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SEDAR45-WP-10

9 September 2015

Please cite this document as:

Pollack, A.G., and G. Walter Ingram, Jr. 2015. Vermilion Snapper Abundance Indices from SEAMAP Groundfish Surveys in the Northern Gulf of Mexico. SEDAR45-WP-10. SEDAR, North Charleston, SC. 23 pp.

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

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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 (summer and fall) were brought under the Southeast Area Monitoring and Assessment Program (SEAMAP). These fisheries independent datasets were used to develop abundance indices for vermilion snapper (Rhomboplites aurorubens). Vermilion snapper data were split into east / west subsets and four abundance indices were developed: East Gulf (2009-2014), West Gulf (1987-2007), West Gulf (2009-2014) and Gulf-wide (2009-2014).

Introduction

The Southeast Fisheries Science Center (SEFSC) 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. SEAMAP 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 vermilion snapper (*Rhomboplites aurorubens*).

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 (SSZ) (between 88° and 97° W

longitude, paired SSZ 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 SSZ 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. In 2014, a new modification was added to the survey design, a depth stratification of 5 - 20 fathoms and 20 – 60 fathoms (G. Pellegrin, personal communication).

Data

A total of 14,796 stations were sampled from 1987- 2014 with 7,577 and 7,219 stations sampled during the summer and fall surveys, respectively (Tables 1 and 2). Trawl data from MSLABS 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. Age data were obtained from the SEFSC Panama City Laboratory.

Data Exclusions

Data for all the models was limited to stations where no problems were reported (i.e. net torn, doors crossed, etc.) and were sampled with a 40 ft. shrimp trawl (data from the state of Texas was not utilized because of the use of a 20 ft. shrimp trawl). For index specific inclusion factors see Table 3.

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 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, these stations were excluded because of the very infrequent catches of vermilion snapper (< 2% of stations sampled) in the primary areas.

From 1987 – 2008 (summer), 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 in 2008, sampling was expanded to cover the eastern GOM, down to the Florida Keys. The other changes to the survey are outlined above in the survey design section and in Pollack and Ingram (2010).

Index Construction

Delta-lognormal modeling methods were used to estimate relative abundance indices for vermilion snapper (Pennington, 1983; Bradu & 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) $$V(I_y) \approx V(c_y)p_y^2 + c_y^2 V(p_y).$$

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 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 are listed in Table 3.

Results and Discussion

Distribution, Size and Age

The distribution of vermilion snapper is presented in Figure 1, with seasonal/annual abundance and distribution presented in the Appendix Figures 1 and 2. Tables 4 – 7 summarize the length information collected for vermilion snapper in the eastern and western GOM by season, with average lengths ranging between 152 and 171 mm. The length frequency distribution of vermilion snapper captured is shown in Figure 2. Based on age data, vermilion snapper from multiple age classes are mixed in the trawl catches, with peak abundance around age 2 (Figure 3).

Index of Abundance

For the SEAMAP Summer Groundfish Survey (East Gulf, 2009 - 2014) abundance index of vermilion snapper, year, depth and SSZ were retained in the binomial submodel, while year, SSZ and time of day were retained in the lognormal submodel. A summary of the factors used in the analysis is presented in Appendix Table 1. Table 8 summarizes the backward selection process and the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 5,741.1 and 1,070.0, respectively. Diagnostic plots for the lognormal submodels are shown in Figure 4, and indicate the distribution of the residuals is approximately normal. Annual abundance indices are presented in Table 9 and Figure 5.

For the SEAMAP Summer/Fall Groundfish Survey (West Gulf – old design, 1987 - 2007) abundance index of vermilion snapper, year, depth zone, season and paired SSZ were retained in the binomial submodel, while year, depth zone and time of day were retained in the lognormal submodel. A summary of the factors used in the analysis is presented in Appendix Table 2. Table 10 summarizes the backward selection process and the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 17,097.8 and 934.6, respectively. Diagnostic plots for the lognormal submodels are shown in Figure 6, and indicate the distribution of the residuals is approximately normal. Annual abundance indices are presented in Table 11 and Figure 7.

For the SEAMAP Summer/Fall Groundfish Survey (West Gulf – new design, 2009 - 2014) abundance index of vermilion snapper, year, depth, season, SSZ and time of day were retained in the binomial submodel, while year, season and SSZ were retained in the lognormal submodel. A summary of the factors used in the analysis is presented in Appendix Table 3. Table 12 summarizes the backward selection process and the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 5,312.6 and 323.1, respectively. There was an increase in AIC between the third and fourth run of the lognormal submodel, however, since season was right at the level of inclusion ($P = 0.0501$), it was allowed to remain in the final model. Diagnostic plots for the lognormal submodels are shown in Figure 8, and indicate the distribution of the residuals is approximately normal. Annual abundance indices are presented in Table 13 and Figure 9.

For the SEAMAP Summer Groundfish Survey (Gulf-wide, 2009 - 2014) abundance index of vermilion snapper, year, depth, season and SSZ were retained in the binomial submodel, while year, SSZ and time of day were retained in the lognormal submodel. A summary of the factors used in the analysis is presented in Appendix Table 4. Table 14 summarizes the backward selection process and the final set of variables used in the submodels and their significance. The AIC for the binomial and lognormal submodels were 12,009.6 and 1,202.2, respectively. Diagnostic plots for the lognormal submodels are shown in Figure 10, and indicate the distribution of the residuals is approximately normal. Annual abundance indices are presented in Table 15 and Figure 11.

Trawl data from the eastern GOM was examined for the possibility of extending the abundance indices back to 1987, but there were several issues. First, the area that was sampled between 1987 and 2007 only encompassed the areas off of Mississippi and Alabama, which is not a high abundance area for vermilion snapper (Figure 1). In addition, during the summer survey, there were seven years (out of 21) which had no catch of vermilion snapper. Even in the years that did have catches, they were either very small (< 10 vermilion snapper) or very large (> 100 vermilion snapper). While the fall survey had fewer instances of zero catch years (four years), only 1,495 vermilion snapper were captured, of which 1,337 fish came from one station in 1990. The 2008 survey year was excluded from the abundance indices because of the change in survey design that occurred halfway through the year.

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Table 1. Number of stations sampled by shrimp statistical zone during the SEAMAP Summer Groundfish Survey from 1987-2014.

	Shrimp Statistical Zone																			
Year	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	Total
1987									28	61	8	34	23	25	20	16	25	28	19	*287*
1988									18	48	10	16	9	19	24	14	25	28	23	*234*
1989									23	31	8	13	20	25	7	15	20	29	24	*215*
1990										69	18	32	17	23	16	20	23	24	20	*262*
1991										46	16	41	15	23	22	24	18	23	26	*254*
1992									1	45	2	36	30	20	25	12	31	26	20	*248*
1993										46	22	29	19	24	19	14	29	24	22	*248*
1994										61	14	27	28	25	17	20	22	26	22	*262*
1995										45	12	26	24	22	23	13	27	26	21	*239*
1996										46	14	35	21	22	18	17	21	26	25	*245*
1997										44	4	26	22	22	23	10	28	26	26	*231*
1998										36	6	28	27	25	18	14	22	36	17	*229*
1999										44	11	31	27	20	23	13	25	32	20	*246*
2000										45	13	27	19	19	27	8	29	31	21	*239*
2001										36	15	24	28	13	3	10	9	17	21	*176*
2002										45	15	34	21	27	19	15	25	29	22	*252*
2003										44	17	26	8	2	17	20	22	26	23	*205*
2004										39	19	28	23	20	25	21	19	25	21	*240*
2005										32	11	9	24	16	21	5	28	22	27	*195*
2006										45	17	29	16	20	23	17	23	31	18	*239*
2007										41	12	11	24	24	23	7	29	32	21	*224*
2008			1	8	11	6	11	8	11	45	24	19	27	23	22	17	24	21	29	*307*
2009			36	23	29	16	17	18	24	67	25	21	37	39	47	53	33	29	23	*537*
2010		31	26	21	26	10	12	14	15	22	5	20	18	21	33	34	27	27	19	*381*
2011	11	24	22	20	29	2	14	11	8	16	7	14	17	24	29	29	18	21	13	*329*
2012	12	39	33	29	30	19	16	17	13	16	7	14	18	25	29	27	20	20	15	*399*
2013	9	27	28	23	19	9	11	9	7	14	5	13	14	21	23	22	16	17	12	*299*
2014	15	32	26	24	30	17	15	9	7	17	6	15	18	22	29	23	18	18	14	*355*
Total	***47***	***153***	***172***	***148***	***174***	***79***	***96***	***86***	***155***	***1146***	***343***	***678***	***594***	***611***	***625***	***510***	***656***	***720***	***584***	***7577***

Table 2. Number of stations sampled by shrimp statistical zone during the SEAMAP Fall Groundfish Survey from 1987-2014.

	Shrimp Statistical Zone																				
Year	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	Total
1987										13	23	30	29	30	17	15	15	15	18	3	*208*
1988										8	28	10	31	24	18	26	19	21	31	20	*236*
1989											45	18	31	23	22	20	17	22	25	26	*249*
1990											52	20	24	27	22	19	18	22	19	27	*250*
1991											46	16	32	18	20	25	24	19	25	22	*247*
1992											34	15	33	14	25	18	17	27	30	18	*231*
1993											73	14	35	21	26	18	16	25	28	18	*274*
1994											50	19	24	27	25	20	21	23	24	20	*253*
1995											40	14	29	26	24	19	14	26	30	19	*241*
1996											45	11	36	23	17	28	13	25	29	24	*251*
1997											44	18	31	22	26	19	18	23	22	24	*247*
1998											44	30	50	14	34	11	15	24	29	22	*273*
1999											42	10	40	18	29	18	12	28	29	22	*248*
2000											43	10	29	28	20	26	12	30	25	21	*244*
2001											45	14	31	23	26	20	14	27	28	23	*251*
2002										1	51	16	27	26	22	23	14	26	30	21	*257*
2003										1	76	20	20	21	24	22	20	23	25	23	*275*
2004											43	6	23	24	17	27	14	24	30	21	*229*
2005											45	21	32	18	33	18	14	23	24	27	*255*
2006										1	46	7	22	14	18	28	13	23	32	19	*223*
2007											33	15	29	26	18	28	17	20	18	26	*230*
2008					15	14	4	4	3	4	36	18	28	34	42	46	44	19	36	20	*367*
2009				20	21	25	10	21	13	12	50	12	23	23	30	49	47	31	36	22	*445*
2010				9	27	27	18	16	11	14	16	7	15	18	26	31	29	18	19	14	*315*
2011								9	11	7	15	6	15	16	27	31	28	21	19	15	*220*
2012			2	3	6	6	17	10	7	5	12	5	11	13	19	23	22	13	14	11	*199*
2013		4	14	12	10	11	10	10	6	5	10	5	11	12	4	12	16	11	14	9	*186*
2014	1	8	31	25	22	24	13	12	7	7	16	5	14	15	22	27	22	15	17	12	*315*
Total	***1***	***12***	***47***	***69***	***101***	***107***	***72***	***82***	***58***	***78***	***1103***	***392***	***755***	***598***	***653***	***667***	***545***	***624***	***706***	***549***	***7219***

Table 3. Levels of each factor that were included in the specific index of relative abundance for vermilion snapper.

Factor	Index			
	East Gulf	West Gulf – Old	West Gulf – New	Gulfwide
Year	2009 – 2014	1987 – 2007	2009 – 2014	2009 – 2014
Season	Summer	Summer / Fall	Summer / Fall	Summer
Statistical Zone	2 – 11	16 – 21	16 – 21	2 – 11, 15 – 21
Depth (m)	9 – 110	27 – 110	27 – 110	9 – 110

Table 4. Summary of the vermilion snapper length data collected during SEAMAP Summer Groundfish Surveys (West Gulf) conducted between 1987 and 2014.

Survey Year	Number of Stations	Number Collected	Number Measured	Minimum Fork Length (mm)	Maximum Fork Length (mm)	Mean Fork Length (mm)	Standard Deviation (mm)
1987	198	49	20	144	288	183	37
1988	168	6	6	134	249	188	42
1989	161	4	4	171	190	182	9
1990	193	9	9	136	220	166	30
1991	208	78	40	38	235	96	70
1992	202	4	4	124	225	192	46
1993	202	16	16	143	204	184	20
1994	201	25	11	101	314	208	49
1995	194	47	24	30	230	68	52
1996	199	163	105	92	251	166	41
1997	187	125	54	109	228	174	32
1998	193	15	11	45	281	193	81
1999	202	72	64	32	348	191	88
2000	194	115	58	32	219	123	58
2001	140	15	7	114	217	159	35
2002	207	174	70	41	401	186	60
2003	161	3	3	172	207	185	19
2004	201	6	6	120	196	160	29
2005	162	26	19	43	235	181	55
2006	194	45	30	149	254	202	24
2007	183	36	21	133	219	176	27
2008	206	53	43	21	243	171	40
2009	307	4	4	176	202	190	11
2010	203	95	62	102	242	163	24
2011	172	6	6	192	330	226	52
2012	175	30	28	95	267	178	42
2013	143	88	58	105	255	163	31
2014	161	24	24	94	208	140	34

Total Number of Years	Total Number of Stations	Total Number Collected	Total Number Measured	Overall Mean Fork Length (mm)
28	5,317	1,333	807	165

Table 5. Summary of the vermilion snapper length data collected during SEAMAP Summer Groundfish Surveys (East Gulf) conducted between 1987 and 2014.

Survey Year	Number of Stations	Number Collected	Number Measured	Minimum Fork Length (mm)	Maximum Fork Length (mm)	Mean Fork Length (mm)	Standard Deviation (mm)
1987	89	239	11	144	171	154	8
1988	66	7	7	106	233	161	61
1989	54	25	25	106	141	127	7
1990	69	0					
1991	46	143	61	133	325	184	48
1992	46	6	6	156	188	172	13
1993	46	5	2	177	266	222	63
1994	61	46	36	169	220	194	13
1995	45	0					
1996	46	9	9	168	306	246	40
1997	44	4	4	178	221	199	21
1998	36	0					
1999	44	7	7	90	204	140	50
2000	45	0					
2001	36	0					
2002	45	5	3	79	239	185	92
2003	44	1	1	180	180	180	.
2004	39	1	1	136	136	136	.
2005	33	18	18	158	204	174	12
2006	45	0					
2007	41	0					
2008	101	141	95	66	299	185	39
2009	230	1097	374	26	277	157	64
2010	178	678	314	33	263	171	49
2011	157	1157	441	104	334	192	43
2012	224	2270	573	34	304	156	67
2013	156	920	363	43	351	166	47
2014	194	567	376	35	295	182	41

Total Number of Years	Total Number of Stations	Total Number Collected	Total Number Measured	Overall Mean Fork Length (mm)
28	2,260	7,346	2,727	171

Table 6. Summary of the vermilion snapper length data collected during SEAMAP Fall Groundfish Surveys (West Gulf) conducted between 1987 and 2014.

Survey Year	Number of Stations	Number Collected	Number Measured	Minimum Fork Length (mm)	Maximum Fork Length (mm)	Mean Fork Length (mm)	Standard Deviation (mm)
1987	172	2	2	197	260	229	45
1988	200	10	10	201	283	225	23
1989	204	53	29	62	250	144	44
1990	197	62	15	91	270	162	59
1991	201	142	98	56	262	144	48
1992	197	49	46	59	262	165	55
1993	201	307	99	60	260	180	47
1994	203	267	131	42	305	148	58
1995	201	88	50	81	214	155	39
1996	205	58	24	74	218	159	43
1997	202	32	11	107	208	148	29
1998	229	15	5	94	234	175	50
1999	205	57	53	60	301	169	66
2000	200	103	45	74	194	123	28
2001	206	103	34	81	236	169	47
2002	205	61	45	80	231	118	31
2003	198	104	30	74	366	256	93
2004	186	182	146	59	338	142	57
2005	210	93	49	94	262	184	30
2006	176	11	9	89	129	109	13
2007	197	94	43	85	245	134	34
2008	287	186	111	126	250	185	22
2009	273	261	162	63	275	124	45
2010	177	87	85	75	276	177	51
2011	178	138	72	50	281	162	60
2012	131	53	38	78	190	118	37
2013	94	57	40	72	188	114	25
2014	149	25	24	114	231	190	23

Total Number of Years	Total Number of Stations	Total Number Collected	Total Number Measured	Overall Mean Fork Length (mm)
28	5,484	2,700	1,506	155

Table 7. Summary of the vermilion snapper length data collected during SEAMAP Fall Groundfish Surveys (East Gulf) conducted between 1987 and 2014.

Survey Year	Number of Stations	Number Collected	Number Measured	Minimum Fork Length (mm)	Maximum Fork Length (mm)	Mean Fork Length (mm)	Standard Deviation (mm)
1987	36	14	4	94	140	119	19
1988	36	0					
1989	45	3	3	91	97	94	3
1990	53	1337	35	114	232	137	30
1991	46	30	30	115	224	143	25
1992	34	0					
1993	73	15	10	78	218	151	41
1994	50	14	14	181	229	195	13
1995	40	18	18	105	209	152	25
1996	46	17	17	157	217	193	19
1997	45	0					
1998	44	2	2	186	196	191	7
1999	43	6	6	78	117	96	13
2000	44	1	1	209	209	209	.
2001	45	26	21	123	295	245	37
2002	52	7	0	.	.	.	.
2003	77	5	5	120	200	141	34
2004	43	1	1	130	130	130	.
2005	45	10	10	176	203	188	9
2006	47	3	3	187	241	222	30
2007	33	0					
2008	80	750	127	48	275	157	53
2009	172	576	250	36	315	166	53
2010	138	1516	222	49	273	175	50
2011	42	119	36	62	300	172	46
2012	68	105	57	60	270	178	39
2013	92	253	132	69	298	166	41
2014	166	2305	654	29	288	128	53

Total Number of Years	Total Number of Stations	Total Number Collected	Total Number Measured	Overall Mean Fork Length (mm)
28	1,735	7,133	1,658	152

Table 8. Summary of backward selection procedure for building delta-lognormal submodels for vermilion snapper SEAMAP Summer Groundfish Survey (East Gulf) index of relative abundance from 2009 to 2014.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 5,754.8)*						*Lognormal Submodel Type 3 Tests (AIC 1,077.6)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	5	1119	7.51	1.50	0.1854	0.1863	5	287	1.74	0.1253
Depth	1	1119	34.96	34.96	<.0001	<.0001	1	287	0.12	0.7265
Statistical Zone	9	1119	55.00	6.11	<.0001	<.0001	9	287	2.62	0.0064
Time of Day	1	1119	0.76	0.76	0.3818	0.3820	1	287	5.74	0.0172
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 5,741.1)*						*Lognormal Submodel Type 3 Tests (AIC 1,070.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	5	1120	7.61	1.52	0.1791	0.1800	5	288	1.72	0.1295
Depth	1	1120	35.00	35.00	<.0001	<.0001		Dropped		
Statistical Zone	9	1120	55.74	6.19	<.0001	<.0001	9	288	2.69	0.0052
Time of Day				Dropped			1	288	5.73	0.0173

Table 9. Indices of vermilion snapper abundance developed using the delta-lognormal (DL) model for SEAMAP Summer Groundfish Survey (East Gulf) from 2009-2014. 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
2009	0.22609	230	4.99914	0.84718	0.27164	0.49684	1.44456
2010	0.24294	177	4.36213	0.73923	0.29826	0.41230	1.32538
2011	0.28025	157	9.49267	1.60868	0.29253	0.90695	2.85336
2012	0.32589	224	7.33948	1.24379	0.23462	0.78286	1.97610
2013	0.30128	156	5.03396	0.85308	0.28506	0.48777	1.49200
2014	0.23438	192	4.17813	0.70805	0.29280	0.39898	1.25652

Table 10. Summary of backward selection procedure for building delta-lognormal submodels for vermilion snapper SEAMAP Fall Groundfish Survey index of relative abundance from 1987 to 2013.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 17,101.2)*						*Lognormal Submodel Type 3 Tests (AIC 937.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	20	2957	49.29	2.46	0.0003	0.0003	20	257	0.67	0.8517
Depth Zone	12	2957	140.21	11.68	<.0001	<.0001	12	257	3.10	0.0004
Season	1	2957	13.02	13.02	0.0003	0.0003	1	257	0.30	0.5825
Paired_SSZ	2	2957	26.53	13.26	<.0001	<.0001	2	257	1.10	0.3336
Time of Day	1	2957	0.08	0.08	0.7757	0.7757	1	257	5.23	0.0231
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 17,097.8)*						*Lognormal Submodel Type 3 Tests (AIC 935.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	20	2958	49.32	2.47	0.0003	0.0003	20	258	0.68	0.8408
Depth Zone	12	2958	140.33	11.69	<.0001	<.0001	12	258	3.13	0.0004
Season	1	2958	13.01	13.01	0.0003	0.0003		Dropped		
Paired_SSZ	2	2958	26.59	13.30	<.0001	<.0001	2	258	1.15	0.3189
Time of Day				Dropped			1	258	5.42	0.0206
Model Run #3	*Binomial Submodel Type 3 Tests (AIC 17,097.8)*						*Lognormal Submodel Type 3 Tests (AIC 934.6)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	20	2958	49.32	2.47	0.0003	0.0003	20	260	0.67	0.8524
Depth Zone	12	2958	140.33	11.69	<.0001	<.0001	12	260	3.33	0.0002
Season	1	2958	13.01	13.01	0.0003	0.0003		Dropped		
Paired_SSZ	2	2958	26.59	13.30	<.0001	<.0001		Dropped		
Time of Day				Dropped			1	260	6.07	0.0144

Table 11. Indices of vermilion snapper abundance developed using the delta-lognormal (DL) model for SEAMAP Fall Groundfish Survey from 1987-2007. 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
1987	0.05042	119	0.38954	0.64698	0.63962	0.20055	2.08718
1988	0.02685	149	0.06951	0.11545	0.76665	0.02963	0.44975
1989	0.07143	140	0.54131	0.89906	0.50161	0.34858	2.31887
1990	0.07246	138	0.29650	0.49246	0.50704	0.18919	1.28186
1991	0.14570	151	0.89889	1.49295	0.35003	0.75641	2.94668
1992	0.05369	149	0.20295	0.33708	0.55847	0.11890	0.95562
1993	0.12500	144	0.87792	1.45812	0.37904	0.70073	3.03415
1994	0.10067	149	0.66158	1.09881	0.41495	0.49513	2.43851
1995	0.11111	144	0.83192	1.38172	0.40278	0.63626	3.00061
1996	0.13014	146	1.26888	2.10746	0.36813	1.03302	4.29940
1997	0.09459	148	0.62283	1.03445	0.42937	0.45439	2.35503
1998	0.07432	148	0.24895	0.41347	0.48275	0.16554	1.03275
1999	0.09934	151	0.79395	1.31866	0.41491	0.59423	2.92623
2000	0.14667	150	0.89446	1.48559	0.34454	0.76031	2.90274
2001	0.09167	120	0.39636	0.65832	0.48152	0.26412	1.64087
2002	0.16556	151	1.12654	1.87105	0.32495	0.99287	3.52597
2003	0.05036	139	0.22652	0.37623	0.59250	0.12560	1.12694
2004	0.14085	142	1.02896	1.70899	0.36169	0.84759	3.44580
2005	0.09924	131	0.41564	0.69033	0.44371	0.29569	1.61167
2006	0.05594	143	0.21427	0.35588	0.56272	0.12466	1.01596
2007	0.14085	142	0.63638	1.05695	0.35981	0.52601	2.12381

Table 12. Summary of backward selection procedure for building delta-lognormal submodels for vermilion snapper SEAMAP Summer / Fall Groundfish Survey (West gulf new design) index of relative abundance from 1987 to 2013.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 5,312.6)*						*Lognormal Submodel Type 3 Tests (AIC 325.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	5	971	5.82	1.16	0.3239	0.3248	5	90	0.28	0.9255
Depth	1	971	16.33	16.33	<.0001	<.0001	1	90	2.00	0.1610
Season	1	971	8.73	8.73	0.0031	0.0032	1	90	3.09	0.0821
Statistical Zone	5	971	21.50	4.30	0.0007	0.0007	5	90	1.79	0.1230
Time of Day	1	971	5.18	5.18	0.0229	0.0231	1	90	3.10	0.0818
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 5,312.6)*						*Lognormal Submodel Type 3 Tests (AIC 321.2)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	5	971	5.82	1.16	0.3239	0.3248	5	91	0.28	0.9249
Depth	1	971	16.33	16.33	<.0001	<.0001		Dropped		
Season	1	971	8.73	8.73	0.0031	0.0032	1	91	4.44	0.0378
Statistical Zone	5	971	21.50	4.30	0.0007	0.0007	5	91	2.08	0.0745
Time of Day	1	971	5.18	5.18	0.0229	0.0231	1	91	2.90	0.0919
Model Run #3	*Binomial Submodel Type 3 Tests (AIC 5,312.6)*						*Lognormal Submodel Type 3 Tests (AIC 323.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	5	971	5.82	1.16	0.3239	0.3248	5	92	0.33	0.8959
Depth	1	971	16.33	16.33	<.0001	<.0001		Dropped		
Season	1	971	8.73	8.73	0.0031	0.0032	1	92	3.94	0.0501
Statistical Zone	5	971	21.50	4.30	0.0007	0.0007	5	92	1.84	0.1135
Time of Day	1	971	5.18	5.18	0.0229	0.0231		Dropped		
Model Run #4	*Binomial Submodel Type 3 Tests (AIC 5,312.6)*						*Lognormal Submodel Type 3 Tests (AIC 332.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	5	971	5.82	1.16	0.3239	0.3248	5	97	0.25	0.9413
Depth	1	971	16.33	16.33	<.0001	<.0001		Dropped		
Season	1	971	8.73	8.73	0.0031	0.0032	1	97	5.40	0.0222
Statistical Zone	5	971	21.50	4.30	0.0007	0.0007		Dropped		
Time of Day	1	971	5.18	5.18	0.0229	0.0231		Dropped		

Table 13. Indices of vermilion snapper abundance developed using the delta-lognormal (DL) model for SEAMAP Fall Groundfish Survey from 2009-2014. 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
2009	0.11111	243	1.18262	0.95613	0.32377	0.50848	1.79788
2010	0.11667	180	1.79550	1.45164	0.35095	0.73424	2.86998
2011	0.09467	169	0.93890	0.75908	0.39586	0.35391	1.62814
2012	0.07692	156	0.98101	0.79313	0.44290	0.34020	1.84904
2013	0.16981	106	1.75269	1.41702	0.38406	0.67482	2.97551
2014	0.07634	131	0.77057	0.62300	0.48511	0.24842	1.56239

Table 14. Summary of backward selection procedure for building delta-lognormal submodels for vermilion snapper SEAMAP Summer Groundfish Survey (Gulf) index of relative abundance from 1987 to 2013.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 12,011.2)*						*Lognormal Submodel Type 3 Tests (AIC 1,210.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	5	2124	8.88	1.78	0.1141	0.1146	5	325	1.29	0.2689
Depth	1	2124	73.09	73.09	<.0001	<.0001	1	325	0.00	0.9837
Statistical Zone	16	2124	256.60	16.04	<.0001	<.0001	16	325	2.53	0.0011
Time of Day	1	2124	0.30	0.30	0.5820	0.5821	1	325	6.77	0.0097
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 12,009.6)*						*Lognormal Submodel Type 3 Tests (AIC 1,202.2)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	5	2125	8.87	1.77	0.1144	0.1150	5	326	1.30	0.2640
Depth	1	2125	72.86	72.86	<.0001	<.0001		Dropped		
Statistical Zone	16	2125	256.58	16.04	<.0001	<.0001	16	326	2.56	0.0009
Time of Day				Dropped			1	326	6.79	0.0096

Table 15. Indices of vermilion snapper abundance developed using the delta-lognormal (DL) model for SEAMAP Summer Groundfish Survey (Gulf) from 2009-2014. 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
2009	0.10998	491	1.64572	0.67174	0.26265	0.40074	1.12602
2010	0.14888	356	2.16239	0.88264	0.26740	0.52182	1.49296
2011	0.15909	308	3.34593	1.36573	0.27316	0.79865	2.33546
2012	0.21429	378	3.10919	1.26910	0.22251	0.81763	1.96984
2013	0.21352	281	2.59216	1.05806	0.25414	0.64152	1.74505
2014	0.15569	334	1.84414	0.75273	0.26919	0.44351	1.27755

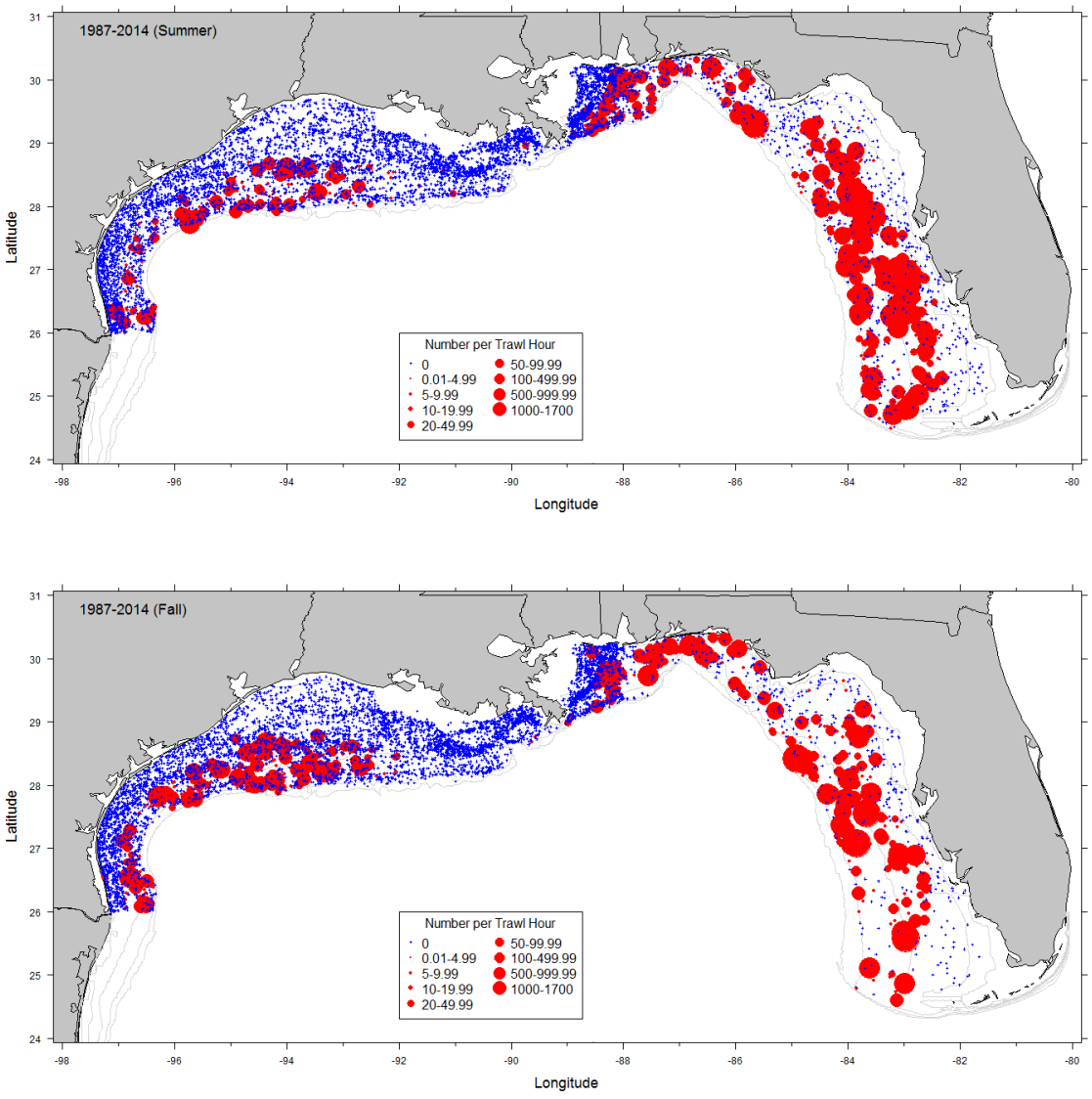


Figure 1. Stations sampled from 1987 to 2014 during the Summer (top) and Fall (bottom) SEAMAP Groundfish Survey with the CPUE for vermilion snapper.

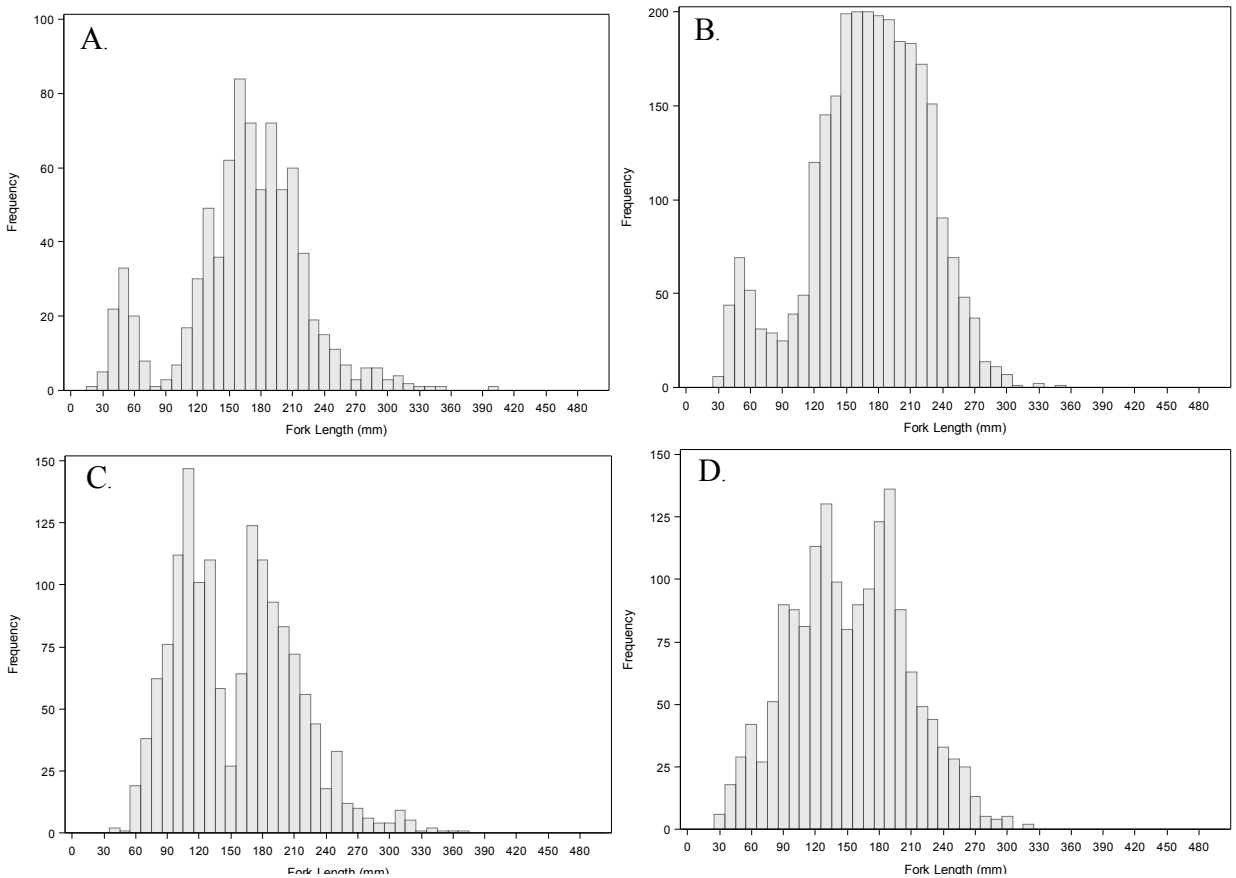


Figure 2. Length frequency histograms for vermilion snapper captured during **A.** Summer (West Gulf), **B.** Summer (East Gulf), **C.** Fall (West Gulf) and **D.** Fall (East Gulf) SEAMAP Groundfish surveys from 1987 - 2014.

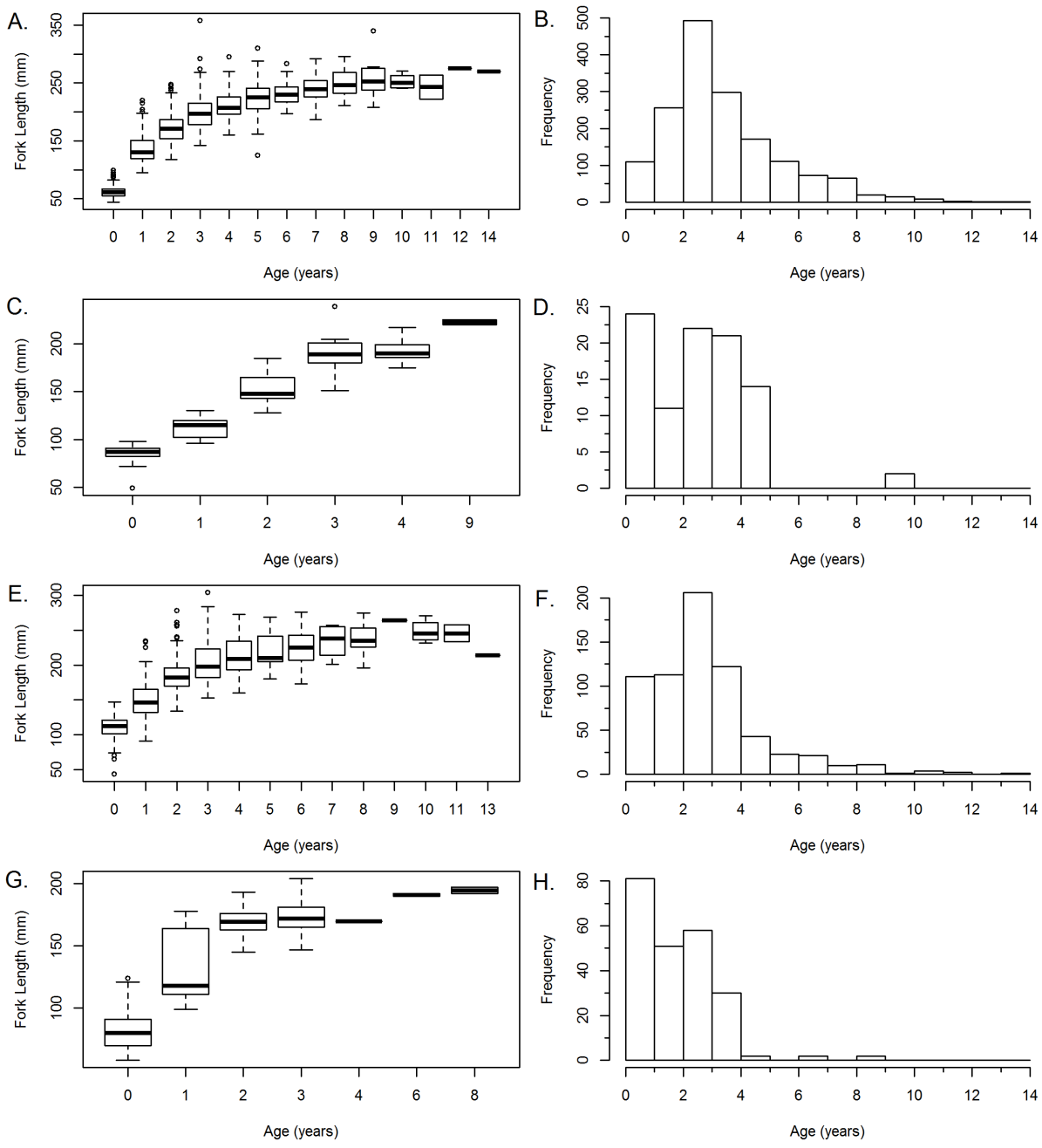


Figure 3. Breakdown of vermilion snapper ages for fish caught in the: Summer / East Gulf (**A.** and **B.**), Summer / West Gulf (**C.** and **D.**), Fall / East Gulf (**E.** and **F.**) and Fall / West Gulf (**G.** and **H.**).

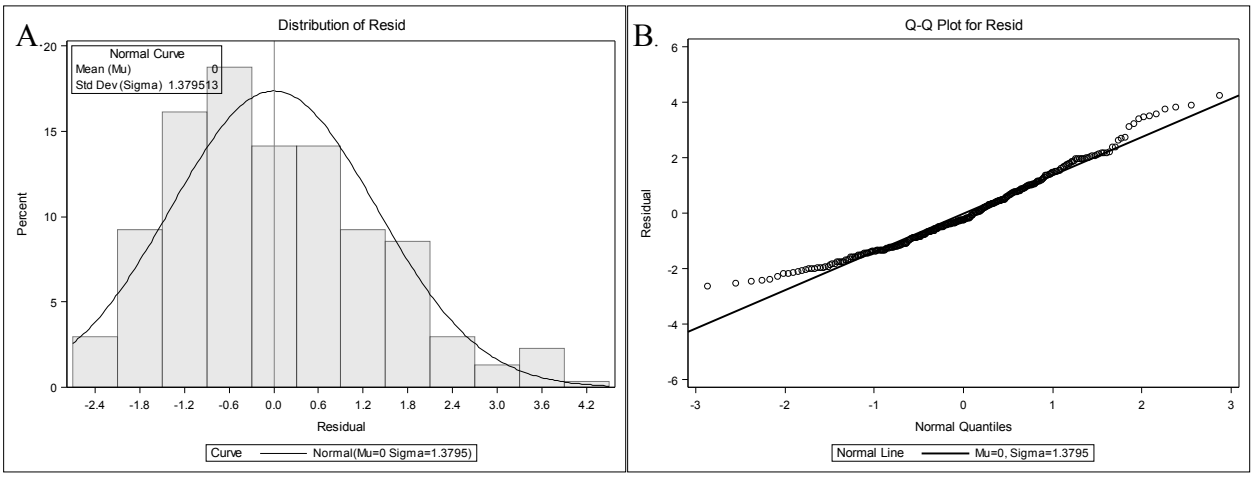


Figure 4. Diagnostic plots for lognormal component of the vermilion snapper SEAMAP Summer Groundfish Survey (East Gulf) model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

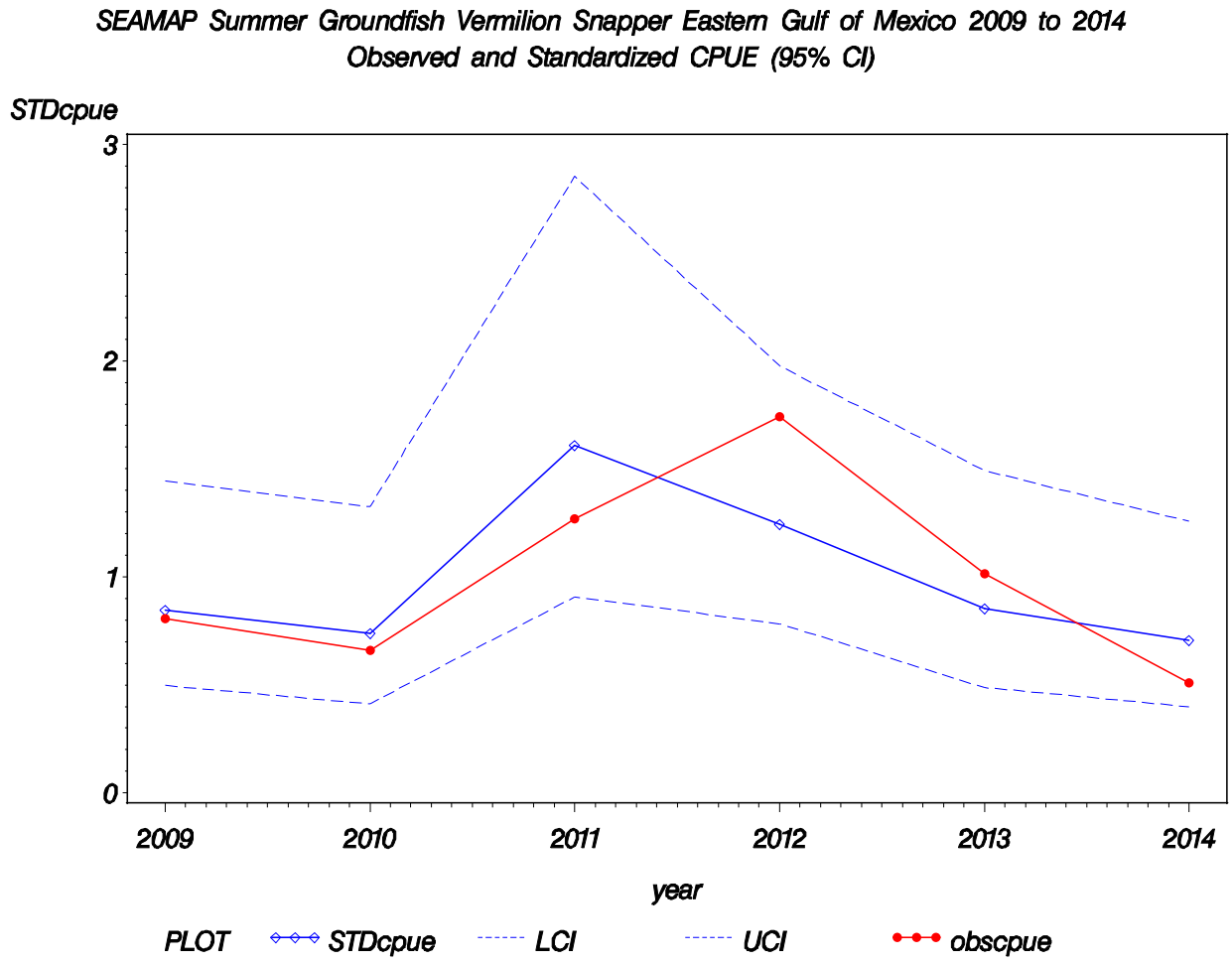


Figure 5. Annual index of abundance for vermilion snapper from the SEAMAP Summer Groundfish Survey (East Gulf) from 2009 – 2014.

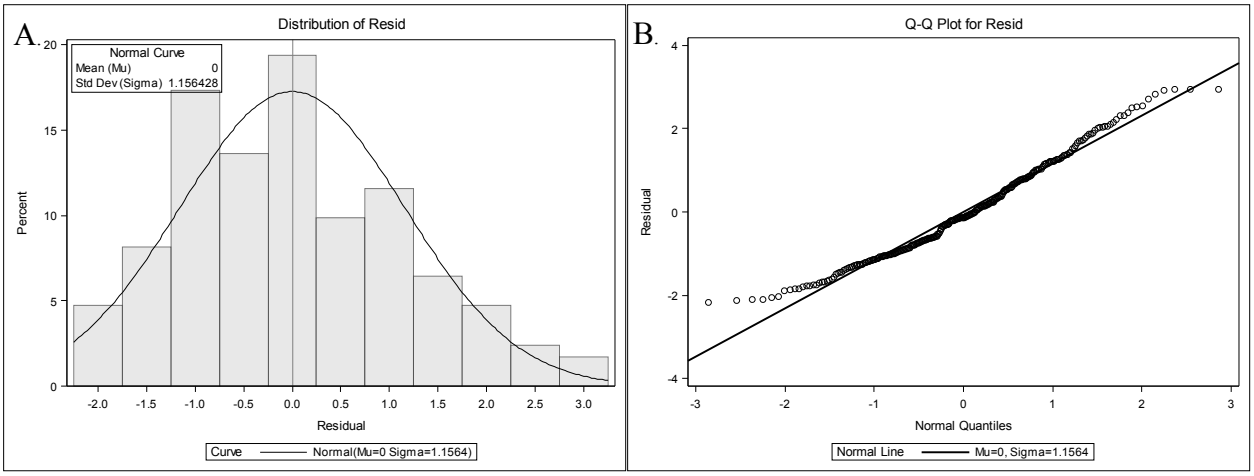


Figure 6. Diagnostic plots for lognormal component of the vermilion snapper SEAMAP Summer / Fall Groundfish Survey (West Gulf – old design) model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

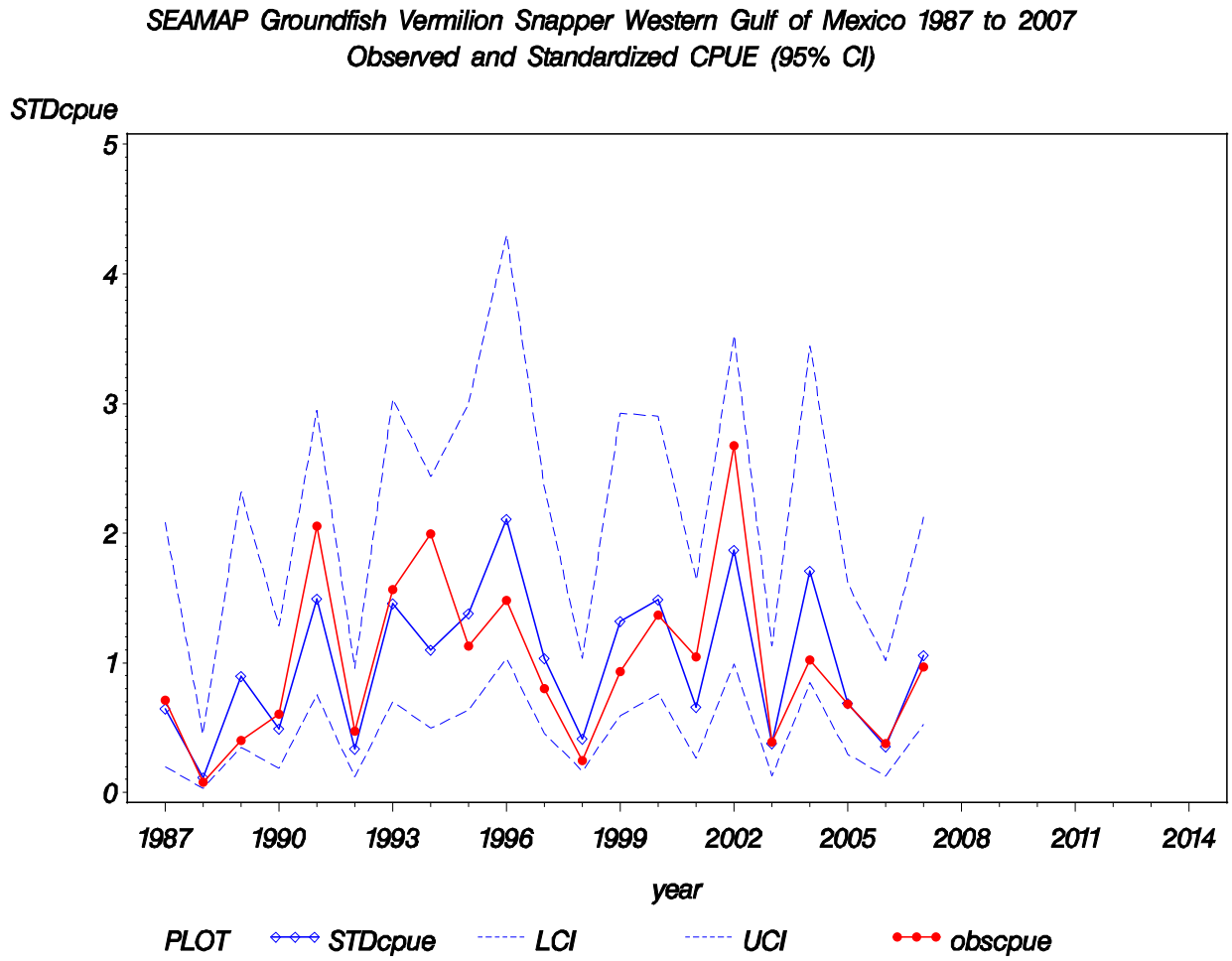


Figure 7. Annual index of abundance for vermilion snapper from the SEAMAP Summer / Fall Groundfish Survey (West Gulf – old design) from 1987 – 2007.

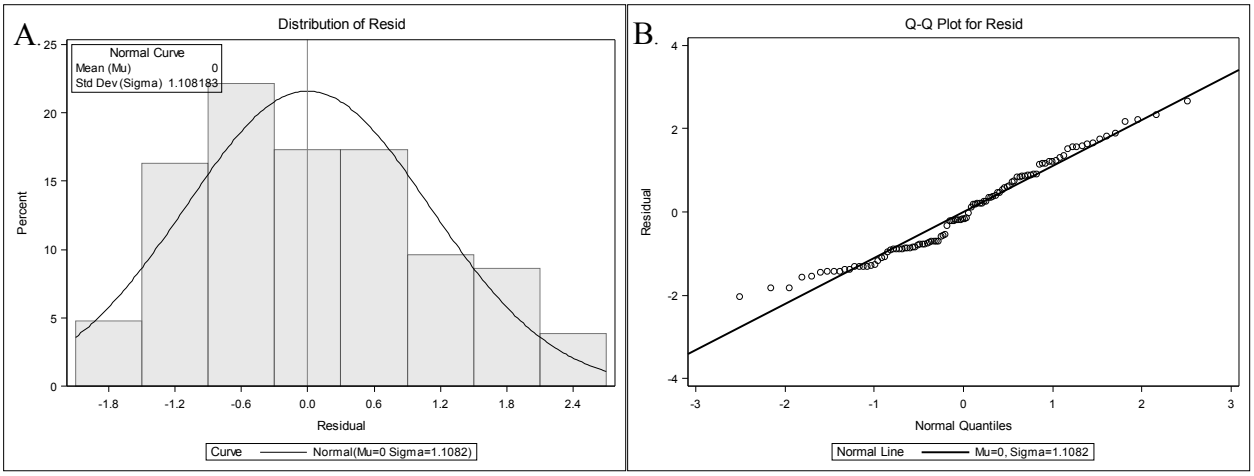


Figure 8. Diagnostic plots for lognormal component of the vermilion snapper SEAMAP Summer / Fall Groundfish Survey (West Gulf – new design) model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

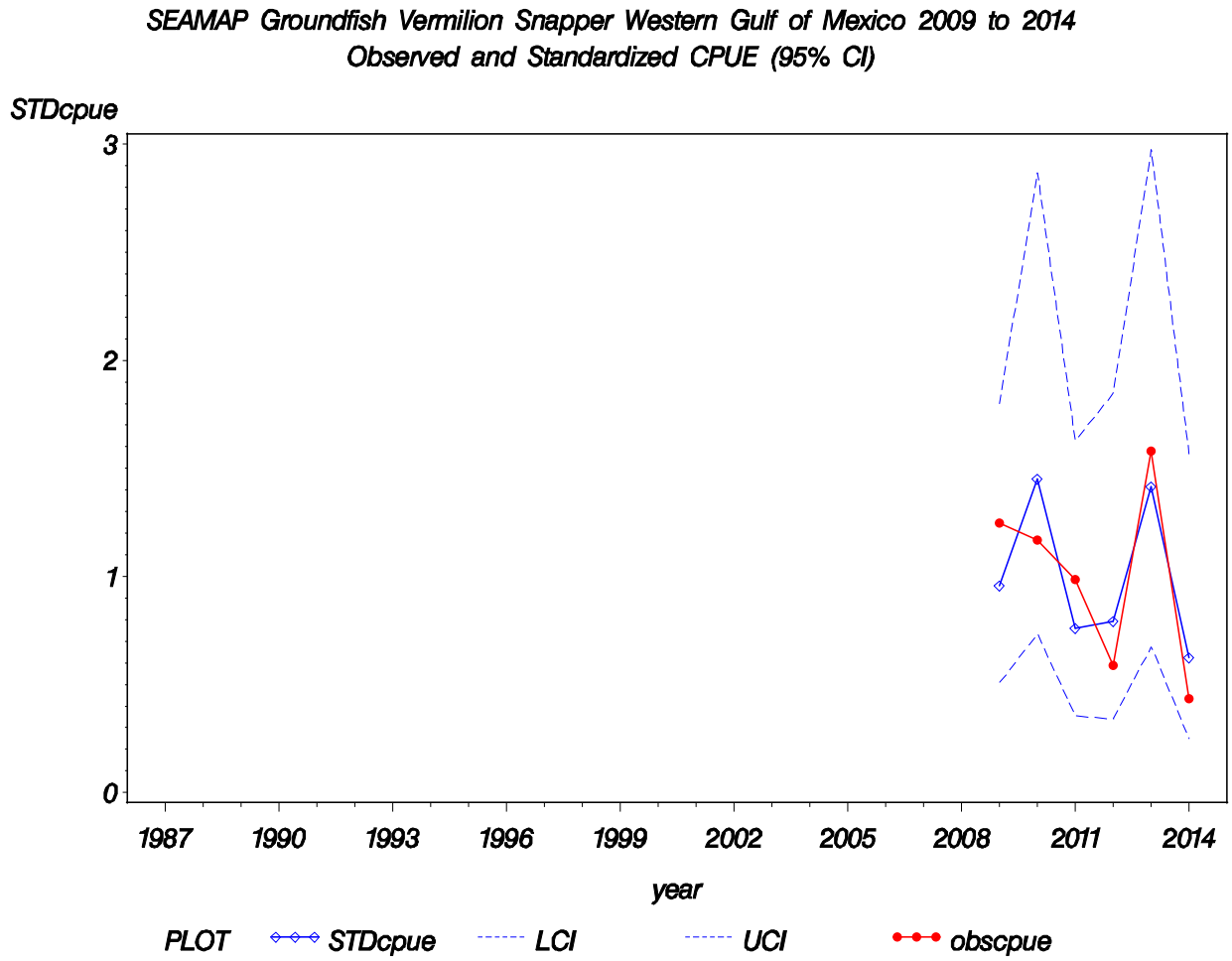


Figure 9. Annual index of abundance for vermilion snapper from the SEAMAP Summer / Fall Groundfish Survey (West Gulf – new design) from 2009 – 2014.

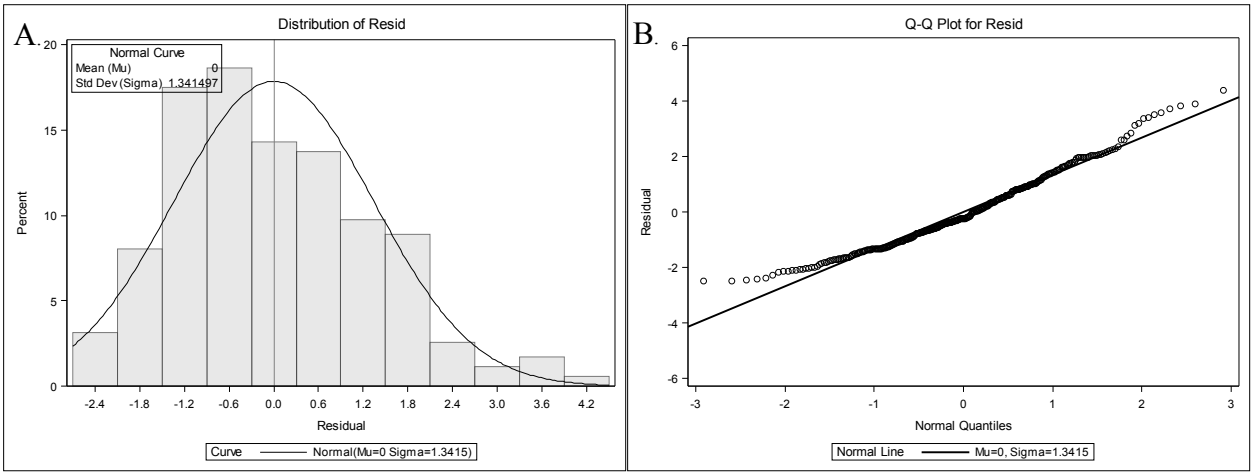


Figure 10. Diagnostic plots for lognormal component of the vermilion snapper SEAMAP Summer Groundfish Survey (Gulf) model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

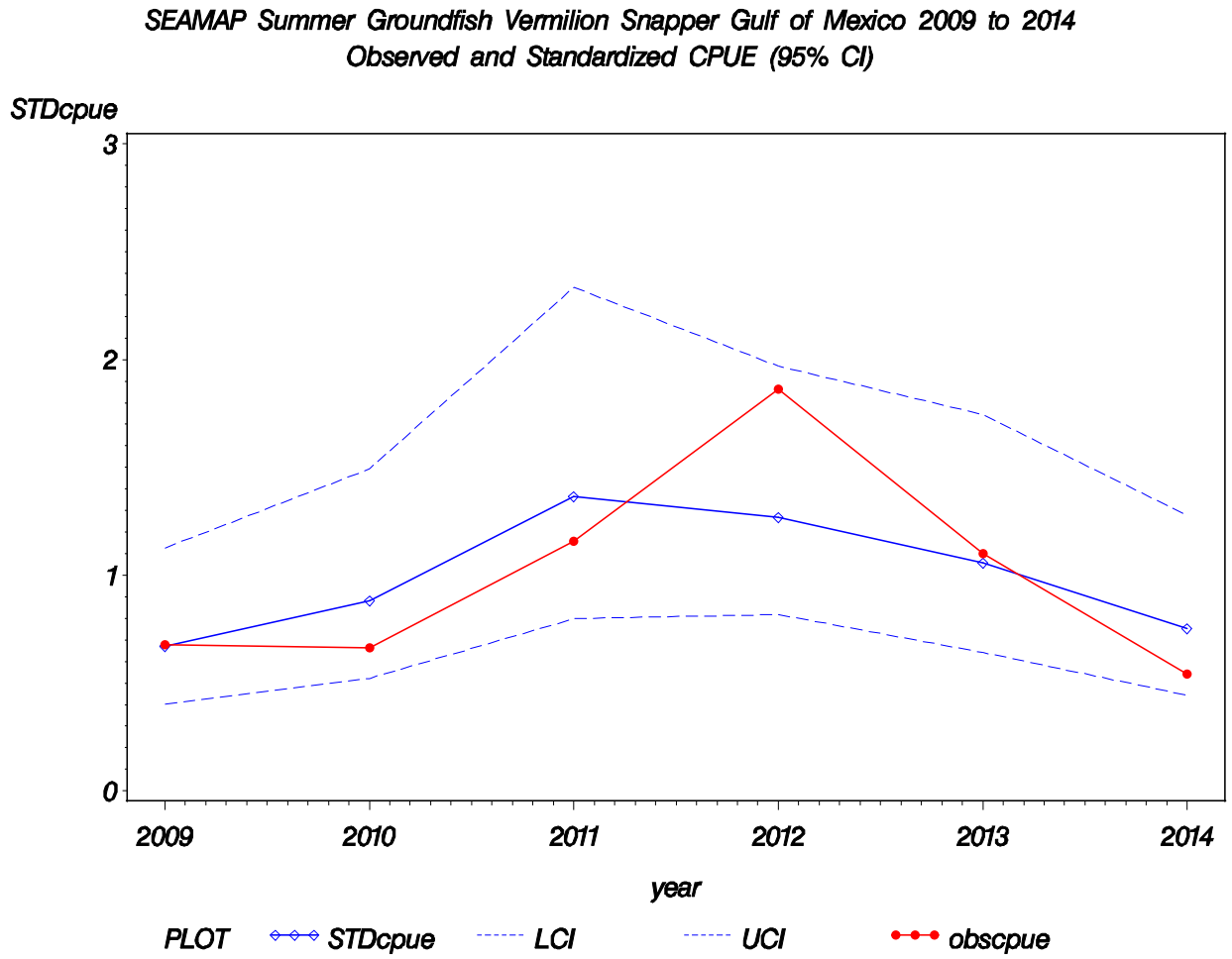


Figure 11. Annual index of abundance for vermilion snapper from the SEAMAP Summer Groundfish Survey (Gulf-wide) from 2009 – 2014.

Appendix

Appendix Table 1. Summary of the factors used in constructing the vermilion snapper abundance index from the SEAMAP Summer Groundfish Survey (East Gulf) data.

Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
STATISTICAL ZONE	2	47	14	0.29787	15.1909
STATISTICAL ZONE	3	153	51	0.33333	8.3692
STATISTICAL ZONE	4	171	67	0.39181	25.8295
STATISTICAL ZONE	5	140	54	0.38571	16.4598
STATISTICAL ZONE	6	163	67	0.41104	13.9588
STATISTICAL ZONE	7	73	10	0.13699	1.6474
STATISTICAL ZONE	8	85	10	0.11765	20.4700
STATISTICAL ZONE	9	78	16	0.20513	3.4808
STATISTICAL ZONE	10	74	14	0.18919	2.7263
STATISTICAL ZONE	11	152	1	0.00658	0.0395
TIME OF DAY	D	668	172	0.25749	14.9136
TIME OF DAY	N	468	132	0.28205	7.1969
YEAR	2009	230	52	0.22609	9.3875
YEAR	2010	177	43	0.24294	7.6512
YEAR	2011	157	44	0.28025	14.7261
YEAR	2012	224	73	0.32589	20.2331
YEAR	2013	156	47	0.30128	11.7949
YEAR	2014	192	45	0.23438	5.9000

Appendix Table 2. Summary of the factors used in constructing the vermilion snapper abundance index from the SEAMAP Summer / Fall Groundfish Survey (West Gulf – old design) data.

Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
DEPTH ZONE	1516	246	7	0.02846	0.31466
DEPTH ZONE	1617	245	6	0.02449	0.40940
DEPTH ZONE	1718	242	7	0.02893	0.80608
DEPTH ZONE	1819	240	10	0.04167	0.57945
DEPTH ZONE	1920	244	20	0.08197	1.43058
DEPTH ZONE	2022	230	27	0.11739	1.20086
DEPTH ZONE	2225	241	24	0.09959	0.39108
DEPTH ZONE	2530	241	58	0.24066	1.13534
DEPTH ZONE	3035	238	54	0.22689	1.42920
DEPTH ZONE	3540	230	32	0.13913	1.44462
DEPTH ZONE	4045	215	23	0.10698	0.82596
DEPTH ZONE	4550	209	18	0.08612	0.76448
DEPTH ZONE	5060	173	8	0.04624	1.79151
SEASON	Fall	1519	178	0.11718	1.10536
SEASON	Summer	1475	116	0.07864	0.77671
PAIRED_SSZ	1617	977	96	0.09826	0.73574
PAIRED_SSZ	1819	843	110	0.13049	1.60944
PAIRED_SSZ	2021	1174	88	0.07496	0.63808
TIME OF DAY	D	1509	151	0.10007	1.11077
TIME OF DAY	N	1485	143	0.09630	0.77342
YEAR	1987	119	6	0.05042	0.66309
YEAR	1988	149	4	0.02685	0.07128
YEAR	1989	140	10	0.07143	0.37524
YEAR	1990	138	10	0.07246	0.56323
YEAR	1991	151	22	0.14570	1.91558
YEAR	1992	149	8	0.05369	0.44230
YEAR	1993	144	18	0.12500	1.45744
YEAR	1994	149	15	0.10067	1.85916
YEAR	1995	144	16	0.11111	1.05203
YEAR	1996	146	19	0.13014	1.38159
YEAR	1997	148	14	0.09459	0.74843
YEAR	1998	148	11	0.07432	0.23002
YEAR	1999	151	15	0.09934	0.86747
YEAR	2000	150	22	0.14667	1.27371
YEAR	2001	120	11	0.09167	0.97526

Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
YEAR	2002	151	25	0.16556	2.49655
YEAR	2003	139	7	0.05036	0.36531
YEAR	2004	142	20	0.14085	0.95481
YEAR	2005	131	13	0.09924	0.63800
YEAR	2006	143	8	0.05594	0.35484
YEAR	2007	142	20	0.14085	0.90207

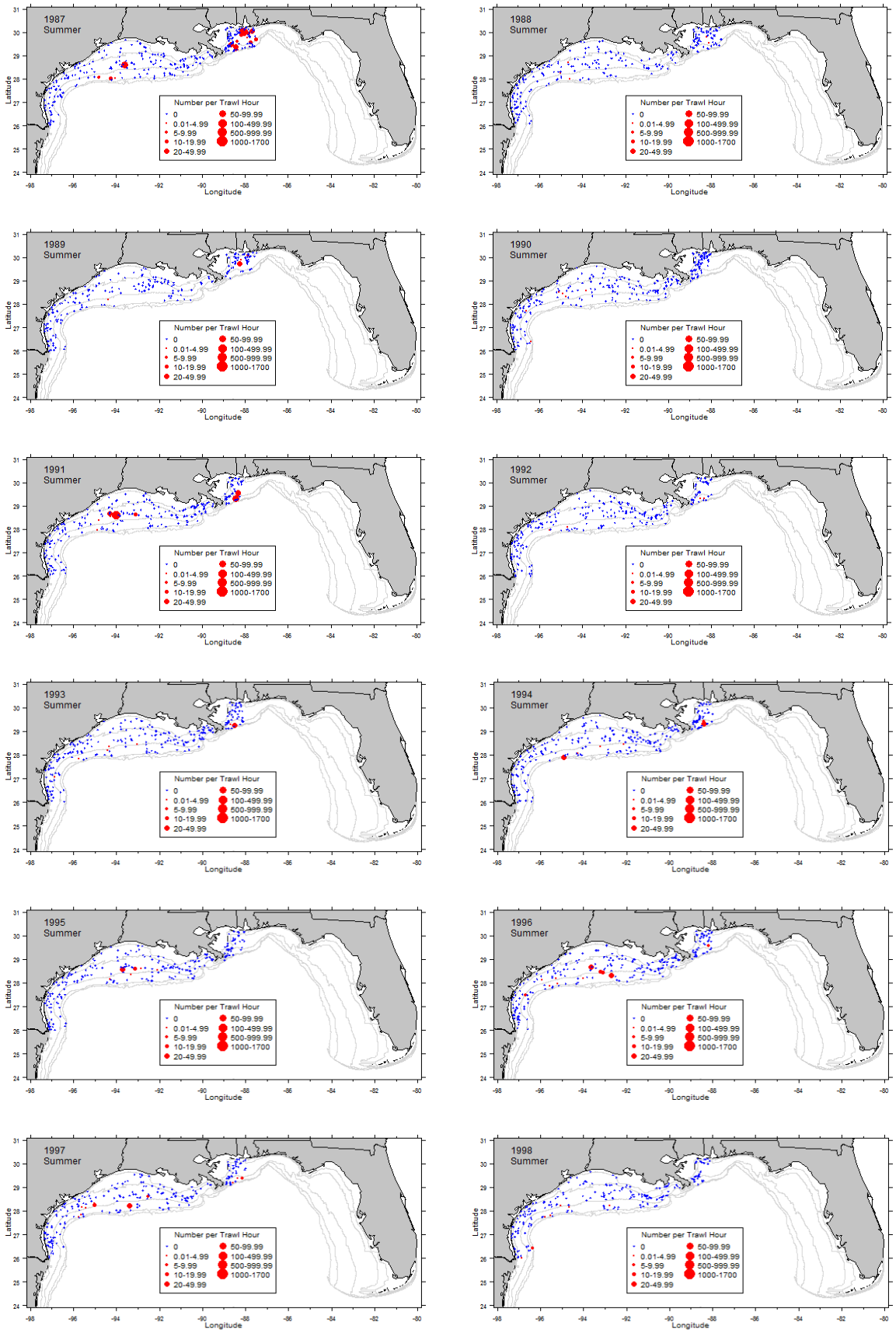
Appendix Table 3. Summary of the factors used in constructing the vermilion snapper abundance index from the SEAMAP Summer / Fall Groundfish Survey (West Gulf – new design) data.

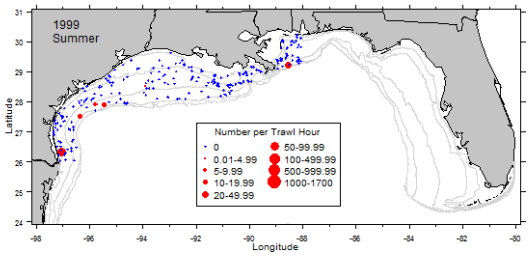
Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
SEASON	Fall	466	61	0.13090	2.63916
SEASON	Summer	519	43	0.08285	0.92898
STATISTICAL ZONE	16	163	9	0.05521	0.47682
STATISTICAL ZONE	17	177	13	0.07345	2.36203
STATISTICAL ZONE	18	169	20	0.11834	1.45777
STATISTICAL ZONE	19	126	4	0.03175	1.18240
STATISTICAL ZONE	20	195	31	0.15897	2.09832
STATISTICAL ZONE	21	155	27	0.17419	2.65593
TOD	D	516	65	0.12597	2.24698
TOD	N	469	39	0.08316	1.17814
YEAR	2009	243	27	0.11111	2.14271
YEAR	2010	180	21	0.11667	2.00817
YEAR	2011	169	16	0.09467	1.69268
YEAR	2012	156	12	0.07692	1.01280
YEAR	2013	106	18	0.16981	2.71630
YEAR	2014	131	10	0.07634	0.74697

Appendix Table 4. Summary of the factors used in constructing the vermilion snapper abundance index from the SEAMAP Summer Groundfish Survey (Gulf-wide) data.

Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
STATISTICAL ZONE	2	47	14	0.29787	15.1909
STATISTICAL ZONE	3	153	51	0.33333	8.3692
STATISTICAL ZONE	4	171	67	0.39181	25.8295
STATISTICAL ZONE	5	140	54	0.38571	16.4598
STATISTICAL ZONE	6	163	67	0.41104	13.9588
STATISTICAL ZONE	7	73	10	0.13699	1.6474
STATISTICAL ZONE	8	85	10	0.11765	20.4700
STATISTICAL ZONE	9	78	16	0.20513	3.4808
STATISTICAL ZONE	10	74	14	0.18919	2.7263
STATISTICAL ZONE	11	152	1	0.00658	0.0395
STATISTICAL ZONE	15	122	2	0.01639	0.0654
STATISTICAL ZONE	16	152	4	0.02632	0.1572
STATISTICAL ZONE	17	190	4	0.02105	0.5849
STATISTICAL ZONE	18	188	8	0.04255	0.3177
STATISTICAL ZONE	19	132	1	0.00758	0.2557
STATISTICAL ZONE	20	132	15	0.11364	1.1149
STATISTICAL ZONE	21	96	11	0.11458	1.1091
TIME OF DAY	D	1246	201	0.16132	8.2645
TIME OF DAY	N	902	148	0.16408	3.9057
YEAR	2009	491	54	0.10998	4.4136
YEAR	2010	356	53	0.14888	4.3324
YEAR	2011	308	49	0.15909	7.5452
YEAR	2012	378	81	0.21429	12.1473
YEAR	2013	281	60	0.21352	7.1701
YEAR	2014	334	52	0.15569	3.5351

Appendix Figure 1. Annual survey effort and catch of vermilion snapper from the SEAMAP Summer Groundfish Survey.

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Summer
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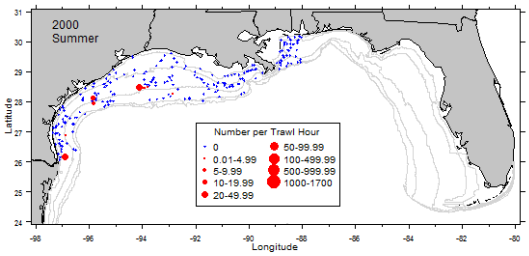
1000-1700
Latitude
Longitude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Summer
Number per Trawl Hour
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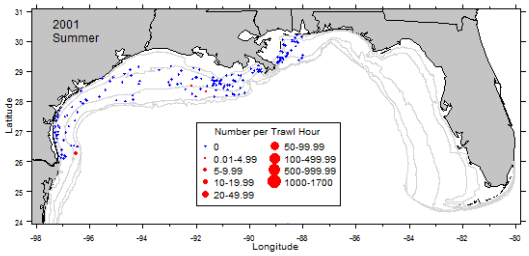
1000-1700
Latitude
Longitude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Summer
Number per Trawl Hour
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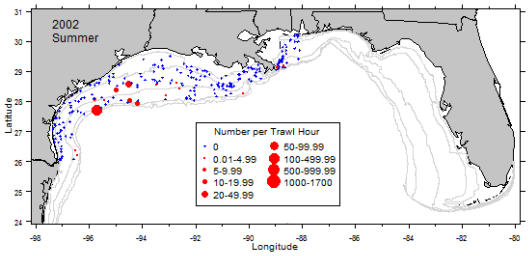
100-499.99
500-999.99
1000-1700
Latitude
Longitude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Summer
Number per Trawl Hour
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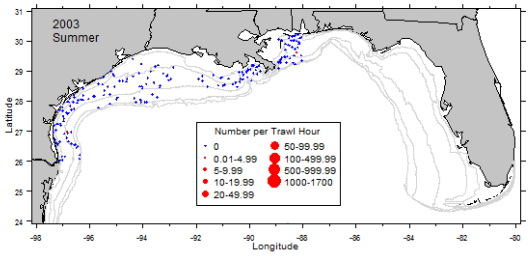
Latitude
Longitude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Summer
Number per Trawl Hour
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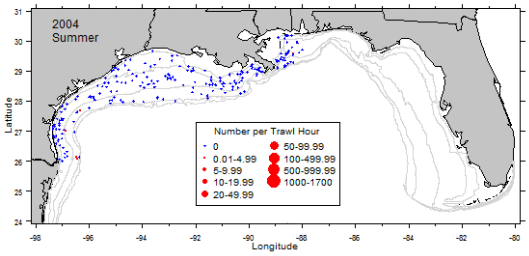
50-99.99
100-499.99
500-999.99
1000-1700
Latitude
Longitude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Summer
Number per Trawl Hour
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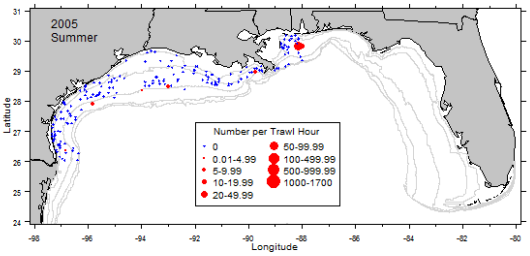
Latitude
Longitude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Summer
Number per Trawl Hour
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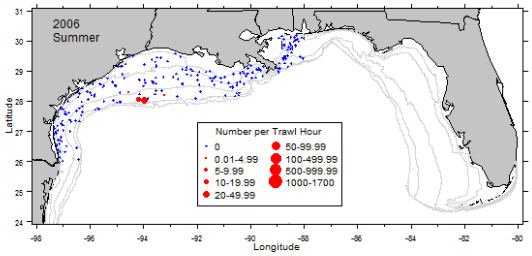
Latitude
Longitude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Summer
Number per Trawl Hour
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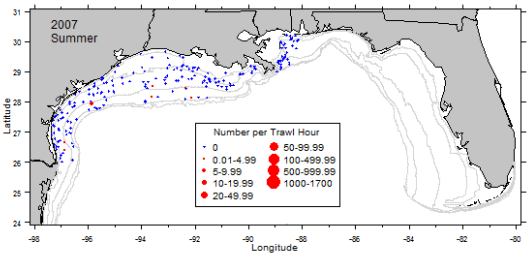
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Summer
Number per Trawl Hour
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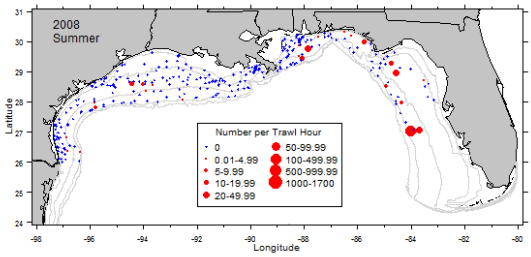
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Summer
Number per Trawl Hour
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Latitude
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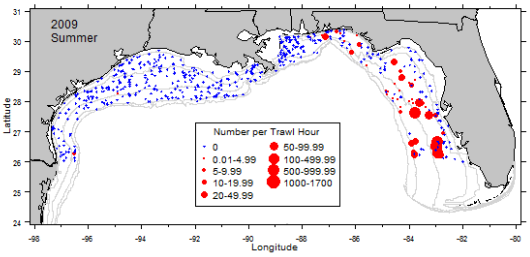
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Summer
Number per Trawl Hour
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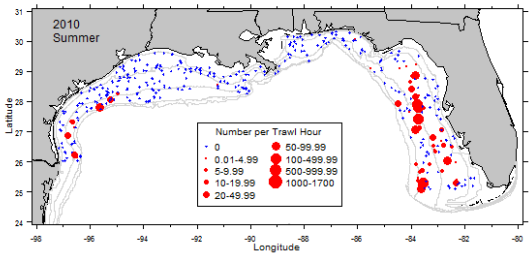
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Number per Trawl Hour
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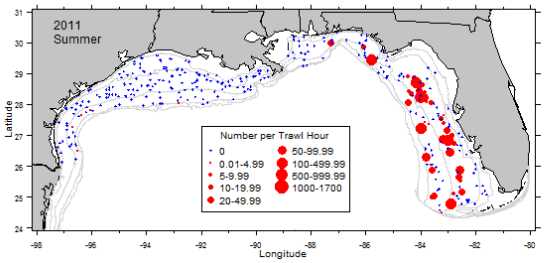
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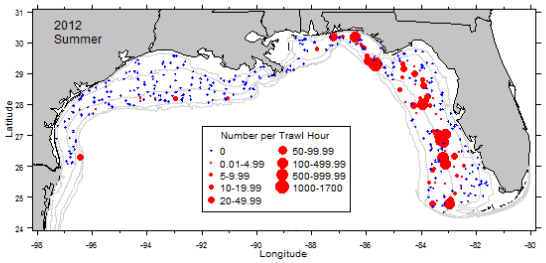
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Summer
Number per Trawl Hour
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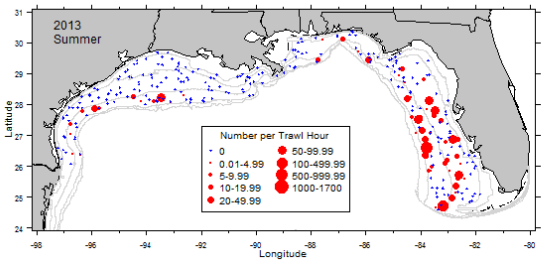
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Summer
Number per Trawl Hour
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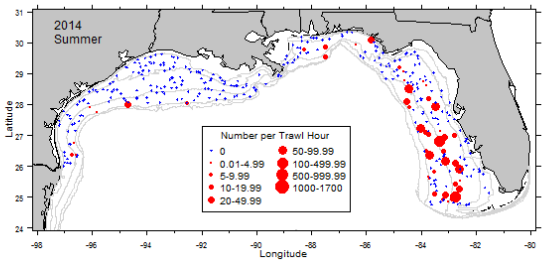
2014
Summer
Number per Trawl Hour
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10-19.99
20-49.99
50-99.99
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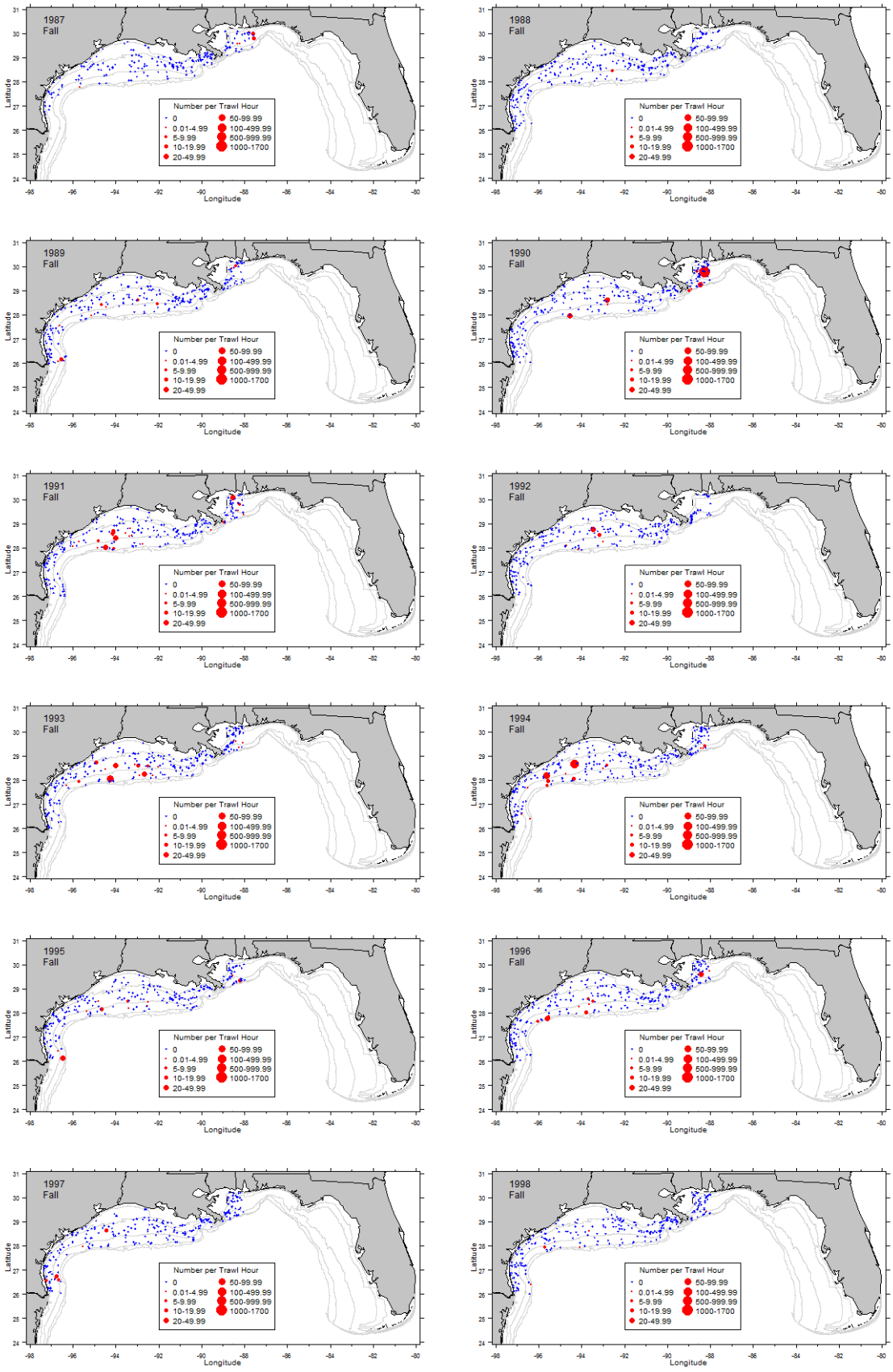
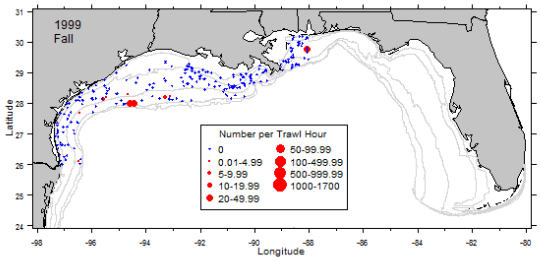
1000-1700
Latitude
Longitude

Appendix Figure 2. Annual survey effort and catch of vermilion snapper from the SEAMAP Fall Groundfish Survey.

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Fall
Number per Trawl Hour
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Latitude
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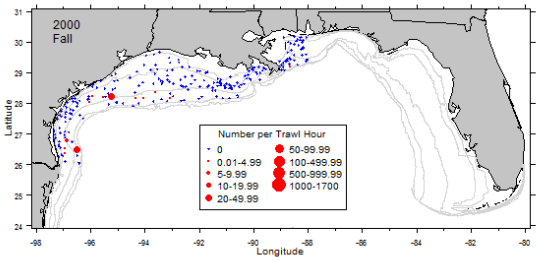
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Fall
Number per Trawl Hour
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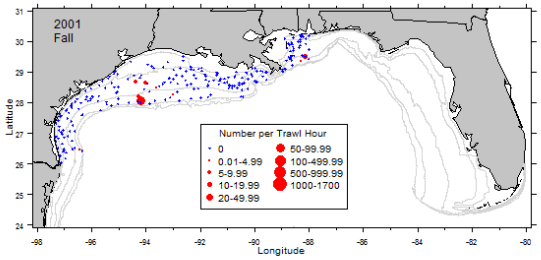
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Fall
Number per Trawl Hour
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Latitude
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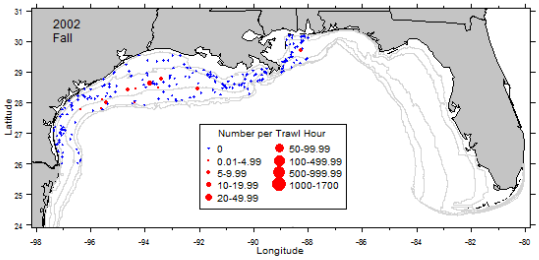
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Fall
Number per Trawl Hour
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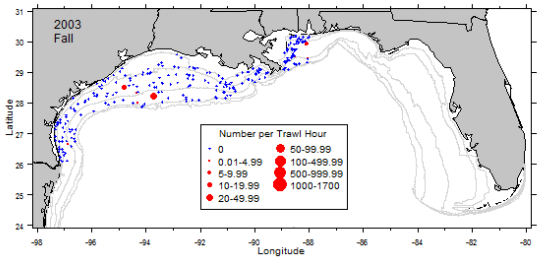
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Fall
Number per Trawl Hour
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Latitude
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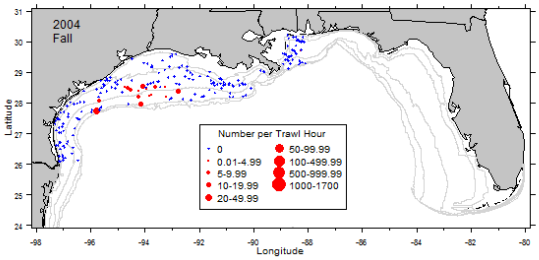
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Fall
Number per Trawl Hour
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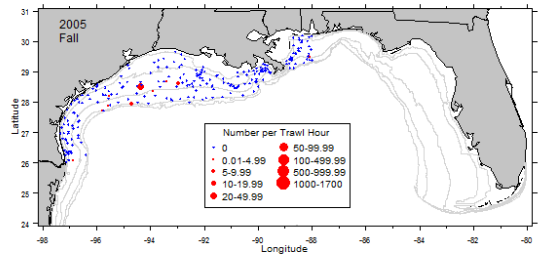
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Fall
Number per Trawl Hour
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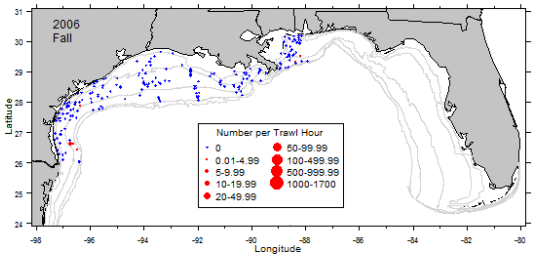
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Fall
Number per Trawl Hour
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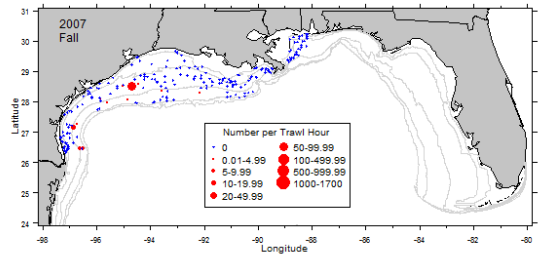
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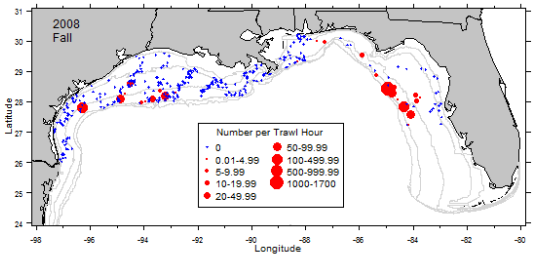
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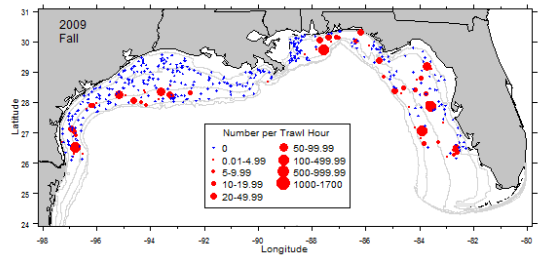
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Fall
Number per Trawl Hour
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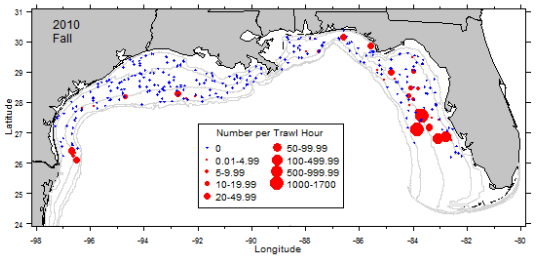
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Fall
Number per Trawl Hour
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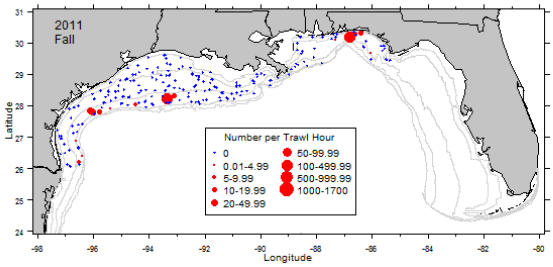
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Fall
Number per Trawl Hour
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10-19.99
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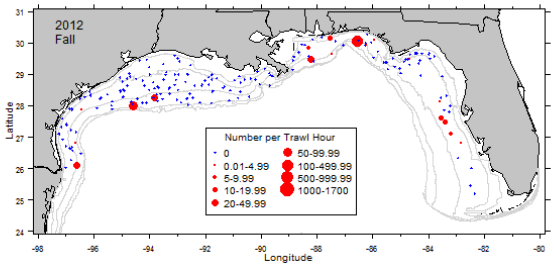
2012
Fall
Number per Trawl Hour
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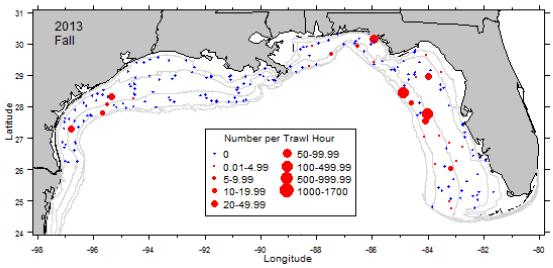
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Fall
Number per Trawl Hour
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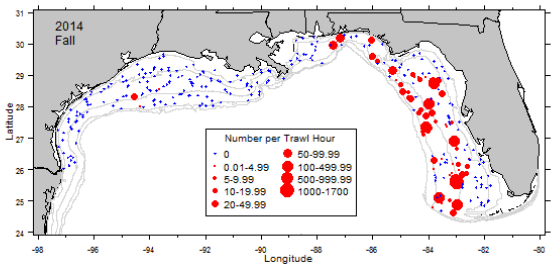
Latitude
Longitude


2014
Fall
Number per Trawl Hour
0
0.01-4.99
5-9.99
10-19.99
20-49.99
50-99.99
100-499.99
500-999.99
1000-1700
Latitude
Longitude