Standardized indices of abundance for Smooth Dogfish, *Mustelus canis*, from the Ocean Gillnet Program conducted by the North Carolina Division of Marine Fisheries

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SEDAR 39 DATA WORKSHOP DOCUMENT

Standardized indices of abundance for Smooth Dogfish, *Mustelus canis*, from the Ocean Gillnet Program conducted by the North Carolina Division of Marine Fisheries

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Summary

This document details the smooth dogfish, *Mustelus canis*, catch from the Ocean Gillnet Program conducted by the North Carolina Division of Marine Fisheries from 2009-2013. Catch per unit effort (CPUE) in number of sharks per gillnet array (270 net yards) were examined by year. The CPUE was standardized using a two-step delta-lognormal approach that models the proportion of positive catch with a binomial error distribution separately from the positive catch, which is modeled using a lognormal distribution. The diagnostics (residual plots) for the model indicated that the standardization process did not perform well. In addition, the CPUE mirrors the proportion of positive catch sets through time and may not be indicative of the true trend in abundance.

Introduction

The North Carolina Division of Marine Fisheries uses the Ocean Gillnet Program to help maintain long-term fisheries independent surveys that will provide data on CPUE, catch composition, abundance, size, age, maturity, and mortality in the Atlantic Ocean for important recreational species. In this document, the Ocean Gillnet time series is modeled to create a standardized index of abundance for smooth dogfish.

Methods

Sampling gear and survey design

Atlantic Ocean sampling used a stratified-random sampling design based on area and water depth, resulting in three sampling areas: Topsail, Masonboro, and Brunswick. Topsail spans from a line extending southwest off New River Inlet south to a line extending southwest off Rich's Inlet, Masonboro spans from Rich's Inlet to Frying Pan Shoals, and Brunswick spans from Frying Pan Shoals to the North Carolina/South Carolina border. SAS/STAT® software procedure PLAN was used to select random sampling grids within each area (SAS Institute 2004). Sampling gear consisted of an array of gill nets (30-yard segments of 2 ½, 3, 3½, 4, 4½, 5, 5½, 6, and 6½ ISM webbing, 270 yards of gill net per sample). If adverse weather conditions or other factors prevented the primary grid in an area from being sampled, alternative grids for that area were randomly selected to increase flexibility and ensure completion of sampling requirements each month.

Nets were deployed as sink gill nets parallel or perpendicular to the shore based on the strata and common fishing techniques for each area. Gear was deployed within an hour of sunset and retrieved the following morning to keep soak times at a standard 12 hours. Twine size was based on the twine size most frequently used by local commercial fishermen in the region (#208 twine or 0.52 mm). All gill nets were constructed with a hanging ratio of 2:1. Nets were constructed with a vertical height between ten and eleven feet. With this configuration, all gill nets were floating and fished the entire water column. Each collection of fish (30-yard net) was sorted into individual species groups. All species groups were enumerated and an aggregate weight (nearest 0.01 kilogram (kg)) was obtained for most species. Individuals were measured to the nearest millimeter fork length (FL) or total length (TL) according to morphology of the species.

Data Analysis

Catch per unit effort (CPUE) in number of sharks per gill net array were used to examine the relative abundance of smooth dogfish caught during the survey. The CPUE was standardized using the Lo et al. (2002) method which models the proportion of positive sets separately from the positive catch. Factors considered as potential influences on the CPUE for these analyses were: year (2009-2013), season (January-March and October-December), and stratum (Masonboro, Brunswick, Topsail). The proportion of sets with positive CPUE values was modeled assuming a binomial distribution with a logit link function and the positive CPUE sets were modeled assuming a lognormal distribution.

Models were fit in a stepwise forward manner adding one potential factor at a time after initially running a null model with no factors included (Gonzáles-Ania et al. 2001, Carlson 2002). Each potential factor was ranked from greatest to least reduction in deviance per degree of freedom when compared to the null model. The factor resulting in the greatest reduction in deviance was then incorporated into the model providing the deviance per degree freedom was reduced by at least 1% from the less complex model. This process was continued until no additional factors met the criteria for incorporation into the final model. The factor "year" was kept in all final models to allow for calculation of indices. All models in the stepwise approach were fitted using the SAS GENMOD procedure (SAS Institute, Inc.). The final models were then run through the SAS GLIMMIX macro to allow fitting of the generalized linear mixed models using the SAS MIXED procedure (Wolfinger, SAS Institute, Inc). The standardized indices of abundance were based on the year effect least square means determined from the combined binomial and lognormal components.

Results

A total of 240 smooth dogfish were caught during 60 sets. The proportion of sets with positive catch (at least one smooth dogfish was caught) was 53%. Smooth dogfish ranged in length from 39 to 109 cm FL (Figure 2). The stepwise construction of each model and the resulting statistics are detailed in Table 1. The diagnostics (residual plots) for the model indicated that the standardization process did not perform well (Figures 3a and 3b). In addition, the CPUE mirrors the proportion of positive catch sets through time and may not be indicative of the true trend in abundance (Figure 3a). The resulting indices of abundance based on the year effect least square means, associated statistics, and nominal indices are reported in Table 2 and are plotted by year in Figure 4.

References

Carlson J.K. 2002. A fishery-independent assessment of shark stock abundance for large coastal species in the northeast Gulf of Mexico. Panama City Laboratory Contribution Series 02-08. 26pp.

González-Ania, L.V., C.A. Brown, and E. Cortés. 2001. Standardized catch rates for yellowfin tuna (*Thunnus albacares*) in the 1992-1999 Gulf of Mexico longline fishery based upon observer programs from Mexico and the United States. Col. Vol. Sci. Pap. ICCAT 52:222-237.

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

Table 1. Results of the stepwise procedure for development of the NCDMF gillnet survey catch rate model for smooth dogfish. DF is the degrees of freedom. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%
NULL	29	39.4295	1.3596		
STRATUM	27	35.6856	1.3217	2.7876	2.7876
YEAR	25	34.4076	1.3763	-1.2283	
SEASON	28	38.1252	1.3616	-0.1471	
STRATUM +					
YEAR	23	29.8037	1.2958	4.6926	1.9050

FINAL MODEL	AIC	BIC	(-2) Res Log Likelihood
STRATUM + YEAR	127.1	128.0	124.9

Type 3 Test of Fixed Effects

Significance (Pr>Chi) of Type 3	STRATUM	YEAR
test of fixed effects for each factor	0.1675	0.3639
DF	2	4
CHI SQUARE	3.57	4.32

POSITIVE CATCHES-LOGNORMAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%
NULL	18	33.1670	1.8426		
SEASON	17	30.4926	1.7937	2.6539	2.6539
YEAR	14	27.0617	1.9330	-4.9061	
STRATUM	16	32.0404	2.0025	-8.6780	
SEASON +					
YEAR	13	20.3834	1.5680	14.9029	12.2490

FINAL MODEL	AIC	BIC	(-2) Res Log Likelihood
SEASON + YEAR	52.4	53.0	50.4

Type 3 Test of Fixed Effects

Significance (Pr>Chi) of Type 3	SEASON	YEAR
test of fixed effects for each factor	0.0390	0.1681
DF	1	4
CHI SQUARE	4.26	6.45

Table 2. NCDMF gillnet survey smooth dogfish analysis number of sets (n sets), catch per nautical mile (catch), number of model observations per year (n obs), number of positive model observations per year (obs pos), proportion of positive model observations per year (obs ppos), nominal cpue as sharks per hook (obs cpue), resulting estimated cpue from the model (est cpue), the lower 95% confidence limit for the est cpue (LCL), the upper 95% confidence limit for the est cpue (UCL), and the coefficient of variation for the estimated cpue (CV).

year	n sets	catch	n obs	obs pos	obs ppos	obs cpue	est cpue	LCL	UCL	CV
2009	12	97	6	4	0.6667	16.1667	24.6109	7.4830	80.9431	0.6521
2010	12	26	6	3	0.5000	4.3333	2.0908	0.5110	8.5546	0.8016
2011	12	38	6	2	0.3333	6.3333	2.6941	0.5169	14.0426	0.9883
2012	12	63	6	5	0.8333	10.5000	7.8584	2.8741	21.4869	0.5365
2013	12	16	6	5	0.8333	2.6667	4.0027	1.4639	10.9445	0.5365

Figure 1. Fork lengths (cm) of smooth dogfish caught during the NCDMF gillnet survey.

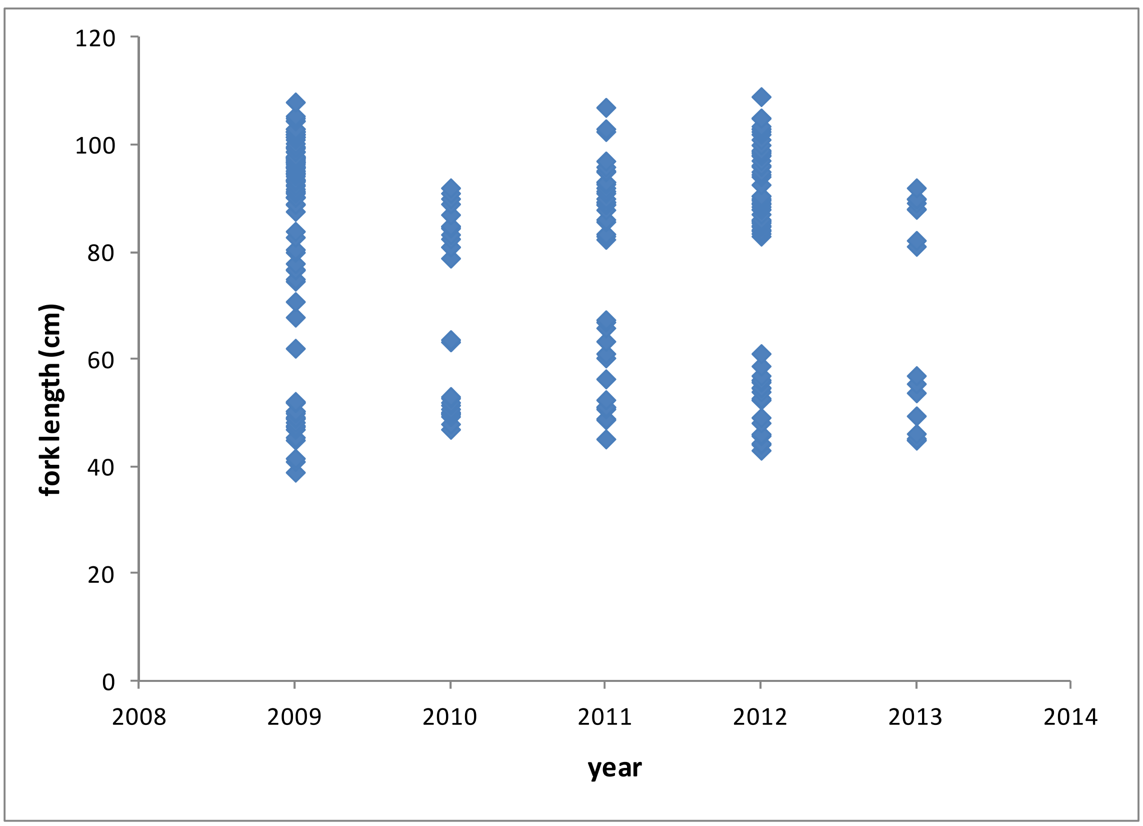
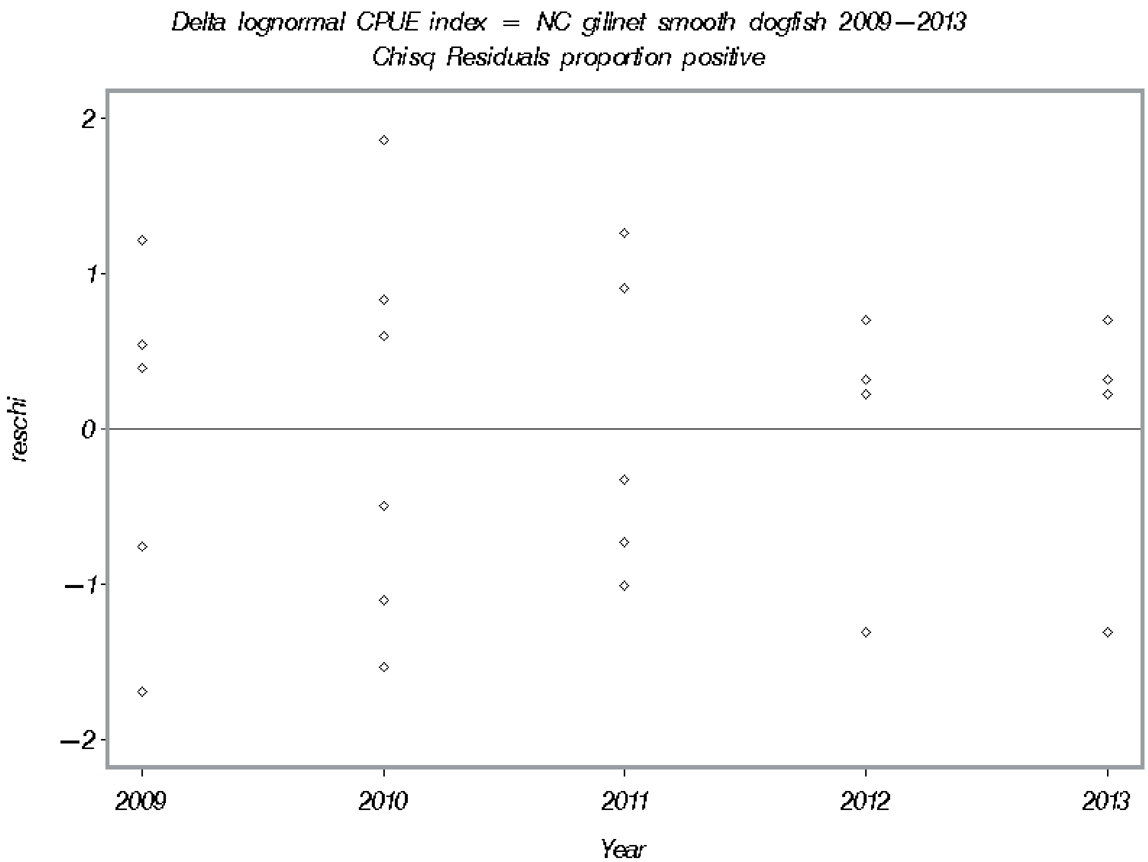


Figure 3a. NCDMF gillnet survey smooth dogfish model diagnostic plots for the binomial component.



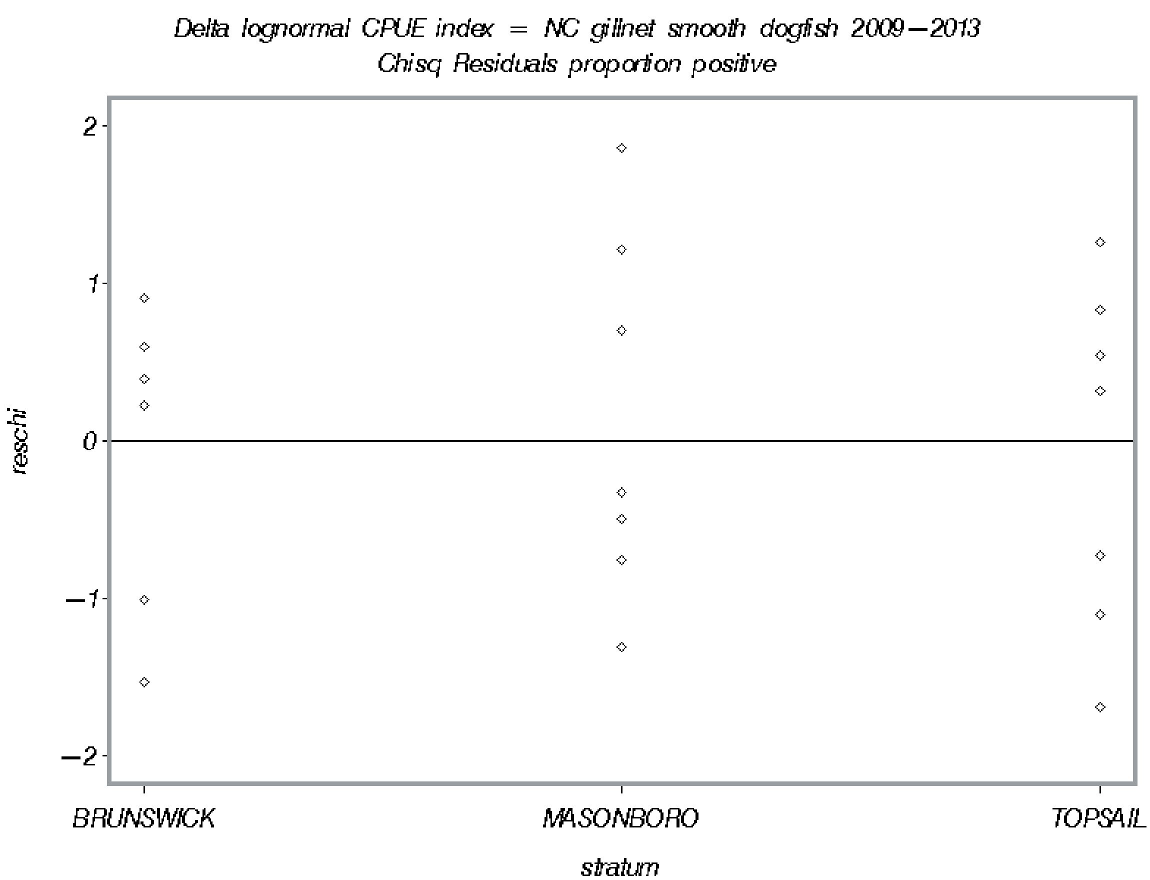


Figure 3a continued. NCDMF gillnet survey smooth dogfish model diagnostic plots for the binomial component.

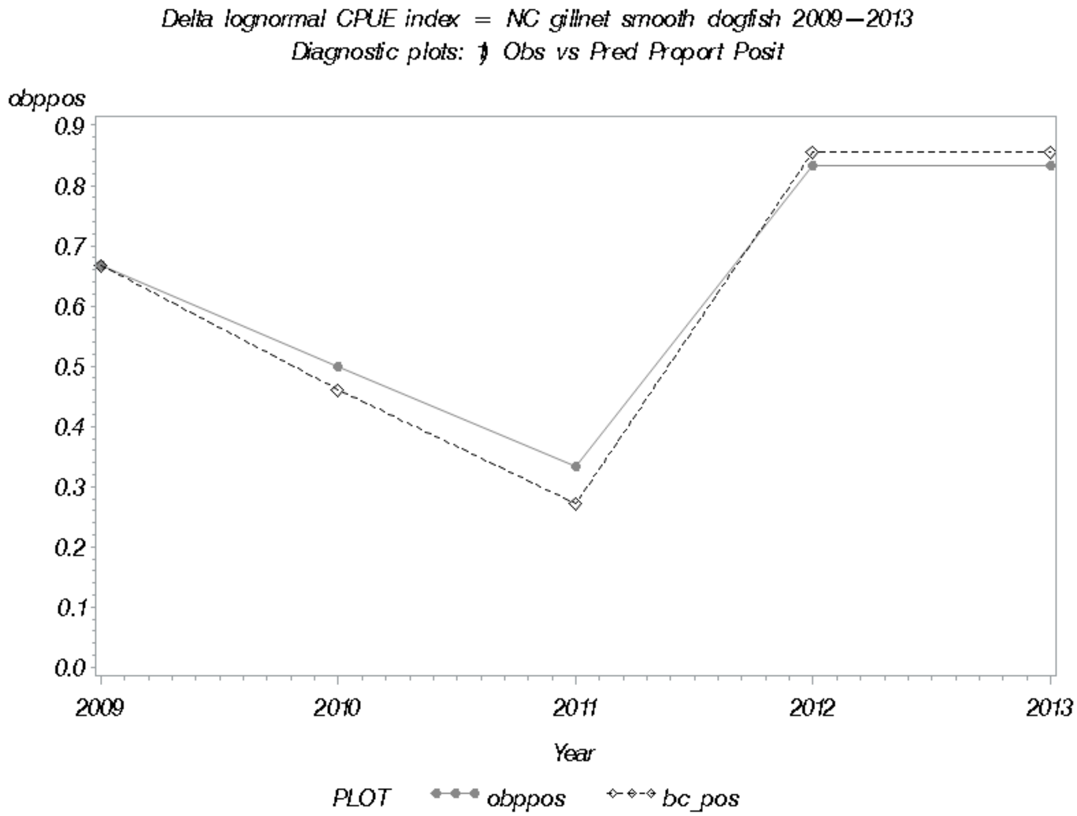


Figure 3b. NCDMF gillnet survey smooth dogfish model diagnostic plots for lognormal component.

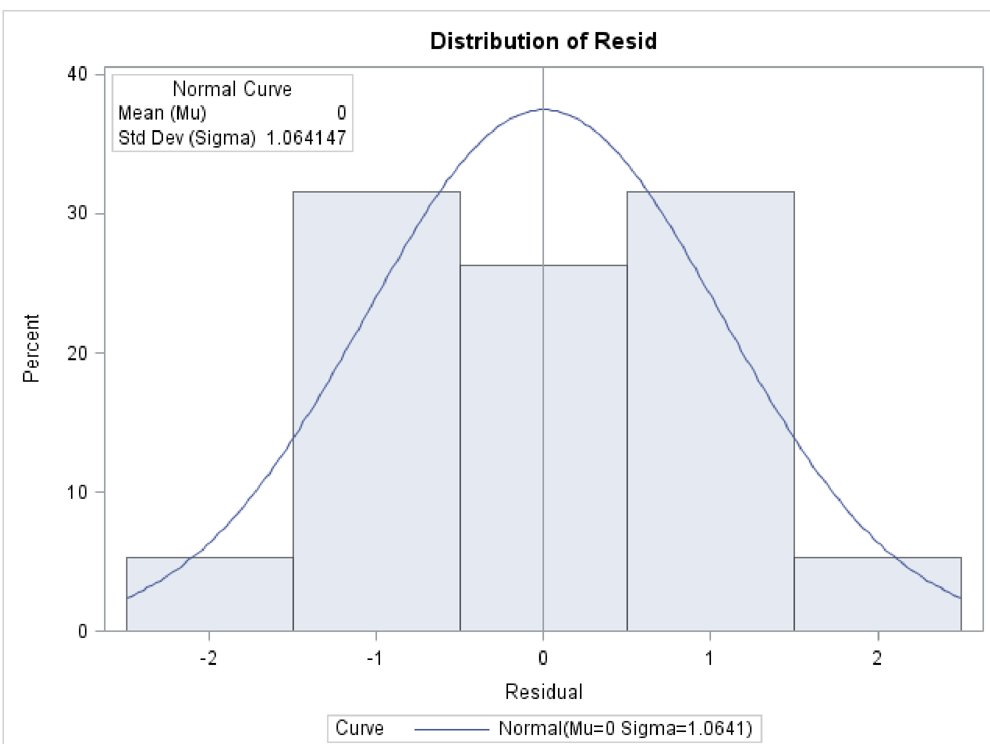
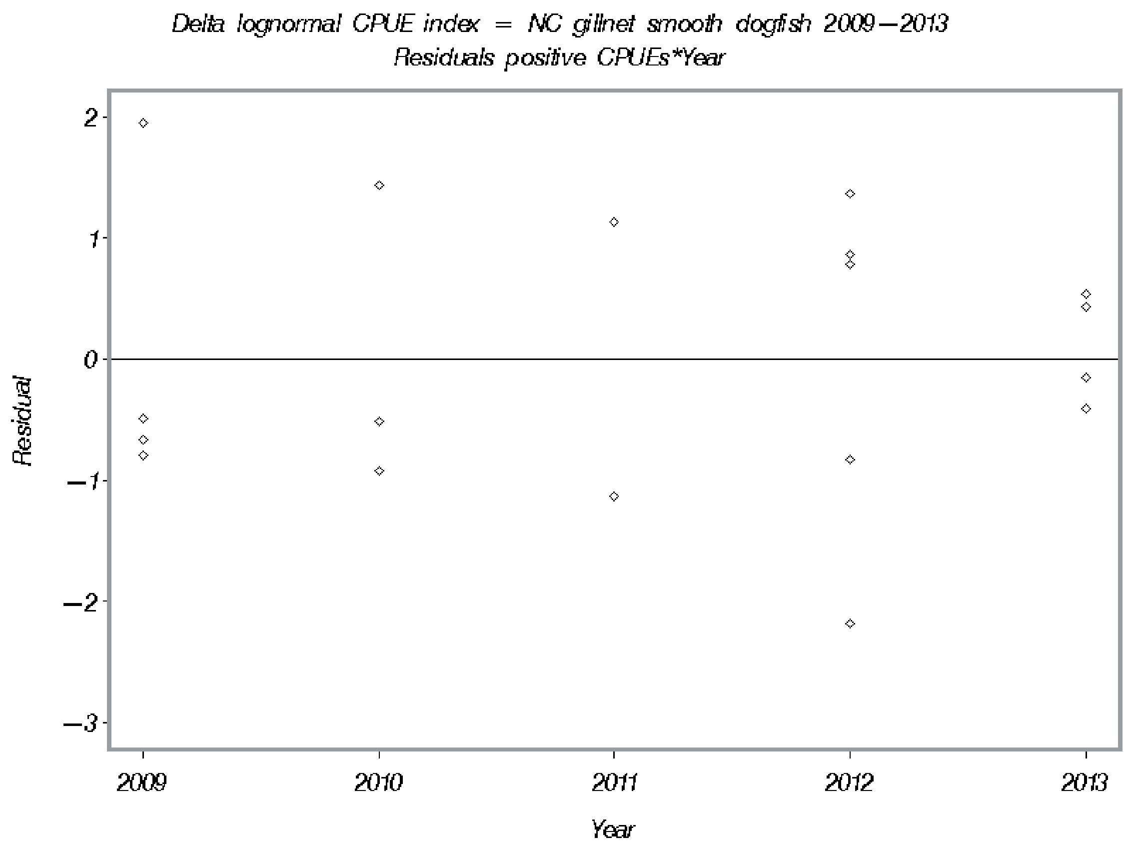


Figure 3b continued. NCDMF gillnet survey smooth dogfish model diagnostic plots for lognormal component.



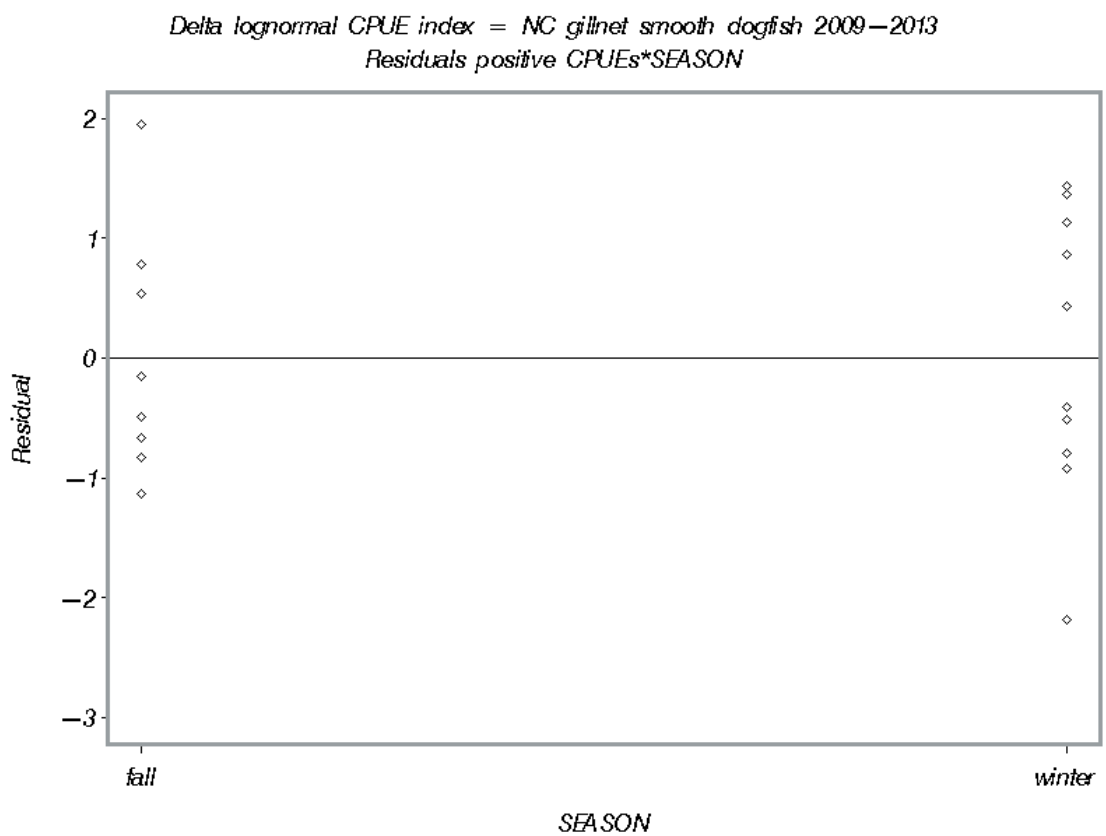


Figure 3b continued. NCDMF gillnet survey smooth dogfish model diagnostic plots for lognormal component.

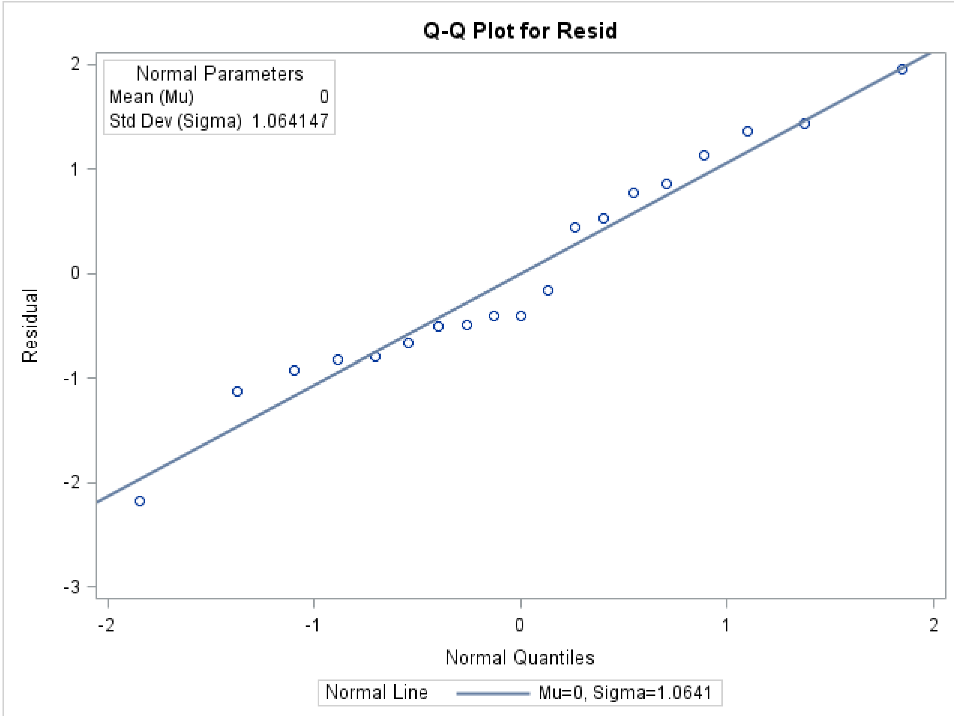


Figure 4. NCDMF gillnet survey smooth dogfish nominal (obcpue) and estimated (estcpue) indices with 95% confidence limits (LCL0, UCL0).