Catch Rate Information Obtained from the NMFS Northeast Longline Survey

L. J. Natanson
and
Camilla T. McCandless

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
Northeast Fisheries Science Center
Narragansett, Rhode Island

October 2005

Summary

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 is presented.

History of the surveys

The Northeast Fisheries Science Center (NEFSC), Coastal Shark Survey is conducted by the Apex Predators Investigation, Narragansett Laboratory, Narragansett, RI. 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. The survey is a major source of fishery independent data for coastal sharks inhabiting the western North Atlantic Ocean.

In 1986, the NEFSC Apex Predators Investigation, NMFS, Narragansett, RI conducted a longline cruise which represented the first systematic survey of sharks covering most of the US Atlantic coast; from Southern New England to mid-Florida in depths from 5 to 200 m. Pre-determined stations were positioned roughly 30 nautical miles (nm) apart, with additional (tagging only) stations in regions of high shark abundance. The cruise was designed to obtain baseline information on the abundance and distribution of large pelagic fishes, primarily sharks, using standard pelagic longline gear fished on the bottom.

Survey procedures and gear were standardized between the NEFSC and Southeast Fisheries Science Center in 1995 to make the surveys comparable and to mimic the gear used in the commercial large coastal shark fishery. Changes to the NEFSC survey were: 1) gear changed from New England pelagic (rope mainline, rope and wire gangions) to Florida bottom (monofilament mainline and gangions), 2) soak time increased from 1 to 3 hrs, 3) bait changed from mackerel to spiny dogfish, 4) stations were limited to depths between 5 and 40 fms, and 5) longline was fished entirely on the bottom, eliminating the pelagic sets of the previous surveys, 6) 300 hooks were fished rather than 100. A brief description of the changes in survey procedures and design are given in the table below.

Year	Gear	Area	Hooks	Soak Time	Bait	Dates
1986	Pelagic LL	Miami, FL - SNE	100	1hr	Mackerel	Jul-Sep
1989	Pelagic LL	Tampa, FL - SNE	100	1hr	Mackerel	Apr-May
1991	Pelagic LL	Miami, FL - SNE	100	1hr	Mackerel	Apr-Jun
1996	Bottom LL	Miami, FL - SNE	300	3hr	Sp Dogfish	Apr-May
1998	Bottom LL	Key West, FL - DE	300	3hr	Sp Dogfish	Apr-May
2001	Bottom LL	Key West, FL – DE	300	3hr	Sp. Dogfish	Apr-May
2004	Bottom LL	Key West, FL – DE	300	3hr	Sp. Dogfish	Apr-Jun

Methods

Station Selection

The initial 1986 survey occupied pre-determined stations from Miami, FL to Woods Hole, MA from 5 to 200 m. The cruise track was repeated during surveys in 1989, 1991, 1996, 1998, 2001 and 2004 except for stations north of Delaware and in depths greater than 40 fm. Tagging only stations or stations where gear was lost during the 1986 - 1991 surveys were not repeated in subsequent years. At locations where gear was lost, the station was moved to a more suitable location based on bottom type, currents, etc. There are currently 88 survey stations with an additional 7 stations that are sampled as time and weather allow.

The current survey (starting with 1996) covers the US continental shelf waters from Key West, FL to Delaware in depths of 5-40 fm (30-80 m). The survey utilizes a fixed station design with stations generally located approximately 30 nm apart except where the continental shelf narrows off Cape Hatteras, NC (Fig. 1).

Longline Gear (series 1: 1986-1991)

During these years, sampling was for both pelagic and large coastal species. In the current analyses only the bottom sets are utilized, thus the "standard gear" described here is that used on the bottom stations. The gear consisted of 100 hook 'Yankee' swordfish style commercial gear. This gear consisted of 5/16 inch tarred nylon mainline, with six-meter (m) gangions

composed of four m of 3/16 inch nylon, two m of 3/32 inch stainless steel leader and a #40 Japanese tuna hook. A standard station consisted of 100 gangions baited with whole Atlantic mackerel (one pound) attached at 50 m intervals. Floats were attached at five hook intervals on 12 m float lines. High flyers were located at each end of the gear.

Once set, the gear fished for one hour with approximately three hours from start of setting to completion of haulback. The mainline covered an average of 3.0 nm. Fishing took place at all times of the day. The number of sets was dependent on distance between stations, weather conditions, and the length of time to complete previous sets during the day.

Longline Gear (series 2: 1996 – Present)

Standard sampling gear consisting of a 300 hook 'Florida' commercial style bottom longline. This gear consists of a 940 lb test monofilament mainline with 12 foot (3.6 m) gangions composed of 730 lb test monofilament with a longline clip at one end and a 3/0 shark hook at the other. Gangions (referred to hereafter simply as 'hooks') baited with chunks of spiny dogfish are attached to the mainline at 60-70 ft (21 m) intervals; 5 lb (2.3 kg) weights are attached every 15 hooks and a bullet float and 15 lb (6.8 kg) weights are placed at 50 hook intervals. A 20 ft (6 m) staff buoy ('high flyer') equipped with radar reflectors and flashers (at night) is attached to a poly ('tag') buoy by a 12 ft (3.6 m) line. The poly buoy is then attached to the mainline and there is a set of these to mark each end of the mainline. To ensure that the gear fishes on the bottom, 20 lb (9.1 kg) weights are placed at the beginning and end of the mainline after a length of line 2-3 times the water depth is let deployed.

Once set, the gear is fished for three hours with approximately six hours from start of setting to completion of haulback. The mainline covers from 2.0 to 5.5 nm with an average of 3.7 nm. Fishing takes place at all times of the day. Number of sets completed per day varies from one to three with an average of 2.5. The number of sets is dependent on distance between stations, weather conditions, and the length of time to complete previous sets during the day.

Data collection

Data is recorded at the beginning and end of each set and haul, when available these data consist of: number of hooks, time, location, surface temperature, depth, air temperature, wind direction and strength and sea state. During all surveys catch data recorded at each station include, at a minimum: species, sex and length (estimated or measured).

Data analysis - Series 1 and 2

Catch per 100 hook and catch per 10,000 hook hours

Analyses were conducted on sandbar, *Carcharhinus plumbeus*, blacktip, *C. limbatus*, and species in the Large Coastal Complex (LCC) (Table 1). For these analyses, catch per unit effort (CPUE) was calculated in terms of both catch per 100 hooks and catch per 10,000 hook hours.

Catch/100 hooks was calculated using the following equation:

$$(a*100)/b$$

where:

a = number of sharks caught, and

b = number of hooks at haulback

Catch/10,000 hook hours was calculated by first determining the soak time (number of hours between first hook in and last hook out) then using the following equation:

$$[a/(s*n)]*10,000$$

where:

a= number of sharks caught,

s = soak time, and

n = number of hooks at haulback

To avoid gear related catch differences CPUE data were only compared within cruise series, thus relative abundances were plotted between 1986, 1989, 1991 (series 1) and 1996, 1998, 2001 and 2004 (series 2) (Table 2; Figures 3-6).

Data Analysis - Series 2

GLM and Lo et al. (1982) methods

For these methods CPUE for each set is defined as the number of sharks divided by the number of hooks multiplied by the soak time. This CPUE was used to examine the trends in relative abundance for large coastal shark species in series 2. The CPUE was standardized using the natural logarithm of the CPUE +1 in a generalized linear model (GLM) which took into account the effects of year (listed above), month (April and May) , and area (1 = <33.8 ^{o} latitude, 2 = 33.8 to 35.7 ^{o} latitude, and 3 = > 35.7 ^{o} latitude) . This analysis was done for five dependent variables: blacktip shark CPUE, sandbar shark CPUE, large coastal complex CPUE, large coastal complex minus prohibited sharks CPUE, and large coastal complex minus prohibited, blacktip and sandbar sharks CPUE. GLM statistical procedures were performed in Statgraphics Plus 3.3 (Statistical Graphics Corporation). Statistically significant differences were determined using an α = 0.05. The standardized indices of abundance were based on the year effect least square means determined from the GLM.

An attempt was also made to standardize the catch rates (number of sharks per set) for each of the five dependent variables using a two-step approach, which models the proportion of positive catch separately from the positive catch. This method was originally proposed by Lo et al. (1992) and is based on a delta-lognormal model. Based on the results of the GLM, factors considered as potential influences on the catch rates for these analyses were: year and area. The proportion of sets with positive catch values was modeled assuming a binomial distribution with a logit link function and the positive catch sets were modeled assuming a Poisson distribution with a log link function. For the positive catch sets an offset of the natural log of the number of hooks multiplied by the soak time of the gear was used for the Poisson model. The

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

Results

GLM and Lo et al. (1982) methods - Series 2

The nominal relative (CPUE/mean) indices of abundance for blacktip sharks, sandbar sharks, large coastal complex, large coastal complex minus prohibited sharks, and large coastal complex minus prohibited, blacktip and sandbar sharks are reported in Table 3 and illustrated in Figures 6-10.

GLM

The GLM for all five dependent variables was significant ($p<.001$) when modeled including the effects of year, month, and area (Table 4). The resulting relative indices of abundance based on the standardized year effects obtained from the GLM analyses for all five dependent variables are reported in Table 5 and illustrated in Figures 6-10.

For blacktip shark CPUE, only year and area had significant effects on CPUE at the α = 0.05 level (Table 4). There were no significant differences in blacktip shark CPUE between the months of April and May from 1996 to 2004 (p=0.266). Post hoc multiple comparisons using Fisher's least significant difference (LSD) procedure indicated that there were significant differences between years 1996 - 1998 and 1996 - 2004 for blacktip shark CPUE at the α = 0.05 level (Table 6). No significant differences were found between the remaining years for blacktip shark CPUE. Fisher's LSD procedure indicated that there were significant differences in blacktip shark CPUE between the southernmost area, 1 (<33. 8 ^{o} latitude) and both areas 2 and 3 (33.8-35.7 ^{o} latitude and >35.7 ^{o} latitude, respectively) at the α = 0.05 level (Table 6).

For sandbar shark CPUE, only year and area had significant effects on CPUE at the α = 0.05 level (Table 4). There were no significant differences in sandbar shark CPUE between the months of April and May from 1996 to 2004 (p=0.706). Post hoc multiple comparisons using Fisher's LSD procedure indicated that there were significant differences between years 1996 – 1998, 1998 - 2001, and 1998 - 2004 for sandbar shark CPUE at the α = 0.05 level (Table 7). No significant differences were found between the remaining years for sandbar shark CPUE. Fisher's LSD procedure indicated that there were significant differences in sandbar shark CPUE between the middle area, 2 and both areas 1 and 3 at the α = 0.05 level (Table 7).

For the large coastal complex CPUE, only year and area had significant effects on CPUE at the α = 0.05 level (Table 4). There were no significant differences in large coastal complex CPUE between the months of April and May from 1996 to 2004 (p=0.113). Post hoc multiple comparisons using Fisher's least significant difference (LSD) procedure indicated that there were significant differences between all year combinations except 2001 - 2004 for the large coastal complex CPUE at the α = 0.05 level (Table 8). Fisher's LSD procedure indicated that there were significant differences in the large coastal complex CPUE between all three areas at the α = 0.05 level (Table 8).

For the large coastal complex minus prohibited sharks CPUE, only year and area had significant effects on CPUE at the α = 0.05 level (Table 4). There were no significant differences in large coastal complex minus prohibited sharks CPUE between the months of April and May from 1996 to 2004 (p=0.091). Post hoc multiple comparisons using Fisher's LSD procedure indicated that there were significant differences between all year combinations except 2001 - 2004 for the large coastal complex minus prohibited sharks CPUE at the α = 0.05 level (Table 9). Fisher's LSD procedure indicated that there were significant differences in the large coastal complex minus prohibited sharks CPUE between all three areas at the α = 0.05 level (Table 9).

For the large coastal complex minus prohibited, blacktip and sandbar sharks CPUE all three independent variables (year, month and area) had significant effects on CPUE at the α = 0.05 level (Table 4). Post hoc multiple comparisons using Fisher's LSD procedure indicated that there were significant differences between years 1996 - 1998, 1996 - 2001, and 1996 - 2004 for the large coastal complex minus prohibited, blacktip and sandbar sharks CPUE at the α = 0.05 level (Table 10). No significant differences were found between the remaining years for the large coastal complex minus prohibited, blacktip and sandbar sharks CPUE. There was a significant difference in large coastal complex minus prohibited, blacktip and sandbar sharks CPUE between April and May during 1996 to 2004 sampling (Tables 4, 10). Fisher's LSD procedure indicated that there were significant differences in the large coastal complex minus prohibited, blacktip and sandbar sharks CPUE between all three areas at the α = 0.05 level (Table 10).

Two-step approach based on Lo et al. method

84.4% of the sets had zero catches of blacktip sharks. The stepwise construction of the binomial model of the probability of catching a blacktip shark and the Poisson model of positive blacktip shark sets is in Table 11. The final binomial model was "Proportion positive blacktip shark sets = Area + Year". The final Poisson model was "Positive blacktip shark sets = Year". Year was not

significant in the final Poisson model but was kept in the final model to allow for calculation of indices.

35.0% of sets had zero catches of sandbar sharks. The stepwise construction of the binomial model of the probability of catching a sandbar shark and the Poisson model of positive sandbar shark sets is in Table 12. The final binomial model was “Proportion positive sandbar shark sets = Area + Year”. The final Poisson model was “Positive sandbar shark sets = Area + Year”. Although the interaction area*year was significant for both models, the increased number of degrees freedom in the interaction precluded estimation of the least square means (used to create the indices of abundance) in the final combined model; therefore, interactions were not included in the final combined model.

24.9% of sets had zero catches of the large coastal complex. The stepwise construction of the binomial model of the probability of catching a large coastal shark and the Poisson model of positive large coastal shark sets is in Table 13. The final binomial model was “Proportion positive large coastal shark sets = Area + Year”. The final Poisson model was “Positive large coastal shark sets = Area + Year”.

26.3% of sets had zero catches of large coastal minus prohibited sharks. The stepwise construction of the binomial model of the probability of catching a large coastal minus prohibited shark and the Poisson model of positive large coastal minus prohibited shark sets is in Table 14. The final binomial model was “Proportion positive large coastal minus prohibited shark sets = Area + Year. The final Poisson model was Positive large coastal minus prohibited shark sets = Area + Year”. Although the interaction area*year was significant for both models, the increased number of degrees freedom in the interaction precluded estimation of the least square means in the final combined model; therefore, interactions were not included in the final combined model.

49.1% of sets had zero catches of large coastal minus prohibited, blacktip and sandbar sharks. The stepwise construction of the binomial model of the probability of catching a large coastal minus prohibited, blacktip and sandbar sharks and the Poisson model of positive large coastal minus prohibited, blacktip and sandbar sharks sets is in Table 15. The final binomial model was

"Proportion positive large coastal minus prohibited, blacktip and sandbar sharks sets = Area + Year". The final Poisson model was "Positive large coastal minus prohibited, blacktip and sandbar sharks sets = Year + Area". Although the interaction area*year was significant for the Poisson model, the increased number of degrees freedom in the interaction precluded estimation of the least square means in the final combined model; therefore, the interaction was not included in the final combined model.

The resulting relative indices of abundance based on the standardized year effects obtained from the Lo et al. method for all five dependent variables are reported in Table 16 and illustrated in Figures 6-10.

References Cited

Carlson J.K. 2002. A fishery-independent assessment of shark stock abundance for large coastal species in the northeast Gulf of Mexico. Panama City Laboratory Contribution Series 02-08. 26pp.

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

Lo, N.C., L.D. Jacobson, and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Can. J. Fish. Aquat. Sci. 49:2515-2526.

Tables

1 Table of LCC by cruise

2 Catch per 100 hook and catch per 10,000 hook hours by cruise

3 Nominal relative (CPUE/mean) abundance indices. CPUE of a set = shark catch/(#hooks*soak time). CV = coefficient of variation, N = the number of sets observed.

4 GLM results for the fitted model. All F-ratios are based on the residual mean square error.

5 GLM relative (index/mean) standardized abundance indices based on the standardized year effects obtained from the GLM analyses. CV = coefficient of variation, N = the number of sets observed.

6 Multiple comparisons for blacktip sharks

7 Multiple comparisons for sandbar sharks

8 Multiple comparisons for large coastal complex

9 Multiple comparisons for large coastal complex – prohibited

10 Multiple comparisons for large coastal complex – prohibited – blacktip – sandbar

11. Results of the stepwise procedure for development of the catch rate model for blacktip sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

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

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

14 Results of the stepwise procedure for development of the catch rate model for large coastal complex - prohibited sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

15 Results of the stepwise procedure for development of the catch rate model for large coastal complex - prohibited, blacktip and sandbar sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

16 Lo et al. method relative (index/mean) standardized abundance indices based on the standardized year effects obtained from the Lo et al. analyses. CV = coefficient of variation, N = the number of sets observed.

Figures

Table 1 Species list and number by year of the Large Coastal Complex caught on NMFS Narragansett shark survey cruises.

	Series 1			Series 2			
	1986	**1989**	**1991**	**1996**	**1998**	**2001**	**2004**
DUSKY	37	13	6	8	38	71	98
SANDBAR	323	295	96	112	638	309	179
BLKTIP	0	5	13	7	36	19	28
SILKY	3	1	2	7	20	10	2
SMOOTH HAMMERHEAD	0	0	1	0	0	0	0
SCALLOPED HAMMERHEAD	21	76	21	2	8	43	25
TIGER	33	29	30	40	137	136	143
SANDTIGER	1	22	16	0	0	1	0
WHITE	0	2	0	0	0	0	0
REEF	0	1	0	3	1	0	0
NURSE	1	1	2	0	0	1	0
GREAT HAMMERHEAD	2	1	0	0	0	2	0
BIGNOSE	1	0	0	0	0	0	0
SPINNER	1	0	0	0	1	1	3
BULL	0	0	0	0	1	1	0

Table 2

Series 1

Sandbar

Year	N	per 10,000 hkhr	per 100 hk
1986	323	177.75	4.14
1989	295	173.01	3.92
1991	96	51.08	1.27

LCC

Year	N	per 10,000 hkhr	per 100 hk
1986	423	232.78	5.42
1989	446	261.57	5.92
1991	187	99.49	2.48

Blacktip

Year	N	per 10,000 hkhr	per 100 hk
1986	0		
1989	5	2.93	0.07
1991	13	6.92	0.17

Series 2

Sandbar

Year	N	per 10,000 hkhr	per 100 hk
1996	111	6.55	0.41
1998	638	43.84	2.44
2001	309	20.89	1.23
2004	179	15.32	0.87

LCC

Year	N	per 10,000 hkhr	per 100 hk
1996	168	9.92	0.63
1998	880	60.48	3.37
2001	594	40.16	2.36
2004	478	40.90	2.32

Blacktip

Year	N	per 10,000 hkhr	per 100 hk
1996	7	0.41	0.03
1998	36	2.47	0.14
2001	19	1.28	0.08
2004	28	2.40	0.14

Table 3. Nominal relative (CPUE/mean) abundance indices. CPUE of a set = shark catch/(#hooks*soak time). CV = coefficient of variation, N = the number of sets observed.

blacktip sharks

YEAR	REL INDEX	LCL	UCL	CV	N
1996	0.214	0.011	0.417	0.989	91
1998	1.482	0.704	2.260	3.745	89
2001	0.815	0.318	1.312	2.339	85
2004	1.488	0.548	2.428	3.983	69

sandbar sharks

YEAR	REL INDEX	LCL	UCL	CV	N
1996	0.301	0.137	0.465	0.798	91
1998	2.016	1.068	2.965	4.566	89
2001	0.965	0.462	1.467	2.362	85
2004	0.718	0.380	1.056	1.433	69

large coastal complex

YEAR	REL INDEX	LCL	UCL	CV	N
1996	0.262	0.163	0.362	0.484	91
1998	1.572	1.012	2.131	2.694	89
2001	1.052	0.673	1.431	1.783	85
2004	1.114	0.787	1.440	1.382	69

large coastal complex - prohibited

YEAR	REL INDEX	LCL	UCL	CV	N
1996	0.277	0.171	0.384	0.519	91
1998	1.670	1.075	2.265	2.864	89
2001	1.046	0.719	1.373	1.538	85
2004	1.007	0.754	1.259	1.070	69

large coastal complex – prohibited, blacktip and sandbar

YEAR	REL INDEX	LCL	UCL	CV	N
1996	0.243	0.152	0.333	0.440	91
1998	1.041	0.667	1.415	1.802	89
2001	1.238	0.887	1.589	1.650	85
2004	1.478	1.006	1.950	2.001	69

Table 4. GLM results for the fitted model. All F-ratios are based on the residual mean square error.

GLM results for blacktip sharks

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	0.00000754512	6	0.00000125752	5.72	0.0000
Residual	0.00007189120	327	2.19851E-7		
Total (Corr.)	0.00007943640	333			

Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
year	0.00000256789	3	8.55963E-7	3.89	0.0093
month	2.72708E-7	1	2.72708E-7	1.24	0.2662
area	0.00000440943	2	0.00000220471	10.03	0.0001
Residual	0.00007189120	327	2.19851E-7		
Total (corrected)	0.0000794364	333			

GLM results for sandbar sharks

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	0.00204376	6	0.0003406270	14.89	0.0000
Residual	0.00747825	327	0.0000228693		
Total (Corr.)	0.00952202	333			

Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
year	0.00053047400	3	0.00017682500	7.73	0.0001
month	0.00000325267	1	0.00000325267	0.14	0.7063
area	0.00139132000	2	0.00069565800	30.42	0.0000
Residual	0.00747825000	327	0.00002286930		
Total (corrected)	0.00952202000	333			

Table 4. continued

GLM results for large coastal complex

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	0.00333173	6	0.0005552880	18.42	0.0000
Residual	0.00985885	327	0.0000301494		
Total (Corr.)	0.01319060	333			

Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
year	0.0009032240	3	0.0003010750	9.99	0.0000
month	0.0000760274	1	0.0000760274	2.52	0.1133
area	0.0021563700	2	0.0010781900	35.76	0.0000
Residual	0.0098588500	327	0.0000301494		
Total (corrected)	0.0131906000	333			

GLM results for large coastal complex - prohibited

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	0.00257253	6	0.0004287540	17.96	0.0000
Residual	0.00780842	327	0.0000238789		
Total (Corr.)	0.01038090	333			

Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
year	0.0008197320	3	0.0002732440	11.44	0.0000
month	0.0000688426	1	0.0000688426	2.88	0.0905
area	0.0016003100	2	0.0008001560	33.51	0.0000
Residual	0.0078084200	327	0.0000238789		
Total (corrected)	0.0103809000	333			

Table 4. continued

GLM results for large coastal complex – prohibited – blacktip – sandbar

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	0.000193605	6	0.00003226750	15.03	0.0000
Residual	0.000701918	327	0.00000214654		
Total (Corr.)	0.000895523	333			

Type III Sums of Squares

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
year	0.0000670121	3	0.00002233740	10.41	0.0000
month	0.0000358226	1	0.00003582260	16.69	0.0001
area	0.0001184130	2	0.00005920630	27.58	0.0000
Residual	0.0007019180	327	0.00000214654		
Total (corrected)	0.0008955230	333			

Table 5. GLM relative (index/mean) standardized abundance indices based on the standardized year effects obtained from the GLM analyses. CV = coefficient of variation, N = the number of sets observed.

blacktip sharks

YEAR	REL INDEX	LCL	UCL	CV	N
1996	-1.056	-3.063	0.951	9.767	91
1998	2.962	0.880	5.044	10.021	89
2001	0.911	-0.874	2.695	8.395	85
2004	1.183	-1.136	3.502	9.827	69

sandbar sharks

YEAR	REL INDEX	LCL	UCL	CV	N
1996	0.470	0.008	0.932	2.248	91
1998	1.851	1.372	2.330	2.306	89
2001	0.955	0.477	1.433	2.247	85
2004	0.724	0.190	1.258	2.262	69

large coastal complex

YEAR	REL INDEX	LCL	UCL	CV	N
1996	0.301	-0.063	0.665	1.773	91
1998	1.599	1.221	1.976	1.819	89
2001	1.045	0.668	1.422	1.772	85
2004	1.055	0.635	1.476	1.783	69

large coastal complex - prohibited

YEAR	REL INDEX	LCL	UCL	CV	N
1996	0.280	-0.099	0.659	1.844	91
1998	1.731	1.338	2.124	1.892	89
2001	1.044	0.652	1.436	1.843	85
2004	0.944	0.506	1.382	1.856	69

large coastal complex – prohibited, blacktip and sandbar

YEAR	REL INDEX	LCL	UCL	CV	N
1996	-0.451	-1.110	0.207	3.205	91
1998	1.117	0.434	1.800	3.288	89
2001	1.517	0.836	2.198	3.203	85
2004	1.817	1.057	2.578	3.224	69

Table 6. Multiple comparisons for blacktip sharks

Multiple comparisons of blacktip CPUE by year

Method: 95.0 percent LSD

year	Count	LS Mean	Homogeneous Groups
1996	91	-0.0000564077	X
2001	85	0.0000486485	XX
2004	69	0.0001467200	X
1998	89	0.0001582660	X

Contrast	Difference	+/- Limits
1996 - 1998	*-0.0002146740	0.000137513
1996 - 2001	-0.0001050560	0.000139139
1996 - 2004	*-0.0002031270	0.000147244
1998 - 2001	0.0001096180	0.000139892
1998 - 2004	0.0000115465	0.000147956
2001 - 2004	-0.0000980712	0.000149469

* denotes a statistically significant difference at the $\alpha = 0.05$ level.

Multiple Comparisons for blacktip CPUE by area

Method: 95.0 percent LSD

area	Count	LS Mean	Homogeneous Groups
>35.7	66	-0.0000259384	X
33.8-35.7	67	-0.0000124764	X
<33.8	201	0.0002613350	X

Contrast	Difference	+/- Limits
33.8-35.7 - <33.8	*-0.000273811	0.000130123
33.8-35.7 - >35.7	0.000013462	0.000159970
<33.8 - >35.7	*0.000287273	0.000130861

* denotes a statistically significant difference at the $\alpha = 0.05$ level.

Table 7. Multiple comparisons for sandbar sharks

Multiple Comparisons for sandbar CPUE by year

Method: 95.0 percent LSD

year	Count	LS Mean	Homogeneous Groups
1996	91	0.00111253	X
2004	69	0.00171402	X
2001	85	0.00226064	X
1998	89	0.00438263	X

Contrast	Difference	+/- Limits
1996 - 1998	*-0.003270100	0.00140251
1996 - 2001	-0.001148110	0.00141910
1996 - 2004	-0.000601497	0.00150176
1998 - 2001	*0.002121990	0.00142678
1998 - 2004	*0.002668610	0.00150902
2001 - 2004	0.000546613	0.00152445

* denotes a statistically significant difference at the α = 0.05 level.

Multiple Comparisons for sandbar CPUE by area

Method: 95.0 percent LSD

area	Count	LS Mean	Homogeneous Groups
>35.7	66	0.0000307832	X
<33.8	201	0.0010816300	X
33.8-35.7	67	0.0059899500	X

Contrast	Difference	+/- Limits
33.8-35.7 - <33.8	*0.00490832	0.00132714
33.8-35.7 - >35.7	*0.00595916	0.00163156
<33.8 - >35.7	0.00105085	0.00133466

* denotes a statistically significant difference at the α = 0.05 level.

Table 8. Multiple comparisons for large coastal complex

Multiple Comparisons for large coastal complex CPUE by year

Method: 95.0 percent LSD

year	Count	LS Mean	Homogeneous Groups
1996	91	0.00103830	X
2001	85	0.00360299	X
2004	69	0.00363831	X
1998	89	0.00551126	X

Contrast	Difference	+/- Limits
1996 - 1998	*-0.0044729600	0.00161035
1996 - 2001	*-0.0025646900	0.00162939
1996 - 2004	*-0.0026000100	0.00172430
1998 - 2001	*0.0019082700	0.00163821
1998 - 2004	*0.0018729500	0.00173264
2001 - 2004	-0.0000353211	0.00175035

* denotes a statistically significant difference at the $\alpha = 0.05$ level.

Multiple Comparisons for large coastal complex CPUE by area

Method: 95.0 percent LSD

area	Count	LS Mean	Homogeneous Groups
>35.7	66	-0.000204801	X
<33.8	201	0.002795370	X
33.8-35.7	67	0.007752570	X

Contrast	Difference	+/- Limits
33.8-35.7 - <33.8	*0.00495720	0.00152381
33.8-35.7 - >35.7	*0.00795737	0.00187333
<33.8 - >35.7	*0.00300017	0.00153244

* denotes a statistically significant difference at the $\alpha = 0.05$ level.

Table 9. Multiple comparisons for large coastal complex – prohibited

Multiple Comparisons for large coastal complex – prohibited CPUE by year

Method: 95.0 percent LSD

year	Count	LS Mean	Homogeneous Groups
1996	91	0.000826733	X
2004	69	0.002784040	X
2001	85	0.003079410	X
1998	89	0.005105620	X

Contrast	Difference	+/- Limits
1996 - 1998	*-0.004278890	0.00143314
1996 - 2001	*-0.002252680	0.00145008
1996 - 2004	*-0.001957310	0.00153455
1998 - 2001	*0.002026210	0.00145793
1998 - 2004	*0.002321580	0.00154197
2001 - 2004	0.000295368	0.00155773

* denotes a statistically significant difference at the $\alpha = 0.05$ level.

Multiple Comparisons for large coastal complex – prohibited CPUE by area

Method: 95.0 percent LSD

area	Count	LS Mean	Homogeneous Groups
>35.7	66	-0.000384178	X
<33.8	201	0.002688250	X
33.8-35.7	67	0.006542780	X

Contrast	Difference	+/- Limits
33.8-35.7 - <33.8	*0.00385452	0.00135612
33.8-35.7 - >35.7	*0.00692696	0.00166718
<33.8 - >35.7	*0.00307243	0.00136381

* denotes a statistically significant difference at the $\alpha = 0.05$ level.

Table 10. Multiple comparisons for large coastal complex – prohibited – blacktip – sandbar

Multiple Comparisons for large coastal complex – prohibited – blacktip – sandbar CPUE by year

Method: 95.0 percent LSD

year	Count	LS Mean	Homogeneous Groups
1996	91	-0.000229643	X
1998	89	0.000568363	X
2001	85	0.000771876	X
2004	69	0.000924767	X

Contrast	Difference	+/- Limits
1996 - 1998	*-0.000798006	0.000429684
1996 - 2001	*-0.001001520	0.000434765
1996 - 2004	*-0.001154410	0.000460091
1998 - 2001	-0.000203513	0.000437118
1998 - 2004	-0.000356404	0.000462315
2001 - 2004	-0.000152891	0.000467041

* denotes a statistically significant difference at the $\alpha = 0.05$ level.

Multiple Comparisons for large coastal complex – prohibited – blacktip – sandbar CPUE by month

Method: 95.0 percent LSD

month	Count	LS Mean	Homogeneous Groups
4	104	0.0000845542	X
5	230	0.0009331280	X

Contrast	Difference	+/- Limits
4 - 5	*-0.000848573	0.000340582

* denotes a statistically significant difference at the $\alpha = 0.05$ level.

Multiple Comparisons for large coastal complex – prohibited – blacktip – sandbar CPUE by month by area

Method: 95.0 percent LSD

area	Count	LS Mean	Homogeneous Groups
>35.7	66	-0.000390083	X
33.8-35.7	67	0.000569249	X
<33.8	201	0.001347360	X

Contrast	Difference	+/- Limits
33.8-35.7 - <33.8	*-0.000778106	0.000406594
33.8-35.7 - >35.7	*0.000959332	0.000499856
<33.8 - >35.7	*0.001737440	0.000408897

* denotes a statistically significant difference at the $\alpha = 0.05$ level.

Table 11. Results of the stepwise procedure for development of the catch rate model for blacktip sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
NULL	333	288.8772	0.8675					
AREA	331	255.8435	0.7729	10.9049	10.9049	-127.9217	33.03	<.0001
YEAR	330	275.3126	0.8343	3.8271		-137.6563	13.56	0.0036
AREA + YEAR	328	240.6420	0.7337	15.4236	4.5187	-120.3210	15.20	0.0017
AREA + YEAR + AREA*YEAR	322	230.5310	0.7159	17.4755	2.0519	-115.2655	Negative of Hessian not positive definite	

FINAL MODEL: AREA + YEAR

Akaike's information criterion	-893.2
Schwartz's Bayesian criterion	-895.1
(-2) Res Log likelihood	1784.3

Type 3 Test of Fixed Effects

	AREA	YEAR
Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	<.0001	0.0036
DF	2	3
CHI SQUARE	21.24	13.52

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
NULL	51	43.3647	0.8503					
YEAR	48	38.9887	0.8123	4.4690	4.4690	-39.8709	4.38	0.2236
AREA	49	40.9176	0.8351	1.7876		-40.8353	2.45	0.2942

FINAL MODEL: YEAR

Akaike's information criterion	-63.1
Schwartz's Bayesian criterion	-64.0
(-2) Res Log likelihood	124.2

Type 3 Test of Fixed Effects

	YEAR
Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	0.2657
DF	3
CHI SQUARE	3.96

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

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
NULL	333	461.8240	1.3869					
AREA	331	410.5401	1.2403	10.5703	10.57034	-205.2701	51.28	<.0001
YEAR	330	455.1271	1.3792	0.5552		-227.5636	6.70	0.0822
AREA + YEAR	328	402.4743	1.2271	11.5221	0.9518	-201.2371	8.07	0.0447
AREA + YEAR + AREA*YEAR	322	380.4385	1.1815	14.8100	3.2879	-190.2192	22.04	0.0012

FINAL MODEL: AREA + YEAR

Akaike's information criterion	-745.9
Schwartz's Bayesian criterion	-747.8
(-2) Res Log likelihood	1489.8

Type 3 Test of Fixed Effects

	AREA	YEAR
Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	<.0001	0.0568
DF	2	3
CHI SQUARE	40.13	7.61

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
NULL	156	2014.2124	12.9116					
AREA	154	1544.0446	10.0263	22.3466	22.3466	1639.0823	470.17	<.0001
YEAR	153	1673.4822	10.9378	15.2870		1574.3635	340.73	<.0001
AREA + YEAR	151	1242.1079	8.2259	36.2906	13.9441	1790.0506	301.94	<.0001
AREA + YEAR + AREA*YEAR	145	1165.7002	8.0393	37.7358	1.4452	1828.2545	76.41	<.0001

FINAL MODEL: AREA + YEAR

Akaike's information criterion	-271.4
Schwartz's Bayesian criterion	-273.0
(-2) Res Log likelihood	540.9

Type 3 Test of Fixed Effects

	AREA	YEAR
Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	<.0001	<.0001
DF	2	3
CHI SQUARE	38.71	27.57

Table 13. Results of the stepwise procedure for development of the catch rate model for large coastal complex. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
NULL	333	374.5373	1.1247					
AREA	331	280.4991	0.8474	24.6555	24.6555	-140.2496	94.04	<.0001
YEAR	330	361.0225	1.0940	2.7296		-180.5112	13.51	0.0036
AREA + YEAR	328	262.4838	0.8003	28.8432	4.1878	-131.2419	18.02	0.0004
AREA + YEAR + AREA*YEAR	322	237.5077	0.7376	34.4181	5.5748	-118.7538	Negative of Hessian not positive definite	

FINAL MODEL: AREA + YEAR

Akaike's information criterion	-849.3
Schwartz's Bayesian criterion	-851.2
(-2) Res Log likelihood	1696.6

Type 3 Test of Fixed Effects

	AREA	YEAR
Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	<.0001	0.0006
DF	2	3
CHI SQUARE	77.05	17.23

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
NULL	250	2871.3738	11.4855					
AREA	248	2169.9059	8.7496	23.8205	23.8205	2888.4938	701.47	<.0001
YEAR	247	2360.8161	9.5580	16.7820		2793.0387	510.56	<.0001
AREA + YEAR	245	1716.1346	7.0046	39.0135	15.1931	3115.3795	453.77	<.0001
AREA +YEAR + AREA*YEAR	239	1650.8249	6.9072	39.8616	0.8480	3148.0343	65.31	<.0001

FINAL MODEL: AREA +YEAR

Akaike's information criterion	-403.1
Schwartz's Bayesian criterion	-404.8
(-2) Res Log likelihood	804.1

Type 3 Test of Fixed Effects

	AREA	YEAR
Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	<.0001	<.0001
DF	2	3
CHI SQUARE	73.69	40.47

Table 14. Results of the stepwise procedure for development of the catch rate model for large coastal complex - prohibited sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
NULL	333	385.2078	1.1568					
AREA	331	288.1862	0.8707	24.7320	24.7320	-144.0931	97.02	<.0001
YEAR	330	376.3308	1.1404	1.4177		-188.1654	8.88	0.0024
AREA + YEAR	328	275.6174	0.8403	27.3600	2.6279	-137.8087	12.57	0.0057
AREA + YEAR + AREA*YEAR	322	253.9716	0.7887	31.8205	4.4606	-126.9858	21.65	0.0014

FINAL MODEL: AREA + YEAR

Akaike's information criterion	-833.2
Schwartz's Bayesian criterion	-835.1
(-2) Res Log likelihood	1664.4

Type 3 Test of Fixed Effects

Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	AREA	YEAR
DF	2	3
CHI SQUARE	77.63	12.42

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
NULL	245	2416.2936	9.8624					
AREA	243	1904.3307	7.8368	20.5386	20.5386	2353.5008	511.96	<.0001
YEAR	242	1922.3817	7.9437	19.4547		2344.4753	493.91	<.0001
AREA + YEAR	240	1460.4894	6.0854	38.2970	17.7584	2575.4214	443.84	<.0001
AREA + YEAR + AREA*YEAR	234	1392.0688	5.9490	39.6800	1.3830	2609.6317	68.42	<.0001

FINAL MODEL: AREA + YEAR

Akaike's information criterion	-381.1
Schwartz's Bayesian criterion	-382.8
(-2) Res Log likelihood	760.2

Type 3 Test of Fixed Effects

Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	AREA	YEAR
DF	2	3
CHI SQUARE	63.36	50.09

Table 15. Results of the stepwise procedure for development of the catch rate model for large coastal complex - prohibited, blacktip and sandbar sharks. %DIF is the percent difference in deviance/DF between each model and the null model. Delta% is the difference in deviance/DF between the newly included factor and the previous entered factor in the model. L is the log likelihood.

PROPORTION POSITIVE-BINOMIAL ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
NULL	333	462.9145	1.3901					
AREA	331	329.2094	0.9946	28.4512	28.4512	-164.6047	133.71	<.0001
YEAR	330	442.0980	1.3397	3.6256		-221.0490	20.82	0.0001
AREA + YEAR	328	299.5105	0.9131	34.3141	5.8629	-149.7553	29.70	<.0001
AREA + YEAR + AREA*YEAR	322	295.7994	0.9186	33.9184	-0.3957	-147.8997	Negative of Hessian not positive definite	

FINAL MODEL: AREA + YEAR

Akaike's information criterion	-613.8
Schwartz's Bayesian criterion	-615.6
(-2) Res Log likelihood	1225.6

Type 3 Test of Fixed Effects

	AREA	YEAR
Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	<.0001	<.0001
DF	1	3
CHI SQUARE	24.48	26.12

POSITIVE CATCHES-POISSON ERROR DISTRIBUTION

FACTOR	DF	DEVIANCE	DEVIANCE/DF	%DIFF	DELTA%	L	CHISQ	PR>CHI
NULL	169	432.9477	2.5618					
YEAR	166	361.8484	2.1798	14.9114	14.9114	161.6181	71.10	<.0001
AREA	168	420.7192	2.5043	2.2445		132.1827	12.23	0.0005
YEAR + AREA	165	349.5498	2.1185	17.3042	2.3928	167.7673	12.30	0.0005
YEAR + AREA + YEAR*AREA	162	337.5426	2.0836	18.6666	1.3623	173.7710	12.01	0.0074

FINAL MODEL: YEAR + AREA

Akaike's information criterion	-381.1
Schwartz's Bayesian criterion	-382.8
(-2) Res Log likelihood	760.2

Type 3 Test of Fixed Effects

	YEAR	AREA
Significance (Pr>Chi) of Type 3 test of fixed effects for each factor	0.0001	0.0221
DF	3	1
CHI SQUARE	20.50	5.24

Table 16. Lo et al. method relative (index/mean) standardized abundance indices based on the standardized year effects obtained from the Lo et al. analyses. CV = coefficient of variation, N = the number of sets observed.

blacktip sharks

YEAR	REL INDEX	LCL	UCL	CV	N
1996	0.202	-19.539	19.944	49.744	91
1998	1.578	-23.994	27.149	8.270	89
2001	0.797	-22.407	24.000	14.861	85
2004	1.423	24.002	26.849	9.114	69

sandbar sharks

YEAR	REL INDEX	LCL	UCL	CV	N
1996	0.321	-4.703	5.345	7.985	91
1998	2.045	-4.681	8.772	1.678	89
2001	1.004	-4.797	6.805	2.947	85
2004	0.629	-5.424	6.683	4.909	69

large coastal complex

YEAR	REL INDEX	LCL	UCL	CV	N
1996	0.232	0.112	0.352	0.263	91
1998	1.609	1.219	1.999	0.124	89
2001	1.051	0.760	1.342	0.141	85
2004	1.108	0.788	1.428	0.147	69

large coastal complex - prohibited

YEAR	REL INDEX	LCL	UCL	CV	N
1996	0.258	-1.246	1.762	2.973	91
1998	1.750	-0.234	3.734	0.578	89
2001	1.037	-0.752	2.825	0.880	85
2004	0.955	-0.829	2.739	0.953	69

large coastal complex – prohibited, blacktip and sandbar

YEAR	REL INDEX	LCL	UCL	CV	N
1996	0.212	-2.646	3.071	6.866	91
1998	1.127	-2.706	4.960	1.735	89
2001	1.282	-1.964	4.528	1.292	85
2004	1.379	-1.983	4.740	1.244	69

Figure 1

Current Survey Stations

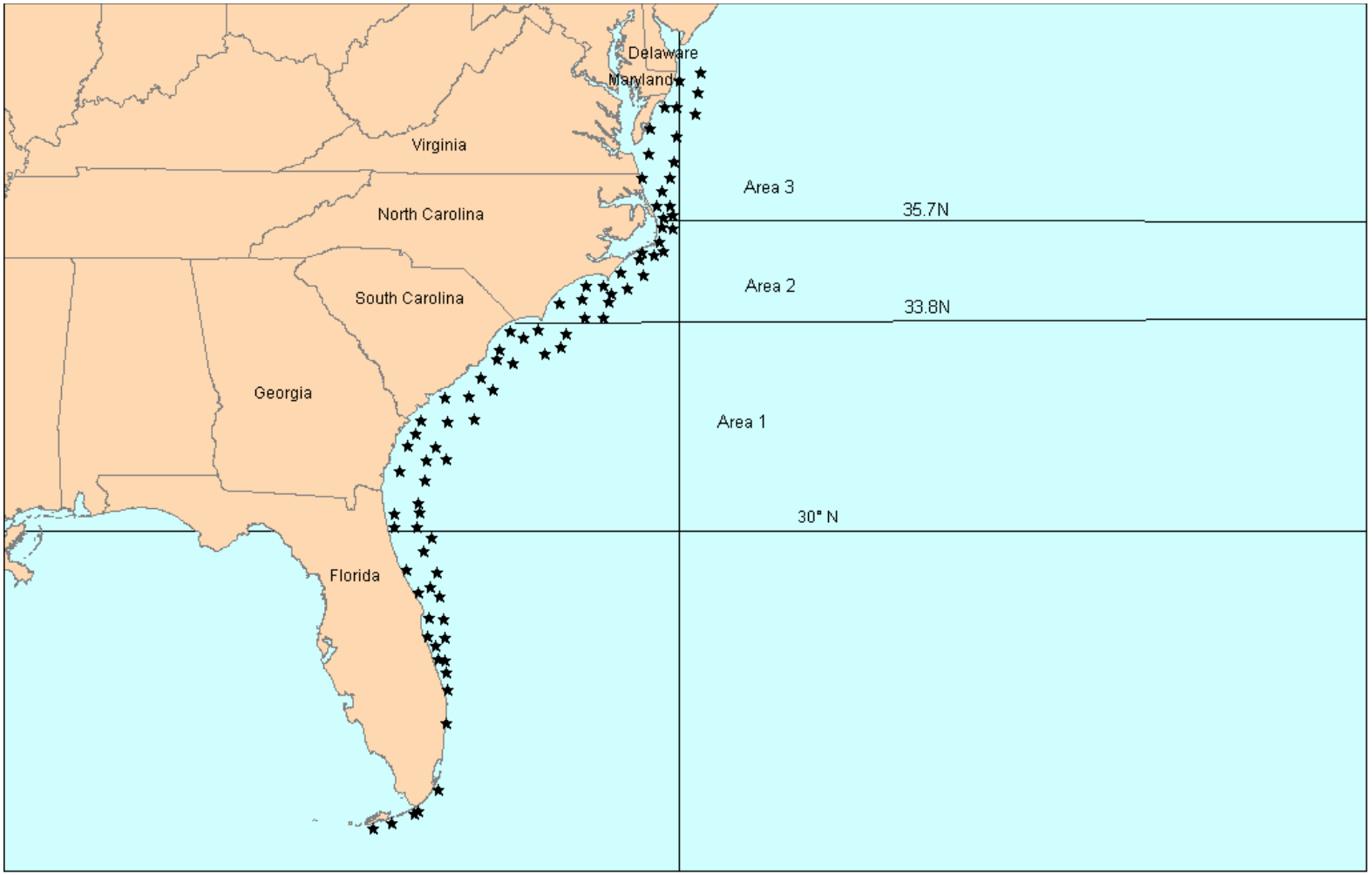

Figure 2

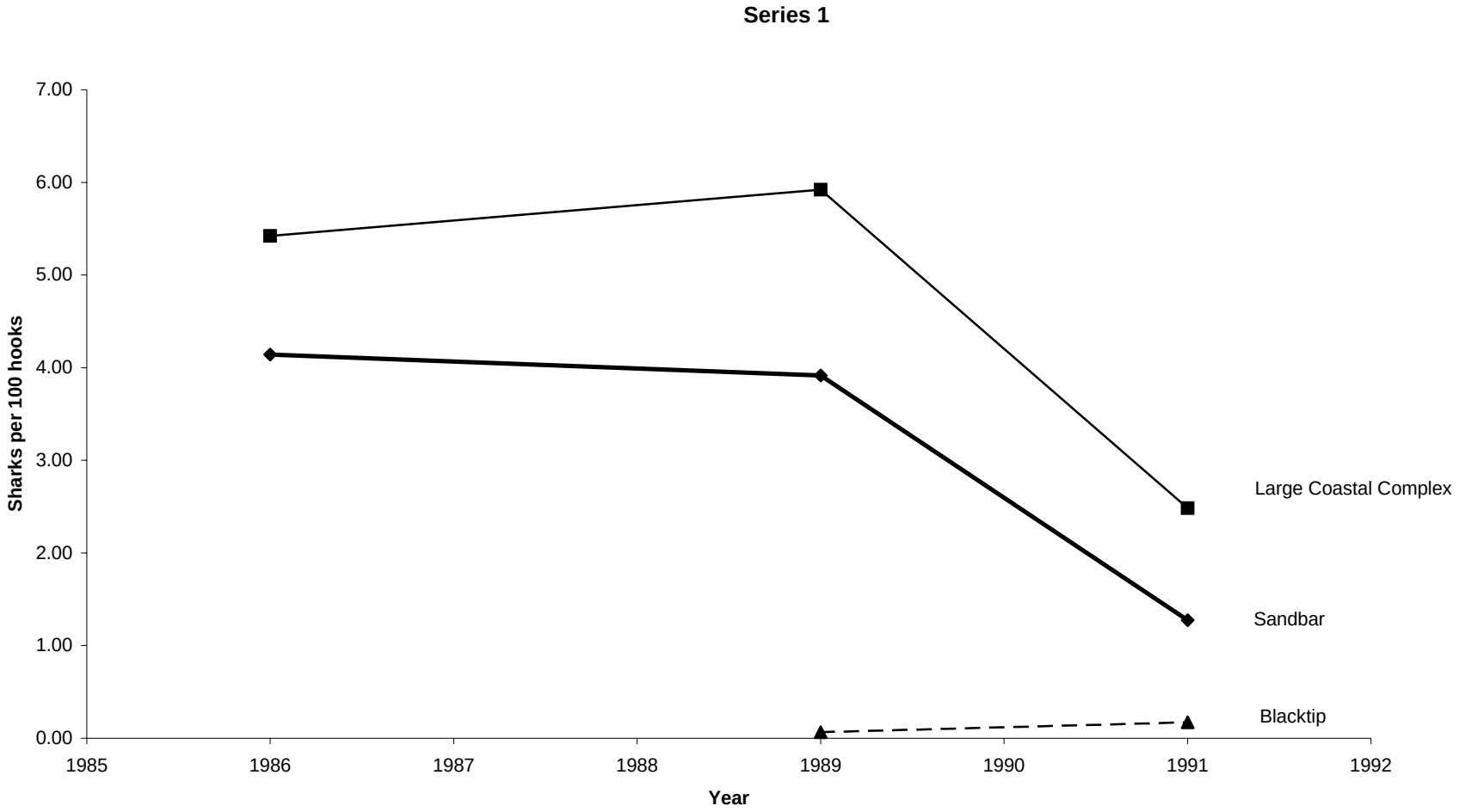
Series 1
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Sharks per 100 hooks
1985
1986
1987
1988
1989
1990
1991
1992
Year
Large Coastal Complex
Sandbar
Blacktip

Figure 3

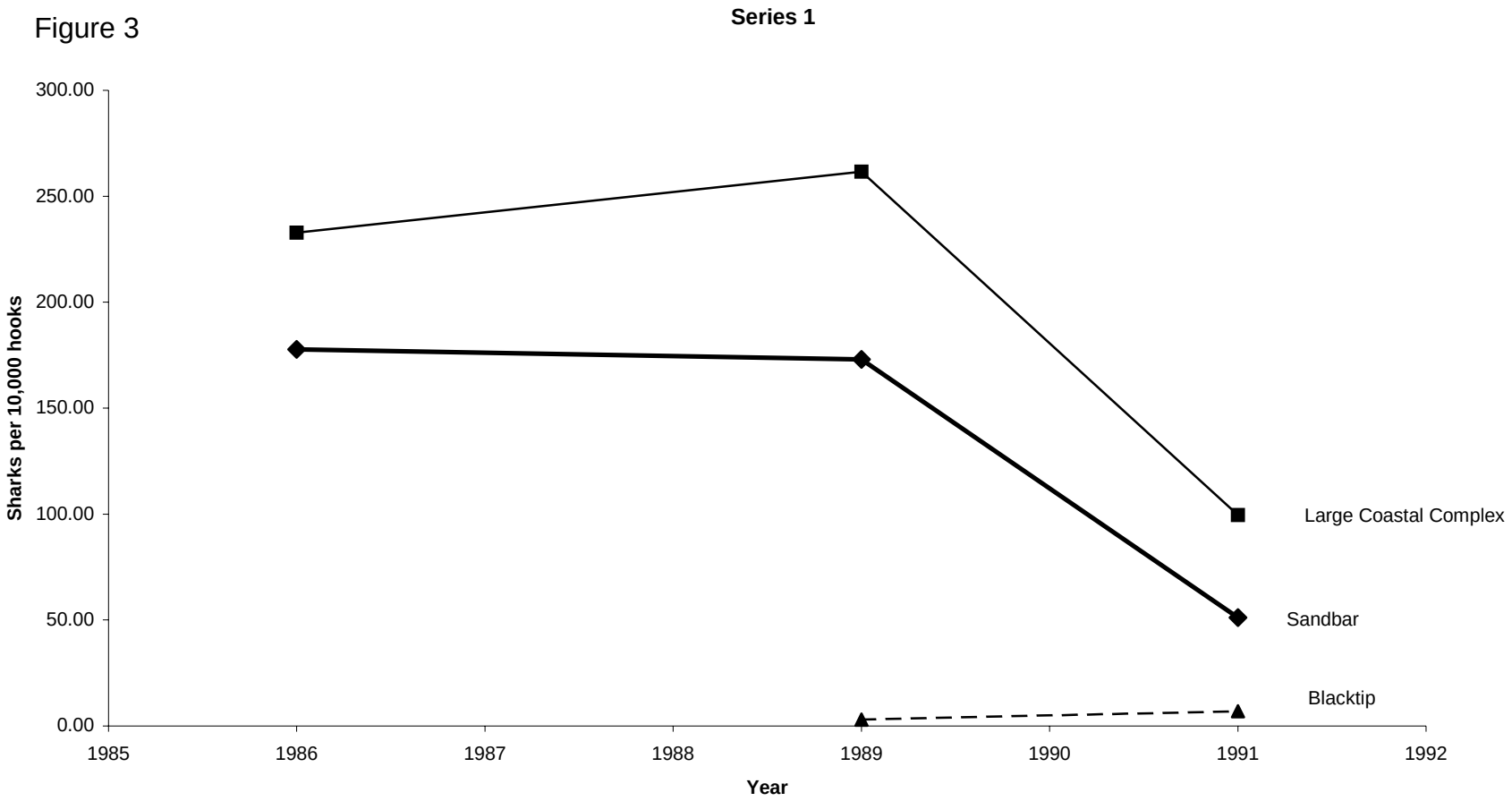
Series 1
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Sharks per 10,000 hooks
1985
1986
1987
1988
1989
1990
1991
1992
Year
Large Coastal Complex
Sandbar
Blacktip

Figure 4

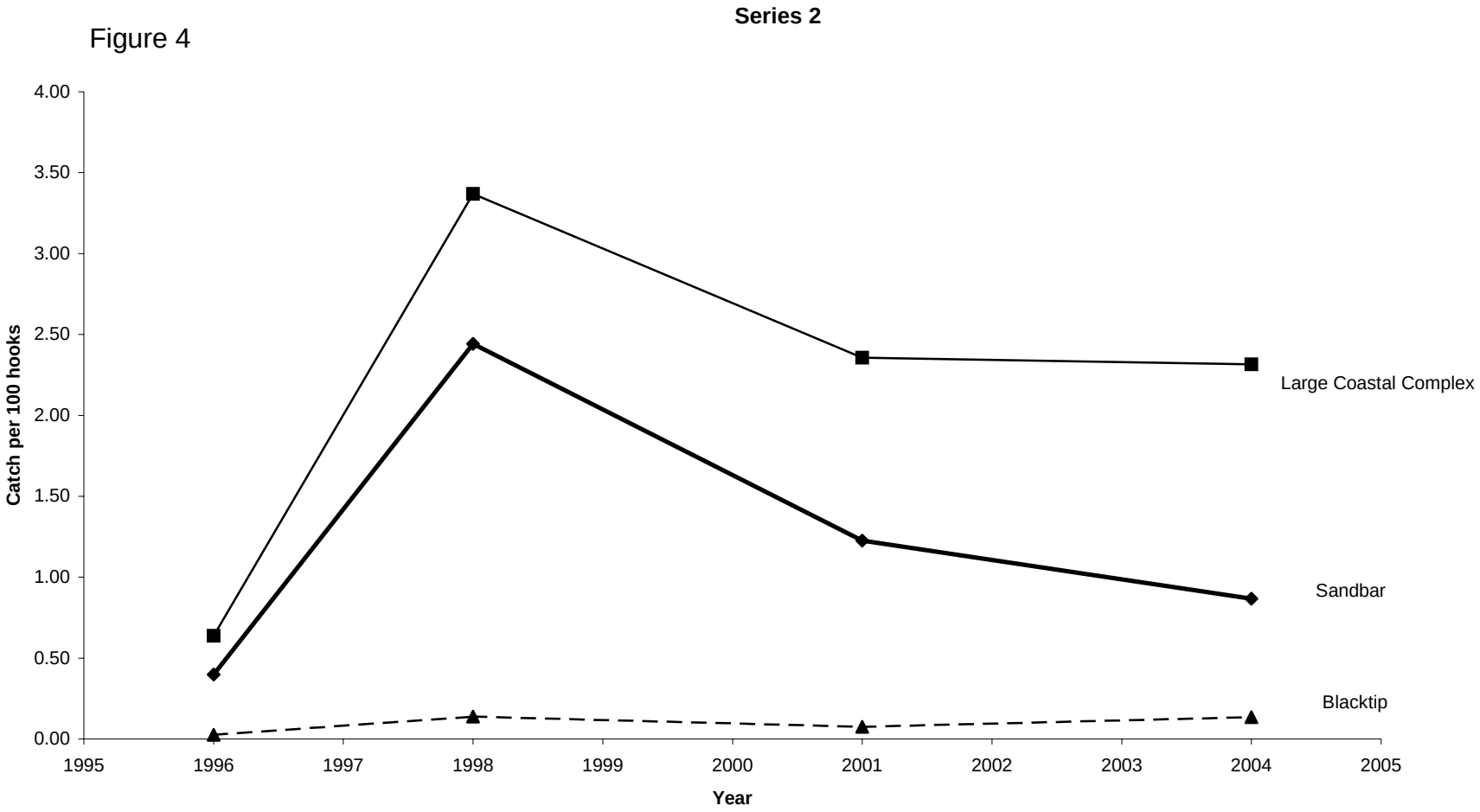
Series 2
Catch per 100 hooks
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year
Large Coastal Complex
Sandbar
Blacktip

Figure 5

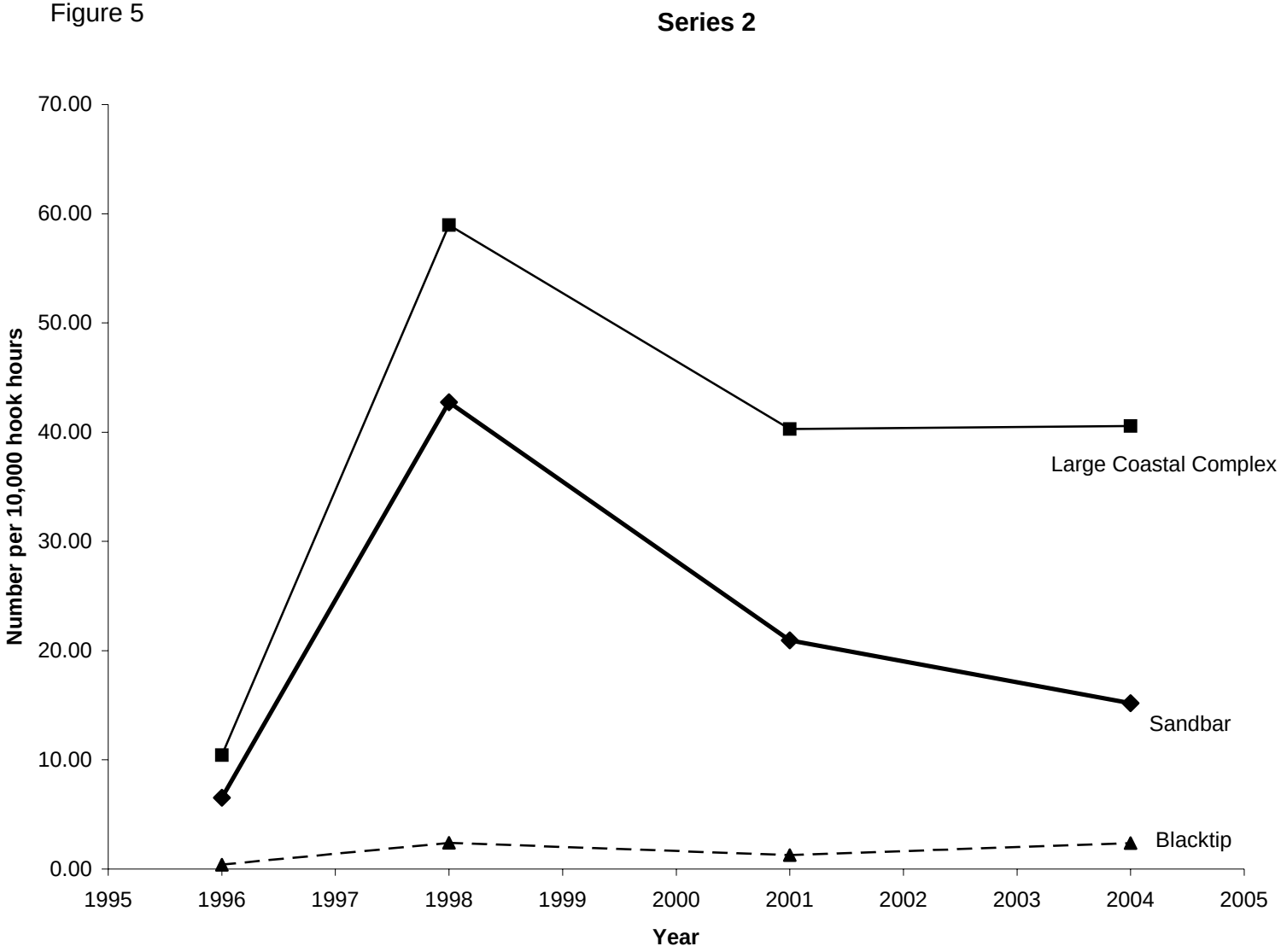
Series 2
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Number per 10,000 hook hours
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year
Large Coastal Complex
Sandbar
Blacktip

Figure 6 Relative (index/mean) indices of abundance by year for blacktip sharks.

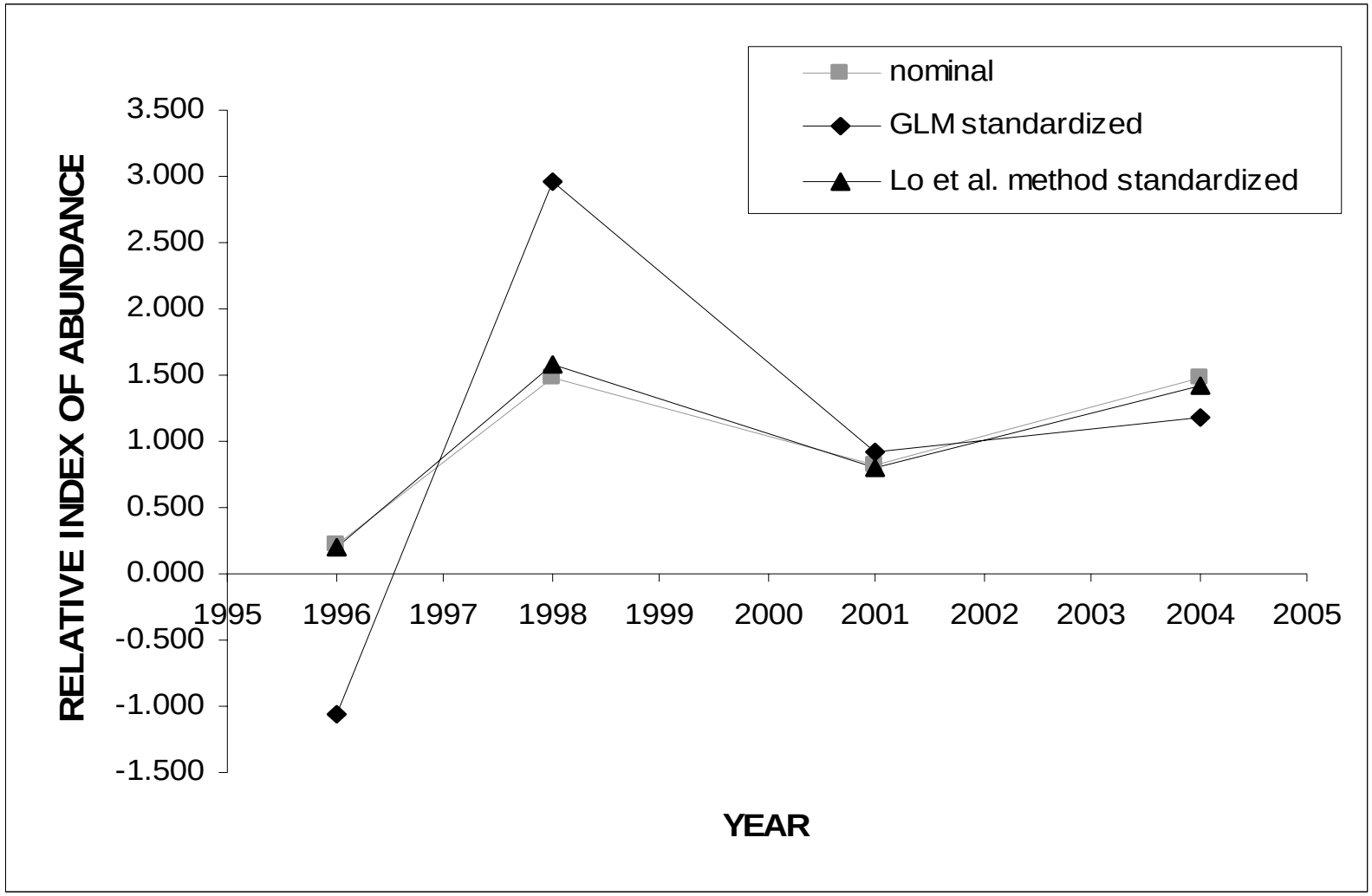

Figure 7. Relative (index/mean) indices of abundance by year for sandbar sharks.

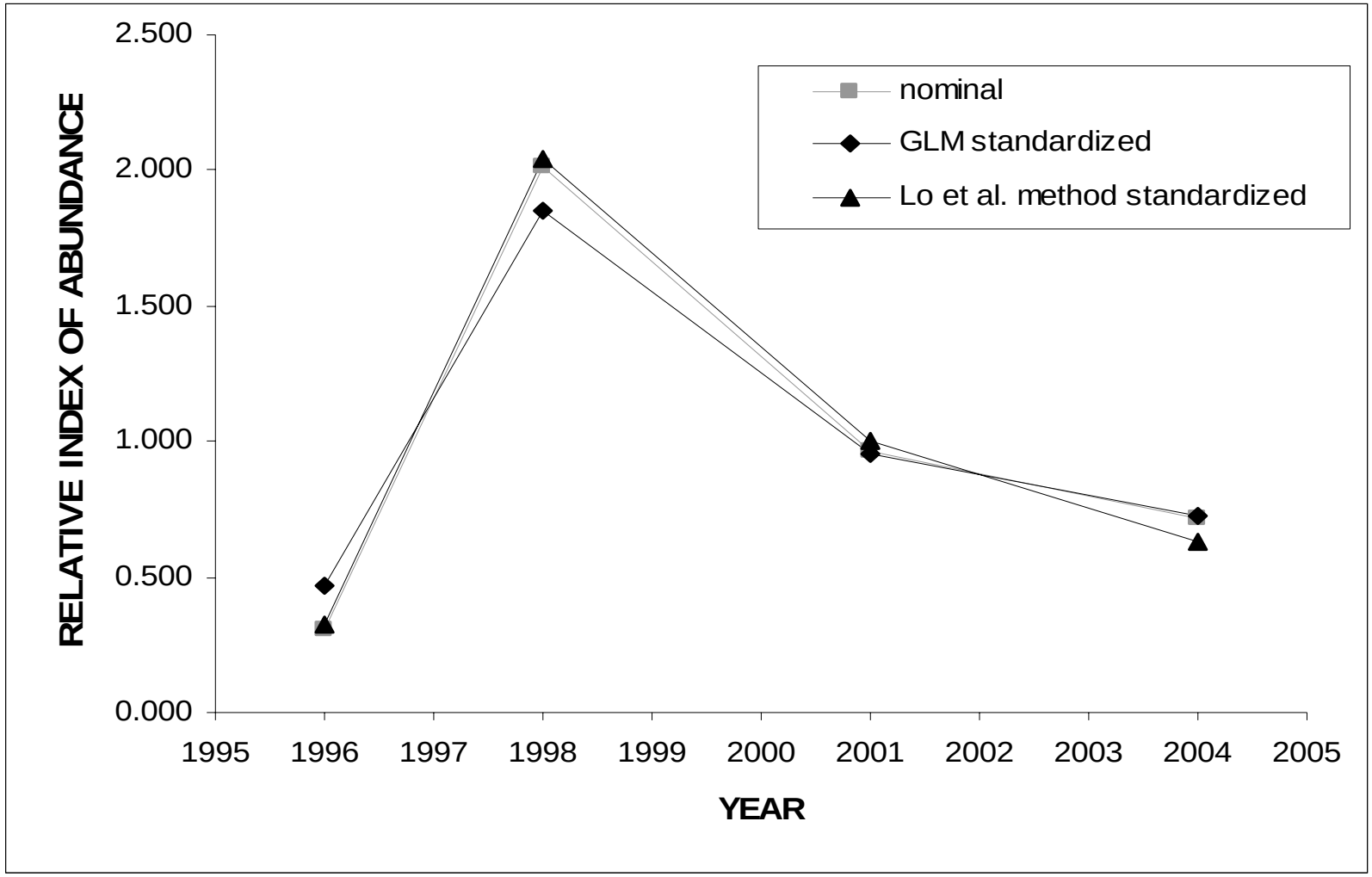

Figure 8. Relative (index/mean) indices of abundance by year for the large coastal complex.

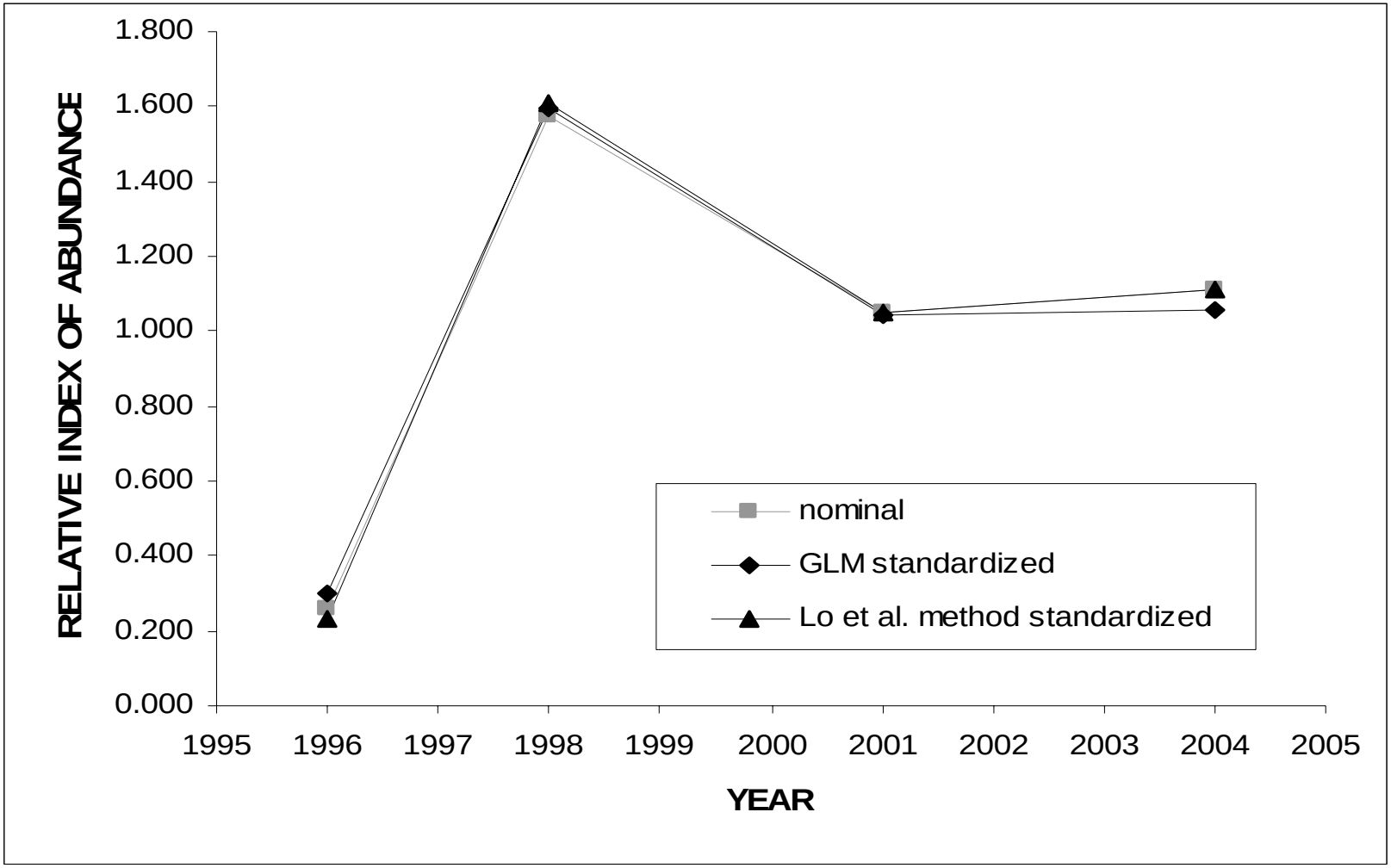

Figure 9. Relative (index/mean) indices of abundance by year for the large coastal complex minus prohibited sharks.

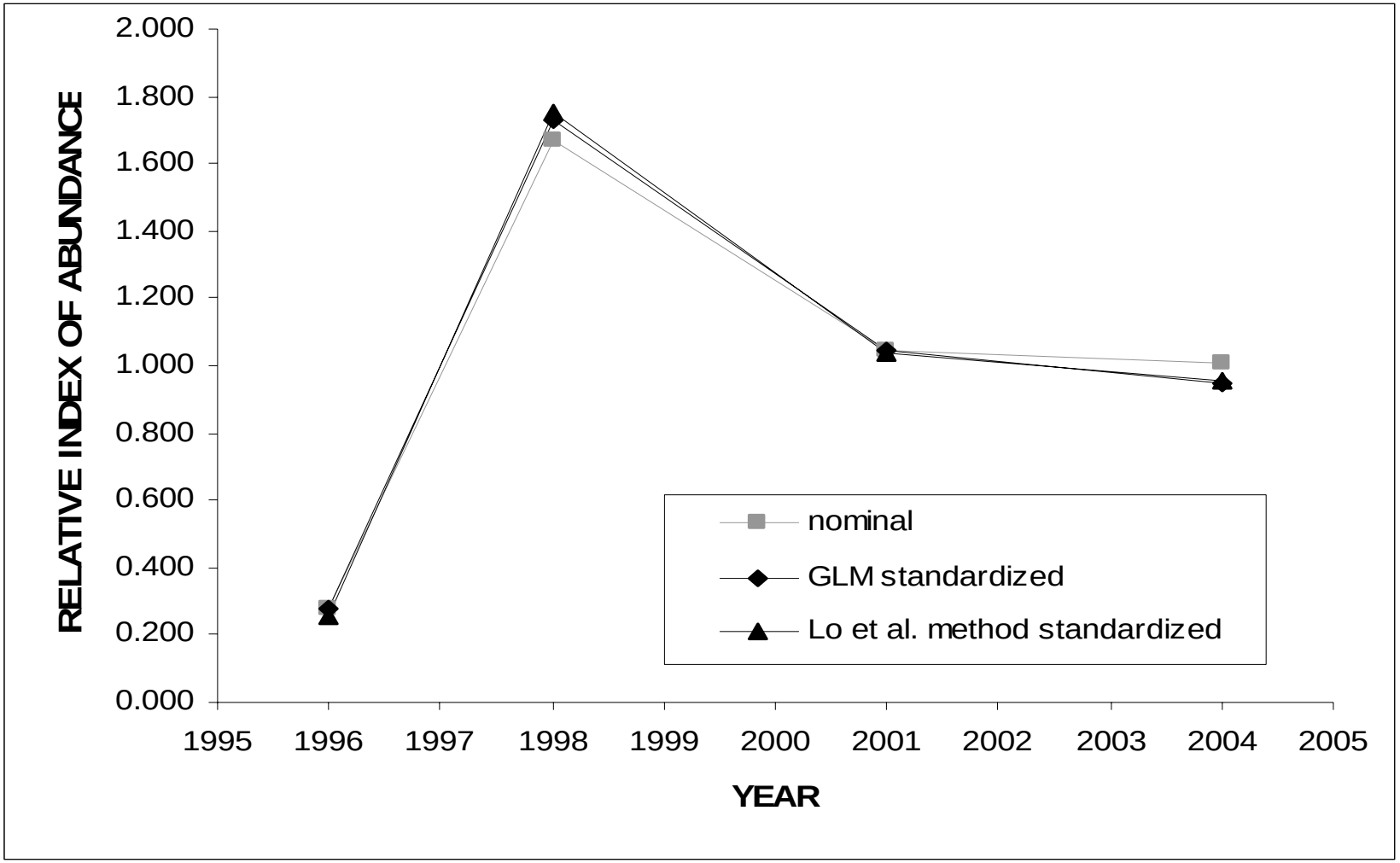

Figure 10. Relative (index/mean) indices of abundance by year for the large coastal complex minus prohibited, blacktip and sandbar sharks.