Abundance Indices of Yellowedge Grouper and Golden Tilefish Collected in NMFS Bottom Longline Surveys in the northern Gulf of Mexico

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Introduction

The Southeast Fisheries Science Center (SEFSC) Mississippi Laboratories has conducted standardized bottom longline surveys in the Gulf of Mexico, Caribbean, and Western North Atlantic since 1995. The objective of these surveys is to provide fisheries independent data for stock assessment purposes for as many species as possible. These surveys are conducted annually in U.S. waters of the Gulf of Mexico (GOM) and/or the Atlantic Ocean (Table 1), and they provide an important source of fisheries independent information on large coastal sharks, snappers and groupers from the GOM and Atlantic. The evolution of these surveys has been the subject of many documents [e.g, Ingram *et al*. 2005 (LCS05/06-DW-27)] and was not described again in this document. Results from analyses of data collected on yellowedge grouper and golden tilefish during these surveys are presented below in order to aid in the current assessment of these stocks in the GOM.

Methods and Results

For the SEDAR 22, we used the time series of data between 2000 and 2009 to develop abundance indices for both yellowedge grouper and golden tilefish for the GOM. Due to the use of J-type hooks and the shallow depths primarily surveyed in early years, very few of these species were captured. With the change to circle-hooks, grouper catches increased by an order of magnitude (LCS05/06-DW-27). Therefore, only survey years 2000 to 2009, during which circle-hooks were employed, were used (Table 1). However, due to the effects of Hurricane Katrina on the distribution of effort, the 2005 survey was dropped from the analysis for both species.

The positions of all stations, within the depth range yellowedge grouper were collected (i.e. 70 – 365 m), and positions of stations where yellowedge grouper were captured were plotted by year and all years combined (Figures 1-11). Survey coverage area varied during the time series due to weather or mechanical problems. Only data from stations within the depth range of capture for yellowedge grouper were used in development of annual indices for this species. Likewise, the positions of all stations, within the depth range golden tilefish were collected (i.e. 125 – 365 m), and positions of stations where golden tilefish were captured were plotted by year and all years combined (Figures 12-22). Only data from stations within the depth range of capture for golden tilefish were used in development of annual indices for this species.

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; 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) $$\ln(\mathbf{c}) = \mathbf{X\beta} + \boldsymbol{\varepsilon}$$

and

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

We used the GLIMMIX and MIXED procedures in SAS (v. 9.1, 2004) to develop the binomial and lognormal submodels, respectively. Similar covariates were tested for inclusion for both submodels: water depth, survey area (three demarcations in the GOM: Eastern Gulf (east of 88^o west longitude); Central Gulf (between 88^o and 93^o west longitude); and Western Gulf (west of 93^o west longitude) and year. A backward selection procedure was used to determine which variables were to be included into each submodel based on type 3 analyses with a level of significance for inclusion of $\alpha = 0.05$. If year was not significant then it was forced into each submodel in order to estimate least-squares means for each year, which are predicted annual population margins (i.e., they estimate the marginal annual means as if over a balanced population).

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 (5), 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 backward selection procedure used to develop the delta-lognormal model is summarized in Table 2 for yellowedge grouper and Table 3 for golden tilefish. For yellowedge grouper, the area effect was dropped from the binomial submodel based on type 3 analyses, and with the variable removal there was a corresponding decrease in AIC (Table 2). For the lognormal submodel for nonzero catch of yellowedge grouper, both area and water depth variables were dropped from the model; the year variable was not significant (Table 2); and the AIC decreased with each step. Figure 23 indicates the approximately normal distribution of the residuals of the lognormal submodel. For golden tilefish, there were no variables were dropped from either submodel (Table 3). Figure 24 indicates the approximately normal distribution of the residuals of the lognormal submodel. Table 4 and Figure 25 summarize indices of yellowedge grouper developed from using a delta-lognormal model. Table 5 and Figure 26 summarize indices of golden tilefish developed from using a delta-lognormal model. Finally, we constructed length frequency histograms for yellowedge grouper (Figure 27) and golden tilefish (Figure 28) collected during this survey in the GOM.

Literature Cited

INGRAM, W., T. Henwood, M. Grace, L. Jones, W. Driggers, and K. Mitchell. 2005. Catch rates, distribution and size composition of large coastal sharks collected during NOAA Fisheries Bottom Longline Surveys from the U.S. Gulf of Mexico and U.S. Atlantic Ocean. LCS05/06-DW-27

LO, N. C. H., L.D. Jacobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49: 2515-1526.

Table 1. NMFS MS Laboratory longline projects, 1995 - 2009. Shaded rows indicate cruises from which data was used in this document. For surveys that occurred in both the Atlantic and Gulf of Mexico within a single survey, only data from the Gulf was used.

Survey	Date	Location	Depth range (m)	Effort (# sets)	Random station selection description.
OT-95-04 (218)	7/23 - 8/17/95	GOM[1]	18 m - 73 m	82	Stations depth stratified and equally allocated within statistical zones; depth strata 18 m - 37 m, 37 m - 55 m, 55 m - 73 m; J hooks.
RS-95-03 (2)	8/10 - 8/24/95	Atlantic[2]	18 m - 73 m	45	Stations depth stratified and equally allocated within statistical zones; depth strata 18 m - 37 m, 37 m - 55 m, 55 m - 73 m; J hooks.
OT-96-04 (222)	7/31 - 9/13/96	GOM and Atlantic	18 m - 73 m	151	Stations depth stratified and equally allocated within statistical zones; depth strata 18 m - 37 m, 37 m - 55 m, 55 m - 73 m; J hooks.
OT-97-04 (227)	7/25 - 9/24/97	Mexican GOM, GOM and Atlantic	9 m - 55 m	259	Stations not depth stratified but equally allocated within 60 linear n. mile zones or statistical zones; J hooks.
OT-98-02 (231)	7/24 - 9/22/98	Mexican GOM, Cuba [3], GOM	9 m - 413 m	216	Stations not depth stratified but equally allocated within 60 linear n. mile zones or statistical zones; J hooks.
OT-99-02 (233)	2/16 - 3/2/99	Atlantic	9 m - 55 m	29	Stations not depth stratified but equally allocated within statistical zones; J hooks.
FE-99-10 SEF	5/6 - 5/19/99	GOM	64 m - 146 m	60	Station coordinates by random longitude and random depth and equally allocated within 10 linear n. mile contiguous sampling blocks; circle hooks.
CARETTA 99-01	8/4 - 9/28/99	GOM	9 m - 55 m	161	Proportional allocation based on continental shelf width within statistical zones; sampling density experiment; hook comparison experiment with 75% J hooks, 25% circle hooks.
GU-00-03 (8)	6/6 - 6/19/00	GOM	64 m - 146 m	59	Station coordinates by random longitude and random depth and equally allocated within 20 linear n. mile contiguous sampling blocks; hook comparison experiment with 75% circle hooks, 25% J hooks.
OT-00-04 (241)	8/3 - 8/28/00	GOM	9 m - 183 m	137	Proportional allocation based on continental shelf width within statistical zones; sampling density experiment; hook comparison experiment with 75% J hooks, 25% circle hooks.
FE-00-12 (2)	9/6 - 10/16/00	Atlantic	9 m - 183 m	105	Proportional allocation based on continental shelf width within statistical zones; sampling density experiment; hook comparison experiment with 75% J hooks, 25% circle hooks.
OT-00-08 (244)	12/6 - 12/12/00	GOM	55 m - 366 m	41	Station coordinates by random longitude and random depth and equally allocated within 10 linear n. mile contiguous sampling blocks; stations depth stratified with 4 stations each block 55 m - 183 m, 2 stations each block 183 m - 366 m; hook comparison experiment with 75% circle hooks, 25% J hooks.
ONJUKU-01	6/1 - 6/20/01	Mexican GOM[4]	9 m - 50 m	38	Proportional allocation based on continental shelf width within 60 linear n. mile sampling zones; circle hooks, Atlantic bonito for bait.
OT-01-04 (247)	7/31 - 9/30/01	GOM	9 m - 366 m	277	Proportional allocation based on continental shelf width within statistical zones; depth stratified, 50% allocation 9 m - 55 m, 40% allocation 55 m - 183 m, 10% allocation 183 m - 366 m; circle hooks.
ONJUKU-01	6/28 - 7/5/02	Mexican GOM[4]	18 m - 217 m	30	Proportional allocation based on continental shelf width within 60 linear n. mile sampling zones; circle hooks, Atlantic bonito for bait
OT-02-04 (251)	7/31 - 9/21/02	GOM and Atlantic	9 m - 366 m	212	Proportional allocation based on continental shelf width within statistical zones; depth stratified, 50% allocation 9 m - 55 m, 40% allocation 55 m - 183 m, 10% allocation 183 m - 366 m; circle hooks.
OT-03-04 (255)	7/29 - 9/29/03	GOM	9 m - 366 m	280	Proportional allocation based on continental shelf width within statistical zones; depth stratified, 50% allocation 9 m - 55 m, 40% allocation 55 m - 183 m, 10% allocation 183 m - 366 m; circle hooks.
GANDY 72-043	07/25 - 08/28/04	Atlantic	8 m – 34 m	40	Proportional allocation based on continental shelf width within statistical zones; depth stratified, 50% allocation 9 m - 55 m, 40% allocation 55 m - 183 m, 10% allocation 183 m - 366 m; circle hooks.
OT-04-04 (260)	7/31 - 9/29/04	GOM	9 m - 366 m	232	Proportional allocation based on continental shelf width within statistical zones; depth stratified, 50% allocation 9 m - 55 m, 40% allocation 55 m - 183 m, 10% allocation 183 m - 366 m; circle hooks.
GANDY 72-044	10/06 - 10/23/04	GOM	7 m – 92 m	17	Proportional allocation based on continental shelf width within statistical zones; depth stratified, 50% allocation 9 m - 55 m, 40% allocation 55 m - 183 m, 10% allocation 183 m - 366 m; circle hooks.
OT-05-04 (266)	8/5 - 8/25/05	GOM and Atlantic	9 m - 366 m	74	Proportional allocation based on continental shelf width within statistical zones; depth stratified, 50% allocation 9 m - 55 m, 40% allocation 55 m - 183 m, 10% allocation 183 m - 366 m; circle hooks.
OT-06-04 (272)	7/29 - 9/24/06	GOM and Atlantic	9 m - 366 m	208	Proportional allocation based on continental shelf width within statistical zones; depth stratified, 50% allocation 9 m - 55 m, 40% allocation 55 m - 183 m, 10% allocation 183 m - 366 m; circle hooks.
OT-07-04 (277)	8/10 - 8/24/07	GOM	9 m - 366 m	156	Proportional allocation based on continental shelf width within statistical zones; depth stratified, 50% allocation 9 m - 55 m, 40% allocation 55 m - 183 m, 10% allocation 183 m - 366 m; circle hooks.
OT-08-04 (283)	8/2 - 9/29/08	GOM and Atlantic	9 m - 366 m	145	Proportional allocation based on continental shelf width within statistical zones; depth stratified, 50% allocation 9 m - 55 m, 40% allocation 55 m - 183 m, 10% allocation 183 m - 366 m; circle hooks.
OT-09-04 (288)	7/30 - 9/29/09	GOM and Atlantic	9 m - 366 m	211	Proportional allocation based on continental shelf width within statistical zones; depth stratified, 50% allocation 9 m - 55 m, 40% allocation 55 m - 183 m, 10% allocation 183 m - 366 m; circle hooks.

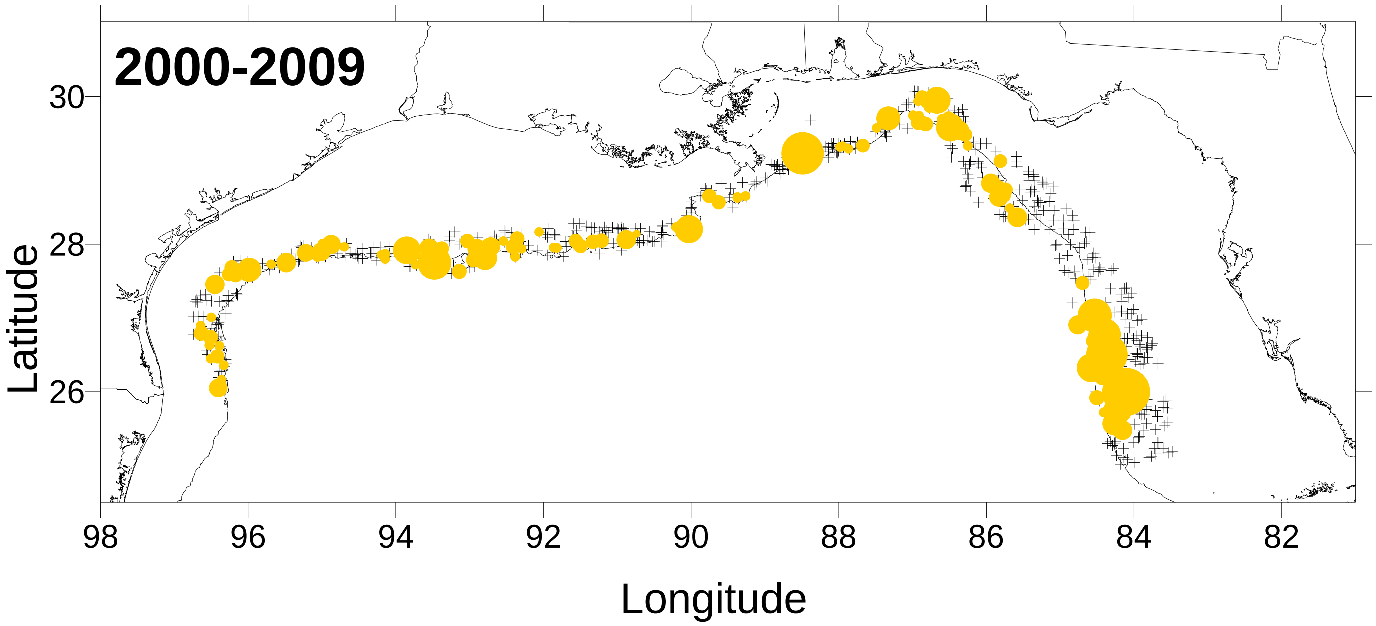


Figure 1. Survey effort included in analyses and CPUE of yellowedge grouper from 2000 through 2009 in the Gulf of Mexico. Crosses indicate effort with no catch. The size of yellow circles is linearly related to positive CPUE (range: 0.4 – 9 yellowedge grouper per 100 hook hours). Symbols in the following figures are on the same scale as described for this figure, in order to facilitate direct comparisons.

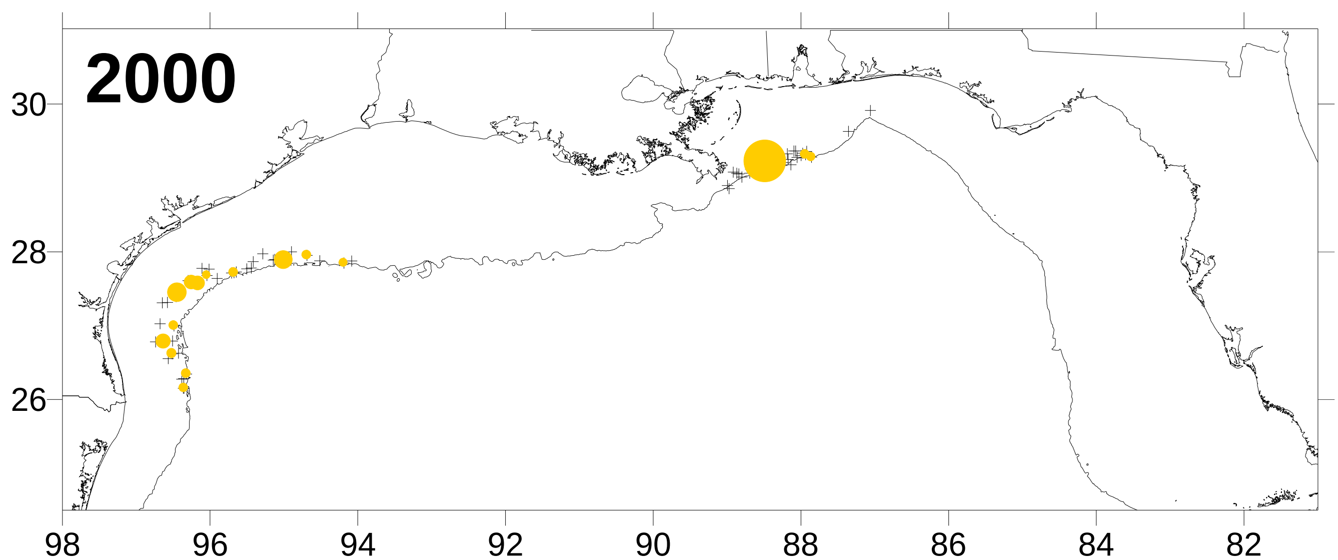


Figure 2. Survey effort and CPUE (range: 0.7 – 7.9 per 100 hook hours) of yellowedge grouper for 2000.

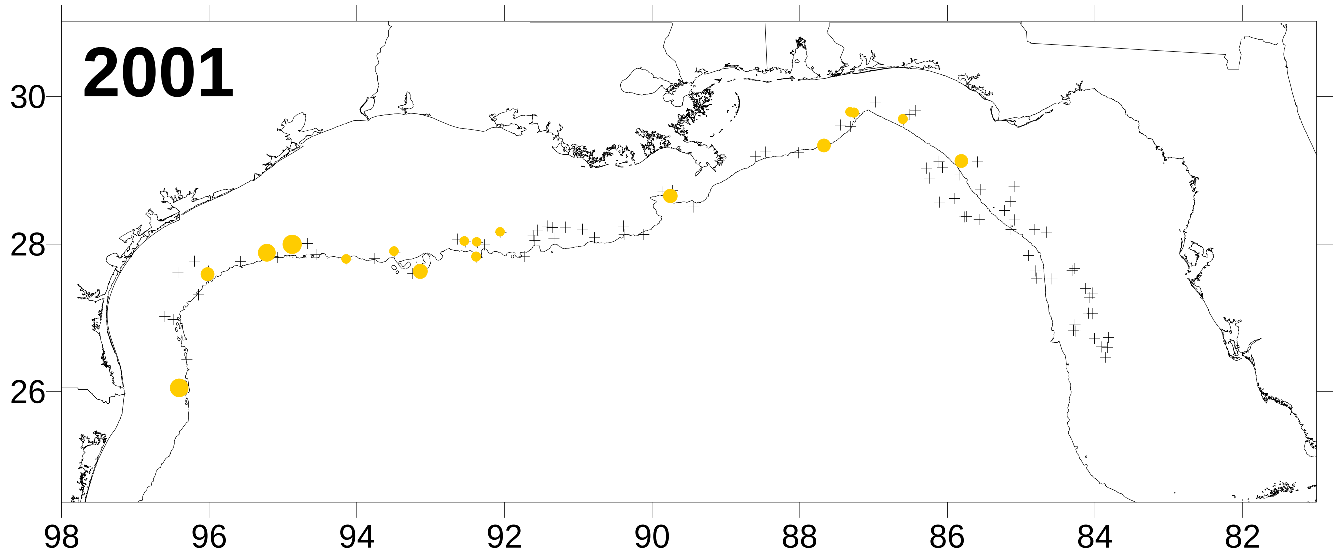


Figure 3. Survey effort and CPUE (range: 0.9 – 3 per 100 hook hours) of yellowedge grouper for 2001.

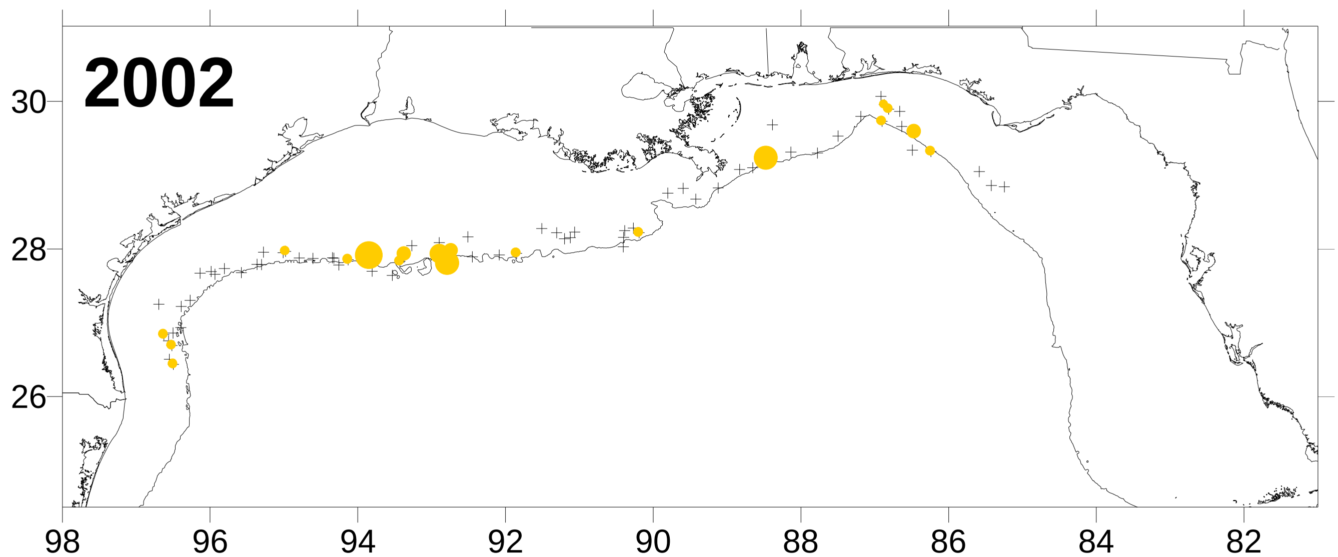


Figure 4. Survey effort and CPUE (range: 0.8 – 4.8 per 100 hook hours) of yellowedge grouper for 2002.

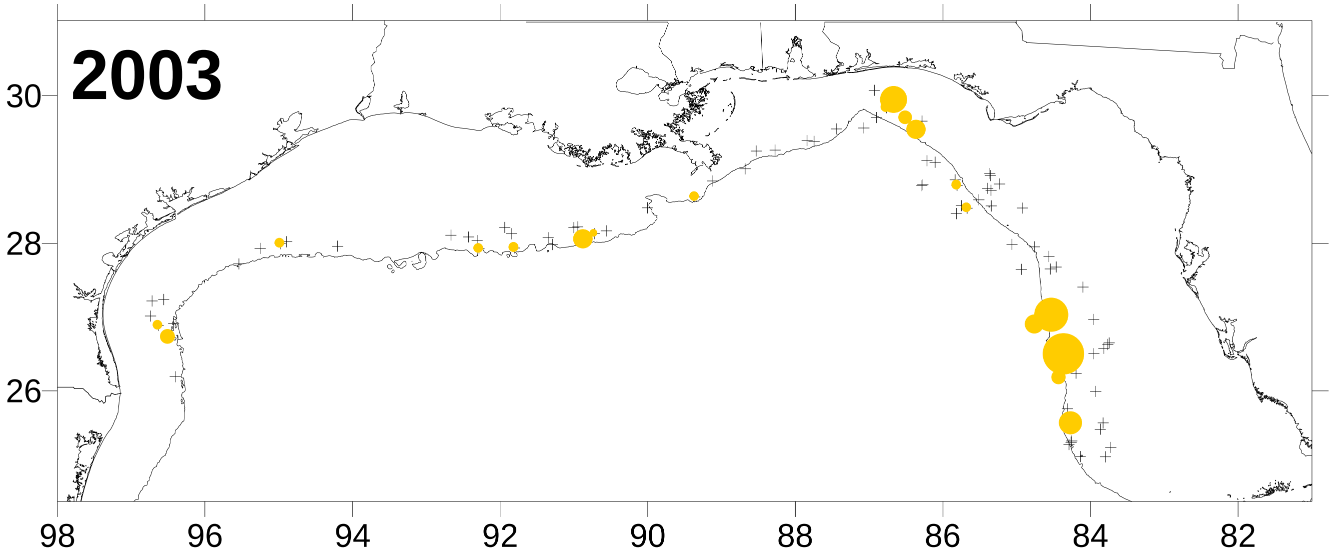


Figure 5. Survey effort and CPUE (range: 0.6 – 7.6 per 100 hook hours) of yellowedge grouper for 2003.

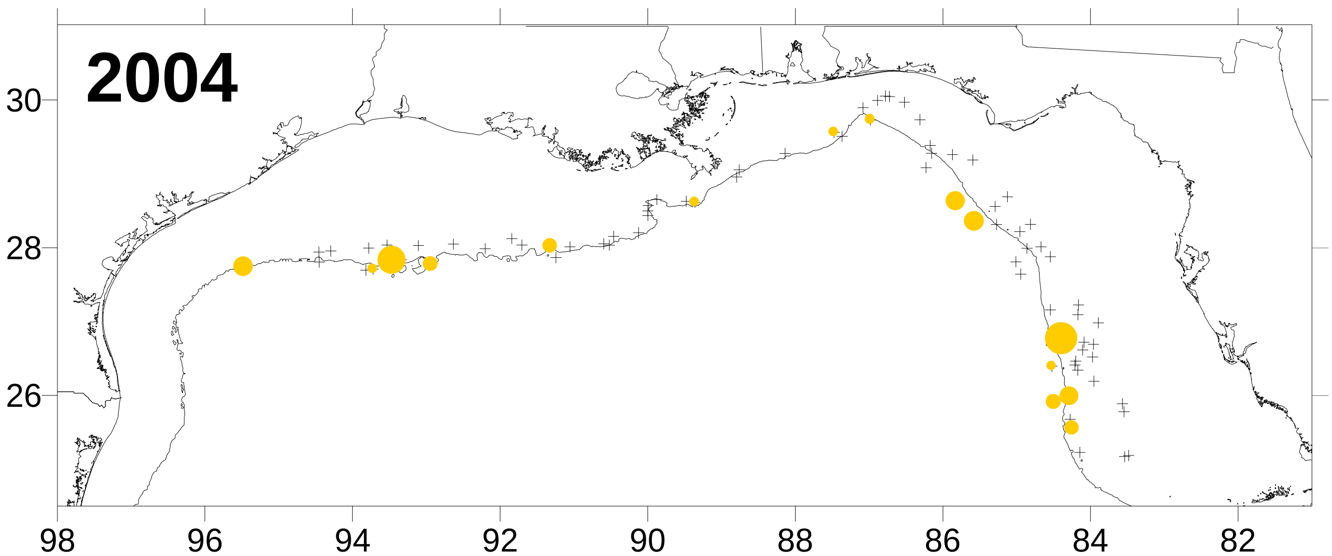


Figure 6. Survey effort and CPUE (range: 0.9 – 5.7 per 100 hook hours) of yellowedge grouper for 2004.

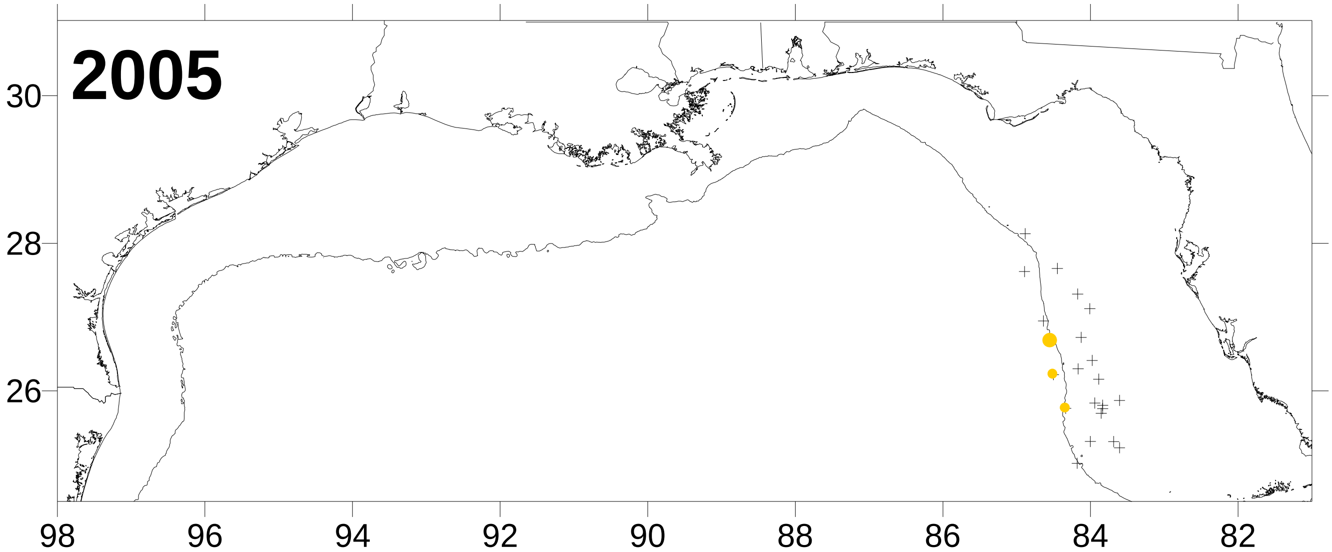


Figure 7. Survey effort and CPUE (range: 1 – 2 per 100 hook hours) of yellowedge grouper for 2005.

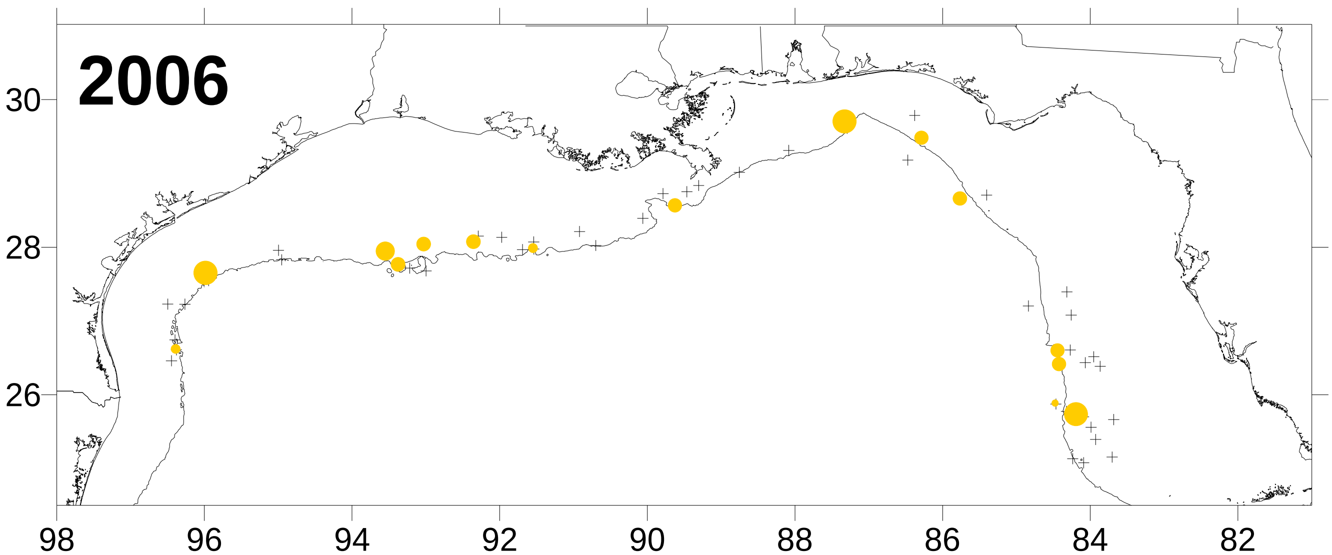


Figure 8. Survey effort and CPUE (range: 0.4 – 4 per 100 hook hours) of yellowedge grouper for 2006.

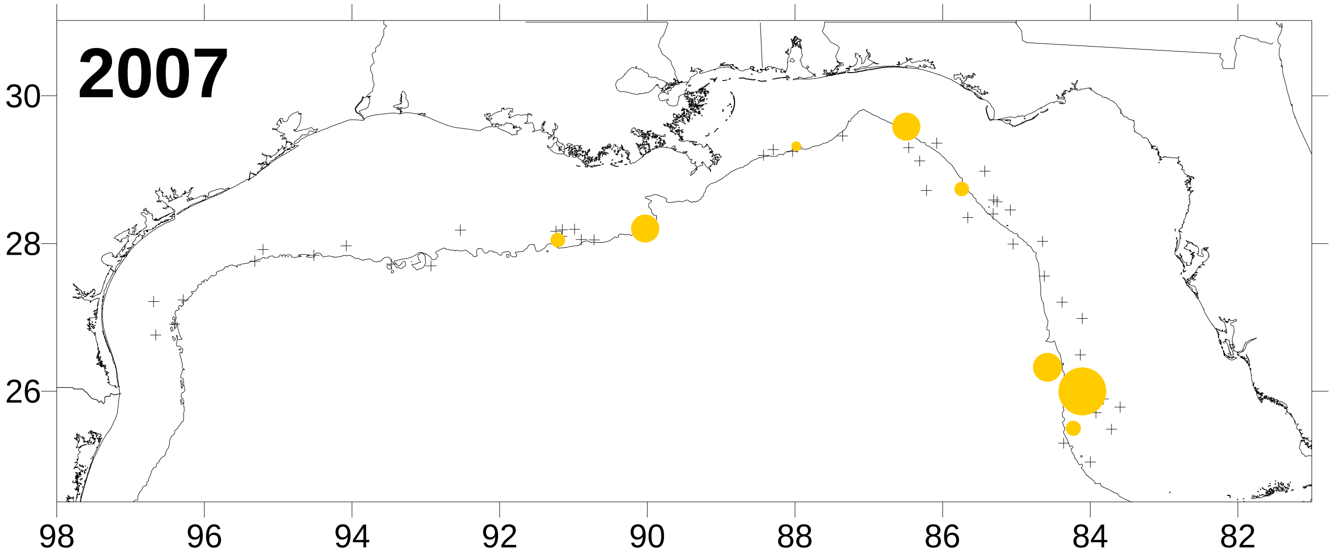


Figure 9. Survey effort and CPUE (range: 0.9 – 9 per 100 hook hours) of yellowedge grouper for 2007.

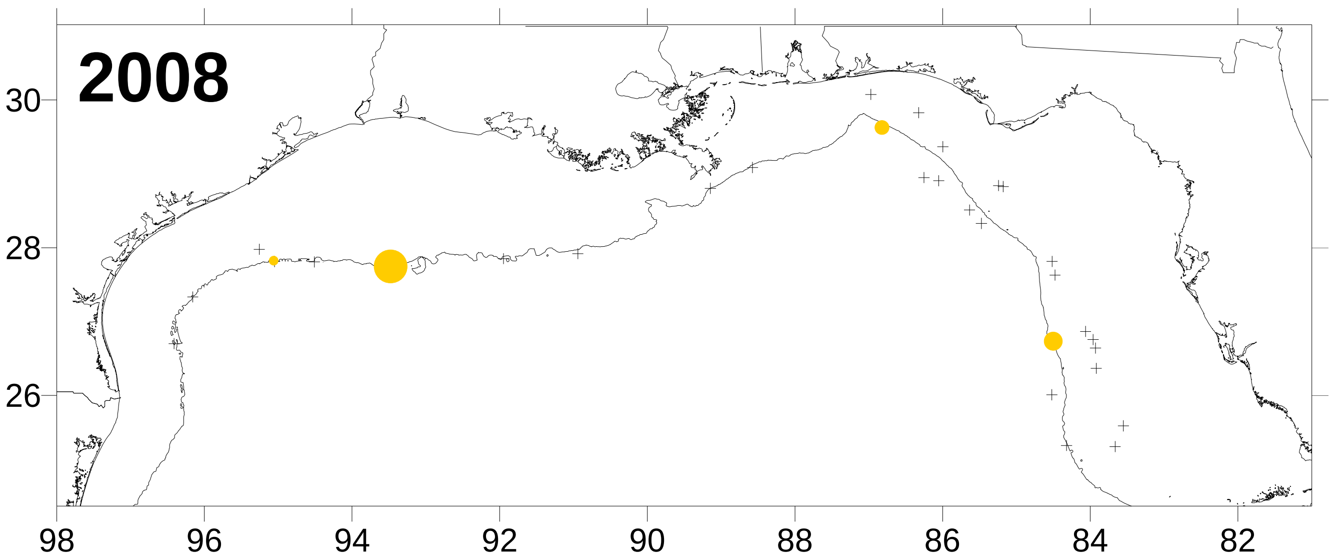


Figure 10. Survey effort and CPUE (range: 1 –6 per 100 hook hours) of yellowedge grouper for 2008.

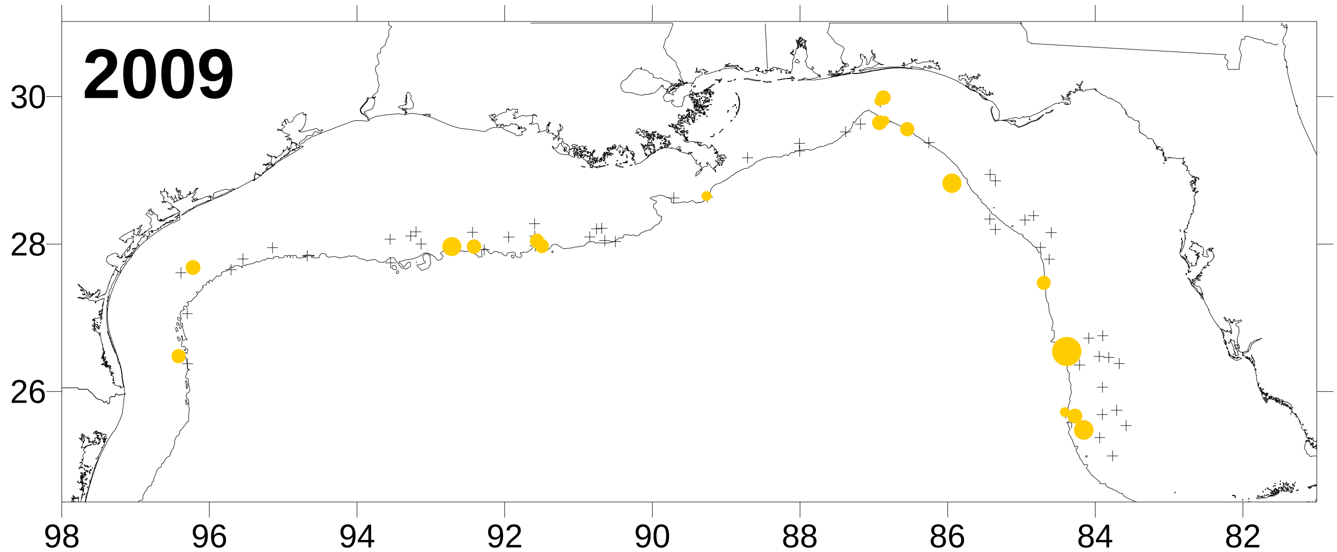


Figure 11. Survey effort and CPUE (range: 1 – 5.1 per 100 hook hours) of yellowedge grouper for 2009.

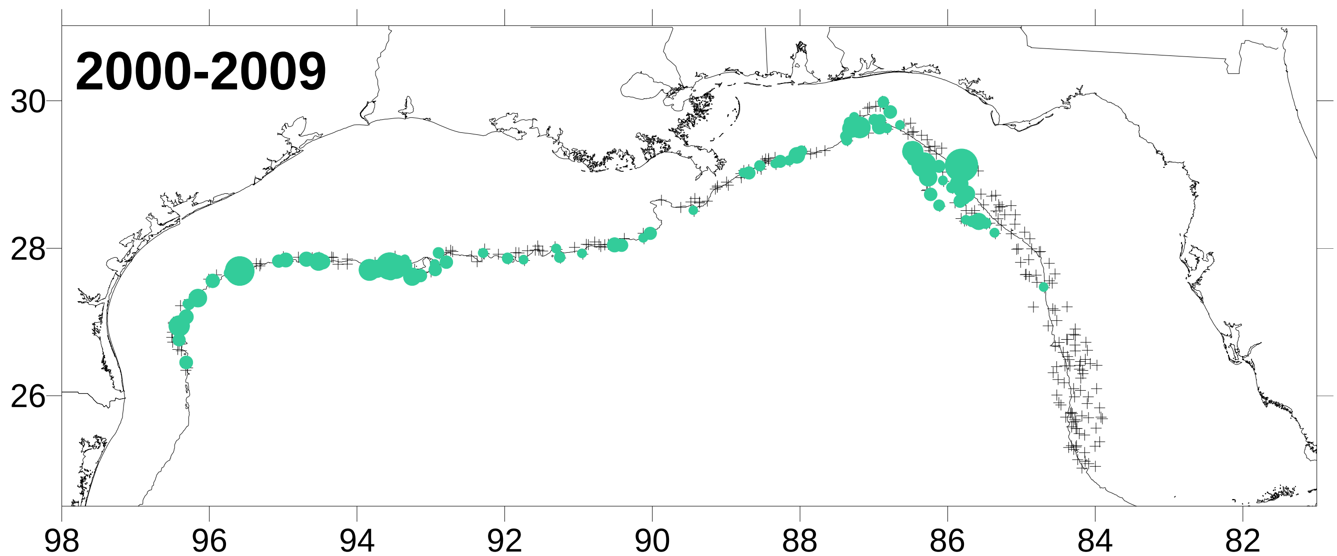


Figure 12. Survey effort included in analyses and CPUE of golden tilefish from 2000 through 2009 in the Gulf of Mexico. Crosses indicate effort with no catch. The size of green circles is linearly related to positive CPUE (range: 0.7 – 14.5 golden tilefish per 100 hook hours). Symbols in the following figures are on the same scale as described for this figure, in order to facilitate direct comparisons.

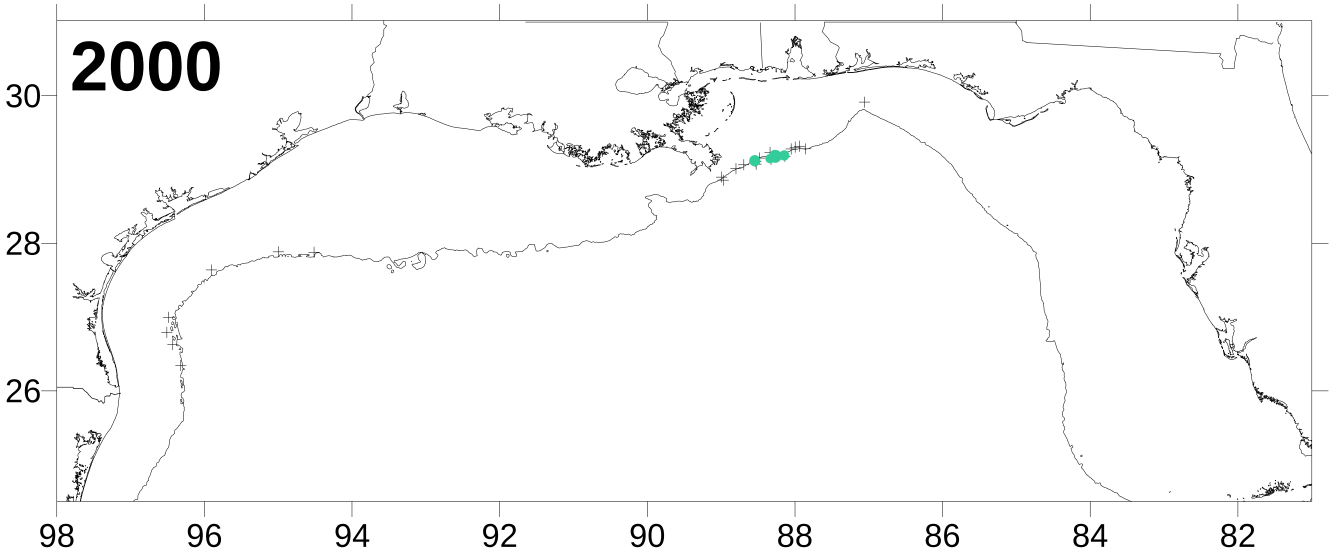


Figure 13. Survey effort and CPUE (range: 0.8 – 2.8 per 100 hook hours) of golden tilefish for 2000.

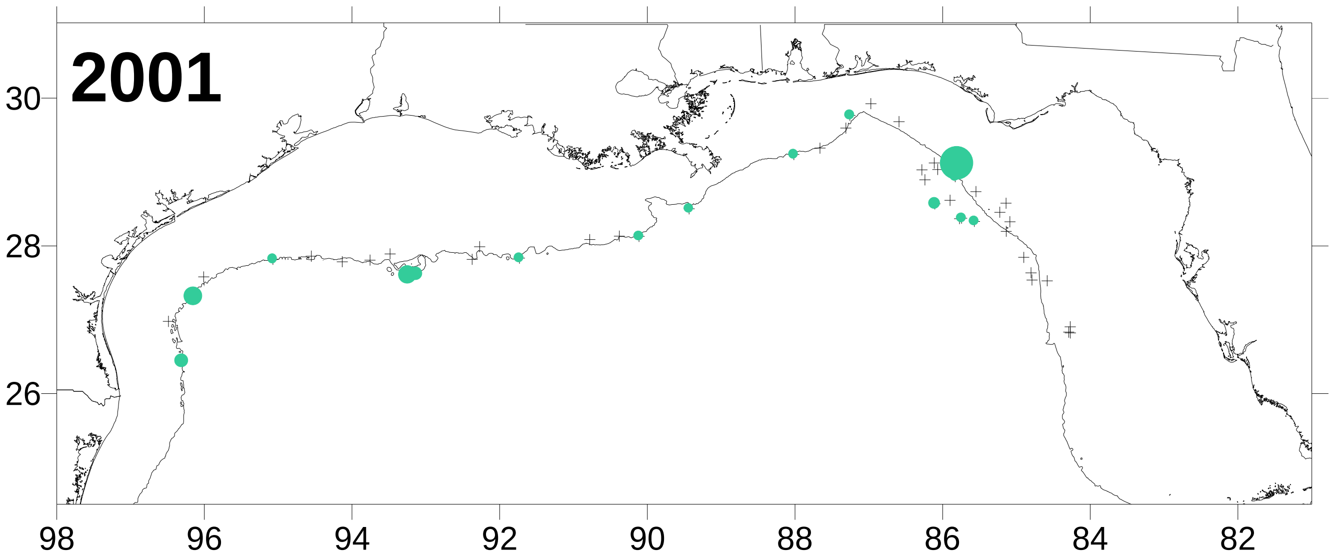


Figure 14. Survey effort and CPUE (range: 0.8 – 14.5 per 100 hook hours) of golden tilefish for 2001.

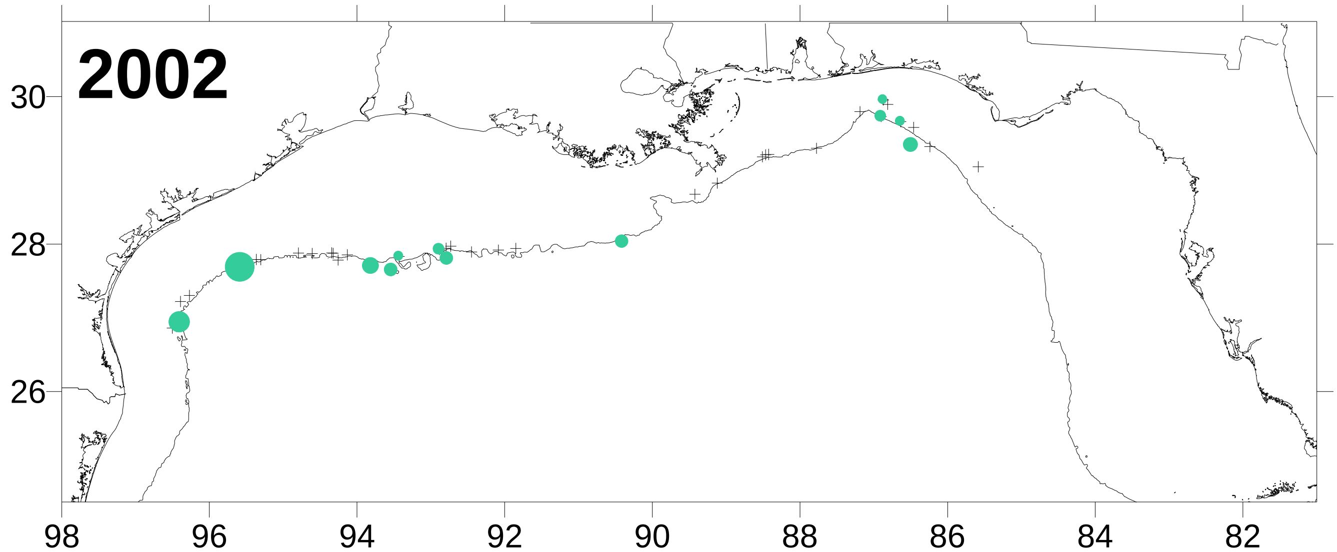


Figure 15. Survey effort and CPUE (range: 0.8 – 12.4 per 100 hook hours) of golden tilefish for 2002.

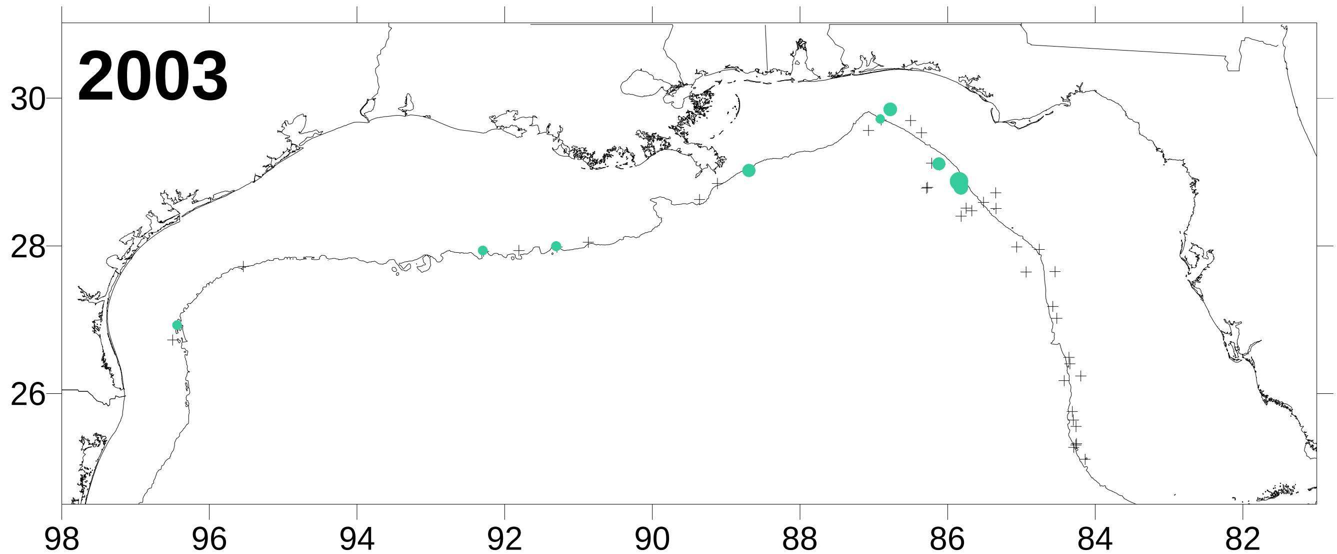


Figure 16. Survey effort and CPUE (range: 0.7 – 6 per 100 hook hours) of golden tilefish for 2003.

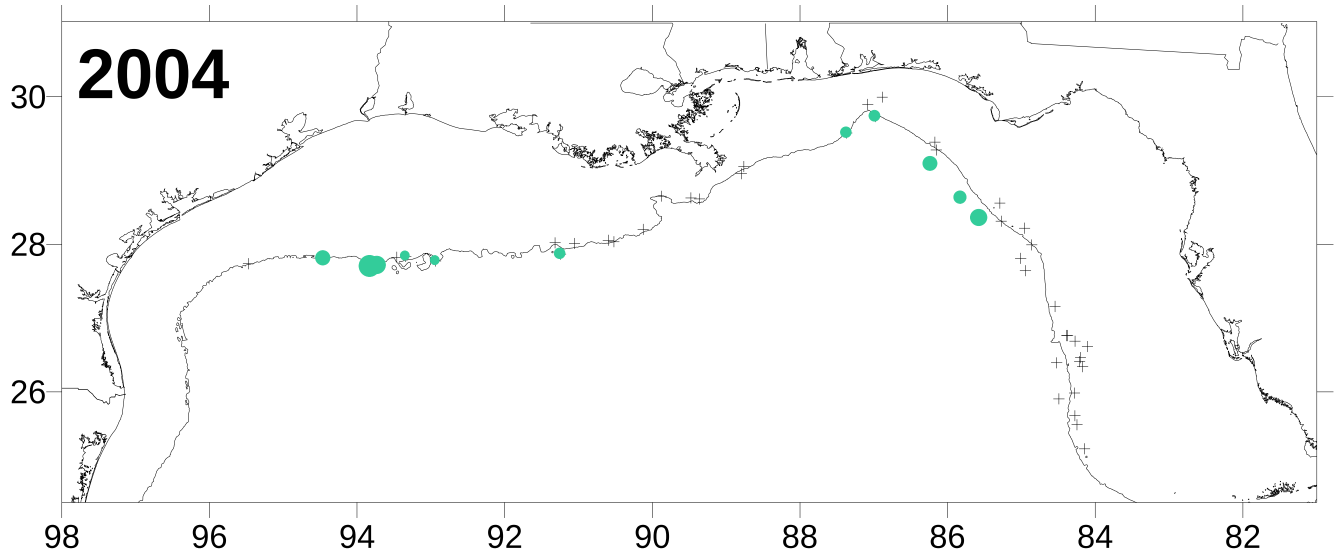


Figure 17. Survey effort and CPUE (range: 1 – 7.9 per 100 hook hours) of golden tilefish for 2004.

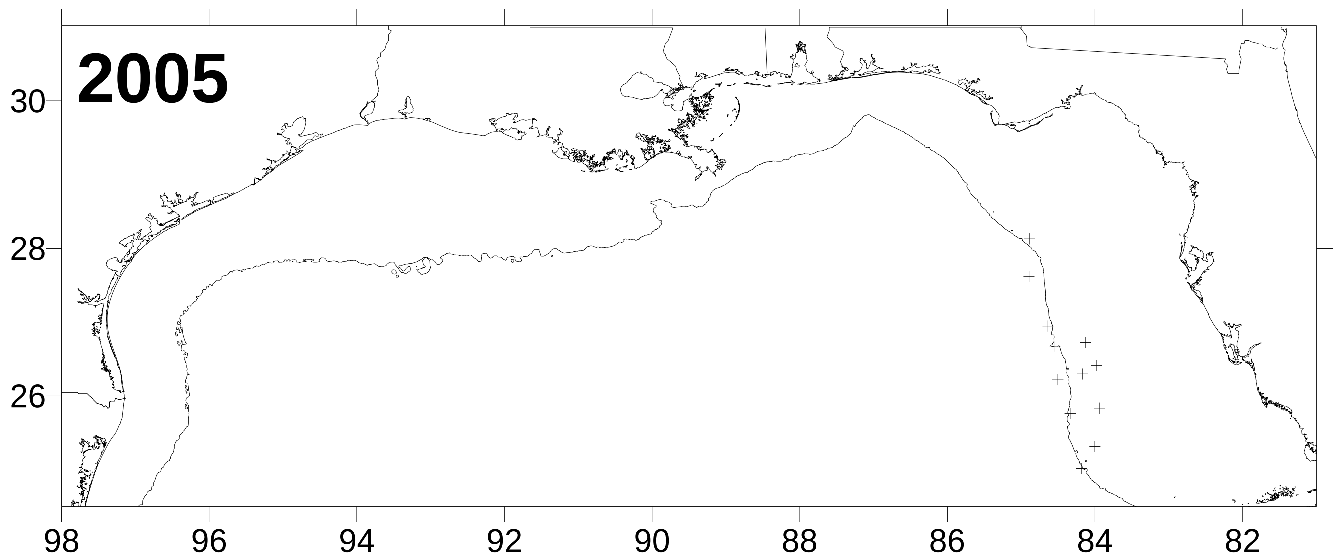


Figure 18. Survey effort and CPUE (range: 0 per 100 hook hours) of golden tilefish for 2005.

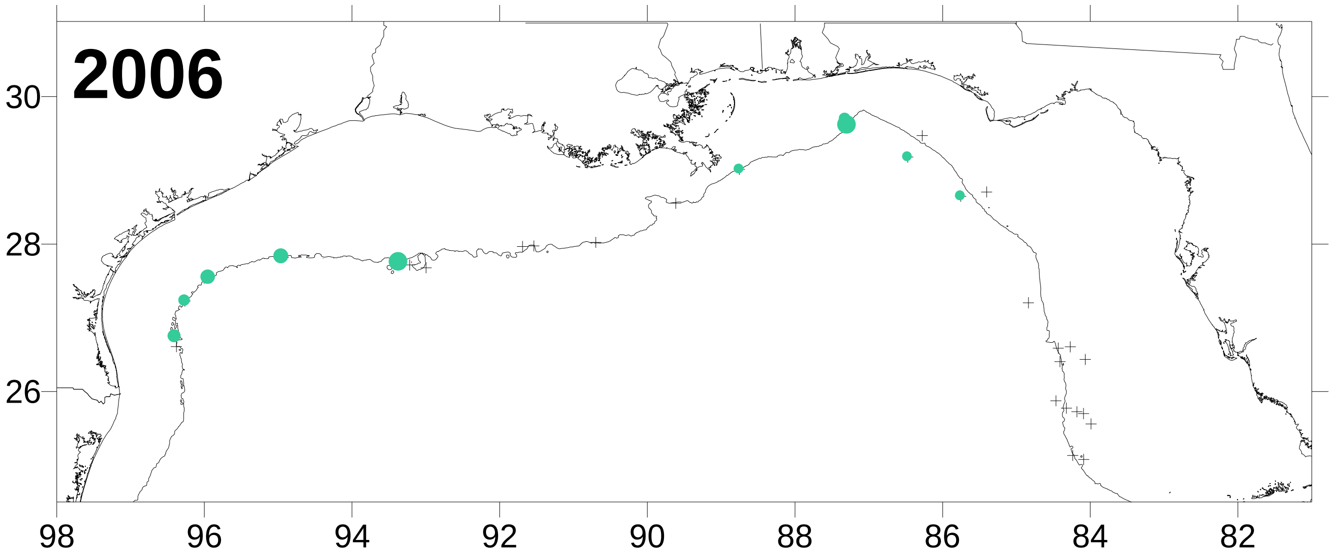


Figure 19. Survey effort and CPUE (range: 1 – 6 per 100 hook hours) of golden tilefish for 2006.

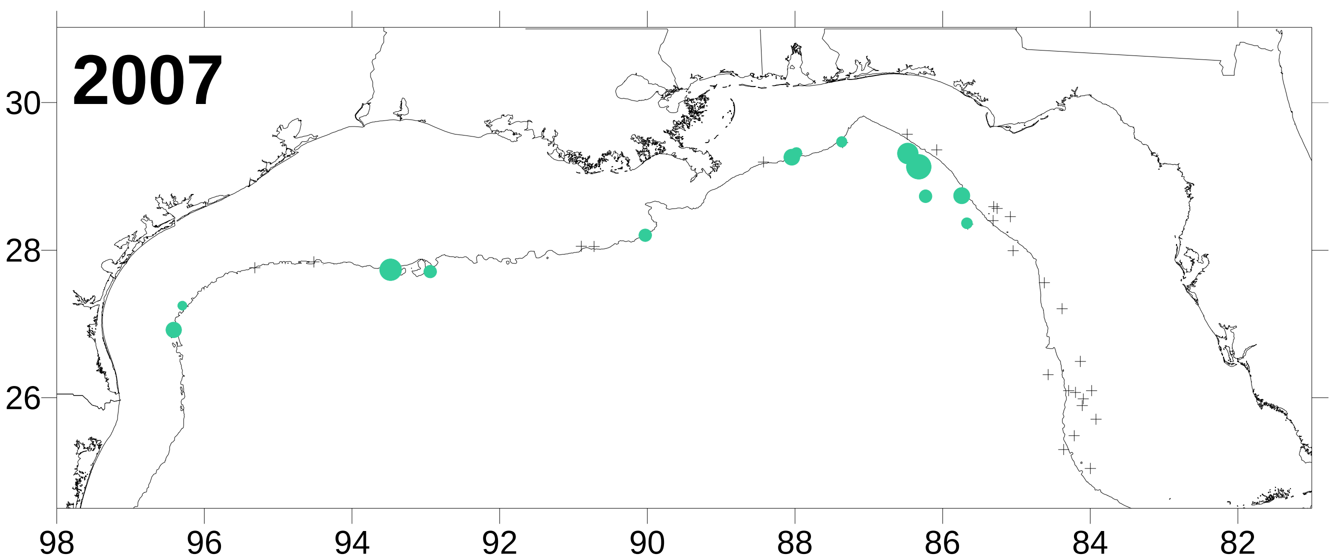


Figure 20. Survey effort and CPUE (range: 1 – 10 per 100 hook hours) of golden tilefish for 2007.

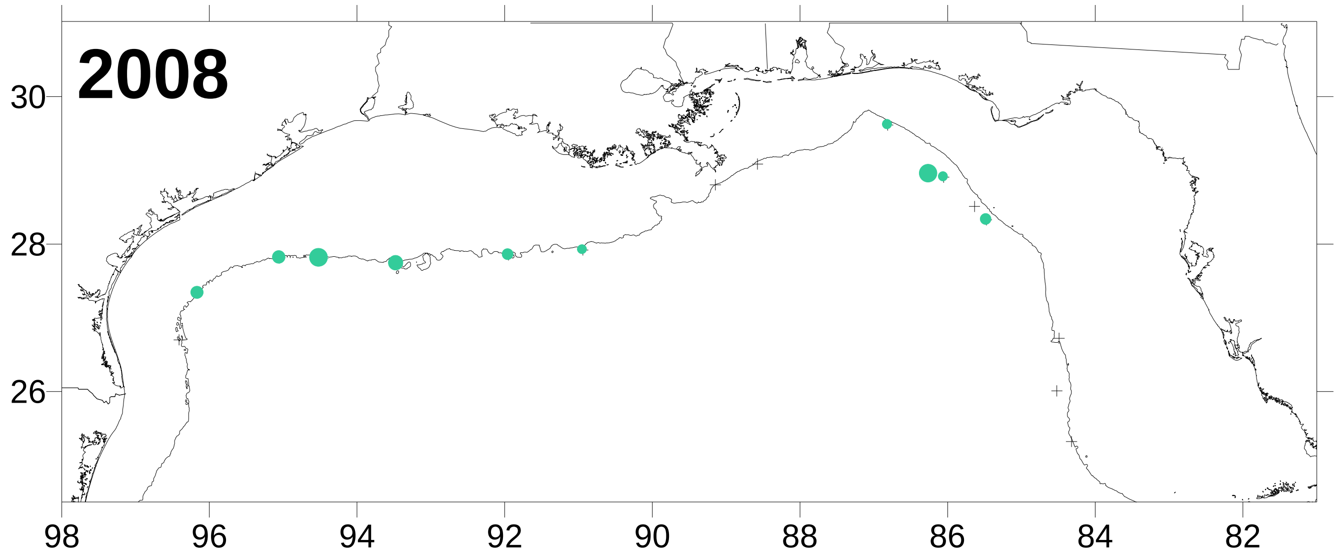


Figure 21. Survey effort and CPUE (range: 1 – 6 per 100 hook hours) of golden tilefish for 2008.

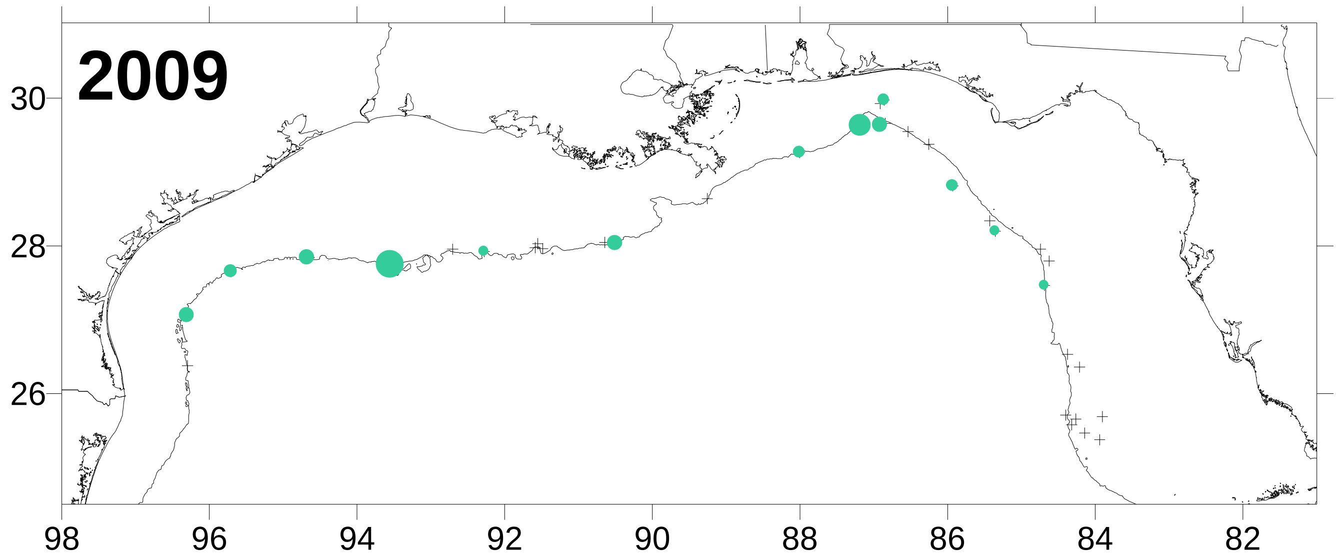


Figure 22. Survey effort and CPUE (range: 1 – 11 per 100 hook hours) of golden tilefish for 2009.

Table 2. Backward selection procedure for building delta-lognormal submodels for yellowedge grouper.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC = 2949.0)*						*Lognormal Submodel Type 3 Tests (AIC = 290.8)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
year	8	624	7.04	0.88	0.5326	0.5332	8	133	1.26	0.2713
area	2	624	2.88	1.44	0.2367	0.2374	2	133	0.09	0.9177
water depth	1	624	4.97	4.97	0.0257	0.0261	1	133	0.01	0.9330
Model Run #2	*Binomial Submodel Type 3 Tests (AIC = 2944.7)*						*Lognormal Submodel Type 3 Tests (AIC = 279.0)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
year	8	626	7.79	0.97	0.4547	0.4558	8	134	1.32	0.2390
area			dropped				2	134	0.09	0.9180
water depth	1	626	5.05	5.05	0.0246	0.0250		dropped		
Model Run #3	*Binomial Submodel Type 3 Tests (AIC = 2944.7)*						*Lognormal Submodel Type 3 Tests (AIC = 274.5)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
year	8	626	7.79	0.97	0.4547	0.4558	8	136	1.64	0.1193
area			dropped					dropped		
water depth	1	626	5.05	5.05	0.0246	0.0250		dropped		

Table 3. Backward selection procedure for building delta-lognormal submodels for golden tilefish.

Model Run #1	*Binomial Submodel Type 3 Tests (AIC = 1604.9)*						*Lognormal Submodel Type 3 Tests (AIC = 218.9)*			
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*	*Num DF*	*Den DF*	*F Value*	*Pr > F*
year	8	309	11.05	1.38	0.1990	0.2040	8	85	1.17	0.3271
area	2	309	9.93	4.96	0.0070	0.0076	2	85	7.48	0.0010
water depth	1	309	54.75	54.75	<.0001	<.0001	1	85	5.98	0.0165

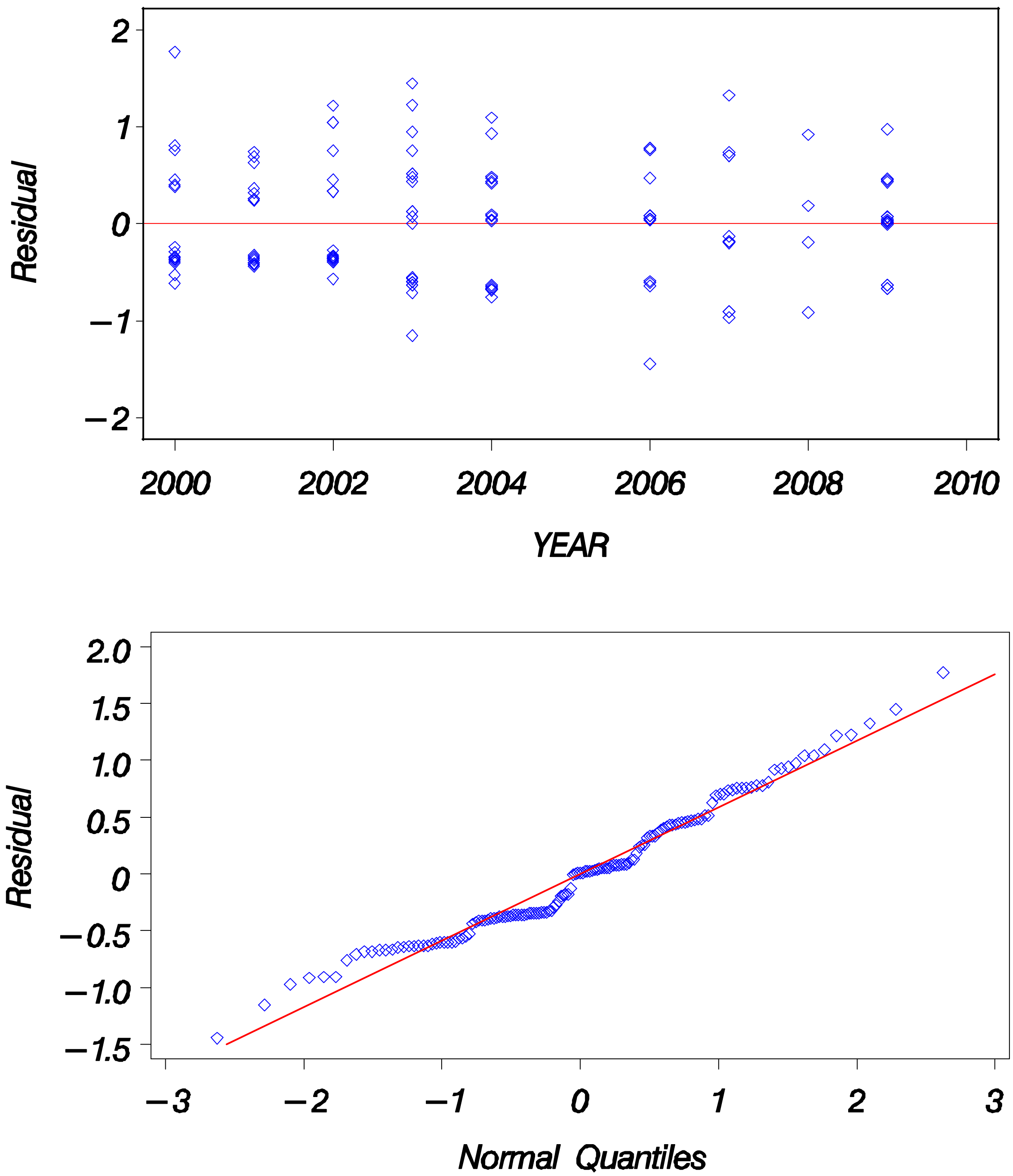
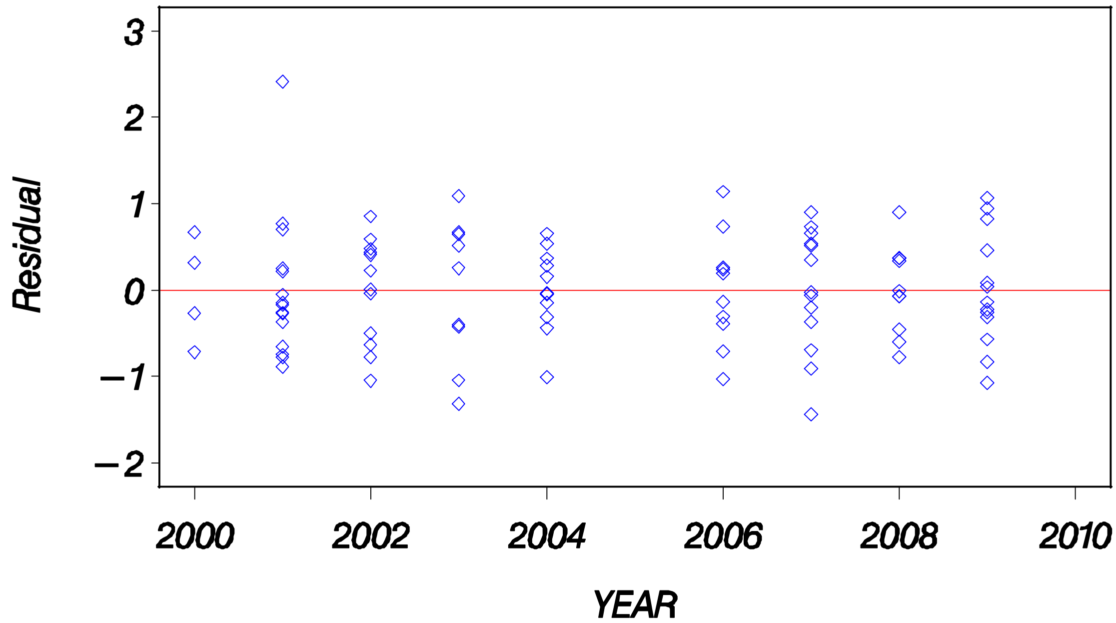


Figure 23. Residual plots of the lognormal submodel for yellowedge grouper. The upper plot is of residuals versus survey year, and the lower is a QQ plot of the residuals.



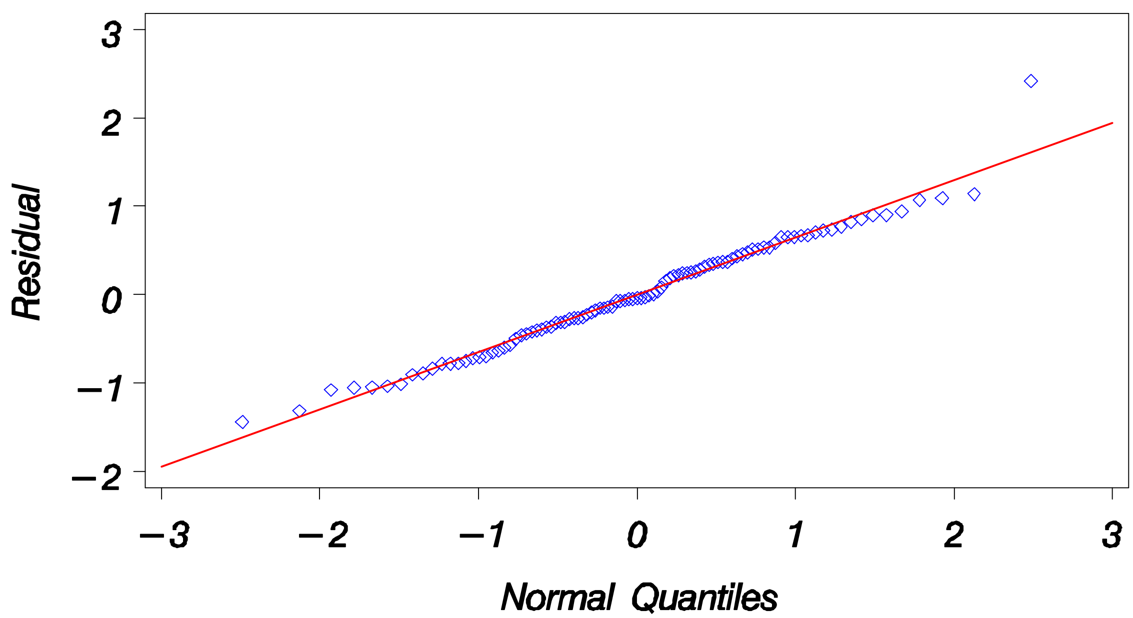


Figure 24. Residual plots of the lognormal submodel for golden tilefish. The upper plot is of residuals versus survey year, and the lower is a QQ plot of the residuals.

Table 4. Indices of yellowedge grouper collected during bottom longline surveys (Index = number per 100 hook hours and Scaled Index = Index scaled to a mean of one) developed with a delta-lognormal model. The nominal frequency, total number of samples included in analyses per year, the CV (coefficient of variation on the mean), and upper and lower 95% confidence intervals on the Scaled Index are listed.

Survey Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
2000	0.24658	73	0.40993	0.87976	0.27905	0.50877	1.52129
2001	0.18085	94	0.29792	0.63937	0.29947	0.35579	1.14896
2002	0.27711	83	0.47234	1.01372	0.24498	0.62549	1.64292
2003	0.23913	92	0.50358	1.08075	0.25655	0.65227	1.79069
2004	0.19277	82	0.42709	0.91659	0.30625	0.50363	1.66819
2006	0.29091	55	0.62509	1.34153	0.29349	0.75496	2.38382
2007	0.20000	55	0.53695	1.15236	0.36998	0.56296	2.35885
2008	0.12903	31	0.32895	0.70598	0.62662	0.22331	2.23190
2009	0.25714	70	0.59173	1.26994	0.27912	0.73431	2.19629

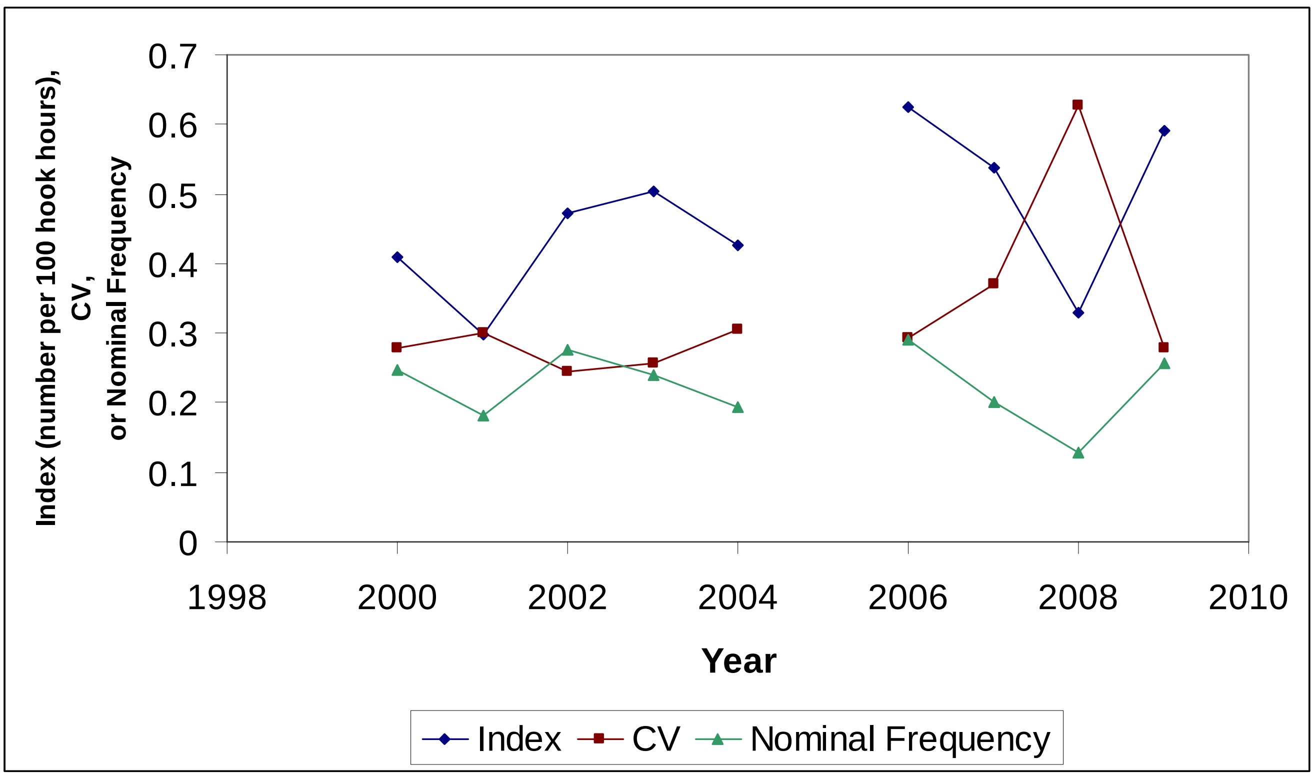


Figure 25. Indices of yellowedge grouper collected during bottom longline surveys (number per 100 hook hours) developed with the delta-lognormal model, coefficient of variation on the mean (CV), and nominal frequency of occurrence.

Table 5. Indices of golden tilefish collected during bottom longline surveys (Index = number per 100 hook hours and Scaled Index = Index scaled to a mean of one) developed with a delta-lognormal model. The nominal frequency, total number of samples included in analyses per year, the CV (coefficient of variation on the mean), and upper and lower 95% confidence intervals on the Scaled Index are listed.

Survey Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
2000	0.17391	23	0.25310	0.26508	0.83492	0.06190	1.13518
2001	0.31915	47	0.48962	0.51279	0.42145	0.22842	1.15120
2002	0.30769	39	1.06216	1.11242	0.42358	0.49366	2.50676
2003	0.20455	44	0.58687	0.61464	0.51860	0.23159	1.63128
2004	0.23404	46	0.73175	0.76638	0.46651	0.31551	1.86156
2006	0.32258	31	0.94970	0.99464	0.43806	0.43027	2.29929
2007	0.34211	38	1.67831	1.75773	0.39300	0.82371	3.75085
2008	0.58824	17	1.13977	1.19371	0.45313	0.50297	2.83307
2009	0.37143	35	1.70206	1.78261	0.34453	0.91234	3.48303

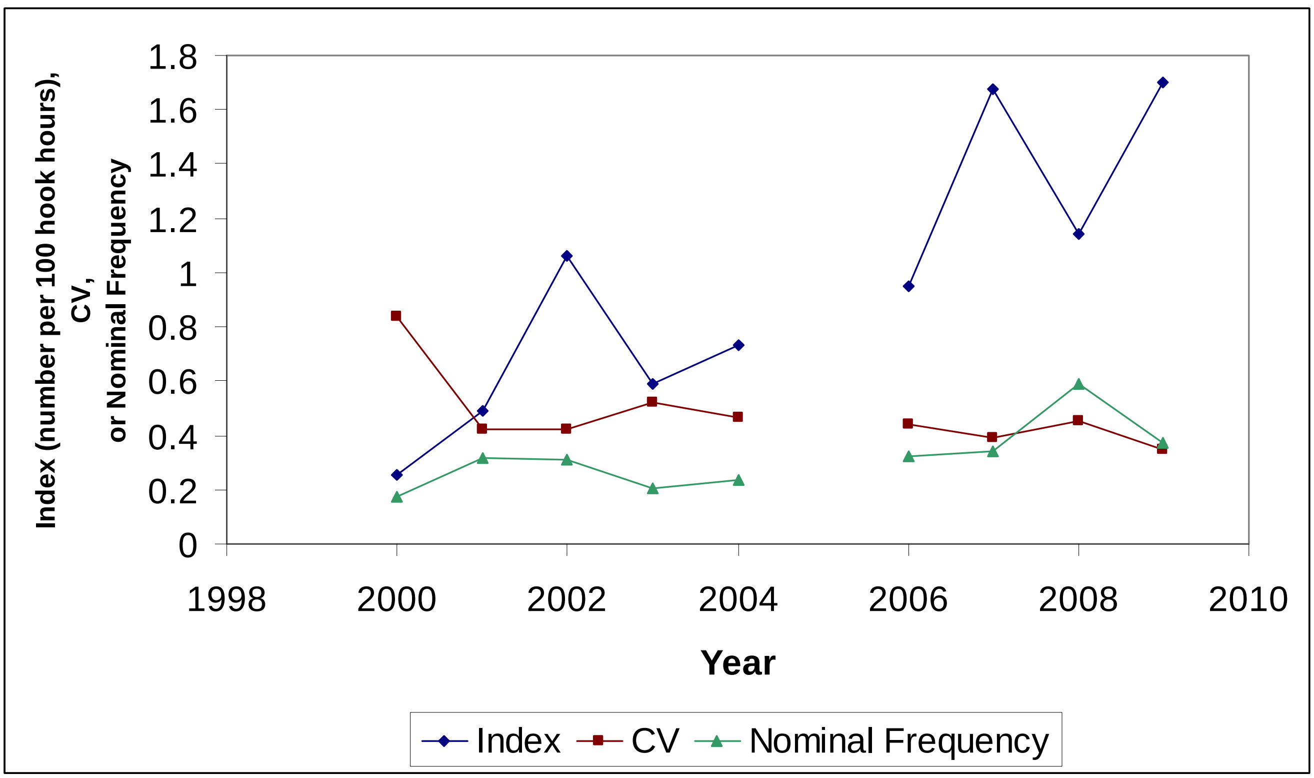


Figure 26. Indices of golden tilefish collected during bottom longline surveys (number per 100 hook hours) developed with the delta-lognormal model, coefficient of variation on the mean (CV), and nominal frequency of occurrence.

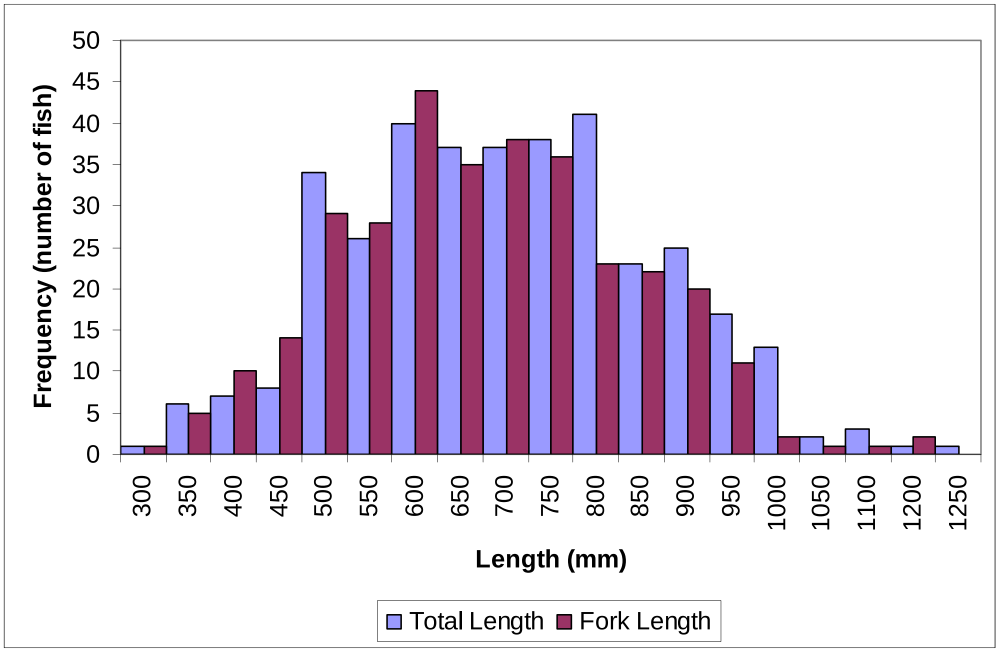


Figure 27. Length frequency histogram of yellowedge grouper total lengths and fork lengths collected during bottom longline surveys (N = 360).

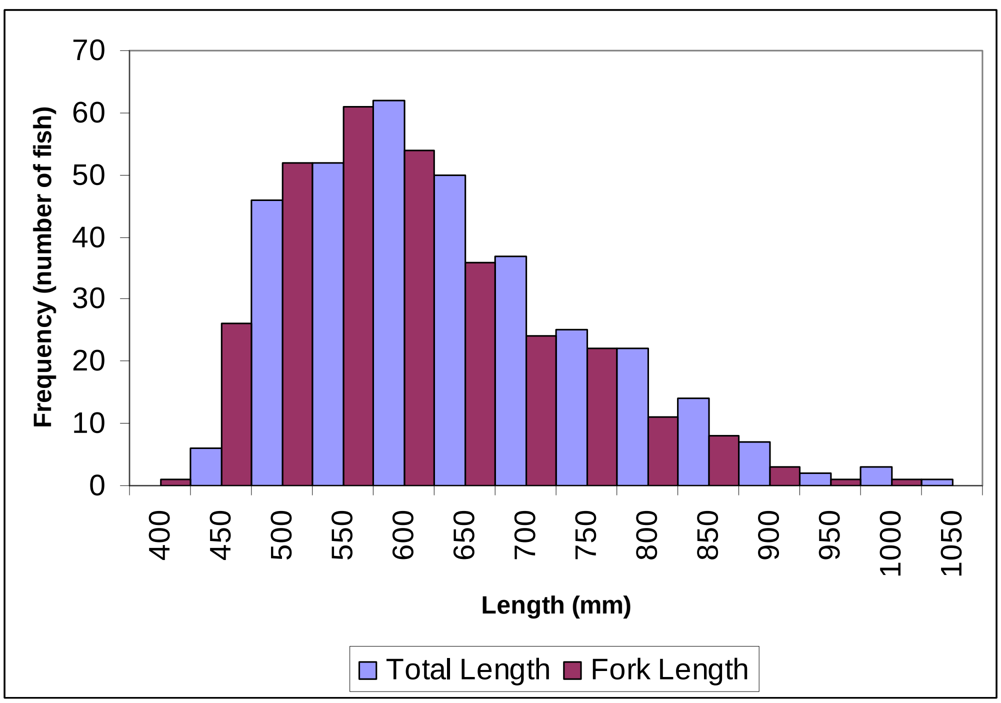


Figure 28. Length frequency histogram of golden tilefish total lengths and fork lengths collected during bottom longline surveys (N = 327).

Addendum 1 to SEDAR 22-DW-07

During the workshop I was asked to incorporate sediment data into the delta-lognormal models for both species. This data is summarized by Rester (2009). The variables included for testing, along with those listed above, were the amounts of mud, clay, and carbonate in core samples taken nearest to the station location and the linear critical sheer stress and sorting factor of the sediment in said core sample. Modeling methods were conducted as described above. The following tables summarize the final type 3 analyses of the terminal run of the backward selection procedure for both submodels and the resulting indices of abundance for both species.

Rester, J. 2009. Distribution of bottom habitat information in the Gulf of Mexico. Gulf States Marine Fisheries Commission NA05NMF4331073.

Yellowedge Grouper

Type 3 Tests of Fixed Effects for the Binomial Submodel for Yellowedge Grouper

Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*
YEAR	9	670	7.24	0.80	0.6121	0.6122
sta_dpth	1	670	5.67	5.67	0.0173	0.0176
Carbonate	1	670	3.93	3.93	0.0474	0.0478
lCritShStrs	1	670	4.72	4.72	0.0299	0.0302

Type 3 Tests of Fixed Effects for the Lognormal Submodel for Yellowedge Grouper

Effect	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	9	147	2.13	0.0308

Survey Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
1999	0.20690	58	0.65188	1.35380	0.36079	0.67253	2.72519
2000	0.24658	73	0.40214	0.83516	0.28528	0.47732	1.46128
2001	0.18085	94	0.28525	0.59241	0.30744	0.32478	1.08056
2002	0.27711	83	0.44878	0.93202	0.25324	0.56608	1.53452
2003	0.23913	92	0.51928	1.07843	0.25894	0.64791	1.79502
2004	0.19277	82	0.42613	0.88497	0.31687	0.47671	1.64286
2006	0.29091	55	0.61077	1.26843	0.30161	0.70302	2.28857
2007	0.20000	55	0.52605	1.09248	0.38985	0.51487	2.31808
2008	0.12903	31	0.34987	0.72660	0.63294	0.22758	2.31983
2009	0.25714	70	0.59501	1.23570	0.28257	0.70986	2.15107

Golden Tilefish

Type 3 Tests of Fixed Effects for the Binomial Submodel for Golden Tilefish

Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*
YEAR	8	302	16.33	2.04	0.0380	0.0416
sta_dpth	1	302	45.28	45.28	<.0001	<.0001
Clay	1	302	8.18	8.18	0.0042	0.0045
Sorting	1	302	8.83	8.83	0.0030	0.0032

Type 3 Tests of Fixed Effects for the Lognormal Submodel for Golden Tilefish

Effect	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	8	87	1.34	0.2355
sta_dpth	1	87	6.35	0.0136

Survey Year	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
2000	0.17391	23	0.10907	0.12277	0.89663	0.02642	0.57048
2001	0.31915	47	0.44762	0.50384	0.44211	0.21641	1.17300
2002	0.30769	39	0.96130	1.08202	0.46269	0.44841	2.61096
2003	0.20455	44	0.35876	0.40381	0.58394	0.13668	1.19308
2004	0.23404	46	0.60633	0.68248	0.50839	0.26160	1.78052
2006	0.32258	31	1.02528	1.15403	0.47514	0.46810	2.84513
2007	0.34211	38	1.73256	1.95014	0.41516	0.87841	4.32945
2008	0.58824	17	1.28212	1.44313	0.45643	0.60459	3.44473
2009	0.37143	35	1.47282	1.65778	0.39634	0.77223	3.55881

Addendum 2 to SEDAR 22-DW-07

Also, during the data workshop, I was asked by the stock assessment scientist to develop indices for three areas of the Gulf. These areas were based on the NMFS shrimp statistical zones, employed in many fishery independent survey designs: southwest Florida (SWFLA), zones 2-5; northwest Florida (NWFLA), zones 6-11; and the western Gulf (WEST), zones 13-21. This area variable and a variable denoting the interaction of this area and year were forced into the models developed for each species in Addendum 1. The following tables and graphs summarize these area-specific abundance indices.

Yellowedge Grouper

Type 3 Tests of Fixed Effects for the Binomial Submodel for Yellowedge Grouper

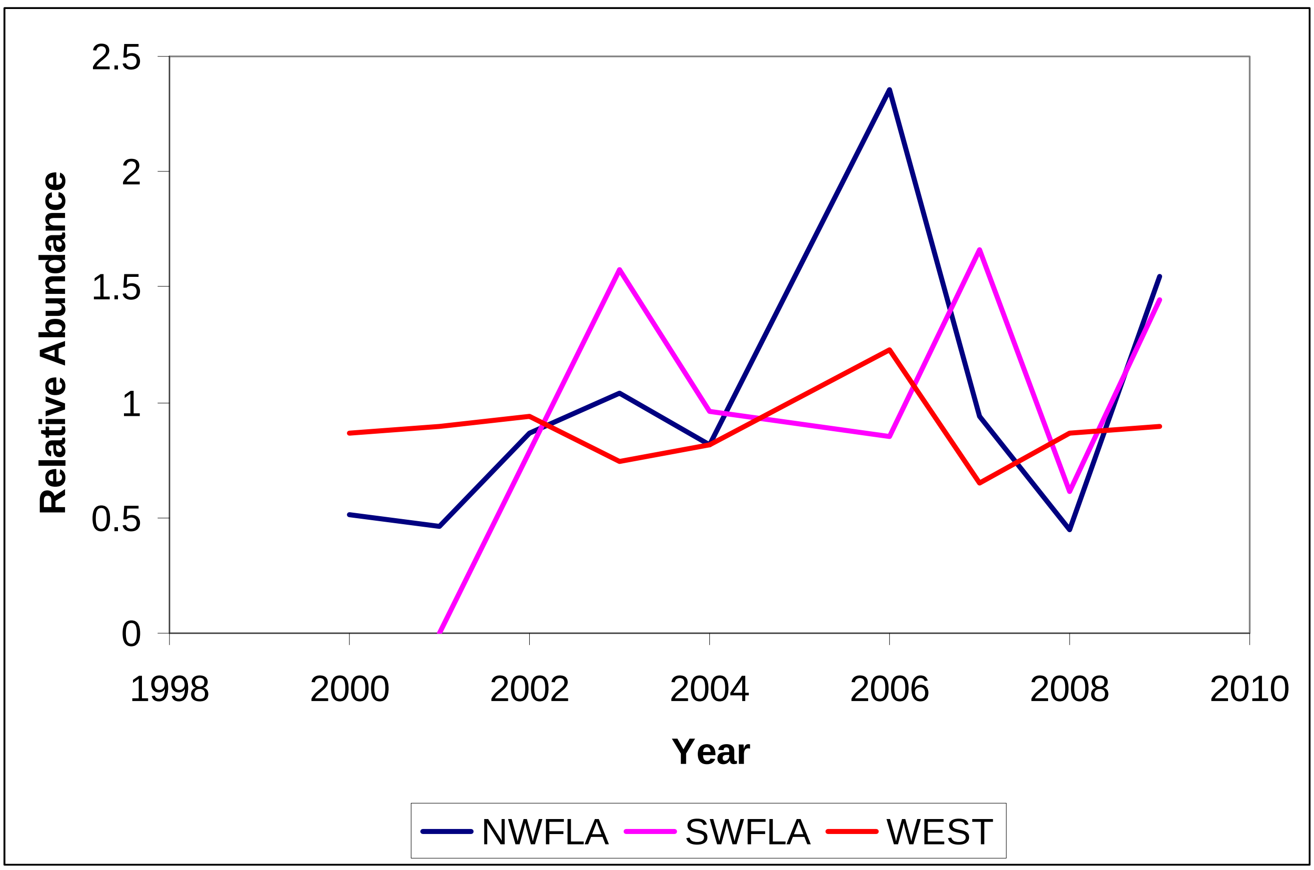
Effect	*Num DF*	*Den DF*	*Chi-Square*	*F Value*	*Pr > ChiSq*	*Pr > F*
YEAR	8	579	6.67	0.83	0.5724	0.5729
Area	2	579	0.44	0.22	0.8015	0.8016
sta_dpth	1	579	4.49	4.49	0.0340	0.0344
Carbonate	1	579	1.50	1.50	0.2204	0.2209
lCritShStrs	1	579	5.22	5.22	0.0223	0.0227
*YEAR*Area*	13	579	6.24	0.48	0.9371	0.9361

Type 3 Tests of Fixed Effects for the Lognormal Submodel for Yellowedge Grouper

Effect	*Num DF*	*Den DF*	*F Value*	*Pr > F*
YEAR	8	121	1.25	0.2745
Area	2	121	0.75	0.4734
*YEAR*Area*	13	121	0.96	0.4976

Survey Year	*Area*	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
2000	NWFLA	0.28571	7	0.24922	0.51119	0.86261	0.11502	2.27188
2001	NWFLA	0.17241	29	0.22536	0.46225	0.56739	0.16070	1.32966
2002	NWFLA	0.33333	15	0.42259	0.86681	0.51609	0.32798	2.29090
2003	NWFLA	0.25000	28	0.50848	1.04299	0.45763	0.43604	2.49477
2004	NWFLA	0.19048	20	0.39862	0.81763	0.61117	0.26498	2.52286
2006	NWFLA	0.42857	7	1.15009	2.35903	0.64875	0.72100	7.71846
2007	NWFLA	0.21429	14	0.45707	0.93752	0.72390	0.25595	3.43401
2008	NWFLA	0.10000	10	0.21671	0.44451	1.24105	0.06445	3.06569
2009	NWFLA	0.37500	16	0.75411	1.54680	0.45852	0.64567	3.70562
2001	SWFLA	0.00000	19	0.00000	0.00000	.	.	.
2003	SWFLA	0.21875	32	0.76688	1.57299	0.46283	0.65172	3.79657
2004	SWFLA	0.16667	30	0.46950	0.96302	0.55196	0.34333	2.70126
2006	SWFLA	0.26316	19	0.41394	0.84906	0.54312	0.30713	2.34717

Survey Year	*Area*	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
2007	SWFLA	0.31579	19	0.80989	1.66122	0.51044	0.63455	4.34896
2008	SWFLA	0.09091	11	0.30008	0.61551	1.24194	0.08917	4.24889
2009	SWFLA	0.25000	20	0.70607	1.44827	0.52878	0.53649	3.90965
2000	WEST	0.24242	66	0.42160	0.86478	0.30227	0.47871	1.56219
2001	WEST	0.26087	46	0.43616	0.89463	0.35504	0.44912	1.78207
2002	WEST	0.26471	68	0.45864	0.94076	0.28859	0.53433	1.65633
2003	WEST	0.25000	32	0.36234	0.74323	0.42124	0.33119	1.66790
2004	WEST	0.21875	32	0.39667	0.81364	0.49316	0.32001	2.06871
2006	WEST	0.27586	29	0.59795	1.22650	0.42760	0.54043	2.78354
2007	WEST	0.09091	22	0.31664	0.64949	0.90307	0.13861	3.04331
2008	WEST	0.20000	10	0.42392	0.86953	0.89709	0.18701	4.04301
2009	WEST	0.20588	34	0.43811	0.89865	0.46790	0.36908	2.18808



Golden Tilefish

Type 3 Tests of Fixed Effects for the Binomial Submodel for Golden Tilefish

Effect	Num DF	Den DF	Chi-Square	F Value	Pr > ChiSq	Pr > F
YEAR	8	221	12.07	1.51	0.1480	0.1552
Area	2	221	0.80	0.40	0.6707	0.6712
sta_dpth	1	221	32.99	32.99	<.0001	<.0001
Clay	1	221	1.80	1.80	0.1793	0.1807
Sorting	1	221	1.10	1.10	0.2944	0.2955
YEAR*Area	7	221	6.97	1.00	0.4318	0.4350

Type 3 Tests of Fixed Effects for the Lognormal Submodel for Golden Tilefish

Effect	Num DF	Den DF	F Value	Pr > F
YEAR	8	78	1.40	0.2087
Area	2	78	1.02	0.3658
sta_dpth	1	78	5.48	0.0218
YEAR*Area	7	78	0.90	0.5110

Survey Year	Area	Nominal Frequency	N	Index	Scaled Index	CV	LCL	UCL
2000	NWFLA	0.00000	4	0.00000	0.00000	.	.	.
2001	NWFLA	0.28571	21	0.36233	0.27630	0.71024	0.07696	0.99193
2002	NWFLA	0.40000	10	1.15490	0.88070	0.58965	0.29537	2.62601
2003	NWFLA	0.29412	17	0.60755	0.46330	0.76620	0.11900	1.80374
2004	NWFLA	0.41667	11	1.62034	1.23564	0.57235	0.42612	3.58307
2006	NWFLA	0.66667	6	1.77768	1.35562	0.47528	0.54973	3.34292
2007	NWFLA	0.53846	13	2.35840	1.79847	0.47926	0.72435	4.46539
2008	NWFLA	0.80000	5	1.47560	1.12527	0.58283	0.38154	3.31868
2009	NWFLA	0.50000	10	1.61015	1.22787	0.57008	0.42500	3.54744
2001	SWFLA	0.00000	7	0.00000	0.00000	.	.	.
2003	SWFLA	0.00000	17	0.00000	0.00000	.	.	.
2004	SWFLA	0.00000	17	0.00000	0.00000	.	.	.
2006	SWFLA	0.00000	12	0.00000	0.00000	.	.	.
2007	SWFLA	0.00000	14	0.00000	0.00000	.	.	.
2008	SWFLA	0.00000	3	0.00000	0.00000	.	.	.
2009	SWFLA	0.09091	11	0.29951	0.22840	1.20561	0.03434	1.51905
2000	WEST	0.21053	19	0.18039	0.13756	0.86394	0.03090	0.61244
2001	WEST	0.47368	19	0.87397	0.66647	0.46705	0.27412	1.62037
2002	WEST	0.27586	29	1.27283	0.97064	0.53226	0.35748	2.63547
2003	WEST	0.40000	10	0.75335	0.57449	0.62844	0.18120	1.82137

Survey Year	*Area*	*Nominal Frequency*	*N*	*Index*	*Scaled Index*	*CV*	*LCL*	*UCL*
2004	WEST	0.33333	18	0.82481	0.62899	0.67514	0.18465	2.14260
2006	WEST	0.46154	13	1.49065	1.13674	0.55433	0.40369	3.20092
2007	WEST	0.54545	11	2.87709	2.19401	0.47416	0.89142	5.40000
2008	WEST	0.66667	9	1.63184	1.24441	0.55130	0.44413	3.48676
2009	WEST	0.50000	14	2.43270	1.85513	0.44300	0.79560	4.32566