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SEDAR49-DW-18

2 May 2016
Updated: 11 May 2016

Please cite this document as:

Pollack, A.G., David S. Hanisko and G. Walter Ingram, Jr. . 2016. Wenchman Abundance Indices from MSLABS Small Pelagics Surveys in the Northern Gulf of Mexico. SEDAR49-DW-18. SEDAR, North Charleston, SC. 15 pp.

Wenchman Abundance Indices from MSLABS Small Pelagics Surveys in the Northern Gulf of Mexico

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Abstract

The Southeast Fisheries Science Center Mississippi Laboratories Small Pelagics Survey began in October of 2002 as an outer shelf and upper slope survey. The objective was to investigate if the distributional range of species collected in Southeast Area Monitoring and Assessment Program (SEAMAP) groundfish surveys extended beyond the geographical boundaries of the commercial shrimping grounds. By 2004, the survey became a mid to outer shelf and upper slope survey in order to overlap some of the area covered by the SEAMAP groundfish survey. A delta-lognormal model was used to develop an abundance index for Wenchman (Pristipomoides aquilonaris). The annual abundance index is relatively stable between 2002 and 2010 with an increase in abundance over the last years of the time series.

Introduction

The Southeast Fisheries Science Center (SEFSC) Mississippi Laboratories (MSLABS) Small Pelagics Survey began in October of 2002 as an outer shelf and upper slope survey (i.e. between 110 and 500 m station depth). It began in order to investigate if the distributional range of species collected in Southeast Area Monitoring and Assessment Program (SEAMAP) groundfish trawls extended beyond the geographical boundaries of the commercial shrimping grounds. Therefore, in order to more effectively evaluate these extensions of distributional range, trawling stations began to be allocated in shallower depth strata to allow geographic overlap with SEAMAP groundfish effort. By 2004, the survey became a mid to outer shelf and upper slope survey (i.e. between 50 and 500 m station depth). While this survey data has not been utilized in previous stock assessments, mainly due to the short duration of the survey, it potentially could provide an important source of fisheries independent information on many commercially and recreationally important species throughout the northern GOM, as it has been occurring for 14 years. The purpose of this document is to provide an abundance index for Wenchman (*Pristipomoides aquilonaris*).

Methodology

Survey Design / Data

Stations were selected with a proportional allocation based on stratum area with 30% effort between 50 and 110 m, 60% effort between 110 and 200 m and 10 % effort between 200 and 500

m. Trawl sampling was conducted using a 27.4 m (90 ft) high-opening fish trawl towed for approximately 30 min. Trawl data was obtained from the SEFSC MSLABS trawl unit leader (Gilmore Pellegrin). A total of 1,410 stations were sampled from 2002- 2014 (Table 1).

Data Exclusions

Data was limited by the following factors:

1. Those stations that did not indicate a problem with the tow,
2. Conducted between 2002 – 2004 and 2007 – 2013
    a. 2005: No survey due to Hurricane Katrina
    b. 2006: Shortened survey because of vessel issues
    c. 2014: Shortened survey because of vessel issues
3. Conducted in statistical zones 3 – 6, 8 – 11, 13 – 21
    a. Zone 7 and 12: No depths within the sample design

Index Construction

Delta-lognormal modeling methods were used to estimate relative abundance indices for Wenchman (Pennington, 1983; Bradu and Mundlak, 1970). 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 (*cf.* Lo *et al*. 1992).

The delta-lognormal index of relative abundance (I_y) 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 using the delta method approximation

$$(4) \qquad V(I_y) \approx V(c_y)p_y^2 + c_y^2 V(p_y).$$

A covariance term is not included in the variance estimator since there is no correlation between the estimator of the proportion positive and the mean CPUE given presence. The two estimators are derived independently and have been shown to not covary for a given year (Christman, unpublished).

The submodels of the delta-lognormal model were built using a backward selection procedure based on type III 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

Year: 2002 – 2004, 2007 – 2013
Statistical Zone: Zones 3 – 6, 8 – 11, 13 – 21
Time of Day: Day, Night
Depth Zone: 50 – 110 m, 110 – 200 m, 200 – 500 m

Results and Discussion

The distribution of Wenchman is presented in Figure 1, with annual abundance and distribution presented in the Appendix Figure 1. The total number of Wenchman captured ranged from 275 to 20,145 (Table 2). Of the 149,539 Wenchman captured during the survey, a total of 11,755 were measured from 2002 – 2014 with an average total length of 145 mm. The length frequency distribution of Wenchman captured is shown in Figure 2.

For the Small Pelagics abundance index of Wenchman, the nominal CPUE and number of stations with a positive catch are presented in Figure 3. Year, depth zone, statistical zone and time of day were retained in both the binomial and lognormal submodels. A summary of the factors used in the analysis is presented in Appendix Table 1. Table 3 summarizes the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 6,748.1and 2,759.0, respectively. The diagnostic plots for the binomial and lognormal submodels are shown in Figures 4-6. Annual abundance indices are presented in Table 4 and Figure 7.

Literature Cited

Bradu, D. and Mundlak, Y. 1970. Estimation in Lognormal Linear Models, Journal of the American Statistical Association, 65: 198-211.

Ingram, G.W., Jr. 2008. Abundance indices of king mackerel, *Scomberomorus cavalla*, collected in fall SEAMAP groundfish surveys in the western U.S. Gulf of Mexico (1972-2007). SEDAR16-DW-08.

Lo, N.C.H., L.D. Jacobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Canadian Journal of Fisheries and Aquatic Science 49:2515-2526.

Ortiz, M. 2006. Standardized catch rates for gag grouper (*Mycteroperca microlepis*) from the marine recreational fisheries statistical survey (MRFSS). SEDAR10-DW-09.

Pennington, M. 1983. Efficient Estimators of Abundance, for Fish and Plankton Surveys. Biometrics, 39: 281-286.

Pollack, A.G. and G. Walter Ingram Jr. 2010. Abundance indices of subadult yellowedge grouper, *Epinephelus flavolimbatus*, collected in summer and fall groundfish surveys in the northern Gulf of Mexico. SEDAR22-DW-06.

Table 1. Number of stations sampled by shrimp statistical zone during the MSLABS Small Pelagics survey from 2002-2014. (Note: No survey was conducted in 2005 due to Hurricane Katrina and in 2006, the vessel was repurposed to conduct the SEAMAP groundfish survey after leg 1)

	Shrimp Statistical Zone																		
Year	2	3	4	5	6	8	9	10	11	13	14	15	16	17	18	19	20	21	***Total***
2002	5	14	19	12	1	18	13	3	2	5	5	7	6	7	4	.	9	2	***132***
2003		10	21	15	2	18	18	4	4	5	4	8	7	8	5	.	11	6	***146***
2004			1	7	2	17	12	4	3	4	5	8	6	9	6	1	9	7	***101***
2005																			
2006							5	4	5	5	7	8	6	11	6		9	7	***73***
2007		1	22	18	5	17	12	3	4	7	7	7	7	9	7	1	12	7	***146***
2008	3	16	22	19	5	18	14	4	5	3	7	8	9	8	7		13	6	***167***
2009	1	7	10	9	4	13	13	4	3	4	8	6	6	10	7	1	11	5	***122***
2010	3	13	13	9	2	11	17	1	4	3	4	10	6	9	6	1	13	5	***130***
2011	2	13	16	12	3	12	11	7	1	3	12	8	8	6	7	2	7	1	***131***
2012		9	11	5	2	10	13	2	1	2	5	10	7	10	5	2	11	6	***111***
2013		2	7	10	4	10	20	3	8	5	4	7	8	9	3	1	9	7	***117***
2014						3	9	3	4	5	6	4							***34***
Total	***14***	***85***	***142***	***116***	***30***	***147***	***157***	***42***	***44***	***51***	***74***	***91***	***76***	***96***	***63***	***9***	***114***	***59***	***1410***

Table 2. Summary of the Wenchman length data collected during MSLABS Small Pelagics surveys conducted between 2002 and 2014. (Note: no survey was conducted in 2005 due to Hurricane Katrina and in 2006, the vessel was repurposed to conduct the SEAMAP groundfish survey after leg 1)

Survey Year	*Number of Stations*	*Number Collected*	*Number Measured*	*Minimum Total Length (mm)*	*Maximum Total Length (mm)*	*Mean Total Length (mm)*	*Standard Deviation (mm)*
2002	132	13376	1068	49	262	170	41
2003	146	9807	1312	36	272	171	46
2004	101	9633	921	36	255	146	58
2005							
2006	73	9489	840	30	252	135	63
2007	146	11483	1223	26	261	151	63
2008	167	14648	1427	29	267	157	57
2009	122	12528	1055	18	284	137	58
2010	130	12337	912	47	278	150	59
2011	131	14472	676	18	252	125	65
2012	111	19151	996	16	260	119	56
2013	117	20145	1050	27	255	112	56
2014	34	2470	275	33	253	139	52

Total Number of Years	Total Number of Stations	Total Number Collected	Total Number Measured	Overall Mean Total Length (mm)
12	1410	149,539	11,755	145

Table 3. Summary of backward selection procedure for building delta-lognormal submodels for Wenchman MSLABS Small Pelagics survey index of relative abundance from 2002 to 2013.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 6748.1)*						*Lognormal Submodel Type 3 Tests (AIC 2759.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	9	1260	16.38	1.82	0.0593	0.0605	9	743	3.41	0.0004
Depth Zone	2	1260	211.88	105.94	<.0001	<.0001	2	743	37.90	<.0001
Statistical Zone	16	1260	178.28	11.14	<.0001	<.0001	16	743	32.59	<.0001
Time of Day	1	1260	5.64	5.64	0.0176	0.0177	1	743	9.90	0.0017

Table 4. Indices of Wenchman abundance developed using the delta-lognormal model for MSLABS Small Pelagics surveys from 2002 to 2013. 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. (Note: No survey was conducted in 2005 due to Hurricane Katrina and in 2006, the vessel was repurposed to conduct the SEAMAP groundfish survey after leg 1)

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
2002	0.70079	127	137.359	1.16426	0.20217	0.78019	1.73740
2003	0.66438	146	106.554	0.90316	0.19524	0.61342	1.32974
2004	0.69307	101	65.853	0.55818	0.24211	0.34631	0.89965
2005							
2006							
2007	0.62329	146	79.822	0.67658	0.19899	0.45619	1.00342
2008	0.60366	164	117.263	0.99393	0.19539	0.67488	1.46379
2009	0.68595	121	129.321	1.09613	0.18820	0.75477	1.59188
2010	0.42520	127	69.402	0.58825	0.25929	0.35318	0.97978
2011	0.44186	129	64.328	0.54524	0.25153	0.33224	0.89480
2012	0.58559	111	216.574	1.83569	0.21750	1.19414	2.82190
2013	0.57265	117	193.321	1.63860	0.21954	1.06175	2.52885

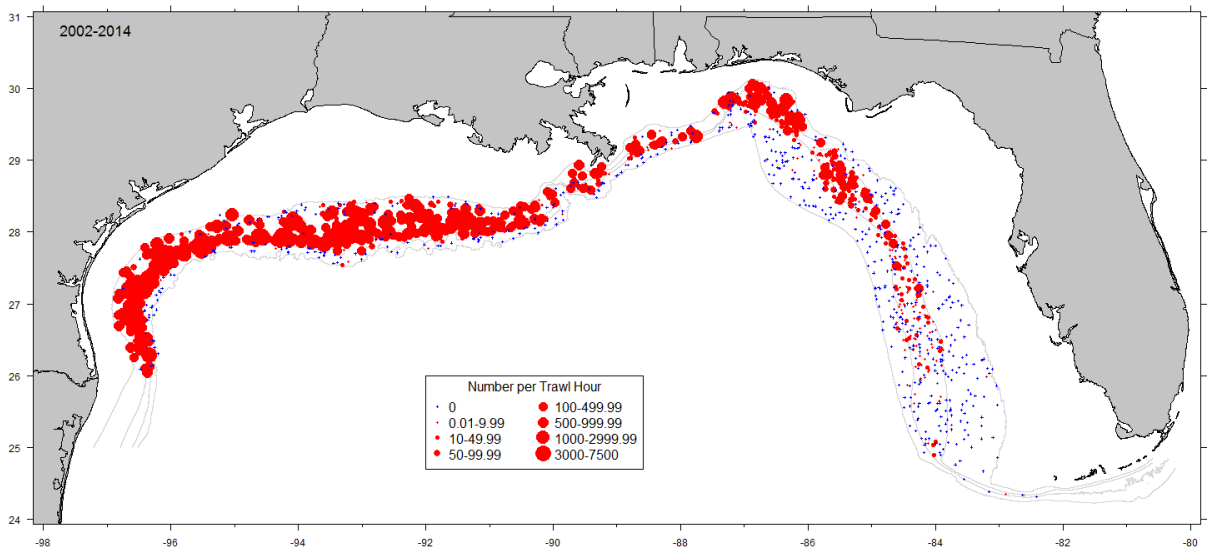

Figure 1. Stations sampled from 2002 to 2014 during the MSLABS Small Pelagics Survey with the CPUE for Wenchman. Contour lines are 50, 110, 200 and 500 m, respectively.

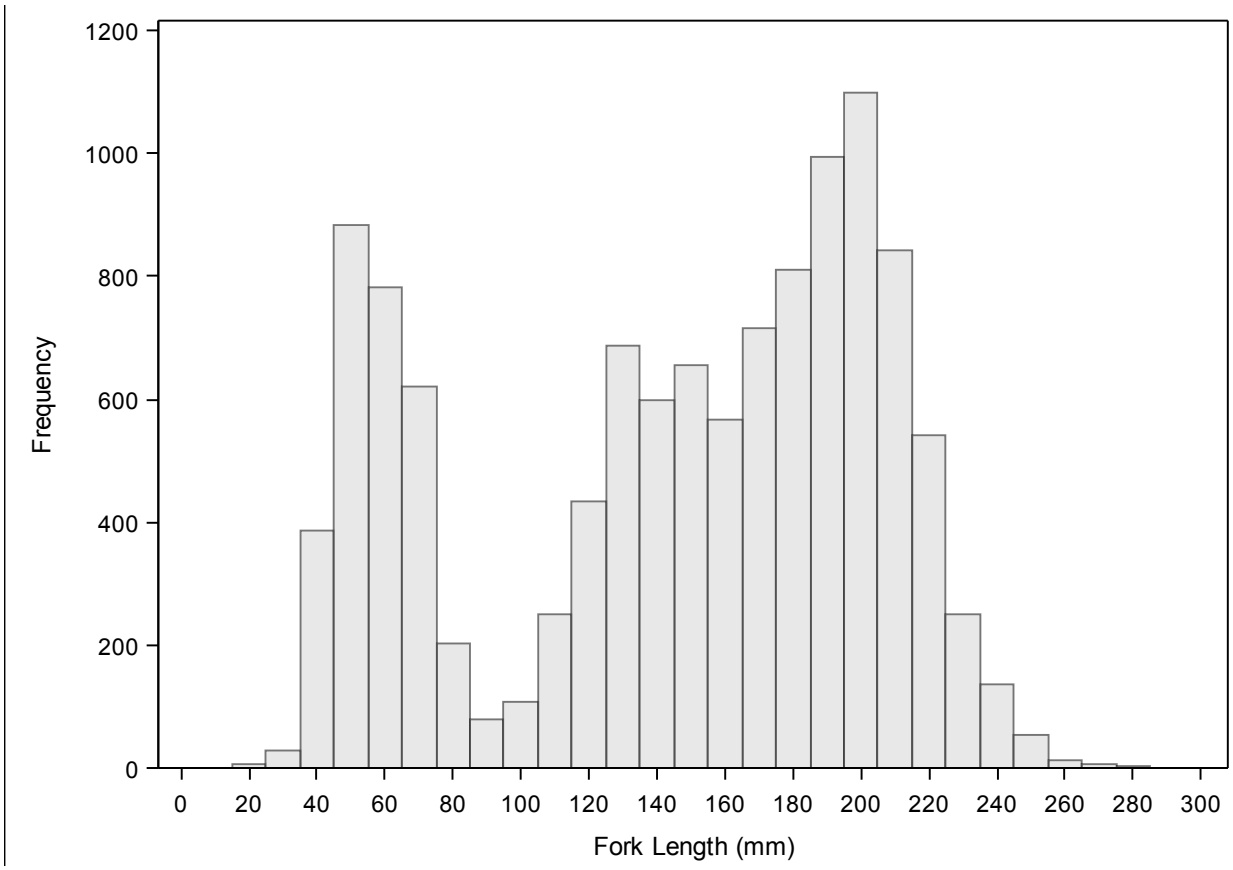

Figure 2. Length frequency histograms for Wenchman captured during MSLABS Small Pelagics surveys from 2002-2014.

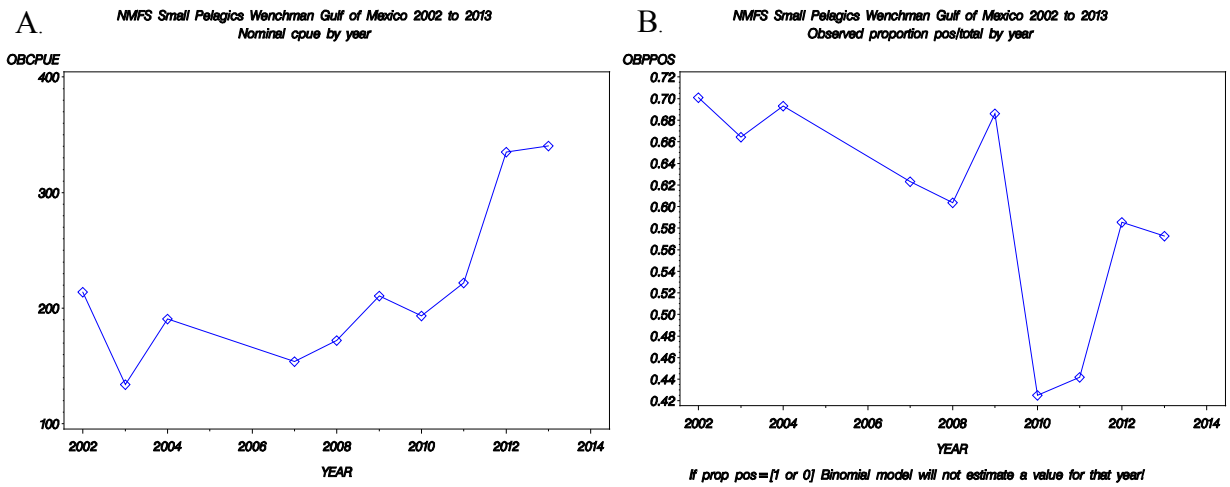

Figure 3. Annual trends for Wenchman captured during MSLABS Small Pelagics surveys from 2002 to 2013 in **A.** nominal CPUE and **B.** proportion of positive stations.

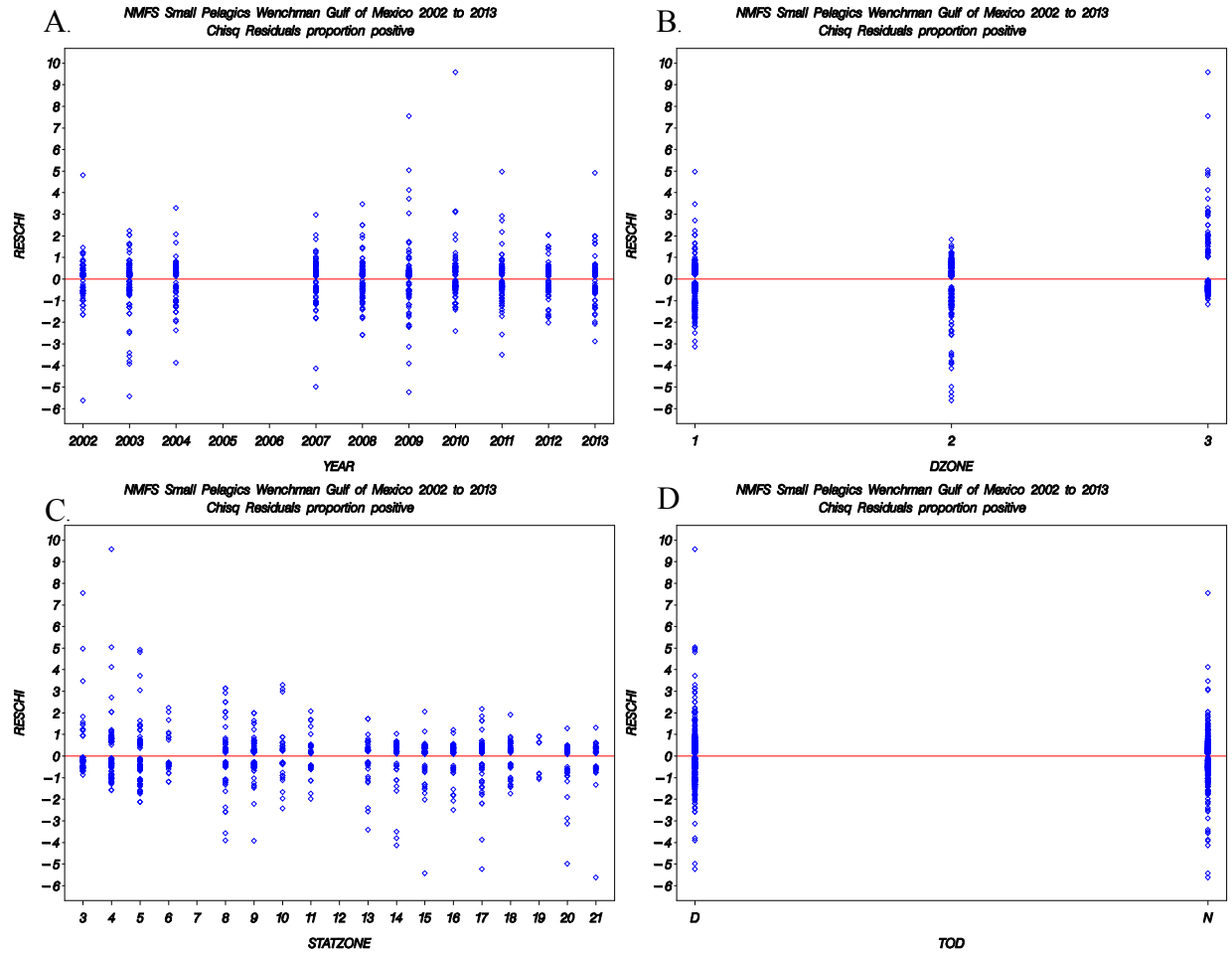

Figure 4. Diagnostic plots for binomial component of the Wenchman MSLABS Small Pelagics surveys model: **A.** the Chi-Square residuals by year, **B.** the Chi-Square residuals by depth zone, **C.** the Chi-Square residuals by statistical zone, and **D.** the Chi-Square residuals by time of day.

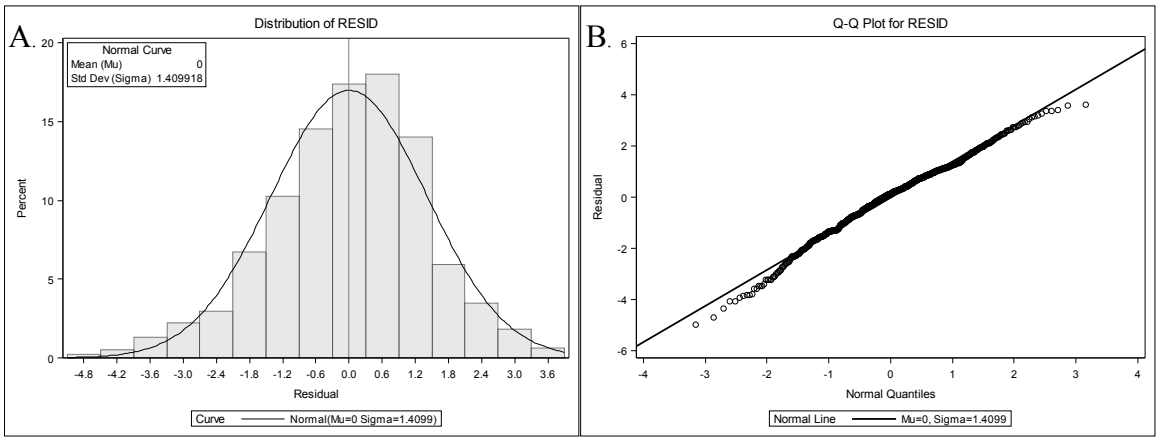

Figure 5. Diagnostic plots for lognormal component of the Wenchman MSLABS Small Pelagics survey model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

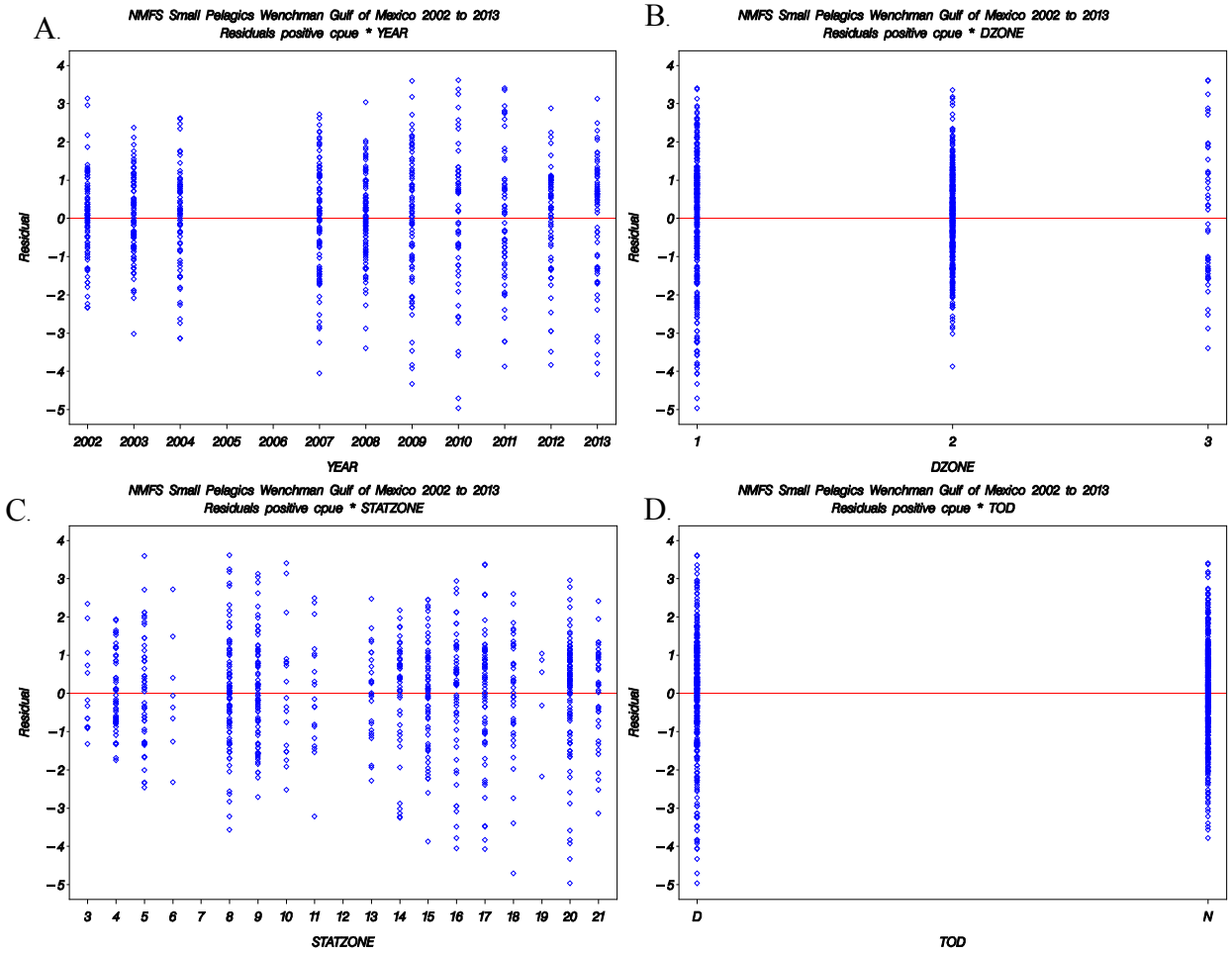

Figure 6. Diagnostic plots for lognormal component of the Wenchman MSLABS Small Pelagics survey model: **A.** the Chi-Square residuals by year, **B.** the Chi-Square residuals by depth zone, **C.** the Chi-Square residuals by statistical zone, and **D.** the Chi-Square residuals by time of day.

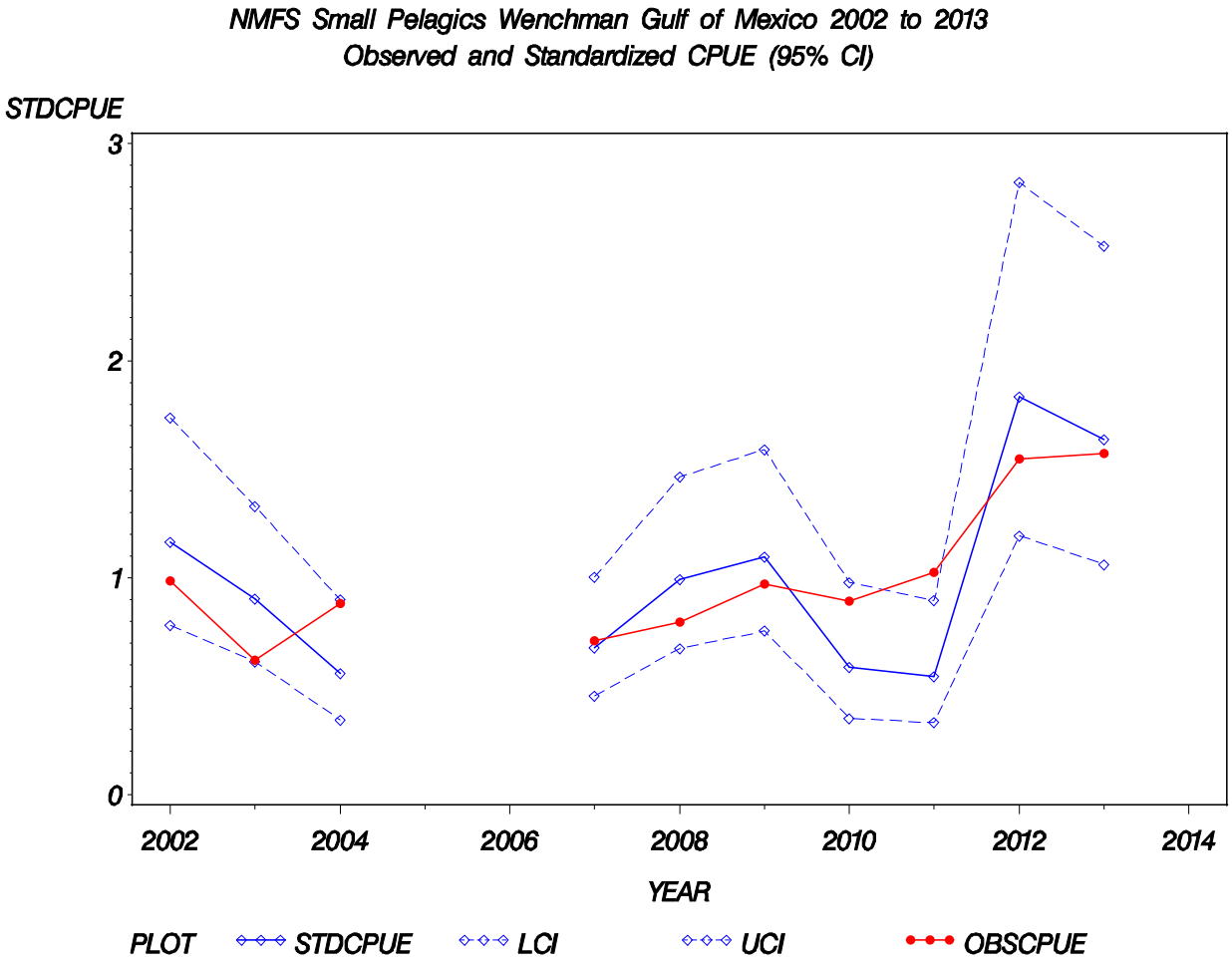

Figure 7. Annual index of abundance for Wenchman from the MSLABS Small Pelagics surveys from 2002 – 2013.

Appendix

Appendix Table 1. Summary of the factors used in constructing the Wenchman abundance index from the MSLABS Small Pelagics survey data.

Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
Year	2002	127	89	0.70079	213.848
Year	2003	146	97	0.66438	134.125
Year	2004	101	70	0.69307	190.752
Year	2007	146	91	0.62329	153.893
Year	2008	164	99	0.60366	172.264
Year	2009	121	83	0.68595	210.769
Year	2010	127	54	0.42520	193.524
Year	2011	129	57	0.44186	221.825
Year	2012	111	65	0.58559	335.214
Year	2013	117	67	0.57265	340.402
Depth Zone	50 – 110 m	472	285	0.60381	362.834
Depth Zone	110 – 200 m	555	439	0.79099	180.331
Depth Zone	200 – 500 m	262	48	0.18321	4.263
Statistical Zone	3	85	14	0.16471	1.030
Statistical Zone	4	142	57	0.40141	2.963
Statistical Zone	5	116	53	0.45690	12.194
Statistical Zone	6	30	8	0.26667	29.291
Statistical Zone	8	144	96	0.66667	39.738
Statistical Zone	9	143	83	0.58042	95.343
Statistical Zone	10	35	18	0.51429	237.195
Statistical Zone	11	35	19	0.54286	83.234
Statistical Zone	13	41	25	0.60976	64.155
Statistical Zone	14	61	47	0.77049	136.893
Statistical Zone	15	79	63	0.79747	298.297
Statistical Zone	16	70	56	0.80000	371.575
Statistical Zone	17	85	62	0.72941	527.787
Statistical Zone	18	57	40	0.70175	422.641
Statistical Zone	19	9	5	0.55556	500.534
Statistical Zone	20	105	89	0.84762	720.082
Statistical Zone	21	52	37	0.71154	566.602
Time of Day	Day	599	333	0.55593	161.846
Time of Day	Night	690	439	0.63623	254.366

Appendix Figure 1. Annual survey effort and catch of Wenchman from the MSLABS Small Pelagics Survey from 2002 – 2014 (Note: no survey was conducted in 2005 because of Hurricane Katrina). Contour lines are 50, 110, 200 and 500 m.