


**Figure A13.** Error distribution ln(CPUE) of the final delta-lognormal 2002 model of Puerto Rico conch landings data, included data from trips=1, 0, or missing. The solid line in each graph is the expected normal distribution.

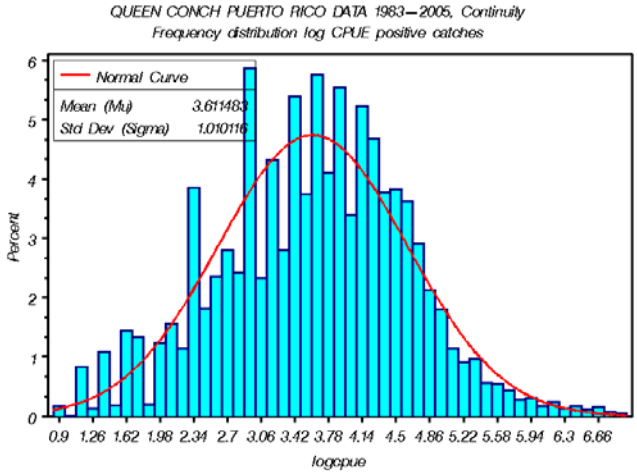



**Figure A14.** QQ plots of residuals of the final delta-lognormal 2002 model of successful catch rates for vessels landing queen conch in Puerto Rico where trips=1, 0, or missing.

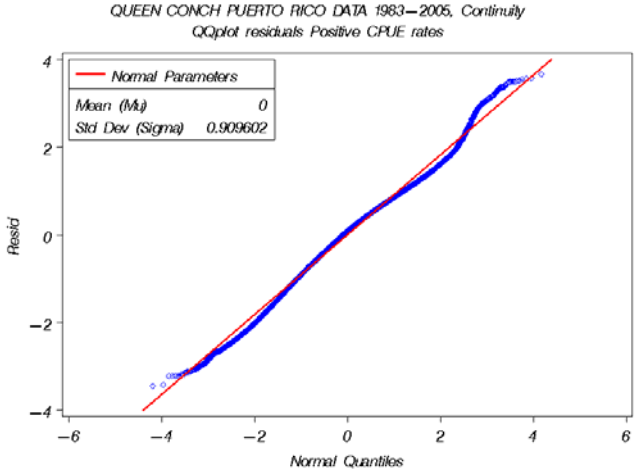



**Figure A15.** Proportion positive trips by year included in the delta-lognormal 2002 model of Puerto Rico conch data where trips=1, 0, or missing.

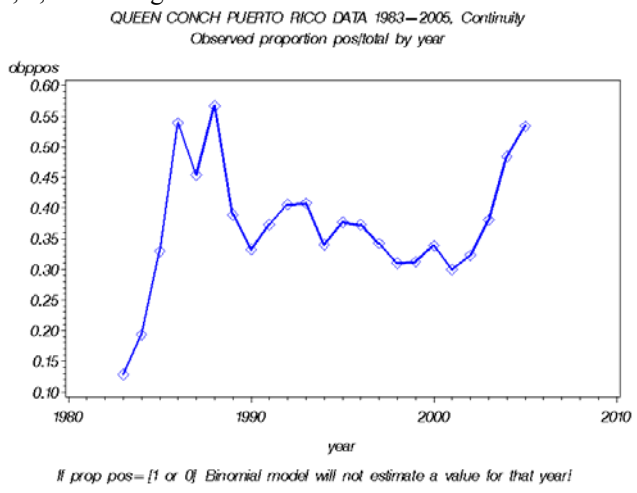


**Figure A16.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

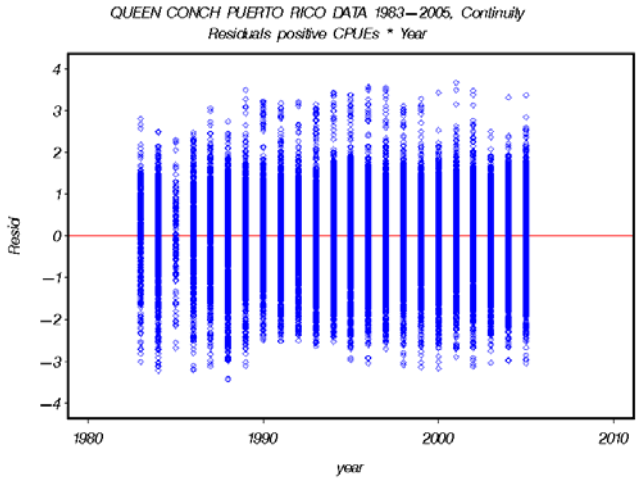



**Figure A17.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

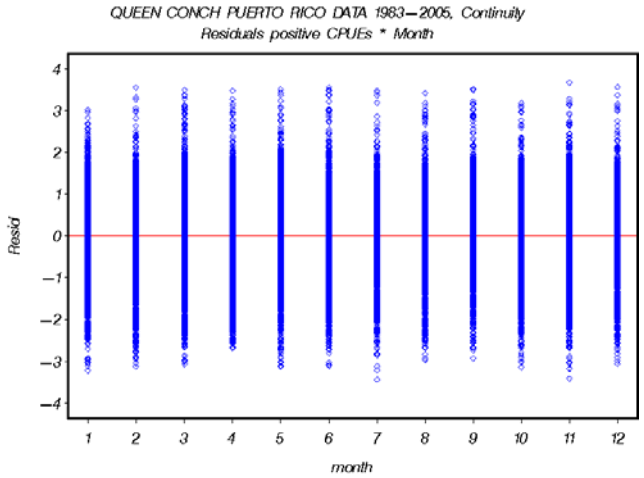



**Figure A18.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

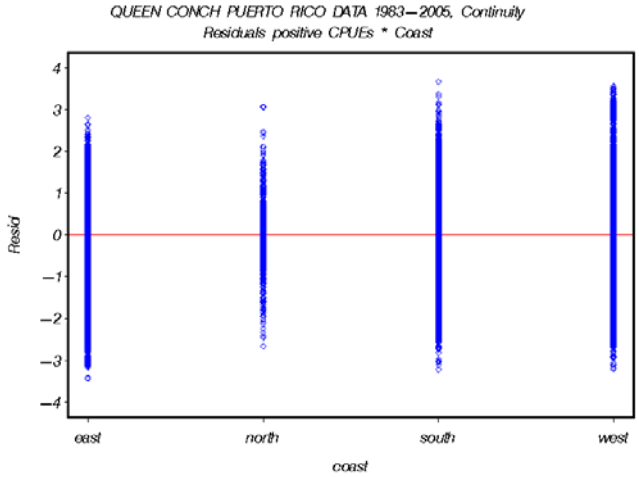


**Figure A19.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

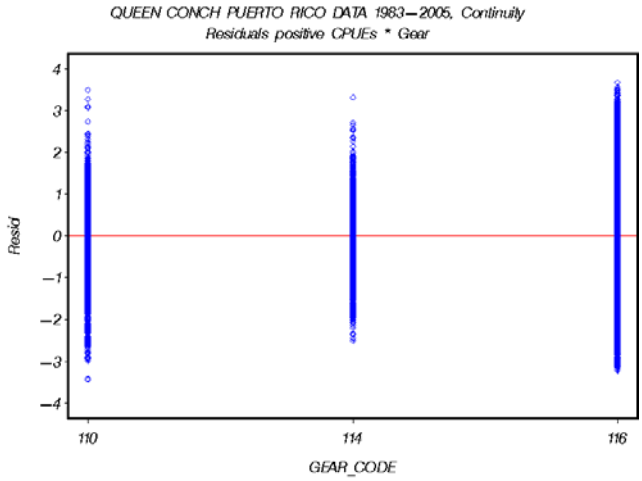



**Figure A20.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico binomial analysis on proportion positive trips where trips=1, 0, or missing.

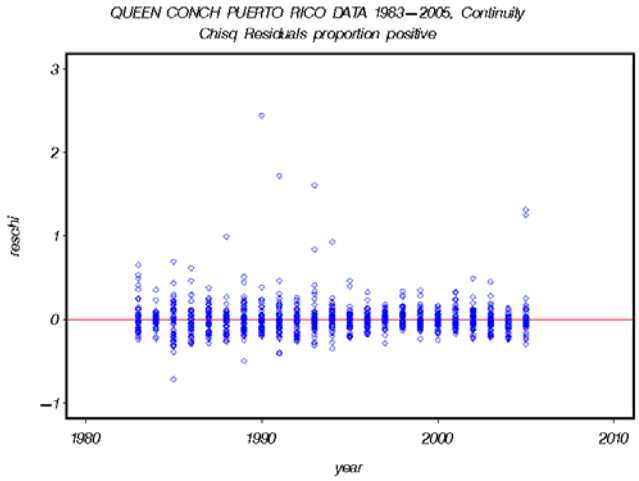



**Figure A21.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico binomial analysis on proportion positive trips where trips=1, 0, or missing.

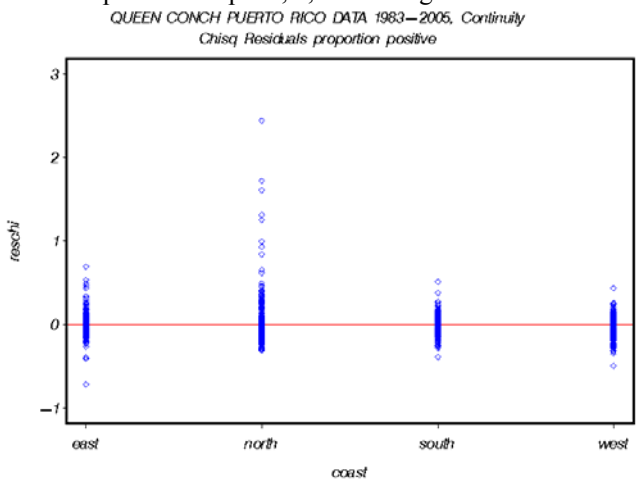


**Figure A22.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico binomial analysis on proportion positive trips where trips=1, 0, or missing.

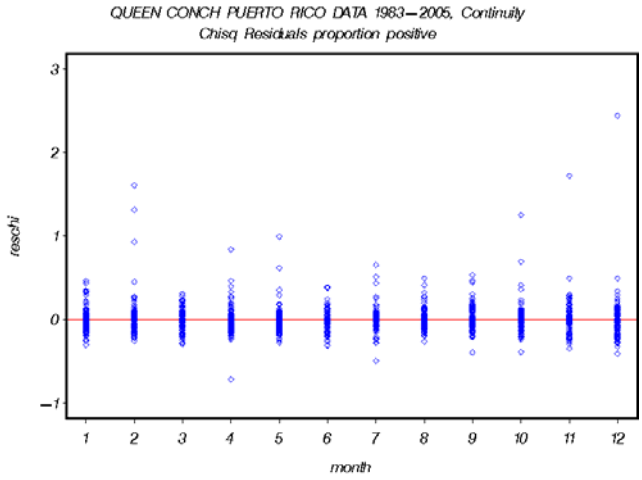



**Figure A23.** Error distribution ln(CPUE) of the final delta-lognormal 2002 model of Puerto Rico conch landings data, included data from trips=1. The solid line in each graph is the expected normal distribution.

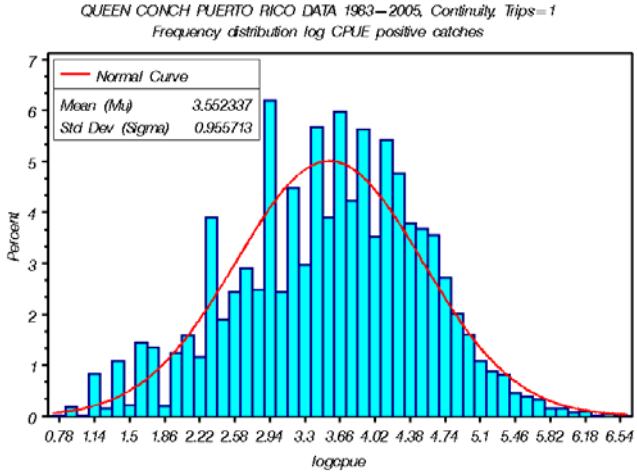



**Figure A24.** QQ plots of residuals of the final delta-lognormal 2002 model of successful catch rates for vessels landing queen conch in Puerto Rico where trips=1.

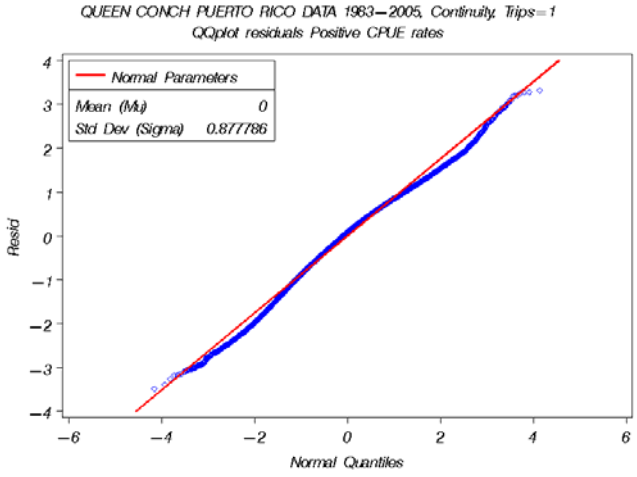


**Figure A25.** Proportion positive trips by year included in the delta-lognormal 2002 model of Puerto Rico conch data where trips=1.

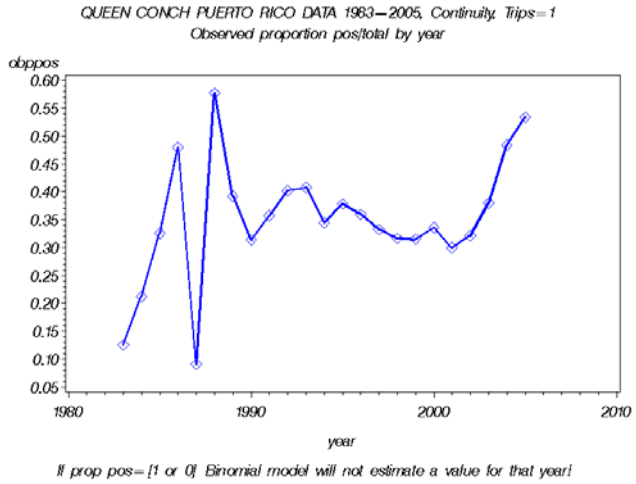



**Figure A26.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

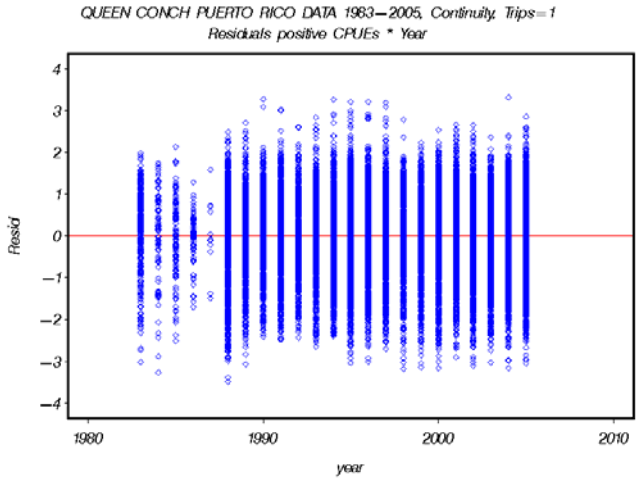



**Figure A27.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

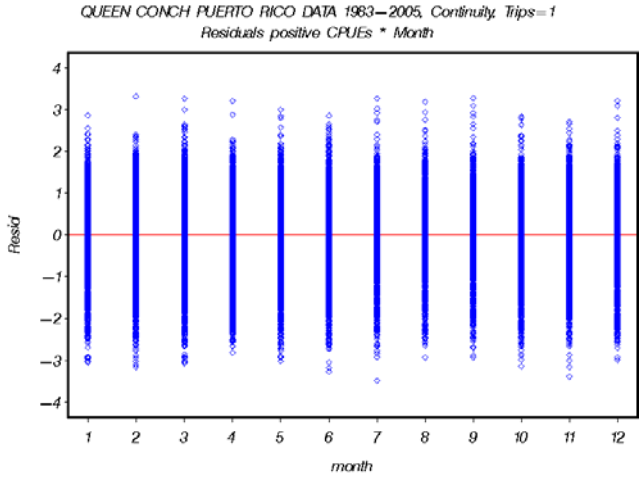


**Figure A28.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

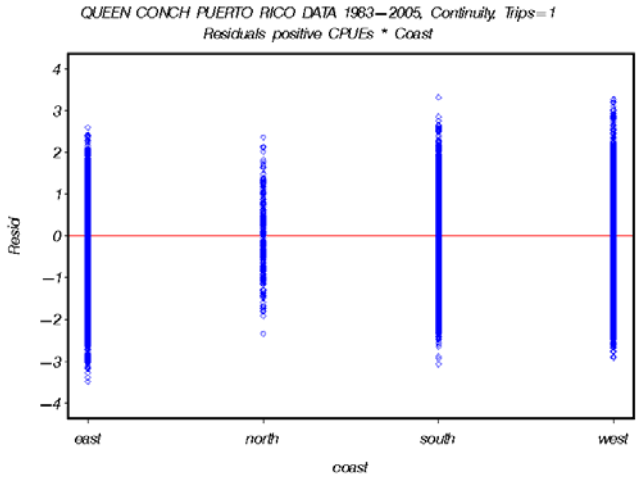



**Figure A29.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

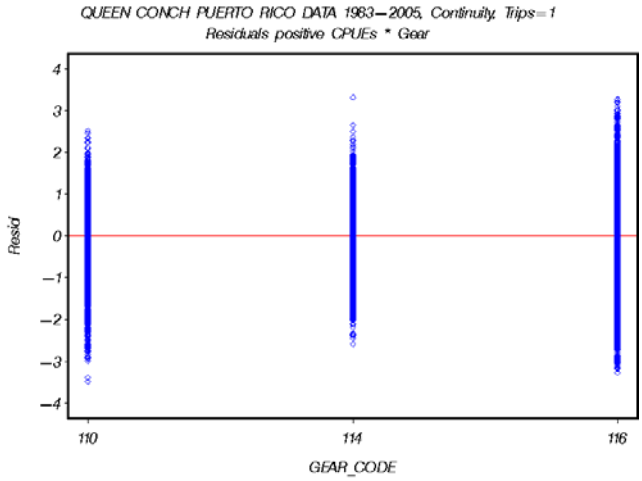



**Figure A30.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico binomial analysis on proportion positive trips where trips=1.

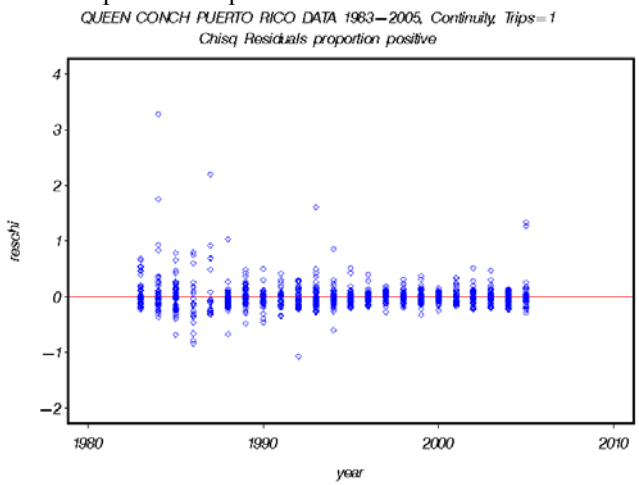


**Figure A31.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico binomial analysis on proportion positive trips where trips=1.

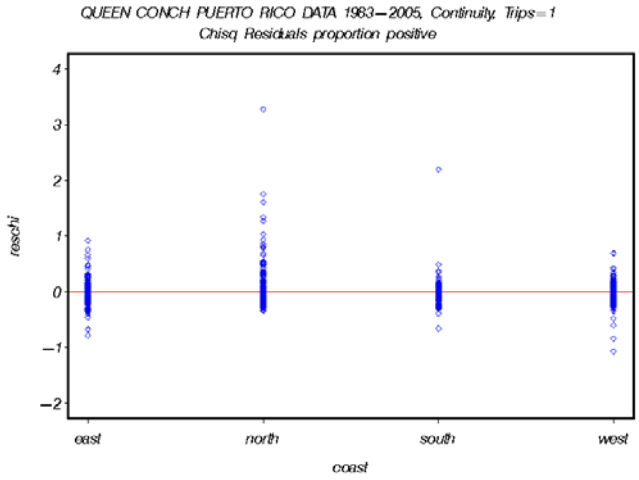



**Figure A32.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico binomial analysis on proportion positive trips where trips=1.

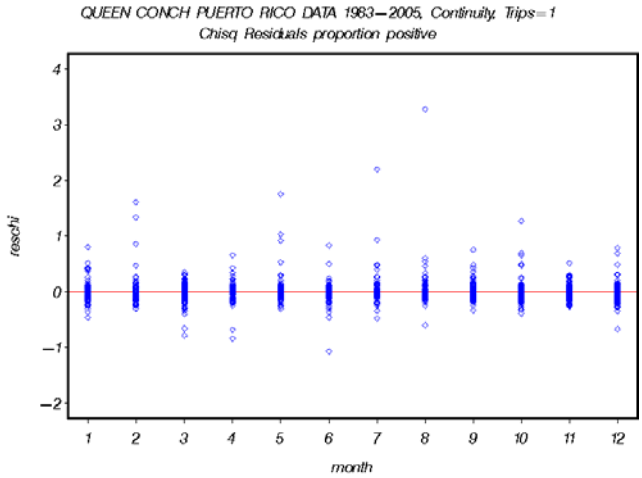



**Figure A33.** Error distribution ln(CPUE) of the final lognormal 2002 model of southwest Puerto Rico conch landings data, included data from trips=1, 0, or missing. The solid line in each graph is the expected normal distribution.

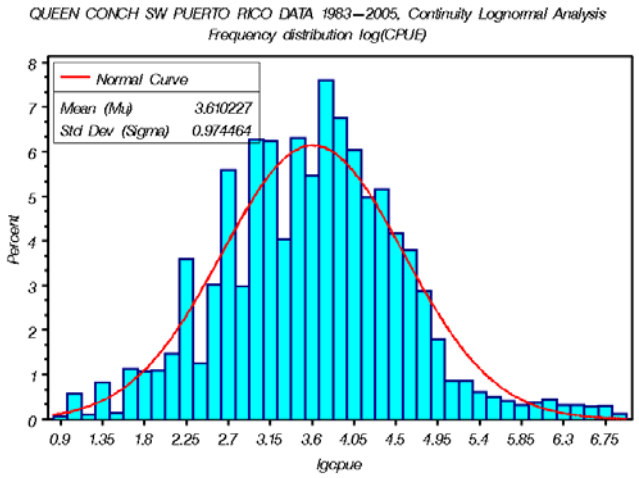


**Figure A34.** QQ plots of residuals of the final lognormal 2002 model of successful catch rates for vessels landing queen conch in southwest Puerto Rico where trips=1, 0, or missing.

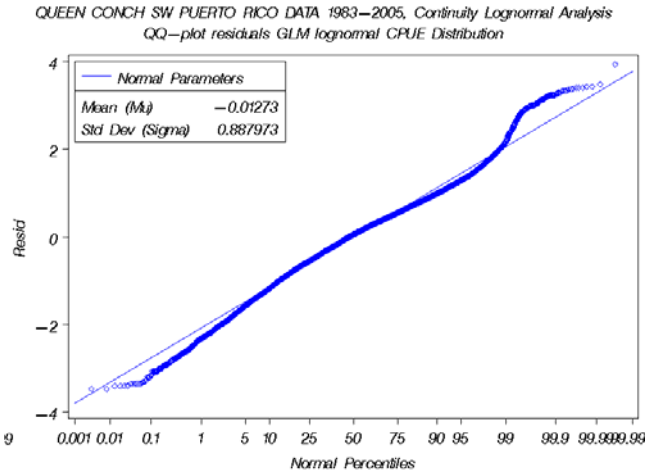



**Figure A35.** Residuals for the lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1, 0, or missing.

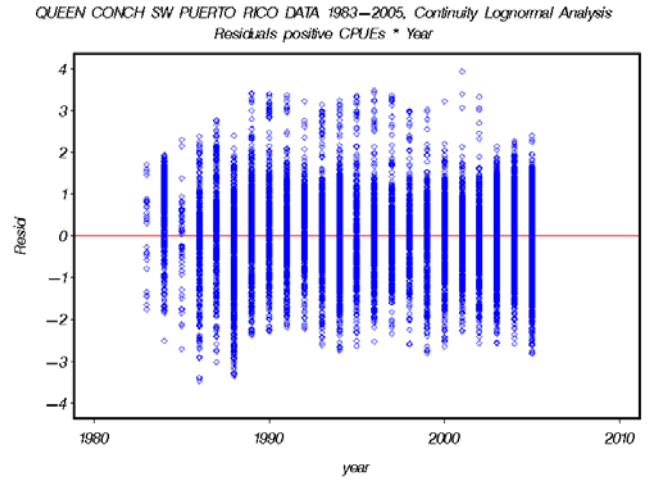



**Figure A36.** Residuals for the lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1, 0, or missing.

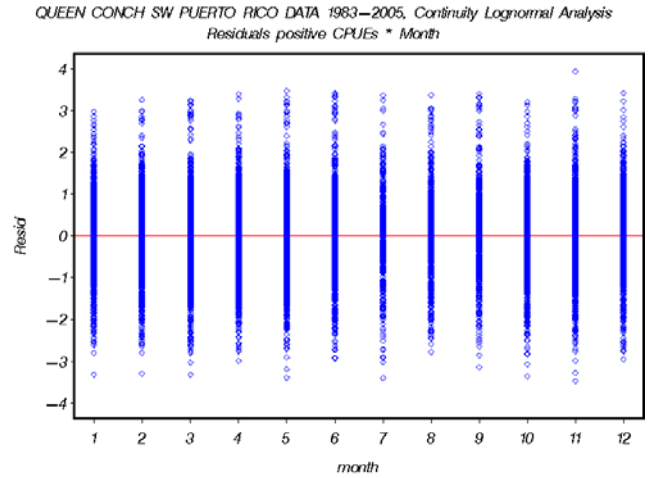


**Figure A37.** Residuals for the lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1, 0, or missing.

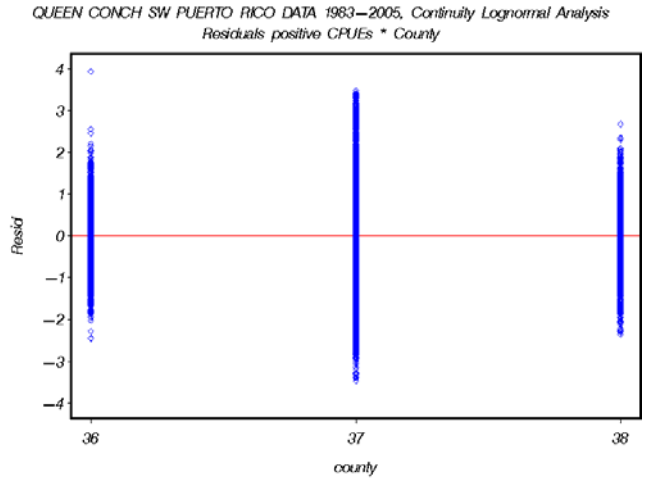



**Figure A38.** Error distribution ln(CPUE) of the final lognormal 2002 model of southwest Puerto Rico conch landings data, included data from trips=1. The solid line in each graph is the expected normal distribution.

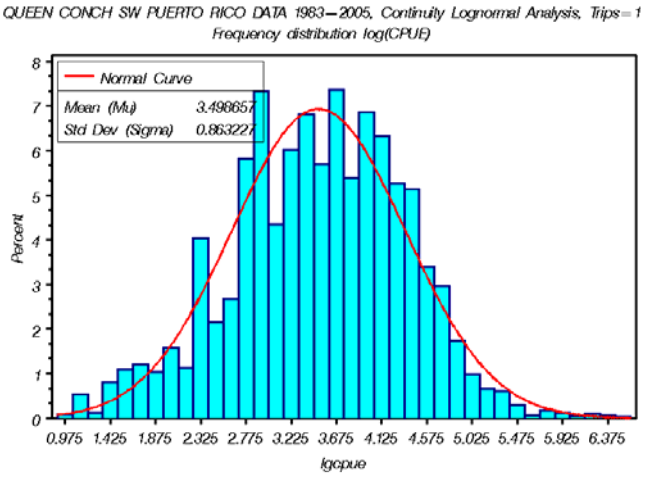



**Figure A39.** QQ plots of residuals of the final lognormal 2002 model of successful catch rates for vessels landing queen conch in southwest Puerto Rico where trips=1.

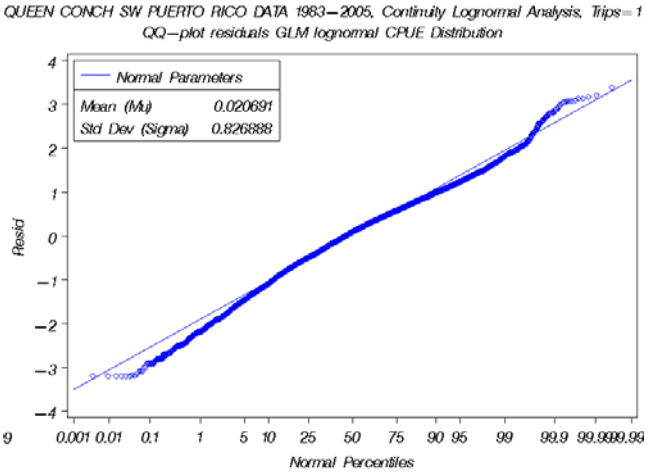


**Figure A40.** Residuals for the lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1.

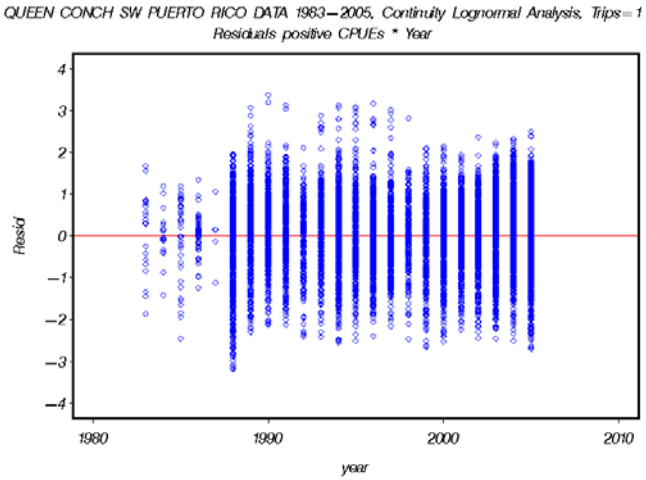



**Figure A41.** Residuals for the lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1.

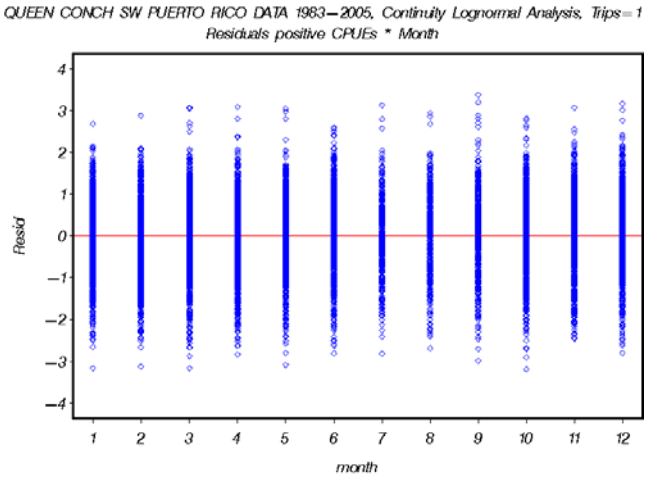



**Figure A42.** Residuals for the lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1.

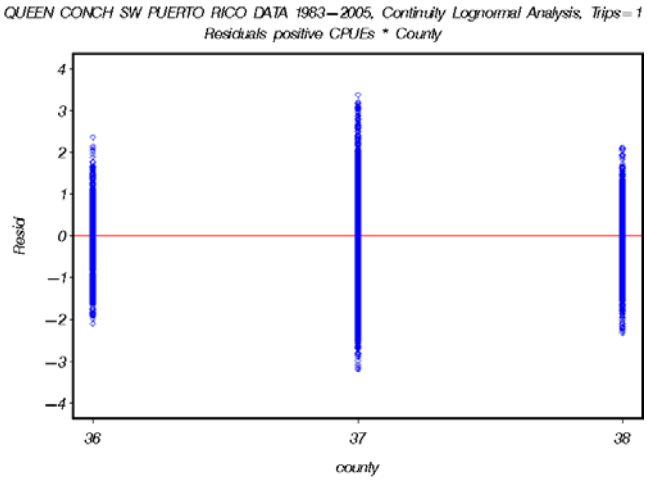


**Figure A43.** Error distribution ln(CPUE) of the final lognormal model of Puerto Rico conch landings data, included trips=1, 0, and missing. The solid line in each graph is the expected normal distribution.

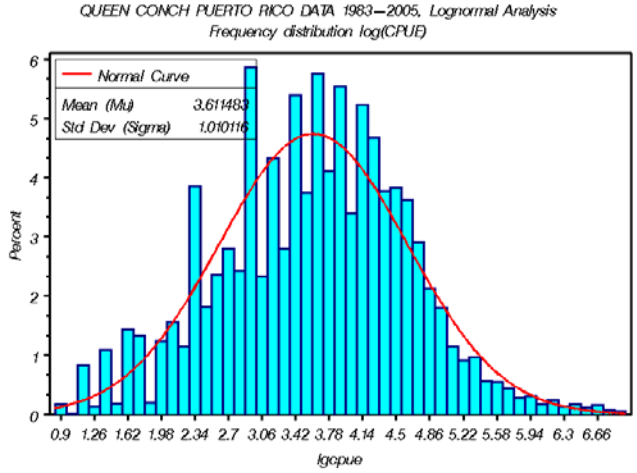



**Figure A44.** QQ plots of residuals of the final lognormal model of successful catch rates for vessels landing queen conch in southwest Puerto Rico where trips=1, 0, and missing.

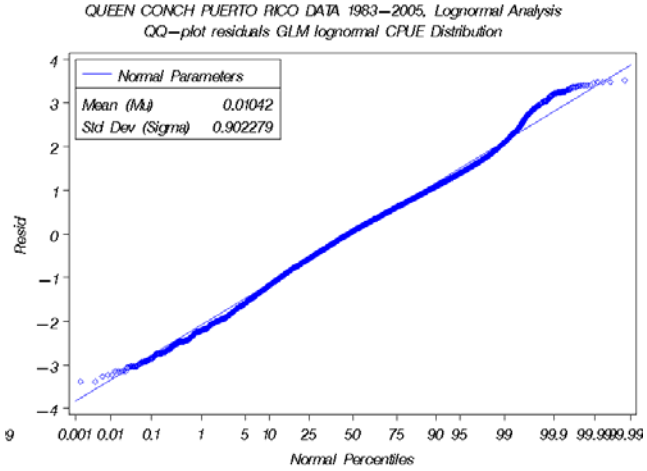



**Figure A45.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

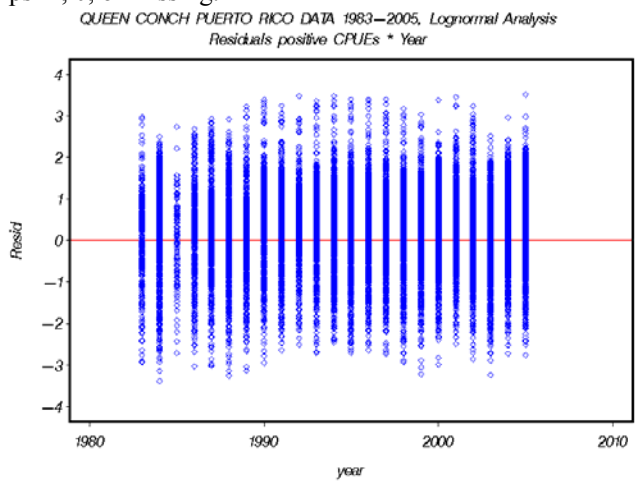


**Figure A46.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

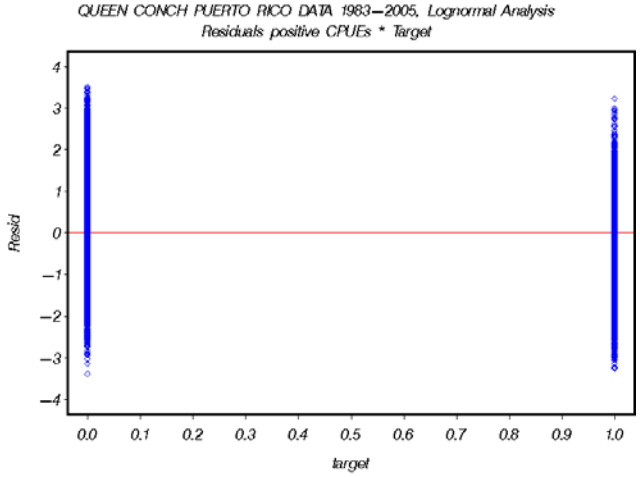



**Figure A47.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

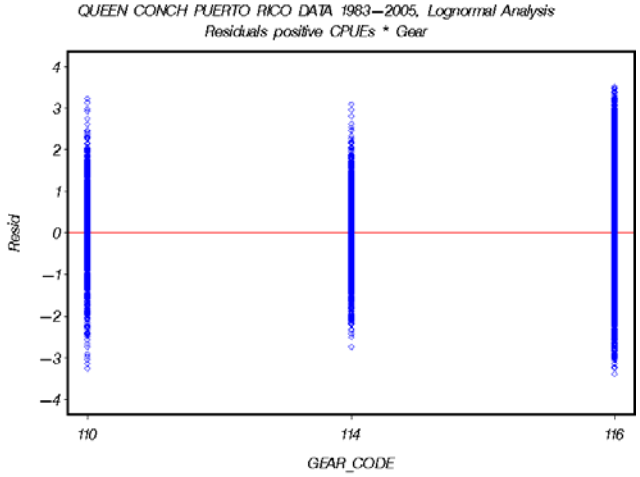



**Figure A48.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

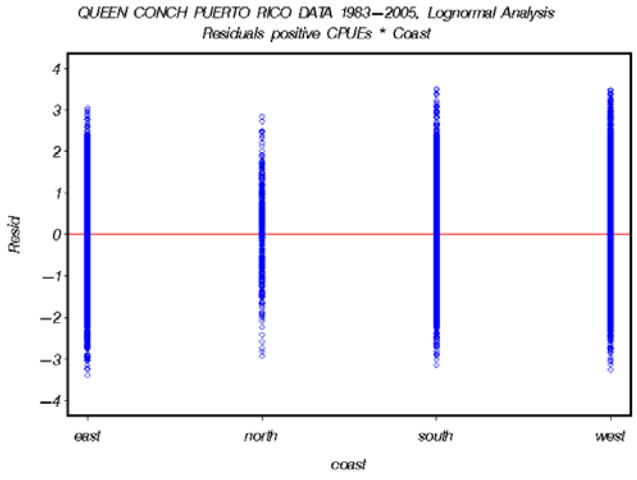


**Figure A49.** Error distribution ln(CPUE) of the final lognormal model of Puerto Rico conch landings data, included trips=1. The solid line in each graph is the expected normal distribution.

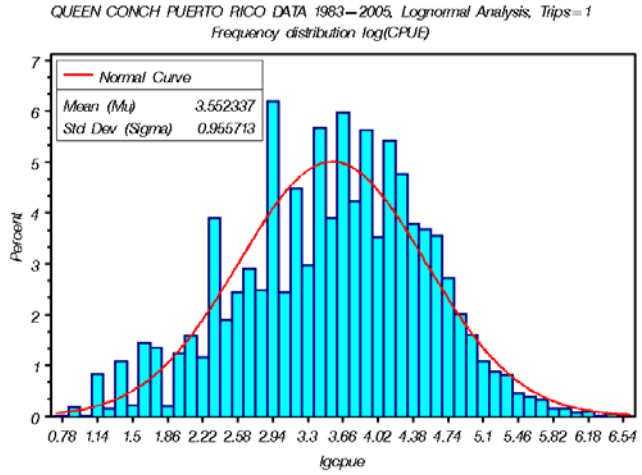



**Figure A50.** QQ plots of residuals of the final lognormal model of successful catch rates for vessels landing queen conch in southwest Puerto Rico where trips=1.

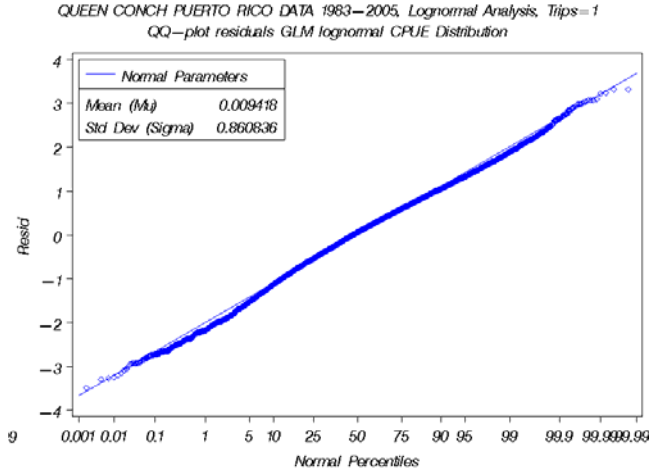



**Figure A51.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

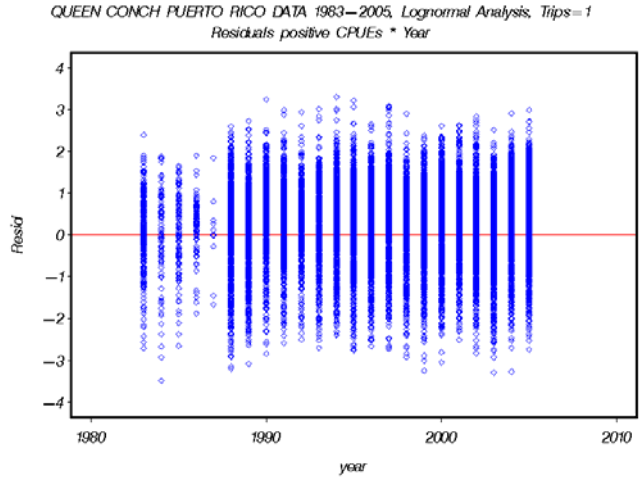


**Figure A52.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

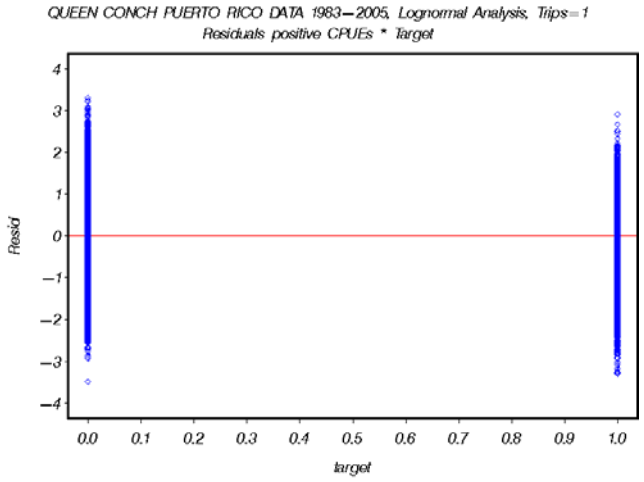



**Figure A53.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

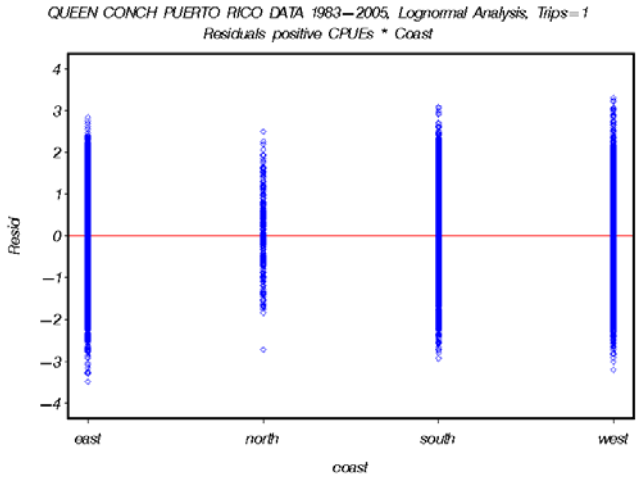



**Figure A54.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

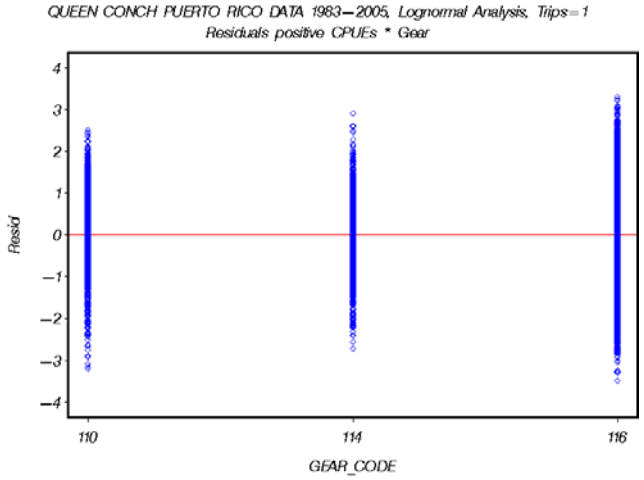


**Figure A55.** Error distribution ln(CPUE) of the final delta-lognormal model of Puerto Rico conch landings data, included trips=1, 0, or missing. The solid line in each graph is the expected normal distribution.

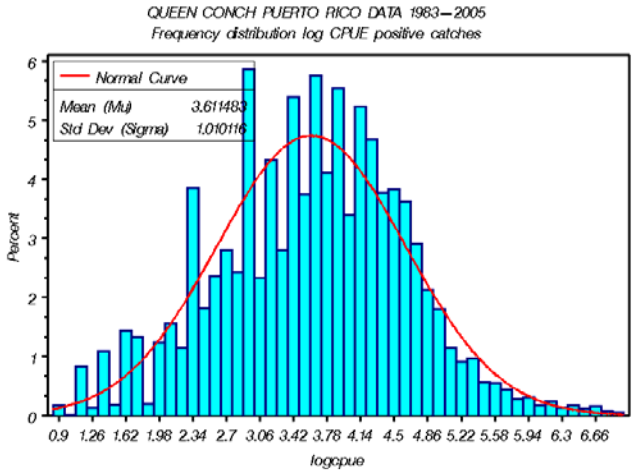



**Figure A56.** QQ plots of residuals of the final delta-lognormal model of successful catch rates for vessels landing queen conch in Puerto Rico where trips=1, 0, or missing.

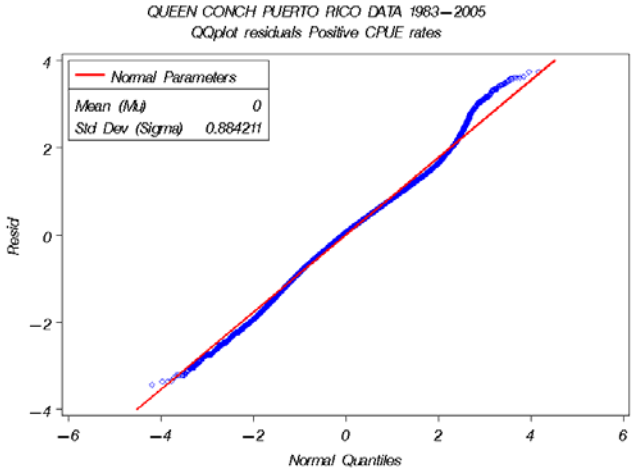



**Figure A57.** Proportion positive trips by year included in the delta-lognormal model of Puerto Rico conch data where trips=1, 0, or missing.

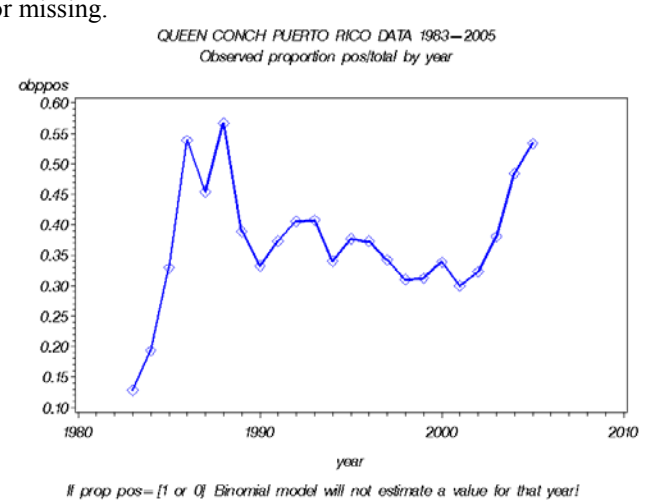


**Figure A58.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

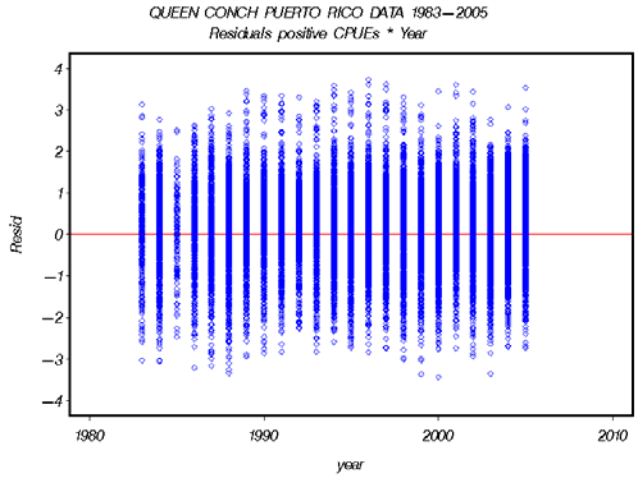



**Figure A59.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

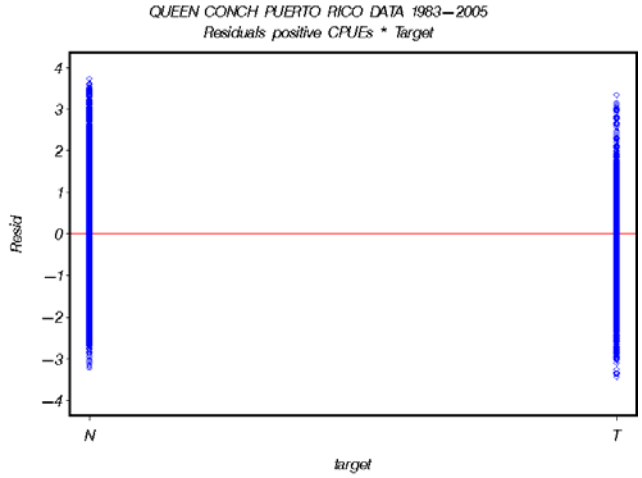



**Figure A60.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1, 0, or missing.

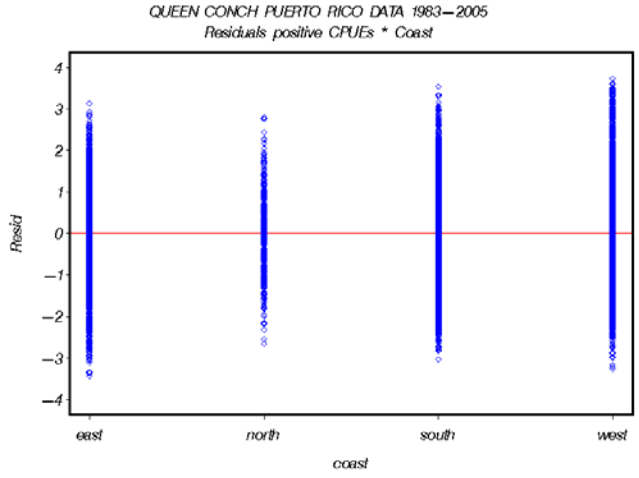


**Figure A61.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico binomial analysis on proportion positive trips where trips=1, 0, or missing.

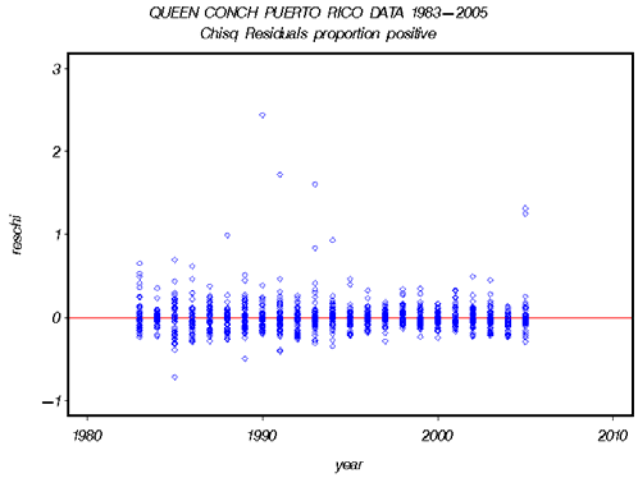



**Figure A62.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico binomial analysis on proportion positive trips where trips=1, 0, or missing.

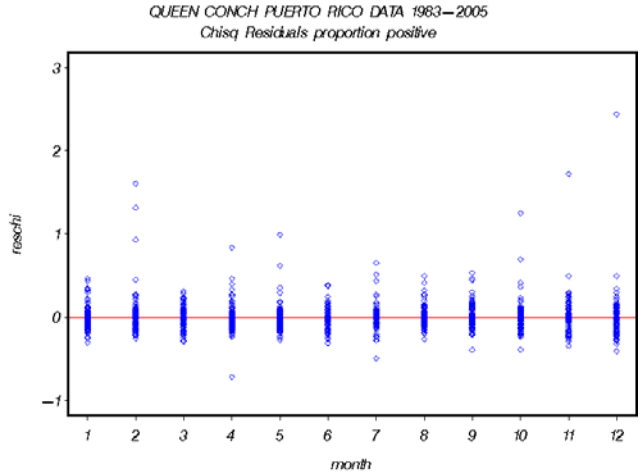



**Figure A63.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico binomial analysis on proportion positive trips where trips=1, 0, or missing.

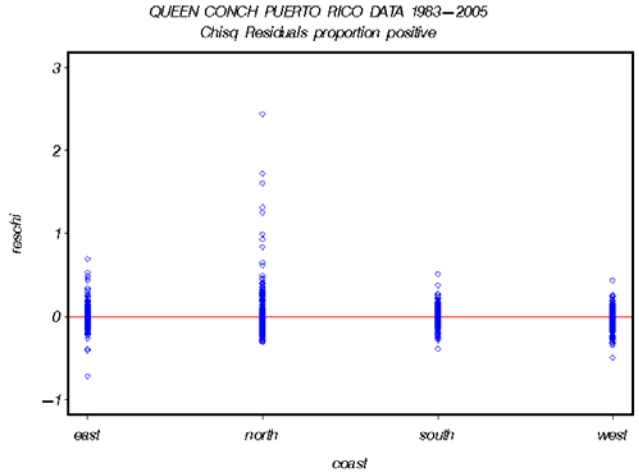


**Figure A64.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico binomial analysis on proportion positive trips where trips=1, 0, or missing.

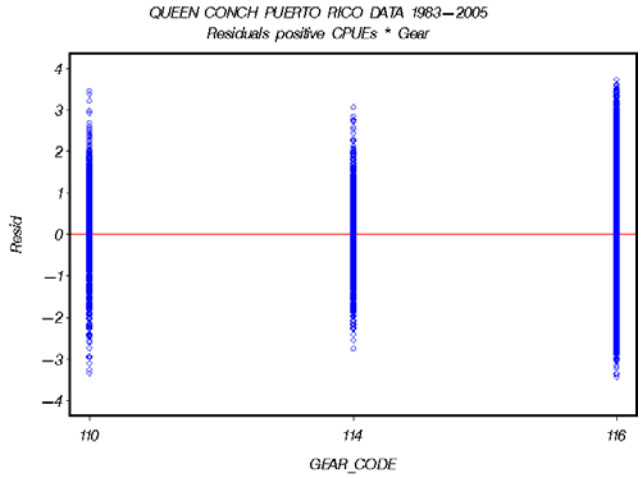



**Figure A65.** Error distribution ln(CPUE) of the final delta-lognormal model of Puerto Rico conch landings data, included trips=1. The solid line in each graph is the expected normal distribution.

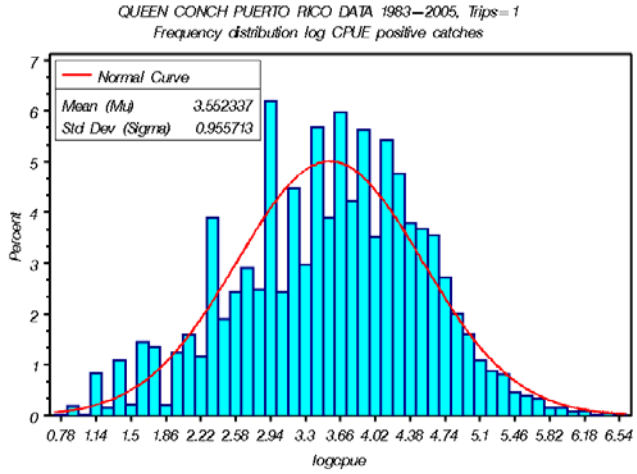



**Figure A66.** QQ plots of residuals of the final delta-lognormal model of successful catch rates for vessels landing queen conch in Puerto Rico where trips=1.

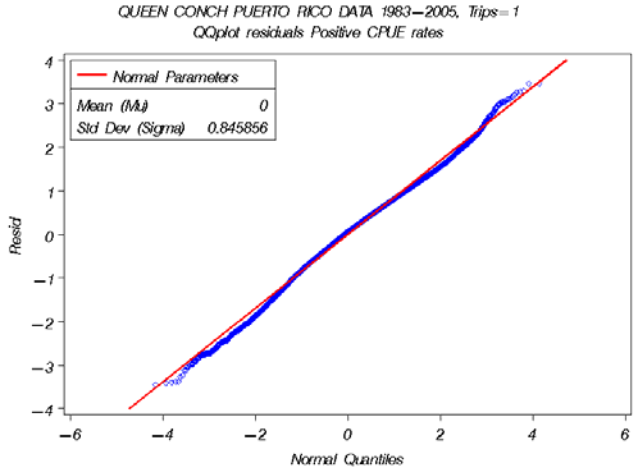


**Figure A67.** Proportion positive trips by year included in the delta-lognormal model of Puerto Rico conch data where trips=1.

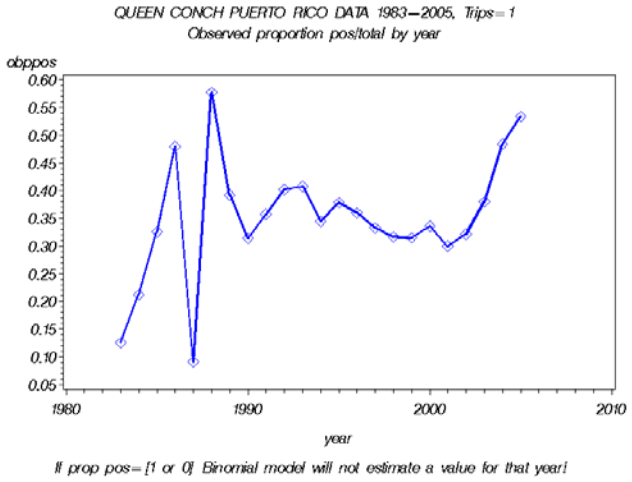



**Figure A68.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

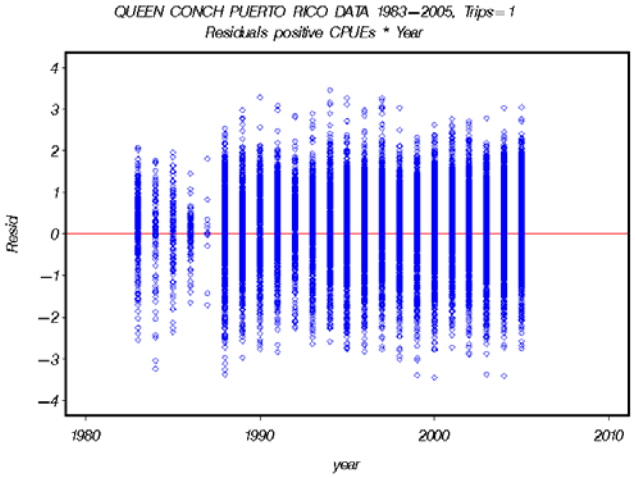



**Figure A69.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

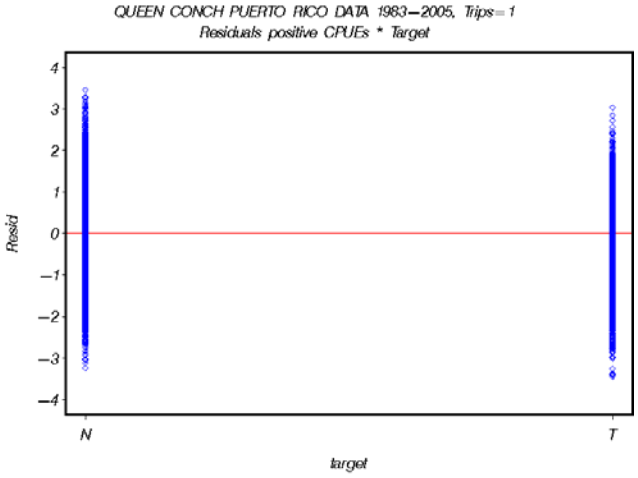


**Figure A70.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

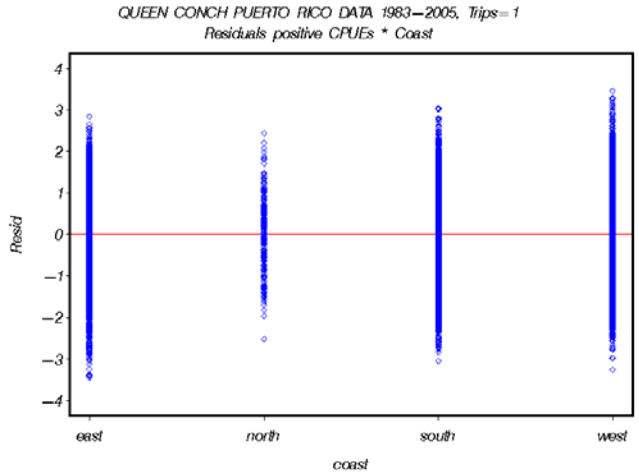



**Figure A71.** Residuals for the lognormal model on successful catch rates for Puerto Rico lognormal analysis on trips=1.

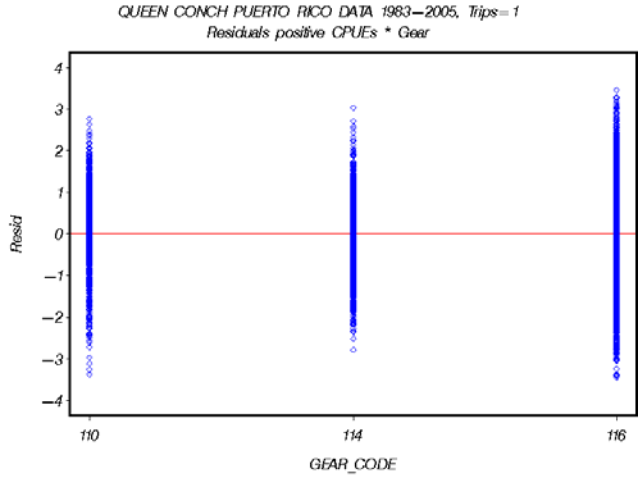



**Figure A72.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico binomial analysis on proportion positive trips where trips=1.

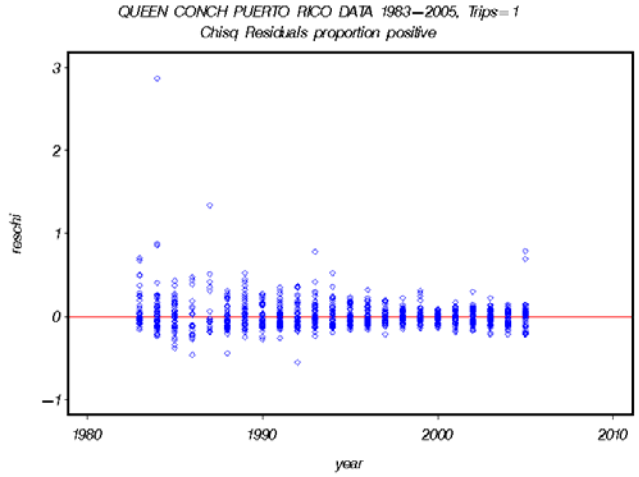


**Figure A73.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico binomial analysis on proportion positive trips where trips=1.

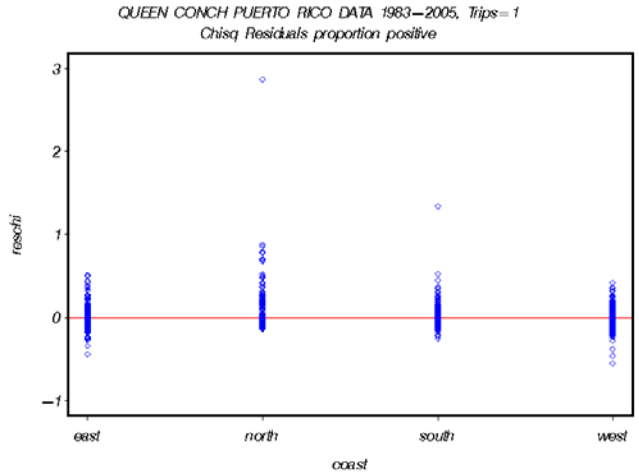



**Figure A74.** Residuals for the delta-lognormal model on successful catch rates for Puerto Rico binomial analysis on proportion positive trips where trips=1.

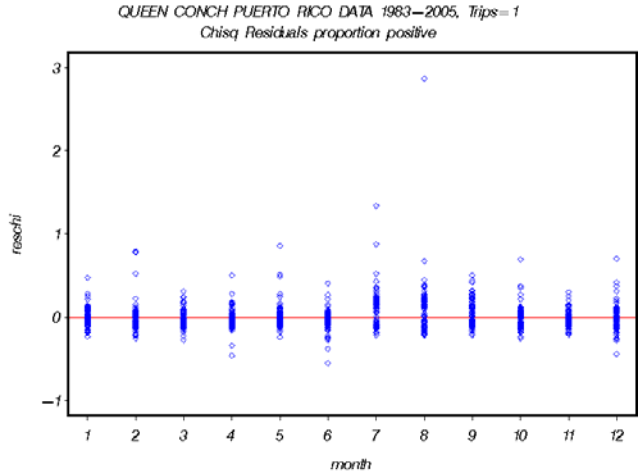



**Figure A75.** Error distribution ln(CPUE) of the final lognormal model of southwest Puerto Rico conch landings data, included trips=1, 0, and missing. The solid line in each graph is the expected normal distribution.

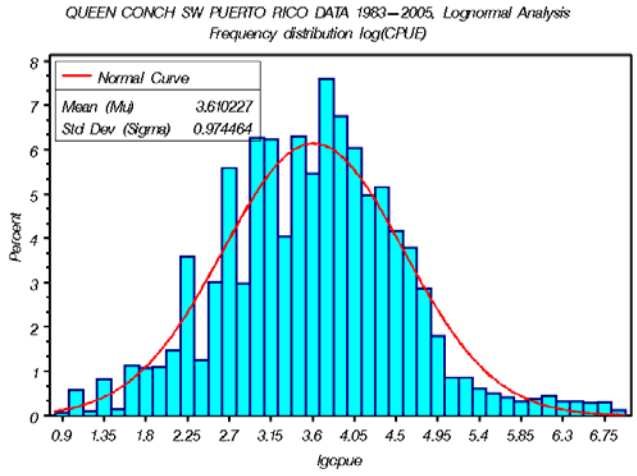


**Figure A76.** QQ plots of residuals of the final lognormal model of successful catch rates for vessels landing queen conch in southwest Puerto Rico where trips=1, 0, and missing.

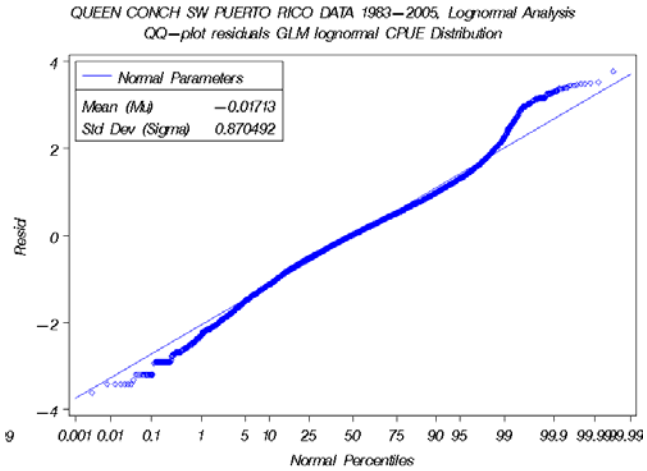



**Figure A77.** Residuals for the lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1, 0, and missing.

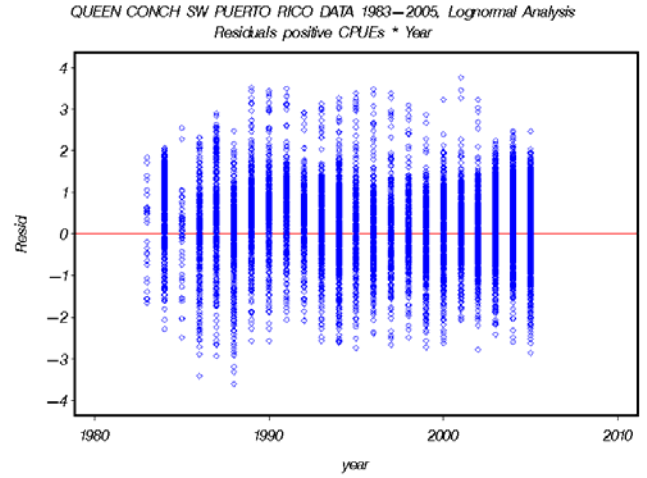



**Figure A78.** Residuals for the lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1, 0, and missing.

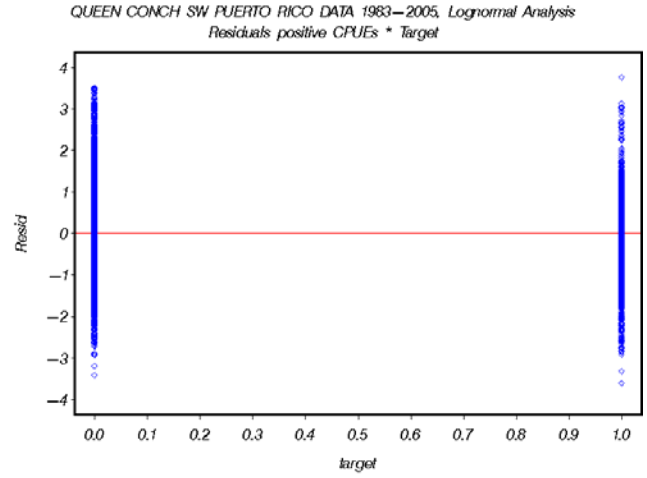


**Figure A79.** Residuals for the lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1, 0, and missing.

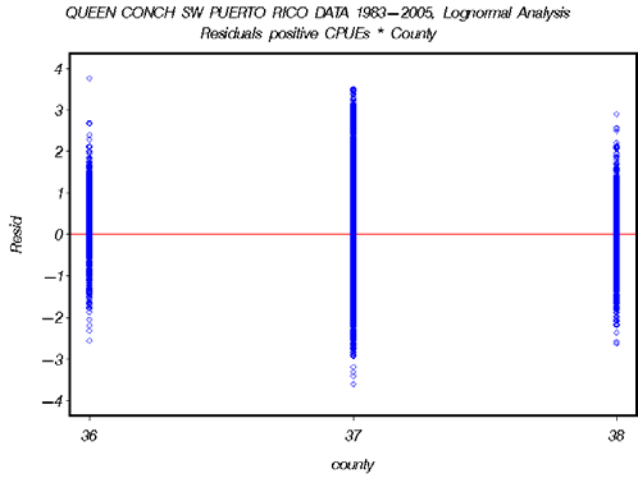



**Figure A80.** Error distribution ln(CPUE) of the final lognormal model of southwest Puerto Rico conch landings data, included trips=1. The solid line in each graph is the expected normal distribution.

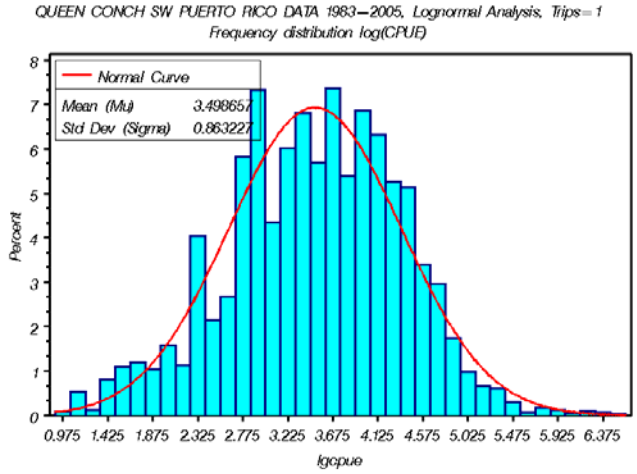



**Figure A81.** QQ plots of residuals of the final lognormal model of successful catch rates for vessels landing queen conch in southwest Puerto Rico where trips=1.

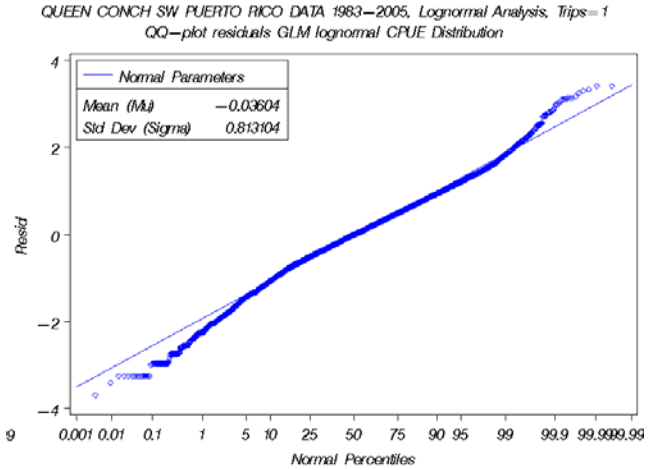


**Figure A82.** Residuals for the lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1.

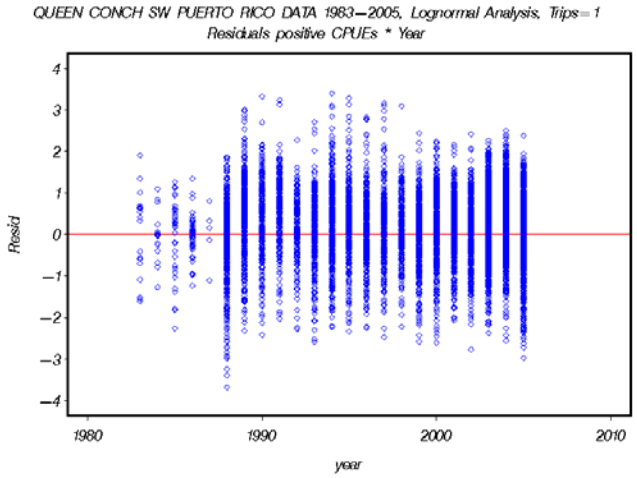



**Figure A83.** Residuals for the lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1.

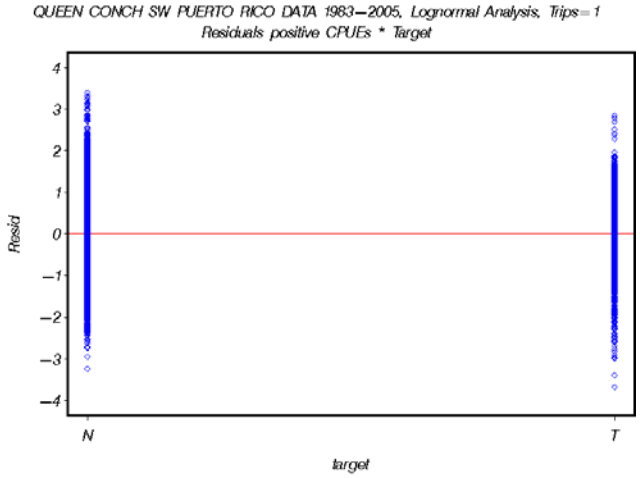



**Figure A84.** Residuals for the lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1.

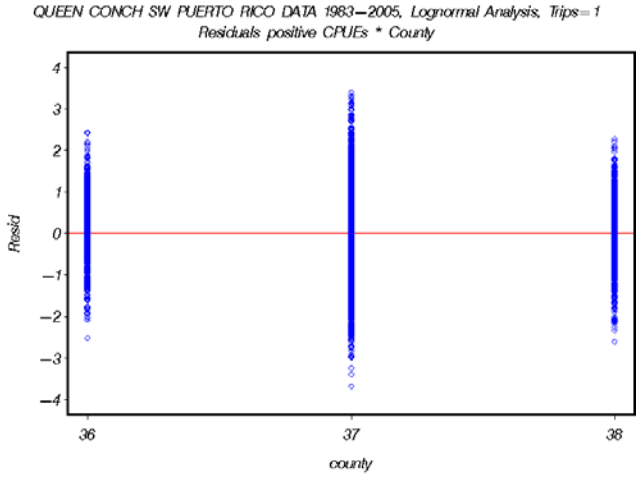


**Figure A85.** Residuals for the lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1.

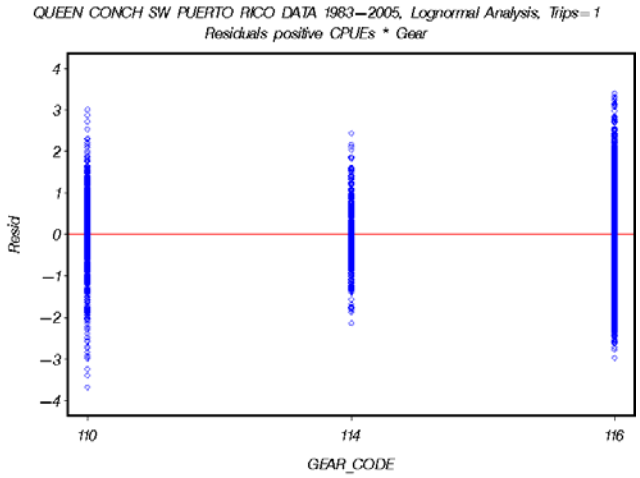



**Figure A86.** Error distribution ln(CPUE) of the final delta-lognormal model of southwest Puerto Rico conch landings data, included trips=1, 0, or missing. The solid line in each graph is the expected normal distribution.

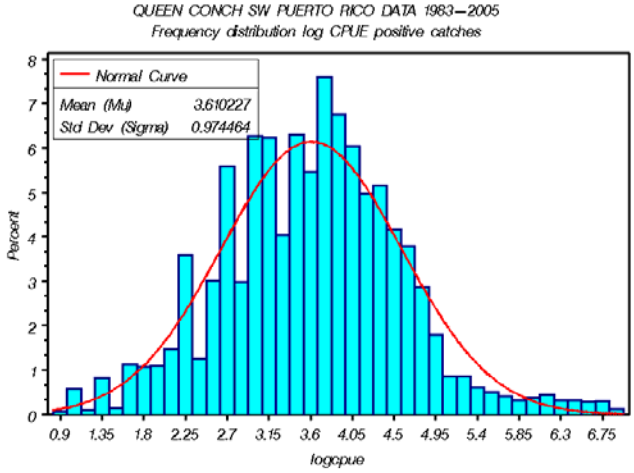



**Figure A87.** QQ plots of residuals of the final delta-lognormal model of successful catch rates for vessels landing queen conch in southwest Puerto Rico where trips=1, 0, or missing.

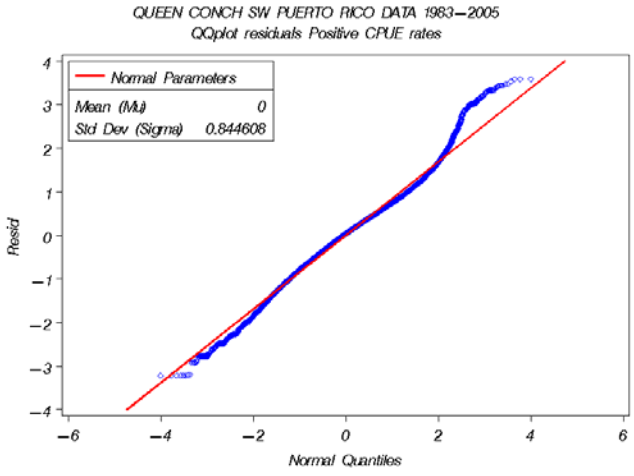


**Figure A88.** Proportion positive trips by year included in the delta-lognormal model of southwest Puerto Rico conch data where trips=1, 0, or missing.

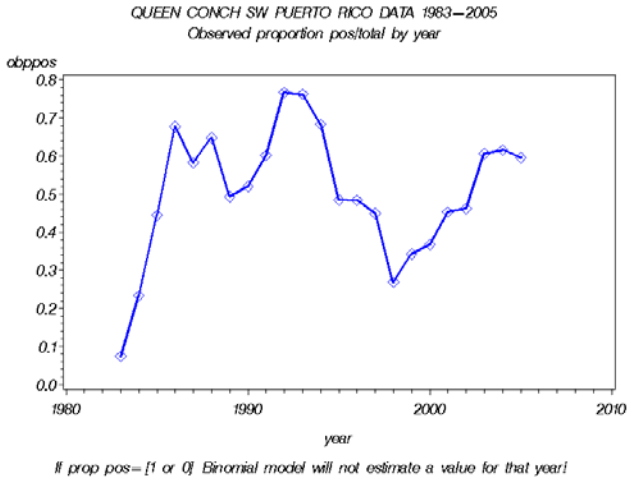



**Figure A89.** Residuals for the delta-lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1, 0, and missing.

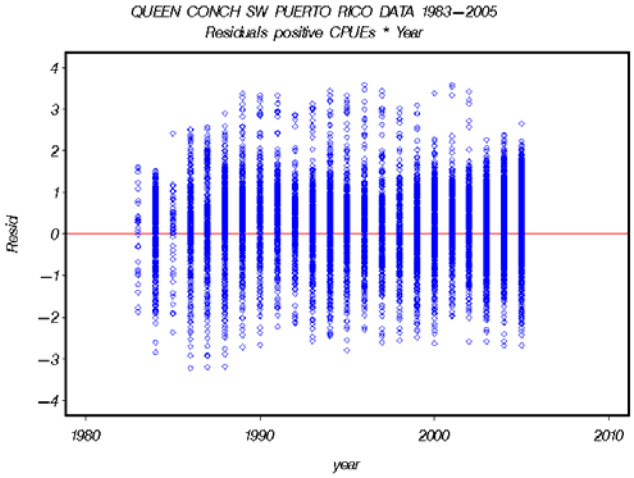



**Figure A90.** Residuals for the delta-lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1, 0, and missing.

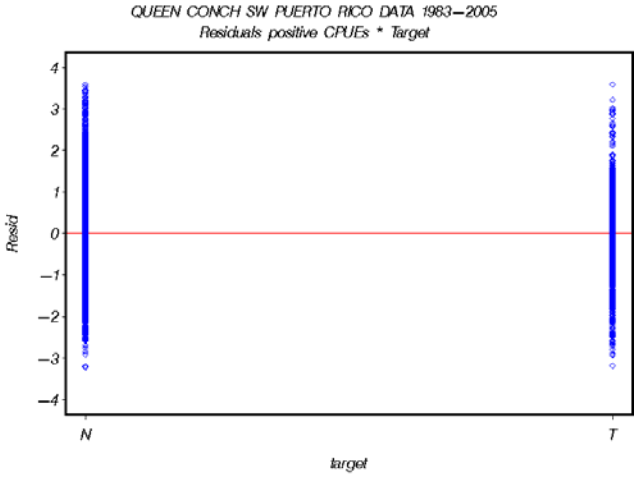


**Figure A91.** Residuals for the delta-lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1, 0, and missing.

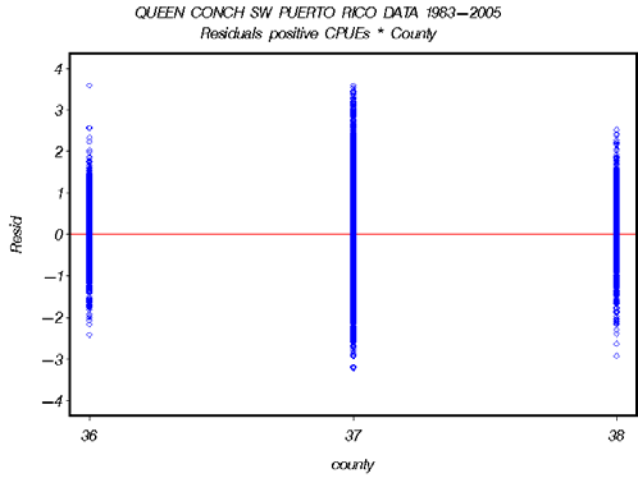



**Figure A92.** Residuals for the delta-lognormal model on successful catch rates for southwest Puerto Rico binomial analysis on proportion positive trips where trips=1, 0, and missing.

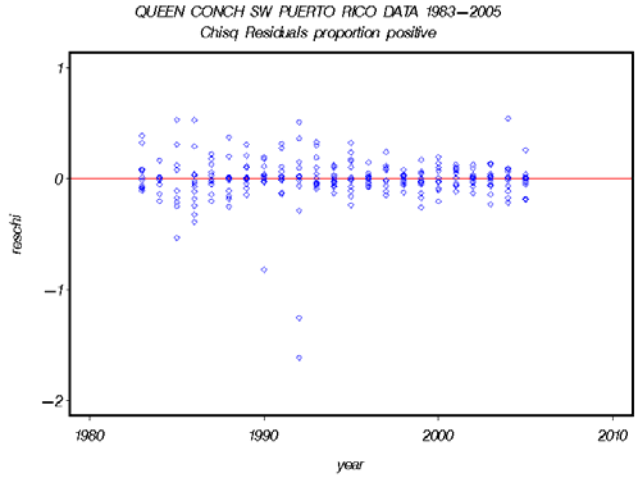



**Figure A93.** Residuals for the delta-lognormal model on successful catch rates for southwest Puerto Rico binomial analysis on proportion positive trips where trips=1, 0, and missing.

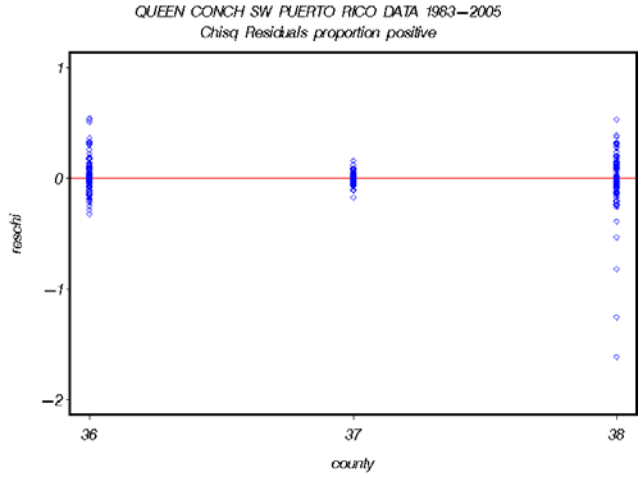


**Figure A94.** Residuals for the delta-lognormal model on successful catch rates for southwest Puerto Rico binomial analysis on proportion positive trips where trips=1, 0, and missing.

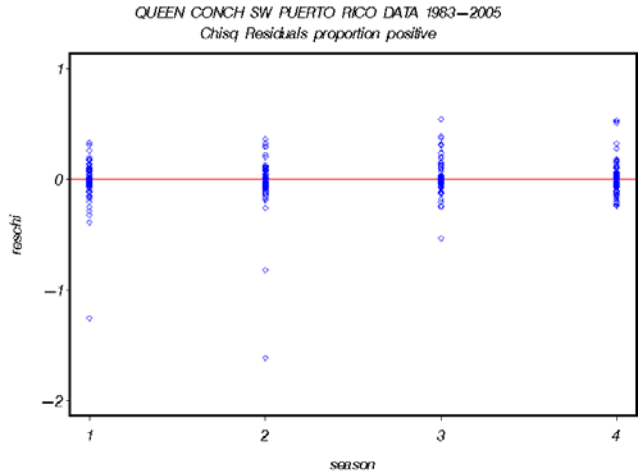



**Figure A95.** Error distribution ln(CPUE) of the final delta-lognormal model of southwest Puerto Rico conch landings data, included trips=1. The solid line in each graph is the expected normal distribution.

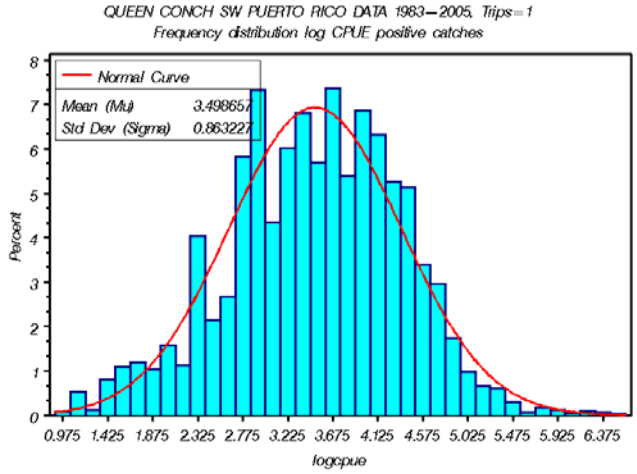



**Figure A96.** QQ plots of residuals of the final delta-lognormal model of successful catch rates for vessels landing queen conch in southwest Puerto Rico where trips=1.

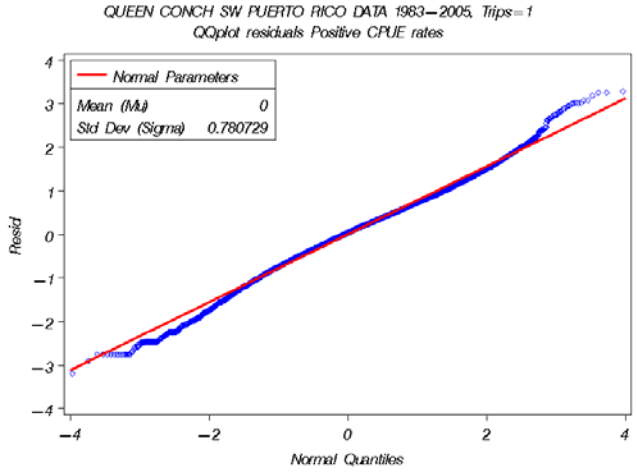


**Figure A97.** Proportion positive trips by year included in the delta-lognormal model of southwest Puerto Rico conch data where trips=1.

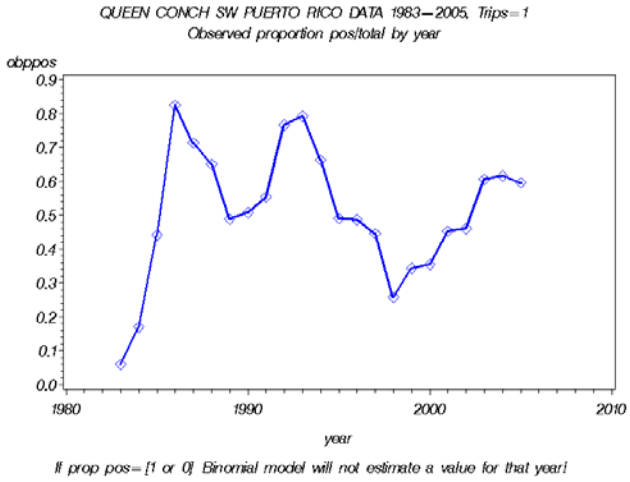



**Figure A98.** Residuals for the delta-lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1.

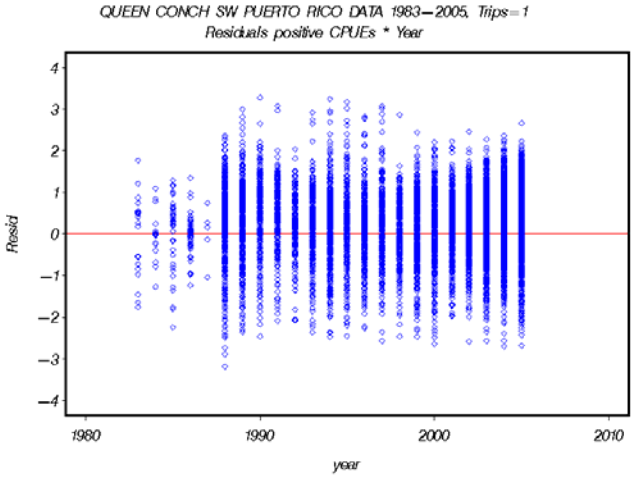



**Figure A99.** Residuals for the delta-lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1.

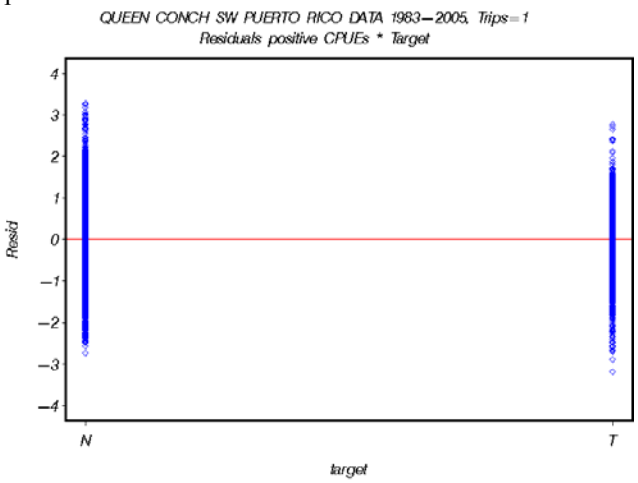


**Figure A100.** Residuals for the delta-lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1.

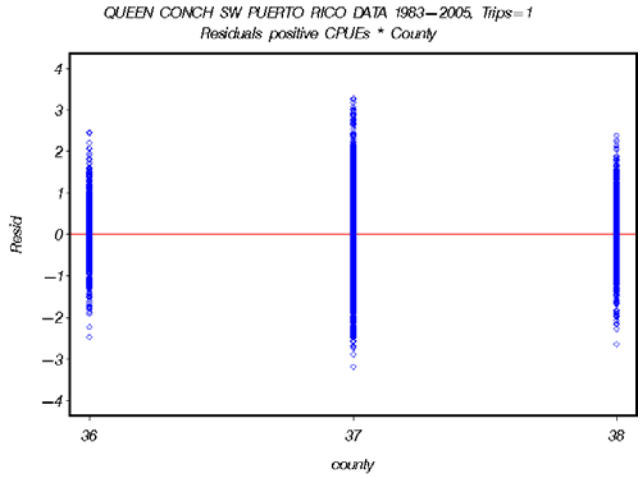



**Figure A101.** Residuals for the delta-lognormal model on successful catch rates for southwest Puerto Rico lognormal analysis on trips=1.

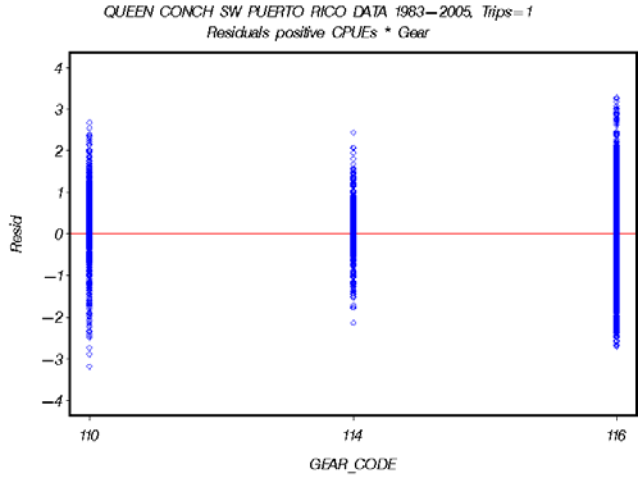



**Figure A102.** Residuals for the delta-lognormal model on successful catch rates for southwest Puerto Rico binomial analysis on proportion positive trips where trips=1.

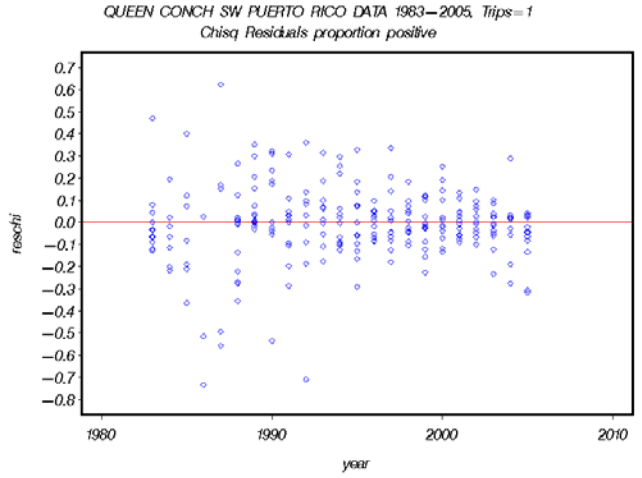


**Figure A103.** Residuals for the delta-lognormal model on successful catch rates for southwest Puerto Rico binomial analysis on proportion positive trips where trips=1.

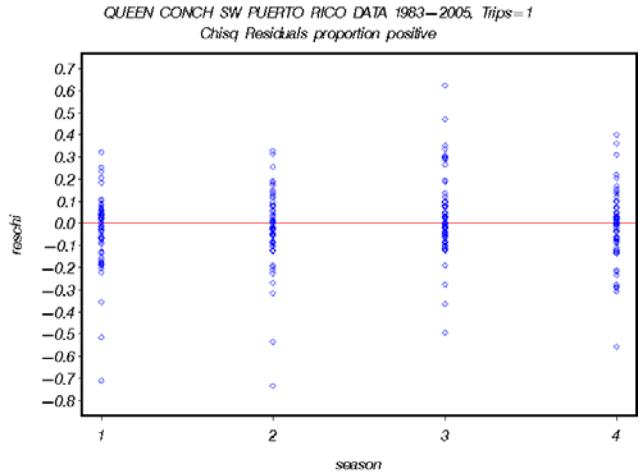



**Figure A104.** Residuals for the delta-lognormal model on successful catch rates for southwest Puerto Rico binomial analysis on proportion positive trips where trips=1.

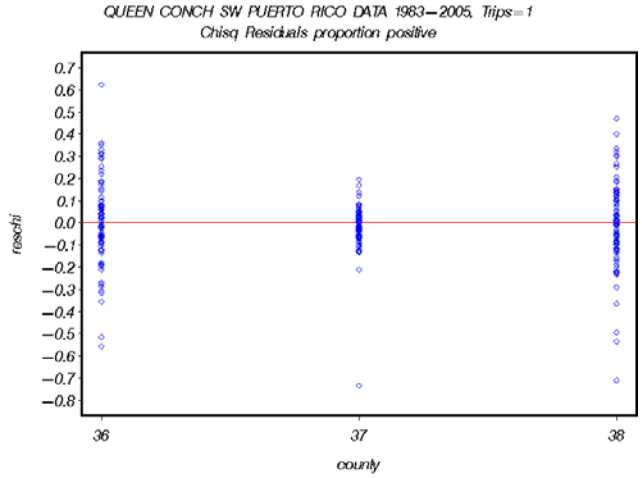



**Figure A105.** Error distribution ln(CPUE) of the final lognormal 2002 model of St. Croix conch landings data. The solid line in each graph is the expected normal distribution.

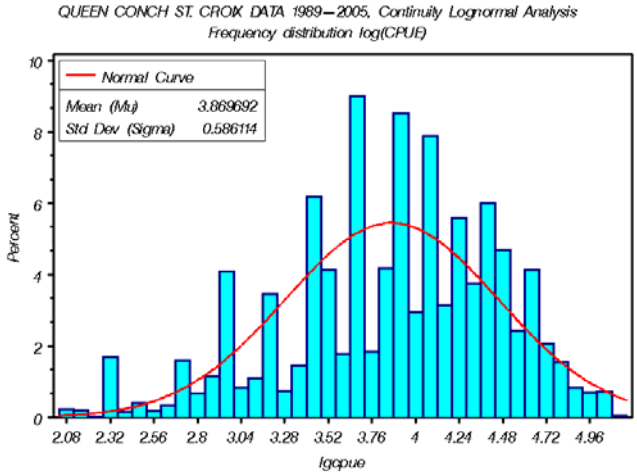


**Figure A106.** QQ plots of residuals of the final 2002 lognormal model of successful catch rates for vessels landing queen conch in St. Croix.

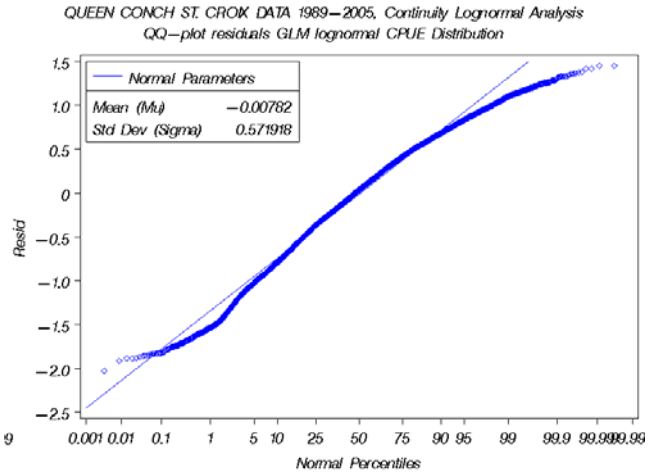



**Figure A107.** Residuals for the 2002 lognormal model on successful catch rates for St. Croix.

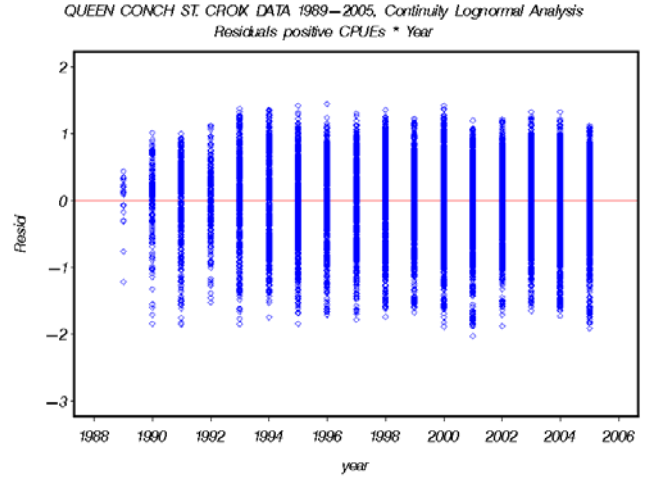



**Figure A108.** Residuals for the 2002 lognormal model on successful catch rates for St. Croix.

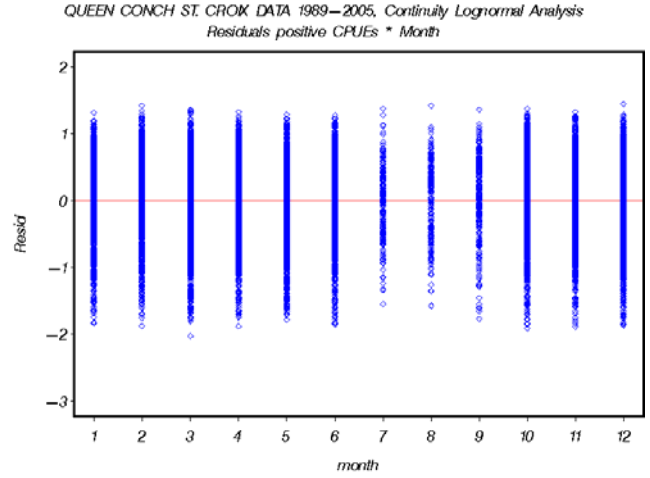


**Figure A109.** Residuals for the 2002 lognormal model on successful catch rates for St. Croix.

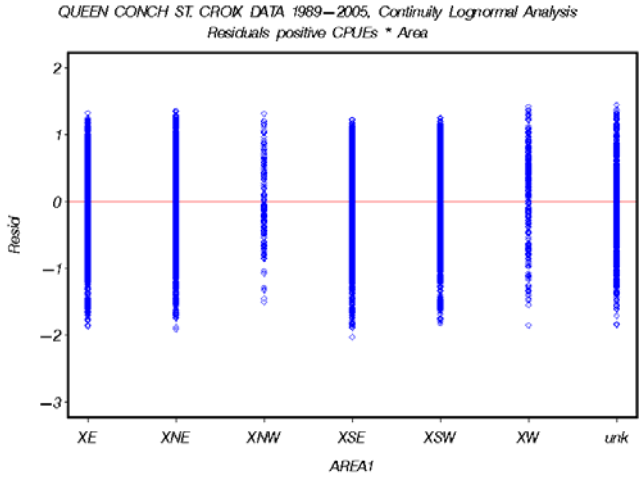



**Figure A110.** Error distribution ln(CPUE) of the final lognormal model of St. Croix conch landings data. The solid line in each graph is the expected normal distribution.

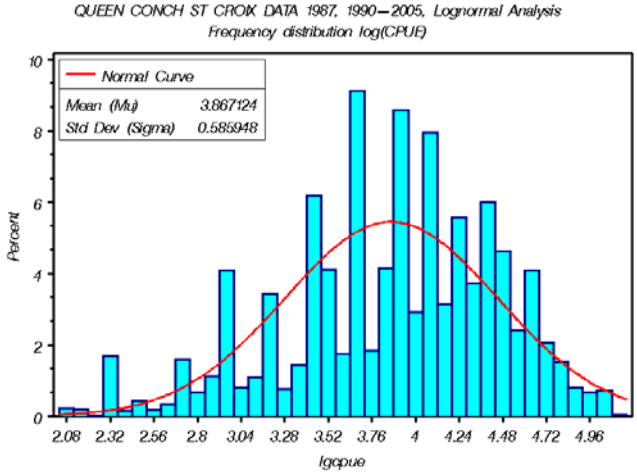



**Figure A111.** QQ plots of residuals of the final lognormal model of successful catch rates for vessels landing queen conch in St. Croix.

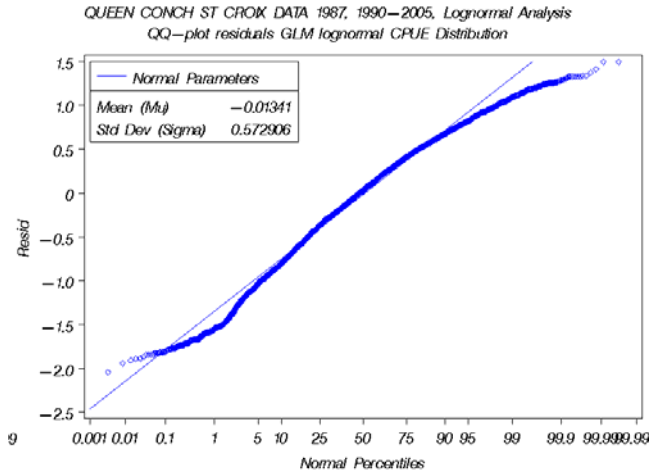


**Figure A112.** Residuals for the lognormal model on successful catch rates for St. Croix.

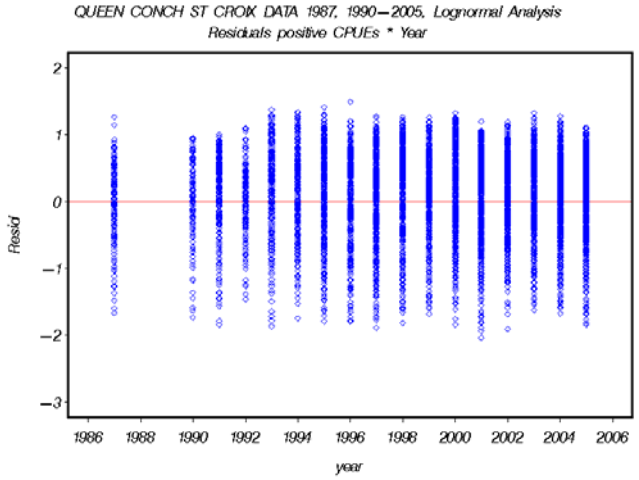



**Figure A113.** Residuals for the lognormal model on successful catch rates for St. Croix.

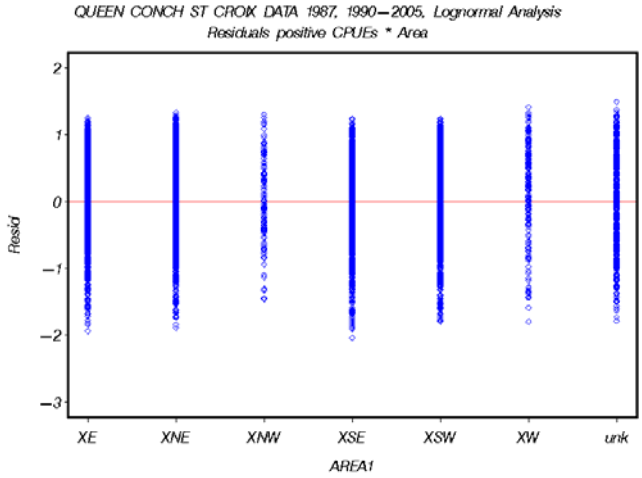



**Figure A114.** Error distribution ln(CPUE) of the final lognormal model of St. Thomas/St. John conch landings data. The solid line in each graph is the expected normal distribution.

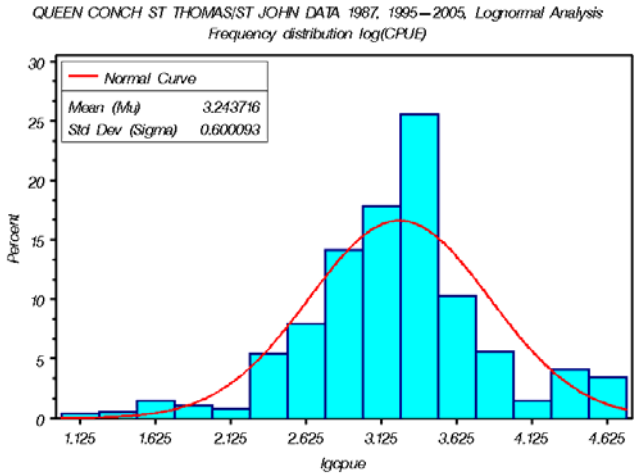


**Figure A115.** QQ plots of residuals of the final lognormal model of successful catch rates for vessels landing queen conch in St. Thomas/St. John.

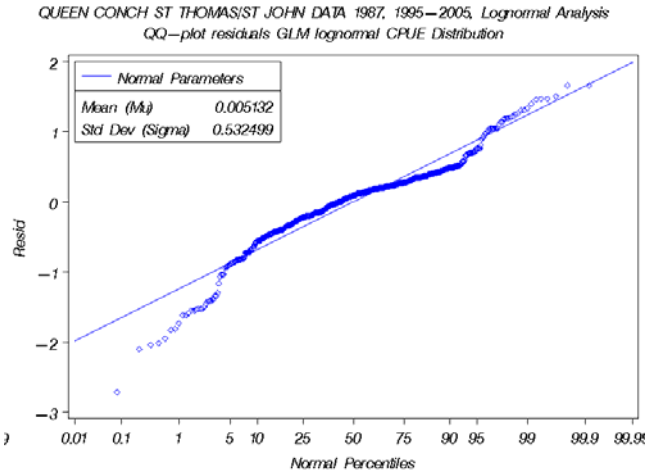



**Figure A116.** Residuals for the lognormal model on successful catch rates for St. Thomas/St. John.

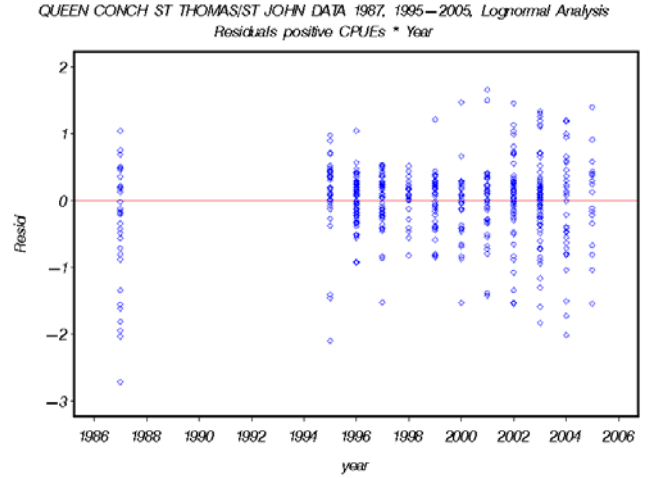



**Figure A117.** Residuals for the lognormal model on successful catch rates for St. Thomas/St. John.