

MULTIPLE THREATS ANALYSIS FOR LOGGERHEAD TURTLES IN THE SOUTHWEST ATLANTIC

Maria Ângela Marcovaldi¹, Laura Prosdocimi², Alejandro Fallabrino³, Bruno Giffoni⁴, Andrés Estrades⁵, Aleksandro dos Santos⁶, Paulo H. Lara⁷, Thais Pires⁸, Danielle Monteiro⁹, Manjula Tiwari¹⁰, Alan Bolten¹¹, Milagros López-Mendilaharsu¹²

1, 4, 6, 7, 8, 12- Fundação Pró-Tamar, Rua Rubens Guelli 134/ 307, Itaipara - Salvador, CEP: 41815-135, Bahia, Brazil. emails: neca@tamar.org.br, bruno@tamar.org.br, alex@tamar.org.br, paulo.lara@tamar.org.br, thais.vet@tamar.org.br, milagros@tamar.org.br
2- Coordinación de Gestión de Pesquerías, Dirección Nacional de Planificación Pesquera, Subsecretaría de Pesca y Acuicultura, Paseo Colón 982 (C1063ACW) C.A.B.A. - Argentina. lprosd@yaho.com.ar
3, 5- Karumbé NGO, Zoo Villa Doloreo, Montevideo, Uruguay, afalla7@gmail.com, tortuguayo@gmail.com

9 - Núcleo de Educação e Monitoramento Ambiental - NEMA, Rua Maria Araújo, 450, Rio Grande, RS, Brazil; and, Laboratório de Ecologia e Conservação da Megafauna Marinha - EcoMega, Universidade Federal do Rio Grande - FURG, Rio Grande, RS, Brazil. danismonteiro@yahoo.com.br
10- NOAA-National Marine Fisheries Service, Marine Turtle Ecology & Assessment Program, Southwest Fisheries Science Center, La Jolla, California, USA. Manjula.Tiwari@noaa.gov
11- Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, Gainesville, Florida USA abolten@ufl.edu



The southwest Atlantic (SWA) is an area of development, feeding and reproduction of loggerhead turtles. The major nesting areas are located in southeastern and northeastern Brazil (Marcovaldi and Chaloupka, 2007). During this part of the life cycle females and hatchlings are mostly threatened by intense coastal development. Mark-recapture data and satellite tracking studies showed that female loggerheads that nest on beaches of Brazil migrate to multiple foraging areas off the coast of South America (Marcovaldi et al. 2010, González-Carman et al. 2011, Barceló et al. 2013). In addition, juvenile loggerheads are mainly found along the slope and oceanic waters off southern Brazil and Uruguay. Both adults and juveniles are subject to a high fishing pressure from multiple fisheries that operate throughout coastal and oceanic environments.

To better understand and quantify main impacts to loggerhead populations in the SWA we conducted a threat analysis. Our analyses were modified from the study conducted by Bolten et al. (2011). Threats were identified and classified for the different life stages and ecosystems inhabited by the sea turtles. For the construction of the matrix we considered 8 life stages: nesting females, eggs, hatchlings, juveniles neritic, juvenile oceanic, adult neritic, adult oceanic. We grouped all identified threats into six main threat categories: fisheries bycatch, resource use (direct and indirect use), habitat alteration, pollution, species interaction and climate change. Additionally, as threats vary depending on the ecosystem inhabited by the turtles, we incorporated three environments: 1) terrestrial (beach), 2) neritic and 3) oceanic. Annual mortality was estimated for each life stage/ ecosystem, with respect to each specific threat. As the information is very heterogeneous and it is difficult to assign actual mortality rates we used a range of mortality values based on the best available information (e.g. published data, projects database information and expert opinion). Mortality range estimates were classified as follows: 0 (no evidence of mortality); >0 (mortality has been documented or is likely to occur, however data are insufficient to estimate mortality); 1-100 (low mortality); 101-1000 (medium mortality); >1000 (high mortality). Sub-lethal effects for certain threats and life stages (which may result in reduced fitness) were also highlighted in the spreadsheets.

Table 1. Annual mortality for each life stage/ecosystem for each type of threat within the different threat categories.

KEY																							
Estimated Annual Mortality	Color Code	Value	Species				Fisheries Bycatch				Resource Use (direct use)		Habitat Alteration				Pollution			Species Interactions			Other factors
			LIFE STAGE	ECOSYSTEM	Trawl	Surface Longline	Gillnet	Other	Legal Harvest	Illegal Harvest	Construction	Traffic (Vessel or Vehicle Strikes)	Light (including oil related)	Noise (including Sonar and Seismic)	Beach Erosion	Marine Debris Ingestion	Marine Debris Entanglement	Chemicals and Toxics	Natural Predators	Exotic Predators	Other	Climate change	
No evidence of mortality		0	Nesting female	Terrestrial Zone					0	>0	SL	SL	SL	0	0	0	0	0	0	>0	SL	0	
Sub-lethal			Egg	Terrestrial Zone					0	L	0	SL	0	0	H	0	0	SL	H	L	SL	0	
>0		1	Hatchling stage	Terrestrial Zone					0	0	SL	SL	H	0	0	0	0	0	H	L	0	0	
LOW (1-100)		30	Swim frenzy, transitional stage	Neritic Zone	0	0	0	0	0	0	0	0	>0	0	0	0	0	0	L	0	0	0	
MEDIUM (101-1000)		300	Juvenile stage	Oceanic Zone	0	H	0	0	0	0	0	0	0	0	0	L	>0	0	0	0	>0	0	
HIGH (>1000)		3000	Adult stage	Oceanic Zone	0	L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			Juvenile stage	Neritic Zone	H	L	L	0	0	>0	0	>0	0	0	0	>0	>0	0	0	0	SL	0	
			Adult stage	Neritic Zone	M	0	L	0	0	>0	L	>0	0	0	0	0	0	0	0	0	0	0	

Table 2. Threat category: fisheries bycatch – estimated annual mortality for each type of fisheries bycatch.

Species		Fisheries Bycatch							TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# OF ADULT FEMALES)	
LIFE STAGE	ECOSYSTEM	Trawl	Surface Longline	Gillnet	Other	SUM	RRV			
Nesting female	Terrestrial Zone							1,000		
Egg	Terrestrial Zone							0,004		
Hatchling stage	Terrestrial Zone							0,004		
Swim frenzy, transitional stage	Neritic Zone	0	0	0	0	0	0,004	0		
Juvenile stage	Oceanic Zone	0	3000	0	0	3000	0,029	87		
Adult stage	Oceanic Zone	0	30	0	0	30	0,789	24		
Juvenile stage	Neritic Zone	3000	30	30	0	3060	0,235	719		
Adult stage	Neritic Zone	300	0	30	0	330	0,789	260		
TOTAL ESTIMATED ADJUSTED ANNUAL MORTALITY (# type of threat)		942	110	31	0					

Results pointed out that fisheries bycatch represent a major threat for loggerheads in the SWA. The trawl fishery was identified as the main source of mortality for neritic juvenile and adult turtles while juveniles in oceanic areas where mostly impacted by the surface longlines (Table 1). In addition, egg and hatchlings are subject to mortality by beach erosion and light pollution, respectively, and both of these stages by the increasing number of natural predators such as foxes and armadillos at nesting beaches (Table 1). After adjusting the summed mortality estimates within each life stage with the relative reproductive value (RRV) of that life stage (see Table 2 as an example), we were able to compare annual mortality for each life stage/ecosystem and threat category (Table 3) as well as for each threat within a threat category (Table 4). However, loggerheads in the SWA should be considered as entirely conservation-dependent, because the reduced mortality for several life stages within the terrestrial zone is the result of decades of intense conservation programs, especially at nesting sites (Marcovaldi and Chaloupka 2007).



Table 3. Annual mortality for each life stage/ecosystem for each threat category adjusted by relative reproductive values (does not include sub-lethal effects).

		CATEGORIES OF THREATS					
LIFE STAGE	ECOSYSTEM	Fisheries bycatch	Resource Use	Habitat Alteration	Pollution	Species interaction	Other factors
Nesting female	Terrestrial Zone						
Egg	Terrestrial Zone						
Hatchling stage	Terrestrial Zone						
Swim frenzy, transitional stage	Neritic Zone						
Juvenile stage	Oceanic Zone						
Adult stage	Oceanic Zone						
Juvenile stage	Neritic Zone						
Adult stage	Neritic Zone						

Table 4. Annual mortality for each threat within a threat category summed for all life stages/ ecosystems and adjusted for RRV for each life stage/ecosystem.

THREAT CATEGORY	SPECIFIC THREAT WITHIN A THREAT CATEGORY					
	Trawl	Surface Longline	Gillnet	Other		
Fisheries bycatch	Legal Harvest	Illegal Harvest				
Resource Use	Construction	Traffic (vessel or vehicle strikes)	Light (including oil related)	Noise (including sonar & seismic)	Beach Erosion	
Habitat Alteration	Marine Debris Ingestion	Marine Debris Entanglement	Chemicals and Toxics			
Pollution	Natural Predators	Exotic Predators	Other			
Species Interaction	Climate change					
Other factors						



Acknowledgements:
Thanks to US Fish and Wildlife Service and NOAA Fisheries for funding support.

Literature Cited:
Barceló C, Domingo A, Miller P, Ortega L, Giffoni B, Sales G, McNaughton L, Marcovaldi, MÁ, Heppell SS, Swimmer Y (2013) High-use areas, seasonal movements and dive patterns of juvenile loggerhead sea turtles in the Southwestern Atlantic Ocean. Marine Ecology Progress Series 479: 235-250
Bolten AB, Crowder LB, Dodd MG, MacPherson SL, Musick JA, Schroeder BA, Witherington BE, Long KJ, Snover ML (2011) Quantifying multiple threats to endangered species: an example from loggerhead sea turtles. Frontiers in Ecology and the Environment 9: 295-301
González Carman V, Álvarez KC, Prosdocimi L, Inchaurrega MC, Dellacasa RF, Faiella A, Echenique C, González R, Andrejuk J, Mianzan HW, Campagna C, Albareda, DA (2011) Argentinian coastal waters: A temperate habitat for three species of threatened sea turtles. Marine Biology Research 7: 500-508
Marcovaldi MÁ, Chaloupka M (2007) Conservation status of the loggerhead sea turtle in Brazil: an encouraging outlook. Endangered Species Research 3: 133-143
Marcovaldi MÁ, Lopez CG, Soares LS, Lima EH, Thomé JC, Almeida AP (2010) Satellite-tracking of female loggerhead turtles highlights fidelity behavior in northeastern Brazil. Endangered Species Research 12: 263-272.