Standardized indices of abundance for Smooth Dogfish, *Mustelus canis*, from the Peconic Bay Small Mesh Trawl Survey conducted by the New York State Department of Environmental Conservation

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SEDAR39-DW-13

17 June 2014

Please cite this document as:

McCandless, C.T. and C. Grahn. 2014. Standardized indices of abundance for Smooth Dogfish, *Mustelus canis*, from the Peconic Bay Small Mesh Trawl Survey conducted by the New York State Department of Environmental Conservation. SEDAR39-DW-13. SEDAR, North Charleston, SC. 12 pp.

SEDAR 39 DATA WORKSHOP DOCUMENT

Standardized indices of abundance for Smooth Dogfish, *Mustelus canis*, from the Peconic Bay Small Mesh Trawl Survey conducted by the New York State Department of Environmental Conservation

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May 2014

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Summary

This document details the smooth dogfish catch from the Peconic Bay Small Mesh Trawl Survey conducted May through October from 1987 to 2013. Catch per unit effort (CPUE) in number of sharks per 10 minute tow 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 standardized relative abundance for smooth dogfish shows a barely discernible increasing trend across the time series with lots of variability and a large peak in abundance during the last three years of the survey. Many of the smooth dogfish caught during this survey are young-of-the-year fish. The trend produced from this survey may not represent the overall population of smooth dogfish in the northwest Atlantic, but would likely provide a good index of recruitment for the species.

Introduction

The Peconic Bay Small Mesh Trawl Survey is used for long-term monitoring and assessment of annual recruitment of important marine finfish species in New York waters, including weakfish, winter flounder, scup, tautog, bluefish and northern puffer. The survey is also used to meet the Atlantic States Marine Fisheries Commission (ASMFC) compliance criteria for the Interstate Fishery Management Plan for winter flounder, horseshoe crab and weakfish. In this document, the Peconic Bay time series is modeled to create a standardized index of abundance for smooth dogfish

Methods

Sampling gear and survey design

The small mesh trawl survey is conducted in the estuarine waters of Peconic Bay, which lie between the north and south forks of eastern Long Island. The research vessel used throughout the survey is the *David H. Wallace*, a 10.7 meter lobster-style workboat. At each random stratified location, a 4.9 meter semi-balloon shrimp trawl with a small mesh liner is towed for 10 minutes at approximately 2.5 knots. From 1987 through 1990, nets were rigged using nylon scissors and tow ropes set by hand and retrieved using a hydraulic lobster pot hauler. Following the 1990 sampling season, the research vessel was re-outfitted to include an A-frame, wire cable and hydraulic trawl winches. For the remainder of the study, wire cable was substituted for the nylon scissor and tow ropes, and nets were set and retrieved using hydraulic winches.

Environmental data (temperature, salinity, dissolved oxygen) is recorded at each station at both the surface and bottom. Fish collected in each tow are sorted, identified, counted and measured to the nearest millimeter (fork or total length). Large catches are subsampled, with length measurements taken on a minimum of 30 randomly selected individual fish of each species.

Data Analysis

Catch per unit effort (CPUE) in number of sharks per 10 minute tow were used to examine the relative abundance of smooth dogfish caught during the Peconic Bay Trawl Survey conducted between 1987 and 2013. The CPUE was standardized using the Lo et al. (2002) method which models the proportion of positive tows separately from the positive catch. Factors considered as potential influences on the CPUE for these analyses were: year (1987– 2013), month (May - October), depth interval (0 – 2.4 m, 2.5-4.9 m, 5-7.4 m, 7.5-9.9, and 10+ m), bottom temperature (<16, 16-18, 19-21, 22-24, 25+ °C), and bottom salinity (<25, 25-26, 27-28, 29-39, 30+ ppt) . The proportion of tows with positive CPUE values was modeled assuming a binomial distribution with a logit link function and the positive CPUE tows 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 3316 smooth dogfish were caught during 10089 tows from 1987 to 2013. Smooth dogfish ranged in length from 18 to 126 cm FL and size remained consistent across time (Figure 1). The proportion of tows with positive catch (at least one smooth dogfish was caught) was 15%. The stepwise construction of each model and the resulting statistics are detailed in Table 1. Model diagnostic plots reveal that the model fit is acceptable (Figures 2a and 2b). 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 Figures 3 and 4. The standardized relative abundance for smooth dogfish shows a barely discernible increasing trend across the time series with lots of variability and a large peak in abundance during the last three years of the survey.

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 NY trawl 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	2186	2826.3823	1.2929		
DEPTH	2182	2560.3449	1.1734	9.2428	9.2428
MONTH	2181	2645.9768	1.2132	6.1644	
TEMP	2181	2665.5988	1.2222	5.4683	
YEAR	2161	2716.1299	1.2569	2.7844	
SALINITY	2182	2785.5834	1.2766	1.2607	
DEPTH +					
MONTH	2177	2355.0191	1.0818	16.3276	7.0848
TEMP	2177	2373.9163	1.0905	15.6547	6.4119
YEAR	2157	2445.2507	1.1336	12.3211	3.0784
SALINITY	2178	2534.0537	1.1635	10.0085	0.7657
DEPTH + MONTH +					
YEAR	2152	2226.6055	1.0347	19.9706	3.6430
TEMP	2172	2323.4872	1.0697	17.2635	0.9359

FINAL MODEL	AIC	BIC	(-2) Res Log Likelihood
DEPTH + MONTH + YEAR	3747.3	3751.8	3745.3

Type 3 Test of Fixed Effects

Significance (Pr>Chi) of Type 3	DEPTH	MONTH	YEAR
test of fixed effects for each factor	<.0001	<.0001	0.0004
DF	4	5	26
CHI SQUARE	171.59	101.29	56.45

POSITIVE CATCHES-LOGNORMAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%
NULL	760	640.0031	0.8421		
YEAR	735	584.6981	0.7955	5.5338	5.5338
MONTH	755	604.0093	0.8000	4.9994	
DEPTH	756	616.3590	0.8153	3.1825	
TEMP	755	617.7459	0.8182	2.8381	
SALINITY	756	639.0548	0.8453	-0.3800	
YEAR +					
MONTH	730	549.5293	0.7528	10.6044	5.0707
DEPTH	731	560.1187	0.7662	9.0132	3.4794
TEMP	730	561.1059	0.7686	8.7282	3.1944
YEAR + MONTH +					
DEPTH	726	524.5357	0.7225	14.2026	3.5981
TEMP	725	543.1623	0.7492	11.0319	0.4275

FINAL MODEL	AIC	BIC	(-2) Res Log Likelihood
YEAR + MONTH + DEPTH	1080.1	1084.1	1078.1

Type 3 Test of Fixed Effects

Significance (Pr>Chi) of Type 3	YEAR	MONTH	DEPTH
test of fixed effects for each factor	<.0001	<.0001	<.0001
DF	26	5	4
CHI SQUARE	140.95	97.86	118.88

Table 2. New York trawl survey smooth dogfish analysis number of tows (n tows), number of sharks (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 catch per 10 minute tow (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 tows	catch	n obs	obs pos	obs ppos	obs cpue	est cpue	LCL	UCL	CV
1987	354	288	28	20	0.7143	10.2857	8.2213	4.8469	13.9448	0.2689
1988	426	222	29	19	0.6552	7.6552	8.3198	4.7087	14.7001	0.2905
1989	420	70	27	12	0.4444	2.5926	1.7963	0.6880	4.6902	0.5089
1990	430	42	28	11	0.3929	1.5000	0.9140	0.3330	2.5083	0.5387
1991	398	120	28	16	0.5714	4.2857	3.8892	1.8704	8.0872	0.3786
1992	411	159	26	15	0.5769	6.1154	3.8033	1.7394	8.3163	0.4066
1993	414	65	27	14	0.5185	2.4074	1.8922	0.8127	4.4056	0.4422
1994	428	78	28	15	0.5357	2.7857	1.8195	0.8214	4.0303	0.4139
1995	376	157	28	19	0.6786	5.6071	5.2791	2.9948	9.3055	0.2892
1996	409	284	30	16	0.5333	9.4667	6.6795	3.1498	14.1647	0.3895
1997	379	117	29	14	0.4828	4.0345	2.8234	1.1988	6.6495	0.4487
1998	395	113	29	19	0.6552	3.8966	4.1505	2.3495	7.3322	0.2904
1999	400	101	30	16	0.5333	3.3667	1.7086	0.8041	3.6303	0.3906
2000	420	101	30	19	0.6333	3.3667	3.4297	1.8932	6.2132	0.3038
2001	414	94	29	17	0.5862	3.2414	2.6210	1.3040	5.2682	0.3600
2002	415	158	30	23	0.7667	5.2667	5.8536	3.8233	8.9619	0.2154
2003	393	77	28	18	0.6429	2.7500	4.0121	2.1879	7.3570	0.3103
2004	407	69	30	16	0.5333	2.3000	2.0946	0.9882	4.4397	0.3893
2005	183	30	15	5	0.3333	2.0000	1.2985	0.3209	5.2538	0.7935
2006	245	25	20	9	0.4500	1.2500	0.7826	0.2597	2.3579	0.5962
2007	379	44	29	16	0.5517	1.5172	1.6008	0.7636	3.3561	0.3832
2008	171	17	14	8	0.5714	1.2143	0.9570	0.3181	2.8792	0.5953
2009	383	46	30	15	0.5000	1.5333	1.2948	0.5798	2.8914	0.4185
2010	302	98	23	16	0.6957	4.2609	2.7111	1.2846	5.7217	0.3869
2011	385	230	29	23	0.7931	7.9310	7.6865	5.0297	11.7465	0.2145
2012	390	297	30	22	0.7333	9.9000	11.4723	7.2314	18.2001	0.2339
2013	362	214	30	22	0.7333	7.1333	7.6444	4.8239	12.1140	0.2333

Figure 1. Fork lengths (cm) of smooth dogfish caught during the New York trawl survey from 1987-2013.

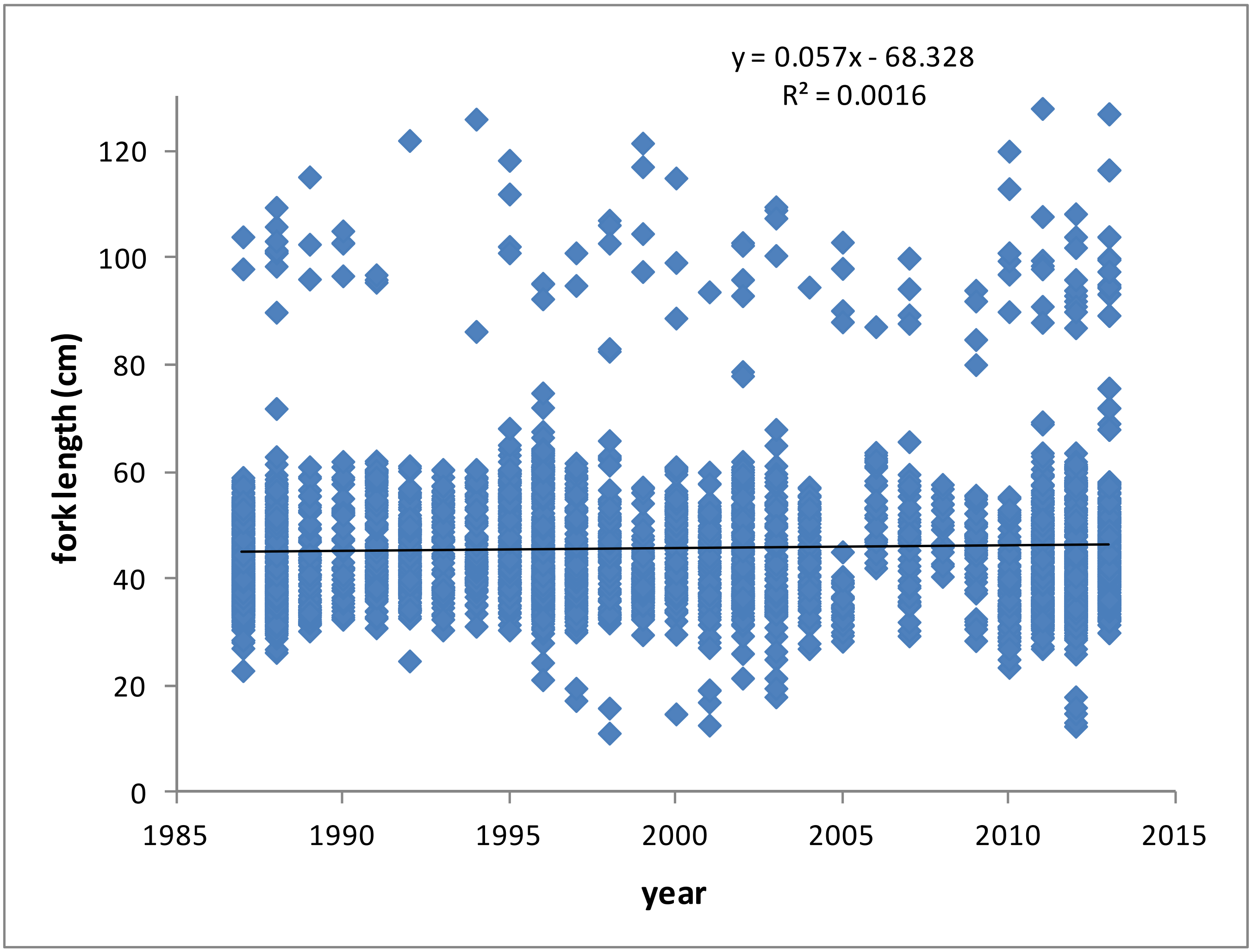
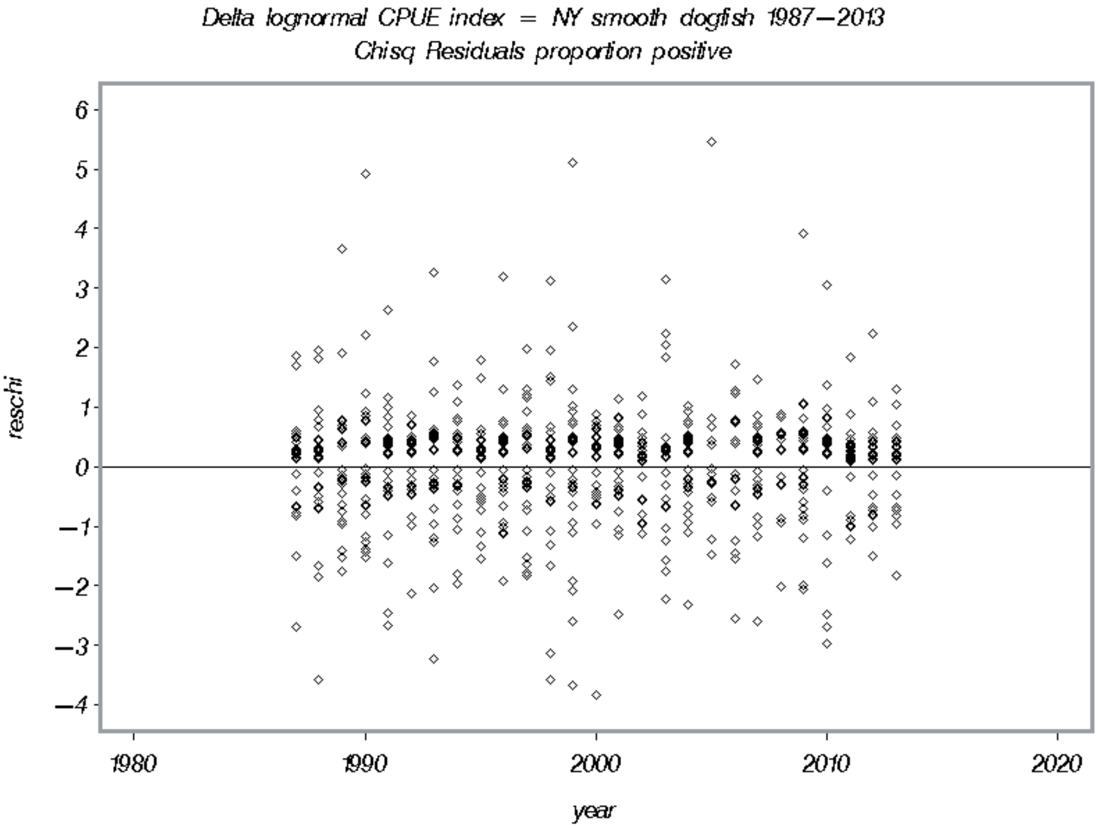


Figure 2a. New York trawl survey smooth dogfish model diagnostic plots for the binomial component.



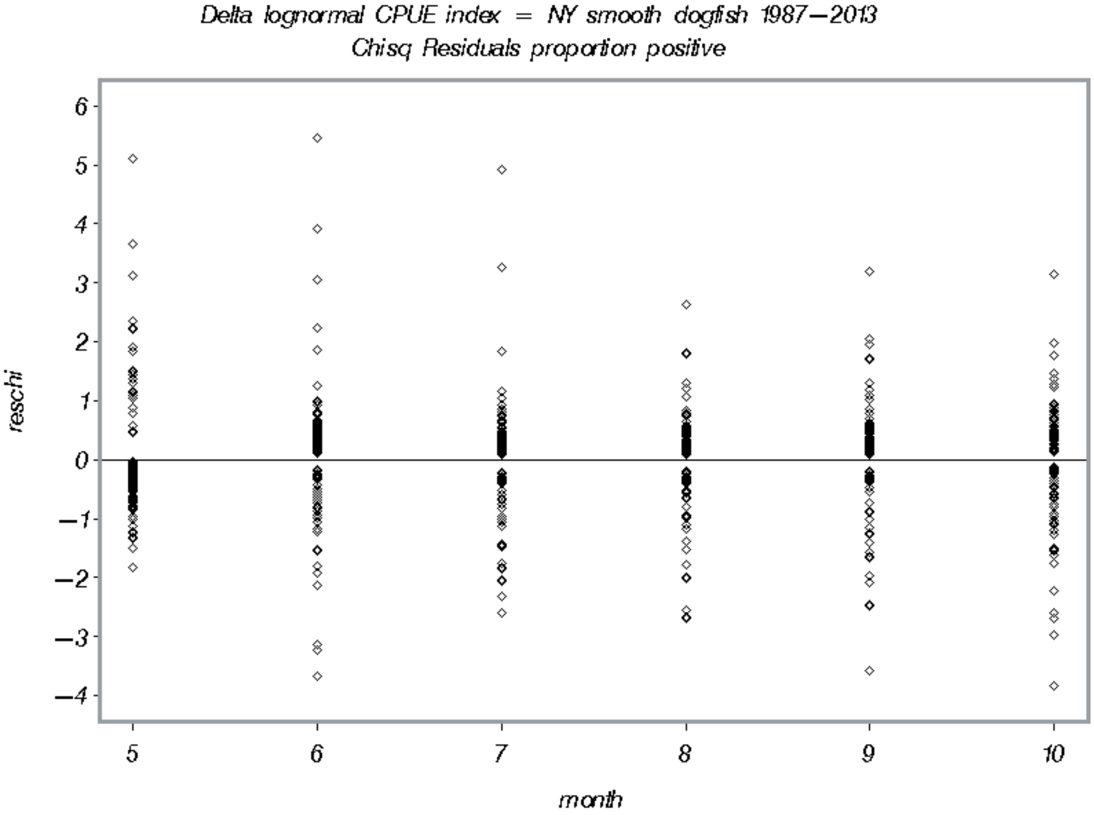
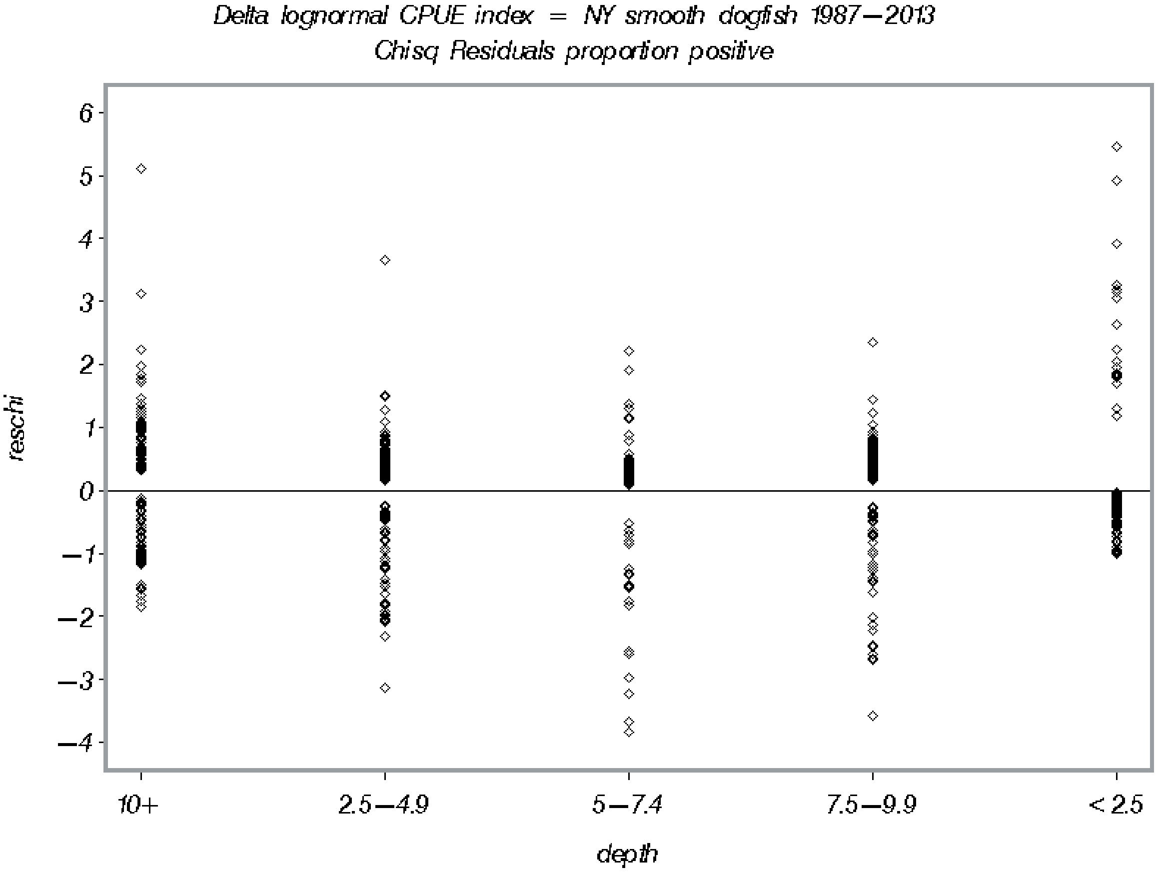


Figure 2a continued. New York trawl survey smooth dogfish model diagnostic plots for the binomial component.



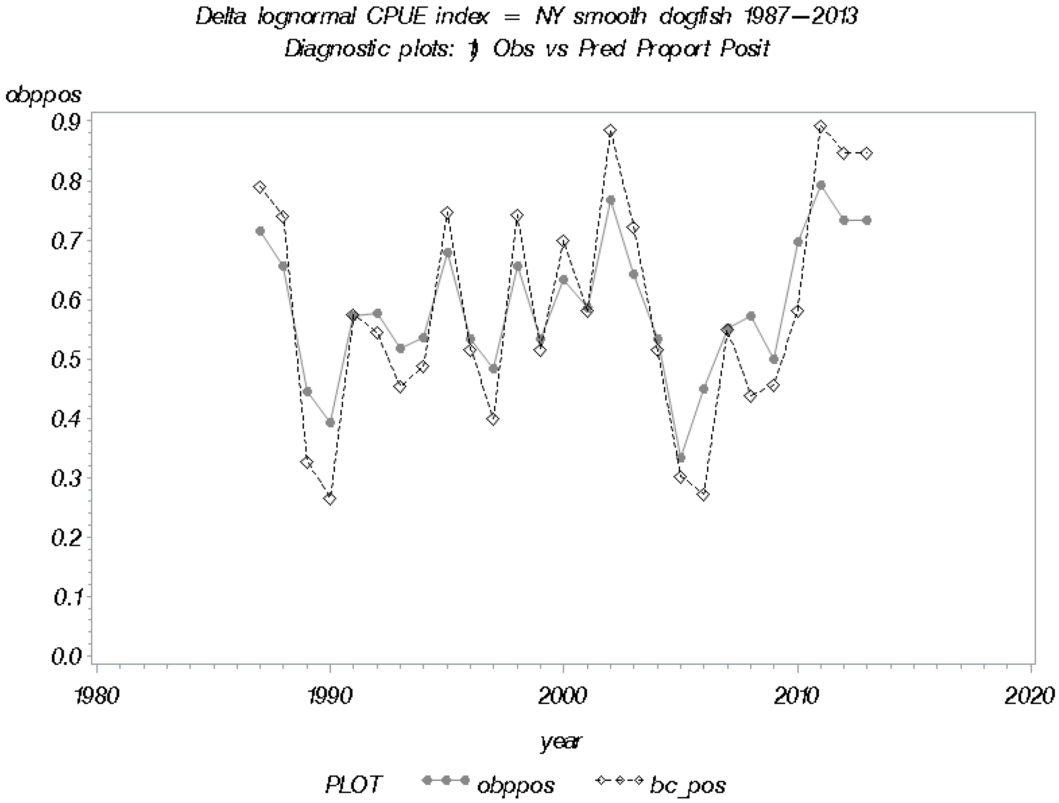
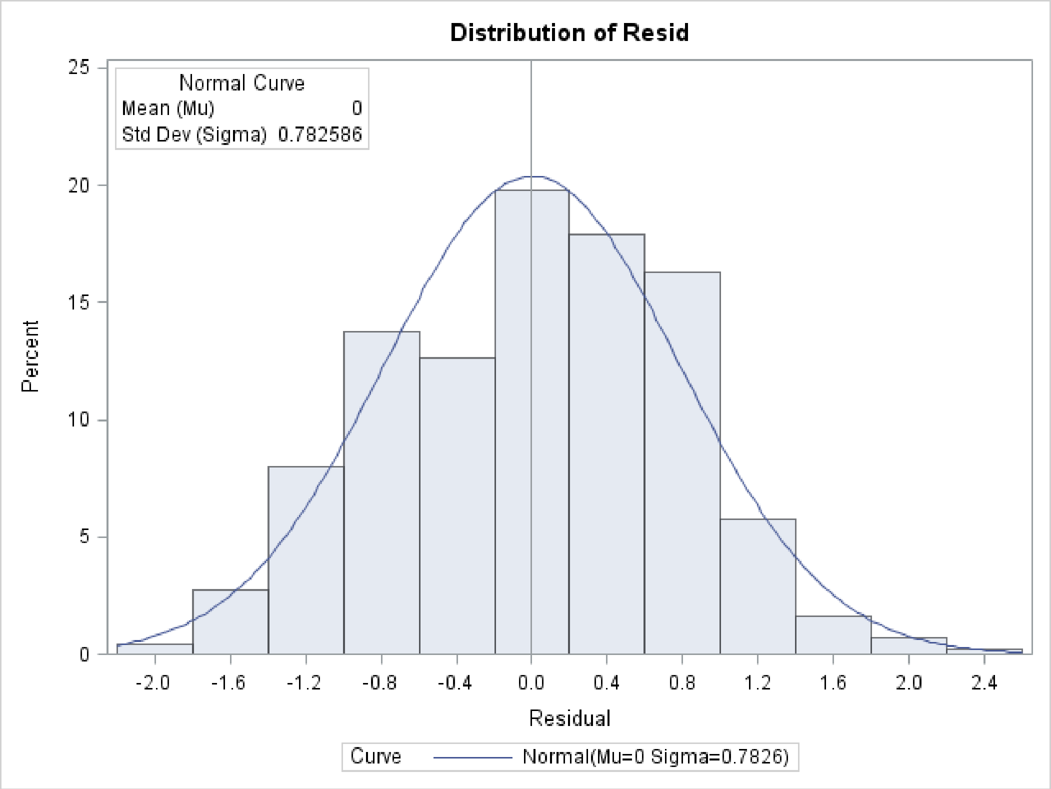


Figure 2b. New York trawl survey smooth dogfish model diagnostic plots for lognormal component.



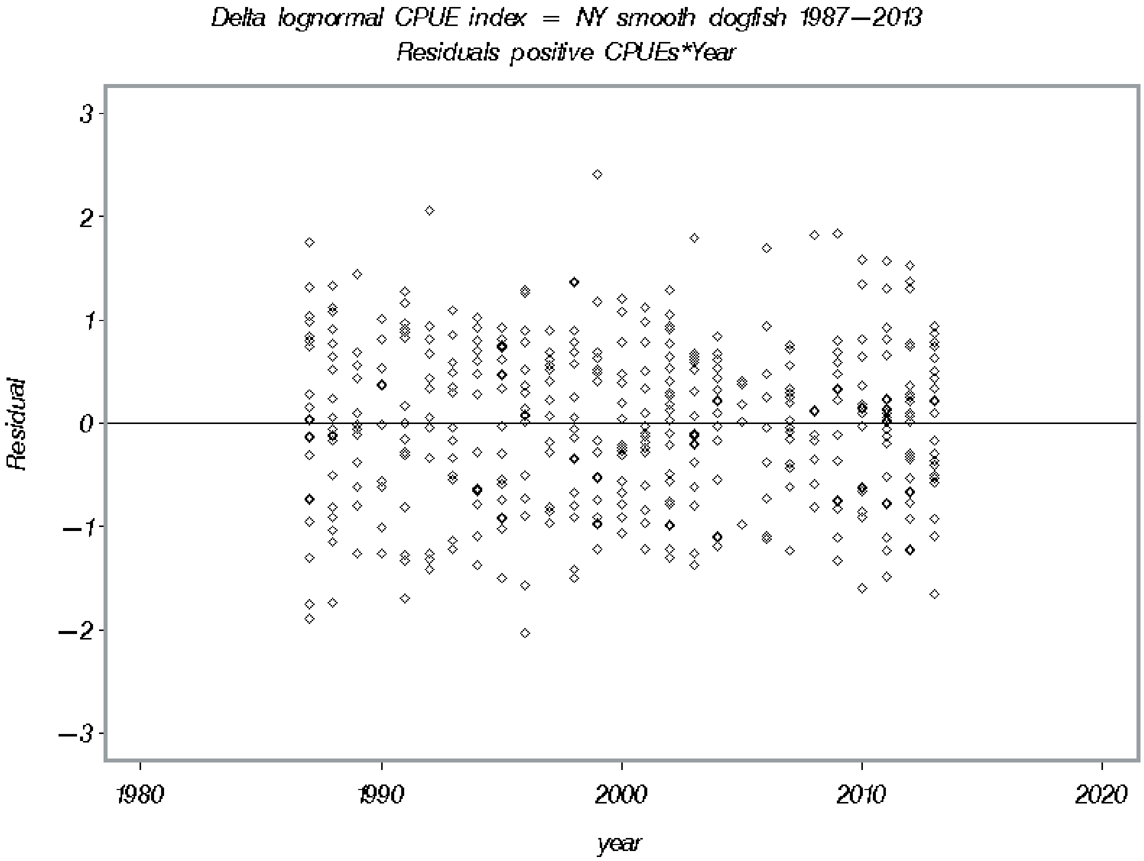
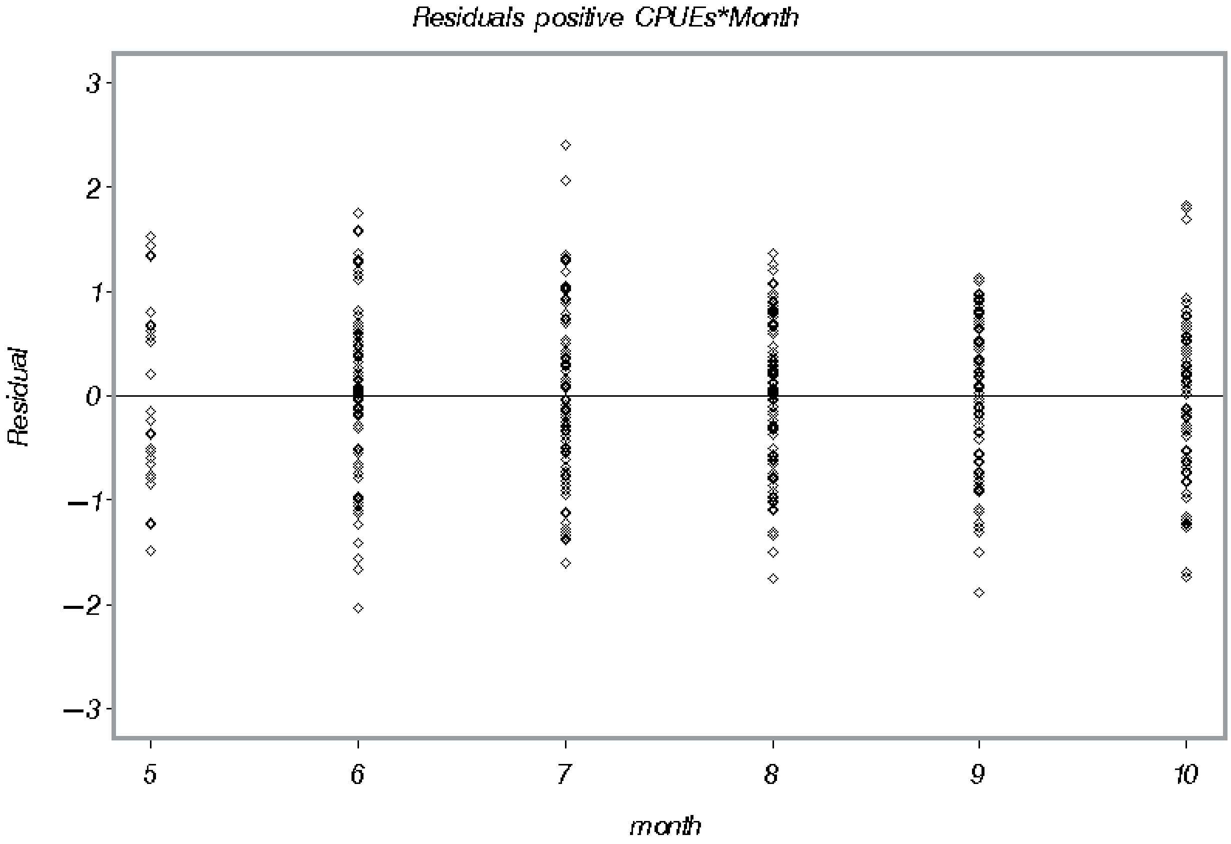


Figure 2b continued. New York trawl survey smooth dogfish model diagnostic plots for lognormal component.



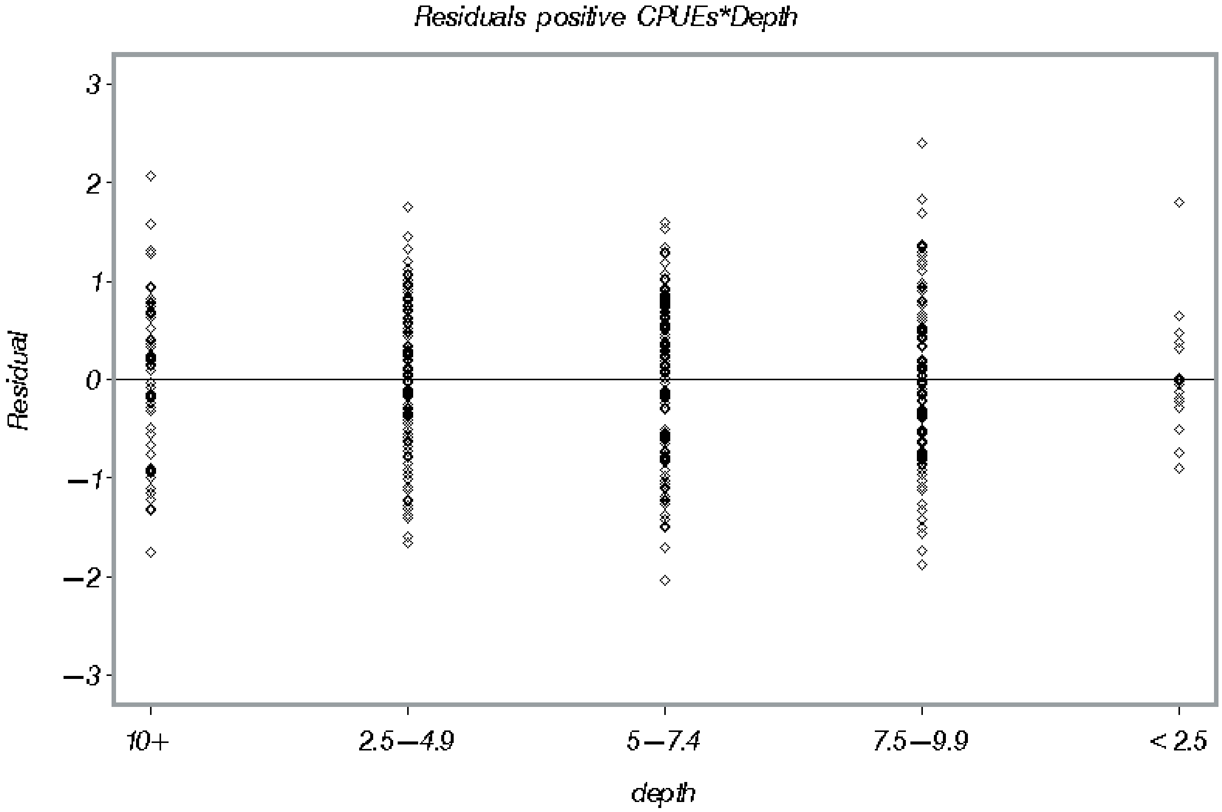


Figure 2b continued. New York trawl survey smooth dogfish model diagnostic plots for lognormal component.

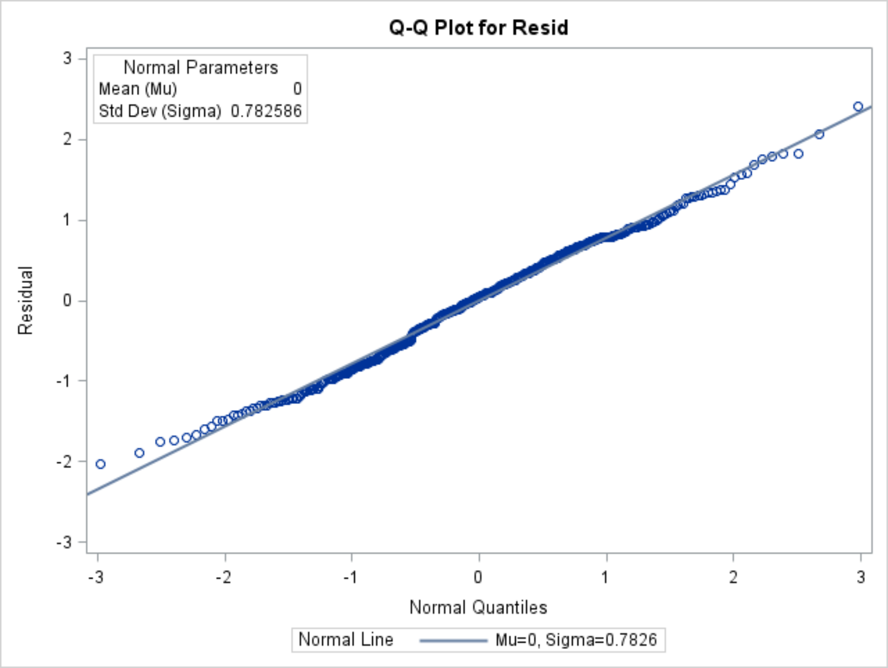


Figure 3. NY trawl survey smooth dogfish nominal (obcpue) and estimated (estcpue) indices with 95% confidence limits (LCI0, UCI0).

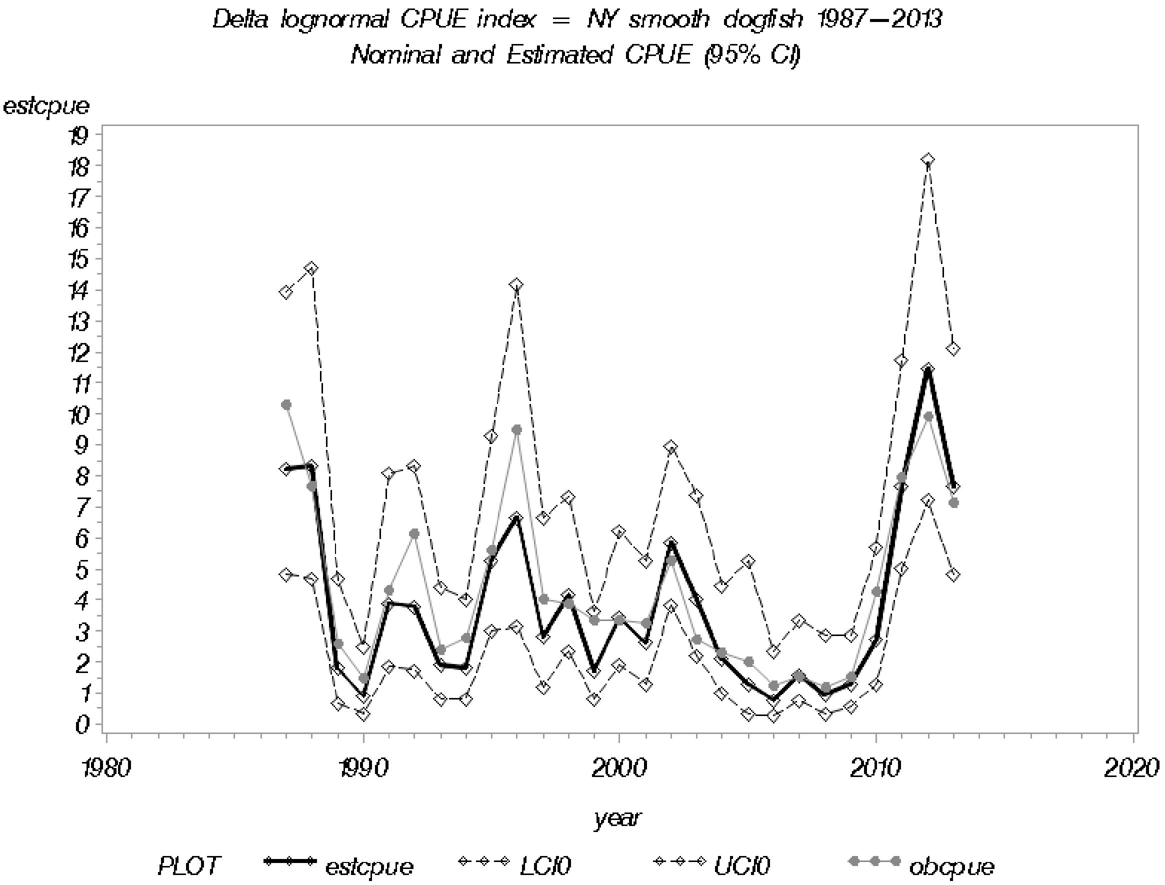


Figure 4. Plot of the standardized index of abundance over time with a linear trend line