Results of Mote Marine Laboratory Shark Tagging Program for blacktip (*Carcharhinus limbatus*) and sandbar (*C. plumbeus*) sharks

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Introduction

Mote Marine Laboratory's Center for Shark Research has been conducting tag and recapture studies of sharks since 1991. These studies have focused on shark species common on the Gulf of Mexico coast of Florida, particularly blacktip and bonnethead sharks. While focused on the Florida coast, tagging has been carried out throughout the Gulf of Mexico. The purpose of this report was to use the data from the Mote Marine Laboratory shark tagging database to provide information relevant to the 2005 stock assessment workshop for large coastal sharks. Two types of information are provided:

1. Movement data for use in interpreting stock structure of blacktip and sandbar sharks.
2. Age and growth data for blacktip sharks.

Materials and methods

Field methods and data collection

This report contains data from sharks captured using a number of gear types including gill net, longline, drumline, rod & reel, and seine net. Collected sharks were identified, sexed, measured (precaudal length, PCL; fork length, FL; total length, TL; and stretch total length, STL) to the nearest cm, weighed to the nearest 0.1 kg (when feasible), and either tagged and released or retained for study. In most cases, small sharks (less than approximately 1.5 m TL) caught and released alive in Mote CSR research were tagged with a nylon-head, plastic barb tag inserted just below the first dorsal fin across the body midline, such that the tag head was firmly anchored in the cartilage and connective tissue below the fin. Other types of conventional tags used in various Mote CSR shark studies have included Rototags, NMFS M-tags, and Mote CSR M-tags.

Movement analysis

Tag-recapture data for blacktip and sandbar sharks for which there were valid tag and recapture locations were plotted using a GIS (ArcView 3.3).

Age and growth analysis

Tag-recapture data for blacktip sharks that had accurate size data at both release and recapture were used to examine age and growth parameters. All sizes used were stretch total length (STL) and males and females were combined for the analysis, although all animals larger than 100 cm at recapture were female. Size at release, size at recapture and days at liberty were used to fit the GROTAG model of Francis (1988) and 95% confidence intervals of the model parameters were estimated using the bootstrap method described by Simpfendorfer (2000). Parameters of the Francis (1988) model were converted to von Bertalanffy parameters and plotted. The value of t_0 for plotting the function was estimated using the mean size at birth from other field studies to obtain the appropriate y-axis intercept.

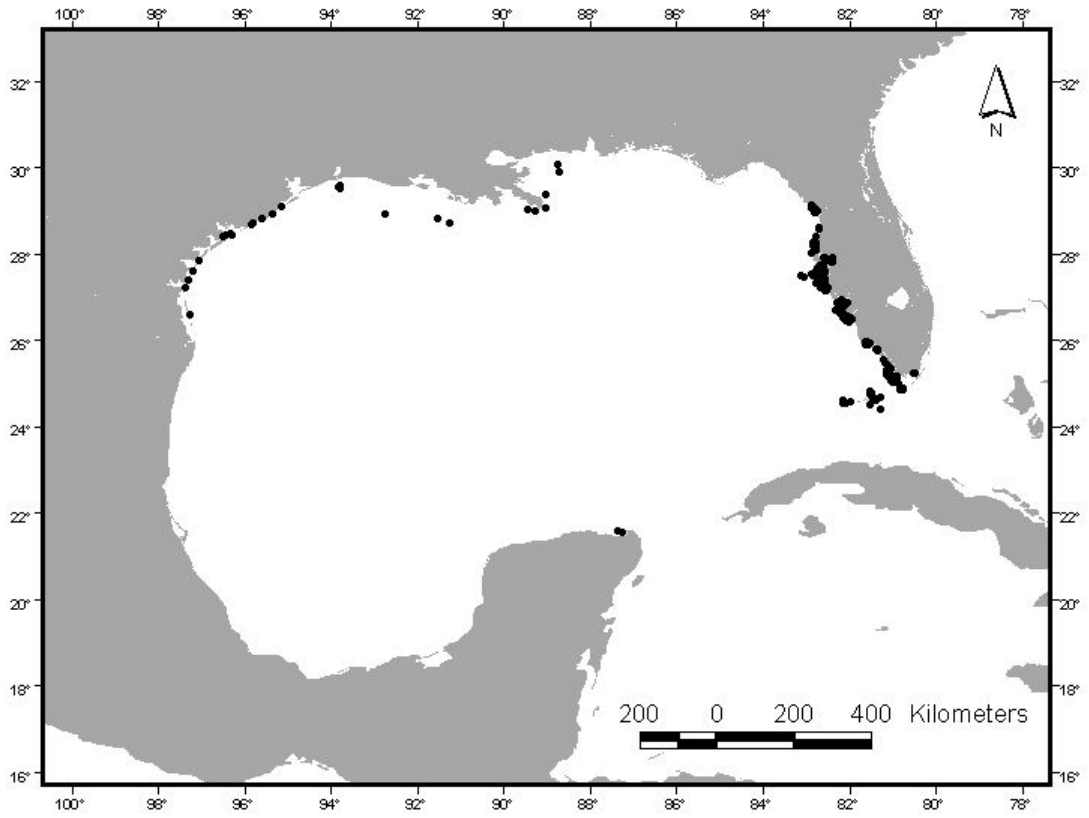
Results and Discussion

The MML tagging database currently includes 14,365 individual from 16 species (Table 1). This includes 4,360 blacktip and 51 sandbar sharks, with 204 and 5 recaptured, respectively. The tagging locations of blacktip sharks are shown in Figure 1 to indicate areas where tag releases occurred.

Table 1. Numbers of shark species tagged and recaptured using Mote Marine Laboratory tags.

Species	No. Tagged	No. Recaps	Recap %	Days at large	Distance (nm)
Sphyrna tiburo	5,436	191	3.5	1 – 2,247	0 – 170
Carcharhinus limbatus	4,360	204	4.7	2 – 3,158	0 – 575
Rhizoprionodon terraenovae	1,325	37	2.8	23 – 2,461	0 – 161
Carcharhinus leucas	940	61	6.5	1 – 1,099	0 – 386
Carcharhinus acronotus	870	26	3.0	1 – 1,820	0 – 60
Ginglymostoma cirratum	555	16	2.9	45 – 1,283	0 – 109
Negaprion brevirostris	426	31	7.3	15 – 1,409	0 – 87
Sphyrna mokarran	116	7	6.0	3 – 2,250	3 – 198
Carcharhinus brevipinna	108	2	1.9	110 – 127	39 – 127
Carcharhinus isodon	75	3	4.0	1 – 118	30 – 330
Carcharhinus plumbeus	51	5	9.8	8 – 308	3 – 795
Sphyrna lewini	43	0	0.0	–	–
Mustelus norrisi	26	0	0.0	–	–
Galeocerdo cuvier	22	2	9.1	278 – 348	4 – 205
Mustelus canis	8	0	0.0	–	–
Carcharhinus falciformis	4	0	0.0	–	–
	14,365	**585**	**4.1**		

Figure 1. Locations of blacktip sharks released with Mote Marine Laboratory shark tags (solid circles).

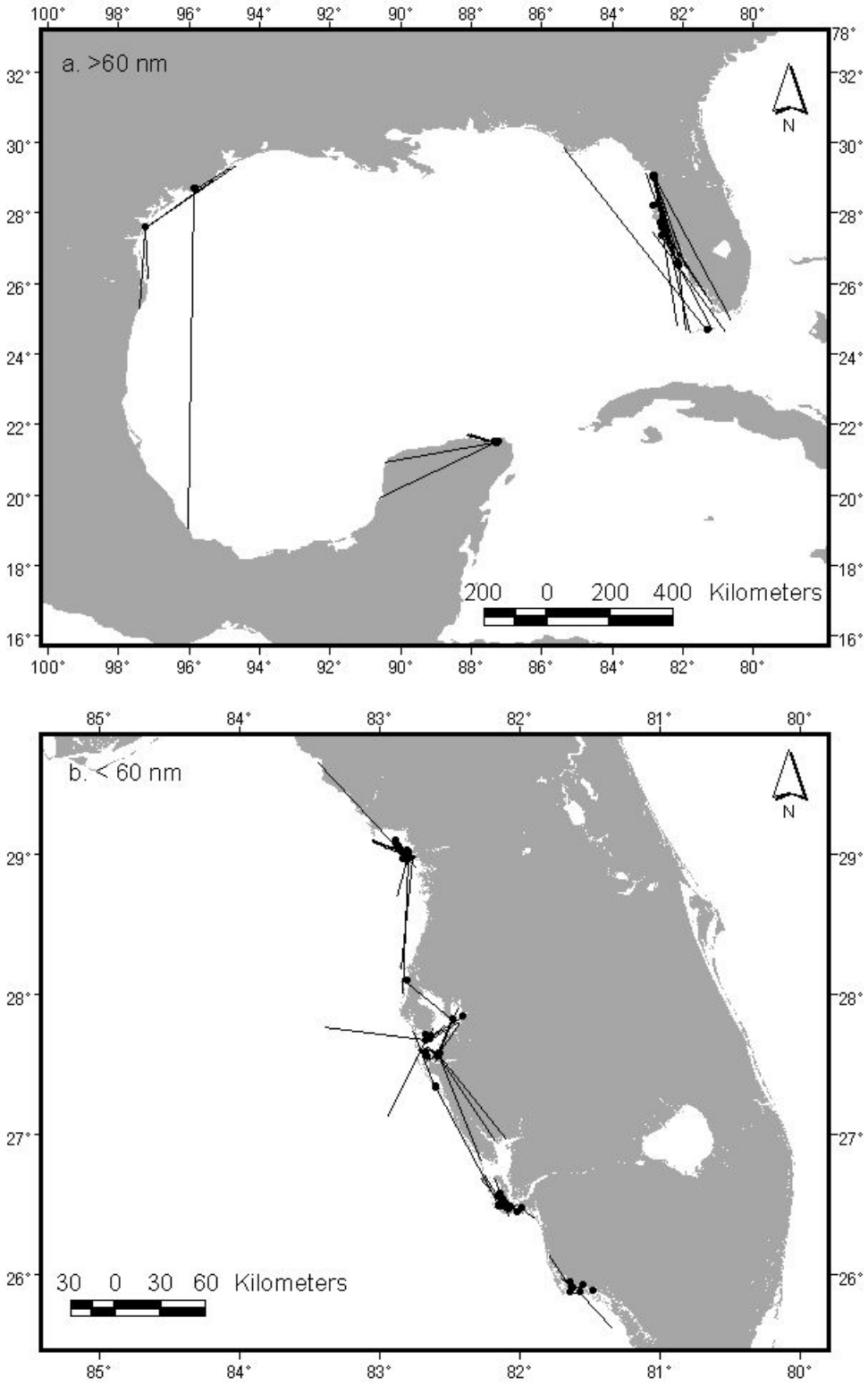


Movements

Blacktip sharks

Tag-recapture data from 204 blacktip sharks was used in the movement analysis (Figure 2). Most of the releases and recaptures occurred on the west coast of Florida between 25ºN and 29ºN. There were no recaptures of animals tagged in the eastern Gulf of Mexico in the western Gulf, or vice versa (Figure 2a). There was also no evidence of movement to the Atlantic coast, which is consistent with the results of Keeney *et al*. (2003) who suggested a separation between these areas based on genetic data. Longer distance movements occurred generally in a north-south direction, most likely corresponding to temperature-mediated seasonal migrations. In the western Gulf there was evidence of movement from Texas into Mexican waters. However, there was no recaptures of sharks released on the Yucatan Peninsula in US waters in either the western or eastern Gulf. The results of these releases in Mexican waters are more fully discussed by Hueter *et al*. (in press). Shorter distance recaptures (Figure 2b) were mostly within and between known nursery areas on the west coast of Florida.

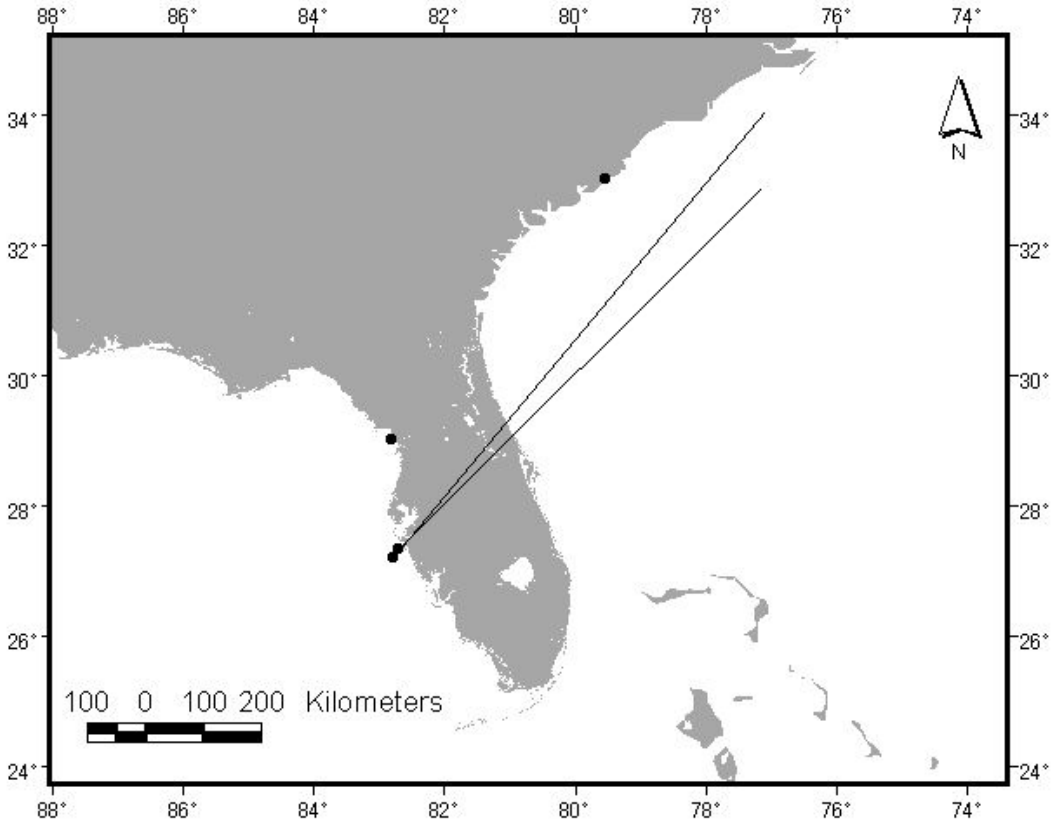
Figure 2. Movements of blacktip sharks in the Gulf of Mexico. Solid circles indicate tagging location, lines indicate shortest straight line distance to the reported point of recapture (A >60 nm; B<60 nm).



Sandbar sharks

Tag-recapture data from four sandbar sharks was available in the MML tagging database. Three recaptures were very close to the point of tag release after only a few days, and two were long-distance movements from the eastern Gulf of Mexico to South Carolina (Figure 3). The movements from the Gulf to South Carolina are consistent with the known migratory patterns of this species (Kohler *et al*. 1998).

Figure 3. Movements of sandbar sharks in the Gulf of Mexico and along the US east coast. Solid circles indicate tagging location; lines indicate shortest straight line distance to the reported point of recapture.



Blacktip shark age and growth

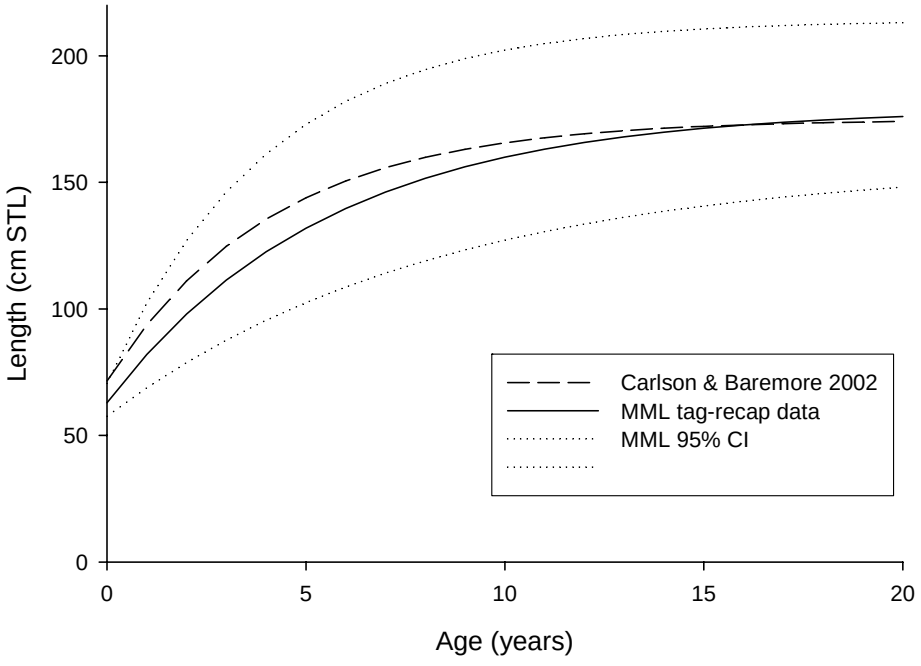
A total of 85 recaptures had sufficient data to be included in the analysis. The GROTAG results (Table 2) indicate that growth at small sizes is rapid, but at adult sizes is around 4 cm per year. Growth variability was low, but measurement error was high. High measurement error was not unexpected in a program where some recaptures come from

recreational and commercial fishermen. The low contamination probability (2%) indicates that there are few erroneous points in the data set. Conversion of the results to von Bertalanffy parameters resulted in values similar to those provided by Carlson and Baremore (2002), but with slightly slower growth rates (Figure 4).

Table 2. Parameter estimates from the GROTAG model for blacktip sharks in the eastern Gulf of Mexico.

Parameter	Estimate	95% CI	Parameter description
GROTAG			
g_{70}	18.07	15.33 – 20.67	Growth rate at 70 cm
g_{150}	4.84	1.43 – 8.09	Growth rate at 150 cm
v	0.11	0.00 – 0.21	Growth variability
s	4.54	3.61 – 5.26	Std dev of measurement error
m	1.23	-0.07 – 2.68	Mean of measurement error
p	0.02		Contamination probability
Von Bertalanffy			
L_∞ (cm STL)	179.2	157.1 – 214.0	
K (yr^{-1})	0.18	0.12 – 0.25	

Figure 4. Von Bertalanffy growth curve and 95% confidence interval estimated from Mote Marine Laboratory tag-recapture data. Data are compared to female Gulf of Mexico curve given by Carlson and Baremore (2002).



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