Standardized indices of abundance for Smooth Dogfish, *Mustelus canis*, from the New Jersey Division of Fish and Wildlife ocean trawl surveys

Camilla T. McCandless, Jennifer Pyle, Greg Hinks, and Linda Barry

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SEDAR 39 DATA WORKSHOP DOCUMENT

Standardized indices of abundance for Smooth Dogfish, *Mustelus canis*, from the New Jersey Division of Fish and Wildlife Ocean Trawl Survey

Camilla T. McCandless
NOAA/NMFS/NEFSC
Apex Predators Program
Narragansett, RI 02882

Jennifer Pyle
Greg Hinks
Linda Barry
New Jersey Division of Fish and Wildlife
Nacote Creek Research Station
Port Republic, NJ 08241

cami.mccandless@noaa.gov
jennifer.pyle@dep.state.nj.us
gregory.hinks@dep.state.nj.us
linda.barry@dep.state.nj.us

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Summary

This document details the smooth dogfish catch from the New Jersey Ocean Trawl Survey between 1988 and 2013. Catch per unit effort (CPUE) in number of sharks per 20 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 nominal and standardized relative abundance for smooth dogfish show an overall increasing trend throughout the majority of the time series with a large peak in 2002. The peak occurs in a year when a high proportion of sets had smooth dogfish catch, and many of them in large numbers. A large peak in 2002 relative abundance was also seen in Long Island Sound.

Introduction

The New Jersey Ocean Trawl Survey is a multispecies survey that started in August 1988 and samples the near shore waters from the entrance of New York Harbor south to the entrance of the Delaware Bay five times a year (January, April, June, August and October). The Division of Fish and Wildlife developed this survey to monitor the abundance and distribution of fish and other marine animals in New Jersey's coastal waters. The survey also helps measure attainment of the Division's goals of restoring and maintaining healthy, plentiful, stocks of saltwater fish for New Jersey fishermen and seafood lovers. In this document, the New Jersey Ocean Trawl time series is modeled to create a standardized index of abundance for smooth dogfish.

Methods

Sampling gear and survey design

Nearly 200 sites, from Sandy Hook to Cape May, are sampled over the course of the year. There are 15 strata with 5 strata assigned to 3 different depth regimes; inshore (3 to 5 fathoms), mid-shore (5 to 10 fathoms), and off-shore (10 to 15 fathoms). Station allocation and location is random and stratified by strata size. Each survey takes about a week to complete. The research vessel currently used for the survey is the *R/V Seawolf*, an 81-foot research vessel. At each random stratified location, a 30-meter otter trawl is towed for 20 minutes at approximately 3 knots. All species taken during these surveys were weighed and measured.

Data Analysis

Catch per unit effort (CPUE) in number of sharks per 20 minute tow were used to examine the relative abundance of smooth dogfish caught during the NJ Ocean Trawl Survey conducted between 1988 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 (1988– 2013), month (January, April, June, August and October), stratum (15 total strata, 5 each at 3-5, 5-10, and 10-15 fathoms), and vessel (5 different vessels have been used across the survey years). 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.

Smooth dogfish lengths were converted from total length to fork length using the following formula (provided by the SEDAR 39 Life History Working Group Chair, William B. Driggers):

$$\text{Sexes combined: } TLcm = 3.43329 + 1.09539*FLcm$$

Results

A total of 73,694 smooth dogfish were caught during 4733 tows from 1988 to 2013. Smooth dogfish ranged in length from 18 to 128 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 52%. 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). There is an outlier in the residual plots for the proportion positive vs. year and month, which comes from the only tow in January to catch a smooth dogfish. 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 nominal and standardized relative abundance for smooth dogfish show an overall increasing trend throughout the majority of the time series with a large peak in 2002. The peak occurs in a year when a high proportion of sets had smooth dogfish catch, and many of them in large numbers. A large peak in 2002 relative abundance was also seen in Long Island Sound (McCandless and Gottschall 2014).

References

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Table 1. Results of the stepwise procedure for development of the NJ 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	1898	2545.5316	1.3412		
MONTH	1894	1054.0209	0.5565	58.5073	58.5073
STRATUM	1884	2510.8213	1.3327	0.6338	
VESSEL	1894	2535.1891	1.3385	0.2013	
YEAR	1873	2514.3217	1.3424	-0.0895	
MONTH +					
YEAR	1869	945.7021	0.5060	62.2726	3.7653

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

Type 3 Test of Fixed Effects

Significance (Pr>Chi) of Type 3	MONTH	YEAR
test of fixed effects for each factor	<.0001	0.0002
DF	4	25
CHI SQUARE	288.46	58.06

POSITIVE CATCHES-LOGNORMAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%
NULL	1151	3172.2243	2.7561		
MONTH	1147	2629.8757	2.2928	16.8100	16.8100
YEAR	1126	2878.7145	2.5566	7.2385	
STRATUM	1137	2929.9854	2.5769	6.5019	
VESSEL	1147	3031.4614	2.6429	4.1073	
MONTH +					
YEAR	1122	2298.9531	2.0490	25.6558	8.8458
STRATUM	1133	2372.8835	2.0943	24.0122	7.2022
VESSEL	1143	2448.2730	2.1420	22.2815	5.4715
MONTH + YEAR +					
STRATUM	1108	2027.592	1.8300	33.6018	7.9460
VESSEL	1121	2291.124	2.0438	25.8445	0.1887

FINAL MODEL	AIC	BIC	(-2) Res Log Likelihood
MONTH + YEAR + STRATUM	3986.9	3991.9	3984.9

Type 3 Test of Fixed Effects

Significance (Pr>Chi) of Type 3	MONTH	YEAR	STRATUM
test of fixed effects for each factor	<.0001	<.0001	<.0001
DF	4	25	14
CHI SQUARE	328.87	188.69	148.29

Table 2. New Jersey 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 20 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
1988	68	540	28	19	0.6786	19.2857	4.6446	1.4987	14.3940	0.6139
1989	167	1312	73	42	0.5753	17.9726	12.3701	5.7045	26.8244	0.4020
1990	171	3719	73	44	0.6027	50.9452	39.4332	20.6693	75.2313	0.3316
1991	189	1708	75	45	0.6000	22.7733	18.6435	9.5759	36.2974	0.3426
1992	191	614	75	38	0.5067	8.1867	5.6848	2.3975	13.4791	0.4526
1993	187	958	75	40	0.5333	12.7733	6.8787	3.0206	15.6643	0.4295
1994	186	1624	75	33	0.4400	21.6533	5.0770	1.9930	12.9332	0.4943
1995	188	2618	75	46	0.6133	34.9067	39.4962	21.0860	73.9807	0.3217
1996	189	2507	75	44	0.5867	33.4267	25.8538	12.7948	52.2416	0.3629
1997	187	1168	75	44	0.5867	15.5733	15.5427	7.6946	31.3957	0.3627
1998	188	1777	75	45	0.6000	23.6933	21.1051	10.8455	41.0702	0.3423
1999	186	3005	75	42	0.5600	40.0667	37.9262	17.5560	81.9319	0.3999
2000	186	2141	75	47	0.6267	28.5467	33.6946	18.6711	60.8067	0.3017
2001	186	3622	75	45	0.6000	48.2933	36.2107	18.6065	70.4711	0.3424
2002	188	5489	75	56	0.7467	73.1867	111.1304	74.5500	165.6601	0.2016
2003	188	4594	75	44	0.5867	61.2533	53.9483	26.7057	108.9812	0.3627
2004	187	3576	75	43	0.5733	47.6800	36.6316	17.5047	76.6580	0.3822
2005	186	5658	75	44	0.5867	75.4400	52.0892	25.7785	105.2538	0.3629
2006	186	3289	75	53	0.7067	43.8533	74.9231	48.3896	116.0059	0.2212
2007	187	4175	75	47	0.6267	55.6667	60.7091	33.6401	109.5595	0.3017
2008	186	1719	75	50	0.6667	22.9200	37.1422	22.5798	61.0966	0.2528
2009	186	3714	75	43	0.5733	49.5200	32.3816	15.4765	67.7522	0.3821
2010	186	1757	75	48	0.6400	23.4267	28.7849	16.5076	50.1932	0.2835
2011	186	4332	75	51	0.6800	57.7600	63.5025	39.5277	102.0187	0.2404
2012	186	4720	75	50	0.6667	62.9333	41.8180	25.4104	68.8198	0.2530
2013	186	3358	75	49	0.6533	44.7733	43.2415	25.5862	73.0797	0.2670

Figure 1. Fork lengths (cm) of smooth dogfish caught during the New Jersey trawl survey from 1988-2013.

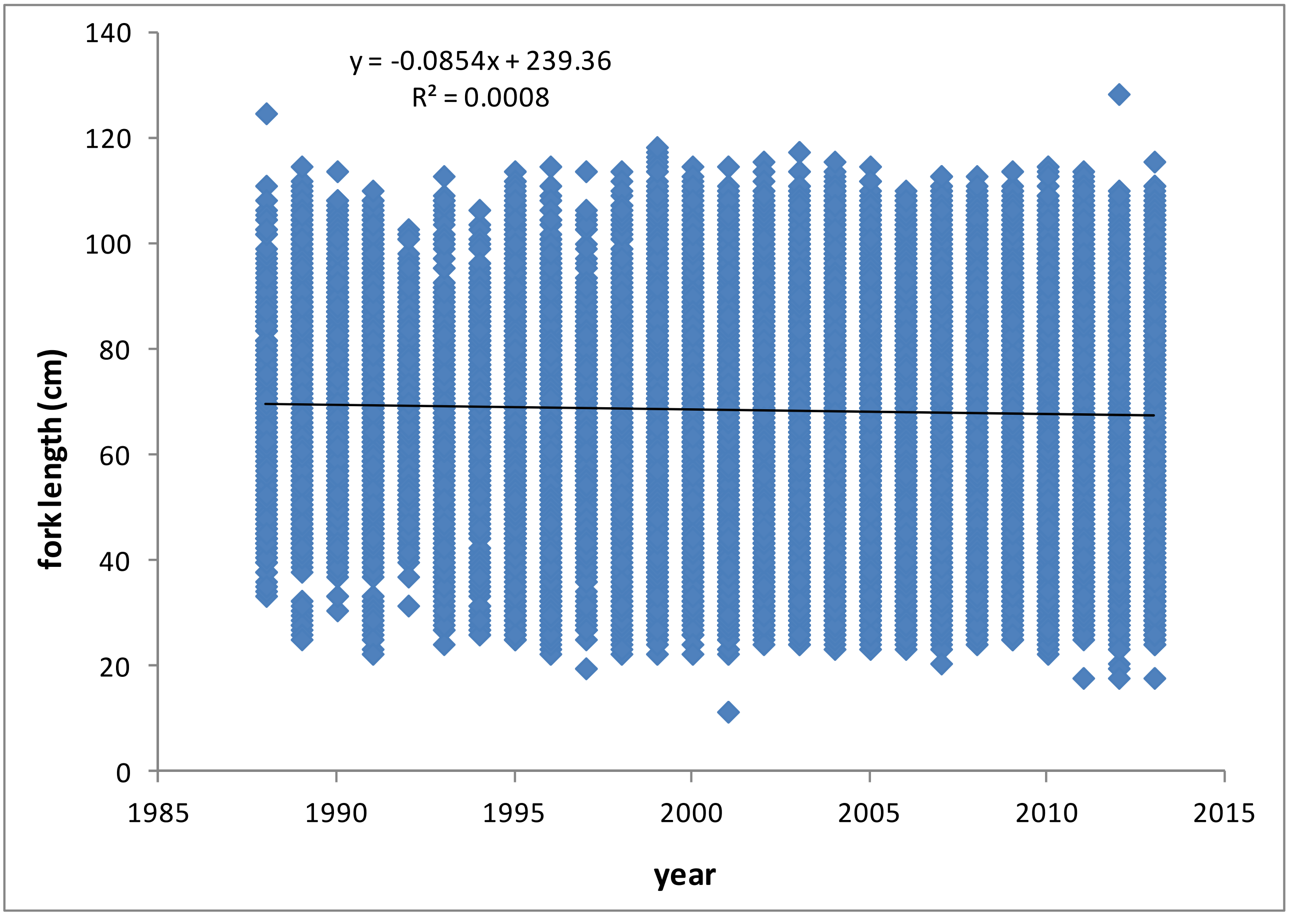
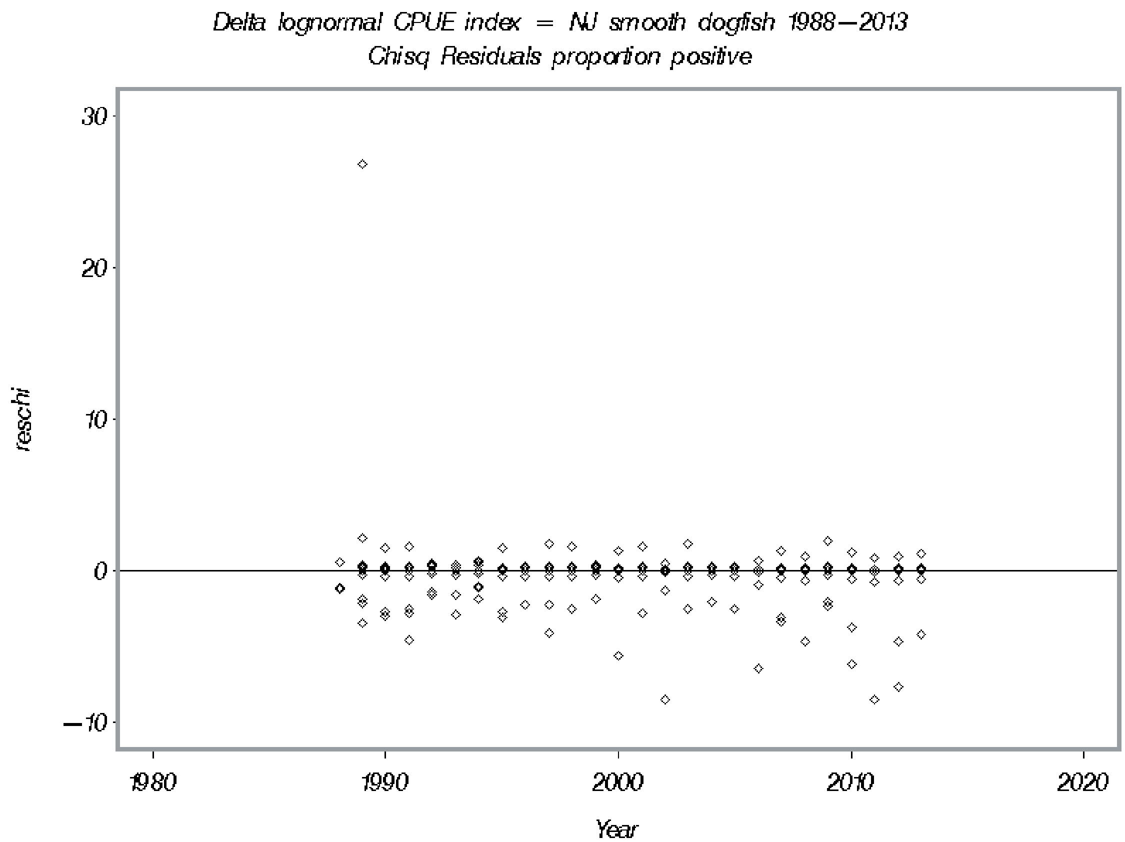


Figure 2a. New Jersey trawl survey smooth dogfish model diagnostic plots for the binomial component.



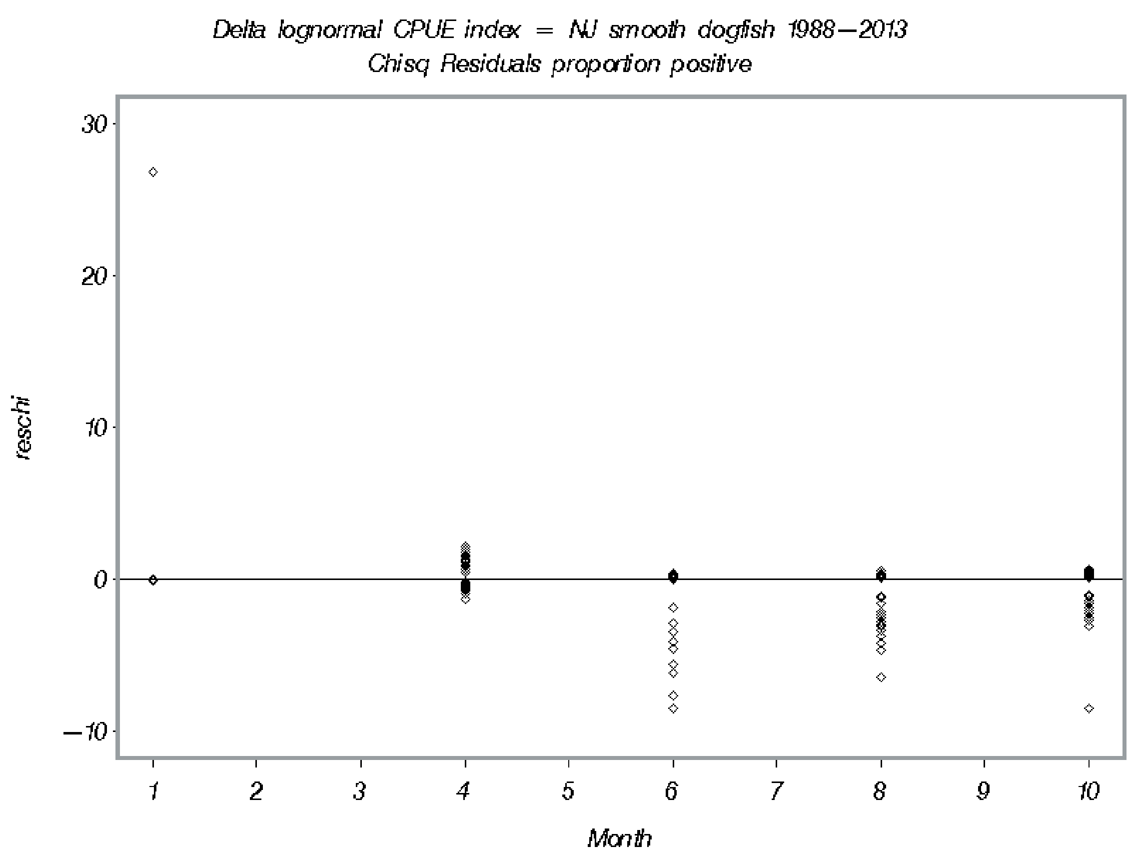


Figure 2a continued. New Jersey trawl survey smooth dogfish model diagnostic plots for the binomial component.

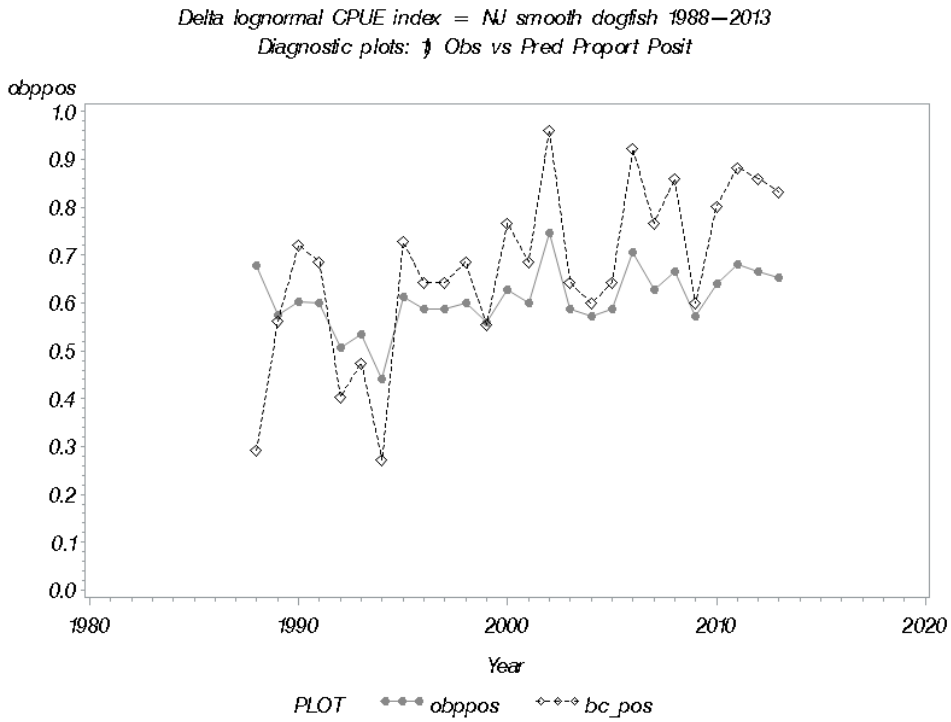


Figure 2b. New Jersey trawl survey smooth dogfish model diagnostic plots for lognormal component.

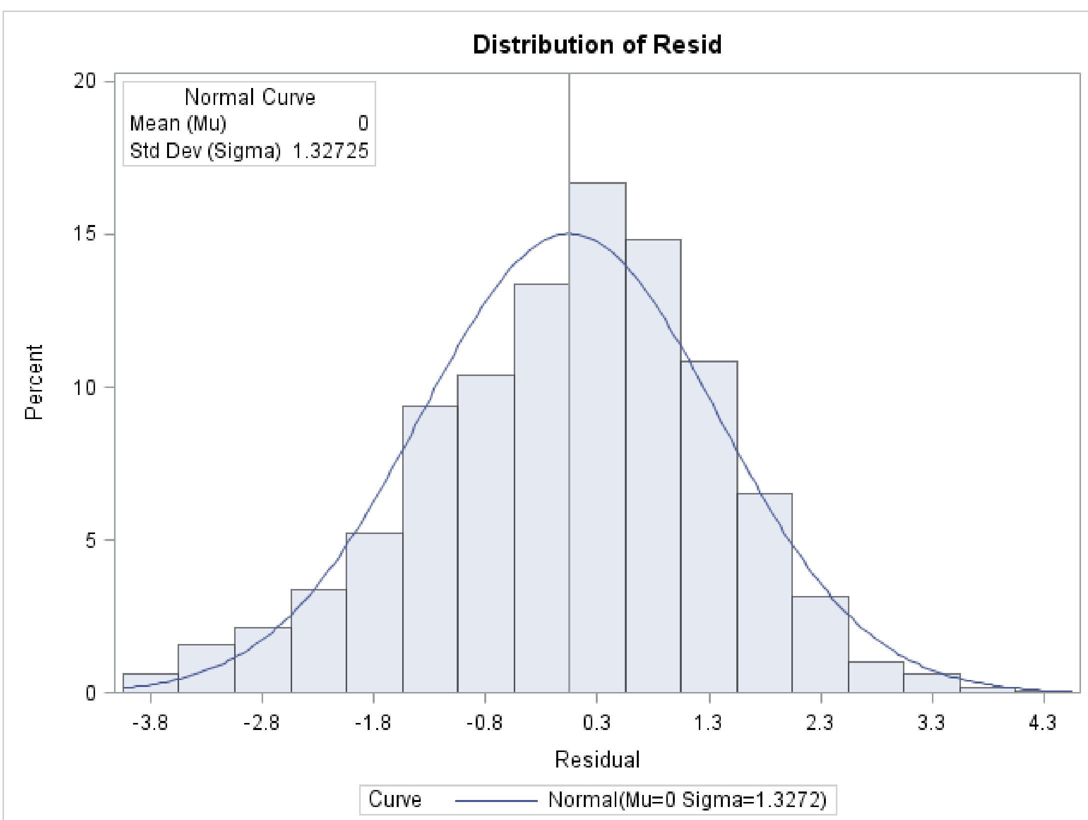
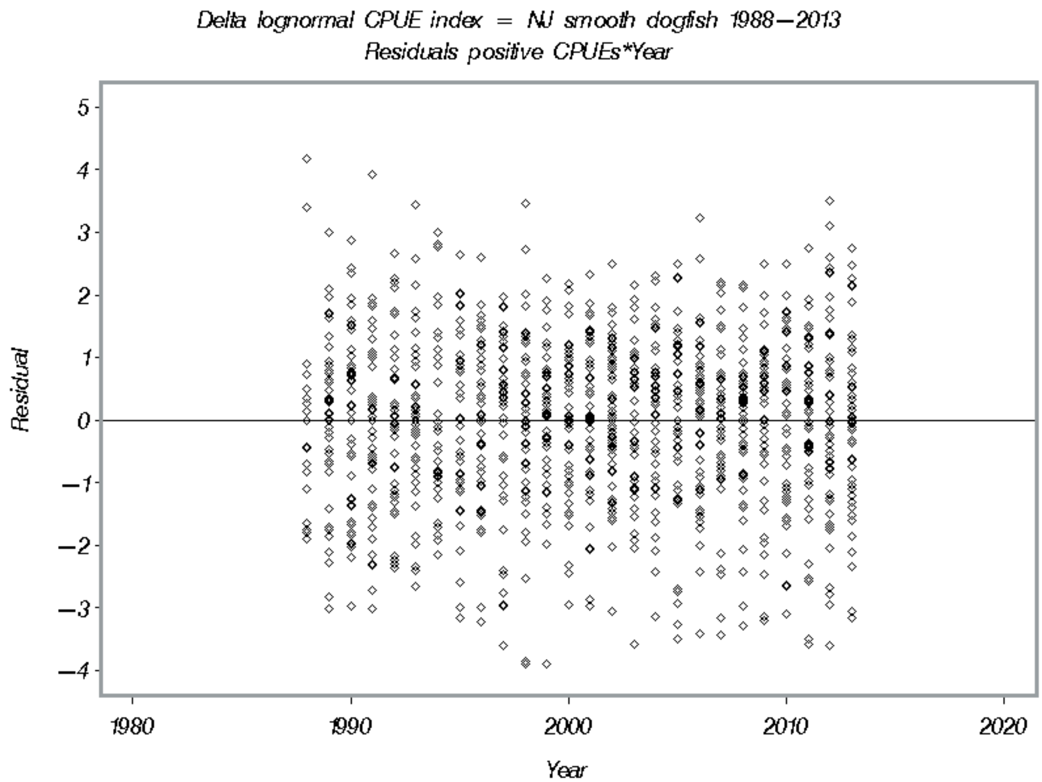


Figure 2b continued. New Jersey trawl survey smooth dogfish model diagnostic plots for lognormal component.



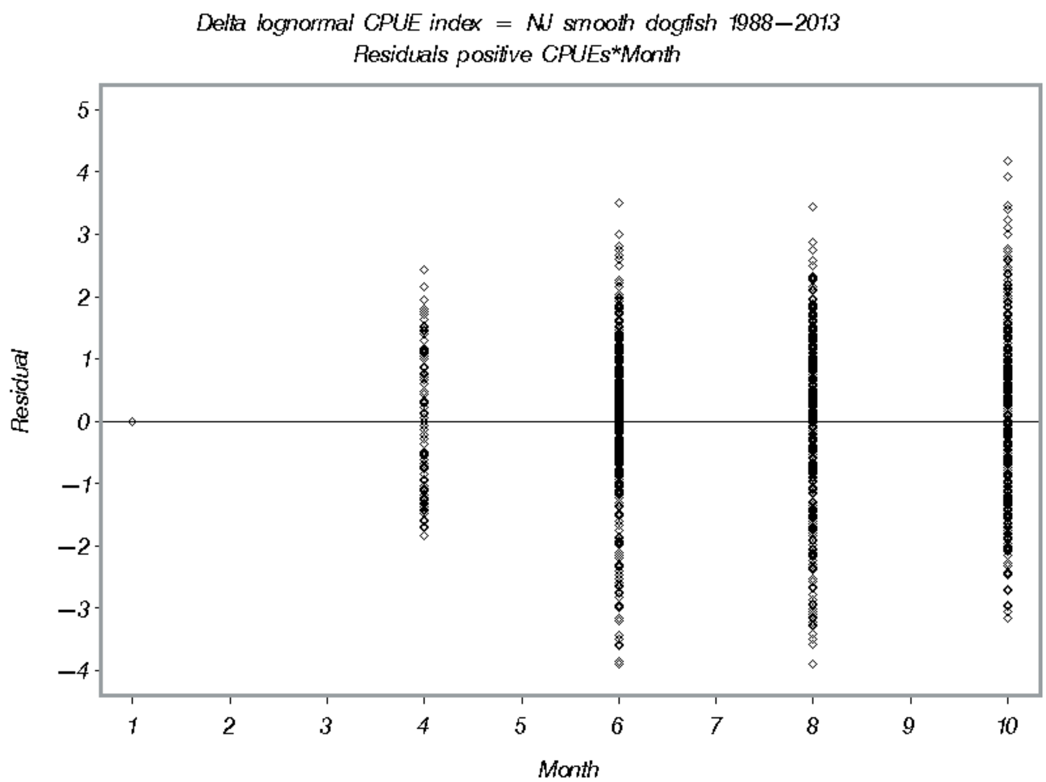
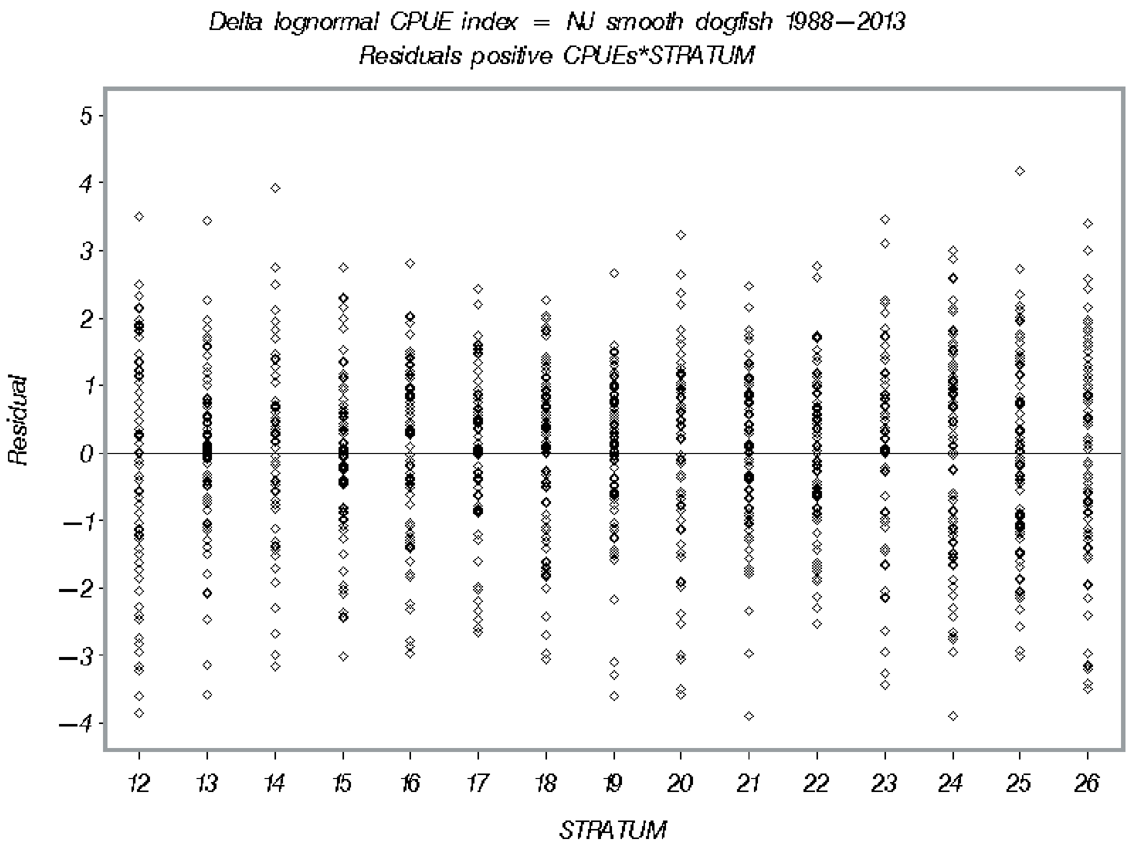


Figure 2b continued. New Jersey trawl survey smooth dogfish model diagnostic plots for lognormal component.



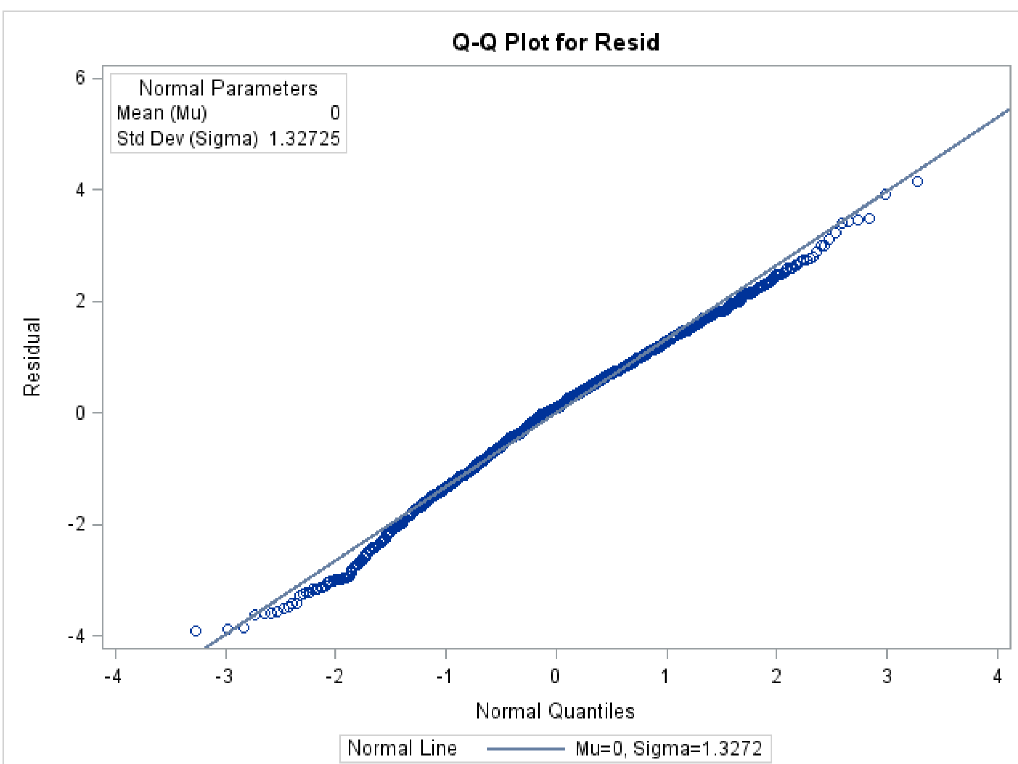
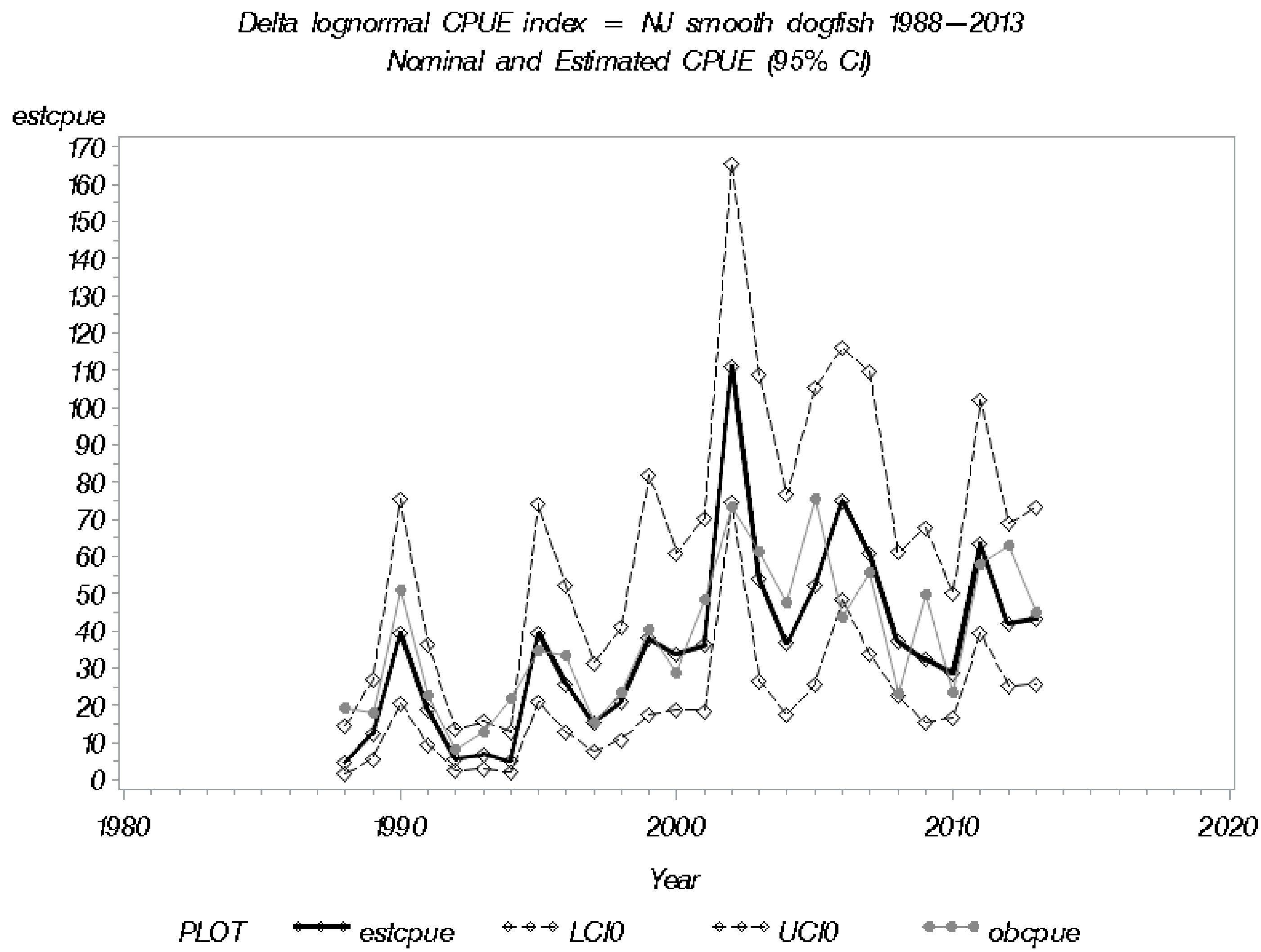


Figure 3. NJ trawl survey smooth dogfish nominal (obcpue) and estimated (estcpue) indices with 95% confidence limits (LCI0, UCI0).



ADDENDUM TO SEDAR39-DW-14

Based on the length of the catch time series that will be used in the assessment model the New Jersey trawl time series needed to be run through the standardization process (delta-lognormal model) using the factors from the original model with an end date of 2012. The resulting index values and trends are reported below.

Table A1. 1988-2012 NJ 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 20 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
1988	68	540	28	19	0.6786	19.2857	4.7080	1.5191	14.5910	0.6140
1989	167	1312	73	42	0.5753	17.9726	12.5361	5.8054	27.0703	0.3996
1990	171	3719	73	44	0.6027	50.9452	39.6233	20.8737	75.2144	0.3289
1991	189	1708	75	45	0.6000	22.7733	18.8233	9.7175	36.4616	0.3398
1992	191	614	75	38	0.5067	8.1867	5.7958	2.4508	13.7067	0.4511
1993	187	958	75	40	0.5333	12.7733	7.0013	3.0848	15.8903	0.4276
1994	186	1624	75	33	0.4400	21.6533	5.1692	2.0316	13.1523	0.4936
1995	188	2618	75	46	0.6133	34.9067	39.8999	21.4143	74.3429	0.3188
1996	189	2507	75	44	0.5867	33.4267	26.1837	13.0215	52.6504	0.3602
1997	187	1168	75	44	0.5867	15.5733	15.6805	7.8009	31.5192	0.3600
1998	188	1777	75	45	0.6000	23.6933	21.3970	11.0524	41.4237	0.3395
1999	186	3005	75	42	0.5600	40.0667	38.4085	17.8530	82.6312	0.3975
2000	186	2141	75	47	0.6267	28.5467	34.1016	18.9959	61.2196	0.2989
2001	186	3622	75	45	0.6000	48.2933	36.7092	18.9601	71.0738	0.3396
2002	188	5489	75	56	0.7467	73.1867	110.9218	74.5286	165.0862	0.2008
2003	188	4594	75	44	0.5867	61.2533	54.8082	27.2643	110.1783	0.3600
2004	187	3576	75	43	0.5733	47.6800	37.2202	17.8667	77.5379	0.3797
2005	186	5658	75	44	0.5867	75.4400	52.9562	26.3357	106.4850	0.3602
2006	186	3289	75	53	0.7067	43.8533	75.0883	48.6311	115.9392	0.2198
2007	187	4175	75	47	0.6267	55.6667	61.4819	34.2469	110.3756	0.2989
2008	186	1719	75	50	0.6667	22.9200	37.3879	22.8241	61.2447	0.2506
2009	186	3714	75	43	0.5733	49.5200	32.9888	15.8383	68.7108	0.3796
2010	186	1757	75	48	0.6400	23.4267	29.1522	16.8016	50.5815	0.2808
2011	186	4332	75	51	0.6800	57.7600	63.8025	39.8626	102.1199	0.2385
2012	186	4720	75	50	0.6667	62.9333	42.0696	25.6694	68.9477	0.2508

Figure A1. 1988-2012 NJ trawl survey smooth dogfish nominal (obcpue) and estimated (estcpue) indices with 95% confidence limits (LCI0, UCI0).