Elevated mercury levels in sharks of Belize

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Abstract: Mercury (Hg) loading in global aquatic ecosystems is a growing concern. Compelling evidence of widespread adverse effects in fish and wildlife populations indicates the rate of transformation to methylmercury is problematic. Long-lived, apex predators such as sharks are at high risk to Hg toxicity. We investigated the occurrence of Hg in sharks from coastal waters of southern Belize. In our pilot study, 101 sharks representing 9 species were analyzed for muscle Hg levels. Highest Hg levels were recorded in bull, blacktip, hammerhead, and nurse sharks. Lowest Hg levels were recorded in bonnethead, sharpnose, and lemon sharks. Over 88% of the sharks sampled exceeded USEPA human health consumption standards. Muscle Hg strongly correlated with size for blacktip and nurse sharks. Such models provide a tool for confidently predicting muscle Hg levels in some shark species used for human consumption. Mercury levels measured in hammerhead and nurse sharks exceeded known adverse effect thresholds for fish. An assessment of the potential negative impacts from Hg on shark survival and reproductive success is needed to support shark conservation and management efforts in Belize and elsewhere.

Lemon shark
(photo by Neil Hammerschlag)

Objectives: In 2006-07, we conducted a pilot study to opportunistically sample sharks from near-shore waters of southern Belize with four objectives:

1. Establish an exposure profile of Hg for sharks;
2. Identify biological Hg hotspots and potential Hg sources;
3. Determine potential human health impacts to high risk user-groups;
4. Determine potential health impacts to sharks.

Methods: Sharks sampled were collected from individuals that were caught by both fisherman and for scientific purposes. Muscle biopsies were taken at the base of the dorsal fin. Muscle samples were then placed in a vacutainer and stored in a reclosable plastic bag in a freezer. The unit of Hg exposure is ug/g and is equivalent to parts per million (ppm). All Hg data are presented on a wet weight (ww) basis. The majority of Hg in the muscle tissue of sharks and groupers is in the methyl form.

Photo by Rachel Graham of Caribbean reef shark (left) and photo by Carol Farneti Foster of a nurse shark (right) sampled in the field.

Study Area: A total of 14 distinct locations were sampled in the Gulf of Honduras along the coast of southern Belize (red circle). Comparison shark muscle Hg concentrations from the U.S. are from southern Florida (white circle).

Scalloped hammerhead shark
(photo by Neil Hammerschlag)

Results: A total of 101 sharks, representing 9 species were sampled and analyzed for Hg exposure in 2006-07 (Table 1). Based on our opportunistically collected samples, 88% of the sharks exceeded USEPA human health consumption standards.

Table 1. Summary of size and Hg levels of sharks sampled.

Common Name	Latin Name	Sample Size	Distinct Locations	Length (mean +/- sd; range) (cm)	Muscle Hg (mean +/- sd; range) (ug/g, ww)
Blacktip Shark	*Carcharhinus limbatus*	16	5	94.0 +/- 28.8 (48.0 – 137.0)	1.02 +/- 0.44 (0.52 – 1.87)
Bonnethead Shark	*Sphyrna tiburo*	6	3	47.6 +/-13.9 (37.0 – 75.0)	0.21 +/- 0.04 (0.16 – 0.27)
Bull Shark	*Carcharhinus leucas*	3	2	164.1 +/- 35.5 (123.1-184.6)	1.56 +/- 0.27 (1.45 – 1.88)
Caribbean Sharpnose Shark	*Rhizoprionodon porosus*	44	8	64.0 +/- 21.3 (17.7 – 115.0)	0.65 +/- 0.40 (0.26 – 1.89)
Great Hammerhead Shark	*Sphyrna mokarran*	7	3	167.1 +/- 51.1 (81.0 – 247.0)	1.49 +/- 0.72 (0.65 – 2.10)
Lemon Shark	*Negaprion brevirostris*	2	2	128.0 +/- .8 (126.0 – 130.0)	0.34 +/- 0.10 (0.26 – 0.41)
Nurse Shark	*Ginglymostoma cirratum*	10	6	177.6 +/- 40.4 (117.0 – 228.0)	1.40 +/- 0.94 (0.09 – 3.20)
Scalloped Hammerhead Shark	*Sphyrna lewini*	12	3	104.4 +/- 51.3 (67.2 – 227.0)	1.29 +/- 1.06 (0.47 – 4.14)
Silky Shark	*Carcharhinus falciformis*	1	1	92.3	0.89

Great hammerhead shark
(photo by Rachel Graham)

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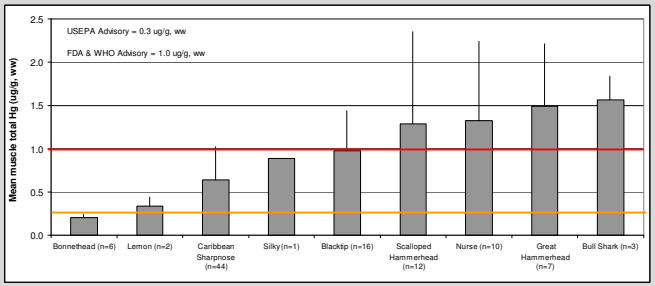
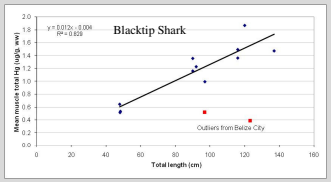
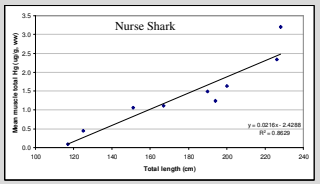
1. *Mercury exposure profile by shark species* - Highest Hg levels were recorded in the bull, blacktip, great hammerhead, scalloped hammerhead, and nurse sharks. Lowest Hg levels were recorded in the bonnethead, sharpnose, lemon and sandbar sharks.

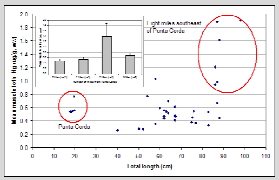


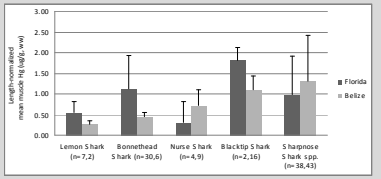
2. Relating shark size with Hg levels - Several studies have found a correlation between increasing size and Hg levels, but many have not. Our findings agree and indicate that muscle Hg correlates for some species, but not others. Orange and red lines approximately represent USEPA and WHO human health standards, respectively.





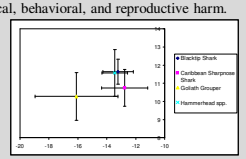
3. Mercury levels vary by location – Within our study area, we detected substantial variation in the muscle Hg levels for one of the more commonly sampled species, the Caribbean sharpnose shark (left figure). Shark Hg levels also vary by location for the same species (right figure). In Belize, length-normalized shark Hg levels are greatest for the Caribbean sharpnose shark and blacktip shark. This tendency holds for Florida populations. Prey and habitat preferences likely dictate spatially-explicit Hg patterns.





Recommendations: We recommend further sampling efforts to better understand (1) potential habitats and geographic locations where biological Hg hotspots exist, (2) shark species and populations that are at greatest risk to elevated Hg levels and (3) levels of Hg body burdens that pose physiological, behavioral, and reproductive harm.

A sampling design that further describes Hg profiles by species, size, age, sex, and foodchain length (determined by stable isotope carbon-nitrogen signatures) will provide insights. Pilot studies that include measures of fitness and reproductive performance will be invaluable for determining risk to populations.



Both atmospheric deposition and waterborne point sources of Hg can be locally and regionally changed through regulations with proven evidence of rapid recovery in biota (at least in freshwater systems). Certain water and land management practices, such as minimizing erosion, can further assist in reducing environmental Hg loads available to near-shore marine organisms. By defining biological Hg hotspots and shark species at greatest risk, ecosystem functions and biotic community structure can be better protected for potential negative impacts from Hg on the overall health of shark populations.