ADDENDUM 01

Characterization of Potential Adverse Health Effects Associated with Consuming Fish from the

Northwestern Gulf of Mexico

(nearshore and offshore waters of Texas)

INTRODUCTION

For the initial survey of nearshore and offshore waters of Texas (Northwestern Gulf of Mexico; NWGOM) conducted in the summer of 2011, the Texas Department of State Health Services (DSHS) Seafood and Aquatic Life Group (SALG) collected 288 fish tissue samples to assess public health implications of consuming mercury-contaminated fish from the NWGOM. Due to the limited geographical sample coverage of the NWGOM, small sample sizes, and lack of larger size classes or older age classes of many fishes assayed in this study, and the variability of mercury concentrations observed in fish tissue samples, the SALG risk assessors were unable to characterize adequately health risks associated with consuming mercury-contaminated fish from the NWGOM. The SALG risk assessors recommended from the initial survey that the DSHS SALG should conduct additional monitoring to characterize adequately health risks associated with consuming mercury-contaminated fishes of the NWGOM. They recommended supplementary monitoring should include collection of larger size classes or older age classes of fishes not represented in the fish samples of the initial assessment and expansion of the sample collection area to include the extreme lower and upper Texas coast to ensure that samples were collected to represent nearshore and offshore waters of the entire Gulf coast of Texas.

This addendum summarizes the results of a supplementary survey of 86 fish samples collected in summer of 2012 from the NWGOM, addresses public health implications of consuming mercury-contaminated fish from the NWGOM through assessment of the combined 2011 and 2012 data, and suggests actions to reduce potential adverse health outcomes.

METHODS

Study methodology not described in the methods section of Addendum 01 may be found in the methods section of the report entitled Characterization of Potential Adverse Health Effects Associated with Consuming Fish from the Northwestern Gulf of Mexico, 2012 beginning on page 3.

Fish Sampling Methods and Description of the NWGOM 2011–2012 Sample Set

In July–August 2012, the SALG staff collected 86 fish samples from the NWGOM. The SALG risk assessors used data from these fish in addition to the 288 fish samples collected in June–

August 2011 to assess the potential for adverse human health outcomes from consuming fish from the NWGOM.

For the July–August 2012 supplementary survey, the SALG selected two ports or general areas to represent the extreme upper and lower Texas coast as sample collection locations: Sabine Pass offshore (SPO) and Port Isabell offshore (PIO; Figure 1). Species collected represent distinct ecological groups (i.e. predators and bottom-dwellers) that have some potential to bio-accumulate chemical contaminants, have a wide geographic distribution, are of local recreational fishing value, and/or that anglers and their families commonly consume. The 86 fish collected from the NWGOM represent all species targeted for collection from this water body (Table 1). The list below contains the number of each target species collected for this survey in descending order: red snapper (23), king mackerel (16), little tunny (9), Atlantic sharpnose shark (8), yellowfin tuna (6), Spanish mackerel (5), crevalle jack (3), swordfish (3), blackfin tuna (2), grey triggerfish (2), mangrove snapper (2), blacktip shark (1), cobia (1), cubera snapper (1), dolphinfish (1), greater amberjack (1), spinner shark (1), and wahoo (1).

The SALG staff utilized hook-and-line sampling techniques to collect 78 fish samples for this project. The SALG staff immediately stored caught fish, selected as samples on wet ice in large insulated chests to ensure interim preservation. The SALG staff released any live fish culled from the catch or not selected as a fish sample for this project. The SALG also worked cooperatively with the organizers of one offshore sport-fishing tournament (Texas Legends Billfish Tournament Port Aransas, Texas, August 8–12, 2012) to collect 8 fish samples for this project (Table 1).

Analytical Laboratory Information

Upon arrival of the fish samples at the laboratory, the DSHS Laboratory Service Section personnel documented receipt of the 86 NWGOM fish samples and recorded the condition of each sample along with its DSHS identification number. Using established USEPA methods, the DSHS laboratory analyzed 86 fish fillets from the NWGOM for mercury.[1]

RESULTS

The DSHS laboratory completed analyses and electronically transmitted the results of the NWGOM samples collected in July–August 2012 to the SALG in October 2012. The laboratory reported the analytical results for mercury.

For reference, Table 1 contains the total number of samples collected. Tables 2a–2b present the results of mercury analyses. Unless otherwise stated, table summaries present the number of samples containing a specific contaminant/number tested, the mean concentration ± 1 standard deviation (68% of samples should fall within one standard deviation of the arithmetic mean in a sample from a normally-distributed population), and, in parentheses under the mean and standard deviation, the minimum and the maximum detected concentrations. Those who prefer to use the range may derive this statistic by subtracting the minimum concentration of a given contaminant from its maximum concentration. In the tables, results may be reported as not detected (ND), below detection limit (BDL) for estimated concentrations, or as reported concentrations.

According to the laboratory's quality control/quality assurance materials, estimated concentrations reported as BDL rely upon the laboratory's method detection limit (MDL) or its reporting limit (RL). The MDL is the minimum concentration of an analyte that can be reported with 99% confidence that the analyte concentration is greater than zero, while the RL is the concentration of an analyte reliably achieved within specified limits of precision and accuracy during routine analyses. Mercury concentrations reported below the RL are qualified as "J-values" in the laboratory data report.[2]

Mercury

Seventy-five of 86 fish tissue samples evaluated from the NWGOM in 2012 contained mercury. Across all species, mercury concentrations ranged from ND (dolphinfish and red snapper) to 2.280 mg/kg (little tunny). The mean mercury concentration for the 86 fish tissue samples assayed was 0.536±0.496 mg/kg. For the following examination of fish tissue samples from the NWGOM, the SALG risk assessors evaluated the combined data from 2011–2012.

Three hundred fifty-six of 374 fish tissue samples evaluated from the NWGOM in 2011–2012 contained mercury (Tables 2a). Across all species, mercury concentrations ranged from ND (dolphinfish, red snapper, and tripletail) to 18.500 mg/kg (blue marlin). The mean mercury concentration for the 374 fish tissue samples assayed was 0.541±1.265 mg/kg (Table 2a).

The relationships between mercury concentration and total length (TL) were positive and significant (p <0.05) for six of 12 species (Figures 2–11). The SALG risk assessors did not include eleven species (blue marlin, bonnethead shark, cubera snapper, greater amberjack, grey triggerfish, lane snapper, mangrove snapper, spinner shark, swordfish, tripletail, and Warsaw grouper) in these analyses due to insufficient sample size or more than 50% of the samples assayed contained ND mercury concentrations. TL explained from 28 to 96% of the variation in mercury concentration (Figures 2–11). Correlation was strongest for wahoo.

Atlantic sharpnose shark

Fifteen Atlantic sharpnose shark ranging from 34.00 to 43.00 inches TL ($\overline{X}$ – 37.9 inches TL) were analyzed for mercury (Table 1). One-hundred percent of the Atlantic sharpnose shark samples examined were of legal size (≥ 24 inches TL [Texas waters]; no length limit [federal waters]).[3,4] Mercury concentrations ranged from 0.478 to 1.890 mg/kg with a mean of 1.034±0.443 and a median of 0.961 mg/kg (Table 2a). The SALG risk assessors computed a Pearson product-moment correlation coefficient to assess the relationship between mercury concentration and TL. There was no correlation between the two variables (r = 0.503, n = 15, p = 0.056).

Blackfin tuna

Ten blackfin tuna ranging from 30.00 to 35.75 inches TL ($\overline{X}$ – 31.9 inches TL) were analyzed for mercury (Table 1). Currently, there is no length limit for blackfin tuna in Texas or federal waters.[3, 4] Mercury concentrations ranged from 0.409 to 1.120 mg/kg with a mean of 0.790±0.241 and a median of 0.746 mg/kg (Table 2a). The SALG risk assessors computed a

Pearson product-moment correlation coefficient to assess the relationship between mercury concentration and TL. There was no correlation between the two variables (r = 0.488, n = 10, p = 0.152).

Blacktip shark

Twenty-one blacktip shark ranging from 28.00 to 69.50 inches TL ($\bar{X}$ – 41.5 inches TL) were analyzed for mercury (Table 1). One-hundred percent of the blacktip shark samples examined were of legal size (≥ 24 inches TL [Texas waters]); the length limit for blacktip shark in federal waters is ≥ 54 inches fork length (FL).[3, 4] Mercury concentrations ranged from 0.053 to 1.690 mg/kg with a mean of 0.252±0.350 and a median of 0.137 mg/kg (Table 2a). The SALG risk assessors computed a Pearson product-moment correlation coefficient to assess the relationship between mercury concentration and TL. Mercury concentrations in blacktip shark were positively related to TL (r^2 = 0.589, n = 21, p <0.0005; Figure 2).

Blue marlin

Three blue marlin ranging from 103.00 to 107.00 inches FL ($\bar{X}$ – 105.7 inches FL) were analyzed for mercury (Table 1). One-hundred percent of the blue marlin samples examined were of legal size (≥ 99 inches FL [federal waters]).[3, 4] Mercury concentrations ranged from 6.200 to 18.500 mg/kg with a mean of 12.900±6.223 and a median of 14.000 mg/kg (Table 2a).

Little tunny "Bonito"

Thirty-six little tunny ranging from 18.50 to 31.00 inches TL ($\bar{X}$ – 26.6 inches TL) were analyzed for mercury (Table 1). Currently, there is no length limit for little tunny in Texas or federal waters.[3, 4] Mercury concentrations ranged from 0.132 to 2.280 mg/kg with a mean of 0.622±0.372 and a median of 0.573 mg/kg (Table 2a). Mercury concentrations in little tunny were positively related to TL (r^2 = 0.639, n = 36, p <0.0005; Figure 3).

Cobia

Eighteen cobia ranging from 38.00 to 57.00 inches TL ($\bar{X}$ – 43.4 inches TL) were analyzed for mercury (Table 1). One-hundred percent of the cobia samples examined were of legal size (≥ 37 inches TL [Texas waters]; ≥ 33 inches FL [federal waters]).[3, 4] Mercury concentrations ranged from 0.127 to 1.080 mg/kg with a mean of 0.442±0.315 and a median of 0.360 mg/kg (Table 2a). The SALG risk assessors computed a Pearson product-moment correlation coefficient to assess the relationship between mercury concentration and TL. There was no correlation between the two variables (r = 0.448, n = 18, p = 0.062).

Crevalle jack

Ten crevalle jack ranging from 33.00 to 41.50 inches TL ($\bar{X}$ – 38.9 inches TL) were analyzed for mercury (Table 1). Currently, there is no length limit for crevalle jack in Texas or federal waters.[3, 4] Mercury concentrations ranged from 0.550 to 1.640 mg/kg with a mean of 1.015±0.317 and a median of 0.919 mg/kg (Tables 2a). The SALG risk assessors computed a

Pearson product-moment correlation coefficient to assess the relationship between mercury concentration and TL. There was no correlation between the two variables ($r = 0.236$, $n = 10$, $p = 0.512$).

Dolphinfish

Twenty-two dolphinfish ranging from 23.50 to 49.00 inches TL ($\bar{X}$ – 35.1 inches TL) were analyzed for mercury (Table 1). Currently, there is no length limit for dolphinfish in Texas or federal waters.[3, 4] Mercury concentrations ranged from ND to 0.573 mg/kg with a mean of 0.145±0.167 and a median of 0.049 mg/kg (Table 2a). Mercury concentrations in dolphinfish were positively related to TL ($r^2 = 0.879$, $n = 22$, $p < 0.0005$; Figure 4).

Gray triggerfish

Two gray triggerfish ranging from 15.00 to 16.00 inches TL ($\bar{X}$ – 15.5 inches TL) were analyzed for mercury (Table 1). Fifty percent of the gray triggerfish samples examined were of legal size (≥ 16 inches TL [Texas waters]; ≥ 14 inches FL [federal waters]).[3, 4] Mercury concentrations ranged from 0.172 to 0.195 mg/kg with a mean of 0.184±0.016 and a median of 0.184 mg/kg (Table 2a).

King mackerel

Eighty-seven king mackerel ranging from 26.00 to 49.50 inches TL ($\bar{X}$ – 37.8 inches TL) were analyzed for mercury (Table 1). Ninety-nine percent of the king mackerel samples examined were of legal size (≥ 27 inches TL [Texas waters]; ≥ 24 inches FL [federal waters]).[3, 4] Mercury concentrations ranged from 0.076 to 1.280 mg/kg with a mean of 0.638±0.228 and a median of 0.628 mg/kg (Tables 2a–2b). The 2011–2012 mean mercury concentrations for king mackerel < 37 inches, 37 to 43 inches, and > 43 inches were 0.523±0.200, 0.685±0.196, and 0.860±0.301 mg/kg, respectively. Mercury concentrations in king mackerel were positively related to TL ($r^2 = 0.380$, $n = 87$, $p < 0.0005$; Figure 5). The SALG risk assessors performed univariate analysis of variance (ANOVA) to test for differences in king mackerel mercury concentration among the three current king mackerel consumption advisory size classes (< 37, 37 to 43, and > 43 inches TL). King mackerel mercury concentrations differed significantly across the three advisory size classes (F [2, 84] = 10.391, $p < 0.0005$; Figure 6). Tukey HSD post-hoc comparisons of the three consumption advisory size classes indicate that the 37 to 43 inches TL size class ($\bar{X} = 0.685$, 95% CI [0.628, 0.743], $p = 0.002$) and the > 43 inches TL size class ($\bar{X} = 0.860$, 95% CI [0.582, 1.139], $p = 0.001$) had significantly higher mercury concentrations than the < 37 inches TL size class ($\bar{X} = 0.523$, 95% CI [0.452, 0.594]). Comparisons between the 37 to 43 inches TL size class and the > 43 inches TL size class indicated that the mean mercury concentrations of the two size classes were not statistically different ($p = 0.098$). Evaluation of mercury concentrations in king mackerel (all size classes) by sampling event indicate that the 1996–1997 and 2011–2012 data do not statistically differ by sampling event (1996–1997, $n = 167$; 2011–2012, $n = 87$; t [252] = 1.011, $p = 0.313$). Mercury concentrations in the combined 1996–2012 king mackerel datasets were positively related to TL ($r^2 = 0.392$, $n = 254$, $p < 0.0005$; Figure 7). The SALG risk assessors performed ANOVA to test for differences in king mackerel mercury concentration among the three king mackerel consumption advisory size classes (< 37, 37 to 43, and > 43 inches TL) for the combined data from the 1996–2012 sampling events. King mackerel mercury concentrations differed significantly across the three advisory size classes (F [2, 251] = 57.354, $p < 0.0005$; Figure 8). Games-Howell post-hoc comparisons of the three consumption advisory size classes indicate that the 37 to 43 inches TL size class ($\overline{X}$ = 0.804, 95% CI [0.750, 0.857], $p < 0.0005$) and the > 43 inches TL size class ($\overline{X}$ = 0.932, 95% CI [0.790, 1.073], $p < 0.0005$) had significantly higher mercury concentrations than the < 37 inches TL size class ($\overline{X}$ = 0.534, 95% CI [0.505, 0.563]). Comparisons between the 37 to 43 inches TL size class and the > 43 inches TL size class indicated that the mean mercury concentrations of the two size classes were not statistically different ($p = 0.202$). The SALG risk assessors also performed a t-test to examine differences in mercury concentrations in king mackerel (1996–2012) between two size classes (≤ 35 and > 35 inches TL). Evaluation of mercury concentrations between the two size classes indicate that king mackerel > 35 inches TL contain significantly higher mercury concentrations than king mackerel ≤ 35 inches TL (1996–2012, n = 254; t [252] = -10.239, $p < 0.0005$; Figure 9).

Lane snapper

Four lane snapper ranging from 16.25 to 17.50 inches TL ($\overline{X}$ – 16.9 inches TL) were analyzed for mercury (Table 1). One-hundred percent of the lane snapper samples examined were of legal size (≥ 8 inches TL [Texas waters]; ≥ 8 inches TL [federal waters]).[3, 4] Mercury concentrations ranged from 0.171 to 0.262 mg/kg with a mean of 0.203±0.043 and a median of 0.190 mg/kg (Table 2a).

Mangrove snapper

Four mangrove snapper ranging from 11.50 to 26.00 inches TL ($\overline{X}$ – 17.3 inches TL) were analyzed for mercury (Table 1). Currently, there is no length limit for mangrove snapper in Texas waters, and 75% of the mangrove snapper samples examined were of legal size for federal waters (≥ 12 inches TL).[3, 4] Mercury concentrations ranged from 0.138 to 0.292 mg/kg with a mean of 0.189±0.070 and a median of 0.162 mg/kg (Table 2a).

Red snapper

Sixty-seven red snapper ranging from 15.25 to 29.25 inches TL ($\overline{X}$ – 20.3 inches TL) were analyzed for mercury (Table 1). One-hundred percent of the red snapper samples examined were of legal size (≥ 15 inches TL) for Texas waters and 97% of the red snapper examined were of legal size for federal waters. (≥ 16 inches TL).[3, 4] Mercury concentrations ranged from ND to 0.701 mg/kg with a mean of 0.102±0.089 and a median of 0.089 mg/kg (Table 2a). Mercury concentrations in red snapper were positively related to TL ($r^2 = 0.279$, $n = 67$, $p < 0.0005$; Figure 10).

Spanish mackerel

Twenty-six Spanish mackerel ranging from 20.00 to 29.50 inches TL ($\overline{X}$ – 25.2 inches TL) were analyzed for mercury (Table 1). One-hundred percent of the Spanish mackerel samples examined were of legal size (≥ 14 inches TL [Texas waters]; ≥ 12 inches FL [federal waters]).[3, 4] Mercury concentrations ranged from 0.057 to 0.425 mg/kg with a mean of 0.227±0.100 and a median of 0.217 mg/kg (Table 2a). The SALG risk assessors computed a Pearson product-moment correlation coefficient to assess the relationship between mercury concentration and TL. There was no correlation between the two variables ($r = 0.119$, $n = 26$, $p = 0.564$).

Swordfish

Six swordfish ranging from 47.00 to 79.50 inches FL ($\bar{X}$ – 63.1 inches FL) were analyzed for mercury (Table 1). One-hundred percent of the swordfish samples examined were of legal size (no length limit [Texas waters]; ≥ 47 inches FL [federal waters]).[3, 4] Mercury concentrations ranged from 0.536 to 1.480 mg/kg with a mean of 0.991±0.328 and a median of 1.035 mg/kg (Table 2a).

Tripletail

Nine tripletail ranging from 17.00 to 23.00 inches TL ($\bar{X}$ – 19.3 inches TL) were analyzed for mercury (Table 1). One-hundred percent of the tripletail samples examined were of legal size (≥ 17 inches TL [Texas waters]; no length limit [federal waters]).[3, 4] Mercury concentrations ranged from ND to 0.056 mg/kg with a mean of 0.026±0.017 and a median of 0.017 mg/kg (Table 2a).

Wahoo

Ten wahoo ranging from 40.00 to 61.75 inches TL ($\bar{X}$ – 48.9 inches TL) were analyzed for mercury (Table 1). Currently, there is no length limit for wahoo in Texas or federal waters.[3, 4] Mercury concentrations ranged from 0.088 to 2.380 mg/kg with a mean of 0.692±0.782 and a median of 0.270 mg/kg (Table 2a). Mercury concentrations in wahoo were positively related to TL ($r^2 = 0.964$, $n = 10$, $p < 0.0005$; Figure 11).

Yellowfin tuna

Nineteen yellowfin tuna ranging from 34.75 to 63.00 inches TL ($\bar{X}$ – 47.0 inches TL) were analyzed for mercury (Table 1). One-hundred percent of the yellowfin tuna samples examined were of legal size (no length limit [Texas waters]; ≥ 27 inches FL [federal waters]).[3, 4] Mercury concentrations ranged from 0.080 to 1.130 mg/kg with a mean of 0.314±0.311 and a median of 0.144 mg/kg (Table 2a). The SALG risk assessors computed a Pearson product-moment correlation coefficient to assess the relationship between mercury concentration and TL. There was no correlation between the two variables ($r = 0.405$, $n = 19$, $p = 0.086$).

DISCUSSION

Risk Characterization

Because variability and uncertainty are inherent to quantitative assessment of risk, the calculated risks of adverse health outcomes from exposure to toxicants can be orders of magnitude above or below actual risks. Variability in calculated and in actual risk may depend upon factors such as the use of animal instead of human studies, use of subchronic rather than chronic studies, interspecies variability, intra-species variability, and database insufficiency. Since most factors used to calculate comparison values result from experimental studies conducted in the laboratory on nonhuman subjects, variability and uncertainty might arise from the study chosen as the "critical" one, the species/strain of animal used in the critical study, the target organ selected as the "critical organ," exposure periods, exposure route, doses, or uncontrolled variations in other conditions.[5] Despite such limitations, risk assessors must calculate parameters to represent potential toxicity to humans who consume contaminants in fish and other environmental media. The DSHS calculated risk parameters for systemic endpoints in those who would consume fish from the NWGOM. Conclusions and recommendations predicated upon the stated goal of the DSHS to protect human health follow the discussion of the relevance of findings to risk.

Characterization of Systemic (Noncancerous) Health Effects from Consumption of Fish from the NWGOM

<u>Mercury</u>

Three hundred fifty-six of 374 fish collected from NWGOM in 2011–2012 contained mercury (Tables 2a–2b). Twenty-six percent of all samples (*n* = 374) analyzed contained mercury concentrations that equaled or exceeded the HAC_{nonca} for mercury (0.700 mg/kg). Mercury concentrations that equaled or exceeded the HAC_{nonca} for mercury were observed in one or more samples of the following species: Atlantic sharpnose shark, blackfin tuna, blacktip shark, blue marlin, little tunny, cobia, crevalle jack, king mackerel, red snapper, swordfish, wahoo, and yellowfin tuna. Mean mercury concentrations for all size classes assayed of Atlantic sharpnose shark, blackfin tuna, blue marlin, crevalle jack, swordfish, and wahoo equaled or exceeded the HAC_{nonca} for mercury.

Significant positive relationships between mercury concentration and TL were observed in many fish from the NWGOM, indicating that mercury concentrations increase as fish grow (Figures 2–11). The six species evaluated (Atlantic sharpnose shark, blackfin tuna, cobia, crevalle jack, Spanish mackerel, and yellowfin tuna) that did not have significant mercury concentration–TL relationships all exhibited positive relationships between the two variables. The significance of these relationships was likely limited by small sample size and size distribution evaluated for each species. The SALG risk assessors evaluated the significant positive relationships and corresponding regression equations to predict the TL by species at which the mercury concentration equaled or exceeded the HAC_{nonca} for mercury. The mercury–TL linear regression equation for blacktip shark estimated that blacktip shark > 54 inches TL contain mercury concentrations equivalent to the HAC_{nonca} for mercury (Figure 2). The usefulness of this estimate is suspect because only one of 21 blacktip shark samples contain mercury equivalent to the HAC_{nonca} for mercury. Additional samples of larger size class blacktip shark > 45 in TL should be collected to validate this estimate. Dolphinfish mercury–TL regression analyses predicted that mercury concentrations equivalent to the HAC_{nonca} for mercury occurred at larger TLs than represented by the study data. Thus, the SALG risk assessors considered the use of mercury regression equation for dolphinfish inappropriate for recommending size class fish consumption advice. The mercury–TL linear regression equation for little tunny estimated that little tunny > 27 inches TL contain mercury concentrations equivalent to the HAC_{nonca} for mercury (Figure 3). The mercury–TL linear regression equation (1996–2011 data; *n* = 254) for king mackerel predicted that king mackerel > 35 inches TL contain mercury concentrations equivalent to the

HAC_{nonca} for mercury (Figure 7). King mackerel size class mean mercury concentrations indicate that king mackerel > 35 inches TL contain mercury concentrations that exceed the HAC_{nonca} for mercury. The mercury–TL linear regression equation for red snapper predicted that up to a reported maximum length of 39 inches TL for this species mercury concentrations equivalent to the HAC_{nonca} for mercury were unattainable (Figure 10). The mercury–TL linear regression equation for wahoo predicted that wahoo > 53 inches TL contain mercury concentrations equivalent to the HAC_{nonca} for mercury (Figure 11).

Meal consumption calculations may be useful for decisions about consumption advice or regulatory actions. The SALG risk assessors calculated the number of eight-ounce meals of fish from the NWGOM that healthy adults could consume without significant risk of adverse systemic effects (Tables 3a–3b). Meal consumption rates were based on the most conservative mercury concentration (i.e. overall mean mercury concentration, predicted mercury concentration by regression equation, or size class mean mercury concentration) by species. The SALG risk assessors estimated that healthy adults could consume 0.6 (eight-ounce) meals per week of Atlantic sharpnose shark, 0.8 (eight-ounce) meals per week of blackfin tuna, 0.1 (eight-ounce) meals per week of blue marlin, 0.8 (eight-ounce) meals per week of little tunny > 27 inches TL, 0.6 (eight-ounce) meals per week of crevalle jack, 0.8 (eight-ounce) meals per week of king mackerel > 35 inches TL, 0.7 (eight-ounce) meals per week of swordfish, or 0.9 (eight-ounce) meals per week of wahoo containing mercury. The SALG risk assessors suggest that fish from the NWGOM contain mercury at concentrations that may pose potential systemic health risks and that people should limit their consumption of fish from the NWGOM. Because the developing nervous system of the human fetus and young children may be especially susceptible to adverse systemic health effects associated with consuming mercury-contaminated fish, the SALG risk assessors recommend more conservative consumption guidance for this sensitive subpopulation.

Notwithstanding, the 2011–2012 NWGOM meal consumption calculations, the SALG risk assessors are also of the opinion that it is important to consider potential exposure when developing fish consumption advisories. Studies have shown that recoveries and yields from whole fish to skin-off fillets range from 17–58%.[6] The SALG risk assessors used an average of 38% recovery and yield from whole fish to skin-off fillets to estimate the number of eight-ounce meals for an average weight fish of each species from the NWGOM in 2011–2012 (Table 4). The recoveries and yields for an average fish of each species from the NWGOM in 2011 ranged from 2.1–328.7 eight-ounce meals. Based on recoveries and yields ($\overline{X}$ – 38%) from whole fish to skin-off fillets for this project, the average NWGOM fish yields 20 pounds of skin-off fillets or approximately 40 eight-ounce meals (Table 4). By comparison, using similar recovery and yield data from Sam Rayburn Reservoir fish (data not shown), the recoveries and yields for Sam Rayburn Reservoir fish ranged from 0.3–15.1 eight-ounce meals. Drawing on the Sam Rayburn Reservoir data to represent the average freshwater fish, the average freshwater fish yields two pounds of skin-off fillets or approximately four eight-ounce meals. This data comparison between fish from the NWGOM and Sam Rayburn Reservoir shows that the average NWGOM fish is much larger than the average freshwater fish and that an average fish from the NWGOM containing a similar mercury concentration to an average freshwater fish is capable of exposing a person to approximately 10 times the amount of mercury. Another way to illustrate the importance of potential exposure from NWGOM fish is to consider the yellowfin tuna mean mercury concentration (0.314 mg/kg) for this project. Based on a mean mercury concentration of 0.314 mg/kg, a person consuming 8 eight-ounce meals per month would exceed the minimal risk level (MRL). The average yellowfin tuna for this project yields 23.6 pounds of skin-off fillets, approximately 47 eight-ounce meals or 10 eight-ounce meals per week. Following the yellowfin tuna example and assuming an average freshwater fish mean mercury concentration of 0.314 mg/kg; an average freshwater fish does not yield the pounds of skin-off fillets necessary to exceed the MRL. Because fish from the NWGOM are of large average size, it is important for high volume fish consumers (persons who eat more than 2 eight-ounce meals per week) to understand that even though an average fish mercury concentration does not exceed the HAC_{nonca} for mercury a person may easily consume enough fish meals to exceed the MRL. For the reasons stated in the above discussion, the SALG risk assessors considered both standard meal consumption calculations and potential exposure scenarios to develop fish consumption advice for fish from the NWGOM.

CONCLUSIONS

The SALG risk assessors prepare risk characterizations to determine public health hazards from consumption of fish and shellfish harvested from Texas waters by recreational or subsistence fishers. If necessary, the SALG may suggest strategies for reducing risk to the health of those who may eat contaminated fish or seafood to risk managers at the DSHS, including the Texas Commissioner of Health.

This study addressed the public health implications of consuming fish from nearshore and offshore waters of Texas (NWGOM). Risk assessors from the SALG conclude from the present characterization of potential adverse health effects from consuming fish from the NWGOM that:

1. Atlantic sharpnose shark, blackfin tuna, blue marlin, little tunny, crevalle jack, king mackerel, swordfish, and wahoo mercury concentrations exceed the DSHS guidelines for protection of human health. Regular or long-term consumption of the preceding fish may result in adverse systemic health effects. Therefore, regular or long-term consumption of these species of fish from the NWGOM **poses an apparent risk to human health**.

2. Dolphinfish, snapper (including lane, mangrove, and red), Spanish mackerel, and tripletail mercury concentrations do not exceed the DSHS guidelines for protection of human health. Therefore, regular consumption of these species of fish containing mercury **poses no apparent risk to human health**.

3. Cobia and yellowfin tuna mercury concentrations do not exceed the DSHS guidelines for protection of human health. However, maximum concentrations of mercury in cobia and yellowfin tuna significantly exceed the DSHS guidelines for protection of human health. Further evaluation of potential exposure scenarios and mercury data for cobia and yellowfin tuna from other sources indicate potential risk to human health. Therefore, regular or long-term consumption of these species of fish from the NWGOM **may pose a risk to human health**.

4. Larger size classes or older age classes of fishes (e.g. cobia, greater amberjack, grouper species, and tilefish) not represented in the fish samples of this assessment may contain mercury concentrations that exceed the DSHS guidelines for protection of human health. Evaluation of mercury data from other sources indicates potential risk to human health. Therefore, regular or long-term consumption of these species of fish from the NWGOM **may pose a risk to human health**.

5. Due to the small sample size and lack of larger size classes or older age classes of some fishes assayed in this study, the absence of some commonly consumed fishes (e.g. tilefish) in this dataset, and the variability of mercury concentrations observed in fish tissue samples, the SALG risk assessors are unable to characterize adequately health risks associated with consuming mercury-contaminated fish from the NWGOM. Because of the limitations of this data and potential exposure, the SALG risk assessors conclude that conservative judgment should be exercised for the recommendation of fish consumption advice until sufficient data is evaluated.

RECOMMENDATIONS

Risk managers at the DSHS have established criteria for issuing fish consumption advisories based on approaches suggested by the EPA.[1,7,8] Risk managers at the DSHS may decide to take some action to protect public health if a risk characterization confirms that people can eat four or fewer meals per month (adults: eight-ounces per meal; children: four ounces per meal) of fish or shellfish from a water body under investigation. Risk management recommendations may be in the form of consumption advice or a ban on possession of fish from the affected water body. Fish or shellfish possession bans are enforceable under subchapter D of the Texas Health and Safety Code, part 436.061(a).[9] Declarations of prohibited harvesting areas are enforceable under the Texas Health and Safety Code, Subchapter D, parts 436.091 and 436.101. The DSHS consumption advice carries no penalty for noncompliance. Consumption advisories, instead, inform the public of potential health hazards associated with consuming contaminated fish or shellfish from Texas waters. With this information, members of the public can make informed decisions about whether and/or how much – contaminated fish or shellfish they wish to consume. The SALG concludes from this risk characterization that consuming fish from the NWGOM **poses an apparent hazard to public health.** Therefore, SALG risk assessors recommend that:

1. No one should consume blue marlin from the NWGOM (Table 5).

2. Pregnant women, women who may become pregnant, women who are nursing infants, and children less than 12 years of age or who weigh less than 75 pounds should not consume blackfin tuna, little tunny, crevalle jack, king mackerel, shark (all species), swordfish, and wahoo from the NWGOM.

3. Women past childbearing age and adult men may consume up to two eight-ounce meals per month of blackfin tuna, little tunny, crevalle jack, king mackerel > 35 inches TL, shark (all species), swordfish, and wahoo from the NWGOM.

4. Women past childbearing age and adult men may consume up to one eight-ounce meal per week of king mackerel < 35 inches TL from the NWGOM.

5. Pregnant women, women who may become pregnant, women who are nursing infants, and children less than 12 years of age or who weigh less than 75 pounds should use caution when eating large cobia or yellowfin tuna. Although, the mean mercury concentrations do not exceed the DSHS guidelines for protection of human health limited data indicate that eating large individual cobia or yellowfin tuna may pose significant health risks.

6. The DSHS SALG should conduct additional monitoring to characterize adequately health risks associated with consuming mercury contaminated fishes of the NWGOM. The supplementary monitoring should include collection of larger size classes or older age classes of cobia, greater amberjack, and grouper species not represented in the fish samples of this assessment and commonly consumed fish such as tilefish, which are absent from this assessment. In addition, the monitoring should include the analyses of other potential contaminants of concern (i.e. PCBs, dioxins, pesticides, etc.) for all commonly consumed fishes of the NWGOM.

Figure 1. The NWGOM Sample Sites

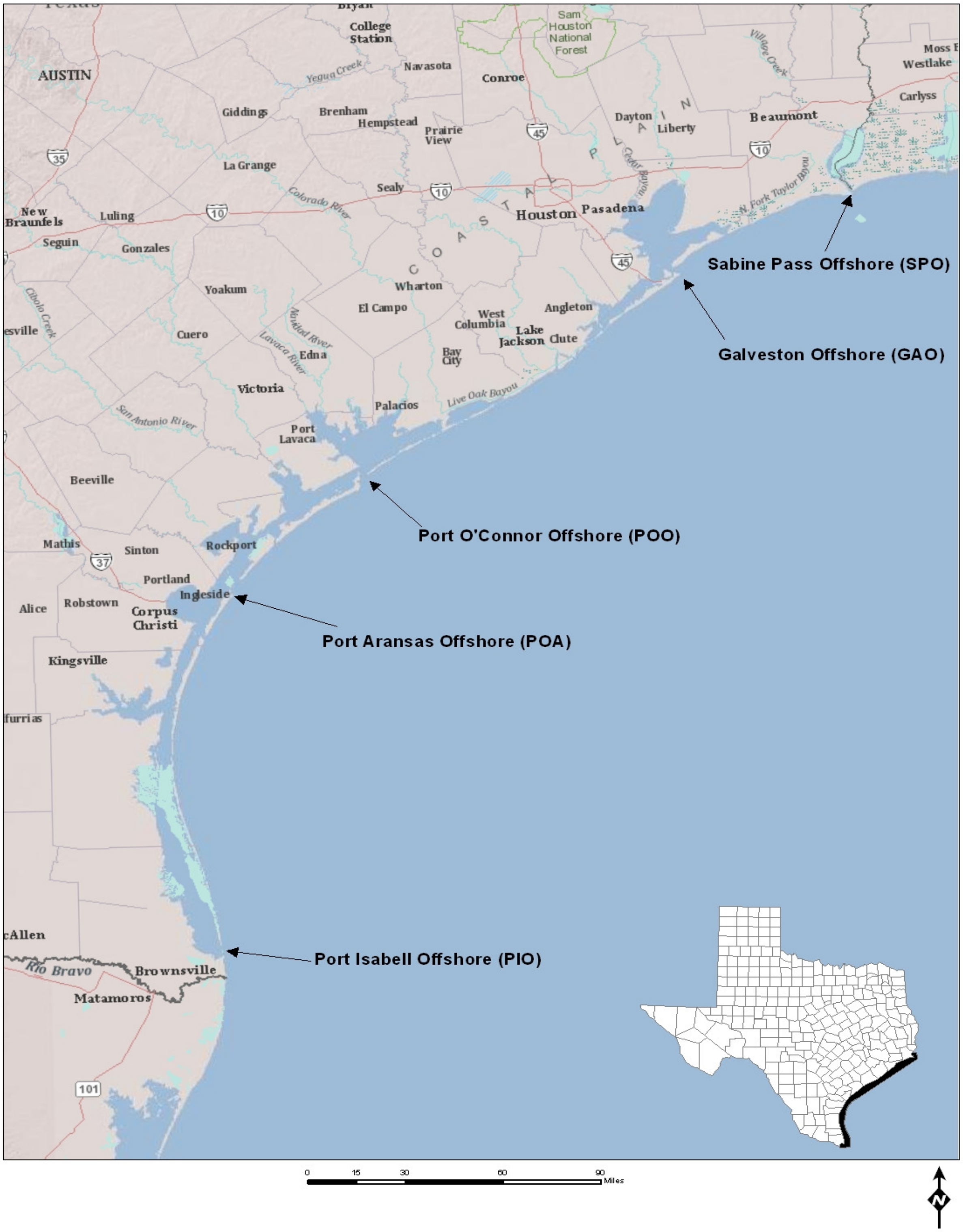


Figure 2. The relationship between mercury concentration and total length for blacktip shark collected from the NWGOM, Texas, 2011–2012.

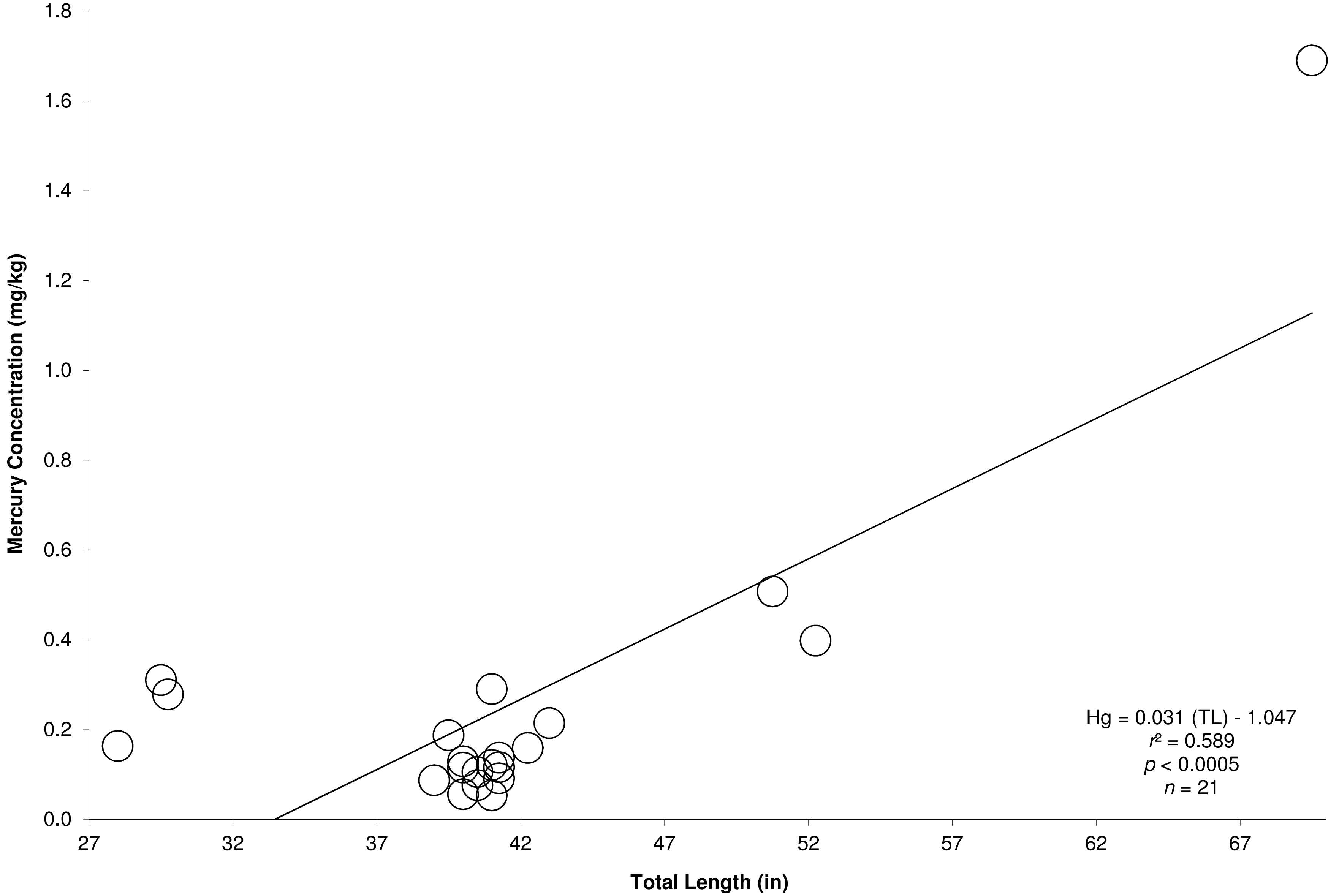


Figure 3. The relationship between mercury concentration and total length for little tunny "bonito" collected from the NWGOM, Texas, 2011–2012.

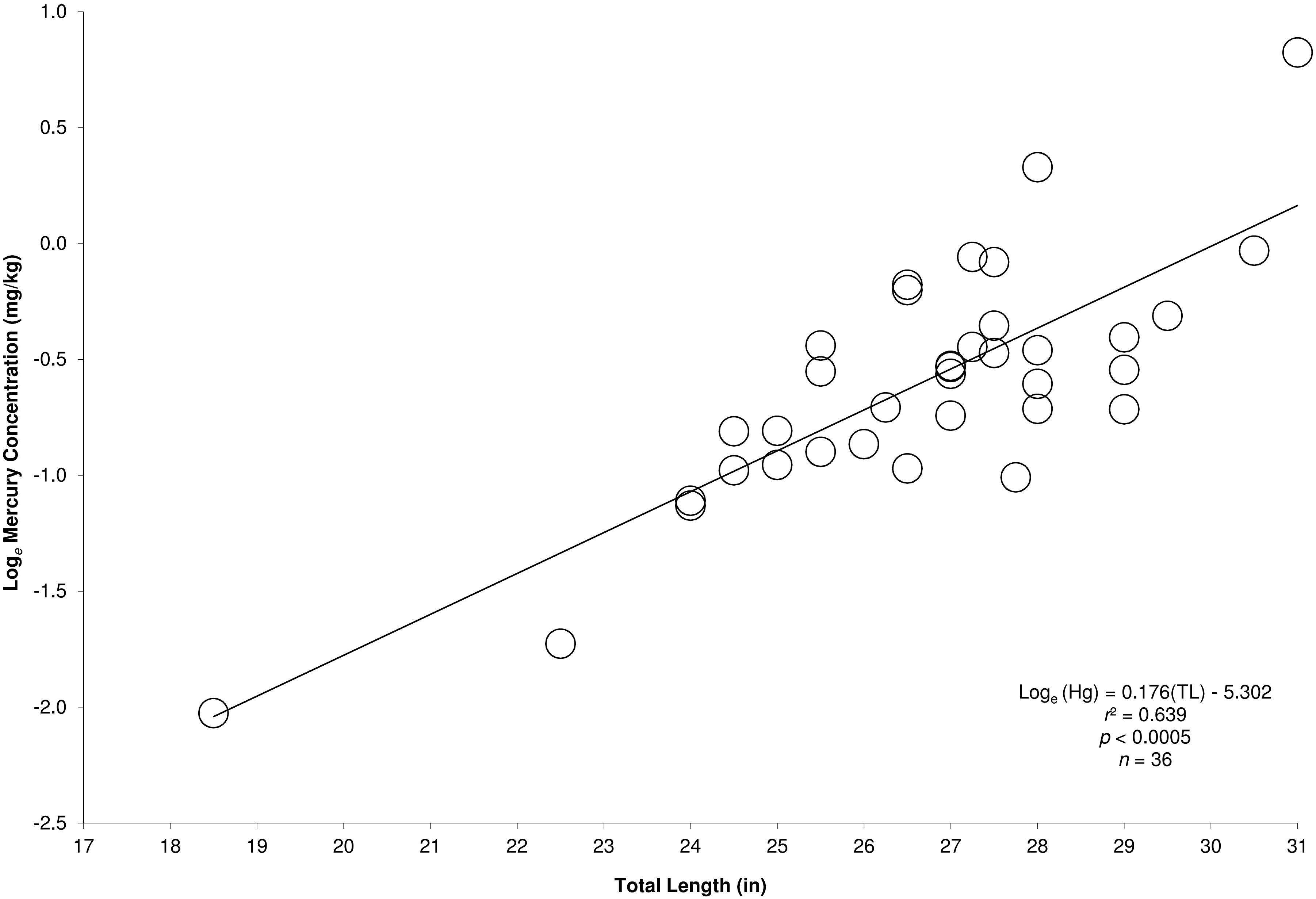


Figure 4. The relationship between mercury concentration and total length for dolphinfish collected from the NWGOM, Texas, 2011–2012.

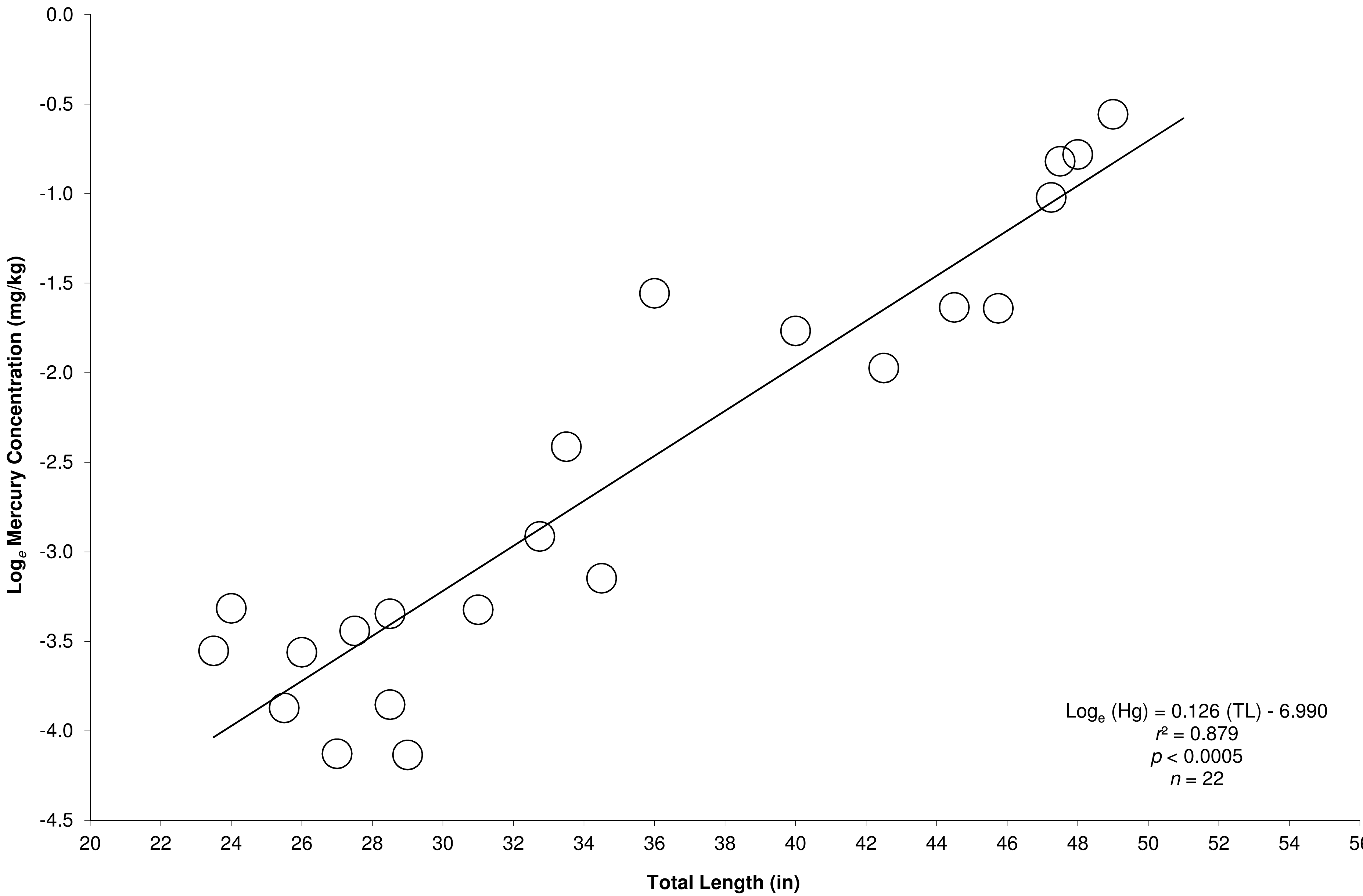


Figure 5. The relationship between mercury concentration and total length for king mackerel collected from the NWGOM, Texas, 2011–2012.

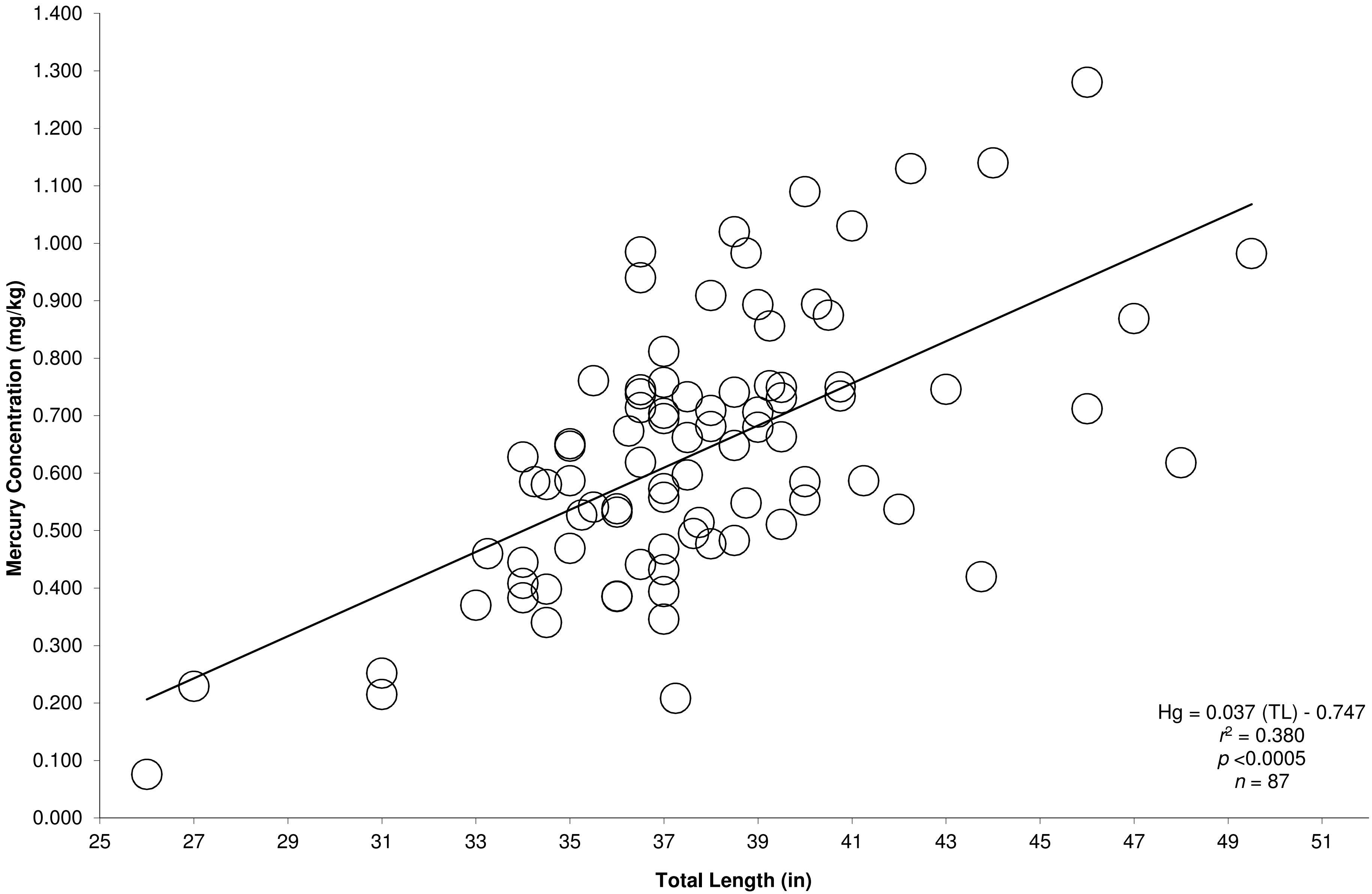


Figure 6. Means plot of mercury (mg/kg, wet wt.) in king mackerel tissue by size class collected from the NWGOM, Texas 2011–2012. The error bars denote the 95% confidence interval of the mean.

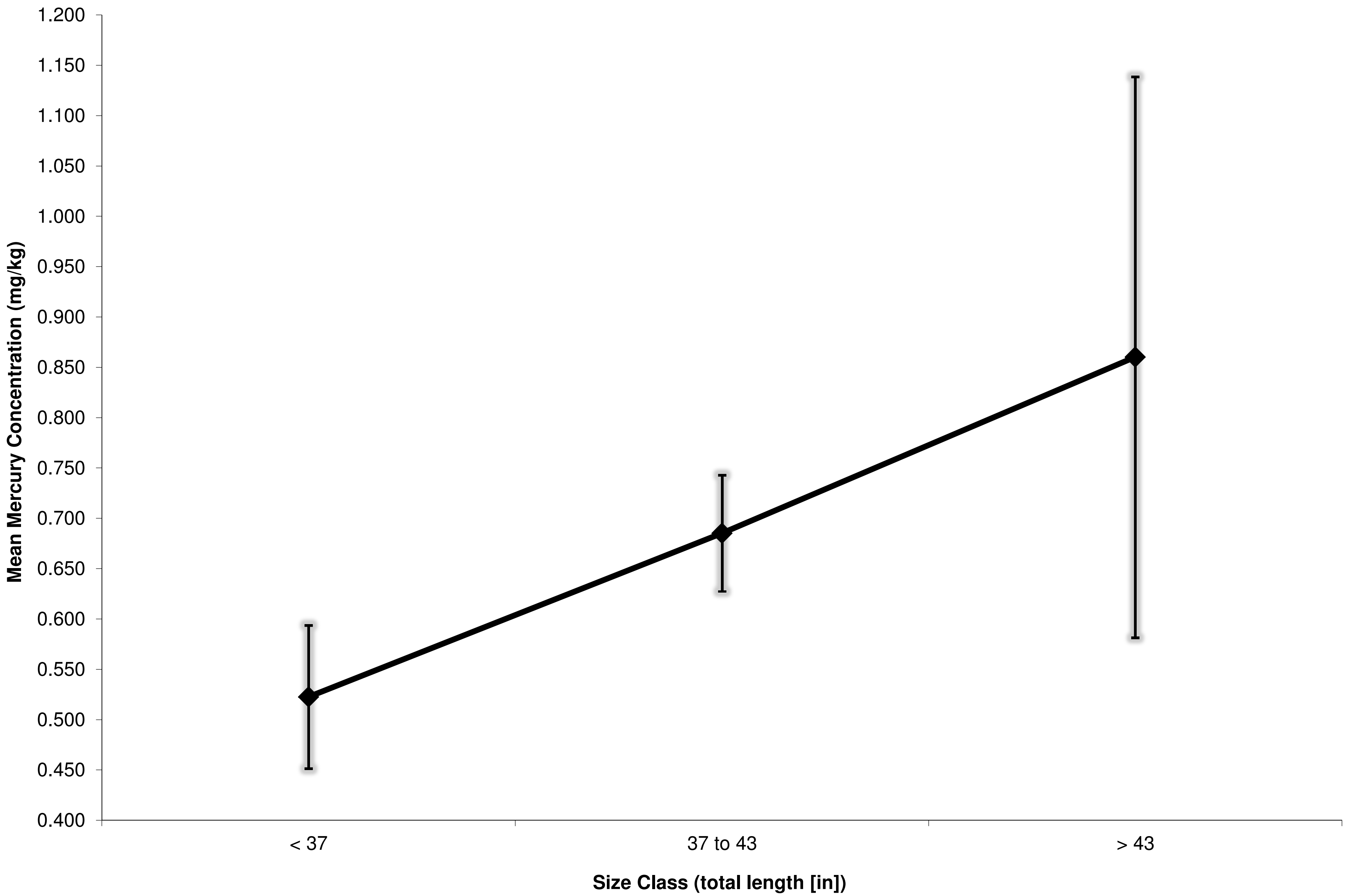


Figure 7. The relationship between mercury concentration and total length for king mackerel collected from the NWGOM, Texas, 1996–2012.

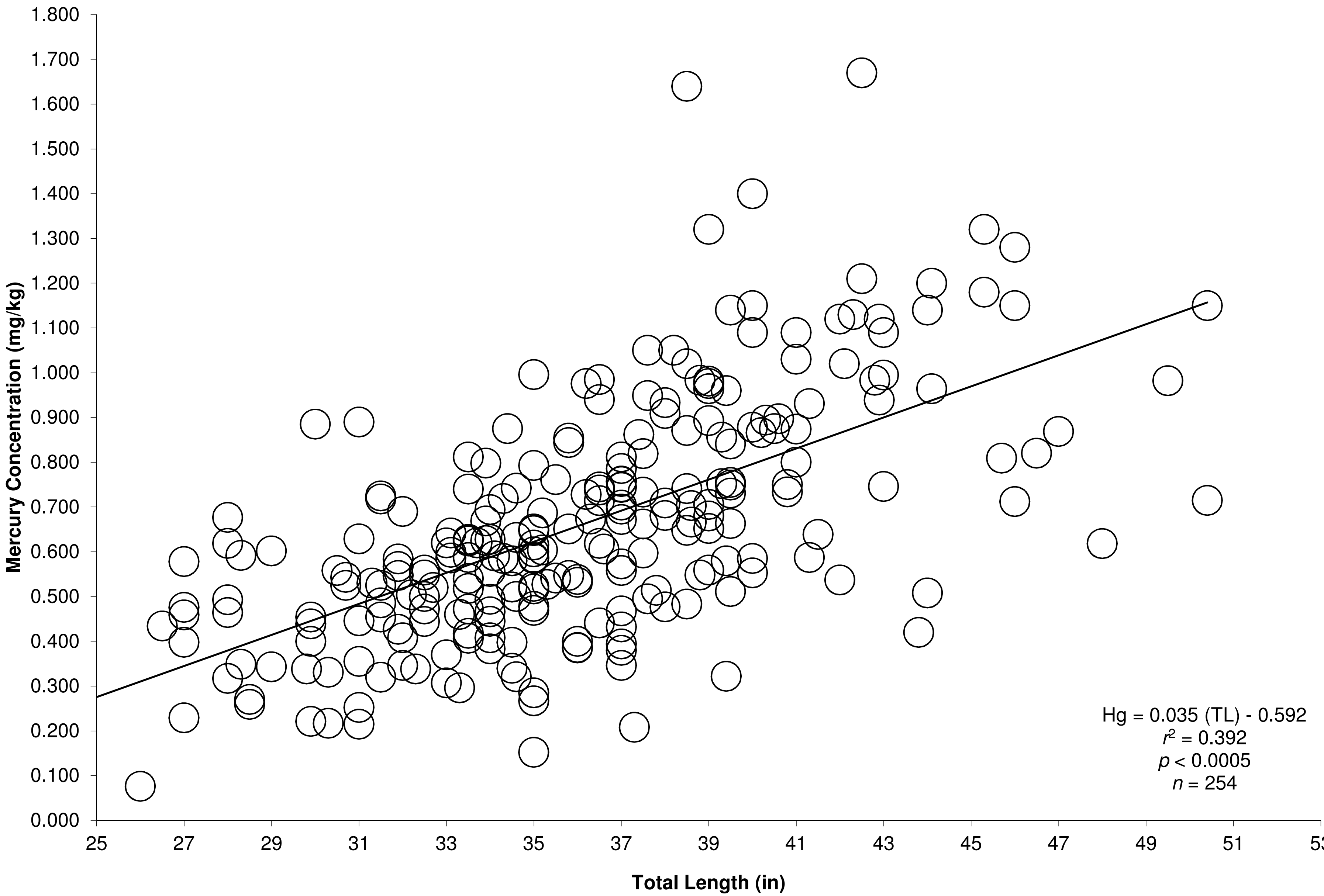


Figure 8. Means plot of mercury (mg/kg, wet wt.) in king mackerel tissue by size class collected from the NWGOM, Texas 1996–2012. The error bars denote the 95% confidence interval of the mean.

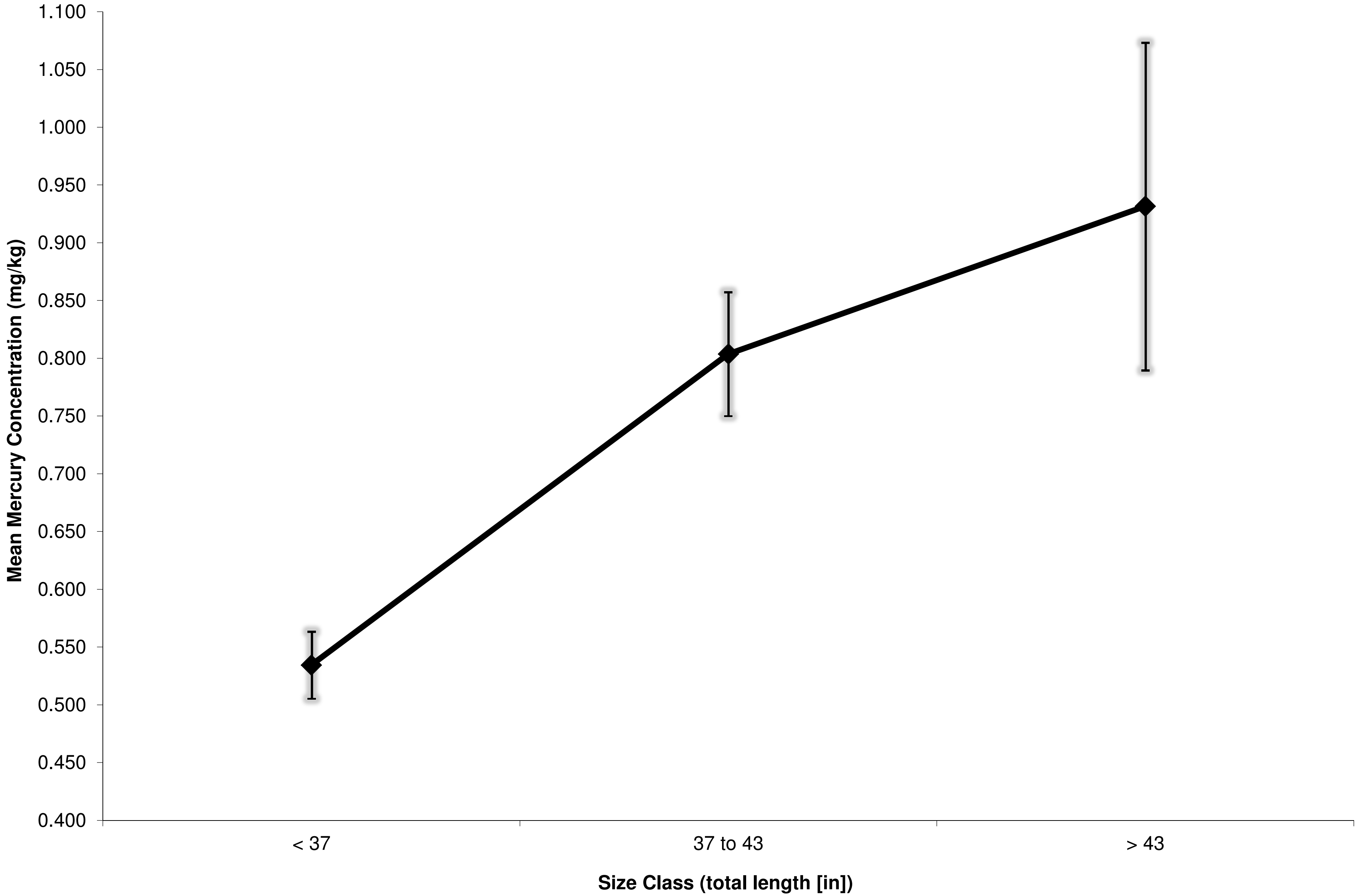


Figure 9. Means plot of mercury (mg/kg, wet wt.) in king mackerel tissue by size class collected from the NWGOM, Texas 1996–2012. The error bars denote the 95% confidence interval of the mean.

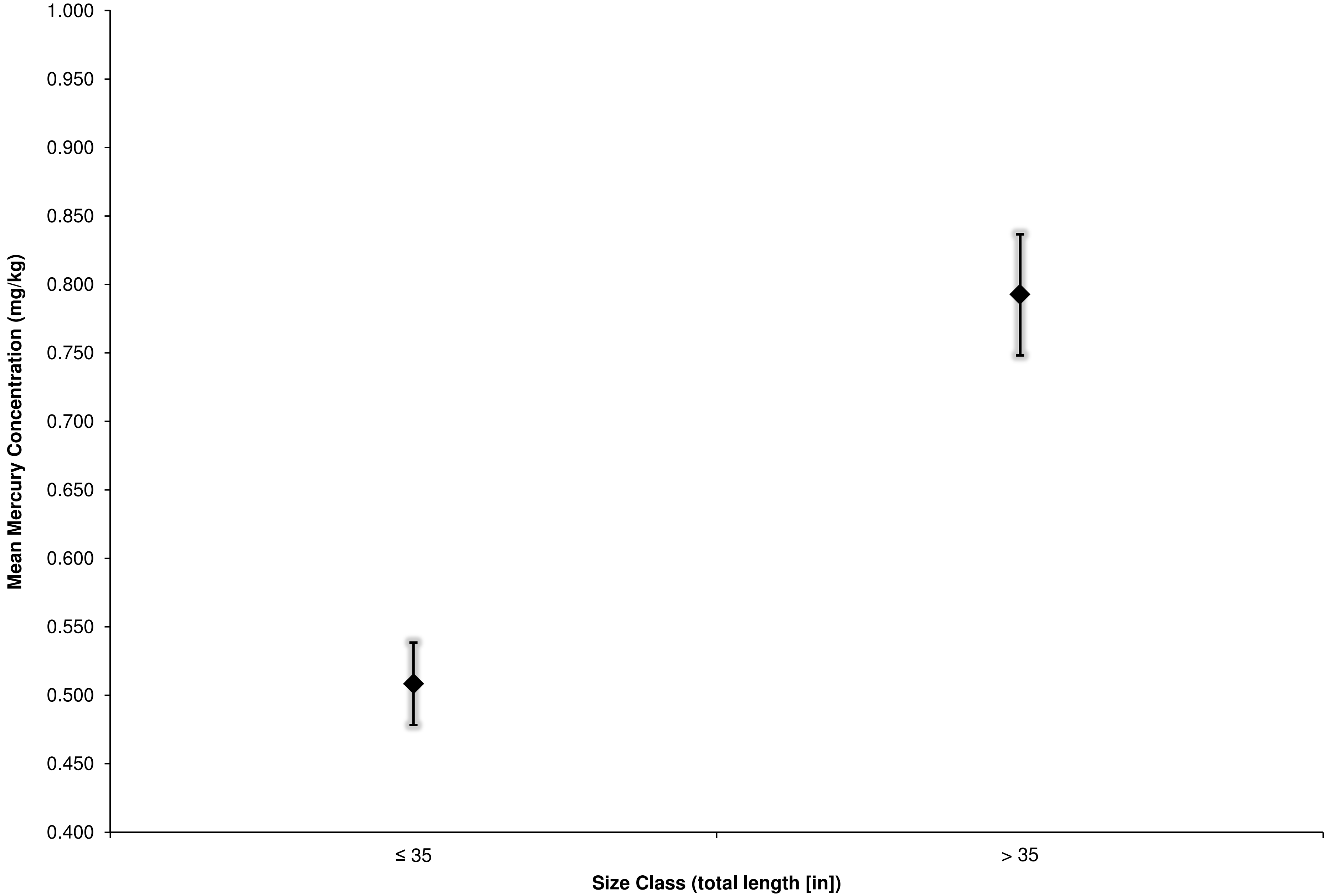


Figure 10. The relationship between mercury concentration and total length for red snapper collected from the NWGOM, Texas, 2011–2012.

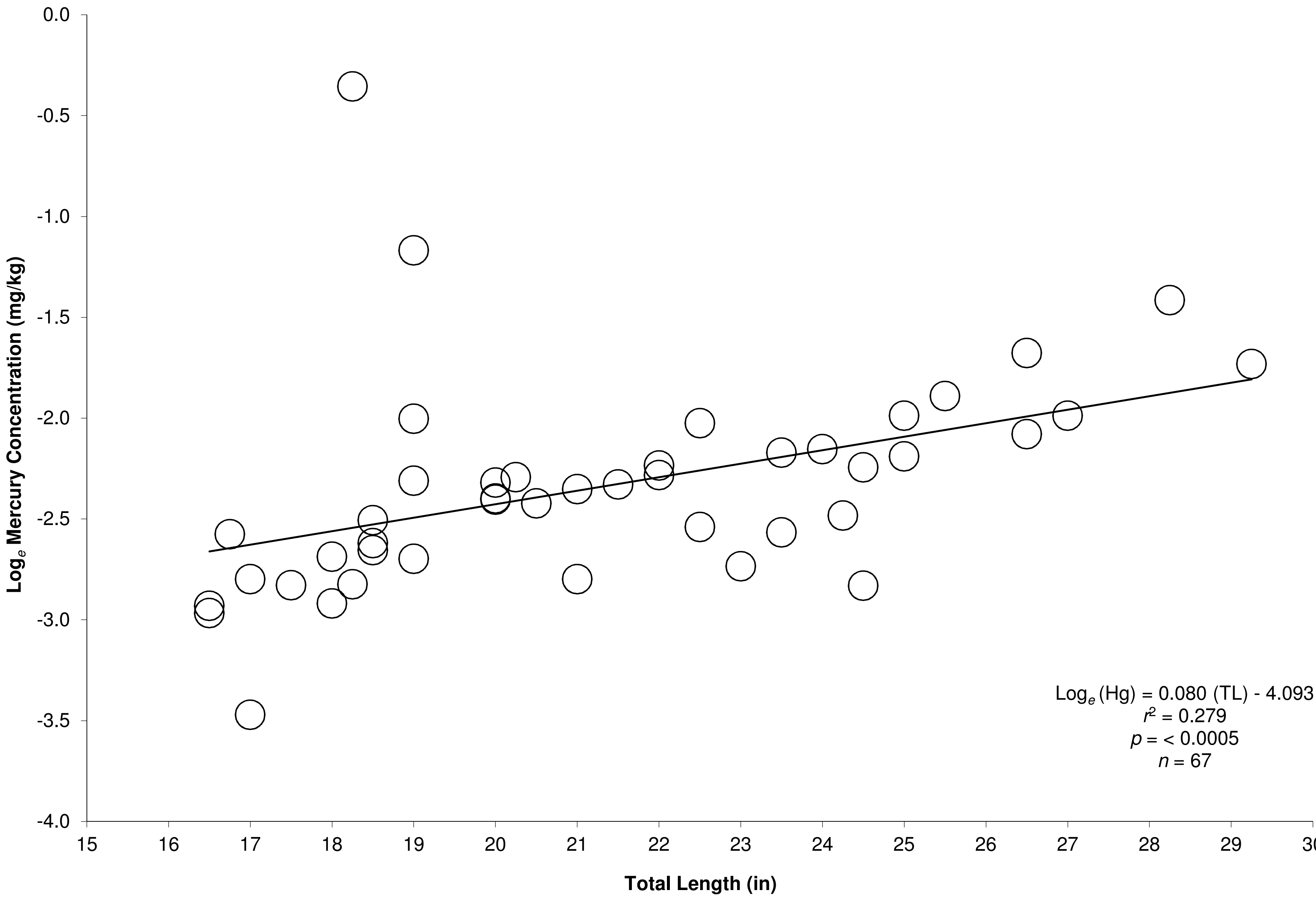
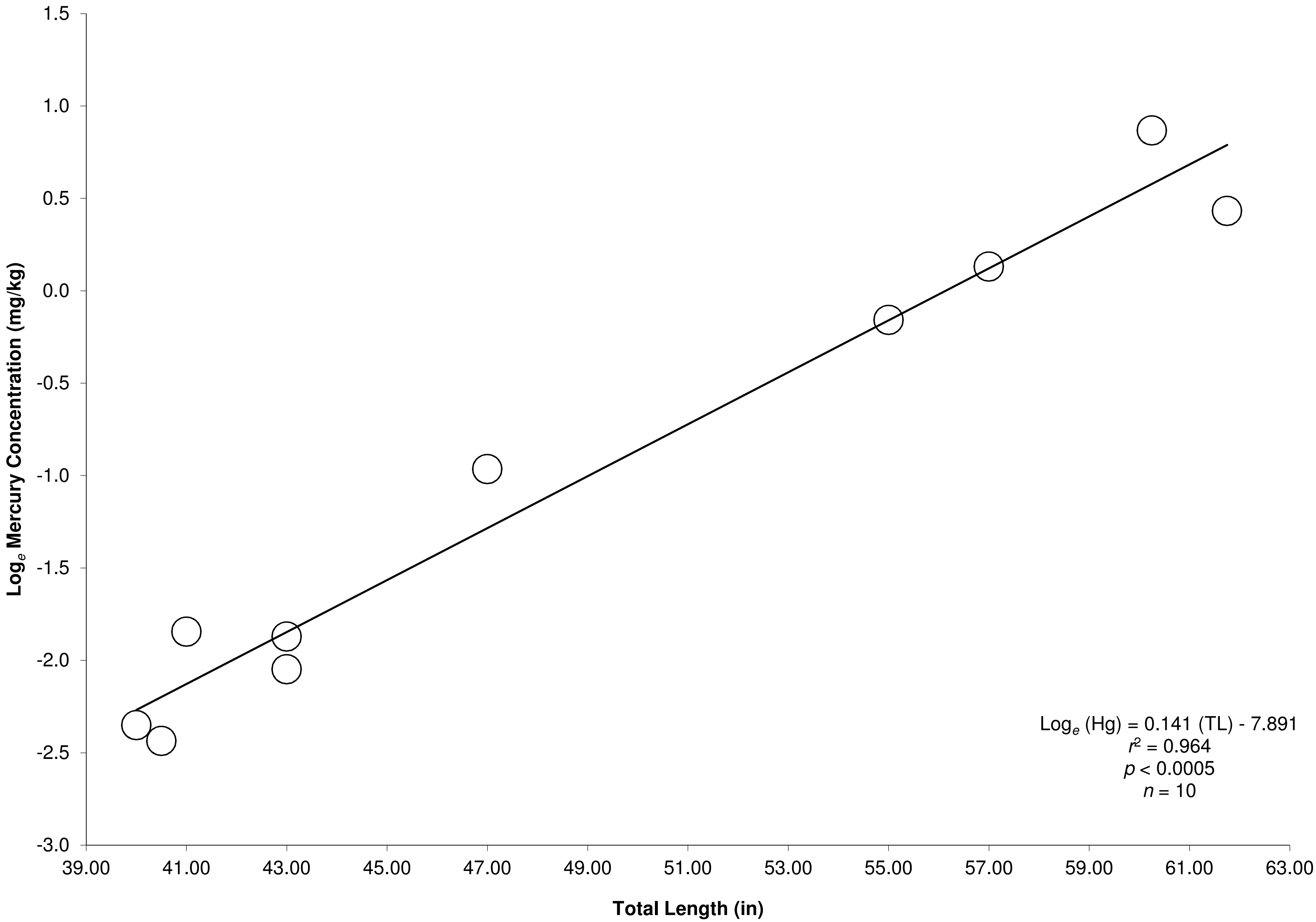


Figure 11. The relationship between mercury concentration and total length for wahoo collected from the NWGOM, Texas, 2011–2012.



TABLES

Table 1. Fish samples collected from the NWGOM in 2011–2012. Sample number, species, total length, and weight recorded for each sample.

Sample Number	Species	Length (in)	Weight (lb)
Site 1 Galveston Offshore			
GAO37	Atlantic sharpnose shark	36.75	N/A
GAO60	Atlantic sharpnose shark	37.00	7.1
GAO43	Atlantic sharpnose shark	37.25	7.7
GAO10	Atlantic sharpnose shark	38.25	7.6
GAO82	Blacktip shark	28.00	4.1
GAO72	Blacktip shark	29.50	4.4
GAO79	Blacktip shark	29.75	4.7
GAO96	Blacktip shark	39.00	11.0
GAO44	Blacktip shark	39.50	11.2
GAO46	Blacktip shark	40.00	12.3
GAO85	Blacktip shark	40.00	11.8
GAO93	Blacktip shark	40.00	10.3
GAO86	Blacktip shark	40.50	12.5
GAO92	Blacktip shark	40.50	11.0
GAO45	Blacktip shark	41.00	13.6
GAO84	Blacktip shark	41.00	11.9
GAO89	Blacktip shark	41.00	13.5
GAO83	Blacktip shark	41.25	13.3
GAO87	Blacktip shark	41.25	12.0
GAO90	Blacktip shark	41.25	12.3
GAO88	Blacktip shark	42.25	13.7
GAO91	Blacktip shark	43.00	13.5
GAO59	Bonnethead shark	41.00	10.4
GAO19	Cobia	38.00	13.3
GAO36	Cobia	39.00	N/A
GAO38	Cobia	41.00	N/A
GAO11	Cobia	41.50	19.1
GAO18	Cobia	43.50	21.1
GAO40	Cobia	44.00	N/A
GAO39	Cobia	45.50	N/A
GAO15	Dolphinfish	32.75	7.4
GAO12	King mackerel	31.00	4.3
GAO14	King mackerel	33.25	7.1
GAO22	King mackerel	35.00	6.7
GAO56	King mackerel	35.00	5.4
GAO20	King mackerel	36.00	8.0

Table 1 cont. Fish samples collected from the NWGOM in 2011–2012. Sample number, species, total length, and weight recorded for each sample.			
Sample Number	**Species**	**Length (in)**	**Weight (lb)**
Site 1 Galveston Offshore			
GAO57	King mackerel	36.25	8.3
GAO21	King mackerel	36.50	8.9
GAO28	King mackerel	37.00	9.3
GAO13	King mackerel	37.50	9.7
GAO35	King mackerel	37.63	N/A
GAO23	King mackerel	38.00	10.1
GAO25	King mackerel	39.00	9.8
GAO26	King mackerel	39.25	11.9
GAO27	King mackerel	39.25	11.6
GAO24	King mackerel	40.00	14.8
GAO55	King mackerel	44.00	11.7
GAO29	King mackerel	48.00	21.5
GAO2	Mangrove snapper	11.50	0.7
GAO1	Mangrove snapper	26.00	7.5
GAO3	Red snapper	19.00	3.5
GAO5	Red snapper	19.00	3.1
GAO8	Red snapper	20.00	3.9
GAO7	Red snapper	20.25	3.8
GAO4	Red snapper	21.00	3.9
GAO6	Red snapper	22.00	5.1
GAO42	Spanish mackerel	20.00	1.5
GAO94	Spanish mackerel	20.00	1.4
GAO58	Spanish mackerel	22.00	1.3
GAO31	Spanish mackerel	24.25	3.0
GAO95	Spanish mackerel	25.00	2.6
GAO52	Spanish mackerel	26.00	2.5
GAO30	Spanish mackerel	26.50	3.8
GAO54	Spanish mackerel	27.00	2.6
GAO53	Spanish mackerel	28.50	N/A
GAO16	Tripletail	17.00	3.4
GAO32	Tripletail	17.50	3.8
GAO61	Tripletail	18.50	4.3
GAO47	Tripletail	19.00	4.7
GAO48	Tripletail	19.50	4.2
GAO49	Tripletail	19.50	4.7
GAO34	Tripletail	20.00	6.5

Table 1 cont. Fish samples collected from the NWGOM in 2011–2012. Sample number, species, total length, and weight recorded for each sample.			
Sample Number	**Species**	**Length (in)**	**Weight (lb)**
Site 1 Galveston Offshore			
GAO41	Tripletail	23.00	7.6
Site 2 Port O'Connor Offshore			
POO124	Atlantic sharpnose shark	34.00	5.3
POO126	Atlantic sharpnose shark	34.25	6.4
POO125	Atlantic sharpnose shark	38.75	8.6
POO108	Blackfin tuna	30.00	15.5
POO107	Blackfin tuna	31.00	16.5
POO106	Blackfin tuna	31.50	16.9
POO105	Blackfin tuna	32.50	16.3
POO104	Blackfin tuna	33.00	19.3
POO103	Blackfin tuna	35.75	18.0
POO128	Blacktip shark	50.75	22.6
POO127	Blacktip shark	52.25	24.1
POO112	Little tunny	24.50	6.3
POO118	Little tunny	24.50	6.4
POO111	Little tunny	25.50	8.6
POO115	Little tunny	25.50	8.2
POO122	Little tunny	26.25	7.6
POO114	Little tunny	26.50	9.3
POO117	Little tunny	26.50	8.7
POO119	Little tunny	27.00	7.3
POO120	Little tunny	27.25	8.6
POO113	Little tunny	27.50	10.7
POO116	Little tunny	27.50	10.3
POO123	Little tunny	27.75	8.3
POO110	Little tunny	28.00	10.6
POO121	Little tunny	28.00	7.9
POO81	Cobia	38.00	N/A
POO50	Cobia	38.25	14.6
POO32	Cobia	40.50	18.2
POO109	Cobia	43.50	19.7
POO80	Cobia	44.75	N/A
POO33	Cobia	48.50	26.5
POO95	Dolphinfish	24.00	N/A
POO101	Crevalle jack	33.00	13.0

Table 1 cont. Fish samples collected from the NWGOM in 2011–2012. Sample number, species, total length, and weight recorded for each sample.			
Sample Number	**Species**	**Length (in)**	**Weight (lb)**
Site 2 Port O'Connor Offshore			
POO54	Crevalle jack	37.00	17.5
POO102	Crevalle jack	38.75	21.0
POO64	Crevalle jack	39.50	20.2
POO62	Crevalle jack	40.00	22.2
POO63	Crevalle jack	40.00	20.2
POO100	Crevalle jack	41.50	28.0
POO85	King mackerel	34.00	N/A
POO70	King mackerel	34.25	N/A
POO78	King mackerel	34.50	N/A
POO87	King mackerel	34.50	N/A
POO89	King mackerel	34.50	N/A
POO79	King mackerel	35.00	N/A
POO75	King mackerel	35.25	N/A
POO76	King mackerel	35.50	N/A
POO83	King mackerel	35.50	N/A
POO48	King mackerel	36.50	9.9
POO60	King mackerel	36.50	9.3
POO72	King mackerel	36.50	N/A
POO49	King mackerel	37.00	8.6
POO55	King mackerel	37.00	10.7
POO57	King mackerel	37.00	11.1
POO66a	King mackerel	37.00	N/A
POO97	King mackerel	37.00	N/A
POO67a	King mackerel	37.25	N/A
POO59	King mackerel	37.50	10.7
POO56	King mackerel	37.75	11.9
POO71	King mackerel	38.00	N/A
POO47	King mackerel	38.50	10.8
POO68	King mackerel	38.50	N/A
POO69	King mackerel	38.75	N/A
POO84	King mackerel	38.75	N/A
POO65a	King mackerel	39.50	N/A
POO82	King mackerel	39.50	N/A
POO88	King mackerel	40.25	N/A
POO73	King mackerel	40.50	N/A
POO58	King mackerel	40.75	12.2

Table 1 cont. Fish samples collected from the NWGOM in 2011–2012. Sample number, species, total length, and weight recorded for each sample.			
Sample Number	**Species**	**Length (in)**	**Weight (lb)**
Site 2 Port O'Connor Offshore			
POO86	King mackerel	40.75	N/A
POO74	King mackerel	41.25	N/A
POO77	King mackerel	43.75	N/A
POO129	King mackerel	46.00	21.8
POO67	Lane snapper	16.25	1.9
POO31	Lane snapper	16.50	2.3
POO66	Lane snapper	17.25	2.1
POO30	Lane snapper	17.50	2.5
POO45	Red snapper	16.75	2.3
POO42	Red snapper	17.00	2.8
POO44	Red snapper	17.50	2.8
POO43	Red snapper	18.00	2.5
POO27	Red snapper	18.25	2.9
POO29	Red snapper	18.25	3.0
POO28	Red snapper	18.50	3.4
POO41	Red snapper	18.50	3.0
POO26	Red snapper	19.00	3.2
POO39	Red snapper	20.00	3.7
POO40	Red snapper	20.00	4.0
POO35	Red snapper	20.50	4.6
POO38	Red snapper	21.50	4.6
POO37	Red snapper	23.00	5.6
POO22	Red snapper	24.00	6.8
POO24	Red snapper	24.25	7.2
POO21	Red snapper	24.50	6.9
POO23	Red snapper	25.00	6.5
POO25	Red snapper	26.50	9.0
POO36	Red snapper	28.25	10.8
POO65	Red snapper	29.25	13.3
POO94	Spanish mackerel	23.00	N/A
POO51	Spanish mackerel	24.25	2.3
POO53	Spanish mackerel	25.00	2.6
POO92	Spanish mackerel	25.00	N/A
POO98	Spanish mackerel	25.00	N/A
POO91	Spanish mackerel	25.25	N/A
POO52	Spanish mackerel	26.25	3.2

Table 1 cont. Fish samples collected from the NWGOM in 2011–2012. Sample number, species, total length, and weight recorded for each sample.			
Sample Number	**Species**	**Length (in)**	**Weight (lb)**
Site 2 Port O'Connor Offshore			
POO46	Spanish mackerel	27.00	3.8
POO93	Spanish mackerel	27.25	N/A
POO34	Spanish mackerel	28.25	3.9
POO90	Spanish mackerel	28.50	N/A
POO61	Tripletail	19.75	5.2
Site 3 Port Aransas Offshore			
PAO62	Blackfin tuna	30.00	17.0
PAO68	Little tunny	18.50	2.0
PAO69	Little tunny	22.50	5.0
PAO60	Little tunny	24.00	6.0
PAO65	Little tunny	24.00	7.0
PAO67	Little tunny	25.50	8.0
PAO71	Little tunny	26.00	7.0
PAO61	Little tunny	27.00	9.0
PAO70	Little tunny	27.00	8.0
PAO72	Little tunny	27.00	11.0
PAO64	Little tunny	28.00	9.0
PAO58	Little tunny	29.00	12.0
PAO59	Little tunny	29.00	10.0
PAO66	Little tunny	29.00	10.0
PAO32	Cobia	41.00	19.5
PAO31	Cobia	42.00	16.6
PAO37	Cobia	53.00	40.0
PAO57	Cobia	57.00	65.0
PAO18	Dolphinfish	23.50	3.0
PAO22	Dolphinfish	25.50	3.2
PAO20	Dolphinfish	26.00	4.1
PAO21	Dolphinfish	27.00	4.0
PAO23	Dolphinfish	28.50	4.6
PAO35	Dolphinfish	28.50	4.5
PAO33	Dolphinfish	29.00	4.2
PAO42	Dolphinfish	31.00	4.9
PAO41	Dolphinfish	33.50	6.9
PAO17	Dolphinfish	34.50	7.8
PAO19	Dolphinfish	36.00	7.4
PAO24	King mackerel	31.00	5.6
PAO38	King mackerel	34.00	6.4

Table 1 cont. Fish samples collected from the NWGOM in 2011–2012. Sample number, species, total length, and weight recorded for each sample.			
Sample Number	**Species**	**Length (in)**	**Weight (lb)**
Site 3 Port Aransas Offshore			
PAO51	King mackerel	34.00	6.9
PAO43	King mackerel	35.00	8.3
PAO46	King mackerel	36.00	8.4
PAO54	King mackerel	36.00	7.1
PAO49	King mackerel	36.50	9.0
PAO36	King mackerel	37.00	9.1
PAO47	King mackerel	37.00	8.6
PAO56	King mackerel	37.50	10.0
PAO48	King mackerel	38.00	7.4
PAO52	King mackerel	38.00	10.6
PAO55	King mackerel	38.50	11.7
PAO44	King mackerel	39.00	10.9
PAO53	King mackerel	39.50	10.2
PAO34	King mackerel	41.00	19.2
PAO39	King mackerel	42.00	14.5
PAO45	King mackerel	43.00	15.4
PAO29	King mackerel	47.00	24.2
PAO50	King mackerel	49.50	29.3
PAO1	Red snapper	16.50	2.1
PAO2	Red snapper	16.50	2.2
PAO9	Red snapper	17.00	2.4
PAO3	Red snapper	18.00	2.8
PAO10	Red snapper	18.50	3.3
PAO11	Red snapper	19.00	3.5
PAO14	Red snapper	21.00	4.8
PAO4	Red snapper	22.00	5.2
PAO12	Red snapper	22.50	5.4
PAO15	Red snapper	22.50	5.7
PAO7	Red snapper	23.50	5.6
PAO28	Red snapper	23.50	6.5
PAO5	Red snapper	24.50	6.4
PAO6	Red snapper	25.00	6.9
PAO13	Red snapper	25.50	7.3
PAO30	Red snapper	26.50	10.7
PAO8	Red snapper	27.00	9.7
PAO40	Spanish mackerel	29.50	4.4

Table 1 cont. Fish samples collected from the NWGOM in 2011–2012. Sample number, species, total length, and weight recorded for each sample.

Sample Number	Species	Length (in)	Weight (lb)
Site 3 Port Aransas Offshore			
PAO27	Wahoo	40.00	9.9
PAO16	Wahoo	40.50	10.2
PAO26	Wahoo	41.00	13.3
PAO25	Wahoo	43.00	13.3
PAO63	Warsaw grouper	40.00	39.0
Site 4 Sabine Pass Offshore			
SPO12	Blacktip shark	69.50	N/A
SPO15	Cobia	42.00	N/A
SPO1	Crevalle jack	38.00	N/A
SPO13	Crevalle jack	41.50	N/A
SPO5	King mackerel	38.50	N/A
SPO7	King mackerel	39.00	N/A
SPO6	King mackerel	39.50	N/A
SPO4	King mackerel	40.00	N/A
SPO3	King mackerel	42.25	N/A
SPO17	Red snapper	16.00	N/A
SPO18	Red snapper	16.00	N/A
SPO19	Red snapper	16.25	N/A
SPO16	Red snapper	16.75	N/A
SPO2	Spanish mackerel	22.00	N/A
SPO9	Spanish mackerel	23.75	N/A
SPO11	Spanish mackerel	24.25	N/A
SPO8	Spanish mackerel	25.25	N/A
SPO10	Spanish mackerel	25.50	N/A
SPO14	Spinner shark	44.50	N/A
Site 5 Port Isabell Offshore			
PIO14	Atlantic sharpnose shark	34.50	7.5
PIO23	Atlantic sharpnose shark	38.00	10.0
PIO24	Atlantic sharpnose shark	38.00	10.5
PIO26	Atlantic sharpnose shark	38.00	10.0
PIO8	Atlantic sharpnose shark	39.00	10.0
PIO27	Atlantic sharpnose shark	40.00	12.0
PIO28	Atlantic sharpnose shark	41.00	11.0
PIO25	Atlantic sharpnose shark	43.00	12.0
PIO7	Blackfin tuna	31.00	17.0
PIO1	Blackfin tuna	32.00	22.0
PIO13	Bonito	25.00	7.5
PIO15	Bonito	25.00	7.0
PIO22	Bonito	26.50	9.0

Table 1 cont. Fish samples collected from the NWGOM in 2011–2012. Sample number, species, total length, and weight recorded for each sample.			
Sample Number	**Species**	**Length (in)**	**Weight (lb)**
Site 5 Port Isabell Offshore			
PIO9	Bonito	27.25	9.0
PIO20	Bonito	27.50	9.0
PIO39	Bonito	28.00	10.0
PIO19	Bonito	29.50	11.0
PIO16	Bonito	30.50	13.0
PIO21	Bonito	31.00	12.5
PIO12	Crevalle jack	40.00	22.0
PIO49	Cubera snapper	28.00	11.0
PIO17	Dolphin	27.50	5.0
PIO51	Greater amberjack	45.00	25.5
PIO46	Gray triggerfish	15.00	2.0
PIO47	Gray triggerfish	16.00	2.5
PIO6	King mackerel	26.00	3.5
PIO29	King mackerel	27.00	4.5
PIO2	King mackerel	33.00	7.0
PIO4	King mackerel	34.00	9.0
PIO3	King mackerel	36.00	10.0
PIO30	King mackerel	36.50	9.0
PIO40	King mackerel	36.50	9.5
PIO10	King mackerel	37.00	11.0
PIO41	King mackerel	37.00	9.5
PIO11	King mackerel	40.00	14.0
PIO5	King mackerel	46.00	25.0
PIO45	Mangrove snapper	15.00	2.0
PIO44	Mangrove snapper	16.50	2.0
PIO48	Red snapper	15.25	2.0
PIO50	Red snapper	15.75	1.5
PIO43	Red snapper	16.50	2.5
PIO52	Red snapper	16.50	2.0
PIO59	Red snapper	16.50	2.5
PIO36	Red snapper	17.00	2.5
PIO56	Red snapper	17.00	3.0
PIO53	Red snapper	17.50	3.0
PIO54	Red snapper	18.00	3.5
PIO33	Red snapper	18.50	3.5
PIO34	Red snapper	19.00	3.0
PIO37	Red snapper	19.00	3.5
PIO35	Red snapper	19.50	4.0

Table 1 cont. Fish samples collected from the NWGOM in 2011–2012. Sample number, species, total length, and weight recorded for each sample.			
Sample Number	**Species**	**Length (in)**	**Weight (lb)**
Site 5 Port Isabell Offshore			
PIO38	Red snapper	20.00	5.0
PIO55	Red snapper	20.00	6.0
PIO57	Red snapper	20.00	4.5
PIO58	Red snapper	21.00	4.5
PIO32	Red snapper	25.50	9.0
PIO31	Red snapper	27.00	9.5
PIO18	Wahoo	43.00	13.5
PIO42	Yellowfin tuna	36.50	25.5
Sport-fishing Offshore Tournaments			
POO4	Blackfin tuna	32.50	21.5
PAO80A	Blue Marlin	103.00	430.0
POO68a	Blue Marlin	107.00	447.5
PAO73	Blue Marlin	107.00	419.0
POO10	Dolphinfish	40.00	19.7
POO11	Dolphinfish	42.50	25.2
POO8	Dolphinfish	44.50	32.9
POO17	Dolphinfish	45.75	30.2
POO20	Dolphinfish	47.25	34.5
POO16	Dolphinfish	47.50	38.9
POO15	Dolphinfish	48.00	38.0
POO13	Dolphinfish	49.00	35.0
PAO76	Swordfish	51.25	64.4
PAO75	Swordfish	73.50	203.0
PAO74A	Swordfish	79.50	281.0
POO18	Wahoo	47.00	19.0
PAO79	Wahoo	55.00	32.5
PAO78	Wahoo	57.00	49.7
POO19	Wahoo	60.25	59.9
POO2	Wahoo	61.75	64.5
POO5	Yellowfin tuna	34.75	24.0
POO9	Yellowfin tuna	38.50	38.0
PAO84	Yellowfin tuna	42.25	39.1
POO12	Yellowfin tuna	42.50	42.7
POO1	Yellowfin tuna	43.25	51.3
POO3	Yellowfin tuna	43.25	46.9
PAO82	Yellowfin tuna	44.00	47.8

Table 1 cont. Fish samples collected from the NWGOM in 2011–2012. Sample number, species, total length, and weight recorded for each sample.

Sample Number	Species	Length (in)	Weight (lb)
Sport-fishing Offshore Tournaments			
PAO81	Yellowfin tuna	44.50	49.8
PAO83	Yellowfin tuna	44.50	49.6
POO14	Yellowfin tuna	45.75	53.0
POO7	Yellowfin tuna	52.25	47.1
POO6	Yellowfin tuna	59.50	91.9
PAO77	Yellowfin tuna	63.00	140.5

Table 2a. Mercury (mg/kg) in fish collected from the NWGOM, 2011–2012.

Species	# Detected/ # Sampled	Mean Concentration ± S.D. (Min-Max)	Health Assessment Comparison Value (mg/kg)	Basis for Comparison Value
Atlantic sharpnose shark	15/15	**1.034**[a]±0.443 (0.478-**1.890**)	0.7	ATSDR chronic oral MRL: 0.0003 mg/kg–day
Blackfin tuna	10/10	**0.790**±0.241 (0.409-**1.120**)		
Blacktip shark	21/21	0.252±0.350 (0.053-**1.690**)		
Blue marlin	3/3	**12.900**±6.223 (**6.200-18.500**)		
Little tunny	36/36	0.622±0.3.72 (0.132-**2.280**)		
Bonnethead shark	1/1	0.547		
Cobia	18/18	0.442±0.315 (0.127-**1.080**)		
Crevalle jack	10/10	**1.015**±0.317 (**0.857-1.480**)		
Cubera snapper	1/1	0.466		
Dolphinfish	20/22	0.145±0.167 (ND-0.573)		
Gray triggerfish	2/2	0.184±0.016 (0.172-0.195)		
Greater amberjack	1/1	0.581		
King mackerel	87/87	0.638±0.228 (0.076-**1.280**)		
Lane snapper	4/4	0.203±0.043 (0.171-0.262)		
Mangrove snapper	4/4	0.189±0.070 (0.138-0.292)		
Red snapper	57/67	0.102±0.089 (ND-**0.701**)		
Spanish mackerel	26/26	0.227±0.100 (0.057-0.425)		
Spinner shark	1/1	0.105		
Swordfish	6/6	**0.991**±0.328 (0.536-**1.480**)		
Tripletail	3/9	0.026±0.017 (ND-0.056)		
Wahoo	10/10	**0.692**±0.782 (0.088-**2.380**)		
Warsaw grouper	1/1	0.416		
Yellowfin tuna	19/19	0.314±0.311 (0.080-**1.130**)		
All fish combined	356/374	0.541±1.265 (ND-**18.500**)		

[a] *Emboldened numbers denote that mercury concentrations equal and/or exceed the DSHS HAC value for mercury.*

Table 2b. Mercury (mg/kg) in selected fish by size class collected from the NWGOM, 1996–2012.				
Species	**# Detected/ # Sampled**	**Mean Concentration ± S.D. (Min-Max)**	**Health Assessment Comparison Value (mg/kg)**	**Basis for Comparison Value**
Mercury				
Little tunny ≤ 27”	20/20	0.471±0.179 (0.132-**0.837**[b])	0.7	ATSDR chronic oral MRL: 0.0003 mg/kg–day
Little tunny > 27”	16/16	**0.811**±0.463 (0.365-**2.280**)		
King mackerel ≤ 35”	118/118	0.508±0.165 (0.076-**0.996**)		
King mackerel > 35”	136/136	**0.793**±0.260 (0.208-**1.670**)		
King mackerel < 37”	143/143	0.534±0.175 (0.076-**0.996**)		
King mackerel 37 to 43”	94/94	**0.804**±0.261 (0.208-**1.670**)		
King mackerel > 43”	17/17	**0.932**±0.276 (0.420-**1.320**)		

[b] *Emboldened numbers denote that mercury concentrations equal and/or exceed the DSHS HAC value for mercury.*

Table 3a. Hazard quotients (HQs) for mercury in fish collected from the NWGOM in 2011–2012. Table 3a also provides suggested weekly eight-ounce meal consumption rates for 70-kg adults.[c]			
Species	**Number (N)**	**Hazard Quotient**	**Meals per Week**
NWGOM All Sites			
Atlantic sharpnose shark	15	**1.48**[d]	**0.6**[e]
Blackfin tuna	10	**1.13**	**0.8**
Blacktip shark	21	0.36	2.6
Blue marlin	3	**18.43**	**0.1**
Little tunny	36	0.89	1.0
Bonnethead shark	1	0.78	1.2
Cobia	18	0.63	1.5
Crevalle jack	10	**1.45**	**0.6**
Cubera snapper	1	0.67	1.4
Dolphinfish	22	0.21	4.5
Gray triggerfish	2	0.26	3.5
Greater amberjack	1	0.83	1.1
King mackerel	87	0.91	1.0
Lane snapper	4	0.29	3.2
Mangrove snapper	4	0.27	3.4
Red snapper	67	0.15	6.3
Spanish mackerel	26	0.32	2.9
Spinner shark	1	0.15	6.2
Swordfish	6	**1.42**	**0.7**
Tripletail	9	0.04	unrestricted[f]
Wahoo	10	**1.00**	**0.9**
Warsaw grouper	1	0.59	1.6
Yellowfin tuna	19	0.45	2.1
All fish combined	288	0.77	1.2

[c] *DSHS assumes that children under 12 years of age and/or those that weigh less than 35 kg eat four-ounce meals.*
[d] *Emboldened numbers denote that the HQ for mercury is ≥ 1.0.*
[e] *Emboldened numbers denote that the calculated allowable meals for an adult are ≤ one meal per week.*
[f] *The term, unrestricted, denotes that the allowable eight-ounce meals per week are > 21.0.*

Table 3b. Hazard quotients (HQs) for mercury in selected fish by size class collected from the NWGOM in 2011–2012. Table 3b also provides suggested weekly eight-ounce meal consumption rates for 70-kg adults.[g]			
Species	**Number (N)**	**Hazard Quotient**	**Meals per Week**
NWGOM All Sites			
Little tunny ≤ 27”	20	0.67	1.4
Little tunny > 27”	16	**1.16**[h]	**0.8**[i]
King mackerel ≤ 35”	118	0.73	1.3
King mackerel > 35”	136	**1.13**	**0.8**
King mackerel < 37”	143	0.76	1.2
King mackerel 37 to 43”	94	**1.15**	**0.8**
King mackerel > 43”	17	**1.33**	**0.7**

[g] *DSHS assumes that children under 12 years of age and/or those that weigh less than 35 kg eat four-ounce meals.*
[h] *Emboldened numbers denote that the HQ for mercury is ≥ 1.0.*
[i] *Emboldened numbers denote that the calculated allowable meals for an adult are ≤ one meal per week.*

Table 4. The number of eight-ounce meals assuming 38% yield from whole fish to skin-off fillets for an average weight fish of each species from the NWGOM, 2011-2012.

Species	Number of Eight-Ounce Meals
Atlantic sharpnose	6.8
Blackfin tuna	13.7
Blacktip shark	9.3
Blue marlin	328.7
Cobia	18.9
Crevalle jack	15.6
Dolphinfish	11.6
King mackerel	7.7
Little tunny	6.6
Red snapper	3.6
Spanish mackerel	2.1
Swordfish	105.2
Tripletail	3.7
Wahoo	21.7
Yellowfin tuna	47.2
NWGOM fish average	40.2

Table 5. Recommended fish consumption advice by species for the NWGOM.			
Contaminant of Concern	**Species**	**Women of Childbearing Age and Children < 12**	**Women Past Childbearing Age and Adult Men**
Mercury	Blackfin tuna	**DO NOT EAT**	2 meals/month
	Blue marlin	**DO NOT EAT**	**DO NOT EAT**
	Little tunny “Bonito”	**DO NOT EAT**	2 meals/month
	Crevalle jack	**DO NOT EAT**	2 meals/month
	King mackerel < 35 inches	**DO NOT EAT**	1 meal/week
	King mackerel > 35 inches	**DO NOT EAT**	2 meals/month
	Shark (all species)	**DO NOT EAT**	2 meals/month
	Swordfish	**DO NOT EAT**	2 meals/month
	Wahoo	**DO NOT EAT**	2 meals/month
	Women of childbearing age and children less than 12 years of age or who weigh less than 75 pounds should use caution when eating large cobia or yellowfin tuna. Mean mercury concentrations for these fish do not exceed the DSHS guidelines for protection of human health, but limited mercury data indicate that eating large individual cobia or yellowfin tuna may pose significant health risks.		

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