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

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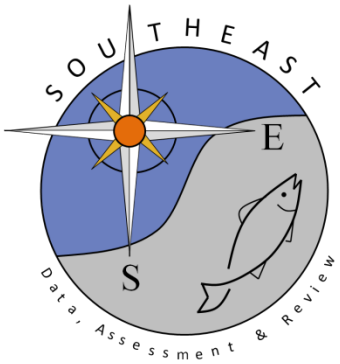

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Abstract

The National Marine Fisheries Service 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 Gray Snapper (Lutjanus griseus). An abundance index was developed covering the area between Cape San Blas, FL and the Florida Keys, FL from 2010-2015 (summer survey only).

Introduction

The National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Mississippi Laboratories (MSLABS) and state partners have conducted standardized fall 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 Gray Snapper (*Lutjanus griseus*).

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 fm), 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 min 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.

Data

A total of 15,487 stations were sampled from 1987- 2015 with 7,945 and 7,542 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 was obtained from the NMFS SEFSC Panama City Laboratory (Lombardi, personal communication).

Data Exclusions

Data 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). Spatial coverage was limited to all stations east of Cape San Blas, FL (SSZ 2 – 7) because of low to zero occurrence of Gray Snapper (Figure 1) in SSZ 8 - 21. Stations from SSZ 1 were excluded because of the lack of coverage throughout the time series. Temporal coverage was limited to 2010 – 2015 because the target SSZs were not sampled during the early part of the survey and limited to only the summer survey because of the inconsistent sampling during the fall survey. Finally, the 2008 and 2009 surveys were excluded because the sampling done by the state of Florida was considered experimental and followed the old SEAMAP protocols, while sampling done by NMFS followed the newer SEAMAP protocols.

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 area were designated the secondary sampling areas; East Florida and Texas were not sampled. During this time, triplicate 10 min tows were done at each station. For the purpose of this analysis, these stations were excluded from analysis.

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 min. 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 Gray Snapper (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) $$V(I_y) \approx V(c_y)p_y^2 + c_y^2 V(p_y).$$

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 Akaike Information Criterion (AIC), while the performance of the lognormal submodel was evaluated based on analyses of residual scatter and quantile-quantile (QQ) plots in addition to AIC. Variables that could be included in the submodels were:

Year: 2010 – 2015
Depth: 9 – 110 m (continuous variable)
SSZ: Zones 2, 3, 4, 5, 6 and 7
Time of Day: Day and Night

Results and Discussion

Distribution, Size and Age

The distribution of Gray Snapper is presented in Figure 1, with seasonal/annual abundance and distribution presented in the Appendix Figures 1 and 2. Gray Snapper primarily occur along the West Florida Shelf and rarely captured in the western GOM. Tables 3 and 4 summarize the length information collected for Gray Snapper, with average fork lengths ranging between 261 and 287 mm in the summer survey and between 116 and 607 mm in the fall survey. The length frequency distribution of Gray Snapper used in the relative abundance index is shown in Figure 2. A total of 568 Gray Snapper otoliths were submitted for age determination. Ages were successfully determined for 530 otoliths, with ages ranging from 1 to 15 years. Analysis of age data collected from Gray Snapper indicated that 59% were three to four years old (Figure 3).

Index of Abundance

For the SEAMAP Summer Groundfish Survey abundance index of Gray Snapper, year, depth, SSZ and time of day were retained in the binomial submodel, while year and SSZ were retained in the lognormal submodel. A summary of the factors used in the analysis is presented in Appendix Table 2. Table 5 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 3997.4 and 503.4, respectively. Diagnostic plots for the lognormal submodels are shown in Figure 4, and indicate the distribution of the residuals is normal. Annual abundance indices are presented in Table 6 and Figure 5.

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Table 1. Number of stations sampled by shrimp statistical zone during the SEAMAP Summer Groundfish Surveys from 1987-2015.

	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										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	16	13	16	7	14	18	25	29	27	20	20	15	*398*
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	25	30	17	15	9	7	17	6	15	18	22	29	23	18	18	14	*356*
2015	1	9	32	29	23	28	26	18	10	8	16	7	15	18	21	29	26	19	20	13	*368*
Total	***1***	***56***	***185***	***201***	***172***	***202***	***105***	***114***	***95***	***163***	***1162***	***350***	***693***	***612***	***632***	***654***	***536***	***675***	***740***	***597***	***7945***

Table 2. Number of stations sampled by shrimp statistical zone during the SEAMAP Fall Groundfish Surveys from 1987-2015.

	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	11	21	13	12	50	12	23	23	30	49	47	31	36	22	*446*
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	23	24	13	12	7	7	16	5	14	15	22	27	22	15	17	12	*316*
2015	1	10	29	25	25	21	15	12	11	11	16	6	13	13	20	27	21	16	17	12	*321*
Total	***2***	***22***	***76***	***94***	***127***	***128***	***88***	***94***	***69***	***89***	***1119***	***398***	***768***	***611***	***673***	***694***	***566***	***640***	***723***	***561***	***7542***

Table 3. Summary of the Gray Snapper length data collected during SEAMAP Summer Groundfish Surveys conducted between 1987 and 2015.

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	287	0					
1988	234	0					
1989	215	0					
1990	262	0					
1991	254	0					
1992	248	0					
1993	248	0					
1994	262	0					
1995	239	0					
1996	245	0					
1997	231	0					
1998	229	0					
1999	246	0					
2000	239	0					
2001	176	0					
2002	252	0					
2003	205	0					
2004	240	0					
2005	195	0					
2006	239	0					
2007	224	0					
2008	307	4	4	257	323	286	27
2009	537	110	109	211	464	287	46
2010	381	114	113	162	424	261	50
2011	329	112	102	171	461	266	53
2012	398	164	156	166	566	266	75
2013	299	97	97	171	516	271	70
2014	356	221	206	174	446	262	44
2015	368	170	144	28	451	264	51

Total Number of Years	Total Number of Stations	Total Number Collected	Total Number Measured	Overall Mean Fork Length (mm)
29	7945	992	931	267

Table 4. Summary of the Gray Snapper length data collected during SEAMAP Fall Groundfish Surveys conducted between 1987 and 2015.

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	208	0					
1988	236	0					
1989	249	0					
1990	250	1	1	116	116	116	.
1991	247	0					
1992	231	2	2	270	303	287	23
1993	274	1	1	607	607	607	.
1994	253	0					
1995	241	1	1	231	231	231	.
1996	251	0					
1997	247	0					
1998	273	0					
1999	248	2	2	234	256	245	16
2000	244	7	1	211	211	211	.
2001	251	0					
2002	257	1	1	303	303	303	.
2003	275	0					
2004	229	1	1	287	287	287	.
2005	255	6	2	298	308	303	7
2006	223	0					
2007	230	2	0	.	.	.	.
2008	367	4	4	310	379	347	31
2009	446	65	65	204	458	304	60
2010	315	47	46	141	519	312	66
2011	220	2	1	341	341	341	.
2012	199	13	13	222	435	279	60
2013	186	38	38	207	471	268	48
2014	316	132	132	183	541	267	55
2015	321	86	86	171	509	275	64

Total Number of Years	Total Number of Stations	Total Number Collected	Total Number Measured	Overall Mean Fork Length (mm)
29	7542	411	397	282

Table 5. Summary of backward selection procedure for building delta-lognormal submodels for Gray Snapper SEAMAP Summer Groundfish Surveys index of relative abundance from 2010 to 2015.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 3997.4)*						*Lognormal Submodel Type 3 Tests (AIC 511.9)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	5	778	4.99	1.00	0.4170	0.4178	5	174	0.49	0.7811
Depth	1	778	70.63	70.63	<.0001	<.0001	1	174	1.81	0.1805
Statistical Zone	5	778	59.13	11.83	<.0001	<.0001	5	174	3.71	0.0032
Time of Day	1	778	13.54	13.54	0.0002	0.0002	1	174	0.31	0.5774
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 3997.4)*						*Lognormal Submodel Type 3 Tests (AIC 510.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	5	778	4.99	1.00	0.4170	0.4178	5	175	0.49	0.7866
Depth	1	778	70.63	70.63	<.0001	<.0001	1	175	1.76	0.1859
Statistical Zone	5	778	59.13	11.83	<.0001	<.0001	5	175	3.69	0.0034
Time of Day	1	778	13.54	13.54	0.0002	0.0002	Dropped			
Model Run #3	*Binomial Submodel Type 3 Tests (AIC 3997.4)*						*Lognormal Submodel Type 3 Tests (AIC 503.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	5	778	4.99	1.00	0.4170	0.4178	5	176	0.46	0.8048
Depth	1	778	70.63	70.63	<.0001	<.0001	Dropped			
Statistical Zone	5	778	59.13	11.83	<.0001	<.0001	5	176	5.00	0.0003
Time of Day	1	778	13.54	13.54	0.0002	0.0002	Dropped			

Table 6. Index of Gray Snapper abundance developed using the delta-lognormal (DL) model for SEAMAP Summer Groundfish Surveys from 2010-2015. 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
2010	0.28947	114	1.30575	1.04289	0.27031	0.61317	1.77376
2011	0.23148	108	1.10306	0.88101	0.29983	0.48993	1.58425
2012	0.22222	162	1.08281	0.86483	0.26503	0.51360	1.45625
2013	0.21739	115	1.01221	0.80844	0.30663	0.44389	1.47239
2014	0.27586	145	1.74679	1.39514	0.23935	0.87018	2.23679
2015	0.19048	147	1.26168	1.00769	0.28325	0.57814	1.75639

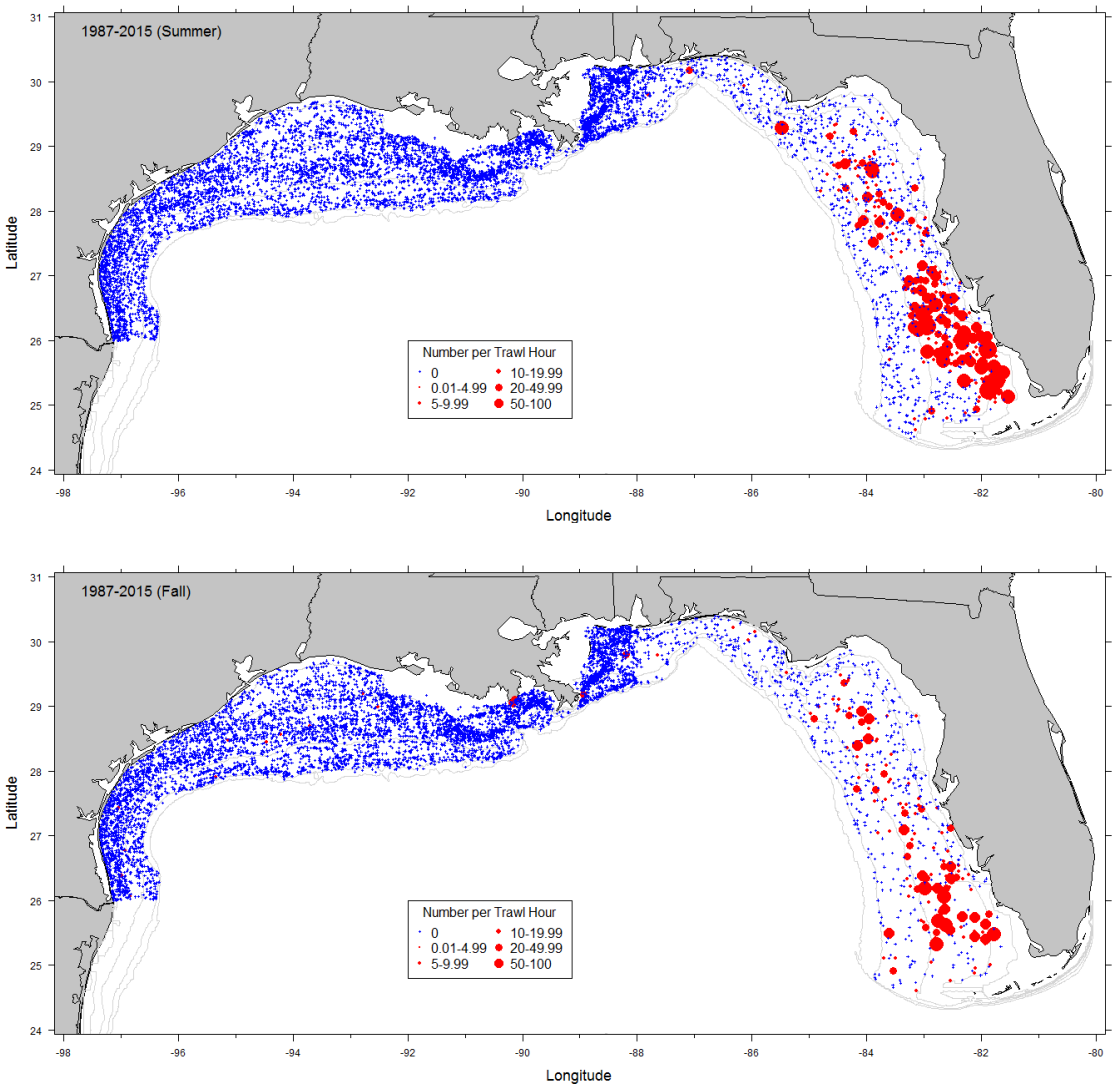


Figure 1. Stations sampled from 1987 to 2015 during the Summer (top) and Fall (bottom) SEAMAP Groundfish Surveys with the CPUE for Gray Snapper.

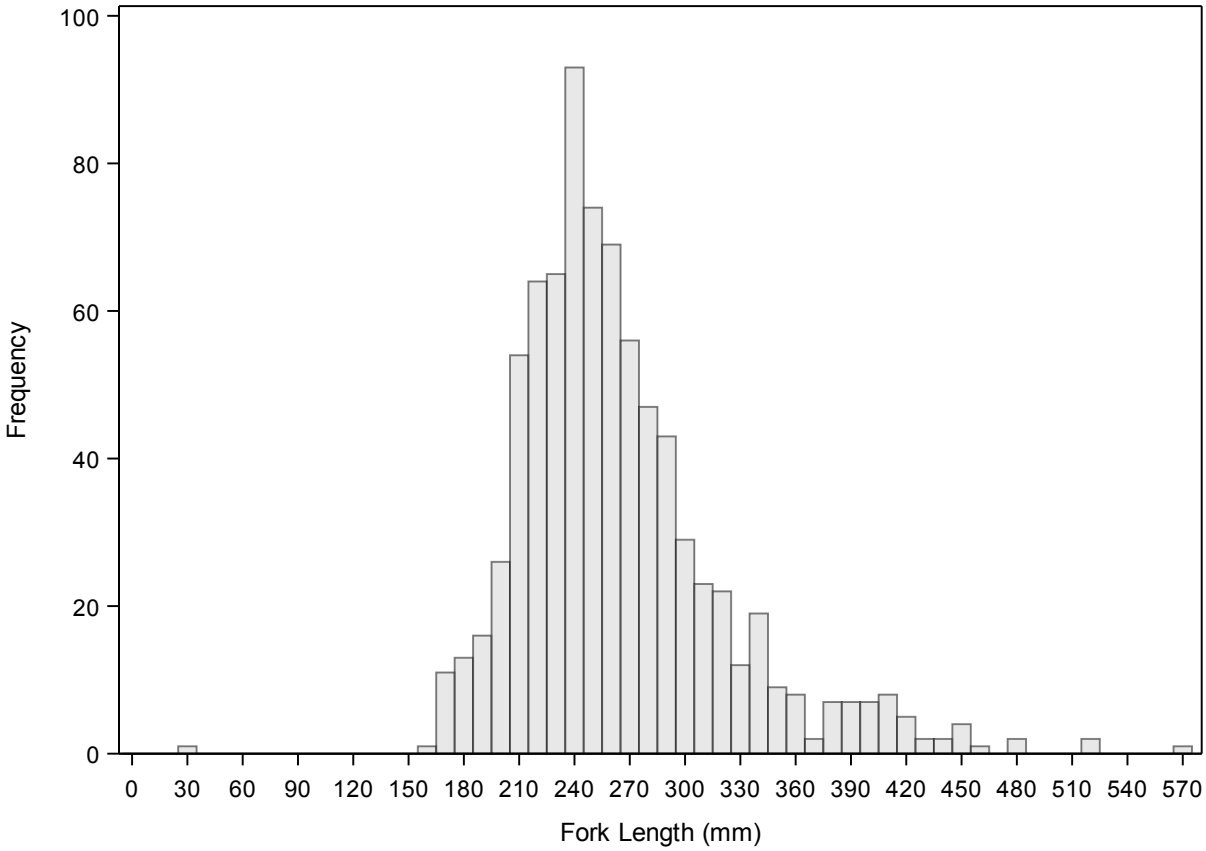


Figure 2. Length frequency histogram for Gray Snapper captured during SEAMAP Summer Groundfish Surveys from 2010 – 2015 east of Cape San Blas, FL.

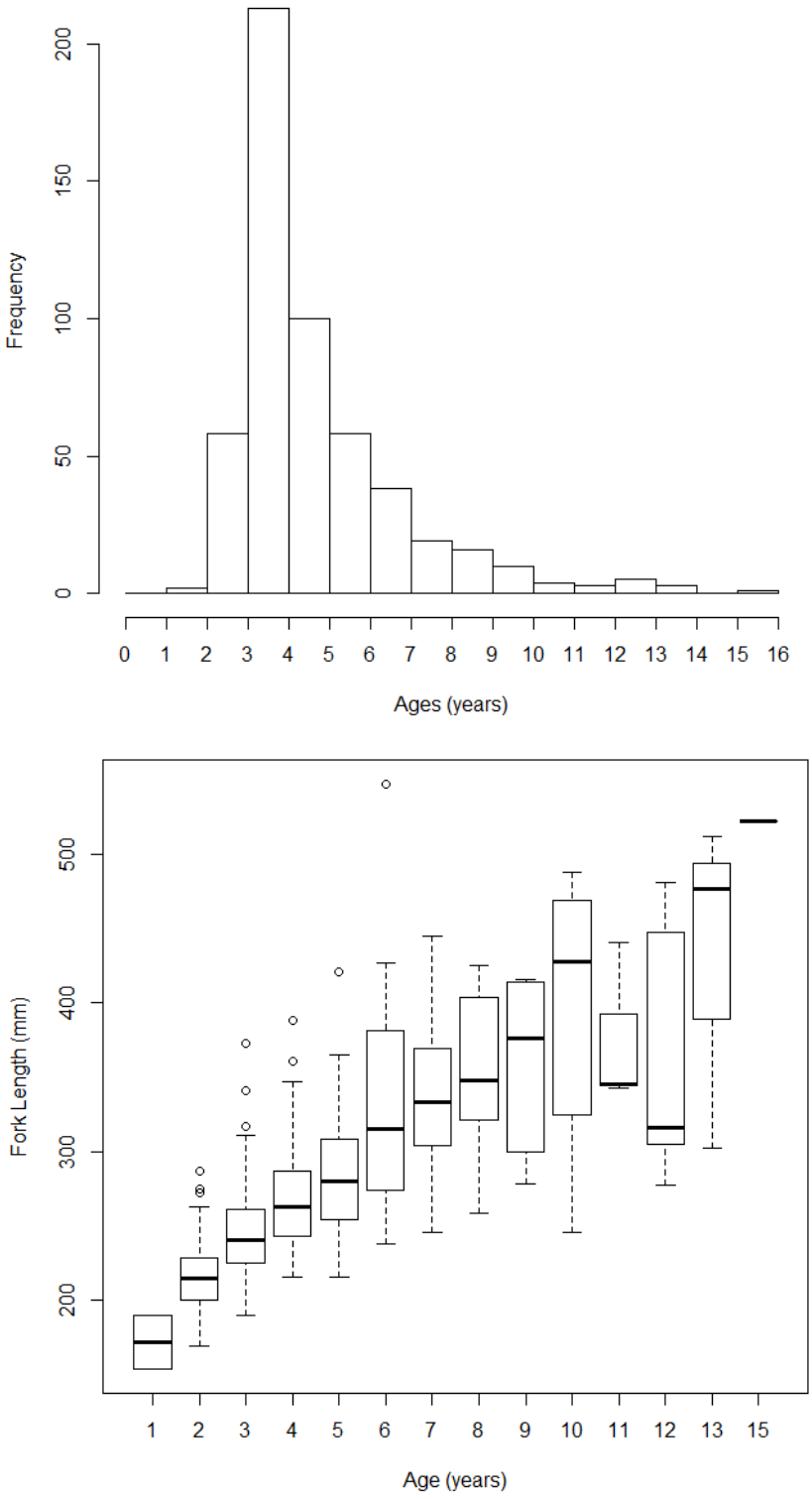


Figure 3. Age distribution of Gray Snapper (n = 530) captured during SEAMAP Groundfish Surveys (top) and length at age information (bottom).

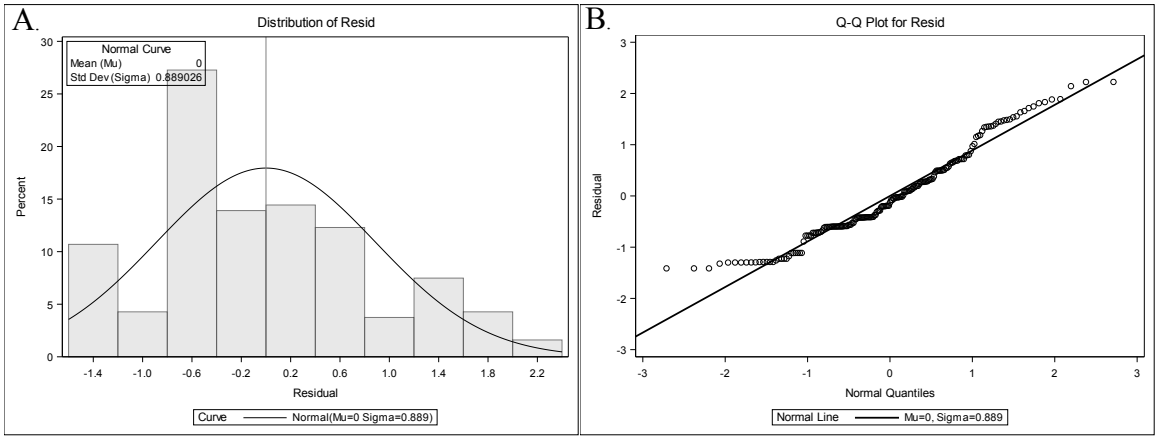


Figure 4. Diagnostic plots for lognormal component of the Gray Snapper SEAMAP Summer Groundfish Surveys (2010 - 2015)) model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).

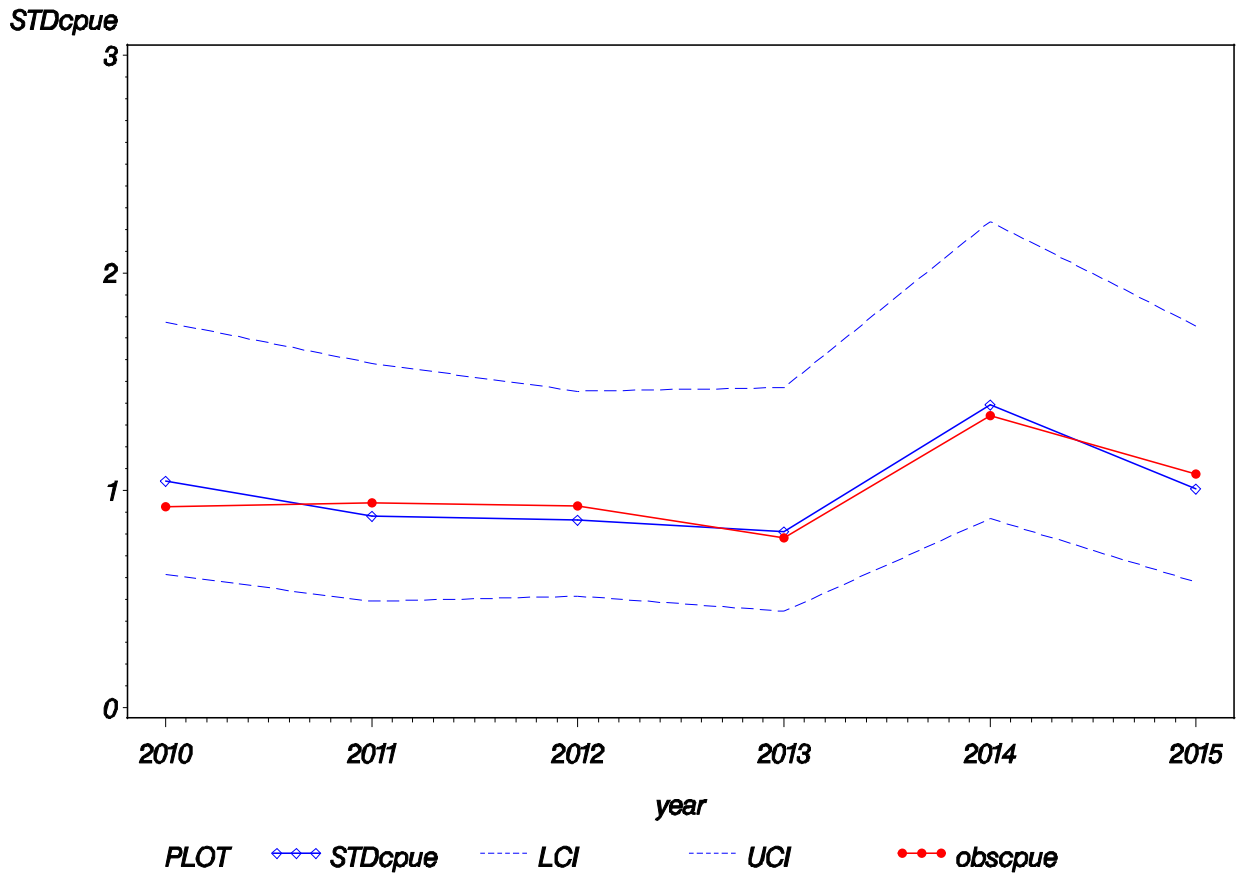


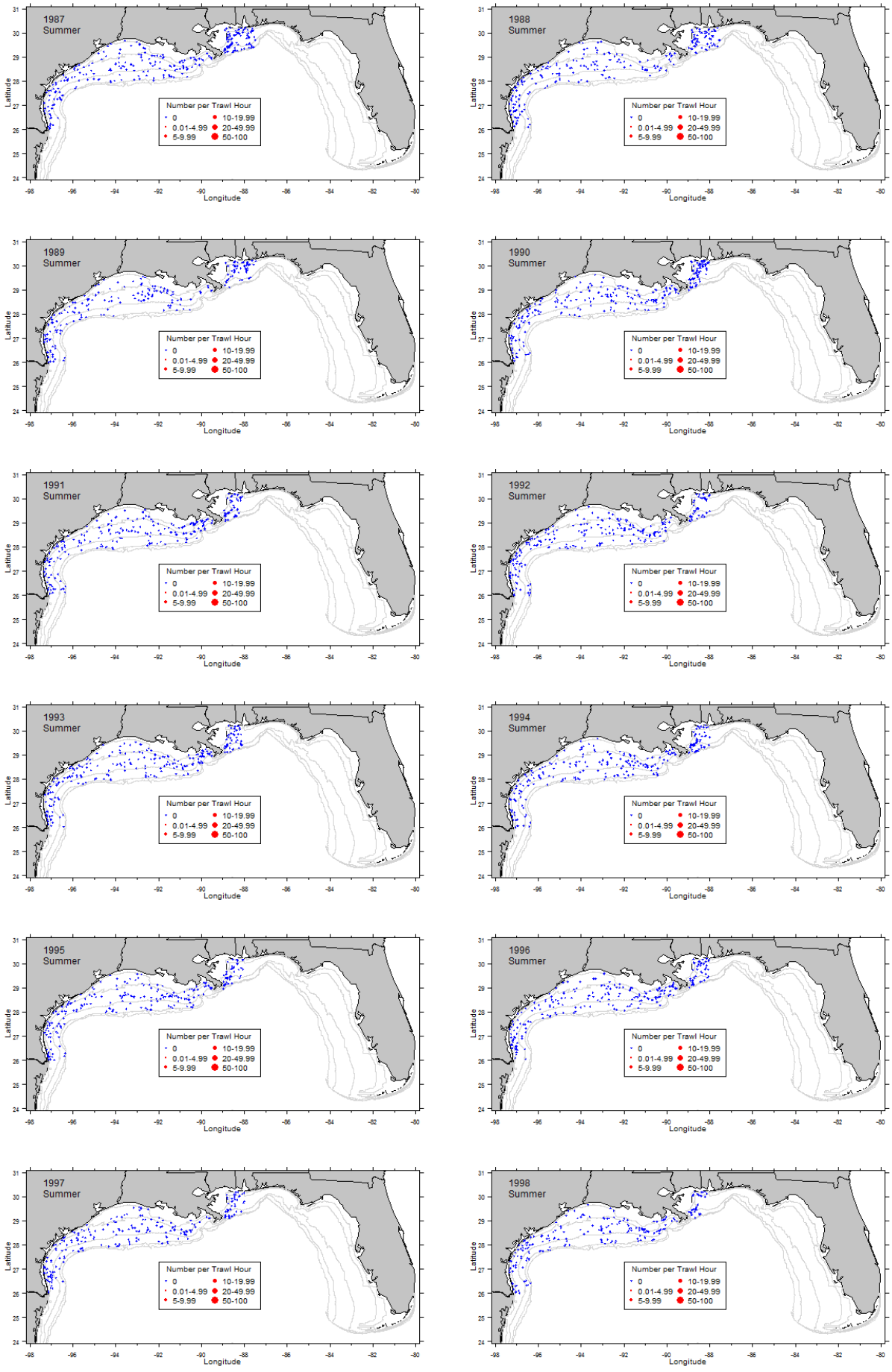
Figure 5. Annual index of abundance for Gray Snapper from the SEAMAP Summer Groundfish Surveys from 2010 – 2015.

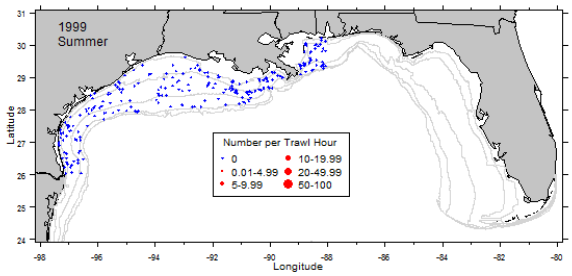
Appendix

Appendix Table 1. Summary of the factors used in constructing the Gray Snapper abundance index from the SEAMAP Summer Groundfish Surveys (Cape San Blas, FL to Florida Keys, FL (2010 - 2015)) data.

Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
STATISTICAL ZONE	2	56	7	0.12500	0.39266
STATISTICAL ZONE	3	185	60	0.32432	4.25080
STATISTICAL ZONE	4	164	61	0.37195	3.78455
STATISTICAL ZONE	5	141	21	0.14894	0.83688
STATISTICAL ZONE	6	162	32	0.19753	0.96122
STATISTICAL ZONE	7	83	6	0.07229	0.26503
TIME OF DAY	Day	449	82	0.18263	1.86957
TIME OF DAY	Night	342	105	0.30702	2.58870
YEAR	2010	114	33	0.28947	1.99333
YEAR	2011	108	25	0.23148	2.03047
YEAR	2012	162	36	0.22222	2.00252
YEAR	2013	115	25	0.21739	1.68587
YEAR	2014	145	40	0.27586	2.89402
YEAR	2015	147	28	0.19048	2.31514

Appendix Figure 1. Annual survey effort and catch of Gray Snapper from the SEAMAP Summer Groundfish Surveys.

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Summer
Number per Trawl Hour
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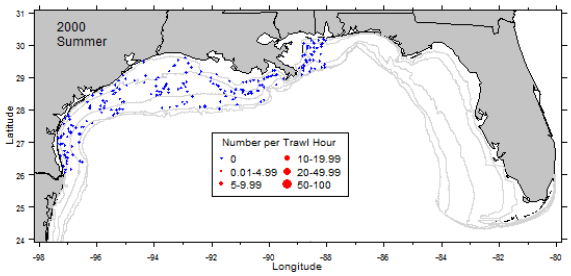
10-19.99
20-49.99
50-100
Latitude
Longitude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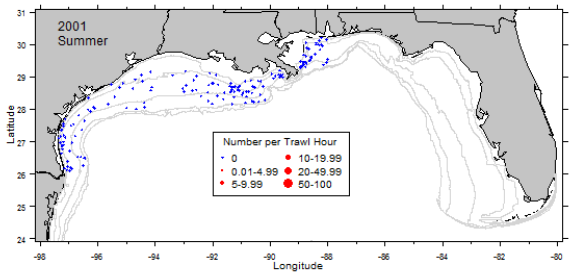
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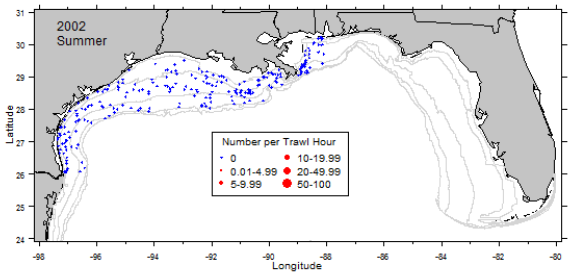
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Summer
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Latitude
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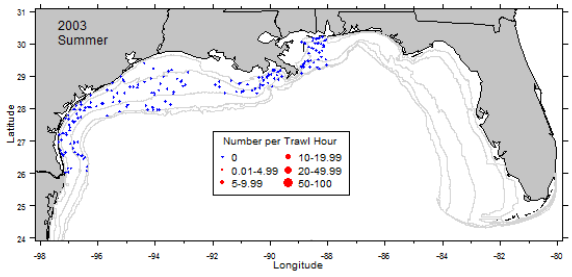
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Summer
Number per Trawl Hour
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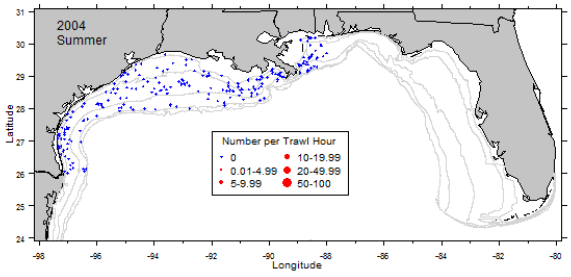
Latitude
Longitude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Number per Trawl Hour
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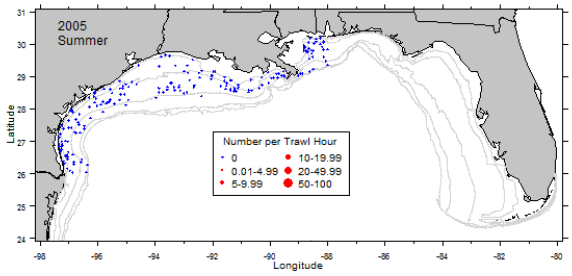
Latitude
Longitude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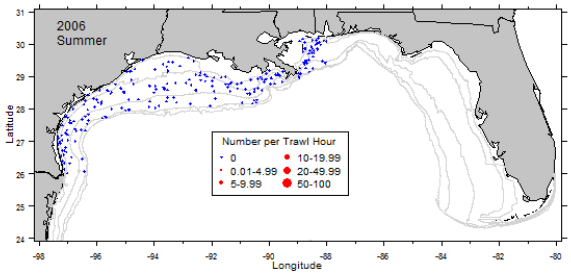
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Summer
Number per Trawl Hour
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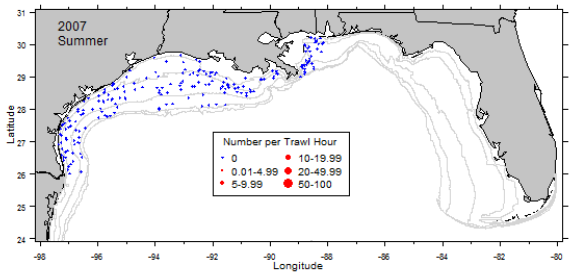
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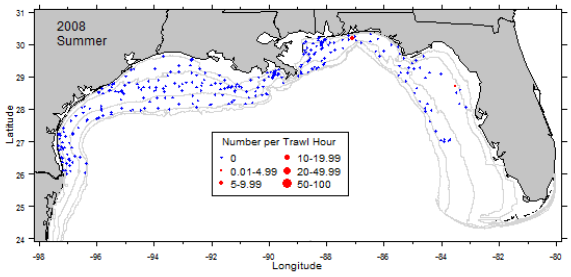
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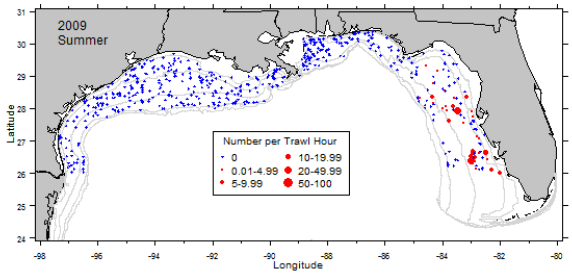
Latitude
Longitude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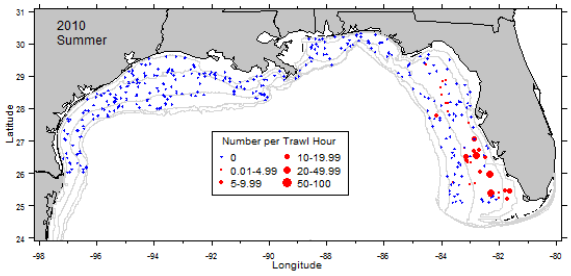
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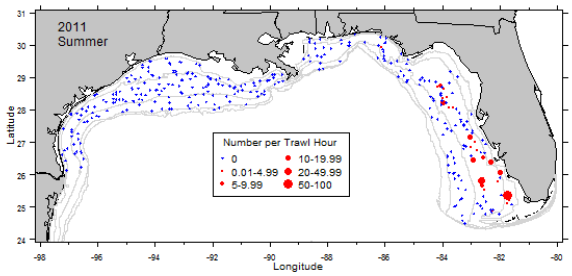
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Number per Trawl Hour
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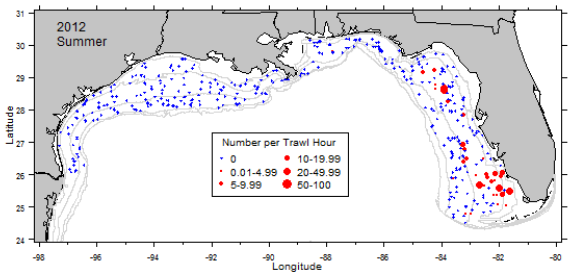
Latitude
Longitude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Summer
Number per Trawl Hour
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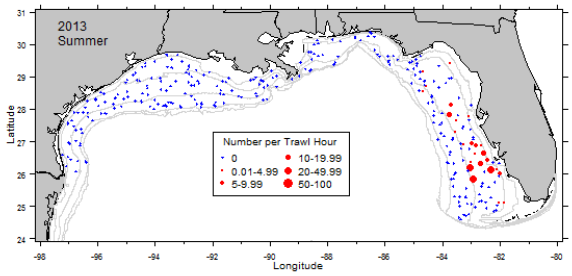
Latitude
Longitude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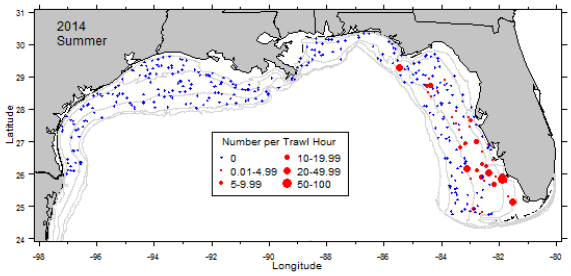
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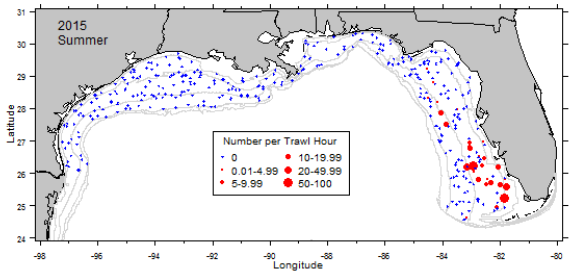
2015
Summer
Number per Trawl Hour
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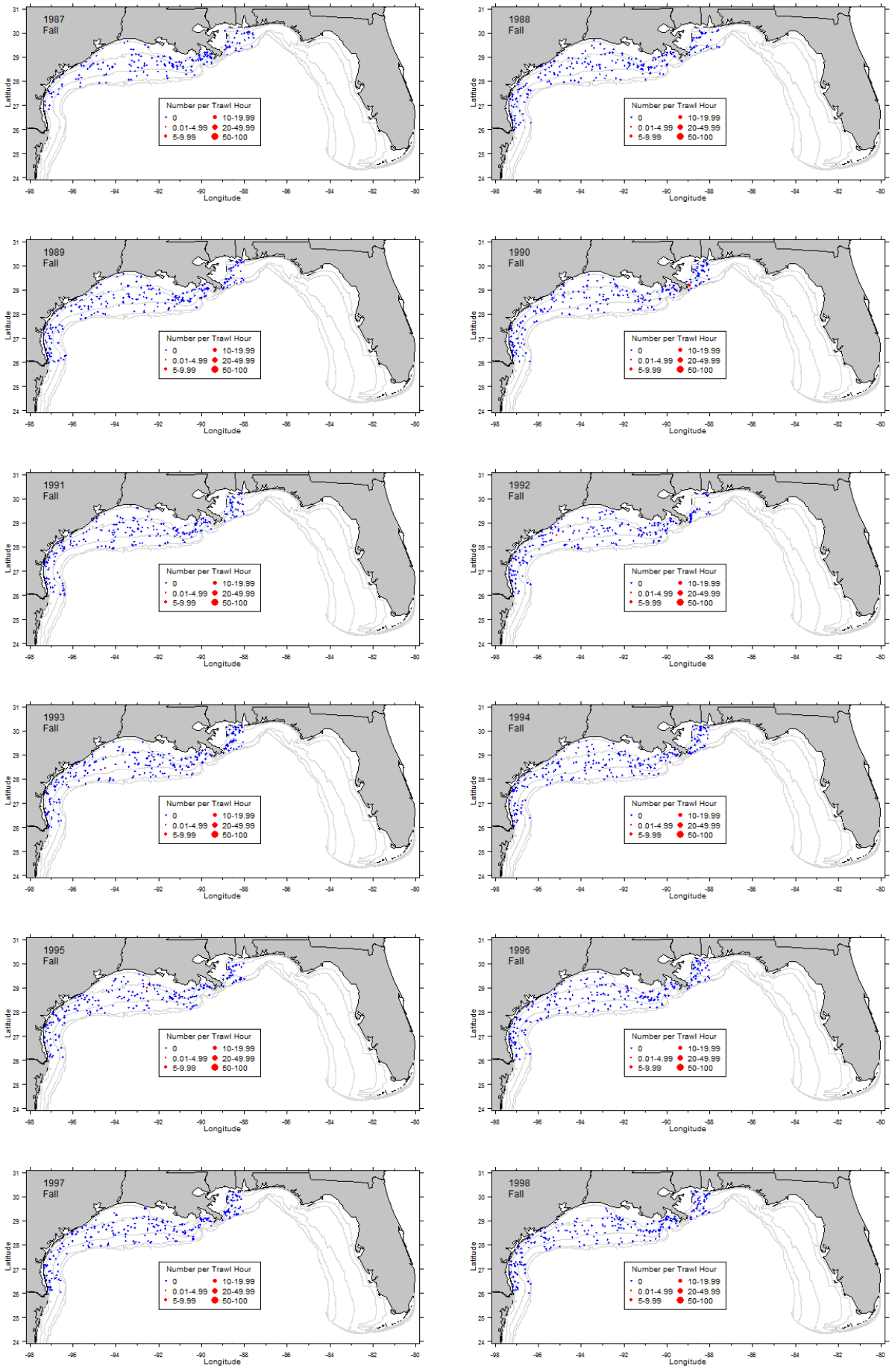
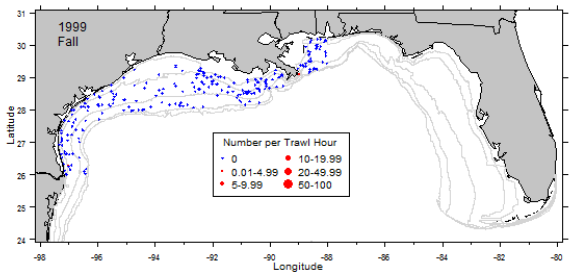
Latitude
Longitude

Appendix Figure 2. Annual survey effort and catch of Gray Snapper from the SEAMAP Fall Groundfish Surveys.

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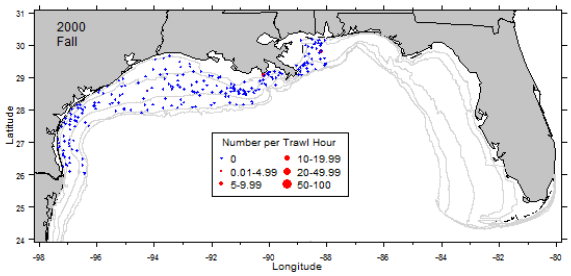
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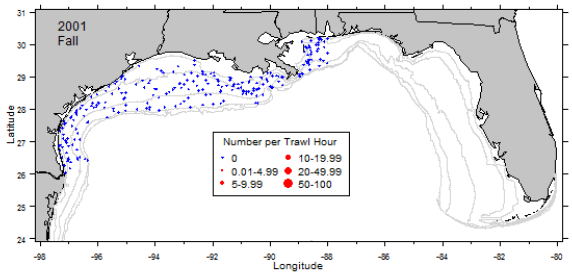
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Fall
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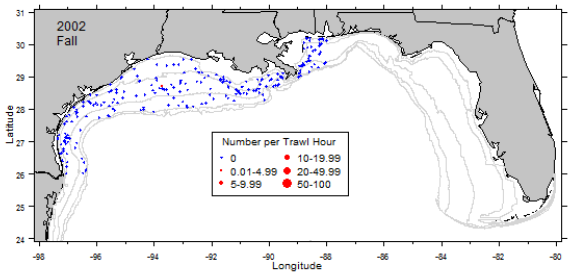
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Fall
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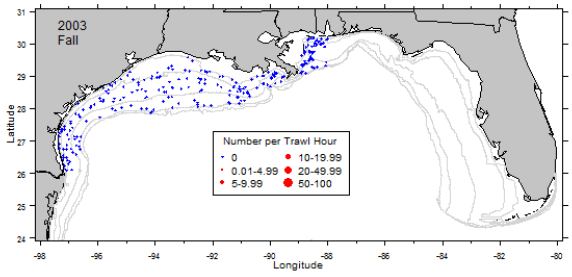
20-49.99
50-100
Latitude
Longitude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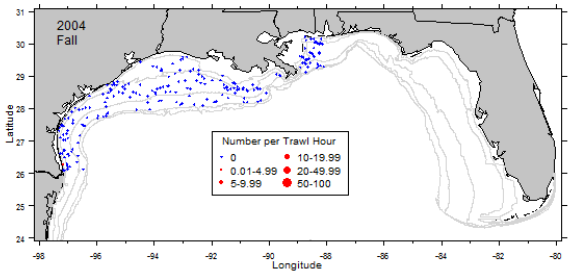
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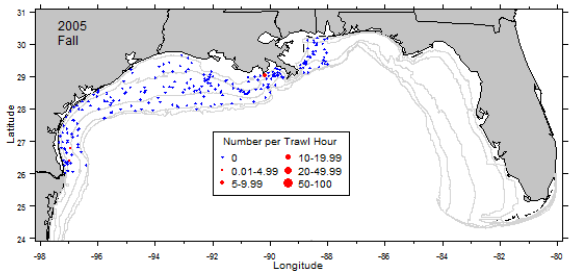
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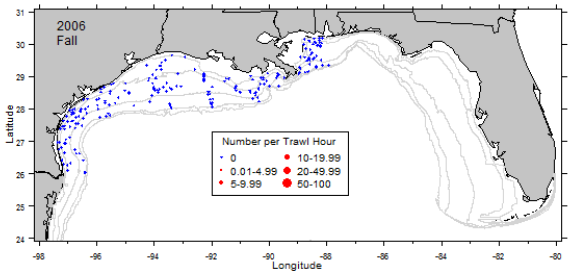
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Fall
Number per Trawl Hour
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Latitude
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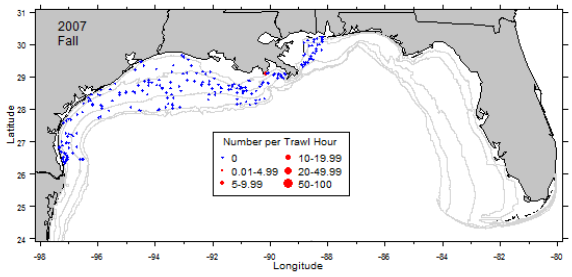
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Fall
Number per Trawl Hour
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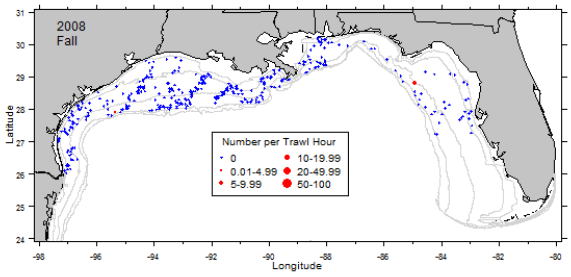
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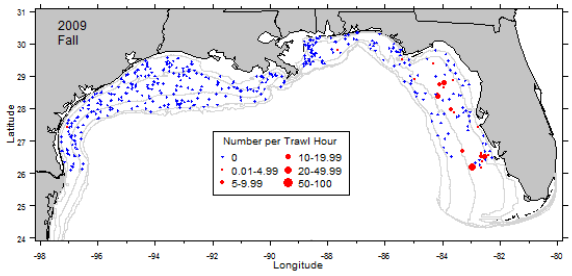
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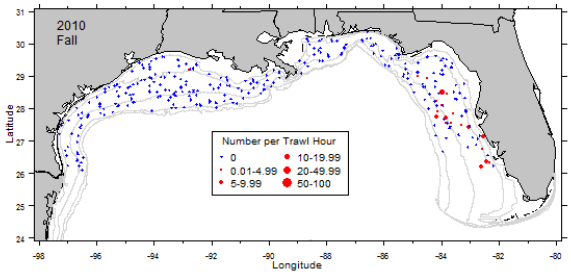
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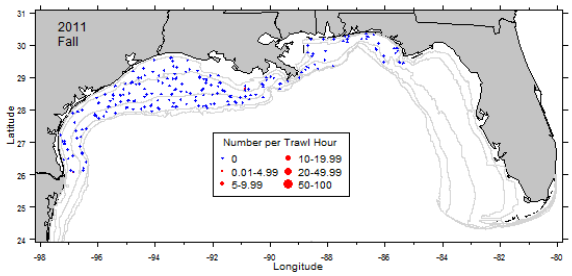
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Fall
Number per Trawl Hour
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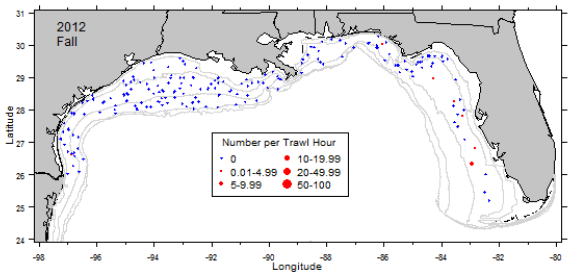
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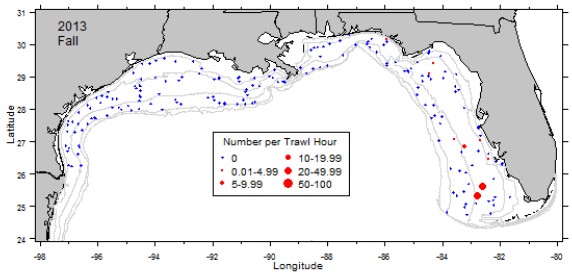
2013
Fall
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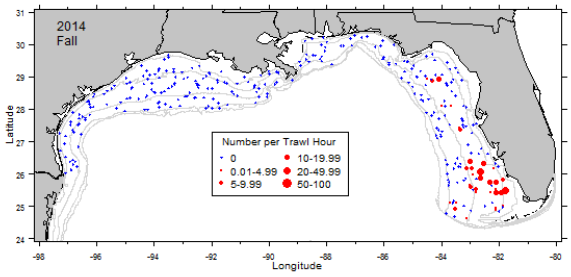
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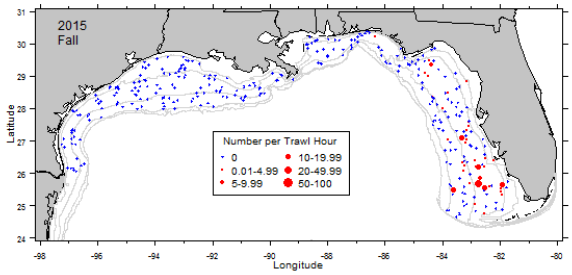

2015
Fall
Number per Trawl Hour
0
0.01-4.99
5-9.99
10-19.99
20-49.99
50-100
Latitude
Longitude

Addendum

During the Data Workshop, the Indices Working Group (IWG) was concerned about the use of statistical zone in the final model because of the lack of positive occurrence in some statistical zones. Since the statistical zones do not have any biological significance, it was decided to combine statistical zones 2 and 3, 4 and 5, and 6 and 7 together. For the SEAMAP Summer Groundfish Survey abundance index of Gray Snapper, year, depth, zone and time of day were retained in the binomial submodel while year, depth and zone were retained in the lognormal submodel. A summary of the factors used in the analysis is presented in 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 3,860.5 and 518.6, respectively. Diagnostic plots for the lognormal submodels are shown in Addendum Figure 1, and indicate the distribution of the residuals is normal. Annual abundance indices are presented in Addendum Table 3 and Addendum Figure 2.

Addendum Table 1. Summary of the factors used in constructing the Gray Snapper abundance index from the SEAMAP Summer Groundfish Survey data.

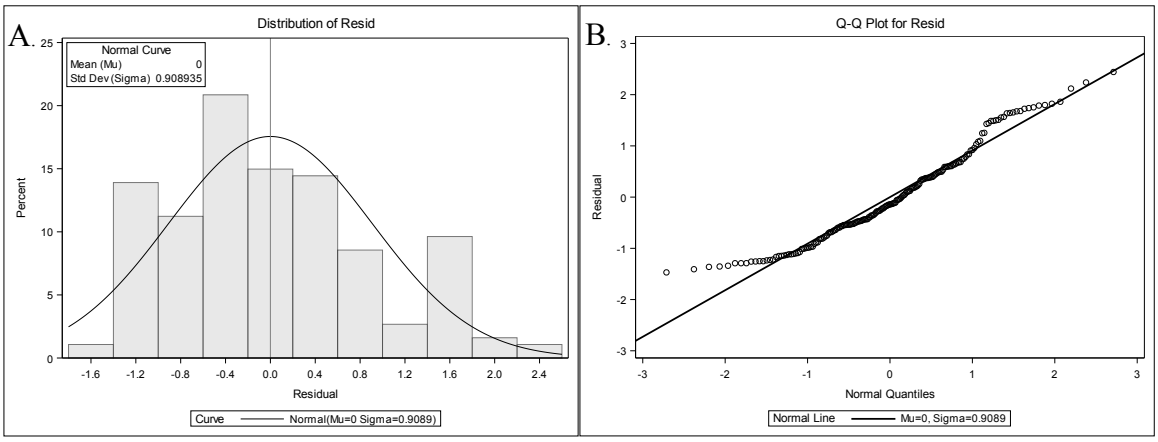
Factor	Level	Number of Observations	Number of Positive Observations	Proportion Positive	Mean CPUE
YEAR	2010	114	33	0.28947	1.99333
YEAR	2011	108	25	0.23148	2.03047
YEAR	2012	162	36	0.22222	2.00252
YEAR	2013	115	25	0.21739	1.68587
YEAR	2014	145	40	0.27586	2.89402
YEAR	2015	147	28	0.19048	2.31514
ZONE	1	241	67	0.27801	3.35430
ZONE	2	305	82	0.26885	2.42186
ZONE	3	245	38	0.15510	0.72537
TIME OF DAY	Day	449	82	0.18263	1.86957
TIME OF DAY	Night	342	105	0.30702	2.58870

Addendum Table 2. Summary of backward selection procedure for building delta-lognormal submodels for Gray Snapper SEAMAP Summer Groundfish Survey index of relative abundance from 2010 to 2015.

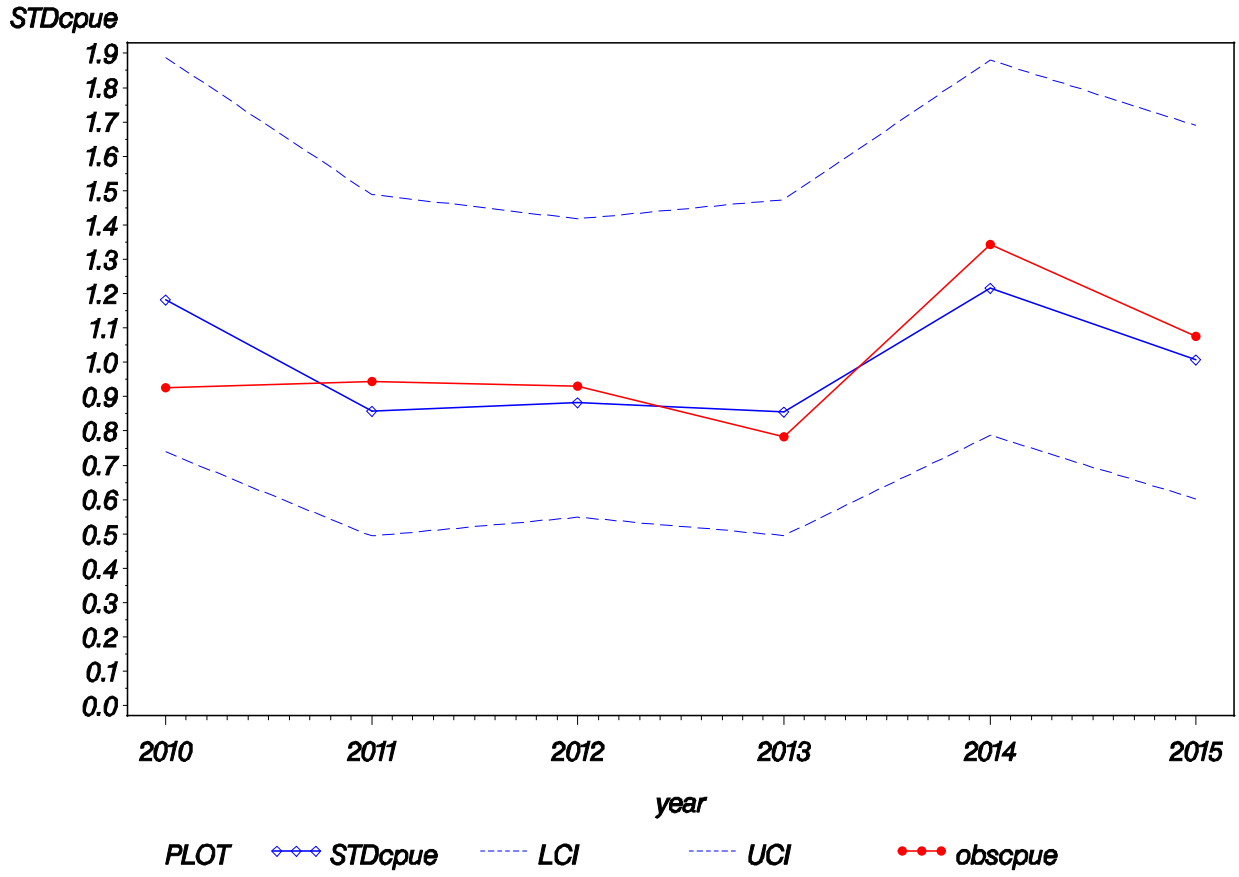
Model Run #1	*Binomial Submodel Type 3 Tests (AIC 3860.5)*						*Lognormal Submodel Type 3 Tests (AIC 520.3)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	5	781	5.82	1.16	0.3242	0.3253	5	177	0.40	0.8459
Depth	1	781	70.24	70.24	<.0001	<.0001	1	177	4.47	0.0359
Zone	2	781	29.52	14.76	<.0001	<.0001	2	177	4.30	0.0150
Time of Day	1	781	11.70	11.70	0.0006	0.0007	1	177	0.39	0.5326
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 3860.5)*						*Lognormal Submodel Type 3 Tests (AIC 518.6)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	5	781	5.82	1.16	0.3242	0.3253	5	178	0.39	0.8557
Depth	1	781	70.24	70.24	<.0001	<.0001	1	178	4.44	0.0364
Zone	2	781	29.52	14.76	<.0001	<.0001	2	178	4.17	0.0170
Time of Day	1	781	11.70	11.70	0.0006	0.0007	Dropped			

Addendum Table 3. Indices of Gray Snapper abundance developed using the delta-lognormal model for SEAMAP Summer Groundfish Survey from 2010-2015. 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	Nominal Frequency	N	Lo Index	Scaled Lo Index	CV	LCL	UCL
2010	0.28947	114	1.94853	1.18118	0.23777	0.73896	1.88803
2011	0.23148	108	1.41469	0.85757	0.28116	0.49396	1.48884
2012	0.22222	162	1.45483	0.88190	0.24070	0.54864	1.41759
2013	0.21739	115	1.40978	0.85459	0.27770	0.49547	1.47400
2014	0.27586	145	2.00699	1.21661	0.22033	0.78712	1.88046
2015	0.19048	147	1.66309	1.00815	0.26248	0.60163	1.68935



Addendum Figure 1. Diagnostic plots for lognormal component of the Gray Snapper SEAMAP Summer Groundfish Survey model: **A.** the frequency distribution of log (CPUE) on positive stations and **B.** the cumulative normalized residuals (QQ plot).



Addendum Figure 2. Annual index of abundance for Gray Snapper from the SEAMAP Summer Groundfish Survey from 2010 – 2015.