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Introduction

The primary objective of the annual Gulf Fishery Independent Survey of Habitat and Ecosystem Resources (G-FISHER), formerly the 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 (Figure 1). 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. greater amberjack, *Seriola dumerili*). 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. Data was not collected in 2020 due to the COVID outbreak. 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 Red Snapper sampled over the history of the survey had fork lengths ranging from 82 mm – 1450 mm, and mean annual fork lengths ranging from 371 – 582 mm (Table 5, Figure 31). 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. Vertical line deployments were discontinued when the SEAMAP vertical line survey was cancelled by Gulf States partners.

Methods

Sampling design

Prior to the initiation of the G-FISHER survey design in 2020, reef area available to select survey sites from was approximately 1771 km², of which 1244 km² was located in the eastern GOM and 527 km² in the western GOM. A two-stage sampling plan was implemented; the first-stage used stratified random sampling to select blocks that were 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 ≤ 20 km² reef, block > 20 km² reef). There were a total of 7 strata. A 0.1 by 0.1 mile grid was then overlaid onto the reef area contained within a given block and the sampling sites (second stage units) were randomly selected from that grid.

The current G-FISHER design employs a stratified-random survey design that was developed based on a retrospective analysis of historical survey data (for a detailed description of analytical methods used to delineate sampling strata and define optimal allocation, see Switzer et al. 2023). Spatially, annual sampling effort is allocated among a combination of six regional strata (Texas, West Louisiana, East Louisiana, North Central Gulf, Big Bend, and South Florida) and three depth strata (Nearshore: 10 – 25 m; Offshore: 25 – 50 m; Deep: 50 – 180 m; Figure 2). Habitat stratification for both natural and artificial reef surveys is based on a combination of relative relief and size of each individual reef feature. Reef features were assigned to individual relief categories as either low-relief (average relief < 0.1 m), moderate relief (average relief 0.1 – 0.5 m) or high relief (average relief > 0.5 m), and size of individual reef features were assigned as small (area < 100 m2), medium (area 100 – 1,000 m2), or large (area > 1,000 m2). Within each stratum, annual sampling effort is allocated optimally based on a combination of managed species richness and estimated total habitat availability. Because the randomized habitat mapping component of the west Gulf is still underway, allocation of sites in the west Gulf are still contained to the original SEAMAP Reef Fish Video survey footprint.

Gear and deployment

The SEAMAP reef fish survey has employed several camcorders in underwater housings 1992 - 2006. In 2006 a stereo video camera system was developed and assembled at the NMFS Mississippi Laboratories - Stennis Space Center Facility and calibration work conducted through 2008 when they were fully implemented and in use from 2008-2018. In 2016 the current Sphere-Cam system was designed and calibration deployments conducted in 2017-2018, and has been in continuous use since then. Horizontal field-of-view (FOV) of the cameras has been maintained between 73-86° for single camera while total coverage of all cameras has ranged from 73 - 360°. While housings were rated to 600 meters max-depth for some systems, the limit of the survey selection was maintained at 150 meters, mainly due to light availability. Across all systems cameras were mounted at a height of 50 cm above the bottom of the array. Deployment is baited with squid and setup as an autonomous ground-tended system with surface buoys marking location.

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. In-Situ data sondes are attached to the camera array as well and collect the same environmental parameters at a slightly slower frequency than the CTD casts. Seabird units are the standard onboard NOAA vessels however the model employed was vessel/cruise dependent.

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 was low and to increase sample size any measureable fish during the video read was measured during this period (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. The survey was spatially restricted to the west in 2001 and was an abbreviated survey and was therefore also removed. 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, or 6) cameras failed to film. In all of these cases, the station is flagged as 'XX' in the data set and dropped. Sites that did not receive a stratum assignment are also dropped and all of those occurred early in the survey (1994-1995). In all, sites were dropped from a data set of records.

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, 2019, and 2021-2023.

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 previous random site selection process for the SEAMAP survey was selected from 10' latitude x 10' longitude blocks. Only blocks containing known reef were eligible for selection. Ten sites were randomly selected from within the blocks. Initial models always included a random block factor to test for autocorrelation among sites within a block.

Strata (ST) = Strata for the SEAMAP survey 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 km^2 reef, block > 20 km^2 reef). There were a total of 7 strata. G-FISHER strata are defined by a combination of six regional strata (Texas, West Louisiana, East Louisiana, North Central Gulf, Big Bend, and South Florida) and three depth strata (Nearshore: 10 – 25 m; Offshore: 25 – 50 m; Deep: 50 – 180 m).

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

Temperature (T) = Water temperature on the bottom (C°) taken during camera deployment via either a TDR placed on the camera array, a CTD cast, or a data sonde.

Dissolved oxygen (DO) = Dissolved oxygen (mg/l) taken via CTD cast slightly away from where the camera was deployed or a data sonde on the array.

Salinity (S) = Salinity (ppt) taken via CTD cast slightly away from where the camera is deployed or a data sonde on the array.

Sand Mud (M) = Percent bottom cover of sand or mud substrates.

Pebble Rubble (B) = Percent bottom cover of pebble or rubble substrates.

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

Manmade (M) = Percent bottom cover of artificial/manmade material.

Unknown substrate (U) - Percent bottom cover of unknown substrate.

Biota Pct Cover (BPC) = Percent bottom cover of attached epifauna or biota on top of substrate.

Grasses Mixed (GM) = Percent bottom cover of grass.

Sponge (SP) = Percent bottom covered by sponge ball, finger, massive, vase, or other species or sponge.

Unknown biota (US) = Percent bottom cover of unknown sessile organisms.

Algae Mixed (AM) = Percent bottom cover of algae.

Hardcoral (HC) = Percent bottom cover of branching, columnar, flat, dead, or mounding coral.

Softcoral (SC) = Percent bottom cover of soft coral and seawhips.

Mixed attached (MI) = Percent bottom cover of mixed attached biota.

Substrate percent total (SPT) = Percent of bottom covered by substrate.

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: > 10% hard coral or >50% rock or >40% soft coral or >10% sponge.

HPerc (HPerc) = Shannon’s H’ diversity index value calculated from percent coverage data of the individual habitat types (e.g. HC, SC, etc…).

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. We explored model fit using two different error distribution models to construct relative abundance indices including poisson and negative binomial. Our analysis is restricted to west Gulf data only as the combined video index will be used for analysis of east Gulf data. Models were run and independent variables tested in the model included year, reef, and depth as fixed effects in the model. Variables with obvious correlation were not tested at the same time but were tested in isolation against the other variables. We used the composite variable 'reef' rather than the percent coverage of individual habitat variables because of the affinity Red Snapper have for 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 explained 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 for the east Gulf. GFISHER survey groups are consistent in determining if the camera landed on reef habitat (i.e.the 'reef' variable). The GLM procedure in R (v. 4.4.0) was 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

Red Snapper were frequently observed at banks in the western GOM (Figures 8-29), and the spatial distributions observed are highly reflective of the reef sampling universe used to select sampling sites for both the SEAMAP and G-FISHER surveys (Figure 2). Gaps in habitat level information existed in regions around the Mississippi river delta, 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. 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 the east Gulf survey, is conducted as part of the GFISHER survey design, and combines all three historic video surveys into a single index of abundance. The west Gulf survey design is still selected from the same selection universe used historically in the SEAMAP Reef Fish Video Survey. Newly collected randomized mapping has yet to be used to redesign the west Gulf portion of GFISHER. 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 provided the best fit based on several fit statistics (Tables 1 and 2), and reasonably low over-dispersion parameters (west Gulf = 1.41). While the over-dispersion parameters and QQ plots could be improved, they were far better than the Poisson model. Additionally, the fits improved the west Gulf regional submodel.

In the west Gulf analysis, variables retained included year, reef, and depth (Table 3). West Gulf Red Snapper proportion positives ranged from 0.02 (1993) to 0.75 (2021) with similarly high values between 2013-2023 (Table 4; Figure 3). Red Snapper standardized index of abundance ranged from 0.09 (1993) to 6.09 (2018), and generally increasing trends in the time series from 2006-2023 (Table 4, Figures 4-6). Coefficient of variation ranged from 17.46% (1994) to 28.72% (2002); values will continue to decrease as knowledge of reef locations and characterization increases (Table 4).

Red Snapper fork lengths in the west GOM ranged from 82.4 mm to 1449.73 mm, with an average of 437.05 mm (Figure 31). The trend in average annual FL does not appear to decrease; however, three of the last five years had lengths in the bottom eight (Table 5).

Literature cited

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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.

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Figure 1. Area covered by historical SouthEast Area Monitoring and Assessment Program (SEAMAP), National Marine Fisheries Service Panama City (NMFS Panama City), Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI) and FWRI expansion surveys. Years in parentheses represent the year in which each survey began.

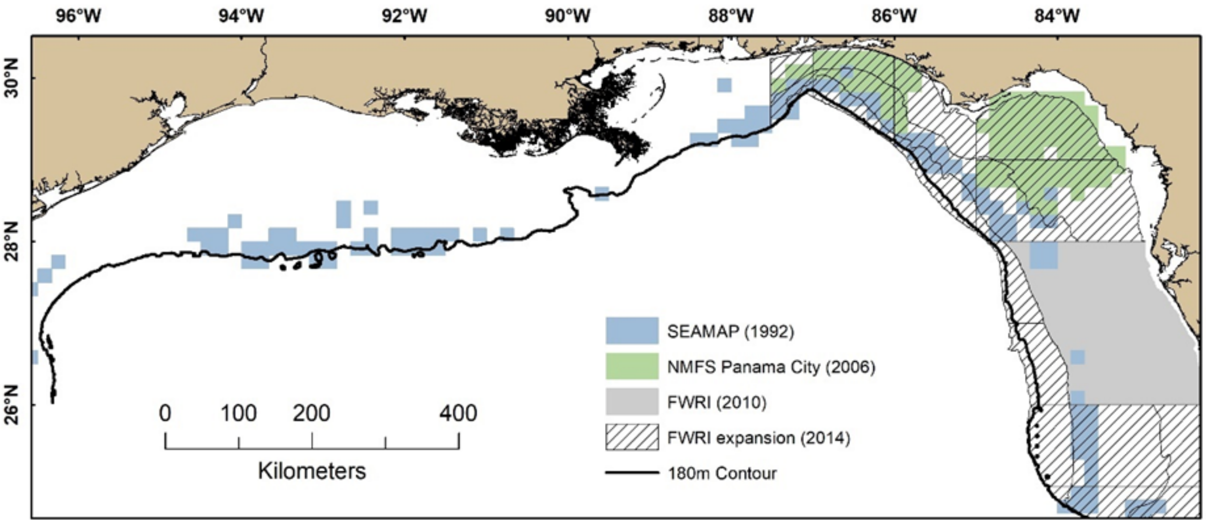


Figure 2. Spatial stratification scheme of the Gulf Fishery Independent Survey of Habitat and Ecosystem Resources (G-FISHER) program.

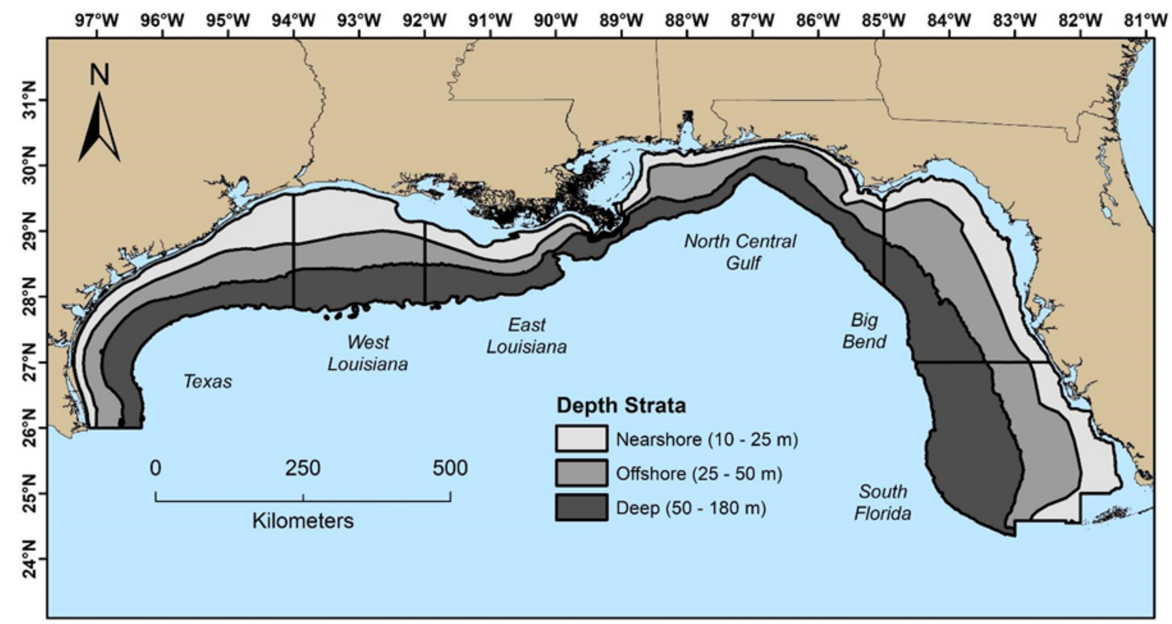


Table 1. Fit statistics output from the poisson and negative binomial models for west Gulf Red Snapper showing that negative binomial model had the lowest ('best') fit statistics of the two models evaluated.

Criterion	Poisson	NegBinom
-2 Log Likelihood	18002.513	11065.04
AIC	18056.513	11121.04
AICc	18057.006	11121.569
BIC	18219.571	11290.136

Table 2. Fit Statistics for conditional distribution from the poisson and negative binomial for west Gulf Red Snapper model runs. Pearson Chi-Square/DF shows the negative binomial model has a value closest to 1.0 of the two models evaluated.

Fit.Statistic	Poisson	NegBinom
Pearson Chi-Square	21444.311	4321.995
Pearson Chi-Square / DF	6.978	1.406

Table 3. Type III fixed effects output from the Negative Binomial for west Gulf Red Snapper model showing that year, habitat complexity, and depth were all significant variables.

term	sumsq	df	F.values	p.value
year	707.69309	24	20.96583	0.00000
reef	25.73023	1	18.29456	0.00002
depth	36.15359	1	25.70572	0.00000
Residuals	4,321.99473	3,073		NA

Table 4. Output for the Negative Binomial index of relative abundance of Red Snapper by year for the west Gulf model run.

Year	nStations	Proportion Positive	Mean MinCount	Standardized Index	CV	LCL	UCL	SE	Run
1993	45	0.02	0.09	0.09	19.05	0.03	0.26	0.00	West
1994	45	0.22	0.33	0.35	17.46	0.18	0.68	0.01	West
1995	41	0.15	0.41	0.45	21.81	0.23	0.87	0.02	West
1996	164	0.18	0.55	0.56	26.86	0.41	0.78	0.01	West
1997	126	0.44	1.18	1.22	23.38	0.89	1.68	0.03	West
2002	93	0.40	1.11	1.09	28.72	0.75	1.58	0.03	West
2004	48	0.27	0.65	0.74	25.85	0.43	1.29	0.03	West
2005	134	0.37	0.90	0.90	22.88	0.66	1.25	0.02	West
2006	136	0.21	0.38	0.38	20.42	0.26	0.56	0.01	West
2007	157	0.39	0.99	0.98	26.16	0.73	1.32	0.02	West
2008	125	0.31	0.75	0.72	25.61	0.51	1.02	0.02	West
2009	165	0.37	1.11	1.08	23.41	0.81	1.44	0.02	West
2010	98	0.55	2.33	2.41	23.54	1.73	3.36	0.06	West
2011	103	0.49	1.66	1.65	22.35	1.18	2.32	0.04	West
2012	200	0.50	1.88	1.92	22.61	1.51	2.46	0.03	West
2013	133	0.68	2.50	2.53	22.12	1.89	3.37	0.05	West
2014	113	0.65	3.48	3.42	20.08	2.53	4.62	0.06	West
2015	54	0.57	2.46	2.50	20.37	1.61	3.88	0.07	West
2016	166	0.70	2.60	2.61	26.63	2.01	3.40	0.05	West
2017	192	0.70	4.73	4.75	20.78	3.75	6.02	0.07	West
2018	186	0.69	6.18	6.09	22.04	4.80	7.71	0.10	West
2019	263	0.56	3.24	3.23	23.97	2.62	3.99	0.05	West
2021	101	0.75	4.74	4.55	25.72	3.32	6.23	0.12	West
2022	115	0.74	4.00	4.01	24.65	2.98	5.40	0.09	West
2023	97	0.71	4.31	4.19	22.14	3.04	5.76	0.09	West

Figure 3. The proportion of positive counts (i.e., counts > 0) for Red Snapper for west Gulf model run.

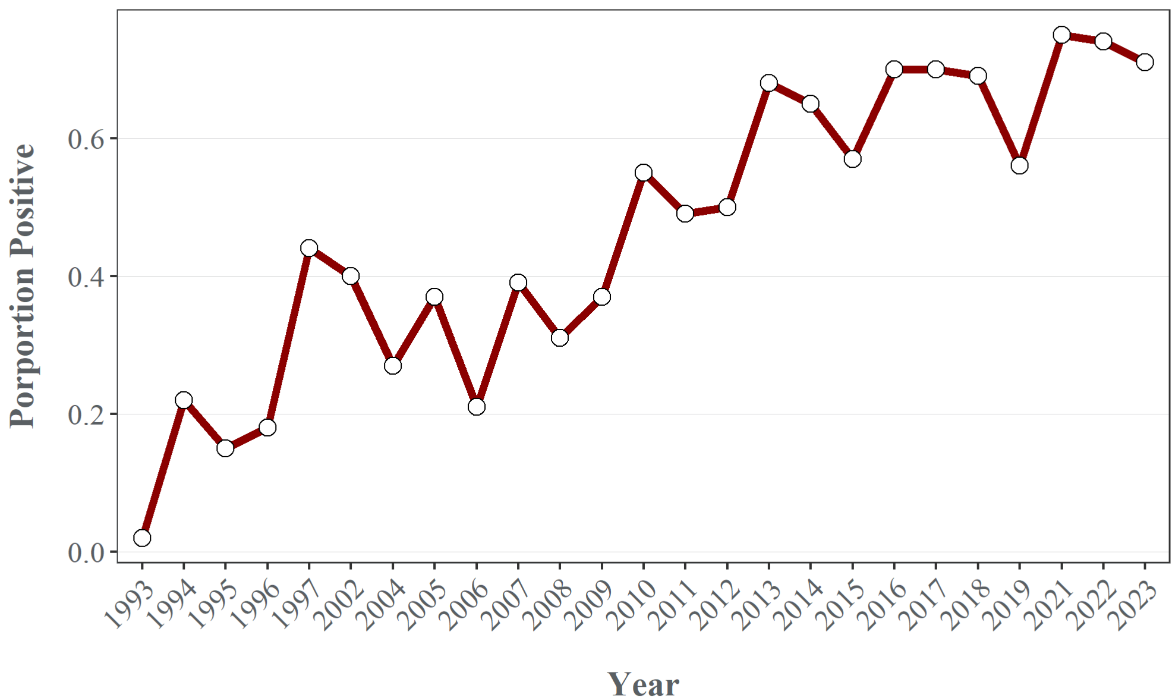


Figure 4. LS means (95% CI) for Red Snapper for the west Gulf Negative Binomial model run.

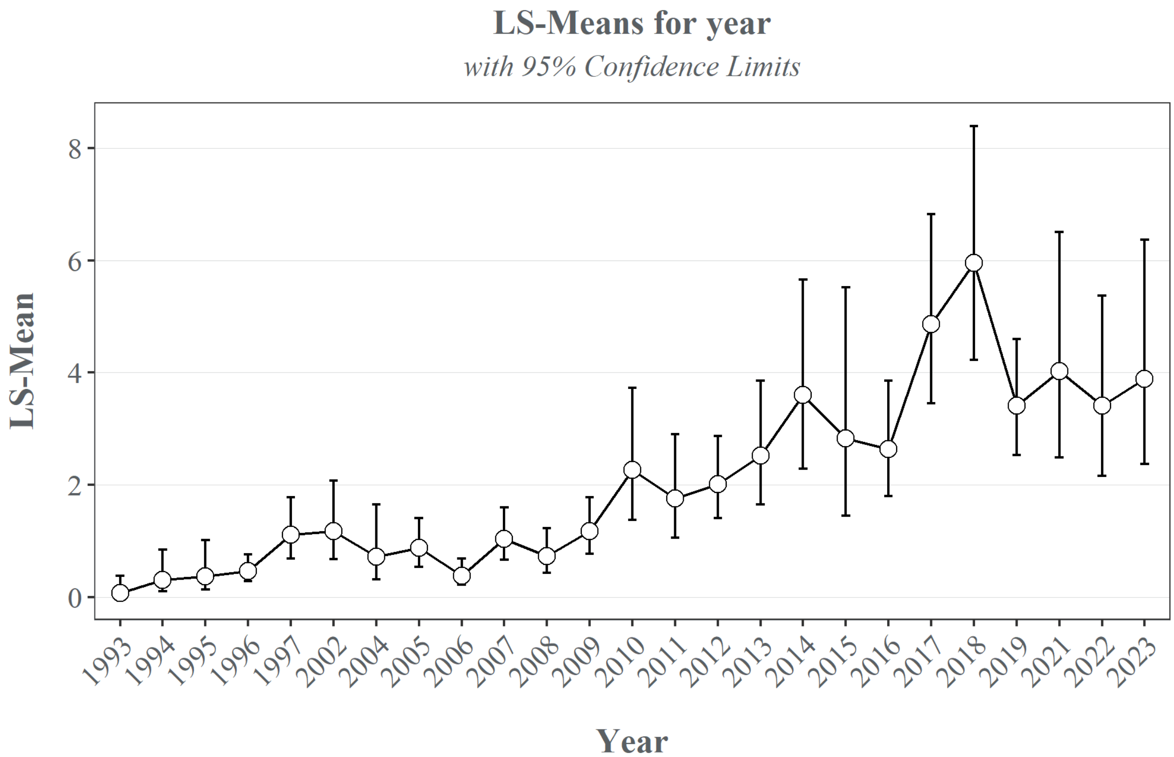


Figure 5. Plot of standardized index with upper and lower confidence limits (dashed lines) for the west Gulf Negative Binomial model run.

Figure 6. Plot of standardized index and mean mincount for Red Snapper for the west Gulf Negative Binomial model run. Shaded region is bounded by the 95% upper and lower confidence limits of the predicted means.

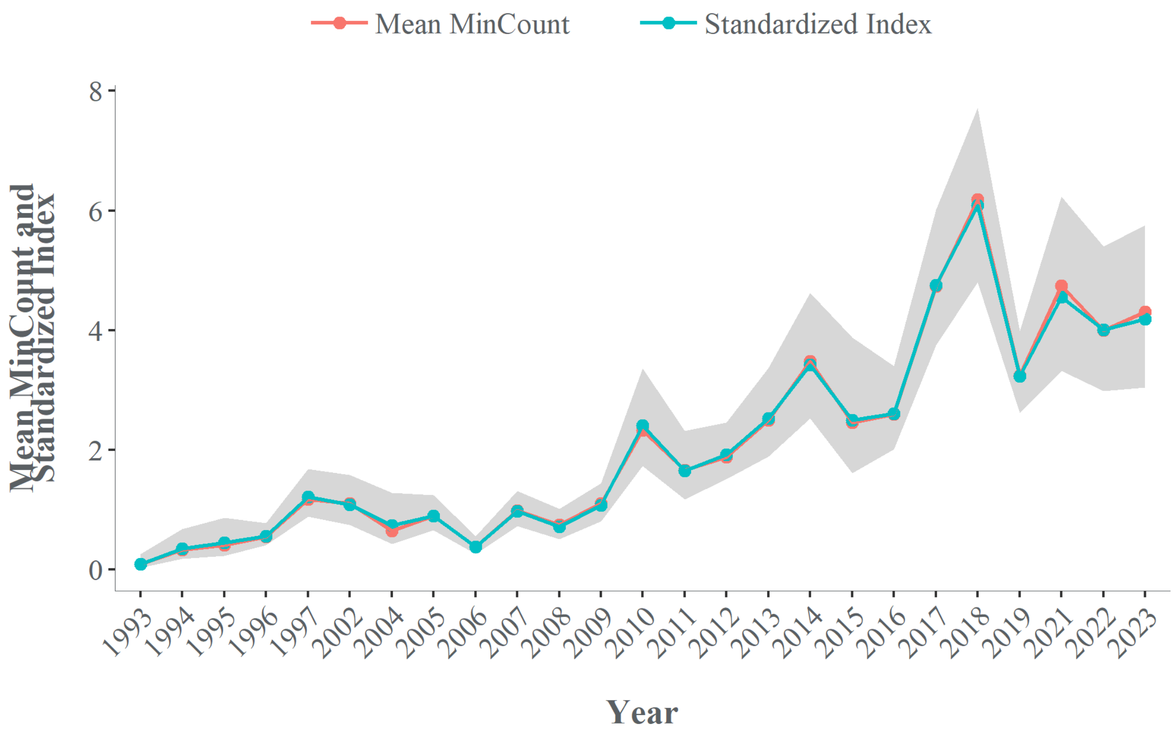


Figure 7. Q-Q plot of residuals for the west Gulf Negative Binomial model run.

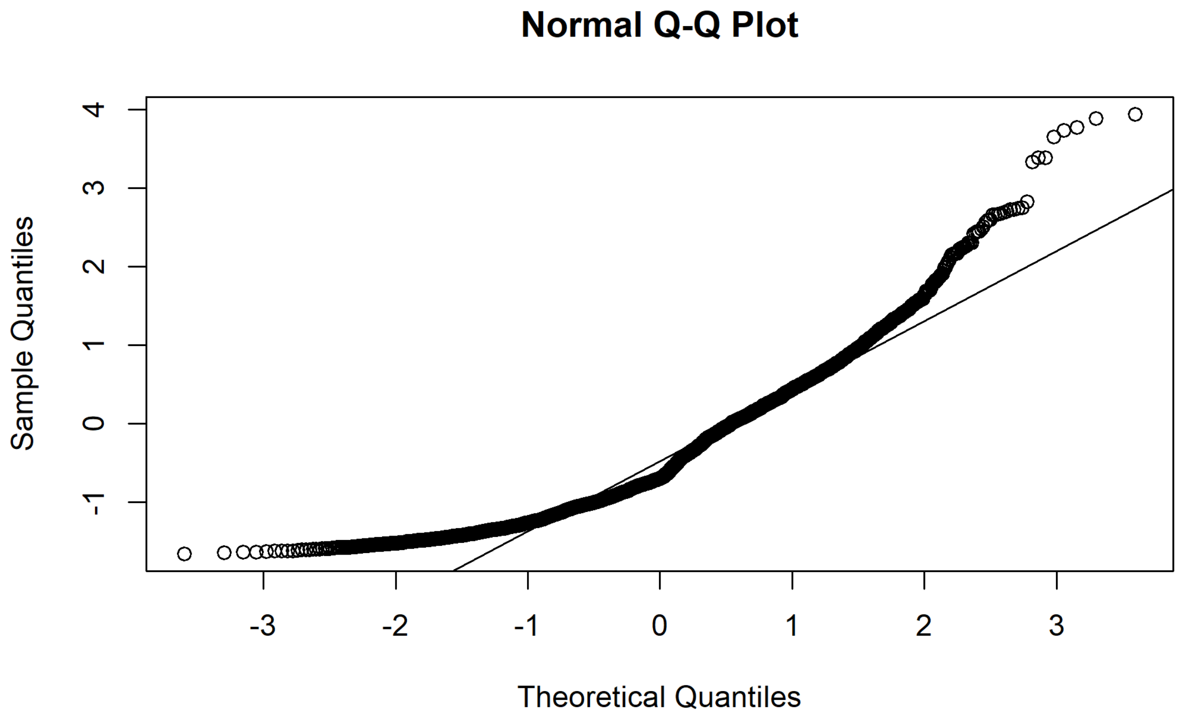


Figure 8. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 1995 for the west Gulf. Contour lines represent 10-200 m bathymetry.

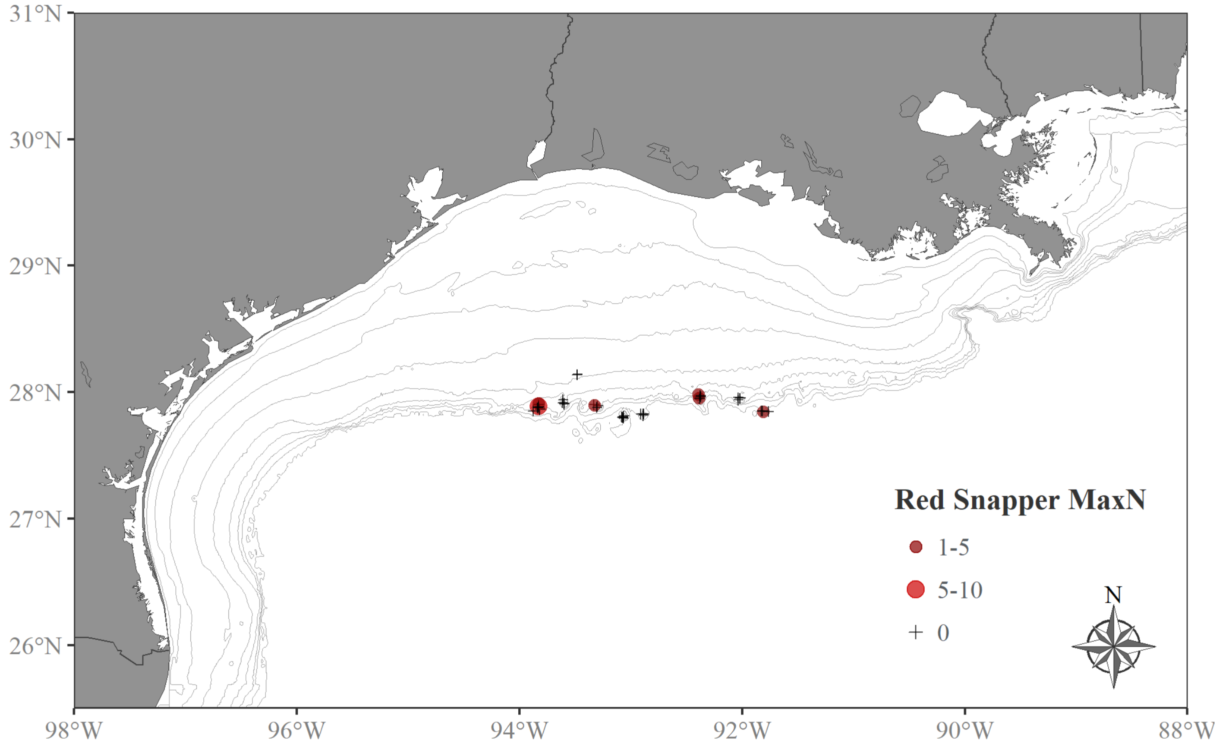


Figure 9. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 1996 for the west Gulf. Contour lines represent 10-200 m bathymetry.

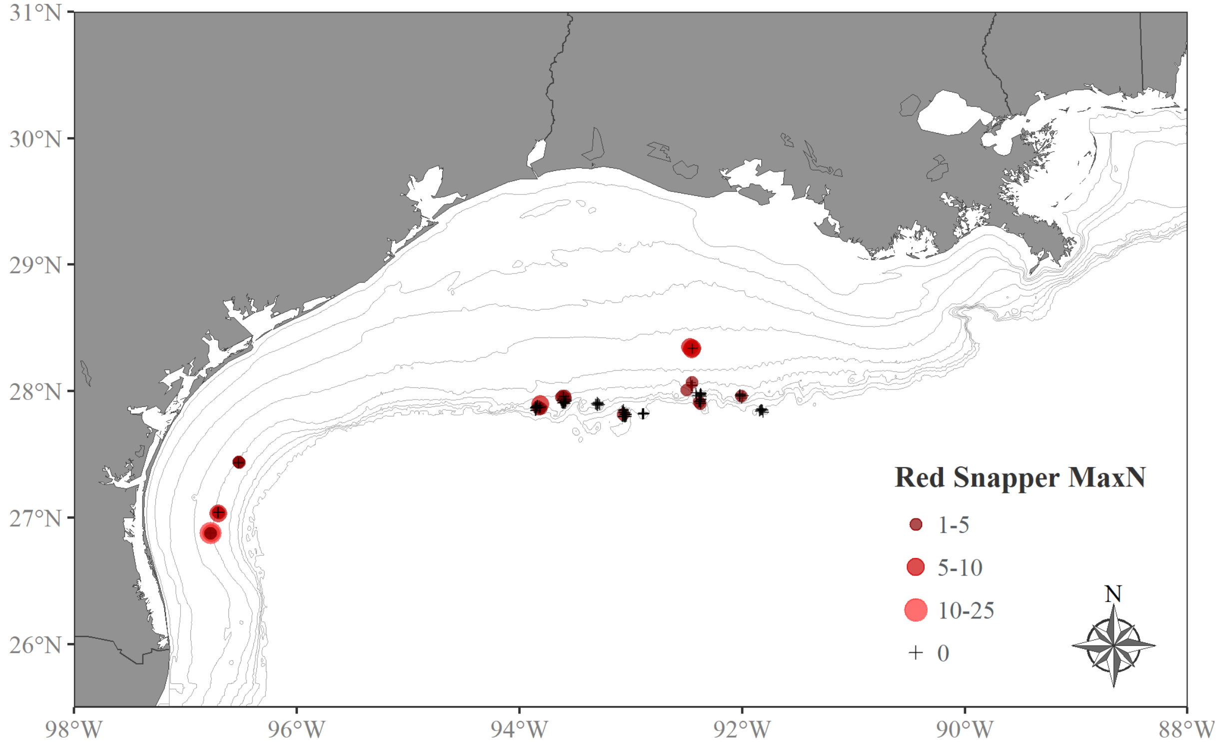


Figure 10. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 1997 for the west Gulf. Contour lines represent 10-200 m bathymetry.

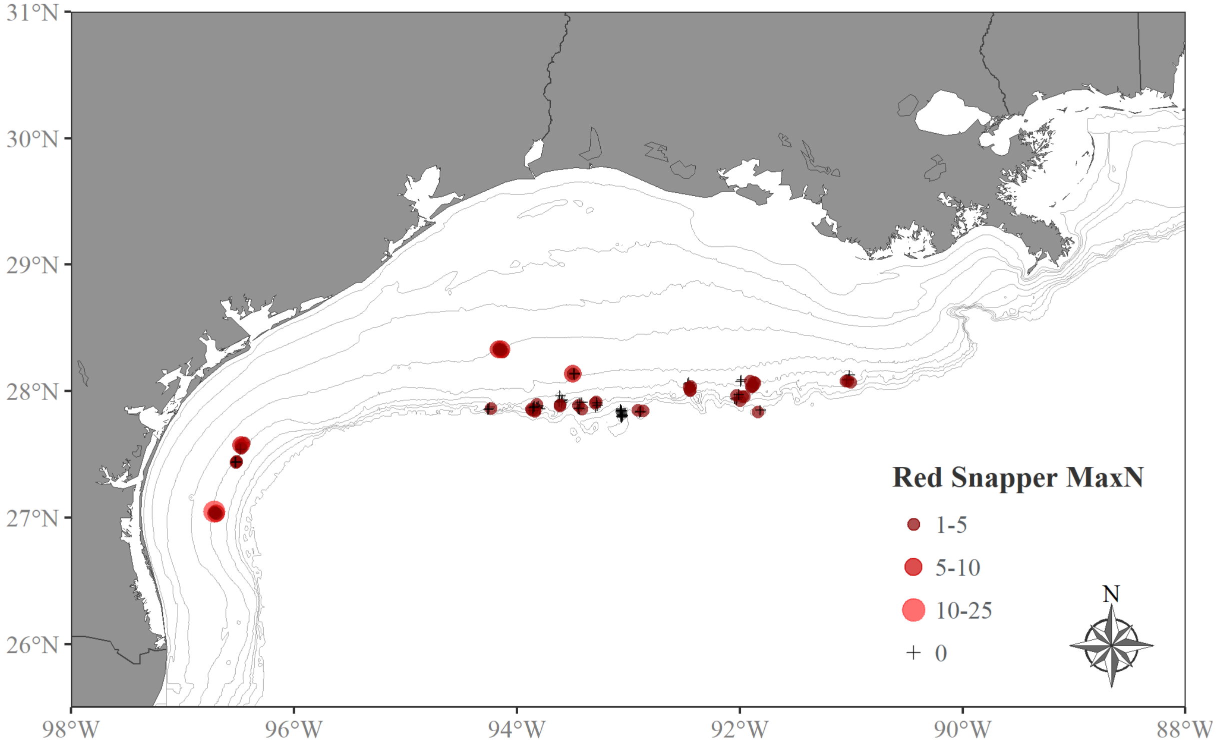


Figure 11. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2002 for the west Gulf. Contour lines represent 10-200 m bathymetry.

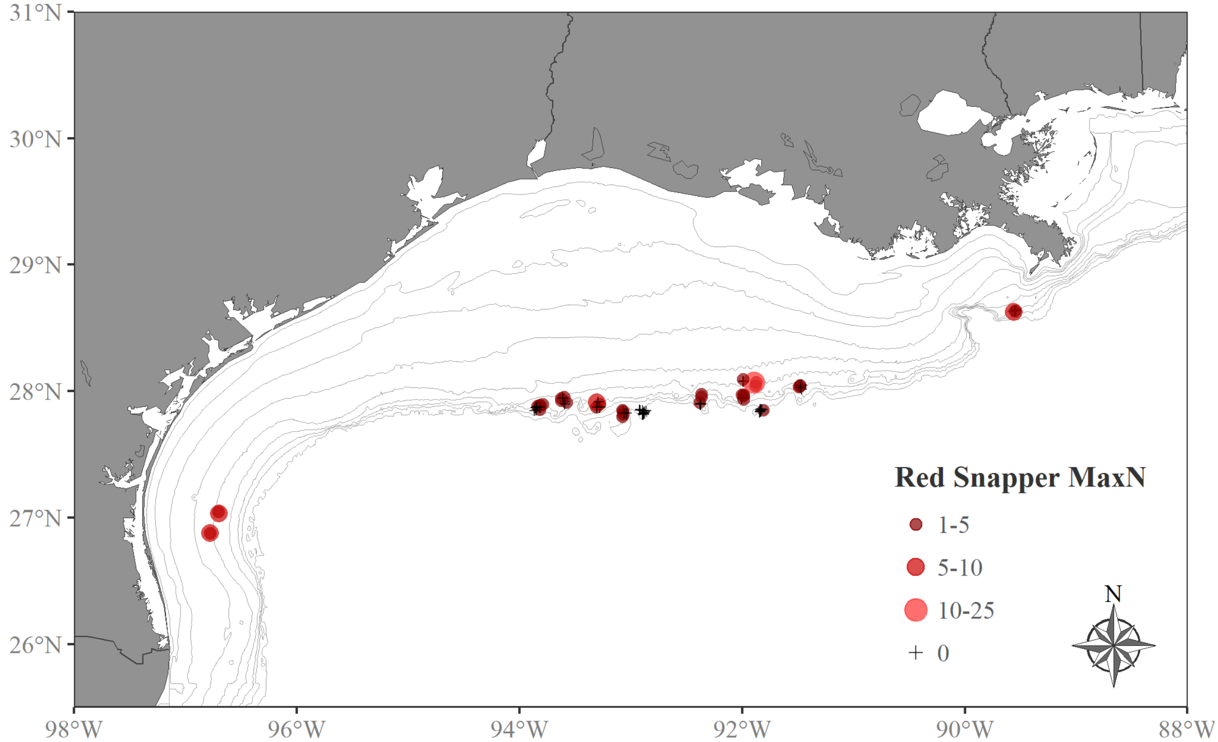


Figure 12. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2004 for the west Gulf. Contour lines represent 10-200 m bathymetry.

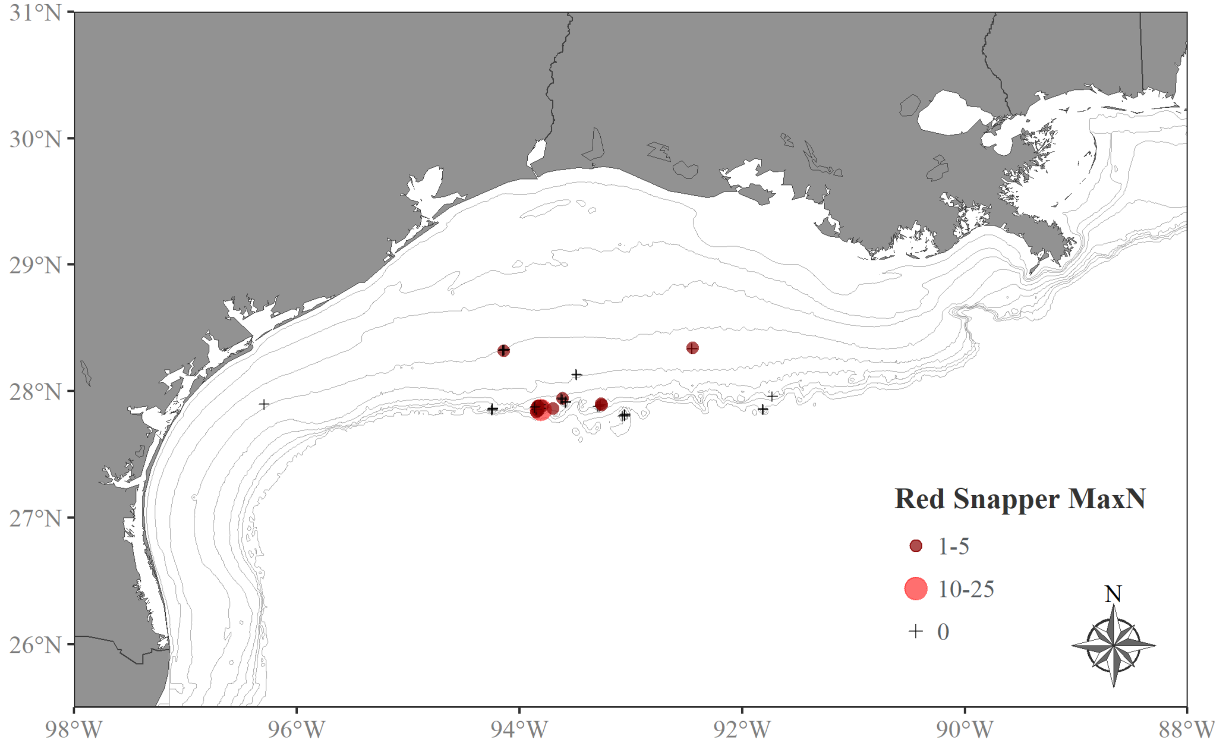


Figure 13. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2005 for the west Gulf. Contour lines represent 10-200 m bathymetry.

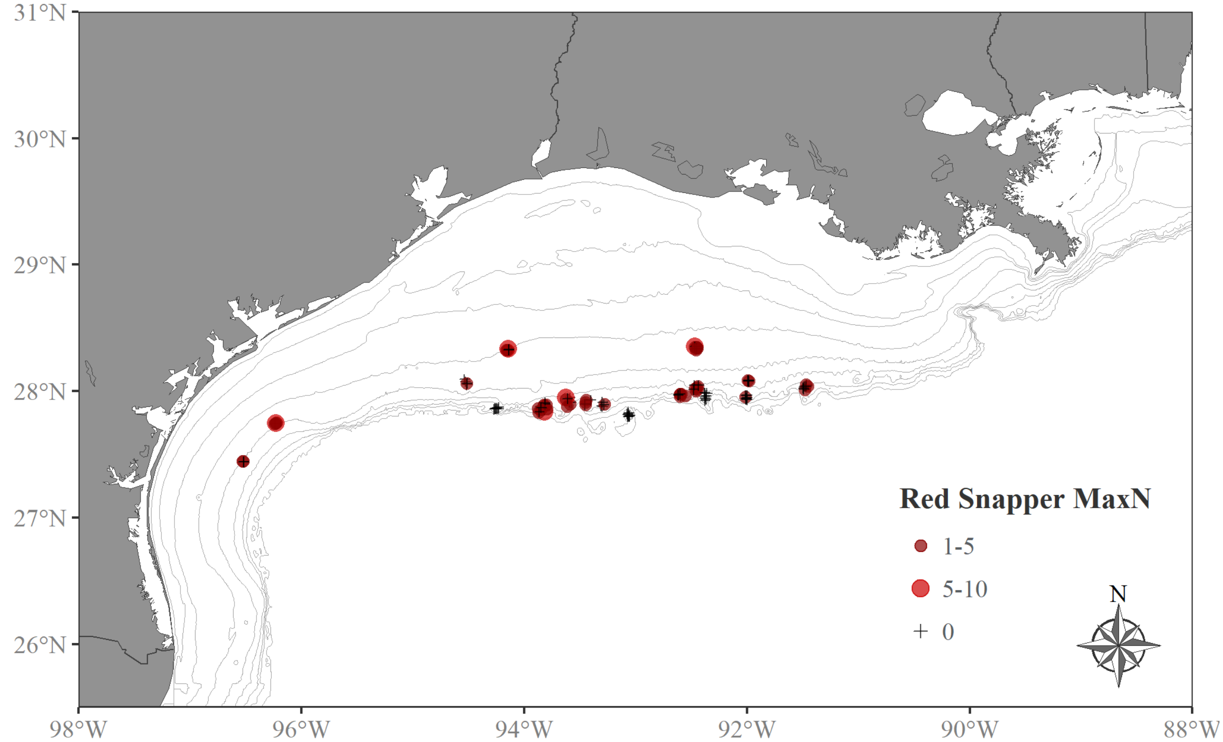


Figure 14. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2006 for the west Gulf. Contour lines represent 10-200 m bathymetry.

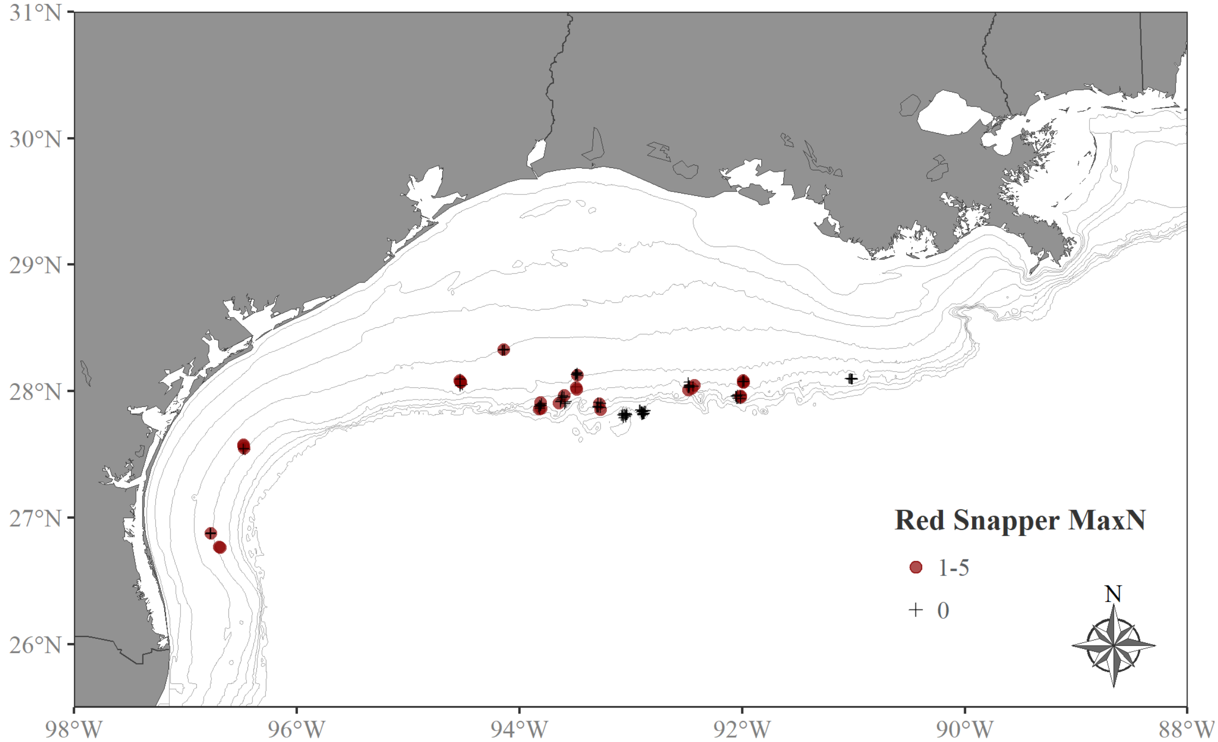


Figure 15. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2007 for the west Gulf. Contour lines represent 10-200 m bathymetry.

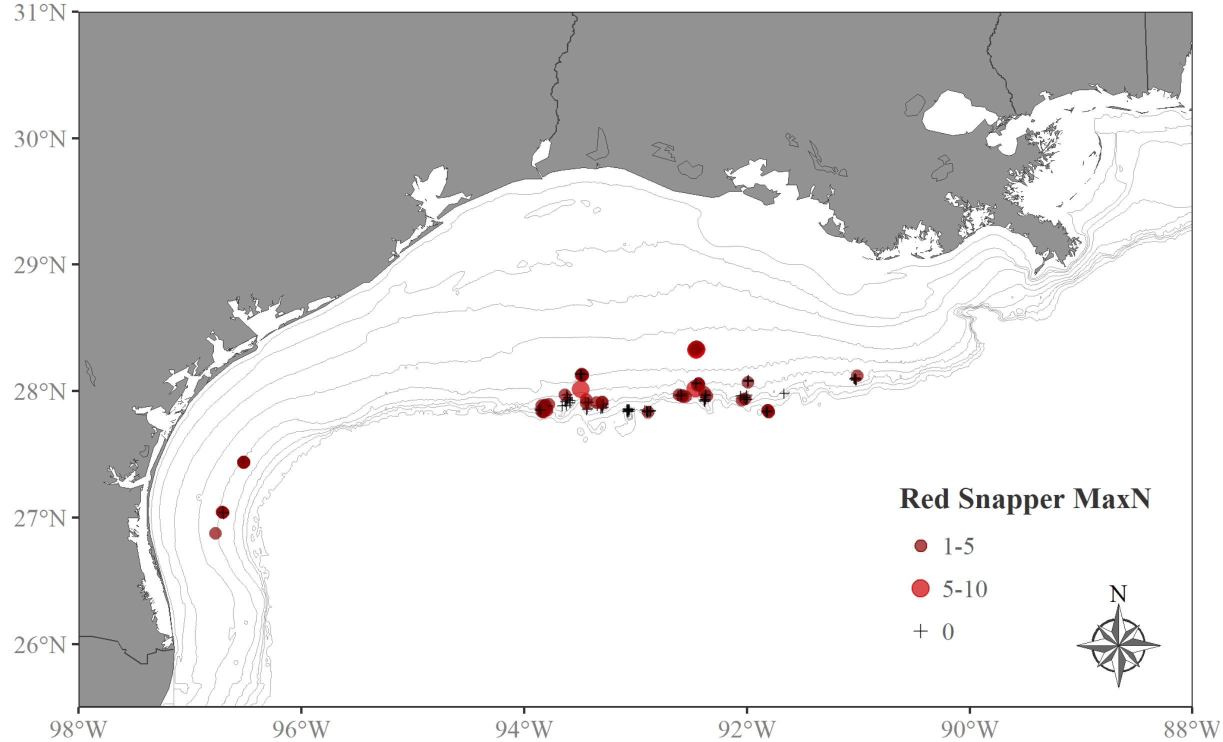


Figure 16. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2008 for the west Gulf. Contour lines represent 10-200 m bathymetry.

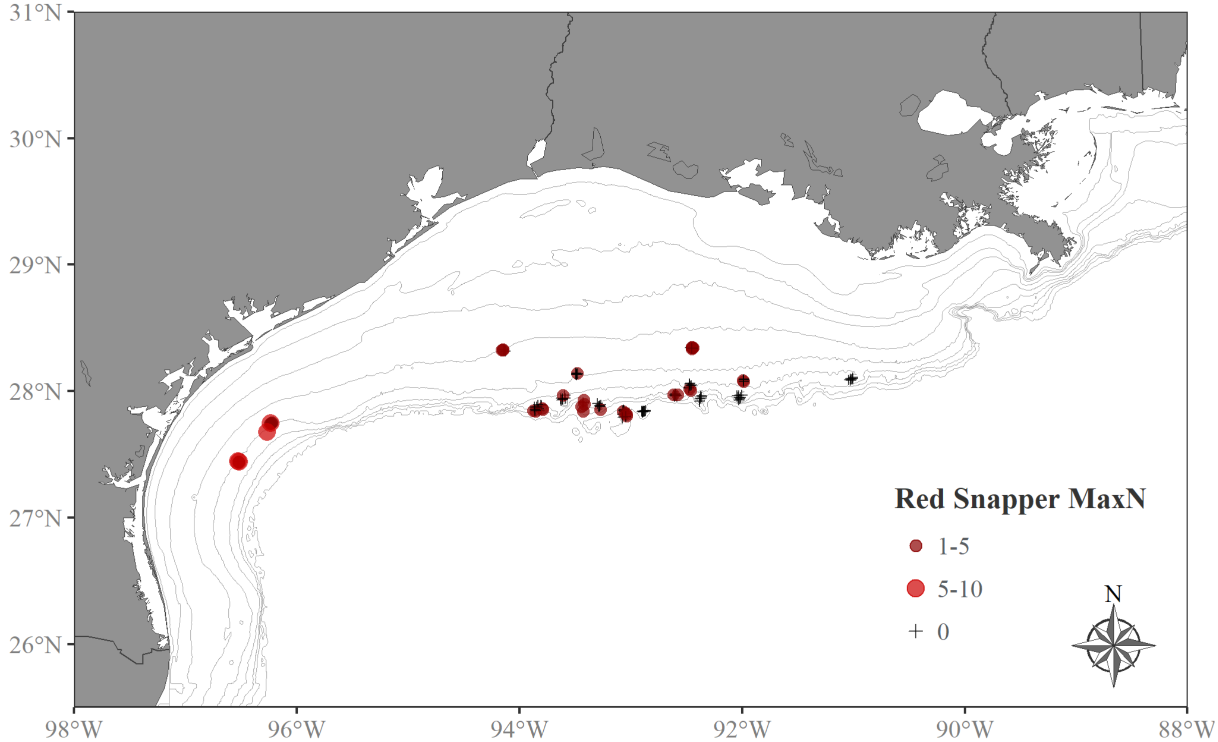


Figure 17. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2009 for the west Gulf. Contour lines represent 10-200 m bathymetry.

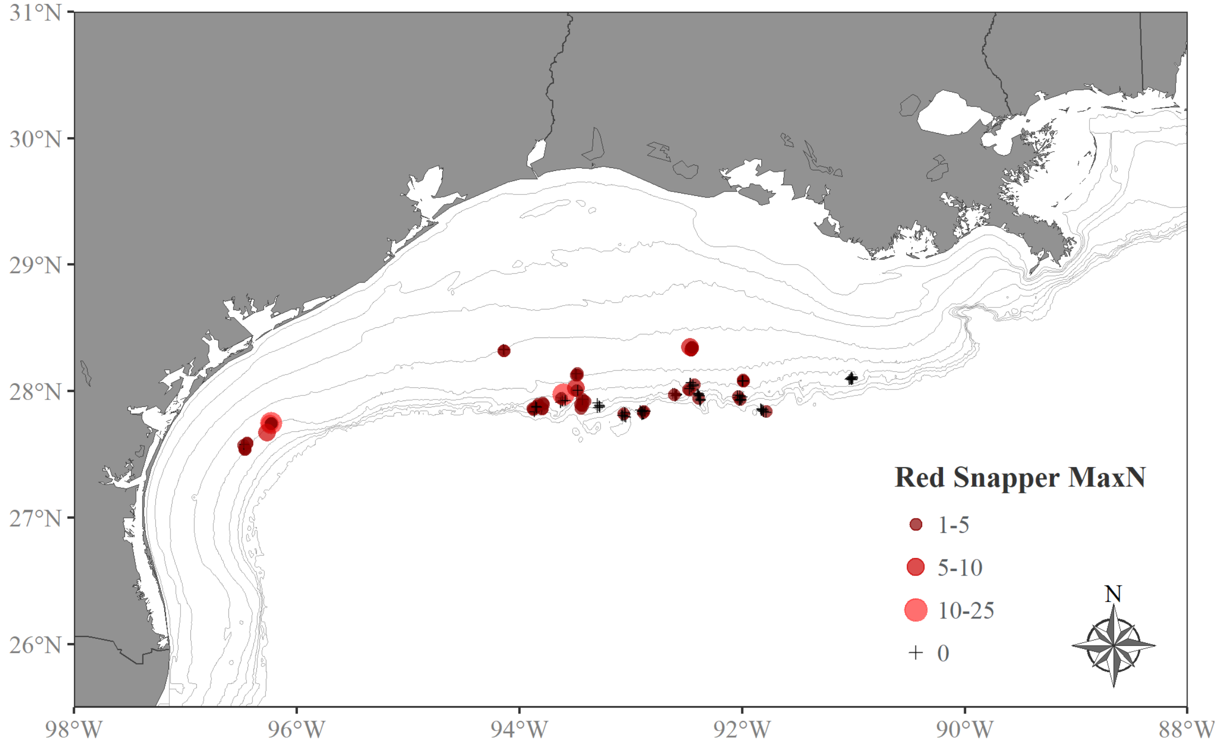


Figure 18. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2010 for the west Gulf. Contour lines represent 10-200 m bathymetry.

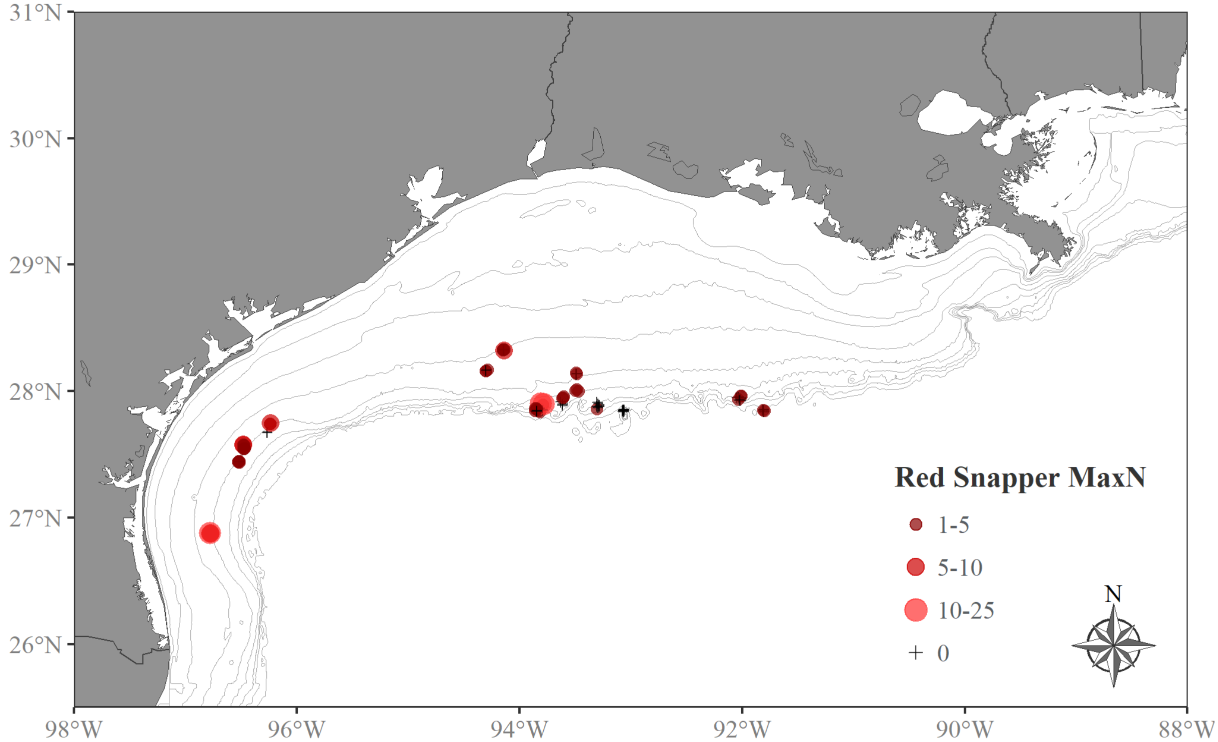


Figure 19. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2011 for the west Gulf. Contour lines represent 10-200 m bathymetry.

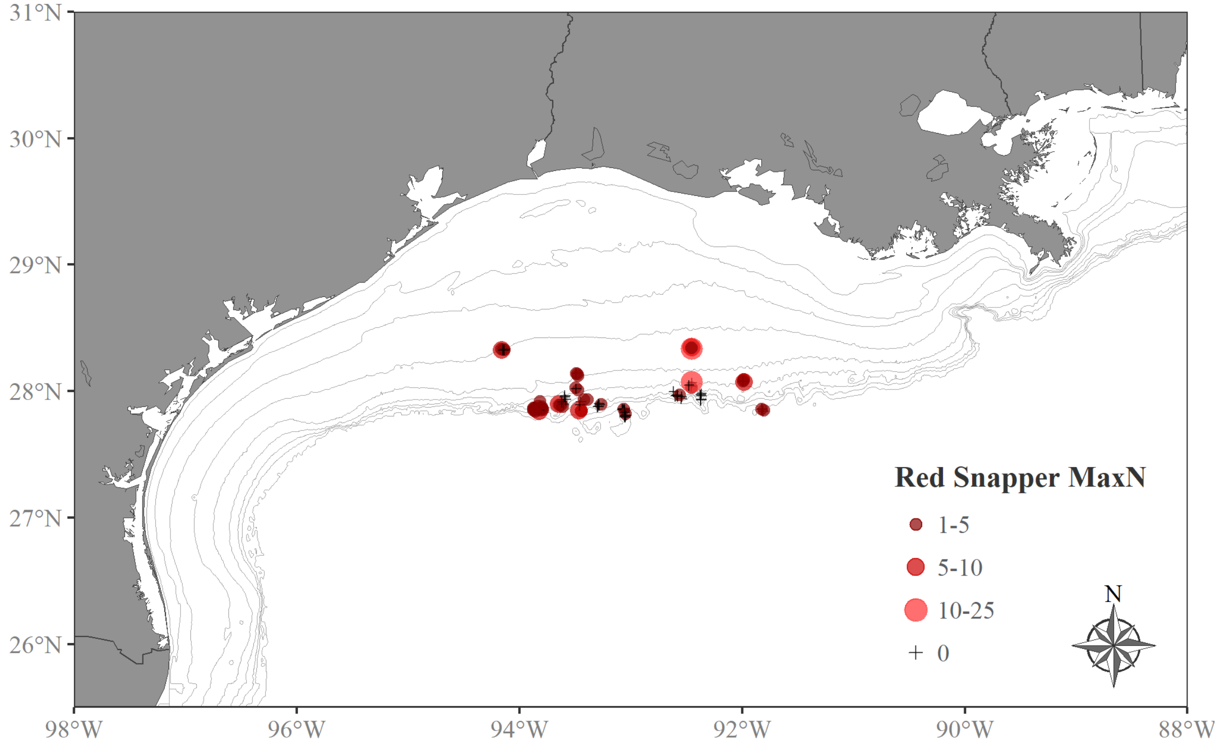


Figure 20. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2012 for the west Gulf. Contour lines represent 10-200 m bathymetry.

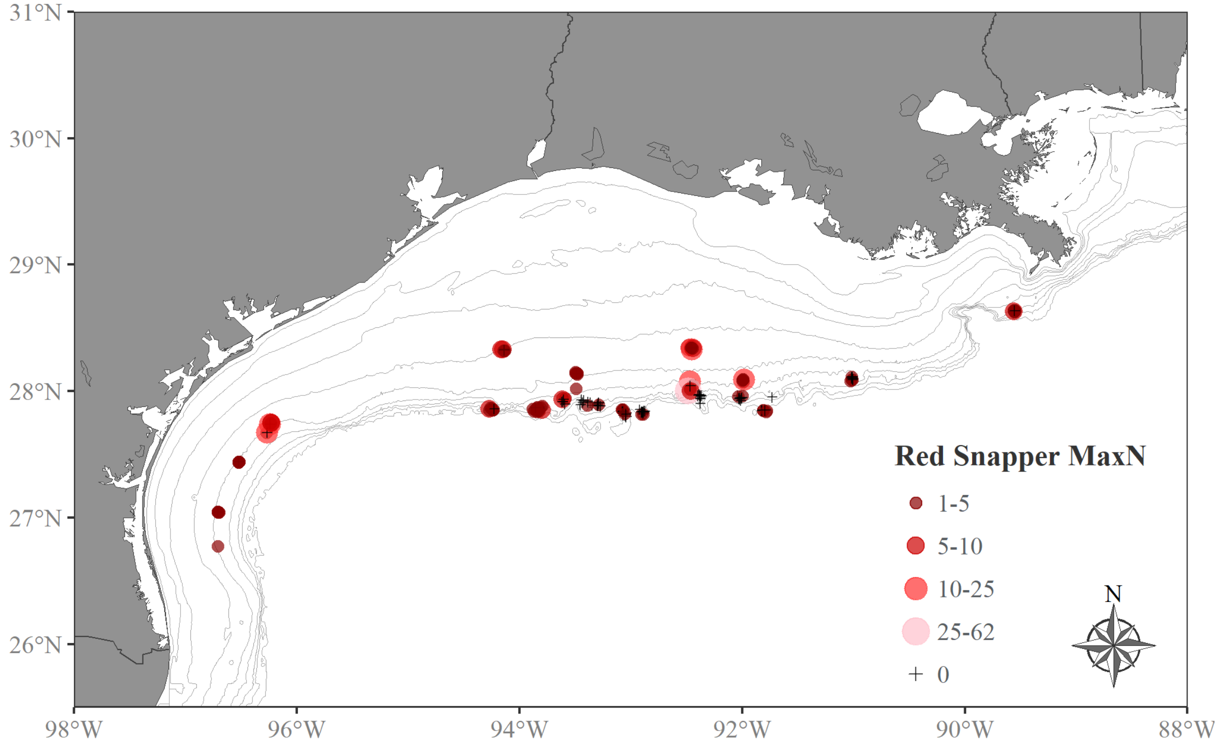


Figure 21. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2013 for the west Gulf. Contour lines represent 10-200 m bathymetry.

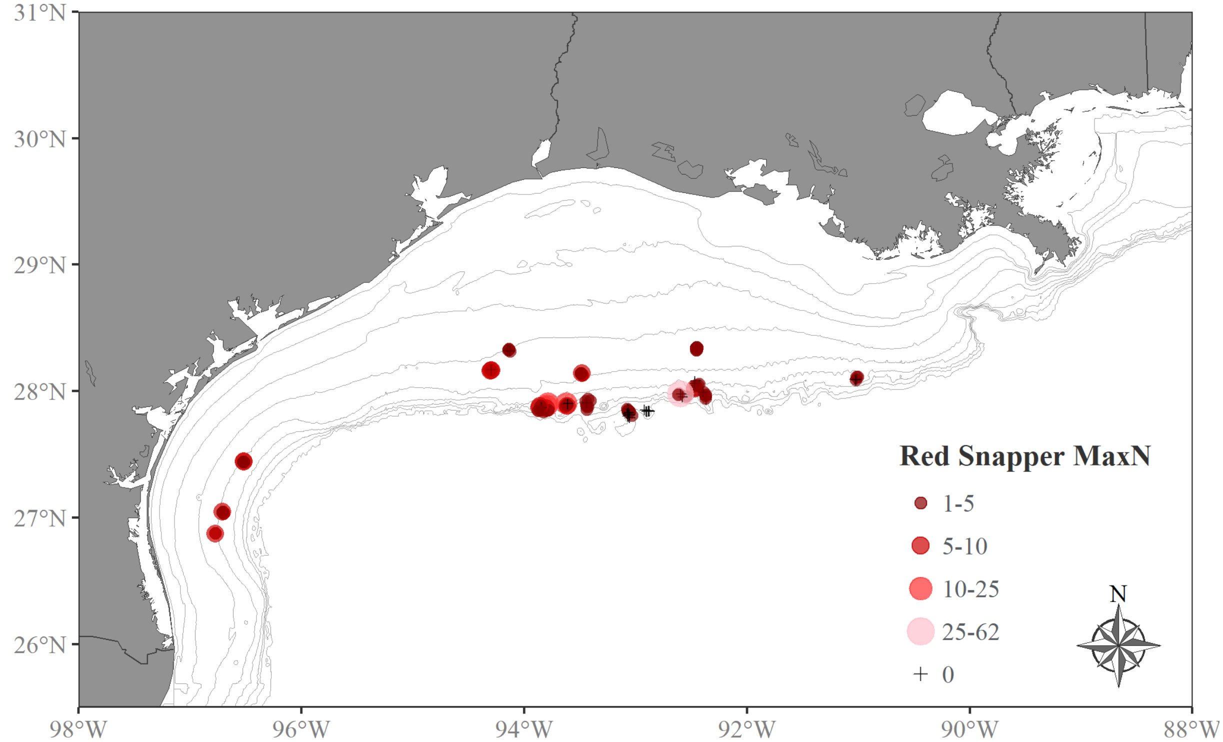


Figure 22. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2014 for the west Gulf. Contour lines represent 10-200 m bathymetry.

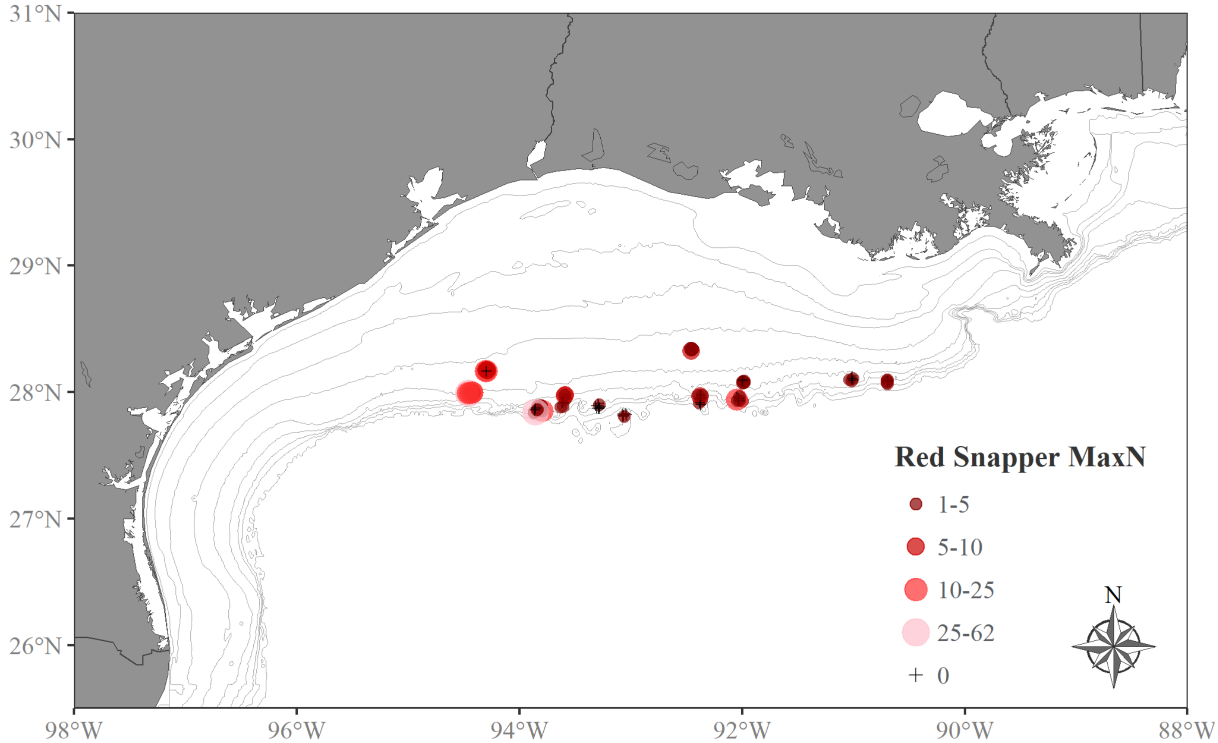


Figure 23. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2015 for the west Gulf. Contour lines represent 10-200 m bathymetry.

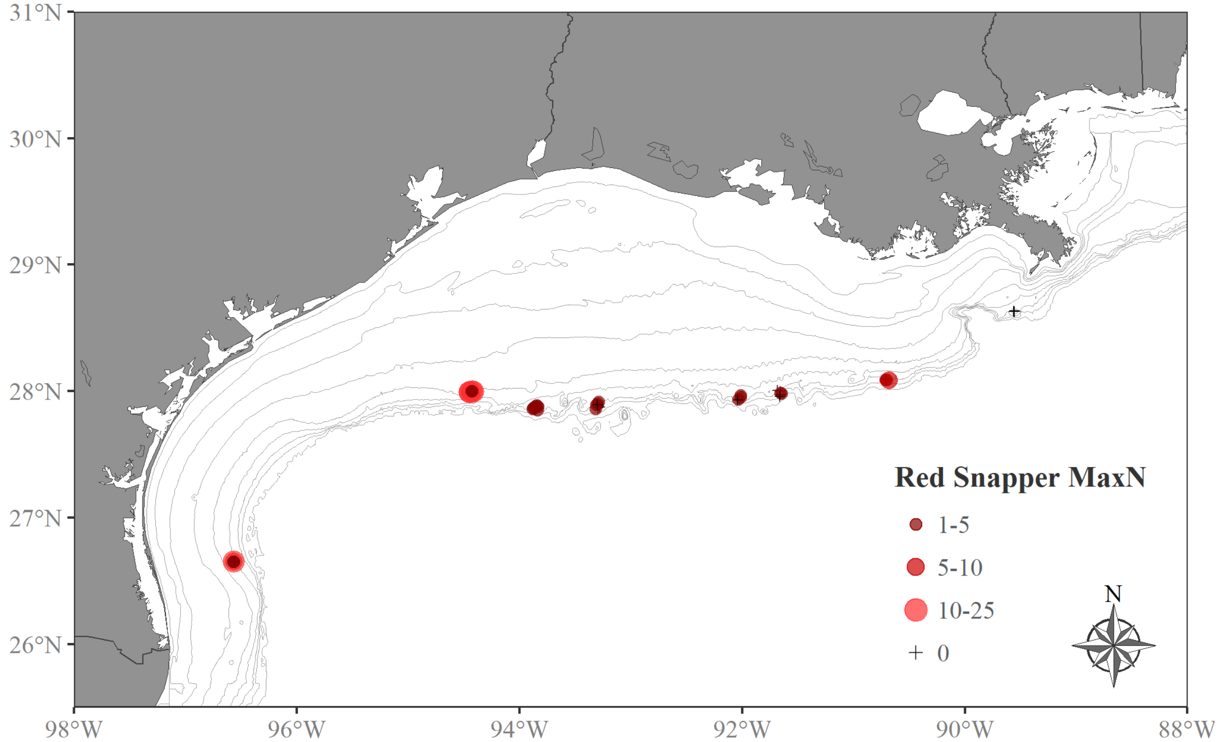


Figure 24. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2016 for the west Gulf. Contour lines represent 10-200 m bathymetry.

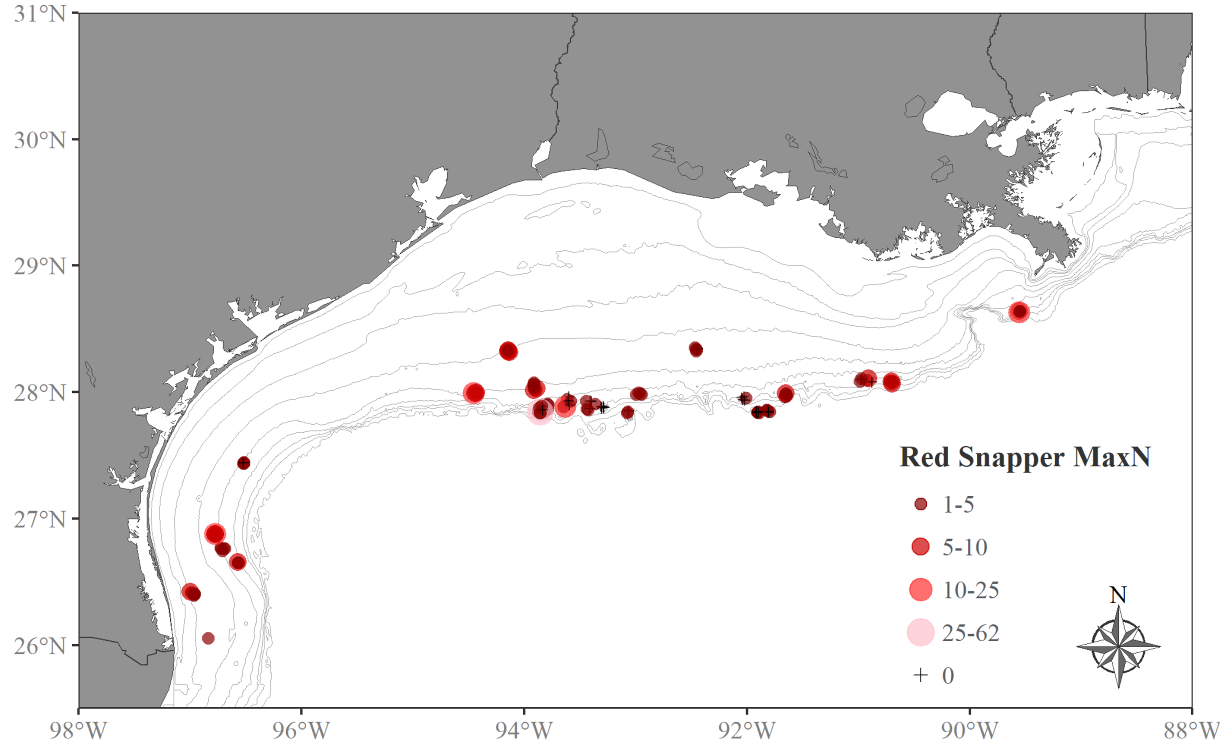


Figure 25. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2017 for the west Gulf. Contour lines represent 10-200 m bathymetry.

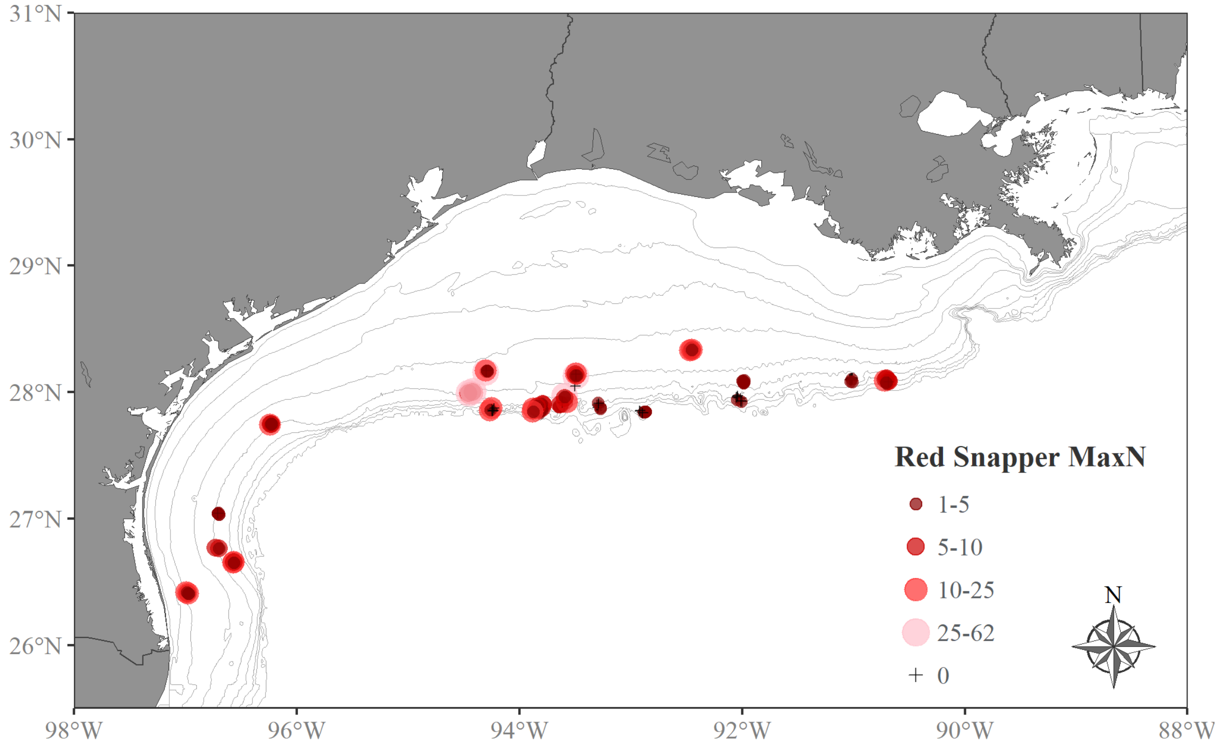


Figure 26. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2018 for the west Gulf. Contour lines represent 10-200 m bathymetry.

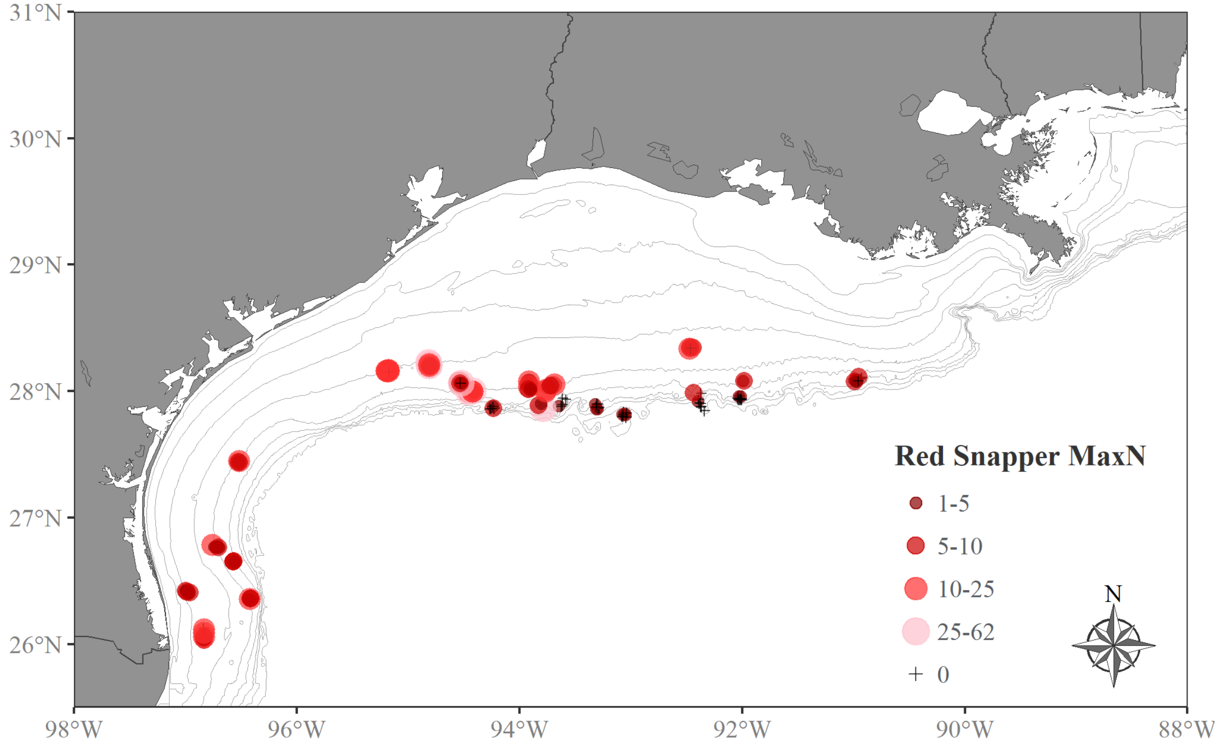


Figure 27. Map of Red Snapper mincounts during the SEAMAP reef fish video survey in 2019 for the west Gulf. Contour lines represent 10-200 m bathymetry.

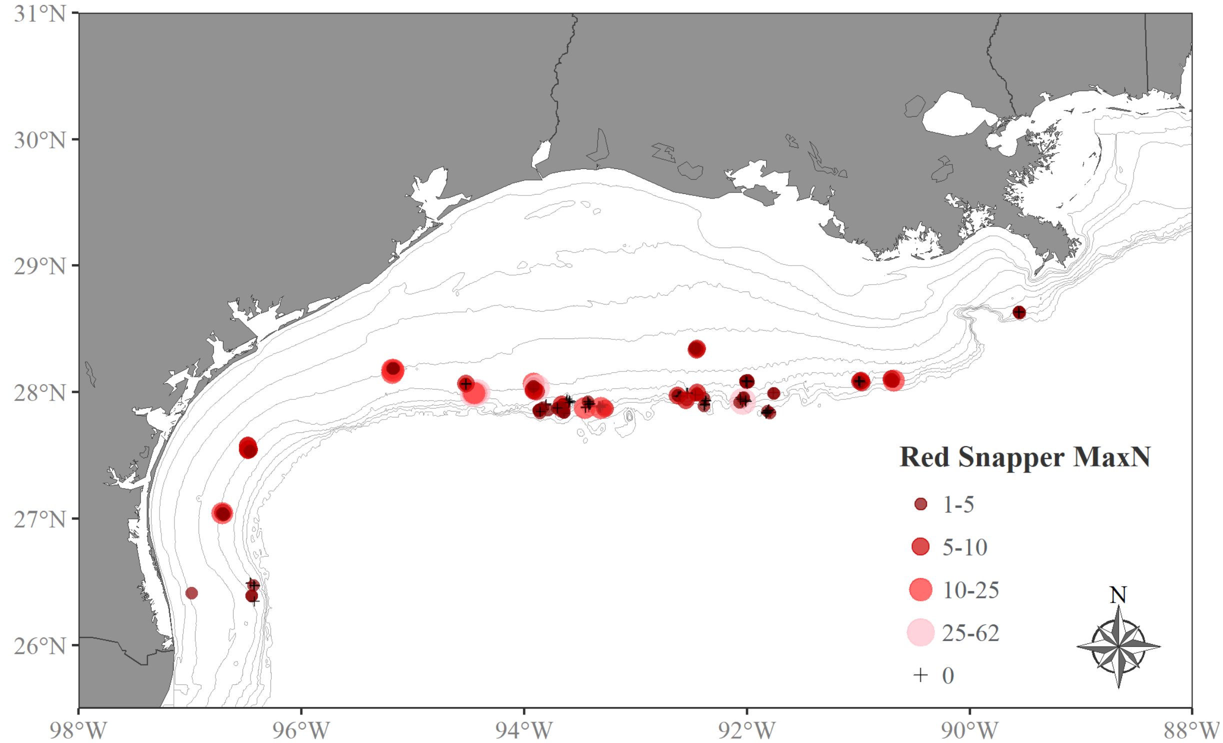


Figure 28. Map of Red Snapper mincounts during the G-FISHER video survey in 2021 for the west Gulf. Contour lines represent 10-200 m bathymetry.

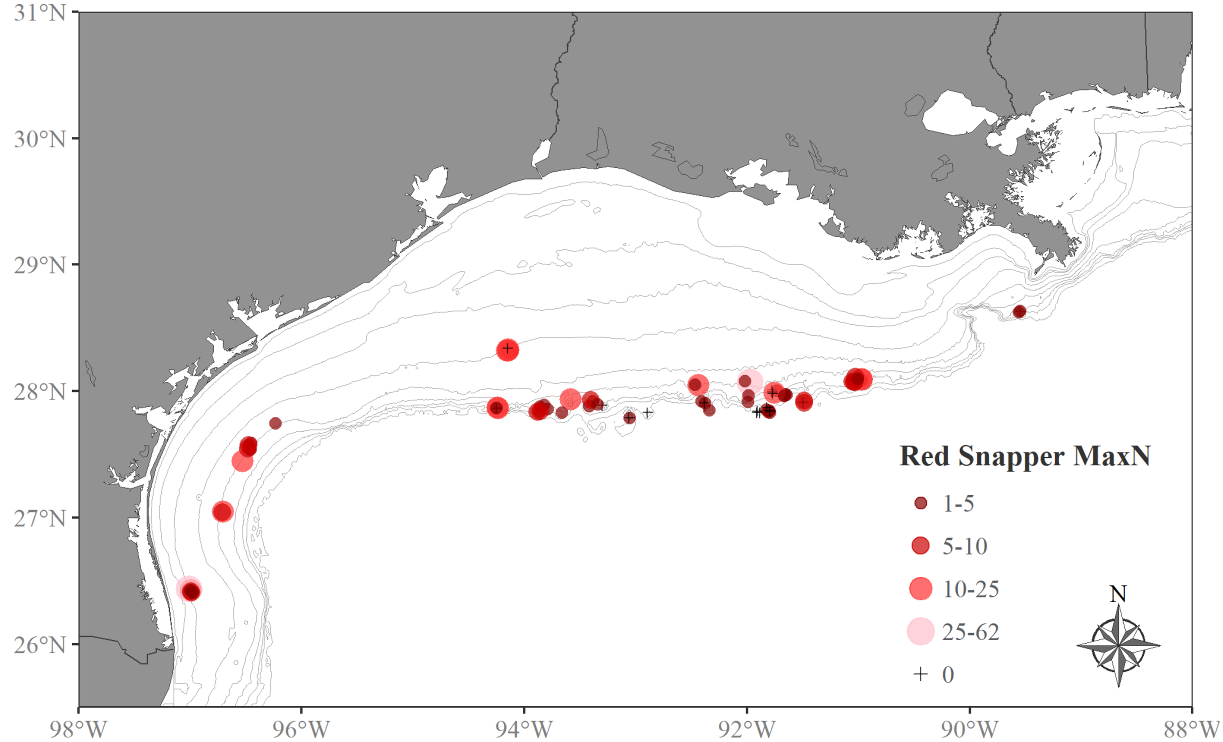


Figure 29. Map of Red Snapper mincounts during the G-FISHER video survey in 2022 for the west Gulf. Contour lines represent 10-200 m bathymetry.

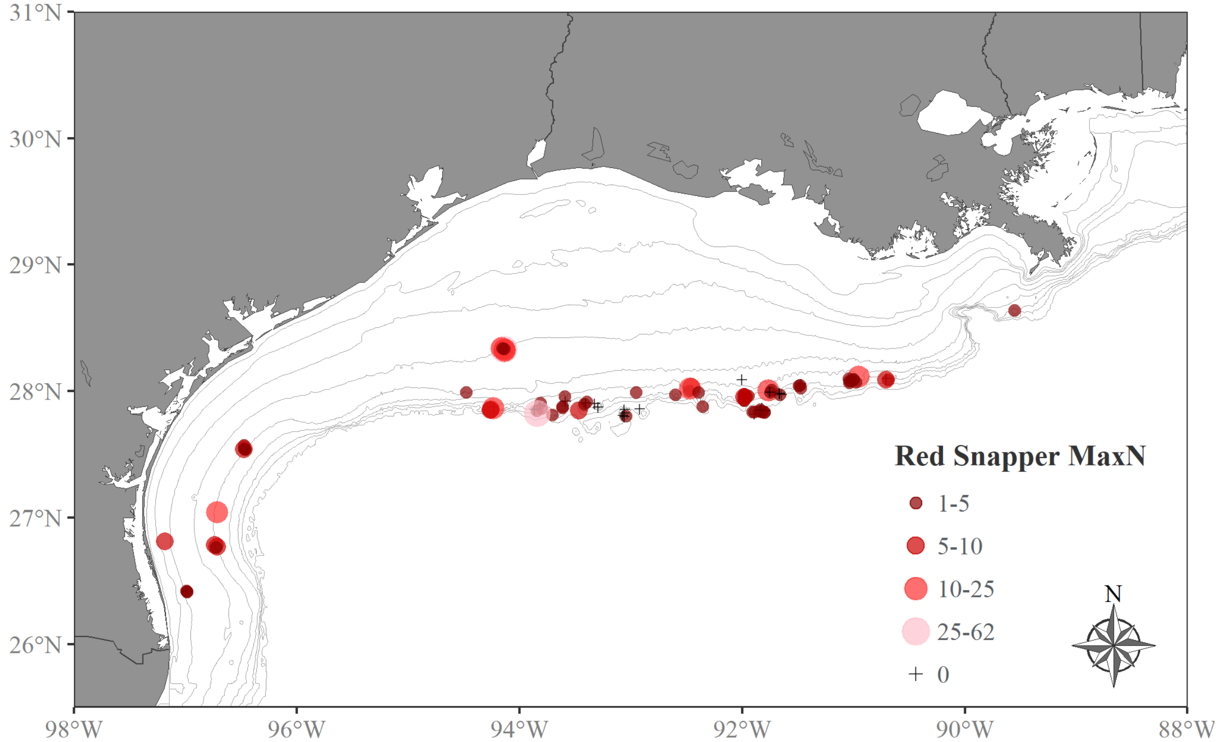
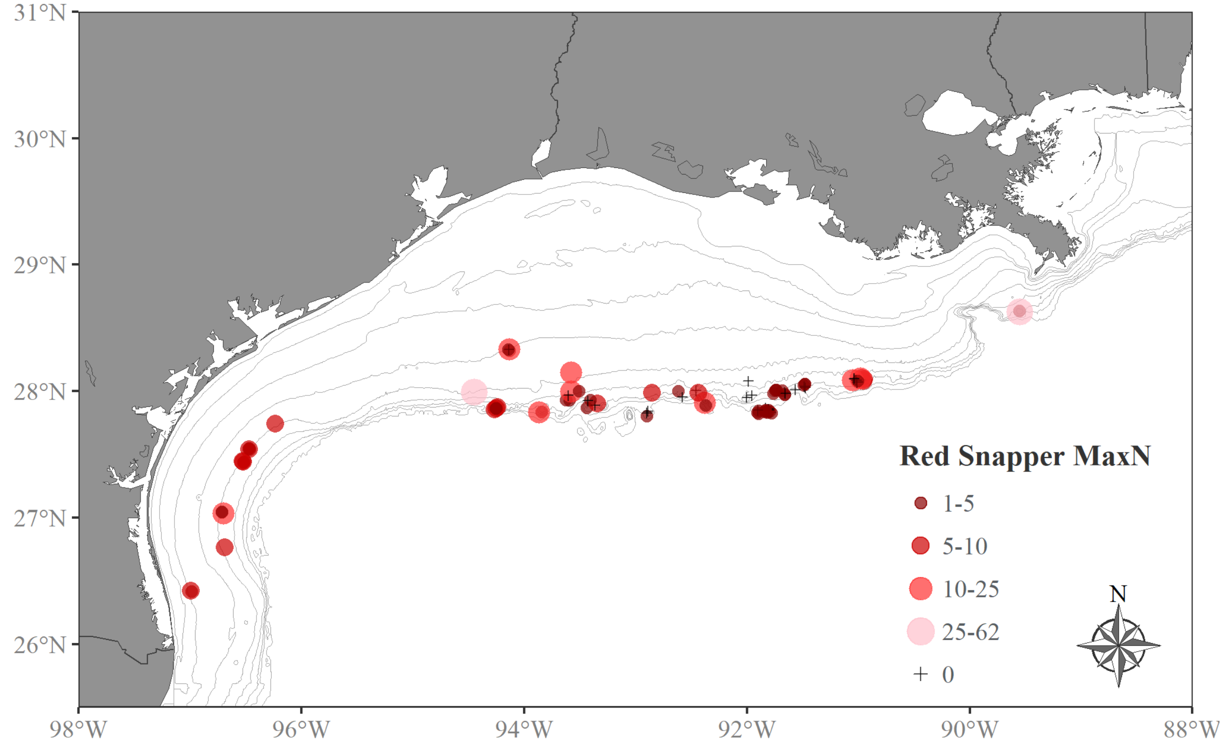
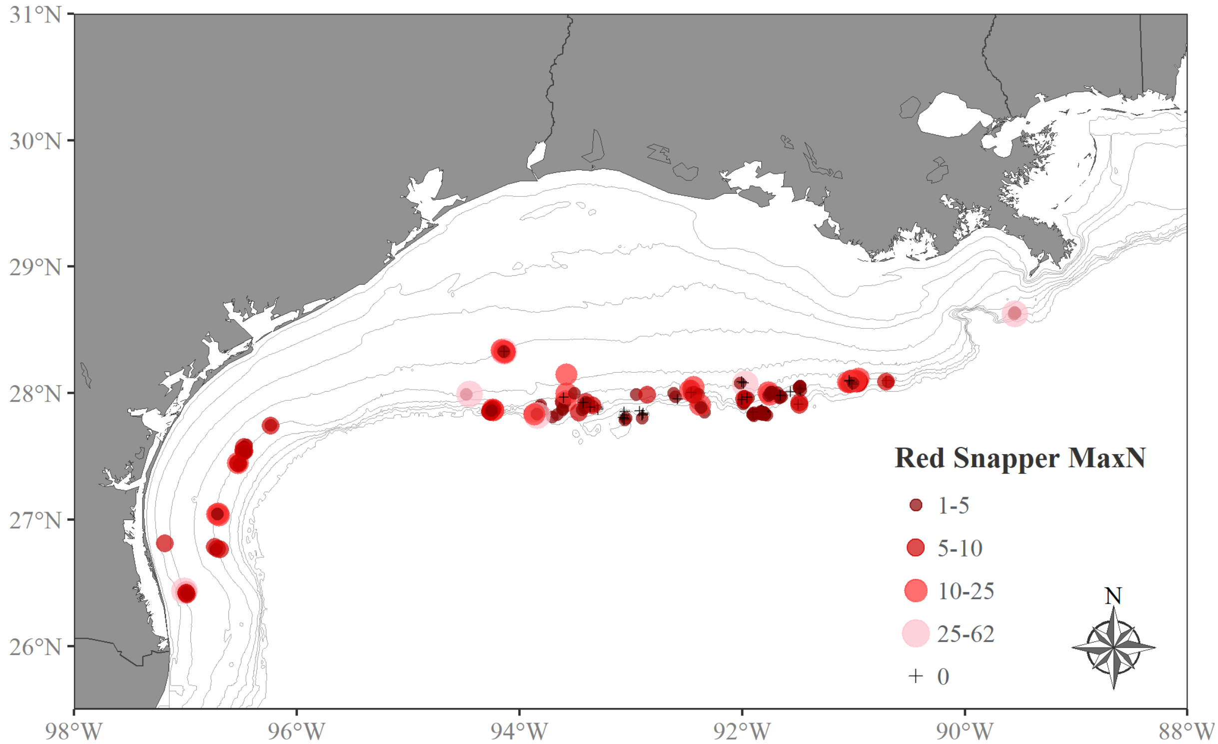


Figure 30. Map of Red Snapper mincounts during the G-FISHER video survey in 2023 for the west Gulf. Contour lines represent 10-200 m bathymetry.





31°N
30°N
29°N
28°N
27°N
26°N
98°W
96°W
94°W
92°W
90°W
88°W
Red Snapper MaxN
1-5
5-10
10-25
25-62
0
N

Table 5. Red Snapper lengths (FL) from the SEAMAP/GFISHER reef fish video cruise from 1993–2023 for the west Gulf.

Year	nFL	MeanFL	SDFL
1995	9	582.33	114.28
1996	104	450.74	110.97
1997	117	421.30	110.05
2002	110	526.55	127.33
2004	299	371.44	105.25
2005	203	442.63	103.60
2006	63	442.16	105.17
2007	273	443.61	134.27
2008	24	466.14	124.70
2009	23	480.31	190.74
2010	71	415.60	100.42
2011	57	450.94	125.55
2012	62	514.79	107.73
2013	96	474.08	119.36
2014	117	443.49	121.53
2015	33	404.48	85.09
2016	128	484.95	122.63
2017	138	497.75	116.30
2018	667	421.97	153.91
2019	321	417.68	149.22
2021	267	442.11	144.86
2022	210	465.61	182.94
2023	438	416.55	179.67

Figure 31. Length frequency histograms of Red Snapper observed in the west Gulf of Mexico during the SEAMAP/GFISHER reef fish video cruises from 1993-2023. Mean west Gulf FL = 437.05 mm (red line).

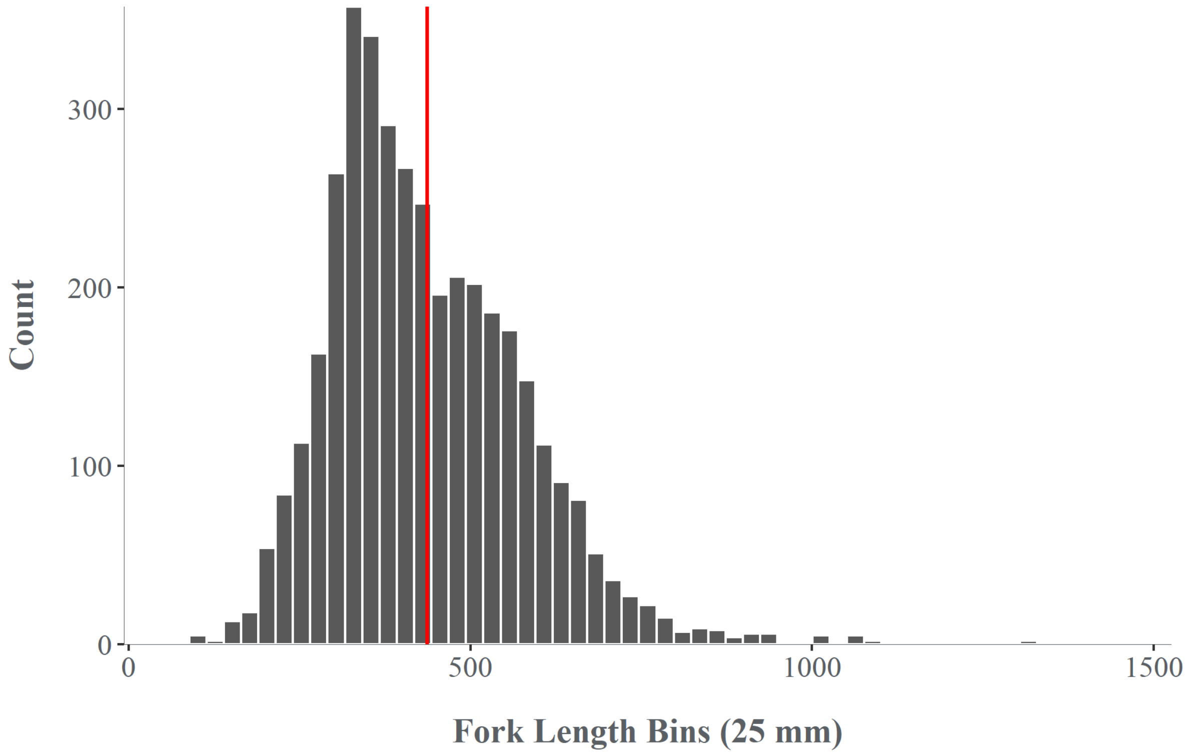


Figure 32. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 1995 for the west Gulf. Red line represents the annual mean of 582.33 mm.

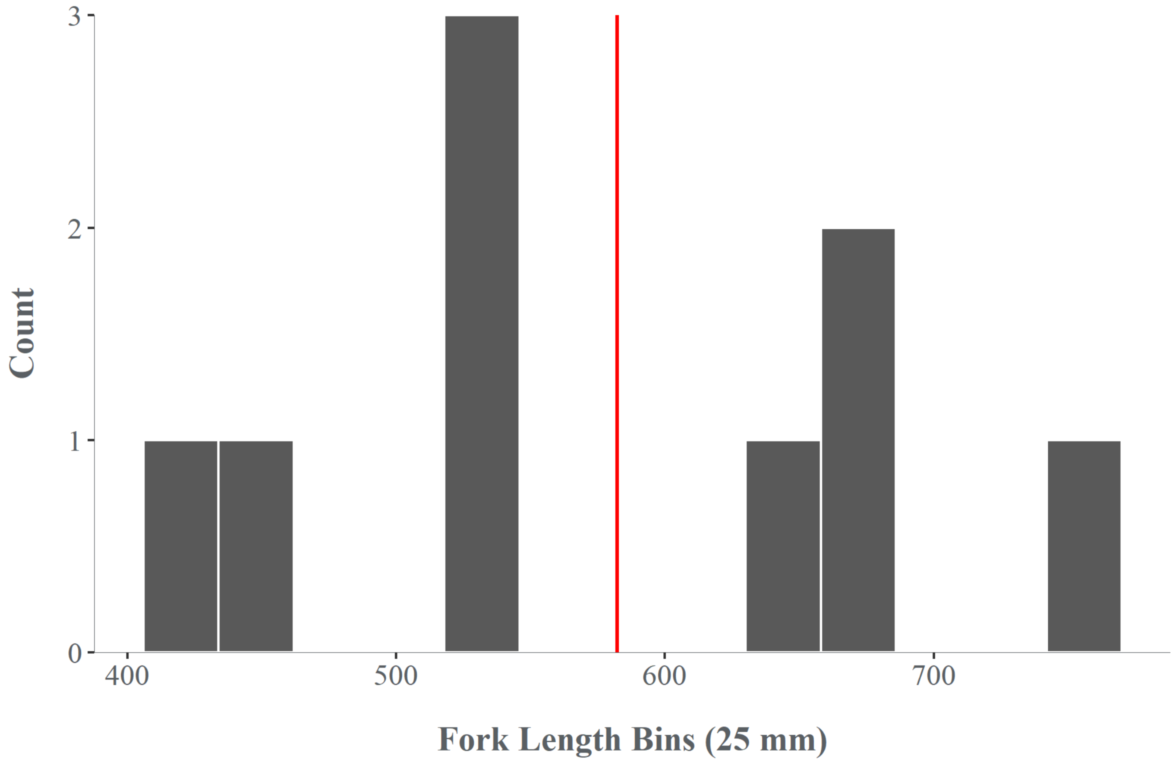


Figure 33. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 1996 for the west Gulf. Red line represents the annual mean of 450.74 mm.

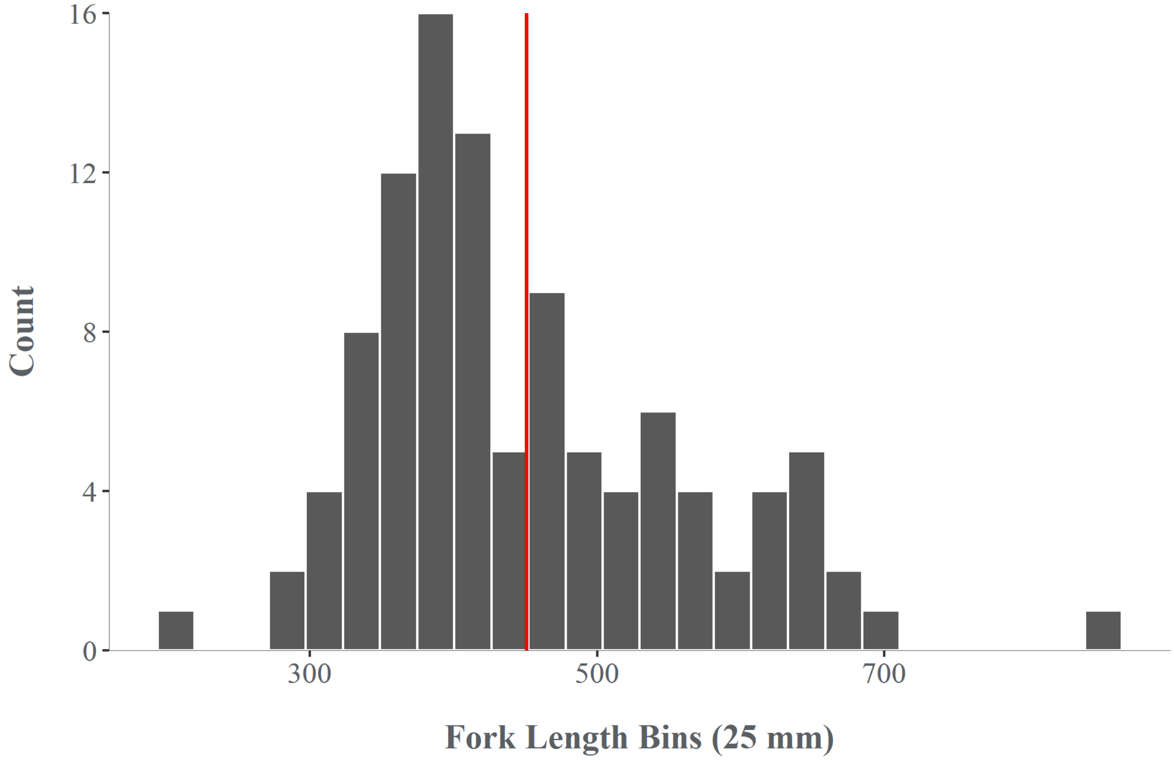


Figure 34. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 1997 for the west Gulf. Red line represents the annual mean of 421.3 mm.

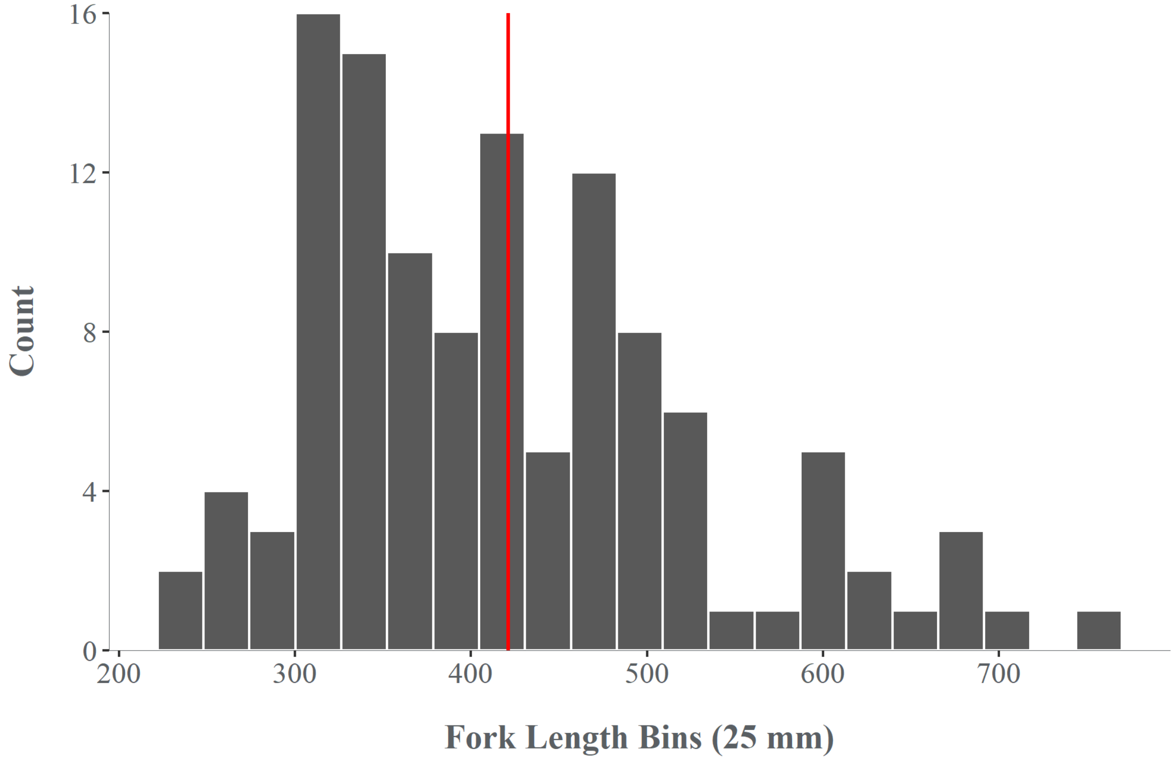


Figure 35. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2002 for the west Gulf. Red line represents the annual mean of 526.55 mm.

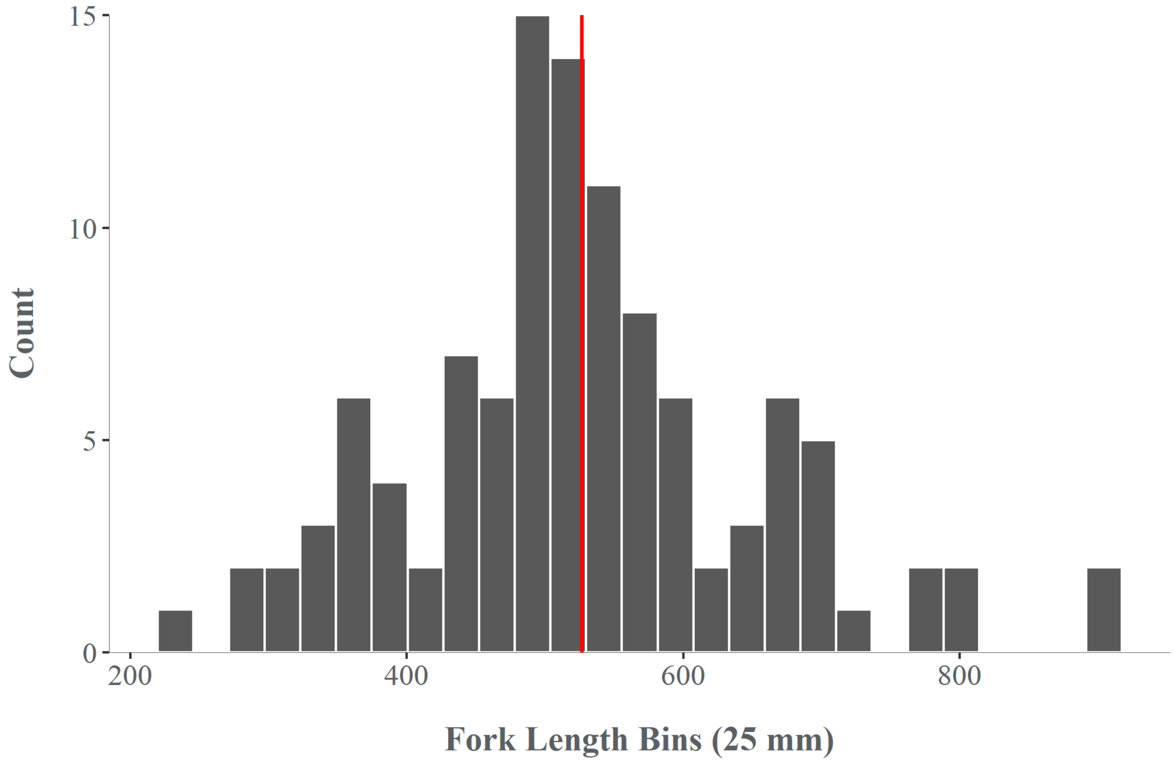


Figure 36. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2004 for the west Gulf. Red line represents the annual mean of 371.44 mm.

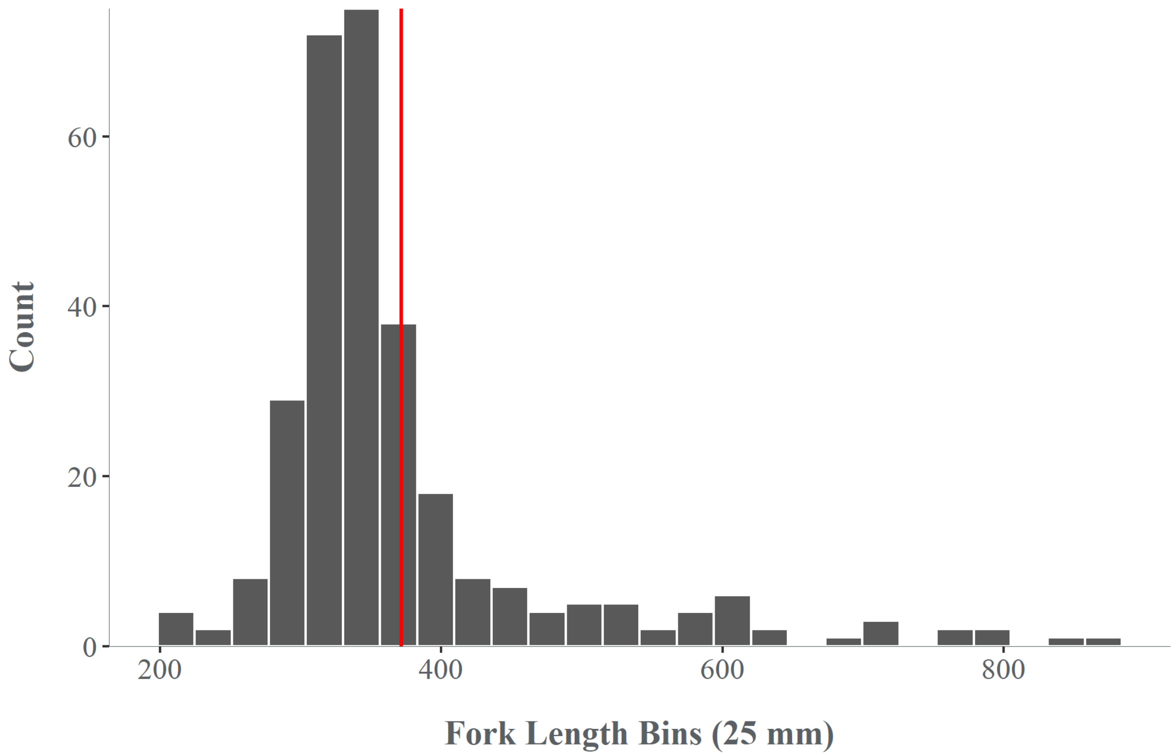


Figure 37. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2005 for the west Gulf. Red line represents the annual mean of 442.63 mm.

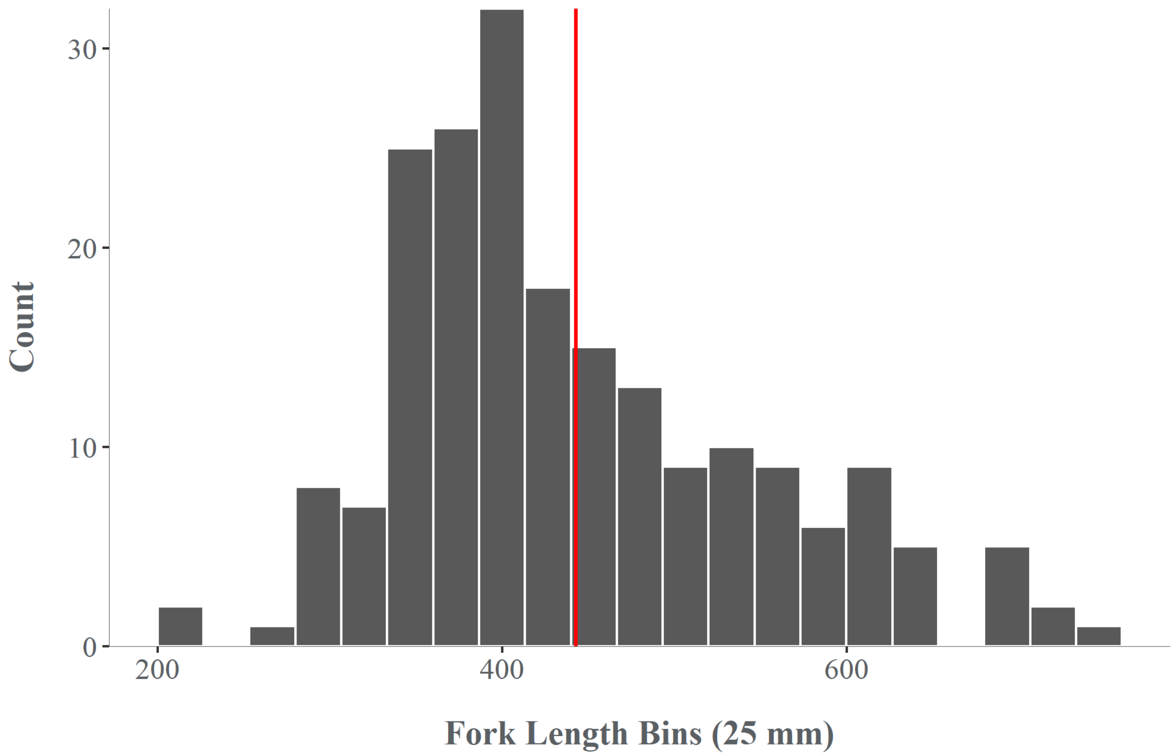


Figure 38. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2006 for the west Gulf. Red line represents the annual mean of 442.16 mm.

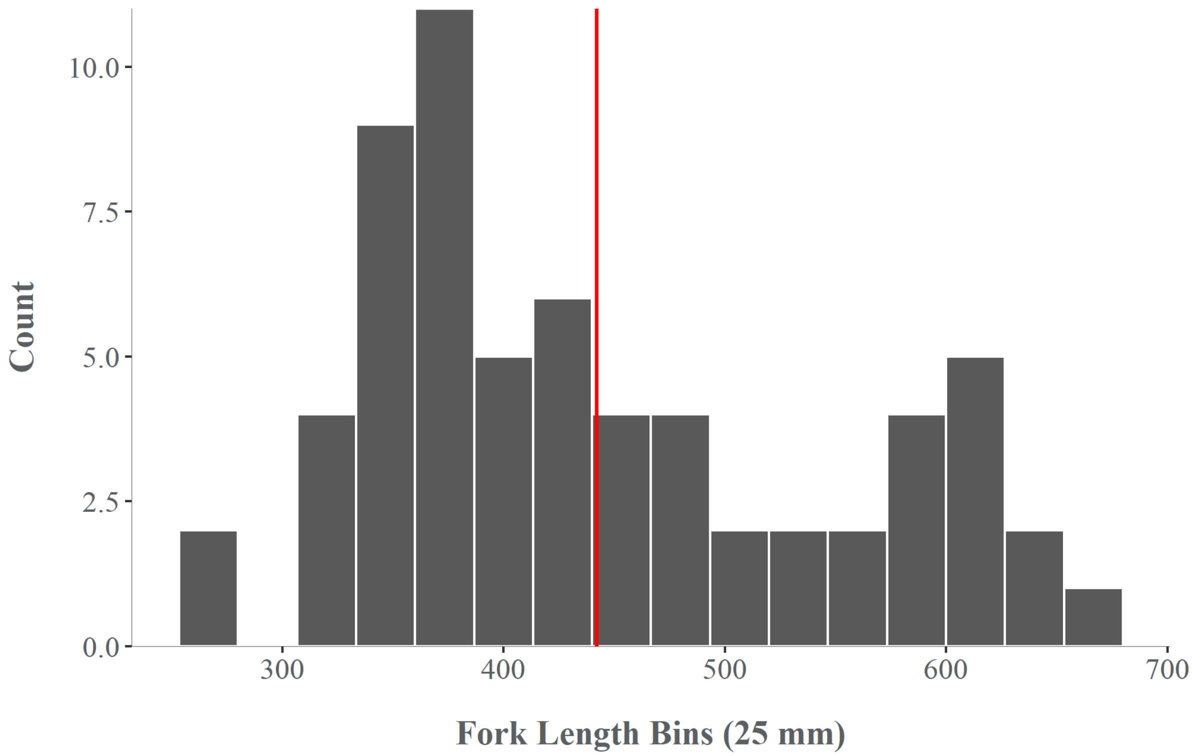


Figure 39. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2007 for the west Gulf. Red line represents the annual mean of 443.61 mm.

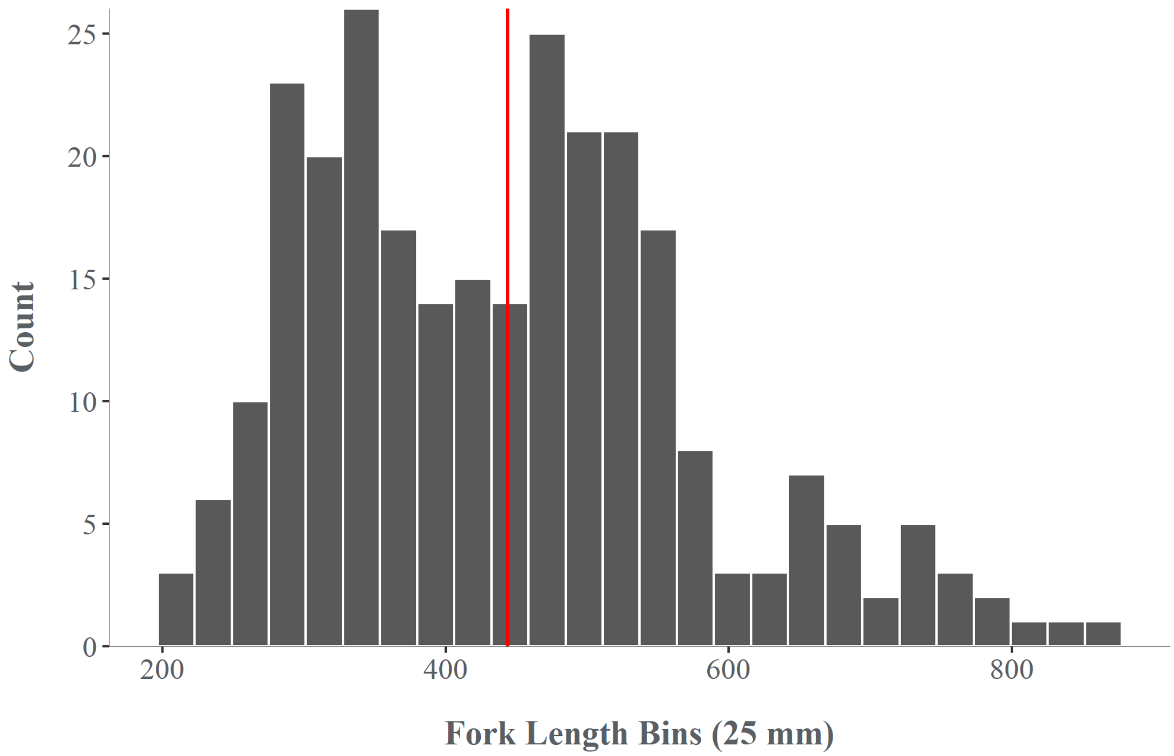


Figure 40. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2008 for the west Gulf. Red line represents the annual mean of 466.14 mm.

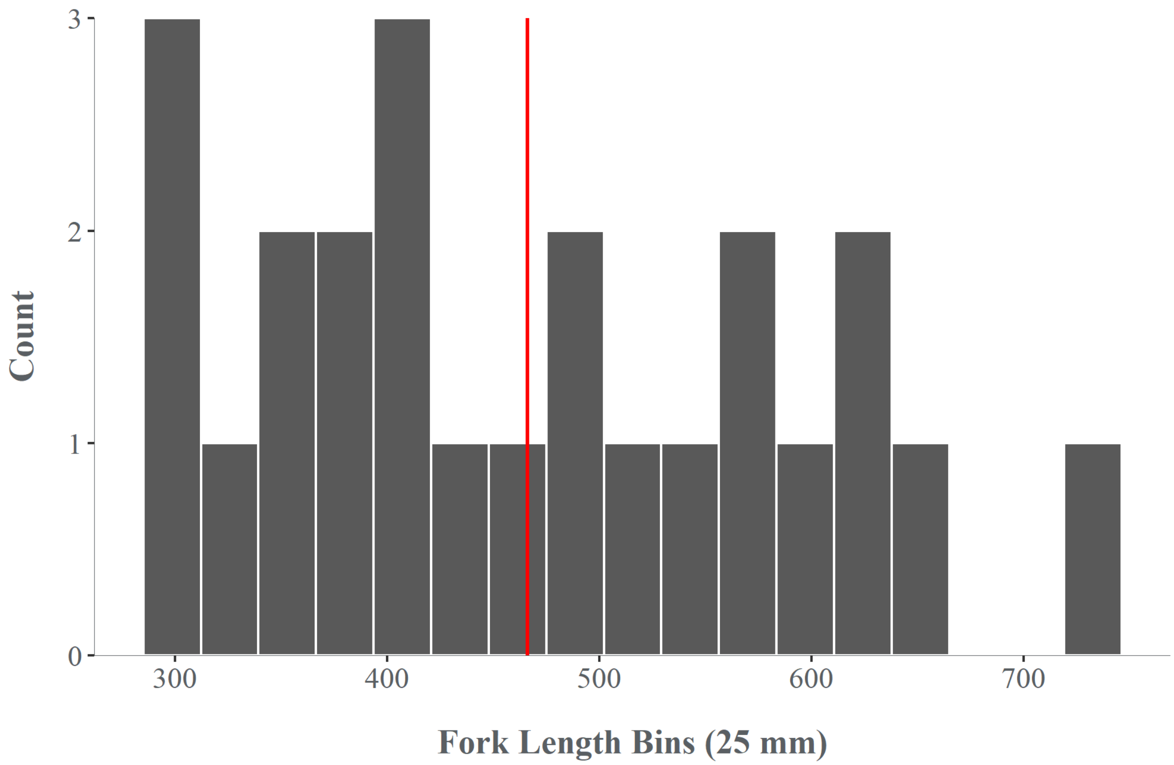


Figure 41. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2009 for the west Gulf. Red line represents the annual mean of 480.31 mm.

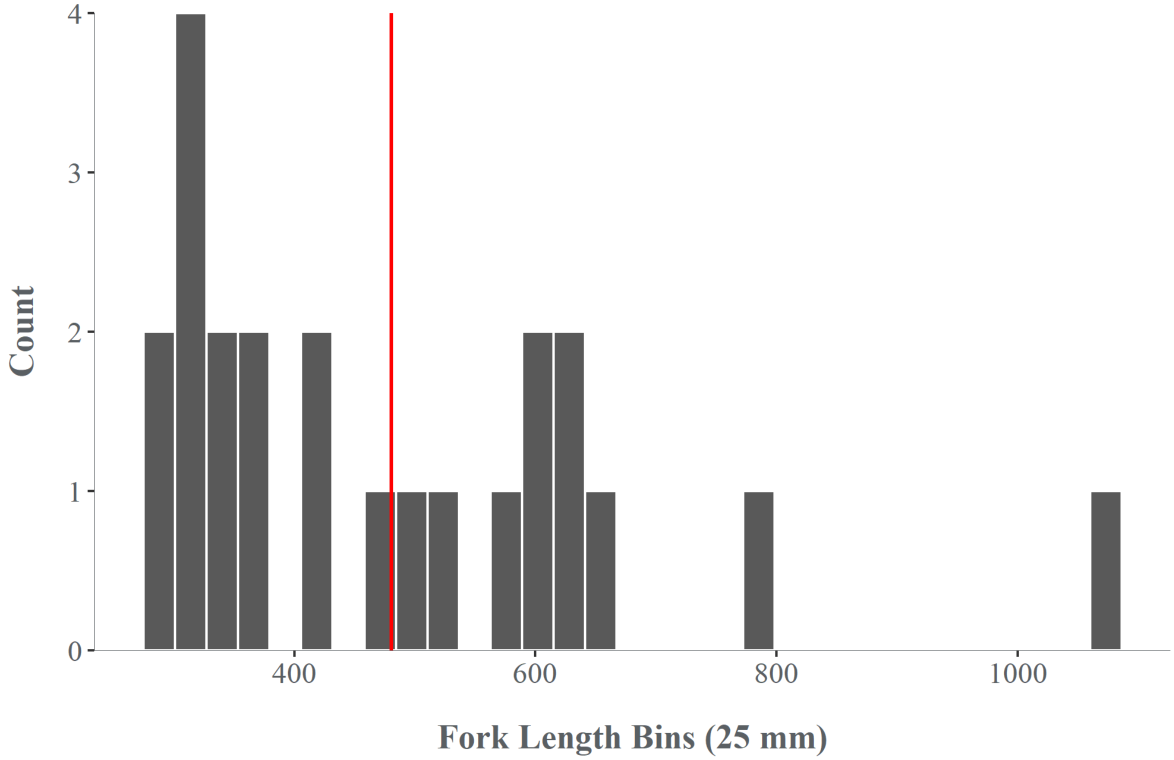


Figure 42. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2010 for the west Gulf. Red line represents the annual mean of 415.6 mm.

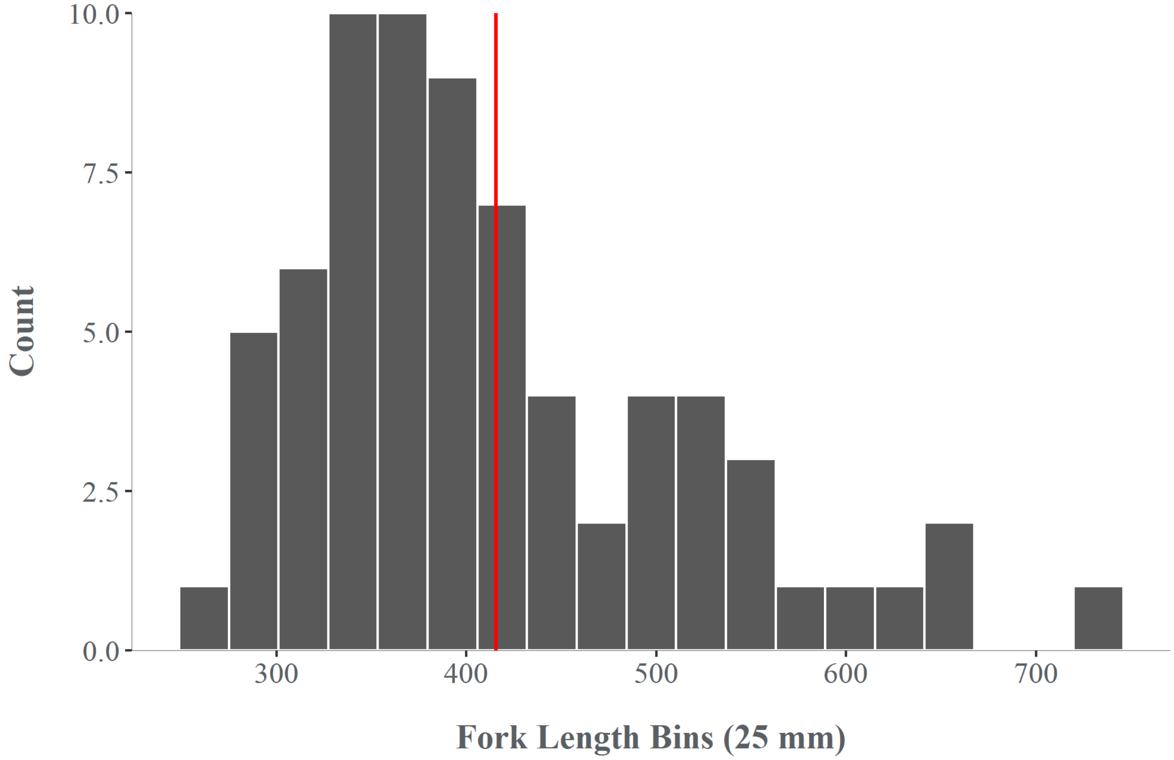


Figure 43. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2011 for the west Gulf. Red line represents the annual mean of 450.94 mm.

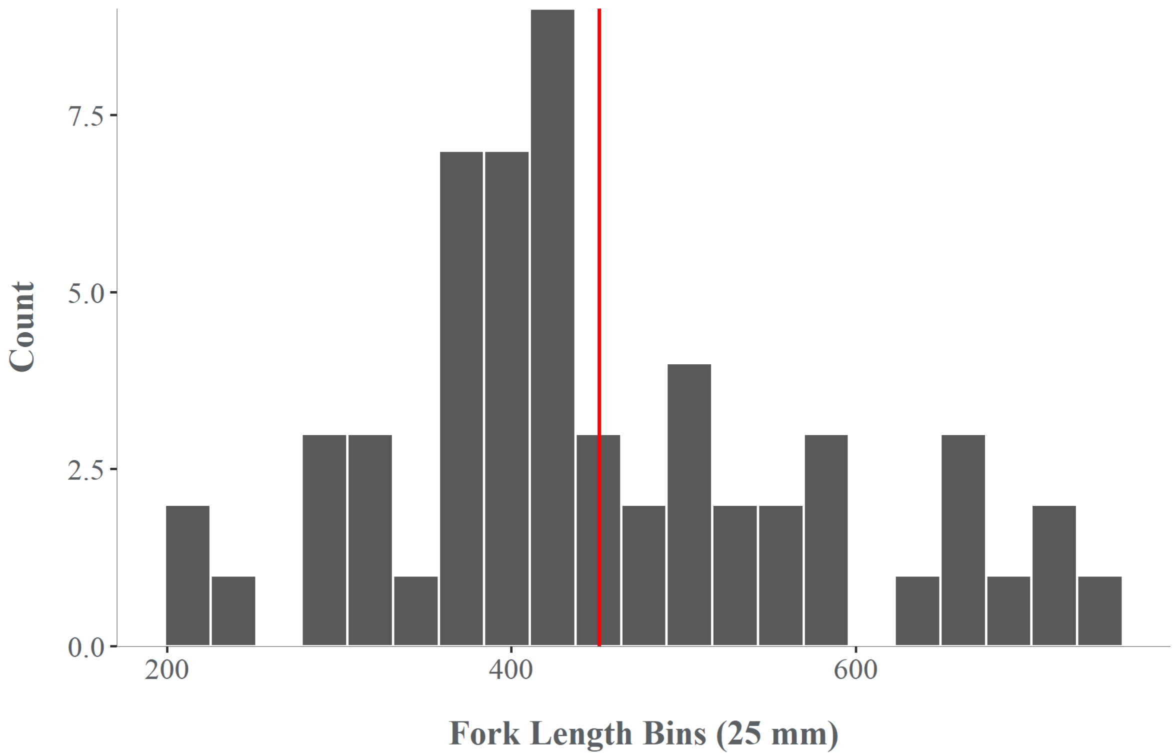


Figure 44. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2012 for the west Gulf. Red line represents the annual mean of 514.79 mm.

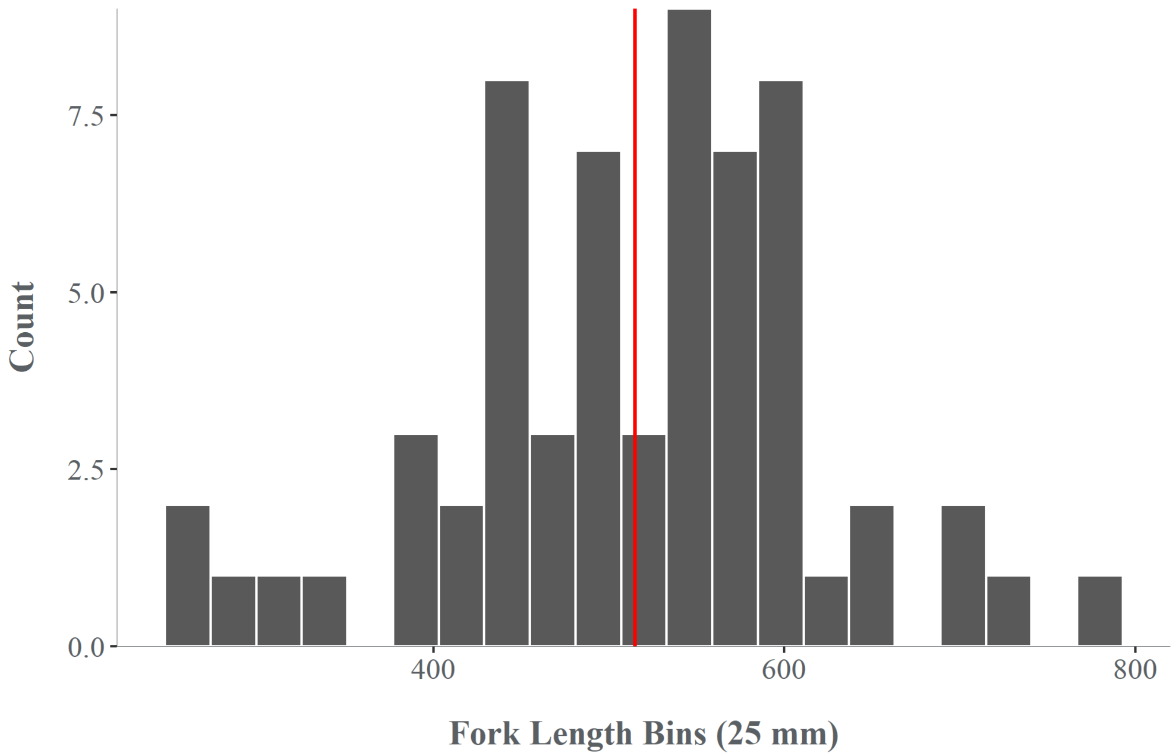


Figure 45. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2013 for the west Gulf. Red line represents the annual mean of 474.08 mm.

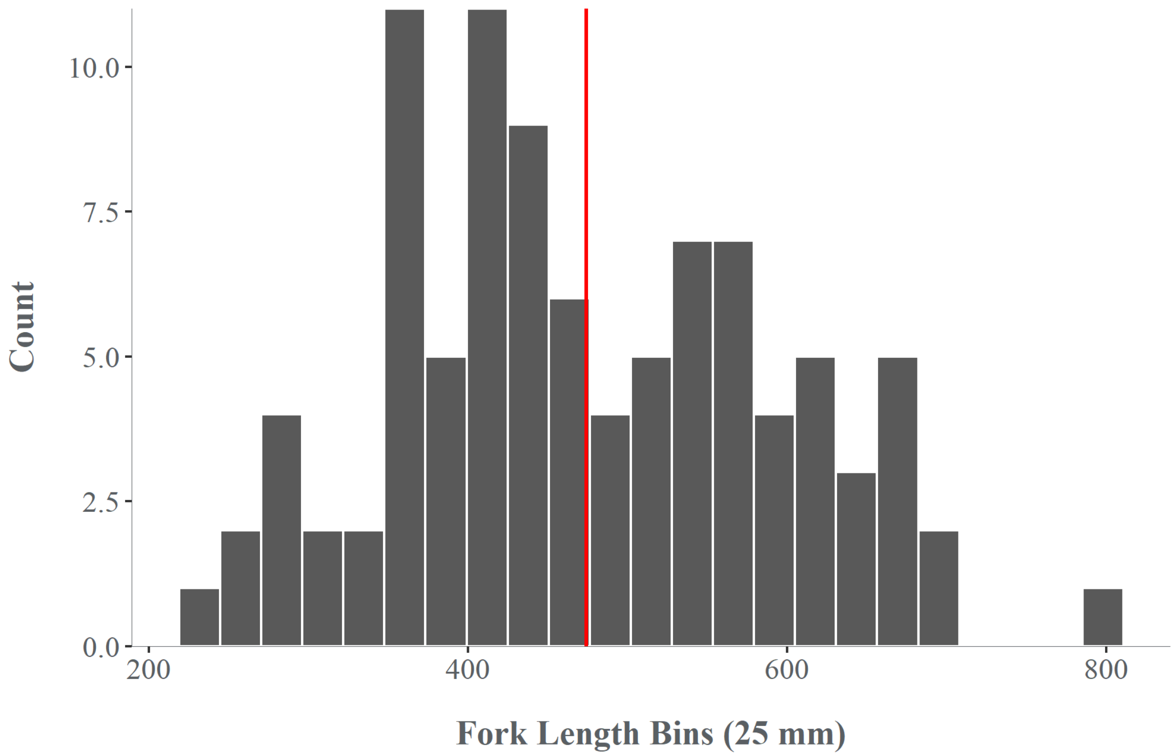


Figure 46. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2014 for the west Gulf. Red line represents the annual mean of 443.49 mm.

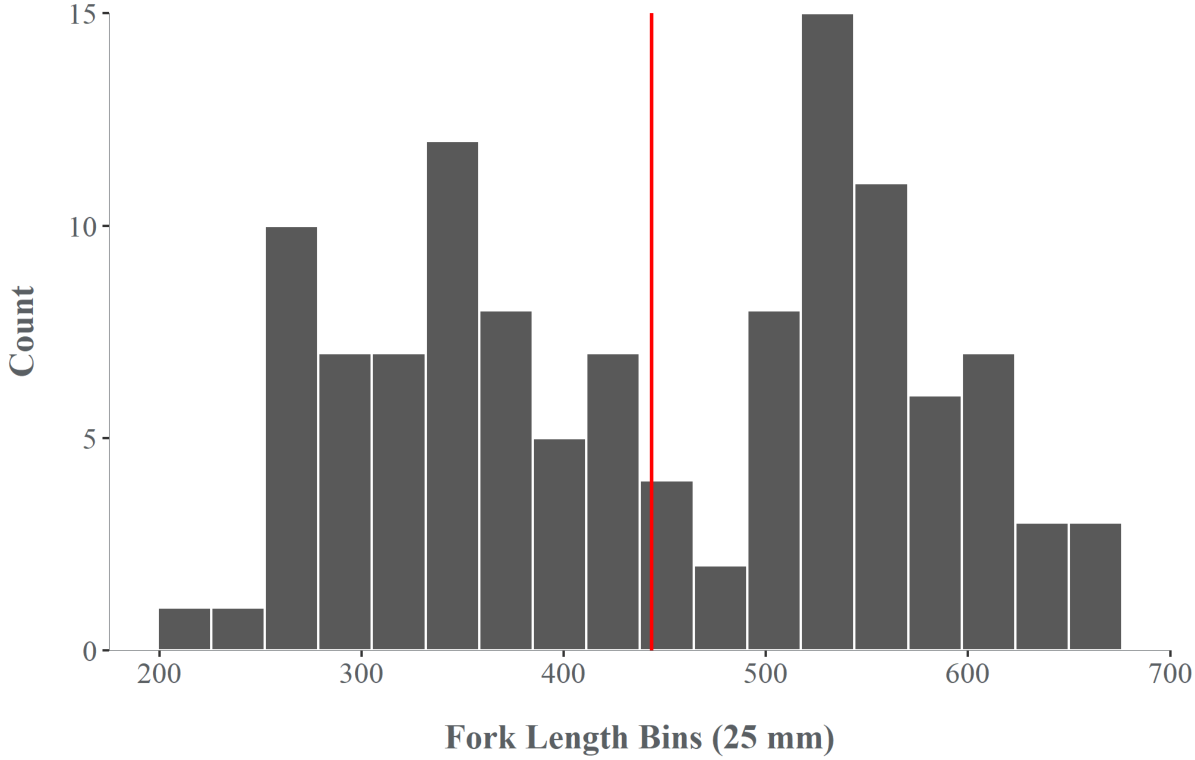


Figure 47. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2015 for the west Gulf. Red line represents the annual mean of 404.48 mm.

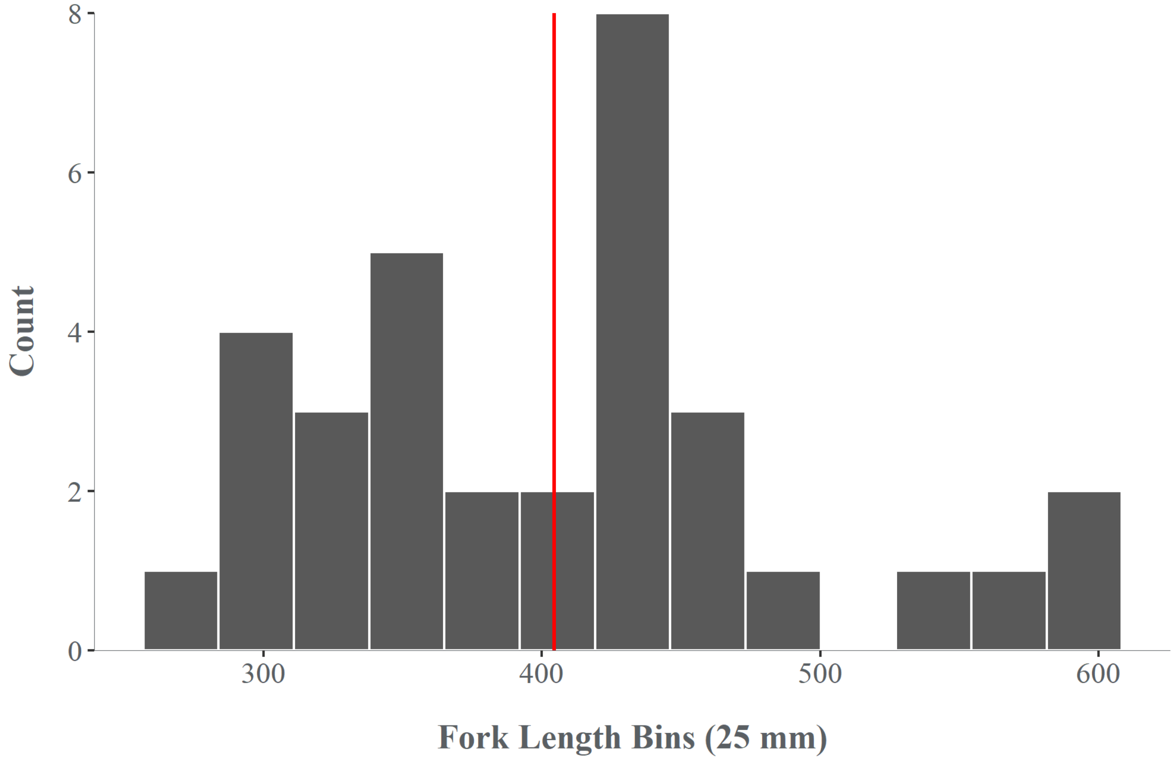


Figure 48. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2016 for the west Gulf. Red line represents the annual mean of 484.95 mm.

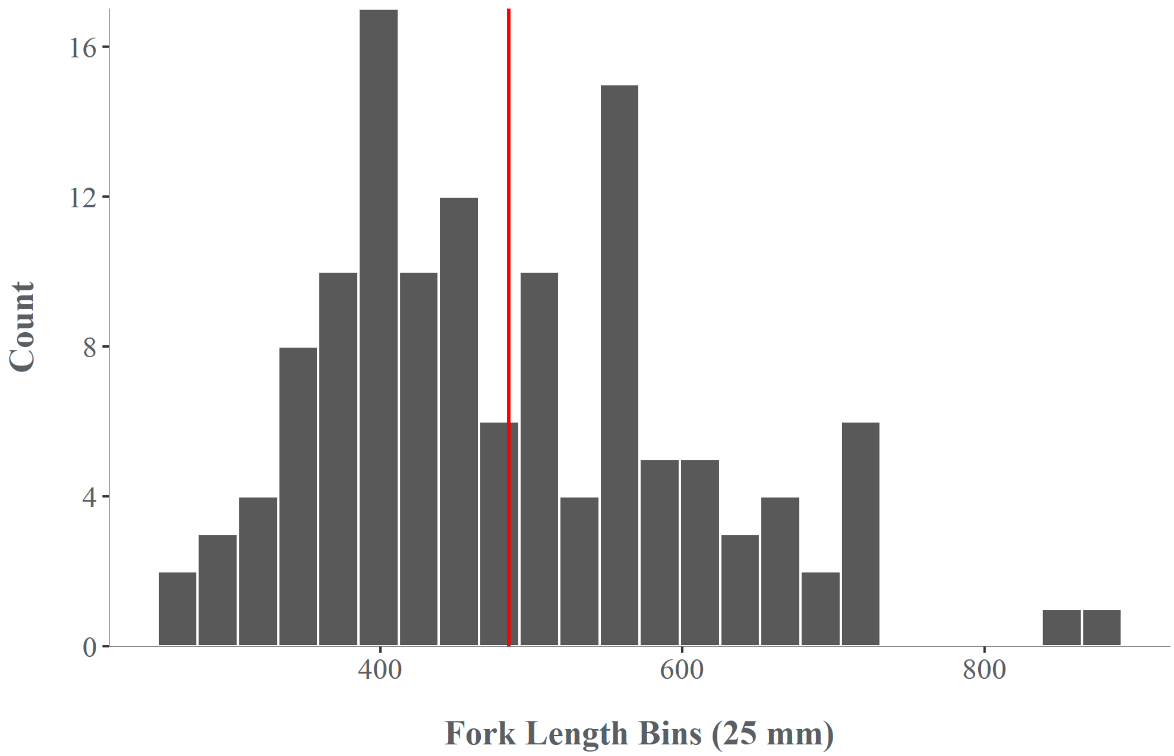


Figure 49. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2017 for the west Gulf. Red line represents the annual mean of 497.75 mm.

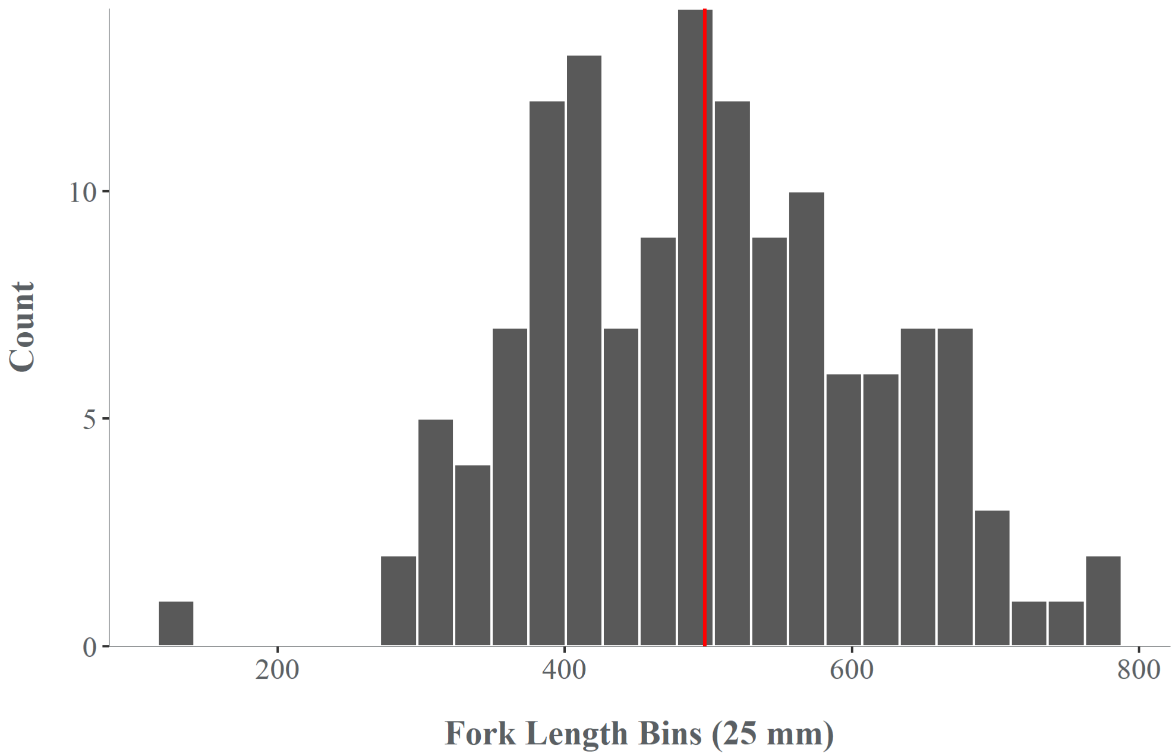


Figure 50. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2018 for the west Gulf. Red line represents the annual mean of 421.97 mm.

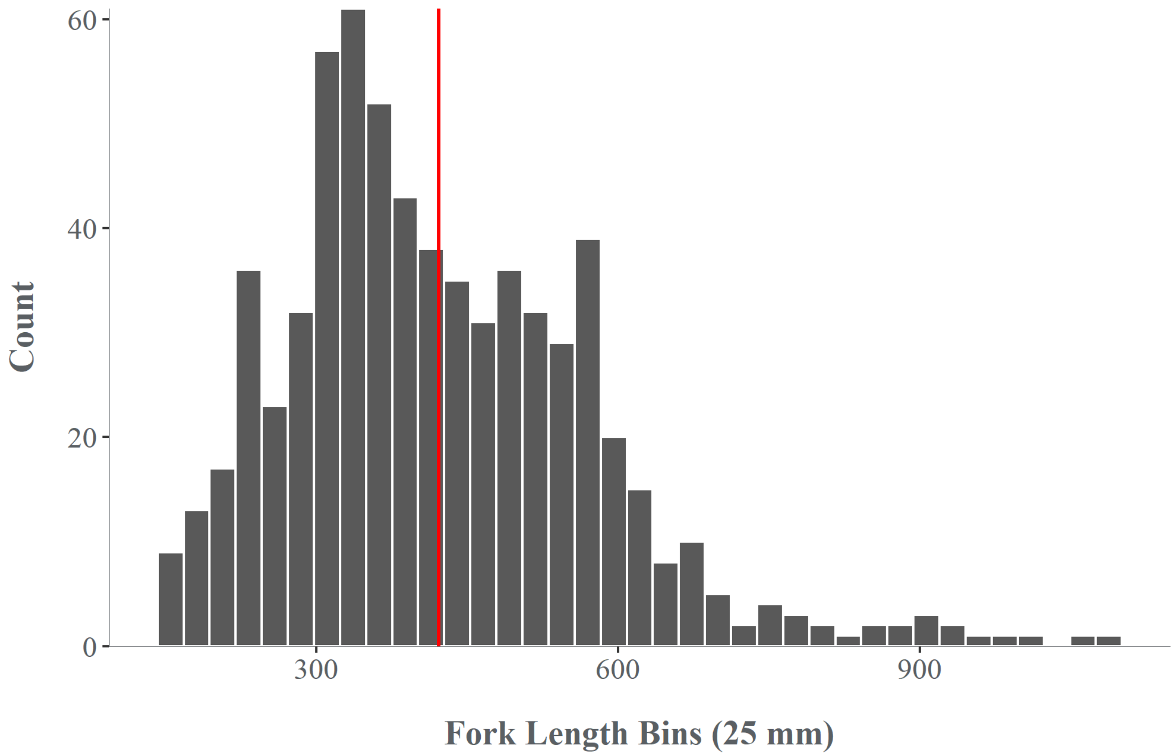


Figure 51. Annual Red Snapper length composition for the SEAMAP reef fish video survey in 2019 for the west Gulf. Red line represents the annual mean of 417.68 mm.

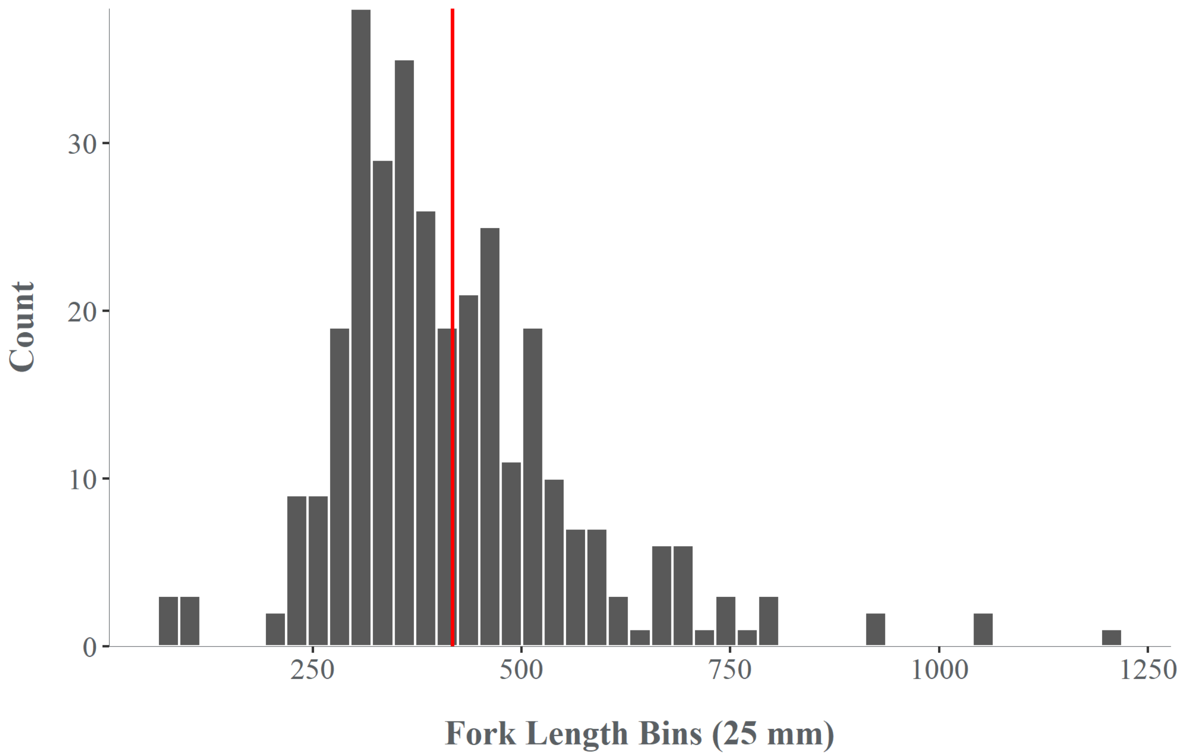


Figure 52. Annual Red Snapper length composition for the G-FISHER video survey in 2021 for the west Gulf. Red line represents the annual mean of 442.11 mm.

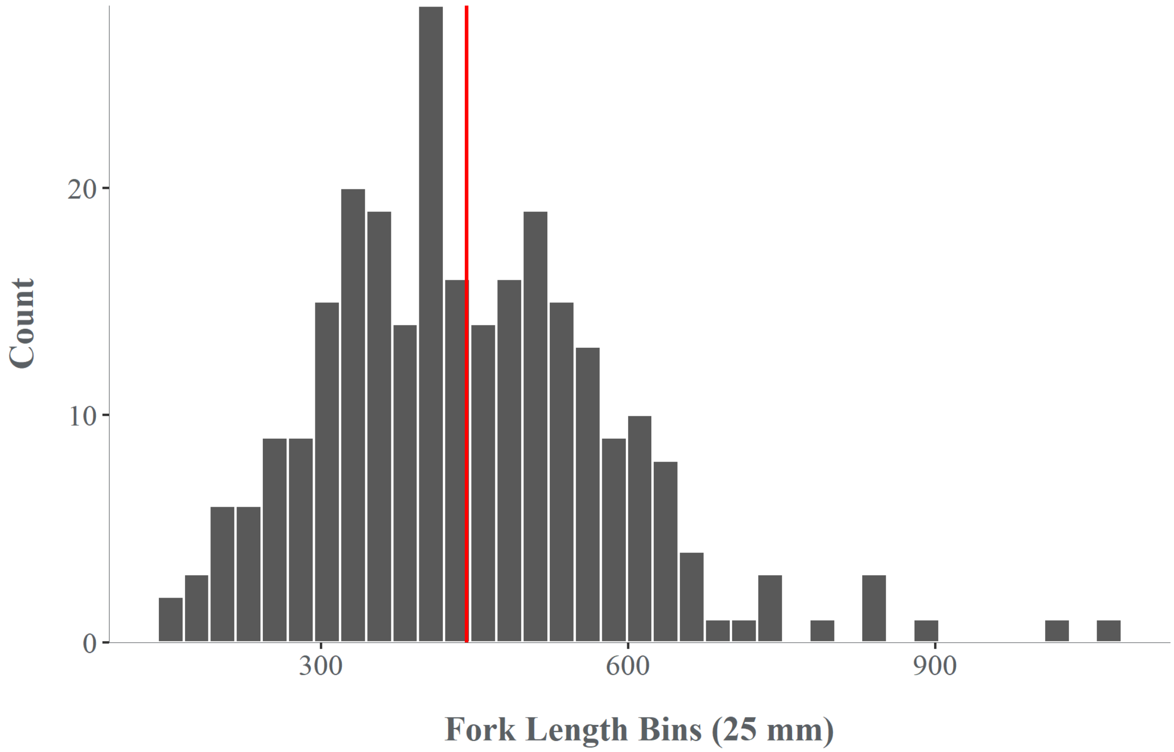


Figure 53. Annual Red Snapper length composition for the G-FISHER video survey in 2022 for the west Gulf. Red line represents the annual mean of 465.61 mm.

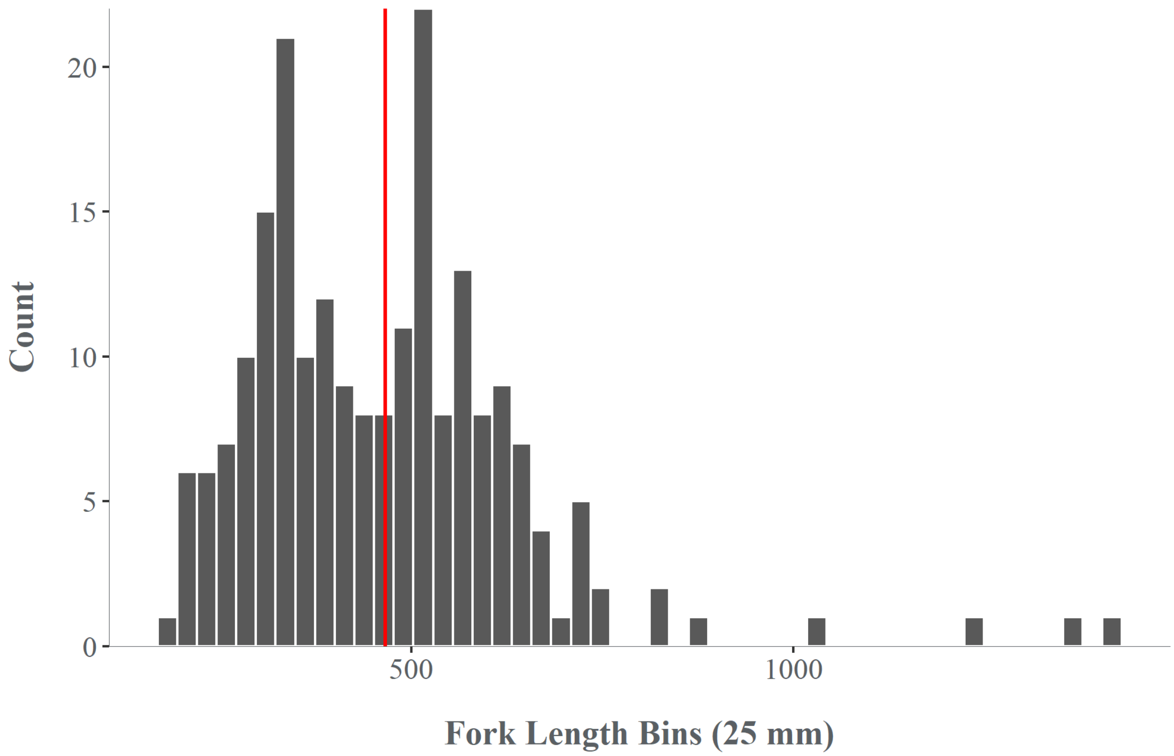


Figure 54. Annual Red Snapper length composition for the G-FISHER video survey in 2023 for the west Gulf. Red line represents the annual mean of 416.55 mm.