Abundance Indices of Subadult Yellowedge Grouper, *Epinephelus flavolimbatus*, Collected in Summer and Fall Groundfish Surveys in the northern Gulf of Mexico

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Introduction and Methodologies

Yellowedge grouper, *Epinephelus flavolimbatus*, are an important species of grouper to the recreational and commercial fisheries in the northern Gulf of Mexico (FAO 2002). Although adult yellowedge grouper are a deepwater species commonly found between 64 to 275 m (McEachran and Fechhelm 2005), subadults are represented in NOAA Fisheries SEAMAP groundfish surveys which sample depths from 9 to 110 m. The purpose of this document is to provide annual abundance indices of subadult yellowedge grouper to the SEDAR 22 Data Workshop for possible use in stock assessment. Data were collected during Summer and Fall SEAMAP Groundfish Surveys (hereafter referred to as groundfish surveys) conducted by NOAA Fisheries in the U.S. Gulf of Mexico from 1972-2008.

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

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

(1) $I_y = c_y p_y,$

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

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

and

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

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

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

where:

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

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

The survey methodologies and descriptions of the datasets used herein have been previously presented in detail by Nichols (2004, SEDAR7-DW1). The basic structure of the groundfish surveys (i.e. 1987- summer of 2008; see SEDAR7-DW1) follows a stratified random station location assignment with strata derived from depth zones (5-6, 6-7, 7-8, 8-9, 9-10, 10-11, 11-12, 12-13, 13-14, 14-15, 15-16, 16-17, 17-18, 18-19, 19-20, 20-22, 22-25, 25-30, 30-35, 35-40, 40-45, 45-50 and 50-60 fathoms), shrimp statistical zones (between 88° and 97° W longitude, statistical zones from west to east: 21-20, 19-18, 17-16, 15-13 and 12-10), and time of day (i.e. day or night).

In the fall of 2008 there was a change in the groundfish survey design. The major changes included a standardized tow time of 30 minutes which no longer had to cover an entire depth zone. The time of day stratification was also dropped and stations could be sampled whenever the survey vessel arrived. The depth zone strata were dropped in favor of a randomized design within each shrimp statistical zone In order to incorporate the early groundfish surveys data (i.e. 1972-1986) and data collected in the fall of 2008, the data were post stratified into the aforementioned strata used in the 1987 – summer of 2008 survey. These strata served as the variables in each submodel of the delta-lognormal approach. In addition, season (i.e. summer or fall) and bottom type (mud dominant, mud very dominant, sand dominant, sand very dominant, gravel dominant, gravel very dominant, rock dominant, rock very dominant) served as additional variables in the submodels. Bottom types were extracted raster cell values from a gridded bottom composition dataset from Rester (2009) obtained by utilizing ARCVIEW Spatial Analyst and the starting position of each individual groundfish survey station.

Due to the deepwater distribution and low occurrences of yellowedge grouper, it was decided to limit the datasets by depth zones and shrimp statistical zones. In each case, only areas

that accounted for 80% of the total catch were considered for analysis. Therefore, all groundfish survey stations in depth zones less than 25 fathoms were excluded. In addition, shrimp statistical zones 10 and 12 were excluded from analysis due to extremely low number of stations sampled. Shrimp statistical zone 19 was excluded because of a lack of stations at suitable depths. Positive catches of yellowedge grouper from shrimp statistical zones 10, 12 and 19 were 3, 0 and 1, respectively, throughout all years. A total of 14,259 groundfish survey stations were trawled from 1972-2008 with a total of 161 occurrences of yellowedge grouper (Figure 1A). By limiting the data as previously described by depth zone and shrimp statistical zone, 3,855 stations were used in the analysis with a total of 146 occurrences of yellowedge grouper (Figure 1B).

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 $\alpha = 0.10$. 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. Yellowedge grouper CPUE (number of fish per trawl-hour) was modeled using this approach.

Five abundance indices were created for yellowedge grouper. The first index incorporates all available years of groundfish survey data (1972-2008), while the second index uses the same years, but the variable area was used in place of shrimp statistical zone. The variable area was derived by examining the distribution of stations by shrimp statistical zone (Table 1). Surveys in the early years were mainly sampled stations in the central Gulf of Mexico, while later surveys were expanded to cover an area from Brownsville, TX to the AL/FL border. Shrimp statistical zones 11, 13, 14 and 15 fell into area 1, while shrimp statistical zones 16, 17, 18, 20 and 21 fell into area 2. The third index only incorporates years where the groundfish survey protocols were standardized between summer and fall (1987-2008). The

fourth index incorporates all available years of groundfish survey data, but is limited to area 1, while the fifth index incorporates groundfish survey data from 1981-2008 and is limited to area 2. Finally, a length frequency histogram was developed to determine which portion of the stock was represented in these analyses.

Results and Discussion

The number of stations sampled per survey year ranged from 76 to 206 with numbers of yellowedge grouper captured ranging from 0 to 17 (Table 2). Of the 238 yellowedge grouper captured, a total of 138 were measured from 1985 – 2008 (before 1985 yellowedge grouper were not measured) with an average total length of 195 mm. A breakdown of the number of stations sampled and the nominal CPUE are presented in Table 3. From the length frequency histogram (Figure 2), the majority of yellowedge grouper captured are less than 350 mm, with only 5 individual fish greater than 350 mm being measured. With maturity believed to occur between 530 and 600 mm (FAO 2002), indices of relative abundance for the subadult stock of yellowedge grouper may be represented in these analyses. The nominal CPUE and number of stations with a positive catch are presented in Figure 3, which indicate spikes in the nominal CPUE seem to be related to increased numbers of stations where yellowedge grouper were captured. In addition, data exploration revealed much higher station CPUE in the early years (1972-1986) when compared to the later years (1987-2008).

The variables that were retained differed slightly among models. For the first model, year, depth zone, shrimp statistical zone, bottom type and season were retained in the binomial submodel. The variables retained in the lognormal submodel were year and depth zone. Table 4 summarizes backward selection procedure used to select the final set of variables used in the binomial submodel and their significance. The AIC for the binomial and lognormal submodels were

21,835.2 and 269.1, respectively. The AIC for the binomial submodel was the lowest in the final model run. However, the AIC for the lognormal submodel was not the lowest of all the model runs, because of the insignificance of the variables dropped a higher AIC in later model runs was deemed acceptable. Figures 4A and 5A indicated the distribution of the residuals of the lognormal submodel is approximately normal.

For the second model, year, area, bottom type and season were retained in the binomial submodel. The variables retained in the lognormal submodel were year and depth zone. Table 5 summarizes backward selection procedure used to select the final set of variables used in the binomial submodel and their significance. The AIC for the binomial and lognormal submodels were 21,485.8 and 269.1, respectively. The AIC for the binomial submodel was the lowest in the final model run. However, once again the AIC for the lognormal submodel was not the lowest of all the model runs, because of the insignificance of the variables dropped a higher AIC in later model runs was deemed acceptable. Figures 4B and 5B indicated the distribution of the residuals of the lognormal submodel is approximately normal. When the AICs from this model (21,485.8 and 269.1, respectively) were compared to the AICs from the first model (21,835.2 and 269.1, respectively), it appears that using area in place of shrimp statistical zone provided a better fit for the binominal submodel. However, there was no change in the fit of the lognormal submodel.

For the third model, year, shrimp statistical zone and bottom type were retained in the binomial submodel. The variables retained in the lognormal submodel were year, shrimp statistical zone and depth zone. Table 6 summarizes backward selection procedure used to select the final set of variables used in the binomial submodel and their significance. The AIC for the binomial and lognormal submodels were 12,738.0 and 198.8, respectively. The AIC for the binomial submodel was the lowest in the final model run. However, once again the AIC for the lognormal submodel was not the lowest of all the model runs, because of the insignificance of the variables dropped a higher

AIC in later model runs was deemed acceptable. Figures 4C and 5C indicated the distribution of the residuals of the lognormal submodel is approximately normal.

For the fourth model, there were an insufficient number of stations with a positive catch and 19 out of 37 years had a CPUE of zero, therefore the delta-lognormal model was not able to converge. In the fifth model, year and shrimp statistical zone were retained in the binomial submodel. The variables retained in the lognormal submodel were year, depth zone and shrimp statistical zone. Table 7 summarizes backward selection procedure used to select the final set of variables used in the binomial submodel and their significance. The AIC for the binomial and lognormal submodels were 7,953.4 and 182.0, respectively. The AIC for the binomial submodel was the lowest in the final model run. However, once again the AIC for the lognormal submodel was not the lowest of all the model runs, because of the insignificance of the variables dropped a higher AIC in later model runs was deemed acceptable. Figures 4D and 5D indicated the distribution of the residuals of the lognormal submodel is approximately normal.

Tables 8 - 11 and Figure 6 summarize indices of yellowedge grouper (number per trawl-hour) developed from the delta-lognormal models. Index values were highest in the early years of the survey (1972-1985) and much lower during the later years. There were also a several years (1972, 1973, 1979, 1984, 1986, and 1987) where no yellowedge grouper were observed during the groundfish surveys. The high variability of the index values in the early years may be related to the difference in survey design and aerial coverage between groundfish surveys before 1987 and groundfish surveys after 1987.

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Table 1. Summary of the location of SEAMAP stations sampled by NOAA Fisheries during Summer and Fall SEAMAP groundfish surveys conducted between 1972 and 2008.

	Shrimp Statistical Zone								
Year	11	13	14	15	16	17	18	20	21
1972	16	14	19	22	5				
1973	30	13	22	17					
1974	62	46	50	48					
1975	33	36	31	20					
1976	35	26	37	27	2				
1977	24	17	26	32	31	7	8	12	2
1978	33	15	29	16					
1979	31	10	27	21					
1980	28	11	23	15					
1981	19	14	16	15	1	1	7	5	3
1982	31	30	32	19	1	6	11	3	6
1983	22	20	18	10	3	5	5	5	1
1984	24	13	26	21	6	4	5	8	4
1985	19	12	16	29	20	1	2	3	3
1986	14	4	7	14	9	12	8	19	11
1987	9	6	6	10	10	9	9	16	1
1988	15	5	11	2	11	10	11	21	12
1989	11	5	7	11	7	3	8	25	10
1990	21	6	8	12	8	7	16	9	13
1991	20	5	11	8	13	9	19	6	19
1992	22		14	9	9	12	18	16	9
1993	19	4	11	9	16	5	14	17	7
1994	20	2	10	12	17	6	20	13	10
1995	15	2	13	7	14	7	12	19	9
1996	15	8	7	11	9	9	9	29	7
1997	14	3	5	14	9	15	8	19	11
1998	15	4	7	12	13	9	9	25	10
1999	17	3	13	7	8	15	14	23	9
2000	17	2	5	13	11	13	6	20	10
2001	11	5	10	8	9	7	9	14	11
2002	17	9	7	8	16	8	9	19	13
2003	19	5	1	8	7	10	16	10	19
2004	14	2	11	9	9	12	7	18	11
2005	17	3	5	6	9	7	6	20	9
2006	18	4	10	4	10	11	8	22	8
2007	9	2	6	6	7	16	3	19	12
2008	24	6	21	19	20	32	15	21	8

Table 2. Summary of the data used in these analyses collected by NOAA Fisheries during Summer and Fall SEAMAP groundfish surveys conducted between 1972 and 2008.

Survey Year	Number of Stations	Number Collected	Number Measured	Minimum Total Length (mm)	Maximum Total Length (mm)	Mean Total Length (mm)	Standard Deviation
1972	76	0	0				
1973	82	0	0				
1974	206	1	0				
1975	120	1	0				
1976	127	16	0				
1977	159	9	0				
1978	93	4	0				
1979	89	0	0				
1980	77	5	0				
1981	81	5	0				
1982	139	5	0				
1983	89	1	0				
1984	111	0	0				
1985	105	10	2	137	139	138	1
1986	98	0	0				
1987	76	0	0				
1988	98	2	2	183	560	372	267
1989	87	1	1	215	215	215	
1990	100	10	4	171	217	197	20
1991	110	9	5	90	254	146	63
1992	109	7	4	90	248	174	65
1993	102	5	4	118	246	166	60
1994	110	9	5	136	325	207	72
1995	98	4	2	132	172	152	28
1996	104	17	12	111	238	171	38
1997	98	6	4	119	296	180	80
1998	104	4	3	147	925	476	403
1999	109	3	3	112	350	263	131
2000	97	9	7	107	177	162	25
2001	84	7	5	165	311	201	62
2002	106	12	11	109	188	149	26
2003	95	13	12	132	857	255	195
2004	93	13	11	138	259	177	40
2005	82	12	10	110	178	158	21
2006	95	16	11	165	250	217	25
2007	80	9	8	102	295	200	69
2008	166	13	12	143	325	183	51

Total Number of Years	Total Number of Stations	Total Number Collected	Total Number Measured	Overall Mean Total Length (mm)
37	3855	238	138	195

Table 3. Summary of the data used in the indices for area 1 and 2 sampled by NOAA Fisheries during Summer and Fall SEAMAP groundfish surveys conducted between 1972 and 2008.

	Area 1			Area 2		
Year	Number of Stations	Number of Positive Catch Stations	Nominal CPUE	Number of Stations	Number of Positive Catch Stations	Nominal CPUE
1972	71	0	0.0000	5	0	0.0000
1973	82	0	0.0000			
1974	206	1	0.0097			
1975	120	1	0.0167			
1976	125	6	0.2560	2	0	0.0000
1977	99	3	0.1818	60	0	0.0000
1978	93	1	0.0860			
1979	89	0	0.0000			
1980	77	4	0.1818			
1981	64	4	0.1607	17	0	0.0000
1982	112	2	0.0357	27	2	0.5892
1983	70	0	0.0000	19	1	0.2871
1984	84	0	0.0000	27	0	0.0000
1985	76	3	0.1216	29	5	0.4018
1986	39	0	0.0000	59	0	0.0000
1987	31	0	0.0000	45	0	0.0000
1988	33	0	0.0000	65	2	0.0280
1989	34	0	0.0000	53	1	0.0072
1990	47	1	0.0791	53	3	0.0925
1991	44	0	0.0000	66	4	0.1081
1992	45	0	0.0000	64	4	0.1240
1993	43	1	0.0091	59	4	0.0582
1994	44	1	0.0505	66	3	0.0897
1995	37	0	0.0000	61	2	0.0470
1996	41	4	0.3733	63	6	0.2134
1997	36	1	0.0476	62	3	0.1210
1998	38	0	0.0000	66	2	0.0675
1999	40	0	0.0000	69	3	0.0343
2000	37	0	0.0000	60	6	0.1458
2001	34	1	0.0205	50	4	0.1153
2002	41	0	0.0000	65	9	0.1840
2003	33	3	0.1469	62	6	0.0962
2004	36	1	0.0356	57	9	0.1881
2005	31	0	0.0000	51	7	0.2481
2006	36	1	0.0918	59	6	0.2848
2007	23	0	0.0000	57	5	0.1701
2008	70	0	0.0000	96	10	0.2183

Table 4. Summary of backward selection procedure for building delta-lognormal submodels for yellowedge grouper index of relative abundance from 1972 to 2008.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 21840.7)*						*Lognormal Submodel Type 3 Tests (AIC 264.2)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	30	3269	48.38	1.61	0.0182	0.0188	30	93	1.85	0.0136
Depth Zone	5	3269	9.99	2.00	0.0755	0.0758	5	93	9.02	<.0001
Shrimp Statistical Zone	8	3269	61.24	7.65	<.0001	<.0001	8	93	1.70	0.1090
Bottom Type	7	3269	12.16	1.74	0.0954	0.0958	7	93	1.22	0.3021
Season	1	3269	3.08	3.08	0.0794	0.0795	1	93	0.06	0.8088
Time of Day	1	3269	0.06	0.06	0.8088	0.8089	1	93	0.16	0.6903
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 21835.2)*						*Lognormal Submodel Type 3 Tests (AIC 262.2)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	30	3270	48.57	1.62	0.0174	0.0180	30	94	1.87	0.0120
Depth Zone	5	3270	10.00	2.00	0.0754	0.0757	5	94	9.25	<.0001
Shrimp Statistical Zone	8	3270	61.36	7.67	<.0001	<.0001	8	94	1.73	0.1005
Bottom Type	7	3270	12.23	1.75	0.0932	0.0936	7	94	1.23	0.2969
Season	1	3270	3.09	3.09	0.0788	0.0789		dropped		
Time of Day				dropped			1	94	0.20	0.6584
Model Run #3	*Binomial Submodel Type 3 Tests (AIC 21835.2)*						*Lognormal Submodel Type 3 Tests (AIC 260.2)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	30	3270	48.57	1.62	0.0174	0.0180	30	95	1.91	0.0097
Depth Zone	5	3270	10.00	2.00	0.0754	0.0757	5	95	9.77	<.0001
Shrimp Statistical Zone	8	3270	61.36	7.67	<.0001	<.0001	8	95	1.75	0.0979
Bottom Type	7	3270	12.23	1.75	0.0932	0.0936	7	95	1.29	0.2626
Season	1	3270	3.09	3.09	0.0788	0.0789		dropped		
Time of Day				dropped				dropped		
Model Run #4	*Binomial Submodel Type 3 Tests (AIC 21835.2)*						*Lognormal Submodel Type 3 Tests (AIC 264.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	30	3270	48.57	1.62	0.0174	0.0180	30	102	1.85	0.0122
Depth Zone	5	3270	10.00	2.00	0.0754	0.0757	5	102	9.35	<.0001
Shrimp Statistical Zone	8	3270	61.36	7.67	<.0001	<.0001	8	102	1.47	0.1781
Bottom Type	7	3270	12.23	1.75	0.0932	0.0936		dropped		
Season	1	3270	3.09	3.09	0.0788	0.0789		dropped		
Time of Day				dropped				dropped		

Table 4 (continued).

Model Run #5	*Binomial Submodel Type 3 Tests (AIC 21835.2)*						*Lognormal Submodel Type 3 Tests (AIC 269.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	30	3270	48.57	1.62	0.0174	0.0180	30	110	3.12	<.0001
Depth Zone	5	3270	10.00	2.00	0.0754	0.0757	5	110	8.98	<.0001
Shrimp Statistical Zone	8	3270	61.36	7.67	<.0001	<.0001		dropped		
Bottom Type	7	3270	12.23	1.75	0.0932	0.0936		dropped		
Season	1	3270	3.09	3.09	0.0788	0.0789		dropped		
Time of Day				dropped				dropped		

Table 5. Summary of backward selection procedure for building delta-lognormal submodels for yellowedge grouper index of relative abundance from 1972 to 2008 using area in place of shrimp statistical zone.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 21586.3)*						*Lognormal Submodel Type 3 Tests (AIC 269.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	30	3276	45.39	1.51	0.0355	0.0364	30	100	2.14	0.0027
Depth Zone	5	3276	8.79	1.76	0.1176	0.1180	5	100	8.65	<.0001
Area	1	3276	33.21	33.21	<.0001	<.0001	1	100	3.13	0.0801
Bottom Type	7	3276	13.81	1.97	0.0546	0.0550	7	100	1.16	0.3339
Season	1	3276	3.54	3.54	0.0598	0.0599	1	100	0.24	0.6259
Time of Day	1	3276	0.11	0.11	0.7353	0.7354	1	100	0.17	0.6824
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 21576.6)*						*Lognormal Submodel Type 3 Tests (AIC 267.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	30	3277	45.67	1.52	0.0334	0.0343	30	101	2.15	0.0025
Depth Zone	5	3277	8.82	1.76	0.1165	0.1169	5	101	9.09	<.0001
Area	1	3277	33.30	33.30	<.0001	<.0001	1	101	3.20	0.0766
Bottom Type	7	3277	13.92	1.99	0.0527	0.0530	7	101	1.20	0.3088
Season	1	3277	3.56	3.56	0.0592	0.0593	1	101	0.19	0.6662
Time of Day				dropped				dropped		
Model Run #3	*Binomial Submodel Type 3 Tests (AIC 21485.8)*						*Lognormal Submodel Type 3 Tests (AIC 265.6)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	30	3282	44.62	1.49	0.0418	0.0428	30	102	2.22	0.0016
Depth Zone				dropped			5	102	9.12	<.0001
Area	1	3282	32.41	32.41	<.0001	<.0001	1	102	3.18	0.0773
Bottom Type	7	3282	16.43	2.35	0.0215	0.0217	7	102	1.20	0.3080
Season	1	3282	3.16	3.16	0.0757	0.0758		dropped		
Time of Day				dropped				dropped		
Model Run #4	*Binomial Submodel Type 3 Tests (AIC 21485.8)*						*Lognormal Submodel Type 3 Tests (AIC 269.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	30	3282	44.62	1.49	0.0418	0.0428	30	109	2.20	0.0017
Depth Zone				dropped			5	109	9.04	<.0001
Area	1	3282	32.41	32.41	<.0001	<.0001	1	109	1.56	0.2144
Bottom Type	7	3282	16.43	2.35	0.0215	0.0217		dropped		
Season	1	3282	3.16	3.16	0.0757	0.0758		dropped		
Time of Day				dropped				dropped		

Table 5 (continued)

Model Run #5	*Binomial Submodel Type 3 Tests (AIC 21485.8)*						*Lognormal Submodel Type 3 Tests (AIC 269.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	30	3282	44.62	1.49	0.0418	0.0428	30	110	3.12	<.0001
Depth Zone				dropped			5	110	8.98	<.0001
Area	1	3282	32.41	32.41	<.0001	<.0001		dropped		
Bottom Type	7	3282	16.43	2.35	0.0215	0.0217		dropped		
Season	1	3282	3.16	3.16	0.0757	0.0758		dropped		
Time of Day				dropped				dropped		

Table 6. Summary of backward selection procedure for building delta-lognormal submodels for yellowedge grouper index of relative abundance from 1988 to 2008.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 12876.8)*						*Lognormal Submodel Type 3 Tests (AIC 196.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	20	2000	33.21	1.66	0.0320	0.0330	20	71	1.36	0.1732
Shrimp Statistical Zone	7	2000	49.18	7.03	<.0001	<.0001	7	71	2.86	0.0109
Bottom Type	7	2000	13.94	1.99	0.0523	0.0529	7	71	1.51	0.1780
Depth Zone	5	2000	7.23	1.45	0.2042	0.2047	5	71	9.83	<.0001
Season	1	2000	2.68	2.68	0.1017	0.1018	1	71	0.04	0.8347
Time of Day	1	2000	0.28	0.28	0.5969	0.5970	1	71	0.13	0.7216
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 12874.0)*						*Lognormal Submodel Type 3 Tests (AIC 194.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	20	2001	33.23	1.66	0.0318	0.0328	20	72	1.39	0.1577
Shrimp Statistical Zone	7	2001	49.15	7.02	<.0001	<.0001	7	72	2.97	0.0086
Bottom Type	7	2001	14.06	2.01	0.0502	0.0508	7	72	1.53	0.1717
Depth Zone	5	2001	7.20	1.44	0.2059	0.2065	5	72	10.07	<.0001
Season	1	2001	2.73	2.73	0.0986	0.0987		dropped		
Time of Day				dropped			1	72	0.11	0.7442
Model Run #3	*Binomial Submodel Type 3 Tests (AIC 12781.0)*						*Lognormal Submodel Type 3 Tests (AIC 192.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	20	2006	33.92	1.70	0.0267	0.0276	20	73	1.41	0.1459
Shrimp Statistical Zone	7	2006	48.84	6.98	<.0001	<.0001	7	73	3.04	0.0074
Bottom Type	7	2006	15.04	2.15	0.0354	0.0359	7	73	1.53	0.1700
Depth Zone				dropped			5	73	10.95	<.0001
Season	1	2006	2.46	2.46	0.1164	0.1166		dropped		
Time of Day				dropped				dropped		
Model Run #4	*Binomial Submodel Type 3 Tests (AIC 12738.0)*						*Lognormal Submodel Type 3 Tests (AIC 198.8)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	20	2007	34.80	1.74	0.0212	0.0220	20	80	1.05	0.4143
Shrimp Statistical Zone	7	2007	50.36	7.19	<.0001	<.0001	7	80	2.63	0.0169
Bottom Type	7	2007	15.34	2.19	0.0319	0.0324		dropped		
Depth Zone				dropped			5	80	10.05	<.0001
Season				dropped				dropped		
Time of Day				dropped				dropped		

Table 7. Summary of backward selection procedure for building delta-lognormal submodels for yellowedge grouper index of relative abundance from 1981 to 2008 from area 2.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 8132.4)*						*Lognormal Submodel Type 3 Tests (AIC 179.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	23	1337	25.35	1.10	0.3326	0.3346	23	65	2.43	0.0028
Depth Zone	5	1337	5.00	1.00	0.4158	0.4163	5	65	9.51	<.0001
Shrimp Statistical Zone	4	1337	17.65	4.41	0.0014	0.0015	4	65	2.69	0.0387
Bottom Type	7	1337	10.19	1.46	0.1778	0.1789	7	65	1.04	0.4129
Season	1	1337	1.20	1.20	0.2732	0.2734	1	65	0.70	0.4065
Time of Day	1	1337	0.53	0.53	0.4683	0.4684	1	65	0.40	0.5288
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 8127.0)*						*Lognormal Submodel Type 3 Tests (AIC 177.9)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	23	1338	25.51	1.11	0.3244	0.3265	23	66	2.46	0.0024
Depth Zone	5	1338	4.93	0.99	0.4248	0.4253	5	66	10.57	<.0001
Shrimp Statistical Zone	4	1338	17.62	4.40	0.0015	0.0015	4	66	2.63	0.0420
Bottom Type	7	1338	10.27	1.47	0.1739	0.1749	7	66	1.03	0.4173
Season	1	1338	1.23	1.23	0.2675	0.2677	1	66	0.57	0.4545
Time of Day				dropped				dropped		
Model Run #3	*Binomial Submodel Type 3 Tests (AIC 8115.7)*						*Lognormal Submodel Type 3 Tests (AIC 176.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	23	1343	25.21	1.10	0.3398	0.3417	23	67	2.47	0.0022
Depth Zone				dropped			5	67	11.03	<.0001
Shrimp Statistical Zone	4	1343	16.86	4.22	0.0021	0.0021	4	67	2.54	0.0481
Bottom Type	7	1343	9.47	1.35	0.2210	0.2220	7	67	1.05	0.4060
Season	1	1343	1.12	1.12	0.2892	0.2894		dropped		
Time of Day				dropped				dropped		
Model Run #4	*Binomial Submodel Type 3 Tests (AIC 8098.4)*						*Lognormal Submodel Type 3 Tests (AIC 182.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	23	1344	26.16	1.14	0.2935	0.2958	23	74	2.44	0.0021
Depth Zone				dropped			5	74	11.69	<.0001
Shrimp Statistical Zone	4	1344	17.53	4.38	0.0015	0.0016	4	74	2.68	0.0383
Bottom Type	7	1344	9.64	1.38	0.2097	0.2108		dropped		
Season				dropped				dropped		
Time of Day				dropped				dropped		

Table 7 (continued)

Model Run #5	*Binomial Submodel Type 3 Tests (AIC 7953.4)*						*Lognormal Submodel Type 3 Tests (AIC 182.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	23	1351	27.95	1.22	0.2178	0.2205	23	74	2.44	0.0021
Depth Zone				dropped			5	74	11.69	<.0001
Shrimp Statistical Zone	4	1351	20.99	5.25	0.0003	0.0003	4	74	2.68	0.0383
Bottom Type				dropped				dropped		
Season				dropped				dropped		
Time of Day				dropped				dropped		

Table 8. Indices of yellowedge grouper developed using the delta-lognormal model for 1972-2008. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1972	0.00000	76	0.00000	0.00000			
1973	0.00000	82	0.00000	0.00000			
1974	0.00485	206	0.03553	0.39888	1.26578	0.05642	2.8201
1975	0.00833	120	0.02239	0.25138	1.32053	0.03370	1.8749
1976	0.04724	127	0.33508	3.76208	0.50671	1.44610	9.7872
1977	0.01887	159	0.06955	0.78090	0.72709	0.21220	2.8737
1978	0.01075	93	0.24830	2.78778	1.17926	0.43089	18.0365
1979	0.00000	89	0.00000	0.00000			
1980	0.05195	77	0.29503	3.31239	0.60695	1.08070	10.1526
1981	0.04938	81	0.15607	1.75226	0.61444	0.56497	5.4347
1982	0.02878	139	0.16372	1.83817	0.61754	0.58978	5.7290
1983	0.01124	89	0.06062	0.68058	1.22376	0.10043	4.6119
1984	0.00000	111	0.00000	0.00000			
1985	0.07619	105	0.30266	3.39809	0.44708	1.44695	7.9802
1986	0.00000	98	0.00000	0.00000			
1987	0.00000	76	0.00000	0.00000			
1988	0.02041	98	0.01240	0.13916	1.04794	0.02488	0.7785
1989	0.01149	87	0.00465	0.05221	1.81178	0.00468	0.5825
1990	0.04000	100	0.05897	0.66203	0.64448	0.20368	2.1519
1991	0.03636	110	0.05417	0.60819	0.66030	0.18262	2.0255
1992	0.03670	109	0.03118	0.35010	0.67847	0.10226	1.1986
1993	0.04902	102	0.02787	0.31292	0.61989	0.10003	0.9789
1994	0.03636	110	0.05162	0.57961	0.66181	0.17363	1.9348
1995	0.02041	98	0.02324	0.26087	0.96538	0.05147	1.3221
1996	0.09615	104	0.13200	1.48200	0.41981	0.66206	3.3174
1997	0.04082	98	0.04148	0.46568	0.66201	0.13946	1.5550
1998	0.01923	104	0.01936	0.21741	0.99147	0.04155	1.1375
1999	0.02752	109	0.01082	0.12150	0.89618	0.02616	0.5643
2000	0.06186	97	0.05302	0.59532	0.54522	0.21460	1.6515
2001	0.05952	84	0.03199	0.35913	0.62539	0.11382	1.1332
2002	0.08491	106	0.07825	0.87856	0.44690	0.37422	2.0626
2003	0.09474	95	0.07705	0.86511	0.45039	0.36626	2.0434
2004	0.10753	93	0.07309	0.82058	0.42700	0.36195	1.8603
2005	0.08537	82	0.06332	0.71092	0.51467	0.26963	1.8744
2006	0.07368	95	0.11925	1.33880	0.48761	0.53156	3.3719
2007	0.06250	80	0.05823	0.65378	0.58950	0.21932	1.9489
2008	0.06024	166	0.05020	0.56364	0.44716	0.23997	1.3239

Table 9. Indices of yellowedge grouper developed using the delta-lognormal model for 1972-2008 using area in place of shrimp statistical zone. 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. (Using area)

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1972	0.00000	76	0.00000	0.00000			
1973	0.00000	82	0.00000	0.00000			
1974	0.00485	206	0.03743	0.37706	1.41756	0.04621	3.0770
1975	0.00833	120	0.02269	0.22854	1.55784	0.02483	2.1033
1976	0.04724	127	0.35211	3.54700	0.50796	1.36054	9.2472
1977	0.01887	159	0.08052	0.81109	0.76475	0.20876	3.1513
1978	0.01075	93	0.25949	2.61403	1.20479	0.39337	17.3708
1979	0.00000	89	0.00000	0.00000			
1980	0.05195	77	0.30230	3.04530	0.61033	0.98826	9.3840
1981	0.04938	81	0.16890	1.70146	0.62585	0.53884	5.3726
1982	0.02878	139	0.19001	1.91411	0.62545	0.60657	6.0402
1983	0.01124	89	0.06862	0.69124	1.30590	0.09400	5.0834
1984	0.00000	111	0.00000	0.00000			
1985	0.07619	105	0.30475	3.06996	0.44826	1.30456	7.2244
1986	0.00000	98	0.00000	0.00000			
1987	0.00000	76	0.00000	0.00000			
1988	0.02041	98	0.01512	0.15227	1.25148	0.02185	1.0613
1989	0.01149	87	0.00506	0.05102	2.48565	0.00308	0.8456
1990	0.04000	100	0.07146	0.71984	0.67682	0.21078	2.4583
1991	0.03636	110	0.06676	0.67247	0.69326	0.19210	2.3540
1992	0.03670	109	0.04082	0.41117	0.73280	0.11081	1.5257
1993	0.04902	102	0.03480	0.35056	0.67474	0.10297	1.1934
1994	0.03636	110	0.06669	0.67181	0.68959	0.19297	2.3388
1995	0.02041	98	0.02722	0.27421	1.09727	0.04634	1.6227
1996	0.09615	104	0.15919	1.60360	0.41924	0.71711	3.5860
1997	0.04082	98	0.05180	0.52180	0.70640	0.14618	1.8626
1998	0.01923	104	0.02333	0.23503	1.13882	0.03794	1.4561
1999	0.02752	109	0.01500	0.15107	1.03768	0.02733	0.8351
2000	0.06186	97	0.06584	0.66330	0.57144	0.22908	1.9206
2001	0.05952	84	0.03669	0.36956	0.68688	0.10658	1.2813
2002	0.08491	106	0.08784	0.88490	0.46246	0.36687	2.1344
2003	0.09474	95	0.09053	0.91196	0.45888	0.38043	2.1861
2004	0.10753	93	0.08752	0.88160	0.43441	0.38382	2.0249
2005	0.08537	82	0.07379	0.74330	0.53252	0.27364	2.0191
2006	0.07368	95	0.13685	1.37856	0.49885	0.53699	3.5391
2007	0.06250	80	0.06922	0.69727	0.61532	0.22450	2.1656
2008	0.06024	166	0.06501	0.65492	0.46131	0.27206	1.5765

Table 10. Indices of yellowedge grouper developed using the delta-lognormal model for 1988-2008. The nominal frequency of occurrence, the number of samples (*N*), the DL Index (number per trawl-hour), the DL indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV), and lower and upper confidence limits (LCL and UCL) for the scaled index are listed.

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1988	0.02041	98	0.01618	0.25910	2.32026	0.01702	3.94522
1989	0.01149	87	0.01091	0.17459	3.82900	0.00633	4.81639
1990	0.04000	100	0.06977	1.11704	0.96482	0.22055	5.65756
1991	0.03636	110	0.06163	0.98662	1.04750	0.17646	5.51643
1992	0.03670	109	0.03923	0.62803	1.16545	0.09851	4.00412
1993	0.04902	102	0.04310	0.69004	1.03574	0.12512	3.80563
1994	0.03636	110	0.06590	1.05502	0.98255	0.20383	5.46069
1995	0.02041	98	0.03568	0.57126	1.69068	0.05592	5.83635
1996	0.09615	104	0.13236	2.11906	0.54785	0.76059	5.90388
1997	0.04082	98	0.05195	0.83173	1.07456	0.14420	4.79730
1998	0.01923	104	0.02209	0.35369	2.05634	0.02701	4.63168
1999	0.02752	109	0.01304	0.20870	2.10081	0.01551	2.80749
2000	0.06186	97	0.06014	0.96288	0.87378	0.21348	4.34297
2001	0.05952	84	0.03819	0.61136	1.10279	0.10268	3.64026
2002	0.08491	106	0.11826	1.89325	0.57817	0.64678	5.54191
2003	0.09474	95	0.10272	1.64451	0.61569	0.52918	5.11053
2004	0.10753	93	0.11214	1.79525	0.55642	0.63536	5.07259
2005	0.08537	82	0.08175	1.30881	0.72316	0.35770	4.78881
2006	0.07368	95	0.11201	1.79320	0.65071	0.54641	5.88484
2007	0.06250	80	0.07315	1.17106	0.86119	0.26399	5.19477
2008	0.06024	166	0.05152	0.82479	0.72456	0.22496	3.02401

Table 11. Indices of yellowedge grouper developed using the delta-lognormal model for 1981-2008 for area 2. 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. (Using area)

Survey Year	Frequency	*N*	DL Index	Scaled Index	CV	LCL	UCL
1981	0.00000	17	0.00000	0.00000			
1982	0.07407	27	0.17038	1.15955	0.93858	0.23654	5.6843
1983	0.05263	19	0.29392	2.00024	1.23981	0.29039	13.7779
1984	0.00000	27	0.00000	0.00000			
1985	0.17241	29	0.95952	6.53002	0.52748	2.42415	17.5901
1986	0.00000	59	0.00000	0.00000			
1987	0.00000	45	0.00000	0.00000			
1988	0.03077	65	0.02945	0.20041	1.27754	0.02802	1.4335
1989	0.01887	53	0.01814	0.12344	2.08955	0.00924	1.6493
1990	0.05660	53	0.07207	0.49045	0.85320	0.11175	2.1526
1991	0.06061	66	0.11126	0.75720	0.71046	0.21085	2.7192
1992	0.06250	64	0.07972	0.54251	0.72217	0.14849	1.9821
1993	0.06780	59	0.06988	0.47560	0.74069	0.12671	1.7851
1994	0.04545	66	0.14092	0.95903	0.77018	0.24494	3.7549
1995	0.03279	61	0.07420	0.50496	1.03992	0.09111	2.7985
1996	0.09524	63	0.11177	0.76062	0.56227	0.26663	2.1698
1997	0.04839	62	0.06984	0.47528	0.84755	0.10911	2.0703
1998	0.03030	66	0.04677	0.31829	1.14848	0.05084	1.9927
1999	0.04348	69	0.02788	0.18977	1.05972	0.03346	1.0761
2000	0.10000	60	0.13565	0.92314	0.55596	0.32696	2.6064
2001	0.08000	50	0.05611	0.38183	0.78108	0.09603	1.5182
2002	0.13846	65	0.23088	1.57128	0.41432	0.70882	3.4832
2003	0.09677	62	0.12055	0.82041	0.55734	0.28992	2.3216
2004	0.15789	57	0.17596	1.19750	0.42652	0.52865	2.7126
2005	0.13725	51	0.13871	0.94401	0.50146	0.36610	2.4342
2006	0.10169	59	0.17968	1.22281	0.53032	0.45181	3.3095
2007	0.08772	57	0.11472	0.78071	0.61068	0.25322	2.4071
2008	0.10417	96	0.09859	0.67094	0.45691	0.28085	1.6028

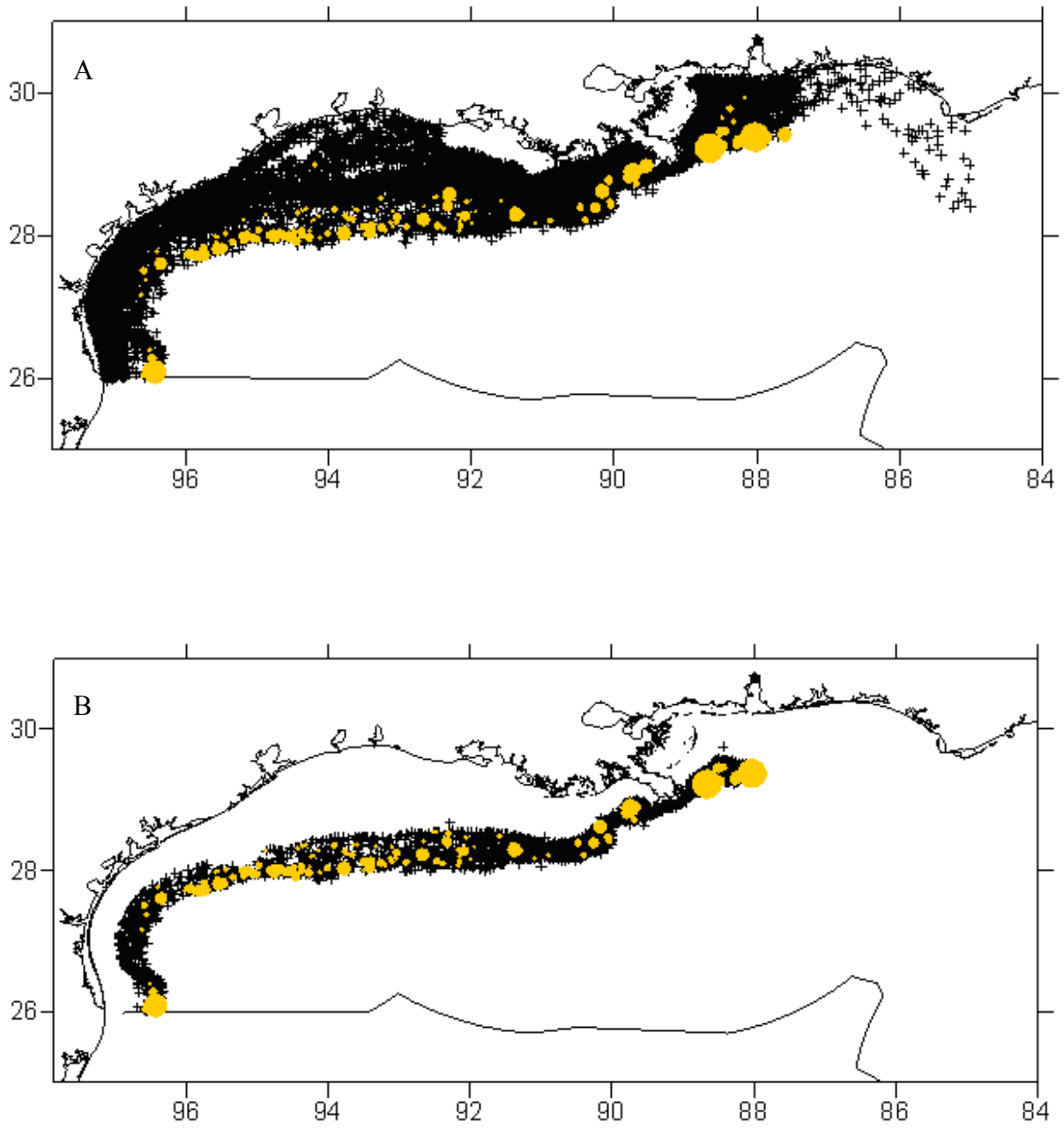


Figure 1. Overview of locations of groundfish survey trawls in the northern Gulf of Mexico conducted between 1972 and 2008. Each + indicates the starting point of a trawl station and the circle represents where yellowedge grouper were captured and the CPUE. The smallest circle represents a CPUE of 0.25 fish per hour, while the largest circle represents a CPUE of 14 fish per hour. A) Location of all groundfish survey stations (N=14,259). B) Location of all groundfish survey stations after limiting stations by depth zone and shrimp statistical zone (N=3,855).

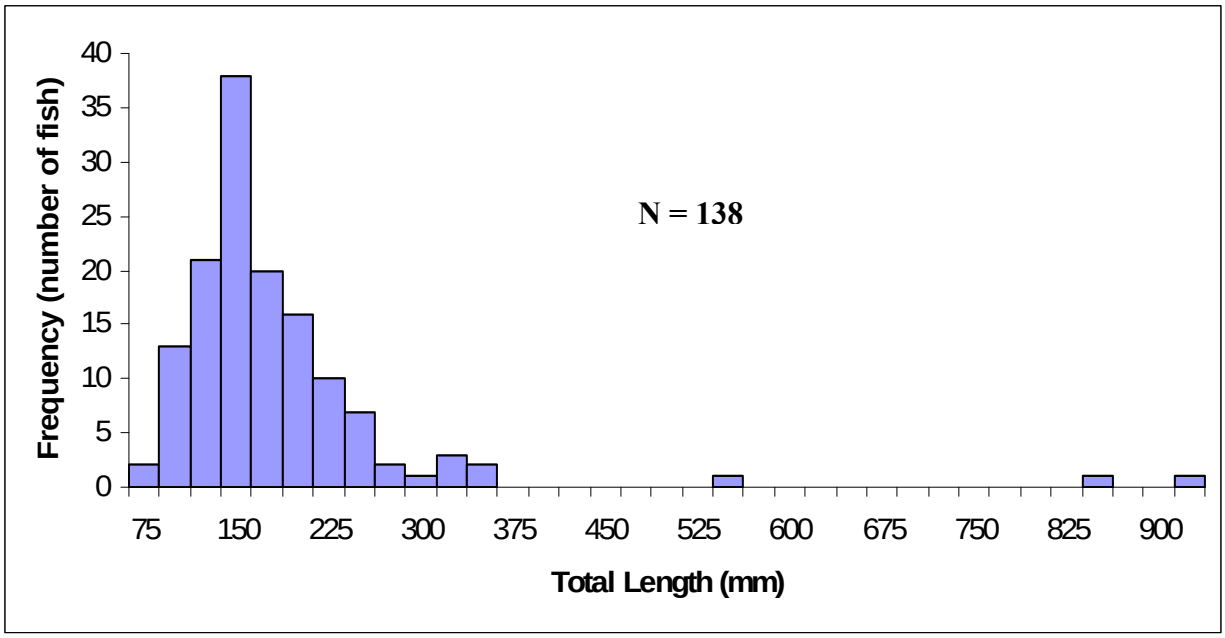


Figure 2. Length frequency histogram for yellowedge grouper collected in NOAA Fisheries Summer and Fall SEAMAP Groundfish Surveys.

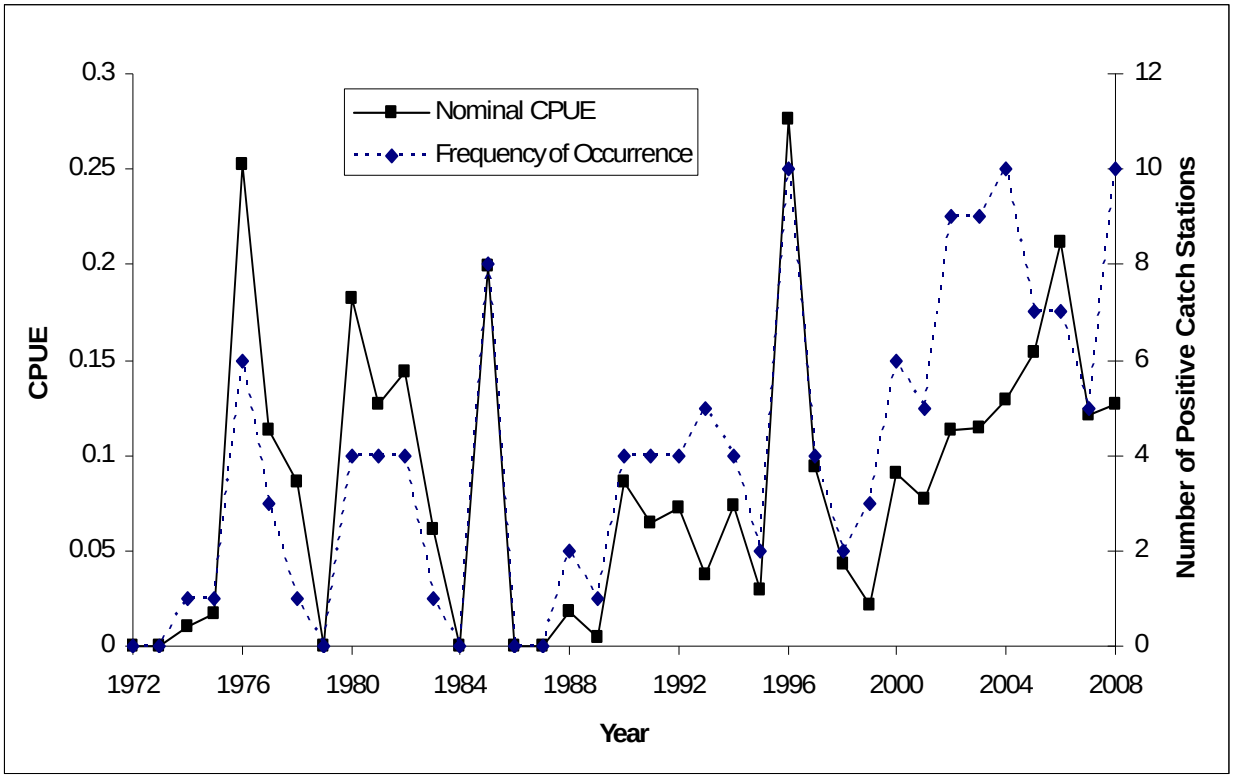


Figure 3. Nominal CPUE (number of fish per trawl-hour) and number of stations with a positive catch of yellowedge grouper collected from 1972 – 2008 by NOAA Fisheries in Summer and Fall Groundfish Surveys.

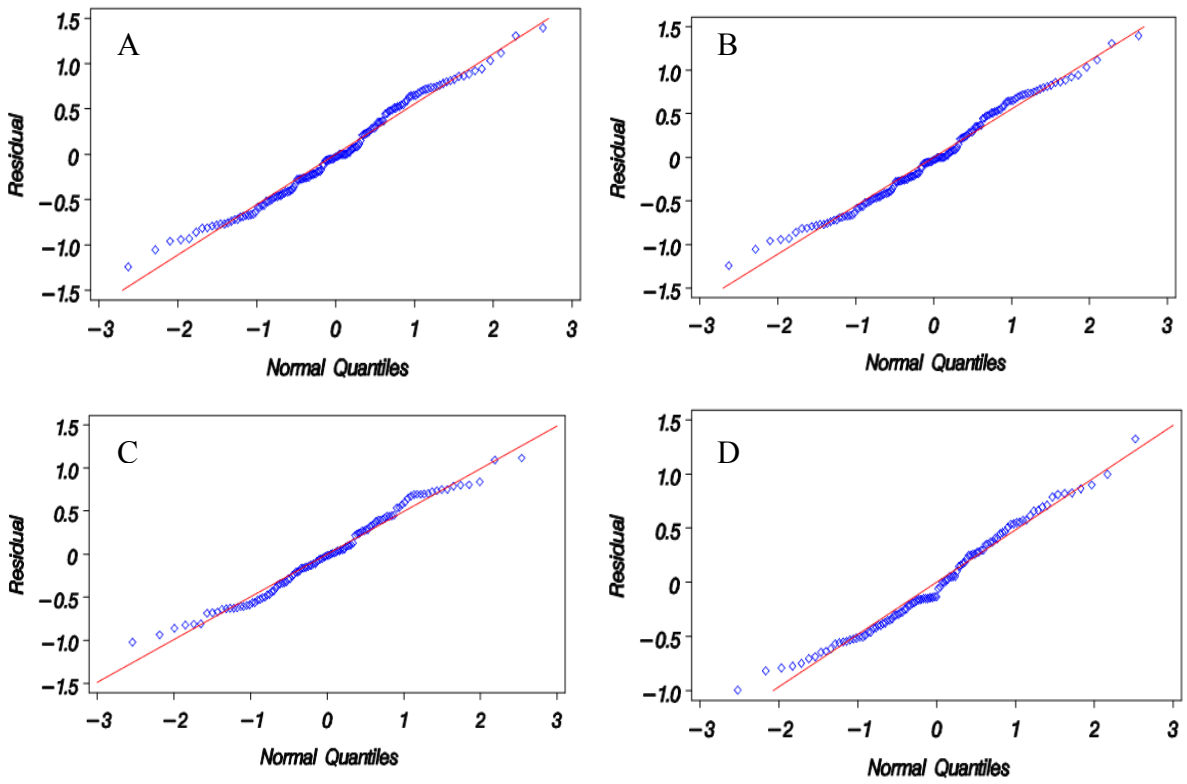


Figure 4. QQ plot of the residuals of the lognormal submodel for: A) 1972 – 2008 (using shrimp statistical zone), B) 1972 – 2008 (using area), C) 1988 – 2008 and D) 1981 – 2008.

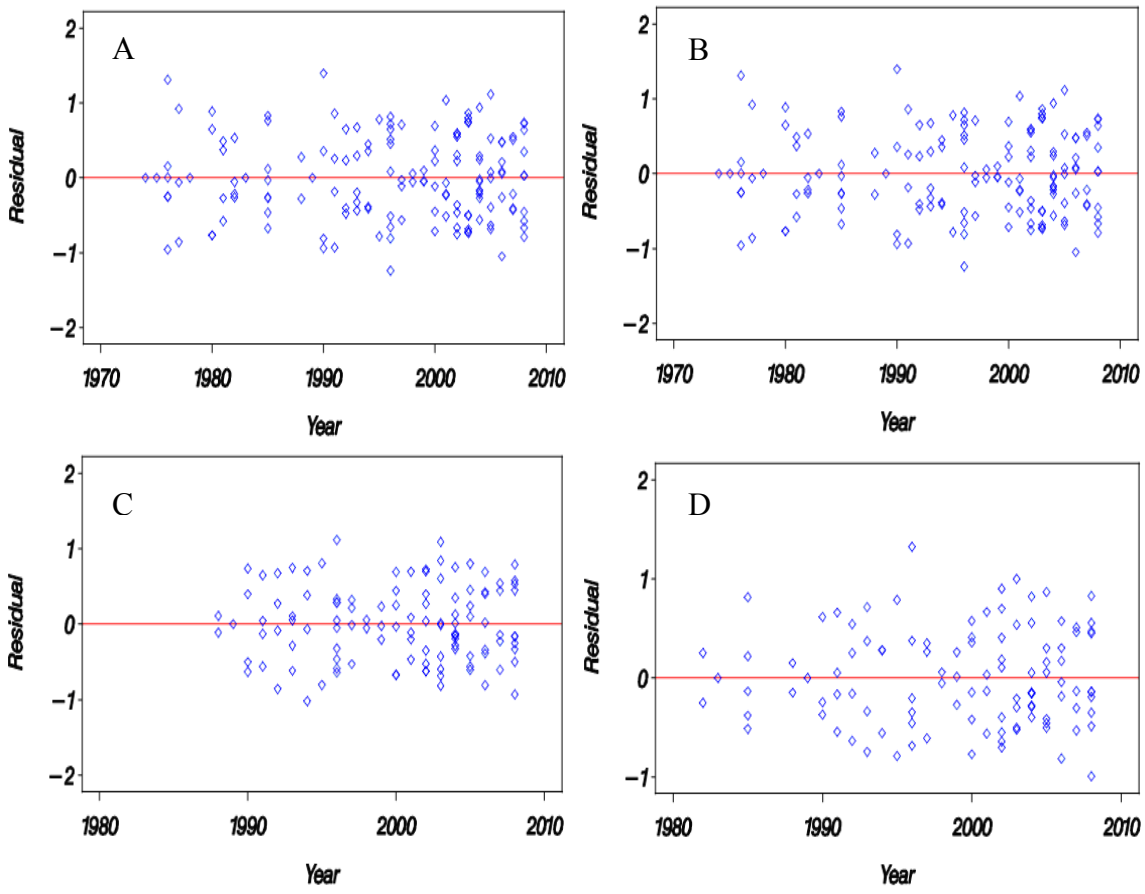


Figure 5. Scatter plot of the residuals of the lognormal submodel for: A) 1972 – 2008 (using shrimp statistical zone), B) 1972 – 2008 (using area), C) 1988 – 2008 and D) 1981 – 2008.

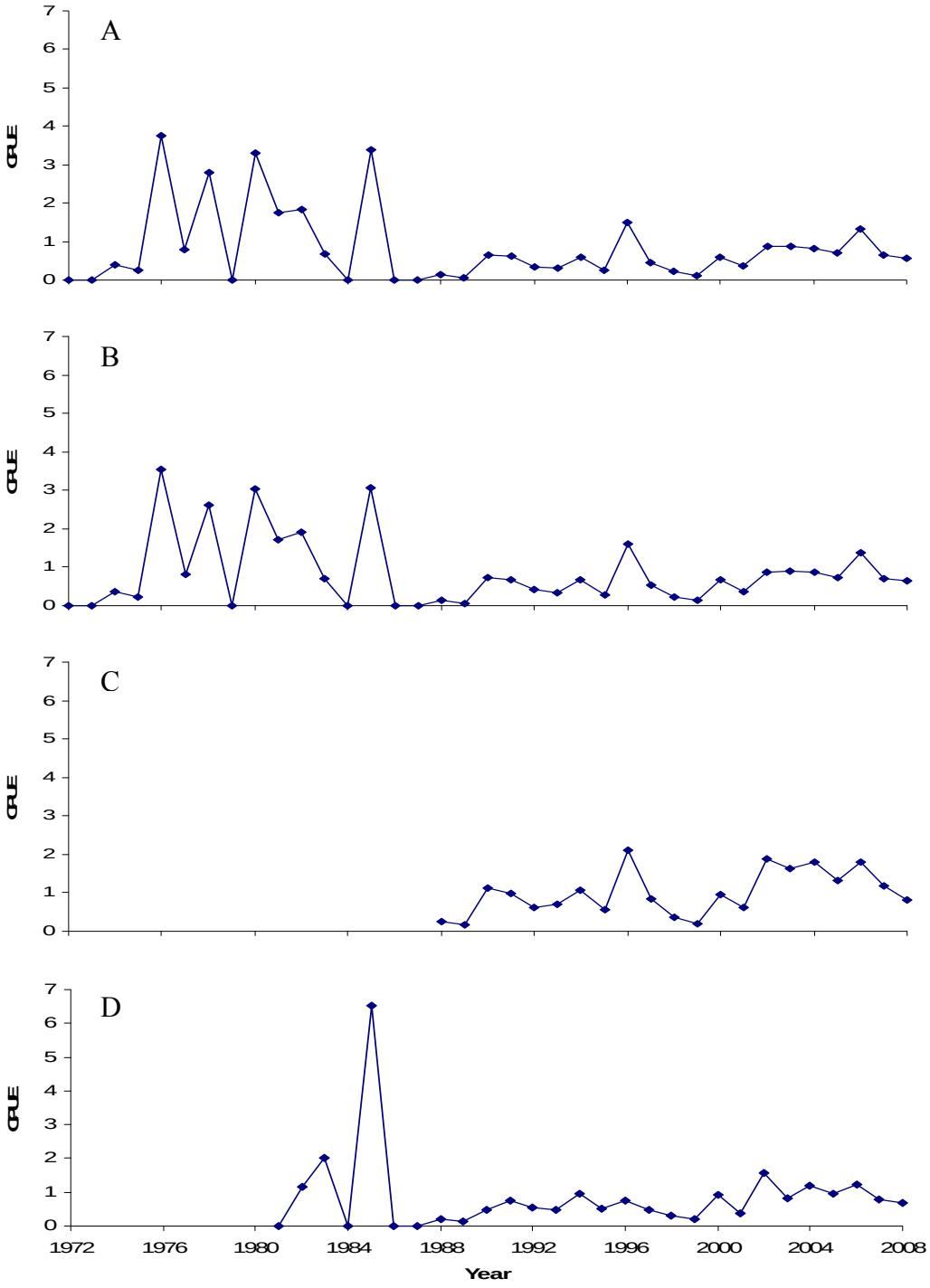
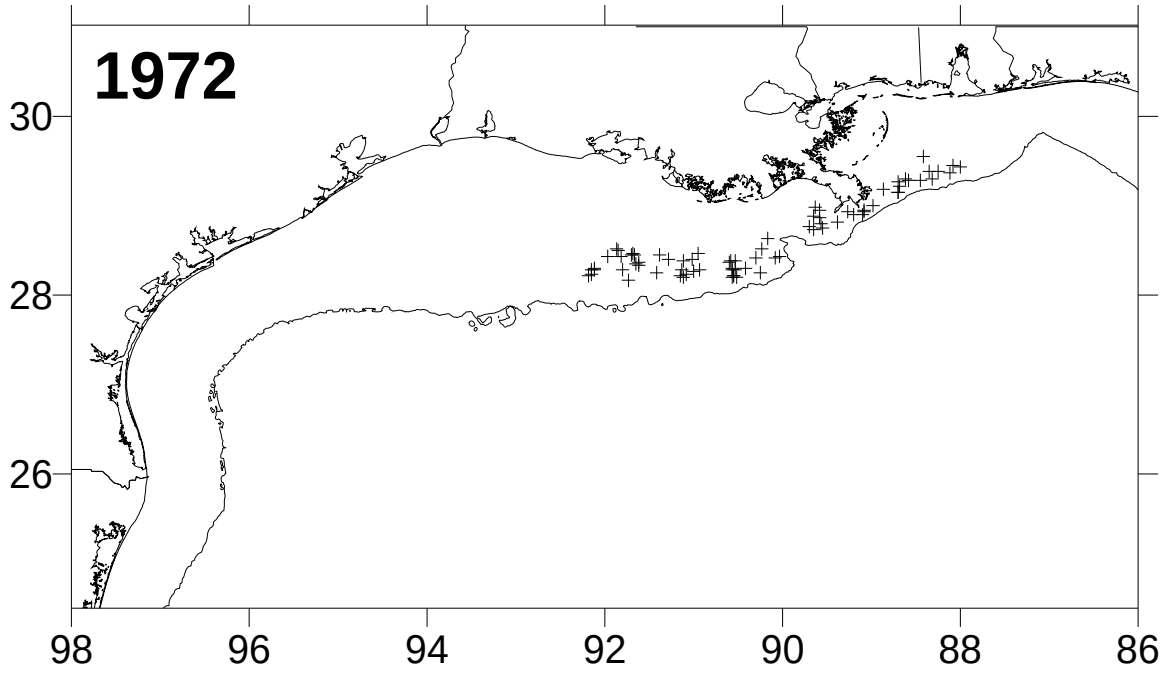


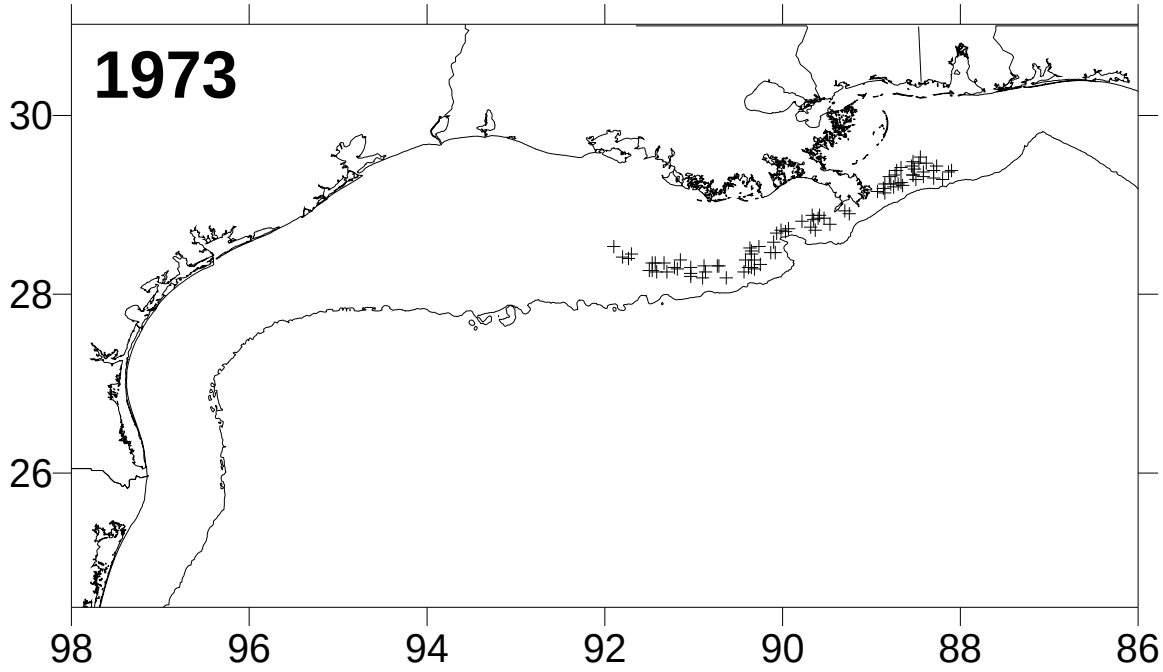
Figure 6. Indices of relative abundance of yellowedge grouper collected in NOAA Fisheries groundfish surveys in the northern Gulf of Mexico. CPUE is the number of fish per trawl-hour. Index values are scaled to a mean of one across the time series with A) 1972 – 2008 index (using shrimp statistical zone), B) 1972 – 2008 index (using area), C) 1988 – 2008 index and D) 1981 – 2008 index.

Appendix for SEDAR 22-DW-06

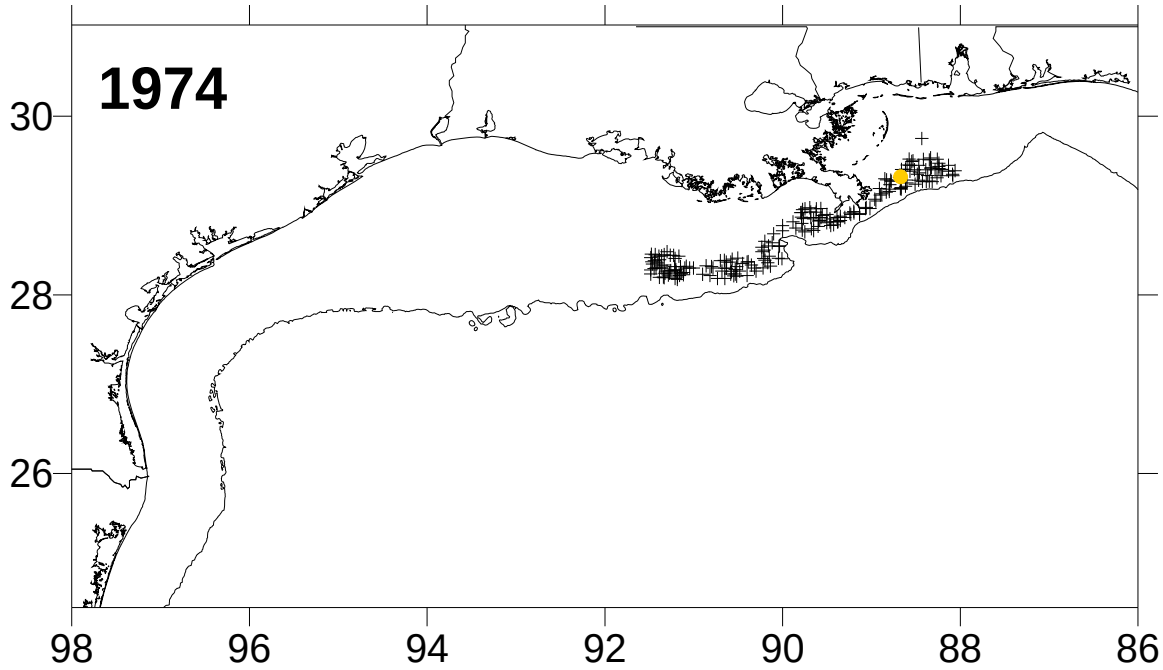
Annual Effort and Catch



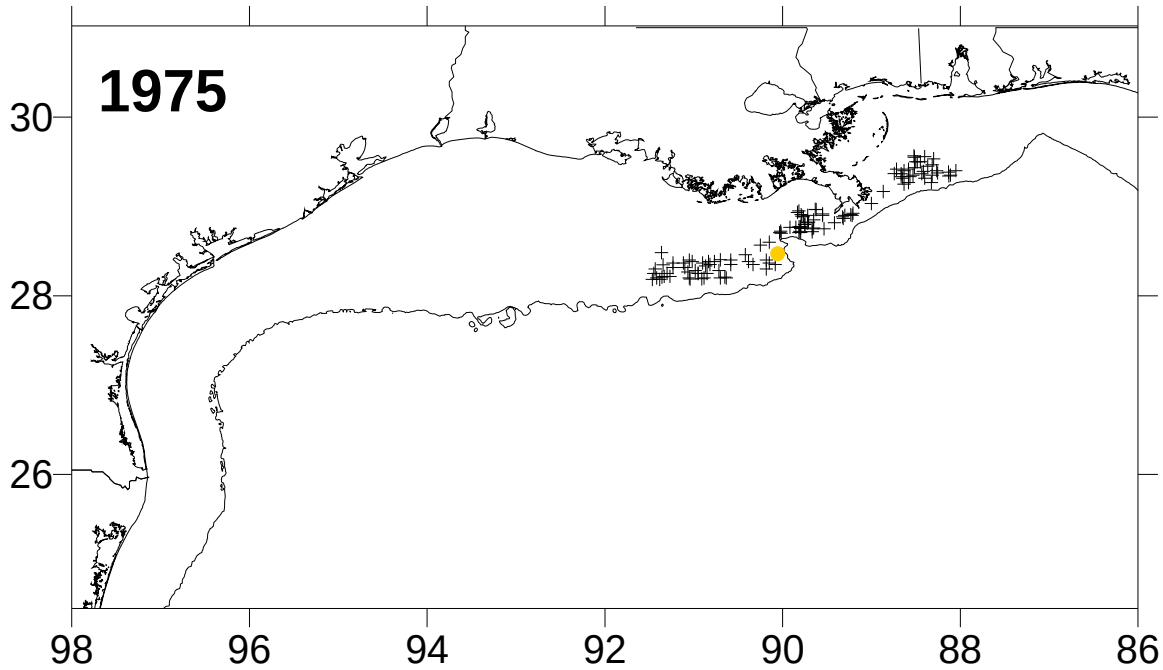
Appendix Figure 1. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1972. Each + indicates the starting point of a trawl (N=76). No yellowedge grouper were collected.



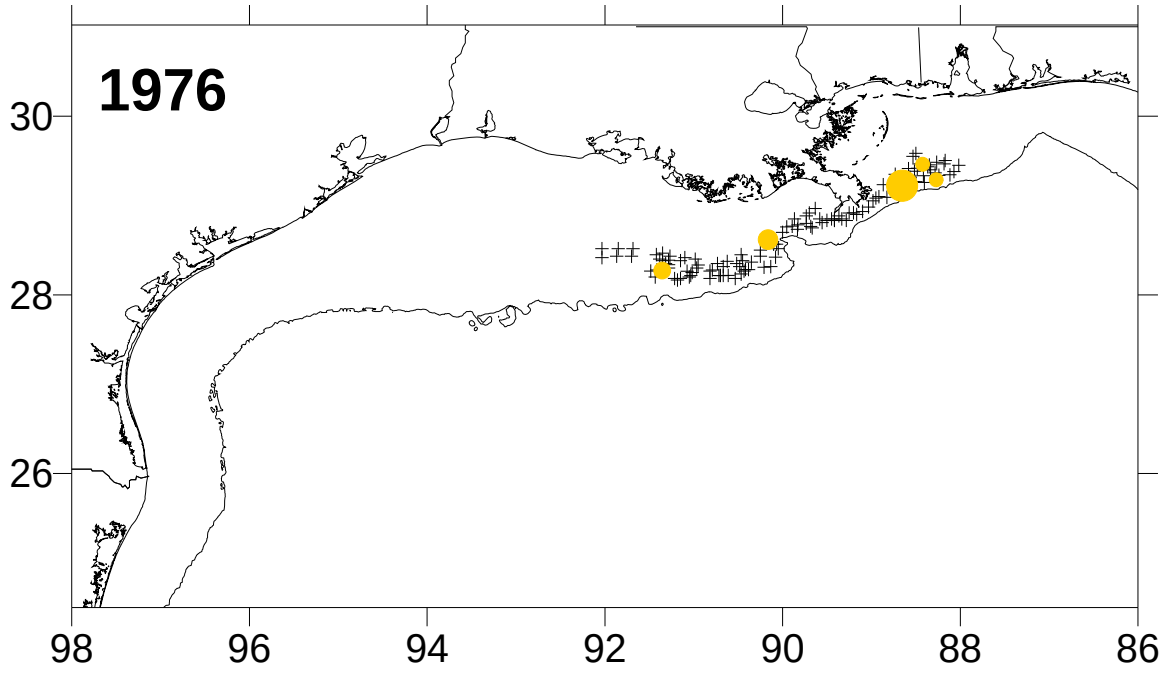
Appendix Figure 2. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1973. Each + indicates the starting point of a trawl (N=82). No yellowedge grouper were collected.



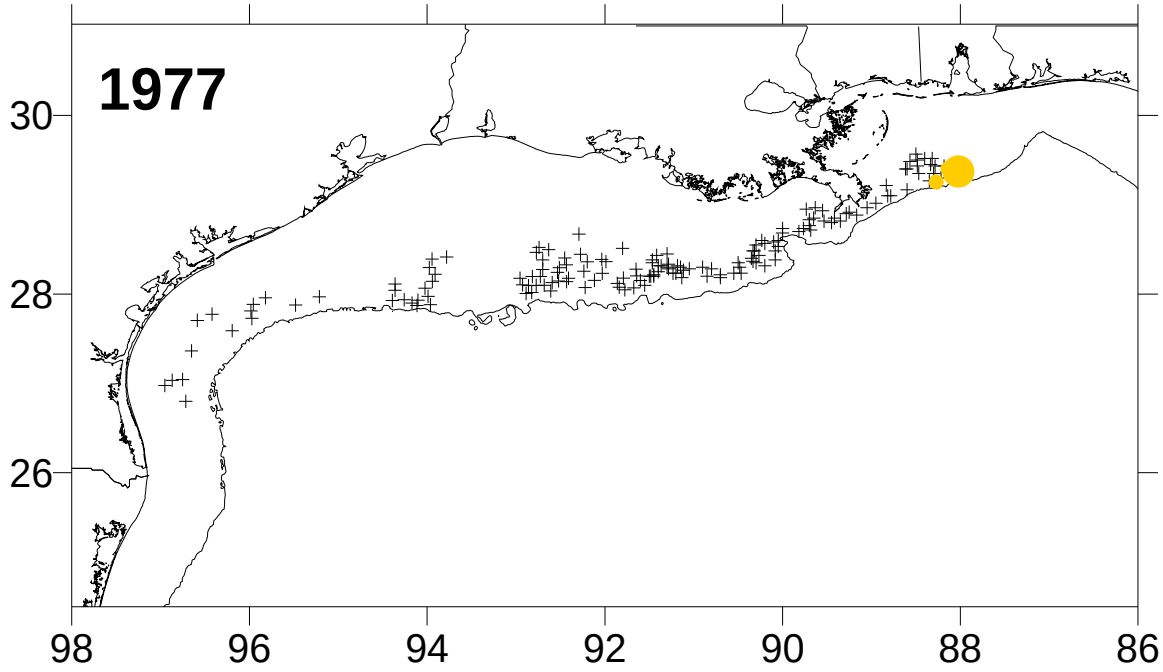
Appendix Figure 3. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1974. Each + indicates the starting point of a trawl station (N=206) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 2 fish per trawl-hour). On this and following charts, the smallest circle represents a CPUE of 1 fish per trawl-hour, while the largest circle represents a CPUE of 14 fish per trawl-hour.



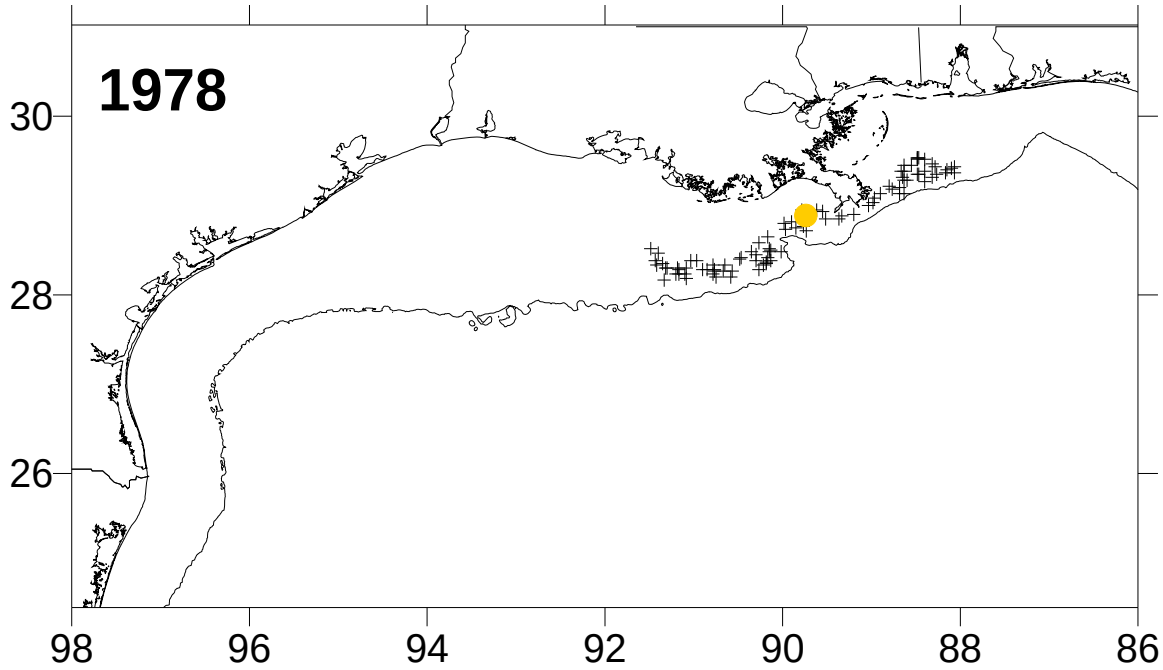
Appendix Figure 4. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1975. Each + indicates the starting point of a trawl station (N=120) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 2 fish per trawl-hour).



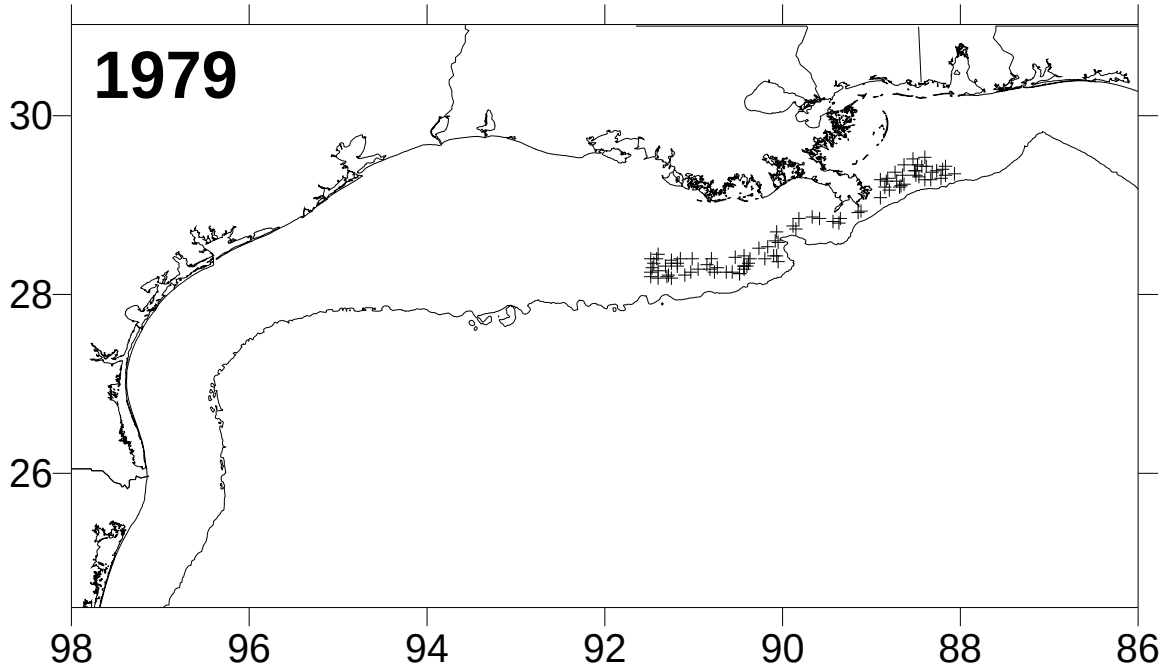
Appendix Figure 5. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1976. Each + indicates the starting point of a trawl station (N=127) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 2-14 fish per trawl-hour).



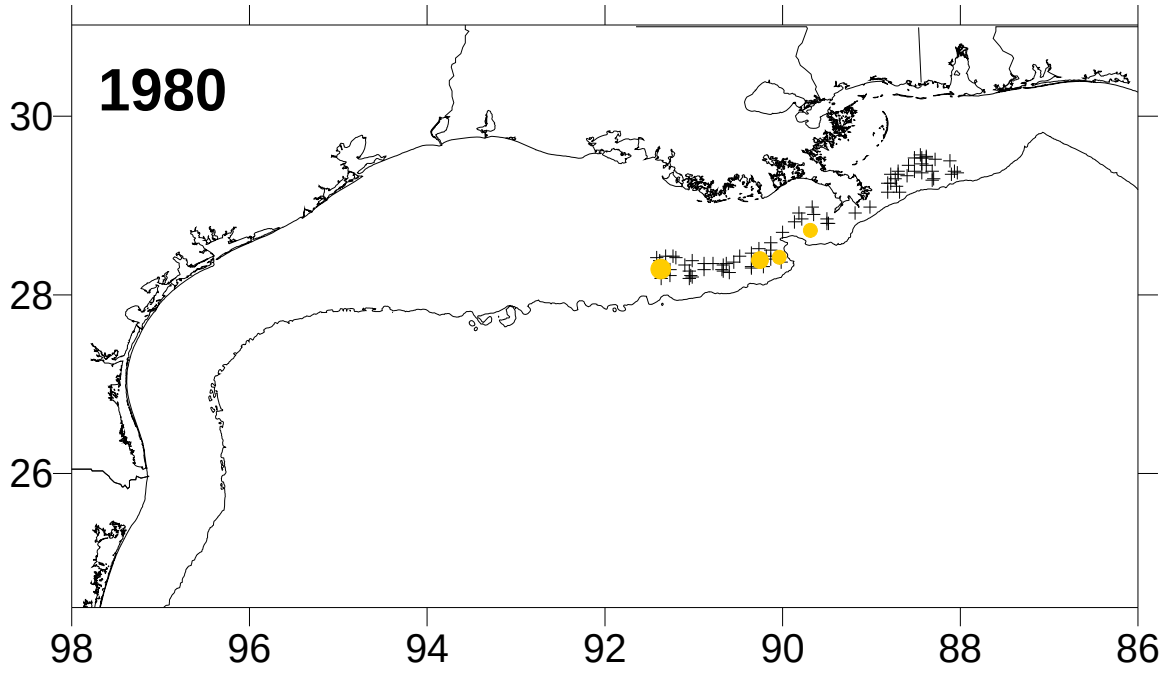
Appendix Figure 6. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1977. Each + indicates the starting point of a trawl station (N=159) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 2-14 fish per trawl-hour).



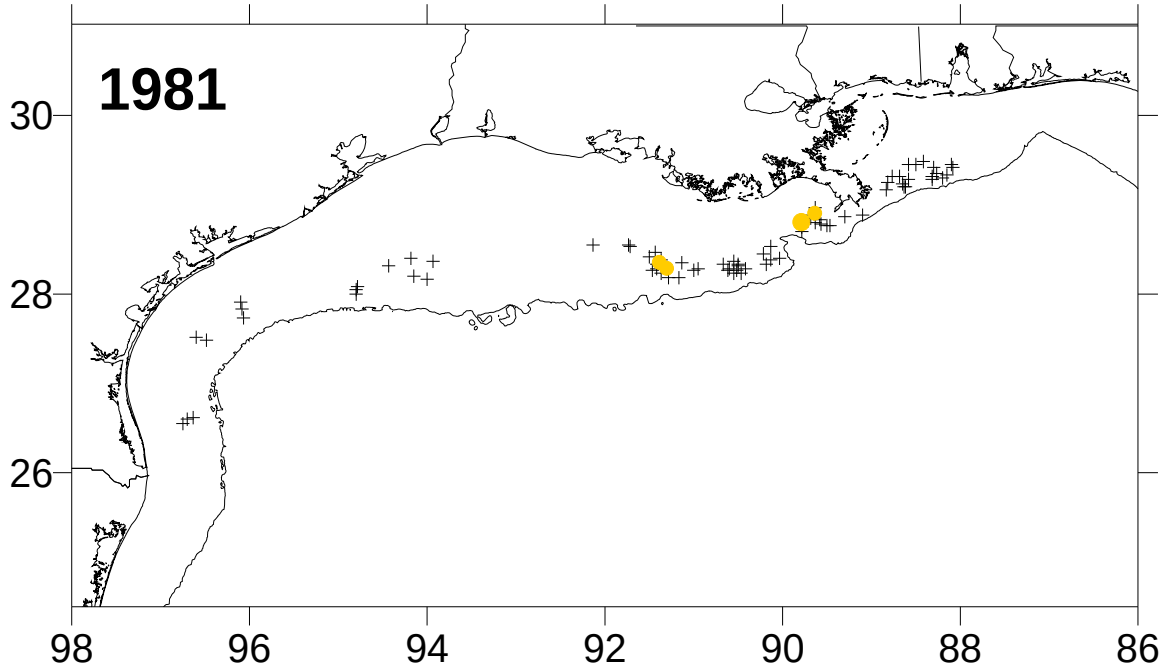
Appendix Figure 7. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1978. Each + indicates the starting point of a trawl station (N=93) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 8 fish per trawl-hour).



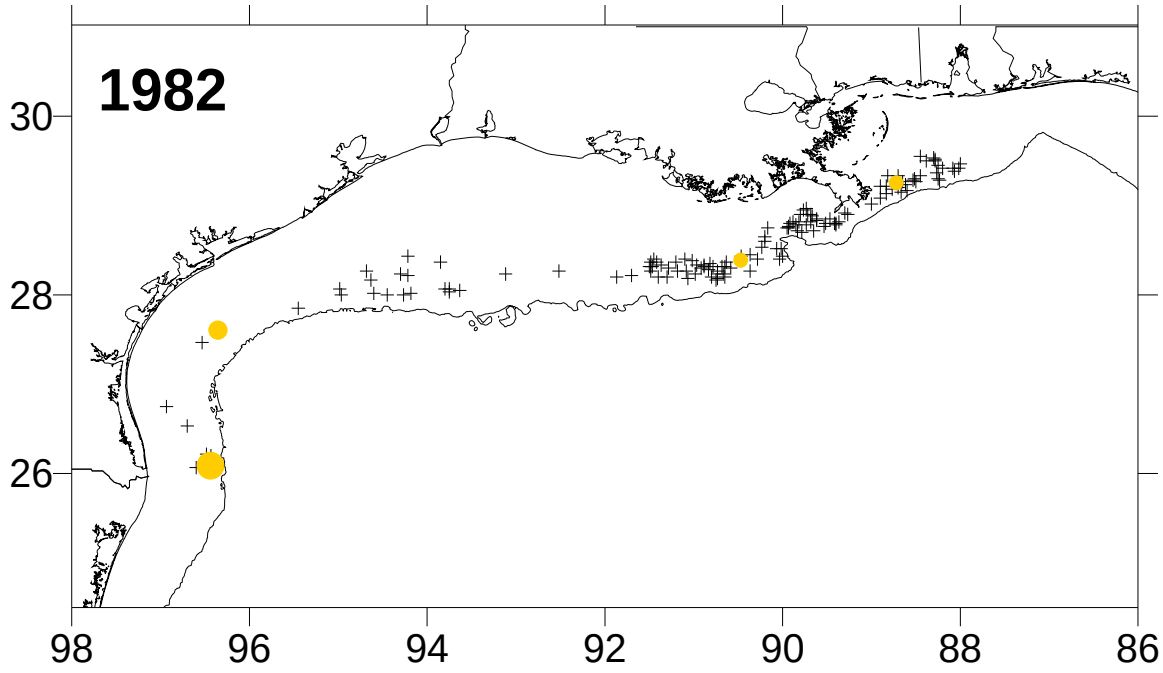
Appendix Figure 8. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1979. Each + indicates the starting point of a trawl (N=89). No yellowedge grouper were collected.



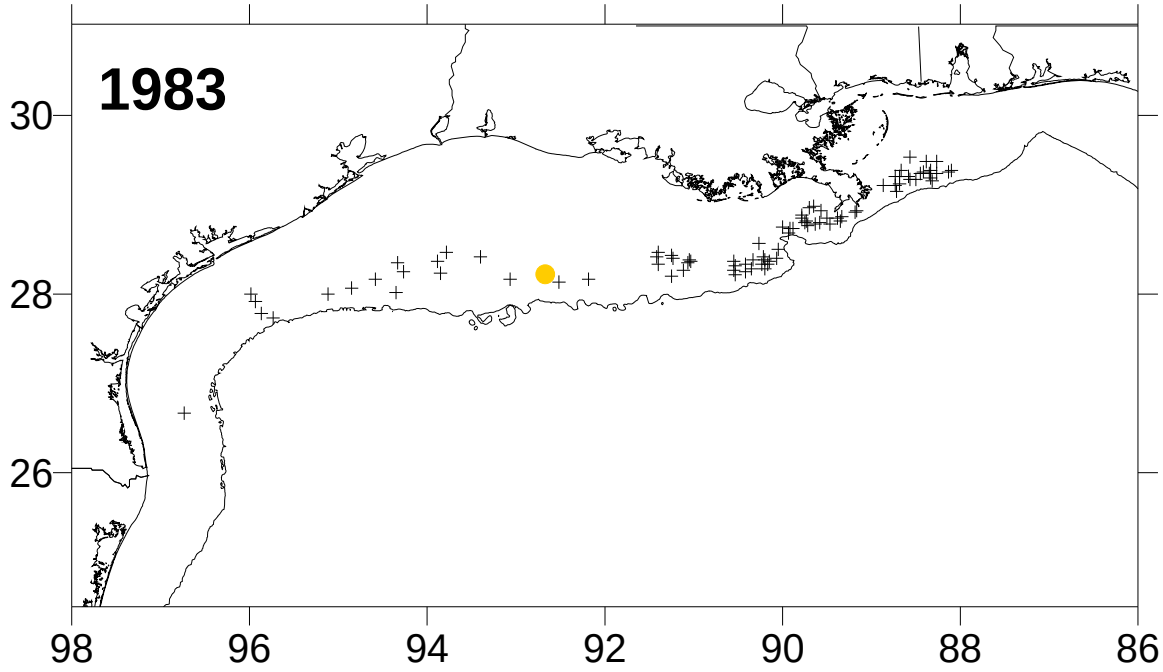
Appendix Figure 9. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1980. Each + indicates the starting point of a trawl station (N=77) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 2-6 fish per trawl-hour).



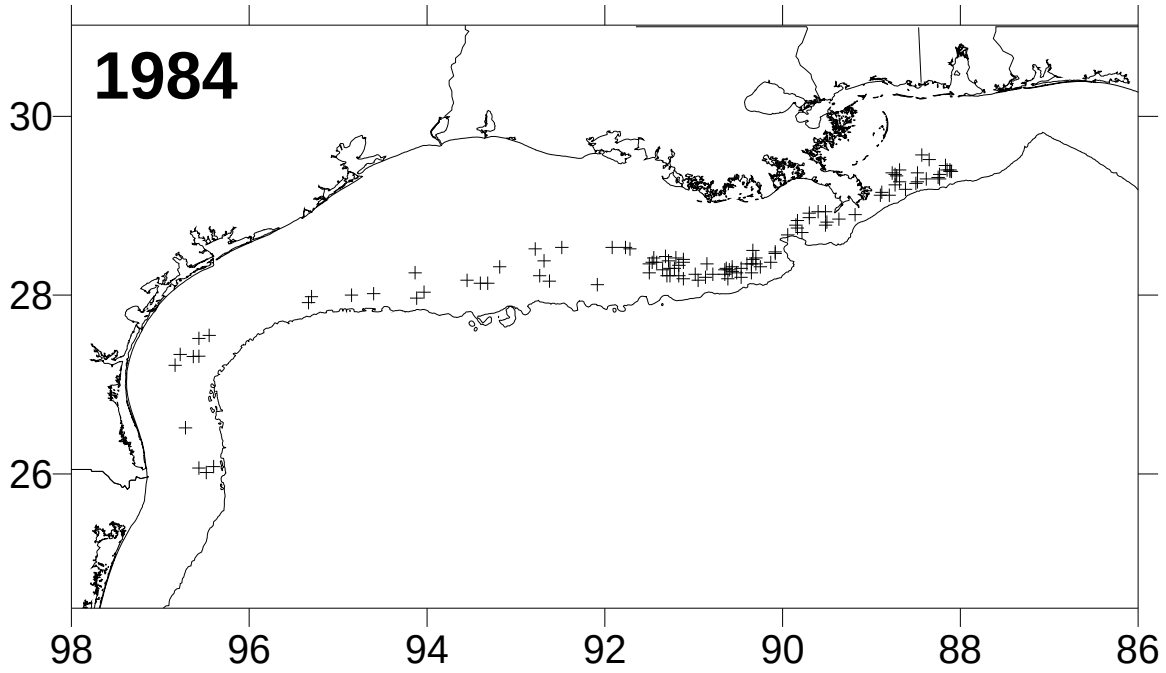
Appendix Figure 10. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1981. Each + indicates the starting point of a trawl station (N=81) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 2-4 fish per trawl-hour).



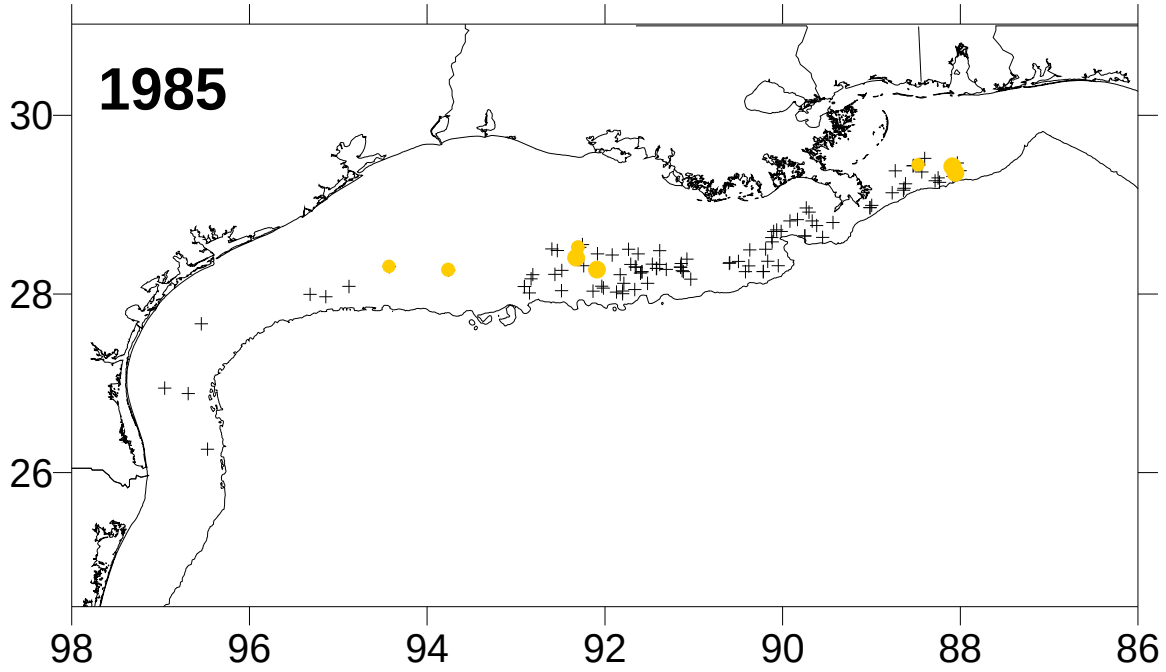
Appendix Figure 11. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1982. Each + indicates the starting point of a trawl station (N=139) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 2-11 fish per trawl-hour).



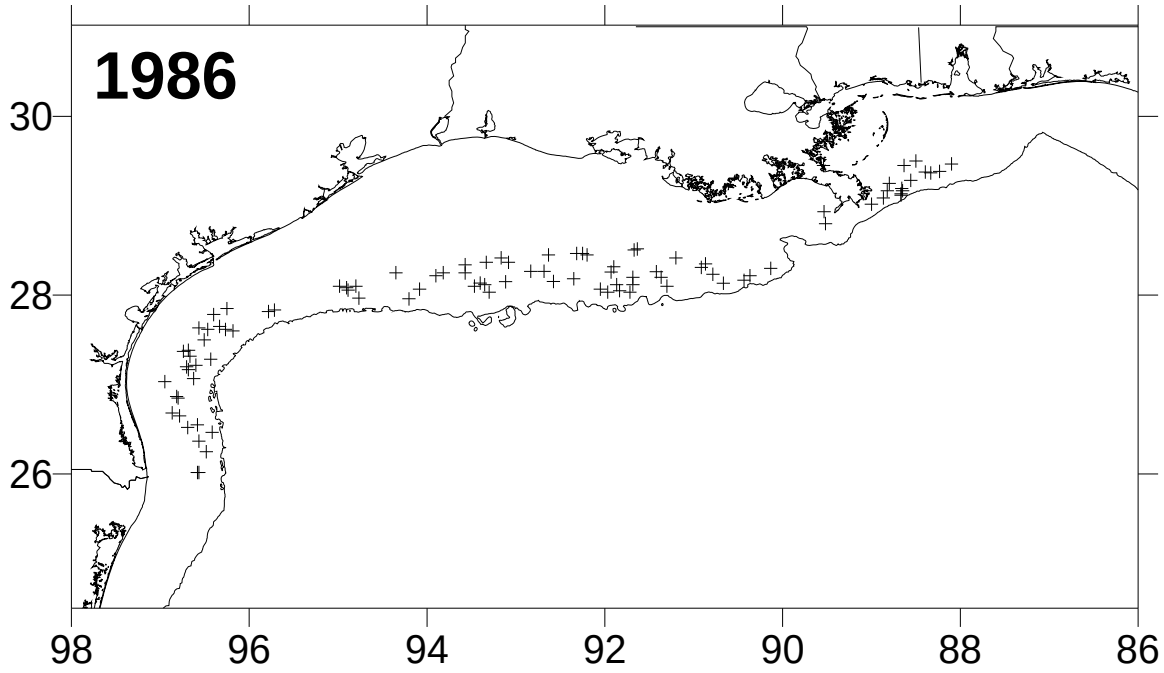
Appendix Figure 12. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1983. Each + indicates the starting point of a trawl station (N=89) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 5 fish per trawl-hour).



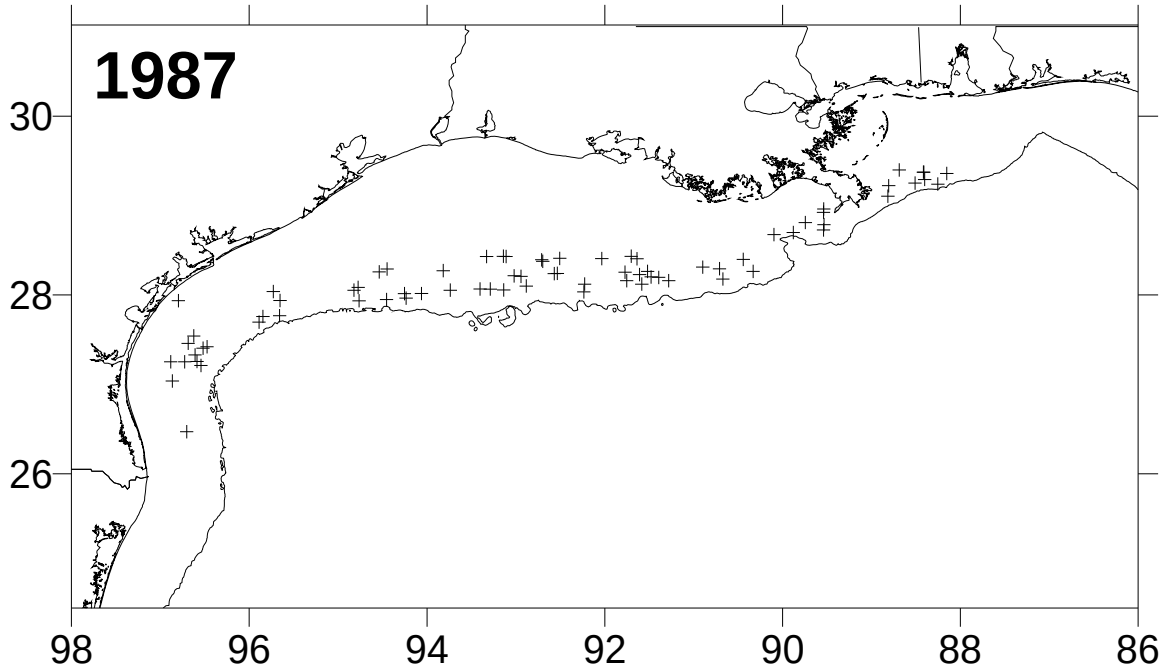
Appendix Figure 13. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1984. Each + indicates the starting point of a trawl (N=111). No yellowedge grouper were collected.



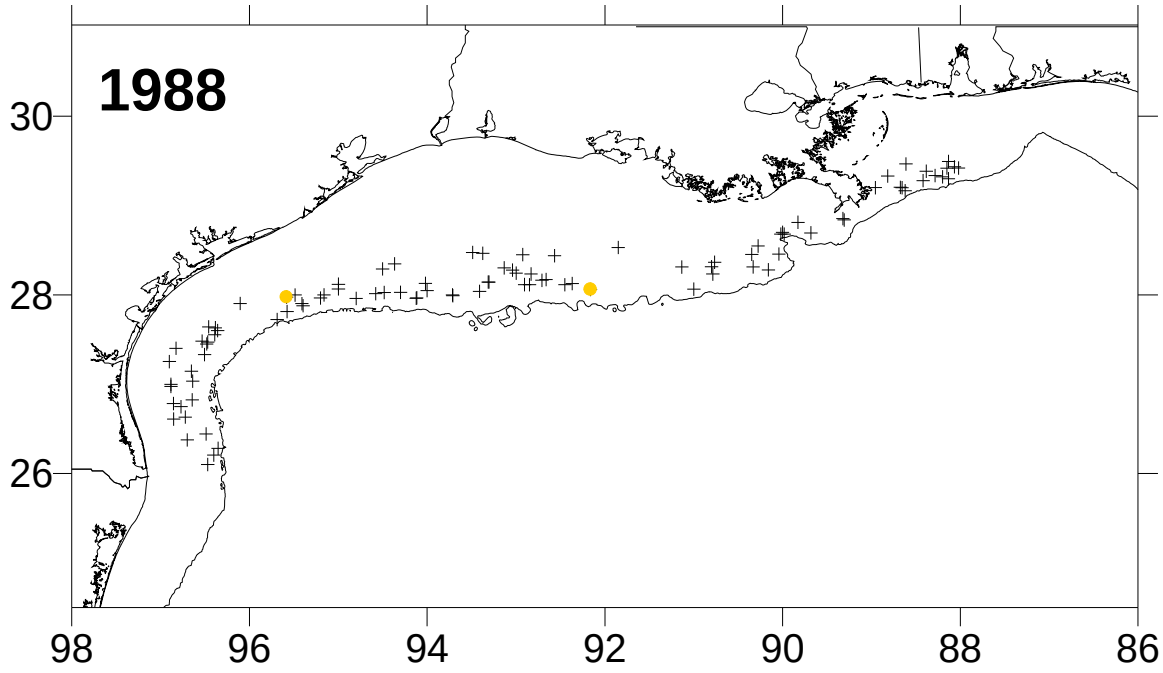
Appendix Figure 14. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1985. Each + indicates the starting point of a trawl station (N=105) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 1-4 fish per trawl-hour).



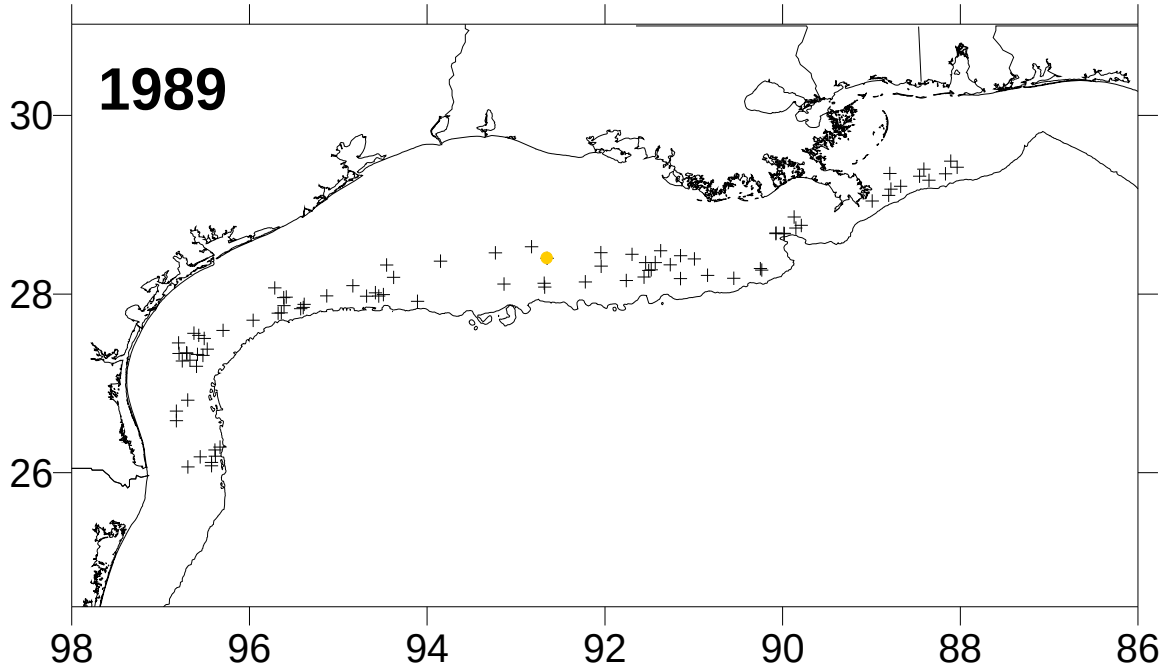
Appendix Figure 15. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1986. Each + indicates the starting point of a trawl (N=98). No yellowedge grouper were collected.



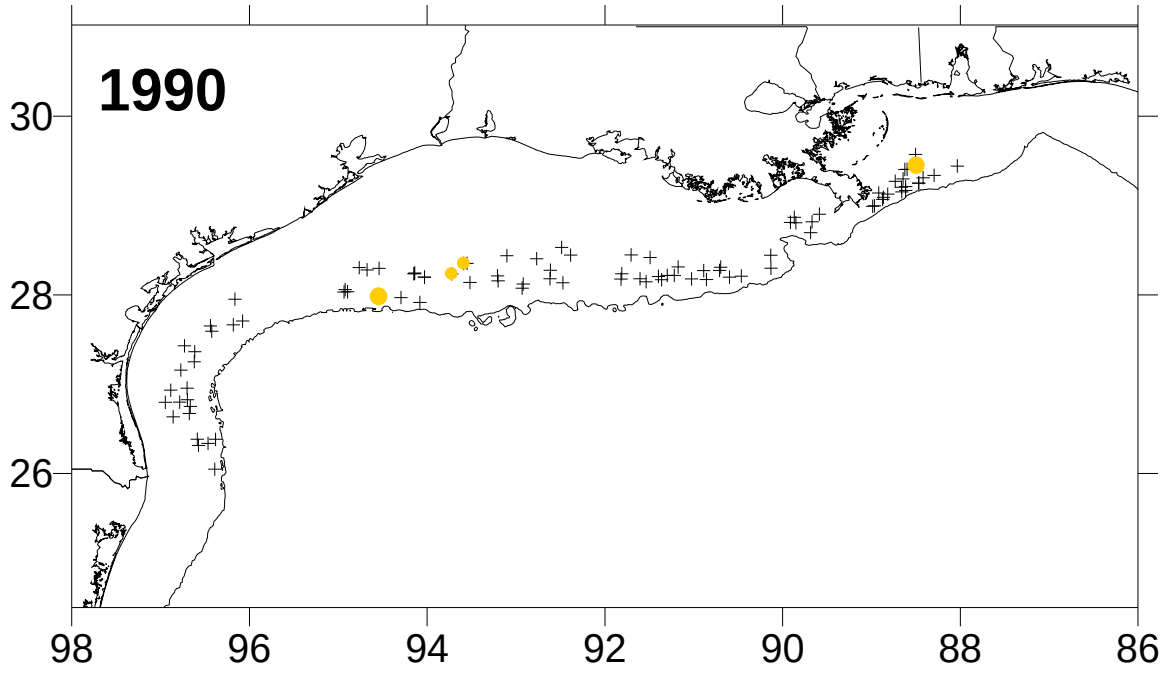
Appendix Figure 16. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1987. Each + indicates the starting point of a trawl (N=76). No yellowedge grouper were collected.



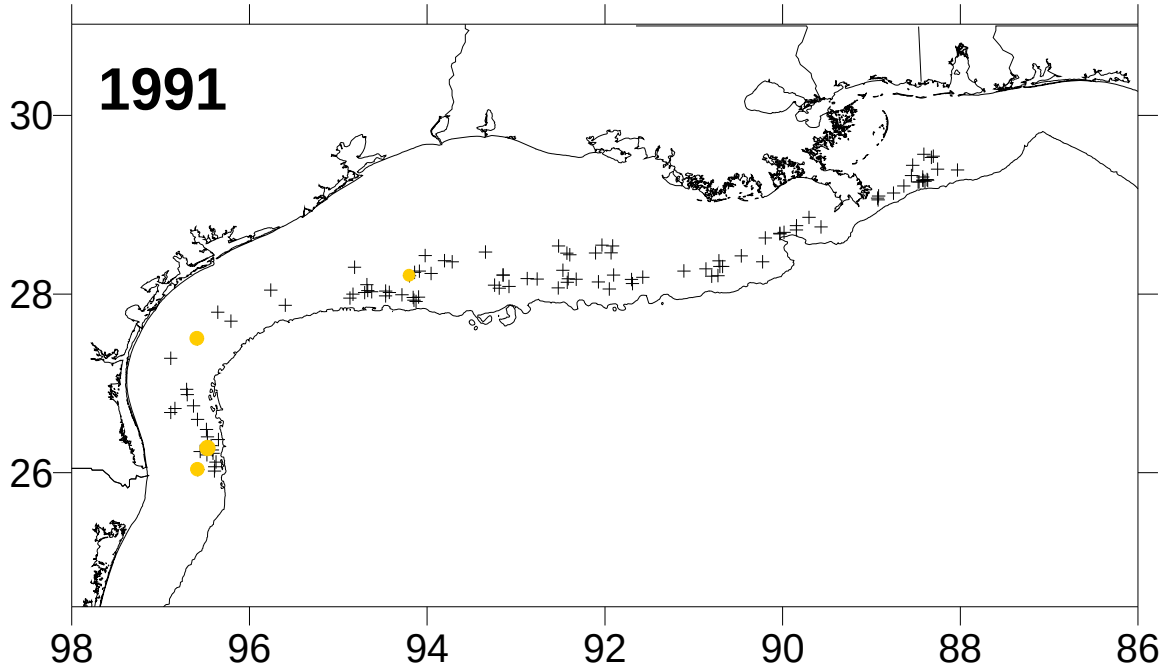
Appendix Figure 17. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1988. Each + indicates the starting point of a trawl station (N=98) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 1 fish per trawl-hour).



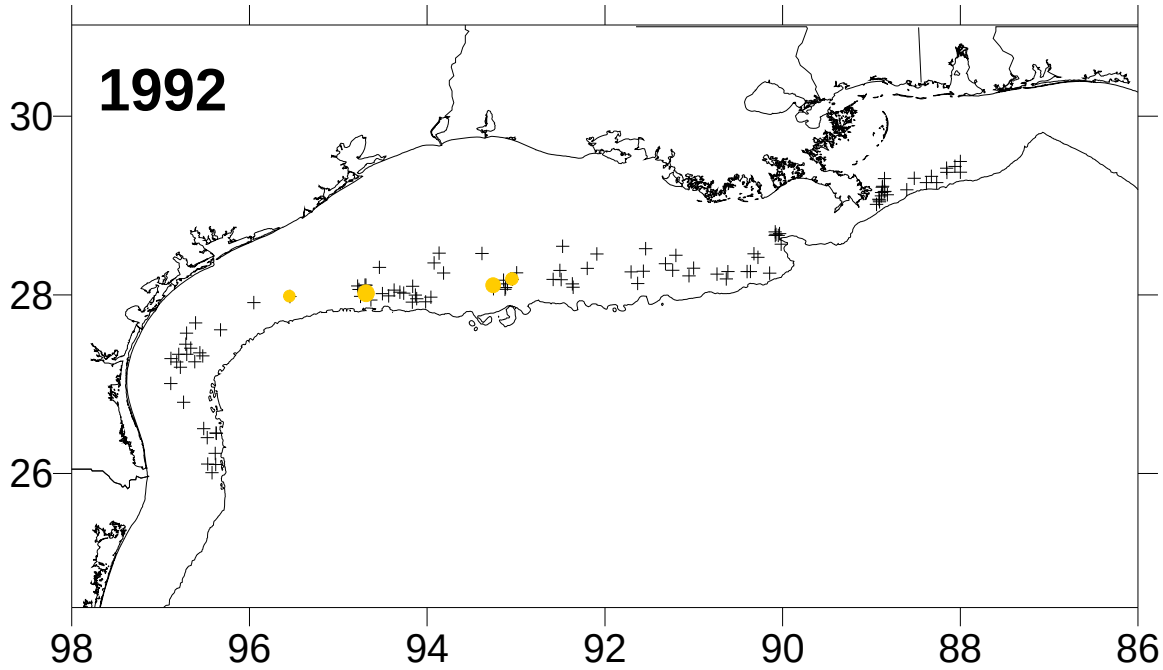
Appendix Figure 18. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1989. Each + indicates the starting point of a trawl station (N=87) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 0.5 fish per trawl-hour).



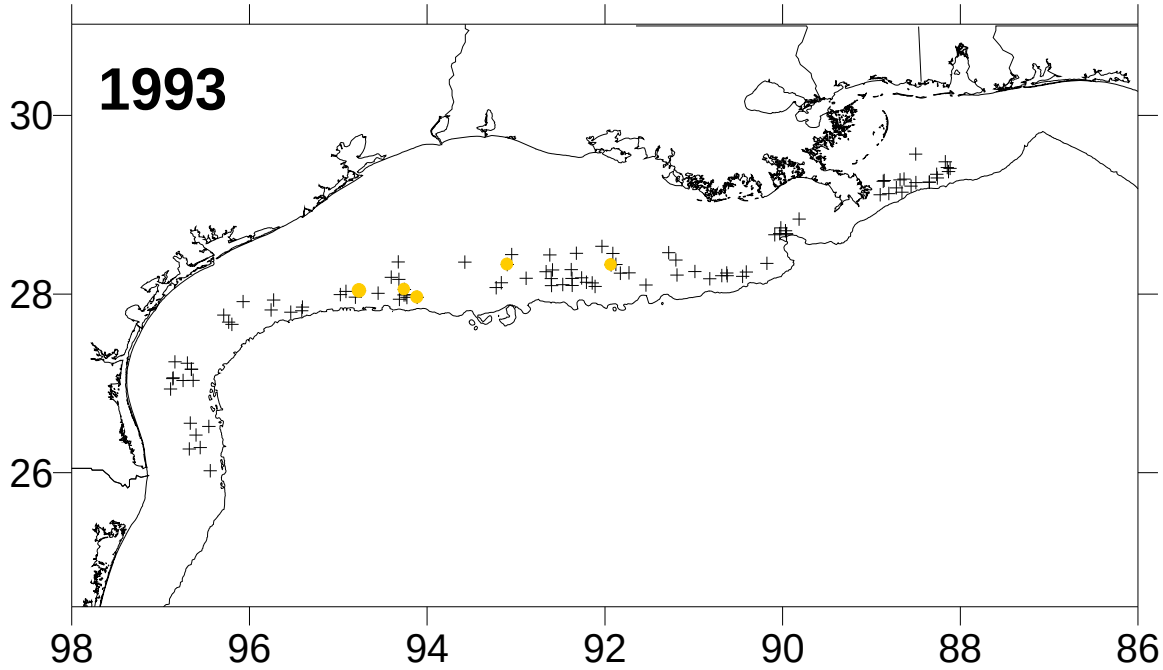
Appendix Figure 19. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1990. Each + indicates the starting point of a trawl station (N=100) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 0.5-4 fish per trawl-hour).



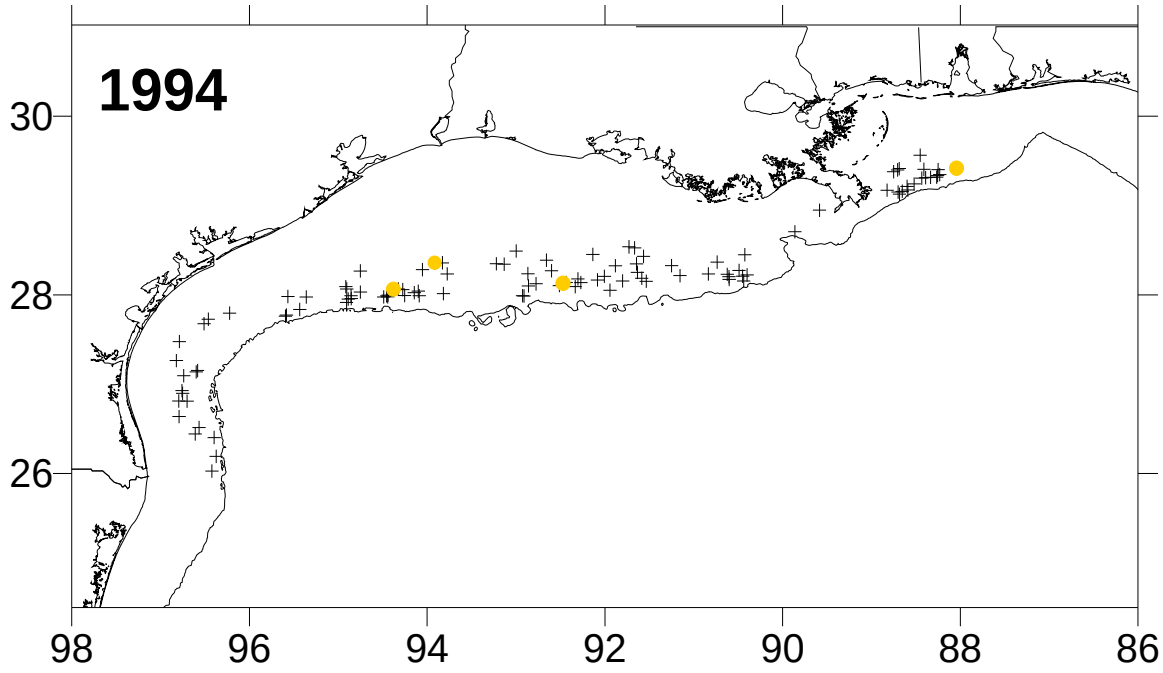
Appendix Figure 20. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1991. Each + indicates the starting point of a trawl station (N=110) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 0.5-3 fish per trawl-hour).



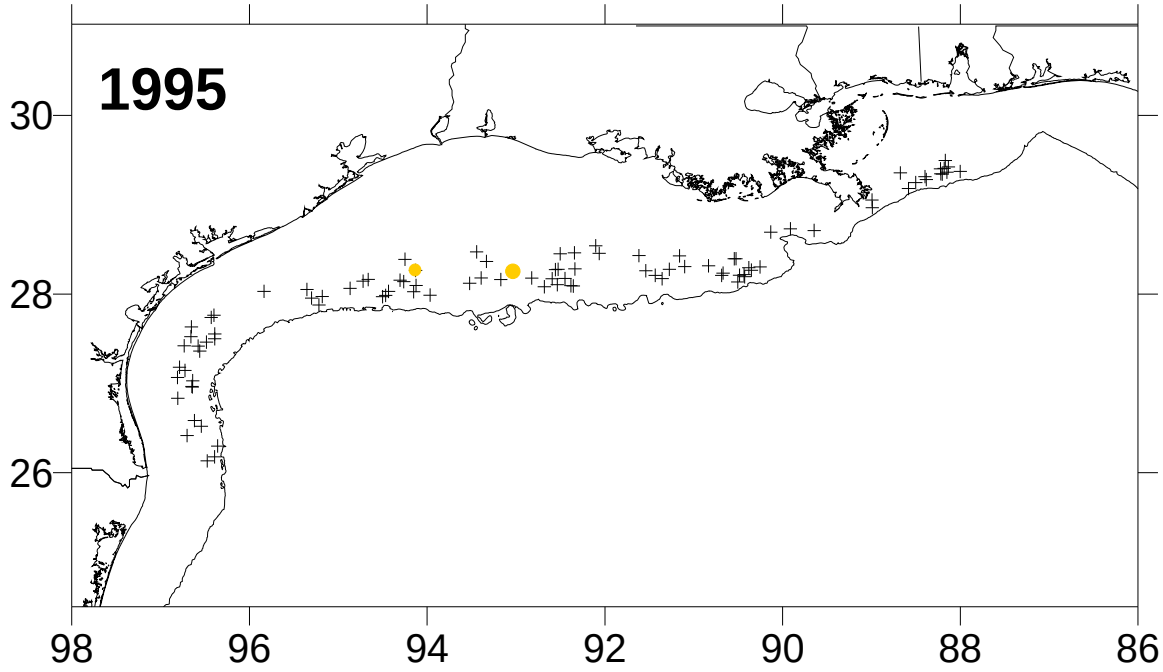
Appendix Figure 21. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1992. Each + indicates the starting point of a trawl station (N=109) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 0.5-4 fish per trawl-hour).



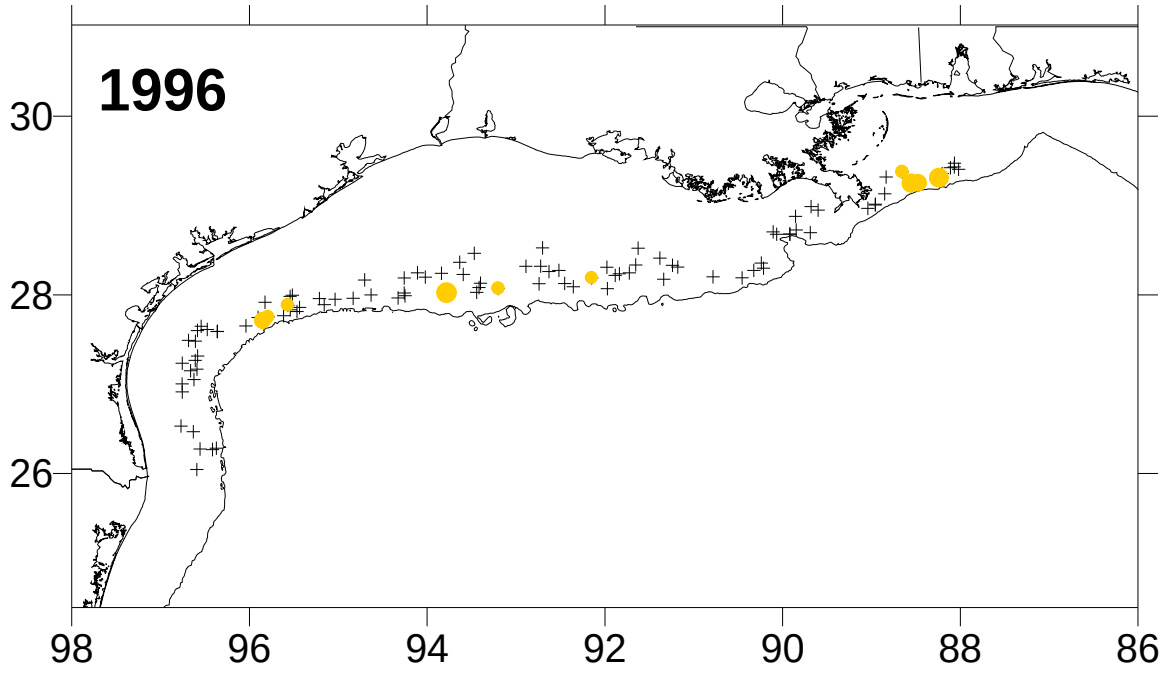
Appendix Figure 22. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1993. Each + indicates the starting point of a trawl station (N=102) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 0.5-2 fish per trawl-hour).



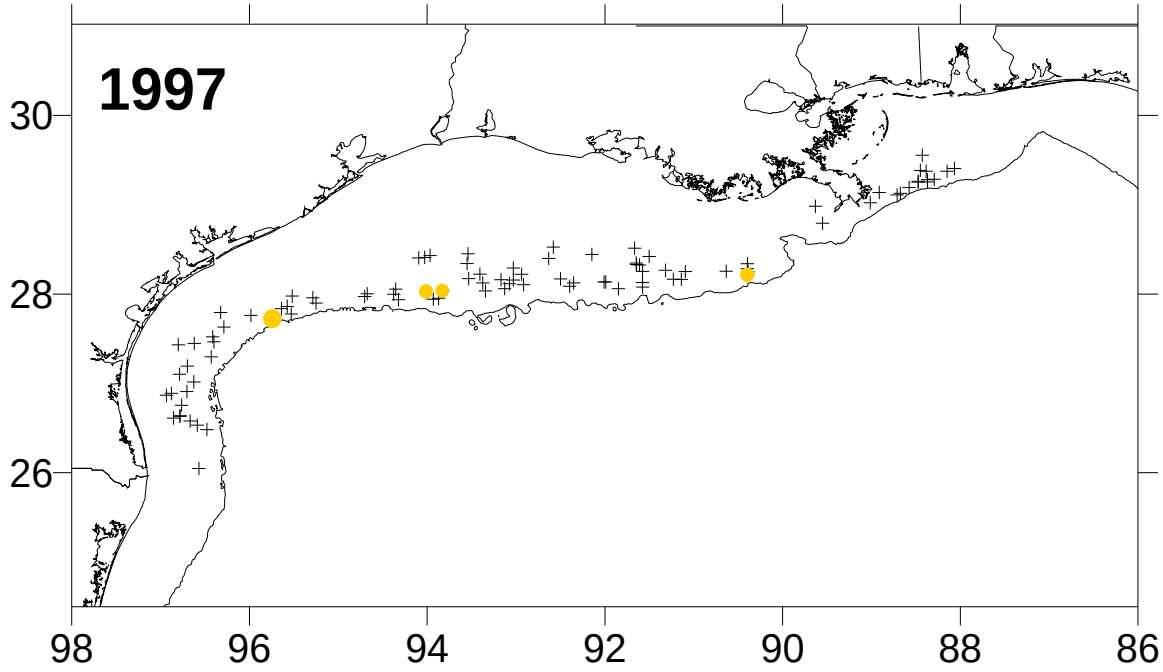
Appendix Figure 23. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1994. Each + indicates the starting point of a trawl station (N=110) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 1.5-2 fish per trawl-hour).



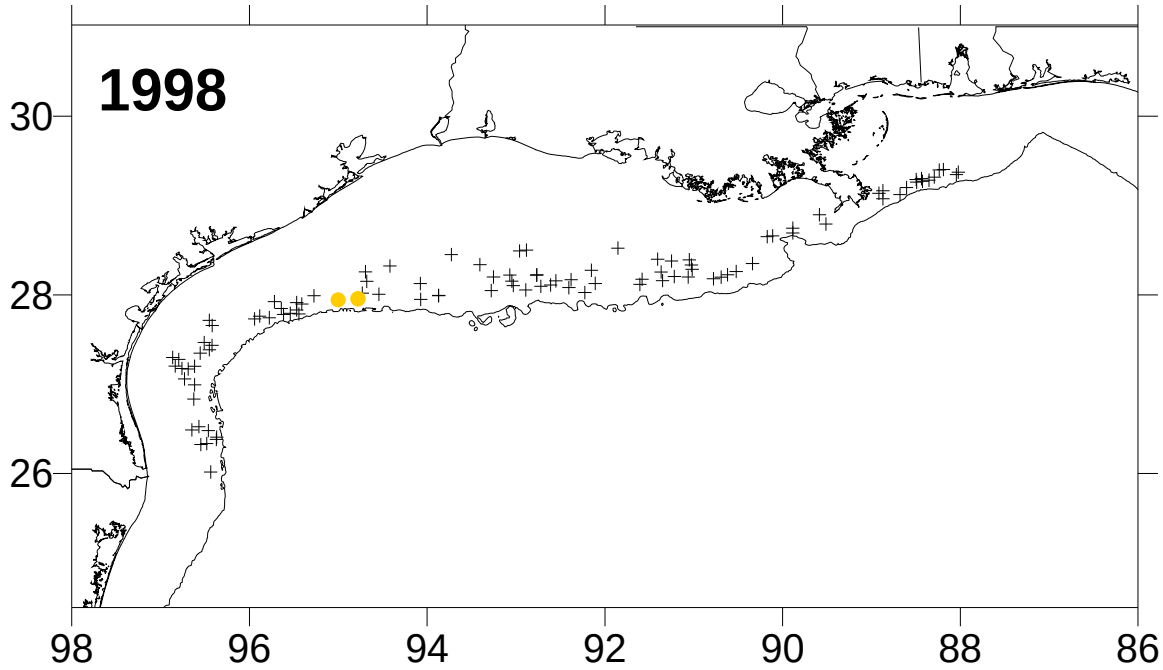
Appendix Figure 24. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1995. Each + indicates the starting point of a trawl station (N=98) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 0.5-2 fish per trawl-hour).



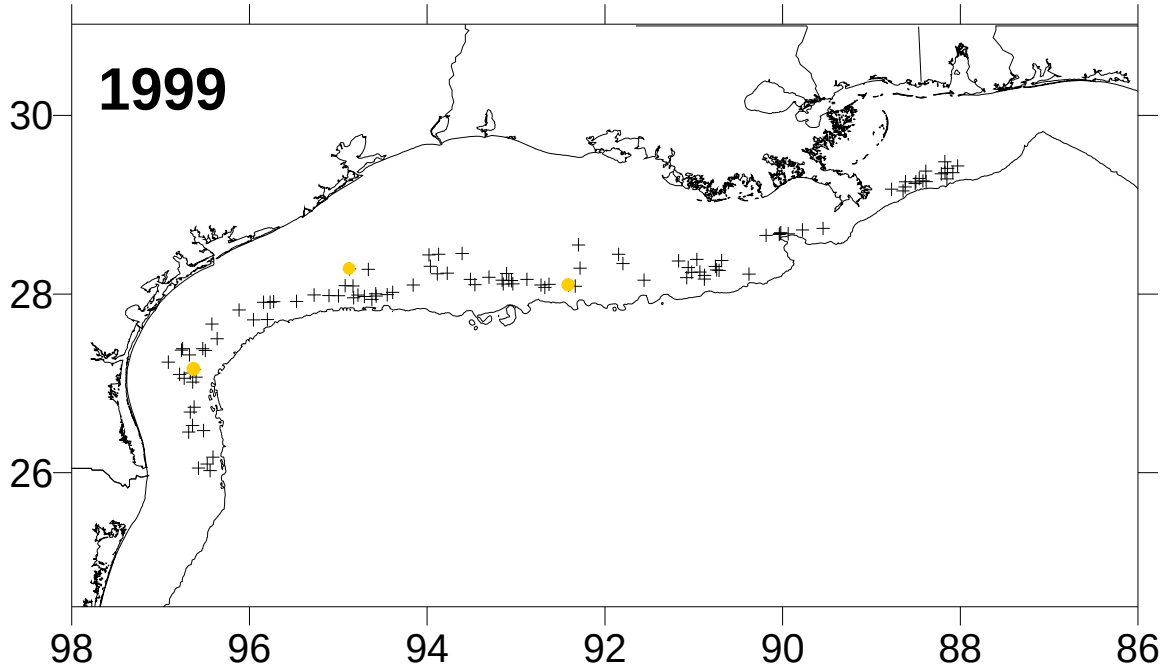
Appendix Figure 25. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1996. Each + indicates the starting point of a trawl station (N=104) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 1-6 fish per trawl-hour).



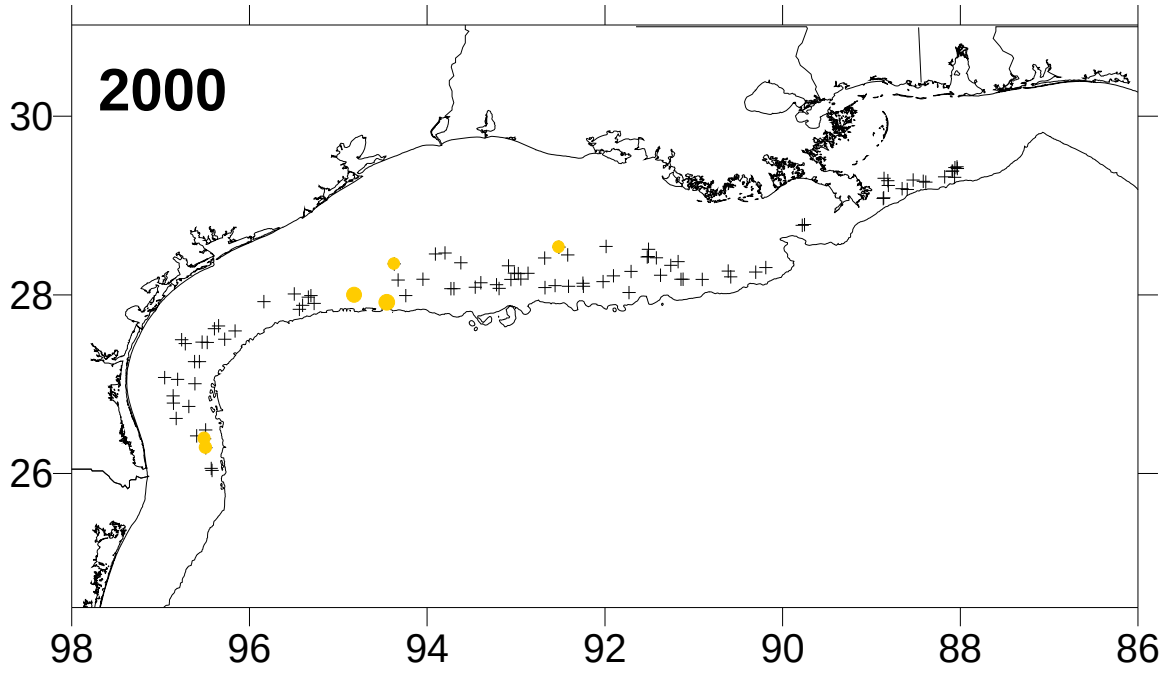
Appendix Figure 26. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1997. Each + indicates the starting point of a trawl station (N=98) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 1-5 fish per trawl-hour).



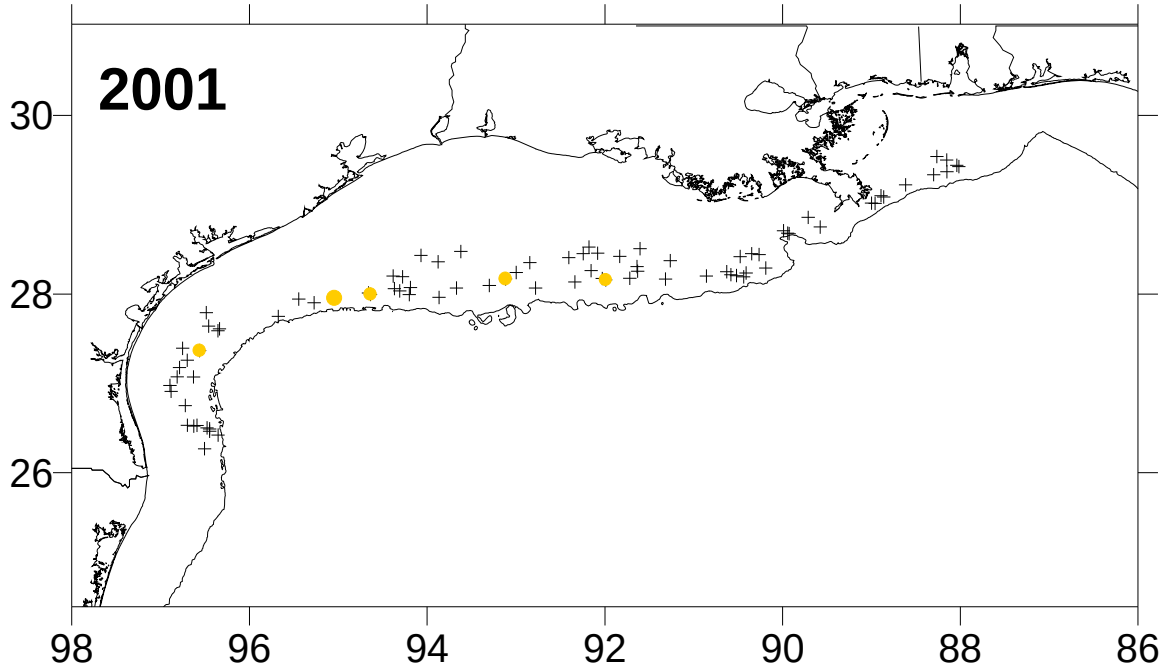
Appendix Figure 27. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1998. Each + indicates the starting point of a trawl station (N=104) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 2 fish per trawl-hour).



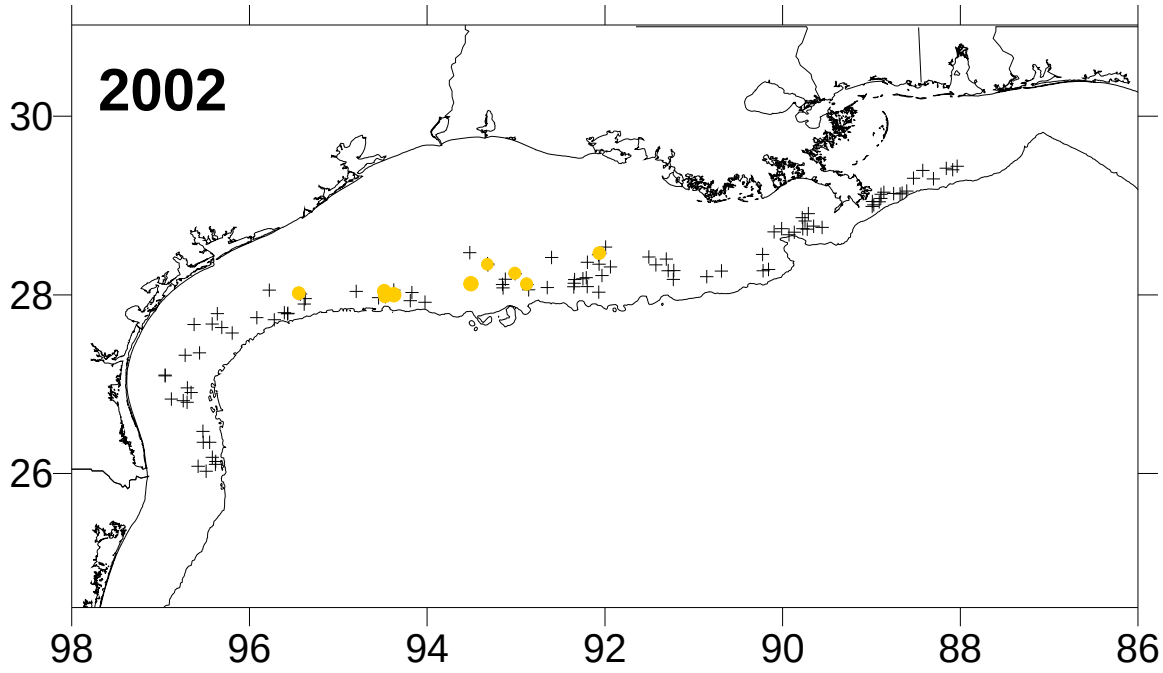
Appendix Figure 28. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 1999. Each + indicates the starting point of a trawl station (N=109) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 0.5-1 fish per trawl-hour).



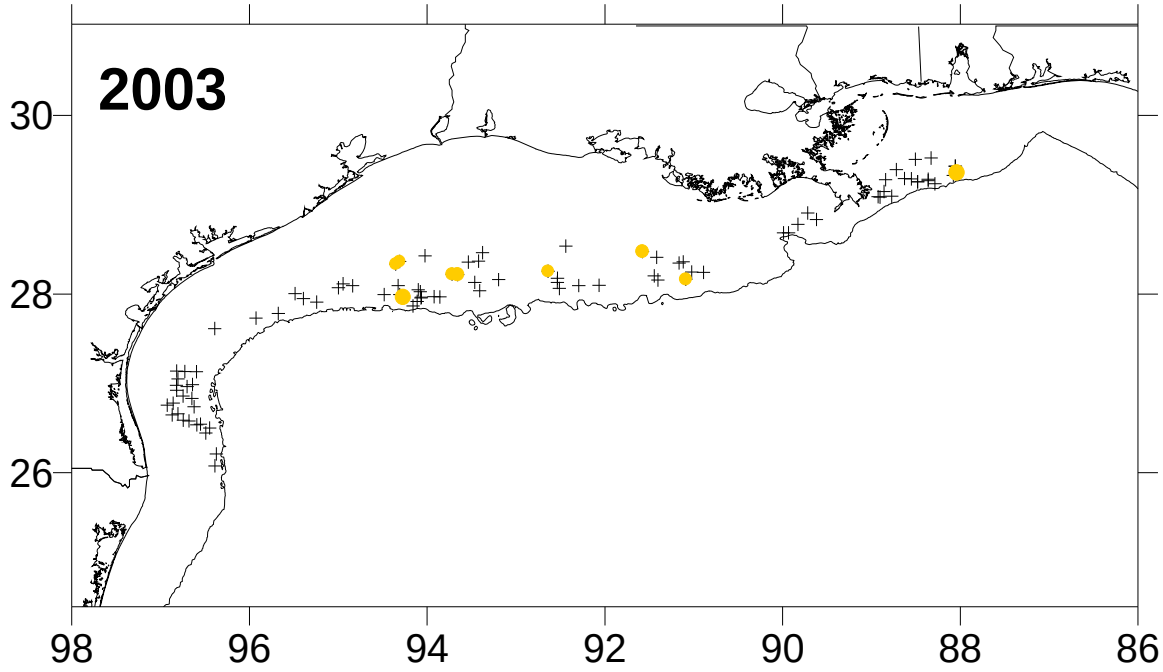
Appendix Figure 29. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 2000. Each + indicates the starting point of a trawl station (N=97) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 0.5-3 fish per trawl-hour).



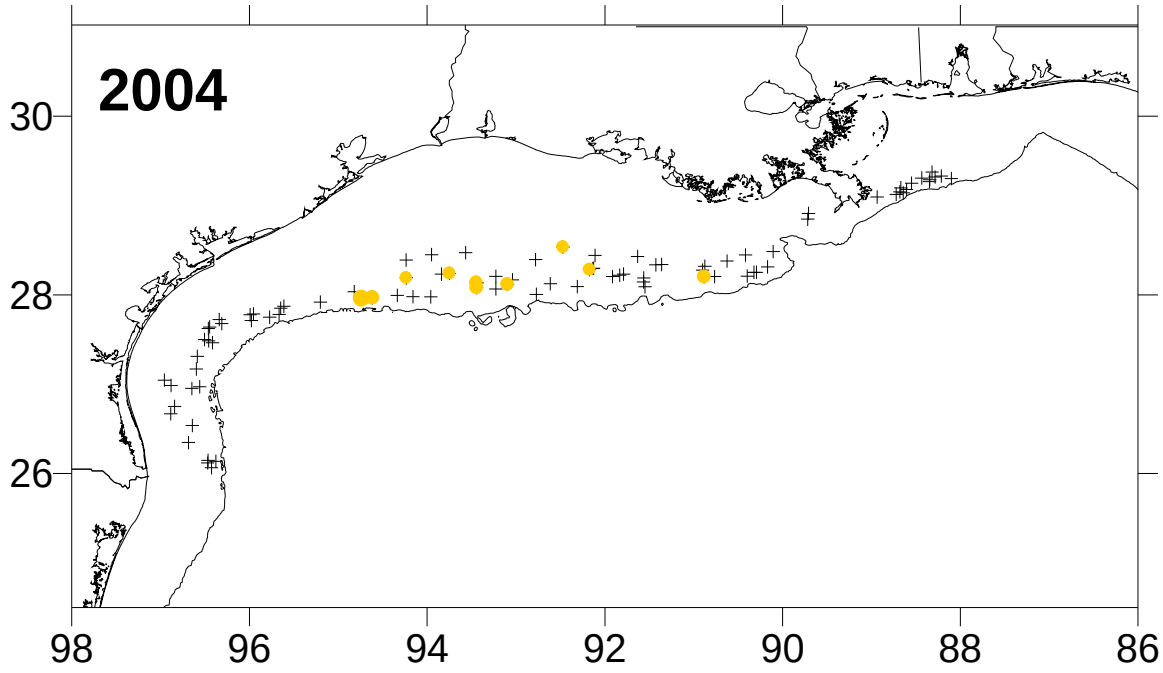
Appendix Figure 30. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 2001. Each + indicates the starting point of a trawl station (N=84) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 0.5-3 fish per trawl-hour).



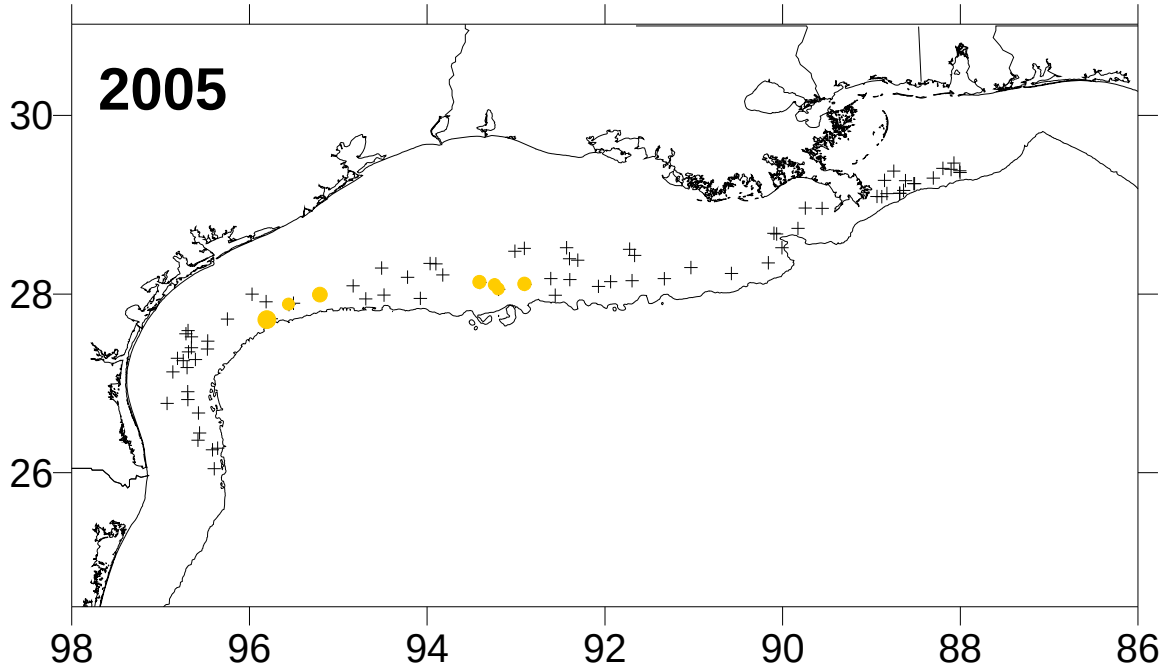
Appendix Figure 31. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 2002. Each + indicates the starting point of a trawl station (N=106) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 0.5-2 fish per trawl-hour).



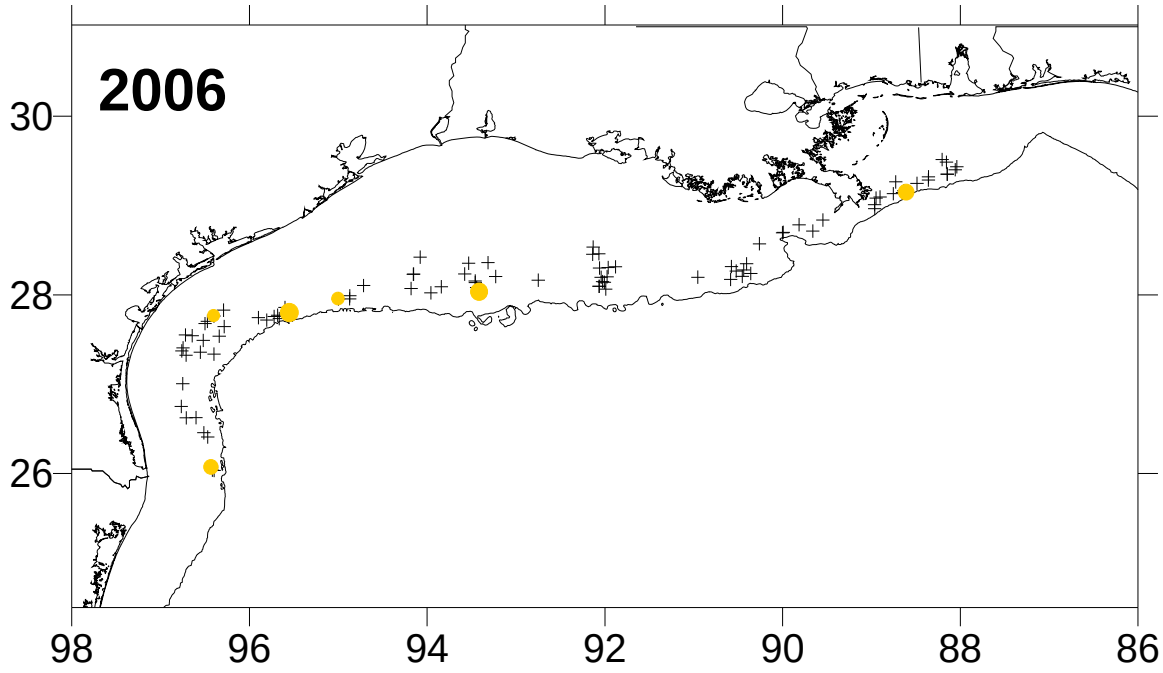
Appendix Figure 32. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 2003. Each + indicates the starting point of a trawl station (N=95) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 0.5-3 fish per trawl-hour).



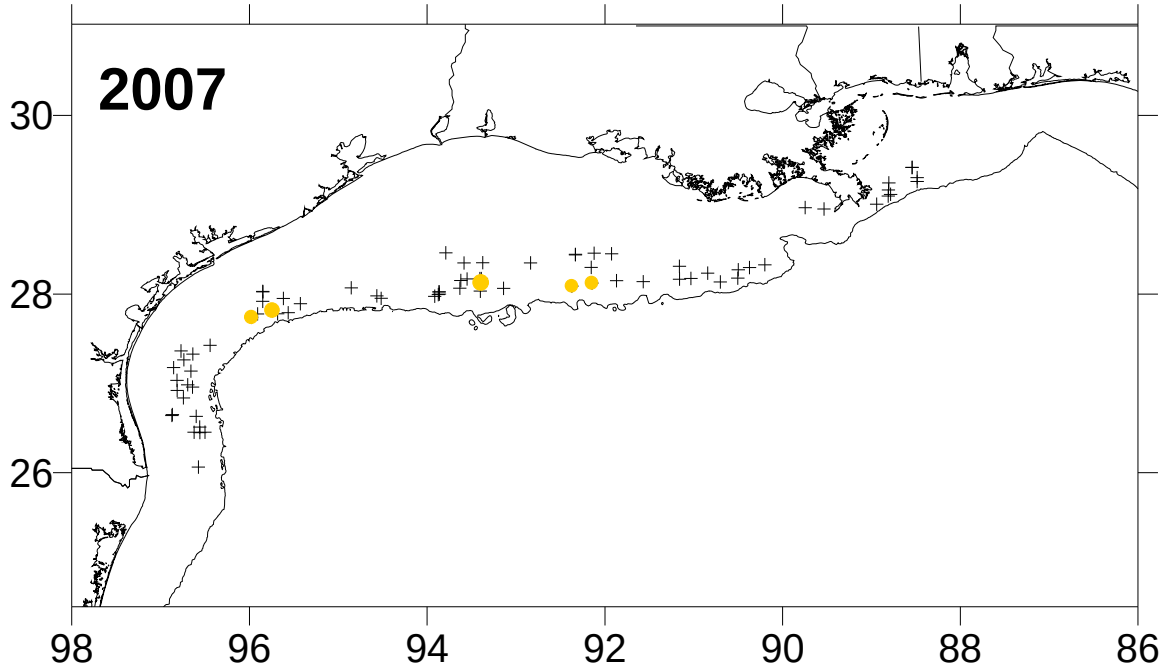
Appendix Figure 33. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 2004. Each + indicates the starting point of a trawl station (N=93) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 0.5-3 fish per trawl-hour).



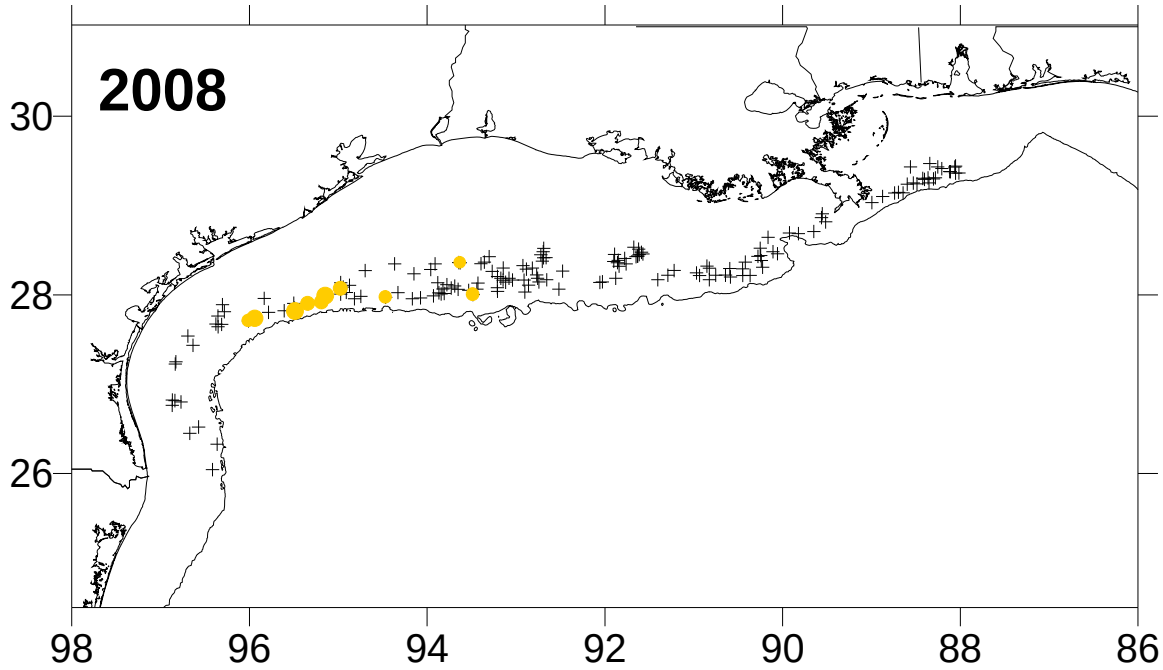
Appendix Figure 34. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 2005. Each + indicates the starting point of a trawl station (N=82) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 0.5-5 fish per trawl-hour).



Appendix Figure 35. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 2006. Each + indicates the starting point of a trawl station (N=95) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 1-5 fish per trawl-hour).



Appendix Figure 36. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 2007. Each + indicates the starting point of a trawl station (N=80) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 1-3 fish per trawl-hour).



Appendix Figure 37. Locations of groundfish survey trawls in the northern Gulf of Mexico conducted in 2008. Each + indicates the starting point of a trawl station (N=166) and the circles represent where yellowedge grouper were captured and the CPUE (Range of nonzero CPUE: 0.5-4 fish per trawl-hour).

Addendum for SEDAR 22-DW-06

After review by the Indices Workgroup there were multiple requests made by the group for additional information about the indices created for yellowedge grouper. The requests were:

- Examine annual nominal CPUE trends by shrimp statistical zone
- Examine overall nominal CPUE by shrimp statistical zone
- Examine distribution by depth zone
- Examine age structure

Based on discussion of the requests above, we were asked to recreate two indices for the yellowedge grouper and to include a new factor (fish time). The two indices were:

- Index that only involves data from the core region sampled from 1972-2008 (shrimp statistical zones 11-15)
- Index with data from entire area sampled (shrimp statistical zones 11-21) from 1987-2008

Annual trends in nominal CPUE in each shrimp statistical zone were examined and no apparent pattern was found between years or shrimp statistical zones (Addendum Figure 1). In addition, the nominal CPUE for the entire time series was examined by shrimp statistical zone and it appears that overall CPUE was slightly higher in the western shrimp statistical zones (16-21) as opposed to the central shrimp statistical zones (11-15) (Addendum Figure 2). With data obtained from the Life History Workgroup, the most fish captured during the groundfish survey are age 1 fish (Addendum Figure 3), with the majority being age 1-3. After examination of the depth distribution for yellowedge grouper (Addendum Figure 4), it appears that we are adequately sampling the area of distribution of the subadults, although it does appear we are missing the deeper end of their range because of survey limitations.

A new factor, fish time, was added to the binomial submodel. This factor represents the amount of time that the shrimp trawl was trawling on the bottom. Fish time was excluded from

the lognormal submodel. All other factors that were included in this model remained the same as in the main body of this document. Addendum Figure 5 shows the total coverage of stations.

For the model which covered the entire sampling area, year, shrimp statistical zone, depth zone and fish time were retained in the binomial submodel. The variables retained in the lognormal submodel were year, shrimp statistical zone and depth zone. Addendum Table 1 summarizes backward selection procedure used to select the final set of variables used in the binomial submodel and their significance. The AIC for the binomial and lognormal submodels were 12947.8 and 198.8, respectively. The AIC for the binomial submodel was the lowest in the final model run. The AIC for the lognormal submodel was not the lowest of all the model runs. However, because of the insignificance of the variables dropped, a higher AIC in later model runs was deemed acceptable. Addendum Figures 6A and 6B indicated the distribution of the residuals of the lognormal submodel is approximately normal. Addendum Table 2 and Addendum Figure 7 summarize indices of yellowedge grouper (number per trawl-hour) developed from this model.

Since groundfish data was available dating back to 1972, it was decided to build an index that described the relative abundance of yellowedge grouper in the area (shrimp statistical zones 11-15) where the survey has historically covered. Due to low sample numbers in shrimp statistical zones 13-15 (Table 1), it was decided to combine those shrimp statistical zones. From this combination, a new factor, region, was introduced into the model. The 'east' region contained shrimp statistical zone 11 and the 'west' region contained shrimp statistical zones 13-15. Addendum Table 3 summaries the annual sample numbers and nominal CPUE for East and West regions. Addendum Figure 8 shows the total coverage of stations.

The delta-lognormal model for 1972-2008 in the north central area (shrimp statistical zones 11-15) was constructed as previously described. The variables retained in the lognormal submodel were year, fish time, region and depth zone (Addendum Table 4). When the lognormal

submodel was run, no variables were significant. Therefore, it was decided to index abundance on modeled frequency of occurrence. Addendum Table 5 and Addendum Figure 9 summarize indices of yellowedge grouper (frequency of occurrence) developed from this model.

Addendum Table 1. Summary of backward selection procedure for building delta-lognormal submodels for yellowedge grouper index of relative abundance from 1987 to 2008 for the northern Gulf of Mexico (shrimp statistical zones 11-21).

Model Run #1	*Binomial Submodel Type 3 Tests (AIC 13027.3)*						*Lognormal Submodel Type 3 Tests (AIC 196.4)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	20	1999	29.65	1.48	0.0757	0.0772	20	71	1.36	0.1732
Shrimp Statistical Zone	7	1999	36.77	5.25	<.0001	<.0001	7	71	2.86	0.0109
Bottom Type	7	1999	13.70	1.96	0.0567	0.0573	7	71	1.51	0.1780
Depth Zone	5	1999	15.21	3.04	0.0095	0.0097	5	71	9.83	<.0001
Season	1	1999	2.45	2.45	0.1179	0.1180	1	71	0.04	0.8347
Time of Day	1	1999	0.16	0.16	0.6853	0.6853	1	71	0.13	0.7216
Fish Time	1	1999	12.84	12.84	0.0003	0.0003		excluded		
Model Run #2	*Binomial Submodel Type 3 Tests (AIC 13025.2)*						*Lognormal Submodel Type 3 Tests (AIC 194.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	20	2000	29.69	1.48	0.0751	0.0766	20	72	1.39	0.1577
Shrimp Statistical Zone	7	2000	36.77	5.25	<.0001	<.0001	7	72	2.97	0.0086
Bottom Type	7	2000	13.80	1.97	0.0548	0.0554	7	72	1.53	0.1717
Depth Zone	5	2000	15.23	3.05	0.0094	0.0096	5	72	10.07	<.0001
Season	1	2000	2.50	2.50	0.1141	0.1143		dropped		
Time of Day				dropped			1	72	0.11	0.7442
Fish Time	1	2000	12.97	12.97	0.0003	0.0003		excluded		
Model Run #3	*Binomial Submodel Type 3 Tests (AIC 12947.8)*						*Lognormal Submodel Type 3 Tests (AIC 192.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	20	2001	31.33	1.57	0.0510	0.0523	20	73	1.41	0.1459
Shrimp Statistical Zone	7	2001	38.74	5.53	<.0001	<.0001	7	73	3.04	0.0074
Bottom Type	7	2001	14.34	2.05	0.0454	0.0459	7	73	1.53	0.1700
Depth Zone	5	2001	15.42	3.08	0.0087	0.0089	5	73	10.95	<.0001
Season				dropped				dropped		
Time of Day				dropped				dropped		
Fish Time	1	2001	13.54	13.54	0.0002	0.0002		excluded		

Addendum Table 1 (continued).

Model Run #4	*Binomial Submodel Type 3 Tests (AIC 12947.8)*						*Lognormal Submodel Type 3 Tests (AIC 198.8)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
Year	20	2001	31.33	1.57	0.0510	0.0523	20	80	1.05	0.4143
Shrimp Statistical Zone	7	2001	38.74	5.53	<.0001	<.0001	7	80	2.63	0.0169
Bottom Type	7	2001	14.34	2.05	0.0454	0.0459		dropped		
Depth Zone	5	2001	15.42	3.08	0.0087	0.0089	5	80	10.05	<.0001
Season				dropped				dropped		
Time of Day				dropped				dropped		
Fish Time	1	2001	13.54	13.54	0.0002	0.0002		excluded		

Addendum Table 2. Indices of yellowedge grouper developed using the delta-lognormal model for 1987-2008. 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	0.0000	76	0.00000	0.00000			
1988	0.02041	98	0.01613	0.28347	2.37249	0.01811	4.43667
1989	0.01149	87	0.01029	0.18089	4.01535	0.00622	5.26367
1990	0.04000	100	0.07165	1.25953	0.96890	0.24744	6.41133
1991	0.03636	110	0.05424	0.95344	1.11989	0.15712	5.78579
1992	0.03670	109	0.03806	0.66896	1.20086	0.10108	4.42722
1993	0.04902	102	0.03718	0.65360	1.12655	0.10692	3.99541
1994	0.03636	110	0.06173	1.08509	1.02027	0.20037	5.87635
1995	0.02041	98	0.03386	0.59525	1.75882	0.05540	6.39541
1996	0.09615	104	0.11453	2.01325	0.58552	0.67969	5.96330
1997	0.04082	98	0.04334	0.76190	1.17310	0.11853	4.89735
1998	0.01923	104	0.02201	0.38698	2.10338	0.02872	5.21363
1999	0.02752	109	0.01140	0.20037	2.28525	0.01341	2.99402
2000	0.06186	97	0.04937	0.86788	0.96439	0.17145	4.39333
2001	0.05952	84	0.03451	0.60668	1.17456	0.09424	3.90568
2002	0.08491	106	0.11324	1.99055	0.59606	0.66078	5.99641
2003	0.09474	95	0.09128	1.60458	0.65687	0.48434	5.31592
2004	0.10753	93	0.08996	1.58142	0.62053	0.50502	4.95203
2005	0.08537	82	0.07370	1.29548	0.76691	0.33242	5.04872
2006	0.07368	95	0.10546	1.85382	0.67683	0.54282	6.33103
2007	0.06250	80	0.05903	1.03761	0.95042	0.20855	5.16238
2008	0.06024	166	0.06367	1.11925	0.68497	0.32373	3.86963

Addendum Table 3. Summary of the data used in the indices for east delta (shrimp statistical zone 11) and west delta (shrimp statistical zones 13-15) sampled by NOAA Fisheries during Summer and Fall SEAMAP groundfish surveys conducted between 1972 and 2008.

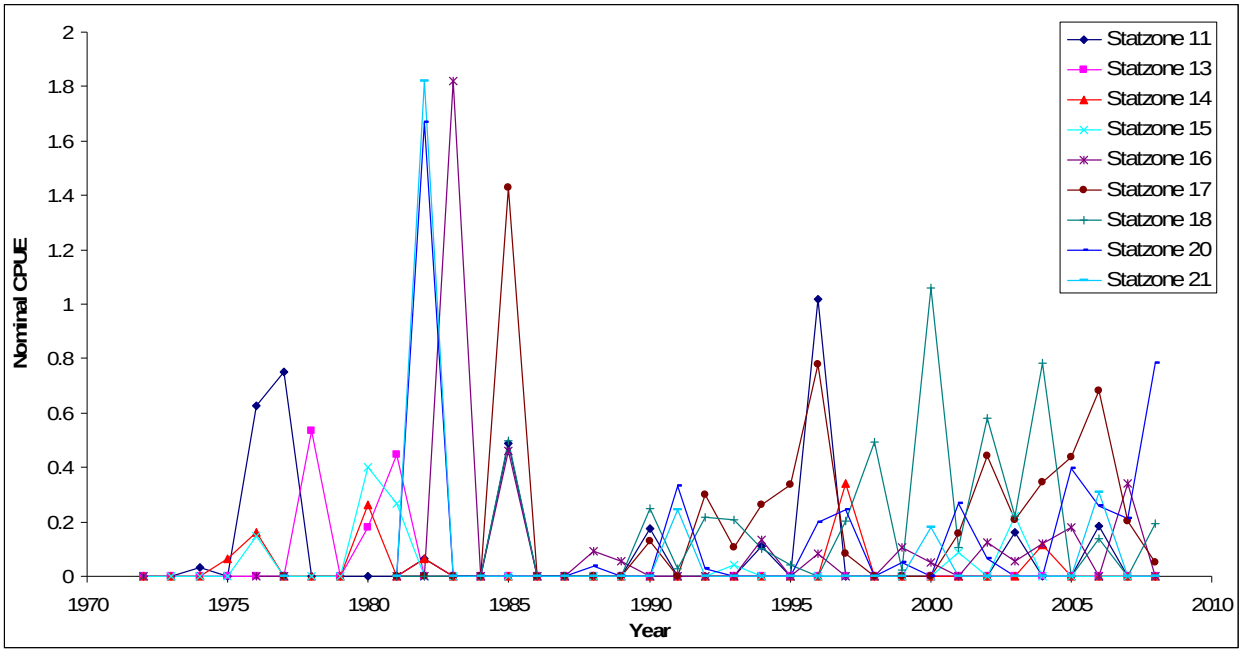
	East Region			West Region		
Year	Number of Stations	Number of Positive Catch Stations	Nominal CPUE	Number of Stations	Number of Positive Catch Stations	Nominal CPUE
1972	16	0	0.0000	55	0	0.0000
1973	30	0	0.0000	52	0	0.0000
1974	62	1	0.0323	144	0	0.0000
1975	33	0	0.0000	87	1	0.0230
1976	35	4	0.6286	90	2	0.1111
1977	24	3	0.7500	75	0	0.0000
1978	33	0	0.0000	60	1	0.1333
1979	31	0	0.0000	58	0	0.0000
1980	28	0	0.0000	49	4	0.2857
1981	19	0	0.0000	45	4	0.2286
1982	31	1	0.0645	81	1	0.0247
1983	22	0	0.0000	48	0	0.0000
1984	24	0	0.0000	60	0	0.0000
1985	19	3	0.4862	57	0	0.0000
1986	14	0	0.0000	25	0	0.0000
1987	9	0	0.0000	22	0	0.0000
1988	15	0	0.0000	18	0	0.0000
1989	11	0	0.0000	23	0	0.0000
1990	21	1	0.1770	26	0	0.0000
1991	20	0	0.0000	24	0	0.0000
1992	22	0	0.0000	23	0	0.0000
1993	19	0	0.0000	24	1	0.0162
1994	20	1	0.1111	24	0	0.0000
1995	15	0	0.0000	22	0	0.0000
1996	15	4	1.0204	26	0	0.0000
1997	14	0	0.0000	22	1	0.0779
1998	15	0	0.0000	23	0	0.0000
1999	17	0	0.0000	23	0	0.0000
2000	17	0	0.0000	20	0	0.0000
2001	11	0	0.0000	23	1	0.0303
2002	17	0	0.0000	24	0	0.0000
2003	19	1	0.1619	14	2	0.1266
2004	14	0	0.0000	22	1	0.0583
2005	17	0	0.0000	14	0	0.0000
2006	18	1	0.1837	18	0	0.0000
2007	9	0	0.0000	14	0	0.0000
2008	24	0	0.0000	46	0	0.0000

Addendum Table 4. Summary of backward selection procedure for building delta-lognormal submodels for yellowedge grouper index of relative abundance from 1972 to 2008 for statistical zones 11-15 in the northern Gulf of Mexico.

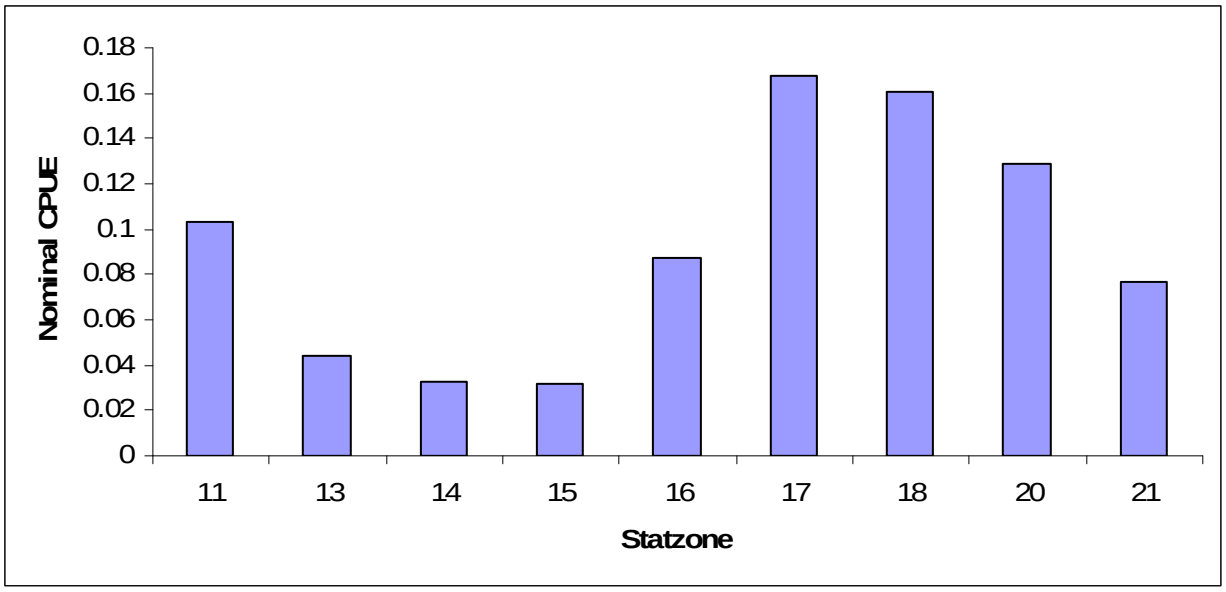
Model Run #1			*Binomial Model Type 3 Tests (AIC 9385.8)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*
Year	17	1295	21.79	1.28	0.1928	0.1950
Fish Time	1	1295	13.43	13.43	0.0002	0.0003
Region	1	1295	7.40	7.40	0.0065	0.0066
Depth Zone	5	1295	13.77	2.75	0.0172	0.0176
Time of Day	1	1295	0.51	0.51	0.4740	0.4741
Season	1	1295	0.03	0.03	0.8708	0.8708
Model Run #2			*Binomial Model Type 3 Tests (AIC 9391.9)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*
Year	17	1296	22.36	1.32	0.1714	0.1737
Fish Time	1	1296	13.39	13.39	0.0003	0.0003
Region	1	1296	7.40	7.40	0.0065	0.0066
Depth Zone	5	1296	13.80	2.76	0.0170	0.0174
Time of Day	1	1296	0.51	0.51	0.4759	0.4760
Season				dropped		
Model Run #3			*Binomial Model Type 3 Tests (AIC 9433.1)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*
Year	17	1297	21.29	1.25	0.2136	0.2158
Fish Time	1	1297	12.80	12.80	0.0003	0.0004
Region	1	1297	6.89	6.89	0.0087	0.0088
Depth Zone	5	1297	13.42	2.68	0.0197	0.0202
Time of Day				dropped		
Season				dropped		

Addendum Table 5. Indices of yellowedge grouper developed using a binomial model for 1972-2008. The nominal frequency of occurrence, the number of samples (*N*), the Index (frequency of occurrence), the indices scaled to a mean of one for the time series, the coefficient of variation on the mean (CV) are listed.

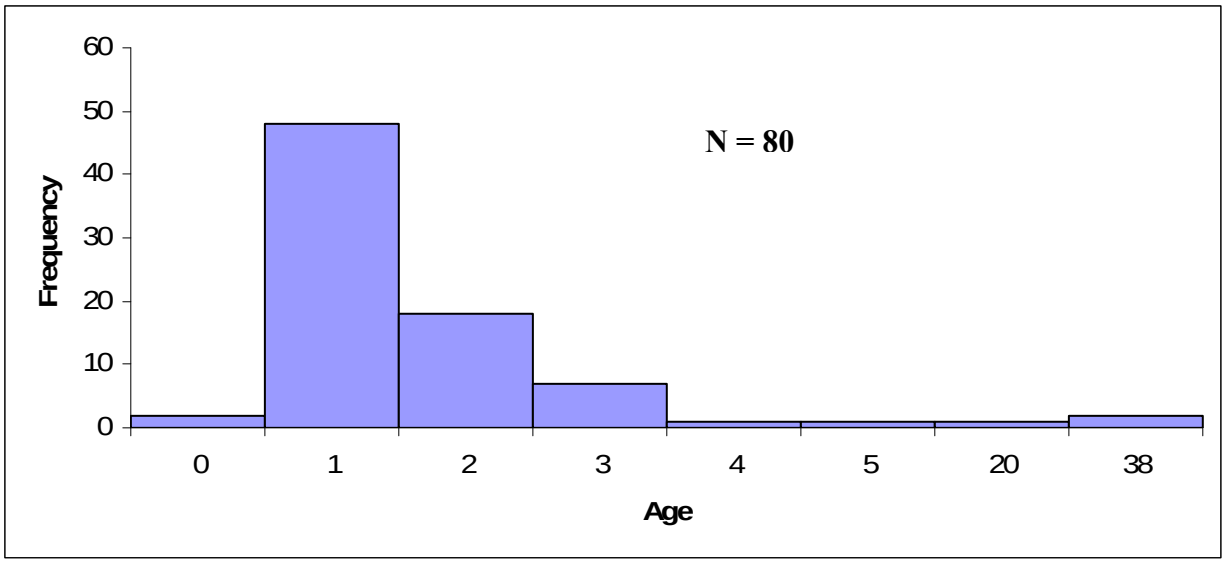
Survey Year	Frequency	*N*	Index	Scaled Index	CV
1972	0.00000	71	0.00000	0.00000	
1973	0.00000	82	0.00000	0.00000	
1974	0.004854	206	0.006213	0.20357	1.02076
1975	0.008333	120	0.012551	0.41125	1.01737
1976	0.048000	125	0.067274	2.20433	0.42036
1977	0.030303	99	0.036586	1.19879	0.59099
1978	0.010753	93	0.014303	0.46865	1.02146
1979	0.00000	89	0.00000	0.00000	
1980	0.051948	77	0.085347	2.79652	0.50322
1981	0.062500	64	0.085211	2.79206	0.50076
1982	0.017857	112	0.02642	0.86569	0.72286
1983	0.00000	70	0.00000	0.00000	
1984	0.00000	84	0.00000	0.00000	
1985	0.039474	76	0.043833	1.43625	0.61785
1986	0.00000	39	0.00000	0.00000	
1987	0.00000	31	0.00000	0.00000	
1988	0.00000	33	0.00000	0.00000	
1989	0.00000	34	0.00000	0.00000	
1990	0.021277	47	0.008361	0.27396	1.07260
1991	0.00000	44	0.00000	0.00000	
1992	0.00000	45	0.00000	0.00000	
1993	0.023256	43	0.009199	0.30141	1.11295
1994	0.022727	44	0.009348	0.30630	1.07189
1995	0.00000	37	0.00000	0.00000	
1996	0.097561	41	0.054722	1.79304	0.56820
1997	0.027778	36	0.008162	0.26743	1.12227
1998	0.00000	38	0.00000	0.00000	
1999	0.00000	40	0.00000	0.00000	
2000	0.00000	37	0.00000	0.00000	
2001	0.029412	34	0.012033	0.39427	1.10039
2002	0.00000	41	0.00000	0.00000	
2003	0.090909	33	0.045736	1.49860	0.66044
2004	0.027778	36	0.011736	0.38454	1.07021
2005	0.00000	31	0.00000	0.00000	
2006	0.027778	36	0.012299	0.40299	1.08513
2007	0.00000	23	0.00000	0.00000	
2008	0.00000	70	0.00000	0.00000	



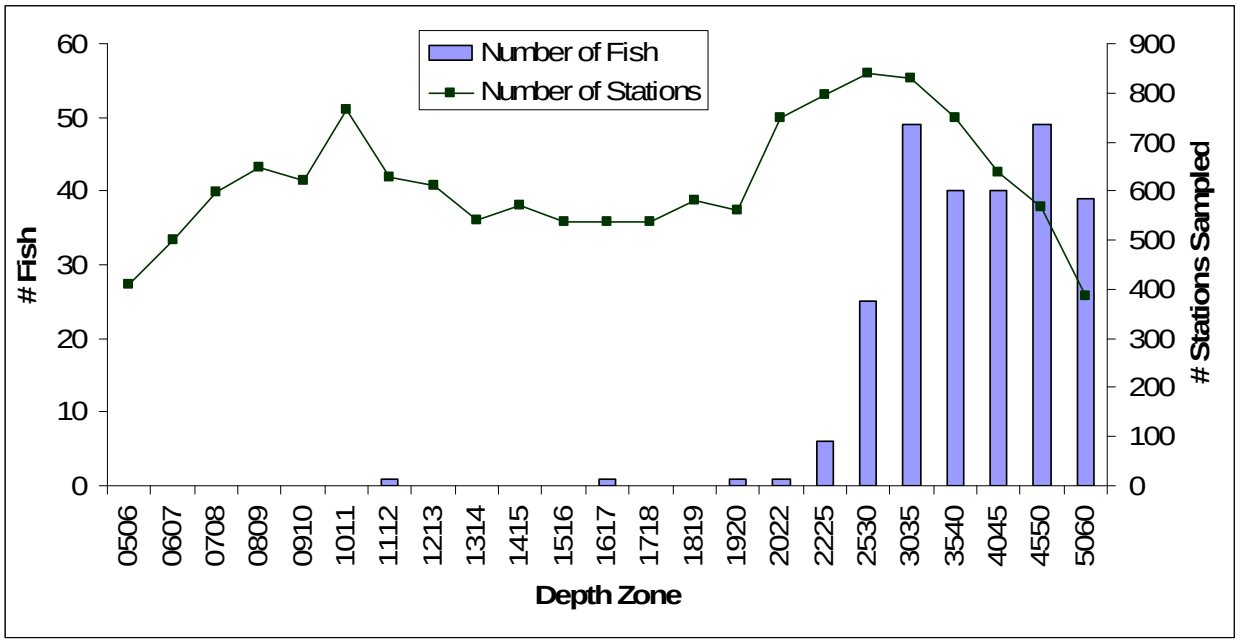
Addendum Figure 1. Annual nominal CPUE (fish per trawl-hour) of yellowedge grouper captured in each shrimp statistical zone during NOAA Fisheries Summer and Fall SEAMAP surveys in the northern Gulf of Mexico.



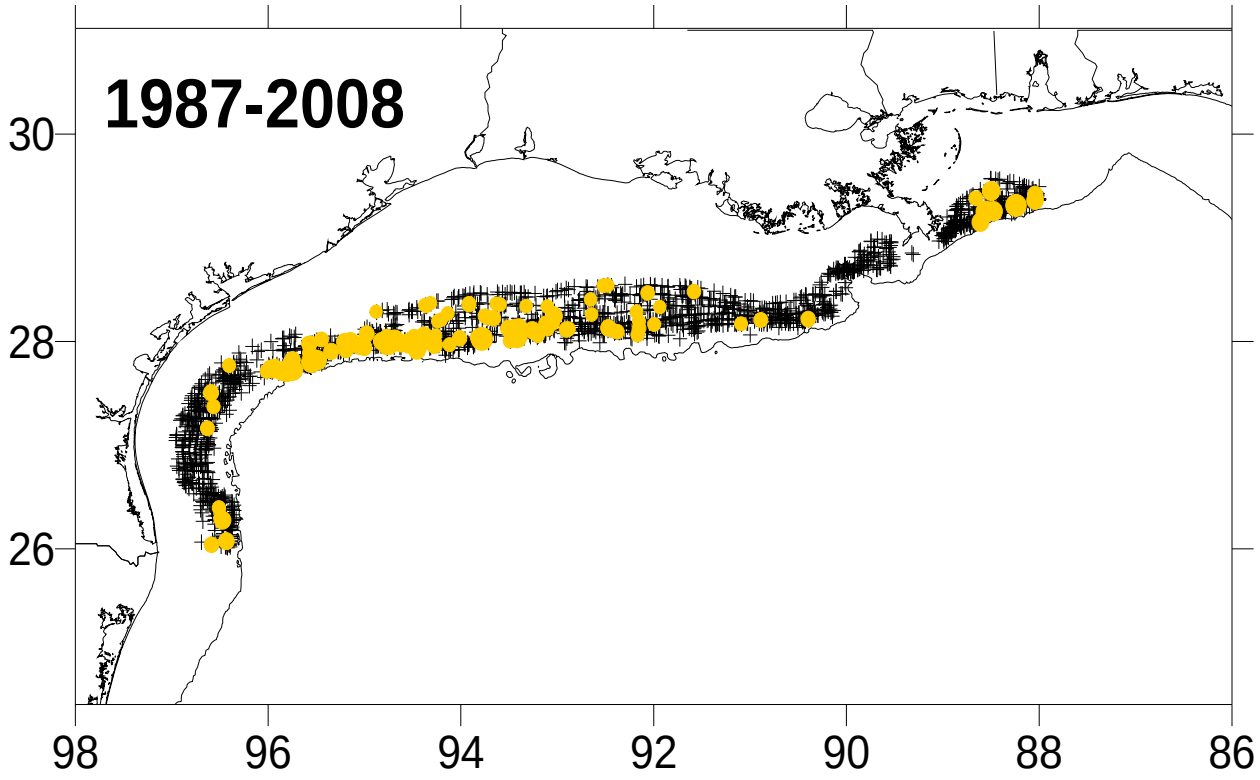
Addendum Figure 2. Nominal CPUE (fish per trawl-hour) from 1972 – 2008 of yellowedge grouper captured in each shrimp statistical zone during NOAA Fisheries Summer and Fall SEAMAP surveys in the northern Gulf of Mexico.



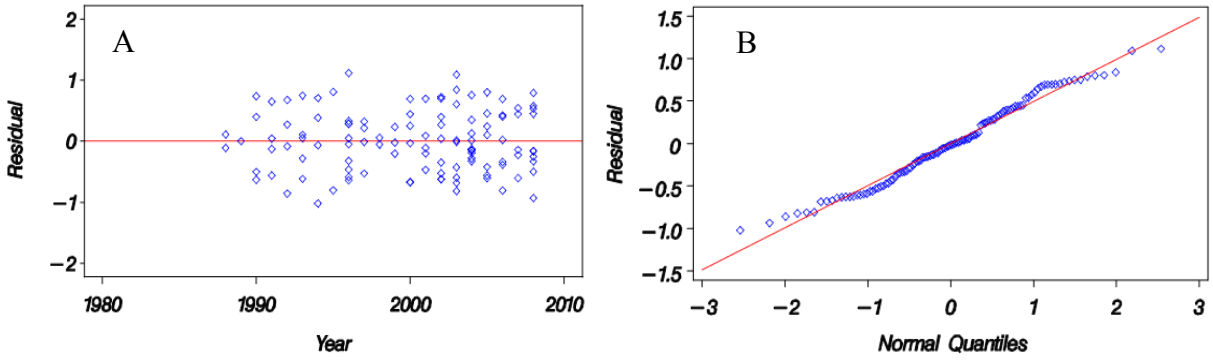
Addendum Figure 3. Age class distribution of yellowedge grouper captured during NOAA Fisheries Summer and Fall SEAMAP groundfish surveys in the northern Gulf of Mexico from 2000 – 2008.



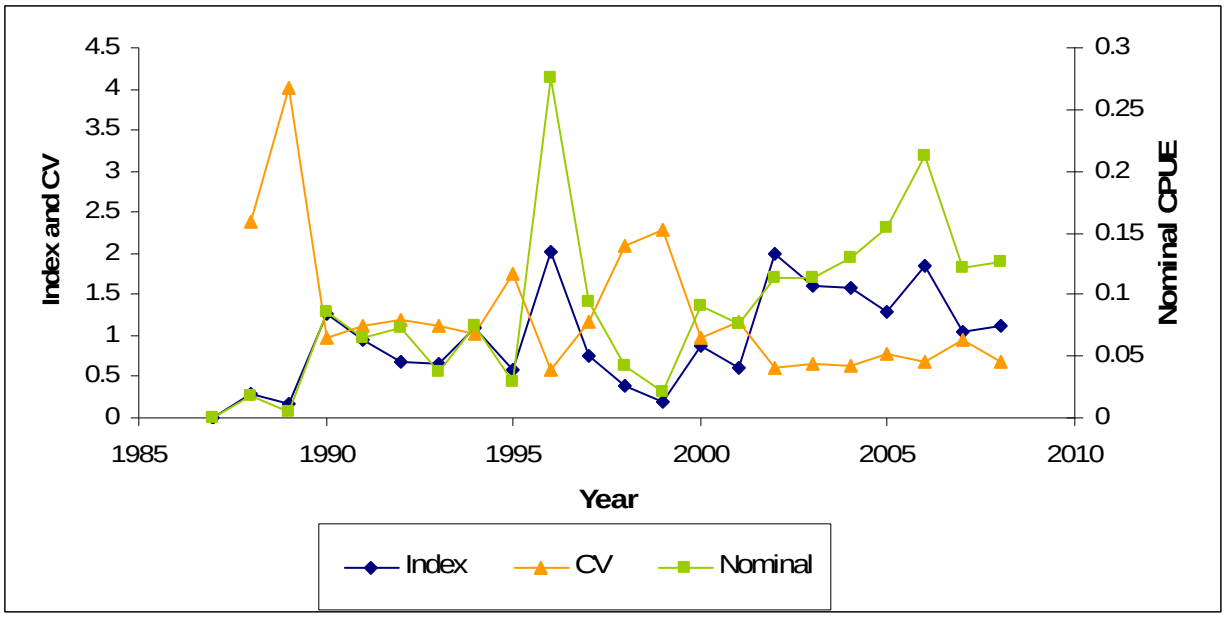
Addendum Figure 4. Distribution of yellowedge grouper by depth zone (in fathoms) captured by NOAA Fisheries Summer and Fall SEAMAP groundfish surveys from 1972 – 2008.



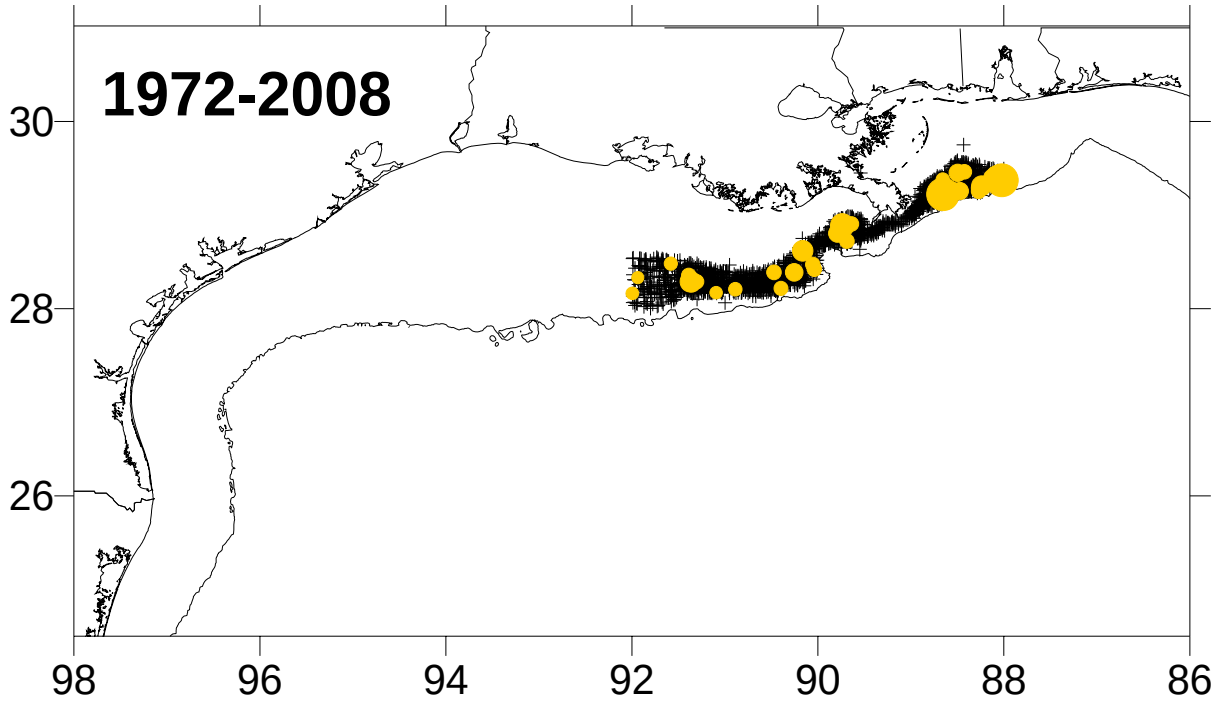
Addendum Figure 5. Overview of locations of groundfish survey trawls in the northern Gulf of Mexico conducted between 1987 and 2008. Each + indicates the starting point of a trawl station and the circle represents where yellowedge grouper were captured and the CPUE. The smallest circle represents a CPUE of 0.25 fish per hour, while the largest circle represents a CPUE of 6 fish per hour.



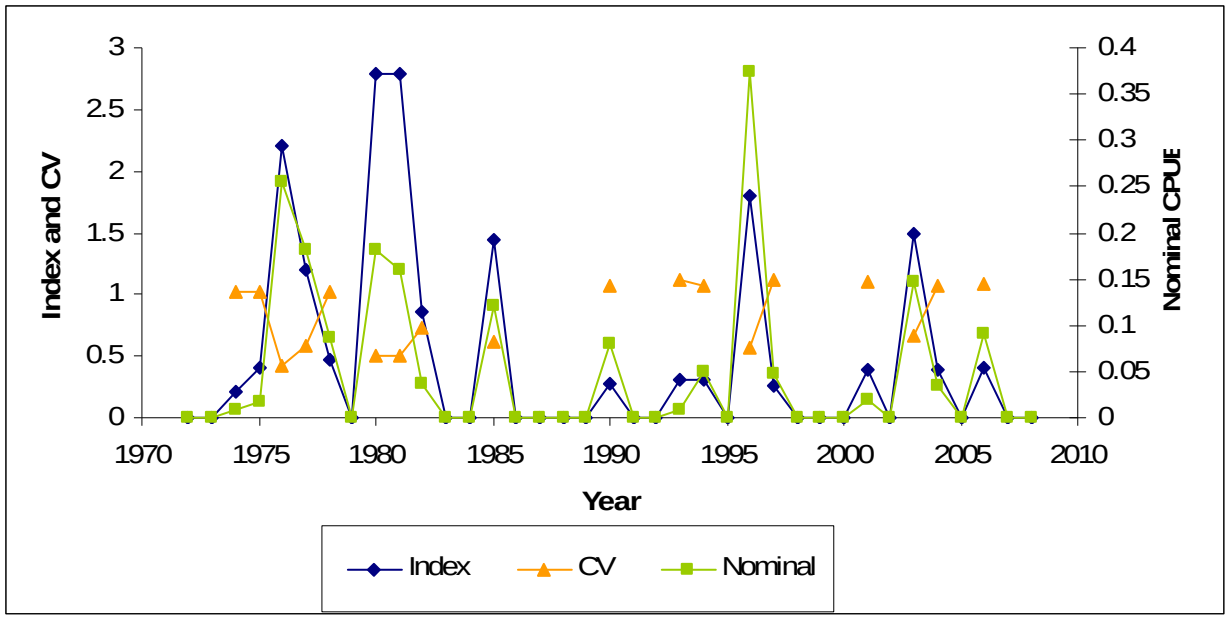
Addendum Figure 6. Normality plots for the lognormal submodel A) scatter plot of the residuals B) QQ plot of the residuals.



Addendum Figure 7. Indices of relative abundance of yellowedge grouper from 1987 – 2008 collected in NOAA Fisheries groundfish surveys in the northern Gulf of Mexico. Index values and nominal CPUE are the number of fish per trawl-hour. Index values are scaled to a mean of one across the time series



Addendum Figure 8. Overview of locations of groundfish survey trawls in the northern Gulf of Mexico conducted between 1972 and 2008. Each + indicates the starting point of a trawl station and the circle represents where yellowedge grouper were captured and the CPUE. The smallest circle represents a CPUE of 0.38 fish per hour, while the largest circle represents a CPUE of 14 fish per hour.



Addendum Figure 9. Indices of relative abundance of yellowedge grouper from 1972 – 2008 collected in NOAA Fisheries groundfish surveys in the northern Gulf of Mexico. Index values model frequency of occurrence and nominal CPUE are the number of fish per trawl-hour. Index values are scaled to a mean of one across the time series