Standardized indices of abundance for Smooth Dogfish, *Mustelus canis*, from the South Carolina Department of Natural Resources red drum longline survey

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SEDAR 39 DATA WORKSHOP DOCUMENT

Standardized indices of abundance for smooth dogfish, *Mustelus canis* caught during the South Carolina Department of Natural Resources red drum longline survey

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Summary

This document details smooth dogfish, *Mustelus canis*, catches from the South Carolina Department of Natural Resources (SCDNR) adult red drum longline survey conducted in South Carolina's estuarine and nearshore waters from 1984-2006. Catch per unit effort (CPUE) in number of sharks per hook hour were used to examine smooth dogfish relative abundance by year. The SCDNR red drum time series used for these analyses ends in 2006 due to a change in gear and sampling design. 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 majority of catches occurred during late November, December, and January (88%), which were not consistently sampled across years. Only 9% of the total sets had smooth dogfish catch. The standardized relative abundance for smooth dogfish shows an overall slight increasing trend throughout the time series with peaks in abundance in 1998 and 2001.

Introduction

The South Carolina Department of Natural Resources (SCDNR) samples the shark bycatch from a long-term longline survey designed to monitor adult red drum *Sciaenops ocellatus* in the coastal waters of South Carolina. This survey was modified from a fixed station to a random stratified station survey in 2007 in response to the needs of stock assessment biologists and to increase coverage along the coast. In addition, the mainline and number of hooks used for the current SCDNR red drum longline survey were reduced to one third of the original mainline length and hook number per set. Smooth dogfish, *Mustelus canis*, are rarely encountered during the current survey. In this document the SCDNR red drum longline time series of smooth dogfish bycatch from 1994 to 2006 is modeled to create a standardized index of abundance for the species.

Methods

Sampling gear and survey design

The locations of the 1994 to 2006 SCDNR red drum fixed estuarine and nearshore sampling areas are shown in Figure 1. SCDNR red drum longline gear consisted of a 272 kg test monofilament mainline that was 1829 m in length and had 30.5 m buoy lines attached at each end. The mainline was equipped with stop sleeves at 30.5 m intervals to prevent gangions from sliding together when a large fish was captured. The gangions consisted of a 0.5 m, 91 kg test monofilament leader, size 120 stainless steel longline snap, 4/0 swivel and either a 14/0 or 15/0 circle hook. A set consisted of 120 hooks and soak times were limited to 45 minutes unless conditions or events dictated otherwise. Sampling was conducted during all months of the year, but the late fall and winter months were not sampled consistently. Station location, water temperature, salinity, and time of day were recorded for each set. The sex, fork length, and total length of all sharks were recorded.

Data Analysis

Catch per unit effort (CPUE) in number of sharks per hook hour were used to examine smooth dogfish relative abundance. The CPUEs were 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 CPUE were: year, month, depth, salinity, temperature, area (each of the estuaries sampled), and set number. The proportion of sets with positive catch values was modeled assuming a binomial distribution with a logit link function and the positive catch 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 provided 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, regardless of its significance, 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 986 smooth dogfish were caught during 1509 longline sets from 1994 to 2006. Smooth dogfish ranged in length from 48 to 119 cm FL (Figure 2). The proportion of sets with positive catch (at least one smooth dogfish caught) was 9%. There were no smooth dogfish caught in 1994 and 2005. The majority of catches occurred during late November, December, and January (88%), which were not consistently sampled across years. The stepwise construction of each model and the resulting statistics for the mixed models are detailed in Table 1. Model diagnostic plots reveal that the model fit is acceptable (Figures 3a and 3b). 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. The model could not produce an index value for 1995. The standardized relative abundance for smooth dogfish shows an overall slight increasing trend throughout the time series with peaks in abundance in 1998 and 2001.

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.

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Table 1. Results of the stepwise procedure for development of the SCDNR red drum longline (1994-2006) catch rate model for smooth dogfish. %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. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%
null	440	425.5556	0.9672		
month	430	204.7205	0.4761	50.7754	50.7754
year	432	369.9705	0.8564	11.4557	
depth	439	383.0185	0.8725	9.7911	
sal	437	403.9356	0.9243	4.4355	
temp	438	406.8612	0.9289	3.9599	
area	436	406.3569	0.932	3.6394	
set	434	410.8604	0.9467	2.1195	
month +					
year	422	181.2039	0.4294	55.6038	4.8284
depth	429	198.1710	0.4619	52.2436	1.4682
temp	428	194.1401	0.4536	53.1017	2.3263
set	424	193.5075	0.4564	52.8122	2.0368
area	426	197.6217	0.4639	52.0368	1.2614
sal	427	202.7782	0.4749	50.8995	0.1241
month + year +					
temp	420	169.5295	0.4036	58.2713	2.6675
set	416	170.9619	0.4110	57.5062	1.9024
depth	421	173.5685	0.4123	57.3718	1.7680
area	418	180.8246	0.4326	55.2730	-0.3309
month + year + temp +					
depth	419	160.4609	0.3830	60.4012	2.1299
set	414	158.6365	0.3832	60.3805	2.1092
month + year + temp + depth +					
set	413	149.9499	0.3631	62.4586	7.1857

FINAL MODEL: month + year + temp + depth + set

AIC 2059.5 **BIC** 2153.8 **(-2) Res LL** 2176.9

Type 3 Test of Fixed Effects

	month	year	temp	depth	set
Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	<.0001	<.0001	0.0003	<.0001	0.1563
DF	7	9	2	1	5
CHI SQUARE	84.2	45.84	16.40	17.24	8.00

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%
null	89	128.5919	1.4449		
year	82	79.2244	0.9662	33.1303	33.1303
set	84	112.9739	1.3449	6.9209	
month	83	116.4384	1.4029	2.9068	
depth	88	124.9909	1.4204	1.6956	
area	88	126.5158	1.4377	0.4983	
sal	88	128.2571	1.4575	-0.8720	
temp	87	128.1311	1.4728	-1.9309	
year +					
month	76	61.5305	0.8096	43.9684	10.8381
set	77	66.0626	0.8580	40.6187	7.4884
depth	81	77.0178	0.9508	34.1961	1.0658
year + month +					
set	71	51.5106	0.7255	49.7889	5.8205
depth	75	58.8974	0.7853	45.6502	1.6818
year + month + set					
depth	70	50.0308	0.7147	50.5364	0.7475

FINAL MODEL: year + month + set

AIC 327.5 **BIC** 330.1 **(-2) Res LL** 325.5

Type 3 Test of Fixed Effects

	year	month	set
Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	<.0001	0.0188	0.4084
DF	10	7	5
CHI SQUARE	58.25	16.79	5.11

Table 2. SCDNR red drum longline (1994-2006) smooth dogfish analysis 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 hour (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 obs	obs pos	obs ppos	obs cpue	est cpue	LCL	UCL	CV
1994	25	0	0	0	.	.	.	.
1995	34	1	0.0294	0.0003	.	.	.	.
1996	98	1	0.0102	0.0001	0.0002	0.0000	0.0015	1.5604
1997	85	8	0.0941	0.0026	0.0076	0.0025	0.0229	0.5959
1998	115	30	0.2609	0.0391	0.0585	0.0317	0.1082	0.3147
1999	92	19	0.2065	0.0142	0.0132	0.0060	0.0288	0.4057
2000	108	4	0.0370	0.0009	0.0035	0.0009	0.0148	0.8148
2001	89	19	0.2135	0.0818	0.1919	0.1009	0.3651	0.3301
2002	105	11	0.1038	0.0069	0.0273	0.0114	0.0656	0.4598
2003	149	9	0.0604	0.0050	0.0119	0.0036	0.0391	0.6511
2004	98	16	0.1633	0.0112	0.0643	0.0322	0.1283	0.3565
2005	49	0	0	0	.	.	.	.
2006	93	6	0.0638	0.0099	0.0352	0.0099	0.1254	0.7049

Figure 1. SCDNR red drum longline fixed nearshore and estuarine sampling stations

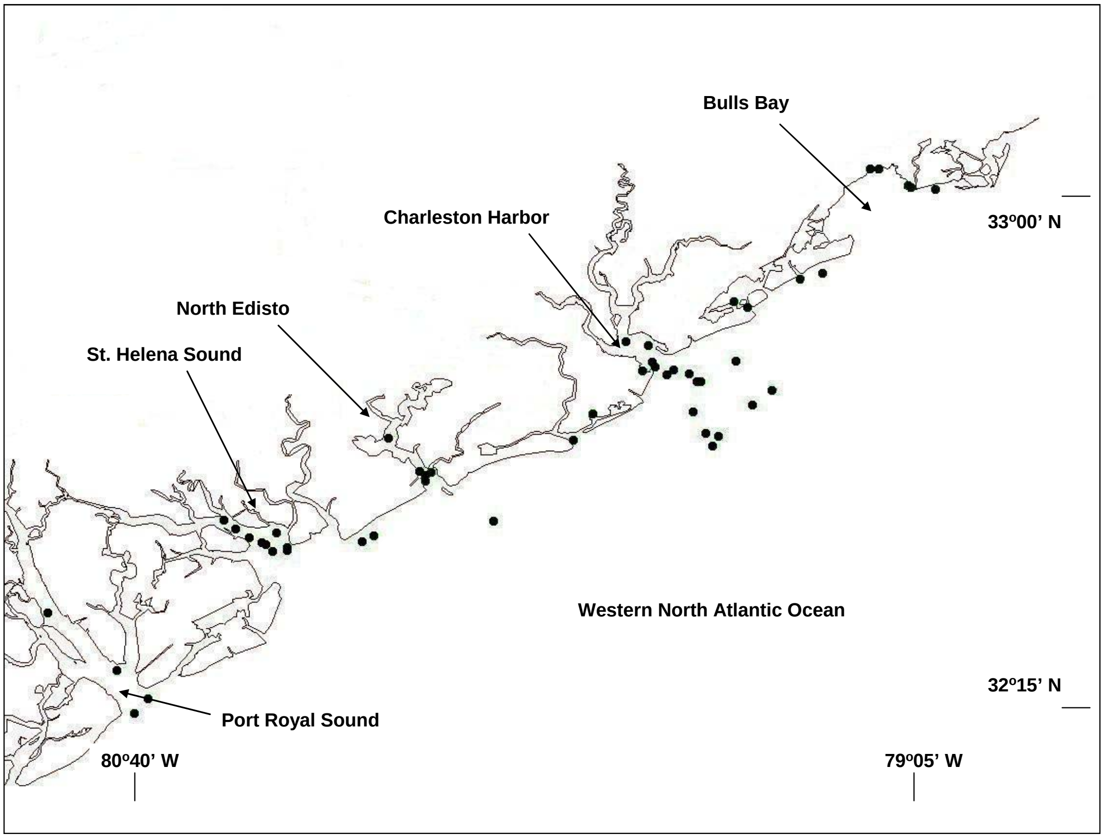


Figure 2. Fork lengths (cm) of smooth dogfish caught during the SCDNR red drum longline survey from 1994-2006.

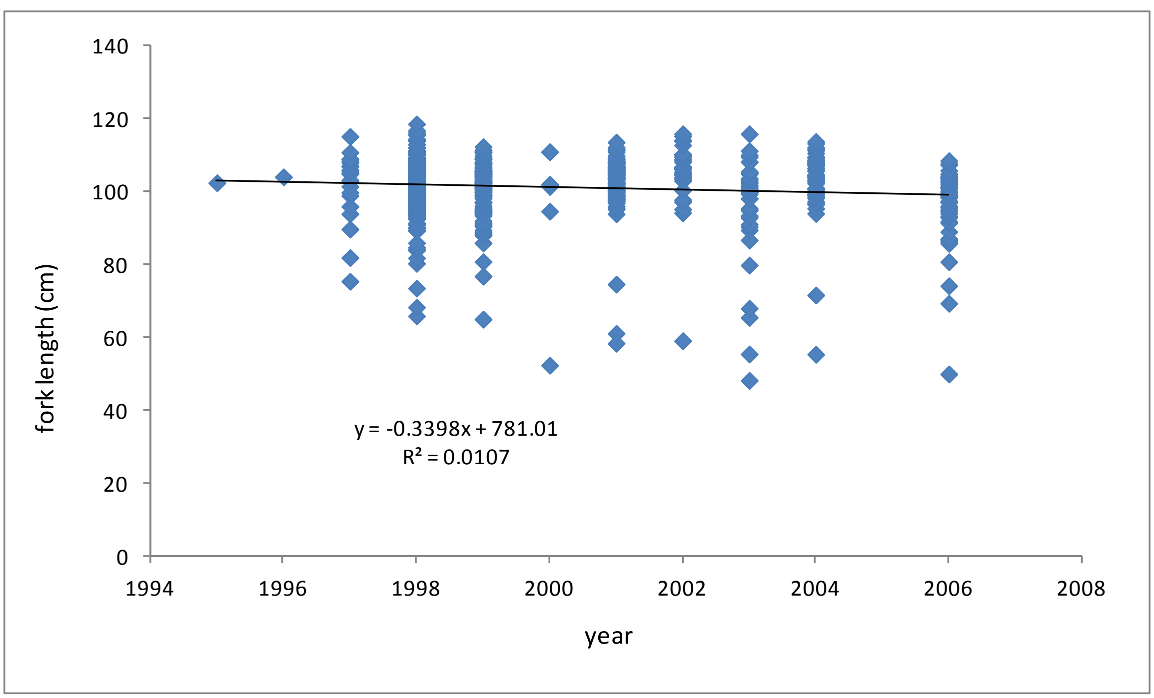
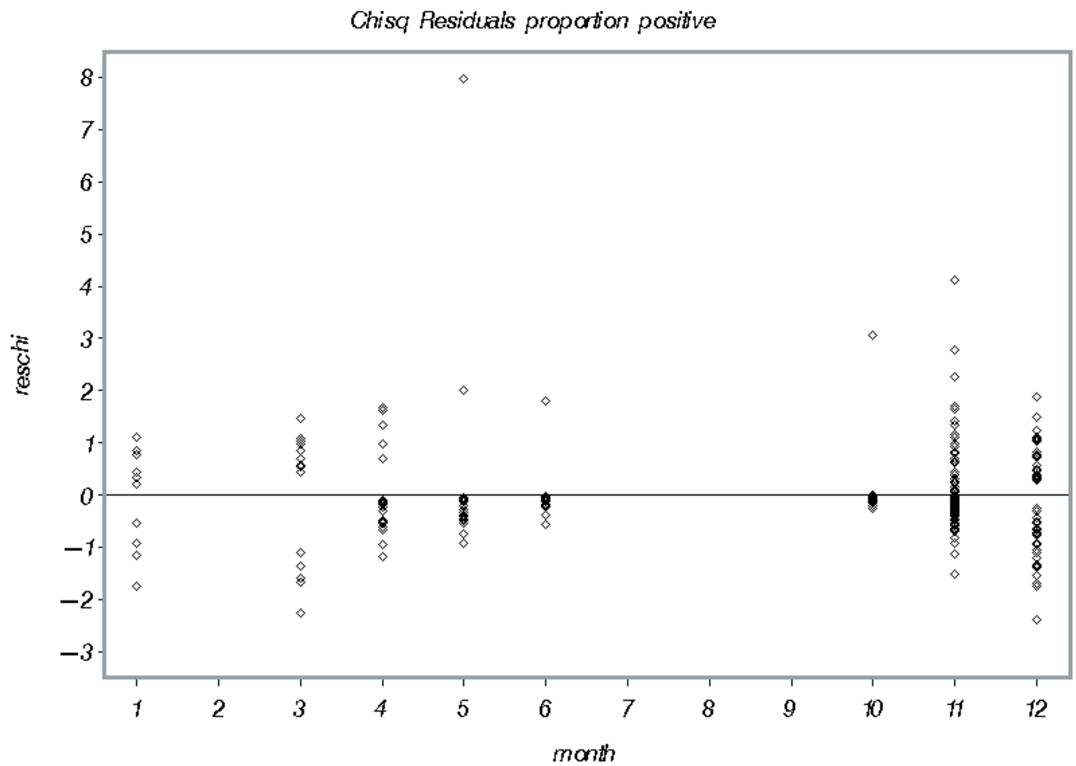


Figure 3a. Diagnostic plots for the binomial component.



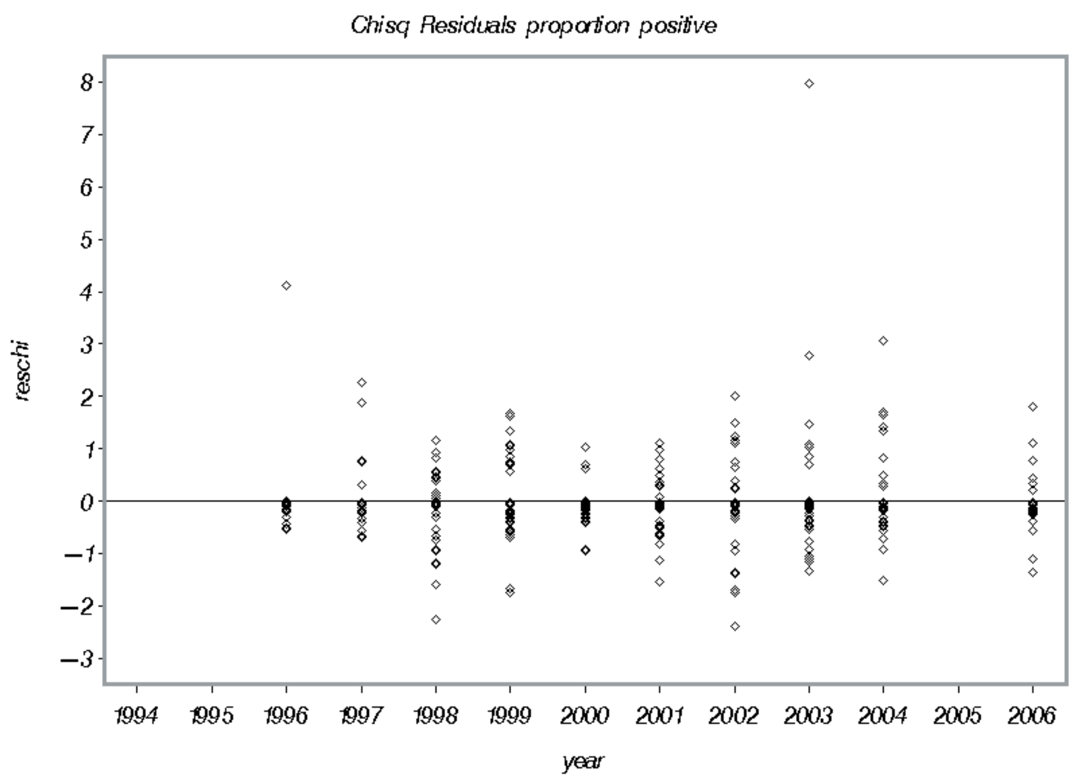
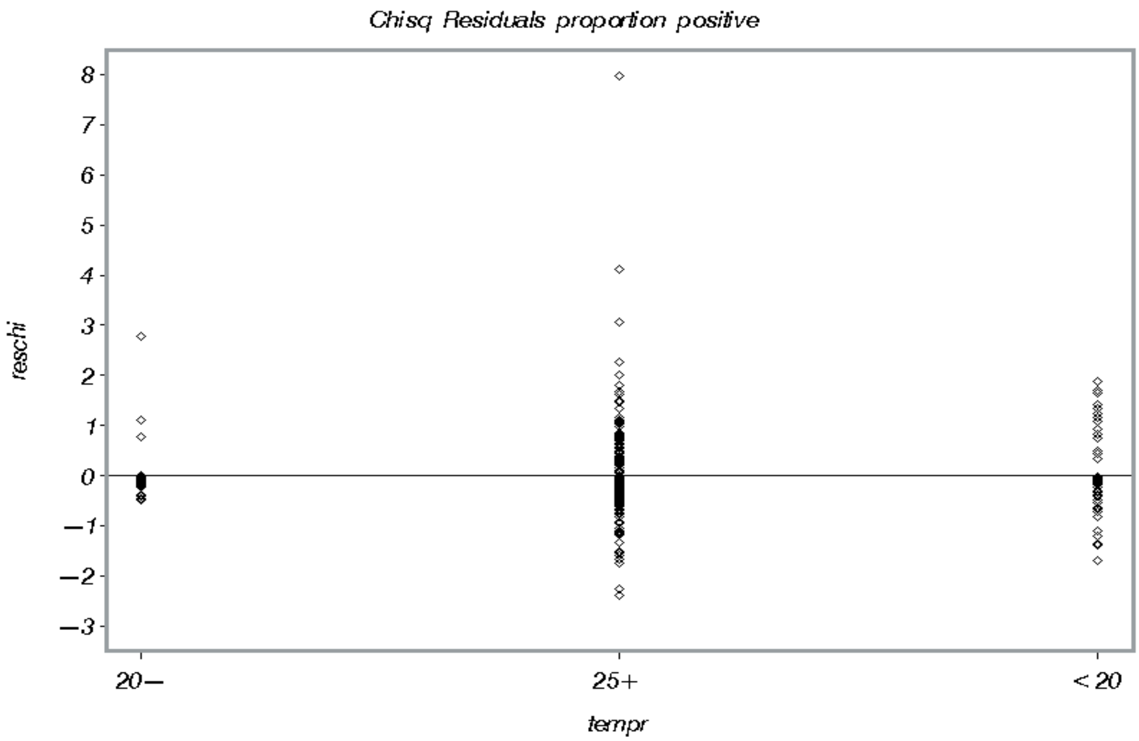


Figure 3a continued. Diagnostic plots for the binomial component.



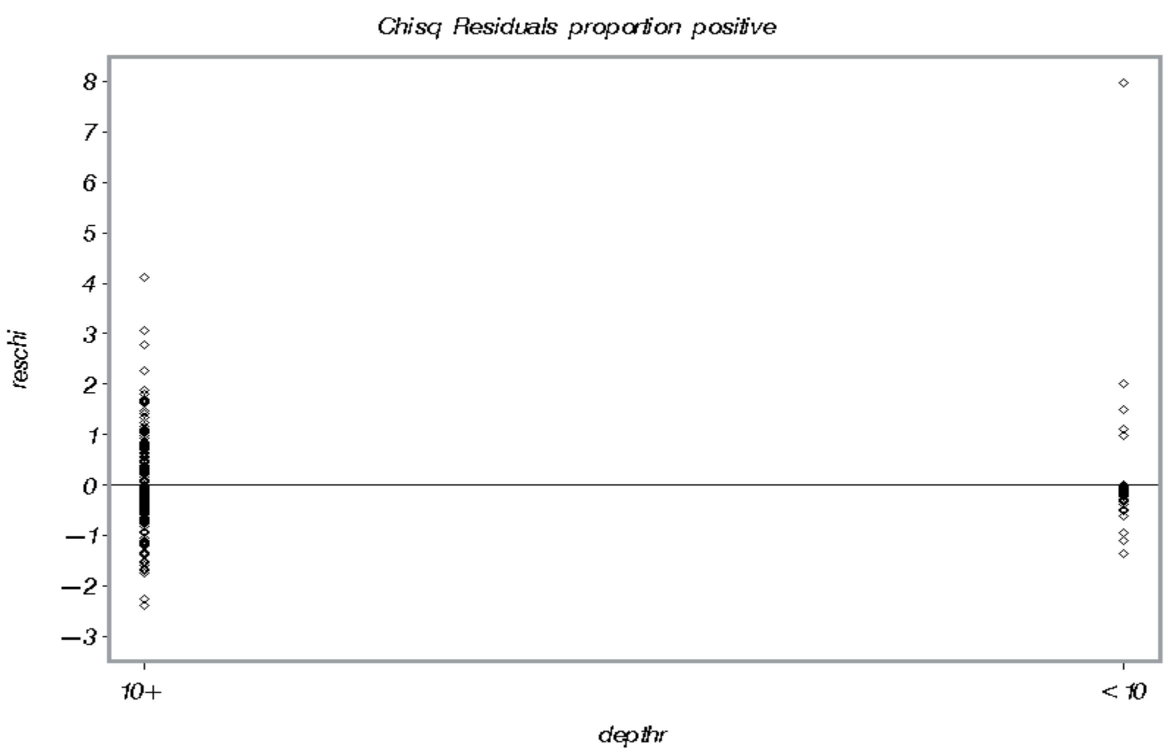
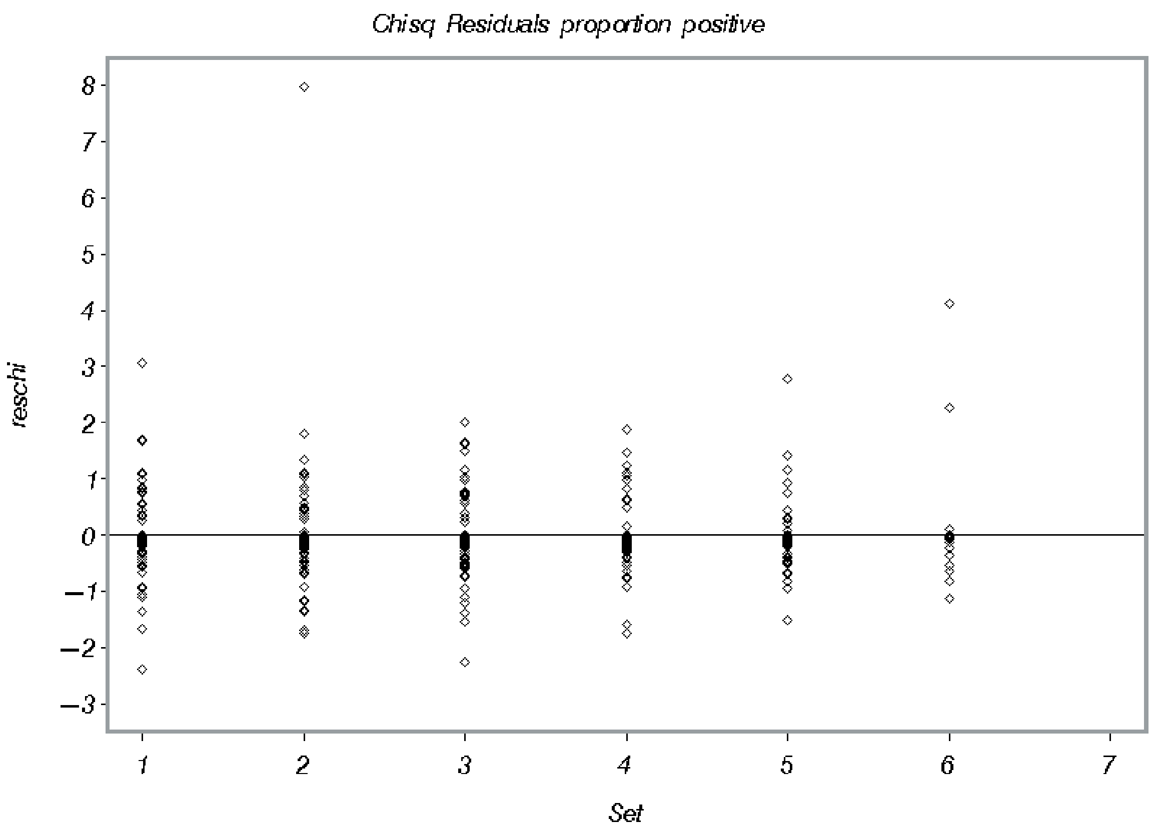


Figure 3a continued. Diagnostic plots for the binomial component.



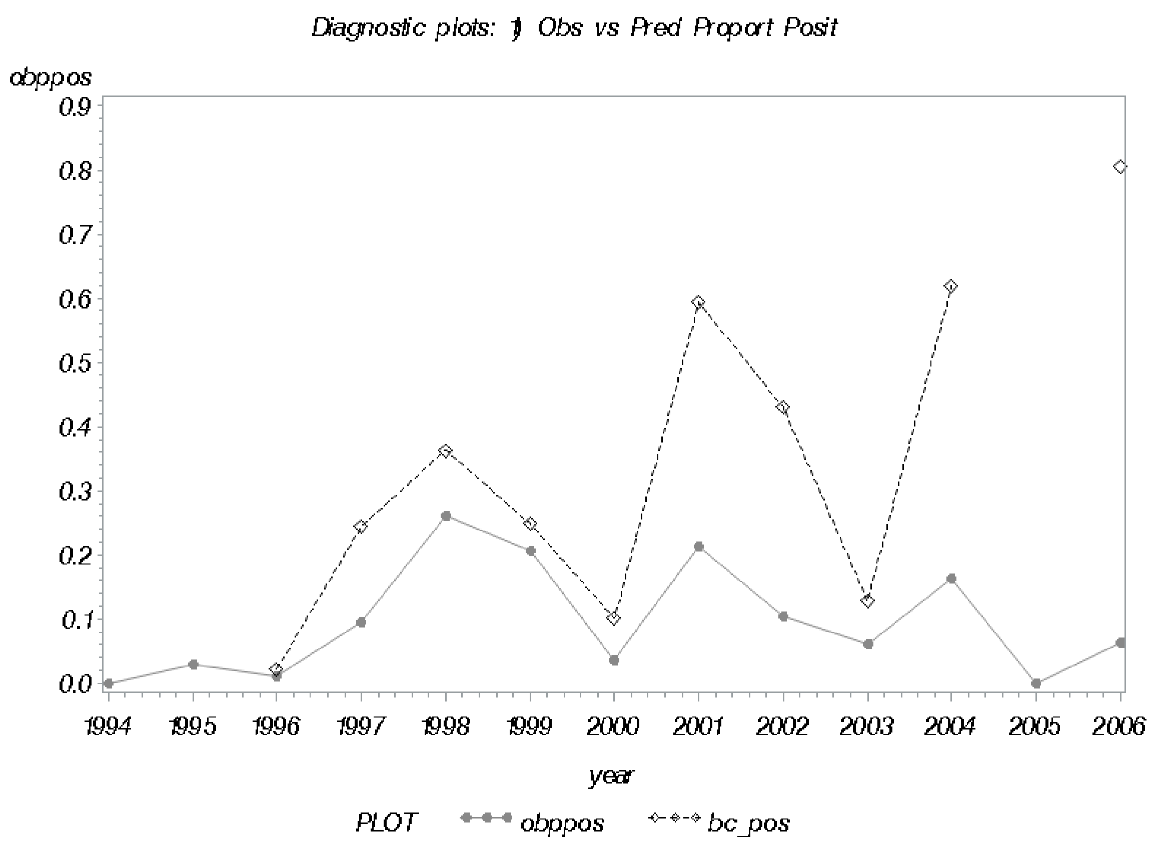
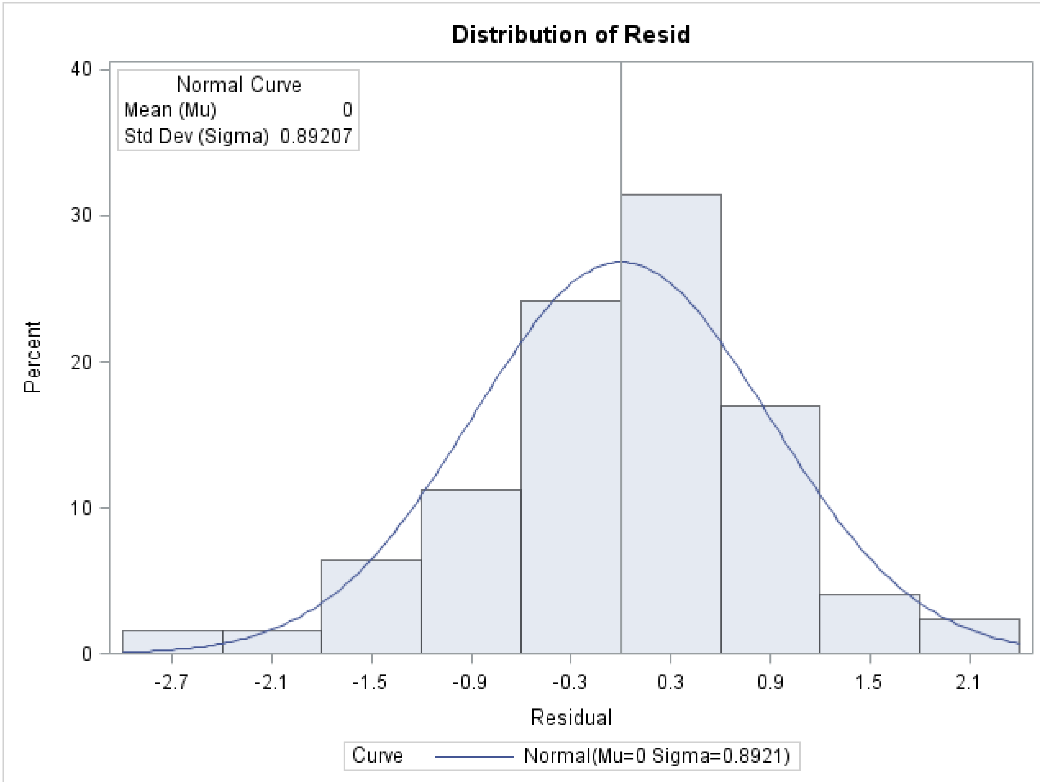


Figure 3b. Diagnostic plots for the lognormal component.



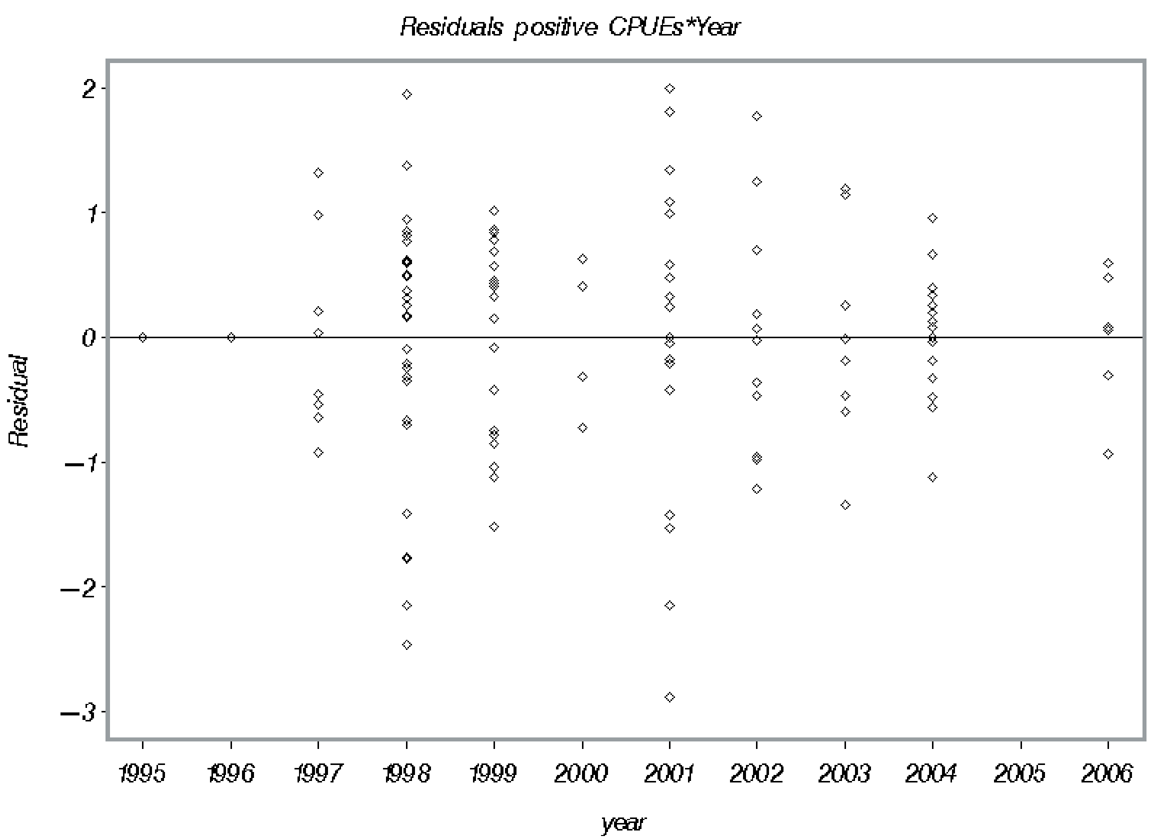
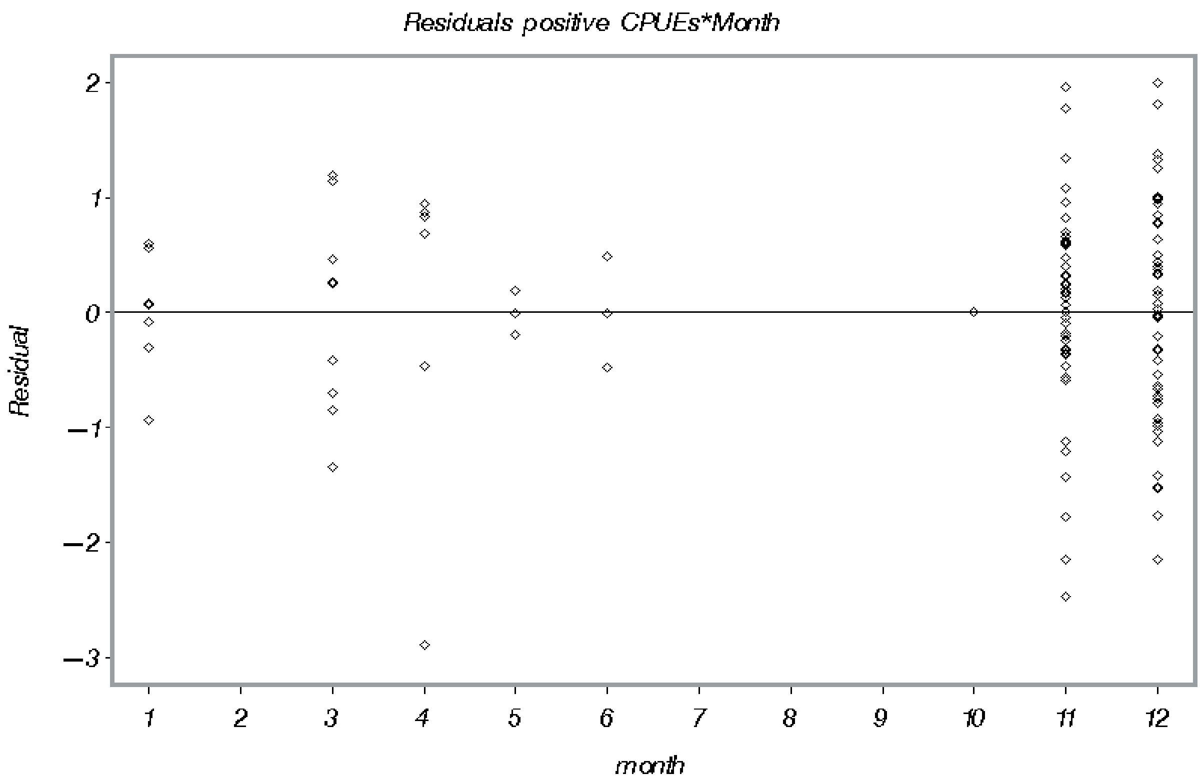


Figure 3b continued. Diagnostic plots for the lognormal component.



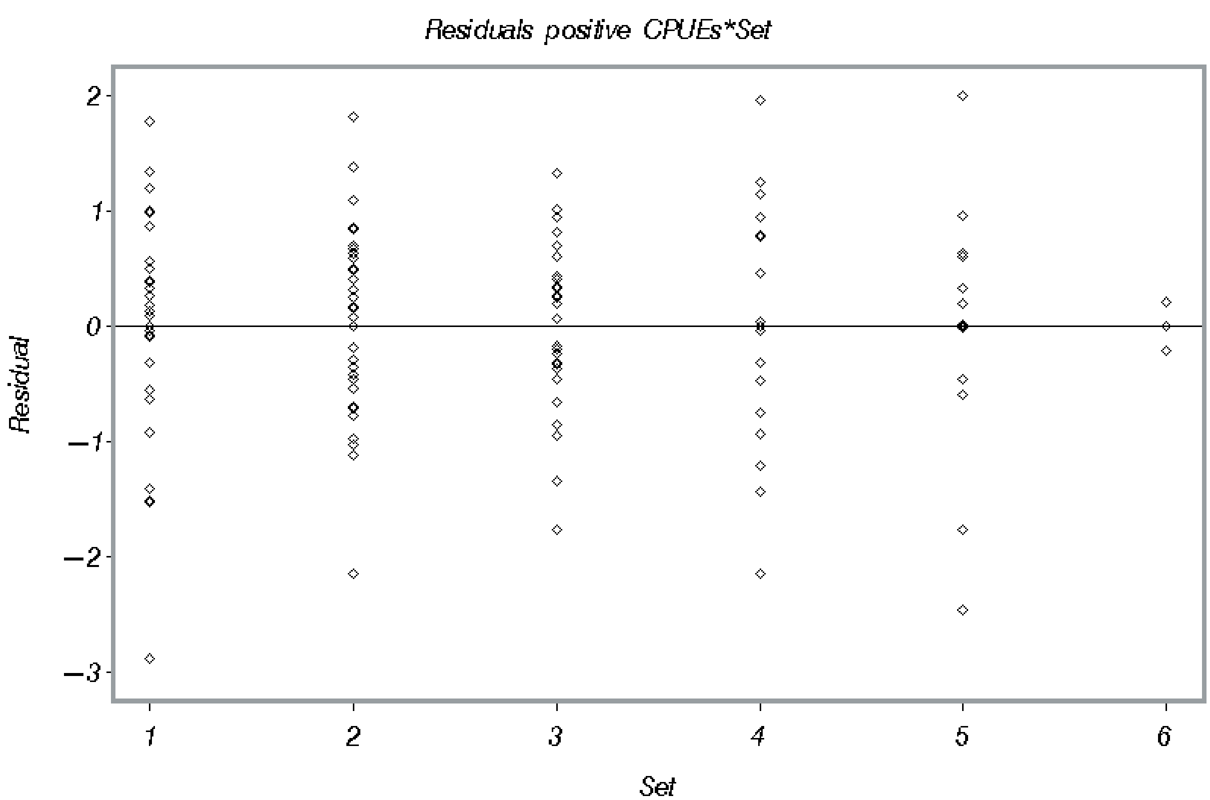


Figure 3b continued. Diagnostic plots for the lognormal component.

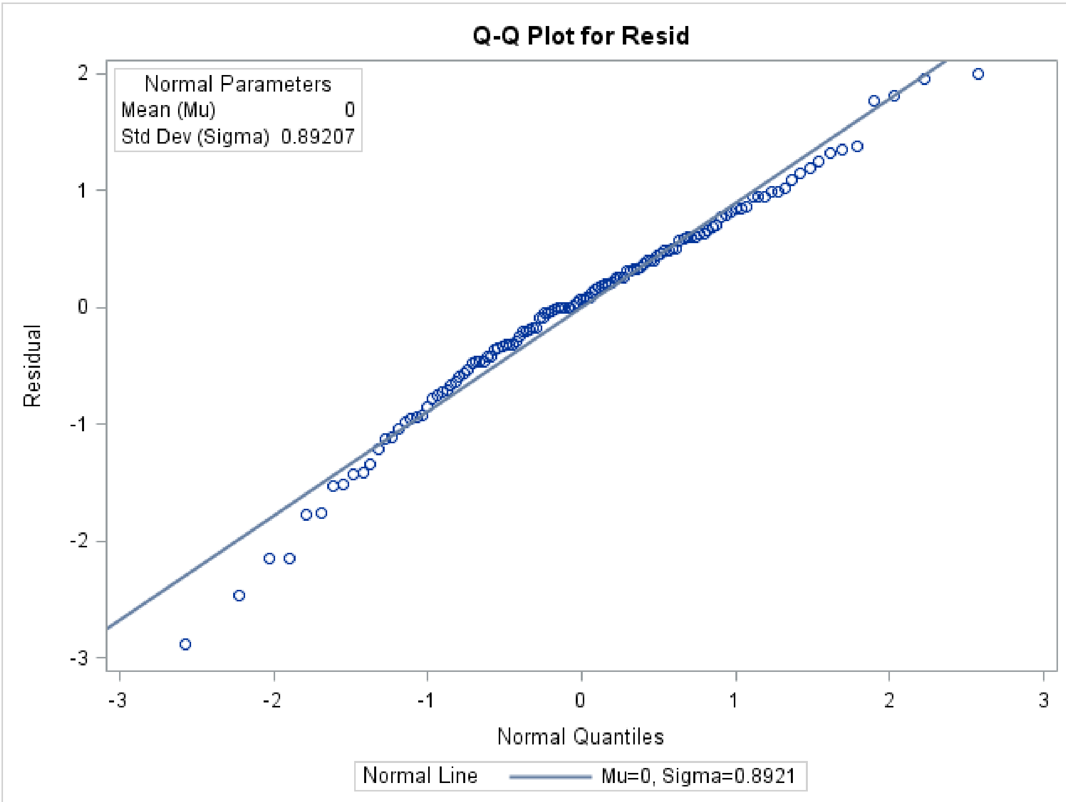


Figure 4. Smooth dogfish nominal (obscpue) and estimated (estcpue) indices with 95% confidence limits (LCI0, UCI0)