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Life history parameters for finetooth sharks, *Carcharhinus isodon*, from the United States South Atlantic Ocean and northern Gulf of Mexico.

John K. Carlson
NOAA/National Marine Fisheries Service, Southeast Fisheries Science Center, 3500 Delwood Beach Road, Panama City, FL 32408, U.S.A. (e-mail:john.carlson@noaa.gov)

J. Marcus Drymon
NOAA/National Marine Fisheries Service, Southeast Fisheries Science Center, Mississippi Laboratories, P.O. Drawer 1207, Pascagoula, Mississippi 39568 U.S.A.
(email: marcus.drymon@noaa.gov)

Julie A. Neer
NOAA/National Marine Fisheries Service, Southeast Fisheries Science Center, 3500 Delwood Beach Road, Panama City, FL 32408, U.S.A. (e-mail:julie.neer@noaa.gov)

Introduction

Several studies have examined the life history of the finetooth shark, *Carcharhinus isodon.* In the US South Atlantic Ocean, Castro (1996) originally reported on the reproduction but an updated study by Drymon et al. (in press) studied the age, growth, and reproduction for individuals collected off South Carolina. In the northeastern Gulf of Mexico, Carlson et al. (2003) determined age, growth, size-at-maturity, natural mortality, productivity, and elasticity of vital rates of the population. Neer and Thompson (2004) reported on the occurrence and aspects of the life history of finetooth shark off Louisiana. 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

Despite being separate studies, all studies processed samples similarly and assigned ages following an analogous algorithm. Details on the processing can be found within each study. Because Neer and Thompson (2004) reported no difference in age and growth between Louisiana and the northeast Gulf of Mexico (Carlson et al. 2003), samples from those areas where combined to produce a single age and growth model and reproductive schedule for the northern Gulf of Mexico. However, Drymon et al. (in press) reported differences in life history between the northeast Gulf of Mexico and South Carolina. Thus, 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 South Carolina 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 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 et al. (2003). Linear regression formulae were determined as FL=1.10(PC)+0.60; TL=1.23(FL)+20.34; and STL=1.10(TL)+11.25. Length-weight relationships are from Castro (1993) as: weight (kg)=$(4.0834*10^{-9})$STL $^{3.03406}$.

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=13.20; p=0.004) but not males (log-likelihood ratio=6.45; p=0.092). The maximum observed ages based on vertebral band counts were 8.2 and 10.3 years for male sharks from the Gulf of Mexico and US South Atlantic, respectively. For females, the oldest aged sharks were 8.1 and 12.3 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 1022 mm in the US South Atlantic and 990 mm for females in the Gulf of Mexico and was found to be significantly different ($p<0.01$). Median fork length at maturity for males is 988 mm and 935 mm for the US South Atlantic and Gulf of Mexico, respectively. Median age-at-maturity was 6.2 and 4.2 years for females, and 4.9 and 3.5 years for males for sharks in the US South Atlantic and Gulf of Mexico, respectively.

Information on fecundity was obtained from Castro (1993) for sharks in the US South Atlantic with a mean of 4.036 pups year^{-1}, SD=0.793, and 2 and 6 reflecting the range of litter sizes reported. Off Louisiana, Neer and Thompson (2004) observed 3 gravid females with litters of 3,4 and 5 pups, respectively. Although information on blacknose sharks from the Gulf of Mexico suggests a one-year reproductive cycle (Sulikowski et al. in press), reproductive cycle of 2 yr is assumed for finetooth shark from both areas (Castro 1993).

Literature cited

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Table 1. Von Bertalanffy growth parameters for male, female, and sex combined for finetooth 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)	1127.5	33.52	1061.3	1193.8	1291.3	58.7	1175.1	1407.5	1200.7	31.7	1138.2	1263.1
K (yr^{-1})	0.31	0.04	0.24	0.39	0.23	0.03	0.17	0.29	0.26	0.02	0.22	0.31
t_o (yr)	-1.83	0.23	-2.28	-1.37	-1.99	0.24	-2.47	-1.53	-1.92	0.17	-2.25	-1.59
N	147				147				294			
South Atlantic Ocean												
L_∞ (FL cm)	1152.5	23.2	1106.2	1198.8	1321.4	44.9	1232.2	1410.6	1244.0	26.1	1192.6	1295.5
K (yr^{-1})	0.33	0.03	0.27	0.39	0.18	0.02	0.15	0.22	0.23	0.02	0.19	0.26
t_o (yr)	-1.53	0.13	-1.79	-1.26	-2.32	0.19	-2.71	-1.94	-2.01	0.13	-2.26	-1.77
N	71				97				167			
Areas combined												
L_∞ (FL cm)	1135.5	19.11	1097.8	1173.1	1267.0	27.4	1213.0	1321.1	1205.8	17.1	1172.2	1239.5
K (yr^{-1})	0.32	0.02	0.28	0.36	0.23	0.02	0.20	0.26	0.27	0.01	0.24	0.29
t_o (yr)	-1.64	0.10	-1.84	-1.43	-1.95	0.12	-2.18	-1.72	-1.83	0.08	-1.98	-1.67

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

Gulf of Mexico

FL	Males	Females	Combined	Age	Males	Females	Combined
550	0.00	0.00	0.00	0.00	0.01	0.00	0.00
600	0.00	0.00	0.00	0.50	0.02	0.00	0.01
650	0.01	0.00	0.00	1.50	0.06	0.00	0.04
700	0.01	0.00	0.01	2.50	0.21	0.02	0.14
750	0.04	0.00	0.02	3.50	0.51	0.18	0.41
800	0.09	0.00	0.06	4.50	0.80	0.69	0.76
850	0.22	0.01	0.15	5.50	0.94	0.96	0.93
900	0.42	0.03	0.33	6.50	0.98	1.00	0.98
950	0.66	0.18	0.58	7.50	1.00	1.00	1.00
1000	0.84	0.59	0.79	8.50	1.00	1.00	1.00
1050	0.93	0.90	0.92				
1100	0.97	0.98	0.97				
1150	0.99	1.00	0.99				
1200	1.00	1.00	1.00				
1250	1.00	1.00	1.00				
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				

South Atlantic

FL	Males	Females	Combined	Age	Males	Females	Combined
550	0.00	0.00	0.00	0.00	0.00	0.00	0.00
600	0.00	0.00	0.00	0.50	0.01	0.00	0.00
650	0.00	0.00	0.00	1.50	0.02	0.00	0.01
700	0.00	0.00	0.00	2.50	0.06	0.02	0.03
750	0.00	0.00	0.00	3.50	0.17	0.05	0.08
800	0.00	0.00	0.00	4.50	0.39	0.13	0.21
850	0.01	0.00	0.00	5.50	0.66	0.31	0.45
900	0.06	0.00	0.01	6.50	0.86	0.58	0.71
950	0.23	0.00	0.07	7.50	0.95	0.81	0.88
1000	0.59	0.00	0.43	8.50	0.98	0.93	0.96
1050	0.87	1.00	0.88	9.50	0.99	0.98	0.98
1100	0.97	1.00	0.99	10.50	1.00	0.99	0.99
1150	0.99	1.00	1.00	11.50	1.00	1.00	1.00
1200	1.00	1.00	1.00	12.50	1.00	1.00	1.00
1250	1.00	1.00	1.00				
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				

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				
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				