SEAMAP Reef Fish Video Survey: Relative Indices of Abundance of Greater Amberjack

Matthew D. Campbell, Kevin R. Rademacher, Paul Felts, Brandi Noble, Joseph Salisbury, and John Moser

SEDAR70-WP-01

5 May 2020

Please cite this document as:

Campbell, Matthew, D., Kevin R. Rademacher, Paul Felts, Brandi Noble, Joseph Salisbury, and John Moser. 2020. SEAMAP Reef Fish Video Survey: Relative Indices of Abundance of Greater Amberjack. SEDAR70-WP-01. SEDAR, North Charleston, SC. 27 pp.

SEAMAP Reef Fish Video Survey: Relative Indices of Abundance of Greater Amberjack

May 2020

Matthew D. Campbell, Kevin R. Rademacher, Paul Felts,
Brandi Noble, Joseph Salisbury, and John Moser
Southeast Fisheries Science Center
Mississippi Laboratories, Pascagoula, MS

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 5-25). Secondary objectives include quantification of habitat types sampled (video, multi-beam 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 August. 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 (MinCount, i.e. MaxN), fish length, habitat type, habitat coverage, bottom topography and water quality. The size of fish sampled with the video gear is species specific however Greater Amberjack sampled over the history of the survey had fork lengths ranging from 101 – 2065 mm, and mean annual fork lengths ranging from 571 – 774 mm (Table 7, Figure 26). 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

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 time. 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). 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 $\leq$ 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. From 2008-2013 Vision Measurement System (VMS, Geometrics Inc.) was used to estimate size of fish and in 2014 we began use of SeaGIS software (SeaGIS Pty. Ltd.). Fish measurement is only performed at the point in the video corresponding to the mincount therefore fish are not measured 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. In 2001 the survey was spatially restricted to the west and was an abbreviated survey and therefore we removed that year as well. 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 2004-2018.

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 $\leq$ 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 area identified as having one of the following: > 5% hard coral or >5% rock or >5% soft coral

Index Construction

Video surveys produce count data that often 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). Delta lognormal models have been frequently used to model video count data (Campbell et al. 2012) but recent exploration of models using negative-binomial, poisson (SEDAR 2015), zero-inflated negative-binomial, and zero-inflated poisson models(Guenther et al. 2014) have been accepted for use in assessments in the southeast U.S. Additionally for certain species like Gulf of Mexico red grouper (SEDAR 2015) it has been determined that a combined video index was useful and included data from NMFS-Mississippi Labs, NMFS-

Panama City, and FWRI index (Walter Ingram). A combined index was submitted for Greater Amberjack to this SEDAR. We explored model fit using three different error distribution models to construct relative abundance indices including delta-lognormal, poisson and negative binomial.

Gulf wide, east gulf, and west gulf models were run and independent variables tested in the model included year, reef, depth and maximum relief as fixed effects in the model (mincount = year + reef + depth + maximum_relief). We used the composite variable 'reef' rather than the percent coverage of individual habitat variables because of the strong relationship that Greater Amberjack have with reef habitat and as a simplifying/aggregating variable to indicate if a camera observed reef habitat. Traditionally the individual coarse habitat metrics by themselves have not explain variability. 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

Greater amberjack were observed at banks in both the western and eastern GOM (Figures 5-25), and the spatial distributions observed are highly reflective of the reef sampling universe used to select sampling sites (Figures 1). Gaps in habitat level information existed in central Florida, Mississippi river delta region, and portions of the Texas coast however those gaps have slowly closed since 50% of the survey time since 2012 was dedicated to habitat mapping with a multi-beam sonar (Figure 1). Thus the main sampling gap remaining in the survey around the shelf break is in close proximity to the Mississippi River Delta where water quality prevents collection of clear video. Inshore areas in the east Gulf are sampled by allied surveys run by NMFS Panama City and Florida Wildlife Research Institute. A separate combined index was submitted for this survey that combines all three surveys into a single index of abundance. 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. Reef blocks from coastal Texas are often not selected for sampling due to small spatial coverage of reef, and frequent high winds and rough sea states during the spring/early summer sampling season.

For all models we determined that the Negative Binomial model fit the data best give more linear relationship observed in the QQ plots (Figure 4), and reasonably low over dispersion parameters (Gulf wide = 2.0, east Gulf = 1.9, and west Gulf = 1.24). While the over dispersion parameters and QQ plots could be improved they were far better than either the Poisson or delta log-normal models. Additionally the fits improved for the regional submodels.

In the Gulf wide analysis variables retained included year, reef, depth, and maxrelief (Table 1). Gulf wide greater amberjack proportion positives ranged from 0.07 (1993) to 0.34

(2002) with a reported value of 0.19 in 2018 (Table 2, Figure 2). Greater amberjack standardized index of abundance ranged from 0.38 (1997) to 1.26 (2002), and reported a value of 0.49 in 2018 (Table 2, Figure 3). Coefficient of variation ranged from 18.5% (2018) to 32% (2002), with the lowest values having been reported in the most recent survey year.

In the east Gulf analysis variables retained included year, reef, depth, and maxrelief (Table 3). Gulf wide greater amberjack proportion positives ranged from 0.07 (1993) to 0.28 (2002) with a reported value of 0.14 in 2018 (Table 4, Figure 2). Greater amberjack standardized index of abundance ranged from 0.22 (1995) to 1.53 (2002), and reported a value of 0.44 in 2018 (Table 4, Figure 3). Coefficient of variation ranged from 41% (2017 and 2018) to 56% (2007), with the lowest values having been reported in the two most recent survey years.

In the west Gulf analysis variables retained included year and maxrelief (Table 5). Gulf wide greater amberjack proportion positives ranged from 0.07 (1993) to 0.43 (2002) with a reported value of 0.24 in 2018 (Table 6, Figure 2). Greater amberjack standardized index of abundance ranged from 0.13 (1993) to 0.93 (1994), and reported a value of 0.52 in 2018 (Table 6, Figure 3). Coefficient of variation ranged from 6.3% (2018) to 13.4% (1997), with the lowest values having been reported in the most recent survey year.

Proportion positives and standardized index values from in 2018 are average relative to all other sample years in the survey outside of a nadir in 1993 and a significant peak in 2002. Gulf wide and east GOM values for proportion positives, lo-index, and standardized index output suggest that gulf wide population trends appear to be in large part driven by eastern populations. Eastern and western Gulf trends largely reflect each other outside of a few sampling years.

Length frequency histograms show that the east and west populations overlap however mean fork lengths were longer in the west Gulf (30 mm). East gulf Greater Amberjack were 18 cm shorter than the Gulf wide average whereas they were 42 cm larger in the west. In most years this trend holds true. Additionally more fish are measured in the east relative to the west owing to more frequent observations in that region.

Literature cited

Campbell, M.D., K.R. Rademacher, P. Felts, B. Noble, M. Felts, and J. Salisbury. 2012. SEAMAP Reef Fish Video Survey: Relative Indices of Abundance of Red Snapper, July 2012. SEDAR31-DW08. SEDAR, North Charleston, SC. 61 pp.

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.

SEDAR, 2015. Southeast Data, Assessment, and Review, Gulf of Mexico Red Grouper - Data Workshop Report. SEDAR-42-DW-report. SEDAR, North Charleston, SC. 286 pp.

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 (1992-2018) new reef tract has been discovered and mapped and therefore this map represents what was available through 2018, and not necessarily what has been available over the entire time series.

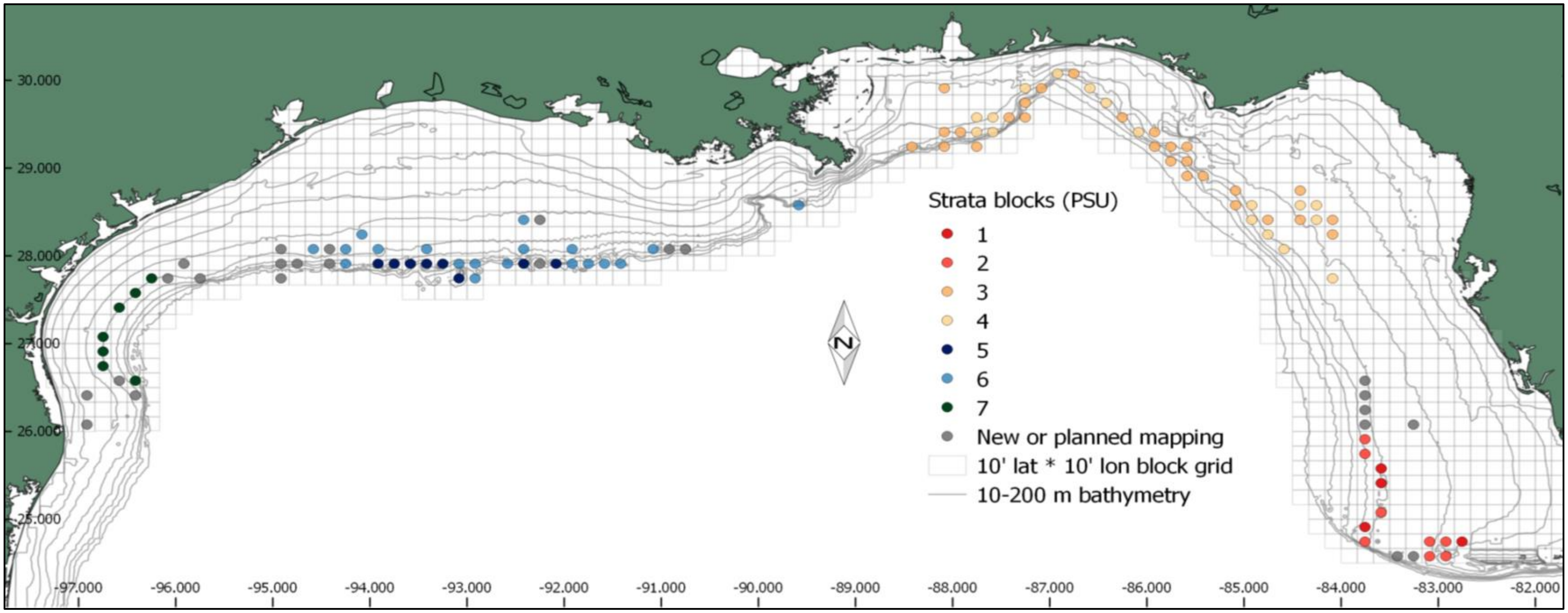


Table 1. Type III fixed effects output from the Negative Binomial for Gulf wide Greater Amberjack model run.

Type III Tests of Fixed Effects				
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
year	20	6462	3.07	<.0001
REEF	1	6462	3.72	0.0537
DPTH	1	6462	12.80	0.0003
MREL	1	6462	7.00	0.0082

Table 2. Output for the negative binomial index of relative abundance of Greater Amberjack by year, Gulf wide model run.

Year	N	Proportion Positive	Nominal Means	Standardized Index	Index CV	95% lci	95% uci
1993	156	0.07	0.38	0.44	23.78	0.42	0.46
1994	120	0.27	0.74	0.64	25.94	0.61	0.67
1995	98	0.26	0.51	0.51	26.89	0.48	0.54
1996	290	0.17	0.38	0.40	22.50	0.39	0.41
1997	281	0.14	0.40	0.38	26.13	0.37	0.39
2002	243	0.34	1.19	1.26	32.96	1.21	1.32
2004	200	0.18	0.46	0.47	22.29	0.45	0.48
2005	397	0.22	0.58	0.57	23.66	0.56	0.58
2006	412	0.15	0.46	0.47	22.37	0.46	0.48
2007	480	0.17	0.53	0.52	29.45	0.51	0.53
2008	321	0.17	0.39	0.39	23.78	0.38	0.40
2009	416	0.22	0.96	1.00	22.92	0.98	1.02
2010	310	0.22	0.49	0.48	20.43	0.47	0.49
2011	425	0.26	0.79	0.79	22.46	0.77	0.81
2012	461	0.25	0.52	0.50	23.11	0.49	0.51
2013	283	0.25	0.49	0.51	21.14	0.49	0.52
2014	313	0.19	0.83	0.80	21.22	0.78	0.82
2015	184	0.17	0.45	0.46	24.47	0.44	0.48
2016	345	0.22	0.57	0.58	26.13	0.56	0.59
2017	387	0.20	0.64	0.63	25.17	0.62	0.65
2018	370	0.19	0.48	0.49	18.53	0.48	0.50

Table 3. Type III fixed effects output from the Negative Binomial for east Gulf Greater Amberjack model run.

Type III Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
year	20	3897	3.32	<.0001
REEF	1	3897	3.45	0.0633
DPTH	1	3897	31.47	<.0001
MREL	1	3897	6.33	0.0119

Table 4. Output for the negative binomial index of relative abundance of Greater Amberjack by year, east Gulf model run.

Year	N	Proportion Positive	Nominal Mean	Standardized Index	Index CV	95% lci	95% uci
1993	111	0.07	0.49	0.78	47.30	0.71	0.85
1994	75	0.17	0.63	0.44	55.29	0.38	0.50
1995	54	0.13	0.19	0.22	52.69	0.19	0.25
1996	125	0.18	0.40	0.41	47.45	0.38	0.45
1997	154	0.08	0.29	0.27	44.33	0.25	0.29
2002	151	0.28	1.47	1.53	55.46	1.39	1.67
2004	149	0.20	0.49	0.48	47.41	0.44	0.51
2005	261	0.20	0.58	0.57	48.88	0.54	0.60
2006	273	0.10	0.34	0.36	51.34	0.34	0.39
2007	309	0.14	0.39	0.44	56.14	0.41	0.46
2008	190	0.14	0.41	0.39	49.25	0.36	0.42
2009	249	0.19	1.29	1.48	46.78	1.40	1.57
2010	204	0.20	0.47	0.46	45.82	0.43	0.49
2011	322	0.24	0.82	0.86	43.01	0.82	0.90
2012	261	0.22	0.54	0.48	50.08	0.45	0.51
2013	147	0.21	0.46	0.47	47.84	0.43	0.50
2014	200	0.17	1.00	0.94	43.83	0.88	1.00
2015	136	0.19	0.55	0.57	47.56	0.53	0.62
2016	177	0.19	0.49	0.47	39.21	0.44	0.49
2017	198	0.13	0.80	0.78	41.57	0.74	0.83
2018	176	0.14	0.44	0.44	41.57	0.41	0.47

Table 5. Type III fixed effects output from the Negative Binomial for west Gulf Greater Amberjack model run.

Type III Tests of Fixed Effects				
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
year	20	2543	1.92	0.0082
MREL	1	2543	2.30	0.1291

Table 6. Output for the negative binomial index of relative abundance of Greater Amberjack by year, west Gulf model run.

Year	N	Proportion Positive	Nominal Mean	Standardized Index	Index CV	95% lci	95% uci
1993	45	0.07	0.13	0.13	8.72	0.13	0.14
1994	45	0.42	0.93	0.93	9.32	0.91	0.96
1995	44	0.41	0.91	0.92	10.72	0.89	0.95
1996	165	0.16	0.36	0.37	10.41	0.36	0.37
1997	127	0.22	0.53	0.53	13.42	0.52	0.54
2002	92	0.43	0.73	0.74	12.55	0.72	0.76
2004	51	0.12	0.35	0.37	11.29	0.35	0.38
2005	136	0.26	0.60	0.60	8.18	0.59	0.61
2006	139	0.23	0.70	0.70	6.96	0.69	0.70
2007	171	0.23	0.80	0.78	11.71	0.76	0.79
2008	131	0.21	0.37	0.37	8.12	0.36	0.37
2009	167	0.26	0.48	0.48	7.30	0.48	0.49
2010	106	0.27	0.54	0.53	7.29	0.53	0.54
2011	103	0.31	0.67	0.67	8.05	0.66	0.68
2012	200	0.29	0.51	0.50	7.30	0.50	0.51
2013	136	0.29	0.54	0.53	6.44	0.52	0.53
2014	113	0.24	0.53	0.53	8.01	0.52	0.53
2015	48	0.13	0.17	0.17	8.87	0.16	0.17
2016	168	0.24	0.65	0.67	7.85	0.66	0.67
2017	189	0.29	0.47	0.47	8.21	0.46	0.47
2018	194	0.24	0.53	0.52	6.30	0.52	0.53

Figure 2. Plot of the proportion positives for Greater Amberjack, for the east, west and Gulf wide model runs.

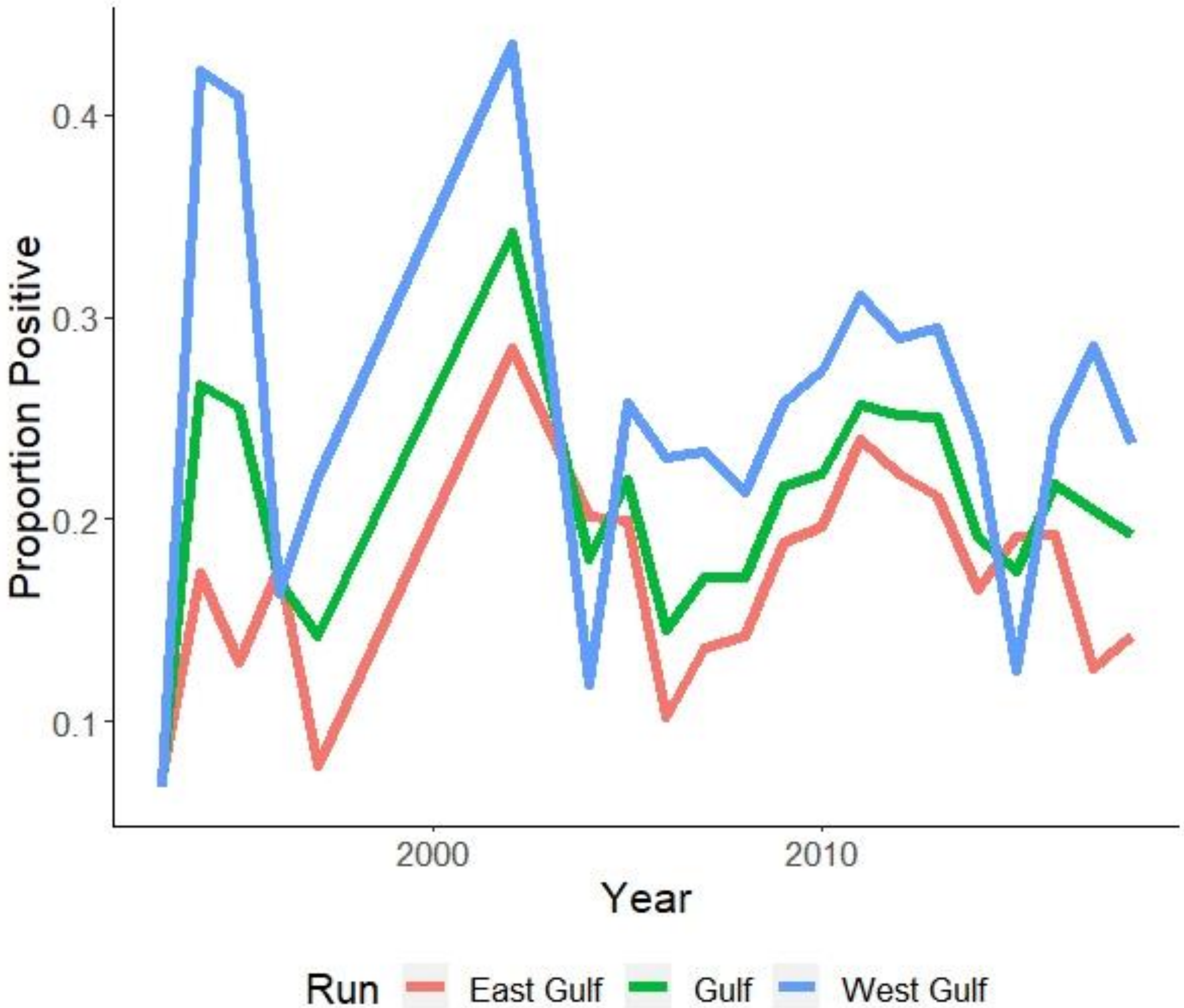


Figure 3. Plot of the standardized indices for Greater Amberjack, for the east, west and Gulf wide model runs.

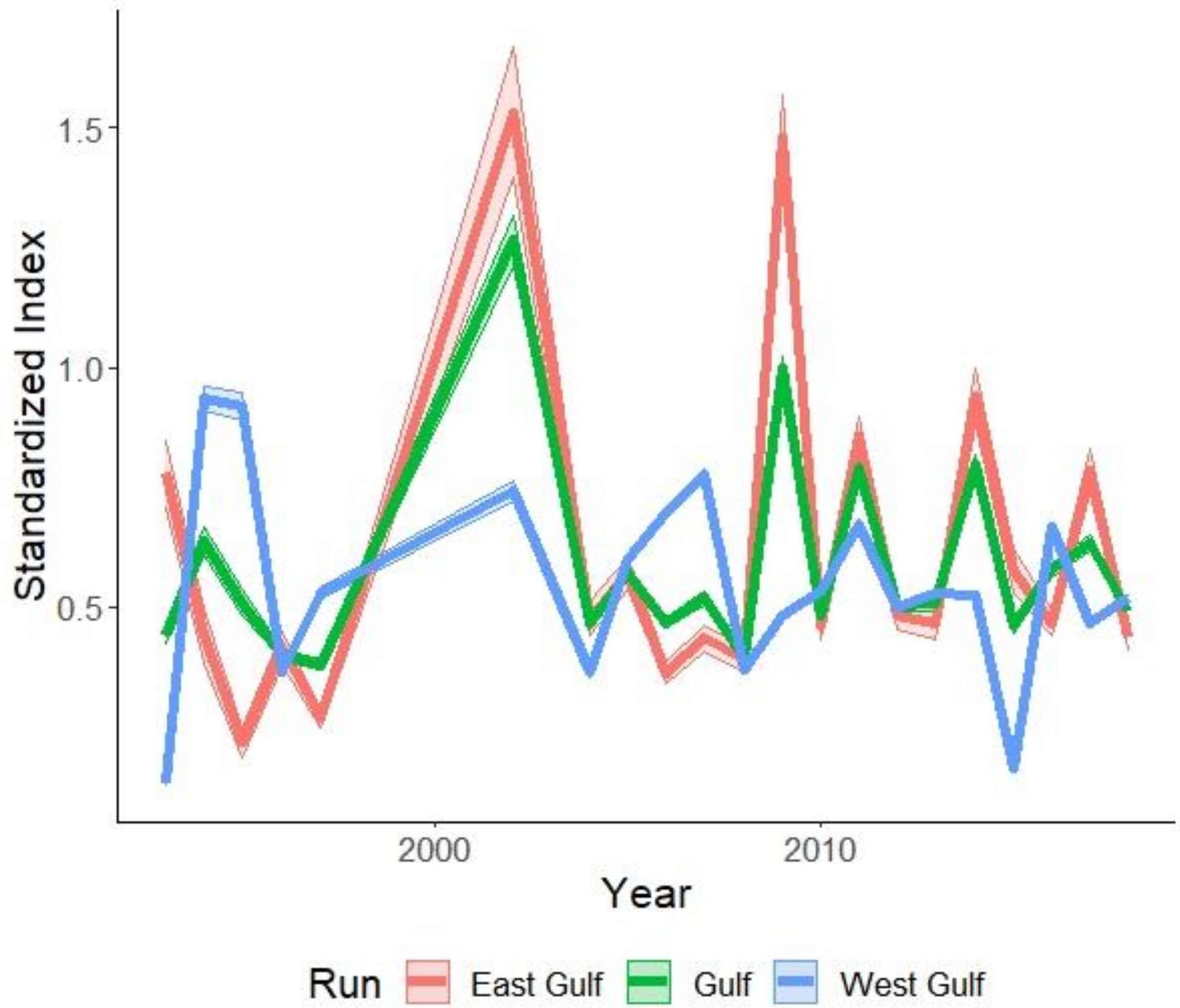
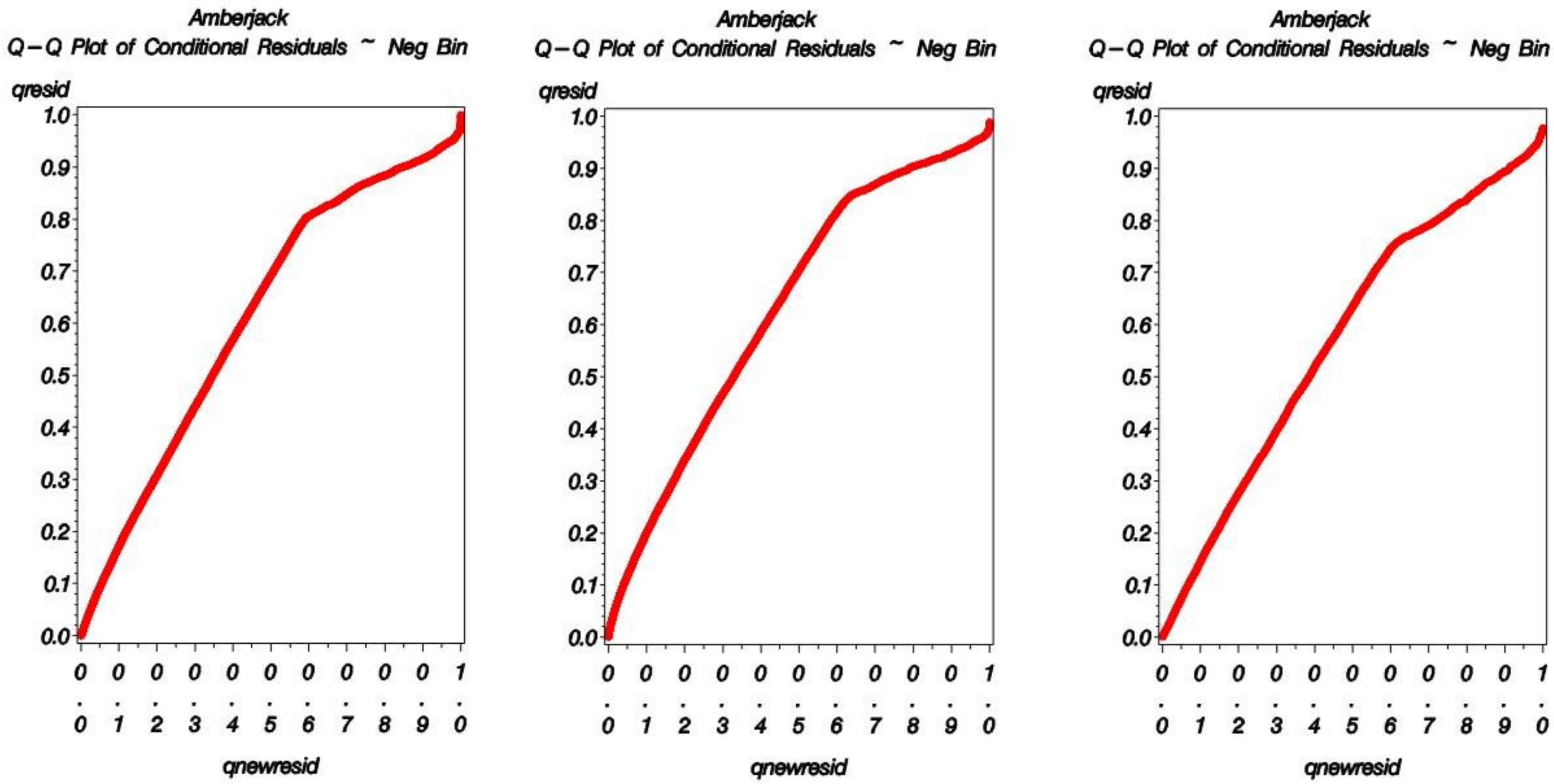


Figure 4. QQ plot of conditional residuals for the east, west and Gulf wide negative binomial model run.



Gulf-wide   East Gulf   West Gulf

Figure 5. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 1993.

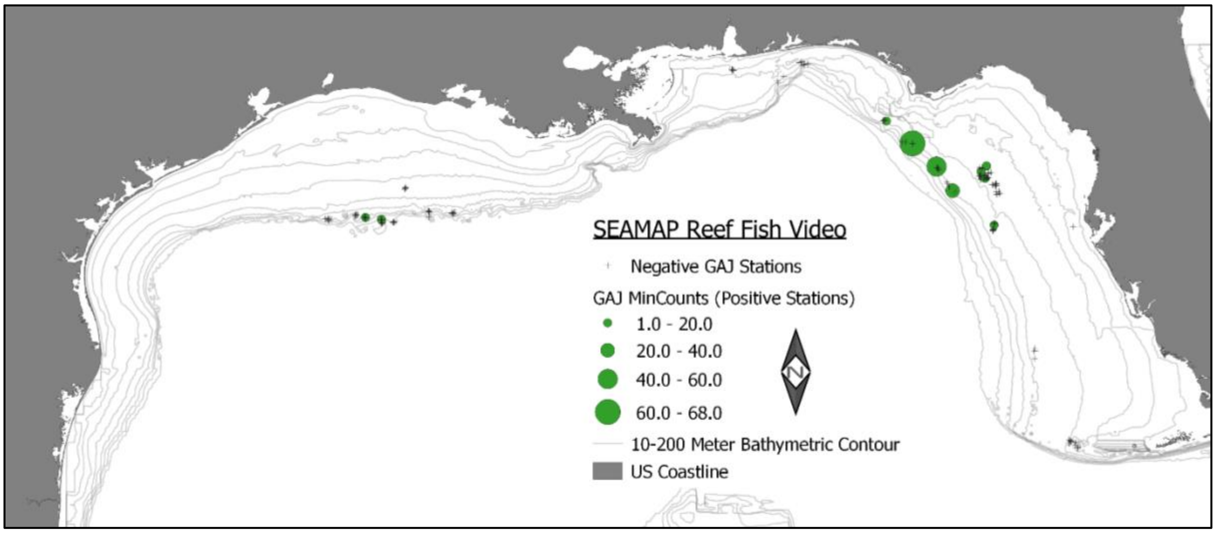


Figure 6. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 1994.

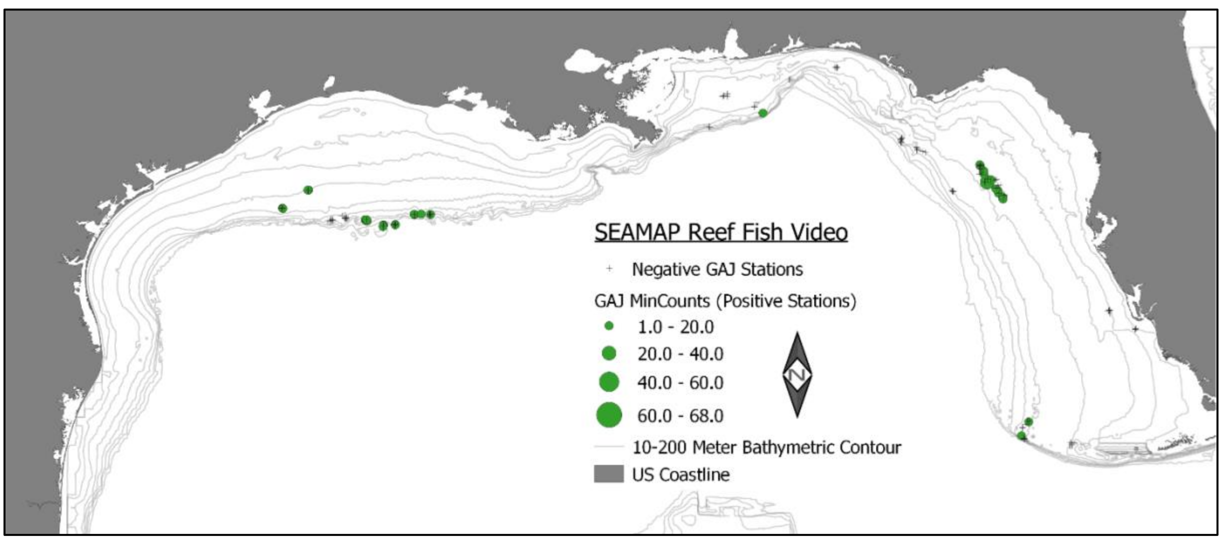


Figure 7. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 1995.

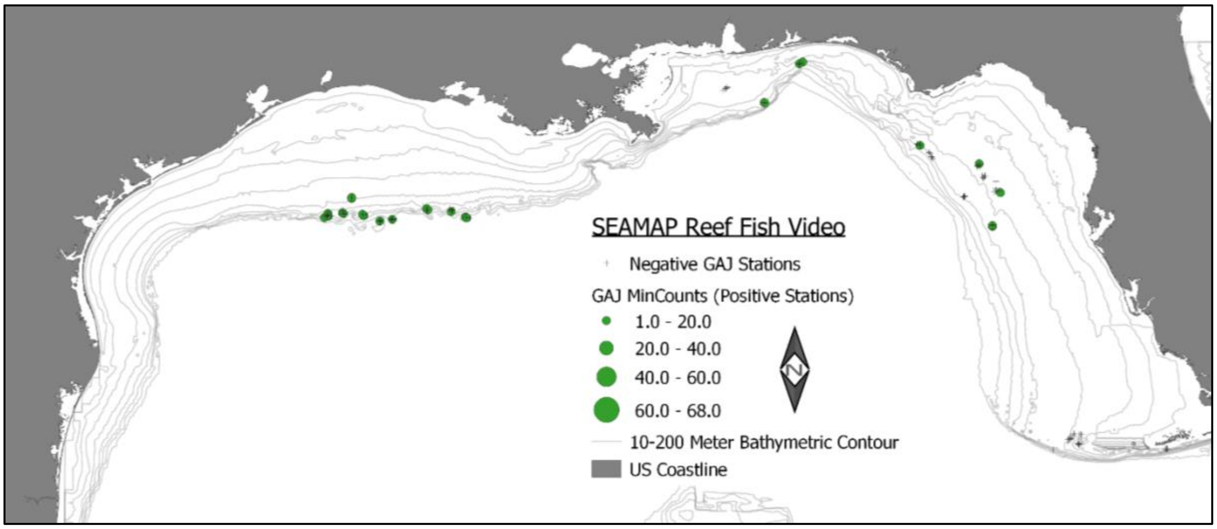


Figure 8. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 1996.

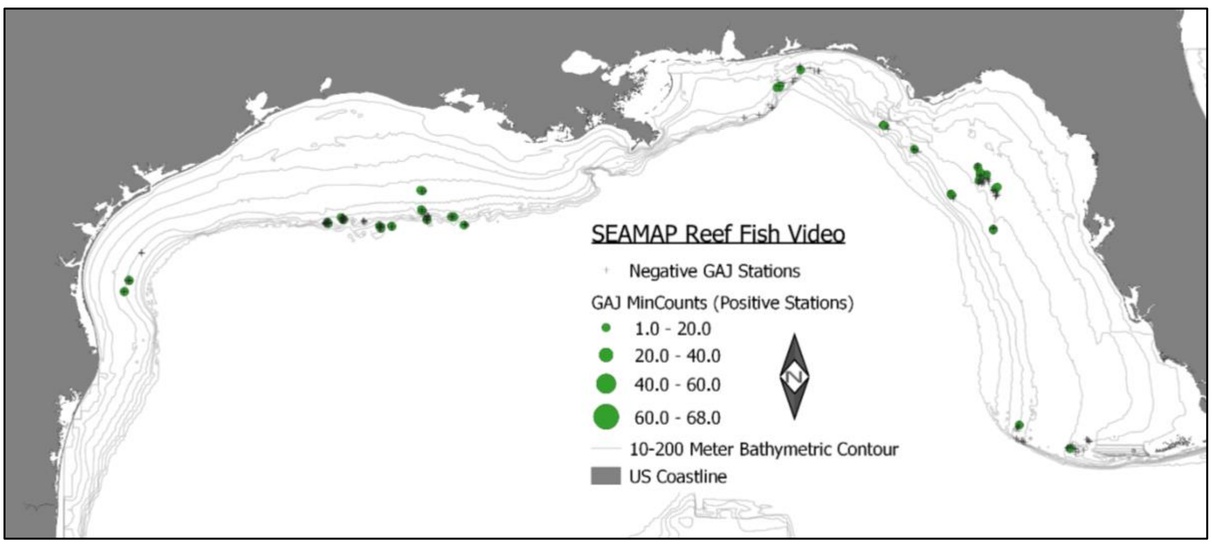


Figure 9. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 1997.

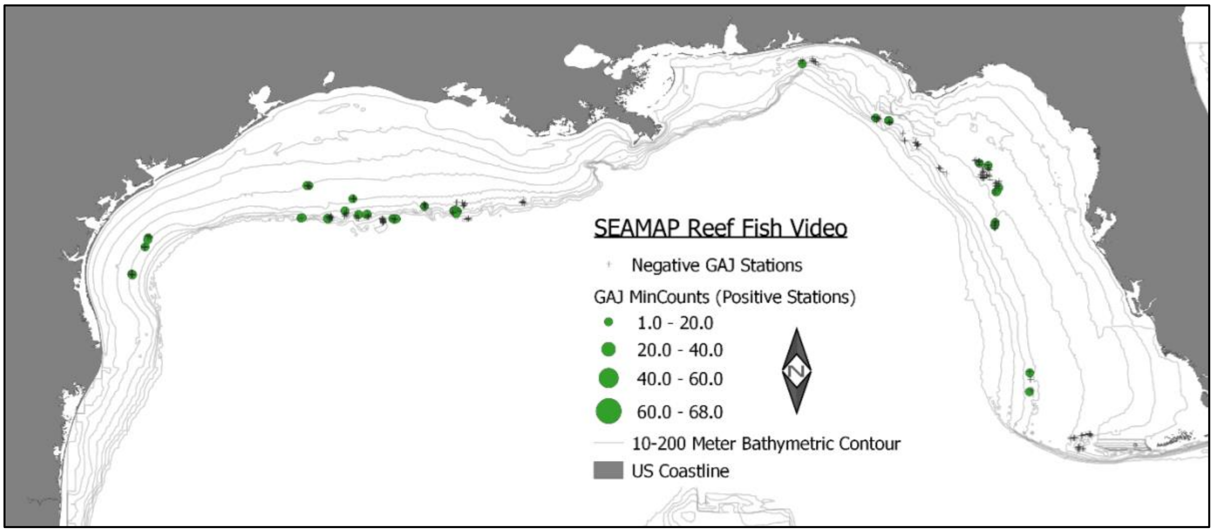


Figure 10. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2002.

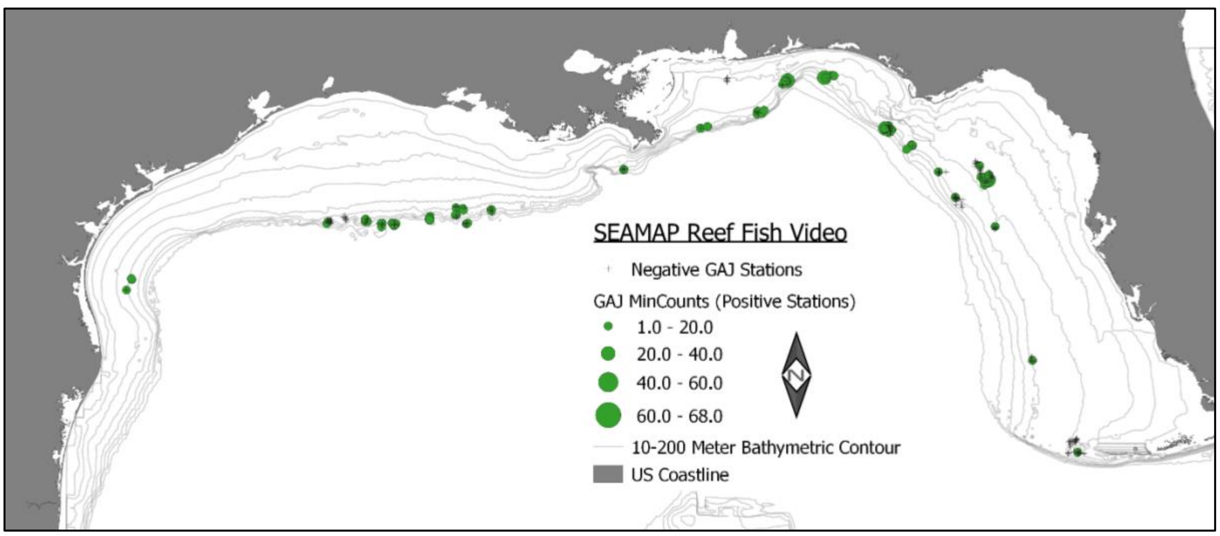


Figure 11. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2004.

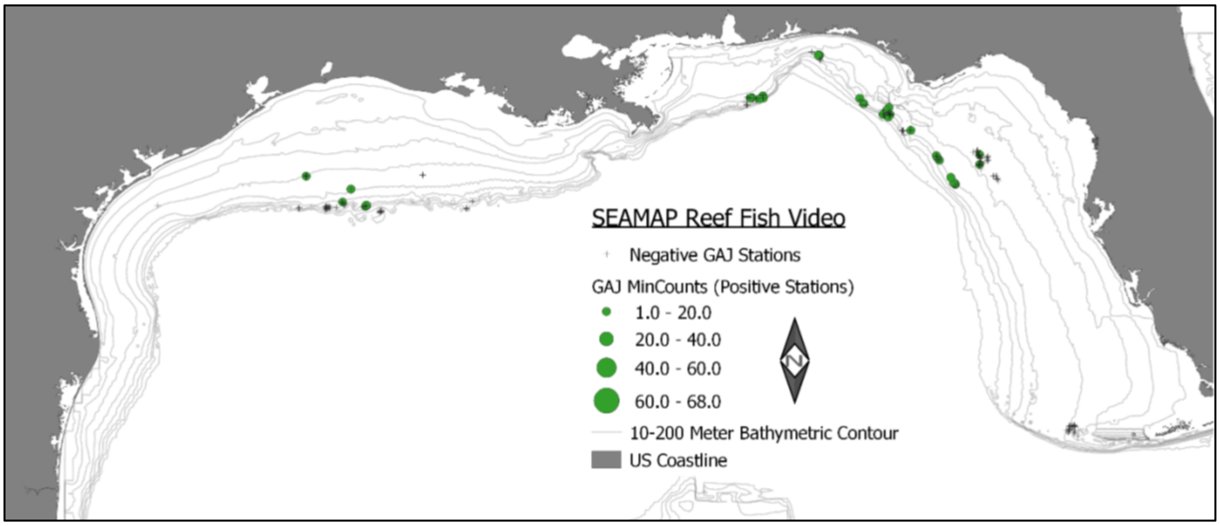


Figure 12. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2005.

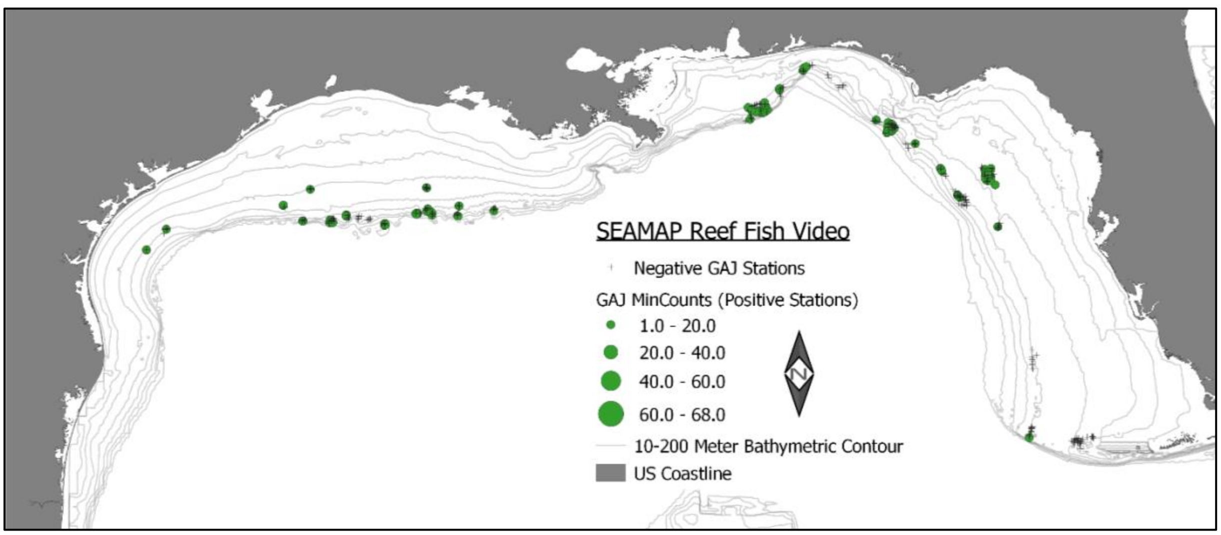


Figure 13. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2006.

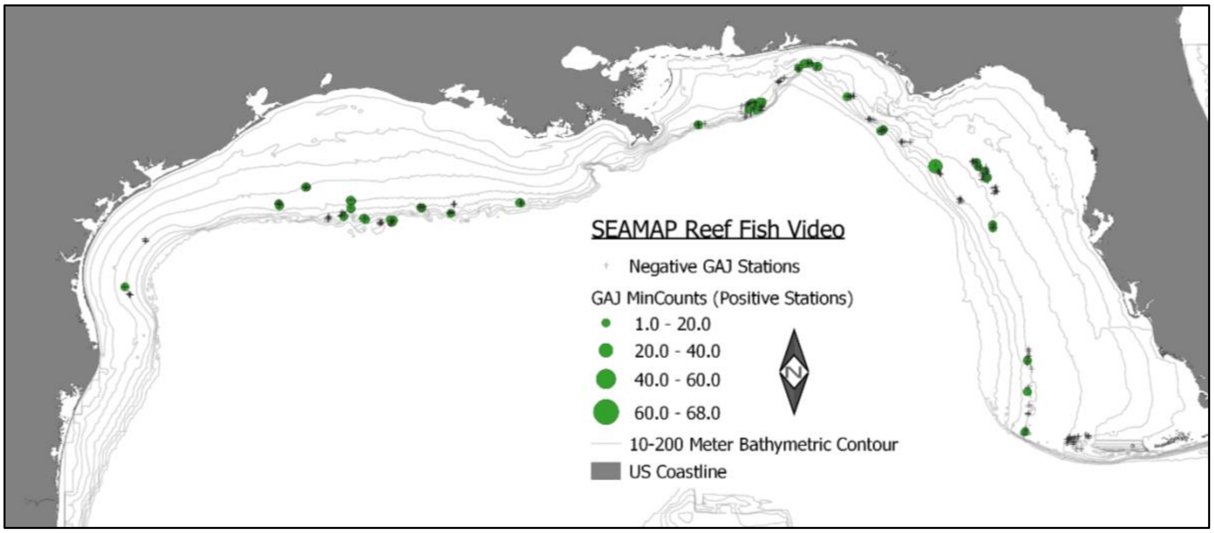


Figure 14. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2007.

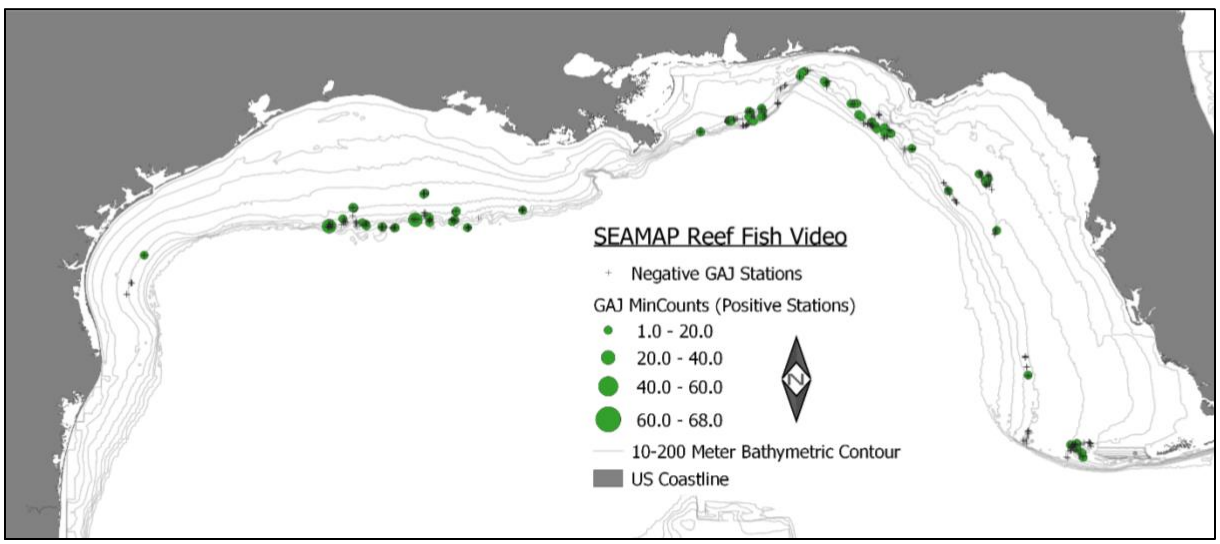


Figure 15. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2008.

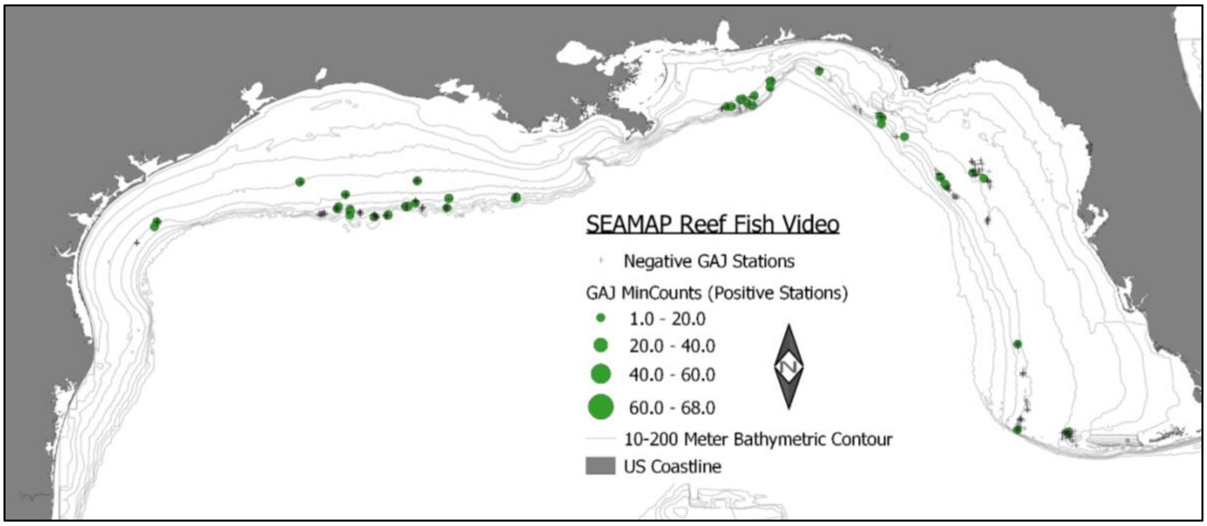


Figure 16. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2009.

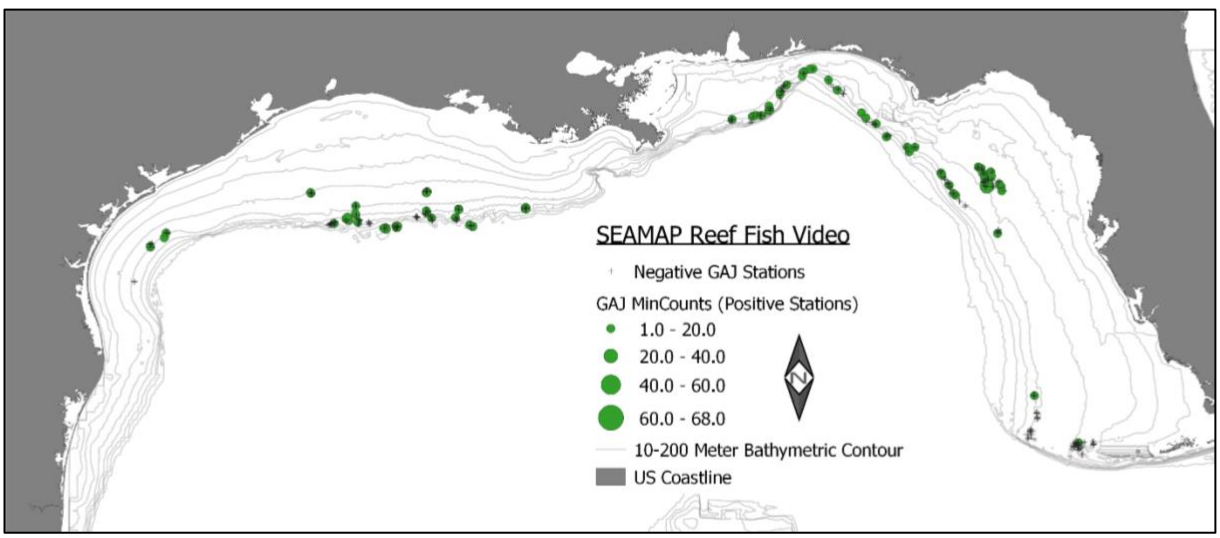


Figure 17. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2010.

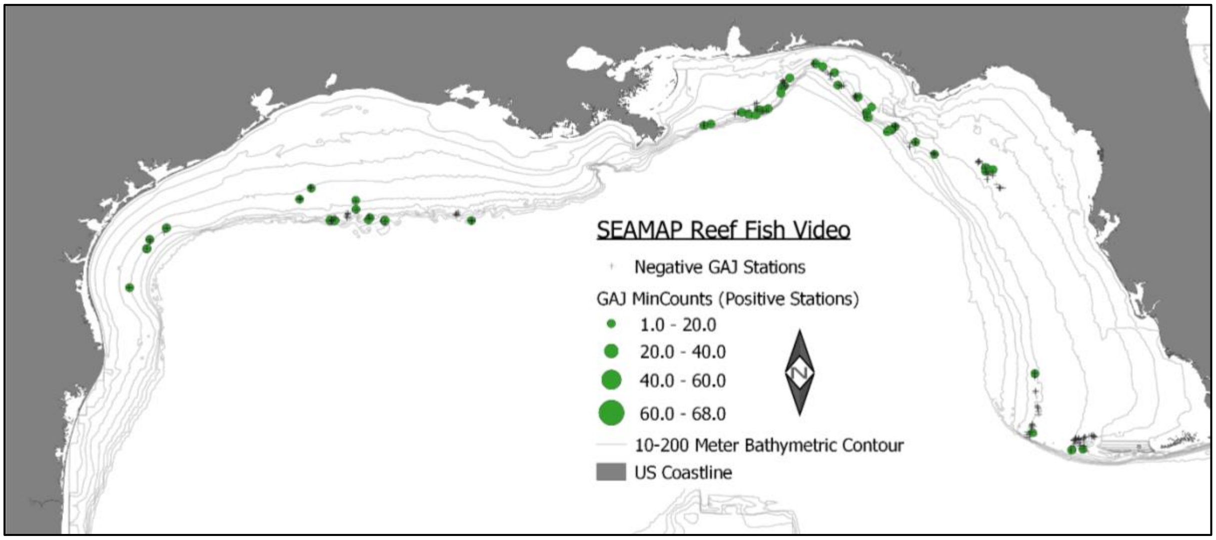


Figure 18. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2011.

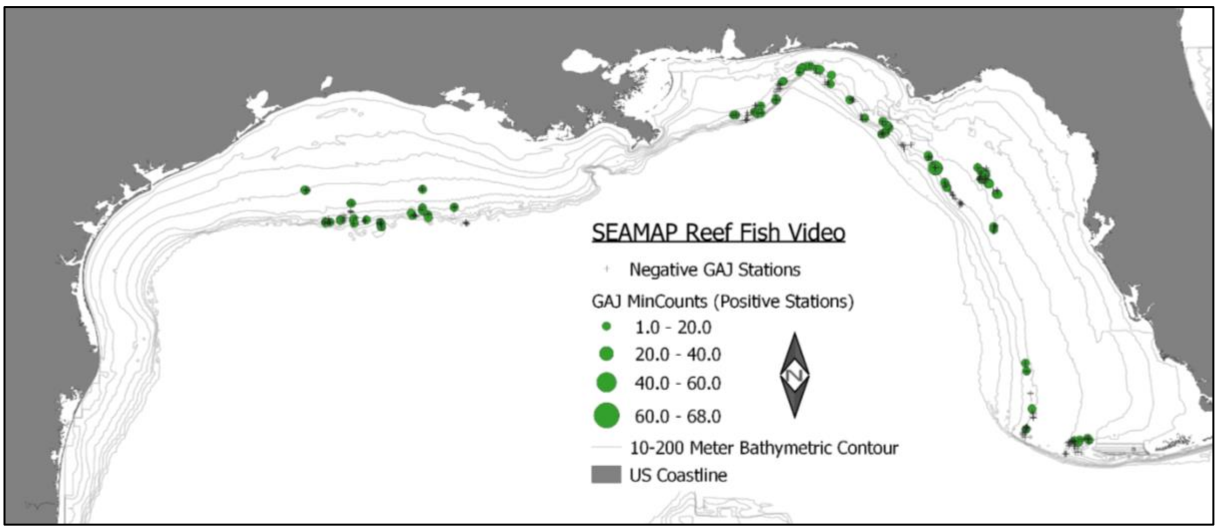


Figure 19. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2012.

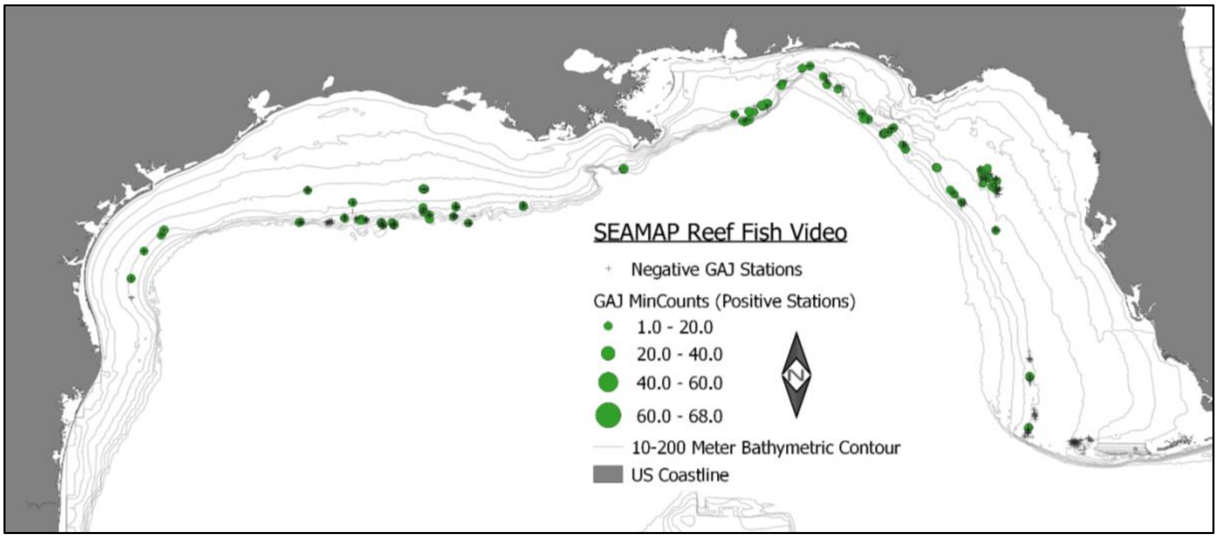


Figure 20. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2013.

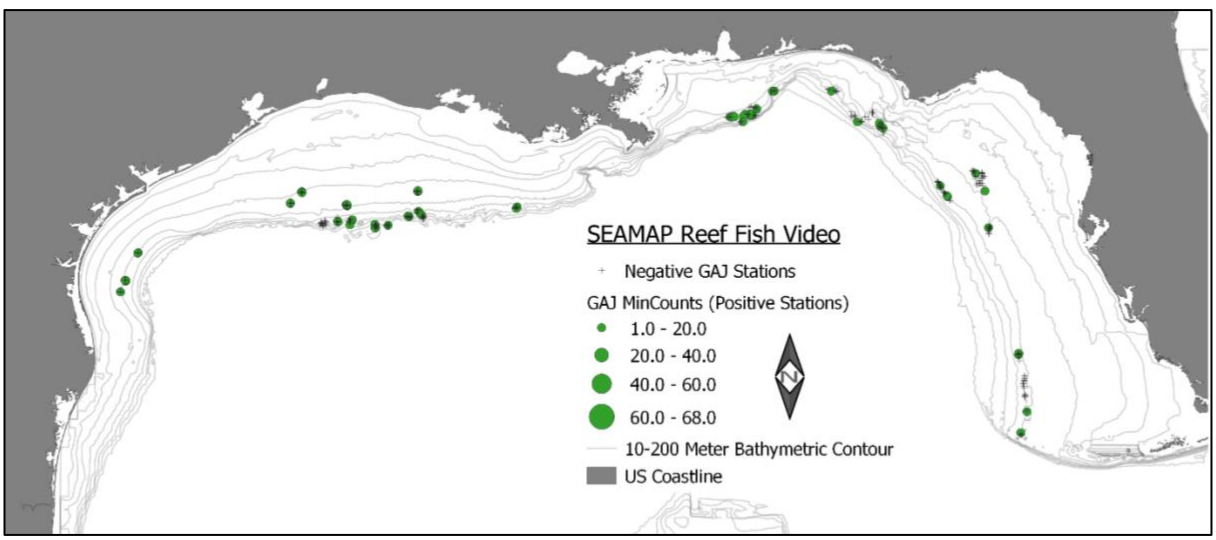


Figure 21. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2014.

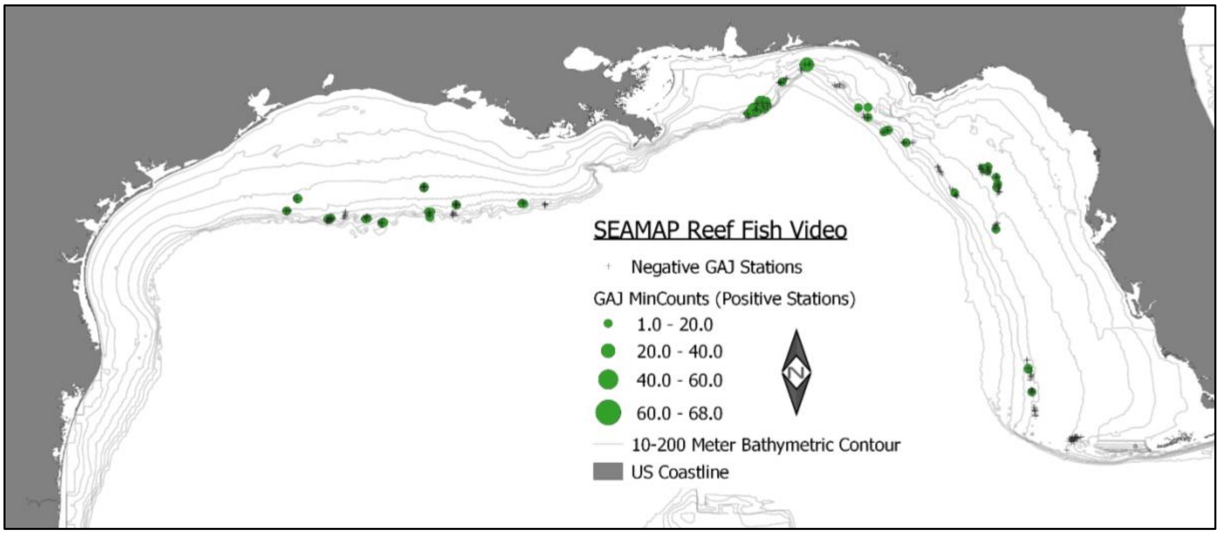


Figure 22. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2015.

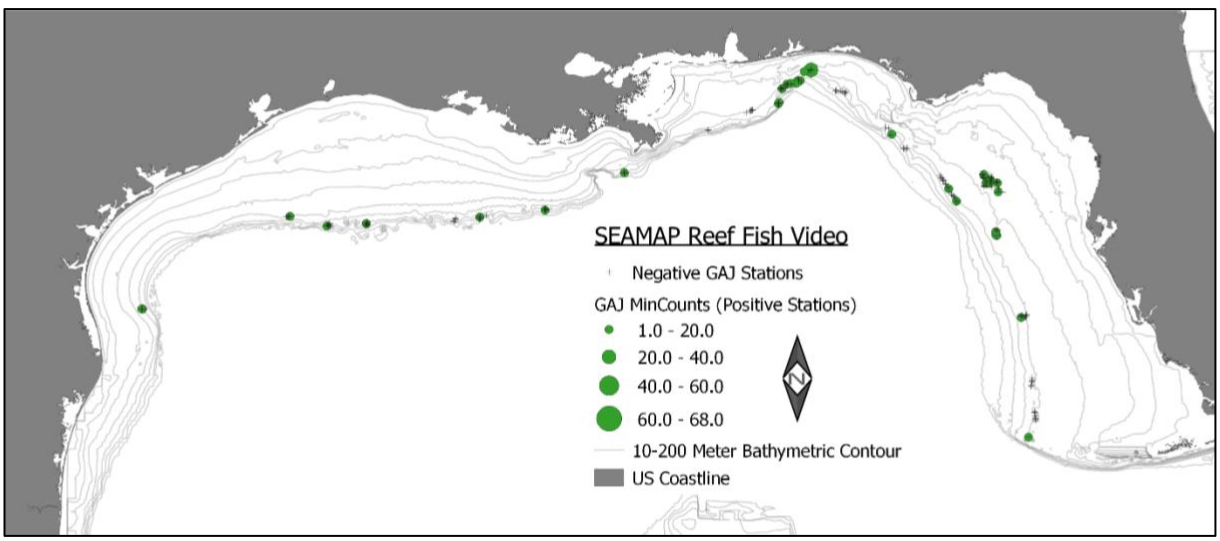


Figure 23. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2016.

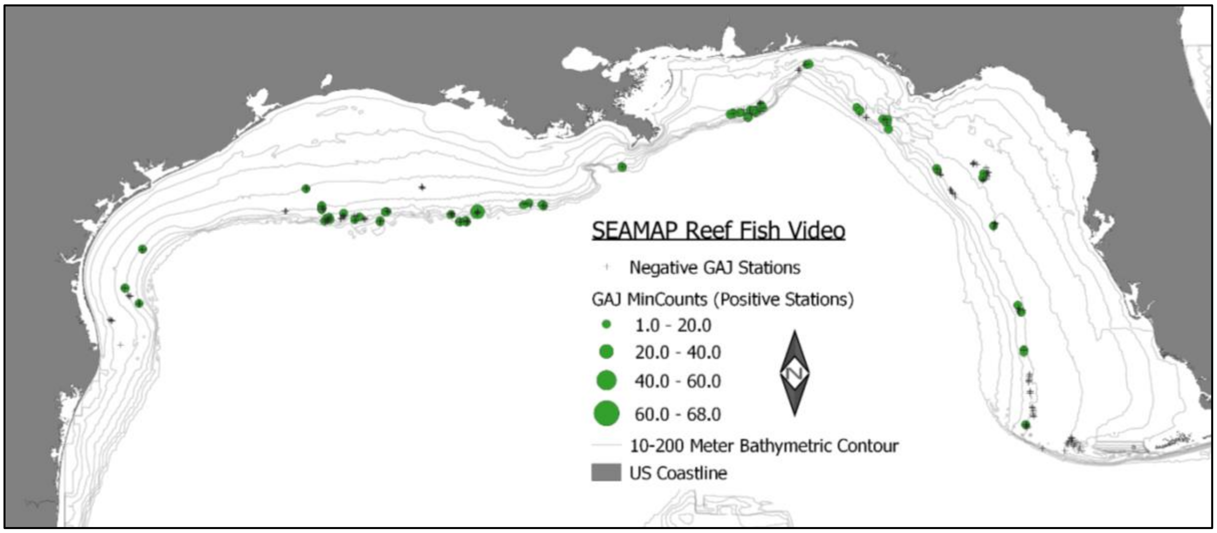


Figure 24. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2017.

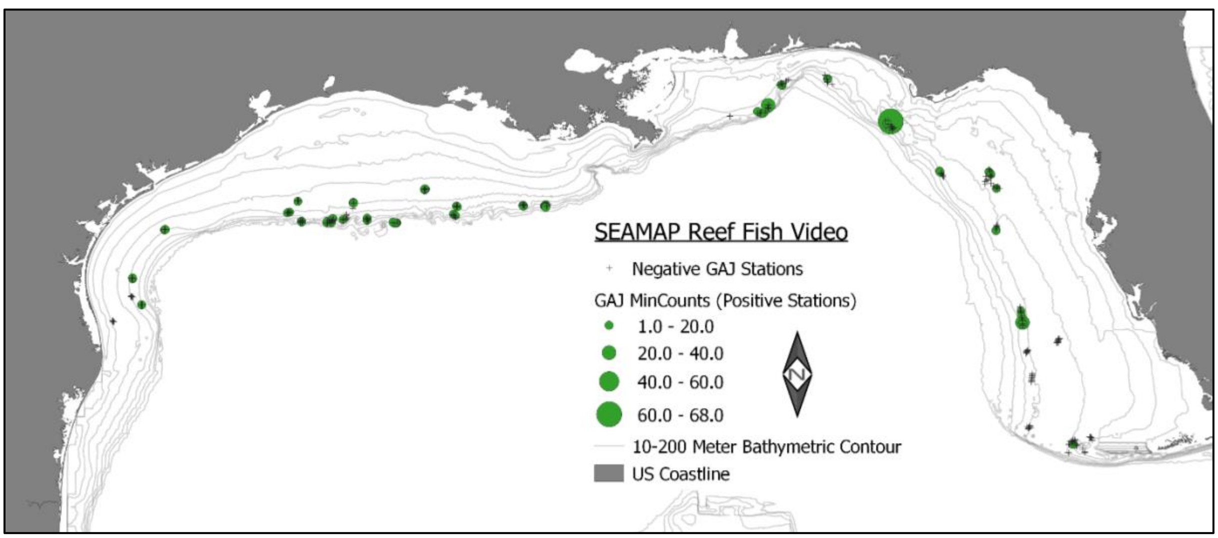


Figure 25. Map of Greater Amberjack mincounts during the SEAMAP reef fish video cruise in 2018.

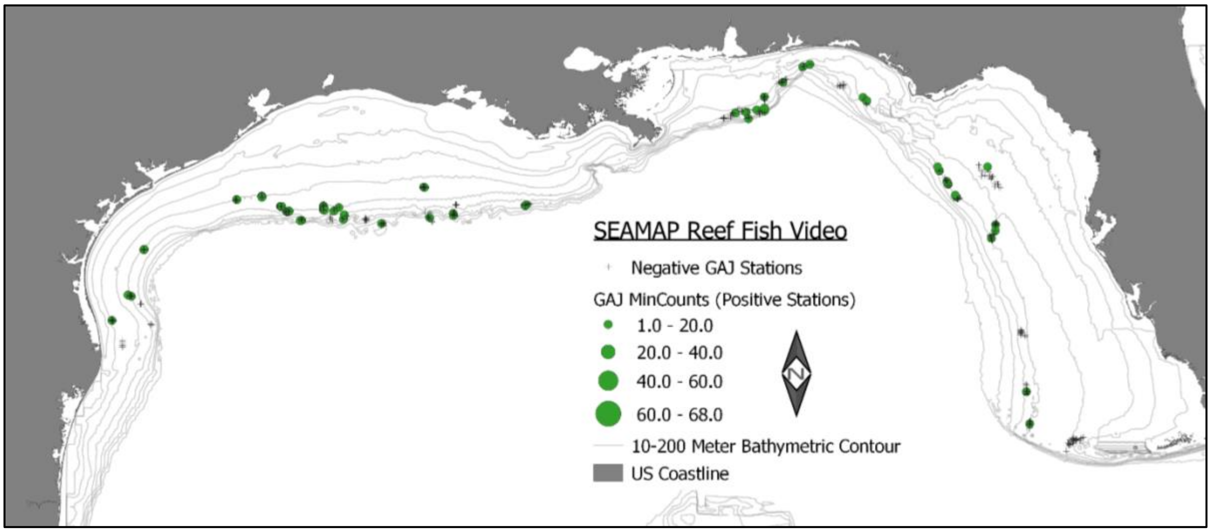


Table 7. Greater Amberjack lengths (TL) from the SEAMAP reef fish video cruise from 1993 – 2018. Includes estimates by region and Gulf wide.

	East Gulf			West Gulf			Gulf Wide		
Year	***N***	***Mean***	***STD***	***N***	***Mean***	***STD***	***N***	***Mean***	***STD***
1995	-	-	-	60	571.88	147.14	60	571.88	147.14
1996	28	640.11	176.71	51	703.43	216.16	79	680.99	204.19
1997	26	565.19	219.23	46	599.65	229.84	72	587.21	225.13
2001	19	707.21	292.07	16	746.38	260.03	35	725.11	274.56
2002	516	559.81	134.71	95	729.73	210.28	611	586.23	161.03
2003	235	668.49	125.23	-	-	-	235	668.49	125.23
2004	283	649.50	184.39	90	458.13	164.22	373	603.33	197.35
2005	172	627.51	186.31	70	683.41	266.08	242	643.68	213.41
2006	308	519.83	140.07	179	708.52	311.08	487	589.18	236.92
2007	341	737.17	239.52	181	730.40	237.51	522	734.82	238.62
2008	14	692.53	201.46	10	643.04	197.86	24	671.91	197.18
2009	60	549.23	175.02	14	987.84	220.53	74	632.21	251.66
2010	31	740.99	247.07	28	557.82	216.86	59	654.06	248.95
2011	74	671.26	260.00	28	667.02	261.52	102	670.10	259.12
2012	104	747.19	251.91	23	899.66	253.69	127	774.80	258.05
2013	72	714.28	254.42	28	711.88	286.15	100	713.61	262.21
2014	19	617.06	230.91	26	737.47	299.59	45	686.63	276.45
2015	38	542.97	129.43	10	658.39	135.85	48	567.02	137.72
2016	49	603.18	131.53	33	907.84	255.33	82	725.79	242.08
2017	36	743.41	202.18	47	787.09	274.88	83	768.14	245.58
Pooled	2425	630.24	199.30	1035	690.85	265.73	3460	648.37	222.97

Figure 26. Length frequency histograms of Greater Amberjack observed during the SEAMAP reef fish video cruise from 1993 - 2018.