Small Coastal Shark Data Workshop Document

Life history parameters for Atlantic sharpnose sharks, *Rhizoprionodon terraenovae*, from the United States South Atlantic Ocean and northern Gulf of Mexico.

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Introduction

Several studies have examined the life history of the Atlantic sharpnose shark, *Rhizoprionodon terraenovae.* In the Gulf of Mexico, Parsons (1983) and Branstetter (1987) originally reported on the reproduction and age and growth, respectively. Recent studies by Loefer and Sedberry (2003) determined age, growth and maturity in the South Atlantic Ocean. Carlson and Baremore (2003) investigated the potential for density dependent changes in biological parameters from that reported by Parsons (1983) and Branstetter (1987). This report summarized those results and provides combined estimates of the life history for populations within the northern Gulf of Mexico and South Atlantic Ocean and Gulf of Mexico.

Materials and methods

Details on the processing of samples can be found within each respective study. Length-at-age data and reproductive information obtained was standardized to a common length (fork length in cm converted using published conversions). Von Bertalanffy growth models were fit to age and length (FL) data for populations in the US South Atlantic, the northern Gulf of Mexico, and combined populations. Growth model parameters were estimated using Marquardt least-squares non-linear regression and SAS statistical software (PROC NONLIN; SAS Inst., Inc).

To quantitatively assess size-at-maturity, the size at which 50% of the population is mature for male and female sharks was determined (i.e., median size-at-maturity). Similarly to age and growth analysis, data from the northern Gulf of Mexico and US South Atlantic were fitted separately and combined to a logistic model:

$$Y=1/(1+e^{-(a+bX)})$$

where Y=the binomial maturity data (immature=0, mature=1) and X=size. Median size-at-maturity was expressed as -a/b. To assess age-at-maturity, observed age was fit to binomial maturity data. When age was not available, sizes were back-transformed to age using each respective von Bertalanffy growth model. If the predicted age was above that observed for the population, ages were adjusted to reflect the oldest aged animal for that area. The model was fitted using maximum likelihood (PROC LOGISTIC; SAS Inst., Inc) and the effects of area and sex were compared used χ^2-tests of likelihood ratios.

Results

Morphometric relationships to convert length measurements are summarized from Carlson and Baremore (2003) for sharks collected in the Gulf of Mexico. Linear regression formulae were determined as: FL= 1.081(PC)+0.784; TL= 1.158(FL)+1.476; and STL= 1.007 (TL)+2.167. In the south Atlantic Ocean, Loefer and Sedberry (2003) summarized length relationships STL = 29.804 + 1.279PCL; TL = 31.678 + 1.254PCL; FL = 11.249 + 1.075PCL.

Sex specific length-weight relationships from Loefer and Sedberry (2003) are: weight (kg)= $e^{(-18.62)}PCL^{(3.04)}$ for females and weight=$e^{(-18.18)}PCL^{(2.96)}$. Length to weight relationships (sex combined) are also available from Carlson and Baremore (2003): weight (kg)=$(5.55519*10^{-6})FL^{3.07395}$.

Von Bertalanffy growth parameters are summarized in Table 1. Significant differences between von Bertalanffy growth curves were found between sharks in the US South Atlantic and Gulf of Mexico for females (log-likelihood ratio=149.2; $p<0.0001$) and males (log-likelihood ratio=138.8; $p<0.0001$). The maximum observed ages based on vertebral band counts were 6.5 and 9.8 years for male sharks from the Gulf of Mexico and US South Atlantic, respectively. For females, the oldest aged sharks were 9.5 and 11.4 years from the Gulf of Mexico and US South Atlantic, respectively

Estimates of size and age-at-maturity for male and female sharks from the Gulf of Mexico were different from those in the US South Atlantic (Table 2). Fork length at which 50% of the population reached maturity is 60.5 cm in the US South Atlantic and 64.2 mm for females in the Gulf of Mexico. Median fork length at maturity for males is 66.8 cm and 61.4 cm for the US South Atlantic and Gulf of Mexico, respectively. Median age-at-maturity was 2.0 and 1.6 years for females, and 2.6 and 1.3 years for males for sharks in the US South Atlantic and Gulf of Mexico, respectively.

Reproductive cycle for Atlantic sharpnose sharks is annual (Parsons, 1983; Loefer and Sedberry, 2003). Carlson and Baremore (2003) reported a significant exponential relationship between maternal total length and number of embryos (litter size=$0.047\exp^{(0.048)}$TL, $r^2=0.65$, $p<0.001$). Average litter size was 5.0 pups (±1.8 S.D.). In the south Atlantic, the mean size of near-term embryos was 32.3 STL (±2.1 S.D) and weight=130 g (±29.8) (Loefer and Sedberry 2003). Litter sizes ranged from one to eight, and generally also increased with female length (Litter size = –11.07 + 0.021 PCL + 1.37). Mean litter size was 3.85 embryos (Loefer and Sedberry 2003).

Combining data from the south Atlantic and Gulf of Mexico results in a maternal length-embryo relationship of litter size=$0.0534\exp^{(0.0544)}$FL, $r^2=0.45$, $p<0.001$ (Figure 1). The average number of pups for combined areas is 4.07 (S.D.=1.56).

Literature cited

Branstetter, S. 1987. Age and growth validation of newborn sharks held in laboratory aquaria, and comments on the life history of the Atlantic sharpnose shark, *Rhizoprionodon terraenovae*. Copeia 1987:291-300.

Carlson, J.K. and I.E. Baremore. 2003. Changes in biological parameters of Atlantic sharpnose shark *Rhizoprionodon terraenovae* in the Gulf of Mexico: evidence for density-dependent growth and maturity? Marine and Freshwater Research 54:227-234.

Loefer J.K. and G.R. Sedberry. 2003. Life history of the Atlantic sharpnose shark (*Rhizoprionodon terraenovae*) (Richardson, 1836) off the southeastern United States. Fishery Bulletin 101:57-88.

Parsons, G. R. 1983. The reproductive biology of the Atlantic sharpnose shark, *Rhizoprionodon terraenovae* (Richardson). Fishery Bulletin U.S. 81:61-73.

Table 1. Von Bertalanffy growth parameters for male, female, and sex combined for Atlantic sharpnose sharks. Estimates are provided for the northern Gulf of Mexico, South Atlantic Ocean, and areas combined. Standard error = S.E. and 95% lower and upper confidence limits = L.C.L and U.C.L, respectively.

	Male	S.E.	L.C.L	U.C.L	Female	S.E.	L.C.L	U.C.L	Combined	S.E.	L.C.L	U.C.L
Northern Gulf of Mexico												
L_∞ (FL cm)	77.8	1.3	75.2	80.3	80.8	1.2	78.5	83.2	79.5	0.9	77.8	81.3
K (yr^{-1})	0.86	0.09	0.68	1.04	0.63	0.06	0.52	0.76	0.73	0.05	0.63	0.84
t_o (yr)	-0.72	0.09	-0.91	-0.53	-1.01	0.12	-1.25	-0.77	-0.86	0.08	-1.00	-0.71
N	161				143				304			
South Atlantic Ocean												
L_∞ (FL cm)	81.3	0.7	79.9	82.6	81.9	0.5	80.8	82.9	81.6	0.4	80.8	82.4
K (yr^{-1})	0.50	0.02	0.45	0.55	0.48	0.02	0.44	0.52	0.49	0.01	0.46	0.52
t_o (yr)	-0.94	0.05	-1.05	-0.83	-0.99	0.05	-1.09	-0.88	-0.97	0.03	-1.04	-0.89
N	379				433				812			
Areas combined												
L_∞ (FL cm)	79.3	0.6	78.16	80.35	80.2	0.4	79.37	81.11	79.8	0.3	79.11	80.48
K (yr^{-1})	0.66	0.03	0.61	0.73	0.61	0.02	0.56	0.66	0.64	0.02	0.60	0.68
t_o (yr)	-0.76	0.05	-0.86	-0.67	-0.84	0.04	-0.93	-0.75	-0.80	0.03	-0.87	-0.74

Table 2. Predicted proportion mature for Atlantic sharpnose sharks by area and sex.

Gulf of Mexico

FL	Males	Females	Combined	Age	Males	Females	Combined
35	0.00	0.00	0.00	0.00	0.01	0.00	0.00
40	0.00	0.00	0.00	0.50	0.05	0.00	0.03
45	0.01	0.00	0.00	1.50	0.67	0.34	0.58
50	0.03	0.00	0.02	2.50	0.99	0.99	0.98
55	0.14	0.00	0.08	3.50	1.00	1.00	1.00
60	0.41	0.08	0.33	4.50	1.00	1.00	1.00
65	0.75	0.61	0.73	5.50	1.00	1.00	1.00
70	0.93	0.97	0.94	6.50		1.00	0.99
75	0.98	1.00	0.99	7.50		1.00	0.99
80	1.00	1.00	1.00	8.50		1.00	0.99
85	1.00	1.00	1.00	9.50		1.00	0.99
90	1.00	1.00	1.00				
95	1.00	1.00	1.00				
100	1.00	1.00	1.00				

South Atlantic

FL	Males	Females	Combined	Age	Males	Females	Combined
35	0.00	0.00	0.00	0.00	0.00	0.01	0.00
40	0.00	0.00	0.00	0.50	0.00	0.04	0.01
45	0.00	0.01	0.00	1.50	0.01	0.25	0.12
50	0.00	0.03	0.00	2.50	0.35	0.73	0.59
55	0.00	0.13	0.03	3.50	0.97	0.96	0.94
60	0.00	0.46	0.18	4.50	1.00	0.99	0.99
65	0.02	0.82	0.64	5.50	1.00	1.00	1.00
70	1.00	0.96	0.94	6.50	1.00	1.00	1.00
75	1.00	0.99	0.99	7.50	1.00	1.00	1.00
80	1.00	1.00	1.00	8.50	1.00	1.00	1.00
85	1.00	1.00	1.00	9.50	1.00	1.00	1.00
90	1.00	1.00	1.00	10.50		1.00	1.00
95	1.00	1.00	1.00	11.50		1.00	1.00
100	1.00	1.00	1.00				

Combined areas

FL	Males	Females	Combined	Age	Males	Females	Combined
550	0.00	0.00	0.00	0.00	0.01	0.00	0.01
600	0.00	0.00	0.00	0.50	0.02	0.00	0.01
650	0.00	0.00	0.00	1.50	0.06	0.01	0.04
700	0.01	0.00	0.01	2.50	0.20	0.03	0.13
750	0.03	0.00	0.02	3.50	0.48	0.14	0.34
800	0.09	0.00	0.05	4.50	0.77	0.43	0.64
850	0.21	0.00	0.12	5.50	0.92	0.78	0.84
900	0.41	0.02	0.29	6.50	0.98	0.94	0.92
950	0.65	0.15	0.54	7.50	0.99	0.99	0.94
1000	0.83	0.57	0.77	8.50	1.00	1.00	0.95
1050	0.93	0.91	0.91	9.50	1.00	1.00	0.95
1100	0.97	0.99	0.97	10.50	1.00	1.00	0.95
1150	0.99	1.00	0.99	11.50	1.00	1.00	0.95
1200	1.00	1.00	1.00	12.50	1.00	1.00	0.95
1250	1.00	1.00	1.00	13.50	1.00	1.00	0.95
1300	1.00	1.00	1.00				
1350	1.00	1.00	1.00				
1400	1.00	1.00	1.00				
1450	1.00	1.00	1.00				

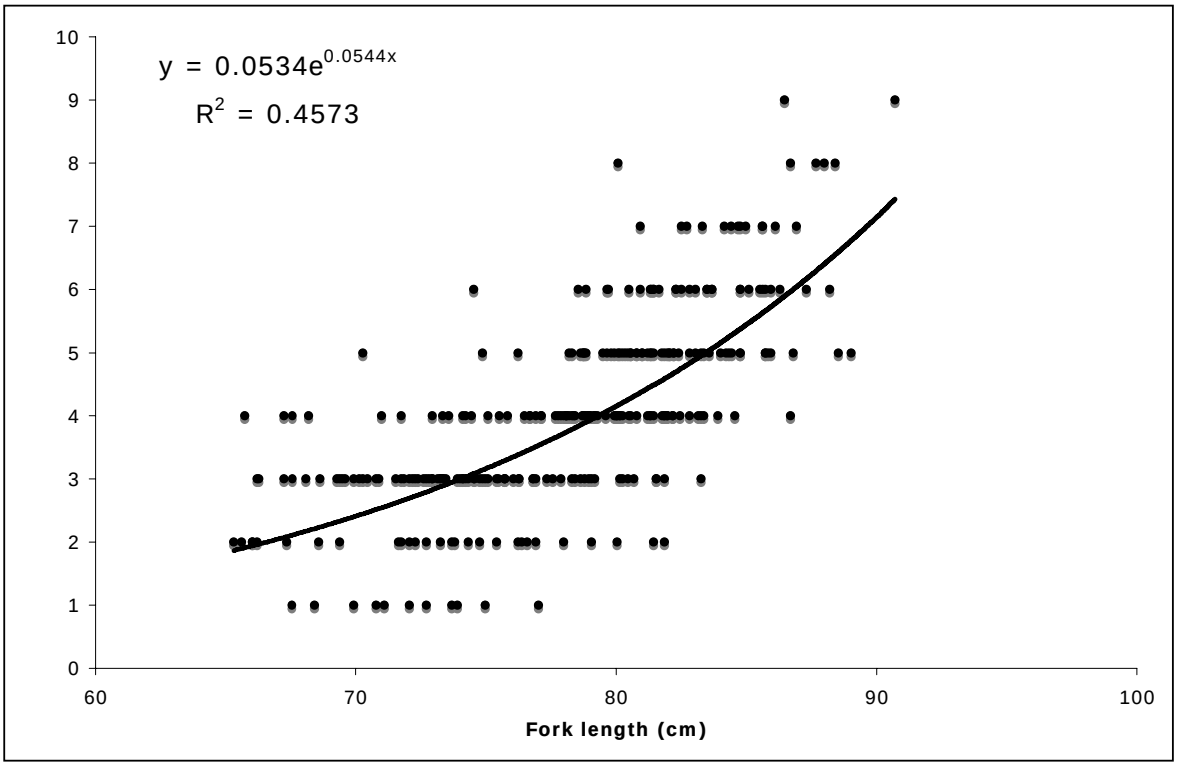

Figure 1. Relationship between maternal size (FL) and number of embryos.

Addendum to Table 2. Predicted proportion mature for Atlantic sharpnose sharks by area and sex.

Combined areas								
FL	Males	Females	Combined		Age	Males	Females	Combined
35	0.00	0.00	0.00		0.00	0.02	0.01	0.01
40	0.00	0.00	0.00		0.50	0.05	0.03	0.04
45	0.00	0.00	0.00		1.50	0.28	0.32	0.30
50	0.01	0.01	0.01		2.50	0.76	0.87	0.81
55	0.05	0.06	0.05		3.50	0.96	0.99	0.98
60	0.24	0.31	0.27		4.50	1.00	1.00	1.00
65	0.65	0.76	0.70		5.50	1.00	1.00	1.00
70	0.91	0.96	0.94		6.50	1.00	1.00	1.00
75	0.98	0.99	0.99		7.50	1.00	1.00	1.00
80	1.00	1.00	1.00		8.50	1.00	1.00	1.00
85	1.00	1.00	1.00		9.50	1.00	1.00	1.00
90	1.00	1.00	1.00		10.50	1.00	1.00	1.00
95	1.00	1.00	1.00		11.50	1.00	1.00	1.00
100	1.00	1.00	1.00					