# SMALL COASTAL SHARK 2007 SEDAR DATA WORKSHOP DOCUMENT

## Standardized catch rates of small coastal sharks from the South Carolina COASTSPAN and SCDNR red drum surveys

Camilla T. McCandless
NOAA/NMFS/NEFSC
Apex Predators Investigation
28 Tarzwell Drive
Narragansett, RI 02882

Glenn F. Ulrich
Carrie Hendrix
Bryan Frazier
South Carolina Department of Natural Resources
Marine Resources Division
217 Ft. Johnson Rd
Charleston, SC 29412

cami.mccandless@noaa.gov
ulrichg@dnr.sc.gov
hendrixc@dnr.sc.gov
frazierbr@dnr.sc.gov

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***Summary***

In an effort to examine the use of South Carolina's estuarine waters as nursery areas for coastal shark species the South Carolina Department of Natural Resources SCDNR) Marine Resources Division, in collaboration with the National Marine Fisheries Service's (NMFS) Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) Survey began sampling for sharks using longline and gillnet methods in several estuaries within South Carolina. In addition to the estuarine areas sampled specifically for sharks, the SCDNR also samples the shark bycatch from a long-term longline survey designed to monitor adult red drum *Sciaenops ocellatus* in the coastal waters of South Carolina. Data from these surveys were used to look at the trends in small coastal shark abundance in South Carolina's estuarine and nearshore waters from 1998 to 2005. Catch per unit effort (CPUE) in number of sharks per hook hour for longline sets and in number of sharks per hour for gillnet sets were examined from March through December. The CPUE was standardized using a modified two-step approach originally proposed by Lo et al (1992) that models the zero catch separately from the positive catch.

***Methods***

**Sampling Gear and Data Collection**

COASTSPAN estuarine sampling locations were selected in the lower reaches of estuaries in depths which would facilitate the deployment and retrieval of gillnets and hand deployed longlines (i.e. current velocity, tidal range, vessel traffic). All estuarine sampling occurred inside of inlets and sampling locations varied with regard to distance from nearshore waters. Estuarine sampling was conducted primarily from April through October with the majority of the effort occurring between May and September. Nearshore sampling stations were those previously selected for adult red drum sampling. Nearshore sampling occurred from immediately outside of the surf zone to 8 km offshore with depths ranging from 3–15 m. These sites were primarily live-bottom areas with low relief, consisting of rock or marl outcrops that were encrusted with sessile invertebrates such as sponges, gorgonians and bryozoans. Nearshore sampling occurred throughout the year with the exception of February; however, nearshore sampling was most intense from September through mid-December (Table 1). The locations of the fixed estuarine and nearshore sampling areas are shown in Figure 1.

The COASTSPAN gillnet used in this study was 231 m long and 3 m deep and was constructed of #177 monofilament twine with a stretched mesh of 10.3 cm. The net was set and inspected for catch at approximately 20-minute intervals to reduce mortality. The COASTSPAN longline gear consisted of 305 m of 0.64 cm braided nylon mainline which supported the use of 50 gangions. Each gangion consisted of a 0.5 m 91 kg test monofilament leader, size120 stainless steel longline snap, 4/0 swivel and a 12/0 circle hook. Prior to the 2000 sampling year the COASTSPAN longline was allowed to soak for 45-60 minutes and then retrieved. After retrieval the gear was either reset or moved to a new location, depending on catch. High bait loss was noted on most sets and therefore the sampling strategy was modified in 2000 and the handline was under run at 15-20 minute intervals. Red drum longline gear consisted of a 272 kg test monofilament mainline that was 1829 m in length and had 30.5 m buoy lines attached at each end. The mainline was equipped with stop sleeves at 30.5 m intervals to prevent gangions from sliding together when a large fish was captured. The gangions were the same as those used on the COASTSPAN longline with the exception that 14/0 and 15/0 circle hooks were employed. A full set consisted of 120 hooks, although conditions in certain sampling areas dictated that 914 m of mainline and 60 gangions be used. Soak times for red drum longline sets were limited to 45 minutes unless conditions or events dictated otherwise.

Station location, water temperature, salinity, and time of day were recorded for each set for all gear types. The sex, weight, fork length, total length, and umbilical scar condition of all sharks were recorded. Umbilical scar condition was recorded in six categories: "umbilical remains," "fresh open," "partially healed," "mostly healed," "well healed," and none. Sharks were then tagged with either a NMFS blue rototag or steel tipped dart tag (M-tag) and released.

**Data Analysis**

Catch per unit effort (CPUE) in number of sharks per hook hour for longline sets and in number of sharks per hour for gillnet sets were used to examine the relative abundance of small

coastal sharks in South Carolina's estuarine and nearshore waters from 1998 to 2005. The CPUE was standardized using the Lo et al. (2002) method which models the proportion of positive sets separately from the positive catch. This analysis was done for the following dependent variables where the data was appropriate: the small coastal shark complex CPUE, Atlantic sharpnose shark CPUE, bonnethead shark CPUE, finetooth shark CPUE, and blacknose shark CPUE. After initial exploratory analysis, factors considered as potential influences on the CPUE for these analyses were year (1998-2005), month (March – December) and area (each of the estuaries, off beaches and nearshore stations) for all gear types.

The proportion of sets with positive CPUE values was modeled assuming a binomial distribution with a logit link function and the positive CPUE sets were modeled assuming a Poisson distribution with a log link function. Models were fit in a stepwise forward manner adding one potential factor at a time after initially running a null model with no factors included (Gonzáles-Ania et al. 2001, Carlson 2002). Each potential factor was ranked from greatest to least reduction in deviance per degree of freedom when compared to the null model. The factor resulting in the greatest reduction in deviance was then incorporated into the model providing the effect was significant at $\alpha = 0.05$ based on a Chi-Square test, and the deviance per degree freedom was reduced by at least 1% from the less complex model. This process was continued until no additional factors met the criteria for incorporation into the final model. All models in the stepwise approach were fitted using the SAS GENMOD procedure (SAS Institute, Inc.). The final models were run through the SAS GLIMMIX macro to allow fitting of the generalized linear mixed models using the SAS MIXED procedure (Wolfinger, SAS Institute, Inc). The factor "year" was kept in all final models, regardless of its significance, to allow for calculation of indices. The standardized indices of abundance were based on the year effect least square means determined from the combined binomial and Poisson components.

***Results***

**Small coastal shark complex**

A total of 3208, 1276, and 5440 small coastal sharks were caught during 432 gillnet sets, 438 COASTSPAN longline sets, and 947 SCDNR red drum longline sets, respectively from 1998 to 2005 (Table 1). The nominal and relative nominal CPUE by year for each time series are reported in Table 1.

The percentage of sets with zero small coastal shark catch was 6.7% for gillnet, 30.8% for COASTSPAN longline and 30.7% for SCDNR red drum longline sets. The stepwise construction of the binomial model of the probability of catching a small coastal shark and the

Poisson model of positive small coastal shark catch sets for gillnet and both longline time series are detailed in Tables 2-4, respectively. The final binomial model for the gillnet series was "proportion positive small coastal shark sets = month + year" and the final Poisson model for the gillnet time series was "positive small coastal shark sets = month + year". The final binomial model for the COASTSPAN longline series was "proportion positive small coastal shark sets = month + year" and the final Poisson model for the COASTSPAN longline time series was "positive small coastal shark sets = year + area + month". The final binomial model for the red drum longline series was "proportion positive small coastal shark sets = month + year" and the final Poisson model for the red drum longline time series was "positive small coastal shark sets = month + area + year". The resulting relative indices of abundance based on the standardized year effects obtained from the Lo et al. method for small coastal sharks for the gillnet and both longline series are reported in Table 5 and are illustrated in Figure 6.

**Atlantic sharpnose sharks**

A total of 1171, 998, and 4740 Atlantic sharpnose sharks were caught during 432 gillnet sets, 438 COASTSPAN longline sets, and 947 SCDNR red drum longline sets, respectively from 1998 to 2005 (Table 6). Of these Atlantic sharpnose sharks, 1166, 996, and 4707 were measured during gillnet, COASTSPAN longline and SCDNR red drum surveys, respectively. These Atlantic sharpnose sharks ranged in size from 20.4 to 90.3, 23.0 to 92.1, and 21.9 to 103.0 cm fork length for gillnet COASTSPAN longline and SCDNR longline surveys, respectively (Figure 2). The nominal and relative nominal CPUE by year for each time series are reported in Table 6.

The percentage of sets with zero Atlantic sharpnose shark catch was 39.4% for gillnet, 39.5% for COASTSPAN longline and 32.3% for red drum longline sets. The stepwise construction of the binomial model of the probability of catching an Atlantic sharpnose shark and the Poisson model of positive Atlantic sharpnose shark catch sets for gillnet and both longline time series are detailed in Tables 7-9, respectively. The final binomial model for the gillnet series was "proportion positive Atlantic sharpnose shark sets = month + year" and the final Poisson model for the gillnet time series was "positive Atlantic sharpnose shark sets = year + month + area". The final binomial model for the COASTSPAN longline series was "proportion positive Atlantic sharpnose shark sets = month + year" and the final Poisson model for the COASTSPAN longline time series was "positive Atlantic sharpnose shark sets = year + month + area". The final binomial model for the red drum longline series was "proportion positive Atlantic sharpnose shark sets = month + year" and the final Poisson model for the red drum longline time series was "positive Atlantic sharpnose shark sets = month + area + year". The

resulting relative indices of abundance based on the standardized year effects obtained from the Lo et al. method for Atlantic sharpnose sharks for the gillnet and both longline series are reported in Table 10 and are illustrated in Figure 7.

**Bonnethead sharks**

A total of 1207, 56, and 31 bonnethead sharks were caught during 432 gillnet sets, 438 COASTSPAN longline sets, and 947 red drum longline sets, respectively from 1998 to 2005 (Table 11). Of these bonnethead sharks, 1210, 56, and 31 were measured during gillnet, COASTSPAN longline and SCDNR red drum surveys, respectively. These bonnethead sharks ranged in size from 37.1 to 107.4, 41.5 to 99.6, and 64.1 to 100.0 cm fork length for gillnet COASTSPAN longline and SCDNR longline surveys, respectively (Figure 3). The nominal and relative nominal CPUE by year for each time series are reported in Table 11.

The percentage of sets with zero bonnethead shark catch was 30.3% for gillnet, 91.6% for COASTSPAN longline and 97.4% for SCDNR red drum longline sets. The stepwise construction of the binomial model of the probability of catching a bonnethead shark and the Poisson model of positive bonnethead shark catch sets for gillnet and both longline time series are detailed in Tables 12-14, respectively. The final binomial model for the gillnet series was "proportion positive bonnethead shark sets = area + month + year" and the final Poisson model for the gillnet time series was "positive bonnethead shark sets = area + month + year". The final binomial model for the COASTSPAN longline series was "proportion positive bonnethead shark sets = year" and the final Poisson model for the COASTSPAN longline time series was "positive bonnethead shark sets = year". The final binomial model for the red drum longline series was "proportion positive bonnethead shark sets = year" and the final Poisson model for the red drum longline time series was "positive bonnethead shark sets = year". The resulting relative indices of abundance based on the standardized year effects obtained from the Lo et al. method for bonnethead sharks for the gillnet and both longline series are reported in Table 15 and are illustrated in Figure 8.

**Finetooth sharks**

A total of 826, 220, and 52 finetooth sharks were caught during 432 gillnet sets, 438 COASTSPAN longline sets, and 947 red drum longline sets, respectively from 1998 to 2005 (Table 16). Of these finetooth sharks, 829, 218, and 49 were measured during gillnet, COASTSPAN longline and SCDNR red drum surveys, respectively. These finetooth sharks ranged in size from 34.7 to 150.0, 42.0 to 98.7, and 50.6 to 127.0 cm fork length for gillnet

COASTSPAN longline and SCDNR longline surveys, respectively (Figure 4). The nominal and relative nominal CPUE by year for each time series are reported in Table 16.

The percentage of sets with zero finetooth shark catch was 45.6% for gillnet, 79.2% for COASTSPAN longline and 95.5% for red drum longline sets. The stepwise construction of the binomial model of the probability of catching a finetooth shark and the Poisson model of positive bonnethead shark catch sets for gillnet and both longline time series are detailed in Tables 17-19, respectively. The final binomial model for the gillnet series was "proportion positive finetooth shark sets = area + month + year" and the final Poisson model for the gillnet time series was "positive finetooth shark sets = month + area + year". The final binomial model for the COASTSPAN longline series was "proportion positive finetooth shark sets = year" and the final Poisson model for the COASTSPAN longline time series was "positive finetooth shark sets = month + year". The final binomial model for the red drum longline series was "proportion positive finetooth shark sets = year" and the final Poisson model for the red drum longline time series was "positive finetooth shark sets = year". The resulting relative indices of abundance based on the standardized year effects obtained from the Lo et al. method for finetooth sharks for the gillnet and both longline series are reported in Table 20 and are illustrated in Figure 9.

**Blacknose sharks**

A total of 4, 2, and 617 blacknose sharks were caught during 432 gillnet sets, 438 COASTSPAN longline sets, and 947 red drum longline sets, respectively from 1998 to 2005 (Table 21). The blacknose sharks caught during the gillnet (96.5, 101.0, 102.0, and 113.0 cm fork length) and COASTSPAN longline (102.0 and 108.0 cm fork length) were included in the small coastal shark complex analyses, but were not analyzed separately. The measured blacknose sharks (595) caught during the red drum longline survey ranged in size from 48.1 to 117.0 cm fork length (Figure 5). The nominal and relative nominal CPUE by year for blacknose sharks from the red drum longline time series are reported in Table 21.

The percentage of sets with zero blacknose shark catch was 73.2% for SCDNR red drum longline sets. The stepwise construction of the binomial model of the probability of catching a blacknose shark and the Poisson model of positive blacknose shark catch sets for the red drum longline time series are detailed in Table 22. The final binomial model for the red drum longline series was "proportion positive blacknose shark sets = year" and the final Poisson model for the red drum longline time series was "positive blacknose shark sets = month + year + area". The resulting relative indices of abundance based on the standardized year effects obtained from the

Lo et al. method for blacknose sharks for the red drum longline series are reported in Table 23 and are illustrated in Figure 10.

### *References*

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González-Ania, L.V., C.A. Brown, and E. Cortés. 2001. Standardized catch rates for yellowfin tuna (*Thunnus albacares*) in the 1992-1999 Gulf of Mexico longline fishery based upon observer programs from Mexico and the United States. Col. Vol. Sci. Pap. ICCAT 52:222-237.

Lo, N.C., 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. 49:2515-2526.

Table 1. Nominal and nominal relative (CPUE/mean) abundance indices for the small coastal sharks caught by gillnet, COASTSPAN longline and SCDNR red drum longline in South Carolina's estuarine and nearshore waters from 1998-2005. LCL = lower confidence limit, UCL = upper confidence limit, CV = coefficient of variation, and N = the number of sets observed for the nominal relative abundance indices.

**gillnet**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 161 | 0.3216 | 0.7842 | 0.5367 | 1.0317 | 1.6700 | 28 |
| 1999 | 101 | 0.3188 | 0.7773 | 0.6628 | 0.8918 | 0.7066 | 23 |
| 2000 | 204 | 0.2725 | 0.6646 | 0.5786 | 0.7505 | 0.7200 | 31 |
| 2001 | 590 | 0.4318 | 1.0530 | 0.9248 | 1.1812 | 1.2655 | 108 |
| 2002 | 520 | 0.5247 | 1.2795 | 0.9601 | 1.5989 | 2.0735 | 69 |
| 2003 | 1023 | 0.8854 | 2.1590 | 1.6956 | 2.6223 | 2.0247 | 89 |
| 2004 | 73 | 0.1739 | 0.4240 | 0.2654 | 0.5827 | 1.4968 | 16 |
| 2005 | 536 | 0.3521 | 0.8585 | 0.7733 | 0.9437 | 0.8185 | 68 |

**COASTSPAN longline**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 28 | 0.0017 | 0.6974 | 0.3590 | 1.0358 | 1.8792 | 15 |
| 1999 | 142 | 0.0019 | 0.7887 | 0.5991 | 0.9782 | 1.0196 | 18 |
| 2000 | 166 | 0.0034 | 1.3914 | 0.9217 | 1.8611 | 2.9040 | 74 |
| 2001 | 394 | 0.0057 | 2.3411 | 2.0855 | 2.5967 | 0.9264 | 72 |
| 2002 | 106 | 0.0015 | 0.6178 | 0.5216 | 0.7140 | 1.0674 | 47 |
| 2003 | 152 | 0.0021 | 0.8614 | 0.7248 | 0.9979 | 1.1211 | 50 |
| 2004 | 131 | 0.0020 | 0.8273 | 0.6926 | 0.9621 | 1.1633 | 51 |
| 2005 | 157 | 0.0012 | 0.4750 | 0.4048 | 0.5452 | 1.5568 | 111 |

**SCDNR red drum longline**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 967 | 0.0014 | 1.0007 | 0.8853 | 1.1161 | 1.3792 | 143 |
| 1999 | 582 | 0.0007 | 0.5054 | 0.4395 | 0.5713 | 1.3975 | 115 |
| 2000 | 827 | 0.0021 | 1.4348 | 1.2683 | 1.6013 | 1.3131 | 128 |
| 2001 | 622 | 0.0023 | 1.6116 | 1.3192 | 1.9039 | 1.9201 | 112 |
| 2002 | 641 | 0.0018 | 1.2373 | 1.0542 | 1.4205 | 1.6551 | 125 |
| 2003 | 865 | 0.0018 | 1.2685 | 1.1008 | 1.4362 | 1.7236 | 170 |
| 2004 | 211 | 0.0007 | 0.4505 | 0.3595 | 0.5415 | 2.0705 | 105 |
| 2005 | 81 | 0.0007 | 0.4912 | 0.3563 | 0.6262 | 1.9230 | 49 |

Table 2. Results of the stepwise procedure for development of the catch rate model for the small coastal complex for gillnet sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 431 | 212.6737 | 0.4934 | | | | | |
| MONTH | 426 | 183.1318 | 0.4299 | 12.8699 | 12.8699 | -91.5659 | 29.54 | <.0001 |
| YEAR | 424 | 194.5722 | 0.4589 | 6.9923 | | -97.2861 | 18.1 | 0.0115 |
| AREA | 428 | 206.8253 | 0.4832 | 2.0673 | | -103.4127 | 5.85 | 0.1192 |
| MONTH + YEAR | 419 | 174.8301 | 0.4173 | 15.4236 | 2.5537 | -87.4151 | 8.3 | 0.3067 |

**FINAL MODEL: MONTH + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 2445.3 |
| **Schwartz's Bayesian criterion** | 2449.3 |
| **(-2) Res Log likelihood** | 2443.3 |

**Type 3 Test of Fixed Effects**

| | MONTH | YEAR |
|---|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | 0.0091 | 0.4494 |
| **DF** | 4 | 6 |
| **CHI SQUARE** | 13.50 | 5.77 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 402 | 2994.9451 | 7.4501 | | | | | |
| MONTH | 397 | 2857.7012 | 7.1982 | 3.3812 | 3.3812 | 3216.779 | 137.24 | <.0001 |
| YEAR | 395 | 2854.0608 | 7.2255 | 3.0147 | | 3218.5992 | 140.88 | <.0001 |
| AREA | 399 | 2949.4903 | 7.3922 | 0.7772 | | 3170.8845 | 45.45 | <.0001 |
| MONTH + YEAR | 390 | 2724.7150 | 6.9864 | 6.2241 | 2.8429 | 3283.2722 | 129.35 | <.0001 |

**FINAL MODEL: MONTH + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 1359.7 |
| **Schwartz's Bayesian criterion** | 1363.7 |
| **(-2) Res Log likelihood** | 1357.7 |

**Type 3 Test of Fixed Effects**

| | MONTH | YEAR |
|---|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | 0.0581 | 0.0890 |
| **DF** | 5 | 7 |
| **CHI SQUARE** | 10.68 | 12.37 |

Table 3. Results of the stepwise procedure for development of the catch rate model for the small coastal shark complex for COASTSPAN longline sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 437 | 541.0775 | 1.2382 | | | | | |
| MONTH | 431 | 471.8188 | 1.0947 | 11.5894 | 11.5894 | -235.9094 | 69.26 | <.0001 |
| YEAR | 430 | 493.0002 | 1.1465 | 7.4059 | | -246.5001 | 48.08 | <.0001 |
| AREA | 429 | 505.6855 | 1.1788 | 4.7973 | | -252.8427 | Negative of Hessian not positive definite | |
| MONTH + | | | | | | | | |
| YEAR | 424 | 424.5248 | 1.0012 | 19.1407 | 7.5513 | -212.2624 | 47.29 | <.0001 |

**FINAL MODEL: MONTH + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 2078.6 |
| **Schwartz's Bayesian criterion** | 2082.7 |
| **(-2) Res Log likelihood** | 2076.6 |

**Type 3 Test of Fixed Effects**

| | MONTH | YEAR |
|---|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | <.0001 | <.0001 |
| **DF** | 5 | 7 |
| **CHI SQUARE** | 43.65 | 37.55 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 302 | 890.0955 | 2.9473 | | | | | |
| YEAR | 295 | 690.2107 | 2.3397 | 20.6155 | 20.6155 | 626.5799 | 199.88 | <.0001 |
| AREA | 295 | 841.3961 | 2.8522 | 3.2267 | | 550.9872 | 48.70 | <.0001 |
| MONTH | 297 | 853.3483 | 2.8732 | 2.5142 | | 545.0111 | 36.75 | <.0001 |
| YEAR + | | | | | | | | |
| AREA | 288 | 634.9209 | 2.2046 | 25.1993 | 4.5839 | 654.2248 | 55.29 | <.0001 |
| MONTH | 290 | 649.9497 | 2.2412 | 23.9575 | | 646.7104 | 40.26 | <.0001 |
| YEAR + AREA + | | | | | | | | |
| MONTH | 283 | 597.2684 | 2.1105 | 28.3921 | 3.1928 | 673.0511 | 37.65 | <.0001 |

**FINAL MODEL: YEAR + AREA + MONTH**

| | |
|---|---|
| **Akaike's information criterion** | 791.5 |
| **Schwartz's Bayesian criterion** | 795.1 |
| **(-2) Res Log likelihood** | 789.5 |

**Type 3 Test of Fixed Effects**

| | YEAR | AREA | MONTH |
|---|---|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | <.0001 | 0.0097 | 0.0246 |
| **DF** | 7 | 7 | 5 |
| **CHI SQUARE** | 74.68 | 18.56 | 12.87 |

Table 4. Results of the stepwise procedure for development of the catch rate model for the small coastal shark complex for SCDNR red drum longline sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 946 | 1168.4314 | 1.2351 | | | | | |
| MONTH | 936 | 1100.7050 | 1.1760 | 4.7850 | 4.7850 | -550.3525 | 67.73 | <.0001 |
| YEAR | 939 | 1119.7707 | 1.1925 | 3.4491 | | -559.8853 | 48.66 | <.0001 |
| AREA | 929 | 980.9009 | 1.0559 | 14.5089 | | -490.4505 | Negative of Hessian not positive definite | |
| MONTH + | | | | | | | | |
| YEAR | 929 | 1041.2616 | 1.1208 | 9.2543 | 4.4693 | -520.6308 | 59.44 | <.0001 |

**FINAL MODEL: MONTH + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 4101.5 |
| **Schwartz's Bayesian criterion** | 4106.3 |
| **(-2) Res Log likelihood** | 4099.5 |

**Type 3 Test of Fixed Effects**

| | MONTH | YEAR |
|---|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | 0.0001 | <.0001 |
| **DF** | 9 | 7 |
| **CHI SQUARE** | 34.21 | 54.49 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 655 | 5621.3272 | 8.5822 | | | | | |
| MONTH | 645 | 4282.6900 | 6.6398 | 22.6329 | 22.6329 | 5040.7171 | 1338.64 | <.0001 |
| YEAR | 648 | 4893.9906 | 7.5525 | 11.9981 | | 4735.0668 | 727.34 | <.0001 |
| AREA | 638 | 5083.1341 | 7.9673 | 7.1648 | | 4640.4950 | 538.19 | <.0001 |
| MONTH + | | | | | | | | |
| AREA | 628 | 3880.9581 | 6.1799 | 27.9917 | 5.3588 | 5241.5831 | 401.73 | <.0001 |
| YEAR | 638 | 3944.4961 | 6.1826 | 27.9602 | | 5209.8141 | 338.19 | <.0001 |
| MONTH + AREA + | | | | | | | | |
| YEAR | 621 | 3345.5014 | 5.3873 | 37.2271 | 9.2354 | 5509.3114 | 535.46 | <.0001 |

**FINAL MODEL: MONTH + AREA + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 1995.6 |
| **Schwartz's Bayesian criterion** | 2000.0 |
| **(-2) Res Log likelihood** | 1993.6 |

**Type 3 Test of Fixed Effects**

| | MONTH | AREA | YEAR |
|---|---|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | <.0001 | <.0001 | <.0001 |
| **DF** | 10 | 17 | 7 |
| **CHI SQUARE** | 143.46 | 78.68 | 71.86 |

Table 5. Relative (index/mean) standardized abundance indices for the small coastal shark complex caught during gillnet, COASTSPAN longline and SCDNR red drum surveys based on the standardized year effects obtained from the Lo et al. analyses. LCL = lower confidence limit, UCL = upper confidence limit, CV = coefficient of variation, and N = the number of sets observed.

**gillnet**

| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | 19.4117 | 0.6713 | 0.1912 | 1.1514 | 0.3649 | 28 |
| 1999 | . | . | . | . | . | 23 |
| 2000 | 24.3004 | 0.8404 | 0.3575 | 1.3232 | 0.2932 | 31 |
| 2001 | 30.9372 | 1.0699 | 0.7402 | 1.3996 | 0.1572 | 108 |
| 2002 | 26.9742 | 0.9328 | 0.6226 | 1.2430 | 0.1697 | 69 |
| 2003 | 43.6883 | 1.5108 | 1.1362 | 1.8855 | 0.1265 | 89 |
| 2004 | 29.0766 | 1.0055 | -0.0055 | 2.0166 | 0.5130 | 16 |
| 2005 | 28.0288 | 0.9693 | 0.6093 | 1.3293 | 0.1895 | 68 |

**COASTSPAN longline**

| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | 0.1772 | 0.7456 | -7.0645 | 8.5556 | 5.3445 | 15 |
| 1999 | 0.3810 | 1.6030 | -7.3872 | 10.5931 | 2.8615 | 18 |
| 2000 | 0.3763 | 1.5835 | -3.8938 | 7.0607 | 1.7648 | 74 |
| 2001 | 0.4920 | 2.0700 | -0.9988 | 5.1389 | 0.7564 | 72 |
| 2002 | 0.1433 | 0.6028 | -3.5351 | 4.7407 | 3.5021 | 47 |
| 2003 | 0.1362 | 0.5729 | -3.6789 | 4.8247 | 3.7866 | 50 |
| 2004 | 0.1302 | 0.5480 | -3.0789 | 4.1749 | 3.3767 | 51 |
| 2005 | 0.0652 | 0.2742 | -2.3507 | 2.8992 | 4.8837 | 111 |

**SCDNR red drum longline**

| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | 0.1564 | 0.9681 | -0.4097 | 2.3459 | 0.7261 | 143 |
| 1999 | 0.0931 | 0.5762 | -0.6825 | 1.8349 | 1.1145 | 115 |
| 2000 | 0.1487 | 0.9208 | -0.9725 | 2.8141 | 1.0490 | 128 |
| 2001 | 0.2404 | 1.4885 | -0.8357 | 3.8128 | 0.7966 | 112 |
| 2002 | 0.2485 | 1.5385 | -1.0738 | 4.1508 | 0.8663 | 125 |
| 2003 | 0.1969 | 1.2189 | -0.7579 | 3.1958 | 0.8274 | 170 |
| 2004 | 0.0706 | 0.4369 | -1.8269 | 2.7006 | 2.6439 | 105 |
| 2005 | 0.1376 | 0.8520 | -4.2067 | 5.9107 | 3.0293 | 49 |

Table 6. Nominal and nominal relative (CPUE/mean) abundance indices for Atlantic sharpnose sharks caught by gillnet, COASTSPAN longline and SCDNR red drum longline in South Carolina's estuarine and nearshore waters from 1998-2005. LCL = lower confidence limit, UCL = upper confidence limit, CV = coefficient of variation, and N = the number of sets observed for the nominal relative abundance indices.

**gillnet**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 88 | 0.1301 | 0.9563 | 0.6259 | 1.2868 | 1.8284 | 28 |
| 1999 | 30 | 0.0905 | 0.6652 | 0.5048 | 0.8256 | 1.1565 | 23 |
| 2000 | 67 | 0.0830 | 0.6100 | 0.4781 | 0.7420 | 1.2043 | 31 |
| 2001 | 125 | 0.0776 | 0.5705 | 0.4341 | 0.7069 | 2.4843 | 108 |
| 2002 | 129 | 0.0772 | 0.5672 | 0.4455 | 0.6889 | 1.7820 | 69 |
| 2003 | 574 | 0.4979 | 3.6592 | 2.4971 | 4.8212 | 2.9960 | 89 |
| 2004 | 13 | 0.0408 | 0.2999 | 0.0712 | 0.5286 | 3.0503 | 16 |
| 2005 | 145 | 0.0914 | 0.6716 | 0.5741 | 0.7690 | 1.1969 | 68 |

**COASTSPAN longline**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 28 | 0.0017 | 0.9125 | 0.4698 | 1.3553 | 1.8792 | 15 |
| 1999 | 141 | 0.0019 | 1.0195 | 0.7694 | 1.2695 | 1.0405 | 18 |
| 2000 | 95 | 0.0020 | 1.1057 | 0.6471 | 1.5642 | 3.5674 | 74 |
| 2001 | 314 | 0.0041 | 2.2072 | 1.9451 | 2.4694 | 1.0079 | 72 |
| 2002 | 74 | 0.0010 | 0.5576 | 0.4525 | 0.6628 | 1.2929 | 47 |
| 2003 | 118 | 0.0016 | 0.8624 | 0.7075 | 1.0173 | 1.2697 | 50 |
| 2004 | 98 | 0.0015 | 0.8044 | 0.6493 | 0.9595 | 1.3771 | 51 |
| 2005 | 130 | 0.0010 | 0.5307 | 0.4434 | 0.6180 | 1.7335 | 111 |

**SCDNR red drum longline**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 965 | 0.0014 | 1.0116 | 0.8946 | 1.1285 | 1.3823 | 143 |
| 1999 | 567 | 0.0007 | 0.4991 | 0.4328 | 0.5654 | 1.4247 | 115 |
| 2000 | 821 | 0.0021 | 1.4429 | 1.2745 | 1.6113 | 1.3205 | 128 |
| 2001 | 614 | 0.0023 | 1.6113 | 1.3191 | 1.9034 | 1.9189 | 112 |
| 2002 | 624 | 0.0017 | 1.2129 | 1.0261 | 1.3996 | 1.7211 | 125 |
| 2003 | 859 | 0.0018 | 1.2743 | 1.1051 | 1.4435 | 1.7311 | 170 |
| 2004 | 209 | 0.0006 | 0.4506 | 0.3583 | 0.5429 | 2.0999 | 105 |
| 2005 | 81 | 0.0007 | 0.4974 | 0.3608 | 0.6341 | 1.9230 | 49 |

Table 7. Results of the stepwise procedure for development of the catch rate model for the Atlantic sharpnose sharks caught during gillnet sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 431 | 579.1357 | 1.3437 | | | | | |
| MONTH | 426 | 513.9147 | 1.2064 | 10.2181 | 10.2181 | -256.9574 | 65.22 | <.0001 |
| YEAR | 424 | 553.2686 | 1.3049 | 2.8875 | | -276.6343 | 25.87 | 0.0005 |
| AREA | 428 | 576.2552 | 1.3464 | -0.2009 | | -288.1276 | 2.88 | 0.4104 |
| | | | | | | | | |
| MONTH | | | | | | | | |
| YEAR | 419 | 501.7004 | 1.1974 | 10.8878 | 0.6698 | -250.8502 | 12.21 | 0.0937 |

**FINAL MODEL: MONTH + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 1901.6 |
| **Schwartz's Bayesian criterion** | 1905.6 |
| **(-2) Res Log likelihood** | 1899.6 |

**Type 3 Test of Fixed Effects**

| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | MONTH | YEAR |
|---|---|---|
| | <.0001 | 0.1119 |
| **DF** | 4 | 7 |
| **CHI SQUARE** | 42.26 | 11.67 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 402 | 2378.2726 | 5.9161 | | | | | |
| MONTH | 397 | 1945.8153 | 4.9013 | 17.1532 | 17.1532 | 296.1646 | 432.46 | <.0001 |
| YEAR | 395 | 1976.5580 | 5.0039 | 15.4189 | | 280.7932 | 401.71 | <.0001 |
| AREA | 399 | 2193.0848 | 5.4965 | 7.0925 | | 172.5298 | 185.19 | <.0001 |
| | | | | | | | | |
| MONTH + | | | | | | | | |
| YEAR | 390 | 1689.6490 | 4.3324 | 26.7693 | 9.6161 | 424.2477 | 256.91 | <.0001 |
| AREA | 394 | 1779.0992 | 4.5155 | 23.6744 | | 379.5226 | 166.72 | <.0001 |
| | | | | | | | | |
| MONTH + YEAR | | | | | | | | |
| AREA | 387 | 1502.7228 | 3.8830 | 34.3655 | 7.5962 | 517.7108 | 186.93 | <.0001 |

**FINAL MODEL: YEAR + MONTH + AREA**

| | |
|---|---|
| **Akaike's information criterion** | 903.7 |
| **Schwartz's Bayesian criterion** | 907.2 |
| **(-2) Res Log likelihood** | 901.7 |

**Type 3 Test of Fixed Effects**

| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | MONTH | YEAR | AREA |
|---|---|---|---|
| | 0.0001 | <.0001 | 0.0217 |
| **DF** | 5 | 7 | 3 |
| **CHI SQUARE** | 25.65 | 37.81 | 9.66 |

Table 8. Results of the stepwise procedure for development of the catch rate model for the Atlantic sharpnose sharks caught during COASTSPAN longline sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 437 | 587.7281 | 1.3449 | | | | | |
| MONTH | 431 | 509.6574 | 1.1825 | 12.0752 | 12.0752 | -254.8287 | 78.07 | <.0001 |
| YEAR | 430 | 553.6725 | 1.2876 | 4.2605 | | -276.8362 | 34.06 | <.0001 |
| AREA | 429 | 549.3712 | 1.2806 | 4.7810 | | -274.6856 | Negative of Hessian not positive definite | |
| MONTH | | | | | | | | |
| YEAR | 424 | 469.1808 | 1.1066 | 17.7188 | 5.6435 | -234.5904 | 40.48 | <.0001 |

**FINAL MODEL: MONTH + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 1999.9 |
| **Schwartz's Bayesian criterion** | 2004.0 |
| **(-2) Res Log likelihood** | 1997.9 |

**Type 3 Test of Fixed Effects**

| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | MONTH | YEAR |
|---|---|---|
| **DF** | 5 | 7 |
| **CHI SQUARE** | 55.11 | 32.20 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 264 | 690.4923 | 2.6155 | | | | | |
| YEAR | 257 | 534.0274 | 2.0779 | 20.5544 | 20.5544 | 430.4923 | 156.46 | <.0001 |
| MONTH | 259 | 631.1729 | 2.4370 | 6.8247 | | 381.9195 | 59.32 | <.0001 |
| AREA | 257 | 626.6943 | 2.4385 | 6.7673 | | 384.1588 | 63.80 | <.0001 |
| YEAR + | | | | | | | | |
| MONTH | 252 | 462.4860 | 1.8353 | 29.8299 | 9.2755 | 466.263 | 71.54 | <.0001 |
| AREA | 250 | 495.9077 | 1.9836 | 24.1598 | | 449.5521 | 38.12 | <.0001 |
| YEAR + MONTH + | | | | | | | | |
| AREA | 245 | 430.2823 | 1.7563 | 32.8503 | 3.0205 | 482.3648 | 32.20 | <.0001 |

**FINAL MODEL: YEAR + MONTH + AREA**

| | |
|---|---|
| **Akaike's information criterion** | 671.5 |
| **Schwartz's Bayesian criterion** | 675.0 |
| **(-2) Res Log likelihood** | 669.5 |

**Type 3 Test of Fixed Effects**

| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | YEAR | MONTH | AREA |
|---|---|---|---|
| **DF** | 7 | 5 | 7 |
| **CHI SQUARE** | 65.78 | 26.19 | 14.73 |

Table 9. Results of the stepwise procedure for development of the catch rate model for the Atlantic sharpnose sharks caught during SCDNR red drum longline sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 946 | 1191.7106 | 1.2597 | | | | | |
| MONTH | 936 | 1119.3907 | 1.1959 | 5.0647 | 5.0647 | -559.6953 | 72.32 | <.0001 |
| YEAR | 939 | 1139.3255 | 1.2133 | 3.6834 | | -569.6628 | 52.39 | <.0001 |
| AREA | 929 | 984.1673 | 1.0594 | 15.9006 | | -492.0837 | Negative of Hessian not positive definite | |
| MONTH + | | | | | | | | |
| YEAR | 929 | 1056.4814 | 1.1372 | 9.7245 | 4.6598 | -528.2407 | 62.91 | <.0001 |

**FINAL MODEL: MONTH + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 4086.5 |
| **Schwartz's Bayesian criterion** | 4091.3 |
| **(-2) Res Log likelihood** | 4084.5 |

**Type 3 Test of Fixed Effects**

| | | |
|---|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | MONTH | YEAR |
| | <.0001 | <.0001 |
| **DF** | 9 | 7 |
| **CHI SQUARE** | 35.33 | 56.99 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 655 | 5727.8012 | 8.7447 | | | | | |
| MONTH | 645 | 4388.7588 | 6.8043 | 22.1894 | 22.1894 | 4934.6627 | 1339.04 | <.0001 |
| YEAR | 648 | 5000.8545 | 7.7174 | 11.7477 | | 4628.6148 | 726.95 | <.0001 |
| AREA | 638 | 5190.9991 | 8.1364 | 6.9562 | | 4533.5425 | 536.80 | <.0001 |
| MONTH + | | | | | | | | |
| AREA | 628 | 3974.6590 | 6.3291 | 27.6236 | 5.4341 | 5141.7126 | 414.10 | <.0001 |
| YEAR | 638 | 4049.5180 | 6.3472 | 27.4166 | | 5104.2831 | 339.24 | <.0001 |
| MONTH + AREA + | | | | | | | | |
| YEAR | 621 | 3430.8930 | 5.5248 | 36.8212 | 9.1976 | 5413.5956 | 543.77 | <.0001 |

**FINAL MODEL: MONTH + AREA + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 1936.9 |
| **Schwartz's Bayesian criterion** | 1941.3 |
| **(-2) Res Log likelihood** | 1934.9 |

**Type 3 Test of Fixed Effects**

| | | | |
|---|---|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | MONTH | AREA | YEAR |
| | <.0001 | <.0001 | <.0001 |
| **DF** | 10 | 17 | 7 |
| **CHI SQUARE** | 133.76 | 72.93 | 72.95 |

Table 10. Relative (index/mean) standardized abundance indices for the Atlantic sharpnose sharks caught during gillnet, COASTSPAN longline and SCDNR red drum surveys based on the standardized year effects obtained from the Lo et al. analyses. LCL = lower confidence limit, UCL = upper confidence limit, CV = coefficient of variation, and N = the number of sets observed.

**gillnet**

| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | 21.9111 | 1.8051 | 0.4646 | 3.1455 | 0.3789 | 28 |
| 1999 | 13.2995 | 1.0956 | -0.6066 | 2.7979 | 0.7927 | 23 |
| 2000 | 8.3603 | 0.6887 | -0.0365 | 1.4139 | 0.5372 | 31 |
| 2001 | 8.5581 | 0.7050 | 0.2314 | 1.1787 | 0.3428 | 108 |
| 2002 | 6.5162 | 0.5368 | 0.1820 | 0.8917 | 0.3373 | 69 |
| 2003 | 23.3457 | 1.9232 | 1.3114 | 2.5351 | 0.1623 | 89 |
| 2004 | 6.4137 | 0.5284 | -0.7844 | 1.8412 | 1.2677 | 16 |
| 2005 | 8.7049 | 0.7171 | 0.2550 | 1.1792 | 0.3288 | 68 |

**COASTSPAN longline**

| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | 0.1704 | 0.8722 | -5.3492 | 7.0936 | 3.6393 | 15 |
| 1999 | 0.2626 | 1.3440 | -5.2761 | 7.9641 | 2.5130 | 18 |
| 2000 | 0.3971 | 2.0328 | -4.2586 | 8.3242 | 1.5790 | 74 |
| 2001 | 0.3879 | 1.9859 | -1.2006 | 5.1724 | 0.8187 | 72 |
| 2002 | 0.0967 | 0.4952 | -3.2003 | 4.1906 | 3.8077 | 47 |
| 2003 | 0.0973 | 0.4981 | -3.1786 | 4.1748 | 3.7658 | 50 |
| 2004 | 0.0913 | 0.4671 | -2.7049 | 3.6390 | 3.4647 | 51 |
| 2005 | 0.0595 | 0.3047 | -2.0840 | 2.6933 | 4.0002 | 111 |

**SCDNR red drum longline**

| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | 0.1570 | 0.9955 | -0.1711 | 2.1622 | 0.5979 | 143 |
| 1999 | 0.0905 | 0.5740 | -0.4959 | 1.6439 | 0.9509 | 115 |
| 2000 | 0.1471 | 0.9327 | -0.6829 | 2.5483 | 0.8838 | 128 |
| 2001 | 0.2340 | 1.4841 | -0.5095 | 3.4776 | 0.6854 | 112 |
| 2002 | 0.2267 | 1.4377 | -0.8141 | 3.6894 | 0.7991 | 125 |
| 2003 | 0.1976 | 1.2531 | -0.4092 | 2.9154 | 0.6768 | 170 |
| 2004 | 0.0689 | 0.4372 | -1.4824 | 2.3568 | 2.2401 | 105 |
| 2005 | 0.1397 | 0.8857 | -3.3552 | 5.1266 | 2.4429 | 49 |

Table 11. Nominal and nominal relative (CPUE/mean) abundance indices for bonnethead sharks caught by gillnet, COASTSPAN longline and SCDNR red drum longline in South Carolina's estuarine and nearshore waters from 1998-2005. LCL = lower confidence limit, UCL = upper confidence limit, CV = coefficient of variation, and N = the number of sets observed for the nominal relative abundance indices.

**gillnet**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 38 | 0.0853 | 0.5677 | 0.3269 | 0.8085 | 2.2443 | 28 |
| 1999 | 53 | 0.1793 | 1.1937 | 0.9537 | 1.4337 | 0.9642 | 23 |
| 2000 | 93 | 0.1207 | 0.8038 | 0.6846 | 0.9230 | 0.8255 | 31 |
| 2001 | 243 | 0.1861 | 1.2396 | 1.0382 | 1.4410 | 1.6885 | 108 |
| 2002 | 188 | 0.1460 | 0.9722 | 0.7555 | 1.1888 | 1.8511 | 69 |
| 2003 | 251 | 0.1845 | 1.2283 | 0.8821 | 1.5745 | 2.6593 | 89 |
| 2004 | 46 | 0.0987 | 0.6573 | 0.3529 | 0.9617 | 1.8525 | 16 |
| 2005 | 295 | 0.2008 | 1.3374 | 1.1316 | 1.5433 | 1.2694 | 68 |

**COASTSPAN longline**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 0 | 0.0000 | 0.0000 | . | . | . | 15 |
| 1999 | 1 | 2.31E-05 | 0.1698 | 0.0000 | 0.3396 | 4.2426 | 18 |
| 2000 | 6 | 0.0006 | 4.2315 | 0.2676 | 8.1954 | 8.0584 | 74 |
| 2001 | 6 | 7.59E-05 | 0.5569 | 0.3038 | 0.8100 | 3.8570 | 72 |
| 2002 | 1 | 1.42E-05 | 0.1041 | 0.0000 | 0.2081 | 6.8557 | 47 |
| 2003 | 10 | 0.0001 | 0.9396 | 0.5908 | 1.2883 | 2.6247 | 50 |
| 2004 | 15 | 0.0002 | 1.2316 | 0.7742 | 1.6889 | 2.6518 | 51 |
| 2005 | 17 | 0.0001 | 0.7666 | 0.5029 | 1.0304 | 3.6243 | 111 |

**SCDNR red drum longline**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 0 | 0.0000 | 0.0000 | . | . | . | 143 |
| 1999 | 3 | 5.05E-06 | 0.4140 | 0.0669 | 0.7612 | 8.9906 | 115 |
| 2000 | 0 | 0.0000 | 0.0000 | . | . | . | 128 |
| 2001 | 0 | 0.0000 | 0.0000 | . | . | . | 112 |
| 2002 | 11 | 3.34E-05 | 2.7376 | 1.6887 | 3.7865 | 4.2836 | 125 |
| 2003 | 13 | 3.89E-05 | 3.1906 | 2.0834 | 4.2978 | 4.5245 | 170 |
| 2004 | 2 | 7.14E-06 | 0.5860 | 0.1711 | 1.0010 | 7.2560 | 105 |
| 2005 | 2 | 1.31E-05 | 1.0718 | 0.3151 | 1.8284 | 4.9423 | 49 |

Table 12. Results of the stepwise procedure for development of the catch rate model for the bonnethead sharks caught during gillnet sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 431 | 528.4628 | 1.2261 | | | | | |
| AREA | 428 | 502.6337 | 1.1744 | 4.2166 | 4.2166 | -251.3168 | 25.83 | <.0001 |
| MONTH | 426 | 498.6815 | 1.1706 | 4.5265 | | -249.3408 | 29.78 | <.0001 |
| YEAR | 424 | 506.2683 | 1.1940 | 2.6181 | | -253.1342 | 22.19 | 0.0024 |
| AREA + | | | | | | | | |
| MONTH | 423 | 473.3782 | 1.1191 | 8.7269 | 4.5102 | -236.6891 | 29.26 | <.0001 |
| YEAR | 421 | 479.5469 | 1.1391 | 7.0957 | | -239.7734 | 23.09 | 0.0016 |
| AREA + MONTH + | | | | | | | | |
| YEAR | 416 | 459.4335 | 1.1044 | 9.9258 | 1.1989 | -229.7168 | 13.94 | 0.0522 |

**FINAL MODEL: AREA + MONTH + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 2022.2 |
| **Schwartz's Bayesian criterion** | 2026.3 |
| **(-2) Res Log likelihood** | 2020.2 |

**Type 3 Test of Fixed Effects**

| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | AREA | MONTH | YEAR |
|---|---|---|---|
| | <.0001 | 0.0071 | 0.0868 |
| **DF** | 3 | 5 | 7 |
| **CHI SQUARE** | 21.40 | 15.93 | 12.45 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 301 | 1167.0118 | 3.8771 | | | | | |
| AREA | 298 | 986.9249 | 3.3118 | 14.5805 | 14.5805 | 429.3361 | 180.09 | <.0001 |
| MONTH | 296 | 1004.3006 | 3.3929 | 12.4887 | | 420.6482 | 162.71 | <.0001 |
| YEAR | 294 | 1108.474 | 3.7703 | 2.7546 | | 368.5615 | 58.54 | <.0001 |
| AREA + | | | | | | | | |
| MONTH | 293 | 868.8421 | 2.9653 | 23.5176 | 8.9371 | 488.3774 | 118.08 | <.0001 |
| YEAR | 291 | 943.7690 | 3.2432 | 16.3498 | | 450.914 | 43.16 | <.0001 |
| AREA + MONTH + | | | | | | | | |
| YEAR | 286 | 842.537 | 2.9459 | 24.0180 | 0.5004 | 501.5300 | 26.31 | 0.0004 |

**FINAL MODEL: AREA + MONTH + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 948.8 |
| **Schwartz's Bayesian criterion** | 952.5 |
| **(-2) Res Log likelihood** | 946.8 |

**Type 3 Test of Fixed Effects**

| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | AREA | MONTH | YEAR |
|---|---|---|---|
| | <.0001 | 0.0003 | 0.5359 |
| **DF** | 3 | 5 | 7 |
| **CHI SQUARE** | 27.11 | 23.48 | 6.03 |

Table 13. Results of the stepwise procedure for development of the catch rate model for bonnethead sharks caught during COASTSPAN longline sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 437 | 253.6588 | 0.5805 | | | | | |
| YEAR | 430 | 242.3382 | 0.5636 | 2.9113 | 2.9113 | -121.1691 | 11.32 | 0.1252 |
| MONTH | 431 | 244.9109 | 0.5682 | 2.1189 | | -122.4555 | 8.75 | 0.1883 |
| AREA | 429 | 248.6868 | 0.5797 | 0.1378 | | -124.3434 | Negative of Hessian not positive definite | |

**FINAL MODEL: YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 2321.9 |
| **Schwartz's Bayesian criterion** | 2325.9 |
| **(-2) Res Log likelihood** | 2319.9 |

**Type 3 Test of Fixed Effects**

| | |
|---|---|
| **Significance (Pr>Chi) of Type 3** | YEAR |
| **test of fixed effects for each factor** | 0.3033 |
| **DF** | 6 |
| **CHI SQUARE** | 7.19 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 36 | 24.4106 | 0.6781 | | | | | |
| AREA | 32 | 21.4706 | 0.6710 | 1.0470 | 1.0470 | -36.3239 | 2.94 | 0.5679 |
| MONTH | 31 | 21.7499 | 0.7016 | -3.4656 | | -36.4636 | 2.66 | 0.7521 |
| YEAR | 30 | 22.4856 | 0.7495 | -10.5294 | | -36.8314 | 1.92 | 0.9265 |

**FINAL MODEL: YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 123.8 |
| **Schwartz's Bayesian criterion** | 125.2 |
| **(-2) Res Log likelihood** | 121.8 |

**Type 3 Test of Fixed Effects**

| | |
|---|---|
| **Significance (Pr>Chi) of Type 3** | YEAR |
| **test of fixed effects for each factor** | 0.9981 |
| **DF** | 6 |
| **CHI SQUARE** | 0.48 |

Table 14. Results of the stepwise procedure for development of the catch rate model for bonnethead sharks caught during SCDNR red drum longline sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 946 | 231.0553 | 0.2442 | | | | | |
| YEAR | 939 | 197.6539 | 0.2105 | 13.8002 | 13.8002 | -98.8269 | 33.40 | <.0001 |
| AREA | 929 | 171.6796 | 0.1848 | 24.3243 | | -85.8398 | Negative of Hessian not positive definite | |
| MONTH | 936 | 185.752 | 0.1985 | 18.7142 | | -92.876 | Negative of Hessian not positive definite | |

**FINAL MODEL: YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 3473.0 |
| **Schwartz's Bayesian criterion** | 3477.4 |
| **(-2) Res Log likelihood** | 3471.0 |

**Type 3 Test of Fixed Effects**

| | |
|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | YEAR 0.2310 |
| **DF** | 4 |
| **CHI SQUARE** | 5.60 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 24 | 9.4307 | 0.3929 | | | | | |
| AREA | 18 | 5.2793 | 0.2933 | 25.3500 | 25.3500 | -25.3219 | 4.15 | 0.6562 |
| MONTH | 20 | 6.7236 | 0.3362 | 14.4312 | | -26.0441 | 2.71 | 0.6080 |
| YEAR | 20 | 6.8988 | 0.3449 | 12.2168 | | -26.1316 | 2.53 | 0.6389 |

**FINAL MODEL: YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 45.4 |
| **Schwartz's Bayesian criterion** | 46.4 |
| **(-2) Res Log likelihood** | 43.4 |

**Type 3 Test of Fixed Effects**

| | |
|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | YEAR 0.2798 |
| **DF** | 4 |
| **CHI SQUARE** | 5.07 |

Table 15. Relative (index/mean) standardized abundance indices for bonnethead sharks caught during gillnet, COASTSPAN longline and SCDNR red drum surveys based on the standardized year effects obtained from the Lo et al. analyses. LCL = lower confidence limit, UCL = upper confidence limit, CV = coefficient of variation, and N = the number of sets observed.

**gillnet**

| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | 5.1129 | 0.4019 | -0.3266 | 1.1304 | 0.9248 | 28 |
| 1999 | 13.2331 | 1.0402 | 0.1106 | 1.9698 | 0.4559 | 23 |
| 2000 | 12.3695 | 0.9723 | 0.1836 | 1.7611 | 0.4139 | 31 |
| 2001 | 13.0919 | 1.0291 | 0.5528 | 1.5055 | 0.2362 | 108 |
| 2002 | 10.3156 | 0.8109 | 0.3533 | 1.2684 | 0.2879 | 69 |
| 2003 | 14.2988 | 1.1240 | 0.6048 | 1.6432 | 0.2357 | 89 |
| 2004 | 17.2291 | 1.3543 | -0.5384 | 3.2470 | 0.7130 | 16 |
| 2005 | 16.1206 | 1.2672 | 0.7149 | 1.8195 | 0.2224 | 68 |

**COASTSPAN longline**

| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | . | . | . | . | . | 15 |
| 1999 | 0.0023 | 0.2816 | -129.7470 | 130.3106 | 235.6186 | 18 |
| 2000 | 0.0058 | 0.6995 | -86.5948 | 87.9937 | 63.6753 | 74 |
| 2001 | 0.0076 | 0.9299 | -99.6766 | 101.5364 | 55.1975 | 72 |
| 2002 | 0.0014 | 0.1725 | -102.5230 | 102.8681 | 303.6872 | 47 |
| 2003 | 0.0128 | 1.5552 | -101.6650 | 104.7756 | 33.8639 | 50 |
| 2004 | 0.0176 | 2.1398 | -103.1590 | 107.4386 | 25.1068 | 51 |
| 2005 | 0.0100 | 1.2216 | -73.0978 | 75.5409 | 31.0407 | 111 |

**SCDNR red drum longline**

| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | . | . | . | . | . | 143 |
| 1999 | 0.2162 | 0.2162 | -100.2520 | 100.6841 | 237.1248 | 115 |
| 2000 | . | . | . | . | . | 128 |
| 2001 | . | . | . | . | . | 112 |
| 2002 | 1.7380 | 1.7380 | -142.0810 | 145.5566 | 42.2187 | 125 |
| 2003 | 1.9086 | 1.9086 | -131.5500 | 135.3674 | 35.6767 | 170 |
| 2004 | 0.4034 | 0.4034 | -151.4140 | 152.2203 | 192.0291 | 105 |
| 2005 | 0.7339 | 0.7339 | -202.9010 | 204.3687 | 141.5693 | 49 |

Table 16. Nominal and nominal relative (CPUE/mean) abundance indices for finetooth sharks caught by gillnet, COASTSPAN longline and SCDNR red drum longline in South Carolina's estuarine and nearshore waters from 1998-2005. LCL = lower confidence limit, UCL = upper confidence limit, CV = coefficient of variation, and N = the number of sets observed for the nominal relative abundance indices.

**gillnet**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 35 | 0.1062 | 0.8597 | 0.4401 | 1.2794 | 2.5827 | 28 |
| 1999 | 18 | 0.0490 | 0.3965 | 0.2621 | 0.5310 | 1.6257 | 23 |
| 2000 | 44 | 0.0688 | 0.5570 | 0.3546 | 0.7595 | 2.0238 | 31 |
| 2001 | 220 | 0.1667 | 1.3491 | 1.0938 | 1.6043 | 1.9660 | 108 |
| 2002 | 203 | 0.3016 | 2.4408 | 1.5496 | 3.3321 | 3.0331 | 69 |
| 2003 | 198 | 0.2031 | 1.6436 | 1.2434 | 2.0437 | 2.2967 | 89 |
| 2004 | 14 | 0.0344 | 0.2783 | 0.1702 | 0.3863 | 1.5530 | 16 |
| 2005 | 94 | 0.0587 | 0.4749 | 0.3971 | 0.5528 | 1.3519 | 68 |

**COASTSPAN longline**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 0 | 0.0000 | 0.0000 | . | . | . | 15 |
| 1999 | 0 | 0.0000 | 0.0000 | . | . | . | 18 |
| 2000 | 65 | 0.0007 | 1.7285 | 1.2365 | 2.2206 | 2.4488 | 74 |
| 2001 | 72 | 0.0015 | 3.4422 | 2.2845 | 4.5998 | 2.8537 | 72 |
| 2002 | 31 | 0.0005 | 1.0411 | 0.7456 | 1.3367 | 1.9462 | 47 |
| 2003 | 24 | 0.0004 | 0.8374 | 0.5004 | 1.1744 | 2.8460 | 50 |
| 2004 | 18 | 0.0003 | 0.8033 | 0.5269 | 1.0797 | 2.4575 | 51 |
| 2005 | 10 | 6.38E-05 | 0.1475 | 0.0961 | 0.1989 | 3.6714 | 111 |

**SCDNR red drum longline**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 1 | 1.30E-06 | 0.0771 | 1.26E-17 | 0.1543 | 11.9583 | 143 |
| 1999 | 14 | 1.69E-05 | 1.0065 | 0.6587 | 1.3542 | 3.7054 | 115 |
| 2000 | 6 | 1.42E-05 | 0.8477 | 0.5022 | 1.1933 | 4.6119 | 128 |
| 2001 | 8 | 2.94E-05 | 1.7524 | 1.0533 | 2.4514 | 4.2216 | 112 |
| 2002 | 17 | 5.72E-05 | 3.4091 | 2.3560 | 4.4623 | 3.4538 | 125 |
| 2003 | 5 | 1.26E-05 | 0.7495 | 0.3092 | 1.1899 | 7.6596 | 170 |
| 2004 | 1 | 2.65E-06 | 0.1576 | 0.0000 | 0.3152 | 10.2470 | 105 |
| 2005 | 0 | 0.0000 | 0.0000 | . | . | . | 49 |

Table 17. Results of the stepwise procedure for development of the catch rate model for finetooth sharks caught during gillnet sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 431 | 595.5322 | 1.3817 | | | | | |
| AREA | 428 | 526.7597 | 1.2307 | 10.9286 | 10.9286 | -263.3798 | 68.77 | <.0001 |
| MONTH | 426 | 570.0731 | 1.3382 | 3.1483 | | -285.0366 | 25.46 | 0.0001 |
| YEAR | 424 | 584.2823 | 1.3780 | 0.2678 | | -292.1411 | 11.25 | 0.1281 |
| AREA + | | | | | | | | |
| MONTH | 423 | 473.6771 | 1.1198 | 18.9549 | 8.0263 | -236.8385 | 53.08 | <.0001 |
| YEAR | 421 | 516.8823 | 1.2277 | 11.1457 | | -258.4411 | 9.88 | 0.1956 |
| AREA + MONTH | | | | | | | | |
| YEAR | 416 | 469.2258 | 1.1279 | 18.3687 | -0.5862 | -234.6129 | 4.45 | 0.7266 |

**FINAL MODEL: AREA + MONTH + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 1907.2 |
| **Schwartz's Bayesian criterion** | 1911.2 |
| **(-2) Res Log likelihood** | 1905.2 |

**Type 3 Test of Fixed Effects**

| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | AREA | MONTH | YEAR |
|---|---|---|---|
| | <.0001 | <.0001 | 0.7367 |
| **DF** | 2 | 4 | 7 |
| **CHI SQUARE** | 65.64 | 27.74 | 4.37 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 234 | 1107.4938 | 4.7329 | | | | | |
| MONTH | 230 | 999.9139 | 4.3475 | 8.1430 | 8.1430 | 116.6067 | 107.58 | <.0001 |
| AREA | 232 | 1008.5367 | 4.3471 | 8.1515 | | 112.2953 | 98.96 | <.0001 |
| YEAR | 227 | 1013.7344 | 4.4658 | 5.6435 | | 109.6965 | 93.76 | <.0001 |
| MONTH + | | | | | | | | |
| AREA | 228 | 840.6321 | 3.6870 | 22.0985 | 13.9555 | 196.2476 | 167.90 | <.0001 |
| YEAR | 223 | 834.2268 | 3.7409 | 20.9597 | | 199.4503 | 165.69 | <.0001 |
| MONTH + AREA + | | | | | | | | |
| YEAR | 221 | 730.3486 | 3.3047 | 30.1760 | 8.0775 | 251.3894 | 110.28 | <.0001 |

**FINAL MODEL: MONTH + AREA + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 908.0 |
| **Schwartz's Bayesian criterion** | 911.4 |
| **(-2) Res Log likelihood** | 906.0 |

**Type 3 Test of Fixed Effects**

| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | MONTH | AREA | YEAR |
|---|---|---|---|
| | <.0001 | 0.0022 | 0.0556 |
| **DF** | 4 | 2 | 7 |
| **CHI SQUARE** | 26.35 | 12.24 | 13.76 |

Table 18. Results of the stepwise procedure for development of the catch rate model for finetooth sharks caught during COASTSPAN longline sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 437 | 447.6159 | 1.0243 | | | | | |
| YEAR | 430 | 408.1965 | 0.9493 | 7.3221 | 7.3221 | -204.0982 | 39.42 | <.0001 |
| MONTH | 431 | 427.7820 | 0.9925 | 3.1046 | | -213.8910 | 19.83 | 0.0030 |
| AREA | 429 | 427.1919 | 0.9958 | 2.7824 | | -213.5959 | Negative of Hessian not positive definite | |
| YEAR + | | | | | | | | |
| MONTH | 424 | 390.3429 | 0.9206 | 10.1240 | 2.8019 | -195.1715 | Negative of Hessian not positive definite | |

**FINAL MODEL: YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 1918.0 |
| **Schwartz's Bayesian criterion** | 1922.0 |
| **(-2) Res Log likelihood** | 1916.0 |

**Type 3 Test of Fixed Effects**

| | |
|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | YEAR 0.0030 |
| **DF** | 5 |
| **CHI SQUARE** | 17.98 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 90 | 221.2603 | 2.4584 | | | | | |
| MONTH | 86 | 159.1598 | 1.8507 | 24.7193 | 24.7193 | -30.8096 | 62.10 | <.0001 |
| YEAR | 85 | 177.2727 | 2.0856 | 15.1643 | | -39.8660 | 43.99 | <.0001 |
| AREA | 87 | 202.2770 | 2.3250 | 5.4263 | | -52.3681 | 18.98 | 0.0003 |
| MONTH + | | | | | | | | |
| YEAR | 81 | 141.7804 | 1.7504 | 28.7992 | 4.0799 | -22.1199 | 17.38 | 0.0038 |
| AREA | 83 | 151.4218 | 1.8244 | 25.7891 | | -26.9405 | 7.74 | 0.0517 |

**FINAL MODEL: MONTH + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 265.4 |
| **Schwartz's Bayesian criterion** | 267.8 |
| **(-2) Res Log likelihood** | 263.4 |

**Type 3 Test of Fixed Effects**

| | | |
|---|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | MONTH 0.0093 | YEAR 0.2827 |
| **DF** | 4 | 5 |
| **CHI SQUARE** | 13.45 | 6.25 |

Table 19. Results of the stepwise procedure for development of the catch rate model for finetooth sharks caught during SCDNR red drum longline sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 946 | 349.9378 | 0.3699 | | | | | |
| YEAR | 939 | 317.9995 | 0.3387 | 8.4347 | 8.4347 | -158.9997 | 31.94 | <.0001 |
| MONTH | 936 | 299.8134 | 0.3203 | 13.4090 | | -149.9067 | Negative of Hessian not positive definite | |
| AREA | 929 | 295.3657 | 0.3179 | 14.0579 | | -147.6828 | Negative of Hessian not positive definite | |

**FINAL MODEL: YEAR**

| | |
|---|---|
| **Akaike's informa** | 5681.7 |
| **Schwartz's Baye** | 5686.5 |
| **(-2) Res Log like** | 5679.7 |

**Type 3 Test of Fixed Effects**

| | |
|---|---|
| **Significance (Pr>Chi) of Type 3** | YEAR |
| **test of fixed effects for each fact** | 0.0045 |
| **DF** | 6 |
| **CHI SQUARE** | 18.82 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 42 | 17.8533 | 0.4251 | | | | | |
| AREA | 37 | 10.3581 | 0.2799 | 34.1567 | 34.1567 | -43.6559 | 7.50 | 0.1863 |
| YEAR | 36 | 12.4779 | 0.3466 | 18.4662 | | -44.7158 | 5.38 | 0.4966 |
| MONTH | 37 | 15.2206 | 0.4114 | 3.2228 | | -46.0872 | 2.63 | 0.7564 |

**FINAL MODEL: YEAR**

| | |
|---|---|
| **Akaike's informa** | 79.3 |
| **Schwartz's Baye** | 80.9 |
| **(-2) Res Log like** | 77.3 |

**Type 3 Test of Fixed Effects**

| | |
|---|---|
| **Significance (Pr>Chi) of Type 3** | YEAR |
| **test of fixed effects for each fact** | 0.0493 |
| **DF** | 6 |
| **CHI SQUARE** | 12.63 |

Table 20. Relative (index/mean) standardized abundance indices for finetooth sharks caught during gillnet, COASTSPAN longline and SCDNR red drum surveys based on the standardized year effects obtained from the Lo et al. analyses. LCL = lower confidence limit, UCL = upper confidence limit, CV = coefficient of variation, and N = the number of sets observed.

**gillnet**

| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | 6.3027 | 0.7656 | -0.5106 | 2.0419 | 0.8505 | 28 |
| 1999 | 4.8784 | 0.5926 | -0.8791 | 2.0644 | 1.2670 | 23 |
| 2000 | 6.4227 | 0.7802 | -0.4169 | 1.9774 | 0.7829 | 31 |
| 2001 | 13.0242 | 1.5822 | 0.7026 | 2.4617 | 0.2836 | 108 |
| 2002 | 12.7509 | 1.5490 | 0.5060 | 2.5919 | 0.3435 | 69 |
| 2003 | 13.7536 | 1.6708 | 0.6490 | 2.6925 | 0.3120 | 89 |
| 2004 | 2.8640 | 0.3479 | -1.0118 | 1.7076 | 1.9939 | 16 |
| 2005 | 5.8580 | 0.7116 | 0.0102 | 1.4131 | 0.5029 | 68 |

**COASTSPAN longline**

| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | . | . | . | . | . | 15 |
| 1999 | . | . | . | . | . | 18 |
| 2000 | 0.0737 | 1.4119 | -15.1701 | 17.9939 | 5.9920 | 74 |
| 2001 | 0.0901 | 1.7281 | -14.0979 | 17.5542 | 4.6724 | 72 |
| 2002 | 0.0560 | 1.0743 | -16.7551 | 18.9036 | 8.4678 | 47 |
| 2003 | 0.0471 | 0.9029 | -19.8877 | 21.6935 | 11.7478 | 50 |
| 2004 | 0.0389 | 0.7460 | -17.2009 | 18.6930 | 12.2737 | 51 |
| 2005 | 0.0071 | 0.1368 | -9.6559 | 9.9294 | 36.5340 | 111 |

**SCDNR red drum longline**

| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | 0.0001 | 0.0775 | -52.6116 | 52.7666 | 346.8456 | 143 |
| 1999 | 0.0017 | 1.0088 | -54.6868 | 56.7044 | 28.1674 | 115 |
| 2000 | 0.0014 | 0.8251 | -68.6478 | 70.2980 | 42.9575 | 128 |
| 2001 | 0.0021 | 1.2346 | -71.8853 | 74.3546 | 30.2161 | 112 |
| 2002 | 0.0051 | 3.0436 | -78.7224 | 84.8096 | 13.7065 | 125 |
| 2003 | 0.0011 | 0.6520 | -71.3102 | 72.6141 | 56.3160 | 170 |
| 2004 | 0.0003 | 0.1583 | -75.1019 | 75.4186 | 242.5173 | 105 |
| 2005 | . | . | . | . | . | 49 |

Table 21. Nominal and nominal relative (CPUE/mean) abundance indices for blacknose sharks caught by SCDNR red drum longline in South Carolina's nearshore waters from 1998-2005. LCL = lower confidence limit, UCL = upper confidence limit, CV = coefficient of variation, and N = the number of sets observed for the nominal relative abundance indices.

**SCDNR red drum longline**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 75 | 0.0001 | 0.5213 | 0.4341 | 0.6086 | 2.0017 | 0.5213 |
| 1999 | 50 | 0.0001 | 0.2942 | 0.2219 | 0.3665 | 2.6343 | 0.2942 |
| 2000 | 148 | 0.0004 | 1.6151 | 1.2972 | 1.9329 | 2.2264 | 1.6151 |
| 2001 | 43 | 0.0002 | 0.7885 | 0.4798 | 1.0972 | 4.1436 | 0.7885 |
| 2002 | 99 | 0.0003 | 1.3326 | 1.0446 | 1.6206 | 2.4164 | 1.3326 |
| 2003 | 122 | 0.0003 | 1.1499 | 0.9647 | 1.3351 | 2.1001 | 1.1499 |
| 2004 | 41 | 0.0001 | 0.5940 | 0.4553 | 0.7328 | 2.3937 | 0.5940 |
| 2005 | 39 | 0.0004 | 1.7044 | 1.0260 | 2.3828 | 2.7863 | 1.7044 |

Table 22. Results of the stepwise procedure for development of the catch rate model for blacknose sharks caught during SCDNR red drum longline sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 946 | 1101.3151 | 1.1642 | | | | | |
| YEAR | 939 | 1081.3917 | 1.1516 | 1.0823 | 1.0823 | -540.6959 | 19.92 | 0.0057 |
| MONTH | 936 | 962.7825 | 1.0286 | 11.6475 | | -481.3913 | Negative of Hessian not positive definite | |
| AREA | 929 | 1018.9379 | 1.0968 | 5.7894 | | -509.4689 | Negative of Hessian not positive definite | |

**FINAL MODEL: YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 4274.0 |
| **Schwartz's Bayesian criterion** | 4278.9 |
| **(-2) Res Log likelihood** | 4272.0 |

**Type 3 Test of Fixed Effects**

| | YEAR |
|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | 0.0095 |
| **DF** | 7 |
| **CHI SQUARE** | 18.60 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 253 | 562.3976 | 2.2229 | | | | | |
| MONTH | 245 | 406.3131 | 1.6584 | 25.3948 | 25.3948 | -59.4691 | 156.08 | <.0001 |
| YEAR | 246 | 416.4655 | 1.6929 | 23.8427 | | -64.5454 | 145.93 | <.0001 |
| AREA | 241 | 494.7043 | 2.0527 | 7.6567 | | -103.6647 | 67.69 | <.0001 |
| MONTH + | | | | | | | | |
| YEAR | 238 | 331.6626 | 1.3935 | 37.3116 | 11.9169 | -22.1439 | 74.65 | <.0001 |
| AREA | 233 | 354.7870 | 1.5227 | 31.4994 | | -33.7061 | 51.53 | <.0001 |
| MONTH + YEAR + | | | | | | | | |
| AREA | 226 | 282.5237 | 1.2501 | 43.7627 | 6.4510 | 2.4256 | 72.26 | <.0001 |

**FINAL MODEL: MONTH + YEAR + AREA**

| | |
|---|---|
| **Akaike's information criterion** | 629.4 |
| **Schwartz's Bayesian criterion** | 632.8 |
| **(-2) Res Log likelihood** | 627.4 |

**Type 3 Test of Fixed Effects**

| | MONTH | YEAR | AREA |
|---|---|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | <.0001 | <.0001 | 0.0016 |
| **DF** | 8 | 7 | 12 |
| **CHI SQUARE** | 64.94 | 49.90 | 31.66 |

Table 23. Relative (index/mean) standardized abundance indices for blacknose sharks caught during SCDNR red drum surveys based on the standardized year effects obtained from the Lo et al. analyses. LCL = lower confidence limit, UCL = upper confidence limit, CV = coefficient of variation, and N = the number of sets observed.

**SCDNR red drum longline**

| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | 0.0155 | 0.6906 | -3.3926 | 4.7737 | 3.0166 | 143 |
| 1999 | 0.0077 | 0.3431 | -3.3906 | 4.0769 | 5.5520 | 115 |
| 2000 | 0.0334 | 1.4873 | -3.7690 | 6.7436 | 1.8031 | 128 |
| 2001 | 0.0162 | 0.7208 | -5.3579 | 6.7994 | 4.3029 | 112 |
| 2002 | 0.0347 | 1.5446 | -4.3956 | 7.4847 | 1.9622 | 125 |
| 2003 | 0.0226 | 1.0086 | -3.2143 | 5.2316 | 2.1361 | 170 |
| 2004 | 0.0152 | 0.6771 | -4.9448 | 6.2989 | 4.2364 | 105 |
| 2005 | 0.0343 | 1.5280 | -9.2465 | 12.3024 | 3.5977 | 49 |

Figure 1. Fixed nearshore and estuarine sampling stations

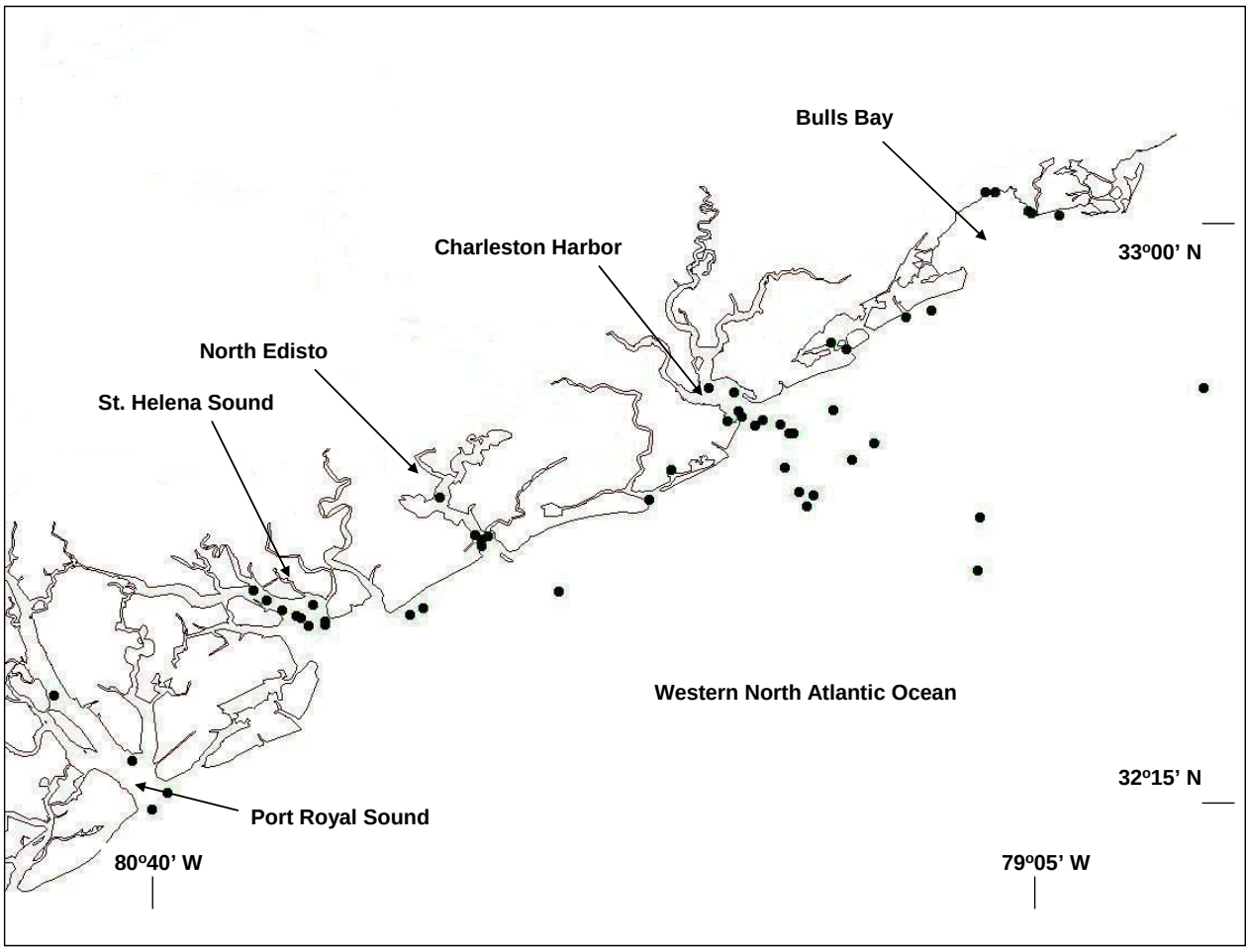
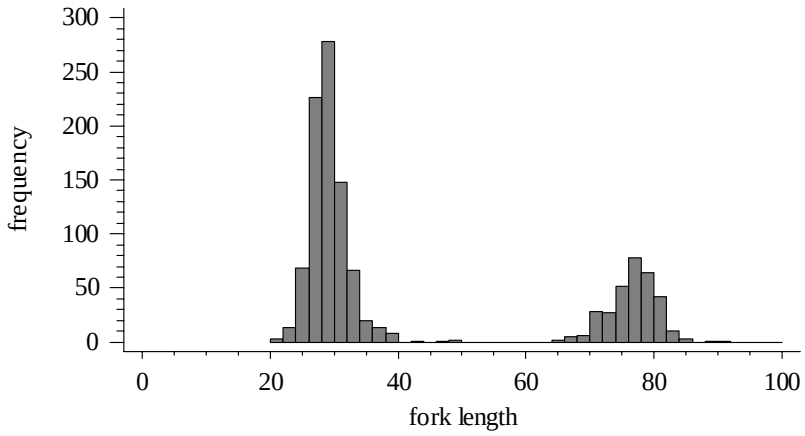
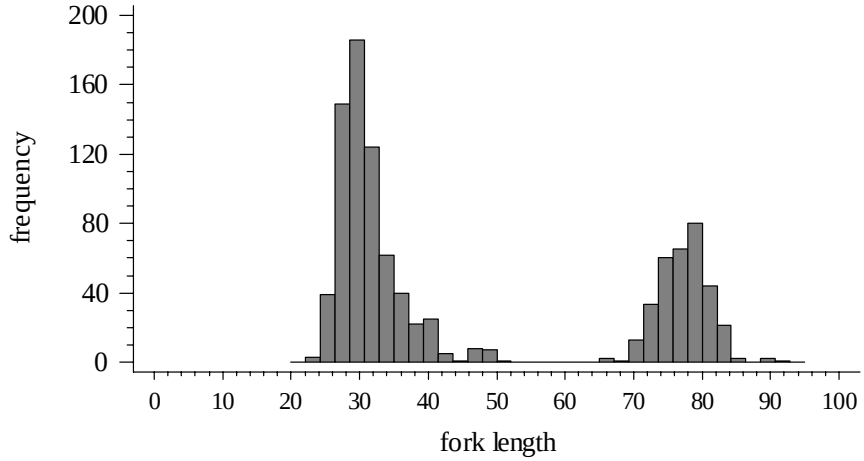


Figure 2. Length frequencies for Atlantic sharpnose sharks caught during A) gillnet, B) COASTPAN longline and C) SCDNR red drum longline sets.

**A**




**B**




**C**

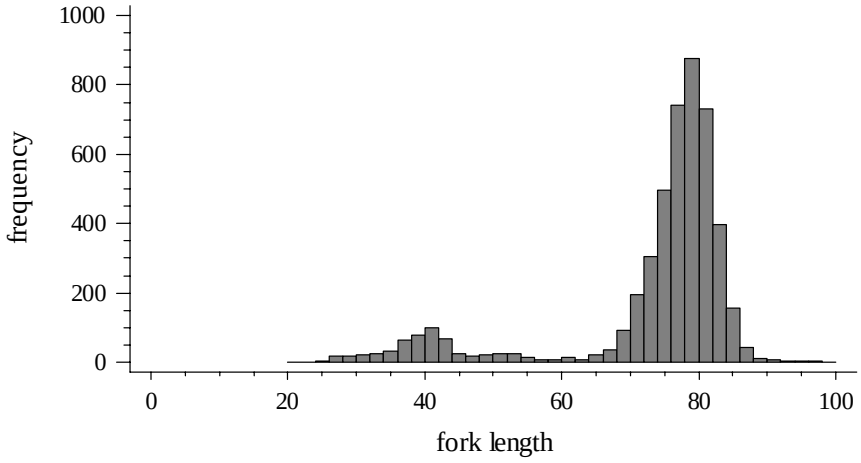
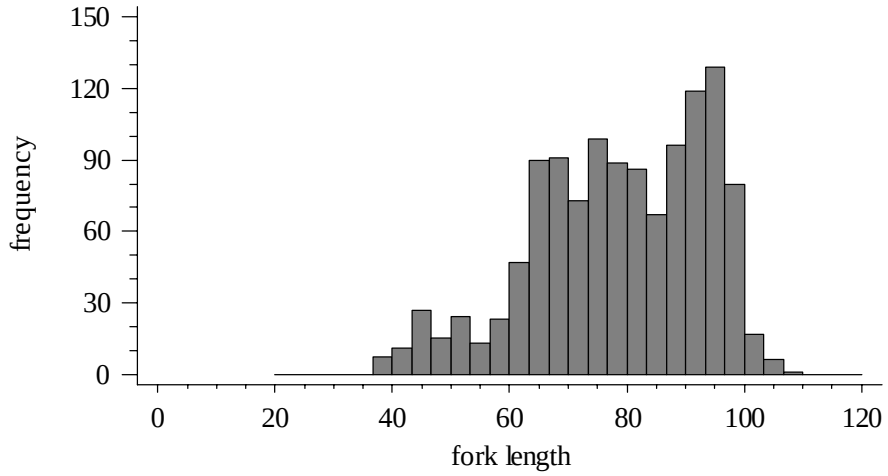
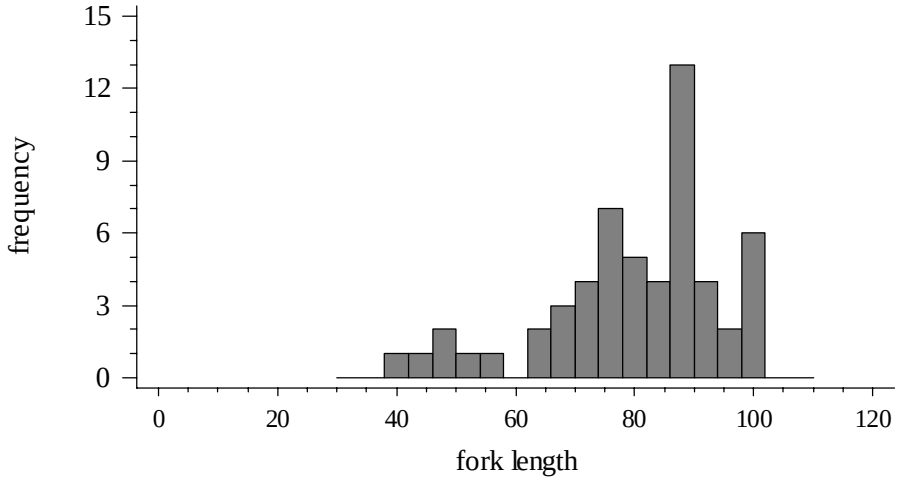


Figure 3. Length frequencies for bonnethead sharks caught during A) gillnet, B) COASTPAN longline and C) SCDNR red drum longline sets.

**A**




**B**




**C**

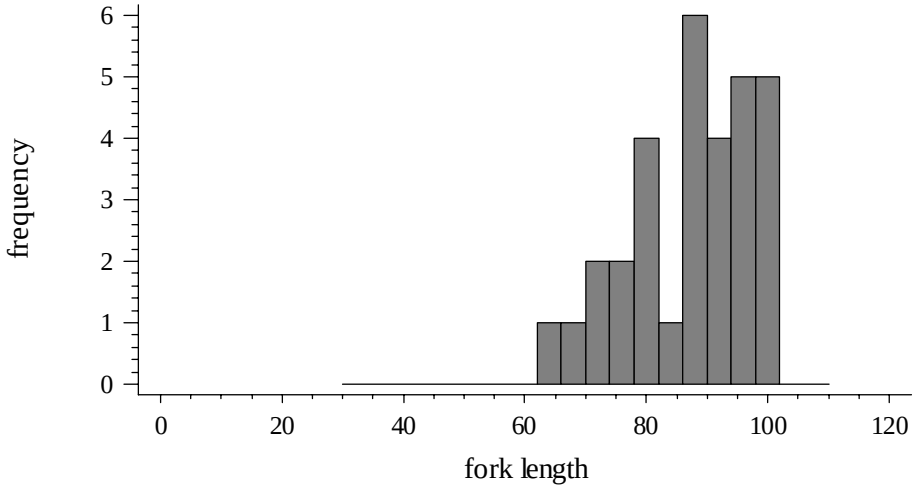
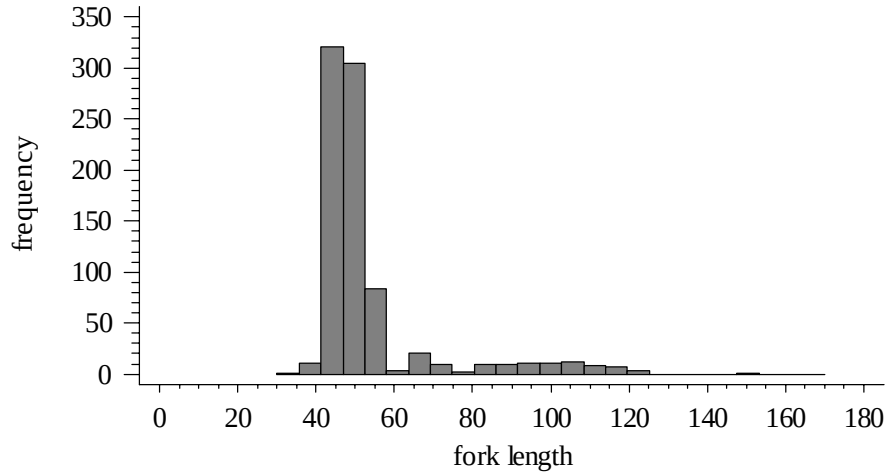
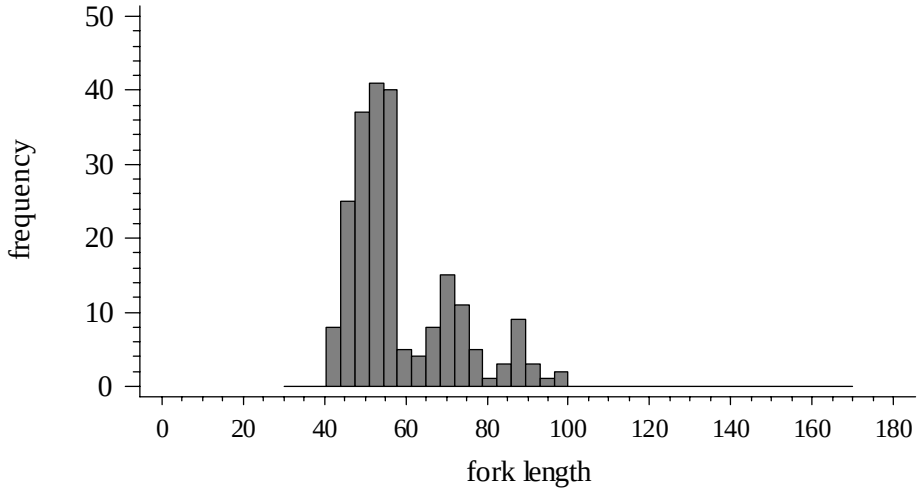


Figure 4. Length frequencies for finetooth sharks caught during A) gillnet, B) COASTPAN longline and C) SCDNR red drum longline sets. Note that scales differ.

**A**




**B**




**C**

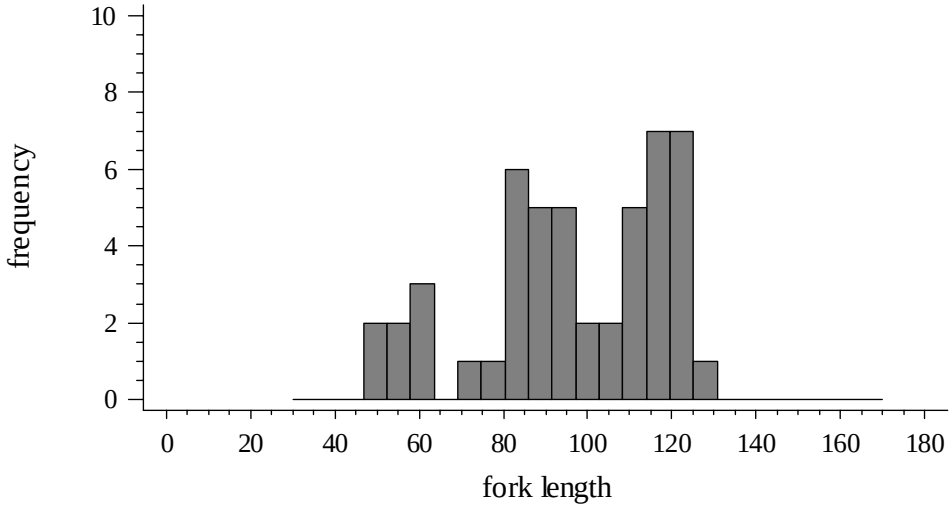


Figure 5. Length frequency for blacknose sharks caught during SCDNR red drum longline sets.

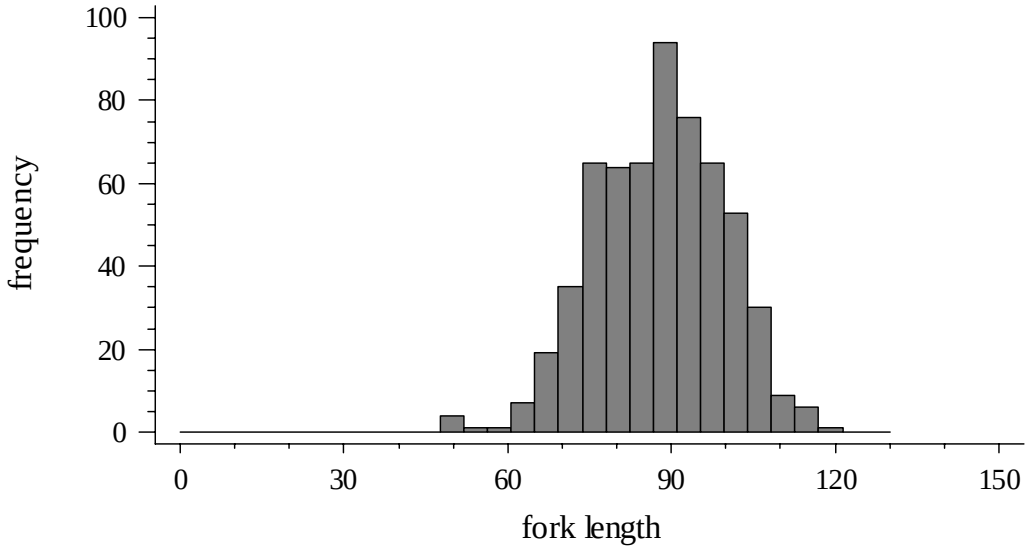
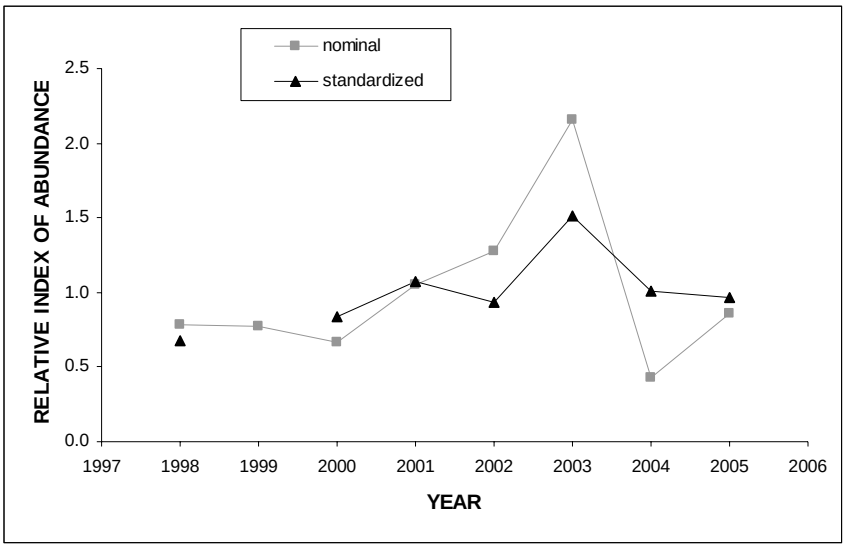
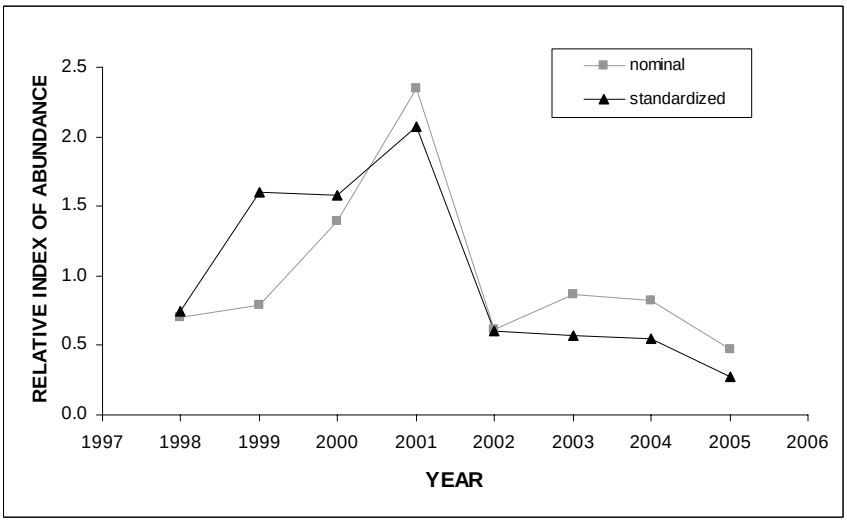


Figure 6. Relative (index/mean) indices of abundance by year for the small coastal shark complex CPUE for (A) gillnet data, (B) COASTSPAN longline data, and (C) SCDNR red drum longline data

**A**




**B**




**C**

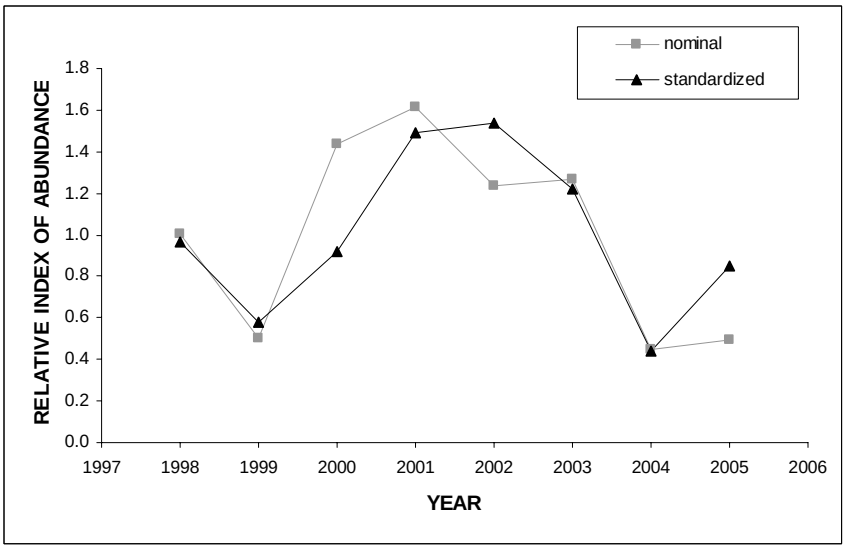
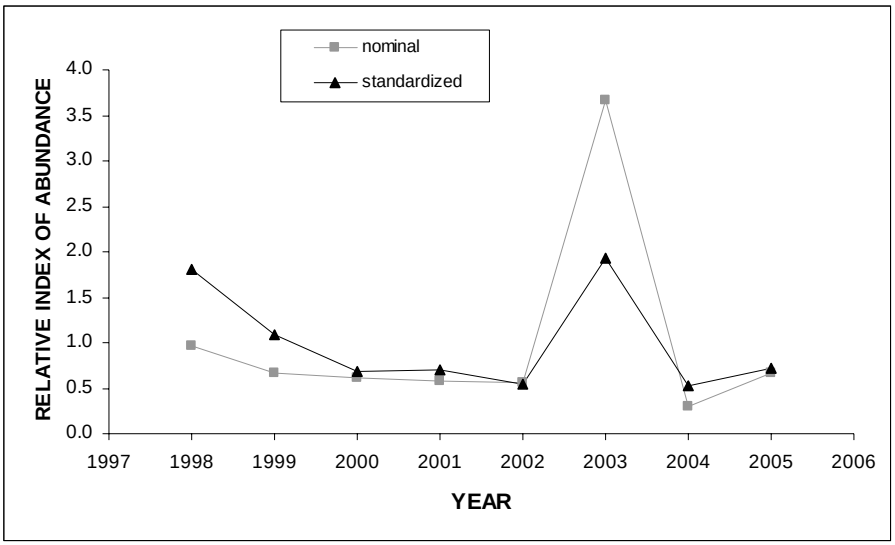
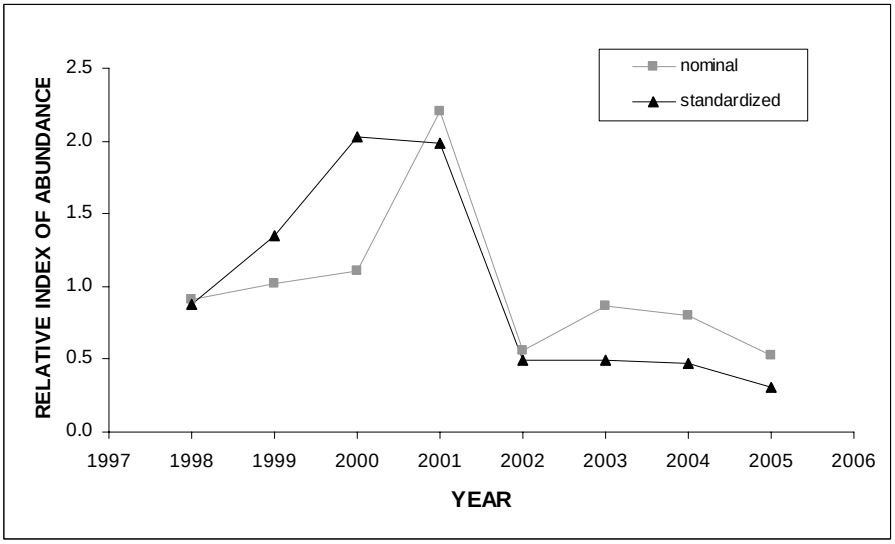


Figure 7. Relative (index/mean) indices of abundance by year for Atlantic sharpnose shark CPUE for (A) gillnet data, (B) COASTSPAN longline data, and (C) SCDNR red drum longline data

**A**




**B**




**C**

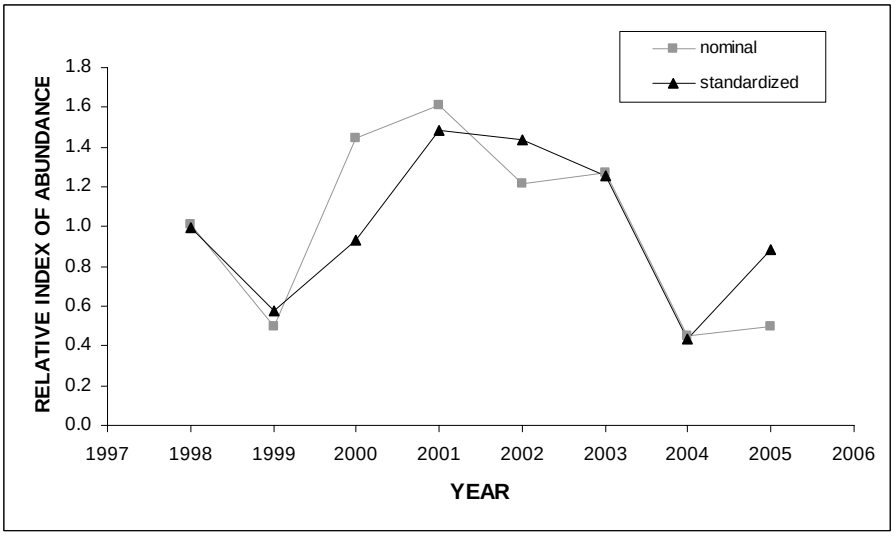
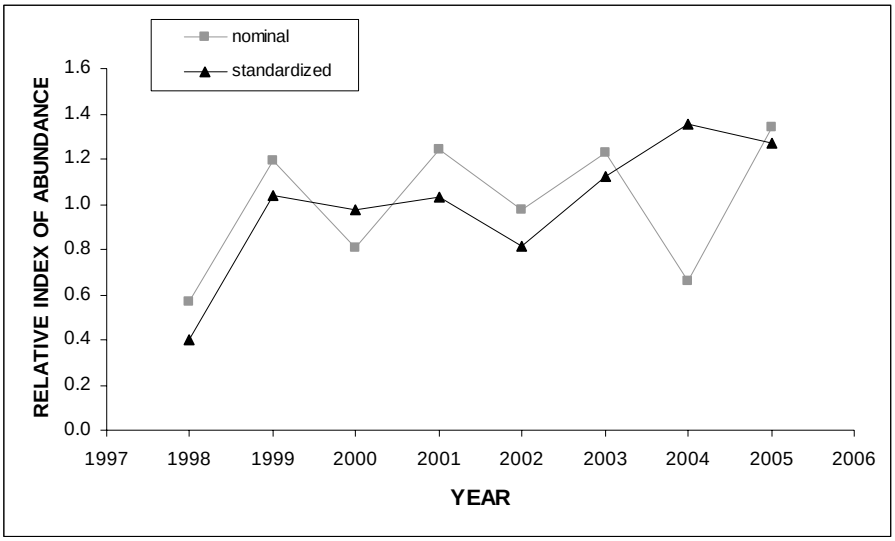
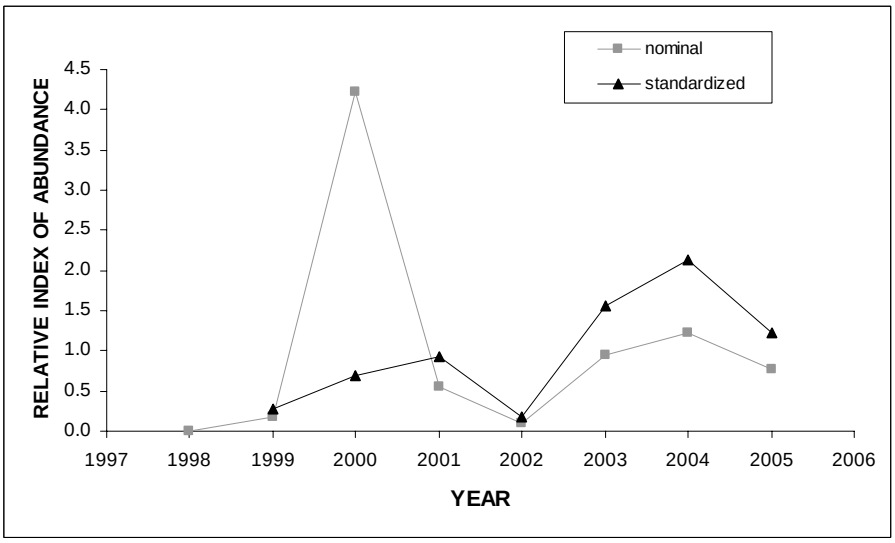


Figure 8. Relative (index/mean) indices of abundance by year for bonnethead shark CPUE for (A) gillnet data, (B) COASTSPAN longline data, and (C) SCDNR red drum longline data

**A**




**B**




**C**

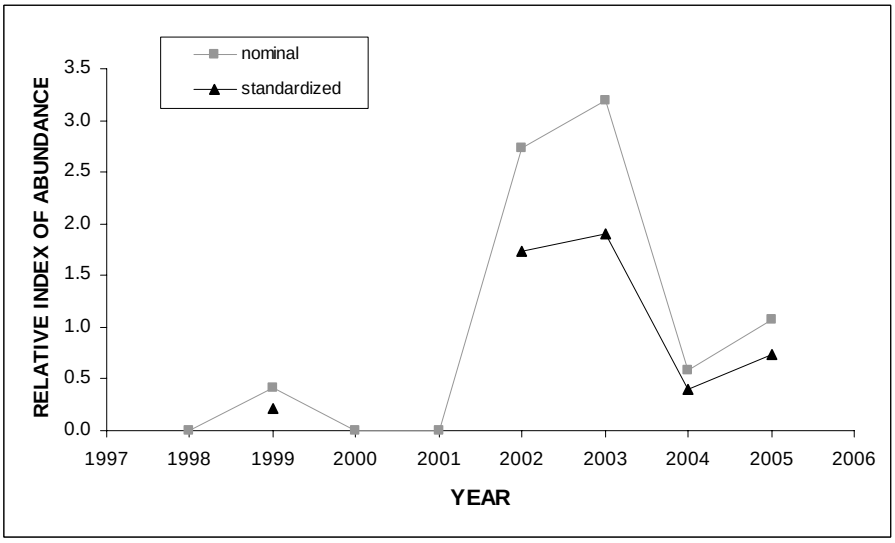
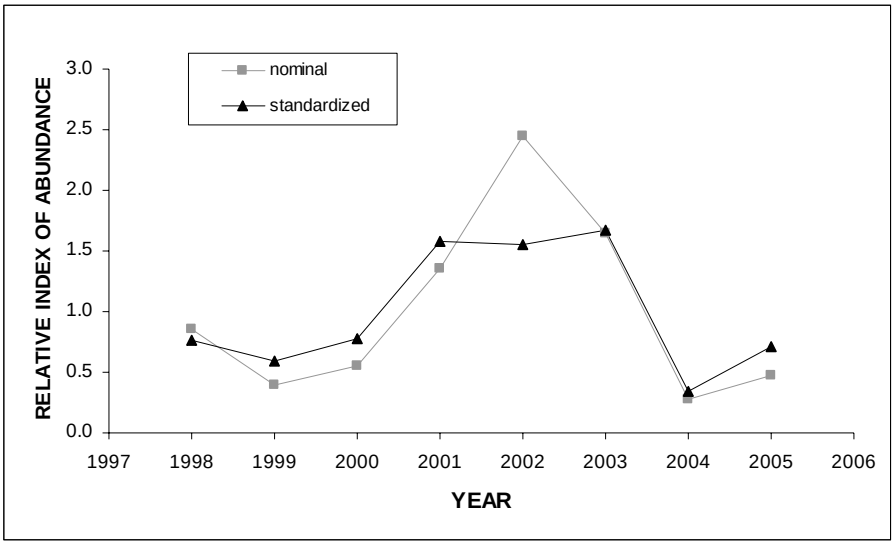
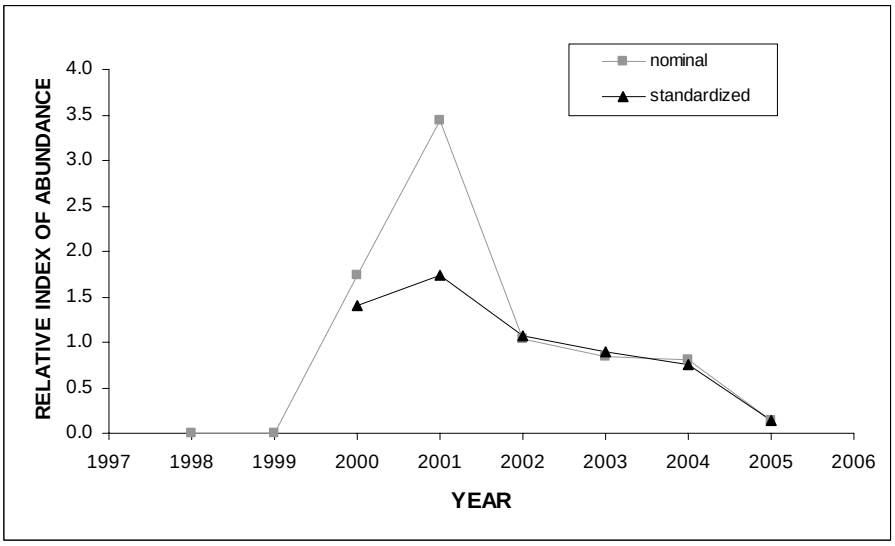


Figure 9. Relative (index/mean) indices of abundance by year for the finetooth shark CPUE for (A) gillnet data, (B) COASTSPAN longline data, and (C) SCDNR red drum longline data

**A**




**B**




**C**

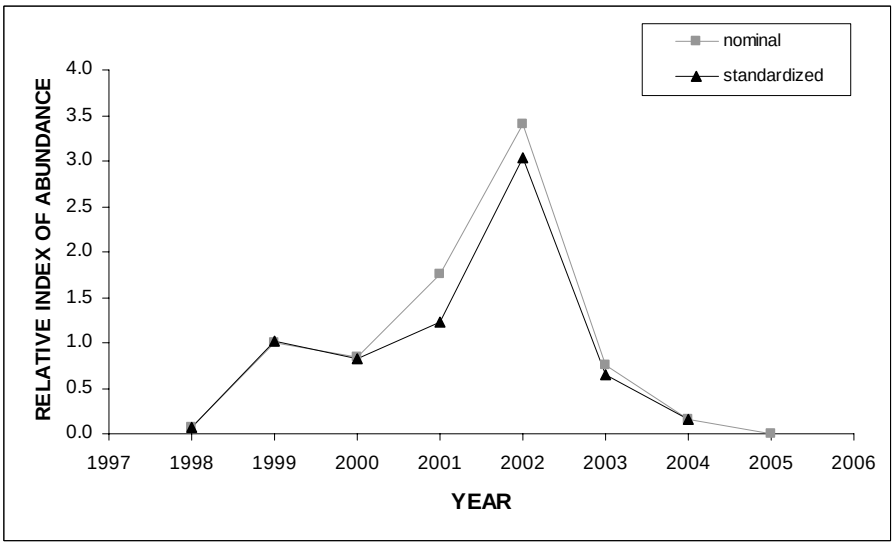
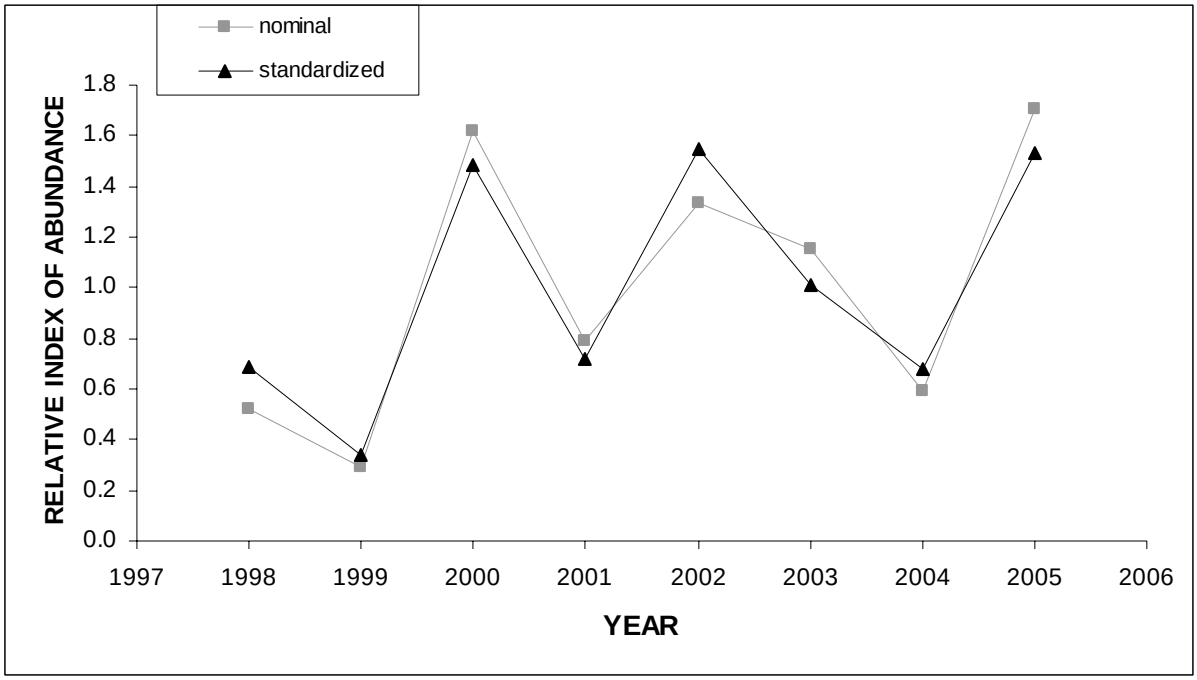


Figure 10. Relative (index/mean) indices of abundance by year for blacknose shark CPUE caught during the SCDNR red drum survey



Addendum to SEDAR 13-DW-30, by Camilla T. McCandless

After initial review of this document it was requested to pull out the young-of-the-year from the species/gear combinations that were recommended for base indices in the age structured analyses. There was one species recommended as a base index for the age structured model and contained young-of-the-year, Atlantic sharpnose sharks. The results are presented here.

Table 1. Nominal and nominal relative (CPUE/mean) abundance indices for Atlantic sharpnose sharks minus young-of-the-year caught by gillnet, COASTSPAN longline and SCDNR red drum longline in South Carolina's estuarine and nearshore waters from 1998-2005. LCL = lower confidence limit, UCL = upper confidence limit, CV = coefficient of variation, and N = the number of sets observed for the nominal relative abundance indices.

**gillnet**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 39 | 1.3929 | 0.8591 | 0.5493 | 1.1688 | 1.9079 | 28 |
| 1999 | 30 | 1.3044 | 0.8045 | 0.6014 | 1.0076 | 1.2108 | 23 |
| 2000 | 54 | 1.6875 | 1.0408 | 0.7760 | 1.3056 | 1.4393 | 31 |
| 2001 | 99 | 0.9167 | 0.5654 | 0.4497 | 0.6810 | 2.1257 | 108 |
| 2002 | 104 | 1.5073 | 0.9296 | 0.7981 | 1.0611 | 1.1749 | 69 |
| 2003 | 376 | 4.2247 | 2.6057 | 2.2073 | 3.0040 | 1.4423 | 89 |
| 2004 | 7 | 0.4375 | 0.2698 | 0.1109 | 0.4288 | 2.3561 | 16 |
| 2005 | 102 | 1.5000 | 0.9252 | 0.7851 | 1.0652 | 1.2485 | 68 |

**SCDNR red drum longline**

| YEAR | CATCH | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|---|
| 1998 | 959 | 6.7063 | 1.4482 | 1.2931 | 1.6033 | 1.2805 | 143 |
| 1999 | 567 | 4.9304 | 1.0647 | 0.9305 | 1.1989 | 1.3517 | 115 |
| 2000 | 820 | 6.4063 | 1.3834 | 1.2192 | 1.5476 | 1.3429 | 128 |
| 2001 | 607 | 5.4196 | 1.1704 | 1.0242 | 1.3165 | 1.3214 | 112 |
| 2002 | 624 | 4.9920 | 1.0780 | 0.9076 | 1.2484 | 1.7669 | 125 |
| 2003 | 846 | 4.9765 | 1.0747 | 0.9264 | 1.2229 | 1.7988 | 170 |
| 2004 | 206 | 1.9619 | 0.4237 | 0.3223 | 0.5251 | 2.4526 | 105 |
| 2005 | 81 | 1.6531 | 0.3570 | 0.2676 | 0.4464 | 1.7531 | 49 |

Table 2. Results of the stepwise procedure for development of the catch rate model for the Atlantic sharpnose sharks minus young-of-the-year caught during gillnet sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 432 | 594.2446 | 1.3756 | | | | | |
| MONTH | 427 | 546.6858 | 1.2803 | 6.9279 | 6.9279 | -273.3429 | 47.56 | <.0001 |
| YEAR | 425 | 569.4837 | 1.3400 | 2.5880 | | -284.7418 | 24.76 | 0.0008 |
| AREA | 429 | 591.4079 | 1.3464 | 2.1227 | | -288.1276 | 2.88 | 0.4104 |
| MONTH | | | | | | | | |
| YEAR | 420 | 533.0157 | 1.2691 | 7.7421 | 0.8142 | -266.5079 | 13.67 | 0.0574 |

**FINAL MODEL: MONTH + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 1868.3 |
| **Schwartz's Bayesian criterion** | 1872.4 |
| **(-2) Res Log likelihood** | 1866.3 |

**Type 3 Test of Fixed Effects**

| | MONTH | YEAR |
|---|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | <.0001 | 0.0697 |
| **DF** | 4 | 7 |
| **CHI SQUARE** | 28.14 | 13.10 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 241 | 823.6637 | 3.4177 | | | | | |
| YEAR | 234 | 671.3501 | 2.8690 | 16.0547 | 16.0547 | 210.6534 | 152.31 | <.0001 |
| MONTH | 236 | 728.4460 | 3.0866 | 9.6878 | | 182.1054 | 95.22 | <.0001 |
| AREA | 238 | 774.2521 | 3.2532 | 4.8132 | | 159.2024 | 49.41 | <.0001 |
| YEAR + | | | | | | | | |
| MONTH | 229 | 615.5659 | 2.6881 | 21.3477 | 5.2930 | 238.5455 | 55.78 | <.0001 |
| AREA | 231 | 642.3149 | 2.7806 | 18.6412 | | 225.1710 | 29.04 | <.0001 |
| YEAR + MONTH | | | | | | | | |
| AREA | 226 | 586.7834 | 2.5964 | 24.0308 | 2.6831 | 252.9367 | 28.78 | <.0001 |

**FINAL MODEL: YEAR + MONTH + AREA**

| | |
|---|---|
| **Akaike's information criterion** | 774.1 |
| **Schwartz's Bayesian criterion** | 777.5 |
| **(-2) Res Log likelihood** | 772.1 |

**Type 3 Test of Fixed Effects**

| | YEAR | MONTH | AREA |
|---|---|---|---|
| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | 0.0003 | 0.0378 | 0.0593 |
| **DF** | 7 | 5 | 3 |
| **CHI SQUARE** | 27.23 | 11.79 | 7.43 |

Table 3. Results of the stepwise procedure for development of the catch rate model for the Atlantic sharpnose sharks minus young-of-the-year caught during SCDNR red drum longline sets. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 946 | 1198.9847 | 1.2674 | | | | | |
| MONTH | 936 | 1129.7168 | 1.2070 | 4.7657 | 4.7657 | -564.8584 | 69.27 | <.0001 |
| YEAR | 939 | 1148.6179 | 1.2232 | 3.4875 | | -574.3089 | 50.37 | <.0001 |
| AREA | 929 | 980.4170 | 1.0553 | 16.7350 | | -490.2085 | Negative of Hessian not positive definite | |
| MONTH + | | | | | | | | |
| YEAR | 929 | 1070.2545 | 1.1521 | 9.0974 | 4.3317 | -535.1273 | 59.46 | <.0001 |

**FINAL MODEL: MONTH + YEAR**

| | |
|---|---|
| **Akaike's information criterion** | 4068.5 |
| **Schwartz's Bayesian criterion** | 4073.3 |
| **(-2) Res Log likelihood** | 4066.5 |

**Type 3 Test of Fixed Effects**

| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | MONTH | YEAR |
|---|---|---|
| | <.0001 | <.0001 |
| **DF** | 9 | 7 |
| **CHI SQUARE** | 33.97 | 53.89 |

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

| FACTOR | DF | DEVIANCE | DEVIANCE/DF | %DIFF | DELTA% | L | CHISQ | PR>CHI |
|---|---|---|---|---|---|---|---|---|
| NULL | 632 | 5458.4343 | 8.6368 | | | | | |
| MONTH | 622 | 4128.6885 | 6.6378 | 23.1451 | 23.1451 | 4998.7115 | 1329.79 | <.0001 |
| YEAR | 625 | 4704.3983 | 7.5270 | 12.8497 | | 4710.8566 | 754.08 | <.0001 |
| AREA | 615 | 4907.1689 | 7.9791 | 7.6151 | | 4609.4713 | 551.31 | <.0001 |
| MONTH + | | | | | | | | |
| YEAR | 615 | 3776.8118 | 6.1412 | 28.8950 | 5.7498 | 5174.6498 | 351.88 | <.0001 |
| AREA | 605 | 3776.5754 | 6.2423 | 27.7244 | | 5174.7680 | 352.11 | <.0001 |
| MONTH + YEAR + | | | | | | | | |
| AREA | 598 | 3246.7372 | 5.4293 | 37.1376 | 8.2426 | 5439.7681 | 530.07 | <.0001 |

**FINAL MODEL: MONTH + YEAR + AREA**

| | |
|---|---|
| **Akaike's information criterion** | 1901.6 |
| **Schwartz's Bayesian criterion** | 1906.0 |
| **(-2) Res Log likelihood** | 1899.6 |

**Type 3 Test of Fixed Effects**

| **Significance (Pr>Chi) of Type 3 test of fixed effects for each factor** | MONTH | YEAR | AREA |
|---|---|---|---|
| | <.0001 | <.0001 | <.0001 |
| **DF** | 10 | 7 | 17 |
| **CHI SQUARE** | 135.53 | 71.86 | 71.53 |

Table 4. Relative (index/mean) standardized abundance indices for the Atlantic sharpnose sharks minus young-of-the-year caught during COASTSPAN gillnet and SCDNR red drum surveys based on the standardized year effects obtained from the Lo et al. analyses. LCL = lower confidence limit, UCL = upper confidence limit, CV = coefficient of variation, and N = the number of sets observed.

**COASTSPAN gillnet**

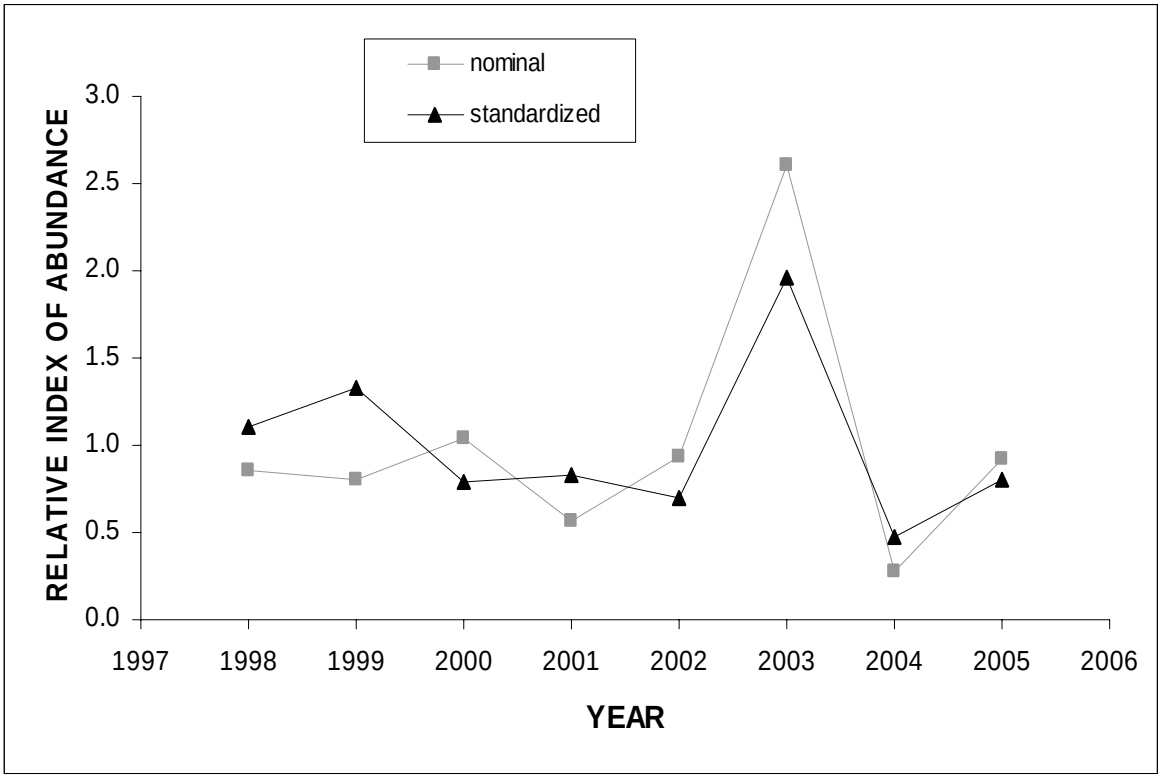
| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | 8.2803 | 1.1110 | -0.0961 | 2.3180 | 0.5543 | 28 |
| 1999 | 9.9234 | 1.3314 | -0.5053 | 3.1682 | 0.7038 | 23 |
| 2000 | 5.8923 | 0.7906 | -0.1284 | 1.7096 | 0.5931 | 31 |
| 2001 | 6.1397 | 0.8238 | 0.2383 | 1.4092 | 0.3626 | 108 |
| 2002 | 5.1817 | 0.6952 | 0.2270 | 1.1635 | 0.3436 | 69 |
| 2003 | 14.6214 | 1.9617 | 1.2485 | 2.6749 | 0.1855 | 89 |
| 2004 | 3.5696 | 0.4789 | -1.0160 | 1.9739 | 1.5926 | 16 |
| 2005 | 6.0177 | 0.8074 | 0.2419 | 1.3729 | 0.3573 | 68 |

**SCDNR red drum longline**

| YEAR | INDEX | REL INDEX | LCL | UCL | CV | N |
|---|---|---|---|---|---|---|
| 1998 | 0.1544 | 0.9828 | -0.4567 | 2.4224 | 0.7473 | 143 |
| 1999 | 0.0901 | 0.5732 | -0.7414 | 1.8879 | 1.1701 | 115 |
| 2000 | 0.1475 | 0.9389 | -1.0305 | 2.9083 | 1.0702 | 128 |
| 2001 | 0.2300 | 1.4635 | -1.0110 | 3.9380 | 0.8627 | 112 |
| 2002 | 0.2265 | 1.4415 | -1.2908 | 4.1739 | 0.9670 | 125 |
| 2003 | 0.1953 | 1.2430 | -0.7700 | 3.2561 | 0.8262 | 170 |
| 2004 | 0.0753 | 0.4794 | -2.0037 | 2.9626 | 2.6425 | 105 |
| 2005 | 0.1379 | 0.8775 | -4.2845 | 6.0396 | 3.0013 | 49 |

**F**igure 1. Relative (index/mean) indices of abundance by year for Atlantic sharpnose shark minus young-of-the-year CPUE for (A) gillnet data and (C) SCDNR red drum longline data

**A**




**B**