LCS05/06: LARGE COASTAL SHARK COMPLEX, BLACKTIP AND SANDBAR SHARKS

LARGE COASTAL SHARK COMPLEX DATA WORKSHOP REPORT

12 JANUARY 2006

Introduction:
The current assessment for the Large Coastal Shark (LCS) Complex was to be run following, as close as possible, the procedures of the Southeast Data, Assessment, and Review (SEDAR) process. The process involves three meeting Workshops: Data, Assessment, and Review. The Data Workshop for the LCS complex was held in Panama City, FL October 31st through November 4th, 2005. Participants are listed in Appendix 1. Initial data compilations and exploratory analyses for SEDAR assessments were requested from participants in the form of "working documents" to be submitted in advance and evaluated over the course of the workshop. A full list of papers submitted is presented in Appendix 2. Minority opinions can be found in Appendix 3.

Three working groups were established to address the quality and suitability of available data for stock assessment. The working groups were: 1) life history, 2) catch statistics, and 3) indices of relative abundance. Participants were initially assigned to one of the groups based on their expertise and the type of documents they were submitting however participants were allowed to participate in any working group they wished. Group rapporteurs reported issues and progress to Data Workshop plenary sessions several times during the week. Written reports from the life history and catch statistics working groups were substantially complete by week's end, whereas the indices group report was only in the preliminary stages. There was some subsequent editing, and some further analyses sketched out during the Data Workshop has been completed. Some additional analyses recommended at the Data Workshop were too extensive to allow completion prior to circulation of the Data Workshop report. These analyses will be reported and evaluated at the Assessment Workshop scheduled for February, 2006.

This report is divided into three sections, paralleling the choice to establish three working groups. Structure within each section was determined by each working group, following some general guidelines derived from SEDARs for other species and the content previously reported from Shark Evaluation Workshops (SEWs). The LCS complex has a history of previous assessments via the SEWs, so this report has expanded discussion on issues that had been difficult or controversial in past work, but is fairly brief on issues that are reasonably well settled. Figures and tables remain within the individual sections, and are numbered in "Section number.figure number" sequence. Lists of references to the general literature (i.e. papers other than the working documents submitted to this Workshop) also remain with the individual sections. Citations to papers submitted to this workshop as "working documents" are made in the text using the identifying numbers assigned by the Shark SEDAR Coordinator (in the form LCS05/06-DW-xx), and refer to the list in Appendix 2.

As is customary for Data Workshop reports, several of the sections contain recommendations for future research efforts. Many of these recommendations are intended to be considered over the next several years, and are not recommendations for work to be completed prior to the Stock Assessment Workshop portion of the LCS SEDAR in February 2006.

This report is a complete and final documentation of the activities, decisions, and recommendations of the Data Workshop. It will also serve as one of 4 components of the final SEDAR Assessment Report. The final SEDAR Assessment Report will be completed following the last workshop in the cycle, the Review Workshop, and will consist of the following sections: I) Introduction; II) Data Workshop Report; III) Assessment Workshop Report; and IV) Review Workshop Report.

LCS 05/06 SEDAR. Data Workshop Terms of Reference

1. Characterize stock structure and develop a unit stock definition.

2. Tabulate available life history information (e.g., age, growth, natural mortality, reproductive characteristics). Provide models to describe growth, maturation, and fecundity by age, sex, or length as appropriate; recommend life history parameters (or ranges of parameters) for use in population modeling; evaluate the adequacy of life-history information for conducting stock assessments.

3. Provide indices of population abundance. Consider fishery dependent and independent data sources; develop index values for appropriate strata (e.g., age, size, area, and fishery); provide measures of precision; conduct analyses evaluating the degree to which available indices adequately represent fishery and population conditions. Document all programs used to develop indices, addressing program objectives, methods, coverage, sampling intensity, and other relevant characteristics.

4. Characterize commercial and recreational catches, including both landings and discard removals, in weight and numbers. Evaluate the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector. Provide length and age distributions if feasible.

5. Evaluate the adequacy of available data for estimating the impacts of current management actions.

6. Recommend assessment methods and models that are appropriate given the quality and scope of the data sets reviewed and management requirements.

7. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on sampling intensity and coverage where possible.

8. Prepare complete documentation of workshop actions and decisions (Section II. of the SEDAR assessment report).

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Life History Working Group Report

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1.1 Summary of Life History Documents

LCS05/06-DW-10:
Life history parameters for blacktip sharks, *Carcharhinus limbatus*, from the United States South Atlantic Bight and Eastern Gulf of Mexico

Summary: Life history traits (e.g., mean size-at-age, growth rate, age-at-maturity) for blacktip sharks were examined for sharks collected from two separate geographical areas (eastern Gulf of Mexico and South Atlantic Bight) to address the potential for separate stocks in southeastern US waters. Samples were obtained from fishery-dependent and independent sources. Growth and logistic models were fitted to observed size-at-age and reproductive ogive data, respectively. Von Bertalanffy growth parameters derived for blacktip shark from the Gulf of Mexico show that they attain a statistically smaller theoretical maximum size (L_∞=141.6 cm vs. L_∞=158.5 cm for female and L_∞=126 cm FL and L_∞=158.5 cm FL for male) and have a faster growth rate (k=0.24 yr^{-1} vs. k=0.16 yr^{-1} for female and k=0.27 yr^{-1} vs. k=0.21 yr^{-1} for male) than conspecifics in the South Atlantic Bight. Mean size-at-age was not significantly different for most ages, and growth rates between ages were similar. Median size- and age-at-maturity were significantly different between sex and area. Size at which 50% of the population is mature was 117.3 cm FL for females and 103.4 cm FL for males in the Gulf of Mexico and 126.6 cm FL for females and 116.7 cm FL for males in the South Atlantic Bight. Median age-at-maturity was 5.7 years and 4.5 years for females and males in the Gulf of Mexico, respectively, while age-at-maturity was 6.7 years for females and 5.0 years for males for sharks from the South Atlantic Bight. Due to varying statistical results, temporal problems of sampling, and potential for gear bias, we could not definitively conclude that differences in life history exist.

LCS05/06-DW-15:
Estimates of natural mortality for sandbar and blacktip shark for use in assessments

Summary: This document reviews ten methods of estimating natural mortality (M) based on life history correlates. Separate estimates for blacktip in the Gulf of Mexico and the Atlantic Ocean were produced, while a single estimate for sandbar was produced. Five of the methods yield a single estimate of M and five yield age-specific estimates. An eleventh estimate of M at age was produced by fitting a negative exponential to the average M over all ten methods. In general, estimates from the Peterson and Wroblewski method, which is based on dry weight, consistently produced lower estimates of M. Also, for blacktip, estimates based on von Bertalanffy growth parameters tended to produce lower estimates than the other methods.

LCS05/06-DW-28:

Genetic heterogeneity among blacktip shark, *Carcharhinus limbatus*, continental nurseries along the U.S. Atlantic and Gulf of Mexico

Summary: Genetic population structure of the blacktip shark, Carcharhinus limbatus, a commercially and recreationally important species in the southeast U.S. shark fishery, was investigated using mitochondrial DNA control region sequences. Neonate blacktip sharks were sampled from three nurseries, Pine Island Sound,Terra Ceia Bay, and Yankeetown, along the Gulf of Mexico coast of Florida (Gulf) and one nursery, Bulls Bay, on the Atlantic Ocean coast of South Carolina (Atlantic). Sequencing of the complete mitochondrial control region of 169 neonates revealed 10 polymorphic sites and 13 haplotypes. Overall haplotype diversity and percent nucleotide diversity were 0.710 and 0.106%, respectively. Haplotype frequencies were compared among nurseries to determine if the high mobility and seasonal migrations of adult blacktip sharks have maintained genetic homogeneity among nurseries in the Atlantic and Gulf. Chi-square analysis and AMOVA did not detect significant structuring of haplotypes among the three Gulf nurseries, P(v2)=0.294, FST=)0.005 to)0.002. All pairwise AMOVA between Gulf nurseries and the Atlantic nursery detected significant partitioning of haplotypes between the Gulf and Atlantic (FST=0.087–0.129, P<0.008), as did comparison between grouped Florida Gulf nurseries and the Atlantic, FCT=0.090, P<0.001. Based upon the dispersal abilities and seasonal migrations of blacktip sharks, these results support the presence of philopatry for nursery areas among female blacktip sharks. Our data also support the treatment of Atlantic and Gulf blacktip shark nursery areas as separate management units.

LCS05/06-DW-29:
Preliminary Tag and Recapture Data for the Sandbar Shark, *Carcharhinus plumbeus*, and the Blacktip Shark, *Carcharhinus limbatus*, in the Western North Atlantic

Summary: Tagging and recapture (T/R) information from the National Marine Fisheries Service (NMFS) Cooperative Shark Tagging Program (CSTP) covering the period from 1963 through 2004 are summarized for the sandbar shark (*Carcharhinus plumbeus*) and the blacktip shark (*Carcharhinus limbatus*) in the western North Atlantic. The extent of the tagging effort, areas of release and recapture, sources of tags and recaptures, capture methods, and movements of tagged sharks are reported. In order to examine regional trends in size and maturation categories, the study area is divided into geographical areas based on tagging distributions which largely reflects the fishing effort patterns of cooperative taggers aboard private, commercial, and research vessels. These tagging regions are defined as East Coast (US), Gulf of Mexico (US), Gulf of Mexico (Mexico), and Other. Only data with information on size, sex, and mark/recapture location were included in the regional analyses. In the sandbar regional database, sharks that were recaptured (N=1,010) were tagged within all areas except the Gulf of Mexico (Mexico) with the great majority (98%) tagged in the East Coast (US). Of the fish tagged off the US East Coast, 19% moved to the US Gulf of Mexico and 3% moved to Mexican Gulf waters. Of the fish tagged in the US Gulf of Mexico, 27% moved to the US East Coast and 7% moved to Mexican Gulf waters. Overall, none of the neonate-sized fish moved between areas and a larger percentage of the mature fish of both sexes moved out of their original tagging area. In the blacktip regional database, sharks that were recaptured (N=143) were tagged within all areas except the Gulf of Mexico (Mexico). Overall movement between tagging areas was rare and occurred primarily between the Gulf of Mexico (US) and Gulf of Mexico (Mexico) regions. A total of 30 *C. limbatus*, tagged off Texas, were recaptured off Mexico, which represents 21% of the recaptures and

1% of the number of tagged fish in the US Gulf of Mexico region. The true extent of this movement is unclear due to the possibility of under-reporting of recaptures.

LCS05/06-DW-39:
Life history parameters of the sandbar shark, *Carcharhinus plumbeus*, in the Northwest Atlantic

Summary: Published data were examined for estimates of life history parameters for the sandbar shark, *Carcharhinus plumbeus*, in the Northwest Atlantic. Studies estimated von Bertalanffy growth parameters through analyses of vertebral centra and tag-recapture methods. Casey et al. (1985) provided estimates of growth following examination of vertebral centra from 475 sandbar sharks. Von Bertalanffy growth parameter estimates from this study were K=0.0501, t_0 = -4.5, and L_∞=233 cm pre-caudal length (PCL) for males and K=0.04, t_0 = -4.9, and L_∞=270 cm PCL for females. Asymptotic size estimates from this study did not agree with empirical maximum size data for the sandbar shark in the Northwest Atlantic. Casey and Natanson (1992) provided revised estimates of growth parameters from long term tag recapture data. Growth parameters estimated from this study were K=0.046, t_0 = -6.45, and L_∞=168 cm PCL for both sexes combined. Sminkey and Musick (1995) reexamined the age and growth parameters of the sandbar shark following population depletion. This study estimated growth parameters from vertebral centra obtained over two time periods, 1980-1981 and 1990-1991. Growth parameter estimates for the 1980-1981 time period were K=0.059, t_0 = -5.4, and L_∞=184 cm PCL for males and K=0.059, t_0 = -4.8, and L_∞=197 cm PCL for females (n = 188). Growth parameter estimates for the 1990-1991 time period were K=0.087, t_0 = -3.8, and L_∞=166 cm PCL for males and K=0.086, t_0 = -3.9, and L_∞=165 cm PCL for females (n = 412). Tag recapture data reported in Grubbs et al. (in press) corroborate growth parameter estimates from the 1990-1991 period presented by Sminkey and Musick (1995). Fecundity estimates for the Northwest Atlantic ranged from 4-12 pups and averaged 8.4 pups litter $^{-1}$ (Clark and von Schmidt 1965; Sminkey and Musick 1995; Cortés 2000). Merson (1998) estimated size at 50% maturity as 133 cm PCL for males and 141 cm PCL for females. These lengths correspond to 15 and 19 years of age for males and females respectively.

LCS05/06-DW-40:
Long-Term Movements, Migration, and Temporal Delineation of a Summer Nursery for Juvenile Sandbar Sharks in the Chesapeake Bay Region

Summary: Delineation of essential fish habitat for exploited populations is critical to proper management. Spatial delineation of summer nurseries for elasmobranchs has received increased attention in recent years; however, temporal patterns of nursery use and the delineation of wintering areas are as critical. The lower Chesapeake Bay is the largest summer nursery for sandbar sharks *Carcharhinus plumbeus* in the western Atlantic. The goals of this study were to delineate temporally the use of the nursery and the migratory movements of juvenile sandbar sharks in this estuary, to determine the location of wintering areas, and to determine if philopatry or homing to natal summer nurseries occurs in subsequent years. Longline sampling conducted between 1990 and 1999 indicated that immigration to the bay occurred from late May to early July and was highly correlated with increasing water temperature. Emigration from the estuary occurred in late September and early October and was highly correlated with decreasing day length. We hypothesize that photoperiod is the environmental trigger to begin fall and spring migrations, whereas temperature may elicit the response

to move into the estuaries that serve as summer nurseries. Between 1995 and 2003, we tagged 2,288 juvenile sandbar sharks. Seventy-three sharks were recaptured following 4–3,124 d at liberty and the distance from tagging locations ranged from 0 to 2,800 km. Recapture data suggest that most sandbar sharks return to their natal estuaries during summer for at least the first 3 years and return to adjacent coastal waters for up to 9 years. These data also indicate that wintering areas are concentrated off the coast of North Carolina between 33°30'N and 34°30'N latitude, primarily in nearshore waters less than 20 m deep, though sharks older than 7 years were recaptured as far as 60 km from shore. Temporal use of this area by juvenile sandbar sharks occurs from late October until late May for at least the first 7 years and up to 10 years.

LCS05/06-DW-44:
Results of Mote Marine Laboratory Shark Tagging Program for blacktip (*Carcharhinus limbatus*) and sandbar (*C. plumbeus*) sharks

Summary: Mote Marine Laboratory's Center for Shark Research (MML) has been conducting tag-recapture studies of sharks since 1991 along Florida's coast and throughout the Gulf of Mexico. The MML tagging database currently includes 14,365 individuals from 16 species including 4,360 blacktip and 51 sandbar sharks, with 204 and 5 recaptured, respectively. Long-term recaps from Florida-tagged blacktips generally demonstrated a north-south movement and there was no evidence of sharks moving into either the western Gulf or the Atlantic. In the western Gulf, there was evidence of movement from Texas into Mexican waters. Young blacktip sharks tagged in the Yucatan Peninsula primarily moved westward and none entered U.S. or Caribbean waters. Tagged sandbar sharks in the eastern Gulf of Mexico demonstrated long-distance movements to South Carolina. Tag-recapture data for 85 blacktip sharks that had accurate size data at both release and recapture were used to examine age and growth parameters using the GROTAG model. These results indicate that growth at small sizes is rapid, but mature size blacktips grow at around 4 cm per year. Growth variability was low, but measurement error was high. Conversion of the results to von Bertalanffy parameters resulted in values similar to published values from vertebral ageing (L_∞ =179 cm STL; K=0.18 yr^{-1}). Growth rates from tag-recapture data were similar to those from vertebral analysis that have previously reported from the Gulf of Mexico.

LCS05/06-DW-46:
Investigations into the winter habitat of juvenile sandbar sharks, C*archarhinus plumbeus*, using pop-up archival satellite transmitters (PSATs)

Summary: Defining areas of aggregation of Atlantic shark species is important for current and future management efforts. Recent studies have found that the principal summer nursery areas for the North Atlantic population of sandbar sharks occur in shallow coastal bays from New Jersey to South Carolina. The principal overwintering areas for this population are likely found off the North and South Carolina coasts. The primary objective of this project was to use a fishery independent method to examine the overwintering location and habitat preferences of large juvenile sandbar sharks. During the summer of 2003, 21 sandbar sharks captured in the Eastern Shore of Virginia bays and lagoons were outfitted with satellite transmitters that were programmed to detach during the winter of 2003/2004. Of the 21 transmitters: four transmitters did not report, 12 released prematurely, and five reported on time. Nine of the transmitters reported during the targeted overwintering period (November 2004 through February 2005). The data from these nine transmitters, was used to examine

winter habitat preferences and the overwintering localities of large juvenile sandbar sharks. Satellite pop-off locations during the overwintering period were concentrated in central North Carolina coastal waters. The sharks predominantly remained in waters ranging from 18 to 22° C and in depths ranging from 0 to 50 m and there was a shift into deeper and slightly colder waters during this period.

LCS05/06-DW-47:
Nursery grounds and maturation of the sandbar shark in the western North Atlantic

Summary: Sandbar sharks from the western North Atlantic and Gulf of Mexico were sampled between 1995 and 1997 to describe development of the reproductive tract, determine range in the length-at-maturity, reassess litter size and outline seasonal gonadal cycle to assess frequency of pregnancy. In males and females marked increases in reproductive tract anatomy occurs at about 140 cm fork length (FL), indicating the transition between juvenile and subadult stages. The smallest mature female was 148 cm FL and largest immature was175 cm FL. The smallest mature male was 139 cm FL and the largest immature was 153 cm FL. Probit analysis was used to produce maturity schedules for males and females. There was no difference in maturity schedules of either sex produced by data collected during this study and data from the National Marine Fisheries Service reproduction database (1971-1996). Length-at-maturity in both female and male sandbar sharks are consistent with reports in the literature, but the maturity schedules produced here describe the range in length-at-maturity. Females produce a mean litter size of eight pups possibly less frequently as every other year.

LIFE HISTORY INFORMATION SUMMARY AND CONSENSUS

1.2 Sandbar shark

1.2.1 Stock definition

After considering the available data, the working group decided that the stock definition should be the Western North Atlantic from southern New England to Gulf of Mexico. Tagging studies suggest that one unit stock exists from Cape Cod south down the U.S. Atlantic coast and into the Gulf of Mexico, extending around the U.S. and Mexican portions of the Gulf of Mexico to the northern Yucatan peninsula (LCS05/06-DW29; LCS05/06-DW40). Genetic studies conducted on specimens from Virginia waters and the Gulf of Mexico further support the existence of a single stock that utilizes the area of Cape Cod to the northern Yucatan Peninsula (Heist et al. 1995, Heist and Gold 1999).

1.2.2 Age and growth

Age and growth of the sandbar shark has been studied extensively in the Northwest Atlantic. Multiple studies have utilized vertebral centra for determining age at size for the sandbar shark in the Northwest Atlantic. Casey et al. (1985) and Sminkey and Musick (1995) estimated age and growth parameters for sandbar sharks from vertebral centra analyses. Casey and Natanson (1992) utilized tag/recapture methods as another means of estimating life history parameters. Sminkey and Musick (1995) reexamined age and growth of the sandbar shark from samples obtained a decade apart, 1980-1981 and 1991-1992. The sample set from 1991-1992 was the most robust sample size and had the greatest size range of any study conducted on sandbar sharks to date. Sminkey and Musick (1995) produced theoretical estimates for maximum size that were in close agreement with empirical values. Minimum and maximum ages assigned to sharks in this study were 1 and 25 years, respectively.

Estimated values from this work were corroborated by LCS05/06-DW-40. The Sminkey and Musick (1995) estimates were determined to be most robust.

Age-length relationships were taken as determined by Sminkey and Musick (1995). Von Bertalanffy parameters used in length at age determination were estimated from analyses of sandbar shark vertebral centra obtained in 1990-1991 time period. All lengths are in cm: PCL=Pre-caudal length, FL=Fork length, TL=Total length.

	Males			**Females**		
Age	**PCL**	**FL**	**TL**	**PCL**	**FL**	**TL**
0	47	52	63	48	54	65
1	57	63	76	58	65	78
2	66	73	88	67	75	90
3	74	83	99	76	84	101
4	82	91	110	83	93	112
5	89	99	119	90	100	121
6	95	106	128	97	107	129
7	101	112	135	102	114	137
8	107	118	143	108	120	144
9	111	124	149	113	125	151
10	116	129	155	117	130	157
11	120	133	161	121	134	162
12	124	137	166	125	138	167
13	128	141	171	128	142	172
14	131	145	175	131	146	176
15	134	148	179	134	149	180
16	136	151	183	137	152	183
17	139	154	186	139	154	187
18	141	156	189	142	157	190
19	143	158	192	144	159	192
20	145	161	194	145	161	195
21	147	162	197	147	163	197
22	148	164	199	149	164	199
23	150	166	201	150	166	201
24	151	167	203	151	167	203
25	152	169	204	152	169	204

1.2.3 Size at maturity

Sminkey and Musick (1995) reported sizes at maturity of 135 and 136 cm PCL for males and females, respectively, but did not construct a fertility schedule. As age-structured models require percent maturity by age as an input, further information was needed. Merson (1998; LCS05/06-DW-47) constructed age-specific maturity ogive schedules for her maturity-at-length data using the age and growth model developed by Sminkey and Musick (1995). There was some discussion as to the appropriateness of using the Merson maturity schedules rather than the size-at-maturity estimates provided by Sminkey and Musick (1995). Questions were also raised regarding the data included in Merson's analyses. As age-structured models require percent maturity by age as an input and the Working Group believed the Merson (1998; LCS05/06-DW-47) analysis complemented the Sminkey and Musick (1995) paper, the consensus was to use the maturity schedules produced by Merson (1998) as reported in LCS05/06-DW-47.

1.2.4 Mortality

After reviewing the estimates of mortality presented in LCS05/06-DW-15, the Working Group recommended the following:

- All point estimates based on VBGF parameters should be excluded, as constant mortality of all age classes was believed to be biologically unrealistic.
- Survivorship of age 1 to maximum age should be based on the average of Chen and Watanabe (1989) and Lorenzen (1996) weight-based methods. Criticism of Peterson and Wroblewski (1984) by others prevented inclusion of this data method because the original method was based on larval fish. However, it was noted that values were similar to other weight-based methods.
- Age 0s survivorship should be based on empirical data published by Heupel and Simpfendorfer (2002) and Manire and Gruber (1993), which were used in 2002 assessment. Gruber et al. (2001) determined a survival rate of juvenile lemon sharks by marking a cohort analysis on a marked population. Annual survival rate estimates varied between 38% and 65%.

1.2.5 Summary of Recommended Life History Parameters

Sandbar shark

Biology	Parameter or model	Reference
Pup Survivorship	S=0.6	See mortality section//SEW 2002 assessment
Adult Mortality	use Chen & Watanabe and Lorenzen weight; use average M at age of those methods	LCS05/06-DW15
S-R function	Beverton-Holt	SEW 2002 assessment
S-R parameters, priors		

steepness or alpha	0.2-0.4	Determined by group[1]
R^0	--	
Prior for r (SP model)	--	
Prior for K (SP model)	--	
Spawning Month	June	
Growth parameters		
Linf (cm PCL)	164 PCL	LCS05/06-DW39
K	0.089	LCS05/06-DW39
t_0	-3.8	LCS05/06-DW39
Length-Weight parameters (FL)	Weight (kg)=(1.09E-05)*Fork length (cm) ^ 3.012	Kohler et al. (1995)
a	FL=1.1*PCL +1	LCS05/06-DW39
b	TL=(FL/0.8175)-0.9933	Kohler et al. (1995)
Reproductive cycle	2 years	LCS05/06-DW39
Fecundity	mean litter size: 8.4 +/ 2.3 (SD)	LCS05/06-DW39
Sex-ratio	1:1	LCS05/06-DW39
stock structure	single stock	See stock section

[1]The value chosen as the steepness of the stock-recruitment curve was based on discussion of several studies that have used a stock-recruit function in stock assessment for sharks. Simpfendorfer et al. (2000) used a steepness of about 0.205 in an age-structured model for whiskery shark, *Furgaleus macki*, off southwestern Australia. Harley (2002) estimated steepness values ranging from 0.25 to 0.67 for porbeagle through a relationship between steepness and maximum reproductive rate proposed by Myers et al. (1999). In the previous stock assessment on small and large coastal sharks, Cortés (2002b) and Cortés et al. (2002) assigned uninformative, uniform prior distributions for steepness ranging from 0.2 to 0.9, in Bayesian surplus production and lagged recruitment, survival, and growth models, respectively.

Maturity Ogive (from LCS05/06-DW-47)

Age	Female Prop. Mature	Age	Male Prop. Mature
13.0	0.01	12.0	0.01
14.0	0.05	13.0	0.05
15.0	0.10	13.0	0.10
15.0	0.15	13.0	0.15
16.0	0.20	14.0	0.20
17.0	0.25	14.0	0.25
17.0	0.30	14.0	0.30
17.0	0.35	14.0	0.35
18.0	0.40	15.0	0.40
18.0	0.45	15.0	0.45
19.0	0.50	15.0	0.50
19.0	0.55	15.0	0.55
19.0	0.60	15.0	0.65
20.0	0.65	16.0	0.70
20.0	0.70	16.0	0.75
21.0	0.75	16.0	0.80
21.0	0.80	17.0	0.85
22.0	0.85	18.0	0.90
23.0	0.90	18.0	0.95
25.0	0.95	19.0	0.99
30.0	0.99		

1.3 Blacktip shark

1.3.1 Stock definition

Although LCS05/06-DW-10 could not definitely conclude that differences exist (from a life history perspective) between the Gulf of Mexico and the Atlantic Ocean, conventional tagging evidence suggests little exchange between the U.S. Atlantic Ocean and Gulf of Mexico (LCS05/06-DW-29; LCS05/06-DW-44). Genetic heterogeneity and female philopatry also demonstrates multiple genetic reproductive stocks among blacktip sharks in the Gulf of Mexico and South Atlantic Bight (LCS05/06-DW-28). Moreover, the group discussed that fishing mortalities are likely different between Gulf of Mexico and Atlantic Ocean, which would necessitate separate stock management. Therefore, blacktip sharks were divided into two stocks: an Atlantic stock defined as from Delaware to the Straits of Florida, and a Gulf of Mexico stock designated as from the Florida Keys throughout the Gulf of Mexico. The group also suggested that the Gulf of Mexico could be further divided into eastern and western stocks based on genetic studies which indicate significant differences in haplotype frequencies in neonates and young-of-the-year individuals between the west coast of Florida and Texas, and on tag/recapture data (LCS05/06-DW29; LCS05/06-DW28; Keeney et al. 2005). However, the limited data on catch rates and lack of life history information from the western Gulf of Mexico precludes separate assessments on these hypothetical two stocks.

1.3.2 Age and growth and maturity

Although there were some caveats associated with the life history study of blacktip sharks (LCS05/06-DW-10), the group chose to adopt the separate life history estimates provided in this document.

1.3.3 Mortality

After reviewing the estimates of mortality presented in LCS05/06-DW-15, the Working Group recommended the following:

- All point estimates based on VBGF should be excluded, as constant mortality of all age classes was believed to be biologically unrealistic.
- Survivorship of Age-1 to maximum age should be based on the average of Chen and Watanabe (1989) and Lorenzen (1996) weight based methods. Criticism of Peterson and Wroblewski (1984) by others prevented inclusion of this data method because the original method was based on larval fish. However, it was noted that values were similar to other weight-based methods.
- Age-0's survivorship should be based on empirical data published by Heupel and Simpfendorfer (2002) and Manire and Gruber (1993), which were used in 2002 assessment. Gruber et al. (2001) determined a survival rate of juvenile lemon sharks by marking a cohort analysis on a marked population. Annual survival rate estimates varied between 38% and 65%.

1.3.4 Summary of Recommended Life History Parameters

1.3.4.1 Atlantic Ocean blacktip shark

Biology	Parameter or model	Reference
Pup Survivorship	0.52	Heupel and Simpfendorfer (2002)
Adult Mortality	use Chen and Watanabe and Lorenzen weight; use average M at age of those methods	LCS05/06-DW15
S-R function	Beverton Holt	SEW 2002 assessment
S-R parameters, priors		
steepness or alpha	0.2 - 0.5	Determined by group[1]
R^0	--	
Prior for r (SP model)	--	
Prior for K (SP model)	--	

Spawning Month	June	
Growth parameters	Male | Female | Combined sexes	LCS05/06-DW10
Linf (cm FL)	147.4 | 158.5 | 150.9	
K	0.209 | 0.16 | 0.1896	
t_0	-2.586 | -3.432 | -2.8899	
Length-Weight parameters	Weight (kg)=(1.0 * 10-5) FL (cm) ^3.0549	Kohler et al. (1995)
a	FL (cm)=(1.1009)PC-0.53	LCS05/06-DW10
b	TL (cm)=(1.1955)FL+1.13	LCS05/06-DW10
	STL=1.0185 (TL)+1.3565	LCS05/06-DW10
Reproductive cycle	2 years	LCS05/06-DW10
Fecundity	Mean: 3.2 +/- 1.1 SD	Castro (1996)
Sex-ratio	1:1	LCS05/06-DW10
Stock structure	2 stocks	See Stock section

Atlantic Maturity Ogive (from LCS05/06-DW10)

Age	Male	Female
0.0	0.0	0.0
1.0	0.2	0.0
2.0	1.2	0.1
3.0	6.3	0.4
4.0	26.6	2.0
5.0	66.2	9.5
6.0	91.1	35.4
7.0	97.9	74.1
8.0	99.2	93.7
9.0	100.0	98.7
10.0	100.0	99.8
11.0	100.0	100.0
12.0	100.0	100.0
13.0	100.0	100.0
14.0	100.0	100.0
15.0	100.0	100.0

1.3.4.2 Gulf of Mexico blacktip shark

Biology	Parameter or model	Reference
Pup Survivorship	0.52	Heupel & Simpfendorfer (2002)
Adult Mortality	use Chen and Watanabe and Lorenzen weight; use average M at age of those methods	LCS05/06-DW15
S-R function	Beverton Holt	SEW 2002 assessment
S-R parameters, priors		
steepness or alpha	0.2 - 0.5	Determined by group[1]
R^0	--	
Prior for r (SP model)	--	
Prior for K (SP model)	--	
Spawning Month	June	
Growth parameters	Male | Female | Combined	LCS05/06-DW10
Linf (cm FL)	126.0 | 141.6 | 139.4	
K	0.277 | 0.241 | 0.2316	
t0	-2.21 | -2.182 | -2.3286	
Length-Weight parameters	Weight (kg)=(1.0 * 10-5) FL length (cm) ^3.0549	Kohler et al. (1995)
a	FL (cm)=(1.1009)PC-0.53	LCS05/06-DW10
b	TL (cm)=(1.1955)FL+1.13	LCS05/06-DW10
	STL=1.0185 (TL)+1.3565	LCS05/06-DW10
Reproductive cycle	2 years	
Fecundity	Mean: 4.4	Castro (1996), Castro (unpublished data)
Sex-ratio	1:1	LCS05/06-DW10
Stock structure	2 stocks	Determined by group

Gulf of Mexico Maturity Ogive (from LCS05/06-DW10)

Age	Male	Female
0	0.0	0.1
1	0.0	0.2
2	0.0	0.6
3	0.3	1.9
4	5.3	5.9
5	53.4	16.6
6	95.9	38.7
7	99.8	66.7
8	100.0	86.5
9	100.0	95.3
10	100.0	98.5
11	100.0	99.6
12	100.0	99.9
13	100.0	100.0
14	100.0	100.0
15	100.0	100.0

1.4 INTRINSIC RATES OF INCREASE FOR LARGE COASTAL SHARKS

The group was also tasked with developing intrinsic rates of increase for 3 scenarios: large coastal aggregate (all 22 species), the large coastal aggregate minus prohibited species (11 species), and the large coastal aggregate minus prohibited species, blacktip, and sandbar sharks (9 species). The group used published demographic analysis by Smith et al. (1998) and Cortés (2002a). The estimates for sand tiger shark were based on a new analysis by Goldman (2004). Details on the methods can be found within those papers. The average intrinsic rate for each grouping was calculated as the average of all species found within the complex for each particular scenario, weighed by the average percentage each species made up within the large coastal group. The average percentage was taken from observer data in the bottom longline fishery from the period 1994-2005.

Species	Percentage of large coastal group	Cortés (2002) (λ)	Smith et al. (1998) (r_{2M})
C. plumbeus	0.51	1.022	0.039
C. limbatus	0.14	0.974	0.078
G. cuvier	0.16	1.246	0.060
G. cirratum	0.04	-	-
S. lewini	0.02	1.086	0.039
C. leucas	0.02	0.998	0.039
C. brevipinna	0.02	1.037	
C. falciformis	0.01	1.108	0.061
S. mokarran	0.01	-	-
N. brevirostris	0.01	1.064	0.048

S. zygaena	0.00	-	-
C. obscurus *	0.04	1.030	0.029
*C. taurus**	0.01	0.989	0.009
C. signatus *	0.00	-	-
C. altimus *	0.00	-	-
C. perezi *	0.00	-	-
C. carcharias **	0.00	1.098	0.056
C. galapagensis	0.00	-	-
LCS (11 of 22 species)		1.001	0.045
LCS (minus prohibited)		1.004	0.046
LCS (minus prohibited - sandbar - blacktip)		0.986	0.043

*indicates prohibited species as of 1999 FMP, implemented commercially in 2000
** indicates prohibited species as of 1997 Final Rule

1.5 RESEARCH RECOMMENDATIONS

- Whereas previous assessments have defined maximum sustainable yield (MSY) as 0.5 of carrying capacity, recent life history analysis and peer-reviewed literature has suggested this level is risk-prone, particularly for K-selected species (Musick et al. 2000). The life history group recommends a more conservative definition of MSY be adopted (i.e. 60-70% MSY or 40% of spawning stock biomass) for this assessment.
- Develop more empirical estimates of natural mortality for large coastal species.
- Research into further refining the separation of Gulf of Mexico stock of blacktip sharks using a combination of genetics, demography/life history and conventional and advance tagging technology (i.e. satellite archival tags).
- Updates on demographics using revised life history information.
- Continue research on life history characteristics of prohibited species.
- Research on stock-recruitment function for sharks.
- Accrue data necessary for ecosystem-based management: trophic relationships, bioenergetics, and diet.

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2. Catch Statistics

Catch Statistics Working Group Summary Report

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2.1 SUMMARY OF CATCH DOCUMENTS

LCS05/06-DW-02
Description of estimates of unreported catches
Anonymous

These data are from a single source, which owned a fleet of vessels that fished in the Gulf of Mexico and off the coast of North Carolina. The estimate for 1988 was determined from company landing records. The estimates for other years were prorated based on the 1988 landings record and financial statements indexing income from shark fishing. The 1996 Working Group did not have any way of determining the amount, if any, of these catches that were included. Therefore, the current Working Group followed the logic of the 1996 Working Group and made the assumption that none of the catches were included and kept these data separate, listing them as unreported.

LCS05/06-DW-04
Description of the databases that contain landings of shark species from the Atlantic Ocean and Gulf of Mexico
Balchowsky, H.A., and Poffenberger, J.

The responsibility for collecting the quantities and value of marine resources (also referred to as 'landings statistics') landed at ports along the Atlantic Ocean and Gulf of Mexico is divided between the Southeast Fisheries Science Center (SEFSC) and the Northeast Regional Office (NERO). Consequently, the landings data for the various species of sharks that are unloaded at dealers located in the Gulf of Mexico or in states along the coast of the Southeastern Atlantic Ocean, or the Southeast Region (i.e., the Atlantic coast south of Virginia), are collected and managed by the SEFSC, Miami, Florida, while the landings of sharks at dealers located in the Northeast Region (north of North Carolina) are reported to and managed by the NERO in Gloucester, Massachusetts. The purpose of this report is to describe (1) the procedures that are used by both the SEFSC and the NERO to collect the data and (2) the databases that house the landings statistics for sharks. The report presents details of the two programs that have been implemented by the SEFSC. The first system is the Pelagic Dealer Compliance program (PDC) and is formerly known as the Quota Monitoring System (QMS; from 1997 to 2002) (please note that 'QMS' now refers to a separate system used by the SEFSC to monitor quotas of groupers and tilefish) and the Swordfish Dealer Compliance (SDC) program (from 1993 to 2000). The second system is the general canvass landings data that are housed in the Accumulated Landings System (ALS). The report also contains a description of the SAFIS (Standard Atlantic Fisheries Information System) that is used by dealers in the Northeast region to report landings data to the NERO.

It should be noted that the data from the PDC and SAFIS are summarized by the SEFSC into monthly reports and sent to the Highly Migratory Species Management Division, National Marine Fisheries Service. This summary is used to monitor the respective fishery quotas for sharks.

LCS05/06-DW-05
SEFSC Pelagic Observer Program data summary for 1992 -2000
Beerkirker et al

This document provides a summary of the Pelagic Observer Program operated by the SEFSC. It was provided as reference material should questions arise as to how the data are collected.

LCS05/06-DW-06
Estimation of catches of sandbar (*Carcharhinus plumbeus*) and blacktip (*C. limbatus*) sharks in the Mexican fisheries of the Gulf of Mexico
Bonfil, R. and Babcock, E.

This document presented detailed estimates of Mexican catches of blacktip and sandbar sharks for the period 1962-2000. Species composition in weight for the different shark fisheries taking place along Mexican waters was estimated from the data given in several Mexican studies. These were then used to estimate the total weight and numbers caught of each species in each state. The estimated total level of blacktip catches ranged from 118,000 to 280,000 sharks per year from 1990-2000. In comparison, the corresponding catch of sandbar sharks was estimated at around 7,000-11,000 sharks per year. Because of constraints in the degree of detail contained in the information used to estimate the species composition in weight, these estimates should be taken as a first approximation, especially for blacktip sharks. It is likely that the numbers of small blacktip sharks taken in Mexican fisheries were overestimated.

It was further explained that catches had to be split between small ("cazon") and large ("tiburon") sharks according to the classification used in the official Mexican fishery statistics and several other studies that were reviewed to prepare the document. The studies used typically included the total number of individuals by species, but no weight was included. When available, length-frequency information was transformed into weight-frequency by using length-weight relationships to calculate the total contribution of each species to the catches by weight. It was noted that blacktip sharks were estimated to make up a larger portion by weight of the total small shark component (60%) than they likely contribute in reality. It was noted that this occurs because length-frequency distributions were not available, only an average size of 110 cm, which was transformed into weight. This average size is based not only on small blacktip sharks, but also on larger individuals, and it is thus likely to be overestimated. Tables 9-14 summarize the estimated catches of sandbar and blacktip shark by state in weight and numbers.

LCS05/06-DW-07
Illegal shark fishing off the coast of Texas by Mexican lanchas
Brewster-Geisz, K. and Eytcheson, M.

Since the mid-1990s, the United States Coast Guard (USCG) has been aware of Mexican fishing vessels fishing for sharks and other species in the U.S. Exclusive Economic Zone (EEZ) off the coast of Texas. The vessels originate from Matamoros, Mexico, and fish in the area surrounding South Padre Island, Texas, anywhere from zero to twenty miles offshore. The USCG has observed an increased amount of activity by these vessels, and numbers of observed incursions into U.S. waters has been documented since 2000. It is believed that these vessels, or lanchas, participate in illegal fishing of shark and red snapper with gillnet and longline gear during the day, and drug and migrant smuggling during the night. The previous large coastal shark (LCS) stock assessments have included Mexican catches and have considered open population models. However, the Mexican catches included in the stock assessment have not included this illegal catch and do not represent the full number of sharks that are taken by Mexican fishermen. The potential harvest of these illegal Mexican

lanchas could have an impact on the amount of commercial quota allocated the U.S. fishermen and may have an impact on the shark rebuilding plan. The Highly Migratory Species Management Division is providing this catch information for possible inclusion in the stock assessment and/or the sensitivity analyses of the models to changes in this catch.

LCS05/06-DW-16
Updated catches of Atlantic sharks
Cortés, E. and Neer, J.

This document presents updated commercial and recreational landings and discard estimates of Atlantic sharks up to 2004, with special emphasis on sharks of the Large Coastal Shark complex. Species-specific information on the geographical distribution of both commercial and recreational catches is presented along with the different gear types used in the commercial fisheries. Length-frequency information and average weights of the catches in three separate recreational surveys and in the directed shark bottom-longline observer program are also included.

LCS05/06-DW-18
Estimation of large coastal sharks dead discards for the US pelagic longline fishing fleet
Diaz, G. A.

This document describes the methodology used to calculate shark discards for the commercial pelagic longline fishery. This methodology was not developed for use with sharks but for use at ICCAT meetings and for calculating discards for swordfish and tuna. In order to maintain consistency, these methods are also used for shark discards. The data comes from both the Pelagic Longline Logbook and Pelagic Observer Programs. Three approaches were used to calculate shark discards: 1) using actual discard rates from the Pelagic Observer Program for areas and quarter with more than 10 sets observed 2) using discard rates estimated directly from the pelagic logbook program for areas and quarters where not sets were observed and 3) using GLM methods to estimate discard rates for areas and quarters with only 1-9 fishing sets observed. For data sets where the proportion of sets with positive catches is low, better estimates can be obtained using a delta log-normal approach. The use of this technique to estimate LCS discards for the pelagic longline fleet will be explored in the near future.

LCS05/06-DW-32
The Commercial Shark Fishery Observer Program: History, collection methodology and summary statistics 1994-2005(I)
Morgan, A. and Burgess, G.H.

The Commercial Shark Fishery Observer Program (CSFOP) was housed at the Florida Museum of Natural History from 1994-2005 and was responsible for hiring, training, and deploying fisheries observers aboard commercial bottom longline vessels targeting large coastal sharks. A total of 34 individual observers observed the capture of 57,265 sharks, representing 34 species during this time

period. The history, methods used for training and data collection, and summary statistics are included in the document.

LCS05/06-DW-34
Estimation of large coastal shark complex, blacktip, and sandbar shark bycatch in the Gulf of Mexico menhaden fishery
Neer, J. and Cortés, E.

Bycatch numbers from the Gulf of Mexico menhaden fishery were estimated for the large coastal shark complex (LCS) as well as for blacktip and sandbar shark individually. Estimates were based on observer data collected in 1994-1995 by de Silva et al. (2001). Two discard rate series are provided for each complex/species, one based on average of observed bycatch (used in the 2002 LCS assessment) and one adjusted for the number of boats in the fishery each year. This document describes how those estimates were obtained, and extends the series through 2004.

LCS05/06-DW-37
Recreational Marine Fishing Surveys in the Gulf of Mexico and Atlantic States, 1981-2004
Phares, P.

Estimates of recreational catch for marine fish species in the Gulf of Mexico and South Atlantic States beginning in 1981 are obtained by a combination of results from three surveys:

- the Marine Recreational Fishery Statistics Survey (MRFSS) conducted by the NOAA Fisheries (also called the National Marine Fisheries Service or NMFS).
- the Texas Marine Sport-Harvest Monitoring Program by the Texas Parks and Wildlife Department (TPWD).
- the Headboat Survey (HBS) conducted by NMFS, Southeast Fisheries Science Center, Beaufort, NC.

These three surveys together provide estimates of catch in numbers (and sometimes weight), estimates of effort, length and weight samples, and catch-effort observations for shore-based and boat fishing. The combined coverage is continuous beginning in 1981 with only minor gaps. In addition, Puerto Rico has been covered since 2000.

The MRFSS and the TPWD survey are both sampling-based, while the Headboat Survey strives to be a census of headboats using logbooks. Differences in survey methodology, strata, data gathered and other quantities estimated must be understood when using the data from the three surveys together. For instance, effort estimates from the three surveys use different measures (angler-trips, man-hours or angler-days) which are not easily standardized. Strata for estimates of catch from the three surveys can be made comparable by summing (e.g., summing Headboat Survey estimates into bi-monthly "waves" to match MRFSS and TPWD), but the lack of estimates for released fish in the TPWD and Headboat Surveys limit some analyses.

LCS05/06-DW-38

Description of the Southeast Fisheries Science Center's logbook program for coastal fisheries
Poffenberger, J.

The Southeast Fisheries Science Center (SEFSC) currently manages two vessel logbook programs. One program principally covers vessels that use pelagic longline gear, and also includes vessels that use other types of gear (harpoon and handline) that target pelagic highly migratory species. This logbook program was initiated in 1986 and has continued uninterrupted since then. The second logbook program was initiated in 1990 by the SEFSC for vessels that held a federal vessel permit to fish in the Gulf reef fish fishery. A similar program was initiated for vessels with federal permits in the snapper-grouper fishery in the South Atlantic region. These two programs (the Gulf reef fishery vessel logbook program and the South Atlantic snapper-grouper vessel logbook program) were combined to form the basis of the coastal fisheries logbook program. In 1993, this program was expanded to include vessels with federal permits in the shark fishery, and in 1999, it was expanded to include vessels with commercial vessel permits in the king and Spanish mackerel fisheries. This coastal fisheries logbook program requires reporting catch and effort data for the entire trip and does not require reporting for individual gear deployments. This report contains a chronology of the coastal fisheries logbook program, how the logbook forms were modified over time, and a description of the record layout and data elements for the coastal fisheries logbook data, as well as a brief explanation of the differences compared to the pelagic longline logbook program.

LCS05/06-DW-42
Review of the Headboat Survey – Questions and Answers
SEFSC

The headboat fishery appears to be a readily identifiable segment of the recreational fishery, and is responsible for high percentages of the recreational catch for some species. Membership in the headboat fleet seems to be known quite accurately, and the boats have been largely accessible to the Headboat Program. The Headboat Program has been used to produce landings, landings per unit effort, and effort estimates for the headboat fishery, and has also been a vehicle for collecting biological samples from the landed catch. These data items are clearly at the core of those needed for stock assessment. This paper constitutes a review of this Headboat Program and its data by the SEFSC. This review is conducted in a question and answer format, evaluates both the scientific and "business" aspects of the Program, and makes recommendations.

2.2. Large Coastal Shark Complex landings and discard estimates

The Catch Statistics working group pointed out that the Large Coastal Shark (LCS) complex landing estimates presented in Table 1 of document LCS-DW-16 included all the 22 species originally part of the complex. A list of species included in the LCS complex, including those that are prohibited, is given in Table 2.1. Given that the 2002 assessment was performed on the LCS complex that included all 22 species, it was decided to use this scenario as a baseline case (BASE scenario). The group discussed other scenarios for which full analyses will be conducted: (1) a catch series that excluded all prohibited species from the entire series (BASE-PROH scenario), and (2) a catch series that excluded

all prohibited species as well as sandbar and blacktip sharks from the entire series (BASE-PROH-SB-BT scenario). The BASE scenario catch estimates are provided in Table 2.2

The working group discussed the BASE-PROH scenario (LCS without prohibited species; Table 2.3) because the catch rate working group had already created the catch rate indices without the prohibited species. To the extent that this series removes the species that cannot be landed, this scenario could give an indication of the status of the LCS complex as it is currently defined by management. The working group also noted that while these species are not landed, they are caught, and that because the fishery has not targeted the prohibited species (with the possible exception of dusky sharks), the catches themselves would not change substantially by removing these species. The working group agreed to recommend this scenario and to provide the catch series needed.

The working group discussed the BASE-PROH-SB-BT scenario (LCS without prohibited species, sandbar sharks, or blacktip sharks; Table 2.4) as a result of a request of NMFS' Highly Migratory Species Management Division. By removing the species that are prohibited or that have species-specific assessments, this scenario could indicate the status of the LCS complex without the confounding effects of the main targeted species and help NMFS determine, or at least narrow down, the species that are driving the status of the complex. The working group agreed to recommend this as a scenario and to provide the catch series needed.

2.2.1. Commercial landings

BASE scenario:
U.S. commercial landings of Atlantic sharks for 1995-2004 were compiled based on Northeast Regional and Southeast Regional general canvass landings data, and the SEFSC quota monitoring data based on southeastern region permitted shark dealer reports. Landings reported in the general canvass and quota monitoring data files from southeastern states were combined to define the species composition and volume of landings. The quota monitoring data generally provide a more diverse species listing than the general canvass data SE, whereas the general canvass data SE apportion a higher volume of shark landings as unclassified. The larger reported landing of a given species in the two data sets was taken as the actual landed volume for that species. The positive difference between the quota monitoring data and the general canvass data was then subtracted from the unclassified shark category of the general canvass data to maintain the total landings volume equal to that reported in the general canvass data files. For the state of North Carolina (NC), it was assumed that some "dogfish" might also have been assigned to the unclassified shark category. To adjust for this possibility, the NC unclassified sharks were apportioned between the large coastal, small coastal, pelagic, prohibited, and dogfish categories based on the reported distribution of landings by species and gear for that state. For states other than NC, the remainder of unclassified shark landings was assigned to the large coastal group unless the harvesting gear was pelagic longline, in which case the landings were assigned to the pelagic group. Finally, the values reported from the NE general canvass landings data were added to produce the final values. Landings prior to 1995 only included data from the general canvass data for both regions as the quota monitoring system was not yet established. Landings estimates for 1981-1985 were determined during the 1996 Shark Evaluation Workshop. Because the present Working Group did not have all the details regarding to how the participants of the 1996 Shark Evaluation Workshop estimated those landings, and therefore could not suggest modifications, the continued the

use of those values was recommended. Continued use of those landings was deemed important for the stock assessment as they represent the early years of the fishery.

The data are collected in landed or dressed weight. Various weight-per-fish estimates were used to convert pounds to numbers of fish. For the period 1981 through 1985, a generic factor of 45 pounds dressed weight per fish was used. For 1986 through 1991, an average weight for all species was used. These averages are those used in the 1992 assessment. For 1992 and 1993, a weight of 40 pounds per fish was used. For 1994 and 1995, predicted weights from lengths based on the shark bottom longline fishery observer program (Branstetter and Burgess 1997) and data from the pelagic longline database were used. Average weights used for 1996-2004 came from shark bottom longline fishery observer program data.

BASE-PROH scenario:
For the period 1995-2004, for which species-specific landings are available, prohibited species were removed from the total LCS landings in the BASE scenario. For the period 1981-1994, during which species-specific landings were not always available, the average contribution of prohibited species to the landings was estimated from the bottom longline shark fishery observer program data for the period 1994-1995 data. The Working Group believed that the bottom longline observer program provided accurate species identification and that the earliest years of program would best represent the species composition during the earliest years of the fishery. This consensus was reached after discussion regarding using the observer-obtained species compositions rather than those from the landings data, due to the limited coverage of the observer program and concerns about how representative it is of the fishery at large.

BASE-PROH-SB-BT scenario:
For the period 1995-2004, for which species-specific landings are available, prohibited species and blacktip and sandbar sharks were removed from the total LCS landings in the BASE scenario. For the period 1981-1994, during which species-specific landings were not always available, the average contribution of prohibited species, blacktip, and sandbar sharks to the landings was estimated from the bottom longline shark fishery observer program data for the period 1994-1995. The Working Group believed that the bottom longline observer program provided accurate species identification and that the earliest years of program would best represent the species composition during the earliest years of the fishery. This consensus was reached after discussion regarding using the observer-obtained species compositions rather than those from the landings data, due to the limited coverage of the observer program and concerns about how representative it is of the fishery at large.

2.2.2 Pelagic longline discard estimates

BASE scenario:
Pelagic longline dead discard estimates for the baseline case are presented in Table 2.2 and were estimated following the methods described in LCS05/06-DW-18.

BASE-PROH scenario:
Estimation of discards for the LCS complex excluding the prohibited species requires estimating the species composition of the discards. For the period 1992-2004, the species composition was extracted

from pelagic longline observer program (PLLOP) data. Initially, for the period 1986 to 1991, the Working Group discussed estimating species composition using the reported discards in the pelagic logbook program to maintain consistency with the method used to estimate total discards for that period (LCS05/06-DW-16), which used logbook-reported data. However, examination of pelagic logbook program data for 1986-1991 revealed that only hammerhead and tiger sharks were recorded. For this reason, it was decided that the species composition from the PLLOP would be used rather than the logbook data to estimate the species composition for the period 1981-1991.

BASE-PROH-SB-BT scenario:
The same logic and procedure as described in the BASE-PROH scenario was applied to exclude blacktip and sandbar sharks, in addition to prohibited species, from the BASE scenario.

2.2.3 Recreational landings

BASE scenario:
Recreational landings presented in Table 2.2 correspond to landings estimated from the Marine Recreational Fishery Statistics Survey (MRFSS), the NMFS Headboat Survey, and the Texas Parks and Wildlife (TXPW) data sets. During 1998-1999, the MRFSS tested a new methodology for the estimation of charterboat effort. This new methodology, called the For Hire Survey (FHS), was deemed to provide better estimates of charterboat fishing effort and was officially adopted in 2000. Thus, landing estimates by the charterboat fleet between the 1981-1997 and 1998-2004 periods cannot be directly compared. The Working Group agreed to use conversion factors that the NMFS Southeast Fisheries Science Center personnel estimated, to adjust charterboat landings for 1981-1997 (Diaz and Phares, document SEDAR7-AW-03). These conversion factors were already used in the last stock assessments of red snapper, greater amberjack, vermillion snapper and gray triggerfish in the Gulf of Mexico. MRFSS landings for the period 1981-1997 were thus re-estimated using these conversion factors and the MRFSS landings used for the period 1998-2004 were also those incorporating this new methodology. Total annual recreational landing estimates are the sum of the MRFSS, Headboat, and TXPW survey estimates.

BASE – PROH scenario:
Catch estimates by species are already provided by the three recreational surveys. Prohibited species were thus excluded from the total LCS catches in the BASE scenario.

BASE-PROH-SB-BT scenario:
Catch estimates by species are already provided by the three recreational surveys. Sandbar, blacktip, and prohibited species were thus excluded from the total LCS catches from the BASE scenario.

2.2.4 Unreported catches

BASE scenario
Unreported large coastal shark (LCS) landings were provided by Mr. Chris Brannon to the National Marine Fisheries Service (NMFS) during the 1996 Shark Evaluation Workshop (SEW). These landings have been part of the LCS database since then.

The entirety of these landings correspond to the Gulf of Mexico during 1986, 1987, 1990 and 1991, while half of the landings correspond to the Gulf of Mexico and the other half to the mid Atlantic during 1988 and 1989. Brannon reported that the Gulf of Mexico landings were approximately 2/3 blacktip sharks, with the remaining third being a combination of sandbar sharks and other LCS species. The Working Group did not have any way of determining the amount, if any, of these catches that was included in landing reports presented in commercial catches. Given the general belief that landings before the current reporting systems were underreported, the Working Group made the assumption that none of the catches were included in commercial catches. As such, the Working Group agreed to keep these data as a separate source of landings in the catch series, listing them as unreported.

BASE – PROH scenario
Average species composition analysis for this data set was performed using species composition from 1994 and 1995 from the bottom longline observer program data was used to apportion the unreported catch to individual species. This decision was based on the understanding that the earliest years of the observer program would best represent the species composition during the earliest years of the fishery. Prohibited species were then removed from the BASE scenario.

BASE – PROH-SB-BT scenario:
The same logic and procedures as described in the BASE-PROH scenario were used to exclude blacktip sharks, sandbar sharks, and prohibited species from the BASE scenario using the information from Brannon where the total annual proportion of blacktip and sandbar sharks is approximately 77%.

2.2.5 Bottom longline discards

*BASE scenario:*Discard estimates for the years 1994-2004 are taken from the bottom longline observer program data. The catch statistics Working Group discussed the best way to estimate catches for the period 1981-1993, when no commercial data regarding coastal discards are available. In the previous stock assessment (2002), the average discard ratio for the period 1994-2001 was used to estimate discards for 1993 and no attempt was made to complete the series for the period 1981-1992.

The Working Group determined that leaving the discard series incomplete was not the optimal choice, since there are data available to back-calculate coastal discards for the earlier years (1981-1992). The Working Group decided against using the average for 1994-2001 because the discard rate was believed to be much higher in 1991 and 1992 than during the period before 1991 and because discard rates may have changed once a number of species, particularly dusky sharks, were prohibited in 2000. The variability in discard rates in the early 1990s was related to shifts within the fin market (shark meat could not be sold in the early 1990s due to mercury issues but shark fins could be sold). To compensate for these variable discard rates, the Working Group decided to use the average discard ratio of the first four years of the bottom longline shark fishery observer program data (1994-1998) as an estimate for the years 1981-1993.

BASE – PROH scenario: Discards were estimated using the species composition obtained from the bottom longline shark fishery observer program data. For the period 1981-1993 (prior to the implementation of the observer program), species composition was estimated using the average proportions in the bottom longline observer program data for the period 1994-1998. This decision was

based on the understanding that the earlier years of the observer program would best represent the species composition during the earliest years of the fishery and will remain consistent with the methods used to estimate coastal discard rates for the same time period. Annual discards were thus calculated as the product of the corresponding commercial landings and the discard rate for that year (accounting for the exclusion of prohibited species in the discard rate).

BASE – PROH-SB-BT scenario:
The same logic and procedures as described in the BASE-PROH scenario were used to exclude sandbar, blacktip, and prohibited species from the BASE scenario.

2.2.6 Mexican catches

BASE scenario:
The working group recommended retention of this series for use in the current assessment. The estimates were derived as follows: Mexican catches of blacktip shark corresponded to 50% of the sum of small fish caught in the states of Tamaulipas and Veracruz as presented in document LCS05/06-DW-06. This percentage was used to take account of the potential mixing of U.S. and Mexican stocks in the Mexican fishing grounds. These two states were selected, as in previous assessments, because they are thought to include catches of blacktip sharks that cross into U.S. waters. For sandbar sharks, the total sum of catches was used because there is no scientific evidence of nursery areas in Mexican waters. The group decided to use the sum of the Mexican catches corresponding to sandbar and blacktip sharks to represent the catch of the LCS complex.

BASE – PROH scenario:
The working group did not recommend any changes to the estimates proposed in the BASE scenario as there is no information to determine what percentage of the landings, if any, belong to prohibited species.

BASE – PROH-SB-BT scenario:
Since the estimated catches for the LCS complex are derived from the sum of the estimates of sandbar and blacktip sharks, estimates will equal zero for this scenario.

2.2.7 Gulf menhaden fishery discards

BASE scenario:
De Silva et al. (2001) reported on bycatch of sharks in the Gulf of Mexico menhaden fishery for the years 1994 and 1995. Based on observer data, the authors indicated that 75% of the sharks encountered in the fishery died: 97% were large coastal and 3% were small coastal sharks. The total number of sharks caught by this fishery was estimated to be about 36,000 in 1994 and 33,000 in 1995, or about 26,200 (36,000*0.75*0.97) and 24,000 large coastal sharks discarded dead in 1994 and 1995, respectively. Rather than using the same bycatch numbers for the entire timeframe, the Working Group recommended adjusting the bycatch estimates based on effort (i.e., number of vessels) in an attempt to reflect changes in fishing effort of the fleet over time, and the associated changes in bycatch numbers. Estimates were obtained as follows: for each year of the series, the number of vessels

operating in the fishery was divided by the average number of vessels operating for the years in which bycatch estimates were available (55 boats in 1994 and 52 boats in 1995; average = 53.5 vessels). This year-specific multiplier was then multiplied by 25,000, the average number of large coastal sharks discarded dead in 1994 and 1995, as reported above. This provides for year-specific bycatch estimates adjusted for the annual number of vessels in the fleet. The number of vessels operating in the Gulf of Mexico menhaden fleet from 1964 – 1997 was obtained from Vaughan et al. (2000; 1964-1997) and Joseph W. Smith, NMFS (personal communication; 1998 – 2004).

BASE – PROH scenario:
No changes to these estimates were recommended for this scenario as there is no evidence that prohibited species are encountered in this fishery.

BASE – PROH-SB-BT scenario:
Bycatch estimates derived in the BASE scenario were adjusted to reflect the proportion of total LCS that the blacktip and sandbar sharks amounted to in the de Silva et al. (2001) study (45.3% and 1.8%, respectively).

2.2.8 Confiscated Mexican catches in US

BASE scenario:
These data represent a new source that was unknown to previous assessment workshops and therefore has not previously been included in total catch estimates. The Working Group agreed to include these data in the catch series and noted that a number of assumptions would need to be agreed upon. To determine the species being caught, the Working Group discussed where the "lanchas" (boats) are fishing, the depth at which they are fishing, how close they are to the Mexican border, and the gear used. The U.S. Coast Guard provided information indicating that the majority of the fish are caught on gillnet gear close to shore (approximately 80 percent) and the rest are caught on longline gear. The U.S. Coast Guard also provided pictures of the type of fish caught in all the incursions. These pictures included sharks, snappers, eels, and dogfish. Upon examination of these photos, the Working Group determined that the coastal sharks photographed were all caught on gillnet gear (as indicated by the marks left on the sharks). The other species caught (i.e., snappers, eels, dogfish) were all deepwater fish that were likely caught using longline gear in deep water. As such, the Working Group decided to assume that 80 percent of the fishing incursions used gillnet gear and would catch coastal sharks.

The Working Group felt that some of the coastal sharks could be small coastal sharks and should not be included in this assessment. The Working Group agreed to use the proportions of species compositions provided in Castillo et al. (1998), which stated that blacktip sharks made up 33% of the catch in Gulf of Mexico Mexican waters. The Working Group further assumed that 50 percent of the total catch represented large coastal sharks.

Regarding the timeframe, the Working Group discussed whether or not to expand the incursion data back into the 1990s. The U.S. Coast Guard did not begin noticing the fishing incursions until 2000. Anecdotal information indicated that the fishing incursions did not occur until after the early 1990s. The Working Group considered starting the time series in 1995 but did not feel there was enough information on which to base assumptions about effort and catches in those years. As such, the

Working Group decided to begin the time series in 2000, which is the year the U.S. Coast Guard started collecting information on fishing incursions.

Most of the discussions focused on how to include these data given the other Mexican catches that have been included in the past. Everyone in the Working Group agreed that any fish confiscated by the U.S. Coast Guard would not be included in the legal Mexican catches and thus, should be included in the assessment. However, the U.S. Coast Guard estimates that 1900 incursions occur in U.S. waters annually. In any given year, only 100 to 212 of those are successfully intercepted, fishery-related incursions. If the numbers are expanded, based on the percentages listed above, approximately 9,500 large coastal sharks may not be included in the legal Mexican catches. However, the Working Group believed, based on the knowledge of the Mexican markets (i.e., everything is sold, there is no quota, etc.), that there would be no reason why the sharks caught on the "lanchas" that return to Mexico would not be included in the legal Mexican landings. As such, the Working Group decided to include only those sharks that could positively be expanded out from the successful incursions (1,000 to 2,120 large coastal sharks).

Final recommendations for the determination of estimates included:
- Use an average of 25 sharks per "lancha" (10 lb dressed weight average)
- To assume that 50 percent of the estimated 1900 incursions are fishery-related incursions
- To assume that 80 percent of the fishery-related incursions use gillnets and would catch coastal sharks
- To include only those sharks confiscated by U.S. Coast Guard, but not expand the series to earlier years since these sharks may have been already reported in the Mexican landings.

Annual estimates from 2000 to 2004 were thus obtained by multiplying 25 sharks per boat by the number of interdicted boats in each year by 50% of LCS by 80% of sharks being caught on gillnets.

BASE – PROH scenario:
The Working Group did not recommend any changes to the estimates proposed in the BASE scenario as there is no information to determine what percentage of the landings, if any, belong to prohibited species.

BASE – PROH–SB-BT scenario:
The proportion of blacktip sharks in the total shark catches in the state of Tamaulipas (33%) as found by Castillo et al. (1998) was used to reduce the estimates from the BASE scenario.

2.3 SUGGESTED SENSITIVITY ANALYSES

The Working Group recommended three modifications to the BASE scenario for use as sensitivity analyses during the Assessment Workshop.

1) Adjust the recreational catch estimate for 1983. This value was deemed to be unrealistically high. Following the logic used in the 1998 and 2002 assessments, the geometric mean value of the 1982 and

1984 estimates (380.8 thousand fish) should replace the 791.1 thousand fish estimate of the BASE scenario for 1983.

2) Remove the unreported catches. This sensitivity analysis was suggested to examine how those values affect the analysis.

3) An 'alternative' catch series (Table 2.5): This sensitivity analysis was suggested to compensate for under-reporting of landings during the earliest years of the time series (1981-1994). The modifications were as follows (following the logic of the 1998 and 2002 assessments):

Commercial landings: For 1981-1985, commercial catches were assumed underreported by 50% and thus the values in the BASE scenario catch table were multiplied by 1.5. For the period 1986-1992, underreporting was assumed by 100% and thus the values in the BASE scenario catch table were multiplied by 2. For 1993, the catches made prior to the mid-year implementation of the FMP were assumed underreported by 100% and thus the values in the BASE scenario catch table were multiplied by 1.5.

Pelagic longline discards: For the period 1981-1986, longline discards were assumed to be equal to 10,000 fish per year. This value is based on anecdotal information regarding the magnitude of the catch of large coastal sharks during that timeframe.

Recreational catch estimates: the geometric mean value of the 1982 and 1984 estimates (380.8 thousand fish) should replace the 791.1 thousand fish estimate of the BASE scenario for 1983.

2.4. SPECIES-SPECIFIC CATCH HISTORIES

The Working Group also prepared species-species catch histories for blacktip (Tables 2.6 and 2.7) and sandbar (Table 2.8) sharks. Based on the recommendation of the life history group that blacktip sharks should be assessed as two separate stocks, Gulf of Mexico and Atlantic Ocean, two catch histories were developed for that species.

2.4.1 Blacktip Gulf of Mexico:

2.4.1.1 Commercial landings:

U.S. total commercial landings of blacktip sharks in 1996-2004 were compiled based on the Southeast and Northeast Regional general canvass landings data, and the SEFSC quota monitoring data. The larger of the two values reported for blacktip sharks in the southeast general canvass and the SEFSC quota monitoring is taken as the value of blacktip landings for the southeast. The landings from the Northeast Regional general canvass data are then added to the southeast landings to produce total U.S. estimates. Commercial landings of blacktip sharks in the Gulf of Mexico for 1996-2004 were obtained by multiplying the total U.S. landings by the proportion of blacktip landings corresponding to the Gulf of Mexico region as obtained from general canvass data. Total U.S. landings from 1987 to 1995 are from the general canvass data only, as the quota monitoring system did not exist and were obtained based on the proportional allocation of commercial landings of unclassified sharks by gear type and

region defined in the 1996 assessment. Landings for the Gulf of Mexico for 1987-1995 were also obtained by multiplying the total US landings by the proportion of blacktip landings corresponding to the Gulf of Mexico region as obtained from general canvass data. For 1981-1986, annual landings were estimated by multiplying the total landings (GOM+SA) by the average proportion corresponding to the GOM in 1987 and 1988 reported in the general canvass program.

Unclassified sharks in 1996-2004 attributed to the LCS grouping were proportionally allocated to blacktip sharks by using the proportion of blacktip sharks observed in the LCS and multiplying the unclassified sharks by that value to estimate the weight of blacktip sharks likely listed as unclassified. The value was then added to the value reported from canvass/quota monitoring to determine the total landings for blacktip sharks.

The data are collected in landed or dressed weight. Various conversions are used to convert dressed weight to number of sharks. The Working Group indicated that the average weight used for the period 1986-1993 in the 2002 assessment was unrealistically low. This value (20.5 lb) was the average of the period 1994-1996. It was decided to use an average weight of 24.0 lb to estimate number of sharks caught for the period 1981-1993. This average weight was a compromise based on discussions among the Working Group participants and information provided by Mr. Chris Brannon regarding the average weight of the blacktip sharks he encountered in his fishing operations during that time period. From 1994 onward, the average weight was determined from bottom longline shark fishery observer program data corresponding to the Gulf of Mexico.

2.4.1.2 Recreational landings

Recreational landings for blacktip sharks in the Gulf of Mexico correspond to landings estimated from the MRFSS, the NMFS Headboat Survey and the TXPW data sets. As explained for the LCS scenarios detailed above, during 1998-1999, the MRFSS tested a new methodology for the estimation of charterboat effort, the For Hire Survey (FHS), which was deemed to provide better estimates of charterboat fishing effort and was officially adopted in 2000. Thus, landing estimates by the charterboat fleet between the 1981-1997 and 1998-2004 periods could not be directly compared. The Working Group agreed to use conversion factors that the NOAA Fisheries Southeast Fisheries Science Center personnel estimated, to adjust charterboat landings for 1981-1997 (Diaz and Phares, document SEDAR7-AW-03). MRFSS landings for the period 1981-1997 were thus re-estimated using these conversion factors and the MRFSS landings used for the period 1998-2004 were also those incorporating this new methodology. Total, annual recreational landing estimates of blacktip sharks in the GOM are the sum of the MRFSS, Headboat, and TXPW survey estimates.

2.4.1.3 Unreported Catches

Unreported large coastal shark (LCS) landings were provided by Mr. Chris Brannon to the National Marine Fisheries Service (NMFS) during the 1996 Shark Evaluation Workshop (SEW). These landings have been part of the LCS database since then.

These landings correspond to the Gulf of Mexico during 1986, 1987, 1990 and 1991, while half of the landings correspond to the Gulf of Mexico and the other half to the mid Atlantic during 1988 and 1989. Brannon reported that the Gulf of Mexico landings were approximately 2/3 blacktip sharks,

with the remaining third being a combination of sandbar sharks and other LCS species. The Working Group did not have any way of determining what amount, if any, of these catches were included in landing reports. Therefore, the Working Group made the assumption that none of the catches were included and kept these data separate, listing them as unreported.

Following the information provided by Mr. Brannon, for the years 1986, 1987, 1990, and 1991, the estimate of unreported blacktip sharks in the Gulf of Mexico was calculated by multiplying the total unreported catch estimate by 66%. For the years 1988 and 1989, the estimate was determined by dividing the total annual unreported catch by 50%, to account for the fact that only half the fleet was in the Gulf of Mexico, then that value was multiplied by 66%.

2.4.1.4 Mexican catches

Mexican catches for blacktip shark corresponded to 50% of the sum of small fish caught in the states of Tamaulipas and Veracruz from document LCS05/06-DW-06. This percentage was used to take account of the potential mixing of U.S. and Mexican stocks in the Mexican fishing grounds.

2.4.1.5 Gulf menhaden fishery discards

Effort-adjusted estimates of dead discards for blacktip shark were determined. De Silva et al. (2001) reported that blacktip sharks represented 45.3% of the total observed bycatch in 1994-1995. Considering the reported 75% mortality rate among all sharks, this results in an estimated bycatch of 12,200 (36,000*0.453*0.75) and 11,200 dead blacktip sharks for the two years. The number of vessels operating in the fishery each year was divided by 53.5 vessels, the average number of vessels operating for the years in which bycatch estimates were available (1994 and 1995). The year-specific multipliers were then multiplied by the average number of blacktip (11,700) sharks discarded dead, as determined previously. This provides for year-specific bycatch estimates adjusted for the annual number of vessels in the fleet.

2.4.1.6 Confiscated Mexican catches in the US

The Group recommended inclusion of the confiscated illegal Mexican catches. The estimates of illegal blacktip shark catch were determined using the following guidelines/assumptions:
- Use of an average of 25 sharks per “lancha” (10 lb dressed weight average)
- Fifty percent of the estimated 1900 incursions are fishery-related incursions
- Eighty percent of the fishery-related incursions used gillnets and would catch coastal sharks
- Data series begins in 2000
- Assume 33% of sharks are blacktip sharks following findings in Castillo et al. (1998)
- Include only those sharks confiscated by U.S. Coast Guard, but not expand the series to earlier years since these sharks may have been already reported in the Mexican landings.

2.4.2 Blacktip Atlantic Ocean:

2.4.2.1 Commercial landings:

The same logic and procedures as described above for blacktip shark in the Gulf of Mexico were used to produce commercial landings estimates for blacktip shark in the Atlantic Ocean.

2.4.2.2 Recreational landings

The same logic and procedures as described above for blacktip shark in the Gulf of Mexico were used to produce recreational catch estimates for blacktip shark in the Atlantic Ocean, however the TXPW survey data are not included.

2.4.2.3 Unreported Catches

Half of the unreported large coastal shark landings provided by Mr. Brannon and already described above correspond to the Atlantic during 1988 and 1989. Brannon reported that approximately 7-10% of the Atlantic landings were blacktip sharks, with the remaining mostly sandbar sharks. The Working Group did not have any way of determining what amount, if any, of these catches were included in landing reports. Therefore, the Working Group made the assumption that none of the catches were included and kept these data separate, listing them as unreported.

Following the information provided by Mr. Brannon, for the years 1988 and 1989, the estimate of unreported blacktip sharks in the Atlantic was determined by dividing the total annual unreported catch by 50%, to account for the fact that only half the fleet was in the Atlantic, then that value was multiplied by 7%.

2.4.3. Sandbar shark:

2.4.3.1. Commercial landings:

The same logic and procedures as described above for blacktip shark in the Gulf of Mexico were used to produce commercial landings estimates for sandbar shark.

The data are collected in landed or dressed weight. Various conversions are used to convert weight to number of sharks. From 1981 to 1985, an average weight of 35.9 was used. From 1986 to 1993, an average weight of 34.5 was used. This value was the average of the average weights from 1994 to 1996 from the bottom longline shark fishery observer program. From 1994 onward, the average weight was determined from data provided from the bottom longline shark fishery observer program.

2.4.3.2 Recreational landings

The same logic and procedures as described above for blacktip shark in the Gulf of Mexico were used to produce recreational catch estimates for sandbar shark.

2.4.3.3 Unreported Catches

As stated above, these landings correspond to the Gulf of Mexico during 1986, 1987, 1990 and 1991, while half of the landings correspond to the Gulf of Mexico and the other half to the mid Atlantic during 1988 and 1989. Mr. Brannon reported that the Atlantic landings were approximately 80%

sandbar sharks, with the remaining being a combination of blacktip sharks and other LCS species. The Working Group did not have any way of determining the amount, if any, of these catches that were included in landing reports. Therefore, the Working Group made the assumption that none of the catches were included and kept these data separate, listing them as unreported.

Following the information provided by Mr. Brannon, for the years 1988 and 1989, the estimate was determined by dividing the total annual unreported catch by 50%, to account for the fact that only half the fleet was in the Atlantic, then that value was multiplied by 80%. Since Brannon reported that the Gulf of Mexico landings were approximately 2/3 blacktip sharks, with the remaining third being a combination of sandbar sharks and other LCS species, for 1986, 1987, 1990, and 1991, the estimate was determined by multiplying the total annual unreported catch by 11% (assumed to represent the proportion of sandbar sharks).

2.4.3.4. Mexican catches

The total sum of catches presented for sandbar sharks in LCS05/06-DW-06 was used because there is no scientific evidence of nursery areas in Mexican waters (thus all sandbar sharks would have come from the U.S.).

2.4.3.5. Gulf menhaden fishery bycatch

Effort-adjusted estimates of dead discards were determined. De Silva et al. (2001) reported that sandbar sharks represented 1.8% of the total observed bycatch in 1994-1995. Considering the reported 75% mortality rate among all sharks, this results in an estimated bycatch of 486 (36,000*0.018*0.75) and 445 dead sandbar sharks in 1994 and 1995, respectively. The number of vessels operating in the fishery each year was divided by 53.5 vessels, the average number of vessels operating for the years in which bycatch estimates were available (1994 and 1995). The year-specific multipliers were then multiplied by the average number of sandbar (465) sharks discarded dead, as determined previously. This provides for year-specific bycatch estimates adjusted for the annual number of vessels in the fleet.

2.5 SPECIES-SPECIFIC SELECTIVITY AND AVAILABILITY

2.5.1 Blacktip Gulf of Mexico:

Commercial fishery and unreported landings: selectivity for these fisheries is assumed to follow a logistic curve that covers the entire age range; availability is assumed to be 1 for all ages.

Recreational fishery, Mexican landings and confiscated illegal Mexican catches: selectivity is assumed to be 1 for ages 0-1 with declining selectivity for later ages, but with lower steepness than for sandbar; availability is assumed to be 1 for all ages.

Menhaden fishery: selectivity and availability are assumed to be 1 for all ages.

2.5.2 Blacktip Atlantic Ocean:

Commercial fishery and unreported landings: selectivity for these fisheries is assumed to follow a logistic curve that covers the entire age range; availability is assumed to be 1 for all ages.

Recreational fishery: selectivity is assumed to be 1 for ages 0-1 with declining selectivity for later ages, but with lower steepness than for sandbar; availability is assumed to be 1 for all ages.

2.5.3 Sandbar shark:

Commercial fishery and unreported landings: selectivity for these fisheries is assumed to follow a logistic curve that covers the entire age range; availability is assumed to be 1 for all ages.

Recreational fishery, Mexican landings and confiscated illegal Mexican catches: selectivity is assumed to be 1 for ages 0-1 with declining selectivity for later ages. Because recreational fishing tournaments aim to catch larger sharks, the descending trend should not be too steep. Availability is assumed to be 1 for all ages.

Menhaden fishery: selectivity was assumed to be 1 for all ages. Availability is maximum (1) for ages 0-2 and decreases steeply to age of maturity.

2.6 Additional discussion

There was much discussion after the Workshop about the discrepancy between the species composition determined by the bottom longline observer program (BLLOP) and that determined from the landings data, especially with regards to sandbar and blacktip sharks. The BLLOP indicates that sandbar sharks comprise 51% of the observed sharks, with blacktip sharks accounting for 14%. This is in contrast to the landings data which suggest that sandbar and blacktip sharks represent approximately equal amounts based on landed weight (for 2004: sandbar sharks 1,223,082 lbs vs. blacktip sharks 1,092,600). It is believed this discrepancy arises mostly from the non-representative sampling coverage in the BLLOP.

Prior to 2002, observer coverage was voluntary, meaning that the coverage was restricted to areas and seasons when fishers were willing to take observers on their vessels. After several years of difficulty getting observers on vessels, observer coverage became mandatory in 2002. Vessels were selected for coverage by HMS using the following criteria:

Vessels are selected randomly from a pool of vessels that (1) have a current directed shark permit, (2) reported fishing for sharks with bottom longline gear in the first season of the previous year, (3) reported greater than 25% of landings from sharks during that season, and, beginning in 2004, (4) have not been selected for all of the past three seasons.

As vessels are randomly selected according to the above criteria, one should get a representative sample. However, as there are more vessels operating in the Atlantic than the Gulf of Mexico, there is

a greater probability of having observer coverage in the Atlantic rather than the Gulf of Mexico. Since the Atlantic is predominantly a sandbar shark fishery and the Gulf of Mexico predominantly a blacktip shark fishery, this may account for the low percentage of blacktip sharks recorded by the BLLOP in comparison to the percentage of sandbar sharks observed.

Despite concerns as to how representative this data is to the fishery at large, the BLLOP data is still believed to provide the most reliable species specific information due to species identification and recording issues by seafood dealers. It is known that some dealers can correctly identify shark species, while others can not (R. Hudson, pers comm.). It is also difficult to get accurate species-specific landings information due to the way in which sharks are weighed in vats at the docks and there may be several species in a vat that are called "blacktip" or "sandbar" on the landing receipt (R. Hudson, pers comm.). Additionally, the dealers should not be buying and reporting prohibited species, however they are still caught in the fishery. The only data available on the prohibited species is from the BLLOP.

2.7 Research Recommendations

- Biological data should be collected on the illegal Mexican shark catch confiscated in U.S. waters, including species, sex, and length.

- Gear-related information, including effort and gear used for each species should be collected on the interdicted Mexican vessels.

-One central electronic database for biological and gear data should be created to keep information regarding the confiscated sharks and vessels.

- Scientists should help the Coast Guard create the database and teach the agents how to identify the species and collect gear information.

- The Atlantic menhaden fishery data should be examined to determine shark bycatch estimates, if available.

- Historical data should be re-examined to determine if the "unreported catch" from Mr. Brannon is or is not already included in the commercial landings.

- Better landings information on number of species, by weight, from the dealers should be sought

- Dockside sampling information would be helpful to verify landings information such as species composition.

- Determine whether port sampler information for large coastal sharks is available and if so, how to access it.

2.8 REFERENCES

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Table 2.1. List of species that were originally part of the Large Coastal Shark complex, including those that are currently prohibited.

Common name	Species name
Sandbar	*Carcharhinus plumbeus*
Silky	*Carcharhinus falciformis*
Tiger	*Galeocerdo cuvier*
Blacktip	*Carcharhinus 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*

Table 2.2. BASE scenario - Catch history for the Large Coastal Shark complex (thousands of fish).

BASELINE SCENARIO

CATCHES OF LARGE COASTAL SHARKS: 22 species (in thousands)

Year	Commercial Landings	Pelagic longline discards	Recreational catches	Unreported catches	Bottom longline discards	Mexican catches	Gulf Menhaden fishery discards	Confiscated Mexican catches in US	Total
1981	16.2	0.9	285.1		0.5	120.0	37.5		460.2
1982	16.2	0.9	539.3		0.5	81.9	38.5		677.3
1983	17.5	0.9	791.1		0.6	85.4	38.0		933.5
1984	23.9	1.3	268.9		0.8	120.7	38.0		453.5
1985	22.2	1.2	400.8		0.7	87.7	34.2		546.9
1986	54	2.9	432.5	24.9	1.7	81.8	33.8		631.6
1987	104.7	9.7	313.9	70.3	3.3	80.2	35.2		617.3
1988	274.6	11.4	308.7	113.3	8.7	89.3	34.2		840.2
1989	351	10.5	228.1	96.3	11.1	105.6	36.1		838.7
1990	267.5	8	218.2	52.1	8.5	122.2	35.2		711.7
1991	200.2	7.5	299.9	11.3	6.3	95.7	27.2		648.1
1992	215.2	20.9	307.2		6.8	103.4	23.9		677.4
1993	169.4	7.3	255.0		5.4	119.8	24.4		581.3
1994	228	8.8	163.9		3.7	110.7	26.1		541.2
1995	222.4	5.2	187.2		5.2	96.0	24.0		540.0
1996	161.0	5.7	197.5		4.8	106.1	23.9		498.9
1997	130.6	5.6	169.7		6.7	83.1	24.4		420.0
1998	174.9	4.3	160.9		6.6	74.1	23.5		444.3
1999	111.5	9.0	82.1		2.9	57.1	25.8		288.4
2000	111.2	9.4	139.0		4.1	52.1	22.1	1.000	338.9
2001	95.8	5.6	136.7		5.5	52.1	20.6	1.470	317.7
2002	123.7	2.43	80.3		4.8	52.1	20.2	1.390	284.9
2003	122.8	3.5	88.4		6.9	52.1	19.7	1.310	294.7
2004	99.0	5.2	67.0		4.5	52.1	20.2	2.120	250.0

Table 2.3. BASE – PROH scenario - Catch history for the Large Coastal Shark complex minus the prohibited species (thousands of fish).

BASELINE - PROHIBITED SCENARIO

CATCHES OF LARGE COASTAL SHARKS: except Prohibited (in thousands)

Year	Commercial Landings	Pelagic longline discards	Recreational catches	Unreported catches	Bottom longline discards	Mexican catches	Gulf Menhaden fishery discards	Confiscated Mexican catches in US	Total
1981	15.1	0.7	223.7		0.5	120.0	37.5		397.5
1982	15.1	0.7	331.9		0.5	81.9	38.5		468.7
1983	16.3	0.7	683.1		0.5	85.4	38		824.1
1984	22.3	1.0	216.5		0.7	120.7	38		399.2
1985	20.7	1.0	355.7		0.7	87.7	34.2		500.0
1986	50.4	2.3	391.1	23.2	1.7	81.8	33.8		584.4
1987	97.7	7.7	274.6	65.6	3.2	80.2	35.2		564.3
1988	256.4	9.1	290.5	105.8	8.4	89.3	34.2		793.6
1989	327.7	8.3	212.9	89.9	10.8	105.6	36.1		791.3
1990	249.7	6.4	206.3	48.6	8.2	122.2	35.2		676.6
1991	186.9	6.0	284.3	10.5	6.1	95.7	27.2		616.7
1992	200.9	19.2	276.1		6.6	103.4	23.9		630.0
1993	158.1	6.3	244.5		5.2	119.8	24.4		558.3
1994	212.9	5.7	153.3		3.0	110.7	26.1		511.7
1995	207.6	4.5	177.3		4.9	96.0	24		514.2
1996	150.1	4.4	181.5		4.7	106.1	23.9		470.7
1997	127.5	5.0	154.0		6.9	83.1	24.4		400.8
1998	168.7	2.2	156.2		6.8	74.1	23.5		431.5
1999	109.0	7.3	76.7		2.8	57.1	25.8		278.7
2000	108.2	4.8	135.8		4.1	52.1	22.1	1.000	328.0
2001	95.7	4.2	129.9		5.0	52.1	20.6	1.470	308.9
2002	123.4	2.4	78.6		4.0	52.1	20.2	1.390	282.0
2003	122.1	3.5	85.7		6.0	52.1	19.7	1.310	290.4
2004	98.9	5.2	66.2		3.2	52.1	20.2	2.120	247.8

Table 2.4. BASE – PROH – SB - BT scenario - Catch history for the Large Coastal Shark complex minus the prohibited species, sandbar, and blacktip sharks (thousands of fish).

BASELINE - PROHIB - SB -BT SCENARIO

CATCHES OF LARGE COASTAL SHARKS: except Prohibited or BT or SB (in thousands)

Year	Commercial Landings	Pelagic longline discards	Recreational catches	Unreported catches	Bottom longline discards	Mexican catches	Gulf Menhaden fishery discards	Confiscated Mexican catches in US	Total
1981	3.8	0.7	38.1		0.4		19.8		62.9
1982	3.8	0.7	215.8		0.4		20.4		241.1
1983	4.1	0.7	222.1		0.5		20.1		247.6
1984	5.7	1.0	119.6		0.7		20.1		147.0
1985	5.3	0.9	169.8		0.6		18.1		194.7
1986	12.8	2.3	99.5	5.3	1.5		17.9		139.2
1987	24.8	7.6	111.8	15.1	2.9		18.6		180.8
1988	65.0	8.9	76.2	24.9	7.6		18.1		200.6
1989	83.1	8.2	67.5	21.1	9.7		19.1		208.7
1990	63.3	6.2	52.4	11.2	7.4		18.6		159.2
1991	47.4	5.9	93.3	2.4	5.5		14.4		168.9
1992	51.0	18.8	80.9		6.0		12.6		169.2
1993	40.1	5.6	105.0		4.7		12.9		168.3
1994	54.0	5.1	70.1		2.9		13.8		145.9
1995	63.9	4.3	82.8		5.2		12.7		168.9
1996	42.4	4.4	57.6		4.8		12.6		121.8
1997	17.3	5.0	38.3		2.9		12.9		76.4
1998	9.1	2.2	41.4		1.5		12.4		66.6
1999	8.5	7.3	24.9		0.6		13.6		54.9
2000	13.3	4.8	51.0		1.1		11.7	0.670	82.5
2001	6.0	4.2	44.3		1.4		10.9	0.985	67.8
2002	15.7	2.4	30.6		0.8		10.7	0.932	61.1
2003	14.0	3.5	40.2		1.6		10.4	0.878	70.6
2004	11.6	5.2	31.3		0.8		10.7	1.420	61.0

Table 2.5. Alternative catch scenario for the Large Coastal Shark complex (fish in thousands).

ALTERNATIVE SCENARIO

CATCHES OF LARGE COASTAL SHARKS (in thousands)

Year	Commercial Landings	Pelagic longline discards	Recreational catches	Unreported catches	Bottom longline discards	Mexican catches	Gulf Menhaden fishery discards	Confiscated Mexican catches in US	Total
1981	24.3	10	285.1		0.8	120.0	37.5		477.7
1982	24.3	10	539.3		0.8	81.9	38.5		694.8
1983	26.25	10	380.8		0.8	85.4	38		541.3
1984	35.85	10	268.9		1.1	120.7	38		474.6
1985	33.3	10	400.8		1.1	87.7	34.2		567.1
1986	108	10	432.5	24.9	3.4	81.8	33.8		694.4
1987	209.4	9.7	313.9	70.3	6.6	80.2	35.2		725.3
1988	549.2	11.4	308.7	113.3	17.3	89.3	34.2		1123.4
1989	702	10.5	228.1	96.3	22.2	105.6	36.1		1200.8
1990	535	8	218.2	52.1	16.9	122.2	35.2		987.6
1991	400.4	7.5	299.9	11.3	12.6	95.7	27.2		854.6
1992	430.4	20.9	307.2		13.6	103.4	23.9		899.4
1993	254.1	7.3	255.0		8.0	119.8	24.4		668.7
1994	228	8.8	163.9		3.7	110.7	26.1		541.2
1995	222.4	5.2	187.2		5.2	96.0	24		540.0
1996	161.0	5.7	197.5		4.8	106.1	23.9		498.9
1997	130.6	5.6	169.7		6.7	83.1	24.4		420.0
1998	174.9	4.3	160.9		6.6	74.1	23.5		444.3
1999	111.5	9	82.1		2.9	57.1	25.8		288.4
2000	111.2	9.4	139.0		4.1	52.1	22.1	1.000	338.9
2001	95.8	5.6	136.7		5.5	52.1	20.6	1.470	317.7
2002	123.7	2.43	80.3		4.8	52.1	20.2	1.390	284.9
2003	122.8	3.5	88.4		6.9	52.1	19.7	1.310	294.7
2004	99.0	5.2	67.0		4.5	52.1	20.2	2.120	250.0

Table 2.6. Species specific catch history for blacktip sharks in the Gulf of Mexico (thousands of fish).

BASELINE SCENARIO
CATCHES OF BLACKTIP SHARKS (in thousands) : GOM

Year	Commercial Landings	Recreational catches	Unreported catches	Mexican catches	Gulf Menhaden fishery discards	Confiscated Mexican catches in US	Total
1981	7.3	52.0		109.9	17.5		186.7
1982	7.3	54.5		70.1	17.9		149.8
1983	7.8	14.7		74.3	17.7		114.5
1984	10.7	23.0		109.0	17.7		160.4
1985	10.0	52.4		79.8	16.0		158.2
1986	55.0	152.5	16.43	72.5	15.7		312.1
1987	52.4	83.5	46.40	73.2	16.4		271.9
1988	137.5	126.9	37.39	80.1	16.0		397.9
1989	159.2	95.1	31.78	97.2	16.8		400.1
1990	80.6	87.8	34.39	111.5	16.4		330.7
1991	39.0	113.6	7.46	86.6	12.7		259.4
1992	53.2	139.2		93.7	11.2		297.2
1993	57.1	99.9		110.7	11.4		279.1
1994	120.0	52.2		102.0	12.2		286.4
1995	84.9	48.8		86.1	11.2		230.9
1996	58.7	59.4		95.3	11.2		224.5
1997	45.2	57.5		74.7	11.4		188.8
1998	62.5	58.4		66.9	10.9		198.7
1999	52.3	22.9		49.1	12.0		136.3
2000	42.1	67.2		45.0	10.3	0.330	165.0
2001	39.4	34.5		45.0	9.6	0.485	129.1
2002	30.0	34.5		45.0	9.4	0.459	119.4
2003	71.5	10.3		45.0	9.2	0.432	136.5
2004	44.2	27.0		45.0	9.4	0.700	126.3

Table 2.7. Species specific catch history for blacktip sharks in the Atlantic Ocean (thousands of fish).

BASELINE SCENARIO

CATCHES OF BLACKTIP SHARKS (in thousands) : ATL

Year	Commercial Landings	Recreational catches	Unreported catches	Total
1981	0.6	4.5		5.0
1982	0.6	28.0		28.6
1983	0.6	29.3		29.9
1984	0.8	16.1		16.9
1985	0.8	53.3		54.0
1986	4.2	13.6	0	17.8
1987	8.6	46.7	0	55.2
1988	0.1	19.7	4.0	23.7
1989	0.5	21.8	3.4	25.7
1990	4.9	7.2	0	12.1
1991	75.3	40.6	0	115.9
1992	97.2	19.6		116.8
1993	71.5	12.8		84.3
1994	81.2	15.9		97.2
1995	66.3	19.4		85.7
1996	41.9	27.9		69.8
1997	36.0	16.3		52.4
1998	32.4	21.5		53.9
1999	6.8	8.8		15.7
2000	9.7	6.8		16.4
2001	9.7	14.9		24.6
2002	20.6	5.3		25.9
2003	18.4	30.1		48.4
2004	13.4	4.3		17.7

Table 2.8. Species specific catch history for sandbar sharks (thousands of fish).

BASELINE SCENARIO

CATCHES OF SANDBAR SHARKS (in thousands)

Year	Commercial	Recreational catches	Unreported catches	Gulf Menhaden fishery	Mexican catches	Total
	Landings			discards		
1981	6.6	129.1		0.7	10.1	146.5
1982	6.6	33.6		0.7	11.8	52.8
1983	7.2	417.0		0.7	11.1	436.0
1984	9.8	57.8		0.7	11.7	80.0
1985	9.1	80.2		0.6	7.9	97.8
1986	23.1	125.6	2.7	0.6	9.4	161.4
1987	66.3	32.7	7.7	0.7	7.0	114.3
1988	79.4	67.7	45.3	0.6	9.1	202.2
1989	122.2	28.6	38.5	0.7	8.3	198.3
1990	116.7	58.8	5.7	0.7	10.7	192.7
1991	95.4	36.8	1.2	0.5	9.1	143.0
1992	100.6	36.4		0.4	9.7	147.1
1993	72.0	26.8		0.5	9.1	108.3
1994	126.5	15.0		0.5	8.8	150.7
1995	84.4	26.3		0.4	9.9	121.0
1996	65.5	36.7		0.4	10.7	113.4
1997	41.4	41.9		0.5	8.4	92.1
1998	62.8	35.0		0.4	7.2	105.4
1999	53.2	20.1		0.5	8.0	81.8
2000	37.3	10.9		0.4	7.1	55.6
2001	50.1	36.1		0.4	7.1	93.7
2002	56.3	8.2		0.4	7.1	72.0
2003	45.2	5.2		0.4	7.1	57.8
2004	39.1	3.6		0.4	7.1	50.1

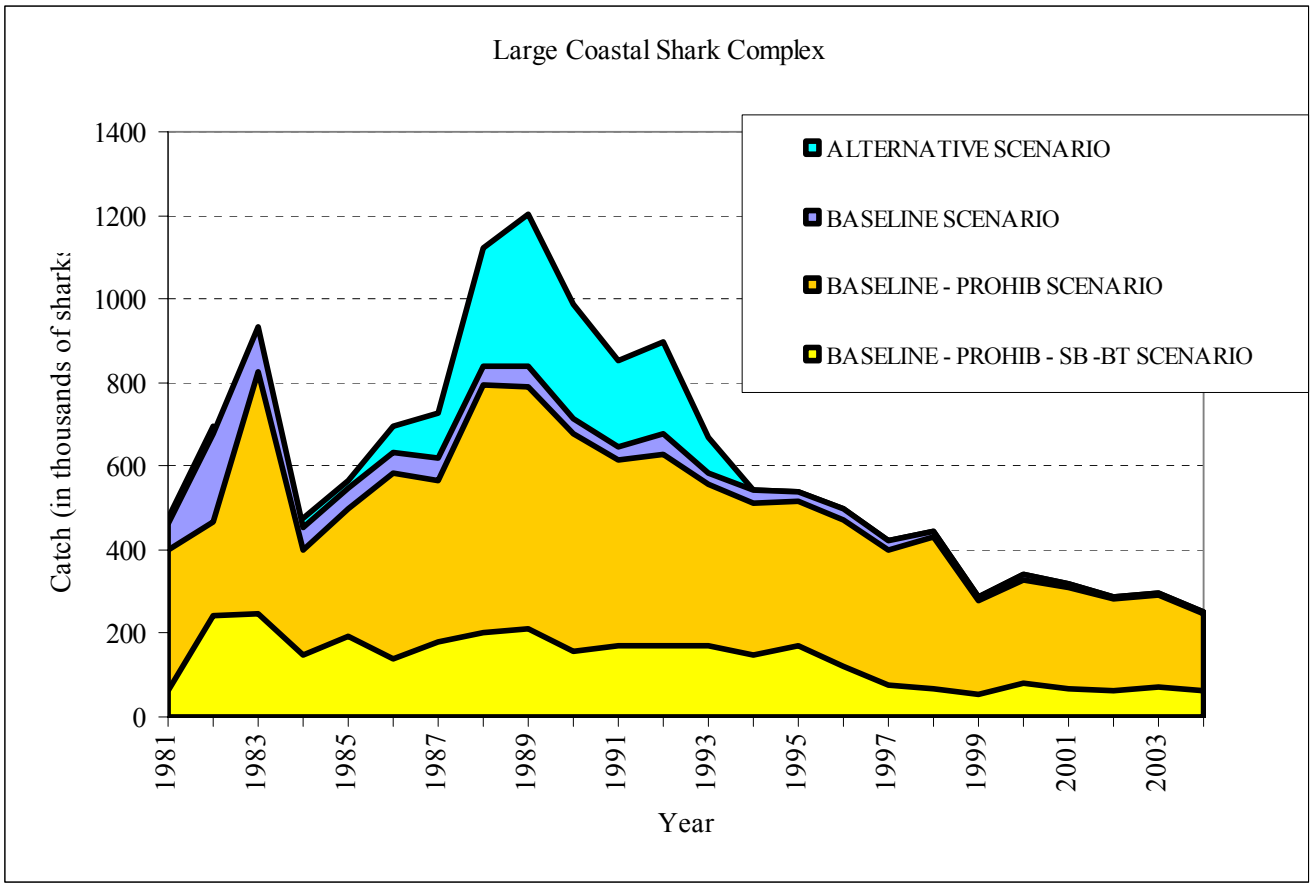

Figure 2.1. Total catches of Large Coastal Sharks (LCS; 22 species), LCS – prohibited species (11 species), and LCS – prohibited species, sandbar and blacktip sharks (9 species). The alternative catch scenario for the LCS complex (22 species) is also shown.

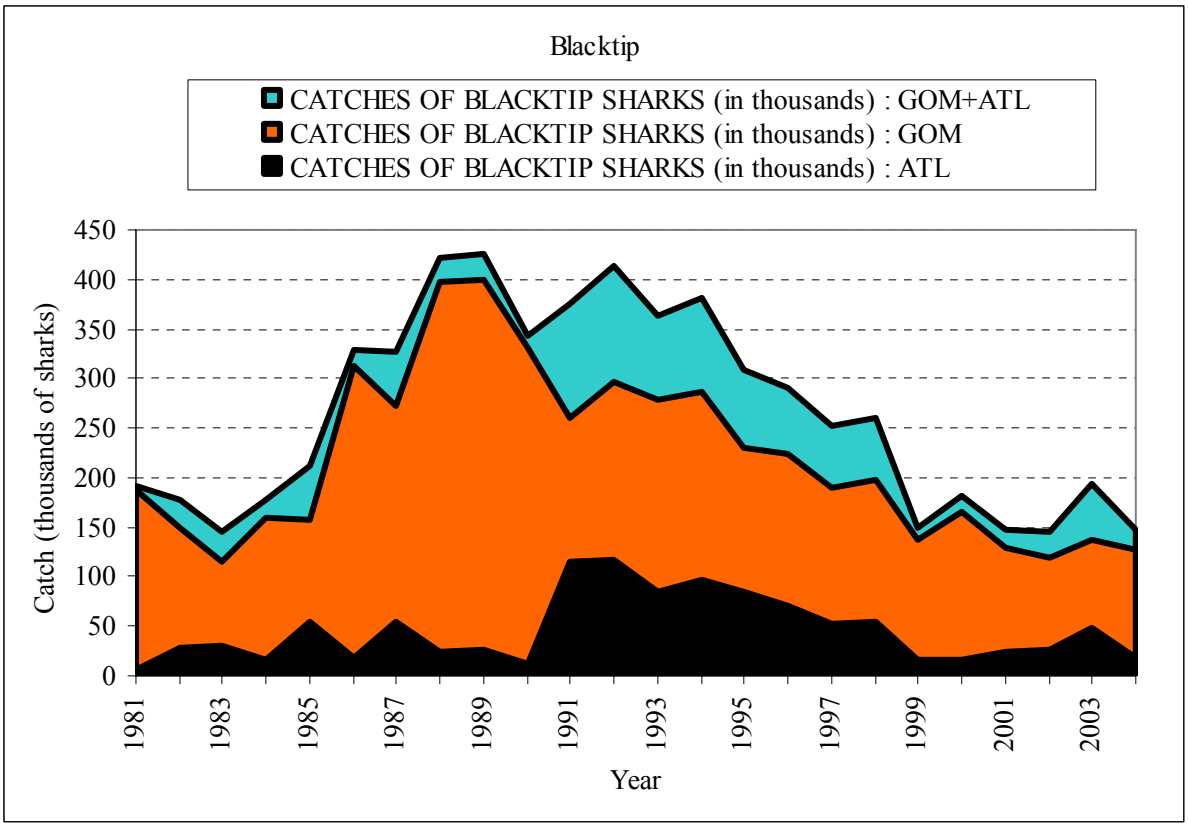

Figure 2.2. Total catches of blacktip sharks in the Gulf of Mexico and Atlantic regions.

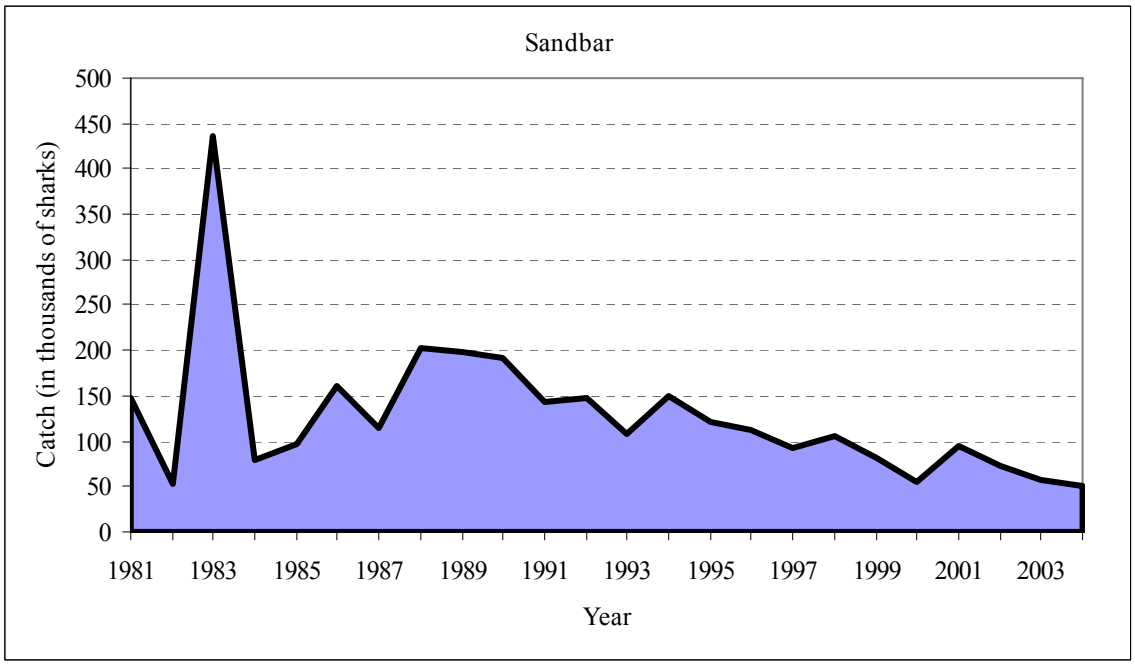

Figure 2.3. Total catches of sandbar sharks.

Abundance Indices Working Group Summary Report

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3.1 SUMMARY OF ABUNDANCE INDEX DOCUMENTS

LCS05/06-DW-01
Documentation for the North Carolina Division of Marine Fisheries catch rate series (NC#)
Anonymous

The paper reports on a fishery dependent survey of directed shark longline trips from 6 vessels from 1988 to 1992. The survey data contained 53 trips and consisted of total weight (kg), number of sharks, total fin weight (kg), days fished, number of sets, number of hooks, miles per set, soak time, location depth, and discard information. A GLM procedure was used and CPUE indices were developed for both numbers and weight.

LCS05/06-DW-09
Standardized catch rates of sandbar (*Carcharhinus plumbeus*) sharks in the Virginia - Massachusetts (U.S.) rod and reel fishery 1986 - 2004
Brown, C.

Abundance indices for sandbar (Carcharhinus plumbeus) sharks off the coast of the United States from Virginia through Massachusetts were developed using data obtained during interviews of rod and reel anglers in 1986-2004. Subsets of the data were analyzed to assess effects of factors such as month, area fished, boat type (private or charter), interview type (dockside or phone) and fishing method on catch per unit effort. Standardized catch rates were estimated through generalized linear models by applying delta-Poisson error distribution assumptions. A stepwise approach was used to quantify the relative importance of the main factors explaining the variance in catch rates.

LCS05/06-DW-11
The Directed Shark Gillnet Fishery: Large Coastal Catch Composition and a Standardized Catch Rate Series
Carlson, J.

A summary of the catch of large coastal sharks and a standardization of catch rate series from the directed shark gillnet fishery was developed based on observer programs from 1993-1995 and 1998-2004. Depending on season and area, large coastal species (primarily blacktip, *Carcharhinus limbatus*) are targeted. Average size of blacktip sharks was similar throughout the observer coverage period. Gillnet selectivity parameters for the blacktip were derived from a fishery independent survey but can be applied to this fishery because of the overlap in mesh sizes. Peak selectivities increased from 550 mm FL for the 8.9 cm and 10.2 cm mesh panel to 850 mm FL for 14.0 cm mesh in 100 mm increments per mesh panel. Selectivity was highest at 1150 mm FL for mesh panel 20.3 cm. Catch rates were standardized for a large coastal aggregate and blacktip shark using a two-part generalized linear model analysis. Depending on species, the final models varied with factors area, season, mesh size, and year. Results from this study indicate that the use of the two-step modeling approach was appropriate for standardizing catch rates for large coastal sharks.

LCS05/06-DW-12

Standardized catch rates of large coastal sharks from a fishery-independent survey in northeast Florida

Carlson, J.K. and D.M. Bethea

Fishery-independent catch rates were standardized using a two-part generalized linear model analysis. One part modeled the proportion of sets that caught any sharks (at least one shark was caught) assuming a binomial distribution with a logit link function while the other part modeled the catch rates of sets with positive catches assuming a Poisson distribution with a log link function. Standardized indices were developed for the large coastal species-aggregate, and blacktip shark, *Carcharhinus limbatus* from a longline survey. From a gillnet survey, catch rates were standardized for the large coastal species-aggregate and blacktip shark. Two additional catch rate series are also developed by age for the blacktip shark; young-of-the year (age 0+) and juvenile (age 1-5). Depending on species, the final models varied with factors area, season, year, and set begin. Although factors such as area and month were significant in most models, results from this study indicate any bias associated with these aspects did not significantly change the trends between nominal and standardized data. Overall, trends were not significant. It is possible additional factors such as sea temperature, dissolved oxygen, and salinity may contribute more to an explanation of the variability within the models. Further analysis using generalized additive models could improve the explanatory ability of the model.

LCS05/06-DW-13

Standardized catch rates of large coastal sharks from the Everglades National Park Creel Survey, 1972-2002

Carlson, J.K., J. Osborne, and T.W. Schmidt

The Everglades National Park was established in 1947 and a fisheries monitoring program by the National Park Service based on sport fisher dock-side interviews began in 1972. Interviewers record landings and releases. Using this data, a

standardized index of abundance was created for large coastal sharks. The delta-lognormal index was constructed by combining two general linear models, a binomial model fit to the proportion of positive trips, and a poisson model fit to positive catches. The standardized abundance index is similar to the nominal CPUE series. Sharks catches were relatively similar throughout the 1970's, declined beginning around 1982, stabilized in the early 1990's, and have somewhat increased since 1994. An index was also constructed for blacktip sharks but deemed unusable because of an increase in species-specific reported that coincided with the purported increase in abundance of blacktip sharks.

LCS05/06-DW-14
Documentation of the South Carolina Department of Natural Resources longline survey catch rate series (SC LL Recent)
Cortés, E.

This document examines catch rate series of large coastal sharks, blacktip, and sandbar sharks that became available for the 2002 evaluation. The series is a fishery-independent longline survey conducted by the South Carolina Department of Natural Resources. The series was subjected to a Generalized Linear Model (GLM) standardization methodology to adjust for factors that affect relative abundance. The approach used treats the proportion of sets with positive catches (i.e., where at least one shark was caught) assuming a binomial error distribution with a logit link function, separately from the catch rates of sets with positive catches assuming a Poisson error distribution with a log link function.

LCS05/06-DW-17
Standardized catch rates of large coastal sharks from the Commercial Shark Fishery Observer Program, 1994-2004
Cortés, E. A. Morgan, and G. Burgess

This document examines catch rate series for several groupings/species of sharks from the Commercial Shark Fishery Observer Program (CSFOP) for the period 1994-2004: all species in the originally defined large coastal shark (LCS) complex (22 species), the LCS complex without prohibited species (11 species), and the LCS complex without prohibited species or blacktip or sandbar sharks (9 species). Additionally, separate analyses were conducted for the sandbar shark and for the blacktip shark (Gulf of Mexico, Atlantic, and the two areas combined). All series were subjected to a Generalized Linear Model (GLM) standardization technique that adjusts for factors that affect relative abundance. The approach used to estimate relative abundance indices is a Generalized Linear Mixed Model that treats separately the proportion of sets with positive catches (i.e., where at least one shark was caught) assuming a binomial error distribution with a logit link function, and the catch rates of sets with positive catches assuming a Poisson error distribution with a log link function. The three standardized LCS series considered showed a positive, statistically significant trend. The standardized series for the sandbar shark was flat and showed high variability around the mean values. The standardized series for the blacktip shark (all areas combined) showed a statistically significant upward tendency, which was also reflected

in the standardized series for blacktip in the Gulf of Mexico, whereas the series for blacktip in the Atlantic fluctuated and showed no discernible trend.

LCS05/06-DW-20
A preliminary analysis of Virginia shark longline data 1974 - 2004
Ha, D.S. and J.A. Musick

This document examines catch rates for the large coastal species complex (LCS) and the sandbar shark (*Carcharhinus plumbeus*), from the Virginia Institute of Marine Science's bottom long-line survey. This survey has sampled a set of seven stations since 1973. In this time, the survey has collected over 5200 sandbar sharks and more then 6,000 large coastal species. The nominal data was transformed with the angular transform and analyzed with a generalized additive model, removing effects of covariates where significant. Over the course of the study (1974-2004) both the sandbar shark and the LCS complex showed significant declines, with no signs of recovery.

LCS05/06-DW-21
Documentation for the Brannon catch rate series
Hester, F.J.

This document reports catch and effort data from the Brannon fleet for the years 1986-1991. The landings were not entered into the NMFS LCS landings data base, and were likely mainly blacktip and sandbar. The landings may be useful for compiling the catch tables, but using the effort data is problematic. This is because some of the boats shifted effort and targeting from Alabama to South Carolina in the middle years of the series and probably took sandbar as well as other LCS.

LCS05/06-DW-22
An evaluation of the content and quality of two Commercial Atlantic Shark Fishery logbook data sets for consideration for stock assessment use
Hester, F.J. and R.H. Hudson

Paper 22 examined the possible utility of using the landings data from the CFL series to construct indexes of abundance. The conclusions were that several steps were necessary:
1) the data needed to be verified, in particular the landings reported in the logbooks needed to be compared with the weights and species reported in the weigh out slips, 2) the vessels involved need to be standardized (by length), 3) the gear type should be restricted to bottom long line setting a minimum of 100 hooks, and 4) trips targeting sharks need to be defined.

Even so, the calculated indexes would be limited to some form of landings by species and weight per trip: *e.g.*, average weight landed per set, or average landed per hook because the data are aggregated by weight landed per trip. Actual catches, as opposed to landed, cannot be determined, nor can numbers taken or discarded.

LCS05/06-DW-23

A review of exploratory longline surveys and biological sampling of sharks from the Sandy Hook and Narragansett labs: 1961-1996.

Hoey, J.J., A. Aires-da-Silva, P. Turner, T. Sye, and N. Kohler

The report provides an inventory of sampling cruises using longline gear from 1961 through 1996 from shark research programs run out of the BSFW Sandy Hook and NMFS Narragansett labs. Most of the survey sets deployed pelagic gear similar to shallow rigged "yankee style" swordfish gear. The major change over time related to the annual proportions of sets deployed in shallow coastal areas versus offshore effort along the edge of the continental shelf and in Gulf Stream waters. Early effort (61-65) was primarily in depths shallower than 50 meters depth in the northern Mid-Atlantic bight, whereas after that effort was primarily deployed along the edge of the continental shelf primarily from Cape Hatteras to Georges Bank. After several geographically unique cruises were identified, annual estimates of consistent inshore and offshore pelagic sets were identified as suitable for additional analyses and standardization. Size frequency histograms were provided for several dominant species.

LCS05/06-DW-24

Catch Rates for Blacktip and Other Large Coastal Shark Species from Mississippi Coastal Waters During 1998–2005

Hoffmayer, E.R., G.R. Parsons, and G.W. Ingram

This document examines catches rate series for the large coastal shark complex (LCS) and blacktip sharks calculated from a gillnet survey which was conducted in the Mississippi coastal waters from 1998 to 2005. As a result of 90 net sets and 354 hours of effort, 446 blacktip and 56 other LCS were collected. Because the work was conducted in a known blacktip nursery area, blacktip shark catch was further divided into young-of-the-young (YOY, age-0) and juvenile catch. Standardized catch rates were estimated using a Generalized Linear Mixed modeling approach assuming a delta-lognormal error distribution. Catch rates did not exhibit a clear pattern because of two years of extremely elevated catch rates in 2000 and 2005. The LCS catch rates exhibited similar patterns to total blacktip catch, primarily because blacktips dominated the LCS catch.

LCS05/06-DW-25

Synopsis of a survey of the Florida recreational shark fishery utilizing shark tournament and selected long-line data (Documentation for the Hudson, Jax, Pt. Salerno, and Tampa Bay Recreational Fishing Tournaments catch series, along with the Crooke longline catch series).

Hueter, R.E.

This synopsis of a 1991 report to the state of Florida examines catch data for four recreational shark tournaments in Florida (Hudson, 1985-91; Jacksonville, 1979-90); Port Salerno, 1976-91; and Tampa Bay, 1985-90). Where possible, catch rate was standardized into a CPUE index of

sharks per registered angler in the tournament. Declining trends in catch rate are evident. Catch comprised almost entirely species from the LCS complex including sandbar, dusky, tiger, hammerhead, bull, lemon, blacktip, spinner and nurse sharks. The report also contains analysis of a small-scale longline operation conducted off Pensacola, Florida from 1975 to 1989, for which meticulous catch records were kept. Catch comprised primarily LCS species including sandbar, blacktip, bull, tiger, dusky, scalloped and great hammerhead, spinner and nurse sharks. An overall decline in CPUE expressed as sharks per hook is evident; however, the lack of accounting for null sets (sets that caught no sharks) in the operation makes the use of these data problematic.

LCS05/06-DW-26

Relative abundance of juvenile blacktip sharks in three Florida Gulf coastal nursery areas, 1995-2004

Hueter, R., J. Tyminski and C. Simpfendorfer

Monthly, random-stratified, fishery-independent sampling by standardized gill net was conducted in three primary nurseries for the blacktip shark in peninsular Florida Gulf coast waters from 1995-2004. Total catch over the study duration comprised 8,257 sharks including 3,842 blacktip sharks, 90% of which were neonate or young-of-the-year (YOY) animals. Standardized catch rates were calculated using a GLM with month, year, area, grid and block (nested within grid) as factors. The GLM also included an interaction term between year and area to investigate if different nurseries had different patterns of catch rates. To assess overall trends in catch rate, the GLM was applied to data from June through August in the two more productive nurseries of Yankeetown and Charlotte Harbor. There were significant differences in catch rates among all factors tested except month. Regression analysis indicated the slope of the catch time series was not significantly different from zero in either nursery, implying no significant increasing or decreasing trend in recruitment to these blacktip shark nurseries from 1995-2004. Environmental factors such as red tide blooms and pulses of fresh water into estuaries following storm events appear to have affected relative abundance of Year-0 blacktip sharks in these nurseries.

LCS05/06-DW-27

Catch rates, distribution and size composition of large coastal sharks collected during NOAA Fisheries Bottom Longline Surveys from the U.S. Gulf of Mexico and U.S. Atlantic Ocean

Ingram, W., T. Henwood, M. Grace, L. Jones, W. Driggers, and K. Mitchell

The Southeast Fisheries Science Center (SEFSC) Mississippi Laboratories has conducted standardized bottom longline surveys in the Gulf of Mexico, Caribbean, and Southern North Atlantic since 1995. This document describes the evolution of this survey including changes in hook-type and depth range over time. The effect of hook type was adjusted for using species and area-specific ratios of circle-hook to J-hook catch rates. Initially, blacktip, sandbar and LCS indices were developed for Atlantic (south of 37°), Gulf of Mexico, Eastern Gulf, Central Gulf, and Western Gulf, resulting in 15 indices. After review by the Indices Workgroup I was asked to

create six indices using the Lo method: blacktip for Gulf of Mexico with year, area and depth as variables (catch rates increase in later years); blacktip for Atlantic south of 37° with year and depth as variables (low catches with breaks in the time series); sandbar for Gulf of Mexico and Atlantic combined with year, area and depth as variables (bounces around, stays about the same over time series); large coastal sharks for Gulf of Mexico and Atlantic combined with year, area and depth as variables (bounces around, maybe an increase in later years); large coastal sharks excluding prohibited species for Gulf of Mexico and Atlantic combined with year, area and depth as variables (bounces around, maybe an increase in later years); large coastal sharks excluding prohibited species, blacktip and sandbar for Gulf of Mexico and Atlantic combined with year, area and depth as variables (bounces around, maybe an increase in later years).

LCS05/06-DW-30

Relative abundance trends for juvenile sandbar sharks in Delaware Bay

McCandless, C.T.

Delaware Bay is one of the principal pupping and nursery grounds for sandbar sharks, *Carcharhinus plumbeus*, in the East Coast waters of the United States (Merson and Pratt 2001). To provide information for effective management of this essential sandbar shark habitat, we need to understand and monitor its use by this species. Researchers from the National Marine Fisheries Service (NMFS) and the University of Rhode Island have been conducting gillnet and/or longline surveys for juvenile sandbar sharks in Delaware Bay since 1995. In 2001, a random stratified sampling plan based on depth and geographic location was initiated to assess and monitor the juvenile sandbar shark population. The geographic regions and depth strata ranges were chosen based on differences seen during sampling for juvenile sandbar sharks in Delaware Bay by the National Marine Fisheries Service from 1995 to 2000. Catch per unit effort (CPUE) in number of sharks per 50-hook set per hour was used to examine the relative abundance of juvenile sandbar sharks in Delaware Bay between the summer nursery seasons from 2001 to 2005. The CPUE was standardized using an offset of the natural logarithm of the CPUE in a generalized linear model which took into account the effects of year, month, region, and depth strata. This study also attempts to standardize the CPUE using a modified two-step approach originally proposed by Lo et al (1992). This approach is based on a delta-lognormal model and is a two-step approach that models the zero catch separately from the positive catch. Results from both standardization methods and the nominal CPUE values indicated that the relative abundance of juvenile age 1+ and young of the year sandbar sharks during the summer nursery season in Delaware Bay from 2001 to 2005 has remained fairly constant with only a significant drop in juvenile age 1+ abundance in 2002, which may be attributed to a large storm that passed through the Bay that year.

LCS05/06-DW-31

Standardized catch rates of large coastal sharks from the United States bottom longline fishery during 1996-2004

McCarthy, K. and D. Abercrombie

The available coastal logbook bottom longline catch per unit effort (CPUE) series, from 1996 - 2004, was used to develop six abundance indices for the large coastal shark species complex, blacktip sharks, and sandbar sharks. Prohibited species and unclassified sharks were excluded from the large coastal shark data set. Separate indices of abundance were calculated for each of two groups of vessels (all bottom longline vessels that fished in seven of the nine years examined and the 20% of vessels with the highest CPUE for large coastal sharks). For all indices developed, the factors YEAR, QUARTER, ZONE (Gulf of Mexico, Atlantic, and south Florida), and VESSEL were examined for inclusion in the catch rate models. For the analyses of the large coastal sharks species complex and blacktip sharks the final models were ***PROPORTION SUCCESSFUL TRIPS=YEAR+VESSEL+QUARTER*** and, for the lognormal model of catch rates on successful trips, ***ln(CPUE)=YEAR+VESSEL+QUARTER***. Final models for the analysis of sandbar sharks were ***PROPORTION SUCCESSFUL TRIPS=YEAR+VESSEL+QUARTER*** and ***ln(CPUE)=YEAR+VESSEL+ZONE***. The delta lognormal model approach (Lo et al. 1992) was used to develop the standardized indices of abundance. The standardized abundance indices developed here are similar to those of Brown (2002) for the years 1996-2001. CPUE is essentially flat during the time series for large coastal sharks and for sandbar sharks. Blacktip shark CPUE gradually increased over time before dropping in 2004.

LCS05/06-DW-33
Catch Rate Information Obtained from the NMFS Northeast Longline Survey
Natanson, L.J.

This document details the Northeast Fisheries Science Center (NEFSC) Coastal Shark Survey, conducted by the Apex Predators Investigation, Narragansett Laboratory, Narragansett, RI from 1986-2004. Its primary objective is to conduct a standardized, systematic survey of the shark populations off the US Atlantic coast to provide unbiased indices of the relative abundance for species inhabiting the waters from Florida to the Mid-Atlantic. It also provides an opportunity to tag sharks as part of the NEFSC Cooperative Shark Tagging Program and to collect biological samples and data used in analyses of life history characteristics (age, growth, reproductive biology, trophic ecology, etc.) and other research of sharks in US coastal waters. Two series of data have been identified based on gear characteristics. Information on gear, station locations, depth, hook numbers, catch, and nominal CPUEs from both series are presented.

LCS05/06-DW-35
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
Ortiz, M.

This document presents indices of abundance from the Pelagic Longline Logbook dataset. Indices were calculated for: Large Coastal Shark complex, Sandbar shark (Gulf of Mexico and Atlantic Ocean Combined), Blacktip (Gulf of Mexico and Atlantic Ocean combined, and both areas separately). The same 5 indices were also calculated from the weighout data. Although the data series cover the years 1981-2004, species specific identification for Blacktip (BT) only

begins in 1992, and for Sandbar (SB) in 1995. Furthermore, BT dominated LCS landings 1992-1994, and then from 1995-2004 SB dominate the landings. The PLL indices for BT show a decline to about 1995 and then is more or less flat. The PLL index for SB shows an increase from 1994-1996, and then is pretty flat until 2003-2004, where there is an upward trend. The LCS index is more or less flat over the whole time series.

LCS05/06-DW-36
Standardized catch rates for blacktip shark (Carcharhinus limbatus), sandbar shark (C. plumbeus), and large coastal complex sharks from the Marine Recreational Fisheries Statistical Survey (MRFSS)
Ortiz, M.

This document presents indices of abundance from the MRFSS database. Indices were calculated for LCS and SB (Gulf of Mexico and Atlantic Ocean Combined), and for Blacktip (Gulf of Mexico and Atlantic Ocean separately). The data spans the years 1981-2004. Sharks represented about 2% of total number of fish, and of that, LCS comprised about 10% - 20%. Within the LCS catch, SB and BT make up 80%. The data were not subsetted. Factors for area, gear, mode, and guild were tested. The BT Atlantic index is fairly trendless, with a possibly slight increasing trend towards the end of the series; in the Gulf of Mexico, no trend was apparent. For SB, a declining trend for most of the time series was observed. In the LCS index, a downward trend in the late 1980s was observed, with a fairly flat trend from 1992-2004.

LCS05/06-DW-41
Documentation for the Charterboat catch rate series
Scott, G. and Lacey

Data collected under a charterboat survey managed by the SEFSC Panama City laboratory were examined for use in developing standardized catch rate indices for sharks. Effort (directed at sharks) and associated catch of sharks was cross-classified by year, month, fishing area, and method of fishing (troll or not troll). Catch rate (sharks per hr fishing) was standardized for these effects through the General Linear Modeling approach, using the method of Lo et al. (1992). Updated data for 1995 are summarized and results of these calculations are presented in the attached tables and figures.

LCS05/06-DW-43
Large coastal shark surveys in eastern Gulf of Mexico, 2001-2004.
Simpfendorfer, C., J. Tyminski and R. Hueter.

Surveys for LCS species were conducted in the eastern Gulf of Mexico (Tampa Bay to Charlotte Harbor) using longlines and drumlines from 2001 onwards. Data from surveys were used to investigate seasonal and inter-annual changes in the abundance of individual species. Blacktip and bull sharks occurred year-round in surveys, sandbar and spinner sharks occurred in all seasons except summer, and lemon sharks occurred in all seasons except winter. The annual

time series showed considerable variation, but were too short to determine any trends in abundance over time. A persistent red tide bloom in coastal waters in 2003 appears to have negatively affected relative abundance of LCS in the area that year.

LCS05/06-DW-45
Documentation for the South Carolina Longline Survey – Early (SCLL Early)
Ulrich, G.

The purpose of this study was to evaluate techniques for conducting fisheries-independent assessments of large coastal sharks and to determine what changes have occurred in their populations in the coastal waters of South Carolina, in response to increased commercial exploitation. The present survey is a continuation of efforts to develop data on the status of these stocks on a regional basis. This report combines data from the 1993-1994 and 1994-1995 projects and compares it to catch composition and CPUE data collected during 1983-1984.

3.2 DISCUSSION OF ABUNDANCE INDICES

Each document was presented to the working group by its author or other representative. The group discussed each index with respect to data quality and completeness, analysis methodology and results, as well as index importance and potential utility. The indices presented to the group are listed in Table 3.1. The group formulated research recommendations for selected index analyses to be implemented, if possible, prior to the assessment being carried out. It was understood that some of the research recommendations might not be completed due to time constraints. The working group also compiled a list of indices recommended for use with each base case, based upon importance of each index and degree of confidence that it is reflective of abundance.

3.2.1 Recommendations

As a result of the decision by the catch statistics working group that separate base case assessments should be conducted for each of the three definitions of a large coastal species group (*BASE*, *BASE-PROH*, and *BASE-PROH-SB-BT* scenarios), a general recommendation was made that all large coastal species indices be recalculated where necessary and possible for each scenario. Also, the blacktip shark indices should be recalculated, if necessary, separately for the Atlantic and Gulf of Mexico.

After discussing each index, the group proposed specific modifications to some of the analyses in order to improve the applicability of the indices for the assessment. In the case of **LCS05/06-DW-09**, the group expressed concern at the large CVs of the index values. The possibility was raised that this was a result of poor fit of the distribution of proportion positives to the assumed binomial distribution. A recommendation was made to recalculate the index standardization assuming a zero-inflated binomial distribution.

It was determined that the indices in **LCS05/06-DW-11** should be recalculated using a correction formulation for units of effort, as well as restricting the blacktip analysis to Atlantic only, as observations from the Gulf of Mexico were sparse and only covered 3 years.

The lead author of **LCS05/06-DW-13** noted that reporting rates for specific species appeared to vary over time, and recommended against using any of the resulting indices except for the total large coastal complex (*BASE*).

The discussion of **LCS05/06-DW-20** included the possibility of developing an index of young-of-year and juveniles in the Chesapeake Bay nursery ground. It was recommended that the Lo et al. (1990) method be used to standardize the catch rates, for consistency with the other standardized indices.

It was recommended that attempts be made to collate suitable data from among the data sets discussed in **LCS05/06-DW-23 (**and possibly merge with the data from **LCS05/06-DW-33)**, and then standardize the resulting catch rate series. Analysis of species composition was recommended as a possible approach to subset data to trips that would target large coastal sharks. The data could also be restricted to a subset of vessels that consistently reported sharks throughout the time series. There is a need to examine effort allocation as well to see if there was an effect of the management actions to close areas. Results from such analyses should be made available for consideration at the assessment meeting, if possible.

It was noted that the catch rate trends in **LCS05/06-DW-24** showed concurrent peaks for multiple age classes. Because both young-of-the-year and juvenile catch rates were elevated in the same years, without any offset to the patterns as might be expected if the indices reflected abundance trends of different age classes and not reflected in subsequent years, it was suggested that these elevated catch rates resulted from sharks being concentrated within the study area (or being dispersed in other years). It was recommended that other factors should be investigated to help explain these elevated catch rates, such as environmental conditions. The catch rate trends in **LCS05/06-DW-26** also showed some concurrent patterns, primarily in 2001 coinciding with a severe red tide event. It was recommended that the analyses be rerun without including 2001 data. Similarly, catch rates in **LCS05/06-DW-30** during 2002 appear to have been affected by the passage of a hurricane; it is recommended that these indices be rerun without including data from 2002.

It was recommended that that the analyses in **LCS05/06-DW-27** be rerun, following the same geographic breakdown as other studies and incorporating area as a factor in the models, if warranted.

With respect to **LCS05/06-DW-31**, the group made several recommendations. First, that the coastal logbook data should be examined to resolve data quality concerns raised by the group. Next, further data exploration should be conducted to find patterns that might suggest ways to better define coastal shark directed trips and/or vessels which tend to catch coastal sharks. It was recommended that additional factors should be examined for inclusion in the models. The group further recommended that the inclusion of available discard data should be examined. Recent developments in analytical procedures should also be incorporated in the additional analyses.

Finally, the blacktip indices will need to be calculated separately for the Gulf of Mexico and the Atlantic.

The indices shown in **LCS05/06-DW-33**, reported as a nominal trend, should be standardized following the Lo et al. (1990) methodology employed for the other standardized indices.

The group expressed concern that the trends observed for blacktip and sandbar sharks in **LCS05/06-DW-35** may reflect changes in targeting, reporting, and management actions. A recommendation was made that the dataset be reanalyzed (although a blacktip index across all areas is no longer needed), selecting sets/trips based on criteria, such as species composition of the catch or bottom depth, to help determine those that would be targeting large coastal sharks (or at least more likely to encounter them). A further recommendation was made to subset the data to boats that appeared to be consistently reporting sharks throughout the time period. The weighout dataset represents landings and begins immediately following the imposition of regulations to land carcasses with fins. This regulatory change may have introduced a change in proportion of sharks landed, and species composition therein, since some species have proportionately large fins. In addition, other changes such as closed areas, defining protected species, and an incentive for fishermen to establish a landing history in order to qualify for a permit all could have potentially biased the proportion of sharks landed. For all of these reasons, the group felt that the weighout series was not an appropriate index and that it would not be possible to standardize the index to eliminate these potentially misleading signals.

The currently available index values, including those updated following the recommendations described above, are shown in Table 3.2 and Figures 3.1 – 3.12.

3.2.2. Base Case Indices

After discussing all of the available indices, the working group compiled a list of indices recommended for use with each base case. Inclusion as a base case index was determined by the importance of the index (higher if the index covers a long time period and/or there are few or no other indices for some years) and the degree of confidence that it is reflective of abundance (higher if the catch rates are standardized though sampling design or analytically, lower if there are concerns about biases not accounted for). The list of recommended indices by group and species (including area for blacktip sharks) is shown in Table 3.3. It should be noted that it may not be possible to produce each of the listed LCS base case indices for every LCS scenario. The list of indices recommended for sensitivity runs is shown in Table 3.4.

The pelagic longline logbook indices (**Pelagic log**) were originally not included as recommended base case indices. The working group expressed concern that pelagic longline fishing activity may be unlikely to encounter coastal species on a consistent basis, in which case the indices derived from that fishery might not be good indicators of abundance. On this basis, these indices were not recommended for use in the base cases. However, the group also considered that it may be possible to reanalyze the pelagic logbook data, following the research recommendations listed above, thereby focusing on the subset of effort more likely to encounter large coastal sharks. Therefore, the group allowed that it may be possible to include the revised pelagic longline

logbook indices among the base case indices if there are convincing indications that the revised indices are reflective of abundance trends. During the calculation of the revised indices, there were indeed such indications. Large coastal sharks appear to be caught in large numbers by the pelagic longline fishery, across a broad geographic range. Such evidence suggests that there is considerable overlap between pelagic longline fishing effort and large coastal shark habitat. Therefore, the **Pelagic log** indices may be considered for use in the base cases.

It may be possible that new indices may be developed from the data bases referenced in **LCS05/06-DW-23** and made available prior to the assessment meeting. In such a case, the indices may be valuable to use during the assessment, but it might not be possible to include them as base case indices.

3.2.3 Recommendations on remaining indices

Many of the remaining indices are recommended for use in sensitivity runs, even though they were not recommended as base case indices. One example is the longline index from **LCS05/06-DW-31** (**Crooke LL**), which represented a long time series of consistently collected data, but for which the presumably valuable information of number of unsuccessful sets is not included. As a result, the **Crooke LL** index might be considered for sensitivity runs, but should not be used for the base cases. Another example of indices that were not considered suitable for use in the base cases, but could be used for sensitivity analyses, is the set of **MRFSS** indices described in **LCS05/06-DW-35**. The main difficulty with the MRFSS indices is the large (and increasing in recent years) proportion of the catch (mainly discarded) which is identified only as "requiem sharks". This grouping may include various large coastal shark species as well as small coastal shark species, and the proportions therein might be influenced by management measures restricting landings of certain species. This may adversely impact the validity of these indices as relative abundance measures for specific species or species groups. However, the MRFSS indices may be valuable in sensitivity runs, and some approach may be taken to apportion the "requiem shark" catches according to other available information on species composition.

In general, the working group determined that most of the remaining indices could likewise be used for sensitivity runs; these are not specifically discussed. However, the working group recommended against the use of some of the available indices. For instance, the group followed the advice of the lead author of **LCS05/06-DW-13** and recommended against the use of the blacktip index from that paper since reporting rates of blacktip sharks appeared to vary over time.

The index from **LCS05/06-DW-1** was not recommended as it is a short series and there was an apparent discontinuity between the periods 1988-1989 and 1990-1992, with speculation within the group that this might reflect changes in methodology. The index described in **LCS05/06-DW-21** was also not recommended as it is not standardized, is not species-specific, and is derived from observations from both the Gulf of Mexico and the Atlantic with unknown allocation between the two areas. The index from **LCS05/06-DW-22** was not recommended because a longer time series, using more observations, is available from the same data set (**LCS05/06-DW-31**).

The nominal catch rate information from shark tournaments, reported in **LCS05/06-DW-25**, were generally not recommended for use since effort information was crude (number of anglers registered with the tournament) and there was no standardization of (nor even information on) the factors which potentially may have influenced catch rates over time other than changing abundance. However, data from the Port Salerno Tournament were collected over a long term using consistent methodology; this particular series may be considered for sensitivity runs.

The weighout data based indices from **LCS05/06-DW-35** were not recommended for the aforementioned reasons (management measures may have influenced the proportion of sharks being landed over time, etc.). The charter boat survey index reported in **LCS05/06-DW-41** was not recommended for use, as catch rates are reported for total sharks only and the proportions of pelagic and coastal sharks are not known. The various indices in **LCS05/06-DW-43** were not recommended for use until more years of data are available.

3.3 INDEX WEIGHTING RECOMMENDATIONS

The working group recommended inverse weighting based upon CVs as the default weighting scheme whenever indices are not given equal weighting.

Table 3.1. A summary of catch series available for review at the LCS 05/06 Data Workshop.

Species	*Series*	*Author*	*Reference*	*Data Source*	*Area*	*Years*	*Season*	*Biomass/ Number*	*Fishery Type*	*Standardized*	*Selectivity Info*	*Age Range*	*Positive Aspects*	*Negative Aspects*	*Utility for Assessment*
Sharks	NC #	Anon.	LCS05/06-DW-01	6 Directed longline boats	North Carolina	1988-1992	All	Biomass/Number	Commercial	GLM	None	None	Historic	Not species specific, low sample sizes, possible changes in fishing methodology not accounted for	Not recommended
SB	LPS	Brown	LCS05/06-DW-09	Angler interviews	Virginia-Mass.	1986-2004	June-October	Number	Recreational	Lo method	Length frequency	None			Usable, revisit cv calculation
LCS	Gillnet Observer	Carlson	LCS05/06-DW-11	Shark drift gillnet fishery	Florida, Georgia	1993-1995, 1998-2004	All	Number	Commercial	Lo method	Length by mesh size (based on fishery independent study)	None	standardized		Rerun with new effort calculation, need to attempt calcs for all LCS scenarios
BT	Gillnet Observer	Carlson	LCS05/06-DW-11	Shark drift gillnet fishery	Florida, Georgia (Atl)	1993-1995, 1998-2004	All	Number	Commercial	Lo method	Length by mesh size (based on fishery independent study)	None	standardized		Rerun with new effort calculation, restricted to Atlantic only
LCS	PC LL	Carlson & Bethea	LCS05/06-DW-12	PC NMFS Longline Survey	NW Florida	1993-2000	Spring, Summer, Fall	Number	Independent	Lo method	Length frequency	None			Usable, need to attempt calcs for all LCS scenarios
BT-Juvenile	PC LL	Carlson & Bethea	LCS05/06-DW-12	PC NMFS Longline Survey	NW Florida	1993-2000	Spring, Summer, Fall	Number	Independent	Lo method	Length frequency	None			Usable
LCS	PC Gillnet	Carlson & Bethea	LCS05/06-DW-12	PC NMFS Gillnet Survey	NW Florida	1996-2004	Spring, Summer, Fall	Number	Independent	Lo method	Length frequency	None			Usable, need to attempt calcs for all LCS scenarios
BT	PC Gillnet	Carlson & Bethea	LCS05/06-DW-12	PC NMFS Gillnet Survey	NW Florida	1996-2004	Spring, Summer, Fall	Number	Independent	Lo method	Length frequency	None			Usable
BT-Juvenile	PC Gillnet - juveniles	Carlson and Bethea	LCS05/06-DW-12	PC NMFS Gillnet Survey	NW Florida	1996-2004	Spring, Summer, Fall	Number	Independent	Lo method	Length frequency	Age 1 to 4 years			Usable
BT-YOY	PC Gillnet – Age 0	Carlson and Bethea	LCS05/06-DW-12	PC NMFS Gillnet Survey	NW Florida	1996-2004	Spring, Summer, Fall	Number	Independent	Lo method	Length frequency	Age-0			Usable
SB	PC Gillnet	Carlson & Bethea	LCS05/06-DW-12	PC NMFS Gillnet Survey	NW Florida	1996-2004	Spring, Summer, Fall	Number	Independent	Lo method	Length frequency	None			Usable, as nominal series
LCS	ENP	Carlson et al.	LCS05/06-DW-13	Angler interviews	Everglades	1972-2002	All (wet and dry seasons)	Number	Recreational	Lo method	None	None			Usable, only possible for total LCS

Species	*Series*	*Author*	*Reference*	*Data Source*	*Area*	*Years*	*Season*	*Biomass/ Number*	*Fishery Type*	*Standardized*	*Selectivity Info*	*Age Range*	*Positive Aspects*	*Negative Aspects*	*Utility for Assessment*
BT	ENP	Carlson et al.	LCS05/06-DW-13	Angler interviews	Everglades	1978-2002	All (wet and dry seasons)	Number	Recreational	Lo method	None	None			Not recommended, changing species id reporting rate
LCS	SC LL Recent	Cortés	LCS05/06-DW-14	Longline surveys	South Carolina	1995-2001	All	Number	Independent	Lo Method	Length frequency	Juveniles			Usable, need to attempt other LCS definition scenarios
BT	SC LL Recent	Cortés	LCS05/06-DW-14	Longline surveys	South Carolina	1995-2001	All	Number	Independent	Lo Method	Length frequency	0-5			Usable
SB	SC LL Recent	Cortés	LCS05/06-DW-14	Longline surveys	South Carolina	1995-2001	All	Number	Independent	Lo Method	Length frequency	1-12			Usable
LCS	BLLOP	Cortés et al.	LCS05/06-DW-17	Directed shark bottom longline fishery	Eastern Gulf, Mid Atlantic Bight, South Atlantic	1994-2004	All	Number	Commercial	Lo method					Usable, need to attempt calcs for all LCS scenarios
BT	BLLOP	Cortés et al.	LCS05/06-DW-17	Directed shark bottom longline fishery	Eastern Gulf, Mid Atlantic Bight, South Atlantic	1994-2004	All	Number	Commercial	Lo method					Usable after rerunning separately for GOM and Atl
SB	BLLOP	Cortés et al.	LCS05/06-DW-17	Directed shark bottom longline fishery	Eastern Gulf, Mid Atlantic Bight, South Atlantic	1994-2004	All	Number	Commercial	Lo method					Usable
LCS (separate indices for 2 of definition scenarios)	VA LL	Ha & Musick	LCS05/06-DW-20	VIMS Bottom Longline Survey	Virginia	1974-2004	Summer	Number	Independent	Transformed data, GAM model	Length frequency	None			Usable, after reanalysis to standardize methods; may be re-analyzed to incorporate additional information
SB	VA LL	Ha and Musick	LCS05/06-DW-20	VIMS Bottom Longline Survey	Virginia	1974-2004	Summer	Number	Independent	Transformed data, GAM model	Length frequency	None			Usable, after reanalysis to standardize methods; may be re-analyzed to incorporate additional information
Sharks	Brannon	Hester	LCS05/06-DW-21	Brannon series	Alabama, North Carolina ?	1986-1991	?	Number	Commercial	Nominal	None	None		Not species specific, not standardized, area unclear	Not recommended
Sharks		Hester and Hudson	LCS05/06-DW-22	Coastal Fishery Logbook	North Atlantic, South Atlantic and Gulf of Mexico	2001-2003	All	Biomass	Commercial	Nominal	None	None	Review of data base/fishing power issues	Short time series	Not recommended; longer time series available from the same data set
Sharks		Hoey et al.	LCS05/06-DW-23	NE Longline Survey	North Atlantic	1961-1993			Independent						Potentially Usable, will be re-analyzed following research recommendations

Species	*Series*	*Author*	*Reference*	*Data Source*	*Area*	*Years*	*Season*	*Biomass/ Number*	*Fishery Type*	*Standardized*	*Selectivity Info*	*Age Range*	*Positive Aspects*	*Negative Aspects*	*Utility for Assessment*
LCS	MS Gillnet	Hoffmayer & Parsons	LCS05/06-DW-24	Gillnet Survey	Mississippi	1998-2005	Spring, Summer, Fall	Number	Independent	Lo method	Length frequency	None		Concurrent changes across age-specific indices suggest common factor(s) not accounted for in standardization	May be usable if reanalysis following research recommendations accounts for concurrent changes
BT	MS Gillnet	Hoffmayer & Parsons	LCS05/06-DW-24	Gillnet Survey	Mississippi	1998-2005	Spring, Summer, Fall	Number	Independent	Lo method	Length frequency	None		Concurrent changes across age-specific indices suggest common factor(s) not accounted for in standardization	May be usable if reanalysis following research recommendations accounts for concurrent changes
BT-YOY	MS Gillnet – Age o	Hoffmayer & Parsons	LCS05/06-DW-24	Gillnet Survey	Mississippi	1998-2005	Spring, Summer, Fall	Number	Independent	Lo method	Length frequency	Age-0		Concurrent changes across age-specific indices suggest common factor(s) not accounted for in standardization	May be usable if reanalysis following research recommendations accounts for concurrent changes
BT - Juvenile	MS Gillnet - juvenile	Hoffmayer & Parsons	LCS05/06-DW-24	Gillnet Survey	Mississippi	1998-2005	Spring, Summer, Fall	Number	Independent	Lo method	Length frequency	Age 1 to 4-5 years		Concurrent changes across age-specific indices suggest common factor(s) not accounted for in standardization	May be usable if reanalysis following research recommendations accounts for concurrent changes
LCS	Jax, Tampa Bay Port Salerno Hudson	Hueter	LCS05/06-DW-25	Multiple Tournaments	Florida	1976-1991	Summer	Number	Recreational	Nominal (sharks per angler)	None	None	Consistent tournament operations, long time series		Some usable as sensitivity
LCS	Crooke LL	Hueter	LCS05/06-DW-25	Crooke data	Florida	1975-1989	?	Number (non-zero catch only)	Commercial	Nominal (sharks per hook)	Length frequency	None	Consistent methods		Usable as sensitivity
BT-YOY	Mote Gillnet-Charlotte Harbor	Hueter et al.	LCS05/06-DW-26	Gillnet Survey	Eastern Gulf (Charlotte Harbor)	1995-2004	May-Sept.	Number	Independent	GLM on log-transformed data	Length frequency	neonate Age-0		Concurrent changes across age-specific indices suggest common factor(s) not accounted for in standardization	May be usable if reanalysis following research recommendations accounts for concurrent changes, should drop 2001 due to red tide
BT-YOY	Mote Gillnet - Yankeetown	Hueter et al.	LCS05/06-DW-26	Gillnet Survey	Eastern Gulf (Yankeetown)	1995-2004	May-Sept.	Number	Independent	GLM on log-transformed data	Length frequency	neonate Age-0		Concurrent changes across age-specific indices suggest common factor(s) not accounted for in standardization	May be usable if reanalysis following research recommendations accounts for concurrent changes
LCS	NMFS LL SE	Ingram et al.	LCS05/06-DW-27	NMFS Bottom Longline Survey	Gulf of Mexico and Atlantic (south of 37° N)	1995-1997, 1999-2004	Summer, Fall	Number	Independent	Lo method	Length frequency	None			Usable

Species	Series	Author	Reference	Data Source	Area	Years	Season	Biomass/ Number	Fishery Type	Standardized	Selectivity Info	Age Range	Positive Aspects	Negative Aspects	Utility for Assessment
LCS (without protected species)	NMFS LL SE	Ingram et al.	LCS05/06-DW-27	NMFS Bottom Longline Survey	Gulf of Mexico and Atlantic (south of 37° N)	1995-1997, 1999-2004	Summer, Fall	Number	Independent	Lo method	Length frequency	None			Usable
LCS (without protected species, sandbar, blacktip)	NMFS LL SE	Ingram et al.	LCS05/06-DW-27	NMFS Bottom Longline Survey	Gulf of Mexico and Atlantic (south of 37° N)	1995-1997, 1999-2004	Summer, Fall	Number	Independent	Lo method	Length frequency	None			Usable
BT	NMFS LL SE	Ingram et al.	LCS05/06-DW-27	NMFS Bottom Longline Survey	Gulf of Mexico	1995-1997, 1999-2004	Summer, Fall	Number	Independent	Lo method	Length frequency	None			Usable
BT	NMFS LL SE	Ingram et al.	LCS05/06-DW-27	NMFS Bottom Longline Survey	Atlantic (south of 37° N)	1995-1997, 1999-2000, 2002, 2004, 2005	Summer, Fall	Number	Independent	Zero-inflated, delta lognormal	Length frequency	None			Usable
SB	NMFS LL SE	Ingram et al.	LCS05/06-DW-27	NMFS Bottom Longline Survey	Gulf of Mexico and Atlantic (south of 37° N)	1995-1997, 1999-2004	Summer, Fall	Number	Independent	Lo method	Length frequency	None			Usable
SB	DE Bay	McCandless	LCS05/06-DW-30	Bottom Longline Survey	Delaware Bay	2001-2005	Summer	Number	Independent	GLM	Length frequency	All juveniles			May be usable if reanalyzed following research recommendations, drop 2002 due to hurricane
SB-YOY	DE Bay – Age 0	McCandless	LCS05/06-DW-30	Bottom Longline Survey	Delaware Bay	2001-2005	Summer	Number	Independent	GLM	Length frequency	YOY			May be usable if reanalyzed following research recommendations
SB-juvenile	DE Bay - juveniles	McCandless	LCS05/06-DW-30	Bottom Longline Survey	Delaware Bay	2001-2005	Summer	Number	Independent	GLM	Length frequency	1+ juveniles			May be usable if reanalyzed following research recommendations, drop 2002 due to hurricane
LCS	Bottom LL Logs	McCarthy and Abercrombie	LCS05/06-DW-31	Coastal Logbook Program	South Atlantic and Gulf of Mexico	1996-2004	All	Biomass	Commercial	Lo method	None	None			Usable after re-analysis following recommendations
BT	Bottom LL Logs	McCarthy and Abercrombie	LCS05/06-DW-31	Coastal Logbook Program	South Atlantic and Gulf of Mexico	1996-2004	All	Biomass	Commercial	Lo method	None	None			Usable after re-analysis following recommendations, separate GOM and Atl

Species	Series	Author	Reference	Data Source	Area	Years	Season	Biomass/ Number	Fishery Type	Standardized	Selectivity Info	Age Range	Positive Aspects	Negative Aspects	Utility for Assessment
SB	Bottom LL Logs	McCarthy and Abercrombie	LCS05/06-DW-31	Coastal Logbook Program	South Atlantic and Gulf of Mexico	1996-2004	All	Biomass	Commercial	Lo method	None	None			Usable after re-analysis following recommendations
LCS	NMFS LL NE	Natanson	LCS05/06-DW-33	NMFS Northeast Bottom Longline Survey	Atlantic	1996, 1998, 2001, 2004	Spring	Number	Independent	Nominal	Length frequency	Age 0 - adult			May be usable, standardization will be attempted as will combining with comparable NE LL data reported in DW-23
BT	NMFS LL NE	Natanson	LCS05/06-DW-33	NMFS Northeast Bottom Longline Survey	Atlantic	1996, 1998, 2001, 2004	Spring	Number	Independent	Nominal	Length frequency	Age 0 - adult			May be usable, standardization will be attempted as will combining with comparable NE LL data reported in DW-23
SB	NMFS LL NE	Natanson	LCS05/06-DW-33	NMFS Northeast Bottom Longline Survey	Atlantic	1996, 1998, 2001, 2004	Spring	Number	Independent	Nominal	Length frequency	Age 0 - adult			May be usable, standardization will be attempted as will combining with comparable NE LL data reported in DW-23
LCS	Pelagic Log	Ortiz	LCS05/06-DW-35	Pelagic Longline Logbook	Atlantic and Gulf of Mexico	1986-2004	All	Number	Commercial	Lo method	None	None			Usable after re-analysis following recommendations, need to attempt calcs for all LCS scenarios
BT	Pelagic Log	Ortiz	LCS05/06-DW-35	Pelagic Longline Logbook	Atlantic and Gulf of Mexico	1992-2004	All	Number	Commercial	Lo method	None	None			Not used if BT assessed separately for GOM and Atl
BT	Pelagic Log	Ortiz	LCS05/06-DW-35	Pelagic Longline Logbook	Atlantic	1992-2004	All	Number	Commercial	Lo method	None	None			Usable after re-analysis following recommendations
BT	Pelagic Log	Ortiz	LCS05/06-DW-35	Pelagic Longline Logbook	Gulf of Mexico	1992-2004	All	Number	Commercial	Lo method	None	None			Usable after re-analysis following recommendations
SB	Pelagic Log	Ortiz	LCS05/06-DW-35	Pelagic Longline Logbook	Atlantic and Gulf of Mexico	1994-2004	All	Number	Commercial	Lo method	None	None			Usable after re-analysis following recommendations
LCS	Weigh-out	Ortiz	LCS05/06-DW-35	Pelagic longline carcass weigh-out data	Atlantic and Gulf of Mexico	1982-2004	All	Biomass	Commercial	Lo method	None	None			Not recommended as landing rates likely influence by factors other than abundance (fishers response to management, etc.)

Species	Series	Author	Reference	Data Source	Area	Years	Season	Biomass/ Number	Fishery Type	Standardized	Selectivity Info	Age Range	Positive Aspects	Negative Aspects	Utility for Assessment
BT	Weigh-out	Ortiz	LCS05/06-DW-35	Pelagic longline carcass weigh-out data	Atlantic and Gulf of Mexico	1983-2004	All	Biomass	Commercial	Lo method	None	None			Not recommended as landing rates likely influence by factors other than abundance (fishers response to management, etc.)
BT	Weigh-out	Ortiz	LCS05/06-DW-35	Pelagic longline carcass weigh-out data	Atlantic	1983-2004	All	Biomass	Commercial	Lo method	None	None			Not recommended as landing rates likely influence by factors other than abundance (fishers response to management, etc.)
BT	Weigh-out	Ortiz	LCS05/06-DW-35	Pelagic longline carcass weigh-out data	Gulf of Mexico	1985-2004	All	Biomass	Commercial	Lo method	None	None			Not recommended as landing rates likely influence by factors other than abundance (fishers response to management, etc.)
LCS	MRFSS	Ortiz	LCS05/06-DW-36	MRFSS	Louisiana-Maine	1981-2004	All	Number	Recreational	Lo method	Length frequency (available TBD)	None			Usable, need to attempt calcs for all LCS scenarios
BT	MRFSS	Ortiz	LCS05/06-DW-36	MRFSS	Louisiana-Florida (GOM)	1981-2004	All	Number	Recreational	Lo method	Length frequency (available TBD)	None			Usable
BT	MRFSS	Ortiz	LCS05/06-DW-36	MRFSS	Florida-Maine (Atlantic)	1981-2004	All	Number	Recreational	Lo method	Length frequency (available TBD)	None			Usable
SB	MRFSS	Ortiz	LCS05/06-DW-36	MRFSS	Louisiana-Maine	1981-2004	All	Number	Recreational	Lo method	Length frequency (available TBD)	None			Usable
Sharks	Charterboat	Scott & Lacey	LCS05/06-DW-41	Charterboat	Texas-North Carolina	1989-1995	?	Number	Recreational	Lo method	None	None		Not species specific, may include high proportion of pelagics	Not recommended absent further information that it is relevant to LCS
BT	Mote DL	Simpfendorfer et al.	LCS05/06-DW-43	Drumline Survey	Eastern Gulf	2001-2004	All	Number	Independent	Nominal	Length frequency	Older juveniles-adults	Standardized stations/methodology		
BT	Mote LL	Simpfendorfer et al.	LCS05/06-DW-43	Longline Survey	Eastern Gulf	2002-2004	All	Number	Independent	Nominal	Length frequency	Older juveniles-adults	Standardized stations/methodology		
SB	Mote DL	Simpfendorfer et al.	LCS05/06-DW-43	Drumline Survey	Eastern Gulf	2002-2004	All	Number	Independent	Nominal	Length frequency	Older juveniles-adults	Standardized stations/methodology		
SB	Mote LL	Simpfendorfer et al.	LCS05/06-DW-43	Longline Survey	Eastern Gulf	2002-2004	All	Number	Independent	Nominal	Length frequency	Older juveniles-adults	Standardized stations/methodology		
LCS	SC LL Early	Ulrich	LCS05/06-DW-45	Longline survey	South Carolina	1983-1984, 1993-1995	All	Number	Independent	nominal	Length frequency		Historical, consistent methodology		Usable

Table 3.2 Available catch rates series for the large coastal shark complex (3 scenarios) , sandbar, and blacktip shark. The index is the relative (divided by the overall mean) estimated mean CPUE and the CV is the estimated precision of the mean value. Type refers to whether the index is fishery – independent (FI) or fishery-dependent (FD), recreational (R) or commercial (C). Observations with a CV of 1.0 are nominal data for which no measure of the precision of the estimate was available. Recommendation refers to the recommendation by the Indices Working Group to include the particular index as a base index (Base), use it for sensitivity runs (Sensitivity) or not recommended for use in the assessment (NR).

Original LCS Definition (22 species)

Document Number	Series Name	Type	Recommendation	Year	Index	CV
LCS05/06-DW-01	NC #	FD - C	NR	1988	0.758	0.422
				1989	1.242	0.232
LCS05/06-DW-11	Gillnet Observer	FD - C	Base	1993	0.338	1.026
				1994	1.050	0.132
				1995	0.299	0.779
				1998	1.088	0.177
				1999	1.336	0.079
				2000	1.239	0.073
				2001	1.179	0.070
				2002	1.077	0.116
				2003	1.112	0.150
				2004	1.281	0.082
LCS05/06-DW-12	PC Longline	FI	Sensitivity	1993	0.816	0.730
				1994	0.386	0.894
				1995	1.272	0.610
				1996	0.858	0.583
				1997	0.926	0.539
				1998	0.725	0.967
				1999	1.174	0.564
				2000	1.844	0.508
LCS05/06-DW-12	PC Gillnet	FI	Base	1996	0.511	0.241
				1997	1.637	0.132
				1998	0.607	0.310
				1999	0.969	0.297
				2000	0.811	0.326
				2001	1.549	0.211
				2002	0.936	0.201
				2003	1.072	0.186
				2004	0.908	0.220
LCS05/06-DW-13	ENP	FD - R	Base	1972	0.598	0.255
				1973	1.575	0.085

				1974	0.985	0.093
				1975	1.987	0.066
				1976	1.165	0.094
				1977	1.409	0.079
				1978	1.126	0.094
				1979	1.114	0.123
				1980	1.469	0.079
				1981	1.001	0.080
				1982	1.099	0.081
				1983	1.368	0.068
				1984	1.279	0.066
				1985	1.071	0.074
				1986	0.921	0.070
				1987	0.942	0.080
				1988	0.993	0.099
				1989	0.604	0.127
				1990	0.548	0.098
				1991	0.504	0.113
				1992	0.910	0.089
				1993	0.523	0.105
				1994	0.911	0.070
				1995	0.762	0.091
				1996	0.900	0.070
				1997	0.922	0.066
				1998	0.855	0.078
				1999	0.753	0.085
				2000	0.966	0.076
				2001	0.838	0.083
				2002	0.900	0.087
LCS05/06-DW-14	SC LL Recent	FI	Base	1995	0.813	0.359
				1996	0.692	0.257
				1997	1.367	0.183
				1998	0.853	0.194
				1999	1.295	0.148
				2000	1.112	0.169
				2001	0.868	0.216
LCS05/06-DW-17	BLLOP	FD - C	Base	1994	0.669	0.335
				1995	0.901	0.219
				1996	0.907	0.143
				1997	0.894	0.287
				1998	1.134	0.178
				1999	1.084	0.280
				2000	1.027	0.363
				2001	0.929	0.299
				2002	1.269	0.265
				2003	1.214	0.188
				2004	0.971	0.187

LCS05/06-DW-20	VA LL	FI	Base	1975	2.508	0.307
				1977	1.994	0.344
				1978	0.975	1.006
				1980	2.063	0.246
				1981	1.795	0.237
				1984	0.658	1.611
				1986	0.612	2.715
				1989	0.790	0.526
				1990	0.815	0.437
				1991	0.702	0.524
				1992	1.231	0.560
				1993	0.794	0.619
				1995	0.811	0.448
				1996	0.766	0.406
				1997	0.753	0.276
				1998	0.737	0.318
				1999	0.710	0.437
				2000	0.777	0.365
				2001	0.737	0.356
				2002	0.685	0.509
				2003	0.546	0.373
				2004	0.541	0.514
LCS05/06-DW-21	Bannon	FD - C	NR	1986	0.657	1
				1987	1.348	1
	* nominal index			1988	1.146	1
				1989	0.833	1
				1990	0.994	1
				1991	1.020	1
LCS05/06-DW-24	MS Gillnet	FI	Sensitivity	1998	0.566	0.528
				1999	0.337	0.574
				2000	1.981	0.421
				2001	0.576	0.717
				2003	0.399	0.741
				2004	0.472	0.598
				2005	2.670	0.455
LCS05/06-DW-25	Hudson	FD - R	NR	1985	0.220	1
				1986	0.100	1
	* nominal index			1987	0.120	1
				1988	0.100	1
				1989	0.050	1
				1990	0.020	1
				1991	0.020	1
LCS05/06-DW-25	Jax	FD - R	NR	1979	0.590	1
				1984	0.710	1
	* nominal index			1990	0.160	1

LCS05/06-DW-25	Tampa Bay	FD - R	NR	1985	0.160	1
				1986	0.090	1
	* nominal index			1987	0.030	1
				1988	0.140	1
				1989	0.060	1
				1990	0.050	1
LCS05/06-DW-25	Port Salerno	FD - R	Sensitivity	1976	0.180	1
				1977	0.810	1
	* nominal index			1979	0.890	1
				1980	0.820	1
				1981	0.390	1
				1982	0.500	1
				1983	0.120	1
				1984	0.100	1
				1985	0.150	1
				1986	0.500	1
				1987	0.320	1
				1988	0.200	1
				1989	0.120	1
				1990	0.200	1
LCS05/06-DW-25	Crooke LL	FD - C	Sensitivity	1975	0.882	1
				1976	0.642	1
				1977	1.043	1
				1978	2.005	1
				1979	0.963	1
				1980	1.283	1
				1981	1.043	1
				1982	1.043	1
				1983	1.123	1
				1984	0.963	1
				1985	1.123	1
				1986	0.882	1
				1987	0.642	1
				1988	0.642	1
				1989	0.722	1
LCS05/06-DW-27	NMFS LL SE	FI	Base	1995	0.849	0.135
				1996	0.449	0.200
				1997	0.626	0.128
				1999	0.499	0.150
				2000	1.042	0.083
				2001	1.120	0.106
				2002	1.220	0.080
				2003	1.846	0.105
				2004	1.349	0.107
LCS05/06-DW-31	Bottom LL Logs	FD - C	Base	1996	0.615	0.164
				1997	0.945	0.103

				1998	0.848	0.099
				1999	1.210	0.090
				2000	1.204	0.098
				2001	1.146	0.095
				2002	0.958	0.092
				2003	1.231	0.089
				2004	0.844	0.103
LCS05/06-DW-33	NMFS LL NE	FI	Base	1996	0.232	0.263
				1998	1.609	0.124
				2001	1.051	0.141
				2004	1.108	0.147
LCS05/06-DW-35	Pelagic Log	FD - C	Base	1992	2.007	0.290
				1993	1.487	0.310
				1994	1.330	0.310
				1995	1.048	0.320
				1996	1.351	0.310
				1997	0.741	0.330
				1998	0.537	0.360
				1999	0.634	0.350
				2000	0.805	0.340
				2001	0.681	0.350
				2002	0.790	0.330
				2003	0.745	0.340
				2004	0.846	0.330
LCS05/06-DW-36	MRFSS - excluding requiem	FD - R	Sensitivity	1981	1.505	0.357
				1982	1.298	0.337
				1983	1.948	0.332
				1984	1.597	0.345
				1985	1.608	0.331
				1986	1.722	0.315
				1987	1.102	0.321
				1988	0.952	0.325
				1989	0.747	0.334
				1990	0.762	0.333
				1991	0.81	0.327
				1992	0.887	0.316
				1993	0.672	0.326
				1994	0.707	0.324
				1995	0.848	0.321
				1996	0.803	0.322
				1997	0.726	0.327
				1998	1.003	0.314
				1999	0.663	0.322
				2000	0.805	0.318
				2001	0.794	0.319
				2002	0.782	0.319
				2003	0.813	0.319

				2004	0.448	0.336
LCS05/06-DW-36	MRFSS - including requiem	FD - R	Sensitivity	1981	1.002	0.350
				1982	1.139	0.316
				1983	1.359	0.319
				1984	1.115	0.332
				1985	1.086	0.319
				1986	1.241	0.299
				1987	0.940	0.305
				1988	0.812	0.311
				1989	0.530	0.328
				1990	0.519	0.328
				1991	0.528	0.322
				1992	0.665	0.304
				1993	0.685	0.307
				1994	0.883	0.298
				1995	0.998	0.296
				1996	0.900	0.300
				1997	0.899	0.301
				1998	1.077	0.292
				1999	0.929	0.295
				2000	1.136	0.291
				2001	1.238	0.289
				2002	1.348	0.286
				2003	1.513	0.286
				2004	1.462	0.288
LCS05/06-DW-41	Charterboat	FD - C	NR	1989	1.145	0.469
				1990	1.031	0.125
				1991	1.080	0.121
				1992	0.837	0.118
				1993	0.945	0.125
				1994	0.928	0.156
				1995	1.036	0.152
LCS05/06-DW-45	SC LL Early	FI	Base	1984	1.79251	1
				1994	0.70317	1
				1995	0.50432	1

LCS minus prohibited species (11 species)

Document Number	Series Name	Type	Recommendation	Year	Index	CV
LCS05/06-DW-11	Gillnet Observer	FD - C	Base	1993	0.338	1.026
				1994	1.05	0.132
				1995	0.299	0.779
				1998	1.088	0.177
				1999	1.336	0.079
				2000	1.239	0.073
				2001	1.179	0.07
				2002	1.077	0.116
				2003	1.112	0.15
				2004	1.281	0.082
LCS05/06-DW-12	PC Longline	FI	Sensitivity	1993	0.816	0.730
				1994	0.386	0.894
				1995	1.272	0.610
				1996	0.858	0.583
				1997	0.926	0.539
				1998	0.725	0.967
				1999	1.174	0.564
				2000	1.844	0.508
LCS05/06-DW-12	PC Gillnet	FI	Base	1996	0.511	0.241
				1997	1.637	0.132
				1998	0.607	0.310
				1999	0.969	0.297
				2000	0.811	0.326
				2001	1.549	0.211
				2002	0.936	0.201
				2003	1.072	0.186
				2004	0.908	0.220
LCS05/06-DW-17	BLLOP	FD - C	Base	1994	0.676	0.238
				1995	0.972	0.172
				1996	0.907	0.153
				1997	0.774	0.295
				1998	1.113	0.172
				1999	1.108	0.253
				2000	1.168	0.333
				2001	0.926	0.242
				2002	1.187	0.160
				2003	1.206	0.131
				2004	0.962	0.150
LCS05/06-DW-24	MS Gillnet	FI	Sensitivity	1998	0.566	0.528
				1999	0.337	0.574

				2000	1.981	0.421
				2001	0.576	0.717
				2003	0.399	0.741
				2004	0.472	0.598
				2005	2.670	0.455
LCS05/06-DW-27	NMFS LL SE	FI	Base	1995	0.848	0.135
				1996	0.438	0.203
				1997	0.628	0.128
				1999	0.501	0.150
				2000	1.044	0.083
				2001	1.127	0.106
				2002	1.207	0.080
				2003	1.850	0.105
				2004	1.356	0.107
LCS05/06-DW-31	Bottom LL Logs	FD - C	Base	1996	0.574	0.152
				1997	0.927	0.110
				1998	0.839	0.103
				1999	1.103	0.092
				2000	1.188	0.101
				2001	1.165	0.099
				2002	1.011	0.097
				2003	1.287	0.094
				2004	0.907	0.107
LCS05/06-DW-33	NMFS LL NE	FI	Base	1996	0.258	2.973
				1998	1.750	0.578
				2001	1.037	0.880
				2004	0.955	0.953
LCS05/06-DW-35	Pelagic Log	FD - C	Base	1992	1.672	0.310
				1993	1.299	0.320
				1994	1.265	0.320
				1995	1.057	0.330
				1996	1.280	0.320
				1997	0.752	0.340
				1998	0.571	0.360
				1999	0.626	0.360
				2000	0.890	0.340
				2001	0.764	0.350
				2002	0.940	0.340
				2003	0.914	0.340
				2004	0.970	0.340
LCS05/06-DW-36	MRFSS - excluding requiem	FD - R	Sensitivity	1981	1.807	0.600
				1982	1.820	0.543
				1983	2.571	0.547
				1984	2.468	0.558
				1985	1.895	0.544

				1986	2.453	0.510
				1987	1.165	0.536
				1988	0.953	0.540
				1989	0.742	0.563
				1990	0.552	0.600
				1991	0.563	0.574
				1992	0.913	0.532
				1993	0.384	0.573
				1994	0.220	0.633
				1995	0.581	0.545
				1996	0.721	0.535
				1997	0.656	0.563
				1998	0.876	0.538
				1999	0.553	0.548
				2000	0.498	0.568
				2001	0.520	0.558
				2002	0.493	0.561
				2003	0.407	0.597
				2004	0.189	0.663
LCS05/06-DW-36	MRFSS - including requiem	FD - R	Sensitivity	1981	0.884	0.37
				1982	1.097	0.325
				1983	1.301	0.328
				1984	1.071	0.341
				1985	1.063	0.327
				1986	1.256	0.305
				1987	0.908	0.312
				1988	0.789	0.318
				1989	0.498	0.34
				1990	0.533	0.336
				1991	0.494	0.334
				1992	0.641	0.312
				1993	0.699	0.312
				1994	0.879	0.304
				1995	1.033	0.301
				1996	0.903	0.305
				1997	0.908	0.307
				1998	1.102	0.297
				1999	0.953	0.3
				2000	1.149	0.296
				2001	1.297	0.293
				2002	1.423	0.291
				2003	1.579	0.29
				2004	1.541	0.292

LCS minus prohibited species, blacktip, and sandbar sharks (9 species)

Document Number	Series Name	Type	Recommendation	Year	Index	CV
LCS05/06-DW-11	Gillnet Observer	FD - C	Base	1993	0.754	0.546
				1994	0.918	0.150
				1995	0.537	0.494
				1998	1.037	0.269
				1999	1.203	0.107
				2000	1.246	0.094
				2001	1.167	0.087
				2002	1.092	0.121
				2003	0.952	0.202
				2004	1.094	0.141
LCS05/06-DW-12	PC Gillnet	FI	Base	1996	0.328	0.532
				1997	1.197	0.272
				1998	0.521	0.494
				1999	0.973	0.463
				2000	1.112	0.411
				2001	1.682	0.309
				2002	1.129	0.280
				2003	1.022	0.276
				2004	1.034	0.314
LCS05/06-DW-17	BLLOP	FD - C	Base	1994	0.614	0.298
				1995	0.756	0.278
				1996	0.810	0.281
				1997	0.903	0.291
				1998	1.298	0.257
				1999	1.067	0.286
				2000	1.056	0.313
				2001	0.983	0.278
				2002	1.478	0.278
				2003	0.959	0.281
				2004	1.078	0.273
LCS05/06-DW-27	NMFS LL SE	FI	Base	1995	0.946	0.152
				1996	0.381	0.236
				1997	0.608	0.145
				1999	0.508	0.186
				2000	1.176	0.092
				2001	1.108	0.125
				2002	1.187	0.095
				2003	1.746	0.132
				2004	1.341	0.120
LCS05/06-DW-31	Bottom LL Logs	FD - C	Base	1996	0.709	0.266

				1997	0.680	0.199
				1998	0.626	0.199
				1999	1.170	0.167
				2000	1.044	0.184
				2001	1.095	0.176
				2002	1.490	0.175
				2003	1.286	0.167
				2004	0.900	0.225
LCS05/06-DW-33	NMFS LL NE	FI	Base	1996	0.212	6.866
				1998	1.127	1.735
				2001	1.282	1.292
				2004	1.379	1.244
LCS05/06-DW-35	Pelagic Log	FD - C	Base	1992	1.814	0.250
				1993	1.298	0.260
				1994	1.431	0.260
				1995	0.962	0.270
				1996	1.030	0.260
				1997	0.648	0.270
				1998	0.592	0.280
				1999	0.763	0.270
				2000	0.906	0.270
				2001	0.749	0.270
				2002	0.858	0.270
				2003	0.915	0.270
				2004	1.035	0.270

Blacktip - Gulf of Mexico

Document Number	Series Name	Type	Recommendation	Year	Index	CV
LCS05/06-DW-12	PC Longline	FI	Sensitivity	1993	0.768	1.288
				1994	0.133	3.244
				1995	1.018	1.244
				1996	0.758	1.087
				1997	1.299	0.704
				1998	0.974	1.328
				1999	1.136	1.011
				2000	1.914	0.92
LCS05/06-DW-12	PC Gillnet	FI	Base	1996	0.695	0.475
				1997	1.397	0.287
				1998	0.565	0.451
				1999	1.209	0.359
				2000	0.769	0.484
				2001	1.583	0.286
				2002	0.872	0.283
				2003	0.909	0.283
				2004	1.001	0.307
LCS05/06-DW-12	PC Gillnet - juveniles	FI	Base	1996	0.980	0.427
				1997	1.513	0.279
				1998	0.639	0.455
				1999	1.068	0.412
				2000	0.649	0.632
				2001	1.408	0.312
				2002	0.854	0.305
				2003	0.790	0.318
				2004	1.098	0.294
LCS05/06-DW-12	PC Gillnet - Age 0	FI	Base	1996	0.152	1.063
				1997	0.782	0.397
				1998	0.654	0.586
				1999	2.101	0.388
				2000	0.676	0.737
				2001	2.130	0.35
				2002	1.260	0.293
				2003	1.012	0.334
				2004	0.232	0.823
LCS05/06-DW-17	BLLOP	FD - C	Base	1994	0.430	1.666
				1995	0.817	0.855
				1996	0.724	1.215
				1997	0.588	2.248
				1998	0.796	1.620

				1999	1.055	1.270
				2001	0.162	9.019
				2002	2.062	0.496
				2003	1.542	0.509
				2004	1.824	0.401
LCS05/06-DW-24	MS Gillnet	FI	Sensitivity	1998	0.584	0.572
				1999	0.352	0.590
				2000	2.771	0.404
				2001	0.565	0.717
				2003	0.374	0.751
				2004	0.413	0.624
				2005	1.940	0.491
LCS05/06-DW-24	MS Gillnet - juveniles	FI	Sensitivity	1998	0.835	0.683
				1999	0.412	0.887
				2000	2.655	0.336
				2001	0.409	1.892
				2003	0.092	1.722
				2004	0.198	1.443
				2005	2.398	0.791
LCS05/06-DW-24	MS Gillnet - Age 0	FI	Sensitivity	1998	0.200	0.684
				1999	0.245	1.011
				2000	3.136	0.556
				2001	0.302	1.633
				2003	0.660	0.764
				2004	0.134	1.177
				2005	2.323	0.982
LCS05/06-DW-26	Mote Gillnet - Yankeetown	FI	Sensitivity	1995	0.578	1.287
				1996	1.564	0.910
				1997	1.299	1.186
				1999	0.541	1.368
				2000	0.530	1.836
				2001	0.966	1.521
				2002	0.823	1.463
				2003	1.126	1.256
				2004	1.574	0.994
LCS05/06-DW-26	Mote Gillnet - Charlotte Harbor	FI	Sensitivity	1995	1.143	1.273
				1997	0.444	2.328
				1999	0.901	1.358
				2000	1.851	0.944
				2002	1.502	1.147
				2003	0.564	1.885

				2004	0.595	1.498
LCS05/06-DW-27	NMFS LL SE	FI	Base	1995	0.554	0.682
				1996	0.380	0.788
				1997	0.409	0.634
				1999	0.341	0.630
				2000	1.517	0.327
				2001	0.898	0.353
				2002	1.436	0.327
				2003	2.237	0.242
				2004	1.228	0.307
LCS05/06-DW-31	Bottom LL Logs	FD - C	Base	1996	0.249	0.362
				1997	0.931	0.236
				1998	0.334	0.247
				1999	1.506	0.219
				2000	0.883	0.240
				2001	0.985	0.225
				2002	1.078	0.210
				2003	1.967	0.199
				2004	1.068	0.232
LCS05/06-DW-35	Pelagic Log	FD - C	Base	1992	2.240	0.540
				1993	1.541	0.590
				1994	2.358	0.570
				1995	1.572	0.590
				1996	0.838	0.630
				1997	0.924	0.630
				1998	0.808	0.660
				1999	0.364	0.790
				2000	0.706	0.680
				2001	0.689	0.690
				2002	0.484	0.760
				2003	0.328	0.790
				2004	0.149	1.090
LCS05/06-DW-36	MRFSS	FD - R	Sensitivity	1981	1.358	0.565
				1982	0.325	0.557
				1983	1.130	0.555
				1984	0.673	0.553
				1985	0.816	0.505
				1986	1.452	0.406
				1987	0.636	0.441
				1988	1.319	0.400
				1989	1.186	0.436
				1990	1.318	0.428
				1991	1.477	0.419
				1992	0.877	0.391
				1993	0.772	0.418
				1994	0.726	0.409

1995	1.027	0.409
1996	1.159	0.403
1997	1.090	0.401
1998	1.471	0.372
1999	0.737	0.382
2000	1.259	0.370
2001	0.661	0.390
2002	0.719	0.381
2003	1.064	0.378
2004	0.747	0.387

Blacktip Shark - Atlantic

Document Number	Series Name	Type	Recommendation	Year	Index	CV
LCS05/06-DW-11	Gillnet Observer	FD - C	Base	1993	0.455	0.888
				1994	0.955	0.174
				1995	0.419	0.681
				1998	1.286	0.164
				1999	1.384	0.081
				2000	1.286	0.068
				2001	1.001	0.098
				2002	0.982	0.145
				2003	1.029	0.187
				2004	1.204	0.122
LCS05/06-DW-14	SC LL Recent	FI	Sensitivity	1995	1.750	0.384
				1996	0.808	0.437
				1997	2.094	0.276
				1998	0.487	0.525
				1999	0.482	0.652
				2000	1.147	0.291
				2001	0.232	1.123
LCS05/06-DW-17	BLLOP	FD - C	Base	1994	0.805	2.423
				1995	2.042	0.854
				1996	1.246	1.640
				1997	0.131	9.878
				1998	0.534	3.352
				1999	0.426	3.775
				2000	0.153	8.354
				2001	0.971	2.814
				2002	4.578	0.012
				2003	0.004	39.339
				2004	0.111	6.517
LCS05/06-DW-27	NMFS LL SE	FI	NR	1995	0	
				1996	0.453	4.403
				1997	0.244	2.725
				1999	0.811	1.706
				2000	0	
				2002	2.748	0.649
				2004	0.745	3.586
				2005	0	
LCS05/06-DW-31	Bottom LL Logs	FD - C	Base	1996	0.678	0.370
				1997	0.474	0.512
				1998	0.689	0.352
				1999	0.423	0.459

				2000	1.005	0.371
				2001	1.620	0.327
				2002	1.948	0.264
				2003	1.081	0.333
				2004	1.083	0.447
LCS05/06-DW-33	NMFS LL NE	FI	Sensitivity	1996	0.202	49.744
				1998	1.578	8.270
				2001	0.797	14.861
				2004	1.423	9.114
LCS05/06-DW-35	Pelagic Log	FD - C	Base	1992	2.970	0.650
				1993	2.272	0.700
				1994	1.960	0.720
				1995	0.975	0.910
				1996	0.987	0.910
				1997	0.710	1.050
				1998	0.481	1.260
				1999	0.504	1.260
				2000	0.363	1.470
				2001	0.286	1.660
				2002	0.362	1.510
				2003	0.452	1.360
				2004	0.678	1.150
LCS05/06-DW-36	MRFSS	FD - R	Sensitivity	1981	1.046	1.023
				1982	0.531	0.787
				1983	1.186	0.718
				1984	1.145	0.747
				1985	1.285	0.621
				1986	1.427	0.577
				1987	0.755	0.637
				1988	0.578	0.681
				1989	0.567	0.684
				1990	0.421	0.755
				1991	0.748	0.627
				1992	1.243	0.545
				1993	0.523	0.687
				1994	2.264	0.511
				1995	1.039	0.577
				1996	0.986	0.577
				1997	0.515	0.660
				1998	1.183	0.546
				1999	0.536	0.633
				2000	0.877	0.583
				2001	1.730	0.529
				2002	1.196	0.550
				2003	1.249	0.560
				2004	0.969	0.585

Sandbar

Document Number	Series Name	Type	Recommendation	Year	Index	CV
LCS05/06-DW-09	LPS	FD - R	Base	1986	3.557	0.173
				1987	0.859	0.323
				1988	2.326	0.209
				1989	3.204	0.136
				1990	1.008	0.247
				1991	2.327	0.264
				1992	1.382	0.233
				1993	0.739	0.872
				1994	0.378	0.755
				1995	0.302	1.255
				1996	0.369	1.092
				1997	0.530	0.834
				1998	0.124	2.138
				1999	0.202	1.994
				2000	0.213	1.990
				2001	0.986	1.064
				2002	0.236	1.721
				2003	0.181	1.663
				2004	0.076	2.136
LCS05/06-DW-12	PC Gillnet	FI	Sensitivity	1996	1.00*	1.667
				1997	2.250	2.963
	* nominal index			1998	1.220	4.773
				1999	0.530	6.789
				2000	0.690	7.200
				2001	1.250	6.667
				2002	0.610	7.273
				2003	0.970	5.429
				2004	0.470	7.588
LCS05/06-DW-14	SC LL Recent	FI	Sensitivity	1995	0.458	1.049
				1996	0.964	0.446
				1997	0.643	0.576
				1998	0.750	0.377
				1999	2.547	0.207
				2000	0.666	0.396
				2001	0.972	0.344
LCS05/06-DW-17	BLLOP	FD - C	Base	1994	0.799	1.027
				1995	0.882	0.832
				1996	1.000	0.843
				1997	0.956	1.182
				1998	1.292	1.391
				1999	0.849	1.529

				2000	0.744	2.009
				2001	1.650	1.600
				2002	0.865	1.266
				2003	1.007	0.902
				2004	0.955	0.976
LCS05/06-DW-20	VA LL	FI	Base	1975	1.900	0.23271
				1977	2.077	0.28711
				1978	1.085	0.58275
				1980	1.995	0.20558
				1981	1.925	0.21419
				1984	0.647	1.01363
				1986	0.665	1.08966
				1989	0.911	0.35817
				1990	0.746	0.29514
				1991	0.788	0.30447
				1992	1.331	0.46767
				1993	0.915	0.40248
				1995	0.860	0.26193
				1996	0.770	0.27439
				1997	0.721	0.22527
				1998	0.826	0.20952
				1999	0.528	0.36478
				2000	0.865	0.28108
				2001	0.754	0.23611
				2002	0.626	0.34985
				2003	0.547	0.26489
				2004	0.519	0.37114
LCS05/06-DW-27	NMFS LL SE	FI	Base	1995	1.293	0.281
				1996	0.831	0.379
				1997	1.301	0.316
				1999	0.390	0.384
				2000	0.971	0.210
				2001	1.041	0.256
				2002	1.072	0.207
				2003	0.880	0.261
				2004	1.221	0.322
LCS05/06-DW-30	DE Bay	FI	Base	2001	0.950	0.205
				2002	0.386	0.332
				2003	1.409	0.182
				2004	1.070	0.212
				2005	1.185	0.212
LCS05/06-DW-30	DE Bay - Age 0	FI	Base	2001	0.645	0.373
				2002	0.518	0.442
				2003	1.776	0.272
				2004	0.877	0.357
				2005	1.183	0.311

LCS05/06-DW-30	DE Bay - juveniles	FI	Base	2001	1.162	0.184
				2002	0.325	0.377
				2003	1.163	0.194
				2004	1.164	0.207
				2005	1.185	0.199
LCS05/06-DW-31	Bottom LL Logs	FD - C	Base	1996	0.789	0.175
				1997	1.002	0.116
				1998	0.919	0.111
				1999	1.150	0.102
				2000	1.171	0.111
				2001	1.115	0.104
				2002	0.887	0.104
				2003	1.170	0.102
				2004	0.798	0.119
LCS05/06-DW-33	NMFS LL NE	FI	Base	1996	0.321	7.985
				1998	2.045	1.678
				2001	1.004	2.947
				2004	0.629	4.909
LCS05/06-DW-35	Pelagic Log	FD - C	Base	1994	0.083	1.270
				1995	0.854	0.650
				1996	2.050	0.600
				1997	0.770	0.660
				1998	0.883	0.660
				1999	1.024	0.670
				2000	1.167	0.660
				2001	1.032	0.670
				2002	0.707	0.690
				2003	0.872	0.690
				2004	1.557	0.650
LCS05/06-DW-36	MRFSS	FD - R	Sensitivity	1981	2.011	0.645
				1982	2.195	0.592
				1983	2.766	0.592
				1984	2.408	0.610
				1985	2.094	0.591
				1986	2.119	0.560
				1987	1.167	0.594
				1988	0.789	0.621
				1989	0.714	0.639
				1990	0.634	0.674
				1991	0.431	0.679
				1992	0.874	0.600
				1993	0.402	0.679
				1994	0.243	0.776
				1995	0.492	0.643
				1996	0.612	0.617

1997	0.504	0.663
1998	0.917	0.603
1999	0.524	0.639
2000	0.525	0.660
2001	0.503	0.651
2002	0.490	0.656
2003	0.386	0.714
2004	0.201	0.836

Table 3.3. Indices recommended as base case indices.

LCS*	Blacktip - Gulf of Mexico	Blacktip - Atlantic	Sandbar
Gillnet Observer	PC Gillnet	Gillnet Observer	LPS
PC Gillnet	PC Gillnet - Juveniles	BLLOP	BLLOP
ENP	PC Gillnet - Age 0	Bottom LL Logs	VA LL
SC LL Recent	BLLOP	Pelagic Log	NMFS LL SE
BLLOP	NMFS LL SE		DE Bay
VA LL	Bottom LL Logs		DE Bay - Age 0
NMFS LL SE	Pelagic Log		DE Bay - Juveniles
Bottom LL Logs			Bottom LL Logs
NMFS LL NE			NMFS LL NE
Pelagic Log			Pelagic Log
SC LL Early			

*3 scenarios

Table 3.4. Indices recommended for use in sensitivity runs.

LCS*	Blacktip - Gulf of Mexico	Blacktip - Atlantic	Sandbar
PC LL	PC LL	SC LL Recent	PC Gillnet
MS Gillnet	MS Gillnet	NMFS LL NE	SC LL Recent
Port Salerno	MS Gillnet - Juveniles	MRFSS	MRFSS
Crooke LL	MS Gillnet - Age 0		
MRFSS - excluding requiem group	MRFSS		
MRFSS - including requiem group	Mote Gillnet - Yankeetown		
	Mote Gillnet - Charlotte Harbor		

*3 scenarios

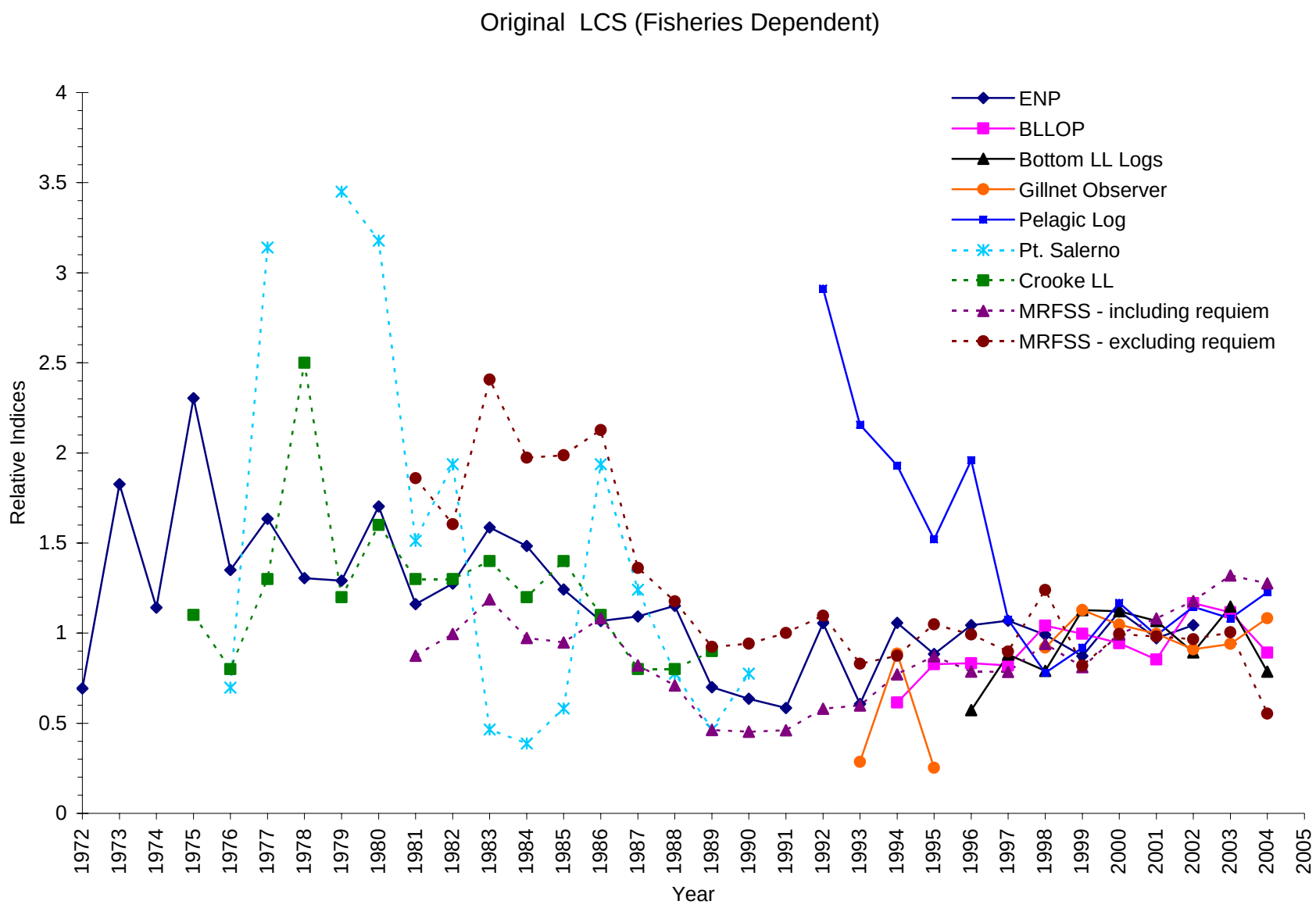

Figure 3.1. Fishery dependent catch rate series for the original large coastal shark complex containing 22 species. Solid lines indicate base case indices while dashed lines are for series to be used in sensitivity analysis. Series are scaled (each series is divided by the mean of the years within that series which overlap between all series) to appear on a common scale.

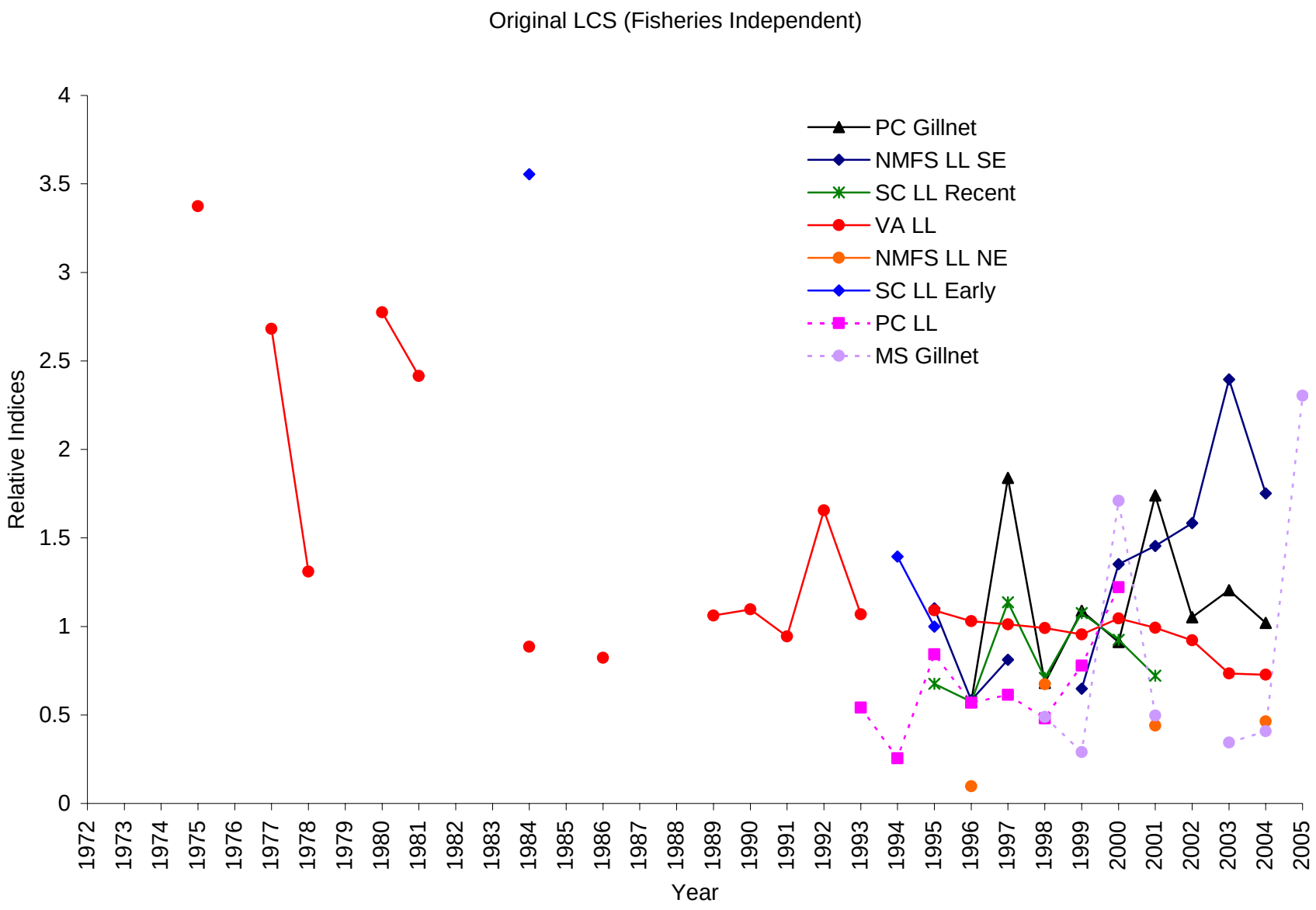

Figure 3.2. Fishery independent catch rate series for the original large coastal shark complex containing 22 species. Solid lines indicate base case indices while dashed lines are for series to be used in sensitivity analysis. Series are scaled (each series is divided by the mean of the years within that series which overlap between all series) to appear on a common scale.

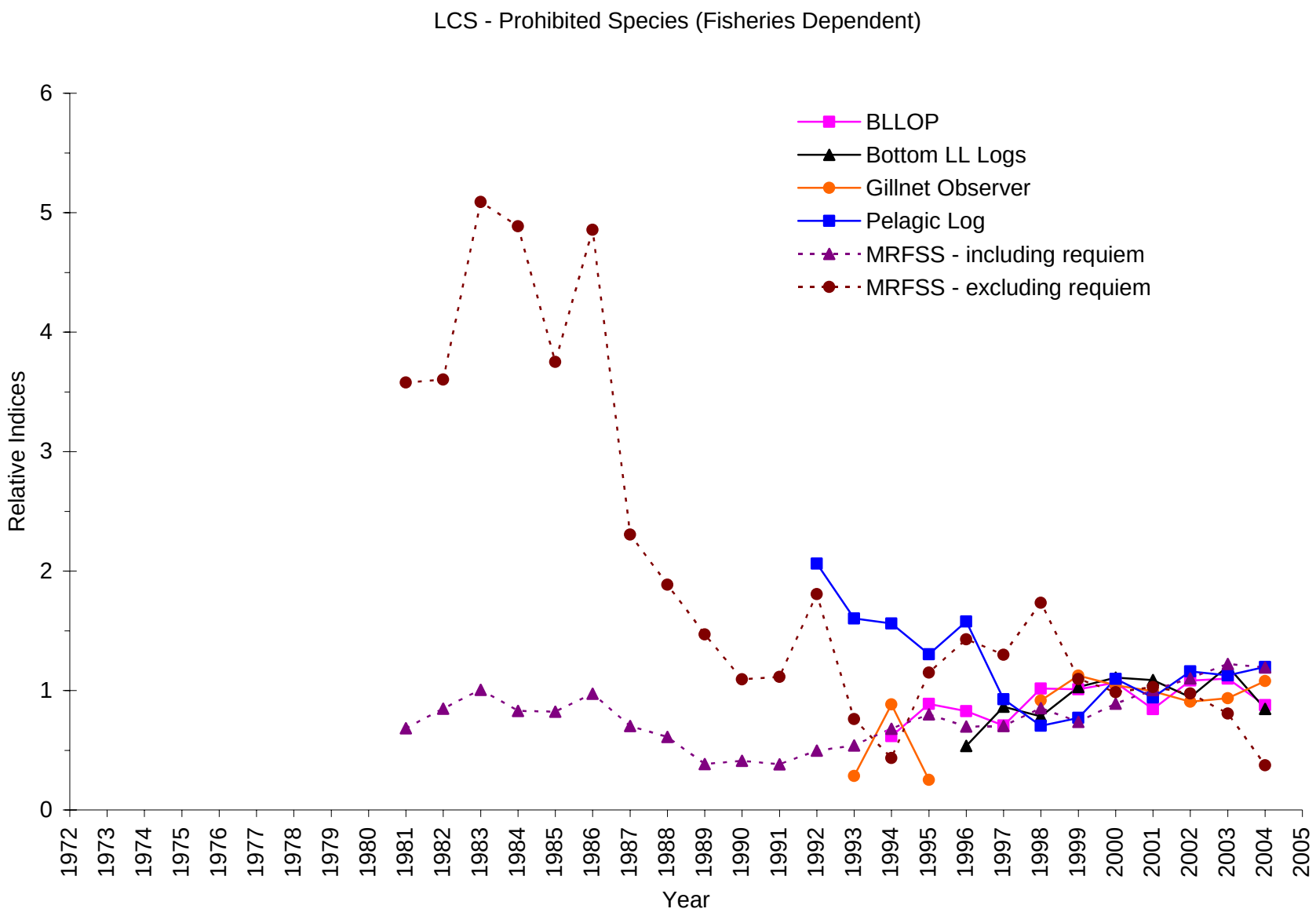

Figure 3.3. Fishery dependent catch rate series for the large coastal shark complex minus prohibited species (11 species). Solid lines indicate base case indices while dashed lines are for series to be used in sensitivity analysis. Series are scaled (each series is divided by the mean of the years within that series which overlap between all series) to appear on a common scale.

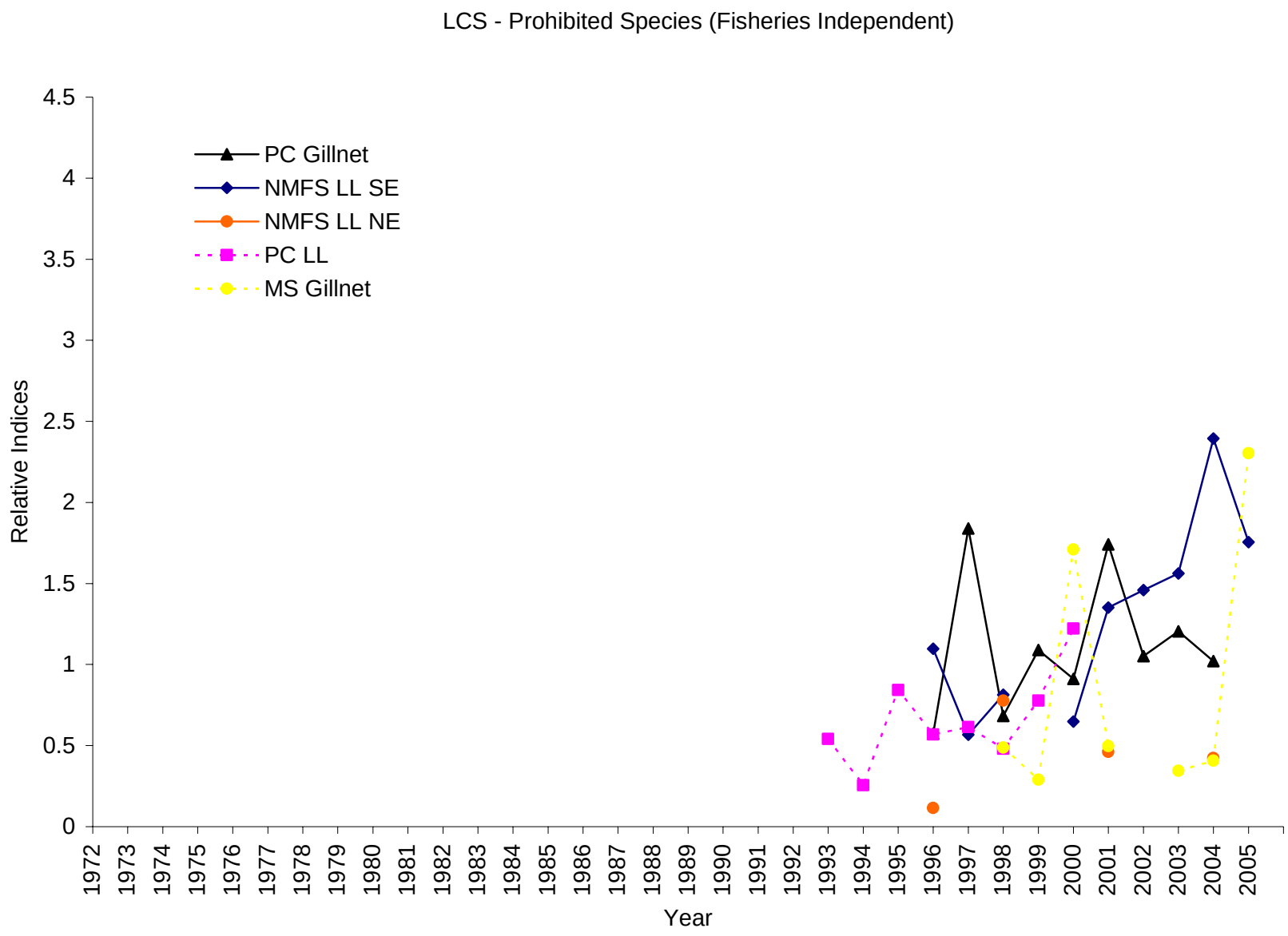

Figure 3.4. Fishery independent catch rate series for the large coastal shark complex minus prohibited species (11 species). Solid lines indicate base case indices while dashed lines are for series to be used in sensitivity analysis. Series are scaled (each series is divided by the mean of the years within that series which overlap between all series) to appear on a common scale.

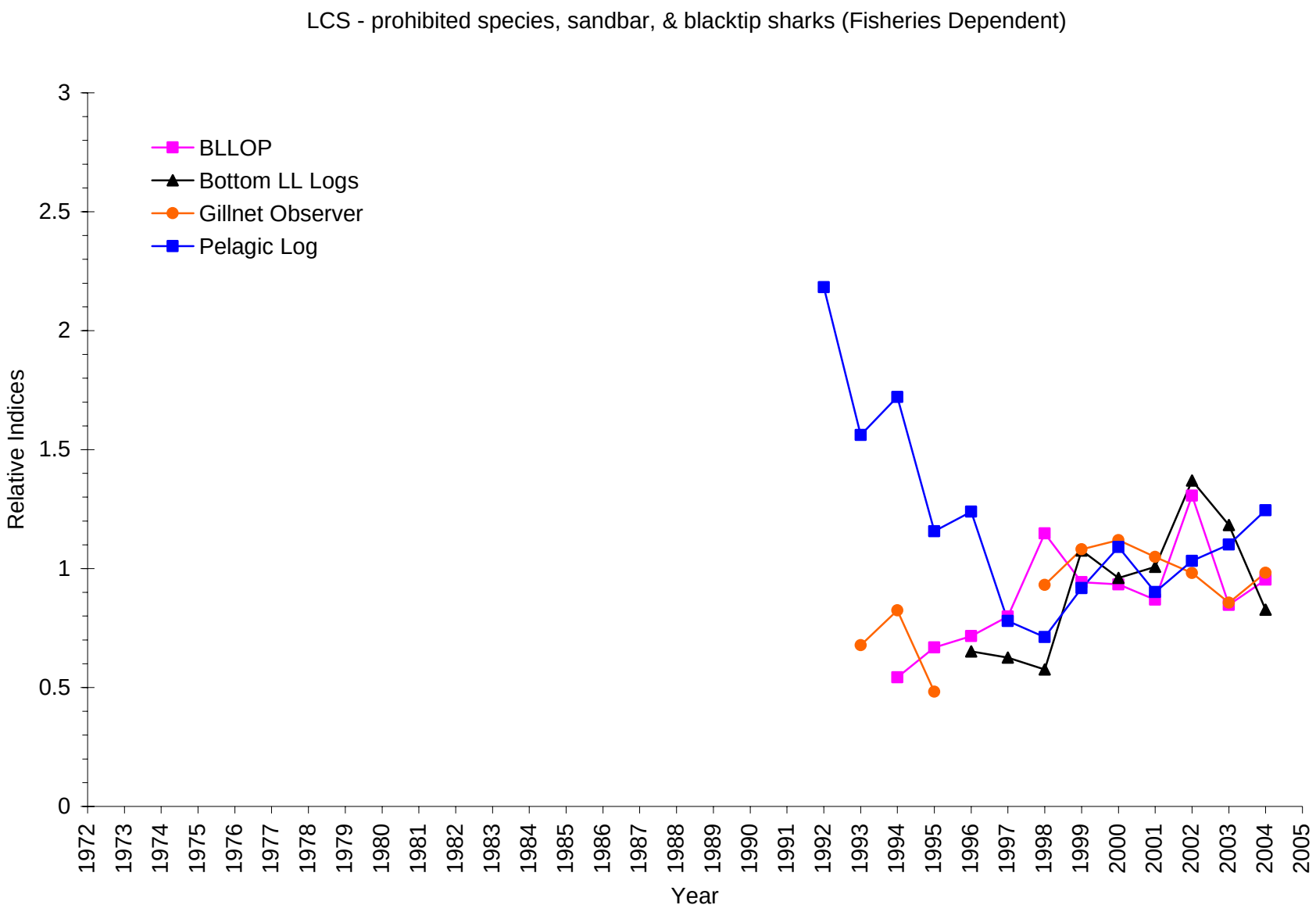

Figure 3.5. Fishery dependent catch rate series for the large coastal shark complex minus prohibited species, blacktip, and sandbar sharks (9 species). Solid lines indicate base case indices while dashed lines are for series to be used in sensitivity analysis. Series are scaled (each series is divided by the mean of the years within that series which overlap between all series) to appear on a common scale.

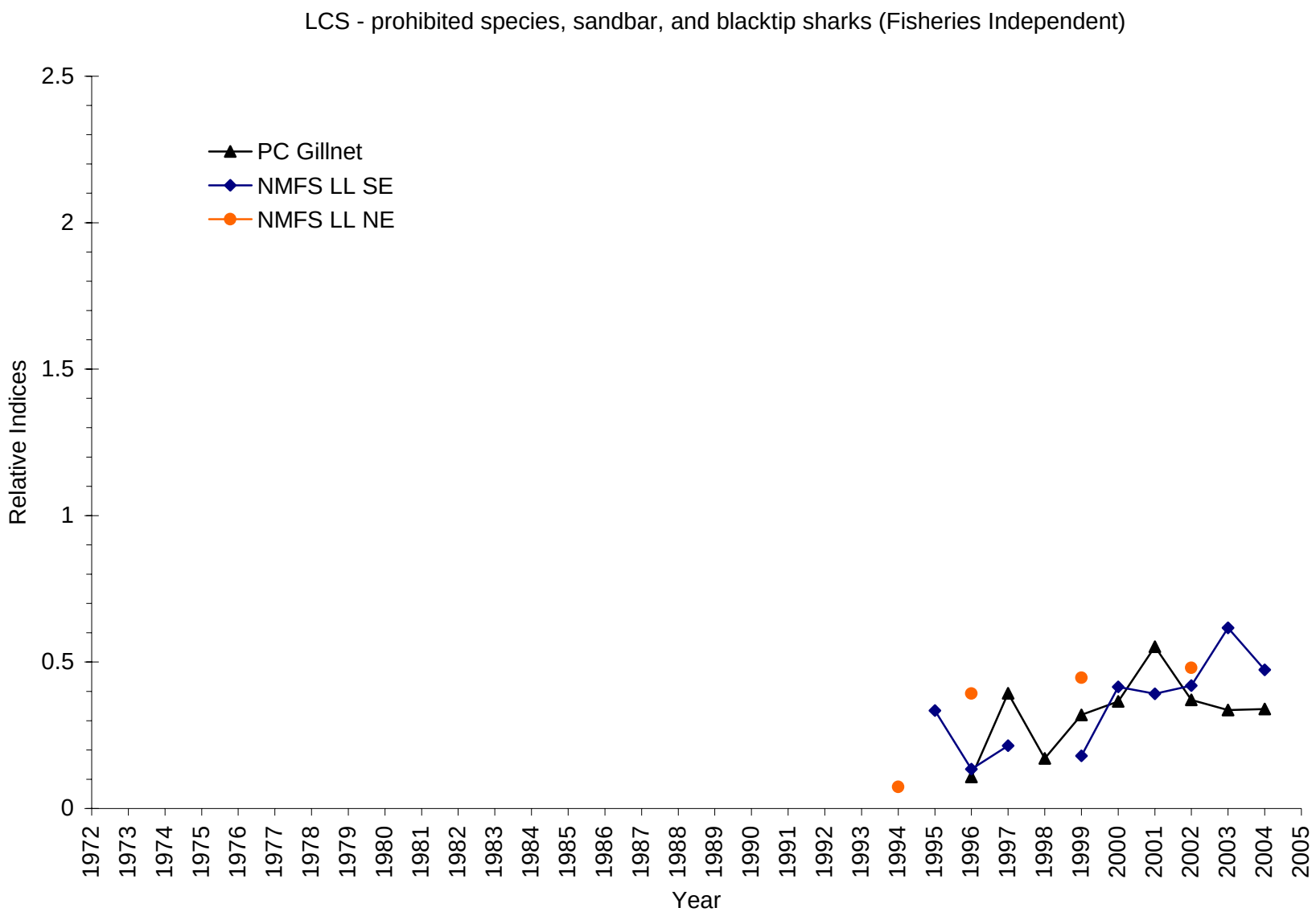

Figure 3.6. Fishery independent catch rate series for the large coastal shark complex minus prohibited species, blacktip, and sandbar sharks (9 species). Solid lines indicate base case indices while dashed lines are for series to be used in sensitivity analysis. Series are scaled (each series is divided by the mean of the years within that series which overlap between all series) to appear on a common scale.

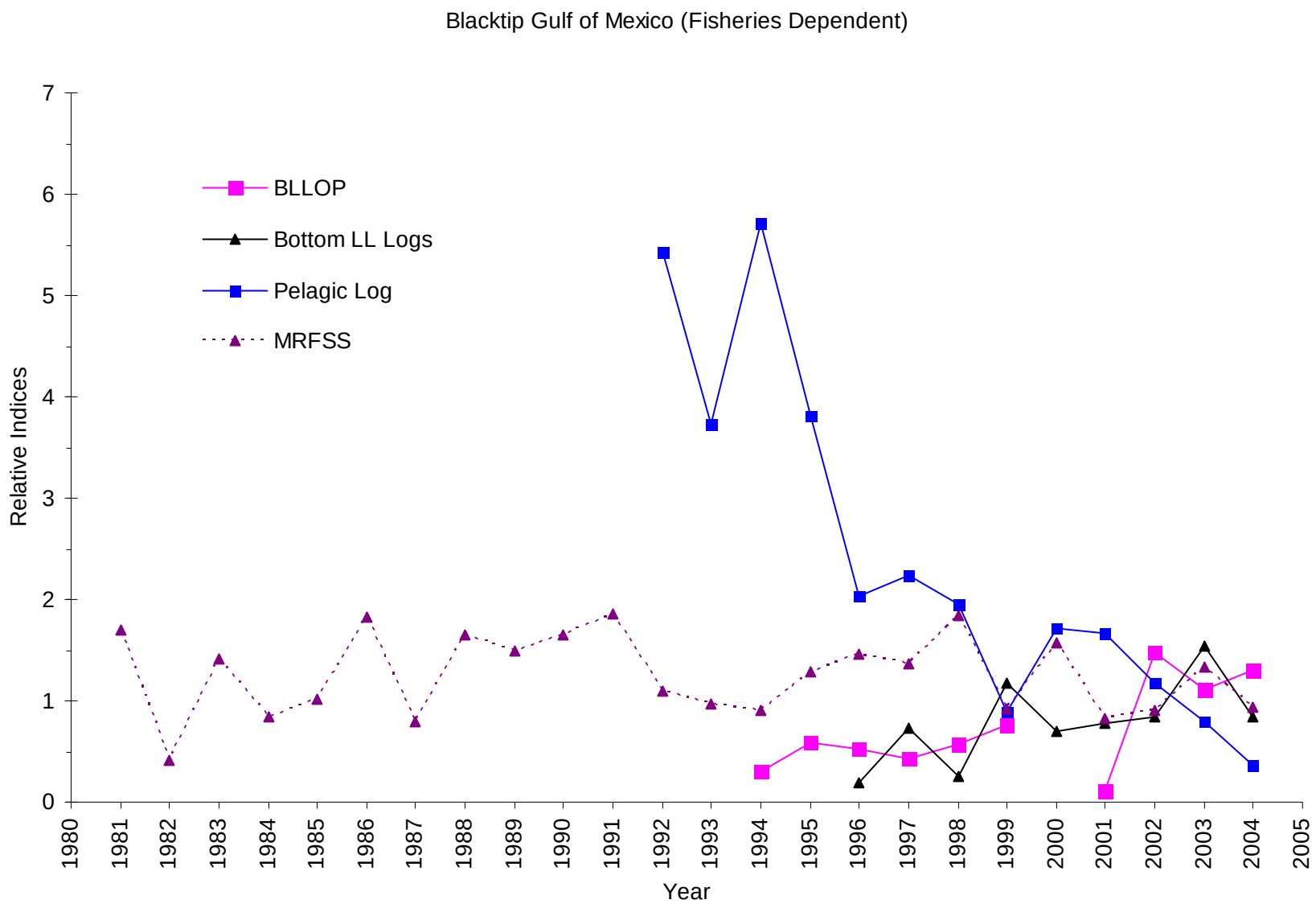

Figure 3.7. Fishery dependent catch rate series for blacktip sharks from the Gulf of Mexico. Solid lines indicate base case indices while dashed lines are for series to be used in sensitivity analysis. Series are scaled (each series is divided by the mean of the years within that series which overlap between all series) to appear on a common scale.

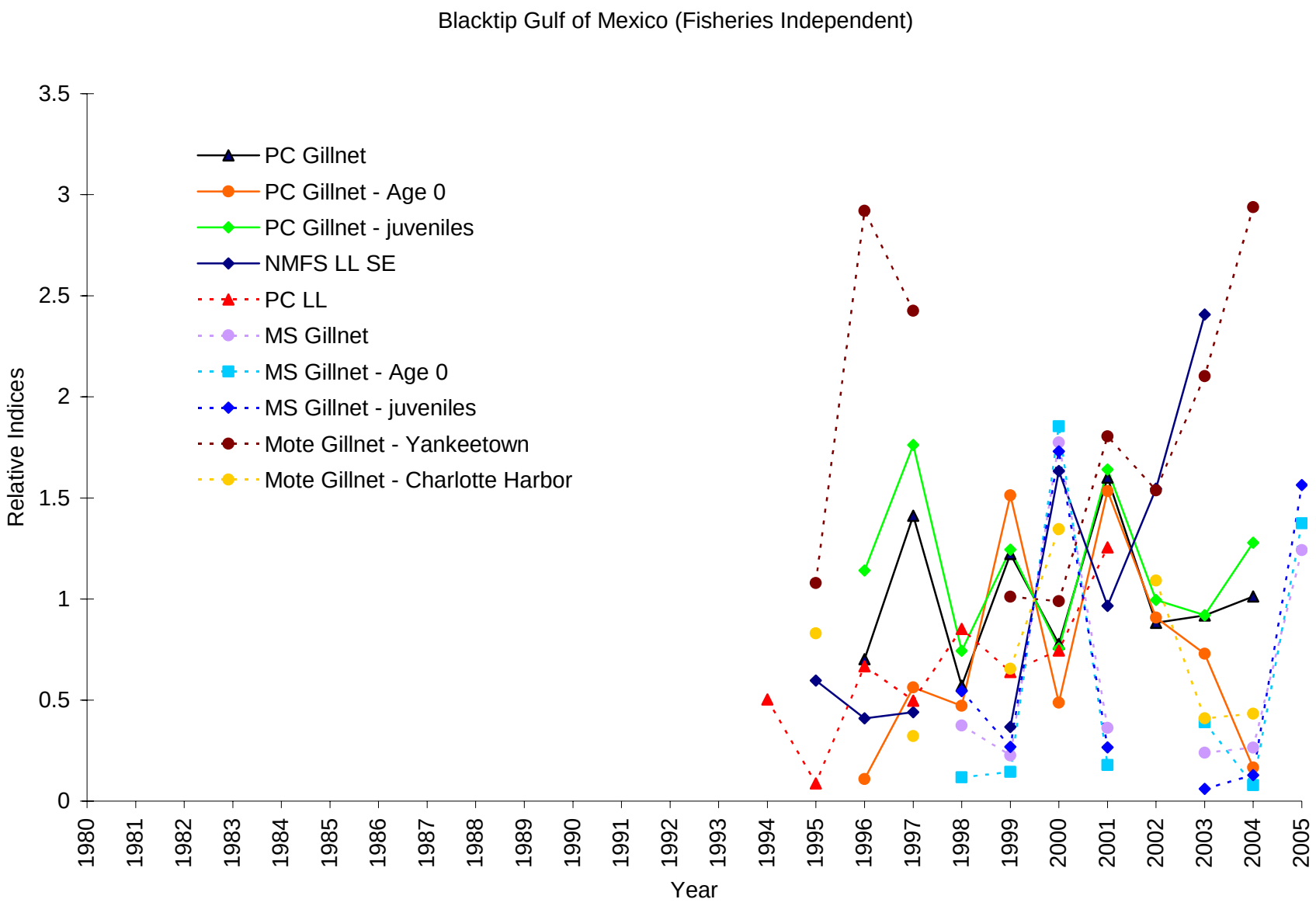

Figure 3.7. Fishery independent catch rate series for blacktip sharks from the Gulf of Mexico. Solid lines indicate base case indices while dashed lines are for series to be used in sensitivity analysis. Series are scaled (each series is divided by the mean of the years within that series which overlap between all series) to appear on a common scale.

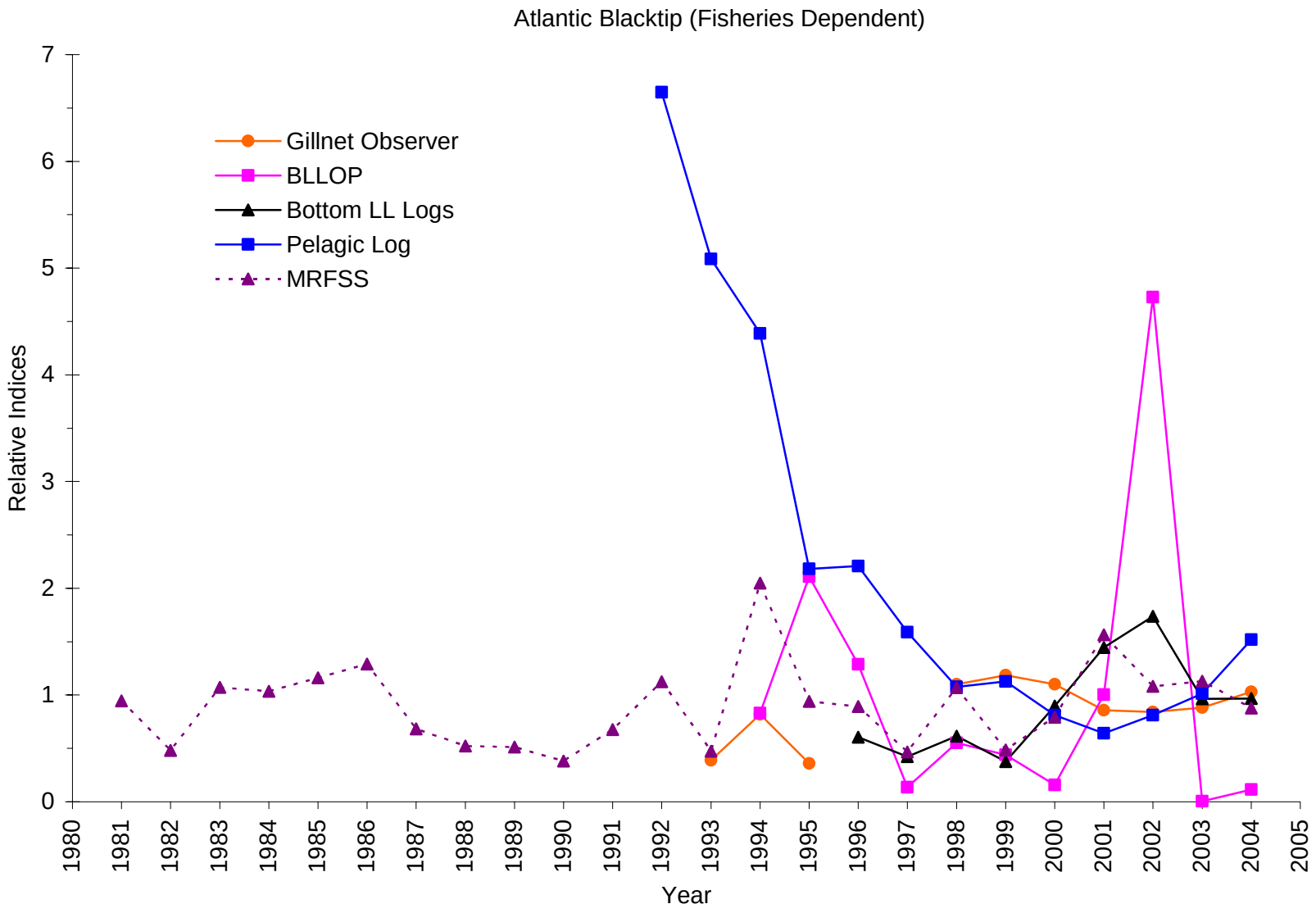

Figure 3.9. Fishery dependent catch rate series for blacktip sharks from the western Atlantic Ocean. Solid lines indicate base case indices while dashed lines are for series to be used in sensitivity analysis. Series are scaled (each series is divided by the mean of the years within that series which overlap between all series) to appear on a common scale.

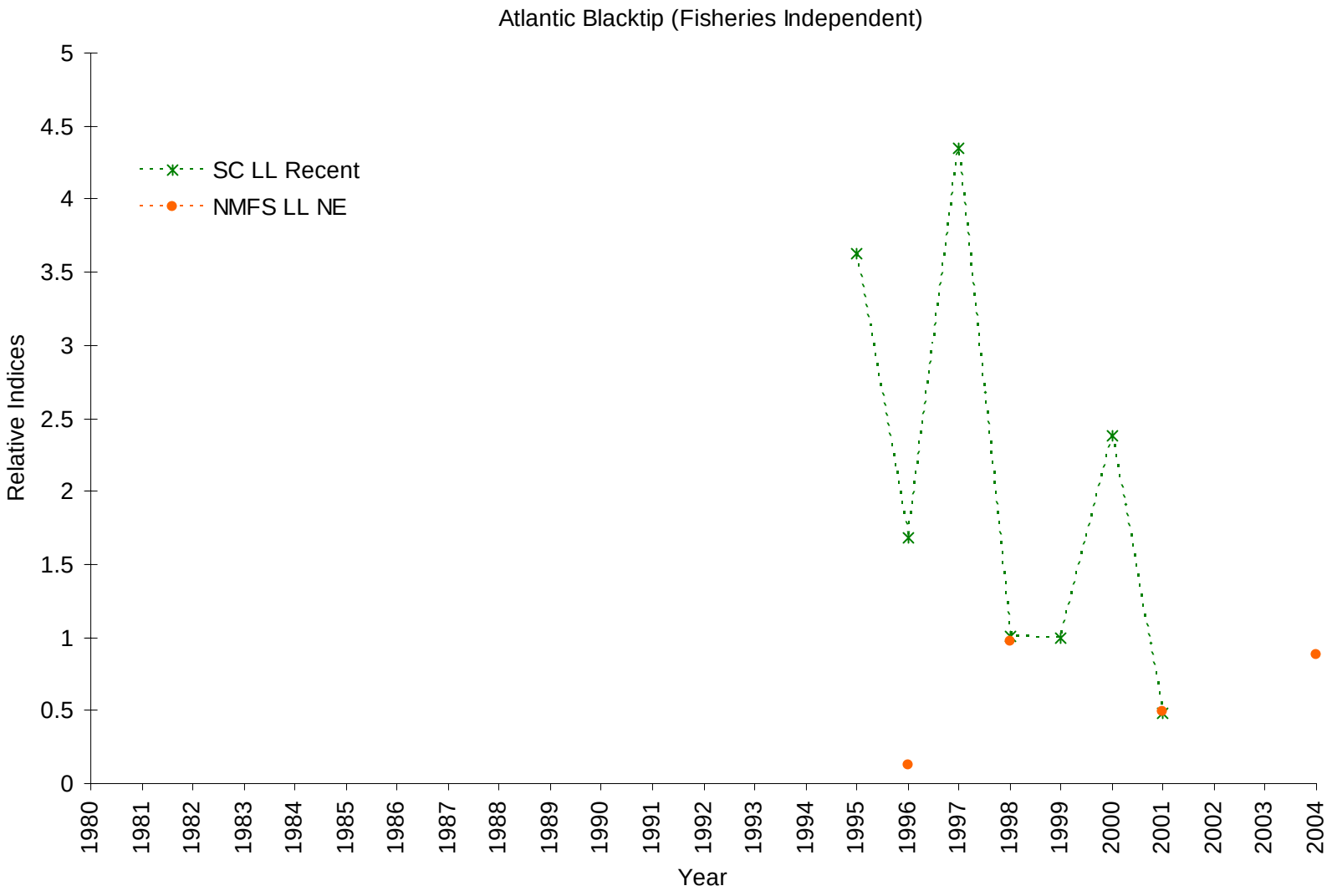

Figure 3.10. Fishery independent catch rate series for blacktip sharks from the western Atlantic Ocean. Solid lines indicate base case indices while dashed lines are for series to be used in sensitivity analysis. Series are scaled (each series is divided by the mean of the years within that series which overlap between all series) to appear on a common scale.

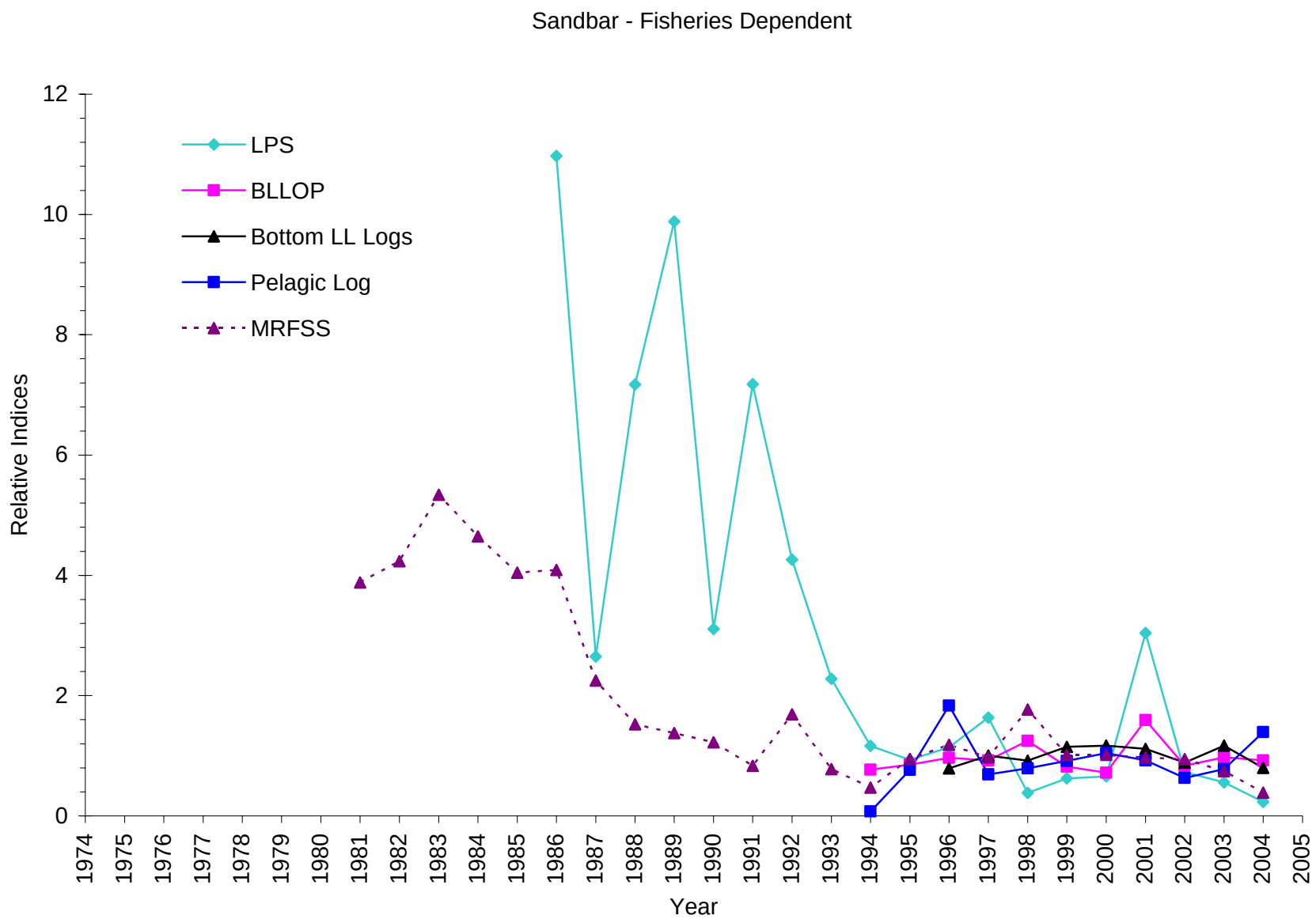

Figure 3.11. Fishery dependent catch rate series for sandbar sharks. Solid lines indicate base case indices while dashed lines are for series to be used in sensitivity analysis. Series are scaled (each series is divided by the mean of the years within that series which overlap between all series) to appear on a common scale.

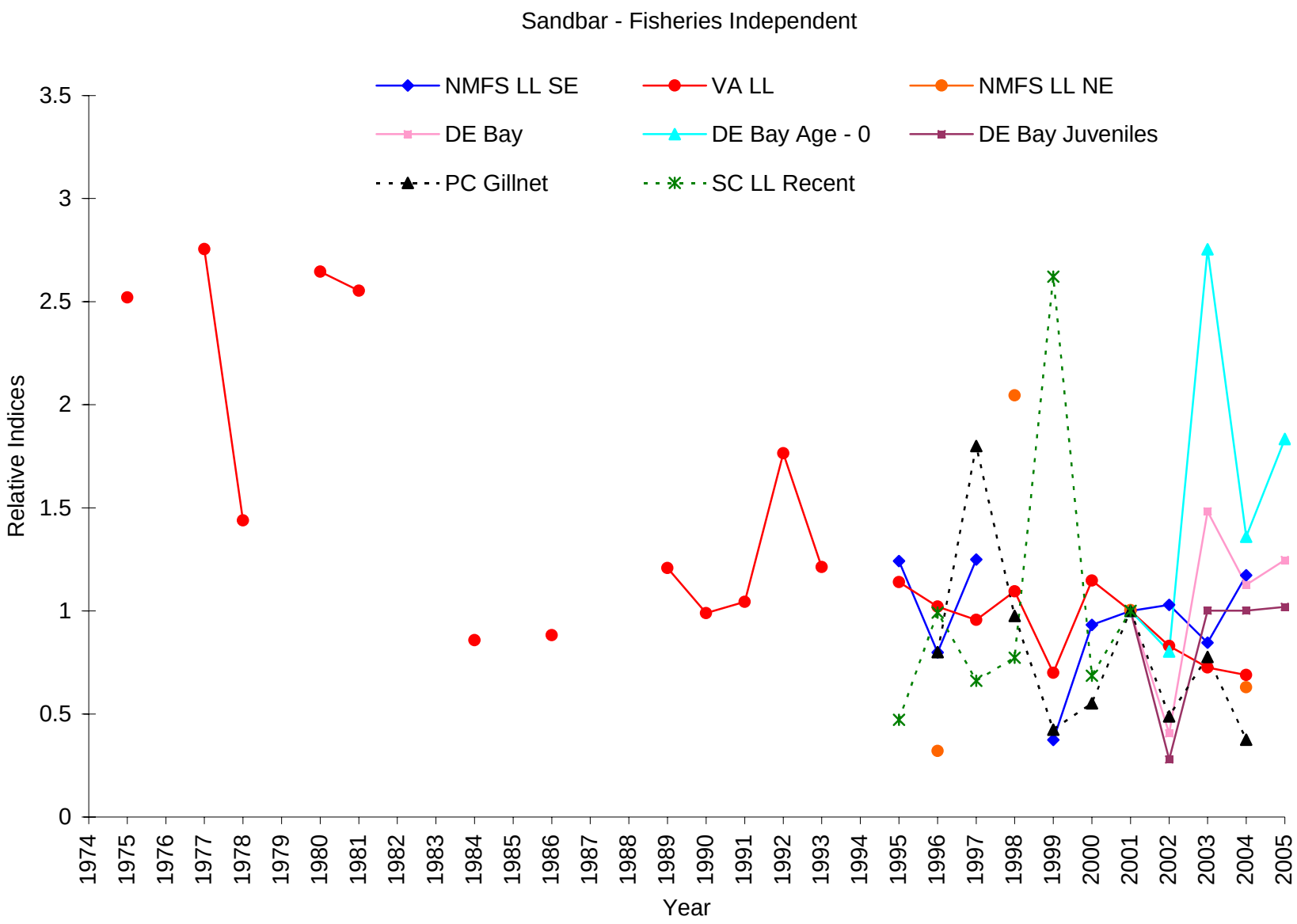

Figure 3.12. Fishery independent catch rate series for sandbar sharks. Solid lines indicate base case indices while dashed lines are for series to be used in sensitivity analysis. Series are scaled (each series is divided by the mean of the years within that series which overlap between all series) to appear on a common scale.

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LCS Data Workshop Working Documents

LCS05/06-DW-01	Anonymous: Documentation for the North Carolina Division of Marine Fisheries catch rate series (NC#)
LCS05/06-DW-02	Anonymous: Description of estimates of unreported catches
LCS05/06-DW-03	Anonymous: Final Meeting Report of the 2002 Shark Evaluation Workshop. NOAA NMFS Panama City Laboratory, Panama City Beach, FL. June 24-28, 2002. Final Meeting Report, 20 August 2002.
LCS05/06-DW-04	Balchowsky & Poffenberger: Description of the Databases that Contain Landings of Shark Species from the Atlantic Ocean and Gulf of Mexico
LCS05/06-DW-05	Beerkircher et al.: SEFSC Pelagic Observer Program data summary for 1992-2000
LCS05/06-DW-06	Bonfil & Babcock: Estimation of catches of sandbar (*Carcharhinus plumbeus*) and blacktip (*C. limbatus*) sharks in the Mexican fisheries of Gulf of Mexico
LCS05/06-DW-07	Brewster-Geisz & Eytcheson: Illegal Fishing off the coast of Texas by Mexican Lanchas
LCS05/06-DW-08	Brewster-Geisz: A summary of the management of Atlantic Large Coastal Sharks
LCS05/06-DW-09	Brown: Standardized catch rates of sandbar (*Carcharhinus plumbeus*) sharks in the Virginia - Massachusetts (U.S.) rod and reel fishery 1986 - 2004
LCS05/06-DW-10	Carlson et al.: Life history parameters for blacktip sharks, *Carcharhinus limbatus*, from the United States South Atlantic Bight and Eastern Gulf of Mexico
LCS05/06-DW-11	Carlson: The Directed Shark Gillnet Fishery: Large Coastal Catch Composition and a Standardized Catch Rate Series.
LCS05/06-DW-12	Carlson & Bethea: Standardized catch rates of large coastal sharks from a fishery-independent survey in northeast Florida
LCS05/06-DW-13	Carlson et al.: Standardized catch rates of large coastal sharks from the Everglades National Park creel survey, 1972 – 2002
LCS05/06-DW-14	Cortés: Documentation of the South Carolina Department of Natural Resources longline survey catch rate series (SC LL Recent)

LCS05/06-DW-15	Cortés & Brooks: Estimates of natural mortality for sandbar and blacktip sharks for use in assessments
LCS05/06-DW-16	Cortés & Neer: Updated catches of Atlantic sharks
LCS05/06-DW-17	Cortés et al.: Standardized catch rates of large coastal sharks from the Commercial Shark Fishery Observer Program, 1994-2004
LCS05/06-DW-18	Diaz: Estimation of large coastal sharks dead discards for the US pelagic longline fishing fleet
LCS05/06-DW-19	Dunnigan: Memo regarding Management Needs for Upcoming Large Coastal Shark (LCS) Stock Assessment
LCS05/06-DW-20	Ha & Musick: A preliminary analysis of Virginia shark longline data 1974 - 2004
LCS05/06-DW-21	Hester: Documentation for the Brannon catch rate series
LCS05/06-DW-22	Hester & Hudson: An evaluation of the content and quality of two Commercial Atlantic Shark Fishery logbook data sets for consideration for stock assessment use
LCS05/06-DW-23	Hoey et al: A review of exploratory longline surveys and biological sampling of sharks from the Sandy Hook and Narragansett labs: 1961-1991
LCS05/06-DW-24	Hoffmayer et al: Catch Rates for Blacktip and Other Large Coastal Shark Species from Mississippi Coastal Waters During 1998–2005
LCS05/06-DW-25	Hueter: Documentation for the Hudson, Jax, Pt. Salerno, and Tampa Bay Recreational Fishing Tournaments catch series, along with the Crooke longline catch rate series
LCS05/06-DW-26	Hueter et al: Relative abundance of juvenile blacktip sharks in three Florida Gulf coast nursery areas, 1995-2004
LCS05/06-DW-27	Ingram et al: Catch rates, distribution and size composition of large coastal sharks collected during NOAA Fisheries Bottom Longline Surveys from the U.S. Gulf of Mexico and U.S. Atlantic Ocean
LCS05/06-DW-28	Keeney et al.: Genetic heterogeneity among blacktip shark, *Carcharhinus limbatus*, continental nurseries along the U.S. Atlantic and Gulf of Mexico

LCS05/06-DW-29	Kohler et al: Preliminary Tag and Recapture Data for the Sandbar Shark, *Carcharhinus plumbeus*, and the Blacktip Shark, *Carcharhinus limbatus*, in the Western North Atlantic
LCS05/06-DW-30	McCandless: Relative abundance trends for juvenile sandbar sharks in Delaware Bay
LCS05/06-DW-31	McCarthy & Abercrombie: Standardized catch rates of large coastal sharks from the United States bottom longline fishery during 1996-2004
LCS05/06-DW-32	Morgan and Burgess: The Commercial Shark Fishery Observer Program: History, collection methodology and summary statistics 1994-2005(1)
LCS05/06-DW-33	Natanson and McCandless: Catch Rate Information Obtained from the NMFS Northeast Longline Survey
LCS05/06-DW-34	Neer and Cortés: Estimation of large coastal shark complex, blacktip, and sandbar shark bycatch in the Gulf of Mexico menhaden fishery
LCS05/06-DW-35	Ortiz: 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
LCS05/06-DW-36	Ortiz: Standardized catch rates for blacktip shark (*Carcharhinus limbatus*), sandbar shark (*C. plumbeus*), and large coastal complex sharks from the Marine Recreational Fisheries Statistical Survey (MRFSS)
LCS05/06-DW-37	Phares: Recreational Marine Fishing Surveys in the Gulf of Mexico and Atlantic States, 1981-2004
LCS05/06-DW-38	Poffenberger: Description of the Southeast Fisheries Science Center's Logbook Program for Coastal Fisheries
LCS05/06-DW-39	Romine & Musick: Life history of the sandbar shark, C. plumbeus, in the Northwestern Atlantic
LCS05/06-DW-40	Grubbs et al.: Long-term movements, migration, and temporal delineation of a summer nursery for juvenile sandbar sharks in the Chesapeake Bay region
LCS05/06-DW-41	Scott & Lacey: Documentation for the Charterboat catch rate series
LCS05/06-DW-42	SEFSC: Review of Headboat Survey – Questions and Answers
LCS05/06-DW-43	Simpfendorfer et al.: Large coastal shark surveys in the eastern Gulf of Mexico 2001-2004

LCS05/06-DW-44	Tyminski et al: Results of Mote Marine Laboratory Shark Tagging Program for blacktip (*Carcharhinus limbatus*) and sandbar (*C. plumbeus*) sharks
LCS05/06-DW-45	Ulrich: Documentation for the South Carolina Longline Survey – Early (SCLL Early)
LCS05/06-DW-46	Conrath & Musick: Investigations into the winter habitat of juvenile sandbar sharks, *Carcharhinus plumbeus*, using pop-up archival satellite transmitters (PSATs).
LCS05/06-DW-47	Merson: Maturation of the sandbar shark in the western North Atlantic

Directed Shark Fisheries, Inc. (DSF)

A Consulting Company

December 26, 2005

Minority statement by Russell Hudson and Frank Hester:

We do not agree that current scientific evidence is sufficient to conclude that blacktip sharks should be divided into two stocks for the assessment. Evidence of female pupping-site fidelity from mtDNA analysis of neonates and a limited number of tag recaptures (LCS05/06-DW29; LCS05/06-DW28; Keeney et al. 20050 does not replace the need identified in LCS05/06-DW-10 for "*A synoptic study sampling* [animals from the commercial catch over] *the entire geographic range of blacktip sharks (i.e., entire Gulf of Mexico and northwest Atlantic Ocean) would be required to fully resolve the question of separate stocks. …*"

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Seafood Coalition (SFC) member

Directed Shark Fisheries, Inc. (DSF)

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January 12, 2006

Minority statement by Russell Hudson and Frank Hester:

Regarding DW-35 V.2, the Appendix still does not address most of the concerns raised at the meeting. In particular, it does not consider the effects of regulatory changes, nor does it consider the effect of federal and state closures to longlining. The two shark species of greatest importance to the commercial (and recreational) fishery are blacktip and sandbar. It is unlikely that these species are available in offshore areas, and CPUE for these two species will be affected by area closures to a different degree than the LCC as a whole.

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