SEAMAP Reef Fish Video Survey: Relative Indices of Abundance of Gray Triggerfish

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February 2015

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Introduction

The primary objective of the annual Southeast Area Monitoring and Assessment Program (SEAMAP) reef fish video survey is to provide an index of the relative abundances of fish species associated with topographic features (e.g reefs, banks, and ledges) located on the continental shelf of the Gulf of Mexico (GOM) from Brownsville, TX to the Dry Tortugas, FL (Figures 1, and 17-33). Secondary objectives include quantification of habitat types sampled (video and side-scan), and collection of environmental data throughout the survey. Because the survey is conducted on topographic features the species assemblages targeted are typically classified as reef fish (e.g. red snapper, *Lutjanus campechanus*), but occasionally fish more commonly associated with pelagic environments are observed (e.g. Amberjack, *Seriola dumerili*). The survey has been executed from 1992-1997, 2001-2002, and 2004-present and historically takes place from April - May, however in limited years the survey was conducted through the end of July. The 2001 survey was abbreviated due to ship scheduling, during which, the only sites that were completed were located in the western Gulf of Mexico. Types of data collected on the survey include diversity, abundance (min-count), fish length, habitat type, habitat coverage, bottom topography and water quality. The size of fish sampled with the video gear is species specific however gray triggerfish sampled over the history of the survey had fork lengths ranging from 178 – 678 mm, and mean annual fork lengths ranging from 303 – 415 mm (Figure 35). Age and reproductive data cannot be collected with the camera gear but beginning with the 2012 survey, a vertical line component was coupled with the video drops to collect hard parts, fin clips, and gonads and was included in the life history information provided by the NMFS Panama City Laboratory.

Methods

Sampling design

Total reef area available to select survey sites from is approximately 1771 km², of which 1244 km² is located in the eastern GOM and 527 km² in the western GOM. The large size of the survey area necessitates a two-stage sampling design to minimize travel times between stations. The first-stage uses stratified random sampling to select blocks that are 10 minutes of latitude by 10 minutes of longitude in dimension (Figure 1). The block strata were defined by geographic region (4 regions: South Florida, Northeast Gulf, Louisiana-Texas Shelf, and South Texas), and by total reef habitat area contained in the block (blocks ≤ 20 km² reef, block > 20 km² reef). There are a total of 7 strata. A 0.1 by 0.1 mile grid is then overlaid onto the reef area contained within a given block and the ultimate sampling sites (second stage units) are randomly selected from that grid.

Gear and deployment

The SEAMAP reef fish survey has employed several camcorders in underwater housings since 1992. Sony VX2000 DCR digital camcorders mounted in Gates PD150M underwater housings were used from 2002 to 2005 and Sony PD170 camcorders during the years 2006 and 2007. In 2008 a stereo video camera system was developed and assembled at the NMFS Mississippi Laboratories - Stennis Space Center Facility and has been used in all subsequent surveys. The stereo video unit consists of a digital stereo still camera head, digital video camera, CPU, and hard drive mounted housed in an aluminum casing. All of the camcorder housings are rated to a maximum depth of 150 meters while the stereo camera housings are rated to 600 meters. Stereo cameras are mounted orthogonally at a height of 50 cm above the bottom of the pod and the array is baited with squid during deployment.

At each sampling site the stereo video unit is deployed for 40 minutes total, however the cameras and CPU delay filming for 5 minutes to allow for descent to the bottom, and settling of suspended sediment following impact. Once turned on, the cameras film for approximately 30 minutes before shutting off and retrieval of the array. During camera deployment the vessel drifts away from the site and a CTD cast is executed, collecting water depth, temperature, conductivity, and transmissivity from the surface to the maximum depth. Seabird units are the standard onboard NOAA vessels however the model employed was vessel/cruise dependent.

Video tape viewing

One video tape from each station is randomly selected for viewing out of all viewable videos. Videos that have issues with visibility, obstructions or camera malfunction cannot be randomly selected and are not viewed. Selected videos are viewed for twenty minutes starting from the time when the view clears from suspended sediment. Viewers identify, and enumerate all species to the lowest taxonomic level during the 20 minute viewable segment. From 1993-2007 the time when each fish entered and left the field of view was recorded a procedure referred to as time in - time out (TITO) and from these data a minimum count was calculated. The minimum count is the maximum number of individuals of a selected taxon in the field of view at one instance. Each 20 minute video is evaluated to determine the highest minimum count observed during a 20 minute recording. From 2008-present the digital video allows the viewer to record a frame number or time stamp of the image when the maximum number of individuals of a species occurred, along with the number of taxon identified in the image, but does not use the TITO method. Both the TITO and current viewing procedure result in the minimum count estimation of abundance (i.e. - mincount). Minimum count methodology is preferred because it prevents counting the same fish multiple times (e.g. if a fish were swimming in circles around the camera).

Fish length measurement

Beginning in 1995 fish lengths were measured from video using lasers attached on the camera system with known geometry. However, the frequency of hitting targets with the laser is low and to increase sample size any measureable fish during the video read was measured (i.e. not just at the mincount), and fish could have potentially been measured twice. The stereo cameras used in 2008-present allow size estimation from fish images. The Vision Measurement System (Geometrics Inc.) was used to estimate size of fish. Fish measurement is only performed at the point in the video corresponding to the mincount therefore there is no potential to measure any fish twice.

Data reduction

Various limitations either in design, implementation, or performance of gear causes limitations in calculating mincount and are therefore dropped from the design-based indices development and analysis as follows. In 1992, each fish was counted every time it came into view over the entire record time and the total of all these counts was the maximum count. Maximum count methodologies are not preferred and the 1992 video tapes were destroyed during Hurricane Katrina and cannot be re-viewed, so 1992 data is excluded from analyses (unknown number of stations). From 1998 – 2000 and in 2003 the survey was not conducted. Occasionally tapes are unable to be read (i.e. organisms cannot be identified to species) for the following reasons including: 1) camera views are more than 50% obstructed, 2) sub-optimal lighting conditions, 3) increased backlighting, 4) increased turbidity, 5) cameras out of focus, 6) cameras failed to film. In all of these cases the station is flagged as 'XX' in the data set and dropped (190 total sites). Sites that did not receive a stratum assignment are also dropped (62) and all of those occurred early in the survey (1994-1995).

Explanatory variables and definitions

Year (Y) = The survey is conducted on an annual basis during the spring and the objective is to calculate standardized observation rates by year. Years included 1993-1997, 2001-2002, and 2004-2014.

Region (R) = The survey is conducted throughout the northern Gulf of Mexico, however historically the SEDAR data workshop has requested separate indices for the western and eastern Gulf which is divided at 89° west longitude. This variable is not included in the model itself.

Block (B) = The first stage of the random site selection process is selected from 10' latitude x 10' longitude blocks. Only blocks containing known reef are eligible for selection. Ten sites are randomly selected from within the blocks. Initial models always include a random block factor to test for autocorrelation among sites within a block.

Strata (ST) = Strata are defined by geographic region (4 regions: South Florida, Northeast Gulf, Louisiana-Texas Shelf, and South Texas), and by total reef habitat area contained in the block (blocks ≤ 20 km² reef, block > 20 km² reef). There are a total of 7 strata.

Depth (D) = Water depth at the lat-lon where the camera was deployed via TDR placed on the array.

Temperature (T) = Water temperature on the bottom (C°) taken during camera deployment via TDR placed on the camera array.

Dissolved oxygen (DO) = Dissolved oxygen (mg/l) taken via CTD cast slightly away from where the camera is deployed.

Salinity (S) = Salinity (ppt) taken via CTD cast slightly away from where the camera is deployed.

Silt sand clay (SSC) = Percent bottom cover of silt, sand, or clay substrates.

Shell gravel (SG) = Percent bottom cover of shell or gravel substrates.

Rock (RK) = Percent bottom cover of rock substrates.

Attached epifauna (AE) = Percent bottom cover of attached epifauna on top of substrate.

Grass (G) = Percent bottom covered by grass.

Sponge (SP) = Percent bottom covered by sponge.

Unknown sessiles (US) = Percent bottom covered by unknown sessile organisms.

Algae (AL) = Percent bottom covered by algae.

Hardcoral (HC) = Percent bottom covered by hard coral.

Softcoral (SC) = Percent bottom covered by soft coral.

Seawhips (SW) = Percent bottom covered by seawhips.

Relief Maximum (RM) = Maximum relief measured from substrate to highest point.

Relief Average (RA) = Average relief measured from substrate to all measurable points.

Reef (RF) = Boolean variable indicating whether or not a station landed on reef or missed reef. It is a composite variable where positive reef stations = > 5% hard coral or >5% rock or >5% soft coral

Index Construction

Video surveys produce count data that do not conform to assumptions of normality and are frequently modeled using Poisson or negative-binomial error distributions (Guenther et al. 2014). Video data frequently has high numbers of 'zero-counts' commonly referred to as 'zero-inflated' data distributions, they are common in ecological count data and are a special case of over dispersion that cannot be easily addressed using traditional transformation procedures (Hall 2000). We used two different error distribution models to construct relative abundance indices and model choice (i.e. poisson and negative binomial) was based on relative abundance indices that were submitted and accepted for use during the red grouper stock assessment including the video survey conducted by Florida Wildlife Research Institute (Guenther et al. 2014), and a combined NMFS-Mississippi Labs, NMFS-Panama City, and FWRI index (personal communication Walter Ingram).

Gulf wide, east gulf, and west gulf models were run and independent variables tested in the model included year and reef as fixed effects and block as a random effect (mincount = year + reef + block). A second set of model runs were performed that excluded the random block effect (mincount = year + reef). We used the composite variable 'reef' rather than the percent coverage of individual habitat variables because of the strong relationship triggerfish have with reef habitat and as a simplifying/aggregating variable to indicate if a camera observed reef habitat. Additionally, in data webinars leading up to the workshop it was decided that a combination of video indices submitted by NMFS-Mississippi Labs, NMFS-Panama City and FWRI was desired. Despite the good coordination between groups the percent habitat cover variables are fairly subjective and may be interpreted different among groups, however groups are consistent in determining if the camera landed on reef habitat (i.e. the 'reef' variable). The GLIMMIX and MIXED procedure in SAS (v. 9.4) were used to develop the binomial and lognormal sub-models in the delta lognormal model (Lo et al. 1992), and GLIMMIX used to develop the poisson and negative binomial models. Best fitting models were determined by evaluating the conditional likelihood, over-dispersion parameter (Pearson chi-square/DF), and visual interpretation of the Q/Q plots.

Results

Initial runs of the delta lognormal model produced poor fits to the data that were non-linear (e.g. 'S shaped' QQ plots), therefore no subsequent runs were made using that error distribution, and only poisson and negative binomial error distributions were used thereafter. Evaluation of model iterations (by region and parameters) showed improved fit statistics for the negative binomial runs regardless of model run (Table 1). Negative binomial models consistently showed lower conditional likelihoods and showed Pearson chi-square /DF that were consistently closer to 1. Both the poisson and negative binomial models showed nearly linear QQ plots (Figures 5, 9, and 13). Therefore the negative binomial model was selected as the best fitting model and we chose to only present model output and graphs from those runs for the Gulf wide, east Gulf, and west Gulf indices.

Gray triggerfish were observed throughout the eastern and western Gulf of Mexico in most years (Figures 14-30). The species is not commonly observed on reefs of the central and southern portions of the west Florida shelf and the Dry Tortugas. While we sampled more stations in the west Gulf in 2001 all of the positive observations were in the east. In 2001 there was reduced effort in the survey due to vessel issues and therefore that year might not be representative but despite this, we left the sample year in the model. Otherwise the spatial distributions observed are highly reflective of the reef sampling universe used to select sampling sites (Figures 1 and 14-30). Gaps in habitat level information exist on the central portion of the west Florida shelf, Mississippi river delta region, and portions of the Texas coast. In most years the survey shows good coverage in the defined sampling universe, and coverage improved through time as the sampling universe expanded and more sites were added to the survey. The most recent mapping and sampling efforts in south Texas and in the central portion of the west Florida shelf were accomplished in 2012-13 but were not available for incorporation into this index.

In all three spatial runs (east, west, and Gulf wide) both year and reef were significant variables (Tables 2 - 4). Through time it appears that the Gulf wide index shows a lot of variability and a slightly declining trend through time. Highest mincounts were observed in 1997, 2002, and 2007, and the lowest was observed in 2001 (Table 5, Figures 3 and 4). Since 2004 mincount observations of gray triggerfish appear to be fairly stable in the Gulf wide model with the exception of two high years in 2007 and 2011 (Figures 3 and 4). Proportion positives reflect the abundance trends in which there is a general decline through the time series (Table 5, Figure 2).

The east gulf showed steeper declines than did the Gulf wide model for proportion positives, observed mincounts, and predicted mincounts (Table 6, Figures 6-8). Highest mincounts were observed in 2002 and 2007 as was the case in the Gulf wide model. Similar to the Gulf wide model the population appears to stabilize around 2004, however the mincount is generally on a negative trend. After 2004 peak abundance was observed in 2007 but does not reflect the 2011 peak observed in the Gulf wide model.

Unlike in the east and the Gulf wide model, the west Gulf model shows a general increasing trend over the course of the time series for the proportion positives, observed mincounts, and predicted mincounts (Table 7, Figures 10-12). Highest mincounts were observed in 1997, 2002, 2008, and 2011. Peaks in 1997 and 2002 were also observed in the eastern and Gulf wide models. Since 2004 the population appears to be stable, but unlike the east and Gulf wide models shows a general increasing trend in abundance.

Annual mean fork lengths for east GOM gray triggerfish have ranged from 178 – 678 mm, and mean annual fork lengths ranging from 303 – 415 mm (Table 8, Figures 31 and 32). Largest fish were measured in the west Gulf in 1995. Peaks in length were observed in 1995, 2003, 2009, 2010, and 2012. There appears to be no difference between length composition for by region (Table 8, Figure 32).

Literature cited

Guenther, C.B., T.S. Switzer, S.F. Keenan, and R.H. McMichael, Jr. 2014. Indices of abundance for Red Grouper (*Epinephelus morio*) from the Florida Fish and Wildlife Research Institute (FWRI) video survey on the West Florida Shelf. SEDAR42-DW-08. SEDAR, North Charleston, SC. 21 pp.

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.

Figure 1. Spatial distribution of known reef from which stations are randomly selected for sampling for the reef fish video survey. Over the history of the survey (1992-2013) new reef tract has been discovered and mapped and therefore this map represents what was available in 2013, and not necessarily what has been available over the entire time series.

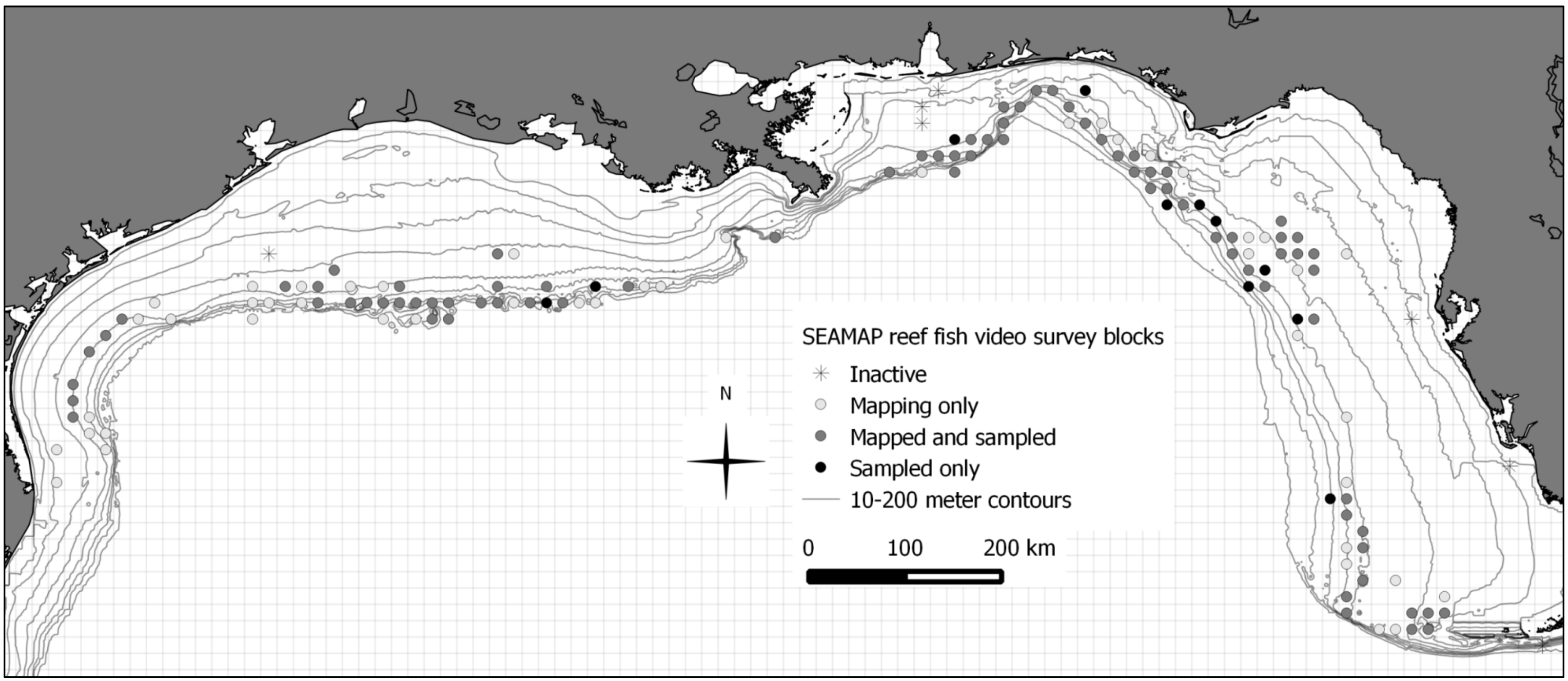

Table 1. Fit statistics (AIC, log likelihood, and pearson chi-square) from each model run for both the negative binomial and poisson error distributions.

Model run		AIC		Log likelihood		Pearson Chi Square	
Region	Parameters	Neg-Bin	Poisson	Neg-Bin	Poisson	Neg-Bin	Poisson
Gulf wide	YR Reef Block	5448	6423	5408	6069	1.12	1.91
Gulf wide	YR Reef	6371	8780	6333	8744	1.49	4.34
East	YR Reef Block	3636	4115	3421	4115	1.13	1.94
East	YR Reef	4173	5650	4135	5614	1.68	4.56
West	YR Reef Block	1807	2109	1736	2071	0.98	1.64
West	YR Reef	2225	3239	2081	3203	1.15	4.36

Table 2. Gulf wide negative binomial (Neg-Bin) model run test of type III fixed effects.

Type III Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
year	16	567	6.06	<.0001
REEF	1	81	72.75	<.0001

Table 3. East Gulf negative binomial (Neg-Bin) model run test of type III fixed effects.

Type III Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
year	16	334	5.69	<.0001
REEF	1	49	68.59	<.0001

Table 4. West Gulf negative binomial (Neg-Bin) model run test of type III fixed effects.

Type III Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
year	16	217	4.12	<.0001
REEF	1	31	6.10	0.0192

Table 5. Output for the negative binomial index of relative abundance of gray triggerfish by year, Gulf wide model run.

Year	N	Proportion positive	Mincount	Mu (no blups)	% CV (no blups)	Mu (blups)	% CV (blups)
1993	159	0.25	0.440	0.147	34.24	0.494	111.88
1994	127	0.30	0.433	0.138	35.91	0.507	146.51
1995	99	0.18	0.313	0.114	36.08	0.314	140.32
1996	298	0.18	0.262	0.108	32.70	0.272	155.97
1997	292	0.27	0.616	0.193	33.37	0.729	151.42
2001	75	0.05	0.067	0.015	32.38	0.061	101.24
2002	243	0.16	0.399	0.173	32.44	0.394	129.94
2004	198	0.18	0.303	0.083	36.54	0.334	158.08
2005	410	0.14	0.244	0.084	36.67	0.255	200.18
2006	415	0.12	0.219	0.065	37.16	0.214	147.12
2007	489	0.10	0.503	0.169	36.69	0.404	182.81
2008	337	0.13	0.217	0.076	37.13	0.226	198.80
2009	429	0.16	0.217	0.066	36.51	0.227	164.61
2010	327	0.10	0.229	0.067	36.41	0.206	171.63
2011	440	0.17	0.314	0.103	36.53	0.309	160.96
2012	481	0.13	0.252	0.065	39.00	0.217	173.15
2013	300	0.12	0.240	0.061	38.95	0.228	188.72

Figure 2. Plot of the proportion positives for gray triggerfish, Gulf wide model run.

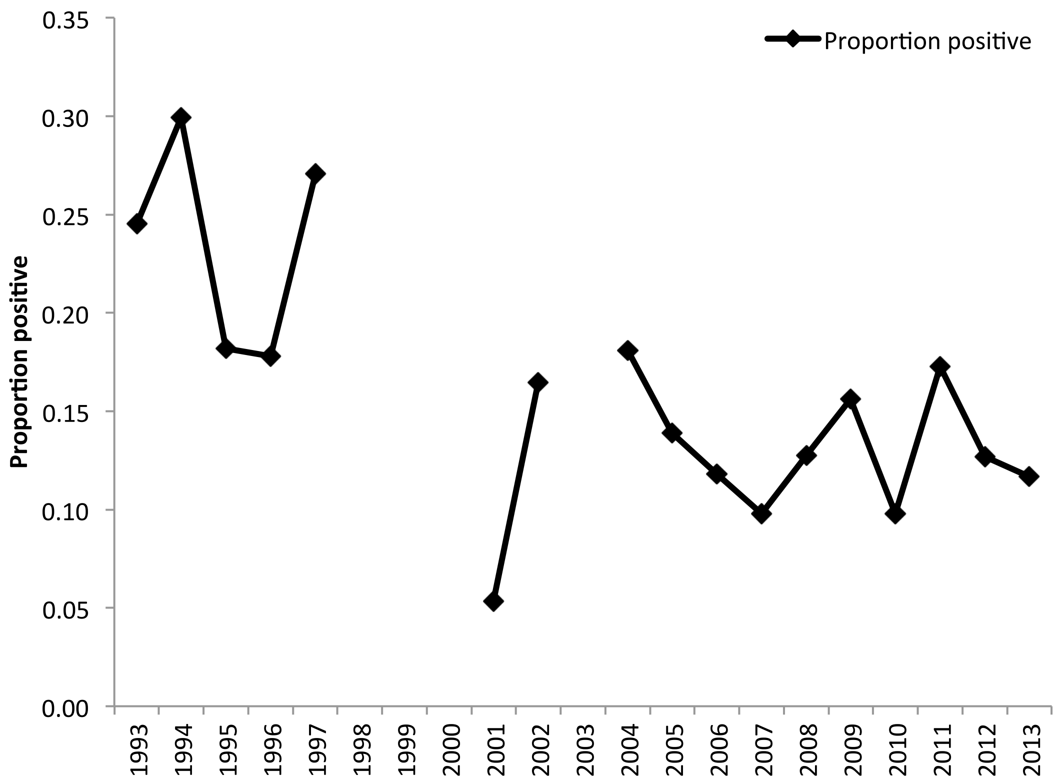

Figure 3. Plot of the least squares means of inverse linked mincount with 95% CI's for gray triggerfish, Gulf wide negative-binomial model run.

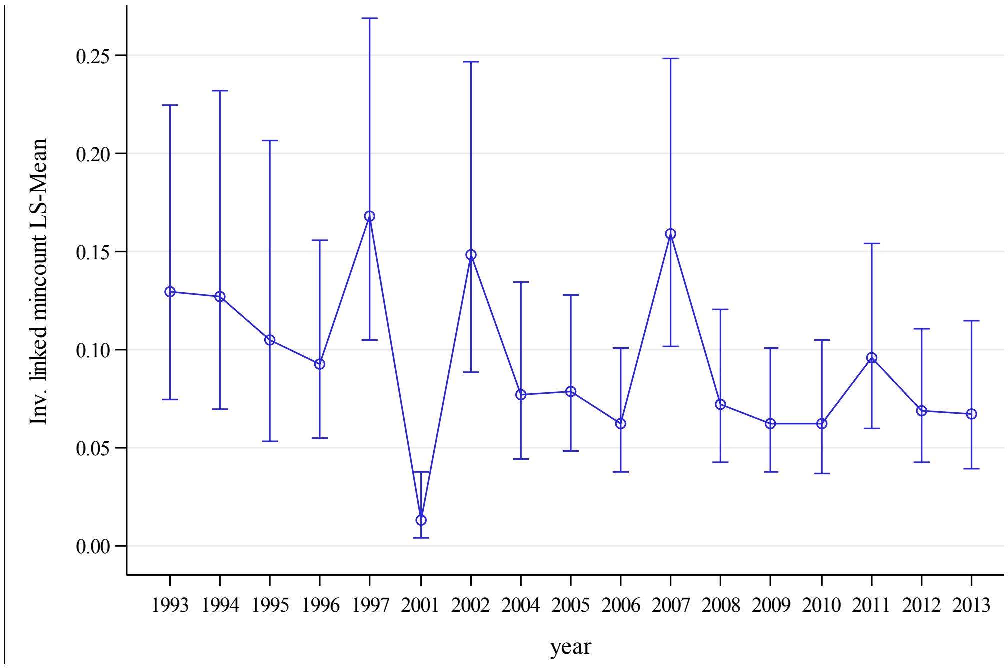

Figure 4. Mean grey triggerfish counts for the observed (mincount) and predicted (Mu no blups & Mu blups) mincounts from the Gulf wide negative binomial model run.

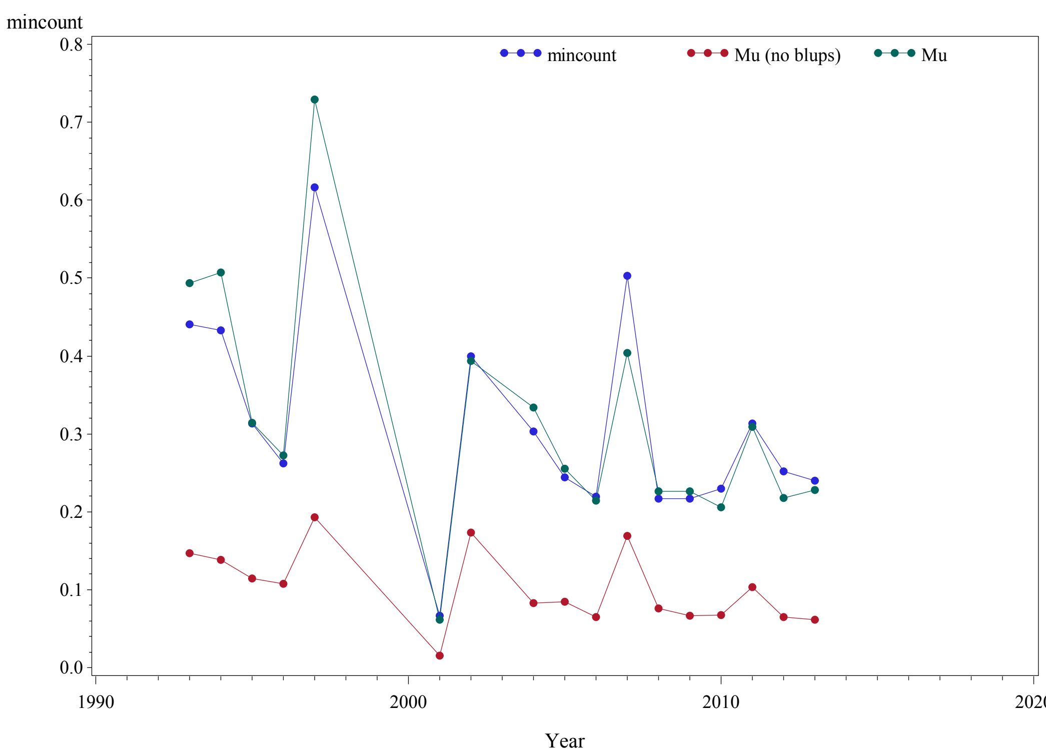

Figure 5. QQ plot of conditional residuals for the Gulf wide negative binomial model run.

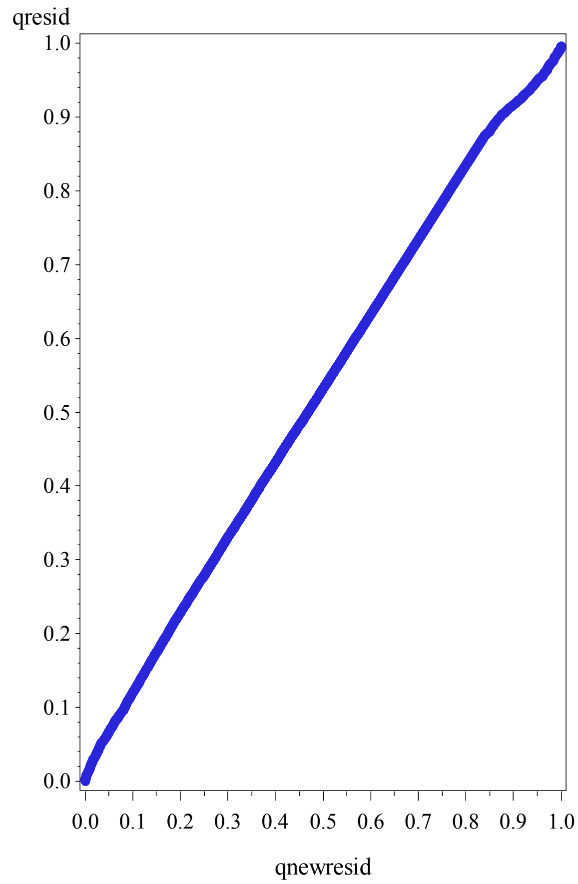

Table 6. Output for the negative binomial index of relative abundance of gray triggerfish by year, east Gulf model run.

Year	N	Proportion positive	Mincount	Mu (no blups)	% CV (no blups)	Mu (blups)	% CV (blups)
1993	114	0.32	0.588	0.150	41.74	0.690	94.99
1994	82	0.37	0.537	0.133	40.31	0.525	107.45
1995	55	0.29	0.509	0.135	40.54	0.512	110.51
1996	133	0.29	0.406	0.112	36.76	0.422	103.86
1997	161	0.31	0.484	0.125	38.23	0.507	93.35
2001	32	0.13	0.156	0.023	38.83	0.145	58.82
2002	151	0.21	0.510	0.189	34.90	0.530	115.37
2004	148	0.19	0.270	0.096	38.68	0.320	115.22
2005	274	0.16	0.226	0.102	42.36	0.227	128.04
2006	276	0.16	0.272	0.086	40.78	0.278	116.05
2007	318	0.11	0.667	0.225	42.53	0.489	154.00
2008	206	0.10	0.150	0.061	41.19	0.156	140.29
2009	262	0.19	0.279	0.087	40.68	0.269	122.14
2010	221	0.09	0.176	0.065	40.34	0.170	144.56
2011	337	0.17	0.234	0.096	41.24	0.243	134.47
2012	281	0.09	0.117	0.041	44.11	0.121	134.49
2013	164	0.09	0.116	0.050	44.39	0.120	132.47

Figure 6. Plot of the proportion positives for gray triggerfish, east Gulf model run.

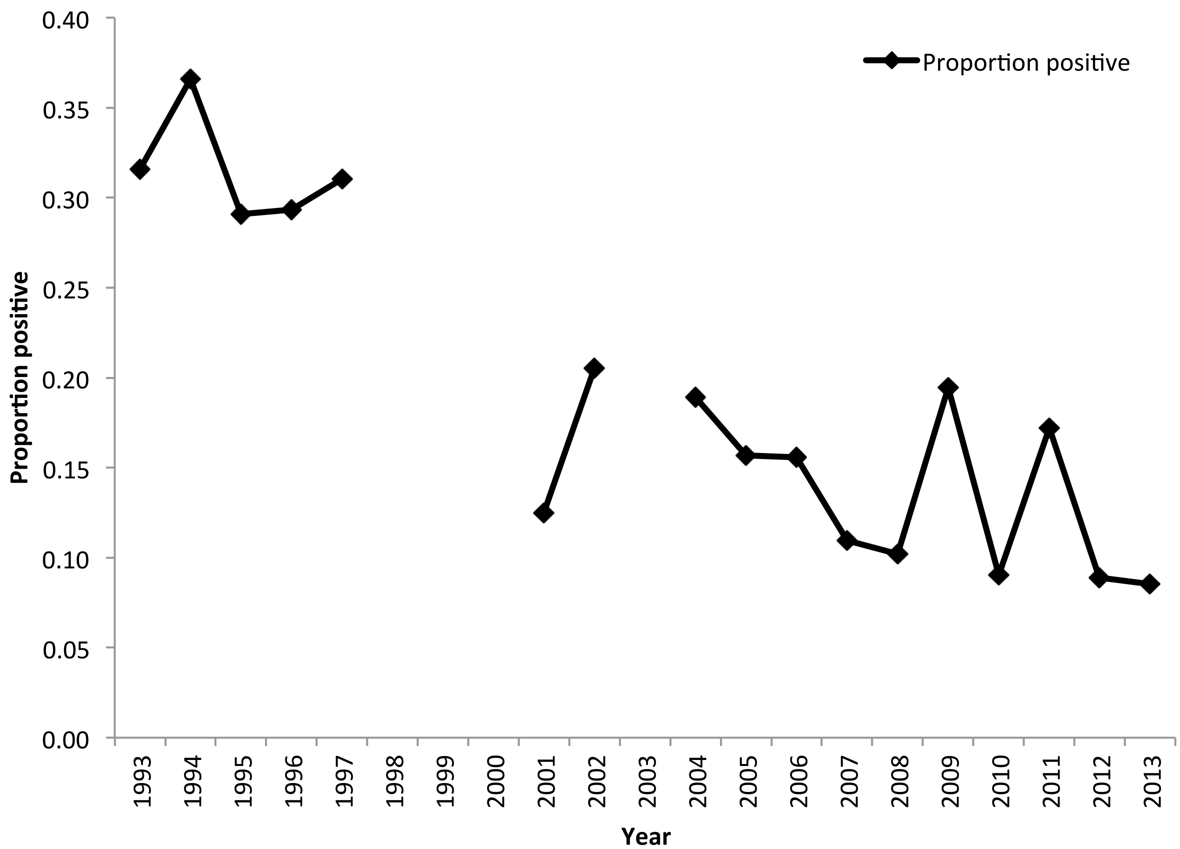

Figure 7. Plot of the least squares means of inverse linked mincount with 95% CI's for gray triggerfish, east Gulf negative binomial model run.

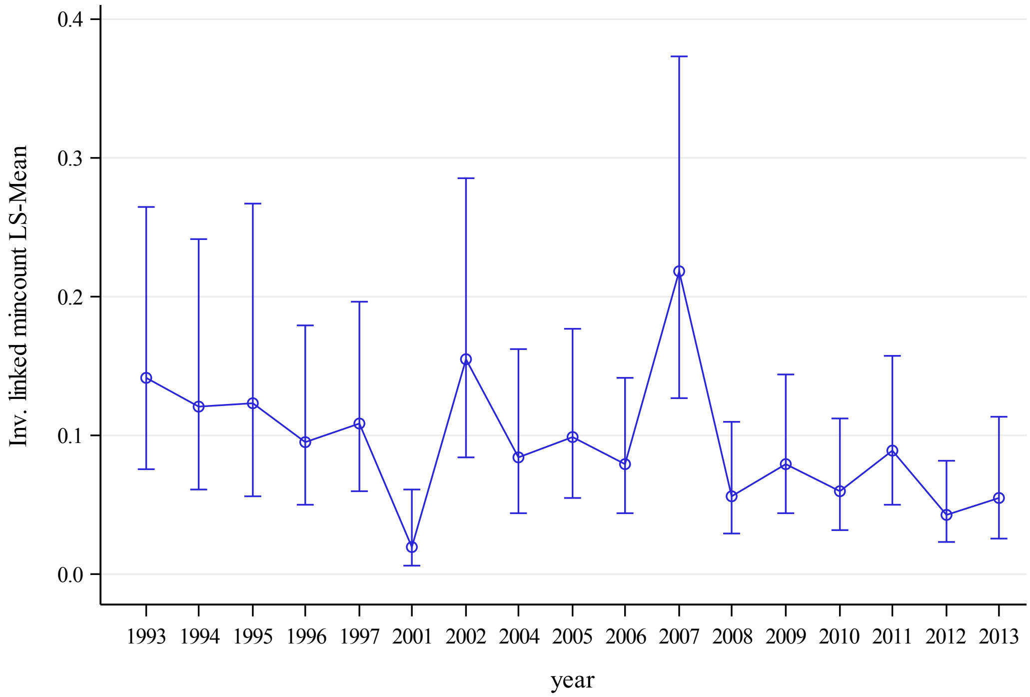

Figure 8. Mean grey triggerfish counts for the observed (mincount) and predicted (Mu no blups & Mu blups) mincounts from the east Gulf negative binomial model run.

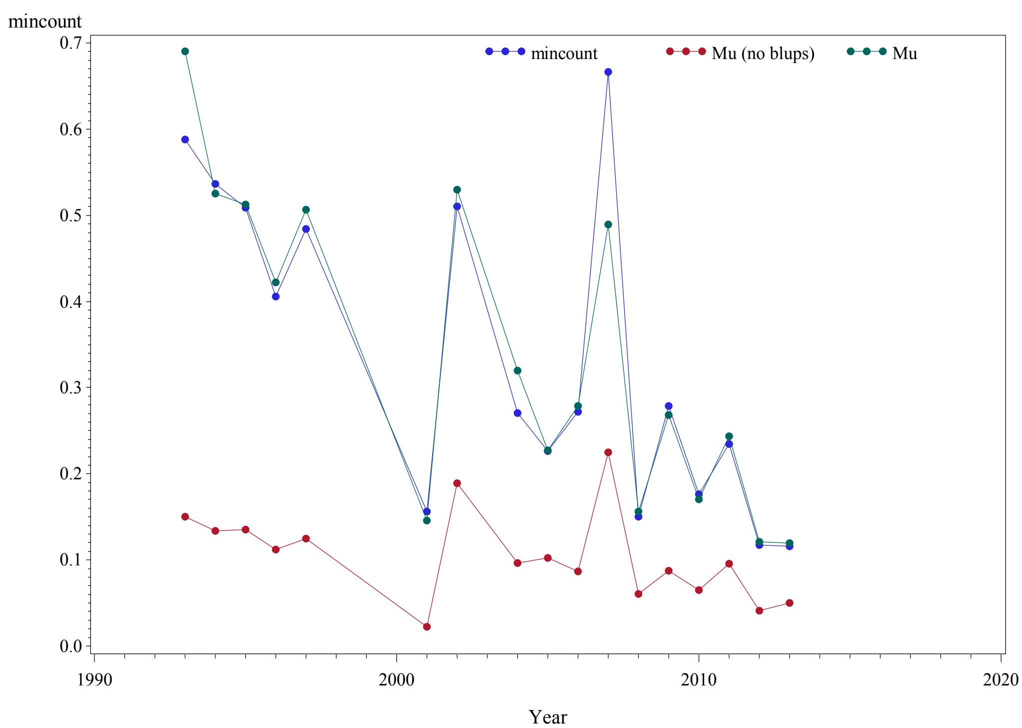

Figure 9. QQ plot of conditional residuals for the east Gulf negative binomial model run.

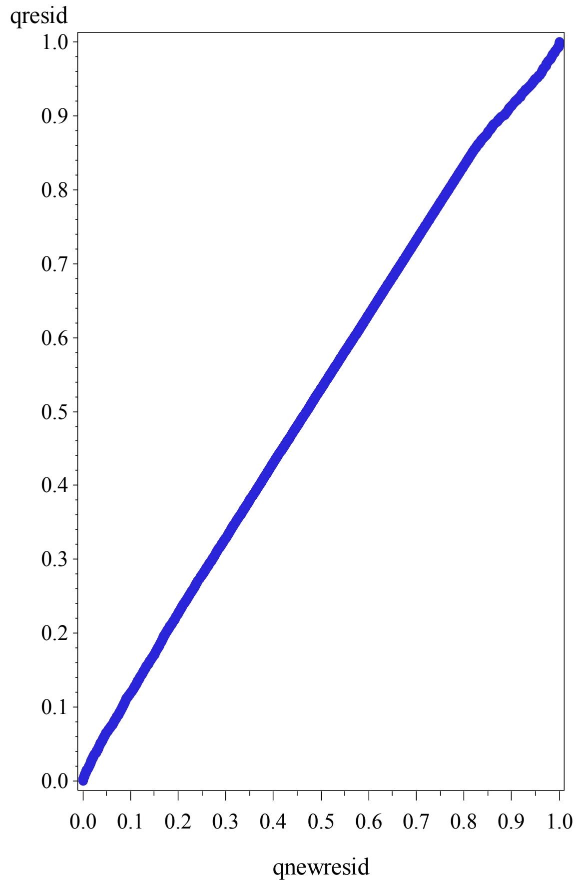

Table 7. Output for the negative binomial index of relative abundance of gray triggerfish by year, west Gulf model run.

Year	N	Proportion positive	Mincount	Mu (no blups)	% CV (no blups)	Mu (blups)	% CV (blups)
1993	45	0.07	0.067	0.095	13.09	0.068	95.77
1994	45	0.18	0.244	0.157	20.28	0.503	228.42
1995	44	0.05	0.068	0.068	20.39	0.089	189.26
1996	165	0.08	0.145	0.091	18.83	0.161	260.70
1997	131	0.22	0.779	0.345	18.68	1.078	207.08
2001	43	0.00	0.000	0.000	18.03	0.000	178.84
2002	92	0.10	0.217	0.167	19.48	0.184	115.20
2004	50	0.14	0.400	0.054	20.71	0.324	184.05
2005	136	0.10	0.279	0.059	19.42	0.256	197.92
2006	139	0.04	0.115	0.030	20.86	0.087	198.63
2007	171	0.08	0.199	0.069	19.37	0.184	228.00
2008	131	0.17	0.321	0.095	20.76	0.358	210.28
2009	167	0.10	0.120	0.032	20.50	0.125	199.96
2010	106	0.11	0.340	0.074	20.61	0.283	178.86
2011	103	0.17	0.573	0.121	20.03	0.552	179.52
2012	200	0.18	0.440	0.096	20.47	0.381	200.02
2013	136	0.15	0.390	0.070	20.06	0.360	173.83

Figure 10. Plot of the proportion positives for gray triggerfish, west Gulf model run.

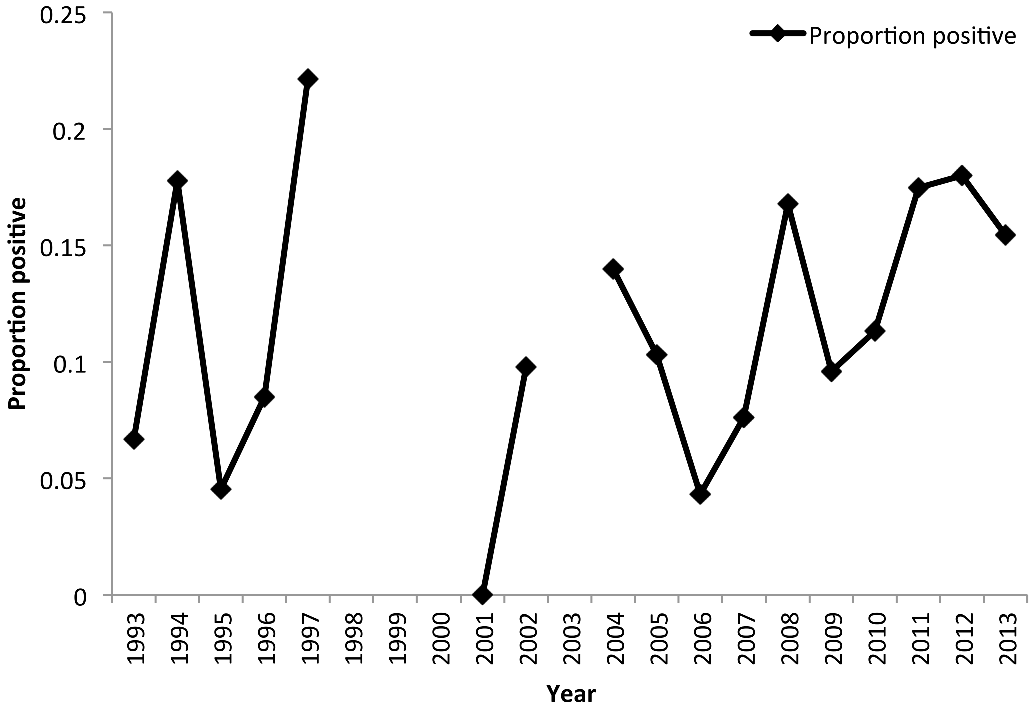

Figure 11. Plot of the least squares means of inverse linked mincount with 95% CI's for gray triggerfish, west Gulf negative binomial model run.

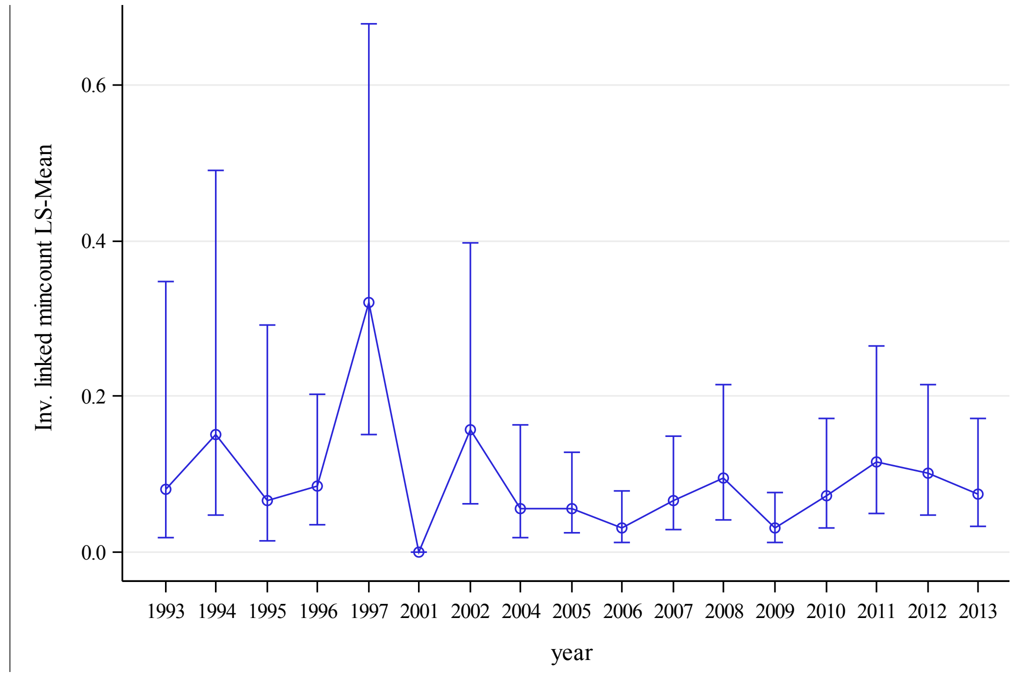

Figure 12. Mean grey triggerfish counts for the observed (mincount) and predicted (Mu no blups & Mu blups) mincounts from the west Gulf negative binomial model run.

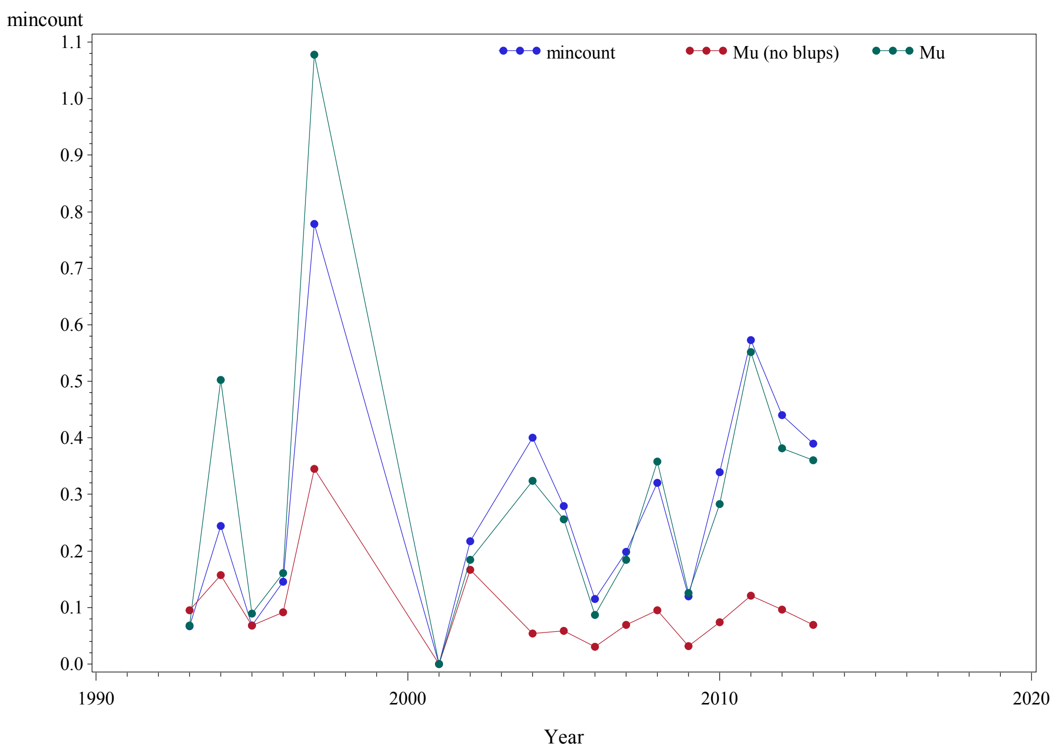

Figure 13. QQ plot of conditional residuals for the west Gulf negative binomial model run.

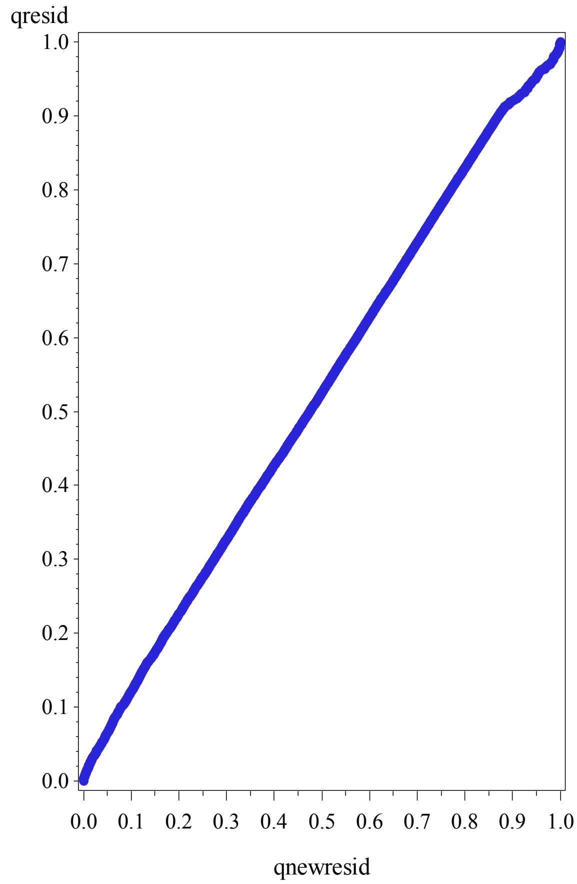

Figure 14. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 1993.

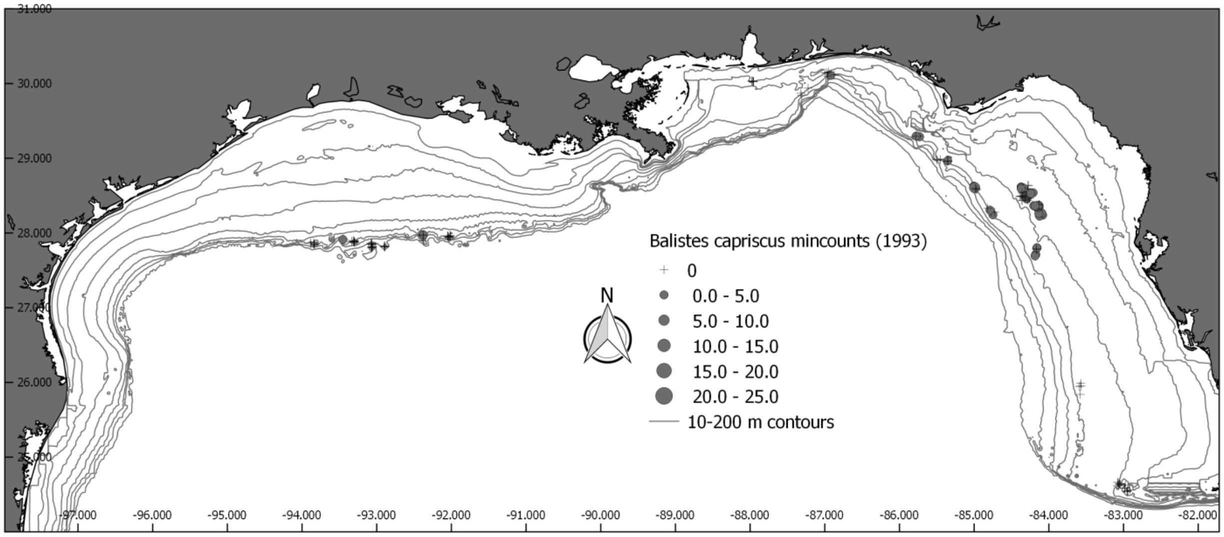

Figure 15. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 1994.

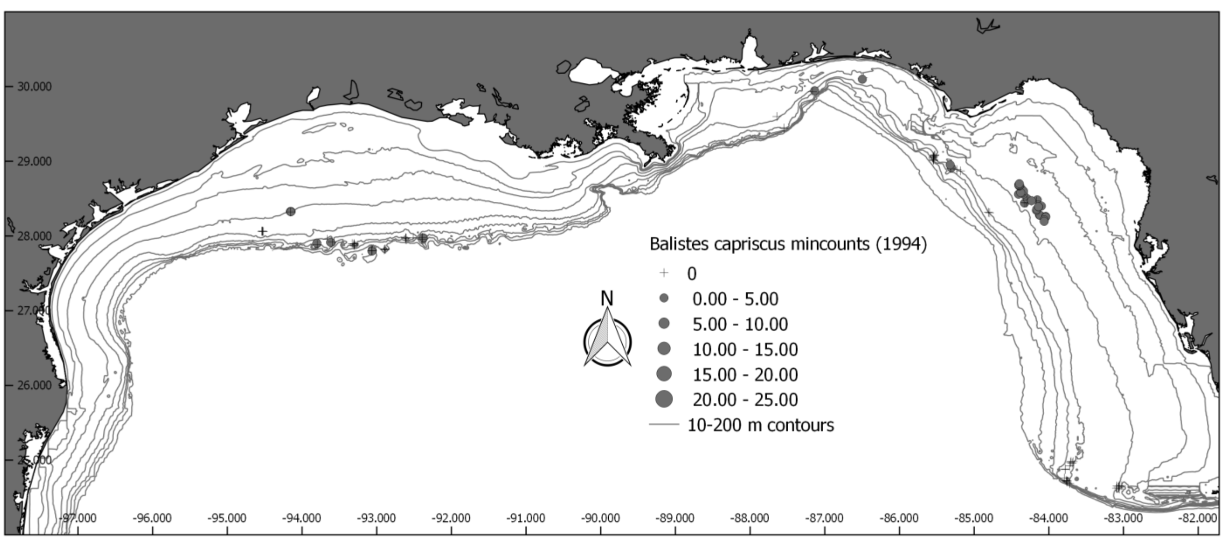

Figure 16. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 1995.

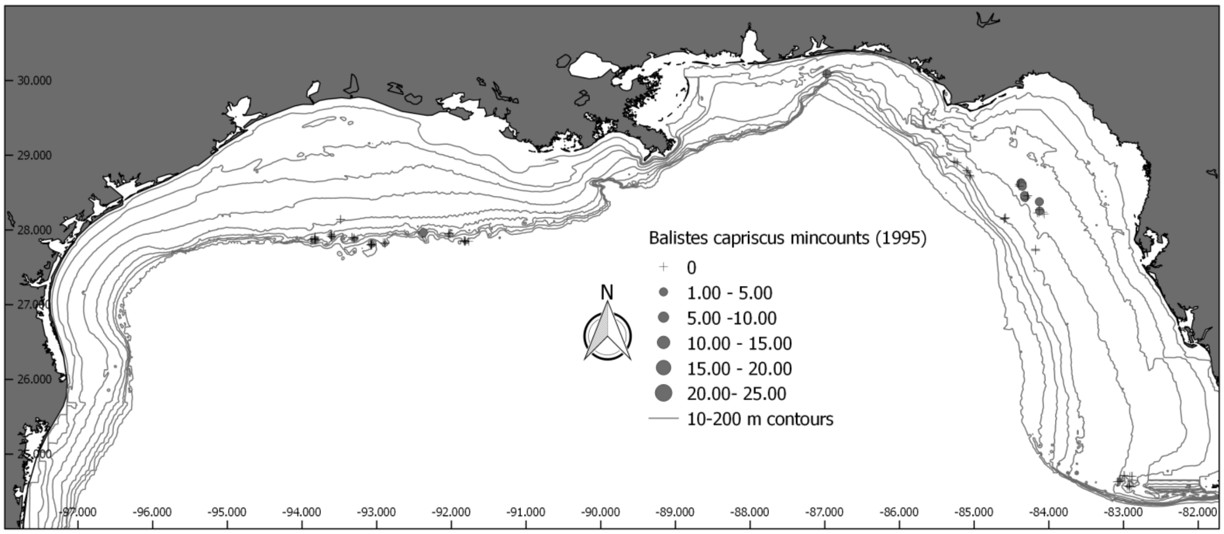

Figure 17. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 1996.

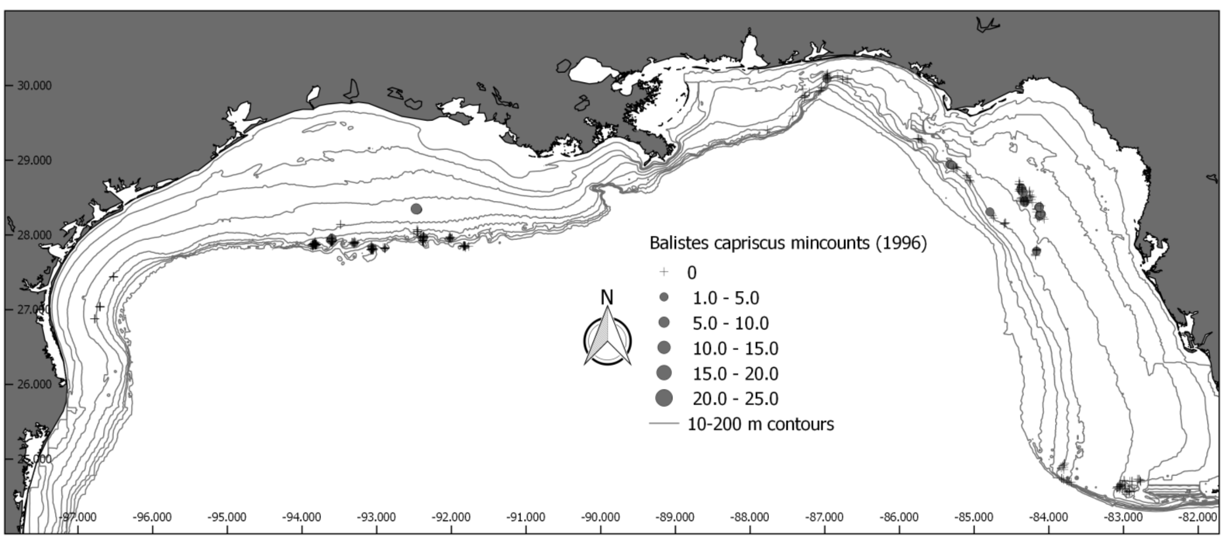

Figure 18. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 1997.

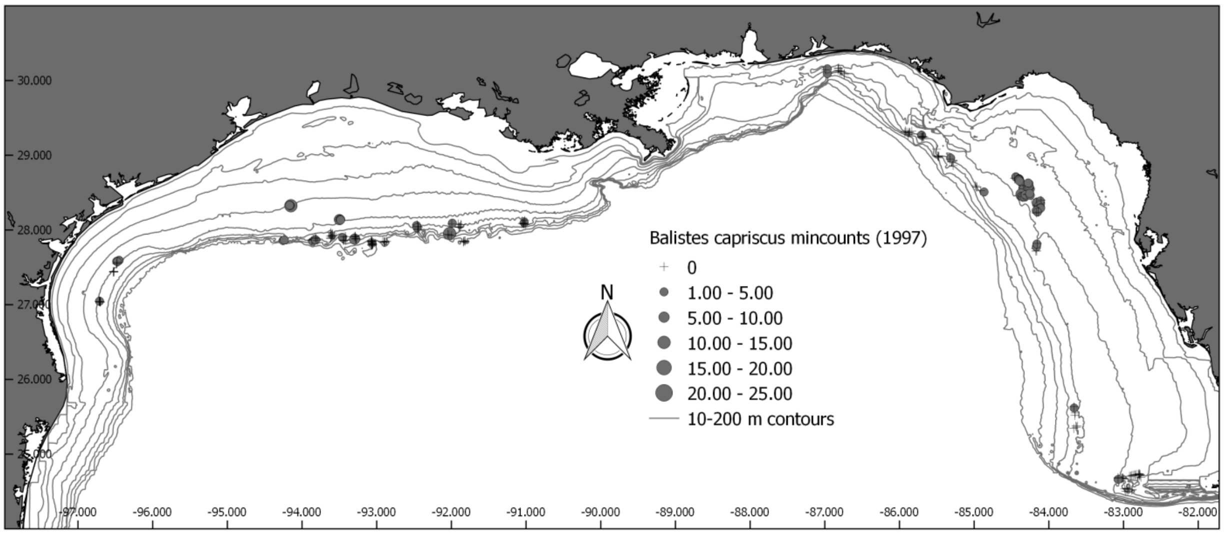

Figure 19. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 2001.

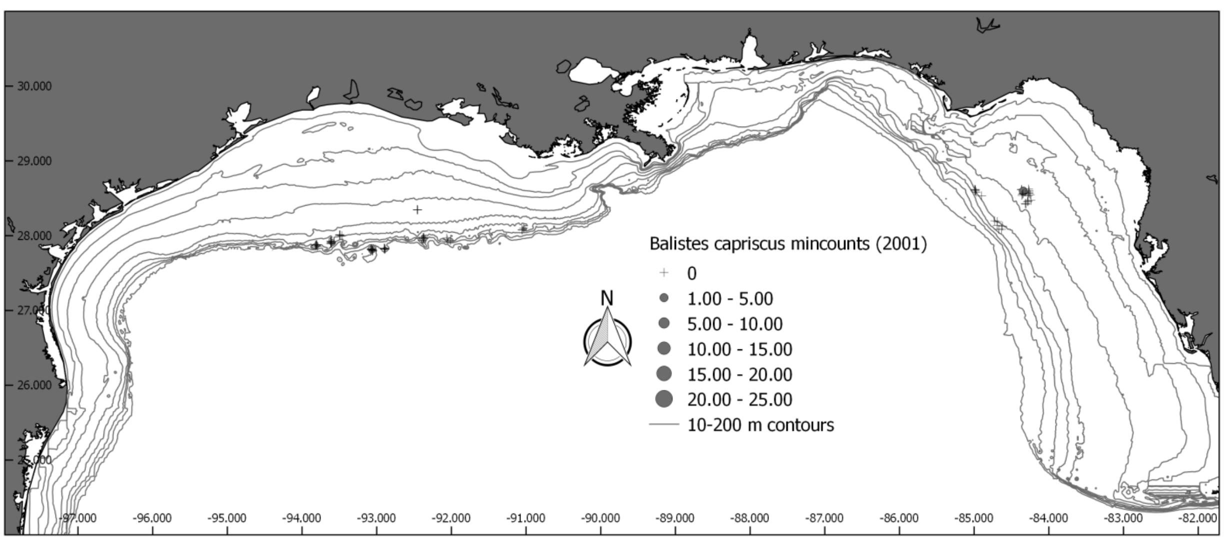

Figure 20. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 2002.

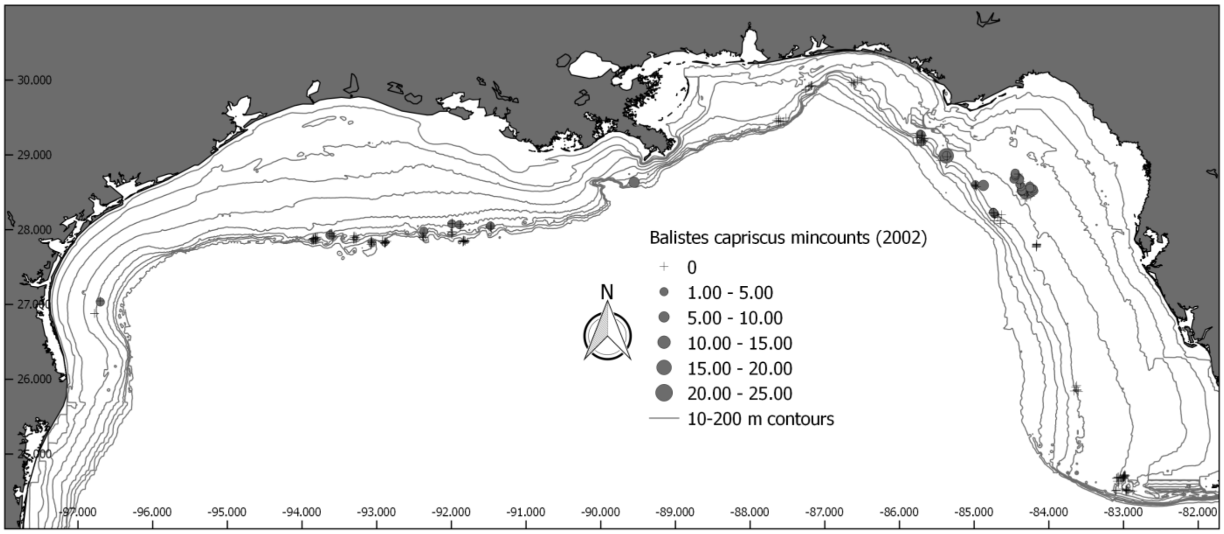

Figure 21. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 2004.

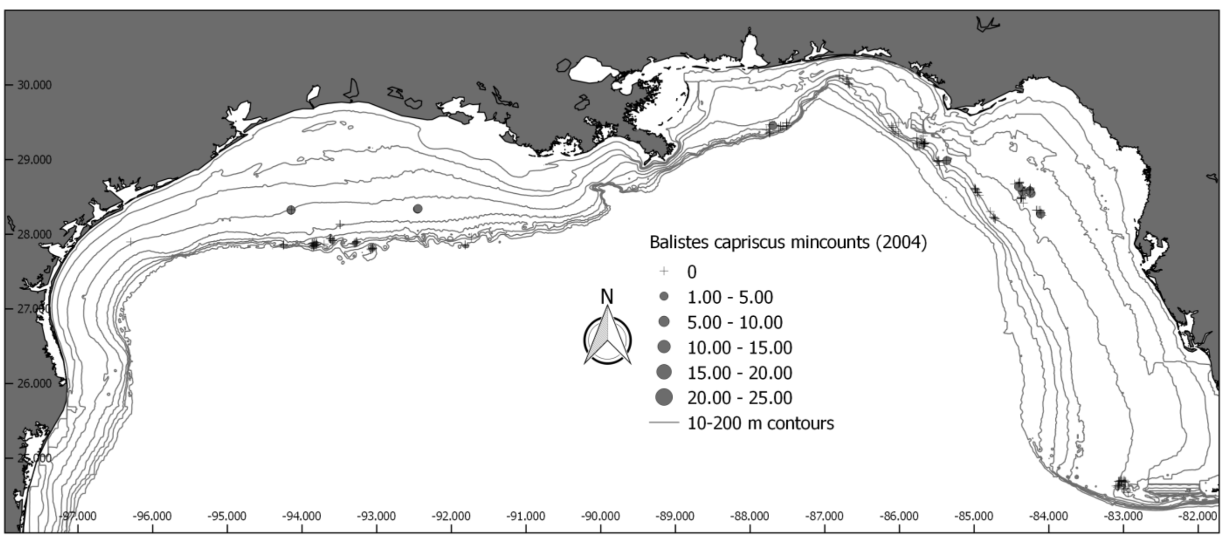

Figure 22. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 2005.

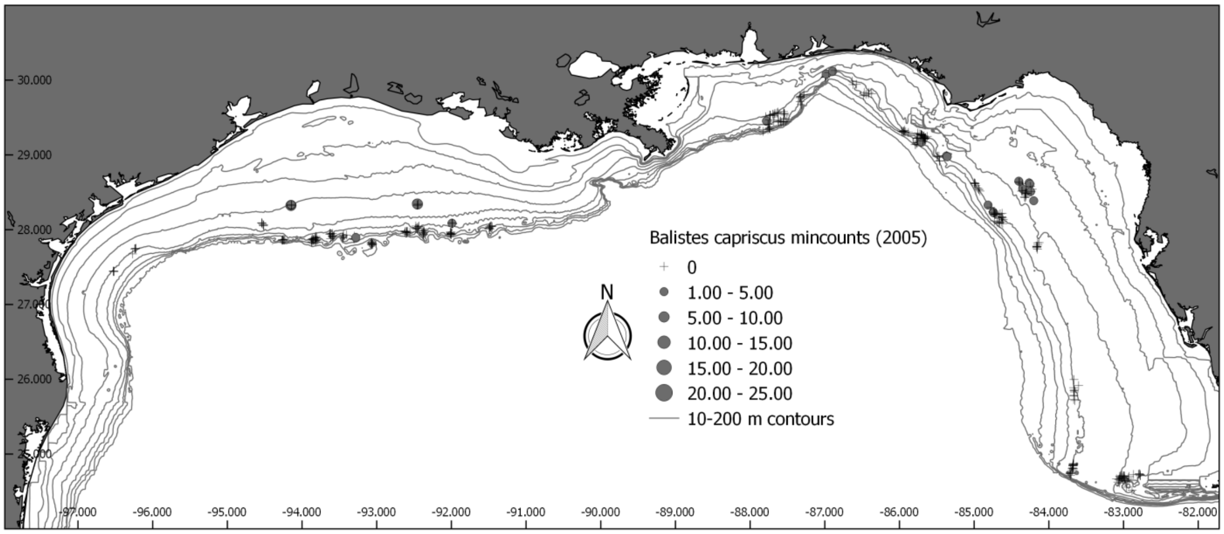

Figure 23. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 2006.

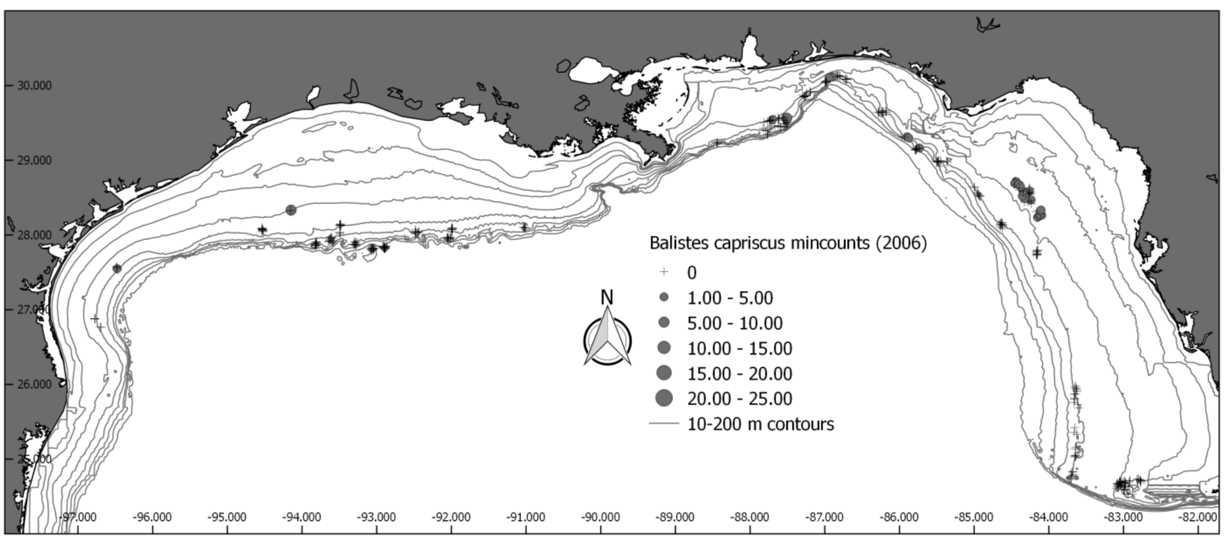

Figure 24. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 2007.

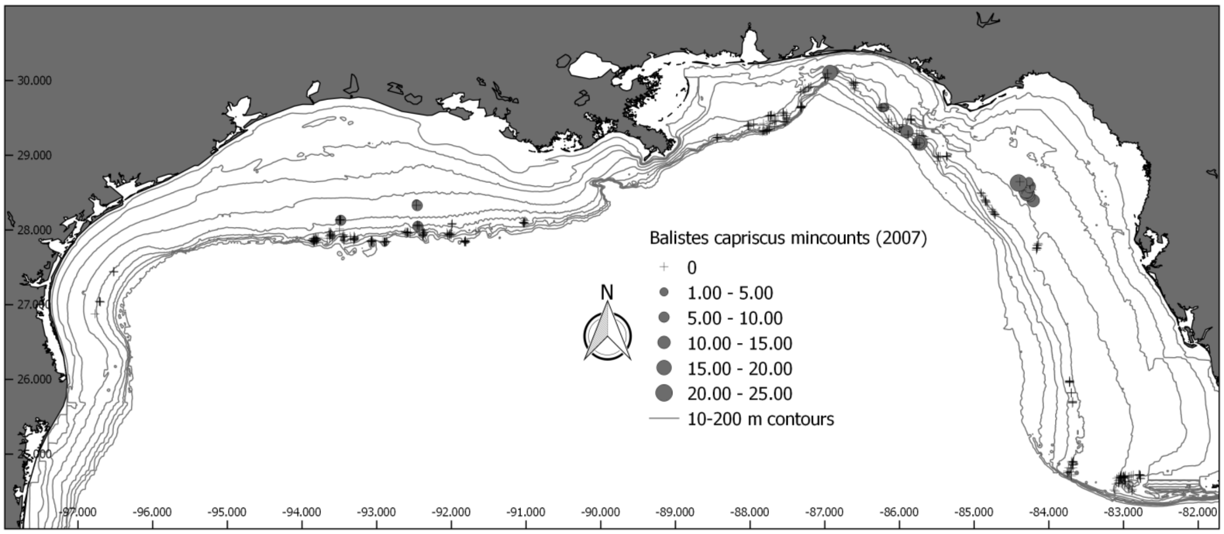

Figure 25. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 2008.

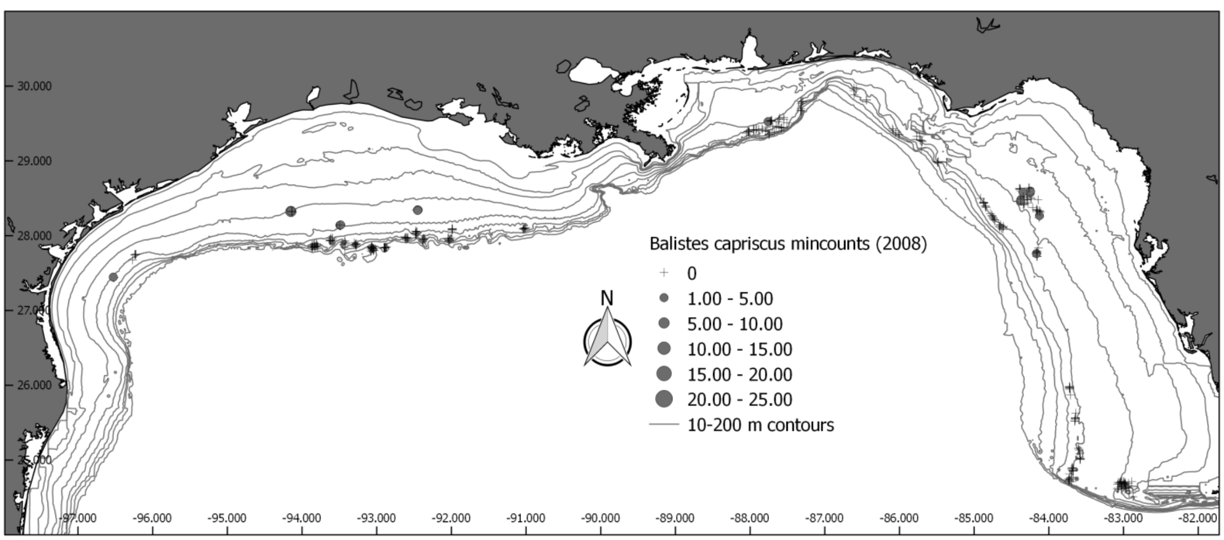

Figure 26. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 2009.

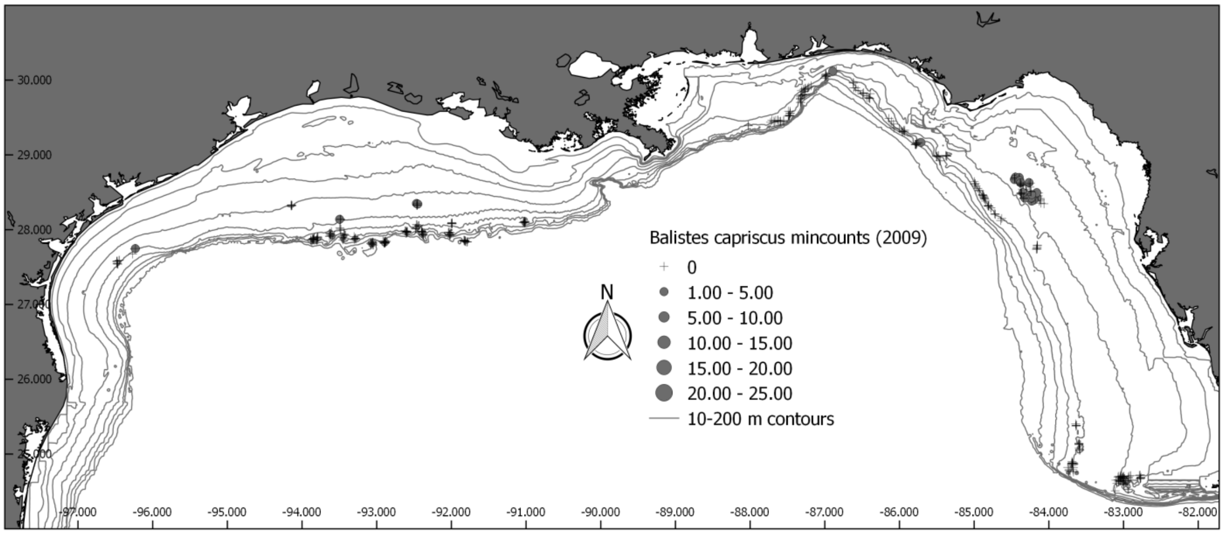

Figure 27. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 2010.

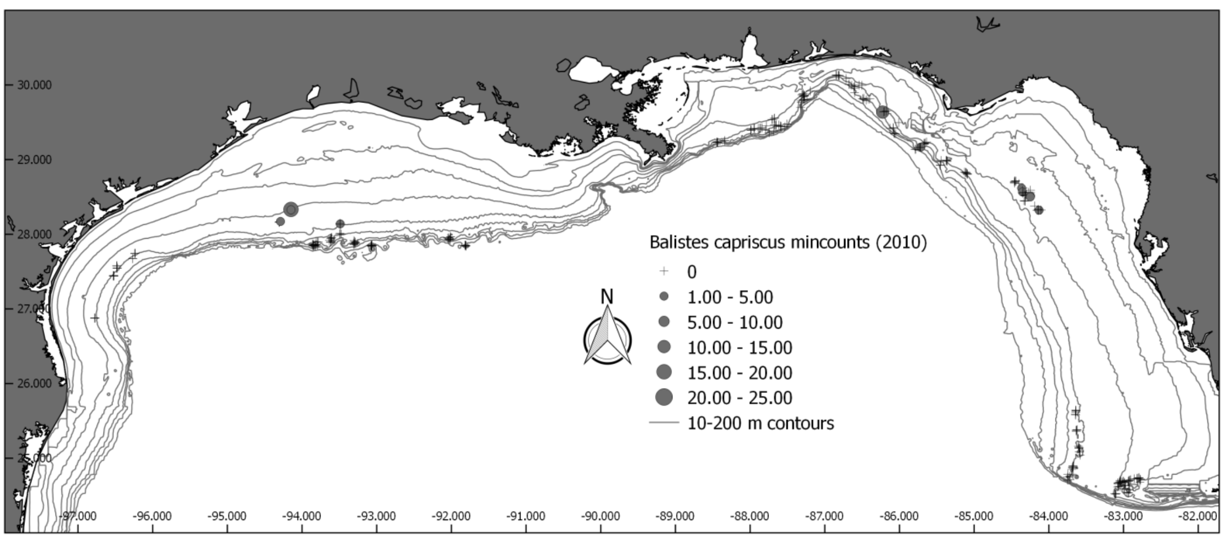

Figure 28. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 2011.

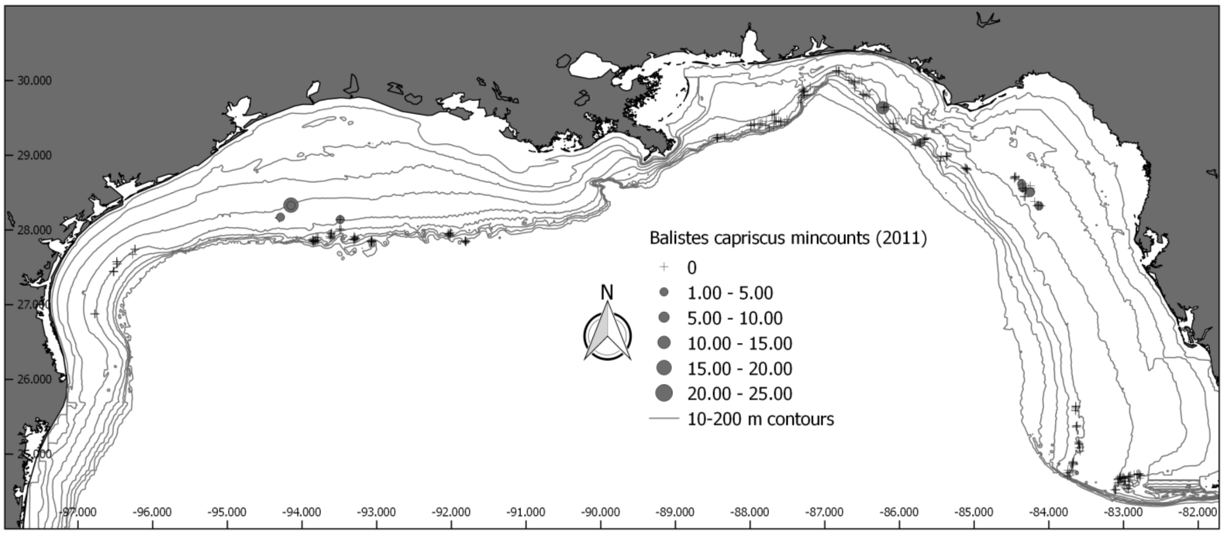

Figure 29. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 2012.

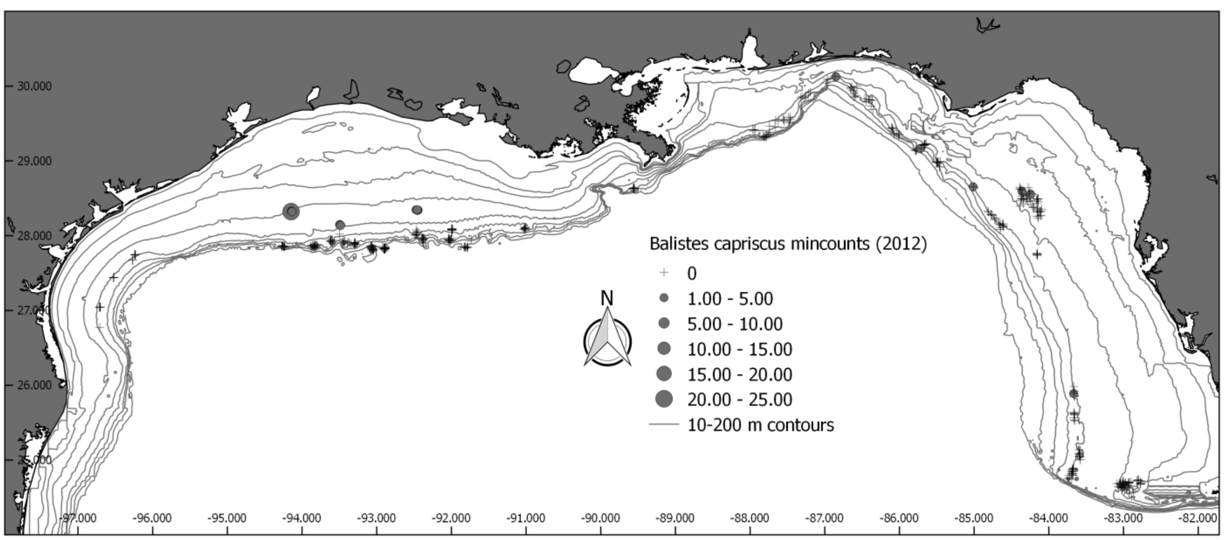

Figure 30. Map of *Balistes capriscus* mincounts during the SEAMAP reef fish video cruise in 2013.

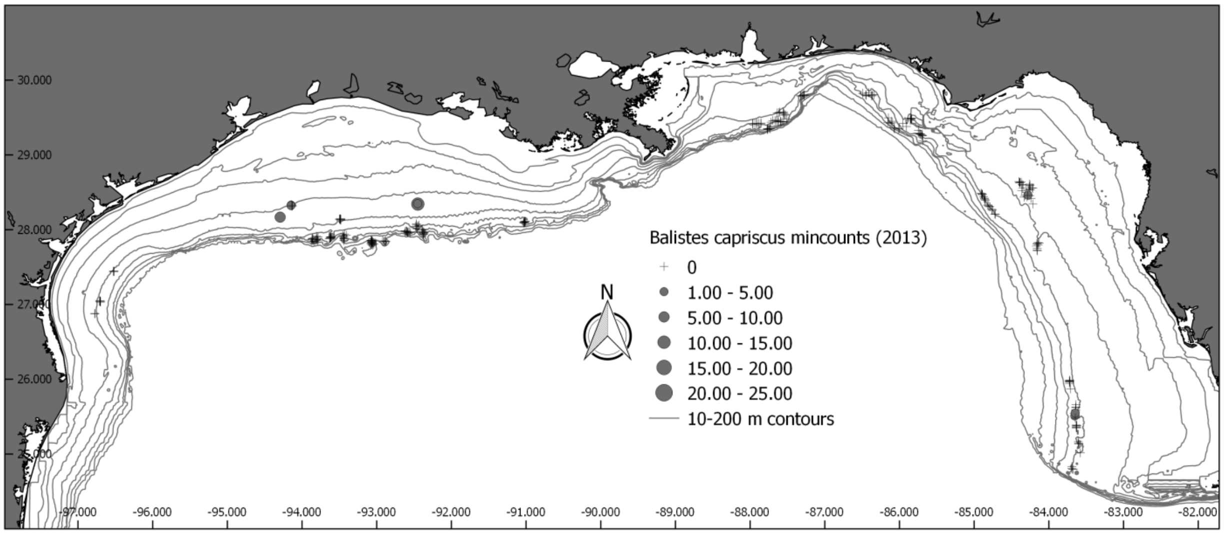

Table 8. *Balistes capriscus* lengths (TL) from the SEAMAP reef fish video cruise from 1993 – 2013. Includes estimates by region and Gulf wide.

	Gulf Wide			East Gulf			West Gulf		
Year	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
1995	4	338.75	103.9114	3	290.6667	48.2113	1	483	na
1996	47	363.0851	78.1773	38	364.8947	81.8422	9	355.4444	63.8907
1997	15	303.5333	44.1634	9	303.1111	36.6348	6	304.1667	57.5584
2002	73	364.0274	66.2583	59	355.5932	65.1323	14	399.5714	60.8652
2003	7	415.7143	41.8239	7	415.7143	41.8239	0	na	na
2004	44	353.8636	64.0111	26	388.3077	46.0459	18	304.1111	53.016
2005	145	357.6069	71.6953	62	365.871	63.5322	83	351.4337	77.0315
2006	156	323.9295	50.0143	88	340.4545	50.8979	68	302.5441	40.002
2007	69	359.7391	80.0988	39	363.1795	73.5344	30	355.2667	89.0052
2008	41	366.0327	73.0282	24	355.056	58.0556	17	381.5294	89.7323
2009	39	357.9927	65.6796	33	348.0515	57.303	6	412.6692	86.7757
2010	12	347.1913	61.4581	1	414.8438	na	11	341.0411	60.4609
2011	65	362.8026	68.3578	44	366.7087	72.8652	21	354.6182	58.6001
2012	35	372.6551	85.2483	20	351.0098	74.5887	15	401.5155	92.3955
2013	31	353.0665	47.9125	8	356.8644	62.2293	23	351.7455	43.4874

Figure 31. Mean lengths of *Balistes capriscus* observed during the SEAMAP reef fish vide
cruise from 1993 - 2013.

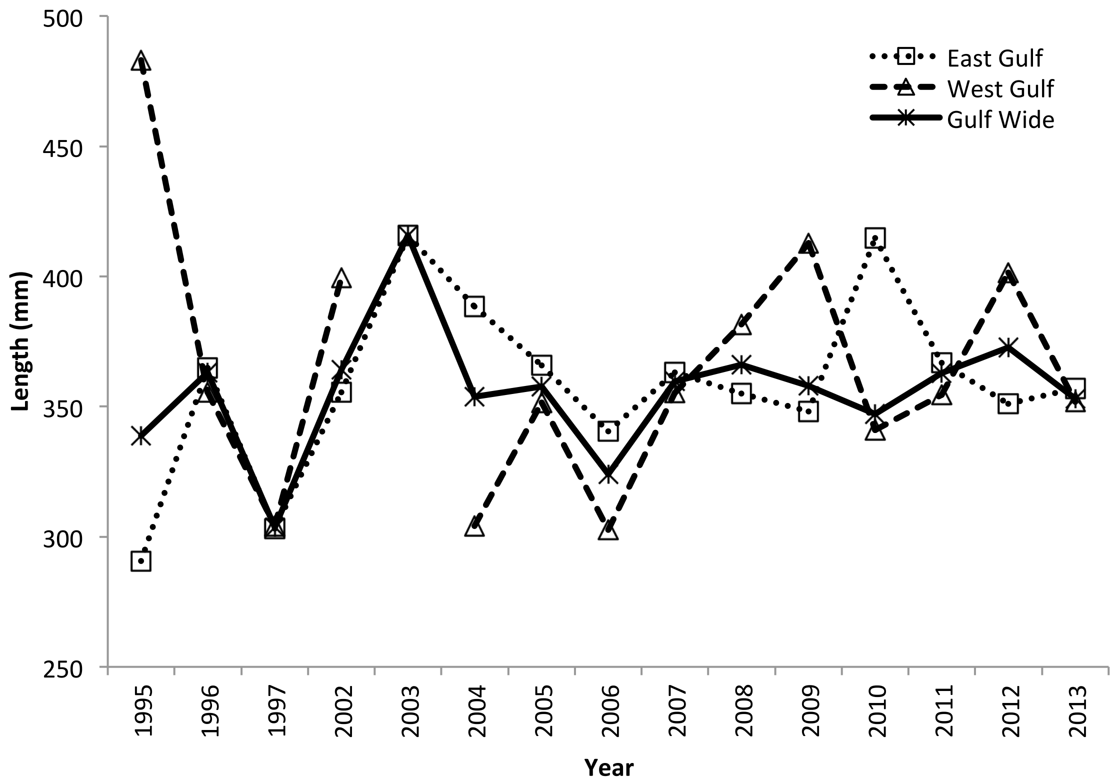

Figure 32. Length frequency histograms of *Balistes capriscus* observed during the SEAMAP reef fish video cruise from 1993 - 2013.