Standardized catch rates of bonnetheads from the Everglades National Park Creel Survey

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SEDAR34-WP-02

Submitted: 6 May 2013
Updated: 8 July 2013

Please cite this document as:

Carlson, J. and J. Osborne. 2013. Standardized catch rates of bonnetheads from the Everglades National Park Creel Survey. SEDAR34-WP-02. SEDAR, North Charleston, SC. 11 pp.

Standardized catch rates of bonnetheads from the Everglades National Park Creel Survey

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SEDAR34-WP-02

Abstract
Using voluntary dockside interviews of sport fishers collected by the Everglades National Park, a standardized index of abundance was created for bonnethead shark using the delta lognormal method. Data has been collected by ENP personnel since 1972. However, the survey expanded it species list in the 1980s to include more than just the "sportfish" species. Therefore, the time series was analyzed from 1983-2011 following analysis conducted for blacktip shark at SEDAR 29. Factors year, area, target, season, fisher were significant main effects in the binomial model and factors year and area and were significant main effects in the lognormal model. The relative abundance trend was a gradual decline since about 1985.

INTRODUCTION

The Everglades National Park was established in 1947 and a fisheries monitoring program by the National Park Service based on sport fisher dock-side interviews began in 1972 (Schmidt et al. 2002). Fisheries data provided by the National Park Service may prove to be a useful long-term time series of relative abundance for monitoring the relative abundance of shark populations, although the area of the survey is limited to south Florida. However, because this data is based on information collected from recreational anglers which normally change fishing tactics, standardization to correct for factors unrelated to abundance such as gear changes, time-of-year, and area are necessary. The present study attempts to standardize an index of abundance for bonnethead sharks based on the monitoring of the recreational fishery in the Everglades National Park.

MATERIAL AND METHODS

Field data collection

Recreation sport fishers were interviewed by Everglades National Park personnel at the Flamingo and Chokoloskee-Everglades City boat ramps upon completion of their fishing trip (Figure 1). Data normally recorded includes trip origin, area fished, number of fish kept and released by species, number of anglers, hours fished, species preference, angler residence, and type of fisher (i.e. skilled, family, novice, sustenance) (Figure 2). Further details on the methodology can be found in Davis and Thue (1979), Tilmant et al. (1986), and Schmidt et al. (2002).

Index Development

Standardized catch rates were modeled for bonnethead sharks. The factors that were expected to influence the catch of sharks were year, fisher, season, and area. For the purposes of analysis, several categorical variables were constructed from the Everglades National Park data set prior to analysis. The factor “Fisher” refers to the skill level of the fishing party. Based on Cass-Calay and Schmidt (2003), two levels were considered from the data; “Skilled” = fishers identified as “Skilled” by Everglades National Park personnel and “Other” = Fishers identified as “family”, “novice” or “sustenance”. The factor “Season” was developed from “Month” to create two periods reflective of rainfall in the Everglades National Park. Those periods are “Dry”= December-May and “Wet”= June-November. The factor “Area” where the fisher reported fishing was refined from the Everglades National Park definitions based on similarity in habitat type (Figure 1).

Because of variations in fishing location, depth, bait and gear choice, we believed that many fishing trips that targeted species normally caught had a low probability to capture a bonnethead. In the absence of detailed and reliable data regarding specific fishing location, bait choice, etc., we used the association statistic calculated by Carlson et al. (2007) at SEDAR13 to attempt to identify trips with a higher probability of catching bonnetheads and refine the dataset. All trips were excluded unless a trip kept or released a bonnethead, or one of the top three species identified as an associate was kept or released.

Indices of abundance were estimated following the Delta method (Lo et al., 1992) by modeling the probability of the non-zero catch assuming a type-3 model with a binomial error distribution and a logit link. The distribution of the positive shark catches was modeled assuming a lognormal distribution.

Catch per unit effort= number of bonnethead sharks caught/hours reported fishing*number of anglers.

Following Ortiz and Arocha (2004), factors most likely to influence abundance were evaluated in a forward stepwise fashion. Initially, a null model was run with no factors entered into the model. Models were then fit in a stepwise forward manner adding one independent variable. Each factor was ranked from greatest to least reduction in deviance per degree of freedom when compared to the null model. The factor with the greatest reduction in deviance was then incorporated into the model providing the effect was significant at $p<0.05$ based on a Chi-Square test, and the deviance per degree of freedom was reduced by at least 1% from the less complex model. The process was continued until no factors met the criterion for incorporation into the final model. Regardless of its level of significance, year was kept in all models. This allows the estimation of the annual indices, which is the main objective of the standardization process, but also accounts for the variability associated with year-interactions. After selecting the set of factors for each error distribution, all factors that included the factor year were treated as random interactions (Ortiz and Arocha, 2004). We applied a Generalized Linear Mixed Modeling (GLMM), approach because these models can predict CPUEs for un-fished fishing cells based on the estimated effects of the explanatory variables as long as these cells were fished in some of the years. The standardized CPUE values for the Delta models were calculated as the product of the expected probability of a non-zero catch and the expected conditional catch rate for sets that had a non- zero catch. The expected probability and expected conditional catch rate were the least square means of the factor year from each of the two analyses that constitute an analysis using the Delta model approach (Lo et al., 1992; Stefansson, 1996). All models were fit using a SAS macro, GLIMMIX (glmm800MaOB.sas: Russ Wolfinger, SAS Institute Inc.) and the MIXED procedure in SAS statistical computer software (PROC GLIMMIX).

Final models were selected based on Akaike Information Criteria (AIC). Models of positive catches were checked for appropriate fit and diagnostics by examining the residuals plotted against the fitted values to check for systematic departures from the assumptions underlying the error distribution; the absolute values of the residuals plotted against the fitted values as a check of the assumed variance function; and the dependent variable was plotted against the linear predictor function as a check of the assumed link function (McCullagh and Nelder, 1989).

RESULTS AND DISCUSSION

Data has been collected by ENP personnel since 1972. However, the survey expanded it species list in the 1980s to include more than just the "sportfish" species. Therefore, the time series was analyzed from 1983-2011 following analysis conducted for blacktip shark at SEDAR 29.Trips were excluded if essential fields were missing, unusable or if a trip did not contain a trip associated with catching a bonnethead shark .

The final ENP dataset analyzed contained 37481 trips. Of those trips, bonnethead sharks were reported caught on 14.5% of trips. The stepwise construction of the model is summarized in Table 1 and the index statistics can be found in Table 2. Table 3 provides a table of the frequency of observations by factor and level. The standardized abundance index is shown in Figure 3 and the diagnostic plots assessing the fit of the models were deemed acceptable (Figure 4). The length distribution (mm TL) of bonnethead sharks measured overall is shown in Figure 5.

Table 1. Analysis of deviance of explanatory variables for the binomial and lognormal generalized linear and mixed model formulations of the proportion of positive and positive catches for bonnethead sharks. Final models selected are in bold.

Proportion positive-Binomial error distribution					
FACTOR	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**
NULL	2.1639				
YEAR	2.0011	7.523	7.52	268.21	<.0001
YEAR+					
AREA	1.5729	27.312	19.79	553.83	<.0001
TARGET	1.7725	18.088		300.3	<.0001
SEASON	1.8921	12.561		140.82	<.0001
FISHER	1.9343	10.610		87.17	<.0001
YEAR+AREA+					
TARGET	1.3994	35.330	8.02	227.36	<.0001
SEASON	1.4334	33.758		178.58	<.0001
FISHER	1.5098	30.228		81.61	<.0001
YEAR+AREA+TARGET+					
SEASON	1.2526	42.114	6.78	186.92	<.0001
FISHER	1.3502	37.603		63.58	<.0001
YEAR+AREA+TARGET+SEASON+					
FISHER	1.2064	44.249	2.14	59.61	<.0001
MIXED MODEL	**AIC**				
YEAR+AREA+TARGET+SEASON+FISHER	4634.8				
YEAR+AREA+TARGET+SEASON+FISHER YEAR*AREA	4573.2				
YEAR+AREA+TARGET+SEASON+FISHER YEAR*TARGET	4635.6				
YEAR+AREA+TARGET+SEASON+FISHER YEAR*SEASON	**4606.9**				
YEAR+AREA+TARGET+SEASON+FISHER YEAR*FISHER	4637.8				
Proportion positive-Lognormal error distribution					
FACTOR	**DEVIANCE/DF**	**%DIFF**	**DELTA%**	**CHISQUARE**	**PR>CHI**

NULL	0.6034				
YEAR	0.5892	2.353	2.353	157.35	<.0001
YEAR+					
AREA	0.5764	4.475	2.121	125.22	<.0001
TARGET	0.5859	2.900		35.91	<.0001
SEASON	0.5863	2.834		28.5	<.0001
FISHER	0.5893	2.337		0.06	0.8006
YEAR+AREA+					
SEASON	0.5729	5.055	0.580	34.15	<.0001
TARGET	0.5743	4.823		24.85	0.0001
MIXED MODEL	**AIC**				
YEAR+AREA	12568.4				
YEAR+AREA YEAR*AREA	**12538.3**				

Table 2. The standardized and nominal index (number of sharks per angler hour) of absolute abundance, and coefficients of variation (CV) for all bonnethead sharks. N=number of interviewed trips.

YEAR	N	ABSOLUTE STANDARDIZED INDEX	CV	ABSOLUTE NOMINAL INDEX	CV
1983	881	0.015	0.81	0.014	0.834
1984	1233	0.058	0.33	0.061	0.314
1985	690	0.038	0.48	0.039	0.462
1986	923	0.031	0.52	0.027	0.600
1987	921	0.030	0.51	0.031	0.499
1988	611	0.039	0.48	0.037	0.501
1989	691	0.031	0.52	0.032	0.497
1990	1767	0.025	0.52	0.023	0.573
1991	1296	0.023	0.64	0.016	0.950
1992	1857	0.038	0.41	0.037	0.429
1993	1210	0.032	0.50	0.022	0.728
1994	2052	0.029	0.47	0.022	0.599
1995	2019	0.029	0.46	0.024	0.552
1996	2591	0.027	0.47	0.021	0.604
1997	2509	0.031	0.45	0.023	0.615
1998	1783	0.023	0.58	0.024	0.562
1999	1955	0.014	0.81	0.019	0.575
2000	1686	0.019	0.67	0.032	0.413
2001	1716	0.017	0.75	0.020	0.642
2002	1250	0.016	0.78	0.020	0.617
2003	1085	0.015	0.85	0.022	0.585
2004	1078	0.018	0.76	0.024	0.560
2005	810	0.014	0.91	0.020	0.661
2006	946	0.011	1.00	0.013	0.840
2007	1000	0.014	0.88	0.016	0.780
2008	797	0.020	0.72	0.022	0.643
2009	757	0.015	0.86	0.017	0.746
2010	675	0.015	0.88	0.018	0.743
2011	690	0.011	1.06	0.016	0.757

Table 3. Frequency of observations by factor and level used in the development of the standardized catch rate series.

FACTOR	LEVEL	FREQUENCY OF TOTAL
Year	1983	2.4
	1984	3.3
	1985	1.8
	1986	2.5
	1987	2.5
	1988	1.6
	1989	1.8
	1990	4.7
	1991	3.5
	1992	5.0
	1993	3.2
	1994	5.5
	1995	5.4
	1996	6.9
	1997	6.7
	1998	4.8
	1999	5.2
	2000	4.5
	2001	4.6
	2002	3.3
	2003	2.9
	2004	2.9
	2005	2.2
	2006	2.5
	2007	2.7
	2008	2.1
	2009	2.0
	2010	1.8
	2011	1.8
Area	CS	14.2
	IF	10.0
	NA	33.9
	OF	2.2
	TI	33.1
	WB	6.7
Season	Dry	52.4
	Wet	47.6
Target	Other	75.0
	Shark	0.7
	Snapper	1.5
	Snook	10.8
	Tarpon	1.1
	Trout	10.8
Fisher	Skilled	45.1
	Other	54.9

Figure 1. Map of the Everglades National Park illustrating the defined fishing areas and the boat launch ramps where fishers were interviewed.

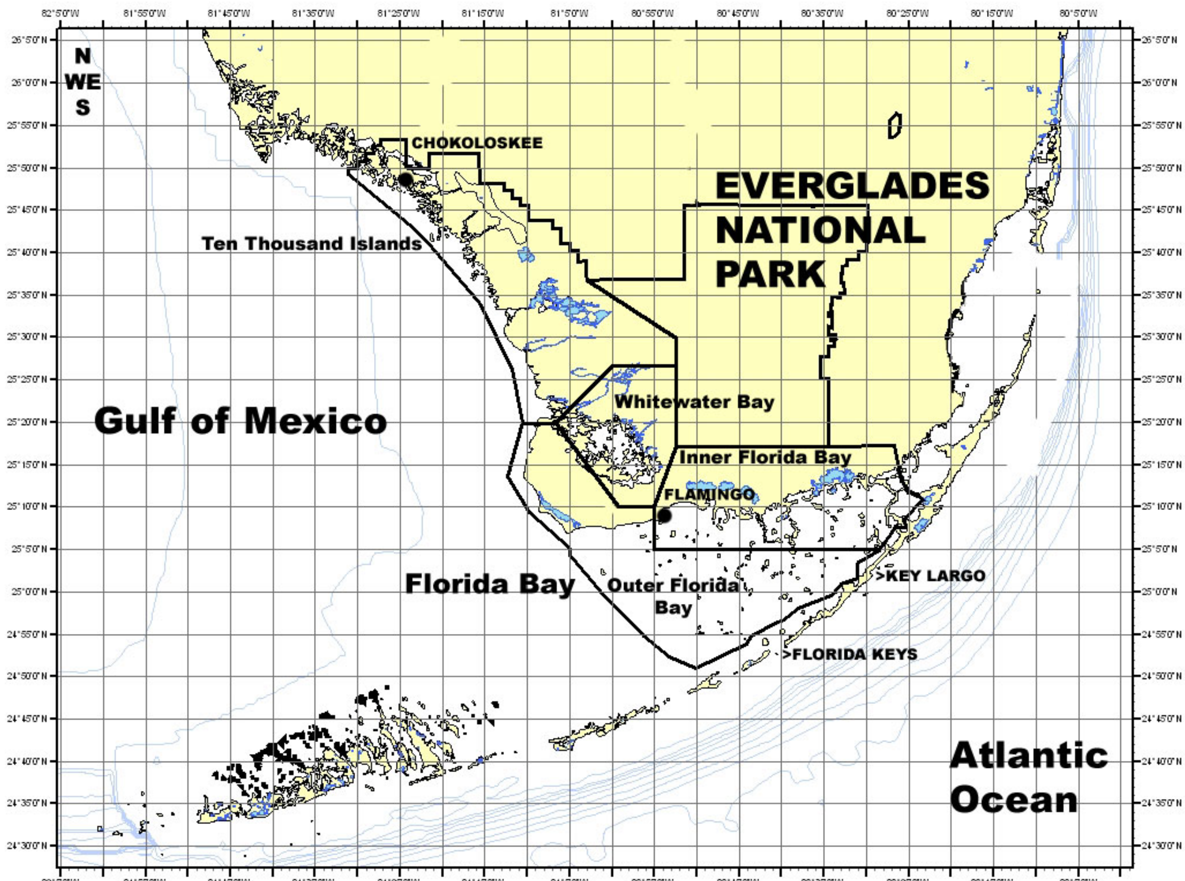


Figure 2. From Davis and Thue (1979), questions asked as part of the sportfishers interview by Everglades Parks personnel.

Sportfishing data are collected by interviewing sportfishermen at the completion of their trips. Fishermen volunteer their information. The interviewer explains that the reason for the interview is to collect data for the purpose of estimating total harvest and monitoring fishery resources. The following questions are suggested to gather the necessary information.

1. What time did you leave the dock to go fishing?

2. How many people on your boat fished? If the answer is none, fill in Column 1-18 and Columns 26-38. The element area fished will be understood to be boating area.

3. How much time did your party spend fishing?

4. Did you prefer to catch a particular species?

5. Where did you fish? If resistance is encountered to this question show them the map of the six areas (Fig. 3) used to record locations, and explain that you only need an answer as to the area fished, not their particular 'fishing hole.'

6. Why did you go fishing? This question will help determine the type fisherman. The skilled fisherman shows his expertise in many ways, such as knowledge of the park waters, fishing experience, fishing rods rigged with appropriate artificial lures or fishing in a specialized manner for particular fish. The family designation is applied to groups of adults and children, or to groups of adults whose primary interest is other than fishing. The novice fisherman has little experience fishing, or little experience in the park. The sustenance fisherman is primarily fishing for food and usually keeps everything caught.

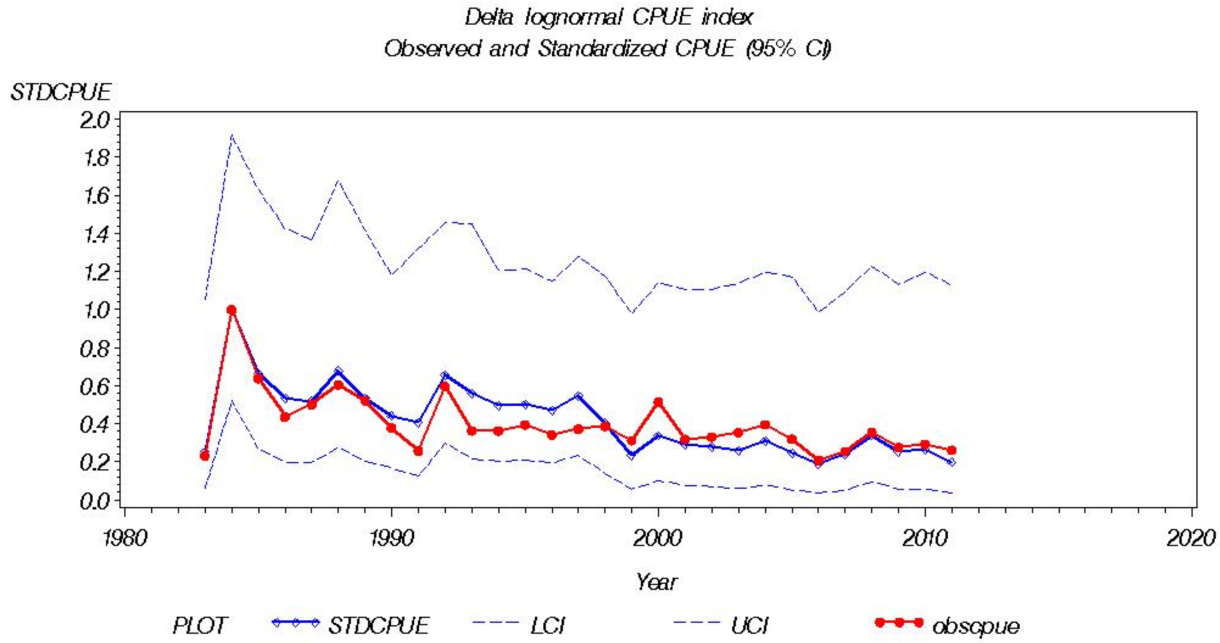
7. Where did you launch your boat?

8. Where are you from? If party members are from different areas, use the residence of the boat owner.

9. What species of fish did you catch? If the answer is more than four species, additional lines may be used for a total of 20 species (five lines). Additional lines are coded only with interview number, date, and species repeats.

10. How many fish of each species did you keep? For confirmation, interviewer must see and count the catch.

Figure 3. Nominal (obscpue) and standardized (STDCPUE) indices of abundance for bonnethead sharks. The dashed lines are the 95% confidence limits (LCL, UCL) for the standardized index. Each index has been divided by the maximum of the index.



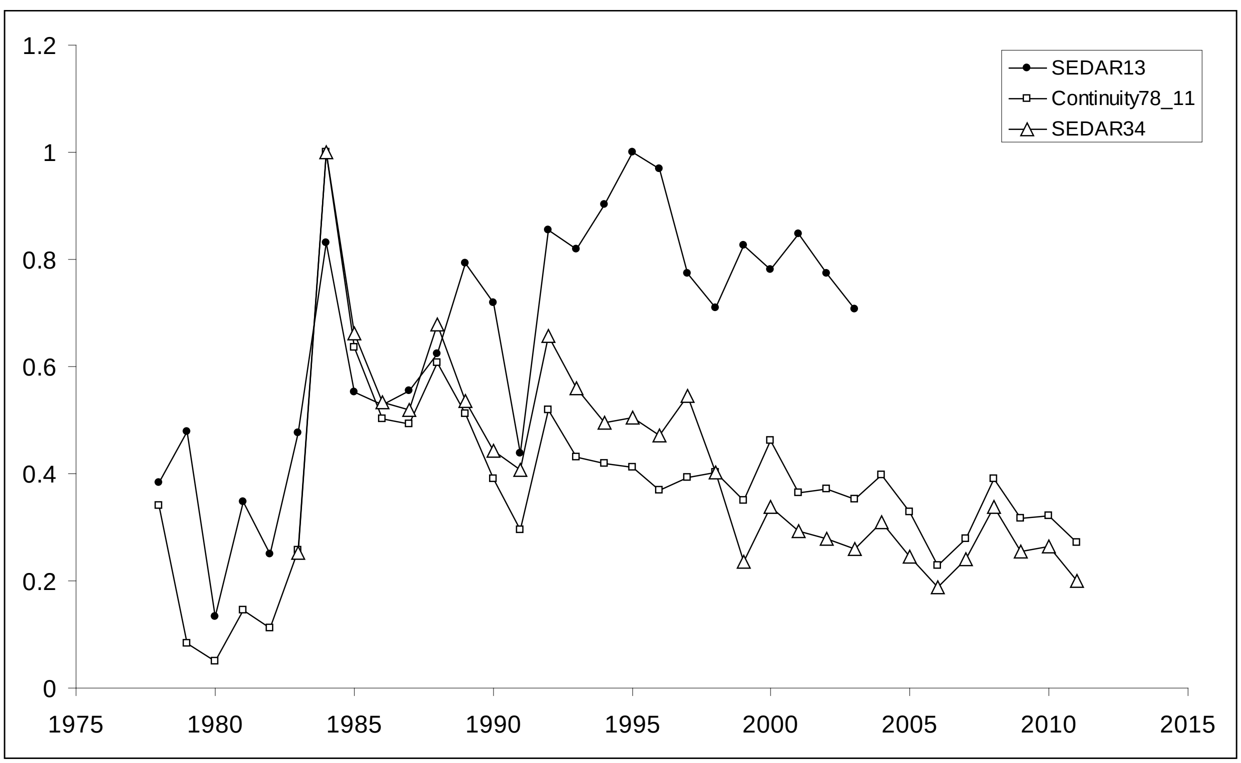


Figure 4. Diagnostic plots of the frequency distribution of residuals, quantile-quantile plots, and distribution of residuals by year.

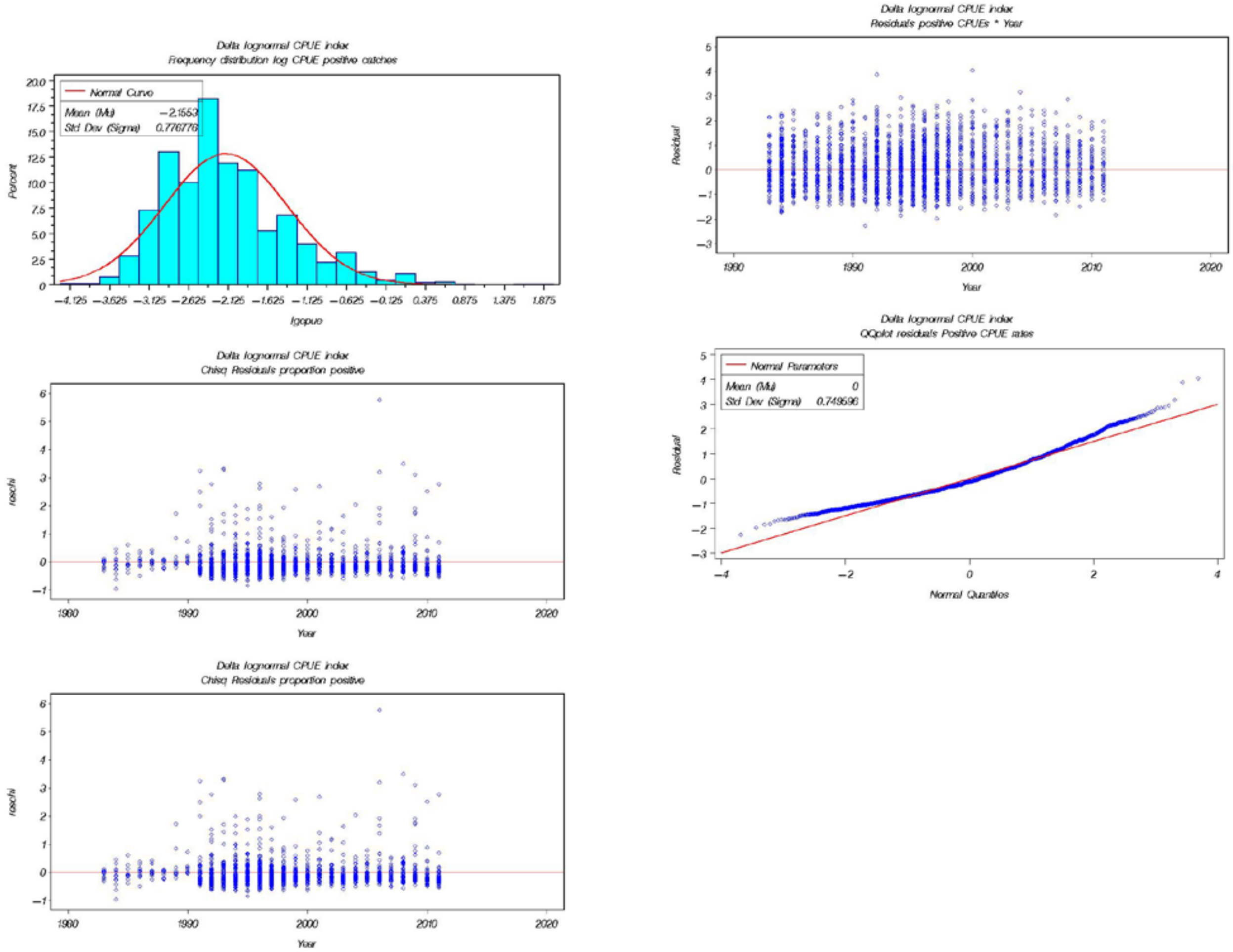
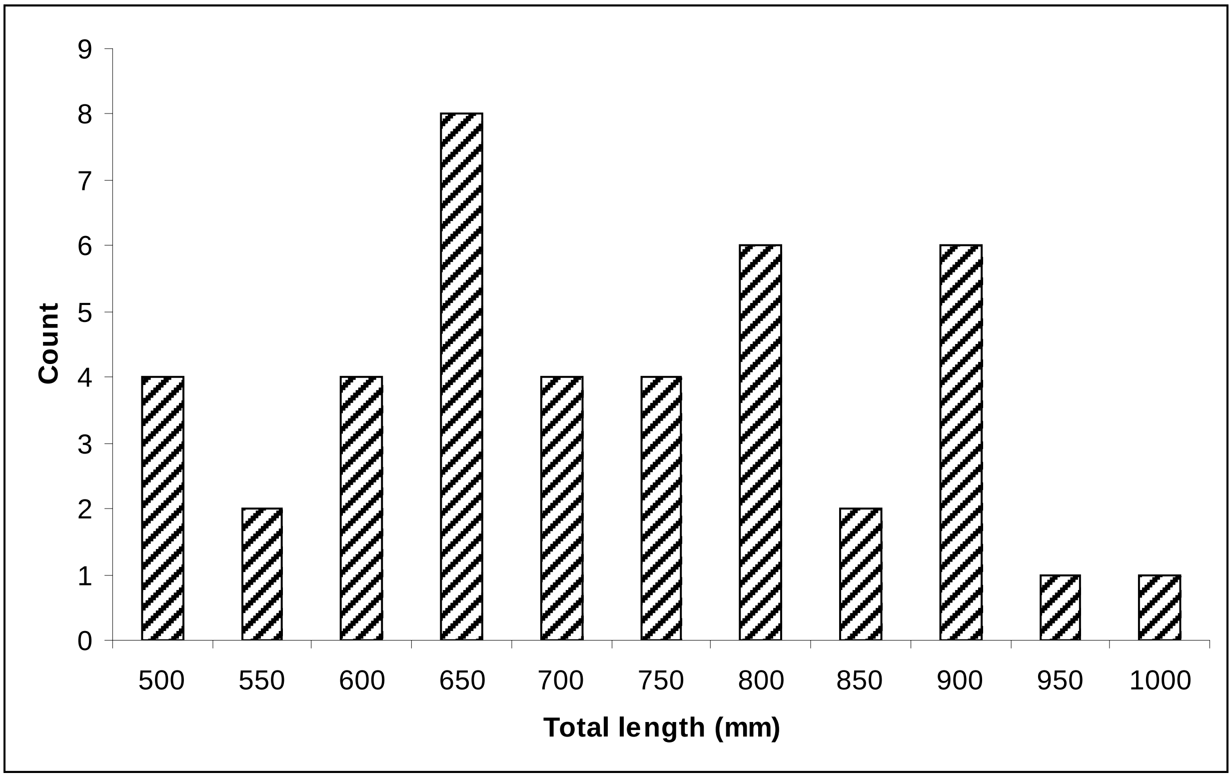


Figure 5. Length frequency distribution of bonnethead sharks caught in the Everglades National Park.



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