Reproductive parameters for Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) from the western North Atlantic Ocean

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SEDAR34-WP-30

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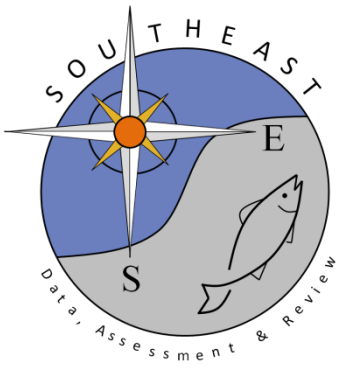

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Reproductive parameters for Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) from the western North Atlantic Ocean.

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Introduction

Since the update on life history parameters for Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) at SEDAR 13, additional data have become available pertaining to the reproductive biology of the species in the northern Gulf of Mexico (GOM) (Hoffmayer et al., in press). This document utilizes raw data from Carlson and Loefer (SEDAR13-DW-08-V2) and Hoffmayer et al. (in press) to provide updated estimates of several important reproductive parameters when treating Atlantic sharpnose sharks in U.S. waters of the western North Atlantic Ocean as a single stock.

Methods

Data from Carlson and Loefer (SEDAR13-DW-08-V2) and Hoffmayer et al. (in press) were merged to calculate updated estimates for age and size at maturity, mean brood size and relationship between maternal length and brood size when treating Atlantic sharpnose sharks in the South Atlantic Bight (SAB) and GOM as a single stock. Maturity ogives were fitted to size, age and binomial maturity data using least squares nonlinear regression for combined regions using the algorithm $Y = 1/(1+e-(a+bx))$ for each sex and both sexes combined. Gulf of Mexico length data provided by Hoffmayer et al. (in press) were back-transformed to calculate ages based on von Bertalanffy growth model parameter estimates presented by Carlson and Loefer (SEDAR13-DW-08-V2) for the GOM. When back transformed ages were less than zero, an age of zero was assigned. When back-transformed ages were greater than the maximum observed ages reported by Carlson and Loefer (SEDAR13-DW-08-V2) for the Gulf of Mexico, those ages were held constant at 9.5 years and 6.5 years for females and males, respectively. Size and age at which 50% of the population was mature was calculated from model parameter estimates as $-a/b$ (Mollet et al., 2000).

As brood size data were not normally distributed, the Mann-Whitney-Wilcoxon W test was used to examine median brood size between the SAB and GOM. The relationship between maternal length and brood size was examined using regression analysis.

Results

When combining reproductive data collected in the SAB and GOM, median fork length at 50% maturity was 62.46 cm FL for females (a = -25.2920, b = 0.404938), 63.18 cm FL for males (a = -23.0231, b = 0.364392), and 62.70 cm FL for sexes combined (a = -22.8164, b = 0.363606). Median age at maturity was 1.33 years for females (a = -5.9641, b = 4.48244), 1.39 years for males (a = -5.58268, b = 4.00855), and 1.36 years for the sexes combined (a = -5.80717, b = 4.26659) (Table 1).

Brood size data were available from 676 gravid females from the South Atlantic Bight (n = 234) and the northern Gulf of Mexico (n = 442) (Figure 1). Brood size for the combined areas ranged from 1 – 9 pups; mean brood size was 4.32 (± 1.66 S.D.). Median brood size was larger in the GOM (median = 5) than in the SAB (median = 4) ($W = 38289.00$, $p < 0.01$) (Figure 2). There was a significant relationship between maternal length and brood size ($F = 614.55.28$, d.f. = 675, $p < 0.01$), which was best described by the following equation:
brood size = exp(-3.03167+0.056090*FL) ($r^2 = 0.48$) (Figure 3).

Literature cited

Carlson, J.K. and Loefer, J. 2007. Life History Parameters for Atlantic Sharpnose Sharks (*Rhizoprionodon terraenovae*), from the United States South Atlantic Ocean and Northern Gulf of Mexico. SEDAR13-DW-08-V2. SEDAR, North Charleston, SC. 7 pp.

Hoffmayer, E.R., Hendon, J.M., Driggers, W.B. III, Jones, L.M. and Sulikowski, J.A. (*In Press*): Variability in the Reproductive Biology of the Atlantic Sharpnose Shark in the Gulf of Mexico. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science.

Mollet, H.F., Cliff, G., Pratt, H.L. Jr. and Stevens, J.D. 2000. Reproductive Biology of the Female Shortfin Mako, *Isurus oxyrinchus* Rafinesque, 1810, with Comments on the Embryonic Development of Lamnoids. Fishery Bulletin. 98: 299-318.

Fork length (cm)	Males	Females	Sexes combined
25	0.00	0.00	0.00
30	0.00	0.00	0.00
35	0.00	0.00	0.00
40	0.00	0.00	0.00
45	0.00	0.00	0.00
50	0.01	0.01	0.01
55	0.05	0.05	0.06
60	0.24	0.27	0.27
65	0.66	0.74	0.69
70	0.92	0.95	0.93
75	0.99	0.99	0.99
80	1.00	1.00	1.00
85	1.00	1.00	1.00
90	1.00	1.00	1.00
95	1.00	1.00	1.00
100	1.00	1.00	1.00

Age (years)	Males	Females	Sexes combined
0	0.00	0.00	0.00
0.5	0.03	0.02	0.02
1.5	0.61	0.68	0.64
2.5	0.99	0.99	0.99
3.5	1.00	1.00	1.00
4.5	1.00	1.00	1.00
5.5	1.00	1.00	1.00
6.5	1.00	1.00	1.00
7.5	1.00	1.00	1.00
8.5	1.00	1.00	1.00
9.5	1.00	1.00	1.00
10.5	1.00	1.00	1.00
11.5	1.00	1.00	1.00
12.5	1.00	1.00	1.00
13.5	1.00	1.00	1.00
14.5	1.00	1.00	1.00

Table 1. Proportion of mature Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) within 5 cm size classes and 1 year age classes by sex.

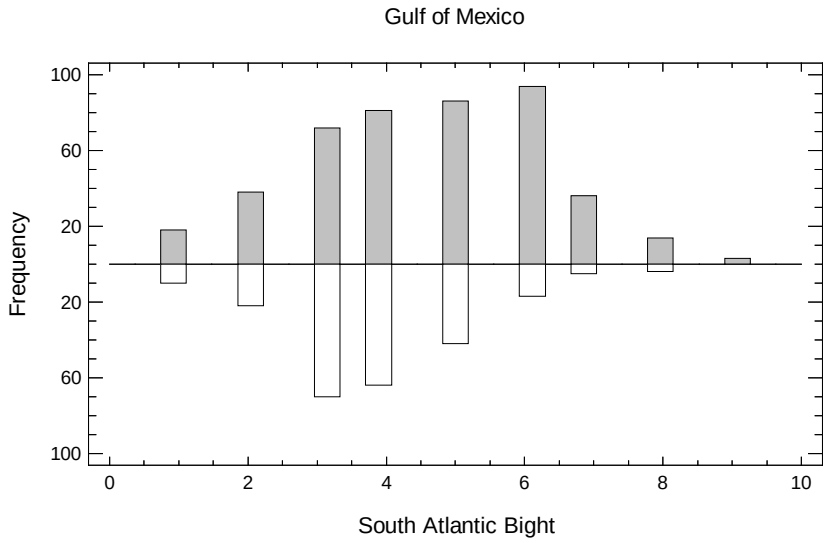

Figure 1. Distribution of brood sizes from gravid female Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) collected in the northern Gulf of Mexico and the South Atlantic Bight. X-axis represents brood size.

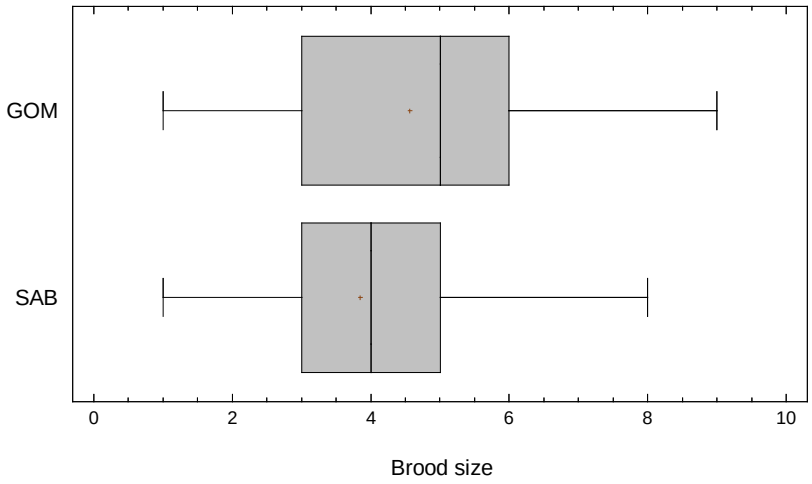

Figure 2. Box and whisker plot of brood sizes of gravid female Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) from the northern Gulf of Mexico (GOM) and the South Atlantic Bight (SAB). Bars represent minimum and maximum observed values, grey box represents lower and upper quantiles, + indicates the mean and center line represents the median

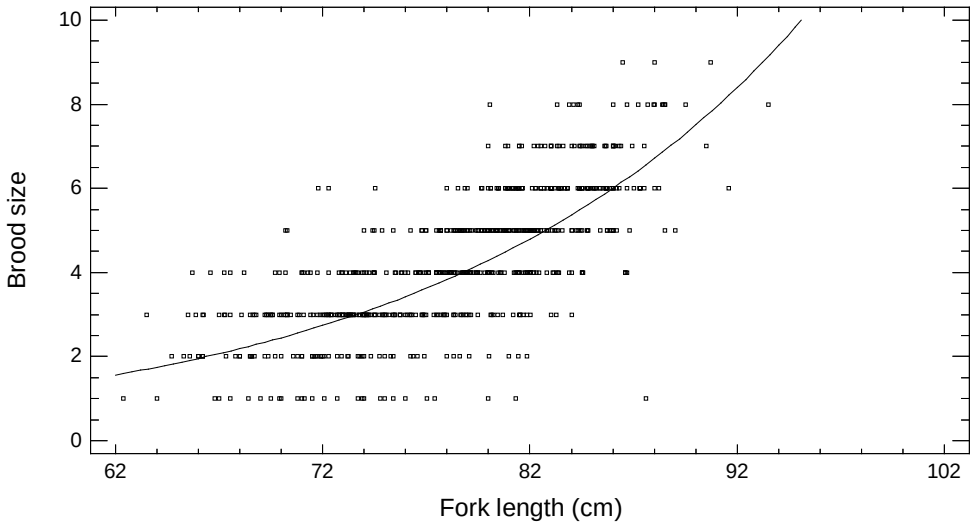

Figure 3. Relationship between maternal length and brood size for gravid female Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) from the northern Gulf of Mexico and the South Atlantic Bight. Brood size = exp(-3.03167+0.056090*FL).

Addendum to SEDAR34-WP-30

Several additional analyses were requested based on discussion of the panel and the need to include data presented in SEDAR17-DW-08-V2 when describing reproductive parameters for the northern Gulf of Mexico.

Maximum age in the northern Gulf of Mexico

SEDAR34-WP-31 reported a male Atlantic sharpnose shark that was tagged and recaptured in the northern Gulf of Mexico after 10.7 years at liberty. The shark was 79 cm fork length when tagged. It was not possible to back transform age at measured size at capture as the measured length was greater than the estimate of L_∞ provided in SEDAR17-DW-08-V2. Therefore, the maximum observed age of 6.5 years for males reported in SEDAR17-DW-08-V2 was used as the age at tagging. The time at liberty of 10.7 years was added to the maximum observed age and resulted in an estimated maximum age of ASN in the GOM of 17.2 years.

Updated estimates for the

Data from SEDAR34-WP-17 and SEDAR17-DW-08-V2 were merged to generate reproductive parameter estimates for females in the South Atlantic Bight (SAB) and Gulf of Mexico (GOM) combined. However, reproductive data specific to females in the GOM were limited to those from SEDAR34-WP-17 and excluded data from SEDAR17-DW-08-V2. When combining reproductive data for the GOM (n = 833) from SEDAR17-DW-08-V2 and SEDAR34-WP-17, median fork length and age at 50% maturity for females were 62.3 cm FL (a = -24.7204, b = 0.394444) and 1.3 years (a = -6.76532, b = 5.15161), respectively (Table 1). Brood size data were available from 442 gravid females from the GOM. Brood size ranged from 1 – 9 pups; mean brood size was 4.57 (± 1.74 S.D.). There was a significant relationship between maternal length and brood size ($F = 450.62$, d.f. = 441, $p < 0.01$), which was best described by the following equation: brood size = exp(-3.07042+0.0570151*FLcm) ($r^2 = 0.51$) (Figure 1.1).

Table 1. Maturity schedules for female Atlantic sharpnose sharks in the northern Gulf of Mexico

FL	Females
25.00	0.00
30.00	0.00
35.00	0.00
40.00	0.00
45.00	0.00
50.00	0.01
55.00	0.05
60.00	0.26
65.00	0.71
70.00	0.95
75.00	0.99
80.00	1.00
85.00	1.00
90.00	1.00
95.00	1.00
100.00	1.00

Age	Females
0	0.00
1	0.17
2	0.97
3	1.00
4	1.00
5	1.00
6	1.00
7	1.00
8	1.00
9	1.00
10	1.00
11	1.00
12	1.00
13	1.00
14	1.00
15	1.00
16	1.00
17	1.00
18	1.00
19	1.00
20	1.00

Figure 1.