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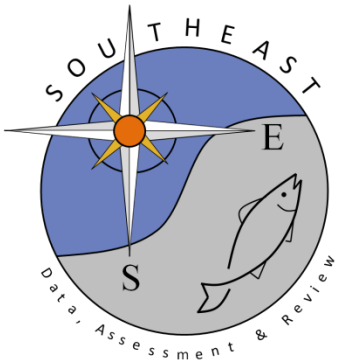

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Smoothhound Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of Mexico

Adam G. Pollack[1] and G. Walter Ingram, Jr.[2]

[1] Riverside Technology, Inc.
NOAA Fisheries, Southeast Fisheries Science Center,
Mississippi Laboratories, Pascagoula, MS

[2] NOAA Fisheries, Southeast Fisheries Science Center,
Mississippi Laboratories, Pascagoula, MS

Abstract

The Southeast Fisheries Science Center Mississippi Laboratories and state partners have conducted groundfish surveys since 1972 in the northern Gulf of Mexico during the summer and fall under several sampling programs. In 1987, both groundfish surveys were brought under the Southeast Area Monitoring and Assessment Program (SEAMAP). These fisheries independent data were used to develop abundance indices for smoothhound sharks (Mustelus sp.). Separate indices were produced using the summer and fall SEAMAP groundfish survey data. In addition, an index was produced using a shortened time series from the fall survey data.

Introduction

The Southeast Fisheries Science Center Mississippi Laboratories (MSLABS) and state partners have conducted standardized groundfish surveys under the Southeast Area Monitoring and Assessment Program (SEAMAP) in the Gulf of Mexico (GOM) since 1987. Prior to 1987, the summer survey was conducted under SEAMAP protocols; however, the fall survey operated independent of SEAMAP and dates back to 1972. The Southeast Area Monitoring and Assessment Program is a collaborative effort between federal, state and university programs, designed to collect, manage and distribute fishery independent data throughout the region. The primary objective of this trawl survey is to collect data on the abundance and distribution of demersal organisms in the northern GOM. This survey, which is conducted semi-annually (summer and fall), provides an important source of fisheries independent information on many commercially and recreationally important species throughout the GOM. The purpose of this document is to provide abundance indices for smoothhound sharks (*Mustelus sp.*).

Methodology

Survey Design

The survey methodologies and descriptions of the datasets used herein have been presented in detail by Nichols (2004) and Pollack and Ingram (2010). A change to the survey design was implemented between the summer and fall surveys of 2008. Prior to the fall survey of 2008, the basic structure of the groundfish surveys (i.e. 1987- summer of 2008) follows a stratified random station location assignment with strata derived from depth zones (5-6, 6-7, 7-8, 8-9, 9-10, 10-11, 11-12, 12-13, 13-14, 14-15, 15-16, 16-17, 17-18, 18-19, 19-20, 20-22, 22-25, 25-30, 30-35, 35-

40, 40-45, 45-50 and 50-60 fathoms), shrimp statistical zones (between 88° and 97° W longitude, statistical zones from west to east: 21-20, 19-18, 17-16, 15-13 and 12-10), and time of day (i.e. day or night). Survey methodology prior to 1987 was presented in detail by Nichols (2004).

Starting in the fall of 2008 and continuing until the present, station allocation is randomized within each shrimp statistical zone with a weighting by area. Other notable changes included a standardized 30 minute tow and dropping the day/night stratification. The main purpose of these changes was to increase the sample size of each survey and expand the survey into the waters off of Florida. Recently, a new modification was added to the survey design, a depth stratification of 5 - 20 fathoms and 20 – 60 fathoms.

Data

A total of 18,423 stations were sampled from 1972- 2012 with 7790 and 10,633 stations sampled during the summer and fall survey, respectively (Tables 1 and 2). Trawl data was obtained from the MSLABS trawl unit leader (Gilmore Pellegrin) and combined with data from the Gulf States Marine Fisheries Commission (GSMFC) database, which contains data collected by state agencies/partners from Alabama, Florida, Louisiana, Mississippi and Texas. For this document, all smoothhound sharks captured (*Mustelus sp., Mustelus canis* (smooth dogfish)*, Mustelus norrisi* (Florida smoothhound)*,* and *Mustelus sinusmexicanus* (Gulf smoothhound)) have been grouped together and were treated as a species complex.

Data Caveats

The survey area has been expanded throughout the course of the fall time series. Prior to 1987, the areas of East Louisiana and Mississippi/Alabama (Figure 1) were considered the primary sampling area, areas directly west and east of the primary were designated the secondary sampling areas; East Florida and Texas were not sampled. During this time, triplicate 10 minute tows were done at each station. For the purpose of this analysis, those stations were collapsed down and treated as a single station.

From 1987 – 2008, the area sampled was from Brownsville, TX to Mobile Bay, AL, sampling rarely extended past Mobile Bay due to an increase in the number of hangs. During this time, tow length was dependent on how long it took to cover a full depth stratum (defined above). However, single tows never exceeded 55 minutes. Full details about this survey can be found in Nichols (2004).

Beginning the 2009, sampling was expanded to cover the eastern GOM, down to the Florida Keys. The other changes to the survey are outline above in the survey design section and in and Pollack and Ingram (2010).

Data Exclusions

Data was limited to only those stations that did not indicate a problem with the tow, and were outside of shrimp statistical zone 12, and between 5 and 60 fathoms. In addition, data collected

by Texas was excluded because of the use of a different gear type (20 foot shrimp trawl vs. the 40 foot shrimp trawl).

Index Construction

Delta-lognormal modeling methods were used to estimate relative abundance indices for smoothhound (Lo *et al*. 1992). The main advantage of using this method is allowance for the probability of zero catch (Ortiz *et al.* 2000). The index computed by this method is a mathematical combination of yearly abundance estimates from two distinct generalized linear models: a binomial (logistic) model which describes proportion of positive abundance values (i.e. presence/absence) and a lognormal model which describes variability in only the nonzero abundance data (Lo *et al*. 1992).

The delta-lognormal index of relative abundance (I_y) as described by Lo *et al*. (1992) was estimated as:

(1) $$I_y = c_y p_y,$$

where c_y is the estimate of mean CPUE for positive catches only for year y, and p_y is the estimate of mean probability of occurrence during year y. Both c_y and p_y were estimated using generalized linear models. Data used to estimate abundance for positive catches (c) and probability of occurrence (p) were assumed to have a lognormal distribution and a binomial distribution, respectively, and modeled using the following equations:

(2) $$\ln(c) = X\beta + \varepsilon$$

and

(3) $$p = \frac{e^{\mathbf{X}\beta+\varepsilon}}{1+e^{\mathbf{X}\beta+\varepsilon}},$$

respectively, where c is a vector of the positive catch data, p is a vector of the presence/absence data, X is the design matrix for main effects, β is the parameter vector for main effects, and ε is a vector of independent normally distributed errors with expectation zero and variance σ^2. Therefore, c_y and p_y were estimated as least-squares means for each year along with their corresponding standard errors, SE (c_y) and SE (p_y), respectively. From these estimates, I_y was calculated, as in equation (1), and its variance calculated as:

(4) $$V(I_y) \approx V(c_y)p_y^2 + c_y^2 V(p_y) + 2c_y p_y \mathrm{Cov}(c, p),$$

where:

(5) $$\mathrm{Cov}(c, p) \approx \rho_{c,p}\left[\mathrm{SE}(c_y)\mathrm{SE}(p_y)\right],$$

and $\rho_{c,p}$ denotes correlation of c and p among years.

The submodels of the delta-lognormal model were built using a backward selection procedure based on type 3 analyses with an inclusion level of significance of $\alpha = 0.05$. Binomial submodel performance was evaluated using AIC, while the performance of the lognormal submodel was evaluated based on analyses of residual scatter and QQ plots in addition to AIC. Variables that could be included in the submodels were:

Submodel Variables (SEAMAP Summer Groundfish)

Year: 1982 – 2012
Depth Zone: 5-60 fathoms (continuous)
Region: Texas, West Louisiana, East Louisiana, Mississippi/Alabama, West Florida, East Florida (Figure 1)
Time of Day: Day, Night

Submodel Variables (SEAMAP Fall Groundfish, 1972-2012)

Year: 1972 – 2012
Region: Texas, West Louisiana, East Louisiana, Mississippi/Alabama, West Florida, East Florida (Figure 1)
Depth: 5 – 60 fathoms (continuous)
Time of Day: Day, Night

Submodel Variables (SEAMAP Fall Groundfish, 1988-2012)

Year: 1988 – 2012
Region: Texas, West Louisiana, East Louisiana, Mississippi/Alabama, West Florida, East Florida (Figure 1)
Depth: 5 – 60 fathoms (continuous)
Time of Day: Day, Night

A variable representing survey design (Early: 1972-1986, Old: 1987-2007 and New: 2008-2012) was considered for inclusion in the submodels for the fall time series. However, when this variable was added to the submodels, the models failed to converge, thus it was removed.

Results and Discussion

Size

The distribution of smoothhound is presented in Figure 2, with seasonal/annual abundance and distribution presented in the Appendix Figure 1. The total number of smoothhound captured ranged from 0 to 50 in the summer (Table 3) and 0 to 29 in the fall (Table 4). Of the 487 smoothhound captured during the summer survey, a total of 441 were measured from 1988 – 2012 with an average total length of 637 mm. While during the fall survey 379 smoothhound were captured, with 289 measured, with an average total length of 701 mm. The length frequency distribution of smoothhound captured is shown in Figure 3.

SEAMAP Summer Groundfish

For the Summer SEAMAP abundance index of smoothhound, the nominal CPUE and number of stations with a positive catch are presented in Figure 4. Year, region, time of day and depth were retained in the binomial submodel, while year and region were retained in the lognormal submodel. A summary of the factors used in the analysis is presented in Appendix Table 1. Table 5 summarizes the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 53,250.3 and 618.8, respectively. The diagnostic plots for the binomial and lognormal submodels are shown in Figures 5-7, and indicated the distribution of the residuals is approximately normal. Annual abundance indices are presented in Table 6 and Figure 8.

SEAMAP Fall Groundfish, 1972 - 2012

For the Fall SEAMAP abundance index (1972 - 2012) of smoothhound, the nominal CPUE and number of stations with a positive catch are presented in Figure 9. Year, region, time of day and depth were retained in the binomial submodel, while year and region were retained in the lognormal submodel. A summary of the factors used in the analysis is presented in Appendix Table 1. Table 7 summarizes the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 74,612.4 and 462.9, respectively. There was a slight increase in AIC between the second and third lognormal submodels (462.4 and 462.9), however due to the insignificance of time of day, this increase was deemed acceptable. The diagnostic plots for the binomial and lognormal submodels are shown in Figures 10-12, and indicated the distribution of the residuals is approximately normal. Annual abundance indices are presented in Table 8 and Figure 13.

SEAMAP Fall Groundfish, 1988 - 2012

For the Fall SEAMAP abundance index (1988 - 2012) of smoothhound, the nominal CPUE and number of stations with a positive catch are presented in Figure 14. Year, region, time of day and depth were retained in both the binomial and lognormal submodels. A summary of the factors used in the analysis is presented in Appendix Table 2. Table 9 summarizes backward selection procedure used to select the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 47,222.6 and 419.0, respectively. The diagnostic plots for the binomial and lognormal submodels are shown in Figures 15-17, and indicated the distribution of the residuals is approximately normal. Annual abundance indices are presented in Table 10 and Figure 18.

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Table 1. Number of stations sampled by shrimp statistical zone during the Summer SEAMAP groundfish survey from 1982-2012.

	Shrimp Statistical Zone																			
Year	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	Total
1982									14	36	24	26	8	1	11	30	10	3	23	**186**
1983							5	19	8	26		6	16	19	25	24	21	5	17	**191**
1984									13	36	10	16	16	22	17	15	23	28	14	**210**
1985									10	48	11	27	12	10	7	7	12	11	10	**165**
1986									17	49	4	20	14	8	11	8	11	14	6	**162**
1987									27	58	8	34	21	25	20	16	25	28	19	**281**
1988									17	46	10	14	9	19	24	14	25	28	23	**229**
1989									21	30	8	13	18	25	7	15	20	29	24	**210**
1990										65	18	31	17	23	16	20	23	24	20	**257**
1991										44	16	41	13	23	22	24	18	23	26	**250**
1992									1	44	2	36	30	20	25	12	31	26	20	**247**
1993										44	22	29	19	24	19	14	29	24	22	**246**
1994										60	12	27	28	25	17	20	22	26	22	**259**
1995										42	12	26	24	22	23	13	27	26	21	**236**
1996										46	14	34	19	22	18	17	21	26	25	**242**
1997										42	4	26	22	22	23	10	28	26	26	**229**
1998										34	6	28	27	25	18	14	22	36	17	**227**
1999										43	11	31	26	20	23	13	25	32	20	**244**
2000										43	11	27	19	19	27	8	29	31	21	**235**
2001										34	15	24	28	13	3	10	9	17	21	**174**
2002										44	15	34	21	27	19	15	25	29	22	**251**
2003										42	17	26	8	2	17	20	22	26	23	**203**
2004										38	19	28	21	20	25	21	19	25	21	**237**
2005										31	10	9	23	16	21	5	28	22	27	**192**
2006										45	17	29	16	20	23	17	23	31	18	**239**
2007										40	12	10	23	22	23	7	29	32	21	**219**
2008			1	8	11	6	11	8	11	42	24	19	27	23	22	17	24	21	29	**304**
2009			36	23	29	16	17	18	24	67	25	20	36	39	46	53	33	29	23	**534**
2010		31	26	21	26	10	12	14	15	22	5	20	16	21	33	34	27	27	19	**379**
2011	11	24	22	20	29	2	15	11	8	10	7	14	17	24	29	29	18	21	13	**324**
2012	12	39	33	29	30	19	16	17	13	16	14	27	27	25	29	27	20	20	15	**428**
Total	***23***	***94***	***118***	***101***	***125***	***53***	***76***	***87***	***199***	***1267***	***383***	***752***	***621***	***626***	***643***	***549***	***699***	***746***	***628***	***7790***

Table 2. Number of stations sampled by shrimp statistical zone during the Fall SEAMAP groundfish survey from 1972-2012.

	Shrimp Statistical Zone																		
Year	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	Total
1972								10	55	27	41	34	17						**184**
1973							11	17	98	34	71	39	2						**272**
1974								12	92	35	73	31							**243**
1975									93	33	80	35	32	7					**280**
1976									108	42	79	56	22						**307**
1977									97	31	76	38							**242**
1978								36	101	32	67	58	25						**319**
1979									109	35	72	55	2						**273**
1980								24	85	22	70	32							**233**
1981								21	85	33	66	49	25						**279**
1982								21	102	41	72	37							**273**
1983								17	82	35	63	25							**222**
1984									82	32	64	47	1						**226**
1985								30	63	23	37	53	32	10	20	20	19	19	**326**
1986						20	10	25	34	13	27	14	27	35	26	23	22	21	**297**
1987								13	22	29	29	26	17	15	15	15	18	3	**202**
1988								8	27	10	28	24	18	26	19	21	31	20	**232**
1989									43	16	31	23	22	20	17	22	25	26	**245**
1990									52	20	22	27	22	19	18	22	19	27	**248**
1991									45	16	32	18	20	25	24	19	25	22	**246**
1992									32	15	31	14	25	18	17	27	30	18	**227**
1993									70	14	35	19	26	18	16	25	28	18	**269**
1994									49	17	24	27	25	20	21	23	24	20	**250**
1995									39	14	29	24	24	19	14	26	30	19	**238**
1996									43	11	36	21	17	28	13	25	29	24	**247**
1997									43	18	31	20	26	19	18	23	22	24	**244**
1998									43	28	50	14	34	11	15	24	29	22	**270**
1999									42	9	38	18	29	18	12	28	29	22	**245**
2000									42	10	27	28	20	26	12	30	25	21	**241**
2001									21	14	30	22	26	20	14	27	28	23	**225**
2002								1	49	16	27	26	22	23	14	26	30	21	**255**
2003								1	74	20	20	21	24	22	20	23	25	23	**273**
2004									43	6	23	24	17	27	14	24	30	21	**229**
2005									43	21	30	18	33	18	14	23	24	27	**251**
2006								1	46	7	22	14	18	28	13	23	32	19	**223**
2007									31	15	27	26	18	28	17	20	18	26	**226**

	Shrimp Statistical Zone																		
Year	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	Total
2008			15	14	4	4	3	4	34	16	28	34	42	46	44	19	36	20	**363**
2009		20	21	25	11	21	13	12	47	12	23	23	30	49	47	31	36	22	**443**
2010		9	27	27	18	16	11	14	16	7	15	18	26	31	29	18	19	14	**315**
2011						9	11	6	11	9	25	21	32	31	28	21	19	15	**238**
2012	2	3	6	6	17	10	7	4	9	10	22	15	19	22	22	13	14	11	**212**
Total	***2***	***32***	***69***	***72***	***50***	***80***	***66***	***277***	***2302***	***848***	***1693***	***1168***	***817***	***679***	***553***	***641***	***716***	***568***	***10633***

Table 3. Summary of the smoothhound length data collected during Summer SEAMAP groundfish surveys conducted between 1982 and 2012. (Note that prior to 1988, no length data for smoothhound is available.)

Survey Year	Number of Stations	Number Collected	Number Measured	Minimum Fork Length (mm)	Maximum Fork Length (mm)	Mean Fork Length (mm)	Standard Deviation (mm)
1982	186	2					
1983	191	0					
1984	210	4					
1985	165	2					
1986	162	4					
1987	281	6					
1988	229	1	1	980	980	980	
1989	210	4	4	525	978	742	243
1990	257	14	14	465	1180	611	229
1991	250	6	5	393	1187	678	307
1992	247	28	26	473	1230	619	178
1993	246	14	13	364	1322	606	248
1994	259	30	29	362	1295	640	221
1995	236	23	21	419	1250	576	204
1996	242	26	25	416	1167	615	238
1997	229	20	18	436	1313	706	302
1998	227	11	11	445	993	711	177
1999	244	11	9	452	860	583	139
2000	235	28	28	420	1181	643	223
2001	174	11	11	472	880	582	124
2002	251	15	14	418	955	581	155
2003	203	12	11	486	1075	650	196
2004	237	14	14	454	1270	679	235
2005	192	9	9	506	961	671	164
2006	239	25	21	426	1180	612	185
2007	219	24	24	473	1130	667	189
2008	304	16	16	486	823	579	93
2009	534	50	48	316	1225	653	209
2010	379	16	13	439	1314	650	231
2011	324	22	21	365	1075	667	191
2012	428	39	35	420	1216	625	219

Total Number of Years	Total Number of Stations	Total Number Collected	Total Number Measured	Overall Mean Fork Length (mm)
31	7790	487	441	637

Table 4. Summary of the smoothhound length data collected during Fall SEAMAP groundfish surveys conducted between 1972 and 2012. (Note that prior to 1988, no length data for smoothhound is available.)

Survey Year	Number of Stations	Number Collected	Number Measured	Minimum Fork Length (mm)	Maximum Fork Length (mm)	Mean Fork Length (mm)	Standard Deviation (mm)
1972	184	1					
1973	272	0					
1974	243	0					
1975	280	3					
1976	307	2					
1977	242	2					
1978	319	9					
1979	273	2					
1980	233	1					
1981	279	1					
1982	273	5					
1983	222	0					
1984	226	0					
1985	326	15					
1986	297	4					
1987	202	0					
1988	232	7	7	569	835	668	100
1989	245	13	9	622	1215	852	212
1990	248	9	9	622	1235	972	248
1991	246	5	5	500	1275	801	291
1992	227	3	3	625	696	649	40
1993	269	12	9	555	1086	756	197
1994	250	21	17	582	1294	901	253
1995	238	17	17	524	1275	800	252
1996	247	11	11	572	957	710	147
1997	244	14	14	537	1202	766	220
1998	270	9	7	609	1095	821	184
1999	245	9	9	574	1050	729	170
2000	241	19	19	550	795	616	78
2001	225	11	11	578	930	706	116
2002	255	10	9	559	739	635	56
2003	273	8	8	404	1201	640	247
2004	229	16	16	534	951	677	140
2005	251	12	12	533	910	700	129
2006	223	29	27	510	1010	642	107

Survey Year	Number of Stations	Number Collected	Number Measured	Minimum Fork Length (mm)	Maximum Fork Length (mm)	Mean Fork Length (mm)	Standard Deviation (mm)
2007	226	9	9	526	765	649	89
2008	363	31	30	415	763	588	68
2009	443	22	16	321	827	581	147
2010	315	14	10	507	755	633	85
2011	238	16	2	588	591	590	2
2012	212	7	3	541	628	579	45

Total Number of Years	Total Number of Stations	Total Number Collected	Total Number Measured	Overall Mean Fork Length (mm)
41	10633	379	289	701

Table 5. Summary of backward selection procedure for building delta-lognormal submodels for smoothhound Summer SEAMAP groundfish survey index of relative abundance from 1982 to 2012.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 53250.3)*						*Lognormal Submodel Type 3 Tests (AIC 629.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	29	2505	68.85	2.36	<.0001	<.0001	29	286	3.50	<.0001
Depth	1	4991	418.68	418.68	<.0001	<.0001	1	286	0.07	0.7863
Region	5	3217	102.48	20.49	<.0001	<.0001	5	286	4.61	0.0005
Time of Day	1	5010	27.80	27.80	<.0001	<.0001	1	286	0.20	0.6583
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 53250.3)*						*Lognormal Submodel Type 3 Tests (AIC 626.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	29	2505	68.85	2.36	<.0001	<.0001	29	287	3.51	<.0001
Depth	1	4991	418.68	418.68	<.0001	<.0001	1	287	0.06	0.8071
Region	5	3217	102.48	20.49	<.0001	<.0001	5	287	4.64	0.0004
Time of Day	1	5010	27.80	27.80	<.0001	<.0001	Dropped			
Model Run #3	*Binomial Submodel Type 3 Tests (AIC 53250.3)*						*Lognormal Submodel Type 3 Tests (AIC 616.8)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	29	2505	68.85	2.36	<.0001	<.0001	29	288	3.52	<.0001
Depth	1	4991	418.68	418.68	<.0001	<.0001	Dropped			
Region	5	3217	102.48	20.49	<.0001	<.0001	5	288	4.77	0.0003
Time of Day	1	5010	27.80	27.80	<.0001	<.0001	Dropped			

Table 6. Indices of smoothhound abundance developed using the delta-lognormal model for Summer SEAMAP groundfish survey from 1982-2012. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1982	0.010753	186	0.018546	0.68569	0.85975	0.15487	3.0358
1983	0	191	0				
1984	0.014286	210	0.012710	0.46994	0.56677	0.16353	1.3504
1985	0.012121	165	0.009599	0.35489	0.71329	0.09841	1.2798
1986	0.024691	162	0.020740	0.76680	0.61316	0.24773	2.3735
1987	0.017794	281	0.015690	0.58012	0.66725	0.17235	1.9526
1988	0.004367	229	0.000945	0.03493	1.05971	0.00616	0.1981
1989	0.014286	210	0.008794	0.32513	0.45027	0.13768	0.7678
1990	0.038911	257	0.022878	0.84584	0.37799	0.40726	1.7568
1991	0.020000	250	0.009085	0.33588	0.50842	0.12874	0.8763
1992	0.068826	247	0.035733	1.32115	0.31792	0.71028	2.4574
1993	0.040650	246	0.017213	0.63641	0.33575	0.33102	1.2235
1994	0.061776	259	0.041759	1.54394	0.33692	0.80134	2.9747
1995	0.059322	236	0.029265	1.08200	0.33940	0.55902	2.0942
1996	0.057851	242	0.025709	0.95053	0.31039	0.51825	1.7434
1997	0.056769	229	0.020574	0.76067	0.37282	0.36970	1.5651
1998	0.035242	227	0.019008	0.70276	0.46956	0.28780	1.7160
1999	0.032787	244	0.012495	0.46197	0.45953	0.19250	1.1087
2000	0.093617	235	0.042008	1.55315	0.30945	0.84831	2.8436
2001	0.040230	174	0.029510	1.09106	0.41439	0.49213	2.4189
2002	0.047809	251	0.022816	0.84355	0.36446	0.41626	1.7095
2003	0.034483	203	0.022841	0.84449	0.37235	0.41078	1.7361
2004	0.037975	237	0.017483	0.64639	0.36859	0.31658	1.3198
2005	0.036458	192	0.029127	1.07689	0.37408	0.52219	2.2208
2006	0.066946	239	0.042803	1.58254	0.31264	0.85922	2.9148
2007	0.063927	219	0.024947	0.92237	0.30250	0.51038	1.6669
2008	0.042763	304	0.015377	0.56852	0.31837	0.30540	1.0583
2009	0.048689	534	0.058582	2.16592	0.58398	0.73304	6.3997
2010	0.031662	379	0.035944	1.32894	0.32978	0.69891	2.5269
2011	0.052469	324	0.065566	2.42413	0.47774	0.97889	6.0031
2012	0.060748	428	0.083667	3.09340	0.66656	0.92001	10.4012

Table 7. Summary of backward selection procedure for building delta-lognormal submodels for smoothhound Fall SEAMAP groundfish survey index of relative abundance from 1972 to 2012.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 74612.4)*						*Lognormal Submodel Type 3 Tests (AIC 469.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	35	3245	179.09	5.08	<.0001	<.0001	35	216	4.14	<.0001
Depth	1	5584	1050.36	1050.36	<.0001	<.0001	1	216	2.52	0.1137
Region	5	2360	104.09	20.81	<.0001	<.0001	5	216	9.54	<.0001
Time of Day	1	6095	56.81	56.81	<.0001	<.0001	1	216	4.02	0.0461
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 74612.4)*						*Lognormal Submodel Type 3 Tests (AIC 462.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	35	3245	179.09	5.08	<.0001	<.0001	35	217	4.05	<.0001
Depth	1	5584	1050.36	1050.36	<.0001	<.0001		Dropped		
Region	5	2360	104.09	20.81	<.0001	<.0001	5	217	9.67	<.0001
Time of Day	1	6095	56.81	56.81	<.0001	<.0001	1	217	3.61	0.0588
Model Run #3	*Binomial Submodel Type 3 Tests (AIC 74612.4)*						*Lognormal Submodel Type 3 Tests (AIC 462.9)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	35	3245	179.09	5.08	<.0001	<.0001	35	218	3.95	<.0001
Depth	1	5584	1050.36	1050.36	<.0001	<.0001		Dropped		
Region	5	2360	104.09	20.81	<.0001	<.0001	5	218	9.98	<.0001
Time of Day	1	6095	56.81	56.81	<.0001	<.0001		Dropped		

Table 8. Indices of smoothhound abundance developed using the delta-lognormal model for Fall SEAMAP groundfish survey 1972-2012. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1972	0.005435	184	0.000314	0.04476	1.55596	0.00487	0.41129
1973	0	272	0				
1974	0	243	0				
1975	0.010714	280	0.006184	0.88029	0.59403	0.29317	2.64323
1976	0.006515	307	0.002180	0.31032	2.95271	0.01520	6.33324
1977	0.008264	242	0.001678	0.23891	0.54866	0.08564	0.66651
1978	0.021944	319	0.009674	1.37707	0.49521	0.53974	3.51340
1979	0.007326	273	0.002369	0.33720	0.55276	0.12006	0.94708
1980	0.004292	233	0.000925	0.13167	0.65350	0.03995	0.43397
1981	0.003584	279	0.000864	0.12303	1.15783	0.01946	0.77805
1982	0.014652	273	0.004444	0.63255	0.46059	0.26309	1.52083
1983	0	222	0				
1984	0	226	0				
1985	0.027607	326	0.012435	1.76999	0.79771	0.43494	7.20288
1986	0.013468	297	0.003200	0.45545	0.94893	0.09171	2.26179
1987	0	202	0				
1988	0.021552	232	0.003679	0.52365	0.51859	0.19730	1.38976
1989	0.036735	245	0.006995	0.99565	0.45456	0.41847	2.36888
1990	0.028226	248	0.007225	1.02838	0.39069	0.48393	2.18537
1991	0.016260	246	0.001793	0.25521	0.46169	0.10595	0.61476
1992	0.013216	227	0.003140	0.44693	0.51926	0.16821	1.18750
1993	0.022305	269	0.003176	0.45209	0.47815	0.18243	1.12034
1994	0.040000	250	0.008167	1.16249	0.40757	0.53075	2.54618
1995	0.063025	238	0.019647	2.79661	0.37934	1.34323	5.82254
1996	0.032389	247	0.004809	0.68458	0.45206	0.28899	1.62172
1997	0.045082	244	0.006394	0.91010	0.44522	0.38880	2.13039
1998	0.022222	270	0.005551	0.79021	0.40751	0.36082	1.73059
1999	0.032653	245	0.004406	0.62709	0.43295	0.27372	1.43666
2000	0.045643	241	0.010805	1.53798	0.37222	0.74830	3.16101
2001	0.035556	225	0.004972	0.70771	0.43386	0.30841	1.62397
2002	0.035294	255	0.004157	0.59174	0.44555	0.25265	1.38596
2003	0.014652	273	0.001448	0.20610	0.46990	0.08436	0.50356
2004	0.043668	229	0.006080	0.86542	0.61724	0.27780	2.69598
2005	0.035857	251	0.005815	0.82769	0.45738	0.34618	1.97893

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
2006	0.062780	223	0.020539	2.92353	0.35581	1.46561	5.83172
2007	0.026549	226	0.006828	0.97194	0.41451	0.43830	2.15526
2008	0.052342	363	0.020259	2.88376	0.48697	1.14625	7.25504
2009	0.036117	443	0.015234	2.16844	0.33525	1.12894	4.16508
2010	0.028571	315	0.014628	2.08224	0.51601	0.78797	5.50239
2011	0.046218	238	0.012812	1.82373	0.62828	0.57538	5.78047
2012	0.023585	212	0.010085	1.43550	0.79051	0.35630	5.78345

Table 9. Summary of backward selection procedure for building delta-lognormal submodels for smoothhound Fall SEAMAP groundfish survey index of relative abundance from 1988 to 2012.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 47222.6)*						*Lognormal Submodel Type 3 Tests (AIC 419.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	24	2247	129.74	5.37	<.0001	<.0001	24	191	3.46	<.0001
Depth	1	4423	973.22	973.22	<.0001	<.0001	1	191	4.65	0.0322
Region	5	2313	79.11	15.82	<.0001	<.0001	5	191	11.54	<.0001
Time of Day	1	4661	30.68	30.68	<.0001	<.0001	1	191	3.93	0.0487

Table 10. Indices of smoothhound abundance developed using the delta-lognormal model for Fall SEAMAP groundfish survey 1988-2012. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1988	0.021552	232	0.004029	0.46641	0.51699	0.17621	1.23454
1989	0.036735	245	0.007776	0.90030	0.44639	0.38382	2.11177
1990	0.028226	248	0.007257	0.84015	0.39919	0.38937	1.81279
1991	0.016260	246	0.001952	0.22603	0.46922	0.09262	0.55162
1992	0.013216	227	0.003362	0.38917	0.52608	0.14481	1.04587
1993	0.022305	269	0.003558	0.41197	0.47500	0.16714	1.01543
1994	0.040000	250	0.008306	0.96155	0.40357	0.44215	2.09107
1995	0.063025	238	0.020471	2.36997	0.36083	1.17724	4.77110
1996	0.032389	247	0.004889	0.56606	0.45262	0.23872	1.34225
1997	0.045082	244	0.006870	0.79530	0.43939	0.34324	1.84275
1998	0.022222	270	0.005675	0.65698	0.41493	0.29605	1.45795
1999	0.032653	245	0.004499	0.52089	0.43864	0.22510	1.20535
2000	0.045643	241	0.010958	1.26867	0.37137	0.61822	2.60350
2001	0.035556	225	0.005330	0.61706	0.43241	0.26960	1.41235
2002	0.035294	255	0.004462	0.51655	0.44626	0.22027	1.21136
2003	0.014652	273	0.001415	0.16381	0.49048	0.06472	0.41459
2004	0.043668	229	0.006638	0.76847	0.61159	0.24889	2.37272
2005	0.035857	251	0.006057	0.70124	0.49531	0.27480	1.78944
2006	0.062780	223	0.020969	2.42763	0.35362	1.22190	4.82316
2007	0.026549	226	0.006325	0.73225	0.42726	0.32285	1.66084
2008	0.052342	363	0.020663	2.39221	0.46255	0.99162	5.77103
2009	0.036117	443	0.015131	1.75177	0.33952	0.90486	3.39136
2010	0.028571	315	0.014894	1.72432	0.51155	0.65743	4.52257
2011	0.046218	238	0.013423	1.55405	0.68616	0.44869	5.38246
2012	0.023585	212	0.011032	1.27719	0.88917	0.27752	5.87775

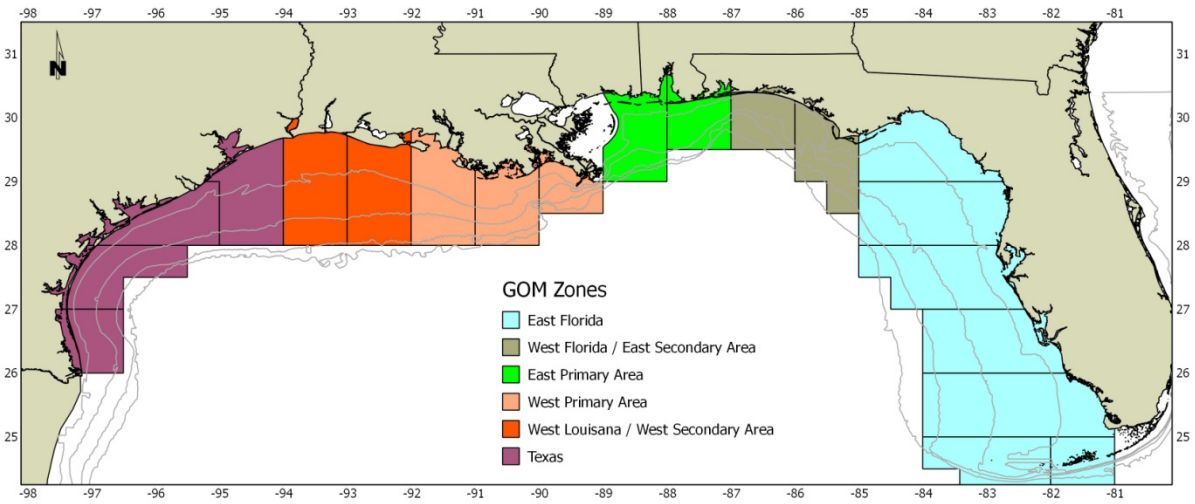


Figure 1. Combined areas for thel SEAMAP groundfish survey.

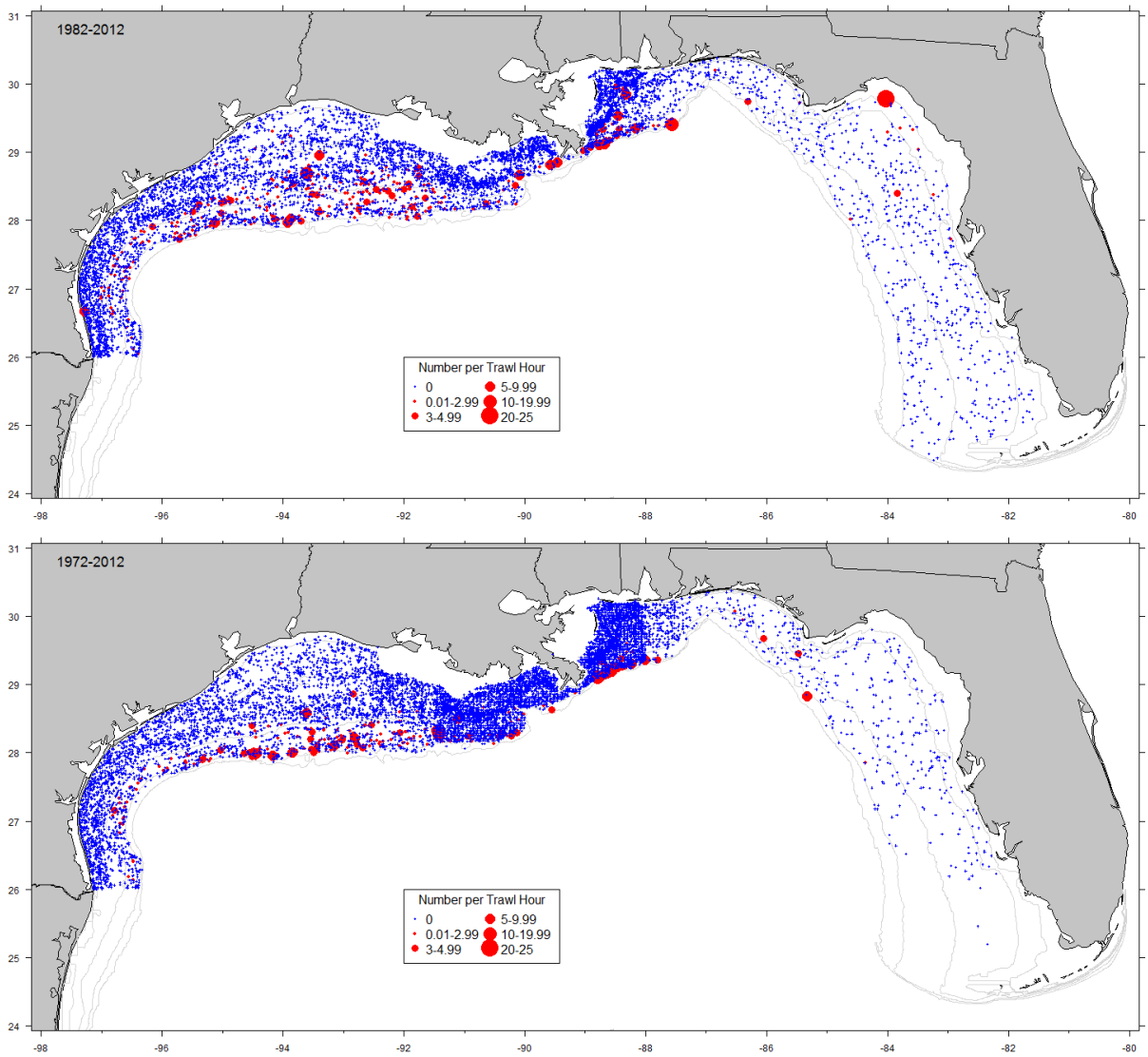


Figure 2. Stations sampled from 1982 to 2012 during the Summer (top) and from 1972 to 2012 during the Fall (bottom) SEAMAP Groundfish Survey with the CPUE for smoothhound.

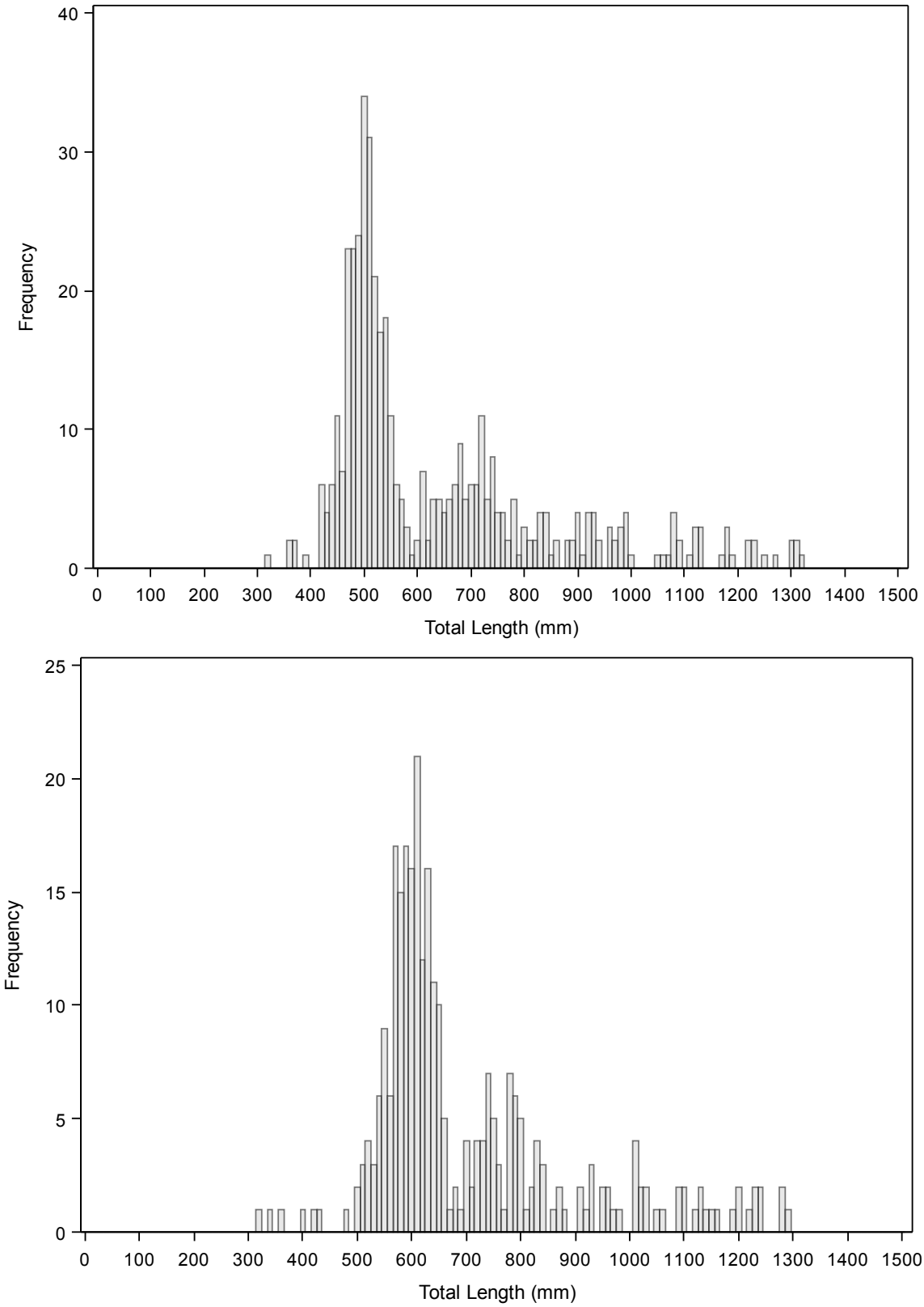


Figure 3. Length frequency histograms for smoothhound captured Summer (top) and Fall (bottom) SEAMAP Groundfish surveys from 1988-2012.

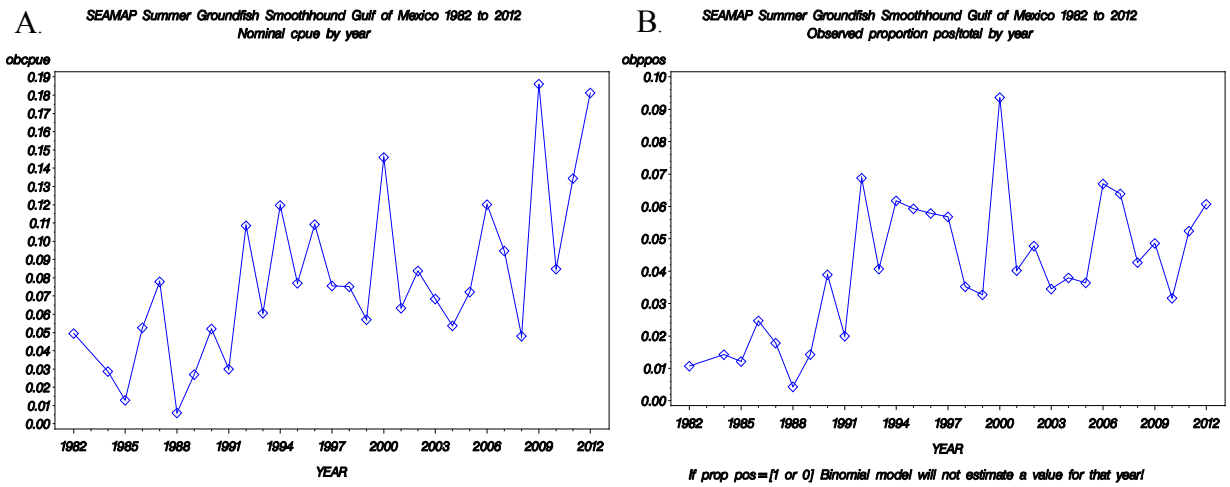


Figure 4. Annual trends for smoothhound captured during Summer SEAMAP Groundfish Surveys from 1982 to 2012 in **A.** nominal CPUE and **B.** proportion of positive stations.

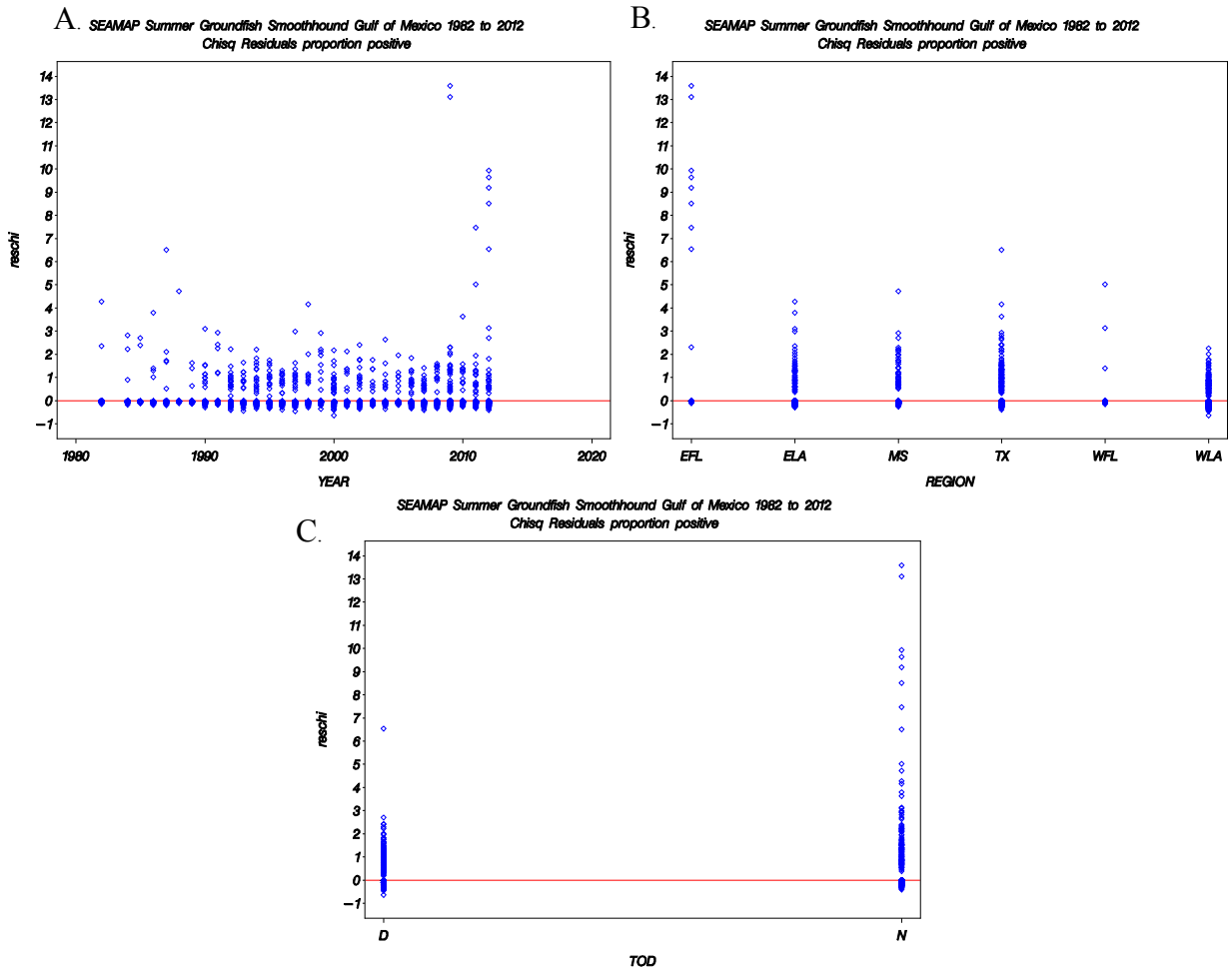


Figure 5. Diagnostic plots for binomial component of the smoothhound Summer SEAMAP Groundfish Survey model: **A.** the Chi-Square residuals by year, **B.** the Chi-Square residuals by region, and **C.** the Chi-Square residuals by time of day.

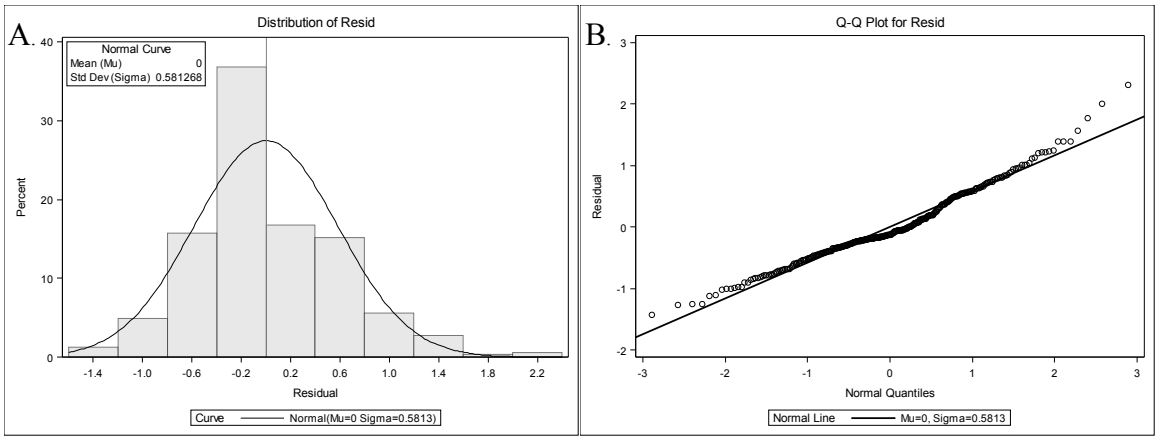


Figure 6. Diagnostic plots for lognormal component of the smoothhound Summer SEAMAP Groundfish Survey model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

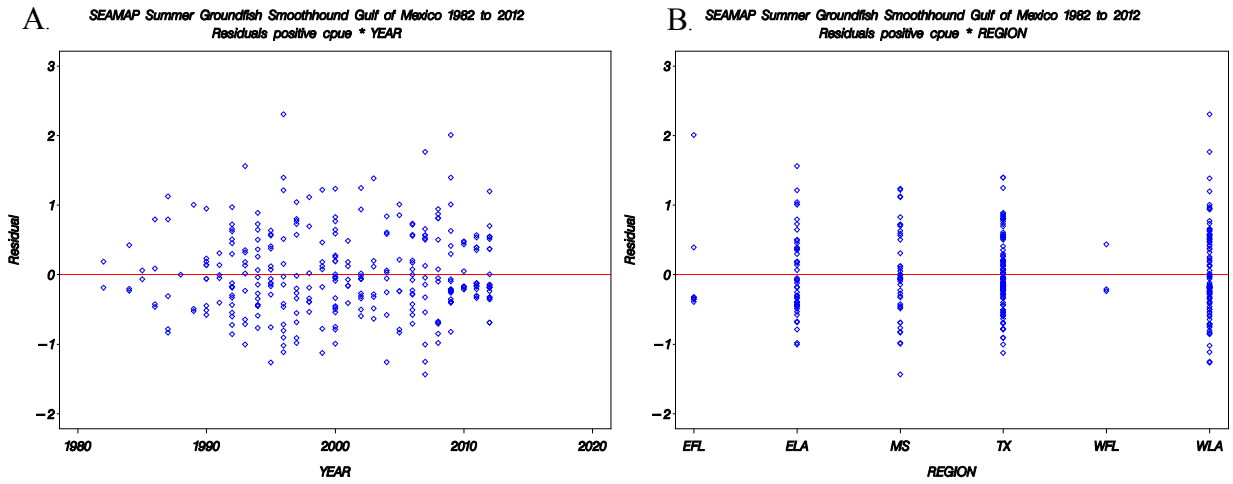


Figure 7. Diagnostic plots for lognormal component of the smoothhound Summer SEAMAP Groundfish Survey model: **A.** the Chi-Square residuals by year, and **B.** the Chi-Square residuals by region.

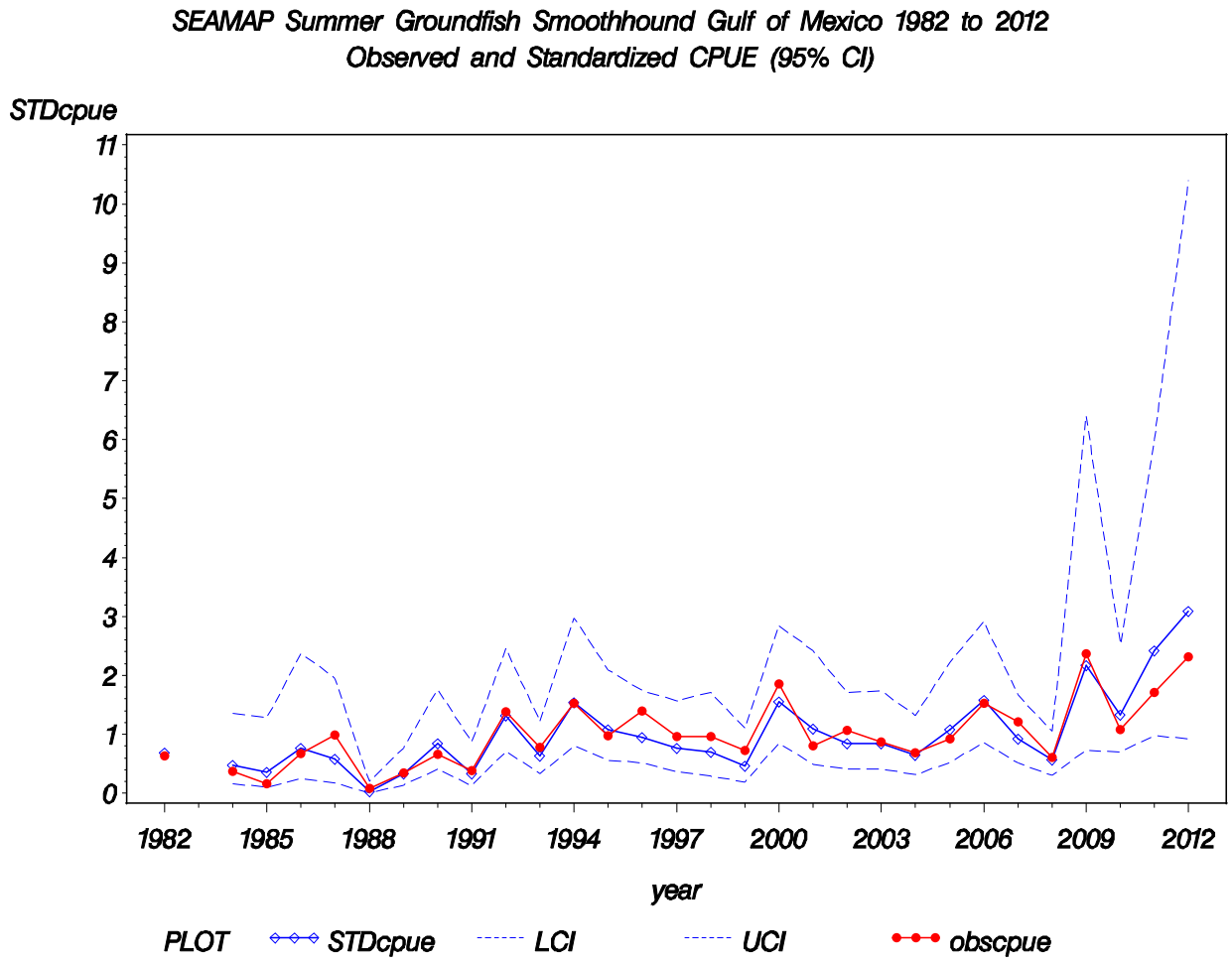


Figure 8. Annual index of abundance for smoothhound from the Summer SEAMAP Groundfish Survey from 1982 – 2012. (Note that the survey has been conducted annually since 1982, in 1983 no smoothhound were captured during the survey.)

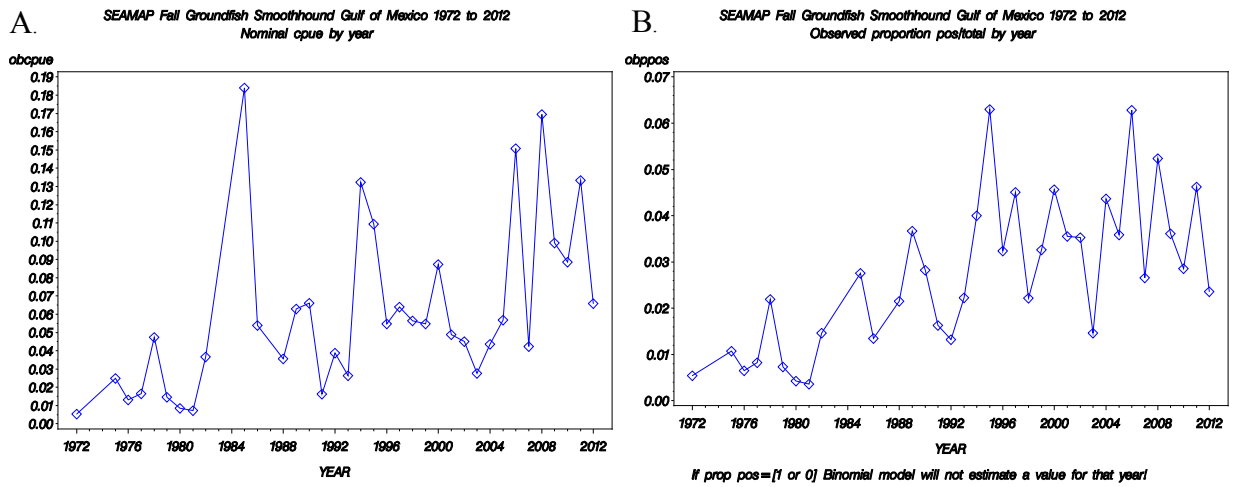


Figure 9. Annual trends for smoothhound captured during Fall SEAMAP Groundfish Surveys from 1972 to 2012 in **A.** nominal CPUE and **B.** proportion of positive stations.

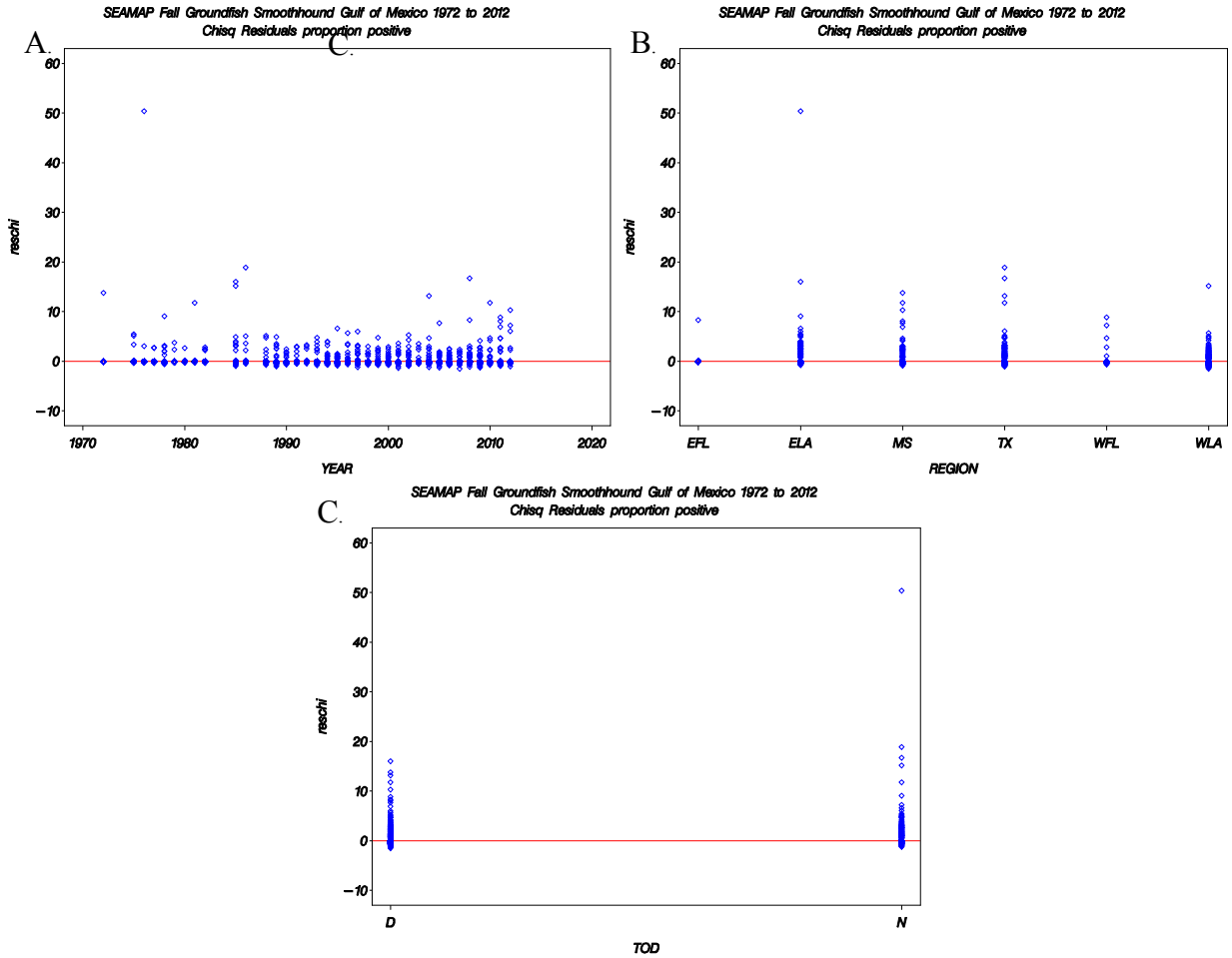


Figure 10. Diagnostic plots for binomial component of the smoothhound Fall SEAMAP Groundfish Survey model: **A.** the Chi-Square residuals by year, **B.** the Chi-Square residuals by region, and **C.** the Chi-Square residuals by time of day.

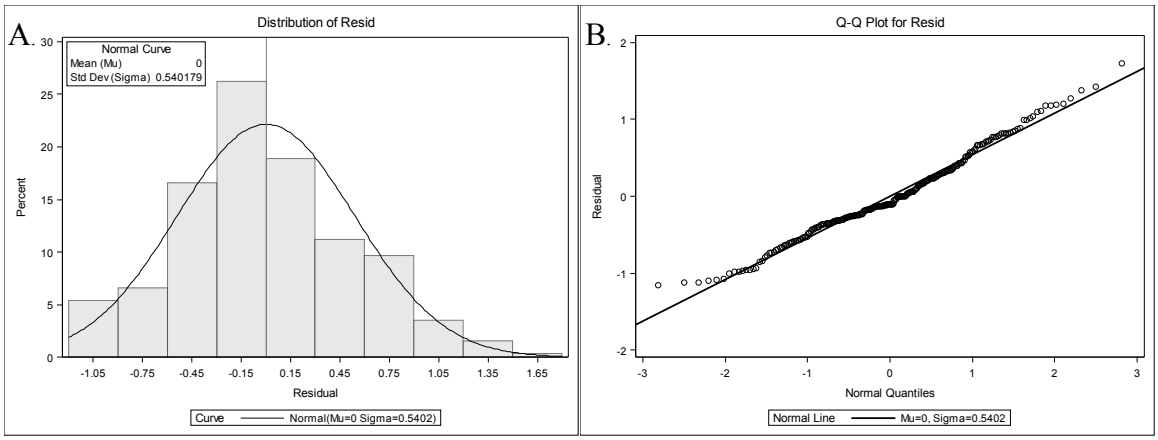


Figure 11. Diagnostic plots for lognormal component of the smoothhound Fall SEAMAP Groundfish Survey model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

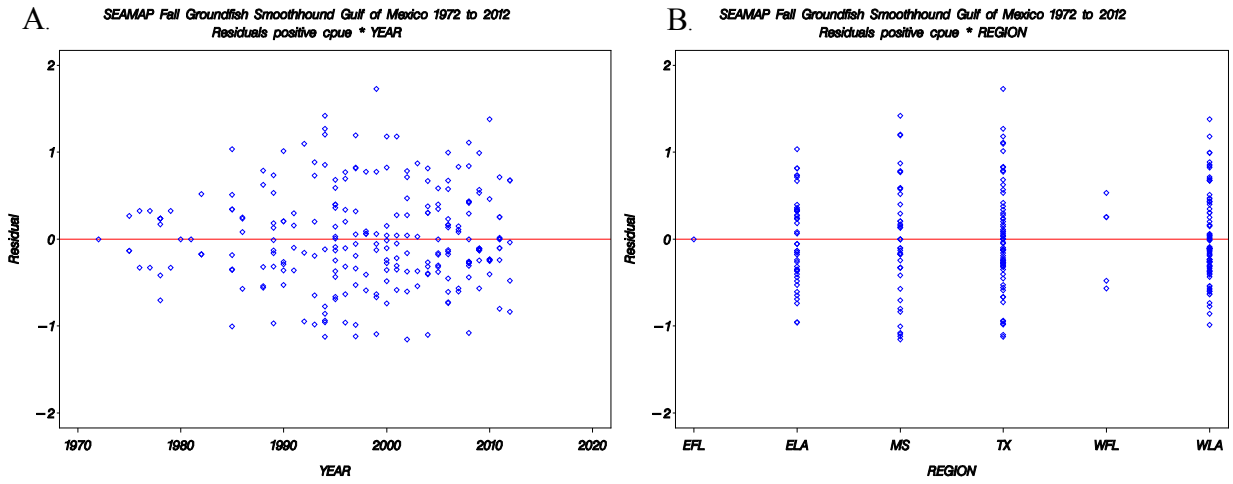


Figure 12. Diagnostic plots for lognormal component of the smoothhound Fall SEAMAP Groundfish Survey model: **A.** the Chi-Square residuals by year, and **B.** the Chi-Square residuals by region.

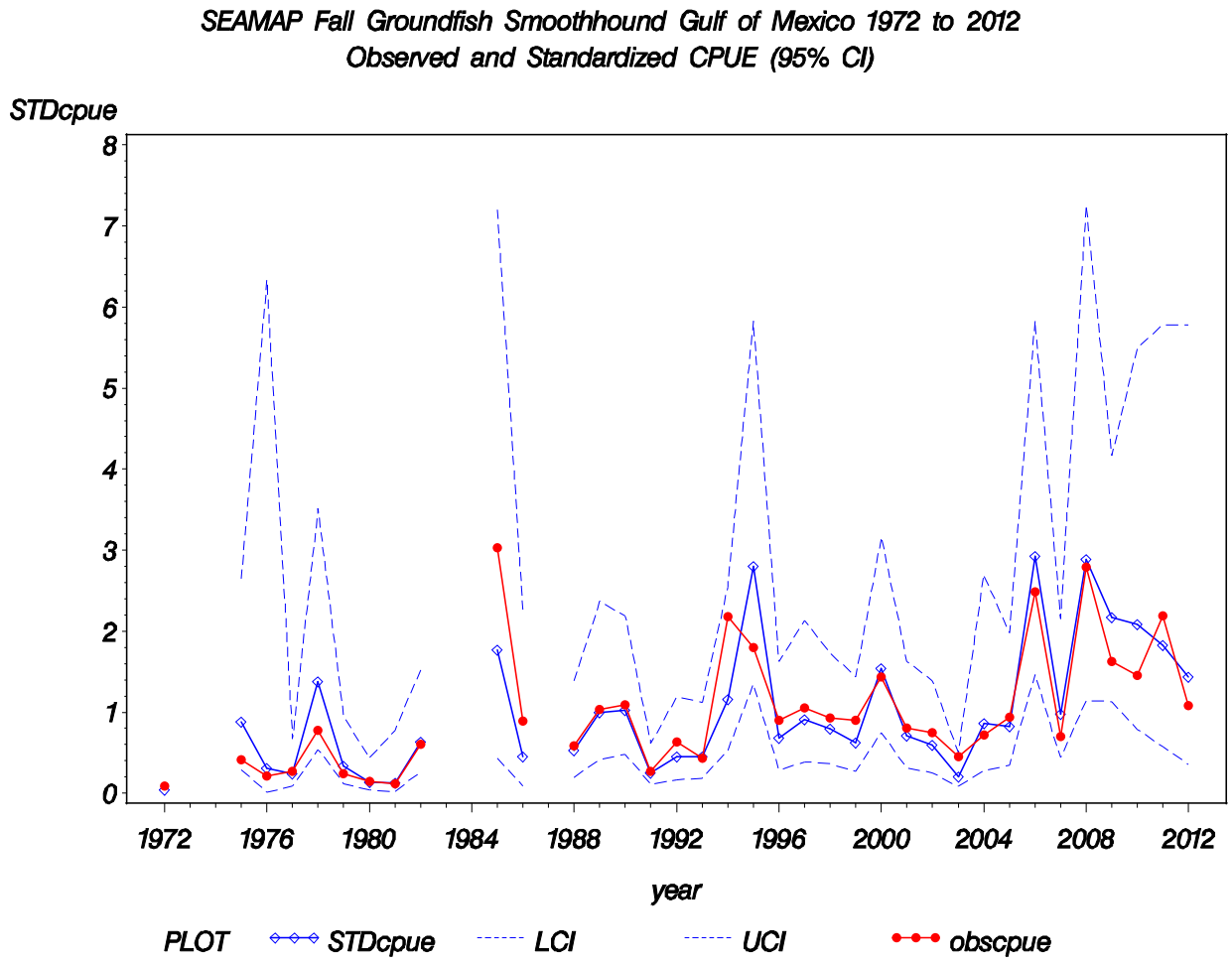


Figure 13. Annual index of abundance for smoothhound from the Fall SEAMAP Groundfish Survey from 1972 – 2012. (Note that the survey has been conducted annually since 1972, in 1973, 1974, 1983, 1984 and 1987 no smoothhound were captured during the survey.)

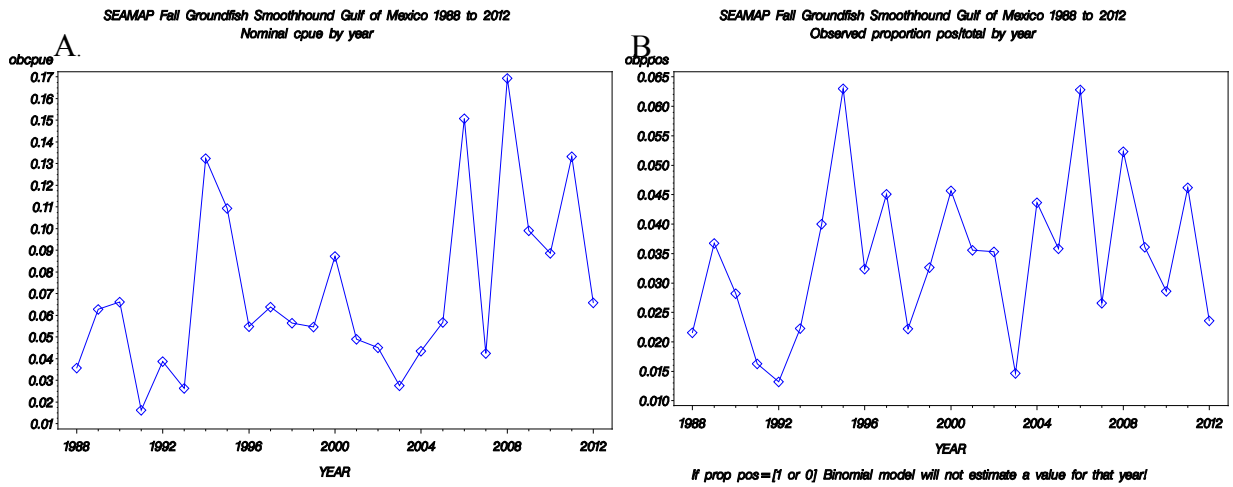


Figure 14. Annual trends for smoothhound captured during Fall SEAMAP Groundfish Surveys from 1988 to 2012 in **A.** nominal CPUE and **B.** proportion of positive stations.

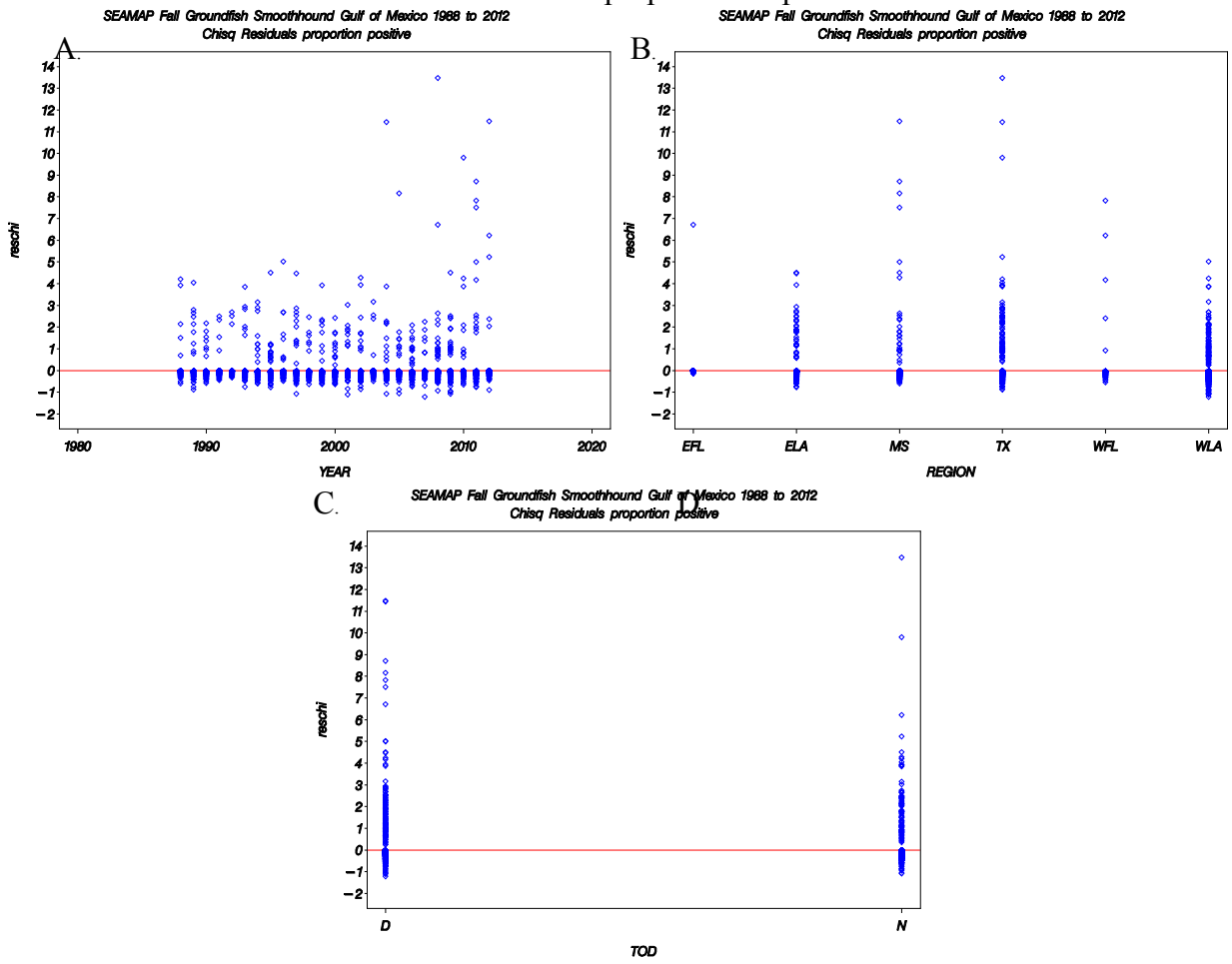


Figure 15. Diagnostic plots for binomial component of the smoothhound Fall SEAMAP Groundfish Survey model: **A.** the Chi-Square residuals by year, **B.** the Chi-Square residuals by region and **C.** the Chi-Square residuals by time of day.

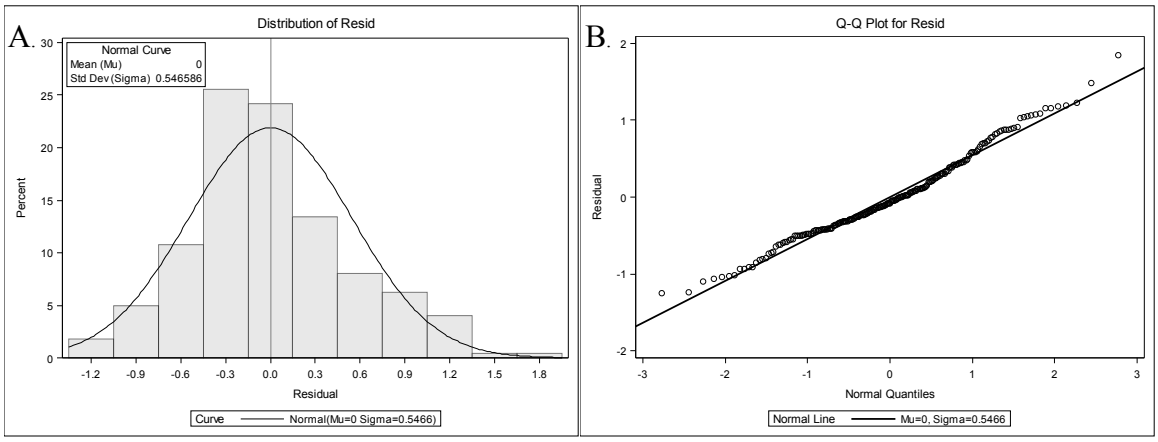


Figure 16. Diagnostic plots for lognormal component of the smoothhound Fall SEAMAP Groundfish Survey model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

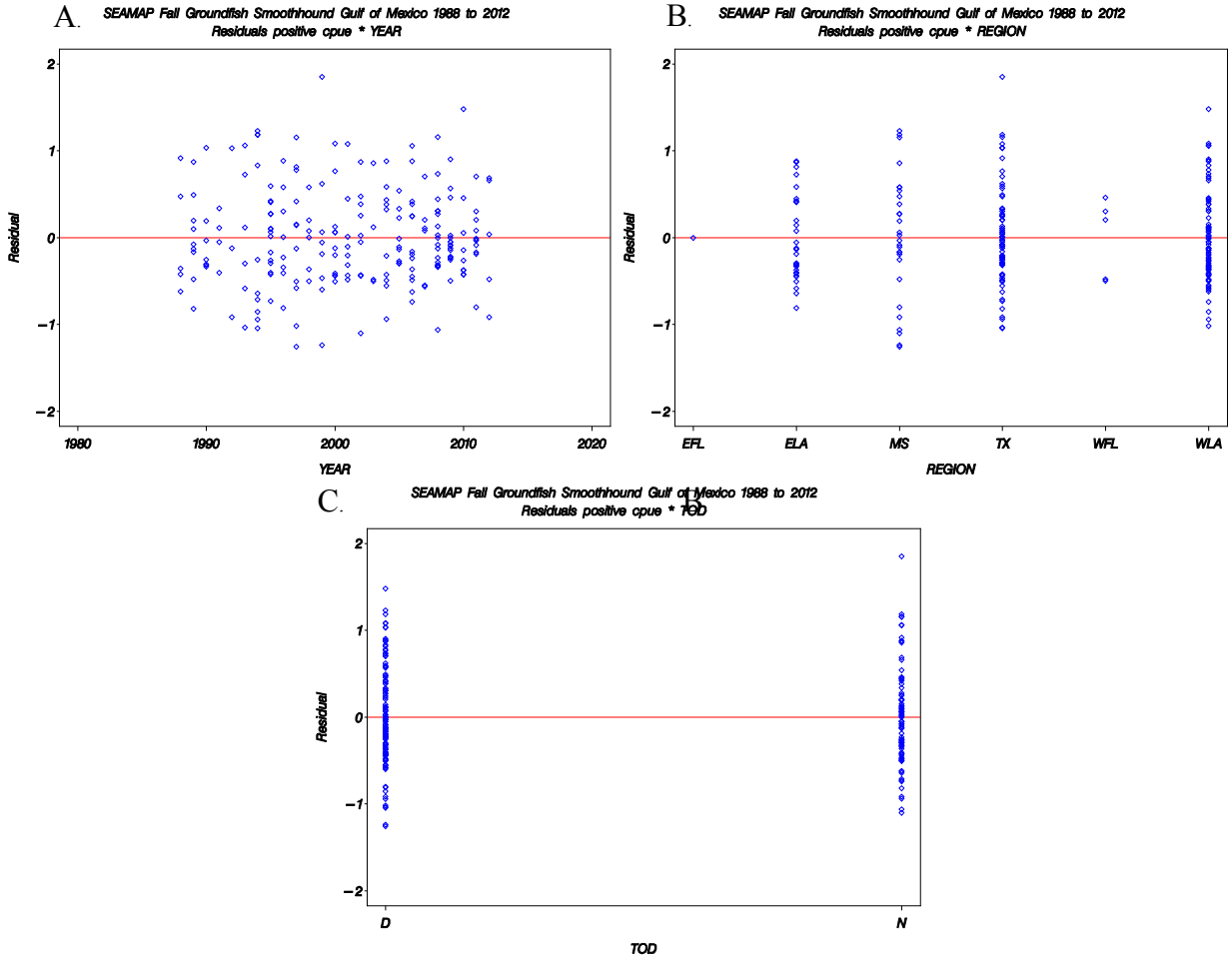


Figure 17. Diagnostic plots for lognormal component of the smoothhound Fall SEAMAP Groundfish Survey model: **A.** the Chi-Square residuals by year, **B.** the Chi-Square residuals by region and **C.** the Chi-Square residuals by time of day.

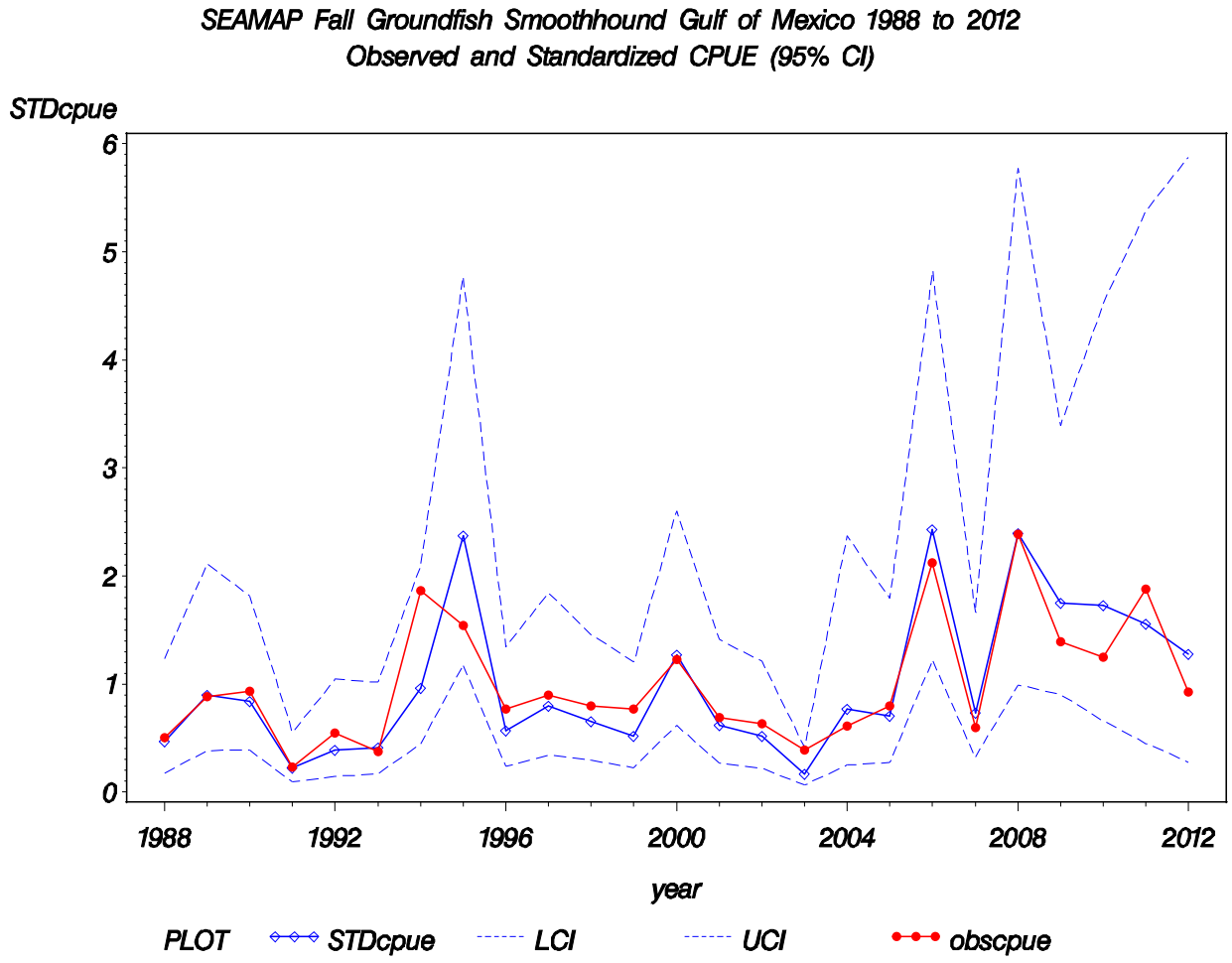


Figure 18. Annual index of abundance for smoothhound from the Fall SEAMAP Groundfish Survey from 1988 – 2012.

Appendix

Appendix Table 1. Summary of the factors used in constructing the smoothhound abundance index from the Summer SEAMAP groundfish survey data.

Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
Year	1982	186	2	0.010753	0.04949
Year	1983	191	0	0	0
Year	1984	210	3	0.014286	0.02875
Year	1985	165	2	0.012121	0.01292
Year	1986	162	4	0.024691	0.05265
Year	1987	281	5	0.017794	0.07797
Year	1988	229	1	0.004367	0.00595
Year	1989	210	3	0.014286	0.02706
Year	1990	257	10	0.038911	0.05205
Year	1991	250	5	0.020000	0.02987
Year	1992	247	17	0.068826	0.10845
Year	1993	246	10	0.040650	0.06070
Year	1994	259	16	0.061776	0.11968
Year	1995	236	14	0.059322	0.07700
Year	1996	242	14	0.057851	0.10907
Year	1997	229	13	0.056769	0.07546
Year	1998	227	8	0.035242	0.07516
Year	1999	244	8	0.032787	0.05704
Year	2000	235	22	0.093617	0.14594
Year	2001	174	7	0.040230	0.06340
Year	2002	251	12	0.047809	0.08370
Year	2003	203	7	0.034483	0.06835
Year	2004	237	9	0.037975	0.05372
Year	2005	192	7	0.036458	0.07227
Year	2006	239	16	0.066946	0.12002
Year	2007	219	14	0.063927	0.09466
Year	2008	304	13	0.042763	0.04806
Year	2009	534	26	0.048689	0.18612
Year	2010	379	12	0.031662	0.08472
Year	2011	324	17	0.052469	0.13445
Year	2012	428	26	0.060748	0.18125

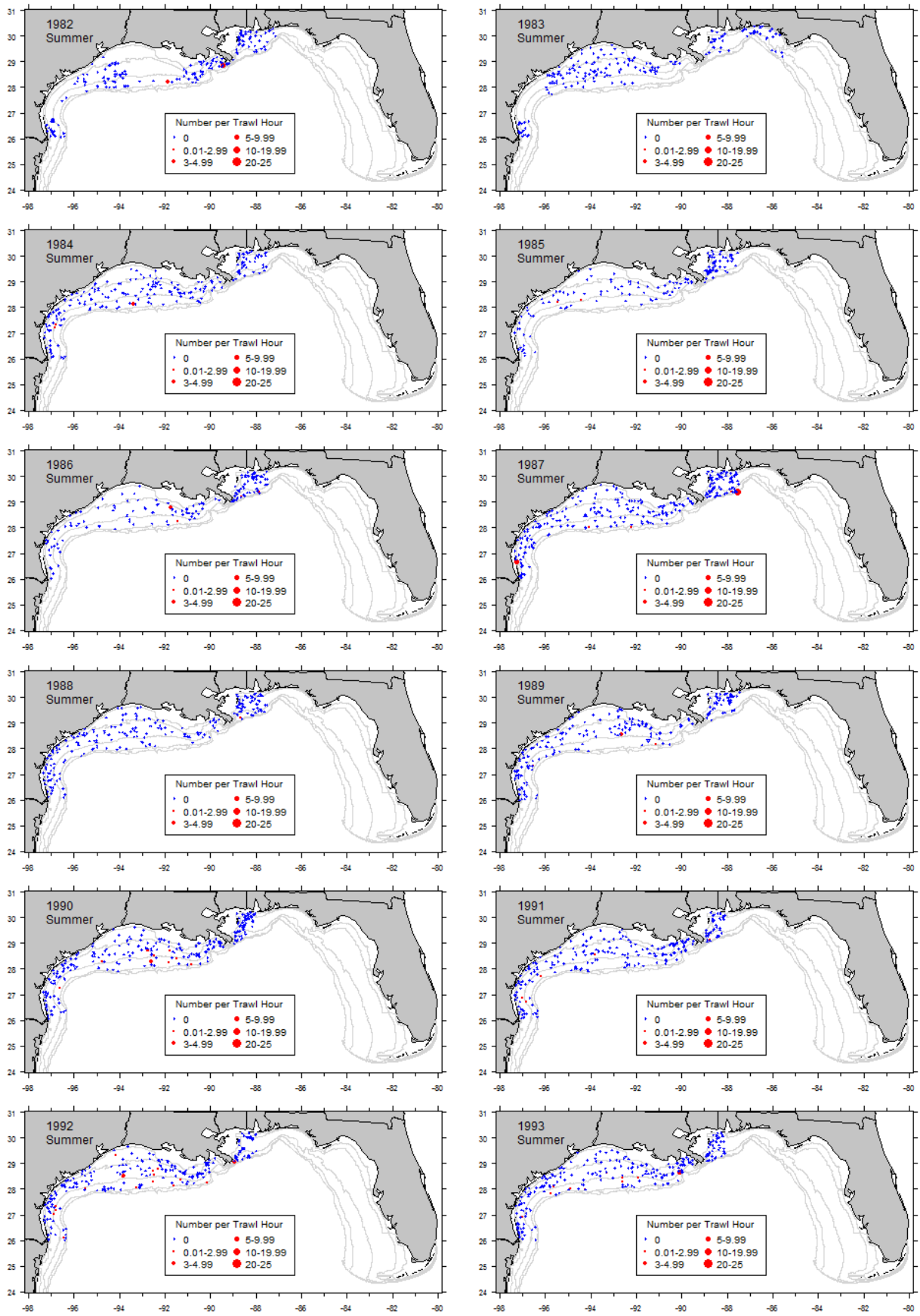
Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
Time of Day	Day	3745	200	0.053405	0.10380
Time of Day	Night	3854	123	0.031915	0.07161
Region	EFL	514	9	0.017510	0.07770
Region	ELA	1734	50	0.028835	0.06423
Region	MS	1432	43	0.030028	0.09111
Region	TX	2555	115	0.045010	0.07499
Region	WFL	139	3	0.021583	0.05747
Region	WLA	1225	103	0.084082	0.14968

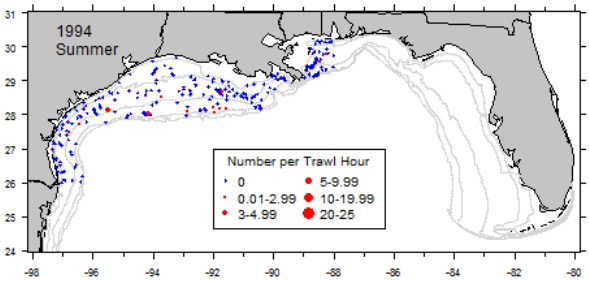
Appendix Table 2. Summary of the factors used in constructing the smoothhound abundance index from the Fall SEAMAP groundfish survey data.

Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
Year	1972	184	1	0.005435	0.00543
Year	1973	272	0	0	0
Year	1974	243	0	0	0
Year	1975	280	3	0.010714	0.02500
Year	1976	307	2	0.006515	0.01303
Year	1977	242	2	0.008264	0.01653
Year	1978	319	7	0.021944	0.04734
Year	1979	273	2	0.007326	0.01465
Year	1980	233	1	0.004292	0.00858
Year	1981	279	1	0.003584	0.00717
Year	1982	273	4	0.014652	0.03663
Year	1983	222	0	0	0
Year	1984	226	0	0	0
Year	1985	326	9	0.027607	0.18405
Year	1986	297	4	0.013468	0.05387
Year	1987	202	0	0	0
Year	1988	232	5	0.021552	0.03571
Year	1989	245	9	0.036735	0.06287
Year	1990	248	7	0.028226	0.06611
Year	1991	246	4	0.016260	0.01624
Year	1992	227	3	0.013216	0.03867
Year	1993	269	6	0.022305	0.02637
Year	1994	250	10	0.040000	0.13236
Year	1995	238	15	0.063025	0.10937
Year	1996	247	8	0.032389	0.05481
Year	1997	244	11	0.045082	0.06397
Year	1998	270	6	0.022222	0.05649
Year	1999	245	8	0.032653	0.05477
Year	2000	241	11	0.045643	0.08722
Year	2001	225	8	0.035556	0.04896
Year	2002	255	9	0.035294	0.04514
Year	2003	273	4	0.014652	0.02761

Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
Year	2004	229	10	0.043668	0.04357
Year	2005	251	9	0.035857	0.05675
Year	2006	223	14	0.062780	0.15084
Year	2007	226	6	0.026549	0.04244
Year	2008	363	19	0.052342	0.16943
Year	2009	443	16	0.036117	0.09907
Year	2010	315	9	0.028571	0.08866
Year	2011	238	11	0.046218	0.13334
Year	2012	212	5	0.023585	0.06579
Region	EFL	225	1	0.004444	0.00889
Region	ELA	3076	49	0.015930	0.03758
Region	MS	2144	43	0.020056	0.07380
Region	TX	2427	74	0.030490	0.05617
Region	WFL	135	5	0.037037	0.13309
Region	WLA	1461	87	0.059548	0.11597
Time of Day	Day	4647	157	0.033785	0.08282
Time of Day	Night	4821	102	0.021157	0.04453

Appendix Figure 1. Annual survey effort and catch of smoothhound from the SEAMAP groundfish survey during the summer (1982-2012) and fall (1972-2012).

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Summer
Number per Trawl Hour
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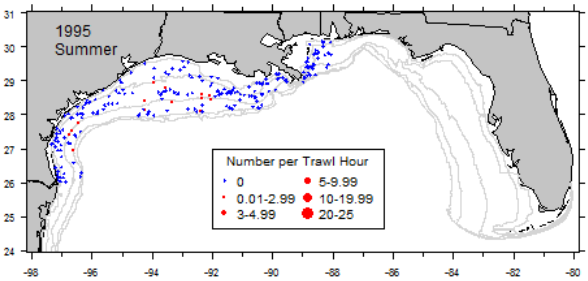
0.01-2.99
3-4.99
5-9.99
10-19.99
20-25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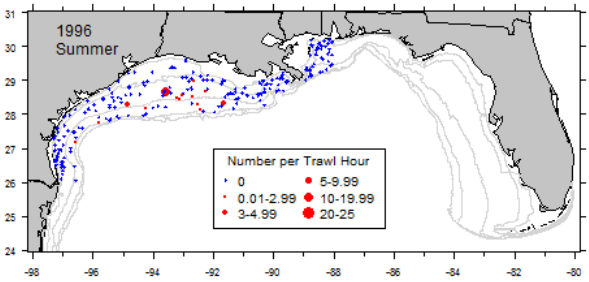
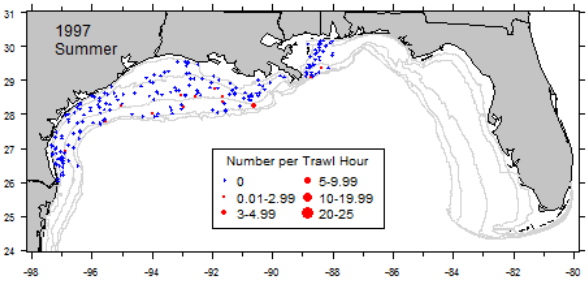
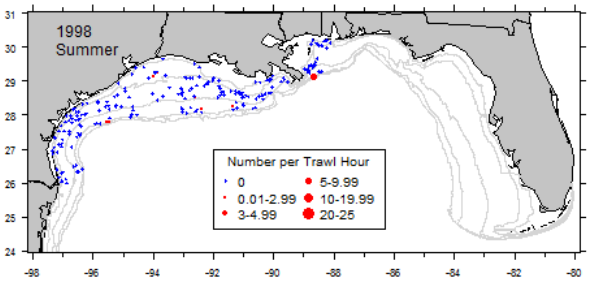
Summer
Number per Trawl Hour
0
0.01-2.99
3-4.99
5-9.99
10-19.99
20-25


1996
Summer
Number per Trawl Hour
0
0.01-2.99
3-4.99
5-9.99
10-19.99
20-25


1997
Summer
Number per Trawl Hour
0
0.01-2.99
3-4.99
5-9.99
10-19.99
20-25


1998
Summer
Number per Trawl Hour
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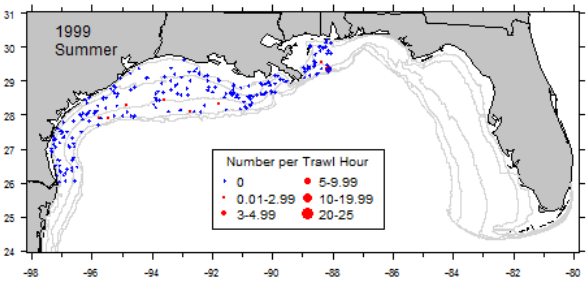
0.01-2.99
3-4.99
5-9.99
10-19.99
20-25


1999
Summer
Number per Trawl Hour
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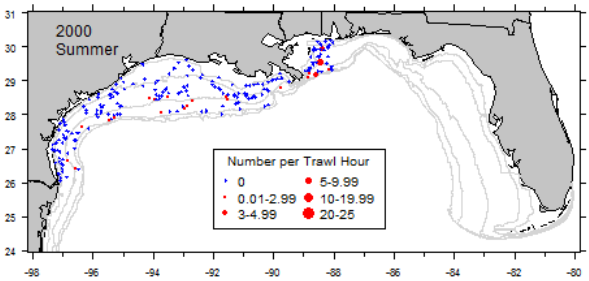
0.01-2.99
3-4.99
5-9.99
10-19.99
20-25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Summer
Number per Trawl Hour
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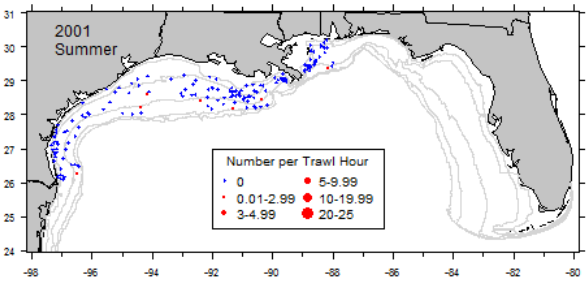
0.01-2.99
3-4.99
5-9.99
10-19.99
20-25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Summer
Number per Trawl Hour
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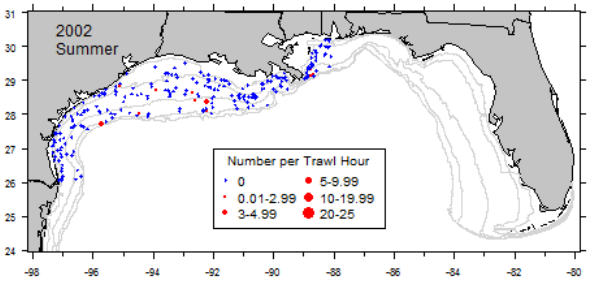
3-4.99
5-9.99
10-19.99
20-25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Summer
Number per Trawl Hour
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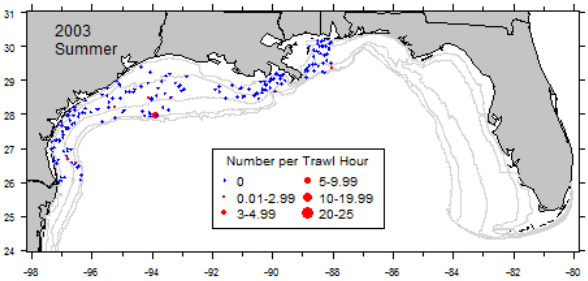
3-4.99
5-9.99
10-19.99
20-25


2003
Summer
Number per Trawl Hour
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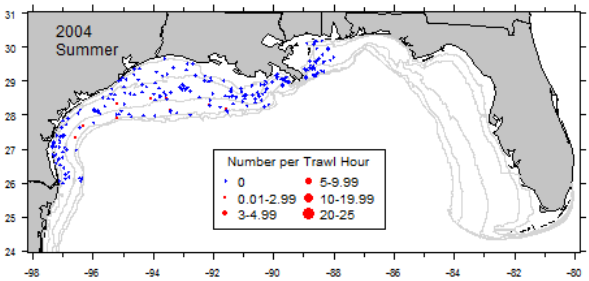
3-4.99
5-9.99
10-19.99
20-25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Summer
Number per Trawl Hour
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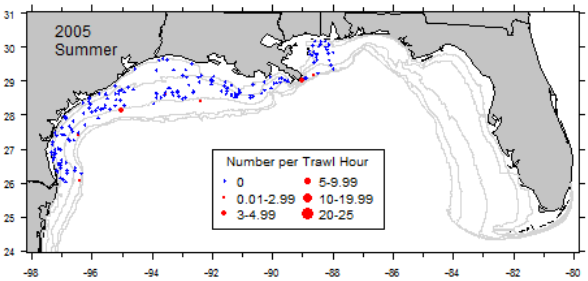
3-4.99
5-9.99
10-19.99
20-25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Summer
Number per Trawl Hour
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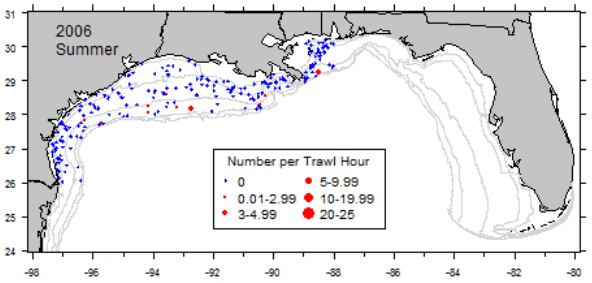
3-4.99
5-9.99
10-19.99
20-25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Summer
Number per Trawl Hour
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3-4.99
5-9.99
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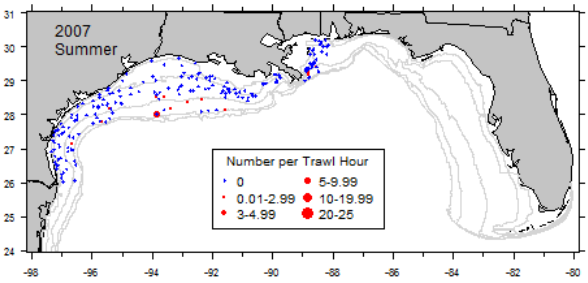
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Summer
Number per Trawl Hour
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5-9.99
10-19.99
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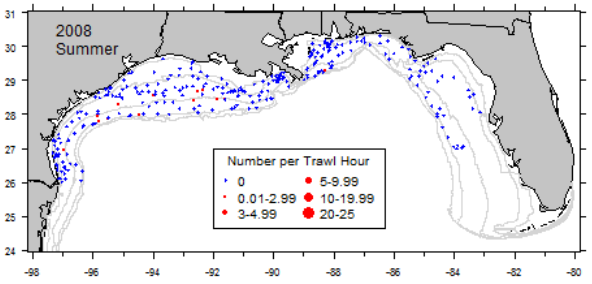
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Summer
Number per Trawl Hour
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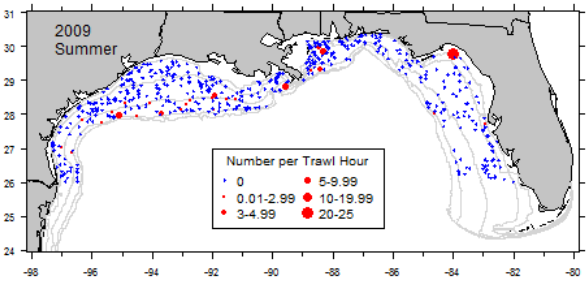
2009
Summer
Number per Trawl Hour
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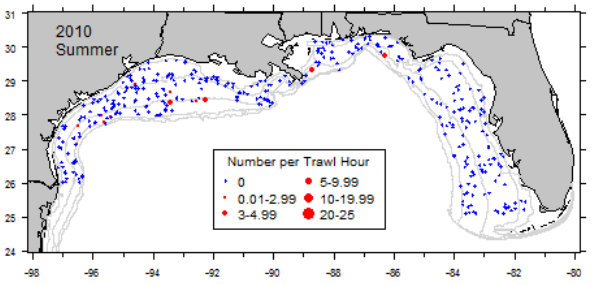
5-9.99
10-19.99
20-25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Summer
Number per Trawl Hour
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3-4.99
5-9.99
10-19.99
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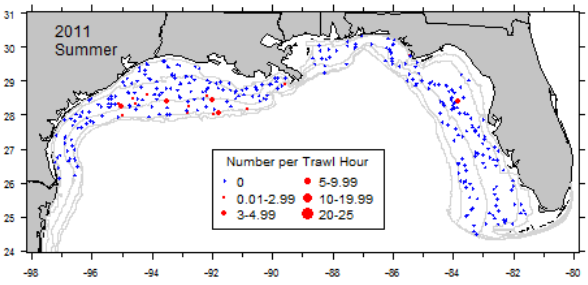
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Summer
Number per Trawl Hour
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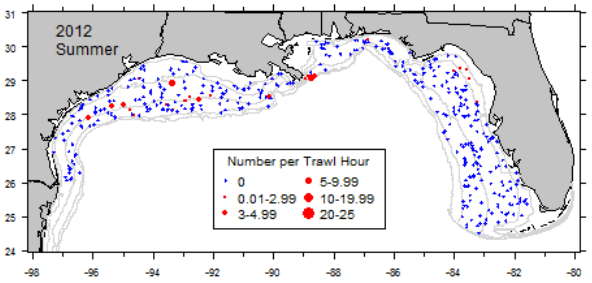
5-9.99
10-19.99
20-25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Summer
Number per Trawl Hour
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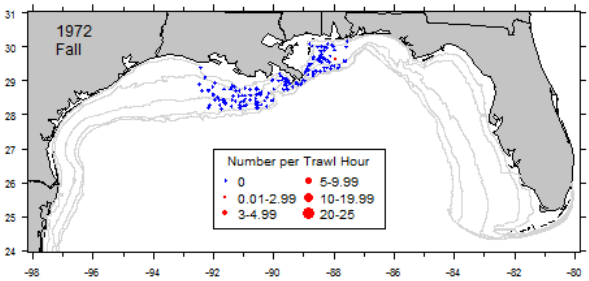
5-9.99
10-19.99
20-25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Fall
Number per Trawl Hour
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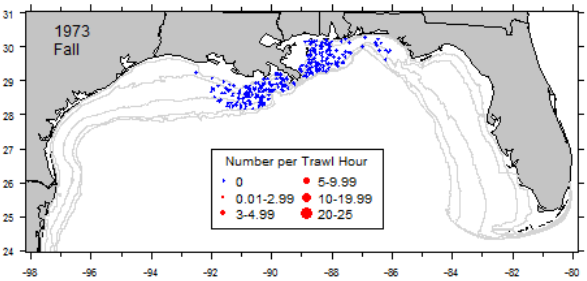
5-9.99
10-19.99
20-25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Fall
Number per Trawl Hour
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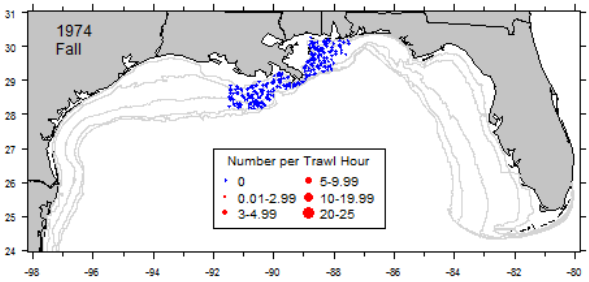
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Fall
Number per Trawl Hour
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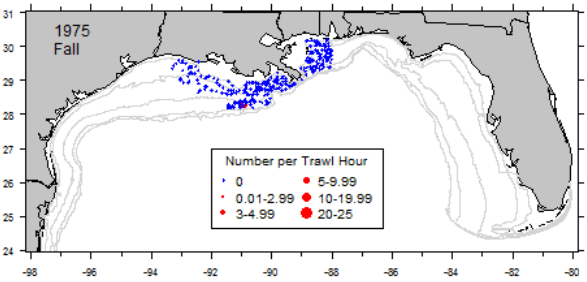
3-4.99
5-9.99
10-19.99
20-25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Fall
Number per Trawl Hour
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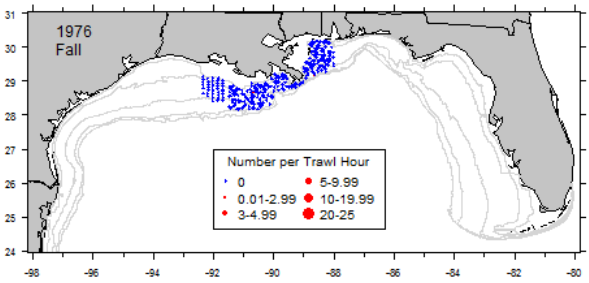
3-4.99
5-9.99
10-19.99
20-25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Fall
Number per Trawl Hour
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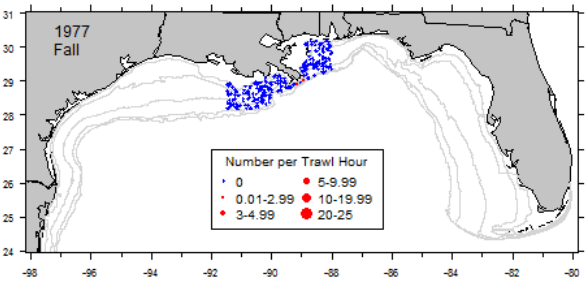
3-4.99
5-9.99
10-19.99
20-25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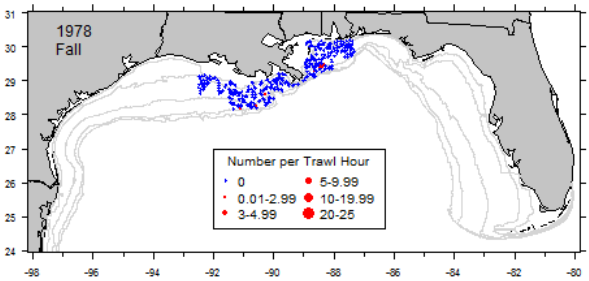
Fall
Number per Trawl Hour
0
0.01-2.99
3-4.99
5-9.99
10-19.99
20-25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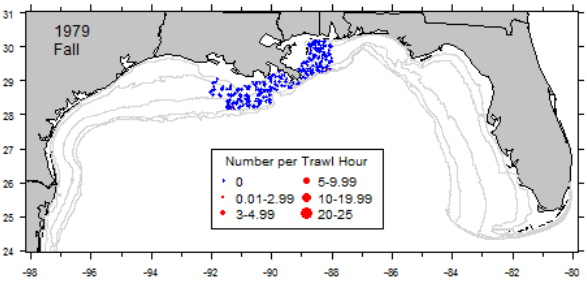
Fall
Number per Trawl Hour
0
0.01-2.99
3-4.99
5-9.99
10-19.99
20-25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Fall
Number per Trawl Hour
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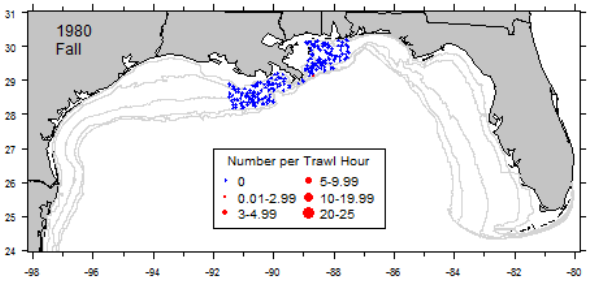
3-4.99
5-9.99
10-19.99
20-25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Fall
Number per Trawl Hour
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0.01-2.99
3-4.99
5-9.99
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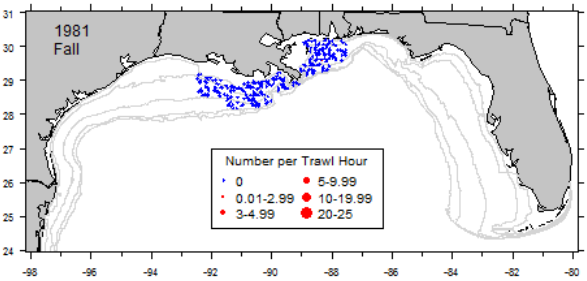
20-25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Fall
Number per Trawl Hour
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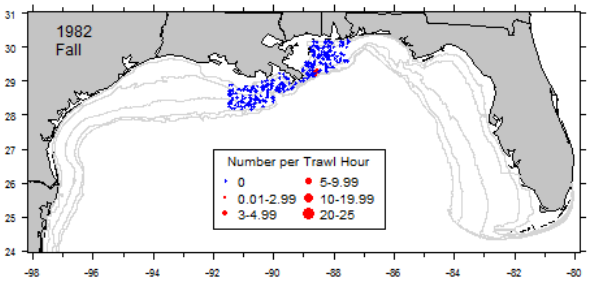
3-4.99
5-9.99
10-19.99
20-25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Fall
Number per Trawl Hour
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3-4.99
5-9.99
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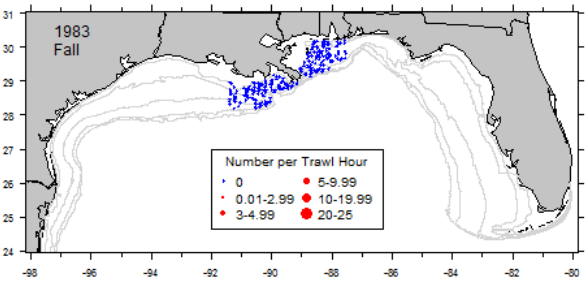
20-25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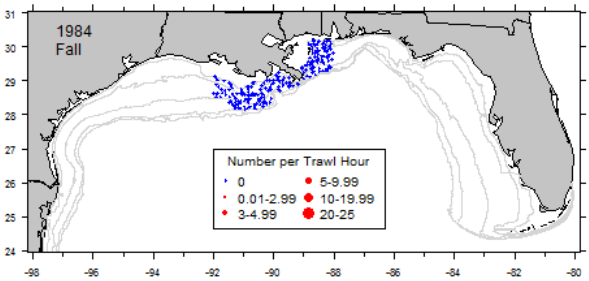
Fall
Number per Trawl Hour
0
0.01-2.99
3-4.99
5-9.99
10-19.99
20-25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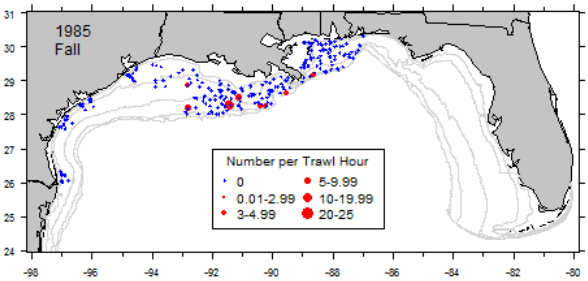
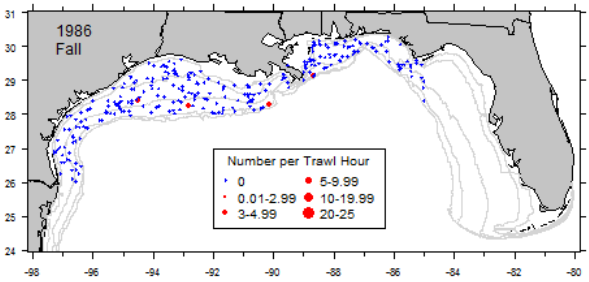
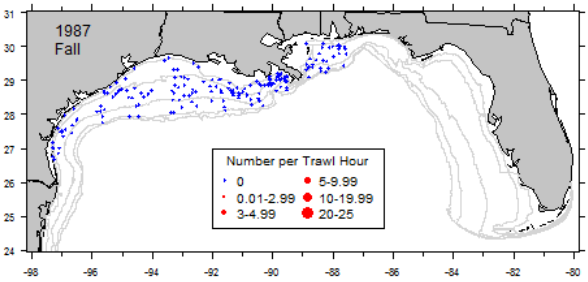
Fall
Number per Trawl Hour
0
0.01-2.99
3-4.99
5-9.99
10-19.99
20-25


1985
Fall
Number per Trawl Hour
0
0.01-2.99
3-4.99
5-9.99
10-19.99
20-25


1986
Fall
Number per Trawl Hour
0
0.01-2.99
3-4.99
5-9.99
10-19.99
20-25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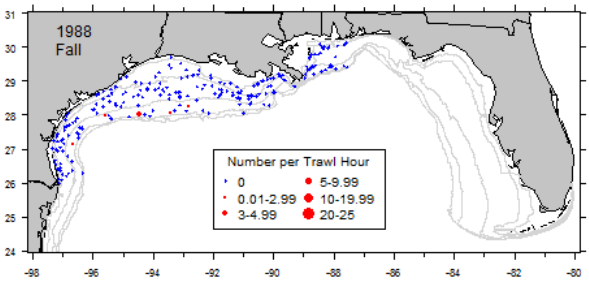
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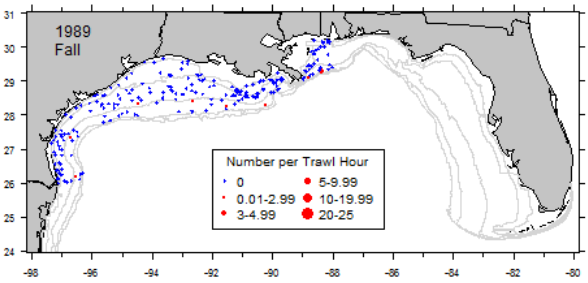
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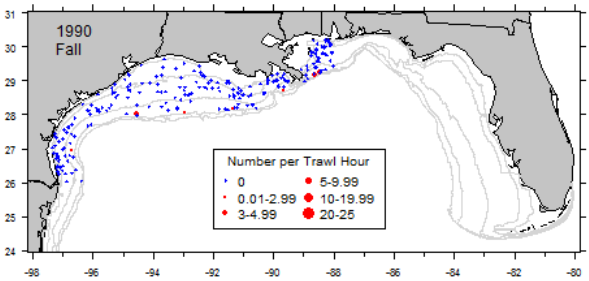
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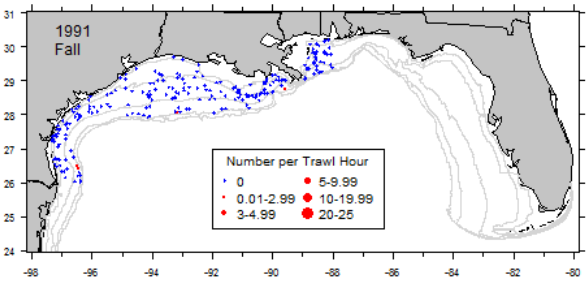
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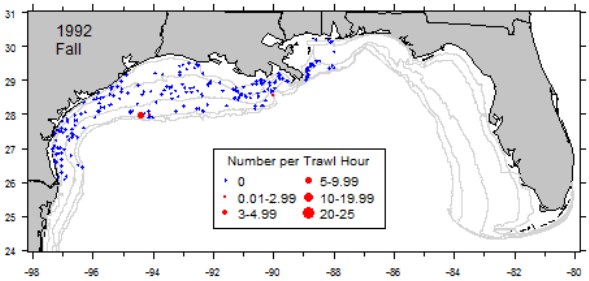
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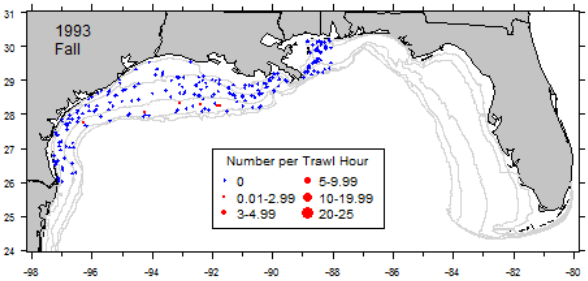
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Fall
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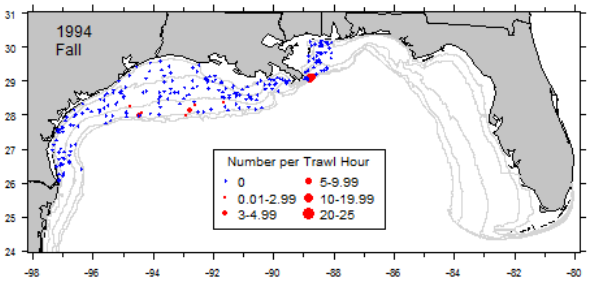
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Number per Trawl Hour
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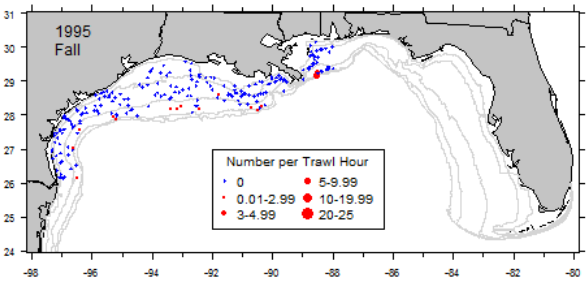
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Fall
Number per Trawl Hour
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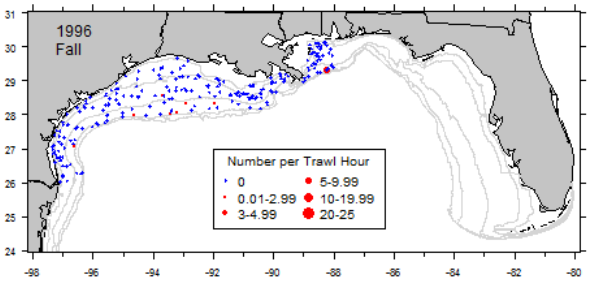
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Fall
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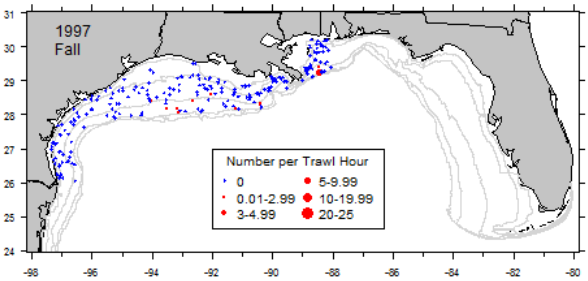
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Fall
Number per Trawl Hour
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3-4.99
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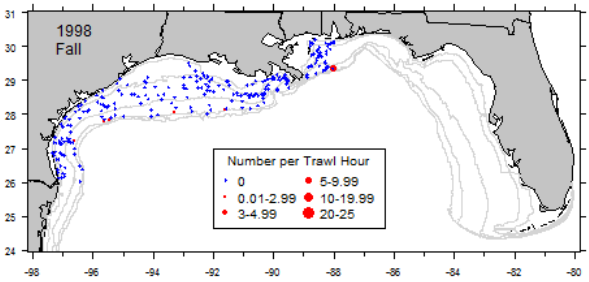
20-25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Fall
Number per Trawl Hour
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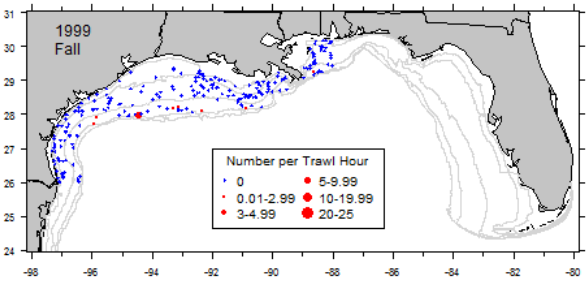
10-19.99
20-25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Fall
Number per Trawl Hour
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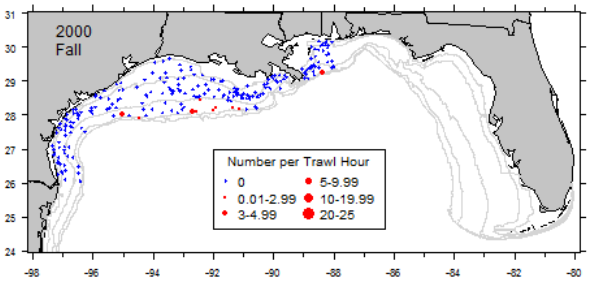
3-4.99
5-9.99
10-19.99
20-25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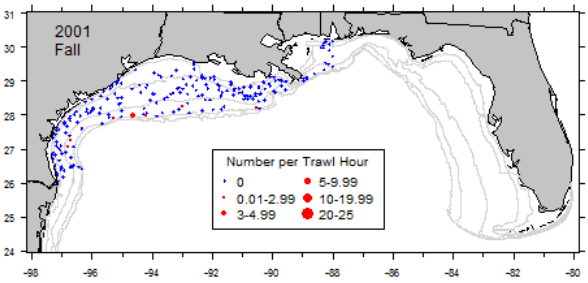
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Fall
Number per Trawl Hour
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3-4.99
5-9.99
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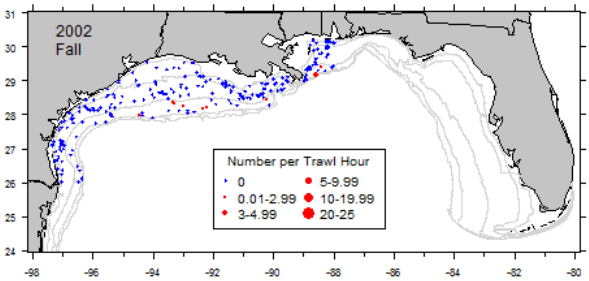
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Fall
Number per Trawl Hour
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3-4.99
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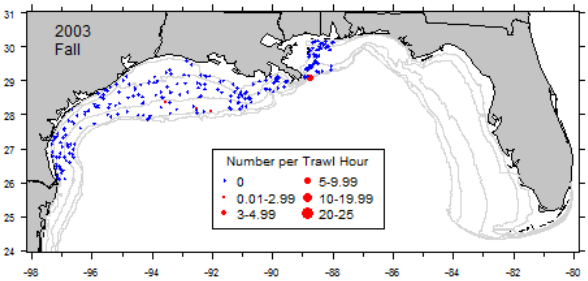
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Fall
Number per Trawl Hour
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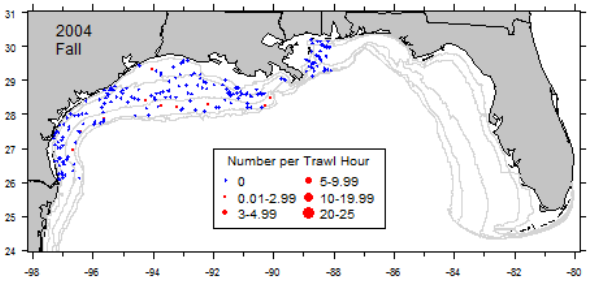
10-19.99
20-25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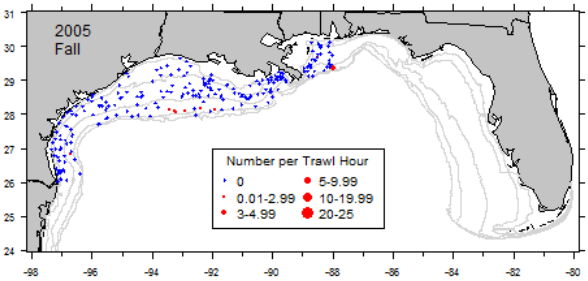
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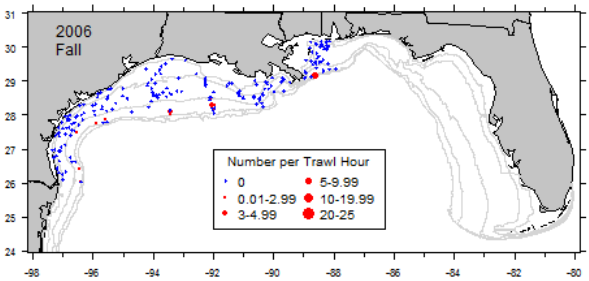
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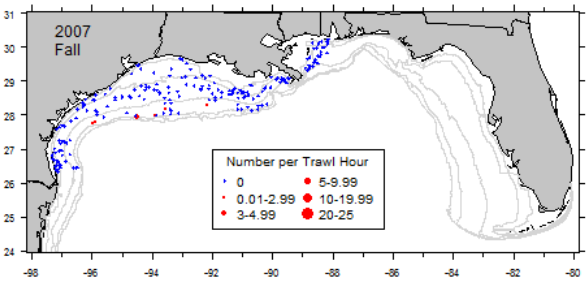
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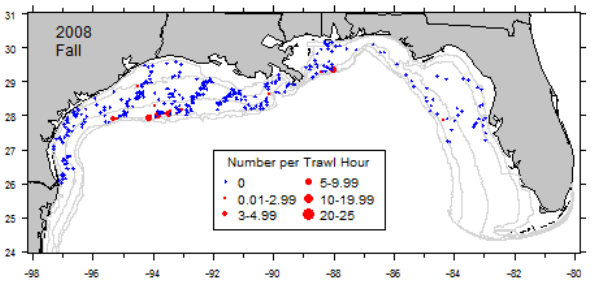
20-25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Fall
Number per Trawl Hour
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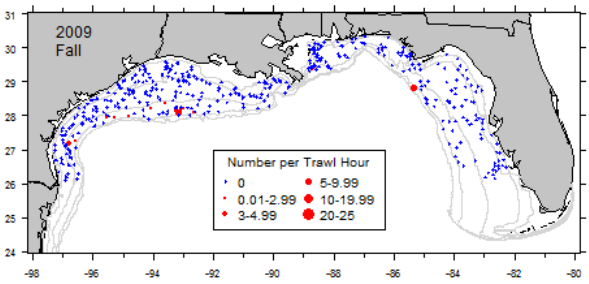
20-25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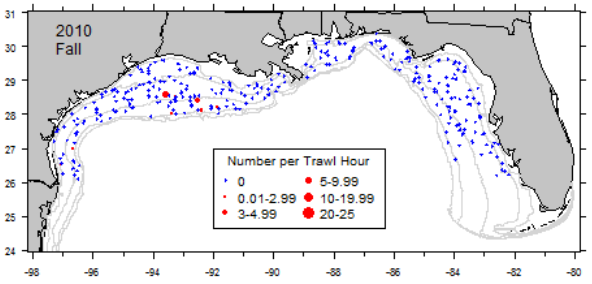
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3-4.99
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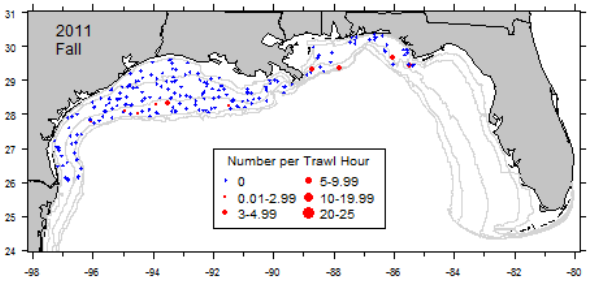
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Fall
Number per Trawl Hour
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0.01-2.99
3-4.99
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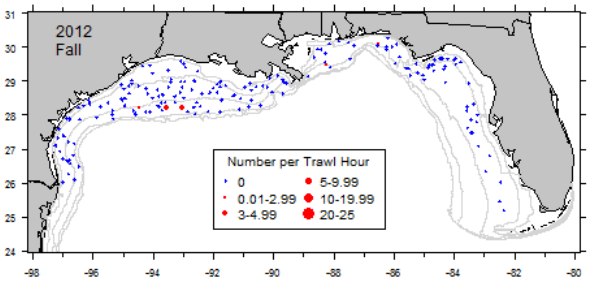
10-19.99
20-25


2012
Fall
Number per Trawl Hour
0
0.01-2.99
3-4.99
5-9.99
10-19.99
20-25

Addendum

During the Data Workshop, several concerns were raised by the Indices Working Group (IWG) about the indices produced from the SEAMAP groundfish data. For the fall time series, the main concern was centered on the changes in survey design between the early years (1972-1986), middle years (1987-2007) and current years (2008-2012). During the course of the survey, the design has been tweaked to more efficiently sample the northern Gulf of Mexico and to increase the sample sizes and extent. Additionally, in the early years, very few smoothhounds were captured, with several years with only one or two positive occurrences (and several years with no catch). The IWG felt that this warranted separating the early data from the rest of the time series.

In addition, the majority of the positive occurrences occurred at depth depths (>50 m), so a decision was made to also limit the data by depth. Using the depth stratum outline in the methodology section, only depths that had a >1% positive occurrence were used to produce the indices. For the summer time series all stations with a depth greater than 33 m (18 fathoms) were used and those with depths greater than 46 m (25 fathoms) in the fall were used. For the early fall time series, all the data was used because of extremely low proportion positives across all depths. Variables that could be included in the submodels were:

Submodel Variables (SEAMAP Summer Groundfish)

Year: 1982 – 2012
Depth Zone: 18-60 fathoms (continuous)
Region: Texas, West Louisiana, East Louisiana, Mississippi/Alabama, West Florida, East Florida (Addendum Figure 1)
Time of Day: Day, Night

Submodel Variables (SEAMAP Fall Groundfish, 1972-1986)

Year: 1972 – 1986
Depth: 5 – 60 fathoms (continuous)
Region: Texas, West Louisiana, East Louisiana, Mississippi/Alabama, West Florida, East Florida (Addendum Figure 1)
Time of Day: Day, Night

Submodel Variables (SEAMAP Fall Groundfish, 1988-2012)

Year: 1988 – 2012
Depth: 25 – 60 fathoms (continuous)
Region: Texas, West Louisiana, East Louisiana, Mississippi/Alabama, West Florida, East Florida (Addendum Figure 1)
Time of Day: Day, Night

SEAMAP Summer Groundfish

For the Summer SEAMAP abundance index of smoothhound, the nominal CPUE and number of stations with a positive catch are presented in Addendum Figure 1. Year, region, time of day and depth were retained in the binomial submodel, while year and region were retained in the lognormal submodel. A summary of the factors used in the analysis is presented in Appendix Addendum Table 1. Addendum Table 2 summarizes the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 17,781.0 and 532.9, respectively. The diagnostic plots for the binomial and lognormal submodels are shown in Addendum Figures 2-4, and indicated the distribution of the residuals is approximately normal. Annual abundance indices are presented in Addendum Table 3 and Addendum Figure 5.

SEAMAP Fall Groundfish, 1972 - 1986

For the Fall SEAMAP abundance index (1972 - 1986) of smoothhound, the nominal CPUE and number of stations with a positive catch are presented in Addendum Figure 6. Year, time of day and depth were retained in the binomial submodel, while year was retained in the lognormal submodel. A summary of the factors used in the analysis is presented in Appendix Addendum Table 4. Addendum Table 5 summarizes the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 24,300.6 and 29.3, respectively. There was a slight increase in AIC between the second and third lognormal submodels (27.6 and 29.3), however due to the insignificance of time of day, this increase was deemed acceptable. The diagnostic plots for the binomial and lognormal submodels are shown in Addendum Figures 7-9, and indicated the distribution of the residuals was divergent from normal. Annual abundance indices are presented in Addendum Table 6 and Addendum Figure 10.

SEAMAP Fall Groundfish, 1988 - 2012

For the Fall SEAMAP abundance index (1988 - 2012) of smoothhound, the nominal CPUE and number of stations with a positive catch are presented in Addendum Figure 11. Year, region, time of day and depth were retained in the binomial submodel, while year and region were retained in the lognormal submodel. A summary of the factors used in the analysis is presented in Appendix Addendum Table 7. Addendum Table 8 summarizes the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 8226.2 and 379.8, respectively. There was a slight increase in AIC between the second and third lognormal submodels (379.1 and 379.8), however due to the insignificance of time of day, this increase was deemed acceptable. The diagnostic plots for the binomial and lognormal submodels are shown in Addendum Figures 12-14, and indicated the distribution of the residuals is approximately normal. Annual abundance indices are presented in Addendum Table 9 and Addendum Figure 15.

Addendum Table 1. Summary of the factors used in constructing the smoothhound abundance index from the Summer SEAMAP groundfish survey data.

Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
Year	1982	98	2	0.02041	0.09392
Year	1983	71	0	0	0
Year	1984	88	3	0.03409	0.06862
Year	1985	56	2	0.03571	0.03807
Year	1986	59	3	0.05085	0.08475
Year	1987	109	4	0.03670	0.15512
Year	1988	91	1	0.01099	0.01499
Year	1989	74	3	0.04054	0.07678
Year	1990	89	7	0.07865	0.10067
Year	1991	100	5	0.05000	0.07467
Year	1992	96	16	0.16667	0.26213
Year	1993	93	10	0.10753	0.16056
Year	1994	105	15	0.14286	0.28444
Year	1995	93	12	0.12903	0.14926
Year	1996	95	12	0.12632	0.16279
Year	1997	89	12	0.13483	0.16822
Year	1998	88	6	0.06818	0.17097
Year	1999	96	8	0.08333	0.14498
Year	2000	92	21	0.22826	0.32931
Year	2001	61	7	0.11475	0.18084
Year	2002	97	10	0.10309	0.19667
Year	2003	71	7	0.09859	0.19543
Year	2004	89	9	0.10112	0.14305
Year	2005	60	7	0.11667	0.23126
Year	2006	91	16	0.17582	0.31521
Year	2007	81	14	0.17284	0.25594
Year	2008	122	13	0.10656	0.11974
Year	2009	216	23	0.10648	0.33077
Year	2010	180	10	0.05556	0.15619
Year	2011	159	15	0.09434	0.23625
Year	2012	226	17	0.07522	0.23805
Time of Day	Day	1530	189	0.12353	0.23619
Time of Day	Night	1534	101	0.06584	0.13068
Region	EFL	245	1	0.00408	0.00816
Region	ELA	578	47	0.08131	0.17977

Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
Region	MS	515	40	0.07767	0.23419
Region	TX	1131	109	0.09637	0.15852
Region	WFL	73	1	0.01370	0.05479
Region	WLA	522	92	0.17625	0.29125

Addendum Table 2. Summary of backward selection procedure for building delta-lognormal submodels for smoothhound Summer SEAMAP groundfish survey index of relative abundance from 1982 to 2012.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 17781.0)*						*Lognormal Submodel Type 3 Tests (AIC 543.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	29	3027	55.66	1.92	0.0021	0.0022	29	253	3.81	<.0001
Depth	1	3027	33.36	33.36	<.0001	<.0001	1	253	1.95	0.1641
Region	5	3027	49.28	9.86	<.0001	<.0001	5	253	4.65	0.0004
Time of Day	1	3027	23.95	23.95	<.0001	<.0001	1	253	0.02	0.8755
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 17781.0)*						*Lognormal Submodel Type 3 Tests (AIC 540.3)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	29	3027	55.66	1.92	0.0021	0.0022	29	254	3.83	<.0001
Depth	1	3027	33.36	33.36	<.0001	<.0001	1	254	1.96	0.1624
Region	5	3027	49.28	9.86	<.0001	<.0001	5	254	4.67	0.0004
Time of Day	1	3027	23.95	23.95	<.0001	<.0001		Dropped		
Model Run #3	*Binomial Submodel Type 3 Tests (AIC 17781.0)*						*Lognormal Submodel Type 3 Tests (AIC 532.9)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	29	3027	55.66	1.92	0.0021	0.0022	29	255	3.80	<.0001
Depth	1	3027	33.36	33.36	<.0001	<.0001		Dropped		
Region	5	3027	49.28	9.86	<.0001	<.0001	5	255	5.10	0.0002
Time of Day	1	3027	23.95	23.95	<.0001	<.0001		Dropped		

Addendum Table 3. Indices of smoothhound abundance developed using the delta-lognormal model for Summer SEAMAP groundfish survey from 1982-2012. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1982	0.02041	98	0.04443	0.65822	0.75939	0.17071	2.53790
1983	0	71	0				
1984	0.03409	88	0.03447	0.51069	0.63438	0.15960	1.63414
1985	0.03571	56	0.02454	0.36354	0.75592	0.09475	1.39475
1986	0.05085	59	0.02959	0.43832	0.63632	0.13657	1.40682
1987	0.03670	109	0.02926	0.43341	0.56440	0.15140	1.24065
1988	0.01099	91	0.00300	0.04445	1.04242	0.00800	0.24705
1989	0.04054	74	0.02588	0.38335	0.63590	0.11952	1.22957
1990	0.07865	89	0.04014	0.59463	0.45184	0.25111	1.40809
1991	0.05000	100	0.02645	0.39181	0.51515	0.14848	1.03387
1992	0.16667	96	0.09667	1.43202	0.34368	0.73404	2.79368
1993	0.10753	93	0.05210	0.77183	0.40053	0.35685	1.66938
1994	0.14286	105	0.11141	1.65042	0.34931	0.83730	3.25319
1995	0.12903	93	0.06413	0.94995	0.37650	0.45862	1.96767
1996	0.12632	95	0.05279	0.78204	0.37574	0.37807	1.61765
1997	0.13483	89	0.05282	0.78251	0.37774	0.37694	1.62447
1998	0.06818	88	0.04701	0.69639	0.48175	0.27928	1.73643
1999	0.08333	96	0.03774	0.55903	0.43305	0.24397	1.28094
2000	0.22826	92	0.11238	1.66479	0.31643	0.89752	3.08798
2001	0.11475	61	0.07731	1.14528	0.45292	0.48274	2.71712
2002	0.10309	97	0.06009	0.89018	0.40095	0.41125	1.92684
2003	0.09859	71	0.06728	0.99666	0.45517	0.41845	2.37380
2004	0.10112	89	0.05317	0.78769	0.41539	0.35466	1.74946
2005	0.11667	60	0.08447	1.25127	0.45211	0.52816	2.96440
2006	0.17582	91	0.12587	1.86455	0.34217	0.95841	3.62739
2007	0.17284	81	0.07478	1.10771	0.35943	0.55165	2.22427
2008	0.10656	122	0.04983	0.73816	0.35889	0.36797	1.48077
2009	0.10648	216	0.14981	2.21925	0.30200	1.22913	4.00695
2010	0.05556	180	0.08258	1.22329	0.39414	0.57209	2.61575
2011	0.09434	159	0.17358	2.57141	0.33509	1.33914	4.93761
2012	0.07522	226	0.14157	2.09718	0.32332	1.11624	3.94016

Addendum Table 4. Summary of the factors used in constructing the smoothhound abundance index from the Fall SEAMAP groundfish survey data.

Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
Year	1972	184	1	0.005435	0.00543
Year	1973	272	0	0	0
Year	1974	243	0	0	0
Year	1975	280	3	0.010714	0.02500
Year	1976	307	2	0.006515	0.01303
Year	1977	242	2	0.008264	0.01653
Year	1978	319	7	0.021944	0.04734
Year	1979	273	2	0.007326	0.01465
Year	1980	233	1	0.004292	0.00858
Year	1981	279	1	0.003584	0.00717
Year	1982	273	4	0.014652	0.03663
Year	1983	222	0	0	0
Year	1984	226	0	0	0
Year	1985	326	9	0.027607	0.18405
Year	1986	297	4	0.013468	0.05387
Region	EFL	1480	17	0.011486	0.04662
Region	ELA	1099	15	0.013649	0.03285
Region	MS	170	1	0.005882	0.02353
Region	TX	30	0	0.000000	0.00000
Region	WFL	234	3	0.012821	0.06838
Region	WLA	1480	17	0.011486	0.04662
Time of Day	Day	1438	22	0.015299	0.05570
Time of Day	Night	1575	14	0.008889	0.02857

Addendum Table 5. Summary of backward selection procedure for building delta-lognormal submodels for smoothhound Fall SEAMAP groundfish survey index of relative abundance from 1972 to 1986.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 24553.1)*						*Lognormal Submodel Type 3 Tests (AIC 37.2)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	10	2967	10.04	1.00	0.4369	0.4372	10	20	5.23	0.0008
Depth	1	2967	41.92	41.92	<.0001	<.0001	1	20	0.09	0.7693
Region	3	2967	3.46	1.15	0.3265	0.3267	3	20	0.18	0.9068
Time of Day	1	2967	3.18	3.18	0.0745	0.0746	1	20	3.75	0.0670
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 24300.6)*						*Lognormal Submodel Type 3 Tests (AIC 35.3)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	10	3000	12.54	1.25	0.2507	0.2513	10	23	8.21	<.0001
Depth	1	3000	48.46	48.46	<.0001	<.0001	1	23	0.60	0.4454
Region				Dropped				Dropped		
Time of Day	1	3000	3.90	3.90	0.0482	0.0483	1	23	4.03	0.0567
Model Run #3	*Binomial Submodel Type 3 Tests (AIC 24300.6)*						*Lognormal Submodel Type 3 Tests (AIC 27.6)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	10	3000	12.54	1.25	0.2507	0.2513	10	24	8.29	<.0001
Depth	1	3000	48.46	48.46	<.0001	<.0001		Dropped		
Region				Dropped				Dropped		
Time of Day	1	3000	3.90	3.90	0.0482	0.0483	1	24	3.96	0.0580
Model Run #4	*Binomial Submodel Type 3 Tests (AIC 24300.6)*						*Lognormal Submodel Type 3 Tests (AIC 29.3)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	10	3000	12.54	1.25	0.2507	0.2513	10	25	7.06	<.0001
Depth	1	3000	48.46	48.46	<.0001	<.0001		Dropped		
Region				Dropped				Dropped		
Time of Day	1	3000	3.90	3.90	0.0482	0.0483		Dropped		

Addendum Table 6. Indices of smoothhound abundance developed using the delta-lognormal model for Fall SEAMAP groundfish survey 1972-1986. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1972	0.005435	184	0.002131	0.12018	1.18553	0.01845	0.7827
1973	0	272	0				
1974	0	243	0				
1975	0.010714	280	0.015037	0.84805	0.70059	0.23963	3.0013
1976	0.006515	307	0.007717	0.43520	.	.	.
1977	0.008264	242	0.007425	0.41876	.	.	.
1978	0.021944	319	0.031019	1.74935	0.47329	0.71183	4.2991
1979	0.007326	273	0.008498	0.47923	.	.	.
1980	0.004292	233	0.004952	0.27928	1.17670	0.04328	1.8020
1981	0.003584	279	0.004583	0.25845	1.17437	0.04015	1.6635
1982	0.014652	273	0.020985	1.18349	0.60843	0.38522	3.6359
1983	0	222	0				
1984	0	226	0				
1985	0.027607	326	0.070720	3.98833	0.49048	1.57582	10.0943
1986	0.013468	297	0.021982	1.23967	0.65755	0.37380	4.1113

Addendum Table 7. Summary of the factors used in constructing the smoothhound abundance index from the Fall SEAMAP groundfish survey data.

Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
Year	1988	56	5	0.08929	0.14796
Year	1989	57	9	0.15789	0.27023
Year	1990	53	7	0.13208	0.30934
Year	1991	57	4	0.07018	0.07007
Year	1992	56	3	0.05357	0.15677
Year	1993	53	6	0.11321	0.13386
Year	1994	57	10	0.17544	0.58051
Year	1995	53	14	0.26415	0.47748
Year	1996	59	7	0.11864	0.19180
Year	1997	55	10	0.18182	0.27182
Year	1998	57	6	0.10526	0.26760
Year	1999	56	8	0.14286	0.23963
Year	2000	52	11	0.21154	0.40422
Year	2001	57	8	0.14035	0.19327
Year	2002	56	9	0.16071	0.20555
Year	2003	59	4	0.06780	0.12776
Year	2004	52	9	0.17308	0.18135
Year	2005	58	8	0.13793	0.20929
Year	2006	52	14	0.26923	0.64686
Year	2007	40	6	0.15000	0.23981
Year	2008	129	18	0.13953	0.46127
Year	2009	115	16	0.13913	0.38163
Year	2010	100	6	0.06000	0.13944
Year	2011	64	6	0.09375	0.21497
Year	2012	52	3	0.05769	0.19150
Region	EFL	46	1	0.02174	0.04348
Region	ELA	327	31	0.09480	0.14026
Region	MS	234	23	0.09829	0.46165
Region	TX	572	70	0.12238	0.22337
Region	WFL	34	2	0.05882	0.23529
Region	WLA	342	80	0.23392	0.40514

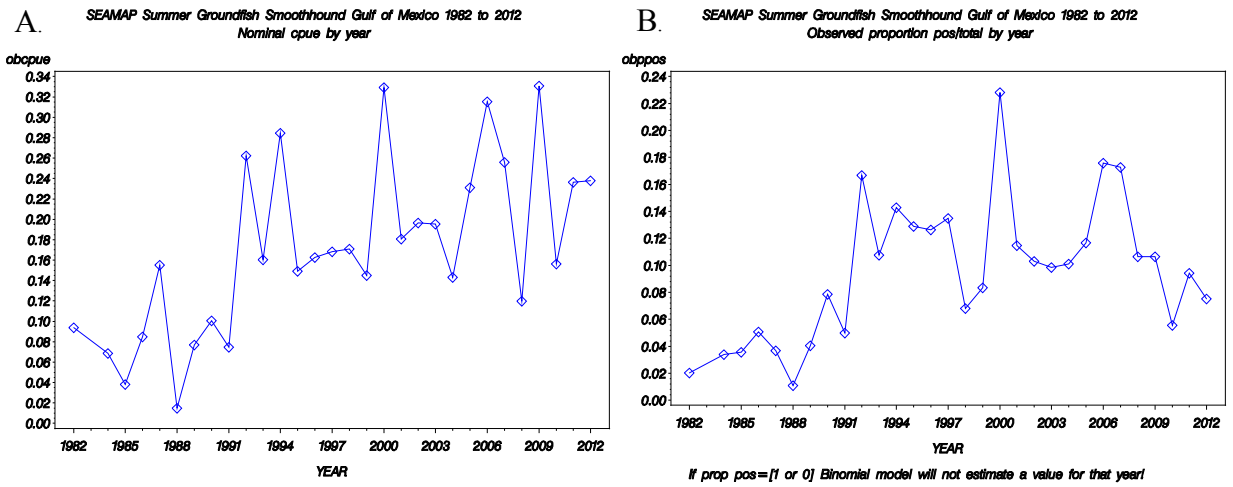
Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
Time of Day	Day	769	123	0.15995	0.34754
Time of Day	Night	786	84	0.10687	0.20733

Addendum Table 8. Summary of backward selection procedure for building delta-lognormal submodels for smoothhound Fall SEAMAP groundfish survey index of relative abundance from 1988 to 2012.

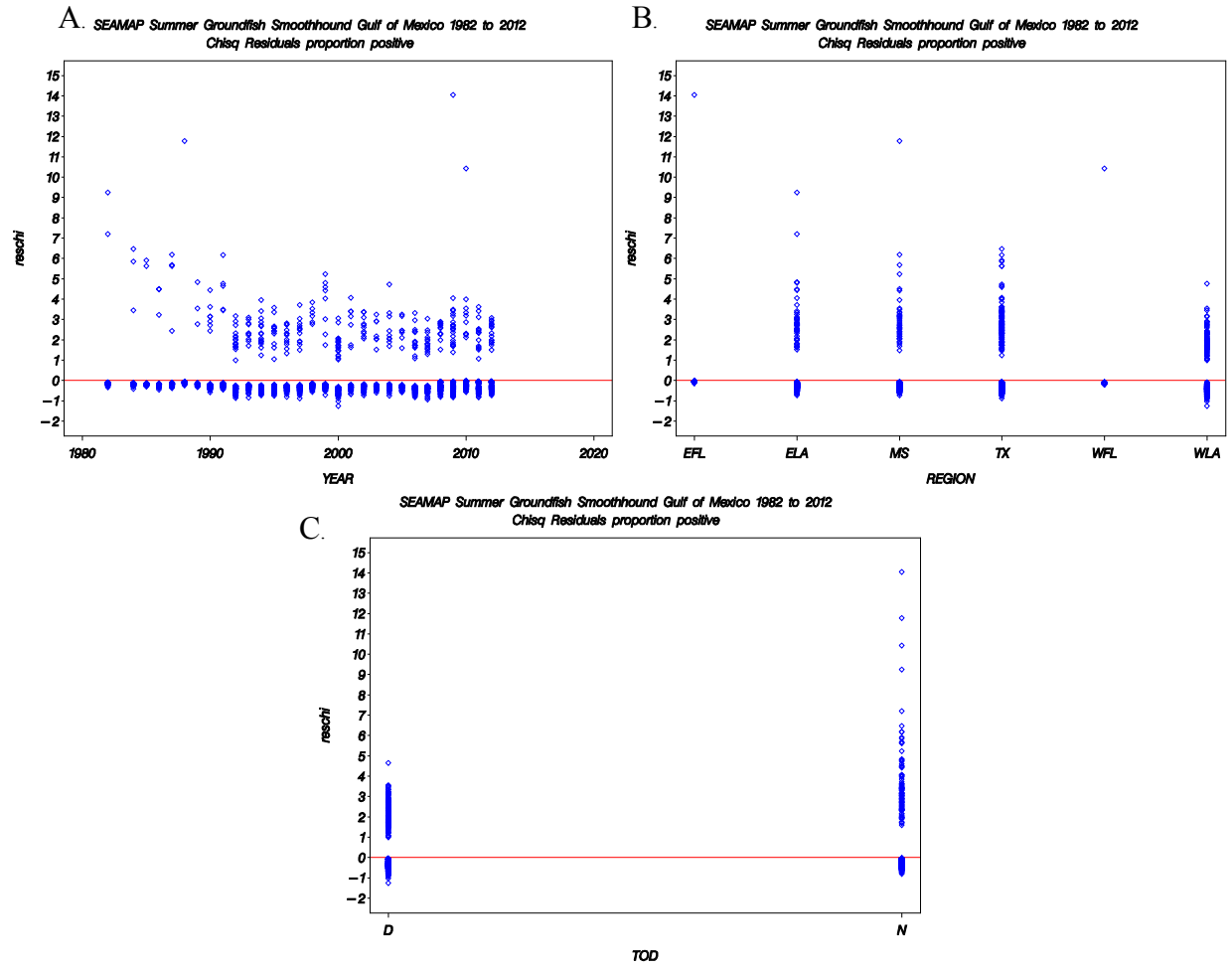
Model Run #1	*Binomial Submodel Type 3 Tests (AIC 8226.2)*						*Lognormal Submodel Type 3 Tests (AIC 384.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	24	1523	38.32	1.60	0.0321	0.0337	24	175	3.36	<.0001
Depth	1	1523	53.38	53.38	<.0001	<.0001	1	175	3.52	0.0623
Region	5	1523	40.41	8.08	<.0001	<.0001	5	175	12.08	<.0001
Time of Day	1	1523	12.67	12.67	0.0004	0.0004	1	175	4.10	0.0445
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 8226.2)*						*Lognormal Submodel Type 3 Tests (AIC 379.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	24	1523	38.32	1.60	0.0321	0.0337	24	176	3.32	<.0001
Depth	1	1523	53.38	53.38	<.0001	<.0001		Dropped		
Region	5	1523	40.41	8.08	<.0001	<.0001	5	176	12.88	<.0001
Time of Day	1	1523	12.67	12.67	0.0004	0.0004	1	176	3.67	0.0571
Model Run #3	*Binomial Submodel Type 3 Tests (AIC 8226.2)*						*Lognormal Submodel Type 3 Tests (AIC 379.8)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	24	1523	38.32	1.60	0.0321	0.0337	24	177	3.28	<.0001
Depth	1	1523	53.38	53.38	<.0001	<.0001		Dropped		
Region	5	1523	40.41	8.08	<.0001	<.0001	5	177	12.72	<.0001
Time of Day	1	1523	12.67	12.67	0.0004	0.0004		Dropped		

Addendum Table 9. Indices of smoothhound abundance developed using the delta-lognormal model for Fall SEAMAP groundfish survey 1988-2012. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

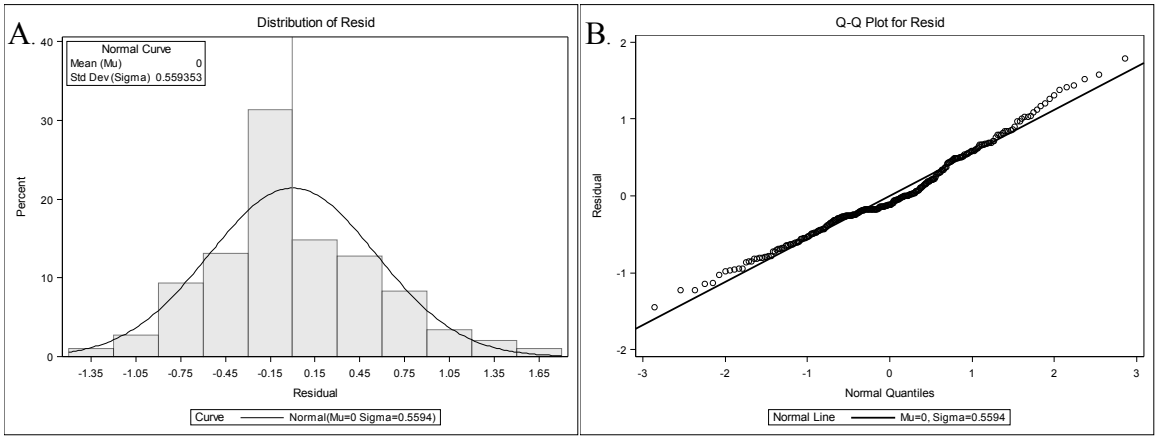
Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1988	0.08929	56	0.08486	0.58393	0.51491	0.22138	1.54022
1989	0.15789	57	0.13841	0.95244	0.40189	0.43928	2.06506
1990	0.13208	53	0.14385	0.98982	0.43969	0.42696	2.29468
1991	0.07018	57	0.04394	0.30235	0.56401	0.10569	0.86495
1992	0.05357	56	0.07237	0.49800	0.63582	0.15528	1.59714
1993	0.11321	53	0.07308	0.50284	0.47433	0.20424	1.23798
1994	0.17544	57	0.16160	1.11198	0.38636	0.52736	2.34469
1995	0.26415	53	0.31810	2.18889	0.32037	1.17144	4.09003
1996	0.11864	59	0.08147	0.56057	0.44832	0.23819	1.31931
1997	0.18182	55	0.11101	0.76387	0.38595	0.36254	1.60947
1998	0.10526	57	0.11646	0.80135	0.47455	0.32537	1.97365
1999	0.14286	56	0.09929	0.68323	0.42803	0.30082	1.55177
2000	0.21154	52	0.21984	1.51271	0.37416	0.73341	3.12005
2001	0.14035	57	0.10907	0.75049	0.42843	0.33020	1.70572
2002	0.16071	56	0.08781	0.60422	0.40599	0.27664	1.31969
2003	0.06780	59	0.03707	0.25505	0.56978	0.08832	0.73653
2004	0.17308	52	0.11403	0.78464	0.40081	0.36259	1.69794
2005	0.13793	58	0.10867	0.74780	0.42635	0.33022	1.69339
2006	0.26923	52	0.37361	2.57085	0.33268	1.34483	4.91458
2007	0.15000	40	0.13900	0.95650	0.48527	0.38130	2.39943
2008	0.13953	129	0.30815	2.12038	0.30068	1.17726	3.81904
2009	0.13913	115	0.28041	1.92955	0.30248	1.06771	3.48706
2010	0.06000	100	0.13504	0.92922	0.45223	0.39214	2.20189
2011	0.09375	64	0.12866	0.88530	0.47624	0.35841	2.18674
2012	0.05769	52	0.14736	1.01403	0.63293	0.31761	3.23750



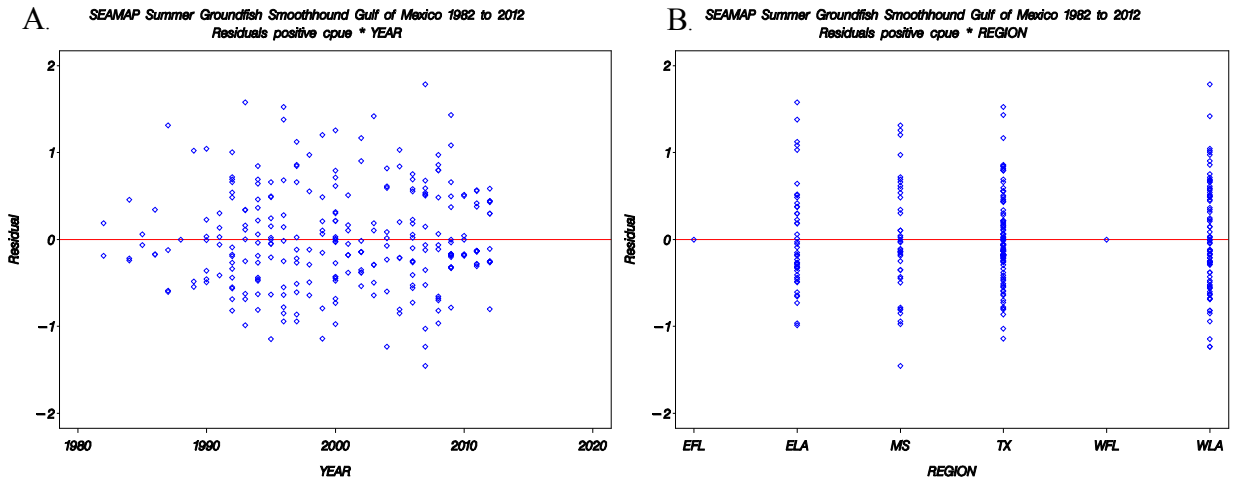
Addendum Figure 1. Annual trends for smoothhound captured during Summer SEAMAP Groundfish Surveys from 1982 to 2012 in **A.** nominal CPUE and **B.** proportion of positive stations.



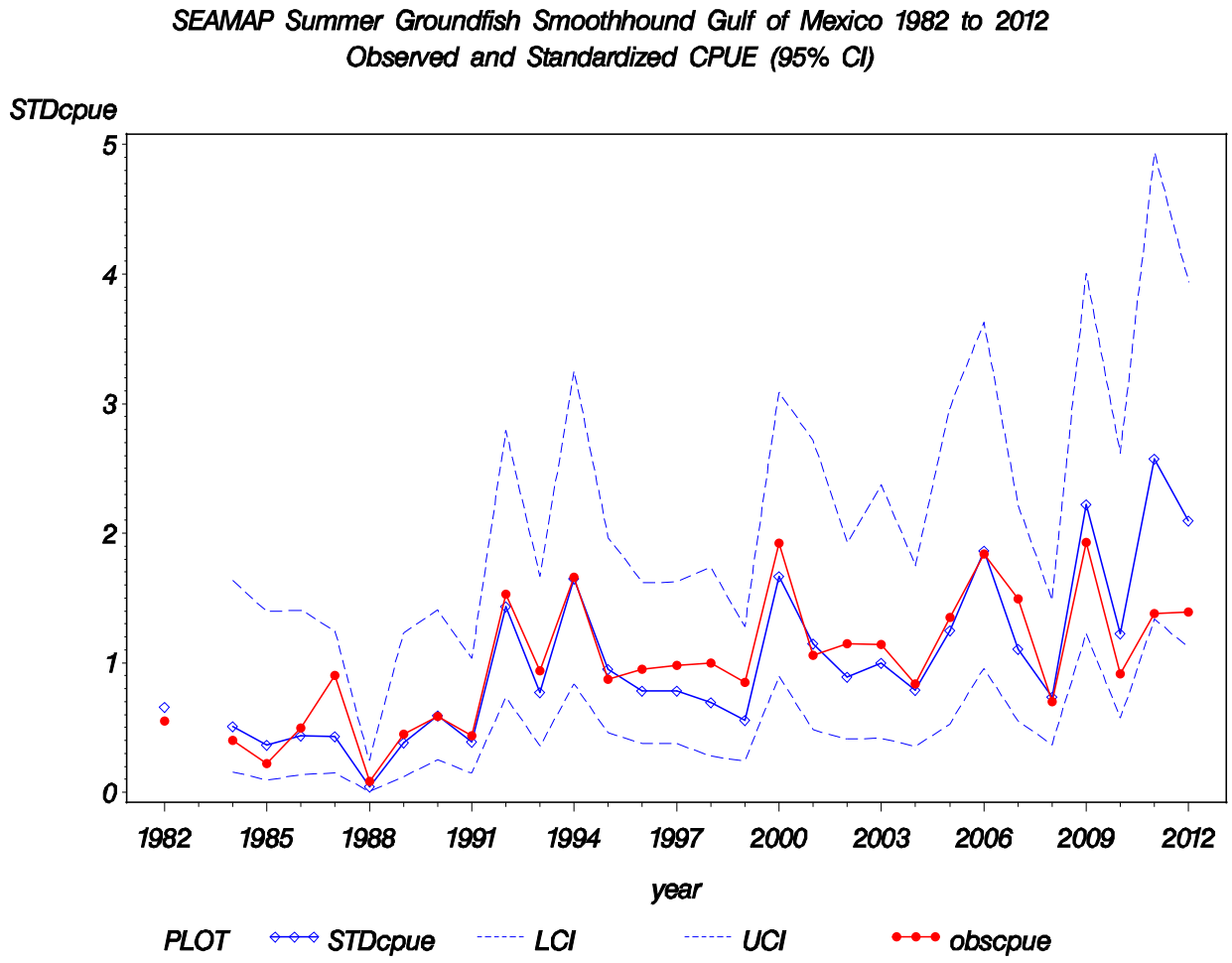
Addendum Figure 2. Diagnostic plots for binomial component of the smoothhound Summer SEAMAP Groundfish Survey model: **A.** the Chi-Square residuals by year, **B.** the Chi-Square residuals by region, and **C.** the Chi-Square residuals by time of day.



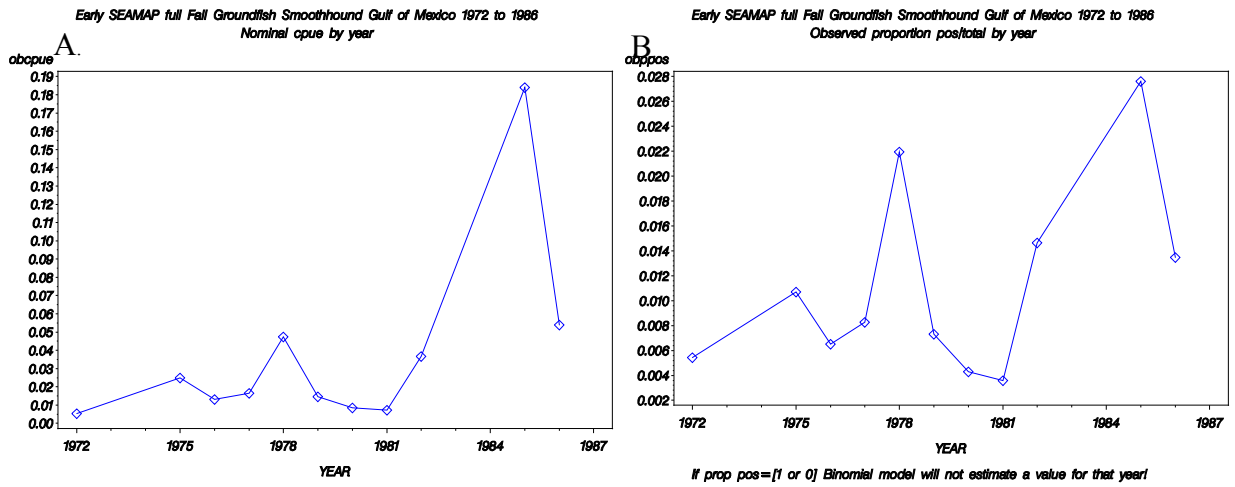
Addendum Figure 3. Diagnostic plots for lognormal component of the smoothhound Summer SEAMAP Groundfish Survey model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).



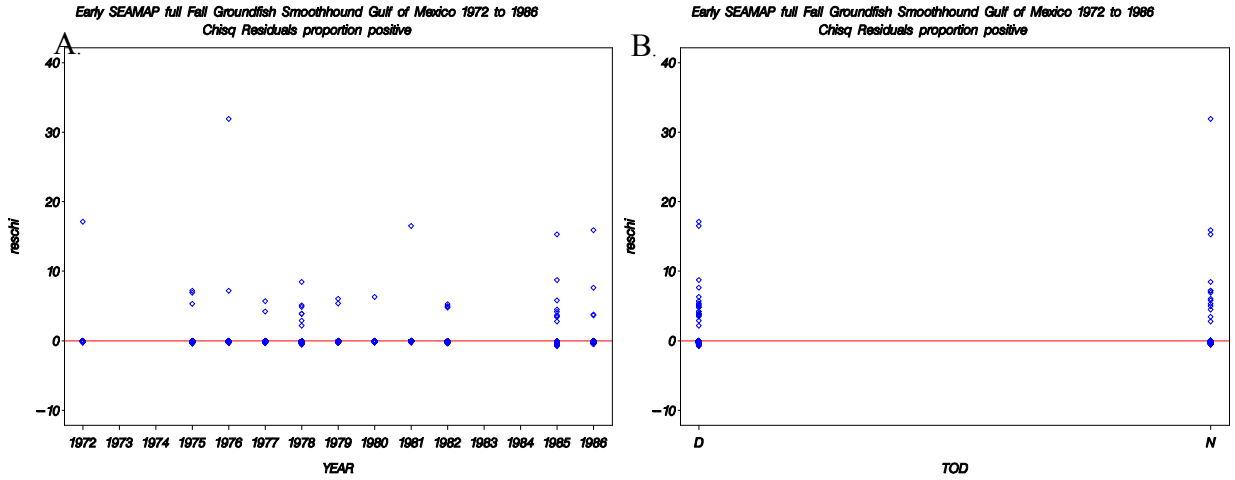
Addendum Figure 4. Diagnostic plots for lognormal component of the smoothhound Summer SEAMAP Groundfish Survey model: **A.** the Chi-Square residuals by year, and **B.** the Chi-Square residuals by region.



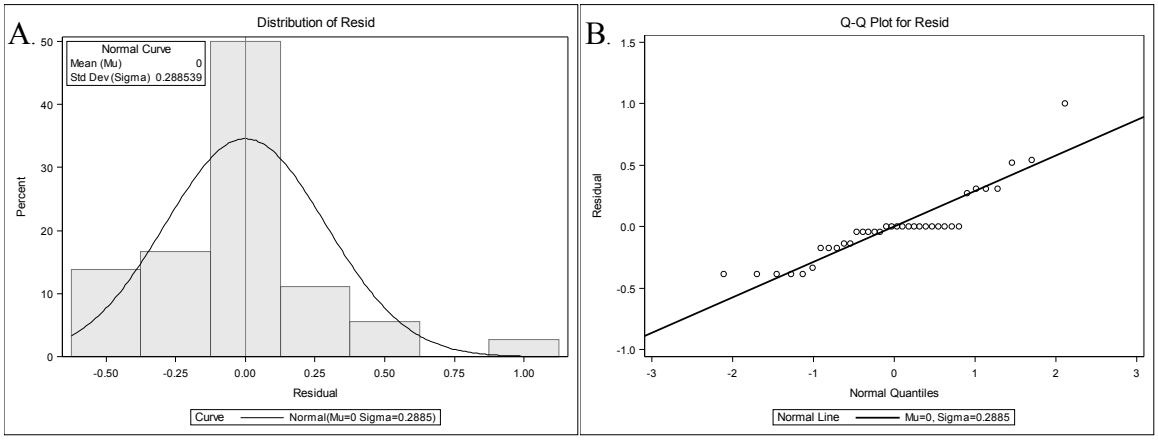
Addendum Figure 5. Annual index of abundance for smoothhound from the Summer SEAMAP Groundfish Survey from 1982 – 2012. (Note that the survey has been conducted annually since 1982, in 1983 no smoothhound were captured during the survey.)



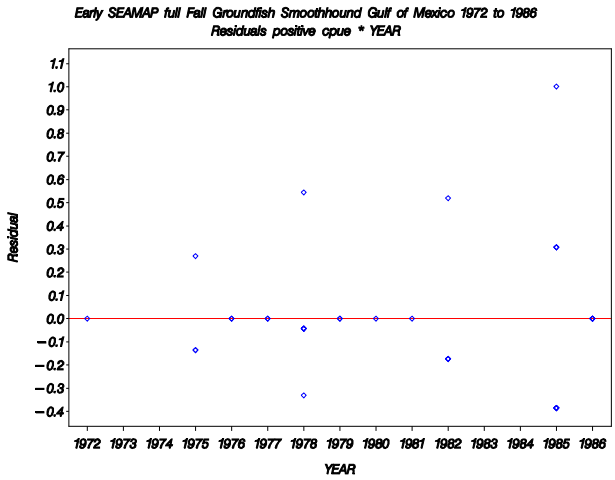
Addendum Figure 6. Annual trends for smoothhound captured during Fall SEAMAP Groundfish Surveys from 1972 to 1986 in **A.** nominal CPUE and **B.** proportion of positive stations.



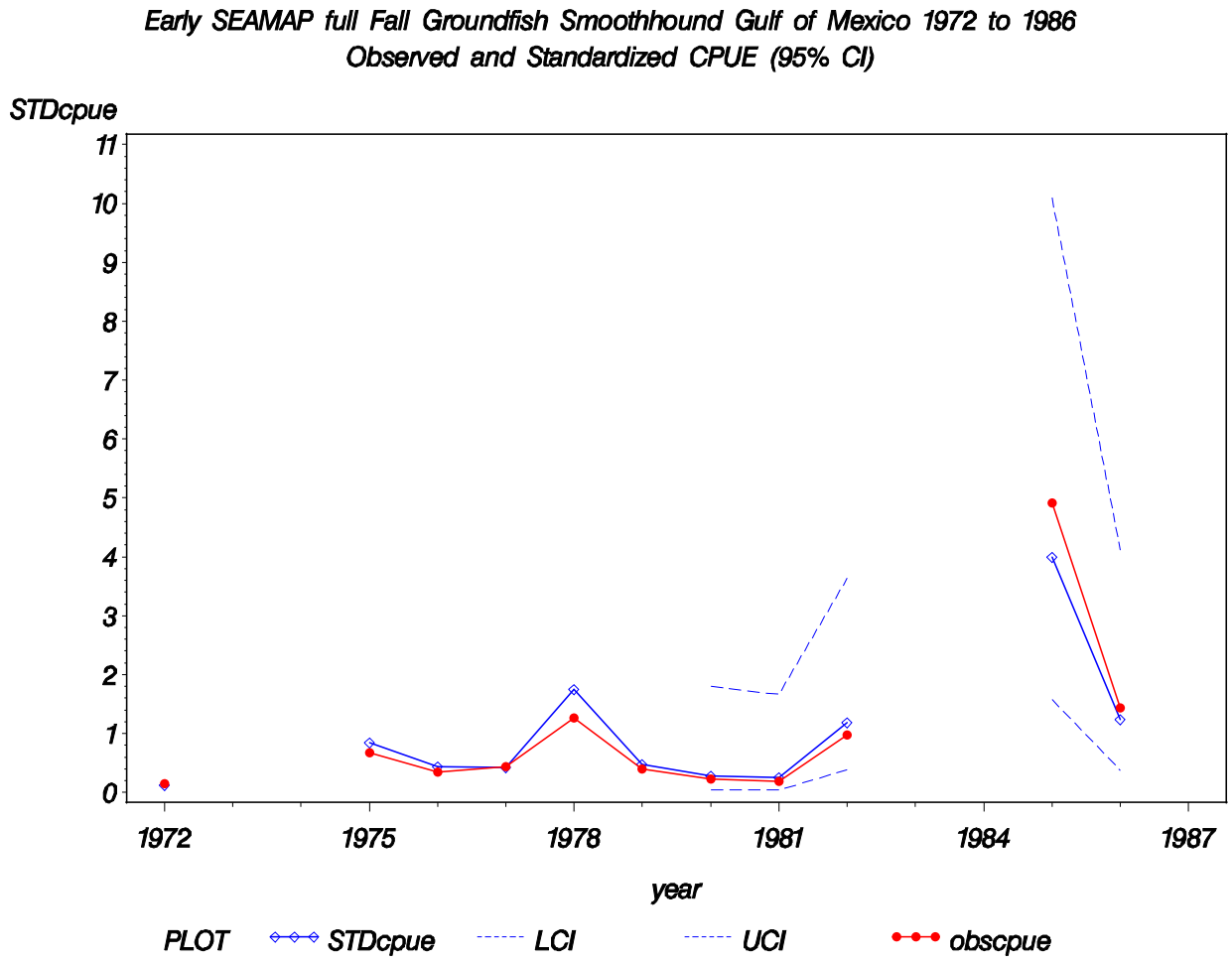
Addendum Figure7. Diagnostic plots for binomial component of the smoothhound Fall SEAMAP Groundfish Survey model: **A.** the Chi-Square residuals by year and **B.** the Chi-Square residuals by time of day.



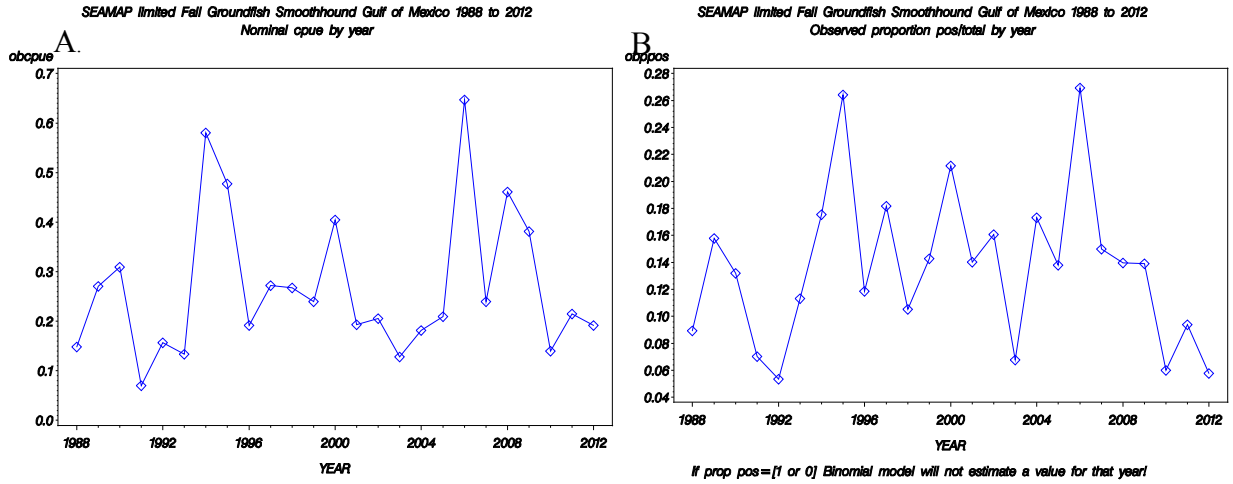
Addendum Figure 8. Diagnostic plots for lognormal component of the smoothhound Fall SEAMAP Groundfish Survey model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).



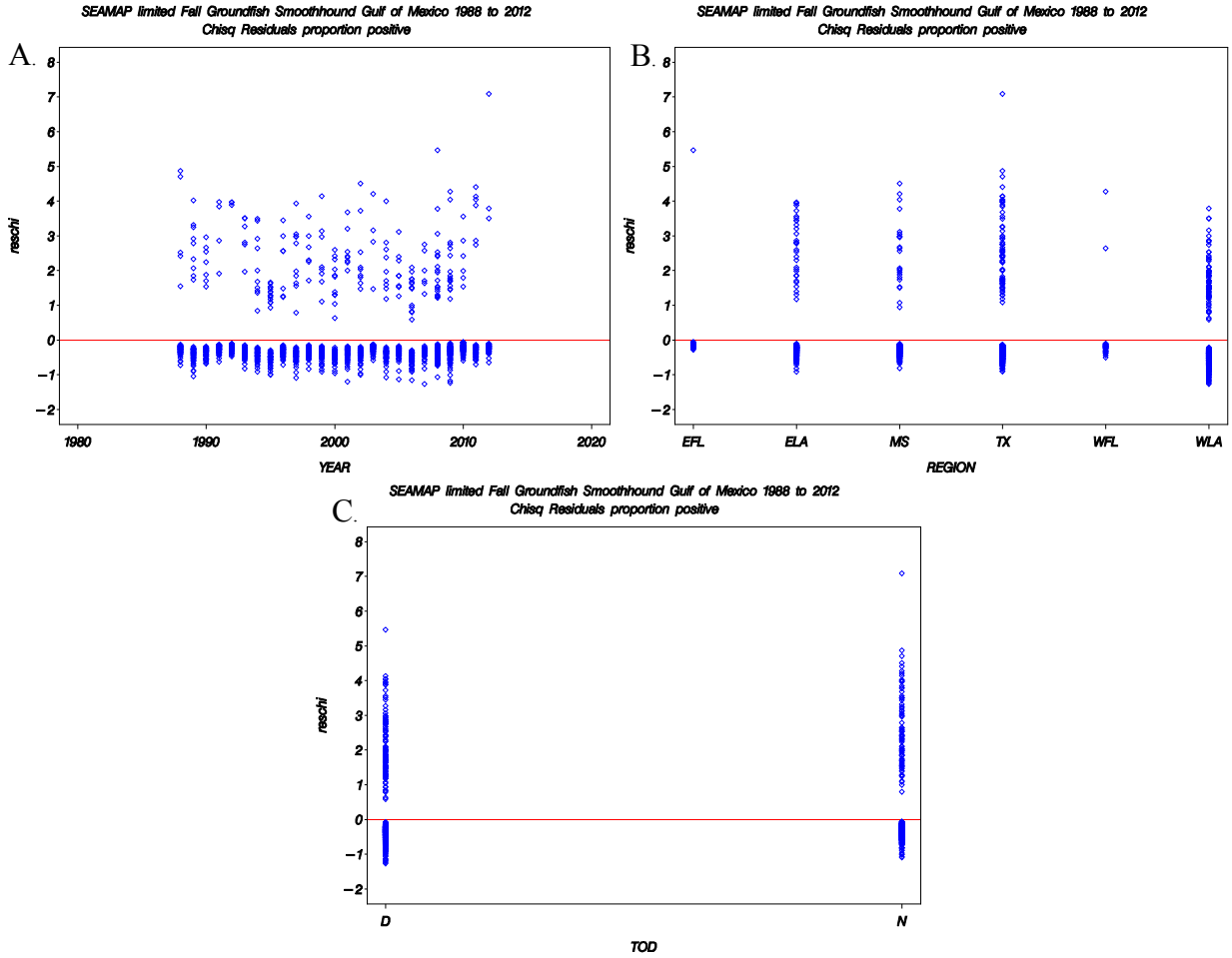
Addendum Figure 9. Diagnostic plots for lognormal component of the smoothhound Fall SEAMAP Groundfish Survey model of the Chi-Square residuals by year.



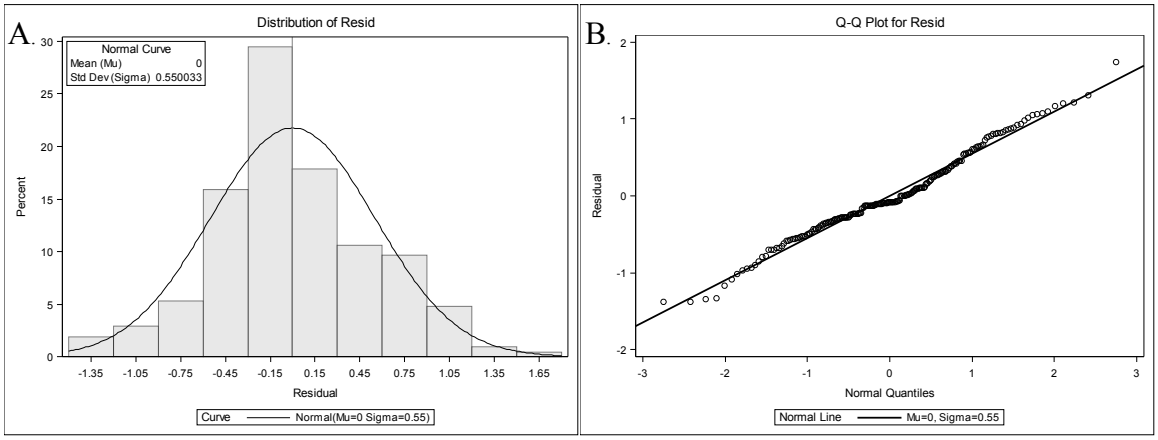
Addendum Figure 10. Annual index of abundance for smoothhound from the Fall SEAMAP Groundfish Survey from 1972 – 1986.



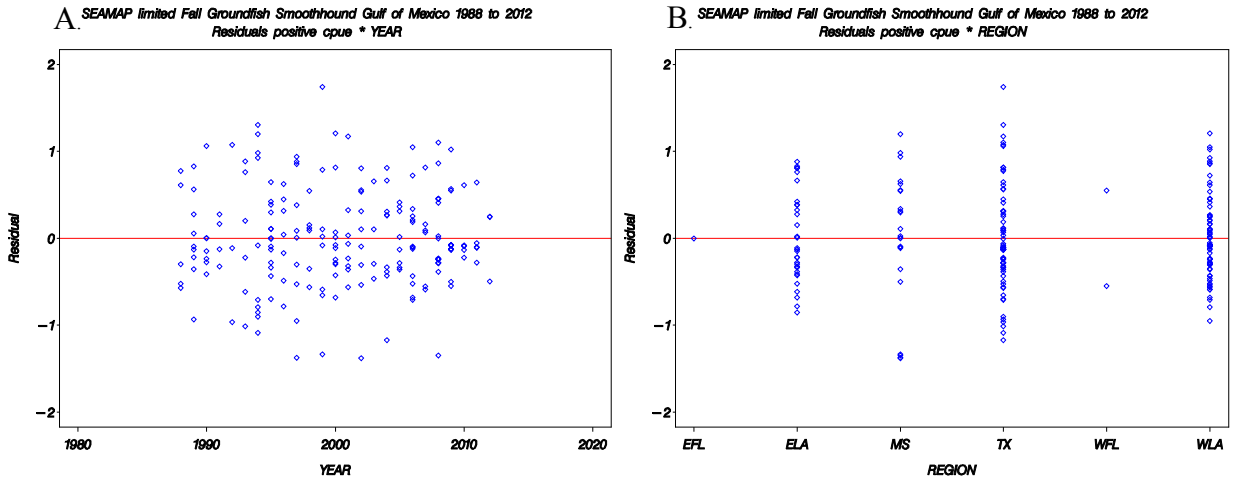
Addendum Figure 11. Annual trends for smoothhound captured during Fall SEAMAP Groundfish Surveys from 1988 to 2012 in **A.** nominal CPUE and **B.** proportion of positive stations.



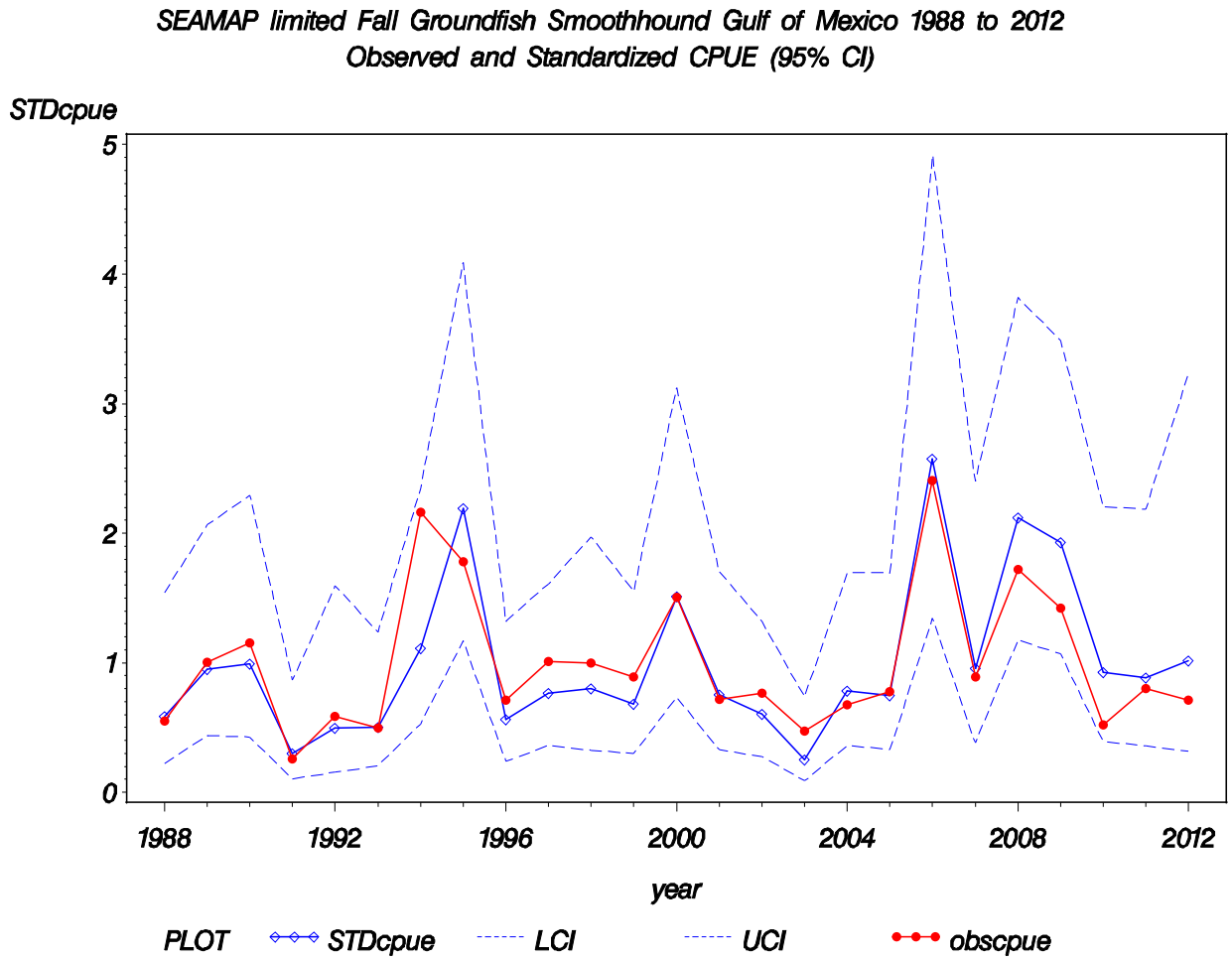
Addendum Figure 12. Diagnostic plots for binomial component of the smoothhound Fall SEAMAP Groundfish Survey model: **A.** the Chi-Square residuals by year, **B.** the Chi-Square residuals by region and **C.** the Chi-Square residuals by time of day.



Addendum Figure 13. Diagnostic plots for lognormal component of the smoothhound Fall SEAMAP Groundfish Survey model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).



Addendum Figure 14. Diagnostic plots for lognormal component of the smoothhound Fall SEAMAP Groundfish Survey model: **A.** the Chi-Square residuals by year and **B.** the Chi-Square residuals by region.



Addendum Figure 15. Annual index of abundance for smoothhound from the Fall SEAMAP Groundfish Survey from 1988 – 2012.