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Vermilion snapper (*Rhomboplites aurorubens*) larval indices of relative abundance from SEAMAP Fall Plankton Surveys, 1986 to 2017

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Abstract: *The Southeast Area Monitoring and Assessment Program (SEAMAP) has supported the collection and analysis of ichthyoplankton samples from resource surveys in the Gulf of Mexico (GOM) since 1982 with the goal of producing a long-term database on the early life stages of fishes. Occurrence and abundance of vermilion snapper (Rhomboplites aurorubens) larvae captured during these surveys had been initially reviewed as a potential fishery-independent index during the Southeast Data, Assessment and Review 9 (SEDAR 9) process. Standardized Indices of larval abundance as a proxy for relative spawning stock size from SEAMAP surveys were incorporated into the vermilion snapper assessment during the SEDAR 45 process. Indices presented in this document are an update to the SEDAR 45 assessment indices, and incorporate the most recent data available from the 1986 to 2017 SEAMAP Fall Plankton Surveys.*

Introduction

The Southeast Area Monitoring and Assessment Program (SEAMAP) has supported the collection and analysis of ichthyoplankton samples from resource surveys in the Gulf of Mexico (GOM) since 1982 with the goal of producing a long-term database on the early life stages of fishes. Occurrence and abundance of vermilion snapper (*Rhomboplites aurorubens*) larvae captured during these surveys were initially reviewed as a potential fishery-independent index to reflect trends in the relative spawning stock size of vermilion snapper during the Southeast Data, Assessment and Review 9 (SEDAR 9) process. At that time, the index working group recommended the development of indices of larval abundance based on bongo net samples collected during the SEAMAP Fall Plankton survey. They also discussed the need to develop an age or size corrected index of abundance to account for inter-annual differences in size (age) composition of vermilion snapper larvae over the index time series, and requested that both adjusted and unadjusted indices be developed for comparison. These indices were to be completed prior to the SEDAR 9 Assessment Workshop in August 2005. Due the destruction of the Southeast Fisheries Science Center, Mississippi Laboratories (SEFSC), Pascagoula Facility by Hurricane Katrina the final indices were not completed in time for the SEDAR 9 final assessment and review. Age adjusted and unadjusted indices were developed for the SEDAR 45 vermilion snapper assessment. Examination of standardized indices based on raw abundance and larval abundance corrected for inter-annual differences in age/size composition found little differences in the trends among them. Therefore, the final indices recommended and adopted for the SEDAR 45 assessment were based on the standardized raw abundance of vermilion snapper larvae greater than 3.4 mm and less than 6.5 mm in body length to account for identification uncertainty of smaller snapper larvae and the effects of gear avoidance by larger rarely caught larvae.

The SEAMAP Fall Plankton Survey conducted primarily during the month of September is the only Gulfwide plankton survey of U.S. continental shelf and coastal waters during the vermilion snapper spawning season occurring from April to October. Currently the time series available for analysis extends from 1986 to 2017. This document outlines the development of vermilion snapper larval indices of relative abundance from these surveys.

Methodology

SEAMAP Plankton Sample Methodologies

The standard sampling gear and methodology used to collect plankton samples during SEAMAP surveys were similar to those recommended by Kramer et al. (1972), Smith and Richardson (1977) and Posgay and Marak (1980). A 61 cm or 60 cm (inside diameter) bongo net fitted with 0.335 mm mesh netting was fished in an oblique tow path from a maximum depth of 200 m or to 2-5 m off the bottom at station depths less than 200 m. Maximum bongo tow depth was calculated using the amount of wire paid out and the wire angle at the 'targeted' maximum tow depth or measured directly using an electronic depth sensor mounted on the tow cable. A mechanical flowmeter was mounted off-center in the mouth of each bongo net to record the volume of water filtered. Water volume filtered during bongo net tows ranged from ~20 to 600 m^3 but was typically 30 to 40 m^3 at the shallowest stations and 300 to 400 m^3 at the deepest stations.

Catches of larvae in bongo net samples were standardized to account for sampling effort and expressed as the number under 10 m^2 sea surface (CPUA, Catch Per Unit Area) by dividing the number of larvae by volume filtered and then multiplying the resultant by the product of 10 and the maximum depth of tow. This procedure results in a less biased estimate of abundance than number per unit of volume filtered alone and permits direct comparison of abundance estimates across samples taken over a wide range of water column depths (Smith and Richardson 1977).

Sample Processing and Identification of Larvae

Initial processing of most SEAMAP plankton samples has been carried out at the Sea Fisheries Institute, Plankton Sorting and Identification Center (ZSIOP), in Szczecin, Poland, under a Joint Studies Agreement with National Marine Fisheries Service (NMFS). Fish eggs and larvae were removed from bongo net samples. Fish eggs were not identified further, whereas, larvae were identified to the lowest possible taxon, which in most cases was the family level. Body length (BL) in mm was measured and recorded.

Vermilion snapper larvae are planktonic and were first identified and described from field collected specimens by Laroche (1977). Despite this initial description and the additional morphological characteristics described since (Lyczkowski-Shultz and Comyns 1992; Comyns and Lyczkowski-Shultz 1993; Drass et al. 2000; and Lindeman et al. 2005), vermilion snapper larvae cannot be consistently distinguished from the larvae of other snappers at sizes < 3.5 mm in length. Size at settlement is presumably ~20 mm (Lindemann et al. 2005). Nearly all specimens of larvae used in these analyses were re-examined by ichthyoplankton specialists at the SEFSC, Mississippi Laboratories following an established identification protocol to assure the accuracy and consistency of vermilion snapper identifications over the time series.

Standardized SEAMAP Station/Sample Data Set

The SEAMAP Fall Plankton sampling area covers the northern GOM from the 10 m isobath out to the continental shelf edge within the U.S. EEZ, and originally comprised approximately 132 designated sampling sites i.e. 'SEAMAP' stations. Beginning in 1999 and continuing to the present, samples have been taken at 11 additional SEAMAP stations located off the continental shelf in the western GOM during the survey. Most stations are located at 30-nautical mile or 0.5° (~56 km) intervals in a fixed, systematic, 2-dimensional (latitude-longitude) grid of transects across the GOM. Some SEAMAP stations are located at < 56 km intervals especially along the continental shelf edge, while others have been moved to avoid obstructions, navigational hazards or shallow water.

The intended sample design for SEAMAP surveys calls for a single bongo sample to be taken at each site (SEAMAP station) in the systematic grid. However, over the years additional samples have been taken using SEAMAP gear and collection methods at locations other than designated SEAMAP stations. Some locations were also sampled more than once during a survey year. In instances where more than one sample was taken at a SEAMAP station, the sample closest to the central position of the systematic grid location was selected for inclusion in the data set. When SEAMAP stations were sampled by more than one vessel during the survey, priority was given to samples taken by the NMFS (and not the state) vessel.

Spatial coverage of the Fall Plankton Survey from 1986 to 2017 has at times been impacted due to severe weather, vessel breakdowns and/or time constraints (Appendix Figure 1). Sampling for both the western (> 89.25° West Longitude) and eastern (< 89.25° West Longitude) GOM was severely curtailed or cancelled due to tropical storms in 1998, 2005 and 2008 and by mechanical issues in 2015. Spatial coverage in the western GOM has been consistent over the time series with the exception of the three years impacted by tropical storms and mechanical issues. In the eastern GOM, spatial coverage has been considerably more variable. Curtailed sampling during the 1988, 1989, 1992, 2002, 2004 and 2017 surveys resulted in large portions of the eastern GOM remaining un-sampled. Another source of spatial variability in the eastern GOM stems from the typical west to east progression of the survey. Due to this progression, any reduction in survey time often limits sampling effort in the southern (Tampa, FL to Key West, FL) portion of the survey area.

Year to year variability in spatial coverage during the Fall Plankton Survey was addressed by limiting observations to samples taken at SEAMAP stations that were sampled during at least 66% of all years for which there was consistent spatial coverage respective for the entire GOM (Figure 1). Therefore, gulfwide (GOM) indices of abundance include all samples taken during at least 14 of the 22 years with consistent spatial coverage. Larvae less than 3.5 mm and greater than 6.5 mm in length were excluded from index samples due to identification uncertainty of smaller larvae and gear avoidance of larger rarely caught larvae.

Index Construction

Delta-lognormal modeling methods were used to estimate relative abundance indices for vermilion 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 CPUA 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) $$p = \frac{e^{\mathbf{X}\boldsymbol{\beta}+\boldsymbol{\varepsilon}}}{1+e^{\mathbf{X}\boldsymbol{\beta}+\boldsymbol{\varepsilon}}},$$

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

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

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

In addition to the delta-lognormal methods, vermilion snapper indices of relative abundance were also estimated using Poisson and negative binomial models. CPUA for the Poisson and negative binomial models was modeled as count data with effort as an offset.

The factors Year, Time of Day (TOD), Subregion and Depth were examined as possible influences on the proportion of positive occurrence, abundance of nonzero catch and counts of vermilion snapper for all models (Table 1). All models were built using a backward selection procedure based on type 3 analyses with an inclusion level of significance of $\alpha = 0.05$. The Year effect is integral to the calculation of annual estimates and is forced into the standardization procedure regardless of significance when at least one other factor is significant. The binomial submodel performance of the delta-lognormal was evaluated using AIC, while the performance of the lognormal submodel of the delta-lognormal, Poisson and negative binomial models were evaluated based on analyses of residual scatter and QQ plots in addition to AIC. QQ and residual scatterplots for the Poisson and negative binomial models were assessed using randomized quantile residuals (Dunn and Smyth, 1996).

Results and Discussion

Distribution, Abundance and Size at Capture

A total of 2,661 vermilion snapper larvae were captured in 2,488 bongo net samples (index samples only) from 22 SEAMAP Fall Plankton surveys from 1986-2016. Captured larvae ranged from 1.7 to 41.0 mm BL with a mean of 4.3 mm and a median of 4.1 mm. Ninety-five per cent of all larvae collected were less than 6.2 mm. Larvae were taken in 29.5 % of samples with a mean CPUA of 4.1 larvae per 10 m^2 sea surface (Table 2). Station depths where larvae were captured ranged from 9 to 534 m with a mean station depth of 67 m and a median station depth of 49 m. Larvae were captured throughout the survey area with higher abundance in the eastern (east of 89.25º longitude) GOM subregions (Table 2 and Figure 2). Daytime versus nighttime sampling closely reflected the expected ratios of light to dark, with 53.2% of samples taken during the day and 46.8% at night. Gear avoidance in bongo nets was apparent between day and night sampling. The mean abundance of vermilion snapper larvae was 2.1 times greater at night than during the day (Table 3).

Indices of Abundance

The delta-lognormal index of vermilion snapper CPUA utilizes the same methodology and statistical distribution as implemented for SEDAR 45. The backward selection procedure retained the factors Year, TOD and Subregion in the binomial submodel, and Year, TOD, Subregion and Depth in the lognormal submodel (Table 4). Diagnostic plots for the lognormal submodel are shown in Figure 3 and indicate the distribution of the lognormal residuals are positively skewed. Annual estimates of relative CPUA for the delta-lognormal index are shown in Table 5 and Figure 4.

Indices of vermilion snapper CPUA were also modeled utilizing Poisson and negative binomial distributions. Factor selection was identical for the Poisson and negative binomial models with Year, TOD and Subregion retained in the models. Diagnostic plots for the Poisson and negative binomial models are shown in Figure 3. Poisson model residuals indicate a high degree of right skew and a lack of fit to higher CPUA observations. The negative binomial model also indicates some degree of right skew and lack of fit to higher CPUA observations but in general provides a good overall fit. Direct comparison of the delta-lognormal positive CPUA model residuals to only the positive CPUA residuals of the negative binomial model indicate a better fit by the negative binomial model (Figure 5). Therefore, the negative binomial model was selected as the best fitting CPUA model. Annual indices of vermilion snapper larval CPUA from the negative binomial model are shown in Table 6 and Figure 6.

The delta-lognormal ((Table 5) index of vermilion snapper relative abundance presented here utilizes the same sample selection methodology and statistical distribution used to develop the SEDAR 45 indices and are recommended as a continuity index. The negative binomial (Table 6) index of vermilion snapper relative abundance utilizes the same sample selection methodology as the delta-lognormal index, but exhibited a better fit to the data, and is therefore recommended as the primary index for inclusion in the updated assessment model.

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Table 1. Factors considered for inclusion into the binomial and lognormal sub-models of the Delta-lognormal approach. Levels represent the maximum.

Factors	Levels	Description
Year	*22*	*1986-1987,1990-1991, 1993-1997, 1999-2001, 2003, 2006-2007 and 2009-2014 and 2016*
Subregion	*4*	*TX = Texas (>93.80 Degrees W Longitude)* *LA = Louisiana (> 89.17 and <= 93.80 Degrees W Longitude)* *MS/AL = Mississippi and Alabama (> 87.25 and <= 89.25)* *FL = Florida (<= 87.25)*
Time of Day (TOD)	*2*	*D = Day (Sunrise to Sunset)* *N = Night (Sunset to Sunrise)*
Depth		*Water Depth*

Table 2. Nominal catch per unit area (CPUA) and proportion positive of larval vermilion snapper in bongo net samples (index samples only) by GOM subregion.

Region	N	CPUA	SE CPUA	Proportion Positive	SE Proportion Positive
TX	556	1.1380	0.1507	0.1619	0.0156
LA	579	2.1689	0.2283	0.2418	0.0178
MS/AL	195	2.6426	0.4775	0.2872	0.0324
FL	1158	6.6377	0.4571	0.3869	0.0143
GOM	2488	4.0556	0.2302	0.2950	0.0091

Table 3. Nominal catch per unit area (CPUA) and proportion positive of larval vermilion snapper in bongo net samples (index samples only) by time of day.

Time of Day	N	CPUA	SE CPUA	Proportion Positive	SE Proportion Positive
Day	1324	2.6758	0.2136	0.2455	0.0118
Night	1164	5.6250	0.4233	0.3514	0.0140

Table 4. Summary of factor selection for the delta-lognormal (top), Poisson (middle) and negative binomial (bottom) modeled indices of Gulf of Mexico vermilion snapper relative abundance.

	Binomial Submodel Type 3 Tests(AIC=2655.10)						*Lognormal Submodel Type 3 Tests (AIC=1543.65)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	21	2642	20.01	0.95	0.5206	0.5208	21	585	2.22	0.0015
TOD	1	2642	36.27	36.27	<.0001	<.0001	1	585	15.20	0.0001
SUBREGION	3	2642	100.32	33.44	<.0001	<.0001	3	585	10.43	<0.0001
DEPTH				Dropped			1	585	16.44	<0.0001

Poisson Type 3 Tests (AIC=8067.98)				
Effect	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	21	2642	17.36	<.0001
TOD	1	2642	237.21	<.0001
SUBREGION	3	2642	182.64	<.0001
DEPTH			Dropped	

Negative Binomial Type 3 Tests (AIC=4924.57)				
Effect	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	21	2642	1.74	0.0199
TOD	1	2642	58.68	<.0001
SUBREGION	3	2642	53.96	<.0001
DEPTH			Dropped	

Table 5. SEAMAP Fall Plankton Survey index of Gulf of Mexico larval vermilion snapper relative abundance developed using the delta-lognormal (DL) model. The year (SurveyYear), nominal frequency of occurrence (NominalFrequency), number of samples (N), the DL CPUA (LoIndex) expresses as the number under 10 m^2 sea surface, the DL index scaled to a mean of one (ScaledLoIndex) for the time series, the coefficient of variation on the mean (CV), and lower (LCL) and upper (UCL) confidence of the scaled index are listed.

SurveyYear	*NominalFrequency*	*N*	*LoIndex*	*ScaledLoIndex*	*CV*	*LCL*	*UCL*
1986	0.12037	108	1.09259	0.48011	0.35127	0.24270	0.94977
1987	0.27119	118	3.05946	1.34442	0.22051	0.86951	2.07871
1988							
1989							
1990	0.28571	70	1.85911	0.81695	0.27454	0.47649	1.40067
1991	0.32432	74	3.57834	1.57243	0.24967	0.96157	2.57134
1992							
1993	0.22857	105	1.31057	0.57590	0.25166	0.35084	0.94534
1994	0.25410	122	2.14509	0.94262	0.22371	0.60589	1.46649
1995	0.21008	119	1.57030	0.69003	0.25173	0.42031	1.13286
1996	0.23932	117	1.96213	0.86222	0.23519	0.54210	1.37136
1997	0.29661	118	2.22811	0.97910	0.20798	0.64877	1.47762
1998							
1999	0.18803	117	1.42934	0.62809	0.26791	0.37097	1.06343
2000	0.21930	114	1.76549	0.77581	0.24983	0.47428	1.26904
2001	0.24107	112	1.83299	0.80547	0.24051	0.50127	1.29427
2002							
2003	0.27500	120	3.07241	1.35011	0.21580	0.88116	2.06863
2004							
2005							
2006	0.25225	111	2.86866	1.26058	0.23268	0.79639	1.99532
2007	0.23577	123	3.62938	1.59486	0.23139	1.01008	2.51818
2008							
2009	0.23770	122	2.73976	1.20393	0.23182	0.76186	1.90251
2010	0.25833	120	2.55670	1.12349	0.22315	0.72292	1.74600
2011	0.26446	121	2.35525	1.03497	0.21903	0.67127	1.59571
2012	0.27350	117	2.71120	1.19138	0.21922	0.77245	1.83751
2013	0.23140	121	1.94041	0.85268	0.23741	0.53382	1.36199
2014	0.25000	116	2.15608	0.94745	0.23079	0.60074	1.49426
2015							
2016	0.28455	123	2.20152	0.96741	0.20857	0.64029	1.46167

Table 6. SEAMAP Fall Plankton Survey index of Gulf of Mexico larval vermilion snapper relative abundance developed using the negative binomial (NB) model. The year (SurveyYear), nominal frequency of occurrence (NominalFrequency), number of samples (N), the NB CPUA (LoIndex) expresses as the number under 10 m^2 sea surface, the NB index scaled to a mean of one (ScaledLoIndex) for the time series, the coefficient of variation on the mean (CV), and lower (LCL) and upper (UCL) confidence of the scaled index are listed.

SurveyYear	*NominalFrequency*	*N*	*Index*	*ScaledIndex*	*CV*	*LCL*	*UCL*
1986	0.14815	108	1.44673	0.60621	0.25263	0.36938	0.99487
1987	0.33051	118	3.24246	1.35865	0.22259	0.87811	2.10217
1988							
1989							
1990	0.28571	70	1.27580	0.53459	0.31101	0.29051	0.98374
1991	0.35135	74	3.23838	1.35694	0.26523	0.80665	2.28265
1992							
1993	0.27619	105	1.41093	0.59121	0.25402	0.35926	0.97290
1994	0.31967	122	2.32389	0.97376	0.22437	0.62715	1.51191
1995	0.28571	119	1.91394	0.80198	0.23523	0.50564	1.27200
1996	0.29915	117	1.55510	0.65162	0.24463	0.40333	1.05275
1997	0.33051	118	2.77406	1.16239	0.22222	0.75180	1.79720
1998							
1999	0.23077	117	1.34097	0.56189	0.24183	0.34971	0.90282
2000	0.29825	114	2.17759	0.91245	0.24125	0.56854	1.46441
2001	0.26786	112	2.16022	0.90517	0.23177	0.57459	1.42597
2002							
2003	0.35000	120	3.64502	1.52734	0.21357	1.00474	2.32175
2004							
2005							
2006	0.31532	111	3.53634	1.48180	0.22550	0.95224	2.30584
2007	0.30081	123	3.93886	1.65046	0.21191	1.08927	2.50077
2008							
2009	0.26230	122	2.65427	1.11219	0.22267	0.71870	1.72111
2010	0.29167	120	2.10878	0.88362	0.23315	0.55939	1.39579
2011	0.30579	121	2.27968	0.95523	0.23078	0.60753	1.50192
2012	0.29060	117	2.17175	0.91000	0.22998	0.57968	1.42857
2013	0.26446	121	2.14897	0.90046	0.23140	0.57200	1.41752
2014	0.35345	116	3.12176	1.30808	0.22589	0.83996	2.03708
2015							
2016	0.33333	123	2.03802	0.85397	0.23107	0.54283	1.34347

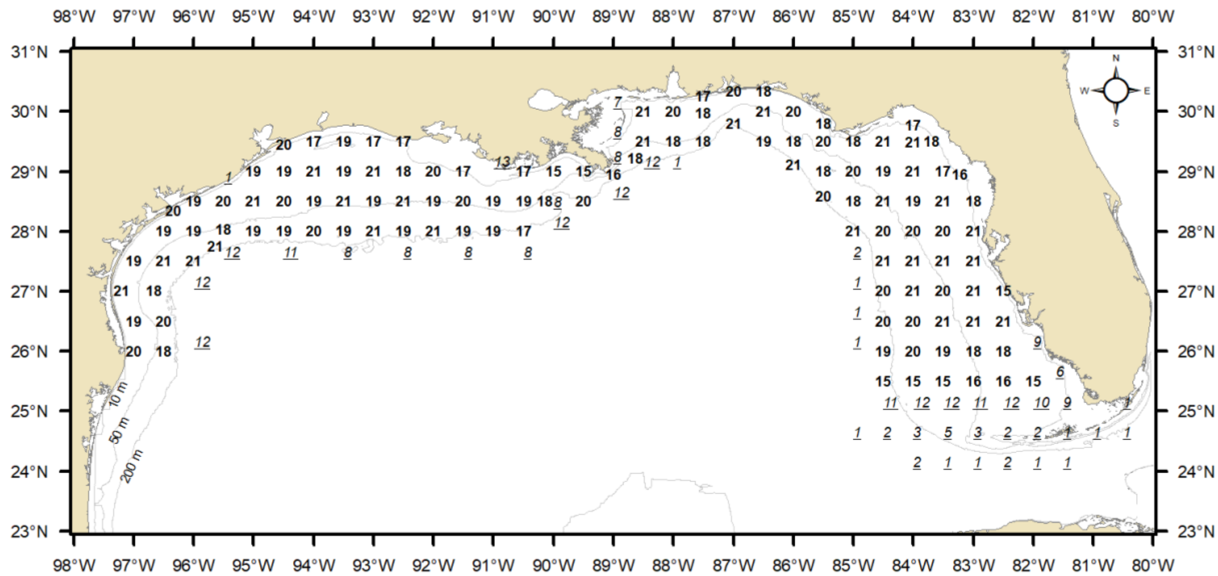


Figure 1. Number of primary bongo net samples taken at each SEAMAP systematic grid location from the annual SEAMAP Fall Plankton Surveys. Only locations with primary samples equal to or exceeding 14 were included in indices. Bold numbers represent locations of primary samples included in the index and those underlined and in italics represent locations of primary samples excluded from the index.

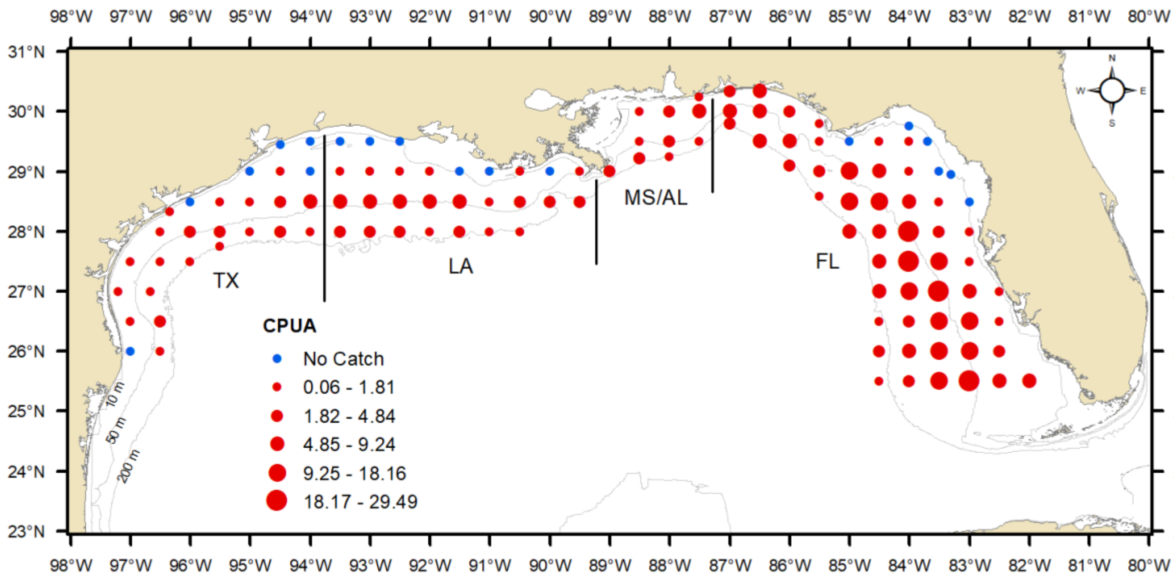


Figure 2. Mean number of vermilion snapper larvae under 10 m^2 sea surface (CPUA) captured during SEAMAP Fall Plankon Surveys from 1986 to 2016 in bongo net index samples. Solid lines delineate the Texas (TX), Louisianna (LA), Mississippi/Alabama (MS/AL) and Florida (FL) subregions.

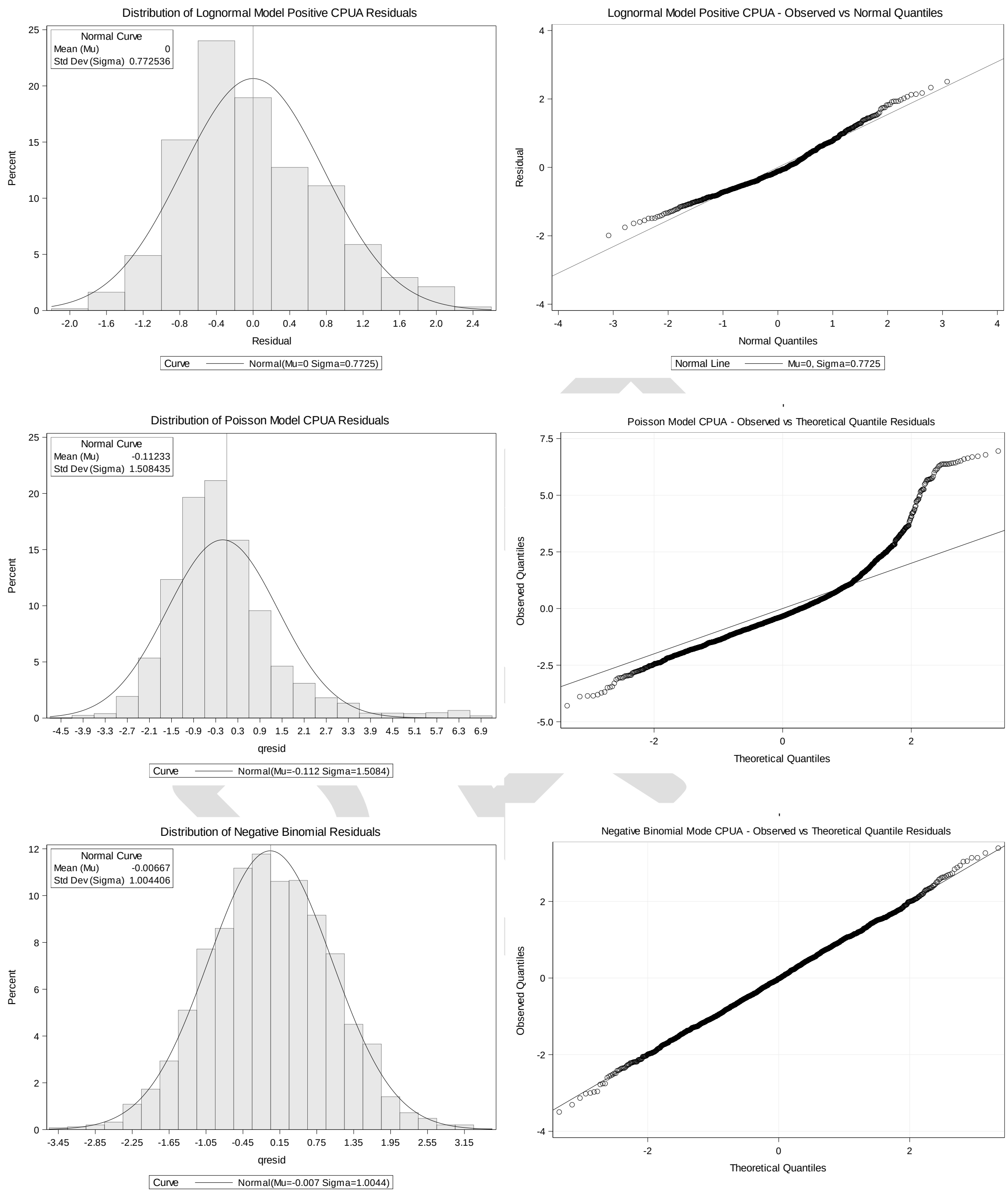


Figure 3. Distributions (left) and QQ plots (right) of residuals from the current delta-lognormal (top) positive catch submodel, Poisson (middle) and negative binomial (bottom) models of larval vermilion snapper CPUA from SEAMAP Fall Plankton Surveys in the Gulf of Mexico.

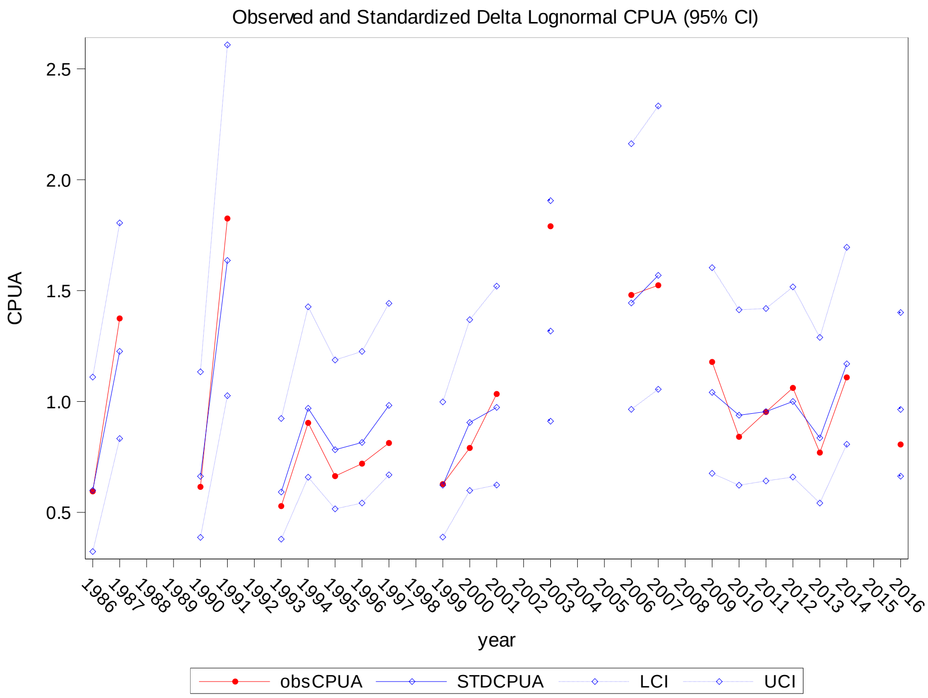


Figure 4. Annual index of Gulf of Mexico larval vermilion snapper abundance from SEAMAP Fall Plankton Surveys from 1986 – 2016.

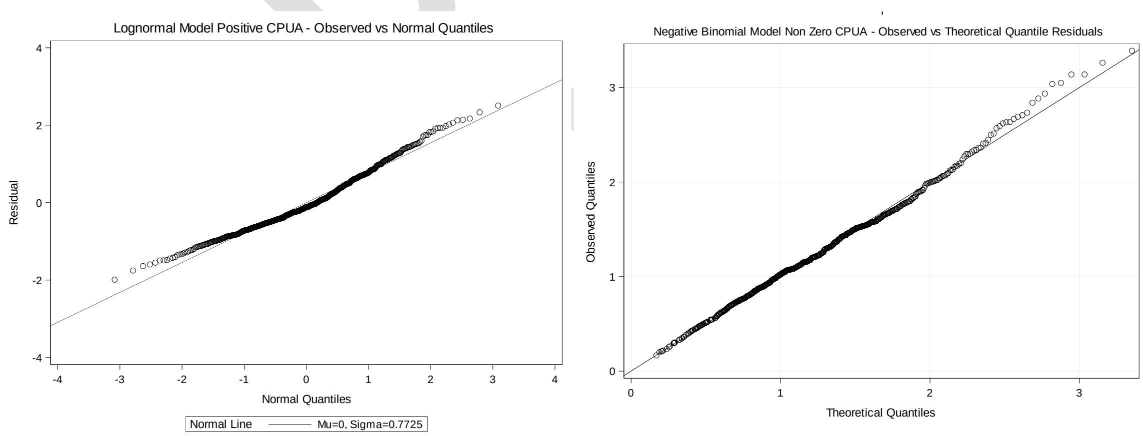


Figure 5. Comparison of QQ plots of the delta-lognormal positive CPUA submodel and negative binomial model subset to only show residuals with positive CPUE.

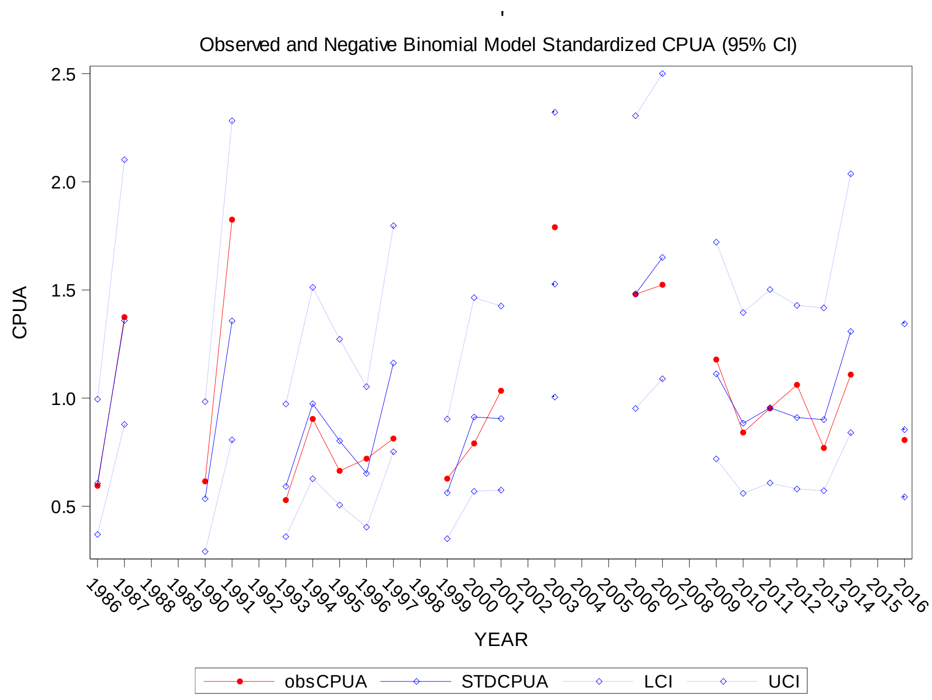
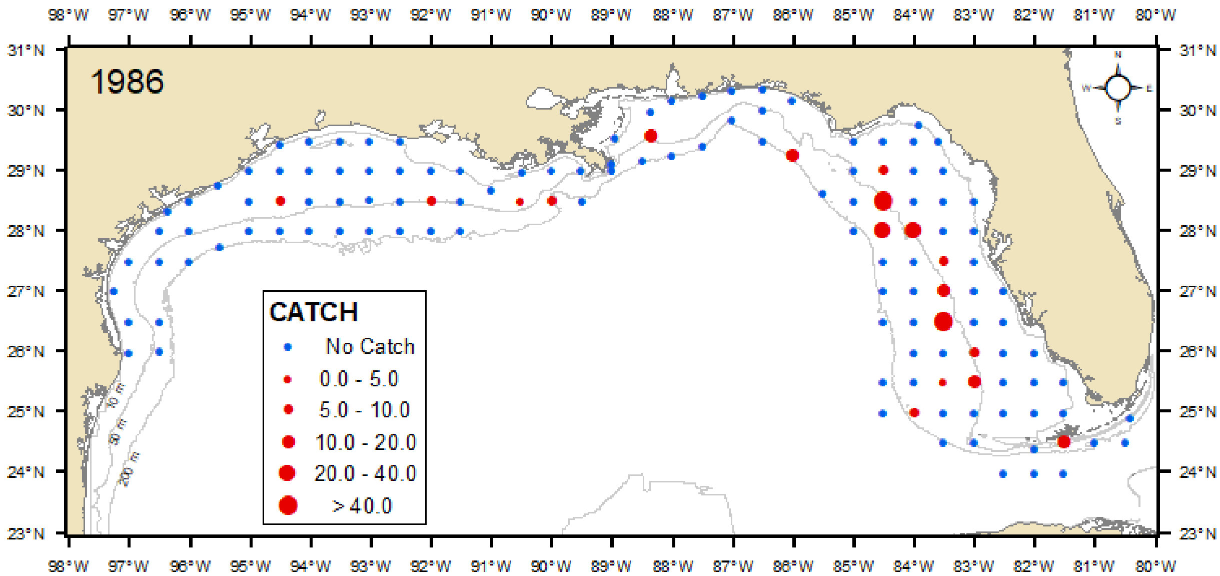
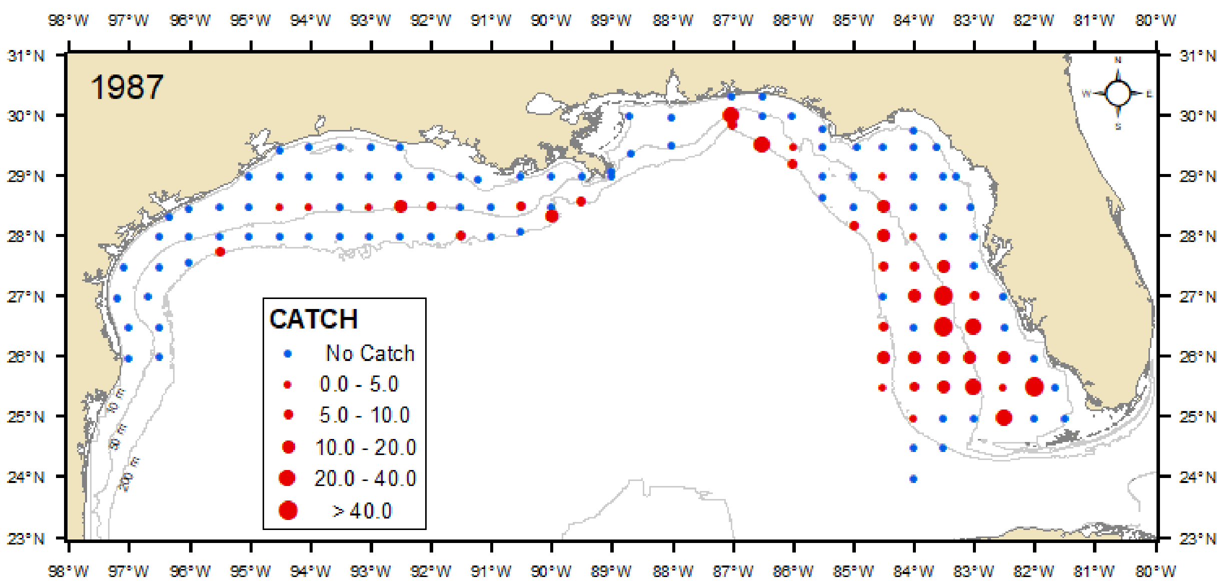
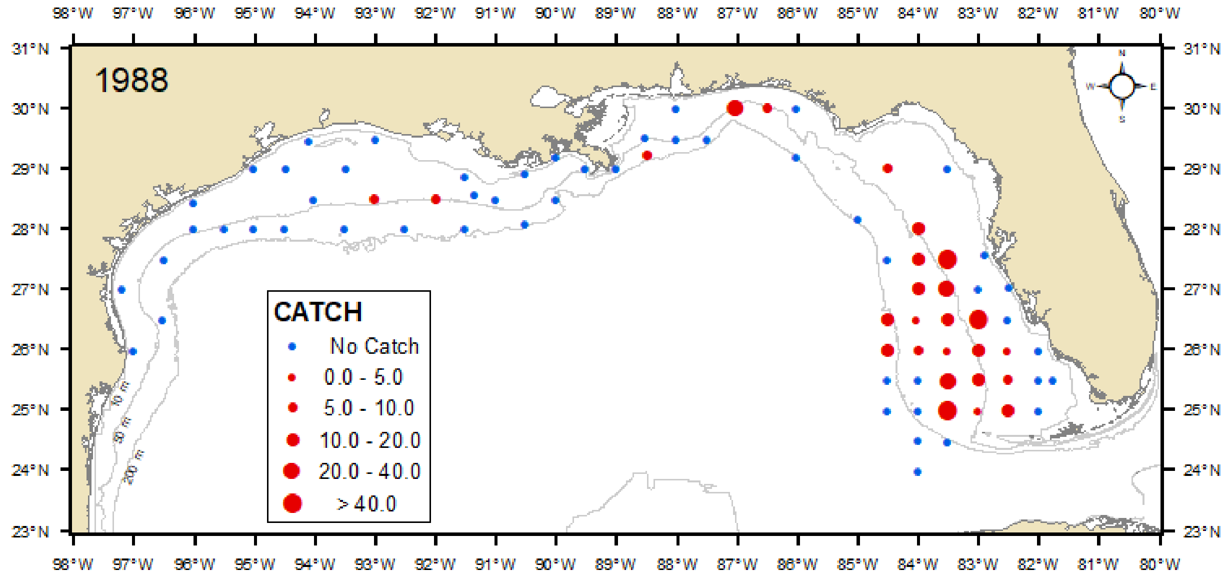


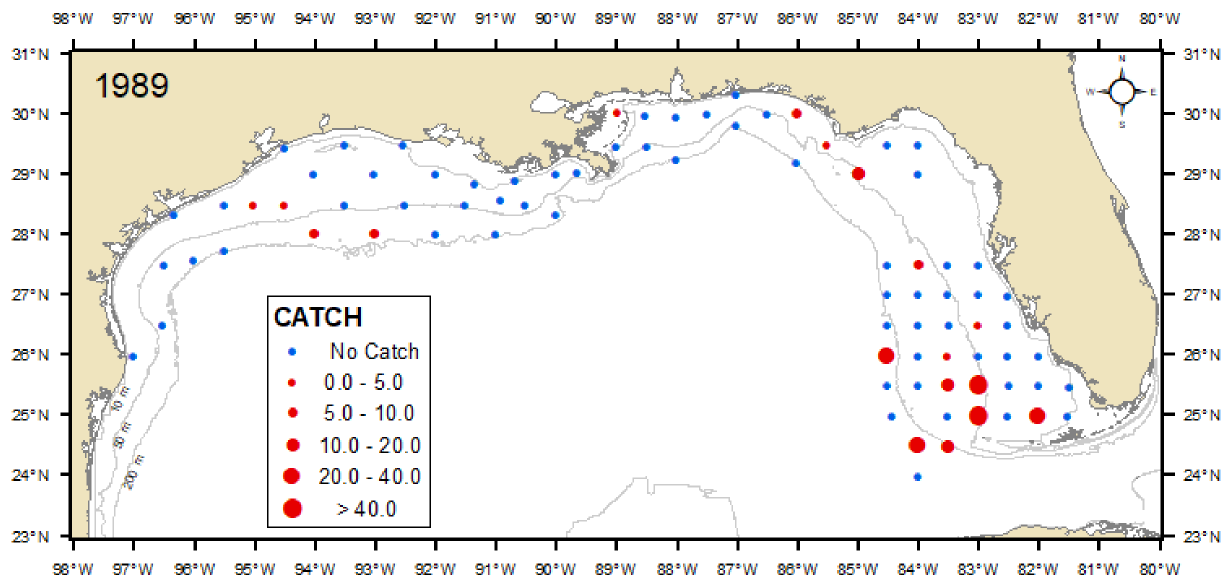
Figure 6. Annual index of Gulf of Mexico larval vermilion snapper abundance from SEAMAP Fall Plankton Surveys from 1986 – 2016.

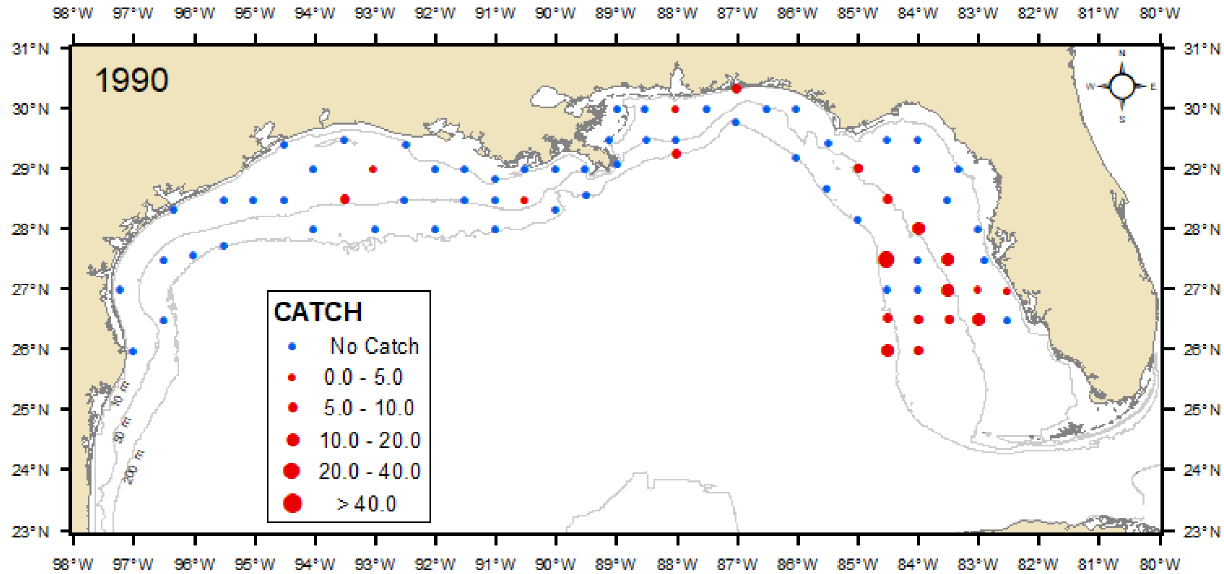
Appendix Figure 1. Annual survey effort and catch per unit area (CPUA) of vermilion snapper from the SEAMAP Fall Plankton Survey conducted from 1986-2017. CPUA is expressed as the number of larvae under 10 m^2. Snapper identifications have not been completed for 2015, therefore the “No Catch” represents station locations.

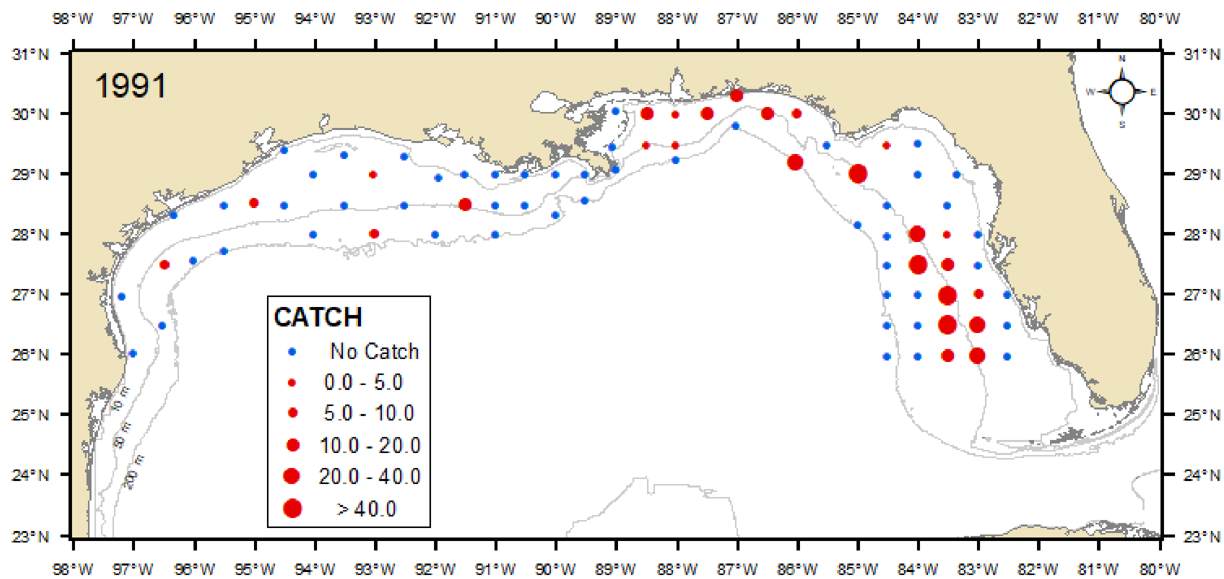


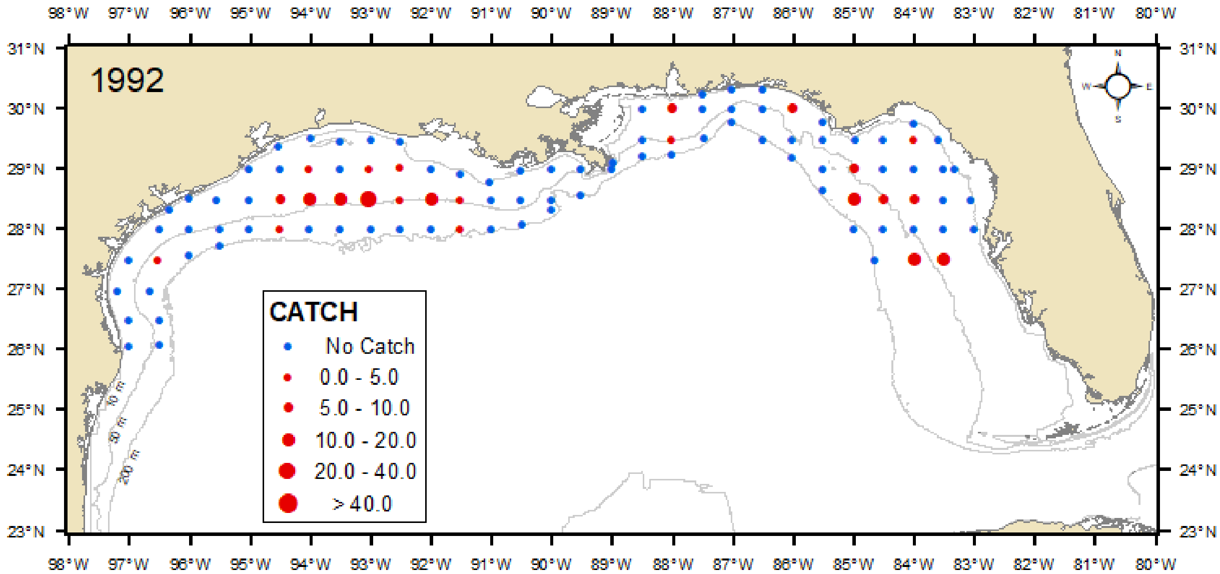


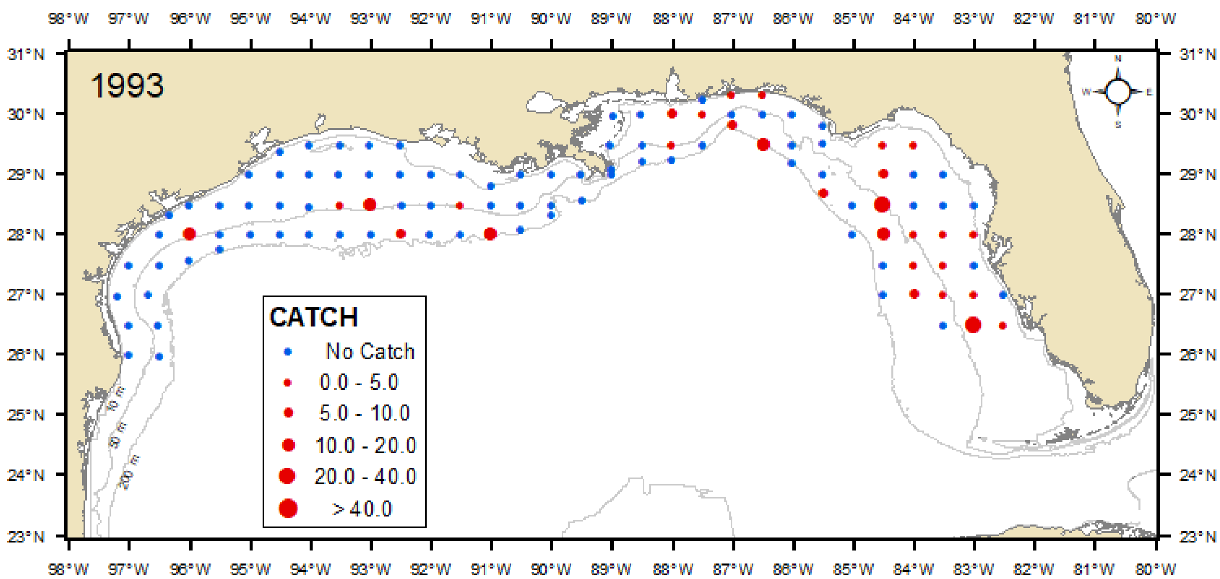

1988
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0

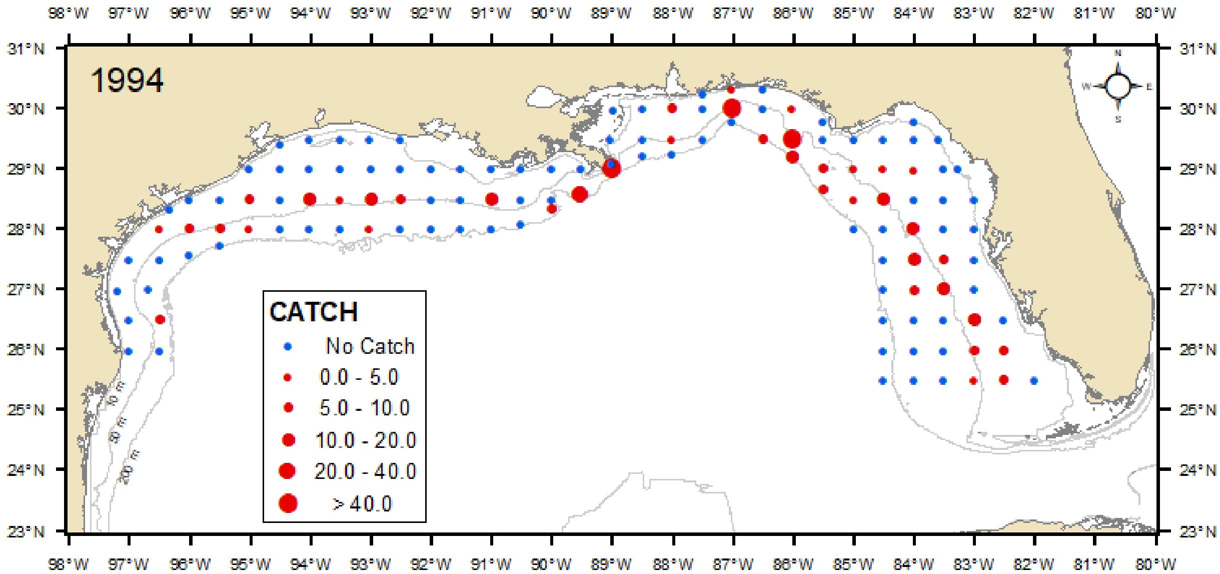

1989
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0

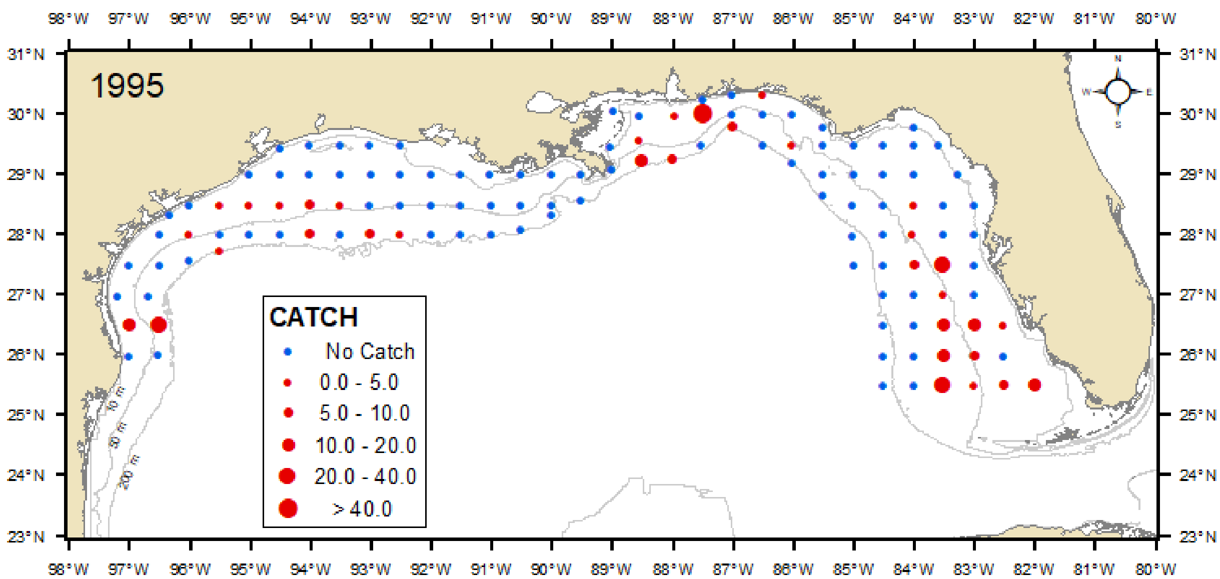

1990
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0
98°W 97°W 96°W 95°W 94°W 93°W 92°W 91°W 90°W 89°W 88°W 87°W 86°W 85°W 84°W 83°W 82°W 81°W 80°W
31°N 30°N 29°N 28°N 27°N 26°N 25°N 24°N 23°N


1991
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0
98°W 97°W 96°W 95°W 94°W 93°W 92°W 91°W 90°W 89°W 88°W 87°W 86°W 85°W 84°W 83°W 82°W 81°W 80°W
31°N 30°N 29°N 28°N 27°N 26°N 25°N 24°N 23°N


1992
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0


1993
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0


1994
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0
98°W 97°W 96°W 95°W 94°W 93°W 92°W 91°W 90°W 89°W 88°W 87°W 86°W 85°W 84°W 83°W 82°W 81°W 80°W
31°N 30°N 29°N 28°N 27°N 26°N 25°N 24°N 23°N


1995
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0
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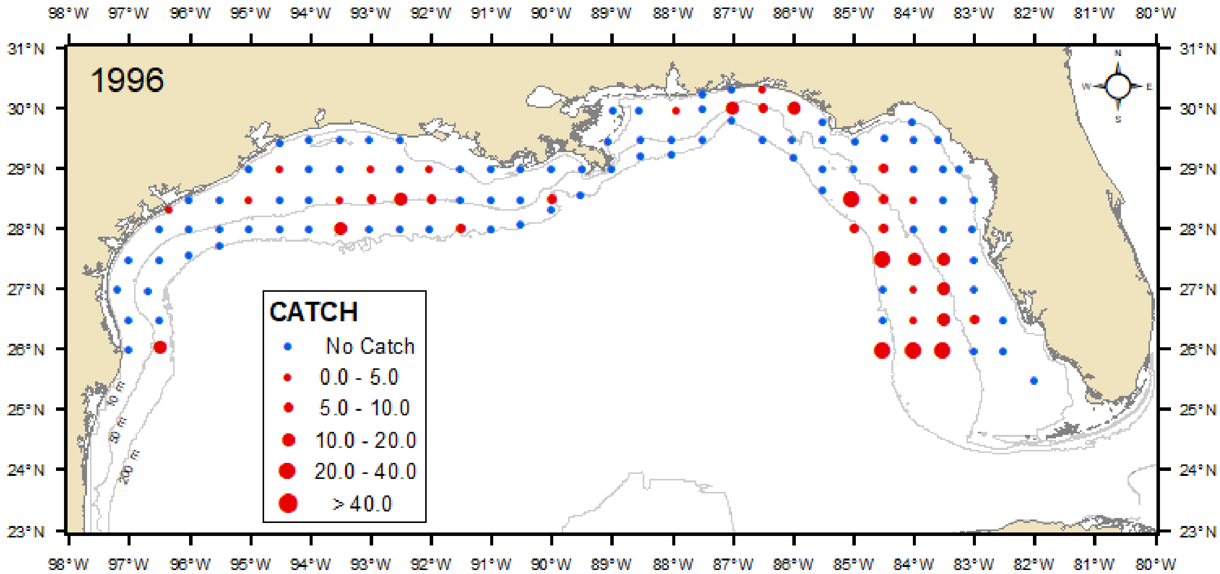
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CATCH
No Catch
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20.0 - 40.0
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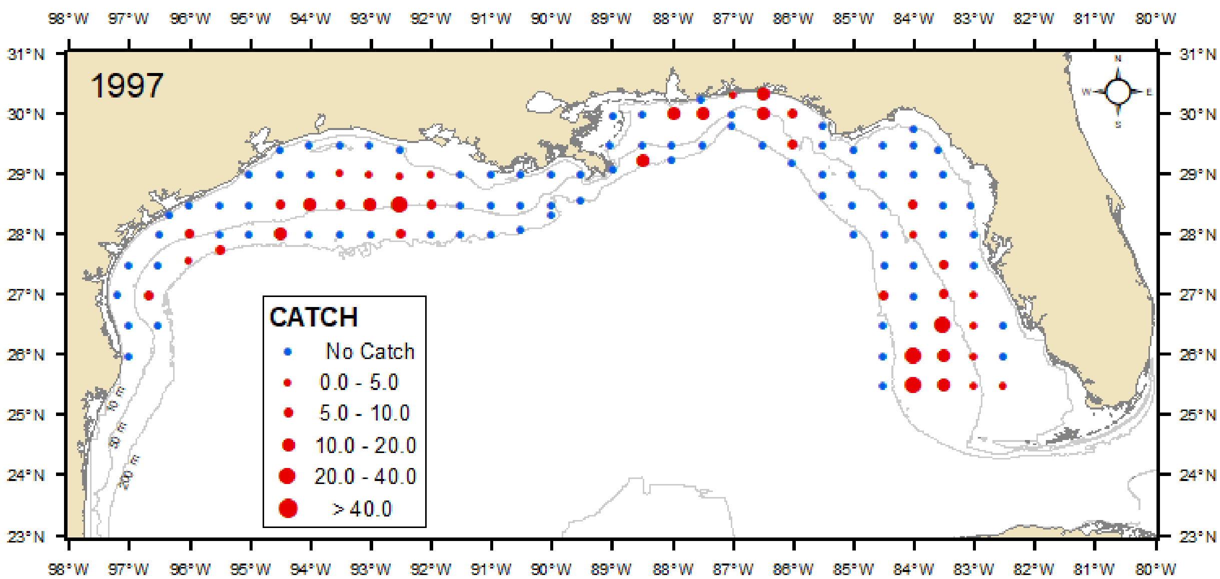
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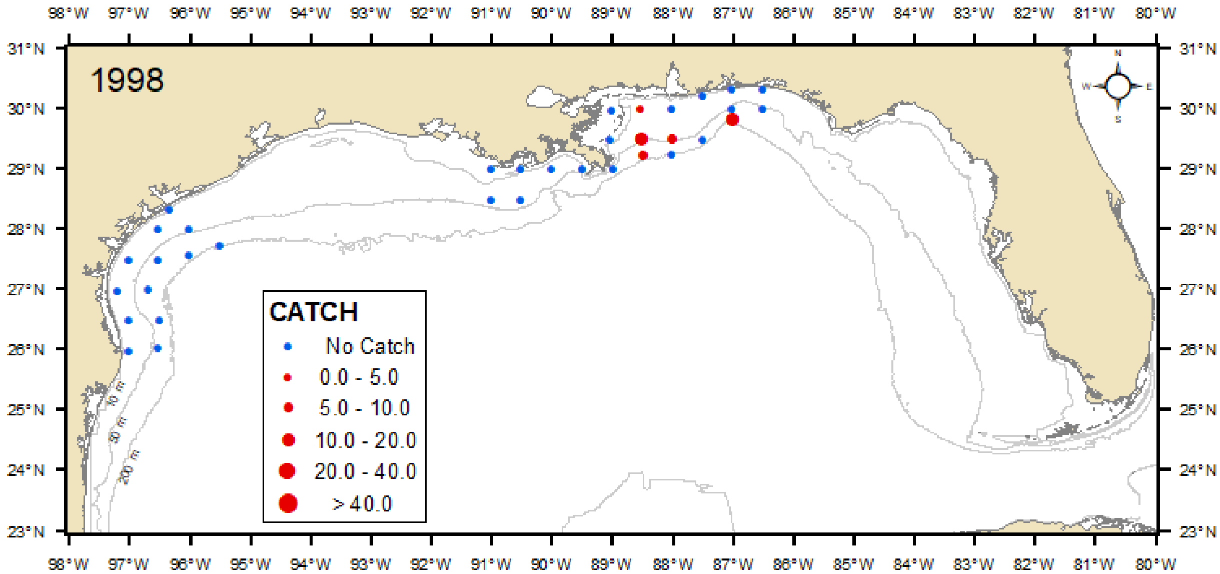
20.0 - 40.0
> 40.0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CATCH
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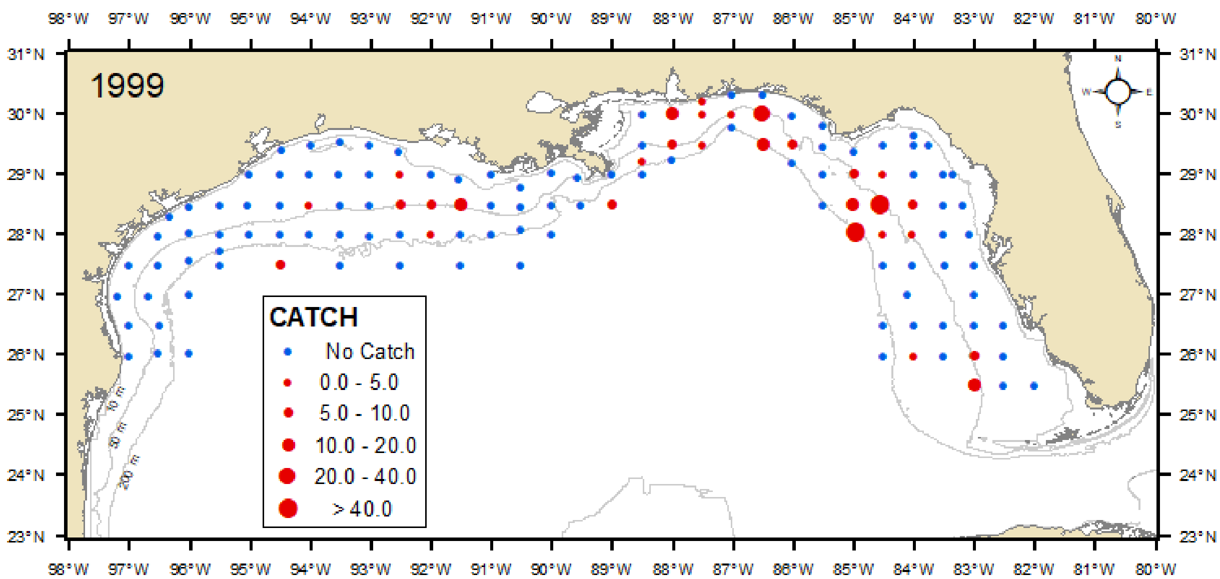
10.0 - 20.0
20.0 - 40.0
> 40.0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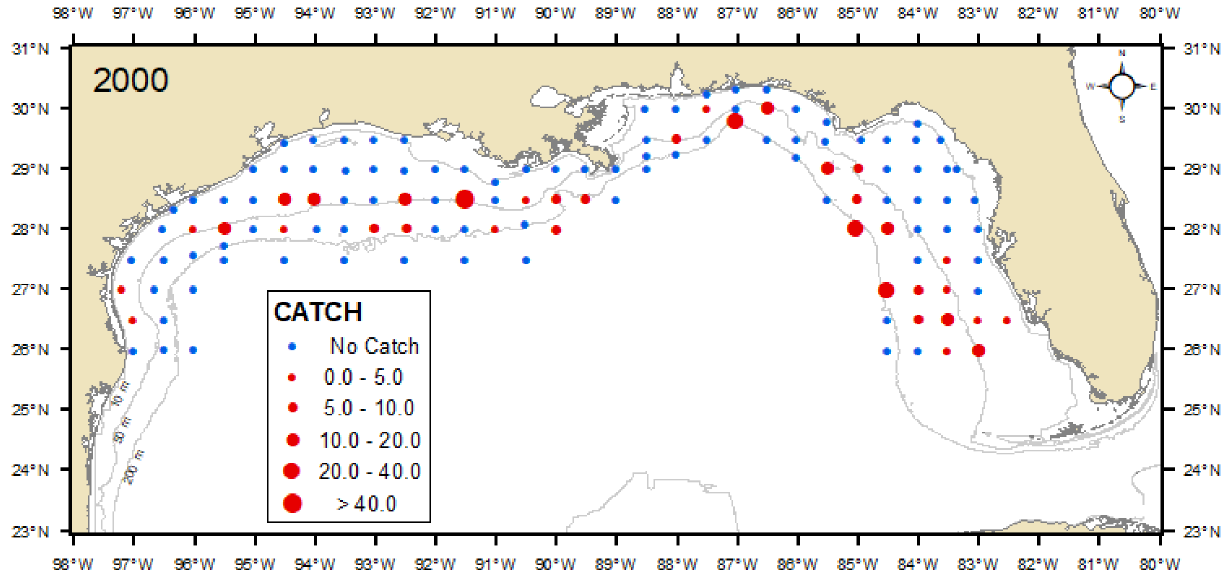
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0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10.0 - 20.0
20.0 - 40.0
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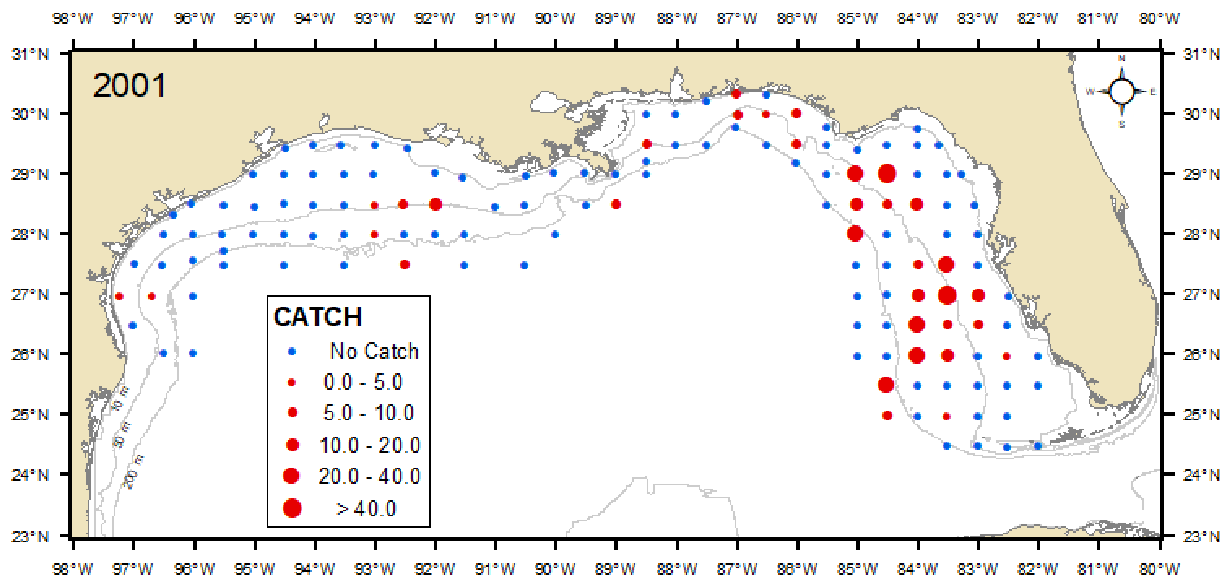
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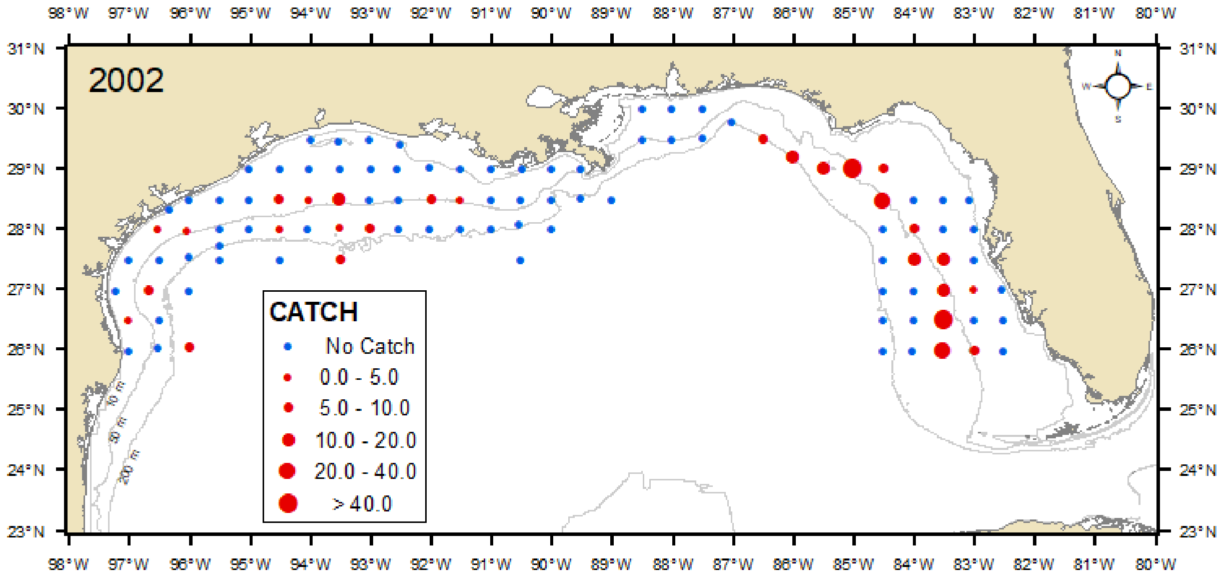
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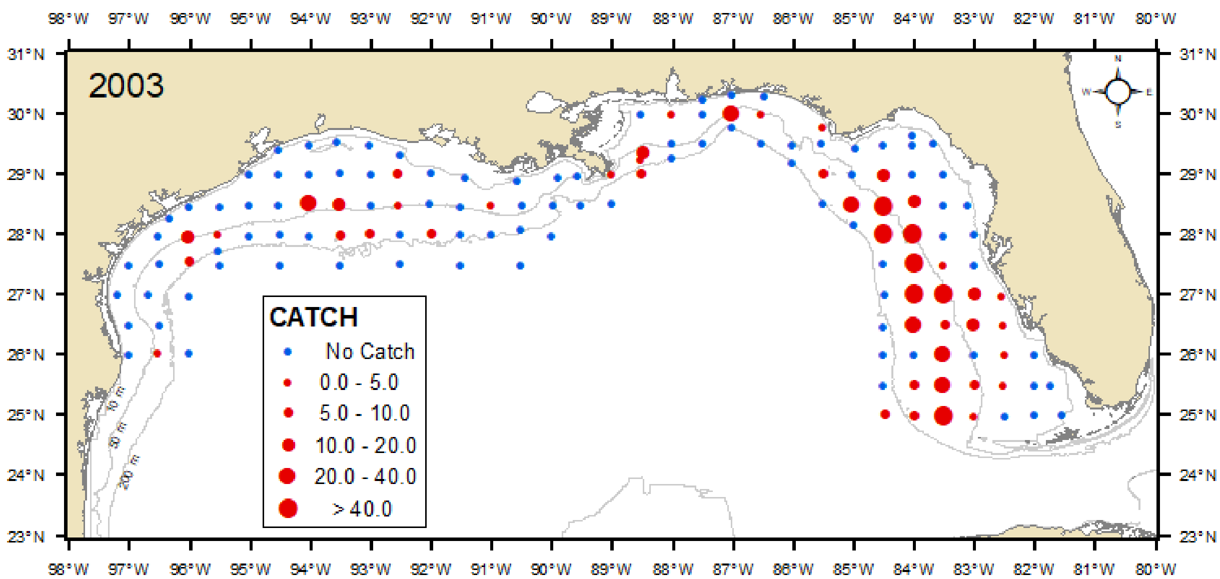
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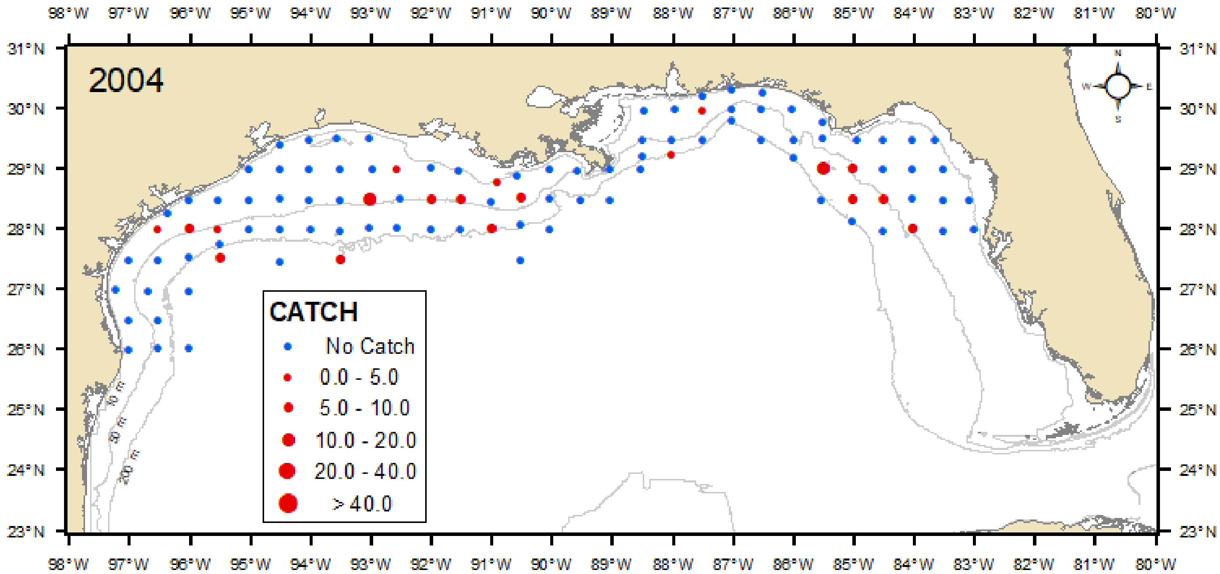
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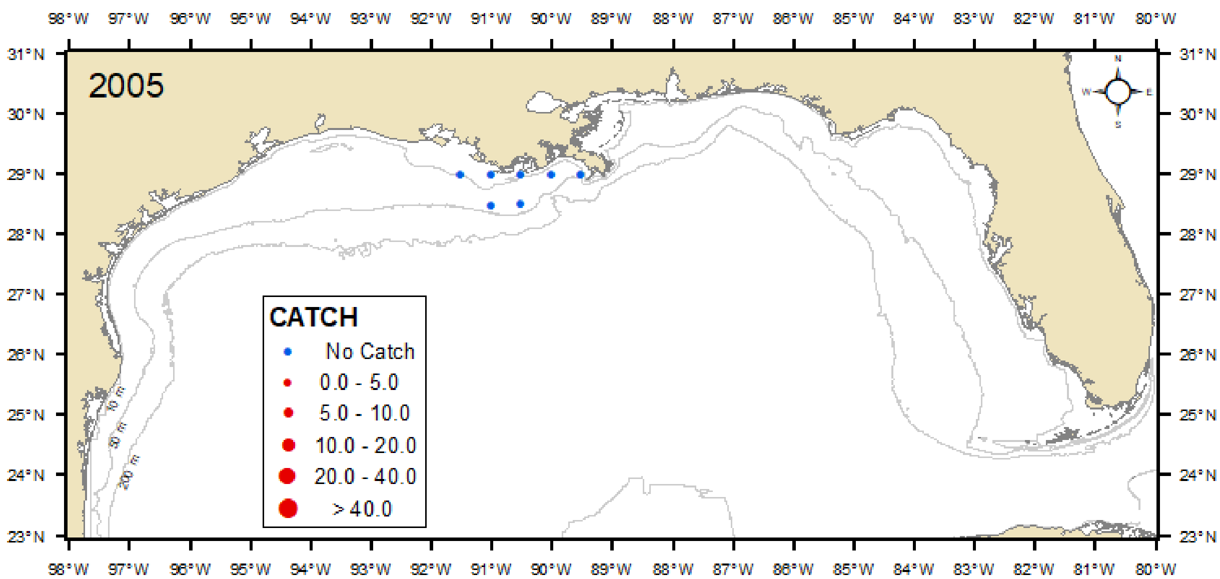
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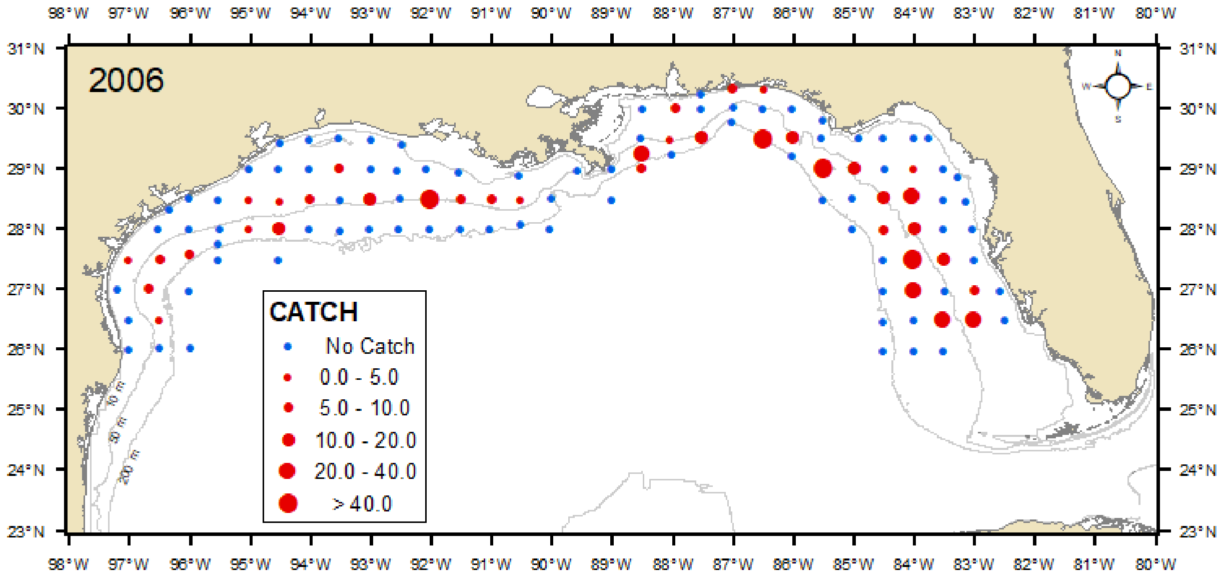
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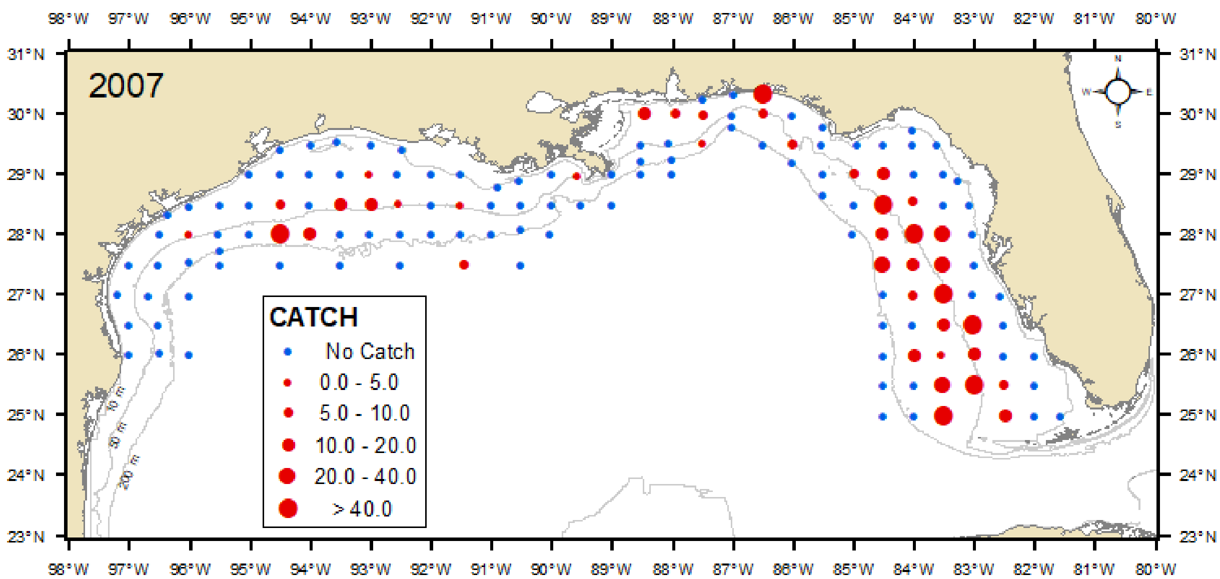
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CATCH
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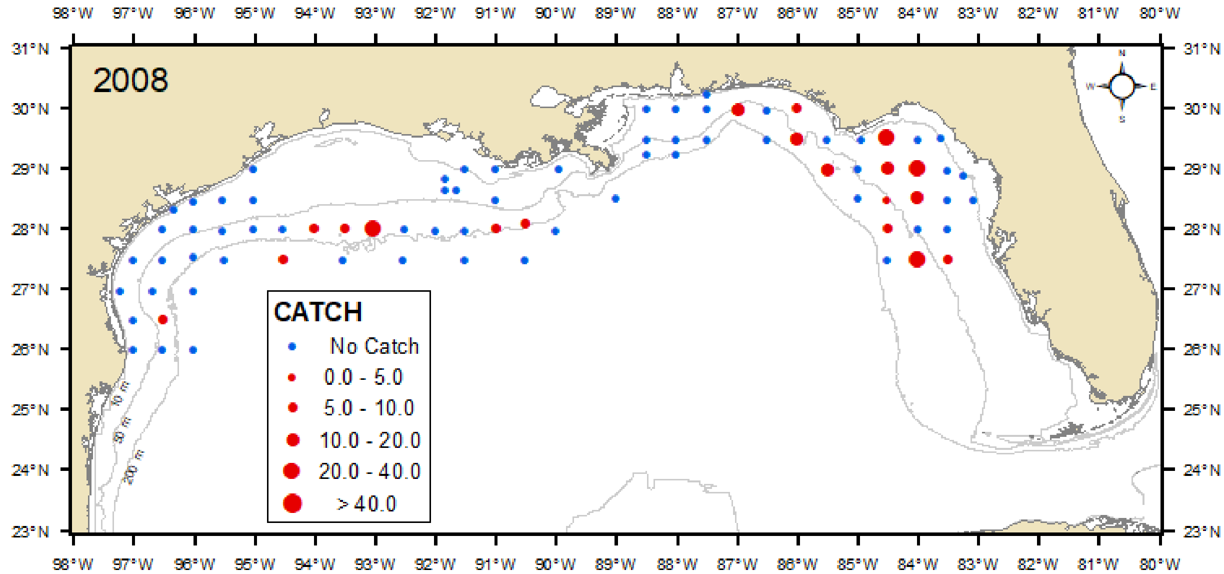
20.0 - 40.0
> 40.0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CATCH
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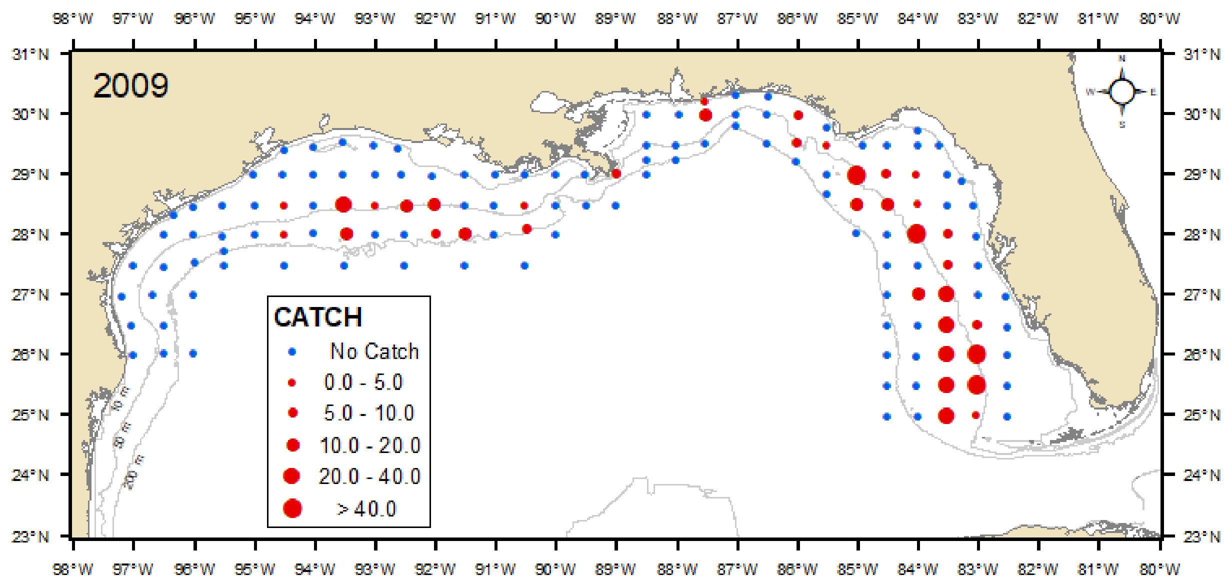
10.0 - 20.0
20.0 - 40.0
> 40.0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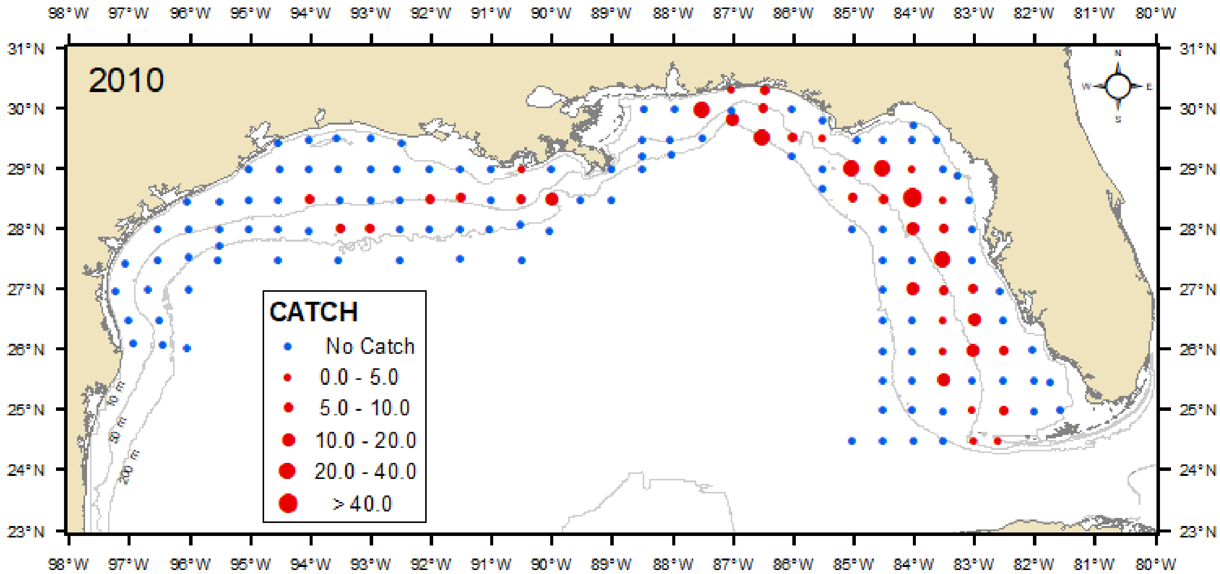
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0


2010
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0
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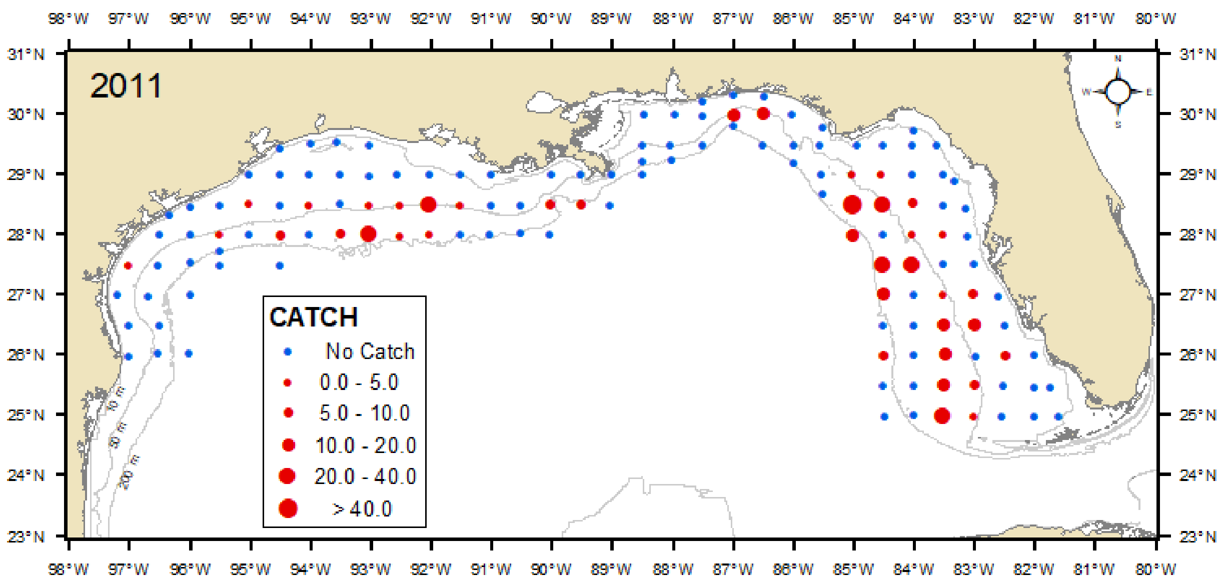
31°N 30°N 29°N 28°N 27°N 26°N 25°N 24°N 23°N


2011
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0
98°W 97°W 96°W 95°W 94°W 93°W 92°W 91°W 90°W 89°W 88°W 87°W 86°W 85°W 84°W 83°W 82°W 81°W 80°W
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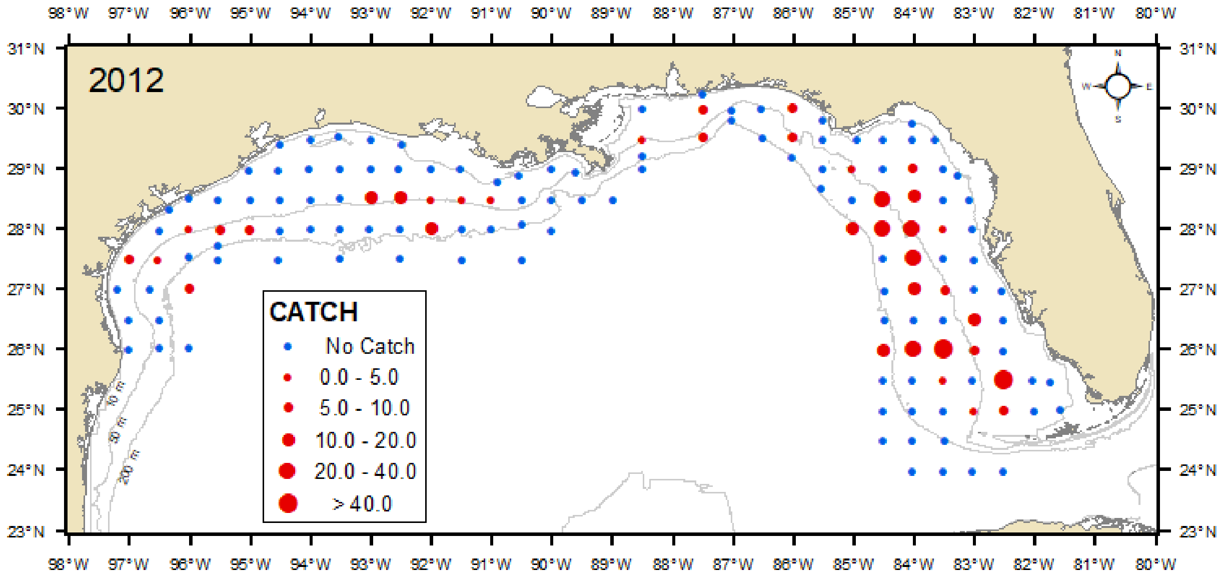
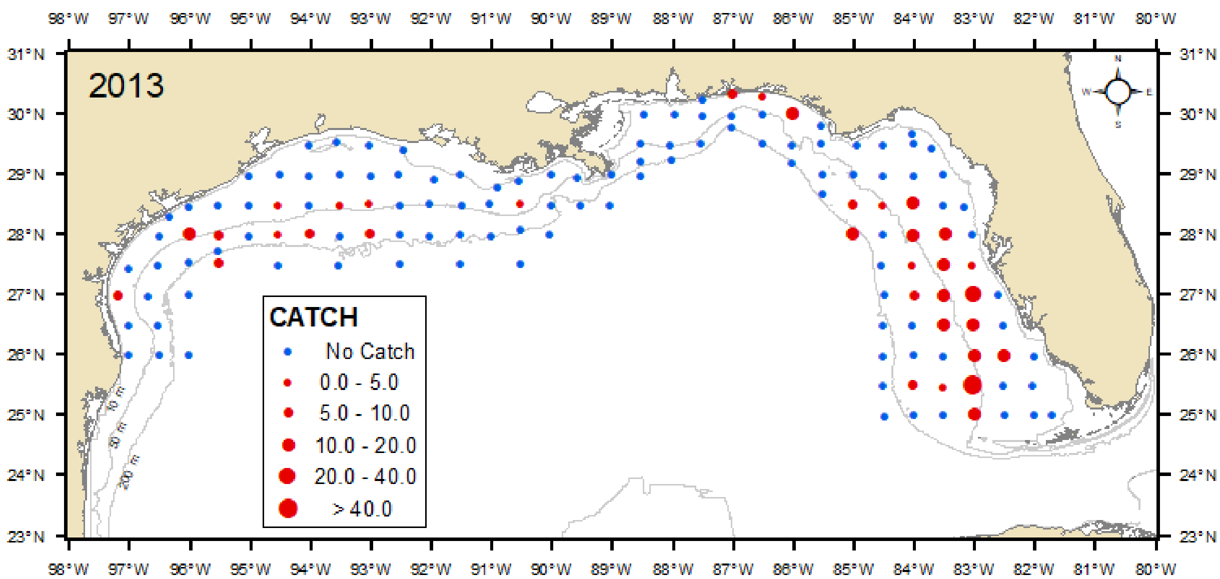
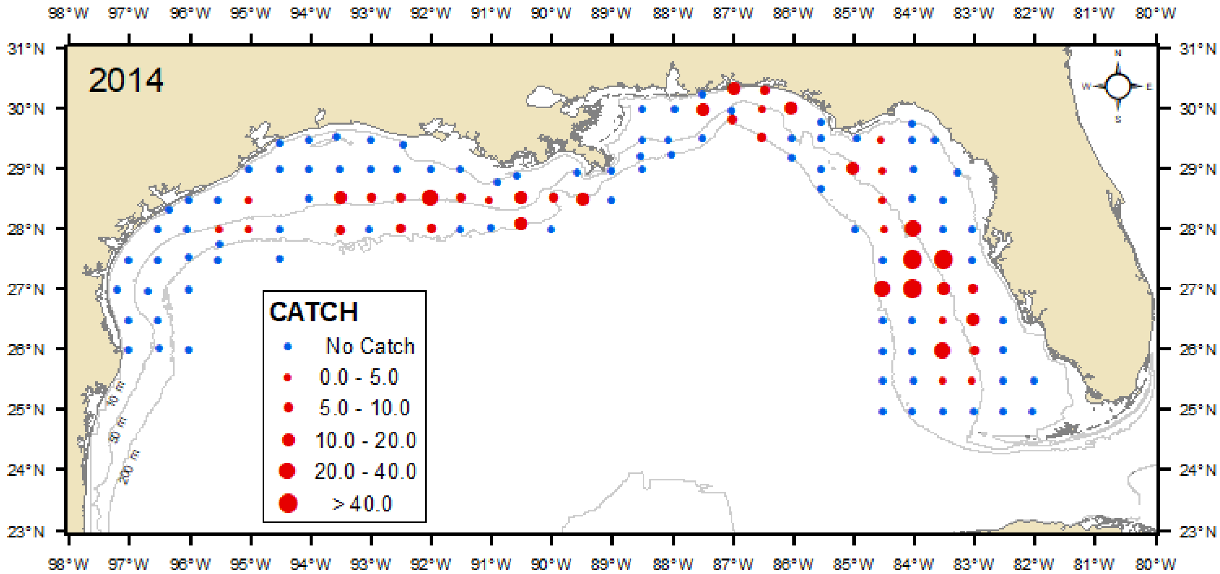
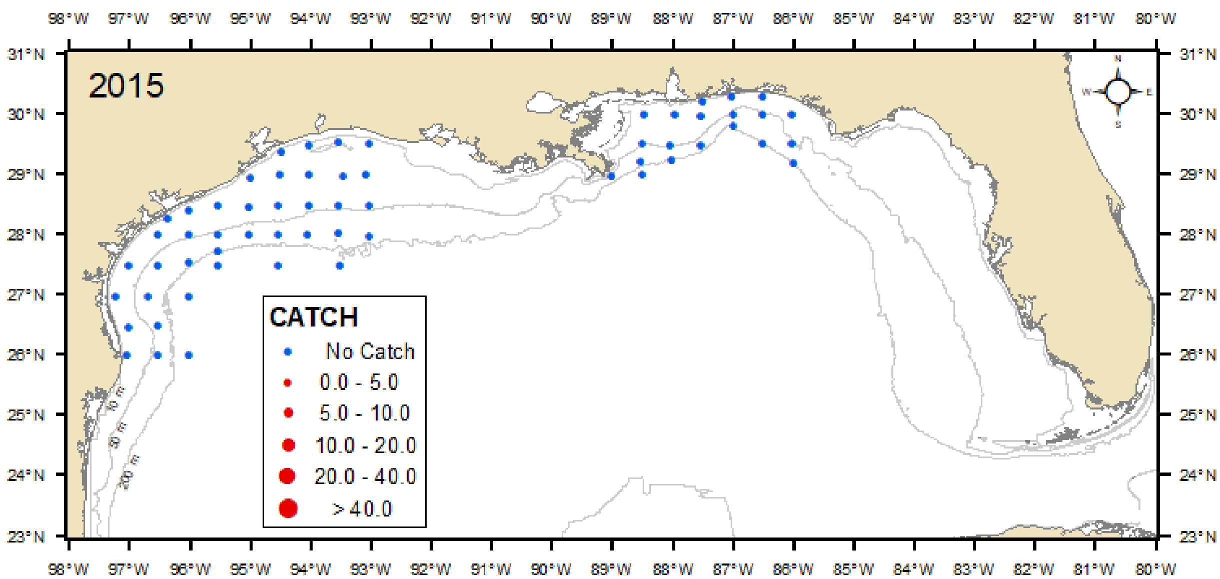

2012
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0
98°W 97°W 96°W 95°W 94°W 93°W 92°W 91°W 90°W 89°W 88°W 87°W 86°W 85°W 84°W 83°W 82°W 81°W 80°W
31°N 30°N 29°N 28°N 27°N 26°N 25°N 24°N 23°N


2013
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0
98°W 97°W 96°W 95°W 94°W 93°W 92°W 91°W 90°W 89°W 88°W 87°W 86°W 85°W 84°W 83°W 82°W 81°W 80°W
31°N 30°N 29°N 28°N 27°N 26°N 25°N 24°N 23°N


2014
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0
98°W 97°W 96°W 95°W 94°W 93°W 92°W 91°W 90°W 89°W 88°W 87°W 86°W 85°W 84°W 83°W 82°W 81°W 80°W
31°N 30°N 29°N 28°N 27°N 26°N 25°N 24°N 23°N


2015
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0
98°W 97°W 96°W 95°W 94°W 93°W 92°W 91°W 90°W 89°W 88°W 87°W 86°W 85°W 84°W 83°W 82°W 81°W 80°W
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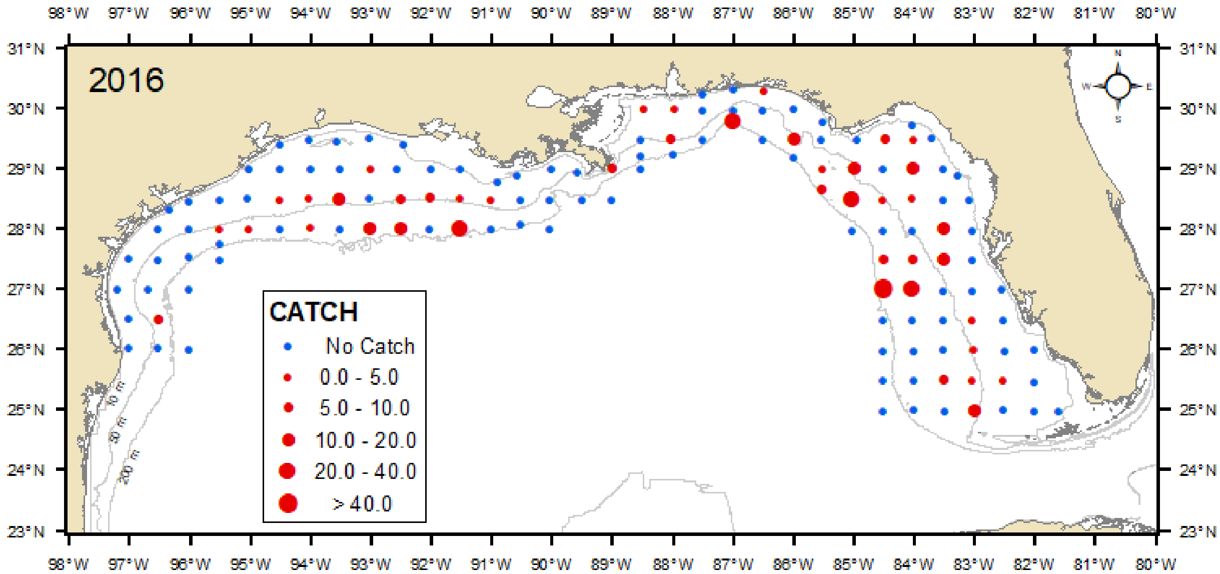
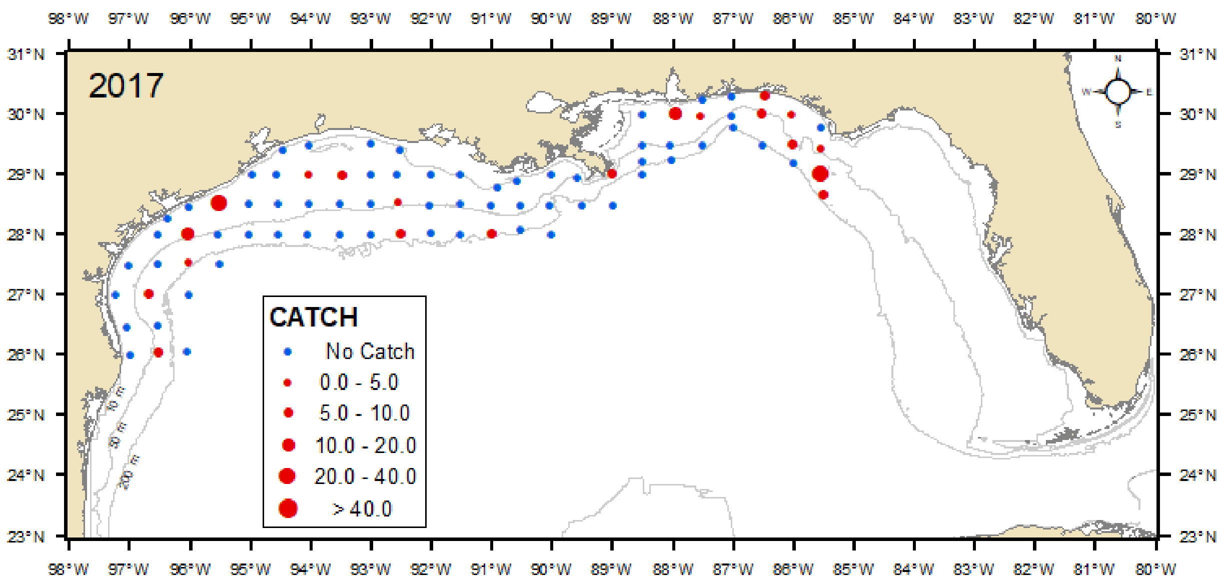

2016
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0
98°W 97°W 96°W 95°W 94°W 93°W 92°W 91°W 90°W 89°W 88°W 87°W 86°W 85°W 84°W 83°W 82°W 81°W 80°W
31°N 30°N 29°N 28°N 27°N 26°N 25°N 24°N 23°N


2017
CATCH
No Catch
0.0 - 5.0
5.0 - 10.0
10.0 - 20.0
20.0 - 40.0
> 40.0
98°W 97°W 96°W 95°W 94°W 93°W 92°W 91°W 90°W 89°W 88°W 87°W 86°W 85°W 84°W 83°W 82°W 81°W 80°W
31°N 30°N 29°N 28°N 27°N 26°N 25°N 24°N 23°N