Annual Indices of Abundance of Mutton Snapper for Florida Estuaries

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Mutton snapper abundance and habitat data collected throughout Florida estuaries [i.e., Apalachicola Bay, Cedar Key, Tampa Bay, Charlotte Harbor, Southern Indian River Lagoon, Northern Indian River Lagoon, and Northeast Florida (St. Johns, Nassau, and St. Marks Rivers)] by the Florida Fish and Wildlife Conservation Commission (FWC), Fish and Wildlife Research Institute's Fisheries-Independent Monitoring program from 1996 to 2004 were analyzed to develop annual indices of abundance. Monthly stratified-random sampling was conducted during the day by using three different seines. The estuaries was divided into 1 x 1 nautical-mile cartographic grids (1 nm^2), and grids with appropriate water depths for each seine were selected as the sampling universe. Samples were stratified by depth and habitat type depending on gear. Due to the extremely low occurrence of mutton snapper in other gears only the data from samples collected with the 183-m center-bag haul seine (183 m x 3 m, 37.5-mm stretch mesh) were used for analyses. These sampling stations were stratified based on the presence or absence of overhanging shoreline vegetation (e.g., fringing mangroves). The seine was deployed by boat, in a rectangular shape (40 m x 103 m) along shorelines and on offshore flats inside the estuary and retrieved by hand. All fishes were identified to the lowest possible taxon, enumerated, and measured to the nearest millimeter (SL), and all juvenile mutton snapper were released alive in the field. For each sample, bottom type, seagrass species, shoreline vegetation species, and coverage of each were qualitatively measured by visual survey. Water-quality data such as salinity (ppt), dissolved oxygen (mg/l^{-1}), and temperature (°C) were recorded using a hand-held data sonde.

In order to develop standardized indices of annual average CPUE (catch per haul) for mutton snapper from Florida estuaries in the Gulf of Mexico and Atlantic, a zero-inflated delta-lognormal model, as described by Ingram et al. (1992), was employed. This index is a mathematical combination of yearly CPUE estimates from two distinct generalized linear models: a zero-inflated binomial model (ZIB) which describes proportion of positive CPUEs (i.e., presence/absence) and lognormal model which describes variability in only the nonzero CPUE data. The NLMIXED and MIXED procedures in SAS were employed to provide yearly index values for both the ZIB and lognormal sub-models, respectively. A backward stepwise selection procedure was employed to develop both sub-models. Type 3 and parameter significance analyses were used to test each parameter for inclusion or exclusion into the sub-model. Both variable inclusion and exclusion significance level was set at an $\alpha = 0.05$. The parameters tested for inclusion in each sub-model were categorical variables of year, estuary, shoreline vegetation type, and the continuous variables of station depth, salinity and temperature, which were normalized to a mean of one. The fit of each model was evaluated using the fit statistics provided by the NLMIXED macro.

Mutton snapper was only collected in Indian River and Tequesta Estuaries, with very few collected in other estuaries. Length frequency histograms of mutton snapper collected from these estuaries (Figures 1 and 2) show that age-0 fish (those ≤ 80 mm SL) were observed only in Indian River. Therefore, an age-0 index was developed with those age-0 fish collected from the

Indian River Estuary, while age-1+ fish (mostly juvenile) were collected from both Indian River and Tequesta Estuaries, and the age-1+ index was developed from these data. Figures 3 and 4 illustrate age-0 and age-1+ mutton snapper collected during this survey. Age-0 mutton snapper had a mean standard length (± standard error) of 43 (± 2) mm (N = 112). Age-1+ mutton snapper had a mean standard length (± standard error) of 141 (± 1) mm (N = 813).

The separate models for age-0 and age-1+ and mutton snapper from Indian River and Tequesta Estuaries converged. For the age-0 mutton snapper, which only occurred in the Indian River Estuary during 1998 through 2006 survey years, the year, depth, temperature and salinity variables were retained in the ZIB, and the year and salinity variables were retained in the lognormal sub-model. Figure 5 summarizes the index values for age-0 mutton snapper. For the age-0 dataset, all years but one had frequencies of occurrence of less than 1 %, resulting in very high CVs. However, an oscillating but generally increasing trend was observed.

For the age-1+ mutton snapper, which occurred in both the Indian River and Tequesta Estuaries during 1999 through 2006 survey years, the year and salinity variables were retained in the ZIB, and the year, bottom vegetation and depth variables were retained in the lognormal sub-model. Figure 6 summarizes the index values for age-1+ mutton snapper. For the age-1+ dataset, all years had frequencies of occurrence of less than 5 %, resulting in very high CVs. Higher index values were observed in later survey years.

INGRAM, G.W., Jr., W.J. Richards, G.P. Scott, and S.C. Turner. 2006. Development of indices of bluefin tuna (*Thunnus thynnus*) spawning biomass in the Gulf of Mexico using delta-lognormal models. ICCAT Working Document SCRS/2006/082.

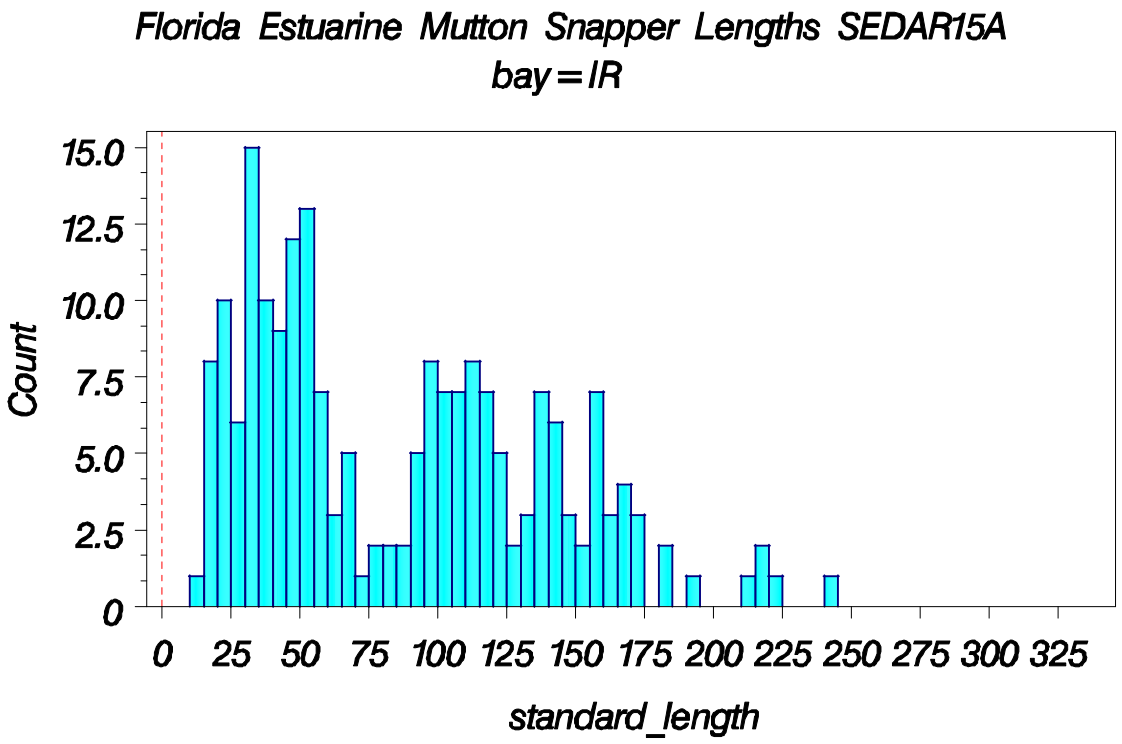


Figure 1. Standard length (mm) frequency histograms for mutton snapper collected from the Indian River Estuary [Mean (SE) = 85 (4) mm; N = 201].

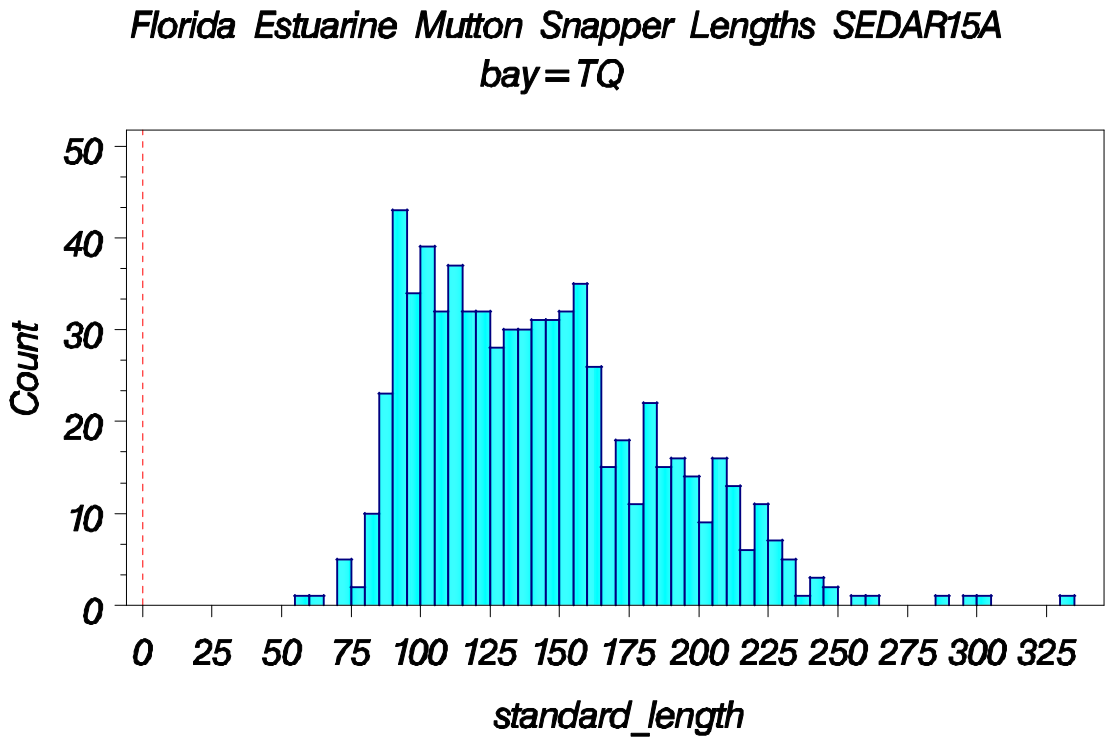


Figure 2. Standard length (mm) frequency histograms for mutton snapper collected from the Tequesta Estuary [Mean (SE) = 142 (2) mm; N = 724].

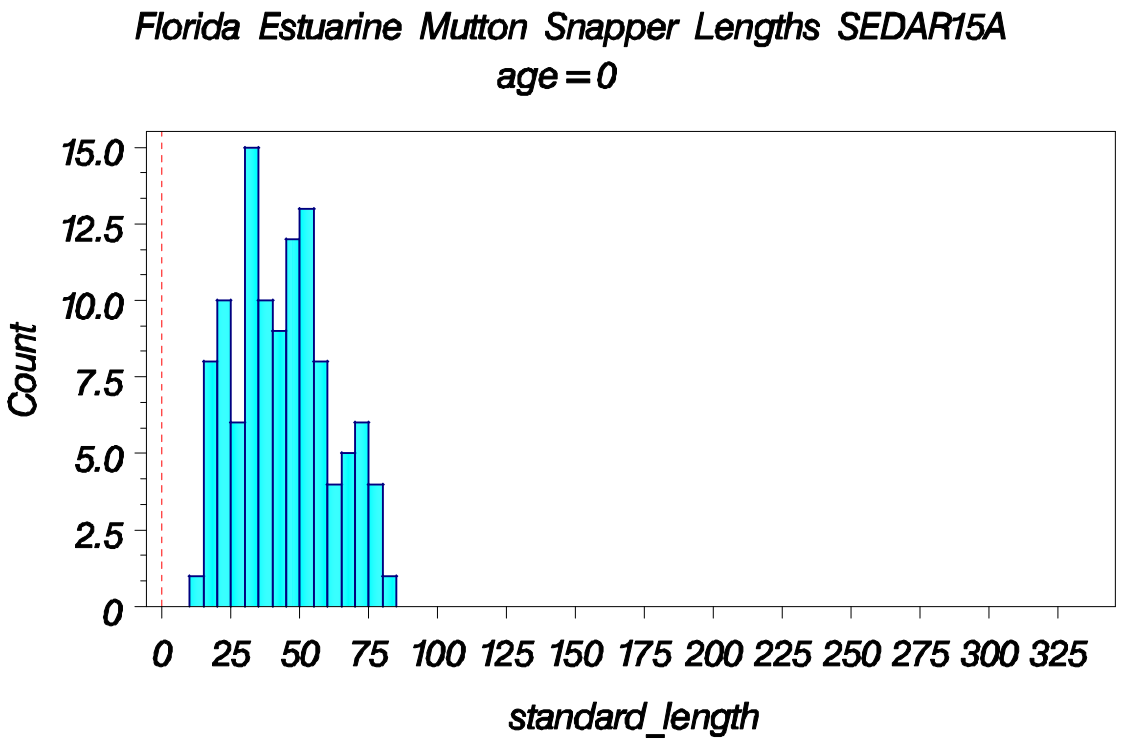


Figure 3. Standard length (mm) frequency histograms for age-0 mutton snapper collected from the Indian River Estuary [Mean (SE) = 43 (2) mm; N = 112].

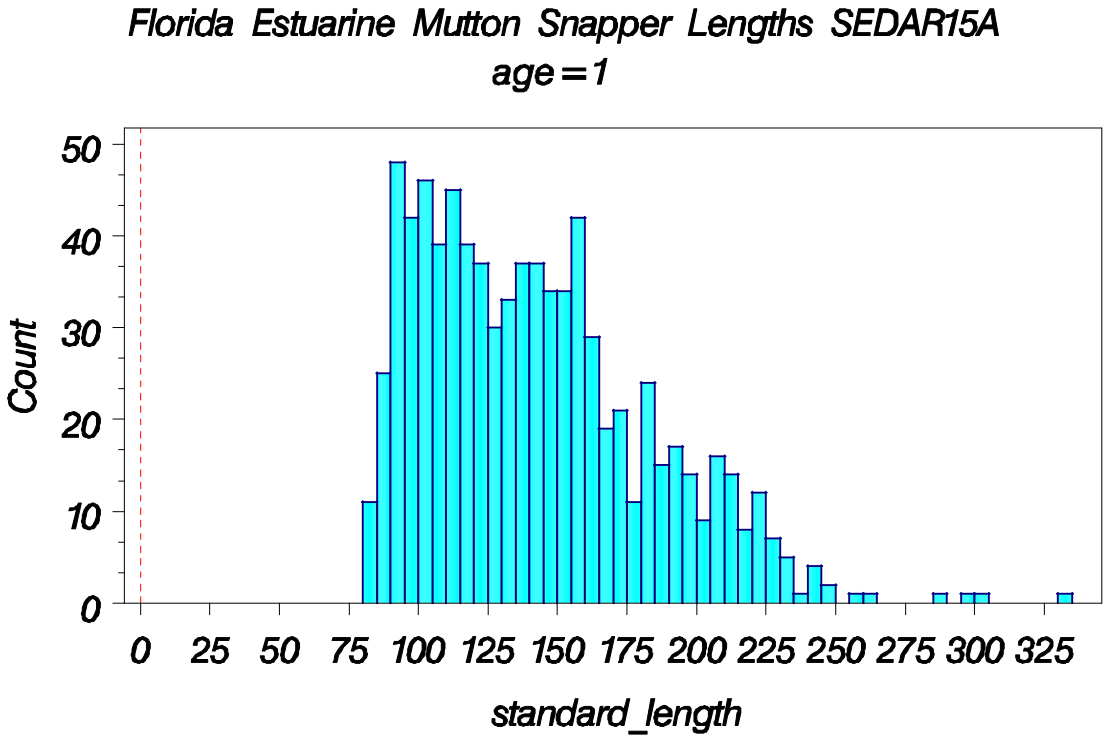
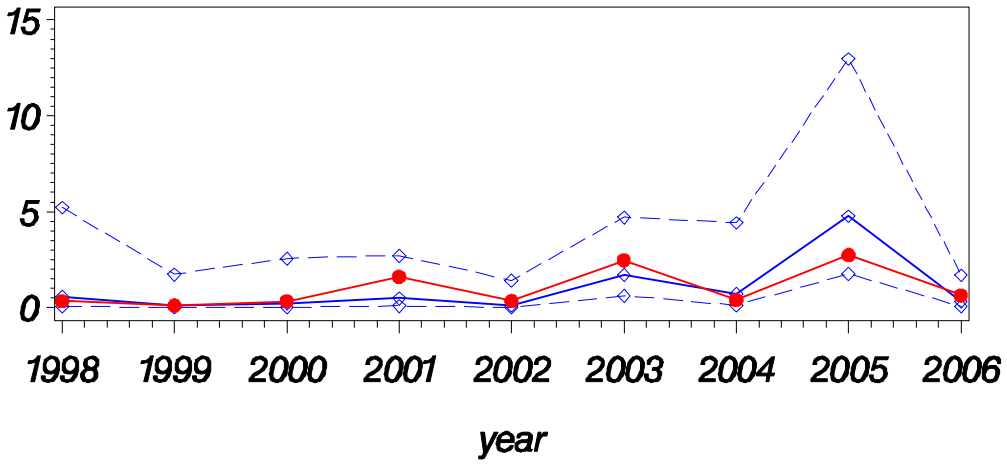
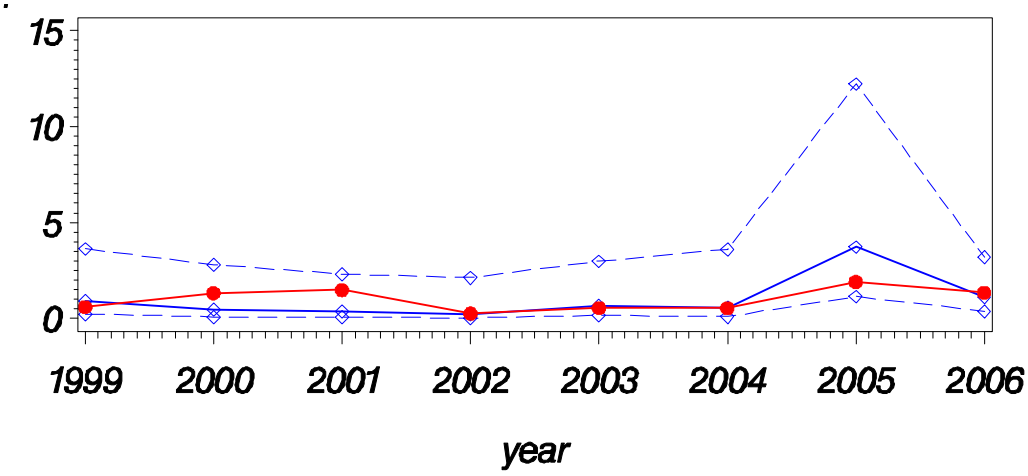


Figure 4. Standard length (mm) frequency histograms for age-1+ mutton snapper collected from the Tequesta and Indian River Estuaries [Mean (SE) = 141 (1) mm; N = 813].



Survey Year	Nominal Frequency	N	Index	Scaled Index	CV	LCL	UCL
1998	0.002101	476	0.04733	0.56667	1.55762	0.06158	5.2144
1999	0.002114	473	0.00882	0.10564	2.46140	0.00645	1.7301
2000	0.002024	494	0.01642	0.19665	2.05187	0.01506	2.5682
2001	0.006383	470	0.04049	0.48481	1.04990	0.08647	2.7182
2002	0.004329	462	0.01112	0.13311	1.75289	0.01244	1.4240
2003	0.023981	417	0.14209	1.70138	0.54428	0.61426	4.7124
2004	0.004975	402	0.06047	0.72403	1.12603	0.11851	4.4234
2005	0.017766	394	0.39799	4.76537	0.53386	1.75041	12.9734
2006	0.007828	511	0.02692	0.32235	0.99171	0.06159	1.6871

Figure 5. Index values for age-0 mutton snapper collected from the Indian River Estuary. N is the number of stations, Index is the index in CPUE units, Scaled Index is that same index normalized to a mean of one, CV is the coefficient of variation on the mean, and LCL and UCL are lower and upper 95% confidence limits for the scaled index (blue lines and symbols). Nominal scaled CPUE values are shown in red.



Survey Year	Nominal Frequency	N	Index	Scaled Index	CV	LCL	UCL
1999	0.020576	243	0.02515	0.90626	0.78604	0.22635	3.6284
2000	0.016949	236	0.01281	0.46163	1.11766	0.07626	2.7944
2001	0.022321	224	0.01003	0.36142	1.16720	0.05658	2.3086
2002	0.012766	235	0.00573	0.20657	1.69880	0.02010	2.1234
2003	0.021930	228	0.01858	0.66946	0.86476	0.15020	2.9837
2004	0.013043	230	0.01564	0.56370	1.16609	0.08835	3.5964
2005	0.017544	228	0.10340	3.72666	0.65027	1.13634	12.2218
2006	0.040486	247	0.03064	1.10431	0.57336	0.38020	3.2075

Figure 6. Index values for age-1+ mutton snapper collected from the Tequesta and Indian River Estuaries. N is the number of stations, Index is the index in CPUE units, Scaled Index is that same index normalized to a mean of one, CV is the coefficient of variation on the mean, and LCL and UCL are lower and upper 95% confidence limits for the scaled index (blue lines and symbols). Nominal scaled CPUE values are shown in red.