Index of Abundance for Pre-Fishery Recruit Red Snapper from Florida Headboat Observer Data

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Type of Index: Fishery-dependent

Fishery: Recreational hook-and-line fishing on head boats

Geographic Region: Sampled vessels operated from northwest Florida to the central west coast of Florida (Figure 1).

Time Period Covered: 2005 through 2007 and June 2009 to present.

Data Collection Methods: Head boats in each of two regions (Figure 1) were randomly selected each week throughout the year for observer coverage. All head boats operating in the two regions voluntarily permitted observers on scheduled trips. Single day trips took place in nearshore and offshore fishing areas (Figure 1) and ranged from 4 to 15 hours in duration. Multi-day trips were sampled as a separate strata in the central west coast region, and these trips were greater than 24 hours in duration and took place farther offshore (Figure 1). One to two observers were scheduled per sampled trip and each observer selected a set of 5 to 10 anglers that they could visually observe. For more detailed methods, see SEDAR 31 working paper submitted by Sauls and Cermak.

Variables Recorded: For each trip sampled, the following variables were collected consistently throughout the time-series:

- Day, month and year
- Region (northwest Florida, central west Florida)
- Trip type (single-day, multi-day)
- Trip duration
- Minimum and maximum depths fished
- Area fished the majority of time (state territorial seas, federal EEZ)
- Number of anglers on board
- Number of anglers observed

For each fish caught by an observed angler, the following variables were collected consistently throughout the time series:

- Species
- Disposition (harvested, released alive, released dead)
- Length (in mm) at the midline was recorded before fish were released or harvested, as time permitted, for all managed species. Red snapper were given high priority, and almost all red snapper were measured before they were released.

Size Composition of Red Snapper:

Figure 2 shows length frequencies for all red snapper observed during June and July by year for 1 cm length bins. Total length in mm was calculated as: 1.89 + 1.06* fork length in mm, and converted to cm. Length frequencies for sublegal sizes (pre-fishery recruits) are included in bins for 40cm (39.5-40.4 cm) and lower. The months of June and July were consistently open to harvest each year during the time series. Other months were excluded since the duration of the harvest season varied each year (Table 1), which could influence length frequencies for observed fish if vessels target legal sized fish during the harvest season and/or avoid red snapper by-catch during the non-harvest season.

Data Exclusions:

Head boat vessel operators throughout the Gulf of Mexico have been required by NMFS to report harvested red snapper on logbook trip reports since the 1980's. The logbook time-series covers a larger geographic region that overlaps temporally and spatially with this data source. Therefore, harvested fish are excluded from this analysis, but could be included if the NMFS logbook is not used as an index for SEDAR 31. In 2005, space was provided on the logbook data sheet to record red snapper discards. Comparisons between individual logbook trip reports and at-sea observer data indicate that self-reported logbook data for numbers of red snapper harvested are reliable, but that discards may be under reported and are frequently omitted on logbook trip reports (Sauls and Brennan, unpublished data). Therefore, self-reported logbook data may not be a reliable data source for constructing a pre-fishery recruit index. This analysis explores the utility of head boat at-sea observer data from Florida for constructing an index of abundance for pre-fishery recruits in the eastern Gulf of Mexico.

There was a reduction in the length of the red snapper harvest season over the course of this time series, and an interruption in funding prevented trips from being sampled every month or every year (Table 1). Temporal changes in the recreational harvest season could affect CPUE if vessels change their fishing areas and methods to target legal-size red snapper when the season is open. Since small red snapper may be more abundant in state waters than in federal waters, the spatial coverage of the harvest season was also important. We identified two months where the red snapper season was consistently open in both federal and state jurisdictions during all years 2005 to 2012. Size limits and bag limits also remained unchanged from 2005 to 2012. Head boat trips were consistently sampled during June and July each year from 2005 to 2012, except 2008. Therefore, we chose the months of June and July to construct an index of abundance. During years when harvest closed mid-way during the month of July, only trips sampled during the portion of the month open to harvest were included in the index (excluded trips after July 24, 2010; July 18, 2011; and July 16, 2012). The year 2010 should be viewed with caution due to spatial shifts in effort following the Deepwater Horizon disaster, when portions of the study area were closed to all fishing during a large portion of June and July.

Data Reduction Techniques:

The proportions of head boat trips with releases of undersized red snapper ranged from roughly 40% and 60% in June and July overall (Figure 3), but the proportions of trips with releases were much greater in the NW FL region (60-100%) than in the TB region (7-31%). Undersized releases of red snapper were observed by at-sea samplers only in head boat catches (Figures 4-5) from average water depths of 50' or deeper (average of minimum and maximum depths for 2005-2007 and 2009-2011). Releases of undersized red snapper tended to be in deeper waters in the TB region compared to the NW FL region. Trips where water depths fished were greater than or equal to 50' in both regions were chosen for analyses from the NW FL and TB regions. The proportion of trips with undersized releases of red snapper appears related to water depth fished (Figure 4), and suggests that the average depth fished may be a useful covariate in the binomial sub-model. However, the rates of releases of undersized red snapper by anglers appear more complex, and changes over time in the NW FL region (Figure 5). While it may be a useful covariate in the model for trips with undersized releases, interaction terms may be necessary to handle this covariate when examining release rates.

A suitable method for selecting a universe of trips to evaluate (i.e., all trips which could have caught undersized red snapper – zeros as well as positives) has not been developed yet, but possibly could be done using clustering techniques (e.g., Shertzer and Williams 2008) or other selection procedures (e.g., Stephens and MacCall 2004). Species caught on trips with undersized red snapper were tabulated by frequency of occurrence, and those occurring on 10% or more of the trips with releases of undersized red snapper were analyzed. The Stephens and MacCall (2004) logistic selection method was attempted using data from NW FL and TB regions, but produced unsatisfactory results and in fact failed to converge successfully using more than one species (in this case, vermilion snapper) and more than a single region. There was little difference between using the occurrence of vermilion snapper to select NW FL trips for the analyses and using the samples from water depths greater than or equal to 50' as described in the preceding section. For the combined NW FL and TB regions, the species assemblages in the two regions caught with undersized red snapper were sufficiently different to cause the logistic selection analyses to be unhelpful. Therefore, all of the trips (with and without releases of undersized red snapper) from the NW FL and TB region from water depths fished of 50' or greater were used without the logistic selection criteria for identifying potential "zero" trips based upon species assemblages.

Model Standardization:

There was one index produced for released undersized red snapper for the combined NW FL and TB regions. Trips with the average number of released undersized red snapper (zero and positive trips) were selected by region, year, month, and average water depth fished. Region, year, and month were used as classification variables, and average water depth fished was used as a potential covariate in the analyses. No interaction terms were included in the model formulations (for a discussion of the use of interaction terms in CPUE standardizations, see SEDAR 2008, S15A Mutton Snapper Review Workshop Consensus Report Section 2.1).

A general linear model [GENMOD procedure (SAS Institute Inc. 2008)] using a forward stepwise selection technique was used to estimate trends in the average number of released undersized red snapper per angler-trip. Two types of model probability distributions were used: binomial (with a logit link function) and gamma (with a log link function) (McCullagh and Nelder 1989). The binomial sub-model analyzed the presence or absence of released undersized red snapper by anglers on a trip, and the gamma sub-model analyzed the average releases of undersized red snapper per angler-trip on positive trips. The forward selection process analyzed the null model (no class variables chosen), and then each class variable or covariate added singly in the sub-model. If the GLM successfully converged, the reduction in deviance from the null model was assessed for each of these runs, and the class variable with the largest percentage reduction in deviance, a significant χ^2 (Chi-square) value, and a lower corrected Akaike Information Criterion (AICc) than other class variables or covariate was selected for the sub-models. The next series of sub-model runs included the variable selected in the previous series along with each of the remaining variables or covariate (one at a time), and each of the resulting two-variable sub-models were assessed for sub-model convergence, the largest percentage reduction in deviance from the null model and significance criteria (χ^2, AICc) as before. This process continued until the percentage reduction in deviance became less than some desired level or until neither variable nor covariate added was significant. For these model runs, a 1% reduction in deviance from the null model was the selected level of acceptance for a suite of class variables. If there were cases when the variable of interest (in this case, year was important) failed to be selected, it would have been included in the sub-model statement so that a year effect could be estimated. However, both of the sub-models included year using the criteria described. Annual values (and associated coefficients of variation) were estimated using the least squares mean method (SAS Institute Inc. 2008) for the year effect.

Model Diagnostics:

The results of the analyses from the forward stepwise selection of variables for the linear models are in Tables 2-3, and the diagnostic plots (standardized residuals by year, q-q plot, and standardized residuals versus the fitted distribution) and scaled index values (index values scaled to their means) over time are in Figures 6-7.

Model Results:

The adjusted average undersized red snapper release rates (numbers per angler-trip), coefficient of variation (as a percentage of the mean), and the scaled index values are in Tables 4-5. A comparison of the adjusted means (rescaled by the n-weighted mean of the series) is in Figure 8. Nominal average undersized red snapper release rates (simple arithmetic and log-transformed means) and adjusted means (Figure 9).

Literature Cited:

McCullagh, P. and J. A. Nelder. 1989. Generalized Linear Models. Second Edition. Monographs on Statistics and Applied Probability 37. Chapman & Hall/CRC. Boca Raton, FL.

SAS Institute, Inc. 2008. SAS/STAT 9.2 User's Guide: The GENMOD Procedure (Book Excerpt). Cary, NC: SAS Institute Inc.

SEDAR 2008. SEDAR 15A Stock Assessment Report 3 (SAR 3). South Atlantic and Gulf of Mexico Mutton Snapper. South Atlantic Fishery Management Council, North Charleston, SC. (http://www.sefsc.noaa.gov/sedar/download/S15%20SAR%203%20Final.pdf?id=DOCUMENT)

Shertzer, K. W. and E. H. Williams. 2008. Fish assemblages and indicator species: reef fishes off the southeastern United States. Fish. Bull. 106: 257-269.

Stephens, A. and A. MacCall. 2004 A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fisheries Research 70: 299-310.

Table 1. Months when head boat trips were sampled and recreational red snapper harvest was either closed the entire month (X), open during any portion of the month in both state and federal waters adjacent to Florida (O), or open only in state waters (S). No trips were sampled during 2008 or the first half of 2009 due to funding. Sampling is ongoing in 2012 and data through July may be available for SEDAR 31.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	X	X	X	O	O	O	O	O	O	O	X	X
2006	X	X	X	O	O	O	O	O	O	O	X	X
2007	X	X	X	S	S	O	O	O	S	S	X	X
2008												
2009						O	O	O	X	X	X	X
2010*	X	X	X	X	X	O	O	X	X	O	O	X
2011	X	X	X	X	X	O	O	X	X	X	X	X
2012	X	X	X	X	X	O	O	ONGOING				

*Portions of federal EEZ and state territorial seas in northwest Florida closed to fishing during June through August due to Deepwater Horizon.

Table 2. Florida at-sea sampling of head boat trips during 2005-2011 in NW FL and TB: Stepwise selection of variables (shaded lines) to include in estimating the proportion of trips with released red snapper using a binomial sub-model (with logit link) based on highest percentage reduction in model deviance and lowest AICc values. The fields include the variables, the degrees of freedom for that variable (df), the deviance of the model with those variables, the mean deviance (deviance/df), the change in mean deviance (Δ mean dev), percent reduction in mean deviance (% change in mean dev), log likelihood, the change in log likelihood from previous run, minus two times the change in log-likelihood, chi-square value, the Chi-square degrees of freedom, the probability of the null hypothesis (Prob Ho), and the corrected Akaike Information Criterion (AICc).

Binomial Sub-model Source	df	log likelihood	Δ log likelihood	Chi-sq	Chi-sq df	Prob Ho	AICC	Δ AICC	Deviance	Mean Deviance	Δ Mean Deviance	% change (null model)	cum % change
Null model	116	-80.75					163.54		161.50	1.392			
Region	115	-54.70	-26.054	52.11	1	< 0.001	113.50	-50.04	109.40	0.951	-0.441	-31.68%	-31.68%
Year	111	-77.47	-3.278	6.55	1	0.256	167.71	+4.17	154.95	1.395	+0.004	+0.26%	
Month	115	-80.73	-0.0203	0.04	1	0.840	165.57	+2.03	161.46	1.404	+0.012	+0.84%	
Depth_avg (covariate)	115	-73.64	-7.116	14.23	1	< 0.001	151.38	-12.16	147.27	1.281	-0.112	-8.02%	
With Region													
Depth_avg (covariate)	114	-46.66	-8.041	16.08	1	< 0.001	99.53	-64.01	93.31	0.819	-0.574	-9.53%	-41.21%
Year	110	-49.93	-4.769	9.54	5	0.089	114.88	-48.65	99.86	0.484	-0.908	-3.12%	
Month	114	-54.70	0.000	0.00	1	1.000	115.61	-47.93	109.40	0.433	-0.960	+0.60%	
With Region and Depth_avg													
Year	109	-41.05	-5.604	11.21	5	0.047	99.44	-64.10	82.11	0.753	-0.639	-4.69%	-45.90%
Month	113	-46.58	-0.081	0.16	1	0.687	101.51	-62.03	93.15	0.824	-0.568	+0.42%	
With Region, Depth_avg, and Year													
Month	108	-41.05	-0.0001	0.0002	1	1.000	101.79	-61.75	82.11	0.760	-0.632	+0.50%	

Table 3. Florida at-sea sampling of head boat trips during 2005-2011 in NW FL and TB: Stepwise selection of variables (shaded lines) to include in estimating the average number of released red snapper per angler-trip using a gamma sub-model (with log link) based on highest percentage reduction in model deviance and lowest AICc values. The fields include the variables, the degrees of freedom for that variable (df), the deviance of the model with those variables, the mean deviance (deviance/df), the change in mean deviance (Δ mean dev), percent reduction in mean deviance (% change in mean dev), log likelihood, the change in log likelihood from previous run, minus two times the change in log-likelihood, chi-square value, the Chi-square degrees of freedom, the probability of the null hypothesis (Prob Ho), and the corrected Akaike Information Criterion (AICc).

Gamma Sub-model Source	df	log likelihood	Δ log likelihood	Chi-sq	Chi-sq df	Prob Ho	AICc	Δ AICc	Deviance	Mean Deviance	Δ Mean Deviance	% change (null model)	cum % change
Null model	62	-72.44					149.08		87.96	1.419			
Region	61	-66.55	-5.89	11.78	1	< 0.001	139.51	-9.57	74.95	1.229	-0.190	-13.39%	-13.39%
Year	57	-64.04	-8.40	16.79	5	0.005	144.12	-4.96	69.96	1.227	-0.191	-13.49%	
Month	61	-70.68	-1.76	3.52	1	0.061	147.77	-1.31	83.88	1.375	-0.044	-3.07%	
Depth_avg (covariate)	61	-72.44	-0.002	0.004	1	0.952	151.28	+2.20	87.96	1.442	+0.023	+1.63%	
With Region													
Year	56	-57.81	-8.81	17.49	5	0.004	134.28	-5.23	58.80	1.050	0.369	-12.59%	-25.99%
Month	60	-65.83	-0.72	1.45	1	0.229	140.35	+0.84	73.48	1.225	0.194	-0.18%	
Depth_avg (covariate)	60	-63.21	-3.34	6.67	1	0.001	135.12	-4.39	68.37	1.140	0.279	-6.29%	
With Region and Year													
Month	55	-56.46	-1.35	2.70	1	0.100	134.31	+0.03	56.61	1.029	0.389	-1.46%	
Depth_avg (covariate)	55	-56.77	-1.04	2.07	1	0.150	134.94	+0.66	57.11	1.038	0.380	-0.82%	

Table 4. Index from delta-gamma model of rates of undersized red snapper released by head boat anglers per trip from trips where average depth fished was 50 feet or deeper. The proportion positives were obtained by the binomial sub-model, and the positives from the product of the binomial and gamma sub-model estimates. Monte Carlo simulations were used to estimate the means, standard errors, and cv values for the delta-gamma model.

Year	proportion positives	n (all)	n (positives)	Mean	Std Error	Lower	Upper	CV (%)
2005	0.866	19	13	0.674	0.234	0.423	1.179	34.71
2006	0.758	15	7	0.799	0.388	0.219	1.168	48.53
2007	0.603	8	6	0.768	0.449	0.289	1.623	58.41
2008								
2009	0.579	27	16	0.461	0.191	0.180	0.885	41.53
2010	0.461	24	12	0.296	0.141	0.120	0.675	47.70
2011	0.227	24	9	0.042	0.026	0.015	0.095	61.01
total		117	63					

Table 5. Index re-scaled to grand mean from the n-weighted annual means.

Year	n (positives)	Mean	Std Error	Lower	Upper	CV (%)
2005	13	1.402	0.487	0.881	2.454	34.71
2006	7	1.664	0.807	0.456	2.432	48.53
2007	6	1.598	0.934	0.602	3.377	58.41
2008						
2009	16	0.960	0.399	0.374	1.841	41.53
2010	12	0.616	0.294	0.249	1.405	47.70
2011	9	0.088	0.054	0.030	0.198	61.01

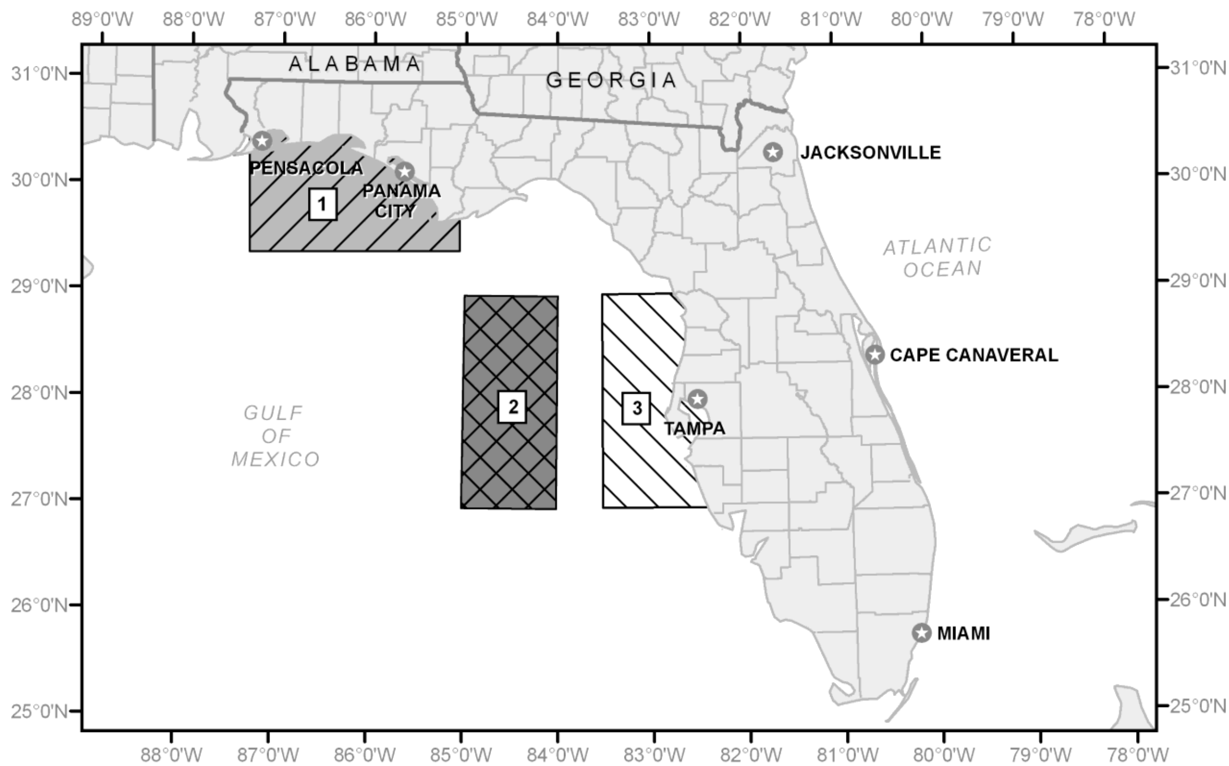


Figure 1. Study areas in the Gulf of Mexico. Box 1 represents the area where half-day and full-day trips originating from the northwestern panhandle region (NW FL) took place, Box 2 represents the area where multi-day trips originating from the central west region adjacent to Tampa Bay (TB) took place, and Box 3 represents the area where half-day and full-day trips originating from the TB region took place.

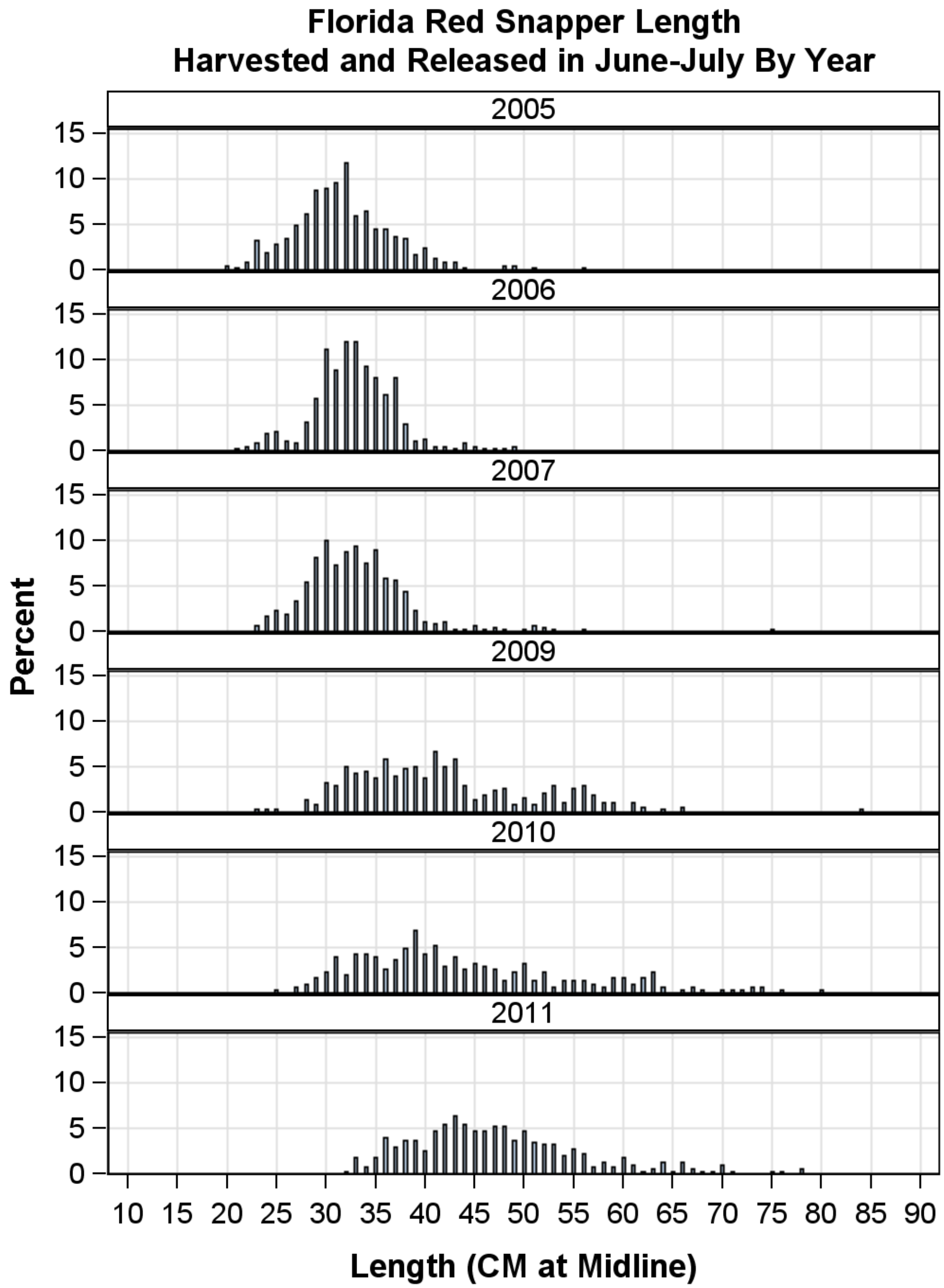
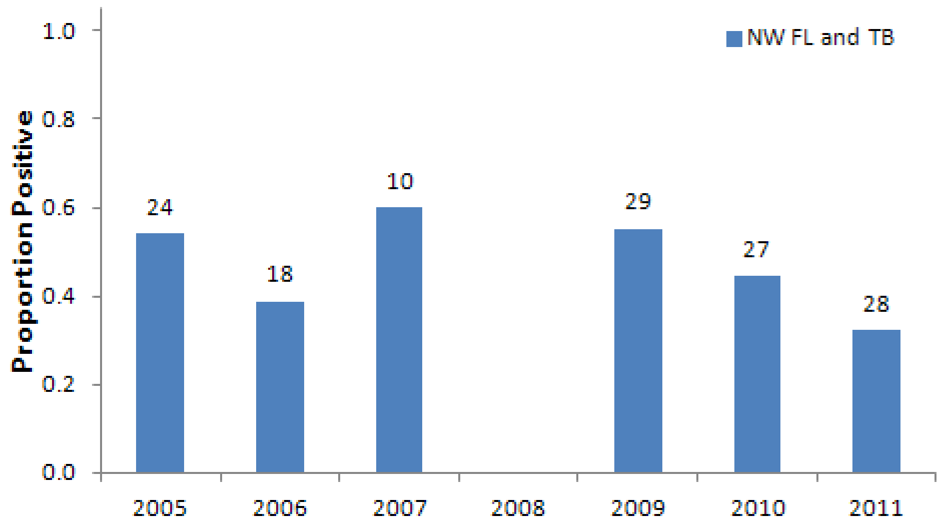


Figure 2. Length frequencies (cm total length) of all red snapper (harvested and released) observed during the months of June and July. Length bins for 40cm and less are sublegal size classes.

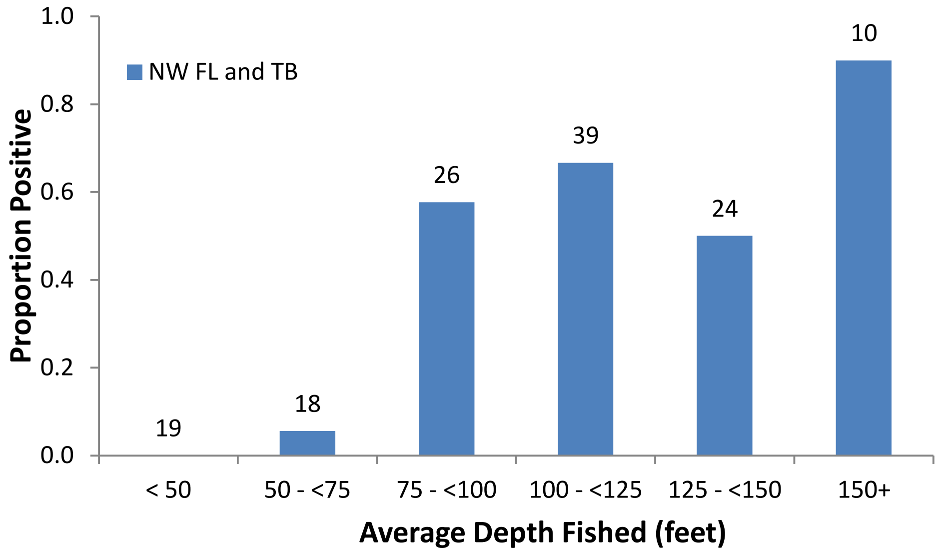
a.) Regions combined.



b.) By region.

Figure 3. Proportion of trips with releases of undersized red snapper. a.) For the combined regions; and b.) For each region. Sample sizes are shown above the columns.

a.) Regions combined.



b.) By region.

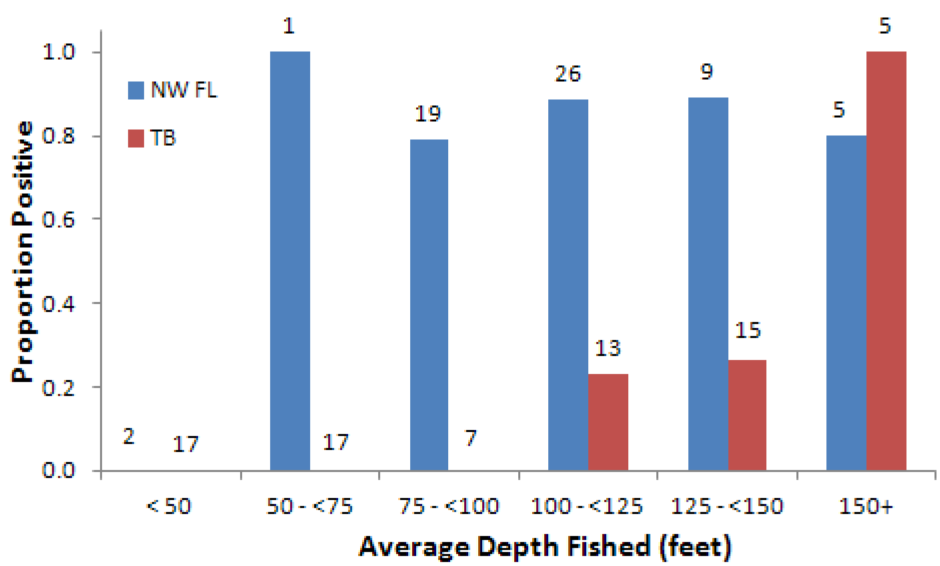
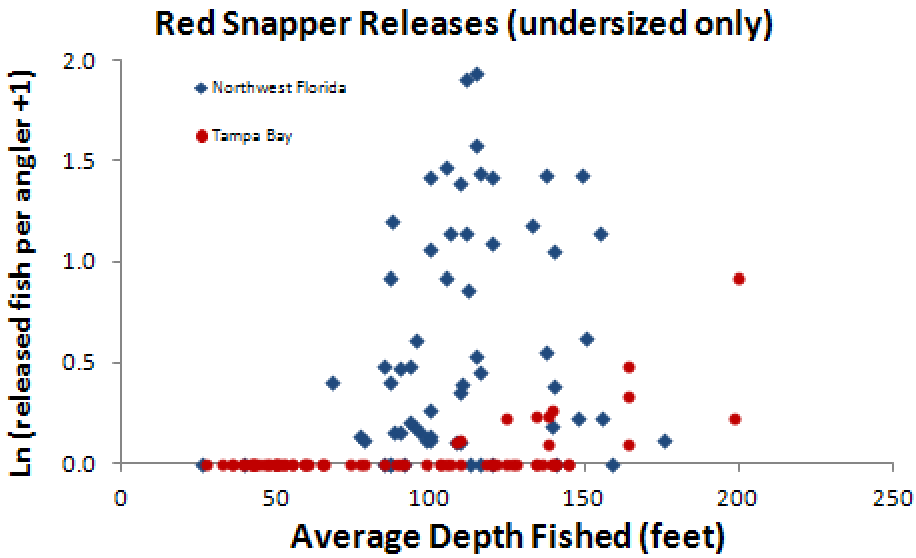


Figure 4. Proportion of trips with releases of undersized red snapper a.) for the combined regions by average water depth; and b.) in each region by average water depth. Sample sizes are shown above the columns.

a.) Released fish rates by region



b.) NW Florida release rates by year, with trend lines

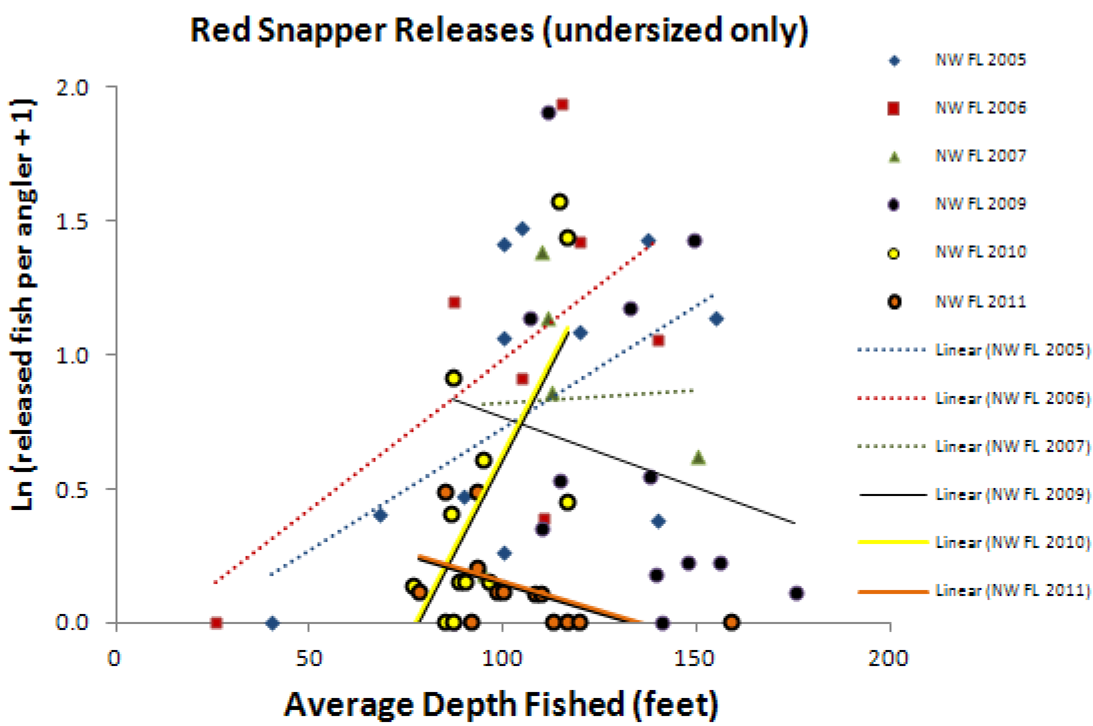
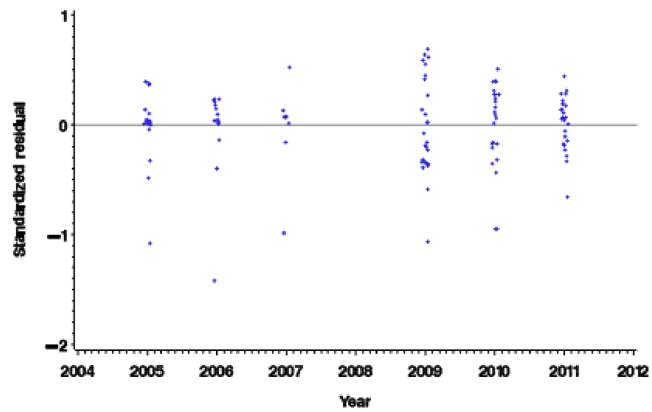
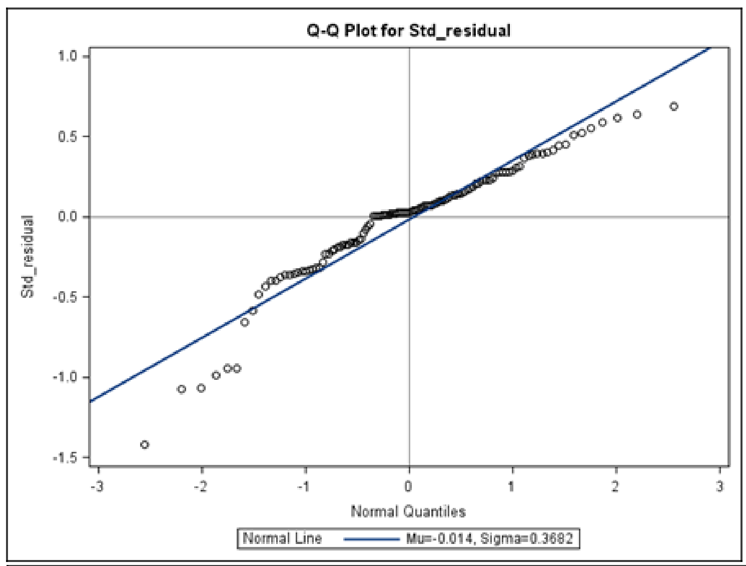


Figure 5. Release rates per angler-trip by average depth fished (in feet) . a.) By region; b.) for the northwest Florida region only, with linear trend lines by year.

a.) Standardized residuals by year.



b.) Q-Q plot



c.) Histogram of standardized residuals and fitted distribution

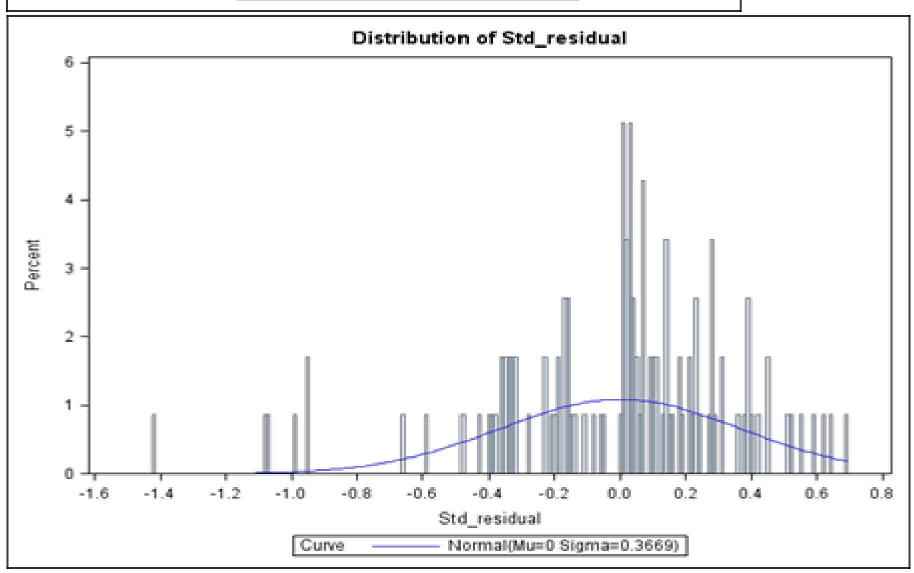
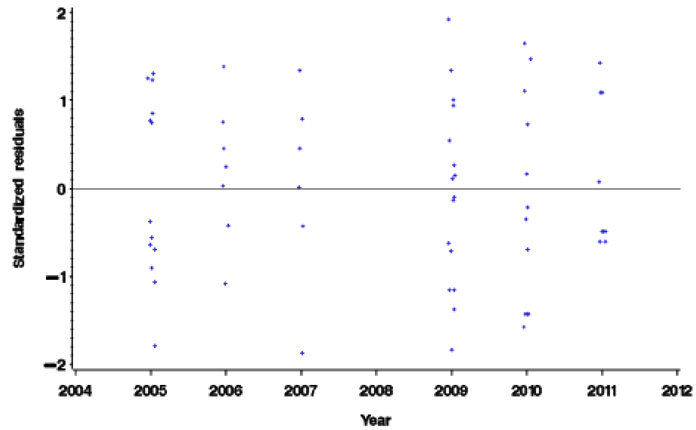
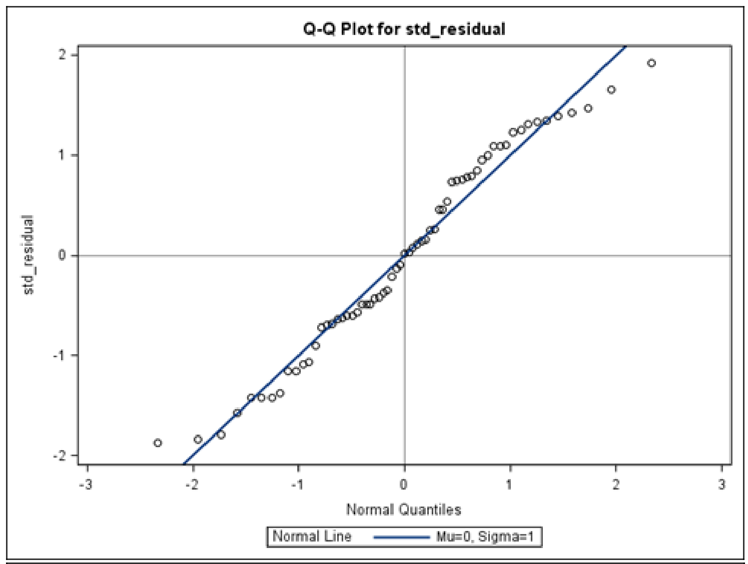


Figure 6. Diagnostics for the binomial sub-model of proportion of at-sea sampled head boat trips with released undersize red snapper in NW FL and TB, 2005-2011.

a.) Standardized residuals by year.



b.) b.) Q-Q plot



c.) Histogram of standardized residuals and fitted distribution

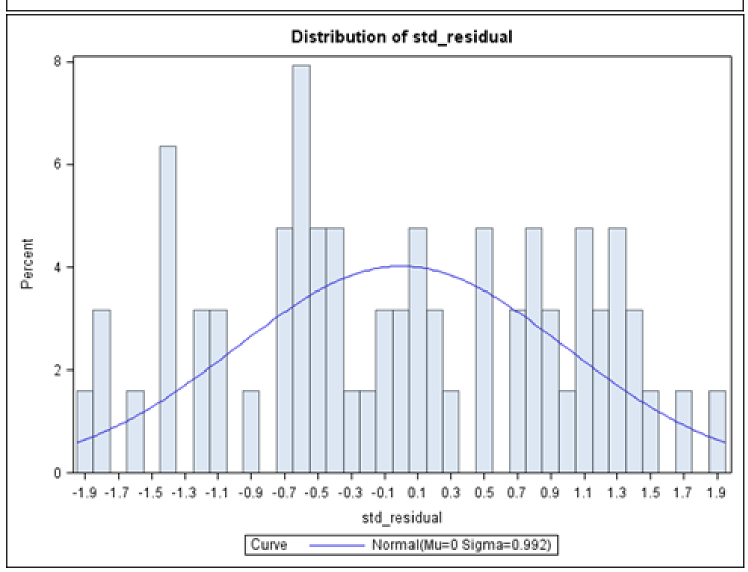


Figure 7. Diagnostics for the gamma sub-model for at-sea sampled head boat trips of average numbers of released undersize red snapper per angler-trip in NW FL and TB, 2005-2011.

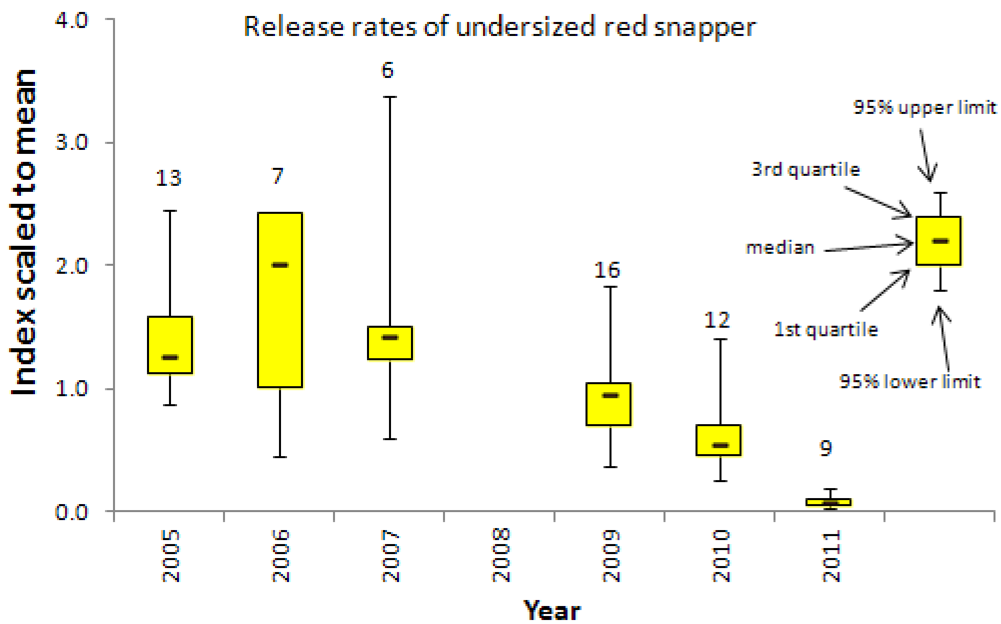


Figure 8. Scaled index for the combined binomial and gamma sub-models for Florida at-sea sampled undersized red snapper releases from head boats in NW FL and TB, 2005-2011. Sample sizes for the positives (gamma sub-model) are shown above the index values. The median values are indicated by the horizontal bars in the shaded boxes representing the 1st and 3rd quartiles. The whiskers extending above and below the boxes are the 95% upper and lower confidence limits, respectively.

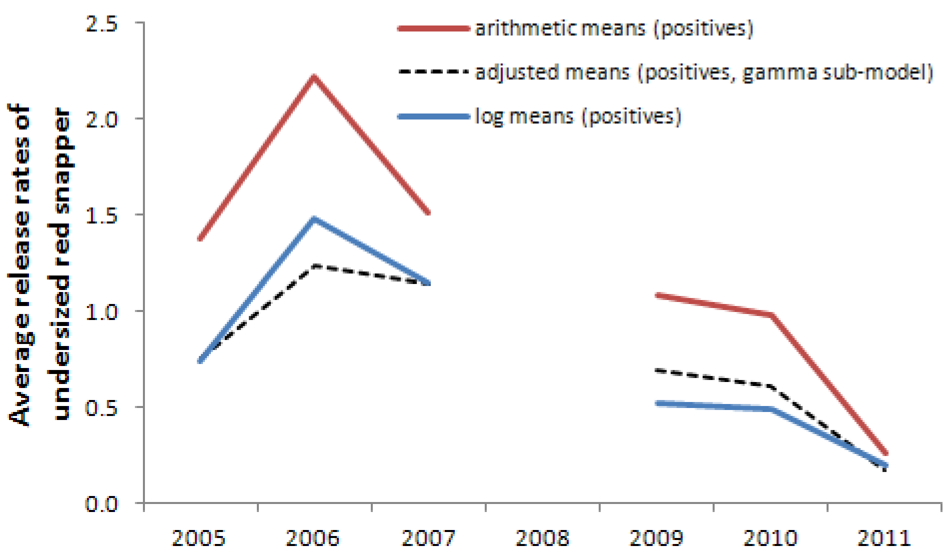


Figure 9. Unscaled arithmetic (positives), log-transformed (positives), and adjusted (gamma sub-model only) means for the combined regions.