

## **Additional estimates of mutton snapper total mortality rates from length observations**

By

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This document provides the results of additional analysis requested during the SEDAR14 review workshop. The primary focus of this follow-up work was to evaluate the potential temporal effect of spawning events on the results of the mean length analysis. Samples were separated into those during the spawning period (March – June) and those during the rest of the year and five different tasks were accomplished:

- Re-evaluate results of mean length analysis for the trap fishery
- Evaluate the length frequencies from the Puerto Rico hook and line fishery and determine if mean length analysis can be conducted.
- Incorporate a selectivity function into the mean length analysis for the hook and line fishery
- Integrate hook and line catch indices into the mean length analysis
- Provide a summary table of the results of all the mean length analyses

### *Re-valuate results of mean length analysis for the trap fishery*

For the trap fishery, splitting the data up into spawning and non-spawning periods showed no obvious significant differences in the length frequency distribution of the samples (Figure 1, 2). A total of 389 fish were sampled during the spawning period and 832 were sampled during the non spawning period. Results of the mean length analysis assuming a single change in mortality, once again indicated an approximate 100% increase in total mortality occurring around 1989. The absolute values of estimated total mortality did reflect a few samples that contained larger fish during the spawning period and resulted in lower estimates of mortality ( $Z_{\text{one}} = 0.37 \text{ yr}^{-1}$  and  $Z_{\text{two}} = 0.75 \text{ yr}^{-1}$  for the spawning period and  $Z_{\text{one}} = 0.51 \text{ yr}^{-1}$  and  $Z_{\text{two}} = 1.09 \text{ yr}^{-1}$  for the non spawning period). The original aggregated estimates ( $Z_{\text{one}} = 0.48$ , and  $Z_{\text{two}} = 0.96$ ) are closer to those of the non spawning period due to the greater sample sizes but all analysis estimated an

approximate 100% increase at this time. Based on the similarities of the length frequency distributions and benefits of the increased sample size, no further analysis was deemed necessary.

*Evaluate the length frequencies from the Puerto Rico hook and line fishery and determine if mean length analysis can be conducted*

For the hook and line fishery, the length frequency distributions differed significantly between spawning and non-spawning periods (Figure 3). During the spawning period fisherman were clearly targeting larger fish. The right descending limb of the size frequency distribution was selected for the mean length analysis and a length at full vulnerability of 630 mm was chosen for both spawning and non spawning periods (Figure 4). There are two differences to be noted between the hook and line and the trap fishery data. First, unlike the trap fishery, a greater number of samples were present from the spawning period. Secondly, the time series of data in the hook and line fishery does not contain a significant number of samples prior to 1990 (i.e. detecting an increase in mortality as indicated by the trap fishery analysis in 1989 would be impossible from this data set).

All hook and line mean length analyses were weighted by sample size and results were consistent with those from the trap fishery (Figure 5). A relatively high mortality rate was estimated for the middle part of the time series ( $1.09 \text{ yr}^{-1}$  from the non spawning period and  $0.79 \text{ yr}^{-1}$  for the spawning period). These are virtually identical to the estimates for the middle part of the time series from the spawning specific trap fishery analysis (preceding section). A reduction in mortality is indicated to have occurred in 1996 or 1997 with an estimated total mortality of  $0.44 \text{ yr}^{-1}$  from both analyses. This is also consistent with the results of the trap fishery two change in mortality model which included information from catch rates that estimated the current total mortality rate to be  $0.50 \text{ yr}^{-1}$ . A reduction in mortality of approximately 50% around 1997 has been indicated by both hook and line and the trap fishery analyses.

*Incorporate a selectivity function into the mean length analysis for the hook and line fishery*

Although very little information is available on the selectivity of the hook and line fishery, we attempted to incorporate a selectivity function into the model to utilize information from the entire length frequency distribution. A discrete form of the mean length analysis was used to incorporate a selectivity function (Available at <http://www.fisheries.vims.edu/hoenig/demons.htm>). A logistic selectivity function was assumed and visually fit to the observed length frequency data (Figure 6). The absolute values estimated for total mortality were very sensitive to definition of selectivity curve but reduction of approximately 40% (ranging from 33 – 43%) was indicated around 1996 (Figure 7). The magnitude of change was consistent with previous results although there can be little confidence in the absolute values without further information on the actual selectivity of the gear.

*Integrate hook and line catch indices into the mean length analysis*

As was done with the trap fishery, the standardized catch indices were used as additional information in the mean length analysis. The methodology is identical to that described for the trap fishery. This analysis was conducted for the spawning period only and results changed little from the mean length only analysis (Figure 8).

*Provide a summary table of the results of all the mean length analyses*

A summary table of base runs for all analyses is presented in Table 1. All results presented have been weighted by sample size and for all but the hook and line selectivity analysis, mean lengths were calculated by each interview day (for selectivity analysis, mean lengths were calculated by year).

Table 1. Summary table of all results from the mean length analyses for mutton snapper in Puerto Rico. Results presented are all weighted by sample size.

Data Set	Type of Analysis	Season	Z <sub>one</sub>	Year of Change	Z <sub>two</sub> (% change)	Year of Change	Z <sub>three</sub> (% change)
Pots	Mean Lengths Only	Combined	0.48	1994	0.96 (100%)	-	-
Pots	Mean Lengths Only	Spawning	0.37	1992	0.75 (103%)	-	-
Pots	Mean Lengths Only	Non-spawning	0.51	1989	1.09 (113%)	-	-
Pots <sup>1</sup>	Mean Lengths Only	Combined	0.48	1994	1.17 (144%)	1999	0.76 (-35%)
Pots	Mean Lengths/Catch Indices	Combined	0.47	1994	0.79 (68%) <sup>2</sup>	-	-
Pots	Mean Lengths/Catch Indices	Combined	0.47	1989	1.21 (157%)	1998	0.50 (-59%)
Hook/Line <sup>3</sup>	Mean Lengths Only	Spawning	-	-	0.79	1997	0.44 (-44%)
Hook/Line <sup>3</sup>	Mean Lengths Only	Non-spawning	-	-	1.02	1996	0.44 (-57%)
Hook/Line <sup>3</sup>	Mean Lengths/Catch Indices	Spawning	-	-	0.81	1994	0.55 (-32%)
Hook/Line <sup>3</sup>	Mean Lengths with Selectivity <sup>4</sup>	Spawning	-	-	0.70	1996	0.41 (-41%)

<sup>1</sup>Improvement of model fit with two additional parameters (second change, Z<sub>three</sub>) not significant

<sup>2</sup>Pattern to residuals indicating additional change in mortality was necessary

<sup>3</sup>First estimated Z placed in Z<sub>two</sub> column for comparison to other analyses

<sup>4</sup>Absolute values extremely sensitive to shape of assumed selectivity curve

Figure 1. Cumulative plot of all individuals in the trap fishery of Puerto Rico (1983–2006) during the spawning period (top plate; March – June) and for the non spawning period (bottom plate; July – February).

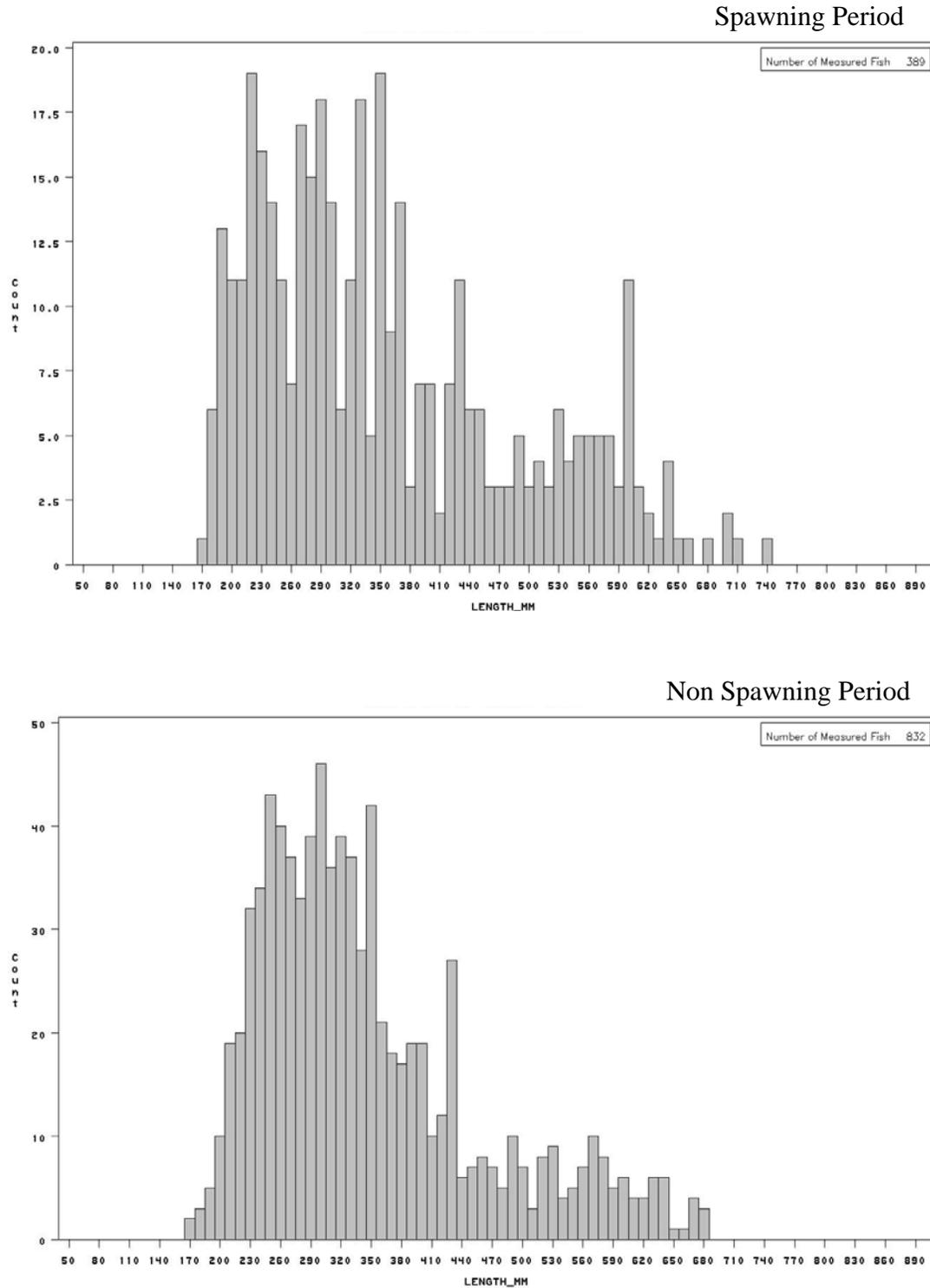


Figure 2. Mean Length calculated for each interview day for the trap fishery of Puerto Rico. Note that there are a few more large fish measured during the spawning period. Sample numbers for each interview day have been indicated by both bubble size and number.

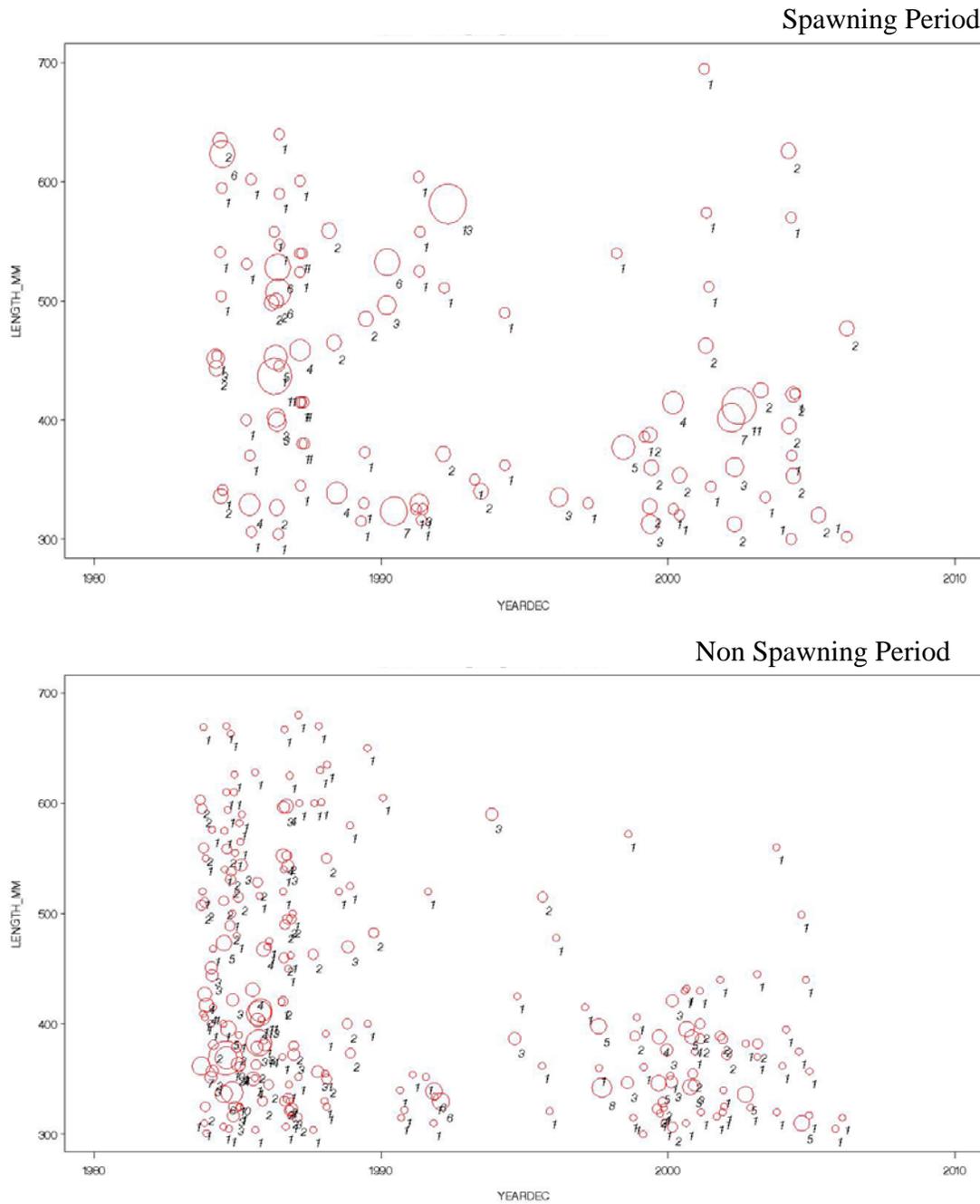


Figure 3. Cumulative plot of all individuals in the hook and line fishery of Puerto Rico (1983– 2006) during the spawning period (top plate; March – June) and for the non spawning period (bottom plate; July – February). The length at full vulnerability (630 mm) chosen for the analysis is indicated by the dashed line.

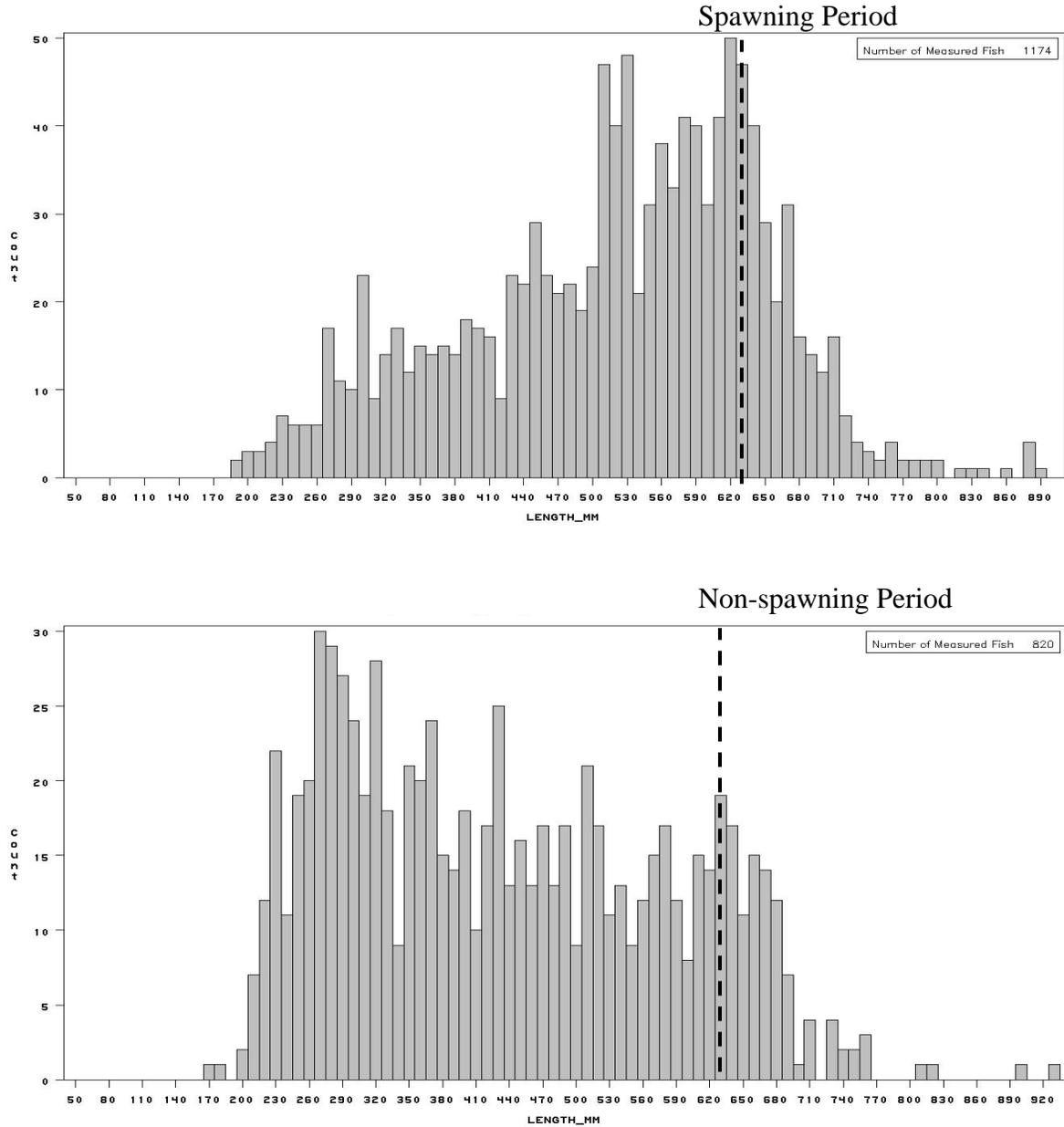


Figure 4. Mean Length calculated by interview day for the hook and line fishery. Sample numbers for each year have been indicated by both bubble size and number.

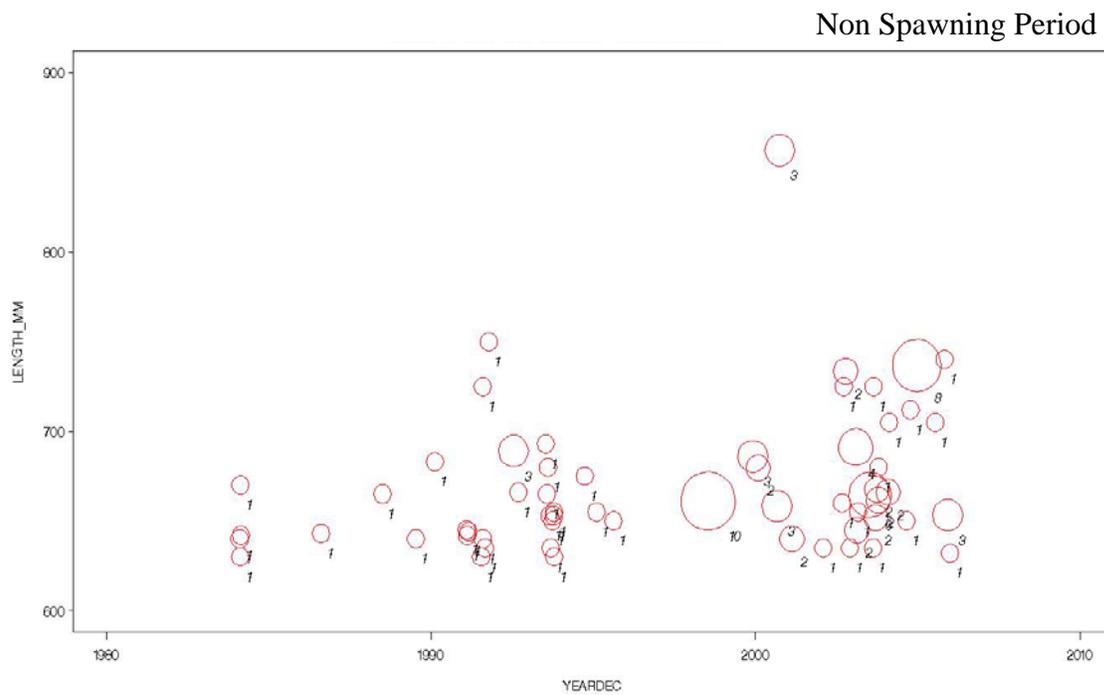
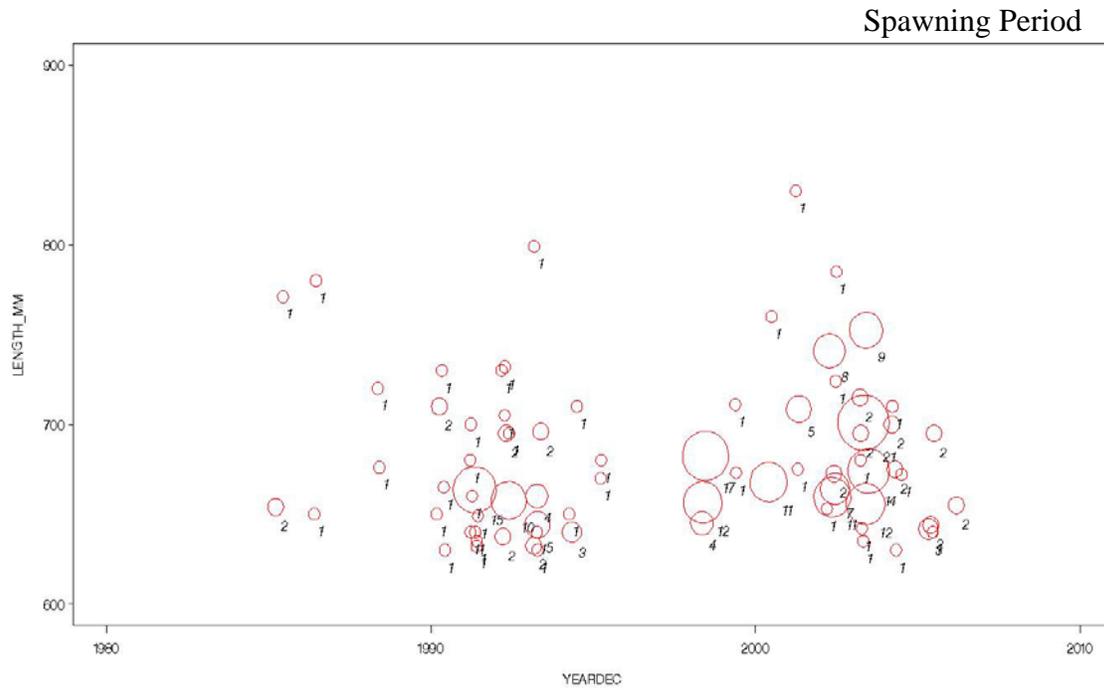
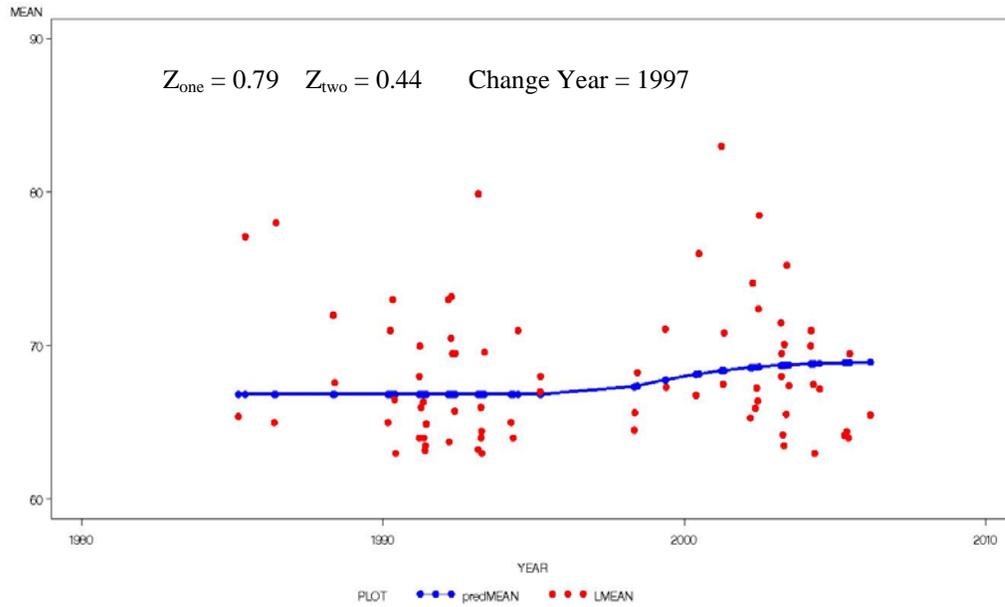


Figure 5. Results of mean length analysis for spawning (top plate) and non spawning periods (bottom plate) in the hook and line fishery of Puerto Rico. Results are indicated on each figure.

### Spawning Period



### Non Spawning Period

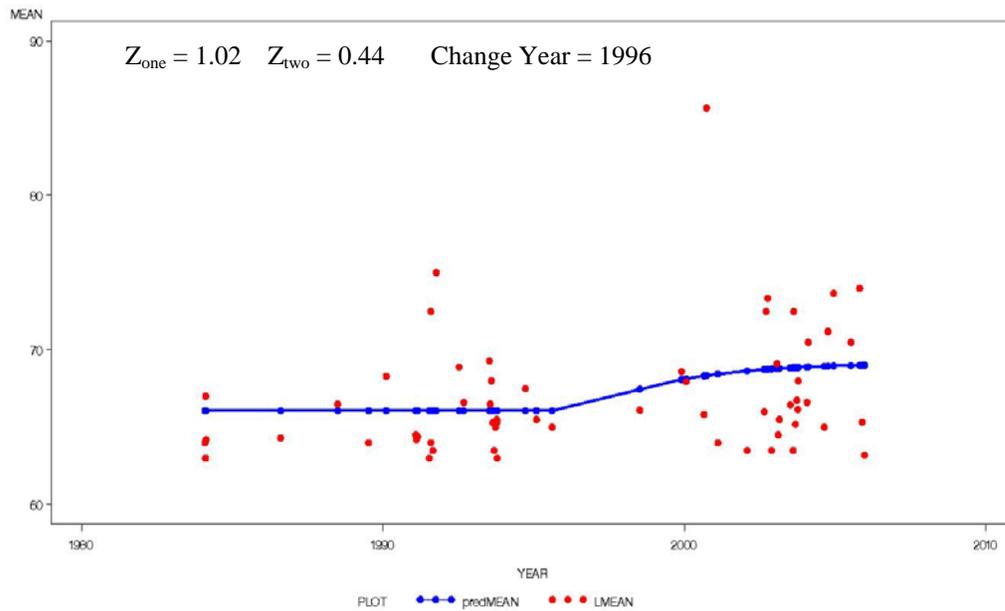


Figure 6. Logistic selectivity function fit to observed length frequency data.

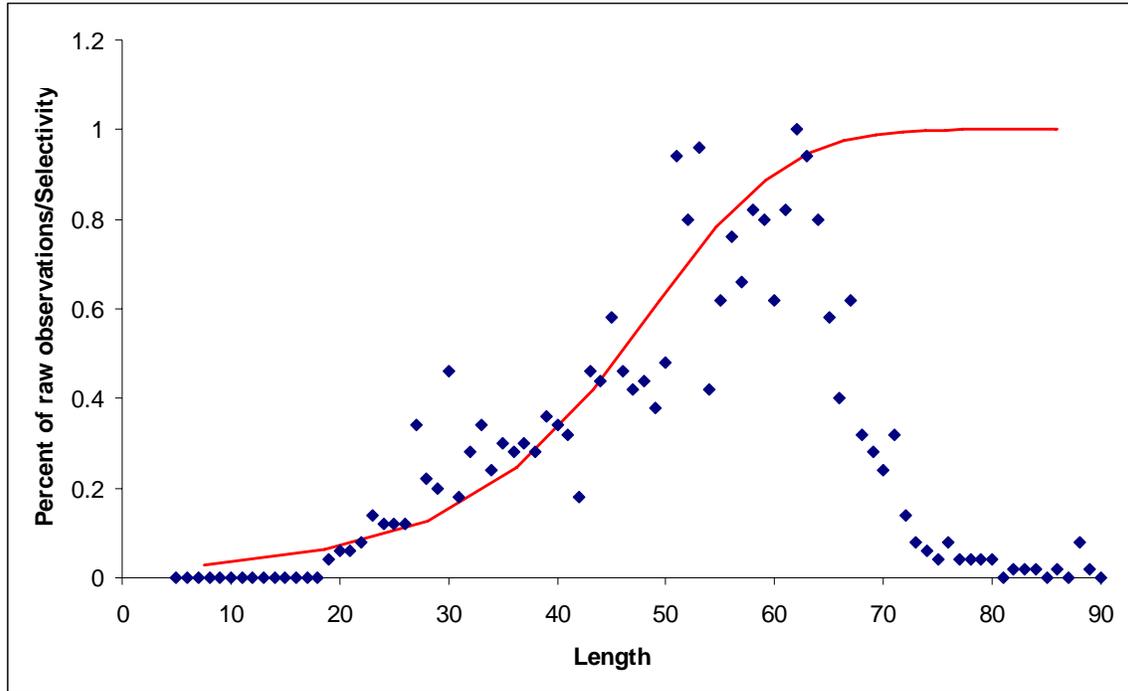
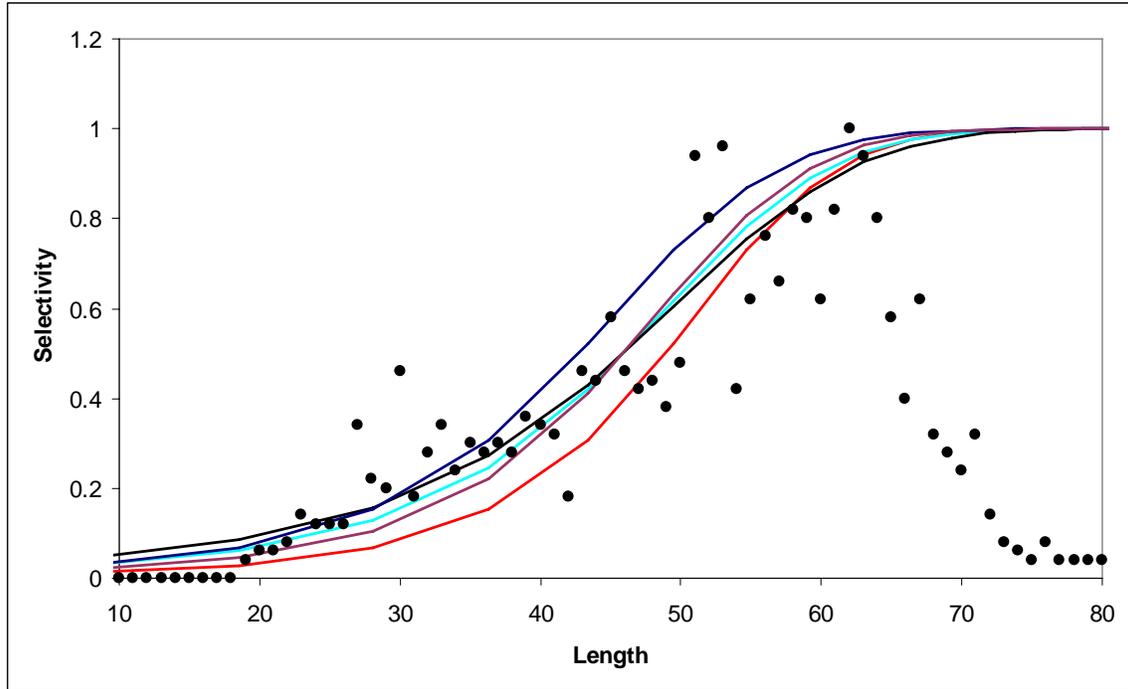


Figure 7. Results of incorporating selectivity function into the mutton snapper mean length analysis for the hook and line data of Puerto Rico. Results were very sensitive to the shape and location parameters selected for the logistic function (see table below).



<b>Z one</b>	<b>Z two</b>	<b>shape, location</b>	<b>% reduction</b>
0.94	0.53	0.9 - 5.5	43.61
0.54	0.33	0.9 - 4.5	38.88
0.70	0.41	0.9 - 5.0	41.42
0.62	0.39	0.8 - 5.0	37.09
0.54	0.36	0.7 - 5.0	33.33

Figure 8. Predicted versus observed catch indices for mean length analysis combined with information from catch rates for the hook and line fishery during the spawning period. Results of the analysis are indicated above the figure.

