STANDARDIZED CATCH RATES FOR BLACKTIP SHARK (*Carcharhinus limbatus*), SANDBAR SHARK (*C. plumbeus*), AND LARGE COASTAL COMPLEX SHARKS FROM THE U.S. LONGLINE FLEET 1981-2004.

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SUMMARY

Sharks catch and effort data from the US Pelagic longline fleet operating in the Western North Atlantic were used to update indices of abundance for the blacktip shark, sandbar shark, and the large coastal complex (LCC) (Bull shark, spinner shark, blacktip shark, silky shark, sandbar shark, great hammerhead shark, scalloped hammerhead shark, smooth hammerhead shark, lemon shark, tiger shark and nurse shark) stocks. Standardized catch rates were estimated using a Generalized Linear Mixed modeling approach assuming a delta-lognormal error distribution. Indices of abundance in units of biomass (dressed weight) were also estimated for landed carcass sharks. The explanatory variables considered for standardization included geographical area, seasonal trimesters, fishing target species, and a fixed factor operational procedure (OP) that classifies the US longline fishing fleet according to boat and fishing gear characteristics, and fishing styles.

KEY WORDS

Catch/effort, abundance, longline, pelagic fisheries, sharks

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Introduction:

Indices of abundance from commercial fisheries have often been used to tune stock assessment models (Haddon 2001, Quinn and Deriso 1999). Data collected from the US pelagic longline fishery were used to develop standardized catch per unit effort (CPUE) indices for several shark stocks in the Western North Atlantic and Gulf of Mexico area. This report updates the methods applied to the available US longline fleet data through 2004 and presents biomass and number of sharks standardized indices for the blacktip shark, sandbar shark and the Large Coastal Complex shark (LCC) [Bull shark, spinner shark, blacktip shark, silky shark, sandbar shark, great hammerhead shark, scalloped hammerhead shark, smooth hammerhead shark, lemon shark, tiger shark and nurse shark] stocks. Standardized catch rates were estimated using the Generalized Linear Mixed Model (GLMM) approach.

Materials and methods:

The pelagic longline fleet is required to report their catch through logbooks. Each report includes the catch in numbers of all caught species and general fishery settings for each longline set (Pelagic Longline Logbook data). They are also required to submit weight-out sheets for each trip, which include individual carcass weights for main target species, landed and marketed in the U.S. (Weight-out data). The Pelagic longline fleet has also an observer program, established in 1992 that monitored the fishing activities of the fleet, recording detailed information on fishing operations, gear characteristics and deployment, environmental related conditions and biological information from all longline catch (Lee and Brown 1998).

The longline fishing grounds of the US fleet extend from the Grand Banks in the North Atlantic to 5°-10° latitude south, off the South America coast, including the Caribbean and the Gulf of Mexico. Eight geographical areas have been defined for spatial classification of this fishery (Fig 1). These include: the Caribbean (CAR, area 1), Gulf of Mexico (GOM, area 2), Florida East coast (FEC, area 3), South-Atlantic Bight (SAB, area 4), Mid-Atlantic Bight (MAB, area 5), New England coastal (NEC, area 6), Northeast Distant waters (NED, area 7) and the Southern offshore (OFS, area 8). Trimesters were used to account for seasonal fishery distribution through the year (Jan-Mar, Apr-Jun, Jul-Sep, and Oct-Dec).

The carcass weight-out data set extends from 1982 through 2004. Each record represents information of catch by vessel-trip, including date, geographical area of the catch, catch in numbers and weight for swordfish, tunas and other market species including sharks, and fishing effort estimated as number of sets per trip times the average number of hooks per set. The US pelagic longline fleet includes at least 1,714 different registered vessels from 1981 to 2003. This fleet has changed in terms of gear technology and fishery operations, Hoey et al (1988) characterized the pelagic longline fleet into nine different vessel-groups based on boat size-power and fishing operations. This classificatory factor has shown to be an important explanatory variable of several species catch rates including swordfish (Ortiz and Cramer 2000) and other target species.

Logbooks became mandatory in 1992; from 1986 to 1991 reporting was voluntary. Logbook data detailed catch landed and released per set in most cases, fishing effort is reported as total number of hooks per set times the number of sets per trip, therefore nominal catch rates were calculated as numbers of sharks caught per 1000 hooks. Swordfish is a main target species of the US pelagic longline fleet; however this fleet also targets tunas (yellowfin, bigeye and bluefin tuna) and to a lesser extends other pelagic species including sharks. A proxy for targeted species was defined based on the proportion of swordfish catch to total catch per trip and grouped into categories, corresponding to the quartiles 0-25%, 25-50%, 50-75%, and 75-100%. This target variable was assumed to control for effects on shark catch rates associated with the diverse species targeted by the fleet.

Figure 2 shows a summary of the reported catch and effort from the Logbook database. For the pelagic longline fleet, sharks in general represent about 25% of their catch, with higher catches and proportions in the early 1990's. Since 1996 peak, effort measure a number of hooks deployed as decrease slightly as well total catch and sharks catch, in the latest years the proportion of sharks is below 20%. Within the sharks catch, the Large Coastal Complex (LCC) is also about 20%, but with increasing proportion in the latest years up to 38% (2001). Blacktip and Sandbar sharks made a bulk of the LCC catch. Bottom panel of Figure 2 shows the percent contribution of these two species to total LCC catch. Important to notice that Sandbar catch was not reported prior to 1994, however in 1995 quickly become the main component of the LCC catch, up to 60-70% until recent years. Instead, Blacktip catch was reported since 1992, but when Sandbar was reported, its proportion of LCC catch drops to about 10%. It is unknown if catch of these species was going on before 1992-94, and being classified as other sharks or unidentified sharks.

By contrast, the landing carcass data indicates a much lower proportion of sharks landed compare to the total landings from the Pelagic longline fleet (Figure 3). On average sharks are 1.8% of total landed catch, with highest proportions in 1996 and 97 (6%). The composition of the sharks landed is shown in the middle panel of Figure 3. LCC sharks become the main component of landed sharks in the mid 1990's, and sandbar is by far the most common species landed. Prior to 1992, there are reports of landed LCC sharks, but the main component was Blacktip sharks (Figure 3, bottom panel).

Standardized indices of abundance were estimated for blacktip shark, sandbar shark and the LCC sharks, for blacktip shark indices were also estimated for the Gulf of Mexico area and the Atlantic coast area. In addition biomass indices were estimated using the carcass Weight-Out data. This biomass index represents landed fish and estimated as total pounds (carcass weight) landed per thousand hooks.

Sharks relative indices of abundance were estimated by Generalized Linear Modeling approach assuming a delta lognormal model distribution. The standardization protocols assumed a delta model with a binomial error distribution for modeling the proportion of positive sets, and a lognormal error distribution for modeling the mean catch rate of successful (i.e. positive sharks catch) sets. The lognormal frequency distributions from the Logbook data and from the carcass weight-out data are shown in Figures 4 and 5, respectively. Parameterization of the models used the GLM structure; for the proportion of successful sets per stratum is assume to follow a binomial distribution where the estimated probability is a linear function of fixed factors and interactions. The logit function was used as a link between the linear factor component and the binomial error. For successful sets, estimated CPUE rates assumed a lognormal distribution of a linear function of fixed and random effect interactions when the *year* term was within the interaction.

A step-wise regression procedure was used to determine the set of systematic factors and interactions that significantly explained the observed variability. As the deviance difference between two consecutive nested models follows a chi-square (χ^2) distribution, this statistic was used to test for the significance of an additional factor(s) in the model. Deviance analysis tables are presented for each data set analysis. Each table includes the deviance for the proportion of positive observations, and the deviance for the positive catch rates. Final selection of the explanatory factors was conditional to: a) the relative percent of deviance explained by adding the factor in consideration, normally factors that explained more than 5% were included in the final model, b) the χ^2 test significance, and c) type III test significance within the final specified model. Once a set of fixed factors was specified, possible first level interactions were evaluated in particular random interactions between the *year* effect and other factors. The significance of random interactions was evaluated between nested models by using the likelihood ratio test (Pinheiro and Bates 2000), the Akaike information criteria (AIC), and the Bayesian information criteria (BIC) (Littell et al 1996). Analyses were done using GLIMMIX and MIXED procedures from the SAS® statistical computer software (SAS Institute Inc. 1997)

Relative indices were calculated as the product of the year effect least square means (LSmeans) from the binomial and the lognormal components. LSmeans estimates were weighted proportional to observed margins in the positive observations data, and for the lognormal estimates, a log-back transformed bias corrections was applied (Lo et al. 1992).

Results and Discussion

The deviance analyses tables for the Blacktip shark CPUE standardization from the Logbook data are shown in Table 1. Table 7 shows the deviance table for the Blacktip shark biomass index derived from the carcass weight-out data. The Logbook index standardization analyses indicated that area, OP, season and target where the main explanatory factors for the proportion of positive sets models. While for the positive catch sets models, the main explanatory factors were area, OP, season and proportion of light-sticks per hook used (Lghtc). Of the interactions evaluated, the year*Area, and year*OP were also important explanatory factors primarily for the positive catch sets models. Tables 2 and 8 present the evaluation of these interactions as random components in the mixed models. For Blacktip shark, deviance tables were also estimated for the Gulf of Mexico and Atlantic coast areas, for space considerations, those tables are not presented, but in general they follow the trends of the combined Blacktip analyses.

The biomass index analyses also reiterated area, OP, target and quarter and the random interactions year*Op, and year*target as main explanatory factors for the proportion of positive trips (Table 7). While area, OP and target and random interactions year*area and year*OP were the main explanatory factors of catch rates for trips with catches of Blacktip shark (Table 8).

Table 13 and Figure 6 show the nominal and standardized CPUE for Blacktip shark from the Logbook data. Figure 8 and Table 16 show the nominal and standardized CPUE for Blacktip shark from the carcass weight-out data, respectively. Reviewing index trends for blacktip there are different for the Logbook data that shows in general a declining trend since 1992 through 1998, and a stabilizing at low levels from 1998 to 2004. Instead, the biomass index derived from the carcass weight-out data, show some increasing trend in 1985 through 1994, peak, followed by a slight decline in subsequent years (1995-2004) (Fig. 6 and 8). However, it is important to mention that the 95% estimated confidence intervals are quite broad for both indices, with CV (coefficient of variation) averaging 60% for the biomass index and 95% for the Logbook index.

The deviance analyses tables for the Sandbar shark CPUE standardization from the Logbook data are shown in Table 3. Table 9 shows the deviance table for the Sandbar shark biomass index derived from the carcass weight-out data. The Logbook index standardization analyses indicated that area, OP, season and Lghtc where the main explanatory factors for the proportion of positive sets models. While for the positive catch sets models, the main explanatory factors were area, OP, season and proportion of light-sticks per hook used (Lghtc). Of the interactions evaluated, the year*Area, and year*OP were also important explanatory factors. Tables 4 and 10 present the evaluation of these interactions as random components in the mixed models.

Table 14 and Figure 7 (top) show the nominal and standardized CPUE for Sandbar shark from the Logbook data. Figure 9 (top) and Table 17 show the nominal and standardized CPUE for Sandbar shark from the carcass weight-out data, respectively. Reviewing index trends for Sandbar shark there are different for the Logbook data that shows in general a constant trend since 1997 through 2003. Instead, the biomass index derived from the carcass weight-out data, show some increasing trend in 1994 through 1996 peak, followed by a decline in subsequent years (1997-2004) (Fig. 7 and 9). Important to mention, also that the 95% estimated confidence intervals are quite broad for both indices, with CV (coefficient of variation) averaging 60% for the biomass index and 70% for the Logbook index.

Finally, the deviance analyses tables for the LCC sharks CPUE standardization from the Logbook data are shown in Table 5. Table 11 shows the deviance table for the LCC sharks biomass index derived from the carcass weight-out data. Tables 6 and 12 present the evaluation of these interactions as random components in the mixed models.

Table 15 and Figure 7 (bottom) show the nominal and standardized CPUE for Sandbar shark from the Logbook data. Figure 9 (bottom) and Table 18 show the nominal and standardized CPUE for Sandbar shark from the carcass weight-out data, respectively. Reviewing index trends for LCC sharks there are different for the Logbook data that shows in general a constant trend since 1995 through 2004. Instead, the biomass index derived from the carcass weight-out data, show some increasing trend in 1990 through 1996 peak, followed by a decline in subsequent years (1997-2004) (Fig. 7 and 9). Important to mention, also that the 95% estimated confidence intervals are quite broad particularly for the biomass index, with CV (coefficient of variation) averaging 90% for the biomass index and 35% for the Logbook index.

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Table 1. Deviance analysis table of explanatory variables in the delta lognormal model for blacktip shark catch rates (number of fish per thousand hooks) from the US Pelagic Longline fishery Logbook. Percent of total deviance refers to the deviance explained by the full model; *p* value refers to the Chi-square probability between consecutive models (alpha = 0.05).

Blacktip Shark CPUE Index PLL

Model factors positive catch rates values	d.f.	Residual deviance	Change in deviance	% of total deviance	*p*
1	1	8718.32292			
Year	12	8504.91642	213.41	11.8%	< 0.001
Year Area	8	8174.83691	330.08	18.2%	< 0.001
Year Area Season	3	7992.19564	182.64	10.1%	< 0.001
Year Area Season Op	7	7606.63205	385.56	21.3%	< 0.001
Year Area Season Op Lghtc	3	7432.47439	174.16	9.6%	< 0.001
Year Area Season Op Lghtc Mngarea2	1	7431.69417	0.78	0.0%	0.377
Year Area Season Op Lghtc Mngarea2 Year*Mngarea2	12	7380.28266	51.41	2.8%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Season	36	7321.61996	110.07	6.1%	< 0.001
Year Area Season Op Lghtc Mngarea2 Area*Season	19	7304.4342	127.26	7.0%	< 0.001
Year Area Season Op Lghtc Mngarea2 Area*Op	24	7238.12877	193.57	10.7%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Area	70	7142.74488	288.95	15.9%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Lghtc	36	7133.06845	298.63	16.5%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Op	70	6904.78078	526.91	29.1%	< 0.001

Model factors proportion positives	d.f.	Residual deviance	Change in deviance	% of total deviance	*p*
1	1	17507.830			
Year	12	16078.181	1429.65	20%	< 0.001
Year Area	8	13172.487	2905.69	41%	< 0.001
Year Area Season	3	12679.039	493.45	7%	< 0.001
Year Area Season Op	7	11663.282	1015.76	15%	< 0.001
Year Area Season Op Lghtc	3	11609.769	53.51	1%	< 0.001
Year Area Season Op Lghtc Mngarea2	1	11550.996	58.77	1%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Mngarea2	12	11388.810	162.19	2%	< 0.001
Year Area Season Op Lghtc Mngarea2 Area*Season	24	11289.732	261.26	4%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Lghtc	36	11265.584	285.41	4%	< 0.001
Year Area Season Op Lghtc Mngarea2 Area*Lghtc	24	11260.993	290.00	4%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Season	36	11140.698	410.30	6%	< 0.001
Year Area Season Op Lghtc Mngarea2 Area*Op	37	11080.641	470.35	7%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Area	96	10725.216	825.78	12%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Op	79	10504.204	1046.79	15%	< 0.001

Table 2. Analysis of mixed model formulations for blacktip shark catch rates from the US Pelagic Longline fishery. Likelihood ratio tests the difference of –2 REM log likelihood between two nested models.

Blacktip Shark PLL GLMixed Model	-2 REM Log likelihood	Akaike's Information Criterion	Schwartz's Bayesian Criterion	Likelihood Ratio Test	
Proportion Positives					
Year Area Season OP	29433.3	29435.3	29441.8		
Year Area Season OP *Year*area*	28499.7	28503.7	28509.2	933.6	0.0000
Year Area Season OP *Year*area Year*OP*	28376.5	28382.5	28390.8	123.2	0.0000
Year Area Season OP *Year*area Year*OP Year*season*	28060.9	28068.9	28080.0	315.6	0.0000
Positives catch rates					
Year Area Season OP Lgthc	19912.4	19914.4	19921.2		
Year Area Season OP Lgthc *Year*area*	19787.0	19791.0	19796.0	125.4	0.0000
Year Area Season OP Lgthc *Year*area Year*OP*	19559.1	19565.1	19572.6	227.9	0.0000
Year Area Season OP Lgthc *Year*area Year*OP Year*Season*	19527.1	19535.1	19545.2	32.0	0.0000
Year Area Season OP Lgthc *Year*area Year*OP Year*Season Year*lgthc*	19428.0	19438.0	19450.6	99.1	0.0000

Table 3. Deviance analysis table of explanatory variables in the delta lognormal model for sandbar shark catch rates (number of fish per thousand hooks) from the US Pelagic Longline fishery Logbook. Percent of total deviance refers to the deviance explained by the full model; p value refers to the Chi-square probability between consecutive models (alpha = 0.05)

Sandbar Shark CPUE Index PLL

Model factors positive catch rates values	d.f.	Residual deviance	Change in deviance	% of total deviance	*p*
1	1	10232.3948			
Year	10	10148.1386	84.26	2.2%	< 0.001
Year Area	7	9433.55056	714.59	18.3%	< 0.001
Year Area Season	3	8553.11105	880.44	22.5%	< 0.001
Year Area Season Op	7	7958.40854	594.70	15.2%	< 0.001
Year Area Season Op Lghtc	3	6507.35219	1451.06	37.1%	< 0.001
Year Area Season Op Lghtc Mngarea2	1	6500.12157	7.23	0.2%	0.007
Year Area Season Op Lghtc Mngarea2 Year*Mngarea2	10	6482.50402	17.62	0.5%	0.062
Year Area Season Op Lghtc Mngarea2 Area*Op	20	6426.84497	73.28	1.9%	< 0.001
Year Area Season Op Lghtc Mngarea2 Area*Season	14	6379.90827	120.21	3.1%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Op	59	6357.8321	142.29	3.6%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Lghtc	28	6350.42539	149.70	3.8%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Season	29	6329.25365	170.87	4.4%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Area	45	6324.70893	175.41	4.5%	< 0.001

Model factors proportion positives	d.f.	Residual deviance	Change in deviance	% of total deviance	*p*
1	_	20874.516			
Year	10	19434.300	1440.22	12%	< 0.001
Year Area	8	14867.018	4567.28	38%	< 0.001
Year Area Season	3	13168.631	1698.39	14%	< 0.001
Year Area Season Op	7	11224.565	1944.07	16%	< 0.001
Year Area Season Op Lghtc	3	9897.150	1327.41	11%	< 0.001
Year Area Season Op Lghtc Mngarea2	1	9759.175	137.97	1%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Mngarea2	10	9698.148	61.03	1%	< 0.001
Year Area Season Op Lghtc Mngarea2 Area*Lghtc	24	9415.730	343.44	3%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Lghtc	30	9400.441	358.73	3%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Season	30	9285.752	473.42	4%	< 0.001
Year Area Season Op Lghtc Mngarea2 Area*Op	36	9187.700	571.48	5%	< 0.001
Year Area Season Op Lghtc Mngarea2 Area*Season	24	9104.906	654.27	5%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Op	67	8832.939	926.24	8%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Area	80	8732.464	1026.71	8%	< 0.001

Table 4. Analyses of mixed model formulations for sandbar shark catch rates from the US Pelagic Longline fishery. Likelihood ratio tests the difference of –2 REM log likelihood between two nested models.

Sandbar Shark PLL GLMixed Model	-2 REM Log likelihood	Akaike's Information Criterion	Schwartz's Bayesian Criterion	Likelihood Ratio Test	
Proportion Positives					
Year Season OP	28022.4	28024.4	28030.7		
Year Season OP *Year*area*	26854.1	26858.1	26863.3	1168.3	0.0000
Year Season OP *Year*area Year*OP*	26717.3	26723.3	26731.0	136.8	0.0000
Year Season OP *Year*area Year*OP Year*season*	26360.3	26368.3	26378.6	357.0	0.0000
Positives catch rates					
Year Area Season OP Lgthc	16207.4	16209.4	16216.0		
Year Area Season OP Lgthc *Year*area*	16158.4	16162.4	16166.7	49.0	0.0000
Year Area Season OP Lgthc *Year*area Year*OP*	16145.7	16151.7	16158.1	12.7	0.0004
Year Area Season OP Lgthc *Year*area Year*OP Year*Season*	16082.8	16090.8	16099.4	62.9	0.0000
Year Area Season OP Lgthc *Year*area Year*OP Year*Season Year*lgthc*	16040.7	16050.7	16061.4	42.1	0.0000

Table 5. Deviance analysis table of explanatory variables in the delta lognormal model for Large Coastal Complex sharks catch rates (number of fish per thousand hooks) from the US Pelagic Longline fishery Logbook. Percent of total deviance refers to the deviance explained by the full model; p value refers to the Chi-square probability between consecutive models (alpha = 0.05).

LCC Shark CPUE Index PLL

Model factors positive catch rates values	d.f.	Residual deviance	Change in deviance	% of total deviance	*p*
1	_	52257.4733			
Year	18	51162.7446	1094.73	8.8%	< 0.001
Year Area	8	47499.9143	3662.83	29.5%	< 0.001
Year Area Season	3	46613.0527	886.86	7.1%	< 0.001
Year Area Season Op	8	43518.6166	3094.44	24.9%	< 0.001
Year Area Season Op Lghtc	3	41467.2052	2051.41	16.5%	< 0.001
Year Area Season Op Lghtc Mngarea2	1	41397.5228	69.68	0.6%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Mngarea2	18	41317.825	79.70	0.6%	< 0.001
Year Area Season Op Lghtc Mngarea2 Area*Op	45	40934.0656	463.46	3.7%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Season	52	40747.1377	650.39	5.2%	< 0.001
Year Area Season Op Lghtc Mngarea2 Area*Season	23	40669.147	728.38	5.9%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Op	122	40169.3761	1228.15	9.9%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Area	133	40064.3893	1333.13	10.7%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Lghtc	54	39850.1885	1547.33	12.5%	< 0.001

Model factors proportion positives	d.f.	Residual deviance	Change in deviance	% of total deviance	*p*
1	_	54298.381			
Year	18	53154.917	1143.46	4%	< 0.001
Year Area	8	36440.301	16714.62	64%	< 0.001
Year Area Season	3	34697.112	1743.19	7%	< 0.001
Year Area Season Op	8	31335.853	3361.26	13%	< 0.001
Year Area Season Op Lghtc	3	31128.646	207.21	1%	< 0.001
Year Area Season Op Lghtc Mngarea2	1	31100.298	28.35	0%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Mngarea2	18	30880.725	219.57	1%	< 0.001
Year Area Season Op Lghtc Mngarea2 Area*Lghtc	24	30324.452	775.85	3%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Season	52	30265.201	835.10	3%	< 0.001
Year Area Season Op Lghtc Mngarea2 Area*Op	55	30124.811	975.49	4%	< 0.001
Year Area Season Op Lghtc Mngarea2 Area*Season	24	30066.544	1033.75	4%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Lghtc	54	29956.662	1143.64	4%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Op	125	28538.002	2562.30	10%	< 0.001
Year Area Season Op Lghtc Mngarea2 Year*Area	143	27998.298	3102.00	12%	< 0.001

Table 6. Analysis of mixed model formulations for LCC shark catch rates from the US Pelagic Longline fishery. Likelihood ratio tests the difference of –2 REM log likelihood between two nested models.

LCC Shark PLL GLMixed Model	-2 REM Log likelihood	Akaike's Information Criterion	Schwartz's Bayesian Criterion	Likelihood Ratio Test	
Proportion Positives					
Year Area Season OP	33279.2	33281.2	33288.1		
Year Area Season OP *Year*area*	32489.6	32493.6	32499.8	789.6	0.0000
Year Area Season OP *Year*area Year*OP*	32313.8	32319.8	32329.2	175.8	0.0000
Year Area Season OP *Year*area Year*OP Year*season*	32181.7	32189.7	32202.2	132.1	0.0000
Positives catch rates					
Year Area Season OP Lgthc	111386.5	111388.5	111397.0		
Year Area Season OP Lgthc *Year*area*	110504.3	110508.3	110514.5	882.2	0.0000
Year Area Season OP Lgthc *Year*area Year*OP*	109974.7	109980.7	109989.9	529.6	0.0000
Year Area Season OP Lgthc *Year*area Year*OP Year*Season*	109637.2	109645.2	109657.5	337.5	0.0000
Year Area Season OP Lgthc *Year*area Year*OP Year*Season Year*lgthc*	108760.7	108770.7	108786.1	876.5	0.0000

Table 7. Deviance analysis table of explanatory variables in the delta lognormal model for Blacktip shark biomass (pounds dressed weight/ thousand hooks) from the US Pelagic Longline fishery Carcass weight-out data.

Blacktip Shark CPUE Index Biomass

Model factors positive catch rates values	d.f.	Residual deviance	Change in deviance	% of total deviance	*p*
1	1	2624.02976			
Year	21	2527.50406	96.53	9.4%	< 0.001
Year Area	5	2287.20329	240.30	23.5%	< 0.001
Year Area Op	7	2198.03499	89.17	8.7%	< 0.001
Year Area Op Targ	3	1979.51583	218.52	21.4%	< 0.001
Year Area Op Targ Qtr	3	1966.71946	12.80	1.3%	0.005
Year Area Op Targ Qtr Area*Targ	14	1922.39891	44.32	4.3%	< 0.001
Year Area Op Targ Qtr Area*Op	20	1915.84008	50.88	5.0%	< 0.001
Year Area Op Targ Qtr Area*Qtr	14	1894.00509	72.71	7.1%	< 0.001
Year Area Op Targ Qtr Op*Targ	20	1889.2975	77.42	7.6%	< 0.001
Year Area Op Targ Qtr Year*Qtr	43	1858.0214	108.70	10.6%	< 0.001
Year Area Op Targ Qtr Year*Targ	54	1812.87232	153.85	15.1%	< 0.001
Year Area Op Targ Qtr Year*Area	64	1669.62417	297.10	29.1%	< 0.001
Year Area Op Targ Qtr Year*Op	90	1602.06939	364.65	35.7%	< 0.001

Model factors proportion positives	d.f.	Residual deviance	Change in deviance	% of total deviance	*p*
1	_	4349.415			
Year	21	4049.154	300.26	19%	< 0.001
Year Area	6	3809.950	239.20	15%	< 0.001
Year Area Op	7	3654.071	155.88	10%	< 0.001
Year Area Op Targ	3	3509.126	144.94	9%	< 0.001
Year Area Op Targ Qtr	3	3282.068	227.06	14%	< 0.001
Year Area Op Targ Qtr Op*Targ	21	3219.945	62.12	4%	< 0.001
Year Area Op Targ Qtr Area*Qtr	18	3208.741	73.33	5%	< 0.001
Year Area Op Targ Qtr Area*Targ	18	3176.431	105.64	7%	< 0.001
Year Area Op Targ Qtr Area*Op	35	3175.453	106.61	7%	< 0.001
Year Area Op Targ Qtr Year*Targ	63	3145.243	136.82	9%	< 0.001
Year Area Op Targ Qtr Year*Area	124	2841.925	440.14	28%	< 0.001
Year Area Op Targ Qtr Year*Qtr	63	2831.289	450.78	29%	< 0.001
Year Area Op Targ Qtr Year*Op	141	2782.843	499.23	32%	< 0.001

Table 8. Analysis of mixed model formulations for biomass blacktip shark catch rates (lbs dressed wgt/ thousand hooks) from the US Pelagic Longline fishery. Likelihood ratio tests the difference of –2 REM log likelihood between two nested models.

Blacktip Shark PLL GLMixed Model Biomass Index	-2 REM Log likelihood	Akaike's Information Criterion	Schwartz's Bayesian Criterion	Likelihood Ratio Test	
Proportion Positives					
Year target OP quarter	30392.8	30394.8	30401.3		
Year target OP quarter *Year*OP*	29936.6	29940.6	29946.9	456.2	0.0000
Year target OP quarter *Year*OP Year*area*	30307.6	30313.6	30323.0	-371.0	N/A
Year target OP quarter *Year*OP Year*area Year*quarter*	30561.7	30567.7	30577.1	-254.1	N/A
Year target OP quarter *Year*OP Year*area Year*quarter Year*target*	30464.5	30472.5	30485.0	97.2	0.0000
Positives catch rates					
Year area quarter OP target	3749.2	3751.2	3756.2		
Year area quarter OP target *Year*area*	3701.7	3705.7	3710.7	47.5	0.0000
Year area quarter OP target *Year*area Year*OP*	3687.5	3693.5	3701.0	14.2	0.0002
Year area quarter OP target *Year*area Year*OP Year*quarter*	3680.0	3688.0	3698.1	7.5	0.0062
Year area quarter OP target *Year*area Year*OP Year*quarter Year*target*	3679.4	3689.4	3702.0	0.6	0.4386

Table 9. Deviance analysis table of explanatory variables in the delta lognormal model for Sandbar shark biomass (pounds dressed weight/ thousand hooks) from the US Pelagic Longline fishery Carcass weight-out data.

Sandbar Shark CPUE Index Biomass

Model factors positive catch rates values	d.f.	Residual deviance	Change in deviance	% of total deviance	*p*
1	_	7477.40479			
Year	15	6998.33993	479.06	14.1%	< 0.001
Year Area	5	6103.36135	894.98	26.4%	< 0.001
Year Area Op	7	5662.41038	440.95	13.0%	< 0.001
Year Area Op Targ	3	4386.806	1275.60	37.6%	< 0.001
Year Area Op Targ Qtr	3	4359.83411	26.97	0.8%	< 0.001
Year Area Op Targ Qtr Area*Qtr	13	4253.76732	106.07	3.1%	< 0.001
Year Area Op Targ Qtr Area*Targ	13	4250.82597	109.01	3.2%	< 0.001
Year Area Op Targ Qtr Area*Op	21	4243.00431	116.83	3.4%	< 0.001
Year Area Op Targ Qtr Op*Targ	17	4223.43252	136.40	4.0%	< 0.001
Year Area Op Targ Qtr Year*Targ	38	4211.27153	148.56	4.4%	< 0.001
Year Area Op Targ Qtr Year*Qtr	28	4180.61928	179.21	5.3%	< 0.001
Year Area Op Targ Qtr Year*Op	53	4120.83334	239.00	7.0%	< 0.001
Year Area Op Targ Qtr Year*Area	46	4083.18703	276.65	8.2%	< 0.001

Model factors proportion positives	d.f.	Residual deviance	Change in deviance	% of total deviance	*p*
1	_	8700.940			
Year	15	7527.583	1173.36	19%	< 0.001
Year Area	6	5768.255	1759.33	28%	< 0.001
Year Area Op	7	5202.446	565.81	9%	< 0.001
Year Area Op Targ	3	4664.710	537.74	9%	< 0.001
Year Area Op Targ Qtr	3	3126.803	1537.91	25%	< 0.001
Year Area Op Targ Qtr Area*Qtr	18	3027.379	99.42	2%	< 0.001
Year Area Op Targ Qtr Op*Targ	21	3024.593	102.21	2%	< 0.001
Year Area Op Targ Qtr Year*Targ	45	2962.749	164.05	3%	< 0.001
Year Area Op Targ Qtr Area*Targ	18	2918.417	208.39	3%	< 0.001
Year Area Op Targ Qtr Area*Op	34	2916.271	210.53	3%	< 0.001
Year Area Op Targ Qtr Year*Op	105	2784.980	341.82	5%	< 0.001
Year Area Op Targ Qtr Year*Area	90	2739.802	387.00	6%	< 0.001
Year Area Op Targ Qtr Year*Qtr	45	2468.337	658.47	11%	< 0.001

Table 10. Analysis of mixed model formulations for biomass Sandbar shark catch rates (lbs dressed wgt/ thousand hooks) from the US Pelagic Longline fishery. Likelihood ratio tests the difference of –2 REM log likelihood between two nested models.

Sandbar Shark PLL GLMixed Model Biomass Index	-2 REM Log likelihood	Akaike's Information Criterion	Schwartz's Bayesian Criterion	Likelihood Ratio Test	
Proportion Positives					
Year target OP quarter	31354.5	31356.5	31362.9		
Year target OP quarter *Year*OP*	31199.4	31203.4	31209.1	155.1	0.0000
Year target OP quarter *Year*OP Year*quarter*	31505.3	31511.3	31519.9	-305.9	N/A
Year target OP quarter *Year*OP Year*quarter Year*area*	32641.8	32649.8	32661.2	-1136.5	N/A
Positives catch rates					
Year area quarter OP target	7028.2	7030.2	7035.7		
Year area quarter OP target *Year*area*	6991.8	6995.8	7000.2	36.4	0.0000
Year area quarter OP target *Year*area Year*OP*	6988.4	6994.4	7001.0	3.4	0.0652
Year area quarter OP target *Year*area Year*OP Year*quarter*	6963.1	6971.1	6980.0	25.3	0.0000

Table 11. Deviance analysis table of explanatory variables in the delta lognormal model for Large Coastal Complex sharks biomass (pounds dressed weight/ thousand hooks) from the US Pelagic Longline fishery Carcass weight-out data.

LCC Shark CPUE Index Biomass

Model factors positive catch rates values	d.f.	Residual deviance	Change in deviance	% of total deviance	*p*
1	_	11947.4755			
Year	22	11214.3802	733.10	14.8%	< 0.001
Year Area	5	10041.34	1173.04	23.6%	< 0.001
Year Area Op	7	9505.53726	535.80	10.8%	< 0.001
Year Area Op Targ	3	8012.34916	1493.19	30.1%	< 0.001
Year Area Op Targ Qtr	3	7990.16533	22.18	0.4%	< 0.001
Year Area Op Targ Qtr Area*Op	22	7737.37733	252.79	5.1%	< 0.001
Year Area Op Targ Qtr Area*Qtr	14	7736.70409	253.46	5.1%	< 0.001
Year Area Op Targ Qtr Area*Targ	15	7680.45978	309.71	6.2%	< 0.001
Year Area Op Targ Qtr Year*Qtr	47	7670.1231	320.04	6.5%	< 0.001
Year Area Op Targ Qtr Op*Targ	20	7649.30221	340.86	6.9%	< 0.001
Year Area Op Targ Qtr Year*Targ	54	7406.95467	583.21	11.8%	< 0.001
Year Area Op Targ Qtr Year*Op	100	7214.1567	776.01	15.6%	< 0.001
Year Area Op Targ Qtr Year*Area	75	6987.03631	1003.13	20.2%	< 0.001

Model factors proportion positives	d.f.	Residual deviance	Change in deviance	% of total deviance	*p*
1	_	11271.606			
Year	22	10258.809	1012.80	15%	< 0.001
Year Area	5	9080.840	1177.97	18%	< 0.001
Year Area Op	7	8530.296	550.54	8%	< 0.001
Year Area Op Targ	3	7874.676	655.62	10%	< 0.001
Year Area Op Targ Qtr	3	5955.576	1919.10	29%	< 0.001
Year Area Op Targ Qtr Op*Targ	21	5795.470	160.11	2%	< 0.001
Year Area Op Targ Qtr Year*Targ	66	5769.790	185.79	3%	< 0.001
Year Area Op Targ Qtr Area*Qtr	15	5664.745	290.83	4%	< 0.001
Year Area Op Targ Qtr Area*Op	30	5592.233	363.34	6%	< 0.001
Year Area Op Targ Qtr Area*Targ	15	5568.609	386.97	6%	< 0.001
Year Area Op Targ Qtr Year*Area	107	5353.321	602.25	9%	< 0.001
Year Area Op Targ Qtr Year*Op	146	5315.618	639.96	10%	< 0.001
Year Area Op Targ Qtr Year*Qtr	66	4689.992	1265.58	19%	< 0.001

Table 12. Analysis of mixed model formulations for biomass LCC sharks catch rates (lbs dressed wgt/ thousand hooks) from the US Pelagic Longline fishery. Likelihood ratio tests the difference of –2 REM log likelihood between two nested models.

LCC Shark PLL GLMixed Model Biomass Index	-2 REM Log likelihood	Akaike's Information Criterion	Schwartz's Bayesian Criterion	Likelihood Ratio Test	
Proportion Positives					
Year Area target OP quarter	30757.2	30759.2	30765.7		
Year Area target OP quarter *Year*OP*	30266.8	30270.8	30277.2	490.4	0.0000
Year Area target OP quarter *Year*OP Year*area*	30471.2	30477.2	30486.7	-204.4	N/A
Year Area target OP quarter *Year*OP Year*area Year*quarter*	30076.0	30084.0	30096.6	395.2	0.0000
Positives catch rates					
Year area quarter OP target	12161.2	12163.2	12169.3		
Year area quarter OP target *Year*area*	11924.8	11928.8	11934.1	236.4	0.0000
Year area quarter OP target *Year*area Year*OP*	11919.3	11925.3	11933.2	5.5	0.0190
Year area quarter OP target *Year*area Year*OP Year*target*	11898.6	11906.6	11917.1	20.7	0.0000
Year area quarter OP target *Year*area Year*OP Year*target Year*quarter*	11863.0	11873.0	11886.2	35.6	0.0000

Table 13. Nominal and standard blacktip shark CPUE series (shark/ thousand hooks) from the Logbook data. For the whole area, Atlantic coast only, and Gulf of Mexico only sub areas.

Year	Nominal	Estimated	Upp CI	Low CI	CV
1992	2.257	2.615	7.601	0.899	57%
1993	2.878	2.277	6.911	0.750	60%
1994	1.416	1.967	6.255	0.619	63%
1995	0.937	1.074	4.172	0.276	76%
1996	0.732	0.959	3.894	0.236	80%
1997	0.791	0.739	3.418	0.160	89%
1998	0.336	0.441	2.703	0.072	113%
1999	0.677	0.466	2.862	0.076	113%
2000	0.448	0.507	2.960	0.087	108%
2001	1.289	0.460	2.880	0.074	115%
2002	0.418	0.579	3.293	0.102	106%
2003	0.432	0.494	3.020	0.081	113%
2004	0.389	0.421	2.936	0.060	125%

Year	Nominal	Estimated	Upp CI	Low CI	CV	Area
1992	2.148	3.067	10.130	0.928	65%	Atlantic
1993	2.393	2.072	7.669	0.560	73%	Atlantic
1994	1.921	2.258	8.112	0.628	71%	Atlantic
1995	1.073	0.995	4.814	0.206	93%	Atlantic
1996	0.823	0.905	4.571	0.179	96%	Atlantic
1997	0.737	0.719	4.126	0.125	107%	Atlantic
1998	0.343	0.423	3.227	0.055	135%	Atlantic
1999	0.655	0.472	3.575	0.062	134%	Atlantic
2000	0.497	0.364	3.198	0.041	150%	Atlantic
2001	0.607	0.292	3.015	0.028	171%	Atlantic
2002	0.345	0.485	3.796	0.062	137%	Atlantic
2003	0.588	0.352	3.285	0.038	157%	Atlantic
2004	0.869	0.596	4.232	0.084	127%	Atlantic

Year	Nominal	Estimated	Upp CI	Low CI	CV	Area
1992	2.493	2.614	6.833	1.000	51%	Gulf Mex
1993	3.921	1.611	4.499	0.577	55%	Gulf Mex
1994	0.778	1.594	4.506	0.564	56%	Gulf Mex
1995	0.833	1.700	4.715	0.613	55%	Gulf Mex
1996	0.612	0.829	2.433	0.283	58%	Gulf Mex
1997	0.802	0.824	2.434	0.279	58%	Gulf Mex
1998	0.315	0.744	2.294	0.241	61%	Gulf Mex
1999	0.621	0.386	1.334	0.112	68%	Gulf Mex
2000	0.357	0.706	2.291	0.218	64%	Gulf Mex
2001	1.531	0.669	2.135	0.209	63%	Gulf Mex
2002	0.381	0.657	2.179	0.198	66%	Gulf Mex
2003	0.269	0.479	1.578	0.146	65%	Gulf Mex
2004	0.086	0.187	0.822	0.042	85%	Gulf Mex

Table 14. Nominal and standard Sandbar shark CPUE (shark/ thousand hooks) from the Logbook data.

Year	Nominal	Estimated	Upp CI	Low CI	CV
1994	0.050	0.067	0.927	0.005	216%
1995	1.640	0.748	2.742	0.204	72%
1996	1.651	1.912	6.043	0.605	63%
1997	1.097	0.686	2.569	0.183	74%
1998	0.855	0.955	3.412	0.267	71%
1999	0.838	1.036	3.768	0.285	72%
2000	1.143	1.130	3.998	0.319	70%
2001	1.028	1.076	3.876	0.299	71%
2002	0.954	0.699	2.739	0.178	77%
2003	1.012	0.927	3.486	0.247	74%
2004	0.731	1.763	5.979	0.520	67%

Table 15. Nominal and standard Large Coastal Complex sharks CPUE (shark/thousand hooks) from the Logbook data.

Year	Nominal	Estimated	Upp CI	Low CI	CV
1986	1.311	2.124	5.085	1.084	40%
1987	0.821	0.762	1.626	0.437	34%
1988	0.872	1.425	2.940	0.845	32%
1989	0.745	1.057	2.150	0.635	31%
1990	0.659	0.872	1.799	0.517	32%
1991	0.756	0.931	1.948	0.544	33%
1992	1.451	1.335	2.707	0.805	31%
1993	1.413	1.110	2.281	0.661	32%
1994	1.096	0.973	2.020	0.573	32%
1995	1.439	0.647	1.369	0.374	33%
1996	1.418	0.792	1.651	0.465	32%
1997	1.102	0.517	1.106	0.295	34%
1998	0.791	0.454	0.989	0.255	35%
1999	0.932	0.474	1.032	0.266	35%
2000	0.949	0.669	1.426	0.384	34%
2001	0.998	0.624	1.339	0.355	34%
2002	0.681	0.775	1.635	0.450	33%
2003	0.883	0.765	1.614	0.443	33%
2004	0.683	0.875	1.827	0.513	33%

Table 16. Nominal and standard Blacktip shark biomass CPUE (wgt/1000 hooks) from the carcass weight-out data. For the whole area, Atlantic coast only, and Gulf of Mexico only sub areas.

Year	Nominal	Estimated	Upp CI	Low CI	CV	std error
1983	0.205	0.197	1.906	0.020	162%	1.02
1984	0.936	1.150	5.867	0.225	97%	3.58
1985	0.211	1.073	6.432	0.179	111%	3.82
1986	0.178	0.153	0.956	0.025	115%	0.56
1987	0.467	0.574	1.989	0.166	69%	1.26
1988	0.222	0.542	1.815	0.162	66%	1.16
1989	0.365	0.434	1.560	0.120	71%	0.99
1990	0.430	0.534	1.661	0.172	62%	1.06
1991	0.767	0.593	1.640	0.214	54%	1.03
1992	2.133	1.818	4.399	0.751	46%	2.71
1993	0.721	1.001	2.554	0.393	50%	1.59
1994	5.516	2.313	5.802	0.922	49%	3.60
1995	1.749	1.368	3.404	0.550	48%	2.11
1996	1.804	1.605	4.018	0.641	48%	2.49
1997	1.220	1.564	4.156	0.589	52%	2.61
1998	0.559	1.149	3.247	0.407	56%	2.05
1999	0.622	0.942	2.621	0.338	55%	1.65
2000	0.803	2.142	5.821	0.788	53%	3.66
2001	0.846	0.841	2.318	0.305	54%	1.46
2002	0.779	1.068	3.243	0.351	60%	2.06
2003	0.933	0.419	1.283	0.137	61%	0.82
2004	0.534	0.520	1.806	0.150	69%	1.15

Year	Nominal	Estimated	Upp CI	Low CI	CV	std error	Area
1983	0.198	0.292	2.808	0.030	161%	1.29	Atlantic
1984	0.860	1.338	7.712	0.232	107%	3.93	Atlantic
1985	0.000	0.000	.	.	0%	.	Atlantic
1986	0.147	0.096	1.106	0.008	185%	0.49	Atlantic
1987	0.375	0.543	2.378	0.124	85%	1.26	Atlantic
1988	0.193	0.534	2.211	0.129	81%	1.18	Atlantic
1989	0.261	0.181	1.061	0.031	109%	0.54	Atlantic
1990	0.424	0.600	2.617	0.137	85%	1.39	Atlantic
1991	0.868	1.071	3.776	0.304	70%	2.04	Atlantic
1992	1.865	1.832	5.445	0.617	59%	2.94	Atlantic
1993	0.792	1.802	5.526	0.588	61%	2.99	Atlantic
1994	5.779	2.799	8.406	0.932	59%	4.55	Atlantic
1995	1.597	0.964	2.984	0.311	61%	1.62	Atlantic
1996	1.227	1.473	4.569	0.475	61%	2.48	Atlantic
1997	0.740	0.594	2.107	0.168	70%	1.14	Atlantic
1998	0.347	0.727	2.776	0.191	75%	1.50	Atlantic
1999	0.554	1.000	3.397	0.294	67%	1.84	Atlantic
2000	0.700	1.263	4.493	0.355	70%	2.43	Atlantic
2001	0.712	0.758	2.545	0.226	67%	1.38	Atlantic
2002	1.045	1.213	4.421	0.333	72%	2.39	Atlantic
2003	1.447	0.956	3.240	0.282	67%	1.76	Atlantic
2004	0.870	0.962	3.699	0.250	76%	1.99	Atlantic
Year	**Nominal**	**Estimated**	**Upp CI**	**Low CI**	**CV**	**std error**	**Area**
1985	1.330	3.761	27.272	0.519	129%	19.88	Gulf Mex
1986	0.291	0.396	3.280	0.048	144%	2.32	Gulf Mex
1987	0.735	0.519	4.003	0.067	136%	2.88	Gulf Mex
1988	0.021	0.042	0.551	0.003	206%	0.35	Gulf Mex
1989	0.857	0.647	3.800	0.110	109%	2.89	Gulf Mex
1990	0.331	1.001	4.886	0.205	93%	3.83	Gulf Mex
1991	0.248	0.220	1.165	0.042	100%	0.90	Gulf Mex
1992	2.683	2.715	10.937	0.674	79%	8.78	Gulf Mex
1993	0.162	0.195	1.037	0.037	100%	0.80	Gulf Mex
1994	1.174	0.578	2.963	0.113	97%	2.31	Gulf Mex
1995	1.548	1.674	7.347	0.381	85%	5.84	Gulf Mex
1996	3.570	0.740	3.341	0.164	87%	2.65	Gulf Mex
1997	2.847	1.383	6.116	0.313	86%	4.86	Gulf Mex
1998	1.271	1.396	6.602	0.295	91%	5.20	Gulf Mex
1999	0.646	0.795	4.551	0.139	107%	3.47	Gulf Mex
2000	0.941	1.621	8.159	0.322	96%	6.37	Gulf Mex
2001	1.147	1.836	10.111	0.333	103%	7.77	Gulf Mex
2002	0.145	0.397	2.808	0.056	127%	2.06	Gulf Mex
2003	0.002	0.008	0.202	0.000	366%	0.12	Gulf Mex
2004	0.051	0.075	0.909	0.006	192%	0.59	Gulf Mex

Table 17. Nominal and standard Sandbar shark biomass CPUE (wgt/1000 hooks) from the carcass weight-out data.

Year	Nominal	Estimated	Upp CI	Low CI	CV	std error
1989	0.0001	0.0005	0.039	0.000	1145%	0.04
1990	0.0004	0.0022	0.062	0.000	396%	0.06
1991	0.002	0.010	0.087	0.001	145%	0.11
1992	0.006	0.013	0.085	0.002	116%	0.11
1993	0.003	0.045	0.263	0.008	109%	0.36
1994	0.913	0.445	1.264	0.156	56%	1.83
1995	1.598	0.733	1.909	0.281	51%	2.73
1996	2.912	4.009	9.657	1.665	46%	13.59
1997	1.799	1.599	4.105	0.623	50%	5.86
1998	0.763	1.562	4.147	0.588	52%	5.95
1999	1.131	1.747	4.507	0.677	50%	6.44
2000	1.541	2.316	6.138	0.874	52%	8.81
2001	2.233	1.594	4.316	0.589	53%	6.21
2002	1.227	0.355	1.018	0.124	56%	1.47
2003	1.489	0.984	2.808	0.345	56%	4.06
2004	0.384	0.585	1.676	0.204	57%	2.43

Table 18. Nominal and standard Large Coastal Complex sharks biomass CPUE (wgt/1000 hooks) from the carcass weight-out data

Year	Nominal	Estimated	Upp CI	Low CI	CV	std error
1982	0.005	0.134	1.507	0.012	183%	1.97
1983	0.029	0.156	1.737	0.014	181%	2.28
1984	0.143	1.082	7.316	0.160	122%	10.67
1985	0.031	0.675	5.423	0.084	140%	7.63
1986	0.025	0.053	0.434	0.006	143%	0.61
1987	0.068	0.519	2.646	0.102	97%	4.06
1988	0.031	0.258	1.387	0.048	101%	2.11
1989	0.052	0.241	1.247	0.047	98%	1.91
1990	0.059	0.335	1.604	0.070	92%	2.49
1991	0.109	0.544	2.439	0.121	87%	3.82
1992	0.313	2.096	8.558	0.513	80%	13.53
1993	0.123	0.694	3.135	0.154	87%	4.90
1994	1.981	2.499	10.420	0.600	82%	16.44
1995	2.327	2.069	8.675	0.494	82%	13.68
1996	3.833	3.888	15.824	0.955	80%	25.03
1997	2.435	1.714	7.504	0.391	85%	11.78
1998	1.063	0.996	4.611	0.215	89%	7.18
1999	1.549	1.165	5.150	0.264	86%	8.07
2000	2.031	1.311	6.206	0.277	91%	9.64
2001	2.782	1.000	4.749	0.211	91%	7.37
2002	1.547	0.441	2.057	0.095	90%	3.20
2003	1.920	0.635	2.885	0.140	88%	4.51

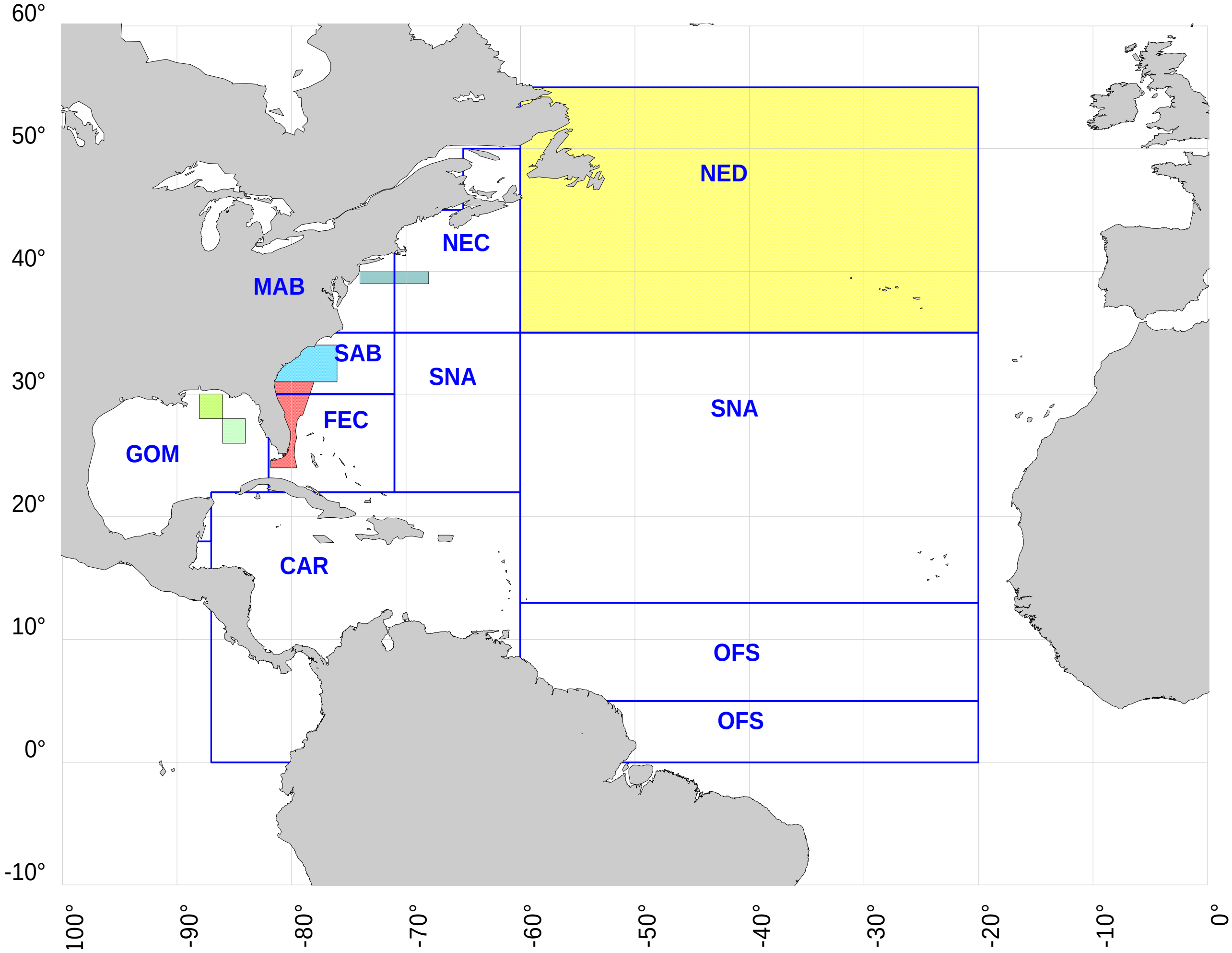


Figure 1. Geographic area classification for the US Pelagic longline fishery: CAR Caribbean, GOM Gulf of Mexico, FEC Florida east coast, SAB south Atlantic bight, MAB mid Atlantic bight, NEC north east coastal, NED north east distant waters, SNA Sargasso area, and OFS offshore waters. Shaded areas represent the current time-area closures affecting the pelagic longline fisheries. Permanent closures: the DeSoto area in the Gulf of Mexico, and the Florida east coast area. Time-area closures: the Charleston Bump in the SAB area closed Feb-Apr, the Bluefin tuna protected area in the MAB and NEC areas closed Jun, and the Grand Banks in the NED area closed from Oct 10/00 to Apr 9/01.

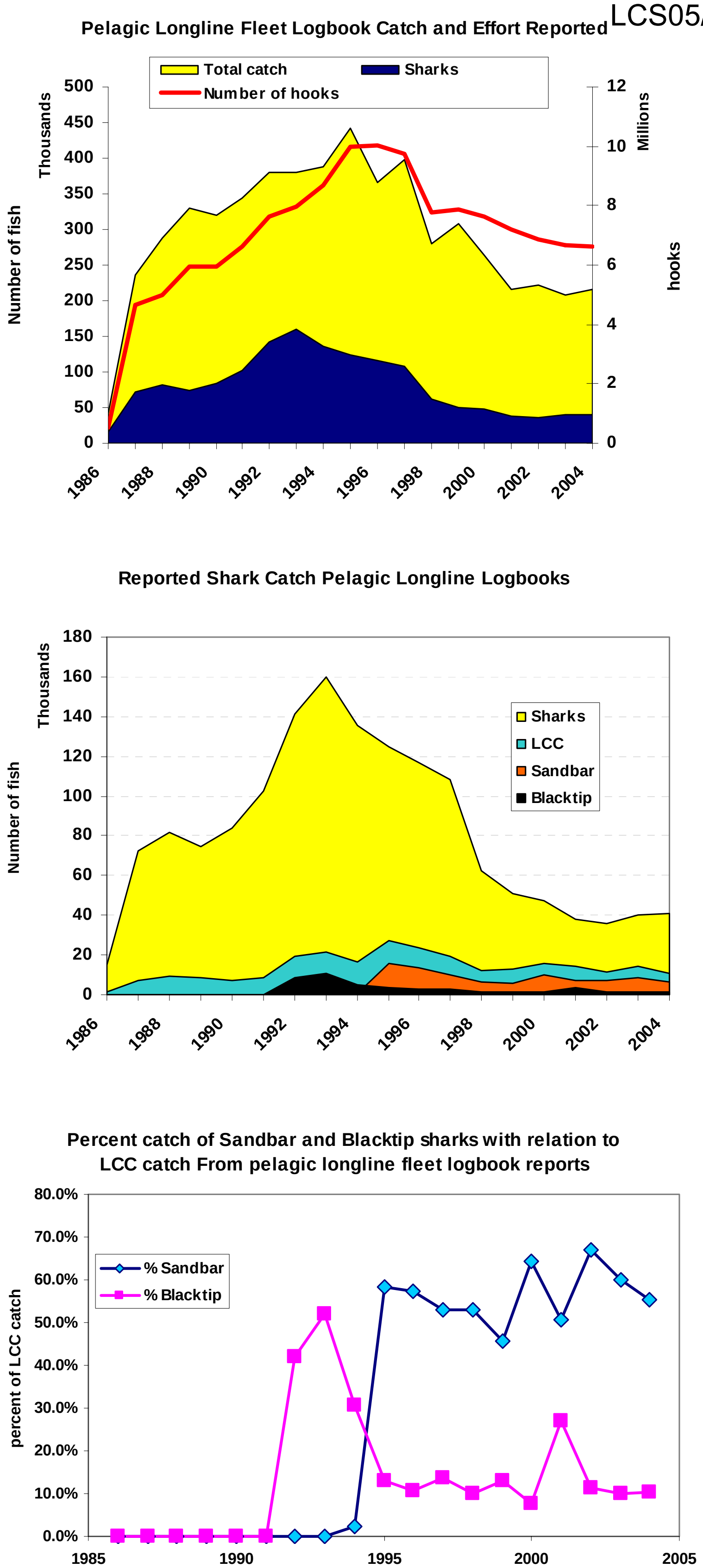
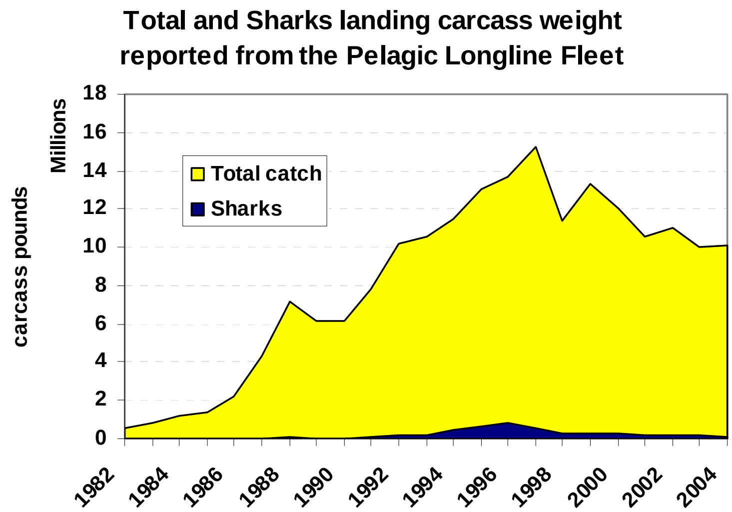
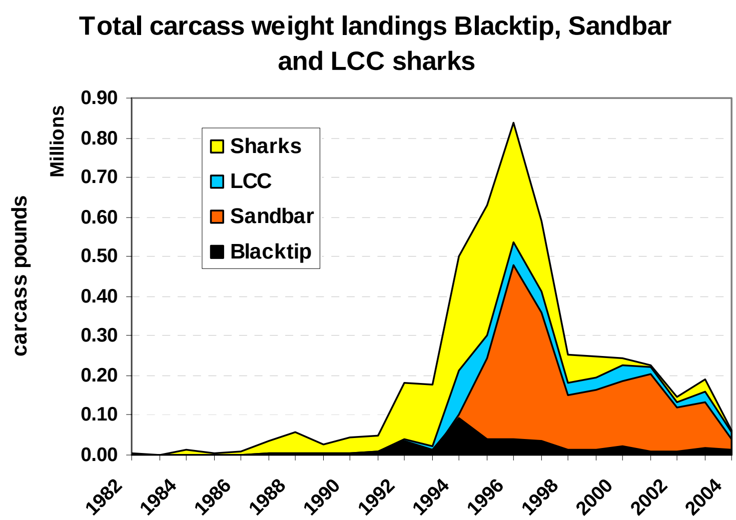


Figure 2. Summary catch and effort annual trends from the Pelagic Longline fleet reported in Logbooks 1986 – 2004. Top panel shows the total catch and shark catch reported as number of fish and fishing effort as number of hooks deployed. Middle panel shows the distribution of sharks catch by group and species. Bottom panel shows the percent of catch contributed by sandbar and blacktip sharks to the Large Coastal Complex (LCC) shark group.





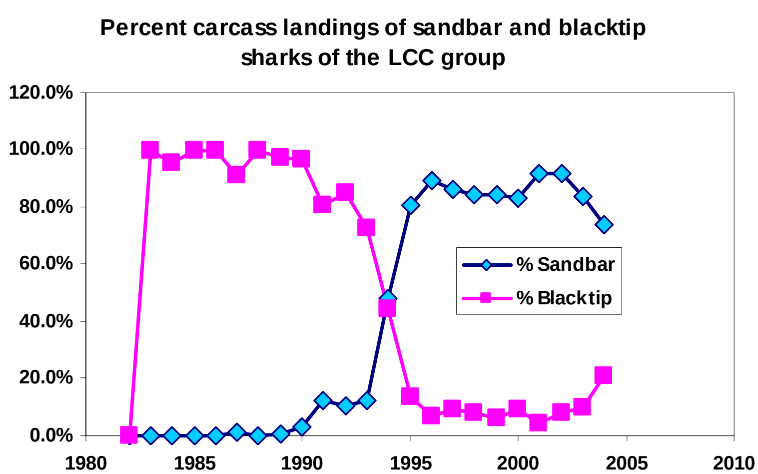


Figure 3. Summary landings annual trends from the Pelagic Longline fleet reported in the carcass weight-out 1982 – 2004. Top panel shows the total and shark landings reported as weight of fish. Middle panel shows the distribution of sharks landings by group and species. Bottom panel shows the percent of landings contributed by sandbar and blacktip sharks to the Large Coastal Complex (LCC) shark group

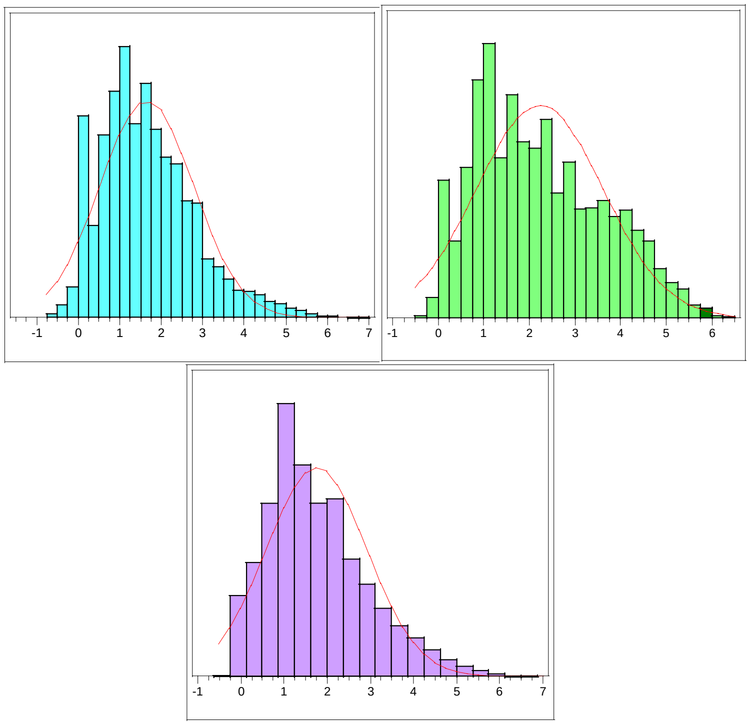


Figure 4. Density frequency distribution of positive catch trips (logCPUE) for blacktip, sandbar (top) and LCC sharks from the Pelagic Longline Logbook data.

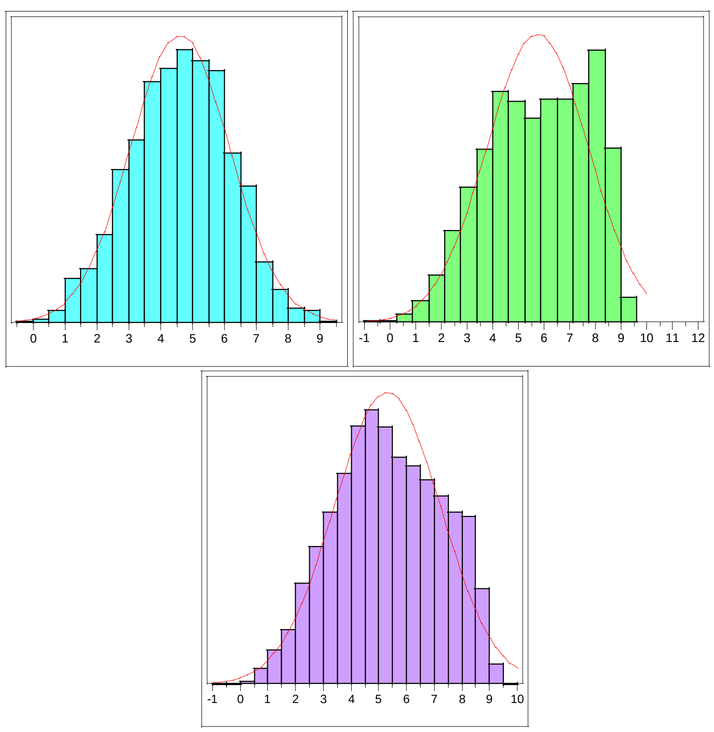


Figure 5. Density frequency distribution of positive landing trips (logCPUE) for blacktip, sandbar (top) and LCC sharks from the Pelagic Longline carcass weight-out data.

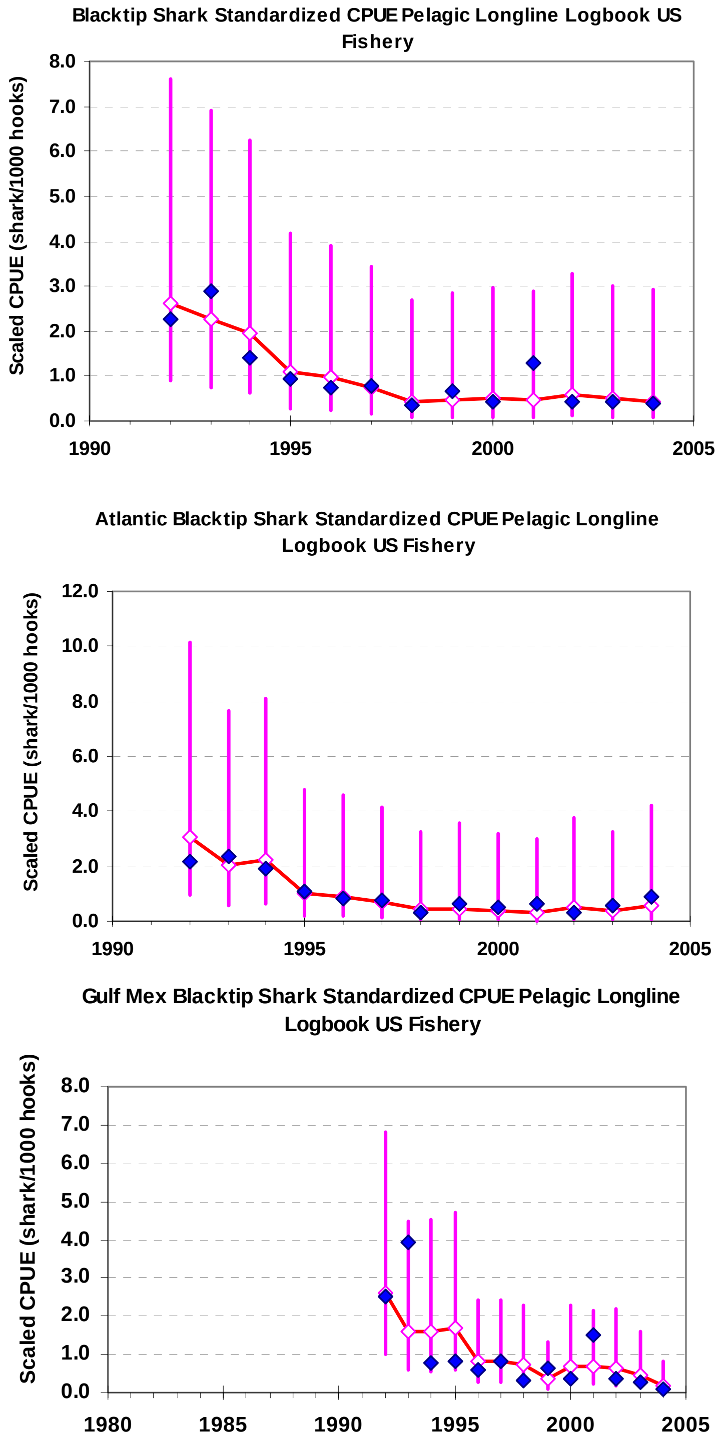
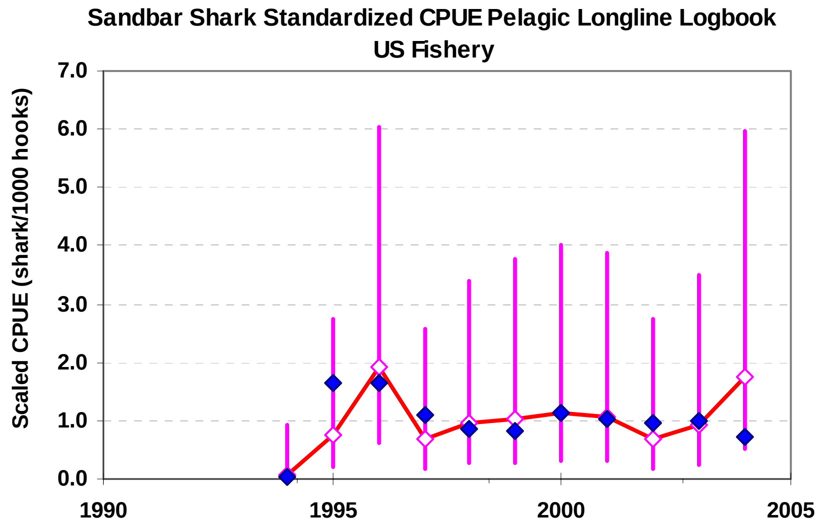


Figure 6 Nominal (solid diamonds) and standard CPUE for Blacktip shark by area from the US Pelagic longline fishery. Bars represent upper and lower estimated 95% confidence intervals for the scaled CPUE value**.** Series are scaled to their corresponding mean.



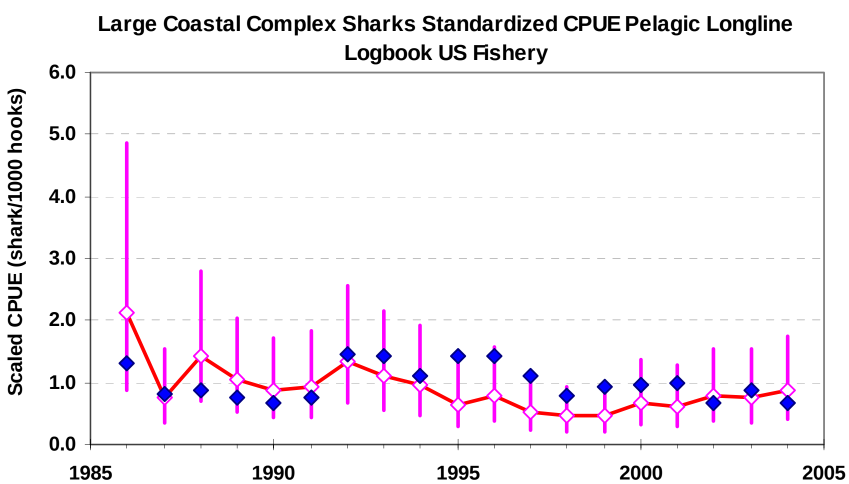


Figure 7. Nominal (solid diamond) and standard CPUE for sandbar shark (top) and Large coastal complex sharks from the Pelagic Longline Logbook data. Bars represent upper and lower estimated 95% confidence intervals for the scaled CPUE value. Series are scaled to their corresponding mean.

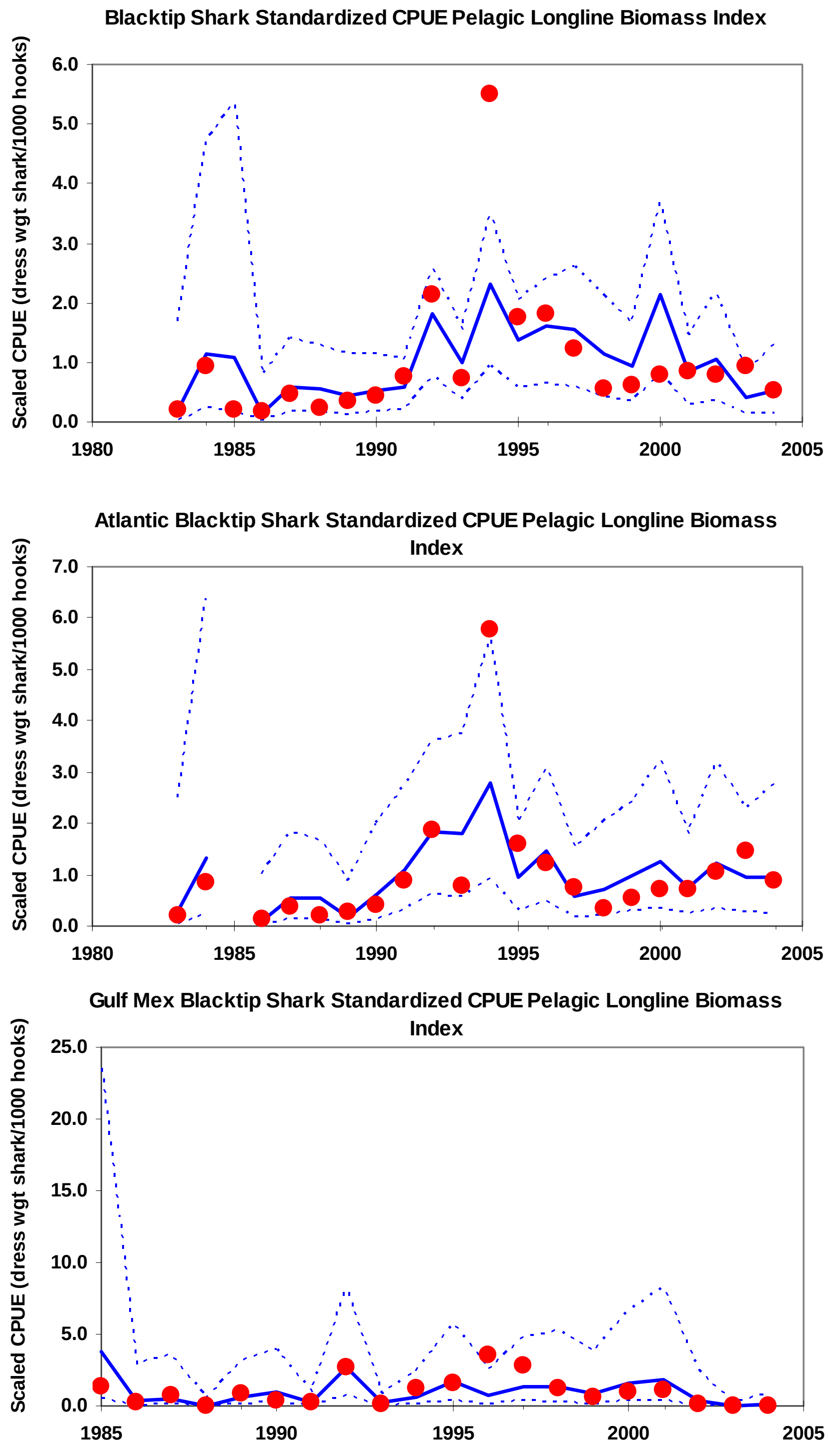
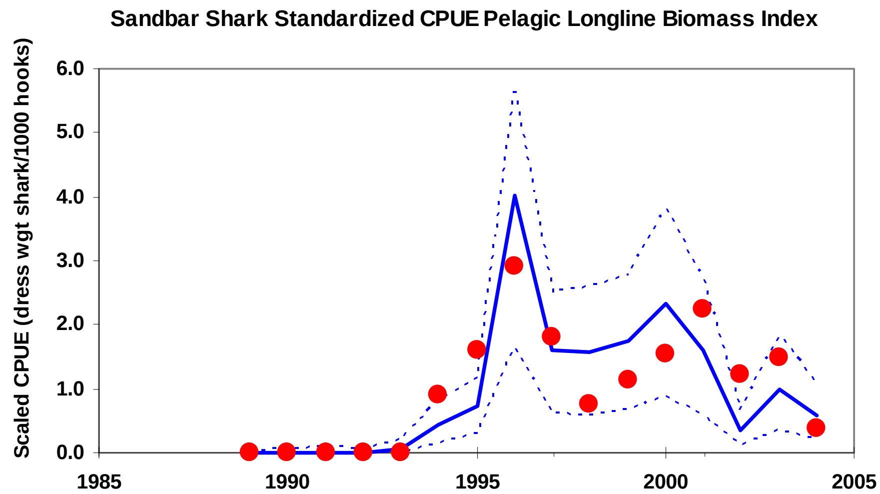


Figure 8. Nominal (solid-circles) and standard CPUE for Blacktip shark by area from the US Pelagic longline fishery carcass weight-out data. Broken lines represent upper and lower estimated 95% confidence intervals for the scaled CPUE value. Series are scaled to their corresponding mean for each age class.



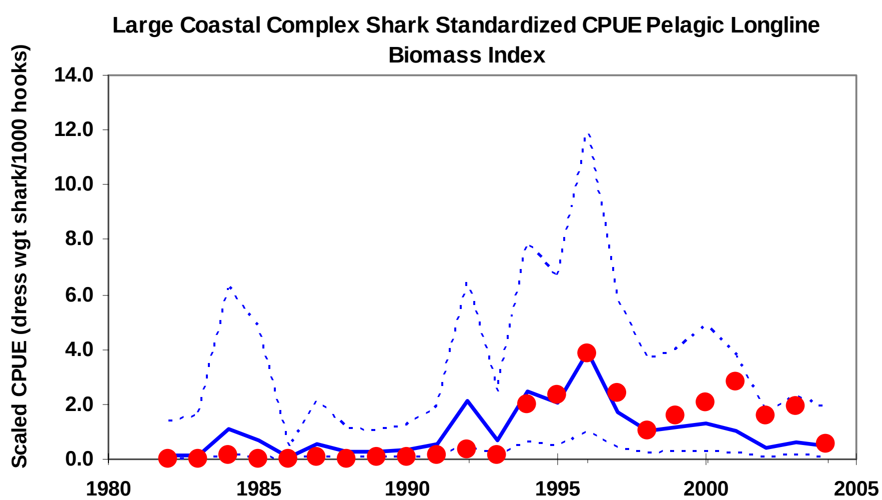


Figure 9. Nominal (solid-circles) and standard CPUE for Sandbar shark (top) and Large Coastal Complex sharks from the US Pelagic longline fishery carcass weight-out data. Broken lines represent upper and lower estimated 95% confidence intervals for the scaled CPUE value. Series are scaled to their corresponding mean for each age class.

Appendix

Response to recommendations by the Data workshop Large Coastal Sharks Complex regarding indices of abundance derived from PLL databases.

Issue 1. "Identify subgroup of observations from the PLL data that better represents effort and catch directed towards shark fisheries. By selecting trips based on species composition to help determine trips that would be targeting large coastal sharks, and or subset the data to boats that appeared to be consistently reporting sharks throughout the time period."

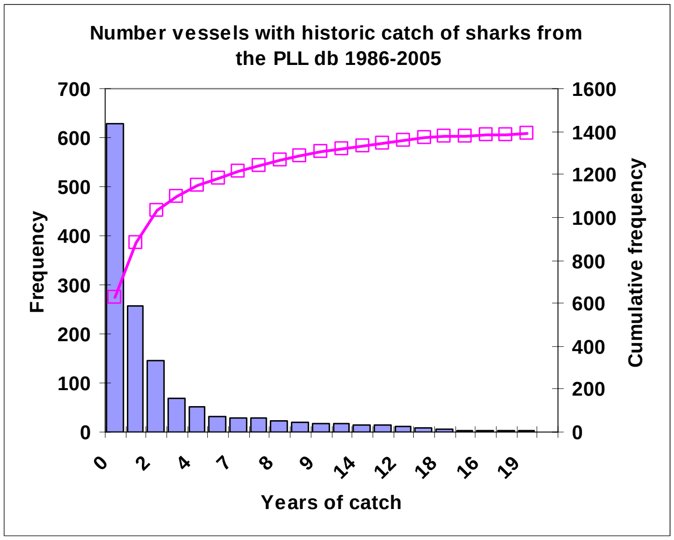
The revision and evaluation of catch rates for large coastal shark complex used the species definition of LCC given in table 4 of LCS05/06-DW-08[1], distinguishing between prohibited and non-prohibited species.

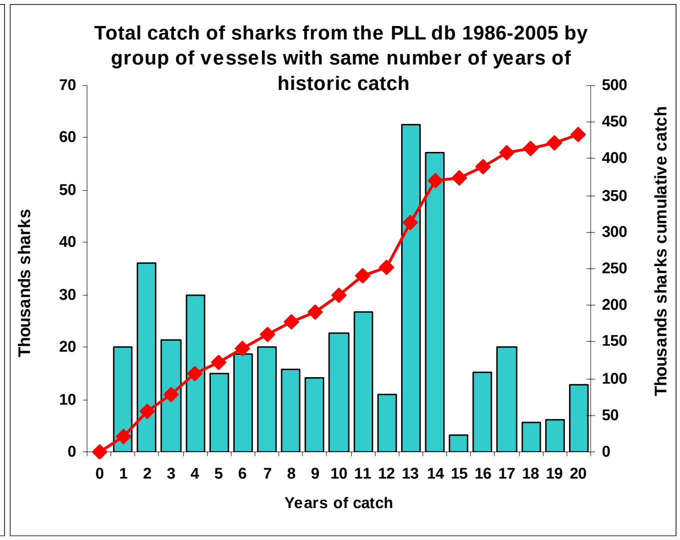
Table 4. List of species that are large coastal sharks (LCC), including those that are prohibited.

Common name	***Species name***
Non-prohibited species	
Sandbar	*Carcharhinus plumbeus*
Silky	*Carcharhinus falciformis*
Tiger	*Galeocerdo cuvier*
Blacktip	*Cancharhinus limbatus*
Spinner	*Carcharhinus brevipinna*
Bull	*Carcharhinus leucas*
Lemon	*Negaprion brevirostris*
Nurse	*Ginglymostoma cirratum*
Scalloped hammerhead	*Sphyrna lewini*
Great hammerhead	*Sphyrna mokarran*
Smooth hammerhead	*Sphyrna zygaena*
Prohibited Species	
Sand tiger	*Odontaspis taurus*
Bigeye sand tiger	*Odontaspis noronhai*
Whale	*Rhincodon typus*
Basking	*Cetorhinus maximus*
White	*Carcharodon carcharias*
Dusky	*Carcharhinus obscurus*
Bignose	*Carcharhinus altimus*
Galapagos	*Carcharhinus galapagensis*
Night	*Carcharhinus signatus*
Caribbean reef	*Carcharhinus perezi*
Narrowtooth	*Carcharhinus brachyurus*

In review the PLL db, it was found that between 1986 and 2005 at least 1388 different vessel_ID have reported catches of any species, of these 760 vessels reported at least once catch of sharks. The figure show the histogram and cumulative number of vessels reporting catch of sharks grouped by the number of years that each vessel has reported positive catches of sharks.
Most vessels have only reported catches in 1 to 5 years, however there are vessels that have consistently catch sharks for at least 8 or more years.

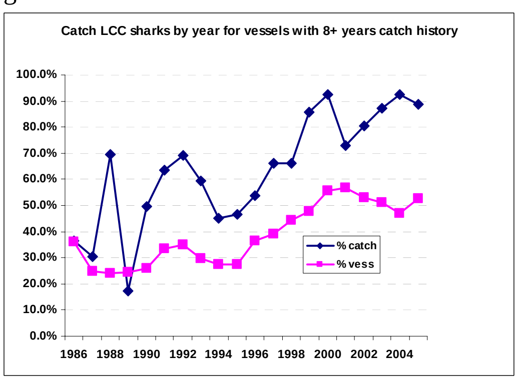
[1] Brewster-Geisz, K. 2005. A summary of the management of Atlantic Large Coastal Sharks. LCS05/06-DW-08.

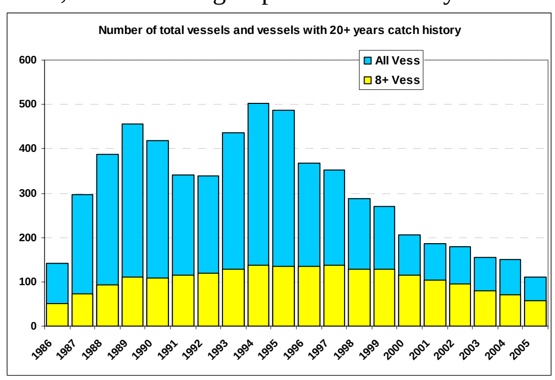


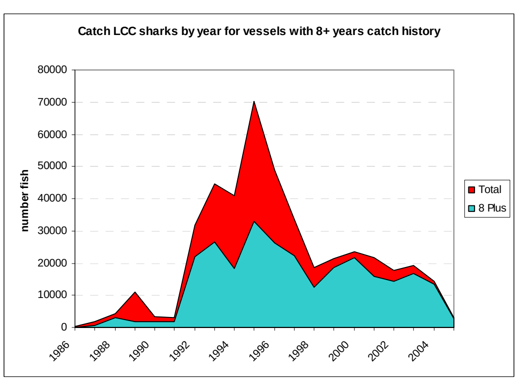


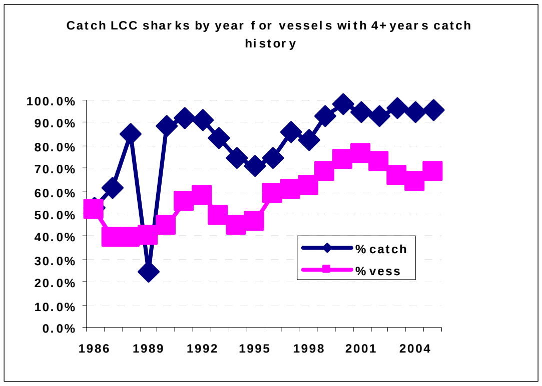
The following plot shows the corresponding catch for the same group of vessels (by number of years of reporting). Vessels that have 8+ years of shark catches accounted for about 62% of the total catch in the 1986-2005 period. However, still vessels with 2-5 years of reporting represent about 25% of total catch. However, these plots show only the total catch and vessel number breakdown in the 1986-2005 period.

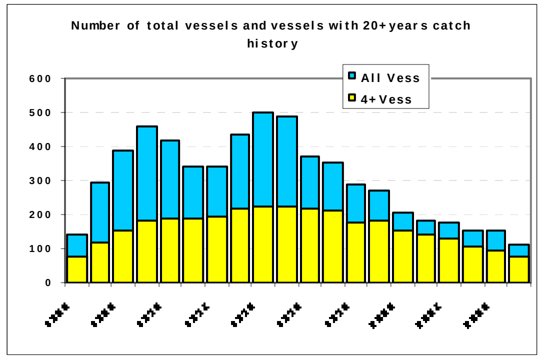
The following plots shows the yearly trends for a particular subgroup of data based on the number of years of historic catch. Yearly trends are presented as percentage of total annual catch (diamonds) or percentage of number of vessels reporting shark catch for that year (squares). Also plots of absolute values are shown. Selecting vessels with 8 or more years of shark catches do represent the bulk of catches particularly in the latest years (1999-2005), however they account only for 50%-70% of the catch in the period 1993 – 1998 when the largest catches of sharks were observed. Similar in 1989, when the 8+ group account for only 20% of total catch.

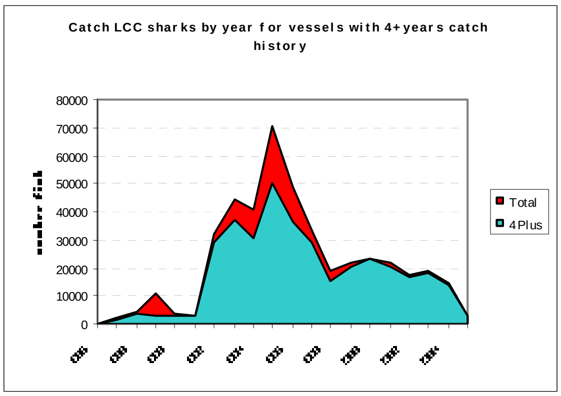












Instead if selecting vessels with 4+ years of shark catches, the overall annual distribution of their proportion of catch is higher and consistent throughout the 1986-2005 period, with exception of 1989*[2]. Therefore it was opted to limit the PLL data to vessels with reported annual catch of sharks for at least 4 or more years for the standardized CPUE analysis for all LCC species.

Other analysis included the review of species composition within trips/hauls. For this, initial correlations of catch were evaluated for all species in the PLL. Table 1 shows the correlations between species, highlighted are those correlations greater than 0.2 (either negative or positive). It was found that only between catches of white marlin (whm) and blue marlin there is a positive correlation, as well between catches of wahoo and yellowfin tuna. Basically there is not correlation between species catches, much less for sharks, if we are looking at the overall catch species composition within trip/hauls. Looking a groups of species (LCC, LLC1 non-prohibited shark species, LLC2 prohibited shark species) and the main target species of this fishery (swordfish, yellowfin, bluefin, bigeye) correlation of catches (Table 2) is again very low. Positive correlations were found between catches of albacore and bigeye, white and blue marlin, and of course between sharks groups (LCC and LLC1 and LLC2). Not correlations between sharks and other species, were found, thus no further analysis on sub setting observations based on species composition by trip was attempted.

Issue 2. Consider bottom depth as a factor or as a filter to subset data from the PLL db.

Bottom depth is not an information collected in the Pelagic logbook fishery, it is however possible to determine bottom depth from bathymetric charts if geo-reference positions are provided. The logbooks in general have latitude longitude information for most of the records in the PLL database. However, this lat-lon point is normally an approximate value of typically the start of the set, with a margin of error of about 10 km. From the observer program data, where geographic coordinates are collected for the beginning and end of both set and haul, was estimated that on average a set will cover an area of 600 km^2, and "drift" up to 45 km (±20) in any direction. Within this mean area of fishing for a single set, is likely that bottom depth can vary greatly and

[2] In 1989 a single vessel reported a total catch of 6683 tiger sharks in the Gulf of Mexico in 1989, from about 30 trips, that catch is alone 60% of the total shark landings in that year. That vessel has no other reported catch of sharks in the 20 year period.

an average bottom depth would be uninformative. Initially we investigated the locations reported with catches of sharks from the PLL database to explore if there is further justification for estimating a mean bottom depth for each record.

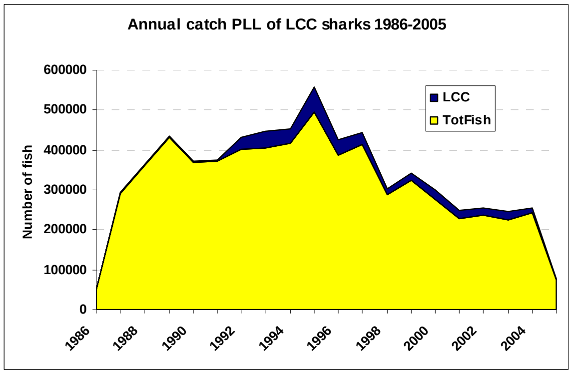
For this purpose, maps of catch of LCC (all species) sharks by 1 degree square (1 lat x 1 lon) were created for the PLL db records with geographic coordinates (Fig 1). This plot shows the total cumulative catch by square degree from 1986-2005, for comparison the top map shows similar distribution for the total fishing effort (hooks deployed) in the same time period. Is clear that most of the LCC shark catch is off the Atlantic coast and Gulf of Mexico, however catches have also been in the Caribbean and from the Grand Banks area. From offshore areas, in the West Central Atlantic, and north of the South American coast catches have also been reported although at much lower levels. In the Atlantic coast, the areas with high catches are both inside the continental self and off the shelf, no surprisingly these areas match with the areas of higher fishing effort deployment.

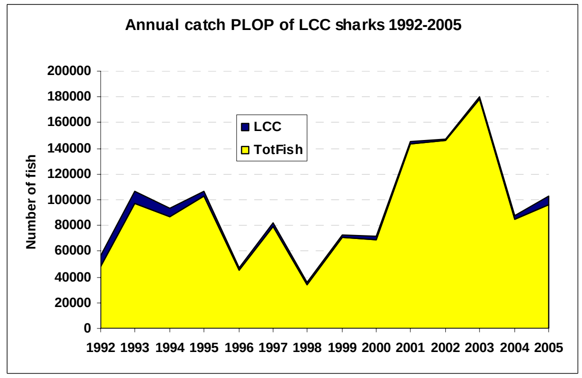
Looking at average cumulative catch rates (LCC sharks per thousand hooks) on one degree square (Fig 2) higher nominal CPUEs tend to occur off the coast, in both Atlantic and Gulf of Mexico regions. Figures 2 and 3 show the average nominal CPUEs for 5 year periods, important to notice the expansion of shark catches during the 1990's both into the Gulf of Mexico and the Caribbean Seas, only by 2000-04, there is a contraction of the areas reporting catches of LCC sharks, concentrating mainly in the near coast areas of the West Atlantic and north Gulf of Mexico. Therefore, LCC shark catch is quite wide spatially distributed in the West Atlantic and Caribbean regions, with the degree of precision or lack of, in terms of set position, bottom depth is unlikely to add more information in explaining catch rates, as it will highly correlated particularly with the current area factor used in the model (see Figure 1 main document, map of areas). Thus it was not carry out estimation of bottom depth as additional factor or filter for standardization of catch rates of LCC sharks.

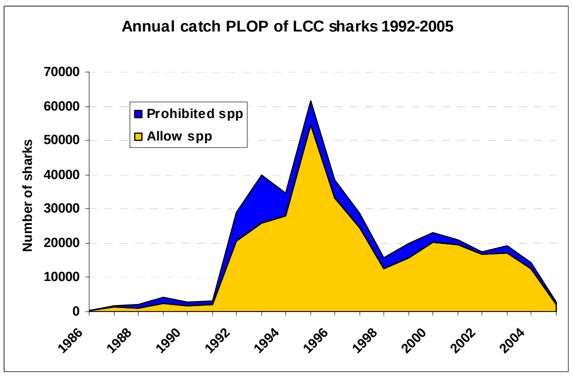
In summary for the PLL database use to generate standardized indices of abundance for LCC sharks the only change or modification introduced was the restriction of data to those vessels that have at least 4 or more years of LCC shark catches. Species catch association or bottom depth were not implemented based on the analyses describe above. The updated standardized indices of abundance for sandbar shark (Atlantic and GOM combined), blacktip shark Atlantic, blacktip shark GOM, and LLC non-prohibited species (Atlantic and GOM combined) are presented in tables 3 to 5, and correspondent figure 4. Indices trends for sandbar and blacktip shark were similar between the updated standard CPUE and those presented in the document SFD-2005/ 042 (Ortiz 2005). However, the LCC index show a different trend, the updated data show in particular an increase of trends in 1992, for both prohibited and non-prohibited species that was not seen in the initial evaluation (Fig 7, SFD-2005/042). In part, this change is due to the different composition of species for the definitions of LCC shark complex, for example in the first analysis dusky shark catches were not included, also change in the data as vessels with less than 4 years of shark catch were excluded from the latest analysis.

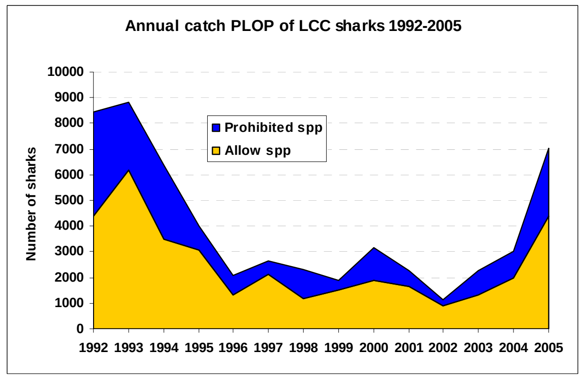
An additional analysis performed was the comparison of LCC shark catch composition between the pelagic longline data (PLL) and the observer program (POP) that covers this fishery. The plots on the left are the distribution of catches of all other fish and sharks (top) and of non-prohibited and prohibited shark species of the LCC groups from the PLL and on the right from the POP data.

On average both the PLL and POP reported about 5-6% of total catch belonging to the LCC shark complex. The observer program reported higher percentage of LCC prohibited shark species, compare to the PLL, but in general they follow a similar trend, with a reduction of the prohibited species in the latest years.





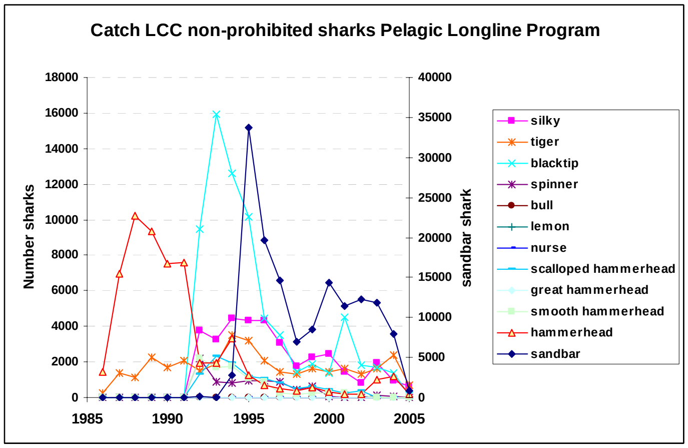


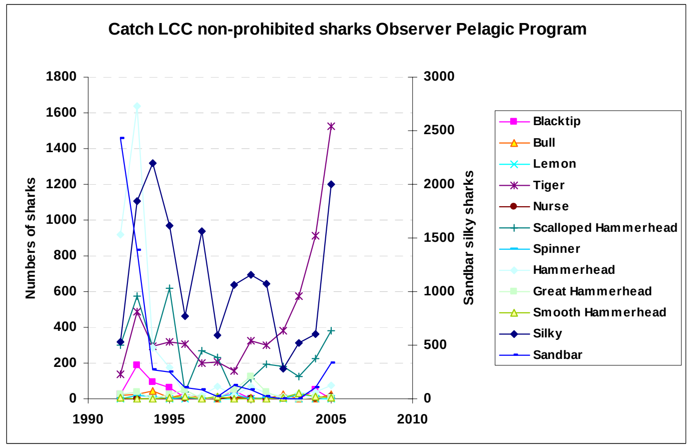


The following plots, also contrast the PLL data (left column) versus the observer program data (POP) (right column). On top are the plots in number for the LCC non-prohibited and prohibited species, and the lower section is the same information but express as percent of each species by year. Notice that the POP started in 1992, while the PLL data is from 1986. For the non-prohibited species, the catch composition between PLL and POP is different; in the POP silky and tiger shark are the main components through the years, with the hammerhead species filling the catch. While in the PLL data, sandbar is by far the most predominant species, followed by blacktip, silky and tiger sharks. Prior to 1992 hammerheads and tiger sharks where the main components reported in the catch of LCC sharks.

In contrast, the composition of catch for prohibited species from both PLL and POP data are similar, at least in predominant species, night and dusky shark are the major components. In the PLL data, dusky shark catches are higher in proportion in the latest years, while the POP indicated that night shark is predominant.

In conclusion, indices derived from the PLL data were standardized for a subset of observation where only vessels with 4 or more years of LCC shark catches were included. Indices trends for sandbar and blacktip shark were similar to those presented at the data workshop, the trend for the LCC group (all species) and LCC non-prohibited species did change compared to those presented ad the data workshop. The additional analyses and results indicated that in 1992, both catch composition and total shark catch reported by PLL data changed compared to 1985-1991, Also catch composition between PLL and the observer program (PLOP) differs for the LCC non-prohibited shark species subgroup. In the observer program data, silky and tiger shark are the main species caught, while in the PLL data sandbar shark is predominant. It is recommended to restrict the index from the PLL to 1992 forward for the LCC non-prohibited shark species. In response to the prior suggestion, the catch rate working group of the DW SEDAR request to restrict standardized indices of LCC groups to 1992 and subsequent years. Tables 6 and 7 present the standard index for LCC non-prohibited species and LCC non-prohibited excluding sandbar and blacktip shark catches. Table 8 presents the standard index for all 22 shark species of the LCC group, note that this index might represent bias reporting, as PLL records primarily landings, and prohibited species may be under reported or their reporting rate may change during the 1992-2004 period. Figures 5 and 6 show the trends of the updated indices for the LCC groups from 1992 on.


Catch LCC non-prohibited sharks Pelagic Longline Program
Number sharks
sandbar shark
silky
tiger
blacktip
spinner
bull
lemon
nurse
scalloped hammerhead
great hammerhead
smooth hammerhead
hammerhead
sandbar


Catch LCC non-prohibited sharks Observer Pelagic Program
Numbers of sharks
Sandbar silky sharks
Blacktip
Bull
Lemon
Tiger
Nurse
Scalloped Hammerhead
Spinner
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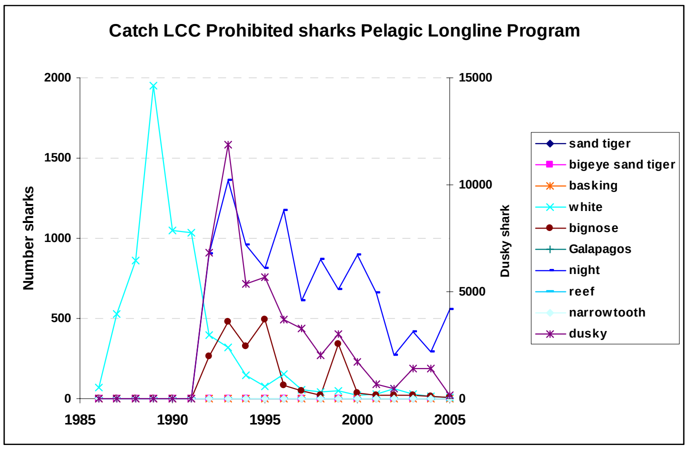
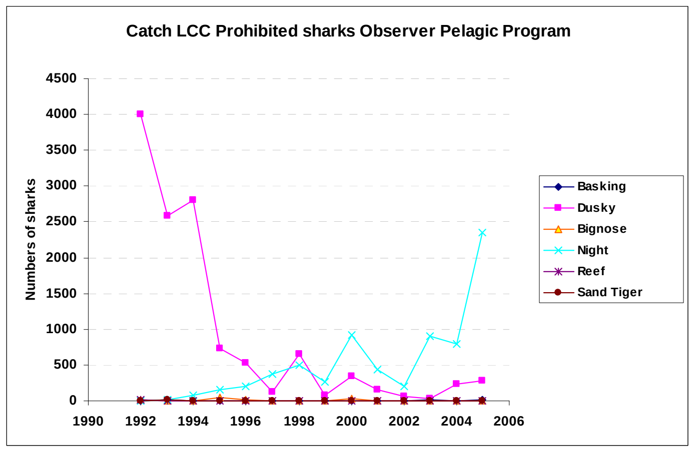
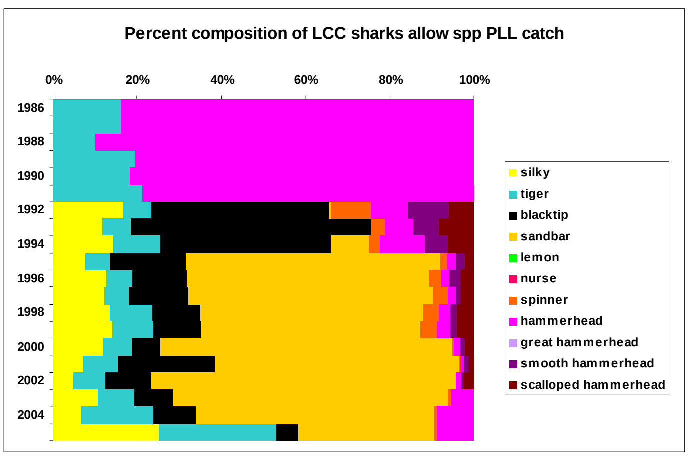
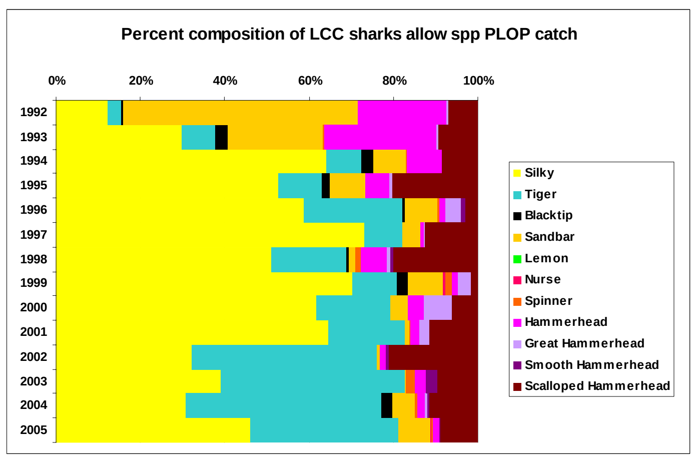
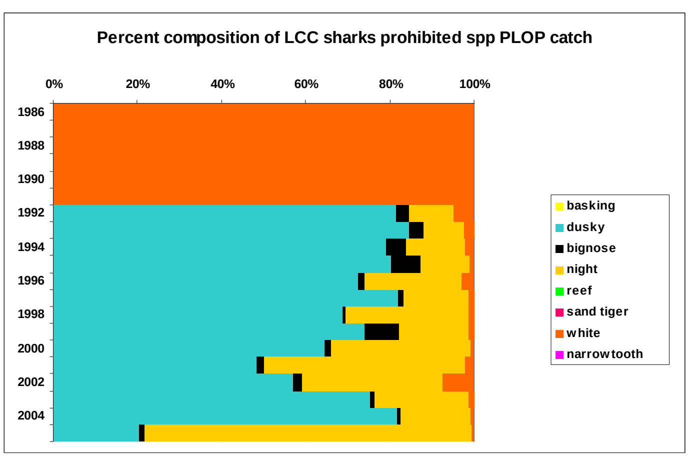
Smooth Hammerhead
Silky
Sandbar


Catch LCC Prohibited sharks Pelagic Longline Program
Number sharks
Dusky shark
sand tiger
bigeye sand tiger
basking
white
bignose
Galapagos
night
reef
narrowtooth
dusky


Catch LCC Prohibited sharks Observer Pelagic Program
Numbers of sharks
Basking
Dusky
Bignose
Night
Reef
Sand Tiger


Percent composition of LCC sharks allow spp PLL catch
silky
tiger
blacktip
sandbar
lemon
nurse
spinner
hammerhead
great hammerhead
smooth hammerhead
scalloped hammerhead


Percent composition of LCC sharks allow spp PLOP catch
Silky
Tiger
Blacktip
Sandbar
Lemon
Nurse
Spinner
Hammerhead
Great Hammerhead
Smooth Hammerhead
Scalloped Hammerhead


Percent composition of LCC sharks prohibited spp PLOP catch
basking
dusky
bignose
night
reef
sand tiger
white
narrowtooth

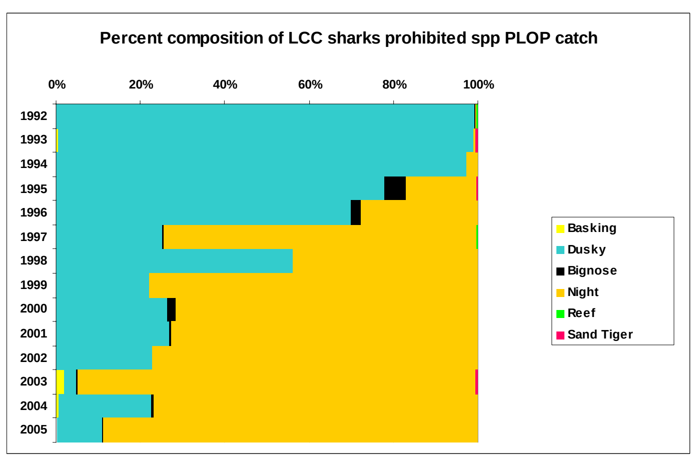

Percent composition of LCC sharks prohibited spp PLOP catch
Basking
Dusky
Bignose
Night
Reef
Sand Tiger

Table 1. Correlation matrix for species catch reported by set in the Pelagic Longline Logbook db 1986-2005. Shades areas indicated cells with correlations higher than 0.2 (either positive or negative correlated).

	swo	bft	alb	bet	yft	skj	bon	tun	blk	bum	sai	spx	whm	amj	brf	dol	kgm	oil	wah	bsh	lma	sma	ocs	por	bth	shp	xth	dus	sbn	sbk	xhh	spl	shh	ghh	sni	fal	ssp	tig	ssb	wsh	sbu	sln	snr	snt	sre	nrw	gal	bak	bes
swo	1.00	-0.01	0.00	0.04	-0.18	-0.02	-0.01	-0.01	-0.03	0.00	0.00	0.01	-0.02	-0.01	0.00	-0.03	-0.01	-0.05	-0.07	0.14	0.10	0.04	0.04	0.00	0.00	0.00	0.01	-0.02	0.00	-0.03	0.01	-0.01	-0.01	0.00	0.04	0.03	-0.01	-0.02	-0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
bft	-0.01	1.00	0.02	0.03	0.00	0.00	0.00	0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.04	0.00	0.01	-0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
alb	0.00	0.02	1.00	0.31	0.03	0.00	0.00	0.00	-0.01	-0.01	-0.02	0.00	0.01	0.00	0.00	-0.01	0.00	-0.01	-0.02	0.04	0.00	0.01	-0.01	0.00	-0.01	0.00	-0.01	-0.01	0.00	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	-0.02	-0.01	-0.01	-0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
bet	0.04	0.03	0.31	1.00	0.01	-0.01	-0.01	0.00	-0.02	-0.01	-0.02	0.00	0.03	0.00	0.00	-0.02	0.00	-0.03	-0.04	0.08	0.03	0.01	0.00	-0.01	0.00	0.00	0.00	-0.02	0.00	-0.02	-0.01	-0.01	0.00	0.00	-0.01	-0.02	-0.01	-0.02	-0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
yft	-0.18	0.00	0.03	0.01	1.00	0.02	0.01	0.01	0.09	0.02	0.02	0.01	0.06	0.01	0.00	0.04	0.02	0.12	0.21	-0.05	-0.01	-0.01	-0.02	-0.01	0.00	0.00	0.00	-0.01	0.00	-0.02	0.00	-0.01	0.00	0.00	-0.02	-0.02	-0.01	-0.03	-0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
skj	-0.02	0.00	0.00	-0.01	0.02	1.00	0.01	0.00	0.07	0.00	0.01	0.00	0.02	0.00	0.00	0.02	0.00	0.02	0.03	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
bon	-0.01	0.00	0.00	-0.01	0.01	0.01	1.00	0.03	0.05	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.04	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
tun	-0.01	0.01	0.00	0.00	0.01	0.00	0.03	1.00	0.02	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
blk	-0.03	0.00	-0.01	-0.02	0.09	0.07	0.05	0.02	1.00	0.07	0.08	0.01	0.11	0.00	0.00	0.03	0.01	0.04	0.10	-0.02	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
bum	0.00	-0.01	-0.01	-0.01	0.02	0.00	0.01	0.00	0.07	1.00	0.13	0.10	0.25	0.00	0.00	0.01	0.00	0.00	0.03	-0.02	0.00	-0.01	0.07	0.00	0.00	0.00	0.01	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sai	0.00	-0.01	-0.02	-0.02	0.02	0.01	0.00	0.00	0.08	0.13	1.00	0.05	0.16	0.00	0.00	0.02	0.00	0.00	0.04	-0.02	-0.01	-0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	-0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
spx	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.10	0.05	1.00	0.07	0.00	0.00	0.01	0.00	0.01	0.01	-0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
whm	-0.02	0.00	0.01	0.03	0.06	0.02	0.01	0.00	0.11	0.25	0.16	0.07	1.00	0.00	0.00	0.04	0.00	-0.01	0.04	-0.01	0.00	-0.01	0.04	0.00	0.01	0.00	0.01	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
amj	-0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	1.00	0.15	0.01	0.02	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
brf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	1.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
dol	-0.03	0.00	-0.01	-0.02	0.04	0.02	0.01	0.00	0.03	0.01	0.02	0.01	0.04	0.01	0.00	1.00	0.03	0.00	0.08	-0.03	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	-0.01	-0.01	0.01	0.00	0.00	0.02	0.01	-0.01	0.00	-0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
kgm	-0.01	0.00	0.00	0.00	0.02	0.00	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.03	1.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
oil	-0.05	-0.01	-0.01	-0.03	0.12	0.02	0.02	0.01	0.04	0.00	0.00	0.01	-0.01	0.01	0.00	0.00	0.00	1.00	0.09	-0.03	-0.02	-0.01	0.02	0.00	-0.01	0.00	-0.01	-0.01	0.00	-0.01	-0.01	-0.01	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
wah	-0.07	0.00	-0.02	-0.04	0.21	0.03	0.01	0.03	0.10	0.03	0.04	0.01	0.04	0.03	0.01	0.08	0.01	0.09	1.00	-0.03	-0.01	-0.01	-0.01	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
bsh	0.14	0.04	0.04	0.08	-0.05	-0.01	0.00	0.00	-0.02	-0.02	-0.02	-0.01	-0.01	0.00	0.00	-0.03	0.00	-0.03	-0.03	1.00	0.07	0.07	-0.01	0.03	0.00	0.00	0.01	-0.01	0.00	-0.01	0.01	-0.01	0.00	0.00	-0.01	-0.01	0.00	-0.02	-0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
lma	0.10	0.00	0.00	0.03	-0.01	0.00	0.00	0.00	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01	0.00	-0.02	-0.01	0.07	1.00	-0.01	-0.01	0.00	0.00	0.00	0.04	-0.01	0.00	0.00	0.03	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sma	0.04	0.01	0.01	0.01	-0.01	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	0.07	-0.01	1.00	-0.01	0.00	0.07	0.00	0.01	0.02	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ocs	0.04	-0.01	-0.01	0.00	-0.02	0.00	0.00	0.00	0.00	0.07	0.03	0.02	0.04	0.00	0.00	0.00	0.00	0.02	-0.01	-0.01	-0.01	-0.01	1.00	0.00	0.02	0.00	0.00	0.00	0.01	0.00	-0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
por	0.00	0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
bth	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.07	0.02	0.00	1.00	0.00	0.03	0.01	0.00	0.00	0.02	0.06	0.03	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
shp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
xth	0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	-0.01	0.00	-0.01	-0.01	0.01	0.04	0.01	0.00	0.00	0.03	0.00	1.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
dus	-0.02	0.00	-0.01	-0.02	-0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	0.02	0.00	0.00	0.01	0.00	0.00	1.00	0.01	0.04	0.01	0.05	0.04	0.00	0.01	0.02	0.00	0.05	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sbn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sbk	-0.03	0.00	-0.01	-0.02	-0.02	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	-0.01	0.00	0.00	-0.01	0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01	1.00	0.00	0.05	0.02	0.00	0.01	0.01	0.06	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
xhh	0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	-0.01	0.01	0.03	0.00	-0.01	0.00	0.02	0.00	0.19	0.01	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
spl	-0.01	0.00	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.01	0.00	-0.01	0.00	0.02	0.01	0.00	0.06	0.00	0.00	0.05	0.00	0.05	0.00	1.00	0.00	0.00	0.02	0.04	0.01	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
shh	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.03	0.00	0.00	0.04	0.00	0.02	0.00	0.00	1.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ghh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sni	0.04	0.00	-0.01	-0.01	-0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.00	-0.01	-0.01	-0.01	-0.01	0.00	0.01	0.00	0.02	0.00	0.00	0.01	0.00	0.01	0.00	0.02	0.01	0.00	1.00	0.06	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
fal	0.03	-0.01	-0.02	-0.02	-0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.00	0.01	0.00	0.04	0.01	0.00	0.06	1.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ssp	-0.01	0.00	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.01	0.00	0.00	0.04	0.00	1.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
tig	-0.02	-0.01	-0.01	-0.02	-0.03	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.05	0.00	0.03	0.02	0.03	0.01	0.00	0.02	0.02	0.02	1.00	0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ssb	-0.06	-0.01	-0.02	-0.03	-0.04	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.02	0.00	0.00	-0.02	0.00	-0.02	-0.01	-0.02	-0.01	0.04	-0.01	0.00	0.01	0.00	0.00	0.07	0.00	0.02	0.01	0.03	0.01	0.00	0.00	0.02	0.02	0.16	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
wsh	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sbu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sln	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
snr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
snt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
sre	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
nrw	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
gal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
bak	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
bes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Table 2. Correlation matrix for main target species and Large Coastal shark complex (LCC) caught by set in the PLL 1985-2005. Shaded areas indicated cells with correlations greater than 0.2 (positive or negative). LCC1 refers to coastal sharks non-prohibited species, and LCC2 refers to coastal sharks prohibited species.

	swo	bft	alb	bet	yft	bum	sai	whm	amj	dol	kgm	oil	sbk	ssb	lcc1	lcc2	lcc
swo	1.000	-0.014	0.000	0.044	-0.176	0.004	0.004	-0.017	-0.007	-0.031	-0.010	-0.054	-0.029	-0.059	-0.060	-0.004	-0.056
bft	-0.014	1.000	0.020	0.034	-0.002	-0.006	-0.008	-0.003	0.001	0.001	-0.001	-0.006	-0.005	-0.006	-0.010	-0.002	-0.010
alb	0.000	0.020	1.000	0.314	0.035	-0.009	-0.021	0.006	-0.001	-0.012	-0.003	-0.015	-0.013	-0.018	-0.027	-0.011	-0.028
bet	0.044	0.034	0.314	1.000	0.012	-0.006	-0.022	0.028	0.002	-0.021	-0.004	-0.027	-0.019	-0.028	-0.040	-0.019	-0.043
yft	-0.176	-0.002	0.035	0.012	1.000	0.017	0.024	0.055	0.007	0.038	0.021	0.118	-0.022	-0.037	-0.050	-0.014	-0.050
bum	0.004	-0.006	-0.009	-0.006	0.017	1.000	0.128	0.249	-0.002	0.011	0.000	-0.003	-0.006	-0.012	-0.011	0.004	-0.009
sai	0.004	-0.008	-0.021	-0.022	0.024	0.128	1.000	0.164	-0.001	0.023	0.000	-0.002	-0.003	-0.009	-0.005	0.006	-0.003
whm	-0.017	-0.003	0.006	0.028	0.055	0.249	0.164	1.000	-0.002	0.038	0.004	-0.006	-0.009	-0.017	-0.017	0.006	-0.014
amj	-0.007	0.001	-0.001	0.002	0.007	-0.002	-0.001	-0.002	1.000	0.005	0.017	0.007	0.002	0.004	0.005	0.000	0.004
dol	-0.031	0.001	-0.012	-0.021	0.038	0.011	0.023	0.038	0.005	1.000	0.033	0.001	-0.011	-0.016	-0.015	0.007	-0.011
kgm	-0.010	-0.001	-0.003	-0.004	0.021	0.000	0.000	0.004	0.017	0.033	1.000	0.003	0.014	0.001	0.008	0.001	0.007
oil	-0.054	-0.006	-0.015	-0.027	0.118	-0.003	-0.002	-0.006	0.007	0.001	0.003	1.000	-0.009	-0.016	-0.021	-0.010	-0.023
sbk	-0.029	-0.005	-0.013	-0.019	-0.022	-0.006	-0.003	-0.009	0.002	-0.011	0.014	-0.009	1.000	0.025	0.533	0.041	0.503
ssb	-0.059	-0.006	-0.018	-0.028	-0.037	-0.012	-0.009	-0.017	0.004	-0.016	0.001	-0.016	0.025	1.000	0.788	0.053	0.742
lcc1	-0.060	-0.010	-0.027	-0.040	-0.050	-0.011	-0.005	-0.017	0.005	-0.015	0.008	-0.021	0.533	0.788	1.000	0.083	0.946
lcc2	-0.004	-0.002	-0.011	-0.019	-0.014	0.004	0.006	0.006	0.000	0.007	0.001	-0.010	0.041	0.053	0.083	1.000	0.402
lcc	-0.056	-0.010	-0.028	-0.043	-0.050	-0.009	-0.003	-0.014	0.004	-0.011	0.007	-0.023	0.503	0.742	0.946	0.402	1.000

Table 3. Standardized catch rates of sandbar shark (Atlantic and Gulf of Mexico US) from the PLL data 1994-2004.

Year	Nominal	Estimated	Upp CI	Low CI	CV
1994	0.233	0.083	0.590	0.012	127%
1995	1.997	0.854	2.790	0.262	65%
1996	1.596	2.050	6.188	0.679	60%
1997	1.103	0.770	2.546	0.233	66%
1998	0.599	0.883	2.948	0.265	66%
1999	0.752	1.024	3.463	0.303	67%
2000	1.080	1.167	3.874	0.351	66%
2001	0.996	1.032	3.475	0.307	67%
2002	1.043	0.707	2.474	0.202	69%
2003	0.989	0.872	3.048	0.249	69%
2004	0.611	1.557	5.112	0.474	65%

Table 4. Standardized catch rates of blacktip shark Atlantic coast from the PLL data 1992-2004.

Year	Nominal	Estimated	Upp CI	Low CI	CV	Area
1992	1.869	2.970	9.742	0.905	65%	Atlantic
1993	2.569	2.272	8.013	0.644	70%	Atlantic
1994	2.200	1.960	7.147	0.537	72%	Atlantic
1995	1.000	0.975	4.633	0.205	91%	Atlantic
1996	0.973	0.987	4.677	0.208	91%	Atlantic
1997	0.674	0.710	3.987	0.126	105%	Atlantic
1998	0.373	0.481	3.391	0.068	126%	Atlantic
1999	0.578	0.504	3.550	0.072	126%	Atlantic
2000	0.484	0.363	3.097	0.043	147%	Atlantic
2001	0.507	0.286	2.853	0.029	166%	Atlantic
2002	0.305	0.362	3.197	0.041	151%	Atlantic
2003	0.646	0.453	3.511	0.058	136%	Atlantic
2004	0.824	0.678	4.253	0.108	115%	Atlantic

Table 5. Standardized catch rates of blacktip shark Gulf of Mexico US from the PLL data 1992-2004.

Year	Nominal	Estimated	Upp CI	Low CI	CV	Area
1992	2.380	2.240	6.186	0.811	54%	Gulf Mex
1993	3.502	1.541	4.572	0.519	59%	Gulf Mex
1994	1.399	2.358	6.797	0.818	57%	Gulf Mex
1995	0.844	1.572	4.687	0.527	59%	Gulf Mex
1996	0.710	0.838	2.652	0.265	63%	Gulf Mex
1997	0.884	0.924	2.945	0.290	63%	Gulf Mex
1998	0.299	0.808	2.684	0.243	66%	Gulf Mex
1999	0.545	0.364	1.471	0.090	79%	Gulf Mex
2000	0.355	0.706	2.435	0.205	68%	Gulf Mex
2001	1.411	0.689	2.405	0.198	69%	Gulf Mex
2002	0.344	0.484	1.864	0.125	76%	Gulf Mex
2003	0.247	0.328	1.322	0.081	79%	Gulf Mex
2004	0.080	0.149	0.874	0.025	109%	Gulf Mex

Table 6. Standardized catch rates of LCC non-prohibited species

Year	Nominal	Estimated	Upp CI	Low CI	CV
1992	1.098	1.672	3.082	0.907	31%
1993	1.125	1.299	2.438	0.692	32%
1994	1.064	1.265	2.382	0.672	32%
1995	1.674	1.057	2.011	0.555	33%
1996	1.440	1.280	2.397	0.684	32%
1997	1.081	0.752	1.467	0.386	34%
1998	0.632	0.571	1.156	0.282	36%
1999	0.821	0.626	1.256	0.312	36%
2000	0.925	0.890	1.732	0.457	34%
2001	0.965	0.764	1.509	0.387	35%
2002	0.758	0.940	1.816	0.486	34%
2003	0.841	0.914	1.777	0.470	34%
2004	0.576	0.970	1.870	0.503	34%

Table 7. Standardized catch rates of LCC non-prohibited excluding sandbar and blacktip sharks.

Year	Nominal	Estimated	Upp CI	Low CI	CV
1992	1.854	1.814	2.993	1.099	25%
1993	1.541	1.298	2.169	0.776	26%
1994	1.591	1.431	2.380	0.860	26%
1995	1.286	0.962	1.621	0.571	27%
1996	1.226	1.030	1.718	0.618	26%
1997	0.972	0.648	1.100	0.381	27%
1998	0.696	0.592	1.029	0.340	28%
1999	0.862	0.763	1.304	0.447	27%
2000	0.772	0.906	1.539	0.533	27%
2001	0.625	0.749	1.281	0.438	27%
2002	0.409	0.858	1.456	0.506	27%
2003	0.665	0.915	1.554	0.538	27%
2004	0.502	1.035	1.752	0.611	27%

Table 8. Standardized catch rates of LLC all 22 shark species

Year	Nominal	Estimated	Upp CI	Low CI	CV
1992	1.309	2.007	3.570	1.128	29%
1993	1.461	1.487	2.702	0.819	31%
1994	1.092	1.330	2.435	0.727	31%
1995	1.581	1.048	1.948	0.563	32%
1996	1.352	1.351	2.463	0.741	31%
1997	1.024	0.741	1.418	0.387	33%
1998	0.641	0.537	1.075	0.268	36%
1999	0.825	0.634	1.250	0.322	35%
2000	0.867	0.805	1.550	0.418	34%
2001	0.857	0.681	1.336	0.347	35%
2002	0.654	0.790	1.515	0.412	33%
2003	0.776	0.745	1.443	0.384	34%
2004	0.561	0.846	1.616	0.443	33%

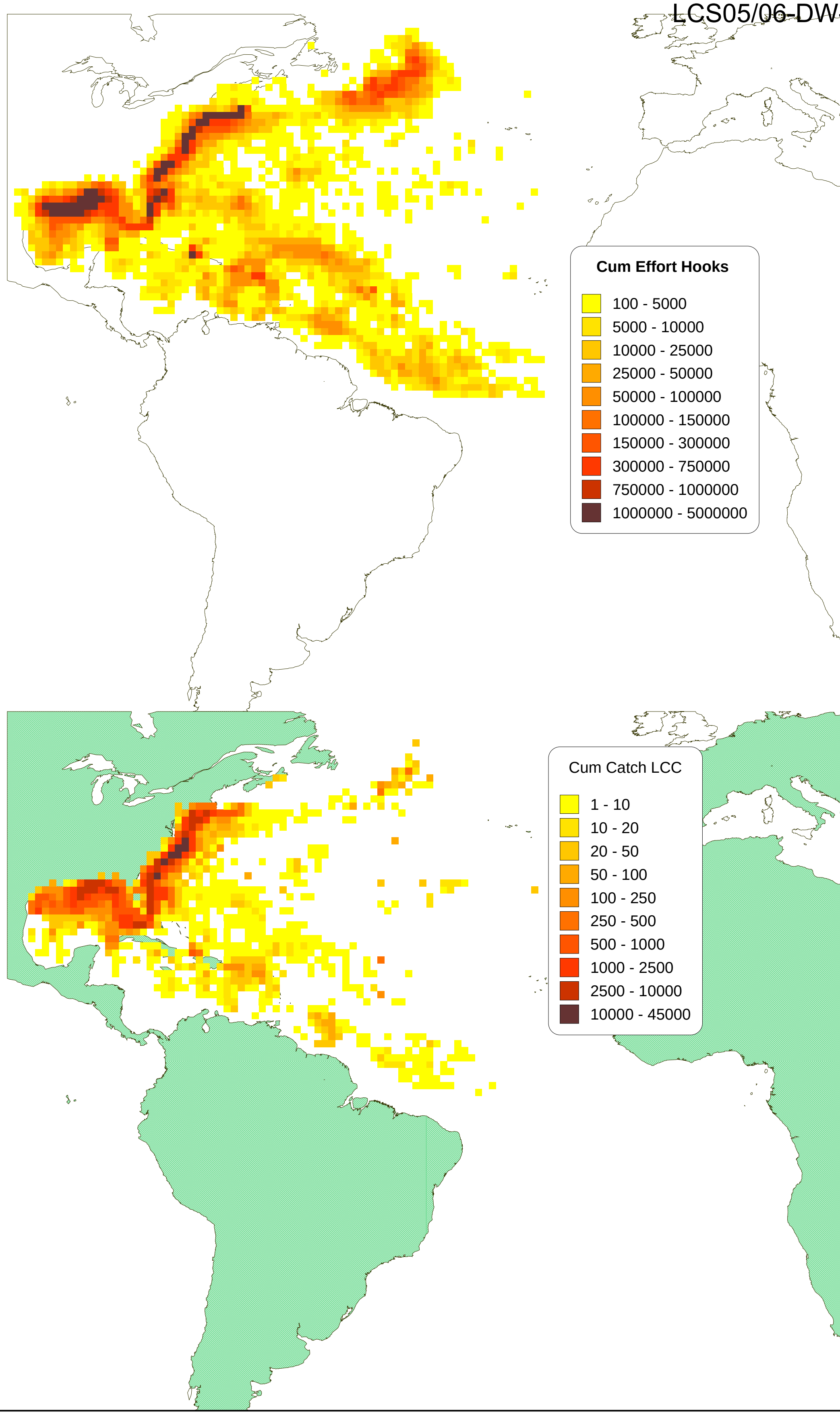


Figure 1. Cumulative effort (hooks deployed, top) and catch (bottom) of large coastal sharks complex (LCC) by 1 degree lat lon reported in the Pelagic Longline Logbook database from 1986-2005.

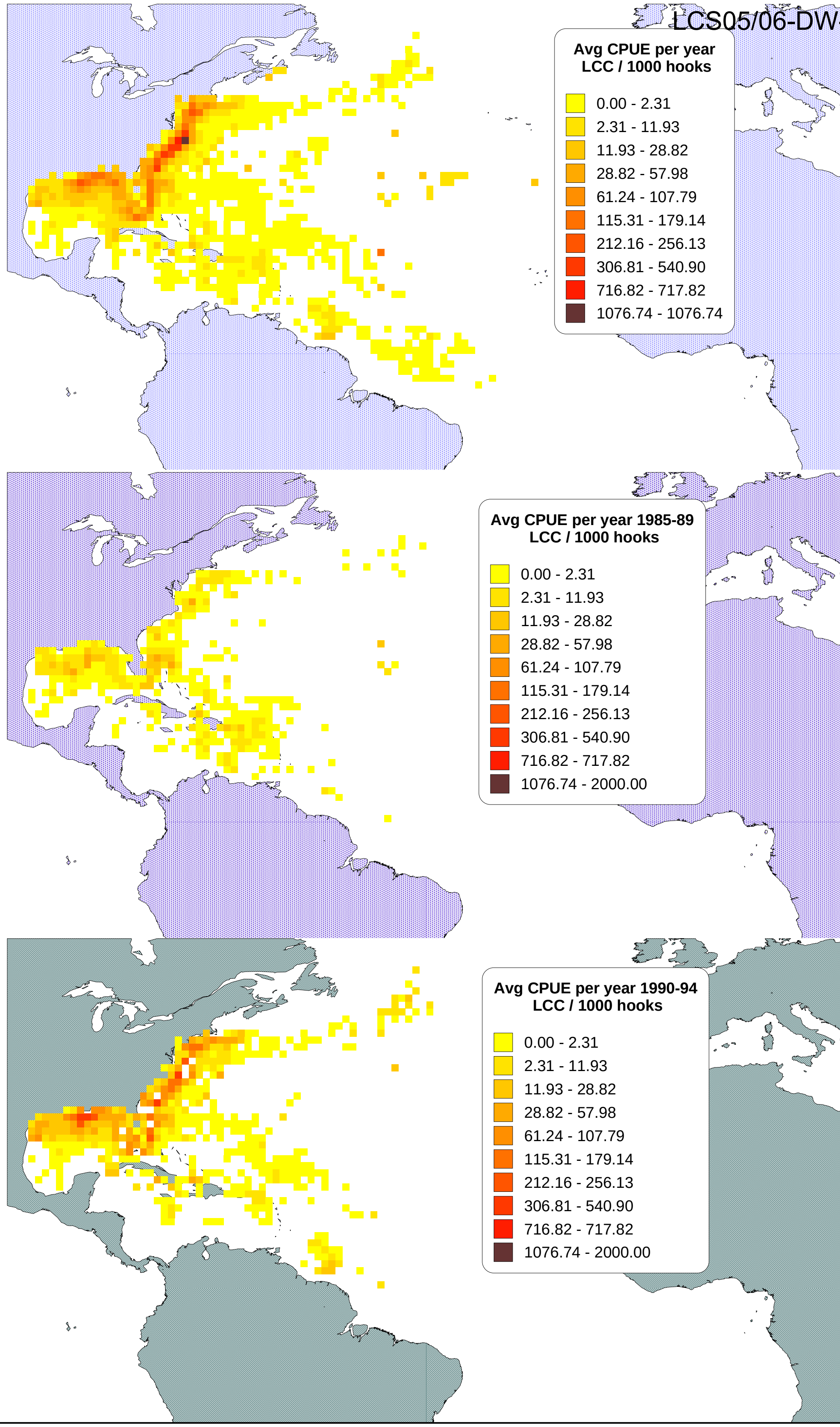


Figure 2. Average nominal catch rates of large coastal sharks complex by 1 degree lat lon reported in the PLL db from 1986-2005 (top), 1986-1989 (middle) and 1990-1994 (bottom).

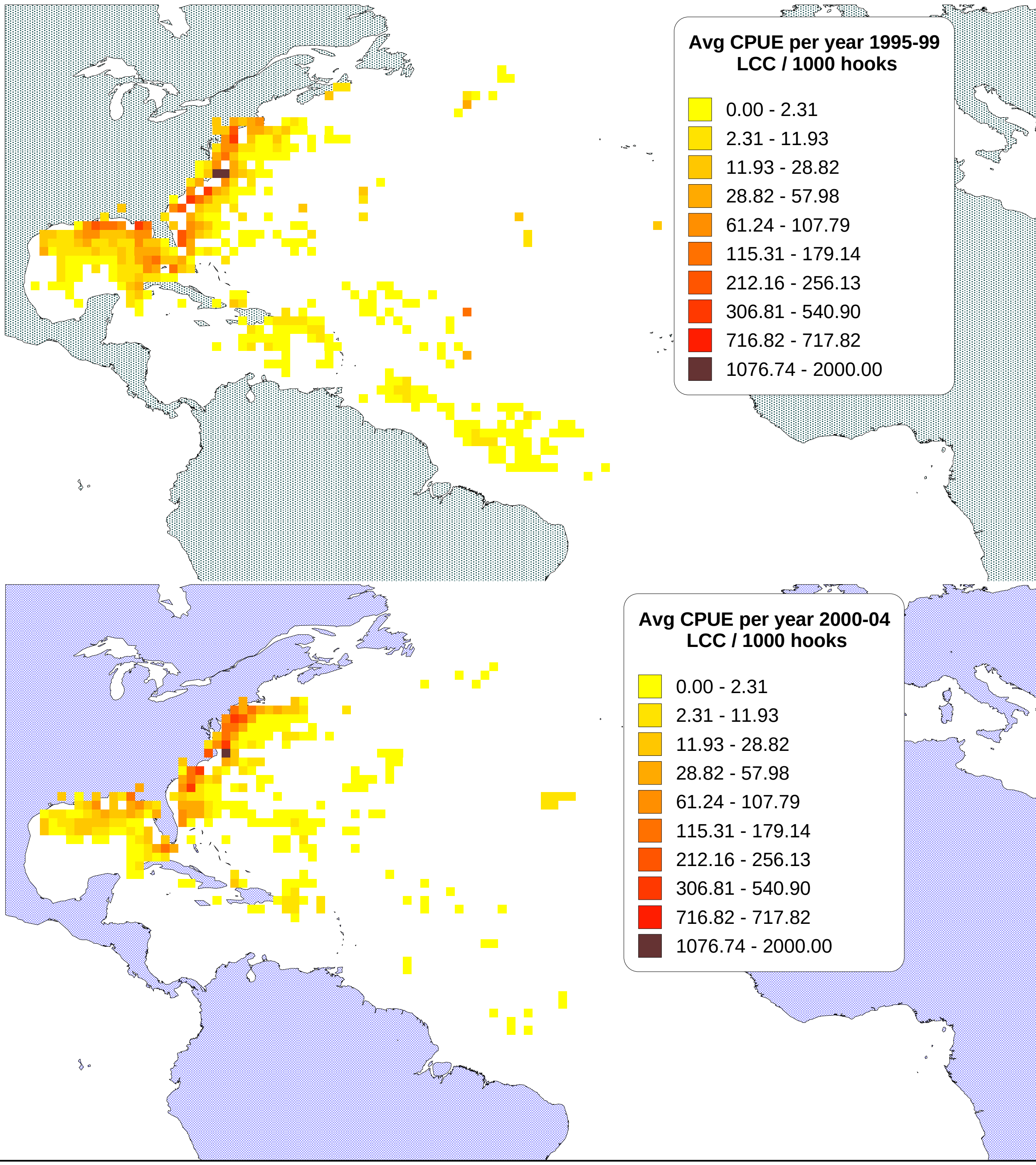


Figure 3. Average nominal catch rates of large coastal sharks complex by 1 degree lat lon reported in the PLL db from 1995-1999 (top), and 2000-2004 (bottom).

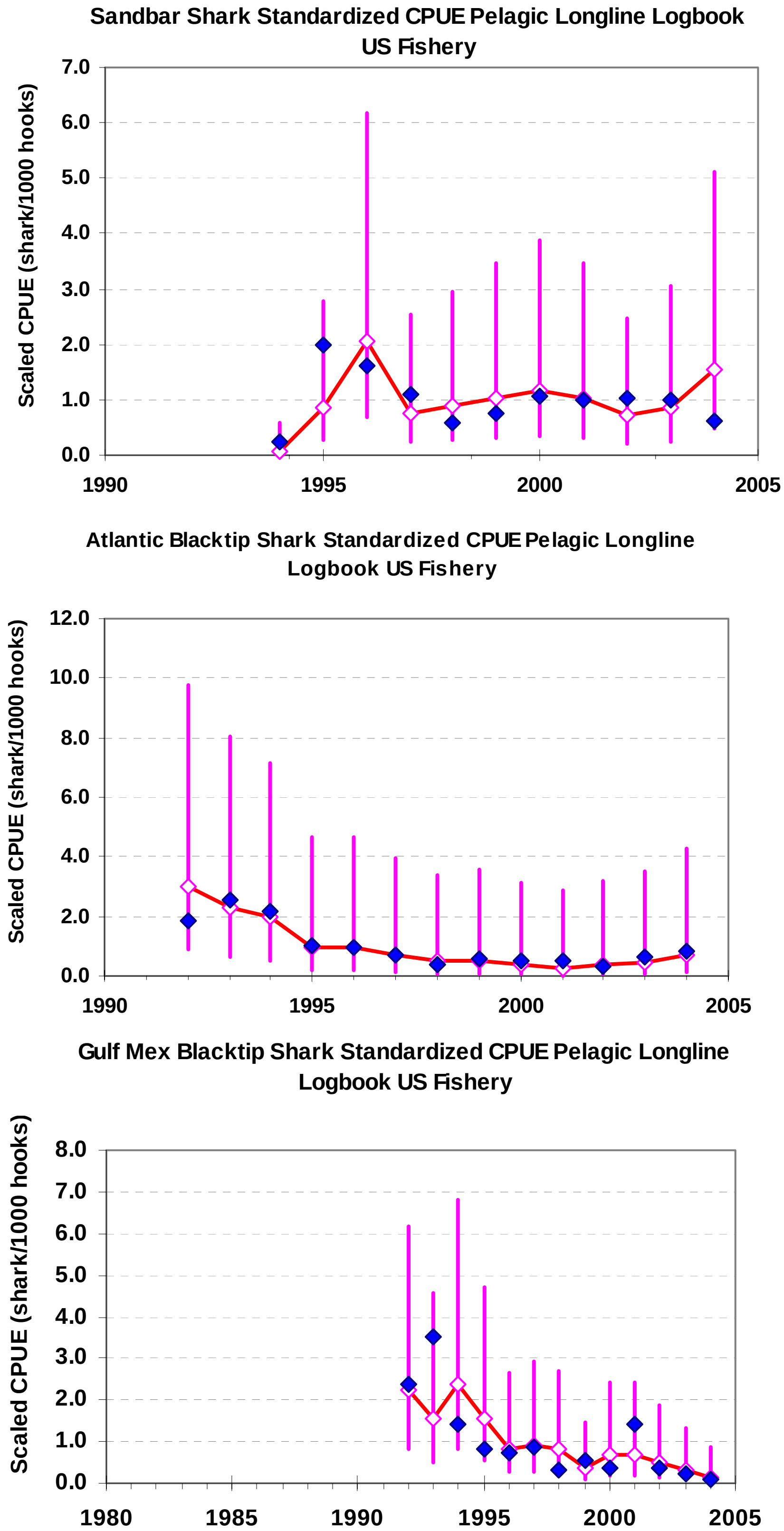
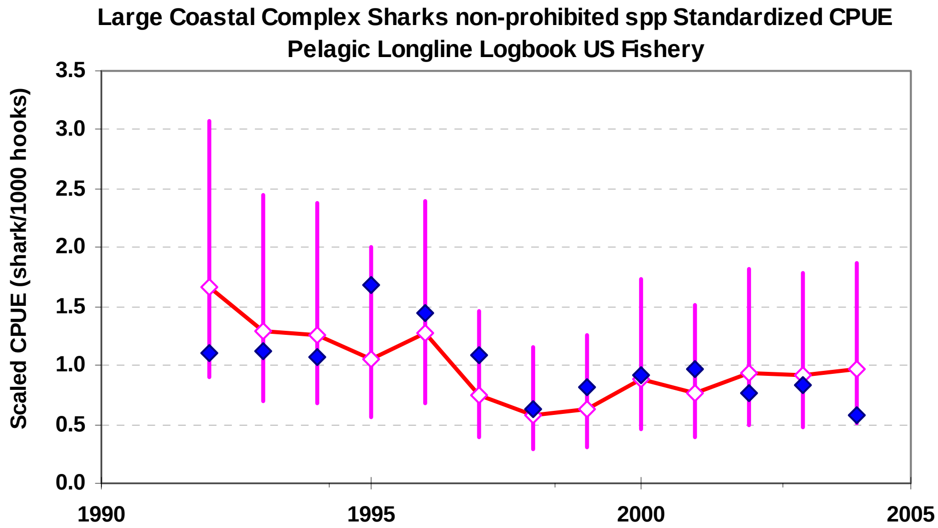


Figure 4. Nominal (solid diamonds) and Standard catch rates for sandbar (top), Atlantic blacktip (middle) and Gulf of Mexico blacktip (bottom) sharks from the PLL db. Bars indicated estimated 95% confidence intervals



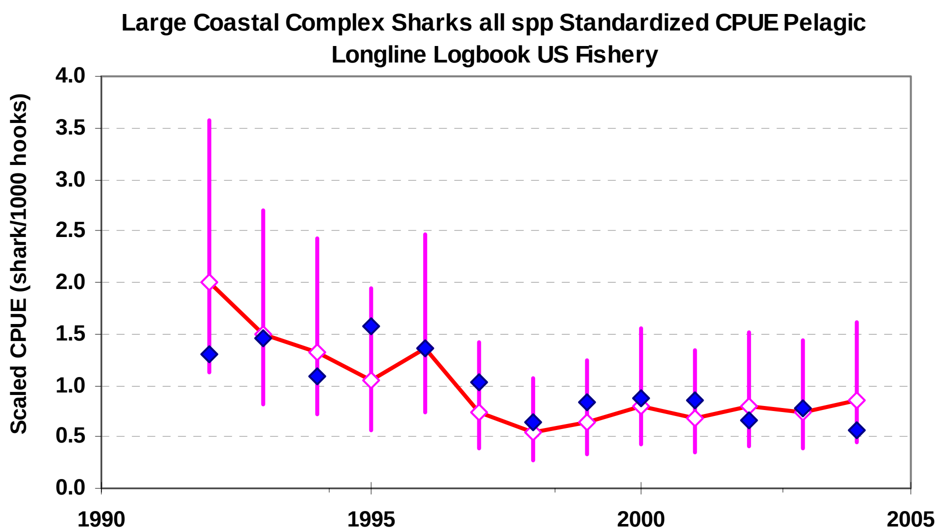


Figure 5. Nominal (solid diamonds) and standard catch rates for large coastal shark complex non-prohibited (top) and all 22 shark species from the PLL data.

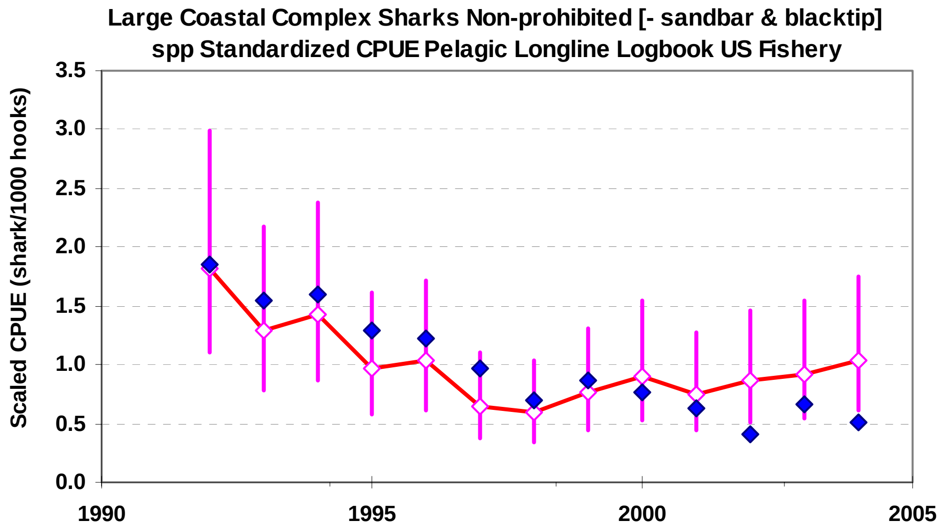


Figure 6. Nominal (solid diamonds) and standard catch rates for LCC non prohibited species excluding sandbar and blacktip shark catches from the PLL data.