Fishery-Independent Catch of Small Coastal Sharks in Texas Bays, 1975-2006

Mark R. Fisher
Texas Parks and Wildlife Department
702 Navigation Circle
Rockport TX 78382

Summary

The Texas Parks and Wildlife Department's long-term fishery-independent monitoring program provides sound scientific information on catch rates, sizes, and distribution of small coastal sharks. Catch rates of the small coastal shark complex have been increasing over time, mostly due to bonnetheads. Lengths indicate no change in the size composition over time. Spatial distribution of catches indicates small coastal sharks are most commonly found in areas with salinities between 20 and 35‰ and particularly along the middle Texas coast.

Introduction

The Texas Parks and Wildlife Department conducts a long-term standardized fishery-independent monitoring program to assess the relative abundance and size of finfish and shellfish in Texas bays (Martinez-Andrade et al. 2005). The TPWD initiated this standardized monitoring program in 1975 using gill nets, with bag seines added in 1977, shrimp trawls in 1982 and oyster dredges in 1984. Shrimp trawls were expanded into Gulf waters in 1985. Of these 4 gears, small coastal sharks (bonnethead, Atlantic sharpnose, finetooth and blacknose) are only routinely captured by gill nets, and only results from that gear will be presented.

Methods

Gill nets are used in each of the ten major Texas bay systems: Sabine Lake, Galveston, Cedar Lakes, East Matagorda, Matagorda, San Antonio, Aransas, Corpus Christi, upper Laguna Madre and lower Laguna Madre (Figure 1). Annual sample sizes by year and bay system are given in Table 1.

The monitoring program utilizes a stratified random sample design, with each of the 10 bay systems as an independent stratum. Gill net sample locations are randomly selected from grids (1 minute latitude by 1 minute longitude) containing ≥15.2 m of shoreline, with each selected grid further subdivided into 144 5-second "gridlets". Sample sites are then randomly selected from gridlets containing ≥15.2 m of shoreline.

Gill nets (monofilament, 183 m long; 1.2 m deep with separate 45.7 m sections of 7.6, 10.2, 12.7 and 15.2 cm stretched mesh tied together in ascending mesh size) are set overnight during each spring and fall season. The spring season begins with the 2nd full week in April and extends for 10 weeks. The fall season begins with the 2nd full week in

Survey Year	*Nominal Frequency*	*N*	*Scaled Index*	*CV*	*LCL*	*UCL*
2001	0.075188	399	1.57041	0.24285	0.83075	2.16425
2002	0.053050	377	1.56393	0.29936	0.74324	2.39916
2003	0.057789	398	1.08511	0.28321	0.53161	1.61477
2004	0.063830	376	1.54939	0.27279	0.77416	2.26067
2005	0.058691	443	1.17065	0.26428	0.59445	1.68069
2006	0.066667	285	1.25440	0.30974	0.58467	1.96206

Atlantic Sharpnose Shark Results

No significant variables were found when running the lognormal submodel. Therefore, the final abundance indices were based only on the occurrence submodel results.

Survey Year	*Scaled Index*	*CV*	*LCL*	*UCL*
1975	1.0797733	1.06271981	0.34331249	3.3960616
1976	0.5537477	1.06777917	0.17539189	1.74829381
1977	0.4786193	1.06744248	0.1516345	1.5107146
1979	0.9829355	0.57739858	0.48471379	1.99326318
1980	0.3294385	1.05840538	0.10508754	1.03275514
1981	0.2784245	1.05569448	0.08899772	0.87103613
1982	0.1666497	1.04405621	0.05374468	0.51674149
1983	0.4628594	0.57609736	0.22856569	0.93731856
1984	1.3164879	0.31216346	0.88078322	1.96772653
1985	1.0677477	0.37421458	0.66258815	1.72065423
1986	2.5601893	0.2178492	1.92759537	3.40038651
1987	0.4736825	0.74371994	0.19755119	1.13578206
1988	2.1766356	0.23826694	1.59690082	2.96683583
1989	0.8753379	0.37621114	0.54189488	1.41395771
1990	0.6525476	0.44161009	0.37411265	1.13820906
1991	1.1006599	0.3746406	0.68266413	1.77459473
1992	0.5776724	0.57740769	0.28486412	1.17145456
1993	0.5307725	0.5753637	0.2623069	1.07400701
1994	0.7025489	0.44099099	0.40306679	1.22454865
1995	0.4390614	0.57517659	0.21702668	0.8882544
1996	1.8911856	0.24638554	1.37332586	2.60432209
1997	0.7171062	0.57519859	0.35445505	1.45079404
1998	0.6538135	0.49690223	0.35201548	1.2143559
1999	2.0354929	0.23902363	1.49192251	2.77710896
2000	1.6120648	0.27506871	1.12925708	2.30129436
2001	0.216018	1.04746557	0.06948433	0.67157233
2002	1.6582685	0.31164122	1.11016075	2.47698753
2003	1.8665014	0.27724652	1.30394349	2.67176268
2004	1.3652233	0.33337969	0.88997806	2.09424793
2005	1.1399013	0.35091616	0.72744868	1.78620858
2006	1.038633	0.37129799	0.64677314	1.66790878

Finetooth Shark Results

No significant variables were found when running the lognormal submodel. Therefore, the final abundance indices were based only on the occurrence submodel results.

Survey Year	*Scaled Index*	*CV*	*LCL*	*UCL*
1976	0.6239668	1.06890709	0.19746489	1.97166472
1979	0.4837901	1.06720087	0.15330063	1.52675754
1980	1.0581532	0.57910075	0.52086213	2.14968262
1981	0.7035265	0.75203507	0.29110377	1.70025132
1982	1.0370078	0.40747664	0.61863771	1.73831169
1983	1.5550712	0.35354108	0.98925583	2.44451052
1984	1.0933956	0.40564061	0.65368603	1.82888109
1985	0.8480204	0.49890909	0.4555544	1.57860089
1986	1.3991235	0.35119647	0.89257362	2.19314861
1988	0.4508385	0.7518077	0.18658714	1.08933193
1989	0.5563014	0.58425721	0.27233789	1.13635022
1990	2.1163065	0.28588676	1.46264105	3.06209993
1991	1.0740123	0.44536505	0.61308347	1.88147702
1992	0.9744525	0.5017179	0.5218353	1.81965022
1993	0.2785031	1.06580196	0.08834366	0.87798014
1994	1.1233517	0.40690196	0.67059985	1.88177646
1995	1.2933963	0.37758856	0.7993868	2.0926965
1996	2.3233556	0.2641259	1.64994422	3.27161439
1997	0.7482844	0.75167785	0.30972821	1.80780923
1999	0.6683722	0.49934089	0.35887478	1.24478357
2000	1.5841461	0.33164627	1.0348758	2.42494702
2001	0.2822917	1.06616729	0.08952074	0.89016901
2002	0.9154215	0.49903754	0.49169157	1.70431336
2003	1.7295211	0.3360163	1.12384765	2.66160909
2004	1.0237919	0.44879518	0.58211423	1.80059133
2005	0.8007956	0.49895478	0.43016339	1.49076733
2006	0.2548026	0.49965422	0.13676547	0.47471309

SCS Complex Results

No significant variables were found when running the lognormal submodel. Therefore, the final abundance indices were based only on the occurrence submodel results.

Survey Year	*Scaled Index*	*CV*	*LCL*	*UCL*
1975	0.7264455	0.70981637	0.31301701	1.68592474
1976	1.2056921	0.29968584	0.81915939	1.77461604
1977	0.3470008	0.55481728	0.17530768	0.6868472
1978	0.3489771	0.55450684	0.1763652	0.69052756
1979	0.669463	0.34243542	0.43163949	1.03832171
1980	1.0190988	0.24822237	0.73832922	1.40663869
1981	0.3988781	0.37089182	0.24850842	0.64023466
1982	0.6989424	0.21404336	0.52879891	0.92383031
1983	1.2626747	0.16707969	1.01463791	1.57134608
1984	1.4039783	0.14920821	1.15457455	1.7072566
1985	0.9151797	0.20262732	0.7025633	1.19214021
1986	1.3871799	0.14757212	1.14318295	1.68325482
1987	0.2335298	0.44435825	0.13346157	0.40862811
1988	1.2717326	0.15501166	1.03798701	1.55811561
1989	0.8792774	0.1866829	0.68893904	1.12220202
1990	1.1823062	0.16172169	0.95665611	1.46118115
1991	1.2442294	0.17524818	0.98933753	1.56479142
1992	0.8219655	0.23542376	0.60521275	1.11634666
1993	1.0363912	0.19799778	0.80034239	1.34205912
1994	0.8590206	0.19957822	0.66202882	1.11462883
1995	0.7506549	0.21301009	0.56867157	0.99087559
1996	1.2557577	0.14990164	1.03175609	1.52839166
1997	0.8438692	0.25644028	0.60508631	1.176882
1998	0.9607987	0.20346246	0.73679674	1.25290216
1999	1.0767402	0.16503518	0.86751545	1.33642508
2000	1.2817786	0.15199794	1.05027826	1.56430593
2001	1.3491367	0.1706543	1.07912585	1.68670758
2002	1.2182085	0.1814249	0.96097483	1.54429842
2003	1.536224	0.15190823	1.25891486	1.87461772
2004	1.3868506	0.16494478	1.11749782	1.72112596
2005	1.3252567	0.16105381	1.07325001	1.6364363
2006	1.1027611	0.22685185	0.82083335	1.48152131

September and extends for 10 weeks. Gill nets are set perpendicular to shore with the smallest mesh shoreward. Nets are set within 1 h before sunset and retrieved within 4 h after the following sunrise. Total fishing time is recorded (nearest 0.1 h), typically between 12 and 14 hours. No grid is sampled more than once per season.

All organisms caught are identified by species and counted. Catch rates are calculated by dividing total number captured by total effort (hours fished). Coastwide estimates are calculated by weighting each stratum by its total shoreline.

Lengths of organisms caught are recorded. In gill nets, up to 19 individuals of each species are measured, within each mesh size, on each sampling day.

In addition to lengths and numbers caught, salinity (‰), water temperature (^{o}C), dissolved oxygen (ppm) and turbidity (Nephelometric Turbidity Units) are measured at the set and pickup for each gill net sample.

Results

A total of 21,310 gill net samples were taken from 1975-2006. Locations of each sample are plotted in Figure 2.

A total of 2,689 small coastal sharks were caught from 1975-2006—1,787 bonnetheads, 559 Atlantic sharpnose, 342 finetooth and 1 blacknose shark. Small coastal sharks were caught in each of the 10 bay strata. Catch rates for the small coastal shark complex and for each species (except blacknose sharks) are presented in Table 2 and Figures 3-6. The single blacknose shark was captured in San Antonio Bay in May 1982.

Catch rates are extremely variable, but exhibit an overall increasing trend over time both for the small coastal shark complex and for bonnetheads (bonnetheads compose two-thirds of the total catch, so these results should mirror each other). Atlantic sharpnose and finetooth shark catch rates are variable, but exhibit no apparent trend over time.

Scatterplots of lengths (TL) of each species display no trend over time (Figures 7-9). Bonnetheads are the smallest of the three species with most ranging between 400 and 1,100 mm. Atlantic sharpnose sharks caught were larger, ranging between 400 and 1,400 mm, but finetooths were the largest, ranging from 500 to 1,500 mm. For the small coastal shark complex, lengths ranged from 230 to 1,750 mm, with 90% between 504 and 986 mm. The interquartile range was 585 to 814 mm.

Gill net capture locations of small coastal sharks (Figure 10) indicate most were caught in the lower portions of each bay system and particularly along the central coast from west Galveston Bay to Corpus Christi Bay. Few sharks were caught in Sabine Lake and the upper portions of Galveston, San Antonio and Aransas Bay. Catches from the lower Laguna Madre were concentrated near each of the two Gulf passes (Mansfield and Brazos Santiago pass) and were sparse in the middle, often hypersaline, section of the lower Laguna Madre.

Annual coastwide catch rates were analyzed for yearly trends and for relationships with mean annual coastwide salinity using general linear models. Results are presented in Tables 3-6. Catch rates of the small coastal shark complex are significantly increasing over time, and are positively related to salinity (Table 3). Higher catches are observed in higher salinities, which agrees with the spatial distribution of catches in Figure 10. Bonnethead catch rates are significantly increasing over time, but are weakly related to salinity (Table 4). Neither Atlantic sharpnose or finetooth catch rates have significantly changed over time, but both are positively related to salinity (Tables 5 and 6).

Finally, numbers of small coastal sharks caught by salinity zone are depicted in Figure 11. Few sharks were caught in salinities less than 20‰ and greater than 45‰, with the highest catches occurring between 25 and 35‰.

Discussion

Fishery-independent gill net catch rates of small coastal sharks have been generally increasing from 1975-2006. Bonnethead catches dominate the small coastal shark complex and are the only species with an increased catch rate. Atlantic sharpnose and finetooth sharks demonstrate a flat trend in cpue over time.

Only one blacknose shark was encountered in 21,310 gill net samples. However, the Texas Parks and Wildlife Department's creel survey intercepted a total of 16 blacknose sharks from 1975-2006, (10 since 2000) but all were caught from the Gulf, not from Texas bays. This species is apparently uncommon off Texas, and only rarely enters Texas bays.

Lengths of small coastal sharks show no change in the size composition over time, indicating little or no change in mortality. Small coastal sharks are not targeted by Texas recreational anglers and typically compose less than 2% of bay sport boat landings (Green and Campbell 2005). Also, as commercial gill nets (and other entangling gears) were outlawed in Texas waters in 1988, the only legal method to harvest a shark is by rod and reel. Strict daily bag and size limits have been in place for both recreational and commercial fishers (1/day, 24" (610 mm) minimum) since September 2000. The previous daily bag of 5/day was enacted in September, 1989.

Salinity preferences of small coastal sharks affect their distribution and abundance in Texas bays. Sabine Lake salinities are strongly influenced by high rainfall rates in southeast Texas and freshwater runoff from the Sabine River; salinities below 15‰ are typical. Shark catches there are low (Figure 10). Similarly, the upper sections of Galveston, San Antonio and Aransas bays are also influenced by river runoff and salinities are typically low, except during periods of extreme drought. Conversely, hypersaline conditions in parts of the Laguna Madre (due to high evaporation rates and little freshwater inflow) also limit the distribution of small coastal sharks; most catches are clustered near the two Gulf inlets.

Small coastal shark catch rates are lower during periods of high rainfall (=low salinity) and higher during drought years. Catch rates increased during the extended drought of the late 1980's, then declined during the high rainfall experienced from 1991-1995. A drought in the late '90's led to increased catches, but normal to above average rainfall from 2001-2004 has caused catch rates to taper off.

References

Green, L. M. and R. Page Campbell. 2005. Trends in Finfish Landings of Sport-Boat Anglers in Texas Marine Waters, May 1974-May 2003. Management Data Series Number 234. Texas Parks and Wildlife Department, Coastal Fisheries Division, Austin.

Martinez-Andrade, F., P. Campbell and B. Fuls. 2005. Trends in Relative Abundance and Size of Selected Finfishes and Shellfishes Along the Texas Coast: November 1975-December 2003. Management Data Series Number 232. Texas Parks and Wildlife Department, Coastal Fisheries Division, Austin.

Table 1. Annual sample sizes for gill nets, by bay and year.

Year	Sabine Lake	Galveston	Cedar Lakes	East Matagorda	Matagorda	San Antonio	Aransas	Corpus Christi	Upper Laguna Madre	Lower Laguna Madre	Total
1975	2	10	0	0	6	6	6	6	6	6	48
1976	0	14	0	4	9	9	9	9	10	90	73
1977	0	16	0	12	14	14	14	14	14	14	112
1978	0	16	0	16	16	16	16	16	16	16	128
1979	0	32	0	24	32	32	32	32	32	32	248
1980	0	24	0	24	24	24	24	24	24	24	192
1981	0	53	0	16	53	53	53	53	53	53	387
1982	0	90	0	20	90	90	90	90	90	90	650
1983	0	90	0	20	90	90	90	90	90	90	650
1984	0	90	0	28	90	90	90	90	90	90	658
1985	0	90	0	40	90	90	90	90	90	90	670
1986	90	90	0	40	90	90	90	90	90	90	760
1987	90	90	0	40	90	90	90	90	90	90	760
1988	90	90	0	40	90	90	90	90	90	90	760
1989	90	90	0	40	90	90	90	90	90	90	760
1990	90	90	0	40	90	90	90	90	90	90	760
1991	90	90	0	40	90	90	90	90	90	90	760
1992	90	90	0	40	90	90	90	90	90	90	760
1993	90	90	0	40	90	90	90	90	90	90	760
1994	90	90	0	40	90	90	90	90	90	90	760
1995	90	90	0	40	90	90	90	90	90	90	760
1996	90	90	40	40	90	90	90	90	90	90	800
1997	90	90	40	40	90	90	90	90	90	90	800
1998	90	90	40	40	90	90	90	90	90	90	800
1999	90	90	40	40	90	90	90	90	90	90	800
2000	90	90	20	40	90	90	90	90	90	90	780
2001	90	90	20	40	90	90	90	90	90	90	780
2002	90	90	20	40	90	90	90	90	90	90	780
2003	90	90	20	40	90	90	90	90	90	90	780
2004	90	90	20	40	90	90	90	90	90	90	780
2005	90	90	20	40	90	90	90	90	90	90	780
2006	90	90	20	40	90	90	90	90	90	90	780
Total	1,898	2,600	300	1,186	2,554	2,554	2,560	2,548	2,556	2,554	21,310

Table 2. Coastwide catch/hour (standard error) of small coastal sharks and coastwide salinity (standard error) from Texas Parks and Wildlife Department gill net samples, by year.

Year	Number of gill net sets	Small Coastal Shark Complex	Bonnethead	Atlantic Sharpnose	Finetooth	Salinity, ‰
1975	48	0.00127 (0.0014)	0.00127 (0.0014)	0 (0)	0 (0)	19.97 (1.3)
1976	73	0.00518 (0.00276)	0.00249 (0.00213)	0 (0)	0.00269 (0.0018)	18.17 (1.03)
1977	112	0.00065 (0.00068)	0 (0)	0.00065 (0.00068)	0 (0)	21.46 (1.01)
1978	128	0.00201 (0.00111)	0.00201 (0.00111)	0 (0)	0 (0)	23.33 (0.87)
1979	248	0.00432 (0.00236)	0.00103 (0.00072)	0.00226 (0.00158)	0.00103 (0.00101)	15.82 (0.67)
1980	192	0.00803 (0.00294)	0.0066 (0.00286)	0.0008 (0.00056)	0.00063 (0.00049)	22.98 (0.67)
1981	387	0.00902 (0.00529)	0.00858 (0.00529)	0.0002 (0.0002)	0.00024 (0.00021)	17.59 (0.55)
1982	650	0.00845 (0.00262)	0.00486 (0.00228)	0.00122 (0.00056)	0.00226 (0.00112)	22.77 (0.4)
1983	650	0.01105 (0.00328)	0.00872 (0.00316)	0.00088 (0.00067)	0.00145 (0.00054)	21.53 (0.44)
1984	658	0.01326 (0.0026)	0.0098 (0.00234)	0.00199 (0.00066)	0.00146 (0.00065)	27.02 (0.38)
1985	670	0.00866 (0.00234)	0.00322 (0.00126)	0.00384 (0.00122)	0.0016 (0.00094)	23.43 (0.41)
1986	760	0.01652 (0.00338)	0.00737 (0.00196)	0.00492 (0.00152)	0.00422 (0.002)	26.48 (0.42)
1987	760	0.00185 (0.00058)	0.00066 (0.00027)	0.00119 (0.00051)	0 (0)	22.01 (0.38)
1988	760	0.01816 (0.00428)	0.00978 (0.00284)	0.00828 (0.00304)	0.0001 (0.0001)	27.87 (0.39)
1989	760	0.00731 (0.00173)	0.00455 (0.00125)	0.0021 (0.00113)	0.00065 (0.00044)	29.18 (0.46)
1990	760	0.01557 (0.00431)	0.01289 (0.0041)	0.00092 (0.0005)	0.00176 (0.00074)	25.79 (0.44)
1991	760	0.00626 (0.0015)	0.00482 (0.00135)	0.00092 (0.00051)	0.00052 (0.00026)	20.72 (0.4)
1992	760	0.00275 (0.00081)	0.00161 (0.00056)	0.00036 (0.00023)	0.00078 (0.00052)	17.4 (0.41)
1993	760	0.00833 (0.00236)	0.00797 (0.00235)	0.00028 (0.00017)	0.00008 (0.00009)	19.96 (0.4)
1994	760	0.00859 (0.00351)	0.00728 (0.00346)	0.00071 (0.00048)	0.00061 (0.00032)	21.26 (0.41)
1995	760	0.00497 (0.00216)	0.00398 (0.00213)	0.00046 (0.00022)	0.00053 (0.00026)	22.65 (0.4)
1996	800	0.01357 (0.00278)	0.00458 (0.00105)	0.00356 (0.00116)	0.00543 (0.00218)	29.61 (0.36)
1997	800	0.00215 (0.00071)	0.00136 (0.00054)	0.00066 (0.00045)	0.00013 (0.00011)	16.89 (0.42)
1998	800	0.0122 (0.00466)	0.01189 (0.00466)	0.00031 (0.0002)	0 (0)	19.38 (0.39)
1999	800	0.00746 (0.0018)	0.00344 (0.00125)	0.00278 (0.0011)	0.00123 (0.0007)	24.85 (0.35)
2000	780	0.01679 (0.00357)	0.01374 (0.00345)	0.00211 (0.0006)	0.00094 (0.0003)	30.57 (0.36)
2001	780	0.00684 (0.00168)	0.00574 (0.00138)	0.00021 (0.00024)	0.00088 (0.00088)	22.14 (0.51)
2002	780	0.01329 (0.00499)	0.01033 (0.0048)	0.0023 (0.00091)	0.00066 (0.00032)	20.17 (0.46)
2003	780	0.01457 (0.0031)	0.01016 (0.00282)	0.00333 (0.00099)	0.00108 (0.00056)	19.21 (0.37)
2004	780	0.00961 (0.00249)	0.0064 (0.00221)	0.00178 (0.00063)	0.00143 (0.00093)	18.37 (0.4)
2005	780	0.00862 (0.00299)	0.00724 (0.00295)	0.00068 (0.0003)	0.00069 (0.00029)	24.16 (0.42)
2006	780	0.01347 (0.0026)	0.00773 (0.00142)	0.00375 (0.00139)	0.002 (0.00071)	26.1 (0.44)

Table 3. General linear model results for cpue of small coastal sharks, with year and annual mean salinity as independent variables. Model F = 10.32, Pr > F = 0.0004. Adjusted r^2 = 0.3756.

Parameter	Estimate	Standard error	t-value	Pr > |t|
Intercept	-4.8464	2.0086	-2.41	0.0224
Year	0.0024	0.0010	2.37	0.0249
Salinity	0.0086	0.0025	3.50	0.0015

Table 4. General linear model results for cpue of bonnethead sharks, with year and annual mean salinity as independent variables. Model F = 5.66, Pr > F = 0.0084. Adjusted r^2 = 0.2311.

Parameter	Estimate	Standard error	t-value	Pr > |t|
Intercept	-4.1982	1.6752	-2.51	0.0181
Year	0.0021	0.0008	2.49	0.0186
Salinity	0.0038	0.0020	1.88	0.0708

Table 5. General linear model results for cpue of Atlantic sharpnose sharks, with year and annual mean salinity as independent variables. Model F = 5.36, Pr > F = 0.0105. Adjusted r^2 = 0.2195.

Parameter	Estimate	Standard error	t-value	Pr > |t|
Intercept	-0.6223	0.8212	-0.76	0.4547
Year	0.0002	0.0004	0.70	0.4902
Salinity	0.0031	0.0010	3.06	0.0048

Table 6. General linear model results for cpue of finetooth sharks, with year and annual mean salinity as independent variables. Model F = 2.71, Pr > F = 0.0831. Adjusted r^2 = 0.0996.

Parameter	Estimate	Standard error	t-value	Pr > |t|
Intercept	-0.0346	0.5917	-0.06	0.9538
Year	0.0000	0.0003	0.02	0.9843
Salinity	0.0017	0.0007	2.30	0.0287

Figure 1. Map of Texas bay systems sampled with gill nets.

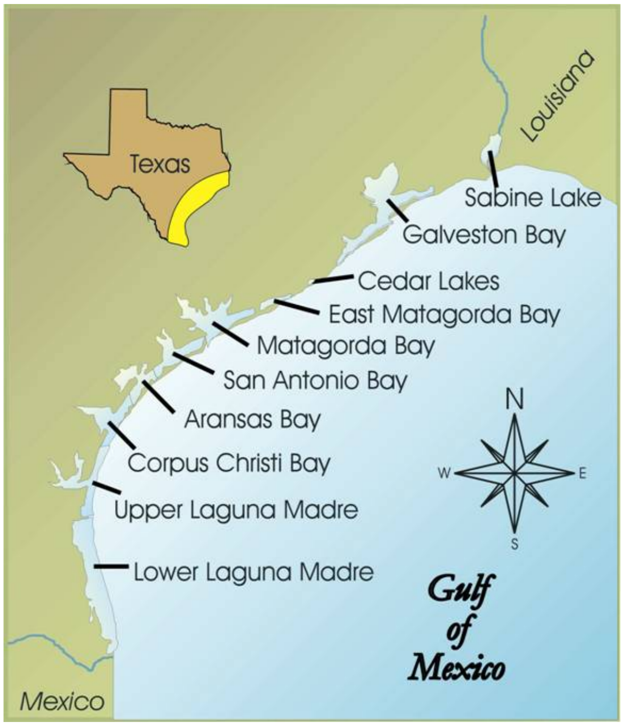


Figure 2. Location of gill net samples, 1975-2006.

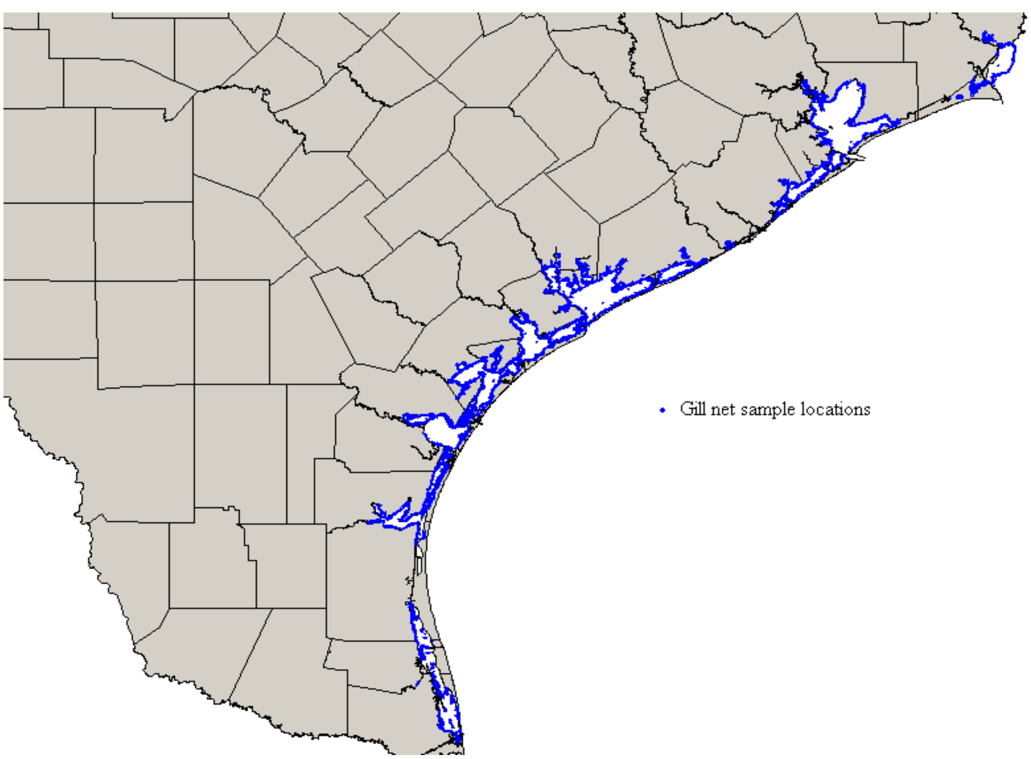


Figure 3. 1975-2006 coastwide gill net CPUE (number/hour) of the small coastal shark complex.

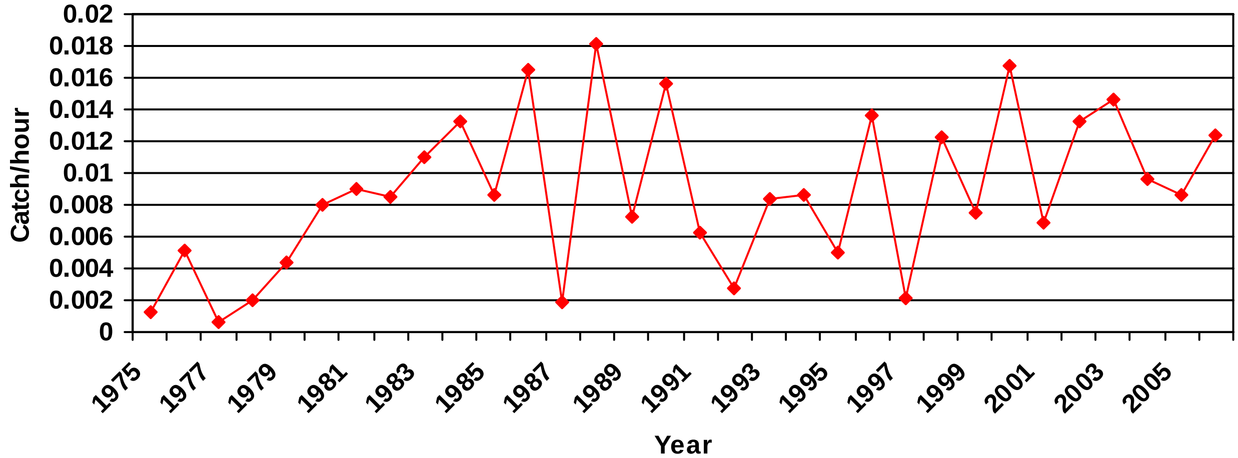


Figure 4. 1975-2006 coastwide gill net CPUE (number/hour) of bonnethead sharks.

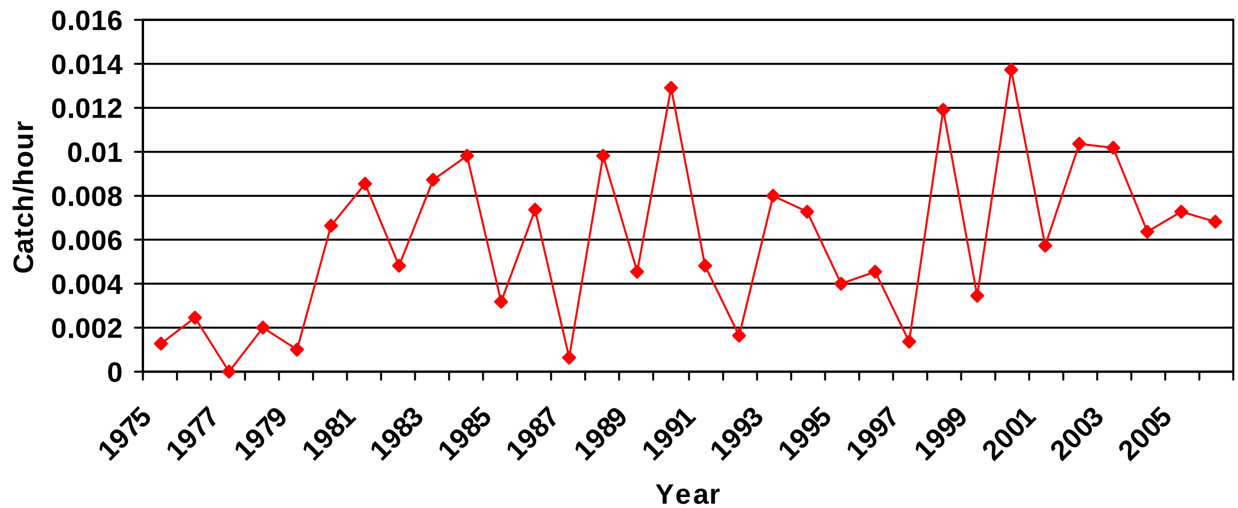


Figure 5. 1975-2006 coastwide gill net CPUE (number/hour) of Atlantic sharpnose sharks.

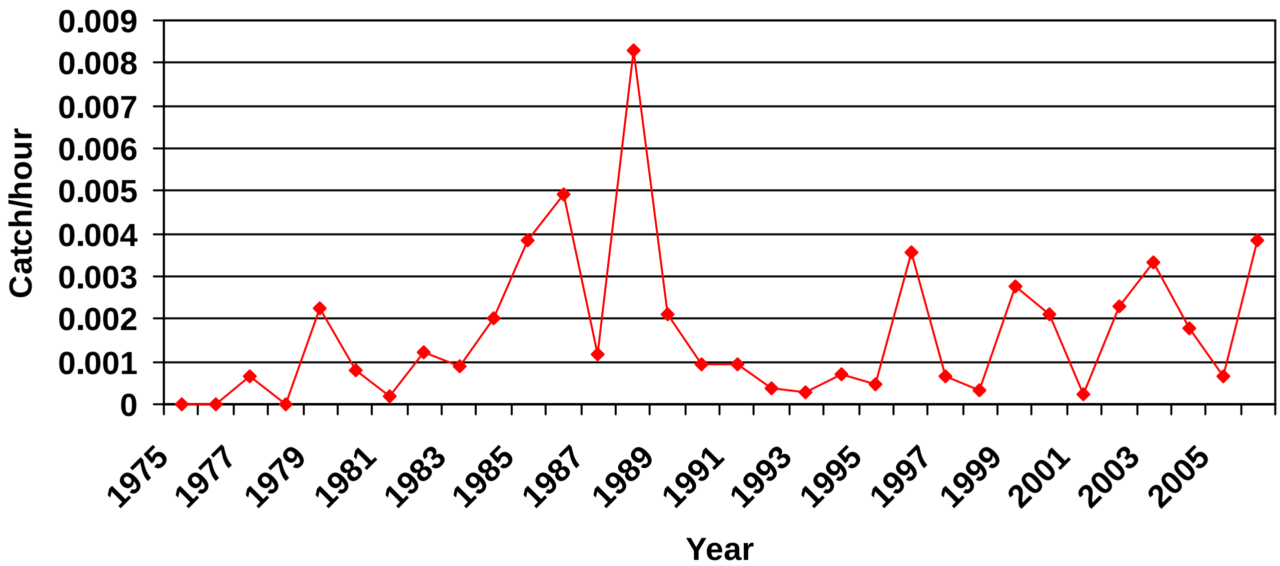


Figure 6. 1975-2006 coastwide gill net CPUE (number/hour) of finetooth sharks.

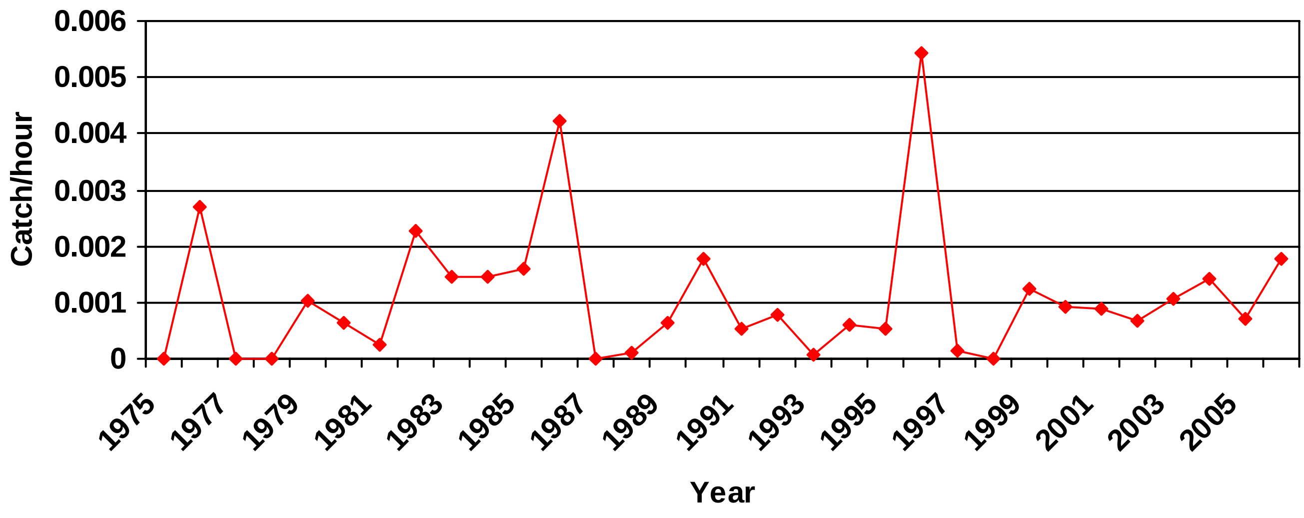


Figure 7. Scatterplot of bonnethead shark lengths (TL) from gill nets.

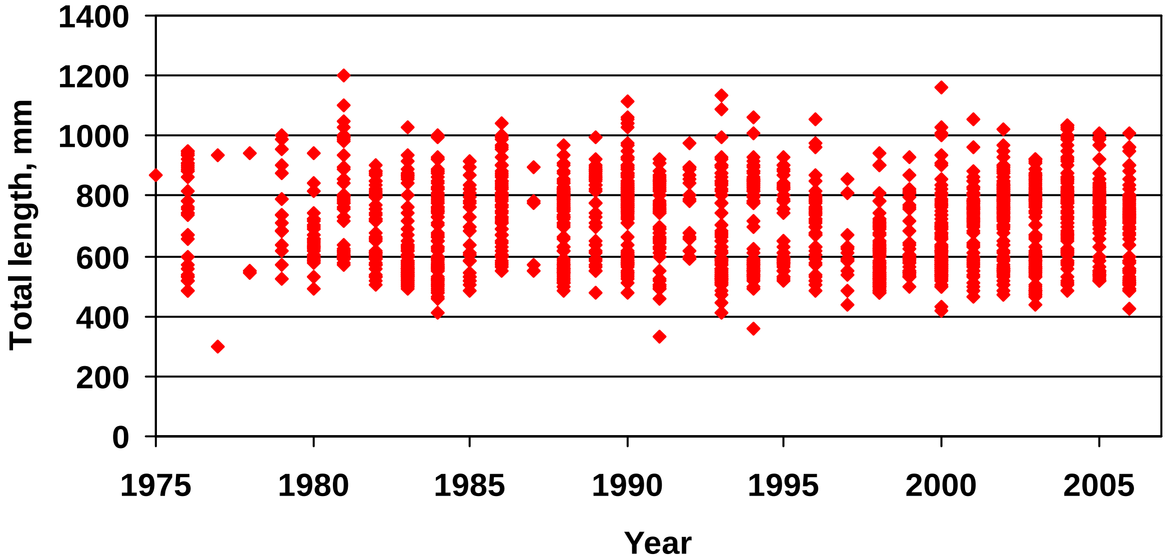


Figure 8. Scatterplot of Atlantic sharpnose shark lengths (TL) from gill nets.

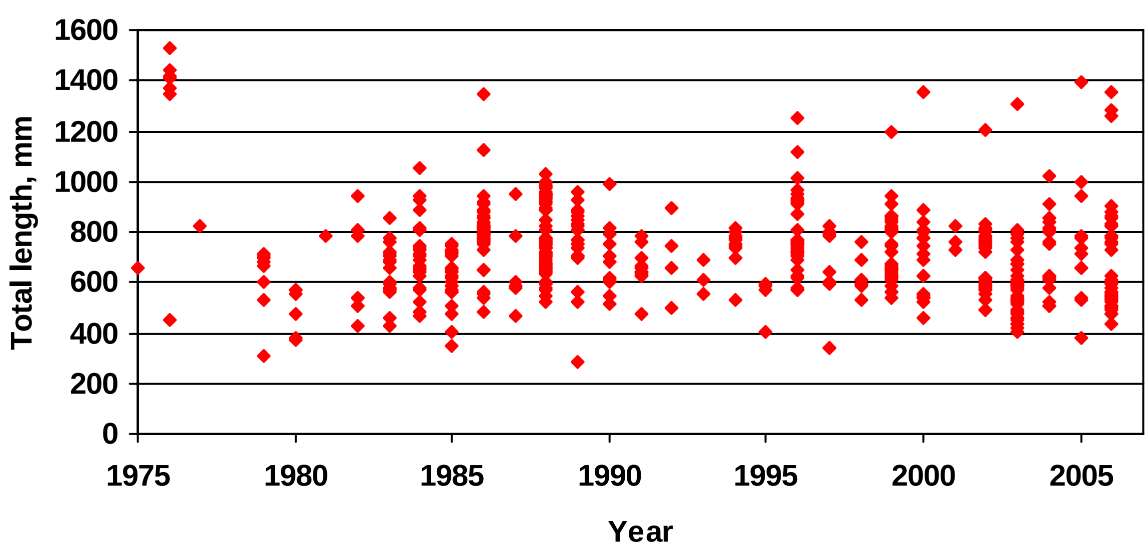


Figure 9. Scatterplot of finetooth shark lengths (TL) from gill nets.

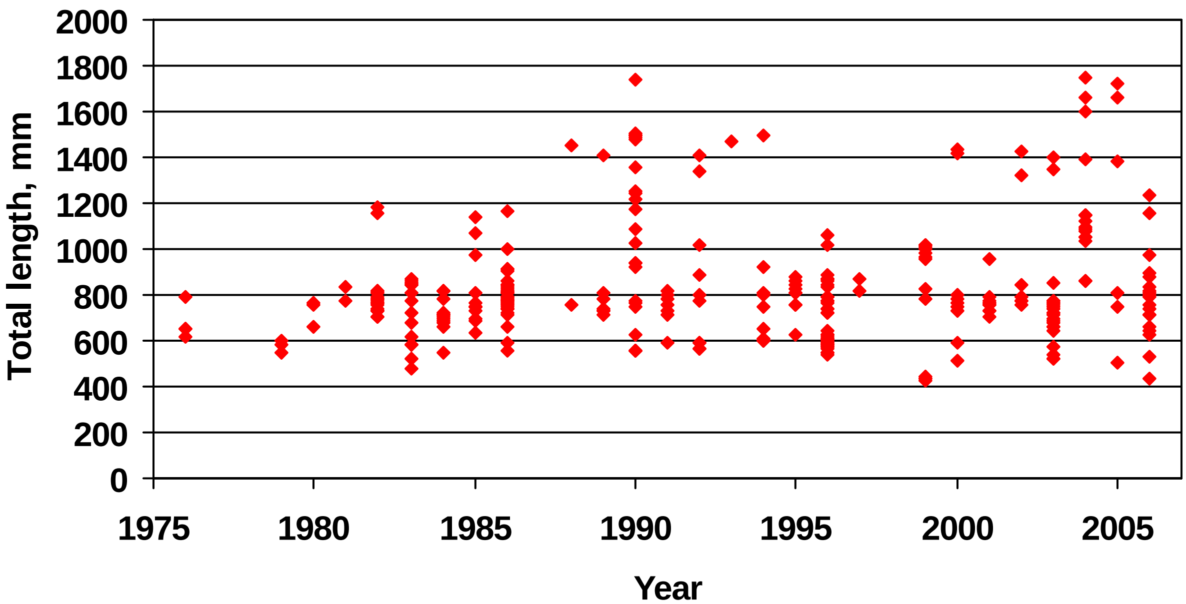


Figure 10. Locations of gill net samples with small coastal sharks present.

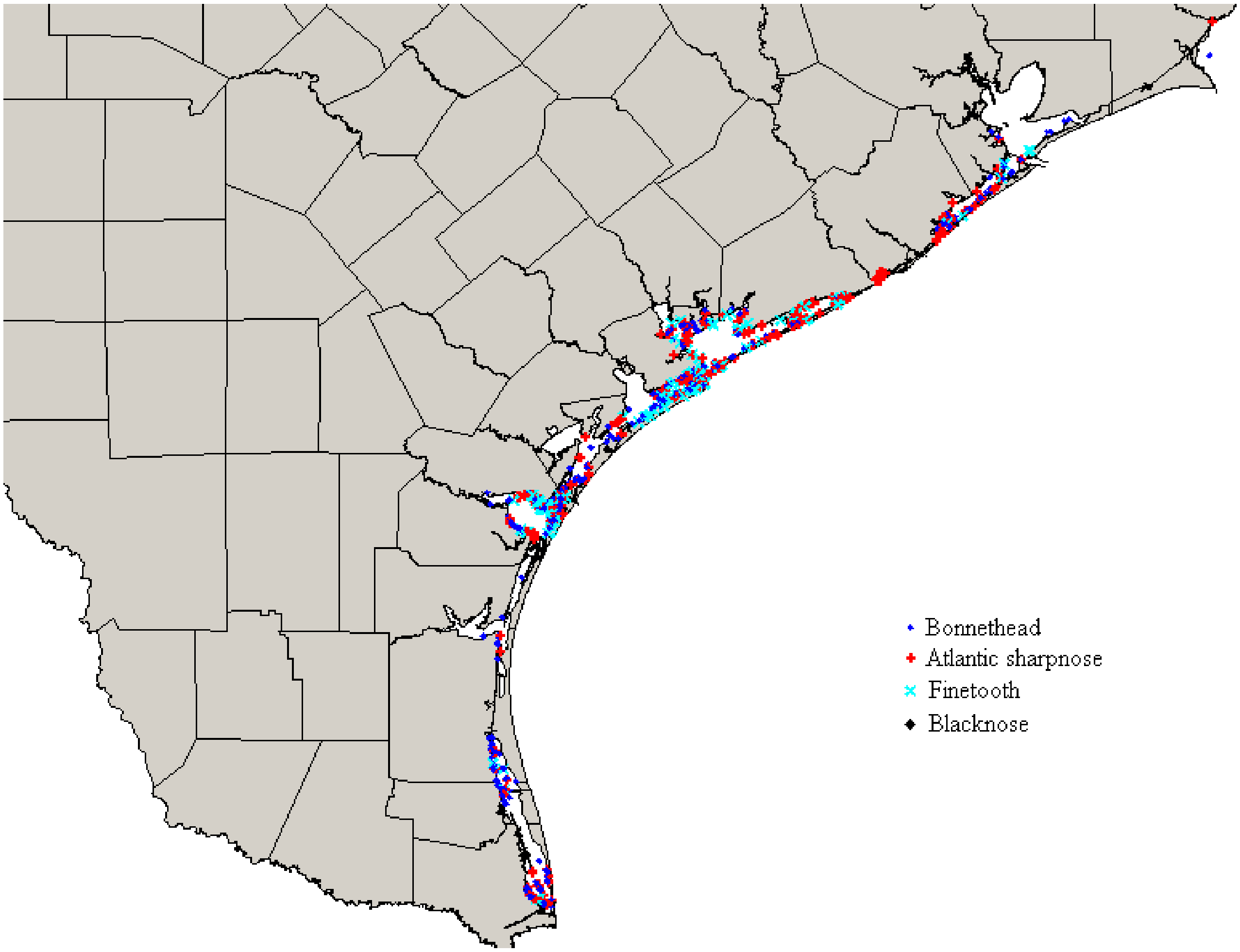
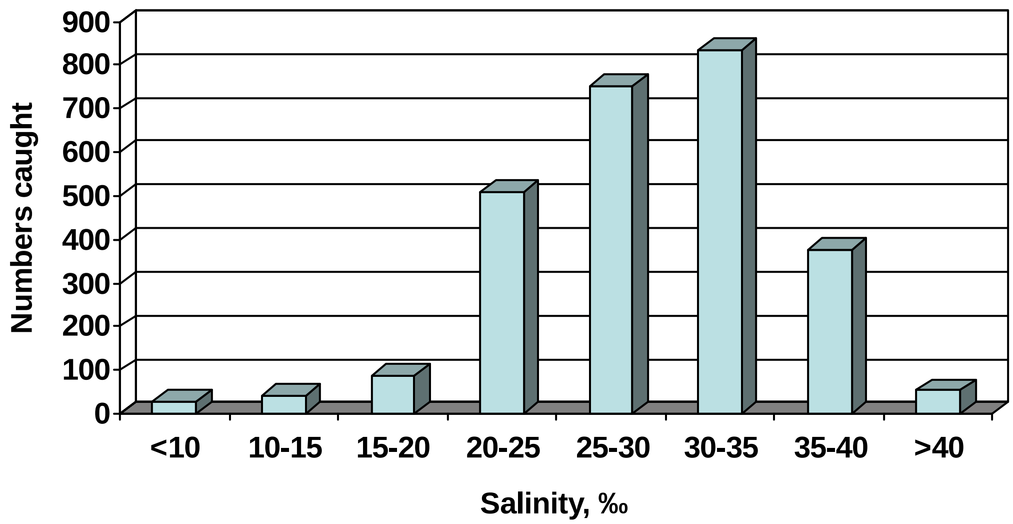


Figure 11. Numbers of small coastal sharks caught, by salinity zone.



Addendum to SEDAR 13-DW-18 by G. Walter Ingram, Jr.

The Indices Working Group were concerned that the values of the Texas indices were nominal. Therefore, I developed the indices again using zero-inflated delta-lognormal (ZIDL) and zero-inflated binomial (ZIB) methodology as described in SEDAR 10-DW-12. The following tables summarize the final index results for bonnethead, Atlantic sharpnose, finetooth, and the SCS complex. Where there were no significant variables found when developing the lognormal submodel, only the results from the occurrence submodel were used for the indices.

Bonnethead Results

For bonnethead both submodels had significant variables, and, therefore, were both used in developing indices.

Survey Year	*Nominal CPUE*	*Index (in CPUE units)*	*Nominal Frequency*	*N*	*Scaled Index*	*CV*	*LCL*	*UCL*
1975	0.13550	0.16358	0.018519	54	0.19158	1.63396	0.01672	1.60003
1976	2.30216	1.57793	0.067669	133	1.84804	0.44025	0.67999	3.66163
1977	0.11312	0.17767	0.013245	151	0.20808	1.09133	0.03022	1.04440
1978	0.15330	0.19903	0.019231	156	0.23311	0.87713	0.04393	0.90169
1979	0.76601	0.55854	0.026596	188	0.65416	0.62171	0.17804	1.75226
1980	0.90054	1.09207	0.046809	235	1.27901	0.40530	0.50062	2.38229
1981	1.30165	0.99730	0.014706	272	1.16802	0.67365	0.29343	3.38955
1982	0.81373	0.64489	0.031915	470	0.75528	0.35546	0.32350	1.28558
1983	1.39259	1.07591	0.055288	416	1.26009	0.28059	0.62039	1.86591
1984	1.36153	1.39699	0.067485	489	1.63614	0.23200	0.88373	2.20836
1985	0.37937	0.45334	0.034230	409	0.53095	0.37630	0.21895	0.93867
1986	0.70077	0.77943	0.045276	508	0.91286	0.28447	0.44615	1.36168
1987	0.06426	0.08967	0.008499	353	0.10502	1.00893	0.01678	0.47912
1988	1.36177	1.22192	0.050000	520	1.43109	0.26323	0.72815	2.05050
1989	0.51074	0.59081	0.030576	556	0.69195	0.33777	0.30617	1.14009
1990	2.08454	1.55976	0.051793	502	1.82677	0.26109	0.93327	2.60683
1991	0.99869	1.04160	0.056701	388	1.21990	0.28698	0.59340	1.82832
1992	0.36486	0.39906	0.034483	319	0.46737	0.43143	0.17465	0.91179
1993	1.26340	0.98374	0.057221	367	1.15215	0.29472	0.55233	1.75212
1994	0.73565	0.66063	0.031818	440	0.77372	0.36799	0.32390	1.34742
1995	0.65651	0.47851	0.026726	449	0.56043	0.40715	0.21864	1.04729
1996	0.46603	0.55816	0.033217	572	0.65371	0.32106	0.29833	1.04428
1997	0.42635	0.49451	0.032609	276	0.57917	0.46470	0.20422	1.19743
1998	2.17519	1.35037	0.051075	372	1.58153	0.30761	0.74009	2.46388
1999	0.46876	0.44143	0.025292	514	0.51699	0.39347	0.20669	0.94277
2000	1.49612	1.33967	0.043011	558	1.56900	0.27351	0.78289	2.29244

Survey Year	Nominal CPUE	Index (in CPUE units)	Nominal Frequency	N	Scaled Index	CV	LCL	UCL
2001	1.17552	1.34087	0.075188	399	1.57041	0.24285	0.83075	2.16425
2002	2.37503	1.33534	0.053050	377	1.56393	0.29936	0.74324	2.39916
2003	1.28271	0.92651	0.057789	398	1.08511	0.28321	0.53161	1.61477
2004	1.50625	1.32292	0.063830	376	1.54939	0.27279	0.77416	2.26067
2005	1.25379	0.99954	0.058691	443	1.17065	0.26428	0.59445	1.68069
2006	0.82629	1.07106	0.066667	285	1.25440	0.30974	0.58467	1.96206

Atlantic Sharpnose Shark Results

No significant variables were found when running the lognormal submodel. Therefore, the final abundance indices were based only on the occurrence submodel results.

Survey Year	Index (frequency of occurrence)	Scaled Index	CV	LCL	UCL
1975	0.01706	1.0797733	1.06271981	0.34331249	3.3960616
1976	0.008749	0.5537477	1.06777917	0.17539189	1.74829381
1977	0.007562	0.4786193	1.06744248	0.1516345	1.5107146
1979	0.01553	0.9829355	0.57739858	0.48471379	1.99326318
1980	0.005205	0.3294385	1.05840538	0.10508754	1.03275514
1981	0.004399	0.2784245	1.05569448	0.08899772	0.87103613
1982	0.002633	0.1666497	1.04405621	0.05374468	0.51674149
1983	0.007313	0.4628594	0.57609736	0.22856569	0.93731856
1984	0.02080	1.3164879	0.31216346	0.88078322	1.96772653
1985	0.01687	1.0677477	0.37421458	0.66258815	1.72065423
1986	0.04045	2.5601893	0.2178492	1.92759537	3.40038651
1987	0.007484	0.4736825	0.74371994	0.19755119	1.13578206
1988	0.03439	2.1766356	0.23826694	1.59690082	2.96683583
1989	0.01383	0.8753379	0.37621114	0.54189488	1.41395771
1990	0.01031	0.6525476	0.44161009	0.37411265	1.13820906
1991	0.01739	1.1006599	0.3746406	0.68266413	1.77459473
1992	0.009127	0.5776724	0.57740769	0.28486412	1.17145456
1993	0.008386	0.5307725	0.5753637	0.2623069	1.07400701
1994	0.01110	0.7025489	0.44099099	0.40306679	1.22454865
1995	0.006937	0.4390614	0.57517659	0.21702668	0.8882544
1996	0.02988	1.8911856	0.24638554	1.37332586	2.60432209
1997	0.01133	0.7171062	0.57519859	0.35445505	1.45079404
1998	0.01033	0.6538135	0.49690223	0.35201548	1.2143559
1999	0.03216	2.0354929	0.23902363	1.49192251	2.77710896
2000	0.02547	1.6120648	0.27506871	1.12925708	2.30129436

2001	0.003413	0.216018	1.04746557	0.06948433	0.67157233
2002	0.02620	1.6582685	0.31164122	1.11016075	2.47698753
2003	0.02949	1.8665014	0.27724652	1.30394349	2.67176268
2004	0.02157	1.3652233	0.33337969	0.88997806	2.09424793
2005	0.01801	1.1399013	0.35091616	0.72744868	1.78620858
2006	0.01641	1.038633	0.37129799	0.64677314	1.66790878

Finetooth Shark Results

No significant variables were found when running the lognormal submodel. Therefore, the final abundance indices were based only on the occurrence submodel results.

Survey Year	*Index (frequency of occurrence)*	*Scaled Index*	*CV*	*LCL*	*UCL*
1976	0.007082	0.6239668	1.06890709	0.19746489	1.97166472
1979	0.005491	0.4837901	1.06720087	0.15330063	1.52675754
1980	0.01201	1.0581532	0.57910075	0.52086213	2.14968262
1981	0.007985	0.7035265	0.75203507	0.29110377	1.70025132
1982	0.01177	1.0370078	0.40747664	0.61863771	1.73831169
1983	0.01765	1.5550712	0.35354108	0.98925583	2.44451052
1984	0.01241	1.0933956	0.40564061	0.65368603	1.82888109
1985	0.009625	0.8480204	0.49890909	0.4555544	1.57860089
1986	0.01588	1.3991235	0.35119647	0.89257362	2.19314861
1988	0.005117	0.4508385	0.7518077	0.18658714	1.08933193
1989	0.006314	0.5563014	0.58425721	0.27233789	1.13635022
1990	0.02402	2.1163065	0.28588676	1.46264105	3.06209993
1991	0.01219	1.0740123	0.44536505	0.61308347	1.88147702
1992	0.01106	0.9744525	0.5017179	0.5218353	1.81965022
1993	0.003161	0.2785031	1.06580196	0.08834366	0.87798014
1994	0.01275	1.1233517	0.40690196	0.67059985	1.88177646
1995	0.01468	1.2933963	0.37758856	0.7993868	2.0926965
1996	0.02637	2.3233556	0.2641259	1.64994422	3.27161439
1997	0.008493	0.7482844	0.75167785	0.30972821	1.80780923
1999	0.007586	0.6683722	0.49934089	0.35887478	1.24478357
2000	0.01798	1.5841461	0.33164627	1.0348758	2.42494702
2001	0.003204	0.2822917	1.06616729	0.08952074	0.89016901
2002	0.01039	0.9154215	0.49903754	0.49169157	1.70431336
2003	0.01963	1.7295211	0.3360163	1.12384765	2.66160909
2004	0.01162	1.0237919	0.44879518	0.58211423	1.80059133
2005	0.009089	0.8007956	0.49895478	0.43016339	1.49076733
2006	0.002892	0.2548026	0.49965422	0.13676547	0.47471309

SCS Complex Results

No significant variables were found when running the lognormal submodel. Therefore, the final abundance indices were based only on the occurrence submodel results.

Survey Year	*Index (frequency of occurrence)*	*Scaled Index*	*CV*	*LCL*	*UCL*
1975	0.04411	0.7264455	0.70981637	0.31301701	1.68592474
1976	0.07321	1.2056921	0.29968584	0.81915939	1.77461604
1977	0.02107	0.3470008	0.55481728	0.17530768	0.6868472
1978	0.02119	0.3489771	0.55450684	0.1763652	0.69052756
1979	0.04065	0.669463	0.34243542	0.43163949	1.03832171
1980	0.06188	1.0190988	0.24822237	0.73832922	1.40663869
1981	0.02422	0.3988781	0.37089182	0.24850842	0.64023466
1982	0.04244	0.6989424	0.21404336	0.52879891	0.92383031
1983	0.07667	1.2626747	0.16707969	1.01463791	1.57134608
1984	0.08525	1.4039783	0.14920821	1.15457455	1.7072566
1985	0.05557	0.9151797	0.20262732	0.7025633	1.19214021
1986	0.08423	1.3871799	0.14757212	1.14318295	1.68325482
1987	0.01418	0.2335298	0.44435825	0.13346157	0.40862811
1988	0.07722	1.2717326	0.15501166	1.03798701	1.55811561
1989	0.05339	0.8792774	0.1866829	0.68893904	1.12220202
1990	0.07179	1.1823062	0.16172169	0.95665611	1.46118115
1991	0.07555	1.2442294	0.17524818	0.98933753	1.56479142
1992	0.04991	0.8219655	0.23542376	0.60521275	1.11634666
1993	0.06293	1.0363912	0.19799778	0.80034239	1.34205912
1994	0.05216	0.8590206	0.19957822	0.66202882	1.11462883
1995	0.04558	0.7506549	0.21301009	0.56867157	0.99087559
1996	0.07625	1.2557577	0.14990164	1.03175609	1.52839166
1997	0.05124	0.8438692	0.25644028	0.60508631	1.176882
1998	0.05834	0.9607987	0.20346246	0.73679674	1.25290216
1999	0.06538	1.0767402	0.16503518	0.86751545	1.33642508
2000	0.07783	1.2817786	0.15199794	1.05027826	1.56430593
2001	0.08192	1.3491367	0.1706543	1.07912585	1.68670758
2002	0.07397	1.2182085	0.1814249	0.96097483	1.54429842
2003	0.09328	1.536224	0.15190823	1.25891486	1.87461772
2004	0.08421	1.3868506	0.16494478	1.11749782	1.72112596
2005	0.08047	1.3252567	0.16105381	1.07325001	1.6364363
2006	0.06696	1.1027611	0.22685185	0.82083335	1.48152131