RELATIVE ABUNDANCE OF JUVENILE BLACKTIP SHARKS IN THREE FLORIDA GULF COASTAL NURSERY AREAS, 1995-2004

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Introduction

The Center for Shark Research (CSR) at Mote Marine Laboratory has been conducting routine surveys of juvenile sharks in Florida Gulf coast nursery areas since 1991. In 1995-97, the CSR conducted a NMFS/MARFIN-funded project on shark nurseries to assess Florida's coastal areas as nurseries specifically for the blacktip shark (*Carcharhinus limbatus*), one of the two most important species in the U.S. east coast shark fishery. The project also documented nursery areas of other shark species, quantified relative abundance of juvenile blacktips and other shark species, determined bycatch mortality of these small sharks and associated fishes in gill net fishing gear, and conducted basic biological studies of shark distribution, feeding, growth and reproduction in the Florida Gulf. Building upon the CSR's MARFIN study, research funded primarily through NMFS Highly Migratory Species (HMS) Division extended the CSR shark nursery studies in the Gulf of Mexico through 2004, allowing a relatively continuous sampling of juvenile sharks in these nurseries in all years except 1998.

This paper examines the results of relative abundance surveys for neonate and young-of-the-year (YOY) blacktip pups in the Florida Gulf nurseries monitored by the CSR since 1995. Trends in abundance of blacktip shark pups from 1995-2004 were analyzed to provide a standardized index of recruitment for this species in the eastern Gulf of Mexico. The analyses were focused on three blacktip nurseries along the Florida Gulf coast: 1) Yankeetown, a nursery in a relatively pristine area of open Gulf near the Withlacoochee River, south of Cedar Key and north of Crystal River; 2) lower Tampa Bay, a semi-enclosed estuarine system that is heavily impacted by human disturbance and 3) Pine Island Sound, a semi-enclosed estuarine nursery in the Charlotte Harbor system that is moderately populated and industrialized. All of these areas are productive nurseries for the blacktip shark as documented by CSR studies dating back to 1991 (Hueter and Manire, 1994). The lower Tampa Bay area was monitored in the 1995-97 MARFIN project but not in later years, and because of this discontinuity is not included in the majority of this paper's analyses.

Field Methods

Monthly, random stratified, fishery-independent sampling by gill net was conducted in the three Florida Gulf shark nurseries from March through October (with sampling in summer months only during 1999-2004) in all years except 1998 (Fig. 1). In each area, two geographically fixed 10 km^2 grids were regularly sampled based upon previous exploratory surveys that revealed subareas with relatively high CPUE of juvenile blacktip sharks (Figs. 2-4). For quantitative assessment of relative abundance, standardized sets were conducted each month in five of the ten 1 x 1 km blocks for each grid (Fig. 5). Sets were made using 0.52 mm monofilament, 11.8 cm stretch mesh, 366 x 3 m weighted gill nets, used because of their relatively high selectivity for small sharks and relatively low bycatch of other species. The net was allowed to soak for one hour before being retrieved. All shark catch was identified, sexed, categorized by stage of maturity (neonate, YOY, older juvenile, or mature), measured and weighed, and live sharks were tagged and released. Physical data including depth, tide, salinity, temperature, dissolved oxygen, bottom type, and weather were collected for each set to characterize shark nursery habitat in the three areas.

Data Analysis

Analyses for this paper were restricted to the neonate and YOY blacktip pups only. YOY catch was screened for current year class only, so that <1year-olds born in the previous calendar year but returning to the natal nursery were eliminated from the analyses, as were older juveniles. The number of neonate and young-of-the-year blacktip sharks caught on each set was converted to catch per unit of effort (CPUE) by dividing by the fishing effort (hours fished, from first mesh in to last mesh out). CPUE data were log-transformed before being analyzed. Standardized catch rates were calculated using a General Linear Model (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 nursery areas had different pattern of catch rates.

Results

A total of 970 quantitative gill net sets were conducted in the three areas from 1995-2004. During the first three years of the study (1995-97), all areas were fished from March to October. The Tampa Bay area was not fished in subsequent years as reflected in the reduced effort (Fig. 6).

During the entire study (1995-2004), a total of 8,257 sharks were captured comprising 13 species of 4 families (Table 1). Catch rates of juvenile blacktip sharks was highest during the summer months and in the nursery areas of Yankeetown and Charlotte Harbor while the Tampa Bay nursery demonstrated the lowest catch rates (Fig. 7). To assess overall trends in catch rate, the GLM was applied to data collected from June through August (the months sampled most consistently) (Fig. 8; Appendix 1). This analysis indicated that there were significant differences in catch rates between all factors tested except month (Table 2). The significant interaction term indicated that Yankeetown and Charlotte Harbor had different patterns of annual catch rates. Regression analysis of the annual catch rates indicated that the slope of the catch time series was not significantly different from zero in Yankeetown (slope=0.019, R^2=0.026) or Charlotte Harbor (slope=-0.009 , R^2=0.01). Analysis by year and grid area yielded similar results with slopes not significantly different from zero (Fig. 9; Appendix 2).

Discussion

Results of our studies indicate that there has been no significant increasing or decreasing trend in recruitment to blacktip shark nursery areas on the Florida Gulf coast in the years between 1995 and 2004. Using data on neonate and YOY blacktip shark abundance in two prominent nursery areas, we find no clear evidence of either stock rebuilding or further depletion of blacktip sharks in the eastern Gulf of Mexico since 1995. The new production of blacktip pups appears highly variable from year to year and may be influenced by a number of factors such as density-dependent compensation or environmental variables.

The lack of a clear trend in these data may also be influenced by environmental perturbations. For example, it is likely that the results of these surveys were affected by periodic (and sometimes severe) blooms of red tide (*Karenia brevis,* a dinoflagellate toxic to fish). Elasmobranchs appear to be highly sensitive to the toxin associated with these blooms and can respond by evacuating affected areas. A severe red tide was documented in the Charlotte Harbor area in 2001 although blooms have been present at varying levels during several of the study years. Additionally, pulses of fresh water as a result of the episodic opening of dams following severe storm events is also likely to have affected this survey's results. Salinities in the Charlotte Harbor nursery have been measured as low as 13 ppt while no neonate/YOY blacktip sharks have been captured in salinities less than 15 ppt. Further, its been demonstrated that juvenile blacktip sharks can move out of shallow bays and estuaries in advance of tropical storms or hurricanes (Heupel *et a*l. 2003).

Conclusions

- No clear increasing or decreasing trend over time in juvenile blacktip shark abundance in sampled nurseries from 1995-2004.
- Environmental perturbations can influence shark abundance data

- Despite stock assessments indicating an increasing abundance of blacktip sharks since the mid 1990s, this study did not detect an increase in recruitment in the nursery areas
- Stock/recruitment relationships for the blacktip are probably complex, there may be other factors that are influencing the number of pups in a given nursery (e.g. density dependent mechanisms).

Acknowledgements

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References

Heupel, M.R., C.A. Simpfendorfer and R.E. Hueter. 2003. Running before the storm: blacktip sharks respond to falling barometric pressure associated with Tropical Storm Gabrielle. Journal of Fish Biology 63:1357-1363.

Hueter, R.E. and C.A. Manire. 1994. Bycatch and catch-release mortality of small sharks in the Gulf coast nursery grounds of Tampa Bay and Charlotte Harbor. Mote Marine Laboratory Technical Report No. 368 (Final report to NOAA/NMFS, MARFIN Project NA17FF0378-01):183 pp.

Table 1. Sharks species and numbers captured during all quantitative gill net sets during the entire study (1995-2004).

Common Name	**Scientific Name**	**No. Captured**
Blacktip	*Carcharhinus limbatus*	3,842
Bonnethead	*Sphyrna tiburo*	3,540
Sharpnose	*Rhizoprionodon terraenovae*	739
Great Hammerhead	*Sphyrna mokarran*	58
Blacknose	*Carcharhinus acronotus*	28
Scalloped Hammerhead	*Sphyrna lewini*	19
Bull	*Carcharhinus leucas*	14
Spinner	*Carcharhinus brevipinna*	7
Nurse	*Ginglymostoma cirratum*	3
Sandbar	*Carcharhinus plumbeus*	3
Lemon	*Negaprion brevirostris*	2
Finetooth	*Carcharhinus isodon*	1
Florida Smoothhound	*Mustelus norrisi*	1
	Total	**8,257**

Table 2. Results of the GLM.

Effect	Deg. of Freedom	F	P
Month	2	2.139	0.119
Year	8	2.214	0.255 *
Area	1	10.239	0.00149 *
Grid (Area)	2	41.99	0.0000001 *
Year*Area	7	4.874	0.00026 *

Fig. 1 Project study sites.

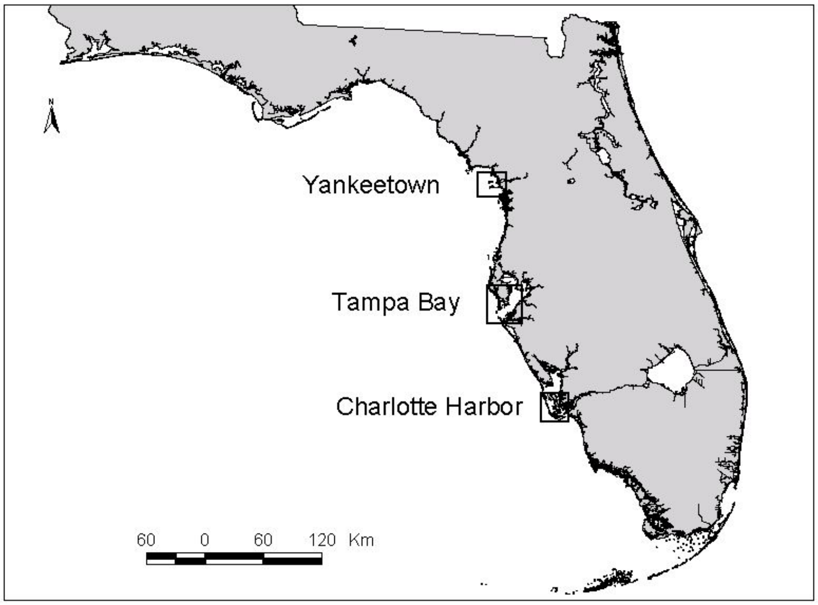


Fig. 2 Yankeetown grid areas of Withlacoochee and Crystal River.

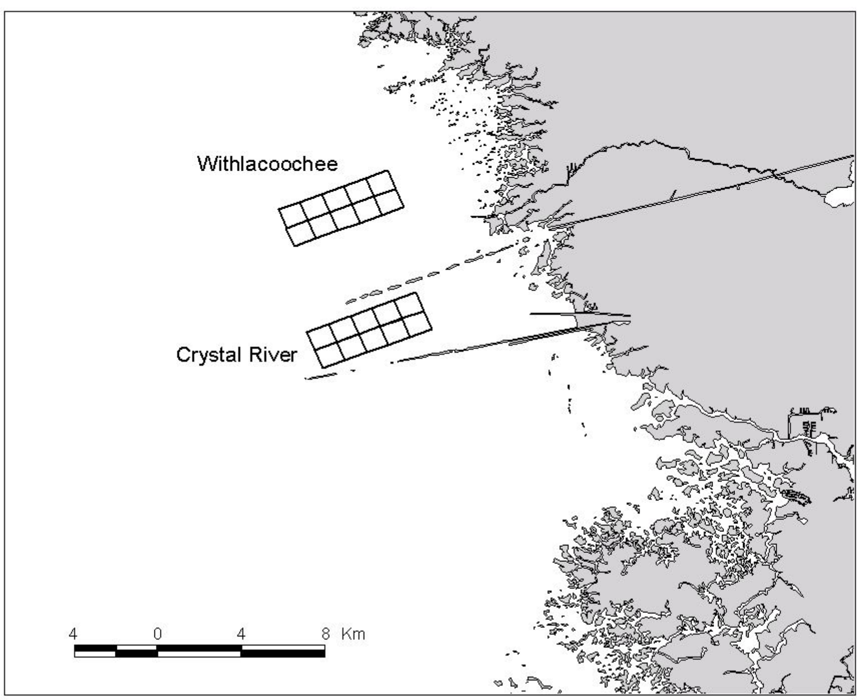


Fig. 3 Tampa Bay grid areas of Pinellas Point and Terra Ceia.

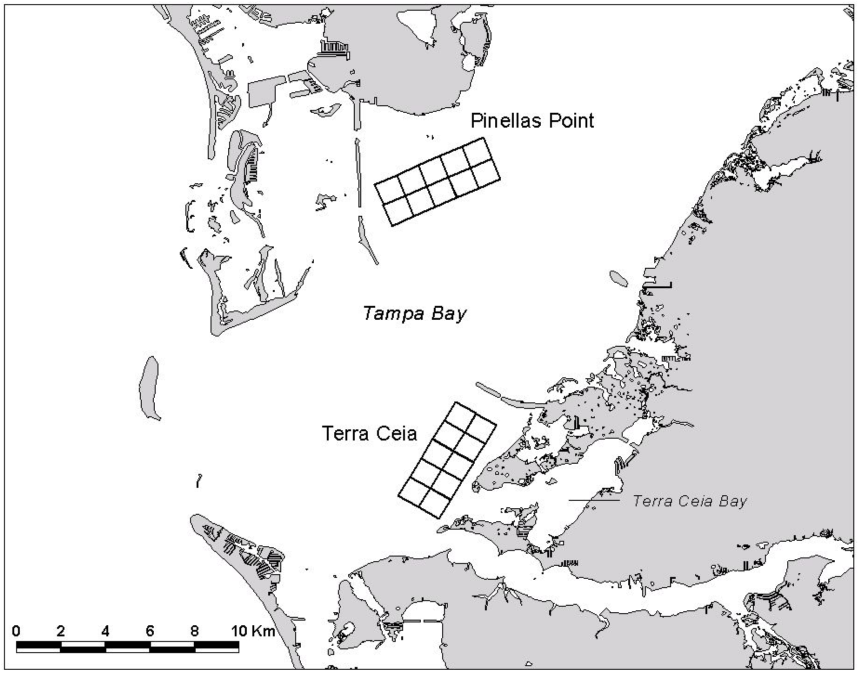


Fig. 4 Charlotte Harbor grid areas of Pine Island and Long Point.

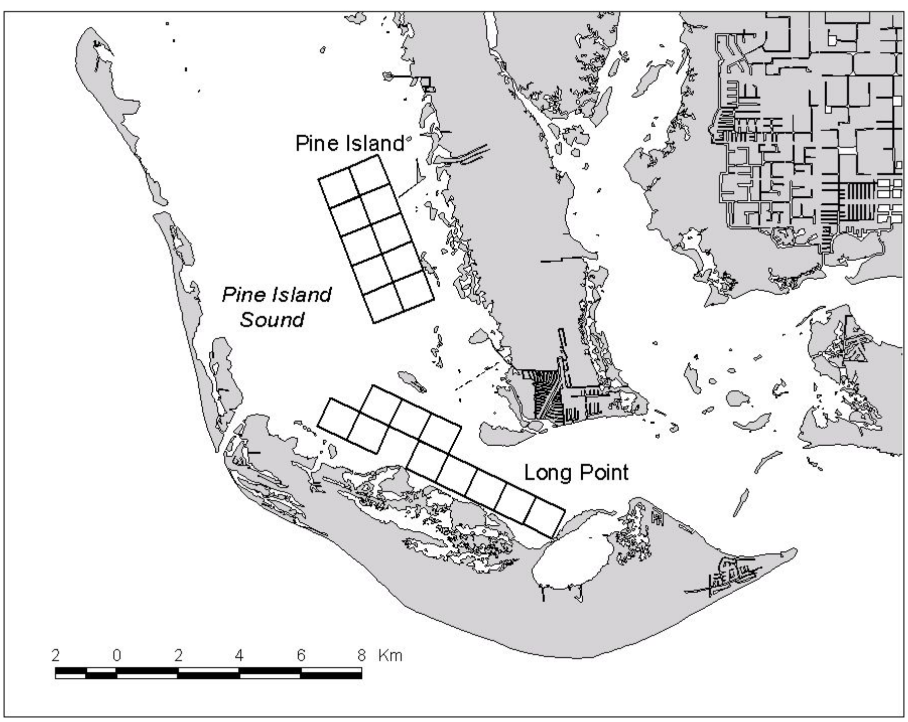


Fig. 5 Example of a typical monthly sampling in the two Yankeetown grids. Sampling consists of gill nets sets in 5 of the 10 quadrants for each grid.

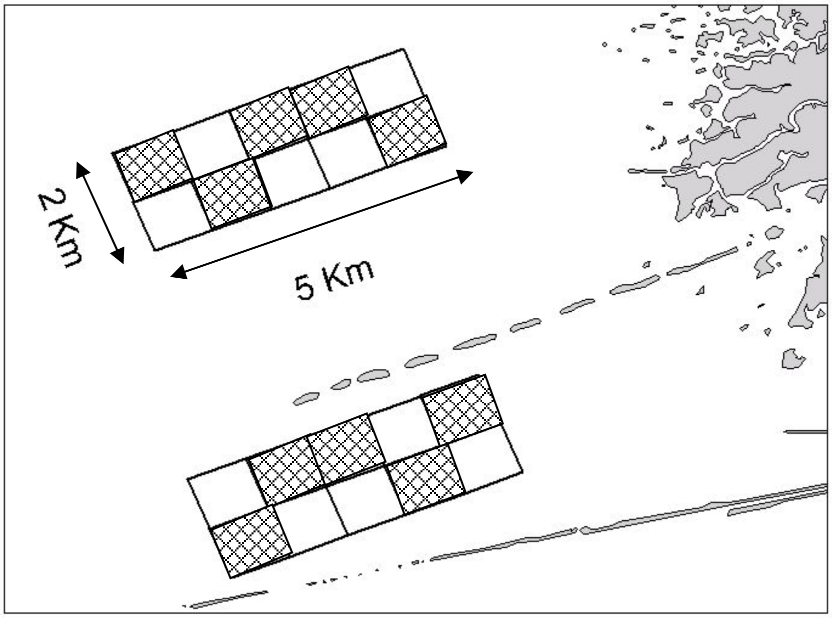


Fig. 6 Sampling effort by area of 970 quantitative gill net sets (1995-2004).

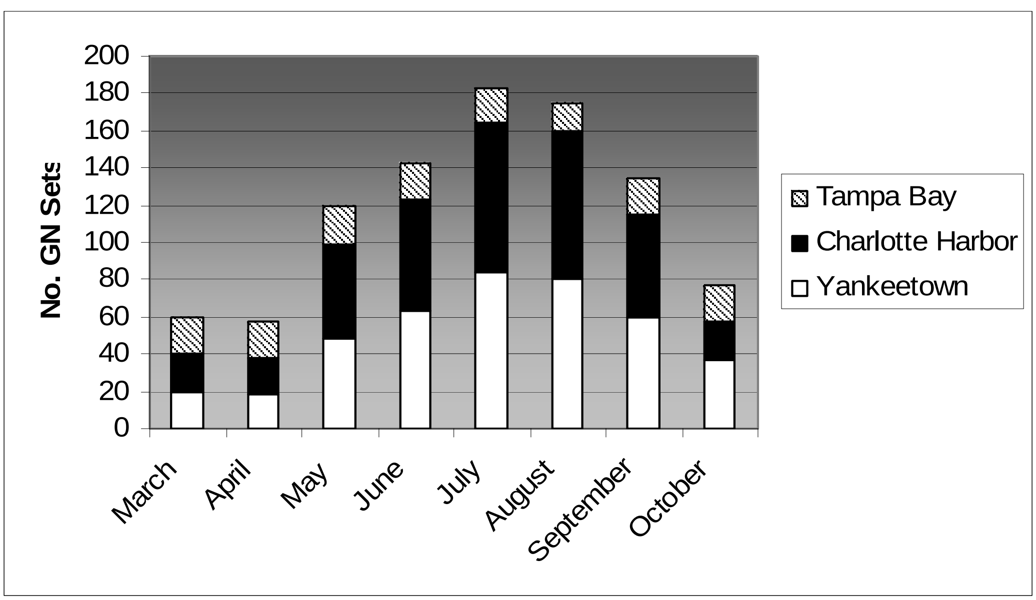


Fig 7. Blacktip catch rates (neonate and YOY) by month during the first three years of the study (1995-1997).

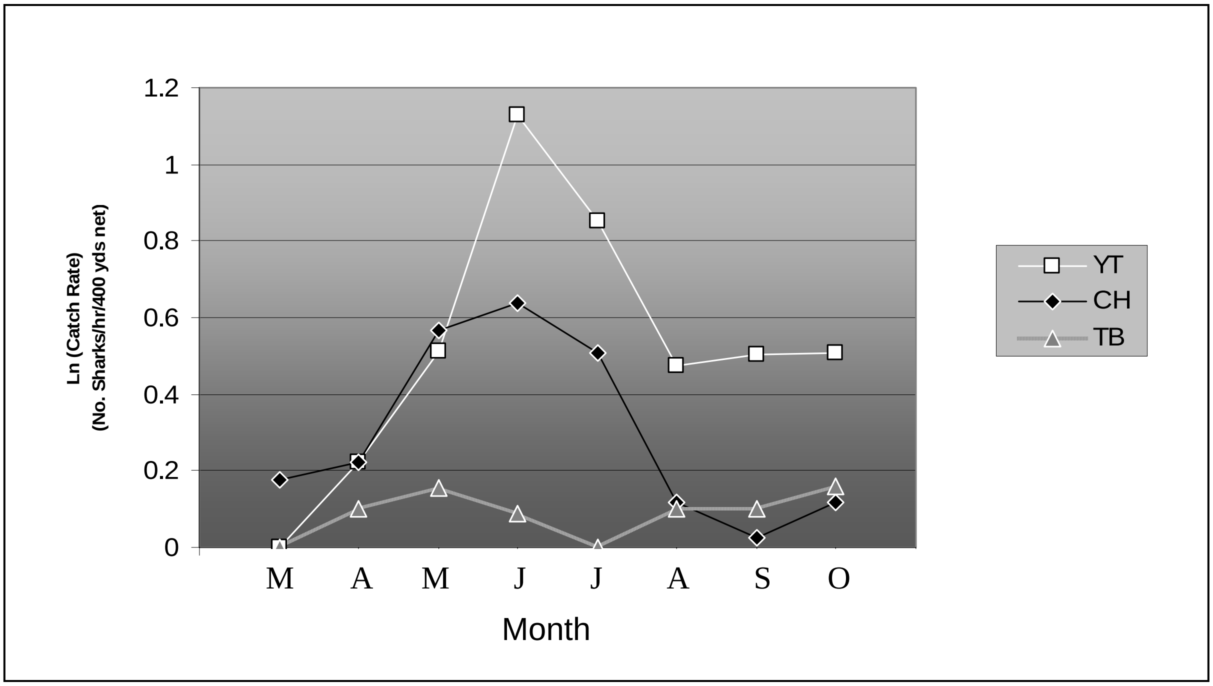


Fig 8. Blacktip shark catch rates by year (June–Aug).

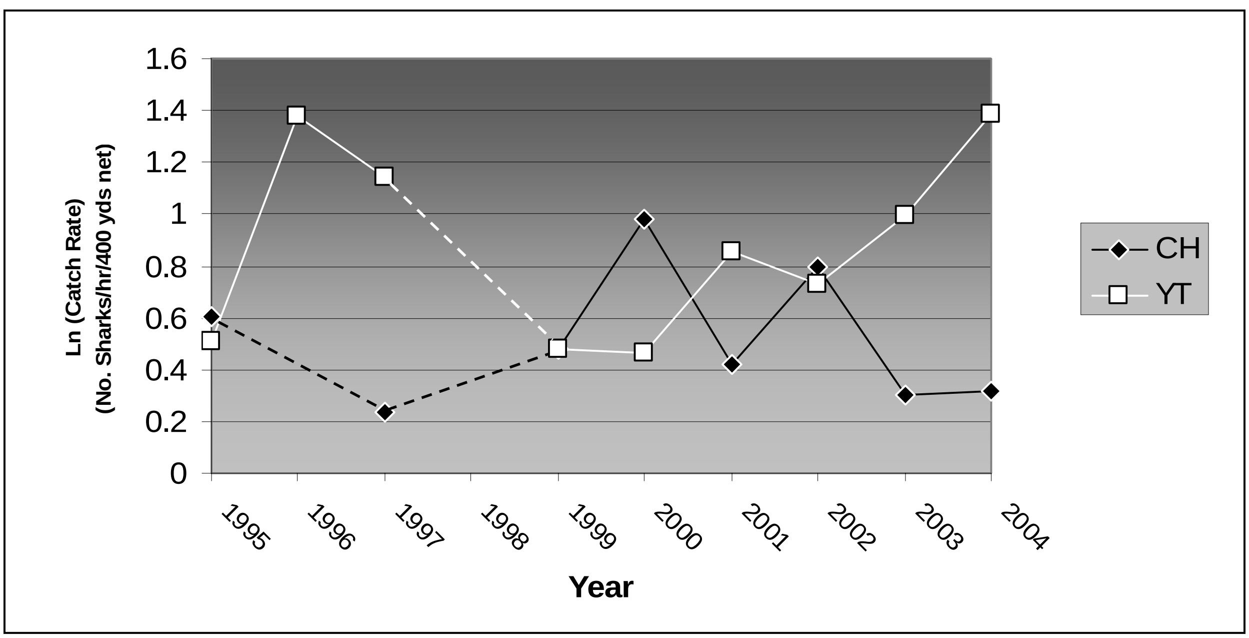
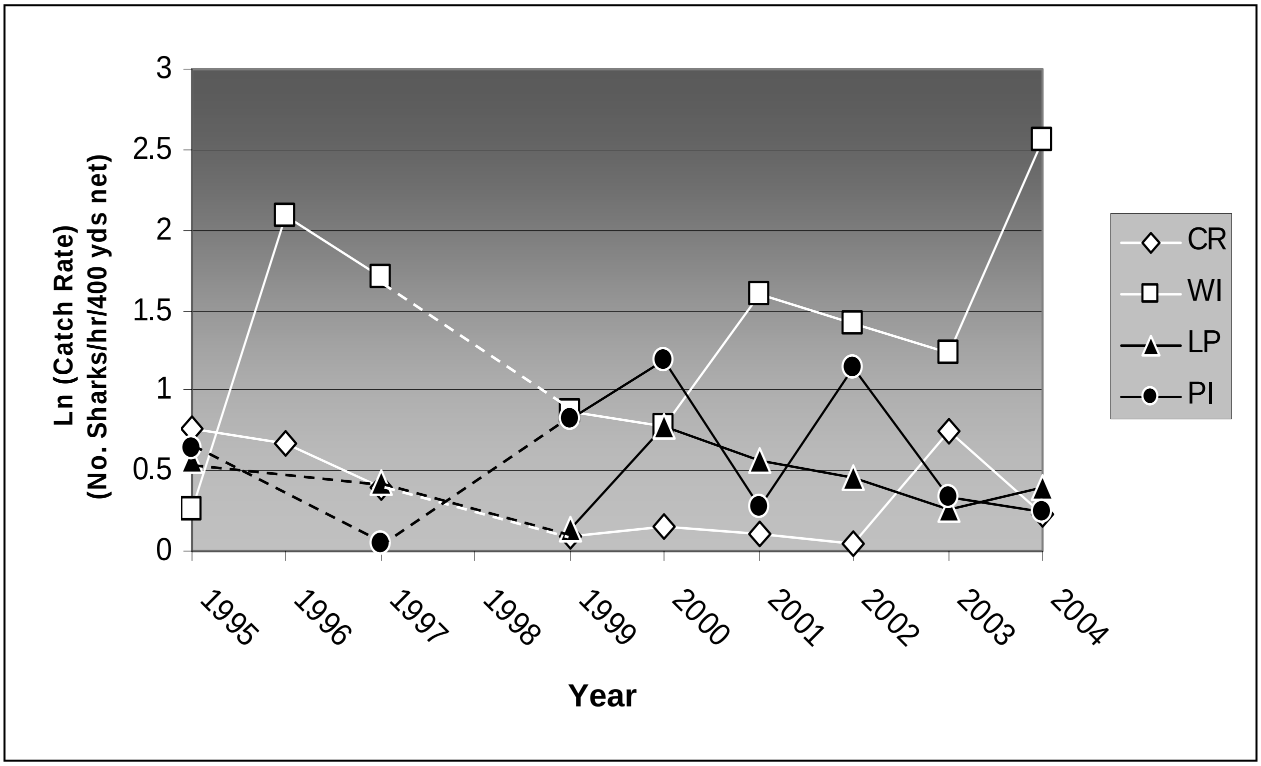


Fig 9. Blacktip shark catch rates by year and grid (June-Aug).



Appendix 1 Log-transformed catch rates of neonate/YOY blacktip sharks by year (June-Aug).

Year	CH	YT
1995	0.60591	0.51020
1996	–	1.38064
1997	0.23530	1.14653
1998	–	–
1999	0.47770	0.47766
2000	0.98153	0.46770
2001	0.42185	0.85326
2002	0.79606	0.72666
2003	0.29919	0.99388
2004	0.31533	1.38924

Appendix 2 Log-transformed catch rates of neonate/YOY blacktip sharks by year and grid area (June-Aug).

Year	CR	WI	LP	PI
1995	0.76596	0.25444	0.57103	0.64079
1996	0.67512	2.08616	–	–
1997	0.40176	1.70510	0.43219	0.03841
1998	–	–	–	–
1999	0.09213	0.86318	0.13564	0.81976
2000	0.15256	0.78284	0.77398	1.18908
2001	0.11191	1.59462	0.56324	0.28046
2002	0.03841	1.41492	0.45722	1.13490
2003	0.75142	1.23635	0.25877	0.33961
2004	0.22102	2.55746	0.38953	0.24113